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F i n a l r e p o r t

Darevsky's viper
Vipera darevskii Vedmederja, Orlov & Tuniyev, 1986

Study area: Javakheti Ridge, Mt. Legli, Ghukasian region, Shirak Province, Armenia

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1. Summary

Development of conservation measures for the Darevsky's viper in the Caucasus

This project was aimed at the development of conservation measures for the Darevsky's viper (*Vipera darevskii*) with the aid of intensive field work which included range clarification, snake marking, census, tracking, studies of distribution across elevations and habitats, daily and seasonal activity patterns, reproduction and other ecological issues, as well as GIS mapping with further extrapolation of habitat data in relation to human activities in the study area (anthropogenic landscapes).

As a species with limited range, Darevsky's viper has been facing extinction and so far is found only in a small area in extreme north-west of Armenia (Shirak Province) near the border with Georgia. It is listed in 2006 IUCN Red List of Threatened Species as a category CR C2b.

We also consider the research history of *Vipera kaznakowi* complex, assess the possible ways of genesis of three species of this complex (*V. kaznakowi, V. dinniki, V.darevskii.*) and provide phylogenetic relationships of these vipers.

The species range stretches along the south-eastern part of the Javakheti Ridge within Armenia to the border with Georgia. The key factor of existence is availability of flat stone plates on the screes which create appropriate microclimate for vipers in harsh highland conditions.

We provide new information about morphology, activity, reproduction and other facets of snake ecology. We discuss the principal threats and consider the possible mitigation ways. Land use for agriculture (pastures, hay grounds, crop lands etc.) and high selectivity of this snake for habitat quality (subalpine meadows at elevations 2600-3000 m) make this species more vulnerable.

We offer the map with new records and delineated range. The core areas comprising the key areas of individual home ranges were studied and are suggested for the spatially focused conservation measures. The project results include a number of recommendations on conservation and are particularly valuable in light of the governmental plan to establish the transboundary (with Georgia) Arpi Lich National Park under financial support of KfW, so they can be incorporated to the Management Plan of this newly created protected area.

Introduction

Caucasus is a geographical region located on the crossroads of Europe and Asia which comprises four countries of former Soviet Union: Armenia, Azerbaijan, Georgia and Russia's North Caucasus. Republic of Armenia (thenceforth – Armenia or RA) is located in north-eastern part of Armenian Highland above the adjoining Iranian and Asia Minor highlands and occupies the area 29743 km^2. Most of the country's territory is situated on elevations around 1500 m which represent the branches and main ridges of the Lesser Caucasus Ridge.
Armenia is located within the geographical coordinates 38°50'-41°18' N and 43°27'-46°37' E. Total length of the state border is 1479 km. Armenia shares its borders with Georgia in the north, Azerbaijan in the north-east, east, south-east and south-west, Iran in the south and Turkey in the west.

Geographical location of Armenia, altitudinal variations, complicated mountainous terrain, soil diversity (about 15 types) and climatic conditions underlie the vertical change of landscape belts from dry subtropics to nival zone and extraordinary diversity of its flora (> 3500 vascular plants) and fauna (> 500 vertebrate species). Nine landscape belts are present in Armenia: lowland semi-desert, lowland arid grassland, lowland sub-forest, lowland and medium-elevation forest, medium-elevation grassland, medium-elevation meadow grassland, highland subalpine, highland alpine and highland subnival.

Economic development, land use for urban expansion (construction, privatization) and agriculture (pastures, hay grounds, animal husbandry), on the one hand, and oprimal management and preservation of biological resources, on the other hand, require through investigations of all biotic components, including taxonomic and ecological richness of reptiles. As economic development makes an increasingly heavy impact on the environment, studies of reptile diversity in Armenia become important as never before as related to disappearing habitats and range shrinkage. A substantial portion of species with restricted ranges and narrow adaptabilitiy thresholds are confined to certain habitats and thus threatened with extinction. One of such species is the Darevsky's viper (*Vipera darevskii*) which is listed in 2006 IUCN Red List of Threatened Species (category CR C2b) as a species with restricted range.
The snake fauna of Armenia which numbers 23 species is significantly affected by vertical (altitudinal) changes. Distribution and association with habitats along the vertical gradient depends upon the thermal regimes, air humidity, atmospheric pressure, terrain, solar radiation, vegetation, interactions with other animals and, especially since the recent times, human pressure. Consideration of all these factors is important to understand the features of current geographical distribution and ecological adaptations.

3. PROJECT MEMBERS

The distinguished herpetologists from former Soviet Union having great experience of working in Armenia and with the Darevsky's viper, as well as young promising scientists were involved in this project.

1. Name: LEVON AGHASYAN
Age: 22
Individual responsibilities in the project: project leader. Participation in field studies, educational activities and data analysis, analysis of museum collections, creation of posters, boucklets (author's text, design, photos).
Professional experience: B.S. - 2000-2004, Faculty of Biology, Yerevan State University; M.S. - 2004-2006, Faculty of Biology, Yerevan State University, Armenia; 2006-present – Researcher, Institute of Zoology of National Academy of Sciences, Armenia.

2. Name: ROMAN AVANESYAN
Age: 23
Individual responsibilities in the project: participation in field studies, educational activities and data analysis.
Professional experience: B.S. - 2000-2004, Faculty of Biology, Yerevan State University; M.S. - 2004-2006, Faculty of Biology, Yerevan State University, Armenia.

3. Name: SAKO TUNIEV
Age: 23
Individual responsibilities in the project: participation in field studies (2005, May-June), educational activities and data analysis, analysis of museum collections.
Professional experience: 2000-2005 student of the Kuban' State University; 2005-2006 – Researcher, Caucasus Biosphere Reserve, Russia; 2006-present – Researcher, National Park, Sochi, Russia.

4. Name: ALEXANDER MALKHASYAN
Age: 34
Individual responsibilities in the project: participation in field studies, and data analysis, photo.
Professional experience: 1992-1996 Faculty of Biology, Yerevan State University, 1996-present Department of Science, Reserve-park complex, Ministry of Nature Protection; 2002-present expert, WWF Caucasus Programme Office, Armenia.

5. Name: KONSTANTIN SHIRYAEV
Age: 29
Individual responsibilities in the project: participation in field studies (2006, May), educational activities and data analysis, analysis of museum collections, consulting on breading of snakes in terrariums.
Professional experience: 1993-1998 Smolensk State Pedagogical Institute, 1999-present herpetologist, Tula Exotarium, Russia.

6. Name: Dr. ARAM AGHASYAN
Age: 47
Individual responsibilities in the project: participation in field studies, educational activities and data analysis, analysis of museum collections, production of project deliverables, creation of booklets (author's text), consulting on Nature Protection Programs in Armenia and particularly in investigated Shirak Province.
Professional experience: 1980-present Scientific Rersearcher, Institute of Zoology of the National Academy of Sciences; 1996-present Ministry of Nature Protection; 2002-present Head of Protected Area Management Department, Agency for Biological Resources Management, Armenia.

7. Name: Dr. NIKOLAI ORLOV
Age: 52
Individual responsibilities in the project: participation in field studies, educational activities and data analysis, analysis of museum collections, production of project deliverables.
Professional experience: 1984-present researcher, Department of Herpetology, Zoological Institute of the Russian Academy of Sciences, Russia.

8. Name: Dr. NATALIA ANANJEVA
Age: 58
Individual responsibilities in the project: project advisor.
Professional experience: 1996-present Head of Division of Ornithology and Herpetology, Zoological Institute of the Russian Academy of Sciences; President of European Herpetological Society. Chair of IUCN/SSC North Eurasia Specialist Group, Russia.

9. Name: BORIS TUNIEV
Age: 47
Individual responsibilities in the project: participation in field studies, educational activities and data analysis, analysis of museum collections, investigations on geobotany – description of snakes' biotopes, production of project deliverables.
Professional experience: 1980-present Deputy Director on Science, Caucasus Biosphere Reserve, Russia, 2006-present – Vice-Director, National Park, Sochi, Russia.

10. Name: Dr. DAVID TARKHNISHVILI
Age: 41
Individual responsibilities in the project: educational activities, analysis of museum collections.
Professional experience: Leading researcher, Department of Ecology, Tbilisi State University (Georgia). 1992-currently Regional Chairman (Caucasus) of DAPTF (Declining Amphibian Population Task Force) of the IUCN/SSC, Georgia.

11. Name: ROMAN KHALIKOV
Age: 26
Individual responsibilities in the project: participation in field studies (2005, May-June), educational activities and data analysis.
Professional experience: 1995-1999 Faculty of Biology & Soil Science, St. Petersbrg State University; 1999-2001 MSc student, ibid.; 1999-2000 Lab assistant Zoological Institute of the Russian academy of Sciences; 2000-present IT manager, Zoological Institute, Russia.

4.1. Nature conservation and protected areas in Armenia

The area of Armenia is 29743 km^2 of which 46.8% are covered by agricultural lands, 34.9% - mountains, highlands etc., 12.7% - forests and 5.6% - water bodies.
The network of specially protected natural areas (PA) which includes state reserves, national parks, sanctuaries and natural monuments covers 10.4% of Armenia (including 4.2% of Lake Sevan surface), but does not contain some important habitats and functions insufficiently because of lacking funding. Beyond the protected areas, nature conservation has been regulated by laws and acts limiting exploitation of natural resources. Environmental issues are gradually becoming the parts of political and socio-economic agenda of today's Armenia as the linkage between biodiversity conservation and human sustainable development is recognized and becomes increasingly evident. The nation's awareness of essential development and application of sustainable utilization and management of biological resources is on the rise.

Table 1. The summary on protected areas of Armenia.

Category	Number	Total area (ha)	% of Armenia
Reserves	3	41422	1.4
Sanctuaries	23	89442	3.0
National parks	2	178102	6.0
Natural monuments	-	-	-
Total		308966	10.4

The PAs of Armenia protect about 60% of flora nad fauna of Armenia.

Despite its richness in natural resources, north-western Armenia still does not have a PA other than the Gulakarak Pine Grove Sanctuary whose status is inadmissible.
In 1993 the Arpi Lich (Lake Arpi) and its wetlands (3139 ha) were given the status of a Ramsar Site what has captured international attention. However, until now its territory does not hold any protection status on the national level, even though the National Strategy of Protected Area Development in Armenia adopted in 2003 contains the plans of the government to establish Arpi Lich National Park in north-western Armenia.
Today, PA management in Armenia has been conducted by two different authorities: Ministry of Nature Protection and Ministry of Agriculture.
The strategic objective of PA functioning and management in the country is their unification into the complex which would be managed by only one state organization. This approach could enable to create a basis for the development of Ecological Network (ECONET) as an important prerequisite of sustainable development.
Small size of the country, high population density (over 100 individuals per km^2) and high levels of industrial and agricultural production in the past have led to drastic changes in the landscapes. Presence of the dense network of settlements complicates the large but compact undisturbed lands to be set aside as PAs. As a result, the boundaries of most PAs are very indented and ignore uniformity of ecosystems, whereas the patches of the PAs are separated by unprotected lands with settlements, fields, roads and other infrastructure.

In the past years Armenia undergoes re-allocation of the state-owned lands, changes in administrative boundaries, provision of lands to rural communities and land privatization. In light of this, it becomes important to identify the rare and endangered species, determine their ranges and incorporate them to the system of PAs. The Darevsky's viper is one of such species. The main threats to it are human pressure and turning of subalpine meadows into the pastures. An equally important problem is low level of local awareness on rational use of natural resources and biodiversity conservation.

4.2. Darevsky's viper as a species contributing to enlargement of the PA network in Armenia

The Caucasus is globally recognized as a Biodiversity Hotspot and a vulnerable Ecoregion. Extraordinary faunistic diversity of the Caucasus can be well illustrated on an example of Armenia which, despite its small area (29743 km^2), accommodates 23 out of 35 species of snakes recorded in the Caucasus which belong to 4 families and 13 genera. Of them, 3 species are listed in Red Data Book of the USSR (*Vipera raddei, Elaphe hohenackeri, Rhynchocalamus melanocephalus),* 4 – in Red Data Book of Armenia (*Vipera raddei, Elaphe hohenackeri, Rhynchocalamus melanocephalus, Telescopus fallax),* and 1 (Darevsky's viper *Vipera darevskii*) in the 2004 IUCN Red List of Threatened Species.

The last known review of living reptiles of Armenia was published over 45 years ago (Darevsky, 1957), and the last review of the snakes of Armenia was published in 1996 (Aghasyan, 1996), so there is a desperate need to update the existing information about the status, ecology, distribution and conservation of these animals.

This project pursues the goal to assess the up-to-date status of the critically endangered Darevsky's viper (*Vipera darevskii*), develop the efficient, concrete and cost-effective conservation measures and suggest them to the government and donors. It well suits the plans of Armenian government and the German foundation KfW to establish the transboundary Armenian-Georgian Arpi National Park which will comprise the key habitats of this snake as well.

Darevsky's viper is an endemic venomous snake found so far only in subalpine zone of the Javakheti Ridge in Armenia Fig.2 (Mt. Achkasar, Ashotsk district of Shirak Province) on elevations 2600-3000 m (Vedmederja et al., 1986). The typical habitats are rocky slopes and moraines with big flat slabs. Snakes live under the slabs all seasons, including winter. Population density is high, but taking into account limited distribution of this viper we estimate its abundance as only 250-300 individuals. This species is adapted to local highland conditions what has changed its thermoregulatory mechanisms, ecology, reproduction and activity patterns. The main threats are livestock breeding and strong habitat selectivity.

5. Aims and Objectives.

Goals.

To obtain first-hand information on the following issues of the Darevsky's viper status, ecology and distribution:

1. Distribution across the landscapes and habitats.
2. Identification, description and mapping of snake home ranges and general range.
3. Sex-age structure of population, sexual dimorphism and geographical variation.
4. Thermobiology, number dynamics, daily and seasonal activity cycles, diet and feeding, mating behaviour, breeding and other aspects of population ecology.
5. Assessment of contemporary status of population and the human impact on the species.
6. Clarification of uncertain systematic position of the Darevsky's viper in light of zoogeographical analysis of all shield-headed vipers of the Caucasus (subgenus Pelias).

Objectives.

- Obtain the most up-to-date and comprehensive information about the status, distribution and ecology of the Darevsky's viper.
- Define and justify from the scientific positions the priority conservation needs and measures for saving this endangered snake, including habitat conservation within the protected area(s).
- Produce the packet of recommendations to the Ministry of Nature Protection, local authorities, KfW and all other beneficiary parties in order to ensure optimal delineation of the boundaries of the newly established Arpi Lich National Park and promote efficient conservation of the key habitats within this protected area.

6. STUDY AREA: SHIRAK PROVINCE OF ARMENIA

6.1. Socio-economic background

Shirak Province is located in north-western Armenia and shares its borders with Turkey and Georgia. Its area makes 9% of Armenia and 66% of population is urban. In 2005 its population made 9.5% of total in the country. The territory planned to be incorporated to Arpi Lich National Park includes the Amasia and Ashotsk districts.

Amasia district

Agricultural lands (ha)	14675
Urban communities	-
Rural communities	19
Rural settlements	26
Total population in thousands, including	8.6
Urban	-
Rural	8.6

In 2005 this district had 2 industrial enterprises, 9 shops, 19 secondary schools, 1 kindergarten, 20 libraries, 1 hospital and 1 clinic.

Ashotsk district

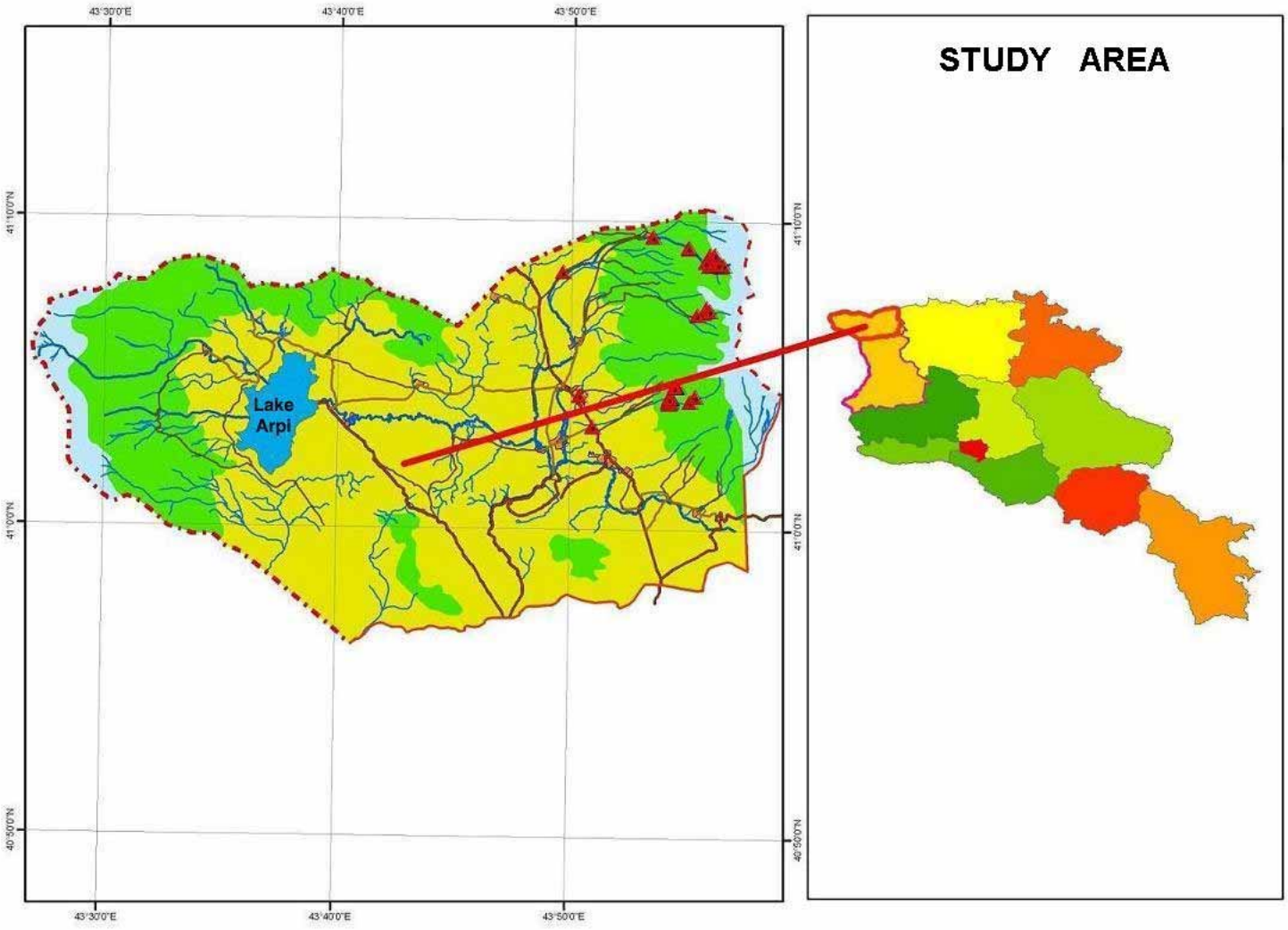
Agricultural lands (ha)	9891
Urban communities	-
Rural communities	25
Rural settlements	25
Total population in thousands, including	12.2
Urban	-
Rural	12.2

In 2005 this district had 2 industrial, 1 construction and 1 transportation enterprises, 38 shops, 19 secondary schools, 4 kindergartens, 24 libraries, 1 hospital and 4 clinics.

6.2. Geographical position and boundaries

The area allocated for the transboundary national park bounds with Georgia in the north, Meskhanka River (the Dzoraget River tributary) in the east and Dzoraget River upstream to the Karakhach Pass (2272 m) in the south. Embracing the headwaters of the left tributaries of the Akhurian River (Artashen and Chair), it stretches along the Chair to the Akhurian and then through the right tributaries reaches the Armenian-Turkish state border.

Map1



6.3. Terrain

The major features of this area are the Javakheti Ridge, Lori Lowland, Javakhq Upland, peaks of Achkasar (3196 m), Erakatar (3008 m) and Mets Ghukasian (3049 m) and the Ashotsk Plateau.

Javakheti Ridge. In Armenia it is called the Javakhq Ridge whose southern part reaches the Karakhach Pass. The slopes are exposed not uniformly. The highest peak is the Mt. Achkasar (3196 m). The traces of the Quarternary glaciation are seen on the ridge tops which also give birth to the rivers Tzakhkashen, Ghukasian and Chichkhan.

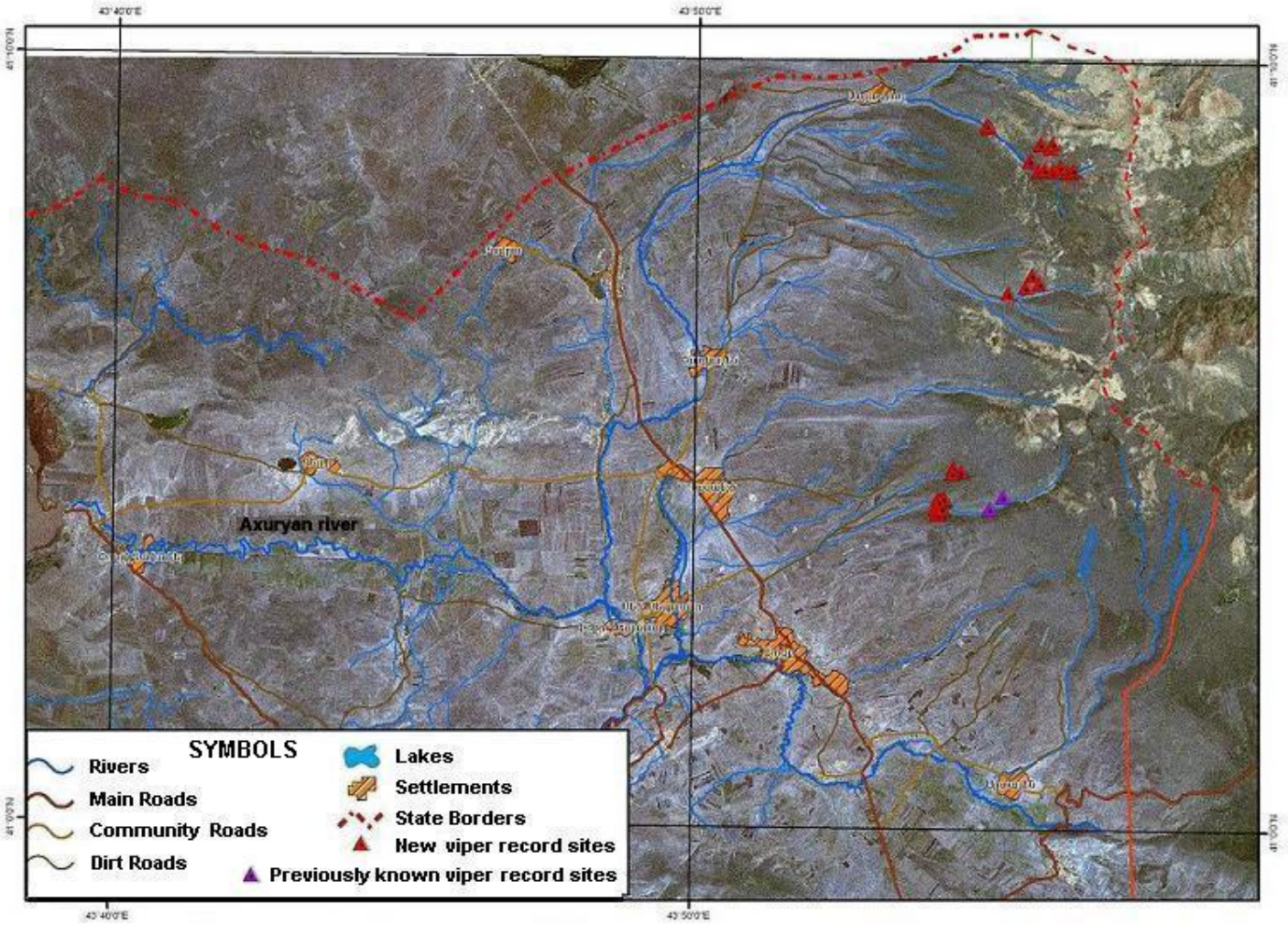
Javakheti Upland. Armenia holds the southern portion of this upland which represents the complex of folded mountains, volcanic plateaus, lava covers and depressions with alternating erosion-accumulative and volcanic types of terrain. This area abounds with mountain lakes and is seismically active.

Lori Lowland. This is a plateau of volcanic origin which is split by the network of tributaries.

Ashotskq Plateau. It is situated among the Shirak, Javakheti, Egnakh and Childyr ridges. It consists of the lava strata and is covered by fluvial and lake deposits. The plateaus is rich in springs and groundwater.

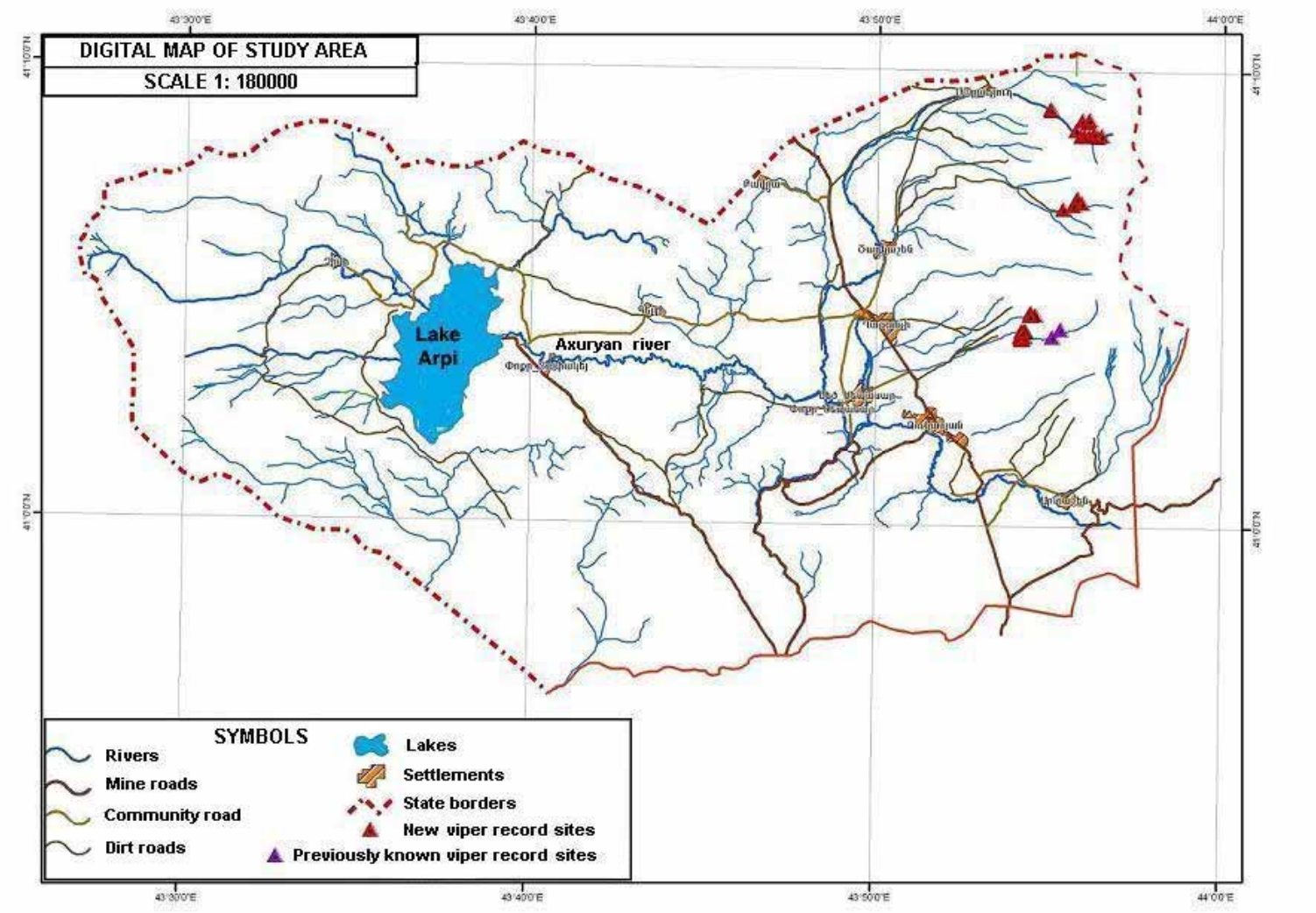
Mts. Erakatar and Mets Ghukasian. They have volcanic origin and engender small mountain brooks which dry up in summer.

Map. 2



6.4. Rivers and lakes

Lake Arpi adjoins the boundaries of Georgia and Turkey and is located in the north-west of the area. By dam it was turned into the reservoir of length 7.3 km, width 4.3 km and size 20 km^2. If is fed by springs and small brooks and functions as a shallow basin for irrigation. The Akhurian River flows out of the lake. The river bed is wide upstream, then it runs to the east and south and enters a deep canyon. The largest tributaries are Ghukasian and Chair rivers. The Dzoraget River begins in the Javakhq Ridge; its largest tributary is the Tashir River. The area abounds with small lakes. In the Lori region there are about ten lakes of eutrophic type. The largest of them (Oranlorulich, Klorlich, Tzrukalich, Tsolakalich, Lodkalich, Zhangotalich and others) take the ancient glacial depressions.



Map.3

6.5. Climate

The study area is diverse in climatic conditions. Winter is harsh in the west and mild in the east. Average air temperature is -12^0C in January and $+17^0$C in July. Snow cover reaches 80 cm, annual precipitation is 700-1000 mm. The depths of soil freezing are 160 cm and more. Duration of the period with mean daily air temperature above 15^0C is less than 80 days.

6.6. Vegetation

Vegetation of this area is represented by almost all macrozonal types of vegetation characteristic for the volcanic uplands of Armenia. Among them are the following:
a) Tragacanths (*Astragalus microcephalus, A. aureus, A. lagurus* and others).
b) Grassland scrubs (dominated by *Spiraea* spp.).
c) Meadow grasslands (formations of *Festuca ovina, Koeleria cristata, Phleum phleoides*; formations of *Cephalaria gigantea, Scabioza caucasica, Achillea setacea, Artemisia absintium, Galium verum, Medicago* spp. and *Trifolium* spp.).
d) Meadows (formation of *Bromus variegata, Dactulis glomerata, Hordeum violaceum* and *Poa longifolia*).
The tree and scrub species are represented unequally. In the Akhurian region their flora numbers 12 families, 27 genera and 44 species and in the Lori region 45 families, 86 genera and 165 species.
More than 70 species of plants growing in north-western Armenia are listed in 1988 Red Data Book of Plants of Armenia.
а) Akhurian – 25 species (*Astragalus campylosema, Crocus adamii, Papaver orientale, Rododendron caucasicum, Verbascum hajastanicum, Viola somchetica* and others).
б) Lori – 47 species (*Nymphaea alba, Acer trautvetteri, Carex bohemica, Iris pumila, Primula amoena, Scilla posenii, Vitis sylvestris* and others).

6.7. Fauna

Lake Arpi harbors the only breeding colony of the endangered Dalmatin pelican (*Pelecanus crispus*) and the largest colony of the Armenian gull (*Larus armeniacus).* The great cormorant *(Phalacrocorax carbo)*, glossy ibis (*Plegadis falcinellus*), black stork (*Ciconia nigra*) and crane (*Grus grus*) occur here in higher numbers than anywhere else in Armenia. This lake is an important stopover site for the migrating birds, including the endangered lesser spotted eagle (*Aquila pomarina*), golden eagle (*Aquila chrysaetos*) and bearded vulture (*Gypaetus barbatus*). Abundance of river otter (*Lutra lutra*) is not high, but stable due to the lake richness in fish which is of commercial value.
The Akhurian River and adjoining wetlands are vitally important for nesting and feeding of waterfowl. Abundant great snipe (*Gallinago media*) and common snipe (*Gallinago gallinago*) are important game species.
The cluster of peatbogs, swamps and ponds located in the relict wetlands of the Lori Plateau has been one of the last refuges for the banded newt (*Triturus vittatus*).
The vertebrate fauna of local wetlands includes 8 fish, 5 amphibians, 2 reptiles, ca. 100 birds and 4 mammals.
The following animals are listed in the 1987 Red Data Book of Animals of Armenia: otter (*Lutra lutra*), European marbled polecat (*Vormela peregusna peregusna*) and 26 species of

birds including the Caspian snowcock(*Tetraogalus caspius*), Armenian gull (*Larus armenicus*), Dalmatin pelican (*Pelicanus crispus*), European pelican (*Pelecanus onocrotalus*), golden eagle (*Aquila chrisaetos*), saker falcon (*Falco cherrug*), harrier (*Circus macrourus*) and others.
The invertebrates are represented in the Ashotsk district by 7 species of rare beetles.

7. FIELDWORK AND RESEARCH

7.1 Methods: fieldwork and follow-up

The field studies were carried out from May 2005 to October 2005 and from March 2006 to May 2006 in the Shirak Province. The period of our field work was 60 days and in that period were done more than 2000 photos by digital photo camera.

The study area covered almost all south-eastern part of the Javakheti Ridge and the lands beyond rural communities in south-western Javakheti Ridge. Work was done at different elevations from 2000 to 3600 m, but most frequently visited elevations were 2200-2700 m. Different landscapes from medium-elevation meadow grasslands to highland alpine were studied, but most attention was paid to the meadow grasslands located along the boundary with highland subalpine belt, including the man-altered landscapes (agricultural lands).
The stationary observations were conducted in 3 sites separated from each other by canyons: (Fig.1) one above the Kazanchi village and two above the Saragyugh village where the snake

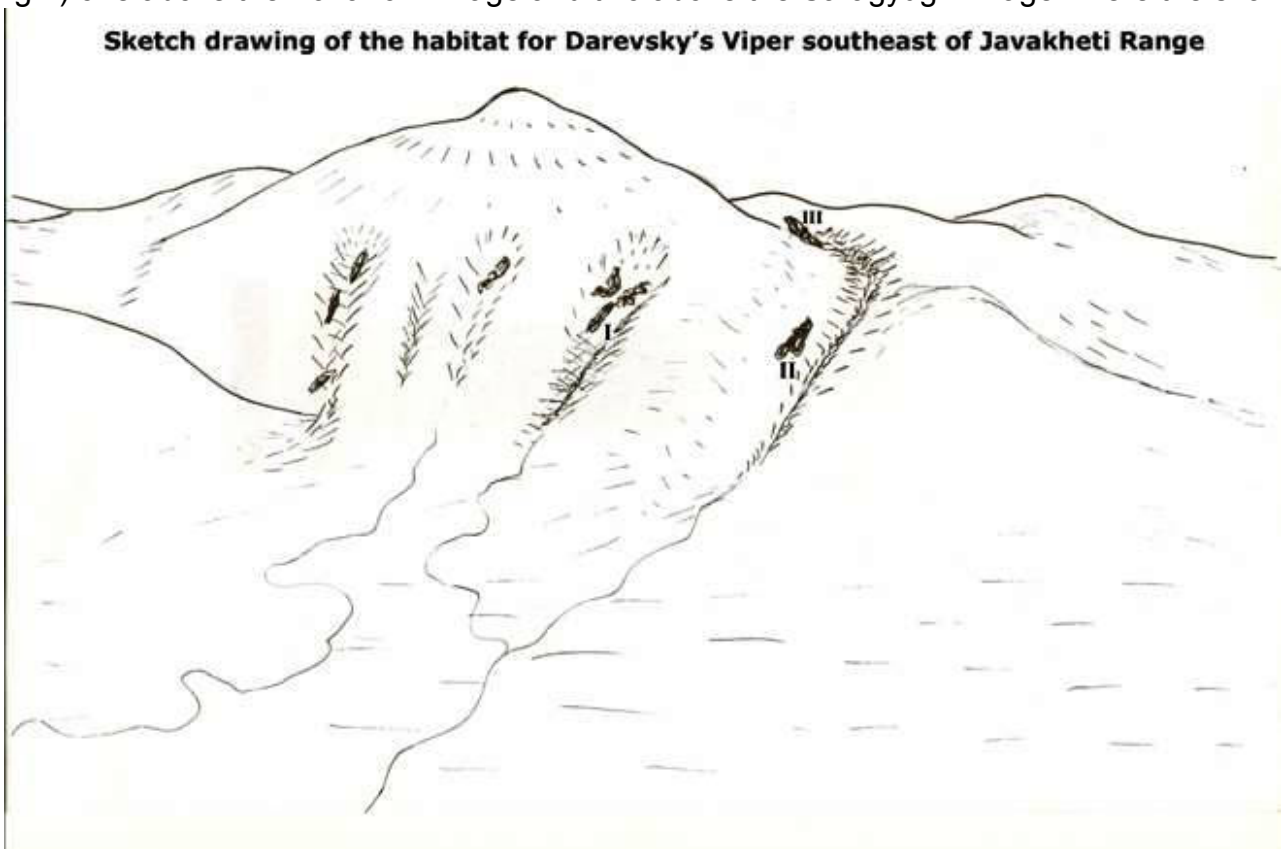


Fig.1 above the Kazanchi village

habitats are less affected by human pressure. We a priori planned the approximate length and direction of routes taking into account the most recent records and the assessment of unstudied area in the Ashotsk district. While on site, we chose the study plots and the routes of morning, day and evening trips depending on seasons, weather and temperature. The route lengths varied from 2 to 8 km per day. We had to do that as local weather conditions are very variable not only between the seasons but also within a single day. Even in summer time the air temperature fluctuations can reach 15-20^{o}C and be accompanied by strong winds and thunders. All routes were mapped.

Each snake record was given an ID which was registered in the field diary and included geographical coordinates, elevation, habitat exposure and description, weather, air temperature and humidity, soil temperature under the sun, in shadow, beneath the stones and in shelters. We also recorded the individual's sex and size, physiological condition, body temperature and behavior (basking, active hunt, mating games etc.).

The snakes were measured, weighed and then released into the wild. The coordinates and elevation were measured by handheld GPS

Magellan - Meridian Platinum. Temperature was measured by mercury thermometer with precision 0.1^{o}C, modified contact thermometer TET-2 and thermometer ACU-RITE. To compose the charts of soil temperature changes in seasons and soil depths, we referred to the Atlas of Climate of Armenian SSR by Bagdasaryan (1975).

Microclimatic studies at the stationary sites included observations of daily variations of air and soil temperatures, relative air humidity and wind velocity by thermo- and hygrographs M-16 AN. The extremes of temperature variations were measured by the maximal and minimal thermometers.

The snakes were marked by cutting of abdominal scutes and putting on head surface the black marks by asphalt varnish and phosphorescent stains in different combinations.

Combinations of four marks on four areas of the head allow to clearly recognize the group up

to 17 individuals before the first moulting, after which the marks are renewed (Fig2).

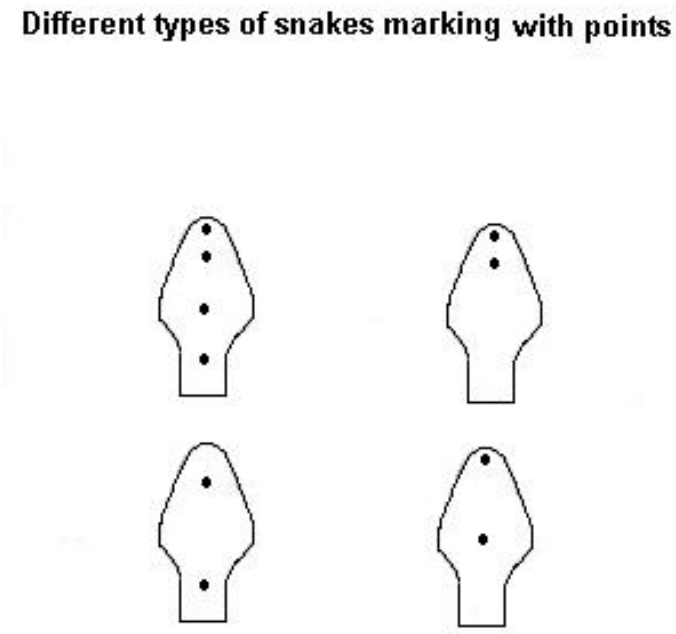


Fig.2

This non-invasive approach allows to safely observe the snakes without disturbing their behavior, especially in young individuals. During this work we captured and marked 87 individuals of V. darevskii and 8 individuals were additionally marked by radiochips (AVID/SUDS).

We also surveyed the snake habitats and collected plant samples for their identification and storage in herbaria.

The snake census was done as described elsewhere (Kashkarov, 1927; Andrushko, 1936; Kaletskaya, 1952; Korotkov, 1980) with some modifications required by terrain conditions.

Diet was studied non-invasively by palpation and stimulation of eructation (Verzhutsky, Zhuravlev, 1977).

Morphometric analysis of individuals was done using the diagnostic features and the scheme of measurements taken from herpetological literature (Bannikov et al., 1977; Scherbak, 1979; Scherbak, Scherban, 1980). All measurements were done by Vernier calipers with precision 0.05 mm. Snake weighting was done by the spring scales PESOLA and cap scales with precision 0.1 g.

The following morphological features were measured:
L.cd. – tail length from the frontal edge of the cloacal aperture to the tail tip,
L. – maximum body length from the muzzle tip to the frontal edge of the cloacal aperture,
Sq – number of spinal scutes in one transverse row in the middle of the body without the abdominal scutes,
Ventr. – number of abdominal scutes from the first transverse scute on the throat to the anal scute without the last one,
A– apical scute
Scd. – number of the pairs of the inferocaudal scutes without the anal scute.
When describing the snake coloration, we referred to the color gradients (Bondartsev, 1954).
Thermobiological investigations (thermoregulation, behavioral reactions, thermoreception, heat re-distribution in the body etc.) were conducted as suggested by Cherlin and Tsellarius (1981).
Studies of some aspects (reproduction, diet, thermoecology, different behavioral reactions etc.) are logistically problematic in the wild, so we used the snakes kept and bred in captivity to get more information about them.

Six terrariums of size 50x60x45 cm with water reservoirs and shelters were used to keep the snakes (Fig3).

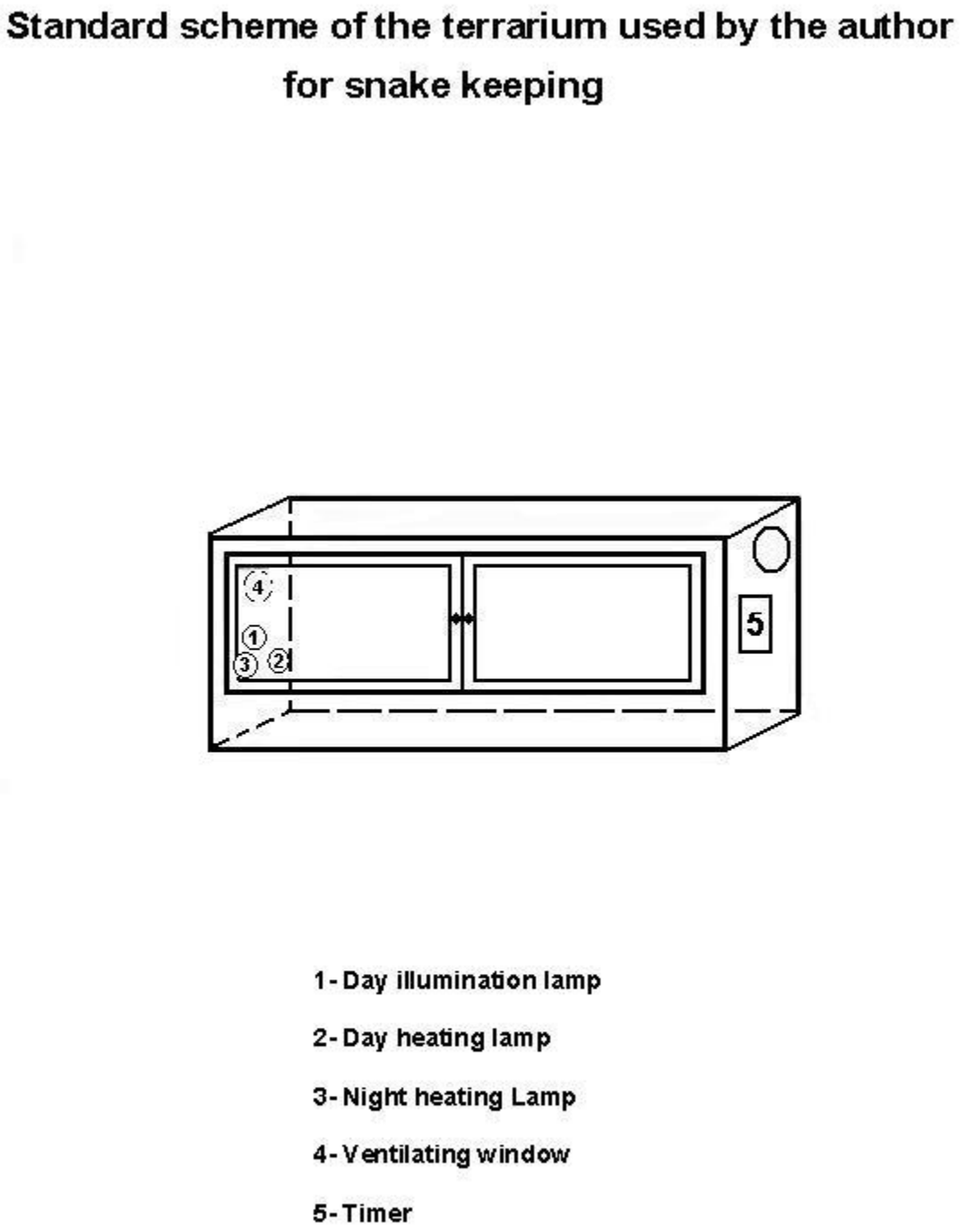


Fig.3

Three lamps connected to thermoregulator (TL-2, “Akvaret”) and operating by regime set at the timer (2-PBM) were used to provide full-day illumination and heat.

All observed events and snakes were shot by photo cameras (Jenoptik C 2.1 LCD, Nikon Φ100, Nikon Coolpix 8700)

8. HISTORY OF RESEARCH AND SYSTEMATIC POSITION OF THE VIPERS OF THE *VIPERA KAZNAKOWI* COMPLEX

Since the time of description of the Caucasian viper *Vipera kaznakowi* by Nikolsky (1909), many synonymous names were suggested as a result of description of new forms and justification of new combinations. Understanding the structure of this species constantly changed. It was considered that *V. kaznakowi* incorporates at least three closely related species disributed mainly in western part of the Caucasus. So the views on the range structure of this species also differed between scientists (Orlov, Tuniev, 1986).

Research of the Caucasian species of vipers (*V. kaznakowi* Nikolsky, 1909; *V. dinniki* (Nikolskii, 1913) and *V. darevskii* Vedmederja, Orlov et Tuniyev, 1986) and the history of their distribution are important to understand phylogenetic relationships of Euro-Siberian vipers of the Caucasus (subgenus Pelias Merrem, 1808) and formation of contemporary snake fauna in western Caucasus. For over a century the issues of snake systematics and relationships in the Caucasus are a matter of scientific debates.

Rugged terrain of the range ensures disjunction of even neighboring populations and contributes to accumulation of locally unique features. Complicated situations arise in the places of co-exstence of several species what can be possibly caused by their hybridization.

High levels of phenotypic polymorphism in snakes of *V. kaznakowi* complex have been another factor of their unclear systematic position. While analyzing old literature where strict localities of individuals are often not given, it becomes impossible to identify geographical origin of individuals.

The vipers from North Caucasus were named as *V. berus* (Rossikov, 1890). Boettger (1893) noted co-existence of two closely related species, *V. berus* and *V. renardi*, in the Caucasus as a phenomenon that deserves further research. Nikolsky (1905) thought that *V. berus* lives in South Caucasus and *V. renardi* in the grasslands and mountains of North Caucasus.

As time passed, many synonyms were suggested for *V. kaznakowi*. New forms were described from North Caucasus and the eastern part of its range which raised dubiety in their belonging to *V. kaznakowi*. They were considered in different combinations within the *V. berus* and *V. ursine* (Nikolsky, 1913, 1916; Basoglu, 1947; Knoepffer, Sochurek, 1955; Kramer, 1961).

Nikolsky (1913) described the common viper of the Caucasus as a new subspecies *V. berus dinniki*, noting its distribution on the northern and southern slopes of the Great Caucasus Ridge from Malaya Laba headwaters to Mt. Elburs. Darevsky (1956) provides a new combination of names for vipers from the Ghukasian region of north-western Armenia – *V. kaznakowi dinniki*.

Recent studies have shown that *V. berus* is absent from the Caucasus. *V. kaznakowi* has been the only valid name for vipers from western Caucasus and the taxonomic status of vipers inhabiting eastern and southern parts of the Caucasus (Daghestan and Armenia) are not considered at all (Terentiev, Chernov, 1949; Martens, 1952, 1960; Klemmer, 1963; Bannikov et al., 1977; Baran, 1977; Harding, Welch, 1980).

Research of old collections and literature has revealed that the majority of above-mentioned authors considered the complexes of *V. ursini* and *V. kaznakowi* as distinct. Most of the difficulties arised in identification of taxonomic position of vipers from eastern part of the range of *V. kaznakowi* range. Apparently, numerous indications of *V. berus* in North Caucasus and South Caucasus are related to the complex of *V. kaznakowi* and not of *V. ursini*. Vedmederja et al. (1986) have analyzed literature and morphometric data on vipers of this complex and

have separated three species: *V. kaznakowi* Nikolsky, 199, *V. dinniki* Nikolsky, 1903 and *V. darevskii* Vedmederja, Orlov et Tinuyev, 1986.
Morphologically, the Darevsky's viper occupies an intermediate position between the two other species (*V. dinniki, V. kaznakowi*) and the steppe vipers of *V. ursini* complex.
The head of vipers *V. berus*, *V. ursini* and *V. kaznakowi* is covered by big scutes (intermaxillar, nasal, naso-intermaxillar, supraorbital, occipital and frontal), contrary to *V. lebetina*, *V. xantina, V. raddei, V. persica* and others which have small scutes on the upper side of the head. Some authors (Marx, Rabb, 1965) consider this feature as important in phylogenetic analysis of vipers.
Close relationship and separated position of *V. berus, V. ursisi* and *V. kaznakowi* within the genus Vipera on a basis of their vertebral structure were indicated by Chkhikvadze and Zerova (1983) who reconstructed their general name as Pelias. These vipers are similar in coloration, behavior and reproduction biology.
Contemporary range of vipers in the Caucasus (Vedmederja et al., 1986) has clear altitudinal boundaries which ensue from their natural history. Generally, all foothill populations of *V. kaznakowi* are homogenous. In the eastern part of the range, *V. dinniki* is geographically disjunct from close *V. ursini renardi* what can be caused by extremely rare records of individuals with intermediate morphological features.
Mayr (1968), Borkin and Darevsky (1980), Solbrig and Solbrig (1982) consider different types of hybridization. Particularly, the cases are known of viable hybrids between the sympatric (co-existing) species which are capable of backward mating with one or both parental forms. The fate of both species is partially dependent on intensity of hybridization and the levels of genetic and ecological sterility of hybrids (Solbrig, Solbrig, 1982).
In most cases, not hybrids but the output of their mating with parental forms (so called introgressive hybridization) becomes more important for evolution. Formation of new taxa at the account of hybridization, i.e. fusion of ancestor genomes or "borrowing" of parts of alien genomes by gene introgression, have been considered as one of the options of hybrid-type speciation (Mayr, 1968; Borkin, Darevsky, 1980).
As some authors guess (Orlov, Tuniev, 1986), history of formation of *V. darevskii* is also linked with penetration of *V. kaznakowi* from the south in Miocene and its further dispersal in the Caucasus. Most leikely, *V. kaznakowi* inhabited a considerable portion of Lesser Caucasus, including Adjaro-Imereti, Meskheti and Javakheti ridges. This hypothesis is supported by finding of a relict population of *V. kaznakowi* in the Baniskhevi Canyon and possible existence of this viper on the Trialeti Ridge (Bakradze, 1969). The Trialeti Ridge could act as a link between the areas currently inhabited by close species, *V. kaznakowi* and *V. darevskii*.
The emergence of *V. darevskii* on the Javakheti Ridge took place in middle Pleistocene when hot arid climate of this region was changed with wetter and chiller one (Orlov, Tuniev, 1986). But then, beginning from middle Pleistocene, aridization and glaciation had led to forest degradation (Agakhaniants, 1981) and vipers, which diversified by that time, survived only in the highest and most humid areas. In the meantime, the newly created grassland ecosystem became to be intensively re-settled by *V. ursini eriwanensis* from Asia Minor Plateau (Reuss, 1933) which then distributed all over the grasslands of Lesser Caucasus and Armenian Highland. The area of hybridization with further speciation possibly existed. In light of this, origin of *V. darevskii* could be explained by hybridization of *V. eriwanensis* with insulated population of *V. kaznakowi* in the area of Javakheti Ridge.
Introgression of genes of *V. eriwanensis* to the small Pleistocene population of *V. kaznakowi* was substantial. The tentatively hybrid origin of *V. darevskii* can be supported by its morphological similarity with *V. eriwanensis* and *V. kaznakowi*.

Morphological features are essential, but insufficient, features to assess the scales of hybridization. To prove or refute the hybrid nature of *V. darevskii*, further studies on its ecology, behavior, genetics and biochemistry are required.

Today, the vipers of subgenus Pelias Merrem, 1829 comprise 14 species inhabiting Europe and North Asia, of which 12 occur in North Eurasia - *Vipera berus* (Linnaeus, 1758), *V. darevskii* Vedmederja, Orlov et Tuniyev, 1986, *V. dinniki* Nikolsky, 1913, *V. eriwanensis* (Reuss, 1933), *V. kaznakowi* Nikolsky, 1909, *V. lotievi* Nilson, Tuniyev, Orlov, Hoggren et Andren, 1995, *V. magnifica* Tuniyev et Ostrovskikh, 2001, *V. nikolskii* Vedmederja, Grubant et Rudaeva, 1986, *V. orlovi* Tuniyev et Ostrovskikh, 2001, *V. renardi* (Christoph, 1861), *V. sachalinensis* Tsarevsky, 1917 and *V. ursinii* (Bonaparte,1835).

9. RESULTS AND DISCUSSION

Name: *Vipera darevskii* Vedmederja, Orlov & Tuniyev, 1986
Terra typica: Mt. Legli, Mokrye Gory (Wet Mountains), Ghukasian district, Armenia

Synonyms:

1956 - Vipera kaznakowi dinniki, Darevsky – AN ArmSSR 9: 127
1984 - Vipera kaznakowi darevskii (nom.nud.) Vedmederja. Vopr. Gerpet. 8: 9
1986 - Vipera darevskii Vedmederja, Orlov, Tr. Zool. Inst. AN SSSR 55: 61

9.1 Morphology.

L.445, L./L.cd. 8,3-9,2, Sq. 21, seldom 19 or 20, Ventr. 132-143, S.cd. 26-28 (oo), 31-36 (oo), A 1 seldom 1, Lab. 9, seldom 8 (n = 87 ind.), maximum body mass 8200mg.

The head slightly flattened on the top, frontal edge of the muzzle slightly rounded. The intermaxillar scute narrow and touching 2 or 1 apical scutes on the head top. The nostril usually recessed in the middle of the nasal scute. Length of the frontal scute exceeds its width on average by 1.4 times. The supraorbital scute separated from frontal scute by 2-3 scutes. The eye surrounded by 7-12, usually 9-10 scutes. Four, seldom 3, inferolabial scutes touch the inferomaxillar scutes.

The body colored brown, grayish or yellow-gray on the back, with zigzag-shaped band of dark brown or black color, sometimes broken into strongly elongated transverse spots. The sides marked by vague spots of the same color on lighter background. The head top clearly marked with X-like oattern. The belly colored gray or blackish with numerous black speckles.

Morphologically, the Darevsky's viper is intermediate between the *V. eriwanensis* and *V. kaznakowi* and, most likely, has been a hybrid derivative of these races (Vedmederja et al., 1986). Our analysis shows that this species could rather

originate from the *V. eriwanensis* and *V. dinniki* as the *V. eriwanensis* and *V. darevskii* co-exist in the meadow grasslands (Tuniev, Orlov, 1986).
The Darevsky's viper is much smaller than *V.* kaznakowi, has narrower head and less distinct neck constriction. From *V. eriwanensis* it differs by higher head and much less sharpnesss of its upper-frontal edge of the muzzle. Colored yellowish what never occurs in *V. ursine*. Maximum body length is longer in females than in males. Males have longer tail. The number of abdominal scutes is higher in females and of inferocaudal scutes in males.

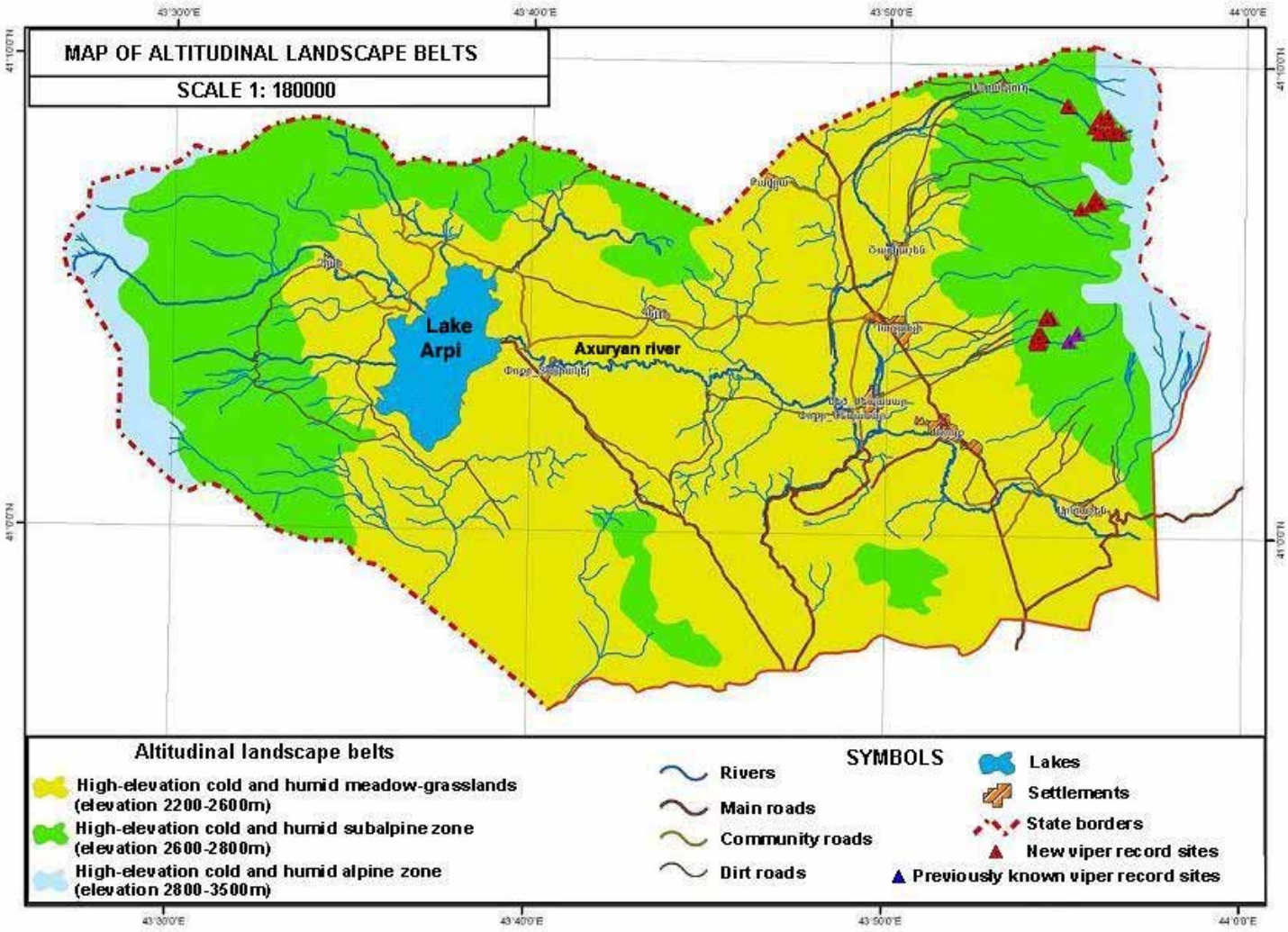
9.2 Distribution.

The range embraces south-eastern Javakheti Ridge within Armenia (Mt. Achkasar, Shirak Province, Ashotsk district) on elevations 2300-3000 m. Before, it was known only from one locality above Kazanchi village. We have found out that the northern boundary of its range stretches to the border with Georgia along the south-western slope of the Javakheti Ridge. New habitats in the vicinities of Saragyugh village were found which are located c. 12 km from the sites of old records. Here, the screes suitable for viper existence are much wider than in previous record sites and the habitats are less affected by human pressure and thus less degraded.

The range map is composed on a basis of records from our monthly field trips across the south-eastern slopes of the Javakheti Ridge. As it shows, the viper range is discontinuous and consisting of several isolated patches and situated in subalpine zone in territory more than 9200 ha.

The eastern boundary of the range is not well known. The records to the east from our study area on south-eastern Javakheti Ridge are not yet known, but are possible, where the range would converge with distribution area of Armenian steppe viper *V. eriwanensis*.

Map 4


MAP OF ALTITUDINAL LANDSCAPE BELTS
SCALE 1: 180000
Lake Arpi
Axuryan river
Altitudinal landscape belts
High-elevation cold and humid meadow-grasslands (elevation 2200-2600m)
High-elevation cold and humid subalpine zone (elevation 2600-2800m)
High-elevation cold and humid alpine zone (elevation 2800-3500m)
SYMBOLS
Rivers
Main roads
Community roads
Dirt roads
Lakes
Settlements
State borders
New viper record sites
Previously known viper record sites

9.3 Habitats.

The most preferable habitats of the Darevsky's viper are screes and mountain moraines with large flat stone slabs in subalpine zone, as well as the rocky outcrops. Here the snakes live all year round, including winter The spaces between the slabs are roomy enough to allow snakes freely move inside them and stay active even during unfavourable weather conditions.

The snake sites are mainly exposed to the south-east. Notably, snakes do not live in screes on the lower elevations of the slopes, even though they have similar terrain and rich prey base (locusts, lizards). The only difference between them and the habitats where Darevsky's vipers are present is in lacking slabs in the former habitats. So, availability of slabs is the key factor of existence of this species.

The range boundary lies between the subalpine and meadow grassland landscapes.

Vegetation of subalpine habitats is represented by grasses and forbs, e.g. *Bromopsis variegata, Hordeum violaceum, Anemonastrum fasciculatum, Betonica macrantha*, *Veronica, Gentiana, Cephalaria, Inula* and *Myosotis* spp. In meadow grasslands the dominating plants are *Festuca versicolor, F. ovina, F. valesiaca, Phleum pratense, Hordeum violaceum, Carex humilis* and *Trifolium ambiguum*.

The same landscapes are also inhabited by the Valentin's lizard *Darevskia* valentine, Armenian rock lizard *Darevskia* armeniaca, green toad *Bufo* viridis, sand lizard *Lacerta* agilis, blind worm *Anguis fragilis* and Asia Minor frog *Rana macrocnemis.* Rodents are numerous, being represented by the common and snow voles (*Microtus arvalis, M. nivalis*).

9.4 Floristic description of the Darevsky's viper habitats.

The habitats of the Darevsky's viper are situated on Mt. Legli in the Wet Mountains of the Javakheti Ridge (Armenia, Shirak Province, Ashotsk district). They cover the slopes of a dormant volcano with western and south-western exposures on elevations 200-2400 m. Terrain is gentle in the foothills and steep in the higher parts. The landscape is subalpine meadow heavily disturbed by livestock grazing. The meadow vegetation alternates with screes and rocky outcrops. The soils are mountain-meadow. Vegetation is represented by the meadows, with some scrubs.

Floristic composition is dominated by *Cephalaria gigantea, Ranunculus caucasicus, Trifolium canescens, Stachis macrantha, Astrantia major, Anemonastrum facsiculatum, Ajuga orientalis, Plantago atrata, Primula macrocalex, Ornithogalum balansae* and *Alchemilla* spp. The species *Pedicularis schelkownikowi, Gentiana pontica, Huinhia pulchra, Fritillaria caucasica* and *Gallium* spp. are rare. The clusters of *Myosotis* spp., *Muscari neglectum, Pulsatilla albana* and *Pulsatilla violaceae* can be found on screes.

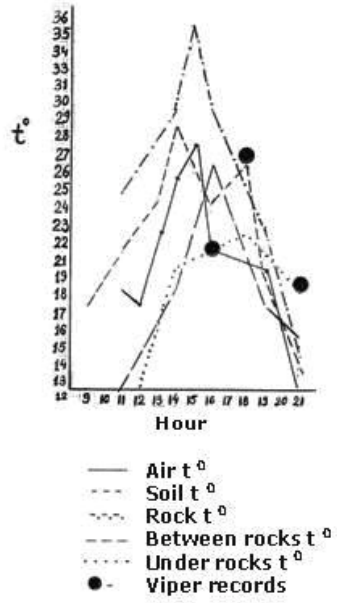
The *Scilla armena, Pushkinia scilloides, Corydallis emanueli* and *Ficaria ficarioides* bloom near the snow patches. The *Gagea* spp. and *Colchicum szovitsii* are rare.

The scrubs are represented by singular *Daphne glomerata, Rubus bushii* and *Rosa* spp.

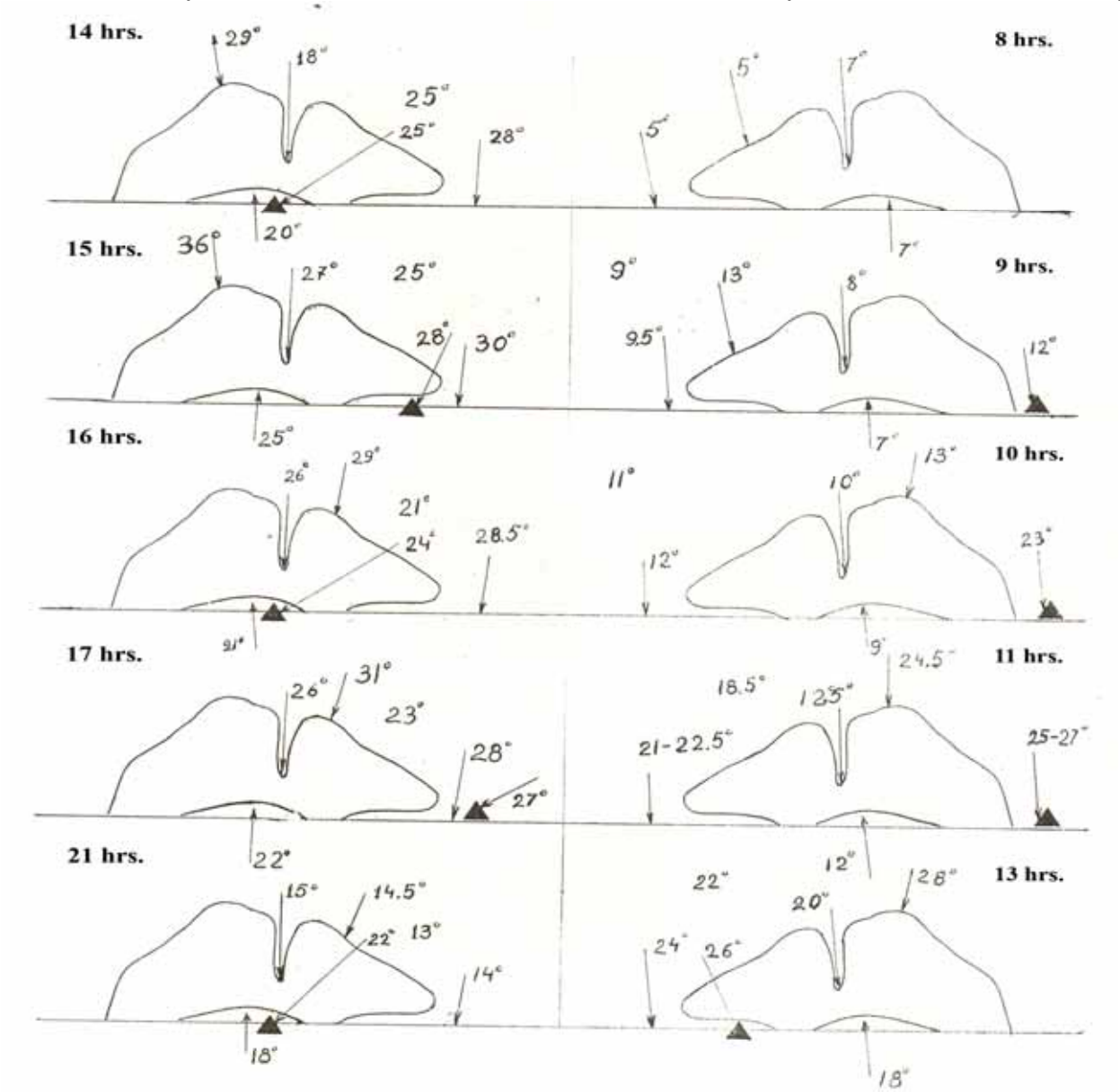
9.5 Activity.

Local climate is moderate, with rather short chilly summer and cold winter. As a results of living in such harsh conditions, the Darevsky's viper is characterized by peculiar thermoregulation which affects adaptability, feeding, reproduction, activity and other aspects.
Activity lasts from late April and early May to middle or late September. We found three sites above Kazanchi village, 2 of which had south-eastern exposure. Above Saragyugh village were 2 sites separated from each other by 5-6 km. Depending on differences in solar ray angles, snow thawing in these sites occurs asynchronously with interval 10-15 days. Consequently, the timing of snake exit from wintering sites, duration of activity periods, reproduction and leave for hibernation also differ between sites. For instance, on one site the snakes were feeding and breeding, while on the neighboring site 300 m apart where snow was just melted (as shown by blooming early spring ephemeroid plants) the snakes did not yet come out of their dens.
Orientation and structure of screes allow vipers to maintain quite high body temperature (25-27^{o}C) during their activity periods at the account of using solar radiation and active movements within the inter-slab spaces where air temperature stays high even in evening (18-20^{o}C). Air temperature fluctuations are very high both on days and nights and vary from 12 to 35^{o}C. (Fig.4) For example, we found active vipers from 19:00 to 21:00 beneath the slabs

Fig.4



when air temperature was 8-10 ^{o}C and soil surface temperature was 12-14 ^{o}C (Fig.5)



Daily records of Darevsky's Viper's dynamics in early June, depending on ambient temperature

Fig.5

To increase body temperature and maximize heat accumulation, vipers correct their position in relation to solar rays. They also flatten their bodies, thus increasing body surface. Dark body color also contributes to increased heat accumulation. Doing so, the snakes can increase their temperature to the levels exceeding those of ambient air. Substrate temperature is also important in snake thermoregulation. To avoid the risk of overheating, vipers change their position or escape to the shadows.

Vipers leave their wintering dens and stay active at air temperatures 10-12oC. For example, in May when air temperature varied from 4 to 8°C in morning hours, rectal temperature of the snake was 25°C.

Soil surface temperature undergoes maximum daily fluctuations whose range decreases with depths. On the depth 1 m fluctuations of soil temperature are undetectable and on the depths of several meters the yearly differences disappear taking this into account, it is possible to forecast the depths and conditions of wintering sites in different areas, using the local atlas of climate as a reference. For example, in the area over Kazanchi village the wintering depths were no less than 1.8-2 m where minimum temperature was 6-8 °C in February

In some cases, range boundaries can be linked with the boundaries of lethal temperatures for a given species. In some cases, ranges correspond to the isotherms, but isotherm does not necessarily reflect the admissible temperatures which ensure normal metabolism (Beagon, Harper, Townsend, 1989).

We compared the ranges of three venomous snakes living in Armenia (*V. raddei, V. eriwanensis, V.darevskii*) and found their correlation with distribution of the isotherm of mean soil temperature in June (Fig.6). For the Darevsky's viper the range corresponds to soil

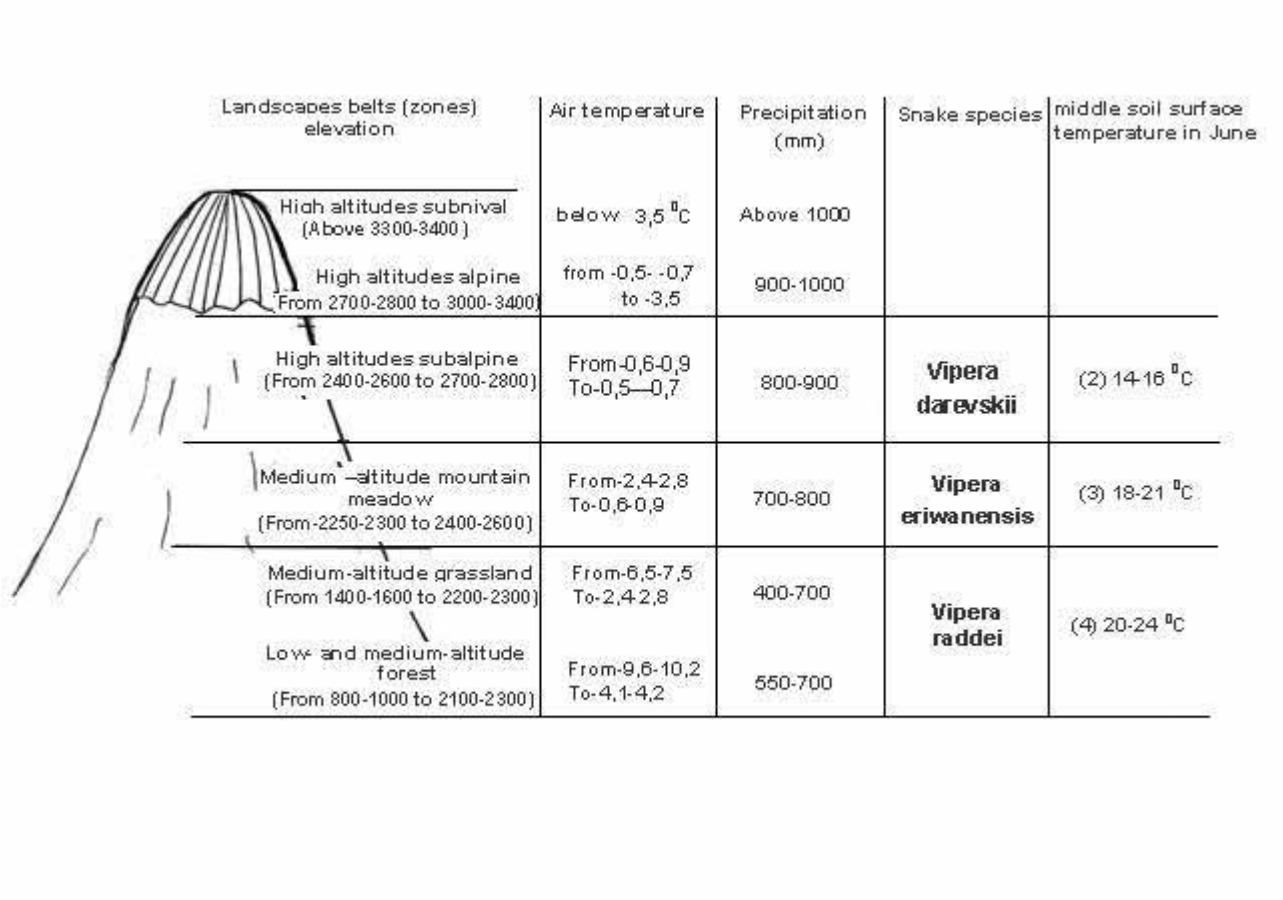


Fig.6

temperature 14-16°C, Armenian viper 20-24°C, Armenian steppe viper 18-21°C.

Homeostasis of animal organism has been maintained by physiological mechanisms and corresponding behavior. Thermoregulation allows to keep body temperature stable on the background of variable temperatures in the ambient environment. The curves of process intensities in the organism (curves of tolerance) are unimodal and bell-shaped whose top

corresponds to the conditions optimal for a given organism. The stenothermic organisms have narrow limits of tolerance and the eurithermic organisms have wide limits (Fig.7).

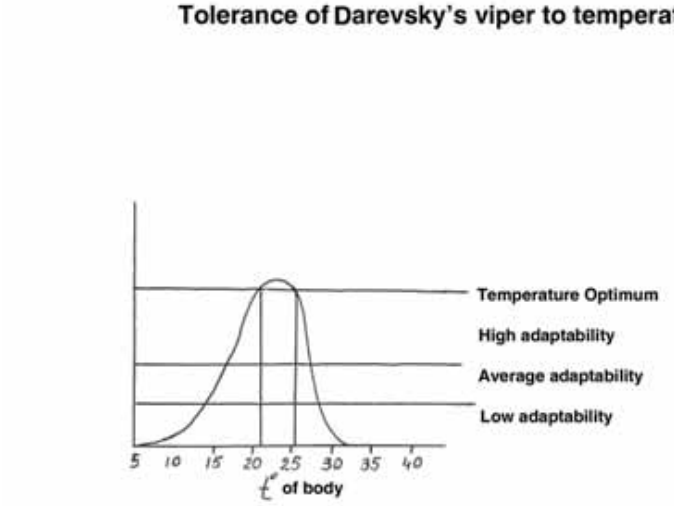


Fig.7

Considering all factors described above, we can surmise that narrow thresholds of adaptability of the Darevsky's viper will lead to significant reduction of its population under disturbance of environmental equilibrium.

9.6 Diet.

The Darevsky's viper feeds mainly on lizards of subgenus Archaeolacerta (*Darevskia armeniaca, D. valentini*) and numerous orthopterous insects. Sometimes it consumes the rodents *Microtus arvalis, M. nivalis* whose abundance is quite high.

9.7 Reproduction.

Mating starts from early to middle May. According to literature (Aghasyan, 1996), the female of L 435 and Lcd. 45 gave birth to 7 offspring of L 114-147
(mean 136.5 mm) and Lcd. 16-22 (mean 18.7 mm). To determine the timing of parturition, we took the pregnant females found in the wild and kept them in terrariums. Two females captured over Kazanchi village on 26 August 2005 gave birth to 6 and 4 offspring on 12 and 14 September 2005.Table (Fig.8)

Two females of Darevsky's viper and their offspring

N	L	L.cd	Masse. mg	sex
1.female	422	47	7700	female
1	157	18	3900	Female or male
2	145	18	3400	Female or male
3	148	16	3700	female
4	146	16	3430	female
5	147	18	4070	male
6	143	22	3600	male
2.female	427	48	8200	female
1	140	22	3700	male
2	141	16	3630	female
3	138	16	3470	female
4	145	16	3770	female

Fig.8

All newborns were measured, weighed and marked by stains. The sizes and body masses of the offspring varied (L 138-157 mm, Lcd. – 16-22 mm, mass 3400-4070 mg). The first female of L 422 mmand Lcd. 47 mm had body mass 77 g before parturition and 49 g after that.

The second female of L 427 mm and Lcd. 48 mm had body mass 82 g before parturition and 39 g after that. Two pregnant females captured over Saragyugh village on 23 and 29 August 2006 produced 9 and 7 offspring, respectively. All they were measured and weighed. Morphometric information is given in table (Fig9).

Two females of Darevsky's viper and their offspring

N	N	L	L.cd	Vent	Sub.cd	Sq	Masses mg	sex	Ap	Lab	Sb.Lab
1.Female	27934	480	157	135	28	19		Female	2	9	10
1	27937	149	21	132	28	21	2500	male	1	9	10
2	27938	158	22	138	34		3700	male	2	9	10
3	27939	156	18	143	28		2900	female	2	10	10
4	27940	153	23	133	36		3700	male	2	9	10
5	27941	150	18	140	27	21	3700	female	2	9	10
6	27942	155	23	137	21		3900	male	2	9	11
7	27943	156	22	136	32	19	3700	male	2	10-9	9-10
8	27944	157	16	141	24	21	3750	female	1	9	10
9	27945	148	21	139	33	19	3600	male	2	9	10
2.Female	27936	448	49	135	25	21		female	2	9	10
1	27933	142	20	136	33	21	3700	male	2		
2	27935	146	20	130	31	21	3650	male	2	9	10
3	27548	149	15	139	22	20	3700	female	1		
4	27549	152	20	135	30	20	3650	male	1		
5	27550	155	19	135	31	19	3600	male	1	9	10
6	27947	156	17	141	24	20	3200	female	1		
7	27946	152	17	139	26	21	3100	female	1		

Fig.9

We made observation of the newborn vipers (moulting, thermoregulation, feeding, behavior). Moulting took place immediately after the birth and lasted 1 hr. After the second moult the newborns started feeding. All offspring and their parents were released in the capture sites.

In captivity, unlike other snakes the Darevsky's vipers require more intense unltraviolet radiation. Young individuals appear on the surface more than adults.

The late timing of parturition allows to surmise that the newborns go to their wintering dens immediately after birth and start feeding after hibernation in spring next year. Possibly, viable sperm can be safely stored in female's sexual ducts and females can also go for wintering in pregnant condition.

9.8 Population.

We counted up to 10-12 individuals per hectare in the key habitats in different seasons. Population size above Saragyugh village is quite high. In mid-June we counted 7 to 8 snakes per 0.5 ha. In total, in this area, we captured, marked and released 19 individuals. Extrapolating information across the suitable habitats, we can guesstimate population size no more than 250-300 in each population. Comparing our information with that obtained from literature, we note population stability over years.

10. Education and cooperation

At the project beginning the project "Development of conservation measures for the Darevsky's viper in the Caucasus" was presented at the workshop held in Fort Royal, USA, from 17 June to 2 July 2005 and organized by BP Conservation.
The progress of this project was presented on the poster "Ecology and conservation of the Darevsky's viper in the Caucasus" at the conference "Society for Conservation Biology" in San Jose in 22-29 June 2006.
The project results were arranged in presentation "On biology and conservation of the Darevsky's viper" at the WWF Caucasus Programme Office on 18 April 2006 and at the BirdLife office on 4 May, 2006 in Yerevan. This presentation contained information on the species ecology and conservation, as well as recommendations on mitigation of human impact on the Darevsky's viper habitats Representatives of several NGOs participated at this workshop (WWF, Armenian Ecotourism Association, (Armenian society of birds protection) authorized person.

The issues of viper conservation and incorporation of its habitats to the newly established transboundary Arpi Lich National Park were discussed. The project information was also presented at the seminars of Laboratory of Vertebrates, Institute of Zoology (23 February, 2006), Department of Zoology of the Yerevan State University (16 March 2006) and at the Shirak Province Division of the State Conservation Inspection (15 May 2006).

One thousand copies of wall calendar (60x40 cm), desktop calendar (19.5x29.5 cm) and booklet (30x21.5 cm) with text and illustrations (maps and photographs) were produced and widely distributed.
Several workshops with local population and chiefs of rural communities were organized in the Shirak Province. Special attention was paid to the plans of establishment of Arpi Lich National Park. Special ecological lessons on biodiversity conservation and particularly about the Darevsky's viper were conducted at the schools of Kazanchi and Saragyugh villages.

11.1. Conclusions

The project results are important to understand ecology and distribution of the critically endangered Darevsky's viper.
Our information can be used for production of new Red Data Book of Animals of Armenia and preparation of database on IUCN reptiles.
Results and their analysis are essential to justify, organize and manage the newly established Arpi Lich National Park and ensure the zoning of this protected area.
The map of administrative boundaries of communities and land-use patterns shows the key habitats of the viper have been owned by state and are located beyond administrative borders of rural communities. (Fig 10)

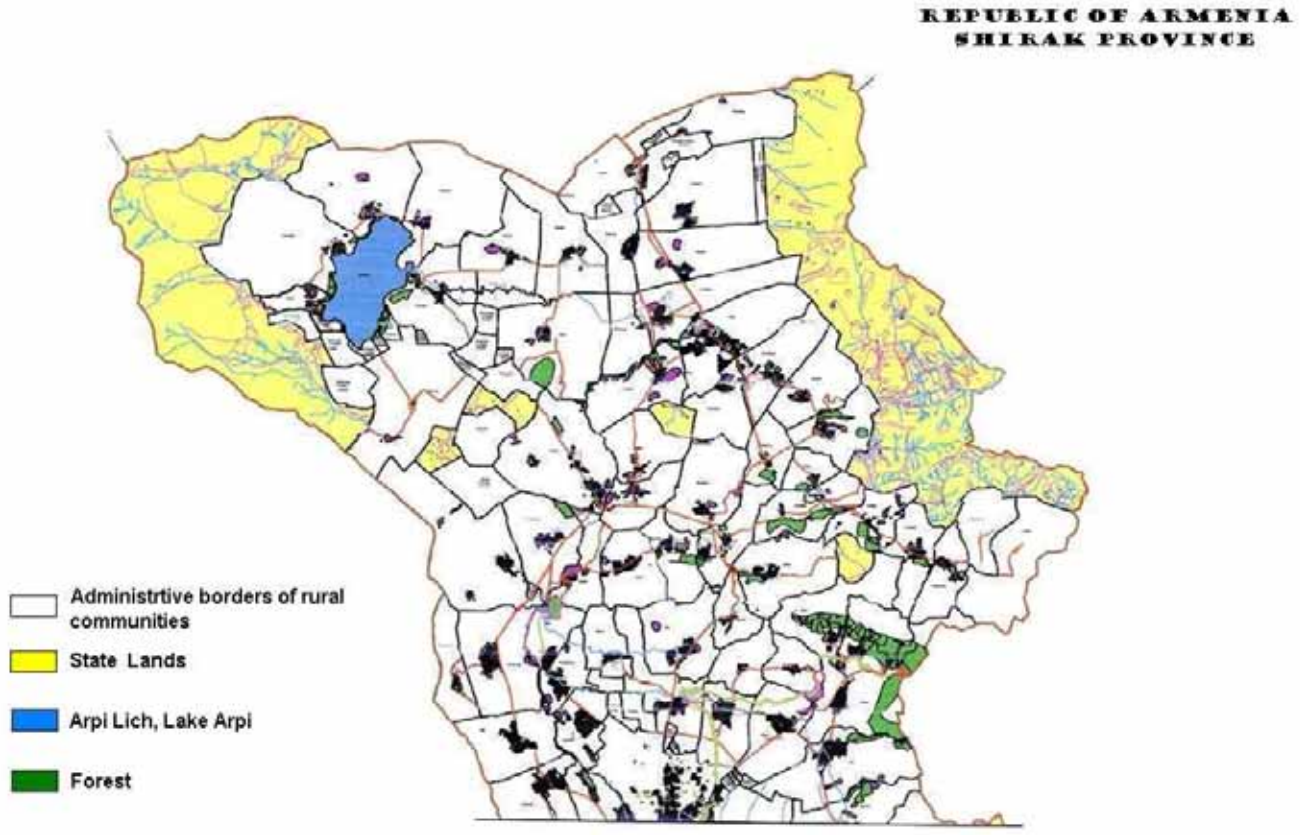


Fig.10
The screes and rocky areas located within the pastures have not been used for agricultural purposes but are valuable for biodiversity conservation. So, these areas can be set aside as a protected area without inflicting economic losses.
The floristic description and GIS maps can be used for mapping of this national park.
The key habitats and their characteristics are revealed through the snake marking and tracking. They are screes and mountain moraines with large stone slabs on the slopes.

The core areas which include the key areas of individual home ranges (including temporary and constant wintering dens) are identified, mapped and suggested for the spatially focused conservation measures.
The principal threats are hay collection and animal husbandry, especially overgrazing. Grazing in spring and autumn are particularly harmful. In the past years, the situation has aggravated by changes in grazing pattern which has been practiced almost all year round.
Strong selectivity of vipers for habitats, i.e. their low adaptability (only subalpine meadows at 2200-2600 m), and fragmented structure of habitats make this species highly vulnerable. So, incorporation of the viper habitats to Arpi National Park must be the fundamental issue for conservation of the Darevsky's viper.

11.2. Recommendations on Darevsky's viper conservation

Currently, biodiversity conservation in Armenia has been implemented in three directions: legislation, space allocation and breeding. We suggest the following activities within these three directions.

Legislation – legislative basis is now favorable. A significant progress is made in the past years when the laws "On conservation of fauna" (2000), "On fines for violation of environmental legislation on infliction of damage to fauna and flora" (2005), Red Data Book of Animals of Armenia (1987) and a number of acts regulate the issues of animal conservation and use. The following work must be done to advance the viper conservation.
а) This species is listed as critically endangered in 2006 IUCN Red List of Threatened Species but is not indicated in the 1987 Red Data Book of Armenia. It is essential to put it into the new edition of the national Red Data Book. This suggestion is ready for submission to the Ministry of Nature Protection which is authorized to manage the Red Data Book.
б) It is important to make amendments in the law "On fines for violation of environmental legislation on infliction of damage to fauna and flora" to include the Darevsky's viper into the list of this law. This change will enable to set higher fines for capturing or destruction of this species. Currently, these fines are the same as for common species and make 5000 Armenian drams (about 10 US dollars). This suggestion will also be submitted to the Ministry of Nature Protection which is authorized for making amendments in legislation.
The strategic objective of this project is to prepare recommendations on organization of Arpi Lich National Park in north-western Armenia.
The project goals are:

- Inventory of flora and fauna of the viper habitats;
- Mapping and zoning of the territory (national park, buffer zone);
- Activities to raise public awareness about the importance of the national park;
- Staffing and training for habitat monitoring;
- Fencing of viper habitats (metallic grid, special entrances for livestock).

Space allocation – The principal threats to Darevsky's vipers are animal husbandry and destruction of vegetation cover by grazing livestock.
Grazing in spring and autumn are particularly destructive. In the past years the situation has aggravated by year-round grazing and increase of cattle heads in some farmers.
Now, the damage caused by grazing to habitats is lower than during the Soviet times. The Soviet practice was to concentrate livestock in large herds which had their constant places for grazing with farms and other infrastructure. During the whole period of grazing livestock was kept on the mountain slopes and grazed by turns in different areas. After the collapse of the

Soviet Union, all these areas were given to rural communities – Mets Sepasar, Pokr Sepasar, Kazanchi, Sizavet, Saragyugh, Zigagyugh, Artashen – which use them as their own pastures and hay grounds.
Currently, individual landowners and companies are involved in animal husbandry.
In Shirak Province the principal livestock owners having from 15 to 150 heads each are not many. The hay grounds are also given to the communities, but there are also large tracts of state-owned land which must be given to locals.
a) The viper habitats can be safely incorporated to the protected area due to their unsuitability for agriculture. This will also allow to increase the fine for capturing or killing the viper by 5 times as specified in the law "On specially protected natural areas".
This approach fits the governmental plan to establish Arpi Lich National Park which was approved by the government on 26 December 2002 in the National Action Plan and National Strategy of Protected Area Development in Armenia.
Currently, many of the viper habitats are still pristine but can be destroyed in the future due to agricultural activities.
b) During their movements livestock generally walk round the screes, but in some places move through them and form well-tramped terraces. Penetration of livestock to these areas can be eliminated by their fencing with metallic grid or cable at height 50 cm. The fences should also be equipped with boards warning about fines.
c) It is important to regulate the regimes of hay collection and grazing throughout the year in order to mitigate their effects on viper habitats. This is possible by means of making agreements with local communities and their chiefs.
d) Local brooks dry up during the summer and livestock has to move upstream to the hearwaters which still hold water. It is feasible to dig reservoirs for livestock watering to prevent livestock movements along the dried river beds. During such movements livestock tramps down the vipers which creep downwards to the same beds to hunt on liards and insects.
e) It is essential to organize awareness-raising campaigns for local schoolchildren, especially in senior classes. In the fuure, it would be reasonable to shoot a film about the Darevsky's viper, its ecology and conservation.

Illegal captures – In the past years, separation of the Darevsky's viper as a distinct species and its inclusion to the IUCN Red List have raised considerable interest to it among the scientists, collectors and terrariumists. As our interviews show, most of local people are not aware of the viper living beside them, so the species can be destroyed by uncontrolled capturing rather than by local people. The proposed measures are:
a) Increase control on domestic market and at custom houses. Provide information materials to personnel of custom houses to prevent unauthorized exports.
b) Create the local group of volunteers, mainly from senior schoolchildren, who could prevent viper captures and inform local department of the State Conservation Inspection.
c) Raise awareness of the State Conservation Inspection itself.

Breeding – on a basis of information obtained from the wild to develop the methods of captive breeding of the Darevsky's viper. In the future, the captive stock could be used to create breeding captive population for reintroduction purposes.

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Distribution List.

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