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On placing and thermobiology of polymorphic population of *Vipera dinniki* (Nikolsky, 1913) (Serpentes, Viperidae) at uppermost Msymta-river valley

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Abstract: Investigated area has about 5 hectares in subalpine belt (1750-1850 m) of uppermost Mzymta-river valley, West Caucasus. This area has two morains, rocky outcrops, high-grass and and mix elfin woodland-meadows. Both morains and rochs are the places of hibernation. There are distinguished 4 phenotypes of *Vipera dinniki*. Among thrm "tigrina"-morph prevails over "nebulosa" - and "bronze"-morphs. The most rare morph is "kaznakovi"-morph. Sexes ratio close to 1 (28 ♂♂ : 33 ♀♀). Adult vipers predominante in the age structure of population. Most not-numerous group is semiadults. Depend on slope exposition the begining and the end oldaily activity have distinctions on the various places of this area but total length of surface activity was similar in each places and had 35% of daily cycle. It was picked out the distinctions in territorial placing between sexes and different age-grades. Thermobiological data of this area demonstrated the exceeding of the body temperature of active males than those of females. Body temperature of representatives of both sexes has stricty dependence on ground temperature than on air temperature. Results testify to existence of differences in thermobiology of various morphs.

Key words: Caucasus, Vipers, Morphs, Thermobiology.

INTRODUCTION

Snake's relations with environmental constrains (as poikilothems) are interesting withing temperature balance firstly. As rule data in literature have given an optimal interval of reptiles activity (PESTINSKY, 1939; BOGDANOV, 1950; 1962; 1965; PERSIANOVA, 1969; KHOZATZKY, ZAHAROV, 1970). *Vipera dinniki* isn't exception in this question (BOZHANSKY, 1986). At the same time thermal ecology of reptiles in various aspects was demonstrated in many articles (ORLOV, 1986; SEXTON *et*, 1992; PATTERSON, 1992; SEMENOV, BORKIN, 1992; PLUMMER, 1993).

Classical work was an article of SERGEYEV (1939) "The body temperature of reptiles in natural surroundings" in which Sergeyev described original method of investigation on temperature relations of reptiles. Based on this method *Echis multisquamatus* was investigated later (CHERLIN, 1977; CHERLIN, TZELLARIUS, 1981). Depend from elevation solar radiation increases up to the mountains. On the Caucasus the influence of solar radiation to hing-mountain reptile's ecology was noteed by STRELNIKOV (1944).

The thermobiology of polymorphic population of *Vipera dinniki* and caucasian vipers in general is unknown. We have tried to observe temperature relations of both sexes and different morphs of *V. dinniki* with ambient temperature during the most active seasonal period.

MATERIAL AND METHODS

Vipera dinniki was studied at the begining of river Mzymta, vicinity of Sochi, Western Caucasus, Russia (altitude 1750 - 1850 m). Investigated area had about 150 hectares and it placed from foothill of mt. Loyub and western shore of lace Kardyvach downwards to place Azmych (at the protected zone along the border of Caucasian Reserve). Two big Pleictocene moraines are on this east- and south-exposed area. Becide it rocky outcrops are present at place Azmych mt. Loyub. This valley cavered by subalpine vegetation (mix high-grass subalpine meadows and elfinwoodland with *Fagus orientalis*, *Betula litwinowii*, *Acer trautvetteri* and so on). Free-flowing parts of morains have some witnesses of Glacial period like lichen *Cladonia*. The same time there are xerophilouse shrubs (*Spiraea hypericifolia*, *Juniperus sabina*) on the rocks after Holocene. Both moraines and rocks are the places of viper's hibernation. Anomals were observed from 4 hibernation centres (5 hectares) of this area: "1st Morain", "2nd Morain", "Loyub", "Azmych".

There are distinguished 4 phenothypes of *V. dinniki*:

1. "kaznacovi"-morph (greyish-yellow or bright-yellow colour-ground with broad black zig-zug, usually combined with black pattern of head).
2. "tigrina"-morph (yellow or orange specimens with transverse diagonal blotchs, pronounced zig-zug is absent; head pattern is not total black

and it separates from dorsal blotchs).
3. "nebulosa"-morph is closed to "tigrina"-morph, but has some differences (greyish-brown colour-ground with indistinct undulate velvety dorsal pattern, usually brown head's pattern is unclear also can connect or separate with body pattern).
4. "bronze"-morph (goldern-grey or old-coopery colour-ground without any pattern or with rudimental zig-zug on the neck. Head pattern is similar with that of "tigrina"-morph).

It was observed the placing of 87 specimens (July-August) along this area. In the middle July cloacal temperature (Tb) of 61adult *V. dinniki* were recorded with a Schultheis fastregistering mercury theremometer (to the nearest 0.1°C).

Each snake was sexed and the following information was recorded: date of capture, time of capture, place of capture,weather, air temperature (Ta) 1.5 m above the ground, ground temperature (Tg) on the surface of land. After measuring snakes were released.

Becide it we recorded microclimate measures on the meteorological plot near lace Kardyvach (open sunny place): air temperature (Ta1) 0.2 m with a recording thermometer (AN-16 Model) in meteorological cabin., ground temperature with maximum and minimum thermometers, soil temperature (Ts) 0.1 m under the ground with a sling thermometer.

Morphs ratio among 61 termometrised vipers was 5 "tigrina": 1 "kaznakovi": 1.5 "nebulosa" : 1.3 "bronze". Vipers of these morphs were found at all 4 hibernation places but in various ratios. At the "1st Morain", there are 5 "bronze" : 2nd Morain" this ratio was 1:1:10:4, at the "Loyub" - 2:5:10:1. At the "Asmych" "kaznakovi"-morph was absent and ratio of other 3 morphs was 1:1:2 correspondingly. According these data most common morph was "tigrina" and the most rare-one was "kaznakovi". The same time volume of "nebulosa"-morph and "bronze"-morph animals was approximatly equal.

Sexes ratio was about 1 (28♂♂:33♀♀). This ratio was constant among each, except "nebulosa"-morph (1♂♂:3.5♀♀). Sexes ratio was quite different at 4 hibernation places. "1st Morain" had 1♂♂:1.1♀♀; "2nd Morain" - 2.67 ♂♂:1♀♀; "Loyub" - 1♂♂:3♀♀ and "Azmych" - 1♂♂:3.75♀♀. But if we'll put into consideration high mobility of males (especially in breeding), we'll have the same ratio about 1 for total area of investigation.

Age-grades of this population had ratio 3.7 juveniles : 1 subadults : 15.7 adults. Among sexes this ratio was: ♂♂-2.3:1:6; ♀♀-4:1:29. Adult animals formed predominant age-grade and most rare group was subadults. This type of ratio describes this population as well as stisfactorily.

Molting is an important characteristic of population. It demonstrates the period of maximum trophic activity. Total number of molt vipers was 44.3%. Among females, there are 39.4% molt animals and among males - 50%. Specific ratio of molt specimens was noteed in different age-grades: 18.2% of juveniles, 100% of subadult and 46.8% of adults.

On the meteorological plot the amplitude of air temperature (Ta1) was from 3.5°C up to 31°C. Mean air temperature at 11oo (beginning of surfacely activity) was 14.0°C and mean air temperature at 14oo (snakes went away to shade and refuges) was 25.13°C (fig.1). Mean-maximum air temperature was 36.32°C. The least daily temperature amplitude was pointed out for soil temperature (Ts) 0.1 m under the ground (Fig.1): Range: 9.5 - 14.0°C and Mean 11.25±0.34.

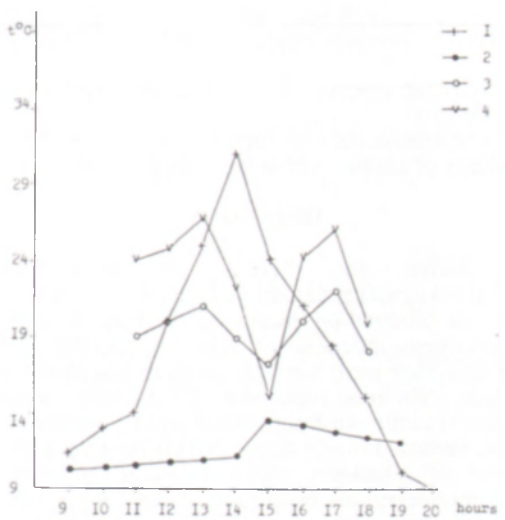

Figure 1: Microclimatical data of meteorological plot and places of capture of *Vipera dinniki* from the uppermost Mzymta-river valley. 1: Ta_1 (air temperature 0.2 m at the meteorologocal plot). 2:- Ts (soil temperature under 0.1 m at meteorological plot). 3: Ta (air temperature 1.5 m at places of viper's capture). 4: Tg (ground temperature at places of viper's capture).

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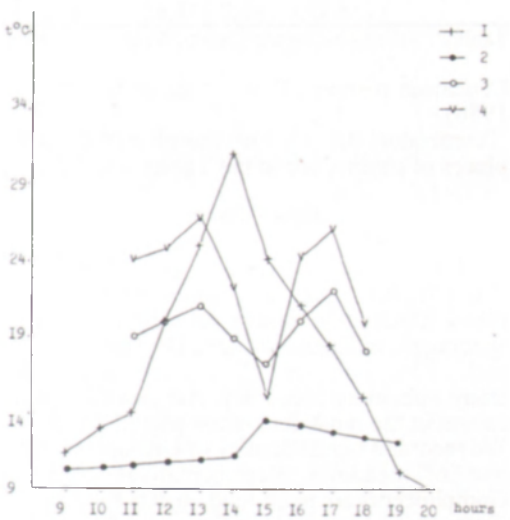

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		Tb	Ta	Tg	Tb -Ta	Tb -Tg
♂♂	(range)	20.5-35.1	15.2-26.2	17.2-37.0	4.4-14.8	(-6)-9.8
	(x±S.D.)	28.47±0.58	19.93±0.52	24.88±0.91	8.54±0.51	3.58±0.74
♀♀	(range)	20.2-32.8	14.4-25.4	16.7-35.0	1.8-14.8	(-5.1)-12.8
	(x±S.D.)	26.74±0.59	18.78±0.44	22.93±0.71	7.97±0.46	3.93±0.62

Table 1: Comparison of body temperature and habital temperatures between sexes of *Vipera dinniki*.

morph		Tb	Ta	Tg	Tb -Ta	Tb -Tg
"nebulosa"	(range)	20.2-31.3	17.0-25.4	20.2-32.4	1.80-9.40	(-0.6)-3.6
	(x±S.D.)	26.49+1.37	19.9+0.86	24.56+1.36	6.58+0.84	1.9+0.58
"tigrina"	(range)	21.8-35.1	15.2-25.2	17.2-37.0	4.2-13.2	(-6.0)-9.80
	(x±S.D.)	27.91+0.59	19.81+0.55	24.24+0.82	8.10+0.43	3.67+0.84
"kaznakovi"	(range)	25.0-30.8	15.8-19.8	18.2-28.0	5.2-14.8	(-3.0)-10.2
	(x±S.D.)	27.50+0.85	17.60+0.61	22.70+1.62	9.90+1.40	4.80+1.96
"bronze"	(range)	21.2-33.6	16.8-23.8	19.4-35.4	4.4-12.0	(-1.8)-8.2
	(x±S.D.)	28.25+1.40	19.55+0.87	23.95+1.81	8.70+0.89	4.3+1.16

Table 2: Thermobiological data of 4 morps *Vipera dinniki* from the uppermost Mzymta-river valley.

Caucasian reserve (TUNIYEV & BEREGOVAYA, 1986).

Temperature data for each morph and sex at the places of capture are in the Tables 1 and 2.

DISCUSSION

During the period of observation (July-August) pregnant females were found at the 4 hibernation places as well as all molt specimens independ of sex. Dry females and males after molt were allocated throughout the stony subalpine meadows. All juveniles were caught at the most dens-grass part of meadows. We recorded bigest density of Orthoptera at the part of meadows. Representatives of genus Gomphocerus are main food objects for juvenile vipers in the hiph-western Caucasus. But it takes place in August-September when grasshoppers rich imago. Noted volume of molt juveniles (18.2%) showed low level of trophic activity in July. The same time subadults had maximum trophic activity (100%) because of difuse dissemination of not-numerous animals and absence of competitors for using equal size-limits of food.

Among adult vipers, there are bigest number of molt males (50%) than molt females (39.4%). Males are very lively and successful in getting prey in comparison with territory conservative females. From other hand, females keep energy ballance for development of embrions firstly. As rule, females don't come out completely on the surface of land. They lie under the ledges of stones and from time to time females put out abask different parts of body.

At middle-day time all population is in hiding under the hot stones and only single specimens go to the dense-grass parts or to the shady banks of streams. In July evening activity can absent if the first half of day was solar. Snakes are under the warm stones and later they go deepper to the burrows and cracks in the rocks and morain-bodis. At the cloudy-weather vipera can be find on the surface during all period of daily activity but males were observed rare than females. Similar notes we recorded at solar vindy weather, when females were found at the vindless warm places protected by stones and blocks. Only pregnant females and juveniles are on the surface during drizzle and formers have more long activity (even if Ta=13°C).

The temperature cut-off seasonal activity of *V.dinniki* was noteed as +5°C (from the end of April till middle of October) and the temperature cut-off of reproductive period was given as +10°C, according to BOZHANSKY (1986). But usually seasonal activity of *V.dinniki* is shorter (May-middle of September).

Depend on slopes exposition and sun-shining time the beginning and the end of daily activity have distinctions on the 4 hibernation places of

investigated area (from 15 minutes between "1st" and "2nd Morains" up to 1.75 h between "Azmych" and "2nd Morain"). But total length of surface activity was similar in each places and had 8.5 h. or 35% of diurnal cycle. CHERLIN & TZELLARIUS (1981) pointed out strict time-limits of snake's activity. These authors have established dependence of daily activity's beginning from the minimum level of soil temperature in the burrows, when air temperature at the same burrows starts to exceed the soil temperature.

Data of temperature measurings (Tab. 1) show some interesting points. Firstly, maximum distance of ambient air temperature and body temperature on surface (Ta-Tb) was close to operative temperatures reported for beginning of the seasonal and diurnal activitis (+13°C). Secondly, body temperature of active males tended to de higher than those of females ($d=1.78$; $t=2.14$; $p<0.05$). Finaly, body temperatures of both sexes had strictly of air (Ta) at place of capture ($r=0.7$). Similar materials were reported for *Echis multisquamatus* (CHERLIN & TZELLARIUS, 1981) and it co-ordinates to those results of special investigations that body absorption of heat takes place mainly through substratum (DUVDEVANI & BORUT, 1974). STRELNIKOV (1944) suggested that it's not necassery high ambient air temperature in the mountains for favorable live of reptiles. Most important role has solar radiation which increases up to the mountains.

In the morning males get warm quick (Fig.2) and they rich maximum body temperature at middle-day time. Whereas females warm up more slowly and they rich of body temperature at 1 hour later, when males begin to reduce body temperature. Due to increasing of Ta and Tg (Fig.1) vipers of both sexes start their active thermoregulation and they choise shade places with cooler Ta and Tg. Distinkt-tracked inverse dependence has maximum at 15oo when due to maximum of ambient overheating snakes choise most cool parts of habitat and they maintain optimal body temperature. According to STRELNIKOV (1944) high-mountain caucasian reptiles die after 20 minuts of direct solar radiation and range of air temperature from 24 to 29°C. Their body overheating had 25°C.

In cloudy weather an ultraviolet radiation isn't so strong and animals can have more long surface activity. But in sunny weather *V. dinniki* reduce daily activity at middle-day time when ambient temperatures are high and they avoid basking.

At the second half of day due to reduction of solar radiation vipera correlate again active their body temperature. Mean body temperature of females riches maximal level again at 15-30 then it reduces to 26°C at 16oo and it stais constant till end of surface activity. Males don't have quite high mean temperature like in the morning but they keep up their body temperature higher than that of females by 3°C.

Viper's behavioral thermoregulation correlates strictly with daily fluctuations in ambient temperatures of environment. Let's comparing data from investigated area and meteorological plot. In the morning air temperature (Fig.1) and snakes habitat's temperature are in direct correlation because air

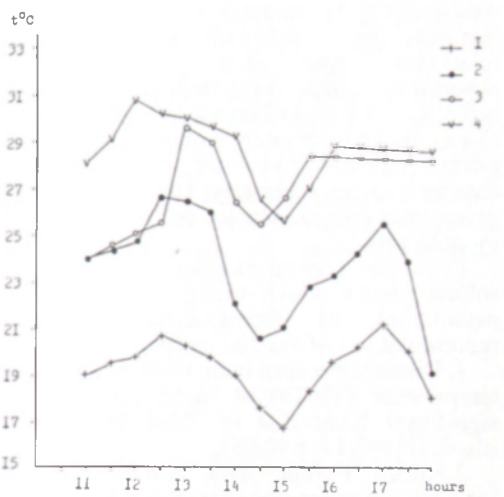

Figure 2: Daily pulsation of body temperature of males and females of *Vipera dinniki* and microclimatical data from the places of capture (uppermost Mzymta-river valley). 1: Ta (air temperature 1.5 m at the places of capture of vipera). 2: Tg (ground temperature at the places of capture of vipers). 3: Tb♀♀ (mean body temperature of females). 4: Tb♂♂ (mean body temperature of males).

temperature raises quicke than soil temperature. Then soil temperature (Ts) go on higher when temperature pick of Ta1 has crossed and air got cool. At the capture places there are minimum means of Ta and Tg the same time because snakes go away of overheating. In the evening Tg1 get cool quicker than that of soil (Ts). Again snakes select behaviral much warm places. Thus habital data of temperature are in negative slope again with ambient temperature as whole. Total

compared-morphs	Tb d	Tb t	Ta d	Ta t	Tg d	Tg t	(Tb -Ta) d	(Tb -Ta) t	(Tb -Tg) d	(Tb -Tg) t
bronze-trigina	0.34	0.22	-0.26	0.20	-0.29	0.14	0.6	0.56	0.63	0.4
bronze-nebulosa	1.76	0.89	-0.35	0.28	-0.61	0.27	2.12	1.72	2.4	1.9
bronze-kaznakovi	0.75	0.42	1.95	1.71	1.25	0.49	-1.2	0.76	-0.5	0.23
tigrina-nebulosa	1.42	1.1	-0.09	0.08	-0.32	0.19	1.52	1.73	1.77	1.48
tigrina-kaznakovi	0.41	0.29	2.21	1.74	1.54	0.78	-1.8	1.59	-1.13	0.67
nebulosa-kaznakovi	1.01	0.55	2.3	1.97	1.86	0.87	-3.3	2.17*	-2.9	1.7

Table 3: Differences on thermobiological data between various morphs of *Vipera dinniki* from the uppermost Mzymta-river valley. d: distance between mean numbers (x_1-x_2); t: t-cristerion; *: $p<0.05$.

period of viper's active thermoregulation continues from 12-30 till 17-00.

It's well known that percentage of melanotic reptiles increases in the moderate latitudes as well as up to the mountains. It was reported in literature also (STRELNIKOV, 1944) about relationship between skin structure/colour and absorption of heat. We examined this question reference to 4 described morphs of *V. dinniki* (Tab. 2). Unfortunately volume of materials made it impossible to compare thermobiological data for each sex separately. That's why we have given joint comparison for both sexes of each morph (Tab. 3).

Even this way of examination has shown follow results which testify to existence of peculiarites of thermoregulation among representatives of various morphs:

1. Distance between body temperature and air temperature (Tb-Ta) of "nebulosa"-morph is significant lover that of "kaznakovi"-morph ($d=-3.32$; $t=2.17$; $p<0.05$).

2. Since "tigrina"- and "nebulosa"-morphs have rov of similar characteristics we compareed the unite sample of these morphs with "kaznakovi"-morph. Result demonstrates authenticity of examinated characteristic (Tb-Ta)($d=-2.4$; $t=2.05$; $p<0.05$). Comparison of unite sample with "bronze"-morph didn't give significant distinction ($d=o.96$; $t=1.01$) in this mean.

These data can show high adaptation of Dinnik's vipers thermoregulation with daily and seasonal fluctuations of solar radiation in the high-mountain belts. Snakes tack between critical maximum and minimum of ambient temperature and they can realize behavioral normal stile of life in thermally favorable environment of the Western Caucasus. What is more, apparantely high polymorphism and thermal distincts in investigated population are results of microevolutional development of this comparatively young species since Pleistocene.

Among described morphs there is "kaznakovi"-morph which is most distinct in (Tb-Ta) mean. It may de indirect evidence as of increased heat-loosing as of possible thermal disadvantage of this morph. Anyhow, "kaznakovi"-morph takes minimal place in total volume of specimens. And this is fixed sign for Mzymta-river population. It's interesting to draw attention to specimens of *Vipera dinniki* from lake Kardyvach which were sampleed there by SOBOLEVSKY in 1928 (Collection of Zoological Museum of Moskow State University; No 2767). In that sample there are as all modern morphs as similar ratio of each morph. This fact corroborates long-period existance of these morphs and prosperity of population as whole.

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