Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2016; 4(5): 960-963

Received: 10-07-2016
Accepted: 11-08-2016

Iskenderov TM
Institute of Zoology, Azerbaijan National Academy of Sciences, block 504, passage 1128, Baku Az 1073, Azerbaijan

Javadov SA
Institute of Zoology, Azerbaijan National Academy of Sciences, block 504, passage 1128, Baku Az 1073, Azerbaijan

Correspondence
Iskenderov TM
Institute of Zoology, Azerbaijan National Academy of Sciences, block 504, passage 1128, Baku Az 1073, Azerbaijan

Some aspects of thermobiology of the South Caucasian Gyurza (*Macrovipera Lebetina Obtusa* Dwigubsky, 1832)

Iskenderov TM and Javadov SA

Abstract
In the paper the daily activity, dynamics of body temperature, and features of behavioral thermoregulation of the South Caucasian gyurza are considered. The most preferred environmental temperature conditions (from 27.5 to 31.5 ^{0}C) as well as crucial (from 38.0 to 39.0 ^{0}C) and lethal (from 40.5 to 42.0 ^{0}C) temperature gradients for gyurza are established. Its resistance to extreme hyperthermal impact of sunshine is experimentally investigated.

Keywords: Snake, South Caucasian Gyurza, termoregulatory behavior

1. Introduction
The South Caucasian gyurza, *Macrovipera lebetina obtusa* (Dwigubsky, 1832) is one of widespread and economically important species of herpetofauna in Azerbaijan. It is characterized as heliothermic and xerophilous species which is well adapted for dwelling in semidesert and steppe ecosystems with dry and hot summer climate.
The sun as a natural factor of environment is not only an important source of heat and useful ultraviolet and infrared radiations, but also the factor determining suitability of environment for life activity of reptiles. Sometimes, the sun plays major role in their life being a crucial factor for reptiles, when their natural biotopes are collapsed and snakes stay in open space under direct exposure to sunlight without any protection from overheating. Therefore, the studying daily dynamics of body temperature of gyurza and its thermoregulatory behavior in hot summer months as well as investigation of its resistance to extreme influence of sunshine is of certain interest. Such information is important not only for studying thermobiology of reptiles, but also for resolving of some practical problems related to rearing and cultivation of gyurza in captivity and also development of preventive procedures to ensure the safety of people from snake bites.
There are a lot of scientific publications concerning thermobiology of different species of reptiles [1-6]. However, the thermobiology of gyurza is studied very poorly [7]. Therefore, our goals were: (1) to study the daily dynamics of interaction between body temperature of gyurza and the temperature of its environment, (2) to reveal the most preferred temperature gradients of environment for this snake, and (3) to establish experimentally the degree of its resistance to extreme influence of solar hyperthermia.

2. Material and Methods
Investigation was conducted in summer months (July - August) 2013 in Gobustan area (Central-Eastern Azerbaijan). This area is characterized by sunny, dry and hot summer climate. Body temperature of 35 individuals of gyurza which were found at different times of day (both day and night) in various habitats was measured. Measurement of body temperature was made orally near throat area by means of the electric thermometer TRT-133. At the same time ambient temperatures of places where snakes were captured were measured with the aid of mercury thermometer, including surface temperature of the soil (rock), temperature in shelters at depth of 12-50 cm and temperature of air at height of 2-3 cm above the ground. The types of thermoregulatory behaviors of snakes were recognized according Cherlin's classification [5].
Observations on gyurza individuals were made in the biotopes located along the mudstone river Jeyran-kechmez, which almost completely dries in the summer period.

Deep dry bank Ravines, thickets of *Tamarix* shrubs, dry ditches and old concrete wells, stony or rocky ledges, the empty winter huts and moggies of sheep-breeding farms are the most favorite habitats of gyurza in this semidesert area in summertime, because of abundance of its main prey (mouse-like rodents, lizards, birds, etc.). Observations were made in the morning, in the afternoon, in the evening and at night.

A field experiment was designed in July 2013 to study resistance of the South Caucasian gyurza to extreme hyperthermal influence of sunshine. An open-air wooden cage was constructed in the field covering a site of semidesert with an area of 24 m² (12 m x 2 m). The ground in the open-air cage was abandoned from any vegetation cover. According to the requirements of experiment the open-air cage was without shadow sites and any shelters which could protect snakes from sunshine. Moreover, to achieve the most extreme condition, the experiment was conducted in the hours of the peak of insolation (14:00 – 15:00).

Seven snakes were used in field experiment. They were collected in the same area and had similar level of fatness, but differed in body length (L = 74 - 92 cm) and probably age. The body temperature of snakes was measured every 5 minutes after starting the experiment. Two indexes were measured: oral temperature (t_o) and the temperature of back surface (t_b). At the same time the temperature of soil and temperature of air at height of 2 - 3 cm above the ground were measured in the enclosure.

3. Results and Discussion

In the morning we found 5 individuals of gyurza in various shelters which body temperature ranged from 27.5 to 31.5 ^{0}C. The environmental temperature varied within 27.0 – 33.5^{0}C (Table 1). The minimal temperature was registered in underground shelters (27.0 ^{0}C), while maximal at substrate surface (soil, rocks etc.). Six snakes were observed near enters of their shelters lying on the ground or rocks and heating. Heating by sunshine is the type of behavior necessary for receiving not only heat, but also a certain portion of infrared and ultra-violet radiations. During reception of solar heat snakes took different poses, laying on the ground with completely straight body or curled up in a ball. As a result of heating the body temperature of snakes increased to the level necessary for active moving. The body temperature of the heated specimens was within 30.0 - 32.5 ^{0}C. Some individuals periodically disappeared, and then were found again heating in a different place. Between 10:00 and 11:00 the body temperature of snakes matched the temperature of their environment that was achieved by thermoneutral behavior (TNB). Gyurzas moved between shadow and lightened sites, thereby, maintaining the body temperature at the required level (30.0 - 32.5 ^{0}C). Due to thermoneutral behavior the snakes implemented the basic behavioral activities, including searching for shelters, hunting for prey, resting etc. We also observed three actively moving pregnant females, apparently seeking for shelters for egg laying. As a result of such behavioral activity of some gyurzas their body temperature reached up to 33.0 ^{0}C, which was apparently due to increasing of the rate of internal metabolic energy produced by the motor activity of organism. For this reason, the body temperature of active snakes was 0.5 -1.0 ^{0}C higher than the ambient temperature.

Table 1: Daily changes of environmental temperature and body temperature of gyurza (Macrovipera lebetina obtusa Dw., 1832) in the summer (July) in Gobustan

Types of behavior of gyurza	Time of the day, environmental temperature (a) body temperature of gyurza (b), t^0 C							
	24:00-06-:00		06:00-12:00		14:00-16:00		20:30-24:00	
	a	*b*	a	b	a	b	a	b
Night sleep	28.0-25.5	29.5-27.5						
Heating			25.5-33.5	27.5-32.5				
Cooling					35.5-39.5	32.5-30.5		
TNB *							31.0-28.0	32.0-29.5

*thermoneutral behavior

By midday (14:00-16:00), the environmental temperature greatly increased. The air temperature reached 36.0 – 40.0 ^{0}C, while ground surface was heated by sunlight to 50.0 – 55.0 ^{0}C. To avoid overheating snakes were hiding in diurnal shelters (shallow burrows, under rocks and bushes, cracks in the soil, etc.). In the daytime we found six individuals in burrows, dry concrete well, under rocks and in abandoned houses of farmers and moggies. The environmental temperature in habitats where snakes were captured varied within 27.0 – 32.0 ^{0}C (Table 1). Such thermoregulatory behavior (cooling) protected snakes from overheating by extreme insolation. While being in diurnal shelters (diurnal rest), gyurzas digest food, rest or sleep. Sometimes snakes move from one shelter to another, or to different sites within the same shelter to find a more favorable place for maintaining and stabilizing body temperature at the required level (thermostabilizing behavior - TSB). The body temperature of gyurzas varied between 27.5 and 32.0 ^{0}C depending on the type of their shelters. The minimal body temperatures were recorded in individuals occupying underground burrows, while the maximal temperatures were registered in individuals occupying terrestrial shelters. Snakes, resting inside abandoned sheep moggies, sometimes moved to different parts of the room, choosing the most suitable places for thermoregulation of body temperature.

In the evening and at midnight (20:30-24:00), when the heat declined, the environmental temperature approximated to the level required for the activity of blunt-nosed vipers (Table 1). This led to increase in snake activity. We found 8 individuals which abandoned their diurnal shelters and exhibited thermoneutral behavior (TNB). Thermoneutral behavior included different behavioral responses associated with feeding and communication. And at this time snakes used the wide range of habitats available in their area. Thus, thermoneutral behavior of gyurzas occurs when the temperature condition of environment and the body temperature are within the range that is necessary for the realization of different behavioral responses [5, 6].

Night observations have shown that the activity of gyurzas in the dark hours (22:30-24:00) is reduced. After midnight no one snake was found to be active. All individuals were found in shelters, resting or sleeping. In six measurements made in night shelters of gyurza the temperatures of environment and the body of snakes ranged respectively between 27.0 – 29.0

^{0}C and 28.0 - 30.0 ^{0}C which persisted almost until the morning (Table 1).

Thus, in the hot summer months thermoregulatory behavior allows gyrzas to avoid overheating by sunlight, and using the various cool shelters to maintain the body temperature at the required level (Figure 1). As it is seen from the Fig. 1, the preferred temperature conditions of the environment for the gyurza are within 28.0 – 31.0 ^{0}C. Despite the considerable fluctuations in ambient temperature, behavioral thermoregulation allows gyurzas to maintain body temperature at the level which necessary to perform daily biological activity (feeding, resting, reproduction, etc.).

The experiment conducted in open-air cage has demonstrated that in the case of disturbance of thermoregulatory behavior, the solar hyperthermia can cause a death of gyurza. The experiment allowed us to establish crucial and lethal temperature gradients of resistance in South Caucasian gyurza.

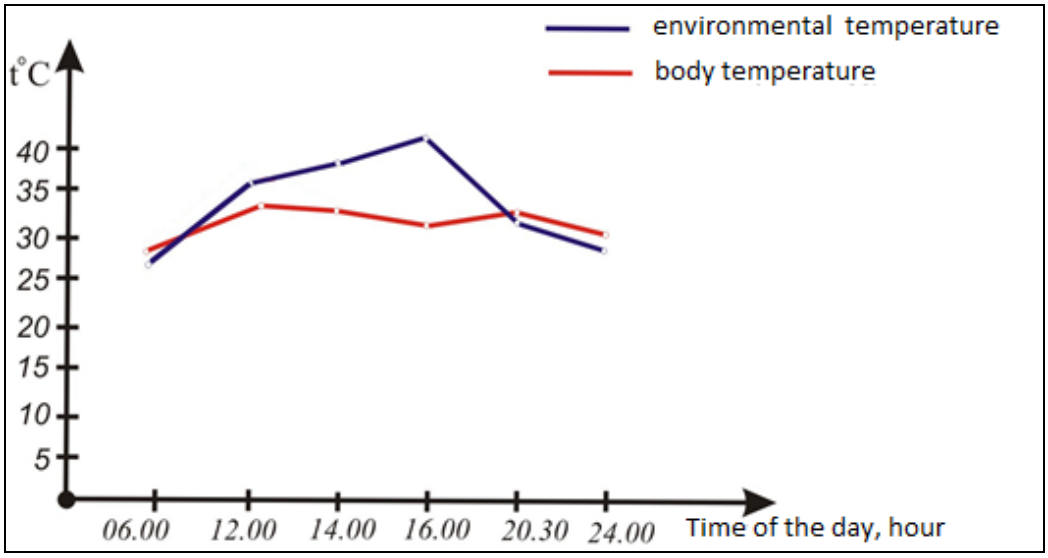

Fig 1: Daily dynamics of environmental temperature and body temperature of gyurza.

Before starting the experiment, the body temperature of individuals varied from 30.0 to 31.5 ^{0}C. The temperature of the air near ground surface in open-air cage was 40.0 ^{0}C. And the temperature of soil surface in the cage reached 50.5 – 55.0 ^{0}C. So, the snakes (7 specimens), released into this enclosure were exposed to hyperthermia from two sources at the same time, the sun rays from the up and hot soil from the down.

From the first moment of the experiment snakes did not show any signs of disturbance and quietly moved within the cage area. Five minutes later the body temperature of snakes (t_o) rose up to 32.0 ^{0}C. Behavior of snakes was still quiet and they moved around the cage, searching for shelters. After next 5 minutes, t_o rose to 35.5 – 36.0 ^{0}C and the temperature of their back (t_b) reached 38.3 – 41.7 ^{0}C. Snakes were actively moving and looking for shelters to protect themselves from hyperthermal influence of sunshine. This was the highest level of body temperature of gyurza, which had no critical consequences. Fifteen minutes after beginning of experiment t_o have reached 38.0 – 39.0 ^{0}C, and t_b increased to 41.7 – 43.4 ^{0}C. At this time the snakes became sluggish, and some of them exhibited uncoordinated movements. Moreover, the response of snakes to hyperthermia was independent of their size. Four individuals which were transferred to shade place and immersed into a cool water bath gradually returned to their normal state. This allows us to estimate the critical level of body temperature of gyurza as being 38.0 – 39.0 ^{0}C (Table 2).

Table 2: Resistance of the South Caucasian gyurza (Macrovipera lebetina obtusa Dw., 1832) to extreme influence of sunshine

Temperature, behavior and state of snakes (10 specimens)	Period of insolation					
	At the beginning of experiment	After 5 minutes	After 10 minutes	After 15 minutes	After 20 minutes	After 25 minutes
-temperature of air near the ground, (t_{n6}) -temperature of soil surface, (t_{nn})	39.5 ^{0}C 58.5 ^{0}C	39.5 ^{0}C 58.6 ^{0}C	39.5 ^{0}C 58.7 ^{0}C	39.5 ^{0}C 58.9 ^{0}C	39.5 ^{0}C 59.1 ^{0}C	39.5 ^{0}C 59.1 ^{0}C
Body temperature of snakes, (t_o)	31.0 - 32.0 ^{0}C	32.8- 33.5 ^{0}C	35.5 - 36.0 ^{0}C	38.0-39.0 ^{0}C	40.5-41.0 ^{0}C	41.5-42.0 ^{0}C
Temperature of the back of snakes, (t_b)	35.5 ^{0}C	36.0^0 - 38.3 ^{0}C	38.3 – 41.7 ^{0}C	41.7- 43.4 ^{0}C	43.4 - 44.5 ^{0}C	44.5 – 45.5 ^{0}C
Behavior and state of snakes	Quiet	Active	Highly active	sluggish	Evidence of thermal shock	Thermal shock with death

Remaining individuals still sustaining hyperthermia continued to move sluggishly, but after 20 – 25 minutes of experiment their t_o reached 40.5 – 42.0 ^{0}C, and t_b 43.0 – 44.0 ^{0}C. At this time snakes almost stopped their movements, crumps took place and then snakes fell in a heat shock. At this state, snakes showed no response to any stimuli and soon died. Thereby, increasing the body temperature up to 40.5 – 42.0 ^{0}C is lethal for gyurza and in our experiment this result was achieved after snakes were exposed to direct insolation during 20 – 25 minutes. The cause of death of gyurza as a result of

hyperthermia, was probably a functional disorder of the central nervous system, which led in turn to disturbance of functioning of other vital organs.

The experiment has shown that hyperthermia, caused by extreme influence of insolation, during first 15 minutes leads to some impairment of state of snakes (weakness, slackness, cramp). Further enhancement of hyperthermia results in thermal shock and finally results in a death. It was revealed that placement of snakes to cool environment at early stages of hyperthermia will allow to avoid a lethal outcome. However, such actions will be ineffective at the later stages which lead to thermal shock and death.

For adaptation to the life in hot arid ecosystems, gyurza and other local species of reptiles have evolved corresponding thermoprotective and thermoregulatory modes of behavior. Depending on micro-climatical conditions of a habitat each species and even subspecies [8] is adapted for the concrete optimum temperature range of the external environment, with concrete upper and lower limits. Of course, the microclimatic parameters of each biotope changes depending on the season of the year. Therefore, in future it is necessary to investigate dynamics of changes of daily activity of snakes and temperatures corresponding to these activities and optimal range in annual cycle of vital activity of *M. l. obtusa*, for every season separately.

The realization of thermoregulatory behaviours by snakes is enabled not only due to physiological mechanisms of an organism, but also requires the presence of some external relief components (various natural or unnatural shelters). Using these shelters snakes perform various forms of thermal protective ("cooling", "night sleeping", etc.) that allow them to avoid overheating. Therefore, the habitats which do not provide conditions that allow the snakes to realize necessary thermoregulatory and thermoprotective behavior are not favorable for them and gyurza do not inhabit these areas.

The factor of presence of the respective shelters in the territory of snakes is important not only for providing temperature-controlled behavior of gyurza, but, besides other vital factors (food, self-defenses, etc.) in general define suitability of this site (biotope) for dwelling of individuals and it is one of the reasons for attachment of snakes to the concrete territory (homing).

In summer time, the South Caucasian gyurza, as well as other species of snakes which live in hot semidesert habitats are active only at night and in the morning time. Despite significant fluctuations of ambient temperature, they maintain the body temperature at normal level, due to their highly evolved thermoregulatory behavior. Snakes abandon areas, lacking different kinds of shelters which are needed for protection from insolation.

4. Conclusion

The most preferred environmental temperature of South Caucasian ranges from 27.5 to 31.5 ^{0}C. The optimal body temperature in daily active snakes is within 28.5 – 32.0 ^{0}C. Due to internal metabolic energy the body temperature of gyurza individuals is 0.5 - 1.0 ^{0}C higher, than the temperature of their environment. It is established that extreme hyperthermal influence of sunshine for 20 - 25 minutes is lethal for the South Caucasian gyurza. The highest body temperatures, which it sustains without harm to organism are within 35.5 – 36.0 ^{0}C, while the temperatures from 38.0 to 39.0 ^{0}C are critical for survival. The body temperatures from 40.5 to 42.0 ^{0}C are fatal. The habitats which do not provide conditions that allow the snakes to realize necessary thermoregulatory and thermal protective behavior are not favorable for them and gyurza do not inhabit these areas.

5. References

1. Grazhdankin AV. Reactions of reptiles of arid territories to high temperatures and insolation. Zoologicheskiy Zhurnal, 1973; 52(4):552-560.
2. Litvinov NA. Body temperature and microclimatic conditions of habitats of reptiles of the Volga basin. Zoologicheskiy Zhurnal, 2008; 87(1):62-74.
3. Litvinov NA, Ganshchuk SV. Termobiology of snakes of Volga-Kama area. Snakes of Eastern Europe, Materials of international conference, Tolyatti, 2003, 50-53.
4. Cherlin VA, Muzychenko IV. The role of burrows in thermoregulation of reptiles. - Applied ethology. Proceedings of the 3rd all-Union conference on animal behavior, Moscow, Nauka, 1983; 3:172-174.
5. Cherlin VA. The ways of adaptation of reptiles to temperature conditions of the environment. Zhurnal Obshchestva Biologov 1983; 44(6):753-764.
6. Cherlin VA. Termobiology of reptiles. General information and research (management). Russian-Baltic Information Centre BLIT Publisher, St.-Petersburg, 2010, 1-124.
7. Sharifov FK. On the daily activity of gyurza in Shirvan steppe of Azerbaijan SSR. Poisonous animals of Central Asia and their poisons. Proceedings of Central Asian conference. Academy of Sciences of Uzbekistan, Tashkent, 1970, 88-90.
8. Cherlin VA, Shepilov SA. Thermal biology of the Central Asian gyurza (*Macrovipera lebetina turanica*) of the Nuratau range and the black gyurza (*Macrovipera lebetina cernovi*) Western Kyzylkum // Zoologicheskiy Zhurnal, 2014; 93(2):242-247.