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Full Length Research Paper

The influence of body temperature on sprint speed and anti-predatory defensive responses of the North African monitor lizard, *Varanus griseus*

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The running speed of the North African monitor lizard, *Varanus griseus* is directly proportional to its body temperature of between 21 and 37°C. Above 37°C, sprint speed does not increase. However, below 21°C, the lizards are extremely sluggish. If pursued at this lowered body temperature the animal finds it difficult to escape and so stays behind and tries to fight the predator. The degree of aggressiveness increases as body temperature is further reduced. This monitor lives in the savanna regions of northern Nigeria where the vegetation is low and hiding places are rare. The lizard might have evolved this anti-predatory mechanism at low body temperatures as its last resort to survive since there is no place to take refuge in a bare area when the predator emerges.

Key words: Body temperature, sprint speed, anti-predatory mechanisms.

INTRODUCTION

Anti-predatory mechanisms in animals include aposematic colouration (as in many insect species, Brower and Brower, 1964), rump patch signals (as in many mammalian species, Smythe, 1970), alarm calls (as in many birds and mammals, Charnov and Krebs, 1975; Dunford, 1977) mobbing of a predator (as in many vertebrate and invertebrate species Andrew, 1961), distraction displays (as in many birds, Armstrong, 1947), death feigns (Edmunds, 1974), flight (Kruuk, 1964), aggressive group defence (Mech, 1970) and so on. The ecological, circumstances facing an animal and its physiological state may often determine how effective each of these mechanisms could be. For instance the usefulness of running away is dependent on the ability to outrun the predator (Kruuk, 1964).

In the case of lizards, body temperature is an important physiological variable that affects their general activities (Huey, 1982; Garland and Kelly, 2006). Cold body temperatures usually make a lizard to be slow in movements and inactive (Hertz et al., 1982, Toro et al., 2003). If, at this time, it comes to hunt for food, the tendency that a predator would catch it is high. More often than not, a lizard at low body temperature is unable to receive fast information through its sense organs (Anderson, 1963; Inoue et al., 2001). Also, cold temperature reduces its olfactory sense so that the animal may not be able to detect easily the smell of a nearby predator or prey (Kruuk, 1964). The lizard is usually not successful in catching nor detecting prey (especially those that are sedentary) that would ordinarily be detected at higher body temperatures (Huey, 1982).

A lizard that is not fully active due to low body temperature may be unable to escape from predators by running. For those that excavate tunnels it takes much longer time than would be expected at higher body temperatures (Hardy, 1962). The behaviour of a lizard therefore largely depends on the attainment of a certain range of temperature at which a type of activity can take place (Hardy, 1962). This means that there are threshold values for emergence from burrows, seeking food and so on (Hardy, 1962; Aranyosi and Freeman, 2004). Other kinds of behaviour such as basking, seeking shelter, 'awakening behaviour' as in racerunners, *Cnemidophorus sexlineatus* (Hardy, 1962), etc are employed when the animal's body temperature goes below or above the threshold value. Aggression and social dominance are usually observed at the peak of their daily body temperatures (Hardy, 1962; Fogel, 2003).

Many workers such as Anderson (1963), Heatwole (1970) and Hertz et al. (1982) have suggested the influence of physiological variables on defensive responses of poikilotherms. Gans and Mendelssohn (1972) reported

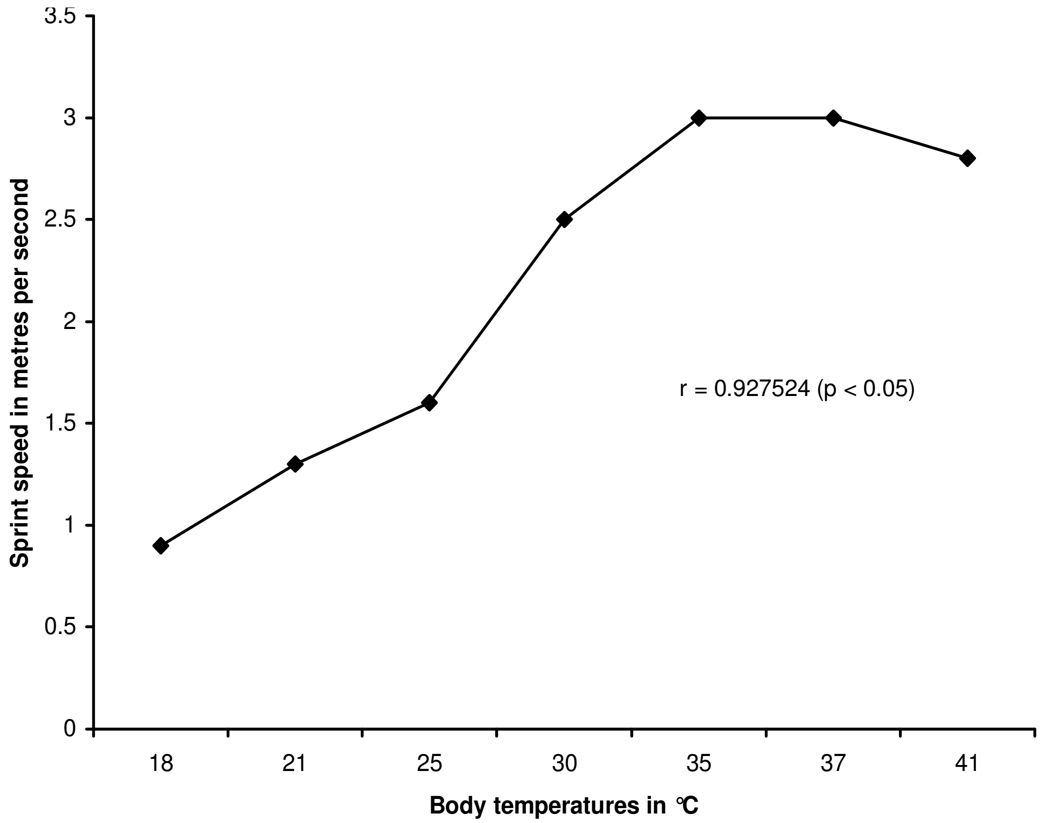

Figure 1. Sprint speed of *Varanus griseus* at various body temperatures.

that the defensive behaviour of horned vipers, *Bitis caudalis* appeared to vary with body temperature.

Rand (1964) maintained that temperature determined the distance the iguanid lizard, *Anolis lineatopus* could run. Degree of fatigue is also thought to influence defensive behaviour of some water snakes, *Natrix sipedon* (Pough, 1978).

This study is focused on a species of monitor lizard, *Varanus griseus* which is found in Northern parts of Nigeria especially in the savanna areas. Very little or no work has been done on the behavioural ecology of African lizards; the paper therefore attempts to determine precisely the influence of body temperature on anti-predatory defence strategies of this North African monitor lizard, *V. griseus*.

MATERIALS AND METHODS

Twelve monitor lizards, *V. griseus* were collected from Maiduguri in Bornu State, Nigeria and brought into Zoology Departmental laboratory of Abia State University, Uturu - Nigeria. They were kept in three rectangular lizard cages (1.0 x 1.0 x 1.0 m) which had a wooden base while the other sides were covered with wire gauze of 0.5 cm in diameter. The stocking rate was four specimens per cage and they were provided daily with drinking water and some food such as millipedes, crickets, snails, grasshoppers, beetles, butterflies and moths.

Their speed of running was determined in a racetrack which was 8 m long and 1 m wide. This racetrack was provided with sand and gravel for excellent traction by following the method of Hertz et al. (1982). Speed of running was determined over a distance of 3 m section of the racetrack (which was located around the centre), since it was apparent that they could not be forced to maintain maximum speeds consistently for the entire 8 m length of the racetrack. The time it took a given lizard to run a distance of 3 m was recorded with a stopwatch. At the other end of the racetrack a pitfall trap (1 m deep) was constructed. Thus it seemed the lizard might had viewed the end of the racetrack as an escape route and was chased to force it attain its maximum speed. When it fell into the trap it was immediately recaptured.

The following temperatures were chosen randomly for each lizard: 35, 37, 25, 18, 41, 30 and 21°C, one temperature for each lizard for a day and three trials per temperature for every lizard. When all the lizards must had been tried at least thrice for each temperature, the above experimental set up was replicated.

The degree aggressiveness was also monitored by recording the rate of tongue flicking (while the mouth of each lizard was opened) at various temperatures: 12, 15, 9 and 18°C.

RESULTS

Maximum sprint speeds for *V. griseus* was directly correlated with body temperature with a Coefficient of linear correlation ($r = 0.927524$, $P < 0.05$) (Figure 1). The running speed was slightly low at temperatures higher than 37°C.

At low body temperatures usually below 21°C these

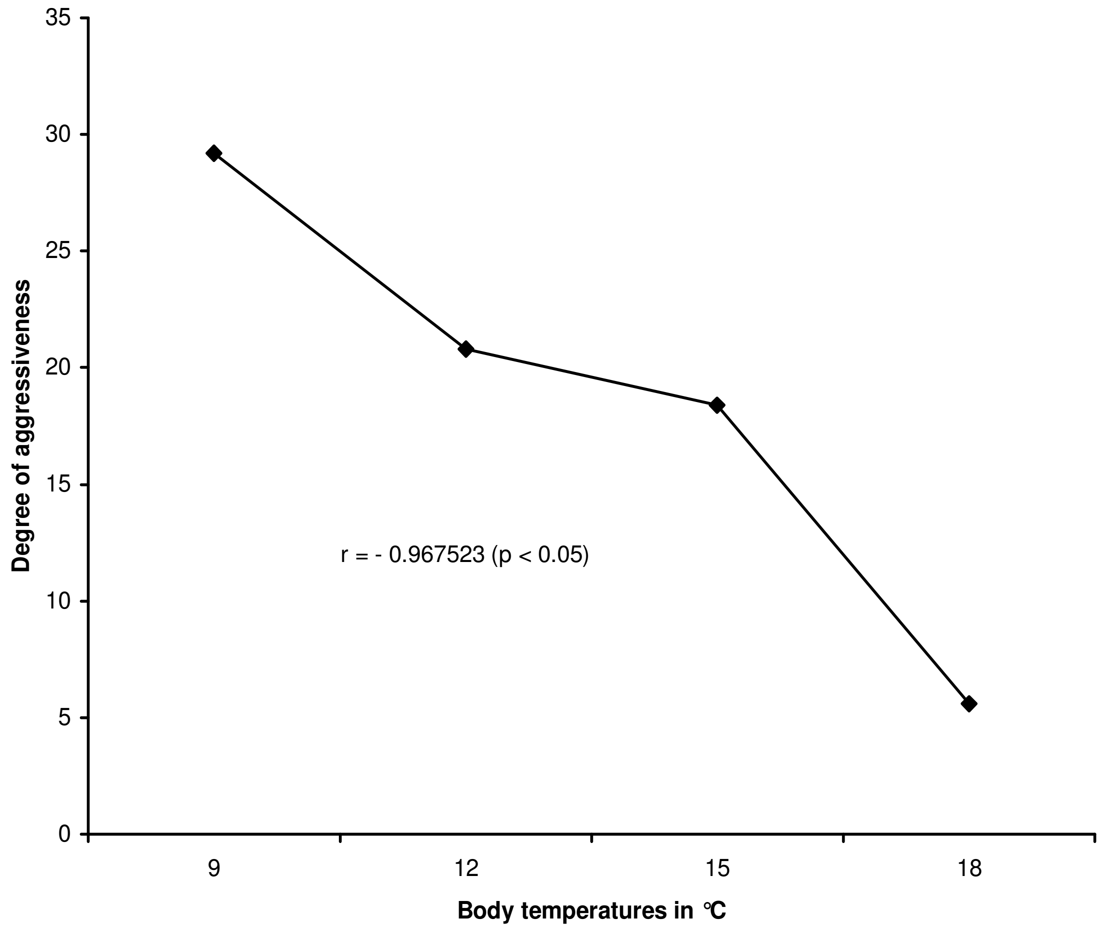

Figure 2. The degree of aggressiveness at various body temperatures *of Varanus griseus* .

lizards did not run at all and if provoked, usually adopted defensive behaviours. The lizard displayed a characteristic threat posture with the body raised slightly and the head elevated. If provoked further, it raised the body higher in the arched-back posture accompanied by loud hissing, inflation of the throat and neck, opening of the mouth very widely and rapid tongue flicking. Sometimes rapid tail vibrations might follow.

Regression analysis showed a negative linear correlation between degree of aggressiveness and body temperature ($r = - 0.967523$, $P < 0.05$) (Figure 2).

DISCUSSION

Temperature is an important ecological factor that influences the physiological state of most poikilotherms (Huey and Slatkin, 1976; Bartholomew, 1977; Okafor, 2004, 2007). This is manifested in the slow response of the monitor lizard, *V. griseus* at lower body temperatures. At higher body temperatures they increase their running speed, so these lizards can easily escape from their potential predators such as different species of snakes like the python, wild mammals and also man. At very low body temperatures, the running speed is considerably reduced, so instead of running which of course would not be of any value to them since this would facilitate their capture, hold their ground and become aggressive and the degree of aggressiveness in inversely proportional to body temperature. Similar types of behaviour have been recorded for many species of lizards (Anderson, 1963; Tracy, 1978; Bennet, 1980; Hertz et al., 1982; Huey, 1982, Eneje, 2008).

V. griseus naturally inhabits open or bare areas where the vegetation is low or sparse, with few large rocks and other refuge objects which can provide good hiding places when the predator is around. This is the type of habitat that exists in northern parts of Nigeria where they are usually found in greater numbers. However, this animal can run fast enough if the temperature is high and successfully escape from their predators, but, when the temperature is low which would make running sluggish and escape difficult, the only alternative left to this animal in order to stay alive is to stay there and fight the predator as much as it can until it dies. That the aggression could be very dangerous is shown by the display of opening its mouth very widely and rapid flicking of its tongue when provoked, at this low body temp so as to inflict an exceptionally painful bite on the predator.

The effect of body temperature on enzymatic reactions that occur in the body has been documented (Fusari, 1984). For instance, a 10°C rise in body temperature is accompanied by almost a double increase in the rate of enzymic reaction (White et al., 1968). At body temperatures above the animal's mean temperature, the reaction ceases altogether (White et al., 1968). This is because enzymes are proteins and high temperatures denature them. Organisms living in situations where the temperature exceeds 45°C either have heat resistant enzymes or are capable of regulating their body temperatures (Fusari, 1984). Temperature also affects nerve transmission in that if the temperature is lowered, synaptic delay increases and this therefore slows the passage of impulse (Kuffler and Nicholls, 1976). The relationships between varied physiological state of an animal and the defensive responses have not been well studied (Mutchiri et al., 2008).

In conclusion, this study and the results of previous similar studies clearly indicate that different physiological variables (such as low body temperature, injury, illness, deformity, fatigue, pregnancy, pain etc.) that reduce sprint speed may consequently induce aggressive reactions in some poikilotherms. Laboratory and field studies of defensive responses of animals should also be geared toward understanding the importance of the physiological state of that animal.

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