

Effect of Temperature and Water Deprivation on Body Temperature in Idmi Gazelle, *Gazella gazella*

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Abstract: Effect of air temperature and water deprivation on body temperature was studied in captive-bred Idmi Gazelle, *Gazella gazella*, during winter and summer. Air temperature ranged from a minimum of 3 °C to a maximum of 19 °C in winter, and from 26 °C to 44 °C in summer. Body temperature did not vary greatly during winter and summer when water was available. In summer, a significant increase in body temperature was recorded apparently because of reduction of evaporation and the accompanied dehydration. Animals were able to withstand water deprivation for 8 days in winter and 3 days in summer. The results indicate that the species might withstand dehydration for relatively long periods in its natural habitat.

Key Words: arabia, Idmi gazelle, *Gazella gazella*, body temperature, water deprivation, hydration, dehydration, rehydration.

Introduction

Desert animals and large mammals in particular face many deterring problems. The most important of these are the high ambient temperature, scarcity of water supply in addition to high solar radiation (Louw and Seely, 1982; Grenot, 1992). Most of the Arabian Peninsula is dry and arid desert, with great variation in atmospheric temperature (Williamson and Delima, 1990). It is necessary for the animals

living therein to be able to cope with the extremes.

Little is known about the ecophysiology of most animals inhabiting arid environments, and less is known about the mammals of the Arabian Peninsula, especially the Arabian gazelles. Most previous studies dealt with different patterns of behaviour. Williamson and Delima (1990) studied water intake of Arabian gazelles, and Tatwany and Goldspink

(1996) reported on the behavioral response of Idmi to changes in dietary water.

The aim of this study was to understand some of the ecological adaptations of *Gazella gazella* Pallas 1766 to the harsh conditions of arid environment. Intense heat and water scarcity are prevailing factors in desert land, and the survival of desert animals depend on how long they cope with it. This study tries to answer the question of how long could the Idmi stay without water during winter and summer. This information could be helpful for successful reintroduction of this species into the wild.

Materials and Methods

The study was carried out at King Khalid Wildlife Research Center (KKWRC), Thumamah (75 km north of Riyadh). Five adult males of Idmi gazelle were selected for this study. Their ages were about 1-2 years and their weights ranged between 17 and 21 kg. Animals were medically checked by veterinarians and housed into five different stables, (3 x 4 m each) with good light and aeration.

The effect of air temperature and water deprivation on body temperature of the gazelles was monitored over three

phases. Starting phase (hydration), gazelles were fed and watered *ad lib* for 5 days during winter and summer, then they were unwatered for 8 days during winter (January) and for 3 days in summer (July) (dehydration phase), after which animals showed signs of weakness. At that point animals were rehydrated for 24 hours during both seasons.

Radio Telemetry System (RTS) was used as described by Williamson *et al.* (1992). Briefly, the system is made up of a radio receiver, a pulse interval timer (accurate to 1 millisecond) and a miniaturized wax-coated transmitter which sends out pulses separated by intervals that vary directly proportional with temperature. The transmitters were calibrated by immersing them in a laboratory water-bath, in which the temperature was varied so that a linear regression could be plotted, with temperature as the independent variable and pulse interval as the dependent variable. Using this relationship, temperature could be calculated from pulse interval to an accuracy of 0.1 °C.

After calibration, transmitters were inserted surgically into the abdominal cavity of each gazelle. Thus, within half an hour after the operation the trans-

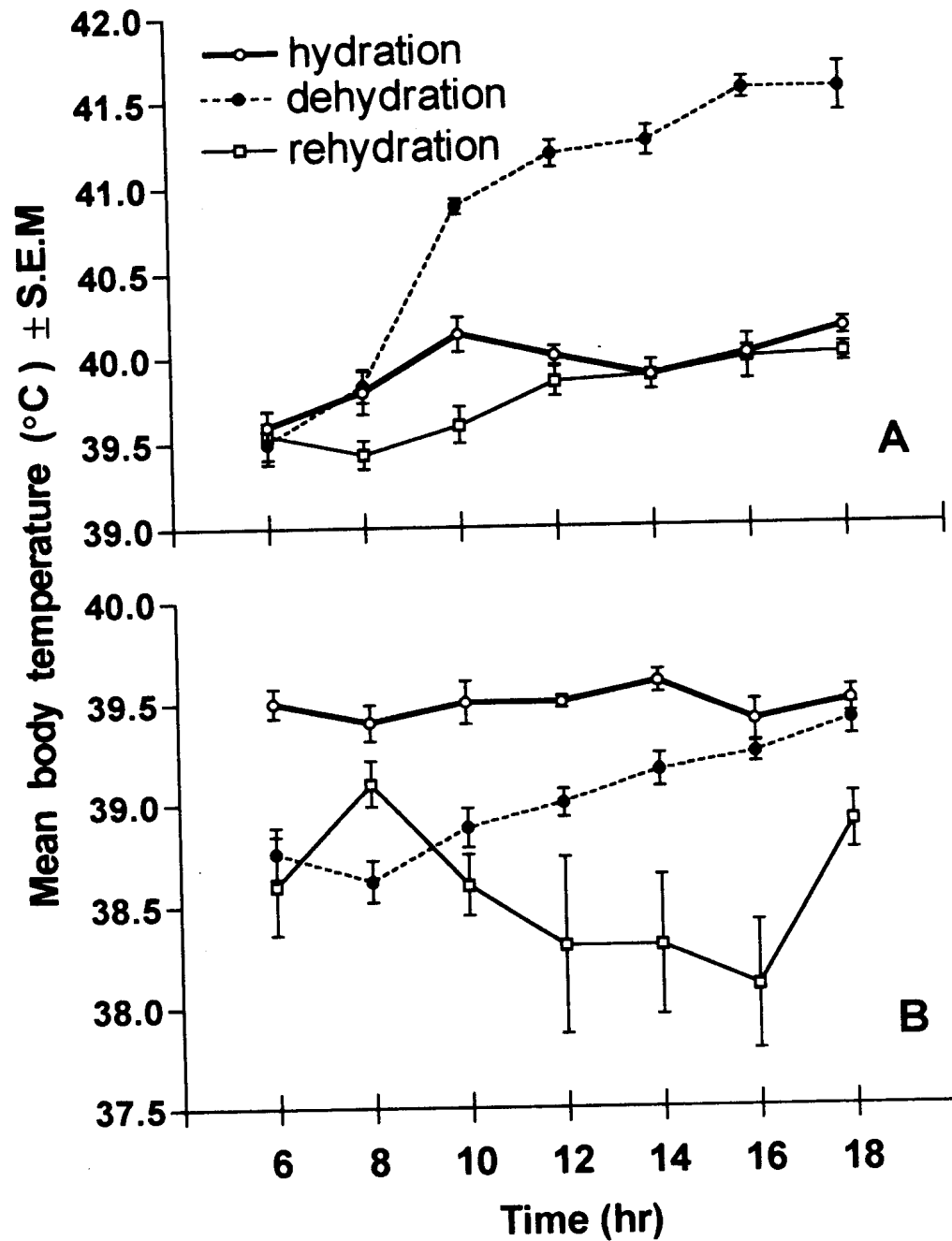


Fig. 1. Variations in mean body temperature of gazelles during the three phases of experiment in summer (A) and winter (B).

mitter started to function and measurements were made. Gazelles were observed and followed-up for four weeks till complete recovery.

Body temperature of all animals was recorded once every 2 hours from 0600 to 1800 hrs both during summer and winter. These readings were taken daily during the three phases of experiment (hydration, deprivation and rehydration).

Statistical analysis was done using Minitab package. Analysis of variance (ANOVA) and Covariance (COVA) were used for comparing the results of the three phases during the two seasons.

Results

Winter

Air temperature ranged from a low of 3-8 °C to a high of 11-19 °C. The relative humidity was high (61-97%) in the early hours of the morning, and low (35-54%) later in the day over the duration of the experiment in winter. In such conditions and with the presence of water, no wide range of difference had been observed in the body temperature (> 0.2 °C). Mean body temperature ranged between 39.4 °C and 39.6 °C. When gazelles were deprived of water, a slight drop of their body temperature

was noticed in early morning, then gradually raised to its normal level. Mean body temperature ranged between 38.6 °C to 39.4 °C during this phase. However; a significant difference of 1.3 °C ($P < 0.05$) was noticed when these animals were given enough water after dehydration (Fig.1A). Body temperature decreased to 38.3 °C after 2 hours of rehydration. This decrease in body temperature continued to its maximum at 1400 hr, then gradually raised to reach their normal level of body temperature, 10 hours after rehydration.

Summer

The atmospheric temperature ranged from a minimum of 26-28 °C to a maximum of 42-44 °C. The relative humidity was 38-40% in the early hours of the day, and was as low as 20-30% in the late hours of the day. In these conditions and when water was available, there was no significant variation in gazelle's body temperature (> 0.5 °C); the body temperature ranged between 39.6 °C at 0600 hr and 40.1 °C at 1800 hr. However; when these animals were dehydrated for three consecutive days, a significant variation ($P < 0.01$) was noticed (2.1 °C) during the day. The lowest animal body

temperature (39.5 °C) was recorded in the morning between 0600-0800 hrs, and the highest (41.6 °C) was in the afternoon (1600-1800 hrs) (Fig. 1B).

When animals were rehydrated, their body temperature dropped slightly (0.1°C), then rose within two hours to follow the same pattern as before dehydration. With availability of water, the animal body temperature did not vary significantly ($P=0.912$) during winter and summer. The variation was 0.2 °C in the morning and 0.7 °C in the late afternoon..

The difference in body temperature was significant in case of the dehydrated group ($P\geq 0.01$). The temperature variation was 1.1 °C in the early hours of the morning and was upto 2.4 °C in the late hours of the day. The variation was insignificant ($P=0.422$) after rehydration of the animals during the two seasons.

Discussion

When water was available, body temperature of all gazelles did not show any differences during winter or summer. Animals maintained their body temperature around its normal level in spite of high summer temperature of 44 °C. Furthermore, the gazelle body

temperature did not vary greatly during the same summer period when water was available.

Water deprivation during summer affected gazelles very greatly, they could only withstand three days, after which all animals were very weak, drowsy and emaciated. In addition, a degree of eyeball retraction and skin turgor was noticed. Similar conditions were reported by Gary *et al.* (1979) on horses, and by Mohamed (1986) on Dorcas gazelle during their studies on the effect of dehydration in summer. High air temperature during summer affect gazelles body temperature, and hence body water balance due to evaporation (Ghobrial, 1967, 1970; Ghobrial and Cloudsley-Thompson, 1966; Taylor, 1972). The rate of evaporation is correlated to animal's temperature (Ghobrial, 1974; Taylor, 1972). Williamson and Delima (1990) found out that evaporation of water increased exponentially as temperature increased in Idmi and Rheem gazelles under similar conditions. They attributed that to the onset of evaporative cooling when air temperature was high.

Low air temperature during winter enhanced gazelles endurance to withstand water deprivation upto 8 days.

Food moisture content might prolong the period of endurance. Food preference could be an important factor in controlling water-temperature relation in the animal body. Williamson and Delima (1990) explained the significant free water consumption of Rheem compared to Idmi to the higher quantity of grain in the Rheem diet. Idmi were found to take more forage which contain higher water content.

During winter dehydration, the animals did not show significance of variation in the body temperature, as the difference was only 0.8 °C. Thus, the animals did not allow for much decrease in their body temperature, although the air temperature was low. This is probably because the animals tend to take more food (while dehydration), in addition to using their own body fat to produce excess heat energy to counter the drop of the air temperature, and succeed to keep a steady body temperature (Tietz, 1987).

The opposite situation occurred when the animals were dehydrated in summer as they allowed for greater variation in their body temperature (2.1 °C) during the day. A directly proportional relationship was noticed between the air

temperature and the animal body temperature during the last periods of dehydration. This was observed when the lowest body temperature was 39.5 °C and the air temperature was 28 °C. The highest recorded body temperature was 41.6 °C when the air temperature was 41 °C at 4-6 pm. It could be explained that this variation in body temperature was accomplished as the animals attempt to reduce evaporation through respiration and sweating at high body and air temperature during the day. Similar results were obtained by Ghobrial (1970) on Afri gazelle, and Taylor (1970a) on Thompson's and Grant's gazelles. When the air temperature started to drop in the afternoon and night, the animals dissipate their body heat to the environment to reach the lowest possible body temperature without much loss of body water through respiration and sweating. These gazelles by so doing resemble very closely other desert mammals (Ghobrial, 1974; Taylor, 1970a, 1970b, 1972; Williamson *et al.*, 1992). Zari and Al-Hazmi (1993) reported that the variations of the rectal temperature of the Arabian camel may exceed 5 °C during summer days.

When the animals were rehydrated in winter, a drop of 1.3 °C in their body temperature was recorded. This could be attributed to the fact that these animals took an ample amount of water (1099 ml/2h), and water temperature was about 4 °C. This situation might have lowered their body temperature for a period of 4 hours. After 10 hours of rehydration, animals body temperature returned to normal. The case was different when these animals were rehydrated during summer as there was no drop of body temperature. Water temperature was about 29 °C and hence did not affect the animal body temperature.

The results obtained in this study, and other reports on desert gazelles showing the reaction of these captive-bred Idmi to water deprivation during winter and summer, indicate that these animals could meet their requirements by efficient exploitation of available resources in their habitat. There is a great need of similar studies on wild-born generations of Idmi to determine how long they could withstand high desert temperature, and how they maintain body temperature around its normal range.

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أثر الحرارة والتعطيش على درجة حرارة جسم
غزال الإدمي *Gazella gazella*

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الملخص : تمت دراسة أثر درجة حرارة الجو والتعطيش على درجة حرارة جسم غزال الأدمي المرباة في الأسر خلال فصل الشتاء وفصل الصيف. وقد تراوحت درجة حرارة الجو ما بين ٣ إلى ٩ °م خلال فصل الشتاء ، و ٢٦ - ٤٤ °م خلال فصل الصيف . لم تكن هناك اختلافات واضحة في درجة حرارة جسم الغزال خلال الصيف أو الشتاء عندما كان الماء متوفراً، بينما ظهرت زيادة واضحة في درجة حرارة الجسم خلال الصيف بسبب انخفاض التبخير والتعطيش . كما وجد أن الغزال يمكن أن يتحمل العطش لفترة ثمانية أيام خلال الشتاء وثلاثة أيام خلال الصيف ، ومن المحتمل أن يتحمل الحيوان فترة أطول في بيئته الطبيعية .