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PHYSIOLOGICAL AND MORPHOLOGICAL ADAPTATION OF ANIMALS IN THE DESERT

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Desert is marked by long dry season with little precipitation. During summer in hot deserts, the daytime temperature may exceed 45 °C (113 °F), and during winter night time, the temperature comes below freezing point. Plants and animals living in the desert need a special adaptation for surviving in this harsh climate. According, the amount of particles in the vegetation increases, which is most difficult for small mammals, such as rodents, which rely on this source for their metabolic water for this climate. Excluding breeding season, respiration, urine, faeces and thermoregulatory process such as sweating and evaporative cooling are the main physiological pathway for water loss in small rodents. Therefore, increasing of urine concentration and reducing the volume of urine are important adaptations (Palgi & Haim 2003; Shanas & Haim 2004). Rodents present in the desert, have reduced their resting metabolic rate (RMR) values than their body mass as per allometric equations (Kleiber & Rogers 1961). This decreasing value is an important adaptation to xeric environments as it allows decreasing heat production on the one hand and conservation of water for thermoregulatory purposes on the other (McNab 1968; Haim & Izhaki 1993).

Desert animals mostly deal with two main adaptations, firstly how to deal with lack of water and secondly how to deal with extremes in temperature. Most desert animals get their water from the food they consume, succulent plants, seeds, or their prey’s blood and body tissue, because of water scarcity. Desert animals, who adapted to live in harsh climate are called xerocoles. Animals face challenges for surviving in the desert environment. Most of the animals behave as a nocturnal, means they sleep during the day in burrows or tunnel under the ground to stay cool and come out during night time, for example, gerbil, jerboa, and kangaroo rat. They rarely need to drink and consume water from the food, which is also known as metabolic water.

Volume 3 – Issue 1
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Thermoregulation

For mammals, homeostasis of body temperature is important for the survival of life. When the ambient temperature is increased, decreasing the internal heat production is essential, either by decreasing generation of internal heat production, or increasing activity of the heat dissipation mechanisms. If the high ambient temperature is continuous, as in the desert during summer, acclimation to heat occurs in animals. This low value is an important adaptation to xeric environments as it allows decreasing heat production on the one hand and conservation of water for thermoregulatory purposes on the other (McNab 1968; Haim & Izhaki 1993). The process of heat acclimation, studied in rats and mice in the laboratory, under conditions of chronic exposure to an ambient temperature at the upper limit of the thermoneutral zone, comprises two distinct phases: (i) short-term heat acclimation, after 2 days; and (ii) long-term heat acclimation, after at least 30 days of exposure to the same conditions (Horowitz 2002). This process ends with reorganization at the level of gene and protein expression, as was discovered in the hypothalamus: the thermoregulatory centre (Schwimmer et al. 2006).

Vasopressin

One of the physiological responses to water restriction and reservation is releasing the hormone Vasopressin (VP) from the pituitary. Vasopressin is an antidiuretic hormone, produced from the cell bodies of the magnocellular neurons of the supra-optic and paraventricular nuclei in the hypothalamus. It is released to the bloodstream from the neural pituitary gland and acts on the kidney glomeruli and contraction of this arterioles helps in reabsorbing of water from the collecting ducts. This direct action of VP in the kidney glomeruli leads to a lowering of plasma filtration and prevents water loss from the vascular compartments to the urine. It also acts on the thermoregulatory responses, as central administration of VP elicits hypothermia, maybe by affecting the metabolic rate as well as peripheral blood vessels vasodilation (Nelson 2005).

Melatonin

Melatonin is the main secretory product of the pineal gland. Pineal melatonin production occurs during the night time and is suppressed by the presence of light. The effects of plasma melatonin are to exhibit a circadian rhythm, with high levels at night and

Volume 3 – Issue 1
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www.agriallis.com

low levels during the day. Longer nights are correlated with a longer period of secretion of melatonin (Cardinali & Pevet 1998). As melatonin is quickly cleared from the circulation following the cessation of its production, the time and duration of melatonin peak reflect the environmental night period (Cardinali & Pevet 1998; Pandi- Perumal et al. 2006). In mammals, melatonin has a various critical role like physiological neuroendocrine and reproductive functions. Melatonin also regulates the reproductive function of seasonal breeding mammals through its inhibitory action at various levels of the hypothalamic–pituitary–gonadal axis. It has been shown that melatonin suppresses GnRH gene expression in an exponential pattern over a span of 24 hours (Roy & Belsham 2002). Melatonin plays a crucial role in the synchronisation of xeric adaptation in particular species and different populations.

Adaptation of desert animals

Camel: The camel is well adapted in the harsh desert environment. It is able to withstand the extreme heat, sparse vegetation, and scarcity of water in desert condition. Its special adaptation includes:

1. Long eyelashes, thin and lit nostrils that can close, which will protect them from blowing sand.
2. Translucent eyelids that will help them to see relatively well.
3. Thick far and wool helps them to withstand cold desert night and provide insulation during day time.
4. Camel hill like hump used for storing fat, not water, they can survive many days without food.
5. Have hard and tough lips for picking up dry and hard vegetation.
6. Can drink up to 30% of its body weight (200 litters in 3 minutes).
7. They have extremely long intestine (colon) for reabsorbing water, and they rarely sweat.
8. Concentrated urine for preventing water loss as much as possible.
9. They have long padded feet that will help them for traveling over soft desert sands and to protect from the heat of the sand.
10. Long strong legs for carrying load on back and for keeping body further away from the sand.

11. A hard flat layer of skin around the stomach and thick leathery patches on knee, protects them from extreme heat while resting on sand.

Fennec fox: This is the smallest of all fox species and are found in the Sahara Desert and elsewhere in North Africa. They are nocturnal which helps them deal with the heat of the desert environment. Some physical adaptations are:

1. They have thick fur and feet for protecting from the heat of sand.
2. Large ear for insulation.
3. Thick and light colour hair coat for protecting cold and provide insulation during daytime.

Conclusion

Desert adaptation impairs physical & mental performance. The key to the survival in hot, dry environment consists in avoiding climatic extremes as far as possible, by a combination of seeking refuge from the most adverse conditions, morphological adaptations, behaviour and specialized physiology. In desert, physiological and morphological adaptation are elongated body shape, water conserving capacity with vasopressin hormone, long legs, ears, thin skin and light skin colour. The exploitation of desert habitat involves a vast complex of adaptation compromises between physiological factors like thermoregulation, water conservation through VP hormone and melanin function etc. Thermal reactions are primarily behavioural; adaptation responses to aridity are mostly physiological. Thus desert adaptation mainly relays upon conservation of water, ability to withstand and protect themselves from the extreme temperature changes.

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Volume 3 – Issue 1
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