Adaptations of arctic mammals

The morphological, physiological, and behavioural adaptations of species of arctic mammals.

The Arctic is found in the northern hemisphere surrounding the north pole of the earth, due to its positioning on the earth it experiences extreme light and temperature conditions throughout the year. The temperature can get as low as -50°C and yearly there is a 67 day long period of darkness and a 84 day long period of light (NWF. ORG). The land mass is made completely of ice and snow and any animal which resides there must be adapted to such extremities in order to survive. The main challenges are extensive heat loss due to low temperatures and finding enough food where it is often scarce (Prestrud 1991). In this essay I plan to look at mammals which live in the Arctic such as the Polar bear and the Arctic fox, to analyse the morphological, physiological and behavioural adaptations they have developed to survive in the arctic environments.

The arctic fox (*Alopex lagopus*) is circumpolar in all arctic tundra habitats near sea shore or on sea ice even on many of the surrounding islands (Macdonald 2010). Due to such harsh environments the arctic fox must reduce heat dissipation in order to survive, which it does by changing its conductance and the temperature difference between the internal and external environment. This can be achieved by both Physiological and behavioural mechanisms (Scholander et al. 1950). Firstly the fur enables the foxes to keep a seasonally constant rate of heat loss as it grows and thickens in winter months, it is also noted that the skin temperature drops slightly in these months, this is thought to be a result of vasoconstriction of the arterioles under the surface of the skin (Underwood 1971). Underwood further found that the increase in fur depth was almost 200% and differed on the different areas of the fox, those areas which were in contact with the snow most when walking or lying down increased the most (underwood and Reynolds 1980). The great insulating properties of the arctic foxes fur are shown in that a fox with a body temperature of 40 ^{o} C and a critical temperature of -40 ^{o} C only needs an increase of 37% heat production to survive in -70 ^{o} C (Scholander et al. 1950).

The size of the Arctic fox is an issue in terms of thermoregulation, the surface area to volume ratio is greater than that of a larger mammal suggesting that there would be a relatively large heat loss in smaller animals. But the arctic fox has overcome this in a few behavioural characteristics. Firstly the snow is a perfect insulator in itself and the arctic fox may find shelter in it by making snow dens, this behaviour allows the fox to decrease the temperature gradient and to avoid weather conditions during times of extreme cold. It is thought that these dens are uses throughout the year (Prestud 1991) and has been noted that many arctic animals live all or parts of the winter in such dens to escape low ambient temperatures (Remmert 1980).

Furthermore when subject to such ambient temperatures the Arctic fox curls up into a ball like shape, concealing its head. Follman (1978) noted the exact way in which the fox curled up, the curled position leaves the parts of the body with the thickest fur on the outside and it reduces the surface area to volume ratio therefore reducing the heat loss. Morphological features such as small ears and muzzle and relatively short legs are thought to be adaptations linked with this curling behaviour to reduce heat loss. Another morphological feature that has been observed in the arctic fox is the fur covered feet pads found in arctic foxes that is not present in other canids, a physiological adaptation that has developed in the foxes is an increase of blood flow to a vascular network in the pads called a rete, these adaptations help stop the freezing of the feet when walking on the below freezing ice (Henshaw et al., 1972). The Arctic fox and many of the other arctic mammals main energy substrate is fat during seasonal fasting and hibernation, these species such as the arctic fox have been found to have large stores of fat before the onset of dormant periods (pond 1978), the subcutaneous fat found in arctic foxes had high concentrations of unsaturated fats which suggested that it was integral in insulating the fox. Foxes had been observed to catch and hide food before winter times, they were seen to hide food in holes and under stones (Prestrud 1991).

The Polar Bear (*Ursus maritimus*) they live on and around the ice covered waters and near the arctic coastlines, as there is a high concentration of ringed seals (*Phoca hispida*) there main pray (MacDonald 2010). Due to the scarce food supply in winter months polar bears need to fast, this fasting period can be for longer than 120 days (Robbins 2012). Polar bears have adapted the ability to enter a hibernation like condition, slowing down there metabolism while still being able to move and walk around, this state is often called ‘ walking hibernation’ which is not found in other species of bear (MacDonald 2010, Robbins 2012). Furthermore pregnant polar bears den during winter to produce cubs, these dens use the insulating properties of the snow to keep away from the harsh conditions of the environment which is similar to the dens of the arctic fox. The pregnant females can go without food for up to 8 months although much longer and the likelihood mortality begins to increase (Robbins 2012). Also during fasting Polar Bears have an incredible physiological adaptation in that they can synthesis proteins and water biochemically and by the recycling of metabolic by-products which is key for fasting for so long (MacDonald 2010).

Polar Bears are adapted to the cold in a number of ways, firstly the Polar Bears are insulated by two layers of fur and a layer of subcutaneous fat which allows them to endure the cold temperatures of the arctic without reduction of body temperature, so much so that the metabolic rate of a Polar bear will not change much event when temperatures are -36 ^{o} C (Polar Bears International 2015). Polar bears have a compact head and a small tail which helps prevent heat loss, the polar bear also has a longer thick neck than other bears which may be an adaptation for swimming in freezing water (MacDonald 2010). The polar bear is also plantigrade, having five toes which are wide and covered in thick fur, the bears use their paws to dig dens and also the paddle like paws are thought to be an adaption for swimming. The adaptions are essential for the survival of the polar bear as it lives around melting ice and its prey is found in the water. Moreover just like the arctic fox the Polar bears dig shelters in snow banks and curl up in to a tight ball, they are also know to cover their muzzles which radiate heat.

In conclusion there are many different morphological, physiological and behavioural adaptations which are important to the survival of animals in the extreme environment of the Arctic tundra. It is hard when evaluating such characteristics to be able to pick out whether the morphological, physiological or behavioural adaptations are more important than any of the others. If we look at morphological we see the vital need for thick fur as an insulator in arctic foxes (Scholander et al. 1950) but we can also see that without the lowering of the basal metabolic rate in arctic animals that they cannot survive when in fasting or hibernation (Prestrud 1991). Also we see the behaviour such as to digging dens and curling up along with behaviour of pack animals such as the grey wolf which huddle together for warmth (encyclopaedia Britannica 2015) as necessary adaptation for survival. Therefore we see that morphological, physiological and behavioural adaptations in arctic mammals all work together as equal importance for survival. It is also interesting to see that there are many similarities of the morphological, physiological and behavioural adaptations between the polar bear and the arctic fox. These similarities are evident of the selection pressures that are present to both these animals living in the same environment, and could lead to the suggestion that over millions of years through convergent evolution we could expect that animals with similar characteristic would appear in similar environments such as Antarctica.

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