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# ANIMAL PHYSIOLOGY ADAPTATION IN HIGHER ALTITUDE: TRANSPORT OF OXYGEN IN MAMMALS AND BIRDS

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## ABSTRACT

The paper has dealt with the physiological adaptation of mammals and birds in higher altitudes. Through intensive research, it has been found that the animals and birds that inhabit the higher altitude or shortly known as hypoxia environment have much more O2 hemoglobin affinity, and their number of red blood cells is increased. The concentration of Oxygen in their blood is more which leads to gaining the potential to adapt to the high-altitude environment. This paper aims to review an article that focuses on the physiological adaptation of mammals and birds in high-altitude environments. This study has also referred to other authentic research articles in order to support the discussion presented by the author of the main research paper. The main intention of this study is to lay information with ample evidence for justifying the potential for surviving in the hypoxia environment is sufficient in inhabiting mammals and birds.

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## INTRODUCTION

The animals that inhabit higher altitude areas or highly elevated environments generally possess numerous adaptation capacities to combat the challenges, including changed developmental rates and size of the body, increased pulmonary ventilation, and increased affinity of Oxygen hemoglobin. The paper will review a research article presented by fewer authors concerning the physiological adaptation of animals in higher altitudes. The paper will also refer to other relevant articles to support the preliminary paper's aspect. The paper will discuss and analyze the evident results to prove that mammals and birds living at higher altitudes have much more capacity to combat environmental consequences.

## DISCUSSION

Since a long time ago, mammals and birds have been the main focus of study of high altitude; this field has been much dominated by human physiology with an aspect that humans can be ideal for combating with the potential to acclimatize themselves to the “hypoxic environment”. For instance, it can be noted from the studies of “Hall and Co-workers” that in 1935 an expedition was held to the Andres of Chile, and it has been found from that expedition that the native mammals lying in the high altitude and the birds had a higher O2-hemoglobin similarity and the camelids of the Andres of Chile did not display an erythrocytic response to high altitude [1]. In the same journey, it was found that individuals have much lower O2 hemoglobin affinity and an important erythrocytic response which contradicted the mammals and birds present there. It can be analyzed from the above factor that the potential to adapt to a high-altitude environment is much more prevalent in mammals and birds compared to humans. The damage of adaptation while staying at a higher altitude described in humans has been demonstrated as

a typical clinical image that has negatively affected fewer individuals living at the higher altitude [1]. The relative physiology that deals with the loss of adaptation have considered that this disease has widely affected the ‘domestic animals’ in the mountains [1]. The researchers wanted to consider the aspects of Oxygen transportation during the “embryonic, growth, and adult stages” of mammals and birds that are “genotypically and phenotypically adapted” to high altitudes to understand the potential and limitations of living beings staying in the mountains [1]. Research that has been completed on the adaptive physiology of living beings and adapted high-altitude mammals and birds has been analyzed by the researchers.

As per the researchers, the high altitude can be considered a multi-environmental stressor, but “hypoxia” is one of the most important components. During the times of evolution, the animals have migrated from the seawater into the freshwater leading to the atmospheric air, and it follows an upsurge in the concentration of Oxygen in the environment [1]. During the recent evolutionary times, the invasion of the mountains has reversed the emerging trend because the Oxygen concentration and its presence in the environment is the opposite function of high altitude. Therefore, it has imposed a huge challenge on visceral life which has emerged at sea level in the maximum concentration of Oxygen. The paper focuses mainly on hypobaric hypoxia, which is the dominant stressor. This paper has defined the terms of Adaptation Physiology that encounters issues of separation of its field that overlays those of “comparative physiology, evolutionary physiology, population genetics, and other relevant biological fields”. It has been derived from other authentic references that the population genomic analysis of humans and animals living in high-altitude areas has recognized enormous candidate genes physiological to hypoxia [2]. The whereabouts of the highland natives have been studied, and it has been found that the native's integrated genomic data, along with experimental measures of physiological performance potentialities and subordinate features, have revealed the relations within the “genotypes and phenotypes” that are “hypoxia responsive” [2]. Bligh and Johnson have published the terminology of thermal physiology, and in it, they have defined the term adaptation as “a change which reduces the physiological strain produced by a stressful component of the total environment.” As per the aspect of Bligh, he has used the term adaptation generally, and he also differentiates genotypic adaptations from phenotypic adaptations, "the genetically determined forms and functions of a species are the genotypic adaptations of organisms to the environment in which they occur." He has also explained that the alterations that happen in response to gradually developing changes in the ecology are mainly known as phenotypic adaptations, as they are known to occur within the lifetime of a certain animal. Considering this case, Bouverot has attacked this notion presented by Bligh and Johnson by explaining that the definition presented by both authors does not have the usage of the term adaptation as per the exact Darwinian sense of genetically secure alterations that is spread to the offspring [3]. He has also discarded the term benefit, which has been mentioned implicitly in the elaboration of the version of Bligh and Johnson.

The researchers have opined that it is very significant to clarify the management of natural selection about preadaptation. The organisms or the preadapted living beings might need lesser or artificial selection in the new atmosphere compared with the organisms whose potential to preadapt to the new atmosphere is absent. Concerning the adaptation of camelids and birds to the hypoxic Andean gradient, the author has considered the act of preadaptation as a genotypic potential to invade a new ecological niche as a consequence of traditionally acquired proper structural or functional alterations. While executing the research concerned with the case of faster invasion of a new niche as it has occurred with the domestic animals that have been introduced in the Andes by the Spaniards, the researchers were manipulated to accept the fact that selection by natural procedure has managed on the animals which has resulted in the minimum level of pre adaptive potential for the hypoxic environment or the higher altitude. It has been found by minutely studying in the laboratory that a group of Castillian chickens has

achieved an increased Hb-0 affinity within 500 years but the time for evolution is very short. However, it has been found that the potential of low hatchability and increased rates of mortality are enough proof that stable natural selection is still operating in those animals. According to them, a special and unique situation happens when an animal adapts to an environment along with stable and stressful features. In this case, the animal belonging to the original environment is preadapted to the stressful feature of the new environment. Referring to another relevant article, it has been recollected that, like any other indigenous animals, Tibetan Chickens at higher altitudes like 2240 – 4100m show unique physiological adaptations to the environment in the Tibetan Plateau [4]. As per the research, the genetic bases of these adaptation made by the Tibetan Chickens does not possess authentic features. The researchers have collected a de novo genome of the chickens belonging to Tibet and again sequenced the complete genomes of 32 more chickens, including the Tibetan chickens, game fowl, village chickens, and Red Junglefowl [4]. It has also been determined that the chickens can be specified into two different groups. Further research has revealed that these two types of chickens have enough potential genetic mechanism which involves adaptation in high altitude. They have also opined that the Tibetan Chicken has documented a breeding history of more than millennia at higher altitudes, their blood has increased numbers of red blood cells, much more concentration of haemoglobin, and a stable affinity for Oxygen in higher altitudes [4]. It is well known that environments at higher altitude is ideal for testing the inbuilt mechanism and procedure of animals while making the physiological adaptation. Higher altitude environments are an ideal fertile ground for examining the mechanism of physiological adaptation [5]. The vertebrates that breathe in the air hypobaric hypoxia is known as a constant environmental stressor which can never be met by behavioural avoidance [5].

Monge has also discussed the transportation of Oxygen including Pulmonary Oxygen Support and Pulmonary oxygen transfer. The ventilator function of mammals and birds living in higher altitude has been elaborated with evidence in the paper. The Pulmonary circulation has also been determined as the main topic of the study. The role of Oxygen Haemoglobin is vital in the discussion made by the researchers. The mammals that have been living in the higher altitudes have a much lower concentrations of erythrocyte. Animals like the Ilama an Guanaco Hb possess a much lower reactivity towards 2,3-DPG when it is compared to any other mammals. Llama Hb possesses asparagine at a position of 8NA instead of the presence of histidine. Histidine is one of the residues that is generally responsible for making the binding of 2,3-DPG. It has been found at the molecular level that the low reactivity of 2.3 DPG to Hb results to higher Hb-0 affinity in the Llamas. These animals have regulation of different mechanisms though they have higher affinity in the environment, and they make responses to several molecular mechanisms. Several authors have found that the animals that generally migrate to the higher altitude develop short-term adaptation within their body and the concentration of haemoglobin increases within them along with a count of red blood cells [6]. It has been found from the study of several practitioners that the populations that inhabit in higher altitudes over many other generations have been exposed to selective pressures. They have adapted both physiologically and genetically in high-altitudinal environments. It has been found in many of cases that when the populations migrated into the higher altitudes, they brought their domestic animals with them including animals like dogs, chickens and livestock [6]. All these domestic animals that were brought were subjected to similar selective pressures as human populations, and it has resulted in similar adaptations to the hypoxic environments within the same timespan as their human cohabitants [6]. Experimental studies of growth and development in animals have been discussed in the paper along with the loss of adaptation, its reasons, and consequences.

## CONCLUSION

It can be deduced from the above discussion that the inhibiting mammals and birds living in higher altitudinal areas are much more prone to the hypoxia environment. They have much more count of red blood cells and the concentration of Oxygen is much more in their blood. The main intention of this study was to review an article and present an overall analysis on the discussion provided by the authors. The paper has also analysed the aspects of other authors that have supported the main research. The aim of this paper is to provide information to the future practitioners in order to execute further projects on the physiology adaptation of mammals and birds in higher altitudes.

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