

Pika's role in the Qinghai-Tibet Plateau ecosystem and effects of biodiversity

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Abstract. The Tibetan Plateau is the largest plateau in the world. Although this plateau is not as rich in species as the rainforest, it still contains some specific flora and fauna (including mammals, birds, and some reptiles). These special organisms make up biodiversity. It refers to the sum total of genes, species and ecosystems within a given area. Biodiversity produces a variety of direct and indirect benefits. These benefits are significant for human health and well-being. On the Tibetan Plateau lives a small mammal called the pika. Pika plays an important role in the plateau ecosystem and has an impact on biodiversity. However, despite the vital role pikas play in the ecosystem, the government considers them to be responsible for the degradation of grasslands and vegetation, and kills them to restore pastures. Some advocates and scholars have made different arguments based on this situation. They believe the pika also protected the plateau ecosystem, rather than damaging the grasslands. There was no direct relationship between grassland degradation and pika. In addition, a decline in the pika population would also lead to a decline in other carnivores. These wild animals may choose to attack poultry and livestock. Conflicts between humans and animals will intensify. If China wants to implement a biodiversity protection policy on the Qinghai-Tibet Plateau. They should observe and acknowledge that pikas play a vital role in the plateau ecosystem and stop killing them. This paper describes the characteristics, habitat, population, reproduction, behavior, plateau adaptation, role in ecosystem and impact on biodiversity of pika.

1 Introduction

Qinghai-Tibet Plateau is the largest Plateau in the world [1]. Although this Plateau is not similar to the rainforest which contains abundant species, it still contains some specific plants and animals. [13] [14] These specific creatures constitute biodiversity. It refers to the summation of genes, species, and ecosystems in a specific region. [15] Biodiversity produces various direct and indirect benefits. There is a category of small mammal-Pika which lives on the Qinghai-Tibet Plateau. pikas play an important role in Plateau's ecosystem and have effects on biodiversity. However, despite pikas playing an essential role in the ecosystem, the government considers that pika is the culprit of the grassland and vegetation degradation and kills them to do the pasture restoration. The plateau pika has long been considered a pest. They multiply in grasslands, making the soil less able to absorb rain, threatening cities and farmland downstream. So, starting in the 1960s, the Chinese government launched a campaign to eradicate the plateau pika. But the campaign can backfire. The presence of pika reduces the chance of surface runoff and flooding. The study illustrates the important role burrowing mammals play in ecosystems, in addition, the amounts of Pikas decreasing also can cause other predators' numbers to decline. These wild animals may choose to attack poultry

and livestock. The conflict between humans and animals will aggravate. If China wants to execute the biodiversity protection policy on the Qinghai-Tibet Plateau. They observe and admit that pikas play crucial roles in the Plateau ecosystem and stop killing them. This essay addresses pikas' characteristics, habitats, populations, reproduction, behaviors, plateau adaptability, roles in the ecosystem, and effects on biodiversity.

2 Habitat

2.1 Habitat Selection

Habitat selection refers to non-random utilization. In other words, creatures will choose specific regions to reside in. Pikas' habitats also can provide essential data for grassland quality evolution, habitat capacity estimation, and relations with livestock research. Plateau pikas are mainly distributed in Gansu and Qinghai provinces [2] [3] [4]. Therefore, scholars and protectors mainly do the pikas' habitats research in these provinces. There are a large number of predators (such as eagle, wolf, fox, and brown bear) that feed on pikas. Hence, pikas choose open spaces as habitats to avoid natural enemies. These habitats can provide a wide field of vision [6][18] [19]. Pikas can discover these

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predators in advance and run away. In these provinces, pikas like to choose the soil that contains lower organic contents and is close to the water source. Pikas living soil environment water contents are usually about 10%-30% [5]. They choose areas where slopes face south. [20] Different provinces' pikas choose different altitudes and slopes. This phenomenon is the result of various topographies and reliefs. All in all, pikas like spacious and loose soil.

2.2 Pore Structure

Plateau pika is a type of small cave animal. The cave is the central area for them. They do not leave their caves far away. These caves' structures, natures, and positions all can affect the pika's survival and reproduction. Their holes are some complex systems and there are many hidden caves within these systems. These hidden caves can help pikas avoid their natural enemies casually. Plateau Pikas' average open caves number is 4.7. The total length of the cave is 6.37 meters and the cave diameter is about 7.1 centimeters. Plateau Pikas live in altitudes from 3000-5100 meters. Different altitudes will cause different climates and vegetation. These factors also will cause the cave structure to be changed. There are still various provinces and regions of Plateau Pikas' cave structure that need to be researched.

3 Population Ecology

3.1 Population Structure

Plateau Pika is a type of social animal. Family is the basic unit of their society and the number of family members are constant. The maximum amount of population is in September while the least amount of population is in May of next year [7] [8] [9].

There is nearly the same number of male and female pikas in a population and they keep constant through the reproducible season. Nevertheless, male pikas numbers are a little more than female pikas in the reproducible season because they will fight with other male pikas owing to their mates.

Plateau Pika's death rate is different in different seasons. Some scientists think that most pikas die in winter owing to the extreme cold and food shortages while some scholars think that pika's death rate in summer is higher than in winter because of the precipitation. Heavy precipitation will drop into caves can cause pikas no access to their caves. After that, their natural enemies can prey on them more easily. Scholars need to take more approaches (such as field trips) to verify these two viewpoints.

The death rate between male and female pikas is also diverse based on various factors, like extremely cold weather, food shortages, and an increasing number of predators. Male pikas' death rate is higher than females because male pikas need to protect females.

3.2 Population Differentiation

Population differentiation is an important link in species form and it is the core of microevolution research. [16] Plateau Pika has a geographical isolation between different regions. Pikas populations in different regions can form distinct sublines. In the Qinghai-Tibet Plateau, the Qinghai-Tibet highway has a blocking effect on the gene exchange of pika on both sides of the highway and causes genetic differentiation within pika populations. Plateau Pikas have high levels of genetic diversity and variations appear within populations. This means that Plateau Pikas have excellent adaptability.

4 Reproductive Pattern

According to microsatellite technology, the plateau pika adopts a multi-mating system, which means that offspring born from the same mother have multiple paternal rights. Aggression is one of the main reasons for the coexistence of multiple marriage systems. The frequency and duration of male brawl behavior in plateau pikas are significantly higher during the peak reproductive period than during the late reproductive period, and significantly higher than in females, resulting in a hierarchical system of multiple male individuals. Compared to male pikas in subordinate positions, dominant male pikas have more opportunities to mate and higher reproductive rates. Plateau pikas breed 2 to 5 offspring per year, with 3 to 7 offspring per litter [10] [11]. The newborn weighs only 8 to 11 grams. The reproductive cycle is about 3 weeks, and female mice enter the next reproductive cycle after giving birth.

According to the patterns of female pregnancy and seasonal changes in food intake, the breeding time of pikas is close to the germination time of alpine meadow plants to facilitate female pikas to supplement more energy [12]. The breeding period of plateau pikas is mainly from April to August each year, but there are also differences in the peak breeding periods in areas with similar elevations. In the Haibei Tibetan Autonomous Prefecture of Qinghai Province at an altitude of 4000 meters and the Dawu area of Maqin County in Qinghai Province at an altitude of nearly 3800 meters, the breeding peak periods are different. The former occurs in late April and May, and the latter occurs in May and June.

5 Behavioral Patterns

The foraging process of pikas usually includes actions such as feeding, chewing, swallowing, moving, and intermittent observation. When plateau pikas encounter significant predation risks, they first determine whether they are within an acceptable range, and then try to reduce the risk as much as possible by increasing observation frequency, observation time, and movement rate. When the risk of predation is high, plateau pikas prioritize their safety, and their feeding range is almost concentrated near the cave entrance. When the risk is low, they tend to feed slightly further away from the cave entrance. Studies have shown that the vigilance behavior of plateau pikas decreases with increasing distance from the cave entrance.

6 Adaptation

The plateau pika has been living in the Qinghai Tibet Plateau for a long time and has a natural adaptability to its low temperature and low oxygen natural environment. According to research, the molecular regulatory mechanisms of physiological adaptation can be elucidated from two aspects.

Physiological mechanism: The basal metabolic rate and non-trembling thermogenic (NST) levels of plateau pika are relatively high. The brown adipose tissue (BAT) and mitochondrial protein content in its body vary seasonally, especially with higher mitochondrial protein content in winter and lower in summer. In addition, lung tissue has a strong oxygen affinity and red blood cells do not overgrow in low-oxygen environments, mainly due to the thin pulmonary artery wall and lack of smooth muscle in high-altitude pika. Due to low hemoglobin concentration and hematocrit, the blood oxygen utilization rate reaches its highest level.

Molecular mechanism: A series of high-level expressed genes related to high-altitude adaptation have been screened out in the body of plateau pika, such as the leptin protein group: Hypoxia-inducible factor (HIF-1 α), myoglobin (MGB), neuroglobin (NGB), Ldh-c (sperm-specific lactate dehydrogenase), and inducible nitric oxide synthase (iN-OS) are all ecological mechanisms by which high-altitude pika adapt to high-altitude hypoxic environments.

We can leverage China's geographical resource advantages, utilize modern molecular biology research methods, and continue to conduct in-depth research and make breakthroughs at the cellular and molecular levels.

7 Grassland Ecosystem

7.1 Relationship Between Plateau Pika and Grassland Degradation

The outbreak of the plateau pika population is actually a response to grassland degradation. Under normal ecological conditions, the density of plateau pika is relatively low, which shows that plateau pika has a favorable effect on alpine meadows. However, when overgrazing reduces pasture grass, the sparse vegetation environment is more conducive to the survival of plateau pika, and the pika population begins to increase. With the increase in pika density, the loss of weed spots, alopecia areata, and ground biomass in plateau habitats continued to increase. Subsequently, the diets of the pika and domestic animals began to overlap significantly, and competition between plateau pika and grazing animals emerged. At the same time, the increase in pika population density led to an increase in burrowing behavior, which damaged the soil structure and accelerated the degradation of grassland structure. Therefore, overgrazing is the root cause of grassland degradation, and plateau pika only plays a catalytic role.

It is unscientific to control pika populations by artificial means to optimize grassland ecosystems. Plateau pika population control can only relieve grassland pressure for

a short time, as pika populations recover quickly once the breeding season arrives. In addition, it is deadly to the natural enemies that feed on the pika. How to realize the stability and long-term utilization of the plateau ecosystem under the premise of protecting the species diversity of the grassland ecosystem is a problem worth exploring.

7.2 Ecological Significance

Plateau pika is a key species in the grassland ecosystem and is of great significance to the Qinghai-Tibet Plateau ecosystem:

(1) The tunnels dug by plateau pika provide habitat and even breeding habitat for birds (such as *Pseudococcyx hemiliasius* and a variety of snow finches) and amphibians.

(2) The activity of plateau pika increased the environmental heterogeneity and increased the plant richness on the grassland floor.

The Plateau Pika is one of the many carnivorous animals of the Tibetan Plateau, such as the bird *Falco cherrug*, the large *Buteo hemiliasius*, *Mustela altaica*, *Vulpes ferrilata*, and *Canis lupus* are the main food sources of the animal species, especially in winter. Analyzed the eating habits of Tibetan foxes and found that a large part of the food composition of Tibetan foxes came from pika, and pika was detected in 99% of the food analysis of Tibetan foxes. Moreover, the density of Tibetan foxes will increase with the increase of pika density, and when the pika density tends to 0, the number of Tibetan foxes will also decrease to 0. If the risk to the survival of the plateau pika continues to increase, it will directly or indirectly affect the survival of these animals that depend on pika as prey. The burrowing behavior of plateau Pika loosened and improved soil conditions, speeding up soil material flow. The residual accumulation it stores and the manure buried under the soil provide a lot of organic matter to the soil. Its burrowing habits also increase the permeability of water in the plateau frozen soil and accelerate the water circulation, so the plateau pika is also considered to be a hydraulic engineer on the plateau, so the plateau is also considered to be a hydraulic engineer on the plateau.

8 Expectation

At present, ecological studies on the Qinghai-Tibet Plateau are mainly concentrated in Qinghai and Gansu regions, while there are few studies on the Ochotona Plateau in Tibet. Some ecological characteristics of plateau pika also vary with different climatic environments. Whether the basic biological characteristics such as cave structure, habitat selection, reproductive characteristics and behavioral time allocation have corresponding adaptive adjustments in the abdomen of Plateau Pika in the Tibetan Plateau deserves further study. With the maturity of next-generation sequencing technologies, it is possible to explore plateau adaptation at the genome and transcriptome levels conducted genome sequencing on *Bos grannies* and found a series of candidate genes related to altitude adaptation through comparative genome and positive selection analysis. Through the combination of comparative genomics

and population genomics, the genetic mechanism of plateau adaptation evolution in Tibetan chickens was revealed. In recent years, transcriptome technology has shown outstanding performance in the field of plateau adaptation. Fortunately, the genome of the American pika (*Ochotona princeps*) is already available in the NCBI database (1.9X). Pika is a representative of small mammals on the Tibetan Plateau and has a unique evolutionary lineage. Secondly, Plateau *Ochotona* has unique adaptive characteristics in terms of behavioral, physiological, and life-history strategies. Finally, unlike domestic animals such as yaks, Tibetan mastiffs, and chickens, the plateau pika has been artificially domesticated, which is purely an adaptation to the extreme natural environment of the plateau. Understanding the molecular mechanism of plateau pika adaptation to extreme environments and comparing it with other domestic animals such as yak, Tibetan mastiff, and Tibetan chicken may bring new light to the study of plateau adaptation. The *Ochotona* species is widely distributed, ranging from 1500 m (Northeast *Ochotona*) to 5100 m (Plateau *Ochotona*). Comparative transcriptome analysis of high and low-altitude relatives is an effective means to study altitude adaptation. It is also worth studying to compare the transcriptome analysis of the plateau rabbit with the related species of the same genus at low altitudes and analyze the plateau adaptability of the plateau rabbit from the transcriptome level.

9 Conclusion

Poisoning critical species in ecosystems such as pikas and other small mammals is short-sighted. At the same time, we should also avoid using other hasty conservation methods, such as planting grass, fencing, etc. These methods may be effective at some stage, but in the long run, they cannot truly be effective. We should consider biodiversity and ecological conservation issues from the right perspective. [17] Experts suggest that we should base our efforts on natural control methods and not completely abandon the goal of controlling burrowing mammal populations. We should also consider natural predators and other environmental factors to achieve the goals of regulating population size and protecting ecosystems.

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