Effects of Plateau Pika Population Characteristics on the Ecosystem of the Qinghai-Tibet Plateau and Recommendations for Prevention and Control

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Abstract. The Qinghai-Tibet Plateau, known as the "third pole of the earth" and the "roof of the world", has a high and cold climate and a sensitive ecological environment. Plateau pika (scientific name Ochotona curzoniae) is widely distributed in the Qinghai-Tibet Plateau region and plays an important role in grassland ecosystems. Pika forms a predatory relationship with many organisms and is one of the main food sources for carnivorous small mammals and birds of prey, playing an important role in its survival. The pika's burrows provide habitat and breeding grounds for birds, contributing to the conservation of species richness on the Tibetan Plateau. At the same time, the pika population has increased dramatically in recent years, and rat infestation has become one of the main factors exacerbating the degradation of highland meadows. The interference of the plateau pika has caused the grass to be eaten in large quantities, causing harm to the development of animal husbandry. At present, the main control means of plateau pika is chemical control through drugs such as C-type botulinum toxin rodenticide, which has certain defects and can be considered to change to the direction of biological control. From the perspective of sustainable development, this paper explores in detail the current status of the plateau pika, the impact of the pika on animal husbandry and ecosystems, and discusses the ecological research of animal husbandry and plateau pika.

Keywords: plateau pika · Qinghai-Tibet plateau · ecosystem · animal husbandry · control

1 Introduction

The plateau pika (scientific name Ochotona curzoniae) belongs to the order Rabbit, Rabbit Family, rabbit rat genus, is a native of the Qinghai-Tibet Plateau.

One of the small dominant mammals unique to the system, also known as the black-lipped pika, is mainly distributed in Qinghai, southern Gansu, northwestern Sichuan and Tibet in China [1]. Plateau pika generally carries out activities during the day, mainly

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feeding on grasses and legumes such as weeping spike Phi alkali grass, Gansu spiny bean and blue flower echinacea [2], which has important ecological significance for maintaining the diversity of grassland ecosystems and improving soil [3]. Some people believe that the large number of plateau pikas will reduce the cover area of pasture, causing grassland degradation [4], which is harmful to animal husbandry and ecological environment in the Qinghai-Tibet Plateau region, so plateau pikas are also regarded as key factors in grassland degradation and other issues; Plateau pika and many local animals and plants are interdependent, is an indispensable part of the food chain, has ecological significance [5], large-scale artificial hunting of plateau pika will cause ecological imbalance on the Qinghai-Tibet Plateau. Based on the development and ecological protection of animal husbandry on the Qinghai-Tibet Plateau, this paper focuses on the impact of the population characteristics of the plateau pika on the ecosystem of the Qinghai-Tibet Plateau by querying the relevant research of the plateau pika and the relevant data of the population characteristics of the plateau pika in recent years, and makes a study on the future animal husbandry development and the ecological research of the plateau pika from the perspective of sustainable development Discussion.

2 Overview of the Current Situation of the Plateau Pika

Plateau pika, burrowing, mainly inhabits alpine meadows, alpine grasslands, its habitat overlaps with pastoral areas. It is the breeding season from April to September every year, and 3–8 litters are laid each time, with strong reproductive ability. Plateau pika has a strong destructive power on grassland, and the main control methods are chemical control.

2.1 Habitat of the Plateau Pika

Plateau pika is a burrowing animal, mainly inhabiting alpine meadows and alpine grassland areas at an altitude of 3100–5100 m [6]. They are able to dig caves in the steppe and build large and sophisticated cave systems. The burrow density of the plateau pika also varies due to differences in temperature, pH, land moisture, soil softness, grassland coverage, and number of natural enemies in different regions. Therefore, by estimating the density of plateau pika caves in a certain area, we can have a preliminary understanding of the soil conditions and ecology of the habitat, and can also grasp the living habits and population density of plateau pikas. In recent years, the foraging behavior of high-density plateau pikas has reduced the yield of pasture, and its burrowing behavior has destroyed the raw grass area [7], resulting in economic losses, which has caused harm to the ecological environment and animal husbandry in the Qinghai-Tibet Plateau region.

The Average Altitude of the Qinghai-Tibet Plateau is above 4,000 m, the climate is cold, the terrain is complex, and there is snow that does not melt all year round. The data shows that between 2001 and 2013, the average snow cover area of the Tibetan Plateau was 419,000 km^2, accounting for 16.7% of the total area of the plateau [8]. Snowfall will interrupt the food supply of the plateau pika, thereby increasing the difficulty of obtaining food, directly determining the survival of the plateau pika, therefore, the plateau pika

will generally choose a relatively large area of bare land, relatively low vegetation as a habitat, and feed on the edge of the nest area with higher vegetation [9], and the pika will cut plants and pile up haystacks to help them survive the winter [3]. In recent years, the animal husbandry industry in the Qinghai-Tibet Plateau region has continued to develop, in order to improve the quality of pasture grass and cover area, reduce the mortality rate of livestock, pastoral herders will take measures to reduce snow cover, while pastoral human activities are more frequent than other areas of the Qinghai-Tibet Plateau, The snow melts, which reduces the snow cover area in the pastoral area, which provides convenient conditions for the survival of the highland pika.

In addition, the plateau pika has a high selection orientation for areas with slopes of less than 5° and within 300 m from the water source, and the selection of light soil and clay loam soil is much higher than that of sandy and gravel soil areas [10], which is suitable for forage growth and herders There is also a lot of overlap in the region. There are many human activities in the pastoral area, the natural enemies of the plateau pika, such as wolves, foxes, eagles and other animals, are less infested, and the abundant grassland resources provide sufficient food for the plateau pika, which is an ideal habitat for them. Studies have shown that the density of highland pikas in grassland meadows and degraded meadow areas accounts for about 50% [11]. In such a case, the habitat of the plateau pika will definitely have an impact on the plateau animal husbandry, based on the choice of habitat of the plateau pika and the high degree of coincidence of the human activity area in the plateau area, if the means of destroying its habitat are used for prevention and control, it is bound to cause “one thousand enemies and eight hundred self-damage”.

2.2 Breeding of Plateau Pikas

Plateau pika is a mammal, the breeding season is from April to September every year, of which May to July is the main breeding season, pregnant rats will appear in large numbers, and the number of fetal litters varies from 3 to 8. During the breeding season, highland pikas have a greater proportion of females than males, with the lowest proportion of males in May and June [12]. Male adults enter estrus in mid-March and reach the peak of reproduction in May; the rate of sexual maturity of females varies between individuals, and some can reach sexual maturity in 2 months and can reproduce in the same year [13]. The survival rate of male larvae is about 53%, the survival rate of female larvae is about 58%, and the survival rate of adult larvae is about 60% [14].

Pikas have a strong reproductive ability and are able to produce a large number of offspring in a short period of time. There are two reasons that usually contribute to the increase in the number of highland pika rabbits: an increase in population reproduction rates and an increase in population migration rates, but the common factor for both situations is the suitable habitat conditions in the region [15]. Pastoral areas have sufficient food, few natural enemies and a comfortable climate, which are suitable for the survival and reproduction of plateau pikas, but the environment of pastoral areas is closely related to the development of animal husbandry, and the forced use of human means to change the pastoral environment may cause greater losses. Therefore, from the perspective of reducing the reproductive capacity of the plateau pika, the use of biological control methods to treat it may be able to reduce the loss caused by control.

2.3 The Current Situation and Existing Problems of the Control of Plateau Pika

In recent years, the continuous development of livestock husbandry and tourism on the plateau, the continuous growth of population and GDP in the Qinghai-Tibet Plateau region, and the increase in livestock carrying capacity have caused serious human stress to the already fragile plateau ecosystem [16], which has increased the pressure on grassland production. Plateau pikas like to eat pasture varieties such as weeping spikes and alkali grasses, and their living habits are not conducive to the growth of pasture grasses, making this population one of the dominant species with serious harm in qinghai-Tibet, and many areas, including Gannan Prefecture and Qinghai Mangya, have carried out prevention and control work.

Studies have shown that the density of highland pikas reaches the lowest point of the year in March every year, when the species has the worst individual physique and is the best control period [17]. If the appropriate dosage and method can be used, the average cave removal rate of the plateau pika can reach 93% [18], and the effective hole reduction rate of C botulinum can reach more than 90% [19]. It can be seen that the current control of plateau pika has a good effect and is relatively mature in terms of technology.

At present, the control method of plateau pika is mainly chemical control. The method is quick to use, easy to use and not limited by region, season or climate. However, the preservation method of some chemical reagents is more complicated, which may cause unnecessary losses in the actual operation process and increase the cost of prevention and control. And because the habitat of the plateau pika overlaps with the pastoral area is high, the probability of chemical poisoning of herders and livestock cannot be ignored. The ecosystem of the Qinghai-Tibet Plateau is fragile, if chemicals pollute water sources and soils in a large area, if they are not treated, it is possible that more nitrogen and phosphorus elements will enter the material cycle of the ecosystem in the region, which may cause eutrophication of soils and rivers, break the original ecological balance, and cause serious harm to the Qinghai-Tibet Plateau, which is not conducive to sustainable development. Taking the widely used C-type botulinicide as an example, the reagent is afraid of alkali and needs to be stored in a cool place away from light; when using this reagent for prevention and control, it is necessary to abstain from grazing 15–20 Days, also toxic to the human body [20]. In contrast, biological control may be able to reduce the damage of chemical reagents to the ecosystems in the region to some extent. Some areas have tried to use biological control methods, such as the establishment of eagle frames, but the current effect is not good, and the Qinghai-Tibet Plateau is wide, the labor cost is too high, and the measures for biological control and adoption need to be further strengthened, which may become the future of plateau pika control One of the directions of research.

3 Negative Impact of Plateau Pika on Local Animal Husbandry

The Qinghai-Tibet Plateau region is dotted with vast natural alpine grasslands, with a total area of 1.5 million. 2.8 billion hm^2. Alpine grassland provides living conditions for nearly 13 million yaks and 50 million Tibetan sheep, and is the home of the vast number of herders [21]. The Qinghai-Tibet Plateau area has strong radiation, sufficient sunshine,

rich grassland resources, complex terrain and geomorphology, which is suitable for the growth of cattle and sheep, and the product quality is high. Plateau animal husbandry is an important sector in local Tibetan production and has made great contributions to driving the local economy.

In recent years, the rapid development of animal husbandry in the plateau, the increase in the number of livestock, and the limited natural production capacity of grasslands have led to a shortage of forage supply. At present, the contradiction between grass and livestock has become one of the important issues in the development of animal husbandry on the Qinghai-Tibet Plateau. Plateau pika is widely distributed, with strong adaptability, fast reproduction speed, under suitable conditions easy to surge in number, and excessive livestock load makes the vegetation coverage decline, giving the pika an opportunity to invade. Once the grassland is invaded, it is likely to cause huge losses in a short period of time. Plateau pika eats forage, there is a competitive relationship with livestock, according to statistics [22], 52 adult pikas consume grass and a Tibetan sheep per day; and the breeding season of this species coincides with the pasture growth season, both around April to September, the time range of pika demand for food rises, a large number of growth period of pasture is eaten before breeding, It not only causes losses to the grassland in the current season, but also affects the subsequent productivity of the grassland, so that the quantity of livestock and the quantity and quality of agricultural products are reduced. In addition, the habit of pika burrowing will destroy the turf, resulting in a decline in forage yield, further aggravating the contradiction between grass and livestock. Therefore, the pika is considered to be the culprit in the degradation of grassland.

4 Effects of Plateau Pika on Ecosystems on the Tibetan Plateau

Plateau pika is a small plant-eating animal, in the position of primary consumer in the food chain, through the predation relationship between the population to connect the producers (such as forage) in the Qinghai-Tibet Plateau ecosystem and higher-level consumers, between the two energy transfer, accelerate the material cycle and energy flow, and promote the stable development of the ecosystem.

4.1 Plateau Pika and Vegetation

Located in southwestern China, also known as the “Roof of the World”, the Tibetan Plateau is the largest plateau in China and the highest in the world. The east-west span of the Qinghai-Tibet Plateau is about 2800 km, with a total area of 2.5 million km^2, accounting for about 25% of the country, the geological composition of the region is complex, the climate change in different regions is large, the natural resources are rich, and the natural grasslands are widely distributed, which has bred countless lives. The vegetation types of the Qinghai-Tibet Plateau are diverse, mainly including alpine deserts, alpine grasslands, alpine meadows and alpine shrublands, etc., and their distribution has obvious zonal differences, and the southern vegetation types below 3000 m above sea level are forests. The main dominant species include spiny bean, cattle felt, white grass and so on [23]. According to the study of Guo Xinlei et al., about 95% of plateau pika

rabbits choose alpine meadows, plateau meadows and degraded meadows as their habitats [11], Therefore, the relationship between plateau pikas and vegetation can mainly focus on the above three types.

Plateau pika mainly changes the biomass distribution and soil structure of grassland plants through direct feeding on vegetation and soil burrowing behavior. If the different populations coordinate with each other so that the population density of the pika is appropriate, then its behavior is beneficial to the sustainable development of the grassland ecosystem. Pika rabbits in the process of movement and excretion can help plants spread seeds, play a positive role in the reproduction of plant populations; their feces and carcasses can become plant nutrients, increase the content of nutrients in the soil, promote the growth of vegetation, improve the quality of forage; the behavior of pika digging soil will turn the soil around the cave, help grass and trees to develop young roots, obtain sufficient water and nutrients, and help water to penetrate into the soil; the climate in alpine meadow areas is cold and covered with snow. The heat emitted by the respiration of the plateau pika and other organisms in the food chain is helpful for snow melting in the surface area of the soil, promoting the germination of plant seeds and the growth of young shoots, improving the survival rate of the plant population, and opening up living space for other animals (such as earthworms, ants, etc.) living in the soil. Thus, "the presence of moderate rodents is a functional manifestation of the self-protection and regulatory mechanisms of meadow ecosystems" [24].

The soil-digging behavior of the plateau pika will cause the number of bare spots on the land to increase, and the habitat will be drought-stricken, which will help the growth of species such as the dry plant Dauri Qin and the berry leaf berry, and its nibbling behavior may also promote the germination of these two planted species [25]. In recent years, due to problems such as soil erosion, the moisture content of the soil on the Qinghai-Tibet Plateau will decrease, resulting in a decrease in the status of hygrophytes in the community. The wide leaf type of Dauri qin and berry leaf can shade the soil, reduce the evaporation of water, alleviate the problems caused by soil erosion, provide space for the growth of wet plants, and maintain the diversity of alpine grasslands [26].

In recent years, the development of plateau animal husbandry has developed many pastoral areas, so that the pika has more suitable habitats, resulting in an increase in the number of pika rabbits, flooding in many areas, and its harm is obvious to all. Highland pika nibbles on high-quality pasture, competes with livestock for food, and destroys the underground grass layer [24]. From Wei Wanrong's research, it can be learned that with the increase of the effective number of holes in the plateau pika, the species richness first increases and then decreases, the vegetation coverage, aboveground biomass, the proportion of grass biomass and the proportion of sedge biomass decrease, and the proportion of weed biomass increases [27]. "Within a certain range, the density of the rat population increased with the decrease of vegetation uniformity, and there was a significant linear correlation between the two [28]." As mentioned above, the appropriate number of plateau pikas is undoubtedly beneficial to the ecosystem, but if its number increases to an uncontrollable point, it will do more harm than good, not only affecting the development of plateau animal husbandry, but also damaging the vegetation of the Qinghai-Tibet Plateau, aggravating soil erosion, resulting in the shrinking of animal habitat and the reduction of food resources. In order to curb the continued large-scale

growth of the pika population, the control of the plateau pika is imminent, but if the species are cut and rooted, it is bound to bring immeasurable losses.

4.2 Plateau Pika and Other Populations

The ecosystem of the Qinghai-Tibet Plateau is fragile and complex, and the plateau pika, as the dominant species in the region, has important significance in terms of ecosystems.

(1) Pika's predators are abundant and can be divided into two categories: carnivorous small mammals represented by Tibetan foxes, weasels and weasels, and birds of prey represented by birds of prey and falcons [22]. Pika is their main food, its number affects the source of energy obtained by the relevant populations in the food chain, once the number of pikas is greatly reduced, predators may look for other organisms to prey on; on the other hand, the number of pika rabbits is also closely related to the population density of its predator population. Data show that 99% of Tibetan fox food analysis detected plateau pika rabbits, and "when the density of pika rabbits approached 0, the number of Tibetan foxes also dropped to 0". If a large number of plateau pikas migrate into the pastoral area, but human activities make it difficult for the natural enemies of the pika to enter the pastoral area, this may cause the population density of the plateau pika to increase in the long run, and the population density of its predators to decrease, which may affect the entire ecosystem of the Tibetan Plateau region. It can be seen that studying the environmental capacity (K value) of the plateau pika in various regions of the Qinghai-Tibet Plateau and controlling its population density within the K range is of great significance to the sustainable development of the plateau ecosystem [29].
(2) The plateau pika has a mowing behavior, that is, the pika will bite off the tall plants around the opening of the hole, so that the light resources in the plant community change, promote the growth of low plants, and at the same time remove the top advantage of the plant, promote the tillering of the plant, and increase the coverage of the plant community [29]. This behavior helps to increase plant species diversity so that more animals can have suitable habitats and adequate food sources, thus providing opportunities for rich animal species diversity.
(3) The burrows of the plateau pika can provide habitat or even breeding habitat for birds (such as ground, etc.) and other small animals [29]. The climate of the Qinghai-Tibet Plateau is harsh, and finding suitable habitats has become a survival problem for many organisms. Taking birds as an example, a variety of birds will choose to nest in mathematics, such as white-waisted snowfinches, brown-necked snow finches, etc., the nests are called underground nests, compared to ground nests, this nest is difficult to be found by natural enemies, and it can protect the safety of young birds [30].

5 Conclusions

At present, the main means of control of plateau pika is chemical control, and its drawbacks are discussed in 1.3 above. In contrast, biological control has the characteristics of

low environmental pollution, low damage to ecosystems, no pesticide residues and long-lasting inhibition. The ecosystem of the Qinghai-Tibet Plateau is fragile, the resilience stability is low, if it is too much affected by the outside world, it is difficult to adjust to a stable state in a short period of time, and the species in the ecosystem are closely related to the environment, and the toxic effect of chemicals will accumulate along the food chain and food web, and it is likely to cause serious consequences if no measures are taken. Therefore, in the third pole region, biological control methods may be more feasible.

Some scholars believe that predator predation can reduce the density of pikas in the short and medium term, but in the surviving individuals of predators, strong individuals have obvious advantages, and predation only eliminates the old, weak, sick and disabled individuals in the pika population, which instead promotes the survival of the fittest in the pika population and optimizes its population structure [31]. Therefore, the method of introducing predatory predators for pika rabbits is slightly thin in the prevention and control of rat infestation, and the plateau area is sparsely populated, the labor cost of setting up eagle frames is too high, it is difficult to ensure coverage, and it needs to be combined with other methods.

According to the discussion above, the seasonal proportion of pikas in reproduction will change, and the number of female individuals will increase. Male pikas make long chirps during courtship, and the song is generally rapid first and then gradually slower. If the rhythm and frequency of the courtship sound can be found out, the song is synthesized artificially [32], and the pika breeding season from April to September is played in the pasture and other rat pests frequently, inducing the female pika to gather, the pika can be captured and related research and treatment. In areas where rat infestation is relatively mild, the method of setting up an eagle frame can be used, supplemented by human means for appropriate control.

In addition to rat infestation, unreasonable animal husbandry activities are also one of the important factors that cause the decline in grassland coverage, and overgrazing and indiscriminate grazing will cause grassland degradation, which in turn will cause ecological balance imbalance in alpine grassland [33]. From the perspective of sustainable development, if we want to achieve the purpose of “harmonious coexistence between man and nature” on the Qinghai-Tibet Plateau and protect the harmonious development of the ecosystem, we must jointly respond in terms of rational grazing and prevention and control of rat pests. In the absence of human interference, the pika can interact with the environment, maintain balance, grassland overgrazing leads to a decline in plant height, grassland vegetation is sparse, just conducive to the survival of pika rabbits; and overgrazing changes the community composition of plants, the proportion of monocotyledonous plants decreases, providing more favorable food resources for pikas [34].

The existence of a large number of plateau pikas is undoubtedly harmful to the ecological environment and the development of animal husbandry, but from the perspective of sustainable development, if the animal husbandry is blindly developed after the rat infestation is controlled, ignoring the consideration of the ecological environment, it is only a symptom but not a cure, which is bound to cause more problems. Judging from

the current situation of the plateau, rat infestation needs to be managed, and the problems of overgrazing and indiscriminate grazing also need to be treated.

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