Pastures in South and Central Tibet (China)
II. Probable Causes of Pasture Degradation

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Der Zustand des Weidelandes in Süd- und Zentral-Tibet (China)
II. Mögliche Ursachen der Degradation

1. Introduction

During the past few winters several nomadic areas in the Tibet Autonomous Region (TAR) of the People's Republic of China have been greatly affected by unusually heavy snowfall. Losses in Nacqu Prefecture alone were estimated at 1.03 million animals or about 15 % of the Prefecture's total livestock population (MILLER, 1998). Thus far there have only been theories about the true causes of these catastrophes. Unusual weather conditions or long-term climatic changes may play a certain role, but most probably only in combination with far-reaching changes in pasture management. An overview of the political and socio-economic changes and their consequences for the pasture ecosystem, including man and wildlife, has been presented by MILLER et al. (1992).

During the course of an interdisciplinary pilot project in August 1998, a joint expedition of Western and Tibetan scientists (see Part I, HOLZNER and KRIECHBAUM, 2000) was carried out covering a vast area of rangeland in southern and central Xizang. The following discussion is based not only on our observations during this trip, but also on the knowledge and opinions of the local officials, experts and nomads.

Zusammenfassung

Die möglichen Ursachen für die Degradation von Weideland und ihr Zusammenhang mit den Winterkatastrophen, bei denen in manchen Gebieten Tibets ein Großteil der Herden durch Futtermangel zugrunde ging, werden an Hand von Aussagen einheimischer Experten und Nomaden, Angaben aus der Fachliteratur und auf Grund von eigenen Untersuchungen und Beobachtungen diskutiert. Eine übergeordnete Rolle spielen gravierende Änderungen in Art, Intensität und Rhythmus der Weidebewirtschaftung. Besonders ausführlich wird die Problematik der lokalen Massenvermehrung von Pfeifhasen diskutiert. Da sie nachweislich die Folge vorhergehender Weidezerstörung ist, können großangelegte Bekämpfungsmaßnahmen nicht zur Verbesserung der Weiden beitragen. Die gravierendste Zerstörung der Weiden, nicht vom Flächenausmaß sondern von der Endgültigkeit her, ist die Gewinnung von Torf, wobei praktisch der gesamte Boden samt Vegetation abgegraben und wegtransportiert wird. Im letzten Kapitel werden die Grundregeln von HAPIE (High Altitude Pasture Integrative Ecology) entworfen.

Schlagworte: Hochweiden, Integrative Ökologie, Degradation, Tibetanisches Hochland, Pfeifhasen.

Summary

The possible causes of pastureland degradation and the extent to which they may be connected with catastrophes suffered in recent winters are discussed. Although the causes are complex and varied, changes in the pastoral system play a crucial role. The pika problem is discussed in detail, because pikas are blamed for pasture degradation in many areas and extermination programs have been carried out. However, the occurrence of pika in great numbers is not the cause, but rather the effect of pastureland degradation. Cutting of turf and peat creates the most serious impact on pastureland - not in terms of expansion but finality. In the last chapter the basic rules of HAPIE (High Altitude Pasture Integrative Ecology) are outlined.

Key words: High Altitude Pastures, Integrative Ecology, Degradation, Pika, Tibetan Plateau.

2. Is climatic drought the main cause of the pasture problems?

The allegedly increasing aridity of the climate was generally viewed by the local experts as the most important factor responsible for the severe deterioration of the pastures.

"Drought" means less precipitation in general, rising temperatures and shifting of precipitation from summer to winter, which means that the moisture supply comes at a time of year when the vegetation is not able to use it. In spring the melted snow and ice are lost for plants growing in sloping areas, because they cannot penetrate into the frozen subsoil.

Of course, it is dangerous to rely on opinions, particularly if they are connected with such an emotional topic as bad weather is for many people. All over the world the crazy changes in weather are a common topic among farmers. On the other hand, these opinions are supported by observations: mountains, which used to be white until summer have much less snow nowadays; springs, irrigation channels and rivers have much less water. The fact that the glaciers are generally withdrawing also supports this view. Scientists support the thesis of long-time general climatic changes in High Asia (LEBER et. al., 1995; MIEHE, 1996).

Travelling through Xizang and discussing this topic with the nomads we had the impression that this drought is not evenly distributed – which should be the case if the climate per se is actually changing. There are some areas where the problem does not seem to exist at all. Although it is true that areas that already have tight water situations are affected earlier or more heavily by increasing aridity, another point has to be considered: It is well known that in arid areas destruction of the plant cover increases aridity. Therefore, widespread, large-scale destruction of pastures by overgrazing and particularly peat-cutting, which has been on the rise recently, may well be one of the factors responsible for local intensification of aridity.

3. Increasing snowfall

An unusually deep snow cover in winter makes access to the plants difficult for animals and is therefore considered the main reason for winter catastrophes along with huge animal losses, which threaten the livelihood of their owners and force them to ask for help. We heard several times that there is now much more snow in winter than used to be. Some winters with particularly serious snow catastrophes seem to support the hypothesis that precipitation is shifting from summer to winter.

However, it seems doubtful whether this can be considered as a general phenomenon on the Tibetan Plateau. The high snowfalls seem to be irregularly distributed – in some areas they have occurred, in others not. In Ngurchu we even heard the surprising observation that, "The snow(fall) shifted from the mountains to the valleys".

Severe snowstorms which lead to catastrophic losses of livestock and wildlife deaths were also common on the Tibetan Plateau in former times (EKVALL, 1968; GOLDSTEIN et al., 1990). Consequently, the fluctuations of snow and livestock are simply natural oscillations – something that may be regarded as normal by an old pastoralist with a good memory.

This point of view brings up some relevant questions:

What did the herdsmen do back in those days to avoid heavy animal losses during the winter? Certainly, one tactic was to reduce animal numbers in autumn. It could even be postulated that such climatic catastrophes helped to regulate livestock numbers depending on the availability of forage in winter (MILLER et al., 1992). Was the main reason for the recent high losses in some areas that these precautions were not observed? (Animal numbers too high, traditional winter pastures already grazed down in summer and autumn, unadapted cattle instead of well adapted yaks, etc.?)

Pasture experts from the European Alps may wonder why the nomads do not make winter provisions like hay. Actually they do, but only limited amounts for their horses. There is practically no lush vegetation (as can be found in the high alpine meadows of Europe) which can be mown and the transport of winter food in the huge quantities needed over the vast distances in Tibet would pose a severe logistical and financial problem.

4. The pika problem

4.1 "Abra" – the main pest in Tibetan pastures?

Pikas (called "abra" in Tibet) are relatives of hares and rabbits, but are much smaller (about 20 cm long) and have shorter ears. In some pasture areas they live in astonishing numbers and are consequently considered major pests. The notion that pikas are a major cause of the poor condition of a pasture seems logically, because it is the usual reaction for humans to think that some outer enemy or pest is the source of our problems.

From the viewpoint of HAPIE, this widespread opinion is not only questionable but also dangerous: It is easy to find a scapegoat to blame the problems on, but it distracts us from looking for the real reasons. In the case of the pikas, huge extermination programs have been organised instead of conducting investigations into the basic causes of pasture degradation.

Despite the extent of pika control programs, the situation of Tibetan grassland apparently could not be improved. As it is impossible to kill all of them, others will soon fill the gaps again, because their reproduction rate will be promoted by low population densities. Moreover, the extermination of pikas in an area creates severe food problems for their predators, such as foxes, weasels and birds of prey. This will reduce the predators' reproduction rate and ultimately lead to their starvation or exodus. Consequently, killing pikas also means reducing of their natural enemies, who assist the pastoralist in pika control. Thus, the effort to control the pika population cannot have the desired results, but will even worsen the problem.

According to our observations in many pika-infested areas and detailed studies in some places (e.g. Tsome, Nacqu Prefecture), pikas are just taking advantage of the previous destruction of pasture land. From both an ecological and an economic point of view (HAPIE), the best method would be to find the prior causes of the deterioration of the pastureland – which are also the causes of the explosion of pika populations – and to start with measurements. Viewed from this angle, improving of pastures will automatically reduce the numbers of pikas that live on them, not vice versa.

Additionally, everything should be done to boost the populations of pika predators. The fact that the prior reduction or elimination of predators by hunting or poisoning appears to have been accompanied by an increase in pika populations is mentioned by MILLER et al. (1992). Laws protecting them may not be enough. Advertising campaigns supporting their image as helpers in the improvement of pastures could serve the purpose better.

4.2 Notes on the biology of pikas

To understand the capacity of these animals to impact pastureland, some knowledge on their distribution and way of life is necessary.

A number of pika species occurs on the Tibetan Plateau, nine of them in Xizang, but only the plateau pikas (or black-lipped pikas, *Ochotona curzoniae*) are ubiquitous on Tibetan pastures (SCHALLER, 1998). They live in small holes, which they can dig themselves, though they are not as efficient at building extensive burrows as rabbits.

The plateau pikas – like most other species of their family which live between scree and under boulders in the snow-rich areas of the Himalayas – collect hay as winter fodder, which they store in the burrow entrances or at other protected sites. But, as it is probably difficult to maintain larger haypiles on the windblown steppes, they apparently also have to feed on surface vegetation during the winter. This is reported to be the case for the large-eared pika (*O. macrotis* = *O. roylei* pp.) living in desert-like plateaus from the Pamir to the Himalayas and Tibet (literature cited in ANGERMANN, 1972). According to SMITH et al. (1990), "At least some populations ... do not cache food haypiles for the winter ... The lack of snow found in their habitat apparently allows for year-round foraging."

Pikas are not evenly distributed throughout the Tibetan rangelands, but rather occur in some areas in high densities, while they are sparsely distributed or even absent in others. The opinion that altitude limits their distribution and that they are restricted to the lower areas does not hold true. According to literature, pikas are found up to 5000–6000 m above sea level. Also our observations in large areas of Xizang and Qinghai proved that distribution is not limited by high altitude – at least in term of the altitudes where pastures are common. In fact, their upper limit also seems to be the limit for pastoralism in Tibet.

The reason why they are absent in some areas and common in others seems rather to be the inadequate features of the soil instead of the altitude or regular heavy snow covers. As they are not as specialised diggers as marmots, for instance, they prefer ground where they can dig easily and where the ground water table is not too high to pose the risk of drowning and freezing. Moreover, they seem to prefer open and/or short vegetation, because it makes it easier for them to spot enemies such as foxes, jackals, weasels or birds of prey. Finally, the nomads themselves and their livestock seem to be the most important factor promoting high pika densities, but this point will be discussed later on.

4.3 Are pikas destroying the pastures?

Of course, there is some direct damage to the pastures caused by the digging activities, but the holes are small and pikas do not throw out the soil in heaps as rabbits or marmots do, but rather distribute it evenly around their burrows. The highest densities of pikas are found on pastureland with sparse vegetation and a lot of bare ground, i.e. "degraded pastures" according to our classification, assuming that a "better" vegetation would be possible under the given climate and soil conditions.

As pika populations are the densest on degraded pastures, it seems to be a logical conclusion that pikas destroy pastures. However, according to our observations, the pikas are not destroying the pastures, but merely invading degraded ones, because the latter are particularly suitable habitats for them, while in optimal pastures they are absent or only found in much lower densities.

Thus, pikas are not the cause, but merely an indicator of degradation. They are a colonising species, like the plants mentioned in Part I of this publication (HOLZNER and KRIECHBAUM, 2000), and may be used as an indicator of recent disturbance of pastureland. This is particularly the case for *Kobresia* pastures (those dominated by *K. pygmaea* as well as those dominated by *K. schoenoides)*, which are very important, especially for yak. In undisturbed pastures of this type, there are practically no pikas, because they cannot penetrate the extremely dense turf. However, pastures where this turf has been opened or destroyed by overgrazing, cutting or burning are their preferred habitats.

Investigations conducted by Chinese scientists led to the same result: When the degree of vegetation cover and the height of vegetation are lowered by overgrazing, pikas may be found in higher densities and consequently are in a position to do greater harm to the pasture environment (SHI, 1983, ZHONG et al., 1985; both cited in SMITH et al., 1990).

4.4 Are pikas competing with livestock for food?

It was reported by Tsering Dorje, the director of Tsome county that 21 pikas need 1 mu of grassland for feeding. (verbal comm.) This would mean that in one grazing season 265 pikas would consume the whole edible biomass in an area of approximately 1 hectare, depending on the type of vegetation, of course. According to literature, pika densities vary from 12 to 380 animals per hectare (KAISER and GEBAUER, 1993).

If we compare the area requirements of livestock with those of pikas, it turns out that the competition for food must be minimal. It is estimated that one sheep or goat requires 45 mu (3 hectares) of sparse vegetation or 18 mu (1.2 hectares) of good pasture in a given season. According to these figures, 945 (378) pikas would consume the food of one sheep. In other words, the food requirements for one pika are between 1/1000 and 1/400 of those for a sheep, which is no surprise considering the extreme difference between the weight of a pika (100–200 g) and that of a sheep (40.000–50.000 g).

Moreover, at low and moderate densities the foraging of pikas is selective and only slightly overlaps with the diet of domestic grazing animals (JIANG and XIA, 1985, 1987; cited in SMITH et al., 1990). It is only when the density is extremely high and at the end of the season when the availability of food resources is already low that the diet of pikas may overlap with that of domestic animals.

Though we have to admit that data are still scarce, it seems to be apparent that the amount of food consumed by pikas is negligible. However, in cases of very high pika densities and very low pasture productivity, competition between pikas and livestock is conceivable. In that case, exterminating the pikas might bring some relief for a short time, but the gain is small, the effort high, and the additional impact on the pasture ecosystem may even worsen the problems.

4.5 Pikas are important members of pasture ecosystems

From the viewpoint of HAPIE, plants, pikas, sheep, goats, yaks and the pastoralists are all members of one biocoenosis. They are parts of a whole and dependent on each other. Obviously, pikas did not multiply just to harm the humans and steal their livestock's food, but rather because something in the whole system changed to a direction favouring their reproduction. The causes for this change, its underlying factors, have to be detected and this is where the improvements must begin.

Until now, we have mainly discussed the negative reputation that has been attributed to pikas. However, they do play an important role in pasture ecosystems. They are even considered to be keystone species – species whose loss would cause an above-average change in other species populations or ecosystem processes – in the Tibetan plateau ecosystem (SMITH and FOGGIN, 1999): They make burrows that are the primary homes to a number of other animals, such as small birds and lizards. As has already been mentioned, they serve as the main prey for most of the predatory animals of the plateau. As we know from other fossorial animals, the digging activity of pikas may aid in the formation, aeration and mixing of soil, and enhance infiltration of water into the soil. Furthermore, they may help to increase local primary plant productivity, because they provide a kind of fertilisation by unearthing mineral rich soil from deeper layers and by the accumulation of their excrements. Because the holes are not vertical, but rather go down into the soil obliquely at a shallow angle, they are no danger for horses and other animals (as are the vertical holes of marmots, for example).

5. Overgrazing

Grazing stimulates vegetation to develop adaptation strategies that lead to a dynamic equilibrium, the OP state, between herbivores and forage, something that enables the pastoralist to obtain reliable production from year to year. Overgrazing means that the grazing increases beyond the regenerative capacity of the vegetation and that the pasture begins to change to vegetation with lower productivity and quality. If overgrazing is repeated over many years, this process leads to degradation (see Part I, HOLZNER and KRIECHBAUM, 2000).

A typical and widespread case is the overgrazing of the so-called giant *Kobresia* bog. Giant *Kobresia* (*K. schoenoides*) is a rather competitive plant which tends to dominate under suitable conditions, leaving very few possibilities for other plants to grow. The two-fold reason for its competitive strength is the formation of dense tussocks, which get broader from year to year and thus push other plants away, and a tall growth that shades smaller plant species. It is conceivable that the plant has yet another ability that enables it to form pure stands: a strategy for keeping the nutrients that have been set free from decomposing plant parts within the plant. One example for such an "internal nutrient cycle" is the European grass species *Molinia*, which grows under comparable conditions and is also able to dominate the vegetation (ELLENBERG, 1986: 771).

This hypothesis would also explain why *Kobresia schoenoides* is resistant to grazing, but nonetheless very sensitive to overgrazing. If the plants' aboveground assimilation organs are repeatedly reduced to a minimum, many of the nutrients from the internal cycle are lost to the stomachs of the herbivores. Thus, the competitive advantage of the *Kobresia schoenoides* over smaller plant species is reduced. The lower level of storage matter also reduces the ability and speed of regrowth of the browsed tussocks. If the lower parts of the plants, near or in the tussocks, are also damaged, the nutrient storage organs are destroyed completely. This leads to the death of the tussocks, which start to decompose in the dry season, a phenomenon that can be observed in many areas of Tibet.

The term "overgrazing" describes only the direct impact on the pasture and the reasons for its degradation. The causes of overgrazing are complex and varied; they are not ecological, but rather cultural, social and economic in nature. Some of them that seem to us the most relevant ones were:

- Increase in human population and animal density,
- Loss of control or abandonment of the equilibrium between herd size/pasture size,
- Change or abandonment of the seasonal grazing pattern (induced by changing political or administrative boundaries, or by stopping the migration of nomads by law or offering socio-economic incentives such as the subsidised house construction).

6. Cutting of turf and peat

There are two types of vegetation in Tibet which accumulate peat or peat-like humus: *Kobresia schoenoides* bog (giant *Kobresia* bog) and *Kobresia pygmaea* turf (pygmy *Kobresia* turf).

6.1 Giant Kobresia pastures and their degradation series

Under situations where the soil is waterlogged for much of the year, the organic material cannot decompose completely and is deposed as peat. Such situations are surprisingly widespread in Tibet and can be found not only in the vicinity of lakes and generally dry rivers, but over huge areas, even hilly or sloped ones, where the melted water accumulates near the soil surface because of the frozen underground.

The vegetation is commonly dominated by *Kobresia schoenoides*, which makes for good pastures. Given slowly increasing grazing pressure, moderate overgrazing and conditions that keep the moisture in the soil, the dead, decomposing tussocks are covered by a dense micro-sedge (*Carex* *microglochin*) vegetation which is good pastureland, but is much less productive than the giant *Kobresia* bog. A stronger impact, however, combined with drying out of the surface leads to complete decomposition of the peat, loss of soil by erosion and desertification. An intermediate state dominated by *Kobresia royleana* is what we call bulb *Kobresia* pasture.

The giant *Kobresia* pastures are very conspicuous in the landscape due to their dark green colour. The intermediate states, in which the tussocks are partly decomposing, slowly and gradually becoming flatter and flatter, are also widespread characteristic landscape elements. The thousands of tiny, spring-green hills with their soft outline set off against the desert-like mountain slopes by the rays of the low-lying sun are a motif often depicted in photographs. We call this type of pasture "hummock pastures". (For further details see HOLZNER and KRIECHBAUM, 1998.)

6.2 The pygmy Kobresia turf

Huge areas at high altitudes (or northern slopes in lower areas) can be covered by a turf of *Kobresia pygmaea* (pygmy *Kobresia* turf). The peat-like underground formed by the living subterranean parts of the plant, as well as by the partly decomposed ones, is hard but springy and extremely dense and therefore resistant against trampling by herbivores, even the large and heavy yak.

6.3 Peat-cutting means sale of the pastures

The cutting of bricks out of these two types of turf, mainly for the purpose of making walls or wind shelters, is an old custom that is being practised increasingly nowadays. The reason is increasing demand, in part because peat bricks are even used to improve road verges and build houses, and especially because trucks can nowadays easily transport large amounts of bricks away from the nomadic areas.

Cutting of turf or peat means removal of the vegetation together with all or most of the soil. During the subsequent years the scarce soil remnants are removed by wind and water. An intermediate state is the *Potentilla bifurca* semi-desert – a vegetation that cannot be called "pasture" any more, because the vegetation coverage and the productivity are extremely low. The final result is desert, stone or gravel pavement, with very scarce vegetation nourished by the remnants of soil which escaped erosion because they were protected under stones.

It is very difficult to assess the extent of this process in the past. But it might be that at least some of the desert-like areas of Tibet are the result of such activity, which might have taken place in regions with a dense human population or located close to towns, where it was profitable for the nomads to sell the peat. There is no doubt, however, that turf-cutting is rather widespread nowadays (though it has been prohibited since 1988). We passed many areas where the turf had obviously just recently been cut away completely on many hectares.

As the removal of turf or peat means the removal of the pastureland forever, this practice seems to be the most severe of the complex of impacts destroying the pastures. Actually, you cannot say that the cutting induces pasture problems, because it simply removes the pastureland and therefore the necessity to look for proper pasture management possibilities. But far worse than having pasture problems to deal with is the notion of having no pastures at all.

Peat-cutting thus is not only a problem for the pastoral use of Xizang. It is a general ecological catastrophe for the whole country, because the land is simply sold and lost forever. Whereas the peat sponge kept the water in the area, the water from rain and melting snow now runs off directly from the land into the rivers instead of being gradually emitted into the air. A regeneration of completely destroyed vegetation is unthinkable or only conceivable within a time span of hundreds or thousands of years.

7. The basic rules of Integrative Ecology of High Altitude Pastures

This preliminary draft is the result of our observations and discussions during our survey in Tibet.

- The preservation of the pastures over centuries in such an extreme and severe environment, such as in Tibet, proves that at least some of the old systems of pastoralism must have been sustainable. It is therefore important to study the old knowledge and to select from it that which can be helpful and adapt it to modern needs.
- Because of the extreme environment, the Tibetan pastures are extremely sensitive ecosystems which can be easily destroyed. Therefore, every new activity (e.g. fencing, fertilising, stock-breeding) must be carefully tested in experiments before it is applied on a large scale.
- The productivity of the vegetation in Tibet is limited. The factors limiting the productivity of the pastures and keeping it at a comparably low level are mainly climatic ones.

The crucial factors are:
- short vegetation period and
- low temperatures during the vegetation period.

These climatic factors cannot be improved by human techniques, except perhaps in a greenhouse.

- Lack of water (and nutrients) does not limit production to the same extent as in warm arid areas.
- Due to the main limiting factors mentioned above, the usual idea of increasing the productivity of pastures by input of water and nutrients will have a rather minor effect, particularly if the costs are compared with the increase in yield. Therefore, irrigation and/or fertilising will be economical only in certain rather small areas. The costs will be high and the benefits relatively low. Moreover, one has to keep in mind the possibility of negative side effects on the very sensitive ecosystem. Therefore, the main principle of pastoralism in Tibet must be to develop techniques to adapt to the difficult natural conditions and not to try to adapt, i.e. manipulate, nature to human concepts.
- As the Tibetan flora is optimally adapted to the difficulties of the climate and the grazing of large herbivores, the productivity of palatable plant biomass can only be raised above the "natural" level by introducing plants in very limited areas. As pastoralism is a "business", it is necessary to calculate the profitability of all investments – even if the initial money comes from outside. In long term, it must be possible to make a living from livestock breeding, otherwise this kind of economy cannot survive. In other words: pasture ecology is unthinkable without economic considerations and, vice versa, economic utilisation of the pastures is, at least in the long run, only possible with appropriate ecological know-how.
- The Tibetan climate is characterised by extreme fluctuations. This is another reason why Western "pasture philosophies" which are based on relatively reliable environmental conditions are unsuitable here. One of the main features of the Tibetan pasture systems is flexibility (see I/2, HOLZNER and KRIECHBAUM, 2000). With their flexible system, the nomads are not only able to survive, but also able to obtain optimal productivity, making the best of the lean years as well as of the fat years. If this flexibility has been lost, it must be developed again, combining the knowledge of contemporary science with ancient know-how and not by simply imitating systems from abroad.
- As the growth conditions for vegetation are difficult in Tibet, any regeneration of destroyed vegetation is extremely slow, the erosion of bare soil by wind, frost and water, however, takes place fast. Therefore, any mistakes may start an irreversible process leading to the complete loss of the pastureland, virtually forever.

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