The composition of haypiles of Turuchan pika 
(Preliminary analysis)

S Y Lenkhoboeva¹, V V Chepinoga², N G Borisova¹, D G Chimitov¹, V A Belova³, A M Skornyakova¹, A A Nikulin¹, N A Nikulina⁴ and O G Ilchenko⁵

¹ Institute of General and Experimental Biology SB RAS, Ulan-Ude, 670047 Russia
² Central Siberian Botanical Garden SB RAS, Novosibirsk, 630090 Russia
³ Irkutsk State University, Irkutsk, 664003 Russia
⁴ A A Ezhevsky Irkutsk State Agrarian University, Irkutsk, 664038 Russia
⁵ Moscow Zoo, Moscow, 123242 Russia

E-mail: sekalana91@mail.ru

Abstract. The species composition and abundance of plants in the Turuchan pika habitat and in its haypiles were studied in the talus surrounded by taiga on the Primorsky ridge. With the Ivlev’s Electivity Index, it was found that the pika was selective in collecting food: Veratrum nigrum and Urtica dioica, being relatively rare in the habitat, were highly preferred and abundant in the haypiles. The bulk of the haypiles also consisted of 4 species (Rubus matsumuranus, Sambucus sibirica, Populus tremula, Spiraea media) with a high abundance in the habitat and collected proportionally with their abundance. Many plant species being abundant in the habitat were not stored by pikas.

1. Introduction

Current climate change can cause reduction in the abundance of food, its nutritional value, the period of time available for animal foraging. The retrospective analysis revealed that the reduced food availability is one of the common proximate causes of population extinctions and declines due to climate change [1]. Pikas inhabiting alpine taluses are considered as sentinels of climate change in Northern America. Pikas of the species group Ochotona alpina-hypreborea occurring in taluses of Northern Asia can also be sensitive to climate warming. Pikas are commonly considered to be herbivorous generalists. However, the detailed studies revealed some degree of diet selectivity in different pika species. Here, we present the results of a preliminary analysis of food storage of Turuchan pika. This species was recently distinguished as an independent one within the Ochotona alpina-hypreborea group. It is distributed within the area previously considered as occupied by Northern pika. Available data on food habits of pikas of this species group were collected in the actual ranges of Northern and Altai pikas, and so there was no data on food habits of this taxon.

Our study aimed to reveal if food selectivity takes place in the food storing of Turuchan pika.
2. Materials and methods
The study was conducted in Eastern Siberia, in the Primorsky Ridge, on the talus (approximately 50x100 m²) in the valley of the Nizhny Kochergat River in August and September 2020. To assess available food resources at the talus and in the vicinity of the talus, we established 19 plots 3×3 m² along the talus edge and six within the bushes at the talus. We estimated the proportion of the plot area covered by every plant species at the height of 25 cm above the surface. This height was chosen as it is the height of a pika standing on its hind legs. Also, we estimated the proportion of the plot area covered by dropping leaves or needles of trees and by elder bushes, along the branches of which pikas climb to the very tips. We used percent cover classes by the Braun-Blanquet method [2].

The species composition and their relative abundance were estimated for 18 haypiles belonging to five individually marked pikas. To reveal the similarity between haypiles and between plant compositions of the plots, we used hierarchical cluster analysis in the STATISTICA 13.2. The selectivity of plant collection was evaluated only for two pikas, for which we knew the plots where they collected plants. The Ivlev’s selectivity index was used for the selectivity assessment [3]:

\[
E = \frac{r_i - p_i}{r_i + p_i},
\]

where \(r_i\) – relative abundance of the plant species in the haypile, \(p_i\) – relative abundance of the same plant species at the plot.

3. Results
One hundred three species of vascular plants, mosses, and lichens were found on the talus and the adjacent territory. The plant communities were divided into two groups: (1) communities growing on the rocky substrate occurred above and on both sides of the talus; (2) communities growing on the fine-grained substrate were adjacent to the talus bottom (figure 1).

![Figure 1. Dendrogram representing the similarity between plant communities growing on and around the talus. Clustering is based on a distance matrix computed with Euclidean distance. The dendrogram was inferred with the Ward method.](image-url)
Thirty-three species of vascular plants belonging to 20 families, as well as fungi (Basidiomycota), lichens (Cladoniaceae), and mosses (Hipnaceae), were found in the haypiles. There were not found 19 species of monocotyledonous angiosperm plants, 47 species of dicotyledons, one species of gymnosperm conifers, three species of ferns, and one species of lichens. The haypiles were divided into three groups (figure 2) as follows:

(1) Five haypiles consisted of 4-11 plant species, with one dominant species accounted for more than 50% of abundance. Common species: *Galium verum* and *Rubus matsumuranus*. In most haypiles, there were: *Populus tremula* and *Padus avium*. Dominant species: *Spiraea flexuosa*, *Veratrum nigrum*, *Rubus matsumuranus*. Two codominants (*Rubus matsumuranus*, *Populus tremula*) with an equal abundance were found in two haypiles, totally accounting for more than half of the haypile. The haypiles were collected by different individuals;

(2) Eight haypiles consisted of 2-8 plant species, of which one dominant accounted for about 60%. In most haypiles, there were: *Populus tremula*, *Rubus matsumuranus*, *Sambucus sibirica*. Dominants: *Populus tremula*, *Sambucus sibirica*, *Veratrum nigrum*. The piles belonged to different individuals;

(3) Five haypiles consisted of 14-19 plant species. The dominant species accounted for more than 50%. Common species: *Galium verum*, *Spiraea flexuosa*, *Vicia unijuga*. In most haypiles, there were: *Populus tremula*, *Padus avium*. Dominant species: *Spiraea flexuosa*, *Sambucus sibirica*, *Veratrum nigrum*, *Rubus matsumuranus*. In one haypile, three species (*Veratrum nigrum*, *Cirsium setosum*, *Populus tremula*) dominated with an equal abundance, totaling 60%. The haypiles belonged to male No. 7.

In terms of abundance, only six species dominated in haypiles (*Veratrum nigrum*, *Rubus matsumuranus*, *Sambucus sibirica*, *Populus tremula*, *Spiraea media*, *Urtica dioica*) – each comprised for more than 8% of the percentage coverage; the rest accounted for 1% or less (table 1). *Veratrum nigrum* and *Urtica dioica* were especially preferred, while both species were not abundant around the talus. At the same time, some abundant species such as *Carex pediformis*, *C. korshinsky*, and *Poa krylovii* (with abundance ranged from 4.1% to 10.4% at the plots) were not gathered by pikas.
### Table 1. Plant species estimators in the hay storing by the Turuchan pika.

| Species               | Abundance | Ivlev’s Index |
|-----------------------|-----------|---------------|
|                       | Haypile   | Plots         |
| Veratrum nigrum       | 21.61     | 0.71 0.94     |
| Rubus matsumuranus     | 18.89     | 10.08 0.3     |
| Sambucus sibirica     | 18        | 8 0.38        |
| Populus tremula       | 15.86     | 4.58 0.55     |
| Spiraea media         | 9.04      | 16.73 -0.29   |
| Urtica dioica         | 8.26      | 0.5 0.89      |
| Lathyrus humilis      | 1.08      | 3.77 -0.55    |
| Betula platyphylla    | 1.69      | 0.82 0.34     |
| Campanula glomerata   | 0.17      | 1.04 -0.72    |
| Larix sibirica        | 0.72      | 0.22 0.53     |
| Galium verum          | 0.64      | 1.41 -0.38    |
| Vicia unijuga         | 0.59      | 1.2 -0.34     |
| Cirsium serratuloides | 0.51      | 0.55 -0.04    |

| Species               | Abundance | Ivlev’s Index |
|-----------------------|-----------|---------------|
|                       | Haypiles  | Plots         |
| Gymnocarpium dryopteris| 0.5   | 0.22 0.4     |
| Hemerocallis minor    | 0.48      | 0.5 -0.02    |
| Polygonatum odoratum  | 0.38      | 0.4 -0.03    |
| Vicia nervata         | 0.27      | 1.74 -0.7    |
| Cotooneaster melanocarpus | 0.21 | 5.43 -0.93  |
| Phlomoides tuberosa   | 0.21      | 0.7 -0.34    |
| Artemisia sericea     | 0.19      | 4.22 -0.91   |
| Sedum aizoon          | 0.15      | 0.35 -0.42   |
| Thalictrum appendiculatum | 0.15 | 0.89 -0.72  |
| Rosa acicularis       | 0.13      | 1.02 -0.77   |
| Poa botryoides        | 0.13      | 0.15 -0.06   |
| Pusus avium           | 0.08      | 2 -0.93      |
| Galium boreale        | 0.06      | 0.7 -0.84    |

*a in bold: abundance values > 8;  
*b in bold: indexes indicating preference (from 0.4 to 1);  
in italics: indexes indicating proportional plant in proportion to its abundance in the environment (from −0.4 to +0.4).

When we treated four haypiles located in the same places at the end of September, as in August, we did not find any plants from the previous haypiles.

The comparison with the haypiles collected by pikas in this settlement in July 2016, when the communities around the talus were similar to those identified by us (Nikulin, unpublished data) [4], revealed significant differences between haypiles gathered during different months (figure 3).

### 4. Discussion

Thus, our preliminary study shows that Turuchan pikas do not collect plants for their winter diet randomly. Out of 103 species growing on the talus and in its immediate vicinity, 71 plant species were not stored by pikas. Six plant species form the bulk of the haypiles, with four ones each comprised 16-21% of the haypiles, two species comprised about 8% each. The proportion of other species was less than 2%. Our findings coincide with data evidenced on foraging selectivity in pikas contrary to earlier opinions on the generality of their foraging. The latter stemmed from the general consideration that herbivores are forced to be generalists due to high variability of the nutritional composition of plants [5, 6] and based on earlier data gathering methods, which did not account for the availability of foraging objects. Applying different methods revealed that pikas are selective in their winter diet, at least [7-10].

To assess availability, we used the method of projective foliar cover. We recognized that the most suitable for our goals is biomass estimation. A very objective measure of biomass is harvesting, i.e., simply removing and weighing all plants within the chosen territory cell. However, we avoided applying this sampling of biomass because of its destructivity for pika surroundings.

For a more correct assessment of selectivity in future investigations, it is necessary to develop methods for underdestructive biomass estimation, on the one hand, and to determine which biomass to estimate, on the other hand. By the latter, we mean that we should determine what plant parts are accessible for pikas and account for them specifically. For example, we observed how pikas cut off almost all leaves of Sambucus sibirica, crawling along the branches to their very tips, contrary to our expectation that only leaves up to 50 cm will be accessible for animals. At the same time, some herbaceous plants that we considered wholly accessible for pikas were not cut by pikas. Their stems possibly were too wide or tough, preventing animals from cutting them off at the base.
Figure 3. Venn diagram illustrating unique and shared plant species in haypiles gathered by pikas in July and September.

Plants with high abundance values in July are in italics; in September – are underlined; woody plants – are in red.

The selectivity in haying by Turuchan pikas differed from that found in American and Northern pikas [8, 9]. The last species were selective in the choice among abundant plants in their surroundings. Contrary to this, Turuchan pikas highly preferred two plant species rare in their environment with a selectivity index of more than 0.9: Veratrum nigrum and Urtica dioica. Moreover, both species were abundant in haypiles (more than 10%). We found that the leaves and stems of Veratrum nigrum comprised on average 20-22% of the haypiles, a large quantity taking into account that this species is poisonous. It is known that all species of the genus Veratrum are characterized by a high content of secondary compounds, namely steroid alkaloids, which are toxic to livestock and humans [11, 12]. The frequent occurrence of toxic plants was found in haypiles of Northern as well as American pikas. In American pikas, toxic plants comprised about 60-77% of haypiles [8], but they were also abundant in plant communities available for animals. In Northern pikas' haypiles toxic plants were not abundant.

Generally, the content of plant alkaloids decreases after plant cutting and drying out [13]. So, plants that are toxic due to their alkaloid loading can become edible for pikas after some time of plant storing in haypiles. Denise Dearing proposed that American pikas store toxic plant species (she proved their toxicity for the pikas) because their antibacterial and antifungal properties can slow down the decomposition of these plants themselves and also contribute to the preservation of other plants in the haypiles [8]. Her experimental study confirmed only the first hypothesis [14]. It was shown that the level of secondary metabolites decreased during storing haypiles to levels readily consumed by pikas in their summer diet, while plants with high levels of secondary compounds retained more biomass and nutrients during storage. At the same time the presence of toxic plants did not decrease degradation of non-toxic plants within hays.

As for Turuchan pikas, up to the moment, we did not estimate how toxic were the plants growing on the talus where we had studied pikas: we noted that our pikas ate Veratrum nigrum several times in July and August, although in a small quantity.

Two other plant species which selectively gathered by Turuchan pikas and at the same time were abundant in haypiles were Populus tremula and Urtica dioica. Both species are known as very qualitative food for livestock. In the study of American pika foraging [15], both species, among others, were tested for nitrogen content, and it was revealed that they contained relatively high quantities of this nutrient: the nettle – above 4%, the green aspen – about 3%, while the average content of plants accessible for pikas...
was less 1.5%. Other species numerous in Turuchan pika haypiles, *Rubus matsumuranus* and *Sambucus sibirica*, were also abundant in plant communities growing on and around the talus.

In our study, we found that pikas transferred dried plants from open niches to deeper ones. So, we concluded that tested haypiles do not reflect all the plants harvested by the animals over the entire haying period. This suggestion is confirmed by the results of the comparison between haypiles gathered in July and September. However, it should be pointed out that *Veratrum nigrum*, *Urtica dioica*, and *Rubus matsumuranus* were most abundant in haypiles gathered both in July and September at this talus.

So, pikas can gather different plant species at different periods. What guides choice changes is unknown at present. Perhaps the preference is dictated by the accumulation of certain nutrients or, conversely, by decreasing some secondary compounds in plants. We observed that pikas, when foraging, showed strong selectivity between individual plants of the same species. They tried to bite off a piece of the plant, stopped, and ran to another one. After trying some plants, they found a particular plant, and then for several trips, they collected leaves or other parts only from this plant.

In conclusion, this study provides a foundation for further work examining how pikas choose plants during the haying period.

**Acknowledgments**

The study was performed within the framework of the state assignment of the Institute of General and Experimental Biology of SB RAS No. 121030900138-8, and partially by RFBR and the Government of the Irkutsk Region grant No. 20-45-38009.

**References**

[1] Cahill A E et al. 2012 How does climate change cause extinction? Proc. of the Royal Society B: Biological Sciences **280** 20121890

[2] Braun-Blanquet J 1965 Plant Soci ology: the study of plant communities (Hafner, London, UK) p 439

[3] Ivlev V S 1955 Experimental Ecology of Fish Nutrition (Moscow: Pishchepromizdat) p 255

[4] Zatsepina O S and Nikulin A A 2014 Species composition of Northern pika (*Ochotona hyperborea* Pall, 1881) in one of the districts of the Baikal region Bulletin of KrasGAU **12** 106–9

[5] Bailey V 1936 The mammals and life zones of Oregon North American Fauna **55** 112–7

[6] Broadbooks H E 1965 Ecology and distribution of the pikas of Washington and Alaska *American Midland Naturalist* **73** 299–335

[7] Millar J S and Zwicket F C 1972 Characteristics and ecological significance of hay piles of pikas *Mammalia* **36** 657–67

[8] Dearing M 1996 Disparate determinants of summer and winter diet selection of a generalist herbivore, Ochotona princeps *Oecologia* **108** 467–78

[9] Gliwicz J, Pagacz S and Wiczuk J 2006 Strategy of food plants selection in the Siberian northern pika *O. hyperborea. Arctic, Antarctic, and Alpine Research* **38** 54–9

[10] Varner J and Dearing M D 2014 Dietary plasticity in pikas as a strategy for atypical resource landscapes *Journal of Mammalogy* **95**(1) 72–81

[11] Telyatev V V 1991 Medicinal Treasures (Irkutsk: Vostochno-Sibirskoe Knizhnoe Izdatelstvo) p 400 (in Russian)

[12] Kuzmenko I N and Kolyasnikova N L 2019 Medicinal and Poisonous Plants (Perm: Prokrost) pp 8–9 (in Russian)

[13] Shelementyev A A 2016 The study of the action of plant alkaloids, a brief description and their effect on the human body Materials of the VIII Int. Student Scientific Conf “Student Scientific Forum”

[14] Dearing M 1997 The function of hylpiles of pikas (*Ochotona princeps*) *Journal of Mammalogy* **78** 1156–63

[15] Leung M 2014 Forage selection by the American pika (*Ochotona princeps*): comparing vegetation communities, pika harvesting, and plant nutrition in contrasting habitats Arctic Antarctic and Alpine Research **38**(1) 54–9