

Quantitative differentiation of types of feeding craters of *Rangifer tarandus fennicus*

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Abstract: During winter 1983–1984 in the Kainuu region of eastern Finland, based on 1,363 api profiles, the Värriö Snow Index (VSI) modelled 3 different types of feeding craters dug by *Rangifer tarandus fennicus*. When mean log VSI of control sites = < ca. 1.4, the animals used suov'dnji (Lappish) or individual, single-use excavations; when mean log VSI of control sites = > 1.4 < ca. 2.1, the animals used fies'ki (Lappish) or cooperative excavations of the perimeter of a site; when mean log VSI of control sites = > ca. 2.6, the animals switched to using čiegar (Lappish) or linear extensions of a suov'dnji, excavated by a sequence of individuals. Čiegar-type feeding resulted in reduction of mean log VSI of feeding sites even though VSI of control sites increased. Čiegar-type feeding is interpreted as a successful behavioural adaptation to the Sub-Marginal Period.

Keywords. *Rangifer*, feeding adaptations, behaviour, winter ecology, snow, cratering, Finland, grazing

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Introduction

Good progress has been made in recent years in quantifying aspects of *Rangifer* winter ecology (e.g. – Pruitt 1979; 1981; 1985), behaviour (Vandal & Barrett 1985), and in translating folk-knowledge about domesticated *Rangifer* into scientific information (Eriksson 1976). Pruitt (1979) classified some of this sort of information into a series of "api-*Rangifer* Periods" that subdivided the snowy portion of the year. Pruitt (1985) noted that "... not all the periods may occur in every region inhabited by *Rangifer* nor possibly in every winter. Moreover, there may be other, as yet undetected, snow periods..." In the light of more recent knowledge it is now necessary to begin the revision and modification of some of these Periods (Table 1).

Materials and methods

This paper concerns data collected during winter 1983–1984 in the Kainuu region of eastern Finland.

The general research design was a comparison of the api at "control" sites scattered widely over the general region with the api directly at the "experimental" sites where *Rangifer* had fed. From the data I calculated the Värriö Snow Index (VSI) (Pruitt 1979). I found that the data collected from 1,363 api profiles and calculated into the Värriö Index modelled the general winter movements and behaviour of *Rangifer tarandus fennicus* (Pruitt 1985). In each time-group the mean log VSI of the "control" and "experimental" or feeding sites were tested by Analysis of Variance (ANOVA). In each case $P=0.01$ to $P=0.05$. The data also offered numerical differentiation of the api parameters associated with the types of feeding craters dug by *Rangifer* (Table 2).

Results

In the early part of the snow season during the Fall Critical Period and the Pre-Threshold Period (Table 1), *Rangifer*, when not feeding on arboreal lichens,

Table 1. Stages or "seasons" of the snowy portion of the year in relation to *Rangifer*.

FALL CRITICAL PERIOD

1. Fluctuating api, possible nast' (Formozov 1946).
2. Intermittent use of suov'dnji -OR- use of arboreal lichens.

PRE-THRESHOLD PERIOD

1. Api less than threshold values for hardness, density or thickness.
2. use of suov'dnji -OR- use of arboreal lichens.

THRESHOLD PERIOD

1. (a) Hardness, density or thickness exceeding tolerance (*not* self-induced).
(b) Searching for gradient and moving down gradient to suitable api.
2. Use of suov'dnji and fies'ki -OR- use of arboreal lichens.

SELF-INDUCED MOVEMENT PERIOD

1. Ideal api hardened by suov'dnji or fies'ki until it is beyond tolerance.
2. Deer leave region with previously-ideal api.

SUB-MARGINAL PERIOD

1. Use of api that exceeds thresholds of hardness, density or thickness. Re-use of areas previously fed over, by using undisturbed api between old suov'dnji or fies'ki.
2. Use of čiegar and fies'ki.

API-MATURATION PERIOD

1. Pukakization reduces hardness of basal layers sufficiently for deer to re-invade previously-deserted areas.
2. Re-use of čiegar and fies'ki; rare use of suov'dnji.

SPRING CRITICAL PERIOD

1. Possible nast' caused by sun and/or rain.
 2. Use of bare south-facing slopes, bare qamaniq, bare anyemanya.
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feed on ground lichens by means of individual feeding craters, termed suov'dnji (Lappish) (Fig. 1) (Pruitt 1979), simple conical or oval excavations in the api, each separated from others like it by undisturbed api. The Threshold Period begins when *Rangifer* add fies'ki (Lappish) (Fig. 2) (Pruitt 1979) to their expressed repertoire of feeding behaviour. Fies'ki are roughly circular sites of thin, hard and



Fig. 1. Arrows point to individual feeding excavations or suov'dnji.

dense snow cover caused by *Rangifer* digging and extending a feeding perimeter expanding into undisturbed api from an original suov'dnji or group of suov'dnji.

During winter 1983–1984 the Threshold Period began in mid-December when the mean log VSI of the control sites increased significantly from 1.64 (N=50) to 2.07 (N=50) ($P=0.01$). At the same time the mean log VSI of feeding sites increased significantly from 0.84 (N=40) to 1.42 (N=40) ($P=0.01$), and *Rangifer* switched from suov'dnji to fies'ki type of feeding activity. For instance, the Myllyniemi control sites on 7 December showed mean log VSI=1.27 (N=25) compared to suov'dnji 8–9 December mean log VSI=0.94 (N=30) ($P=0.05$). Later in the winter the Kotajärvi control sites on 7 March showed mean log VSI=2.55 (N=25) compared to Haapakaarre fies'ki on 3 March with mean log VSI=2.10 (N=10) ($P < 0.05 > 0.01$). Still later in the winter the Myllyniemi control sites on 5 April showed mean log VSI=2.78 (N=25) compared to fies'ki on Multisaari on 7 April with mean log VSI=1.44 (N=20) ($P < 0.01$). Note that this behavioural chan-

ge did not result in any relief from environmental resistance because the mean log VSI of feeding sites increased by about the same amount as that of control sites, although continuing to be significantly less. Feeding along the perimeter of *fies'ki* did mean, however, than an animal was not required to move as much snow as with *suov'dnji* in order to encounter subnivean vegetation.

A third type of feeding crater is termed *čiegar* (Lappish) (Fig. 3) (Pruitt 1979). These are linear extensions through undisturbed *api* of a sequential series of *suov'dnji*. Actual feeding on ground vegetation occurs only at the terminal end of a *čiegar*. Excavated snow is kicked back, partially filling the trench with snow that sinters and becomes very hard.

In early March 1984 *Rangifer* began to use *čiegar* with the result that mean log VSI of feeding sites decreased from 2.13 (N=40) to 1.74 (N=40), a difference significant at $P=0.01$, in spite of the fact that mean log VSI of the control sites increased from 2.60 (N=50) to 3.07 (N=50), a difference significant at $P=0.01$. For example, Kotajärvi control sites on 7 March showed mean log VSI=2.55 (N=25) compared to Haapakaarre *fies'ki* plus *čiegar* feeding sites on 3 March mean log VSI=2.10 (N=10), a difference significant at $P < 0.05 > 0.01$.



Fig. 2. Arrows point to excavated walls of cooperative feeding area or *fies'ki*.

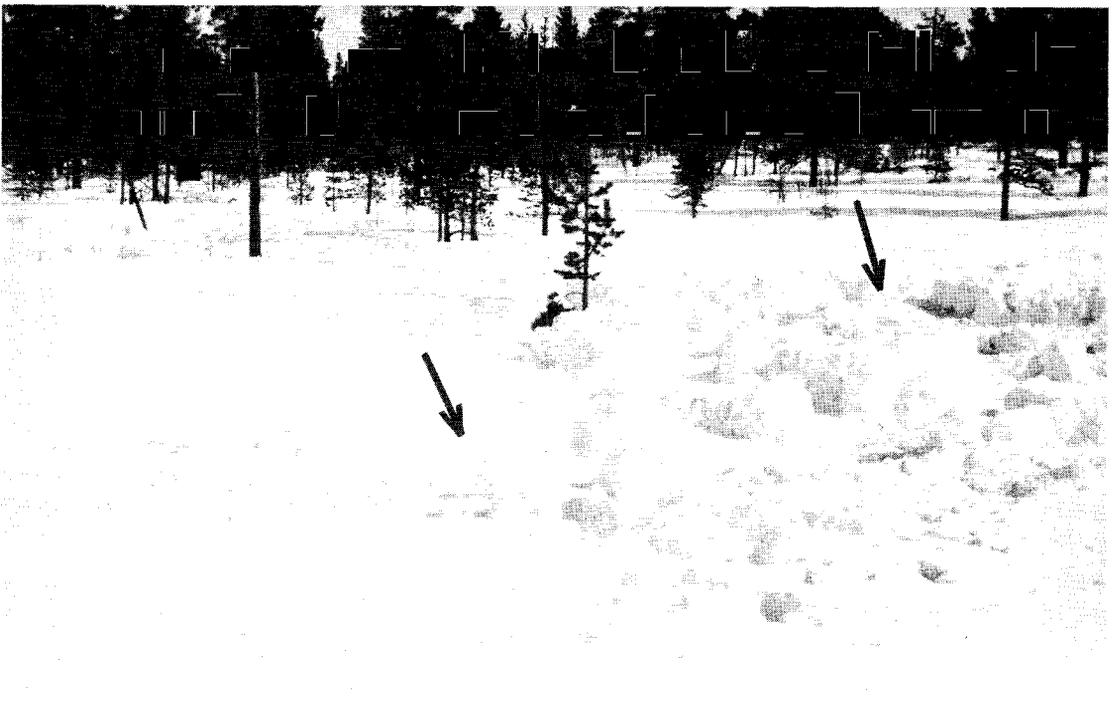


Fig. 3. Arrows point to actual feeding site at end of *čiegar*.

Table 2. Log Värriö Snow Index (VSI) of control and feeding sites in relation to type of feeding craters dug by *Rangifer tarandus fennicus*, winter 1983–1984, Kainuu region, Finland

	Log VSI	Type of feeding crater
Control sites	< 1.64	
Feeding sites	< 0.94	suov'dnji
Control sites	> 1.64 < 2.07	
Feeding sites	> 0.94 < 1.42	fies'ki
Control sites	> 2.60 < 3.07	
Feeding sites	> 1.74 < 2.13	čiegar

Discussion

The use of čiegar beginning in early March was accompanied by a decrease in feeding VSI even though at the same time the control sites had an increase in VSI. Thus we can conclude that čiegar-type feeding successfully meets the challenge of increased environmental resistance. It is, therefore, a behavioural adaptation for feeding during the Sub-Marginal Period.

Because this sequence of feeding craters from suov'dnji to fie'ki to čiegar involves an individual moving progressively less api, there is a comparable saving in expenditure of energy. Čiegar begin to be used at the time of year when the individual's energy reserves may be approaching the pessimum.

There is no consistent relationship between density and hardness of api (Pruitt 1990). Therefore, VSI, which incorporates hardness and thickness relations only, is a more sensitive indicator of *Rangifer*-feeding crater relationships than are techniques which incorporate density (e.g. Fancy & White 1985).

Pruitt (1985) described how *R. t. fennicus*, during the Sub-Marginal Period, detected, dug down to and fed on lichens, *Dicranum* sp. and *Vaccinium* spp. on the tops of decaying tree stumps. These sites showed mean log VSI=0.76 (N=10) while normal suov'dnji in the vicinity showed mean log VSI=2.10 (N=10), a difference significant at $P < 0.01$. Brown & Theberge (1990) observed *R. t. caribou* to feed selectively on tops of glacial erratic boulders where the api was thinner. Unfortunately, they did not report the quantitative differentiation of such behaviour.

The results reported here are from only one region during one winter. Table 1 brings the "api-*Rangifer* Periods" up to date. One may note several behavioural implications from analyzing these changes. Fies'ki may be made by a single individual but they

usually occur as a cooperative effort. Such behaviour means a change in the usual *Rangifer* autonomous feeding behaviour in order to allow such close physical proximity and cooperative effort.

Knowledge of these different types of feeding behaviour has management implications. These different types of feeding signs are distinguishable from the air so that, if one knows the limits of VSI at which the different types are made by the local population of *Rangifer*, one may thus gain considerable knowledge about the snow cover from aerial survey

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Errata:

In the paper by W. OL. Pruitt in Rangifer No. 1, 1992 on page 31 *the captions to figures 2 and 3 are transposed*. On page 29 the reference (Pruitt 1985) shall be: (Pruitt 1989). On page 31, in the reference list, *Pruitt 1985* shall be Pruitt 1989 and the figures 15–22 shall be corrected to 13–20.

Dissertations



Margareta Stéen defended her PhD thesis *Elaphostrongylosis. A clinical, pathological and taxonomical study with special emphasis on the infection in moose* at the Swedish University of Agriculture, Uppsala, Sweden on December 13, 1991.

She was born in 1949, grew up in the countryside and, from an early age, developed a keen interest in natural history and hunting. After a basic education in agricultural sciences she studied biology at The University of Uppsala and graduated from The Swedish University of Agricultural Sciences (SLU), Faculty of Veterinary Medicine in 1983.

After the veterinary education, she was engaged at The National Veterinary Institute, mainly working with game animals until she started the research work for her doctorate in 1990.

She is currently engaged on a project entitled "Infection in moose", the aim of which is to determine whether a disease responsible for widespread death of moose in southwest Sweden is caused by a virus.

Abstract: Parasitic infections of moose (*Alces alces*) by nematodes in the genus *Elaphostrongylus* (Protostrongylidae: Elaphostrongylinae), were investigated. The studies focused primarily on the clinical parasitology, pathology and taxonomic relationships of a previously undescribed species, *Elaphostrongylus alces*. This parasite was distinguished from *Elaphostrongylus cervi* and *Elaphostrongylus rangiferi* on the basis of host preference, localization sites within hosts, and morphological characters.

Histological examinations of dead moose from wild populations in Sweden revealed a high incidence of elaphostrongylosis. Adult *Elaphostrongylus alces* were usually found in the epidurum of the spinal cord, but also occurred in muscle fasciae. Adult parasites provoked little or no inflammatory response in the surrounding tissue but parasite eggs, usually located in granuloma formations, elicited pronounced inflammatory reactions in the central nervous system and the epineurium, perineurium and endoneurium of the spinal nerves.

Female *Elaphostrongylus alces* were longer, wider, with a characteristic bottle-shaped esophagus diverging from females of other *Elaphostrongylus* species. Male *Elaphostrongylus alces* has long, slender dorsal ribs in their genital bursae in contrast with the short, broad ribs found in congeners.