Uneven sex ratio of voles in the food of *Aegolius funereus* and *Strix aluco*

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In spring 1977 the sex ratio of surplus voles (96 *Clethrionomys glareolus* and 131 *Microtus* sp.) in the nests of *Aegolius funereus* and *Strix aluco* was studied at Pirkanmaa (61° 30′ N, 23° 50′ E), southern Finland. The sex ratios of these voles were also investigated by small mammal trappings in the study area. When the sex ratio was compared with the assumed 1:1 ratio in the field, a highly significant predominance of *Clethrionomys* males was found in the surplus food of *Aegolius funereus*. The *Microtus* material showed a slight male predominance for *Aegolius funereus* but only an indication of such a predominance for *Strix aluco*. About the same sex ratios were found in small mammal trappings. It is suggested that in the spring male voles are more vulnerable to avian predation than females.

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Introduction

Predation of owls on small mammals has been studied mainly from the point of view of the composition of their food and their food consumption. The quality of the prey individuals (e.g. sex and age) has rarely been examined, although selective predation has been demonstrated to have a clear impact on prey population dynamics (MACAHTHUR 1960, SLOBODKIN 1968).

When the breeding season of voles begins in spring, male mortality is high (CHITTY & PHIPPS 1966, KREBS 1966, ZEJDA 1967, BOONSTRA 1977, MYLLYMÄKI 1977), and in some cases this fact could be due to selective predation on male voles.

The surplus prey generally found in owl nests provides useful material for studies of prey selection. In our paper we present sex ratio data on surplus voles, *Clethrionomys glareolus* and *Microtus sp.*, collected in the nests of Tengmalm's Owl *Aegolius funereus* and the Tawny Owl *Strix aluco*. These data are compared with the results obtained in small mammal trappings.

Study area, material and methods

Since the 1960s we have annually monitored the population dynamics of hole nesting owls at Pirkanmaa, southern Finland. The material for this study was collected in the communes around the city of Tampere (61° 30' N, 23° 50' E). In April and May 1977 we examined

the surplus prey in the nests of Tengmalm's Owls and Tawny Owls. We define the surplus prey as those prey individuals which have not been eaten immediately, put are lying in the nest box available for analysis. These surplus animals are later consumed by the owl family. We found surplus prey in 26 Tengmalm's Owl and in 18 Tawny Owl nests. In addition, four nest boxes visited but not used for nesting by Tengmalm's Owls contained surplus prey. Nests with eggs or small young provided most of the prey material.

In total the surplus prey numbered 424 individuals, 91.5 % of which were voles. The sex of 96 *Clethrionomys glareolus* and 131 *Microtus* sp. was examined. As a great number of the voles were partially eaten, the two *Microtus* species *(M. agrestis* and *M. arvalis)* were treated jointly. The latter is less common in the study area as is shown later in the text. The surplus prey consisted entirely of adult voles. Sex was determined by external examination of the genitals. In some cases it was also necessary to study the gonads.

In May 1973 and 1977 as well as in September—November 1976 and 1977 we made small mammal trappings with snap traps in various parts of the study area. The traps were set in lines, two traps baited with cheese being placed at each trapping station. The stations were situated at 10-m intervals. Each time the trapping was done during three nights and the traps were checked daily. In 1973 we had only one trapping area, but later there were seven to nine. The trap nights totalled 7743. Fifty-seven per cent of the trappings were done in forest habitats and the rest on meadows, clear-cut areas and agricultural fields. As a result we caught 298 *Clethrionomys* and 190 *Microtus* voles. Analysis of a sample of 75 *Microtus* voles showed that there were 88.0 % *agrestis* and 12.0 % *arvalis*. Sex was determined on 227 *Clethrionomys* and 93 *Microtus* voles by examination of the gonads.

In the years 1976—77, the population dynamics of *Clethrionomys* and *Microtus* in the study area was briefly as follows (LAGERSTRÖM, unpubl.). In autumn 1976 *Clethrionomys* was numerous but decreased to a low level in 1977, the decrease occuring in winter in the communes east of Tampere but in spring in the western part of the study area. The *Microtus* voles were increasing gradually since the low in 1974, and peaked in summer 1977.

Results

In spring 1977 the surplus prey of Tengmalm's Owl showed a significantly higher male-to-female ratio for *Clethrionomys* than the assumed 1:1 ratio in the field (binomial *t*-test, $t=3.45$, $P<0.001$; Table 1). The surplus of *Microtus* males was only indicative ($t=1.73$, $P<0.10$). Tawny Owls had slightly more males than females of *Microtus* in their surplus food. Thus, the sex ratio of *Microtus* in the prey of the two owls was about the same. The material of *Clethrionomys* in the Tawny Owl nests was too small ($N=5$) for analysis. Towards late spring the sex ratio of the chief prey species for each owl (see page 152) tended to even out. The diet of Tengmalm's Owl also appeared to change: in April the *Clethrionomys* -to- *Microtus* ratio was 100:63 ($N=147$) but in May 100:97 ($N=137$; $P<0.20$).

Small mammal trappings in May 1973 and 1977 showed a significant predominance of males ($t=2.66$, $P<0.01$) in *Clethrionomys* and a slightly higher percentage of males than fe-

TABLE 1. The sex ratio of *Clethrionomys glareolus* and *Microtus* sp. in the surplus prey of Tengmalm's Owl *Aegolius funereus* and the Tawny Owl *Stix aluco* in spring 1977.

Colection period	Tengmalm's Owl				Tawny Owl	
	Clethr. glareolus		*Microtus* sp.		*Microtus* sp.	
	♂♂ %	*N*	♂♂ %	*N*	♂♂ %	*N*
21 April — 10 May	71.1	45	59.5	37	60.9	23
11 May — 30 May	63.0	46	60.0	40	51.6	31
Total in spring	67.0	91	59.7	77	55.6	54

males in *Microtus* (Table 2). In autumn 1976 and 1977, the sex ratio of *Clethrionomys* was 1:1 but in *Microtus* more males than females were trapped ($t=2.05$, $P<0.05$).

Discussion

Studies of prey selection use data on the structure of the prey population as well as on the diet of the predator. The trappability of small mammals differs according to species, age, sex, reproductive condition and season (SMITH et al. 1975). Thus, the original trapping results used as such may give a non-realistic idea of the population structure. MYLLYMÄKI (1977), who took into consideration the different trappability of these sexes in *Microtus agrestis*, found an even sex ratio in overwintered populations (see also HANSSON 1969). The studies made on *Clethrionomys glareolus* in northern Finland (modified from VIRO 1974) and Czechoslovakia (ZEJDA 1967) showed that when breeding starts in spring the sex ratio is even, but unfortunately these authors failed to take account of the different trappability of the sexes. HANSSON (1969) presented data from northern Sweden which show that spring populations of *Clethrionomys glareolus* had a surplus of adult males during the peak year, while during the other years the sex ratios of adult animals were even.

In our study area, *Clethrionomys glareolus* populations were already declining in spring 1977 so that we were not dealing with a peak year. According to the trapping results obtained by us in autumn, the populations started wintering with a 1:1 sex ratio. Thus we assume that in spring 1977 both voles had an even sex ratio in the field.

TABLE 2. The sex ratio of *Clethrionomys glareolus* and *Microtus* sp. in snap traps in spring 1973 and 1977 and in autumn 1976 and 1977.

Trapping period	*Cl. glareolus* ♂♂ %	*N*	*Microtus* sp. ♂♂ %	*N*
May 1973	60.0	15	52.9	17
May 1977	71.9	32	58.3	36
Total in spring	68.1	47	56.6	53
Sept.—Oct. 1976	48.6	107	52.4	21
Oct.—Nov. 1977	49.3	73	82.4	17
Total in autumn	48.9	180	65.8	38

The sex ratios in *Clethrionomys* and *Microtus* were about the same in the surplus prey and in the trapping results. In this respect owls and traps were catching voles in the same way. Higher activity (vulnerability) of *Clethrionomys* males can explain their predominance in the prey and the traps. SOUTHERN & LOWE (1968) studied pellets of the Tawny Owl and found more males of both the Wood Mouse *Apodemus flavicollis* (60.5 %) and *Clethrionomys glareolus* (56.6 %). Their trapping results were also consistent with their prey data, and their material originated from different seasons of the year. They concluded that in general males are more active and own larger territories than females and are thus caught more often by owls and traps. The high percentage (65.0 %) of males in Brown Lemmings *Lemmus sibiricus* caught in spring by the Snowy Owl *Nyctea scandiaca* was also explained on the activity basis (THOMPSON 1955, according to BOONSTRA 1977). In summer, when young lemmings and a vegetation cover were present, predation became non-selective as to sex. MAHER (1970) described an interesting change in the foraging of the Pomarine Skua *Stercorarius pomarinus* during the breeding

season. In spring the Skuas preyed mainly upon male Brown Lemmings by visual cues from the air. But in summer they dug Brown Lemmings non-selectively from the ground. The results of our study support the idea that the small mammals caught by avian predators in the spring are more often male than female. According to BOONSTRA (1977), the birds and mammals preying on *Microtus townsendii* were consistently non-selective as to sex, but he did not deal with the spring populations separately.

At Pirkanmaa the chief food item of Tengmalm's Owl is *Clethrionomys glareolus* (SULKAVA & SULKAVA 1971). The Tawny Owl feeds mainly on *Microtus* voles and birds (MIKKOLA 1968, 1977). The relative abundance of *Microtus* voles in spring 1977 was seen in the surplus prey. Moreover, the large size of *Microtus* voles as compared with *Clethrionomys* may increase the remains of these voles left lying in the nest. The surplus prey of Tengmalm's Owl suggested a change in the sex ratio of *Clethrionomys* during spring, but not in that of *Microtus*. In the surplus prey of the Tawny Owl, however, the sex ratio of *Microtus* seemed to alter in late spring. A change in the activity of the vole sexes can only partly explain these results, and it thus seems that selective predation on males by owls can occasionally change the sex ratio in the population of their chief prey within the hunting range.

KREBS & MYERS (1974) considered that predators must be highly selective in their action to regulate microtine cycles, and the existence of such strong selectivity is not supported by the literature. Our data demonstrated slightly heavier predation pressure on males than on females in *Clethrionomys* and *Microtus* in spring. An opposite example was given by MACLEAN et al. (1974) from weasels *Mustela nivalis* in Alaska. They found that weasels preyed mainly on female lemmings *Lemmus trimucronatus* and *Dicrostonyx groenlandicus* in their winter nests. The sheltering behaviour of small mammal females during breeding evidently protects them against avian predators but is not so effective against mammalian predators.

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Selostus: **Koirasvoittoisuutta helmi- ja lehtopöllön keväisessä myyräsaaliissa**

Keväällä 1977 tarkastettiin Pirkanmaalla 26:lta helmi- ja 18:lta lehtopöllön pesäpöntöltä tavattujen ylijäämämyyrien sukupuoli. Metsämyyrien (N=96) ja *Microtus*-lajien (pääasiassa peltomyyriä) (N=131) kohdalla aineisto oli riittävä johtopäätöksien tekemiseen. Tutkimusalueella suoritettiin myös pikkunisäkäspyyntiä tappavilla loukuilla keväinä 1973 ja 1977 sekä syksyinä 1976 ja 1977 ja verrattiin saatua sukupuolijakaumaa pöllöjen ylijäämäsaaliista todettuun.

Kirjallisuustietojen perusteella talvehtineissa metsä- ja peltomyyräpopulaatioissa on koiraita ja naaraita yhtä paljon. Siitä huolimatta helmipöllön metsämyyräsaalis oli erittäin merkitsevästi ja *Microtus*-saalis suuntaa-antavasti koirasvoittoista (taul. 1). Sitä vastoin lehtopöllön *Microtus*-saaliissa koirasvaltaisuus ei ollut yhtä selväpiirteistä. Tulokset olivat yhtäpitäviä verrattaessa niitä keväisen loukkupyynnin tuloksiin (taul. 2). Myyräkoiraiden suurempi aktiivisuus (esilläolo) naaraisiin verrattuna selittänee havainnot.

Ylijäämäsaaliin koirasvoittoisuus oli suurinta alkukeväästä ja väheni lievästi kevään kuluessa. Sukupuolten välisten aktiivisuuserojen tasoittuminen on yhtenä ilmiön selityksenä, mutta mahdollisesti myös pöllöjen suorittama myyräkoiraiden verotus oli vaikuttamassa sukupuolijakaumiin. Tähän viittasi mm. se, että sukupuolijakautuma muuttui vain kummankin pöllölajin pääsaaliskohteen suhteen. Pikkunisäkäs-

naaraiden piileskelevä käyttäytyminen suojaa niitä petolinnuilta, mutta toisaalta ne ovat käytävistöissä saalistavien nisäkäspetojen ulottuvilla.

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