Insects in the diet of urban kestrels from central Europe: An alternative prey or constant component of the diet?

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During the years 1996–1998, the diet composition was assessed from pellets of kestrels in České Budějovice. Within the total number of 5226 prey individuals, insects made up 15.2% by numbers and 0.3% by weight. In the summer and early autumn, the abundance of insects was highest. It was partially caused by including pellets from juvenile kestrels that contained more insect remains than pellets from adults in general. Two main insect groups were found in the diet – beetles (mostly medium-sized Carabidae) and Ensifera (large Tettigoniidae). In the low vole year, the intake of beetles was higher in comparison with high vole year, whereas the intake of Ensifera was rather stable in both years. Our results support the "alternative" role of beetles in the diet of kestrels. However, the beetles are energetically incomparable with voles and are partially at least caught during the hunting on voles. Ensifera were more likely hunted with purpose. Contrary to beetles their proportion at individual roosting sites was balanced.

1. Introduction

The important role of insect prey in the diet of kestrels has been recorded many times before (i. e. Itämies & Korpimäki 1987, Davis 1975), especially in southern latitudes (i. e. Aparicio 1990, 2000, Piatella *et al.* 1999). The significance of this prey also increases when voles (*Microtus* sp.) become rare (i. e. Cavé 1968, Korpimäki 1985). The variation of insects in the diet of kestrels was recorded also within a year, especially the relatively important role of insects during the winter months (Davis 1975, Yalden & Warburton 1979). However, the main peak of insect in the diet comes in late summer or autumn months (Village 1982). This phenomenon was indirectly explained by hunting on insect prey by non-experienced juvenile kestrels (Shrubb 1982).

In central Europe, the role of insect in the diet should be less pronounced (reviewed by Korpimäki 1985). However, we have recorded a relatively high proportion of insects (by number) in the diet of kestrels from České Budějovice (Riegert 2001). Therefore we aimed at a more detailed analysis and tried to discover factors determining occurrence of main insect components.

We tested two null hypotheses: (1) The representation of insects in the diet does not depend on vole availability. (2) The representation of insects in the diet of juvenile and adult kestrels does not differ.

2. Material and methods

2.1. Study population and pellet collecting

We studied the diet composition of kestrels in the medium sized city of České Budějovice (Southern Bohemia, 250 m a. s. l., 49°58'N, 14°29'E; 40 km²; radius of the city 4 km; 100,000 inhabitants). The population of kestrels in České Budějovice varies between 40 and 50 pairs. The kestrels breed in the centre (in lofts or ventilation shafts) as well as on outskirts (on industrial buildings or in nest boxes). Breeding density is higher in the centre while the number of breeding pairs is more balanced as the area of outskirts is larger. The females disappear from České Budějovice in the course of autumn whereas the males winter there and they leave their breeding ranges for periods with continuous snow cover only.

All kestrels from České Budějovice feed outside the city predominantly and hunting is rarely observable inside the built-up areas. Within a radius of 5 kilometres of the continuously built-up areas, the hunting grounds include ruderal habitats (16%), either cut or not cut meadows (49%) and fields (35%).

The pellet collecting was made at individual roosting sites of kestrels in the centre of the city as well as in the outskirts (during the summer, the temporary roosting sites of juvenile kestrels were included too). In total we made 261 collections at 21 sites, in the period between August 1996 and October 1998, from which 31 collections (11.9%) came from roosting sites of juvenile kestrels in the post-fledgling period. The interval between two pellet controls varied between 8 to 42 days (mean 19.7 ± 8.3 days). The distribution of controls during the year and the number of pellets is shown in the appendix. The August was the only month with low number of collections, therefore it was excluded from statistical analyses.

To make sure of the categorisation of roosting sites between adult kestrels and juveniles, we made irregular night-controls with flashlight (at least one at each site per month). The roosting behaviour of juvenile kestrels was quite different from adult birds, since they tried to spend the night together or close to each other, especially in the early post-fledging period (personal observation). On the other hand adult birds roosted solitary. The

juveniles' roosting sites were recorded between June and November, yet the highest number of collections (18 from 35) came from July.

2.2. Pellet analysis

In total, we identified 5,226 prey individuals (4,577 pellets) in the diet of kestrels (see Appendix). The pellets were dried and all feather-remains were identified. The rest was dissolved in a solution of NaOH (Schueler 1972). Small mammals were determined by skulls using Anděra and Horáček (1982) and birds by beak and humeri using a reference collection. All beetles' remains were identified according to sculpture, coloration and size of coverts. However, unidentified individuals represent the great part of data on beetles (72.1%), when the remains of coverts were incomplete or milled. Ensifera were identified by the presence of apertures on legs. The presence of earthworms was not proved. Number of heads or mandibles (in Ensifera), coxae and other parts of legs determined the number of individuals. The total number of prey individuals was given by most number of identified parts of the body (i. e. one head and seven legs give two individuals, one head and six legs give one individual). The data on weight of prey groups (Ensifera, beetles, voles, shrews, birds and lizards) were taken from Hudec and Černý (1977), Itämies and Korpimäki (1987) and Carillo et al. (1995). Data on lengths of insect prey were taken from Javorek (1968) and Zahradník (1987).

2.3. Vole trapping

From the year 1997 we estimated the vole numbers on hunting grounds used by kestrels from České Budějovice (within a radius of 5 kilometres of the continuously built-up area). We used pitfall traps (plastic bottles with a cut neck and capacity of 2 l), totalling a 100 in number, each year. These traps were installed at 10 kestrel hunting grounds in late July (10 traps made up a trap line). All occurred habitat types were covered (50 traps were installed in meadows, 30 in fields and 20 in ruderal habitats). The traps were filled with a 4% fusion of formaldehyde and exposed for 17 days. In each

year the trapping effort was 1700 trap-nights. The numbers of voles caught: 34 (1997), 154 (1998), 45 (1999), 19 (2000), 29 (2001), 79 (2002).

2.4. Observations on hunting behaviour

The data on hunting behaviour were adopted from another authors' project, realised in České Budějovice during 1999–2002. Hunting grounds have been visited during the breeding season, from the late April to half of July. We gathered data on 302 hunting actions of adult birds. Besides the hunting success, we analysed the time, which was spent on ground after landing.

2.5. Statistical analyses

The data from the year 1996 were excluded from analyses, because the abundance of the common vole was not estimated in this year. Before the analyses, we recalculated the data in collections to individuals per one pellet. The changes of abundance were analysed using Generalised Linear Models (GLM, forward selection of factors, logit link function; Mc Cullagh & Nelder 1989). The selection and order of factors in a model was defined by Mallows Cp-statistics (Mallows 1973). We included mean temperature and mean precipitation in the course of control period, summer vole number and month into independent variables. To avoid pseudoreplications by repeating collections at one site, we involved the factor "site" into analyses. As the observed trends had differed for the two main insect components we computed three models that differed in dependent variable: a) all insects together, b) beetles only, c) Ensifera only. Ants or cockroaches were not analysed separately, because their proportions were too small (<2% of all insects). Using GLM analysis we tested the influence of vole abundance and hunting success to time spent on ground by kestrels after landing.

The Multivariate percentage data on diet composition (including vertebrates) were computed by Redundancy Analysis (RDA) in CANOCO (Braak & Šmilauer 1998) and visualised in CANODRAW (Šmilauer 1992). The data from collections were summarised by the month, for both years separately and percentages of each

component in the diet were log-transformed. Mean temperature and mean precipitation in the course of control period and summer vole numbers were included into environmental variables. Because the vole proportion in the diet was incomparably higher than proportion of other individuals, its percentages were weighted at 0.011.

The analysis of abundance of prey components between adult and juvenile kestrels was based on Kruskal-Wallis tests using STATISTICA Software (Statsoft, Inc. 1996). We used only data that belong to period when juveniles are present at roosting sites (July–November).

3. Results

3.1. Overall diet composition

The common vole (*Microtus arvalis*) was the most dominant prey in the diet. Its overall proportion was 77.9% by numbers (n = 4073) and 90.7% by weight. Other vertebrates, represented by other mammals, birds and lizards, made only 6.9% by numbers (n = 362) and 9.0% by weight. The insect prey made 15.2% by numbers (n = 796), yet only 0.3% by weight. Within the year (monthly data averaged) the proportion of insect varied between 3.6 and 31.5% (by numbers) or 0.0 and 1.4% (by weight). Other invertebrates were not recorded. The abundance (individuals per pellet) of insect prey showed two decreases during the winters 1996/97 and 1997/98 (Fig. 1). In the year 1998, the followed up increase during the breeding season and summer was less prominent. The abundance of voles in the diet was found to be increasing towards the year 1998 and that of other vertebrates was decreasing.

3.2. Insects in the diet

The remnants of insects were found in 62.1% of collections (162 from 261). Among insects, the proportion of beetles (Coleoptera) was 75,5% by numbers, Ensifera making up 23.9% and ants (Formicidae) and cockroaches (Blattodea) together 0.6%.

The proportion of beetles was high during the months of October and November 1996, and

Fig. 1. The changes of abundance (individuals per pellet) of insects, voles and other vertebrates in the diet of kestrels, years 1996–1998. A – autumn (Sep–Nov), W – winter (Dec–Feb), B – breeding season (Mar–May), S – summer (Jun–Aug).
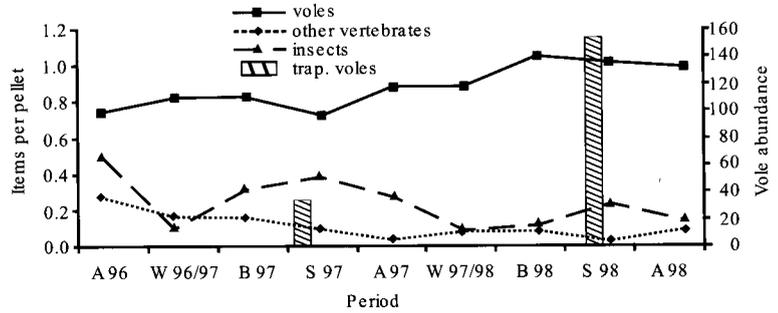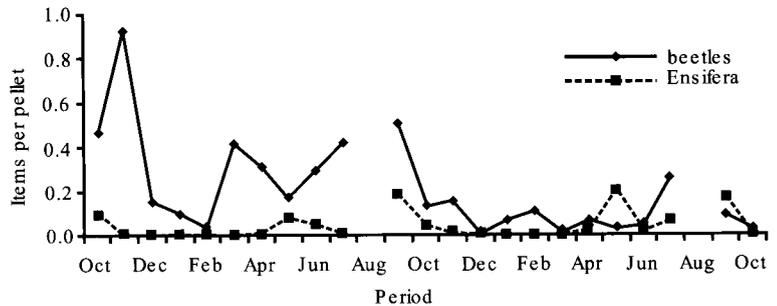

Fig. 2. Seasonal variation in abundance (individuals per pellet) of Ensifera and beetles in the diet. Data from Oct. 1996 to Oct. 1998.

March, July and September 1997 (Fig. 2). The lowest abundance was found in the winters 1996/97 and 1997/98. Among determined beetles (see Appendix), the most dominant groups were Carabidae (56.0%), Scarabeidae (15.7%), Dytiscidae (12.0%) and Curculionidae (8.8%). Carabidae were the only beetles that were found in the diet most of the year through, including the winter months. Their abundance was highest during the summer (June and July) and the same was true for Scarabaeidae. The third most dominant family of beetles, Dytiscidae, became most abundant in March.

The great number of beetles remained unidentified (73.1%), since only coxae and other parts of legs (especially from small species) were found. These could be considered in most cases being from small Carabidae, not true *Carabus* species.

Ensifera were recorded in the period between April and November. Their abundance were higher during the year 1998, with the peak in May and September (Fig. 2). Most of them (>90%), belonged to the family Tettigoniidae. The rest probably belonged to family Gryllidae.

Site, summer vole numbers and mean temperature in the course of control period significantly affected the abundance (individuals per pellet) of in-

Table 1. Factors affecting the abundance (individuals per pellet) of insect prey in the diet of urban kestrels (only significant relations included). Poisson GLM models, forward selection based on Cp-statistics. For all models, n = 251 collections.

Dep. var.	Indep. var.	Explained var. (%)	β	P
Insects	site	30.9	–	0.0001
	vole numbers	2.8	*	0.0214
	temperature	2.6	0.12	0.0221
Beetles	site	38.2	–	0.0001
	vole numbers	3.3	*	0.0001
	temperature	0.1	0.14	0.0341
Ensifera	temperature	3.1	0.19	0.0042

* The intake was lower in 1998

sects in the diet whereas the precipitation and the month had no significant effect (Table 1). In the year 1998, when the vole availability increased, the proportion of insect in the diet was lower. With increasing temperature the proportion of insect was higher (r_s = 0.22, P = 0.03, n = 261). When beetles and Ensifera were tested separately, the site and the vole availability had significant effect to the changes in abundance of beetles only. The model containing beetles only explained even
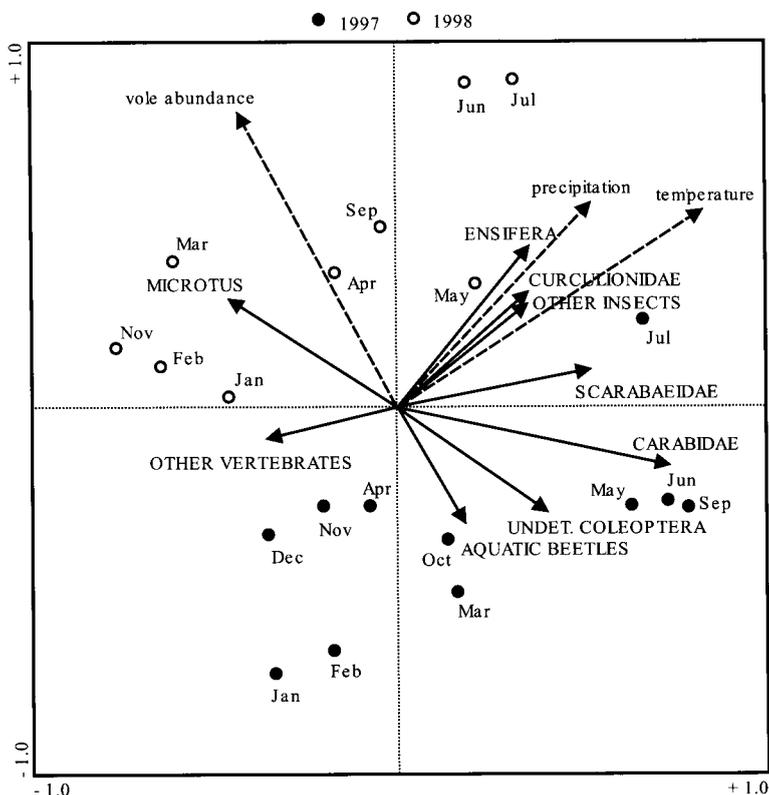
Fig. 3. The projection scores of main recorded invertebrate and vertebrate prey groups (from percentages), related to environmental factors. RDA, I and II canonical axes together 96.2%. Monte Carlo permutation test. Weight given to proportion of voles = 0.011.
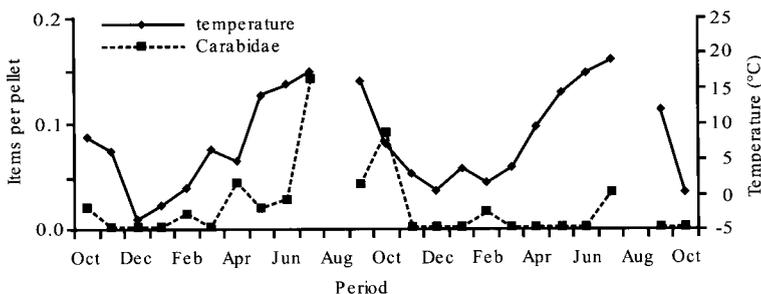

Fig. 4. The changes in abundance of Carabidae in the diet and mean month temperature. Data from Oct. 1996 to Oct. 1998 (n = 89).

more variability than the model with all insects. The mean temperature positively affected the abundance in both, Ensifera and beetles, yet the relationship was more pronounced in Ensifera.

Despite the fact that the influence of environmental factors tested in multivariate analysis (Fig. 3) was only indicative (temperature, P = 0.11; precipitation, P = 0.18; vole numbers, P = 0.10; Monte Carlo permutation tests, RDA), the pattern of data is similar to previous tests. Two independent gradients were found in the data. The first was correlated with the mean month temperature, second with the availability of voles. The precipitation

were positively correlated with the temperature (r_S = 0.71, P < 0.05, n = 27). Along gradients, both the collections (sites) and diet components (species) formed well-distinguished groups. The availability of voles markedly separated the years, which apparently differed in the representation of voles and most of beetles (Scarabaeidae, Carabidae, aquatic and unidentified groups) in the diet. The proportion of voles in the diet correlated with the vole availability positively, whereas the proportion of beetles showed a negative relationship. The proportion of other vertebrates, Ensifera, Curculionidae and other insects were correlated with the

temperature gradient. The relationship was nega-
tive in vertebrates and positive in insects. The
border between warm and cold periods was set by
the collections from May 1997, March and April
1998.

Carabidae were the only group of beetles that's
relatively high numbers enabled detailed analysis.
There was a positive correlation between the abun-
dance of Carabidae and mean month temperature
($r_s = 0.51$, P = 0.012, n = 27). The spring changes
of Carabidae abundance clearly followed the
changes in temperature, with a one-month delay
(Fig. 4). With the single exception of September
1997, the autumn abundance followed actual tem-
perature in the month. In the year 1998, when vole
numbers on hunting grounds increased, the
relation became less prominent.

3.3. Insect diet of adult and juvenile kestrels

The analysis of diet composition between adult
and juvenile kestrels showed that the intake of in-
sects was significantly higher in juvenile individu-
als (Kruskal-Wallis test, H = 8.44, P = 0.004, n =
123; Fig. 5). The intake of insects by juvenile kes-
trels did not change between the years (Kruskal-
Wallis test, H = 0.47, P = 0.490, n = 31). On the
contrary, adult and juvenile kestrels do not differ
in the intake of voles (Kruskal-Wallis test, H =
0.82, P = 0.775, n = 123; Fig. 5).

3.4. Size of insect prey

The distribution of insect prey length in the diet is
clearly bimodal with the peaks between 10–15 and
30–35 mm (Fig. 6). Medium sized Carabidae,
Scarabeaidae and Curculionidae beetles give the
first one and Ensifera the second one. Formicidae,
Byrrhidae, Hydrophilidae (*Hydrobius fuscipes*
only) and Histeridae represent the smallest prey in-
dividuals (<10 mm) and Ensifera the largest prey
(>30 mm).

3.5. Hunting behaviour

With the increasing vole abundance, the time spent
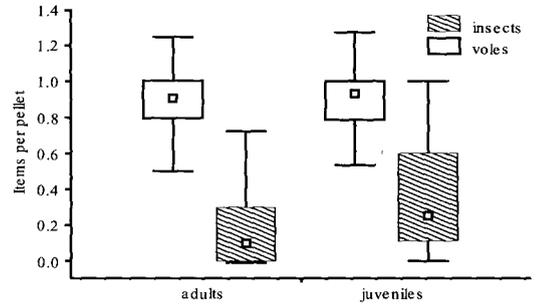on ground after strike was decreasing (Table 2).

Fig. 5. The intake of voles and insect prey (individuals
per pellet) by adult kestrels and post-fledgling juve-
niles, Kruskal-Wallis median test (H = 8.44, P =
0.004, n = 132,). Median, 25–75%, non-outlier range.

After negative strikes, the kestrels spent on ground
more time, but the difference was indicative only.

4. Discussion

4.1. The role of insects in kestrel's diet

The role of insect prey in the diet of kestrels in-
creases from north to south and in areas with cli-
mates influenced by the Atlantic (Korpimäki
1985, Aparicio 1990, Village 1990). Its proportion
in the diet in České Budějovice was quite low, in
comparison with southern (Fernández-Alonzo
1985, Aparicio 1990, Carillo *et al.* 1995, Piatella *et
al.* 1999) and western Europe (Fairley & McLean
1965, Thiollay 1968, Davis 1975, Village 1982).
The proportion of insect was rather similar to other
studies from central Europe (9% – Romanowski
1996, 4.7% – Plesník 1992), yet was slightly
higher (15.7%).

Among insects, beetles were the most domi-

Table 2. The influence of tested factors to time spent
on ground by kestrels after landing (n = 302). Poisson
GLM models, forward selection based on Cp-statis-
tics.

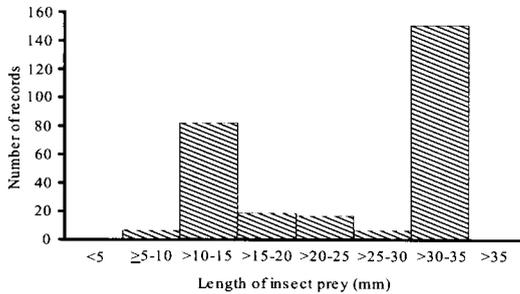| Independent var.	Explained var. (%)	β	P
Vole abundance (items)	8.6	−0.84	0.0009
Hunting success (y/n)	1.3	*	0.1012

* The time-delay was longer after non-successful strikes

Fig. 6. The distribution of length categories (in mm) of insect prey in the diet, n = 283.

nant group that composed over 75% of the insect remains. This result corresponds well with other works on kestrels diet (i.e. Plesník 1992, Piatella *et al.* 1999). Among beetles, the Carabidae were found in the diet most frequently as showed by other studies at similar and northern latitudes also (i.e. Davis 1975, Itämies & Korpimäki 1987). In the Canary Islands, Carabidae are less numerous and they are substituted for Scarabaeidae and Tenebrionidae (Carillo *et al.* 1995). The importance of Scarabaeidae (genus *Geotrupes*) in the diet of kestrels was also docummented by many studies from islands of United Kingdom (Simms 1961, Fairley & McLean 1965, Davis 1975, Yalden & Warburton 1979, Village 1982). In the recent study, remains of Scarabaeidae were less abundant and in most of cases belonging to genus *Rhizotrogus* (see Appendix). The proportion of the third most numerous group – Dytiscidae – is quite high in comparison with all mentioned studies. This result may have something to do with the large number of fishponds in the surroundings of České Budějovice. However, the family is not represented by large species, but small ones of genus *Colymbetes*, whose occurrence in the diet of kestrels was recorded in western Finland too (Itämies & Korpimäki 1987).

The representation of other insects was nearly restricted to Ensifera (mostly Tettigoniidae), whose overall proportion (3,1%) was similar to other urban studies from central (Plesník 1992) and western (Thiolay 1968) Europe.

We can conclude by saying that the insect component in the diet of kestrels from České Budějovice is similar to other kestrel populations

from central Europe. This is not surprising in case that the kestrels from České Budějovice predominately feed in surrounding rural landscape.

4.2. Why kestrels in central Europe prey on insects?

The highest peak of insect prey was found in summer and early autumn. We have no data about insect abundance on the hunting grounds and therefore we are not able reject directly the null hypothesis that the representation of insect prey is determined by its availability only.

Shrubb (1982) explains the increase of insect prey in the diet during the summer and early autumn by the hunting behaviour of juvenile kestrels and our results are consistent with his finding. The pellets from temporary roosting sites of juvenile kestrels contain a higher number of insects than those from adult birds. Moreover, the abundance of insects in the diet of juvenile kestrels did not decreased in the year with high abundance of voles. Therefore juvenile kestrels contribute to the summer and early autumn peak of insect prey at least.

Shrub (l.c.) assigns the higher proportion of insects in the diet of juvenile kestrels to their low hunting ability. However, there are alternative explanations. Juvenile kestrels may be forced out to the worse hunting grounds. We have no indications supporting this hypothesis, as we have not observed any attacks of adult kestrels against juvenile ones. Another explanation is that the juvenile kestrels have less pronounced feeding preferences only. Our finding, that there is no difference in the number of voles in pellets among adult and juvenile kestrels, support this hypothesis. The insects do not substitute the voles in the diet of juvenile kestrels they only supplement them. Therefore the insects in the diet of juvenile kestrels do not represent an alternative prey in the sense of "Optimal Foraging Theory" (Stephens & Krebs 1986).

The abundance of beetles in the pellets differed between sites markedly that indicated great individual variability. Additionally, beetles in diet occurred in low vole year more frequently. The impact of temperature was less pronounced, showing the differences between warm and cold months. The increased abundance of beetles during the summer was prominent in the year 1997 only,

when vole availability was lower.

This result supports findings of other studies that beetles play the role of alternative prey in kestrels (i.e.Yalden and Warburton 1979, Village 1982, Korpimäki 1985). However, taking the weight of recorded beetles into consideration, their proportion in the diet is negligible (see also Itämies and Korpimäki 1987, Plesník 1992). The "Optimal Foranging Theory" predicts that prey types are added to the diet in order of their profitability (Stephens & Krebs 1986). However, the profitability of beetles is much lower than that of other potential alternative prey. Especially birds should be attractive for the urban kestrels. However, their representation in the diet remains low and stable. We suppose that minimum hunting costs compensate disadvantage of beetles as alternative prey. Village (1983) and Shrubb (1982) pointed that insects are caught with purpose, from hovering near the ground. We did not observe such hunting behaviour. We suppose that at least some beetles are caught during the hunting on voles. In agreement with the statement, the time spent on ground by kestrels after strike from "normal hovering" was longer during low vole year. We suppose that this time-delay could be used for hunting on beetles. The indicative difference in time-delay was also found between successful and non-successful strikes. This result may indicate that searching for beetles is more intensive if more profitable prey is lost.

In contrast, Ensifera were found in the diet independent to the availability of voles. Their occurrence in the diet is probably limited by temperature only. The representation of Ensifera also did not differ between sites significantly, in contrary with beetles and voles. Ensifera identified in pellets (in most cases large Tettigoniidae) are approximately 6.5 times heavier than beetles. Therefore we suppose that hunting of Ensifera was done with purpose. Moreover the Ensifera represent equally preferred prey as voles do. The similar role of Ensifera was found before, especially in southern and western populations of kestrels (Thiollay 1968, Carillo *et al.* 1995, Piatella *et al.* 1999, Aparicio 2000). Their representation was higher in one order however.

We can reject both null hypothesis formulated in Introduction. In České Budějovice the representation of insects in the diet of kestrel increase with the decreasing vole availability. However, this conclusion is valid for beetles only that form less profitable component of the insect prey. The representation of insect in the diet of juvenile kestrels is higher than that of adult ones. However, the insect prey does not substitute the voles in the diet of juvenile kestrels.

Hyönteiset tuulihaukan ravinnossa: vaihtoehtosaalista vai pysyvä osa ravintoa?

Artikkelin kirjoittajat analysoivat tuulihaukan ravinnon koostumusta vuosina 1996–1998 České Budějovicen kaupungissa. Kirjoittajat keräsivät oksennuspalloja 21 tuulihaukan levähdyspaikalta 261 eri kertaa. Lisäksi arvioitiin myyrien määrä sekä havainnointiin haukkojen saalistuskäyttäytymistä. Oksennuspallonäytteitä kertyi kaikkiaan 4 577 kappaletta ja niistä määritettiin yhteensä 5 226 saalisyksilöä.

Tuulihaukan pääsaalislajiksi havaittiin kenttämyyrä; saalisyksilöistä kenttämyyriä oli 78 %. Hyönteisten osuus saalisyksilöistä oli keskimäärin 15 %. Saalisyksilöiden painosta hyönteisten osuus oli vain 0,3 %. Suurimmillaan hyönteisten osuus saalisyksilöistä oli kesällä ja alkusyksyllä. Nuorten tuulihaukkojen näytteissä oli enemmän hyönteisiä kuin vanhojen lintujen näytteissä. Pääasiallisia tuulihaukan saalishyönteisryhmiä olivat kovakuoriaiset (erityisesti keskikokoiset maakiitäjäiset) sekä suorasiipisiin kuuluvat pitkäsarviset (erityisesti isot hepokatit). Huonoina myyrävuosina haukat käyttivät ravintonaan enemmän kovakuoriaisia kuin hyvinä myyrävuosina.

Myyräkantojen koon vaihtelu ei sen sijaan vaikuttanut pitkäsarvisten määrään tuulihaukan oksennuspalloissa. Tulosten mukaan kovakuoriaiset näyttävät olevan tuulihaukoille vaihtoehtoista saalista, jota käytetään, kun myyriä on vähän. Kovakuoriaiset eivät kuitenkaan ole energeettisesti rin-

nastettavissa myyriin ja ilmeisesti tuulihaukka ainakin osittain saalistaa niitä myyränpyynnin yhteydessä. Hepokatteja tuulihaukka näyttää sen sijaan saalistavan tarkoituksellisesti.

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Appendix. The number of prey individuals in the diet of kestrels in České Budějovice during the years 1996–1998 and its annual changes.

Family/Order	taxa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	total	% by numbers
Byrrhidae	*Byrrhus* sp.	0	0	0	0	0	0	1	0	0	0	0	0	1	0.02
Carabidae	*C. granulatus*	0	0	0	0	2	0	1	0	0	0	0	0	3	0.06
	C. scheidleri	0	2	0	0	0	0	3	0	1	0	0	0	6	0.11
	Carabus sp.	0	1	0	0	3	0	8	0	0	0	0	0	12	0.23
	undet.	0	2	3	6	2	20	13	0	12	10	0	0	68	1.30
Cerambycidae	*Spondylis buprest.*	0	0	0	0	0	0	1	0	0	0	0	0	1	0.02
	Aromia moschata	0	0	0	0	0	0	0	0	1	0	0	0	1	0.02
Curculionidae	*Otiorrhynchus*	0	0	0	0	0	0	11	1	2	0	0	0	14	0.27
Dytiscidae	*Colymbetes fuscipes*	0	0	13	1	3	0	0	0	0	2	0	0	19	0.36
Hydrophillidae	*Hydrobius fuscipes*	0	0	1	0	0	0	0	0	0	0	0	0	1	0.02
Histeridae	*Hister* sp.	0	0	0	0	0	0	0	0	0	1	0	0	1	0.02
Scarabeidae	*Aphodius prodromus*	0	0	0	0	0	0	0	0	0	0	0	0	1	0.02
	Potosia cuprea	0	0	0	0	0	0	1	0	0	0	0	0	1	0.02
	Rhizotrogus sp.	0	0	0	0	0	5	18	0	0	0	0	0	23	0.44
Silphidae	*Necrophorus* sp.	0	0	0	0	0	0	0	0	1	1	0	0	2	0.04
Coleoptera undet.		22	22	35	62	28	25	50	6	65	79	40	8	442	8.46
COLEOPTERA		22	27	52	70	38	51	111	7	82	93	40	8	601	11.50
ENSIFERA		0	0	0	9	28	14	22	2	82	30	3	0	190	3.64
FORMICOIDEA		0	0	0	0	0	0	4	0	0	0	0	0	4	0.08
BLATTODEA		0	0	0	0	0	1	0	0	0	0	0	0	1	0.02
MICROTINAE	*Microtus arvalis*	240	302	365	458	413	356	572	10	339	597	238	183	4073	77.94
OTHER VERT.		21	31	29	54	37	33	29	6	18	65	8	31	362	6.93
Total number		283	360	446	591	516	454	734	25	521	785	289	222	5226	100.00
Number of collections		15	19	21	37	29	28	42	1	15	27	17	10	261	
Number of pellets		279	349	395	480	436	403	625	35	399	690	274	212	4577	