

Spiders (Araneae) as bird food

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ABSTRACT

The diet of 40 bird species (passerines, woodpeckers, Coraciiformes) was studied using the neck ring method and dropping analysis. Altogether 60,335 food items out of 7,919 food samples were examined. One hundred and sixteen spider species belonging to 60 genera and 20 families were found in the food of 34 bird species. *Diaea dorsata*, *Xysticus lanio*, *Philodromus rufus*, *Araniella cucurbitina* and species of the genus *Coelotes* played the important role in the diet. Rare species like *Dipoena inornata*, *Entelecara erythropus*, *Hypsosinga albobittata*, *Pardosa sordidata*, *Cheiracanthium montanum*, *Marpissa radiata*, *Sitticus caricis* and *Araniella proxima* (first record for Slovakia) were found.

INTRODUCTION

Spiders are important food for many everttebratophagous (insectivorous) and omnivorous birds. Their proportion and species composition in food of some bird species during the breeding period is mentioned by several authors (e.g. Bureš 1986; Prokofjeva 1986; Török 1988; Török & Tóth 1988; Sacher & Dornbusch 1990; Renner & Dick 1992; Krištín 1994, 1995).

Bird predation, as one of the reasons of winter mortality in spruce-living spiders, was studied by Askenmo *et al.* (1977), Norberg (1977) and Gunnarsson (1983). Thaler (1973) observed the behaviour of goldcrests (*Regulus r. regulus*), foraging in spruce during winter in the surroundings of Innsbruck (Austria), which preferred small spiders (about 2 mm long). The composition and proportion of arachnids in the food of *Turdus philomelos* in winter samples is reported by Fraticelli (1982). Walzberg (1993) studied the food of *Lanius collurio* and the proportion of arachnids in its diet. The articles mentioned concern detailed studies and deal with very narrow fields; more general data are not available.

The aims of the present study were:

1. to analyse the food variability and to determine the proportion of spiders in the diet of 40 selected bird species,
2. to present a survey of the determinable taxa of spiders occurring in the food of nestlings of 21 selected bird species and their qualitative and quantitative structure.

MATERIAL AND METHODS

The diet of 40 bird species (passerines, woodpeckers, Coraciiformes) was studied using the neck ring method and dropping analysis. The study area was mainly located in oak-beech forests, pastures and hedges in Slovakia and Bavaria. The research period lasted from May to July in the years 1978-1994. During the study 60,335 food items out of 7,919 food samples were examined. From 11 Slovak localities only 1,176 spider specimens of 3,191 spider items (neck ring samples, 21 bird species) could be determined to the family, genus or species level. The relative abundance (n %) of each spider taxon out of all determined specimens ($\Sigma n = 1,176$) and relative frequency (f %) of each spider taxon out of all food samples with determined spider taxa ($\Sigma f = 610$) are given in Tab. 2.

RESULTS

I. Food of selected bird species during the breeding period

During the breeding period 40 investigated bird species consumed a wide spectrum of different taxonomical groups. Caterpillars of Lepidoptera (butterflies and moths), Coleoptera (beetles), Hymenoptera, Homoptera and Diptera (flies and midges) were eudominant components for majority of bird species.

Spiders (3,191 items = 5.3 %) were found in the food of 34 bird species (Tab. 1). In the food of 12 bird species spiders were found eudominantly (n > 10 %). The highest proportion of spiders was observed in the food of *Remiz pendulinus* (35.2 %), *Picoides tridactylus* (33.6 %) and *Parus caeruleus* (31.3 %) (Tab. 1).

II. Species composition of spiders in bird food

The spider specimens from 11 Slovakian localities were assigned to 116 species, 60 genera and 20 families (more than 1/8 of the Slovakian spider fauna), including rare and interesting species: *Dipoena inornata*, *Entelecara erythropus*, *Hypsosinga albobittata*, *Pardosa sordidata*, *Cheiracanthium montanum*, *Marpissa radiata*, *Sitticus caricis*, and *Araniella proxima*, the latter being new for the country.

The most abundant and most frequent spider species were (Tab. 2): *Xysticus lanio* (found in 11 bird species with n = 15.2 %), *Diaea dorsata* (in 11 bird species with 11.8 %), *Araneus triguttatus* (in 10 bird species with 3.3 %), and *Araniella cucurbitina* (in 10 bird species with 3.3 %).

Tab. 1. Food of 40 bird species during the breeding period 1978-1994 in 3 biotopes (in %, F/D - absolute frequency/dominance, GL - Gastropoda, Lumbriidae, IDC - Isopoda, Diplopoda, Chilopoda, AR - Araneae, OP - Opiliones, Ps - Pseudoscorpiones, OR - Orthoptera, HE - Heteroptera, HO - Homoptera, CO - Coleoptera, HY - Hymenoptera, LE - Lepidoptera, DI - Diptera, VEG - plant seeds, OTH - others).

Food group	AR	OP	GL	IDC	OR	HE	HO	CO	HY	LE	DI	VEG	OTH
Bird species	F/	D	Ps										
<i>Aegithalos caudatus</i>	16/	173	1.2					69.4	4.6	0.6	16.2	9.8	-
<i>Anthus trivialis</i>	71/	233	13.7	0.4		9.9	1.7	13.4	6.9	4.3	28.0	24.5	-
<i>Certhia familiaris</i>	82/	809	8.3	4.6	0.1		2.1	40.7	1.4	1.2	15.1	9.6	19.0
<i>Carduelis chloris</i>	13/	267	-	-	-	-	-	-	14.2	-	-	-	85.8
<i>Carduelis cannabina</i>	10/	525	-	-	-	-	-	0.2	1.5	-	-	-	98.3
<i>Coc. coccothraustes</i>	11/	267	5.6	-	1.1	0.7	-	-	15.4	0.4	49.4	0.4	27.0
<i>Dendrocopos major</i>	31/	1,390	1.0	3.7	0.1	0.4	0.7	14.9	8.2	47.8	6.3	11.5	5.0
<i>Dryocopus martius</i>	39/	6,092	0.1	-	-	-	0.1	0.1	6.6	92.9	0.2	0.1	-
<i>Emberiza citrinella</i>	43/	241	5.0	-	0.4	-	10.4	-	3.4	7.1	0.4	28.6	21.6
<i>Erethacus rubecula</i>	150/	457	14.9	2.6	0.7	6.6	0.2	11.8	14.0	8.8	16.6	16.6	0.2
<i>Ficedula albicollis</i>	451/	3,432	10.3	2.6	0.3	2.7	0.4	5.6	4.3	19.3	14.4	16.3	18.0
<i>Jynx torquilla</i>	52/	3,996	-	-	0.1	-	-	0.1	0.1	99.7	-	-	-
<i>Lanius collurio</i>	24/	144	0.7	-	0.7	11.1	6.9	-	49.1	16.7	9.7	3.5	0.7
<i>Lanius minor</i>	260/	346	-	-	0.6	1.7	64.6	-	19.2	-	14.2	-	0.3
<i>Lanius excubitor</i>	125/	544	1.5	-	-	0.8	8.9	1.5	36.8	32.4	3.2	1.5	13.4
<i>Merops apiaster</i>	125/	2,174	-	-	-	-	0.2	2.6	16.3	70.5	2.9	5.1	2.4
<i>Oenanthe oenanthe</i>	65/	234	5.1	-	0.8	0.8	11.9	-	5.5	22.1	13.6	11.1	0.4
<i>Parus ater</i>	206/	1,104	15.5	0.4	0.8	-	3.7	1.1	44.9	1.2	0.9	27.6	2.4
<i>Parus caeruleus</i>	250/	550	31.3	-	1.1	-	-	1.1	4.2	4.2	-	56.9	0.7
<i>Parus major</i>	773/	1,287	17.4	1.5	1.8	-	1.1	-	2.3	5.4	0.2	60.3	9.5

Tab. 1 cont.

Food group	AR		OP	GL	IDC	OR	HE	HO	CO	HY	LE	DI	VEG	OTH	
	F/	D													
<i>Parus palustris</i>	293/	1,836	7.8	-	0.6	0.1	1.6	11.3	2.0	0.4	69.3	7.0	-	-	
<i>Passer domesticus</i>	106/	612	8.9	-	0.4	1.2	2.3	17.8	26.5	0.8	22.2	9.5	5.9	4.5	
<i>Passer montanus</i>	1120/	5,820	4.2	0.2	0.8	0.2	1.3	25.8	20.8	0.7	29.0	12.4	4.4	0.2	
<i>Phoenicurus ochruros</i>	40/	225	3.6	7.1	0.9	3.5	0.4	9.8	30.7	19.6	10.2	12.9	-	-	
<i>Phylloscopus collybita</i>	233/	1,365	11.2	0.3	2.6	0.1	0.8	23.7	0.2	2.2	15.5	25.1	-	9.8	
<i>P. sibiratrix</i>	90/	312	16.1	1.5	4.5	-	-	10.6	5.8	1.6	11.2	38.8	-	5.8	
<i>Pica pica</i>	223/	2,561	1.5	-	3.6	0.1	0.2	0.03	39.8	0.6	17.6	31.0	4.2	1.	
<i>Picoides tridactylus</i>	162/	812	33.6	0.6	0.7	0.1	-	0.6	50.5	5.7	-	7.8	-	0.4	
<i>Picus viridis</i>	41/	4,050	0.2	-	-	-	-	-	0.2	99.6	-	-	-	-	
<i>Prunella modularis</i>	173/	3,957	4.5	16.1	1.6	0.8	0.1	38.7	3.4	2.3	7.7	9.0	-	15.3	
<i>Remiz pendulinus</i>	260/	856	35.2	-	1.6	-	-	46.3	1.2	0.2	14.2	-	-	0.3	
<i>Sturnus vulgaris</i>	121/	685	9.2	-	3.2	3.4	7.0	0.4	45.7	1.6	21.7	5.1	1.2	-	
<i>Siitta europaea</i>	1585/	10,892	3.3	5.8	0.7	0.4	0.1	17.2	15.0	2.4	28.7	14.7	0.1	2.0.	
<i>Sylvia atricapilla</i>	23/	171	5.8	-	2.9	0.6	-	28.1	15.8	0.6	15.2	10.5	14.6	-	
<i>Sylvia borin</i>	14/	117	8.5	-	-	-	-	23.0	16.2	7.6	15.4	12.7	15.4	-	
<i>Sylvia curruca</i>	22/	136	10.3	-	1.5	-	1.5	22.0	9.6	5.1	27.2	7.3	5.1	2.2	
<i>T. troglodytes</i>	94/	522	20.7	8.4	-	6.9	-	1.0	15.1	1.5	7.1	29.9	-	9.4	
<i>Turdus merula</i>	86/	160	3.6	1.3	18.8	10.7	-	0.6	12.4	4.4	34.4	8.8	3.1	1.3	
<i>Turdus philomelos</i>	130/	239	2.5	2.9	37.2	3.3	-	2.9	14.6	2.1	16.3	17.1	-	0.4	
<i>Upupa epops</i>	306/	742	-	-	-	0.3	40.6	-	43.5	8.4	6.8	0.2	-	-	
Total	7919/	60,335	322.3	68.9	93.7	44.0	153.3	67.7	501.5	609.0	570.7	749.7	405.7	293.5	104.0

Tab. 2. Spiders in the food of selected 21 bird species in Central Europe (n - abundance, n % - relative abundance, f - frequency, f % - relative frequency).

Spider species	Bird species	n	n%	f	f%
Segestriidae					
<i>Segestria senoculata</i> (L.)	<i>Certhia familiaris</i> L.	4	0.34	3	0.49
	<i>Ficedula albicollis</i> (Temm.)	1	0.09	1	0.16
	<i>Oenanthe oenanthe</i> (L.)	1	0.09	1	0.16
	<i>Sitta europaea</i> L.	1	0.09	1	0.16
Mimetidae					
<i>Ero furcata</i> (Villers)	<i>Prunella modularis</i> (L.)	2	0.17	2	0.33
	<i>Troglodytes troglodytes</i> (L.)	2	0.17	2	0.33
<i>Dipoena inornata</i> (O. P.-C.)	<i>Anthus trivialis</i> (L.)	1	0.09	1	0.16
<i>Enoplognatha ovata</i> (Clerck)	<i>Anthus trivialis</i> (L.)	1	0.09	1	0.16
	<i>Phylloscopus sibilatrix</i> (Bechst.)	1	0.09	1	0.16
	<i>Prunella modularis</i> (L.)	18	1.53	4	0.66
	<i>Troglodytes troglodytes</i> (L.)	1	0.09	1	0.16
<i>Episinus angulatus</i> (Black.)	<i>Prunella modularis</i> (L.)	2	0.17	2	0.33
<i>Robertus truncorum</i> (L. K.)	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16
<i>Theridion impressum</i> L. K.	<i>Anthus trivialis</i> (L.)	2	0.17	1	0.16
<i>Theridion bimaculatum</i> (L.)	<i>Anthus trivialis</i> (L.)	1	0.09	1	0.16
<i>Theridion nigrovariegatum</i> Sim.	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16
<i>Theridion pictum</i> (Walck.)	<i>Certhia familiaris</i> L.	2	0.17	1	0.16
<i>Theridion tinctum</i> (Walck.)	<i>Anthus trivialis</i> (L.)	1	0.09	1	0.16
<i>Theridion varians</i> Hahn	<i>Phylloscopus collybita</i> (Vieil.)	4	0.34	3	0.49
	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16
Linyphiidae					
<i>Bathyphantes nigrinus</i> (Westr.)	<i>Prunella modularis</i> (L.)	2	0.17	2	0.33
<i>Diplocephalus picinus</i> (Black.)	<i>Prunella modularis</i> (L.)	13	1.11	4	0.66
<i>Dismodicus bifrons</i> (Black.)	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16
<i>Entelecara erythropus</i> (Westr.)	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16
<i>Erigone atra</i> Black.	<i>Anthus trivialis</i> (L.)	1	0.09	1	0.16
<i>Gonatium rubellum</i> (Black.)	<i>Prunella modularis</i> (L.)	4	0.34	3	0.49
<i>Lepthyphantes</i> sp.	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16
<i>Lepthyphantes cristatus</i> (Menge)	<i>Prunella modularis</i> (L.)	9	0.77	5	0.82
<i>Lepthyphantes flavipes</i> (Black.)	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16
<i>Lepthyphantes mughi</i> (Fickert)	<i>Prunella modularis</i> (L.)	17	1.45	2	0.33
<i>Lepthyphantes tenebricola</i> (Wider)	<i>Prunella modularis</i> (L.)	6	0.51	3	0.49
<i>Linyphia</i> sp.	<i>Ficedula albicollis</i> (Temm.)	1	0.09	1	0.16
<i>Linyphia</i> sp.	<i>Phylloscopus collybita</i> (Vieil.)	1	0.09	1	0.16
<i>Linyphia hortensis</i> Sund.	<i>Sitta europaea</i> L.	4	0.34	3	0.49
	<i>Troglodytes troglodytes</i> (L.)	3	0.26	1	0.16
<i>Linyphia triangularis</i> (Clerck)	<i>Phylloscopus collybita</i> (Vieil.)	3	0.26	1	0.16
<i>Linyphiidae non det.</i>	<i>Erithacus rubecula</i> (L.)	1	0.09	1	0.16
	<i>Parus palustris</i> L.	1	0.09	1	0.16
	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16

Tab. 2 cont.

Spider species	Bird species	n	n%	f	f%
<i>Micrargus herbigradus</i> (Black.)	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16
<i>Microneta viaria</i> (Black.)	<i>Prunella modularis</i> (L.)	3	0.26	3	0.49
<i>Neriere emphana</i> (Walck.)	<i>Coccothraustes coccothraustes</i> (L.)	1	0.09	1	0.16
<i>Neriere peltata</i> (Wider)	<i>Phylloscopus collybita</i> (Vieil.)	6	0.51	5	0.82
<i>Neriere radiata</i> (Walck.)	<i>Ficedula albicollis</i> (Temm.)	2	0.17	1	0.16
	<i>Phylloscopus collybita</i> (Vieil.)	2	0.17	2	0.33
<i>Trematocephalus cristatus</i> (Wider)	<i>Phylloscopus collybita</i> (Vieil.)	2	0.17	2	0.33
<i>Walckenaeria acuminata</i> Black.	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16
<i>Walckenaeria antica</i> (Wider)	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16
<i>Walckenaeria cuspidata</i> Black.	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16
Tetragnathidae					
<i>Metellina menzei</i> (Black.)	<i>Parus major</i> L.	1	0.09	1	0.16
<i>Pachygnatha degeeri</i> Sund.	<i>Anthus trivialis</i> (L.)	2	0.17	1	0.16
<i>Pachygnatha listeri</i> Sund.	<i>Prunella modularis</i> (L.)	2	0.17	2	0.33
<i>Tetragnatha</i> sp.	<i>Anthus trivialis</i> (L.)	1	0.09	1	0.16
<i>Tetragnatha pinicola</i> L. K.	<i>Passer montanus</i> (L.)	1	0.09	1	0.16
Araneidae					
<i>Araneus</i> sp.	<i>Ficedula albicollis</i> (Temm.)	1	0.09	1	0.16
	<i>Parus ater</i> L.	1	0.09	1	0.16
	<i>Parus palustris</i> L.	1	0.09	1	0.16
	<i>Remiz pendulinus</i> (L.)	1	0.09	1	0.16
	<i>Sitta europaea</i> L.	1	0.09	1	0.16
<i>Araneus alsine</i> (Walck.)	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16
<i>Araneus diadematus</i> Clerck	<i>Parus ater</i> L.	4	0.34	1	0.16
	<i>Parus palustris</i> L.	1	0.09	1	0.16
	<i>Phylloscopus collybita</i> (Vieil.)	2	0.17	1	0.16
	<i>Sitta europaea</i> L.	1	0.09	1	0.16
<i>Araneus marmoreus</i> Clerck	<i>Parus major</i> L.	2	0.17	2	0.33
	<i>Remiz pendulinus</i> (L.)	1	0.09	1	0.16
<i>Araneus triguttatus</i> (Fabr.)	<i>Certhia familiaris</i> L.	1	0.09	1	0.16
	<i>Erithacus rubecula</i> (L.)	2	0.17	1	0.16
	<i>Ficedula albicollis</i> (Temm.)	2	0.17	2	0.33
	<i>Parus ater</i> L.	4	0.34	3	0.49
	<i>Parus caeruleus</i> L.	11	0.94	4	0.66
	<i>Parus major</i> L.	4	0.34	1	0.16
	<i>Parus palustris</i> L.	1	0.09	1	0.16
	<i>Phylloscopus collybita</i> (Vieil.)	10	0.85	5	0.82
	<i>Phylloscopus sibilatrix</i> (Bechst.)	1	0.09	1	0.16
	<i>Sitta europaea</i> L.	2	0.17	2	0.33
<i>Araniella</i> sp.	<i>Coccothraustes coccothraustes</i> (L.)	6	0.51	2	0.33
	<i>Erithacus rubecula</i> (L.)	1	0.09	1	0.16
	<i>Ficedula albicollis</i> (Temm.)	7	0.60	5	0.82
	<i>Parus caeruleus</i> L.	3	0.26	1	0.16
	<i>Parus palustris</i> L.	2	0.17	1	0.16
	<i>Phylloscopus collybita</i> (Vieil.)	6	0.51	2	0.33

Tab. 2 cont.

Spider species	Bird species	n	n%	f	f%	
<i>Araniella alpica</i> (L. K.)	<i>Ficedula albicollis</i> (Temm.)	2	0.17	2	0.33	
	<i>Parus ater</i> L.	5	0.43	2	0.33	
	<i>Parus caeruleus</i> L.	4	0.34	2	0.33	
	<i>Sitta europaea</i> L.	1	0.09	1	0.16	
<i>Araniella cucurbitina</i> (Clerck)	<i>Anthus trivialis</i> (L.)	1	0.09	1	0.16	
	<i>Erithacus rubecula</i> (L.)	1	0.09	1	0.16	
	<i>Ficedula albicollis</i> (Temm.)	6	0.51	4	0.66	
	<i>Parus ater</i> L.	4	0.34	2	0.33	
	<i>Parus caeruleus</i> L.	3	0.26	2	0.33	
	<i>Parus major</i> L.	3	0.26	1	0.16	
	<i>Parus palustris</i> L.	1	0.09	1	0.16	
	<i>Phylloscopus collybita</i> (Vieil.)	18	1.53	5	0.82	
	<i>Remiz pendulinus</i> (L.)	2	0.17	2	0.33	
	<i>Araniella inconspicua</i> (Sim.)	<i>Parus caeruleus</i> L.	1	0.09	1	0.16
		<i>Parus palustris</i> L.	2	0.17	2	0.33
<i>Araniella opisthographa</i> (Kulcz.)	<i>Coccothraustes coccothraustes</i> (L.)	3	0.26	1	0.16	
	<i>Ficedula albicollis</i> (Temm.)	2	0.17	2	0.33	
	<i>Parus ater</i> L.	3	0.26	1	0.16	
<i>Araniella opisthographa</i> (Kulcz.)	<i>Parus major</i> L.	1	0.09	1	0.16	
	<i>Passer montanus</i> (L.)	1	0.09	1	0.16	
<i>Araniella proxima</i> (Kulcz.)	<i>Parus ater</i> L.	3	0.26	1	0.16	
	<i>Phylloscopus sibilatrix</i> (Bechst.)	1	0.09	1	0.16	
	<i>Sitta europaea</i> L.	1	0.09	1	0.16	
<i>Cyclosa conica</i> (Pallas)	<i>Erithacus rubecula</i> (L.)	1	0.09	1	0.16	
	<i>Ficedula albicollis</i> (Temm.)	7	0.60	4	0.66	
	<i>Parus caeruleus</i> L.	5	0.43	3	0.49	
	<i>Parus palustris</i> L.	2	0.17	2	0.33	
	<i>Phylloscopus collybita</i> (Vieil.)	8	0.68	3	0.49	
	<i>Phylloscopus sibilatrix</i> (Bechst.)	2	0.17	2	0.33	
<i>Gibbaranea bituberculata</i> (Walck.)	<i>Parus ater</i> L.	2	0.17	2	0.33	
	<i>Sitta europaea</i> L.	1	0.09	1	0.16	
<i>Gibbaranea gibbosa</i> (Walck.)	<i>Parus cristatus</i> L.	2	0.17	1	0.16	
	<i>Parus major</i> L.	1	0.09	1	0.16	
<i>Hypsosinga albobittata</i> (Westr.)	<i>Anthus trivialis</i> (L.)	2	0.17	1	0.16	
	<i>Phoenicurus ochruros</i> (Gmelin)	1	0.09	1	0.16	
<i>Hypsosinga heri</i> (Hahn)	<i>Remiz pendulinus</i> (L.)	1	0.09	1	0.16	
<i>Larinioides cornutus</i> (Clerck)	<i>Remiz pendulinus</i> (L.)	5	0.43	2	0.33	
<i>Singa nitidula</i> C. L. K.	<i>Remiz pendulinus</i> (L.)	11	0.94	3	0.49	
Lycosidae						
<i>Alopecosa aculeata</i> (Clerck)	<i>Oenanthe oenanthe</i> (L.)	2	0.17	1	0.16	
<i>Alopecosa pulverulenta</i> (Clerck)	<i>Phoenicurus ochruros</i> (Gmelin)	2	0.17	1	0.16	
<i>Alopecosa trabalis</i> (Clerck)	<i>Oenanthe oenanthe</i> (L.)	3	0.26	1	0.16	
<i>Lycosidae non det.</i>	<i>Parus palustris</i> L.	1	0.09	1	0.16	
<i>Pardosa</i> sp.	<i>Erithacus rubecula</i> (L.)	1	0.09	1	0.16	
	<i>Motacilla alba</i> L.	1	0.09	1	0.16	

Tab. 2 cont.

Spider species	Bird species	n	n%	f	f%
<i>Pardosa amentata</i> (Clerck)	<i>Erithacus rubecula</i> (L.)	1	0.09	1	0.16
	<i>Motacilla alba</i> L.	1	0.09	1	0.16
<i>Pardosa lugubris</i> (Walck.)	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16
	<i>Sitta europaea</i> L.	1	0.09	1	0.16
<i>Pardosa monticola</i> (Clerck)	<i>Anthus trivialis</i> (L.)	2	0.17	1	0.16
<i>Pardosa riparia</i> (C. L. K.)	<i>Motacilla alba</i> L.	1	0.09	1	0.16
<i>Pardosa sordidata</i> (Thor.)	<i>Motacilla alba</i> L.	1	0.09	1	0.16
<i>Pirata hygrophilus</i> Thor.	<i>Anthus trivialis</i> (L.)	1	0.09	1	0.16
	<i>Erithacus rubecula</i> (L.)	3	0.26	3	0.49
	<i>Motacilla alba</i> L.	1	0.09	1	0.16
Pisauridae					
<i>Pisaura mirabilis</i> (Clerck)	<i>Anthus trivialis</i> (L.)	4	0.34	1	0.16
	<i>Parus ater</i> L.	1	0.09	1	0.16
	<i>Parus major</i> L.	3	0.26	2	0.33
	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16
Agelenidae					
<i>Histoipona torpida</i> (C. L. K.)	<i>Erithacus rubecula</i> (L.)	2	0.17	2	0.33
	<i>Ficedula albicollis</i> (Temmm.)	4	0.34	3	0.49
<i>Tegenaria</i> sp.	<i>Certhia familiaris</i> L.	1	0.09	1	0.16
<i>Tegenaria silvestris</i> L. K.	<i>Certhia familiaris</i> L.	1	0.09	1	0.16
	<i>Ficedula albicollis</i> (Temmm.)	2	0.17	1	0.16
	<i>Parus major</i> L.	4	0.34	2	0.33
	<i>Sitta europaea</i> L.	3	0.26	3	0.49
	<i>Troglodytes troglodytes</i> (L.)	4	0.34	2	0.33
Dictynidae					
<i>Nigma flavescens</i> (Walck.)	<i>Phylloscopus collybita</i> (Vieil.)	6	0.51	4	0.66
	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16
Amaurobiidae					
<i>Amaurobiidae</i> non det.	<i>Ficedula albicollis</i> (Temmm.)	1	0.09	1	0.16
<i>Amaurobius</i> sp.	<i>Ficedula albicollis</i> (Temmm.)	1	0.09	1	0.16
<i>Amaurobius fenestralis</i> (Stroem)	<i>Ficedula albicollis</i> (Temmm.)	3	0.26	2	0.33
	<i>Parus major</i> L.	6	0.51	2	0.33
	<i>Sitta europaea</i> L.	9	0.77	5	0.82
	<i>Troglodytes troglodytes</i> (L.)	6	0.51	1	0.16
<i>Amaurobius ferox</i> (Walck.)	<i>Certhia familiaris</i> L.	4	0.34	2	0.33
	<i>Sitta europaea</i> L.	2	0.17	2	0.33
<i>Amaurobius jugorum</i> L. K.	<i>Prunella modularis</i> (L.)	2	0.17	1	0.16
<i>Callobius claustrarius</i> (Hahn)	<i>Erithacus rubecula</i> (L.)	1	0.09	1	0.16
	<i>Ficedula albicollis</i> (Temmm.)	1	0.09	1	0.16
	<i>Parus major</i> L.	1	0.09	1	0.16
	<i>Sitta europaea</i> L.	6	0.51	6	0.98
<i>Coelotes</i> sp.	<i>Erithacus rubecula</i> (L.)	2	0.17	2	0.33
	<i>Ficedula albicollis</i> (Temmm.)	8	0.68	5	0.82
	<i>Parus major</i> L.	2	0.17	2	0.33

Tab. 2 cont.

Spider species	Bird species	n	n%	f	f%
	<i>Troglodytes troglodytes</i> (L.)	7	0.60	1	0.16
<i>Coelotes atropos</i> (Walck.)	<i>Certhia familiaris</i> L.	1	0.09	1	0.16
	<i>Ficedula albicollis</i> (Temm.)	1	0.09	1	0.16
	<i>Parus major</i> L.	3	0.26	2	0.33
	<i>Sitta europaea</i> L.	5	0.43	4	0.66
<i>Coelotes inermis</i> (L. K.)	<i>Certhia familiaris</i> L.	1	0.09	1	0.16
	<i>Erithacus rubecula</i> (L.)	9	0.77	3	0.49
	<i>Ficedula albicollis</i> (Temm.)	6	0.51	2	0.33
	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16
Anyphaenidae					
<i>Anyphaena accentuata</i> (Walck.)	<i>Certhia familiaris</i> L.	15	1.28	4	0.66
	<i>Coccothraustes coccothraustes</i> (L.)	1	0.09	1	0.16
	<i>Dendrocopos major</i> (L.)	4	0.34	1	0.16
	<i>Ficedula albicollis</i> (Temm.)	1	0.09	1	0.16
	<i>Parus ater</i> L.	1	0.09	1	0.16
	<i>Parus caeruleus</i> L.	3	0.26	2	0.33
	<i>Parus palustris</i> L.	5	0.43	2	0.33
	<i>Passer montanus</i> (L.)	1	0.09	1	0.16
	<i>Phylloscopus sibilatrix</i> (Bechst.)	2	0.17	2	0.33
	<i>Sitta europaea</i> L.	4	0.34	4	0.66
Liocranidae					
<i>Agroeca brunnea</i> (Black.)	<i>Ficedula albicollis</i> (Temm.)	1	0.09	1	0.16
Clubionidae					
<i>Cheiracanthium montanum</i> L. K.	<i>Parus major</i> L.	1	0.09	1	0.16
<i>Cheiracanthium pennyi</i> O. P.-C.	<i>Remiz pendulinus</i> (L.)	1	0.09	1	0.16
<i>Clubiona</i> sp.	<i>Erithacus rubecula</i> (L.)	1	0.09	1	0.16
	<i>Ficedula albicollis</i> (Temm.)	2	0.17	1	0.16
	<i>Parus ater</i> L.	2	0.17	2	0.33
	<i>Parus caeruleus</i> L.	1	0.09	1	0.16
	<i>Parus palustris</i> L.	5	0.43	3	0.49
	<i>Phylloscopus collybita</i> (Vieil.)	2	0.17	2	0.33
	<i>Remiz pendulinus</i> (L.)	2	0.17	2	0.33
	<i>Sitta europaea</i> L.	7	0.60	5	0.82
	<i>Troglodytes troglodytes</i> (L.)	1	0.09	1	0.16
<i>Clubiona caerulescens</i> L. K.	<i>Parus ater</i> L.	2	0.17	2	0.33
	<i>Parus caeruleus</i> L.	7	0.60	1	0.16
	<i>Parus palustris</i> L.	6	0.51	3	0.49
<i>Clubiona caerulescens</i> L. K.	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16
	<i>Sitta europaea</i> L.	2	0.17	2	0.33
<i>Clubiona comta</i> C. L. K.	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16
<i>Clubiona corticalis</i> (Walck.)	<i>Ficedula albicollis</i> (Temm.)	1	0.09	1	0.16
<i>Clubiona lutescens</i> Westr.	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16
	<i>Remiz pendulinus</i> (L.)	1	0.09	1	0.16
<i>Clubiona pallidula</i> (Clerck)	<i>Erithacus rubecula</i> (L.)	1	0.09	1	0.16

Tab. 2 cont.

Spider species	Bird species	n	n%	f	f%
	<i>Ficedula albicollis</i> (Temm.)	2	0.17	2	0.33
	<i>Parus ater</i> L.	6	0.51	3	0.49
	<i>Parus caeruleus</i> L.	17	1.45	2	0.33
	<i>Parus major</i> L.	8	0.68	3	0.49
	<i>Parus palustris</i> L.	5	0.43	2	0.33
	<i>Phylloscopus sibilatrix</i> (Bechst.)	1	0.09	1	0.16
	<i>Remiz pendulinus</i> (L.)	13	1.11	7	1.15
	<i>Sitta europaea</i> L.	2	0.17	2	0.33
<i>Clubiona phragmitis</i> C..L. K.	<i>Remiz pendulinus</i> (L.)	25	2.13	4	0.66
<i>Clubiona stagnatilis</i> Kulcz.	<i>Remiz pendulinus</i> (L.)	1	0.09	1	0.16
<i>Clubiona terrestris</i> Westr.	<i>Parus palustris</i> L.	14	1.19	1	0.16
Gnaphosidae					
<i>Drassodes pubescens</i> (Thor.)	<i>Anthus trivialis</i> (L.)	1	0.09	1	0.16
<i>Haplodrassus signifer</i> (C. L. K.)	<i>Ficedula albicollis</i> (Temm.)	1	0.09	1	0.16
<i>Haplodrassus silvestris</i> (Black.)	<i>Erethacus rubecula</i> (L.)	2	0.17	2	0.33
	<i>Ficedula albicollis</i> (Temm.)	2	0.17	2	0.33
Zoridae					
<i>Zora nemoralis</i> (Black.)	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16
<i>Zora spinimana</i> (Sund.)	<i>Prunella modularis</i> (L.)	12	1.02	4	0.66
	<i>Troglodytes troglodytes</i> (L.)	2	0.17	1	0.16
Heteropodidae					
<i>Micrommata virescens</i> (Clerck)	<i>Parus major</i> L.	4	0.34	3	0.49
	<i>Parus palustris</i> L.	1	0.09	1	0.16
	<i>Phylloscopus sibilatrix</i> (Bechst.)	1	0.09	1	0.16
Philodromidae					
<i>Philodromus</i> sp.	<i>Anthus trivialis</i> (L.)	1	0.09	1	0.16
	<i>Parus ater</i> L.	1	0.09	1	0.16
	<i>Parus palustris</i> L.	3	0.26	1	0.16
	<i>Phylloscopus collybita</i> (Vieil.)	1	0.09	1	0.16
<i>Philodromus aureolus</i> (Clerck)	<i>Ficedula albicollis</i> (Temm.)	6	0.51	5	0.82
	<i>Parus ater</i> L.	6	0.51	3	0.49
	<i>Parus caeruleus</i> L.	3	0.26	2	0.33
	<i>Parus major</i> L.	1	0.09	1	0.16
	<i>Parus palustris</i> L.	3	0.26	2	0.33
	<i>Phylloscopus collybita</i> (Vieil.)	7	0.60	3	0.49
	<i>Phylloscopus sibilatrix</i> (Bechst.)	2	0.17	2	0.33
	<i>Sitta europaea</i> L.	5	0.43	4	0.66
<i>Philodromus cespitum</i> (Walck.)	<i>Ficedula albicollis</i> (Temm.)	1	0.09	1	0.16
	<i>Remiz pendulinus</i> (L.)	1	0.09	1	0.16
<i>Philodromus collinus</i> C. L. K.	<i>Ficedula albicollis</i> (Temm.)	2	0.17	1	0.16
	<i>Parus ater</i> L.	1	0.09	1	0.16
	<i>Phylloscopus collybita</i> (Vieil.)	1	0.09	1	0.16
<i>Philodromus dispar</i> Walck.	<i>Ficedula albicollis</i> (Temm.)	1	0.09	1	0.16
	<i>Parus caeruleus</i> L.	1	0.09	1	0.16

Tab. 2 cont.

Spider species	Bird species	n	n%	f	f%
	<i>Sitta europaea</i> L.	1	0.09	1	0.16
<i>Philodromus margaritatus</i> (Clerck)	<i>Ficedula albicollis</i> (Temm.)	1	0.09	1	0.16
	<i>Parus ater</i> L.	1	0.09	1	0.16
<i>Philodromus margaritatus</i> (Clerck)	<i>Sitta europaea</i> L.	6	0.51	3	0.49
<i>Philodromus rufus</i> Walck.	<i>Coccothraustes coccothraustes</i> (L.)	2	0.17	2	0.33
	<i>Ficedula albicollis</i> (Temm.)	4	0.34	3	0.49
	<i>Parus ater</i> L.	1	0.09	1	0.16
	<i>Phylloscopus collybita</i> (Vieil.)	3	0.26	2	0.33
	<i>Phylloscopus sibilatrix</i> (Bechst.)	2	0.17	1	0.16
	<i>Sitta europaea</i> L.	1	0.09	1	0.16
Thomisidae					
<i>Diaea dorsata</i> (Fabr.)	<i>Certhia familiaris</i> L.	1	0.09	1	0.16
	<i>Coccothraustes coccothraustes</i> (L.)	3	0.26	2	0.33
	<i>Erithacus rubecula</i> (L.)	3	0.26	2	0.33
	<i>Ficedula albicollis</i> (Temm.)	56	4.76	5	2.46
	<i>Parus ater</i> L.	25	2.13	4	0.66
	<i>Parus caeruleus</i> L.	14	1.19	3	0.49
	<i>Parus palustris</i> L.	6	0.51	4	0.66
	<i>Phoenicurus ochruros</i> (Gmellin)	3	0.26	2	0.33
	<i>Phylloscopus collybita</i> (Vieil.)	6	0.51	5	0.82
	<i>Phylloscopus sibilatrix</i> (Bechst.)	15	1.28	6	0.98
	<i>Sitta europaea</i> L.	6	0.51	6	0.98
<i>Misumena vatia</i> (Clerck)	<i>Sitta europaea</i> L.	2	0.17	1	0.16
<i>Xysticus</i> sp.	<i>Anthus trivialis</i> (L.)	3	0.26	1	0.16
	<i>Certhia familiaris</i> L.	1	0.09	1	0.16
	<i>Ficedula albicollis</i> (Temm.)	4	0.34	4	0.66
	<i>Parus ater</i> L.	1	0.09	1	0.16
	<i>Parus palustris</i> L.	1	0.09	1	0.16
	<i>Phylloscopus collybita</i> (Vieil.)	5	0.43	4	0.66
	<i>Sitta europaea</i> L.	2	0.17	2	0.33
<i>Xysticus audax</i> (Schrank)	<i>Parus ater</i> L.	1	0.09	1	0.16
<i>Xysticus bifasciatus</i> C. L. K.	<i>Erithacus rubecula</i> (L.)	1	0.09	1	0.16
	<i>Oenanthe oenanthe</i> (L.)	2	0.17	1	0.16
	<i>Phoenicurus ochruros</i> (Gmellin)	1	0.09	1	0.16
<i>Xysticus cristatus</i> (Clerck)	<i>Anthus trivialis</i> (L.)	1	0.09	1	0.16
	<i>Erithacus rubecula</i> (L.)	2	0.17	1	0.16
	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16
<i>Xysticus erraticus</i> (Black.)	<i>Anthus trivialis</i> (L.)	3	0.26	1	0.16
	<i>Oenanthe oenanthe</i> (L.)	1	0.09	1	0.16
<i>Xysticus gallicus</i> Sim.	<i>Motacilla alba</i> L.	1	0.09	1	0.16
	<i>Phoenicurus ochruros</i> (Gmellin)	1	0.09	1	0.16
<i>Xysticus kochi</i> Thor.	<i>Passer montanus</i> (L.)	1	0.09	1	0.16
<i>Xysticus lanio</i> C. L. K.	<i>Certhia familiaris</i> L.	5	0.43	2	0.33
	<i>Erithacus rubecula</i> (L.)	4	0.34	3	0.49
	<i>Ficedula albicollis</i> (Temm.)	28	2.38	2	1.97

Tab. 2 cont.

Spider species	Bird species	n	n%	f	f%	
	<i>Parus ater</i> L.	24	2.04	4	0.66	
	<i>Parus caeruleus</i> L.	48	4.08	4	0.66	
	<i>Parus major</i> L.	14	1.19	6	0.98	
	<i>Parus palustris</i> L.	10	0.85	6	0.98	
	<i>Passer montanus</i> (L.)	1	0.09	1	0.16	
	<i>Phylloscopus collybita</i> (Vieil.)	2	0.17	1	0.16	
	<i>Phylloscopus sibilatrix</i> (Bechst.)	9	0.77	5	0.82	
	<i>Sitta europaea</i> L.	34	2.89	1	3	2.13
Salticidae						
<i>Ballus chalybeius</i> (Walck.)	<i>Certhia familiaris</i> L.	1	0.09	1	0.16	
	<i>Ficedula albicollis</i> (Temm.)	1	0.09	1	0.16	
<i>Carrhotus bicolor</i> (Walck.)	<i>Certhia familiaris</i> L.	1	0.09	1	0.16	
	<i>Ficedula albicollis</i> (Temm.)	2	0.17	1	0.16	
	<i>Parus major</i> L.	2	0.17	2	0.33	
	<i>Parus palustris</i> L.	1	0.09	1	0.16	
	<i>Sitta europaea</i> L.	1	0.09	1	0.16	
<i>Dendryphantès hastatus</i> (Clerck)	<i>Parus ater</i> L.	3	0.26	2	0.33	
	<i>Parus palustris</i> L.	1	0.09	1	0.16	
<i>Dendryphantès rudis</i> (Sund.)	<i>Certhia familiaris</i> L.	1	0.09	1	0.16	
	<i>Parus ater</i> L.	4	0.34	1	0.16	
	<i>Sitta europaea</i> L.	1	0.09	1	0.16	
<i>Evarcha</i> sp.	<i>Parus ater</i> L.	1	0.09	1	0.16	
	<i>Prunella modularis</i> (L.)	1	0.09	1	0.16	
<i>Evarcha arcuata</i> (Clerck)	<i>Ficedula albicollis</i> (Temm.)	1	0.09	1	0.16	
	<i>Parus palustris</i> L.	3	0.26	1	0.16	
<i>Evarcha flammata</i> (Clerck)	<i>Ficedula albicollis</i> (Temm.)	1	0.09	1	0.16	
	<i>Parus major</i> L.	1	0.09	1	0.16	
	<i>Phylloscopus collybita</i> (V.)	5	0.43	5	0.82	
<i>Heliophanus aeneus</i> (Hahn)	<i>Erithacus rubecula</i> (L.)	1	0.09	1	0.16	
<i>Marpissa radiata</i> (Grube)	<i>Remiz pendulinus</i> (L.)	1	0.09	1	0.16	
<i>Neon reticulatus</i> (Black.)	<i>Prunella modularis</i> (L.)	8	0.68	4	0.66	
	<i>Troglodytes troglodytes</i> (L.)	1	0.09	1	0.16	
<i>Sitticus caricis</i> (Westr.)	<i>Ficedula albicollis</i> (Temm.)	1	0.09	1	0.16	
<i>Sitticus rupicola</i> (C. L. K.)	<i>Motacilla alba</i> L.	9	0.77	1	0.16	

The highest number of genera and species belonged to Linyphiidae, Araneidae and Salticidae (Tab. 3).

Species composition of spiders in the bird food reflects the foraging strategies and niches of birds. For example, foliage gleaning forest birds (type *Parus*) preferred the crown and foliage living spiders (*Diaea dorsata*, *Philodromus* spp., *Xysticus lanio*, *Clubiona* spp., *Araneus triguttatus*, *Araniella* spp.). Foliage gleaning marsh birds (type *Remiz*) preferred the marsh living spiders (*Clubiona phragmitis*, *Marpissa radiata*). Ground living spiders (Lycosidae, *Coelotes* spp., *Tegenaria* spp., *Neon reticulatus*) were

found to be characteristic in the food of ground foraging birds (type *Troglodytes*, *Prunella*) (compare Krištín. 1992).

DISCUSSION

So far only limited data concerning spider composition in bird food during the breeding period are available. Bureš (1986) found an eudominant portion of spiders in the food of the collared flycatcher (*Ficedula albicollis*) ($n = 10.0 - 16.6$ %, 43 spider species). Like in our results, *Diaea dorsata*, *Xysticus lanio*, *Philodromus rufus*, *Araniella cucurbitina* and species of the genus *Coelotes* played an important role there. Being characteristic and abundant species in central-European forests they are very important in food supply for forest passerines. Krištín (1994) found that 10 % of the food of the nuthatch nestling (*Sitta europaea*) in mixed beech forests in central Slovakia consists of spiders (43 species from 14 families), though in our research the proportion of spiders in nestlings' food is lower. The proportion of spiders in food of blue tit (*Parus caeruleus*) during the breeding period on two localities near Budapest (Hungary) in mixed oak and hornbeam forests was 36.4 % and 11.9 %, respectively, with an eudominant proportion of the family Thomisidae. In the same locality, spiders formed only 1.9 % of great tit (*Parus major*) food (Török & Tóth 1988). Their results for the blue tit agree with ours. In the food of blue tit nestlings we found spiders to occur eudominantly with 31.3 %. The proportion of spiders in great tit food was much higher (17.4 %). Spiders predominated in the food of the great spotted woodpecker (*Dendrocopus major*) in a medium-age turkey-oak forest near Budapest (Török 1988). In our samples they form only 1 % of the diet. In the southern part of the Saint-Petersburg region (Russia) 19.6 % of willow tit (*Parus montanus*) diet consists of spiders (Prokofjeva 1986). Sacher and Dornbusch (1990) reported a 73 % frequency of arachnids in food samples of 4 bird species (*Parus major*, *Parus ater*, *Phoenicurus phoenicurus* and *Ficedula hypoleuca*) where spiders formed approximately 11 % of the food items. The family Agelenidae occurred most frequently (36 %) and was mainly represented by the genus *Coelotes*. The significant proportion of this genus was found also in food of nestlings of other bird species, such as *Erithacus rubecula*, *Ficedula albicollis*, *Parus major*, *Sitta europaea*, *Troglodytes troglodytes*.

The proportion of spiders and spider species composition in the bird diet vary considerably depending, on one hand, on spider densities (Gunnarson 1983), body size (Gunnarson 1983; Török 1988; Thaler 1973), season and biotope type, and, on the other hand, on bird species, its food strategy, food specialisation and food niche. The foraging success of birds hunting for spiders is also affected by the ambient temperature. The number of spiders caught by caged great tit (*Parus major*) in a 10 minute test increased in

sigmoid fashion with an ambient temperature between 2 and 13 °C (Avery & Krebs 1984).

Tab. 3. List of spider families and absolute number of their genera and species in food of selected 21 bird species in Central Europe

Family	No. of genera	No. of species
Segestriidae	1	1
Mimetidae	1	1
Theridiidae	5	10
Linyphiidae	13	21
Tetragnathidae	3	4
Araneidae	7	16
Lycosidae	3	9
Pisauridae	1	1
Agelenidae	2	2
Dictynidae	1	1
Amaurobiidae	3	6
Anyphaenidae	1	1
Liocranidae	1	1
Clubionidae	2	10
Gnaphosidae	2	3
Zoridae	1	2
Heteropodidae	1	1
Philodromidae	1	6
Thomisidae	3	9
Salticidae	8	11
No. of families 20	60	116

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