5. Literatur

Grote, H. (1936): Beiträge zur Biologie südostrussischer Steppenvögel. Beitr. Fortpfl.-biol. der Vögel 12: 195–206. • Johansen, H. (1944): Die Vogelfauna Westsibiriens. II. Tl., 1. Folge. J. Orn. 92: 1–105. • Kipp, F. A. (1958): Zur Geschichte des Vogelzuges auf der Grundlage der Flügelanpassungen. Vogelwarte 19: 233–242. • Ders. (1959): Der Handflügel-index als flugbiologisches Maß. Vogelwarte 20: 77–86. • Ders. (1961): Flügelbau und Zugverhalten bei den Anatiden. Vogelwarte 21: 28–36. • Meinertzhagen, R. (1954): Birds of Arabia. Edinburgh & London. • Mühlethaler, F. (1952): Beobachtungen am Bergfinkenschlafplatz bei Thun 1950/51. Orn. Beob. 49: 173–182. • Peus, F. (1954): Zur Kenntnis der Brutvögel Griechenlands. Bonn. Zool. Beitr., Sonderband I. • Schäfer, E. (1938): Ornithologische Forschungsergebnisse zweier Forschungsreisen nach Tibet. J. Orn. 86: Sonderheft. • Smith, K. K. (1965): The Birds of Marocco. Ibis 107: 493–526.

Anschrift des Verfassers: Dr. F. A. Kipp, Zeppelinstr. 35, 7000 Stuttgart 1.

Die Vogelwarte, 28, 1976: 180–190

Feeding Ecology of the Goldcrest *(Regulus regulus)* during Spring Migration in Denmark

By Karsten Laursen*)

1. Introduction

The feeding ecology of the Goldcrest during breeding season and autumn has been thoroughly studied by Palmgren (1932), but investigations on this subject during migration have not yet been made.

2. Materials and methods

The present study was conducted during the spring of 1974 on the island of Hjelm, 6 km east of the peninsula of Djursland in Kattegat (56.08 N, 10.48 E). The area of the island is 70 ha, about half of which rises 30–40 m above sea level, surrounded by steep hawthorn-covered slopes. On this central plateau are abandoned fields and occasional plantations of trees and shrubs.

In order to determine the number of insects on the island the vgetation was divided into three types of habitats: a) spruce plantation (*Picea sitchensis* and *P. glauca*), covering about 4 ha, b) high slopes covered with hawthorn (*Crataegus* sp.), about 10 ha, c) occasional patches of vegetation in the middle of the island, consisting of mixed trees and shrubs, about 4 ha. These consist mainly of spruce (*Picea abies*), birch (*Betula pendula*), cherry plum (*Prunus cerasifera*), bird cherry (*Cerasus avium*) and apple (*Malus domestica*).

The number of insects in the three habitats was determined by two methods: 1) by catching the insects on the branches and 2) by trapping the flying insects.

The insects on the branches were trapped in a plastic-bag which was slipped carefully over a random branch. The bag was then closed and the branch cut off. Each sample consisted of two branches with a total length of 1,5–2 m. The insects were poisoned and the contents counted. The part of the branches carrying needles or leaves was then measured.

The procedure was a little different as to the spruce branches, these being infested with aphis. Aphis do not fall off when killed, as their proboscis is stuck in the spruce needle. Consequently the spruce branches were first placed in cans containing methyl isobutyl keton gases (Southwood 1971). This poison make the aphis withdraw their proboscis from the needle and then die. They may then easily be shaken off the branches. In this study the method had an effectiveness of about 95%.

Samples were collected from all three habitats once a week. 100 samples were taken from the spruce plantation, 60 samples from two sites on the hawthorn-covered slopes and 30 samples from the small plantations with mixed vegetation.

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*) Medd. nr. 2 fra Hjelm Fuglestation. Lektor J. Rabøl has criticized the manuscript and stud. scient. O. Lomholt has been helpful in identifying some of the insects. The Danish Natural Science Research has supported the investigation, j. nr. 511–3087.

The flying insects were trapped in the three habitats as well. They were trapped daily in Malaise-traps. These traps have a ground area of 2 × 2 m, and a height of 1,80 m. From the centre radiate 4 arms covered by a pyramidal roof. In the top of the roof is a lock, leading the insects into a poison-glass. During their normal activities the insects are stopped by the radiating arms, move towards the bright ceiling and are directed into the poison-glass. The capture indicates the activity × number of insects (Southwood 1971).

There were used 5 traps; they were open 8 hours daily from one hour after sunrise. The Malaise-traps were distributed with two on the hawthorn slopes, two in the mixed vegetation and 1 in the spruce plantation. Net weight when dry was measured in all samples by drying them at 60 °C for 3 hours and weighing them on Mettler-scales.

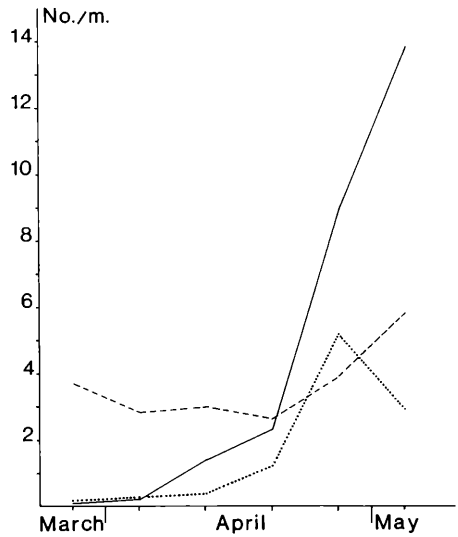
Tabel 1: The distribution and number of birds on dates.

Date	26/3	27/3	28/3	29/3	30/3	31/3	1/4	2/4	3/4	4/4	5/4	6/4	7/4	10/4	11/4	16/4	18/4
No.	1	1	3	4	5	7	1	2	40	11	3	5	1	2	1	1	1

During the period from 26/3 – 18/4 89 Goldcrests died from various causes. Their distribution on dates is shown in Table 1. These Goldcrests were collected and used in this study. A few hours after the birds had been brought in their stomachs were preserved. The stomach contents were analysed under a binocular microscope. In the period where the birds were collected the pincipal migration of Goldcrest passed through Denmark (Hansen 1975).

3. Results

A comparison of the number of insects/m branch in the three habitats is given in Fig. 1. This figure shows that in the period when the Goldcrests were collected the spruce plantation was the habitat containing the greatest number of insects. During the last part of the period studied the hawthorn-slopes carried the greatest number of insects. In Fig. 2 the habitats are compared as to weight of insects in mg/m branch. Here, too, the spruce plantation contains the greatest amount of insects, but it is apparent that the difference between the curves has become less in the first two weeks which indicates that the animals here on an average are smaller than in the two other habitats.



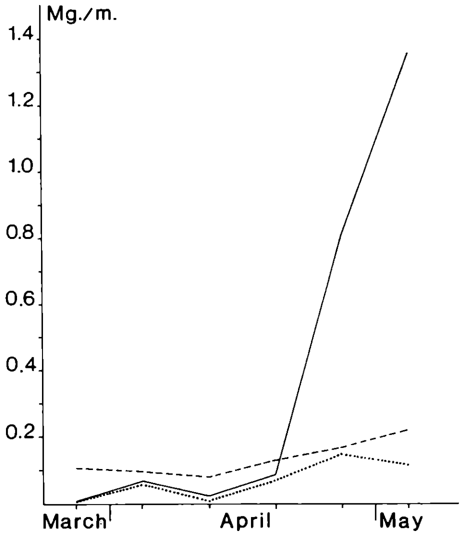
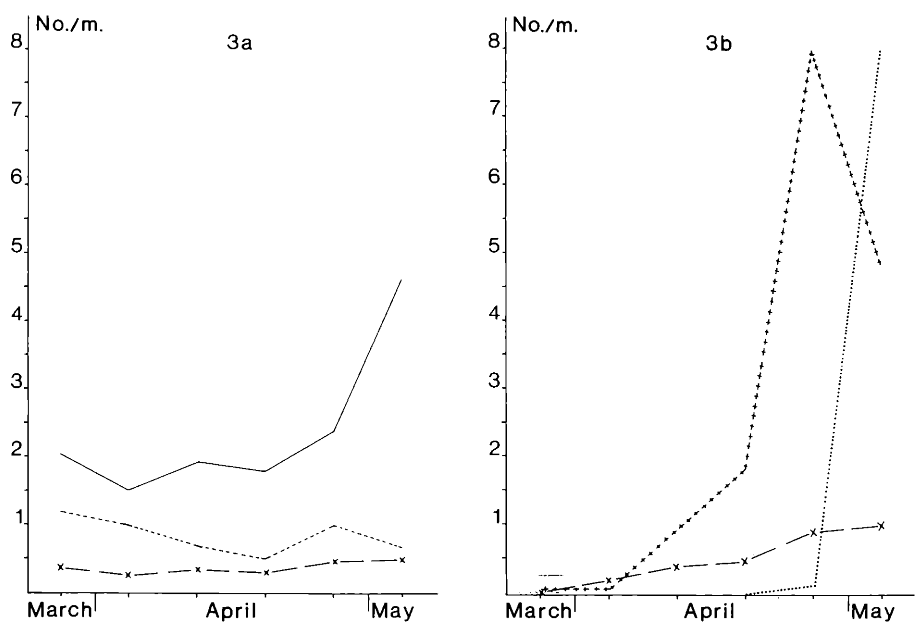


Fig. 1 (left): Number of animals/metre branch in the three habitats in the period.
Spruce: ---- Hawthorn: ——— Mixed trees: ········
Fig. 2 (right): Weight of animals in mg/metre branch in the three habitats in the period. Symbols see fig. 1.

The number of dominant insects in each habitat is shown in Fig. 3 a—c. In the spruce plantation aphis (*Elatobium abietinum*) predominate (almost 2/m branch). On the hawthorn-slopes and in the mixed vegetation the number of insects is very low in the beginning of the period while increasing numbers of the bigger insects appear after the first and the third week of April, respectively, and are dominated by caterpillars.

The number of flying insects in the three habitats is shown in Fig. 4. The hawthorn-slopes seem to have the greatest number of flying insects. The spruce plantation and mixed vegetation take turns in having most insects and on the average of the whole period they have about equally many, i. e., the spruce plantation 9,5 and the mixed vegetation 10,0 insects/day. Common to all habitats is that the number of insects vary from day to day. This variation is due to physical factors like temperature, windforce etc. (this subject will be treated in a coming paper).

The most important flying insects were: spruce plantation: gnats *Nematocera* (*Chironomidae* and *Cecidomyiidae*), hawthorn-slopes: flies *Brachycera* (*Muscidae*), gnats *Nematocera* (*Cecidomyiidae* and *Chironomidae*), wasps *Hymenoptera* (*Parasitica* and *Apidae*), mixed vegetation: flies *Brachycera* (*Muscidae*), gnats *Nematocera* (*Chironomidae*), wasps *Hymenoptera* (*Apidae*). The composition and distribution of the flying insects will not be dealt with further as they only account for 8 % of the food of the Goldcrest. The results of the food analysis are shown in Table 2. Here are given all animal foods items together with the number of birds which have taken the food item in question. Table 3 shows the number of birds with various vegetable fragments. Most of the birds have probably not taken these food items with immediate nutrition in view as 14 of the 20 birds which have eaten stem/grass/moss have done so in variating numbers from 1 to 6 with an average of 3 fragments. This number is so low that it is considered of no importance to the birds. The remaining 6 birds with these food items had the following numbers: 15, 20, 22, about 45, about 120, and about 600. The size of these items was about 2 × ½ mm. These amount are so great that they must have been taken on purpose and have some importance for the nutrition of the birds. Of the 8 birds which had eaten ovuli-



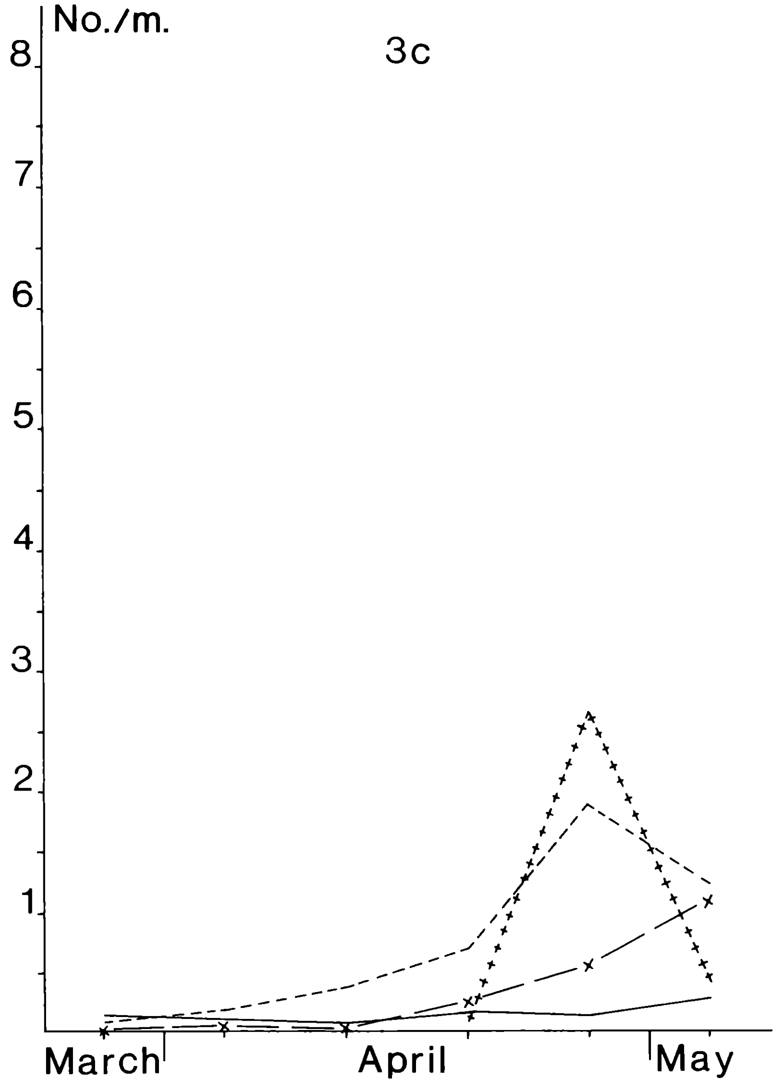


Fig. 3: The most important groups of animals in each habitat. A: Spruce. B: Hawthorn. C: Mixed trees.
Aphidoidea: ——— Thysanoptera: – – – – Lepidoptera cat.: + + + +
Psylloidea nymph: Other: × – – ×

fereous scale of spruce one bird had one seed from a pea flower (*Papilionaceae*) as well, 3 birds had a total of 5 spruce seeds (*Picea*), and 2 of these had part of a ovuliferous scale as well. The remaining 3 birds had only a fragment of a ovuliferous scale each. It is to be supposed, then, that parts of ovuliferous scale have been swallowed during the search for spruce seeds. Of the total of 89 birds examined 4 did not contain any food items whatever. Of the remaining 85 birds (95,5 %) all contained animal food items, 25 (29,4 %) vegetable food items as well. Of the total of 772 animal food items three insect groups predominate: *Psylloidea* 180 (23,3 %), *Lepidoptera larvae* 173 (22,4 %) and *Curculionidae* 130 (16,8 %).

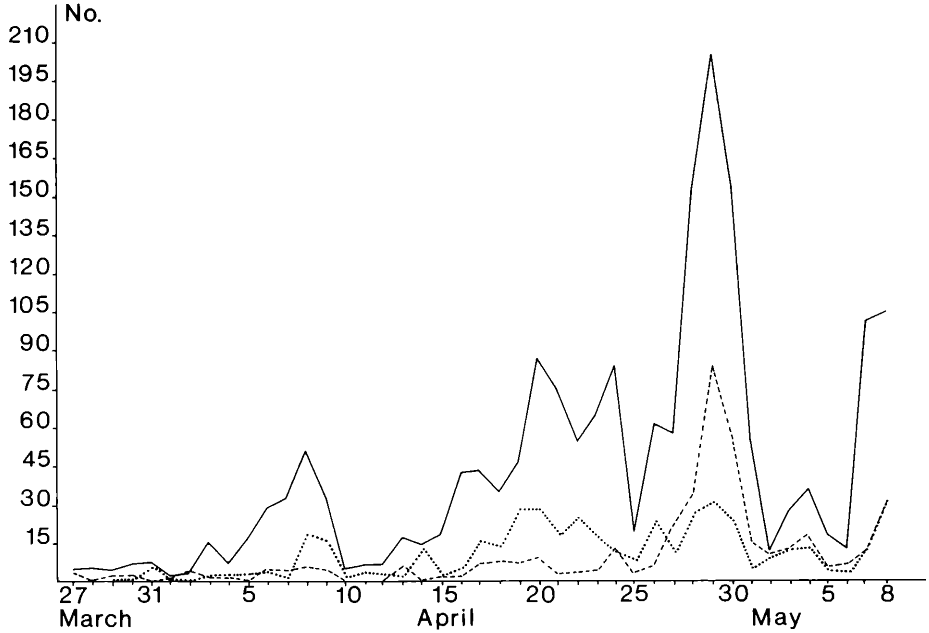


Fig. 4: Number of flying insects in the three habitats.
Spruce: ---- Hawthorn: ——— Mixed trees:

Tabel 2: The prey taken by Goldcrest. The number of every food item, and the number of birds where it has been found.

	Number of Prey	Number of Birds
Insecta		
Heteroptera		
Lygaeidae	9	7
Nabidae	3	2
Cydnidae	1	1
Heteroptera sp.	4	2
Auchenorrhyncha		
Fulgoroidea	3	3
Sternorrhyncha		
Psylloidea	180	50
Aphidoidea	10	4
Thysanoptera	1	1
Coleoptera		
Carabidae	7	7
Staphylinidae	10	7
Lathridiidae	49	21
Salpingidae	5	5
Coccinellidae	4	4
Curculionidae	130	41
Coleoptera sp.	20	17
Coleoptera larva	1	1
Hymenoptera		
Cynipoidea	13	6
Chalcidoidea	17	14
Proctotrupidea	1	1
Hymenoptera sp.	12	10
Diptera		
Nematocera		
Mycetophilidae	7	6
Trichoceridae	1	1
Brachycera		
Phoridae	1	1
Brachycera sp.	4	4
Lepidoptera		
Lepidoptera cat.	173	33
Insecta sp.	19	15
Insecta larva sp.	3	3
Arachnida		
Araneae	60	41
Acarina		
Ixodidae	5	4
Oribatidae	3	2
Gastropoda	2	2
Egg	14	4
Total	772	89

Tabel 3: The kind of vegetable fragments there have been taken, the number of birds where it has been found and the number of plants.

Vegetable fragments	Number of birds	Number of plant fragments
Stem/grass/moss	20	Mean 43, rang from 1–600
Seed/ovuliferous scale from spruce	7	Total 9
Seed from pea flower	2	Total 2
Stamen	1	Total 1

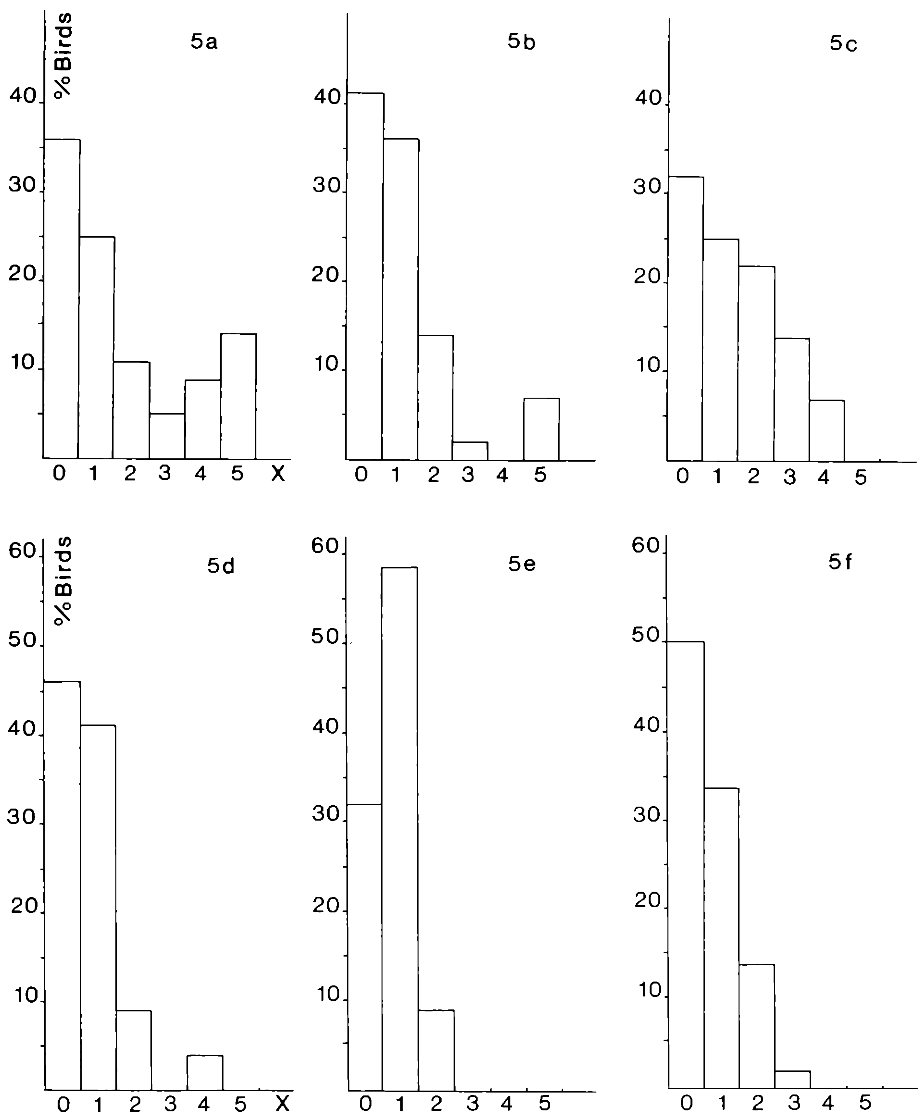


Fig. 5: Frequency of different prey in the birds' stomach, n = 44. The abscissa shows the relative number of prey. A: *Psylloidea*. B: *Lepidoptera* cat. C: *Curculionidae*. D: *Coleoptera* (*Lathridiidae*, *Salpingidae*, *Dromius*). E: *Aranea*. F: Flying insects (*Hymenoptera*, *Diptera*).

Tabel 4: A further identifikation of the animal food item, and the number in which it has been found. The normal habitat of the prey from literature, and in last column if it has been found on Hjelm (only this investigation).

Species/genus	Number of Prey	Number of Birds	Habitat	Hjelm
Curculionidae: Total	130	41	HANSEN 1965	
Mecinus pyraster	10	7	*Plantago* (herb)	+
Gymnetron pascuorum	56	33	*Plantago* (herb)	+
Apion pomonae	8	4	*Vicia/Lathyrus* (herb)	+
Apion cerdo	5	3	*Vicia/Lathyrus* (herb)	+
Apion curtirostre	11	8	*Rumex* (herb)	+
Apion sanguineum	2	2	*Rumex* (herb)	÷
Apion sp.	6	4		
Strophsoma capitatus	3	3	Tree/Bush (mainly conifer)	+
Otiorhynchus sp.	1	1	Tree/Bush	
Lathridiidae: Total	49	21	HANSEN 1951	
Corticarina gibbosa	25	12	In plant debris/on leaves	+
Lathridius transversus	8	4	Under bark/in plant debris	+
Lathridius lardarius	3	3	In plant debris	+
Lathridius nodifer	1	1	In mouldy plant debris	÷
Salpingidae: Total	5	5	HANSEN & LARSSON 1945	
Rinosimus planirostris	5	5	Under bark of deciduous trees	÷
Coccinellidae: Total	4	4	HANSEN 1951	
Rhizobius litura	2	2	Herbs on sandy places	+
Aphidecta oblitterata	1	1	Coniferous trees	+
Coccinella undecimpunctata	1	1	Near salt water	+
Carabidae: Total	7	7	HANSEN 1968	
Dromius quadrimaculata	1	1	Under bark of decidous/coniferous	+
Dromius liniaris	4	4	*Ammophila* (grass)	+
Dromius sp.	2	2		
Staphylinidae: Total	10	7	HANSEN 1952	
Xantholinus linearis	2	1	On ground/under plant debris	+
Conosoma sp.	2	2		
Psylloidae: Total	180	50	BROHMER et al. 1927	
Psylla melononeura	163	37	*Crataegus*, summer/coniferous, winter	+
Trioza sp.	7	7	Bushes, summer/coniferous, winter	+
Heteroptera: Total	17	8	JENSEN-HAARUP 1912	
Nabis ferus	3	2	Grass/herb	+
Sehirus morio	1	1	In soil	÷
Lygaidae sp.	8	6		
Gastropoda: Total	2	2	STEENBERG 1911	
Pupilla unidentata	1	1	On ground under stones/branches	÷

In order to analyse the food choice further Fig. 5 a—f gives a frequency distribution for 6 important insect groups. These have been chosen on the following criteria: they constitute a considerable part of the food, have a reasonable probability of being preserved (thick cuticle), and/or have a characteristic biology. Furthermore, only birds with a minimum of 5 prey have been included, belonging to one of the 6 animal groups. The frequency analysis comprises 44 birds (49,9 %) and 570 prey (73,8 %). Five prey as a minimum has been chosen in order to include a great number of birds in the analysis.

As Fig. 5 a–f shows a great part of the birds have not taken the prey in question. The zero-groups thus lie from 32–50 % of the birds. It is obvious, too, that the lowest frequencies dominate which means that few of that prey have been taken and that other animals have been taken as well. Furthermore, it seems that only within the groups *Psylloidae* and *Lepidoptera* larvae some birds have eaten mainly one of these groups of prey.

In the case of some prey a further identification has been possible than has been given in Table 2. This applies to *Coleoptera, Psylloidae, Heteroptera* and *Gastropoda* (Table 4). For all species and genera their normal habitats from literature have been given and if they have been found on Hjelm. Species not found live either in the soil, under the bark or in places where standard collections have not been undertaken (see later). In this way it cannot be excluded that they may be found.

4. Discussion

Food analysis: Using the stomach contents in the determination of food choice and number of prey offers many difficulties. This subject has been discussed thoroughly by PALMGREN (1932). The difficulties are not great when the fragments can be identified, but grow when the fragments in question cannot be assigned to any definite insect group. It is difficult to decide if a fragment belongs to an insect which has already been identified or if it has to be grouped with an unidentified group. In this study fragments which are unidentifiable are assigned to an identified insect if there is a reasonable probability of their belonging. This may have caused the unidentified groups to be too small and the total number of insects too low. Another problem in identifying the stomach contents is the thinly sclerotized insects. These quickly disappear or become unidentifiable fragments. As the stomachs were preserved after a couple of hours and as thinly sclerotized animals (*Aphidoidea* and *Thysanoptera*) were found nonetheless, it must be presumed that the important factor in this disintegration is the contraction of the stomach and that the acid and the enzymes have a limited effect on chitin. *Aphidoidea* and *Thysanoptera* are thus underrepresented in this analysis as they quickly disintegrate in the living bird. As regards the number of prey minimum numbers are used so that 10 stigmata from Psylloid-wings represent 5 Psylloids.

Food amount and choice: During the period from 26/3 to 10/4 when the main part of the Goldcrests were collected the spruce plantation was the best habitat both as regards weight and number of insects. There were 3–4 insects/m branch with a weight of about 0,1 mg. According to GIBB (1960) the daily food demand of the Goldcrest is about 2,0 g net weight when dry. If this is compared to the amount of food present in the spruce plantation it means that a Goldcrest has to cover about 20 km/d or 1,5 km/h to meet its food demand. This distance seems unrealistic even if we cut down the daily food demand to the half. As a comparison can be mentioned that HOGSTAD (1970) calculated that the Goldcrest in Nov./Dec. flew 300 m/h and in Jan./Feb. 150 m/h. The decrease in travel speed is suggested to be correlated with a decrease in food amount and then a more carefully search.

It is obvious, then, that the spruce plantation and the two other habitats had an insect population too small to support a population of Goldcrests. With this in mind the frequency analysis of prey may be interpreted to mean that the big zero-groups show that during their search the birds have not met the prey in question and that there is no indication of preference. Furthermore, the great number of birds with low frequency of prey shows that the food has been of an all-round composition and that means that the birds have taken what they have come across of the groups in question. An exception is constituted by *Psylloidea* as a preference seems to exist, they being not particularly numerous in the habitats. An explanation may be that *Psylloidea* is an important part of the food of the Goldcrest in other seasons as well (PALMGREN 1932) and the bird may thus be accustomed to hunting this prey. According to the same study by PALMGREN *Aphis* constituted a considerable part of the food of the Coldcrest. In this study they only constituted 1,3 %. If dates and places for the Goldcrests which had eaten aphis are examined it turns out that they were found in the spruce plantation on the dates 26/3 — 31/3, i. e. in the beginning of the period studied, before the main migration of the Goldcrests. In Fig. 3 a is seen a decrease of aphis during this period.

The Goldcrests were seen foraging in all three habitats, but after a few days it was obvious that they foraged in the fields along the spruce plantation and along the hedgerows and in greater numbers in the dry salt marsh at a considerable distance (20—30 m) from the foot of the hawthorn-slopes. In order to examine the amount of food in the grass and on the herbs soil samples were taken in two salt marsh localities, in the fields and in the plantation. The results of these soil samples are shown in Table 5 together with the number of insects on the branches during the period from 28/3 — 26/4. Between these is shown the food choice of the Goldcrest

Tabel 5: The fauna on the branches from three habitats in animals/metre branch. Food of Goldcrest in % of the total identified animals. The fauna in lower vegetation (herbs and grass) and on the ground shown in animals/30 cm². Marsh I and II are dry marshes situated below the slopes at north east and south. (F): Flying insects caught in Malaise traps in the habitats. +': Present, but not counted (*Collembola*).

Period 28/3–6/4	Animals/metre branch			% of total *Regulus* r.	Animals/30 cm² (Ground)			
	Spruce	Hawthorn	Mixed		Marsh I	Marsh II	Field	Spruce
Thysanoptera	1.12	0.01	0.13	0.1	+			
Aphidoidea	1.79		0.10	1.4				
Psylloidea	0.09	0.02		25.1				
Aranea	0.20	0.07	0.02	8.4	1.65	1.05	0.55	
Lepidoptera cat.	0.03	0.03	0.02	24.2	0.80	0.05	0.05	
Coleoptera larva				0.1	0.15	0.25	0.25	
Auchenorrhyncha	+			0.4	+			
Heteroptera			0.02	2.4	0.30	0.70		
Lathridiidae				6.8		0.05		0.10
Salpigidae				0.7				
Carabidae				1.0	0.10	0.35	0.15	
Curculionidae				18.2	0.05	0.25	0.15	
Coccinellidae				0.6		0.05	0.05	
Staphylinidae				1.4	0.35	0.15	0.20	
Acarina		+		1.1	0.25	0.05	0.15	
Gastropoda				0.3	0.40	0.10		
Hymenoptera	+	(F)	(F)	6.0				
Nematocera	(F)	(F)	(F)	1.1				
Brachycera	+ (F)	(F)	(F)	0.7	+			
Formicidae					0.45	1.55		
Oniscidae						2.65	0.15	
Collembola			+		+'	+'	+'	+'
Chilopoda						0.70	0.20	

in $^0/_0$ of the total number of identified insects. The flying insects from the three habitats are given in the same Table at (F) under the insects on the branches. As to this Table it must be mentioned that the *Lepidoptera* larvae in the soil were mainly *Pyralidae* and those on the branches *Geometridae*. Fragments of both have been found in the stomach contents, but it has not been possible to determine how many belonging to which group.

From Table 5 it appears that almost all the insect groups which have been found in the vegetation have been taken by the Goldcrest. The exceptions are ant (*Formicidea*), woodlouse (*Oniscidae*), scolopendra (*Chilopoda*) and springtail (*Collembola*). As to groundbeetles genera have been found in the soil which have not been taken by the Goldcrest either. This may be because they are able to give off a corrosive secretion and are therefore avoided by the birds.

The animals on grass and herbs in Table 5 constitude a substantiable part of the food of the Goldcrest and it appears from Table 4 that a great deal of the prey of the Goldcrest lives on grass and herbs, in the case of some of them in the soil, even.

The main migration of Goldcrests takes place in a period, where the food amount is very little. It has been shown that the food amount on the branches in the beginning of April is too little to feed a population of Goldcrests. Contrarily the food amount in the last part of April has grown to 5 times as big and the best habitat has now 0,8 mg/m. This correspond to a feeding speed of 166/h. This feeding speed is very close to that measured by Hogstad (1970) in a period with little food amount (Jan./Feb.). This means that the food amount in the last part of April would have been big enough to support a Goldcrest population. In that way the migration of Goldcrests is supposed to take place 3 weeks before there is enough food on the branches. This means that it is important to perform the migration early and to be one of the first in the breeding areas, although it means that the food amount in this period is very little.

The Goldcrest has foraged in all three habitats, also on the ground, and it appears from the study that it has exploited the animal food items present and supplemented these with vegetable food as well. In the light of this its choice of habitat and food in the spring must be described as very flexible in relation to that of the breeding season and during migration the Goldcrest can best be characterized as an eurotroph species. This must be regarded as a result of an adaptation to migration in the early Spring when food is scarce and the bird has to exploit all food resources.

5. Summary

The study was conducted on the island of Hjelm during the Spring of 1974 in the period from 28/3—8/5. Quantitative measurements of the number of insects on the branches and in the air have been made in three habitats. The results of these are given in Figs. 1—4. At the same time (Table 1) the food choice of the Goldcrest has been examined and the results of this are given in Table 2, 3 showing that the Goldcrest takes both animal and vegetable food. A frequency analysis has been calculated for the most important prey in Table 5a—f showing that the prey of the birds are distributed over several groups. The Goldcrests were seen foraging on the ground and consequently the study was supplemented with soil samples from 4 localities. The results of these have been given in Table 5 together with the other studies and the food of the Goldcrest. These show that the Goldcrest has exploited almost all food items present.

6. Zusammenfassung

Nahrungsökologische Untersuchungen der Wintergoldhähnchen beim Frühjahrszug in Dänemark

Die Untersuchung wurde auf der Insel Hjelm im Jahre 1974 in der Zeit vom 28. 3. bis 6. 5. vorgenommen. In drei Gebieten hat man quantitative Messungen der Insektenmenge auf Zweigen und in der Luft vorgenommen. Die Ergebnisse dieser Untersuchungen sind in

Fig. 1—4 dargestellt. Im gleichen Zeitraum (Tabelle 1) wurde die Nahrungswahl des Wintergoldhähnchens untersucht, und diese Ergebnisse gehen aus Tabelle 2 und 3 hervor. Wie man sieht, hat das Wintergoldhähnchen animalische und vegetabilische Nahrungsstoffe zu sich genommen. Die wichtigsten animalischen Nahrungsstoffe waren Blattflöhe, Schmetterlingslarven und Rüsselkäfer. Eine Häufigkeitsanalyse über die wichtigsten Beutetiere ist in Tabelle 5a–f dargestellt. Sie zeigt, daß die Beutetiere der einzelnen Vögel über mehrere Insektengruppen verteilt waren. Die Wintergoldhähnchen hat man beobachtet, wie sie auf der Erde Nahrung suchten, weshalb man an vier Stellen Nahrungsproben am Boden sammelte. Die Ergebnisse sind zusammen mit den übrigen Insektenuntersuchungen aus Tabelle 5 zu ersehen. Außerdem ist in Tabelle 5 die Nahrungswahl des Wintergoldhähnchens in Prozent von der totalen Anzahl der bestimmten Tiere angegeben. Es geht daraus hervor, daß das Wintergoldhähnchen fast alle Nahrungsressourcen ausgenutzt hat, die es gab.

7. References

Brohmer, P., P. Ehrmann & G. Ulmer (1927): Die Tierwelt Mitteleuropas. Bd. IV, 3 Lf. • Gibb, J. (1954): Feeding ecology of tits, with notes on Treecreeper and Goldcrest. Ibis 96: 513–543. • Ders. (1960): Population of tits and Goldcrests and their food supply in pine plantation. Ibis 102: 163–208. • Hogstad, O. (1970): Movements of Winter Flocks of Goldcrests (*Regulus regulus* L.): Nytt Mag. Zool. 18: 33–39. • Hansen, K. (1973): Trækundersøgelser på Hjelm 1970–72. Flora & Fauna 3: 53–65. • Ders. (1975): Hjelm Fuglestation 1974. Feltornithologen 2: 78–89. • Hansen, V. & S. Larsson (1945): Danmarks Fauna no. 50. Gads, København. • Hansen, V. (1951): Ibid. no. 56. • Ders. (1952): Ibid. no. 58. • Ders. (1965): Ibid. no. 76. • Ders. (1968): Ibid. no. 76. • Jensen-Haarup, A. (1912): Ibid. no. 12. • Kroll, H. (1972): Zur Nahrungsökologie der Gartengrasmücke (*Sylvia borin*) beim Herbstzug 1969 auf Helgoland. Vogelwarte 26: 280–285. • Palmgren, P. (1932): Zur Biologie von *Regulus r. regulus* (L.) und *Parus atricapillus borealis* Selys. Acta. Zool. Fenn. 14: 1–113. • Palmgren, P. (1936): Über die Massenwechsel bei *Regulus r. regulus* (L.). Ornis. Fenn. 13: 159–164. • Southwood, T. R. E. (1971): Ecological Methods. Chapman and Hall, London. • Steenberg, C. (1911): Danmarks Fauna, no. 10. Gads, København. • Vauk, G., & E. Wittig (1971): Nahrungsökologische Untersuchungen an Frühjahrsdurchzüglern der Amsel (*Turdus merula*) auf der Insel Helgoland. Vogelwarte 26: 238–245.

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Die Vogelwarte, 28, 1976: 190–206

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Einfluß des Alters der Mehlschwalbe *(Delichon urbica)* auf ihre Brut

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1. Einleitung

Im Dorf Riet (Stadt Vaihingen/Enz; über Lage und klimatische Verhältnisse s. Rheinwald & Gutscher 1969) untersucht Gutscher seit 1961 die Mehlschwalben-Population. Die brutbiologischen Untersuchungen werden nahezu ausschließlich an Kunstnestern durchgeführt, die es auch ermöglichen, die Altvögel auf einfache Weise zu fangen. Wegen der großen Ortstreue der Mehlschwalbe (Rheinwald & Gutscher 1969; Rheinwald 1976) sind viele der Brutvögel in Riet schon als Nestling beringt worden, wodurch ihr genaues Alter bekannt ist. Zusammen mit den brutbiologischen Angaben ermöglicht uns dies, den Einfluß des Alters auf die Brut zu analysieren. Besonders interessiert uns, inwieweit die Reproduktion vom Alter abhängt.

Analysen der Brutbiologie bei Vögeln sind von verschiedenen Autoren vorgelegt worden. Bei den Arbeiten von Coulson (z. B. Coulson & White 1958 a und b) geht es besonders um die Frage, welchen Einfluß der Paarzusammenhalt und das Alter auf den Bruterfolg der Dreizehenmöwe (*Rissa tridactyla*) hat. Ganz entsprechend