ORNIS FENNICA

SUOMEN LINTUTIETEELLISEN YHDISTYKSEN JULKAISEMA

UTGIVEN AV ORNITOLOGISKA FÖRENINGEN I FINLAND

TOIMITUS REDAKTION: O. KALELA G. NORDSTRÖM

XXXIX

No 1 . 1962

Animal food of capercaillie *(Tetrao urogallus)* and black grouse *(Lyrurus tetrix)* in autumn

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Plant food comprises the bulk of the nutrition of adult tetraonids throughout the year (MARTIN, ZIM & NELSON 1951, SEMENOV – TIAN – SHANSKY 1959). This holds particularly true with respect to the winter diet, since all tetraonid species breed and overwinter in a climate of arctic or boreal type.

However, in summer the diet includes some amount of invertebrate animal matter. This paper deals with the animal species found in crop samples of capercaillie and black grouse collected in several areas in Finland during September, October and November. A more general account of the crop contents will be published later.

According to previous studies (see below) adult tetraonids utilize some animal food in spring, summer and autumn. In spite of the vital importance of animal food for tetraonid chicks, plant food predominates in the diet of the adult birds even in summer, since the quantity of animal matter consumed is rarely large. The diet consists of numerous invertebrate species, particularly insects, but also Isopoda, Arachnida, Myriapoda, Annelida and Gastropoda. Important groups seem to be ants (Hymenoptera, Formicidae), beetles (Coleoptera) and flies (Diptera). Vertebrate food is only exceptionally consumed (see BUMP et al. 1947).

According to COLLINGE (1924–27), 22.5 per cent »of the total food consumed» by adult red grouse (*Lagopus scoticus*) is animal matter, the bulk of which consists of »injurious insects». This figure is surprisingly high, particularly since the winter foods are not treated separately.

At all events, juvenile birds of adult size are probably included in the adult category, which is likely to make the percentage higher.

BEER (1943) stated that 1.7 per cent (volume) of the total food of adult blue grouse (*Dendragapus* sp.) is animal matter. It is utilized from May to the beginning of October, the peak (about 15 per cent) being in August. The groups mentioned as most important are carpenter ants, beetles and grasshoppers.

BUMP et al. (1947, table 25, p. 198) gave a comprehensive list of animal species (580 different identifications) found in the crops of adult and juvenile ruffed grouse (*Bonasa umbellus*).Animal matter, however, comprised only 1.1 per cent (volume) of the total food of the 1093 adult ruffed grouse examined. The groups most frequently occurring in the crops were Hymenoptera, Coleptera, Arachnida, Orthoptera, Hemiptera & Homoptera, and Lepidoptera.

In Norway, KAASA (1959) found animal food in the crops of black grouse from May to November. Ants and beetles were the groups best represented. The total amount of animal food consumed was generally small.

SEMENOV—TIAN—SHANSKY (1959) presented data on the food habits of both capercaillie and black grouse. Adult capercaillie were found to utilize animal food from May to October. The peak of the frequency was in August, when 24 per cent of the crops also contained some animal matter. The respective figures were 11 per cent in September and 1 per cent in October. Adult black grouse seemed to take animal food more frequently than capercaillie in autumn, for in September 64 per cent of the crops of this species and in October 17 contained animal matter. This difference in the frequencies between capercaillie and black grouse may be partly due to the fact that adult and juvenile capercaillie collected in September were treated separately but the respective age classes of black grouse collectively.

Material and methods

The material analyzed comprises 1482 crop samples of capercaillie and black grouse collected in September, October and November between 1956 and 1960. The samples had been removed from birds shot during the open season and sent in by the voluntary co-operators of the Game Research Institute of the Finnish Game Foundation. Samples have been collected from each of the 11 administrative districts of Finland (excl. Aland). In addition to the crop the left wing of each bird was also submitted for species identification, sexing and age class determination (cf. KOSKIMIES 1953). Birds hatched the preceding summer are called juveniles (juv), older ones (more than one year old) adults (ad).

The numbers of samples and sex and age distribution of the two species are given in the following table.

		ad	juv	
Capercaillie (total 651)	♂	187	196	
	♀	129	139	
Black grouse (total 183)	♂	216	279	
	♀	162	174	
	Σ	694	788	1482

There were 329 samples of 1956, 213 of 1957, 204 of 1958, 450 of 1959, and 286 of 1960. Samples of 1961 had not all been analyzed when the manuscript was prepared. Thus the 1961 material is not included in this paper with the exception of some additions to the list of identified food items (table 1, p. 5).

In order to make storage and dispatch of the samples as easy as possible, the co-operators were advised to dry the crop contents in a warm place. Samples were sent in immediately after the hunting season. Thus most of the samples received were dry. Many delicate invertebrates were broken into pieces during transportation, which sometimes made identification at species level impossible. Because dry material is concerned, the volumetric method was found too time-consuming and impractical. Only the weight (and often also the number of individuals) was recorded separately for each food item found in a crop.

Occurrence of animal matter in crops

Of the 1482 samples analyzed, 158 (10.7 per cent) contained animal matter. In each of them there was only a small amount of animal food, i.e. generally less than 50 mg (dry weight). The proportion of animal food was very low (less than 1 per cent in September). Hence we have omitted the gravimetric percentage figures, which are too much affected by the amount of vegetable food. The frequency of occurrence of animal matter in the crops is considered to be a better indicator of the differences and trends in the utilization of animal food.

The frequency of occurrence (per cent, actual number of crops in brackets) of animal matter in samples from the different sex and age class groups of the two species is shown in the following table:

		ad	juv
Capercaillie	♂	2.1 (4)	17.9 (35)
	♀	3.1 (4)	11.5 (16)
Black grouse	♂	2.7 (6)	15.8 (44)
	♀	6.7 (11)	21.8 (38)
Both species		3.6 (25)	16.9 (133)

There is no statistically significant difference between capercaillie and black grouse. However, female black grouse seem to take in animal food more frequently than capercaillie and male black grouse. Within the adult group (of both species) this difference is statistically significant ($\chi^2 = 6.0$, $P < 0.05$). Within the juvenile group the difference is not quite significant at the 95 per cent probability level ($\chi^2 = 3.6$, $P < 0.1$).

On the other hand, it is evident that in September the juveniles of both species and sexes still show a stronger tendency to feed on animal matter than the adults. Animal food was found in 16.9 per cent of the crops of the juvenile birds. This is significantly higher than the figure for the adult birds (3.6 per cent) ($\chi^2 = 61.0$, $P < 0.001$). The amount of animal food per crop was small even in the samples from juvenile birds. Figure 1 illustratates the trend in the frequency values for each

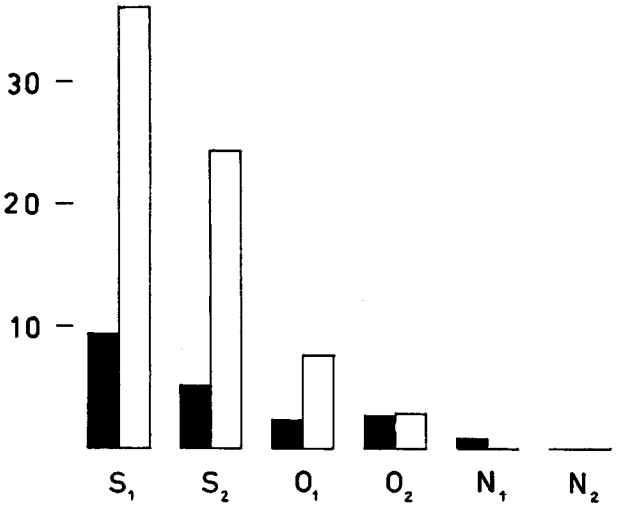

Fig. 1. Frequency (per cent) of occurrence of animal food in crops in each half-month period from September to November. Black columns, adults; white columns, juveniles. Data of both species combined.

half month period from September to November. Data of both species for the years 1956—60 are combined.

The decreasing frequency of animal food can be basically ascribed to its decreasing availability in nature during the autumn. It is also affected by the gradual change in the feeding habits of the birds from terrestrial to arboreal. When feeding occurs mainly in trees (capercaillie: pine needles; black grouse: catkins of birch) the chances that the birds will come across the invertebrates still available in the field layer are small.

The difference between adult and juvenile birds is greatest during the first half of September. The decreasing trend shown by the juvenile birds is much steeper than that shown by the adult birds. This observation is in good conformity with the data published by SEMENOV – TIAN – SHANSKY (1959). He has clearly shown that in September juvenile capercaillie still feed more on animal matter than do adults (frequency in juveniles 42 per cent, in adults 11 per cent). This greater tendency of juvenile birds to pick up small animals is obviously related to the vital importance of animal food for the growing chicks. It has been shown by several investigators (eg. LESLIE 1912: *Lagopus scoticus*; LID & MEIDELL 1933: *Lagopus lagopus*; BEER 1943: *Dendragapus*;

BUMP et al. 1947: *Bonasa*; KAASA 1959: *Lyrurus*; and RAJALA 1959: *Tetrao*) that during the first few weeks of their life tetraonid chicks feed exclusively or almost so on animal food. Later there is a gradual increase in the proportion of vegetable matter in the diet. This process reaches a natural culmination in October—November, when the juvenile birds also start to feed in trees.

Invertebrate species found in crop samples

The different items of animal food found in the crops of capercaillie and black grouse are listed in table 1. This list is compiled mainly on the basis of the 1960 material. Animal food items in the material of the

Table 1. Systematic list of the animal food items identified from the crop samples. Further explanation in text.

Gastropoda

Pulmonata
- *Columella edentula*
- *Discus ruderatus* (1959)
- *Eulota fruticum* (1959)

Insecta

Orthoptera
- *Ectobius* sp.

Hemiptera
- *Corixa* sp.
- *Lygus* sp. (1961)
- *Stenodema holsatus*
- *S. calcaratus*
- *Elasmucha grisea*
- *Elasmostethus interstinctus* (1959)

Homoptera
- *Tettigella viridis*

Lepidoptera
- Psychidae sp., case of larva
- Geometridae sp., larva (1959)
- Noctuidae sp., imago
- microlepidoptera, pupa

Diptera
- Tipulidae sp.
- Syrphidae sp.
- unidentified pupae

Coleoptera
- *Pterostichus nigrita* (1959)
- *P. cupreus* (1959)
- *Coccinella 7-punctata*
- *C. hieroglyphica* (1961)
- *C. trifasciata* (1959)
- *Hippodamia 7-maculata* (1959)
- *Adalia bipunctata* (1959)
- *Chilochorus renipustulatus*
- *Lochmaea suturalis*
- *Lema cyanella* (1961)
- *Plateumaris discolor* (1961)
- *Apion* sp. (1959)
- *Hylobius* sp. (1959)
- *Aphodius fimetarius*

Hymenoptera
- Terebrantes, unidentified sp.
- *Lasius niger*
- *Formica rufa*
- *F. fusca*
- *Camponotus herculeanus* (1961)
- *Myrmica* sp. (1961)
- unidentified pupa

Arachnoidea

Araneida spp.

Phalangida spp

Table 2. Numbers of crops in which members of some invertebrate groups have been found to occur. Further explanation in text.

	Material of 1960	Whole material 1956–1960
Hymenoptera	22	103
Formicidae	21	94
others	1	9
Coleoptera	15	57
Coccinellidae	10	30
Chrysomelidae	4	10
Curculionidae	—	4
Carabidae	—	3
unidentified	1	10
Hemiptera	2	10
Lepidoptera, larvae	—	4
Arachnoidea	4	23

years 1956–59 were generally identified only at family or genus level. Some species have been included in the list, even though not found in 1960. In such cases the year of occurrence and identification is given in brackets.

Table 2 shows the number of crops in which members of some orders and families have been found. Data of 1960 are presented separately for the reasons stated above.

The three snail species found in the crops must be considered to be quite unusual as food items. These species are to be found on e.g. *Vaccinium myrtillus*-growth. Thus it is possible that they have been swallowed unintentionally with the food plant.

Among the insects, ants are evidently the group occurring most frequently in the crops. *Formica rufa* is the commonest of the ant species. It was identified in 20 samples in 1960. There is only one reliable identification of each of the other 4 species listed. To a limited extent the common occurrence of ants in the crops of capercaillie and black grouse can be ascribed to the habit of these birds of dusting on the fringes of ant hills. This may explain the fact that it is ants that form the bulk of the insects found in the crops of the adult birds. On the other hand, it can be supposed that ants, as common and actively moving objects, often catch the attention of the birds and are then picked up.

Anting behaviour has not been observed in capercaillie and black grouse in Finland, but it was reported by Reymond (1948). It is doubt-

ful, however, whether tetraonids perform true anting (cf. POULSEN 1956) and, thus, it appears that anting is unlikely to be the explanation of the frequent occurrence of ants in the crops.

Besides ants, beetles (Coleoptera) are also rather frequently taken by capercaillie and black grouse. The beetle family most often represented in the crops was Coccinellidae (ladybird beetles). The occurrence of different coccinellid species has shown yearly variations. *Coccinella 7-punctata* was common in 1959 (15 crops of occurrence), while in 1960, for instance, it was found in only one crop. On the other hand, *Chilocorus renipustulatus*, which had not been found before, occurred in 9 crops in 1960. These variations are assumed to reflect parallel population fluctuations in nature.

Another family of beetles worth mentioning is Chrysomelidae. The *Lochmea* species (4 crops 1960) was found in crops containing heather (*Calluna vulgaris*). Thus, it is likely that *L. suturalis* is concerned, since heather is the food plant of this species. In one sample crop of 1961, two live *Plateumaris* sp. were found about 3 days after the the bird had been shot. Thus, even rather large insects can be swallowed alive and are probably not killed before reaching the gizzard.

Other groups of insects seem to be quite accidental. The Dipteran pupae mentioned in the list may be of some flesh fly, and thus developed during drying and storing.

Some Arachnoidea were likewise found in the crops. Identification of species has not been done, however, owing to the incompleteness of the specimens.

Regrettably, our material does not cover the summer, which is obviously the most interesting period from the point of view of a study of the consumption of animal food. Thus, a direct comparison with the results of previous studies is difficult. At all events, much similarity can be observed in the utilization of animal food by the woodland grouse studied, irrespective of continent (Old World: capercaillie and black grouse; New World: blue grouse and ruffed grouse; see references above). The amounts eaten by adult birds of each species are small in proportion to the plant food. Also the animal groups most frequently represented in the diet are roughly the same. Ants and beetles seem generally to be the commonest groups. There are, of course, also many differences between the species, which may be at least partly ascribed to differences in the availability of food items.

Remarks on the nutritive importance and selection of animal food

It is known from investigations on nutritional physiology that the protein content of animal food is generally higher than that of vegetable food (see e.g. BECK & BECK 1955). Thus animal food is likely to be of vital importance for growing tetraonid chicks as a source of protein. The contribution of animal protein to the nutrition of adult capercaillie and black grouse seems slight, however, since only very small amounts of animal food are consumed even at the beginning of September, when it still is available in fairly large quantities.

The same also holds true with respect to the juvenile birds in autumn. Animal food was found in only one crop in three and the amount per crop was small. Juvenile birds, in fact, still gain weight in September (KOSKIMIES 1958, own unpublished data) but obviously they are already well adapted to utilize plant food. It is especially worth noting that juvenile females of black grouse (the smallest type concerned) attain adult weight in early September but seem to feed more on animal matter than juvenile capercaillie and juvenile males of black grouse, which still continue to grow. Taking of animal food by the juvenile birds thus seems not directly connected with greater intensity of growth.

The occurrence of animal food in crops is much affected by the availability of the food items in nature. Some of the invertebrate species are only found in crops containing their food plant. In such cases it is possible that the animals have been unintentionally taken by birds when feeding on the plant species in question.

However, it is difficult to explain the occurrence of such insects as ants and ladybird beetles without supposing some active selection. It seems likely that capercaillie and black grouse have a tendency to peck on small moving objects. This would account for the frequent occurrence of ants, for instance. This behavioural tendency is probably stronger in juvenile birds than in adults. On the other hand, many ladybird beetles with bright colours are easily discernible (at least to the human eye) against green leaves. It even seems possible that they may sometimes be mistaken for berries. In some years ladybird beetles are very abundant, which, of course, increases the likelihood of their being eaten by grouse.

Taste seems not much to affect the selection of animal food items. At all events, the ladybird beetles, generally believed to have an unpleasant taste, are at least as frequently eaten by grouse as other

beetles. In addition, it may be mentioned that at Evo Game Research Station in the summer of 1961 captive young capercaillie and black grouse were fed with sawfly larvae of the genus *Diprion*. Chicks were observed to eat the larvae in large quantities in spite of the fact that they are known to be avoided by some passerine birds (TINBERGEN 1960, PROP 1960). The unpalatability of these larvae is thought to be based on a sharp resinous taste, which according to our observations does not, repel grouse.

PALMGREN et al. (1937) claim that some passerine birds avoid feeding on ants and animals resembling ants, which naturally is the necessary presupposition to ant mimicry. On the other hand, others assert that passerine birds often eat ants and the very existence of ant mimicry has even been questioned (cf. eg. POULSEN 1956). At all events, it is clearly shown by our data that the ant habitus affords at least no absolute protection against capercaillie and black grouse.

Animal food items as vectors for parasites

Some of the invertebrate species eaten by birds act as intermediate hosts of parasitic helminths. »The Committee of Inquiry on Grouse Disease» (LESLIE 1912) long ago made an attempt to find out which insect species are intermediate hosts of some helminths parasitizing red grouse.

Some of the common cestode parasites of capercaillie and black grouse belong to the genus *Raillietina* (SPREHN 1932, LUND 1946 and 1952, RYKOVSKY 1960). At least *Raillietina urogalli* (Modeer 1790) has also been identified from Finnish grouse (cf. MUROMA 1951). It is known that ants and beetles, for instance, are intermediate hosts of the species of *Raillietina* (FIEBIGER 1947, CHANDLER 1950, ROTHSCHILD & CLAY 1957). It is to be borne in mind that ants and beetles are the very two groups of insects most frequently represented in the crops of capercaillie and black grouse in autumn. Two *Myrmica* species have been found to be important intermediate hosts of *R. urogalli* on the grouse moors of Scotland (MUIR 1954). Consequently, RYKOVSKY (1960) states that the common occurrence of *R. urogalli* in the chicks of black grouse in his study area is a result of the great proportion of ants in the diet of the chicks.

Formica rufa (the commonest ant species eaten by capercaillie and black grouse) has been assumed to be a vector of a *Raillietina* species

(*R. friedbergi* (v. Linstow 1878); JOYEUX & BAER 1936). Thus, the possibility exists that it is a vector of *R. urogalli*, too.

In this connection the results established by BENDELL (1955) are of particular interest. According to him, two parasitic helminths, *Dispharynx nasuta* Rud. and *Plagiorhynchus formosus* Van Cleave, cause considerable mortality among the chicks of blue grouse in his study area in British Columbia. BENDELL (op.cit.) states that the high frequency of occurrence and association of these two parasites may be explained by the fact that both worms have Isopoda as their intermediate host. As might be expected, isopods are a common item in the diet of blue grouse chicks.

It is, of course, understandable that during the course of evolution parasites have become adapted to utilize as vectors those species which are frequently eaten by the final host. Tetraonids, afford good examples of such relationships. Studies on the transmission of the endoparasites of capercaillie and black grouse could elucidate the interrelations of the host, vector, and parasite populations concerned, as well as the role of this factor complex in the population control of the grouse.

Summary

1. This study is based on analyses of 651 crop samples of capercaillie and 831 samples of black grouse. Samples were collected from different parts of Finland in September, October and November of the years 1956—1960. The sex and age class of each individual was determined by examination of the left wing.

2. Altogether 158 crops (10.7 per cent) were observed to contain animal matter. There was no significant difference between the species. Females of black grouse were found to utilize animal food more frequently than capercaillie or males of black grouse. The amount of animal food per crop was very small (percentage weight about 1).

3. The trend towards decreasing consumption of animal food was shown by both age classes from early September to November. Juvenile birds showed a stronger tendency to pick up small animals than adult ones. This difference was greatest at the beginning of September. It gradually diminished until in mid-October the juveniles attained the adult diet (see Fig. 1.).

4. Species of Gastropoda, Insecta, and Arachnoidea were found in the crops (table 1). The commonest groups were ants and beetles

(table 2). Owing to the small amount utilized, animal food is unlikely to contribute much to the nourishment in autumn. Many of the animals found in the crops may have been swallowed unintentionally with plant food. Grouse are stated to have a behavioural tendency to pick up small moving objects (e.g. ants). Taste does not seem much to affect the selection.

5. The function of animal food items as vectors of endoparasites of birds is discussed.

Aknowledgements. First of all we are grateful to the numerous cooperators of the Game Research Institute. Without their voluntary assistance in collecting the crop samples this study would have been impossible. To Dr. JUKKA KOSKIMIES, Director of the Game Research Institute, we are particularly obliged for encouraging advice and critical reading of the manuscript. Our sincere thanks are also due to Dr. PAAVO KONTKANEN for valuable aid in identifying some insect specimens, to Mr. LAURI KOLI, Lic. Ph., for identifying the gastropods, and to Dr. EINO OINONEN for confirming the identifications of the ant species. Mrs. IRJA HELMINEN, Mr. SAKARI PETRO, M.A., and Mr. KYÖSTI VALANNE have assisted in analyzing the crop contents. We are very gratefull for their careful work.

Mrs. JEAN MARGARET PERTTUNEN, B.Sc., has revised the language of our manuscript, for which we express our gratitude.

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Selostus: Metson ja teeren syksyisestä eläinravinnosta

Tutkimus perustuu 651 metson ja 831 teeren kupunäytteeseen vuosilta 1956—1960. Näytteiden keräys suoritettiin Suomen Riistanhoito-Säätiön riistantutkimuslaitoksen avustajakunnan välityksellä ko. lajien metsästysaikoina. Täten näytteitä saatiin vain syys- (ja talvi-) kuukausilta. Jokaisen lintuyksilön laji, sukupuoli ja ikäluokka voitiin määrittää samassa yhteydessä kerätyn vasenman siiven perusteella. Kupujen sisältämää kasviravintoa tullaan myöhemmin käsittelemään toisessa kirjoituksessa.

Yhteensä 158 kupua (10.7 %) sisälsi eläinravintoa. Lajien välillä ei todettu olevan merkitsevää eroa eläinravinnon käytössä. Sensijaan nuoret linnut (saman vuoden poikaset) käyttävät syksyllä enemmän eläinravintoa kuin aikuiset. Useat eri tutkimukset ovat osoittaneet, että metsäkanalintujen poikaset syövät ensimmäisinä elinviikkoinaan runsaammin eläin- kuin kasviravintoa. Poikasten kasvaessa eläinravinnon osuus supistuu vähitellen, mutta ero aikuisten lintujen ravinnonkäyttöön nähden säilyy lokakuun alkupuoliskolle saakka. Eläinravinnon käytön väheneminen syksyllä on luonnollisesti seuraus saatavissa olevien hyönteisten ym. selkärangattomien eläinten määrän pienenemisestä. Muutos on kuitenkin nuorilla linnuilla jyrkempi kuin aikuisilla, mikä viittaa nuorilla linnuilla tapahtuvaan muutokseen ravinnonhankintakäyttäytymisessä.

Eläinravinnolla ei voida katsoa olevan suurta merkitystä metson ja teeren syksyisessä ravitsemuksessa, koska eläinravintoa käytetään vain pieniä määriä (yleensä alle 50 mg kuvussa). Osa taulukossa 1 luetelluista eläinravintokohteista lienee joutunut linnun kupuun sattumalta kasviravinnon mukana. Useimmin kuvuissa eslintyvät ryhmät ovat muurahaiset, leppäpirkot ja hämähäkit. Metsolla ja teerellä näyttää olevan taipumus nokkia pieniä, liikkuvia kohteita, kuten muurahaisia. Leppäpirkot lienevät kirkasvärisinä myös linnuille helposti havaittavia. Maku ei vaikuttane paljon metson ja teeren eläinravinnon valintaan, sillä yleisesti pahanmakuisina pidettyjä lajeja on löydetty kuvuista (mm. leppäpirkot ja eräät luteet).

Kirjallisuustietojen perusteella muurahaiset ja kovakuoriaiset, jotka ovat yleisimmät ryhmät metson ja teeren eläinravinnossa, voivat toimia *Rallietina*-sukuun kuuluvien heisimatojen väli-isäntinä. Eläinravinnon käytöllä voidaan siksi otaksua olevan merkitystä myös metson ja teeren eräiden suolistoloisten (mm. *Rallietina urogalli*) leviämiselle. Tarkemmat tutkimukset ovat kuitenkin tarpeen kysymykseen tulevien väli-isäntälajien osoittamiseksi.