DANISH REVIEW
of
GAME BIOLOGY

Edited by
Jagtraadets vildtbiologiske Undersøgelser

Managing editor: R. Spärck, Zoological Museum, Copenhagen

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Investigations

on

the Feeding-habits of the House-sparrow (*Passer domesticus*) and the Tree-sparrow (*Passer montanus*)

by

Marie Hammer

Copenhagen 1948

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INTRODUCTION

In 1941 an investigation into the feeding-habits of the house-sparrow was initiated. The intention was to examine whether the house-sparrow really does so much damage as is ordinarily supposed and, if so, whether there was sufficient reason for reducing the number of birds. In order to elucidate this question it is necessary to have a very thorough knowledge of what it eats. It was with this end in view that an investigation into the feeding-habits of the house-sparrow and the tree-sparrow was undertaken during the period 1941 to 1944. All the plants in this investigation were determined by Mag. scient. M. KØIE.

THE MATERIAL

At regular intervals — at first once a month or more frequently — a number of house-sparrows was despatched to the Zoological Museum in Copenhagen. The sparrows were caught at different stations of agricultural research; they were selected so that the birds used as material for the investigation came from various parts of the country. In this way it was feasible, by examining the contents of their gullet and stomach, to obtain a fairly thorough knowledge of the most important food-stuffs eaten by the sparrows in various parts of the country throughout the year.

The distribution of the material collected is listed in table 1, which includes all the sparrows examined. From this it will be seen that certain stations — Lyngby, Tystofte and Ribe — have been examined fairly regularly in the course of several years, while the greater number of stations have yielded but few collections of specimens or even only one. At the former stations it is possible to follow up the food of the sparrow throughout the year, while at the latter one can get some idea of the food of the sparrow at the season and district in question. In all 2657 house-sparrows, adults and young, and 501 tree-sparrows, adults and young, have been collected, and besides 130 young ones, the species of which was not determined. The house-sparrow and the tree-sparrow will be treated separately.

The gullets and stomachs were taken out and very thoroughly investigated as to contents. Unfortunately, the gullet in by far the most cases was empty, and when it did contain food (grain, seeds, insects etc.) it was in such small

Table 1. *List of the material of*

Localities	1941												1942											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Sjælland:																								
Ramløse	—	—	—	—	—	—	—	—	—	—	23	—	—	—	—	—	—	—	—	—	—	—	—	—
Lille Lyngby	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hillerød	—	—	—	—	—	—	—	25	—	32	—	—	10	15	—	—	—	—	—	—	—	—	—	—
Toftesten, O. Sundby	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	17	—	—	—	—	—	—
Slangerup	—	—	—	—	—	—	—	—	15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Vejenbrød	—	—	—	—	2	18	7	—	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Holte	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lyngby	—	—	—	—	10	49	57	92	11	—	29	14	—	10	7	10	19	9	19	76	—	—	39	26
Springforbi	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hellerup	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8	13	—	5	—	—
Botanisk Have, Kbhvn.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15	—	—	—	—
Universitetsgaarden	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Amager	—	—	—	—	—	—	—	30	36	3	—	—	—	—	—	—	—	—	—	—	50	78	—	—
Taarnby	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Herlev	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Farum	—	—	—	—	—	—	—	8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirke Hyllinge	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	77	—	—	—
Brofælde, Uggerløse	—	—	—	—	—	—	—	—	—	—	16	31	—	—	—	—	—	—	—	17	—	—	—	—
Tystofte	—	—	—	—	10	11	11	10	14	21	28	24	21	14	18	12	—	—	15	13	14	5	—	—
Karrebæksminde	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gaunø	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Fyn:																								
Aarslev	—	—	—	—	15	37	22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Jylland:																								
Studsgaard	—	—	—	—	4	12	14	8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Brigsted	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10	—	—	—	—	—	—
Vorsø	—	—	—	—	—	30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Borris	—	—	—	—	13	—	38	15	14	6	—	14	—	7	—	—	—	—	—	—	—	—	—	—
Skarrild, Kibæk	—	—	—	—	—	—	—	—	—	—	—	—	8	—	—	—	—	—	—	—	—	—	—	—
Grindsted	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	11	—	—	—	—	—	—
Vejen, Askov	—	—	—	—	—	10	—	27	—	—	38	—	14	—	—	—	—	—	—	—	—	—	—	—
Lundgaard	—	—	—	—	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ribe	—	—	—	—	—	—	29	38	—	25	—	16	4	—	—	—	—	52	11	—	34	18	11	14
Bornholm:																								
Svaneke	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	14	—	—	—	—	—	—
Aakirkeby	—	—	—	—	—	—	—	22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Christians Ø	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	23	—	—	—	—	—	—
In all per month and year	—	—	—	—	61	167	178	275	99	87	134	99	57	46	25	22	19	136	53	134	175	106	50	40

House-sparrow collected.

1943												1944												1941	1942	1943	1944	In all per Locality
1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12					
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	23	—	—	—	23
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	2
19	44	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	57	25	63	—	145
—	—	—	—	—	—	—	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	17	4	—	21
—	—	—	—	—	—	—	—	—	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15	—	6	—	21
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	34	—	—	—	34
—	—	—	—	—	54	—	—	—	—	—	—	—	—	—	—	—	14	—	21	—	—	—	—	—	—	54	35	89
21	10	8	18	6	37	—	—	—	3	10	13	—	—	—	8	—	7	—	—	—	—	—	—	262	215	126	15	618
—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	26	—	—	26
—	—	—	13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15	13	—	28
—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1
—	—	—	—	—	—	—	—	72	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	69	128	72	—	269
—	—	—	—	—	—	—	—	—	23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	23	—	23
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8	—	—	—	8
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	77	—	—	77
—	—	—	—	—	—	—	—	—	—	9	14	—	—	—	—	—	—	—	—	—	—	—	—	47	17	23	—	87
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	129	112	—	—	241
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	24	—	—	—	—	—	—	—	—	—	—	—	24	24
—	—	—	—	—	—	15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15	—	15
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	74	—	—	—	74
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	38	—	—	—	38
—	—	—	—	—	18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10	18	—	28
—	—	—	—	—	22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30	—	22	—	52
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100	7	—	—	107
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8	—	—	8
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	11	—	—	11
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	75	14	—	—	89
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7	—	—	—	7
24	—	41	19	—	43	10	—	18	—	23	—	—	—	—	—	—	—	—	—	—	—	—	—	108	144	178	—	430
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	14	—	—	14
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	22	—	—	—	22
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	23	—	—	23
64	54	49	50	6	175	25	1	90	32	46	27	—	—	—	32	—	22	—	21	—	—	—	—	1100	863	619	75	2657

quantities that nothing could be said as to how much a sparrow is able to consume at a time. The quantity of grain which a sparrow can eat in a day has however been determined by feeding experiments (see p. 34 ff.). The contents of the gullet may thus only help to identify certain insects and the like which are always very much crushed in the stomach. Thus the contents of the stomach is frequently found as a mixture of single grains, chaff, grains of starch, seeds, husks of seeds, and bits of chitin mixed with whole coxae, femura, crania and the like from the hardest chitinized insects, as weevils (*Curculionidae*), dung beetles (*Aphodiinae*) and others; but some quite soft and frail insects (*Aphididae*) are also found in an easily recognizable state. The considerable decomposition effected in the stomach, however, made it very difficult, in most cases, to determine the genus or species of the animals found.

The sparrows were identified as to sex, and examined separately; like the young birds (nestlings and young ones just able to fly). It was evident that there is no difference between the sexes as to nutrition. The quite small young ones, the nestlings, however, get a quite definite food, which, as soon as they have learned to fly, and to find their own food, will consist of the same things as that of the adult birds.

LITERATURE CONCERNING THE FEEDING-HABITS OF THE SPARROW

„The House-Sparrow is still with us and more numerous than ever, and its habits are the same as they were a hundred years ago. For fifty years at least the „Sparrow Question" has been debated in and out of season, and the bird has been condemned by practically every individual who has investigated its feeding habits. Its depredations are deplorable in the extreme, whilst the financial loss which it occasions amounts to some millions of pounds sterling per annum." (COLLINGE 1924—27.)

If people for many years, in spite of these hard words, have been, and to a certain extent, still are, in doubt regarding the noxiousness or benefit of the house-sparrow, it is due, partly to the fact that the sparrow behaves very differently in the various parts of the country, and partly to the fact that the investigations of its feeding habits have been undertaken as a whole regardless of how intensively the soil was cultivated. Where there are only some few sparrows they are often looked upon with benevolence on account of their great consumption of insects; where they are numerous, the great damage caused in the cornfields is obvious. As the distribution of the sparrows is in exact proportion to that of the cultivation of corn, it will most often happen

that there are very many sparrows in a district with many cornfields, while areas with fruit trees or woods, or mainly meadows or heath, have a proportionally small or maybe an exceedingly small number of sparrows. As a consequence of these circumstances an estimate of the possible damage done by the sparrows should be made with a fair allowance of the conditions to which the sparrows are subjected.

In „The economic importance of the house-sparrow, *Passer domesticus* L.: A Review" (1945) SOUTHERN has reviewed the results obtained by the various authors. KALMBACH (1940) and COLLINGE (1924—27) are especially important; they have analysed the diet of the sparrow in different areas in America and England. First of all it should be pointed out that, on the whole, the diet of the sparrow consists of grain, weed-seeds and insects and the proportion of these three ingredients and also their composition decide the benefit or noxiousness of the sparrows in the area in question. COLLINGE found that the diet of the sparrow in agricultural districts in England consists of 75 per cent grain, while in fruit-growing districts and suburban areas it only contains 17 per cent grain. Nestlings in agricultural districts ate up to 40 per cent grain, while the food in the other areas was almost exclusively animal. Weed-seeds constitute, in England, in agricultural districts 10 per cent of the food of the sparrow, in other areas 20 per cent. The figures are the same in America.

From this scanty information it will be seen that the food of the sparrow is very different in suburban districts and in the country, and that the food of nestlings is different from that of the adults.

The most exhaustive information as to the nutrition of the sparrow will be found in KALMBACH (1940): „Economic status of the English sparrow in the United States". The information is based upon an examination of about 8000 sparrows, collected during a long period, from 1879 to 1925, in various parts of U. S. A. Despite the rather heterogeneous material KALMBACH succeeded in giving an excellent picture of the diet of the sparrow throughout the year in U. S. A. I have here presented one of KALMBACH's figures (fig. 1) as it shows, better than words can do, the composition of the diet and how it changes from month to month. From this will be seen that animal food constitutes only a very small part of the diet of the adult sparrow. The majority is eaten in May and June during brooding time. Of the vegetable food, which during the greater part of the year constitutes about 100 per cent of their nutrition, grain forms by far the greater part, while grass and weed-seeds only in the autumn have any importance as source of nutrition.

KALMBACH's investigation is remarkable in that he was obviously able to divide the grain devoured into two portions: partly corn stolen by sparrows from the crop, for instance from sheaves in the fields, from stables and barns;

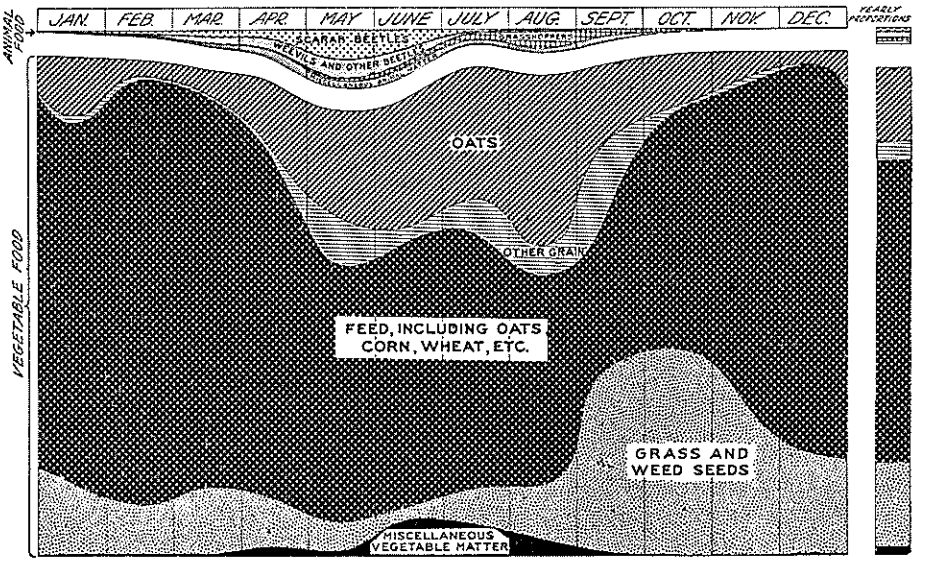


Fig. 1. (From KALMBACH (1940). See the text.)

partly all the corn collected by sparrows in chicken yards, from horse dung on the roads, and so on. This last part, „the feed" constitutes a very large portion of all grain eaten, about 75 per cent. In September, when this food group constitutes the least quantity, it was 31,5 per cent; in February, when maximum is reached, it was 84,2 per cent of the diet. This means a great loss to chicken farms and the like, and KALMBACH calls attention to the fact that this waste of corn can, and ought to be, avoided by feeding chickens and the like inside their houses or by putting fine-mesh wire-netting over the chicken yards. If this could be accomplished, sparrows would not be able to get their main food in that way and this might cause either a decrease of their number or a change in their way of living.

According to KALMBACH's information oats are the cereal most often found in the stomachs (see fig. 1), while wheat and other cereals are of second importance. This must be due to the fact that there were not collected so many sparrows in wheat districts as in oat districts. KALMBACH writes: „When opportunity affords, the birds will feed on it (wheat) exclusively and to repletion. This fact is of greater importance than the mere percentage the wheat forms of the stomach contents, as it indicates the possible damage that may result from the presence of large flocks of these birds in wheat-raising areas."

In California the damage worked by the sparrows to buds, twigs and leaves was not inconsiderable; in one case fruit buds had been completely

stripped from some branches. The damage done to grapes may also be considerable.

In order to show the benefit as well as the harm done by the sparrow, KALMBACH shows in a diagram (fig. 2) the benefit and the damage done by the sparrows in devouring various food elements. He also gives information as to the indifferent components of the food. By way of comparison a diagram is given showing the diet of nestlings. From this will be seen that nestlings must

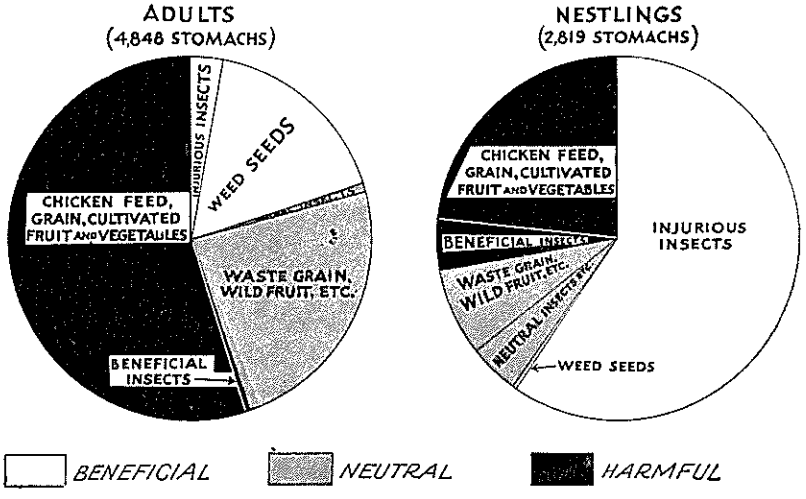


Fig. 2. (From KALMBACH (1940). See the text).

decidedly be reckoned useful owing to their large consumption of destructive insects. This is true for quite small nestlings in a still higher degree.

As regards the final result relating to the benefit or injury of the sparrow, KALMBACH says that ,,it may be stated that the ratio of the generally beneficial work of the nestlings to the largely injurious tendencies of the adults, judged on the basis of the time element involved, is something in excess of 1 to 4,5 or, expressed differently, about 18 per cent of the feeding activities of the species are the commendable one of the nestlings, whereas more that 82 per cent are those of the adults, which this study has shown are often detrimental to agriculture."

COLLINGE (1924—27) examined 758 adults and 476 nestlings partly from agricultural districts, partly from fruit-growing districts, and also from suburban districts. The figures from these various districts were surprising. In agricultural districts cereals constitute 75,0 per cent, weed-seeds 10,0 per cent and injurious insects 5,0 per cent. The rest (10 per cent) consists of mixed vegetable (5 per cent) and animal food (5 per cent). In fruit-growing districts

cereals constitute only 17 per cent, weed-seeds 20,0 per cent, injurious insects, on the contrary, 35,0 per cent. The remaining 28 per cent are constituted by miscellaneous vegetable matter (14 per cent), blossom buds (9 per cent) and earthworms (5 per cent). While animal food in agricultural districts thus constitutes only 10 per cent, in fruit-growing districts there are 40 per cent animal food. In nestlings injurious insects constitute 88 and other animal food 7,5 per cent, while the remaining part (only 4,5 per cent) is miscellaneous vegetable matter. COLLINGE (1914) examined especially the diet of nestlings, partly in fruit-growing districts and partly in suburban districts, 287 in all. He found a striking difference as regards the diet in the various districts so that the number of insects devoured was 3 times bigger in fruit-growing districts than in suburban districts. With the exception of some few spiders and earthworms he found that the entire diet consisted of injurious insects. According to COLLINGE the adult birds, during the brooding period, live on the same food as the young ones. As it is very difficult to arrive at any satisfactory and convincing results as to the economic significance of the sparrow, COLLINGE is of opinion ,,that if this species were considerably reduced in number, the good that it would do would probably more than compensate for the harm, especially in fruit-growing districts."

Several of the authors here quoted have not had a material as large as that of KALMBACH and COLLINGE to support their view, and the results obtained are not as exhaustive:

SCHLEH (1883) calls attention to the fact that when the adult sparrows only eat insects during summer in brooding time, it is not on account of a lack of insects during the rest of the year, but because the house-sparrow is a decided vegetarian and despises animal food. FLORENCE (1912, 1914 and 1915) examined about 150 house-sparrows through several years. By far the greater part of the diet consisted of grain; besides that some seeds, some leaves and very few insects were found. The material examined, in my opinion, is insufficient to give an idea of the diet of the sparrow.

According to RUSINOVA (1926) the adult sparrow in Turkestan (*P. montanus dilutus*, *P. domesticus indicus* and *P. hispaniolensis transcapicus*) is ,,a plantivorous-insectivorous bird; 94,5 per cent of all the food is composed of the seeds of plants and 5,5 per cent of insects. The seeds of cultivated plants compose 9,9 per cent of all food. — 77,8 per cent of the food of the young birds consists of insects, whereas the nestlings exclusively feed upon insects. The destructive role of the sparrows is so great only because there are too many of them."

KASHKAROV (1926) likewise calls attention to the very great number in Turkestan. In one village 14584 nests were found, that is about 100000 birds within a radius of 25 kilometres. KASHKAROV is of opinion that *P. d. indicus*

is the most destructive. In one single district 30 per cent of the wheat was spoilt; in others spring cereals: barley, oats and millet, cannot be sown at all. According to KASHKAROV „not all the races of the crops are deteriorated by sparrows in a like degree. There are sorts of wheat and barley with some „immunity" against the sparrows. It is possible that in that direction we ought to look for the means of control of sparrow pest." By JOURDAIN (1938) it is mentioned that grain constitutes 75 per cent of the food in agricultural districts in Great Britain; in towns the food consists of insects, street refuse and a little seed. In districts where fruit is grown, on the other hand, a great many insects are eaten, but seeds, buds, fruit, grain and other things as well.

MANSFELD (1939) found no essential difference in the diet of adult birds, by examination of stomach contents of 197 house-sparrows and 63 tree-sparrows in August until April. MANSFELD is surprised that there were no insects in the food (1 *Agrotis* with the tree-sparrows) in the period of examination, despite the fact that in nature, far into the month of October, larvae, beetles and grasshoppers were found everywhere. Firstly, the sparrow material investigated by MANSFELD is far too small to give an approximately correct idea of the nutrition, secondly, according to my investigations, the sparrows do not eat many insects outside the brooding period even if they abound everywhere. The bill of the sparrow is very suitable for larger seeds and grains, which the bird husks and cracks, so that the devouring of insects seems almost unnatural for it. As to the nutrition of nestlings of the house-sparrow MANSFELD found that: at the beginning nothing but insects is eaten, from the 5th—6th day about 20 per cent milky grains of corn, boiled potato and pieces of green leaves, gradually more and more; on the 10th day the vegetable matter constitutes about 50 per cent, on the 14th day already 75—80 per cent. The nestlings of the tree-sparrow received mostly the same food; MANSFELD mentions, however, that the July—August broods received a proportionally large number of coccinellids and their larvae together with syrphids.

HÄRDTH (1943) states that the testified damage done to a barley field of ¼ hectar was 80 per cent.

As to the extinction of house-sparrows WALSH proposes (1904—05) strewing poisoned grains (wheat) dipped in a solution of rabbit phosphorus poison on the newly sown fields. The sparrows like it, and at one test about one thousand sparrows were killed. Also MUSSON (1904—05) recommends extinction, and proposes various expedients. Frequently it is proposed to catch the birds by means of swinging traps.

Authors who have made investigations as to the diet of sparrows admit that despite the great benefit of the sparrow during the hatching season the birds ought to be kept down, if they are not to become a veritable pest.

THE DIET OF THE HOUSE-SPARROW

It is already known that the house-sparrow to a great extent derives its food from grain stolen in the fields, in stacks, in barns and in poultry yards, or picks it out of horse dung. Its devastating activities in unripe cornfields, where it causes great damage by breaking numerous stems (a devastation that may completely ruin whole fields at the test farms), have resulted in active persecution. That the house-sparrow may be of considerable benefit in so far as it devours such harmful insects as caterpillars (*Lepidoptera* larvae), plant-lice (*Aphididae*) and others, is also known, but apparently the damage done is grater, or at leat more noticeable.

A great many of the stomachs contain grain; indeed, at certain seasons almost all stomachs contain grain. Weed-seeds are nearly always found as well, while animal food is found in the largest quantities during the summer months and is almost totally absent the rest of the year. In figures 3—5 these three main types of food for all localities are shown; the ordinate shows the percentage of sparrows that have eaten corn, weed-seeds and insects respectively, and on the abcissa is the months of the year. From the curve showing the presence of grain in the stomachs it will be seen that one hundred per cent, or almost one hundred per cent, of the sparrows contain grain all the year round except in the middle of summer when the percentage of 1941 in July was only 78; the same was the case in July 1942, while in 1943 it did not go below 94. Simultaneously with this decline in the curve for grain there was a rise in the curve for the sparrows that had eaten insects. The exact time for this peak, however, varies somewhat from year to year. In 1941 it came in May—July, in 1942 already in May—June, while in 1943 it seems to extend from May to September (August this year has no samples). This peak in the

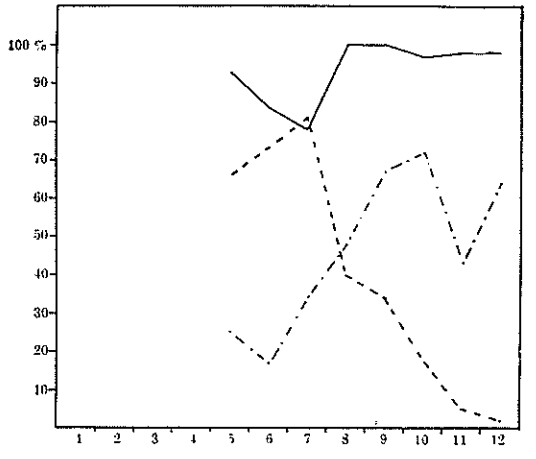


Fig. 3. Percentage of sparrows which in 1941 have eaten

grains ———

insects - - - - - -

weed seeds —·—·—·—

insect curve coincides with the breeding season, and is due to the fact that during these months, not only are nestlings fed with animal food, but also young ones able to fly and fully-grown birds in a great measure eat insects during summer. In spring, autumn and winter only a small percentage of sparrows contain animal food. The curve for weed-seeds in all three years shows an increase towards the autumn, when there are large quantities of ripe seeds about. During winter and spring a comparatively small percentage of sparrows eats weed-seeds; at this time of the year grain is the most important food-stuff. As regards the various stations, similar observations have been made. Thus fig. 6 shows the results from the station Tystofte in 1941. The peak of the insect curve is plainly seen in June.

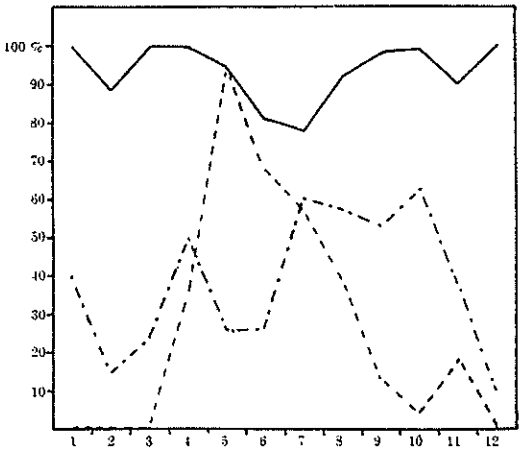


Fig. 4. Percentage of sparrows which in 1942 have eaten

grains ——————
insects - - - - - -
weed seeds -·-·-·-

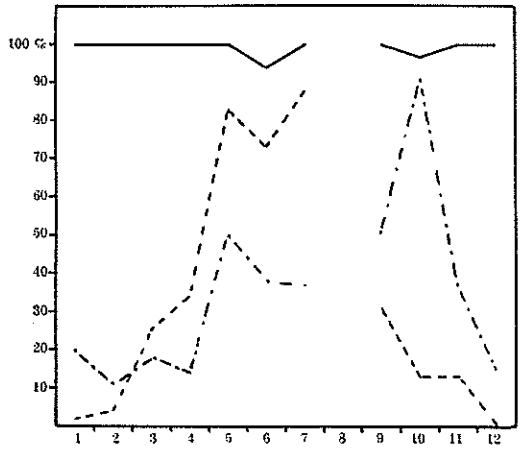


Fig. 5. Percentage of sparrows which in 1943 have eaten

grains ——————
insects - - - - - -
weed seeds -·-·-·-

(Material from August is lacking).

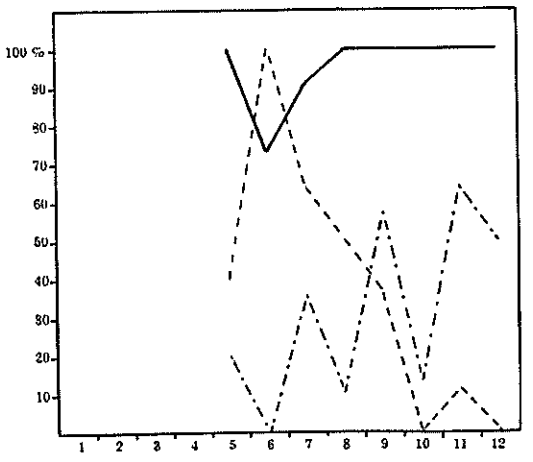


Fig. 6. Percentage of sparrows which in 1941 at the station Tystofte have eaten

grains ——————
insects - - - - - -
weed seeds —·—·—·—

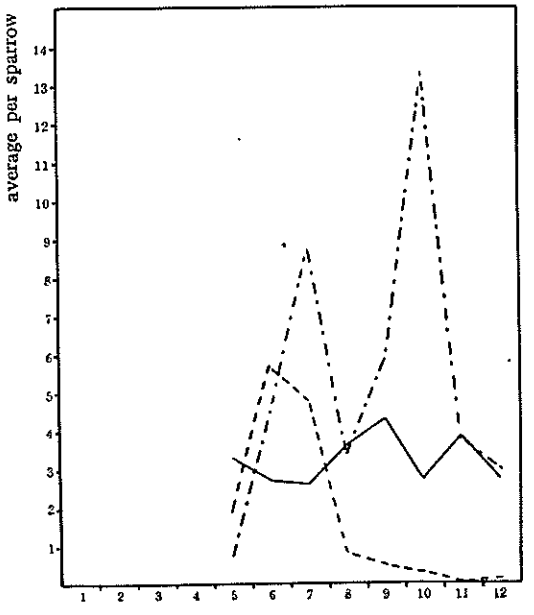


Fig. 7. The average number of

grains ——————
insects - - - - - -
weed seeds —·—·—·—

eaten per sparrow in 1941.

If it is to be determined how large a quantity of these main kinds of food-stuffs a sparrow can eat, it proves to be very difficult to arrive at even an approximately correct result. That a sparrow has been eating grain is easy to see because of pieces of chaff in the stomach, but how many grains are represented by these remains? As it is impossible to decide, grain remains are

always calculated as one grain, and the figures in the tables which are obtained in this way represent the smallest quantities eaten by the sparrow in question. The same is the case as regards weed-seeds and insects; whole seeds have been counted, and insect remains that may be identified are counted, while crushed chitin is only given as one insect if it has been impossible to identify several individuals. Based upon these minimum figures it was calculated how many grains, weed-seeds, and insects a sparrow had eaten per month on an average.

From fig. 7—9 comprising sparrows from all localities from 1941, 1942 and 1943 respectively, the ordinate shows the average grain, weed-seeds and insects per sparrow, the months being shown by the abcissa. In spite of the relatively low figures, given for the reason stated above, a reliable picture of the relationship between grain, weed-seed and insects besides a picture of the distribution of the three food-stuffs throughout the year can be obtained. The somewhat small average amount of grain per sparrow in the middle of

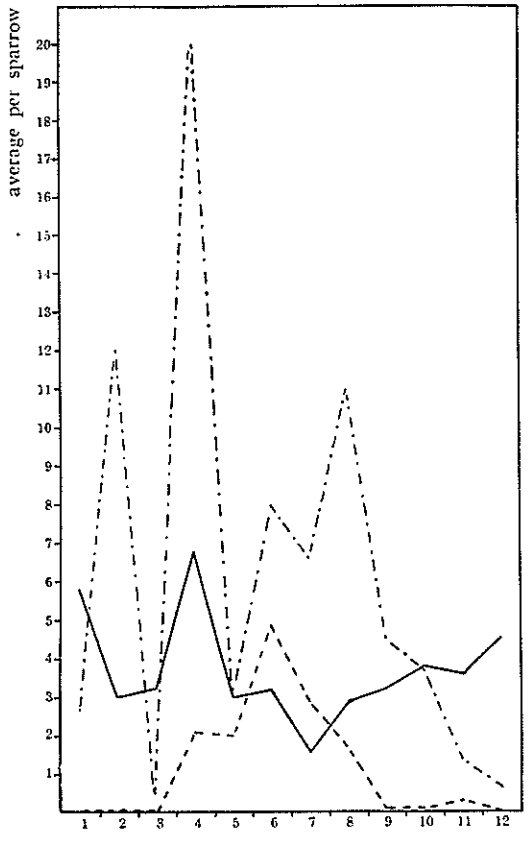


Fig. 8. The average number of

grains ——————

insects – – – – – –

weed seeds —·—·—·—

eaten per sparrow in 1942.

the summer is in complete harmony with the smaller number of sparrows that at this time of the year eat grain (see figs. 3—5), whilst the peak of the insect-curve is reached in June—July, at the same period when the greater percentage of sparrows eat insects (figs. 3—5). The average consumption of weed-seed rises in figs. 7 and 9 in the autumn months in accordance with the rise of the curve which indicates the percentage of sparrows that eat weed-seed (figs. 3—5). In 1942 (fig. 8) the curve attains a somewhat higher level in the winter and spring months; this is due to the fact that some sparrows

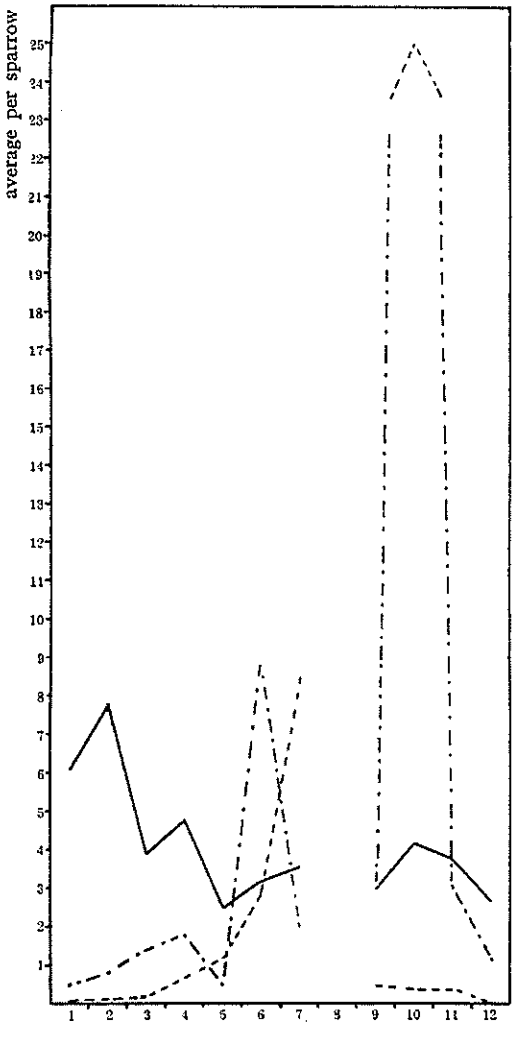


Fig. 9. The average number of

grains ———

insects – – – – –

weed seeds –·–·–·–

eaten per sparrow in 1943. The average number for October 66,8 is indicated by a broken line.

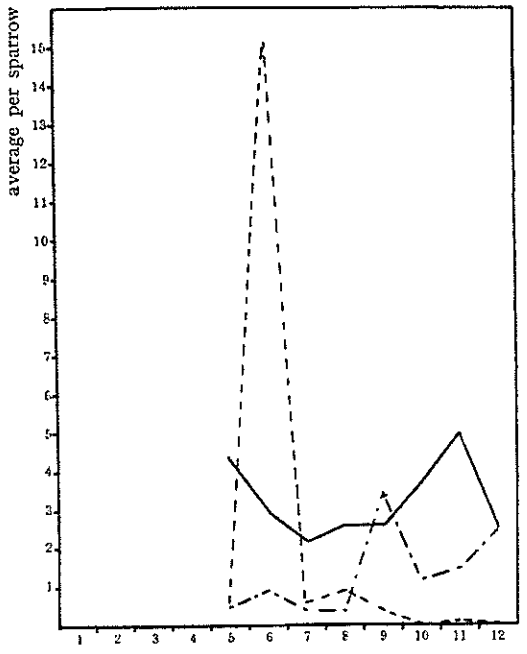


Fig. 10. The average number of

grains ——————

insects – – – – –

weed seeds –·–·–·–

eaten per sparrow at the station Tystofte in 1941.

have been exceptionally rich in weed-seeds. At the station of Lyngby and Tystofte alone (fig. 10) one will find a similarity between the shape of these three curves, which represent the three most important divisions of the food-stuffs eaten throughout the year. On account of incomplete information in certain instances in the material gathered, the curves are often broken.

After having stated the fact that the house sparrow feeds on corn, weed-seeds and insects and that these food-stuffs succeed one another, it would be interesting to know what kinds of grain, what weed-seeds and what insects the sparrows mostly prefer.

Grains.

An enumeration of all the grains the sort of which it has been possible to determine from the years 1941—44, will show that oats are greatly preferred to the other sorts of grain[1]).

In fig. 11 the columns indicate the aggregate number of grains of each sort, determined by the investigation. The curve indicates the number of sparrows that have eaten the variety of grain in question. While only 185 rye

[1]) However, this may be due to the fact that the sparrows have been unable to procure wheat in these years because of the war, and that the hard winters have spoiled the wheat to a great extent; the sparrows seem sometimes to prefer wheat to oats (see p. 40—41).

grains have been found, 1273 wheat grains and 1526 barley grains were found; on the other hand, there was almost as much oats as other grain sorts together (2770). It gives a somewhat different picture when it is noted how many sparrows have eaten the different kinds of grain. While only 61 sparrows have been found with rye in the gullet and stomach corresponding to the small number of rye grains, 417 sparrows have been caught with wheat and 628 and 621 with barley and oats respectively. The fact that nearly the same number of sparrows are able to eat about double the number of oat grains as of barley grains, must be considered in connection with the fact that the sparrows as a rule husk the oat grains, so that the husked grain takes up less space than originally; perhaps also the smallest grains are preferred, as the size of the grain evidently determines what the sparrow is actually able to devour.

In fig. 12 the columns indicate the distribution of the various sorts of grain throughout one year, as present in the food of the sparrows. On the ordinate is indicated the devoured number of grains per 100 sparrows, on the abcissa the months of the year. As seen from figures 7—10 there is a marked decrease in the consumption of grains in the middle of the summer, when large quantities of animal food forms part of their diet. In spring the consumption is greatest, it is somewhat less in the autumn; this may possibly be due to the abundance of weed-seeds at this season.

As the sparrows do not, to any considerable extent, find the grain where it grows, but gather it where men or animals leave it, this statement cannot

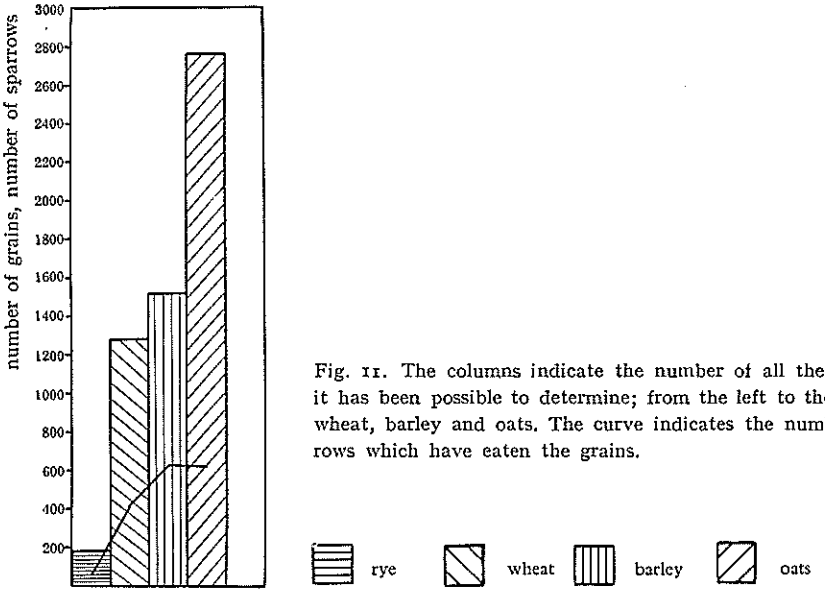


Fig. 11. The columns indicate the number of all the grains that it has been possible to determine; from the left to the right: rye, wheat, barley and oats. The curve indicates the number of sparrows which have eaten the grains.

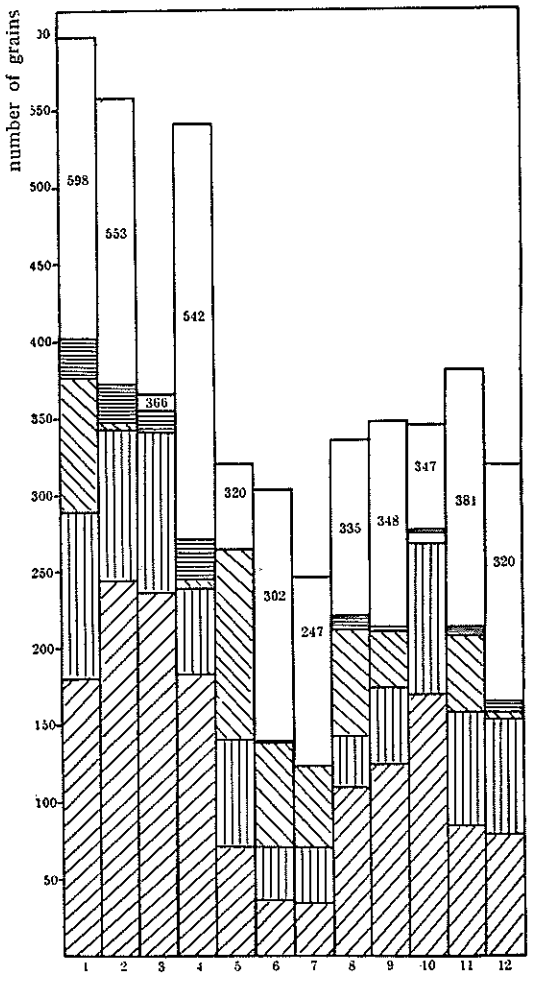


Fig. 12. The columns indicate the number of grains which 100 sparrows on an average have eaten in the course of a year. The differently shaded areas indicate the various sorts of corn.

rye
wheat
barley
oats
undetermined cereals (referred to fragments stated as 1 grain per sparrow; this undetermined part of the columns is thus not as correct as the rest).

indicate anything of significance of the ripening of the grain to the provision of the sparrows' food. It will be seen from fig. 12 that oats and barley are an important source of nutrition all the year round, and these two sorts of grain constitute undoubtedly the main part of the diet of the sparrow during the greater part of the year[1]). As barley and oats may be found in nature only a small part of the year — in fields that have been sown or in ripe corn-

[1]) Under normal conditions, when there is better access to wheat, the aspect may be somewhat different. Perhaps the wheat is the most important food of the sparrow (see p. 40—41) just as KALMBACH found in U.S.A.

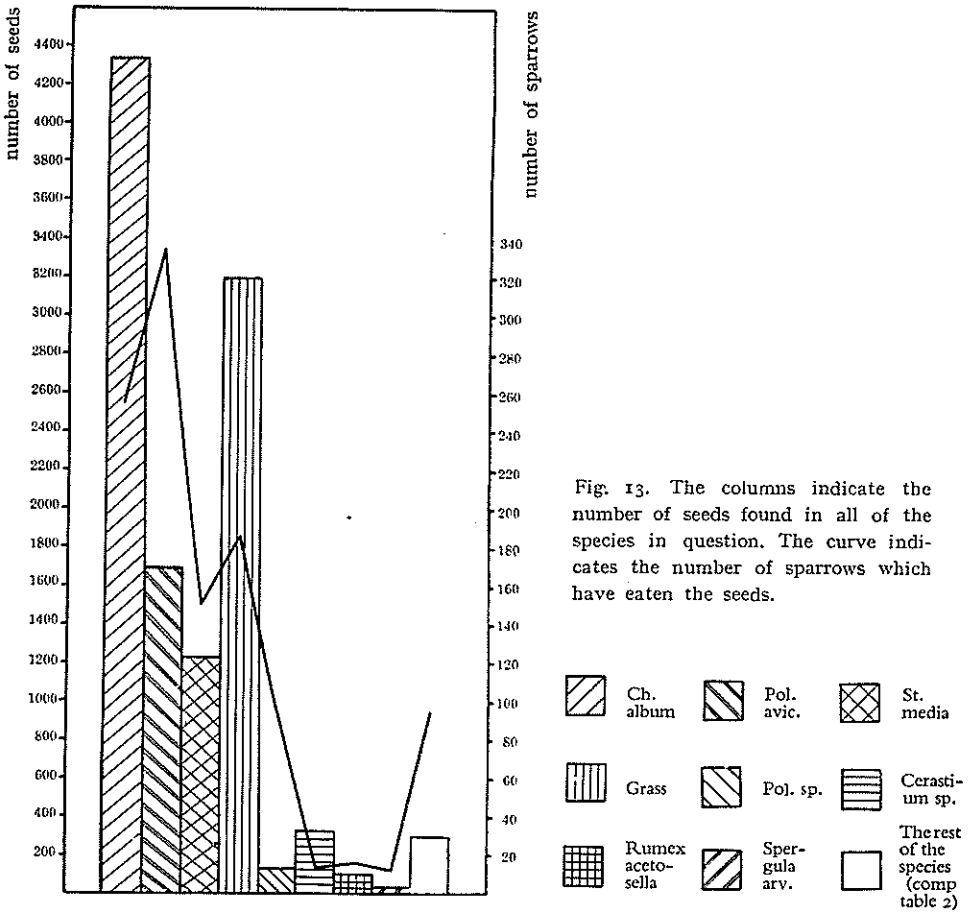


Fig. 13. The columns indicate the number of seeds found in all of the species in question. The curve indicates the number of sparrows which have eaten the seeds.

fields, and later in the stubble — the sparrows must get the grain in other ways, partly from horse dung, partly from stacks, barns, and poultry yards — and probably it is especially from this latter source that the sparrows feed so greedily. The grains found are nearly always fresh, without sprouts and apparantly have not been in the soil as seed. Wheat is also eaten in large quantities and, strangely enough, mostly during summer[1]). Thus the wheat in the stomachs originates from chicken yards. All the year through rye is found in the stomachs, but this cereal is probably not very important as a source of nutrition; it is too little estimated for that.

[1]) This may be due to the fact that the wheat, despite its use as fodder having been prohibited during the war, was used for feeding chickens, in which capacity it is very much used. At any rate, the largest consumption takes place when chickens are reared.

Weed-seeds and other vegetable food-stuffs.

From the examination of weed-seeds it appears that there are amazingly few species that play any great rôle in the diet of the house-sparrow and that it is the same species in all the districts that is used for food. The most important species are *Chenopodium album, Stellaria media, Poa annua and Polygonum spp.*, and in small quantities *Cerastium arvense, Cerastium caespitosum, Spergula arvensis* and *Rumex acetosella.* In fig. 13 the columns indicate the number of grains found of these species from all the stations from 1941—44. The curve indicates the number of sparrows that have eaten seeds of the species in question. *Chenopodium album* is by far the most numerous and thus constitutes a not inconsiderable part of the food of the house-sparrow. The significance of these seeds as a source of nutrition is augmented by the fairly large size of the seeds. Also grass-seeds (notably *Poa annua*) are eaten in large quantities. *Polygonum aviculare* and *Stellaria media* are also very common in the food of the house-sparrow, while the other species of *Polygonum* are only found now and then and in small quantities. Common to all these species, perhaps with the exception of grass, is the fairly large size of the seeds, and this may be the reason why these species are especially sought by wild birds, as both partridges and pheasants to a great extent eat them too. The size alone cannot be the reason, though, as many seeds still larger, as *Vicia, Pisum* and others, are rejected; their great contents of starch is doubtless one reason why the sparrows especially prefer them. May it not be that these species, so coveted by wild birds, and which are all to be found within some few, closely related families, contain substances needed by these birds? For instance nitrogenous matter. According to KØIE (Dansk Jagtlexikon pag. 323, 1944) buckwheat contains 11,3 per cent nitrogenous matter (albumen, protein) and according to the same the chemical composition of the species of *Polygonum* is not in the main very different from the closely related buckwheat. Compared with clover (13,6 per cent) and lucerne (16,2 per cent), which are comparatively rich in protein, and the corn species (9—10 per cent), buckwheat is consequently fairly rich in protein. The column to the extreme right in fig. 13 indicates seeds of all the rest of the species that have been found, 32 species in all (compare table 2). As will be seen these 32 species represent only a small part of the aggregate number of seeds. Besides those indicated in table 2 some have been found which could not be determined; these undetermined seeds appear only singly in the food of the sparrows.

In fig. 14 the weed-seeds are given in columns month by month. The columns represent the number of seeds which 100 sparrows have eaten on an average in the course of a year. From the figure will be seen that a single of the species cannot be said to be of decisive importance in the household of

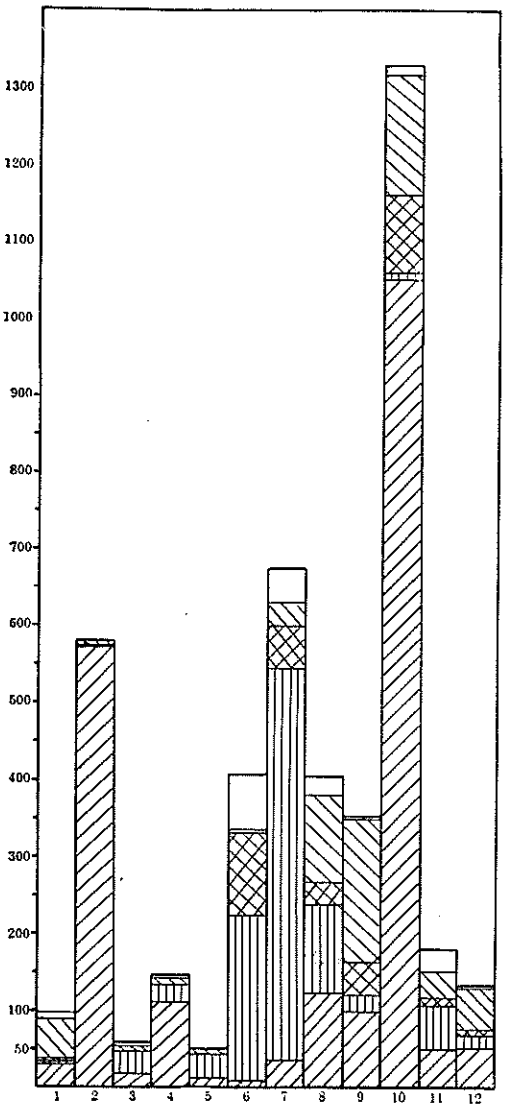


Fig. 14. The columns indicate the number of seeds which 100 sparrows have eaten on an average in the course of a year. The differently shaded areas indicate the most important species.

the sparrow at the cost of the rest. Apparently the four groups: the *Chenopodium album*, grass, *Stellaria media*, and *Polygonum* species all play a considerable rôle as they replace each other as ingredients of diet. In the middle of summer — in June—July — grass plays a preponderate part, partly together with *Stellaria media*, but already in September grass-seeds are rare while

Stellaria media is still eaten in relatively large quantities in October. These two ingredients are replaced as early as August, partly by *Chenopodium album* and the species of *Polygonum;* in October, especially, *Chenopodium album* is by far the most numerous; later in the autumn and during winter the seeds in the food are chiefly represented by *Chenopodium album* and *Polygonum,* mixed with a small amount of grass, while *Stellaria media* is almost entirely lacking during the six months of the winter season.

In table 2 there is a list of all the plant species found in the gullets and stomachs of the house sparrow. As will be seen from the list, some few sparrows have even eaten moss stems, potatoes, cherries, pinaceous aciculae and flax and millet. Several of these ought to be classed with corn, but as they have

Table 2.

A list of all the plants (except grain) found during this investigation of house-sparrows in 1941—44.

List of plant species	number of specimens found	eaten by number of sparrows	List of plant species	number of specimens found	eaten by number of sparrows
Moss stems	1	1	*Cruciferae* (indet.)	47	12
Pinaceous aciculae	6	2	*Capsella bursa pastoris*	2	2
Carex sp.	7	1	*Sisymbrium sophia*	32	3
Gramineae	3195	187	*Oxalis acetosella*	4	1
Panicum	28	7	*Linum usitatissimum*	2	2
Zea mays	1	1	*Geranium pusillum*	1	1
Betula	15	2	*Fragaria*	49	8
Rumex acetosella	96	16	*Rubus idaeus*	1	1
Polygonum tomentosum	87	57	— sp.	2	1
— *persicaria*	16	8	*Cerasus avium*	1	1
— *aviculare*	1689	336	*Papilionaceae* (indet.)	1	1
— *convolvolus*	30	30	*Pisum* sp.	3	3
Centrosperma (indet.)	7	1	*Trifolium* sp.	11	6
Caryophyllaceae (Cerastium?)	8	1	*Myosotis* sp.	3	1
Cerastium caespitosum	240	3	*Solanum tuberosum*	2	2
— *arvense*	96	11	*Veronica agrestis*	6	2
Stellaria media	1226	150	*Plantago major*	3	1
Spergula arvensis	35	12	*Sambucus nigra*	16	8
Chenopodium album	4341	256	*Compositae* (indet.)	2	2
Atriplex sp.	23	16	*Circium* sp.	2	1
Ranunculus sp.	5	2	*Hypochoeris radicata*	1	1
Papaver sp.	4	2			

only been eaten in very small quantities, and as they cannot be said to be the natural diet of house-sparrows in this country, it is more convenient to include them in this list. In the table it is also indicated how many sparrows have eaten the species in question; from this will be seen whether a species has been eaten accidentally, or whether it belongs to the ordinary food of the sparrow. It should also be pointed out here that the stations do not deviate from each other by any special plants, or only by some few characteristic species.

Insects and other animal food-stuffs.

Just as there are only some few species within the weed-seeds which are eaten in considerable quantities by the house-sparrow, the same is the case as regards insects. Here likewise some few groups are preferred. What apparently is conducive to the selection of some insect is the speed with which it moves, as the sparrow cannot catch quickly flying insects, but are obliged to stick to slowly creeping animals, such as caterpillars, weevils, fly larvae and plant-lice; the latter are picked up in bushes and trees.

In fig. 15 all the insects and other animals, found in 1941—44 at all the stations, are embodied into larger groups, orders, and set out systematically. Farthest to the left a mixed group, chitin, comprising all the insects which have been crushed so much that only some indeterminable chitin fragments were left. As a consequence of the considerable destructive power of the stomach this group is very large and is only second to beetles (*Coleoptera*), to which a very large part of the chitin remains may safely be referred, and to *Hemiptera*, *Diptera* and *Lepidoptera*. Besides *Coleoptera* which represent about half of all determined insects, *Hemiptera*, *Diptera* and *Lepidoptera* are most frequently found. Within the individual orders, e. g. the *Coleoptera*, it is seen that the slow weevils (*Curculionidae*) and dung beetles (*Aphodiinae*) constitute more than 50 per cent. Within the *Hemiptera* the greater part of the animals eaten are plant-lice (*Aphididae*); within the *Diptera* it is mostly larvae, pupae and newly emerged imagines that have been eaten, and within the *Lepidoptera* the sparrows have almost exclusively eaten larvae and pupae. All the other orders play only an insignificant rôle to the sparrows. However, it is worth noticing that sparrows willingly eat even freshwater animals or brackish water animals in regions where, in consequence of the nature of the district, they must live near the water, for instance on the small island Vorsø and similar places; from such districts are found molluscs (*Hydrobia* and *Littorina*) and crustaceans (*Gammarus*) probably gathered on the beach, together with, e. g., the *Coelopa frigida* (compare table 3).

The curve in fig. 15 indicates the number of sparrows that have eaten samples of the order in question. As might have been expected, most (962)

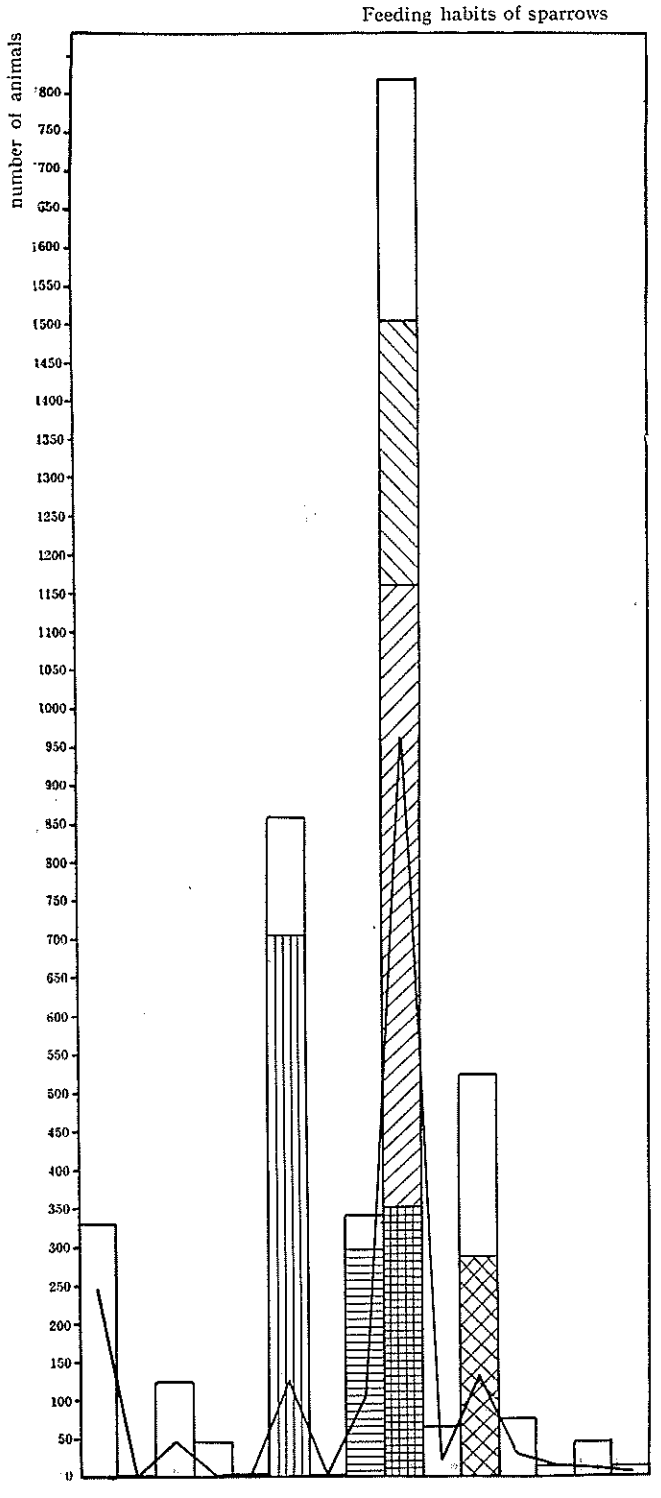
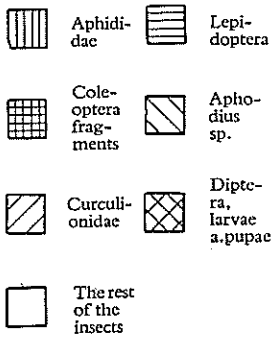


Fig. 15. The columns indicate the number of all the insects and other animals that can be reckoned as belonging to orders. The various orders are set out systematically; from the left towards the right: Chitin, *Apterygota, Orthoptera, Psocoptera, Thysanoptera, Hemiptera, Neuroptera, Lepidoptera, Coleoptera, Hymenoptera, Diptera, Arachnida, Crustacea, Mollusca* and *Lumbricidae.*

The most important elements of food is indicated by differently shaded areas:



The curve indicates the number of sparrows that have eaten the animals.

have eaten *Coleoptera*, corresponding to the very large number of beetles found. Next comes the number of sparrows which have eaten *Diptera* (129), *Hemiptera* (127) and *Lepidoptera* (104): so in almost the same succession as the frequency of insects found. As regards *Aphididae* the small size of the animals is significant, as one single sparrow is able to eat many more plant-lice than, for instance, caterpillars or weevils; this is undoubtedly the reason why the large number of plant-lice corresponds with the capture of comparatively few sparrows. Thus one single sparrow from Vorsø contained 30 plant-lice, in June 1943, which is a lot, considering the smal quantity usually found in the stomach.

From figures 7—10 it is seen that in the middle of the summer, the sparrows, to a great extent, feed on insects and the like, and that the animal part in their diet outside this time of the year is inconsiderable. If an investigation is made, to find out when the most important groups of insects are especially dominant in the food, we get a picture as that in fig. 16, where

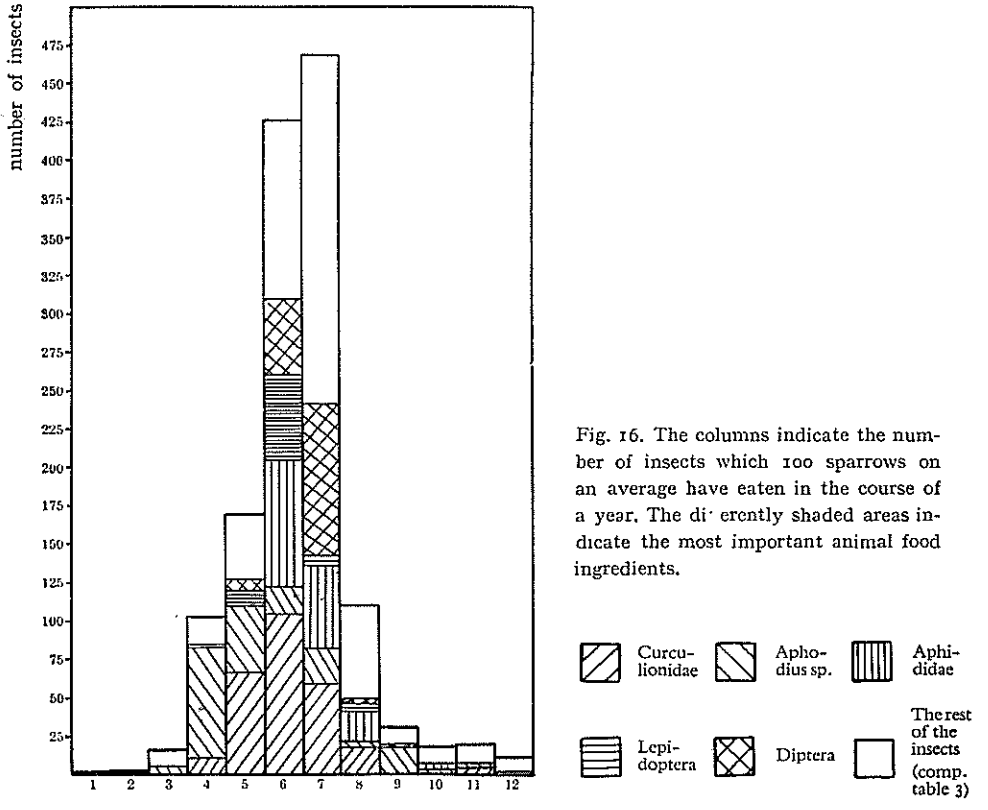


Fig. 16. The columns indicate the number of insects which 100 sparrows on an average have eaten in the course of a year. The di· erently shaded areas indicate the most important animal food ingredients.

the number of insects per 100 sparrows has been calculated throughout the year. From this it will be seen that weevils are present during a very large part of the year with the peak in June. Dung beetles (*Aphodius* spp.), on the other hand, are caught in large quantities in the spring, where they abound in horse dung, while later on they form only a small part of the animal food. In the middle of the summer, in June—July, plant-lice (*Aphididae*), flies (*Diptera*) and to a certain extent butterflies (*Lepidoptera*), constitute a large part of the nutrition of the sparrows, even if other insects are also eaten just in these months in large quantities. The capture of *Aphididae* and *Lepidoptera* is nearly exclusively limited to these months. After August the capture of insects is very slight and it has certainly no longer any great significance in the food of the sparrows, as the young ones presumably now are ready to fly.

A further statement of what insects were found by this examination of the nutrition of the sparrows is given in table 3. It should, however, be underlined, that this animal list is far from being exhaustive, as the remains of the insects, as previously mentioned, are very difficult to determine. The amount found should be multiplied many times in order to correspond to reality, and the selection of insects devoured by the sparrows is probably far more abundant than what is proved by this investigation. In any case I have many times seen sparrows pick pupae of the apple-weevil out of the faded, closed apple blossom and eat them, but have never found these frail insects in either gullet or stomach. This is only one example of an insect that was specially observed, but never found, although it may be eaten by the thousand year after year. As previously pointed out, it is mostly strongly chitinized insects that have been identified. This table shows the quantities in which the largest insect groups occur in the diet of the sparrows. What is of the greatest interest, is however, not whether any particular insect group has some importance as food for the sparrow, but whether the insect group in question means something to man, whether its representatives devastate crops in gardens and in fields or whether they are useful to man in that they eat injurious insects. It is by no means always possible to make a clear distinction between injurious and beneficial insects. As an example of the fact that the sparrow eats insects useful to man may be mentioned golden eyes (*Chrysopa*) that principally live on plant-lice, and lady-birds (*Coccinea*) and their larvae, which also live on plant-lice. Beekeepers state that sparrows snatch bees at the bee hives. Injurious insects taken by sparrows are for instance plant-lice (*Aphididae*) and other *Heteroptera*, such as *Psyllidae*. Also caterpillars (*Lepidoptera*) must, to some extent, be considered as belonging to insects that are wholly injurious, and the sparrows are very useful in that they eat them, not to mention *Cassida*, *Phyllotreta*, *Curculionidae* and *Phyllopertha horticola*, all of them being extremely injurious. Later on the question of whether sparrows

Table 3. *List of all the animals found during this investigation of the house-sparrow (P. domesticus) in 1941—44.*

List of animals	number of individuals found	eaten by number of sparrows	List of animals	number of individuals found	eaten by number of sparrows
Chitin	332	248	*Lamellicornia*	11	9
Sminthuridae	1	1	*Phyllopertha horticola*	56	38
Collembola	1	1	*Aphodius* sp.	223	146
Forficulidae	1	1	— *fimetarius*	123	46
Blattidae	1	1	*Ichneumonidae*	9	9
Acridiidae	123	45	*Chalcidoidea*	3	2
Pseudopsocus, Mesopsocus	46	2	*Cynipoidea*	1	1
Thysanoptera	2	2	*Myrmicidae*	50	7
Heteroptera	5	4	*Diptera*	102	?
Pentatomidae	1	1	*Nematocera*	50	15
Cikadidae	2	3	*Tipulidae*	1	1
Psyllidae	143	12	*Culicidae*	1	1
Aphididae	704	106	*Chironomidae*	2	1
Coccidae	1	1	*Brachycera*	138	66
Chrysopa sp.	1	1	*Tabanidae*	1	1
Lepidoptera	74	38	*Asilidae*	1	1
Microlepidoptera	71	11	*Phoridae*	1	1
Coleophora	15	5	*Empidae*	2	1
Macrolepidoptera	53	23	*Dolichopodidae*	1	1
Geometridae	127	27	*Chloropidae*	2	1
Coleoptera fragments	349	273	*Scatophaga* sp.	1	1
Carabidae	29	25	*Coelopa frigida*	13	2
Carabus nemoralis	1	1	*Borboridae*	2	2
Silpha opaca	15	7	*Sphaerocera* sp.	1	1
Coccinea sp.	31	12	*Pandora* sp.	1	1
— *7-punctata*	2	1	*Anthomyidae*	148	21
Micraspis 12-punctata	3	1	*Syrphidae*	1	1
Halysio 22-punctata	1	1	*Musca domestica*	46	9
Byrrhus sp.	1	1	*Calliphora + Lucilia* sp.	9	5
Elateridae	21	16	*Tachinidae*	2	1
Chrysomelidae	11	1	*Arachnidae*	8	7
Gastroidea polygoni	4	1	*Thomicidae*	1	1
Cassida sp.	21	18	*Opilionidea*	22	4
— *nobilis*	2	1	*Oribatidae*	13	5
— *nebulosa*	26	7	*Nothrus* sp.	1	1
Staphylinidae	1	1	*Gamasidae*	28	8
Phyllotreta nemorum	13	1	*Oniscoidea*	2	2
— *undulata*	35	5	*Gammarus* sp.	4	3
Phyllotreta atra & nigripes	32	3	*Hydrobia ulvae*	27	2
Curculionidae	777	342	*Littorina* sp.	5	4
Apion sp.	4	4	*Mytilus edulis*	11	2
Centorrhynchus sp.	26	2	*Lumbricidae*	5	2
Strophosomus sp.	4	1	*Crustacea* fragments	6	6

are benefical or not will be discussed. Fairly indifferent animals, such as *Areneina, Opilionidea, Oribatidae* and marine *Mollusca,* are also eaten, although rarely in any great numbers.

The localities examined differ somewhat from each other as to the composition of the fauna, not only because some localities — as previously mentioned — have both freshwater forms and brackishwater forms, but also on account of the different nature of the localities. Thus the cultivated localities as Lyngby and Tystofte vary from Ribe and Borris, the latter two being in marsh and heath districts respectively. In table 4 the animals found at the most important localities, and from the more widely different localities, have been listed in systematic order. Only animals from 1941, 1942 and 1943 have been notified, as only some few insects were found in 1944. As will be seen, Ribe and Borris have a comparatively large number of grasshoppers (*Acrididae*) which are completely absent in such cultivated districts as Lyngby and Tystofte. *Orthoptera* are from several quarters (KALMBACH, ARINKINA and KOLESNIKOV) pointed out as constituting a very essential part of the food of the young ones. However, as regards most of the animal species there is no difference from one locality to another. In the Botanical Gardens in Copenhagen hardly any insects have been observed in the few samples taken, probably on account of the season (April and August), but perhaps also because the sparrows get ample food in various forms of human food that are put out for them, as was found to be the case with many of the sparrows. A very special locality as Christians Ø near Bornholm in the Baltic does not show any great divergence from the average; even a form like *Cassida,* living on *Chenopodium* and *Atriplex,* but mostly on cultivated soil where it is damaging to turnips, is not lacking. The three last localities, Vorsø, Søvind and Gaunø are somewhat influenced by their situation near the sea. However, as regards most forms there is no difference between these localities and the rest. The diverging character is due to the comparatively frequent interference of gnats (*Nematocera,* presumably brackish-water *Chironomidae*), and to the occurrence of the fly *Coelopa frigida* which belongs to beaches in washed up seaweed and the like, and especially to the purely marine element: *Gammarus* and other crustaceans, as well as the snails *Hydrobia ulvae* and *Littorina* sp. The snails may have been collected in the belief that they were stones; otherwise the sparrows must be supposed to prefer this special food as there cannot very well be any lack of animal food at the localities in question.

Table 4.

List of the animals caught by the house-sparrow in the most important and widely divergent localities.

List of animals	Tystofte			Lyngby			Ribe			Borris	Vejenbrød	Bot. Have	Christians Ø	Vorsø	Søvind	Gaunø
	1941	1942	1943	1941	1942	1943	1941	1942	1943	1941	1941	1942	1942	1943	1943	1943
Sminthuridae	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Blattidae	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
Acrididae	—	—	—	—	—	—	53	—	—	19	—	—	—	—	—	—
Pseudopsccus	—	—	—	—	—	—	—	46	—	—	—	—	—	—	—	—
Heteroptera	—	—	—	—	—	—	1	—	—	—	1	1	—	—	—	1
Pentatomidae	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
Cikadidae	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
Psyllidae	—	7	—	20	—	10	—	—	—	—	—	—	—	—	—	—
Aphididae	—	7	—	13	67	3	1	162	12	4	11	4	26	46	—	88
Lepidoptera	1	—	—	3	1	—	1	—	5	2	4	—	—	2	3	—
Microlepidoptera	—	—	—	—	1	—	—	1	—	—	—	—	4	—	38	—
Coleophora sp.	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—
Macrolepidoptera	—	—	—	2	—	—	—	4	—	1	9	—	5	—	1	4
Geometridae	4	—	—	6	—	—	—	2	—	—	11	—	34	2	3	—
Chrysopa. sp.	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
Coleoptera fragm.	22	3	—	39	34	3	15	23	7	27	5	—	5	4	16	20
Carabidae	7	—	—	—	—	—	—	3	—	—	3	—	2	—	2	1
Carabus nemoralis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Silpha opaca	—	—	—	—	—	—	—	—	1	6	8	—	—	—	—	—
Coccinea sp.	—	—	—	—	—	—	—	1	—	1	—	—	—	1	—	5
— 7. punct.	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Elateridae	2	—	—	2	—	—	—	—	—	—	6	—	—	1	—	—
Gastroidea polygoni	—	—	—	3	—	—	—	—	—	3	—	—	—	—	—	—
Cassida sp.	—	—	—	—	—	1	—	3	—	—	—	—	5	—	—	—
— nebulosa	—	—	—	10	—	—	—	—	—	—	—	—	—	—	—	—
Phyllotreta sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
— undulata	—	—	—	32	1	—	—	—	—	—	—	—	—	—	—	1
— atra & nigripes	—	—	—	32	—	—	—	—	—	—	—	—	—	—	—	—
Curculionidae	60	10	—	145	56	62	1	31	8	10	50	—	11	12	13	10
Apion sp.	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
Ceutorrhyncus sp.	—	—	—	26	—	—	—	—	—	—	—	—	—	—	—	—
Lamellicornia	3	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
Phyllopertha horticola	—	—	—	2	—	—	—	—	—	10	13	—	—	—	—	—
Aphodius sp.	6	—	—	13	4	27	22	5	9	31	4	—	3	—	—	3
— fimetarius	—	—	—	—	51	—	3	1	6	1	—	—	—	—	—	—
Ichneumonidae + Chalcididae	1+2	—	—	2	—	—	—	—	—	2	1	—	—	—	—	—

(Table 4).

List of animals	Tystofte			Lyngby			Ribe			Borris	Vejenbrød	Bot. Have	Christians Ø	Vorsø	Sørvind	Gaunø
	1941	1942	1943	1941	1942	1943	1941	1942	1943	1941	1941	1942	1942	1943	1943	1943
Myrmicidae	—	—	—	3	3	—	—	—	41	1	—	—	—	—	—	—
Diptera	73	—	—	28	—	—	—	—	—	1	—	—	—	—	—	—
Nematocera	—	—	—	—	—	1	—	—	2	—	—	—	—	34	1	2
Brachycera	—	—	—	—	1	—	—	5	4	37	—	2	—	4	3	—
Tabanidae	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
Asilidae	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Empididae	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
Dolichopodidae	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
Chloropidae	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scatophaga sp.	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
Coelopa frigida	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13	—
Borboridae	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Anthomyidae	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
Musca domestica	—	—	—	—	—	—	—	—	—	36	—	—	—	—	—	—
Lucilia sp.	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
Tachinidae	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Arachnidae	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	3
Thomicidae	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
Opilionidea	—	—	—	22	—	—	—	—	—	—	—	—	—	—	—	—
Oribatidae	—	—	—	1	—	—	—	1	10	—	—	—	1	—	—	—
Oniscoidea	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—
Gammarus sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—
Crustacea	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6	—
Hydrobia ulvae	—	—	—	—	—	—	—	—	—	—	—	—	—	27	—	—
Littorina sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	—
Lumbricidae	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—

THE DIET OF THE YOUNG BIRDS

Presumably the quite small, newly hatched young feed exclusively on animals. Unfortunately, the newly hatched nestlings of *P.domesticus* have not been included in this investigation, and consequently the food of the nestling is never purely animal but mixed with a small amount of vegetable food. From table 5 it will be seen that a very large percentage of the nestlings eat grain; in June and July, the only months from which a fairly considerable amount of material has been collected, the figures are 88 and 78 per cent

Table 5.

Percentage of nestlings which in 1941—43 have eaten grains, insects and weed seeds.

Number of nestlings	May 2	June 45	July 69	August 2
Grains	100 %	88 %	78 %	100 %
Insects	100 —	93 —	100 —	100 —
Weed seeds	50 —	4 —	3 —	50 —

respectively while only very few nestlings have weed-seeds, 4 and 3 per cent respectively. However, as might be expected, insects are found in almost all nestlings, and, as will be seen from table 6, the insects constitute the main part of the food numerically and probably also as regards weight. The period in which the nestlings are fed with insects is very short, apparently perhaps only some few days, whereafter they go slowly over to the food of the adults with an increasing amount of seeds and grain. As soon as the nestlings are fledged, there is no discernible difference between their food and that of their parents. Also the food of the full-fledged young ones consists mainly of insects, but the same is the case of the food of adult sparrows during the same months.

Besides the young of the house-sparrows (*P.dom.*) there is a fairly large amount of undetermined young ones. In table 19 will be found information as to the localities where they were shot, together with the date and number. On the whole there are 130 young ones, of which 88 per cent are nestlings, the rest full-fledged young ones. As it is impossible to distinguish young ones of

Table 6.

The average number of grains, insects and weed seeds per nestling in 1941—43.

Number of nestlings	May 2	June 45	July 69	August 2
Grains	7,5	2,3	1,8	1
Insects	4,0	8,9	9,0	15,5
Weed seeds	0,5	0,4	0,1	0,5

Table 7.

Percentage of young ones (Passer sp.) which in 1941—43 have eaten grains, insects and weed seeds.

(88 % nestlings) Number of young ones (P. sp.)	May 15	June 50	July 65
Grains	100 %	68 %	66 %
Insects	100 —	98 —	97 —
Weed seeds	20 —	22 —	20 —

the house-sparrow from young ones of the tree-sparrow, and as no information was given from those that sent them in as to from which species of sparrow the young ones in question came, they will not be filed as young ones of *Passer domesticus*, although there is a great probability that the main part, at any rate, belongs to this species.

As will be seen from tables 5 and 6, 7 and 8, June and July are the months when nestlings are especially numerous. A comparison between tables 5 and 7 shows that the percentage of young ones of *Passer sp.*, which eat grain, is lower than that of *P. domesticus*, the percentage as to insects is the same, and the percentage as to weed-seeds is considerably larger in *P. sp.* (May and August with *P. dom.* cannot be taken into account owing to the small number of young ones). This might indicate, that part of these undetermined young ones are from tree-sparrows, since a lower percentage of tree-sparrows, compared with house-sparrows, eat grain, and a higher percentage eat weed-seed (compare pag. 47). Furthermore, a comparison with table 6 and 8, where the average number of grains, insects and weed-seeds per young one has been

Table 8.

The average number of grains, insects and weed seeds per young one (Passer sp.) in 1941—43.

(88 % nestlings) Number of young ones (P. sp.)	May 15	June 50	July 65
Grains	1,8	1,0	1,7
Insects	12,5	24,1	23,2
Weed seeds	1,0	0,2	0,7

stated, shows that *P. sp.* has a smaller average consumption of cereals than *P. dom.*, a much larger consumption of insects, while the amount of weed-seeds per young one is almost the same in *P. sp.* and in *P. dom.* This might also indicate that there may be a good many young ones of the tree-sparrow among the undetermined young ones. The tree-sparrow lives for a great part on insects only while grain does not play the same role to that bird as to the house-sparrow. The tree-sparrow takes a great part of its nutrition from weed-seeds, but as it is here a question of nestlings, the feeding with weed-seeds has presumably not commenced for good. It may be that the young ones do not start eating weed-seeds in any considerable degree until they are able to find them themselves; there may be certain technical difficulties for the house-sparrow in putting the very small seeds into the beak of the young ones. In quite small nestlings of *P.* sp. barley grains, seeds and bits of leaves were found besides insects. This might indicate that at no time are the young ones fed exclusively with animal food even if the animal food constitutes by far the greater part until the young ones are full-fledged and begin to search their food themselves, and even still longer. A large, full-fledged young which was to have been used for food tests with various kinds of grains, did not eat grain at all. It turned out that the mother, the whole day, fed the young, which was in a cage in the garden, with insects. This was continued day after day for six days, after which time the mother kept completely away from it. The number of „visits" to the young one per hour was observed for a short time (compare table 18).

HOW MUCH IS A HOUSE-SPARROW ABLE TO EAT?

As previously mentioned, it is only very small quantities of grain, insects and seeds that are found in the gullet and stomach, and thus it is not feasible to find the proper quantity of food eaten by a house-sparrow. Rarely more than 30 grains are found in the gullet, mainly even fewer. The highest figures for grains in the gullet are 54, 39, 38, 33 and 26. SCHLEH (1883) found 10 grains in one sparrow, and on the basis of this he calculated what an enormous number of sparrows (36—40000) would be necessary to devour 1 hl even if they took 5 meals a day. These low figures must be due to the very speedy digestion of the sparrow. In order to elucidate how long time the sparrow takes to digest grain, a feeding test was made. Some sparrows had for some time been used for tests; the day in question they had nothing to eat until 11 o'clock and their cages had been cleaned (tables 9—10) early in the morning. At 11,05 each sparrow was given 40 grains. After half an hour it was counted how much each bird had eaten. One hour after the feeding, sparrow number

Table 9 (see text). *Experiment.*

	at 11^{05}	at 11^{30}	at 12^{05}	at 13^{10}	at 14^{15}
	fed	eaten	eaten	eaten	eaten
Sparrow no. 1.....	40 grains	14 grains	(killed) 19½ grains	—	—
— - 2.....	40 —	11 —	—	34 grains	(killed) all
— - 3.....	40 —	20 —	—	(killed) all	—

The sparrows were observed half an hour before they were killed.

Table 10 (see text). *Experiment.*

Sparrow no. 1 killed after 1 hour, had eaten 19½ grains of which ca. 13 passed stomach (5½ eaten in last ½ hour).
Sparrow no. 2 killed after 3 hours, had eaten 40 grains of which ca. 37 passed stomach (6 eaten in last ½ hour).
Sparrow no. 3 killed after 2 hours, had eaten 40 grains of which ca. 37 passed stomach (20 eaten in last ½ hour).

one was killed; it had eaten 19½ grains. Two hours after feeding number 3 was killed; it had eaten all. Three hours after feeding number 2 was killed; it had also eaten all. Then the stomachs were examined in order to see how far the digestion of the grains eaten had proceeded. From table 10 it will be seen that digestion in the stomach takes place very quickly, as number 1 which was killed 1 hour after feeding had only 6½ grains in its stomach, i. e. that 13 grains had already passed the stomach in the course of an hour. Number 3, killed 2 hours after feeding, had only 3 of 40 grains eaten left in the stomach, i. e. that 37 grains had passed the stomach in the course of 2 hours; of the 40 grains eaten, moreover, the 20 had been eaten in the last half hour, i. e. that 17 grains had passed the stomach in the course of ½ hour. Number 2, killed 3 hours after feeding, had likewise only 3 grains left in the stomach; here 37 grains had passed the stomach in the course of 3 hours; of the 40 grains eaten 6 were eaten during the last half hour; of these 3 had passed the stomach. Table 11 shows a similar test.

These preliminary tests plainly show that the digestion of the sparrow is fairly active and that the food may presumably have left the stomach within an hour after feeding. Moreover, this explains the very small quantities of food found in gullet and stomach. Only if a sparrow is shot immediately after having eaten, it is to be expected that the gullet will be full.

Table 11. *Experiment.*

17. XI.	at 16 fed	at 17^{25}	examined
Sparrow no. 1 ♀	25 barley	all eaten, killed	gullet: 10 whole grains. stomach: 3½ grains + chaff.
— 2 ♀	25 wheat	— , —	gullet: 11 whole grains. stomach: 1 + 2 half + chaff.

As just mentioned only very few grains were found in the stomachs. The figures for insects and weed-seeds are mostly correspondingly small. The following instances show the largest numbers of insects found in one stomach:

Nestlings:

Ribe in July 1941: 12—14 grasshoppers, remains of *Aphodius*.

Tystofte in June 1941: 4—5 small weevils, 6—7 large weevils, 2—3 *Aphodius* sp., 11 flies (*Anthomyidae*) remains of click beetle, 2 beetles.

Tystofte in June 1941: 2—3 large weevils, remains of small weevil, 15 flies (*Anthomyidae*), remains of click beetle, 2 large beetles, 2 fly puparia, 2 *Coccinea 7-punctata*, 2 tachins imagines.

Borris in July 1941: 5 puparia, 8 larvae of *Musca domestica*, remains of *Phyllopertha horticola*, remains of fly.

Studsgaard in June 1941: 13 geometrid larvae, 15 weevils, ca. 30 *Calliphora?* imagines, 1 beetle, remains of 6 largish beetles.

Studsgaard in June 1941: 2 geometrid larvae, 20 weevils, 7—8 caterpillars, 2 small weevils, remains of 2—3 large beetles.

Full-fledged young ones:

Lyngby in June 1941: 6—7 weevils, remains of beetle, remains of click beetle, remains of *Aphodius* sp., 3 earthworm cocoons.

Adults:

Vorsø in June 1941: 26 puparia of *Anthomyidae*, 1 *Gammarus*.

Vorsø in June 1941: 11 geometrid larvae, 1 caterpillar of *Microlepidoptera*, 3 larvae of *Anthomyidae*.

As it is obvious that the few grains found in the gullet do not correspond to what one sparrow is able to eat at a time, some feeding experiments were made. The experiments were made with newly-caught, adult sparrows, kept in small, separate cages during October, as the consumption of grains in this month is comparatively large. As will be seen from table 12, the sparrows,

Table 12. *Feeding experiments (see text).*

	24. X. at 8^{30} at 16^{30}	25. X. at 8^{10} at 16^{20}	26. X. at 8^{30}	27. X. at 8^{30}
Sparrow no. 1 ..	150 grains of oats + 100	+ 250 + 100	+ 300 (2)	+ 300 (2)
— - 2 ..	150 — - - + 100	+ 250 + 100 (3)	+ 300 (30)	+ 300 (12)
— - 3 ..	150 — - - + 100	+ 250 + 100	+ 300 (25)	+ 300 (10)
— - 4 ..	150 — - - + 100	+ 250 + 100	+ 300	+ 300
	eaten 250 grains	eaten not quite 350 grains	eaten ca. 300 grains	

on the first day, were fed with 150 grains, later in the day they received 100 grains more. The following morning, when everything had been eaten, they were immediately fed with 250 grains, later in the day with 100. One sparrow (no. 2) had only 3 grains left from the morning meal. On the morning of the third day most of them had not eaten all (left 2, 30 and 25 grains respectively), consequently the rations for the previous day, 350 grains, might be considered too large. Therefore, the sparrows were immediately fed with only 300 grains as this day's ration. On the morning of the fourth day some grains were also left over (2, 12 and 10), but together with the remains from the previous day the consumption had been about 300 grains per sparrow. On the 1st day the sparrows had eaten 250 grains each, the 2nd day not quite 350 grains, and the 3rd day about 300; the 4th day was not determined. According to this, the daily requirement of a sparrow was estimated at 300 grains.

Another experiment was made with 6 sparrows. From the test (see table 13) which lasted for 11 days, it was concluded that each sparrow, on an average, ate 290 grains of oats per day in the first four days of the experiment. This corresponds to 11,0 gr. oats. In the course of the following 6 days 9 gr. barley were eaten daily on an average per sparrow. As regards normal, active sparrows the daily consumption of barley may safely be estimated at 10 gr. per sparrow.

In order to check whether this estimate of 10 gr per day is approximately correct it may be compared with the consumption of hens and chickens (by Mr. BÆLUM, verbal communication) (table 14).

The sparrows tested were scarcely full-grown and had but little opportunity to fly, so that the food may have been rather plentiful. For the free

Table 13.

Feeding experiments (compare the text).

	27. X. at 8^{30} fed with	28. at 9 remained,	at 17^{30} fed with	remained	29. at 9 remained,	at 17^{30} fed with	30. at 8^{30} remained	at 9^{50} fed with
Sparrow no. 1 ..	300 oats[1]	÷(183)[2]	+11,3 gr. oats	(½)	(27)	+ 11,3 gr. oats	(45)	+ 11,3 gr. oats
— - 2 ..	300 —	(2)	+11,3 -	— (6-7)	(1)	+ 11,3 - — (50)	(55)	+ 10 gr. barley (at 12^{30})
— - 3 ..	300 —	(49)	+11,3 -	— (c.50)	(53)	+ 11,3 - —	(80)	+ 11,3 - oats
— - 4 ..	300 —	(24)	+11,3 -	— (c.50)	(35)	+ 11,3 - —	(18)	+ 11,3 - —
— - 5 ..	300 —		+11,3 -	—	(3)	+ 11,3 - — (50)	(34)	+ 11,3 - —
— - 6 ..	300 —		+11,3 -	—		+ 11,3 - — (50)	(10)	+ 11,3 - —

	31. at 8^{30} remained, fed with	1. XI. at 9^{30} remained, fed with	at 11^{30} remained, fed with	at 15^{15} remained, fed with
Sparrow no. 1 ..	÷(23) + 10 gr. barley	(64)		+ 8 gr. barley
— - 2 ..	(85)	+ 8 gr. barley		
— - 3 ..	+ 10 - —	(47)		(10)
— - 4 ..	÷(11) + 10 - —	(50)		(1) + 8 gr. barley
— - 5 ..	÷(15) + 10 - —	(21) + 8 gr. barley		
— - 6 ..	÷(2) + 10 - —	(42)	(8) + 8 gr. barley	

	2. at 8^{30} remained, fed with	3. at 8^{30} remained, fed with	at 15^{45} remained, fed with	4. at 8^{45} remained, fed with
Sparrow no. 1 ..	(68) + 10 gr. barley	(106)		(11) + 8 gr. barley
— - 2 ..	(28) + 10 - —	(100)	(5) + 10 gr. barley	(148)
— - 3 ..	dead			
— - 4 ..	(63) + 10 - —	(86)		(6) + 8 - —
— - 5 ..	+ 10 - —	(3) + 10 gr. barley	(almost nothing)	(6) + 8 - —
— - 6 ..	(13) + 10 - —	(200 fallen to the floor)		(9) + 8 - —

[1]) 300 grains of oat weighed 11,3 gr in October 1941 (in June 1945 300 grains of oat weighed 9,5 gr); 300 grains of barley weighed 12,5 gr in October 1941 (in June 1945 300 grains of barley weighed 12,6 gr).

[2]) ÷ = remains of grains taken away.

(Table 13)

	5. at 8^{45} remained, fed with	6. at ? remained	at 13^{10} remained	at 14^{15} remained
Sparrow no. 1 ..	(34) + 8 gr. barley	(29)dead ♂		
— - 2 ..	(18) + 8 - —	(34)killed ♂ at 12^{30} [3])		
— - 3 ..				
— - 4 ..	(6) + 8 - —	(12)	(6)	(0) killed ♀ [5])
— - 5 ..	+ 8 - —	(2)	killed [4])	
— - 6 ..	(12) dead			

[3]) The stomach contained 5 almost whole, 2 halves and 1 quarter of grain + chaffs, stones and sand.
[4]) The stomach contained 2 almost whole, ca. 9 halves of grains + chaffs, stones and sand.
[5]) The stomach contained 3 almost whole grains + chaffs, stones and sand.

sparrows on the other hand, it may be estimated that at least $^2/_3$ of their number during late summer are young birds in growth, and, furthermore, the consumption is large on account of their flying; thus the order of size may safely be considered exceedingly probable.

The various amounts of oats and barley, corresponding to the daily requirement are in accordance with the result stated in fig. 11 that the sparrows eat much more oats than barley; this is due, presumably, as previously mentioned, to the fact that the oats are husked and the chaff only fill up small space after this process. Furthermore, it means, that sparrows cause far more damage in oat fields than in barley fields. And, moreover, it looks as if the sparrows prefer oats to barley. Anyhow, free, adult sparrows ate only the oats from mixed oats and barley thrown to them so long as they were observed. By food tests it was ascertained that fledgelings are not partial to barley as

Table 14.

	Daily consumption of barley in gr	Corresponding to caloric unit per kg body weight per 24 hours net
Hen weighing approximately 2 kg during non-egglaying period...	ca. 70	50—65
— — — 2 - — egglaying period.....	110—120	95—100
Newly hatched chicken of approximately 40 gr.....	10—12	425—500
Sparrow of approximately 30 gr.....	10	560

Table 15.

Feeding experiments with oats and barley on fledgelings (see text)

13. VII. 45	at 10^{15} fed	10^{45} remained	11^{15} remained	12^{15} remained
Sparrow no. 1 ..	15 oats + 15 barley	13 o + 15 b	3 o + 15 b	o o + 14 b
— - 2 ..	15 — + 15 —	15 o + 15 b	1 o + 12 b	o o + 9 b
— - 3 ..	15 — + 15 —	13 o + 15 b	8 o + 14 b	o o + 14 b

13. VII. 45	12^{45} remained, fed	13^{15} remained	14^{00} remained, fed	15^{45} remained	22^{00} remained
Sparrow no. 1 ..	14 b 15 oats	o o + 14 b	13b 25oats+10barley	o o + 22 b	o b
— - 2 ..	6 b 15 —	o o + 5 b	1b 25 — +10 —	o o + 10 b	o b
— - 3 ..	11 b 15 —	o o + 11 b	11b 25 — +10 —	o o + 10 b	o b

long as they can find oats (see table 15)· in certain cases wheat was preferred to oats (tables 16—17). This partiality for oats may also explain the very large consumption of oats (compare figs. 11 and 12).

In order to be able to calculate how large an amount of grains one sparrow eats in the course of a month it is necessary first to know the weight of the other food elements given in the month in question. The proportion between the various elements is seen from figs. 7—9. As regards grains and weed-seeds the weight is easy to state, as there are records in the literature on the weight of the separate species. Thus 25 grains weigh about 1 gr. Compared with this the amounts with which the sparrows were fed in October 1941 were: 25 grains of oats = 0,94 gr, 25 grains of barley = 1,04 gr. Weights in June 1945 were: 25 grains of oats = 0,80 gr, 25 grains of barley = 1,05 gr.

Table 16. *Experiment.*

18. VII. 45	at 11^{40} fed with	at 13^{40} remained, fed with	at 14^{40} remained	at 17^{40} remained
Sparrow no. 1 ..	25 wheat + 25 oats	4 wheat + 25 oats 25 wheat	22 wheat + 25 oats	o wheat + 8 oats
— - 2 ..	25 — + 25 —	o — + 22 — 25 —	7 — + 22 —	o — + 5 —
— - 3 ..	25 — + 25 —	23 — + 4 — 25 —	37 — + o —	13 — + o —

Table 17. *Experiment.*

4. X. 45	at 10 fed with	at 12 remained, fed with[1])	at 14 remained
Sparrow no. 1 ..	50 wheat + 50 oats	45 wheat + 12 oats	50 wheat + 50 oats	50 wheat + 27 oats
— - 2 ..	50 — + 50 —	15 — + 0 —	50 — + 50 —	45 — + 0 —, fed with 50 oats

	at 16 remained	at 16 fed with	at 17[20] remained
Sparrow no. 1 ..	37 wheat + 0 oats	50 oats	37 wheat + 7 oats
— - 2 ..	38 — + 0 —	50 —	38 — + 20 oats (The bowl poured over the grains)

[1]) the old thrown away

The species of weed-seeds that are of importance to the nutrition of the sparrow have the following weights, according to KORSMO (1925):

870 seeds of *Chenopodium album* 1 gr.
1660 seeds of *Stellaria media* 1 gr.
370 seeds of *Polygonum aviculare* 1 gr.
About 300 seeds of *Polygonum* sp. 1 gr. (Mean for *P. convolvolus, P. tomentosum* and *P. persicaria*).
5000 seeds of *Poa annua* about 1 gr.

As regards all the other seeds of less importance the presumable mean weight is put at 1000 seeds equal to 1 gr.

When, based on figs. 12 and 14 together with these weights, a curve is drawn of the amounts of grain and seeds eaten, on an average, by 100 sparrows during 1 year, a figure like fig. 17 is obtained. Of course, the figures arrived at are far too small as a consequence of the fact that gullet and stomach always contain only a small part of the day's consumption, but from fig. 17 one gets an idea of the proportion between the weights of grains and seeds devoured.

From fig. 17 it will be seen that the amount of seeds consumed is only a small part of the aggregate weight and that, probably, the seeds are to be considered only as a sort of spice or supplementary food of some sort or other. As regards the curve for grain, it is peculiar that the consumption is far greater in winter than in the autumn. (The far smaller consumption during summer when a great many insects are eaten, is obvious.) As the amount of seeds eaten during the autumn, on an average larger, (compare fig. 14) cannot

Fig. 17. The curves signify the weights in grm. of

grains ——— and

weed seeds -·-·-·-·-

which 100 sparrows have on an average eaten in the course of a year.

counter-balance the smaller amount of grain (compare fig. 17), it must be the winter's consumption of grain that preponderates, and is disproportionally large. This may be considered due to the far lower temperatures prevailing during these months. In order to keep warm the sparrows are evidently obliged considerably to increase their consumption.

In order to be able to calculate the annual consumption of grain of the sparrows the unequal demands at the various seasons must be taken into account. The feeding tests made in October—November at a time when insects are not eaten, and when the temperature had not yet fallen very much, show

that the daily consumption was 11 gr oats or 9 gr barley. As the tests were made on sparrows at rest in cages with no room for flying the consumption as regards „working" sparrows must certainly be somewhat larger and may average 12 gr oats or 10 gr barley, possibly more.

Based on this level, the consumption in September, October, November and December, when conditions are presumed to be similar, must be about 12 gr of oats or 10 gr of barley daily, perhaps a bit less during the earlier months and a bit more in the later months. In January, February, March and April the mean consumption is about 50 per cent greater (compare fig. 12), that is, about 18 gr oats or 15 gr barley, while in the summer months May, June, July and August it is 25 per cent less than during the autumn, that is, on an average about 9 gr oats or 7,5 gr barley.This smaller consumption of grains during summer is at the same time partly characteristic of the nutritious value represented by the animals eaten.

Thus the annual consumption of a sparrow will be:

January, February, March, April.....	=120×18 gr	oats	=2160 gr	or	120×15 gr	barley	=1800 gr
May, June, July, August....	=120× 9 -	—	=1080 -	-	120×7,5 -	—	= 900 -
September, October, November, December.....	=120×12 -	—	=1440 -	-	120×10 -	—	=1200 -
			4680 gr		or		3900 gr
			oats				barley

For instance, 100 sparrows on an isolated farm will, accordingly, eat 468 kg oats or 390 kg barley annually on an average. The consumption of wheat will presumably be of nearly the same quantity as of barley. Perhaps this figure is too high, if the consumption has been specially large during the winter months on account of the very severe winters of 1941—42 and 1942—43.

As the quantity of grain found in gullet and stomach is only a very small part of the daily consumption of the sparrow and will have to be multiplied many times if it is to attain the true level, the quantities of seeds and insects found will likewise, presumably, constitute only a small part of the quantity eaten. For instance, the average number of grains has been stated to be about 4 per sparrow (compare figs. 7—10) in October while the number really eaten by the sparrow will be about 12 gr oats = 319 × 30 = 9570 grains of oats or 10 gr barley = 238 × 30 = 7140 grains of barley, that is, about 1785—2400 times larger, on an average 2100 (compare tables 12—13). If we compare the examples on page 00 of insects found in the stomachs it will be seen that, if a corresponding multiplicity of the quantity of insects be necessary in order to get near the quantity really consumed, the sparrows eat an enormous

amount of insects. However, it is probable that the quantities of insects cannot be multiplied in the same degree as grains, as the hard, chitinous parts will certainly remain longer in the stomach because of the more difficult process of digestion.

DOES THE HOUSE-SPARROW CAUSE DAMAGE?

If this question is put to farmers, gardeners and other people concerned, the answers will differ considerably, and will be based on personal observations. A very great number of farmers will, without hesitation, answer in the affirmative, as they think of the devastation done by the sparrows at the border of the fields before harvest and of the large holes in the thatched roofs and of the thefts of grain in poultry-yards, in barns and stables. It was said at a manor house in Sjælland that, all through the time of threshing, you could not throw a coin into the barn without hitting a sparrow, and in such cases it must be admitted that considerable quantities of grain are bound to disappear in that way. Owners of chicken farms also maintain that sparrows are injurious, as they steal much fodder (compare p. 7, KALMBACH), and also carry contagious diseases to the poultry. However, many gardeners and not a few farmers are in doubt as to the injury caused, and they maintain that the sparrows devour a good many insects by which the indubitable damage is counter-balanced. A grower of cauliflower alleged that starlings and sparrows saved him several laborious and expensive sprayings annually by picking injurious animals from the seed plants. Once the birds had discovered the injurious animals they passed over the entire field in a few days; thus the field was cleaned just as well as by spraying.

Amongst the numerous insects found during this investigation there are such injurious animals as the black carrion beetle (*Silpha opaca*), halticids (*Phyllotreta nemorum* and other species), *Cassida nebulosa*, *Phyllopertha horticola* and others, but the numbers found do not present a clear picture of the actual quantity. As regards grain it turned out that the amount found in October was 2100 times too small. If the same holds good of the insects considerable figures will be attained; however, there is a probability that part of the chitinous substance of the insects is so hard that it is retained in the stomach for a longer time than grains which are comparatively easily crushed. If we multiply with not more than 1800 (based on fig. 16), one house-sparrow eats

on an average	1850	insects	in April
—	3060	—	- May
—	7660	—	- June
—	8450	—	- July
—	1980	—	- August.

If we compare the contents of sparrow's stomachs, stated on p. 00, it will be seen, for instance, that the sparrow from Studsgaard, June 1941 (containing 13 geometrid larvae, about 30 newly hatched *Calliphora*, 15 weevils besides remains of 7 other beetles), by eating such a portion four times only each day, the figure given in the survey is arrived at. Thus the figures given cannot be considered unreasonable. KALMBACH mentions, among other things, a brood of 5 half-fledged young that had eaten 55 larvae plus 1 adult of alfalfa weevils, 85 larvae plus 4 adults, 110 larvae plus 2 adults, 123 larvae plus 1 adult respectively together with 2 nestlings that had eaten 250 and 130 sawfly larvae respectively.

By simple observation the figures seem fairly plausible. A young sparrow was caught and put into a cage in the garden for feeding tests; it was fed through the netting with insects by its mother. The mother sparrow was observed one hour at a time, and the number of „bits" received by the young was counted as far as possible; the duration of the interval between visits was also noted. From these observations it is seen (table 18) that the young one

Table 18.

Shows the number of visits and also the number of bits, which a young caged sparrow received per hour from its mother.

Time of observation	11^{45}—12^{45} July 13th 1945
Time of the visit	11^{49} 50 50 51 55 57 58 58 59 12^{01} 25 27 29 31 34 36 38
Number of bits	2 3 3 1 1 6 3 3 4 5 2 2 1 3 2 1 2 = 44

Time of observation	15^{55}—16^{55} July 13th 1945
Time of the visit	15^{55} 16^{22} 24 [illegible] 38 39 [illegible] 40 47 53
Number of bits	3 11 1 5 7 2 4 2 2 1 = 38

evidently eats almost continuosly. The number of „bits" received is surely too small, as it is difficult to see exactly what is happening when the young is being fed. When the young opens its mouth widely and the mother puts something into its bill, it looks, at a distance, like a short kiss between the two, but frequently the „kiss" is long and it looks as if there might be given several „bits" without separation of the bills. The number of „bits" received by the young in the course of an hour was about 40, on an average, probably more. If the young is fed in just 7—8 hours a day with the same intensity, one attains the calculated number of insects for July: 8450. If the length of day at this time is taken into consideration, an 8-hour working day for the mother sparrow can very well be imagined.

COLLINGE (1912) found on an average 20,2 visits per hour in May. As the visits began one day immediately after 4 a. m. and continued until 7,30 p. m. he is of opinion that the daily number of visits to the nest will probably be between 220 and 260.

The attacks of the destructive animals mentioned take place mainly in May, June and July, exactly in those months when the sparrows eat most insects. If a flock of sparrows takes only part of its consumption from these destructive animals that mostly are easily approached and caught, a considerable amount of harm may certainly be done to the destructive animals. As an example some instances may be given, in which destructive insects have been found:

4 sparrows of 27 had eaten on July 20 1941 at Borris 6 *Silpha opaca*
3 — - 22 — — - — 4 — - Lyngby 64 *Phyllotreta* sp.
2 — - 7 — — - — 10 — - Vejenbrød 18 *Cassida nebulosa*

If we attempt to calculate what the flocks of sparrows in question (calculated as consisting of 100 individuals) may have eaten of destructive animals during the half month in which the destruction is especially obvious, the result is that about 80000 *Silpha* larvae, about 80000 *Phyllotreta* and about 46000 *Cassida* larvae and adult individuals are eaten. From this result it was calculated that only 15, 14 and 19 per cent respectively of the flocks ate the destructive animals in question (the percentage in which the destructive animals in question were actually found); if it were calculated that all the sparrows had eaten them the result would have been figures of six or seven figures.

As regards *Phyllotreta* it is known, from CHR. STAPEL's spraying tests, that in serious attacks there are 60000—120000 per hectar cabbage beetroot fields, but in a less serious attack there are 20000—30000 per hectar. Without calculating very high it may be assumed that the sparrows on a farm will be able to keep the halticids in check if there is not an insect more readily obtainable in great numbers still nearer. As is well known, the sparrow does not care to go very far for its food, in the highest a few kilometres. KASHKAROV states that the damage caused by sparrows to the harvest only takes place about 3—3½ kilometres from their nests.

The result of this and other investigations into the feeding habits of the house-sparrow must be that the sparrow is very useful as a nestling, and also, in a certain degree, as a fledgeling. As an adult it is very destructive, in the first place to the grain; but it is fairly useful in brooding time when it eats a quantity of insects. By a possible decimation of the flocks, the benefit done by the adult birds will perhaps be continued by other small birds, as it is well-known that the sparrow has ousted many small birds, according to KALMBACH,

including, the Barn Swallow, by taking its nests. A decimation of the sparrow population must be so arranged that the nestlings are preserved during the period in which they live exclusively on insects. Later on the fledgelings may easily be caught in „swing-traps", whereas the adult birds are very suspicious and difficult to catch. By steadily catching the fledgelings, the sparrow population may be kept well in check. Moreover, if chicken-runs and the like are kept covered, a very large quantity of grain may be saved by preventing the sparrows from eating with the fowl.

FEEDING HABITS OF THE TREE-SPARROW

An investigation into the food of the tree-sparrow in this connection is not as interesting as an investigation into that of the house-sparrow, as the tree-sparrows constitute only a small part of the number of sparrows. Moreover, it does not live in such close relationship to man as the house-sparrow, consequently it has not the same opportunity to eat grain as the house-sparrow. If the tree-sparrow, nevertheless, has been made the object of an investigation, it is due to the fact that the material sent in contained a fair percentage of tree-sparrows that had been shot simultaneously with house-sparrows, as these two species are often seen together in flocks in the fields. Consequently the tree-sparrows investigated come from the same localities as the house-sparrows. Table 19 gives a survey of the places from where the tree-sparrows came and of the time of the year in which they were shot.

When, as in the case of house-sparrows, graphs are made of the percentage of tree-sparrows that have eaten grains, weed-seeds and insects respectively, the picture is somewhat different from that of the house-sparrows. From figs. 18—19 it will be seen that the percentage of tree-sparrows eating grain varies very much, without being as high as that of house-sparrows, and it does not show any perceptible decline in the middle of summer. All the year round the percentage of tree-sparrows eating corn is, on an average, far lower than that of house-sparrows. But then the percentage of tree-sparrows that eat weed-seeds is on an average very much higher than that of the house-sparrow all the year round, even if the summer shows a marked decline in the curve of those that eat seeds. Also the insect curve deviates a good deal from that of the house-sparrow. During the months of winter and autumn there is only a very small percentage of house-sparrows eating insects while the percentage as to insects in the middle of summer is near 100. With the tree-sparrow, however, a very large percentage eats insects during a large part of the year, and only in the coldest months is the percentage of tree-sparrows eating insects very small as is in the case of the house-sparrows.

Table 19.

List of the material of tree-sparrow (Passer montanus) and

Localities P. montanus	1941												1942											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Sjælland:																								
Ramløse	—	—	—	—	—	—	—	—	—	—	6	—	—	—	—	—	—	—	—	—	—	—	—	—
Lille Lyngby	—	—	—	—	—	—	—	—	37	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hillerød	—	—	—	—	—	—	—	8	—	6	—	—	15	—	—	—	—	—	—	—	—	—	—	—
Toftesten, O. Sundby	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—
Vejenbrød	—	—	—	—	21	2	1	—	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Holte	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lyngby	—	—	—	—	8	4	2	12	—	—	—	12	—	5	3	3	1	7	—	1	—	—	—	1
Hellerup	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9	—	—	—
Amager	—	—	—	—	—	—	—	1	1	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Farum	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirke Hyllinge	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	11	—	—	—
Brofælde, Uggerløse	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Tystofte	—	—	—	—	6	7	12	7	16	1	1	1	—	9	2	7	—	16	3	2	2	8	—	—
Gaunø	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Jylland:																								
Studsgaard	—	—	—	—	4	3	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Borris	—	—	—	—	1	—	9	—	1	6	—	—	—	2	15	—	—	—	—	—	—	—	—	—
Skarrild, Kibæk	—	—	—	—	—	—	—	—	—	—	—	—	6	—	—	—	—	—	—	—	—	—	—	—
Vejen, Askov	—	—	—	—	—	—	—	5	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
Ribe	—	—	—	—	—	—	4	3	—	9	—	5	13	—	—	—	—	—	10	—	4	4	3	8
in all per month per year	—	—	—	—	40	16	28	39	61	25	8	18	34	16	20	10	1	26	13	12	17	12	3	9
Localities P. sp.																								
Sjælland:																								
Toftesten, O. Sundby	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	17	—	—	—	—	—	—
Tystofte	—	—	—	—	—	14	—	—	—	—	—	—	—	—	—	—	—	—	15	—	—	—	—	—
Samsø	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Fyn:																								
Aarslev	—	—	—	—	—	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Jylland:																								
Studsgaard	—	—	—	—	—	6	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gjerrild	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Borris	—	—	—	—	—	—	30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ribe	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

of undetermined young ones (Passer sp.), mostly nestlings.

1943												1941	1942	1943	in all per locality
1	2	3	4	5	6	7	8	9	10	11	12				
												6	—	—	6
												37	—	—	37
2	20											14	15	22	51
										9		—	3	9	12
												30	—	—	30
						2						—	—	2	2
2	8	—	5	2	5	—	—	—	—	—	3	38	21	25	84
												—	9	—	9
												5	—	—	5
												1	—	—	1
												—	11	—	11
											1	—	—	1	1
												51	49	—	100
						2						—	—	2	2
												9	—	—	9
												17	17	—	34
												—	6	—	6
												6	—	—	6
19	—	5	—	—	2	2	—	2	—	2	—	21	42	32	95
23	28	5	5	2	7	6	—	2	—	11	4	per year 235	173	93	501 in all *P. montanus*
												—	17	—	17
												14	15	—	29
						19						—	—	19	19
												5	—	—	5
												7	—	—	7
				15								—	—	15	15
												30	—	—	30
					8							—	—	8	8
												per year 56	32	42	130 in all P. sp. young ones

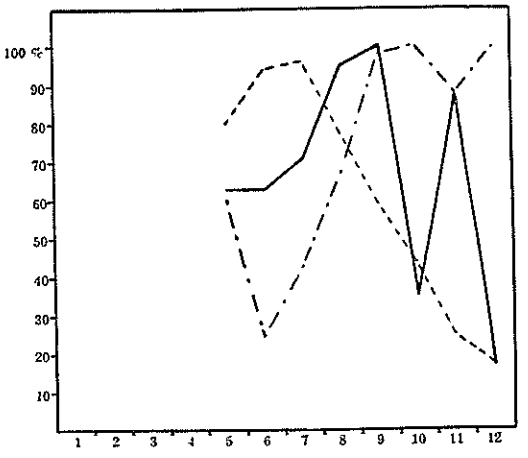


Fig. 18. Percentage of tree-sparrows (*P. montanus*) which in 1941 have eaten

grains ——————
insects – – – – – –
weed seeds —·—·—·—

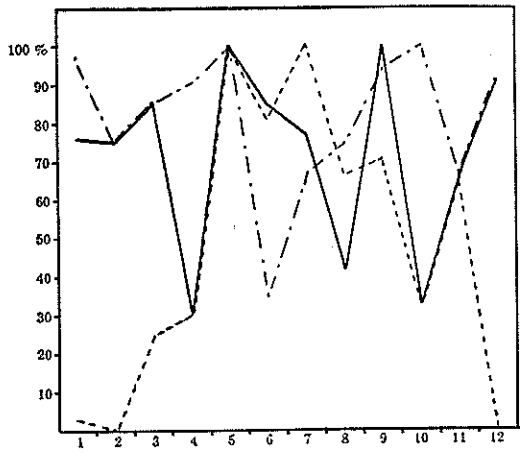


Fig. 19. Percentage of tree-sparrows (*P. montanus*) which in 1942 have eaten

grains ——————
insects – – – – – –
weed seeds —·—·—·—

A very large proportion of the tree-sparrows eat also weed-seeds and insects in the greater part of the year, while the percentage of tree-sparrows eating grain varies very much, and it is considerably lower than for the house-sparrows.

Furthermore, if we investigate how much of these three main component parts of the food the tree-sparrows devour, compared with the house-sparrows, there are considerable divergences (figs. 20—21). The average number of grains per month is far lower in the tree-sparrow than in the house-sparrow, the number of insects is slightly higher and the number of weed-seeds on an average considerably greater than in the house-sparrow. While the average

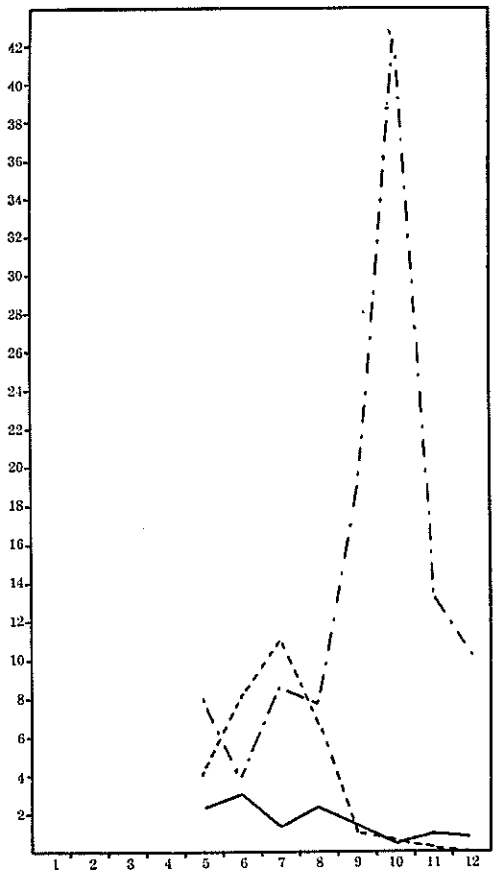


Fig. 20. The average number of

grains ——————
insects - - - - - -
weed seeds —·—·—·—

eaten per tree-sparrow (*P. montanus*) in 1941.

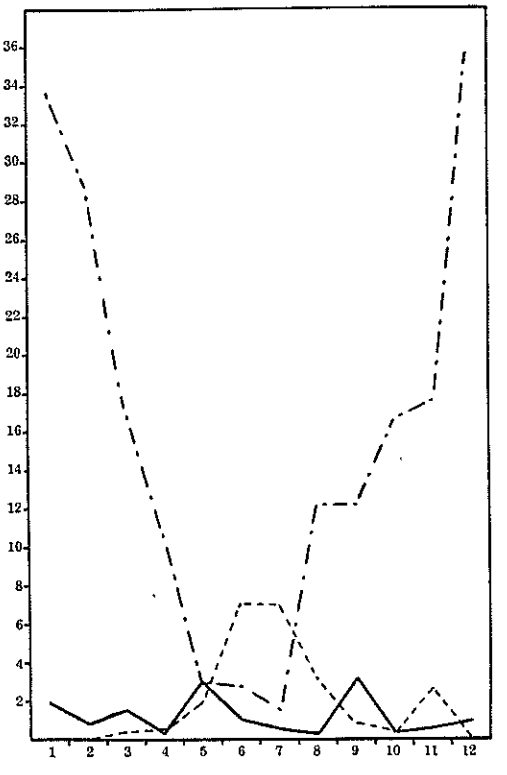


Fig. 21. The average number of

grains ——————
insects - - - - -
weed seeds —·—·—·—

eaten per tree-sparrow (*P. montanus*) in 1942.

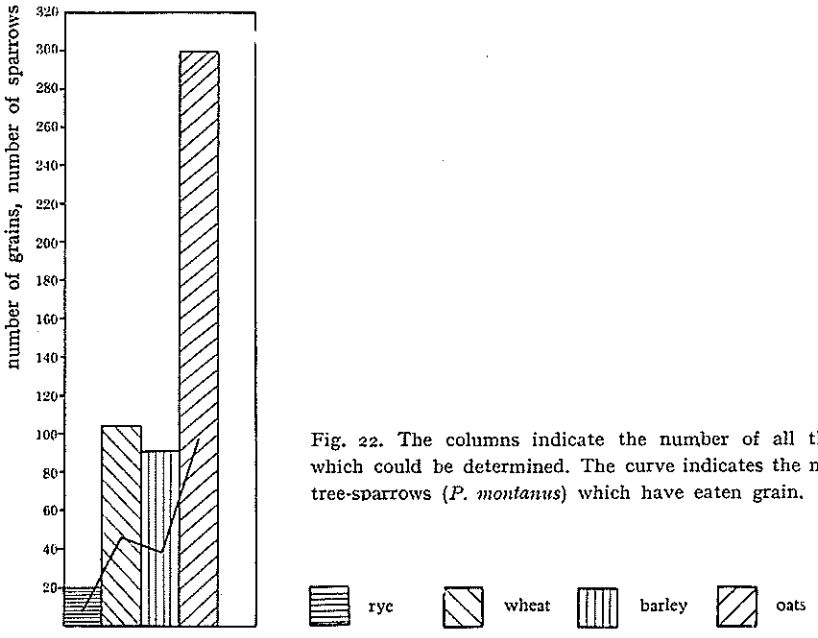


Fig. 22. The columns indicate the number of all the grains which could be determined. The curve indicates the number of tree-sparrows (*P. montanus*) which have eaten grain.

number of seeds varies very much with the house-sparrow all the year round, it is very high in the tree-sparrow during the greatest part of the six winter months; the curve has a decided decline in the summer when the insect curve attains its maximum. A comparison of results from figs. 18—19 and figs. 20—21 shows that the tree-sparrow, on the whole, lives on insects in summer, on weed-seeds in the autumn and winter, and that grain apparently plays a lesser rôle in their diet than insects and weed-seeds.

If we then investigate what the three main components of food — grain, seeds and insects — consist of for the tree-sparrow there are some deviations from the food of the house-sparrow. As regards grain the proportion between the four sorts of grain is about the same in the house-sparrow and the tree-sparrow (compare fig. 11 and fig. 22). The tree-sparrow also prefers oats to barley and wheat, and rye is only eaten in small quantities. The occurence of the four sorts of cereal in the food during the year (fig. 23) shows a more casual picture than was the case with the house-sparrow, which may be due partly to less reliable material. Thus in April only rye has been eaten, which is due to the fact that during that month only a few sparrows, which happened to have eaten rye were caught, while the chance that the sparrows which might have been shot would have eaten one of the other cereals, was just as great or greater. This accidental occurrence of cereals in the diet all the year round

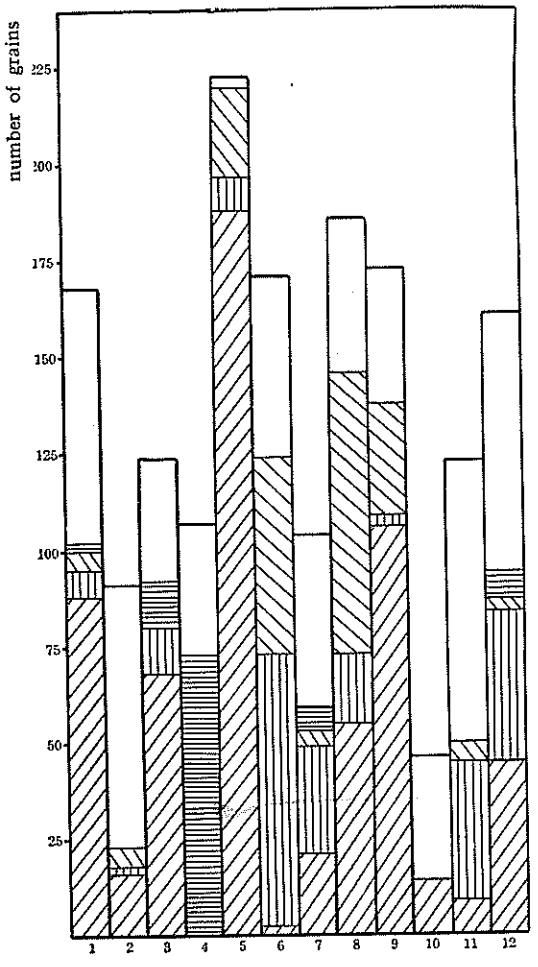
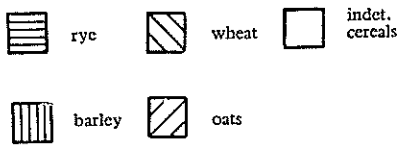


Fig. 23. The columns indicate the number of grains eaten on an average by 100 tree-sparrows (*P. montanus*) in the course of a year.



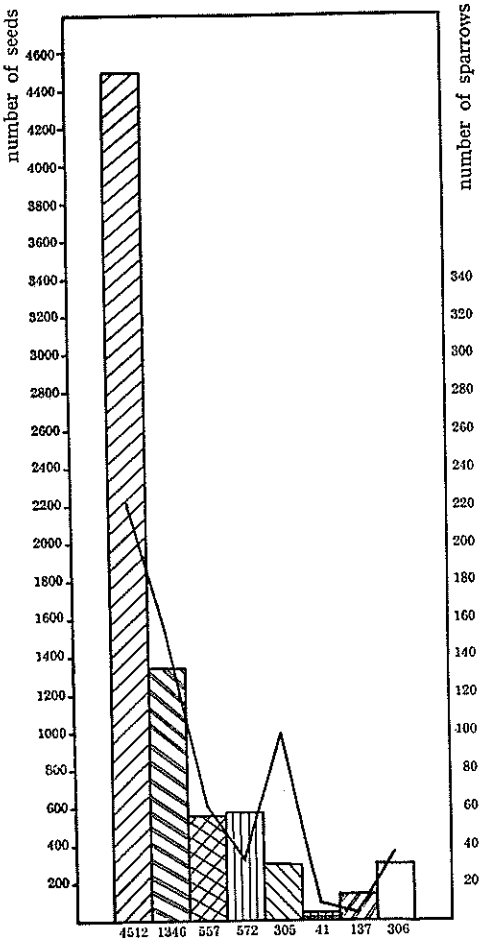
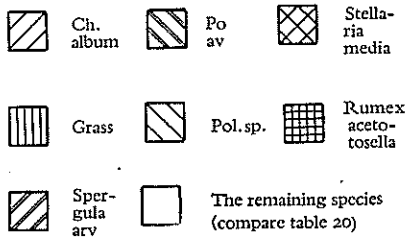


Fig. 24. The columns indicate the number of weed seeds which have been found in all of the species in question. The curve indicates the number of tree-sparrows (*P. montanus*) which have eaten the seeds. →



tends to show that the tree-sparrow takes the grain whereever it happens to find it. The quantities eaten during the various months fluctuate very much, and are not less during summer as is the case with the house-sparrow. The quantity per 100 tree-sparrows, on the other hand, is considerably less than per 100 house-sparrows: about $^1/_3$ of the consumption of the house-sparrow.

As regards weed-seeds it will be seen that the tree-sparrow is still more specialised than the house-sparrow. From fig. 24 it will be seen that *Chenopodium album* is so numerous in the food of the tree-sparrow that it constitutes a far greater part than all the other seeds together. *Polygonum aviculare* and *Stellaria media* are also eaten in fairly large quantities as was also the case with the house-sparrow. But grass does not play the same role to the tree-sparrow as to the house-sparrow. Several species of *Polygonum* (see table 20), *Rumex acetosella* and *Spergula arvensis* are eaten in smaller quantities, while all the other species of plants found (about 20 species) together only constitute a very small part of the aggregate quantity of seeds. The small number of

Table 20.

List of all the plants (cereals excepted) found by this investigation of the tree-sparrow (P. montanus) in 1941—43.

List of plants	number of specimens found	eaten by number of sparrows	List of plants	number of specimens found	eaten by number of sparrows
Gramineae	572	33	*Viola* sp.	12	1
Panicum	3	2	*Euphorbia helioscopia*	3	1
Cannabis sativa	3	1	*Potentilla* sp.	72	2
Rumex acetosella	41	9	*Linum usitatissimum*	15	2
Polygonum tomentosum	237	79	*Trifolium* sp.	1	1
— *persicaria*	55	8	*Lycopsis arvensis*	1	1
— *aviculare*	1346	152	*Solanum tuberosum*	1	1
— *convolvolus*	13	12	*Veronica* sp.	1	1
Caryophyllaceae (indet.)	1	1	*Rhinanthus* sp.	13	3
Stellaria media	557	62	*Plantago major*	3	2
Spergula arvensis	137	4	*Compositae* (indet.)	30	2
Chenopodium album	4512	221	*Circium* sp.	2	2
Atriplex sp.	16	8	*Chrysanthemum leucanth.*	6	2
Spinacia	10	3	*Taraxacum* sp.	5	1
Cruciferae (indet.)	8	2			

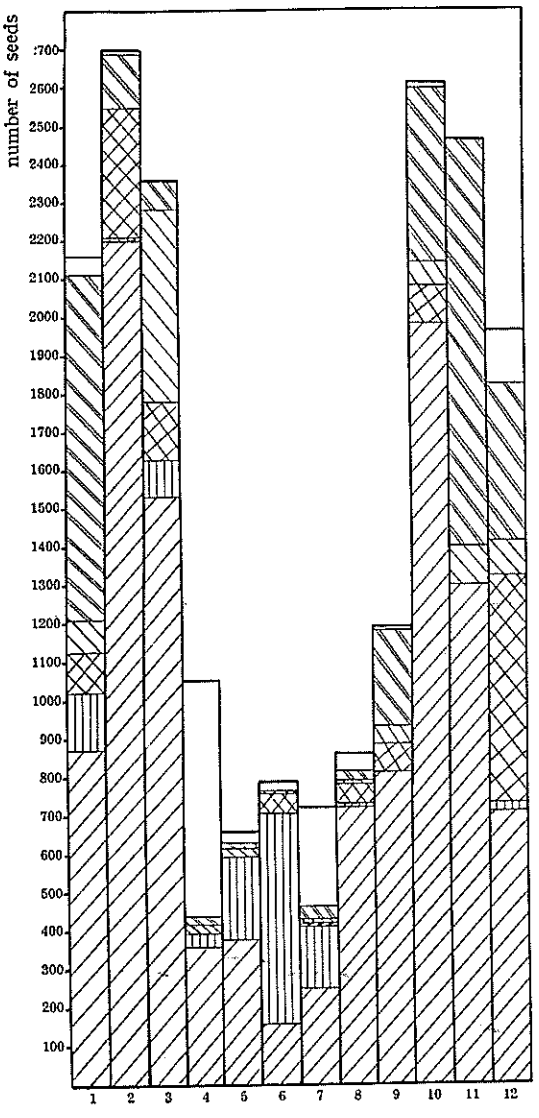


Fig. 25. The columns indicate the number of weed seeds, on an average eaten by 100 tree-sparrows (*P. montanus*) in the course of a year. The differently shaded areas indicate the most important species.

Ch. album
Grass
St. media
Pol. sp.
Pol. avic.
The rest of the species (comp. table 20)

different plants in table 20 also show that the tree-sparrow is only interested in a very few species. The occurrence of the various seeds in the food month for month all the year round (fig. 25) shows that *Chenopodium album* is the most important throughout the year. *Polygonum aviculare*, however, constitutes a considerable part of the weed-seeds devoured in November, December and

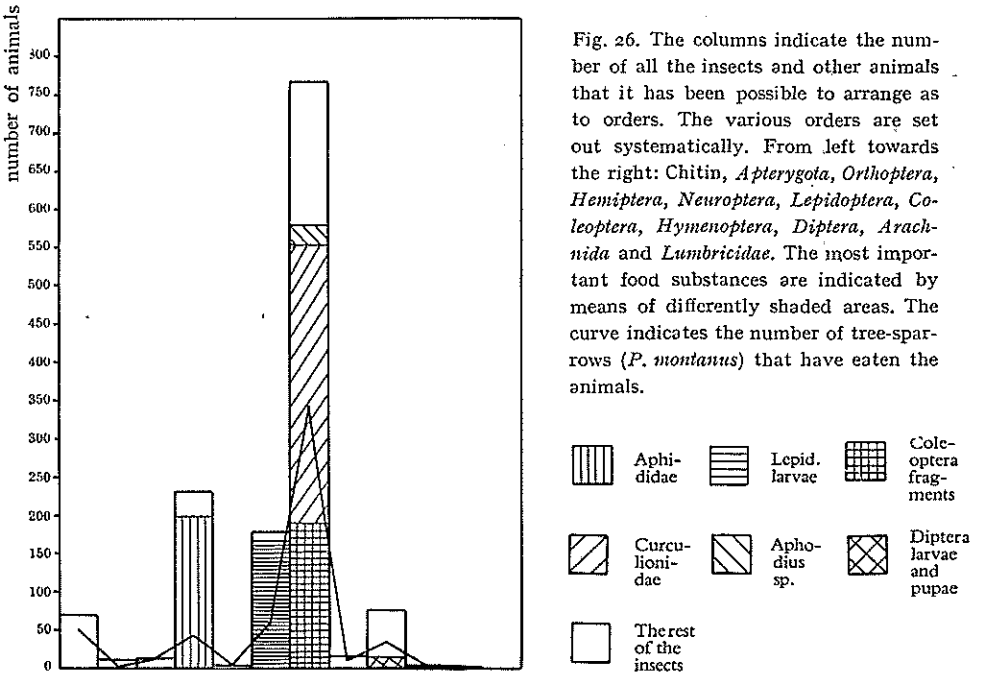


Fig. 26. The columns indicate the number of all the insects and other animals that it has been possible to arrange as to orders. The various orders are set out systematically. From left towards the right: Chitin, *Apterygota, Orthoptera, Hemiptera, Neuroptera, Lepidoptera, Coleoptera, Hymenoptera, Diptera, Arachnida* and *Lumbricidae*. The most important food substances are indicated by means of differently shaded areas. The curve indicates the number of tree-sparrows (*P. montanus*) that have eaten the animals.

January. Grass and *Stellaria media* are eaten in the same quantity as in the case of house-sparrows, but because of the very large quantity of *Chenopodium album* eaten by the tree-sparrows, grass and *Stellaria media* form only a small part of the aggregate quantity of seeds. Like the house-sparrow, the tree-sparrow seeks grass especially during the summer months, while *Stellaria media* is found in the food almost throughout the year, but it is numerous only in the winter months. The quantity of weed-seeds eaten by 100 tree-sparrows per month is many times greater than that eaten by a corresponding quantity of house-sparrows.

If we look at the insects preferred by the tree-sparrow, they are about the same as those taken by the house-sparrow (fig. 26). Beetles (*Coleoptera*) constitute the greater part, but while the house-sparrow eats dung beetles in great masses these do not mean much to the tree-sparrows; this probably indicates that the tree-sparrows do not swarm near horse-dung as do the house-sparrows, which fact is in accordance with the observations made. Of beetles the weevils form the greater part. As with the house-sparrow, plant-lice, caterpillars, larvae and pupae of flies are very much sought after while the rest of the insects (compare table 21) play a lesser rôle. From a comparison between fig. 15 and fig. 27 it will be seen that the quantity of animals eaten

by 100 tree-sparrows per month is twice the quantity eaten by 100 house-sparrows.

From this investigation into the diet of the house-sparrow and the tree-sparrow one gets the clear impression that these two species are two widely different birds as regards their way of living; they cannot be considered from the same point of view when their probable benefit or noxiousness are to be discussed.

As it has been shown in the above that the consumption of grain by the tree-sparrow is only $^1/_3$ of that of the house-sparrow while its consumption of insects is well over double the quantity, and the quantity of weed-seeds eaten

Table 21.

List of all the animals found in P. montanus.

List of animals	number of individuals found	eaten by number of sparrows	List of animals	number of individuals found	eaten by number of sparrows
Chitin	71	52	*Cassida* sp.	6	5
Collembola	10	1	— *nebulosa*	33	15
Sminthuridae	1	1	*Phyllotreta undulata*	1	1
Forficulidae	2	2	— sp.	29	4
Acridiidae	10	9	*Curculionidae*	271	137
Heteroptera	21	4	*Apion* sp.	10	4
Pentatomidae	2	1	*Centorrhynchus* sp.	86	13
Cikadidae	4	4	*Lamellicornia*	7	2
Psyllidae	6	1	*Phyllopertha horticola*	6	5
Aphididae	199	33	*Aphodius* sp.	25	21
Chrysopa sp.	2	2	*Byrrhus* sp.	1	1
Lepidoptera	25	19	*Staphylinidae*	4	1
Microlepidoptera	5	3	*Ichneumonidae*	13	9
Coleophora sp.	38	8	*Myrmicidae*	3	1
Macrolepidoptera	46	20	*Nematocera*	10	1
Geometridae	63	9	*Brachycera*	60	29
Coleoptera fragments	188	86	*Scatophaga stercoraria*	1	1
Carabidae	50	14	*Pandora*	2	1
Coccinea 7-punctata	20	15	*Syrphidae*	2	1
— sp.	2	1	*Tachinidae*	2	2
Elateridae	18	11	*Arachnidae*	4	4
Chrysomelidae	11	8	*Lumbricidae*	2	2

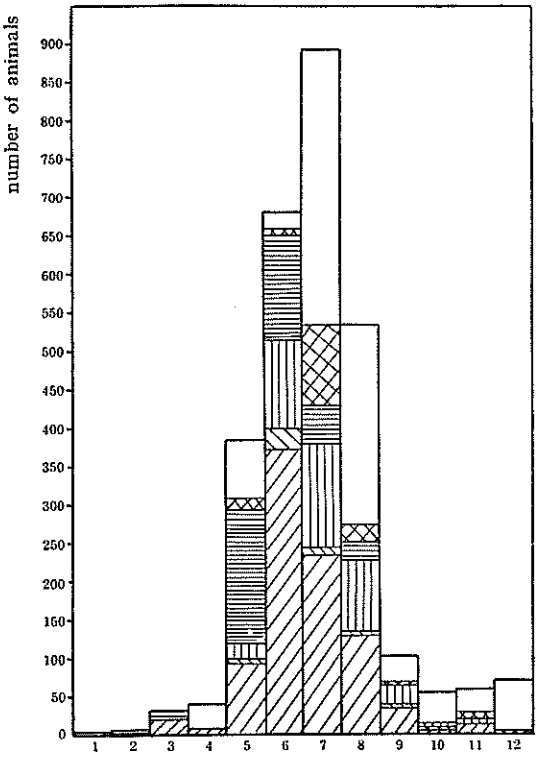


Fig. 27. The columns indicate the number of insects which 100 tree-sparrows (*P. montanus*) on an average devoured in the course of a year. The differently shaded areas indicate the most important feeding animal ingredients.

by it is many times larger, there can be no doubt that the tree-sparrow is a bird very useful indeed to man; its presence in gardens and fields is, therefore, highly desirable.

SUMMARY

This investigation of 2657 House-sparrows and 501 Tree-sparrows has shown that these two species have a different food demand. During the greater part of the year the House-sparrows feed on grains, especially oats. The reason is perhaps that during the severe winters of 1940—41 and 1941—42 in which wheat was very sparse the sparrows were not able to obtain their most preferred cereal: wheat. In the summer months, i. e. in the brooding time a great number of insects is devoured not only by the nestlings, but also by the adults. Throughout the year, but especially in the autumn a great quantity of weed seeds (*Chenopodium album, Stellaria media, Poa annua* etc.) is consumed. Through feeding experiments it turned out that one hundred sparrows yearly eat about 470 kg oats or 390 kg barley. As the number of

devoured insects is correspondingly great: one sparrow eats about 23000 insects during the months April to August among which are many noxious insects, it is obvious that the House-sparrow is beneficial during the brooding time when especially animal food is eaten, but on the contrary very injurious through the greater part of the year on account of its considerable consumption of grain.

The Tree-sparrows, on the other hand especially feed on weed seeds throughout the year, and the consumption of grain is much smaller than that of the House-sparrow (only $^1/_3$). As the consumption of insects is very great — more than twice as much as that of the House-sparrow — there is no doubt that this bird is of great benefit.

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Eimeria bucephalae n. sp. (Coccidia) pathogenic in Goldeneye (Bucephala clangula L.) in Denmark

by

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and

Holger Madsen

Copenhagen 1948

INTRODUCTION

Our knowledge of the coccidia parasitic in Anseres (*Anseriformes*) on the whole is rather defective. This subject has been elucidated relatively best in domestic geese, in which coccidiosis is of rather frequent occurrence. This applies especially to the well-known renal coccidiosis, the cause of which — *Eimeria truncata* — was demonstrated by RAILLIET & LUCET in 1890. Later, several authors have shown that various species of coccidia occur also in the intestinal tract in domestic geese and that they also may have a pathogenic effect. The question about the species of these coccidia was not established, however, till 1932—33 when A. KOTLÁN reported his comprehensive studies in this subject, showing that three species of Eimeria may occur in the intestines in domestic geese — though different in frequency.

Also in domestic ducks has the occurrence of coccidia in the intestine been demonstrated, and PAVLOV states that the renal coccidia (*Eimeria truncata*) encountered in geese sometimes are found as parasites in domestic ducks. However, experiments performed by BÉLA TIBOLDI on transmission of this coccidium as well as of one of the coccidia occurring in geese (*Eimeria parvula*) to ducks turned out negative. Our knowledge of coccidia occurring in domestic ducks, claimed in some cases to have been pathogenic, is very incomplete, as the description of these organisms usually is too defective to allow of any determination of the species. One exception to this rule is *Tyzzeria perniciosa* described by ENA A. ALLEN (1936) which was found in the small intestine in a young Pekin duck from Long Island. In experiments on transmission this species proved to be exceedingly pathogenic to ducklings. This coccidium belongs to the subfamily *Cryptosporidiinae;* it forms elliptic oocysts, measuring 9-10.8 × 10-13.3 μ, in which 8 sporozoites are formed directly, without sporocysts. The reports published hitherto convey the impression that coccidia on the whole are not of frequent occurrence in domestic ducks. In this connection, however, it is to be mentioned that no systematic studies on this subject appear to have been reported hitherto.

Our knowledge of this subject as far as wild Anseres are concerned is even more defective. In the literature available to the writers nothing is found about the presence of coccidia or coccidiosis in these birds. It is to be mentioned, however, that in summer 1942 the Serum Laboratory received 4 dead goslings of the graylag (*Anser cinereus*), which all showed the presence of very intensive renal coccidiosis. These goslings had been caught together with

several others while they were quite young — on a breeding ground here in Denmark — and they had been raised in screened yards for the purpose of subsequent distribution in various parts of the country. In the course of the summer, then, these goslings were distributed, but later several of them died of renal coccidiosis. The pathological changes were quite typical, and the coccidia found in great amounts in the kidneys quite corresponded to the description of *Eimeria truncata*.

PATHOLOGICAL AND EPIDEMIOLOGICAL CONDITIONS

In the following a fairly detailed description will be given of some cases of severe intestinal coccidiosis in goldeneye (*Bucephala clangula*). Various circumstances in the appearance of these cases present some interesting features. Thus, among others, the coccidia here observed belong to a species that has not been described before.

All the cases examined originate from the same place in Limfjorden — from the so-called Halkær Bredning south of Sebbersund (North Jutland). The ducks here examined were sent to us by Mr. ANDERS DAHL, Halkær, who also has furnished the following information about the occurence of goldeneyes in that locality and some observation on the appearance of the disease among the ducks.

The first case was examined on July 26, 1941 when Mr. Dahl sent us a goldeneye that had died from some disease and informed us that in the past couple of months more than 50 dead ducks had been found — all goldeneyes. Every summer these ducks used to be very numerous in Halkær Bredning where often they were seen in large flocks, containing also other duck species. In summer 1941, however, these other species had practically failed to come, and the goldeneyes were not as numerous as usual. In contrast to previous summers, when the goldeneyes were found everywhere on Halkær Bredning, they now stayed only at the seaside and in the outlet of the Halkær creek, opening into the Halkær Bredning, where otherwise the ducks usually did not come at all at this time of the year. From the creek they crawled up on dry land where they were found to be sitting dead.

The goldeneye received was a female, 1 year old, greatly emaciated. The parenchymatous organs presented no pathological changes; and the same applied to the oral cavity, fauces and trachea. The crop was completely empty, and the gizzard contained only some small stones. The entire small intestine was the site of pronounced pathological changes; the serosa was markedly congested throughout, and the intestinal wall was greatly thickened. The intestinal contents were fairly abundant, in consistency rather like ointment,

though somewhat granular, reddish-yellow in color. In large parts of the gut, in particular the caudal, the mucosa was the site of extensive thick, yellowish, rather soft pseudomembranous patches of exudate which were not removable by washing — though by cautious scraping. Under this exudate the mucous membrane appeared somewhat red and injected. The coeca and rectum were contracted, practically empty, but otherwise without any macroscopic pathological changes.

Neither by microscopy nor by means of cultures could the presence of bacteria in the liver be demonstrated. Cultures on bromcresolpurple-lactose-agar from the intestinal contents showed vigorous growth of colon-like bacteria, but no non-lactose-fermenting bacteria — above all, no *Salmonella*.

Microscopic examination of the contents of the small intestine revealed a multitude of coccidial oocysts of a rather characteristic, elongated, oval and slender form of considerable size. In a 4 per cent potassium bichromate suspension of intestinal contents, placed in a moist chamber at room temperature a great many of the oocysts were seen to form spores. Commencing sporulation was observed after 4 days.

As the outcome of this preliminary examination suggested the possibility that here we were dealing with a hitherto unknown coccidial species, and as the data received about the occurrence of the disease made it desirable to follow its course somewhat more closely we asked for more ducks — both some that were found dead and others that were shot, but apparently ill.

In the following period we then received 11 goldeneyes from the locality mentioned: namely: 1 duck (female, „spontaneously" dead) on August 11th, 1 duck (male, shot) on September 1th, 2 ducks (males, shot) on September 5th; 3 ducks (1 male, 2 females, shot) on September 15th, 3 ducks (1 male, 2 females, shot) on September 17th, and 1 duck (male, „spontaneously" dead) on October 25th. All these ducks were young-birds (1 year old), and they were all severely attacked by coccidiosis.

The pathologic-anatomical changes were largely in keeping with those observed in the first goldeneye received. All the birds showed a pronounced degree of enteritis, even though the changes in the intestinal mucosa might vary somewhat. Thus, 3 ducks showed more or less extensive pseudomembranes as described above. In 3 ducks the intestinal mucosa was markedly congested, red in color, but without any patches of exudate; and one duck presented an acute hemorrhagic inflammation of the intestine with bloody contents in all sections of the gut. Finally 4 ducks showed characteristic multiple whitish processes, (varying in size from millet seed to lentil), in the thickened and congested mucosa of the small intestine. Usually these processes were present in very large numbers in large parts of the small intestine; they were easily visible on the surface of the gut, showing through the serosa.

In all these ducks a great number of oocysts were found in the intestinal content, being most numerous in the cases where the characteristic multiple processes were found in the intestine. Here numerous oocysts were seen in every field under the microscope. Morphologically they quite resembled those observed in the first duck received.

The high mortality among the goldeneyes continued through autumn 1941. Thus, towards the end of October, we were informed that many dead goldeneyes could still be found in the locality here concerned.

The following summer we were informed that the goldeneyes were unusually numerous in the Halkær Bredning and that no morbidity or mortality like those in 1941 were observed among the ducks. Not until September 24, 1942 did we receive the first goldeneye which was found dead on the shore, together with the information that prior to this only one dead goldeneye had been found.

The specimen which we received — a male with beginning transition from the summer plumage to the pompous plumage — was severely attacked by coccidiosis. The bird was quite emaciated and showed pronounced pathological changes, especially in the small intestine, which was greatly thickened throughout. The intestinal wall was filled everywhere with round or elongated whitish, here and there confluent processes (about the size of millet seed) showing through the serosa (Fig. 1). The mucous membrane was completely covered by thick, greyish-yellow diphtheroid patches of exudate. The intestinal contents were rather abundant, thin, reddish in color. In the duodenum the diphtheroid processes were more solitary, not so diffusely extensive and confluent as in the jejunum. Similar, though more scattered diphtheroid patches were seen also on the mucous membrane of the coeca and rectum; and these two sections of the gut were almost empty.

The feces as well as the contents of the small intestine and the coeca showed myriads of oocysts of the same characteristic appearance as observed

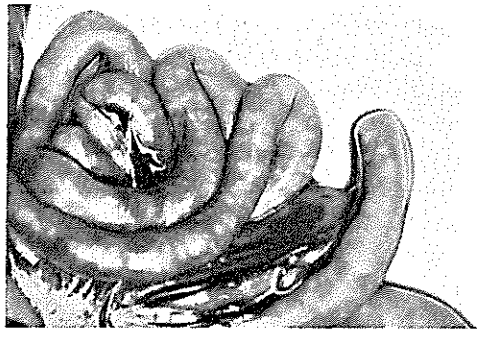

Fig. 1. Small intestine of goldeneye with multiple coccidial processes. ¾ natural size.

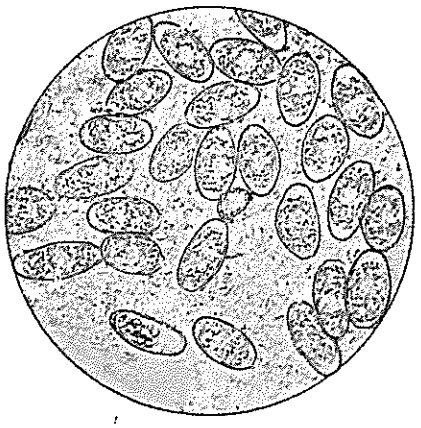

Fig. 2. Smear of contents from the small intestine of goldeneye. *Eimeria bucephalae.* Magnif. × 340.

in the ducks examined the preceeding year. Fig. 2, a microphoto of an unstained preparation of contents of the small intestine of the duck received in September 1942, gives a good idea of the mass of oocysts.

As to the occurrence of coccidiosis in the following years no particular information can be given. Mr. DAHL has stated that in the locality mentioned above some dead goldeneyes were found every summer, but they had been so cadaverous that they were not suitable for examination. Nor has any shot diseased ducks been sent to our laboratory, but this is probably chiefly due to the lack of cartridges prevailing in the later years. During these years, furthermore, the traffic was so poor that it would take 2—3 days to send the birds from that locality to our laboratory — and then it was even in the hot season that such material was available. Thus only birds that had been shot shortly before were suitable for such shipment, and even the ducks of this category showed pronounced postmortal changes, especially in the digestive tract, when they arrived at our laboratory. This naturally made it impossible to carry out any detailed histological examination of the relation of the coccidia to the intestinal epithelium.

From the data obtained, the wide spreading and pronounced malignancy of the coccidiosis among the goldeneyes in 1941 appear not to have recurred in the following years, even though every summer some dead goldeneyes can be found in the aforementioned locality. As to the cause of the fulminant outbreak of the disease in 1941 it is rather difficult to offer any suggestion. In this connection, a question of considerable interest is whether this coccidial species occurs more or less frequently in healthy individuals. As yet no investigation into this question has been carried out, but such studies will be taken up. It is also to be pointed out that the outbreak in the summer 1941

was preceded by a long and hard winter which conceivably may have lowered the general resfisance of these birds in some degree, thus making them more susceptible to the infection with the coccidia. But, of, course this suggestion is entirely hypothetical.

As already mentioned, the goldeneyes received for examination were relatively young individuals. This is quite in keeping with statements concerning the occurrence of goldeneyes in Denmark: that the relatively few summering individuals chiefly are younger birds, not yet capable of breeding[1]). So far, data have been available only concerning sick and dead goldeneyes, not about other kinds of ducks. Attempts were made to obtain some other ducks from that locality, shot at the time when the sick and dead goldeneyes occurred, but the result was very poor. On October 25, 1941 we received a shot teal (*Anas crecca*), a female. The nutrition of this bird was only middling, but no disease could be demonstrated — in particular, no coccidia were found. Further, a shot scaup (*Aythya marila*), female, was received on November 11, 1943. It was somewhat emaciated and hence it was considered sick. The examination revealed a pronounced catarrh of the small intestine; no coccidia could be demonstrated, whereas there were numerous small trematodes (*Cryptocotyle concava*)[2]) in the contents of the small intestine.

Sporulating oocysts originating from one of the goldeneyes received were employed in an experiment on transmission to a tufted duck (*Aythya fuligula*), this species of ducks being the nearest relative to the goldeneye that was at our disposal at that time. Through repeated examinations of the feces from this tufted duck it was ascertained that it was not infected with coccidia, and then it was repeatedly fed considerable amounts of freshly sporulated oocysts from goldeneyes. These attempts to infect the tufted duck did not turn out successful, however, as examination of the feces (after the flottation method) for more than 2 months gave always a negative result.

HISTOLOGY

Before going on to a detailed description of the coccidia found in the goldeneyes, it will be appropriate to mention that the small intestine from several of the goldeneyes were also examined histologically, sections being stained with hemalum-eosin and with iron trioxyhematin—acid fuchsin—picric acid (van Gieson). As mentioned above, however, on account of postmortal

[1]) R. Hørring: Danmarks Fauna, Fugle, I; 1919, p. 147.
Heilmann & Manniche: Danmarks Fugleliv, Vol. I, 1928, p. 206.
F. Salomonsen in Dansk Jagtleksikon, 1944, p. 604.

[2]) kindly determined by Dr. phil. HANS ROTH.

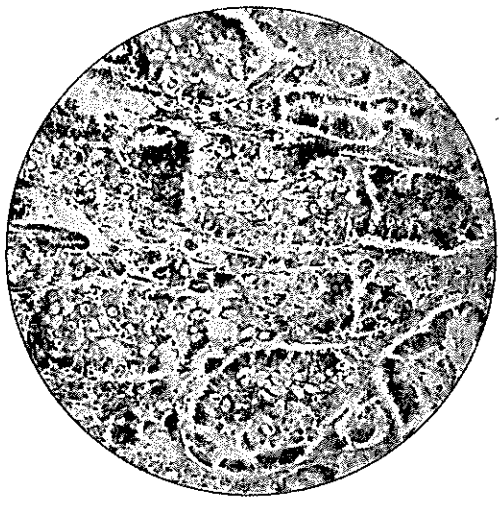

Fig. 3. Section from the jejunum of goldeneye. The crypts of Lieberkühn are filled with coccidia (*Eimeria bucephalae*). Stained with iron trioxyhematin (van Gieson). Magnif. × 100.

changes the material was suitable but poorly for this purpose. The epithelium was largely detached or altogether absent, and the nuclei stained but poorly or not at all. The macroscopic, fairly well defined foci consisted chiefly in markedly dilated crypts of Lieberkühn, in which the epithelium had been lost and which now were filled with oocysts and masses of detritus (Fig. 3). Here and there the interglandular tissue was increased and contained an abundance of collagenic fibrils. In addition there was marked infiltration, among others, with leukocytes and eosinophils. In those areas where the mucous membrane was covered by diptheroid patches of exudate, it was largely necrotic. This necrotic tissue was filled with bacteria which had invaded the mucous membrane through the epithelium destroyed by the coccidia. No doubt, the diphtheroid inflammation was due chiefly to this secondary bacterial infection.

DESCRIPTION OF THE SPECIES

In addition to *Eimeria truncata* (Raillet & Lucet 1890), found in the kidneys of the domestic goose, KOTLÁN 1932—33 has described 3 other coccidial species, all occurring in the small intestine, especially the jejunum of the domestic goose, namely: *E. anseris*, *E. parvula* and *E. nocens*. The two firstmentioned are clearly different from our species, whereas *E. nocens* presents several points of resemblance. In the following, however, an account will be given of differences between *E. nocens* and our species.

The occurrence of coccidiosis, as mentioned above, has been observed also in the domestic duck, but no description of the parasites has been given. From other birds living in habitats in connection with water, 5 coccidial species are known: *E. paludosa* (Leger & Hesse 1922) from the coot (*Fulica atra*), moor-hen (*Gallinula chloropus*) and the American coot (*Fulica americana*) (Roudabush 1942); *E. urnula* (Hoare 1933) from *Phalacrocorax carbo-lugubris*; *E. meservei* (Coatney 1935) from *Sterna forsteri*; *E. polycephali* (Yakimoff &

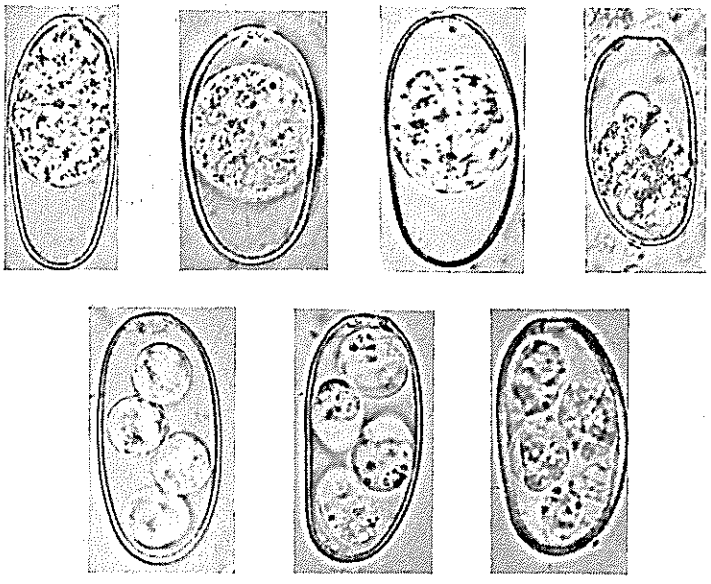

Fig. 4. Occysts of *Eimeria bucephalae*. Magnif. × 1000.

Matschoulsky 1939) (= *E. paludosa*?) from *Porphyrio poliocephalus seistanicus* and *E. roscoviensis* (Labbé 1893) from a number of waders, from *Phalacrocorax cristatus* and *Motacilla alba*. According to our present knowledge, the last-mentioned coccidial species is quite uncertain, its description being rather unsatisfactory, probably involving several species. The new species here presented differs clearly from all the above-mentioned in appearance as well as in size.

Eimeria bucephalae n. sp. (Figs. 1, 2 & 4).

The oocysts vary considerably in shape, although they are always longer than broad, mostly ovoidal, but sometimes with straight sides — or, one side may be indented, giving the oocyst the shape of a kidney. In transverse

section the oocyst is circular. A micropyle is almost always present, rather narrow. The oocyst shell is lightly brownish in color, finely sculptured. The sculpturation is visible only with the oil immersion objective. A few polar inclusions are seen within the micropyle. No residual body is formed within the oocyst. The four spores are rather stout, each containing a residual body. The protoplasm mass in the unsporulated oocyst is rather large, rounded, the surface beeing smooth.

The dimensions are as follows: Length 25—39 μ, mean 30.3 $\pm$ 0.2 μ, σ = $\pm$ 2.5 μ, the variation coefficient being 8.2. Width 13—20 μ, mean 15.6 $\pm$

Table 1.

Length and breadth of oocysts of Eimeria bucephalae *n. sp. Measuring unit 1.03 μ. The Roman numerals indicate the measurements known from* Eimeria nocens *Kotlán 1933. The figures in parenthesis give the shape index (length/breadth).*

Length → ↓Breadth	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	Number
13		I (1,92)		2 (2,08)	I (2,16)	I (2,23)		I (2,38)		I (2,54)						7
14		2 (1,78)	I (1,86)	5 (1,93)	2 (2,00)	II (2,07)	5 (2,14)	7 (2,22)	I (2,28)		I (2,43)	I (2,50)				36
15			4 (1,73)	6 (1,80)	8 (1,87)	10 (1,93)	10 (2,00)	5 (2,06)	5 (2,14)	I (2,20)	I (2,26)	4 (2,34)				54
16	I I (1,50)	I (1,56)	3 (1,62)	7 (1,69)	9 (1,75)	7 (1,81)	6 (1,87)	2 (1,94)	I (2,00)		3 (2,12)				I (2,38)	4II
17		I (1,47)	I (1,53)	2 (1,59)	4 (1,65)	5 (1,71)	I (1,76)	4 (1,82)		3 (1,94)	I (2,00)					2oII
18				2 I (1,50)	3 (1,55)	I (1,61)	3 (1,67)	3 (1,72)					I (2,00)			13I
19		I (1,32)		I (1,42)	I (1,47)	3 I (1,53)	I (1,58)	I I (1,63)	3 (1,68)			I (1,84)				8VI
20					I (1,46)				I (1,60)							1I
21									I (1,52)							I
22					I (1,27)											I
23		I (1,09)														I
Number	1 I	4 II	8 I	24 II	27III	38 I	25 I	23 I	11 I	5	6	6	1	0	1	180

0.1 μ, $\sigma = \pm$ 1.5, the variation coefficient being 9.5. The shape index (length/width) varies from 1.5 to 2.5, mean 2.0 $\pm$ 0.2, $\sigma = \pm$ 0.2, the variation coefficient being 15.0. The size of the spores is about 15 $\times$ 7 μ. The correlation coefficient between length and width of the oocyst is small, r = 0.16 $\pm$ 0.073, indicating that they vary rather independently. The infection occurs in the small intestine, giving in later stages round or elongated whitish processes, showing through the serosa. Sporulation commences within 4 days at room temperature. The host is the golden eye (*Bucephala clangula*).

From Table 1 it is evident that *E. nocens*, from the intestine of the domestic goose is a shorter and more stout form. The fine sculpturation encountered in our species has not been mentioned by KOTLÁN. So, provisionally, it seems justified to look upon the coccidia occurring in the jejunum of the goldeneye as a new species. Feeding experiments only can decide this question definitively (no control infection of goldeneye was practicable at that time). But the failure of the above-mentioned infection of the tufted duck makes it probable that here we really are dealing with a separate species. No doubt, a more thorough investigation of the coccidia in anatine birds will prove highly interesting.

SUMMARY

Description is given of a violent intestinal coccidiosis in young goldeneyes (*Bucephala clangula*), summering in Limfjorden (North Jutland). The dead birds were found to be markedly emaciated and suffering from severe, partly diphtheroid, inflammation of the small intestine. The intestinal contents and feces were found to contain enormous amounts of oocysts of a coccidium, *Eimeria bucephalae* n. sp., the morphological characters of which are given in the above description.

An experiment with feeding sporulated oocysts to a tufted duck (*Aythya fuligula*) turned out negative.

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(* not seen).

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