

ON THE FOOD HABITS  
OF  
THE DIVING DUCKS  
IN DENMARK

BY  
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### PREFACE

The present investigation of the food of Diving Ducks, occurring in Denmark, was carried out at Jagtfondens Vildtbiologiske Undersøgelser (Nørregade 10, Copenhagen, K.).

Several persons have helped to procure the ducks and the author wishes to express his sincerest thanks to all sportsmen who have provided material and in particular to Mr. Bøje Benzon, D. Sc., Mr. K. Christensen, Mr. Harry Madsen and Mr. Ludvig Svendsen.

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### INTRODUCTION

No detailed investigations on the food habits of the Diving Ducks in Denmark have previously been made, and our knowledge of the food habits of these birds in northwestern Europe is, upon the whole, based only on scattered and scanty records. In NAUMANN'S 'Naturgeschichte der Vögel Mitteleuropas' (2d. ed. 1905) some information is given on the diet of the Diving Ducks in the Baltic and the fresh-waters of Germany and Central Europe. In WITHERBY'S 'A Practical Handbook of British Birds' (2d. ed. 1924) summary information is given of what may be eaten by the Diving Ducks in Great Britain in marine as well as fresh-water habitats. COLLETT, in his 'Mindre Meddelelser vedrørende Norges Fuglefauna' (Notes on the birds of Norway) (1877-94) gives some records of the food of Diving Ducks in Norway; and other authors too have contributed—in scattered notes—to our knowledge of the food habits of the Diving Ducks in Europe.

The Eider alone has had its food habits more thoroughly studied on this continent. EVANS (1909) gave a detailed list of the food items found in the stomachs of 42 Eiders collected at the Orkney Islands, COLLINGE in his book 'The Food of some British Wild Birds' (2d. ed. 1924-27) statistically analysed the stomach contents of 24 Eiders, and SOOT-RYEN (1941) thoroughly discussed the food of the Eider as it appeared from stomach analyses of 44 specimens of all ages collected in most northern Norway.

Outside Europe the food habits of the Diving Ducks, however, have been studied in detail in North America, where COTTAM in 1939 published the results of an investigation on the almost 7,000 stomach contents of about 20 different species, which during a number of years had been collected by the Biological Survey, U.S. Dept. of Agriculture. Some of the species treated in this report are the same as, or only subspecifically different from those occurring in Denmark; and COTTAM'S report, therefore, more clearly showed what a study of stomach contents of Danish Diving Ducks might reveal than did the scanty records in the European literature.

#### Material.

The present survey of the food habits of the Diving Ducks in Denmark is based on analyses of the stomach contents, including both gizzard and gullet,

of 2,307 birds collected mainly in the years 1940-43. The material comprises—apart from a single King Eider (*Somateria spectabilis* (L.)) and a few Redcrested Pochards (*Netta rufina* (Pall.))—the 8 species common in Denmark, viz.

Common Eider (Danish: Ederfugl), *Somateria mollissima mollissima* (L.)  
 Common Scoter (Danish: Sortand), *Melanitta nigra nigra* (L.), (*Oidemia n.*)  
 Velvet Scoter (Danish: Fløjlsand), *Melanitta fusca fusca* (L.), (*Oidemia f.*)  
 Longtailed Duck (Danish: Havlit, amr.: Old Squaw), *Clangula hyemalis* (L.)  
 Golden-Eye (Danish: Hvinand), *Bucephala clangula clangula* (L.)  
 Tufted Duck (Danish: Troidand), *Aythya fuligula* (L.), (*Nyroca f.*)  
 Scaup (Danish: Bjergand), *Aythya marila marila* (L.), (*Nyroca m.*)  
 Pochard (Danish: Taffeland), *Aythya ferina ferina* (L.), (*Nyroca f.*)

Apart from the Pochard these species have a northern (arctic) distribution. In Denmark they occur mainly as winter-visitors or passage-migrants, only the Pochard, and the Eider, and to some extent also the Tufted Duck occur also as nesting birds. Young birds of all the species may, however, be met with as summer-visitors.

The Pochard is typically a fresh-water bird which also here in Denmark, even as a passage-migrant or winter-visitor, stays mainly on fresh-water or at any rate in fjord areas with much vegetation. Also the Tufted Duck breeds in Denmark in fresh-water habitats and may also as a winter-visitor often stay in large flocks on the inland lakes as long as they are free from ice. Otherwise the Diving Ducks in Denmark are almost exclusively maritime, the less skilled divers staying near the coasts, the more skilled ones, as the Eider, the Scoters, and the Longtailed Duck, often well out to sea.

The birds for this investigation—in accordance with the occurrence of the Diving Ducks in Denmark—were collected almost exclusively in the winter months and were mainly obtained in marine habitats, partly fairly salt ones in the Kattegat area, partly more brackish ones in the Baltic area and the Sound. A smaller part was obtained in fjord areas, especially the Ringkøbing fjord area, and several birds collected here had apparently fed, besides in the brackish-water localities also in the fresh-water localities of the area. Only a very small part of the examined stomach contents was from pronounced fresh-water localities.

The birds were shot by various hunters in the different areas, and detailed information of the conditions under which they were obtained has only been available in a few instances. What would have been of interest to know is, among other things, the hour at which the birds were killed, the feeding activity, if any,

previous to collecting, the depth at which the birds had been feeding, and the kind of foods at all available in the locality. The lack of such detailed information has, however, not been of much disadvantage in the present investigation which has dealt with a sufficiently large material to give a fair picture of the food habits in general of the Diving Ducks in Denmark. The casual method of obtaining the material for the investigation has involved, however, that several of the stomachs examined were empty, or contained only gravel or sand, and that rather many of the stomach contents were only small.

#### Method of investigation and representation of the results.

The birds were received intact at the Institute of Game Biology. Here the stomachs including the gullets were removed and their contents analysed, the various food items, as far as it was possible, identified, and the number of each food item and the sizes estimated.

In the beginning of the investigation the volumetric method employed by the U.S. Bureau of Biological Survey—and used in the representation of the results in COTTAM'S 'Food Habits of North American Diving Ducks'—was used along with the numerical method. Soon, however, the volumetric method was abandoned since it became evident that this method of investigation could only be used with advantage for well filled stomachs. When the stomachs contain only the broken fragments of the calcareous or chitinous parts of molluscs and crustaceans, as did most of those available for the present investigation, the volumetric method—which moreover is very unhandy—in accuracy must be much inferior to the numerical method. The representation of the accumulated data therefore in this report has been based solely on the numerical method, in the summaries of the composition of the diet, however, with a slight correction for the average rôle played by the various foods in the mixed stomach contents.

In the following accounts the number of occurrences of each type of food within the material examined of each species of Diving Duck is stated. If the stomachs has been equally filled it would have been worth while to record also the total number of each kind of food found in all the examined stomachs of each species of bird, which numbers then might have been directly compared. Since the stomachs have been filled to such a varying degree and often have contained only a small amount of food remains such a way of representing the results would, however, have given a distorted aspect of the actual conditions. Food items, which accidentally were present in a great number in a single well filled stomach, i. e. of a bird collected immediately after having gorged itself with this particular kind of food, might be found in a much greater total number than

other kinds of food which are more regularly eaten but have only been represented in small quantities in the stomach contents. The figure indicating the number of occurrences of a particular food item as the single stomach content is of interest since it is not much affected by the varying size of the stomach contents, and in the following this figure therefore has been recorded besides the number of total occurrences. The best way to represent the results would, of course, have been to record each stomach analysis, as done e. g. by SOOR-RYEN (1941) in his account of the food of the Eider in northern Norway. This could not, however, be done, but a number of analyses, partly selected at random and partly of stomach contents made up of especially many different items, have been recorded in extenso in the appendix.

In well filled stomachs each content represents a single meal, otherwise it may represent only part of a meal. However, each stomach content, whether small or large, has been regarded as a meal in the following discussion. The rôle played by the various food items in the composition of the individual stomach contents or meals is of essential interest besides the number of occurrences; some fairly frequently recorded foods may be of little value in the individual meals, e. g. some small snails, whereas other rarely recorded foods may form the major part of the meals in question, e. g. fishes. In the quantitative assessment of the food of the Diving Ducks in Denmark attempt has therefore been made of taking this factor into consideration for the major groups of foods, i.e. molluscs, crustaceans, etc. In computing the percentage ratio of the different foods in the composition of the diet that part of the material which comprised stomach contents of only a single type of food, i. e. meals drawn upon one particularly kind of food only, has first been considered. This part of the material would give identical results whether treated according to the numerical or to the volumetric method of analysis; and, as will appear from the following, stomach contents of only single food items have made up a fairly considerable part of the material available. In the remaining part of the materials, consisting of mixed meals, a slight correction has been made, before computing the percentage ratios, regarding the average importance of the different types of foods in the individual meals, whether, e. g. the particular food might be estimated to form half of the meals on average or perhaps one-third. It should be noted however that a computation based solely on the number of occurrences would have given only slightly different figures.

When computing the percentage ratios in a material as the present one, which largely consists of stomach contents which for some time have been subjected both to mechanical and chemical decomposition in the stomachs, a certain error must be allowed for, because the various food items may resist this treat-

ment to a varying degree and therefore remain identifiable in the stomachs for a varying length of time. Food items without any hard parts, which may remain identifiable in the stomachs, are much too rarely recorded; and foods which quickly become disintegrated into fragments small enough to pass out into the intestine, as small soft-bodied crustaceans and bivalves, are too rarely recorded in comparison with foods which may resist the trituration in the gizzard for a long time, e. g. the strong chitinous claws of crabs or the chitinous jaws of rag-worms. A larger material of well filled stomachs and gullets would therefore have been desirable, and would also have given a more reliable picture of the ratio between crustaceans and molluscs in the diet of those species of Diving Ducks which feed extensively on small soft-bodied crustaceans than may have been the case in the present investigation. On the other hand, the well filled stomachs which have been available seem to show that most of the food items which are generally eaten by the Diving Ducks in Denmark have parts which, at any rate for some time, remain identifiable in the stomachs.

It should be borne in mind, however, that an investigation as the present shows primarily what food items at all are acceptable for the species studied, and, secondly, what items are preferred. The quantitative assessment of the diet of the various species must necessarily be of a low order of accuracy. It is absurd to hold that such and such a species subsists on for instance 50.4 % of such and such a food, even if such a percentage has been computed on the basis of even a very large material, and when COLLINGE (1924-27) on the basis of materials of often less than half a score of stomach contents without comments records the composition of the diet to two places of decimals he certainly overrates the accuracy of stomach investigations.

The present material of stomach contents was collected, as already pointed out, almost exclusively during the winter. Therefore it can not show any seasonal variation and consequently was treated as a whole in this respect. An attempt has been made, however, to discriminate between the different habitats from which the material was obtained, viz. salt-water habitats, open brackish-water habitats in the Baltic area, brackish-water habitats in fjord areas with vegetation, and fresh-water habitats; but a clear discrimination has not always been possible.

The stomach contents examined were all from adult birds.

## EIDER

*Somateria mollissima mollissima* (L.)

The Eider is a common winter-visitor in Denmark and occurs also in certain localities as a nesting species. It prefers the open sea and visits only seldom fjord areas. It is the largest of the Danish species of Diving Ducks and perhaps the most skilled diver among them. HØRRING (1919) states that it generally works at depths of 20 to 30 m or less, but that it may also collect its food on the bottom in depths of up to 60 m. Thus the Eider should be able to forage practically everywhere in the Danish waters. Probably, however, the depth for diving do not usually exceed more than 10-15 m.

## Material.

A total of 373 birds have been examined, but a rather considerable part proved to be without definite food remains. Half a hundred of these birds were collected at openings in the ice during a severe winter and may have eaten up the food obtainable within reach from the opening. Their stomachs were, however, not quite empty, a few contained traces of eelgrass (*Zostera*) and wrack (*Fucus*), one contained the remains of a hydroid colony, and usually they also contained a little gravel. These practically empty stomachs were ignored, however, and for the computation of the composition of the diet of the Eider then 296 stomach contents comprising a smaller or larger amount of food remains were available.

These 296 birds were collected from October to February and, a few, in April. The greater part of the material was obtained in January 1941. Marine localities in the Kattegat area furnished 261 birds, viz. Læsø (124 birds), Anholt (3 birds), Samsø (12 birds), Sejrobugt (112 birds), Kalundborg (9 birds), and Lillebælt (1 bird), and 35 birds were obtained in localities of more brackish water in the Baltic area and the southern part of the Sound, viz. Svendborg (1 bird), Drogden and Kalvebodstrand, near Copenhagen (11 birds), and Køgebugt (23 birds).

## The food in the Kattegat area (salt-water habitats).

Molluscs constitute the principal food of the Eider in the Kattegat area. They were taken by 222 of the examined birds (85.1 %) and formed the bulk of the content in most of the stomachs. 112 stomach contents (42.9 %) consisted solely of molluscs and 7 other comprised in addition only traces of barnacles, which were probably always taken incidentally along with the blue mussels.

Bivalves, as might be expected, supply the most important molluscan food. 205 of the Eiders (78.5 %) had consumed this kind of food, 71 of them (27.2 %)

had made their whole meal on bivalves, and 7 more had in addition only taken barnacles.

The Blue Mussel (*Mytilus edulis*) is by far the most important single food species of the Eider. 179 of the birds (68.6 %) had consumed this bivalve; 64 of them (24.5 %) had taken it as their sole food, and if the incidentally consumed barnacles are ignored then more than one-fourth of the Eiders (73 birds or 27.2 %) had fed exclusively on blue mussels. Blue mussels formed the principal part of the stomach contents also in many other instances. The size of the blue mussels eaten varies somewhat; individuals about 3-4 cm long seem to be preferred, but also much larger ones may be swallowed, and such of about 8 cm length have been recorded in the stomachs at hand. Many blue mussels not more than about 1 mm long have also been taken, in which cases, however, the Eiders must usually have foraged in places where large numbers of mussels might be shovelled up at a time. The number of blue mussels in the stomach contents naturally varies with the extent to which the stomachs have been filled, and it was usually difficult to estimate because the shells were crushed. Great quantities of blue mussels have, however, often been taken at a single meal. One Eider shot immediately after having foraged thus was found to have gorged itself on about 1,600 specimens of blue mussels, varying in size from about a few mm til about 20 mm, and in addition this bird contained some fragments of larger blue mussels, 15 small crabs (*Carcinus maenas*) of up to 20 mm breadth of carapace, and the remains of 6 small common sea-stars (*Asterias rubens*).

Cockles (*Cardium spp.*) are next to the blue mussels the bivalves most frequently taken by the Eider, but in relative importance as a source of food they rank far below that species; and they are also of less importance than both the periwinkles, the dog whelk, the shore crab, and the common sea-star. Cockles were eaten by 30 of the Eiders (11.5 %) and in 6 instances (2.3 %) they were the sole kind of food taken. The Common Edible Cockle (*Cardium edule*) has been the most frequently recorded species, being found in 27 of the stomach contents at hand, of which 26, however, belonged among the 124 Eiders obtained at Læsø. The number of common cockles in each stomach usually was only one or a few, the largest number recorded was about 20 individuals one of which measuring 15-20 mm whereas the others were only 3-7 mm large. None of the common cockles eaten has been much larger than about 20 mm. Another species of cockle (*Cardium nodosum*) was consumed by at least three of the examined Eiders; one of them, collected at Samsø, had made its meal on no less than 4,000 individuals of about 8 mm, altogether amounting to about 150 ccm, whereas two of the birds from Læsø had taken single individuals.

Table 1.

Frequency of occurrences of the more common food items in the examined stomach contents of Danish Eiders (*Somateria mollissima mollissima*).

| Food items                                      | Salt-water localities in the Kattegat area |   | Localities of low salinity in the Baltic area (including the Sound) |   |
|---|--|---|---|---|
|   | 261 birds                                  |   | 35 birds  |   |
|   | Number of birds in which present           | Number of birds in which solely present | Number of birds in which present                                    | Number of birds in which solely present |
| <i>Mollusca</i> .....                           | 222 (85.1%)                                | 112 (42.9%)                             | 26 (74.3%)  | 14 (40.0%)                              |
| Bivalvia .....                                  | 205 (78.5%)                                | 71 (27.2%)                              | 25 (71.4%)  | 13 (37.1%)                              |
| <i>Mytilus edulis</i> .....                     | 179 (68.6%)                                | 64 (24.5%)                              | 24 (68.5%)  | 13 (37.1%)                              |
| <i>Cardium</i> spp. ( <i>edule</i> )* .....     | 30 (11.5%)                                 | 6 (2.3%)                                | 1 (2.9%)  | —                                       |
| <i>Mya</i> spp. ( <i>truncata</i> ) .....       | 14 (5.4%)                                  | 2 (0.8%)                                | —   | —                                       |
| <i>Spisula</i> spp. ....                        | 13 (4.9%)                                  | —                                       | —   | —                                       |
| Gastropoda .....                                | 114 (43.7%)                                | 19 (7.3%)                               | 2 (5.7%)  | 1 (2.9%)                                |
| <i>Littorina</i> spp. ( <i>littorea</i> ) ..... | 58 (22.2%)                                 | 11 (4.2%)                               | 1 (2.9%)  | —                                       |
| <i>Nassa</i> spp. ( <i>reticulata</i> ) .....   | 45 (17.3%)                                 | 3 (1.1%)                                | 1 (2.9%)  | 1 (2.9%)                                |
| <i>Buccinum undatum</i> .....                   | 22 (8.4%)                                  | 4 (1.5%)                                | —   | —                                       |
| <i>Crustacea</i> .....                          | 101 (38.7%)                                | 12 (4.6%)                               | 2 (5.7%)  | 1 (2.9%)                                |
| <i>Carcinus maenas</i> .....                    | 80 (30.7%)                                 | 12 (4.6%)                               | —   | —                                       |
| <i>Balanus</i> spp. ....                        | 24 (9.2%)                                  | —                                       | —   | —                                       |
| <i>Eupagurus bernhardus</i> .....               | 7 (2.9%)                                   | —                                       | —   | —                                       |
| <i>Gammarus</i> spp. & <i>Idothea</i> spp. .... | 8 (3.0%)                                   | —                                       | 2 (5.7%)  | 1 (2.9%)                                |
| <i>Echinodermata</i> .....                      | 76 (29.1%)                                 | 5 (1.9%)                                | —   | —                                       |
| <i>Asterias rubens</i> .....                    | 70 (26.8%)                                 | 4 (1.5%)                                | —   | —                                       |
| Echinoids .....                                 | 9 (3.3%)                                   | —                                       | —   | —                                       |
| <i>Pisces</i> .....                             | 7 (2.7%)                                   | 1 (0.4%)                                | 19 (65.3%)  | 6 (17.1%)                               |
| <i>Gasterosteus aculeatus</i> .....             | 2 (0.8%)                                   | —                                       | 16 (45.4%)  | 5 (14.3%)                               |
| <i>Clupea harengus</i> .....                    | —  | —                                       | 4 (11.4%)   | 1 (2.9%)                                |
| Spawn of fish .....                             | 5 (1.9%)                                   | —                                       | 2 (5.7%)  | —                                       |
| <i>Annelida</i> .....                           | 4 (1.4%)                                   | —                                       | —   | —                                       |

\* In parenthesis is indicated the most important species.

Clams or Gapers (*Mya* spp.) also seem to be of some importance as food for the Eider. Fourteen of the birds (5.4%) of which 13 were obtained in the Læsø area, had consumed these bivalves. When identification was possible the species always proved to be *Mya truncata*. In half the cases the Myas taken were small, with shells of only a few mm to at most a few cm long, but 6 of the Eiders had swallowed individuals of *Mya truncata* with a length of shell of 4 to 6 cm. Two of the Eiders had made their entire meal upon 5 and 7 large Myas respectively. In one instance the detached siphon of a fairly large individual was the only remains of the *Mya* present in the stomach content.

The large individuals of *Mya truncata* are burrowed fairly deep into the bottom, and beforehand it was not to be expected that the Eiders could reach them. Five of the six Eiders which had taken large Myas were obtained from one foraging flock. It may be guessed therefore that exceptional conditions have prevailed in the locality, and that the large Myas have been accidentally exposed, either, for instance, during a severe storm with the waves reaching down to the bottom and stirring up the sand covering the Myas, or perhaps by the propelling of a passing ship. The single, detached siphon found in one stomach might evidence that the Eiders are able to pull out the Myas by means of the siphon, which then occasionally might be torn off. It is more probable, however, that this detached siphon is the remains of a dead individual which during the process of decaying had been separated from its shells, as discussed in more detail p. 196.

*Spisula* spp. is another type of clam eaten by a fair number of the examined Eiders. *Spisula subtruncata* was found in 10 birds from Læsø, and *Spisula solida* in two birds from Læsø and in one from Sejro-bugt. One individual of *Spisula solida* was 22 mm long, but otherwise the *Spisulas* taken were small. They were never found in more than small numbers in the stomach contents.

Of the other bivalves eaten by the Eiders examined, none was present in more than 1-3 stomachs, and the said species, *Cyprina islandica* (3 birds), *Modiola modiolus* (2 birds), *Modiolaria* sp. (1 bird), *Venus gallina* (2 birds), *Macoma calcarea* (1 bird), *Astarte elliptica* (1 bird) and *Corbula gibba* (1 bird), seem of no appreciable importance in the diet in general of the Eider in Denmark. They may, however, be of great importance in individual meals. A single specimen of *Macoma calcarea* thus supplied the sole food in an Eider from Læsø; one bird from Lillebælt had made its entire meal on 3 large individuals of *Cyprina islandica*, 40 to 52 mm in length; 10 specimens of the rather small *Corbula gibba* formed the bulk of the stomach content of a bird from Sejro bugt; and 7 *Astarte elliptica* supplied the major part of the meal of another bird from the same locality.

Gastropods ranked in importance as food for the Eider in the Kattegat area next after bivalves. 114 of the birds (43.7 %) had made a smaller or larger part of their meal on various gastropods; 19 of them (7.3 %) had fed exclusively on this food, and 2 other birds contained in addition only single individuals of barnacles.

Periwinkles (*Littorina spp.*) had been consumed by 58 of the Eiders (22.2 %) and were the sole article of food present in the stomachs in 11 instances (4.2 %). The Common Periwinkle (*Littorina littorea*) is by far the most frequently identified species and may have been present in all the 58 stomachs, in 3 stomachs, however, also the Flat Periwinkle (*Littorina obtusata*) was found. Usually, only a single or a few individuals of periwinkles were present in each stomach, and the greatest number recorded in one meal was about 20 individuals of 4 to 10 mm. The largest periwinkles eaten have measured about 25 mm, most, however, have been much smaller. In some instances, the periwinkles recorded in the stomach contents have been only shells housing hermit crabs.

Dog Whelks (*Nassa spp.*) had been taken by 45 Eiders (17.3 %). In several cases they formed a major part of the meal and in 3 instances they were the sole food. The species usually eaten is *Nassa reticulata* (44 birds or 16.9 %), only in one instance was the species *Nassa pygmaea* recorded. The greatest number of dog whelks from any single meal was 27 individuals which formed the bulk of the stomach content in question. The largest individuals eaten have measured about 27 mm and fairly large specimens have, on the whole, been the usual in the stomachs.

The Common Whelk (*Buccinum undatum*) had been taken by 22 of the birds (8.4 %), 4 of which had made their entire meal on this species. The largest of the common whelks swallowed measured about 5 cm, the smallest recorded are juvenile specimens of about 7-9 mm. In at least one instance a mass of egg-capsules had been consumed, remains of the chitinous capsules being present in the stomach in addition to fragments of juvenile individuals; and perhaps masses of egg-capsules have been eaten also in other cases where juvenile common whelks are present in the stomach contents. The larger individuals have been taken only in a number of 1 or 2 in each meal, but as many as 10 of the juvenile individuals might be included in one meal. Also a few of the common whelks recorded were only shells housing hermit crabs.

Another whelk, *Neptunea antiqua*, had been eaten by 4 Eiders, from Kalundborg, Samsø, and Sejro-bugt respectively, in one instance a single individual of about 4 cm as the major part of the meal, in the three other instances juvenile individuals in a number of up to 6 per meal.

Several other species of gastropods have been recorded in the stomachs of

the Eiders examined, but none of them have been of any appreciable importance. Some of the small species (*Hydrobiids* and *Rissoids*) have probably also been consumed incidentally along with other food. The species in question are: *Hydrobia spp.* (6 birds), *Bittium reticulatum* (4 birds), *Rissoa membranacea* (3 birds), *Rissoa inconspicua* (2 birds), *Rissoa sp.*, *Aporrhais pes-pellicani*, *Lunatia nitida*, *Turritella sp.*, *Gibbula sp.*, *Lacuna divaricata*, and *Cylichna sp.*, all taken in one meal each.

The Coat of Mail Snail (*Boreochiton marmoreus*) has finally been recorded from two stomach contents.

Crustaceans were present in 101 (38.7 %) of the Eiders at hand from the Kattegat area. In 15 instances the crustaceans were only one or a few barnacles taken incidentally along with blue mussels, but although these be ignored no less than 86 birds (33.0 %) had made crustaceans a smaller or larger part of their meal, and 12 birds (4.6 %) had taken no other food.

The Common Shore Crab (*Carcinus maenas*) is the most frequently consumed crustacean in the Kattegat area. In the diet of the Eider here this species seems to rank next in importance after the blue mussel, only the common sea-star (*Asterias rubens*) being of about equal value. In all, 80 of the Eiders examined (30.7 %) had caught shore crabs, and 12 of them (4.6 %) had fed exclusively on this food. The number of crabs taken at a single meal has varied from one to at least a dozen. The largest individuals consumed have had a breadth of carapace of about 6 cm; and one bird contained the remains of 5 such large crabs. Usually, however, the crabs taken have been smaller, with a breadth of carapace of about 20-30 mm; and many of the specimens eaten have been but small ones with a breadth of carapace of less than 10 mm.

There is some uncertainty regarding the assessment of the importance of the larger crustaceans, e. g. crabs, in the diet of the Eider as compared with the importance of the molluscan food. The strong, chitinous claws of the larger individuals or crabs seem very resistant to the trituration in the gizzard and probably remain in the stomachs for a longer time than the shells of molluscs, which may be more easily and rapidly disintegrated into fragments small enough to pass out into the intestine. Remains of crabs were found e. g. in 47 of the 124 Eiders available from Læsø and only in 20 of these Eiders were more than the claws present.

Other crabs eaten by the Eiders from the Kattegat area include Spider Crabs (*Hyas araneus*), consumed by 4 birds from Læsø, in numbers from 1 to 3 large specimens with a length of carapace about 55 mm, and Swimming Crabs (*Portunus spp.*), taken in single individuals by 3 birds.

Hermit Crabs (*Eupagurus bernhardus*) had been taken by 7 of the Eiders



(2.9 %). In 3 instances they were found intact in their houses, *Littorina* shells, 15 and 25 mm large, and a shell of a small *Aporrhais*. Also other stomachs contained remains of gastropod shells which might have served as houses for the hermit crabs present, as shells of *Littorina*, *Nassa*, and, in one instance, of *Buccinum*. One stomach, however, contained remains of a large hermit crab (pincers), but no trace of any gastropod shell which it might have inhabited. This evidence how the more strongly chitinous parts of the skeleton of large crustaceans may be more resistant to the treatment in the gizzards than the calcareous shells of molluscs.

Other comparatively large crustaceans found in the examined stomach contents were the Common Shrimp (*Crangon vulgaris*), taken by two birds, and the Squat Lobster (*Galathea strigosa*), taken by one bird.

Barnacles (*Balanus* spp., cf. *crenatus* and *balanoides*) were present in 24 of the examined stomachs (9.2 %), but at most only in a number of a few in each. In the present material they always appear to have been taken incidentally along with certain molluscs, blue mussels and periwinkles. Barnacles are known, however, to be purposely sought by Diving Ducks in some instances. Thus COTTAM (1939 p. 118) records a meal made by a White-winged Scoter on more than 100 large barnacles.

Smaller crustaceans were present in 8 of the stomachs (3.0 %), viz. Isopods, exclusively *Idothea* spp., in 5 stomachs, and Amphipods, probably always *Gammarus* spp., in 3 stomachs. These small crustaceans were never present in more than 1 to 2 individuals per stomach content, and probably they have been consumed incidentally or adventiously along with other food.

Echinoderms form a regular part of the diet of the Eider in the salt-water habitats. They were consumed by 76 of the birds at hand (29.1 %) and formed the entire meal in 5 instances (1.9 %).

The Common Sea-star (*Asterias rubens*) is by far the most frequently taken echinoderm; and in the diet of the Eider in the Kattegat area this species is of an importance equalling that of the shore crab, second only to the importance of the blue mussel. In total 70 of the Eiders (26.8 %) have consumed sea-stars, and in 4 instances such supplied the entire meal. Usually it was not possible to state the numbers of sea-stars in the stomachs, since generally only a heap of skeletal remains was present. One Eider, however, had made its meal on at least 10 sea-stars and probably some more, all about 3-4 cm in diameter, but usually only one or a few individuals seem to have been taken in each meal. The largest sea-star found relatively intact in the stomachs was about 7 cm in diameter, but judging from the skeletal remains much larger specimens may have been swallowed in some instances.

Sea-Urchins (*Echinoidea*) supplied part of the food of 9 of the Eiders examined (3.3 %). Regular Echinoids were taken by 7 birds, usually *Strongylocentrotus droebachiensis*, as large as 4 cm in diameter, and in one instance a small *Psammechinus miliaris*. Irregular Echinoids, always the Heart-Urchin (*Echinocardium cordatum*), were taken by 4 birds. One bird had included individuals of both *Echinocardium* and *Strongylocentrotus* in its meal.

Brittlestars (*Ophiuroidea*) were noted in single individuals in 3 stomach contents, the species are *Ophiothrix fragilis*, *Ophiura texturata*, and *Amphiura* sp.

Polychaetes were recorded from 4 stomachs only, in two instances the jaws of Rag-Worms (*Nereis* spp.), in one instance the jaws of a Scale-Worm (*Polynoinae*), and in one instance bristles, probably of *Pectinaria*.

Fishes had been eaten by 7 of the examined Eiders from the Kattegat area (2.7 %), and 1 bird had made its meal entirely on this kind of food. The fishes taken were small Codfish (*Gadus morrhua*) in 3 instances, Gobies (*Gobius* sp.) also in 3 instances, Threespined Stickleback (*Gasterosteus aculeatus*) in one instance; and in another instance only unidentifiable traces of fish bones were found. The Eider which had made its meal on fish alone had included in it all the three identified species, one individual of each, and may perhaps have specialized on catching this kind of food. Fish, as it is discussed in more detail below, must, however, be considered forming a regular though insignificant part of the diet of the Eider.

Spawn of fish. - 5 Eiders collected in one locality at Læsø had foraged on a spawning ground of fish and consumed great quantities of eggs, several thousands in one of the meals represented.

Other animal items found in the stomachs are traces of hydroid colonies in a few instances and of a polyzoan colony in one instance. These items were probably taken accidentally.

Vegetable matter was recorded from about 10 % of the stomachs, but never in greater quantities than traces. It was mostly very small bits of Red Algae (about 1 mm) and only in a few instances very small quantities of Wrack (*Fucus*) and Eelgrass (*Zostera*). Undoubtedly, these items had always been taken accidentally along with other food, e. g. growing on the blue mussels eaten. The vegetable matter, however, though not taken purposely, can not be denied some value in the diet of the bird.

The composition of the food of the Eider in the marine habitats in the Kattegat area as shown by the present investigation is as follows: Molluscs about 67 % (Bivalves about 54.5 % and Gastropods about 17 %), Crustaceans about 17 %, Echinoderms about 15 %, Fishes less than 2 %, and Polychaetes less than 1 %.

The most important single food item in the area is by far the Blue Mussel (*Mytilus edulis*), accounting for about one-third of the diet of the Eiders here, and next in order come the Common Shore Crab (*Carcinus maenas*) and the Common Sea-Star (*Asterias rubens*), each accounting for about one-sixth of the diet, and far behind these follow the Periwinkles (*Littorina spp.*) and the Dog Whelks (*Nassa spp.*), together forming about one-tenth of the diet. The remaining one-fifth of the food is supplied by a large variety of animal species of which the more prominent are the Cockles (*Cardium spp.*), Clams (*Mya spp.*), and the Common Whelk (*Buccinum undatum*). None of the other food species recorded have been of much importance in the Eider's food in general, though they may have formed the bulk of individual meals.

The food in the southern Sound and the Baltic area  
(open brackish-water habitats).

The Blue Mussel (*Mytilus edulis*) supplies also in this area a very important part of the food of the Eider. All the 12 birds obtained from Kalvebodstrand, Drogden, and Svendborg had subsisted solely on this species, and 12 of the 23 birds available from the Køge-bugt had likewise taken blue mussels, though only in one instance as the sole food.

Molluscs in total formed food for 14 of the 23 Eiders obtained in Køge-bugt, viz. Blue Mussels taken by the said 12 birds, one of which had also taken a single Periwinkle (*Littorina littorea*); a few Cockles (*Cardium spp.*) taken by 1 bird, and a single Dog Whelk (*Nassa reticulata*) as the only food item in 1 stomach.

Fish, however, had supplied the principal food for the Eiders collected foraging in Køge-bugt, January 11, 1941. No less than 19 of them (more than fourth-fifth of the birds at hand) had fed on fish, primarily the Threespined Stickleback (*Gasterosteus aculeatus*), which had been consumed by 16 birds in up to about 10 individuals at a meal, but also Herring (*Clupea harengus*) of which four birds had taken a single individual each, and Eel (*Anguilla anguilla*) of which a small individual had been taken by one bird. Two of the Eiders had also consumed a quantity of fish spawn. Fishes formed in six instances the entire stomach content, and in two other instances the content consisted only of sticklebacks besides the fish spawn mentioned.

The only other food found taken by the Eiders available from Køge-bugt were Crustaceans, one bird having taken some fifty amphiods (*Gammarus zaddachi*) in addition to blue mussels, and another having made its whole meal on some isopods (*Idothea balthica*) and a few *Gammarus*.

Fishes are stated in the literature to be included in the diet of the Eider, but there seem to be no definite record to the effect that living fishes have been caught. COLLETT (1894 p. 283) is of the opinion that the Eider no doubt takes fishes when possible, and says that the bird (in Norway) is stated to take young cod in particular. COLLETT, however, also records how Eiders have been observed diving into shoals of young herring without paying attention to the living fishes and only collecting dead ones or other food on the bottom; he says that the fishermen usually deny that the Eider takes living fishes; and he finally says that it seems to appear from the available accounts that fishes are not a normal or daily food for the Eider.

COTTAM (1939) records fish as taken by no less than 7 of the 11 examined Northern Eiders (*Somateria mollissima borealis*), whereas fishes were only taken by 2 of the 96 examined American Eiders (*Somateria mollissima dresseri*).

HOLBØLL (1843 p. 87) states that he himself has never found fish remains in any of the stomachs of Eiders which he had opened (in Greenland) though sometimes spawn of fish, but that he has received information of repeated finds of Fatherlashers (*Cottus*) in Eiders from Frederikshaab, S.W. Greenland.

COLLINGE (1924-27) records fish as 5 volumen percent of the food found in the 24 Eiders from Great Britain examined by him.

It is probable that many of the fishes consumed by the Eider were dead or in other ways immobilized individuals. Dr. PALUDAN has thus told me that the fishermen on Bornholm, where Eiders are fairly common also near the coasts, sometimes complain of the Eiders taking fishes out of their nets. — But, on the other hand, there is every indication that the Eider may also catch living fishes, otherwise fishes probably would not have been so regularly found in the stomach contents as has been the case. Presumably, however, fishes are fed on mainly when or where other more acceptable food, as for instance molluscs, is scarce or missing; and probably this has been the case for the Eiders at hand from the Køge-bugt, inasmuch as also the crustaceans included in the food here were such that are not normally eaten by the Eider, being of a size below that which this Diving Duck apparently considers most appropriate for its food.

The composition of the food of the Eiders examined from the Sound and the Baltic can be given as follows: Molluscs about 58 % (Bivalves about 52 % and Gastropods about 6 %), Pisces about 37 %, and Crustaceans about 4-5 %. These percentage ratios, however, certainly do not apply to the diet in general of the Eider in this area. The material available for computing food percentages (only 35 stomach contents) has been much too small to eliminate the effects of the 19, probably fairly unusual meals on fishes. In the diet of the Eider in the Baltic, molluscs, and especially the blue mussel,

must be as prominent as in the diet of the other large maritime Diving Ducks, and thus probably constituting the dominant source of the food, since crabs and sea-stars, which were the principal other food items in the Kattegat area, do not occur here. Isopods and amphipods may be expected to be of relatively higher importance in the Baltic than in the more salt areas with a greater variety of food items to choose among. SEGERSTRÅLE (1947) in a single but well filled stomach of an Eider from the inner Baltic also found isopods (*Mesidothea entomon*) as the major part of the content while the remaining part was made up of some baltic clams (*Macoma baltica*). Also HOLLBØL (1843) records amphipods as part of the food of the Eider (in Greenland), but taken rarely in comparison with molluscs, crabs, and sea-urchins.

Gravel and small stones, always rounded and usually about 7–10 mm in diameter, were present in most of the stomachs examined, but often in single numbers and rarely more than about ten per stomach. One of the Eiders was found, however, to have in its stomach no less than 50–75 small stones besides a quantity of fine gravel, which, however, may have been swallowed incidentally in the gathering of the fish spawn on which the bird had mainly fed. The largest stone found in any stomach was 19 mm in diameter. Pebbles and gravel were often found in otherwise empty stomachs, but were missing in many stomachs containing remains of meals.

#### Remarks

The food habits of the Eider—as mentioned in the introduction—have previously been studied, in a few instances also quantitatively analysed. The results of the present investigation therefore are not unexpected; but crabs and in particular sea-stars are found to be more important as food for the Eider in Denmark than might have been suspected. SCHIØLER (1925 p. 199) thus states that in more than a hundred Danish Eiders examined he never found other food remains than bivalves and gastropods, but he has probably overlooked the crabs and sea-stars the remains of which usually are inconspicuous in comparison with the shell fragments of the molluscs.

All authors agree that molluscs form the principal food of the Eider, and everywhere in marine habitats blue mussels appear to be one of the most prominent food items. Blue mussels probably constitutes between 30 per cent and 60 per cent of the food of the Eider in general. In addition to molluscs most authors also record crustaceans as food items, especially crabs but also amphipods (FABER 1822 p. 69, HOLBØLL 1843 p. 87, etc.), and also echinoderms, especially sea-urchins, are often recorded.

Food items recorded in the literature, of other kinds than those found in the

present material, include sea-anemones (EVANS 1909)—a food item which also in Denmark may be of some importance, but due to the absence of any hard parts have small chances of being recorded in comparison with the other foods taken—further they include ascidians and alcyonarians (KRABBE 1907), cuttlefish (EVANS 1909, COTTAM 1939), and various insects (COLLINGE 1924–27, COTTAM 1939, SOOT-RYEN 1941, etc.). These items too are obtainable for the Eider in Denmark, but can form only an insignificant part of its food here.

All authors agree that vegetable food is of no importance, and it seems to be usually agreed that the very small quantities of algae and eel-grass which are fairly regularly found in the stomach contents have been taken only accidentally in the gathering of animal food items.

COLLINGE (1924–27) and COTTAM (1939) have published percentage ratios of the composition of the food of the Eiders examined by them, computed on the basis of the volumetric method of analysis. Their figures are reproduced in the accompanying table 2 for comparison with the percentages computed on the present material (on the basis of the numerical method of analysis with a slight correction for the average importance of the foods in the mixed meals, as described p. 163). Further, the table includes a computation of the composition of the food taken by the 23 adult Eiders examined by SOOT-RYEN (1941). It is noteworthy how excellent the information on the composition of the diet of the Eider derived from these different investigations agree.

The foods primarily taken by the Eider, blue mussels, crabs, and sea-stars, are immobile or only slow-moving species which live on the bottom and therefore are easily collected, the sea-stars e. g. can be directly picked up, whereas blue mussels may have to be detached from stones etc. Other species eaten by the Eider, as the heart-urchin, clams, and cockles, may have to be ploughed up by the beak, but the individuals taken have probably never been more than superficially burrowed.

The Eider in general do not seem to recognize items smaller than about 1 cm as appropriate food, if other and larger food items are obtainable, unless the small items are present in such accumulations that they can be shovelled up in some quantity at a time. The largest bivalves recorded eaten by the Eiders examined were blue mussels of about 8 cm and clams with shells of 6 cm length or inclusive of the siphon up to about 10 cm. MILLAIS (1913 II p. 18) records, however, having seen an Eider taking a Razor-shell (*Ensis siliqua*) no less than 10 inches (about 25 cm) long and 3 inches in circumference; of course the bird could not swallow this bivalve entirely and half of it still stuck out of its beak when it was shot. The largest crabs swallowed by the Eiders at hand may inclusive of the legs have measured 15 (–20) cm and the largest of the fishes taken

Table 2.

The composition of the food of the Eider as computed in various investigations.

| Kind of food                        | Common Eider Denmark | Common Eider Great Britain | Common Eider Northern Norway | Northern Eider North America | American Eider North America |
|-------------------------------------|----------------------|----------------------------|------------------------------|------------------------------|------------------------------|
|                                     | 296 birds            | 24 birds Collinge 1924     | 23 birds (Soot-Ryen 1941)*   | 10 birds Cottam 1939         | 96 birds Cottam 1939         |
| Molluscs . . . . .                  | ca. 68 %             | 51.5 %                     | ca. 59 %                     | 70.34 %                      | 81.72 %                      |
| (Bivalves) . . . . .                | (ca. 51 %)           | (+)                        | (ca. 19 %)                   | (58 %)                       | (75 %)                       |
| (Gastropods) . . . . .              | (ca. 17 %)           | (+)                        | (ca. 40 %)                   | (12 %)                       | ( 7 %)                       |
| Crustaceans . . . . .               | ca. 15.5 %           | 24.5 %                     | ca. 26 %                     | 14.32 %                      | 6.85 %                       |
| Echinoderms . . . . .               | ca. 10.5 %           | 4.5 %                      | ca. 14 %                     | 3.32 %                       | 5.34 %                       |
| Pisces . . . . .                    | ca. 5.5 %            | 5.0 %                      |                              | 8.91 %                       | +                            |
| Annelida . . . . .                  | ca. 0.5 %            | 6.5 %                      |                              |                              |                              |
| Insects . . . . .                   |                      | 3.5 %                      |                              |                              | 2.20 %                       |
| Miscellaneous animal food . . . . . |                      |                            |                              | 2.48 %                       | 0.20 %                       |
| Vegetable food . . . . .            | +                    | 4.5 %                      | +                            | 0.63 %                       | 3.69 %                       |

\* This computation is based on the figures of SOOT-RYEN'S table VIII.

may have been of the same length. Food items of this size must of course be stored in the gullet until they become gradually triturated in the gizzard from the one end.

The conclusion to be drawn is that the Eider feeds on every kind of aquatic animals if only of a suitable size, from about 0.5-1 cm to about 10 cm, and regarding the smaller items if present in such accumulations that they shall not have to be picked up singly; further the food items must not be too mobile. The immobile molluscs which are easily crushed in its powerful gizzard therefore become the chief food of the Eider, whereas fishes are only rarely taken and then

always sluggish bottom forms (if not dead individuals). The Eider may dive and take its food at considerable depths, but forage probably mostly in water not deeper than 10-15 m, at which depths it may obtain all the food species recorded in the present material.

## COMMON SCOTER

*Melanitta nigra nigra* (L.).

The Common Scoter is an arctic species which in Denmark occurs exclusively but very commonly as a winter-visitor or passage-migrant. It mainly stays out to sea and is a skilled diver which can take its food at considerable depths. The present material thus includes some birds which are known to have foraged at depths of 20-30 m. DEWAR (1924) found that most of the dives which he observed were made at depths of 2-3 m and records as the greatest dive only 7 m; but according to other statements in the literature the usual feeding depth would seem to be about 10 to 20 m.

## Material.

A total of 301 Common Scoters have been examined, but a rather considerable number, collected during the winter of 1940-41, were starving birds with empty stomachs, so only 218 stomach contents were available for a study of the composition of the diet. These were from birds collected mainly in the years 1940 and 1941, during the months October to April, but chiefly January. They were obtained in the following localities: Sejrbøgt (102 birds), Kalundborg (4 birds), Samsø (16 birds), Allingåbro (28 birds), and Læsø (68 birds), all of which are salt-water localities in the Kattegat area; one bird was obtained at Rømø in the North Sea area; a few localities in the brackish Baltic area were represented, viz. Bornholm (6 birds) and Svendborg (2 birds); and a single fresh-water locality near Ringkøbing (1 bird).

The food in the salt-water habitats (the Kattegat area).

Molluscs are by far the principal food items. They have been included in nearly every meal examined, viz. 210 of the meals or 95.9 %; 165 birds (75.3 %) had fed exclusively on molluscs, and if the barnacles taken accidentally along with the blue mussels are ignored no less than 174 birds (79.4 %) have subsisted solely on molluscs.

Bivalves were found in 208 of the Common Scoters examined (95.0 %) and were the only food taken in 139 instances (63.5 %); if the accidentally included barnacles are ignored we get 148 meals (67.4 %).

The Blue Mussel (*Mytilus edulis*) was the most frequently recorded species, being present in 111 of the meals (50.7 %) and forming the entire meal of 63 birds (28.8 %); 6 meals included in addition only traces of barnacles; and blue mussels formed the major part of the meals also in other instances. The sizes of the blue mussels taken varied from about 3–5 mm to usually about 20 mm, but sometimes also individuals of 30–40 mm length have been swallowed.

Cockles (*Cardium spp.*) were the next frequently taken bivalves, and in the diet of the Common Scoters examined they were of an importance almost equalling that of the blue mussel. 93 of the birds (42.5 %) had fed on cockles, and 36 of them (16.4 %) exclusively. The most frequently identified species is the Common Edible Cockle (*Cardium edule*), which was present in 51 meals (23.3 %) and in 27 of them (12.3 %) as the sole food; but *Cardium nodosum* has been almost as frequently recorded, viz. from 45 meals (20.5 %) of which 9 (4.5 %) were made exclusively on this species. While *Cardium edule*, however, has been taken in several different localities, then *Cardium nodosum* had been almost exclusively taken by the Common Scoters available from the north-western Kattegat, in particular from Læsø in October 1940. In a few instances both species of cockles were included in the same meal. The number of cockles in each stomach content seldom exceeded 10. One bird was found to have 14 cockles in its gullet, and the remains of about half as many in its gizzard. The size of the cockles eaten varied from quite small specimens to some measuring about 15 mm.

Several other species of bivalves have been of importance as food for the Common Scoters from the Kattegat area. The Baltic Clam (*Macoma baltica*) was taken by 15 birds (6.8 %), in 4 instances as the sole food. The Clams (*Mya spp.*) were taken by 17 birds (7.8 %) and formed the entire stomach content in 3 instances; in general the Myas eaten were small ones with a length of shell of about 10 mm, only in one instance have the remains been recorded of a *Mya truncata* with shells about 4 cm. Usually it was impossible to identify the Myas to species, but besides *Mya truncata* also *Mya arenaria* appear to have been represented. Another clam, *Spisula spp.*, was consumed by 16 of the birds, viz. *Spisula subtruncata* by 15 birds (6.8 %) and *Spisula solida* by 1 bird. No meals were made exclusively on *Spisula*, but several comprised *Spisula* along with *Cardium nodosum* only. Finally, the clam *Venus gallina* was recorded in 11 stomachs (5.1 %) and in 2 of them (0.9 %) as the sole content.

The other bivalves recorded eaten by the Common Scoters examined only

supplied a small part of a single or a few meals, they are: *Nucula nitida* (3 meals), small *Cyprina islandica* (1 meal), *Saxicava arctica* (1 meal), and *Tellina sp.* (1 meal). Unidentifiable traces of small bivalves have further been recorded in a few instances.

Gastropods were consumed by 35 of the Common Scoters available from salt-water habitats (16.0 %) and supplied the entire meal in 2 instances (0.9 %).

The Dog Whelk (*Nassa reticulata*) was the most frequently recorded gastropod. 24 birds (10.9 %) had fed on this species, and several of them had made it a major part of their meal though none had taken it as the only food. The number of dog whelks in a single meal varied from 1 to 38 individuals. Usually only fairly small individuals of about 10 mm have been taken. In the diet of the Common Scoter the dog whelk ranks third in importance, only the blue mussel and cockles are more important, and only the tubeworms, *Pectinaria*, are of about the same value.

Periwinkles (*Littorina*) had been taken by 9 birds (4.1 %) of which 2 contained no other food. Only the Common Periwinkle (*Littorina littorea*) has been identified.

Of other gastropods only the small Hydrobias have been recorded from the Common Scoters examined. The one bird obtained at Rømø in the North Sea area had consumed a great many individuals in addition to a small quantity of blue mussel, and 2 other birds had taken a few individuals each.

Crustaceans have supplied a regular, though small, part of the food of the Common Scoters at hand. 24 stomach contents (10.9 %) included crustaceans, in 9 instances, however, it were only barnacles along with blue mussels and perhaps other molluscs; but 5 of the meals (2.3 %) consisted entirely of crustaceans. Mostly small species have been consumed. Crabs, the claws of a small *Carcinus maenas*, have been recorded only once, and so has the unidentifiable remains of a Shrimp (*Carididae*). Isopods (*Idothea spp.*), however, had been taken by 12 of the birds (5.5 %), single individuals were the sole food present in 5 instances, but one meal consisted of a very great number of *Idotheas* in addition to some blue mussels. Amphipods had been taken by 3 birds, in 2 instances probably *Gammarus sp.*, 1 and 2 individuals respectively, in the third instance a single *Caprella sp.* Barnacles were present, altogether, in 10 stomachs (4.6 %) but never in more than 1 or 2 individuals and, as already pointed out, were probably consumed accidentally or incidentally along with the blue mussels.

Annelid worms (*Polychaetes*) are likewise a constant food of the Common Scoter. In order of importance they may be compared to the crustaceans and in the present material they presumably supplied a greater part of the food

Table 3.  
Frequency of occurrences of the more common food items in the examined stomach contents of Danish Common Scoters (*Melanitta nigra nigra*).

| Food items                                    | Salt-water localities almost exclusively in the Kattegat area |   | Localities of low salinity in the Baltic |   |
|---|---|---|--|---|
|   | 219 birds   |   | 8 birds                                  |   |
|   | Number of birds in which present                              | Number of birds in which solely present | Number of birds in which present         | Number of birds in which solely present |
| <i>Mollusca</i> . . . . .                     | 210 (95.9%)   | 165 (75.3%)                             | 8 (100%)                                 | 6 (75%)                                 |
| <i>Bivalvia</i> . . . . .                     | 208 (95.0%)   | 139 (63.5%)                             | 8 (100%)                                 | 4 (50%)                                 |
| <i>Mytilus edulis</i> . . . . .               | 111 (50.7%)   | 63 (28.8%)                              | 8 (100%)                                 | —                                       |
| <i>Cardium</i> spp. . . . .                   | 93 (42.5%)  | 36 (16.4%)                              | —  | —                                       |
| <i>Mya</i> spp. ( <i>truncata</i> ) . . . . . | 17 (7.8%)   | 3 (1.4%)                                | —  | —                                       |
| <i>Macoma baltica</i> . . . . .               | 15 (6.8%)   | 4 (1.8%)                                | —  | —                                       |
| <i>Spisula</i> spp. . . . .                   | 16 (7.3%)   | —                                       | —  | —                                       |
| <i>Venus gallina</i> . . . . .                | 11 (5.1%)   | 2 (0.9%)                                | —  | —                                       |
| <i>Gastropoda</i> . . . . .                   | 35 (16.0%)  | 2 (0.9%)                                | 3 (37.5%)                                | —                                       |
| <i>Nassa reticulata</i> . . . . .             | 24 (10.9%)  | —                                       | —  | —                                       |
| <i>Littorina littorea</i> . . . . .           | 9 (4.1%)  | 2 (0.9%)                                | —  | —                                       |
| <i>Crustacea</i> . . . . .                    | 24 (10.9%)  | 5 (2.3%)                                | 2 (25.0%)                                | —                                       |
| Isopods & Amphipods . . . . .                 | 15 (6.8%)   | 4 (1.8%)                                | 2 (25.0%)                                | —                                       |
| <i>Balanus</i> spp. . . . .                   | 10 (4.6%)   | —                                       | —  | —                                       |
| <i>Echinodermata</i> . . . . .                | 9 (4.1%)  | 2 (0.9%)                                | —  | —                                       |
| <i>Asterias rubens</i> . . . . .              | 7 (3.2%)  | 1 (0.5%)                                | —  | —                                       |
| <i>Annelida</i> . . . . .                     | 28 (12.8%)  | 2 (0.9%)                                | —  | —                                       |
| <i>Pectinaria</i> spp. . . . .                | 26 (11.8%)  | 1 (0.5%)                                | —  | —                                       |

than these. 28 of the birds (12.8%) had remains of polychaetes in their stomachs, in 2 instances (0.9%) as the sole food remains. Tube-worms (*Pectinaria* spp.) were the most frequently recorded, from 26 meals among which the two consisting exclusively of polychaetes. Rag-worms (*Nereis* spp.) were recorded in 2 instances, and in one instance some bristles of another, unidentifiable polychaete were found. Usually the only remains of *Pectinaria* recorded in the stomachs are the stout, bright golden-yellow bristles of the forepart of the body; only in

one instance were some remains of the worms themselves as also fragments of the sand tubes found, but several other stomachs containing bristles of *Pectinaria* include considerable quantities of sand which no doubt in the main originate from the worm tubes. The only remains of *Nereis* recorded have been the jaws. It is evident that many polychaetes without such strong bristles or jaws as the species of *Pectinaria* and *Nereis* may be regularly eaten by the Common Scoter, but stand little chance of being recorded in a material as the present one. The other polychaetes possibly consumed, besides the very common rag-worms and tube-worms, can, however, be only of insignificant value for the diet of the bird.

Echinoderms were included in 9 of the examined meals (4.1%) and in 2 instances (0.9%) were the sole food taken. Seven birds, all obtained in a flock foraging in a locality near Sejrø, had to a great extent subsisted on the common sea-star (*Asterias rubens*), and 2 other birds had consumed heart-urchins (*Echinocardium cordatum*). Each of these echinoderms formed the entire meal in one instance.

Traces of Hydroids and Polyzoans, taken adventitiously or incidentally along with molluscs, were recorded in a few instances.

Vegetable matter has been recorded from 10–20% of the examined stomach contents, usually only traces of red algae and very rarely brown algae and sometimes eelgrass. In general the vegetable matter must have been obtained accidentally in the gathering of animal food, yet one of the Common Scoters, collected in January in Saltbækvig, Sejrø-bugt, appears to have purposely taken vegetable food since it had in its stomach a 40 mm long piece of leaf of eelgrass (*Zostera*). Among the 56 starving birds obtained from ice openings in Sejrø-bugt, all without animal food remains in their stomachs, 5 contained, in addition to gravel and small stones, also very small quantities of algae and eelgrass, which may have been taken adventitiously due to lack of animal items if not quite accidentally in the futile search for food.

Gravel and small stones were frequently present in the stomach contents, and were particularly frequent and numerous in stomachs without or with only small quantities of food remains. Among the 56 stomach contents of starving birds mentioned above only 12 were quite empty, all the other contained a varying quantity of gravel or small stones. Also sand was often found in the stomachs, but generally seem to have been derived from the tubes of *Pectinaria*.

The composition of the food of the Common Scoter in the marine habitats as expressed in percentages based on the present material is: Molluscs about 77% (Bivalves about 66%, and Gastropods about 11%), Polychaetes about 10%, Crustaceans about 9%, and Echinoderms about 4%.

About  $\frac{2}{3}$  of the total food consisted of the following four items: Blue Mussels (*Mytilus edulis*) about  $\frac{1}{4}$ – $\frac{1}{3}$  of the food, Cockles (*Cardium spp.*) about  $\frac{1}{5}$ – $\frac{1}{4}$  of the food, and Dog Whelks (*Nassa reticulata*) and Pectinarias each about  $\frac{1}{10}$  of the food.

The food of the Common Scoter in the open brackish-water areas of the Baltic may merely be suggested since not more than 8 stomach contents have been available. Blue Mussels (*Mytilus edulis*) were included in all the stomach contents, 4 of them consisting exclusively of this food. Gastropods were present in 3 stomachs, single individuals of *Neretina fluviatilis* in 2 instances and 5 Hydrobiids in 1 instance; a few individuals of *Gammarus* were recorded in 2 instances.

The food of the Common Scoter in fresh-water localities. – A single bird obtained in the Ringkøbing-fjord area in November is available for showing the tendency. It had made 50–60 Caddisfly larvae (*Phryganea*) the principal part of its meal and contained, in addition, traces of another, unidentifiable insect, besides three small stones.

#### Remarks.

The records on the food habits of the Common Scoter in the literature are few. In NAUMANN'S 'Naturgeschichte Vögel Mitteleuropas' the food is stated to be mainly molluscs, and to a smaller extent also worms, small fishes, insects, and vegetable matter. Blue mussels as large as 35 mm are recorded as the chief food. Of vegetable matter nodular roots supposed to be of *Polygonum amphibium* are mentioned. MILLAIS (1913 II p. 59) says that: 'the Common Scoter feeds principally on conchylia and to a lesser degree on sea and fresh-water worms, small fish, crabs, insects, and portions of water-plants. On the sea their principal food is the edible mussel, *Mytilus edulis*'. In WITHERBY'S Handbook (1924 p. 372) the food of the species is summarized as follows: 'At sea mainly mollusca, especially mussels (*Mytilus edulis*), also *Cardium*, *Solen*, *Margarita*, etc.', and as also recorded 'small crustacea (sandhoppers and shrimps)'. 'On freshwater, besides mollusca (*Anodonta*, etc.), worms, insects and small fish, and roots of water plants (*Potamogeton*, etc.)'.

GÄTKE (1891) has recorded the following instance which evidences how much the selection of the food depends on its availability: A ship with a cargo of the smaller grey horse-beans went aground near Heligoland whereafter the current dispersed the beans over a large area of the bottom at a depth of about 10

fathoms. A flock of more than a thousand Common Scoters then aggregated over this area—just as Diving Ducks will collect over beds of mussels—and subsisted for over a month exclusively on the beans.

The present investigation shows that the Common Scoter favours feeding on areas of sandy bottom where it takes immobile food species which can be directly collected on the bottom or in the most superficial layer, viz. cockles, various clams, dog whelks, isopods, and Pectinarias, the annelid worms characteristic of the sand bottom. The Common Scoter also consumes very large quantities of blue mussels, but probably does not seek them on the submerged reefs as did the Eider. Judging from the food species recorded during the present investigation the Common Scoter must in general feed at some depth, and feeding at depths from 10 m to more than 20 m seems to be usual.

The preferred size of the food items as regards the hard-shelled molluscs seems to be from about 1 cm (0.5–1 cm) to about 2 cm. The largest blue mussels swallowed by the Common Scoters here reported upon have been between 3 and 4 cm large, the largest clams about 4 cm, and such large ones have been recorded only exceptionally. The most often recorded worm, *Pectinaria*, measures about 7 cm in length.

Fishes were not found taken by any of the Common Scoters at hand, but are recorded as food in the literature. No doubt fishes must be taken as frequently as by its relative, the Velvet Scoter (4.2 % of the here examined Velvet Scoters had included fish in their meals), in particular when found in dead individuals. Whether living and healthy fishes are regularly caught by the Common Scoter may be doubtful.

The composition of the diet of the Common Scoter in the Baltic area is presumably the same as in the Kattegat area, i. e., consisting almost exclusively of molluscs. In fresh-water localities insects may be the principal food along with fresh-water molluscs, and, in addition, is here taken a quantity of plant food including vegetative growth, which may also sometimes be consumed in the marine habitats.

The food habits of the Common Scoter has not previously been subjected to statistical analysis, but COTTAM (1939) has given an account of the composition of the food of the three common North-American species of Scoters, based in part, however, on birds obtained in fresh-water habitats. His results are reproduced in the accompanying table 5, p. 194, for comparison with the results obtained during the present investigation on the Common Scoter and the Velvet Scoter. A short discussion is given p. 194 under the latter species.

## VELVET SCOTER

*Melanitta fusca fusca* (L.).

The Velvet Scoter is a northern species, which is very common in Denmark as a winter-visitor and passage-migrant. It occurs almost exclusively in the marine habitats, but besides out to sea also often near the coasts. HØRRING (1919) states that it frequently obtains its food at depths of up to 16–20 m. The present material includes some birds which were collected when feeding in water of 14 m and 20–30 m depth respectively. The greatest dive recorded by DEWAR (1924) was only 6 m.

## Material.

A total of 175 birds were examined, 157 of which had a varying quantity of food remains in their stomachs. These birds were collected, mainly in the years 1940–42, from the end of October to February; a small number was also obtained at the beginning of April. From salt-water localities in the Kattegat area 144 birds were available, viz. Læsø (48 birds), Allingaebro (4 birds), Samsø (16 birds), and Sejrsø-bugt (76 birds). The brackish water of the Baltic area furnished 13 birds, viz. Drogden near Copenhagen (1 bird), Køge-bugt (1 bird), Møen (1 bird), and Bornholm (10 birds).

## The food in the salt-water habitats of the Kattegat area.

Molluscs formed the principal food of the Velvet Scoter in this area. 140 of the birds at hand (97.2 %) had taken this kind of food, and 98 of them (68.1 %) exclusively. In two other instances the only other items in addition to molluscs were traces of barnacles.

Bivalves is the most frequently recorded food, taken by 119 of the birds (82.6 %), and by 44 of them (30.6 %) as the sole food. In one instance the meal included besides molluscs only traces of barnacles. Many different species are taken, the Velvet Scoter being able to feed in comparatively deep water; but only few of them are of major importance, the most prominent being cockles and blue mussels.

Cockles (*Cardium spp.*) formed the principal food items along with the dog whelk (*Nassa reticulata*). Fifty of the birds (34.7 %) had fed on cockles; 11 of them (7.6 %) had subsisted exclusively on such, and 11 other birds had in addition taken dog whelks only. Also clams (*Mya spp.*) were often included in meals on cockles and dog whelks. The number of cockles taken in the individual meal has varied from 1 to about 30–40 specimens. The Common Edible Cockle (*Cardium edule*) was taken in 38 instances (26.4 %), in 8 of which as

the sole food. The largest specimens consumed measured about 2 cm, and about 10 specimens were the average number per meal. Another cockle, *Cardium nodosum*, was taken in 12 instances (8.3 %), in 3 of which exclusively. On average this species was taken in larger quantities, but in smaller sizes, the largest recorded were only about 0.5 cm.

The Blue Mussel (*Mytilus edulis*) was the next frequently consumed bivalve and the food item third in importance. 34 of the birds (23.6 %) had taken blue mussels, and in 13 instances (9.0 %) they formed the entire meal. Small specimens of about 5 to 20 mm were the usually recorded, and the largest consumed were not much more than 3 cm. The number taken in each meal was often a few hundred.

Common Clams (*Mya spp.*) had been taken in 23 meals (16.0 %), in one instance as the sole food, but otherwise usually along with cockles and dog whelks. *Mya arenaria* was identified in one instance, otherwise the species when identifiable was always *Mya truncata*. Usually only a few small individuals have been included in each meal; some Velvet Scoters from Læsø had, however, taken fairly big individuals; one had thus consumed about 6 individuals of 3–4 cm. No clams larger than about 3–4 cm have been taken.

*Macoma calcarea* were recorded from 15 of the examined stomach contents (10.4 %). No less than 12 of these, however, were from a flock of Velvet Scoters which had been feeding near Læsø and apparently mainly subsisted on this bivalve. Six of the birds had made their entire meal upon them and taken them in quantities of up to 6 specimens of 3–4 cm per meal. One bird contained in addition to a few *Macoma calcarea* also a single *Macoma baltica*.

*Spisula spp.* were included in 13 meals in numbers from 1 to about 10 individuals, usually of about 10–12 mm. *Spisula solida* has been identified once, otherwise the species seem to have been *Spisula subtruncata*. Meals of *Spisula* usually included also *Cardium nodosum* and *Nassa reticulata*.

*Venus spp.* had been taken by 10 birds, all of which were collected at Læsø. In the 9 instances it were 2–3 up to 3 cm large *Venus gallina*, in the one instance a *Venus fasciata*.

Some other bivalves were recorded from a varying number of the birds examined, but none of them seem to be of any great value in the diet of the Velvet Scoter in general, though they may be of value to limited numbers of birds feeding in certain localities. The small *Nucula spp.* had been taken by 9 birds (6.3 %) in numbers of up to about 10 per meal; *Nucula nucleus* was identified in one instance, otherwise the species was *Nucula nitida*. Seven birds had taken 1 to 4 individuals of *Astarte elliptica*, from small specimens to some a little more than 2 cm in length. Seven birds had included single, small, at most 2 cm large,



*Cyprina islandica* in their meals. Three birds had taken *Modiolaria nigra*; and one had taken *Leda pernula*.

Gastropods also form an important part of the food of the Velvet Scoter; many different species are consumed, but dog whelks and periwinkles are by far the most prominent. Gastropods in all supplied food for 82 (56.9 %) of the examined birds and in 14 instances (9.7 %) formed the entire meal.

Dog Whelks (*Nassa spp.*) had been taken by 49 (34.0 %) of the examined Velvet Scoters. The Common Dog Whelk (*Nassa reticulata*) is the species most frequently taken (48 birds, 33.3 %) and is on the whole the most frequently recorded food species in the present material. Five birds had drawn their entire meal from *Nassa reticulata*, and many others had made the major part of their meal upon it. One Velvet Scoter collected at Samsø was found to have swallowed about 85-100 *Nassa reticulata*, in addition to some individuals of the sand-bottom polychaete *Pectinaria*. The largest dog whelks recorded in the stomach contents measured about 2.5 cm. The other dog whelk recorded, *Nassa pygmaea*, was only present in one meal in a number of 2 individuals.

Periwinkles (*Littorina spp.*) had been taken by 32 of the Velvet Scoters (22.2 %), 8 of which, all obtained in Sejro-bugt, had fed only on periwinkles; otherwise meals on periwinkles usually also included blue mussels. The largest number of periwinkles found in any stomach content has been 17, the largest size recorded about 22 mm. The Common Periwinkle (*Littorina littorea*) were present in all 32 stomach contents including periwinkles, and in addition *Littorina obtusata* was represented in at least 8 of them, and *Littorina saxatilis* in at least 1 of them.

The Common Whelk (*Buccinum undatum*) has supplied part, often an important part, of the meals of 6 of the examined Velvet Scoters (4.2 %). Fairly large individuals have been swallowed in a few instances. One bird thus had in its stomach the remains of 4 common whelks which must have been from about 3.5 to about 5-6 cm large, and in addition 7 small individuals of 6 to 12 mm. Incidentally a few of the largest shells have been dead ones housing hermit crabs, whose remains were also found in the stomach.

Many other gastropods were recorded from the examined Velvet Scoters, but as a rule formed only a relatively small part of the meals in question. Six birds had in their meals included one or a few *Bela turricula*; three birds had taken from 1 to 2 individuals of *Lunatia nitida*; two birds single individuals of *Lunatia catena*; and the following have been recorded each in one instance: *Aporrhais pes-pelecani*, *Scalaria turtonia*, *Turritella terebra*, and *Gibbula cinerarius*. The following small species may have been taken only accidentally or incidentally in the gathering other food, viz. *Bittium reticulatum* (3 birds), *Rissoa violacea*

(1 bird), *Rissoa striata* (2 birds), and *Hydrobia sp.* (3 birds). Yet one Velvet Scoter had fed on a few hundred *Hydrobia* in addition to dog whelks, periwinkles, swimming crabs, etc.

Crustaceans were included in 23 (16.0 %) of the meals examined. No meal consisted exclusively of crustaceans; and usually they formed only a small part of the stomach content. In 2 stomachs the crustaceans recorded were barnacles only.

The Common Shore Crab (*Carcinus maenas*) were found taken by 8 of the birds (5.6 %). Usually the individuals taken were small, but claws of individuals which may have measured about 4 cm across the carapace have been found in a few instances. One bird have included about 10 small individuals in a meal, but usually only a single one had been taken. Swimming Crabs (*Portunus spp.*) were recorded from two other stomach contents.

Hermit Crabs (*Eupagurus bernhardus*) were found in 6 of the stomachs at hand (4.2 %). In one instance it was hermit crabs inhabiting medium sized shells of common whelk, but otherwise they were very small individuals inhabiting the shells of dog whelks. In one instance the remains (claws) of the hermit crab were found, but no gastropod shell, which, as pointed out above, may indicate how the strong chitinous skeleton of larger crustaceans may resist the trituration and digestion in the gizzards for a longer time than the calcareous shells of molluscs.

The other crustaceans taken comprise: isopods (*Idothea sp.*) taken by 4 birds in a number of 1 or a few individuals per meal; an amphiod (*Gammarus sp.*) taken by 1 bird; a *Mysis* taken by 1 bird; and in 4 instances barnacles (*Balanus sp.*).

Echinoderms had been consumed by 14 (9.7 %) of the Velvet Scoters from salt-water localities, and 2 of them (1.4 %) had made their entire meal upon this kind of food. The Heart-urchin (*Echinocardium cordatum*) has formed part of the meal of 9 birds (6.3 %), and sometimes several individuals have been included in one meal. The regular echinoid *Strongylocentrotus droebachiensis* had been taken by 1 bird. The Common Sea-star (*Asterias rubens*) was recorded in 3 instances; and unidentifiable remains of Brittle-stars (*Ophiuroidea*) in 3 other instances.

Polychaetes were included in the meals of 12 (8.3 %) of the birds from salt-water localities. In one instance it was an almost intact Lug-worm (*Arenicola marina*) of 12 cm length, taken by a bird from Læsø; in 7 instances the polychaetes were represented in the stomachs only by the stout, golden-yellow bristles of *Pectinaria*; in 3 instances only by the jaws of Rag-worms (*Nereis*); and in one instance only by some unidentifiable bristles, which at any rate did

Table 4.  
Frequency of occurrences of the more common food items in the examined stomach contents of Danish Velvet-Scoters (*Melanitta fusca fusca*),

| Food items  | Salt-water localities in the Kattegat area |   | Localities of low salinity in the Sound and Baltic |   |
|---|--|---|--|---|
|   | 144 birds                                  |   | 13 birds   |   |
|   | Number of birds in which present           | Number of birds in which solely present | Number of birds in which present                   | Number of birds in which solely present |
| <i>Mollusca</i> . . . . .                           | 140 (97.2%)                                | 98 (68.1%)                              | 13 (100%)  | 10 (76.6%)                              |
| <i>Bivalvia</i> . . . . .                           | 119 (82.6%)                                | 44 (30.6%)                              | 13 (100%)  | 9 (69.2%)                               |
| <i>Mytilus edulis</i> . . . . .                     | 34 (23.6%)                                 | 13 (9.0%)                               | 10 (76.9%)   | 6 (46.2%)                               |
| <i>Cardium</i> spp. ( <i>edule</i> ) . . . . .      | 50 (34.7%)                                 | 11 (7.6%)                               | 1 (7.7%)   | —                                       |
| <i>Mya</i> spp. ( <i>truncata</i> ) . . . . .       | 23 (16.0%)                                 | 1 (0.7%)                                | —  | —                                       |
| <i>Macoma</i> spp. . . . .                          | 15 (10.4%)                                 | 6 (4.2%)                                | 3 (23.1%)  | 3 (23.1%)                               |
| <i>Spisula</i> spp. . . . .                         | 13 (9.0%)                                  | —                                       | —  | —                                       |
| <i>Venus gallina</i> . . . . .                      | 9 (6.3%)                                   | —                                       | —  | —                                       |
| <i>Nucula</i> spp. ( <i>nitida</i> ) . . . . .      | 9 (6.3%)                                   | —                                       | —  | —                                       |
| <i>Astarte elliptica</i> . . . . .                  | 8 (5.6%)                                   | —                                       | —  | —                                       |
| <i>Cyprina islandica</i> . . . . .                  | 7 (4.9%)                                   | —                                       | —  | —                                       |
| <i>Gastropoda</i> . . . . .                         | 82 (56.9%)                                 | 14 (9.7%)                               | 1 (7.7%)   | —                                       |
| <i>Nassa</i> spp. ( <i>reticulata</i> ) . . . . .   | 49 (34.0%)                                 | 5 (3.4%)                                | —  | —                                       |
| <i>Littorina</i> spp. ( <i>littorea</i> ) . . . . . | 32 (22.2%)                                 | 8 (5.6%)                                | 1 (7.7%)   | —                                       |
| <i>Buccinum undatum</i> . . . . .                   | 6 (4.2%)                                   | —                                       | —  | —                                       |
| <i>Bela turricula</i> . . . . .                     | 6 (4.2%)                                   | —                                       | —  | —                                       |
| <i>Crustacea</i> . . . . .                          | 23 (16.0%)                                 | —                                       | 3 (23.1%)  | —                                       |
| <i>Carcinus maenas</i> . . . . .                    | 8 (5.6%)                                   | —                                       | —  | —                                       |
| <i>Eupagurus bernhardus</i> . . . . .               | 6 (4.2%)                                   | —                                       | —  | —                                       |
| <i>Echinodermata</i> . . . . .                      | 14 (9.7%)                                  | 2 (1.4%)                                | —  | —                                       |
| <i>Echinocardium cordatum</i> . . . . .             | 9 (6.3%)                                   | —                                       | —  | —                                       |
| <i>Picces</i> . . . . .                             | 6 (4.2%)                                   | —                                       | —  | —                                       |
| <i>Annelida</i> . . . . .                           | 12 (8.3%)                                  | —                                       | —  | —                                       |
| <i>Pectinaria</i> spp. . . . .                      | 7 (4.9%)                                   | —                                       | —  | —                                       |

not belong to any of the above mentioned species. The lug-worms neither has jaws nor strong bristles which, when the soft parts are digested, may remain for some time in the stomachs and show that such a worm was eaten. It is therefore due to chance only that this species can be listed here among the food items of the Velvet Scoters. The lug-worm, however, in spite of its commonness, is probably of very little value as food for the Diving Ducks, since it is normally burrowed too deep in the bottom for being ploughed up by the birds.

Fishes were found in 6 of the examined stomach contents (4.2%). Two of the Velvet Scoters had taken Three-spined Sticklebacks (*Gasterosteus aculeatus*); one bird had taken a single Herring (*Clupea harengus*); and 1 bird had taken a *Gobius*; whereas in 2 instances only a few unidentifiable bones were present (in one instance presumably of a small Gadid). Whether the Velvet Scoter catches living fishes is unknown, the individuals eaten may have been dead or half-dead ones.

The other animal items recorded during this investigation are a 2.5 cm large Ascidian; and traces of Hydroids and Polyzoans in a few instances, taken accidentally along with other items.

Vegetable matter were present in very small quantities in 5-10% of the examined stomach contents; mostly it was traces of Red Algae, very rarely traces of Wracks (*Fucus*), and only once a bit of Eelgrass (*Zostera*). The vegetable matter must have been taken accidentally with the animal food.

Sand, gravel, and small stones were present in many stomachs, but just as frequently absent. The largest stones recorded were about 15 mm. The number of small stones in each stomach rarely exceeded about 10; larger quantities of gravel were found only in a few instances; one gizzard was, however, filled to the utmost with a large quantity of gravel and contained in addition only a trace of very small blue mussels.

The composition of the food of the Velvet Scoter in the marine habitat of the Kattegat area as computed on the basis of the present material is as follows: Molluscs about 83% (Bivalves about 53%, and Gastropods about 30%), Crustaceans about 6%, Echinoderms about 5%, Polychaetes about 4%, and Fishes about 2%. About half of the food consisted of Dog Whelks (*Nassa*), Cockles (*Cardium*), and Blue Mussels (*Mytilus*) in about equal quantities.

The food of the Velvet Scoter in the brackish-water of the Baltic area are suggested from the 13 stomach contents available. Molluscs were found in all 13 stomachs and were the sole content in the 9 of them. All 13 stomachs contained also Bivalves; Blue Mussels (*Mytilus edulis*) in 10 instances, in 6 of which as the sole content; and the Baltic Clam (*Macoma*

*baltica*) as the only content in 3 instances, in quantities of up to about 100 individuals per stomach. The Common Edible Cockle (*Cardium edule*), the Common Periwinkle (*Littorina littorea*), and a few very small Barnacles (*Balanus*), were found in 1 instance each. A few *Gammarus sp.* were found in 2 instances.

Remarks.

Published records on the food habits of the Velvet Scoter in Europe are scanty. In NAUMANN'S 'Vögel Mitteleuropas' (1905 p. 256) the food habits are stated to be similar to those of the Common Scoter, and as food items are mentioned: molluscs, small crustaceans, insects, worms, and small fishes. Further it is stated, however, that the Velvet Scoter, much more frequently than its relative the Common Scoter, takes vegetable food as tubers, roots, buds, and seeds of water plants. It is also recorded that the Velvet Scoter in fresh-water may dabble in the driftline and here take various vegetable matter, insects, and water-snails.

COLLETT (1877 p. 204) in his Notes on the Birds of Norway records that a Velvet Scoter, obtained from Mjosen at Lillehammer, in its stomach had many individuals of the fresh-water amphipod *Pallasea*. Further he records (1881 p. 377) that a bird from Drøbak contained bivalves and many gastropod shells with hermit crabs; and (1894 p. 293) that in the stomachs of ducklings of Velvet Scoters from the small lakes in the high mountains of Southern Norway he found insects and gravel, but no fishes.

MILLAIS (1913) says that the food of the Velvet Scoter consists 'chiefly of conchylia and crustacea, which they gain from a considerable depth'.

In WITHERBY'S Handbook (1924) the food is given as: 'Chiefly marine mollusca, including *Mytilus edulis* (commonly), *Solen*, *Buccinum*, *Cardium*, *Mactra*, *Tellina*, and *Donax*; also crustaceans (small crabs etc.)'.

The Velvet Scoter is not as distinctly bound to the open sea as is the Common Scoter, but forage also, fairly frequently, nearer the coasts. From the present investigation it appears also that periwinkles and small crabs, which preferably live among the stones of the shallower water, constitute a greater part of the diet of the Velvet Scoter than of the Common Scoter; a larger assortment of food species has also been recorded as taken by the former bird. Like the Common Scoter also the Velvet Scoter favours feeding on sandy bottom, where it takes cockles, clams as *Mya*, *Spisula*, and *Venus*, dog whelks, heart-urchins, and *Pectinaria*. And like the Common Scoter it obtains its food easily even at such considerable depths as 20 m or more.

That the blue mussel has been less prominent in the diet of the examined material of Velvet Scoters than was the case of the Common Scoters is accidental.

Table 5.

Summary of the composition of the food of different Scoters as computed by COTTAM, 1939, and in the present investigation.

| Kind of food                                       | Common Scoter<br>( <i>Melanitta nigra</i> )<br>Denmark | Velvet Scoter<br>( <i>Melanitta fusca</i> )<br>Denmark | Whitewinged Scoter<br>( <i>Melanitta deglandi</i> )<br>North America | Surf Scoter<br>( <i>Melanitta perspicilla</i> )<br>North America | American Scoter<br>( <i>Oidemia americana</i> )<br>North America |
|--|--|--|--|--|--|
|  | 228 birds  | 157 birds  | 819 birds<br>Cottam 1939   | 168 birds<br>Cottam 1939   | 124 birds<br>Cottam 1939   |
| Molluscs . . . . .                                 | ca. 89 %   | ca. 86 %   | 75.34 %  | 60.80 %  | 65.19 %  |
| (Bivalves) . . . . .                               | (ca. 78 %)   | (ca. 55 %)   | (63.31 %)  | (50.01 %)  | (55.91 %)  |
| (Gastropods) . . . . .                             | (ca. 11 %)   | (ca. 31 %)   | (12.03 %)  | (10.79 %)  | ( 9.28 %)  |
| Crustaceans . . . . .                              | ca. 5 %  | ca. 6 %  | 13.18 %  | 10.26 %  | 17.33 %  |
| Echinoderms . . . . .                              | ca. 2 %  | ca. 4 %  | 0.89 %   | 1.83 %   | 1.52 %   |
| Polychaetes . . . . .                              | ca. 4 %  | ca. 2 %  | +  | +  | +  |
| Insects . . . . .                                  | +  |  | 2.46 %   | 9.61 %   | 3.19 %   |
| Miscellaneous animal food (mostly worms) . . . . . |  |  | 1.41 %   | 2.03 %   | 0.74 %   |
| Pisces . . . . .                                   |  | ca. 2 %  | 1.73 %   | 3.37 %   | 1.69 %   |
| Vegetable food . . . . .                           | +  | +  | 5.88 %   | 12.10 %  | 10.34 %  |

In the diet in general in Denmark the reverse may be supposed to be the case, inasmuch as the former species feeds more frequently near the coasts.

Fish, which was not recorded among the food items of the Common Scoters at hand, were found eaten by 4.2 % of the Velvet Scoters, and is computed to form about 2 % of the total food. This figure agrees with what COTTAM (1939) found for the North American species of Scoters. Fish thus appear to be of no appreciable importance in the diet of the Scoters, and, as pointed out above, it may be discussed whether living fish are caught.

COTTAM's conclusion when discussing the species of fish recorded from the stomachs were that: 'when easily obtained these fishes seemed entirely acceptable'.

The Velvet Scoter is slightly larger than the Common Scoter, and the maximum size of the hard-shelled items it swallows appears likewise slightly larger. Bivalves as large as 4 cm (*Mya truncata*) and gastropods of about 5 (maybe 6) cm (*Buccinum undatum*) were found taken by the examined birds. The largest fishes consumed were considerably longer, at least about 10 cm, and the largest worm recorded was at least 12 cm. The usual minimum-size of acceptable food items appears to be about 5 mm, at any rate not much less.

In the accompanying table 5 the compositions of the food of the Danish Scoters as computed in this investigation are compared with the figures computed by COTTAM (1939) regarding the composition of the diet of the American Scoters, of which the Whitewinged Scoter (*Melanitta deglandi*) may be only a subspecies of the Common Scoter (*Melanitta nigra*). The agreement of the figures regarding the larger groups of foods is convincing.

Of the Whitewinged Scoter COTTAM had a material collected throughout the year inclusive of some from fresh-water localities. On the latter localities the food consisted of various insects, as caddisfly larvae, dragonfly larvae, lacewing larvae, water-boatmen, beetles, and others, and also fishes as minnows, and a quantity of plant food, which during summer should supply up to  $\frac{1}{4}$  of the food, and mostly consists of the vegetative parts of subaquatic plants, especially pondweeds, najadaceae, and eelgrass. — In the main, however, vegetable matter seems of little importance in the diet of the Velvet Scoter, though some birds in some localities may occasionally rely chiefly on this kind of food.

#### LONGTAILED DUCK

*Clangula hyemalis* (L.).

The Longtailed Duck is an arctic species, but is very common and numerous in Denmark as a winter-visitor. It stays mainly out to sea, especially at night, whereas during daytime it may go nearer to the coasts in order to forage. Only very rarely does it occur in the fjord areas or on the large lakes. The species is a skilled diver which usually obtains its food at depths of several metres. HØRRING (1919) records the depths at which the Longtailed Duck usually feeds as 5 to 10 m, and according to various authors (cf. COTTAM 1939 p. 74) it may easily reach the bottom at depths of about 30 m and at times perform even considerably greater dives.

#### Material.

The number of Longtailed Ducks examined is 189, of which 174 had a varying quantity of food remains in their stomachs. These 174 birds were obtained from November to April, 1940-47, from the following localities: Salt-water localities in the Kattegat area (110 birds), viz. Storebælt (3 birds), Lillebælt (20 birds), Rørvig (9 birds), Sejro-bugt (31 birds), Samsø (41 birds), Grenaa (1 bird) and Læsø (5 birds); and a salt-water locality near Ringkøbing in the North Sea area (3 birds). 59 birds were collected in the brackish water of the Baltic around Bornholm and Christiansø; and 2 birds were from fresh-water localities in the Ringkøbing-fjord area.

#### The food in the salt-water habitats (mainly the Kattegat area).

The food taken by the Longtailed Duck here comprises a great variety of species, depending both on the rich fauna of the area and on the birds' eminent diving ability which allows it to seek its food in the animal communities of some depth and to take also more mobile species.

Molluscs were the food most frequently taken. 106 birds (93.8 %) had fed on such, and 44 of them (38.9 %) had subsisted exclusively on molluscs.

Bivalves were the most prominent, as usual for Diving Ducks feeding in marine habitats; they occurred in 92 of the meals (81.4 %), and in 32 of them (28.3 %) as the sole food.

Cockles (*Cardium spp.*) constituted the principal bivalve food of the Longtailed Ducks at hand, but probably this does not apply as distinctly to the diet in general, since the 58 individuals (51.3 %) which had fed on these bivalves were all obtained in the three localities, Lillebælt, Sejro-bugt, and Samsø. The species of cockles taken was almost exclusively the small *Cardium nodosum*, which was recorded from all the 58 stomachs. Only one bird had also taken, in addition to many *Cardium nodosum*, a few, medium-sized Common Edible Cockle (*Cardium edule*). The 20 birds obtained in Lillebælt, February 27. and 28. 1947, had subsisted mainly on *Cardium nodosum*, and 13 of them had taken no other kind of food. 16 Longtailed Duck, in all, had drawn their entire meal from this species; and large quantities was sometimes found in the single stomachs; one contained thus about 500-600 *Cardium nodosum* of 2 to 9 mm.

The Blue Mussel (*Mytilus edulis*) were taken by 50 (44.2 %) of the Longtailed Ducks examined, and 8 of them, 6 of which from one foraging flock from Samsø, had made this bivalve their sole food. The largest blue mussels swallowed were about 2 cm long, but most were considerably smaller. Large numbers were

sometimes taken in one meal, thus one bird from Samsø in addition to some other food had gorged itself on about 1,500 individuals of 1 to 9 mm, which, in all, amounted to about 24 ccm. It is probable that the blue mussel is the most important single food species in the diet of the Longtailed Duck in general in the marine habitats, since it was more evenly distributed in the examined birds than the cockles.

The Clams, *Spisula spp.*, were included in 17 (15 %) of the meals examined, 14 of which, however, were made by birds from one foraging flock in Sejrø-bugt. All the *Spisulas* taken were very small, only a few mm large, but as many as 100 or more were often found in the individual stomach contents. The species consumed by the birds from Sejrø-bugt probably was *Spisula solida*, whereas 1 bird from Samsø had taken *Spisula subtruncata*.

The Common Clams (*Mya spp.*) were included in the meals of 7 of the Longtailed Ducks examined. In the 4 instances it were small individuals of 5 to 10 mm length in quantities of up to about 50 individuals per meal. One Longtailed Duck, obtained at Rødvig in southern Kattegat, November 27, 1941, however, was found gorged with more than 100 about 2 cm long siphons of a *Mya spp.*, 94 siphons in the gullet and the remains of about 15 in the gizzard. In addition, the bird had included a few other small molluscs and crustaceans in its meal. That a Diving Duck at a single meal should be able to collect such a large number of siphons of living individuals of this fairly deeply burrowed bivalve seems improbable, also that so many siphons could be obtained without at least some shells being included. No doubt also the bird in question has not fed upon living individuals of *Mya*, but upon one of the aggregations of detached siphons which occasionally may be found after a severe storm. The *Mya* species burrow themselves deep into the bottom and reach to the surface by means of their long siphons; individuals with about 3 cm long shells are found about 10 cm down in the bottom, the largest individuals with shells of about 6-8 cm even as far down as 25 cm. During severe storms the waves may reach down to the bottom and stir up the sand covering the *Myas*, exposing at first the smaller and maybe later also the larger individuals (cp. SCHÄFER 1950). The waves now wash the *Myas* away dying, and when dead the shells fall from the soft parts of which the main body soon decay, while the muscular siphons are more resistant and may accumulate in smaller or larger quantities which may for many days be carried about by the waves before they decay, are washed ashore or, for instance, consumed by a Diving Duck.

Other bivalves recorded from the investigated material of Longtailed Duck include *Astarte elliptica*, taken in numbers of up to 8 individuals of 6 to 10 mm by 7 birds from four different localities, and further some species which have

been eaten by a single or a few birds only, but which may form the bulk of the individual meals. Two birds from Assens in Lillebælt had consumed respectively 1 and about 50 individuals of *Scrobicularia plana*; five birds had taken up to a few individuals of the small *Nucula nitida*, and 1 bird had taken *Nucula tenuis*. Four birds had consumed *Macoma spp.*, in 1 instance, at least, *Macoma baltica*. Five birds, all from Sejrø-bugt, had included some few *Corbula gibba* in their meals. Three birds from Samsø had consumed 1 to 3 individuals of the Razor-shell *Cultellus pellucidus*, the largest of the individuals swallowed being about 30 mm long. Four birds, from Sejrø and Samsø, had taken *Modiolaria spp.*, *Modiolaria discors* identified in 2 instances and *M. nigra* in 1 instance. Single individuals of small *Cyprina islandica* have been found in 2 stomachs, and a single individual of *Leda minuta* in 1 stomach.

Gastropods were taken by 36 (31.9 %) of the Longtailed Ducks examined from salt-water habitats, but they formed the sole food in one instance only.

Periwinkles (*Littorina spp.*) were taken by 15 birds (13.3 %); identified were the Common Periwinkle (*Littorina littorea*) (5 instances), *Littorina obtusata* (2 instances), and *Littorina saxatilis* (2 instances). From 1 to about 20 periwinkles were consumed per meal, and 1 meal was made entirely on this gastropod.

The Common Dog Whelk (*Nassa reticulata*) had been included in 11 meals, in numbers varying from 1 to 13; the largest specimens taken were at most about 10 mm.

The other gastropods recorded comprise: *Hydrobia spp.*, small numbers taken by 12 birds; *Lacuna divaricata*, taken by 3 birds in numbers up to about 25; *Rissoa spp.*, taken by 4 birds, *Rissoa violacea* and *R. inconspicua* each in 2 instances, and *R. striata* in 1 instance; and the following, each represented in 1 meal: *Bittium reticulatum*; *Lunatia sp.*; a 6 mm large *Buccinum undatum*; *Eulimma philippi*; and *Cylichna sp.* The brackish-water species *Neretina fluviatilis* had finally been taken by 2 birds from Samsø, in a number of 1 and 12 individuals respectively, along with blue mussels and other items.

An unidentified small *Nudibranch* was found in a stomach content of a bird from Samsø.

Crustaceans supply a very considerable part of the food of the Longtailed Duck, but only small forms are taken. In all, 62 birds (54.9 %) had fed upon crustaceans, but only 5 of them (3.5 %) had such as the only food remains in their stomachs.

Amphipods were consumed by 28 (24.8 %) of the examined birds and along with the isopods form the major part of the crustacean food taken. When identification has been possible the amphipods proved, almost exclusively, to be

*Gammarus spp.*, among other *G. locusta*. *Gammarus spp.* were included in at least 15 meals, and one of these was made entirely upon a large number of these creatures; and up to several hundred Gammarids formed the major part of the stomach content in some other instances. Other amphipods identified were *Amphithoe rubricata*, of which 2 individuals along with 1 *Gammarus locusta* were found intact in the gullet of a bird obtained at Rødvig; and the easily recognizable *Caprella spp.* (among which *C. linearis*) which had been taken, in part in large numbers, by 5 birds, by 1 of them as the sole food item. In a few instances it was evident that the remains of amphipods recorded were neither of Gammarids nor *Caprella*, though otherwise no identification was possible.

Isopods, always *Idothea spp.* (among which *Idothea baltica*, *I. granulosa*, and *I. viridis*), were taken by 26 (23.0%) of the Longtailed Ducks examined, and in one instance formed the entire meal. The quantity included in each meal varied from a single individual to about 200 in several instances.

Mysids had been fed upon by 9 of the birds (7.0%). One of them, from Samsø, had drawn its whole meal from a large quantity of these small crustaceans, but otherwise only single individuals have been recorded in the stomach contents.

Shrimps (*Carididae*) were included in 5 meals of Longtailed Ducks from different localities in numbers varying from 1 to a few individuals.

The Common Shore Crab (*Carcinus maenas*) was taken by 3 of the Longtailed Ducks (2.7%), but always only single and very small individuals; breadth of carapace not exceeding 5-10 mm.

Barnacles finally were recorded in 3 instances only, always along with blue mussels.

In 6 instances the remains of crustaceans found in the stomachs consisted solely of an unidentifiable powder.

Fishes were third in importance in the diet of the Longtailed Ducks at hand from salt-water habitats, but of course were of much less value than the molluscs and crustaceans. 16 birds (14.4%) had consumed fishes, and 1 bird had done so exclusively. In 3 instances unidentifiable bones only were recorded, but otherwise Gobies (*Gobius spp.*) were identified in 10 instances; 1 bird from Samsø had in its stomach bones of about 10 individuals and in addition about half a hundred otoliths; Threespined Sticklebacks (*Gasterosteus aculeatus*) were identified in 3 instances, 1 to a few individuals per meal; and in one instance the bones found may have been of a small Codfish (*Gadidae*).

Polychaetes were recorded in 11 (9.7%) of the examined meals. In 3 instances bristles of the Tube-worm *Pectinaria* were found; in 2 instances jaws of 1 and 3 Rag-worms (*Nereis sp.*) respectively; and in 2 instances respectively jaws of 1, and jaws and bristles of several Scale-worms (*Polynoinae*). In 3 in-

Table 6.

Frequency of occurrences of the more common food items in the examined stomach contents of Danish Longtailed Ducks (*Clangula hyemalis*).

| Food items                              | Salt-water localities almost exclusively in the Kattegat area |   | Localities of low salinity in the Baltic |   |
|---|---|---|--|---|
|   | 113 birds   |   | 59 birds                                 |   |
|   | Number of birds in which present                              | Number of birds in which solely present | Number of birds in which present         | Number of birds in which solely present |
| <i>Mollusca</i> . . . . .               | 106 (93.8%)   | 44 (38.9%)                              | 56 (94.9%)                               | 30 (50.8%)                              |
| <i>Bivalvia</i> . . . . .               | 92 (81.4%)  | 32 (28.3%)                              | 56 (94.9%)                               | 29 (49.2%)                              |
| <i>Mytilus edulis</i> . . . . .         | 50 (44.2%)  | 8 (7.1%)                                | 54 (91.5%)                               | 26 (44.1%)                              |
| <i>Cardium spp. (nodosum)</i> . . . . . | 58 (51.3%)  | 16 (14.1%)                              | —  | —                                       |
| <i>Spisula spp.</i> . . . . .           | 17 (15.0%)  | —                                       | —  | —                                       |
| <i>Astarte elliptica</i> . . . . .      | 7 (6.2%)  | —                                       | —  | —                                       |
| <i>Macoma spp. (baltica)</i> . . . . .  | 4 (3.5%)  | —                                       | 6 (10.2%)                                | 2 (3.4%)                                |
| <i>Nucula spp. (nitida)</i> . . . . .   | 6 (5.3%)  | —                                       | —  | —                                       |
| <i>Gastropoda</i> . . . . .             | 36 (31.9%)  | 1 (0.9%)                                | 7 (11.9%)                                | —                                       |
| <i>Littorina spp.</i> . . . . .         | 15 (13.3%)  | 1 (0.9%)                                | 1 (1.7%)                                 | —                                       |
| <i>Nassa reticulata</i> . . . . .       | 11 (9.7%)   | —                                       | —  | —                                       |
| <i>Hydrobia spp.</i> . . . . .          | 12 (10.6%)  | —                                       | 2 (3.4%)                                 | —                                       |
| <i>Neretina fluviatilis</i> . . . . .   | 2 (1.8%)  | —                                       | 5 (8.5%)                                 | —                                       |
| <i>Crustacea</i> . . . . .              | 62 (54.9%)  | 4 (3.5%)                                | 29 (49.2%)                               | 3 (5.1%)                                |
| <i>Amphipoda</i> . . . . .              | 28 (24.8%)  | 2 (1.8%)                                | 24 (40.7%)                               | —                                       |
| <i>Isopoda (Idothea)</i> . . . . .      | 26 (23.0%)  | 1 (0.9%)                                | 14 (23.7%)                               | —                                       |
| <i>Mysidae</i> . . . . .                | 9 (7.0%)  | 1 (0.9%)                                | —  | —                                       |
| <i>Echinodermata</i> . . . . .          | 8 (7.1%)  | —                                       | —  | —                                       |
| <i>Pisces</i> . . . . .                 | 16 (14.2%)  | 1 (0.9%)                                | —  | —                                       |
| <i>Gobius spp.</i> . . . . .            | 10 (8.8%)   | 1 (0.9%)                                | —  | —                                       |
| <i>Annelida</i> . . . . .               | 11 (9.7%)   | —                                       | 1 (1.7%)                                 | —                                       |

stances unidentifiable bristles were recorded, and in 1 instance the polychaetes found in the stomach content were merely 2 young bottom-stages, which of course had been swallowed quite accidentally.

Echinoderms had been taken by 8 of the Longtailed Ducks (7.1 %), viz. small individuals of the Common Sea-star (*Asterias rubens*) in 2 instances, 1 small Heart-urchin (*Echinocardium cordatum*) in 1 instance; and 1 to a few individuals of Brittle-stars (*Ophiurodidea*) in 5 instances, in one instance a Brittle-star was found in the gullet and could be identified as *Ophiura albida*.

Hydroid and Polyzoan colonies were found in very small quantities in a few instances, naturally swallowed accidentally along with other food.

Vegetable matter. — Traces of Red Algae, sometimes also Brown Algae, and a single time Eelgrass, were found in about 5 % of the examined stomach contents, taken accidentally, mainly along with blue mussels. A single bird from Læsø in addition to small Myas and Hydrobias had also taken a single seed of Bulrush (*Scirpus maritimus*).

Gravel was usually present in small quantities in the stomach contents; in 1 instance a small stone of 14 mm was found, otherwise the largest pebbles measured about 8 mm. There have been no correlation between the kind of stomach content and the absence of presence of gravel or the quantity thereof.

The composition of the food of the Longtailed Duck in marine habitats as it may be computed on the basis of the present material is: Molluscs about 60 % (Bivalves about 47 %, and Gastropods about 13 %), Crustaceans about 28 %, Fishes about 7 %, Polychaetes about 3 %, and Echinoderms about 2 %. The food items most prominent in the present material were in order of importance: Cockles (*Cardium*), Blue Mussel (*Mytilus edulis*), *Gammarus*, and *Idothea*. Other important foods have included for instance the small fish, *Gobius spp.*

#### The food of the Longtailed Duck in the Baltic area.

From the Baltic in the vicinity of Bornholm 59 birds have been available. Due to the poorer fauna of this brackish-water area in comparison with the Kattegat area a much smaller number of different food species is taken, and blue mussels have been by far the most prominent food.

Molluscs were consumed by 56 (94.9 %) of the examined birds, and formed the entire meal in 30 instances (50.8 %). Bivalves were the most important, and were included in all the 56 meals upon Molluscs, whereas Gastropods were present in only 7 instances (11.9 %). 29 meals (49.2 %) consisted solely of bivalves.

The Bivalves taken by the Longtailed Duck in the Baltic area are primarily blue mussels and baltic clams, the only species recorded in the present material. The Blue Mussel (*Mytilus edulis*) were taken by 54 of the birds (91.5 %).

and 26 of them (44.1 %) had subsisted solely on this species, and several others had made it the principal part of their meals. No individuals larger than 2 cm have been recorded. The Baltic Mussel (*Macoma baltica*) were taken by 6 of the birds (10.2 %) and in 2 instances formed the entire meal. The largest number of this bivalve found in any meal was about 20 medium-sized individuals.

The Gastropods recorded from the Longtailed Duck in the Baltic area include: *Neretina fluviatilis*, 1 to about 12 individuals taken by 5 birds; a few Hydrobiids, taken by 2 birds; and a small Periwinkle (*Littorina sp.*) taken by 1 bird.

Crustaceans had been eaten by 29 of the birds (49.2 %), by 3 of them exclusively. Amphipods, as far as identifiable always *Gammarus spp.* (among which *Gammarus zaddachi* and *G. dübeni*), had been taken by 24 birds (40.7 %) in quantities varying from a single individual to several hundred per meal. One bird thus contained about 300 *Gammarus* in its gullet and had in the gizzard the remains of at least as many. Isopods had been taken by 14 birds (23.7 %). In the 13 instances it were *Idothea spp.* (among which *Idothea baltica* and *I. viridis*), usually taken only in small numbers, yet sometimes in quantities of about 100 individuals. In one instance the isopods taken were only a few specimens of the small *Iæra marina*. A few individuals of Shrimps were included in 1 meal, but could not be identified.

Polychaetes. — A single jaw of a Scale-worm (*Polynoïnae*) was found in the stomach content of one of the Longtailed Ducks from the Baltic.

The composition of the diet of the Longtailed Duck in the Baltic area as shown by the present material is, expressed in percentages: Molluscs about 73 % (Bivalves 65 %, and Gastropods 8 %), and Crustaceans about 27 %. The Blue Mussel (*Mytilus edulis*) supplied about  $\frac{2}{3}$  of the food.

These percentages probably are about adequate in broad features, but do not include fishes which no doubt form a regular, though not very important part, of the diet of the Longtailed Duck in general.

#### The food of the Longtailed Duck in fjord areas.

Only 2 birds, collected in the Ringkøbing fjord area in October, have been available for a suggestion of the food taken by the Longtailed Duck in such habitats. Both birds had foraged on insects, crustaceans, and seeds. In the one instance the stomach content consisted of 3 midge larvae (*Chironomidae*), 2 small snails (*Hydrobiidae*), trace of an unidentifiable small crustacean (not *Gammarus*), and some seeds, viz. 2 of pondweed (*Potamogeton sp.*), 2 of a bulrush (*Scirpus tabernaemontani*), and 2 of wigeongrass (*Ruppia sp.*). In the other in-

stance the stomach content consisted of a large quantity of comminuted Gammarids, 3 crane-fly larvae (*Tipulidae*) of about 10 mm, remains of 2 water-boatmen (*Corixa sp.*), some fruiting bodies of muskgrass (*Characeae*), 1 seed of widgeongrass (*Ruppia sp.*), and a small quantity of pieces of leaves of eelgrass (*Zostera*).

#### Remarks.

In NAUMANN'S 'Vögel Mitteleuropas' (1905 p. 208) the food of the Longtailed Duck is stated to be chiefly molluscs, especially blue mussel (*Mytilus edulis*), common edible cockle (*Cardium edule*), and *Tellina cornea*, from the very smallest to about 2.5 cm large individuals. Also small crustaceans, and small fishes as young flatfishes (*Pleuronectes*), cod (*Gadus callarias*), and many others. Rarely insects and worms, but more often seeds, buds, tubers, and other parts of various aquatic plants.

In WITHERBY'S 'Handbook of British Birds' (1924 p. 345) the food of the Longtailed Duck is given as 'Mainly animal; esp. mollusca (*Cardium*, *Buccinum*, *Lacuna*, *Tellina*, *Patella*, *Mytilus*, *Cyclope*, *Littorina*, etc.), also crustacea (shrimps, small crabs, sandhoppers, etc.), pteropoda, and some vegetable matter (algae, roots, mosses, etc.). In summer freshwater insects and their larvae. Including diptera (*Chironomida*, etc.), hemiptera (*Corixa*). Small red worms also recorded'.

MILLAIS (1913 II p. 122) stated that the Longtailed Ducks rely on animal food during winter, but that 'In summer they eat largely the roots, seeds, buds, and young shoots of various water plants, as well as insects and worms'.

COLLETT (1877 p. 202) records that in 2 Longtailed Ducks in Norway he found traces of plants, and in another specimen many *Phryganea* larvae.

In Greenland the Longtailed Duck according to HOLBØLL (1843 p. 76) takes such molluscs as *Modiola*, *Margarita*, *Tellina*, and *Mya*, and such crustaceans as amphipods. FABER (1822 p. 71) states that he found only the remains of vegetable food in the Longtailed Ducks from the breeding grounds in Iceland.

The Longtailed Duck is among the species whose food habits in North America have been dealt with by COTTAM (1939). On the basis of 190 birds collected at all seasons and in part also obtained from fresh-water localities, COTTAM computed the composition of the diet as follows: crustaceans 48.23 %, molluscs 15.70 % (bivalves 9.38 %, gastropods and others 6.32 %), insects 10.77 %, fishes 9.71 %, miscellaneous food (chiefly polychaetes) 3.52 %, and plant food 12.07 %.

The present investigation shows, like the American investigation, crustaceans and molluscs as the most important food items for the Longtailed Duck; but

whereas crustaceans in the North American material formed about half the total food, it in the present material supplied only about one-fourth, and thus in importance rank below the molluscs which accounted for about  $\frac{2}{3}$  of the food (in the American material only for  $\frac{1}{5}$ ). This inconsistency, however, is more apparent than real. The Danish material shows the composition of the winter food and almost exclusively comprised birds foraging in marine or brackish habitats. It has thus been obtained in a season when the consuming of molluscs will be relatively larger in relation to the consuming of crustaceans than during summer, and further it has been obtained in places where molluscs are relatively much more important as food items than in fresh-water habitats, which furnished part of COTTAM'S material.

COTTAM (1939 p. 76) states that 'Most writers, because of insufficient stomach examinations have overemphasized the importance of molluscs in the diet of the old squaw.' - The Longtailed Duck, in general, do not seem to show any special preference for either small molluscs or crustaceans, if equally easily obtained. Molluscs, however, will always be a stable food in marine localities at all seasons, whereas the consumption of crustaceans will show seasonal variations. On the other hand, the importance of crustaceans in the diet of the Longtailed Duck has undoubtedly been much underestimated. Their importance is even greater than expressed in the percentage ratios computed in both the American and the present investigation, where molluscs and crustaceans have been treated as if remaining for an equal length of time in the stomachs, which is not the case, as also pointed out by COTTAM. In the Danish material of Longtailed Ducks from marine habitats—if the frequency of occurrences is used as basis for computing food percentages—molluscs constitute 52.5 % and crustaceans 30.7 % of the food. But while molluscs are the sole food recorded in 38.9 % of the birds, crustaceans are recorded solely only in 3.5 %. Or, while about  $\frac{4}{5}$  of the stomachs including molluscs had such as their sole content, the same applied for only  $\frac{1}{10}$  of those with crustaceans. These figures indicate how far more rapidly the small crustaceans become triturated and digested than the molluscs. Therefore it seems justifiable here to estimate that the value of the crustaceans in the diet has been at least as great as that of the molluscs, perhaps even greater. Whether the one or the other is true, however, is of less importance. The present study along with COTTAM'S emphasizes that the small crustaceans constitute a readily acceptable and very important food for the Longtailed Duck.

COTTAM found that stomachs containing only soft-bodied crustaceans or similar food were usually thin and weak, whereas stomachs of birds of the same species having fed extensively on large, hard mussels were usually much more muscular.



Such a difference, implying that some individuals of Longtailed Ducks should specialize on crustacean food, others on molluscan food, has, however, not been evident in the present material though the stomachs were often of much varying muscularity.

COTTAM's results as to which kinds of crustaceans and molluscs are preferred by the Longtailed Duck agree closely with the condition in Denmark. Amphipods, especially *Gammarus* and *Caprella*, were also in America the most prominent crustacean food items, but crabs were more important in the American material than in the present one. COTTAM records also various fresh-water crustaceans as food, among others water-fleas (*Daphniae*) and their egg-cases. Bivalves were also in America the principal molluscan food, primarily *Mytilus* and next *Astarte* and *Cardium*.

COTTAM records insects as 'largely a warm weather food' which during summer averaged about  $\frac{1}{5}$  of the diet of the Longtailed Duck. They were mainly larvae of caddisflies (*Trichoptera*) and midges (*Chironomidae*). During winter, however, insects constituted only 3.8 % of the food.

Of fishes taken by the Longtailed Ducks of the American material flatfishes (*Pleuronectidae*) and herring and other clupeidae and their eggs were the most prominent. None of these species have been recorded from the Danish birds, but no doubt they may at certain times and in certain localities be of some importance to a limited number of birds.

Concerning the plant food of the Longtailed Duck COTTAM writes (1939 p.78): 'Vegetable material seemed to be acceptable at any time of the year, with 6.47 percent in December the minimum and 19.83 in May the maximum'. Further is stated that 'drift material seemed to be most commonly taken, probably in part accidentally or incidentally to the process of capturing water fleas or other forms of animal life that frequently live in the meshes of submerged plants or in drifting plant debris.' The most prominent plant foods were grains such as barley, wheat, corn, and oats, which COTTAM concludes was 'undoubtedly taken as artificial feed or bait'. One of the Longtailed Ducks at hand had likewise fed on grains of barley, undoubtedly taken in a place where artificial food had been laid out, for which reason this bird was not included in the material used for computing food percentages. COTTAM also found that vegetative parts of wild grasses were consumed in quantity on the nesting grounds.

The diet of the Longtailed Duck in Denmark during winter is almost exclusively animal, consisting of small molluscs and crustaceans. On the whole, however, this Diving Duck is very adaptable in its food selection, not only do it catch fairly mobile animals (in part among the vegetation) in addition to picking up immobile items on the bottom, but it may also eat vegetative matter,

even occasionally go on land to feed on different plants, grasses and mosses, etc. (MACKAY, *The Auk*, 1892 p. 335, and others).

The sizes of the food items of the Longtailed Duck vary regarding the hard-shelled items from the smallest ones to such of about 2 cm. The largest bivalve recorded swallowed in the present material was a razor-shell of about 30 mm, and apparently of an exceptional size. Soft-bodied items are swallowed in larger sizes, but none of the fishes recorded was in such a condition as to allow any definite estimation of size.

## GOLDEN-EYE

### *Bucephala clangula clangula* (L.).

The Golden-Eye nests in arctic and subarctic areas. It is presumed that the species also breeds in Denmark, but there are no safe records as yet. In Denmark it is also only rare as summer-visitor, but it is very common as passage-migrant and winter-visitor, occurring mostly in the coastal waters of marine and brackish localities, but also visiting the large inland lakes. The Golden-Eye usually feeds at depths of about 1 to 6 m, preferring the shallow feeding-grounds, —DEWAR (1924) records 1 to 4 m for the dives observed by him—and probably the Golden-Eye never dives in depths of more than 8 to 10 m; but it is otherwise an expert, very restless and active diver. Occasionally the species may dabble in the drift line.

### Material.

In total 230 Golden-Eyes were examined; as usual some were without food remains in their stomachs so that only 213 stomach contents were available for the statistical analysis of the diet. These were from birds collected during October to February and in the following localities: in salt-water habitats in the Kattegat area (90 birds), viz. Kalundborg (3 birds), Holbæk (3 birds), Frederikssund (9 birds), Sejrsø-bugt (16 birds), Samsø (5 birds), Læsø (19 birds), Dalby Ore at Randers (21 birds), and Allingaebro (14 birds); in brackish-water habitats in the Sound and the Baltic area (52 birds), viz. Drogden and the Sound (31 birds), Kalvebodstrand (6 birds), Fakse-bugt and Køge-bugt (8 birds), and Bornholm (10 birds); in fresh-water habitats (10 birds), viz. Samsø (4 birds), Ribe (1 bird), Kalundborg (2 birds), Kalvebodstrand (2 birds), and Møen (1 bird). Finally, a number of birds has been available from fjord areas where foraging has taken place both in more or less brackish water as well as in fresh-water. These birds therefore were treated separately in the following, viz. 38 birds

from the Ringkøbing-fjord area, 19 birds from the Limfjord area, and 3 birds from Rømø in the shallow sea off the west coast of Jutland.

The food in the salt-water localities in the Kattegat area.

The Golden-Eye must feed almost exclusively on animal food in these localities, but it takes a great variety of such, crustaceans, small molluscs, fishes, and also worms, apparently eaten equally readily when only available.

Crustaceans were the most frequently recorded food items. 69 of the Golden-Eyes at hand (76.7 %) had fed on this kind of food and 18 of them (20 %) exclusively so.

Shrimps and Prawns (*Carididae*) supplied the major part of the crustacean food and are the most frequently food items; they were taken by 29 birds (32.2 %), formed the entire meal in 2 instances and a major part in several other instances. The Common Shrimp (*Crangon vulgaris*) was identified in 17 instances among which the 2 meals on shrimps alone. The small prawn, *Palaemonetes varians*, has been identified in 1 instance and the same applies to *Palaemon fabricii*; otherwise, however, the shrimps and prawns consumed were in a too far advanced state of digestion for identification. One bird, obtained at Dalby Ore near Randers in the northwestern Kattegat, October 19, 1942, had about 100 of the common shrimps in its meal, 36 individuals were found in the gullet and the remains of a great many in the gizzard. In some instances only a single individual of shrimp was found. Of the Golden-Eyes having subsisted on shrimps 18, however, were obtained from one single flock foraging in the said locality in the northwestern Kattegat, so that the present material may have given undue emphasis to the rôle of shrimps in the diet of the Golden-Eye in general.

Isopods (*Idothea spp.*) are the next frequently taken crustaceans in the material and supplied food for 20 of the birds (22.2 %), in 3 instances exclusively. Idotheas have been important in particular to the Golden-Eyes obtained in Sejro-bugt, January 25, 1941, 11 of the 16 birds available having taken these crustaceans in varying numbers, in the 9 instances as their principal food. Very large numbers of Idotheas may be included in a single meal; thus one bird was found to have 96 individuals in its gullet and the remains of about 200 in the gizzard; in addition this meal also comprised a few very small blue mussels.

Amphipods had been consumed by 16 of the Golden-Eyes (17.8 %), often in large quantities. Usually the amphipods taken were *Gammarus spp.* (among other *Gammarus locusta* and *Gammarus duebeni*). In one instance only, another though unidentifiable amphipod was recorded. A Golden-Eye collected in the

Limfjord area had in its gullet between 375 and 400 *Gammarus* and in its gizzard the comminuted remains of many more, besides other food remains.

The Common Shore Crab (*Carcinus maenas*) was taken by 13 of the birds (14.4 %), in a number varying from 1 to about 10 small individuals per meal. No crab larger than about 15 mm breadth of carapace has been recorded and most were somewhat smaller. One bird from the northwestern Kattegat had the claws of a small Swimming Crab (*Portunus spp.*) in its stomach; and 2 other birds had taken single small individuals of the Hermit Crab (*Eupagurus bernhardus*).

Mysids (at any rate in part *Mysis flexuosa*) is also a fairly important food for the Golden-Eye. 13 birds (14.4 %) had fed on these small crustaceans and 3 of them had taken no other food. They have often been taken in considerable quantities in the single meals.

In 6 instances the remains of crustaceans recorded have consisted only of a fine, unidentifiable powder, and several meals may have included other kinds of crustaceans than it has been possible to identify.

Molluscs were recorded slightly less frequently in the Golden-Eyes examined from the Kattegat area than were crustaceans. Molluscs were found in 63 stomachs (70.0 %), and were in 15 of these (16.7 %) the only kind of food. Only small individuals of this hard-shelled food are taken by the Golden-Eye, which may probably account for the fact that bivalves are less prominent than is usually the case in the diet of the Diving Ducks.

Gastropods had been fed on by 41 birds (45.7 %), by 7 of them (7.8 %) exclusively.

Periwinkles (*Littorina spp.*) are in the material at hand the most frequently recorded food next to the shrimps. Considering the relative importance in the meals of the various foods, periwinkles, however, are probably less important in the diet of the Golden-Eye in general than both amphipods and isopods and also blue mussels. 23 birds (25.6 %) had eaten periwinkles, 4 of them as the sole food; usually only a few specimens had been taken per meal; yet one bird had made its meal on about 40 *Littorina littorea* of 4-7 mm, in addition to a few very small blue mussels. *Littorina littorea* was identified in 11 meals, one of which consisting exclusively of a few periwinkles; *Littorina obtusata* was recorded in 9 instances, 8 birds from Læsø and 1 from Sejro, and a few individuals of this periwinkle formed in 2 instances the entire stomach content.

*Hydrobia spp.* were included in 20 meals (25.6 %). One Golden-Eye, obtained at Havnsø, Sejro-bugt, December 1, 1941, had made its meal on several hundred of these small snails, in addition to small numbers of periwinkles and Rissoids. Usually only a few Hydrobias were present in each stomach content.

Other gastropods eaten by the examined Golden-Eyes include: the Common Dog Whelk (*Nassa reticulata*), small individuals taken by 4 birds, and another Dog Whelk (*Nassa pygmaea*) taken by 1 bird; further the following small species: *Bittium reticulatum*, a few individuals taken by 4 birds; *Rissoa inconspicua*, 1 and more than 20 individuals respectively taken by 2 birds; *Rissoa membranacea*, 15 individuals taken by 1 bird; and *Brachystomia rissoides*, 1 individual taken by 1 bird.

Bivalves had been taken by 38 of the Golden-Eyes from the Kattegat area (42.2 %); in 5 instances (5.6 %) they made up the whole meal.

The Blue Mussel (*Mytilus edulis*) is as usual the most important bivalve food, having been fed on by 20 birds (22.2 %) and in 2 instances taken as the sole food. As many as 50-100 small individuals might be taken in one meal, but the blue mussel is generally not so dominant in the meals of the Golden-Eye as was usually the case in the other Diving Ducks reported upon here. The largest blue mussels swallowed were about 12 mm long, but usually the individuals eaten were smaller.

Cockles (*Cardium spp.*) had been consumed by 16 of the Golden-Eyes (17.8 %) and in 1 instance formed the entire meal. One bird, collected at Besser Rev, Samsø, had taken about 50 *Cardium nodosum* of 3 to 5 mm, in addition to some other food, otherwise the species taken, when identifiable, was always the Common Edible Cockle (*Cardium edule*), always eaten in small individuals and never more than about 6 per meal.

The Clam *Spisula* (probably always *Spisula subtruncata*) had been included in the meals of 12 of the Golden-Eyes from the northwestern Kattegat (13.3 %), only small specimens have been taken but often in a number of about 20 per meal.

The Baltic Clam (*Macoma baltica*) had been taken in a number of 1 to 2 by 4 of the birds (3 from Læsø, and 1 from the Isefjord). About 20 young Gapers (*Mya truncata*) of about 10 mm had been eaten by 1 bird, a very small *Mya sp.*, and a small *Modiolaria sp.* by 2 other birds.

Fishes supplied a fairly important part of the diet of the Golden-Eyes at hand from the Kattegat area. 20 birds (22.2 %) had taken this food, and though none of the meals have consisted entirely of fishes such often supplied the bulk of the stomach content. The fishes found intact in the stomachs measured from about 4 to about 7 cm, and no eaten fish has been more than about 7-10 cm, judging from the bones found.

Gobies (*Gobius spp.*) had been taken by 9 birds. One stomach contained the remains and bones of about 10 individuals and in addition about 76 otoliths; but otherwise only single or a few individuals had been eaten.

The Threespined Stickleback (*Gasterosteus aculeatus*) supplied food for 6 birds and were taken in numbers varying from 1 to about 6.

The other fishes recorded are a small Codfish (*Gadus sp.*), a small Butterfish (*Pholis gunellus*), and a small flatfish (*Pleuronectidae*). In 5 instances only unidentifiable fish bones were found.

Polychaetes were recorded from 16 of the stomach contents (17.8 %) and in 1 instance were the sole food remains present. Jaws of Rag-worms (*Nereis spp.*) were present in 9 stomachs, in 1 stomach thus 10 large jaws, in another one about 20 small jaws. Bristles of the tube-worm *Pectinaria* were found in 4 stomachs, in one as the sole content; and jaws of Scale-worms (*Polynoinae*) were found in 3 stomachs.

Other animal items include the remains of a Jellyfish (perhaps *Aurelia aurita*) along with various molluscs and crustaceans; traces of Hydroids and Polyzoans, taken in a few instances accidentally or incidentally in the gathering other food; the remains of a large Hymenoptera in 1 instance; and in another instance about 50 eggs of diptera (probably *Culicidae*) which, however, were probably derived from the stomachs of Gobies, bones of which were also recorded in the stomach of the bird.

Plant food.—Four of the birds had included seeds in their meals. One bird, obtained at Samsø in December month, had taken a seed of Bulrush (*Scirpus sp.*) in addition to numerous *Gammarus* and some vegetative parts of Pondweed. Respectively 1 and 12 seeds of Pondweed (*Potamogeton sp.*) were eaten by 2 birds from the northwestern Kattegat which had otherwise fed on shrimps and gobies. One bird from Allingaebro had made its meal on 11 seeds of the pondweed *Potamogeton natans*, 1 of Burreed (*Sparganium sp.*), and 1 of Sorrel (*Rumex sp.*) in addition to various crustaceans, a cockle and a threespined stickleback.

Vegetable matter was only infrequently recorded; traces of Red Algae thus only in a few instances in agreement with that blue mussels, along with which the red algae become taken accidentally, are eaten less frequently by this Diving Duck than by most of the other species of this study. In the stomach contents which include crustaceans, traces of Eelgrass were, on the other hand, sometimes recorded, apparently taken accidentally along with the crustaceans, in a few instances also traces of pondweed or wigeongrass. Only 3 of the Golden-Eyes had more than a trace of vegetative growth in their stomachs and these may have fed purposely on this food. In the one instance it is a small quantity of remains of stems and leaves of eelgrass (*Zostera*), and in the 2 other instances pieces of stems and leaves of pondweed (*Potamogeton*).

The composition of the food taken by the Golden-Eye in the

Table 7.

Frequency of occurrences of the more common food items in the examined

| Food items                   | Salt-water localities in the Kattegat area |   | Localities of low salinity in the Baltic area (including the Sound) |   |
|------------------------------|--|---|---|---|
|                              | 90 birds                                   |   | 52 birds  |   |
|                              | Number of birds in which present           | Number of birds in which solely present | Number of birds in which present                                    | Number of birds in which solely present |
| <b>Mollusca</b> .....        | <b>63 (70.0 %)</b>                         | <b>15 (16.7 %)</b>                      | <b>44 (84.6 %)</b>  | <b>12 (23.1 %)</b>                      |
| Bivalvia .....               | 38 (42.2 %)                                | 5 (5.6 %)                               | 40 (76.9 %)   | 5 (9.6 %)                               |
| Mytilus edulis .....         | 20 (22.2 %)                                | 2 (2.2 %)                               | 38 (73.1 %)   | 4 (7.7 %)                               |
| Cardium spp. ....            | 16 (17.8 %)                                | 1 (1.1 %)                               | 1 (1.9 %)   | —                                       |
| Spisula subtruncata .....    | 12 (13.3 %)                                | —                                       | —   | —                                       |
| Macoma baltica .....         | 4 (4.4 %)                                  | —                                       | 1 (1.9 %)   | 1 (1.9 %)                               |
| Mya spp. ....                | 2 (2.2 %)                                  | —                                       | 4 (7.7 %)   | —                                       |
| <b>Gastropoda</b> .....      | <b>41 (45.7 %)</b>                         | <b>7 (7.8 %)</b>                        | <b>29 (55.8 %)</b>  | <b>1 (1.9 %)</b>                        |
| Littorina spp. ....          | 23 (25.6 %)                                | 4 (4.4 %)                               | 13 (25.0 %)   | 1 (1.9 %)                               |
| Hydrobia spp. ....           | 20 (22.2 %)                                | —                                       | 22 (42.3 %)   | —                                       |
| Neretina fluviatilis .....   | —  | —                                       | 8 (15.4 %)  | —                                       |
| Bittium reticulatum .....    | 4 (4.4 %)                                  | —                                       | 2 (3.8 %)   | —                                       |
| Nassa spp. ....              | —  | —                                       | —   | —                                       |
| <b>Crustacea</b> .....       | <b>69 (76.7 %)</b>                         | <b>18 (20.0 %)</b>                      | <b>39 (75.0 %)</b>  | <b>4 (7.7 %)</b>                        |
| Carididae .....              | 29 (32.2 %)                                | —                                       | 1 (1.9 %)   | —                                       |
| Carcinus maenas .....        | 13 (14.4 %)                                | —                                       | 3 (5.8 %)   | —                                       |
| Amphipoda (Gammarus) .....   | 16 (17.8 %)                                | —                                       | 23 (44.2 %)   | —                                       |
| Idothea spp. ....            | 20 (22.2 %)                                | 3 (3.3 %)                               | 17 (32.7 %)   | —                                       |
| Mysidae .....                | 13 (14.4 %)                                | 1 (1.1 %)                               | 1 (1.9 %)   | —                                       |
| <b>Pisces</b> .....          | <b>20 (22.2 %)</b>                         | —                                       | <b>7 (13.5 %)</b>   | —                                       |
| Gobius spp. ....             | 9 (10.0 %)                                 | —                                       | 4 (7.6 %)   | —                                       |
| Gasterosteus aculeatus ..... | 6 (6.7 %)                                  | —                                       | —   | —                                       |
| <b>Annelida</b> .....        | <b>16 (17.8 %)</b>                         | <b>1 (1.1 %)</b>                        | <b>4 (7.7 %)</b>  | <b>1 (1.9 %)</b>                        |
| Nereis spp. ....             | 9 (10.0 %)                                 | —                                       | 3 (5.8 %)   | 1 (1.9 %)                               |
| <b>Insecta</b> .....         | —  | —                                       | —   | —                                       |
| <b>Plant food</b> .....      | <b>6 (6.7 %)</b>                           | —                                       | <b>3 (5.8 %)</b>  | —                                       |
| Seeds .....                  | 4 (4.4 %)                                  | —                                       | 2 (3.8 %)   | —                                       |
| Ruppia .....                 | —  | —                                       | 1 (1.9 %)   | —                                       |
| Potamogeton spp. ....        | 3 (3.3 %)                                  | —                                       | 1 (1.9 %)   | —                                       |
| Scirpus spp. ....            | 1 (1.1 %)                                  | —                                       | 1 (1.9 %)   | —                                       |
| Chara (Oogonia) .....        | —  | —                                       | —   | —                                       |
| Vegetative growth .....      | 3 (3.3 %)                                  | —                                       | (1.9 %)   | —                                       |

stomach contents of Danish Golden-Eyes (*Bucephala clangula clangula*).

| Food items                   | Brackish-water localities in the Ringkøbing-fjord area |   | Brackish-water localities in the Limfjord area |   |
|------------------------------|--|---|--|---|
|                              | 38 birds   |   | 19 birds                                       |   |
|                              | Number of birds in which present                       | Number of birds in which solely present | Number of birds in which present               | Number of birds in which solely present |
| <b>Mollusca</b> .....        | <b>26 (68.4 %)</b>                                     | <b>2 (5.3 %)</b>                        | <b>15 (78.9 %)</b>                             | <b>2 (10.5 %)</b>                       |
| Bivalvia .....               | 14 (36.8 %)  | 1 (2.6 %)                               | 5 (26.3 %)                                     | 1 (5.3 %)                               |
| Mytilus edulis .....         | 2 (5.3 %)  | 2 (5.3 %)                               | —  | —                                       |
| Cardium spp. ....            | 2 (5.3 %)  | —                                       | 1 (5.3 %)                                      | 1 (5.3 %)                               |
| Spisula subtruncata .....    | —  | —                                       | 1 (5.3 %)                                      | —                                       |
| Macoma baltica .....         | —  | —                                       | —  | —                                       |
| Mya spp. ....                | 11 (28.9 %)  | 1 (2.6 %)                               | 4 (21.1 %)                                     | —                                       |
| <b>Gastropoda</b> .....      | <b>22 (57.8 %)</b>                                     | <b>1 (2.6 %)</b>                        | <b>14 (73.7 %)</b>                             | —                                       |
| Littorina spp. ....          | 4 (10.5 %)   | —                                       | 2 (10.5 %)                                     | —                                       |
| Hydrobia spp. ....           | 19 (50.0 %)  | —                                       | 8 (42.1 %)                                     | —                                       |
| Neretina fluviatilis .....   | 3 (7.9 %)  | —                                       | —  | —                                       |
| Bittium reticulatum .....    | —  | —                                       | 3 (15.8 %)                                     | —                                       |
| Nassa spp. ....              | —  | —                                       | 2 (10.5 %)                                     | —                                       |
| <b>Crustacea</b> .....       | <b>24 (63.2 %)</b>                                     | <b>2 (5.3 %)</b>                        | <b>13 (68.4 %)</b>                             | —                                       |
| Carididae .....              | 2 (5.3 %)  | —                                       | —  | —                                       |
| Carcinus maenas .....        | —  | —                                       | —  | 1 (5.3 %)                               |
| Amphipoda (Gammarus) .....   | 11 (28.9 %)  | 2 (5.3 %)                               | 8 (42.1 %)                                     | —                                       |
| Idothea spp. ....            | 2 (5.3 %)  | —                                       | 2 (10.5 %)                                     | —                                       |
| Mysidae .....                | —  | —                                       | —  | —                                       |
| <b>Pisces</b> .....          | <b>6 (15.8 %)</b>                                      | —                                       | <b>1 (5.3 %)</b>                               | —                                       |
| Gobius spp. ....             | 1 (2.6 %)  | —                                       | 1 (5.3 %)                                      | —                                       |
| Gasterosteus aculeatus ..... | 3 (7.9 %)  | —                                       | —  | —                                       |
| <b>Annelida</b> .....        | <b>1 (2.6 %)</b>                                       | —                                       | —  | —                                       |
| Nereis spp. ....             | 1 (2.6 %)  | —                                       | —  | —                                       |
| <b>Insecta</b> .....         | <b>4 (10.5 %)</b>                                      | —                                       | <b>5 (26.3 %)</b>                              | —                                       |
| <b>Plant food</b> .....      | <b>29 (76.4 %)</b>                                     | —                                       | <b>16 (84.2 %)</b>                             | —                                       |
| Seeds .....                  | 26 (68.4 %)  | —                                       | 15 (78.9 %)                                    | —                                       |
| Ruppia .....                 | 13 (34.2 %)  | —                                       | 12 (63.2 %)                                    | —                                       |
| Potamogeton spp. ....        | 21 (55.3 %)  | —                                       | 9 (47.4 %)                                     | —                                       |
| Scirpus spp. ....            | 8 (21.1 %)   | —                                       | 3 (15.8 %)                                     | —                                       |
| Chara (Oogonia) .....        | 10 (26.3 %)  | —                                       | —  | —                                       |
| Vegetative growth .....      | 8 (21.1 %)   | —                                       | 5 (26.3 %)                                     | —                                       |

salt-water habitats of the Kattegat area as it may be computed on the basis of the present material is: Crustaceans about 43 %, Molluscs about 39 % (Bivalves about 19 %, Gastropods about 20 %), Fishes about 10 %, Polychaetes about 5-6 %, and Plant food about 1-2 %.

The most prominent food items are in order of their importance: Shrimps (about 10 % of the food), Idotheas, Blue Mussel, Gammarids, and Periwinkles, which together account for almost half the total food, and the following of about equal value: Cockles, Spisulas, Mysids, and perhaps small Crabs.

The food of the Golden-Eye in the brackish water of the Sound and the Baltic area.

Molluscs were the most frequently recorded food in the 52 stomach contents of Golden-Eyes available from this area, being present in 44 of them (84.6 %) and in 12 (23.1 %) exclusively. Bivalves were recorded from 40 of the stomach contents (76.9 %), in 5 instances as the sole food, and Gastropods were recorded from 29 of them (55.8 %) and in 1 instance formed the entire content.

Bivalves.—Small Blue Mussels (*Mytilus edulis*) were the most important single food species; they have been taken by 38 birds (73.1 %), were in 4 instances (7.7 %) the sole food consumed and formed also in most other cases the bulk of the meals. Ten medium-sized individuals of the Baltic Clam (*Macoma baltica*) supplied the entire meal for a Golden-Eye obtained at Bornholm. Small Clams (*Mya sp.*) of only about 1.5 to 5 mm were taken by 4 birds in numbers from 1 to 7 individuals. 20-30 about 5 mm large Common Edible Cockles (*Cardium edule*) formed the major part of the meal of a Golden-Eye from the Sound.

Gastropods.—The small *Hydrobia spp.* were consumed by 22 birds (42.3 %) in quantities varying from 1 to about 500 individuals, these latter constituting a considerable part of the meal of a bird from Køge-bugt which had in addition fed on very small crabs and dog whelks. 13 birds (25.0 %) had taken from 1 to about 20 small Periwinkles (*Littorina spp.*), in 10 instances identified as *Littorina saxatilis*, in 2 instances as *Littorina littorea*. From 1 to 20 individuals of the brackish-water species *Neretina fluviatilis* had been taken by 8 birds, 7 of which from Bornholm and 1 from the Sound. Finally, 2 birds from Køge-bugt had taken respectively a few and 18 Common Dog Whelks (*Nassa reticulata*) of only about 2 mm.

Crustaceans were included in 39 of the examined meals (75.0 %) and were the only food found in 4 instances. Small species, mostly *Gammarus* and *Idothea*, were recorded, often in large quantities, from 35 stomach contents, but in several

instances they were ground to a fine, unidentifiable powder. *Gammarus spp.* (among which *G. locusta*, and *G. zaddachi*) were identified in 23 instances (44.2%), and *Idothea spp.* (among which *I. locusta*, and *I. viridis*) in 17 instances. A large quantity of *Mysids* formed the entire stomach content of a bird from Møen. Three Golden-Eyes from the Sound and Køge-bugt had taken some very small Common Shore Crabs (*Carcinus maenas*). One bird from the southern Sound had caught a few Prawns, probably *Palaemon fabricii*, in addition to a few Gobies.

Fishes had been taken by 7 of the Golden-Eyes (13.5 %), at least in 4 instances *Gobius spp.*, up to as many as 6-7 per meal, whereas otherwise only unidentifiable remains on bones were present.

Polychaetes were recorded from 4 stomach contents, in 3 instances Ragworms (*Nereis spp.*), respectively the jaws and bristles of a fairly large individual, and about 150 and 225 jaws of small individuals, in the last instance as the entire stomach content; finally bristles which may have been of *Pectinaria* were found in 1 instance.

Plant food.—One Golden-Eye had consumed a small quantity of vegetative growth of Pondweed (*Potamogeton pectinatus?*) in addition to blue mussels and other animal food. Of vegetative matter otherwise but traces of Algae have been recorded, in a few instances only and no doubt taken accidentally. Seeds had been taken by 2 birds. In the one instance a single seed of Knotweed (*Polygonum persicaria*) along with blue mussels and small crustaceans. In the other instance 35 seeds of Bulrush (*Scirpus maritimus*), 1 of Wigeongrass (*Ruppia sp.*), and 1 of Pondweed (*Potamogeton sp.*) along with fishes.

The composition of the food of the Golden-Eye in the Sound and Baltic area as shown by the present material is, expressed in percentages: Molluscs about 50 % (Bivalves about 29 %, Gastropods about 21 %), Fishes about 6.5 %, Polychaetes about 3.5 %, and Plant food about 2-3 %.

The food of the Golden-Eye in the fjord areas.

A number of birds have been obtained from fjord areas, namely 38 birds from the Ringkøbing fjord area, and 19 birds from the Limfjord area. In these areas foraging has taken place not only in the more or less brackish waters of the fjords, but also in the neighbouring fresh-waters.

The Ringkøbing-fjord area.

The 38 Golden-Eyes from this area were all obtained during October and November. Molluscs, crustaceans, and seeds each were represented in about  $\frac{2}{3}$  of the stomachs.

Molluscs were present in 26 stomach contents (68.4 %), and in 2 of them exclusively. In 8 instances, however, the molluscs were represented only by a few individuals of the small Hydrobiids.

Bivalves had been taken by 14 birds (36.8 %), viz. from 1 to 20 Clams (*Mya* sp.) of about 10 mm in 11 instances, in one of which the fragments of a single shell were the only food remains present; a few very small Blue Mussels (*Mytilus edulis*) in 2 instances; and a small Cockle (*Cardium* sp.) in 2 instances.

Gastropods had been taken by 22 birds (57.8 %), and by one of them as the only food. *Hydrobia* spp. were present in 19 instances (50 %) and in 8 instances were the only molluscan food, the quantities taken varying from 1 to about 150 per meal. Periwinkles (*Littorina* spp.) were taken by 4 birds, in 2 instances *Littorina saxatilis* in a quantity of up to 150–200 very small individuals in the single meal; and in another instance a single individual of *Littorina obtusata* along with 60–70 *Rissoa* sp. The brackish-water or fresh-water species *Neretina fluviatilis* had been taken by 3 birds in a number of from 1 to about 10; and a single Golden-Eye had fed on about half a dozen of the fresh-water snail *Limnaea ovata* in addition to other distinct fresh-water food.

Crustaceans were taken by 24 birds (63.2 %). Amphipods, probably always *Gammarus* sp., had been taken in at least 11 instances; in 2 of which as the sole food and in several other instances as the major part of the meal. A few Shrimps (*Crangon vulgaris*) were identified in 2 stomach contents, a few *Idothea* sp. in 2 other instances, and a single Ostracod in 1 instance. Otherwise only unidentifiable debris of crustaceans were present.

Fishes had been taken by 6 of the Golden-Eyes (15.8 %), viz. single individuals of the Threespined Stickleback (*Gasterosteus aculeatus*) by 3 birds, and at least 2 small individuals of *Gobius* sp. by 1 bird. In 2 instances only unidentifiable remains of bones were present.

Anura.—A few bones of a small Frog were found in 1 stomach along with other fresh-water foods.

Insects had been taken by 4 birds (10.5 %). Larvae of Midges (*Chironomidae*) in 2 instances, respectively a single individual along with food taken in salt or brackish water, and about 30–50 individuals along with food apparently obtained in fresh-water, among other a larva of Diving Beetle (*Haliplus*). Many heads of Caddisfly larvae (*Trichoptera*) were found in 1 stomach. Unidentifiable debris of Beetles (?) were found in 1 instance.

Polychaetes.—Traces of a single small Rag-worm were found in 1 stomach.

Seeds were an important food for the Golden-Eyes from the Ringkøbing-fjord area, having been eaten in varying numbers by 26 of the birds (68.4 %). One bird had drawn its meal solely from about 70 seeds in addition to a small

quantity of vegetative matter. Seeds of Pondweeds (*Potamogeton* spp.) were the most frequently recorded, being taken by 21 birds (55.3 %), and often in some quantity, one stomach thus contained 60 entire seeds in addition to the remains of many more. In 9 instances the species in question was *Potamogeton pectinatus*. Seeds of Wigeongrass (*Ruppia* spp.) had been taken by 13 birds in quantities varying from 1 to half a hundred per meal. Seeds of Bulrushes (*Scirpus* spp.) were taken by 8 birds, in quantities varying from 1 *Scirpus maritimus* to 60 *Scirpus tabernaemontani*. The species, when identifiable, were *Scirpus maritimus*, *S. palustris*, and *S. lacuster*, each in 1 stomach content, and *Scirpus tabernaemontani* in 6 stomach contents. Other seeds recorded were: 2 of Coontail (*Ceratophyllum demersum*) in 1 stomach, and single seeds of Burreed (*Sparganium* sp.), Sedge (*Carex* sp.), and Eelgrass (*Zostera* sp.). Fruiting bodies and often also bulblets, and other vegetative parts of Muskgrass (*Characeae*) had finally been included in the meals of 10 of the birds (26.3 %) in quantities varying from traces to about 400 fruiting bodies per meal.

Vegetative matter was infrequently present along with the seeds, only in one instance a piece of stem of Pondweed, otherwise always traces of Muskgrass. Small quantities of vegetative matter were in 3 instances the only plant food taken, viz. respectively a piece of rootstock of Eelgrass (*Zostera*), vegetative parts of Muskgrass (*Characeae*), and some unidentifiable green vegetative growths.

#### The Limfjord area.

From this area 19 Golden-Eyes were available, collected during October and November months. The composition of their food has been about the same as of the birds from the Ringkøbing-fjord area, only more distinct salt-water species have been included along with fresh-water forms.

Molluscs had been taken by 15 birds (78.9 %), by 2 of them as the sole food, viz. Bivalves (5 birds), and Gastropods (14 birds).

The Bivalves taken include: Small Clams (*Mya* sp.) of about 5–10 mm (4 birds); small Cockles (*Cardium* sp.) as the entire meal of 1 bird; and about 10 small *Spisula subtruncata* as the major part of 1 meal.

The Gastropods taken are: *Hydrobia* spp., taken by 8 birds; Periwinkles (*Littorina* spp.), taken by 2 birds; *Bittium reticulatum*, taken by 3 birds in numbers varying from 1 to 53 per meal; *Nassa pygmaea*, a few individuals taken by 2 birds which had in addition eaten insects; and a small *Gibbula tumidus* in 1 meal.

Crustaceans supplied food for 13 of the birds (68.4 %). Gammarids were present at least in 11 instances, often in very large quantities; *Idothea* sp. were

found in 2 instances, only in small numbers; and 1 bird had taken about 20 very small Common Shore Crabs (*Carcinus maenas*) of a breadth of carapace not more than about 5 mm.

Insects were eaten by 5 of the birds (26.3%), each of them having taken 1 to 2 Water-boatmen (*Corixa sp.*), two of them in addition 1 and 12 Caddisfly larvae (*Trichoptera*) respectively, and one bird also a few larvae of Crane-flies (*Tipulidae*).

Fishes were taken by only 1 of the Golden-Eyes from the Limfjord, viz. a few very small *Gobius sp.*

Plant food.—Seeds had been included in 15 of the meals (78.9%) of the Golden-Eyes of the Limfjord area and in 2 of the instances were the only food taken. Twelve birds had taken from 1 to 15 seeds of Wigeongrass (*Ruppia spp.*); 9 birds had taken from 1 to 15 seeds of Pondweed (*Potamogeton spp.*), exclusively *Potamogeton pectinatus* apart from one instance in which also a single seed of another unidentified species of pondweed was present; 3 birds had taken single seeds of Bulrushes (*Scirpus spp.*), in the 2 instances *Scirpus maritimus*; and 1 bird had also taken 3 seeds of Horned Pondweed (*Zannichellia sp.*). Vegetative matter was found in some few instances in very small quantities, always of Wigeongrass (*Ruppia*), viz. in 1 instance a 5 mm long piece as the sole plant food in the stomach in question, and in 5 instances in stomachs containing also seeds of the same plant.

The composition of the food of the Golden-Eye in fjord areas during winter as it may be computed on the basis of the present material from the Ringkøbing-fjord and the Limfjord areas is: Animal food about 68% and Plant food about 32%, viz. Molluscs about 30% (Bivalves about 11%, Gastropods about 19%), Crustaceans about 27%, Pisces about 4–5%, Polychaetes about 0.5%, Insects about 6%, Seeds about 28%, and Vegetative matter about 4%.

From the shallow sea round Rømø in the North Sea area 3 Golden-Eyes were available. Two of them were obtained together in the middle of November and had in their stomachs bones of some very small fishes, probably Gobies, and also remains of respectively 2 and 6 unidentified Shrimps. One of them also contained a fragment of a small Cockle (*Cardium*), a small *Hydrobia*, and remains of a few Water-boatmen (*Corixa sp.*). The other one in addition to the fishes and shrimps contained a fragment of a small bivalve, perhaps Blue Mussel, a jaw of a small Rag-worm (*Nereis sp.*), and further 31 seeds, viz. 23 *Potamogeton natans*, 1 *Potamogeton pectinatus*, 4 *Ruppia sp.*, and 3 *Scirpus maritimus*. The

third Golden-Eye from Rømø was obtained at the beginning of December and had eaten a great many larvae of Midges (*Chironomidae*); in the gullet it had 175–200 individuals of up to 23 mm length and in the gizzard the remains of perhaps a hundred more; in addition the bird had taken a single small Fresh-water Mite (*Hydrachnidae*), and many seeds, viz. about 175 *Potamogeton pectinatus*, about 75 *Scirpus maritimus*, and 1 *Zostera*.

#### The food of the Golden-Eye in fresh-water habitats.

A small number of Golden-Eyes having foraged exclusively in fresh-water habitats have been available, and together with the material dealt with from the fjord areas they give some idea of the composition of the diet of the Golden-Eye in such localities.

One bird obtained from a locality near Ribe in the beginning of November, had made its meal on a 10–15 cm long Eel (*Anguilla anguilla*) in addition to a few Caddisfly larvae (*Trichoptera*) and small Crustaceans (only traces left).

Two Golden-Eyes were collected at Kalvebodstrand, near Copenhagen, in November. One of them had foraged on 50–100 Water-boatmen (*Corixa sp.*) and a few Snails (*Limnaea sp.*). The other had taken many Caddisfly larvae, viz. 1 *Phryganea sp.* and 50–75 *Hydropsyche sp.*, along with 20–30 Midge larvae (*Chironomidae*), 1 *Limnaea sp.*, and an unidentifiable seed (*Scirpus?*), besides a few vegetative parts of Pondweed (*Potamogeton*).

One bird obtained from Møen in February contained only 3 seeds of the Pondweed *Potamogeton natans*, and 1 seed of the Bulrush *Scirpus lacuster*.

Two birds from Kalundborg in December contained the unidentifiable remains of some seeds, and 5 Caddisfly larvae (*Trichoptera*) respectively.

Four Golden-Eyes were obtained on Samsø in November. Two of them had subsisted on plant food: In the one instance 11 seeds of Pondweed, 6 of *Potamogeton pectinatus*, and 5 of an unidentified *Potamogeton sp.*; in the other instance: 16 seeds of the yellow Water-Lily (*Nuphar luteum*), and about 200 seeds of Pondweed, viz. about 75 of *Potamogeton natans* and the remaining consisting of various unidentified species of *Potamogeton*, and in addition some dead vegetative matter. The two other birds from Samsø had eaten respectively about 20 Midge larvae (*Chironomidae*) along with a number of very small Hydrobiids; and about 100 Caddisfly larvae (*Trichoptera*), some Midge larvae (*Chironomidae*), and a single seed of Bulrush (*Scirpus palustris*).

In fresh-water during winter the Golden-Eye thus subsists primarily on various aquatic insects and seeds of aquatic plants, and in addition takes such small crustaceans and molluscs as are available, and some fish; and also a small

quantity of vegetative growth, which kind of food probably may prove to be more important during the warmer months of the year.

A few Golden-Eyes, not included in the statistically treated material, had grains in their stomachs as the only food remains, no doubt obtained from out-laid artificial feed, the birds in question having been collected in harbours and near cities during severe winters.

Sand, gravel, and sometimes a few small stones, exceptionally as large as 11 mm, but usually much smaller, were present in small quantities in almost every stomach content examined.

#### Remarks.

In the European literature there are a few summarily accounts of the food habits of the Golden-Eye.

In NAUMANN'S 'Naturgeschichte Vögel Mitteleuropas' the food of the Golden-Eye is stated to be chiefly bivalves and small watersnails, small crustaceans, fishes, and water insects (for instance caddisfly larvae); also frogs and tadpoles, and also tubers, buds, and seeds of water plants. Further is recorded a report of water-shrews eaten by the Golden-Eye, and that some Golden-Eyes in Montenegro were found to have subsisted exclusively on the Medicinal Leech (*Hirudo medicinalis*).

In WITHERBY'S Handbook (1924 p. 335) the diet of the Golden-Eye is given as: 'Almost entirely animal: mollusca, both fresh and salt water (*Limnaea peregra*, *L. stagnalis*, *Littorina littorea*, *Neretina*, *Rissoa labiosa*, *Lacuna quadrijasciata*, *Physa*, *Montacuta* etc.); small fish (including small trout and young eels); crustacea (*Idothea*, *Cypris*, sandhoppers, shrimps, small crabs, etc.); earthworms; insects, especially water-beetles (*Helophorus*, *Dytiscus*, etc.) and neuroptera larvae (Phryganiidae) and larvae of Odonata'. Small quantities of algae, and seeds and remains of aquatic plants are also recorded.

MILLAIS (1913 I p. 91) states that the food of the Golden-Eyes in Britain consists 'primarily of salt and fresh water mussels, watersnails, species of crabs fish, frogs, tadpoles, and water-insects of many kinds'. He further adds: 'They are also said to eat the roots and seeds of certain water-plants, but of this I have neither seen nor heard a direct proof. On the sea I have only found the remains of crabs, mussels, and other shell-fish mixed with quantities of coarse sand and small stones. In a small pond they will soon catch all the small fish . . . .'

COLLETT (1877 p. 202) says that fairly considerable quantities of vegetable matter are included in the diet of the Golden-Eye, when it stays on fresh-water. In a bird obtained in Oslo fjord he found the stomach content made up entirely of a great number of the crustacean *Palaemon squilla*.

The American subspecies of the Golden-Eye, *Bucephala clangula americana*, is among the Diving Ducks whose food habits have been analysed in detail by COTTAM (1939). On the basis of a material of 400 stomach contents, collected at all seasons and in many different localities, the composition of the food was computed as follows: Crustaceans 32.42 %, Insects 27.98 %, Molluscs 9.71 %, Fishes 3.16 %, Miscellaneous animal food 0.64 %, and Plant food 26.09 %.

The percentage ratios of the composition of the diet of the Golden-Eye recorded in North America thus are about the same which hold good for the diet of the Golden-Eye in fresh-water and fjord areas in Denmark. In the diet of the species in general in Denmark molluscs are, however, much more prominent. The results of the two investigations are also not directly comparable since the present study only illustrates the diet during winter. COTTAM states for instance concerning the most important insect food of the American material, viz. larvae of caddisflies, that it ranged from 1.12 % in January to 32.20 % in April; and he states about the blue mussel that it during January supplied 14.28 % of the food, but scarcely a trace during April, May, and September.

COTTAM notes (p. 60) that 'It was a distinct surprise to find that molluscs were not more prominent in the American goldeneyes' diet'. In the diet of the Golden-Eye 'in Denmark during winter molluscs were found to supply about 30-40 %. In the total diet in general of the species in Northern Europe molluscs are, however, considerably less prominent than in the winter food alone and may comprise a percentage similar to that found in the American material.

The bivalves and gastropods recorded as food for the American Golden-Eye are very similar to those eaten in Denmark. COTTAM (1930 p. 60) has, however, a statement to the effect that the Golden-Eye should be able to extract the meat of the bivalves without consuming the hard calcareous shell. COTTAM states that several stomachs contained only the meat of bivalves and that 'Apparently the feat is accomplished by a very quick jerk at the shell when the valves are open'. If this is a correct interpretation it is a very unusual way of feeding for a Diving Duck, and one cannot help wondering whether not these birds have eaten dead bivalves of which the meat had been separated from the shells due to progressing decay, as is supposed to be the case with the clams found in the meal of the Longtailed Duck discussed above p. 196. In this connection, however, attention must also be called to the fact that BENT (1925 p. 43) when recording the food habits of the Longtailed Duck stated that 'as the mussels open their shells to procure food they are picked out by the ducks'.

In the main also the other food items of the Golden-Eye in America, besides molluscs, are similar to those taken in Denmark. COTTAM records of food items in addition sea-urchins and sponges, and among the insects some terrestrial



forms, as ants; but these may have been such which have been blown into the water by the wind.

It is evident both from this study and from the literature that the Golden-Eye is very adaptable in its food selection, taking not only immobile bottom animals, but also catching more mobile forms as fish and shrimps etc. The Golden-Eye dives only to moderate depths for which reason many food items taken by e. g. the Longtailed Duck does not appear in its diet, but the Golden-Eye, on the other hand, frequents many different habitats and for this reason, too, takes a great variety of food species. Seeds of various aquatic plants and aquatic insects are of value in its diet, and also seeds of terrestrial plants and insects may be included when carried into the water by the wind and then driven into the drift line where the Golden-Eye may sometimes be dabbling. The Golden-Eye is also reported to take food on the surface, e. g. Duckweed (*Lemna spp.*).

The largest hard food items recorded in the present material have been blue mussels of only about 12 mm, and most molluscs eaten have been considerably smaller. The largest crustaceans taken have been shrimps of about 4 cm; the largest fish, an eel, has been between 10 and 15 cm long.

#### TUFTED DUCK

*Aythya fuligula* (L.).

The Tufted Duck breeds in various fresh-water localities in Denmark, though not in large numbers. It is very common, however, as a winter-visitor and passage-migrant, both in fresh-water, especially the large lakes, and at the coasts and in the fjords. The species mostly feeds at smaller depths, 1-2 m, but may dive to about 5 m, which is probably the greatest depth to which ever dived.

#### Material.

Of the 262 birds examined, 226 were available for the statistical analysis of the composition of the diet, whereas the other ones had empty stomachs or contained only food taken on artificial feeding grounds, as grains (barley and oats), pieces of turnips, bread, and fish offal.

The greater part of the material was obtained from salt or brackish-water localities. Only a few Tufted Ducks were available from distinct fresh-water localities, but a number of the birds collected in fjord areas had fed in part on fresh-water food. By far the greater part of the material was collected during

the winter months October to February; only a few birds were from other months, viz. August, March, and April. Salt-water localities in the Kattegat area have furnished 17 birds, viz. Holbæk (5 birds), Kalundborg (4 birds), Saltbækvig (2 birds), Samsø (5 birds), and Allingaebro (1 bird). Brackish-water localities in the Sound and the Baltic area furnished 176 birds, viz. the Sound inclusive of Kalvebodstrand and Drogden (170 birds), Præstø-bugt (2 birds), Møen (2 birds), and Bornholm (2 birds). Some birds were taken in pronounced fjord areas, viz. Frederikssund in Roskilde-fjord (7 birds), and from various localities in the Ringkøbing-fjord area (23 birds). From distinct fresh-water localities finally 4 birds were available: 1 from Esrom Sø, and 3 from St. Jørgens Sø.

The food in the salt-water localities of the Kattegat area.

The Tufted Duck subsists in these localities almost exclusively on animal matter. Molluscs supply the major part of the food, but also small crustaceans are of some importance, and fishes too, apparently.

Molluscs had been eaten by 15 of the 17 birds available (88.2%), in 8 instances as the sole food. Gastropods were taken by 12 of the examined birds (70.6%), by 4 of them exclusively, and Bivalves were taken by 8 birds (47.1%) and exclusively by 1 of them.

Bivalves.—Small Cockles (*Cardium spp.*, mostly and probably always *C. edule*) had been taken by 7 birds; small Blue Mussels (*Mytilus edulis*) by 4 birds; and many small Baltic Clams (*Macoma baltica*) by 1 bird; and one bird, obtained from the Northwestern Kattegat, had in its meal included both about 10 very small *Mya sp.* and about 5 very small to small *Spisula subtruncata*, in addition to a few shrimps and a very small crab.

Gastropods.—The small Hydrobiids (*Hydrobia ulvae*, *H. ventrosa*, and *H. jenkinsi*) had been taken by 6 of the birds (35.3%), usually in a quantity of a few hundred, and in one instance as the sole food. Periwinkles were included in the meals of 5 birds, all 5 having taken *Littorina littorea* and the 3 of them in addition *Littorina saxatilis* var. *tenebrosa*. The number included in each meal varied from a few only to about 100 individuals of *Littorina saxatilis* of about 2 to 4 mm besides a few *L. littorea*. The largest Periwinkles recorded were only about 7 mm. Four of the 5 Tufted Ducks from Holbæk had eaten small Dog Whelks (*Nassa reticulata*), one of them about 26 individuals of about 4 mm. Another bird from Holbæk had also included about 500 *Bittium reticulatum* of 1 to 6 mm in its meal; and one bird from Samsø had taken a very small Common Whelk (*Buccinum undatum*). One bird from Kalundborg had taken a few *Nere-*

*tina fluviatilis*, in addition to about 200 *Hydrobia jenkinsi*; thus this bird had not been foraging in a pronounced salt-water locality.

Crustaceans were found taken by 4 of the birds (23.5 %); in 4 instances a few Amphipods, probably always *Gammarus sp.*, in one of the birds as the sole food remains; and in 1 instance, a bird from Northwestern Kattegat, 2-3 unidentifiable Shrimps and a very small Shore Crab (*Carcinus maenas*).

Fishes, exclusively Gobies (*Gobius sp.*) supplied food for 4 of the 5 Tufted Ducks obtained at Holbæk, November 20, 1941. One bird had fed entirely on fish, and in all instances they constituted the bulk of the meals; one stomach contained remains and bones of 20 individuals or more. The largest of the fishes consumed were at least about 6 cm long.

Vegetable matter.—Traces of Eelgrass (*Zostera*) were recorded from a few stomachs, but may have been taken accidentally or incidentally along with the molluscan food. The bird from Kalundborg which had included brackish-water gastropods in its meal had also taken 8 seeds of Pondweed (*Potamogeton sp.*).

The food in the Sound and the Baltic area.

A large material of Tufted Ducks (176 birds) has been available from these areas, showing that the food taken here is made up, almost exclusively, of molluscs, and besides comprises only small quantities of crustaceans, fishes, insects, and seeds.

Molluscs were included in almost every one of the meals of the Tufted Ducks from these areas (taken by 172 birds or 97.7 %), and 148 of the birds (84.1 %) had subsisted exclusively on this kind of food and 3 others contained only in addition a few small, accidentally consumed barnacles. Bivalves, mostly Blue Mussels, supplied food for 162 birds (92.0 %), for 51 of them (29.0 %) exclusively; and Gastropods supplied food for 104 birds (59.1 %) but formed only in 5 instances the entire stomach content.

The Blue Mussel (*Mytilus edulis*) has been by far the most important food item for the examined Tufted Ducks; 159 of the birds (90.3 %) had fed upon this bivalve and mostly made it a major part of their meals. 49 of the birds (27.8 %) had thus subsisted solely on blue mussels. The largest individuals recorded were about 25 mm, but in general they measured from about 3 to 15 mm.

Cockles (*Cardium spp.*) formed part of the meals in 34 birds (19.3 %). Usually only very small individuals, less than 5 mm, have been taken, but some were up to about 15 mm. One bird had consumed 15 individuals of 7 to 15 mm in addition to other food, and another had taken about 20 very small individuals;

Table 8. Frequency of occurrences of the more common food items in the examined stomach contents of Danish Tufted Ducks (*Aythya fuligula*).

| Food items                                     | Salt-water localities in the Kattegat area |   | Localities of low salinity in the Baltic area (including the Sound) |   | Brackish-water localities in the Ringkøbing-fjord area |   |
|--|--|---|---|---|--|---|
|  | 17 birds                                   |   | 176 birds   |   | 22 birds   |   |
|  | Number of birds in which present           | Number of birds in which solely present | Number of birds in which present                                    | Number of birds in which solely present | Number of birds in which present                       | Number of birds in which solely present |
| <i>Mollusca</i> . . . . .                      | 15 (88.2%)                                 | 8 (47.1%)                               | 172 (97.7%)   | 148 (84.1%)                             | 13 (59.1%)   | 1 (4.5%)                                |
| Bivalvia . . . . .                             | 8 (47.1%)                                  | 1 (5.9%)                                | 162 (92.0%)   | 51 (29.0%)                              | 4 (18.2%)  | —                                       |
| <i>Mytilus edulis</i> . . . . .                | 4 (23.5%)                                  | —                                       | 159 (90.3%)   | 49 (27.8%)                              | 1 (4.5%)   | —                                       |
| <i>Cardium</i> spp. ( <i>edule</i> ) . . . . . | 7 (41.2%)                                  | —                                       | 34 (19.3%)  | —                                       | 1 (4.5%)   | —                                       |
| <i>Mya</i> spp. . . . .                        | 1 (5.9%)                                   | —                                       | 6 (3.4%)  | —                                       | —  | —                                       |
| <i>Macoma baltica</i> . . . . .                | 1 (5.9%)                                   | —                                       | 3 (1.7%)  | —                                       | —  | —                                       |
| Gastropoda . . . . .                           | 12 (70.6%)                                 | 4 (23.5%)                               | 104 (59.1%)   | 5 (2.8%)                                | 12 (54.5%)   | 1 (4.5%)                                |
| <i>Littorina</i> spp. . . . .                  | 5 (29.4%)                                  | —                                       | 77 (43.8%)  | 1 (0.6%)                                | 1 (4.5%)   | —                                       |
| <i>Hydrobia</i> spp. . . . .                   | 6 (35.3%)                                  | 1 (5.9%)                                | 76 (43.2%)  | —                                       | 6 (27.3%)  | —                                       |
| <i>Nassa reticulata</i> . . . . .              | 4 (23.5%)                                  | —                                       | 3 (1.7%)  | —                                       | 1 (4.5%)   | —                                       |
| <i>Neretina fluviatilis</i> . . . . .          | 1 (5.9%)                                   | —                                       | 2 (1.1%)  | —                                       | 4 (18.2%)  | —                                       |
| <i>Limnaea</i> sp. . . . .                     | —  | —                                       | —   | —                                       | 5 (22.7%)  | —                                       |
| <i>Crustacea</i> . . . . .                     | 4 (23.5%)                                  | 1 (5.9%)                                | 13 (7.4%)   | —                                       | 7 (31.8%)  | —                                       |
| (Amphipoda & Isopoda)                          |  |   |   |   |  |   |
| <i>Pisces</i> . . . . .                        | 4 (23.5%)                                  | 1 (5.9%)                                | 2 (1.1%)  | —                                       | 3 (13.6%)  | —                                       |
| (Gobius & Gasterosteus)                        |  |   |   |   |  |   |
| <i>Insecta</i> . . . . .                       | —  | —                                       | 3 (1.7%)  | —                                       | 11 (50.0%)   | —                                       |
| <i>Plant food</i> . . . . .                    | 1 (5.9%)                                   | —                                       | 14 (8.0%)   | —                                       | 19 (86.4%)   | 1 (4.5%)                                |
| Seeds . . . . .                                | 1 (5.9%)                                   | —                                       | 9 (5.1%)  | —                                       | 19 (86.4%)   | 1 (4.5%)                                |
| <i>Ruppia</i> spp. . . . .                     | —  | —                                       | 1 (0.6%)  | —                                       | 10 (45.5%)   | —                                       |
| <i>Potamogeton</i> spp. . . . .                | 1 (5.9%)                                   | —                                       | 6 (3.4%)  | —                                       | 7 (31.8%)  | —                                       |
| <i>Scirpus</i> spp. . . . .                    | —  | —                                       | 6 (3.4%)  | —                                       | 13 (59.1%)   | —                                       |
| Vegetative growth . . . . .                    | —  | —                                       | 6 (3.4%)  | —                                       | 2 (9.1%)   | —                                       |

but usually only 1 or a few cockles were included in each meal. Only *Cardium edule* has been identified.

The other bivalves recorded from the stomach contents are: Small Clams (*Mya spp.*) of at most 10 mm length, taken by 4 birds, *Mya arenaria* and *Mya truncata* each identified in one instance; single individuals of small Baltic Clams (*Macoma baltica*) taken by 3 birds; and fragments of a *Modiolaria discors* found in the stomach content of a bird from Kalvebodstrand.

Gastropods.—Periwinkles and Hydrobiids, as was to be expected, were the only gastropods of any importance in the diet of the Tufted Duck in the open brackish-water areas of the Sound and the Baltic. 77 of the birds (43.8 %) had made Periwinkles part of their meals, almost in equal degree both *Littorina littorea* (at least 30 birds) and *Littorina saxatilis* (at least 27 birds); only in 5 instances both species were identified in the same stomach content. The largest individuals taken of *Littorina littorea* were about 15–18 mm, the largest of *Littorina saxatilis* about 7–8 mm. As many as 40 individuals were found in one meal, but on average only 5 have been recorded. 27 of the examined stomach contents consisted solely of periwinkles and blue mussels.

Hydrobiids formed part of 76 of the examined stomach contents (43.2 %), often only a few individuals were present, but in 11 instances the number varied from 100 to about 300. Their size never exceeds about 5 mm. Both *Hydrobia ventrosa* and *Hydrobia ulvae* were identified.

Other gastropods recorded are: Dog Whelks (*Nassa reticulata*) taken by 3 birds, by one of them in a number of 7 individuals of 15–17 mm; the small *Bittium reticulata* taken by 1 bird in a number of about 100; a single *Rissoa membranacea* taken by 1 bird; and a few *Neretina fluviatilis* taken by 2 birds.

Crustaceans had been eaten by 13 (7.4 %) of the Tufted Ducks examined from the Sound and the Baltic; but were in 4 instances represented only by Barnacles taken along with blue mussels. Barnacles (*Balanus*) were recorded from 5 stomachs in all; from 1 to a few Amphipods (probably always *Gammarus*) were recorded in 8 instances, and single individuals of *Idothea sp.* in 2 instances.

Insects were included in 3 of the examined meals along with seeds and various molluscs. In 2 instances a few Water-boatmen (*Corixa sp.*) and in 1 instance probably the remains of a Midge larva (Chironomidae).

Fishes.—A few unidentifiable bones were recorded from 2 stomach contents (1.1 %).

Plant food were found in some quantity in 14 (8.0 %) of the examined meals of Tufted Ducks from the Sound and the Baltic; but traces of Red Algae and Eelgrass, probably taken accidentally along with blue mussels and peri-

winkles, were present in another 10 % of the stomachs. Seeds were taken by 9 birds (5.1 %), and single seeds of the Pondweed *Potamogeton pectinatus* in 2 instances formed the whole stomach content, and 1 to 12 seeds of the same species were found in 4 other stomachs; seeds of Bulrushes (*Scirpus spp.*) were likewise found in 6 stomachs, 1 to 3 seeds in each, in the 5 instances *Scirpus maritimus*; 2 seeds of Wigeongrass (*Ruppia sp.*) were recorded in 1 stomach; and a single seed of Elder (*Sambuccus nigra*) in 1 instance. Vegetative matter more than traces, were found in 6 stomach contents, mostly pieces of stems and leaves of Eelgrass (*Zostera*), in 1 instance thus a 5 cm long leaf. Traces, plant fibers, of Eelgrass had been recorded from another 9 stomach contents.

The composition of the diet of the Tufted Duck in the marine habitats off the coasts in Denmark as it may be computed on the materials at hand from the Kattegat and the Baltic (as appears from the above, the diet is identical in the two areas) is: Molluscs about 90 % (Bivalves about 56 %, and Gastropods about 34 %), Crustaceans about 5 %, Fishes about 2 %, and various Plant food about 3 %. The Blue Mussel form about half the diet, and the only other important food items are Periwinkles, Cockles, and Hydrobiids.

#### The food of the Tufted Duck in the fjord areas.

For a determination of the food habits of the Tufted Duck in the vegetation-enclosed fjord areas of brackish-water 23 birds from the Ringkøbing-fjord area and 7 from the Roskilde-fjord were available. In these areas seeds are of some value, and also sometimes aquatic insects.

#### The Ringkøbing Fjord area.

Among the 23 birds available from this area some may have foraged exclusively in the neighbouring fresh-waters, but most have been feeding on the brackish-water animals and plants. A single bird had in its stomach remains of a purely marine meal, dog whelks, periwinkles, and hydrobiids, and has therefore been ignored in the computation of food percentages (compare table 12). In the remaining 22 birds the food taken were molluscs (13 birds) (gastropods in 12 instances and bivalves in 4 instances), crustaceans (7 birds), insects (11 birds), fishes (3 birds), and seeds (19 birds).

The Bivalves taken comprise: 1 small blue mussel (*Mytilus edulis*), 1 bird; a few very small cockles (*Cardium sp.*), 1 bird; and the fresh-water bivalve *Sphaerium sp.*, taken by 2 birds in a number of about 20–25 individuals of about 2 mm.

The Gastropods include the following more or less pronounced marine species: Common Periwinkle (*Littorina littorea*), a few individuals taken by 1 bird; Dog Whelk (*Nassa reticulata*), a 6 mm large individual taken by 1 bird; Hydrobiids (*H. ulvae* and *H. ventrosa*), from a few to about 300 individuals of 4 mm taken by 6 birds. Further the following more or less distinct fresh-water forms: *Neretina fluviatilis*, taken by 6 birds in numbers up to 12 per meal; *Limnaea* spp., taken by 5 birds, in 3 instances only some few unidentifiable individuals, but in 2 other instances about 225 *Limnaea ovata* of about 8 mm, and about 100 *Limnaea truncata* of 2-8 mm; finally, 2 *Planorbis contortus* of 3-5 mm taken by 1 bird.

The Crustaceans recorded were in 4 instances *Gammarus* spp., in the one instance the debris of a large quantity, in the other instance the remains of at least 20 individuals of the fresh-water species *Gammarus lacustris*. One stomach included traces of the fresh-water isopod *Asellus aquaticus*. A few Ostracods were recorded in 1 instance, and a few winter eggs of Water-fleas (*Daphniae*) in 1 instance.

The Fishes taken were in all 3 instances Threespined Sticklebacks (*Gasterosteus aculeatus*). One bird, obtained at the end of April, had included in its meal a quantity of unidentified fish spawn.

The Insects, which had been taken by 11 of the birds, include Midge larvae (Chironomidae), taken by 5 birds in quantities varying from a few to about 600 individuals, amounting to 11 ccm; Caddisfly larvae (Trichoptera), from 1 to about 10 individuals taken by 3 birds, (*Phryganea* sp., and *Hydropsyche* sp. have been identified); a Crane fly larva (Tipulida), 1 instance; a small larva of Waterbeetle (*Ilybius* sp.), 1 instance; a few Water-boatmen (*Corixa* sp.), 1 instance; and in 3 instances debris of from 1 to some Beetles (Coleoptera), among which Water-beetles (Dytiscidae), Leaf-beetles (*Donacia* sp.), a small Scarabeid, and unidentified ones.

Seeds were included in most (19) of the examined stomach contents of Tufted Duck from the Ringkøbing-fjord area; 1 stomach content consisted exclusively of seeds, and several others mainly so. Thirteen birds had taken seeds of Bulrushes (*Scirpus* spp.) in quantities varying from 1 to more than 150 per meal, viz. *Scirpus lacuster* (7 birds), *S. tabernaemontani* (3 birds), *S. palustris* (1 bird), and *S. maritimus* (3 birds). Ten birds had taken from 1 to more than 100 seeds of Wigeongrasses (*Ruppia* spp. among with *R. maritima*). Ten birds had taken from 1 to about 100 seeds of Pondweeds (*Potamogeton* spp.), identified were: *Potamogeton natans* (3 birds), and *P. pectinatus* (2 birds). Seeds of Horned Pondweed (*Zannichellia* sp.) had been taken by 2 birds of which the one had gorged itself with more than 1,000 such seeds in addition to other food. A few

seeds of Spikerush (*Heleocharis* sp.) were taken by 3 birds. A few seeds of Burreed (*Sparganium* sp.) were taken by 2 birds. The following seeds were each present in one meal, 1 seed of Goosefoot (*Chenopodium* sp.), 8 seeds of Buckbean (*Menyanthes trifoliata*), 10 seeds of Scurvy-grass (*Cochlearia* sp.), and about 300-400 seeds of Hawkbit (*Leontodon autumnalis*).

Vegetable matter.—2 of the birds having taken seeds had also eaten some few about 2 cm large undertermined pieces of green vegetative growth, and small traces of plant fibers were recorded in a few other instances.

#### Roskilde-fjord area (Frederikssund).

From this area 7 Tufted Ducks are available. They had exclusively subsisted on molluscs and seeds and all of them had included both these foods in their meals.

Bivalves were taken by 5 of the birds, small Cockles (*Cardium* sp.) by all 5, the Baltic Clam (*Macoma baltica*) by 2 of them, and small Blue Mussels (*Mytilus edulis*) by 2 others.

Gastropods had been taken by all 7 birds: Periwinkles (*Littorina saxatilis* var. *tenebrosa*) in 5 instances, up to 30 individuals of about 6 mm in a meal; a few to about 100 *Hydrobia* sp. in 5 instances; and up to 20 Rissoid shells in 3 instances, respectively *Rissoa membranacea* and *R. inconspicua*.

The Seeds taken include: Pondweeds (*Potamogeton* sp.), eaten by 5 birds, mainly *P. pectinatus*, up to 12 seeds per meal, and in one instance in addition about 100 seeds of probably *P. filiformis*; Bulrushes (*Scirpus* spp.), 1-20 seeds taken by 4 birds, in 3 instances *Scirpus tabernaemontani*, in 1 instance *S. lacuster*; Wigeongrasses (*Ruppia* sp.) up to about 200 seeds taken by 5 birds; 8 seeds of Horned Pondweed (*Zannichellia* sp.) taken by 1 bird; and 1 seed of Eelgrass (*Zostera nana*) taken by 1 bird.

The composition of the food of the Tufted Duck in the fjord areas during winter expressed in percentages computed on the present material is: Animal food about 60% and Plant food about 40%, viz. Molluscs about 30% (Bivalves about 9%, Gastropods about 21%), Crustaceans about 10%, Fishes about 4-5%, Insects about 16%, Seeds about 38%, and Vegetable matter about 2%.

#### The food of the Tufted Duck in fresh-water habitats.

A suggestion may be had of the feeding tendencies of the Tufted Duck in fresh-water habitats from the food found taken in the brackish water of the

vegetation-enclosed fjords, and besides 4 birds have been available from pronounced fresh-water localities.

Three birds were obtained from St. Jørgens Sø (lake) in Copenhagen and had in their stomachs remains from foraging in the lake as well as from foraging in the Sound, whereto the Tufted Ducks of the lake often return during the night. The food which must have been taken in the Sound included blue mussels, cockles, periwinkles, and barnacles. The food taken in the lake included a small beetle in 1 bird, and from several to about 200 1-2 mm large individuals of the fresh-water snail *Bythinia tentaculata* in 2 birds. All 3 birds had in addition taken a few seeds, *Scirpus* sp. and unidentified ones, and 2 of them also a small quantity of vegetative material, mosses and unidentified plant fibers.

One Tufted Duck was available from the large fresh-water lake Esrom Sø and contained in its stomach about 30 individuals of the bivalve *Dreissena polymorpha*, 5 to 22 mm large, more than 10 individuals of the small crustacean *Asellus aquaticus*, the remains of a small caddisfly larva (Trichoptera), the remains of some very small, unidentified gastropods of two different species, and a 3 cm long piece of unidentified green vegetative growth.

The diet of the Tufted Duck in fresh-water habitats thus is made up of all kinds of available molluscs, crustaceans, aquatic insects and their larvae, and fishes, further of seeds of aquatic plants, and, during winter, a very small percentage of vegetative material, a larger quantity possibly during summer.

Sand and gravel in small quantities were very often included in the stomach contents. One or a few small stones, less than 10 mm, were likewise often present, and in a few instances a larger number—up to about 25 small stones of 5 to 13 mm—formed the bulk of the stomach contents.

#### Remarks.

The food of the Tufted Duck in Germany is stated in NAUMANN'S 'Vögel Mitteleuropas' (1905 p. 143) to be mostly animal, though sometimes also to a large extent plant food as tubers, buds, seeds, and other parts of aquatic plants. As animal foods are mentioned insects, small fishes, spawn, tadpoles and small frogs, snails and mussels, at the sea mostly molluscs, in the Baltic e. g. periwinkles.

In WITHERBY'S 'Handbook of British Birds' (1924 p. 324) the food of the Tufted Duck is recorded as: 'Varied, both animal and vegetable but chiefly former. Small fish, and spawn, frogs, tadpoles, mollusca, both fresh and salt-water (*Limnaea*, *Rissoa*, *Littorina*, *Mytilus*, *Pisidium*, etc.), large number of insects, especially diptera, but also water-beetles, *Notonecta*, etc. Also grass,

duckweed (*Lemna*), berries of hawthorn and water-plants (*Polygonum*, *Potamogeton*, *Rumex*, etc.)'.

MILLAIS (1913 I p. 51) states about the Tufted Duck that 'Its chief food consists of aquatic animals of various kinds, freshwater mussels and snails, insects, frogs, and tadpoles', and further he says that it 'like most of the freshwater diving ducks will take quantities of food on the surface as flies, diptera, and duckweed, of which it is especially fond'.

From the present investigation it appears that the diet in general of the Tufted Duck in Denmark when occurring at the coasts, whether in salt or more brackish water, consists for the greater part and often almost exclusively of Molluscs (50-95 %), and further includes some Crustaceans (0-15 %), and sometimes some fish (0-15 %). The very small quantities of mobile food species found in the stomachs of Tufted Ducks may indicate, however, that the fishes taken mostly have been dead ones, which the Tufted Duck also may have a fair chance of finding in some quantity when feeding near the driftline.

The largest hard-shelled food items recorded in the present investigation were blue mussels of about 25 mm, the largest soft-bodied items were fishes at least 6 cm long.

#### SCAUP

##### *Aythya marila marila* (L.).

The Scaup is a very common winter-visitor and passage-migrant in Denmark, mainly occurring at the coasts and in the fjords, but sometimes also on the large fresh-water lakes. Perhaps the species sometimes breeds in northern Denmark, but no safe instances are known. The species is also very rare in Denmark during summer. The Scaup feeds mainly at depths of a few metres and probably it never dives deeper than about 6, perhaps 10 m.

#### Material.

In total, 140 birds were examined of which 122 had smaller or larger quantities of food remains in their stomachs. From more or less distinct salt-water localities in the Kattegat area 46 birds were available, obtained from September to February in the following localities: the Roskilde-fjord-Isefjord area (5 birds), Sejrsø-bugt (17 birds), Samsø (13 birds), localities in the northwestern Kattegat (11 birds, 8 of which from Allingåbro). From the Sound and Baltic area 65 Scaups were available, all obtained in November to February, viz. from the Sound, inclusive of Kalvebodstrand and Drogden, (42 birds), Præstø-fjord and

Fakse-bugt (15 birds), and Bornholm (8 birds). Further, 11 birds were collected in the Ringkøbing-fjord area, 1 at the end of April, the others during October and November.

The food in the salt-water localities of the Kattegat area.

The food taken in this area by the Scaups examined has been mainly animal, but 5 of the 8 Scaups from Allingaebro had also included seeds in their meals.

Molluscs were included in practically every meal, 45 of the birds (97.8 %) having taken this food. Molluscs supplied the entire meal in 30 instances (65.2 %) and the major part in most other instances.

Bivalves is the principal molluscan food, taken by 38 birds (82.6 %), by 15 of them (32.6 %) as the sole food.

The Blue Mussel (*Mytilus edulis*) has been the most frequently recorded food item, in all taken by 27 birds (58.7 %), in 13 instances (28.3 %) as their sole food, and it has also been the chief food in several other instances. The blue mussels consumed vary from very small to about 30 mm long individuals, but in a single instance also some larger ones (4-5 cm?) had been swallowed.

Cockles (*Cardium spp.*, when identifiable always *C. edule*) were included in 11 of the meals examined (23.9 %) and made up the entire meal in 2 instances. The size varies from about 5 mm to about 2-3 cm. Many small or about 6 large individuals might be taken in a single meal. Cockles are third in order of importance for the diet of the Scaup in the salt-water habitats, periwinkles being next in importance after the blue mussel.

Only one other bivalve has been recorded as food in the present material, viz. the Clam *Spisula subtruncata*, which had been eaten by 4 of the birds from the northwestern Kattegat, by 2 of them exclusively. The number of individuals in one meal varies from about 20 to at least 50, the size from about 5 to 18 mm.

Gastropods were eaten by 28 of the Scaups (60.9 %), but formed the sole food in 2 instances only.

Periwinkles (*Littorina spp.*) are the most frequently consumed gastropods, taken by 18 of the birds (39.1 %), and is the next important food in the diet of the Scaup in general in the marine habitats. The species identified were *Littorina obtusata*, taken by 4 birds foraging in the same locality at Samsø; *Littorina littorea*, taken by 4 other birds; and *Littorina saxatilis* of which 20-30 small individuals had been consumed by 1 bird from Allingaebro. One bird had made its entire meal on a few individuals of Periwinkles.

The Dog Whelk (*Nassa reticulata*) were included in 8 of the meals examined (17.4 %) in a number of 1 to 7 individuals, mostly less than 10 mm long.

Other Gastropods eaten by the Scaups from the Kattegat area were the small *Hydrobia sp.* which formed part of 7 meals (15.2 %) in quantities from 1 to at least 350 individuals per meal; *Rissoa spp.*, in 1 instance *Rissoa membranacea*, of which a few individuals were taken by 2 birds; and finally *Bittium reticulatum* of which 1 bird had taken a few individuals.

Fish were taken by 4 of the Scaups (8.7 %), all of them, however, birds obtained in the Roskilde-fjord and Isefjord area, viz. 3 birds from Frederikssund and 1 bird from Holbæk. All the fishes were Gobies, but in 1 meal apparently two different species were included. The number of gobies included in one meal has varied from a few to at least 6. The largest intact individual present measured about 4 cm in length.

Crustaceans were only found in 3 of the stomach contents (6.5 %), viz. Isopods, *Idothea sp.*, singly in 2 instances, and trace of a Barnacle (*Balanus*) in 1 instance.

Other animal food recorded was Annelid worms, *Pectinaria sp.*, taken by 2 birds from Allingaebro; and Insects, viz. remains of a few Water-boatmen (*Corixa sp.*) found in the stomach of a Scaup which had otherwise fed on cockles and hydrobias, and the unidentifiable traces of a Beetle in a meal otherwise consisting of a few hydrobias and a large quantity of seeds of *Zannichellia* and *Ruppia*.

Plant food.—Seeds, as already mentioned, had been included in the meals of 5 of the 8 Scaups from Allingaebro (10.9 % of the material from the Kattegat area) in addition to blue mussels, periwinkles, and in part also dog whelks and pectinarias. The seeds taken are: Horned Pondweed (*Zannichellia sp.*), taken by 1 bird in a number of about 600 seeds, and Wigeongrass (*Ruppia sp.*), taken by the same bird in a number of 200 seeds, and in a number of 11 seeds by another one; single seeds of the Bulrush *Scirpus maritima*, taken by 2 birds; and finally a single seed of Pondweed (*Potamogeton sp.*), taken by 1 bird besides also a quantity of leaves of same. Vegetative matter was further found in a few other stomach contents, traces of Red Algae, and also small quantities of leaves of Eelgrass (*Zostera*). Four birds, in all, had consumed more than a trace of vegetable matter in addition to the animal food.

Sand, gravel, and, or, a few small stones were usually included in the stomach contents, often the small stones were between 10 and 25 mm, and the largest was 18 mm. A larger amount of sand and gravel was sometimes present, but as a rule a single or a few small stones or a small quantity of sand, rarely neither sand nor gravel.

The food taken by the Scaup in the salt-water localities in the Kattegat area as expressed in percentages computed on the present material

Table 9.

Frequency of occurrences of the more common food items in the examined stomach contents of Danish Scaups (*Aythya marila marila*).

| Food items   | Salt-water localities in the Kattegat area |   | Localities of low salinity in the Baltic including the Sound |   | Brackish-water localities in the Ringkøbing fjord area |
|--|--|---|--|---|--|
|  | 46 birds                                   |   | 65 birds   |   | 11 birds   |
|  | Number of birds in which present           | Number of birds in which solely present | Number of birds in which present                             | Number of birds in which solely present | Number of birds in which present                       |
| <i>Mollusca</i> . . . . .  | 45 (97.8%)                                 | 30 (65.5%)                              | 65 (100%)  | 57 (87.7%)                              | 10 (91.0%)   |
| Bivalvia . . . . .   | 38 (82.6%)                                 | 15 (32.6%)                              | 65 (100%)  | 41 (63.1%)                              | 3 (27.3%)  |
| <i>Mytilus edulis</i> . . . . .  | 27 (58.7%)                                 | 13 (28.3%)                              | 54 (83.1%)   | 31 (47.7%)                              | 1 (9.1%)   |
| <i>Cardium</i> sp. (edule) . . . . .   | 11 (23.9%)                                 | 1 (2.2%)                                | 9 (13.8%)  | 1 (1.5%)                                | 2 (18.2%)  |
| <i>Macoma baltica</i> . . . . .  | —  | —                                       | 12 (18.5%)   | 7 (10.8%)                               | —  |
| <i>Spisula</i> spp. (sub-truncata) . . . . .                                     | 4 (8.7%)                                   | 2 (4.3%)                                | —  | —                                       | —  |
| Gastropoda . . . . .   | 28 (60.9%)                                 | 2 (4.3%)                                | 21 (32.3%)   | —                                       | 9 (81.8%)  |
| <i>Littorina</i> spp. . . . .  | 18 (39.1%)                                 | 1 (2.2%)                                | 11 (16.9%)   | —                                       | —  |
| <i>Nassa reticulata</i> . . . . .  | 8 (17.4%)                                  | —                                       | —  | —                                       | —  |
| <i>Hydrobia</i> spp. . . . .   | 7 (15.2%)                                  | —                                       | —  | —                                       | 9 (81.8%)  |
| <i>Neretina fluviatilis</i> . . . . .  | —  | —                                       | 2 (3.1%)   | —                                       | 2 (18.2%)  |
| <i>Crustacea</i> . . . . .<br>(Amphipoda & Isopoda)                              | 3 (6.5%)                                   | —                                       | 1 (1.5%)   | —                                       | 3 (27.3%)  |
| <i>Pisces</i> . . . . .<br>( <i>Gobius</i> & <i>Gasterosteus</i> )               | 4 (8.7%)                                   | 1 (2.2%)                                | 2 (3.1%)   | —                                       | —  |
| <i>Annelida</i> . . . . .  | 2 (4.3%)                                   | —                                       | 2 (3.1%)   | —                                       | —  |
| <i>Insecta</i> . . . . .   | 2 (4.3%)                                   | —                                       | —  | —                                       | 3 (27.3%)  |
| Plant food . . . . .   | 7 (15.2%)                                  | —                                       | 5 (7.7%)   | —                                       | 11 (100%)  |
| Seeds . . . . .<br>( <i>Ruppia</i> , <i>Potamogeton</i> , <i>Scirpus</i> , etc.) | 5 (10.9%)                                  | —                                       | 4 (6.2%)   | —                                       | 11 (100%)  |
| Vegetative growth . . . . .  | 4 (8.7%)                                   | —                                       | 3 (4.6%)   | —                                       | 4 (36.4%)  |

is: Molluscs about 83% (Bivalves about 53%, and Gastropods about 30%), Crustaceans about 2%, Fishes about 6%, Polychaetes about 2%, Insects about 1%, and Plant food about 6%.

The food in the brackish water of the Sound and the Baltic area.

Molluscs are the principal food and were present in each of the 65 meals of Scaups examined from this area, in no less than 57 instances (87.7%) as the sole content.

Bivalves were the most important, being present in all meals and the only food in 41 instances (63.1%). The Blue Mussel (*Mytilus edulis*) has been the most important single food species, taken by 54 birds (83.1%), and by 31 of them (47.7%) exclusively. The next frequently recorded bivalve and also the next important food item was the Baltic Mussel (*Macoma baltica*), which had been taken by 12 of the Scaups (18.5%), of which, however, 11 were among 15 birds obtained in the same area in the Præstø-fjord in November 1941. Seven birds (12.8%) had fed only on *Macoma baltica*. In size the bivalves taken varies from very small to 15–20 mm. The largest number found in any stomach was about 10. Cockles (*Cardium* spp.) were also of importance as food items; they had been eaten by 9 birds (13.8%) and by 1 of them as the sole food; *Cardium edule* was the most frequently identified, in one instance, however, the species may have been *Cardium exiguum*. Clams, *Mya truncata* and *Mya* sp., had been taken by 3 of the Scaups (4.6%), always small individuals of 5–10 mm, and in one meal at least as many as 20.

Gastropods. 21 of the Scaups examined (32.3%) had included different gastropods in their meals. Most frequently recorded were the small Hydrobiids, which had been consumed by 13 birds (20.0%) in numbers varying from 1 to several hundred. Next frequently were Periwinkles (*Littorina* spp.) of which a single or a few, usually fairly small individuals, were found in 11 stomach contents (16.9%); *Littorina saxatilis* were identified in 5 instances and *Littorina littorea* in 4 instances, 1 meal included both species. 2 of the birds collected at Bornholm had also taken a few *Neretina fluviatilis*.

Fishes had been taken by 2 of the Scaups from Kalvebodstrand, a Three-spined Stickleback (*Gasterosteus aculeatus*) by the one, a *Gobius* sp. by the other.

Other animal food recorded included only Rag-worms (*Nereis* sp.), in 2 instances, and unidentifiable debris of small Crustaceans, in 1 instance.

Plant food.—Seeds were consumed by 4 of the Scaups, 3 of which from

Præstø-fjord, and 1 from Kalvebodstrand, viz. a few seeds of the Bulrush *Scirpus maritimus*, taken by all 4 birds; a few seeds of Pondweed (*Potamogeton pectinatus*), taken by 2 birds; and a seed of Wigeongrass (*Ruppia*) in 1 instance. A stone of plum was found in a stomach otherwise containing remains of Cockles.

Vegetative matter had been found in small quantities in 2 of the meals on seeds, viz. small pieces of stems and leaves probably of Pondweed; and 1 bird had consumed a large quantity of pieces of leaves of Eelgrass (*Zostera*) and Wigeongrass (*Ruppia*) in addition to a few blue mussels. Traces of Red Algae, taken accidentally, were present in a few instances along with blue mussels.

The composition of the diet of the Scaup off the coasts in the Sound and Baltic area thus is the same as in the more salt localities of the Kattegat area. The Scaup feeds primarily on Molluscs, and the most important food species, the Blue Mussel, Cockles, and Periwinkles, are commonly distributed in both areas.

#### The food of the Scaup in the fjord areas.

The composition of the food of the Scaup in the vegetation-enclosed fjords is suggested by 11 birds available from the Ringkøbing-fjord area. In such areas seeds supply a very considerable part of the winter food, replacing in part the molluscs; further is taken some vegetative growth, and during the summer such food may probably be of more importance. All 11 Scaups had fed on seeds, 10 of the birds had in addition taken molluscs, 3 of them also crustaceans, and 3 also insects.

The Molluscs taken were mostly Gastropods (taken by 9 birds), viz. the small Hydrobiids in 9 instances (*Hydrobia ventrosa* and *Hydrobia jenkinsi* have been identified) in numbers varying from a few to several hundred; a few *Neritina fluviatilis* in 2 instances; and the remains of a few small unidentifiable gastropods in 1 instance. Bivalves were taken by 3 birds only; small Cockles (*Cardium*) in 2 instances, a single very small Blue Mussel (*Mytilus edulis*) in 1 instance, and in another instance a very small Clam (*Mya* sp.).

The Crustaceans probably in all 3 instances were *Gammarus* sp., in the 2 instances traces only, in the third instance remains of several individuals.

The Insects consumed were Midge larvae (Chironomidae) in 2 instances, about 10 and 20 individuals respectively, traces of an unidentifiable medium-sized Beetle (Coleoptera) in 1 instance, and in another instance debris of a quite unidentifiable insect.

The Seeds taken in the Ringkøbing-fjord area were primarily of Pondweeds

(*Potamogeton* spp.), present in 10 of the 11 examined stomach contents, in numbers from 1 to about 110 seeds. In at least half the instances the species in question was *Potamogeton pectinatus*. Seeds of Bulrushes (*Scirpus* spp.) and Wigeongrass (*Ruppia* spp.) were almost as important and were each present in 7 stomach contents in numbers varying from a single seed to 200 seeds of *Scirpus* in addition to 300 of *Ruppia*; *Scirpus maritimus* and *Scirpus tabernaemontani* each could be identified in 5 instances, *Scirpus lacuster* in 1 instance, and *Ruppia maritima* in some instances. Horned Pondweed (*Zannichellia* sp.) were present in 2 instances, 1 and 800 seeds respectively, and the Spikerush *Heleocharis palustris* in single seeds in 2 instances. Small quantities of fruiting bodies of Muskgrass (Characeae) were included in 2 stomach contents.

Vegetative growths had been taken in small quantities by 6 of the 11 Scaups available from a fjord area, in 4 instances of Bulrushes and Pondweeds, and in 2 instances of Muskgrasses (other birds than those having taken fruiting bodies of muskgrass).

The composition of the food in a fjord area as expressed in percentages on the present material is: Animal food about 57%; Molluscs about 35% (Bivalves about 9%, Gastropods about 24%), Crustaceans about 11%, Insects about 11%; Plant food about 43% (Seeds about 34% and vegetative growth about 9%). It goes without saying, that these figures merely suggest the tendency.

#### Remarks.

In NAUMANN'S 'Naturgeschichte Vögel Mitteleuropas' (1905 p. 153) the food of the Scaup is stated to be chiefly animal, molluscs, e. g. periwinkles, insects, and small fishes, but also some vegetable food as tubers, seeds, and green vegetative growths of aquatic plants.

In WITHERBY'S 'Handbook of British Birds' (1924 p. 329) the food of the Scaup is given as follows: 'Almost entirely animal, but buds and seeds of water-plants are eaten in summer, and *Zostera* has been recorded, as well as algae, which are brought to the surface for eating. Staple food molluscs: young mussels (*Mytilus edulis*), cockles (*Cardium*); also *Littorina littorea*, *L. retusa*, *Lacuna*, *Rissoa*, *Cerithium*, *Nassa*, *Pisidium*, and *Nucula*; also small crustacea. Many insects (Diptera) and small fish taken in freshwater lakes in summer'.

MILLAIS (1913 I p. 74) says that 'In the winter months Scaup feed little on vegetable food, unless they are regularly frequenting freshwater lakes. On sea I have never seen them touch the soft roots of *Zostera marina*, so dearly loved by the Wigeon and Brent Geese, although they eat seeds freely. Even in summer they only live partly on the ripe and unripe seeds of floating or submerged water plants, for in the contents of the stomachs of the Scaup this season are always



found quantities of water insects and small fish. Their principal food is small shell-fish of all kinds.'

The Scaup, it appears, is primarily a mollusc-feeder, in the present material 80-95 % of the food were supplied by Molluscs. Crustaceans have been of little value for the birds at hand, and the records in the literature also seem to show that they are only of slight importance for the diet in general of the Scaup. Aquatic insects are taken in some quantity when available and also annelid worms. Fishes are also taken, but in so small a percentage that possibly it is only when dead or half dead individuals are found. Seeds when available are taken as readily as are Molluscs. Sometimes also vegetative growths are included in the meals; this food, however, is of very little importance during the winter half of the year, and even during the summer half this food does not seem to be given much attention by the Scaup.

The largest hard-shelled food items recorded in the present material were blue mussels about 4 cm long or slightly more, but such large items are the exceptions.

#### POCHARD

##### *Aythya ferina ferina* (L.)

The Pochard—though it is not a common bird in Denmark—is the species of Diving Duck most commonly breeding here, choosing as nesting places mainly fresh-water localities at the large inland lakes. Besides as summer-resident the species occurs also as a passage-migrant during spring and autumn, staying at the inland lakes and in the fjords. Limited numbers also stay in Denmark as winter-visitors. The Pochard mostly feeds in very shallow water and probably it never dives farther than a few metres. In the quite shallow water it may also forage in the manner of a surface-feeding duck, by tilting the body vertically and only immersing the head and forebody. It may also take its food on the surface itself, or dabble for it in the mud along the shore.

##### Material.

In total 138 Pochards were examined, 118 of which contained a smaller or larger quantity of food remains. The material was mostly obtained during the winter half of the year and mainly consisted of migrating birds and winter-visitors. The largest number of the birds was collected in the Sound and the Baltic areas (66 birds), viz. from August: Saltholm (3 birds), and Møen (1 bird); from October: Amager, Kalvebodstrand, and Køge-bugt (4 birds), and Vordingborg (1 bird); from January: Kalvebodstrand (2 birds), Møen (27 birds), and

Faaborg (24 birds). From the Kattegat area 32 stomach contents were available, viz. from September: Saltbækvig (2 birds), and Allingaebro (1 bird); from October: Allingaebro (1 bird); from January: Hadsund (23 birds), and Samsø (1 bird); from February: Roskilde-fjord (2 birds); and from May: Nykøbing Sjælland (2 birds). Further were available 10 birds obtained in the Limfjord area in January, and 10 birds from the Ringkøbing-fjord area, viz. Hov Vig in August (2 birds), Henne Kirkeby in October (1 bird), Ringkøbing in October (1 bird), Holmsland in October (1 bird), Nymindegab in November (3 birds), and Hov Vig in April (1 bird).

The material, though including birds from several of the months of the year, is insufficient for a statistical analysis of the seasonal variation of the food in general of the Pochard; thus no birds were available from the summer months. The material has therefore been treated as a whole as were also the materials of the other species of Danish Diving Ducks reported upon. Nor was reason found for any discrimination between birds obtained in the Kattegat area, the Sound and the Baltic, and in the Limfjord and Ringkøbing-fjord areas, since the Pochard largely frequents similar habitats in these areas, and since the stomach contents at hand from the various areas have not shown any noticeable differences.

##### The food of the Pochard in Denmark.

Plant food, both seeds and vegetable growth, constitutes a major part of the diet of the Pochard, but also animal food is taken in quantities. As already pointed out, the material, however, does not give an exact picture of the composition of the diet in general throughout the year. A larger percentage of the examined birds have subsisted exclusively or mainly on animal food than would have been the case if a material of birds evenly distributed over all seasons had been studied.

##### Animal food.

Animal food items had been taken by 72 of the 118 Pochards examined (61.0 %), and 13 of them (11 %) had subsisted exclusively on this type of food. These latter birds were all obtained during December and January and, of course, usually in more or less pronounced marine localities, which, however, have been well distributed, viz. Hadsund, and Samsø, both in the Kattegat area, and Faaborg, the Sound, Køge-bugt, and Møen, all in the Baltic area inclusive of the Sound.

Molluscs were the principal animal food taken by the examined Pochards; various species having been eaten by 40 of the birds (33.9 %) and in 12 instances

(10.2 %) forming the entire meal. Bivalves were taken by 37 of the birds (31.4%), by 6 of them (5.1 %) as the sole food, whereas Gastropods were taken by 30 birds and were the sole food in two instances.

The Blue Mussel (*Mytilus edulis*) is the bivalve most frequently recorded in the stomach contents; it was present in 19 stomachs (16.1 %) and supplied the entire content in 2 instances (1.7 %). Probably the blue mussel is the most important single animal food species for the Pochard in salt-water or brackish-water localities (both the small snails, *Hydrobia spp.*, and small rag-worms, *Nereis spp.*, have been slightly more frequently recorded, but in general they have been of less importance in the individual meals). The blue mussel is, however, by far not so prominent in the diet of the Pochard as is otherwise the case for the Diving Ducks. The largest blue mussels swallowed by the Pochards examined were about 3.5 cm long, but sizes between 5 mm and 20 mm were the most frequent.

Cockles (*Cardium spp.*)—when identification was possible always the Common Edible Cockle (*Cardium edule*)—had been taken by 14 of the Pochards (11.9 %) and were in 2 instances (1.7 %) the sole article of food. Usually only a few small individuals had been taken in each meal, but one bird, collected at Samsø in January, had made its meal on a fair number of medium-sized individuals.

The Baltic Clams (*Macoma baltica*) supplied part of the food for 14 of the Pochards (11.9 %), of which the greater part (12 birds) were obtained at the two Baltic localities, Møen and Faaborg. One bird from the Limfjord area had also taken this bivalve, and one from Hadsund in the Kattegat area had made its entire meal on several medium-sized individuals; one of the Pochards from the Baltic likewise had fed only on *Macoma baltica*, and in several other instances these formed the bulk of the meal. The largest number taken in one meal was about 20–30 individuals, the largest size recorded about 2 cm.

Clams or Gapers (*Mya spp.*) had been taken by 2 of the birds from the Baltic, a few individuals of about 2 cm in each instance.

Unidentifiable remains of bivalves were present in 3 of the stomach contents.

The small snails, *Hydrobia spp.*, were the Gastropods most frequently recorded, supplying part of the meals in 21 instances (17.8 %). Sometimes only a few individuals had been taken, but they may also be consumed in considerable numbers, up to at least 400 individuals, at a single meal. *Hydrobia jenkinsi* and *Hydrobia ventrosa* are presumably the most frequently taken species.

Periwinkles (*Littorina spp.*) had been eaten by 15 birds (12.7 %), when identifiable they proved to be *Littorina littorea* in 8 instances and *Littorina saxatilis* in 4 instances, both species have sometimes been taken in the same

meal. The largest size recorded was between 10 and 15 mm, otherwise only small specimens were consumed.

Of other marine gastropods only a single individual of a *Rissoa sp.* has been found in one stomach.

The fresh-water or brackish-water gastropod, *Neretina fluviatilis*, was found in small numbers in 3 of the Pochards, from Faaborg and Allingaebro respectively, one of the birds having some few individuals as the sole food in its stomach.

A single individual of the fresh-water gastropod, *Limnaea sp.*, had been taken by one of the Pochards obtained in the Ringkøbing-fjord area.

Crustaceans supplied part of the meals of 12 of the examined Pochards (10.2 %) but have never been taken in more than very small quantities. Single individuals of *Gammarus* were taken by 3 birds, 2 of them from the Ringkøbing-fjord area and the third from the Limfjord area; a single Barnacle (*Balanus sp.*) was taken by a bird which had also fed on periwinkles; and very small numbers of Ostracods were consumed by 9 birds from the Ringkøbing-fjord area, the Kattegat area, and the Sound and the Baltic. The bulk of the stomach contents including ostracods was usually formed by the fruiting bodies of muskgrass (Characeae), and the ostracods thus must have been consumed quite accidentally in the gathering of this food. One stomach, in which fruiting bodies of muskgrass constituted the principal content, also contained a few of the thick-shelled winter eggs of water-fleas (Daphniae), likewise taken accidentally in the gathering of the fruiting bodies of the muskgrass.

Another animal item found in varying numbers in the stomach contents including fruiting bodies of muskgrass is the about 1 mm large lids of the egg capsules of the gastropod *Neretina fluviatilis*, likewise taken quite accidentally along with the fruiting bodies. In the same stomachs also jaws of small Rag-worms (*Nereis spp.*) were frequently recorded, and these too may likewise have been an accidental content in the stomachs.

Fishes had been taken by 3 of the Pochards (2.5 %), viz. single individuals of Sticklebacks (*Gasterosteus sp.*) by 2 birds from the Ringkøbing-fjord area and Allingaebro respectively, and in the third instance, also a bird from the Ringkøbing-fjord area, an unidentifiable species; only a trace of bones was present.

Insects, as might be expected, were a fairly frequently taken food and formed the bulk of individual meals. In fresh-water localities they must be an important food for the Pochard, and insects furnished even in the material at hand, from brackish-water localities mainly, part of 18 of the examined stomach contents (15.3 %).

Midge larvae (Chironomidae) were the most important insect food. Seven Pochards (5.9 %) had made their meals in part on these insects and sometimes consumed them in very large quantities. One bird obtained in the Ringkøbing-fjord area in April had eaten about 500 midge larvae, and another bird from the same area in October contained no less than about 1.000 individuals in its gullet and gizzard. The former of these birds had also eaten about 1.000 small eggs which may be of midges.

Beetles (Coleoptera) of various species were found in 8 of the examined stomach contents (6.8 %), always in single numbers only; in one instance it was a small Water-beetle (Hydrophilidae), in another instance a *Helophorus* sp., otherwise the beetles were unidentifiable.

Other insects recorded include: Crane-fly larvae (Tipulidae), taken by 3 birds in a number of 1 to a few individuals; small larvae of Diving Beetles (Dytiscidae), taken by 2 birds in a number of a few individuals; and the following, each from a single stomach content: a few Mosquito larvae (Culicidae); about 25 unidentified Diptera larvae of about 25 mm length; some few, small Caddisfly larvae (Trichoptera) of two different species; a single Water-boatman (*Corixa* sp.); an unidentified Hemiptera; a small Fly; and in two instances unidentifiable traces of insects. The same stomach of course sometimes contained more kinds of insects. One bird had further consumed about half a hundred of the small Spring-tails (Colembola) accidentally along with a large quantity of fruiting bodies of muskgrass.

Annelid Worms.—Jaws of small Rag-Worms (*Nereis* spp.) have been of fairly frequent occurrence, included in no less than 23 (19.5 %) of the stomach contents of Pochards at hand. It is, however, somewhat doubtful whether all these jaws were actually derived from rag-worms eaten. The stomach contents in which the jaws are found usually include also fruiting bodies of muskgrass in varying quantities, and in 7 instances the contents consisted solely of these two items. Only 4 stomach contents included jaws of rag-worms without fruiting bodies of muskgrass. The chitinous jaws of rag-worms may resist decomposition long after the death of the worms, and like the lids of the egg capsules of *Neretina* they may accumulate in the drift line along the shore together with the fruiting bodies of muskgrass of which the Pochard is very fond, and they may therefore go quite accidentally into the stomachs along with this food. This fact accounts for their frequent occurrence, but of course rag-worms when obtainable must be accepted as food by the Pochard. As many as 100 jaws, representing at least 50 worms, were found in one stomach which in addition only contained the remains of some small cockles. But usually only some few jaws were recorded in each stomach.

Table 10.  
Frequency of occurrences of the more common food items in the examined stomach contents of Danish Pochards (*Aythya ferina ferina*).

| Food items                     | Mainly brackish-water localities in fjord areas or at the Baltic coasts |   |
|--------------------------------|---|---|
|                                | 118 birds   |   |
|                                | Number of birds in which present  | Number of birds in which solely present |
| <i>Animal food</i> . . . . .   | 72 (61.0 %)   | 13 (11.0 %)                             |
| <i>Mollusca</i> . . . . .      | 40 (33.9 %)   | 12 (10.2 %)                             |
| Bivalvia . . . . .             | 37 (31.4 %)   | 6 ( 5.1 %)                              |
| Mytilus edulis . . . . .       | 19 (16.1 %)   | 2 ( 1.7 %)                              |
| Cardium edule . . . . .        | 14 (11.9 %)   | 2 ( 1.7 %)                              |
| Macoma baltica . . . . .       | 14 (11.9 %)   | 2 ( 1.7 %)                              |
| Gastropoda . . . . .           | 30 (25.4 %)   | 2 ( 1.7 %)                              |
| Littorina spp. . . . .         | 15 (12.7 %)   | —                                       |
| Hydrobia spp. . . . .          | 21 (17.8 %)   | —                                       |
| Neretina fluviatilis . . . . . | 3 ( 2.5 %)  | 1 ( 0.8 %)                              |
| <i>Crustacea</i> . . . . .     | 12 (10.2 %)   | —                                       |
| Ostracoda . . . . .            | 9 ( 7.6 %)  | —                                       |
| <i>Pisces</i> . . . . .        | 3 (2.5 %)   | —                                       |
| (Gasterosteus)                 |   |   |
| <i>Insecta</i> . . . . .       | 18 (15.3 %)   | —                                       |
| Chironomidae, larvae . . . . . | 7 ( 5.9 %)  | —                                       |
| Coleoptera . . . . .           | 8 ( 6.8 %)  | —                                       |
| Tipulidae, larvae . . . . .    | 3 ( 2.5 %)  | —                                       |
| <i>Annelida</i> . . . . .      | 22 (18.6 %)*  | —                                       |
| (Nereis)                       |   |   |
| <i>Plant food</i> . . . . .    | 105 (89.0 %)  | 42 (35.6 %)                             |
| Seeds . . . . .                | 88 (74.6 %)   | 22 (18.6 %)                             |
| Potamogeton spp. . . . .       | 30 (25.4 %)   | 3 ( 2.5 %)                              |
| Scirpus spp. . . . .           | 25 (21.2 %)   | 1 ( 0.8 %)                              |
| Ruppia spp. . . . .            | 10 ( 8.5 %)   | —                                       |
| Zanichellia sp. . . . .        | 9 ( 7.6 %)  | 1 ( 0.8 %)                              |
| Zostera sp. . . . .            | 9 ( 7.6 %)  | 1 ( 0.8 %)                              |
| Chara (Oogonia) . . . . .      | 44 (37.3 %)   | 8 ( 6.8 %)                              |
| Vegetable growth . . . . .     | 42 (35.6 %)   | 11 ( 9.3 %)                             |

\* Confer the text p. 240.

## Plant food.

Plant food supplies the principal part of the diet of the Pochard, and birds having taken such food were present from every month represented in the material and from the following localities: Møen, Køge-bugt, Amager, Saltholm, the Sound, and Faaborg, all in the Baltic-Sound area; Saltbækvig, and Hadsund, in the Kattegat area; and further some localities in the Ringkøbing-fjord area. In all, 105 of the Pochards examined (89.0 %) had eaten some plant food, and 42 (35.6 %) had taken no other kind of food. Besides seeds of various kinds, which when available are also readily accepted as food by other Diving Ducks, the Pochard also consumes quantities of green vegetable matter, to which the other Diving Ducks dealt with in this report usually pay very little attention. 42 of the examined birds (35.6 %) had consumed vegetable growth and 11 of them (9.3 %) had made their entire meal on such food. Seeds had been taken by 56 of the birds (47.5 %) and in 14 instances (11.9 %) supplied the entire meal. If fruiting bodies of Muskgrass are included under seeds 88 of the birds (74.6 %) have taken such food, and 22 of them (18.6 %) only such food.

Fruiting Bodies of Muskgrass (Characeae) seem eagerly sought by the Pochard—as already mentioned—and are the most frequently recorded plant food. In all, they were present in varying quantities in 44 of the examined stomach contents (37.3 %). In 8 stomachs they were the sole food remains present, 12 stomachs in addition contained only seeds and perhaps also some green vegetable matter, and 4 stomachs besides fruiting bodies of muskgrass contained only green vegetable matter but no seeds. 19 stomachs contained the fruiting bodies as the only plant food in addition to animal items which in 7 instances were represented only by jaws of rag-worms. Great quantities of the fruiting bodies of muskgrass may be taken in a single meal; several ccm were found in the gullets of some of the examined birds, and in one well filled stomach, inclusive of the gullet, in which fruiting bodies of muskgrass formed the major part of the content, their number has been estimated at about 100,000. Another bird contained 50,000 and a third one 15,000 of these items. This food must be obtained by the Pochard in places where it has accumulated by the currents and thus can be easily shovelled up, and perhaps it is mostly obtained by dabbling in the drift line along the shore.

Pondweeds Seeds (*Potamogeton spp.*) were the seeds most frequently recorded in the examined material and for the diet of the Pochard in general they seem second in importance only to the fruiting bodies of muskgrass. 30 of the birds (25.4 %) had in their meals included a varying, though usually small number of seeds of pondweed (1 to 150 seeds), and 3 birds had taken such seeds

as their only food, 2, 15, and about 120 seeds respectively, besides debris of some. The most frequently recorded species was *Potamogeton pectinatus*, taken by at least 9 birds, and *Potamogeton natans*, also taken by at least 9 birds. In 3 instances the species in question were probably *Potamogeton perfoliatus*, in 1 instance probably *Potamogeton filiformis*, otherwise the species have not been identified. Seeds of as many as at least 3 different species of pondweeds were present in one stomach.

Bulrush Seeds (*Scirpus spp.*) were also very important in the diet of the Pochards examined. 25 of the birds (21.2 %) had taken these in a number varying from 1 to about 50 per meal, and in one stomach 4 seeds of *Scirpus maritimus* were the only food remains present. Seeds of *Scirpus maritimus* were, in all, identified in 10 stomach contents, seeds of *Scirpus tabernaemontani* in 7 stomachs, these two species were often taken together, and seeds of *Scirpus lacuster* were identified in 4 instances.

Horned Pondweed Seeds (*Zannichellia sp.*) had been consumed by 9 birds (7.6 %). One bird had 35 of these seeds besides debris of some more as the only food remains in its stomach, and another one had included more than 100 of them in its meal. Otherwise the number present in the stomach contents varied from a few to about 20.

Eelgrass Seeds (*Zostera spp.*) supplied food for 9 of the birds (7.6 %), and 1 Pochard had taken such as its sole food. The number taken in each meal varied from a few to about 350.

Wigeongrass Seeds (*Ruppia spp.*) were eaten by 10 birds (8.5 %) in a number of 1 to about 30 per meal.

The other seeds identified in the stomach contents of Pochards examined include the following, each taken by 1 bird: Smartweed (*Polygonum tomentosum*), 2 seeds; a Sedge (*Carex sp.*), 1 seed; Water-Lily (*Nuphar sp.*), 3 seeds; a Grass (*Graminea*), 1 seed; Goosefoot (*Chenopodium sp.*), 1 seed; and Burreed (*Sparganium sp.*), 1 seed. In a few instances only unidentifiable remains of seeds were present.

Green vegetable matter had been consumed in varying quantity by 42 birds (35.6 %), and 10 of them (8.5 %) had taken no other kind of food. Most often the vegetable matter were of Pondweed (*Potamogeton*); both rootstocks, shoots, leaves, and tubers are taken, and several of the birds seem to have made the major part of their meal upon this plant. One bird, for instance, had in its gullet 2 shoots of pondweed, 6 and 8 cm long respectively. Leaves and root stocks of Eelgrass (*Zostera*) have also frequently been taken and in at least 2 instances formed the entire meal. Vegetable parts of Muskgrass (Characeae) were also frequently found in the stomachs, and likewise leaves of Wigeon-

grass (*Ruppia*). One Pochard obtained at Saltholm in August had made its entire meal on a large quantity of Duckweed (*Lemna sp.*), and another bird collected at Faaborg in January had made most of its meal on a considerable quantity of Canadian Pondweed (*Helodea canadensis*). Sea Lettuce (*Ulva lactuca*) had been taken by 2 birds, but Algae were otherwise only found as traces in a few of the stomachs.

Sand, fine or coarse, were regularly found in some quantity in the stomach contents of the Pochard. One bird e. g. contained as much as 5 ccm of sand. More rarely the stomach contents also include a few to a dozen small gravel, usually less than 10 mm large, only exceptionally as large as 15 mm.

The composition of the food of the Pochard in Denmark during the winter half of the year as computed on the basis of the present material is: Animal food about 37 %, and Plant food about 63 %. The animal food comprises: Molluscs about 22 % (Bivalves about 12 %, and Gastropods about 10 %), Insects about 7 %, Polychaetes about 6 %, Fishes about 1 %, and Crustaceans about 1 %. (The percentage figure of the polychaetes may be too large as discussed on p. 240). The plant food consists of seeds, including fruiting bodies of muskgrass, about 43 %, and green vegetable matter about 20 %.

These figures, however, as pointed out above, illustrate the composition of the winter food. The summer food must show a considerably higher percentage of plant food, especially green vegetable matter, and during that season, when a much larger part of the Pochards forage in fresh-water, insects undoubtedly are the most important animal food.

#### Remarks.

In NAUMANN'S 'Vögel Mitteleuropas' (1905) the food of the Pochard in fresh-water habitats is stated to consist chiefly of vegetable matter, during summer and autumn almost exclusively, viz. seeds, tubers, and various other vegetative parts; also aquatic insects, and—mostly during winter and spring—small fishes, molluscs, and sometimes small frogs.

In WITHERBY'S 'Handbook of British Birds' (1924 p. 317) the food is summarized as follows: 'Mainly vegetable; roots and buds of aquatic plants (*Potamogeton*, *Myriophyllum*, *Ceratophyllum*), also *Clyceria*, *Polygonum*, and seeds of these as well as reeds, rushes, etc. Also small fish, worms, tadpoles, aquatic insects (water-beetles, etc.) and mollusca (*Tellina*, *Pisidium* and other small freshwater forms)'.

MILLAIS (1913 I p. 23) states that 'The principal food in summer and autumn is vegetable and freshwater molluscs. They eat large quantities of the roots, leaves, and flowers of aquatic plants, which they take and swallow at the

bottom. They are especially fond of the seeds of *Polygonum amphibium*, and, in the autumn, of the seeds of *Potamogeton marinus* and *P. pectinatus*, also the tender parts of *Myriophyllum*'. And MILLAIS further states that 'In summer the young birds eat quantities of floating insects, but the old birds seem to take few of these, although they catch numbers of water beetles, small fish, tadpoles, and small frogs'.

The material of stomach contents of Pochards examined here, though it has mostly been obtained during the winter months and in localities of a more or less marine character, strongly emphasizes how the Pochard is essentially a plant feeder, relying in its diet—in contrast to the other species of Diving Ducks dealt with in this report—to a large extent of the vegetative parts of various aquatic plants, even during winter when animal food is comparatively more easily obtained.

The Pochard, in addition to feeding in the usual manner of a Diving Duck, by diving and taking the food on the bottom, may also feed in the very shallow water and in the drift line along the shore in the manner of a surface-feeding Duck. As food it recognizes the same items as do the other species of Diving Ducks dealt with here, when feeding in similar habitats, for instance molluscs as large as up to 35 mm, and in addition the Pochard pays much attention to vegetative matter of which it tears off and swallows parts, for instance shoots as long as 8 cm. Even so small items as the fruiting bodies of the Muskgrasses are readily fed on if they can be shovelled up in quantities.

#### GENERAL REMARKS

The food habits in Northwestern Europe of the species of Diving Ducks here treated were previously known in broad outline; and detailed information of some of the species was available from North America. The results of the present investigation, therefore, are not very surprising, qualitatively upon the whole agreeing with the literature. The investigation, based on systematically undertaken stomach analyses, has, however, also given some quantitative information, and the material examined has been sufficiently large to maintain that the results obtained reflect—within reasonable margins of error—the composition of the diet in general of the eight species of Diving Ducks discussed, of course only regarding the larger groups of food items, e. g. molluscs, crustaceans, etc., whereas there is a considerable variation in the different localities as to which particular species of these groups are taken.

The results obtained are summarized in the accompanying two tables. Table 11 (p. 247) summarizes the composition of the food taken in marine or brackish-water on the sea or at the open coasts without shore vegetation\*, table 12 (p. 248) the food taken in fjord areas with shore vegetation.

In the marine habitats the diet of the Diving Ducks consists practically exclusively of animals, at any rate during the autumn and winter, the seasons at which the present material was collected. In the summer half of the year some of the species may take, to a small extent, vegetative growth, especially eel-grass, and the Pochard for instance feeds extensively on vegetative growth where possible, also during winter.

The most important group of food items for the Diving Ducks in general in marine habitats is the molluscs, especially the bivalves, and prominent among these is the Common Blue Mussel or Edible Mussel, *Mytilus edulis*. In the whole range of the northern Diving Ducks blue mussels (Mytilidae) are their prime food.

The Diving Ducks obtain their molluscan food by diving, and taking it and swallowing it whole at the bottom, each species of Diving Duck of this hard-shelled food preferring specimens within certain size limits. While the usual maximum-size of the individual molluscs eaten is fairly fixed, the minimum-size regarded as appropriate, however, may be considerably lowered when great accumulations of the food items are present so that the birds may shovel up the food. Food items which can be collected directly on the bottom are preferred, but the Diving Ducks may also rake up superficially burrowing molluscs or other food species, and sometimes the food, as various molluscs, barnacles, sea-anemones, etc., may be detached from stones and the like, but this only by the larger species of Diving Ducks and especially the Eider.

Four of the species, Common Scoter, Velvet Scoter, Tufted Duck, and Scaup, are in the marine habitats almost exclusively molluscs feeders. But all Diving Ducks, besides taking immobile or only slow-moving food animals, may catch also some more mobile food animals. Fishes, when easily obtainable, are readily taken by all Diving Ducks, and at least the Longtailed Duck and the Golden-Eye regularly catch living fish, maybe also the Eider does so. But when fishes are so regularly found also in the stomach contents of the shallow-water Diving Ducks of the genus *Aythya* this may be due to the fact that these species when feeding near the driftline have a fair chance of finding dead individuals. The Longtailed Duck and the Golden-Eye also eat great quantities of crustacean food, especially Amphipods and Isopods. To the Golden-Eye crustaceans as food

\* Some few birds included in this summary have fed, however, at coasts with shore vegetation and thus also eaten some seeds, but a clear distinction between birds obtained in the two different habitats, open marine habitats and closed fjord areas, was not always possible.

Table 11. Summary of the Food of Diving Ducks in Denmark in marine habitats (including the Baltic Area \*).

| Kind of Food                       | Eider<br>( <i>Somateria mollissima mollissima</i> )<br>296<br>Stomach contents | Common Scoter<br>( <i>Melanitta nigra nigra</i> )<br>227<br>Stomach contents | Velvet Scoter<br>( <i>Melanitta fusca fusca</i> )<br>157<br>Stomach contents | Longtailed Duck<br>( <i>Clangula hyemalis</i> )<br>272<br>Stomach contents | Golden-Eye<br>( <i>Bucephala clangula clangula</i> )<br>144<br>Stomach contents | Tufted Duck<br>( <i>Aythya fuligula</i> )<br>193<br>Stomach contents | Scaup<br>( <i>Aythya marila marila</i> )<br>III<br>Stomach contents | Pochard<br>( <i>Aythya ferina ferina</i> )<br>+++<br>(+++)<br>(+++) |
|------------------------------------|--|--|--|--|---|--|---|---|
| Molluscs.....                      | ca. 68 %<br>(ca. 51 %)   | ca. 89 %<br>(ca. 78 %)   | ca. 86 %<br>(ca. 55 %)   | ca. 65 %<br>(ca. 51 %)   | ca. 42 %<br>(ca. 21 %)  | ca. 90 %<br>(ca. 56 %)   | ca. 90 %<br>(ca. 67 %)  | +++   |
| (Bivalves).....                    | ca. 17 %   | ca. 11 %   | ca. 31 %   | ca. 14 %   | ca. 21 %  | ca. 34 %   | ca. 23 %  | (+++)   |
| (Gastropods).....                  |  |  |  |  |   |  |   | (+++)   |
| Crustaceans.....                   | ca. 15.5 %   | ca. 5 %  | ca. 6 %  | ca. 27 %   | ca. 41 %  | ca. 5 %  | ca. 2 %   | +   |
| Pisces.....                        | ca. 5.5 %  |  | ca. 2 %  | ca. 4.7 %  | ca. 8 %   | ca. 2 %  | ca. 3.5 %   | +   |
| Echinoderms.....                   | ca. 10.5 %   | ca. 2 %  | ca. 4 %  | ca. 1.5 %  |   |  |   |   |
| Annelids.....                      | ca. 0.5 %  | ca. 4 %  | ca. 2 %  | ca. 1.8 %  | ca. 7 %   |  | ca. 1.5 %   | +   |
| Plant food.....                    |  |  |  |  |   |  |   |   |
| (Seeds and vegetative growth)..... |  |  |  |  | ca. 2 %   | ca. 3 %  | ca. 3 %   | +++   |

\* Of course a larger assortment of species are taken in the Kattegat area with its richer fauna than in the brackish water of the Baltic, in particular regarding the more skilled divers, but the percentage ratios in the diet of the various food groups are in the main the same in the two areas. Only regarding the Eider there is a distinct difference since two of its most prominent food items in the salt-water habitats, viz. the Sea-star *Asterias rubens*, and the Shore Crab, *Carcinus maenas*, do not occur in the more brackish areas.

Table 12.

Summary of the Food of Diving Ducks in Denmark in the fjord-areas  
(brackish-water habitats).

| Kind of food             | Golden-Eye<br>( <i>Bucephala clangula clangula</i> ) | Tufted Duck<br>( <i>Aythya fuligula</i> ) | Scaup<br>( <i>Aythya marila marila</i> ) | Pochard<br>( <i>Aythya ferina ferina</i> ) |
|--------------------------|--|---|--|--|
|                          | 57<br>Stomach<br>contents                            | 29<br>Stomach<br>contents                 | 11<br>Stomach<br>contents                | 118<br>Stomach<br>contents                 |
| Molluscs.....            | ca. 30 %   | ca. 30 %                                  | ca. 35 %                                 | ca. 22 %                                   |
| (Bivalves).....          | (ca. 11 %)   | (ca. 9 %)                                 | (ca. 9 %)                                | (ca. 12 %)                                 |
| (Gastropods).....        | (ca. 19 %)   | (ca. 21 %)                                | (ca. 24 %)                               | (ca. 10 %)                                 |
| Crustaceans.....         | ca. 27 %   | ca. 10 %                                  | ca. 11 %                                 | ca. 1 %                                    |
| Pisces.....              | ca. 4-5 %  | ca. 4-5 %                                 |  | ca. 1 %                                    |
| Annelids.....            | ca. 0.5 %  |   |  | ca. 6 %*                                   |
| Insects.....             | ca. 6 %  | ca. 16 %                                  | ca. 11 %                                 | ca. 7 %                                    |
| Plant food.....          | ca. 32 %   | ca. 40 %                                  | ca. 43 %                                 | ca. 63 %                                   |
| (Seeds).....             | (ca. 28 %)   | (ca. 38 %)                                | (ca. 34 %)                               | (ca. 43 %)                                 |
| (Vegetative growth)..... | (ca. 4 %)  | (ca. 2 %)                                 | (ca. 9 %)                                | (ca. 20 %)                                 |

\* Confer the text p. 240.

are of an importance equalling that of the molluscs, each of these foods making up 2/5 of the total food taken by the birds examined, and in the diet of the Longtailed Duck crustaceans constitute between 1/4 and 1/3 in the examined birds, whereas molluscs made up most of the remaining 2/3. The Eider consumes a considerable quantity of crustacean food when crabs are available and thus occupies an intermediate position between the predominantly mollusc feeders and those feeding almost equally on molluscs and crustaceans.

Soft-bodied food items as fish, soft-shelled crustacea, and worms, may be taken by the Diving Ducks in considerably larger individuals than the hard-shelled items.

The typically bottom-feeding Diving Ducks in general never manipulate their food, this being picked up and swallowed whole; and when only the soft parts

of bivalves are found in the stomach contents then the said birds may have fed on dead individuals which have been separated from their shells due to decaying (cf. p. 196). Both BENT (1925) and COTTAM (1939) have, however, statements to the effect that Diving Ducks are able to pick out the soft parts of bivalves from the shells when open.

Large food items, as large bivalves or fishes, are sometimes brought to the surface and then placed in the beak so that they may be most conveniently swallowed; and other food items, especially vegetable matter, may be brought to the surface in order to be broken up before swallowed. MILLAIS (1913 II p. 18) describes this for Eiders feeding on fish entrails thrown over board from fishing vessels, and he further records (p. 73) that he has seen Velvet Scoters bringing to the surface quite large crabs and breaking them up before swallowing.

In the fjord areas and protected coastal areas with a rich shore vegetation the diet of the Diving Ducks, in addition to the kind of foods taken in marine habitats, also comprises quantities of seeds of aquatic plants. These seeds are mostly taken on the bottom in the same way as are molluscs, and the Diving Ducks, of course, do not discriminate between these kinds of food. If seeds in appropriate sizes were available for the true Sea-Ducks they would be taken as readily as any other foods, which is illustrated for instance by GÄTKE's account, referred to above, p. 184, of the Scoters feeding on beans washed out from a wreck.

Whereas the species of Diving Ducks which in Denmark are restricted to the sea are essentially animal feeders, not taking any vegetable food beyond the very small quantities of algae and eelgrass accidentally consumed along with the molluscs, the species which also or mainly occur in the brackish fjord areas or in fresh-water habitats, Golden-Eye, Tufted Duck, Scaup, and Pochard, are to some extent also plant feeders. During the winter all these species make seeds about 1/3 to 2/5 of their total diet in these habitats, and they may further eat some vegetable growth. Only the Pochard, however, subsists to a measurable degree on such food, vegetative growth, even during the winter season, forming 1/5 of its diet. The vegetative growth is mostly torn off and swallowed at the bottom, but larger pieces may be brought to the surface and broken up before consumed. Not always do the Diving Ducks of the brackish and fresh-water habitats feed exclusively in the typical manner by diving, especially the Pochard, and sometimes also other species, may feed in the quite shallow water by tilting over in the manner of a surface-feeding duck and may also take food floating on the surface, even dabble for food in the drift line along shore.

The Golden-Eye subsists, of course, also in the brackish fjord areas to a large extent on crustaceans; and both this species, the Tufted Duck, the Scaup, and

the Pochard take readily aquatic insects. Molluscs are also in the fjord areas an important food for the Diving Ducks, but since other acceptable foods are available they do not form as prominent a part as in the marine habitats.

The kind of food taken by the Diving Ducks is primarily a question of availability, and, of course, the kind of haunts selected by the various species is the most important factor, alone accounting for the exclusive animal diet of the true Sea-Ducks. Among the available food items the most easily obtainable within suitable size limits are preferred. The reason why molluscs constitute so prominent a part in the diet of the Diving Ducks is thus due to their usual abundance and accessibility. When a plentiful supply of an acceptable food is found the birds usually subsists on this until the supply becomes exhausted; there after they may turn to other foods, as crustaceans or fishes, which must be relied upon in localities where molluscs are scarce, as e. g. some brackish-water localities and many fresh-waters. According to the literature most species of Diving Ducks seem to have a rather wide degree of adaptability in food selection, and to some extent this is also illustrated by the present material, especially as regards the Golden-Eye.

The list of the different food items is most comprehensive for those species of Diving Ducks which occur in the most varied habitats and dive to the greatest depths. The largest number of different food items in a single stomach content was about a dozen, but such meals have only rarely been recorded. The average number of food species taken in each meal in the examined material have been only about 2-3, and on average much less than two groups of food items, molluscs, crustaceans, echinoderms, etc. had been taken in each meal, only the Golden-Eye had on average made its meal on slightly more than two groups of foods.

The percentage ratios calculated for the various kind of foods, molluscs, crustaceans, seeds, etc., may, as already mentioned, be regarded as adequate, and giving a reasonably true picture of the actual ratio. The percentage figures given of many of the single food species, however, should be regarded with great caution; probably they are about adequate for the more commonly taken species, but for the more rarely recorded food species it is a matter of chance in how great a percentage they have been present.

## SUMMARY

The Danish Institute of Game Biology has been engaged for some time on a study of the food habits of the Diving Ducks, analysing the stomach contents of more than 2,300 birds. The Diving Ducks in Denmark are mostly winter-visitors and passage-migrants, and the study therefore has dealt primarily with the winter food. The records in the European literature, though scattered and scanty, and COTTAM's report (1939) on the food habits of the North American Diving Ducks had given some idea of the results to be expected from this investigation and nor have these been surprising. The investigation, however, has emphasized how the species of Diving Ducks in Denmark occupy ecological niches which, though overlapping, are different in the main, and that the various species therefore compete in regard to their food to a smaller degree than might have been expected. The different species of Diving Ducks partly occur in different types of localities and dives to different depths and partly select food items within different size limits; some species are also more dependent on immobile or slow-moving food items than others.

The most skilled divers, Eiders, Scoters, and Longtailed Duck, in general feed at depths from a few metres to 20-30 metres, or more, and occur almost exclusively out to sea or off the open coasts, feeding, therefore, primarily on animal food.

The Eider (table 1, p. 168) mainly takes food items in sizes from about (1)-2 cm and upwards and seem to prefer feeding on submerged reefs, where it takes various molluscs, especially 3-4 cm large Blue Mussels, and also Crabs and Sea-stars, in salt-water habitats relying for 1/3 of its diet on this kind of food.

The Scoters (tables 3-4, p. 182, 190) take molluscs mainly 1/2-1 cm to about 2 cm large and prefer feeding on areas of sandy bottom, perhaps because it is more easy to find food of suitable sizes here than on the reefs. Crabs and Sea-stars are of little importance in their diet, whereas such molluscs as Dog Whelks, along with Cockles and Clams, are eaten in great quantities. There is a slight difference in the feeding grounds selected by the two species since the Common Scoter stays rather exclusively out to sea whereas the Velvet Scoter also goes



near the coasts and into the fjords. This species therefore consumes a greater variety of foods.

The Longtailed Duck (table 6, p. 199), which also feeds at rather considerable depths, in general 5 m, or more, takes molluscs in sizes from the smallest specimens upwards to about 1 (-2) cm, and in addition this active and brisk diver takes many small crustaceans, *Gammarus*, *Idothea*, *Mysis*, etc., which form about 1/4 to 1/3 of its diet (or more). This Diving Duck also takes fish more regularly than do the above mentioned species.

The Golden-Eye (table 7, p. 210), likewise an active and brisk diver, in its food habits resembles the Longtailed Duck, but feeds at shallower depths, from the drift line to at most about 6-7 m; and besides at open coasts this species also occurs in fjord areas enclosed by vegetation and sometimes also in fresh-water lakes, and, therefore, it also consumes a quantity of seeds and aquatic plants.

The Tufted Duck (table 8, p. 223) and the Scaup (table 9, p. 232) both feed at comparatively shallow depths and take molluscs of the same sizes as do the Golden-Eye and the Longtailed Duck besides somewhat larger specimens (up to 2-3 cm), but being more clumsy divers they depend much more on molluscs alone as food than do the other two species. Both the Tufted Duck and the Scaup occur near the coasts, but while the Scaup prefers open water and more rarely occurs in habitats enclosed by vegetation, the Tufted Duck, besides in the fjords, also frequently stays in fresh-water.

The Pochard (table 10, p. 241) prefers fresh-water localities or at any rate fjord areas with a rich shore vegetation. It differs in its diet much from the other Danish Diving Ducks treated, subsisting to a large extent on vegetative growth, and, upon the whole, this species in its food habits much more resembles a surface-feeding Duck than a typical Diving Duck.

The present investigation, in agreement with the literature, indicates that the Diving Ducks, if needs must be, may show a fairly wide degree of adaptability in their food selection. In general, however, the food selected by the various species is rather uniform. What items are included in the diet will naturally depend primarily on the habitats selected as haunts,—which might be termed the primary psychological factor. Other psychological factors deciding the food selection is the habitual way of feeding, whether, for instance, the particular species of Diving Duck, besides taking its food on the bottom after diving for it, can also recognize floating items as food, or whether besides animal items and the like (seeds), which can be swallowed whole, it can also recognize vegetative growths as food and tear off parts of such for consuming. Also the size of the food items taken, at any rate the minimum-size recognized as appropriate food,

are psychologically determined. The Pochard and the Golden-Eye generally feed in the most different ways, but it appears that all other Diving Ducks if straying outside their habitual haunts may sometimes feed in equally different ways—even sometimes browse on land. Besides being psychologically determined the kind of food included in the diet depends also on some factors which may be termed the physiological ones, e. g. how large items can be swallowed, how swift ones captured, and how great dives performed.

## APPENDIX

In the following a number of stomach analyses are given in extenso, inter alia to illustrate the composition of the meals comprising many food items.

## EIDER

(*Somateria mollissima mollissima*).

Eider, ser. no. 31. Læsø, 28/12 1940.

Venus gallina, 1 specimen of 22 mm.  
Nassa reticulata, 1 of 23 mm.  
Carcinus maenas, remains of 4, medium-sized ones to large ones.  
Asterias rubens, remains of 10-12 of 30-40 mm in diameter.

Eider, ser. no. 111. Læsø, 14/1 1941.

## Gullet:

Mytilus edulis, ca. 225 of ca. 1 to 8 mm.  
Spisula solida, 1 of 7 mm.  
Carcinus maenas, 2 of 8 mm in breadth of carapace.  
Idothea baltica, 2.  
Gammarus locusta, 1 and head of another.  
Asterias rubens, remains of 1 of ca. 30 mm in diameter.

## Gizzard:

Gravel, 1 of 9 mm.  
Mytilus edulis, debris of many very small specimens.  
Littorina littorea, remains of 5 of 4 to 6 mm.  
Littorina obtusata, remains of 4 of ca. 3 mm.  
Idothea sp., remains of 1.

Eider, ser. no. 122. Sejro, 18/1 1941.

Some coarse sand, 2 pebbles of ca. 12 mm.  
Mytilus edulis, fragments of 1 of ca. 20 mm.  
Littorina littorea, 1 of 6 mm.  
Lacuna divaricata, 1 of 3 mm.  
Carcinus maenas, remains of 1 of ca. 8 mm breadth of carapace.  
Amphipoda, remains of 1.  
Asterias rubens, remains of calcareous skeleton of 1 or more.  
Polynoid sp., a few bristles and jaws of 1 scale-worm.  
Pisces sp., a few, small, unidentifiable bones.

Eider, ser. no. 272. Læsø, February 1941.

Gravel, about 20 of up to 11 mm.  
Mytilus edulis, fragments of 2 of 30 mm and 7 mm respectively.

Cardium edule, fragments of 4 (2 of 5-7 mm and 2 of 12 mm).  
Nassa reticulata, 11, partly crushed, of 9 to 20 mm.  
Buccinum undatum, fragments of 1 small.  
Littorina sp., fragments of 1.  
Gibbula cinerarius, fragments of 1.  
Hydrobia sp., 2.  
Carcinus maenas, remains of 4, 2 of 5-7 mm breadth of carapace and 2 somewhat larger.  
Balanus sp., a few fragments.  
Caridid sp., remains of abdomen of 1 prawn.  
Asterias rubens, remains of skeleton of 1.  
Gobius sp., bones of 4 small.  
Fucus, and Zostera?, trace of.

Eider, ser. no. 278. Læsø, February 1941.

Gravel, 2.  
Mytilus edulis, fragments of 2 large specimens.  
Cardium edule, fragments of 1 or more small specimens.  
Nassa reticulata, remains of 11, 7 of 20 to 23 mm, and 4 of 3 to 5 mm.  
Buccinum undatum, fragments of 4 (or more) fairly large.  
Carcinus maenas, remains of 1 fairly large.  
Eupagurus bernhardus, claws of 1.  
Balanus sp., a few fragments.  
Isopod sp., trace of.  
Asterias rubens, remains of skeleton.  
Gobius sp., some bones.

Eider, ser. no. 277. Læsø, February 1941.

Gravel, ca. 15 of up to 10 mm.  
Mytilus edulis, fragments of 1 of ca. 15 mm and of a few of 5 to 10 mm.  
Cardium edule, fragments of some very small to small.  
Spisula subtruncata, fragments of several medium-sized.  
Macoma baltica, fragments of some medium-sized.  
Mya sp., fragments of some very small.  
Balanus sp., a few fragments.  
Red Algae (Ahnfeltia), trace.

Eider, ser. no. 304. Læsø, February 1941.

Gravel, 4 of up to 15 mm, and some sand.  
Mytilus edulis, fragments of 1 of ca. 30 mm.  
Echinocardium cordatum, debris of 1 (or more).  
Strongylocentrotus droebachiensis, a few remains of 1.  
Asterias rubens, remains of skeleton of 1.  
Fucus, trace.

Eider, ser. no. 309. Læsø, February 1941.

Gravel, a few of up to 10 mm.  
Littorina littorea, 12 shells, 11 of 2 to 8 mm and 1 of 25 mm, this latter with an Eupagurus.  
Aporrhais pes-pellicani, the 6 mm large top of a worn shell, housing an Eupagurus.  
Nassa reticulata, 2 shells of 8 and 21 mm.

Lunatia nitida, 1 shell of 11 mm.  
 Bittium reticulatum, 1 shell of 4 mm.  
 Rissoa sp., 1 shell of 3/4 mm.  
 Eupagurus bernhardus, the said 2 small specimens, and in addition claws of 1 or 2 more, small ones.  
 Carcinus maenas, claws of 2, 1 very large and 1 small.  
 Asterias rubens, much skeleton of a few or more specimens.  
 Laomedea sp., a few remains of a hydroid colony  
 Fucus, trace.

Eider, ser. no. 312. Vesterø, Læsø, 10/4 1941. Depth at which the bird was feeding: 7 m.

Gravel and some coarse sand.  
 Mytilus edulis, fragments of 1-2 medium-sized.  
 Littorina littorea, fragments of 2 large.  
 Buccinum undatum, fragments of 3 small.  
 Nassa reticulata, 3 of ca. 25 mm, and fragments of 4 more.  
 Carcinus maenas, a claw of 1 medium-sized.  
 Asterias rubens, trace of skeleton.  
 Spawn of fish, a large quantity, constituting the main part of the stomach content.

Eider, ser. no. 88. Køge-bugt, 11/1 1941.

Gravel, ca. 10 of up to 8 mm.  
 Cardium edule, fragments of 1 medium-sized and 1 smaller.  
 Gasterosteus aculeatus, bones of several.  
 Anguilla anguilla, bones of 1 small.  
 Zostera, trace.

## COMMON SCOTER

(*Melanitta nigra nigra*).

Common Scoter, ser. no. 297. Kalundborg, 20/11 1940.

Gravel, a small quantity, including 2 of ca. 6 mm.  
 Mytilus edulis, fragments of some, very small to small.  
 Macoma baltica, fragments of 1-2.  
 Cardium (nodosum?), fragments of some very small.  
 Littorina littorea, 1 of ca. 3 mm, and fragments of a few.  
 Nassa reticulata, 4, 3 small of 1 1/2 to 3 mm and 1 of ca. 10 mm.

Common Scoter, ser. no. 229. Læsø Rende, 9/4 1941. Depth at which the bird was feeding: 20-30 m.

Sand and several gravel, 1 small stone of ca. 15 mm.  
 Venus gallina, fragments of 3.  
 Nucula sp., fragment of 1.  
 Pectinaria (auricoma?), bristles, and fragments of sand-tube.

Common Scoter, ser. no. 225. East-Bornholm, February 1941.

Gullet:  
 Gravel, 1.  
 Mytilus edulis, 53 of 7 to 17 mm.  
 Neretina fluviatilis, 1 small.  
 Gizzard:  
 Gravel, a few.  
 Mytilus edulis, fragments of many very small to small.

## VELVET SCOTER

(*Melanitta melanitta*).

Velvet Scoter, ser. no. 64. Sejro, 23/1 1941.

Gravel, 5 of ca. 9 to 11 mm.  
 Mytilus edulis, fragments of a few very small.  
 Littorina littorea, 2 of 12-14 mm.  
 Bittium reticulatum, 1 of ca. 4 mm.  
 Idothea sp., remains of 3 4.  
 Amphipoda sp., remains of 1.  
 Asterias rubens, remains of 1 small.

Velvet Scoter, ser. no. 72. Sejro, 25/1 1941.

Some sand and 2 gravel.  
 Cardium edule, fragments of some medium-sized.  
 Nassa reticulata, fragments of 10 of ca. 8 to 14 mm.  
 Spisula sp., fragments of 1 medium-sized.  
 Gasterosteus aculeatus?, a few bones of fish.

Velvet Scoter, ser. no. 20. Læsø, 28/12 1940.

Nassa reticulata, 36 partly crushed specimens of 4 to 22 mm.  
 Littorina littorea, 2 of 10-12 mm.  
 Carcinus maenas, remains of 1 small.  
 Eupagurus bernhardus, remains of 2 small.  
 Echinocardium cordatum, remains of skeleton of ca. 2.  
 Ophiuroid sp., trace of skeleton.

Velvet Scoter, ser. no. 119. Læsø, January 1941.

Venus gallina, fragments of 2.  
 Buccinum undatum, fragments of 7 small ones of ca. 6 to 12 mm, and 4 large ones of ca. 35 to 55 mm.  
 Littorina littorea, fragments of 7 large ones, and 1 shell inhabited by a hermit crab.  
 Gibbula cinerarius, 1 of ca. 7 mm.  
 Eupagurus bernhardus, 3 specimens, besides the said one remains of 2 somewhat larger.

Velvet Scoter, ser. no. 115. Læsø, January 1941.

Cardium edule, fragments of several small to medium-sized.  
 Macoma calcarea, fragments of 2-3.  
 Macoma baltica, fragments of 1.  
 Nucula (nitida?), fragments of a few.  
 Spisula subtruncata, fragments of 1 small.  
 Nassa reticulata, fragments of 1 of ca. 23 mm.  
 Bela turricula, 5 of ca. 13 to 18 mm.  
 Buccinum undatum, 1 of 8-9 mm.  
 Littorina (littorea?), fragments of a few medium-sized.  
 Eupagurus bernhardus, remains of 1 small.  
 Arenicola marina, 1 entire lug-worm ca. 12 cm long.

Velvet Scoter, ser. no. 129. Læsø Rende, 9/4 1941. Depth at which the bird was feeding: 20-30 m  
 Venus gallina, fragments of 1.  
 Nucula nitida, ca. 10, more or less fragmentary.  
 Macoma calcarea, fragments of 5.  
 Mya truncata, fragments of 6 rather small.  
 Bela turricula, 1.

Velvet Scoter, ser. no. 132. Nordre Rønne, Læsø, 10/4 1941. Depth at which the bird was feeding:  
 14 m.

Some sand.  
 Buccinum undatum, 1 small of 5 mm, and 1 large of 40 mm.  
 Bela turricula, 2.  
 Nassa pygmaea, 1 and fragments of 1-2.  
 Lunatia nitida, fragments of 1 medium-sized and 1 small.  
 Nucula nitida, 1 of ca. 14 mm.  
 Cyprina islandica, fragments of 1 very small.  
 Macoma calcarea?, fragment.  
 Echinocardium cordatum, some fragments.

Velvet Scoter, ser. no. 133. Nordre Rønner, Læsø, 10/4 1941. Depth at which the bird was feeding:  
 14 m.

Venus gallina, fragments of 2.  
 Cyprina islandica, fragments of 1 rather small.  
 Lunatia nitida, fragments of 1.  
 Buccinum undatum, fragments of 1 small.  
 Aporrhais pes-pellicani, 1 small.  
 Eupagurus bernhardus, remains of 1 small.  
 Asterias rubens, remains of skeleton.

## LONGTAILED DUCK

(Clangula hyemalis).

Longtailed Duck, ser. no. 16. Samsø, 15/2 1941.

## Gullet:

Cardium nodosum, 49 of 4.5 to 6.5 mm.

## Gizzard:

Gravel, fairly many.  
 Cardium nodosum, fragments and remains of ca. 150 of 3 to 9 mm.  
 Astarte elliptica, fragments and remains of ca. 7 of 2.5 to 10 mm.  
 Cyprina islandica, fragments of 1 very small.  
 Cultellus?, fragment.  
 Mysis sp., 1 and unidentifiable remains of another small crustacean.

Longtailed Duck, ser. no. 65. Samsø, 28/2 1941.

Sand and gravel, some.

Mytilus edulis, fragments of several very small to small.  
 Idothea sp., remains of a few.  
 Polynoid sp., many bristles and fragments of several jaws.  
 Pisces indet., a few vertebrae of a small specimen.  
 Rhodophyceae, trace.

Longtailed Duck, ser. no. 148. Samsø, 24/2 1943.

## Gullet:

Mytilus edulis, ca. 1.480 of 1 to 9 mm, amounts to about 24 ccm.  
 Modiolaria marmorata, 4 of 1 to 3 mm.  
 Lacuna divaricata, 1 of 4 mm.  
 Littorina obtusata, 1 of ca. 2 mm.  
 Buccinum undatum, fragments of 1 of ca. 6 mm.  
 Idothea granulosa, 5.  
 Caprella sp., remains of 2.  
 Amphipoda indet., remains of 2.  
 Balanus balanoides, remains of 1.  
 Nudibranch sp., remains of 1.  
 Rhodophyceae, trace.

## Gizzard:

Sand, fine to coarse, about 40 gravel, amounting to about 6 ccm.  
 Mytilus edulis, ca. 50 and fragments of some of up to 8 mm.  
 Lacuna divaricata, ca. 25 more or less intact.  
 Idothea sp., remains of some few.  
 Amphipoda sp., remains of a few.  
 Rhodophyceae, trace.

Longtailed Duck, ser. no. 10. Sejro, 25/1 1941.

## Gullet:

Idothea baltica, 2 of 7 to 13 mm.

## Gizzard:

Mytilus edulis, fragments of a few very small.  
 Nucula nitida, 1 and fragments of 2-3.  
 Spisula sp., fragments of 1 small.  
 Lacuna divaricata, 1 of 3 mm.  
 Rissoa (inconspicua?), 1 of 1 mm.  
 Eulima philippi, 1 of 3.5 mm.  
 Idothea baltica, 1 small.  
 Crustacea indet., remains of a small specimen.  
 Gadid?, unidentifiable remains of bones of a small fish.  
 Ophiuroid sp., remains of calcareous skeleton of 1.

Longtailed Duck, ser. no. 114. Sejro, 1/1 1942.

Gravel, a little, 1 of 6 mm.  
 Cardium nodosum, fragments of many  
 Spisula solida, fragments of a few.  
 Modiolaria nigra, fragments of a few.  
 Corbula gibba, 1 of 5 mm and fragments of 2 more.  
 Nassa sp., 1 of 2 mm.  
 Amphipoda?, debris of small crustaceans.  
 Gobius sp., bones of a few.  
 Gasterosteus aculeatus, bones of 1.

Longtailed Duck, ser. no. 79. Rødvig, 27/11 1941.

## Gullet:

Sand and gravel, some.  
 Mya sp., 94 siphons of specimens which may have had valves of about 3-4 cm.  
 Mytilus edulis, 9 of 1 to 8 mm.  
 Hydrobia ulvae, 5 of 2 mm.  
 Idothea sp., 1 of 6 mm.  
 Gammarus (locusta?), 1.  
 Amphitoe rubricata, 2.

## Gizzard:

Mya sp., the remains of about 15 siphons, and a few shell fragments.  
 Mytilus edulis, a few fragments of very small.

Longtailed Duck, ser. no. 185. Assens, 28/2 1943.

Gravel, a little quantity of fine.  
 Scrobicularia plana, debris of about 50.  
 Mya sp., a 20 mm long siphon.  
 Cardium nodosum, a few besides debris of some.  
 Nassa reticulata, 14 intact and debris of some, 2.5 to 8 mm.  
 Caridea indet., fairly much debris of shrimps.  
 Pectinaria sp., some bristles and a few fragments of the sand-tubes.  
 Ophiura sp., a little skeleton.  
 Gobius sp., some bones of a few small specimens.

Longtailed Duck, ser. no. 134. Rønne, Bornholm, 10/2 1941.

Gravel, some fine.  
 Macoma baltica, fragments of about 10.  
 Mytilus edulis, a few of ca. 5 mm.  
 Neretina fluviatilis, fragment of 1.  
 Gammarus sp., remains of a few.  
 Idothea baltica, remains of a few.

## GOLDEN-EYE

(*Bucephala clangula clangula*).

Golden-Eye, ser. no. 153. Frederikssund, 23/11 1941.

Some sand, a little gravel, and a few small stones of 6-7 mm.  
 Mytilus edulis, fragments of some very small ones.  
 Gastropod sp., a few fragments of an unidentifiable specimen.  
 Idothea sp., debris of some.  
 Misidae sp., debris of some.  
 Nereis sp., jaws of about half a score of very small polychaetes.  
 Gasterosteus aculeatus, bones of 3-4.  
 Ruppia, trace.

Golden-Eye, ser. no. 211. Dalby Ore, Randers, 19/10 1942.

Gravel, a little, fine.  
 Mya?, fragments of 1 very small.  
 Cardium (edule?), fragments of very small.

Littorina littorea, fragments of some very small to medium-sized.  
 Carcinus maenas, claws of 1 small.  
 Crangon vulgaris, remains of about half a score.  
 Gobius sp., some bones of 1 fairly large.

Golden-Eye, ser. no. 118. Ringkøbing, 4/11 1941.

Some gravel and a small stone of 6 mm.  
 Amphipoda sp., remains of 1.  
 Hydroid sp., trace.  
 Characeae sp., 300-400 fruiting bodies of Muskgrass and some vegetative fragments.  
 Ruppia sp., ca. 50 seeds.  
 Potamogeton sp., ca. 40 seeds and debris of some more.  
 Scirpus (tabernaemontani?), ca. 20 seeds.  
 Sparganium, 1 seed.  
 Zostera sp., 1 seed.

Golden-Eye, ser. no. 182. Langøre, Samsø, 6/12 1941.

## Gullet:

Gammarus locusta, 100-150.  
 Gizzard:  
 Gravel, some, up to 5 mm.  
 Gammarus sp., remains and debris of a large quantity.  
 Hydrobia sp., 4.  
 Potamogeton sp., a small quantity of pieces of stems and leaves.  
 Scirpus sp., 1 seed.

Golden-Eye, ser. no. 180. Kalvebodstrand, 5/12 1941.

Sand and Gravel, a small quantity.  
 Mytilus edulis, fragments of some very small.  
 Hydrobia sp., fragment of a few.  
 Littorina (rudis?), fragments of 1 very small.  
 Gammarus?, remains of 1 small crustacean.  
 Nereis sp., remains, mostly jaws, of about 100-150 very small.  
 Potamogeton (pectinatus?), pieces of stems and leaves.

Golden-Eye, ser. no. 18. Køge-bugt, 11/1 1941.

Mya sp., 3 of 2 to 4 mm.  
 Hydrobia ulvae, ca. 400-500 of ca. 1 to 1.5 mm.  
 Nassa reticulata, 18 of ca. 2 mm.  
 Carcinus maenas, claws and other remains of ca. 15 very small, breadth of carapaces about 5 to 10 mm.

## TUFTED DUCK

(*Aythya fuligula*).

Tufted Duck, ser. no. 241. Allingaebro, 3/10 1942.

A little sand and fine gravel.  
 Mya sp., remains of several very small.  
 Spisula subtruncata, remains of a few very small to small.  
 Caridea sp., remains of 2-3.  
 Carcinus maenas, 1 claw of a small specimen.

Tufted Duck, ser. no. 248. Allingaebro, 19/10 1948.

A fairly large quantity of fine gravel and 1 small stone of 11 mm.  
Gammarus (locusta?), remains of 6.  
Hydrobia ventrosa, remains of about half a dozen.  
Zanichellia (major?), ca. 1,000 seeds.  
Ruppia sp., ca. 100 seeds.

Tufted Duck, ser. no. 19. Samsø, 12/1 1941.

Some small stones.  
Mytilus edulis, fragments of several of 3 to 20 mm.  
Cardium edule, fragments of several very small.  
Hydrobia ulvae, 6 and some fragments.  
Littorina littorea, remains of at least 6 of up to 4 mm.  
Buccinum undatum, fragment of 1 very small.

Tufted Duck, ser. no. 201. Frederikssund, 1/11 1941.

Some gravel and sand.  
Mytilus edulis, some fragments of very small.  
Cardium (nodosum?), some fragments of very small.  
Bivalvia indet., 1 fragment of a small specimen.  
Littorina saxatilis var. tenebrosa, remains of 20-30 of up to 6 mm.  
Rissoa membranacea, remains of ca. 20.  
Rissoa inconspicua, a few remains.  
Hydrobia ventrosa, remains of ca. 40 and some very small specimens.  
Potamogeton sp., 11 seeds.  
Scirpus tabernaemontani, 6 seeds.

Tufted Duck, ser. no. 222. Holbæk, 20/11 1941.

A small quantity of sand and fine gravel.  
Mytilus edulis, a few very small, less than 1 mm.  
Cardium sp., some fragments of 1.  
Nassa reticulata, remains of about 26 of 3 to 4.5 mm.  
Gobius sp., bones of about 20 small specimens.

Tufted Duck, ser. no. 101. Øresund, 25/1 1941.

14 small stones of up to 11 mm.  
Cardium edule, a few fragments.  
Mytilus edulis, a few fragments of small.  
Hydrobia sp., debris of several hundreds of up to 4 mm.  
Balanus sp., a few fragments.  
Corixa sp., remains of about 6.  
Scirpus maritimus, 3 seeds and debris of some.  
Sambucus nigra, 1 seed.

Tufted Duck, ser. no. 188. Drogden, 25/1 1941.

Gullet:  
Mytilus edulis, 1 of 14 mm  
Littorina sp., 12 very small.  
Hydrobia ulvae, ca. 75.

## Gizzard:

About 20 gravel of up to 7 mm.  
Mytilus edulis, debris of ca. 50 of 3 to 14 mm.  
Littorina littorea, fragments of a few.  
Neretina fluviatilis, fragments of a few.  
Hydrobia ulvae, remains of 10-20.  
Trace of green vegetable matter.

Tufted Duck, ser. no. 256. Kalvebodstrand, 31/1 1947.

7 small stones of 8 to 13 mm.  
Hydrobia sp., debris of many.  
Littorina littorea, debris of several large specimens.  
Nassa reticulata, remains of 7 of 15 to 17 mm.  
Bittium reticulatum, remains of at least 200 of up to 6 mm.  
Modiolaria discors, 1 fragment.  
Cardium sp., fragment of 1 small.

## SCAUP

(*Aythya marila marila*).

Scaup, ser. no. 95. November 1941.

Some gravel.  
Hydrobia jenkinsi, fragments of several hundred.  
Neretina fluviatilis, 2 and some fragments.  
Potamogeton pectinatus, 1 seed and remains of some.  
Potamogeton (perfoliatus?), 17 seeds.  
Scirpus tabernaemontani, 1 seed.  
Scirpus sp., a piece of stem and some other remains.

Scaup, ser. no. 86. Nørre Nebel, 3/11 1941.

Sand and gravel, in a fair quantity, and a few small stones of up to 7 mm.  
Hydrobia sp., remains of ca. 20.  
Gammarus sp., remains of several.  
Chironomidae, remains of some larvae.  
Coleoptera indet., 1 leg.  
Ruppia sp., 6 seeds.  
Scirpus maritimus, 1 seed.  
Potamogeton pectinatus, 12 seeds.  
Characeae, some few fruiting bodies.

Scaup, ser. no. 73. Sejro, 25/1 1941.

Some gravel and 3 small stones.  
Mytilus edulis, many very small to small.  
Littorina littorea, remains of some very small to small.  
Littorina obtusata, remains of some very small to small.  
Bittium reticulatum, remains of 2.  
Rissoa sp., remains of 1.  
Balanus (crenatus?), remains of some.  
Red Algae (Phylloporus), some small pieces.

Scaup, ser. no. 112. Allingaebro, 22/11 1941.

Sand, a small quantity.

Spisula subtruncata, fragments of many individuals of 5 to 10 mm.

Nassa reticulata, remains of 7 of 5 to 10 mm.

Littorina littorea, remains of 2 of 7 mm.

Hydrobia sp., 1 of 2 mm.

Pectinaria sp., several bristles and a piece of sand tube.

Scirpus maritimus, 1 seed.

POCHARD

(*Aythya ferina ferina*).

Pochard, ser. no. 36. Hadsund, 3/3 1947.

Some fine to coarse sand and a little gravel of up to 6 mm.

Mytilus edulis, 1 of 17 mm and fragments of several.

Cardium edule, debris of a few small.

Littorina littorea, debris of a few.

Pochard, ser. no. 43. Hadsund, 6/1 1947.

Gullet:

Characeae, about 6.000 7.000 fruiting bodies.

Zannichellia sp., remains of about 6 seeds.

Ruppia?, a small quantity of vegetable matter.

Cardium sp., a few fragments of small.

Hydrobia sp., about 130 small.

Ostracoda, some few.

Mytilus edulis, fragment of 1 small.

Littorina sp., remains of 1.

Nereis sp., 5 small jaws.

Diptera indet., remains of legs.

Neretina fluviatilis, about 300 lids of egg capsules.

Gizzard:

A large quantity of sand and some coarse gravel of up to 4 mm.

Characeae, 2.000-3.000 fruiting bodies.

Graminea, 1 seed.

Vegetative matter, trace.

Hydrobia sp., remains of more than 100 small ones.

Littorina saxatilis, remains of a few very small.

Cardium edule, 1 of 2 mm and fragments of some more of ca. 2 mm besides of several larger ones.

Ostracoda, some.

Nereis sp., 4 jaws.

Helophorus (minutus?), a wing.

Neretina fluviatilis, more than 100 lids of egg-capsules.

Pochard, ser. no. 15. Hov Vig, 27/4 1943.

Gullet:

Chironomidae, about 300 larvae and a few pupae.

Culicidae, a few larvae and pupae.

Haliplus (ruficollis?), 1 larvae of 8 mm.

Hydrobia ventrosa, 3.

Gizzard:

A little gravel and a small stone of 8 mm.

Cardium sp., some debris of small specimens.

Gammarus sp., remains of 1.

Chironomidae, remains of a few hundred larvae and ca. 1.000 eggs.

Gasterosteus sp., a few bones of 1.

Potamogeton pectinatus, ca. 10 seeds of.

Ruppia sp., 6 seeds.

Scirpus maritimus, 2 seeds.

Scirpus tabernaemontani, 8 seeds.

Pochard, ser. no. 13. Vordingborg, 26/10 1942.

A fair quantity of sand and fine gravel.

Chironomidae, many larvae and a good deal of debris of same.

Tipulida, 1 larva.

Hemiptera, 1 small.

Coleoptera, head of a very small.

Ostracoda, some.

Nematoda, 1 very small.

Potamogeton natans, ca. 80 seeds.

Potamogeton sp., ca. 20 small seeds.

Polygonum tomentosum, 2 seeds.

Scirpus lacustris, 2 seeds.

Scirpus tabernaemontani, ca. 15 seeds.

A small quantity of green vegetative growth.

F. Jensenius Madsen

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