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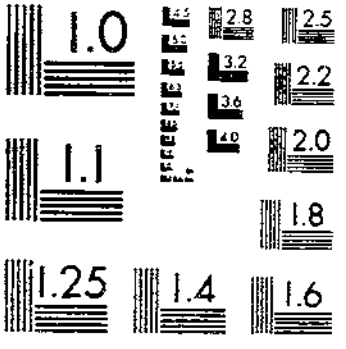

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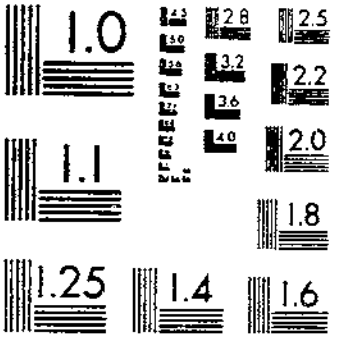

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UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

FOOD HABITS OF NORTH AMERICAN DIVING DUCKS[1]

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CONTENTS

	Page
...oduction	1
...conomic importance of ducks	1
...rpose and method of the study	2
...stematic position and description of ducks	3
...lominantly plant feeders	4
...yroca	4
Redhead (*Nyroca americana*)	6
Ring-necked duck (*Nyroca collaris*)	14
Canvasback (*Nyroca valisineria*)	23
Greater scaup duck (*Nyroca marila*)	30
Lesser scaup duck (*Nyroca affinis*)	38
...ismaturinae	46
Ruddy duck (*Erismatura jamaicensis rubida*)	46
Masked duck (*Nomonyx dominicus*)	52
...mmary of food of inland divers	53
...opagation of preferred plants	55
...lominantly animal feeders	56
...ideneyes and bufflehead	56
American goldeneye (*Glaucionetta clangula americana*)	56
Barrow's goldeneye (*Glaucionetta islandica*)	65
Bufflehead (*Charitonetta albeola*)	68
Predominantly animal feeders—Continued.	
Clangula, Histrionicus, and Camptorhynchus	73
Old squaw (*Clangula hyemalis*)	73
Harlequin duck (*Histrionicus histrionicus*)	80
Labrador duck (*Camptorhynchus labradorius*)	86
Eiders	87
Steller's eider (*Polysticta stelleri*)	88
Northern eider (*Somateria mollissima borealis*)	93
American eider (*Somateria mollissima dresseri*)	95
Pacific eider (*Somateria v-nigra*)	101
King eider (*Somateria spectabilis*)	105
Spectacled eider (*Arctonetta fischeri*)	110
Scoters	113
White-winged scoter (*Melanitta deglandi*)	114
Surf scoter (*Melanitta perspicillata*)	121
American scoter (*Oidemia americana*)	127
Summary of food of sea ducks	131
Summary	133
Literature cited	135

INTRODUCTION

ECONOMIC IMPORTANCE OF DUCKS

...t is difficult to overrate the economic importance of ducks, and ...doubtedly their esthetic and recreational worth is fully as great. ...e mergansers are sometimes condemned because of their fish-eating ...ctivities and are not highly prized as game, but most of the other ...cies are of great economic value. As game birds, they help main... trade in guns, ammunition, and sporting goods and bring custom trade to country hotels and boarding houses as well. In the development and maintenance of duck clubs and shooting preserves, commerce and industry are stimulated, so that directly and indirectly the ...ting of these birds affords worthwhile employment. In certain ...ions of the country the gathering and preparation of the down of eiders is an important industry. During the pioneer and settle-

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ment days of our country waterfowl afforded an important source of food, and they still contribute to the sustentation of the aborigines of far northern regions. Formerly the food value of waterfowl taken in the United States reached several million dollars annually.

The recent precipitous decline in the abundance of waterfowl has been alarming. Drought, encroachment of man into their nesting territory, drainage, reclamation, overshooting, and perhaps the increase of crows on their nesting grounds are some of the factors responsible. It is hoped that the present efforts toward restoration and conservation will halt this decline and cause a return of the birds to more satisfactory numbers.

One of the fundamentals of any restoration and game-management plan is to shape the environment to fit the needs of the animals considered. Food and cover are the primary essentials. The fallibility of field observation alone in determining what is taken as food by various forms of wildlife has been demonstrated innumerable times to workers in economic biology. The only safe guide in ascertaining the food requirements of any species is to find out, by stomach analyses, what is actually eaten by that species under varying circumstances and in different localities.

PURPOSE AND METHOD OF THE STUDY

The Biological Survey has been engaged in food-habits studies for more than half a century. In its Food Habits laboratory it has accumulated great numbers of stomachs, including gizzards and gullets, of birds of many groups, many of which have been examined. An appreciable number of diving duck stomachs have been analyzed by W. L. McAtee, W. F. Kubichek, D. C. Mabbott, and the writer. Reports on food habits of North American shoal-water, or river, ducks by McAtee (*57*, *58*)[2] and Mabbott (*53*) and on ducks of the genus *Nyroca* by Kubichek (*47*) have been published. The present bulletin[3] deals with a study of the food habits of North American diving ducks, exclusive of mergansers. It is based both on field studies and on the analyses of the stomach contents (including both gizzard and gullet) of 6,665 adults and 140 juveniles.

In accordance with the standard followed for many years, the food percentages in this bulletin have been computed by the volumetric method, described by the writer[4] as follows:

> When the individual stomach examination is completed, the results are tabulated on a card and filed systematically. While the numbers of occurrences of individuals of each specific item in the stomach are recorded, the final results are expressed in percentages of volume. In general, bulk or volume percentages have been found to be much more reliable and more rapidly computed than those based on weight. Where the items in a stomach are of sufficient volume, the

[2] Italic numbers in parentheses refer to Literature Cited, p. 135.

[3] Grateful acknowledgment is made to officials of the National Museum of Canada, particularly to P. A. Taverner, for submitting good series of stomachs of juvenile birds and of the more northern diving ducks, without which this study would have been very incomplete; to members of the U. S. National Museum, especially to Paul Bartsch and William B. Marshall, of the Division of Mollusks and Cenozoic Invertebrates, and to Waldo L. Schmitt, Clarence Shoemaker, Mary J. Rathbun, and James O. Maloney, of the Division of Marine Invertebrates, for expert service in identifying questionable mollusks and crustaceans; and to Phoebe Knappen, Lois E. Graham, and other members of Food Habits staff for willing and efficient assistance in compiling tabulations and computing percentages.

[4] COTTAM, CLARENCE.—ECONOMIC ORNITHOLOGY AND THE CORRELATION OF LABORATORY AND FIELD METHODS. U. S. Bur. Biol. Survey Wildlife Research and Mangt. Leaflet BS–30. January 1936. [Mimeographed.]

components are usually measured in a vial of appropriate size and computed on the basis of 100 percent. If, for example, the stomach contents consisted of but four items and measured 5, 10, 15, and 20 mm, respectively, they would obviously represent 10, 20, 30, and 40 percent, respectively of the food content of the particular stomach. Gravel is frequently found, and among certain species of waterfowl it is usually greater both by weight and volume than the food. It is, therefore, first computed as a percentage of the total stomach content; then the food proper, after excluding the gravel, is computed also on the basis of 100 percent.

In figuring the percentages, each month was considered as a unit to prevent undue emphasis being placed on a larger series of stomachs taken at any one period of the year. A given month was ignored if too few stomachs were taken to make the figure representative.

For marsh and aquatic plants the nomenclature adopted by Hotchkiss [5] has been followed.

SYSTEMATIC POSITION AND DESCRIPTION OF DUCKS

North American ducks are members of the family Anatidae of the order Anseriformes. This order includes about 230 species and varieties of birds that inhabit all parts of the world, of which North American species, including 17 extralimital ones, number 77.

The ducks have lamellate bills, that is, the edges of both mandibles have toothlike projections that alternate above and below, interlocking when closed to form an effective sieve that enables the birds to strain out from the water the necessary food items, often including rather minute plants and animals. The bill has a distinct nail, or dertrum, at the end and is more or less flattened except in mergansers, in which it is rather slender and rounded and toothed. The tongue is thick and fleshy, with a naillike or horny tip, and is fringed along the edges. The three front toes are fully webbed, but the hind toe, or hallux, which is slightly elevated, is free and reduced in size.

Most species of ducks go through an incomplete postnuptial molt in midsummer. All flight feathers (except the inner secondaries) and all tail feathers are lost almost simultaneously, during which time—a period of 3 or 4 weeks—the birds are flightless and the males are said to be in eclipse plumage, as they lose their brightly colored dress and approximate the plumage of the females.

There is considerable diversity in the nesting habits of the various species. Although most of them build their nests in marshes or on the adjacent uplands, a few nest in stumps or holes in trees. The eggs are plain white, buffy, or olive in color and oval in shape. The young are eminently precocious, leaving the nest as soon as hatched.

Most of our ducks, including all the more highly prized game species, are more or less migratory, although individuals of certain species may be found in a given locality at all periods of the year. Evidence indicates that in their flight the birds adhere more or less to their ancestral flyways. In distribution they are found from the icebound arctic regions to tropical Mexico and Central America, and even to South America, where three species occur. Different species, however, inhabit different parts of the country. Some of the eiders, for example, are restricted entirely to the arctic region, whereas

[5] HOTCHKISS, NEIL.—CHECK-LIST OF MARSH AND AQUATIC PLANTS OF THE UNITED STATES. U. S. Bur. Biol. Survey Wildlife and Research Mangt. Leaflet BS–72. December 1936. [Mimeographed.]

others breed in the far north and winter in the United States and Mexico. Some species are predominantly coastal, but others prefer the inland lakes, marshes, and streams.

The North American diving ducks are known also as deep-water, sea, or bay ducks. The 22 forms discussed here are members of 2 subfamilies of the family Anatidae, namely, the Nyrocinae, with 21 native and 5 extralimital forms, and the Erismaturinae, with 2 representatives. The Nyrocinae group includes some of the choicest game species—the canvasback, redhead, ringneck, and scaups—as well as species of only slightly less value, including the goldeneyes, bufflehead, harlequins, old squaw, scoters, and eiders. In the United States the subfamily Erismaturinae has one representative that is common, the ruddy duck, and one that is only an occasional visitor, the masked duck, which is restricted otherwise to lands south of the United States, including the West Indies. This bulletin is limited to the native North American diving species, because the extralimital forms are birds native to other lands that have occurred in the United States, Canada, or Alaska as rare visitors or accidentals only, and consequently there are but few data and few stomachs available for a determination of their food tendencies here.

The most obvious external character that distinguishes the diving ducks from the nondiving, or shoal-water, species is the expanded, flaplike membrane forming the lower part of the hind toe. Other identifying characters are relatively larger toes, with broader webs, and somewhat shorter legs placed farther back on the body, both adaptations that facilitate a more active and continuous life in the water. The divers leave the water with more difficulty and at a slower speed than do the other waterfowl, although they fly swiftly and well. As would be expected they are the species most commonly observed at sea and in the more open and broad expanses of water. They usually feed entirely submerged, commonly in water 1 to 15 feet deep, but at times some of them undoubtedly feed deeper; whereas the dabbling ducks as a rule merely tip or feed on surface material and therefore usually feed in shallow water or in marshes, immersing not more than the fore part of their bodies.

PREDOMINANTLY PLANT FEEDERS

NYROCA

The members of the genus *Nyroca*, which in North America comprises the redhead, ring-necked duck, canvasback, and greater and lesser scaups, are among our most prized game ducks and certainly represent the most important sporting birds of the diving-duck groups. It is in hunting them that the sink box and battery have had their greatest use—and abuse. Modern gunning practices—excessive use of bait, decoys, battery, sink box, scull boat, and repeating guns—probably would not have been serious had each been used separately, but their use in combination has without doubt proved too heavy a drain on these rafting inland divers, and the present crisis with respect to their scarcity is in a measure chargeable to the so-called sportsman who too frequently insists on almost unrestrained or unlimited gunning for himself but is in favor of the brand of conservation that does not affect him.

It should be pointed out, however, that gunning has been only one of the factors responsible for the diminution of this genus. Extensive drought has been perhaps the most serious and devastating single factor in recent years. It was estimated that in the summer of 1934 about 100,000 square miles of some of the best nesting territory for these birds was practically obliterated by drought. The serious effect of this on the redhead is apparent when it is realized that fully three-fourths of its hereditary nesting grounds was virtually dried up and destroyed at that time. Another major factor that has been militating against these birds has been the encroachment of man with his excessive and often unwise reclamation and drainage projects that destroy their nesting territory. Crows, too, have probably become progressively more important in accelerating the decline of waterfowl populations, as along with a reduced duck-nesting population there has been an increasing overabundance of these predators on the duck-breeding grounds.

All members of the genus *Nyroca* are, of course, closely related; consequently it is not surprising that they possess many characteristics in common. Collectively and as individual species they are frequently referred to as raft ducks, because of their tendency to form compact flocks during the greater part of the year. They are not only gregarious with members of their own kind but readily and often join flocks of other related divers. Most of them have a pronounced bump of curiosity that often gets them into trouble. They are all readily attracted by bait, and despite the fact that there are marked differences among the various species, as a unit they are far less wary and more easily attracted by decoys than perhaps any other group of waterfowl.

All are inland breeders, and some, including the redhead, have a surprisingly restricted breeding range. The center of breeding abundance extends from the North Central States to the southern half of the prairie Provinces of Canada, though the scaups (particularly the greater) breed considerably farther north. In winter the greater scaup is largely restricted to the coasts, the ringneck, even when normally abundant, is uncommon in the northeastern part of the United States, and the other species are usually widely scattered throughout the United States, extending southward to the Gulf of Mexico and beyond.

All these birds are most at home on broad waters. All are excellent divers and obtain their food largely beneath the surface of the water and well away from shore, though they may occasionally be seen dabbling in very shallow water near the margin. Most of their feeding is done by day, though they are said to feed sometimes during bright moonlit nights. In their food habits they have much in common with the surface feeders (Anatinae) in that they are all predominantly vegetarian with the exception of the greater scaup, and even this species often draws most of its food from the plant kingdom. In general, they take more of the subterranean parts of the plant, that is, winter buds, tubers, and rootstalks, and of the green vegetative parts, than of the seeds.

Because of the flocking tendencies and inherent "dumbness" of the members of the genus *Nyroca*, the excessive gunning carried on under modern practices has been more devastating to them than to most other waterfowl; certainly it has wrought more serious and alarm-

ing consequences to this group than to any of the other divers, except possibly the ruddy duck.

As seen in flocks, ducks of this genus may be locally abundant, yet in considering the country as a whole they may be alarmingly scarce and some species even on the verge of extinction. Consequently, local shooters are not always cognizant of the entire situation. Frequently the duck hunter who sees only a very local concentration insists on applying this Utopian abundance to the country at large and too often therefore will not practice reasonable conservation measures. As an example of local concentrations, a gunning club on Chesapeake Bay reported an abundance of canvasbacks yet a grave scarcity of redheads and scaups. At the same time, another club scarcely 2 miles distant reported almost no canvasbacks but an abundance of redheads and scaups. These particular flocks, or rafts, of ducks had become accustomed to feeding on bait near particular points and blinds and consequently did not shift far in their daily movements. Naturally club members felt that because certain species were present at their baited blinds in sufficient numbers to afford good shooting there must be an unlimited supply of these birds throughout the country. They were alarmed only to the extent that certain species were rare or absent in the vicinity of their particular shooting boxes.

By the use of bait and decoys, the birds of this genus can often be brought almost to the point of a gun barrel. Fear, caution, and natural wariness vanish. Even in the presence of a bounteous supply of natural food, bait in the form of most grains is readily consumed and eagerness on the part of the birds to obtain it makes good shooting possible at least every other day when the fowl are at all common. A marked difference in regard to bait is noticeable in most other waterfowl, particularly black ducks, pintails, mallards, and goldeneyes. During a baiting experiment conducted at an important shooting area in Chesapeake Bay it was frequently noted that birds coming to a baited ground did little circling and often alighted within 25 feet of a blind placed conspicuously on stilts nearly 300 yards from shore. Scaups were the least cautious and most stupid. On one occasion they circled the blind within easy shooting distance and after three of their number had been dropped flew off a hundred yards or so and returned directly over the same shooting stand at close range, where they received a second bombardment. Canvasbacks were noticeably much more cautious than scaups but vastly more trusting and less wary than black ducks, wigeons, or goldeneyes. In wariness, redheads and ringnecks seem to stand about midway between canvasbacks and scaups.

REDHEAD (Nyroca americana)

(Pl. 1, facing p. 8)

Perhaps no species of waterfowl has decreased in the past 20 years more alarmingly than the redhead. Many competent observers believe that it is in imminent danger of extinction, and it seems already to have been extirpated throughout a large part of the country. The species has been perhaps more seriously affected than other members of the Nyrocinae because its breeding territory is more restricted and because the major part of this was largely destroyed during the

drought period. Furthermore, practically all of its breeding range lies within the agricultural belt of the United States and the southern prairie Provinces of Canada, where the birds have been unfavorably affected successively by reclamation, settlement, and agricultural operations. Moreover, the redhead's confiding disposition, meriting for it at times the name "fool duck," together with the undisputed savor of its flesh, has invited incessant persecution.

Originally its principal breeding areas included a section of northern Utah, California, Nevada, eastern Washington and Oregon, northern Nebraska, eastern North Dakota and South Dakota, southern Saskatchewan, Manitoba, Alberta, and a strip in British Columbia. Normally it winters in the Pacific-coast region from northern Washington and southern British Columbia to southern California; in the Atlantic-coast region from New Jersey to northern Florida; in the Mississippi Valley from Kentucky southward into the Gulf-coast region west to southern Texas; and in western Mexico. On the wintering grounds it is perfectly at home in fresh, brackish, or salt water and in this way seems to occupy an ecological niche midway between the true sea ducks and the inland puddle ducks.

In distribution the redhead is often erratic, as it sometimes appears in numbers in a given area and then for a few years almost deserts it, only to reappear there later in goodly abundance. Unlike most of the surface feeders it restricts its nesting sites to dense vegetative areas comparatively close to rather deep water. Like the ruddy, it is a bird of the channels and the deeper shallows instead of the mud flats and meadows.

The redheads are truly gregarious, often feeding and milling about in extremely dense flocks. In migration, they often fly high in V-shaped flocks or long irregular lines; on the feeding grounds, the flock "boils up" in what appears to be a most bewildering and uncoordinated manner. The birds are most active in the early morning and late evening and, if disturbed, rest during much of the midday.

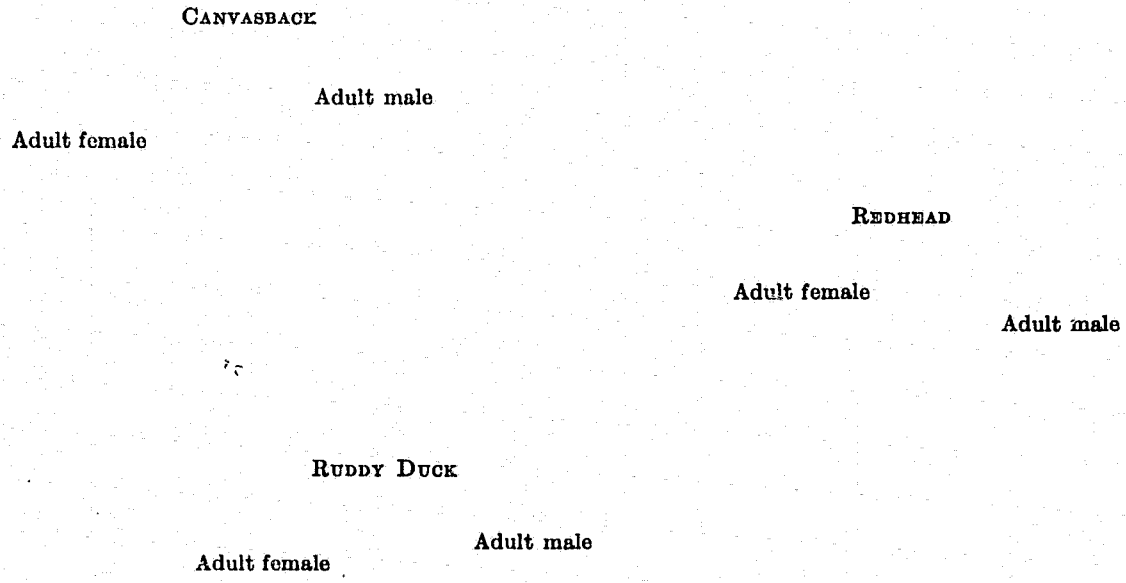
The appearance of the redhead is unmistakable, although it is often confused by many gunners with its more celebrated congener, the canvasback. The shorter bill and the prominent forehead, as well as the noticeably darker color of the back, readily distinguish it, however.

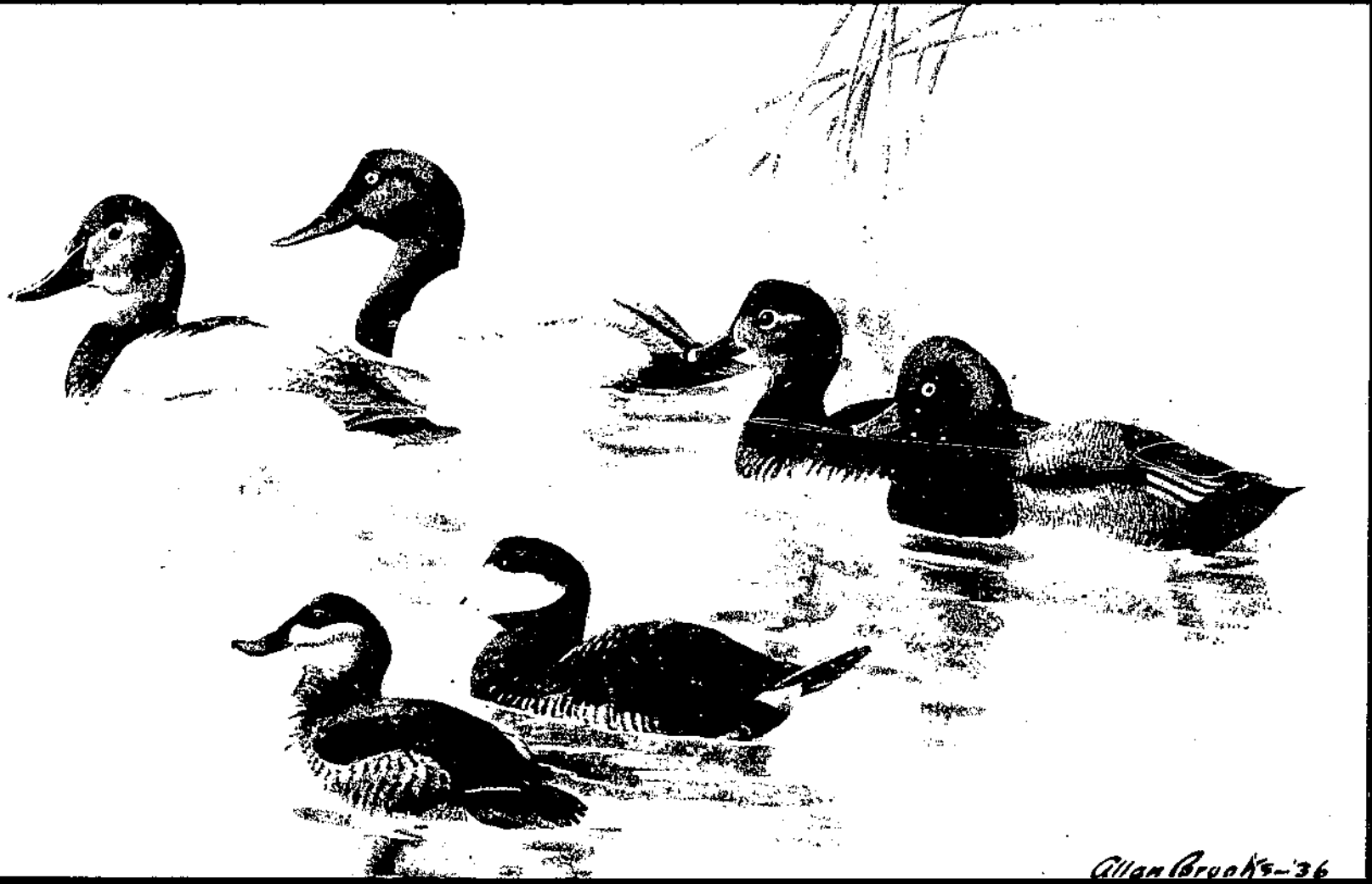
Food of Adults

The redhead is predominantly a vegetarian, as about nine-tenths of its food came from the plant kingdom and more than two-thirds of the birds fed on plant material exclusively. As is common among vegetarian species, gravel was taken in quantity, often equaling the food in volume and averaging 34.71 percent of the stomach contents. Feathers were occasionally consumed, though less frequently than by most of the true sea ducks.

To show what a voracious feeder the redhead may sometimes become, the results of the laboratory examination of one adult bird taken on Oak Lake, Manitoba, may be of interest. Fragments of the following, each expressed in percentage of total food, were found: 11 red-legged grasshoppers (*Melanoplus femur-rubrum*), 40; 1 *Melanoplus* species, 3; 1 clear-winged grasshopper (*Camnula pellucida*), 4; 26 undetermined grasshoppers, 48; eggshell, trace; 7 water boatmen, 2; 1 six-spotted leafhopper (*Cicadula sexnotata*), trace; 3 ground

PLATE 1.—INLAND DIVERS.




Allan Brooks-'36

beetles, 1; 1 dung beetle (*Aphodius*), trace; 1 leaf beetle, trace; undetermined beetles, trace; 1 fungus gnat (*Sciara*), trace; 5 adults and several larvae of midges (*Chironomus*) of two species, 1; 2 seeds of bulrush (*Scirpus*), trace; wood pulp and undetermined plant fiber, 1. In addition to the food, several gizzard worms (nematodes) and fine gravel formed 5 percent of the bulk of the stomach content.

For a determination of the food habits of the adult redhead, 402 stomachs were available, but only 364 were sufficiently full to be used in the computation of food percentages (tables 1 and 8). The stomachs were obtained from 26 States and 5 Canadian Provinces and were taken each month except May and August. British Columbia contributed 85 stomachs; Texas, 52; Utah, 48; Wisconsin, 33; North Carolina, 27; Colorado, 24; Arkansas, 11; Virginia, 10; and the remaining States and Provinces, smaller numbers.

TABLE 1.—*Redhead (Nyroca americana): Food, by volume percentages, of 364 adults taken during 10 months of the year*

Kind of food	Percentage of food	Kind of food	Percentage of food
PLANT FOOD (89.66 percent)		PLANT FOOD (89.66 percent)—continued	
Pondweeds (Najadaceae)	32.27	Duckweeds (*Lemna*)	1.33
Sago pondweed (*Potamogeton pectinatus*)	9.06	Waterlilies (Nymphaeaceae)	1.31
Other *Potamogeton* species	15.54	Coontail (*Ceratophyllum demersum*)	1.29
Wigeongrass (*Ruppia maritima*)	5.30	Smartweeds (*Polygonum*)	.06
Naiads (*Najas*)	1.32	Miscellaneous plant food	12.66
Miscellaneous	1.05	ANIMAL FOOD (10.34 percent)	
Muskgrass and other algae	23.17		
Muskgrass (Characeae)	21.44	Insects	5.89
Miscellaneous algae	1.73	Grasshoppers (Orthoptera)	1.85
Sedges (Cyperaceae)	7.72	Midges (Chironomidae)	1.38
Bulrushes (*Scirpus*)	6.50	Caddisflies (Trichoptera)	1.29
Miscellaneous	1.22	Miscellaneous	1.37
Grasses (Gramineae)	6.25	Mollusks	3.86
Wildrice (*Zizania aquatica*)	1.89	Gastropods	2.85
Whitetop (*Fluminea festucacea*)	1.74	Pelecypods	.73
Panicums (*Panicum*)	1.60	Undetermined	.28
Miscellaneous	1.02	Miscellaneous animal food	.59
Wildcelery (*Vallisneria spiralis*)	2.70		

PLANT FOOD—89.66 PERCENT

Plants formed nearly 90 percent of the food of the redhead and made up the entire meal of more than 70 percent of the birds. This species feeds less on buds and tubers than the canvasback and more on submerged leaves and stems.

Pirnie (*82, p. 308*) found that pondweeds were the principal food of 16 redheads collected in Michigan, although muskgrass, wildcelery, bulrush, and cultivated barley had been freely consumed, along with smaller quantities of dogwood berries and burreed and coontail seeds. Mayfly and caddisfly larvae and a few univalves and bivalves were also taken.

Pondweeds (32.27 percent).—Najadaceae contributed about a third of the redhead's food and formed a part of most of the meals. They were taken in each of the 10 months. Frequently the entire meal was drawn from a single species. Underground rootstalks, seeds, and green vegetative parts were ingested.

Nearly half the 364 birds (176, or 48.35 percent) had fed on one or more species of *Potamogeton*. Sago pondweed (*P. pectinatus*)

(9.06 percent) and other tuber-producing species were eagerly taken, and many others (15.54 percent), including undetermined species, were eaten. Almost 600 seeds, along with macerated parts of tubers and leaves, of sago pondweed, more than 600 seeds of *P. pusillus*, and 1,242 miscellaneous *Potamogeton* seeds were found in individual stomachs. A considerable number of the birds had consumed more than 100 seeds at a single meal. Claspingleaf pondweed (*P. perfoliatus*), or redhead-grass or tealeaf, as it is locally known in the Chesapeake area, was important in furnishing a bounteous supply of seeds and green vegetative material. The nodes of the stems seem to be almost as readily sought as the seeds. On a number of occasions the writer has seen small, washed-up windrows of drifted leaves and internodes of this plant that had been uprooted and rather finely snapped off by the mandibles of feeding rafts of redheads and canvasbacks in their efforts to obtain the harder and more luscious nodes. Some of the leaves and basal underground portions of the plant had also been taken. The leaves of the more finely dissected species, such as *P. pectinatus*, *P. filiformis*, and *P. pusillus*, seemed more acceptable than the wider- and coarser-leaved varieties.

Wigeongrass (*Ruppia maritima*) (5.30 percent) in the form of seeds, rhizomes, and leaves had been eaten by 78, or 21.43 percent, of the redheads and supplied the sole article of food for a number, 1 bird having obtained 1,400 of the distinctively marked black seeds.

Naiads (1.32 percent), including at least *Najas flexilis*, *N. guadalupensis*, and *N. marina*, had been taken by 17, or 4.67 percent, of the redheads, 1 bird having consumed approximately 2,000 and others 1,600 and 1,200 seeds.

Miscellaneous pondweeds (1.05 percent) comprised horned pondweed (*Zannichellia palustris*) (0.74 percent) and eelgrass (*Zostera marina*) (0.31 percent). Though not taken by many redheads, they formed the major or sole food item for a few, 737 seeds with fiber of horned pondweed and 593 seeds with rhizomes and leafy material of eelgrass having been found in individual stomachs.

Muskgrass and other algae (23.17 percent).—It was somewhat of a surprise to find that the fruiting bodies (oögonia), bulblets, and other vegetative parts of muskgrass formed such a high percentage (21.44) of the food of the redhead and miscellaneous identified and undetermined algae 1.73 percent. Of the 364 birds, 100, or 27.47 percent, had fed on these materials. That muskgrass is an entirely acceptable food may be shown from the fact that of the redheads that had obtained it, two-thirds had made it their entire meal, even in many areas where other excellent duck foods are abundant. One bird taken on Currituck Sound, N. C., had ingested 71,600 oögonia of a species of *Chara*, which made up 76 percent of the meal. Doubtless these had been taken with considerable plant material but, being tougher, had persisted in the stomach even after every other trace of the plant had disappeared. Of the 55 redheads taken during January, 47 were from Okanagan Landing, British Columbia, and *Chara* supplied approximately 94 percent of their food. During February, it formed more than 80 percent of the food.

Sedges (7.72 percent).—Cyperaceae of 15 or more species were taken in varying numbers by nearly half the redheads. Consumption was restricted almost entirely to the seeds. Apparently the vegetative growth is too tough and fibrous. Seeds of several species of

Scirpus (6.50 percent) were identified in 112, or nearly 31 percent, of the stomachs, the most important of which were the inland alkali bulrush (*S. paludosus*) (2.76 percent) and the common three-square (*S. americanus*) (1.77 percent). Other species identified were *S. acutus*, *S. robustus*, *S. validus*, *S. fluviatilis*, *S. etuberculatus*, and *S. debilis*. More than 1,800 seeds were taken by one bird and 1,600 by another. Miscellaneous sedges (1.22 percent), in order of importance, included *Carex*, *Eleocharis*, *Cladium*, and *Cyperus*. One bird had consumed 2,775 *Carex* and 670 *Eleocharis* seeds.

Grasses (6.25 percent).—Seeds and a limited quantity of vegetative growth of many species of grasses were taken by the redhead, yet only three—wildrice (*Zizania aquatica*) (1.89 percent), whitetop (*Fluminea festucacea*) (1.74 percent), and species of *Panicum* (1.60 percent)—amounted to as much as 1 percent of the food each. Wildrice had been eaten by 13 birds, with a maximum of 135 seeds in a single stomach; and 118 whitetop and 300 panicum seeds were found in individual stomachs. The whitetop is here undoubtedly given undue importance, because it occurred as an important food in a limited series of birds taken in July. A more representative and larger series of stomachs would almost certainly show it to be of less importance.

Among the miscellaneous grasses (1.02 percent) was wild millet (*Echinochloa crusgalli*), 800 seeds of which were found in a single stomach. Bait in the form of both wheat and corn was also recognized, but it amounted to much less than 1 percent because very few of the birds were obtained in a baited area at a time when baiting was practiced. In brackish or salt-water areas at least, redheads will take bait in preference to the best natural food.

Wildcelery (2.70 percent).—Wildcelery (*Vallisneria spiralis*), a fall and winter food, supplies luscious winter buds and seeds that are at times consumed in such quantity as to form the only article of diet, but the fact that only 17 birds had fed on this plant shows that the redhead is not dependent upon it and that it is not taken to the extent that popular opinion would indicate. In areas where abundant it seems to be the staple diet, but the range of the redhead is more extensive than that of the plant. Warren (*91, p. 42*) examined the stomach contents of 21 redheads killed on the celebrated wildcelery beds of Susquehanna Flats, near Havre de Grace, Md., and found that the birds had subsisted entirely on plant material, most of which was wildcelery.

Duckweeds (1.33 percent).—The presence of these floating plants in the stomachs of the redheads is convincing evidence that part of their food is obtained without diving. In November *Lemna* comprised 12.45 percent of the food of the 40 birds collected and was the principal item in the food of the 10 taken in Arkansas.

Waterlilies (1.31 percent).—The banana waterlily (*Castalia flava*) was the most important of the Nymphaeaceae as a redhead food. This one species formed from 60 to 100 percent of the meal of 8 birds collected in Texas, and during December it contributed more than 8 percent of the food of 76 birds. Seeds of the watershield (*Brasenia schreberi*) and of both the white and yellow waterlilies (*Castalia* and *Nymphaea*) were also taken. Maximum numbers of waterlily seeds found in individual stomachs were 160 *C. odorata* and 76 *B. schreberi*.

Coontail (1.29 percent).—Seeds and plant fiber of *Ceratophyllum demersum* were taken by 21 redheads. They reached their highest value in April, when they supplied 6.52 percent of the food, in one instance forming the entire meal. A single stomach contained 60 seeds.

Smartweeds (0.96 percent).—Seeds of several species of *Polygonum* were ingested by many of the redheads, usually in rather small numbers, although one bird had taken 700 seeds of *P. lapathifolium.* The species most frequently taken were *P. lapathifolium, P. amphibium, P. hydropiper, P. hydropiperoides, P. pensylvanicum, P. persicaria,* and *P. sagittatum.* The seeds were consumed in largest numbers in March and April, supplying 4.18 percent of the food in March and 4.74 percent in April.

Miscellaneous plant food (12.66 percent).—Undetermined plant material (11 percent) formed a comparatively high percentage of the redhead's food, because the bird is to some extent a browser and after the tender aquatic stems and leaves eaten have been subjected to gastric digestion they soon become unrecognizable. Many plants or their seeds were often very important for single meals yet were of slight value in the total intake. Large numbers of seeds found in individual stomachs include 5,000 pigweed (*Amaranthus*), 280 watermilfoil (*Myriophyllum spicatum*), 46 giant burreed (*Sparganium eurycarpum*), 70 burreed (*S. americanum*), and 25 ragweed (*Ambrosia artemisiifolia*). It is of interest that three birds had fed on seeds of the poisonous waterhemlock (*Cicuta*), one having taken 90. Other important miscellaneous plants include marestail (*Hippuris vulgaris*), arrowhead (*Sagittaria*), wild grape (*Vitis*), dock (*Rumex*), sweetflag (*Acorus calamus*), willow (*Salix*), heliotrope (*Heliotropium*), vervain (*Verbena*), bedstraw (*Galium*), rose (*Rosa*), white clover (*Trifolium repens*), mermaidweed (*Proserpinaca pectinata*), and dodder (*Cuscuta*). Audubon (*3, v. 4, p. 199*) states that large acorns and beechnuts are also taken.

ANIMAL FOOD—10.34 PERCENT

The extent to which animal matter is consumed by the redhead has often been overrated. Of the birds examined, only 0.8 percent (three birds) had fed exclusively on animal matter and only slightly more than 8 percent had made it as much as half their meal or more. It consisted mostly of insects and mollusks, but the kind and quantity taken varied considerably with the season and the locality. Insect food, prominent during summer and fall, was of only slight value during the rest of the year; whereas molluscan food was unimportant except during the winter when many of the birds fed in tidal bays along the coast. The quantity of animal food consumed ranged from 0.07 percent in February to 27.09 percent in December, averaging 23.87 percent in June and 19.80 in July.

Insects (5.89 percent).—Only three groups of insects—grasshoppers and their relatives, midge larvae, and caddisfly larvae—contributed more than 1 percent each of the food. Grasshoppers (1.85 percent) formed nearly a fifth (18.20 percent) of the food of five July birds, and the adult bird taken on Oak Lake, Manitoba (p. 7), had its gullet and gizzard gorged with grasshoppers or their remains. It is thus apparent that orthopterous food is readily acceptable, but as its availability for waterfowl can be depended upon only

infrequently, it is probably more important in this tabulation than a larger and more representative series of stomachs would indicate. Midge larvae (1.38 percent), which are ingested by many inland waterfowl, often in large numbers, had been fed upon to a limited degree during 8 of the 10 months and formed 13.31 percent of the food of 16 redheads taken in June. Two birds from the Athabaska Delta had eaten 750 and 300 midge larvae. Caddisfly larvae (1.29 percent) were procured in considerable numbers by several birds and during June and September supplied 6.56 and 5.55 percent, respectively, of the food.

Miscellaneous insects (1.37 percent) represented 73 different species or groups and included adults or larval forms of many beetles, aquatic bugs, two-winged insects, dragonflies and damsel flies, Mayflies, stone flies, and lacewing insects.

Mollusks (3.86 percent).—These were obtained mostly in November, December, and January, when the redheads were most abundant along the coast in brackish waters. Gastropods (univalves) (2.85 percent) supplied the bulk of the molluscan food, but not one of the 42 species identified amounted to as much as 1 percent of the food, although several were important for certain months. As a rule, the smaller shells were taken, sometimes in surprising numbers. More than 2,400 flat-coils (*Planorbis parvus*), 1,000 *Bittium alternatum*, 400 dove-shells (*Mitrella lunata*), 275 valve-shells (*Valvata tricarinata*), 170 *Amnicola limosa*, and 45 *Anachis avara* were found in single stomachs. The principal pelecypods (bivalves) (0.73 percent) taken were *Anomalocardia cuneimeris;* short razor clams (*Ensis*); gem clams (*Gemma gemma*); nut-clams (*Nucula proxima*); pea-shells (*Pisidium*), which formed 70 percent of the meal of one bird; and mussels. Some undetermined molluscan species (0.28 percent) were taken.

Miscellaneous animal food (0.59 percent).—Although seven kinds of crustaceans were taken, amphipods were the most important and supplied the bulk of the miscellaneous percentage. One redhead taken at Tomales Bay, Calif., had made 95 percent of its meal on a species of *Allorchestes*. Those who have claimed that crustaceans form an important or necessary part of the redhead's diet have obviously overestimated their value. Small, worthless fish were noted in but four stomachs, and in only one meal did they form as much as 20 percent of the food. Other miscellaneous animal foods, none of which formed more than a trace of any meal, included water mites (*Hydrachnidae*), spiders and harvestmen, clamworms (*Nereis*), bryozoans, hydroids, and fresh-water sponges. Audubon (*3, v. 4, p. 199*), who often stressed unusual food items, writes of the redheads: "I have found their stomach crammed with young tadpoles and small water-lizards, as well as blades of the grasses growing around the banks." In Louisiana he found them eating small fishes.

Food of Juveniles

It is unfortunate that only three juvenile redheads (downy young) were available. They were obtained in Utah, Manitoba, and Saskatchewan. From the analyses of the stomach contents it appears that young redheads are highly adaptable and accept whatever food is available within size limits. Two of the birds had made their

entire meal on the seeds and succulent herbaceous growth of plant material; and the third, 93 percent of its meal on animal food.

The plant food taken (69 percent) is summarized in the following groups and percentages: Pondweeds (*Potamogeton*), 33.33; alkali bulrush (*Scirpus paludosus*) and common three-square (*S. americanus*), 30.67; watermilfoil (*Myriophyllum*), 0.34; wigeongrass (*Ruppia maritima*), a trace; and undetermined plant debris, 4.66. More than 300 alkali bulrush seeds and 39 pondweed seeds were taken by individual birds.

A summary of the animal food (31 percent) by groups and percentages is as follows: Water boatmen, 16.66; beetles, including dung beetles (*Aphodius*), leaf beetles, and undetermined Scarabaeidae and Histeridae, 5.32; grasshoppers, 2.67; nymphs of damsel flies, 2.34; hymenopterans, 2; water mites, 1; miscellaneous crustaceans and bryozoans, 1.01.

RING-NECKED DUCK (Nyroca collaris)

(Pl. 2, facing p. 16)

Although resembling the scaups in superficial appearance, the ring-necked duck, or ringneck, locally known as ringbill, bluebill, blackjack, marsh bluebill, ring-necked blackbird, pond bluebill, tufted duck, and black duck, has closer anatomical affinities with the redhead. In the field, the adult male may readily be distinguished from the scaups by its gray speculum and noticeably darker back and from the redhead by its dark head and banded bill and the crescent-shaped white marks in front of the bend of the wing. Under favorable conditions the female ringneck also is distinguishable.

Though its geographic distribution is somewhat similar to that of the lesser scaup, the ringneck is typically a fresh-water duck of the interior, being uncommon along the coast and in the northeastern section of the United States and most adjacent parts of Canada. It breeds in the interior from the northern United States to central British Columbia, and from the Prairie Provinces to western Ontario, with outlying stations in New Brunswick and eastern Maine. During the winter it frequents somewhat more southern regions than the greater scaup, extending southward into Mexico. The ringnecks seem to prefer the marshes and sloughs to the open lakes and streams and therefore are less common in broad open water than are any others of their tribe. They fly in small flocks and feed in more scattered groups than do their more gregarious congeners.

The ringneck is decidedly more nervous and alert than the scaups and in its food habits has more in common with the redhead and canvasback, although it forages in somewhat shallower and more marshy situations and subsists to a larger extent upon seeds of both submerged and marsh plants. It is a good diver and well able to obtain food at considerable depths. It swims rapidly and lightly and seems to rise with more ease and speed than other American members of this genus. Its swift and sometimes irregular flight makes it a challenge to the skill of the best marksman. It is decoyed easily and in comparison with most of the surface feeders cannot be classed as particularly wary.

During recent years this choice game bird has experienced a precipitous decrease in numbers and is now common in only a few localities. As a table bird it is one of the best, undoubtedly superior

to the scaups, but perhaps not quite so choice as the celery-fed canvasback.

Food of Adults

That the ringneck is adaptable or has a wide-ranging appetite may be shown from the fact that the average meal consisted of more than 1,100 items of nearly 7 species, the number of species taken in a meal ranging from 1 to 22. When an acceptable food was discovered, it frequently formed the entire meal. Nearly 9 percent of the birds had made their meal on single species or closely related groups of species.

Of the 753 available stomachs of adult ringnecks, collected in 20 States and 5 Canadian Provinces during 9 months of the year, 742 were full enough to be used in computing food percentages (tables 2 and 8). The distribution is less general than it appears, as 423 of these stomachs were taken in Florida, 148 in Louisiana, and 64 in Arkansas—17 stomachs taken in Virginia being the largest number obtained in any of the remaining States or Provinces—and as 126 were collected in November, 204 in December, 208 in January, and 148 in February—18 being the maximum taken in any remaining month. Consequently, the results are more indicative of the bird's winter food in the Southern States than representative of its feeding tendencies throughout the year over the whole country. The fact that each month is considered as a unit in deriving percentages does, however, prevent extreme emphasis being placed on the large number of birds collected in Florida and other southern States during the winter months, when most of the collections were made. On the other hand, two few stomachs for a given month may unduly stress the importance of minor items. It is probable that a larger and more representative series of stomachs collected between March and September will change, to some extent, the figures herein given for the total consumption.

Table 2.—*Ring-necked duck (Nyroca collaris): Food, by volume percentages, of 742 adults taken during 9 months of the year*

Kind of food	Percentage of food	Kind of food	Percentage of food
PLANT FOOD (81.47 percent)		PLANT FOOD (81.47 per cent)—contd.	
Waterlilies (Nymphaeaceae)	14.58	Muskgrass (Characeae) and other algae	4.83
Watershield (*Brasenia schreberi*)	10.55	Delta duckpotato (*Sagittaria platyphylla* and other *Sagittaria*)	3.75
Spatterdock (*Nymphaea macrophylla*)	1.79	Coontail (*Ceratophyllum demersum*)	3.58
Waterlily (*Castalia odorata*)	1.21	Burreeds (*Sparganium*)	1.34
Miscellaneous	1.01	Miscellaneous plant food	17.13
Pondweeds (Naiadaceae)	13.45		
Pondweeds (*Potamogeton*)	11.97	ANIMAL FOOD (15.53 percent)	
Naiads (*Najas*)	1.10		
Miscellaneous	.38	Insects	10.75
Sedges (Cyperaceae)	6.28	Dragonflies and damselflies (Odonata)	3.83
Jointed spikerush (*Eleocharis interstincta*)	2.65	Caddisflies (Trichoptera)	2.39
Bulrushes (*Scirpus*)	4.45	Midges (Chironomidae)	1.16
Miscellaneous	1.16	Water bugs (Hemiptera)	1.07
Grasses (Gramineae)	8.13	Beetles (Coleoptera)	.96
Wildrice (*Zizania aquatica*)	5.38	Miscellaneous	1.34
Miscellaneous	2.75	Molluscks	5.97
Smartweeds (*Polygonum*)	8.44	River shells (*Goniobasis*)	1.03
Swamp smartweed (*P. hydropiperoides*)	2.94	Other gastropods	2.50
Largeseed smartweed (*P. pensylvanicum*)	1.33	Miscellaneous	2.44
Water smartweed (*P. amphibium*)	1.09	Miscellaneous animal food	1.81
Miscellaneous	1.08		

PLATE 2.—INLAND DIVERS.

LESSER SCAUP DUCK

Adult female

Adult male

GREATER SCAUP DUCK

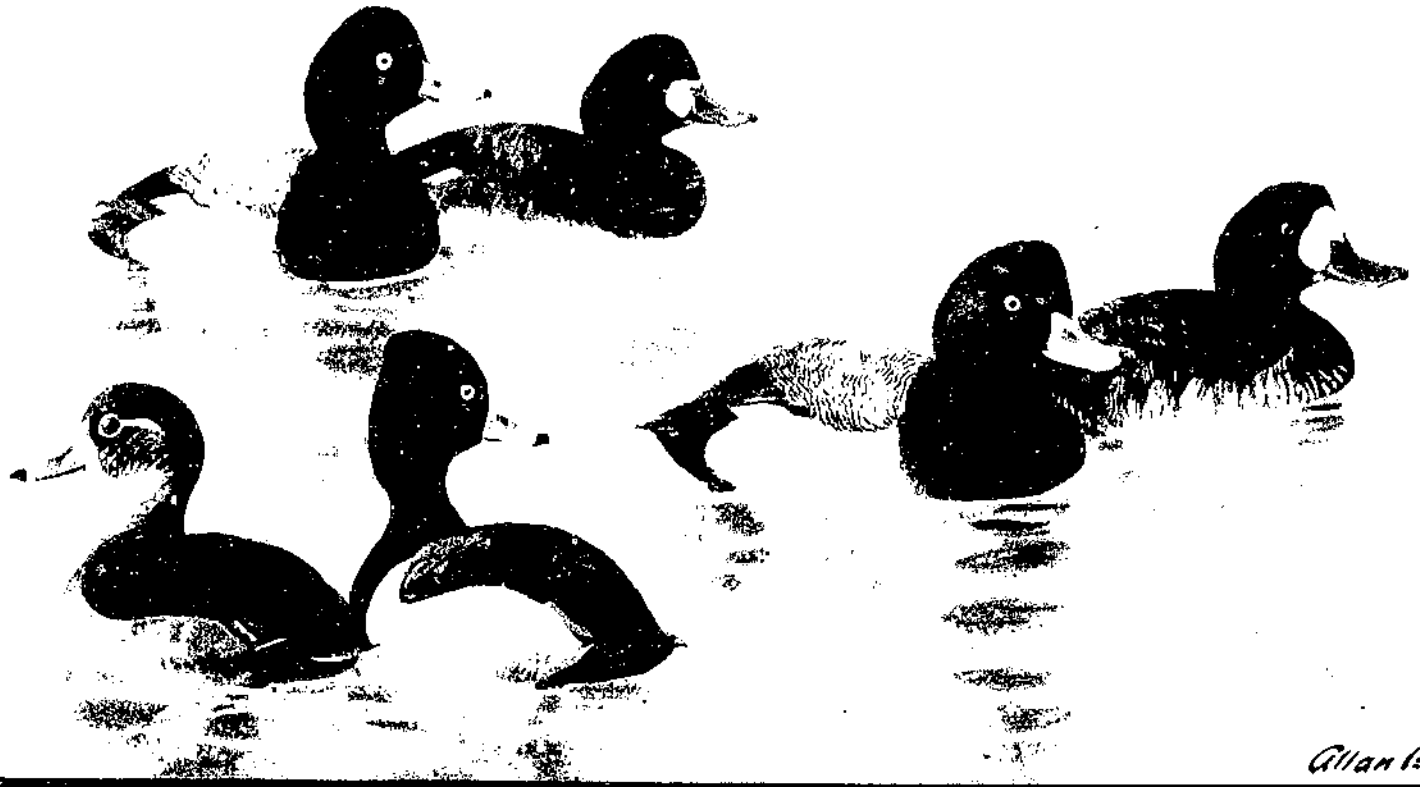
Adult female

Adult male

RING-NECKED DUCK

Adult male

Adult female


Allan Brooks-36

PLANT FOOD—81.47 PERCENT

That the ringneck usually prefers plant to animal food may be concluded from the fact that more than 70 percent of the birds had fed exclusively on plants. In the average meal, 14 species of plants each amounted to more than 1 percent—a larger number than was found in the diet of any other diving duck. Green vegetative parts, as well as underground rootstalks and tubers, were freely consumed.

Pirnie (*82, p. 309*) found that nine ringnecks taken in Michigan had been feeding on plants similar to those found in the present study. Eight of the birds had each made all or part of their meal on seeds or plant fiber of the pondweeds; two, on bushy pondweed; two, on burreed seeds; three, on sedge seeds; and two, on bulrush seeds; two each, on seeds of yellow waterlily and watershield; one, on coontail seed; and two, on undetermined plant material. Howell (*44, p. 62*) reported that 10 ringnecks taken in Alabama had been subsisting on pondweeds (*Najas*, *Potamogeton*, and *Ruppia*), wildrice, coontail, watershield, and sour gum, along with caddisfly larvae and snails.

Waterlilies (14.56 percent).—Watershield (*Brasenia schreberi*) (10.55 percent) entered into the diet of the ringneck most prominently during the winter, forming nearly a third (31.88 percent) of the food of the 208 birds collected during January. It made up the entire meal of 16 birds, and its rather large seeds—often with a limited quantity of plant material—were noted in more than half (53 percent) the stomachs, 920 having been ingested by a single bird. The writer (*18, p. 38*) found that 41.4 percent of the food in 192 full stomachs of ring-necked ducks collected in Florida during the winter consisted of waterlilies, of which the watershield was the most important. These stomachs were examined in the Food Habits laboratory of the Biological Survey and are included in the percentages given in this bulletin.

Seeds of Florida spatterdock (*Nymphaea macrophylla*) (1.79 percent) had been taken by more than 9 percent of the birds, and the white waterlily (*Castalia odorata*) (1.21 percent) was found in 211 stomachs. Miscellaneous waterlilies (1.01 percent), including the banana waterlily, were taken less frequently, probably because few of the birds were collected where they occur. They were the sole item consumed by 16 birds.

Pondweeds (13.45 percent).—Najadaceae, which during November supplied more than a fourth (26.22 percent) of the food of the ringnecks, consisted largely of species of *Potamogeton* (11.97 percent). Considerably more than half of the birds had fed on seeds, rootstalks, tubers, or green vegetative material of this genus. *P. illinoensis* and sago pondweed (*P. pectinatus*) appeared to be the most important, supplying 1.74 and 1.51 percent, respectively. Other species included tealeaf, or claspingleaf pondweed (*P. perfoliatus*), *P. pusillus*, *P. foliosus*, whitestem pondweed (*P. praelongus*), variableleaf pondweed (*P. gramineus*), *P. friesii*, *P. filiformis*, ribbonleaf pondweed (*P. epihydrus*), longleaf pondweed (*P. americanus*), and floatingleaf pondweed (*P. natans*). Large numbers of seeds noted in individual stomachs included 1,520 *P. perfoliatus*, 510 *P. foliosus*, 250 *P. pectinatus*, and 620 miscellaneous potamogetons. Naiads (1.10 percent), mostly northern naiad (*Najas flexilis*) and southern naiad

(*N. guadalupensis*), were second in importance in the pondweed family. More than 200 seeds, along with considerable plant material, were taken at a single meal. Miscellaneous Najadaceae (0.38 percent) included wigeongrass (*Ruppia maritima*), shoalgrass (*Halodule wrightii*), and horned pondweed (*Zannichellia palustris*). It was a surprise to find 3,200 wigeongrass seeds in a single stomach.

Shoalgrass is listed in botanical books as being restricted to southern Florida and Cuba, but it has been found growing abundantly in favored areas on the Gulf coast to southern Texas and north on the Atlantic coast to New River, N. C. Although it has not been recognized as a valuable waterfowl food in the past, recent field observations along the Gulf and Atlantic coasts where it occurs have convinced the writer that it is of major importance in this saline tidal zone. Four ringnecks collected near Bayou La Batre, Ala., had all feasted on its rhizomes and leafy material. Because the ringneck is less abundant, however, in the salt- and brackish-water area along the coast, shoalgrass is probably of less value to it than to Canada geese, scaups, and black ducks.

Sedges (8.26 percent).—It was interesting to note that the jointed spikerush (*Eleocharis interstincta*) (2.65 percent) was the most important species of the sedge family in the ringneck's diet. It formed a part of the meal of 268 of the 742 birds and the entire meal of 1. One bird had ingested 1,380 seeds at 1 meal; another, 1,340. As the seeds are so similar to those of the squarestem spikerush (*E. quadrangulata*), it is probable that some of them were really of the latter species. In the southeastern part of the United States both of these sedges are obviously of high value and merit encouragement in a waterfowl habitat.

Bulrushes are of value to all inland ducks and even to a few of the typical sea divers. Seeds of various *Scirpus* species (4.45 percent) were obtained in all parts of the country by about half the ringnecks and were fed upon exclusively by three. The common three-square (*S. americanus*) and the swamp bulrush (*S. etuberculatus*), a southeastern species, were taken most frequently, the latter by 134 birds. Approximately 2,800 common three-square seeds were taken at a single meal. Seeds of all of the other common larger-seeded bulrushes were also taken, though not so often.

Miscellaneous Cyperaceae (1.16 percent) included species of all the common sedges not already listed, those of highest value being of the genera *Carex*, *Cladium*, *Cyperus*, *Rynchospora*, and *Fimbristylis*.

Grasses (8.13 percent).—Wildrice (*Zizania aquatica*) (5.38 percent) supplied the major part of the grass food, and seven birds taken in September had made nearly 38 percent of their meal on its seeds. It is probably a major food item of ringnecks in the North Central States.

Miscellaneous grass foods (2.75 percent) were of many species. Seeds of the giant cutgrass (*Zizaniopsis miliacea*), a weed pest in that it crowds out more desirable plants, were obtained by a few birds. Other grasses of some importance included wild millet (*Echinochloa*, mostly *E. crusgalli*), panicum (*Panicum*), pigeongrass, or setaria (*Setaria*), rice cutgrass (*Leersia oryzoides*), dropseed (*Sporobolus*), crabgrass (*Digitaria*), mannagrass (*Glyceria*), and paspalum (*Paspalum*). More than 450 seeds of *Sporobolus gracilis*, 150 seeds of *Panicum*, and 128 seeds of *Setaria lutescens* were found in single

stomachs. Bait in almost any form was readily consumed when available. It formed the entire meal of 1 bird, and more than 230 rice seeds (*Oryza sativa*) were found in 1 stomach and kernels of corn and other cultivated grains in others.

Smartweeds (6.44 percent).—Seeds of *Polygonum*, of which 12 species were identified, appeared to be acceptable whenever available. Because the ringneck is much more of a marsh duck than any of its close relatives, it more often finds these seeds. The swamp smartweed (*P. hydropiperoides*) (2.94 percent) was taken most frequently, having been ingested by 203, or 27.4 percent, of the 742 birds and having comprised 12.38 percent of the food of the 208 birds collected in January. Almost incredible numbers of seeds were taken by individual birds, 9,840 at one meal and only slightly smaller numbers at several others. Largeseed smartweed (*P. pensylvanicum*) (1.33 percent) and water smartweed (*P. amphibium*) (1.09 percent) were also important. The principal miscellaneous species (1.08 percent) included the dotted smartweed (*P. punctatum*), waterpepper (*P. hydropiper*), marsh smartweed (*P. muhlenbergii*), smartweed (*P. portoricense*), and nodding smartweed (*P. lapathifolium*).

The mixed contents of several ringneck stomachs collected in eastern South Carolina and submitted to the Biological Survey for identification gave the following groups and percentages of food: *Polygonum hydropiperoides*, 80; *P. pensylvanicum*, 10; *Brasenia schreberi*, 2; *Echinochloa crusgalli*, 2; *Eleocharis quadrangulata*, 1; seeds of *Commelina*, *Zizaniopsis miliacea*, and a species of *Myrica*, each a trace.

Muskgrass and other algae (4.83 percent).—Muskgrass (4.36 percent) was of frequent occurrence. Six birds collected during April had made it nearly a third of their food. One stomach contained 35,000 oögonia, or reproductive bodies, along with considerable plant fiber, and another 11,000, and three ringnecks had made their entire meal on such parts. Rockweed (*Fucus*) and various green algae were of considerable importance (0.47 percent) to a number of birds.

Sagittaria (3.75 percent).—Like many southern birds, the ringnecked duck feeds extensively, when opportunity permits, on the delta duckpotato (*Sagittaria platyphylla*). This was the only species of *Sagittaria* identified in this study, but a small quantity of food of the genus (0.46 percent) could not be identified as to species. Only the birds collected in the coastal States had obtained this food, which consequently was taken only during November, December, and January. The tubers of the plant were obtained by 84 birds, 2 of which had fed on them exclusively. Although the evidence thus indicates that the tubers of *S. platyphylla* are of considerable value, the more northern species of the genus are of little consequence as a food for the ringneck.

Coontail (3.58 percent).—Because of its adaptability and its abundance in so many bodies of water, *Ceratophyllum demersum* is often considered somewhat a weed species, as it frequently crowds out the more desirable duck-food plants. The large seeds and dissected leaves seem to be more acceptable as food to the ringneck than they are to most other waterfowl: 2 of the birds had fed exclusively on the seeds, 138 had included them in the meal, and 1 had ingested 200 of them along with considerable dissected leafy material. The plant entered into the diet each of the 9 months. It formed 13.29

percent of the food of 7 September specimens and 17.74 percent of that of 51 birds taken at Menasha, Ark., 39 of them having fed rather extensively on it.

Burreeds (1.34 percent).—The hard seeds of five species of *Sparganium* were of frequent occurrence, usually in comparatively small numbers, but in a few instances comprising the major part of a meal. Nine ringnecks collected in July had fed on them to the extent of 5.23 percent of their food.

Miscellaneous plant food (17.13 percent).—In addition to vegetable material too far digested to be longer recognizable (12.30 percent), a heterogeneous assembly of plants was found in the ringnecks' stomachs. It consisted of many species taken either in small numbers or infrequently, some of which were important in localized areas. The duckweeds were of most value (0.99 percent), and species of *Lemna* (0.70 percent) comprised about 2.50 percent of the food of the birds taken in November and December. More than 100 plants were ingested at one meal. The southern duckweed, wolffiella (mostly *Wolffiella floridana*), was of slightly less value (0.29 percent) but occurred in about equal frequency. McAtee (*55, p. 3*) found that 15 ringnecks taken in Arkansas in November and December had consumed duckweed to the extent of 21.7 percent of their food.

Watermilfoils (*Myriophyllum*) (0.92 percent) were of considerable importance to a relatively few birds, although they were taken to a slight extent by a fair number. More than 7,760 seeds were found in a single stomach, and the seeds and plant fiber comprised 5 percent of the food during July. Marestail (*Hippuris vulgaris*) was of considerably less value, although it occurred in the meals of several birds.

Wildcelery (*Vallisneria spiralis*) (0.28 percent) is obviously less important to the ringneck, even in the north, than it is to the redhead and canvasback. It was of most value during January, when it formed slightly less than 2 percent of the food. The species of celery occurring in Florida, where the greatest number of birds were collected, is an extremely broad-leaved variety (*V. americana*) that does not commonly form prominent winter buds as does the northern form (*V. spiralis*). This southern form apparently has little food value, as it was not recognized in any of the stomach contents. Frogbit (*Limnobium spongia*) (0.48 percent), another member of the Hydrocharitaceae family, seemed to be more valuable to the ringneck than wildcelery. It supplied 4.35 percent of the food of 204 birds taken in December. McAtee (*55, p. 5*) found that it formed 35 percent of the food of 25 birds collected in Louisiana in December.

Creeping waterprimrose (*Jussiaea diffusa*) (0.46 percent) is of considerable significance and readily accepted at times at least, as it formed 4.19 percent of the food of the 204 December birds and 4 of them had made their entire meal on it. It is of greatest value in the South Central States in areas that alternate irregularly between a submerged and an emergent condition.

It was somewhat surprising to find that the seeds of ragweed (*Ambrosia artemisiifolia*), eaten by 16 birds in March, averaged 0.66 percent for the 9 months and that buttonbush seeds (*Cephalanthus*) were of frequent occurrence and averaged 0.42 percent. The presence of such foods is doubtless largely attributable to drift.

Dodder (*Cuscuta*) was found in 13 stomachs, and wild grapes in 21. Although roundleaf waterhyssop (*Bacopa rotundifolia*) was not of frequent occurence, it was of considerable value to a few ringnecks, one of which had consumed more than 10,000 of its tiny seeds. Leaves of the plant are freely taken by many species of duck, and this easily propagated plant is particularly valuable on newly created ponds.

The pine family was represented in 11 stomachs by the seeds of loblolly pine (*Pinus taeda*) (0.02 percent). A few cones of baldcypress (*Taxodium distichum*) were found in two stomachs. Cypress galls (0.09 percent) were taken by a number of birds.

The more important remaining miscellaneous plants eaten by the ringnecks include pickerelweed (*Pontedaria cordata*), planer tree (*Planera aquatica*), sumac (*Rhus*), centella (*Centella asiatica*), sour gum (*Nyssa*), buttonweed (*Diodia teres*), bedstraw (*Galium*), floatingheart (*Nymphoides aquaticum*), and plumeless thistle (*Carduus*).

ANIMAL FOOD—18.53 PERCENT

Animal food was of greatest value to the ringneck during the summer months and consisted mainly of insects and mollusks. Many miscellaneous animal species were taken, but none was of appreciable importance in the average meal.

Insects (10.75 percent).—The nymphs of dragonflies and damsel flies (3.83 percent) were of first importance to the ringneck and formed nearly 14 percent of the food of 18 birds taken during October. One bird had eaten 20 in a single meal. Caddisfly larvae and cases (2.39 percent) were next in order and supplied more than 11 percent of the food during July. Following, in relative importance, were the midge larvae (1.16 percent); water boatmen and other water bugs (1.07 percent); beetles (0.96 percent), consisting of diving beetles (Dytiscidae) and others, 27 different kinds having been identified; and a large number of miscellaneous insects (1.34 percent).

Mollusks (5.97 percent).—Molluscan food, which was taken almost entirely during the winter months, consisted largely of gastropods (3.53 percent) of many species, only one of which—river shells (*Goniobasis*) (1.03 percent)—supplied as much as 1 percent of the total food. In February they made up 3.04 and in March 6.25 percent of the food. The 68 ringnecks taken in November and December had fed on species of *Neritina*, one bird having consumed 47; yet this mollusk averaged but 0.50 percent of the food for the 9 months. The other most important gastropod shells included dove-shell (*Mitrella*), *Anachis avara*, flat-coil (*Planorbis*), lathe-shell (*Acteocina canaliculata*), *Physa*, *Turbonilla*, *Bittium*, dog whelk (*Nassarius*), *Mangilia*, and *Amnicola*. In individual stomachs were found 280 dove-shells, 228 *Amnicola floridana*, and 194 flat-coils. Miscellaneous mollusks (2.44 percent) included pelecypods (0.06 percent) and unidentifiable species (2.38 percent).

Miscellaneous animal food (1.81 percent).—Many species of animal forms were represented, but none was of appreciable importance in the average meal. Undetermined animal matter, fish, spiders, water mites, crabs, water fleas, amphipods, annelid worms, bryozoans, and fresh-water sponges were taken. Fish consumption was surprisingly low (0.11 percent), and the fish eaten had no sporting value. Traut-

man (*89*) found that a ringneck taken in Buckeye Lake, Ohio, in December, was gorged with gizzard shad (*Dorosoma cepedianum*) and even had two in its throat. These fish are abundant in the lake, and weather conditions at the time made them easily procurable.

Ringnecks are reported to feed also on tadpoles, as well as on minnows and snails. Audubon (*3, v. 3, p. 260*) writes that while in ponds they eat snails, all kinds of aquatic insects, and seeds of grasses and that—

> When on rivers their usual food consists of small fish and crays, the latter of which they procure at the bottom. A male which I shot near Louisville, in the beginning of May, exhibited a protuberance of the neck so very remarkable as to induce me to cut the skin, when I found a frog, the body of which was nearly 2 inches long, and which had almost choked the bird.

Munro (*69, p. 148*) reports that two birds taken on southern Vancouver Island, British Columbia, in December, contained 3 dragonfly numphs, 1 chrysomelid beetle (*Donacia proxima*), 14 bivalves (*Pisidium variabile*), approximately 30 seeds of yellow pondlily (*Nymphaea*), and rootstalks of horsetail (*Equisetum palustre*).

FOOD OF JUVENILES

The stomachs of 10 juvenile ringnecks, taken in Alberta and Ontario, 9 in July and 1 in September, were available for laboratory analysis (table 3). Although the exact ages of the birds were not known, it appeared that the younger ones had adhered more completely to an insect diet. Each developing chick had ingested insects, seeds, and plant fiber and had taken an average of 14.4 species, and each had swallowed considerable fine sand, which measured as much in aggregate bulk as did the food consumed.

TABLE 3.—*Ring-necked duck (Nyroca collaris): Food, by volume percentages, of 10 juveniles, 9 taken in July and 1 in September*

Kind of food	Percentage of food	Kind of food	Percentage of food
PLANT FOOD (63.10 percent)		ANIMAL FOOD (36.90 percent)	
Wildrice (*Zizania aquatica*)	28.10	Dragonflies (Libellulidae)	4.10
Burreeds (*Sparganium*)	13.00	Dragonflies (*Somatochlora*)	2.80
Muskgrass (Characeae)	6.10	Dragonflies (*Boyeria*)	1.00
Sedges (Cyperaceae)	5.80	Other Anisoptera and Zygoptera	14.40
Bulrushes (*Scirpus*)	1.70	Caddisflies (Trichoptera)	4.20
Sedges (*Carex*) and miscellaneous	4.20	Beetles (Coleoptera): Diving (Dytiscidae) and others	3.70
Spatterdock (*Nymphaea advena*)	4.00	Water boatmen (Corixidae) and back swimmers (*Notonecta*)	2.60
Pondweeds (*Potamogeton*)	2.30	Miscellaneous insects	4.10
Miscellaneous plant food	3.70		

PLANT FOOD—63.10 PERCENT

Many of the same species of plants were eaten by both juvenile and adult ringnecks. Seeds of wildrice (*Zizania aquatica*) (28.10 percent) were first in importance in this limited series of juveniles, 6 of the 10 birds having made this the principal article of food. Seeds of three species of burreed (*Sparganium*) (13 percent) were taken by 8 birds, 6 of which had each taken from 135 to considerably more than 400 seeds. Fruiting bodies (oögonia) and plant fiber of muskgrass (6.10 percent) were third in importance, although they

contributed to the meals of but four birds and in two of these amounted to only a trace. One bird had ingested more than 11,000 oögonia. Sedges (5.90 percent), which formed a part of the meal of every juvenile examined, consisted of seeds of *Scirpus* (1.70 percent) and of *Carex* and miscellaneous sedges, mostly *Cladium* (4.20 percent). Seeds of the spatterdock (*Nymphaea advena*) (4 percent) were obtained by six birds. Seeds and plant fiber of eight species of *Potamogeton* (2.30 percent) were identified in seven stomachs. Of the miscellaneous plants (3.70 percent), 2.90 percent was supplied by unidentified plant debris and drift and 0.80 percent by arrowwood (*Viburnum*), marestail (*Hippuris vulgaris*), watermilfoil (*Myriophyllum*), crowberry (*Empetrum nigrum*), undetermined grass, and moss.

ANIMAL FOOD—36.90 PERCENT

Aside from a few Daphnidae ephippia, statoblasts of Bryozoa, and a trace of unidentifiable mollusks, all the animal matter eaten by the young ringnecks consisted of insects. Odonata nymphs (22.30 percent)—dragonflies and damsel flies—were obtained by each bird as follows, expressed in percentages: Libellulidae, 4.10; *Somatochlora*, 2.80; *Boyeria*, 1; and others, 14.40. Larvae of caddisflies (4.20 percent) formed 30 percent of the meal of one bird. Beetles (3.70 percent) consisted of predaceous diving beetles (Dytiscidae) and a few others. Water boatmen and back swimmers (*Notonecta*) (2.60 percent) and miscellaneous insect food (4.10 percent), including grasshoppers (Acrididae), larvae of nerve-winged insects (Chrysopidae and Sialidae), moth larvae, ants (*Myrmica*), and a limited amount of unidentifiable material, made up the remaining animal food.

CANVASBACK (Nyroca valisineria)

(Pl. 1, facing p. 8)

The lordly canvasback, a distinctly Nearctic species, is perhaps to the epicure the most celebrated of ducks; certainly it is the most prized of the divers. It is the wariest of the *Nyroca* group, and therefore more skill is required on the part of the hunter to bag it than to take any of its near relatives. It is supposed to acquire its delectable flavor from the wildcelery buds (*Vallisneria spiralis*) from which it has been given its specific Latin name. Undoubtedly the pondweeds, upon which it feeds most extensively, and perhaps many other submerged aquatics are just as efficacious in helping to produce the pleasing flavor. Huntington (*45, p. 173*) writes that on the Pacific coast the birds feed on wapato (*Sagittaria variabilis*), which renders their flesh equally as delicious as that of the celery-fed birds of the East. According to Forbush (*33, p. 237*) and Dawson and Bowles (*23, p. 793*), however, the canvasback on the Pacific coast sometimes feeds on decaying dead salmon and so becomes unfit for human food; and Grinnell, Bryant, and Storer (*38, p. 154*) state:

> In California the Canvasback partakes of more animal food, for wild celery does not grow in this state. On the shallow waters of the tidelands and marshes, it feeds extensively on crustaceans and shellfish, thereby acquiring a "fishy" taste and thus becoming undesirable as a table bird. The stomachs of some Canvasbacks collected on San Pablo Bay contained clams (*Mya arenaria*), and snails (*Odostomia* sp.); one stomach from Tia Juana Slough, near San

Diego, contained periwinkles (*Cerithidea californica*), and another from the same place contained grass-blades, stems and roots. A stomach from Guadalupe, San Luis Obispo County, was filled with barley, there being 22 whole kernels and many hulls * * *.

The canvasback is more tolerant of cold weather than either the ringneck or redhead, yet, late as is its departure, it migrates even into Mexico. Its flight, though apparently labored, is strong, rapid, and well sustained. In migration and in daily aerial movements it is often seen in large wedge-shaped flocks, and it gathers in large flocks on the bays or broad inland waters during the middle of the day and night to rest and sleep. Its long neck, larger size, white back, and characteristic flock movements readily distinguish it from its near relatives, with which it often consorts. It frequents much the same habitats as the redhead except that it is better adapted to deeper water and adheres more consistently to fresh-water areas. It is an expert diver, descending at times, it is said, to depths of 25 feet to obtain its food. It is perhaps more a digger of roots and other subterranean plant parts than any other of its tribe. It swims low on the water like a grebe and dives quickly, throwing itself upward and forward, apparently to gain impetus in the descent. It often swims long distances under the water and is reported to use wings as well as feet in this process.

Food of Adults

Canvasbacks are greedy feeders. During a baiting experiment performed on the Chesapeake, a flock was permitted to feed in about 10 feet of water at a baited shooting blind similar to all others in the neighborhood for 3 to almost 5 minutes, during which time not more than five short dives for grain were made. Three birds were killed: one had 20 kernels of corn, 2 kernels of wheat, and a few pieces of eelgrass in its gullet; another had swallowed 29 kernels of corn, 1 kernel of wheat, and a little eelgrass; and the third (a female) had obtained 20 kernels of corn and a little eelgrass.

As further indication that the canvasback is often a glutton, it may be stated that as many as 23 species of food were taken at a single meal. On the other hand, 79 birds (more than 18 percent) had made their entire meal on only 1 species, 62 on a single plant, and 17 on a single animal, indicating that when a satisfactory food is found it is often taken in quantity. The average meal was composed of 188 individual items comprising 5.64 species.

Of 461 available stomachs of adult canvasbacks, only 427 were full enough to be used in computing food percentages (tables 4 and 8). The stomachs were obtained in 25 States, Alaska, and 5 Canadian Provinces in every month except July and August, as follows: 162 came from Louisiana, 38 from Maryland, 36 from Texas, 34 from Wisconsin, 23 from Utah, 15 each from Alberta and Virginia, 14 from Colorado, 12 each from Washington and Oregon, 10 from North Dakota, and smaller numbers from Alaska and the remaining Provinces and States extending from Maine and Alaska to Alabama and Nevada. With the exception of the unusually large number taken in Louisiana—mostly during January and February—the collections could be considered very representative of the range of the species. The winter months from October to March were well represented with 379 stomachs, but only 48 stomachs were taken in the summer months, April, May, June, and September.

TABLE 4.—*Canvasback (Nyroca valisineria): Food, by volume percentages, of 427 adults taken during 10 months of the year*

Kind of food	Percentage of food	Kind of food	Percentage of food
PLANT FOOD (80.59 percent)		PLANT FOOD (80.59 per cent)—continued	
Pondweeds (Najadaceae)	29.88	Burreeds (*Sparganium*)	2.50
Sago pondweed (*Potamogeton pectinatus*)	12.53	Watermilfoils (*Myriophyllum*) and marestail (*Hippuris vulgaris*)	2.06
Claspingleaf pondweed (*Potamogeton perfoliatus*)	1.10	Muskgrass (Characeae) and other algae	1.50
Other *Potamogeton* species	14.85	Miscellaneous plant food	10.20
Miscellaneous	1.40	ANIMAL FOOD (19.41 percent)	
Wildcelery (*Vallisneria spiralis*)	8.81	Mollusks	6.80
Delta duckpotato (*Sagittaria platyphylla*) and other waterplantains (Alismaceae)	7.77	*Macoma* shells	2.95
Grasses (Gramineae)	7.61	Other pelecypods	1.49
Wildrice (*Zizania aquatica*)	5.14	*Neretina reclivata*	2.21
Miscellaneous, including bait	2.37	Other gastropods	1.28
Sedges (Cyperaceae)	6.30	Undetermined	.87
Common three-square (*Scirpus americanus*)	1.27	Insects	9.13
Other *Scirpus* species	3.27	Caddisflies (Trichoptera)	5.20
Miscellaneous	1.76	Midges (Chironomidae)	1.05
Banana waterlily (*Castalia flava*) and other waterlilies (Nymphaeaceae)	4.06	Miscellaneous	1.88
		Fishes (Pisces)	2.03
		Miscellaneous animal food	.45

PLANT FOOD—80.59 PERCENT

Of the 427 canvasbacks, 185 (43.33 percent) had made their entire meal on plant foods, the kind and quantity varying greatly with the season and locality. Even though availability within limits appeared to be the principal factor governing selection, some degree of selectivity was manifest, as 62 birds had made their entire meal on a single plant species as follows: 20 on the seeds, tubers, and green vegetative growth of sago pondweed (*Potamogeton pectinatus*); 16 on undetermined *Potamogeton* species; 6 each on bulrush (*Scirpus*) seeds and banana waterlily (*Castalia flava*); 5 on wildcelery (*Vallisneria spiralis*); 4 each on muskgrass (*Chara*) and *Sagittaria;* and 1 on wigeongrass (*Ruppia maritima*). Subterranean parts of the plants, such as tubers, succulent rootstalks, winter buds, or other food-storage organs, seemed to be preferred to the green vegetative growth or even to seeds.

Pondweeds (29.88 percent).—Perhaps because of their wide distribution in the localities and habitats most frequented by the canvasback, Najadaceae supplied nearly three-tenths of the entire food. They were eaten in each of the 10 months and formed 28.02 percent of the winter and 32.71 percent of the summer food. Tubers, seeds, underground rootstalks, and green vegetative growth were all taken.

Perhaps because the canvasbacks are predominantly fresh-water inhabitants, most of those examined had fed on some species of *Potamogeton* (28.48 percent), which furnished more than 95 percent of all pondweed food and more than three-fourths of the food for September. Sago pondweed (*P. pectinatus*) (12.53 percent) was found in more than a fourth of the stomachs and during September, October, and November comprised 40.55, 23.78, and 25.16 percent of the food, respectively. More than 500 seeds were found in 1 stomach and 324, 212, and 175 in others; and 1 gizzard and gullet contained 59 tubers and another 57, some of which measured one-

half inch in thickness and three-fourths of an inch in length. Claspingleaf pondweed (*P. perfoliatus*), known also as tealeaf and redhead-grass, appeared to be the second most important pondweed (1.10 percent), although many other related species (14.85 percent) entered into the diet. In a single stomach, 2,500 miscellaneous *Potamogeton* seeds were found.

Miscellaneous pondweeds of other genera (1.40 percent) in the order of importance included wigeongrass (*Ruppia*), nearly 2,400 seeds of which were found in a single stomach; naiad (*Najas*); eelgrass (*Zostera marina*); and horned pondweed (*Zannichellia palustris*).

Nuttall (*75, p. 431*) mentions finding both eelgrass and wigeongrass in the stomachs of birds he examined and regarded these foods as being very important. Kumlien and Hollister (*48, p. 22*) concluded that the abundance of pondweeds was the chief factor regulating the numbers of canvasbacks, as well as the length of their stay, in Wisconsin. Pirnie (*82, pp. 307–308*) found that sago pondweed or other potamogetons had been taken by seven of eight birds collected in Michigan, naiad by one of the seven, and muskgrass and sedge seed by another. Barley, probably taken as bait, was the sole item in the stomach of the eighth bird. Two of the birds had also fed on Mayfly larvae and snails.

Wildcelery (8.81 percent).—That wildcelery (*Vallisneria spiralis*) is an important canvasback food is shown by the fact that it averaged a little more than a twelfth of the food for the 10 months, although only about 1 out of every 7 birds had obtained it. Five of the birds taken in winter had made it their entire meal, and others had drawn upon it for most of their meal. Winter food-storage buds along with smaller amounts of underground rootstalks, green basal vegetative leaves, and seeds were eaten. At least 93 buds were found in a single stomach. Four birds taken on the Susquehanna Flats near Havre de Grace, Md., and examined by Warren (*91, p. 43*) had fed exclusively on this plant. Many writers speak of the importance of wildcelery as a canvasback food.

Wildcelery has a limited distribution, occurring little beyond the confines of eastern United States, and therefore is not available for the birds in the western half of the country nor for any of the birds on their breeding grounds. In the present study, not a bird collected between the last of April and early October had obtained even a trace of it. Where it does occur, there is probably no better food for the canvasback, and there is probably no other food that helps to produce a better quality of flesh. Therefore, the canvasback is most highly prized in those sections of the country where this plant abounds. At a number of lakes where wildcelery occurred, however, pondweeds formed the only article of diet, indicating that wildcelery, though admittedly an excellent food species, is not superior to some of the pondweeds and is not always taken in preference to a number of other foods.

Delta duckpotato and other waterplantains (7.77 percent).—The Alismaceae found in the stomachs of the canvasbacks consisted largely of *Sagittaria* (7.32 percent), although a small quantity (0.45 percent) of *Alisma* and *Damasonium* was present. The only species of *Sagittaria* identified was a southern form, the delta duckpotato (*S. platyphylla*), all the occurrences of which were in the stomachs

of birds taken in Louisiana, practically all in an area on the Mississippi Delta. Because considerably more than a third (162) of the stomachs came from Louisiana during December, January, and February, it would seem, however, that the rating here given is somewhat high and that a more equitably distributed series of stomachs would undoubtedly show this plant to be of less value for the country as a whole. For the Mississippi Delta of Louisiana it is obviously of outstanding merit, and it should be considered in any waterfowl management plan for the Mississippi-Gulf coast region. As most of the birds taken during February were from this area, the delta duckpotato supplied more than half the food for that month, 38 tubers having been taken at a single meal. Furthermore, nearly all the canvasbacks collected in this area had fed on this plant, 103 of 113 birds obtained near Triumph, La., having made it more than 66 percent of their meal. The use of this food is illustrated in plate 3, *A*, *c* and *d*.

Grasses (7.51 percent).—Of the various Gramineae eaten, wildrice seeds (*Zizania aquatica*) (5.14 percent) were most important. They had been obtained by 26 birds, 1 having ingested 128 and another 116. As a local food, wildrice seed proved to be very important in Wisconsin.

Miscellaneous grasses (2.37 percent) consisted largely (1.46 percent) of species of *Panicum* and *Setaria* and of wild millet (*Echinochloa crusgalli*), more than 340 seeds of the latter having been obtained by 1 bird. Bait in the form of corn, wheat, and rice aggregated nearly 1 percent. It does not rate high because comparatively few birds were taken in a baited area, but as previously mentioned, it is accepted readily and usually in preference to an abundant natural food. Wilson and Bonaparte (*96, p. 224*) noted as early as 1831 that the canvasback would readily feed on grains, especially wheat, and Phillips (*81, v. 3, p. 131*) wrote of the wreck of a vessel of wheat on Lake Erie, stating that canvasbacks lived almost entirely on the cargo during the following winter.

Sedges (6.30 percent).—Cyperaceae, particularly several species of *Scirpus* (4.54 percent), were of frequent occurrence in the canvasback's food. About 3 of every 10 birds had fed on the seeds of the common three-square (*S. americanus*) (1.27 percent) (pl. 3, *A*, *a*), a surprisingly large number of which were taken occasionally, 5,228 having been found in a single stomach. Other *Scirpus* species (3.27 percent) of outstanding value included the alkali bulrush (*S. paludosus*); river bulrush (*S. fluviatilis*), 1 bird having taken 480 seeds at a single meal; Olney's three-square (*S. olneyi*), 2 birds having ingested 3,200 seeds apiece at one meal; saltmarsh bulrush (*S. robustus*); and the hardstem and softstem bulrushes (*S. acutus* and *S. validus*). Miscellaneous sedges (1.76 percent) of several species were taken, as a rule the seeds only, but occasionally the more tender parts of the green vegetation. Unidentified *Carex* species were taken by 27 birds, and 850 seeds were found in 1 stomach. Seeds of spikerushes (*Eleocharis*) were of slightly less value.

Banana waterlily and other waterlilies (4.06 percent).—Locally the Nymphaeaceae are of major importance. In the coastal area of the Gulf States, the banana waterlily (*Castalia flava*) (3.96 percent) is one of the outstanding duck foods. McAtee (*56, p. 37*) reported that 37 canvasbacks collected in December at Lake Surprise, Tex.,

had eaten various parts of this plant to the extent of 71.6 percent of their diet. Of the canvasbacks examined for this bulletin that were taken during December, half were collected at the same lake and half from parts of the country where the banana waterlily does not occur, yet this species supplied nearly 40 percent of the food for the month. Seeds of the white waterlily (*Castalia*), watershield (*Brasenia schreberi*), and spatterdock, or yellow waterlily (*Nymphaea*), were of importance to a few birds, having been taken by 19, 3, and 1 individuals, respectively.

Burreeds (2.50 percent).—Species of *Sparganium* had been eaten by 36 canvasbacks, 14 of which had fed on the giant burreed (*S. curycarpum*), 1 bird having consumed 296 seeds. Several birds had drawn most of their meal from these plants.

Watermilfoils (2.06 percent).—Seeds and dissected plant leaves of *Myriophyllum* (1.99 percent) entered into the diet of 46 birds, mostly during the early spring and summer, 1,224 seeds having been ingested at a single meal and more than 1,000 at another. The only other member of the watermilfoil family taken was *Hippuris vulgaris* (0.07 percent).

Muskgrass and other algae (1.50 percent).—The canvasback differs markedly from the redhead in its comparatively light consumption of these foods. Usually only a relatively small quantity was taken, yet four birds had made their entire meal on the small bulblets, oögonia, and green plant fiber.

Miscellaneous plant food (10.20 percent).—Because of the difficulty in accurately identifying partly digested tubers, rootstalks, or green vegetative material, 8.59 percent of the food was classified as unidentifiable vegetable debris. The identified miscellaneous plant food (1.61 percent) was drawn from a large variety of plants, the more important of which were smartweeds (*Polygonum*), coontail (*Ceratophyllum demersum*), bedstraw (*Galium*), wild grape (*Vitis*), dogwood (*Cornus*), goosefoot (*Chenopodium*), duckweeds (*Lemna* and *Spirodela polyrhiza*), waxmyrtle (*Myrica*), water buttercup (*Ranunculus*), beggarticks, or sticktights (*Bidens*), and baldcypress (*Taxodium distichum*). Some of these formed the principal items of several meals yet were taken infrequently; others appeared as a trace or a very low percent of many meals. One bird had taken more than 1,600 plants of duckweed; another, 1,450 goosefoot seeds (*Chenopodium*); and a third, 380 waterpepper (*Polygonum hydropiper*) and 50 waxmyrtle seeds.

A report from Rehoboth Bay, Del., indicates that the canvasbacks in company with other raft ducks frequently feed on tomato-seed waste thrown out into the bay by a canning factory. Lowery (*52, p. 18*) comments that in Louisiana this species feeds on acorns.

ANIMAL FOOD—19.41 PERCENT

Animal food, which in summer comprised 21.49 percent of the intake and in winter 18.02, was almost equally divided between mollusks, consumed principally during the winter, and insects, prominent in the summer bill of fare. Fish and miscellaneous animal matter supplied the remainder.

As evidence that the canvasback is able to subsist entirely on animal food, at least for short intervals, it may be stated that 30 birds (7.03

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A, Stomach contents of a canvasback (*Nyroca valisineria*): *a*, 1,600 seeds of three-square (*Scirpus americanus*); *b*, fragments of 1 crab and bivalves; *c* and *d*, 23 whole tubers and fragments of others of delta duckpotato (*Sagittaria platyphylla*). *B*, Wigeongrass (*Ruppia maritima*) from Dorchester County, Md., July 25, 1935, showing fruiting plant with vegetative parts below, × ½.

percent) had fed exclusively on such food and that more than half these had made the entire meal on a single group of aquatic creatures as follows: 10 on *Macoma* shells; 6 on other mollusks; and 1 on caddisfly larvae.

Mollusks (8.80 percent).—Of the pelecypods (4.44 percent), *Macoma* shells (2.95 percent) seemed to be the most acceptable. They were not available to many of the birds, however, as the canvasback does not normally occur in numbers in a salt-water habitat. Of the 19 birds that were able to obtain these mollusks, 10 had made them 100 percent of the meal and 9 had eaten them almost exclusively. The principal other bivalves (1.49 percent) taken were *Mactra*, gem clams (*Gemma gemma*) and other Veneridae, and *Astarte*.

Of the gastropods (3.49), *Neritina reclivata* (2.21 percent) was the most important. It was taken by 112 of the birds collected in Louisiana. The principal other univalves (1.28 percent) were flat-coils (*Planorbis*), dove-shells (*Mitrella*), *Anachis*, dog whelks (*Nassarius*), lathe-shells (*Acteocina canaliculata*), *Bittium*, *Lymnaea*, *Turbonilla*, and flood-shells (*Fluminicola*).

Undetermined mollusks averaged only 0.87 percent of the food for the 10 months.

Insects (8.13 percent).—Although many species of insects were consumed, yet nearly two-thirds of the volume of food drawn from this large order consisted of caddisfly larvae and their cases (5.20 percent). One bird had made its entire meal on them; and four birds taken in May, 28 percent of their meal. Midge larvae (1.05 percent) supplied 4.12 percent of the food in March. Miscellaneous insects (1.88 percent) consisted primarily of diving beetles (Dytiscidae) and other beetles; nymphs of Mayflies; dragonflies; damsel flies; various water bugs, principally water boatmen, back swimmers (*Notonecta*), and water striders (*Gerris*); and undetermined hymenopterans.

Fishes (2.03 percent).—Small fishes occurred in 32 of the 427 stomachs yet were considered unimportant because they were species of relatively little economic value. Trautman (*89*) reports finding gizzard shad (*Dorosoma cepedianum*) in the stomachs of canvasbacks taken in Buckeye Lake, Ohio, in December.

Miscellaneous animal food (0.45 percent).—The tooth of a rat and the vertebrae and tooth fragments of a muskrat (*Ondatra rivalicia*) were noted in stomachs. These unusual items were probably picked up as gravel. Annelid worms (0.29 percent) supplied 1.33 percent of the January and 1.64 percent of the February food. Crabs (pl. 3, *A*, *b*) and other crustaceans (0.07 percent) were consumed by relatively few birds.

Audubon (*3, v. 4, p. 3*) wrote that when wildcelery is unavailable, the canvasbacks—

> are obliged to have recourse to fishes, tadpoles, water-lizards, leeches, snails, and mollusca, as well as such seeds as they can meet with; all [of] which have been in greater or less quantity found in their stomach.

Lead shot pellets are sometimes picked up by these ducks as they feed. This is altogether too common an occurrence in baited areas where large numbers of shot are expelled over a limited area where the birds repeatedly feed, with the result that large numbers of birds experience a lingering death and that those that do recover probably become sterile. The writer found 96 shot (lead pellets) in a single gizzard of this species.

Food of Juveniles

Eight juvenile canvasbacks from Alberta and Saskatchewan were available for food habits study. Three were taken early in September and had apparently grown out of the downy stage, although they were still unable to fly. Nearly two-thirds of the total food of the group was plant material, and on an average 19.62 species of food were consumed in one meal. Gravel formed 12 percent of the stomach contents.

The three older birds had drawn practically all of their food from pondweeds (*Potamogeton*) and bulrushes (*Scirpus*). As a rule, the five younger birds appeared to have been more indiscriminate in their feeding. More than half their food consisted of animal matter (56.20 percent), and four of them had stressed insect food, even though they had consumed considerable vegetable material.

PLANT FOOD—64.38 PERCENT

The plant food consumed by the juvenile canvasbacks may be summarized by groups and percentages as follows: Pondweeds (*Potamogeton*), 36.63; bulrushes (*Scirpus*), 5.12; sedge (*Carex*), 1.13; common spikerush (*Eleocharis palustris*), 1; burreeds (*Sparganium*), 6.62; watermilfoil (*Myriophyllum*) and marestail (*Hippuris vulgaris*), 4.26; bugleweed (*Lycopus lucidus*), 2.88; miscellaneous plants and vegetable debris, 6.74, the more important of which include smartweeds (*Polygonum*), goosefoot (*Chenopodium*), dock (*Rumex*), water buttercup (*Ranunculus*), bedstraw (*Galium*), muskgrass, and grasses.

ANIMAL FOOD—35.62 PERCENT

Insects (35.26 percent) supplied all but a fraction of the animal food in the following groups and percentages: Caddisflies, 19.01; water boatmen, 8.38; various water beetles (mostly Dytiscidae), 3.63; midge larvae, 1.50; miscellaneous insects, including nymphs of dragonflies and Mayflies, ants and other Hymenoptera, and various two-winged flies, 2.74. Mollusks and crustaceans composed the 0.36 percent miscellaneous animal food.

GREATER SCAUP DUCK (Nyroca marila)

(Pl. 2, facing p. 16)

The two American species of scaups, the greater scaup duck (*Nyroca marila*) and the lesser scaup duck (*N. affinis*), also variously known as blackheads, bluebills, broadbills, or raft ducks, are almost indistinguishable under ordinary field conditions, although when both species of the same sex are together within range they can usually be separated. Under optimum light conditions the adult male greater scaup shows greenish instead of purplish reflection on its head. Full-plumaged adults of both sexes may be distinguished from their lesser cousins by a white or near-white mark on the outer web of the inner primaries. Not infrequently, however, intergrades are found, which make the separation more difficult. Because these two closely related species often appear to merge in size and color they are frequently confused by field workers, and as many of the stomachs used in this study were obtained from field cooperators it is not improbable

that a limited number have been improperly classified. Care has been taken, however, to keep the records as accurate as possible.

The greater scaup, as its name implies, is the larger of the two species. It is the more northern in distribution and adheres more persistently to the salt-water bays along the coast. Because it is relatively uncommon inland during the winter season it is frequently referred to as the bay blackhead, bay broadbill, bay bluebill, or bay scaup. It is a common breeder in the northern parts of North America, Europe, and Asia. In North America it nests from the arctic tundra near the coast southward at least to the international boundary. Its winters are spent primarily along or near the Pacific coast from the Aleutian Islands to northern Baja California and on the Atlantic coast from New England to southern North Carolina. Limited numbers of birds also extend far beyond these limits.

These ducks are able divers and usually feed in deeper water than any of the preceding species, although at times they may be seen dabbling in the mud along the shore with the surface feeders or feeding on the drift caught in the tide. They are readily attracted to a bounteous food supply, whether bait or the natural growth of pondweeds, wildrice, or wildcelery. They often feed in rather large flocks and may be seen diving separately, indiscriminately, or all in unison. They are truly raft ducks and frequently join mixed flocks of other species of this genus. In their daily movement they seem to go in and out with the tide. If persistently persecuted they often go to sea and return to the feeding grounds at night. This is said to be particularly true during bright moonlight nights.

The greater scaup is naturally a confiding bird although perhaps less trusting than its smaller relative. It dives quickly and, when wounded and pursued, swims long distances under water or with only the beak protruding in order to obtain air. In common with other divers, it is said that as an act of last resort in its efforts to escape it will seize underwater vegetation in its bill and hold on tenaciously until death. Many a hunter has pursued a cripple and completely lost track of it after a single dive.

This species has undoubtedly experienced a tremendous reduction in numbers during the past decade, but it has obviously held up far better than any other member of the tribe, probably owing to the fact that it is more northern and more coastal in distribution. Although acceptable as a table bird, it is regarded as second-rate in comparison with the preceding species, except when fattened on the luscious parts of wildcelery, pondweeds, wildrice, or other choice vegetable foods.

Food of Adults

These scaups are the most omnivorous of the American *Nyroca* group and seem content and at home in an area where either vegetable or animal food abounds. It seems to make little difference to them whether mollusks, crustaceans, pondweeds, wildrice, or other foods are present so long as there is a bounteous supply. The birds examined had subsisted almost equally upon animal and plant foods, but those taken inland during the winter months usually showed a preponderance of plant material, whereas the coastal birds more often derived most of their food from mollusks and other pelagic or littoral forms of life. They seemed to have grown equally fat on an almost exclu-

sive animal or almost exclusive plant diet. Nearly half the birds (48.14 percent) had made their entire meal on animal foods and nearly a fourth (21.54 percent) on plant foods. It is also significant that although many species of food were consumed, yet individual meals were often derived from only one or two, 1 bird in every 8 (12.5 percent) having made its entire meal on a single animal species and 1 in every 17 (5.85 percent) on a single kind of plant. Consequently there was an average of only 6.33 species of food a meal. Gravel was taken freely and formed 17.83 percent of the total bulk.

Pirnie (*82, pp. 309–310*) examined the stomachs of 12 greater scaups collected in Michigan. Eight had fed on pondweeds and bushy pondweeds, four rather extensively. The distended stomach of a bird that had suffered from lead poisoning contained 1,000 seeds of the latter. Six birds had fed on wildcelery. Muskgrass, watershield, and burreed had each been taken once. Caddisfly larvae and clams were found in four stomachs; snails, in six; beetles, in two; and a dragonfly nymph and a waterbug in one.

John J. Lynch [6] reported a number of greater scaups taken in Rhode Island that were suffering from acute lead poisoning. Typical of most birds suffering from such poisoning, which is altogether too widespead, their stomachs were greatly distended, owing perhaps to partial or complete paralysis of the intestines and gizzards, which caused retention of food in the stomach. One bird had its gullet filled, 80 percent of the contents being *Potamogeton pusillus* and 20 percent beetles and snails. Six other birds had made from a trace to 90 percent of their meal on this same pondweed. Sago pondweed (*P. pectinatus*), coontail (*Ceratophyllum demersum*), and grass blades appeared in other stomachs. Beetles, mostly whirligigs (*Gyrinus*) and diving beetles (*Dytiscus*) were also noted. Mollusks, comprising 5 and 75 percent of two stomachs, were identified as sphere-shells (*Sphaerium*) and species of *Physa*, *Bulima*, and *Planorbis*.

From reports of European writers it appears that the Old World forms of the greater scaup (considered a separate subspecies by some and classed as identical with the American form by others) have feeding habits that closely parallel those of the American birds.

The stomachs of 832 adult greater scaups, collected in 25 States, Alaska, and 7 Canadian Provinces in every month except August, were analyzed in the laboratory, but only 752 were sufficiently full to be used in the computation of food percentages (tables 5 and 8). These collections could hardly be considered a normal distribution, as 310 stomachs came from Oyster Bay, Wash.—all but a few on or near oyster beds—in an effort to ascertain the relation of the greater scaup to the oyster industry. Other areas supplying rather large numbers of birds included British Columbia, 70; North Carolina, 67; Utah, 51; Massachusetts, 35; Wisconsin, 31; Alaska, 23; and New York, 21. As would be expected, most of the birds were obtained during the winter months, 168 having been taken in November and only 58 from April to September, a number insufficient to show more than trends in food habits.

[6] Letter in files of U. S. Biological Survey from John J. Lynch, Newport, R. I., dated April 7, 1935.

TABLE 5.—*Greater scaup duck (Nyroca marila): Food, by volume percentages, of 752 adults taken during 11 months of the year*

Kind of food	Percentage of food	Kind of food	Percentage of food
PLANT FOOD (46.52 percent)		ANIMAL FOOD (53.48 percent)—contd.	
Pondweeds (Najadaceae)	18.86	Mollusks—Continued.	
Pondweeds (*Potamogeton*)	12.16	Blue mussel (*Mytilus edulis*)	4.31
Wigeongrass (*Ruppia maritima*)	4.88	*Macoma* shells	3.76
Naiads (*Najas*) and miscellaneous	1.52	Rock clam (*Protothaca staminea*)	3.03
Muskgrass (Characeae)	5.41	Other pelecypods	2.13
Watermilfoils (Haloragidaceae)	4.84	Dog whelks (*Nassarius*)	3.48
Marestail (*Hippuris vulgaris*)	3.44	*Lymnaea* shells	3.09
Watermilfoils (*Myriophyllum*)	1.50	*Campeloma* shells	1.64
Sedges (Cyperaceae)	3.28	Other gastropods	6.37
Bulrushes (*Scirpus*)	1.49	Undetermined	1.34
Sedges (*Carex*)	1.16	Insects	7.15
Miscellaneous	.63	Caddisflies (Trichoptera)	2.61
Wildrice (*Zizania aquatica*) and other grasses (Gramineae)	2.03	Midges (Chironomidae)	1.32
Wildcelery (*Vallisneria spiralis*)	1.52	Beetles (Coleoptera)	1.31
Miscellaneous plant food	9.58	Miscellaneous	1.91
		Crustaceans	6.84
ANIMAL FOOD (53.48 percent)		Amphipods	2.17
		Mud crabs (*Hemigrapsus*)	1.74
Mollusks	39.12	Barnacles (Balanidae)	1.67
Oyster (*Ostrea lurida*)	9.97	Miscellaneous	1.26
		Miscellaneous animal food	.37

PLANT FOOD—46.52 PERCENT

Pondweeds (18.86 percent).—The greater scaup, like all others of its tribe, is partial to the pondweeds, subsisting on seeds, subterranean rootstalks, and green vegetative fiber. Most important of the pondweeds were 11 or more species of *Potamogeton* (12.16 percent), of which sago pondweed (*P. pectinatus*) furnished 3.92 percent, 1,600 seeds having been ingested at a single meal. Wigeongrass (*Ruppia maritima*) (4.88 percent), the most important pondweed species, entered into the meal of one out of every five birds and furnished the entire meal of six. One bird had consumed 1,350 seeds and plant material. Naiads (1.27 percent) were taken by 57 of the 752 birds and formed the entire meal of 1. Miscellaneous pondweeds (0.55 percent), including eelgrass (*Zostera marina*), surfgras (*Phyllospadix*), and horned pondweed (*Zannichellia palustris*), were taken by fewer birds.

Muskgrass (5.41 percent).—Although only 1 bird in 7 had obtained muskgrass, it apparently was avidly consumed when available, as it contributed 100 percent of the meal of 26 greater scaups. McAtee (*55, p. 1*) found that three-fifths of the food of 35 big bluebills taken in Currituck Sound, N. C., in November 1909, consisted of "musk grasses," and Kubichek (*47, p. 118*) found that the stomach of one bird taken in the same locality in February contained 83,000 whole oögonia and pieces of about three times as many more, making a total for one meal of about 332,000 items—the greatest number known to have been taken by any bird. Obviously these ovoid reproductive bodies were not picked up individually or in groups off the plants but were ingested with plant fiber and being more resistant remained in the gizzard after the vegetative parts had been digested and passed on into the intestines. Kubichek found also (*47, p. 118*) that 52 of 67 greater scaups taken at Okanagan Landing, British Columbia, from November to February had fed on *Chara*, some of them extensively.

It may be added that practically all other ducks, except mergansers, taken at this locality had drawn heavily upon this food.

Watermilfoils (4.94 percent).—It was somewhat surprising to find that both seeds and plant fiber of *Hippuris vulgaris* (3.44 percent) and species of *Myriophyllum* (1.50 percent) entered so prominently into the diet of the greater scaup. It is possible that a larger and more representative series of birds taken during the summer months would reduce the relative rating of these plants, all but a trace of which were obtained as summer food, largely from Alaska and Canada. Eight birds taken in May had made 31.53 percent of their meal on them, and for the five summer months April to September, exclusive of August, marestail amounted to 2.81 and watermilfoil to 9.55 percent. Slightly fewer than 1,000 seeds were taken at a single meal.

Sedges (3.28 percent).—It is not surprising that a diving duck that usually feeds in broad expanses of water should obtain so small a part of its food from such marsh plants as the sedges. Although seeds of many species of Cyperaceae were ingested, those of *Scirpus* (1.49 percent) and *Carex* (1.16 percent) were most frequently taken. Miscellaneous species (0.63 percent) supplied the remainder of the sedge food. Large numbers of seeds taken in one meal include alkali bulrush (*Scirpus paludosus*), 156; *S. debilis*, 211; saltmarsh bulrush (*S. robustus*), 89; other *Scirpus* species, 181; *Carex*, 308; and spikerush (*Eleocharis*), 372. Two birds had made their entire meal on sedge seeds.

Wildrice and other grasses (2.93 percent).—The seeds of wildrice (*Zizania aquatica*) (2.02 percent) furnished 12.30 percent of the meal of 10 greater scaups taken in September, 1 bird having consumed more than 275. Panicum seeds (*Panicum*) supplied 4 percent of the food of 24 birds taken in April. Seeds of bull grass, or paspalum (*Paspalum*), wild millet (*Echinochloa*), green foxtail grass (*Setaria viridis*), rice cutgrass (*Leersia oryzoides*), bluegrass (*Poa*), fescue (*Festuca*), and saltgrass (*Distichlis spicata*) were taken by a fair number of birds. Undoubtedly any grass that produces sizable seeds is acceptable. Bait, both wheat and corn, was found in limited quantity, although from field observation it is apparent that these birds accept bait of almost any variety. They are known to feed on peas, beans, and cultivated rice and will probably accept other vegetables.

Wildcelery (1.52 percent).—Wildcelery (*Vallisneria spiralis*) entered into the meal of 49 greater scaups, but in only comparatively few instances did it form the major item. It was entirely a winter food and supplied 11.70 percent of the food of the 168 birds taken in November, a goodly number of which were from Currituck Sound, N. C.

Miscellaneous plant food (9.58 percent).—In addition to indeterminable, finely comminuted vegetation (5.40 percent), seeds and vegetative fiber of a great many identified plants entered into the diet of the greater scaup, although individually they were of minor significance except to a few birds or in localized areas. The most important include crowberry (*Empetrum nigrum*), which was of value for inland nesting birds and formed more than 2 percent of the food for each of 3 summer months; 10 or more species of smartweeds (*Polygonum*), consumed in small numbers by 64 birds; coontail (*Ceratophyllum demersum*), taken by 42 birds; arrowhead (*Sagittaria*), obtained by only 8 birds yet forming the sole stomach con-

tent of 4; burreeds (*Sparganium*) of four species, taken by 24 birds; acnida (*Acnida*); duckweed (*Lemna*); bedstraw (*Galium trifidum*); cloudberry (*Rubus chamaemorus*); glasswort (*Salicornia*); water buttercup (*Ranunculus*); watershield (*Brasenia schreberi*); waxmyrtle (*Myrica*); dock (*Rumex*); beggarticks (*Bidens*); dogwood (*Cornus*); pepperwort (*Marsilea*); spatterdock (*Nymphaea*); buttonbush (*Cephalanthus occidentalis*); centella (*Centella asiatica*); and moss plant fiber. Large numbers of seeds that occurred in individual stomachs included 7,680 glasswort (*Salicornia ambigua*), 222 crowberry, 300 ladysthumb (*Polygonum persicaria*), 157 water smartweed (*P. amphibium*), 79 burreed, 65 acnida, and 100 waxmyrtle (*Myrica cerifera*).

ANIMAL FOOD—53.48 PERCENT

Mollusks (39.12 percent).—Phillips (*81, v. 3, p. 262*) states that the scaup often comes to the surface with a large mollusk, holding it midway between the mandibles, and, after adjusting it to the correct position by rapid jaw motion, quickly swallows it, taking a few sips of water at the same time; and Wilson and Bonaparte (*96, p. 227*) quote Willoughby to the effect that this duck feeds on a certain small shellfish called scaup from which it derived its common name. In this study, molluscan food contributed the largest percentage of the total food of the greater scaup and constituted 84.73 percent of the food of the 310 birds collected at Oyster Bay, Wash., from April to October.

Because so many of the birds were collected at or near important oyster beds along both coasts—particularly the 310 at Oyster Bay, Wash.—it was not surprising to discover that oysters constituted an abnormally large percentage of the food (9.97 percent), and that nearly one-third of the birds had the remains of oysters in their gizzards or gullets and 65 (8.64 percent) of the birds had fed exclusively on them. Because the west-coast oysters (*Ostrea lurida*) are smaller than the eastern or introduced Japanese species, they are more frequently ingested by the birds. Depredations upon them are less serious than upon the larger varieties.

Kubichek (*47, p. 119*) has well summarized the degree of depredations on oysters at Oyster Bay, Wash, as follows:

> Oysters (*Ostrea lurida*) formed 41.58 per cent of the food of the ducks taken there; 231 out of the 310 contained this item of food and fragments representing 48, 40, 39, 36, 34, 30, 24, 23 and on down were found in individual stomachs. These large numbers very probably represented several meals, for the diagnostic parts are hard and not as readily crushed as the rest of the shell. The largest oysters remaining whole in the stomachs measured as follows: 1⅝″ x 1¼″, 1⅜″ x 1⅛″, 1⅜″ x 1″, 1⅝″ x 1⅛″.

Although these studies show the bird at its worst rather than under average conditions, they indicate that at times and places control may be necessary. Further discussion of shellfish depredations in general and details regarding control measures are given under the white-winged scoter (p. 116).

Other commercial shellfishes were inconsequential as food for the greater scaup. A single small hard-shelled clam had been taken by each of 2 birds, a soft-shelled clam by 1, and from 1 to 3 scallops by each of 18, averaging 0.03 percent, trace, and 0.17 percent, respec-

tively, of the total food. The fact that a considerable number of the birds were taken in areas where these shellfishes are common in order to determine their relation to the shellfish industries indicates that under normal conditions the birds are not a serious menace to such industries. On the Massachusetts coast, 24 birds, taken mostly over scallop beds, had fed on scallops to the extent of only 3.17 percent of their food, indicating that the damage to this industry is probably negligible under all but the most unusual circumstances.

Of the pelecypods (23.20 percent), the blue mussel (*Mytilus edulis*) (4.31 percent) was second in importance. It occurred in 180 of the 752 stomachs, in 2 of which it was the sole food item. Single stomachs contained 96 and 80 of these abundant mussels in various stages of disintegration. Obviously most of these were small specimens.

Shells of the genus *Macoma* (3.76 percent) and the hard rock clam (*Protothaca staminea*) (3.03 percent) were found in 100 and 109 stomachs, respectively, many of which were procured in the same areas as the oysters. Six birds taken on the west coast had fed exclusively on *Macoma* shells, and Norton (*74, p. 439*) reported that a greater scaup taken on Fox Islands, Maine, in winter had fed extensively on shells of *M. balthica*. Fragments of 70 rock clams were taken from a single stomach.

The more important other pelecypods taken (2.13 percent) included *Mulinia lateralis*, 146 shells having been found in 1 stomach and 3 birds having made their entire meal on it; nut-clam (*Nucula proxima*); ark clams (*Arca*); pearl clams (*Unionidae*); sphere-shells (*Sphaerium*) pea-shells (*Pisidium*); horse mussel (*Modiolus*); gem shells (*Gemma gemma*); scallops (*Pecten*), cockleshells (*Cardium*); *Mactra* shells; hard-shelled clams (*Venus mercenaria*); and giant saxidome (*Saxidomus giganteus*).

A great many gastropods (14.58 percent) were taken by the greater scaup, yet only three genera—*Nassarius*, *Lymnaea*, and *Campeloma*—averaged as much as 1 percent each of the total food. The first, the dog whelks (3.48 percent), being abundant coastal shells, entered more commonly into the winter food. They had been taken by 132 of the 752 birds and furnished the entire meal of 7. A single gullet and gizzard contained 285. The second, *Lymnaea* (3.09 percent), was an important summer food, forming 21.60 percent in July and 8.13 in April, yet it was of only slight value in winter. The importance of *Campeloma* (1.64 percent) is undoubtedly overemphasized, as it occurred as an important food item only in July, when but five birds were taken, a number too small to be more than suggestive that such fresh-water mollusks are acceptable.

Practically all of the other gastropods taken (6.37 percent) entered into the winter diet exclusively. No species averaged as much as 1 percent of the total food, yet some were of frequent occurrence and occasionally were taken in large numbers. One meal was composed entirely of shells of *Amnicola cincinnatiensis*, 128 whole ones and fragments of many others. Dove-shells (*Mitrella*) were taken by 65 birds, 1,100 at a single meal; small *Bittium* shells, by 54, the almost incredible number of 3,000 having been found in one stomach; lathe-shells (*Acteocina canaliculata*), by 29, one stomach containing 1,700 individuals; dove-shells (*Anachis*) by 40; periwinkles (*Littorina*) by 38; rock shells (*Thais*) by 32; limpets (*Acmaea*) by 19;

Trifovis adversa by 11, one stomach containing 745; and the oyster drill (*Urosalpinx cinereus*) by 7, one stomach containing 21 individuals. The other more important gastropods taken included *Mangilia plicosa*, river-shells (*Goniobasis*), moon shells (*Polinices*), slipper-shells (*Crepidula*), tower-shells (*Pleurotoma*), top shells (*Margarites*), risso-shells (*Alvania*), *Nitidella gouldi*, flat-coil (*Planorbis*), *Neritina*, chink-shells (*Lacuna*), *Odostomia*, *Turbonilla*, and olive shells (*Olivella*).

Undetermined species (1.34 percent) formed the remaining molluscan food.

Insects (7.15 percent).—These were the second most important animal food and were taken largely in summer. Caddisflies, midge larvae and beetles—mostly diving beetles (Dytiscidae)—were the principal victims. Caddisflies (2.61 percent) entered into the food of 153 of the 752 greater scaups and supplied 20.46 percent of that of 11 taken in June. Mandibular remains of 344 were noted in a single stomach. Midges (1.32 percent) were eaten by 37 birds, 433 larvae having been ingested in a single meal. Miscellaneous insects (1.91 percent) consisted mainly of aquatic bugs (mostly Corixidae) and of larvae of dragonflies, damsel flies, crane flies (*Tipula*), salt flies and Mayflies, although many other species were present. Water boatmen were taken by 26 birds, and 43 were noted in one stomach.

Crustaceans (6.84 percent).—Amphipods (2.17 percent) were the most important crustacean food. West coast mud crabs of the genus *Hemigrapsus* (1.74 percent) were ingested by 32 greater scaups, 1 of which had gorged itself on 19 small ones. Barnacles (mostly *Balanus glandula*) (1.67 percent) occurred in the stomachs of 134 birds. They appeared at times to have been taken incidentally with other food, yet occasionally they formed the major part of a meal and two birds had gorged themselves solely on these hard-shelled crustaceans.

Miscellaneous crustaceans (1.26 percent) included east coast mud crabs—which were of slightly less value than the west coast ones and were fed upon by 31 birds—other crabs, crawfish, shrimp, isopods, fairy shrimp, ostracods, and undetermined soft-bodied species. Phillips (*81, v. 3, p. 262*) wrote of the report that some greater scaups on the west coast of Florida were feeding on sand bugs (*Hippa*) as "a very unusual feeding habit for any diving duck." Knight (*46, p. 98*) found that along the coast of Maine these birds were feeding on "small crustaceans of the surface swimming varieties, also many small mussels and [other] mollusks."

Miscellaneous animal food (0.37 percent).—This group included fishes of several kinds, a field mouse (Microtinae), a lemming (*Lemmus*), sea urchins (*Strongylocentrotus dröbachiensis*), water mites, spiders of three species, amphictenids, nereids and other polychaete worms, bryozoans, hydroids, sponge, and foraminiferans. Bruette (*14, p. 321*) wrote that in the summer time the greater scaups "are apt to feed nearer the shore line, taking food in shallower water where tadpoles, snails and small fishes may be had in abundance." Trautman (*89*) found them feeding on gizzard shad (*Dorosoma cepedianum*) in Ohio in December.

Food of Juveniles

Only three juvenile greater scaups, all taken on July 10, at Igiak Bay, Alaska, were available for stomach analysis. The food of the three was almost identical in kind but varied in quantity, averaging 7.5 species to a stomach. One bird, labeled "very young," had made 55 percent of its meal on animal food; the two others, 39 and 32 percent.

A summary of the plant food (58 percent) by groups and percentages is as follows: Pondweeds (*Potamogeton*), 2.67; crowberry (*Empetrum nigrum*), 3; marestail (*Hippuris vulgaris*), 2; and miscellaneous and undetermined plant material, including seeds of spikerush (*Eleocharis*), 50.33.

The animal food (42 percent) is summarized in the following groups and percentages: Cladocerans, 23.33; caddisfly larvae, 15.67; hymenopterans, 1; and miscellaneous and undetermined insects, 2.

LESSER SCAUP DUCK (Nyroca affinis)

(Pl. 2, facing p. 16)

Unlike its larger relative, which it closely parallels in habits and characteristics, the lesser scaup is distinctly an American bird. Formerly it was much more abundant than its near relative, but in recent years it has witnessed an alarming decline in numbers. It is much more southern in distribution than the greater scaup, whose range extends along the coast, yet it is more widely distributed and much more common in the interior. It is the common inland breeder in the southern Prairie Provinces, British Columbia, and the North Central States, although its breeding range extends northward into Alaska and the region of the Mackenzie and Anderson Rivers and westward to Hudson Bay and southern Ontario; and in winter it migrates as far south as Mexico and occasionally even Panama. It is usually found on broad expanses of water, although individuals not infrequently inhabit small ponds and marshes. Its autumnal migration is considerably well in advance of that of the greater scaup, whereas the northward spring flight is often much delayed. Its flight is speedy and usually straight, often in compact mass formation.

Lesser scaups are less enthusiastically hunted than others of their tribe and usually are less acceptable to the epicure than most of the surface feeders, although when fattened on bait or the better varieties of fresh- or brackish-water plants they become thoroughly acceptable as table ducks. The same methods of hunting are employed to obtain these birds as are used to bag others of the genus *Nyroca*. They are perhaps the most easily taken of any, because they are naturally more confiding and slower to learn from experience that man is their worst enemy. That they respond quickly to protection and feed and may be brought in sizable numbers even within large cities is witnessed by the annual concentration at Lake Merritt in Oakland, Calif.

Although they are good divers and well adapted to an aquatic environment, they usually feed in comparatively shallow water, but at times they may be found feeding in water 15 to 20 feet deep. On Pungo River, in coastal North Carolina, the writer (*19*) found a

flock of approximately 325 lesser scaups diving almost in unison, with only 2 to 6 birds left on the surface, presumably to serve as sentinels. The water was more than 16 feet deep, and the birds remained under the surface about 1 minute at each dive. Dives in water 8 to 10 feet deep are usually less than half that duration.

Poisonings Incidental to Feeding

LEAD POISONING

In areas where excessive shooting is carried on, the lesser scaup frequently swallows lead shot. Perhaps its method of feeding on bottom ooze accounts for its ingesting more shot than other species of waterfowl that inhabit the same general area. Because of the lingering nature of the illness induced by lead poisoning, the losses from this cause are perhaps more extreme than has been generally realized. As would be expected, ingestion of shot is more common in spring after the gunning season than earlier in fall, when a blanket of sediment has covered the shot. The serious part of this trouble lies in the fact that the better and more attractive lakes where food is most plentiful are the places where the birds are normally most concentrated and where consequently duck shooting is more common and more lead shot expelled into the water over the feeding grounds. Probably the shot is taken both as gravel and as weed seeds.

Of 477 birds taken in the gunning season in April 1909 (before the enactment of a Federal law prohibiting spring shooting) on lakes in the vicinity of Marquette, Wis., it was found that 365 (more than 76.5 percent) had consumed a total of 4,191 lead pellets—an average of 11.5 shots per bird—and that individual stomachs contained from 1 to 58 shot pellets. It is probable that some of the birds that had no lead in the gizzard had passed this poison into the intestines and had become affected by it. Obviously the shot that had produced the most damage was not visible, as it had disintegrated. The seriousness of lead poisoning was clearly shown by Wetmore (*93, pp. 7–8*) in experimental work demonstrating that the ingestion of six pellets of No. 6 shot always proved fatal to a duck. It is well known that lead acts as an abortifacient in mammalian females and produces sterility in birds. Consequently, lead poisoning may be a factor of considerable importance in the decline of our waterfowl.

PHOSPHORUS POISONING

Phosphorus poisoning likewise has been a menace near three Federal army posts in the eastern United States, where during military practice, bits of phosphorus have been expelled into the water over important waterfowl feeding grounds, causing high duck mortality in these limited areas. It is hoped that the condition is now corrected.

BOTULISM

A much more alarming cause of death of waterfowl that has been brought about through their feeding habits is the disease originally called alkali poisoning, now known to be a form of botulism. Hundreds of thousands of ducks have perished as a result of this disease,

The diving species, however, are less seriously affected than the surface feeders because they usually feed in deeper water and therefore consume fewer *Clostridium botulinum* type C, the causative organism, which thrives in decaying organic waste.

Food of Adults

The lesser scaup is content to feed on either plant or animal matter, as nearly 52 percent of the birds had fed exclusively on the former and 8.18 percent entirely on the latter. Although this duck is perhaps as omnivorous a feeder as any of our waterfowl it will make all or most of its meal on comparatively few species, when such acceptable food is sufficiently available. A single item formed the entire meal of 7.33 percent of the birds. For the year there was an average of 7.70 kinds of food a meal, even though one bird had ingested 56 species. Fine gravel comprised 23.33 percent of the total stomach content.

As is characteristic of omnivorous feeders, these birds sometimes become scavengers. Dawson (*22, p. 1811*) states that they commonly gather in excited mobs at Santa Barbara, Calif., "to contest with the gulls the flotsam of outfall sewers." The writer has seen them feeding in similar situations at a number of places along the eastern seaboard. Stomach examination gives further support to this feeding characteristic. A small series of birds taken near Milwaukee, Wis., and Monroe, Mich., had obviously fed at the mouth of a sewer, as they were filled with slaughterhouse debris, cow hair, rubber bands, paper, and undetermined drift. In Rehoboth Bay, Del., a small flock was daily seen feeding on tomato seeds thrown out into the bay by a canning factory.

Laboratory data on food habits of adult lesser scaups were gleaned from analyses of 1,244 stomachs, 1,051 of which were sufficiently filled to be used in computing food percentages (tables 6 and 8). The stomachs were taken in widely separated localities, having been collected in 30 States, the District of Columbia, Alaska, 5 Canadian Provinces, and Puerto Rico, as follows: 516 in Wisconsin, 141 in North Carolina, 92 in Florida, 51 in Oregon, 35 in Alberta, 23 in Massachusetts, 22 in Alabama, 17 in North Dakota, 15 in Maryland, 14 in Louisiana, 13 each in Saskatchewan and Texas, 12 in Illinois, 11 in Pennsylvania, and smaller numbers in the remaining localities. The birds were obtained each month of the year, but because only six were taken in August, the August birds were grouped with those taken in September. The distribution during the various months was fairly representative with the exception of April, when 507 were collected, 477 in Wisconsin—mostly in wildrice lakes in the vicinity of Marquette.

TABLE 6.—*Lesser scaup duck (Nyroca affinis): Food, by volume percentages, of 1,051 adults taken during 12 months of the year*

Kind of food	Percentage of food	Kind of food	Percentage of food
PLANT FOOD (59.55 percent)		ANIMAL FOOD (40.45 percent)	
Pondweeds (Najadaceae)	18.36	Mollusks	24.93
Pondweeds (*Potamogeton*)	10.52	*Amnicola* shells	1.70
Wigeongrass (*Ruppia maritima*)	5.24	Keel-shell (*Carinifex newberryi*)	1.63
Naiads (*Najas*)	1.28	Flat-coils (*Planorbis*)	1.55
Horned pondweed (*Zannichellia palustris*) and eelgrass (*Zostera marina*)	1.32	Dog whelks (*Nassarius*)	1.09
Grasses (Gramineae)	9.82	Other gastropods	9.72
Wildrice (*Zizania aquatica*)	7.13	Pelecypods	3.85
Miscellaneous	2.49	Undetermined	5.39
Sedges (Cyperaceae)	6.39	Insects	12.05
Bulrushes (*Scirpus*)	4.74	Caddisflies (Trichoptera)	3.67
Miscellaneous	1.59	Dragonflies and damselflies (Odonata)	2.30
Wildcelery (*Vallisneria spiralis*)	5.17	Water boatmen (Corixidae)	2.11
Muskgrass (Characeae) and other algae	2.57	Midges (Chironomidae)	1.67
Waterlilies (Nymphaeaceae)	2.08	Beetles (Coleoptera)	1.52
Coontail (*Ceratophyllum demersum*)	1.50	Miscellaneous	.78
Watermilfoils (*Myriophyllum*) and marestail (*Hippuris vulgaris*)	1.41	Crustaceans	1.34
Smartweeds (*Polygonum*)	1.28	Miscellaneous animal food	2.13
Arrowheads (*Sagittaria*)	1.01		
Miscellaneous plant food	10.22		

PLANT FOOD—59.55 PERCENT

Plant food, consisting of a large variety of species, was eaten exclusively by almost 52 percent of the lesser scaups and made up 98.32 percent of the food of the 507 birds taken during April.

Pondweeds (18.36 percent).—Najadaceae were the most important plants consumed; and of these the genus *Potamogeton* (10.52 percent), including at least nine species, ranked first. Considerably more than half the birds had fed on it. More than 400 seeds were found in a single stomach, and 12 birds taken in September had made pondweeds of this genus 27 percent of their meal. Sago pondweed (*P. pectinatus*), in the form of seeds, tubers, or rootstalks, occurred in about 1 of every 10 stomachs and comprised slightly more than 1 percent of the total food.

Wigeongrass (*Ruppia maritima*) (5.24 percent) had been taken by nearly a fourth of the birds. One bird had ingested 4,000 seeds at a single meal, and 11 had made their entire meal on it. McAtee (*55, p. 16*) found that 19 lesser scaups collected at St. Vincent Island, Fla., in January, "had eaten it, principally the seeds, to the extent of over 63 percent of their food,"; and Grinnell, Bryant, and Storer (*38, p. 163*) stated that eight stomachs of this bird, taken in California, contained quantities of wigeongrass seeds.

Naiads (1.28 percent) (predominantly *Najas flexilis*) entered into the diet of approximately one-third of the birds, one Wisconsin specimen having consumed 2,416 seeds along with considerable green vegetative fiber.

Of 19 lesser scaups collected in Michigan and examined by Pirnie (*82, p. 310*) 9 had fed on species of *Potamogeton* and 6 on naiads.

The horned pondweed (*Zannichellia palustris*) (1.19 percent), although less frequently consumed, supplied most of the meal of several birds and furnished 12.53 percent of the food of 30 of the birds collected in April. One bird had ingested more than 10,000 of the characteristic elongate horny seeds. Eelgrass (*Zostera marina*)

(0.13 percent) was of frequent occurrence in limited quantity in birds along the coast.

Grasses (9.62 percent).—Of the grass food, wildrice (*Zizania aquatica*) (7.13 percent) was the most important. Nearly half the lesser scaups had fed on its seeds, indicating that this choice grain is readily acceptable whenever available. It made up the entire meal of 26 birds, all but a small part of the meal of many others, and 67.50 percent of that of the 507 collected during April. Its importance as a food may be more fully realized when it is known that most of the birds were taken in Wisconsin where there was an abundance of several of the best duck foods.

Seeds and plant fiber of many miscellaneous grasses were consumed (2.49 percent). Bait in the form of corn, wheat, and rice was taken whenever opportunity afforded, but inasmuch as relatively few of the lesser scaups were taken in an area where baiting was permitted, it contributed only 0.53 percent of the food. The most important of the miscellaneous wild grasses were *Panicum*, wild millet (*Echinochloa*)—more than 2,000 seeds of which were taken by one bird—*Paspalum*, rice cutgrass (*Leersia oryzoides*), *Agrostis*, buffalo grass (*Buchloë dactyloides*), *Setaria*, and fescue grass (*Festuca*).

Sedges (6.33 percent).—Bulrushes of the genus *Scirpus* (4.74 percent) supplied the major part of the sedge food. The common three-square (*S. americanus*) was identified in 241 stomachs, with a maximum of 1,629 seeds in 1; hardstem bulrush (*S. acutus*), in 35, with a maximum of 1,225 whole and fragments of many more seeds; river bulrush (*S. fluviatilis*), in 338, with a maximum of 75 seeds; alkali bulrush (*S. paludosus*), in 10, with 420 seeds in 1; softstem bulrush (*S. validus*), in 7; saltmarsh bulrush (*S. robustus*), in 13; *S. debilis*, in 14; swamp bulrush (*S. etuberculatus*), in 3; and unidentified *Scirpus* species, in 443. Although seeds of this genus were consumed each month, they were taken most frequently late in summer and in fall, when they are most plentiful. They supplied the major item of several meals, yet none of the birds fed solely upon them. Usually but few seeds were obtained at a meal.

Among the miscellaneous sedges (1.59 percent), seeds of *Carex* supplied slightly less than 1 percent of the food, yet were of frequent occurrence. Seeds of several species of spikerush (*Eleocharis*), sawgrass (*Cladium*), cyperus (*Cyperus*), and beakrush (*Rynchospora*) were important for individual birds or for short periods of the year.

Wildcelery (5.17 percent).—Winter buds and a few seeds of wildcelery (*Vallisneria spiralis*) entered into the diet of 183 of the 1,051 adult lesser scaups and composed the entire meal of 6.

Muskgrass and other algae (2.57 percent).—About 1 bird in 10 had fed on muskgrass (2.28 percent), which entered into the diet in 9 of the 12 months. Its plant fiber, bulblets, and oögonia formed 17.72 percent of the food of 180 birds collected in November; and 2 birds had fed exclusively on it, plant fiber and 630 bulblets having been found in 1 stomach and 20,600 oögonia in the other. McAtee (*55, p. 1*) found that three-fifths of the food of 70 lesser scaups taken on Currituck Sound, N. C., in November, consisted of muskgrass.

It was interesting to find that 5 birds taken in January at St. Marks, Fla., and vicinity, had subsisted principally upon a filamentous alga (*Vaucheria*), which made up 98, 94, 55, 48, and 45 per-

cent, respectively, of their meal and comprised 3.24 percent of the food of 105 birds for the month but only 0.29 percent of the total intake.

Waterlilies (2.08 percent).—Seeds of white waterlilies (*Castalia*) (1.36 percent) had been taken by 23 birds, 1 having consumed 800 and 1 having made its entire meal on them. Banana waterlily (*C. flava*) made the major item of the meal of six birds. Watershield (*Brasenia schreberi*) and spatterdock (*Nymphaea*) entered into the diet of 39 and 13 birds, respectively, together averaging 0.72 percent of the total food. Waterlilies made up 8.57 percent of the food of 14 birds taken in May.

Coontail (1.50 percent).—About one-fourth of the lesser scaups had eaten the seeds or plant fiber of coontail (*Ceratophyllum demersum*).

Watermilfoils (1.41 percent).—One-sixth of the lesser scaups had ingested *Myriophyllum*, and some had taken *Hippuris vulgaris*.

Smartweeds (1.28 percent).—More than one-fourth of the birds had taken smartweeds (*Polygonum*) of 12 or more species.

Arrowheads (1.01 percent).—The value of *Sagittaria*, eaten by 12 lesser scaups, may be slightly overrated, because it was found mostly in stomachs of birds taken in March and May, months that are represented by few birds. If the same number of birds had eaten it when a larger series of stomachs was collected its rating obviously would have been lower. One bird had made its entire meal on the tubers of this plant.

Miscellaneous plant food (10.22 percent).—Burreeds (*Sparganium*) (0.82 percent) of five or more species entered into the diet of almost one-tenth of the birds and occasionally constituted a large part of the meal; more commonly, however, the seeds served as a very minor item. Phillips (*80, p. 199*) found in the stomachs of four lesser scaups collected in eastern Massachusetts "seeds of bur reed, bayberry, and saw-grass (*Cladium effusum*), and snails (*Lunatia heros*), and ants." The other more important miscellaneous plants, in addition to the unidentified vegetable material, include bedstraw (*Galium*); dock (*Rumex*); horsetail (*Equisetum*), one bird from Pennsylvania, taken in March, having made 99 percent of its meal on this supposedly poisonous plant; plant fiber of waterweed (*Anacharis canadensis*), taken only during April by 20 birds; duckweed (*Lemna* and *Wolffiella*); waxmyrtle (*Myrica*); bogbean (*Menyanthes trifoliata*); centella (*Centella asiatica*); buttonbush (*Cephalanthus occidentalis*); dodder (*Cuscuta*); hickory nuts (*Hicoria*); moss; pickerelweed (*Pontederia cordata*); buttercup (*Ranunculus*); rosemary (*Ceratiola ericoides*); ragweed (*Ambrosia*); bramble (*Rubus*); and glasswort (*Salicornia*).

ANIMAL FOOD—10.45 PERCENT

Although animal matter was less important than vegetable in the food of the lesser scaup, a much larger assortment of animal species was taken. Of the birds examined, 8.18 percent had fed exclusively on a variety of animal foods and 2 percent had made their last meal on a single species. During February, May, July, and December, animal foods made up slightly more than half the total content.

Mollusks (24.03 percent).—Unlike its larger kinsman, the lesser scaup drew the major part of its molluscan food from the univalves (gastropods) (15.69 percent). Although many kinds were ingested, only four species or genera contributed as much as 1 percent of the food, in percentages as follows: *Amnicola*, 1.70—obtained by only 34 birds, 3 of which had made them the entire meal; keel-shell (*Carinifex newberryi*), 1.63—taken by only 25 birds, 6 of which had fed on it exclusively; flat-coils (*Planorbis*), 1.55; and dog whelks (*Nassarius*), 1.09.

So many other gastropods (9.72 percent), including unidentifiable ones, were consumed by the lesser scaup that only the more important are here recorded as follows: *Lymnaea* shells—often taken in large numbers, 137 having been counted in 1 stomach and 1 bird having fed on them exclusively; *Bittium; Gillia altilis; Alvania;* flood-shells (*Fluminicola*); *Physa;* dove-shells (*Mitrella*); *Viviparus; Acteocina;* moon shells (*Natica*); *Anachis; Neritina reclivata;* river-shells (*Goniobasis*); *Paludestrina; Bythinella;* periwinkles (*Littorina*); horn-shells (*Cerithidea*); *Pleurocera; Marginella; Rissoa;* and slipper-shells (*Crepidula*). Many of these were ingested frequently, yet because of their small size or because they were taken in small numbers no one of them alone ranked high as food. Frequently, however, some of them were taken in surprisingly large numbers, examples of which are more than 1,600 *Bythinella tenuipes*, 775 *Bittium*, 400 *Turbonilla*, 450 *Mitrella lunata*, 190 *Physa*, and 123 *Neritina reclivata*. Eight lesser scaups collected by Baker (*8, p. 267*) in coastal Florida had all fed on mollusks, most of which were *Rissoina cancellata*.

It was somewhat surprising to find that no species or group of pelecypods (3.85 percent) contributed as much as 1 percent of the food. Those of greatest importance were fresh-water clams; *Rangia; Parastarte triquetra*—846 having been consumed at a single meal; blue mussel (*Mytilus edulis*); sphere-shells (*Sphaerium*); *Pisidium; Mulinia lateralis;* cockleshells (*Cardium*); gem shells (*Gemma gemma*); ark shells (*Arca*); nut-clam (*Nucula*); and *Macoma*.

Undetermined mollusks (5.39 percent) made up the remaining molluscan food.

Insects (13.05 percent).—Most of the nearly 150 identified species or genera of insects eaten by the lesser scaup were taken in summer. As with many other inland ducks, caddisflies (3.67 percent) were consumed extensively. They were fed upon each month but entered most prominently into the summer diet, amounting to more than 15 percent in June. The remains of 207 larvae were found in one stomach. Odonata (2.30 percent), including both dragonflies and damsel flies, were second in importance of insect food, 14 different species having been identified and 47 nymphs having been taken at a single meal. Water boatmen (2.11 percent), eaten by more than a sixth of the birds, supplied 7.21 percent of the food of the 14 birds collected in May. Midge larvae (1.67 percent), ingested by 1 in every 14 of the birds, furnished 10 percent of the food in May, and 485 were taken at a single meal. Beetles (1.52 percent), 70 species of which were identified, were made up mostly of predaceous diving forms, largely Dytiscidae, with Gyrinidae, Haliplidae, Curculionidae, and Carabidae supplying most of the remaining volume. One bird from Arizona had made its entire meal on snout beetles (*Sphe-*

nophorus); one bird had consumed 185 large dytiscid larvae at a single meal; and a third bird had eaten 72 Sialidae. Miscellaneous insects (0.78 percent) consisted of undetermined forms.

Phillips (*81, v. 3, p. 281*) found that stomachs collected in summer at the Athabaska Delta contained 55 to 99 percent animal matter, consisting chiefly of midge larvae, water boatmen, and caddisfly and dragonfly larvae, although moderate quantities of seeds of burreeds (*Sparganium multipedunculatum*), milfoil (*Myriophyllium spicatum*), and rushes (*Scirpus*) were also present. Wetmore (*92, p. 754; 94, p. 15*) found that in the lower bay of Bear River, the largest tributary of Great Salt Lake, Utah, the lesser scaup was feeding extensively on brine shrimps (*Artemia fertilis*) and immature alkali flies (*Ephydra hians, E. subopaca,* and *E. gracilis*), which are exceedingly abundant there.

Crustaceans (1.34 percent).—Amphipods, isopods, crabs, shrimps, crawfishes, barnacles, and numerous other small soft-bodied forms of many species were taken by the lesser scaup each month of the year, yet only rarely did they constitute the major part of a meal.

Miscellaneous animal food (2.13 percent).—This included fishes of eight species (0.94 percent); carrion and undetermined animal matter; water mites, with 70 occurrences; spiders; annelid worms, including earthworms and clamworms; a leech (*Glossiphonia complanata*); bryozoans; hydroids; and sponges. One bird had made its entire meal on a sunfish (*Lepomis pallidus*) and another on fish eggs, probably salmonid. Other fishes consumed were mostly coarse and worthless varieties, including, in the order of importance, sail-finned killifish (*Mollienesia latipinna*); nine-spined stickleback (*Pungitius pungitius*); sunfish; minnows; and pike (*Esox americanus*). Trautman (*89*) states that four lesser scaups taken in Buckeye Lake, Ohio, in December were gorged with gizzard shad (*Dorosoma cepedianum*), numbers of which were floating at or near the surface in a numbed and helpless condition owing to a sudden decline in temperature.

Food of Juveniles

The stomachs of 17 juvenile lesser scaups collected in Alberta Saskatchewan, and Manitoba were analyzed.

ANIMAL FOOD—88.47 PERCENT

In contrast to the adults it was found that the juveniles fed predominantly on insects (88.31 percent), largely beetles (38.53 percent). The insects consumed and the percentages they formed of the food are as follows: Predaceous diving beetles (Dytiscidae), 34.77; water scavengers (Hydrophilidae), 1.48; miscellaneous beetles, 2.28; midge larvae, 16.71; water boatmen, 16.41; dragonfly nymphs, 8.42; damsel fly nymphs, 2.82; caddisfly larvae, 2.35; grasshoppers and their relatives, 1.17; and miscellaneous insects, including Mayfly nymphs, miscellaneous water bugs, moth larvae, larvae of two-winged flies, and wasps and ants, 1.90.

Other animal foods (1.16 percent), in the order of their importance, included mollusks; bryozoans, largely *Cristatella mucedo;* water fleas; ostracods, water mites; spiders; and fishes.

PLANT FOOD—10.53 PERCENT

Vegetable food (10.53 percent) of the juveniles, which consisted of seeds and other parts of many plants, are listed in the order of importance, in percentages, as follows: Sedges, 2.35, of which bulrushes (*Scirpus*) supplied 1.29 and miscellaneous sedges, 1.06; pondweeds, 1.66, of which *Potamogeton* species supplied 1.48 and wigeongrass (*Ruppia maritima*) 0.18; burreeds (*Sparganium*), 1.59; watermilfoils (*Myriophyllum* and *Hippuris vulgaris*), 1.23; and miscellaneous other plants, including buttercup (*Ranunculus*), smartweeds (*Polygonum*), bedstraw (*Galium*), coontail (*Ceratophyllum demersum*), muskgrass, waterplantain (*Alisma plantago-aquatica*), undetermined grasses, cinquefoil (*Potentilla*), bramble (*Rubus*), and Canada thistle (*Cirsium arvense*), 3.70.

ERISMATURINAE

RUDDY DUCK (Erismatura jamaicensis rubida)[7]

(Pl. 1, facing p. 8)

The ruddy duck is the only common North American representative of one of the most peculiar and distinctive genera of all diving ducks; and the subfamily Erismaturinae to which it belongs, although of early origin and widely distributed, has but little in common with other groups of ducks. The bird is one of the most interesting to the naturalist but has slight attraction for the accomplished sportsman. It is stupid and unsuspecting and chooses to escape its enemies by diving rather than by flight. Consequently it is easy game for the gunner. Its unusual, stiff, woodpeckerlike tail, huge head, short neck, clumsy feet and legs, and characteristic flight and manner in the water make it familiar to everyone who has once seen it. The large air sac opening off the windpipe of the male, which is inflated during courtship display, is particularly distinctive, and the fact that the plumage in winter is entirely different from that in summer is peculiar among ducks.

The principal breeding range of the ruddy includes the southern Prairie Provinces of Canada and the North Central States, with important nesting areas in Utah, Idaho, and California. Straggling pairs breed at favored places across the continent. The bird winters in the Pacific coast region from southern Oregon to southern California and in the Atlantic and Gulf coast regions from Massachusetts to Texas and over much of Mexico. In comparison with its somewhat restricted breeding area it has an unusually large wintering territory, which makes it particularly vulnerable to the gunning public. As early as 1912 Forbush (*32, p. 167*) wrote: "The species has been decreasing steadily, and is in danger of extinction unless better protected." He quoted J. C. Phillips to the effect that the ruddy had decreased 60 percent in 15 years on account of heavy market shooting in the South. As clearly as its diminution was evident at that time it could then be considered abundant in comparison with its general scarcity today. In addition to the heavy

[7] This and the succeeding species (*Nomonyx dominicus*) are treated following the genus *Nyroca* rather than in systematic order succeeding the American scoter *Oidemia americana* because of the close similarity in food.

toll taken by hunters, it has had a great enemy in recent years in the protracted drought, which destroyed considerably more than 50 percent of its normal breeding range, and it has also been adversely affected by agriculture, reclamation, and drainage. The species is indeed in a critical state and is nearing extermination. To forestall this the Federal Government imposed a closed gunning season on the bird in 1933.

Food of Adults

As is to be expected of a species that feeds so frequently on bottom ooze, the food of the ruddy is extremely variable, covering a wide range of plants and animals, but the better known duck foods are drawn upon most freely. In this study, the number of species of food in a stomach averaged slightly fewer than 11, yet there was great variation, 1 stomach containing 35. As is common with all other waterfowl, gravel was a conspicuous item in most stomachs, averaging 38.19 percent of the entire contents.

Laboratory examinations of 181 stomachs of adult ruddy ducks were made; but only 163 stomachs were full enough to be used in determining food percentages (tables 7 and 8). The birds were taken in 31 States, the District of Columbia, and 5 Canadian Provinces during 9 months of the year. Too few stomachs were collected in January, February, and August to have these months figure in the percentages.

TABLE 7.—*Ruddy duck (Erismatura jamaicensis rubida): Food, by volume percentages, of 163 adults taken during 9 months of the year*

Kind of food	Percentage of food	Kind of food	Percentage of food
PLANT FOOD (72.41 percent)		ANIMAL FOOD (27.59 percent)	
Pondweeds (Najadaceae)	29.59	Insects	21.87
Pondweeds (*Potamogeton*)	21.44	Midges (Chironomidae) and horseflies (Tabanidae)	14.89
Wigeongrass (*Ruppia maritima*)	4.58	Caddisflies (Trichoptera)	2.12
Naiads (*Najas*)	2.71	Water boatmen (Corixidae)	1.18
Eelgrass (*Zostera marina*) and horned pondweed (*Zannichellia palustris*)	.81	Miscellaneous	3.68
Sedges (Cyperaceae)	18.38	Mollusks	2.75
Bulrushes (*Scirpus*)	15.73	Gastropods	1.13
Miscellaneous	2.66	Pelecypods	1.32
Muskgrass (Characeae) and other algae	3.91	Crustaceans	2.54
Wildcelery (*Vallisneria spiralis*)	2.42	Miscellaneous animal food	.43
Smartweeds (*Polygonum*)	1.53		
Coontail (*Ceratophyllum demersum*)	1.35		
Watermilfoils (*Myriophyllum* and marestail, *Hippuris vulgaris*)	1.17		
Grasses (Gramineae)	1.05		
Miscellaneous plant food	12.98		

PLANT FOOD—72.41 PERCENT

Bent (*10, p. 157*) writes:

> Being decidedly a diving duck, the ruddy duck obtains most of its food on the bottom and subsists very largely on a vegetable diet, hence its flesh is usually well flavored. While living on the inland ponds, marshes, and streams, it feeds on the seeds, roots, and stems of grasses and the bulbs and leaves of aquatic plants * * *.

Field and laboratory studies confirm this statement. In the 163 stomachs examined, plant food contributed nearly three-fourths

(72.41 percent) of all the food. Although some plants occurred repeatedly, others, as could be expected, were of major importance only in certain sections.

Pondweeds (29.59 percent).—Najadaceae furnished by far the largest food percentage of any plant family. Various species of *Potamogeton* (21.44 percent), including sago pondweed (*P. pectinatus*), appeared as the dominant and favorite food of the ruddy duck. They occurred in 121, or 74 percent, of the stomachs, ranging from a mere trace to 99 percent of the meal. Seeds were taken most commonly, although tubers, particularly from sago pondweed, were consumed by many birds in rather large quantities. Stems and leafy material, especially those of redhead-grass, or claspingleaf pondweed (*P. perfoliatus*), also were taken by many birds.

Wigeongrass (4.58 percent) was second of the pondweeds in importance and third of specific plant foods. Its seeds, rhizomes, or plant fiber were taken by 51 of the birds, usually in small quantities but occasionally making up most of the meal, 97 percent in 1 instance and 92 percent in another. Bent (*10, p. 158*) reports finding ruddy ducks in the Currituck Sound district of North Carolina and Virginia feeding almost exclusively on the seeds of the "foxtail grass," which he says is apparently the same thing as *Ruppia maritima*.

Naiads, or bushy pondweeds (*Najas flexilis*, *N. guadalupensis*, and *N. marina*), were found to be of more than ordinary value (2.71 percent). Although they were the principal food in only a comparatively few stomachs, traces occurred in 30, or 18 percent, of the stomachs. One well-filled stomach from California contained 4,750 seeds, which formed 80 percent of the meal. Barrows (*9, p. 109*) reports that he "once took from the crop and stomach of a single Ruddy Duck at Middletown, Conn., 22,000 seeds of a species of pondweed (*Naias*) * * *."

Eelgrass (*Zostera marina*) (0.48 percent) made up 82 percent of the contents of one stomach, the only one in which it was identified. Possibly it formed some of the unidentified vegetable debris. The horned pondweed (*Zannichellia palustris*) (0.38 percent) occurred in but eight stomachs.

Sedges (18.38 percent).—Cyperaceae, particularly members of the genus *Scirpus* (15.72 percent), were very constant and important in the bill of fare of the ruddy duck. The common three-square (*S. americanus*), softstem bulrush (*S. validus*), and other *Scirpus* species were the principal sedges taken and were second in importance as a plant food in both bulk and frequency, occurring in 114, or 70 percent, of all the stomachs examined.

The seeds of miscellaneous Cyperaceae (2.66 percent), particularly *Carex*, *Cyperus*, and *Eleocharis*, were of frequent occurrence—1 or more of these genera having been noted in 72, or 44 percent, of the stomachs—but in only a few instances were they of major importance. One bird from Alabama had made 83 percent of its meal on 175 tubers of a cyperus.

Muskgrass and other algae (3.94 percent).—Muskgrasses of the genera *Chara* and *Nitella* formed nearly all of the algae taken by the ruddy duck, having been found in 31 of the 44 stomachs that contained any algae. Other seaweeds amounted to a mere trace. In a number of stomachs *Chara* with its oögonia was the principal item,

forming 94 percent of the food in each of three and occurring in three gizzards in only slightly smaller quantities. One bird from Currituck Sound, N. C., in addition to considerable plant fiber, had consumed more than 200,000 oögonia of *Chara*, which indicates the minute size of items that may be strained out and ingested by this duck.

Wildcelery (2.42 percent).—Although a number of relatively important duck foods are members of the frogbit family, only wildcelery (*Vallisneria spiralis*) was of noticeable importance to the ruddy. Apparently it was not available to many of the birds, as it occurred only in the stomachs of those collected during October and November, when it averaged 7.89 and 6.10 percent, respectively, of the food for the month. It usually made up most of the meal whenever taken, and in each of eight stomachs its winter buds averaged 86 percent of the meal.

Smartweeds (1.53 percent).—The smartweeds (*Polygonum*) are one of the plants of which the seeds alone furnish an important article of food for a great many species of birds. For the ruddy duck, seeds of various species of this genus were taken in each of the 9 months, reaching their greatest value in March and April. As would be expected seeds of the species that are more tolerant of excessive moisture, or more water-loving, were most frequently taken. They occurred in 31 of the 163 stomachs. Usually the number was small, but in a few instances many more than 100 were found.

Coontail (1.35 percent).—Although taken occasionally by many of the inland waterfowl, coontail (*Ceratophyllum demersum*) is consumed in quantity by only a few species. For the ruddy it was found in 7 percent of the stomachs. Its seeds occurred in seven of nine stomachs from California and averaged 42 percent of the food of the lot. During November it amounted to slightly less than one-tenth of the food consumed, and it was taken in only three other months, even as a trace.

Watermilfoils (1.17 percent).—Although more than a fourth of the birds had fed on seeds of *Myriophyllum*, these were of noticeable importance in but a relatively few stomachs; in fact, in only one instance did they amount to as much as 30 percent of a meal. During September they formed more than 3.5 percent of the food. Marestail (*Hippuris vulgaris*) formed but a trace of the food.

Grasses (1.05 percent).—Miscellaneous grasses of several species, taken in each of the 9 months, occurred in nearly one-fourth of the stomachs yet were unimportant in all but a few. In no meal did a grass amount to as much as a fourth of the food, and in most instances the Gramineae formed but a trace or a very small percentage. From observation, Audubon (*3, v. 4, p. 328*) concluded that on fresh waters the ruddy's "food generally consists of the roots and blades of such grasses as spring from the bottom of rivers and ponds, as well as of the seeds of many Gramineae."

Miscellaneous plant food (12.98 percent).—The ruddy duck frequently feeds on minute plants and animals, and the vegetable material that it ingests in feeding on drift material is often comminuted beyond positive recognition. Consequently, 9.90 percent of the average stomach content was relegated to the category of unidentified plant material, much of which may have been ground-up vegetative growth of pondweeds, wildcelery, and such plants as coontail, water-

milfoil, or submerged grasses or sedges. Identified plants, each of which was of value locally or with an individual ruddy yet averaged less than 1 percent of the total food, include the seeds of watershield (*Brasenia schreberi*), 0.33 percent; bait in the form of corn or wheat, 0.54 percent; and waxmyrtle (*Myrica*) and arrowhead (*Sagittaria*), which is occasionally taken but only infrequently in appreciable quantity, each 0.36 percent. Arrowhead occurred as the dominant item in only one stomach, where it formed 97 percent of the meal. Other species forming still smaller percentages include heliotrope (*Heliotropium*), duckweed (*Lemna*), vervain (*Verbena*), birch (*Betula*), and pigweed (*Amaranthus*). Each of these and other plants, though important items in a few stomachs, were infrequently taken.

ANIMAL FOOD—27.59 PERCENT

The animal food of the ruddy duck ranged from more than 20 percent of the food in September and November to 39 percent in June. A large variety of animal material was eaten, although soft-bodied aquatic insect larvae seemed to be most acceptable.

Insects (21.87 percent).—Dipterous flies (14.89 percent) predominated in the insect food, and it appears that the ruddy duck draws upon midge larvae for most of its animal food. This may be from preference, or it may be due to the ruddy's method of feeding on muddy bottoms or to the availability and excessive abundance of Chironomidae. These small, soft-bodied larvae made up all but a fraction of the dipterous food, occurred in 80 of the 163 stomachs, and were taken in each of the 9 months in varying quantities, forming 31.62 percent of the food in July, 1.44 percent in August, and 2.75 percent in December. As many as 1,420 individuals were ingested in a single meal. Caddisfly larvae (2.12 percent) were eaten with moderate frequency (46 times) but usually in comparatively small numbers, partly, perhaps, because they are not common in much of the habitat most frequented by ruddies. Water boatmen (1.18 percent) were next in food value.

A great many miscellaneous insects (3.68 percent) were taken but not any one in sufficient quantity to furnish as much as 1 percent of the total food. The larvae and adults of many kinds of beetles (0.84 percent) were devoured by 65 of the birds. Predaceous diving beetles, which are a pest in fishponds, were the most frequently taken. Dragonfly and damsel fly nymphs (0.82 percent), noted in 28 stomachs, composed 3.50 percent of the food in December. Mayfly nymphs, present in 17 stomachs, constituted a slightly lower percentage. It appeared that any kind of insect was acceptable. As further evidence in this regard, Aughey (*5, p. 60*), one of the pioneers in economic ornithology, reported finding 31 locusts and 20 other insects in a single stomach from Sarpy County, Nebr.

Mollusks (2.75 percent).—The ruddy duck, whose food in general is quite typical of that of the surface feeders, consumes the fewest mollusks of any of our common North American diving ducks. In fact, only two ducks—the wood duck and the gadwall—both shoal-water species, take fewer. Mollusks occurred in almost a fourth of the gizzards, yet were of major importance in but a few. Gastropods (1.43 percent) and pelecypods (1.32 percent) were taken in about

equal numbers. Although many species of shellfishes and many individuals were consumed they were most often unusually small ones.

Crustaceans (2.54 percent).—Crustacean food, most frequently in the form of amphipods, was recognized in 42 stomachs. Although the volume consumed was usually very small, a few birds had feasted heavily on these aquatic creatures, one having made them 98 percent of its meal.

Miscellaneous animal food (0.43 percent).—Many miscellaneous animal forms were consumed, including marine worms, water mites, bryozoans, fishes, sponges, and hydroids. Fish bones occurred in seven stomachs, yet no species of commercial or sporting value were recognized.

Food of Juveniles

Gizzards of 14 well-filled juvenile ruddy ducks taken in July and August from North Dakota, Utah, Alberta, Manitoba, and Saskatchewan were available for study. As would be expected, protein foods in the form of animal matter were dominant in the average meal. Only five birds had derived the major part of the food from the vegetable kingdom. As with the adult birds, many kinds of animal and plant foods were consumed, the average meal containing 11.21 species. Gravel formed a conspicuous item, amounting to 30.71 percent as against 38.19 for adults.

Casual observation by Vernon Bailey, retired chief field naturalist of the Biological Survey, on the stomach contents of downy or young birds that were collected in New Mexico, showed food tendencies similar to the more detailed studies here recorded. Insects and sedge seeds formed the principal food items.

Animal food—63.14 percent

The animal food of the juvenile ruddy ducks consisted almost exclusively of soft-bodied creatures—insects (54.15 percent) and crustaceans (8.71 percent). It was somewhat surprising to note that mollusks, a minnow, and miscellaneous animal matter aggregated only 0.28 percent.

Of the insects, the larvae of midges seemed to be most eagerly sought. They stood first in importance of all the foods, as together with a few horsefly larvae they contributed a little more than a third (34.29 percent) of the total intake, and 6 of the 10 juveniles that had eaten these minute larvae had made them the principal item of their meal. Water boatmen (6.50 percent), the next most valuable insect food, were found in all but one of the stomachs. Beetles (4.64 percent), both larval and adult forms, were frequently taken in comparatively small numbers. They were present in all but three stomachs yet formed the main article of food in only one. Mayflies (4.43 percent) were apparently taken when available. Many kinds of miscellaneous insects (4.29 percent) were consumed, their total volume suggesting that availability is the principal determining factor in their selection. Amphipods and a few other crustaceans were taken in quantity and formed 71 percent of the meal in one of the nine stomachs in which found.

PLANT FOOD—56.86 PERCENT

Pondweeds of the genus *Potamogeton*, which were the most important food for the adult ruddy ducks (21.44 percent) were sixth in importance of all foods for the young (4.07 percent) and second of plant foods. Seeds, tubers, and plant material were consumed. Seeds of bulrushes (*Scirpus*) were second in importance of all foods for both adults (15.72 percent) and young (18.15 percent). All but one juvenile had fed on them, and some had made them the principal food. Miscellaneous sedges represented about the same species for adults (2.66 percent) and young (2.86 percent). Watermilfoil (*Myriophyllum*) was more important to the young (2.71 percent) than to the adults (1.17 percent). Miscellaneous plant items (1.57 percent), each of which furnished less than 1 percent of the food taken by the juveniles, included marestail (*Hippuris vulgaris*); algae; muskgrass (*Chara*), small quantities occurring in 3 of the 14 stomachs; grasses; and wildcelery (*Vallisneria spiralis*). Unidentifiable plant matter averaged 7.50 percent.

MASKED DUCK (Nomonyx dominicus)

The masked duck, a little, tropical, black-faced relative of the ruddy duck, is a rare straggler in temperate North America, having been collected in Maryland, Massachusetts, Vermont, Wisconsin, and Texas. It breeds and apparently is resident in the West Indies and South America south to northern Argentina. Like the ruddy duck, it is reported to be most at home when in the water where it can swim and dive, yet it flies far and swiftly. Though said to wander thousands of miles beyond the regular boundaries of its range, in seeking escape from its enemies it is reported to prefer diving or hiding among the emergent vegetation rather than resorting to flying.

Food of Adults

Few specific data are at hand regarding the food habits of the masked duck. No stomachs of the bird from the United States are available for study, but three from individuals that were collected near Habana, Cuba, in January have been examined in the Biological Survey laboratory. These ducks had made practically all of their meal on swamp smartweed seeds (*Polygonum hydropiperoides*), having taken 260, 250, and 140, respectively. Seeds of dodder (*Cuscuta*) likewise had been taken by each bird, yet in total bulk formed but a trace. Seeds of *Fimbristylis* occurred in two stomachs, and those of sawgrass (*Cladium jamaicense*) formed a trace in the third.

Comments of field observers also point to the fact that the masked duck is predominantly vegetarian. Gosse (*35, p. 405*) found "only seeds mostly comminuted" in the stomach of a Jamaica specimen; von Pelzeln (*78, p. 321*) found seeds in the crops and stomachs of specimens killed in Brazil; and Phillips (*81, v. 4, p. 147*) states that—

Gundlach describes the diet as consisting of seeds of grasses, roots, tubers, insects, and small crustaceans. In Panama, W. Percy (*in litt.*) found them feeding on "wild flax." Stomachs from birds collected by him in Cuba contained nothing but vegetable matter.

It is probable that the young and adults during the nesting season feed to some extent at least on aquatic insects and other aquatic animal life.

SUMMARY OF FOOD OF INLAND DIVERS

The feeding habits of the five members of the genus *Nyroca* and the ruddy are similar in many respects. A summary of the foods eaten is given in table 8, from which it is apparent that the food of this group of birds, with the exception of that of the greater scaup, is predominantly vegetable, but that relatively few plants have outstanding value to the group as food. Most of these are also of great value to the surface-feeding ducks (Anatinae).

TABLE 8.—*Summary of food, by volume percentages, of Nyroca and ruddy ducks*

Kind of food	Redhead (*N. americana*)	Ring-necked duck (*N. collaris*)	Canvas-back (*N. valisineria*)	Greater scaup duck (*N. marila*)	Lesser scaup duck (*N. affinis*)	Ruddy duck (*Erismatura jamaicensis rubida*)
Stomachs used	*Number* 364	*Number* 742	*Number* 427	*Number* 752	*Number* 1,051	*Number* 163
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Plant food	89.66	81.47	90.59	46.52	59.55	72.41
Muskgrass (Characeae) and other algae	23.17	4.83	1.50	5.41	2.57	3.94
Burreeds (*Sparganium*)	.20	1.34	2.50	.37	.82	.30
Pondweeds (Najadaceae)	32.27	13.45	29.88	18.86	18.36	29.11
Sagittaria and other waterplantains	.07	3.75	7.77	.43	1.01	.38
Wildcelery (*Vallisneria spiralis*)	2.70	.28	8.81	1.52	5.17	2.42
Wildrice (*Zizania aquatica*) and other grasses (Gramineae)	6.25	8.13	7.51	2.93	9.62	1.05
Sedges (Cyperaceae)	7.72	8.26	6.30	3.28	6.33	18.38
Smartweeds (*Polygonum*)	.95	6.44	.46	.61	1.28	1.53
Coontail (*Ceratophyllum demersum*)	1.29	3.58	.28	.52	1.50	1.35
Waterlilies (Nymphaeaceae)	1.31	14.56	4.06	.11	2.08	.81
Watermilfoils (Haloragidaceae)	.48	.96	2.06	4.94	1.41	1.17
Miscellaneous [1]	13.24	15.89	9.46	7.54	9.40	11.99
Animal food	10.34	18.53	19.41	53.48	40.45	27.59
Insects	5.89	10.75	8.13	7.15	12.05	21.87
Crustaceans	.44	.13	.07	6.84	1.34	2.54
Mollusks	3.86	5.97	8.80	39.12	24.93	2.73
Gastropods	2.85	3.53	3.49	14.58	15.89	1.43
Pelecypods	.73	.06	4.43	23.20	3.85	1.32
Undetermined	.28	2.38	.88	1.34	5.29	----------
Fishes (Pisces)	.07	.11	2.03	.16	.94	[2]
Miscellaneous [1]	.08	1.57	.38	.21	1.19	.43

[1] For purposes of comparison, miscellaneous groupings in this table necessarily differ from those in tables 1 to 7.
[2] Trace.

The submerged plants having the greatest value to the *Nyroca* and ruddy ducks include sago pondweed (*Potamogeton pectinatus*) (fig. 1), claspingleaf pondweed, or redhead-grass (*P. perfoliatus*), wigeongrass (*Ruppia maritima*) (pl. 3, *B*), wildcelery (*Vallisneria spiralis*) (fig. 2), naiads (*Najas flexilis* or *N. guadalupensis*), and muskgrass (*Chara*) (fig. 3). The floating or marsh plants of greatest utility include watershield (*Brasenia schreberi*), wildrice (*Zizania aquatica*) (fig. 4), bulrushes (*Scirpus*, particularly *S. americanus* and *S. occidentalis*), smartweeds (*Polygonum*), banana waterlily (*Castalia flava*), and the delta duckpotato (*Sagittaria platyphylla*) (pl. 3, *A*, *c* and *d*). Wildcelery and wildrice are restricted in distribution to the eastern and north-central United States and the adjacent Canadian territory, and banana waterlily and delta duckpotato are of value only in a limited section of the South.

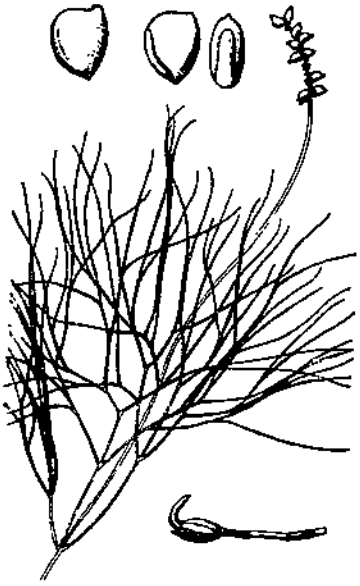

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FIGURE 1.—Sago pondweed (*Potamogeton pectinatus*): Seeds, ×2½; part of plant with fruiting head, ×½; and germinating tuber with attached rootstalk, ×1. (Drawing by A. C. Martin.)

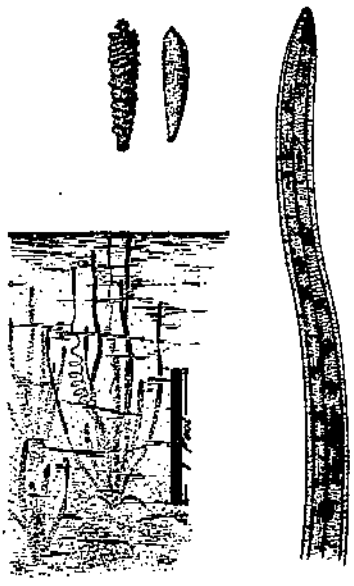

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FIGURE 2.—Wildcelery (*Vallisneria spiralis*): Two seeds, ×5, one normal and other with covering removed; habitat sketch of plant; and tip of single leaf, ×½. (Drawing by A. C. Martin.)

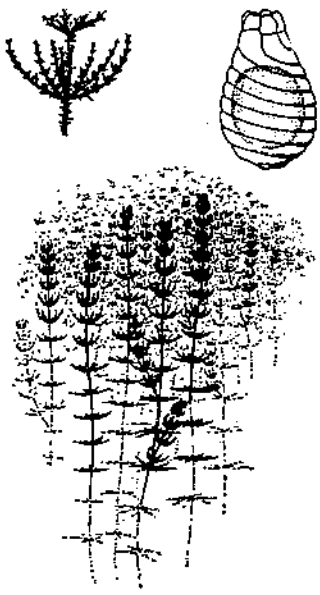

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FIGURE 3.—Muskgrass (*Chara*): Whorl of branches bearing oögonia, ×1; oögonium, a propagative structure, ×12½; and habitat sketch of bed of plants. (Drawing by A. C. Martin.)

PROPAGATION OF PREFERRED PLANTS

The preferred foods of the predominantly plant-feeding ducks are the submerged plants listed above. Because its tubers, seeds, running rootstalks, and green leaves are readily eaten and because it is highly adaptable—growing in either fresh or brackish water—and almost continental in distribution, sago pondweed (fig. 1) is perhaps the best wild-duck food known. This, other *Potamogeton* species, and wigeongrass may be propagated by planting tubers or by inserting the larger ends of rhizomes or stems, cut in foot lengths, in mud balls and dropping the balls into water of appropriate depth where the bottom is fairly soft. Seeds also may be harvested and planted, although this method is slower and more expensive. The parts of wildcelery usually planted are the winter buds and rootstalks. Naiads, eelgrass (*Zostera marina*) (fig. 5), horned pond-

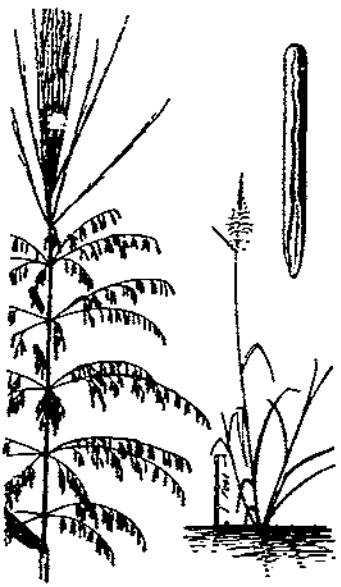


FIGURE 4.—Wildrice (*Zizania aquatica*): Inflorescence, showing pistillate part above and staminate below, ×⅛; seed, ×2½; and habitat sketch of plant. (Drawing by A. C. Martin.)

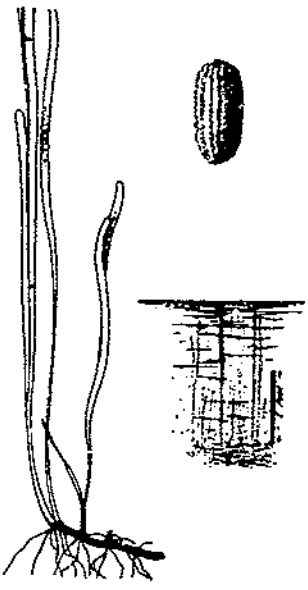


FIGURE 5.—Eelgrass (*Zostera marina*): Part of plant showing leaves and dhizome, ×½; seed, ×5; and habitat sketch of plant. (Drawing by A. C. Martin.)

weed (*Zannichellia palustris*), and a few submerged aquatics have their seeds in the axil of the plant or in a sheath or spadix enveloped by leaves. These and muskgrass can therefore be more economically propagated by harvesting considerable plant material along with the parts producing seeds or oögonia (as in muskgrass) in summer and fall, cutting them in small pieces, and placing them in the water, weighting them down with mud. Rapid vegetative reproduction follows when the tuberous structures of muskgrass are planted. New plant growth also develops from oögonia. Bulrushes and other perennials with rootstalks can be propagated best by using the underground parts, which, of course, must be kept wet and planted as soon

as possible after digging them up. Detailed information on the propagation of wild-duck foods is presented in a recent bulletin of the Department (*63*).[8]

PREDOMINANTLY ANIMAL FEEDERS

GOLDENEYES AND BUFFLEHEAD

Brief comment may be made regarding the American goldeneye, Barrow's goldeneye, and the bufflehead as a group, because they are closely related and have much in common. Although the bufflehead is separated from the two goldeneyes in the American Ornithologists' Union Check-List (*2, pp. 53–54*) as a distinct genus, some authorities, including Peters (*79, p. 177*), group the three into the single genus *Bucephala*. All three birds have short chunky heads and are easily differentiated from other species, and all have a characteristic wing beat and a distinctive posture on the water.

Because these ducks are tree nesters, breeding birds occur only in wooded sections, mostly north of the international boundary. The birds occupy holes in either deciduous or evergreen trees. Natural cavities or deserted large woodpecker holes are sometimes used. The breeding pairs are widely scattered, there seldom being more than one or two pairs to a lake.

These expert divers are restless and active, usually frequenting large expanses of water rather than small ponds or enclosed shallow sloughs. They are less gregarious than most other waterfowl and rarely consort with surface feeders or with other divers. They seem to be less social, more distrustful, and warier than most of the other diving species. Decoys of the ordinary type have little attraction for them. All are readily attracted by bait, but repeated shooting for a few days in succession is sure to drive them away. All are day feeders and have much in common in food habits and choice of diet.

AMERICAN GOLDENEYE (Glaucionetta clangula americana)

(Pl. 4, facing p. 64)

At least in the southern half of its wintering grounds the American goldeneye is a true harbinger of winter, rarely making its appearance in appreciable numbers until the balmy days have practically all passed. Ordinarily the full-plumaged old males are the last to arrive, not abandoning their northern haunts until the icy waters are frozen over. Furthermore, the goldeneye is one of the first to leave in the spring. It nests across the continent where appropriate habitats occur and goes as far north as it can find suitable timber for nesting sites. In winter it seems to prefer the coastal waters, although it is found inland in sizable numbers wherever there are large bodies of water. Though it ranges as far south as the Gulf of Mexico, it can be considered a common winter bird only south to southern North Carolina and California.

The American goldeneye is widely and aptly known as the "whistler," because of the shrill whistle produced by its wing beats. Its flight is swift and strong, and in migration it travels at rather high elevations. A marked difference is noted in the relative degree

[8] Lists of dealers in duck-food plants may be obtained by writing to the U. S. Biological Survey, Washington, D. C.

of wariness of the adults and young and also of the same birds at the beginning and close of the gunning season. This goldeneye does not seem to be so noticeably on the decline as most other waterfowl. As a table duck, it is second-rate; however, in areas where heavy baiting is practiced its flesh becomes decidedly more palatable and compares favorably with most of the choicer varieties.

Food of Adults

Its extremely wary and distrustful nature causes the American goldeneye to react differently from other waterfowl on the feeding grounds during the gunning season. Along with the *Nyroca* ducks, it is readily attracted to bait and accepts it in preference to most, if not all, other kinds of feed. Daily shooting, however, will drive it away; consequently successful shooting cannot ordinarily be practiced more than twice a week. Even under such conditions, incoming birds always alight beyond shooting distance and very cautiously swim to the baited area. At the slightest sound they leap into the air and fly away. At a baited area in Chesapeake Bay, the writer noted that the birds coming up from a dive after wheat or corn, placed in 8 to 15 feet of water, would always be swimming at full speed away from the blind when they reached the surface. Not infrequently the last birds to come up would take wing almost the instant they reached the surface upon finding that others of their kind were a rod or more away from them. When the birds spring into the air at a false alarm, which is a common occurrence and usually for no discernible cause, they quickly fly back just beyond shooting distance and swim to the bait. They remain at the outer border of the baited area, whereas scaups and other *Nyroca* ducks often alight within 25 feet of the blind and even innocently feed under its very shadow. The writer has observed the bird feeding in water at depths from 4 to 20 feet. When not molested it may occasionally be found dabbling in the mud along the shore with surface feeders and scaups.

The facts determined in the present study seem to show that this goldeneye is often a voracious feeder, consuming a great variety of items, as the species of plants or animals averaged more than 7.25 a meal. The kind of material eaten apparently varies greatly with the particular area where the bird feeds. Although nearly three-fourths (73.91 percent) of the food was animal matter, the bird seems to be highly adaptable and able to survive in good condition on almost any type of food available. During May and October, more than half the food was vegetable, yet it was during a summer month (July) that the smallest quantity (10.50 percent) of plant food was consumed. It seems that when a plentiful supply of an acceptable food is found little else is sought. As further evidence along this line it may be stated that nearly 44 percent of the birds had fed exclusively on animal foods and nearly 71 percent to the extent of 90 percent or more of their meal and that on the other hand, more than 3 percent had fed exclusively on vegetable foods and 7 percent to the extent of at least 90 percent of their meal.

Perhaps because of the tendency of the species to shift from the interior, where it spends the summer and fall, to the coast in winter, there is a noticeable shift in the kinds of food consumed during the different seasons. As would be expected, insects and plants reach

their maximum value as a goldeneye food in summer, when the birds are inland, and crustaceans and mollusks—which usually abound more commonly along the coast or brackish waters—in winter.

About 1 bird in every 10 examined had taken feather material, probably largely from its own body while preening. Usually this formed only a trace of the contents, occasionally 10 percent. No correlation whatever could be found between the type of food consumed and the presence or absence of feathers. Gravel comprised almost a fourth (24.51 percent) of the gizzard content.

The laboratory data for the present study are based on examinations of 428 stomachs of adult American goldeneyes, 395 of which were sufficiently full to be used in determining food percentages (tables 9 and 26). The material is from localities well distributed over the continent and is truly representative, as the birds were collected in 25 States, Alaska, and 5 Canadian Provinces in every month of the year except June and August.

TABLE 9.—*American goldeneye (Glaucionetta clangula americana): Food, by volume percentages, of 395 adults taken during 10 months of the year*

Kind of food	Percentage of food	Kind of food	Percentage of food
ANIMAL FOOD (73.91 percent)		ANIMAL FOOD (73.91 percent)—continued	
Crustaceans	32.42	Mollusks	9.71
Mud crabs (*Hemigrapsus*)	10.56	Blue mussel (*Mytilus edulis*) and other Mytilidae	2.53
Mud crab (*Neopanope texana-sayi*)	3.76	Other pelecypods	1.67
Other crabs	1.85	*Lymnaea* shells	1.00
Crawfishes (Astacidae)	5.03	Other gastropods	3.59
Amphipods	4.28	Undetermined	.92
Shrimps	1.37	Fishes (Pisces)	3.16
Miscellaneous	5.57	Miscellaneous animal food	.64
Insects	27.98	PLANT FOOD (26.09 percent)	
Caddisflies (Trichoptera)	12.32	Pondweeds (mostly *Potamogeton*)	8.62
Water boatmen (Corixidae)	2.75	Wildcelery (*Vallisneria spiralis*)	3.42
Dragonflies and damselflies (Odonata)	2.60	Spatterdocks (*Nymphaea*)	1.38
Mayflies (Ephemeroptera)	1.83	Grains (bait)	1.35
Salt flies (*Ephydra*)	1.52	Bulrushes (*Scirpus*)	1.11
Beetles (Coleoptera)	1.45	Miscellaneous plant food	10.21
Miscellaneous	5.51		

ANIMAL FOOD—73.91 PERCENT

Crustaceans (32.42 percent).—The principal animal food of the American goldeneye consisted of crustaceans, about half of which were crabs. Most important of these were the west coast mud crabs (*Hemigrapsus oregonensis* and *H. nudus*) (10.56 percent), as practically every west coast bird taken in an area where they occur had fed on them extensively and in many stomachs they were almost the sole items. During November they formed 35.63 percent of the food of the 54 birds collected; and in each of 2 other months, more than 20 percent. At Oyster Bay, Wash., 20 goldeneyes taken during November in an investigation to determine the relation of various waterfowl to the oyster industry had made mud crabs 96.20 percent of their food, and it was indeed a surprise to find the remains of 26 in a single stomach and gullet and only slightly smaller numbers in several others. Birds collected on the Atlantic coast were found to have been subsisting upon the eastern mud crab (*Neopanope texana-sayi*) (3.76 percent). By counting pinchers (chelae) it was evident

that at least 36 of these crabs had not long before been consumed by 1 bird and only slightly smaller numbers by others. Other crabs (1.85 percent) included mud crabs (*Hexapanopeus angustifrons* and *Lophopanopeus*), cancer or rock crabs (*Cancer*), hermit crabs (*Pagurus*), and one small blue, or common edible crab (*Callinectes sapidus*).

Audubon (*3, v. 4, pp. 321–322; 4, pp. 363–364*) discovered the American goldeneye hunting for crawfishes in the clay bottom of "the shallow fording-place of Canoe Creek near Henderson in Kentucky." The present study well confirms that observation, as 5.03 percent of the entire food consisted of crawfishes. During March *Cambarus* and *Astacus* supplied 13.71 percent of the food; and in February and October, 5.00 and 6.60 percent, respectively. Amphipods (4.28 percent), only slightly less valuable, were taken by more birds. Species of *Gammarellus*, *Hyalella*, *Ischyrocerus*, and *Pseudalibrotus* were most frequently identified. Shrimps (1.37 percent) were less important. Miscellaneous crustaceans (5.57 percent) included isopods, barnacles, and undetermined forms.

Insects (27.98 percent).—Considering that so many of the American goldeneyes were collected along the coasts, both east and west, it was somewhat surprising to find that insects entered so prominently into the diet. Caddisflies (12.32 percent), including species at least of *Glossosoma*, *Polycentropus*, *Molanna*, *Triaenodes*, *Phryganea*, and *Brachycentropus*, were by odds the most important. These submerged aquatic larvae entered into the bill of fare in each of the 10 months, ranging from 1.12 percent in January to 23.20 percent in April. By counting mandibles it was shown that 544 larvae had been consumed by a single bird.

Water boatmen (2.75 percent) were taken by many of the birds and supplied 10.55 percent of the food of those collected during September. Odonata nymphs (2.60 percent), both dragonflies and damsel flies, were next in importance. Dragonfly nymphs furnished 11.60 percent of the food of the birds collected during August, and 25 were found in a single stomach. Mayflies (1.83 percent) were taken in each of the 10 months. They supplied nearly 8 percent of the food for July, and 75 nymphs were noted in a single stomach. Salt flies (1.52 percent) were consumed by fewer birds, but they furnished 14.17 percent of the food during November and 672 larvae were found in a single stomach. Beetles (1.45 percent) of many species were taken. Wetmore (*92, p. 755; 94, p. 15*) found goldeneyes on the lower bay of Bear River, Utah, subsisting largely on the brine flies and immature alkali flies that are abundant there.

Miscellaneous insects (5.51 percent) included an unusually large assortment of species, many of which were noticeably important as food for one or more months, yet none averaged as much as 1 percent of the total intake. Most of them were aquatic species, but some land forms, including ants (*Lasius* and others), were taken in quantity by individual birds. The miscellaneous insects of outstanding value include larvae of stone flies and lacewings; aquatic bugs, especially the back swimmers (*Notonecta*) and giant water bugs (*Belostoma*); larvae of several two-winged flies, especially midges and horseflies; and ants. As evidence that some of these were the major food items for individual birds it was noted that considerably more than 1,500 midge (*Chironomus*) larvae were taken at a single meal.

Mollusks (9.71 percent).—It was a distinct surprise to find that mollusks were not more prominent in the American goldeneye's diet. Although many species of both bivalves (pelecypods) and univalves (gastropods) were consumed, some in quantity by individual birds or for limited periods, only one species (or genus) of each class averaged 1 percent or more of the food, namely, the blue mussel (*Mytilus edulis*) and *Lymnaea* shells. Mollusks were taken most commonly in winter. During January, for example, the blue mussel alone supplied 14.38 percent of the food, yet during April, May, and September, all molluscan foods amounted to scarcely a trace.

An unusual accomplishment of the goldeneye, which does not seem to be shared by other waterfowl, is its method of extracting the meat of the bivalve without consuming the hard calcareous shell. Several stomachs contained only the meat of pelecypods or only a small piece of broken shell with the meat. A fair number of fresh-water mussels had obviously been taken in this way. Apparently the feat is accomplished by a very quick jerk at the shell when the valves are open. The thinner and smaller shells are swallowed whole, as they are by all other mollusk-feeding ducks.

The most important pelecypod food was furnished by the Mytilidae (2.53 percent), mostly by the common blue mussel (2.34 percent). Although taken by many of the birds, this species often formed only a minor part of the meal, but at times coastal birds ate it almost exclusively, one individual having consumed the almost unbelievable number of 520 small shells at a single meal. Of the other pelecypods (1.67 percent) obtained, *Macoma* shells, nut-clams (*Nucula proxima*), and ark shells (*Arca*) were important. Although young commercial mollusks were taken by a few birds, they did not enter prominently into the food. Oysters formed but 0.07 and scallops 0.04 percent of the food. This is significant, inasmuch as a fair number of the birds were taken over or near planted shellfish beds.

Species of *Lymnaea* (1 percent) were taken by many of the birds, occasionally in considerable numbers. Of the many other gastropods (3.59 percent) found in the stomachs, the most important were river-shells (*Goniobasis*), dog whelks (*Nassarius*), dove-shell (*Anachis avara*) and other Columbellidae, *Scila terebralis*, *Bittium*, Amnicolidae (*Fluminicola* and *Amnicola*), chink-shells (*Lacuna*), periwinkles (*Littorina*), flat-coils (*Planorbis*), keel-shell (*Carinifex newberryi*), *Physa*, and limpets (*Acmaea*). Examples of large numbers of these mollusks entering into single meals are the following: 137 *Littorina*, 116 *Lacuna vincta*, 68 *Bittium minimum*, 62 medium-sized *Goniobasis virginica*, 28 *Mitrella lunata*, 24 *Nassarius obsoleta*, and 17 *Physa*.

Undetermined forms (0.92 percent) made up the remaining molluscan food.

Fishes (3.16 percent).—The percentage that fishes formed of its food shows that the American goldeneye has a very much less extreme piscatorial tendency than is usually credited to it. Perhaps the female is often called a fish duck because it is frequently mistaken for the female merganser, and it is probable that it is this misconception that has tended to bring the species into disrepute with the angler and commercial fisherman. That the bird occasionally accepts fishes in numbers cannot be denied, but as a rule fish remains formed but a comparatively small part of the stomach contents.

Availability within size limits and ease of collection obviously were the factors governing selection. Johnny darters formed the entire meal of one bird; sail-finned killifish, 99 percent of the meal of a bird from Texas; and numerous minnows and sculpins, the major part of the meals of other birds.

Various species of fishes were found, in some instances several in the same stomach. The kinds taken and the number of stomachs in which found are as follows: Unidentifiable remains, 16, 2 occurrences consisting of otolith fragments only and 1 of a tooth; sticklebacks (Gasterosteidae), 24, including species of *Gasterosteus* in 3 and nine-spined sticklebacks (*Apeltes quadracus*) in 17; sculpins (Cottidae), 17, including species of *Cottus* in 1 and *Cottus ictalops* in 1; sand launces (*Ammodytes americanus*), 7; minnows (Cyprinidae), 6; mosquito fishes (Poeciliidae), 3; cunners (*Tautogolabrus adspersus*), 3; darters (Etheostomidae), 2, including johnny darters (*Boleosoma nigrum*), in 1; sunfishes (Centrarchidae), 2, including warmouths (*Chaenobryttus gulosus*), in 1; goby (Gobiidae), 1; pipefish (*Sygnathus*), 1; yellow perch (*Perca flavescens*), 1; and sail-finned killifish (*Mollienesia latipinna*), 1.

In these 84 occurrences (sometimes more than one in the same stomach) only the sunfishes and yellow perch can be considered of even moderate worth to the angler. No trout were captured, even though some of the birds were collected on trout streams to determine their relation to sporting fish. It is probable that an occasional trout is taken, yet the facts here shown indicate that serious depredation must indeed be very exceptional. Some of the fishes taken, particularly the sticklebacks and some of the minnows and sculpins, are noted spawn-eaters, and others are competitors of the sporting fish for food.

Taverner (*87, p. 99*) and others speak of the bird as occasionally being a scavenger. In some of the western streams it is said to feed extensively on salmon that have died after spawning.

Miscellaneous animal food (0.64 percent).—This included many species, none of which, however, was of very great significance except for individual meals. As with other birds here considered, some of the invertebrate items obtained, such as hydroids, were of fairly frequent occurrence, yet they rarely formed more than a trace in any stomach. Polychaete worms, particularly Nereidae, and sea urchins (*Strongylocentrotus dröbachiensis*) were of much value to a limited number of birds, though not consumed very often. Additional miscellaneous items included water mites, centipedes, bryozoans, and sponges.

PLANT FOOD—26.09 PERCENT

Pondweeds (8.62 percent).—The dominant vegetable food of the American goldeneye consisted of seeds, tubers, and vegetative growth of pondweeds of the genus *Potamogeton* (7.91 percent), which, during October supplied more than a fourth (27.30 percent) of the rations. The species identified were sago pondweed (*P. pectinatus*), claspingleaf pondweed (*P. perfoliatus*), *P. pusillus*, floatingleaf pondweed (*P. natans*), longleaf pondweed (*P. americanus*), *P. angustifolius*, whitestem pondweed (*P. praelongus*), and ribbonleaf pondweed (*P. epihydrus*). One stomach contained 75 small tubers and an-

other more than 80 seeds of sago pondweed. Other pondweeds (0.71 percent) included eelgrass (*Zostera marina*), wigeongrass (*Ruppia*), naiads (*Najas*), and horned pondweed (*Zannichellia palustris*). A single stomach contained 320 seeds of eelgrass; another, 79 seeds of wigeongrass.

Wildcelery (3.42 percent).—Wildcelery (*Vallisneria spiralis*) was second in importance as a plant food. Three American goldeneyes collected in October had made 100, 97, and 90 percent, respectively, of their meal on this choice food.

Spatterdocks (1.38 percent).—The seeds of spatterdock (*Nymphaea*) ranked third as a plant food for this species.

Grains (bait) (1.35 percent).—The bait obtained by the American goldeneye consisted of corn, wheat, barley, peas, beans, and buckwheat. The extent to which such food is taken is almost entirely determined by the quantity available. From field observation it is evident that grains of various kinds are usually taken in preference to most natural foods, because it requires less effort for a bird to make a meal on it than to search out native seeds or rootstalks that are widely scattered.

Bulrushes (1.11 percent).—Several species of *Scirpus*, largely hardstem bulrush (*S. acutus*), common three-square (*S. americanus*), and alkali bulrush (*S. paludosus*), were of frequent occurrence, and during September, seeds of these plants supplied 5.37 percent of the food. One bird had consumed 1,431 seeds of the common three-square.

Miscellaneous plant food (10.21 percent).—A great many additional plants were eaten by the American goldeneye, yet individually none of them supplied as much as 1 percent of the food. Many of them were not only of great value for specific meals but were of noticeable importance during one or more months; others were of great value in certain sections of the country. The principal ones in about the order of their importance are muskgrass (*Chara*) and other algae, sedge (*Carex*), smartweed (mostly *Polygonum amphibium* and *P. lapathifolium*), burreed (mostly *Sparganium eurycarpum*), coontail (*Ceratophyllum demersum*), waterweed (*Anacharis canadensis*), wild millet (*Echinochloa*), oak (*Quercus*), watermilfoil (*Myriophyllum*), sawgrass (*Cladium*), miscellaneous grasses, miscellaneous sedges, moss plant fiber, duckweed (*Lemna*), dock (*Rumex*), waxmyrtle (*Myrica*), watershield (*Brasenia schreberi*), water buttercup (*Ranunculus*), bramble (*Rubus*), marestail (*Hippuris vulgaris*), dogwood (*Cornus*), wild grape (*Vitis*), and waterplantain (*Alisma plantago-aquatica*). As evidence that these plants or their seeds were of considerable importance to individual birds, the following examples of rather large numbers of oögonia or seeds found in single stomachs may be given: 1,100 oögonia of *Chara*, in addition to plant fiber, and 648 seeds of *Carex*. 175 of *Rubus villosus?*. 118 of *Eleocharis palustris*, more than 100 of *Echinochloa crusgalli*, and 55 of *Polygonum amphibium*.

The stomach of a bird collected in a Massachusetts lake by Phillips (*80, p. 200*) "contained seeds of pondweed, water-lily, bayberry, and bur-reed, buds and roots of wild celery, and bits of water boatmen, and dragonfly nymphs." According to Yorke (*97, p. 71*) the plants fed upon by the bird are teal moss (*Limnobium*), large blue flag (*Iris versicolor*), duckweed (Lemnaceae), waterplantain (Alis-

maceae), pondweed (Najadaceae), mud aquatic plants (Selaginellaceae), moss teal moss (Salvinaceae), waterwort (Elatinaceae), floating heart (Gentinaceae), watermilfoil (*Myriophyllum*), water starwort (*Callitriche*), water herbs (Lentibulariaceae), bladderwort (*Utricularia*), pickerel weed (Pontederiaceae), and moss plants (Mayacaceae).

Food of Juveniles

Stomachs of 13 juvenile American goldeneyes were available for computation of food percentages (table 10). The birds, taken in June and July in Alberta and Ontario, were all small, and at least two of them were downy young, not long out of the nest.

TABLE 10.—*American goldeneye (Glaucionetta clangula americana): Food, by volume percentages, of 13 juveniles taken during June and July*

Kind of food	Percentage of food	Kind of food	Percentage of food
ANIMAL FOOD (84.08 percent)		ANIMAL FOOD (84.08 percent)—contd.	
Insects	70.62	Water mites (Hydrachnidae)	10.15
Diving beetles (Dytiscidae)	19.30	Ostracods	2.77
Other beetles (Coleoptera)	1.63	Miscellaneous animal food	.54
Caddisflies (Trichoptera)	17.15		
Dragonflies (Anisoptera)	8.92	PLANT FOOD (15.92 percent)	
Damsel flies (*Enallagma* and other Zygoptera)	7.77	Cattails (*Typha*)	5.61
Water boatmen (Corixidae)	3.46	Bulrushes (*Scirpus*)	3.92
Back swimmers (*Notonecta*)	3.00	Sedges (*Carex*)	1.38
Ants and other Hymenoptera	2.46	Miscellaneous plant food	5.01
Miscellaneous	6.93		

ANIMAL FOOD—84.08 PERCENT

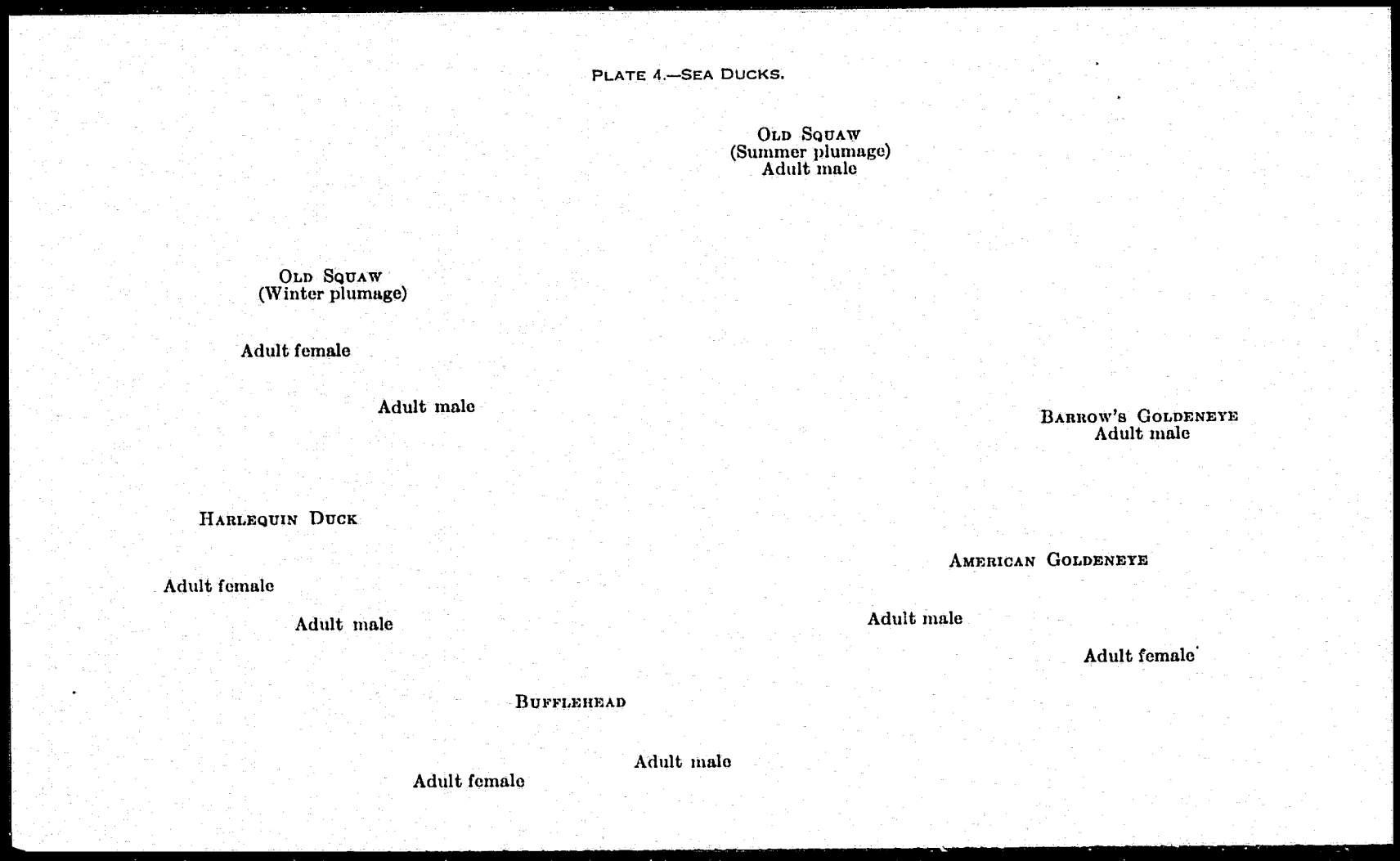
Often, comparatively small items were consumed. Insect material (70.62 percent) formed the bulk of the juveniles' food in the following groups and percentages: Beetles and their larvae, 20.93, mostly diving beetles (Dytiscidae), 19.30; caddisfly larvae and cases, including *Phryganea interrupta*, 17.15, one stomach containing the remains of 40 larvae; Odonata, 16.69, including dragonflies, 8.92, and damsel flies (*Enallagma*, 3.23, and others), 7.77, one bird having eaten 25 nymphs; water boatmen, 3.46; back swimmers (*Notonecta*), 3; miscellaneous hymenopterans, mostly ants, 2.46; and miscellaneous insects, 6.93, including midges and other Diptera, moth larvae, water bugs (*Belostoma* and others), stone fly nymphs, Mayfly nymphs, lacewing larvae, and undetermined forms.

Water mites (10.15 percent) and ostracods (2.77 percent) were freely consumed. Miscellaneous animal food (0.54 percent) consisted of mollusks, fresh-water sponges, and bryozoans. It was surprising that both soft-bodied crustaceans and the smaller mollusks did not enter more prominently into the food.

PLANT FOOD—15.92 PERCENT

Vegetable foods seemed to have been taken rather indiscriminantly by the juvenile American goldeneye, seeds, plant fiber, and drifting debris having been readily gobbled up. The pappus and fruiting body of cattail (*Typha*) (5.61 percent), usually considered worthless as a duck food, formed 73 percent of the meal of one youngster.

PLATE 4.—SEA DUCKS.



A larger and more representative series of stomachs would undoubtedly show this plant to be of less value. Four species of bulrush (*Scirpus*) seeds (3.92 percent) had been taken by 10 of the 13 birds, 1 of which had procured 305. Sedge (*Carex*) (1.38 percent) came next, individual birds having consumed 69, 22, and 16 seeds.

In addition to some undetermined vegetable debris, miscellaneous plants (5.01 percent) comprised pondweeds (*Potamogeton*), spikerush (*Eleocharis*) and other sedges, watermilfoil (*Myriophyllum*), marestail (*Hippuris vulgaris*), arrowwood (*Viburnum*), bearberry (*Arctostaphylos*), buttercup (*Ranunculus*), muskgrass (*Chara*) and other algae, burreed (*Sparganium*), waterplantain (*Alisma plantago-aquatica*), undetermined grass dock (*Rumex*), waterlily (*Castalia*), goosefoot (*Chenopodium*), dogwood (*Cornus*), mint (Labiatae), and snowberry (*Symphoricarpos*).

BARROW'S GOLDENEYE (Glaucionetta islandica)

(Pl. 4, facing p. 64)

Unless our present concepts are considerably in error, Barrow's goldeneye possesses one of the most peculiar and remarkable distributions of any North American bird. It breeds as an isolated nester in Greenland, Iceland, on the Labrador coast, and possibly also in Ungava. Beyond that, in a westerly direction, nothing is known of the bird as a breeder until we reach the Rocky Mountains, where it breeds (often commonly) from south-central Alaska to Colorado and California. Much yet is to be learned regarding its movements, distribution, and habitat.

Though the trachea and, to a lesser extent, the bill of this species are quite different anatomically from those of the American goldeneye, yet in the field under normal conditions the two species are extremely difficult to differentiate and few, if any, observers can distinguish the females and young of the two. Consequently Barrow's goldeneye may have been overlooked in many places. It may be much more common on the North Atlantic coast than is realized, as it readily associates with the American goldeneye during migration and in winter.

In habits, characteristics, and food, these two species are much alike. Although normally a tree nester, Barrow's goldeneye does not hesitate to accept a hole in a rock or cliff when natural tree cavities are not available. In the far West, it is restricted as a breeder entirely to the mountainous sections, nesting at times at an elevation of 10,000 feet, and it is a common summer resident of the numerous small mountain lakes, near which it nests and to which it brings its downy young almost as soon as they are out of the shell. The breeding males are said to desert the females for unknown quarters as soon as incubation is begun.

Food of Adults

Little difference in the food tendencies was detected in the eastern and western Barrow's goldeneyes. Crustaceans and mollusks were taken more extensively during winter, and insects and vegetable foods during summer. In contrast with the American goldeneye this species seems to subsist somewhat more upon insects (36.40 and 27.98 percent) and mollusks (19.16 and 9.71 percent) and less upon crusta-

ceans (17.71 and 32.42 percent). These differences in food tendencies are probably explainable on the basis of distribution and would perhaps have been slight if both species had been taken in equal numbers at the same time and place.

For a determination of the food of the adult Barrow's goldeneye, 81 stomachs were available, 53 from British Columbia, 10 from Quebec, 9 from Alaska, 5 from Oregon, 2 from New Brunswick, and 1 each from Vermont and Colorado. Each month except August was represented. In computing food percentages (tables 11 and 26), 71 stomachs were full enough to be used.

TABLE 11.—*Barrow's goldeneye (Glaucionetta islandica): Food, by volume percentages, of 71 adults taken during 11 months of the year*

Kind of food	Percentage of food	Kind of food	Percentage of food
ANIMAL FOOD (77.66 percent)		ANIMAL FOOD (77.66 percent)—continued	
Insects	36.40	Mollusks—Continued.	
Damsel flies (*Enallagma* and other Zygoptera)	3.47	Chitons and undetermined	0.87
Dragonflies (Anisoptera)	1.30	Crustaceans	17.71
Undetermined Odonata	4.91	Amphipods	9.23
Caddisflies (Trichoptera)	6.32	Isopods	1.79
Water boatmen (Corixidae)	5.33	Crawfishes (*Astacus*)	1.47
Back swimmers (*Notonecta*)	2.46	Other decapods	1.02
Midges (Chironomidae)	2.54	Miscellaneous	4.20
Beetles (Coleoptera)	2.10	Fishes (Pisces)	1.14
Miscellaneous	7.97	Miscellaneous animal food	3.25
Mollusks	19.16	PLANT FOOD (22.34 percent)	
Blue mussel (*Mytilus edulis* and other Mytilidae)	12.25	Pondweeds (*Potamogeton* and others)	8.17
Other pelecypods	.98	Wildcelery (*Vallisneria spiralis*)	1.57
Periwinkles (Littorinidae)	2.49	Miscellaneous plant food	12.60
Other gastropods	2.57		

ANIMAL FOOD—77.66 PERCENT

Insects (36.40 percent).—Insects, which constituted the principal food of Barrow's goldeneye, were consumed in greater quantity than is generally believed. Most important were the Odonata (9.68 percent), consisting of damsel fly nymphs (largely *Enallagma*) (3.47 percent), dragonfly nymphs (1.30 percent), and undetermined species (4.91 percent). Other insects taken, listed in order of importance in percentages, were caddisfly larvae and cases, 6.32; water boatmen, 5.33; back swimmers (*Notonecta*), 2.46; midge larvae (mostly *Chironomus*), 2.54; and various aquatic beetles and their larvae (principally predaceous diving beetles, Dytiscidae), 2.10. Miscellaneous insects (7.97 percent) included Mayflies, lacewings, stone flies, ants, and various two-winged flies. The following large numbers of individual insects were taken at single meals: More than 1,575 midge larvae; more than 125 damsel fly nymphs (mostly *Enallagma*); 22 crawling water beetles (*Haliplus*); and 450, 132, and 96 caddisflies.

Mollusks (19.16 percent).—The principal contributors to the molluscan food of Barrow's goldeneye were the Mytilidae (12.25 percent), particularly the blue mussel (*Mytilus edulis*) (11.77 percent), a staple food of many ducks. One bird had gorged itself on 627 young shells, and 2 others had swallowed 287 and 96 respectively. Numerous other pelecypods (0.98 percent) were taken but not in

quantity. Littorinidae (2.49 percent), the principal gastropod food, consisted mostly of the common periwinkle (*Littorina*) (2.39 percent), but chink-shells (*Lacuna*) (0.10 percent) were also taken. Numerous other univalves (2.57 percent) were consumed. The remaining molluscan food was made up of a few chitons (0.01 percent) and undetermined mollusks (0.86 percent).

Crustaceans (17.71 percent).—Several Barrow's goldeneyes had made their entire meal on one or more of the following crustaceans: Amphipods (9.23 percent); isopods (1.79 percent); crawfishes (*Astacus*) (1.47 percent) and other decapods, mostly crabs (1.02 percent); and miscellaneous, including undetermined, forms (4.20 percent). Inland, the goldeneyes seem to be partial to crawfishes. Munro (*67, p. 5*) states that inland wintering birds hunt for these creatures so persistently that by the end of winter the feathers on the birds' foreheads are generally worn off through much rubbing against submerged stones trying to locate and dislodge the crawfish. He states also (*67, p. 4*) that the species in the Okanagan Valley of British Columbia has a marked predilection for lakes that are strongly alkaline, even though they may possess little aquatic vegetation, as "such lakes are rich in small crustaceans, the chief food of this duck."

Fishes (1.14 percent).—Various species of fishes, mostly worthless sculpins, were taken. The effect of this consumption is perhaps more significant than the figures here would indicate inasmuch as a fair part of the occurrence was of fish spawn, which did not amount to a very high percent. Eggs apparently are digested quite rapidly. Where fishes or fish spawn are abundant in a body of water frequented by Barrow's goldeneye, there is little doubt but that the bird would feed on such easily obtainable food. At Henderson Lake, Vancouver Island, British Columbia, Munro (*68, p. 113*) found that under conditions that could be classed as similar to those at a large hatchery this duck was feeding extensively on the spawn of sockeye salmon. The birds came during daylight hours and fed along the sandy bottoms where immense numbers of salmon were depositing their eggs. Of 20 birds shot and examined, all that had had time to feed contained salmon eggs, 300 being noted in a single stomach. In the region of salmon canneries these ducks are said to lose much of their normal shyness and boldly gorge on decaying fish. Under normal conditions, however, it does not seem that this species should be considered a serious enemy of fishing interests.

Miscellaneous animal food (3.25 percent).—This consisted of a salamander (*Ambystoma*); water mites, taken at times in large numbers; sea urchins; starfishes; earthworms; marine worms; hydroids; and fresh-water sponges. Some of these were important for individual meals, but none averaged as much as 1 percent of the food.

PLANT FOOD—22.34 PERCENT

Pondweeds (8.17 percent).—Species of *Potamogeton* (7.96 percent) were first in importance of the plant foods for Barrow's goldeneye, forming almost the same percentage as for the American goldeneye (7.91 percent). Five December birds had made more than a third of their meals on this plant group. One bird had consumed 200 sago pondweed (*P. pectinatus*) seeds. Other Najadaceae taken

(0.21 percent) were the horned pondweed (*Zannichellia palustris*), one bird having gathered more than 100 seeds along with plant fiber, and wigeongrass (*Ruppia maritima*).

Wildcelery (1.57 percent).—Wildcelery (*Vallisneria spiralis*) supplied a surprisingly large percentage of the food, considering the fact that it is not a native of the West. One bird, collected on Lake Champlain, Vt., had made its entire meal on the winter buds of this plant.

Miscellaneous plant food (12.60 percent).—A large assortment of miscellaneous plants, comprising most of the species fed upon by the American goldeneye, were taken. Grains are included in this group. The stomach of a bird taken in Colorado contained 25 muskmelon (*Cucumis melo*) seeds and fragments of oats, along with seeds of ragweed (*Ambrosia trifida*), dipterous larvae, and remains of half a dozen earthworms.

Food of Juveniles

Five juvenile Barrow's goldeneyes, four from Okanagan Valley, British Columbia, and one from Alaska were available for stomach analysis. Three were downy young taken in June, and two were immature birds collected in September and October. No appreciable difference was noted in the kind of food taken by the very young and that taken by the birds approaching maturity, except that the two latter had fed on fewer species. The September bird had made 96 percent of its meal on amphipods and undetermined soft-bodied crustaceans and the October specimen had drawn equally as heavily upon the larvae of caddisflies. The three downy young had subsisted on many different kinds of insects, taking an average of 9.4 species a meal.

The food taken, most of which was animal matter (98.40 percent), may be summarized by groups and percentages as follows: Caddisfly larvae (*Hydropsyche*), 9; miscellaneous caddisflies, 25.60; nymphs of damsel flies (*Enallagma*), 2.40; miscellaneous and undetermined Odonata, mostly dragonfly nymphs, 25.80; water boatmen, 3.80; back swimmers (*Notonecta*), 2.80; ants, 2.40; adults and larvae of water beetles, mostly Haliplidae, 2; miscellaneous insects, including nymphs, larvae, or adults of mosquitoes (*Culex*), miscellaneous two-winged flies, and lacewing flies, 4.60; miscellaneous amphipods, 18; miscellaneous, including undetermined, crustaceans, 1.60; mollusks, 0.40; undetermined fish bones noted in one stomach, a trace; and miscellaneous vegetable material, including plant fiber or seeds of algae, sedge (*Carex*), marestail (*Hippuris vulgaris*), pine needles, and undetermined debris, 1.60.

BUFFLEHEAD (Charitonetta albeola)

(Pl. 4, facing p. 64)

The dainty little bufflehead, dipper, or butterball, smallest of the sea ducks, is one of the most elegant and charming of nature's creatures. The white breast and iridescent fluffy head of the male glisten as it buoyantly rides the surf or gracefully paddles about on inland lakes or coastal bays. The female is dull and inconspicuous in color and much smaller than her mate. Though an inland breeder, the

bufflehead is most at home on coastal bays, occurring south to South Carolina, California, and even to the Gulf of Mexico in winter. It is truly a "hard-weather fowl" as it lingers in its northern haunts until frozen out or driven south by wintry gales. It flies with notable speed close to the water, vibrating its wings with great rapidity. In alighting it drops into the water with a tumultuous splash, sliding along for a little distance over the surface. When it has once alighted it seems to prefer the water to the air and will often dive rather than fly to escape its enemies. It is an expert diver and plunges under the water with grebelike speed. In feeding, it seems to prefer water ranging from 4 to 15 feet deep and occurs most commonly on the larger and more open bodies of water. Though many other birds may be found on the same body of water, these attractive, lively, and restless "spirit-ducks" usually prefer to be left alone or to float about in pairs or small disorganized party groups.

Because of its general scarcity the bufflehead has for a number of years been placed by the Federal Government on the list of fully protected birds. Despite its quickness and vivacity it is more stupid and curious than either of its two close relatives, the goldeneyes, and consequently falls prey more easily to the unappreciative gunner. Its table quality seems to vary considerably, some praising it as among the choicest of game, others declaring it unfit for human consumption. Perhaps this difference depends much on the age, food, and general physical condition of the bird.

Food of Adults

The food habits of the bufflehead have much in common with those of the two goldeneyes. The major similarities and differences in the food of the three are shown in table 26 (p. 132).

The feeding habits of this species are neatly described by Neltje Blanchan (*11, p. 124*) as follows:

> A bufflehead overtakes and eats little fish under water or equally nimble insects on the surface, probes the muddy bottom of the lake for small shell fish, nibbles the sea-wrack and other vegetable growth of the salt-water inlets, all the while toughening its flesh by constant exercise and making it rank by a fishy diet, until none but the hungriest of sportsmen care to bag it.

Bent (*10, p. 28*) writes:

> The bufflehead obtains its food by diving, usually feeding in small companies so that one or more remain on the surface to watch for approaching dangers while the others are below; sometimes only one remains above, but it is only rarely that all go below at once; should the sentinel become alarmed it communicates in some way with the others which come to the surface and all swim or fly away to a safe distance.

A total of 302 stomachs of adult buffleheads, some accompanied by well-filled gullets, have been examined in the Biological Survey laboratory. Of these, 282 were sufficiently full to be used in computations of the food percentages (tables 12 and 26). The birds were obtained in 24 States, the District of Columbia, Alaska, and 4 Canadian Provinces and were taken in every month of the year except June and September in numbers ranging from 5 in August to 80 in November. British Columbia furnished 46 stomachs; Washington, 38; Maine, 34; Oregon, 30; Alaska, 24; Wisconsin and Alberta, each 17; New York, 15; and the remaining States and Provinces, smaller numbers.

TABLE 12.—*Bufflehead (Charitonetta albeola): Food, by volume percentages, of 282 adults taken during 10 months of the year*

Kind of food	Percentage of food	Kind of food	Percentage of food
ANIMAL FOOD (79.02 percent)		ANIMAL FOOD (79.02 percent)—contd.	
Insects	40.68	Mollusks—Continued.	
Caddisflies (Trichoptera)	7.68	Flood-shells (Amnicolidae)	1.20
Water boatmen (Corixidae)	6.31	Periwinkles (Littorinidae)	1.16
Beetles (Coleoptera)	6.14	Other gastropods	3.31
Dragonflies and damsel flies (Odonata)	5.29	Tellen shells (*Tellina*)	1.41
Mayflies (Ephemeroptera)	3.85	Other pelecypods	3.39
Midges (Chironomidae)	2.42	Chitons and undetermined	.76
Syrphus flies (Syrphidae)	2.11	Fishes (Pisces)	3.78
Other two-winged flies (Diptera)	1.24	Miscellaneous animal food	2.14
Miscellaneous	5.64		
Crustaceans	16.74	PLANT FOOD (20.98 percent)	
Amphipods	4.94		
Shrimps	3.34	Pondweeds (Najadaceae)	7.47
Crabs	2.47	Pondweeds (*Potamogeton*)	4.47
Isopods	1.62	Naiads (*Najas*)	1.57
Miscellaneous	4.37	Wigeongrass (*Ruppia maritima*) and eelgrass (*Zostera marina*)	1.43
Mollusks	15.68	Miscellaneous plant food	13.51
Flat-coils (*Planorbis*)	2.28		
Lymnaea shells	2.17		

ANIMAL FOOD—79.02 PERCENT

Insects (40.68 percent).—Caddisfly larvae with their cases (7.68 percent) were important to the bufflehead in each of the 10 months, averaging 19.60 percent of the food during March and approximately 15 percent during May. The remains of 110 individuals were noted in a single stomach.

Water boatmen (6.31 percent), second in importance as an insect food, ranked first during the summer months when the birds were nesting. Dixon (*25, p. 48*) found that an adult female collected by him at Eagle Lake, Lassen County, Calif., in June had made 45 percent of its meal on water boatmen and 45 percent on damsel fly nymphs.

Various beetles and their larvae (6.14 percent), particularly predaceous diving varieties (Dytiscidae), supplied nearly 41 percent of the food of the 11 July birds but were rather unimportant during most of the winter. In the stomachs of five buffleheads taken in Pennsylvania, Warren (*91, p. 45*) found only coleopterous insects and small shells.

Other insect foods may be segregated in the following groups and percentages: Odonata nymphs, 5.29, mostly dragonflies but including also some damsel flies; nymphs of Mayflies, 3.85; larvae of midges, 2.42; larvae of *Syrphus* flies, 2.11, obtained only during March, when they amounted to more than a fifth of the month's food; other two-winged fly larvae, 1.24; and many miscellaneous insects, 5.64, mostly larvae, including especially stone flies and lacewings. Almost the entire meal of several birds was made on a single species of insect, more than 1,200 midge larvae in one instance and 22 Mayfly nymphs and 150 larvae of salt flies in others. Aughey (*5, p. 60*) found that a bufflehead taken in Lancaster County, Nebr., had fed on grasshoppers.

Crustaceans (16.74 percent).—These consisted primarily of soft-bodied creatures and were taken freely during both winter and summer. Listed in percentages in the order of relative importance, they

are as follows: Amphipods, 4.94; shrimps, 3.34; crabs, 2.47, largely mud crabs (*Hemigrapsus oregonensis* of the west coast and *Neopanope texana-sayi* of the east coast); isopods, 1.62; and miscellaneous, 4.37, including particularly crawfishes, barnacles, mysids, and cumaceans, along with undetermined soft-bodied debris. Crabs were much less important to the bufflehead than to the American goldeneye, although an occasional old bird fed on them extensively. The remains of 25 west coast mud crabs were found in a single stomach. Crawfishes, although apparently readily consumed, did not seem to be sought out so eagerly as by the goldeneyes. Each of two birds had consumed more than 1,000 ephippia of water fleas (*Daphnia*).

Mollusks (15.68 percent).—These consisted largely of univalves (gastropods), in contrast to the fact that bivalves (pelecypods) are the principal molluscan food of most sea ducks. Perhaps because of its smaller size the bufflehead chooses the smaller univalves in preference to the bivalves, many of which are much larger.

The gastropod food (10.12 percent) consisted of the following, expressed in percentages of the food: Flat-coils (*Planorbis*), 2.28; species of *Lymnaea*, 2.17, which made up almost 14 percent of the food of 40 birds in January and 7.20 percent of that of 10 in March, 1 bird having taken 20 shells; flood-shells (principally *Amnicola* and *Fluminicola*), 1.20; periwinkles, 1.16; and other forms, 3.31, the most important of which were dove-shells (*Mitrella lunata*), river-shells (*Goniobasis*), *Bittium* shells, and moon shells (*Polinices*). Individual birds had often gorged on these shells. One bird had consumed 59 *Bittium alternatum;* one, 51 *Planorbis;* and one, 44 *Goniobasis virginica* shells.

Tellen shells (*Tellina*) (1.41 percent), the bivalves taken most extensively, supplied 14.15 percent of the food of the 35 December birds. The principal other pelecypod food (3.39 percent) included Mytilidae, sphere-shells (*Sphaerium*), *Macoma* shells, rock clams (*Protothaca staminea*), and common fresh-water clams. Unlike most other seafowl, the bufflehead fed but sparingly upon the blue mussel (0.48 percent), which during January formed 2.55 and in February 1.26 percent of the food. One bird had made most of its meal on 30 of these shells. A few horse mussels (*Modiolaria*) (0.05 percent) were identified.

Fishes (3.78 percent).—As a rule, the bufflehead does not feed extensively upon fishes and so cannot normally be considered their serious enemy. Occasionally, however, most of a meal is drawn from this source. Usually only sculpins, sticklebacks, gobies, and other noncommercial varieties are taken, although an occasional young sport fish may be consumed and also, under favorable conditions, fish spawn may at times be fed upon to a considerable extent. In this study it was found that fishes had been taken by 14.50 percent of the birds but that only two birds had fed on valuable species, and that sparingly—one having taken a small eel and the other a small sunfish. According to Trautman (*89*), a bird taken in Ohio had made a part of its meal on gizzard shad (*Dorosoma cepedianum*), and Knight (*46, p. 103*) writes that in inland regions in Maine the bufflehead feeds on "chubs, shiners, small trout fry, and other small fish."

Miscellaneous animal food (2.14 percent).—This consisted of annelid worms, including earthworms and marine worms; sea urchins; starfish; brittle stars; water mites; spiders; harvestmen; myriapods; hydroids; bryozoans; foraminifera; and sponges. The remains of 116 Nereidae were found in a single bufflehead stomach.

PLANT FOOD—20.98 PERCENT

Pondweeds (7.47 percent).—Species of *Potamogeton* (4.47 percent) supplied the principal source of vegetable food for the bufflehead, as they did for both the goldeneyes; and many meals were made almost exclusively on them. Seeds, tubers, underground rootstalks, or green vegetative growth of several species entered into the bill of fare each month, in quantities ranging from 0.60 percent in March to 9.56 percent in October. No fewer than 210 seeds each of sago pondweed (*P. pectinatus*) and claspingleaf pondweed, or redhead-grass (*P. perfoliatus*), were found in single stomachs; and 332 seeds of *P. filiformis*, in another.

Naiads (*Najas flexilis* and others) (1.57 percent) ranked second in importance as a plant food. More than 600 seeds were taken by 1 bird at a single meal and only slightly smaller numbers by several others. The evidence indicates that wherever the plant was abundant it was freely taken. Wigeongrass (1.32 percent) was the only other plant species contributing more than 1 percent of the total intake. Some eelgrass (0.11 percent) was taken.

Miscellaneous plant food (13.51 percent).—Although the seeds or vegetative parts of a number of other plants were taken, the principal miscellaneous ones were wildcelery (*Vallisneria spiralis*); bulrushes (*Scirpus*); smartweeds (*Polygonum*); watermilfoil (*Myriophyllum*); burreed (*Sparganium*); muskgrasses and other algae; wildrice (*Zizania aquatica*); waterplantain (*Alisma plantago-aquatica*); coontail (*Ceratophyllum demersum*); watershield (*Brasenia schreberi*); miscellaneous sedges including *Carex*, spikerush (*Eleocharis*), and cyperus (*Cyperus*); marestail (*Hippuris vulgaris*); miscellaneous grasses; and spatterdock (*Nymphaea*). Bait was taken sparingly. All of the above plants were consumed in quantity by individual birds, and some were of considerable importance for 1 or more months. More than 6,500 oögonia, along with plant fiber, of muskgrass were noted in one stomach, and nearly 450 common three-square (*Scirpus americanus*) and 130 watermilfoil seeds in another. It shows that the bufflehead is adaptable so far as food is concerned and can subsist on whatever is available. Some of the plants were very important in certain sections but have a restricted distribution. For example, wildcelery, which is a most important duck food, is indigenous to the eastern part of the country and is therefore not available to western or far northern birds, so that although it supplied 5 percent of the food during March it did not occur even as a trace in the bill of fare during the summer months.

FOOD OF JUVENILES

Only three juvenile buffleheads, all downy young collected late in June near Red Deer, Alberta, Canada, were available. All had fed almost exclusively on insects. Their food is summarized in per-

centages as follows: Dragonflies and damsel flies (*Enallagma* and others). 58.66; adults and larvae of beetles, mostly predaceous diving beetles (Dytiscidae), 24.66; larvae and cases of caddisflies, 12.67; miscellaneous and undetermined insects, 2.34; and miscellaneous and undetermined plant material, including seeds of a species of *Potentilla*, 1.67.

Four downy young collected in June at Eagle Lake, Lassen County, Calif., by Dixon (*25, p. 48; 39, p. 179*) had also subsisted primarily upon insects, chiefly water boatmen and damsel fly nymphs, each of which contributed 43.75 percent of the total food. Back swimmers and annelid worms each supplied 1.25 percent. The remaining 10 percent was sand.

CLANGULA, HISTRIONICUS, AND CAMPTORHYNCHUS

OLD SQUAW (Clangula hyemalis)

(Pl. 4, facing p. 64)

Because it is so lively, showy, and clamorous, the old squaw is familiar to every fisherman, shore shooter, and naturalist who frequents the waters of any northern coast. It is known by more than a score of local names, most of which are descriptive of appearance or habit. Among them may be noted longtail, pintail or sea-pintail, fish duck, cockertail, swallowtail, noisy duck, South-southerly, coween, old-granny, and old wife. The last two names, as well as the term "old squaw," were probably given because the bird is so loquacious. Drifting ice floes, noisy seas, and arctic winds seem to afford a congenial habitat for this hardy and handsome duck. Attractive dress and posture, characteristic social nature, and distinctive and almost incessant yet pleasing babble give it a truly striking personality that immeasurably enlivens an otherwise dreary coast. In appearance, structure, sequence of molts, habits, and curious voice, it stands in a class by itself and consequently forms a monotypic genus. Although the bird is too restless to remain long in one place, it is unsuspecting and easily captured by those who know its ways and use decoys.

During the nesting season the old squaw is one of the most northerly breeders and is circumpolar in distribution. In winter it commonly extends southward to the Great Lakes, northern California, and southern North Carolina. The birds gather in good-sized flocks and in spring are said to be particularly playful. When going from one feeding ground to another they fly swiftly some 10 to 20 feet above the water and if a shot is fired into the flock often all the birds will pitch headlong into the water, generally rising again immediately. When feeding, they frequently string out in a line and dive successively one after another or with little regard to flock activity. Although gregarious, they are very independent of other waterfowl and even on the feeding ground where other sea ducks are obtaining a meal they tend to keep somewhat aloof.

The bird is a powerful diver, using to some extent both wings and legs in its under-water movements. Phillips (*81, v. 3, pp. 357–358*) states that it normally feeds in 12 to 25 feet of water but at times goes much deeper. He records a maximum time under water of 90 seconds, but W. J. Breckenridge, as quoted by Roberts (*84, p. 273*), gives 80 seconds. While performing some baiting experiments in Chesapeake

Bay, the writer observed these birds feeding on wheat in water 15 to 22 feet deep. Grain was taken from the gullets of the birds after diving. Barrows (*9, p. 103*) writes that one fisherman told of seeing the bird caught repeatedly in gill nets at a depth of 30 fathoms (180 feet). Numerous other reports give only slightly less extreme depths. Forbush (*33, p. 142*) quotes W. D. Hoare, former governor of Wisconsin, to the effect that lake fishermen there take the birds in nets set at a depth of 50 to 100 feet. Eaton (*28, p. 214*) states that in the Great Lakes this bird is frequently taken in gill nets at a depth of 15 and sometimes 27 fathoms. Mackay (*60, pp. 334–335*) writes that in 1888, when one could stand on the highlands of Nantucket and see only ice on the sea as far as the horizon, old squaws were reduced to skin and bones and some apparently starved to death, indicating that they were unable to obtain sufficient acceptable food by diving in deep sea water outside the ice. A letter dated April 23, 1935, in the files of the Biological Survey, from Regional Director Daniel H. Janzen, after he had made an investigation in the Great Lakes region relative to losses of ducks caught in gill nets, states that great losses to ducks, particularly old squaws, occur from their being caught in gill nets placed for fish at surprising depths. He quotes one commercial fisherman to the effect that more than 500 pounds of "fish ducks"—mostly if not entirely old squaws—were taken in Lake Michigan in one haul of his 8,400-foot gill net placed in water 80 to 150 feet deep. He states that one Frankfort, Mich., firm, which has between 5 and 6 miles of nets, which are usually set between 90 and 180 feet, was reported to have taken more than 1,500 of these birds at one haul in December 1934, in nets that the operators maintain were at such depths. Numerous other reports indicate that these birds can reach at least the 75-foot level under water. It does seem evident that unusual depths are reached.

Although such diving depths are almost incredible, the above reports are still more startling in their revelation of the appalling destruction of bird life by fish nets. The old squaw has been receding in numbers for many years, and were it not for its extended distribution, especially during the breeding season, it probably would be extinct, along with the dodo and the great auk. Its down is said to be almost as valuable as that of the eider, and facts indicate that the species has suffered much at the hands of feather hunters, eggers, fishermen, and gunners. Even though their flesh is neither very palatable nor nutritious, thousands of old squaws have been shot because they challenge the marksmanship of the most expert gunner.

Food of Adults

Many notes on food preferences of this species are extant, yet most of these are a bit contrary to the results obtained in this study. In its general food tendencies the old squaw, or longtail, shows a closer affinity to Steller's eider and the harlequin duck than to any of the other divers. Crustacean material serves as the chief article of food for all three species. The gizzards of birds that feed on soft-bodied crustaceans are usually smaller and thinner than those of birds that feed primarily on such hard material as mollusks. It seems probable also that digestion of the soft-bodied material is more rapid. Consequently these birds seem to feed oftener than many

other species. It was noted that a stomach that contained only soft-bodied material, such as amphipods or related crustaceans, was usually thin and weak, whereas the stomach of a bird of the same species that had fed extensively on large, hard mussels was usually much more muscular. It seems that repeated use or disuse modifies materially the thickness and strength of the muscle in the stomach wall.

Fragmentary and scattered accounts by European ornithologists give evidence that the old squaw in Europe subsists on food similar to that taken by the bird in this country. Some of the same genera of mollusks and crustaceans are reported to be taken by the bird on both continents.

In this study there was an average of slightly fewer than 6.5 species of food a stomach. Gravel averaged 33.24 percent of the stomach volume—a larger percentage than that found for birds that feed more extensively on hard-shelled forms, such as mollusks. Feathers from the body were of frequent occurrence, occasionally forming a considerable part of the stomach contents.

Laboratory examinations of 227 stomachs of adult old squaws were made. The birds were obtained in each month of the year except September from 13 States, Alaska, and 8 Canadian Provinces, as follows: Alaska, 56; Maine, 36; Manitoba, 31; New York, 24; Massachusetts, 14; Illinois, 13; British Columbia, 10; and each of the remaining States and Provinces, smaller numbers. Only 190 stomachs were sufficiently full to be used in computations of food percentages (tables 13 and 26).

TABLE 13.—*Old squaw (Clangula hyemalis): Food, by volume percentages, of 190 adults taken during 11 months of the year*

Kind of food	Percentage of food	Kind of food	Percentage of food
ANIMAL FOOD (87.93 percent)		ANIMAL FOOD (87.93 percent,—contd.	
Crustaceans	48.23	Mollusks—Continued.	
Amphipods (*Gammarus*)	2.90	Chitons and undetermined	1.00
Amphipods (*Caprella*)	1.42	Insects	10.77
Other amphipods	13.74	Caddisflies (Trichoptera)	6.63
Mud crab (*Neopanope texana-sayi*)	3.33	Midges (Chironomidae)	2.15
Mud crab (*Hexapanopeus angustifrons*)	2.37	Short-beaked mosquitoes (*Corethra*)	1.01
Other crabs	3.55	Miscellaneous	.08
Shrimps (*Crago*)	1.53	Fishes (Pisces)	9.71
Other shrimps	2.64	Flatfishes (Pleuronectidae)	2.30
Crawfishes (*Cambarus*)	2.88	Herring, etc. (Clupeidae)	1.82
Mysids (*Thysanoessa* and others)	3.22	Sculpins (Cottidae)	1.04
Fairy shrimp (*Lepidurus glacialis*)	1.25	Minnows (Cyprinidae)	.88
Isopods	1.15	Miscellaneous	3.67
Miscellaneous animal food	8.25	Miscellaneous animal food	3.52
Mollusks	15.70	PLANT FOOD (12.07 percent)	
Blue mussel (*Mytilus edulis*) and other Mytilidae	2.83	Grasses (Gramineae)	3.56
Other pelecypods	6.55	Grains (bait)	2.46
Chink-shells (*Lacuna*) and periwinkles (*Littorina*)	1.39	Miscellaneous wild grasses	1.10
Other gastropods	4.02	Pondweeds (Najadaceae)	1.51
		Miscellaneous plant food	7.00

ANIMAL FOOD—87.93 PERCENT

Crustaceans (*48.23* percent).—Amphipods (18.06 percent), consisting of *Gammarus* (2.90 percent), *Caprella* (1.42 percent), and other genera (13.74 percent), were the most important crustacean food of the old squaws, one of which had eaten approximately 1,000 of these

creatures. Crabs (9.25 percent) ranked second, and as many as 18 were taken at a single meal. Mud crabs (*Neopanope texana-sayi*, 3.33 percent, and *Hexapanopeus angustifrons*, 2.37 percent) were fed upon most commonly, although many others (3.55 percent) were consumed, including cancer, or rock crabs (*Cancer*), hermit crabs (*Pagurus*), blue crabs (*Callinectes sapidus*), spider crabs (*Oxyrhyncha*), sand crabs (*Emerita*), and undetermined species. Shrimp food (4.17 percent) consisted of species of *Crago* (1.53 percent) and other forms (2.64 percent), which included undetermined species. Crawfishes (*Cambarus*) (2.88 percent) were very valuable from December through April, supplying nearly a fifth of the food during February. Mysids (3.22 percent) were important, as various *Thysanoessa* (1.57 percent) and miscellaneous (1.65 percent) species were taken. One bird that had its gizzard and gullet gorged contained about 2,000 mysids. Other crustaceans that furnished more than 1 percent of the food were a northern fairy shrimp (*Lepidurus glacialis*) (1.25 percent) and isopods (1.15 percent). Miscellaneous crustaceans (8.25 percent) included barnacles, cumaceans, daphnids, copepods, and undetermined soft-bodied forms. Birds from the far north had fed extensively and often exclusively upon soft-bodied crustacean material. One July bird from Churchill, Manitoba, had made three-fourths of its meal on water fleas and their egg cases, and from 300 to 500 ephippia were found in several other stomachs.

Mollusks (15.70 percent).—Most writers, because of insufficient laboratory stomach examinations, have overemphasized the importance of mollusks in the diet of the old squaw. In this study only 15.70 percent of the food was found drawn from this source. Because these harder and more resistant shells are much slower of trituration and digestion than the soft-bodied crustaceans, it is evident that the relative intake must be somewhat less than the figure here given.

As is common for many sea birds, the blue mussel (*Mytilus edulis*) (2.77 percent) and other Mytilidae (0.06 percent) supplied the principal source of shell food for the old squaw. No fewer than 57 small blue mussels were taken at a single meal. Many other bivalves (6.55 percent), including undetermined forms, were taken. The principal clam shells noted were *Astarte*; rock cockle (*Cardium*), one bird having taken 60 young ones; *Mactra; Saxicava;* rock clam (*Protothaca*); Veneridae, including gem (*Gemma*), one bird having consumed 46; *Tellina; Macoma;* and razor clam (*Siliqua*). As to the commercial shellfishes, one bird had taken a scallop (*Pecten*) and another a small quahog (*Venus mercenaria*).

Of the gastropods, the Littorinidae (1.30 percent), consisting of the chink-shell (*Lacuna*) (1.24 percent) and periwinkles (*Littorina*) (0.06 percent), were the only group to contribute as much as 1 percent of the food of the old squaw. One bird had consumed 28 *Lacuna vincta* shells. Of the host of other gastropods (4.02 percent), which included undetermined species, the following supplied the bulk but were by no means the only ones taken: Dog whelks (*Nassarius*); *Anachis; Polinices triseriata;* dove-shells (*Mitrella*), 217 *M. lunata* shells having been found in 1 stomach; river-shells (*Goniobasis*); *Cerithiopsis; Bittium, Alvania;* slipper-shells (*Crepidula*); moon shells (*Natica* and *Polinices*); *Turbonilla; Margarites; Lora;* lathe-shells (*Acteocina canaliculata*), 36 having been taken by 1 bird; and

limpets (*Acmaea*). Many of these shells were of major importance for several meals; and a few of them, for an entire month. For example, small *Bittium* shells (0.40 percent) furnished 2.50 percent of the food of 16 November birds and 1 percent of that of 21 January birds. Likewise, the river-shell supplied 3.19 percent of the January and 1.92 percent of the February food.

Chitons (0.01 percent) and undetermined mollusks (0.99 percent) made up the remaining molluscan food.

Insects (10.77 percent).—Largely a warm weather food, insects averaged 19.65 percent of the diet of the old squaw during summer and only 3.80 percent for the remainder of the year. Although many species were consumed, the larvae of two orders, Trichoptera (caddisflies) (6.63 percent) and Diptera (two-winged flies) (3.16 percent), made up the bulk. Trichopterans were eaten in each of the 11 months except April, but mostly during the 5 warmer months, when they formed 12.98 percent of the food—in August constituting more than a fourth (27.14 percent) of the entire food of 7 birds; during the cooler 5 months they averaged only 1.34 percent. Dipterans consisted largely of larvae of midges (2.15 percent) and short-beaked mosquitoes (*Corethra*) (1.01 percent), neither of which group formed as much as 1 percent of the winter food, although they made up 3.66 and 2.22 percent, respectively, of the summer diet. Miscellaneous insect material (0.98 percent) consisted largely of damsel fly larvae and a lesser number of beetles and water bugs. Pirnie (*82, p. 312*) found 450 midge larvae in the stomach of an old squaw collected in March on the Huron River, Ann Arbor, Mich.

Fishes (9.71 percent).—Although slightly less than a tenth of the food of the old squaw consisted of fishes, the relative rating of this group of aquatic forms is decidedly less than most popular accounts would indicate. From the evidence at hand it would seem that availability within size range is the principal factor governing the selection of fishes. Small forms of little or no commercial value are generally taken, although a species highly prized for sport or human food is just as readily acceptable.

Most fishes of the family Pleuronectidae are considered rather valuable, and flatfishes (2.30 percent), which are members of this family, constituted the principal food of three birds taken at Comox, British Columbia, during July. These birds had the remains of 8, 17, and 10 individuals in their stomachs, representing 94, 92, and 89 percent of the meal, respectively.

Fishes of the family Clupeidae, of which the herring is a member, are of moderate worth. This group of fishes or their eggs (1.82 percent) entered prominently into the diet of the bird during March, when they contributed about one-fifth of the food. Four Alaskan birds had made most of their meal on herring eggs: one that had gorged itself to the limit contained 11,000 in its gullet and stomach and two others each contained many more than 7,000. Two birds collected by Munro and Clemens (*70, p. 37*) had fed primarily on herring ova, and the volume of one of the stomachs filled a 25 cc receptacle.

Sculpins (1.04 percent), which during October formed 7 percent of the food, and minnows (0.88 percent), which in March made up 4.16 percent of the food, were taken by more birds than any other group of fishes. Miscellaneous fish food (3.67 percent) included

tomcod (*Microgadus proximus*), killifish (*Fundulus*), gobies (including *Gobiosoma bosci*), sand launce (*Ammodytes americanus*), sticklebacks (including *Gasterosteus aculeatus* and *Apeltes quadracus*), suckers (Catostomidae), cunners (*Tautogolabrus adspersus*), and indeterminable species.

Warren (*91, p. 46*) states that the stomachs of 5 old squaws collected near Harrisburg, Pa., contained fishes, mussels, beetles, and sand; Loring (*51, p. 86*) reports finding 52 small pike in the stomach of an old squaw taken near Oswego, N. Y.; and Bent (*10, p. 43*) quotes Edwin D. Hull as stating that in winter in Jackson Park, Chicago, the silvery minnows (*Notropis atherinoides*)—

> seem to be almost, if not entirely, the sole source of food for the old squaw in this locality. The stomach of an adult female found floating in a lagoon April 1, 1912, contained approximately 140 [?] of these minnows, all entire [?], besides many fragments of the same fish, but no other food. The fish averaged about 2 inches in length.

Miscellaneous animal food (3.52 percent).—The most important of the miscellaneous animal forms were polychaete worms (1.22 percent), largely amphictenids, with their tubular caddisflylike sand cases, on which seven August birds had made 12.13 percent of their meal. Ascidians, or sea squirts (0.68 percent), supplied 6.57 percent of the food of 14 October birds, 1 of which had made most of a meal on them. The remaining 1.62 percent included sea urchins, sand dollars, starfish, bryozoans, hydroids, coral, undetermined coelenterates, and two species of foraminiferans. Some of these were of frequent occurrence, yet in only a few instances did any of them form even the major part of a meal.

PLANT FOOD—12.07 PERCENT

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. Only 1 of the 190 meals was drawn exclusively from the vegetable kingdom, and more than a third of the birds had taken no more than a trace of plant material for their last meal. Many plant species were consumed, yet 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.

Grasses (3.56 percent).—Barley (*Hordeum vulgare*) (1.43 percent), undoubtedly taken as artificial feed or bait, was found in several stomachs. One bird, taken early in April near the Chicago lake front, had made 76 percent of its meal on it, and another, obtained from the same locality in February, 40 percent. Other grains (1.03 percent) noted were wheat and corn, both taken as bait in limited quantity, and oats. The gullet of a bird killed on Chesapeake Bay, Md., contained 35 wheat kernels, and a bird taken in October in Michigan had gorged itself on wheat and oats. Although these stomachs containing bait were probably exceptions, it is significant that the bait aggregated 2.46 percent of the entire stomach material. Vegetative parts of wild grasses (1.10 percent) were often consumed in quantity while the birds were on the nesting grounds. Seven August birds had made 11.43 percent of their meal on this material.

Pondweeds (1.51 percent).—Almost 1 bird in 10 had fed on some species of *Potamogeton* (0.79 percent), and as many as 45 seeds were found in a single stomach. Eelgrass (*Zostera marina*) (0.61 percent) was taken by a great many birds, yet only during January and February did it average more than 1 percent of the monthly food. Wigeongrass (*Ruppia maritima*) and horned pondweed (*Zannichellia palustris*) were important for a few meals. Nuttall (*75, p. 454*) speaks of old squaws feeding on eelgrass and other marine plants.

Miscellaneous plant food (7 percent).—This included a great variety of identified plants, as well as wood pulp and undetermined vegetable material (4.65 percent). One unusual bird, taken near Norwalk, Conn., in October, had made more than a third of its meal on northern fox grape (*Vitis labrusca*), about a third on chokeberry (*Aronia*), and a tenth on poison-ivy (*Toxicodendron radicans*). The following plants were quite important for a limited number of meals: Algae of several species, various sedges, duckweed (*Lemna*), crowberry (*Empetrum nigrum*), and bramble (*Rubus*).

Murdoch (*71, p. 118*) found old squaws in Alaska during the nesting season feeding almost exclusively upon undetermined plant material. As further evidence that they will accept forage, Mackay (*60, p. 335*) states that in the severe winter of 1888 he found them going to the uplands on Nantucket in flocks to feed in the dried fine topgrass (*Anthoxanthum odoratum*). Yorke (*97, p. 72*) says that old squaws feed on teal moss (*Limnobium*), large blue flag (*Iris versicolor*), duckweed (Lemnaceae), waterplantain (Alismaceae), pondweed (Najadaceae), mud aquatic plants (Selaginellaceae), water herbs (Lentibulariaceae), pickerel weed (Pontederiaceae), moss plants (Mayacaceae), and moss teal moss (Salviniaceae).

Food of Juveniles

Most writers who have mentioned the food of the juvenile old squaws state that they subsist largely on insects; but the facts determined in the present study do not support this belief, as three-fourths of the food was supplied by small soft-bodied crustaceans and only 1.29 percent by insects. The stomachs of 36 July-taken juveniles were available for analysis and computation of food percentages (table 14). Of these, 22, all downy young, were from Churchill, Manitoba, 3 from James Bay, Canada, and 11 from Alaska.

Table 14.—*Old squaw (Clangula hyemalis): Food, by volume percentages, of 36 juveniles taken during July*

Kind of food	Percentage of food	Kind of food	Percentage of food
ANIMAL FOOD (77.39 percent)		ANIMAL FOOD (77.39 percent)—contd.	
Crustaceans	75.62	Miscellaneous animal food	0.48
Phyllopod (*Branchinecta paludosa*)	11.73		
Other phyllopods	21.22	PLANT FOOD (22.61 percent)	
Water fleas (Daphnidae)	7.75		
Mysids	2.23	Marestail (*Hippuris vulgaris*)	3.53
Amphipods	1.87	Crowberry (*Empetrum nigrum*)	1.06
Other soft-bodied forms	30.82	Miscellaneous plant food	18.02
Insects	1.29		

ANIMAL FOOD—77.39 PERCENT

The crustacean food (75.62 percent) of the juvenile old squaws was made up of the following groups and percentages: *Branchinecta paludosa*, 11.73, and other phyllopods, 21.22; water fleas, including *Daphnia*, 7.75, more than 400 ephippia having been found in a single stomach; mysids, 2.23; amphipods, 1.87; and other soft-bodied crustaceans, including undetermined forms, 30.82. Specific identification was often difficult because of rapid digestion.

The quantity of insect material taken (1.29 percent) was surprisingly small. Beetles were the most important and included predaceous diving beetles (Dytiscidae), ground beetles (Carabidae, including *Hydroporus niger*), whirligigs (Gyrinidae), blister beetles (Meloidae, including *Lytta*), and water scavengers (Hydrophilidae). Caddisfly larvae, two-winged flies, and undetermined insects were also present.

Miscellaneous animal food (0.48 percent) included mollusks, hydroids, water mites, and undetermined animal debris. It is interesting to note the unusually small quantity of molluscan food. Although 9 of the juveniles had taken it, in only one instance did it furnish as much as 5 percent of the meal.

PLANT FOOD—22.61 PERCENT

Vegetable material seems to have been gathered without discrimination by the juvenile old squaws, for many species entered into the bill of fare, although only two made up as much as 1 percent—marestail (*Hippuris vulgaris*) (3.53 percent), which was taken in greatest quantity, 45, 37, 36, and 33 seeds, along with some plant fiber, having been taken by 4 birds, respectively, and crowberry (*Empetrum nigrum*) (1.06 percent). The miscellaneous species (18.02 percent), seeds or plant fiber of which were taken, are named in the order of their importance as follows: Drift, wood pulp, and undetermined debris; moss plant fiber; pondweeds (*Potamogeton*); bramble (*Rubus*); sedge (*Carex*); filamentous algae; spikerush (*Eleocharis*); grasses; sedges; Labrador-tea (*Ledum decumbens*); conifer needles; birch fruit (*Betula*); cinquefoil (*Potentilla*); water buttercup (*Ranunculus*); and Alpine bearberry (*Arctostaphylos alpina*).

HARLEQUIN DUCK (*Histrionicus histrionicus*)

(Pl. 4, facing p. 64)

The adult male harlequin duck is attractively and fantastically decorated with bizarre spots and patches. Perhaps the only American waterfowl to excel it in beauty is the wood duck. Until 1915, when Brooks (*13, p. 393*) separated the west-coast form from the eastern *Histrionicus histrionicus histrionicus* and gave it the name *H. h. pacificus*, the American harlequins were regarded as being of one race. The two races are here considered jointly, because their habits, food, and choice of habitats are nearly identical and because they can be separated only on the basis of small details of color.

The eastern form is exceedingly rare except perhaps in the far north, where it is said to breed in northern Labrador, southern Baffin Island, southern Greenland, and Iceland. In winter it occurs along the coast south to Maine, with straggling records extending to New Jersey.

The western form appears much more abundant, although it is frequently reported to be approaching extinction. Undoubtedly it has experienced a marked decrease in numbers. Dawson (*22, p. 1827*) points out that there has been a reduction in the species, yet he adds: "* * * the impression of Harlequin's rarity can be removed only by a visit to the secluded islets of northern archipelagoes." Apparently it is most common along the coast of the Aleutian Islands and Alaska. In summer it occurs as far south as Montana, Wyoming, Colorado, and central California. Breeding pairs frequent the turbulent, foam-flecked mountain streams or pot-holed glacial lakes to nest either on the ground or in holes of trees or cliffs. The bird winters mainly along the northwest Pacific coast, where it is most commonly seen at the exposed surf-washed beach amid the tumult of the breakers. It is as much at home walking on the rocks or sand as in buoyantly riding the crest of the sea, and it is said to evidence none of the awkwardness in walking that is so characteristic of most sea ducks.

Although the harlequins are proficient divers they seem to dive with greater effort than do other Nyrocinae. They apparently prefer to feed in rough water that is broken by rocks and surf and even feed in shallow streams, where they can walk along the bottom and obtain food by dipping down and immersing merely the head. Because they feed in shallow water, their dives are of short duration. Alford (*1, p. 108*) records the time as being from 13 to 24 seconds.

Bruette (*14, p. 339*) notes that the harlequin's food is largely animal; hence he concludes that its flesh is not very palatable and therefore "not eaten at all. It makes use of whatever food offers, insects, mussels, fish or clams." It probably serves, however, as an acceptable article of diet to the natives of the far north.

Food of Adults

In its habits and food preferences, as well as in its choice of habitat, the harlequin stands in a class almost by itself. Phillips (*81, v. 3, p. 375*) says that like the goldeneyes and eiders it feeds almost exclusively by day, coming in each morning to its favorite ledges and rocky coves. Palmer (*77, p. 379*) writes of its coming in regularly at 7 p. m. to roost on the rocks of St. Paul Island in the Pribilof group.

With a few exceptions the foods that appeared in greatest frequency in the gizzards are those commonly found in the harlequin's peculiar habitat, which is one that precludes much opportunity for a great deal of varied plant food. Consequently, during both summer and winter, the birds subsist principally upon an animal diet (98.32 percent) made up mainly of crustaceans (57.13 percent)—crabs, amphipods, and others—and mollusks (24.68 percent), including many limpets, or tent shells (*Acmaea*) and chitons, or coat-of-mail shells (*Chiton*). The chitons, which appear as the dominant molluscan food, are comparatively rare as a food for all other ducks. Most commonly they are found securely attached by suction to rocky coastal surfaces, from which experienced collectors find great difficulty in detaching them. The harlequin's ability to dislodge the shells, which seem almost a part of the rock itself, is a matter of no small wonder.

That the harlequin is not averse to some vegetable food, however, is shown by the splendid life-history study of a single pair in the Yosemite Valley by the Michaels (*65, pp. 19–20*). They found that the pair ate pieces of bread thrown into the water or left in a floating feeding tray and that the female ate macaroni, cooked potatoes, and raisins also. It may be significant to point out that not once did they "note the Harlequins feeding on roots, grasses or other growing vegetation."

The number of food species taken by the birds examined for this study varied greatly but averaged 12.2 a stomach—a comparatively large number. The quantity of gravel consumed, 19.04 percent of the stomach volume, is somewhat smaller than that taken by many species of waterfowl. Perhaps mollusk shells and hard bits of carapace and claws of crabs served the same purpose in the mechanical comminution of the food.

Although the data are not so complete as desired, laboratory analyses were made of 70 stomachs of adult harlequins taken during the 7 months January, February, March, June, July, August, and September—a time sufficient to be at least indicative of food tendencies. Only 63 stomachs were considered full enough to be used in the computation of food percentages (tables 15 and 26). Of these, 36 were obtained along the coast of Alaska, 21 from the British Columbia coast, 2 each in Quebec and Wyoming, and 1 each in Alberta and California. The Quebec birds, taken at Bonaventure Island, are the only ones from the eastern coast. The content of their stomachs does not seem to be noticeably different from that of the stomachs obtained in similar situations along the west coast.

TABLE 15.—*Harlequin duck (Histrionicus histrionicus): Food, by volume percentages, of 63 adults taken during 7 months of the year*

Kind of food	Percentage of food	Kind of food	Percentage of food
ANIMAL FOOD (98.32 percent)[1]		ANIMAL FOOD (98.32 percent)—contd.	
Crustaceans	57.13	Mollusks—Continued.	
Mud crabs (*Hemigrapsus*)	14.41	Top shells (*Margarites*)	2.20
Hermit crabs (*Pagurus*)	7.36	Limpets (*Acmaea*)	2.06
Crabs (*Dermaturus*)	2.52	Other gastropods	4.34
Porcelain crab (*Petrolisthes*)	1.70	Blue mussel (*Mytilus edulis*)	1.51
Other decapods	1.57	Other pelecypods	1.43
Amphipods	13.99	Insects	10.20
Isopods (*Mesidotea*)	2.09	Stone flies (Plecoptera)	6.47
Other isopods	1.92	Water boatmen (Corixidae)	1.48
Miscellaneous soft-bodied crustaceans	5.11	Midges (Chironomidae)	1.27
Barnacles (Balanidae)	6.46	Miscellaneous	.98
Mollusks	24.68	Echinoderms: Sea urchin (*Strongylocentrotus drobachiensis*) and others	2.44
Coat-of-mail shells (*Chiton*)	8.72	Fishes (Pisces)	2.40
Chink-shells (*Lacuna*)	2.29	Miscellaneous animal food	1.47
Periwinkles (*Littorina*)	2.13		

[1]Most of the 1.68 percent plant food had to be classed as unidentifiable drift or ground-up debris.

ANIMAL FOOD—98.32 PERCENT

Crustaceans (57.13 percent).—This large and varied group of arthropods was the harlequin's principal sustenance in each of the seven months. In fact, crustaceans occurred in all but 5 of the 63 stomachs. Decapods (27.56 percent), mostly the smaller crabs of various species, and soft-bodied crustaceans (23.11 percent) seemed

to be almost equally acceptable. The birds in the far north took amphipods, isopods, and other soft-bodied crustaceans in greater amounts and in greater frequency than the harder shelled forms, whereas the opposite was true of the more southern coastal birds.

In volume, the west-coast mud crab (*Hemigrapsus*) was first in importance (14.41 percent), although it was identified in the stomachs in but four of the seven months. It averaged 44.71 percent of the total food in July, 34 percent in August, 20.62 percent in September, and 1.5 percent of the daily consumption in January. One specimen taken from a gizzard measured 26 by 20 by 10 mm. The relative value of this crab, which unquestionably ranks very high as a staple food item to the harlequin, probably was accentuated because a disproportionally large number of the birds were taken near Comox, British Columbia, where practically all the birds had subsisted mainly on these crabs. One heavily gorged gullet and gizzard contained the remains of 60 crabs; two others, of 28 and 22. Whitfield (*95*) reports finding the remains of three east coast mud crabs (*Panopeus depressa*) in the stomach of a bird taken on Long Island.

Hermit crabs (*Pagurus*) (7.36 percent) were taken with greater frequency than the free-swimming mud crabs, but not in such numbers because they are usually consumed while enclosed in their appropriated shell houses. They were found in almost a third of the stomachs, in two instances forming more than 85 percent of the meal, and were taken during each of the seven months except August. Their absence in that month undoubtedly merely represents a too limited collection of material. Single stomachs contained 26 and 20 of these asymmetrical creatures.

Other crabs were consumed by many of the harlequins. Of these, species of *Dermaturus* (2.52 percent) and *Petrolisthes* (1.70 percent) were the most important. During January, *Dermaturus* was a major crustacean food, forming nearly 17 percent of the total food. One stomach contained 21 crabs of this genus, which formed 95 percent of the meal. A California bird taken in March had its stomach and gullet gorged with fragments of 97 individuals of *Petrolisthes eriomerus*, which formed 87 percent of the meal. Other decapods (1.57 percent) consisted of many other species of crabs that were taken by fewer birds or in smaller numbers—the rock crab (*Cancer*), spider crab (*Oxyrhyncha*), and flat-topped crab (*Pachycheles pubescens*) being most frequently noted—and shrimp.

Amphipods (13.99 percent) of many species formed a constant and important animal food and in total bulk were the second most important group in the harlequin's food. In amounts varying from a trace to 91 percent, they were found in more than two-fifths of the stomachs. In September they formed 28.75 and in January 26.44 percent of the food.

Isopods (4.01 percent), a group of soft-bodied crustaceans with dorsoventrally flattened bodies, were consumed by many of the harlequins. They consisted of the large circumpolar *Mesidotea* (2.09 percent), on which one bird had made 75 percent of its meal, and other forms (1.92 percent). A collector on St. Paul Island reported finding 80 of these creatures in the gullet of one bird. Grinnell (*98, p. 191*) found harlequins at Chicogof Island, Alaska, feeding extensively on isopod crustaceans, gathered at high tide from under stones on the beach.

Miscellaneous soft-bodied crustaceans (5.11 percent) included mysids (0.96 percent) and undetermined forms (4.15 percent), which probably were made up largely of finely comminuted amphipods and isopods but which may have included unrecognizable shrimp debris as well. These soft-bodied creatures are quickly broken down beyond recognition in a bird's stomach. Of 11 well-filled stomachs examined (included herein) for their report of birds of the Pribilof Islands, Preble and McAtee (*83, p. 52*) found that amphipods formed 51.4, hermit crabs 25.1, and mollusks 19 percent of the total food.

Although sessile barnacles are frequently taken by most sea ducks, their selection may be considered mostly accidental, inasmuch as they are often attached by byssal or other secretions to what seems normally to be more desirable food, such as the common blue mussel. As a food they are comparatively unimportant to most ducks. In this respect they are an exception to the harlequin, however, as they averaged 6.46 percent of its food and occurred in each of the seven months considered. In one stomach they formed 97 percent of the entire meal.

Mollusks (24.68 percent).—Most field workers who are familiar with the harlequin make particular mention that it feeds to a considerable extent on shellfish, which they regard as the principal source of the bird's food supply. This is probably traceable to the fact that mollusks are more recognizable when partly broken up than are many of the crustaceans or the soft-bodied insect larvae. Mollusks are an important and constant source of food, yet they rank far below the crustaceans in relative importance to this particular bird.

As already stated, the jointed, armored mollusks, or coat-of-mail shells (*Chiton*) (8.72 percent), occurred most frequently and constituted a larger percentage of the food than they did for any other American duck. They were found in about half the stomachs, forming from a mere trace to three-fourths of the meal.

The Littorinidae, the principal gastropods consumed, consisted of chink-shells (*Lacuna*) (2.29 percent) and periwinkles (*Littorina*) (2.13 percent), the former with 15 occurrences and the latter with 23. One or the other of these genera was taken in each of the 7 months, and 237 shells were found in a single stomach. The top shells (*Margarites*) (2.20 percent), although not of frequent occurrence, appeared in numbers in a few stomachs. Limpets (*Acmaea*) (2.06 percent) formed from a trace to nearly 9 percent of the food of the various months. A large assortment of other univalves (4.34 percent), usually of rather small size, were taken, including undetermined forms (2.82 percent). The most commonly taken identified genera (1.52 percent) included *Mitrella*, *Odostomia*, *Buccinum*, *Natica*, *Bittium*, *Nassarius*, *Trichotropis*, and *Tonicella*. Phillips (*81 v. 3, p. 377*) states that the shellfish consumed by this bird are small, although he has seen "spiral shells from 15 to 20 mm. long taken from the stomach of one shot in Maine in winter." Whitfield (*95*) reports findings 39 little shells (*Astyris lunata*) and several periwinkles as part of a meal in a single stomach.

It is somewhat surprising to find that bivalves were relatively unimportant in comparison with univalves as food for the harlequin. Bent (*10, p. 55*) states: "The common black [blue] mussel (*Mytilus*

edulis) is one of its main food supplies; these mollusks grow in immense beds on shallow ledges and are easily obtained." Similar remarks are given by Turner (*90, p. 134*), who also says that in Alaska these ducks are frequently caught by mussels and held until drowned. Although the statement that the mussel is an important food item is true for most sea ducks it is not particularly applicable to this species. The blue mussel (1.51 percent) was of rather frequent occurrence but usually formed only a trace of the food. The other pelecypods (1.43 percent) most commonly taken were *Macoma*, *Tellina*, and *Saxicava* shells.

Insects (10.20 percent).—Numerous writers mention the acceptability of insects as food for the harlequin. Obviously these are consumed primarily during summer and early fall. Perhaps no food is more indicative of this bird's distinctive habitat than are some of the insects occurring in its diet. The fact that more than half of the insect food was made up of stoneflies (6.47 percent) assuredly reflects feeding in a swift-flowing stream. Two Wyoming birds, taken early in August, had made 90 and 91 percent of their entire meal on the nymphs of these insects. During September water boatmen (1.48 percent) formed more than one-tenth of the monthly food and midge larvae (1.27 percent) were only slightly less valuable. Miscellaneous insects (0.98 percent) were predominantly caddisfly larvae and cases, but a few beetles and Mayflies also were taken.

Echinoderms (2.44 percent).—The sea-loving harlequin consumed many invertebrates, most of which, however, though taken in numbers by a few birds, are relatively unimportant except in the aggregate. The most important of these forms and one that may be considered a possible exception to the above statement is the spiny sea urchin (*Strongylocentrotus dröbachiensis*) (1.54 percent), which occurred in almost two-fifths of the stomachs, most commonly as only a trace or a very small percentage yet in a few instances amounting to more than 15 percent of the meal. During February it formed 4 percent of the food. Starfish (0.79 percent) formed as much as 3.37 percent of the food for the January birds. In one stomach seven or eight small individuals were found, making 30 percent of the meal. Sand dollars (0.11 percent) were particularly important to a few birds.

Fishes (2.40 percent).—Inasmuch as fish or fish-egg remains occurred in appreciable quantity only in stomachs taken in a single month—February—when only seven stomachs were available, it seems probable that a larger and more representative series of birds would show that the harlequin is not so piscivorous as the facts here recorded would indicate. One February stomach that was less than one-third full contained nothing but fish remains. Consequently this item shows a disproportionately large percentage in the total food consumption. Fishes occurred in 16 of the 63 stomachs and fish eggs in 2. Sculpins were most frequently taken. Only once was a desirable fish identified. This was a small salmonid (*Salmo*) that formed 3 percent of the meal. That the harlequin will take fish and fish eggs when available is clearly indicated by the frequency of occurrences, yet the destruction wrought normally is probably not excessive.

An investigation carried on by the Canadian Government (*70*) to ascertain the possible relation of ducks and other birds to the decreasing herring abundance revealed that several species of diving ducks were feeding to a slight extent on both the eggs and young fish. About 9,000 herring eggs were found in the digestive tract of one harlequin—the largest number present in any bird examined (*70, p. 43*)—yet it was concluded (*70, p. 45*):

> At the present time, the amount of destruction of herring by ducks does not appear to be abnormal or excessive and if there has been a reduction in numbers of herring it is a relatively recent condition and attributable primarily to man's interference with natural conditions.

Miscellaneous animal food (*1.47 percent*).—The miscellaneous forms occurring several times in the harlequin's diet include nereid worms, ascidians, bryozoans, sea spiders, and hydroids. In frequency of occurrence, hydroids appear important to most of the true sea ducks, yet in total bulk and probably in nutritional value also, they are insignificant.

PLANT FOOD—1.68 PERCENT

It appears that acceptable vegetable food is exceedingly rare in the peculiar habitat of the harlequin. Most of that taken had to be classed as unidentifiable drift or ground-up debris. Under normal conditions it seems that seeds or plant substances are usually taken incidentally if not accidentally in the course of the birds' search for animal matter. The birds are frequently seen feeding in the kelp beds, yet kelp and other seaweeds (algae) occurred only as a trace in the food. One summer bird from Alberta had taken a few seeds of a pondweed (*Potamogeton*). Others of the better known duck foods were not noted. Leaf fragments of a willow (*Salix*), undoubtedly taken as drift, occurred in one stomach. Munro and Clemens, (*70, p. 38*) found ground-up sea lettuce (*Ulva lactuca*) forming 20 percent of the food of one bird collected March 31 off the British Columbia coast, and other writers mention that vegetable foods form a constant part of the diet.

LABRADOR DUCK (*Camptorhynchus labradorius*)

A mere recital of the known facts regarding the Labrador, or sand-shoal, duck (also vernacularly known as the pied duck and skunk duck) would be little other than an obituary. What little is known about its life history, distribution, food habits, and cause of extinction has already been published and repeatedly quoted by various writers. Graphic and rather complete accounts are to be found in Phillips (*81, v. 4, pp. 57–63*), Forbush (*32, pp. 411–416*), Dutcher (*27*), and Bent (*10, pp. 62–67*). It is believed that the species bred formerly on the coast of the Ungava Peninsula and wintered on the Atlantic coast from Nova Scotia to New Jersey and possibly to Chesapeake Bay.

Although positive proof is lacking, the evidence seems to support the conclusion reached by Coues (*21, p. 935*) that "the extinction of the species is credibly believed to have been due to extirpation by human agency." It is known that the bird was killed for its feathers and as food and that its eggs and young were wantonly destroyed. The last specimen of which the writer has record is one reported by

Gregg (*37*) as taken near Elmira, Chemung County, N. Y., December 12, 1878.

Although there is no record of detailed laboratory stomach examination of this bird, some data on its food habits are at hand. Audubon (*3, v. 4, pp. 271–272; 4, pp. 329–330*) wrote:

> A bird-stuffer whom I knew at Camden had many fine specimens, all of which he had procured by baiting fish-hooks with the common mussel, on a "trot-line" sunk a few feet beneath the surface, but on which he never found one alive, on account of the manner in which these Ducks dive and flounder when securely hooked * * *. It procures its food by diving amidst the rolling surf over sand or mud bars; although at times it comes along the shore, and searches in the manner of the Spoonbill Duck. Its usual fare consists of small shell-fish, fry, and various kinds of sea-weeds, along with which it swallows much sand and gravel.

Wilson and Bonaparte (*96, p. 218*) inform us that "its principal food appears to be shellfish, which it procures by diving." The stomach of a male "contained small clams, and some glutinous matter." Maynard (*64, p. 456*) observes that in habits this duck resembled other sea ducks, feeding largely upon mollusks which it procured by diving. Bent (*10, p. 64*) comments: "Other writers say that it fed on shellfish which it obtained by diving on the sand shoals, whence it derived the common name of 'sand shoal duck.'" Dutcher (*37, p. 214*) reports that S. F. Cheney, of Grand Manan, New Brunswick, wrote to him in 1890:

> The female Labrador duck I gave to Mr. Herrick was with some Old Squaws or Long-tailed Ducks when I shot it, and I think there were no others of the kind with it. This one had small shells in its crop. It dove to the bottom with the Squaws.

As all of the typical sea ducks, particularly those closely related to the Labrador duck, feed to a considerable extent on the common edible mussel (*Mytilus edulis*), which is so abundant in the original range of this bird, it seems probable that this and other molluscans, as well as crustaceans, entered prominently into the bird's bill of fare.

EIDERS

The eiders do not form a recognized systematic subdivision of ducks, as they consist of three separate genera, yet they have much in common in habits, distribution, habitats, and economic importance. All are large and sturdily built. The males have broad masses of contrasting black and white, with paler suffusions of other shades. The females are rather evenly colored in shades of brown that are more or less cross-barred. All spend most of their time in the water and are expert divers. They fly well yet leave the water with considerable effort. Their flight is steady and unwavering, usually close to the water and not unlike that of the scoters. Truly gregarious birds, they often associate with other sea ducks. On the breeding grounds most of the species are reported to nest habitually in colonies.

A number of writers refer to eiders as being the most regular ducks in their daily movements. During fall and winter at least they seem to feed entirely by day. At such times they feed on the shoals but at night proceed to the open ocean over deep water, often many miles from their accustomed feeding shoals. In summer, of course, they spend more time on land.

Although not particularly confiding, these birds are rarely very wild and are therefore often shot from open rowboats during the gunning season. On the breeding grounds they are said to show very little fear of man, even if molested by egg stealers.

The eiders (particularly the North Atlantic ones of the genus *Somateria*) are notable as the source of the eider down of commerce, which is the under, or body, down plucked by the female to line the nest and cover the eggs. The feathers are gathered both during and after nesting, and in some areas, as in Iceland, landowners have a proprietary right in the eiders that nest on their lands. Under such conditions strict protection is afforded and every inducement offered to insure a large nesting population.

There are six races of northern breeding eiders. According to the American Ornithologists' Union Check-List (*2, pp. 56–57*) the genus *Somateria* consists of four common American forms representing three species, one of which is divided into two subspecies. These, with Steller's and the spectacled eiders, are among the most northern breeding and wintering waterfowl and are truly characteristic of the ice-bound and storm-swept coasts where they live, and as a consequence the food of all but Steller's and the spectacled eiders during the nesting season is predominantly of marine origin. Eiders are apparently oblivious of inclement weather so long as open water and a plentiful food supply of mollusks, crustaceans, and other marine or littoral invertebrates are available. Evidently nature has adapted them to withstand temperatures of −20° to −60° F. better than the balmy climate of the southern coasts. At any rate, they are among the hardiest of ducks and migrate little beyond the point where ice forces them out of their summer haunts, rarely south of Long Island on the Atlantic coast or south of southern Alaska on the Pacific, even during the most severe weather. Concerning their favored habitats Phillips (*81, v. 4, p. 89*) graphically writes:

> Eiders are more wedded to the sea than any [others] of the duck tribe. All of the others, even Scoters, Long-tails and Harlequins, resort to far-inland fresh waters to breed, and cut across thousands of miles of inland country. Not so with the sea-born Eiders, who travel an immense distance around land masses, such as Alaska and East Siberia, in order to reach their summer destinations. It is true here and there they will follow a few miles up a river in order to reach some inland bay or island-studded lake, particularly well adapted for safe nesting, but such localities are always, so far as I know, within short over-water flights of the open sea, perhaps never over 15 or 20 miles.

STELLER'S EIDER (Polysticta stelleri)

Steller's eider, the smallest and least eiderlike of any of the group bearing that name and a distinctively beautiful bird, is a lover of cold weather and of the ice-bound, cheerless coasts so numerous in the arctic region. It is most abundant on the coasts of the Bering Sea and the adjoining Arctic Ocean from Taimyr Peninsula and Point Barrow south to St. Lawrence Island and the Yukon Delta. It migrates comparatively little in winter, extending southward to the Aleutian Islands, east to the Kenai Peninsula, and west to the Commander and Kurile Islands. Perhaps it occurs in greatest concentration on the Siberian coasts. Members of this species commonly associate with the Pacific and king eiders. They are often reported to feed in very compact flocks. In speaking of their daily move-

ments, Phillips (*81, v. 4, p. 68*) quotes Lord William Percy as stating that the birds spent the day—

> drifting along a reef of rocks until carried into deep water by the tide. After resting for some time, parties of from 20 to 50 would leave the flock at frequent intervals and fly up to their starting place, and so in half an hour the whole flock would be over the reef again.

Phillips further states that the bird is warier than any of the other eiders, yet—

> is one of those fearless species which seem to delight in the roughest, deepest and rockiest coast-lines, where clear water comes close to the land. It is a fresh-water breeder, never found in coast-line colonies like the Common Elder.

Food of Adults

Published information on the food of Steller's eider is limited. In referring to the feeding habits of these divers, Murdoch (*71, p. 119*) states:

> When the open water forms along shore, that is, in the latter part of July and early part of August, they are to be found in large flocks along the beach, collecting in "beds" at a safe distance from the shore, feeding on marine invertebrates * * *.

Bretherton (*12, p. 78*) reports that at Kodiak Island in winter their food is about the same as that of the harlequin and that they obtain it in deep water and seldom feed near the shore. Phillips (*81, v. 4, p. 69*) states that he has been told that about the tundra pools in western Alaska they sometimes feed by tipping up like a mallard, "but of course this is not the usual method." It is apparent, therefore, that the birds feed most commonly by diving and sometimes, it seems, at a considerable depth.

The stomachs of 79 adult Steller's eiders were examined. Of these 77 were collected during May, June, and July, and 2 in December and February. Only 66 stomachs, all taken in Alaska and Siberia in summer, were full enough to be used in the computation of food percentages (tables 16 and 26). The number of species of food in a meal averaged slightly fewer than 10.

As a rule, only American-collected stomachs are used in tabulations of food percentages. In this instance, however, the 33 Siberian coastal birds came from localities and situations very similar and rather close to those from which the Alaskan birds were taken. Furthermore, they were found to have consumed many of the same species of marine life and the same kinds of foods in general as the Alaskan birds. The Siberian birds were all collected by Lord William Percy during June and July 1914 at St. Lawrence Bay and Lütke Island. Most of the Alaskan stomachs were taken at Hooper Bay, Igiak Bay, and Unimak Island, but one was from St. Paul Island and two were from St. George Island.

The contents of the two winter stomachs may be of interest. The December bird had made practically 100 percent of its meal on amphipods but had taken a trace of mollusks, algae, and other plant fiber. The February bird had made 25 percent of its meal on amphipods, 60 percent on two species of univalves (*Polinices recluziana* and *Melanella*), and 15 percent on a bivalve (*Cardium ciliatum*) and a trace of echinoderm.

TABLE 16.—*Steller's eider (Polysticta stelleri): Food, by volume percentages, of 66 adults taken in May, June, and July*

Kind of food	Percentage of food	Kind of food	Percentage of food
ANIMAL FOOD (87.14 percent)		ANIMAL FOOD (87.14 percent)—contd.	
Crustaceans	45.21	Fishes (Pisces)	2.28
Amphipods	38.62	Foraminiferans	1.09
Miscellaneous	6.59	Miscellaneous animal food	.20
Mollusks	18.27	PLANT FOOD (12.86 percent)	
Pelecypods	14.70		
Gastropods	3.61	Pondweeds (Najadaceae)	3.39
Undetermined	.96	Pondweeds (*Potamogeton*)	2.23
Insects	13.01	Eelgrass (*Zostera marina*)	1.16
Midges (Chironomidae)	8.05	Crowberry (*Empetrum nigrum*)	1.07
Caddisflies (Trichoptera)	2.50	Algae	.76
Miscellaneous	2.46	Miscellaneous plant food	7.64
Annelid worms (Nereidae)	3.33		
Sand dollars (Scutellidae)	2.76		

ANIMAL FOOD—87.14 PERCENT

Considering the fact that so few stomachs were analyzed and that only the nesting season was represented, a surprisingly large number of animal species was consumed.

Crustaceans (45.21 percent).—Crustaceans, particularly soft-bodied species, were first in order of frequency of occurrence as well as in volume consumed, and there were only a few meals in which these creatures did not form a part. In its fondness for crustaceans Steller's eider has much in common with the old squaw, harlequin, spectacled eider and, to a lesser extent, other northern sea ducks. Its distinct preference for soft-bodied forms is evidenced by the fact that amphipods, isopods, and barnacles formed almost half of all food consumed, whereas crabs made up less than 1 percent. Fifteen genera of amphipods (38.62 percent) were recognized. The two winter birds likewise had fed on these creatures, indicating that they are eagerly sought not only in summer but at other times of the year as well. Miscellaneous crustaceans (6.59 percent) comprised isopods (1.68 percent); crabs of several species (0.68 percent); barnacles (1.62 percent), which were noted in more than one-fourth of the stomachs and were probably taken in part accidentally through being attached to some of the mollusks and other invertebrates that were consumed; and undetermined, finely comminuted forms (2.61 percent).

Mollusks (19.27 percent).—The molluscan or shellfish consumption of Steller's eider was very unevenly divided as to pelecypods (14.70 percent) and gastropods (3.61 percent). It is not known whether such a difference could be explained on the basis of preference or availability. Pelecypods of 12 or more species were ingested in varying quantities by considerably more than half the birds. The common blue mussel (*Mytilus edulis*) (1.21 percent) was taken by nine birds; the razor clam (*Siliqua*) (4.41 percent), by only seven, but in very large quantities; Tellinidae (2 percent)—*Tellina* and *Macoma* and perhaps other species—by six; and the Arctic rock borer (*Saxicava arctica*) (1.45 percent), by eight. Other clams taken were the nut-shell (*Nucula proxima*), soft-shelled clam (*Mya arenaria*), *Liocyma becki*, and *Astarte*. The gastropods of greatest value were

olive shells (Olividae), moon shells (*Natica*), and periwinkles (*Littorina*). Undetermined mollusks made up the remaining 0.96 percent.

Insects (13.01 percent).—The insect diet reflects clearly the type of habitat frequented by Steller's eider during the breeding season and shows clearly the contrast between it and that of the harlequin, which consumed a comparable percentage (10.20) of insects and which also occurs commonly in the far north. The harlequin is unique in feeding primarily on stone fly larvae, which are most common in fairly swift mountain streams, whereas Steller's eider did not show even a trace of these insects in its diet but instead fed most commonly on the insects that frequent the quiet fresh-water pools of the arctic tundra. Midge larvae (8.05 percent) were taken in quantity by a fifth of the birds and formed more than a fifth of the food in May; caddisfly larvae (2.50 percent) occurred in 18 stomachs; a two-winged fly (*Limnophila*) formed 1.32 percent of the average meal; and other insects that occurred frequently include shore-flies (*Scatella*), flies of the genus *Spilogna*, horseflies (*Chrysops*), predaceous diving beetles (Dytiscidae), and ground beetles (Carabidae).

Annelid worms (3.33 percent).—These worms, particularly clamworms, formed a consistent food item, occuring in more than a fourth of the stomachs, and were taken by Steller's eider both in greater frequency and in greater quantity than by any other waterfowl species.

Sand dollars (2.76 percent).—Sand dollars likewise are probably taken in greater volume and frequency by Steller's eider than by most other waterfowl. They occurred in 15 percent of the gizzards and formed more than 8 percent of the food during May.

Fishes (2.28 percent).—Fish remains, small, coarse varieties usually, were found in 14 of the 66 stomachs. In no instance was a fish of value to the angler or commercial fisherman recognized.

Foraminifera (1.08 percent).—Perhaps no article of diet is more surprising than the one-celled foraminiferans (mostly *Elphidium arcticum*) that entered into the meals of approximately 15 percent of the Steller's eiders. They were taken to a slight extent in each of the 3 months and formed 3.23 percent of the food during May.

Miscellaneous animal food (0.20 percent).—Five species of hydroids and one bryozoan were taken, the former occurring in nearly 18 percent of the stomachs and in similar frequency as for other sea ducks.

PLANT FOOD—12.86 PERCENT

Most writers state that Steller's eider takes very little vegetable material. This assumption is probably correct for all seasons except summer when the bird is nesting at fresh-water areas. At such a time and under such circumstances a fair quantity of vegetable food is consumed, in this study averaging 18.31 percent of the food for May, 14 percent for June, and 6.26 percent for July.

Pondweeds (3.39 percent).—Species of *Potamogeton* (2.23 percent)—including both seeds and vegetable growth—and eelgrass (*Zostera marina*) (1.16 percent) both occurred rather frequently but usually in relatively small quantities, possibly taken in part incidentally or adventitiously while the birds were gathering the small crustaceans found within the plant meshes. The quantity taken by

certain individuals, however, would preclude the possibility of all the pondweeds having been taken in this manner.

Crowberry (1.07 percent).—About one-fourth of the birds had taken crowberries (*Empetrum nigrum*).

Algae (0.76 percent).—Various kinds of algae were taken.

Miscellaneous plant food (7.64 percent).—During the nesting season (May, June, and July) some of the vegetable material seemed to be in the form of drift and perhaps was taken incidentally with water fleas (amphipods), as these creatures are frequently found in such debris. At any rate, more than a third (4.71 percent) of the total vegetable food was classified either as wood pulp (1.13 percent) or undetermined vegetable material (3.58 percent). Sedges (a little less than 1 percent), mostly seeds and plant fiber of *Carex*, were procured in small quantities by nearly one-fourth of the birds. In a like manner, marestail (*Hippuris vulgaris*) seeds, with a little plant fiber (0.73 percent), also found in about one-fourth of the stomachs, were consumed in relatively small quantities. A surprisingly large assortment of other seeds and vegetative material was taken in small quantities by a fairly large percentage of the birds but averaged only slightly in excess of 1 percent of the total. These included cloudberry (*Rubus chamaemorus*), silverweed (*Potentilla anserina*), rose (*Rosa*), bedstraw (*Galium*), bearberry (*Arctostaphylos*), dwarf cornel, or bunchberry (*Cornus canadensis*), buttercup (*Ranunculus*), saltbush (*Atriplex*), goosefoot (*Chenopodium*), grass, moss, burreed (*Sparganium*), conifer needles, and horsetail (*Equisetum*).

Food of Juveniles

Too few juvenile Steller's eiders were available to more than suggest food tendencies. If the four stomachs examined are typical, the food is quite different from what would normally be expected. The young of most avian species subsist on animal matter to a much greater extent than do adults. In this instance the reverse is true, as 40.25 percent of the juvenile food was obtained from the plant kingdom as contrasted with 12.86 for the adult.

Animal food—59.75 percent

Insects, chiefly aquatic species, contributed more than a third (34 percent) of the entire juvenile food. Caddisfly larvae and their cases were of primary importance (18.5 percent), and midge larvae (*Chironomus*) were of only slightly less value (12.5 percent). The remaining 3 percent was divided among four species of two-winged flies and five species of beetles.

Clamworms averaged 20.5 percent of the juvenile food—a surprisingly large proportion and so far as known the largest taken by any species of water bird. Sessile barnacles constituted 1.5 percent and soft-bodied crustaceans only 1.25 percent. This marked contrast to the adult in the consumption of soft-bodied crustaceans can probably be explained in part by the difference in habitat of the juveniles and adults. Fewer crustaceans and more insects are usually available at the inland fresh-water tundra pools, where the juveniles occur, than along the sea coast or in the ocean, where many of the adults were taken while feeding. Mollusks, fishes, and sand dollars averaged 1.25, 1, and 0.25 percent, respectively, of the juvenile food.

PLANT FOOD—40.25 PERCENT

The following plant foods were consumed in the accompanying percentages: Pondweeds (*Potamogeton*), 11; fruit of crowberry (*Empetrum nigrum*), 5; algae (including *Spirogyra*), 2; horsetail (*Equisetum*), 1.5; fescue grass (*Festuca*), 0.5; sedge (*Carex*), 1; grass and sedge plant fiber, 4.75; marestail (*Hippuris vulgaris*), 1.75; burreed (*Sparganium*), buttercup (*Ranunculus*), and cloudberry (*Rubus chamaemorus*), each 0.25; silverweed (*Potentilla anserina*), 0.5; wood pulp, 3.5; and undetermined plant fiber, 8.

NORTHERN EIDER (Somateria mollissima borealis)

The northern, American, and Pacific eiders are very similar and by some writers are all regarded as varieties of the same species (*Somateria mollissima*). The northern eider (*S. m. borealis*) is at home on the coastal islands of Greenland and eastern Arctic islands south to northern Labrador and Quebec. In the North Atlantic, particularly in Hudson Bay and Labrador, it may be found intergrading with the American eider (*S. m. dresseri*). Westward, it is possible that it intergrades with the Pacific form (*S. v-nigra*). In winter it regularly occurs as far south as Maine and occasionally to Massachusetts. At such times it is commonly associated with the common east coast form (*S. m. dresseri*). Nests of the birds are often found very close to each other. Elliot (*29, p. 226*) writes:

> When incubation has commenced the males retire to the sea and remain in flocks near the shore, leading an idle, careless kind of a bachelor life, free from all family duties, and when moulting time arrives they go farther out to sea, and do not return to the females and young until the autumn * * * the young are conducted to the water by the female, * * * and she remains with her little family until they are full grown and are joined by the males, later in the year. This Duck does not seem to mind cold, and has been known to endure a temperature of 50° below zero without any inconvenience. Of course it could remain in such extreme frost only in places where the water was kept open, and comparatively free from ice, by the rapidity of the current or tide rifts.

FOOD OF ADULTS

Eiders obtain their food almost wholly by diving to moderate depths, and it appears that almost any kind of marine animal life of the appropriate size is acceptable and easily digested by the birds' powerful gizzards. Most of this food seems to be found on or about the sunken ledges or submerged reefs of the rocky shores, which support a profusion of marine invertebrates and often a rank growth of seaweeds. Bent (*10, p. 88*) states that these birds, like other members of this tribe, feed mainly at low tide—

> when the food supply is only a few fathoms below the water surface; they often dive to depths of 6 or 8 fathoms and sometimes 10 fathoms, but when forced by the rising tide to too great exertion in diving, they move off to some other feeding ground or rest and play until the tide favors them again.

Phillips (*81 v. 4, p. 91*) reports that, like the harlequin, these birds freely use their wings in their under-water movements.

Of the limited number of 11 stomachs available for analysis, which were collected in August, October, November, and February, 7 well-filled ones were positively identified as being northern eiders and 4, from Wolstenholme, Canada, labeled only as *S. mollissima*, were

FOOD HABITS OF NORTH AMERICAN DIVING DUCKS

COTTAM, C.

thought to be. In computing food percentages (tables 17 and 26), 10 stomachs were used. The data are too meager to be more than suggestive of food preferences, but they seem to demonstrate that the northern eider, like the others of the genus *Somateria*, are predominantly mollusk feeders.

The eleventh stomach, one of the four from Canada collected without adequate data, had been gorged with many blue and horse mussels (Mytilidae), limpet shells (*Acmaea*), top shells (*Margarites*), undetermined bivalves, remains of a crab, and a trace of marine algae.

TABLE 17.—*Northern eider (Somateria mollissima borealis): Food, by volume percentages, of 10 adults taken during 4 months of the year*

Kind of food	Percentage of food	Kind of food	Percentage of food
ANIMAL FOOD (99.37 percent)[1]		ANIMAL FOOD (99.37 percent)—contd.	
Mollusks	70.34	Crustaceans	14.32
Blue mussel (*Mytilus edulis*) and other Mytilidae	39.65	Amphipods	10.65
Soft-shelled clams (*Mya*)	5.33	Miscellaneous	3.67
Astarte shells	4.17	Fishes (Pisces)	8.91
Other pelecypods	8.73	Echinoderms: Sea urchin (*Strongylocentrotus drobachiensis*) and starfish (Asteroidea)	3.32
Whelks (*Buccinum*)	2.70	Miscellaneous animal food	2.48
Other gastropods	8.67		
Miscellaneous	1.09		

[1] The 0.63 percent plant fiber was probably taken adventitiously in gathering animal food.

ANIMAL FOOD—99.37 PERCENT

Mollusks (70.34 percent).—Mollusks formed the principal bulk of the animal matter eaten by the northern eider. It appears that any mollusk of appropriate size occurring in the preferred feeding habitats of the species is acceptable. Bivalves (pelecypods) (57.88 percent), which were much more important than univalves (gastropods), consisted mostly of Mytilidae (39.65 percent), which seemed to be the chief sustenance of this duck, as they made up nearly two-fifths of the total food. Most important of these was the blue mussel (*Mytilus edulis*) (12.78 percent). A northern soft-shelled clam (*Mya*) (5.33 percent), and *Astarte* shells (4.17 percent) also provided palatable provender. Among the other bivalves taken (8.73 percent), the Arctic rock borer (*Saxicava arctica*) was valuable. Gastropods (11.37 percent) consisted of whelks (*Buccinum*) (2.70 percent) and other forms (8.67 percent), the latter including moon shells (*Natica*), bubble shells (*Bulla*), and dog whelks (*Nassarius*). Miscellaneous mollusks (1.09 percent) comprised squid (*Loligo*) (0.42 percent) and undetermined forms (0.67 percent).

Halkett (*41, p. 105*), who spent considerable time in the frozen north, examined 20 gizzards of the northern eider and found in them the following items: Numerous shells of *Acmaea testudinalis;* numerous fragments of valves of *Tonicella marmorata;* a few shells of *Margarita cinerea*; egg-capsules, opercula, and shells of undetermined gastropods; numerous valves of *Crenella*, fragments of valves of lamellibranchs; various parts of the shells of a toad crab (*Hyas*) and other crustaceans; fragments of an ophiuran; a few bones of a very small teleost; bits of algae; and numerous small stones.

Kumlien (*49, p. 90*) writes of the northern eider:

> Their food in autumn consists almost entirely of mollusks. I have taken shells from the oesophagus more than 2 inches in length; from a single bird I have taken out 43 shells, varying from 1/16 to 2 inches in length.

Millais (*66, v. 2, p. 18*), gives the following almost unbelievable account of a 10-inch razor clam being consumed:

> I remember once, in Orkney, running down to a flock of feeding Eiders that for the moment had vanished beneath the waves. One rose near the boat with something like a thick stick projecting 5 or 6 inches from its mouth, which it was unable to close. I shot the bird, an old female, and found that the obstruction, when drawn out, was a razor shell (*Ensis siliqua*), 10 inches long and 3 inches in circumference. How any bird, even with the digestion of a sea-duck, could assimilate so tough a morsel with a hard and thick shell seemed a marvel; but it is doubtless the case that they are able to break them up * * *.

Crustaceans (14.32 percent).—These were second in importance in the northern eider's food and consisted of amphipods (10.65 percent) and miscellaneous forms (3.67 percent).

Fishes (8.91 percent).—These comprised a much larger percentage than expected and perhaps larger than if more gizzards had been available. All the fishes identified were sculpins (Cottidae). They were taken by 7 of the 11 birds.

Echinoderms (3.32 percent).—These consisted of sea urchins (*Strongylocentrotus drobachiensis*) (3.25 percent), taken by two of the birds, and starfishes (0.07 percent).

Miscellaneous animal food (2.48 percent).—Insects, marine worms, and foraminiferans completed the animal food.

PLANT FOOD—0.63 PERCENT

Plant fiber was probably taken by the northern eider incidentally or accidentally in the gathering of animal foods. It consisted of small quantities of several species of algae, grass, sedge, and indeterminable plant fiber.

AMERICAN EIDER (Somateria mollissima dresseri)

(Pl. 5, facing p. 96)

The American, or common, eider is a large and splendid bird appropriately named "sea duck," as it is truly a sea bird. Economically it is of great value in that it forms the principal source of American eider down. In the past it has been ruthlessly destroyed for its plumage. Although not so palatable as many other American waterfowl and not of exceptional value as a sporting bird, it has experienced such reckless killing and egging that only a small fraction of the original numbers remain. It is probable that the birds have escaped extinction because many breed in the far north beyond the regions frequented commonly by white men and perhaps also because they are so hardy that they seek more southern shores only during the most inclement winter weather when storms and cold almost prohibit gunning. Because of their relative scarcity they were accorded full protection by Federal regulation in 1918. A favorable response was shortly noted, and by 1931 they had shown a sufficient increase to justify a restricted open season.

Townsend (*88, pp. 15–16*) has appropriately pointed out that if the principle of conservation is applied there is no reason why the

PLATE 5.—SEA DUCKS.

FOUR SCOTERS

KING EIDER
Adult female

KING EIDER
Adult male

AMERICAN EIDER

Adult female

Adult male

AMERICAN SCOTER

Adult female

Adult male

WHITE-WINGED SCOTER

Immature bird

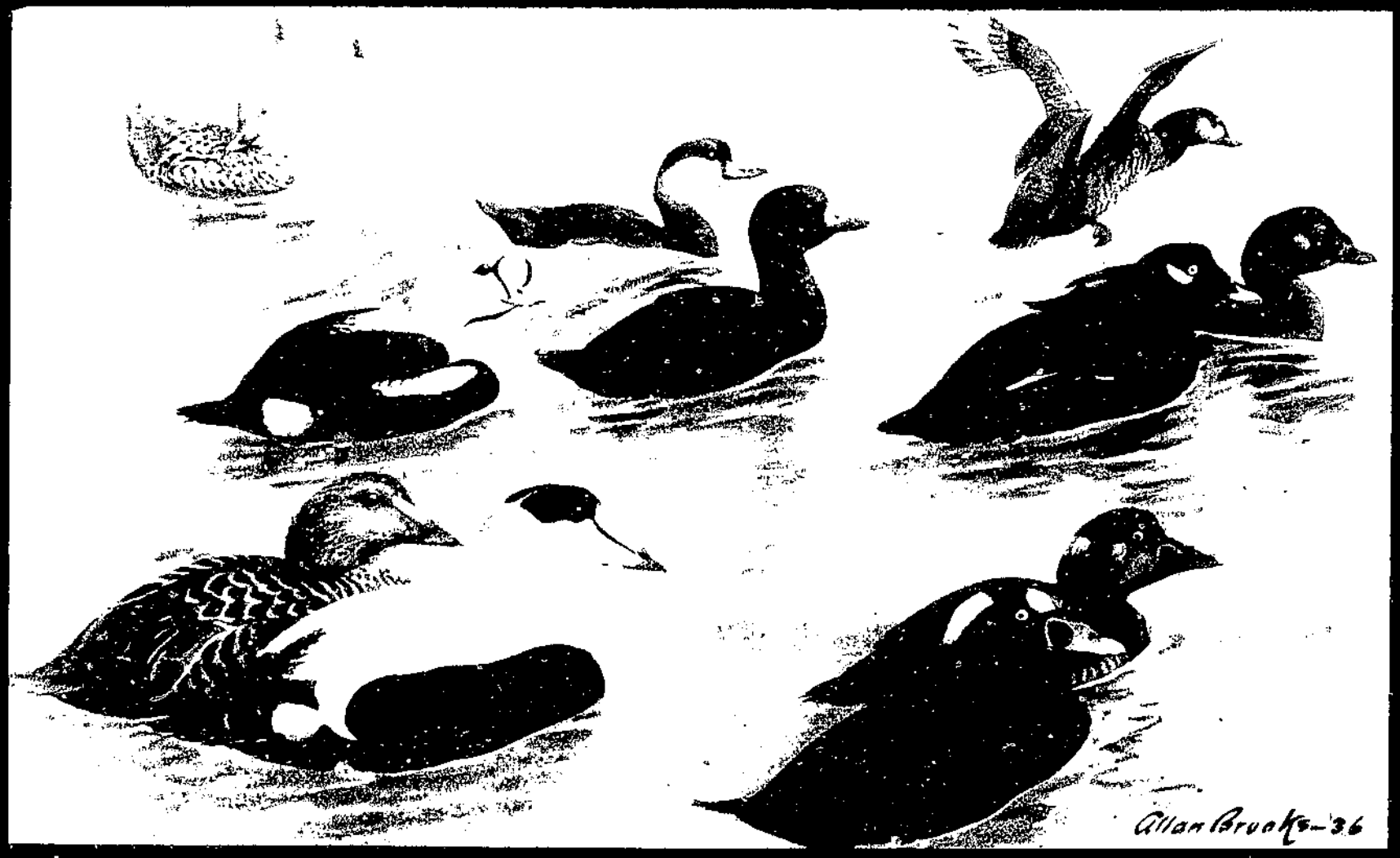
Adult female

Adult male

SURF SCOTER

Adult female

Adult male


Allan Brooks—36

eider should not be made a source of considerable income in the production of down without any reduction of its natural abundance. He also quotes various authors to the effect that when given protection and encouraged, as in Iceland and Scandinavia, the eider becomes very tame and seems to seek nesting sites close to human habitation.

This species now nests from Labrador to eastern Maine and occurs regularly in winter southward along the coast to Long Island. In winter during periods of severe weather it may be found at favored land points or rocky island shores in tremendous concentrations.

Like all other waterfowl, these eiders have many natural enemies. They are said to be fed upon by sharks and other large predatory fishes and seals. On the land they must ever be on the alert for predaceous gulls, ravens, falcons, and Arctic foxes and wolves.

Food of Adults

The American eider's food is obtained mainly by diving, usually from a point just beyond the surf. The birds detach mussels from the rocks and come to the surface outside the breaker. Forbush (*33, p. 267*) reports that he has seen a male eider "taking mussels off a rock, sometimes at the surface and sometimes by submerging head and neck, but this must be unusual." Lewis (*50, p. 3*) asserts that "mussels, sea-cucumbers, star-fish, and similar organisms, which they obtain by diving to the sea-bottom, constitute most of their food." Smith (*85*) states that although these birds will eat anything that a domestic duck will eat, they subsist chiefly on shellfish, such as mussels. Barrows (*9, p. 104*) writes that "they feed mainly, if not entirely, on aquatic animals, such as crabs, barnacles, clams, mussels, snails and fish * * *." Austin (*6, p. 52*) records that their food consists "mainly of mollusks, crustaceans, and echinoderms, vegetable food taking very little place in the diet."

The evidence in the present study also shows clearly that this species is predominantly an animal feeder with a noticeable preponderance of mollusks in its food. In the aggregate many species of plants and animals were consumed, yet the individual birds made most of their meal on one or at least a few specific items. An average of 5.4 species a meal was taken—a much smaller number than for most other waterfowl. Gravel was found in considerable quantity, averaging 14.10 percent of the total stomach content.

The reports of two writers seem to indicate that the European eider (*Somateria m. mollissima*) feeds on essentially the same types of marine foods as does the American form. Florence (*31, p. 208*) found periwinkles (*Littorina obtusata*), claws of a small crab, fragments of acorn shells (*Balanus*), and seaweeds (Ulvaceae and *Corallina*) in a half-full stomach of the European representative and a few small shells and many fragments of the blue mussel and remains of crabs in a nearly empty stomach. Collinge (*16, pp. 223–224*) states that the European eider "has been accused of damaging mussel-beds, but there is very little evidence to support such statements." In the stomach contents of 24 specimens he found that mollusks comprised 51.5 percent; crustaceans, 24.5; annelid worms, 6.5; fishes, 5; echinoderms, 4.5; insects, 3.5; and vegetable matter, 4.5.

For the present study, 117 stomachs of adult American eiders, taken in the 5 months January, February, July, November, and December, were available. Of these the 96 that were full enough to be used in computations of food percentages (tables 18 and 26) were collected at widely separated points along the coast from Rhode Island, Massachusetts, Maine, and Nova Scotia northward to Labrador and Hudson Bay.

TABLE 18.—*American eider (Somateria mollissima dresseri): Food, by volume percentages, of 96 adults taken during 5 months of the year*

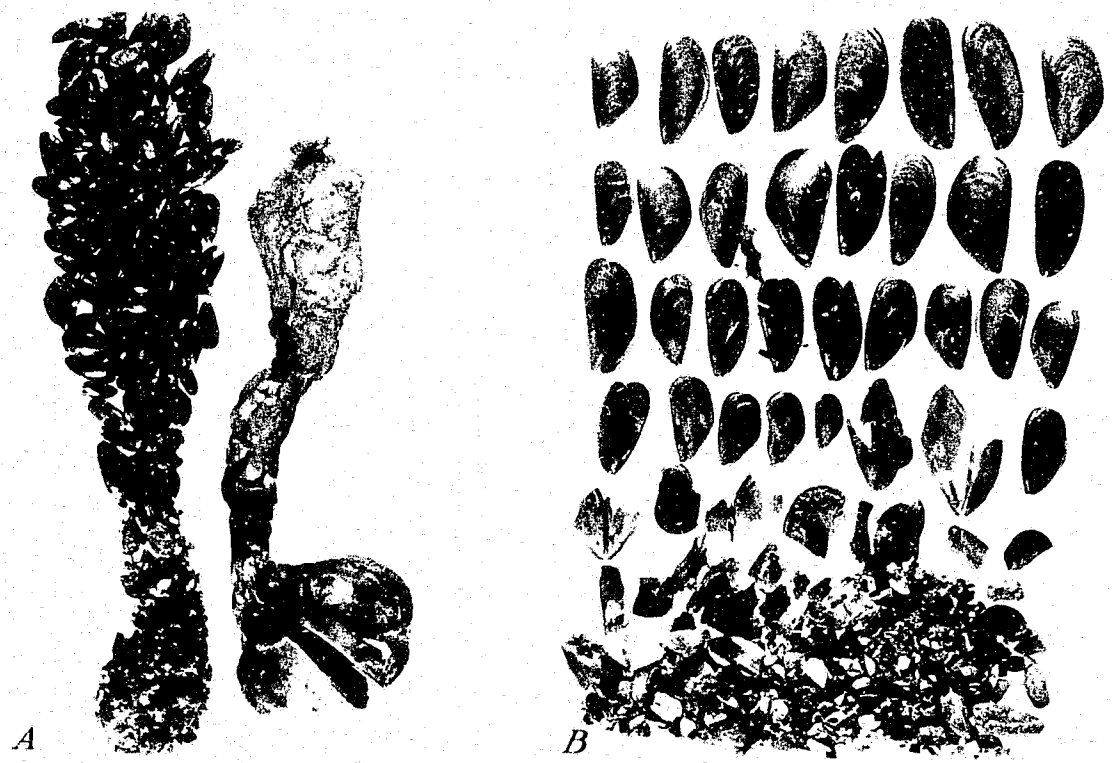
Kind of food	Percentage of food	Kind of food	Percentage of food
ANIMAL FOOD (96.31 percent)[1]		ANIMAL FOOD (96.31 percent)—continued	
Mollusks	81.72	Crustaceans	8.85
Blue mussel (*Mytilus edulis*) and horse mussels (*Modiolus*)	66.76	Crabs	5.61
Cyprina islandica	2.53	Miscellaneous	1.24
Arctic rock borer (*Saxicava arctica*)	2.14	Echinoderms	5.34
Other pelecypods	3.74	Sea urchin (*Strongylocentrotus drobachiensis*) and other Echinoidea	4.42
Oyster drill (*Urosalpinx cinereus*)	1.35	Miscellaneous	.92
Other gastropods	4.96	Insects	2.20
Undetermined	.24	Miscellaneous animal food	.20

[1] Most of the 3.69 percent plant food consisted of drift and undetermined material, with no identified species contributing as much as 1 percent of the total.

ANIMAL FOOD—96.31 PERCENT

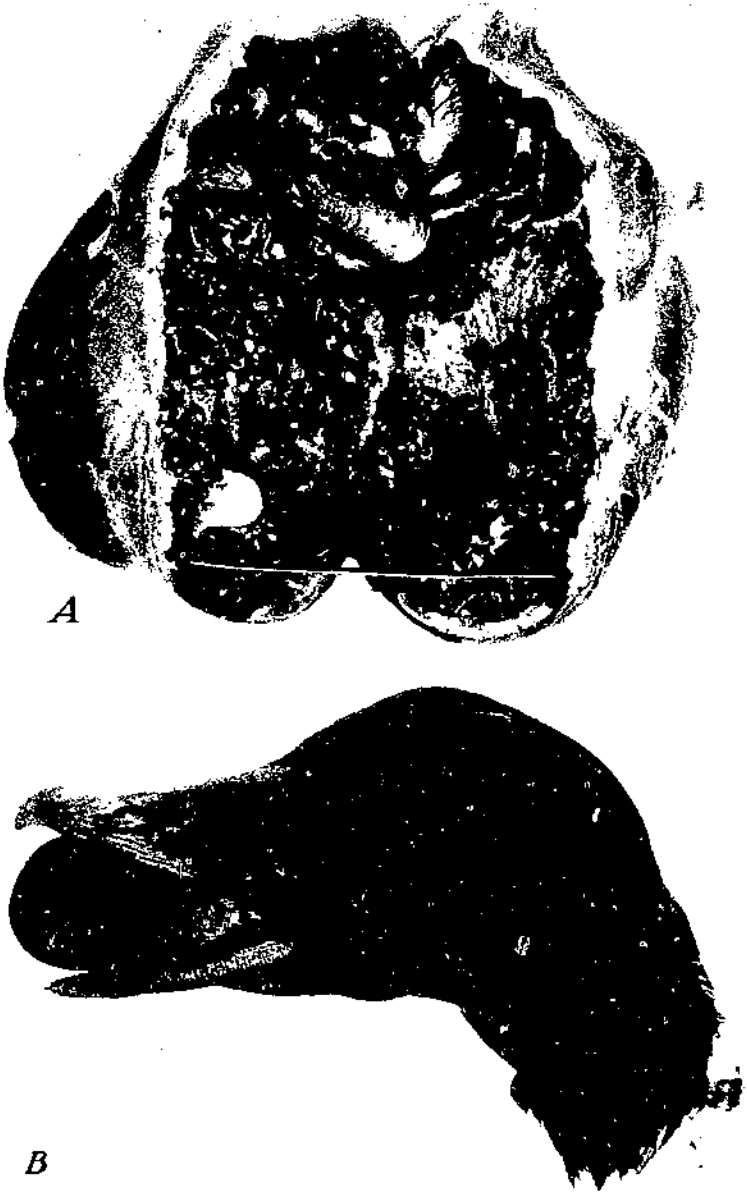
Mollusks (81.72 percent).—The American, or common, eider is unique in its excessive consumption of the common blue mussel (*Mytilus edulis*) (66.73 percent). This bivalve enters into the diet of all species of coastal waterfowl, and no other marine or coastal animal species is so important as a food for American waterfowl, yet with no other bird is it of such great value as with our common east-coast eider duck, comprising as it does more than two-thirds of its total food. In fact, no other duck subsists to such an extent upon any single food species. Perhaps the only case comparable to it is the singular consumption of eelgrass (*Zostera marina*) by the sea brant (*Branta bernicla*) prior to 1931 before the nearly complete disappearance of this plant along the North American Atlantic coast. The fact that the blue mussel formed a part of the meal of 78, or 81.2 percent, of the 96 birds, and the entire meal of 38, or nearly 40 percent, indicates that this food not only is very acceptable but also contains most of the necessary food elements. It was the principal food item in each of the five months, comprising more than half of the food in each month except February, when it formed 48.50 percent. As only six stomachs were collected that month, however, it is probable that a larger and more representative series would show a larger percentage. Even the nine July birds had made this shellfish 56.56 percent of their meal. Some horse mussels (*Modiolus*) (0.03 percent) were infrequently found.

Although mussels of nearly all sizes from tiny young to mature shells were consumed, it is apparent that shells up to three-fourths mature size were most frequently taken. Remains of 185 shells—an incredible number—were found in a single gullet and gizzard (pl. 6, *A*), and another well-filled gullet and gizzard contained larger shells,



B5566M, B5569M

A, 185 blue mussels (*Mytilus edulis*) and the expanded gullet and gizzard of the American eider (*Somateria mollissima dresseri*) from which removed, showing somewhat the progressive mechanical trituration of shells, × ⅕. *B*, Meal of an American eider: 36 whole or nearly whole blue mussels and fragments of 22 others.



B55813M, B55714M

A, Gizzard of an American eider (*Somateria mollissima dresseri*) showing whole mollusks in cardiac end and an unusually large pebble in lower left side. *B*, Head of female American eider that was strangled or starved to death by having the valves of a blue mussel (*Mytilus edulis*) clamp down on its tongue.

36 whole mussels, and fragments of 22 others (pl. 6, *B*). Plate 7, *A*, shows the powerful opened gizzard of yet another bird, in the cardiac end of which may be seen 19 unbroken shells that had just been swallowed. The gullet of another bird contained 11 entire mussels ranging from 1⅛ by ⅝ inches to 1⅜₁₆ by ¾ inches; and the stomach or gizzard of the same bird, 6 entire mussels from ⅞ by ½ inch to 1½ by ¾ inches and remains of 7 more. Occasionally the tongue of a bird is caught between the valves of an open mussel, which usually results in the bird's death (pl. 7, *B*). The mussel tightly clamps the tongue, causing strangulation or starvation.

Although the period of digestion of these sea birds is not definitely known, it is conceded to be rapid. Perhaps most of the food in a well-filled gizzard is digested in 3 or 4 hours. The evidence seems to indicate that the more food consumed the more rapid the digestion and the more incomplete the operation of the digestive process on the various individual food items. At the loafing or resting ground near an abundant food supply it is not uncommon to find the open shells of small mussels entirely intact in the bird droppings. The writer has found some measuring three-eighths of an inch in length. All larger mussel shells are, of course, rather finely broken. All the mollusk-feeding seafowl have strong and powerful gizzards that mechanically and readily break the shells into small pieces upon which the chemical secretions more quickly operate. It is said that the grinding of the gizzard can sometimes be heard if the observer places his ear near the body of a live duck that has recently fed upon these mollusks.

The bivalve *Cyprina islandica* (2.53 percent) and the Arctic rock borer (*Saxicava arctica*) (2.14 percent) were also taken in quantity by the American eider. Other pelecypods (3.74 percent) found in the stomachs included *Astarte castanea*, *Macoma*, scallops (*Pecten irradians*) (0.5 percent), ark shells (*Arca*), fresh-water clams (Unionidae), and the quahogs (*Venus mercenaria*).

Shellfishes of commercial value, mostly scallops, are occasionally taken but obviously are not sought out in preference to the common blue mussel that is so abundant along the North Atlantic coast. The Biological Survey has conducted a number of investigations to determine the relationship of American eiders to the shellfish industries and has concluded that only under exceptional circumstances do they cause any noticeable damage. Examination of a number of stomachs of birds collected over planted scallop beds showed that only occasionally was a shellfish of commercial value taken. The destruction of blue mussels cannot be considered of economic importance, because, even though these bivalves are occasionally used for commercial purposes, they are excessively abundant along the New England coast and tend to crowd out the varieties of shellfishes that have more commercial value. As evidence that they are considered a pest to commercial fisheries is the fact that 70 to 80 men were employed under an emergency project along the northern Massachusetts coast during periods of 1935 and 1936 to scrape mussels from original clam flats in an effort to restore the clam fishery.

Gastropods (6.31 percent) of many species were taken. It is perhaps significant that the most important one was the injurious oyster drill (*Urosalpinx cinereus*) (1.35 percent), upon which 21 December birds had fed to the extent of 6.48 percent of their meal. One bird from Nantucket, Mass., had consumed 39 mature individuals of this

destructive shell and another 32, representing 66 and 60 percent, respectively, of the food of the two meals. Of the other univalves (4.96 percent) taken, those of frequent occurrence were slipper-shells (*Crepidula fornicata*), moon shells (*Natica*), periwinkles (*Littorina*), dog whelks (*Nassarius*), whelks (*Buccinum*), limpets (*Acmaea*), dove-shells (*Mitrella lunata* and *Anachis avara*), and rock shells (*Thais*).

Undetermined mollusks formed only a small percentage (0.24) of the food.

Crustaceans (6.85 percent).—These ranked next to mollusks in order of importance as food for the American eider. They consisted mostly of crabs (5.61 percent), the most valuable of which were the common toad crab (*Hyas araneus*), rock crabs (*Cancer irroratus*), mud crabs (mostly *Neopanope texana-sayi*), and hermit crabs (*Pagurus*). Two spiny chitinous toad crabs were taken by a single bird, forming 83 percent of the meal. The rock and mud crabs were of most frequent occurrence. Miscellaneous crustaceans (1.24 percent) consisted of barnacles, amphipods, isopods, and others. Even though they did not contribute greatly to the bulk percentage, some were of frequent occurrence. Whitfield (*95*) mentions that the crop of a bird taken at Montauk Point, Long Island, contained—

> the remains of 5 right claws of *Cancer irroratus*, our common sand crab, * * *. The last dinner consisted of an individual entire, a small female burdened with a large quantity of eggs under the flipper, making an object nearly two inches by one and three-eighths, and almost an inch thick, which he must have taken into his crop at a single gulp, without even disturbing a limb.

Echinoderms (5.34 percent).—As further evidence of the toughness and strength of the gizzard wall of the eiders, it was found that spiny sea urchins (4.42 percent), mostly *Strongylocentrotus dröbachiensis* (2.13 percent), entered frequently into the bill of fare. During February they were second in importance as food, forming 21.82 percent of the total consumption. Miscellaneous echinoderms (0.92 percent) included brittle stars (*Ophiopholis aculeata*) (0.73 percent), consumed only during February, when they constituted 3.66 percent of the food, and starfish (0.19 percent), which formed 0.75 percent of the December food.

Insects (2.20 percent).—Inasmuch as only one summer month (July) was represented, insects perhaps did not form so large a percentage of total food as they would have if adequate collections had been made throughout the summer. During July they aggregated 11 percent of the total intake. Caddisfly larvae (2.18 percent) comprised all but a trace of the bulk of insects consumed and formed 10.89 percent of the food for February. Other insect items noted were diving beetles (mostly Dytiscidae), water boatmen, dipterous larvae, and caterpillars.

Miscellaneous animal food (0.20 percent).—Miscellaneous animal items were of frequent occurrence but of slight bulk. Those most commonly taken were several species of hybroids, bryozoans, and annelid worms. Fish occurred in two stomachs, one of which contained a trace of an unidentifiable species and the other a snakefish (*Lumpenus lampetraeformis*) that amounted to 4 percent of the meal. Mackay (*61, p. 224*) reports that stomachs of birds shot at Woods Hole in February contained sculpin spawn in perfect condi-

tion, stuck together in small masses. When mollusks are not abundant and when other food is scarce it is probable that fishes enter more prominently into the diet.

PLANT FOOD—3.69 PERCENT

Perhaps the 3.69 percent that plant material formed of the American eider's food would have been greater had there been stomachs from additional summer months, because in July, the only summer month represented, plant material furnished 12.33 percent of the food, whereas in the four winter months it appeared to be of incidental if not largely adventitious occurrence in the food. Only three stomachs, each of which was not more than a third full, contained a preponderance of plant material, and 83 percent of the stomachs contained none or merely a trace. Wood pulp, drift, and undetermined plant material were the principal vegetable items in each month and averaged 1.97 percent of the total intake. No species or small taxonomic group of plants averaged as much as 1 percent of the total food, and only one species averaged that much of the food in any month. That was the crowberry (*Empetrum nigrum*) (0.49 percent), which comprised 2.44 percent of the food in July. Other plants taken include several species of algae, moss, eelgrass (*Zostera marina*), bearberry (*Arctostaphylos*), buttercup (*Ranunculus*), sedge (*Carex*), and conifer needle fragments. Bailey (7, *p. 231*) mentions an eider that flew aboard a steamer off Cape Cod, Mass., and lived for 10 days on celery tops but refused all other foods.

PACIFIC EIDER (Somateria v-nigra)

Much that has been written of the habits and characteristics of the Atlantic, or American, eider would be equally applicable to the Pacific eider, which is readily separated from other eiders by the prominent V-shaped black mark on the chin and throat, which gives it its descriptive specific name—"v-nigra." This species inhabits the Arctic coast and islands from Coronation Gulf to the shores of Bering Sea, with smaller numbers extending southward along the Aleutian Islands and Alaskan Peninsula. Most of the birds migrate but little; therefore they stay so far removed from observers both in winter and summer that detailed information regarding their status is not available. They are said to occur at times in prodigious numbers in Bering Straits. During the breeding season nesting birds seem to be less gregarious than any of their close relatives.

FOOD OF ADULTS

Although the Pacific eider is regarded as being much more closely related to the American and northern than to the king eider, its selection of food seems to be more like that of the latter species. As with all other eiders a wide variety of sea organisms is represented in the food, ranging from algae and foraminiferans through most of the principal groups to the vertebrates of the chordates; and as with the other eiders of the genus *Somateria*, mollusks entered most prominently into the food, the percentage being almost identical with that of molluscan food for the king eider and noticeably smaller than that

for the American and northern eiders. Most of its foods are obtained by diving, and sometimes, apparently, they are taken at considerable depths. Elliot (*29, p. 231*) states that the species feeds principally on "mussels and other bivalves, and it seeks these sometimes in water 30 or 40 feet deep." Gravel was present in practically all stomachs and averaged 13.70 percent of the entire bulk. The number of food species in a meal varied greatly but averaged 8.27.

Examinations were made of the stomachs of 69 adult Pacific eiders collected during the 6 months January, February, March, May, June, and July, 67 along the Alaskan coast and 2 in Siberia. In computing food percentages (tables 19 and 26), 61 of the stomachs from Alaska, all well-filled, were used.

Of the two birds from Siberia, taken in July, one had made 70 percent of its meal on amphipods (*Anonyx nugax*), 15 percent on miscellaneous gastropods, and 15 percent on pelecypods, and the other had taken hermit crabs (*Pagurus trigonocheirus*) to the extent of 95 percent of its meal and bivalves, 5 percent.

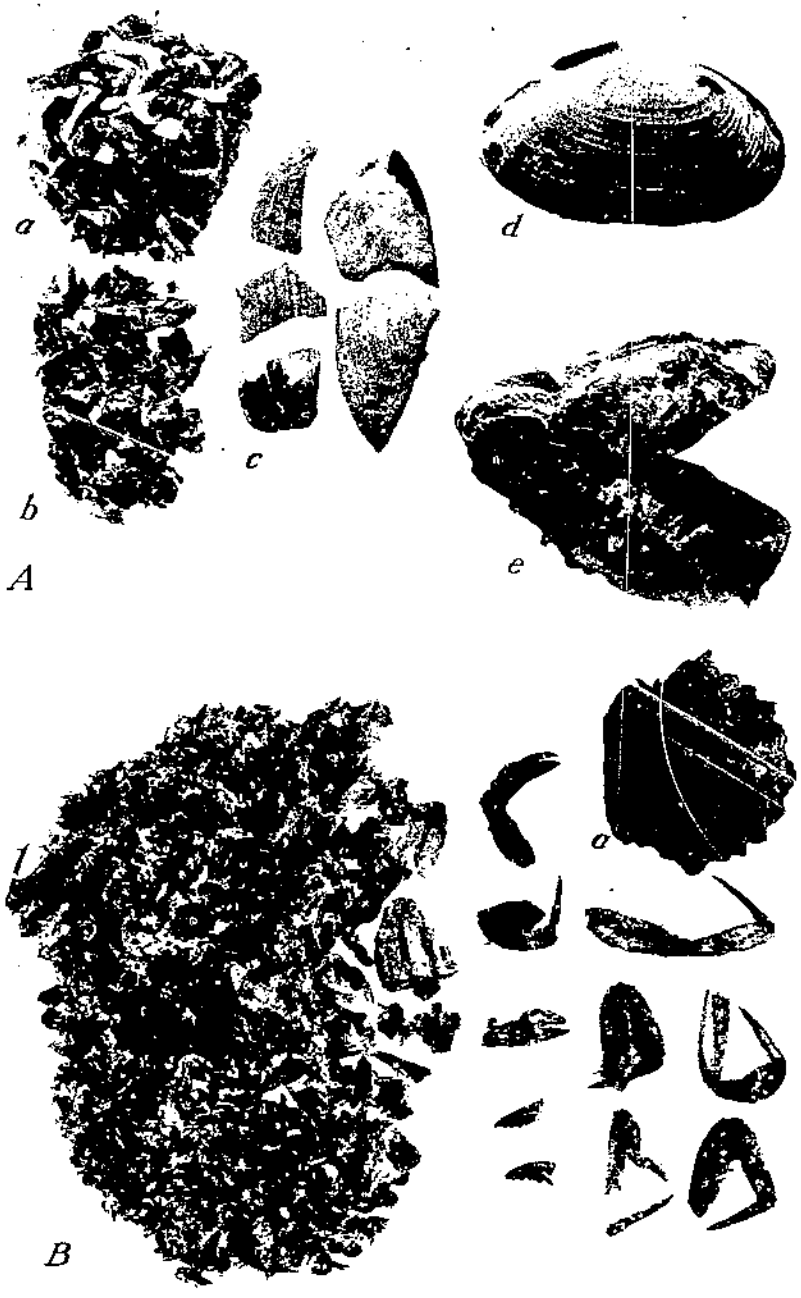
TABLE 19.—*Pacific eider (Somateria v-nigra): Food, by volume percentages, of 61 adults taken during 6 months of the year*

Kind of food	Percentage of food	Kind of food	Percentage of food
ANIMAL FOOD (95.26 percent)		ANIMAL FOOD (95.26 percent)—contd.	
Mollusks	45.97	Crustaceans—Continued.	
Blue mussel (*Mytilus edulis*), horse mussel (*Modiolaria verrucosa*), and other Mytilidae	11.80	Isopods	3.94
Razor clams (*Siliqua*)	5.70	Shrimps	3.07
Tellen shells (*Tellina*)	5.12	Barnacles	2.06
Astarte shells	2.21	Miscellaneous	1.28
Other pelecypods	3.31	Echinoderms	14.40
Periwinkles (*Littorina*)	6.09	Sand dollar (*Echinarachnius parma*)	6.04
Rock shells (*Thais*)	1.39	Starfish (Asteroidea)	5.93
Other gastropods	8.44	Sea urchin (*Strongylocentrotus drobachiensis*)	2.43
Chitons and undetermined	1.91	Fishes (Pisces)	1.51
Crustaceans	30.65	Miscellaneous animal food	2.73
Horse crab (*Telmessus cheiragonus*)	8.18	PLANT FOOD (4.74 percent)	
Box crab (*Lopholithodes mandtii*)	5.31		
Other crabs	2.46	Algae	3.5
Amphipods	4.35	Miscellaneous plant food	1.2

ANIMAL FOOD—95.26 PERCENT

Mollusks (45.97 percent).—Although the percentage of the Pacific eider's food furnished by the Mytilidae was large (11.80), it was considerably less than for the other *Somateria* eiders. The blue mussel (*Mytilus edulis*) (6.02 percent) occurred in 20 of the 61 stomachs and ranged from a trace to as much as 86 percent of a meal. One stomach contained 31 whole individuals and fragments of 23 others. The closely related horse mussel (*Modiolaria verrucosa*) (2.94 percent) occurred 13 times. The remaining Mytilidae (2.84 percent) consisted of miscellaneous forms.

Of the 28.14 percent bivalve (pelecypod) food, razor clams (*Siliqua*) (5.70 percent) were second in importance, forming a part of the meal of 18 birds. Tellen shells (mostly *Tellina lutea*) (5.12 percent) were of scarcely less value, and incredibly large ones were swallowed. One specimen that had just entered a stomach measured 68 by 41 mm (pl. 8, *A*, *c* and *d*). This stomach also contained plant



B557 M. B557 AM

A, Gizzard of a Pacific eider (*Somateria v-nigra*) and contents: *a*, Remains of six razor shells (*Siliqua*), a tellen shell (*Tellina*), a nut-shell (*Nucella*); *b*, remains of seven large isopods (*Mesidotea entomon*) and a sand dollar (*Echinarachnius parma*); *c* and *d*, valves of a tellen shell (*Tellina lutea*) that measured 68 by 41 mm; *e*, empty gizzard. *B*, Meal of a Pacific eider: Fragments of three horse crabs (*Telmessus cheiragonus*), a Caprellidae, an isopod and other crustaceans, a periwinkle (*Littorina*), two *Macoma* shells, an undetermined mollusk, eelgrass, (*Zostera marina*), and algae. The carapace of the large horse crab (*a*) measured 39 by 43 mm.

fiber and fragments of the following items: A tellen shell, six razor clams, an undetermined bivalve, a nut-shell (*Nucella*), a sand dollar (*Echinarachnius parma*), and seven large isopods (*Mesidotea entomon*). The genus *Astarte* (2.21 percent) entered into the diet of but 10 birds yet was important when it occurred. Other pelecypods (3.31 percent) consumed were Arctic rock borer (*Saxicava arctica*), *Macoma*, cockleshells (*Cardium ciliatum*), *Cyprina islandica*, venus-heart (*Venericardia ventricosa*), northern scallop (*Pecten islandicus*), and unidentifiable fragments.

Univalves (gastropods) (15.92 percent) included a rather large variety of shells, yet only two genera averaged more than 1 percent each of the food, namely, periwinkles (*Littorina*) (6.09 percent) and rock shells (*Thais*) (1.39 percent). An unusually large assortment of other gastropods (8.44 percent) were taken.

Chitons (0.07 percent) and undetermined mollusks (1.84 percent) made up the remaining molluscan food.

Crustaceans (30.65 percent).—Of these, the horse crab (*Telmessus cheiragonus*) (8.18 percent) was the most important to the Pacific eider. One bird had made 93 percent of its meal on one small and two large individuals, the largest of which measured 39 by 43 mm (pl. 8, *B*, *a*). How such large, sharp, almost spiny objects can be swallowed without injury to a bird that has what appears to be a comparatively small mouth and gullet is a marvel. Box crabs (*Lopholithodes mandtii*) (5.31 percent) were next in importance. Other crabs (2.46 percent) consisted of spider crabs (*Oregonia gracilis*) (0.98 percent) and *Hapalogaster grebnitzkii* and hermit crabs (*Pagurus*) (1.48 percent). The remaining crustacean food, in percentages, comprised amphipods (mostly *Gammarus pribilofensis*) 4.35; isopods (mostly *Mesidotea entomon*), 3.94; shrimps (including *Crago* and *Spirontocaris polaris*), 3.07; barnacles, 2.06, of which Balanidae furnished 1.60 percent; and miscellaneous forms, 1.28.

Echinoderms (14.40 percent).—The eider ducks are peculiar in their frequent and extensive consumption of echinoderms, and for the Pacific eider this ubiquitous group of marine invertebrates aggregated more than a seventh of the food and occurred as a part of more than half the meals. Those taken, in percentages, included the sand dollar (*Echinarachnius parma*), 6.04, the species taken by the greatest number of birds; starfish (*Leptasterias* and others), 5.93; and the spiny, spheroidal sea urchin (*Strongylocentrotus dröbachiensis*), 2.43.

Fishes (1.51 percent).—Fish fragments, mostly flatfishes and sculpins, occurred in 7 of the 61 stomachs.

Miscellaneous animal food (2.73 percent).—Marine worms (mostly Nereidae) (1.33 percent) entered into the diet of one-sixth of the birds. The remaining 1.40 percent was made up of hydroids of several species, taken by many birds but forming scarcely more than a trace of the volume; foraminiferans, found in 5 stomachs; bryozoans, found in 14 stomachs; sea spiders (*Ammothea pribilofensis*), found in 3 stomachs; insects, mostly salt, or brine fly larvae, of noticeable value to only 1 bird, in whose stomach 2,500 larvae were found; and 1 ascidian, or sea squirt (*Boltenia ovifera*), forming 1 percent of the meal of 1 bird and a trace of that of another but only a trace of the total food.

PLANT FOOD—4.74 PERCENT

As is characteristic of other members of the genus *Somateria*, the Pacific eider does not draw heavily upon the plant kingdom for food. It was a surprise to find, however, that unlike other eiders, more vegetable food was taken during winter than during summer. It is entirely possible that a larger series of stomachs would change the percentage somewhat, but the evidence is clear that relatively little plant food, except marine algae, is taken at any season by adult birds. Vegetable food occurred in 63 percent of the stomachs, but in only one stomach, which was but a third full, did it amount to more than 40 percent of the contents. It would appear that most of it, except perhaps some of the marine algae, was of accidental or incidental occurrence.

Algae (3.53 percent).—Nearly three-fourths of all the vegetable food consisted of marine algae, most of which were species of the plume alga (*Ptilota*) (2.45 percent), which occurred in 19 of the 61 stomachs in quantities ranging from a trace to 36 percent of the meal. Algae were found at least as a trace in 25 stomachs. The stomachs containing the highest percentage usually were not particularly well filled, but the quantity taken indicates that algae are in part sought after. Some of the plume alga, however, obviously had been taken incidentally, as it had been growing on the backs of hermit crabs and on mollusk shells.

Miscellaneous plant food (1.21 percent).—Drift and unidentifiable vegetable debris in small quantities was of frequent occurrence (1 percent). The following other plants (0.21 percent) were consumed in very small quantities: Eelgrass (*Zostera marina*), wild-rye (*Elymus villosissimus*), sedges (mostly *Carex*), Alpine-azalea (*Loiseleuria procumbens*), and a moss. None of these averaged more than 3 percent of a single meal.

FOOD OF JUVENILES

Those who maintain that the young of a bird species subsist primarily and to a much greater extent on animal food than do the adults of the same race will find no support to their contention here. Although seven juvenile stomachs are too few to permit of more than generalized statements about food preferences, the data show quite convincingly that the young Pacific eiders consume more plant than animal matter.

PLANT FOOD—71.43 PERCENT

Six of the seven juveniles had drawn 65 percent or more of their meal from the vegetable kingdom, and one of these, a downy duck marked "very young," had made 90 percent of its meal on plant food. It seems that the young birds browse on the growing vegetation and ingest most any kind of drifting material. Consequently, most of the vegetable food could not be identified beyond the family. The kinds taken, expressed in percentages, were as follows: Sedges, mostly plant material, 8.14; unidentified algae, 6.57; muskgrass plant fiber and oögonia (*Chara* and *Nitella* ?), 1.86; and miscellaneous material, 54.86, which included eelgrass (*Zostera marina*), fed upon by one bird, and crowberry (*Empetrum nigrum*), eaten by two, yet

neither amounting to as much as 1 percent, plant fiber of grass, unidentified vegetable debris, and wood pulp.

ANIMAL FOOD—28.57 PERCENT

Animal foods noted in the juvenile Pacific eider stomachs were of varied kinds. Listed in percentages, in order of importance they are as follows: Mollusks, 11.57, made up mostly of bivalves (pelecypods), including small razor clams (*Siliqua*) and tellen shells; insects, 7, consisting largely (4.29 percent) of caddisfly larvae but including smaller numbers of beetles, whose presence indicates that some of the birds had been feeding in fresh-water tundra pools, and brine fly larvae (*Ephydra*), suggesting brackish areas; soft-bodied crustaceans, 5.57, including amphipods and water fleas; undetermined fish remains, 2.86; and miscellaneous animal matter, 1.57.

KING EIDER (Somateria spectabilis)

(Pl. 5, facing p. 96)

The king eider, one of the handsomest of the group, has a circumpolar distribution and may be found over a wider territory than any other of its congeners. It is said to occur in numbers farther out at sea than any other waterfowl. Even though most of the birds of this species remain as far north in winter as there is open water, some may be found in comparatively southern latitudes. They wander much more than any others of this group, and therefore stragglers may turn up in all sorts of unexpected inland places where the common and Pacific eiders are never seen. Although this species is gregarious it is said to be much less sociable both summer and winter than any of its relatives and wilder in disposition, although Nelson (*72, p. 80*) writes of its being tame on the breeding grounds. In its feeding habits and in the kinds of food consumed it seems to show a closer relationship to the Pacific eider than to any other species, although it usually feeds farther away from shore and in deeper water than related forms. It is reported to hug the shore line in migration, however, and sometimes in its daily movements; consequently many of its numbers fall prey to the Eskimos. The species is not highly prized by the epicure, however, perhaps because of the nature of its food.

Hanna (*42, p. 408*) found this eider abundant in all the lakes near the sea, where "many of the birds were paired and were evidently nesting." Phillips (*81, v. 4, p. 121*) states that—

> the actual breeding sites are characteristic in that they are almost always in fresh ponds or tundra pools removed a little way from the sea and never on outlying islands or on the actual coast-line. No doubt this duck is far more plentiful than is commonly supposed for it comes little in contact with civilized man, and its nests being much more scattered are less easily discovered and robbed.

Eider down is not often gathered from the nests of these birds, because they are more widely scattered than those of the American, or common, eider. It is valuable, however, and is taken from collected birds to furnish a part of the eider down of commerce. Skins with their feathers have also furnished a part of the Eskimo dress.

Food of Adults

There seems to be convincing evidence that the king eider can and does feed in deeper water and stays under longer than most if not all other ducks, with the possible exception of the old squaw. Hagerup (*40, p. 19*) asserts that it seeks rather deeper water than *S. borealis*. Norton (*73, p. 18*) found the birds feeding in unusually deep water off the coast of Maine. Sterling (*86*) gives record of a bird taken in a gill net 55 feet below the surface, on Lake Erie. In writing of the birds of Pribilof Islands, Preble and McAtee (*83, p. 57*) state that Hanna notes that this species can descend to the bottom in 30 fathoms of water, because one that he shot just after it came to the surface of water of this depth had freshly swallowed mollusks in its gullet. These peculiar feeding habits do, of course, have a marked bearing upon the kinds of food obtained, and as with related species a large variety of invertebrate forms is consumed.

The following examples indicate that the king eider is both a voracious and omnivorous feeder. One November bird collected at Shirleg Bay, Ottawa River, Ontario, had taken 142 caddisfly larval cases, 1 small frog (*Rana*), a fish, 42 or more bugs, 131 beetles, 1 nerve-winged insect (Neuroptera), 2 dragonfly larvae (Libellulidae), 1 isopod (*Mancasellus*), 1 univalve, more than 16 bivalves (mostly *Unio*), statoblasts of a bryozoan, algae (part *Spirogyra*), 2 seeds of spikerush (*Eleocharis*), 1 of cyperus, 1 of sedge (*Carex*), and 1 of waterplantain (*Alisma plantago-aquatica*), besides a small quantity of undertermined vegetable debris and wood pulp, probably taken as drift. Another bird taken at the same locality, with its stomach equally gorged, had consumed 28 species, many of which were the same as those above listed. Similar results were noted by Embody (*30, p. 630*), who found that a specimen taken late in November on the Seneca River, N. Y., contained 1 johnny darter fish (*Boleosoma nigrum olmstedi*), 2 leopard frogs (*Rana pipiens*) and bones of another, 5 whirligig-beetles (*Gyrinus*), 2 water boatmen (*Corixa*), 72 fresh-water amphipods (*Gammarus fasciatus*), 2 small snails (*Planorbis*), 1 *Asellus*, 3 *Physa*, 1 small *Limnaea*, several pieces of shell of a large bivalve, 2 small unidentifiable seeds, and 3 small pieces of leaves of some aquatic plant.

In this study the average number of specific items in a stomach was 8.13, which, although not large, is greater than the number taken by other eiders that are more selective or restricted in their food tendencies. Many of the stomachs were only partly filled: consequently the quantity of gravel (24 percent of the stomach volume) was larger than that taken by some other eiders.

The number of adult king eider stomachs available for examination was 95, but as 6 of these were nearly empty and 4 were preserved with insufficient data as to the time of collection, the food percentages (tables 20 and 26) are based on the analyses of only 85 stomachs. These were collected primarily in Alaska, but also in three States, two Canadian Provinces, and Siberia, during the six months January, February, March, May, June, and November.

The 4 stomachs that had only the year of collection designated—3 collected in Alaska and 1 in Manitoba—contained food similar to that in the 85 stomachs. It may be summarized, in groups and percentages, as follows: Blue mussel, 23.75; other pelecypods, including the

horse mussel (*Modiolaria*), 8.50; periwinkles (*Littorina*), 22.75; other gastropods, 1.50; amphipods, 31.50; other crustaceans, 0.50; miscellaneous animal matter, including hydroids, bryozoans, clamworms, and sea urchins, 1.75; and algae, 9.75.

TABLE 20.—*King eider (Somateria spectabilis): Food, by volume percentages, of 85 adults taken during 6 months of the year*

Kind of food	Percentage of food	Kind of food	Percentage of food
ANIMAL FOOD (94.49 percent)		ANIMAL FOOD (94.49 percent)—contd.	
Mollusks	45.75	Crustaceans—Continued.	
Blue mussel (*Mytilus edulis*) and horse mussel (*Modiolaria*)	19.81	Miscellaneous	1.04
Rock borer (*Saxicava arctica*)	1.86	Echinoderms	17.20
Razor clams (*Siliqua*)	1.76	Sand dollar (*Echinarachnius parma*)	8.01
Venus-heart (*Venericardia ventricosa*)	1.19	Sea urchin (*Strongylocentrotus drobachiensis*)	5.63
Tellen shells (*Tellina*)	1.14	Miscellaneous	3.56
Other pelecypods	8.78	Insects (Trichoptera and others)	5.20
Tachyrhynchus erosa	2.27	Sea anemone (*Aulactinia capitata*)	2.38
Periwinkles (*Littorina*)	1.88	Miscellaneous animal food	5.35
Other gastropods	5.75	PLANT FOOD (5.51 percent)	
Chitons and undetermined	1.31		
Crustaceans	18.61	Eelgrass (*Zostera marina*) and wigeongrass (*Ruppia maritima*)	2.43
King crab (*Dermaturus mandtii*)	9.09	Algae	2.21
Cancer crabs (*Cancer*)	2.26	Miscellaneous plant food	.87
Other crabs	1.93		
Amphipods	2.29		
Sessile barnacles (Balanidae)	2.00		

ANIMAL FOOD—94.49 PERCENT

That the king eider is predominantly an animal feeder is indicated by the fact that approximately three-fifths of the birds had fed exclusively on animal forms.

Mollusks (45.75 percent).—All but 9 of the 85 birds had taken one or more mollusks, slightly more than three-fourths of which were bivalves (pelecypods) (34.54 percent). As is typical of other *Somateria* eiders, the king eider consumed Mytilidae (19.81 percent) in greater volume than any other group, making them nearly one-fifth of its food. The blue mussel (*Mytilus edulis*) (17.16 percent) and the horse mussel (*Modiolaria*) (2.65 percent) entered into the diet of more than two-thirds of the birds in quantities ranging from a mere trace to 100 percent. Many other bivalves were found, yet none seemed to be of outstanding importance. It is probable that relative availability in the accustomed habitat constituted the primary determining factor in the relative consumption. The pelecypods other than Mytilidae that entered most prominently into the diet and their percentages were: Rock borer (*Saxicava arctica*), 1.86; razor clam (*Siliqua*), 1.76; venus-heart (*Venericardia ventricosa*), 1.19; and tellen shells (*Tellina*), 1.14. Other bivalves (8.78 percent) included cockleshells (*Cardium*), northern scallops (*Pecten islandicus*), freshwater clams, oysters (*Ostrea*), and undetermined forms. All of them, except the oyster, were taken by two or more of the birds.

Although many univalves (gastropods) (9.90 percent) entered into the diet, only species of two genera, namely *Tachyrhynchus erosa* (2.27 percent) and the periwinkle (*Littorina*) (1.88 percent), supplied more than 1 percent. Other gastropods (5.75 percent) included moon shells (*Natica*), rock shells (*Thais*), dove-shells (*Mitrella*),

whelks (*Buccinum*), oyster drill (*Urosalpinx cinereus*), hairy-shell (*Trichotropis nucellatus*), limpets (*Acmaea*), top shells (*Margarites*), and undetermined species.

Coat-of-mail shells (*Chiton*) (0.55 percent) and undetermined species (0.76 percent) made up the remaining molluscan food (1.31 percent).

Preble and McAtee (*83, p. 57*) found that 53 eiders taken on the Pribilof Islands had made 34.36 percent of their meals on mollusks. Like other eiders, they consumed shells of almost unbelievable size. Collett, as reported by Dresser (*26, Somateria spectabilis, p. 6* [=*648*]), found that two adult males taken in winter in northern Norway were full of mollusks, chiefly "*Pecten islandicus, Cyprina islandica,* and *Mytilus modiola,*" some of these being unbroken and more than an inch in diameter. Whitfield (*95*) speaks of finding remains of cancer crabs (*Cancer irroratus*), shells of young blue mussels, and a young moon shell (*Lunatia heros*) in the stomach of a king eider. Some species of shells not noted in the present study are reported by other workers as found in the king eider's food.

Crustaceans (18.61 percent).—As a class, crustaceans were second in importance of all foods eaten by the king eiders. The king crab (*Dermaturus mandtii*) (9.09 percent) supplied nearly half the crustacean food, entered into the diet of about two-fifths of the birds, and during January contributed nearly one-fourth of the food. Cancer crabs (*Cancer*) (2.26 percent) were second in importance. Included among the other crabs (1.93 percent) were hermit crabs (*Pagurus*), which averaged slightly less than 1 percent of the food. Amphipods (2.29 percent) were of frequent occurrence, and sessile barnacles (2 percent) entered into the rations of even a larger number of birds. Miscellaneous crustaceans (1.04 percent) were mostly soft-bodied species. Norton (*74, p. 439*) found the gullet of one bird taken off the Maine coast filled with the common sea flea (*Gammarus locusta*) and that of another with young cancer crabs (*Cancer irroratus*).

Echinoderms (17.20 percent).—The most distinctive feature of the food of this majestic bird is its unusually high consumption of echinoderms, which represent almost one-fifth of the food. Most species of waterfowl that feed extensively on littoral or pelagic forms consume a trace of these creatures occasionally, yet only a few ducks afford them a prominent place in the diet and none makes them such an important part of the food as does the king eider. The most relished of these sea creatures of radial symmetry was the sand dollar (*Echinarachnius parma*) (8.01 percent). Next in favor was the spiny spheroidal sea urchin (*Strongylocentrotus*, mostly *S. dröbachiensis*) (5.63 percent), which occurred in about one-fifth of the stomachs. Miscellaneous echinoderms (3.56 percent) consisted of starfish and brittle stars. Norton (*73, p. 18*) states that upon dissection of king eiders taken off the coast of Maine in April, their favorite food proved to be young holothurians, or sea cucumbers (*Pentacta frondosa*).

Insects (5.20 percent).—Insect remains, largely in the form of caddisfly larvae, but with smaller numbers of beetles and water bugs, entered prominently into the diet of June and November birds. Mayfly larvae, two-winged flies, and miscellaneous undetermined insect fragments formed but a trace of the stomach contents.

Sea anemone (2.38 percent).—The sea anemone (*Aulactinia capitata*) is fed upon at times by the king eider, as 12 were found in a single stomach, representing all but a trace of the meal.

Miscellaneous animal food (5.35 percent).—Bryozoans (1.31 percent) were taken by the king eider in each of the six months and here formed the largest percentage of that food for any North American waterfowl. Osburn (*76, p. 452*) states that he identified specimens of Bryozoa sent from ducks taken at the Pribilof Islands as *Crisia, Menipea pribiloft, Myriozoum subgracile*, and *Cellepora surcularis*. Marine worms (1.24 percent) likewise were frequently consumed, having been taken by nearly one-third of the birds. The remaining miscellaneous foods (2.80 percent) each averaged less than 1 percent. A sea squirt, or ascidian (*Boltenia ovifera*), made up 10 percent of the meal of one bird. Fishes or their eggs (0.63 percent) formed from a trace to 50 percent of the meal of 11 of the 85 birds. They were largely sculpins, and no valuable species were identified. Hydroids were found in 23 stomachs, foraminiferans in 5, a coral in 2, and frogs (*Rana*) in 2. Colonial hydroids at times seemed to be purposefully taken and were noted each month in larger volume than was the case with other species of sea birds. During November they amounted to more than 1 percent of the food. From the above it appears that the king eider is less discriminating in the choice of its food and takes more of the lower invertebrates than do other seafowl.

PLANT FOOD—5.51 PERCENT

Manniche (*62, p. 105*), in commenting on his observations in Greenland, writes:

> In the season in which the King-Eider lives in fresh water its food consists principally of plants. In the stomachs, which I examined, I found however many remnants of insects, especially larvae of gnats. In the stomachs of downy young ones I found indeterminable remnants of crustaceans, plants and small stones.

The facts obtained in the present study do not give much support to the observation relating to a preponderance of vegetable food during the summer season, as 35 May and June stomachs gave an average of but 7.5 percent vegetable matter. It is possible that if more stomachs had been taken at or near the nesting sites, or the tundra pools, the percent would have been somewhat higher. Plant food formed half or more of the meal in only 3 of the 85 stomachs, and judging by the nature of their food, which was of marine origin, all three birds had taken it while in the ocean or on a coastal bay.

Eelgrass and wigeongrass (2.43 percent).—Eelgrass (*Zostera marina*) was obviously sought by the king eider, as 2 of the birds had made most of their meal on it and 7 had fed on it to so considerable an extent that it formed 2.38 percent of the entire food of the 85 birds. Wigeongrass (*Ruppia maritima*) (0.05 percent) was less important.

Algae (2.21 percent).—Algae were of frequent occurrence and consisted mostly of plume algae (*Ptilota*).

Miscellaneous plant food (0.87 percent).—This group consisted of unidentifiable plant substance.

SPECTACLED EIDER (*Arctonetta fischeri*)

Perhaps less is known of the life history and habits of the spectacled, or Fischer's, eider than of those of any other living species of North American duck. This is probably due to its restricted breeding range and local distribution in the far north, for this attractively and distinctively colored bird occupies a limited area in northwestern Alaska and northeastern Siberia. It is said to favor shallow, muddy places, a habitat entirely distasteful to Steller's eider. It nests near fresh or brackish tundra pools close to the seacoast.

Nelson (*72, pp. 76–78*), to whom we are indebted for most of our knowledge of the habits and distribution of the species, writes:

> Its restricted range has, up to the present time, rendered this bird among the least known of our water-fowl. Even in the districts where it occurs it is so extremely local that a few miles may lead one to places they never visit * * *.
>
> * * * these Eiders breed from the head of Norton Bay south to the mouth of the Kuskoquim, at least. Saint Michaels may be noted as the center of abundance * * *.
>
> The spectacled eider is so restricted in its range and so local in its distribution, even where it occurs, that, like the Labrador Duck and the Great Auk, it may readily be so reduced in numbers as to become a comparatively rare bird. A species limited in the breeding season to the salt marshes between the head of Norton Bay and the mouth of the Kuskoquim River occupies but a very small territory, and a glance at the map will show this coast line not to exceed 400 miles, even following its indentations. The width of the breeding ground will not exceed 1 or 2 miles, and there are long stretches where it does not breed at all.
>
> In addition to the natural struggle for existence, the species has to contend against thousands of shotguns in the hands of natives. The diminution in all the species of waterfowl breeding along the coast is more and more marked each season, and while this may mean a desertion of one region for another in the case of the great majority of geese and ducks, yet for such narrowly-limited species as the Spectacled Eider, and to a less extent the Emperor Goose, this diminution is but the beginning of extermination * * *.

Bent (*10, p. 75*) assures us that the bird has decreased on the Alaskan coast since Nelson's early investigations and concludes that it is now to be found in greatest numbers "somewhere in northeastern Siberia, where it is one of the commonest eiders." Phillips (*81, v. 4, p. 75*) says: "It has the ear-marks of a disappearing species and without much doubt it will vanish ultimately from Alaskan waters."

Food of Adults

Bruette (*14, p. 344*) writes that the food of the spectacled eider—

> is about the same as that of Steller's eider, though the Spectacled Eider prefers more shallow water for feeding, than the related species. It frequents brackish pools and there obtains a good supply of small fish and mollusks, in addition to whatever weed seeds happen to be available.

Nelson (*72, p. 77*) states that this species subsists during the summer on small crustaceans, grass, seeds, and such other food as the brackish pools afford.

The data obtained in the present study indicate that this species is more of a vegetarian than the other eiders. In its comparatively low consumption of crustaceans, it differs noticeably from Steller's eider, and in its fondness for mollusks it shows a closer affinity to the more typical eiders (*Somateria*).

The stomachs of 22 adult spectacled eiders, 20 collected during the breeding season in May, June, and July and 2 in January, which were available for examination, are too few in number to give more than a suggestion of food preferences. Only 16 of the summer stomachs were full enough to be used in the computation of food percentages (tables 21 and 26).

The two January stomachs contained mostly amphipods and other soft-bodied crustaceans (90.5 percent). The molluscan food (5 percent) consisted mostly of pelecypods (4.5 percent)—the common blue mussel (*Mytilus edulis*) and the closely related horse mussel (*Modiolaria*)—and of a few gastropods (0.5 percent). The remaining groups, in percentages, were as follows: Sand dollars (*Echinarachnius parma*), 1.5; a byrozoan, which made up 2 percent of the contents of one stomach, 1; and protozoans, starfish, a sculpin, and algae, each of which amounted to 1 percent in one of the two stomachs, 2.

TABLE 21.—*Spectacled eider (Arctonetta fischeri): Food, by volume percentages, of 16 adults taken in May, June, and July*

Kind of food	Percentage of food	Kind of food	Percentage of food
ANIMAL FOOD (77.30 percent)		PLANT FOOD (22.70 percent)	
Mollusks	42.26	Pondweeds (Najadaceae)	6.98
Razor clams (*Siliqua*)	19.00	*Potamogeton*, mainly sago pondweed (*P. pectinatus*)	6.31
Other pelecypods	15.05	Horned pondweed (*Zannichellia palustris*)	.67
Moon shells (*Natica*)	1.87	Crowberry (*Empetrum nigrum*)	1.51
Other gastropods	5.76	Marestail (*Hippuris vulgaris*)	1.36
Undetermined	.58	Sedges (*Carex*, etc.) and grasses (Gramineae)	2.22
Insects	31.51	Miscellaneous plant food	10.63
Caddisflies (Trichoptera)	26.12		
Midges (Chironomidae)	5.07		
Miscellaneous	.32		
Crustaceans	2.56		
Miscellaneous animal food	.97		

ANIMAL FOOD—77.30 PERCENT

Mollusks (42.26 percent).—Mollusks supplied the largest volume of animal food for the spectacled eider. Bivalves (pelecypods) (34.05 percent) predominated, and more than half of these were razor clams (19 percent), which furnished 57 percent of the entire food of eight birds taken in May. Of the univalves (gastropods) (7.63 percent), the moon shell (1.87 percent) was most important. Some undetermined species of mollusks (0.58 percent) were taken. The birds examined were all taken in summer. It is probable that the consumption of mollusks would be even greater in winter, because winter birds do more of their feeding in the ocean or salt-water bays, where, it seems evident, the food would show a marked reduction in vegetable and insect material and a corresponding increase in marine invertebrates, such as mollusks and crustaceans.

Insects (31.51 percent).—Although insect food seemed to be eagerly sought, it is probably of light value except during the summer months when the pools of the arctic tundra have thawed. Caddisfly larvae (26.12 percent) were eaten in abundance, and for the limited number of June and July birds formed 45.20 and 32.67 percent, respectively, of the food. Midge larvae (5.07 percent),

which are such an important food item for many waterfowl, were next in importance. The miscellaneous insect food (0.32 percent) consisted mostly of beetle larvae.

Crustaceans (2.56 percent).—Isopods (mostly *Mesidotea entomon*) supplied the principal crustacean food.

Miscellaneous animal food (0.97 percent).—This includes undetermined animal matter (0.76 percent), a trace of a coarse species of fish (found in only one stomach), and fragments of lemming mice (*Lemmus*), sand dollars, and hydroids.

PLANT FOOD—22.70 PERCENT

Pondweeds (6.98 percent).—The most important plant foods entering into the diet of the spectacled eider for the three months (summer) were the pondweeds, particularly sago pondweed (*Potamogeton pectinatus*) and related *Potamogeton* species (6.31 percent), 193 seeds of which were found in one stomach. The horned pondweed (*Zannichellia palustris*) (0.67 percent) was also eaten, one bird near St. Michaels, Alaska, having taken more than 700 seeds.

Crowberry (1.51 percent).—The fruit and seeds of crowberry (*Empetrum nigrum*) were ingested.

Marestail (1.36 percent).—Seeds and a small amount of plant fiber of marestail (*Hippuris vulgaris*) were taken, one stomach containing 154 seeds.

Sedges and grasses (2.22 percent).—Seeds and plant fiber of sedges, mostly *Carex*, and grasses formed part of the food.

Miscellaneous plant food (10.63 percent).—Most of this consisted of unidentifiable plant fiber, drift, and wood pulp (9.75 percent). Miscellaneous seeds, forming from a trace to less than 1 percent of the food, included buttercup (*Ranunculus*), bramble (*Rubus*), silverweed (*Potentilla*), dogwood (*Cornus*), algae, and mosses.

Food of Juveniles

Analyses of five juvenile spectacled eider stomachs collected during May, June, and July indicate that the juvenile and adult foods were very similar, except that proportionately more plant material entered into the diet of the young, as was the case with the juvenile Steller's eiders. Contrary to the general rule, the young of both these eiders seem to require less protein, or at any rate, less animal matter than do the adults. As is typical of other praecocial young, the juvenile spectacled eiders fed on a large variety of objects, averaging slightly less than 13 species a stomach as compared with nearly 10 for the adults. Gravel formed 1.6 percent of the stomach volume for the juveniles as compared with 10.32 percent for the adults.

ANIMAL FOOD—53.60 PERCENT

Insects furnished about 70 percent of the animal food. Caddisfly larvae and their cases, by far the most important food consumed by each of the five juvenile spectacled eiders, averaged 37 percent of the total volume; and midge larvae, crawling water beetles (*Haliplus longulus*), and undetermined insect remains, 0.20 percent each. Fragments of ground-up bivalves (pelecypods) furnished 6.60 percent; univalve (gastropod) fragments, 6.40; ostracods (*Candona ikiakica*),

1.20; water fleas (with ephippia), 1; bryozoans, a trace; and undetermined animal debris, 0.80.

PLANT FOOD—46.40 PERCENT

Plant food averaged 46.40 percent of the food of the juvenile spectacled eiders as against 22.70 percent for the adults. Seeds and plant fiber of marestail (*Hippuris vulgaris*) averaged 13.80 percent; pondweed (*Potamogeton*) seeds and plant fiber, 7; crowberry (*Empetrum nigrum*) seeds and fruit, 6.80; plant fiber of grasses and sedges, 2.20; seeds of sedge (*Carex*), 1; seeds and plant fiber of buttercup (*Ranunculus*), bramble (*Rubus*), silverweed (*Potentilla*), and moss, averaging less than 1 percent each, 1.40; and finely comminuted, undetermined vegetable debris, 14.20.

SCOTERS

The scoters, formerly classed as members of one genus, are now systematically separated into two genera, *Melanitta* and *Oidemia*. These large, heavily built birds, known also as coots, sea coots, gray coots, and black ducks, are the characteristic salt-water ducks of middle temperate latitudes. They and the eiders are the largest of our sea ducks, but the scoters are the better known of the two groups because they occur in more southern latitudes. The males are predominantly black, the two *Melanitta* species having small patches of white. The bills are swollen at the base and are highly colored, giving rise to the familiar appellations horse-nosed coot, blossom-bill, butter-billed coot, and skunkhead. The females, largely without distinctive pattern, are colored in heavy masses of very dark brown with light areas around the head. These and their juveniles in first autumn plumage are difficult to distinguish. In size, shape, gait, flight, and general appearance the three North American species are much alike.

Like the eiders, with which they have much in common in food habits, the scoters are expert divers, feeding primarily—except during the breeding season—on marine foods, predominantly mollusks; consequently all have been vigorously condemned by the shell fishermen. Although not averse to the open ocean, the scoters generally frequent the quieter waters of bays and estuaries, where they find a more abundant and more accessible food supply. Their exact distribution is largely determined or influenced by the relative degree of availability of acceptable food.

Though predominantly and typically sea ducks except during the breeding season, the scoters are all noticeably less pelagic than the eiders, frequenting in limited numbers the larger inland bodies of water, such as the Great Lakes. Unlike the eiders, they usually nest at great distances inland on the borders of fresh-water ponds. As they winter along both North American coasts, extended migration flights are made. During the winter months these birds are seldom off the water except for short flights to and from their favored feeding grounds. The three species frequently intermingle on the wintering grounds, forming large flocks, but in migration many flocks are composed of but a single species.

All scoters are peculiar in the late migration of young and females—which may be explained by the late nesting habits—and in the

fact that adult males with a few females, which may be nonbreeders, precede this main flight of young and females by about a month. Migration proceeds both by day and by night, and, judging from the limited data available, extended nonstop flights often occur. In Norfolk, Conn., after midnight on October 22, 1933, some 300 American scoters (nearly all adult males), perhaps becoming confused by airplane beacons and a dense low fog, dropped to the ground. The writer (*20*) found that stomachs of eight of the birds killed by the fall were practically empty, indicating that some time had passed since they had eaten.

The flesh of these ducks is dark and is said to be strong and fishy, particularly in winter adults. The young, or "gray coots," however, are much less objectionable and are eagerly sought, especially along the northern coasts. "Coot shooting" is the favorite sport of many gunners along the New England coast. As none of the scoters are very cautious, they are readily attracted by decoys and so fall easy prey to the experienced coot shooter. Mackay (*59, p. 282*) writes:

> When wounded and closely pursued, they will frequently dive to the bottom (always using their wings as well as feet at such times in swimming under water) and retain hold of the rockweed with the bill until drowned.

WHITE-WINGED SCOTER (Melanitta deglandi)

(Pl. 5, facing p. 96)

The white-winged scoter is the largest and most readily distinguished of its tribe and is probably the most abundant scoter along the New England coast. It is the only one exhibiting a white speculum, which Hanna states (*43, p. 252*) makes it an excellent target "for the man with the shot gun out after fresh meat in the dim light of the arctic winter morning." It occurs as a breeder in the interior of North America from North Dakota and northeastern Washington northward through Alaska to Hudson Bay, Ungava, and the Gulf of St. Lawrence. Limited numbers of the birds winter on the Great Lakes, but most of them may be found along both coasts southward to southern California and South Carolina. Like other sea ducks with which they consort, they usually fly rather close to the water while on their feeding and loafing "ground," yet in migration when flying overland they travel at high elevations and with considerable speed. In getting under way they need a great deal of sea room. Their flight is comparatively slow and clumsy.

In obtaining food, they dive to varying depths. Alford (*1, p. 108*) mentions their feeding in 24 feet of water, and Bent (*10, p. 135*) says they sometimes feed in 40 feet. Most of their feeding and diving, however, is probably in water less than 15 feet deep. According to Roberts (*84, pp. 275–276*) W. J. Breckenridge found that in six consecutive dives a male averaged 57.5 seconds under water and 12 seconds on the surface between dives and a female 62 and 11 seconds.

There is little doubt but that the species has declined alarmingly in numbers during recent years, owing perhaps to many factors but largely to drought and to encroachment upon its nesting territory by civilization. Shooters generally consider it the dumbest of all true sea ducks and find it easily attracted to decoys and brought nearer the water by a shrill whistle.

Food of Adults

The information at hand indicates that the white-winged scoter is predominantly an animal feeder, as more than 89 percent of the birds had taken animal food exclusively, and that, as is characteristic of all scoters, it finds mollusks, particularly bivalves, the most acceptable food. The fact that this duck breeds in the interior and winters mostly along the coast in a salt-water habitat suggests, however, a rather wide degree of adaptability in food selection, and there is little doubt that a more representative series of birds taken from the interior would show a higher degree of vegetable consumption. Evidence of such adaptability in the choice of food is presented in McAtee's report (*54, p. 8*) of a number of individuals on a Wisconsin lake in fall feeding almost exclusively on the tender winter buds of wildcelery. The writer found, however, that although the white-winged scoter is adaptable, the number of kinds of food in a meal averaged fewer than four. It seems that when an acceptable food is found it is consumed in quantity and often exclusively.

Almost every bird examined for this study had consumed some sand or gravel but in smaller volume than is the case with many other waterfowl. The quantity found in reasonably full stomachs ranged from a trace to about 50 percent, yet the total averaged but 7.22 percent of the stomach content. Probably a smaller quantity of this abrasive material is taken because the mollusks, which are consumed excessively, themselves serve as effective grinding material. This species seems to take larger bits of gravel than is usually the case. One bird had swallowed a pebble measuring 11 mm across; another bird, one measuring 25 by 18 by 12 mm. As is common with other waterfowl, feathers, probably from the bird's own body, were found in nearly 5 percent of the gizzards.

From the writings of European workers, it appears that the velvet scoter (*Oidemia fusca*), the closest relative of the American white-winged scoter and regarded by many as being only subspecifically different, has food habits very similar to the American bird. They mention that it feeds on the blue mussel (*Mytilus edulis*), cockles (*Cardium*), cancer crabs (*Cancer*), *Mactra*, *Tellen*, and razor clams (*Solen*), all genera readily acceptable to the American form.

The stomachs of 903 adult white-winged scoters were examined, but only 819 of these (including gizzards and gullets), taken during every month except June and September, were full enough to be used in the determination of food percentages (tables 22 and 26). Although the birds were collected at widely separated areas, representing 15 States, Alaska, and 5 Canadian Provinces, more than 83 percent of them were taken along the coasts of Massachusetts and Washington, all but a few during a series of investigations to ascertain their relation to commercial shellfish industries.

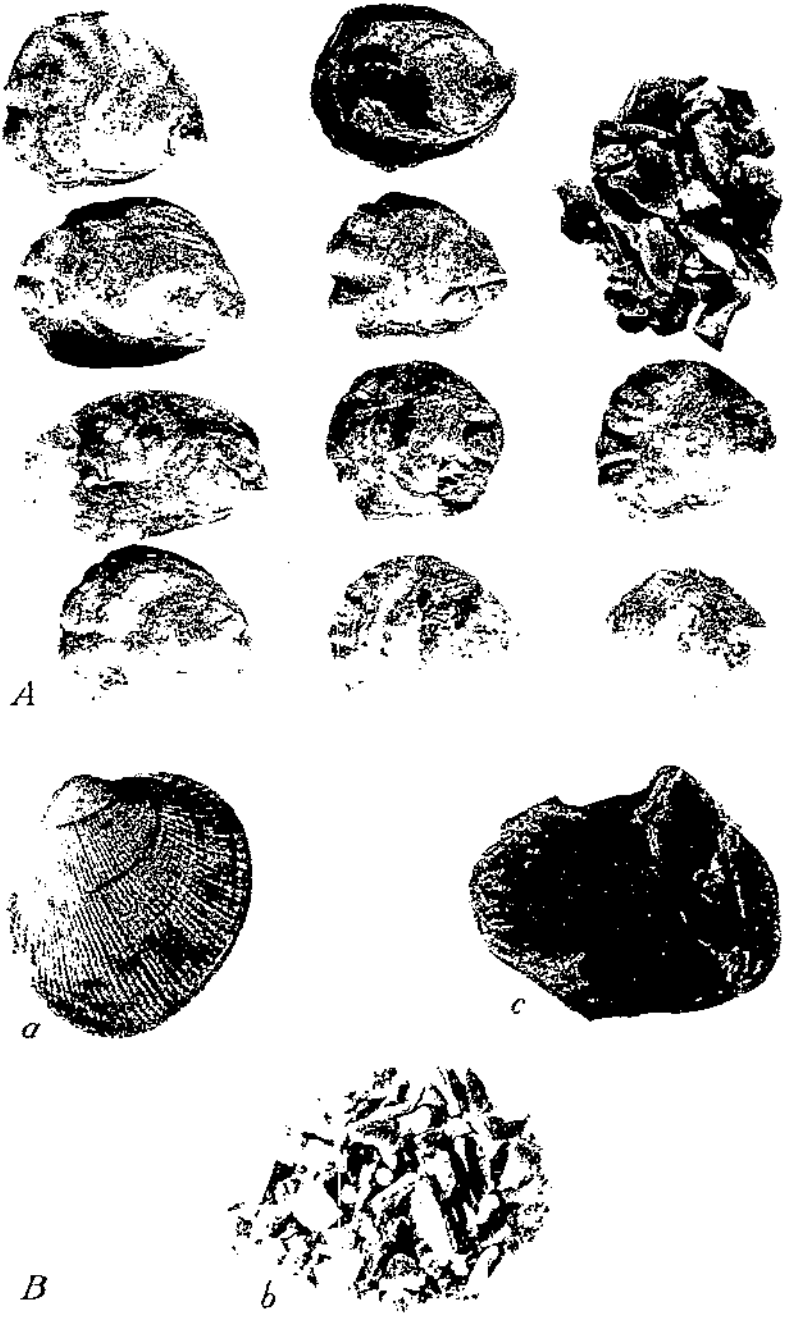
TABLE 22.—*White-winged scoter (Melanitta deglandi): Food, by volume percentages, of 819 adults taken during 10 months of the year*

Kind of food	Percentage of food	Kind of food	Percentage of food
ANIMAL FOOD (94.12 percent)		ANIMAL FOOD (94.12 percent)—continued	
Mollusks	75.34	Crustaceans—Continued.	
Rock clams (*Protothaca*)	14.27	Mud crabs (*Hemigrapsus*)	1.02
Oyster (*Ostrea lurida*)	13.86	Other crabs	1.38
Blue mussel (*Mytilus edulis*) and other Mytilidae	11.98	Crawfishes (*Cambarus*)	.36
Macoma and *Tellina* shells	5.52	Amphipods	3.53
Razor clams (*Siliqua*)	4.97	Barnacles (Balanidae) and others	2.99
Scallop (*Pecten irradians*)	3.23	Miscellaneous	.88
Surf clam (*Mactra solidissima*)	1.12	Insects (Trichoptera and others)	2.46
Hard-shelled clam (*Venus mercenaria*)	1.10	Fishes (Pisces)	1.73
Other pelecypods	7.26	Miscellaneous animal food	1.41
Dog whelks (*Nassarius*)	2.01	PLANT FOOD (5.88 percent)	
Moon shells (Naticidae)	2.43		
Slipper shells (*Crepidula*)	2.15	Eelgrass (*Zostera marina*) and other pondweeds (*Potamogeton*)	1.09
Other gastropods	2.52	Burreed (*Sparganium*)	1.20
Chitons and undetermined	2.32	Miscellaneous plant food	2.70
Crustaceans	13.18		
Rock crabs (*Cancer*)	2.00		

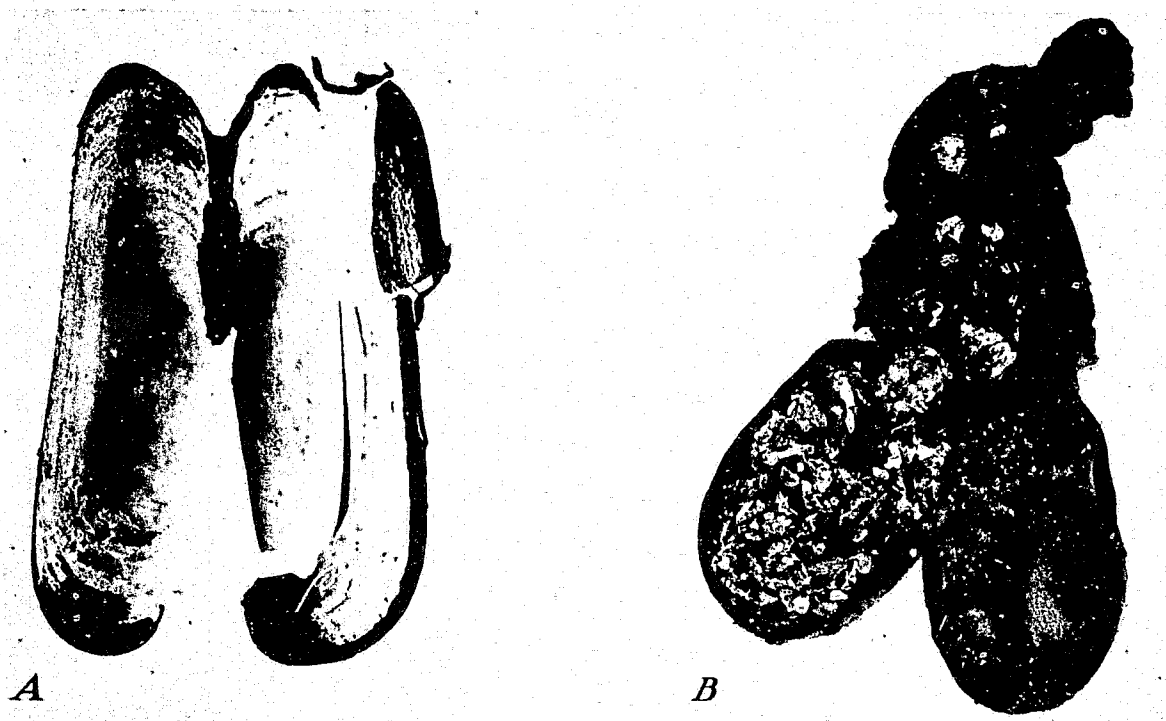
ANIMAL FOOD—94.12 PERCENT

Mollusks (75.34 percent).—More than three-fourths of the entire food of the white-winged scoter consisted of mollusks, mostly bivalves (pelecypods) (63.31 percent). It seems that within size limits, availability is the primary factor governing the bird's selection of these foods, so that concentrations of these birds on a planted commercial shellfish bed may result in great damage, although elsewhere these seafowl cause little or no destruction. Conspicuous examples of serious depredations have occurred at planted beds in Massachusetts and Washington, and because, as stated, so many of these mollusk-feeding birds were taken at these localities over planted beds of oysters, scallops, and both hard- and soft-shelled clams, it is not surprising that they took many commercial clams. Consequently the results here recorded show the bird at its worst as a predator on commercially valuable shellfishes and should be considered more damaging to the bird than average conditions would justify. In this, as in all instances, the results of stomach examinations must be rationally interpreted on the basis of all the information available.

In this study commercial shellfishes, including oysters (*Ostrea lurida*) (13.86 percent), scallops (*Pecten irradians*) (3.23 percent), quahogs, or hard-shelled clams (*Venus mercenaria*) (1.10 percent), and soft-shelled clams (*Mya arenaria*) (0.29 percent), aggregated slightly less than a fifth (18.48 percent) of the food. Specific investigation at commercial beds in Massachusetts showed that scallops formed about half the food of a series of white-winged scoters collected there, and a similar investigation at planted oyster beds in Washington revealed that oysters were supplying a like quantity. Although it is apparent that such examples represent extreme cases, yet under such circumstances protective measures or control operations are imperative. Fortunately these birds, along with most of the true sea ducks, feed almost entirely by day and are fairly easily driven out by the operation of a motorboat equipped with loud sirens, particularly when combined with a little shooting. Conse-



A, Contents of gullet and gizzard of a white-winged scoter (*Melanitta deglandi*): 10 whole oysters and fragments of others and 5 limpets (*Lemaca patina*), the largest oyster measuring more than 51 mm long and another almost 38 mm wide. *B*, Stomach of a white-winged scoter and contents: *a*, Whole rock clam (*Protothaca staminea*), 54 by 45 by 29 mm; *b*, fragments of 6 rock clams; *c*, empty stomach.



B5573M; B4368M

A, Clam (*Tagelus gibbus*), measuring 77 by 27 by 22 mm and weighing 21½ g, taken from gullet of a white-winged scoter (*Melanitta deglandi*). *B*, Opened gizzard and proventriculus of a white-winged scoter showing the progressive trituration of hard-coated barnacles (*Balanus glandula*) as they pass into the muscular gizzard. The contents consisted of more than 100 barnacles; fragments of 9 blue mussels (*Mytilus edulis*), 1 limpet (*Acmaea pelta*), 4 periwinkles (*Littorina scutulata*), 4 amphipods (*Hyale*), and 1 ant; and plant debris.

quently, economical remedial measures can be applied without destroying many of the birds.

The strength and degree of elasticity in the stomach of this seafowl is surprising. The gullet of a bird collected over an oyster bed near Olympia, Wash., contained 10 oysters, one measuring more than 51 mm in length and another almost 38 mm in width (pl. 9, *A*). In addition, remains of other oysters were found in the hard, muscular gizzard. The remains of 46 young oysters were found in another gizzard and only slightly smaller numbers in several others. The gullet of a bird taken on a scallop bed near Edgartown, Mass., contained four entire shells measuring 1¾ by 1⅝, 1 11/16 by 1⅝, 1⅝ by 1⅝, and 1⅜ by 1⅜ inches, respectively, and the remains of three scallops of similar size were found in the gizzard. When shot, one Virginia bird had just swallowed four hard-shelled clams averaging more than 1 inch across. The strength and grinding power of the scoter's gizzard is marvelous, as many mollusks that a man's fingers cannot break are found in it being ground and chemically disintegrated. It requires a brisk blow with a hammer to break the shells of such mollusks as the quahog (*Venus mercenaria*), rock clam (*Protothaca staminea*), or rock shells (*Thais*), yet these seem to be acceptable articles in the diet of this bird.

Mackay (*59, p. 280*) writes of a white-winged scoter feeding on a clam "about the size of a silver dollar; it cut the skin of the neck when the bird struck the beach after being shot. Mussels measuring 2½ inches by 1 inch have been taken from them." Although such large bivalves as these are sometimes consumed, the mussels, of varying sizes, are usually smaller than half a dollar. A number of records are given of a clam closing on the tongue or mandible of a bird and causing its death by strangulation.

The rock clam of the west coast (14.27 percent) was the most important single food of the white-winged scoter and was the principal item in a large percentage of the stomachs of the birds collected there. Only a few western birds had not obtained any. One bird taken at Oyster Bay, Wash., had swallowed a heavy one measuring 54 by 45 by 29 mm (pl. 9, *B*); in addition its stomach contained seven broken shells of the same species and one oyster.

Mytilidae (11.98 percent), consisting of the blue mussel (*Mytilus edulis*) (11.58 percent) and related species (0.40 percent), occurred in nearly a fourth of the stomachs. The blue mussel was the principal food item taken by the birds collected on the Atlantic seaboard away from commercial shellfish beds, and its relative rating undoubtedly would have been much higher had collections of birds been made without regard to shellfish industries. A single stomach contained 30 shells. Forbush (*32, p. 162*) reports that three birds taken from Nantucket, Mass., had eaten only this mussel.

Tellinidae (5.52 percent), consisting of *Macoma* (5.50 percent) and *Tellina* (0.02 percent) shells, were consumed by about one-fifth of the birds. One individual had made most of its meal on 20 of these shells. Razor clams (*Siliqua*) (4.97 percent) also appeared to be entirely acceptable. Surf clams (*Mactra solidissima*) (1.12 percent) formed only slightly less than one-tenth of the food of 47 October birds taken along the Atlantic coast. Birds collected near Long Island, N. Y., had subsisted largely on them.

The other pelecypods (7.26 percent), each of which averaged less than 1 percent, included cockleshells (*Cardium*), which, although not taken by many birds, made up most of the meals of a few; nut-clams (*Nucula*), one stomach containing 80 *N. proxima;* ark clam (*Arca*); *Anodonta; Astarte; Saxidomus giganteus; Saxicava;* and *Pandora.* One large male bird, weighing 1.76 kg, had swallowed a clam (*Tagelus gibbus*) that weighed 21½ g and measured 77 by 27 by 22 mm (pl. 10, *A*).

Of the gastropods (9.71 percent), the principal ones included dog whelks (*Nassarius*) (2.61 percent), moon shells (Naticidae) (2.43 percent), and slipper-shells (*Crepidula*) (2.15 percent), all of which, though frequently consumed, were of major importance in only a relatively few instances. One bird had taken 60 dog whelks; another, 92 slipper-shells.

Many other gastropods (2.52 percent) were identified in the stomachs of this scoter. None of these furnished as much as 1 percent of the food, yet some of them made up the major part of several meals and in a few instances more than 100 shells were noted. The most important among these included oyster drills (*Urosalpinx cinereus*), rock shells (*Thais*), periwinkles (*Littorina*), dove-shells (*Mitrella* and *Anachis*), olive shells (*Oliva*), limpets (*Acmaea*), river-shells (*Goniobasis*), and keel-shells (*Carinifex newberryi*). Grinnell, Bryant, and Storer (*38, p. 200*) found seven univalves (one *Olivella biplicata*, four *O. intorta*, one *Nassarius perpinguis*, one *Mangilia variegata*), and one hermit crab (*Pagurus*) in the stomach contents of a bird collected at Monterey, Calif.

The remaining mollusks (2.32 percent) comprised chitons (0.02 percent) and undetermined forms (2.30 percent).

Crustaceans (13.18 percent).—Crabs, crawfishes, and undetermined decapods were of frequent occurrence in the stomachs of the white-winged scoter and for a number of the birds formed the staple article of the meal. The most important crab was the rock crab (*Cancer*) (2 percent), 11 of which were taken in a single meal, forming the entire content. West coast mud, or shore, crabs (*Hemigrapsus*) (1.02 percent) were taken by 33 birds, 1 bird having made its entire meal on 17 and the others having taken only slightly smaller numbers. Other crabs (1.38 percent) included other mud crabs (*Neopanope* and *Hexapanopeus*), hermit crabs (*Pagurus*), horse crabs (*Telmessus cheiragonus*), and spider crabs. Crawfishes (1.38 percent) were consumed only during the summer and supplied more than 13 percent of the food of 15 July birds.

Amphipods (3.53 percent), including both marine and fresh-water species, were consumed in varying number by about 5 percent of the birds.

Barnacles (2.99 percent), mostly Balanidae, were identified in about 16 percent of the stomachs. In some instances it appeared that the fragments had been taken adventitiously or incidentally along with certain mollusks, but in others these hard-shelled, immobile forms had been purposely sought, as is clearly evidenced in plate 10, *B*. The bird from which this gizzard was removed had taken more than 100 barnacles (*Balanus glandula*), some entire, and others in all stages of disintegration as they progressed from the gullet to the pyloric end of the gizzard.

Miscellaneous crustaceans (0.88 percent) consisted of mysids and undetermined soft-bodied forms.

Insects (2.46 percent).—Insects were taken largely during the summer and fall. Caddisfly larvae (1.69 percent) composed 12.66 percent of the food during July, 2.43 in August, and 1.74 percent in October. Of the other insects taken (0.77 percent), the principal ones were dragonfly larvae, grasshoppers, lacewing larvae, water boatmen, beetles, and larvae of moths, midges, and other two-winged flies.

Fishes (1.73 percent).—The white-winged scoter cannot be regarded as a serious enemy of fishing interests. The evidence indicates that the fishes generally consumed in greatest numbers are small sluggish varieties that normally are the dominant species in those areas most frequented by these birds. In the order of their importance as food for this scoter the following fishes may be listed: Minnows, midshipman (*Porichthys notatus*), herring, sculpins (including *Myoxocephalus*), undetermined fishes, flatfishes (Heterosomata), and sand launce (*Ammodytes americanus*). Obviously, availability and ease of capture are important factors governing the selection and when easily obtained these fishes seemed to be entirely acceptable. One Manitoba bird taken in July had made 85 percent of its meal on 28 cyprinids. Trautman (*89*) mentions finding a gizzard shad (*Dorosoma cepedianum*) in the stomach of a bird taken in Ohio. Munro and Clemens (*70, p. 39*) report that in one of three birds taken at Vancouver Island herring ova made up 3 percent of the stomach contents, the remainder of which consisted largely of mollusks and crabs.

Miscellaneous animal food (1.41 percent).—This consisted primarily of echinoderms (0.89 percent)—including sand dollars, (mostly *Echinarachnius parma*), sea urchins (*Strongylocentrotus dröbachiensis*), starfishes, and brittle stars—which for a limited number of meals were particularly important. Grinnell, Bryant, and Storer (*38, p. 200*) report finding several sand dollars in the stomach contents of a bird collected at Monterey, Calif. Ascidians, water mites and other arachnids, foraminiferans, undetermined coelenterates, hydroids of six species, coral, bryozoans, clamworms and other marine annelids, and unidentifiable animal debris made up the remaining miscellaneous animal food (0.52 percent). In only a few meals were any of these items of importance.

PLANT FOOD—5.88 PERCENT

Although the seeds and vegetative parts of a fair number of plants were recognized in the laboratory examinations, plant food was relatively unimportant to the white-winged scoter, but, as stated, a more representative series of birds collected from the interior would doubtless show a higher percentage. Only two plants—eelgrass and burreed—amounted to more than 1 percent of the food. Vegetable material formed only a trace of the meal in less than 11 percent of the stomachs and more than 50 percent of the meal in only 2.4 percent. Only three birds had fed on it exclusively. During July, it supplied 23 percent of the food, 12 of the 15 birds taken that month having eaten it.

Pondweeds (1.98 percent).—Eelgrass (*Zostera marina*) (1.28 percent), *Potamogeton* species (0.70 percent), and a trace of wigeongrass

(*Ruppia maritima*) were taken. One bird had made its entire meal on eelgrass, and two others had gorged themselves on the tubers or subterranean parts of sago pondweed (*Potamogeton pectinatus*) and wildcelery (*Vallisneria spiralis*).

Burreed (1.20 percent).—The burreed (mostly *Sparganium eurycarpum*) was the next most important plant.

Miscellaneous plant food (2.70 percent).—Other plants relished in individual meals were coontail (*Ceratophyllum demersum*), dock (*Rumex*), sedges, barley (*Hordeum*), and moss. Plants of lesser value were muskgrass and other algae, watershield (*Brasenia schreberi*), watermilfoil (*Myriophyllum*), and grass. Unidentifiable plant debris and wood pulp aggregated 1.69 percent.

Yorke (*97, p. 71*) reports the following families of plants as being identified in the food of white-winged scoters: Duckweeds (Lemnaceae), pondweeds (Najadaceae), and mud aquatic plants (Selaginellaceae), moss teal moss (Salviniaceae), waterwort (Elatinaceae), floating heart (Gentianaceae), water herbs (Lentibulariaceae), pickerel weed (Pontederiaceae), and moss plants (Mayacaceae). He has also noted the following genera: *Iris*, *Myriophyllum*, *Callitriche*, and *Utricularia*. Greenwood (*36*) states that a number of birds taken in Iowa in October 1930 had fed mostly on vegetation that year and that as a result their flesh was palatable.

Food of Juveniles

The four stomachs available for study are too few to show more than tendencies, but in food habits the juvenile white-winged and surf scoters appear to differ from each other more noticeably than do the adults. Although both juveniles are predominantly animal feeders, the former seems to be only half as much a vegetarian as the latter, 10 percent as compared with 20.43. The young whitewings examined had subsisted primarily on crustaceans (76.25 percent), whereas the young surf scoters had merely tasted these forms and had relied on insects for the bulk of their protein diet (61 percent). The facts seem to suggest also that the young white-winged scoter cares less for mollusks.

Animal food—90 percent

The crustacean food (76.25 percent) consisted, in percentages, of amphipods (both *Hyalella azteca* and *Gammarus limnaeus*), 54.25; decapods, 19.25; isopods, 1.50; and barnacles, 1.25. Soft-bodied forms seemed to be preferred, although related groups were taken freely. The insects (8.50 percent) taken were, in percentages, caddisfly larvae, 2; beetles, including *Berosus* and *Haliplus*, 1.75; sialids, 1.75; and miscellaneous and undetermined forms, including grasshoppers and water boatmen, 3. Mollusks contributed 4.50 and miscellaneous animal matter 0.75 percent.

Plant food—10 percent

Plant food, both seeds and vegetative parts, seemed to be rather indiscriminately consumed. The following groups were noted in the percentages given: Grass, 2; bulrush, (*Scirpus*), 1.75; muskgrass, 1;

miscellaneous plants, including pondweeds (*Potamogeton*), horned pondweed (*Zannichellia palustris*), watermilfoil (*Myriophyllum*), and undetermined vegetable debris, 5.25.

SURF SCOTER (Melanitta perspicillata)

(Pl. 5, facing p. 96)

The surf scoter is variously known as patchhead, surf coot, surf duck, skunkhead, mussel bill, king coot, and bald-headed sea coot. The adult male is easily recognizable by its swollen and bizarre-appearing beak of contrasting colors of black, white, carmine, and yellow and its head and neck patches of white abruptly surrounded by black. In the field it is difficult to separate the female from the female American scoter, both of which are of more somber hues. The surf scoter is the most familiar coot along the Atlantic coast from New England southward through Pamlico Sound, N. C., and on the Pacific coast, and a fair number of nonbreeders remain in northern waters throughout the year. It is undoubtedly the most abundant and certainly the most widely distributed of the three American scoters, although like its congeners, it has sustained an enormous decrease. It breeds in clean, fresh-water ponds in the interior, from the northern prairie Provinces of Canada northward to western Alaska and Mackenzie Bay and to James Bay and Newfoundland. Although it can typically be regarded as a coastal bird, a limited number remain in the interior during the winter, particularly on large bodies of water, such as the Great Lakes. It is less inclined to drift inland than is the white-winged scoter. It hugs the coast on migration farther to the north than either of its close relatives and therefore has a noticeably different inland distribution. The birds fly in large flocks or irregular bunches without any attempt at regular formation.

The surf scoter is fully equal to most other sea ducks as a diver and depends on diving in the daily pursuit of food and at times also to escape from enemies. Although it is often seen feeding in mixed flocks of other seafowl in quiet coastal estuaries, it is not uncommon to observe it just outside the breakers, and it is often seen diving or "scooting" through the foaming crest of a breaking wave. According to Phillips (*81 v. 4, p. 52*) the diving extends from 6 to 30 feet. Alford (*1, pp. 107–108*) noted that the time under water is usually from 19 to 32 seconds and much more irregular than the time spent above water, probably because of the varying depths of the dives. Bruette (*14, p. 363*) contends that, different from either of the related species, it prefers to feed in shallow water, but "if need be he can dive as deeply as any of his tribe." It is interesting to fly over these birds in an airplane, not too far above them, and see an entire flock disappear almost all at once and after an amazing lapse of time reappear in a much more scattered flock. The bird dives with an awkward, quick splash, opening its wings as it goes under. From reports of other observers the wings are used as rudders in its subaqueous progression.

Although all scoters are regarded by gunners as being comparatively tame, this species seems a little less confiding and less absurdly foolish than the white-winged. Old birds, like those of related

species, are said to be quite unpalatable and tough unless skinned and cleaned immediately after killing and carefully parboiled before being cooked according to approved, tested methods.

Food of Adults

The surf scoter has much in common with the others of its tribe in food and feeding habits, although the details differ. It seems definitely to be more partial to vegetable food than its white-winged relative, and the data indicate that where appropriate plant foods are available they are consumed in quantity. Although some of the birds had made their meal on many items, more had been satisfied with only a few foods, making the average slightly more than five species a meal. Perhaps because the heavier-shelled mollusks were eaten in smaller numbers, gravel was taken more freely, forming 18.21 percent of the total stomach contents. A few feathers (fragmentary) from the birds' own bodies likewise were frequently noted. As with all the other species of divers studied, an occasional individual showed a fairly heavy infestation of gizzard worms (nematodes).

Laboratory examination of 217 stomachs of adult surf scoters revealed that only 168 were full enough to be used in evaluating total food percentages (tables 23 and 26). These were collected in 13 States, Alaska, and 7 Canadian Provinces in every month of the year. The comparatively large number of nearly empty stomachs—49, or almost one-fourth (22.6 percent) of those examined—indicates that these birds were taken a considerable period after feeding. Inasmuch as the birds are day feeders they usually begin their breakfast shortly after daylight. A number of the empty stomachs were reported taken between 8 and 10 a. m., which indicates the rapidity with which heavy mollusks can be digested and passed on into the intestines.

Table 23.—*Surf scoter (Melanitta perspicillata): Food, by volume percentages, of 168 adults taken during 12 months of the year*

Kind of food	Percentage of food	Kind of food	Percentage of food
ANIMAL FOOD (87.90 percent)		ANIMAL FOOD (87.90 percent)—contd.	
Mollusks	60. 80	Insects	9. 61
Blue mussel (*Mytilus edulis*) and other Mytilidae	28. 74	Caddisflies (Trichoptera)	3. 23
Macoma shells	7. 23	Dragonflies and damsel flies (Odonata)	1. 85
Mactra shells	3. 37	Diving beetles (Dytiscidae)	1. 54
Razor clams (*Siliqua* and related Solenidae)	1. 33	Miscellaneous	2. 99
Rock clam (*Protothaca staminea*)	1. 11	Fishes (Pisces)	3. 37
Other pelecypods	8. 23	Echinoderms	1. 83
Periwinkles (*Littorina*)	2. 18	Miscellaneous animal food	2. 03
Other gastropods	6. 59		
Chitons and undetermined	2. 02	PLANT FOOD (12.10 percent)	
Crustaceans	10. 28	Pondweeds (Najadaceae)	8. 24
Barnacles (Balanidae)	2. 50	Pondweeds (*Potamogeton*)	1. 27
Sand crab (*Emerita analoga*)	1. 80	Eelgrass (*Zostera marina*)	1. 14
Mud crabs (*Hemigrapsus*)	1. 39	Wigeongrass (*Ruppia maritima*) and horned pondweed (*Zannichellia palustris*)	. 83
Other crabs	2. 27	Miscellaneous plant food	8. 86
Amphipods	1. 03		
Miscellaneous	1. 27		

ANIMAL FOOD—87.90 PERCENT

Mollusks (60.80 percent).—Like the other scoters, the surf scoter draws more heavily upon mollusks for food throughout the year than upon any other group. Also, like others of its tribe, it consumes mostly bivalves (pelecypods), which averaged 50.01 percent of its food, as compared with 63.31 for the white-winged and 55.91 for the American scoter. The birds examined for this study were collected in widely separated areas, and as was the case for the preceding species, a fair number of them were taken during an investigation to determine their relation to shellfish industries. The fact that so few commercial shellfishes were consumed indicates that shellfish depredations by the scoter are uncommon and exceptional. Any mollusk-feeding bird may be destructive to a limited extent where commercial shellfishes abound. It was interesting to discover that oysters formed but 0.79 percent of the food, that only nine of the birds had taken them, and that none of the nine had taken more than two individuals. During March, when 11 birds were collected—most of them in an oyster area—these choice shells made up 6.76 percent of the food. Depredations upon scallops were at a minimum, as only a trace of one shell was found in one bird's stomach. No hard- or soft-shelled clams were found. From the evidence available it appears that the surf scoter cannot be considered a serious menace to the shellfish industry.

Like many other sea ducks the surf scoter seems to be partial to the blue mussel (*Mytilus edulis*) (27.72 percent). This abundant species and a few related Mytilidae (1.02 percent) averaged more than a fourth (28.74 percent) of the food. Considerably more than half the birds had fed on the blue mussel in quantities ranging from a trace to 100 percent of the meal. One individual had gorged itself on more than 1,100 shells, obviously most of them very young, and another had the remains of 212 small ones in its gizzard.

Second in importance of molluscan food were *Macoma* shells (7.23 percent), which during February formed nearly 40 percent of the food and in December 18.18. Shells of the genus *Mactra* (3.37 percent) were not of such frequent occurrence, although 34 were taken at a single meal, forming 100 percent of the food. Razor clams (*Siliqua* and related Solenidae) (1.33 percent) and the rock clam, or ribbed rock-venus (*Protothaca staminea*) (1.11 percent), were both important in individual meals but were infrequently taken. Of the other pelecypods (8.23 percent) the most important identified forms were nut-clams (mostly *Nucula proxima*), 42 in a single stomach; *Astarte; Cyprina islandica;* sphere-shells (*Sphaerium*); venus-heart (*Venericardia*); and California soft-shelled clams (*Cryptomya californica*).

Of the univalves (gastropods), periwinkles (*Littorina*) (2.18 percent) were the only ones that supplied as much as 1 percent of the food. In a single stomach, 574 shells were found, making up 94 percent of the meal and, with the rest of the stomach content, measuring 30 cc. Of the other gastropods (6.59 percent) noted, the most important included dog whelks (*Nassarius*), moon shell (*Polinices heros*), lathe-shells (*Acteocina*), and olive shells (*Olivella*), but many others were taken in limited numbers. More than 1,000 chink-shells (*Lacuna*) and rissoid shells (*Rissoa*) were taken at a single meal.

Undetermined mollusks (2.01 percent) and a few chitons (0.01 percent) made up the remaining molluscan food (2.02 percent).

Crustaceans (10.26 percent).—Crustaceans of many species were consumed during both summer and winter. Sessile barnacles (2.50 percent) were of frequent occurrence and were occasionally the largest component of a meal. Crabs (5.46 percent) were taken in numbers and formed the largest unit of crustacean food, but only two groups or genera amounted to more than 1 percent, namely, sand crabs (*Emerita analoga*) (1.80 percent), 22 of which were ingested by a single bird, and mud crabs (*Hemigrapsus*) (1.39 percent), which furnished 8.91 percent of the food of 11 January birds from the west coast, 22 having been found in a single stomach. Other crabs (2.27 percent) taken included east coast mud crabs (*Neopanope texana-sayi* and *Hexapanopeus*); cancer crabs (*Cancer*); and hermit crabs (*Pagurus*), 40 of which were found in one stomach. The remaining crustacean food consisted of soft-bodied amphipods (1.03 percent) and miscellaneous forms (1.27 percent).

Insects (9.61 percent).—During summer, insects supplied more than a fifth of the food of the surf scoter; in winter, scarcely more than a trace; and for the year, slightly less than a tenth, which is almost four times as much as for the white-winged scoter and more than three times as much as for the American. Caddisfly larvae (3.23 percent) occurred in greater frequency and bulk than any other group. A single meal included 25 large cases of these larvae, and 7 June birds had made almost a fourth of their meal on them. Dragonfly and damsel fly larvae (1.85 percent) and predaceous diving beetles (dytiscid larvae and adults) (1.54 percent) likewise were important, forming 4.04 and 3.38 percent, respectively, of the summer food. One bird obtained 26 dragonfly larvae; and another, 95 diving beetles or their larvae. Many other insects entered into the summer bill of fare. Prominent among the miscellaneous lot (2.99 percent) should be mentioned water boatmen, stone fly larvae, several water beetles, giant water bugs (*Belostoma*). and midge and other dipterous larvae.

Fishes (3.37 percent).—As a predator upon fishes the surf scoter is perhaps more justly condemned than either of the other scoters, although most of the fishes captured by it were varieties of little or no value from man's viewpoint. Only sand launces (*Ammodytes*) and killifish (*Fundulus*) were identified. In their studies of water birds in relation to herring in Canada, Munro and Clemens (*70, p. 42*) found, however, that under such favorable conditions as occurred near Vancouver this species occasionally feeds extensively upon herring ova, as four of five birds collected on known herring spawning grounds during the spawning season had fed upon the eggs to the extent of 90, 93, 90, and 45 per cent of the stomach contents, which measured 8, 5, 3, and 14 cc. Audubon (*3, v. 4, p. 164*) also found these birds not averse to fishes, as the latter occurred in each stomach he examined.

Echinoderms (1.83 percent).—Sea urchins (mostly *Strongylocentrotus dröbachiensis*) averaged 9.22 percent of the food in February; and sand dollars (*Echinarachnius*) and starfishes, 3.04 and 3.48 percent, respectively, of that in November. Individual meals were formed almost entirely of each of these items.

Miscellaneous animal food (2.03 percent).—This consisted mostly of marine worms (1.22 percent), on which individual birds had fed almost exclusively. In December, 11 birds had made more than 9 percent of their meal on clamworms (mostly *Nereis vexillosa*). Other miscellaneous items (0.81 percent) were sea anemones, sea spiders, hydroids, and sponges.

PLANT FOOD—12.10 PERCENT

Such a varied assortment of plants entered into the surf scoter's diet that it appears as if little discrimination is exercised in feeding. Seeds, subterranean root stems, and green vegetative parts were all taken. Plant material amounted to 1 percent or more of the meal in 43 percent of the stomachs, and to 50 percent or more in nearly 25 percent. In only two instances was it taken exclusively, one bird having made its entire meal on wigeongrass and the other, 99 percent of its meal on wildcelery and 1 percent on the seeds of watershield.

As would be expected, more vegetable foods were consumed in summer than in winter. From April to September they aggregated 18.38 percent, of which pondweeds formed 2.61 percent, eelgrass 1.08, and numerous miscellaneous plants—including undetermined vegetable debris—14.69 percent. During the other six months eelgrass formed 1.20, wigeongrass 1.01, and miscellaneous plant material and vegetable debris 4.66 percent.

Pondweeds (3.24 percent).—Only species of *Potamogeton* (1.27 percent, perhaps mostly sago pondweed (*P. pectinatus*) and eelgrass (*Zostera marina*) (1.14 percent), were taken with sufficient frequency and in sufficient quantity to constitute more than 1 percent of the food, sago pondweed having been consumed by about 9.5 and eelgrass by nearly 12 percent of the birds. The *Potamogeton* species were, of course, available only to inland birds (principally in summer), whereas the eelgrass is restricted to the strongly saline areas along the coast and is therefore an item of importance during migration and in winter. Wigeongrass (*Ruppia maritima*) (0.55 percent) was taken in small quantities by a number of birds and in one instance composed the entire meal. One bird had taken 160 seeds of this species. Horned pondweed (*Zannichellia palustris*) (0.28 percent) was of great value to a few birds.

Miscellaneous plant food (8.86 percent).—This was an aggregation of many vegetable foods, including wood pulp and unidentified debris, none of which averaged 1 percent of the total food, yet several of which were of outstanding value to a few birds. The principal identified species were as follows: Wildcelery (*Vallisneria spiralis*); watershield (*Brasenia schreberi*); cladium, or sawgrass (mostly *Cladium mariscoides*); burreed (*Sparganium*); rushes (*Scirpus*) and other sedges, one bird having consumed 182 *Carex* seeds, along with plant fiber; wild red cherry (*Prunus pennsylvanica*); moss; and algae, including muskgrass.

FOOD OF JUVENILES

Examinations of the stomachs of seven July and August juvenile surf scoters collected in Canada and Alaska revealed a truly varied diet, consisting of about four-fifths animal and one-fifth plant food

(table 24). Five of the birds had drawn on insects and mollusks for more than 90 percent of their food, and one had made 98 percent of its meal on seeds and other plant material.

TABLE 24.—*Surf scoter (Melanitta perspicillata): Food, by volume percentages, of seven juveniles taken during July and August*

Kind of food	Percentage of food	Kind of food	Percentage of food
ANIMAL FOOD (79.57 percent)		PLANT FOOD (20.43 percent)	
Insects	61.00	Crowberry (*Empetrum nigrum*)	10.29
Beetles (Coleoptera)	16.72	Sedges (Cyperaceae)	5.43
Mayflies (Ephemeroptera)	14.00	Sedge (*Carex*)	4.42
Aquatic bugs (Hemiptera)	12.57	Miscellaneous	1.01
Caddisflies (Trichoptera)	6.86	Pondweeds (*Potamogeton*)	1.57
Dragonflies (Odonata)	1.14	Miscellaneous plant food	3.14
Miscellaneous	9.71		
Mollusks	18.57		
Mussels (Mytilidae)	14.43		
Miscellaneous	4.14		

ANIMAL FOOD—79.57 PERCENT

Although many species of animals were consumed by the young surf scoters, it was interesting to find that insects and their larvae, mostly aquatic forms, made up 61 percent of the food. The larvae of Mayflies (14 percent) represented the most important family, but the combined volume of aquatic beetles or their larvae, representing several families, supplied a still larger proportion of the food (16.72 percent) in the following groups and percentages: Water beetles (*Peltodytes*) and other crawling water beetles (Haliplidae), 7.14; predaceous diving beetles (Dytiscidae, mostly *Dytiscus*), 5.15; whirligig beetles (Gyrinidae), 2.14; miscellaneous and undetermined, 2.29. Caddisfly larvae (6.86 percent) contributed to the total nearly double the quantity taken by the adults during the summer but less than a third that taken by adults during June, the period when they were most freely taken. Aquatic bugs (12.57 percent) were divided in percentages, as follows: Giant water bugs (Belostomatidae), 6.43; water boatmen (Corixidae), 2.57; and miscellaneous, 3.57. Dragonfly nymphs (1.14 percent) came next. Miscellaneous insects (9.71 percent) included midge larvae and undetermined species.

Molluscan food (18.57 percent) consisted largely of Mytilidae (14.43 percent)—the blue mussel (*Mytilus edulis*) and related species—and miscellaneous forms (4.14 percent).

PLANT FOOD—20.43 PERCENT

A summary of the plant food of the seven juveniles, expressed in percentages, is as follows: Crowberry (*Empetrum nigrum*) fruit and seeds, 10.29, one bird having taken 758 seeds; *Carex* (mostly *C. hyalinolepis*), 4.42, the bird just mentioned having taken 182 seeds of this also; *Potamogeton* seeds and plant fiber, 1.57; miscellaneous sedge seeds, including spikerush (*Eleocharis*), bulrush (*Scirpus*), and cladium (*Cladium*), 1.01; and miscellaneous seeds, including plant debris, 3.14.

AMERICAN SCOTER (Oidemia americana)

(Pl. 5, facing p. 96)

The American, or black, scoter is the least common, least known, and least scoterlike of the three scoters. It is at home as a nester in the subarctic regions across the continent, being rare or absent in the interior. It also breeds in northeastern Asia, and its closest relative, the English black duck or common scoter, differing from it only subspecifically according to most authorities, breeds in northern Eurasia. The American representative commonly winters on the Atlantic coast from Maine to New Jersey and on the Pacific coast from the Pribilof and Aleutian Islands to southern California. The distinctive and conspicuous brilliant yellow of the bill has given it the common names of butterbill, yellowbill, and butternose. The male is the only scoter with shiny black plumage undivided by white markings.

Although characteristically a sea duck and able to feed in deep water, the American scoter does not seem to choose such a boisterous ocean as do the eiders, harlequins, or old squaw. It seems to prefer some protection, such as is found in coastal bays and sounds where the water depth does not exceed 25 feet and where nature has supplied a bounteous crop of mussels. Grinnell, Bryant, and Storer (*38, p. 196*) say that it is an excellent diver and can forage in water 40 feet in depth. Dewar (*24, p. 120*), in his exhaustive series of diving records at Gullane, situated on the Firth of Forth, found no feeding by its European representative at more than 21 feet and 80 percent of all dives referred to depths of water ranging from 6 to 12 feet.

Food of Adults

Although in the aggregate many species of animal and plant foods were taken by the American scoters, most of the individual meals were composed of but few. It seems that when an acceptable food is found the birds feed on it avidly and largely to the exclusion of other kinds, which accounts for the surprisingly low average of 4.38 species a meal. The number of individual items (not species) that could be counted averaged 21.70 a meal. Gravel formed 12.68 percent of the average stomach content.

The stomachs of 168 adult American scoters were examined, 124 of which were considered full enough to be used in the computation of food percentages (tables 25 and 26). They were collected in every month except April and August from eight States, Alaska, and four Canadian Provinces. The data show that these birds, like other members of the tribe, are predominantly animal feeders in every month taken and that they subsist largely upon mollusks, particularly pelecypods.

TABLE 25.—*American scoter (Oidemia americana): Food, by volume percentages, of 124 adults taken during 10 months*

Kind of food	Percentage of food	Kind of food	Percentage of food
ANIMAL FOOD (89.66 percent)		ANIMAL FOOD (89.66 percent)—contd.	
Mollusks	65.19	Crustaceans—Continued.	
Blue mussel (*Mytilus edulis*) and other Mytilidae	26.76	Amphipods and isopods	1.39
Short razor clams (*Siliqua*)	6.89	Miscellaneous	2.60
Oyster (*Ostrea lurida*)	6.23	Insects	3.18
Rock clam (*Protothaca staminea*)	5.37	Caddisflies (Trichoptera)	2.23
Hard-shelled clam (*Venus mercenaria*)	3.84	Miscellaneous	.96
Tellina and *Macoma* shells	1.97	Fishes (Pisces)	1.69
Other pelecypods	4.85	Echinoderms	1.52
Periwinkles (*Littorina*)	1.21	Miscellaneous animal food	.74
Limpets (*Acmaea*)	1.20	PLANT FOOD (10.34 percent)	
Other gastropods	2.41		
Chitons and undetermined	4.46	Pondweeds (Najadaceae)	4.70
Crustaceans	17.33	Eelgrass (*Zostera marina*)	4.03
Sessile barnacles (Balanidae)	7.27	Pondweeds (*Potamogeton*) and wigeongrass (*Ruppia maritima*)	.57
Goose barnacles (*Lepas*)	1.30	Muskgrass (Characeae) and other algae	2.13
Claw shrimp (*Limnadia lenticularis*)	2.40	Miscellaneous plant food	3.51
Other decapods	2.37		

ANIMAL FOOD—89.66 PERCENT

Mollusks (65.19 percent).—Bivalves (pelecypods) (55.91 percent) furnished most of the molluscan food. Of these the Mytilidae (26.76 percent) were the most important, and as is characteristic of so many seafowl, the American scoter drew to a greater extent upon the common blue mussel (*Mytilus edulis*) (24.30 percent) than upon any other species of food. It entered into the diet of about half the birds, ranging from a trace to 100 percent of the meal, and one stomach contained 78 of these abundant mussels. Other bivalves were freely taken, however, often in large numbers, suggesting that availability rather than choice is the principal factor governing their consumption. Concerning the food of this species, Forbush (*32, p. 159*) states:

> Its food consists largely of mussels, and when feeding on fresh water it prefers the *Unios* or fresh-water clams to most other foods. Thirteen Massachusetts specimens were found to have eaten nearly 95 percent of mussels, the remaining 5 percent of the stomach contents was composed of starfish and periwinkles.

The short razor clam (*Siliqua*) (6.89 percent) was second in importance of the molluscan food. It comprised 63.22 percent of the entire consumption of 14 birds taken in May, mostly off the coast of Maine, 1 of which had taken 20 shells in a single meal.

For reasons explained in the discussion of the white-winged scoter, many of the American scoters also were taken at or over oyster, scallop, and other commercial clam beds. As this was an effort to see the bird at its worst and to collect it in numbers where it was suspected of causing loss to shell fisheries, it should not be surprising that such an indiscriminate mollusk feeder should have consumed shellfishes of commercial value. There is no question but that this species, along with other members of its tribe, is capable of serious injury over planted commercial shellfish beds. Forbush (*33, p. 273*) points out, however, that although it may do some injury at times, its feeding "on small, unmarketable, edible shellfish" usually "results merely in a necessary thinning." It was found that practically all occurrences of young oysters (6.23 percent) were in the stomachs

of birds collected over planted shellfish beds during January and February, when they furnished 17.64 and 44.40 percent, respectively, of the bill of fare. One bird had consumed 45 young ones. It is apparent that there is little or no effort on the birds' part to search out these highly prized mollusks. By patrol or by the use of frightening devices, it should be possible, at little cost, to prevent any injury that might result at planted commercial beds from the feeding tendencies of these scoters.

The hard rock clam (*Protothaca staminea*) (5.37 percent), an outstanding food on the west coast, had been taken by 22 American scoters collected on the Washington coast during January and February to the extent of 17.46 and 36.20 percent, respectively, of the monthly food. The hard-shelled clam, or quahog (*Venus mercenaria*) (3.84 percent), was taken occasionally in numbers, as 100 small seed clams were found in a single stomach. The percentage for this clam is undoubtedly high, as two of the five September birds had made it 98 and 85 percent, respectively, of the meal. If a larger and more representative series of birds had been taken during this period, this apparent depredation would doubtless have been negligible. Many of the birds took *Tellina* and *Macoma* (mostly *M. nasuta*) shells (1.97 percent); and fragments of cockle shells (*Cardium*) were included among the other pelecypods (4.85 percent) consumed, each of which averaged less than 1 percent of the total food.

Univalves (gastropods) (4.82 percent), although important, seem minor when compared with the pelecypods consumed. The most valuable ones were periwinkles (*Littorina*) (1.21 percent) and limpets (*Acmaea*) (1.20 percent). Many others (2.41 percent) were taken, but no one made up as much as 1 percent of the food. The most important of these were the slipper-shell (*Crepidula*), chink-shell (*Lacuna*), moon shell (*Natica*), and dove-shells (*Anachis avara* and *Mitrella lunata*). Dog whelks (*Nassarius*), horn-shells (*Bittium*), rock shells (*Thais*), and oyster drill (*Urosalpinx cinereus*) were also taken.

The remaining molluscan food (4.46 percent) consisted of chitons (0.05 percent) and undetermined forms (4.41 percent).

Munro and Clemens (*70, p. 33*) report that the stomach contents of an American scoter, with a volume of 14 cc, contained 25 percent small gastropods, consisting of *Margarites lurulata*, *Alectrion mendica*, *Bittium eschrichtii*, *Cerithiopsis stejnegeri*, *Acmaea mitre*, *Littorina sitchana*, and *Columbella*, and 30 percent pelecypods, consisting of *Mytilus edulis*, two small mussels, and fragments of others. In another stomach, they found that 91 gastropods of the following species comprised 10 percent of the volume: *Columbella gausapata*, *Merovia* (*marginella*) *pyriformis*, *Alnarria compacta* and *A. montereyensis*, *Margarites*, *Lacuna divaricata* and other *Lacuna*, and *Cerithiopsis*.

Crustaceans (*17.33 percent*).—In its consumption of the hard-shelled barnacles, the American scoter far exceeds other members of its tribe. Sessile barnacles (mostly *Balanus glandula* and *Chthamalus*) (7.27 percent) were of frequent occurrence, having been identified in about one of every five stomachs. Goose barnacles (*Lepas*) (1.30 percent) were of slightly less value. Claw shrimp (*Limnadia lenticularis*) (2.40 percent) represented the major part of the food

of two Alaskan July birds. Other decapods (2.37 percent) included crabs (1.20 percent), various species of which were the principal items in the diet of several birds, the most important being mud crabs (*Neopanope texana-sayi* and *Hemigrapsus*), cancer crabs (*Cancer irroratus* and another), hermit crabs (*Pagurus*), and mussel crabs (*Pinnotheres maculatus*); crawfishes (*Cambarus*); and shrimps (*Crago* and others).

In the stomach of a bird collected in British Columbia, Munro and Clemens (*70, p. 38*) found one whole mud crab (*Hemigrapsus nudus*), measuring 16 mm, and fragments of another, and an empty limpet shell (*Acmaea*).

Amphipods and isopods (1.39 percent) of various species and miscellaneous crustaceans (2.60 percent), which included unidentified species, were taken.

Insects (3.19 percent).—As would be expected, insect consumption by the American scoter was restricted almost entirely to the summer and consisted largely of caddisfly larvae (2.23 percent), which formed 5.57 percent of the summer food and 12.14 percent of the food in June. Miscellaneous insects (0.96 percent) included hymenopterous forms, mostly ants, which constituted 1.25 percent of the summer food.

Fishes (1.69 percent).—Of the 124 stomachs, 9 contained fishes, but none of those identified were of commercial or sporting value. One July bird, taken in Alaska and labeled as a juvenile (therefore not included in these tabulations)—unfortunately the only juvenile of the lot examined—had made more than half of its slender meal on fishes. Munro and Clemens (*70, p. 38*) found that one bird taken in British Columbia had made 80 percent of its meal on herring ova.

Echinoderms (1.52 percent).—These included sand dollars, sea urchins, starfishes, and brittle stars, which were the dominant food items in individual stomachs.

Miscellaneous animal food (0.74 percent).—Numerous miscellaneous items were identified in many stomachs. One bird collected in October had made 15 percent of its meal on a tunicate. As with other sea ducks, hydroids of various species were noted, yet they formed little more than a trace in the total volume. Other miscellaneous items included small numbers of marine worms (mostly clamworms) and sea spiders.

PLANT FOOD—10.34 PERCENT

As indicative of the fact that the American scoter is predominantly an animal feeder, it was found that nearly two-thirds (64 percent) of the birds had taken no plant material or only a trace and that less than 10 percent had drawn upon plant foods for more than half their meal, in no instance exclusively.

As comparatively few stomachs were obtained from the interior, where it would be expected that the birds would subsist more heavily upon plant food, there was no appreciable difference in the quantity of vegetable consumption during winter and summer. In winter, it averaged 8.68 and in summer 12.83 percent. Yorke (*97, p. 71*) reports that while on inland lakes and ponds, this species feeds on a variety of vegetable foods, such as duckweed (Lemnaceae), pondweeds (Najadaceae), large blue flag (*Iris versicolor*), watermilfoil

(*Myriophyllum*), bladderwort (*Utricularia*), and several other water plants.

Pondweeds (4.70 percent).—Eelgrass (*Zostera marina*) (4.03 percent) was the only plant food that seemed to have been eagerly sought by the American scoter. It was taken by 24 of the birds, 7 of which made from 65 to 85 percent of their meal on the rhizomes and basal leaf stems. Other Najadaceae consumed were species of *Potamogeton* (0.40 percent) and wigeongrass (0.27 percent).

Muskgrass and other algae (3.13 percent).—Muskgrass and other algae were taken with moderate frequency, yet only the former (*Chara* and *Nitella* ?), on which one bird had made 91 percent of its meal, was consumed in appreciable quantity. Munro and Clemens (*70, p. 38*) found that an American scoter taken on the coast of British Columbia had made 5 percent of its meal on an undetermined alga and another 10 percent of its meal on sea lettuce (*Ulva lactuca*) and unidentified algae.

Miscellaneous plant food (3.51 percent).—Other plant species or groups taken by several birds, yet averaging less than 1 percent each, included *Panicum* and undetermined grasses; *Scirpus*, *Carex*, and undetermined sedges; *Cladium mariscoides;* buttercup (*Ranunculus*); marestail (*Hippuris vulgaris*); crowberry (*Empetrum nigrum*); moss; wood pulp, conifer needles, and other drift; and undetermined vegetable debris. One bird had taken a small quantity of bait in the form of Indian corn (*Zea mays*). As additional evidence that scoters will eat grain, C. W. Buttler, as reported by Cooke (*17, p. 73*), writes that on May 2, 1883, he saw 50 American scoters at Anna, Ill., "all busily engaged in picking up millet seed that had just been sown"; Chapman (*15, p. 12*) records an instance related by a reliable fisherman of scoters feeding on grain after a shipwreck off Holy Island off the Northumberland coast; and Gätke (*34, p. 531*) tells of these ducks devouring small grey horsebeans in 10 fathoms of water after a wreck near Helgoland.

SUMMARY OF FOOD OF SEA DUCKS

The food of the more typical North American sea ducks, exclusive of extralimital and extinct species, is summarized for comparative purposes in table 26. From the data presented it is apparent that all these ducks are preeminently animal feeders, with mollusks the most important food for eight species, crustaceans for four, and insects for two.

TABLE 26.—*Summary of food, by volume percentages, of the more typical sea ducks*

Kind of food	American goldeneye (*Glaucionetta clangula americana*)	Barrow's goldeneye (*Glaucionetta islandica*)	Bufflehead (*Charitonetta albeola*)	Old squaw (*Clangula hyemalis*)	Harlequin duck (*Histrionicus histrionicus*)	Steller's eider (*Polysticta stelleri*) [1]	Northern eider (*Somateria mollissima borealis*)	American eider (*Somateria mollissima dresseri*)	Pacific eider (*Somateria v-nigra*)	King eider (*Somateria spectabilis*)	Spectacled eider (*Arctonetta fischeri*) [1]	White-winged scoter (*Melanitta deglandi*)	Surf scoter (*Melanitta perspicillata*)	American scoter (*Oidemia americana*)
Stomachs used	*Number* 395	*Number* 71	*Number* 282	*Number* 190	*Number* 63	*Number* 66	*Number* 10	*Number* 96	*Number* 61	*Number* 85	*Number* 16	*Number* 819	*Number* 168	*Number* 124
Animal food	*Percent* 73.91	*Percent* 77.66	*Percent* 79.02	*Percent* 87.93	*Percent* 98.32	*Percent* 87.14	*Percent* 99.37	*Percent* 96.31	*Percent* 95.26	*Percent* 94.49	*Percent* 77.30	*Percent* 94.12	*Percent* 87.90	*Percent* 89.66
Echinoderms	.02	.....	.09	.32	2.44	2.76	3.32	5.34	14.40	17.20	.07	.89	1.83	1.52
Insects	27.98	36.40	40.68	10.77	10.20	13.01	(2)	2.20	.27	5.20	31.51	2.46	9.61	3.10
Caddisflies (Trichoptera)	12.32	6.32	7.68	6.63	.61	2.50	.....	2.18	.....	3.89	26.12	1.69	3.23	2.23
Miscellaneous [3]	15.66	30.08	33.00	4.14	9.59	10.51	(2)	.02	.27	1.31	5.39	.77	6.38	.96
Crustaceans	32.42	17.71	16.74	48.23	57.13	45.21	14.32	6.85	30.65	18.61	2.56	13.18	10.26	17.38
Amphipods and isopods	5.00	11.02	6.56	19.21	18.00	40.30	11.72	.09	8.29	2.87	1.62	3.56	1.26	1.39
Crabs and other decapods	22.57	2.49	5.81	16.30	27.56	.68	.83	5.61	19.02	13.28	.....	5.78	5.46	2.37
Barnacles (Cirripedia)	.48	.25	.10	.85	6.46	1.62	.08	.77	2.06	2.00	.....	2.99	2.58	8.57
Miscellaneous [3]	4.37	3.95	4.27	11.87	5.11	2.61	1.69	.38	1.28	.46	.94	.85	.96	5.00
Mollusks	9.71	10.16	15.68	15.70	24.68	19.27	70.34	81.72	45.97	45.75	42.26	75.34	60.80	65.19
Blue mussel (*Mytilus edulis*) and other Mytilidae	2.53	12.25	.53	2.92	1.51	1.21	39.65	66.76	11.80	19.81	.....	11.98	28.74	26.76
Rock clam (*Protothaca*)	.21	.....	.09	.06	.....	.....	.....	.....	.....	.....	.....	14.27	1.11	5.37
Razor clam (*Siliqua*)	.....	.....	.....	.49	.....	4.41	.....	.....	5.70	1.76	19.00	4.97	1.33	6.89
Oysters and scallops	.11	.....	.....	.02	.....	.....	.....	.50	.01	.59	.....	17.09	.83	6.24
Other pelecypods [3]	1.35	.98	4.18	5.89	1.43	9.08	18.23	7.91	10.63	12.38	15.05	15.00	18.00	10.65
Littorinidae	.52	2.49	1.16	1.30	4.42	.22	.....	.76	6.09	1.88	.....	.16	2.18	1.21
Other gastropods [3]	4.07	2.57	8.96	4.02	8.60	3.39	11.37	5.55	9.83	8.02	7.63	9.55	6.59	3.61
Chitons and undetermined	.92	.87	.76	1.00	[4] 8.72	.96	[5] 1.09	.24	1.91	1.31	.58	2.32	2.02	4.46
Fishes (Pisces)	3.16	1.14	3.78	9.71	2.40	2.28	8.91	.04	1.51	.63	.07	1.73	3.37	1.69
Miscellaneous animal food [3]	.62	3.25	2.05	3.20	1.47	4.61	2.48	.16	2.46	7.10	.83	.52	2.03	.74
Plant food	26.09	22.34	20.98	12.07	1.68	12.86	.63	3.69	4.74	5.51	22.70	5.88	12.10	10.34
Muskgrass (Characeae) and other algae	.80	.38	.44	.56	.10	.76	.23	.89	3.53	2.21	.13	.29	.33	2.61
Pondweeds (Najadaceae)	8.62	8.17	7.47	1.51	(2)	3.39	.....	.12	.13	2.43	6.98	1.98	3.24	4.70
Wildcelery (*Vallisneria spiralis*)	3.42	1.57	.81	.....	(2)	.....	.....	.....	.....	.....	.....	.21	.38	.....
Miscellaneous plant food [3]	13.25	12.22	12.26	10.00	1.58	8.71	.40	2.68	1.08	.87	15.59	3.40	8.15	3.03

[1] Summer months only are represented.
[2] Trace.
[3] Because used for comparison, some of the miscellaneous groupings in this table necessarily differ from those in tables 9 to 25.
[4] All chitons.
[5] Of this, 0.48 percent was squid and 0.61 undetermined forms.

Fishes are taken in limited numbers by all species of diving ducks, yet for no species of the group here treated did they average as much as a tenth of the food. The facts indicate that the old squaw is the most piscatorially inclined, but that, like the others, it draws its fish food primarily from the coarse and worthless varieties.

In general, bivalves (pelecypods) are much more important as molluscan food than univalves (gastropods). Considering the sea ducks as a whole the most important single food item is the blue mussel (*Mytilus edulis*), which for the American eider averaged 66.73 percent of the food. The only sea duck that can be considered an enemy of commercial shellfish is the white-winged scoter, and its depredations are not severe except locally or in unusual situations.

A wide difference is shown in the consumption of crustaceans: some of the ducks, including the American goldeneye and the Pacific eider, draw most freely upon the harder-shelled forms, whereas the old squaw, Steller's eider, and others prefer the softer-bodied varieties.

Insects are of significant value as summer food for more than half these species, the goldeneyes, bufflehead, and spectacled eider drawing approximately a third of their annual food from this source. Caddisflies (Trichoptera) were the principal insects taken, although diving-beetles (Dytiscidae), midge larvae (Chironomidae), and water boatmen (Corixidae) were of considerable value.

Starfishes, sea urchins, and sand dollars (Echinodermata) were not of great value except to the Pacific and king eiders, for which they formed about a seventh and a sixth of the food, respectively.

As with the *Nyroca* ducks, the most important plant foods were the pondweeds, although eelgrass, the principal pondweed taken by all except the goldeneye-bufflehead group, being limited to the saline areas of the coast, was relatively unimportant to the various species of *Nyroca*.

SUMMARY

The North American diving ducks are readily distinguished from the shoal-water species by their characteristic method of feeding. As their group name implies, they usually dive to obtain their food and feed submerged, whereas the shoal-water ducks feed either at the surface or by tipping. Different species of divers feed at different depths, most of them at 2 to 10 feet, although some of the typical sea divers at times feed at much greater depths.

Perhaps without exception all the diving ducks have noticeably decreased in numbers during recent years, some of them, including the redhead and ruddy duck, to an alarming degree. Outstanding factors responsible for their unfortunate decline include drought, encroachment of civilization into their hereditary breeding grounds, and overshooting. It is hoped that through the application of principles of conservation and restoration now being practiced they may be restored to a more satisfactory abundance. The success of such practices is in part dependent upon an accurate determination of the food requirements of the species considered.

This bulletin reports upon the food habits of the native North American diving ducks, exclusive of mergansers, as determined from critical analyses made in the Food Habits laboratory of the Survey,

of the contents of 6,665 adult and 140 juvenile stomachs (including gullets and gizzards), and with food percentages computed by the volumetric method. It treats of 22 divers, roughly divided into two major groups, the inland divers and the sea ducks. The inland divers, which, with the exception of the greater scaup duck, feed predominantly on plant food, include the five native members of the genus *Nyroca*—the redhead, ring-necked duck, canvasback, and greater and lesser scaup ducks—and the two Erismaturinae—the ruddy duck and the masked duck—the latter an occasional visitor in the United States but restricted mostly to lands south of our border. The sea ducks, which subsist primarily on animal food, include the American and Barrow's goldeneyes, bufflehead, old squaw, harlequin duck (two races), extinct Labrador duck, six eiders of three genera, and three scoters of two genera.

The inland divers are predominantly plant feeders, and the food of all the species is similar in many respects. Relatively few plants appear to be of outstanding value. Most important are the Najadaceae, or submerged pondweeds, including the sago pondweed (*Potamogeton pectinatus*), claspingleaf pondweed (*P. perfoliatus*), wigeongrass (*Ruppia maritima*), and the northern and southern naiads (*Najas flexilis* and *N. guadalupensis*). Other important species or plant groups are wildcelery (*Vallisneria spiralis*), muskgrass (Characeae), watershield (*Brasenia schreberi*), wildrice (*Zizania aquatica*), bulrushes of the genus *Scirpus*, smartweeds (*Polygonum*), and, in restricted southern areas, the banana waterlily (*Castalia flava*) and the delta duckpotato (*Sagittaria platyphylla*). The sago pondweed, because of its great adaptability to both brackish and relatively fresh water and its almost continental distribution, extending as it does from the Atlantic to the Pacific and from the brackish pools in the arctic tundra to the highland lakes of southern Mexico, is perhaps the most important single duck-food plant known. Seeds, tubers, rhizomes, and, to a lesser extent, the green vegetative plant fiber are avidly consumed by many species of ducks. The most important animal foods of the inland divers are mollusks and insects—particularly caddisfly larvae, midge larvae, water bugs and water beetles.

All the sea ducks are primarily animal feeders, with mollusks the most important food for eight species, crustaceans for four, and insects for two. Although fishes are acceptable to all the species here treated, they are consumed in small numbers and the kinds taken are rarely of commercial or sporting significance. The old squaw, which seems to be the most piscatorially inclined of the sea ducks, drew slightly less than one-tenth of its food from fishes, and nearly 60 percent of these were coarse and worthless varieties.

The scoters and the *Somateria* eiders are the most persistent mollusk feeders. Ordinarily bivalves are of much greater food value than univalves. The blue mussel (*Mytilus edulis*) is by far the most important sea food consumed, and it averaged 66.73 percent of the food of the American eider. In general, it may be concluded, that, within limits, availability is the most important factor governing selection of mollusks. As a consequence, some of the sea ducks, particularly the white-winged scoter, when feeding over a bed of planted shellfish, such as oysters, scallops, or clams, may cause considerable economic loss. The size and hardness of some of the mollusks con-

sumed, such as rock clams, hard-shelled clams, and oysters, is indeed surprising. Disintegration of shells in the gizzard is brought about both through mechanical and chemical means.

Both hard- and soft-bodied crustaceans are freely consumed. The old squaw and Steller's eider, for instance, are persistent feeders on the latter, whereas the American goldeneye, harlequin duck, Pacific eider, and others seem to prefer the hard, chitinized crustaceans.

As would be expected, insects are of significant value only during the summer or nesting season. Despite this, the goldeneyes, bufflehead, and spectacled eider drew approximately one-third of their total sustenance from this source.

Starfishes, sea urchins, and sand dollars are of great value only to the Pacific and king eiders, for which they formed about one-seventh and one-sixth of the food, respectively.

Plant food, mostly pondweeds, supplied slightly more than one-fifth of the food of the goldeneyes, bufflehead, and spectacled eider, but with other species of sea ducks it appeared relatively insignificant as far as bulk was concerned.

Alimentary material of a few juveniles of most of the species treated was examined. Some of the juveniles, as Steller's and the Pacific eiders, showed an indiscriminate but decidedly greater preference for plant food than did the adults of the same species. This is surprising, inasmuch as juveniles are usually as much protein feeders as their elders, or more. Juveniles of the other species feed principally upon insects, crustaceans, and small mollusks. As a rule the young are far more indiscriminate in their food consumption than are the adults. When an acceptable food is found the adults often make their entire meal on a single species or related group of species.

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