

ILLINOIS NATURAL HISTORY SURVEY
Bulletin

*Printed by Authority of
the State of Illinois*



Food Habits
of Migratory Ducks
in Illinois

HARRY G. ANDERSON

STATE OF ILLINOIS • WILLIAM G. STRATTON, *Governor*

DEPARTMENT OF REGISTRATION AND EDUCATION • VERA M. BINKS, *Director*

NATURAL HISTORY SURVEY DIVISION • HARLOW B. MILLS, *Chief*

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Aerial view of property belonging to a duck hunting club in the Illinois River valley. The buildings are surrounded by water, uncultivated bottomland, and cropland. Material for the duck food study reported here was obtained from this club and many others like it along the Illinois and Mississippi rivers.

Food Habits of Migratory Ducks in Illinois *

HARRY G. ANDERSON†

TWENTY-FIVE years ago the waterfowl population of North America had dropped to such a low point that management of this resource became an important concern of both state and federal wildlife agencies. As a basis for an effective, long-time program of management for the waterfowl of the Mississippi Flyway, detailed information about the diet of ducks that migrate through Illinois was considered essential.

More than 30 years of drainage, siltation, and pollution had materially reduced the extent and quality of the Illinois feeding grounds that waterfowl had used for centuries. Fortunately for some species of ducks, in the 1930's, mechanical corn pickers came into widespread use in the state. Mechanical picking left more waste corn in the fields and made it more easily available than did picking by hand. Mallards and black ducks were quick to take advantage of the new food supply.

Previous to 1938, only a small amount of research had been done on the food habits of ducks using Illinois as a stopover on their migration flights. An analysis of the contents of 185 duck gizzards collected in Illinois had been made by Martin & Uhler (1939:5), and a study of the contents of 79 duck gizzards collected from the Starved Rock Pool near Ottawa and the Duck Island area near Banner, Illinois, had been made by Bellrose (1938). The need for more data on the food habits of waterfowl in Illinois resulted in the investigation herein reported.

Formally designated as Project 2-R, "Correlation of Food Supplies With Food Uses Among Illinois Game Birds," the investigation was a unit in the program made possible by the Federal Aid in Wildlife Restoration Act and was approved in May, 1939, by the Bureau of Biological

Survey of the United States Department of Agriculture (now Fish and Wildlife Service of the United States Department of the Interior). The project was officially begun on June 1, 1939, and terminated on June 30, 1941. Part of the material and information on which the investigation was based was collected in 1938. Some of the data derived from the project have been included in previous publications (Hawkins, Bellrose, & Anderson 1939; Bellrose & Anderson 1940, 1943; Bellrose 1941, 1959). Delay in publication of the final report on the project resulted largely from the author's service in the armed forces during World War II and subsequent employment elsewhere.

Supervision of Project 2-R was assigned to the Illinois Natural History Survey by the Illinois Department of Conservation. The project was administered by the late Dr. Theodore H. Frison, representing the Natural History Survey, and Anton J. Tomasek, representing the Department of Conservation. Dr. Lee E. Yeager, Arthur S. Hawkins, and Frank C. Bellrose provided technical supervision; all three were members of the Natural History Survey staff at the time of the investigation.

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The writer of this paper gratefully acknowledges the assistance of many persons. He extends his thanks to personnel of the United States Bureau of Biological Survey, later the Fish and Wildlife Service, for permitting use of the Patuxent Research Laboratory and for giving instruction in food habits studies during the early stages of this project, especially Dr. Alec Martin for his many helpful suggestions and his encouragement. He expresses his appreciation to many present and former members of the staff of the Illinois Natural History Survey, especially Dr. Herbert H. Ross, Dr. Carl O. Mohr, and Dr. B. D. Burks for their aid in identifying insects; the late Dr. Leo R. Tehon for

*Federal Aid Project 2-R. Supervision of this project was assigned by the Illinois Department of Conservation to the Illinois Natural History Survey.

†Leader, Federal Aid Project 2-R, June 1, 1939-June 30, 1941; now employed by the United States Fish and Wildlife Service.

his aid in identifying seeds; William Marquardt, Robert Welk, and William Robertson for their statistical assistance; Dr. Harlow B. Mills and Dr. Thomas G. Scott for their many helpful suggestions; and Frank C. Bellrose and James S. Ayars for their assistance in the writing and editing of this report.

Finally, the author extends his thanks to a great many individual hunters and duck clubs for whole-hearted co-operation in the field investigations and in the preservation of material.

STUDY PROCEDURE

Two general steps were involved in the study procedure: (1) the collection of duck gizzards from strategic locations along the Illinois River and the Mississippi River and (2) the laboratory analysis of collected material.

The limited duration of this investigation made it desirable to choose collection sites that would yield a large quantity of gizzards within the short time of three hunting seasons and that would provide representative samples of the important duck species using the major river valleys in Illinois, frontispiece. Twenty-one sites were selected along the Illinois River between Ottawa and Florence, Illinois, and 11 sites were selected along the Mississippi River between Rock Island and Quincy, Illinois, fig. 1. Gizzards were obtained during the hunting seasons of 1938, 1939, and 1940 by Arthur S. Hawkins and Frank C. Bellrose of the Illinois Natural History Survey and the author.

Arrangements were made for collecting the gizzards of ducks taken by members of duck hunting clubs, by individual hunters, and others. At most hunting clubs, members had their ducks dressed as they brought the birds in from marshes or lakes, fig. 2; the clubs were a source of large numbers of gizzards. Individual or freelance hunters often hired local professional duck pickers to clean their kills; these pickers were another source of gizzards.

Co-operators were supplied with jars partially filled with a 10 per cent formaldehyde solution; each jar bore a printed label denoting a species of duck. Duck pickers were instructed to drop each giz-

zard into an appropriate jar. Gizzards were collected from the co-operators once each week and stored until such time as their contents could be analyzed.

During the three fall hunting periods of 1938-1940, 4,977 gizzards were collected, table 1; 90.52 per cent (4,505) of the gizzards came from locations along the Illinois River and 9.48 per cent (472)



Fig. 1.—Map showing the areas from which duck gizzards were collected in the autumns of 1938, 1939, and 1940 between Ottawa and Florence on the Illinois River and between Rock Island and Quincy on the Mississippi River.

came from collecting sites along the Mississippi River. The sample from the Illinois River valley represented 1.6 per cent of the 1938 kill estimated for that region, 2.2 per cent of the 1939 kill, and 0.5 per cent of the 1940 kill. A breakdown of the number of gizzards obtained from 17 species of ducks is given in table 1 by year and river system. The species are listed



Fig. 2.—Picking ducks at a hunting club in the Illinois River valley. Duck gizzards collected from this and similar clubs provided most of the material on which the present study is based. As ducks were dressed, each gizzard was placed in a jar containing a formaldehyde solution and bearing a printed label that denoted the duck species represented. Nearly 5,000 gizzards representing 17 species of ducks were collected.

Table 1.—Number of waterfowl gizzards collected in Illinois, 1938–1940, at stations along the Illinois and Mississippi rivers.

KIND OF DUCK	1938		1939		1940		TOTAL
	ILLINOIS RIVER	MISSISSIPPI RIVER	ILLINOIS RIVER	MISSISSIPPI RIVER	ILLINOIS RIVER	MISSISSIPPI RIVER	
Common mallard*.	822	38	1,289	42	428	206	2,825
American pintail..	268	9	467	.....	115	22	881
Lesser scaup.....	73	53	66	.....	.....	28	220
Blue-winged teal..	57	6	63	1	1	1	129
Green-winged teal	199	2	164	.....	3	25	393
Baldpate.....	87	1	61	.....	4	7	160
Ring-necked duck..	97	7	16	.....	.....	.....	120
Gadwall.....	26	3	59	.....	6	4	98
Canvasback.....	14	4	9	.....	1	.....	28
Shoveler.....	25	2	34	.....	.....	1	62
Ruddy duck.....	.....	.....	1	.....	4	.....	5
Wood duck.....	6	3	4	.....	9	4	26
Plack duck*.....	.....	.....	10	.....	1	.....	11
Redhead.....	12	2	.....	.....	.....	.....	14
Common goldeneye	2	1	.....	.....	.....	.....	3
Greater scaup.....	.....	.....	.....	.....	1	.....	1
Oldsquaw.....	.....	.....	.....	.....	1	.....	1
Total.....	1,688	131	2,243	43	574	298	4,977

*An unknown, but probably small, number of gizzards of the black duck may be included with gizzards of the common mallard. Some hunters did not distinguish between these two species. Gizzards from individuals listed here in the black duck category were from birds identified by the author.

in descending order of the estimated numbers of individuals in the fall flight.

The procedure in making analyses of the gizzard contents was in accordance with standard practices followed by the United States Bureau of Biological Survey (now United States Fish and Wildlife Service) for food habits studies (Cottam 1936:9-10). The contents were separated first into organic and inorganic substances and the volume of each expressed as a percentage of the total volume. The organic foods were then separated into plant and animal foods and the volume of each group expressed as a percentage of the total organic volume. As an example, the contents of a mallard gizzard were 8 cc. (80 per cent) organic material and 2 cc. (20 per cent) inorganic material. Of the total organic foods, 6 cc. (75 per cent) consisted of plant foods and 2 cc. (25 per cent) of animal foods.

Inorganic material was found in the gizzards in small to large amounts and

consisted primarily of sand, gravel, and calcareous shell material. Individual particles were classified as to size in millimeters as well as to type and volume.

An effort was made to identify each item in the organic contents, even though it constituted only a trace or a fraction of 1 per cent of the volume, tables 38 and 39. The technical names of most identifiable plant items listed in table 38 were taken from *Gray's Manual of Botany* (Fernald 1950). The technical names of animal items listed in table 39 were taken from several authorities and depended upon the groups of animals involved. Seeds of some of the duck food plants discussed in this report are shown in fig. 3.

FOODS OF VARIOUS SPECIES

Data obtained from this study provided important facts about food preferences of each of the species of ducks represented. The proportions of plant and animal foods

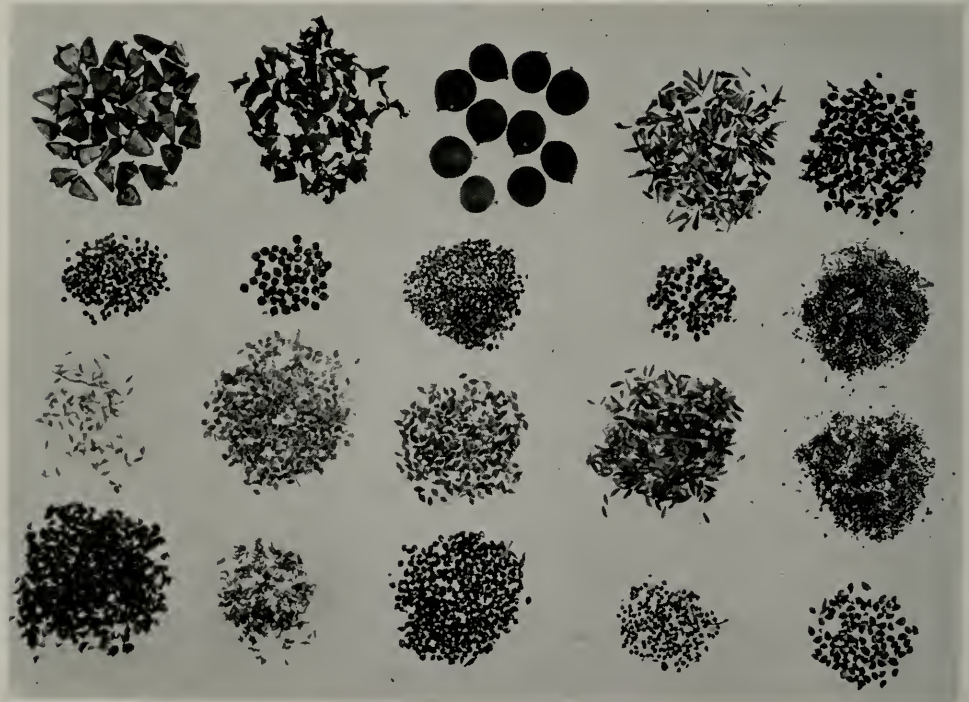


Fig. 3.—Seeds included in the autumn diet of ducks migrating through Illinois: (top row, left to right) giant bur-reed, pickerelweed, American lotus, buttonbush, longleaf pondweed; (second row, left to right) nodding smartweed, large-seeded smartweed, swamp smartweed, marsh smartweed, chufa; (third row, left to right) Walter's millet, Japanese millet, wild millet, rice cutgrass, water-hemp; (bottom row, left to right) duck-potato, lophotocarpus, American bulrush, soft-stem bulrush, sago pondweed.

in the gizzards of the most important species are shown in fig. 4.

Common Mallard *Anas platyrhynchos*

Because hunters co-operating in this study seldom distinguished between the common mallard, *Anas platyrhynchos*, and the black mallard or black duck, *A. rubripes*, undoubtedly a few of the 2,825 gizzards labeled as those of common mallards, table 2, were from black ducks.

A mallard gizzard was assumed to be full if its gross contents amounted to 16 cc.

or more. The contents of individual gizzards ranged from 0.5 to 24.0 cc. and averaged 8.28 cc. per gizzard. Fewer than 250 of the mallard gizzards were less than one-quarter full or more than three-quarters full. Most of the gizzards with small amounts of food were collected early in the season, while most of those nearly full were collected between November 20 and December 5, a time when corn was available in large quantities.

The gross contents of the 2,825 mallard gizzards amounted to 22,379.73 cc., of which 37.25 per cent (8,335.46 cc.) was

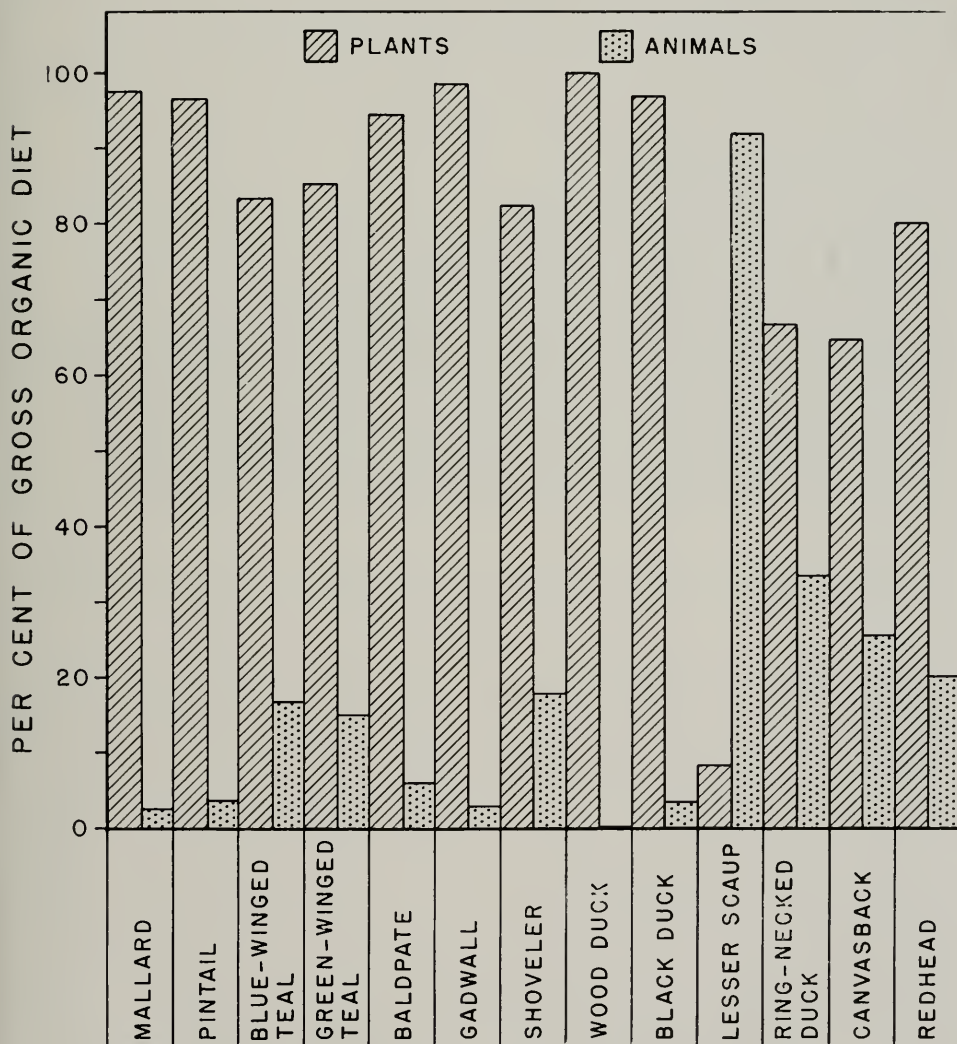


Fig. 4.—Volumetric percentages of plant and of animal material in nearly 5,000 duck gizzards collected in Illinois in the autumns of 1938, 1939, and 1940. Each of the most important duck species is considered separately.

Table 2.—Mallard gizzards collected in Illinois in approximately 2-week periods, 1938–1940.

YEAR	NUMBER OF GIZZARDS				TOTAL
	OCTOBER 16–31	NOVEMBER 1–15	NOVEMBER 16–30	DECEMBER 1–15	
1938.....	282	272	306	.....	860
1939.....	389	325	396	207	1,317
1940.....	149	120	258	107	634
Total.....	820	717	960	314	2,811*

*Fourteen gizzards could not be dated to bimonthly periods; hence, they are not included in this total. However, they are included in tables 3 and 4.

Table 3.—The most important plant foods identified in 2,825 mallard gizzards collected in Illinois, 1938–1940.

PLANT	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTI- METERS)	PER CENT OF TOTAL ORGANIC CONTENTS
TOTAL PLANT.....		13,725.53	97.73
<i>Zea mays</i> , corn	1,256	6,652.11	47.37
<i>Leersia oryzoides</i> , rice cutgrass.....	575	1,801.33	12.83
<i>Ceratophyllum demersum</i> , coontail.....	406	1,085.11	7.73
<i>Polygonum</i>			
<i>coccineum</i> , marsh smartweed.....	1,315	583.40	4.15
<i>pensylvanicum</i> , large-seeded smartweed.....	419	172.68	1.23
<i>lapathifolium</i> , nodding smartweed.....	587	125.39	0.89
<i>hydropiperoides</i> , mild water-pepper.....	147	61.12	0.44
<i>punctatum</i> , dotted smartweed.....	133	40.54	0.29
<i>persicaria</i> , lady's thumb.....	43	12.59	0.09
<i>hydropiper</i> , water-pepper.....	62	7.50	0.05
<i>sagittatum</i> , arrow-leaved tearthumb.....	3	0.60	0.004
<i>scandens</i> , climbing false buckwheat.....	10	0.38	0.003
<i>amphibium</i> , water lady's thumb.....	1	0.05	0.0004
Unidentified.....	8	2.16	0.02
<i>Echinochloa</i>			
<i>crusgalli</i> , wild millet.....	391	684.14	4.87
<i>waleri</i> , Walter's millet.....	94	127.13	0.91
Unidentified.....	1	1.40	0.01
<i>Cyperus</i>			
<i>esulentus</i> , chufa.....	190	185.39	1.32
<i>erythrorhizos</i> , red-rooted nut-grass.....	96	152.70	1.09
<i>strigosus</i> , nut-grass.....	113	125.55	0.89
Unidentified.....	15	39.18	0.28
<i>Acnida altissima</i> , water-hemp.....	298	358.78	2.55
<i>Potamogeton</i>			
<i>nodosus</i> , longleaf pondweed.....	823	191.96	1.37
<i>pectinatus</i> , sago pondweed.....	409	75.22	0.54
<i>foliosus</i> , leafy pondweed.....	104	23.49	0.17
<i>pusillus</i> , small pondweed.....	57	10.30	0.07
<i>perfoliatus</i> , thoroughwort pondweed.....	3	8.40	0.06
<i>praelongus</i> , white-stem pondweed.....	4	1.40	0.01
<i>amplifolius</i> , large-leaved pondweed.....	2	0.11	0.0008
Unidentified.....	29	1.54	0.01
<i>Sagittaria</i>			
<i>latifolia</i> , duck-potato.....	89	177.41	1.26
<i>cuneata</i> , wapato.....	1	0.50	0.004
Unidentified.....	1	1.30	0.009
<i>Triticum aestivum</i> , wheat.....	38	154.40	1.10
<i>Cephalanthus occidentalis</i> , buttonbush.....	382	147.43	1.05
Other plants.....	1,919	712.84	5.08

grit and 62.75 per cent (14,044.27 cc.) was organic in substance, tables 3 and 4. In 80 per cent of the mallard gizzards, the organic matter consisted of plant parts exclusively.

Plant Foods (97.73 Per Cent of Organic Contents).—Plant parts, which formed nearly 98 per cent of the food in the mallard gizzards, appeared in all but

some gizzards, leaves and stems of coon-tail, and rootstocks or tubers of rice cut-grass, chufa, and duck-potato constituted the entire plant contents.

Listed in table 3 are the most important plant foods found in the mallard gizzards collected for this study. Corn made up almost half of the total volume of plant foods; the amount of corn in the gizzards

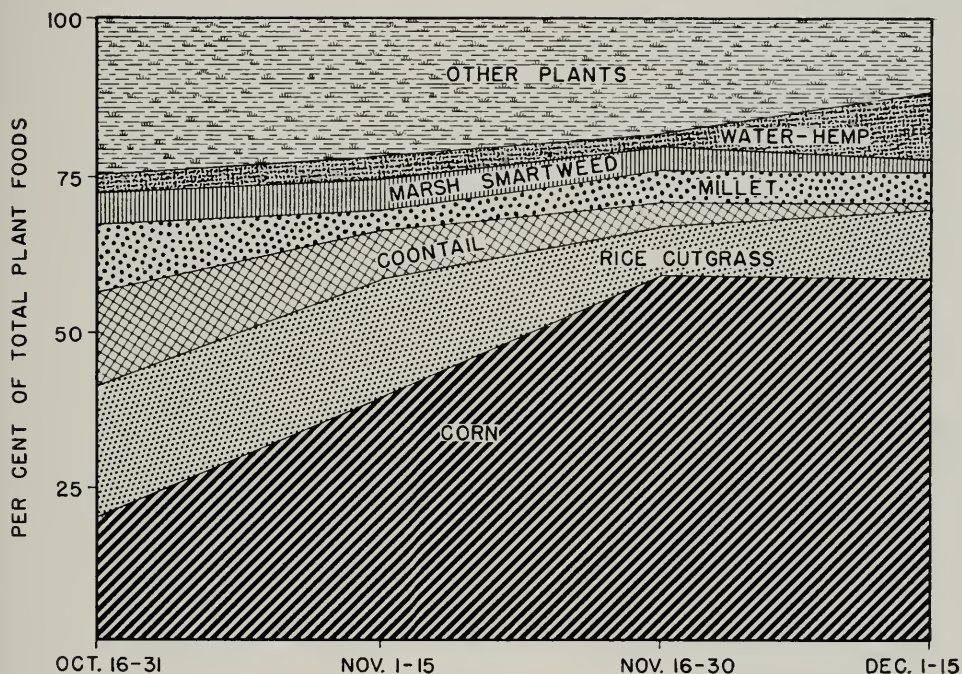


Fig. 5.—Principal plant foods consumed by mallards in Illinois from mid-October to mid-December, 1938-1940, as determined by volumetric analyses of gizzard contents. The curves represent the averages for the periods indicated.

13 of the gizzards. The plant contents of individual mallard gizzards ranged from a trace to 20 cc. and averaged 4.86 cc. per gizzard. The proportion of the organic contents made up of plant structures ranged from 95.17 per cent in 1938 to 99.28 per cent in 1940. Field observations in the areas from which the gizzards were collected in the 3-year period showed that water levels fluctuated from year to year, thus allowing native food plants to be more easily accessible in some years than in others.

Although there was some plant debris that could not be identified (0.02 per cent), 101 species of plants in the mallard gizzards were identified. Most of the material was in the form of seeds, but, in

was proportionally greater late in the season than early, fig. 5. Rice cutgrass, coon-tail, wild millet or barnyard grass, and marsh smartweed comprised more than half of the volume of native wild foods. The volume of emergent and moist-soil plant parts was four times as great as the volume of submergent vegetation.

Plant species that individually made up less than 1.0 per cent of the total organic volume had been ingested either in small units by a large number of mallards or in large volumes by a few birds. Some of the plant particles may have been taken incidentally along with more desirable foods.

Animal Foods (2.27 Per Cent of Organic Contents).—Animal matter was found in mallard gizzards taken in each

Table 4.—The most important animal foods identified in 2,825 mallard gizzards collected in Illinois, 1938–1940.

ANIMAL	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
<i>TOTAL ANIMAL</i> .....	.....	318.74	2.27
BRYOZOA statoblasts.....	20	0.30	0.002
MOLLUSCA			
GASTROPODA, snails			
<i>Stagnicola</i>	1	0.60	0.004
<i>Planorbis</i>	2	1.50	0.01
<i>Helisoma trivolvis</i>	2	0.47	0.003
<i>Carinifex newberryi</i>	1	0.40	0.003
<i>Physa</i>	4	1.20	0.009
<i>Campeloma</i>	11	9.60	0.07
<i>Annicola</i>	4	3.30	0.024
<i>Flummicola</i>	1	3.80	0.03
<i>Pleurocera</i>	6	2.20	0.02
Unidentified Gastropoda.....	45	22.40	0.16
PELECYPODA, mussels			
Sphaeriidae			
<i>Pisidium</i>	1	1.30	0.009
<i>Musculium transversum</i>	7	9.20	0.07
<i>Sphaerium</i>	11	20.90	0.15
Unidentified Sphaeriidae.....	1	2.70	0.02
Unionidae, fresh-water clams.....	5	3.40	0.02
Unidentified Pelecypoda.....	11	10.70	0.08
UNIDENTIFIED MOLLUSCA.....	16	8.20	0.06
ARTHROPODA			
CRUSTACEA			
Ostracoda.....	2	t	.....
Malacostraca			
Decapoda, <i>Cambarus virilis</i> , crayfish.....	10	20.40	0.14
Amphipoda, <i>Gammarus</i>	2	0.07	0.0005
Isopoda, <i>Asellus</i>	6	0.58	0.004
INSECTA			
Neuroptera, <i>Corydalis cornuta</i> , hellgrammites... ..	1	0.50	0.004
Ephemeroptera, <i>Hexagenia</i> nymphs, mayflies... ..	49	15.12	0.11
Odonata			
Anisoptera, dragonflies			
<i>Aeshna</i>	2	0.30	0.002
<i>Gomphus notatus</i>	1	0.40	0.003
Unidentified Anisoptera.....	1	0.20	0.001
Zygoptera, Coenagrionidae nymphs, damselflies.....	7	8.00	0.06
Unidentified odonata nymphs.....	4	1.40	0.01
Homoptera, Cicadellidae, leafhoppers.....	2	0.20	0.001
Hemiptera			
Corixidae, <i>Corixa</i> , water boatmen.....	169	75.79	0.54
Notonectidae, <i>Notonecta</i> , backswimmers.....	2	0.30	0.002
Nepidae, <i>Ranatra</i> , waterscorpions.....	1	0.60	0.004
Belostomatidae, water bugs.....	17	15.20	0.11
Gerridae nymphs, water striders.....	1	t	.....
Lygaeidae, <i>Lygaeus</i> , chinch bugs.....	1	t	.....
Pentatomidae, stink bugs.....	3	0.40	0.003
Unidentified Hemiptera.....	1	0.40	0.003
Coleoptera			
Carabidae, ground beetles.....	28	0.61	0.004
Halipidae.....	2	0.07	0.0005
Dytiscidae, diving beetles.....	121	13.39	0.10
Gyrinidae, whirligig beetles.....	4	0.42	0.003
Hydrophilidae, water scavenger beetles.....	6	6.60	0.05
Staphylinidae, rove beetles.....	3	0.04	0.0003
Buprestidae, flatheaded wood borers.....	1	t	.....

Table 4.—Continued.

ANIMAL	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
Elmidae.....	1	t	.....
Scarabaeidae, <i>Aphodius distinctus</i> , scarab beetles.....	2	0.06	0.0004
Chrysomelidae, leaf beetles.....	4	0.26	0.002
Curculionidae, snout beetles.....	15	2.80	0.02
Unidentified Coleoptera.....	4	0.50	0.004
Trichoptera, caddisflies			
Hydroptilidae.....	28	0.77	0.005
Hydropsychidae, <i>Hydropsyche</i> larvae.....	5	8.20	0.06
Unidentified Trichoptera cases.....	7	3.16	0.02
Lepidoptera			
Noctuidae, cutworm moths.....	2	0.29	0.002
Unidentified Lepidoptera moths.....	1	0.10	0.0007
Diptera			
Chironomid larvae, midges.....	72	27.20	0.19
Tabanidae, horse flies.....	1	0.20	0.001
Unidentified Diptera.....	11	1.13	0.008
Hymenoptera			
Formicidae, ants.....	4	t	.....
Tiphiidae, <i>Tiphia</i> , tephid wasps.....	1	t	.....
Unidentified Insecta.....	10	3.77	0.03
ARACHNIDA.....	13	0.62	0.004
ACARINA, water mites.....	19	t	.....
CHORDATA			
PISCES, fish.....	14	0.22	0.002
AMPHIBIA, frogs.....	1	1.00	0.007
NONFOOD			
PARASITIC WORMS.....	1	0.20	0.001
FEATHERS.....	43	4.90	0.03
UNIDENTIFIED.....	3	0.20	0.001

of the collecting periods of the fall months, the greatest volume from November 16 to freeze-up. Even though animal foods were found in 580 mallard gizzards, they appeared to be relatively unimportant in the fall diet. The animal remains in individual gizzards amounted to only a trace, except in a few gizzards which held as much as 12 cc. each.

An animal group was considered an important source of mallard food if it provided at least 0.1 per cent of the total organic contents. Of the animal foods found in the mallard gizzards, table 4, about two-thirds of the volume consisted of insects and approximately one-third of snails and mussels.

Inorganic Contents (37.25 Per Cent of Total Contents).—Grit and other inorganic material in individual mallard gizzards varied from a trace to 9.4 cc. and averaged 2.95 cc. per gizzard. Except for calcareous material in one gizzard, the inorganic contents consisted of stones ranging in size from minute to 19 mm. (largest

dimension); however, in most instances, the stones did not exceed 4 mm.

American Pintail

Anas acuta

In about 80 per cent of the pintail gizzards collected, table 5, the organic contents consisted of plant material exclusively. Vegetation was found in 99 per cent of the gizzards. These percentages seem to indicate that the pintail, in Illinois at least, utilizes vegetation to a slightly greater degree than does the mallard. Of the pintail gizzards collected, 31 came from the Mississippi River area and 850 from the Illinois River valley.

A pintail gizzard was assumed to be full if the gross contents amounted to 14.0 cc. or more; the average was 6.2 cc., and the extremes ranged from a trace to 16.5 cc. Approximately 210 gizzards were either less than one-quarter or more than three-quarters full, and only 6 were classified as full. In no collecting period were the proportions of full and nearly full gizzards

significantly greater than in any other. Fatty tissue was much in evidence around most of the pintail gizzards.

The gross contents of 881 pintail gizzards amounted to 5,431.91 cc., of which 37.52 per cent (2,038.20 cc.) was grit and

Table 5.—Pintail gizzards collected in Illinois in approximately 2-week periods, 1938–1940.

YEAR	NUMBER OF GIZZARDS				TOTAL
	OCTOBER 16-31	NOVEMBER 1-15	NOVEMBER 16-30	DECEMBER 1-15*	
1938...	135	71	71	.....	277
1939...	202	86	92	87	467
1940...	76	32	29	.....	137
Total.....	413	189	192	87	881

*No pintail gizzards collected in this period in 1938 and 1940; an early freeze occurred in 1938.

Table 6.—The most important plant foods identified in 881 American pintail gizzards collected in Illinois, 1938–1940.

PLANT	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
TOTAL PLANT.....	.....	3,291.44	96.99
<i>Echinochloa</i>			
<i>crusgalli</i> , wild millet.....	198	436.65	12.88
<i>walteri</i> , Walter's millet.....	98	265.73	7.83
<i>Leersia oryzoides</i> , rice cutgras.....	271	555.29	16.36
<i>Zea mays</i> , corn.....	138	532.92	15.70
<i>Cyperus</i>			
<i>erythrorhizos</i> , red-rooted nut-grass.....	183	298.72	8.80
<i>strigosus</i> , nut-grass.....	135	131.28	3.87
<i>esculentus</i> , chufa.....	83	55.10	1.62
Unidentified.....	4	8.40	0.25
<i>Polygonum</i>			
<i>coccineum</i> , marsh smartweed.....	422	126.97	3.74
<i>lapathifolium</i> , nodding smartweed.....	257	45.96	1.35
<i>hydropiperoides</i> , mild water-pepper.....	56	21.10	0.62
<i>pensylvanicum</i> , large-seeded smartweed.....	87	18.55	0.55
<i>punctatum</i> , dotted smartweed.....	36	15.24	0.45
<i>persicaria</i> , lady's thumb.....	49	5.32	0.16
<i>hydropiper</i> , water-pepper.....	16	2.95	0.09
<i>amphibium</i> , water lady's thumb.....	3	0.02	0.0006
Unidentified.....	2	0.30	0.009
<i>Ceratophyllum demersum</i> , coontail.....	110	216.25	6.37
<i>Acnida alissima</i> , water-hemp.....	198	117.88	3.47
<i>Potamogeton</i>			
<i>nodosus</i> , longleaf pondweed.....	223	48.01	1.41
<i>pectinatus</i> , sago pondweed.....	107	20.28	0.60
<i>foliosus</i> , leafy pondweed.....	61	16.79	0.49
<i>pusillus</i> , small pondweed.....	16	3.04	0.09
Other <i>Potamogeton</i>	4	t	.....
<i>Eragrostis hypnoides</i> , teal grass.....	45	81.30	2.40
<i>Cephalanthus occidentalis</i> , buttonbush.....	154	61.62	1.82
<i>Sagittaria</i>			
<i>latifolia</i> , duck-potato.....	29	36.56	1.08
Unidentified.....	1	0.01	0.0003
<i>Lemna</i>			
<i>minor</i> , lesser duckweed..	34	33.69	0.99
Unidentified.....	1	1.8	0.05
Other plants.....	394	133.71	3.94

Table 7.—The most important animal foods identified in 881 American pintail gizzards collected in Illinois, 1938–1940.

ANIMAL	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
TOTAL ANIMAL.....		102.27	3.01
BRYOZOA statoblasts.....	15	1.44	0.04
MOLLUSCA			
GASTROPODA, snails			
<i>Planorbis</i>	2	t	.....
<i>Helisoma trivolvis</i>	1	0.70	0.02
<i>Gyraulus parvus</i>	1	0.10	0.003
<i>Physa gyrina</i>	1	0.10	0.003
<i>Campelema</i>	4	3.70	0.11
<i>Lioptax subglobosus</i>	1	0.30	0.009
<i>Amnicola</i>	1	0.40	0.01
Unidentified Gastropoda.....	22	15.54	0.46
PELECYPODA, mussels			
Sphaeriidae			
<i>Pisidium</i>	4	5.08	0.15
<i>Musculium transversum</i>	2	2.70	0.08
<i>Sphaerium</i>	7	6.70	0.20
Unionidae, fresh-water clams.....	1	1.70	0.05
Unidentified Pelecypoda.....	8	4.30	0.13
UNIDENTIFIED MOLLUSCA.....	12	6.07	0.18
ARTHROPODA			
CRUSTACEA			
Ostracoda.....	3	0.50	0.01
Malacostraca			
Amphipoda, <i>Gammarus</i>	1	t	.....
Isopoda, <i>Asellus</i>	2	0.11	0.003
INSECTA			
Orthoptera, grasshoppers			
<i>Neoconocephalus</i>	1	0.20	0.006
Ephemeroptera, mayflies			
<i>Hexagenia</i> nymphs.....	9	4.50	0.13
<i>Caenis</i> nymphs.....	1	0.10	0.003
Odonata			
Anisoptera, dragonflies			
<i>Anax junius</i>	3	2.90	0.09
Anisoptera nymphs.....	1	0.10	0.003
Zygoptera, damselflies			
<i>Coenagrionidae</i>	1	0.10	0.003
Zygoptera nymphs.....	2	0.90	0.03
Unidentified Odonata.....	2	0.90	0.03
Hemiptera			
Corixidae, <i>Corixa</i> , water boatmen.....	27	6.73	0.20
Nepidae, <i>Ranatra</i> , waterscorpions.....	1	0.20	0.006
Pelastomatidae, predaceous water bugs.....	5	2.53	0.07
Miridae, <i>Lygus lineolaris</i>	1	0.02	0.0006
Lygaeidae, <i>Lygaeus kalmii</i> , chinch bugs.....	1	0.03	0.0009
Unidentified Hemiptera.....	1	t	.....
Coleoptera			
Carabidae, ground beetles			
<i>Casnonia pennsylvanica</i>	1	0.04	0.001
Unidentified Carabidae.....	9	t	.....
Haliplidae.....	1	6.10	0.003
Dytiscidae, diving beetles			
<i>Colymbetes</i>	1	0.20	0.006
Unidentified Dytiscidae.....	41	7.30	0.22
Hydrophilidae larvae, water scavenger beetles	2	0.20	0.006
Staphylinidae, rove beetles.....	1	0.20	0.006
Scarabaeidae, <i>Aphodius distinctus</i> , scarab beetles.....	1	0.05	0.001

Table 7.—Continued.

ANIMAL	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
Chrysomelidae, leaf beetles			
<i>Diabrotica undecimpunctata howardi</i>	1	t	.....
<i>Lixus</i>	1	0.20	0.006
Unidentified Chrysomelidae.....	1	t	.....
Curculionidae, snout beetles.....	2	t	.....
Trichoptera			
Hydroptilidae cases, caddisflies.....	33	3.42	0.10
Hydropsychidae, <i>Hydropsyche</i>	1	0.30	0.009
Unidentified Trichoptera.....	5	0.25	0.007
Diptera			
Chironomidae larvae, midges.....	39	18.09	0.53
Unidentified Diptera.....	2	0.03	0.0009
Hymenoptera			
Ichneumonidae, ichneumon flies.....	1	t	.....
Tiphiidae, <i>Tiphia</i>	1	0.10	0.003
Formicidae, ants.....	2	0.10	0.003
Unidentified Hymenoptera.....	1	0.96	0.03
Unidentified Insecta.....	1	t	.....
ARACHNIDA			
Araneae, spiders			
Argiopoidea.....	1	0.03	0.0009
Unidentified Araneae.....	1	t	.....
Unidentified Arachnida.....	3	t	.....
ACARINA, <i>Hydracarina</i> , water mites.....	18	0.22	0.006
CHORDATA			
PISCES, fish.....	2	t	.....
NONFOOD, feathers.....	15	1.23	0.04
UNIDENTIFIED.....	1	0.60	0.02

62.48 per cent (3,393.71 cc.) was organic material, tables 6 and 7.

Plant Foods (96.99 Per Cent of Organic Contents).—Plant parts, which formed approximately 97 per cent of the organic matter found in the pintail gizzards, appeared in all but eight of the gizzards. The plant contents of individual gizzards ranged from a trace to 14.0 cc. and averaged 3.7 cc. per gizzard. The volume of plant structures in the pintail gizzards was nearly 8 per cent greater in 1939 and 1940 than in 1938. More moist-soil plants were available to migrating ducks in 1939 and 1940 than in 1938, as indicated in a study by Bellrose (1941: 252–3). Moist-soil plants were more abundant along the Illinois River than along the Mississippi, a condition reflected in the larger percentage of structures of these plants noted in gizzards collected along the Illinois.

Some plant debris in the 881 pintail gizzards could not be identified; however, 73 species of emergent, submergent, moist-soil, and terrestrial plants were classified.

In most of these gizzards, seeds comprised the greater volume; in a few, the entire contents consisted of vegetative parts from such plants as rice cutgrass, duck-potato, and coontail.

Any plant providing at least 1.0 per cent of the total organic contents of gizzards of the pintail was regarded as an important source of food for this species, table 6. Principal food plants were the millets, rice cutgrass, corn, the nut-grasses, marsh smartweed, nodding smartweed, coontail, water-hemp, longleaf pondweed, teal grass, buttonbush, duck-potato, known also as common arrowhead, and duckweed.

Laboratory analyses of gizzard contents indicated that the pintails represented fed primarily on wild native plants, apparently taking corn only when the wild food supply was low. Field observations corroborated the laboratory findings; pintails were seldom observed among the mallard flocks flying to and from cornfields. It was noted that pintails used corn more frequently along the Mississippi River, where

moist-soil plants were decidedly less abundant, than in the Illinois River valley.

Animal Foods (3.01 Per Cent of Organic Contents).—Animal matter was found in a few pintail gizzards taken in each collecting period; it was most abundant during the period October 16–31. This type of food was found in 202 of the pintail gizzards, but only 8 contained animal matter exclusively.

Most pintail gizzards contained only traces of animal matter; however, one gizzard contained 11.5 cc. of midge larvae.

a larger percentage of animal matter than did those of the mallard or the pintail. Plant structures occurred in 53 per cent of the blue-winged teal gizzards analyzed. Most blue-winged teals leave Illinois before the middle of November, and only one gizzard representing the blue-wings was collected after that time, table 8. Only eight gizzards of the blue-winged teal were collected from the Mississippi River region.

A blue-winged teal gizzard was considered full if the gross contents amounted to

Table 8.—Blue-winged teal gizzards collected in Illinois in approximately 2-week periods, 1938–1940.

YEAR	NUMBER OF GIZZARDS				TOTAL
	OCTOBER 16-31	NOVEMBER 1-15	NOVEMBER 16-30	DECEMBER 1-15	
1938.....	62	.....	1	.....	63
1939.....	34	30	.....	.....	64
1940.....	2	.....	.....	.....	2
Total.....	98	30	1	0	129

The volume of animal foods averaged 0.51 cc. per gizzard.

An animal group represented by at least 0.1 per cent of the total organic volume was considered important in the diet of the pintail, table 7. Of the animal foods in the pintail gizzards, 49.62 per cent consisted of insects and 46.34 per cent represented the phylum Mollusca, about equally divided between snails and bivalves. Feathers, crustaceans, fish, water mites, and unidentified material were represented in the remaining percentage.

Inorganic Contents (37.52 Per Cent of Total Contents).—The volume of inorganic material in individual pintail gizzards ranged from a trace to 10.1 cc. and averaged 2.31 cc. per gizzard. Grit particles varied considerably in shape, roughness, and size. About 64 per cent of the particles ranged from minute to 4 mm., 26 per cent between 4 and 8 mm., and 10 per cent from 8 to 18 mm. (largest dimension).

Blue-Winged Teal
Anas discors

In the material collected for this study, gizzards of the blue-winged teal contained

3.7 cc. Degrees of fullness varied greatly among the samples, and the contents of the individual gizzards ranged from a trace to 3.9 cc.; the average amounted to 2.03 cc. per gizzard, slightly over half of the capacity.

The total contents of the 129 gizzards collected from blue-winged teals amounted to 261.87 cc., of which 39.35 per cent (103.05 cc.) was inorganic and 60.65 per cent (158.82 cc.) was organic material.

Plant Foods (83.63 Per Cent of Organic Contents).—Plant structures constituted more than four-fifths of the organic food present in the blue-winged teal gizzards. The plant contents of individual gizzards ranged from a trace to 3 cc.; the average was 1 cc. More moist-soil plants were accessible in 1939 and 1940 than in 1938; the plant contents per gizzard averaged 0.7 cc. in 1938, 1.3 cc. in 1939, and 0.9 cc. in 1940.

Thirty-nine species of plants from the gizzards of the blue-wings were identified. These plants were predominantly moist-soil species. The major portion of the material consisted of seeds and seed coats; however, stem and leaf fragments of coontail and sago pondweed were present.

A plant making up at least 1.0 per cent of the organic material was considered an important blue-winged teal food, table 9. Thirteen species and one genus, aggregating 76.66 per cent of the organic contents, were in this category: three nut-grasses, two millets, coontail, water-hemp, marsh

diet than that of the mallard or the pintail. In the majority of blue-winged teal gizzards containing animal parts, the animal contents ranged in volume from 0.1 to 1.0 cc.; some gizzards contained only a trace of animal matter and others as much as 2 cc. each. The animal groups considered

Table 9.—The most important plant foods identified in 129 blue-winged teal gizzards collected in Illinois, 1938–1940.

PLANT	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
TOTAL PLANT.....	.....	132.82	83.63
<i>Cyperus</i>			
<i>erythrorhizos</i> , red-rooted nut-grass.....	81	66.00	41.56
<i>strigosus</i> , nut-grass.....	33	4.50	2.83
<i>esculentus</i> , chufa.....	18	4.80	3.02
Unidentified.....	1	0.20	0.13
<i>Echinochloa</i>			
<i>crusgalli</i> , wild millet.....	15	7.30	4.60
<i>walteri</i> , Walter's millet.....	5	2.80	1.76
<i>Ceratophyllum</i>			
<i>demersum</i> , coontail.....	9	4.46	2.81
Unidentified.....	4	4.30	2.71
<i>Acnida altissima</i> , water-hemp.....	47	6.68	4.21
<i>Polygonum</i>			
<i>coccineum</i> , marsh smartweed.....	43	4.66	2.93
<i>lapathifolium</i> , nodding smartweed.....	45	0.79	0.50
<i>pensylvanicum</i> , large-seeded smartweed.....	12	0.48	0.30
<i>punctatum</i> , dotted smartweed.....	9	0.03	0.02
Other <i>Polygonum</i>	10	t	.....
<i>Eragrostis hypnoides</i> , teal grass.....	12	5.92	3.73
<i>Cephalanthus occidentalis</i> , buttonbush.....	15	3.97	2.50
<i>Panicum dichotomiflorum</i> , fall panic-grass.....	4	3.10	1.95
<i>Lemna minor</i> , lesser duckweed.....	6	2.89	1.82
<i>Leersia oryzoides</i> , rice cutgrass.....	10	2.53	1.59
<i>Potamogeton</i>			
<i>epiphydrus</i> , ribbon-leaf pondweed.....	1	1.30	0.82
<i>nodosus</i> , longleaf pondweed.....	10	0.55	0.35
<i>pectinatus</i> , sago pondweed.....	5	0.27	0.17
Other <i>Potamogeton</i>	4	0.01	0.01
Other plants.....	96	5.28	3.32

smartweed, teal grass, buttonbush, fall panic-grass, lesser duckweed, rice cutgrass, and the pondweeds as a group.

Any plant species or group represented by less than 1.0 per cent of the organic contents was considered to be of secondary importance. Plant parts of species in this category were found in many gizzards in small volumes, or in a few gizzards in large volumes.

Animal Foods (16.37 Per Cent of Organic Contents).—Because the blue-winged teal feeds extensively in shallow water areas, animal foods might be expected to constitute a greater part of its

most important were those that contributed at least 0.1 per cent each to the organic contents, table 10.

About 74 per cent of the volume of animal material in the gizzards of blue-wings consisted of insects. The Mollusca group made up about 17 per cent of the animal material. The crustaceans comprised about 5 per cent.

Inorganic Contents (39.35 Per Cent of Total Contents).—Grit present in individual blue-winged teal gizzards ranged in volume from a trace to 2 cc. and averaged 0.4 cc. Particles varied in size from sand to gravel stones of 4 mm. (largest

Table 10.—The most important animal foods identified in 129 blue-winged teal gizzards collected in Illinois, 1938–1940.

ANIMAL	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
TOTAL ANIMAL.....	.....	26.00	16.37
BRYOZOA statoblasts.....	11	0.80	0.50
MOLLUSCA			
GASTROPODA, snails			
<i>Gyraulus parvus</i>	1	0.10	0.06
Unidentified Gastropoda.....	6	0.90	0.57
PELECYPODA, mussels			
<i>Pisidium</i>	1	0.20	0.13
<i>Sphaerium</i>	3	0.70	0.44
UNIDENTIFIED MOLLUSCA.....	10	2.50	1.57
ARTHROPODA			
CRUSTACEA			
Copepoda.....	1	1.00	0.63
Ostracoda.....	11	0.40	0.25
INSECTA			
Ephemeroptera, <i>Hexagenia</i> , mayflies.....	3	0.10	0.06
Hemiptera, <i>Corixa</i> , water boatmen.....	29	8.35	5.25
Coleoptera			
Carabidae, ground beetles.....	1	t	.....
Dytiscidae, diving beetles.....	4	0.10	0.06
Gyrinidae, whirligig beetles.....	1	t	.....
Curculionidae, snout beetles.....	1	0.10	0.06
Trichoptera			
Hydroptilidae cases, caddisflies.....	14	0.10	0.06
Unidentified Trichoptera cases.....	1	0.10	0.06
Diptera, Chironomidae, midges.....	26	9.25	5.82
Unidentified Insecta.....	1	1.20	0.75
ARACHNIDA.....	1	t	.....
ACARINA, <i>Hydracarina</i> , water mites.....	5	0.10	0.06
NONFOOD, feathers.....	1	t	.....

dimension) ; however, the particles seldom exceeded 2 mm. each.

Green-Winged Teal
Anas carolinensis

The green-winged teal gizzards collected for this study contained a larger proportion of animal matter than was found in gizzards of the mallard, pintail, or blue-winged teal; yet the green-winged teal proved to be very much a vegetarian. Twenty-seven of the gizzards listed in table 11 were collected along the Mississippi River and 366 along the Illinois River.

A green-winged teal gizzard was considered full if the gross contents amounted to 3.5 cc. or more. The contents of individual gizzards ranged in volume from 0.4 to 4.5 cc. and averaged 1.0 cc. per gizzard. Over four-fifths of the gizzards were more than one-fourth full.

The total contents of all green-winged

teal gizzards amounted to 778.30 cc., of which 41.94 per cent (326.45 cc.) was inorganic and 58.06 per cent (451.85 cc.) was organic.

Plant Foods (84.96 Per Cent of Organic Contents).—Plant parts were found in 390 of the 393 green-winged teal gizzards collected; only grit was present in the other 3. Plant food in individual gizzards ranged from a trace to 2.8 cc. in volume and averaged 0.98 cc. per gizzard. As with gizzards of the blue-winged teal and the pintail, the green-winged gizzards contained a larger proportion of plant material in 1939 and 1940 than in 1938, probably because of greater availability of moist-soil species. The average volume of plant material per gizzard was 0.78 cc. in 1938, 1.22 cc. in 1939, and 0.90 cc. in 1940. The quantity of plant structures was greater in green-winged teal gizzards collected along the Illinois River than in those obtained along the Mississippi River.

This fact probably reflected differences in plant food availability.

In the gizzards of the green-wings, there was some plant debris (0.09 per cent) that could not be identified; struc-

tures representing 63 species of emergent, moist-soil, submergent, and terrestrial plants were identified. Seeds and seed-coat fragments comprised the bulk of the plant structures, although coontail stems

Table 11.—Green-winged teal gizzards collected in Illinois in approximately 2-week periods, 1938–1940.

YEAR	NUMBER OF GIZZARDS				TOTAL
	OCTOBER 16–31	NOVEMBER 1–15	NOVEMBER 16–30	DECEMBER 1–15	
1938.....	85	62	54	.....	201
1939.....	31	51	47	35	164
1940.....	5	6	14	3	28
Total.....	121	119	115	38	393

Table 12.—The most important plant foods identified in 393 green-winged teal gizzards collected in Illinois, 1938–1940.

PLANT	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
TOTAL PLANT.....	.....	383.91	84.96
<i>Cyperus</i>			
<i>erythrorhizos</i> , red-rooted nut-grass.....	212	135.98	30.09
<i>strigosus</i> , nut-grass.....	90	29.30	6.48
<i>esculentus</i> , chufa.....	73	19.06	4.22
<i>ferax</i>	7	0.90	0.20
<i>Echinochloa</i>			
<i>crusgalli</i> , wild millet.....	75	31.20	6.90
<i>walteri</i> , Walter's millet.....	39	14.51	3.21
Unidentified.....	1	t	.....
<i>Eragrostis</i>			
<i>hypnoides</i> , teal grass.....	30	21.72	4.81
Unidentified.....	2	0.40	0.09
<i>Polygonum</i>			
<i>coccineum</i> , marsh smartweed.....	10	10.85	2.40
<i>lapathifolium</i> , nodding smartweed.....	128	5.12	1.13
<i>pensylvanicum</i> , large-seeded smartweed.....	35	3.00	0.66
<i>punctatum</i> , dotted smartweed.....	14	0.11	0.02
<i>hydropiper</i> , water-pepper.....	5	0.10	0.02
<i>persicaria</i> , lady's thumb.....	14	0.05	0.01
Other <i>Polygonum</i>	11	1.55	0.34
<i>Lemna minor</i> , lesser duckweed.....	58	17.92	3.97
<i>Ceratophyllum demersum</i> , coontail.....	26	16.65	3.68
<i>Juncus</i> , bog rush.....	23	11.78	2.61
<i>Leersia oryzoides</i> , rice cutgrass.....	34	8.97	1.99
<i>Acnida altissima</i> , water-hemp.....	131	8.27	1.83
<i>Potamogeton</i>			
<i>foliosus</i> , leafy pondweed.....	23	3.45	0.76
<i>nodosus</i> , longleaf pondweed.....	27	2.50	0.55
<i>pusillus</i> , small pondweed.....	11	0.81	0.18
<i>pectinatus</i> , sago pondweed.....	15	0.49	0.11
<i>epiphydrus</i> , ribbon-leaf pondweed.....	1	0.05	0.01
Other <i>Potamogeton</i>	4	0.15	0.03
<i>Zea mays</i> , corn.....	12	7.05	1.56
<i>Cephalanthus occidentalis</i> , buttonbush.....	35	5.46	1.21
<i>Sagittaria latifolia</i> , duck-potato.....	21	4.63	1.02
Other plants.....	251	21.88	4.84

and leaves and duckweed particles were numerous.

Plant foods that contributed at least 1.0 per cent each to the total organic contents

of the gizzards of green-wings and in the aggregate amounted to more than 75 per cent of the organic contents were three nut-grasses, two millets, teal grass, marsh

Table 13.—The most important animal foods identified in 393 green-winged teal gizzards collected in Illinois, 1938–1940.

ANIMAL	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
TOTAL ANIMAL.....		67.94	15.04
BRYOZOA statoblasts.....	69	5.33	1.18
MOLLUSCA			
GASTROPODA, snails			
<i>Gyraulus parvus</i>	1	0.08	0.02
<i>Physa gyrina</i>	1	1.70	0.38
Unidentified Gastropoda.....	26	8.26	1.83
PELECYPODA, <i>Sphaerium</i> , seed shells.....	1	0.10	0.02
UNIDENTIFIED MOLLUSCA.....	15	4.56	1.01
ARTHROPODA			
CRUSTACEA			
Branchiopoda			
Fairy shrimps.....	1	1.30	0.29
Unidentified Branchiopoda.....	2	0.10	0.02
Copepoda			
<i>Cyclops</i>	3	1.40	0.31
<i>Canthocampus</i>	2	t	
Unidentified Copepoda.....	1	1.20	0.27
Ostracoda			
<i>Candona</i>	2	0.02	0.004
<i>Cypris</i>	1	0.01	0.002
Unidentified Ostracoda.....	57	1.43	0.32
Malacostraca			
Amphipoda, <i>Gammarus</i>	3	t	
Isopoda, <i>Asellus</i>	2	0.10	0.02
INSECTA			
Orthoptera, Tettigoniidae, grasshoppers.....	1	0.30	0.07
Ephemeroptera, mayflies			
<i>Hexagenia</i> nymphs.....	2	0.30	0.07
<i>Caenis</i> nymphs.....	1	t	
Odonata			
Anisoptera, <i>Aeshna</i> , dragonflies.....	3	0.30	0.07
Zygoptera, Coenagrionidae, damselflies.....	4	3.60	0.80
Odonata nymphs.....	3	1.50	0.33
Hemiptera, <i>Corixa</i> , water boatmen.....	58	15.34	3.39
Coleoptera			
Carabidae, ground beetles.....	8	0.11	0.02
Dytiscidae, diving beetles.....	33	0.67	0.15
Gyrinidae, whirligig beetles.....	2	t	
Staphylinidae, rove beetles.....	1	t	
Elmidae.....	1	t	
Chrysomelidae, <i>Diabrotica undecimpunctata howardi</i> , leaf beetles.....	1	t	
Unidentified Coleoptera.....	1	0.05	0.01
Trichoptera			
Hydroptilidae cases, caddisflies.....	43	1.24	0.27
Unidentified Trichoptera.....	3	0.20	0.04
Diptera, Chironomidae larvae, midges.....	66	17.24	3.82
Hymenoptera			
Ichneumonidae, ichneumon flies.....	1	0.05	0.01
Formicidae, ants.....	1	t	
Unidentified Insecta.....	2	0.12	0.03
ARACHNIDA.....	1	t	
ACARINA, <i>Hydracarina</i> , water mites.....	20	0.04	0.009
NONFOOD, feathers.....	12	1.29	0.29

smartweed, nodding smartweed, lesser duckweed, coontail, rice cutgrass, water-hemp, the pondweeds as a group, corn, buttonbush, and duck-potato, table 12. Most of these plants grow on mud flats or moist sand bars.

Animal Foods (15.04 Per Cent of Organic Contents).—Animal matter appeared in more than half of the gizzards of the green-winged teals and in a few gizzards in greater volume than the plant foods. It was found in gizzards collected in all four periods but in the greatest percentage in those collected from October 16 through November 15.

Individual gizzards of the green-winged teals contained a trace to 3.1 cc. of animal parts and averaged 0.31 cc. More than a third of them contained 0.1 to 1.0 cc. of

animal matter each. An animal group representing at least 0.1 per cent of the total organic contents of the gizzards of these teals was considered important, table 13.

Insects comprised a little less than two-thirds of the volume of animal matter in gizzards of the green-wings. In greatest volumes were midge larvae, water boatmen, and Odonata nymphs. The Mollusca group, represented principally by snails, made up 21.64 per cent of the animal contents. Other important animal foods were Bryozoa statoblasts and crustaceans.

Inorganic Contents (41.94 Per Cent of Total Contents).—In most of the green-winged teal gizzards collected, almost one-half of the gross contents consisted of inorganic material. The volume of inorganic matter in individual gizzards

Table 14.—Baldpate gizzards collected in Illinois in approximately 2-week periods, 1938–1940.

YEAR	NUMBER OF GIZZARDS				TOTAL
	OCTOBER 16-31	NOVEMBER 1-15	NOVEMBER 16-30	DECEMBER 1-15	
1938.....	64	23	1	.....	88
1939.....	19	30	3	9	61
1940.....	4	6	1	.....	11
Total.....	87	59	5	9	160

Table 15.—The most important plant foods identified in 160 baldpate gizzards collected in Illinois, 1938–1940.

PLANT	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
TOTAL PLANT.....		318.75	93.66
<i>Ceratophyllum demersum</i> , coontail.....	116	237.93	69.91
<i>Potamogeton</i>			
<i>nodosus</i> , longleaf pondweed.....	24	5.77	1.70
<i>pectinatus</i> , sago pondweed.....	10	4.20	1.23
<i>foliosus</i> , leafy pondweed.....	4	4.10	1.20
<i>Leersia oryzoides</i> , rice cutgrass.....	12	12.60	3.70
<i>Polygonum</i>			
<i>coccineum</i> , marsh smartweed.....	60	10.87	3.19
<i>pensylvanicum</i> , large-seeded smartweed.....	5	0.25	0.07
<i>lapathifolium</i> , nodding smartweed.....	18	0.14	0.04
<i>hydropiperoides</i> , mild water-pepper.....	5	0.10	0.03
<i>punctatum</i> , dotted smartweed.....	5	0.03	0.01
Other <i>Polygonum</i>	1	0.10	0.03
<i>Cephalanthus occidentalis</i> , buttonbush.....	28	9.20	2.70
<i>Ulothrix zonata</i> , algae.....	3	8.60	2.53
<i>Zea mays</i> , corn.....	4	6.80	2.00
<i>Sagittaria latifolia</i> , duck-potato.....	3	5.10	1.50
<i>Lemna minor</i> , lesser duckweed.....	7	4.20	1.23
Other plants.....	56	8.76	2.57

ranged from a trace to 1.9 cc. and averaged 0.8 cc. Gravel particles varied in size from minute to 9 mm. (largest dimension), but seldom exceeded 3 mm. Very little other inorganic material was present in gizzards containing grit particles 7, 8, or 9 mm. in size.

Baldpate

Mareca americana

Analyses of the contents of gizzards collected for this study indicated that in Illinois the baldpate, or widgeon, during the fall months is primarily a vegetarian; it appears to ingest animal foods only incidentally with plant parts. Because the baldpate reaches its peak population in this state early in the fall, most of the gizzards representing this species were obtained during the first two collecting periods, table 14. Of the 160 samples, only 8 were

collected from stations along the Mississippi River.

A baldpate gizzard, about as large as that of a mallard or pintail, was considered to have a capacity of 13 cc. Gross contents of individual gizzards ranged from 1.4 to 11.0 cc. and averaged 4.99 cc. Nearly one-fifth of the gizzards were less than one-quarter full and none was full. Even on gizzards in which the contents averaged less than half the gizzard capacity, fatty tissue was prevalent.

The gross material in the 160 gizzards of baldpates totaled 799.82 cc. Of this amount, 57.45 per cent (459.50 cc.) consisted of grit and the remaining 42.55 per cent (340.32 cc.) consisted of plant and animal parts.

Plant Foods (93.66 Per Cent of Organic Contents).—In 1938, plant structures made up 91 per cent of the organic

Table 16.—The most important animal foods identified in 160 baldpate gizzards collected in Illinois, 1938–1940.

ANIMAL	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
TOTAL ANIMAL.....		21.57	6.34
BRYOZOA statoblasts.....	5	0.20	0.06
MOLLUSCA			
GASTROPODA, snails			
<i>Gyraulus parvus</i>	1	0.30	0.09
<i>Physa</i>	1	0.20	0.06
Unidentified Gastropoda.....	3	2.10	0.62
UNIDENTIFIED MOLLUSCA shells.....	1	0.10	0.03
ARTHROPODA			
CRUSTACEA, <i>Asellus</i>	1	0.05	0.015
INSECTA			
Ephemeroptera, <i>Hexagenia</i> nymphs, mayflies...	1	0.10	0.03
Odonata nymphs, dragonflies.....	1	1.20	0.35
Homoptera, Cicadellidae, leafhoppers			
<i>Draculacephala</i>	1	t	.....
Unidentified Homoptera.....	1	t	.....
Hemiptera			
<i>Corixa</i> , water boatmen.....	17	14.00	4.11
<i>Lygus lineolaris</i>	1	t	.....
Coleoptera			
Carabidae, <i>Omophron</i>	1	0.20	0.06
Dytiscidae, diving beetles.....	4	1.90	0.56
Scarabaeidae, <i>Geotrupes</i> , scarab beetles.....	1	0.20	0.06
Chrysomelidae, <i>Diabrotica</i> , leaf beetles.....	1	t	.....
Trichoptera			
Hydroptilidae cases, caddisflies.....	5	0.02	0.006
Unidentified Trichoptera cases.....	2	0.10	0.03
Diptera			
Chironomidae larvae, midges.....	2	0.90	0.26
Unidentified Diptera larvae.....	1	t	.....
ARACHNIDA.....	1	t	.....
ACARINA, <i>Hydracarina</i> , water mites.....	2	t	.....
NONFOOD, feathers.....	2	t	.....

contents of the baldpate gizzards; in 1939 and 1940 they represented 100 per cent of the organic material. Volumes in individual gizzards varied considerably; in a number of gizzards only a trace of plant material was found, while in others the plant contents ranged up to 6.5 cc. The average was 1.99 cc., a rather low volume for the size of the gizzard.

Plant debris amounting to 0.33 per cent of the organic contents of the baldpate gizzards could not be keyed to species because of its finely ground condition; however, 34 species of plants were identified. The bulk of this plant material consisted of stems and leaves of coontail. The remaining plant material, except for algae and duckweed, consisted of seeds and seed coats.

Of 11 plants important to the baldpate (plants constituting at least 1.0 per cent of the total organic contents of the baldpate gizzards collected), coontail appeared to be the most important, table 15. Nearly three-fourths of the organic volume consisted of this plant. Field observations showed that baldpate concentrations were usually found in lakes or sloughs where coontail beds flourished. Corn was found in only four baldpate gizzards, and this was probably bait. Moist-soil plants in some gizzards indicated the birds had fed on flooded mud flats.

Plant species of lesser importance, those that contributed less than 1.0 per cent of the organic contents of the baldpate gizzards, were taken by only a few baldpates but in fairly large amounts. Most of these were moist-soil plants important to the teal and the pintail.

Animal Foods (6.34 Per Cent of Organic Contents).—Most of the animal foods found in the baldpate gizzards, table 16, were species associated with submerged plant beds and had been ingested probably

while the birds were browsing on coontail. Volumes in individual gizzards ranged from a trace to 6.8 cc., most of them less than 0.5 cc.

Aquatic insects, most of them water boatmen, comprised more than four-fifths of the animal material found in the baldpate gizzards. The Mollusca group was represented only by univalves. Bryozoans, water mites, crustaceans, and feathers were present in very small amounts.

Inorganic Contents (57.45 Per Cent of Total Contents).—The inorganic material in individual baldpate gizzards varied in volume from 0.5 to 5.1 cc. and averaged 2.87 cc. Most of the grit consisted of fine, white sand crystals. In four-fifths of the gizzards, stones were less than 2 mm. in size (largest dimension). In the remaining 20 per cent, there were, in addition to the fine sand, a few stones ranging from 3 to 10 mm. in size.

Gadwall

Anas strepera

This study indicated that the gadwall, like the baldpate, is primarily a vegetarian in the fall months in Illinois. Four-fifths of the gadwall gizzards collected for this study contained no animal material. Material was collected for the first three of the four collecting periods in the years of this study, table 17. Of the 98 gizzards obtained, only 7 were from the Mississippi River.

A gadwall gizzard was considered to have a capacity of 14 cc. None was filled to capacity; the contents of individual gizzards ranged in volume from 1.0 to 10.5 cc. and averaged 5.2 cc. One gizzard was completely empty; its condition indicated the bird was emaciated and probably sick. About one-tenth of the gizzards were less than one-quarter full; in these the con-

Table 17.—Gadwall gizzards collected in Illinois in approximately 2-week periods, 1938–1940.

YEAR	NUMBER OF GIZZARDS				TOTAL
	OCTOBER 16-31	NOVEMBER 1-15	NOVEMBER 16-30	DECEMBER 1-15	
1938.....	19	4	6	.....	29
1939.....	7	38	14	.....	59
1940.....	1	9	.....	.....	10
Total.....	27	51	20	0	98

tents were mostly grit. No gizzard was more than three-quarters full; yet most birds were apparently healthy when shot, since fatty tissue was evident.

The total contents of the gadwall gizzards amounted to 509.29 cc., of which 74.04 per cent (377.10 cc.) was grit and 25.96 per cent (132.19 cc.) was organic

material. Vegetable foods comprised 97.21 per cent and animal foods 2.79 per cent of the organic contents, tables 18 and 19.

Plant Foods (97.21 Per Cent of Organic Contents).—Plant items were found in 89 of the 98 gadwall gizzards; only gritty material was found in the remaining 9. The plant food contents of indi-

Table 18.—The most important plant foods identified in 98 gadwall gizzards collected in Illinois, 1938–1940.

PLANT	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
TOTAL PLANT.....		128.50	97.21
<i>Ceratophyllum demersum</i> , coontail.....	48	94.98	71.85
Algae.....	13	9.80	7.41
<i>Polygonum</i>			
<i>coccineum</i> , marsh smartweed.....	18	4.32	3.27
<i>lapathifolium</i> , nodding smartweed.....	10	0.10	0.08
<i>pensylvanicum</i> , large-seeded smartweed.....	5	0.02	0.02
Other <i>Polygonum</i>	3	t	.....
<i>Echinochloa crusgalli</i> , wild millet.....	10	3.30	2.50
<i>Digitaria</i>			
<i>sanguinalis</i> , crab-grass.....	1	2.50	1.89
<i>ischaemum</i> , smooth crab-grass.....	1	0.30	0.23
<i>Leersia oryzoides</i> , rice cutgrass.....	8	1.80	1.36
<i>Scirpus</i>			
<i>acutus</i> , hard-stem bulrush	2	1.30	0.98
<i>fluvialis</i> , river-bulrush.....	2	0.25	0.19
<i>validus</i> , soft-stem bulrush.....	2	0.10	0.08
<i>Potamogeton nodosus</i> , longleaf pondweed.....	6	1.60	1.21
<i>Heteranthera dubia</i> , mud-plantain.....	1	1.40	1.06
Other plants.....	47	6.73	5.09

Table 19.—The most important animal foods identified in 98 gadwall gizzards collected in Illinois, 1938–1940.

ANIMAL	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
TOTAL ANIMAL.....		3.69	2.79
MOLLUSCA, shells.....	1	t	.....
ARTHROPODA			
CRUSTACEA, Ostracoda.....	1	t	.....
INSECTA			
Hemiptera, <i>Corixa</i> , water boatmen.....	8	0.33	0.25
Coleoptera			
Dytiscidae, diving beetles.....	6	t	.....
Scarabaeidae, <i>Aphodius distinctus</i> , scarab beetles.....	1	0.02	0.02
Trichoptera, Hydroptilidae, caddisflies.....	4	t	.....
Lepidoptera larvae, moths.....	1	t	.....
Diptera			
Orthorrhapha, Chironomidae larvae, midges ..	3	2.90	2.19
Cyclorrhapha	1	0.02	0.02
ARACHNIDA.....	1	0.10	0.08
ACARINA, <i>Hydracarina</i> , water mites.....	1	t	.....
NONFOOD, feathers.....	6	0.32	0.24

vidual gizzards varied from a trace to 6 cc. and averaged 1.3 cc.

Thirty-four species of plants from the gadwall gizzards were identified; 0.88 per cent of the plant material was too finely ground to be recognized. The major portion of the plant material consisted of the stems and leaves of coontail and the entire plants and particles of duckweed and algae.

Plant groups contributing at least 1.0 per cent each to the organic contents of the

tals, each under 1 mm. in size. Occasionally, a stone up to 5 mm. (largest dimension) was found.

Shoveler
Spatula clypeata

Analyses of the contents of the duck gizzards collected in 1938, 1939, and 1940 indicated that, although animal foods are more readily consumed by the shoveler than by any other species of the dabbling group, this duck is still very much a vege-

Table 20.—Shoveler gizzards collected in Illinois in approximately 2-week periods, 1938–1940.

YEAR	NUMBER OF GIZZARDS				TOTAL
	OCTOBER 16-31	NOVEMBER 1-15	NOVEMBER 16-30	DECEMBER 1-15	
1938.....	19	1	7	.....	27
1939.....	9	23	.....	2	34
1940.....	.....	1	.....	.....	1
Total.....	28	25	7	2	62

gadwall gizzards were coontail, algae, marsh smartweed, wild millet, crab-grass, rice cutgrass, longleaf pondweed, and mud plantain, table 18. Coontail comprised nearly three-fourths of the organic contents. Moist-soil plant parts were found in the gizzards of gadwalls that had apparently visited flooded mud flats.

Twenty-six species of plants contributed less than 1.0 per cent each to the organic contents of the gadwall gizzards. Some of these plants had been taken in large amounts by only a few gadwalls and some had been taken in small amounts by a comparatively large number of birds.

Animal Foods (2.79 Per Cent of Organic Contents).—Animal organisms were present in one-fourth of the gadwall gizzards. The animal contents of individual gizzards ranged from a trace to 1.7 cc. and averaged 0.14 cc. Only two groups of animals, the water boatmen and midge larvae, made up as much as 0.1 per cent of the organic contents, table 19.

Inorganic Contents (74.04 Per Cent of Total Contents).—Grit predominated in the gross contents of the gadwall gizzards. In individual gizzards, grit ranged in volume from a trace to 6.6 cc. and averaged 3.85 cc. per gizzard. The grit was mostly in the form of fine, white sand crys-

tian during the fall months in Illinois. Because of their rather unsavory flavor, shovelers are, by some hunters, allowed to pass; or, if one of these ducks is killed, usually it is left in the marsh. Because this situation prevailed in 1938–1940, an adequate sample of shoveler gizzards was difficult to obtain, table 20. Only 3 of the 62 gizzards collected were obtained from Mississippi River stations.

A shoveler gizzard was considered full if its gross contents amounted to 6 cc. Contents of individual gizzards ranged in volume from 0.7 to 7.0 cc. and averaged 3.3 cc. Only 4 of the 62 shoveler gizzards were less than one-quarter full, and 16 were more than three-quarters full. Shovelers represented by these gizzards appeared to have obtained an adequate food supply during their autumn stay in Illinois.

The total contents of the shoveler gizzards amounted to 204.86 cc., of which 51.89 per cent (106.30 cc.) was inorganic and 48.11 per cent (98.56 cc.) was organic. The supposition that the unsavory flavor of the shoveler results from a diet of animal food was not substantiated by the present study. Plant structures formed 82.36 per cent and animal matter only 17.64 per cent of the organic material of

the shoveler gizzards collected, tables 21 and 22.

Plant Foods (82.36 Per Cent of Organic Contents).—The shoveler, more than any other species of duck, skims food from the surfaces of lake and marsh bottoms in very shallow water, much of it less than an inch in depth. Because of this

Nine plants, each represented by at least 1.0 per cent of the organic contents, provided the bulk of the food in the shoveler gizzards, table 21. Plants making up less than 1.0 per cent each of the total organic contents were not considered important even though they appeared in large volumes in a few gizzards. Their occurrence

Table 21.—The most important plant foods identified in 62 shoveler gizzards collected in Illinois, 1938–1940.

PLANT	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
TOTAL PLANT.....	.....	81.17	82.36
<i>Cyperus</i>			
<i>erythrorhizos</i> , red-rooted nut-grass	26	28.56	28.98
<i>esculentus</i> , chufa.....	4	1.75	1.78
<i>strigosus</i> , nut-grass.....	8	0.90	0.91
<i>Cephalanthus occidentalis</i> , buttonbush.....	24	16.50	16.74
<i>Zea mays</i> , corn.....	8	11.10	11.26
<i>Ceratophyllum demersum</i> , coontail	12	9.10	9.23
<i>Echinochloa</i>			
<i>crusgalli</i> , wild millet.....	11	5.12	5.19
<i>walteri</i> , Walter's millet.....	1	0.20	0.20
<i>Nelumbo lutea</i> , American lotus.....	1	2.00	2.03
<i>Polygonum</i>			
<i>coccineum</i> , marsh smartweed.....	33	1.18	1.20
<i>pennsylvanicum</i> , large-seeded smartweed.....	4	0.30	0.30
<i>lappathifolium</i> , nodding smartweed.....	9	0.12	0.12
<i>punctatum</i> , dotted smartweed	4	0.10	0.10
Other <i>Polygonum</i>	11	t	.....
<i>Eragrostis hypnoides</i> , teal grass.....	1	1.60	1.62
<i>Potamogeton</i>			
<i>nodosus</i> , longleaf pondweed.....	13	0.67	0.68
<i>pectinatus</i> , sago pondweed.....	3	0.40	0.41
Other <i>Potamogeton</i>	11	0.10	0.10
Other plants.....	45	1.47	1.49

habit, the shoveler ingests large numbers of moist-soil plant seeds. The percentage of these seeds was greater in the shoveler gizzards collected in 1939 and 1940 than in those collected in 1938 probably because of the greater accessibility and availability of the seeds on inundated mud flats in the later years. The plant contents of individual gizzards ranged from a trace to 6.3 cc. and averaged 1.3 cc.

Parts of plants representing 42 species and some debris that could not be identified were found in the shoveler gizzards. The bulk of the vegetative structures was seeds and seed fragments of moist-soil plants, some stems and leaves of coontail, and seeds of the buttonbush, plant foods similar to those consumed by the blue-winged teal and the green-winged teal.

in only a few gizzards indicated a local feeding condition.

Animal Foods (17.64 Per Cent of Organic Contents).—Animal matter appeared in 50 of the 62 shoveler gizzards, but exclusively in only 6. The animal contents of individual gizzards varied from a trace to 2.4 cc.; most gizzards contained less than 1 cc. each of animal structures. Insect adults and larvae comprised 61.13 per cent and the Mollusca group 20.24 per cent of the volume of animal foods in the shoveler gizzards, table 22.

Inorganic Contents (51.89 Per Cent of Total Contents).—The volume of inorganic material in individual shoveler gizzards ranged from 0.6 to 5.5 cc. and averaged 1.71 cc. per gizzard. Most of the gravel particles were less than 2 mm. in

Table 22.—The most important animal foods identified in 62 shoveler gizzards collected in Illinois, 1938–1940.

ANIMAL	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
<i>TOTAL ANIMAL</i>		17.39	17.64
BRYOZOA statoblasts.....	12	0.70	0.71
MOLLUSCA			
GASTROPODA, snails			
<i>Gyraulus parvus</i>	1	t	.....
Unidentified Gastropoda.....	5	1.20	1.22
PELECYPODA, mussels			
<i>Pisidium</i>	1	0.02	0.02
Unidentified Pelecypoda.....	1	1.30	1.32
UNIDENTIFIED MOLLUSCA.....	6	1.00	1.01
ARTHROPODA			
CRUSTACEA			
Copepoda, <i>Canthocampus</i>	2	0.70	0.71
Ostracoda.....	28	1.84	1.87
INSECTA			
Ephemeroptera, <i>Hexagenia</i> , mayflies.....	2	0.10	0.12
Hemiptera			
<i>Corixa</i> , water boatmen.....	26	8.84	8.96
Unidentified Hemiptera.....	1	0.05	0.05
Coleoptera			
Carabidae, ground beetles.....	1	t	.....
Dytiscidae, diving beetles.....	8	0.15	0.15
Gyrinidae, whirligig beetles.....	1	t	.....
Staphylinidae, rove beetles.....	1	0.05	0.05
Scarabaeidae, scarab beetles			
<i>Aphodius</i>			
<i>distinctus</i>	1	0.05	0.05
<i>femoralis</i>	1	0.05	0.05
Trichoptera, Hydroptilidae cases, caddisflies.....	4	0.44	0.45
Diptera			
Chironomidae larvae, midges.....	4	0.60	0.61
Unidentified Diptera.....	1	0.30	0.30
Unidentified Insecta.....	1	t	.....
ACARINA, <i>Hydracarina</i> , water mites.....	4	t	.....
NONFOOD, feathers.....	1	t	.....

size (largest dimension); a few stones were as large as 5 mm.

Wood Duck

Aix sponsa

Because the wood duck was legally protected at the time of this study, only a few gizzards of this species were available for examination. A small sample was obtained from confiscated birds. Twenty-six gizzards were collected: 9 in the period October 15–31 and 17 in the period November 1–15, 1938, 1939, and 1940. Seven of the gizzards were collected from Mississippi River stations.

A wood duck gizzard was considered full if the gross contents amounted to 9 cc. The contents of individual gizzards ranged in volume from 2 to 10 cc. and averaged 5.6 cc. per gizzard.

The gross contents of all wood duck gizzards collected amounted to 171.38 cc., of which 29.00 per cent (49.70 cc.) was grit and 71.00 per cent (121.68 cc.) was organic substance. Of the organic material, plant foods amounted to 99.85 per cent and animal foods to only 0.15 per cent, tables 23 and 24.

Plant Foods (99.85 Per Cent of Organic Contents).—The wood duck, as indicated by the small sample of gizzards collected, can be considered a vegetarian during the fall months in Illinois. Plant structures appeared in all the wood duck gizzards collected. The plant contents of individual gizzards ranged in volume from 0.8 to 9.6 cc. and averaged 4.7 cc. per gizzard.

Examination of the contents of the wood duck gizzards indicated that during

the autumn months the wood duck diet in Illinois is similar to the mallard diet in that corn is the major food. In the years of this study, wood ducks were frequently observed flying to and from mechanically picked cornfields located close to the wooded lakes and sloughs where these ducks congregated. Twenty-two plant species were identified in the wood duck gizzards collected, but only eight of these were represented by at least 1.0 per cent each of the organic contents, table 23.

Plants of secondary importance (those that contributed less than 1.0 per cent each to the total organic contents of the wood duck gizzards) were not found in large quantities in any of these gizzards. The only plants in this group worthy of mention were the lotus and the dogwood.

Animal Foods (0.15 Per Cent of Organic Contents).—This study indicated that animal organisms are relatively unimportant to the wood duck during the fall months in Illinois, table 24.

Table 23.—The most important plant foods identified in 26 wood duck gizzards collected in Illinois, 1938–1940.

PLANT	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
TOTAL PLANT.....		121.50	99.85
<i>Zea mays</i> , corn.....	11	58.87	48.38
<i>Quercus</i>			
<i>palustris</i> , pin oak.....	1	5.80	4.77
Unidentified.....	2	12.40	10.19
<i>Echinochloa crusgalli</i> , wild millet.....	1	14.70	12.08
<i>Ceratophyllum</i>			
<i>demersum</i> , coontail.....	2	2.80	2.30
Unidentified.....	1	5.10	4.19
<i>Cephalanthus occidentalis</i> , buttonbush.....	6	5.21	4.28
<i>Potamogeton</i>			
<i>nodosus</i> , longleaf pondweed.....	5	5.20	4.27
<i>pectinatus</i> , sago pondweed.....	1	t	.....
<i>Leersia oryzoides</i> , rice cutgrass.....	3	4.60	3.78
<i>Vitis cordifolia</i> , frost grape.....	2	2.50	2.05
<i>Polygonum</i>			
<i>coccineum</i> , marsh smartweed.....	7	1.09	0.90
<i>hydropiperoides</i> , mild water-pepper.....	1	0.40	0.33
Other <i>Polygonum</i>	7	t	.....
Other plants.....	10	2.83	2.33

Table 24.—The most important animal foods identified in 26 wood duck gizzards collected in Illinois, 1938–1940.

ANIMAL	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
TOTAL ANIMAL.....		0.18	0.15
ARTHROPODA, INSECTA			
Orthoptera, grasshoppers			
Rhaphidophorinae.....	1	t	.....
Unidentified Saltatoria.....	1	0.02	0.02
Hemiptera			
<i>Corixa</i> , water boatmen.....	2	t	.....
Unidentified Hemiptera.....	1	0.02	0.02
Coleoptera, Chrysomelidae, leaf beetles			
<i>Diabrotica undecimpunctata howardi</i>	1	0.02	0.02
Unidentified Coleoptera.....	1	0.02	0.02
NONFOOD, feathers.....	1	0.10	0.08
UNIDENTIFIED ANIMAL.....	1	t	.....

Table 25.—The most important plant foods identified in 11 black duck gizzards collected in Illinois, 1938–1940.

PLANT	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
<i>TOTAL PLANT</i>		46.60	96.88
<i>Ceratophyllum demersum</i> , coontail.....	6	19.00	39.50
<i>Echinochloa crusgalli</i> , wild millet.....	1	7.60	15.80
<i>Leersia oryzoides</i> , rice cutgrass.....	1	4.70	9.77
<i>Potamogeton</i>			
<i>nodosus</i> , longleaf pondweed.....	7	3.70	7.69
<i>pectinatus</i> , sago pondweed.....	1	0.70	1.46
<i>pusillus</i> , small pondweed.....	1	0.05	0.10
<i>Zea mays</i> , corn.....	1	3.30	6.86
<i>Cephalanthus occidentalis</i> , buttonbush.....	3	2.70	5.61
<i>Acnida altissima</i> , water-hemp.....	1	2.70	5.61
<i>Polygonum</i>			
<i>coccineum</i> , marsh smartweed.....	5	1.60	3.33
Other <i>Polygonum</i>	4	t	.....
Other plants.....	8	0.55	1.14

Inorganic Contents (29.00 Per Cent of Total Contents).—Inorganic material, present in all wood duck gizzards examined, ranged in volume from 0.4 to 5.6 cc. in individual gizzards and averaged 1.9 cc. per gizzard. Most of the gravel particles were under 2 mm. in size (largest dimension); however, a few stones ranged in size up to 12 mm. In the gizzards in which corn predominated as food, grit particles seldom exceeded 2 mm. in size.

Black Duck *Anas rubripes*

Few gizzards labeled as those of black ducks were examined. Co-operators seldom distinguished between the common mallard and the black duck or black mal-

lard; for accuracy, the writer did not designate as black duck gizzards any he had not collected personally. Eleven gizzards known to be those of the black duck were obtained in 1939 and 1940 in the period October 15–November 15.

The capacity of a black duck gizzard was considered to be 17 cc. None of the black duck gizzards examined was completely full. The contents of individual gizzards ranged in volume from 0.6 to 10.2 cc. and averaged 6.9 cc. per gizzard.

The gross contents of the black duck gizzards amounted to 75.60 cc., of which 36.38 per cent (27.50 cc.) was grit and 63.62 per cent (48.10 cc.) was organic matter. Plant parts comprised 96.88 per cent of the foods, while animal structures

Table 26.—The most important animal foods identified in 11 black duck gizzards collected in Illinois, 1938–1940.

ANIMAL	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
<i>TOTAL ANIMAL</i>		1.50	3.12
MOLLUSCA			
PELECYPODA, mussels.....	1	0.30	0.62
UNIDENTIFIED MOLLUSCA.....	1	0.50	1.04
ARTHROPODA, INSECTA			
Ephemeroptera, <i>Hexagenia</i> , mayflies.....	1	0.60	1.25
Coleoptera			
Dytiscidae, diving beetles.....	2	t	.....
Hydrophilidae, water scavenger beetles.....	1	0.10	0.21
Trichoptera, caddisflies.....	1	t	.....

amounted to 3.12 per cent, tables 25 and 26.

Plant Foods (96.88 Per Cent of Organic Contents).—Plant parts appeared in all black duck gizzards collected. The plant contents of individual gizzards ranged in volume from 0.1 to 8.7 cc. and averaged 4.2 cc. per gizzard. Twenty plant species were identified; the nine that were considered important constituted 95.63 per cent of all organic foods, table 25.

In general, the diet of the black duck was similar to that of the common mallard. Corn might have been more important on the list of foods of the black duck if collections had been made later in the fall and if a larger sample had been taken.

Animal Foods (3.12 Per Cent of Organic Contents).—Only a few kinds of animal organisms were represented in the 11 black duck gizzards, table 26.

Inorganic Contents (36.38 Per Cent of Total Contents).—Gravel was present in all black duck gizzards collected; in individual gizzards, it ranged in volume

from a trace to 4.5 cc. Stones varied in size from minute to 9 mm. (largest dimension); however, most inorganic particles were less than 2 mm. in size.

Lesser Scaup
Aythya affinis

Lesser scaups are usually considered omnivorous feeders, but this study indicated their preference for animal foods during the fall months in Illinois. Data were obtained from 220 lesser scaup gizzards collected in the periods shown in table 27. Of the total, 81 were from the Mississippi River and 139 from the Illinois River stations.

A lesser scaup gizzard was considered full if its gross contents amounted to 5.7 cc. or more. The contents of individual lesser scaup gizzards ranged in volume from a trace to 10.5 cc. and averaged 2.86 cc. Approximately one-third of the gizzards were less than one-quarter full; four of these were empty and showed indications of lead poisoning. Only 10 were more than three-quarters full. Fatty tissue surrounded most of the gizzards.

Table 27.—Lesser scaup gizzards collected in Illinois in approximately 2-week periods, 1938–1940.

YEAR	NUMBER OF GIZZARDS				TOTAL
	OCTOBER 16–31	NOVEMBER 1–15	NOVEMBER 16–30	DECEMBER 1–15	
1938.....	.....	58	68	.....	126
1939.....	.....	19	37	10	66
1940.....	1	2	25	.....	28
Total.....	1	79	130	10	220

Table 28.—The most important plant foods identified in 220 lesser scaup gizzards collected in Illinois, 1938–1940.

PLANT	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS ¹)	PER CENT OF TOTAL ORGANIC CONTENTS ²
TOTAL PLANT.....	.....	39.49	9.65
Potamogeton			
pectinatus, sago pondweed.....	32	4.29	1.05
nodosus, longleaf pondweed.....	58	3.41	0.83
foliosus, leafy pondweed.....	12	3.00	0.73
pusillus, small pondweed.....	6	0.67	0.16
Other Potamogeton.....	7	0.15	0.04
Ceratophyllum demersum, coontail.....	21	9.71	2.37
Other plants.....	212	18.26	4.46

Table 29.—The most important animal foods identified in 220 lesser scaup gizzards collected in Illinois, 1938–1940.

ANIMAL	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
TOTAL ANIMAL.....		369.87	90.35
BRYOZOA statoblasts.....	1	t	
MOLLUSCA			
GASTROPODA, snails			
<i>Gyraulus parvus</i>	2	t	
<i>Viviparus viviparus</i>	2	4.90	1.20
<i>Campeloma</i>	16	29.00	7.08
<i>Lioplax subcarinata</i>	8	4.35	1.06
<i>Amnicola</i>			
<i>peracuta</i>	1	0.50	0.12
Unidentified <i>Amnicola</i>	15	23.30	5.69
(<i>Probythinella</i>)			
<i>binneyana</i>	29	23.25	5.68
Unidentified <i>Amnicola</i> (<i>Probythinella</i>).....	1	1.50	0.37
<i>Flummicola</i>	3	2.80	0.68
<i>Somatogyrus</i>			
<i>subglobosus</i>	2	0.30	0.07
Unidentified <i>Somatogyrus</i>	1	0.80	0.20
<i>Pleurocera</i>	11	3.40	0.83
<i>Neritina</i>	2	2.50	0.61
Unidentified Gastropoda.....	57	80.88	19.76
PELECYPODA, mussels			
Sphaeriidae			
<i>Pisidium</i>	8	12.70	3.10
<i>Musculium transversum</i>	9	13.10	3.20
<i>Sphaerium</i>			
<i>stamineum</i>	1	0.40	0.10
Unidentified <i>Sphaerium</i>	27	71.60	17.49
Unidentified Sphaeriidae.....	9	34.30	8.38
Unionidae, fresh-water clams.....	12	10.59	2.59
Unidentified Pelecypoda.....	8	1.14	0.28
UNIDENTIFIED MOLLUSCA.....	23	31.11	7.60
ARTHROPODA			
Crustacea			
<i>Cambarus virilis</i> , crayfish.....	1	0.10	0.02
INSECTA			
Ephemeroptera, <i>Hexagenia</i> nymphs, mayflies.....	30	13.56	3.31
Odonata, <i>Anax junius</i> , dragonflies.....	2	0.70	0.17
Hemiptera			
Corixidae, <i>Corixa</i> , water boatmen.....	7	1.00	0.24
Gerridae, <i>Gerris remigis</i> , water striders.....	1	0.20	0.05
Coreidae, squash bugs.....	1	0.12	0.03
Unidentified Hemiptera.....	1	0.10	0.02
Coleoptera			
Carabidae, ground beetles.....	1	t	
Dytiscidae, diving beetles.....	6	0.50	0.12
Hydrophilidae, water scavenger beetles.....	1	t	
Scarabaeidae, <i>Aphodius femoralis</i>	1	0.10	0.02
Curculionidae, snout beetles.....	1	t	
Trichoptera, Hydroptilidae cases, caddisflies.....	1	t	
Diptera			
Chironomidae larvae, midges.....	1	0.20	0.05
Anthomyiidae.....	2	0.29	0.07
Unidentified Diptera.....	2	t	
Hymenoptera, Formicidae, ants.....	1	0.08	0.02
ARACHNIDA			
Araneae, spiders.....	1	t	
Unidentified Arachnida.....	2	0.10	0.02
NONFOOD, feathers.....	2	0.40	0.10
UNIDENTIFIED.....	1	t	

The gross contents of the 220 lesser scaup gizzards amounted to 630.26 cc., of which 35.05 per cent (220.90 cc.) was grit and 64.95 per cent (409.36 cc.) was organic material. Reflecting the apparently carnivorous appetite of the lesser scaups in Illinois, animal matter amounted to 90.35 per cent of the organic foods, while plant structures constituted only 9.65 per cent.

Plant Foods (9.65 Per Cent of Organic Contents).—In Illinois, lesser scaup ducks do much of their feeding on submergent vegetation at water depths of 3 to

important single plant, it was second in importance to the pondweeds as a group.

Animal Foods (90.35 Per Cent of Organic Contents).—Animal matter was found in lesser scaup gizzards taken in all collecting periods, but in greatest amounts in those taken in the last 2 weeks of November. It was found in four-fifths of the lesser scaup gizzards, exclusively in one-fifth. The animal contents of individual gizzards ranged in volume from a trace to 9.5 cc. and averaged 1.68 cc. per gizzard.

The principal animals represented in the gizzards of lesser scaups, table 29,

Table 30.—Ring-necked duck gizzards collected in Illinois in approximately 2-week periods, 1938–1940.

YEAR	NUMBER OF GIZZARDS				TOTAL
	OCTOBER 16-31	NOVEMBER 1-15	NOVEMBER 16-30	DECEMBER 1-15	
1938.....	2	52	50	.....	104
1939.....	4	6	3	3	16
1940*.....	.....	.....	.....	.....	0
Total.....	6	58	53	3	120

*In this year, no ring-necked ducks were found among the ducks bagged and used for collection material.

5 feet and on mollusks and other animals at depths up to 15 feet.

Plant structures were found in 140 of the 220 lesser scaup gizzards collected. Only 13.33 per cent of the organic contents of the gizzards collected in 1938 consisted of plant material. Comparable figures were 16.51 per cent for 1939 and 42.50 per cent for 1940; stable water conditions in 1940 resulted in a marked increase in submergent plant beds (Bellrose 1941:249–50, 252).

Plant material ranged in volume from a trace to 3.7 cc. in individual lesser scaup gizzards and averaged 0.18 cc. per gizzard. The bulk of the plant material was composed of seeds and seed fragments of several submergent plants and the stems and leaves of coontail.

In all, 38 plant species were identified in the gizzards of lesser scaups; however, only a few of these were represented by at least 0.5 per cent each of the organic diet, table 28. Three species of pondweed contributed a large volume of plant material and occurred in a large number of gizzards. Although coontail was the most

were from the Mollusca phylum, which accounted for 95.28 per cent of the animal foods. Snails contributed 47.98 per cent of the animal material and the bivalves 38.89 per cent. Shells of the brackish water snail (*Neritina*) occurred in two gizzards. The snails of this genus apparently were ingested on the wintering grounds and the shells retained in the gizzards through the breeding season. Most aquatic insects in the gizzards were adult mayflies or larvae. No fish fragments were found.

Inorganic Contents (35.05 Per Cent of Total Contents).—No attempt was made to segregate gravel from calcareous shell material in the lesser scaup gizzards; both materials act as grinding agents. Gravel was present in all of the gizzards; individual particles ranged from minute to 11 mm. in size (largest dimension).

Ring-Necked Duck
Aythya collaris

Although ring-necked ducks are excellent divers and can obtain food at considerable depths, they prefer shallow waters,

marshes, and sloughs. Of the 120 ring-necked duck gizzards collected, table 30, 7 were from the Mississippi River region and 113 from the Illinois River valley.

A ring-necked duck gizzard was considered full if the gross contents amounted to 8.5 cc. or more. The contents of individual gizzards ranged in volume from 0.4 to 11.0 cc. and averaged 3.7 cc. per gizzard. Most of the gizzards were surrounded by heavy fatty tissue.

The gross contents of the 120 gizzards of ring-necks amounted to 445.65 cc., of which 41.31 per cent (184.10 cc.) was grit and 58.69 per cent (261.55 cc.) was organic material. Plants comprised 65.93 per cent of the organic foods, and animal matter made up 34.07 per cent, tables 31 and 32.

Plant Foods (65.93 Per Cent of Organic Contents).—Plant structures were present in nearly all the ring-necked duck

gizzards. The plant contents of individual gizzards varied from a trace to 9.1 cc. and averaged 1.44 cc. per gizzard. Most of the gizzards contained less than 2 cc. of plant material each; the few with more than 2 cc. contained plant material exclusively. Plant material in the gizzards of ring-necked ducks increased from 64.10 per cent of organic contents in 1938 to 75.20 per cent in 1939, paralleling the increase in duck food plants in Illinois River valley lakes (Bellrose 1941:249–53).

Although the gizzards of ring-necks contained some unidentifiable plant debris, 44 species of submergent, emergent, and moist-soil plants were recognized. Seeds and seed fragments formed the bulk of the structures; however, the stems and leaves of coontail and the tubers of duck-potato and chufa were present.

The 11 plants most important to the ring-neck (plants that contributed 1.0 per

Table 31.—The most important plant foods identified in 120 ring-necked duck gizzards collected in Illinois, 1938–1940.

PLANT	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
TOTAL PLANT.....		172.45	65.93
<i>Ceratophyllum demersum</i> , coontail.....	35	45.54	17.41
<i>Zea mays</i> , corn.....	10	36.40	13.92
<i>Potamogeton</i>			
<i>nodosus</i> , longleaf pondweed.....	50	20.38	7.79
<i>pectinatus</i> , sago pondweed.....	34	8.25	3.15
<i>pusillus</i> , small pondweed.....	11	3.56	1.36
<i>foliosus</i> , leafy pondweed.....	5	3.20	1.22
<i>gramineus</i> , variable-leaf pondweed.....	1	0.40	0.15
<i>praelongus</i> , white-stem pondweed.....	1	0.30	0.11
Other <i>Potamogeton</i>	2	0.20	0.08
<i>Polygonum</i>			
<i>coccineum</i> , marsh smartweed.....	54	13.61	5.20
<i>lapathifolium</i> , nodding smartweed.....	36	1.25	0.48
<i>pensylvanicum</i> , large-seeded smartweed.....	10	0.74	0.28
<i>punctatum</i> , dotted smartweed.....	1	0.30	0.11
<i>hydropiper</i> , water-pepper.....	1	0.20	0.08
Other <i>Polygonum</i>	2	0.10	0.04
<i>Cyperus</i>			
<i>erthyrorhizos</i> , red-rooted nut-grass.....	13	7.85	3.00
<i>esculentus</i> , chufa.....	2	0.10	0.04
<i>Sagittaria latifolia</i> , duck-potato.....	1	6.70	2.56
<i>Cephalanthus occidentalis</i> , buttonbush.....	19	3.78	1.45
<i>Scirpus</i>			
<i>fluvialis</i> , river-bulrush.....	15	3.27	1.25
<i>acutus</i> , hard-stem bulrush.....	7	0.45	0.17
<i>validus</i> , soft-stem bulrush.....	3	0.02	0.01
Unidentified.....	1	0.03	0.01
<i>Sparganium</i>			
<i>eurycarpum</i> , giant bur-reed.....	8	1.13	0.43
Unidentified.....	10	2.44	0.93
Other plants.....	67	12.25	4.68

cent or more each to the organic contents of the gizzards representing this species, table 31) totaled almost 60 per cent of the volume of food in the gizzards.

Parts of the secondary food plants were found in relatively large quantities in a few gizzards of the ring-necks, but in most gizzards only traces or small quantities were noted.

Animal Foods (34.07 Per Cent of Organic Contents).—Animal matter was found in 80 ring-necked duck gizzards and was represented in the four collecting periods. The animal contents of individual gizzards varied from a trace to 7.6 cc. and averaged 0.73 cc. per gizzard. Only four

gizzards contained animal food exclusively.

Of the total animal material in the gizzards of the ring-necks, mollusks represented more than 70 per cent by volume; more than half of the volume of mollusks consisted of univalves, table 32. Adults and larvae of insects constituted nearly 25 per cent of the volume of animal matter. Bryozoan statoblasts, fish, crustaceans, spiders, and water mites were present in insignificant amounts.

Inorganic Contents (41.31 Per Cent of Total Contents).—The volume of inorganic material in the gizzards of the ring-necks ranged from a trace to 7 cc. and

Table 32.—The most important animal foods identified in 120 ring-necked duck gizzards collected in Illinois, 1938–1940.

ANIMAL	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
TOTAL ANIMAL.....	.....	89.10	34.07
BRYOZOA statoblasts	2	1.20	0.46
MOLLUSCA			
GASTROPODA, snails			
<i>Stagnicola</i>	2	5.10	1.95
<i>Physa</i>	1	0.20	0.08
<i>Viviparus viviparus</i>	1	0.20	0.08
<i>Amnicola (Probythinella) binneyana</i>	3	2.40	0.92
<i>Campeloma</i>	4	3.70	1.41
<i>Flumnicola</i>	2	0.70	0.27
<i>Somatogyrus subglobosus</i>	1	0.60	0.23
<i>Pleurocera</i>	1	0.20	0.08
Unidentified Gastropoda.....	14	20.29	7.76
PELECYPODA, Sphaeriidae, mussels			
<i>Pisidium</i>	4	4.30	1.64
<i>Musculium transversum</i>	3	5.20	1.99
<i>Sphaerium</i>	5	9.20	3.52
UNIDENTIFIED MOLLUSCA.....	9	13.40	5.12
ARTHROPODA			
CRUSTACEA, <i>Gammarus fasciatus</i> , gammarid . .	1	t	.....
INSECTA			
Ephemeroptera, <i>Hexagenia</i> nymphs, mayflies..	7	8.20	3.13
Hemiptera			
Corixidae, <i>Corixa</i> , water boatmen. . .	17	2.36	0.90
Belostomatidae, <i>Benacus</i> nymphs, water bugs	1	0.12	0.05
Coleoptera			
Carabidae, ground beetles.....	4	0.68	0.26
Dytiscidae, diving beetles.....	6	0.06	0.02
Gyrinidae, whirligig beetles.....	1	0.05	0.02
Scarabaeidae, <i>Aphodius distinctus</i> , scarab beetles.....	1	0.60	0.23
Chrysomelidae, <i>Chaetocnema</i> , leaf beetles.....	1	t	.....
Unidentified Coleoptera.....	1	t	.....
Trichoptera.....	6	0.10	0.04
Diptera, Chironomidae larvae, midges.....	19	9.33	3.57
Hymenoptera, Ichneumonidae, ichneumon flies..	1	t	.....
ARACHNIDA, Araneae, spiders.....	1	t	.....
ACARINA, <i>Hydracarina</i> , water mites.....	5	0.01	0.004
CHORDATA, Pisces.....	1	t	.....
NONFOOD, feathers.....	5	0.90	0.34

averaged 1.53 cc. per gizzard. Gravel particles ranged in size from minute to 13 mm. (largest dimension). In 80 per cent of the gizzards, grit particles seldom exceeded 3 mm. each. Apparently calcareous shell material served as grit, for gravel was absent from many gizzards.

Canvasback

Aythya valisineria

The canvasback is an omnivorous feeder in Illinois, this study indicated. Many of the canvasback gizzards collected (61 per

cent) contained only vegetable matter, while a few (8 per cent) contained animal matter exclusively. Because few canvasbacks were killed in Illinois while field work for this study was being done, only a small number of canvasback gizzards were collected. Of the 23 collected, 18 were obtained in 1938, 9 in 1939, and 1 in 1940; 4 of these were from the Mississippi River area. One gizzard was taken in the period October 15–31, 13 in November 1–15, 13 in November 16–30, and 1 in December 1–15.

Table 33.—The most important plant foods identified in 28 canvasback gizzards collected in Illinois, 1938–1940.

PLANT	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
TOTAL PLANT.....		89.32	65.00
<i>Potamogeton</i>			
<i>nodosus</i> , longleaf pondweed.....	20	34.26	24.93
<i>pectinatus</i> , sago pondweed.....	7	11.62	8.46
<i>pusillus</i> , small pondweed.....	1	0.20	0.15
<i>foliosus</i> , leafy pondweed.....	1	0.10	0.07
<i>Sagittaria latifolia</i> , duck-potato.....	6	24.91	18.13
<i>Ceratophyllum demersum</i> , coontail.....	7	15.00	10.91
Other plants.....	43	3.23	2.35

Table 34.—The most important animal foods identified in 28 canvasback gizzards collected in Illinois, 1938–1940.

ANIMAL	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
TOTAL ANIMAL.....		48.10	35.00
MOLLUSCA			
GASTROPODA, snails			
<i>Amnicola</i>	1	2.30	1.67
<i>Flumnicola</i>	1	1.30	0.95
Unidentified Gastropoda.....	1	2.70	1.96
PELECYPODA, mussels			
<i>Sphaerium</i>	1	1.10	0.80
Unidentified Pelecypoda.....	1	2.70	1.97
ARTHROPODA, INSECTA			
Ephemeroptera, <i>Hexagenia</i> nymphs, mayflies.....	3	0.95	0.69
Hemiptera, <i>Corixa</i> , water boatmen.....	2	0.10	0.07
Coleoptera			
Carabidae, ground beetles.....	1	t	
Dytiscidae, diving beetles.....	1	0.05	0.04
Dryopidae.....	1	t	
Curculionidae, snout beetles.....	1	0.20	0.14
Diptera			
Chironomidae larvae, midges.....	5	32.00	21.28
Tabanidae, <i>Tabanus</i> larvae, horse flies.....	1	0.30	0.20
Unidentified Diptera larvae.....	1	4.30	2.86
CHORDATA, Pisces.....	1	t	
NONFOOD, feathers.....	1	0.10	0.07

Table 35.—The most important plant foods identified in 14 redhead gizzards collected in Illinois, 1938.

PLANT	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
<i>TOTAL PLANT</i>		40 30	77.93
<i>Potamogeton</i>			
<i>nodosus</i> , longleaf pondweed	7	17.03	32.93
<i>pectinatus</i> , sago pondweed	6	0 27	0.52
Other <i>Potamogeton</i>	1	t	.....
<i>Ceratophyllum demersum</i> , coontail.....	4	7.40	14.31
<i>Echinochloa crusgalli</i> , wild millet.....	2	4 30	8.32
<i>Zea mays</i> , corn.....	1	2 60	5.03
<i>Polygonum</i>			
<i>coccineum</i> , marsh smartweed.....	5	1 89	3.66
<i>lapathifolium</i> , nodding smartweed.....	4	0 35	0.68
<i>pensylvanicum</i> , large-seeded smartweed.....	2	0 25	0.48
<i>punctatum</i> , dotted smartweed.....	1	0 10	0.19
<i>Scirpus</i>			
<i>validus</i> , soft-stem bulrush.....	5	0 80	1.55
<i>fluviatilis</i> , river-bulrush.....	4	0.15	0.29
<i>Ambrosia</i>			
<i>artemisiifolia</i> , common ragweed.....	1	t	.....
Unidentified.....	1	0.65	1.26
Other plants.....	8	4 51	8.72

A canvasback gizzard was considered full if the gross contents amounted to 14.5 cc. or more. The contents of individual gizzards ranged in volume from 0.8 to 17.5 cc. and averaged 7.91 per gizzard.

In this study, 221.72 cc. of material was obtained from the 28 canvasback gizzards; of this material, 38.02 per cent (84.30 cc.) was grit and 61.98 per cent (137.42 cc.) was organic material. Plant structures comprised 65.00 per cent and animal parts 35.00 per cent of the organic foods, tables 33 and 34.

Plant Foods (65.00 Per Cent of Organic Contents).—Plant structures were found in nearly all the canvasback gizzards collected; the plant food contents of individual gizzards ranged from 0.1 to 12.0 cc. and averaged 3.14 per gizzard.

Plants that furnished at least 1.0 per cent each of the organic contents of the canvasback gizzards were considered important, table 33. These were longleaf and sago pondweeds, duck-potato, and coontail, which together amounted to nearly two-thirds of the organic material. Twenty plant species that individually contributed less than 1.0 per cent of the organic contents were considered of secondary importance. Some of these may have been important locally but in most

canvasback gizzards they were found in small quantities.

Animal Foods (35.00 Per Cent of Organic Contents).—Animal parts were found in two-fifths of the canvasback gizzards; the animal contents of individual gizzards varied from a trace to 11.3 cc. and averaged 1.72 cc. per gizzard. Animal forms considered important were those that contributed at least 0.5 per cent each to the organic contents, table 34.

Inorganic Contents (38.02 Per Cent of Total Contents).—The volume of inorganic material in individual gizzards of the canvasback varied from 0.5 to 5.5 cc. each. The quantity of gravel was smaller in gizzards containing snail parts than in others; evidently the shell material took the place of stones. Gravel particles ranged from minute to 11 mm. in size (largest dimension); most stones were no larger than 2 mm.

Redhead

Aythya americana

Fourteen gizzards of the redhead duck were collected, all in the period November 1–15, 1938. Data from this small sample have limited value.

The capacity of a redhead gizzard was considered to be 14 cc.; however, none of

Table 36.—The most important animal foods identified in 14 redhead gizzards collected in Illinois, 1938.

ANIMAL	OCCURRENCE (NUMBER OF GIZZARDS)	VOLUME (CUBIC CENTIMETERS)	PER CENT OF TOTAL ORGANIC CONTENTS
TOTAL ANIMAL.....	.....	11.41	22.07
BRYOZOA statoblasts.....	1	t	.....
ARTHROPODA			
INSECTA			
Ephemeroptera, <i>Ilexagenia</i> , mayflies	1	0.30	0.58
Hemiptera, <i>Corixa</i> , water boatmen.....	1	0.01	0.02
Coleoptera, Dytiscidae, diving beetles.....	1	t	.....
Trichoptera.....	2	1.50	2.90
Lepidoptera.....	1	0.09	0.17
Diptera, Chironomidae larvae, midges.....	6	9.50	18.37
ARACHNIDA			
Argiopoidea, spiders.....	1	0.01	0.02
Unidentified Arachnida.....	1	t	.....
ACARINA, <i>Hydracarina</i> , water mites.....	1	t	.....
NONFOOD, feathers.....	1	t	.....

the gizzards collected contained this volume of material. Gross contents of individual gizzards ranged from 3.2 to 10.0 cc. each and averaged 6.47 cc. per gizzard. Of the 90.61 cc. of material, 42.93 per cent (38.90 cc.) was grit and 57.07 per cent (51.71 cc.) was organic substance. Plants contributed 77.93 per cent of the organic contents and animal organisms 22.07 per cent, tables 35 and 36.

Plant Foods (77.93 Per Cent of Organic Contents).—Plant structures were found in 13 of the 14 redhead gizzards; the plant contents of individual gizzards ranged in volume from 0.8 to 6.9 cc. and averaged 3.1 cc. per gizzard. The bulk of the material consisted of longleaf pondweed seeds. Nineteen food plants were identified; six species contributed at least 1.0 per cent each to the organic contents, table 35. Seeds of the alkali bulrush, a western species not indigenous to Illinois, were found in one gizzard.

Animal Foods (22.07 Per Cent of Organic Contents).—Animal organisms were present in 12 of the 14 redhead gizzards; the animal matter in individual gizzards ranged from a trace to 4.3 cc. Midges were found in six of the gizzards, table 36.

Inorganic Contents (42.93 Per Cent of Total Contents).—The grit contents of individual gizzards of the redhead ranged from 0.9 to 4.8 cc. and averaged 2.78 cc. per gizzard. A major portion of

the inorganic material consisted of quartz particles varying in size from minute to 2 mm. (largest dimension); the material included an occasional stone up to 11 mm.

Ruddy Duck *Oxyura jamaicensis*

Only five ruddy duck gizzards were collected for this study. All were obtained between October 15 and November 15, 1939 and 1940. The gross contents of these gizzards amounted to 16.6 cc., of which 63.86 per cent (10.6 cc.) was grit and 36.14 per cent (6.0 cc.) was organic material. Of the organic food, plant structures amounted to 23.33 per cent and animal matter to 76.67 per cent.

Plant Foods (23.33 Per Cent of Organic Contents).—Plant parts appeared in three of the five ruddy duck gizzards; only a trace in two and 1.4 cc. in the other. Four species of plants were represented: coontail made up almost 100 per cent of the bulk; longleaf pondweed, leafy pondweed, and wild millet appeared as traces.

Animal Foods (76.67 Per Cent of Organic Contents).—Animal structures were found in all five ruddy duck gizzards. The animal contents of individual gizzards ranged from a trace to 1.7 cc. Midge larvae comprised almost 100 per cent of the animal matter; water boatmen and water beetles appeared as traces.

Inorganic Contents (63.86 Per Cent of Total Contents).—Gravel made up

nearly two-thirds of the gross contents of the ruddy duck gizzards. The inorganic contents of individual gizzards ranged from 1.2 to 4.0 cc. and averaged 2.1 cc. Most gravel particles were each smaller than 2 mm. (largest dimension).

Common Goldeneye
Bucephala clangula

Only three goldeneye gizzards were obtained for this study, all of them in the period November 14–30, 1938. The total gross contents amounted to 2.6 cc., of which 50.00 per cent (1.3 cc.) was grit and 50.00 per cent (1.3 cc.) was organic material. Longleaf pondweed, which constituted 15.38 per cent of the organic contents, was the only important plant species represented, while mayfly nymphs, which constituted 84.62 per cent of the organic contents, was the only animal food.

Greater Scaup
Aythya marila

The gizzard of one greater scaup was collected on November 16, 1940. It contained grit material amounting to 1.0 cc. and no animal or plant structures.

Oldsquaw
Clangula hyemalis

The gizzard of one oldsquaw duck was obtained in the fall of 1940. It contained

2.7 cc. of material, of which 11.11 per cent (0.3 cc.) was grit and 88.89 per cent (2.4 cc.) consisted of plant and animal matter. Coontail made up the entire plant contents (41.67 per cent of the organic material), while fish bones, midges, and snails made up the animal contents (58.33 per cent of the organic material).

PLANT FOODS

Data derived from analyses of the contents of waterfowl gizzards collected in Illinois in the autumns of 1938, 1939, and 1940 were used in making evaluations of the most important plants utilized as food by waterfowl migrating through the state.

Although no completely satisfactory evaluations of the importance of various kinds of food plants are possible, a rough evaluation of each of the most important kinds was given by an index figure obtained by multiplying the number of gizzards in which the kind of plant was found (occurrences) by the actual figure indicating the percentage it constituted of the total plant volume (for example, for *Zea mays*, multiplying 1,445 by 39.36, figures derived from table 38).

The nineteen species of plants that were most utilized by ducks in their southward migrations through Illinois are listed in table 37. These plants were the favored

Table 37.—Occurrence-percentage index ratings of plant foods identified in duck gizzards collected along the Illinois River, Ottawa to Florence (4,505 gizzards), and along the Mississippi River, Rock Island to Quincy (472 gizzards), 1938–1940 (derived from table 38).

PLANT	INDEX NUMBER
<i>Zea mays</i> , corn.....	56,875
<i>Leersia oryzoides</i> , rice cutgrass.....	11,862
<i>Polygonum coccineum</i> , marsh smartweed.....	8,249
<i>Ceratophyllum demersum</i> , coontail.....	7,734
<i>Echinochloa crusgalli</i> , wild millet.....	4,605
<i>Potamogeton nodosus</i> , longleaf pondweed.....	2,293
<i>Cyperus erythrorhizos</i> , red-rooted nut-grass.....	2,289
<i>Acnida altissima</i> , water-hemp.....	1,849
<i>Polygonum lapathifolium</i> , nodding smartweed.....	1,111
<i>Cephalanthus occidentalis</i> , buttonbush.....	956
<i>Polygonum pennsylvanicum</i> , large-seeded smartweed.....	635
<i>Cyperus strigosus</i> , nut-grass.....	605
<i>Cyperus esculentus</i> , chufa.....	554
<i>Echinochloa walteri</i> , Walter's millet.....	537
<i>Potamogeton pectinatus</i> , sago pondweed.....	427
<i>Sagittaria latifolia</i> , duck-potato.....	232
<i>Scirpus fluviatilis</i> , river-bulrush.....	156
<i>Eragrostis hypnoides</i> , teal grass.....	116
<i>Sparganium eurycarpum</i> , giant bur-reed.....	112

Table 38.—Plant foods of ducks taken along the Illinois River, Ottawa to Florence (4,505 gizzards), and along the Mississippi River, Rock Island to Quincy (472 gizzards), 1938–1940.

PLANT	ILLINOIS RIVER			MISSISSIPPI RIVER		
	Occurrence (Number of Gizzards)	Volume (Cubic Centimeters)	Per Cent of Organic Contents	Occurrence (Number of Gizzards)	Volume (Cubic Centimeters)	Per Cent of Organic Contents
<i>TOTAL PLANT</i>		17,234.88	94.82		1,342.78	90.36
<i>Zea mays</i> , corn.....	1,262	6,429.05	35.38	183	883.20	59.44
<i>Leersia oryzoides</i> , rice cutgrass.....	880	2,339.58	12.87	41	52.62	3.54
<i>Ceratophyllum demersum</i> , coontail....	795	1,751.63	9.64	14	24.10	1.62
<i>Echinochloa</i>						
<i>crusgalli</i> , wild millet.....	669	1,165.32	6.41	46	30.22	2.03
<i>walteri</i> , Walter's millet.....	243	410.67	2.26			
Unidentified.....	2	1.40	0.01			
<i>Cyperus</i>						
<i>erthyrorhizos</i> , red-rooted nut-grass..	613	683.11	3.76	4	6.90	0.46
<i>strigosus</i> , nut-grass.....	378	289.13	1.59	6	3.60	0.24
<i>esculentus</i> , chufa.....	384	267.42	1.47	1	t	
<i>ferax</i>	3	0.20	t	4	0.70	0.05
Unidentified.....	20	47.78	0.26			
<i>Polygonum</i>						
<i>coccineum</i> , marsh smartweed.....	1,995	760.02	4.18	17	1.32	0.09
<i>lappathifolium</i> , nodding smartweed..	1,028	161.01	0.89	117	19.65	1.32
<i>pennsylvanicum</i> , large-seeded smart- weed.....	480	141.63	0.78	119	56.19	3.78
<i>hydropiperoides</i> , mild water-pepper.	219	82.32	0.45	6	0.40	0.03
<i>punctatum</i> , dotted smartweed.....	173	35.31	0.19	36	21.36	1.44
<i>persicaria</i> , lady's thumb.....	101	11.71	0.06	15	6.25	0.42
<i>hydropiper</i> , water-pepper.....	61	6.75	0.04	28	4.00	0.27
<i>scandens</i> , climbing false buckwheat	7	0.33	t	4	0.15	0.01
<i>sagittatum</i> , arrow-leaved tearthumb	2	0.20	t	1	0.40	0.03
<i>amphibium</i> , water lady's thumb...	1	0.05	t	3	0.02	t
<i>aviculare</i> , prostrate knotweed.....				1	t	
Unidentified.....	15	2.71	0.01	4	1.70	0.11
<i>Potamogeton</i>						
<i>nodosus</i> , longleaf pondweed.....	1,252	329.65	1.81	22	5.40	0.36
<i>pectinatus</i> , sago pondweed.....	596	104.22	0.57	34	21.77	1.47
<i>foliosus</i> , leafy pondweed.....	179	40.03	0.22	42	14.10	0.95
<i>pusillus</i> , small pondweed.....	98	17.76	0.10	6	0.87	0.06
<i>perfoliatus</i> , thoroughwort pondweed	3	8.40	0.05			
<i>praelongus</i> , white-stem pondweed ..	5	1.70	0.01			
<i>amphifolius</i> , large-leaved pondweed	2	0.11	t			
<i>epiphydrus</i> , ribbon-leaf pondweed ..	2	0.05	t	2	1.30	0.09
<i>gramineus</i> , variable-leaf pondweed ..				1	0.40	0.03
Unidentified.....	44	2.04	0.01	5	0.20	0.01
<i>Acnida altissima</i> , water-hemp.....	691	494.59	2.72	4	0.32	0.02
<i>Sagittaria</i>						
<i>latifolia</i> , duck-potato.....	156	254.41	1.40	11	3.44	0.23
<i>cuneata</i> , wapato.....	1	0.50	t			
Unidentified.....	2	1.31	0.01			
<i>Cephalanthus occidentalis</i> , buttonbush	660	252.88	1.39	30	4.77	0.32
<i>Eragrostis</i>						
<i>hypnoides</i> , teal grass.....	114	188.71	1.04			
Unidentified.....	2	0.40	t			
<i>Triticum aestivum</i> , wheat.....	46	169.90	0.93	1	4.40	0.30
<i>Lemna</i>						
<i>minor</i> , lesser duckweed.....	152	95.91	0.53	8	8.30	0.56
Unidentified.....	2	3.20	0.02			

Table 38.—Continued.

PLANT	ILLINOIS RIVER			MISSISSIPPI RIVER		
	Occurrence (Number of Giz- zards)	Volume (Cubic Centi- meters)	Per Cent of Organic Contents	Occurrence (Number of Giz- zards)	Volume (Cubic Centi- meters)	Per Cent of Organic Contents
<i>Sparganium</i>						
<i>curycarpum</i> , giant bur-reed.....	286	60.36	0.33	24	6.57	0.44
Unidentified.....	134	31.74	0.17	16	6.61	0.44
<i>Scirpus</i>						
<i>fluvialis</i> , river-bulrush.....	464	47.97	0.25	46	8.83	0.58
<i>atrovirens</i> , green bulrush.....	3	9.50	0.05			
<i>acutus</i> , hard-stem bulrush.....	171	8.90	0.05	52	14.39	0.97
<i>validus</i> , soft-stem bulrush.....	72	3.58	0.02	27	2.10	0.14
<i>paludosus</i> , alkali bulrush.....	5	3.30	0.02	5	1.80	0.12
<i>americanus</i> , American bulrush.....				5	2.30	0.15
Unidentified.....	2	1.63	0.01	1	0.70	0.05
Algae.....	45	58.29	0.32	9	21.50	1.45
<i>Nelumbo lutea</i> , American lotus.....	43	55.60	0.31	1	1.00	0.07
<i>Quercus</i>						
<i>alba</i> , white oak.....	3	16.90	0.09			
<i>palustris</i> , pin oak.....				1	5.80	0.39
Unidentified acorns.....	8	38.10	0.21	2	12.40	0.83
<i>Fagopyrum sagittatum</i> , common buck- wheat.....	8	37.40	0.21			
<i>Rumex</i>						
<i>altissimus</i> , pale dock.....	62	27.05	0.15	11	11.60	0.78
<i>acetosella</i> , field sorrel.....	1	t		2	t	
Unidentified.....	10	0.08	t	2	0.50	0.03
<i>Bidens</i>						
<i>frondosa</i> , beggar-ticks.....	11	20.68	0.11	3	0.73	0.05
Unidentified.....	29	1.95	0.01	2	0.10	0.01
<i>Ambrosia</i>						
<i>artemisiifolia</i> , common ragweed.....	28	7.94	0.04	5	0.10	0.01
<i>trifida</i> , great ragweed.....	20	7.55	0.04	1	0.20	0.01
<i>psilostachya</i> , western ragweed.....	85	1.07	t	1	t	
Unidentified.....	1	0.65	t			
<i>Najas</i>						
<i>guadalupensis</i> , southern naiad.....	18	14.35	0.08	1	0.50	0.03
<i>flexilis</i> , northern naiad.....	16	1.10	t			
Unidentified.....	3	1.30	0.01			
<i>Eleocharis</i>						
<i>palustris</i> , common spike-rush.....	69	8.44	0.05	11	0.80	0.05
<i>obtus</i> , blunt spike-rush.....	99	4.22	0.02	20	1.31	0.09
<i>parvula</i> , dwarf spike-rush.....	1	2.00	0.01			
Unidentified.....	8	t				
<i>Heteranthera dubia</i> , mud-plantain.....	5	14.30	0.08			
<i>Juncus</i> , bog-rush.....	24	12.58	0.07			
Bark, roots, and wood.....	8	8.15	0.04	4	1.03	0.07
<i>Ranunculus</i> , buttercup.....	7	8.10	0.04			
<i>Nymphaea tuberosa</i> , yellow water-lily.....	10	6.58	0.04	1	t	
<i>Chenopodium</i>						
<i>album</i> , lamb's-quarters.....	12	6.41	0.04	4	t	
Unidentified.....	1	t				
<i>Alisma subcordatum</i> , water-plantain.....	1	6.20	0.03			
<i>Salix</i> , willow.....	16	6.17	0.03	2	2.60	0.17
<i>Cornus</i> , dogwood.....	75	6.04	0.03	8	0.20	0.01
<i>Lippia lanceolata</i> , fog-fruit.....	219	5.60	0.03	8	0.90	0.06
<i>Vigna sinensis</i> , cow-pea.....	1	5.20	0.03			
<i>Myriophyllum</i>						
<i>heterophyllum</i> , water-milfoil.....	10	0.50	t			
Unidentified.....	60	4.23	0.02	26	2.78	0.19

Table 38.—Continued.

PLANT	ILLINOIS RIVER			MISSISSIPPI RIVER		
	Occurrence (Number of Giz- zards)	Volume (Cubic Centi- meters)	Per Cent of Organic Contents	Occurrence (Number of Giz- zards)	Volume (Cubic Centi- meters)	Per Cent of Organic Contents
<i>Spartina pectinata</i> , prairie cord-grass .	2	4.20	0.02			
<i>Carex</i>						
<i>rostrata</i> , beaked sedge				1	0.10	0.01
Unidentified	33	4.13	0.02	9	3.20	0.22
<i>Lophotocarpus</i>	12	4.10	0.02			
<i>Ipomea hederacea</i> , ivy-leaved morning- glory	35	4.04	0.02	1	t	
<i>Zannichellia palustris</i> , horned pond- weed	5	3.60	0.02			
<i>Sida spinosa</i> , prickly sida	34	3.56	0.02	5	0.20	0.01
Gramineae	2	3.30	0.02			
<i>Paspalum</i>						
<i>ciliatifolium</i> , ciliate-leaved paspalum	2	3.25	0.02	1	1.50	0.10
Unidentified	1	t				
<i>Vitis</i>						
<i>cordifolia</i> , frost grape	4	0.25	t	2	2.50	0.17
Unidentified	56	2.82	0.02	10	17.72	1.19
<i>Potentilla</i> , cinquefoil	1	3.00	0.02			
<i>Digitaria</i>						
<i>sanguinalis</i> , crab-grass	3	2.50	0.01	2	0.30	0.02
<i>ischaemum</i> , smooth crab-grass	4	0.30	t	2	0.50	0.03
<i>Anacharis canadensis</i> , waterweed	1	2.10	0.01			
<i>Panicum</i>						
<i>dichotomiflorum</i> , fall panic-grass . .	38	1.90	0.01	7	4.90	0.33
<i>capillare</i> , old-witch grass	18	0.11	t	2	t	
Bean, navy	1	1.50	0.01			
<i>Verbena</i>						
<i>hastata</i> , blue vervain	1	0.80	t			
Unidentified	4	0.05	t			
<i>Abutilon theophrasti</i> , velvet-leaf	37	0.83	t	1	0.03	t
<i>Hibiscus</i>						
<i>militaris</i> , scarlet rose-mallow	2	0.50	t	2	t	
Unidentified	5	0.06	t			
<i>Setaria</i>						
<i>italica</i> , German millet	3	6.40	0.04			
<i>glauca</i> , yellow foxtail	17	0.50	t	5	0.10	0.01
<i>viridis</i> , green foxtail	1	t		1	t	
<i>Celtis occidentalis</i> , hackberry	1	0.50	t			
Compositae	1	0.40	t			
<i>Crataegus</i> , hawthorn	2	0.30	t			
<i>Solanum</i> , nightshade	1	0.30	t			
<i>Leguminosae</i>	1	0.30	t			
<i>Rhus</i>						
<i>glabra</i> , smooth sumac	18	0.18	t	7	0.20	0.01
<i>radicans</i> , poison ivy	6	0.10	t	1	t	
Unidentified	1	t		1	t	
<i>Phaseolus</i> , wild bean	1	0.20	t			
<i>Strophostyles</i>						
<i>helvola</i> , trailing wild bean	1	0.10	t			
Unidentified	2	t				
<i>Pontederia cordata</i> , heart-shaped pickerelweed	2	0.08	t			
<i>Cladium mariscoides</i> , twig-rush	16	0.07	t	2	0.04	t
<i>Cassia fasciculata</i> , partridge-pea	1	0.03	t			
<i>Amaranthus</i>						
<i>retroflexus</i> , green amaranth	1	t				
Unidentified	1	0.01	t			

Table 38.—Continued.

PLANT	ILLINOIS RIVER			MISSISSIPPI RIVER		
	Occurrence (Number of Gizzards)	Volume (Cubic Centi- meters)	Per Cent of Organic Contents	Occurrence (Number of Gizzards)	Volume (Cubic Centi- meters)	Per Cent of Organic Contents
<i>Rubus</i>						
<i>flagellaris</i> , northern dewberry.....	4	0.02	t			
Unidentified.....	5	t				
<i>Ammannia coccinea</i> , tooth-cup.....				4	3.10	0.21
<i>Avena sativa</i> , oats.....	1	t				
<i>Convolvulus arvensis</i> , field-bindweed.....				1	t	
<i>Cuscuta</i> , dodder.....	17	t		3	0.10	0.01
<i>Diodia teres</i> , buttonweed.....	1	t				
<i>Geum</i> , avens.....				1	t	
<i>Phytolacca americana</i> , common pokeweed.....	5	t		1	t	
<i>Portulaca</i> , purslane.....				1	2.30	0.15
<i>Rosa</i> , rose.....	3	t				
<i>Sorghum vulgare</i> , sorghum.....				1	1.40	0.09
<i>Prunus</i> , cherry.....	2	t				
<i>Symphoricarpos orbiculatus</i> , coral- berry.....				3	1.10	0.07
<i>Trifolium</i> , clover.....	1	t				
Unidentified plant.....	73	63 68	0.35	23	18.09	1.22

ones in each of the 3 years of this study; from year to year the relative positions of some of them changed within the group as a result of changes in abundance or accessibility.

Food plants favored by the various species of ducks differed with the feeding habits of the birds. Foods utilized by ducks of the teal size were mainly from small-seeded plants, while those utilized by the mallard were principally from corn and from large-seeded native wild plants. The puddlers fed principally on emergent and moist-soil plants, while the divers fed largely on submergent plants. There were exceptions in each waterfowl group, however, such as the gadwall and the baldpate, which fed primarily on a submergent plant, coontail, and the ring-necked duck and the redhead, which fed extensively on emergent plants.

Of the plants represented in the gizzards collected for this study, 95 native wild plants and 4 domestic plants were identified to species, table 38. The 19 important species listed in table 37 and discussed in the following pages constituted 92.91 per cent of the total plant material. Analyses of gizzard contents showed that the plants increased or decreased in use-

fulness to ducks during the fall season as weather conditions and water levels varied.

Corn *Zea mays*

Corn was the most important food both in volume and in number of duck gizzards in which it was found (occurrences), table 38. It comprised 37.20 per cent of all organic foods in the gizzards, primarily because it was the staple food of the mallard, which made up over 50 per cent of the duck flight. It appeared in 1,445 gizzards, of which 86.92 per cent were mallard and 9.55 per cent were pintail. Of the 26 wood duck gizzards that were collected, 11 contained corn.

Use of this grain depended largely upon the time of corn harvest. In 1939, corn ripened early, and harvesting was well along by October 15; in that year, mallard gizzards collected early in the season were gorged with kernels of waste corn. However, in 1940, corn harvesting did not commence until late in October or early November, and native wild foods appeared in gizzards in large volumes until the waste corn was available. The volume of corn increased from October 16 to De-

cember 15, even though the number of duck gizzards containing corn decreased.

Rice Cutgrass

Leersia oryzoides

Rice cutgrass, fig. 6, was shown by this study, tables 37 and 38, to be the most important wild native food plant in Illinois during the autumn. This plant was spotty in distribution, but apparently wherever the seeds, rootstocks, and tender shoots were accessible they were avidly

consumed. Pintails and mallards were the most important consumers. As many as 2,000 seeds were taken from a single pintail gizzard.

Plant structures of rice cutgrass, found in 921 duck gizzards, comprised 12.17 per cent of the entire organic contents of the 4,977 gizzards examined. Rice cutgrass provided a good, staple food throughout the fall months. The volume of rice cutgrass structures in gizzards decreased gradually from 16.83 per cent of the plant



Fig. 6.—Rice cutgrass (*Leersia oryzoides*), known also as saw-grass. This plant grows on moist soil in shallow water. Ducks feed on the seeds and rootstocks.

foods in late October to 11.75 per cent in early December.

Marsh Smartweed

Polygonum coccineum

Marsh smartweed, fig. 7, ranked fourth among wild native food plants in percentage of total organic contents of the duck gizzards examined, table 38; it was second among wild plants and third among all plants in the occurrence-percentage index rating, table 37. In the region and years of this study it was an abundant plant, but

in much of the region it was low in seed production. In a few areas where water level conditions were favorable, it produced an abundance of seeds in 1938 and 1939. Because of sporadic seed production (Low & Bellrose 1944:14), this plant varied from year to year in usefulness as a source of duck food. All important species of ducks fed on the seeds, but these seeds seldom made up the bulk of the plant food for any one duck.

Marsh smartweed seeds were found in a large number of gizzards (2,012), but



Fig. 7.—Marsh smartweed (*Polygonum coccineum*), sometimes called redtop because of its pink-red blossoms. When it grows in water 6 to 18 inches deep it produces seed that rates high as duck food.

never in large quantities. Because the seeds drop early in the fall, this smartweed is considered a good early season source of food. In October, this plant represented 5.50 per cent of the plant food but, by early December, only 1.85 per cent. Marsh smartweed rated as an important

baldpate and gadwall were the most avid feeders. During October, when waste corn was scarce, mallards fed extensively on coontail.

Coontail structures, which were found in 809 gizzards, represented 9.03 per cent of the total organic contents of all giz-



Fig. 8.—Coontail or hornwort (*Ceratophyllum demersum*). A favorite food of baldpates, gadwalls, and ring-necked ducks, it grows best in stable or semistable waters that are fairly clear and protected from wave action. Ducks feed principally on the leaves and stems.

waterfowl food plant despite the relatively small quantities of its seed ingested by individual birds.

Coontail

Ceratophyllum demersum

Coontail, fig. 8, which occurred commonly in all stable and semistable water areas involved in the study, ranked second among wild native food plants in percentage of the total organic contents of all duck gizzards examined, table 38, but it rated fourth in the occurrence-percentage index, table 37. Seed production of coontail was low in the years of this study; leaves and stems were the principal structures found in the gizzards. This study showed that all species of ducks of which there was an adequate sample fed upon this plant; the

zards. Analyses showed that utilization of coontail rapidly decreased during the fall season, from 16.84 per cent of the volume of plant foods in October to 2.20 per cent in December. Despite the decrease in volume, coontail appeared to be an important source of food through most of the fall.

Wild Millet

Echinochloa crusgalli

Because some difficulty was experienced in separating the seeds of wild millet from the seeds of Japanese millet, *Echinochloa frumentacea*, undoubtedly some seeds classified as wild millet were those of the Japanese species. However, in the years in which gizzards were collected for this study, the acreage of Japanese millet in Illinois was comparatively small.

Wild millet, fig. 9, ranked third among wild native food plants in percentage of the total organic contents of all duck gizzards examined, table 38. Although its occurrence was spotty in the Illinois and Mississippi river valleys in the years of this study, it ranked fifth in the occurrence-percentage index, table 37. During 1939 and 1940, water level conditions in some areas were very favorable for luxuriant growth and heavy seed production of millets (Bellrose 1941:253). Seeds of the wild millet were found in the gizzards of most ducks and were especially numerous in those of pintails, mallards, and green-winged teals. A few pintail gizzards held as many as 1,000 seeds each, and the craws another 3,500.

Wild millet seeds or other plant parts appeared in 715 gizzards and constituted

6.08 per cent of the total organic contents of the gizzards examined. The heaviest consumption of wild millet occurred in October, when this plant represented 10.76 per cent of the plant foods in the gizzards; the consumption decreased to 3.90 per cent by December, probably as a result of a decline in availability of millet seed and a shift by the mallard and the pintail to a corn diet.

Because the seeds remained on the plants until late fall, wild millet proved to be an excellent source of food for ducks; also, the rank stem growth provided protective cover.

Longleaf Pondweed

Potamogeton nodosus

The longleaf pondweed, fig. 10, is considered one of the good duck food plants

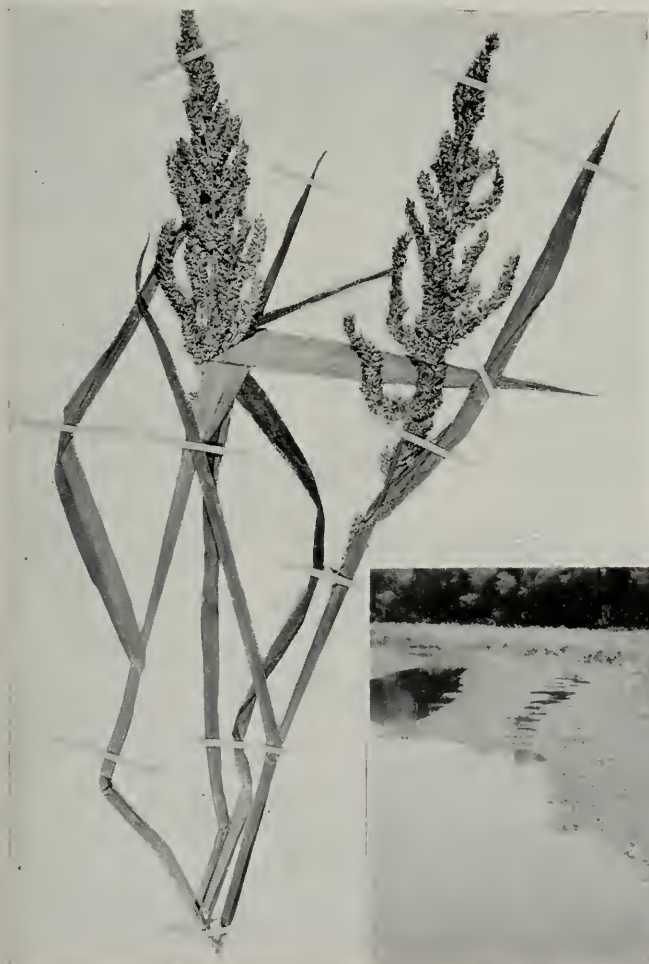


Fig. 9.—Wild millet (*Echinochloa crusgalli*). Known also as barnyard-grass, this moist-soil plant produces seeds that are consumed in large quantities by mallards, pintails, teals, and other ducks. The inset shows wild millet growing on a mud flat from which water has receded. In 1939 and 1940, water levels along the Illinois River were especially favorable for growth and seed production of millets. The millets provide cover as well as food for ducks.



in many parts of the United States. In Illinois, it was present in small amounts in nearly all the river-bottom lakes in the region and years involved in the present study; usually it produced an abundance of seed. In the gizzards of all important species of waterfowl included in this report, the seeds and occasionally the stems or leaves were found.

Longleaf pondweed plant parts, found in 1,274 gizzards, amounted to 1.70 per cent of the total organic contents of all gizzards examined, table 38. It ranked sixth in the occurrence-percentage index, table 37. Apparently, use of this plant varied from one period to another, but at no time did it constitute more than a supplemental food.

Red-Rooted Nut-Grass

Cyperus erythrorhizos

Red-rooted nut-grass, a moist-soil plant that grows on mud flats and mud banks of both the Illinois and Mississippi river valleys, ranked sixth among food plants in percentage of total organic contents of gizzards examined, table 38, and seventh in the occurrence-percentage index, table 37. Because growing conditions were

much better for plants of this type in 1939 and 1940 than in 1938 (Bellrose 1941: 252-3), the volume of seed and its accessibility to ducks was greater. This nut-grass was found in significant amounts in the gizzards of several of the important duck species; it made up the largest percentages of organic material in gizzards of the blue-winged teal, green-winged teal, and shoveler. In most cases, the entire seed head had been clipped off; in other cases, individual seeds had been strained from the bottom ooze or from the water surface. Some pintail gizzards contained amounts estimated at 25,000 seeds each.

This plant was represented in 617 gizzards, table 38, and constituted 3.71 per cent of the plant contents or 3.51 per cent of the total organic contents of all duck gizzards examined. There appeared to be little change in the rate of its utilization as the fall months advanced. This nut-grass appeared to be an excellent all-season duck food.

Water-Hemp

Achida altissima

Water-hemp, or pigweed, fig. 11, an important moist-soil plant that occurs on



Fig. 10.—Longleaf pondweed (*Potamogeton nodosus*), known also as deer's tongue. Ducks feed on the seeds of this plant.



Fig. 11.—Water-hemp or pigweed (*Amaranthus altissima*). This plant grows well on mud flats.

mud flats, ditchbanks, and similar areas, is a good source of duck food in seasons favorable to its growth. It ranked eighth in the occurrence-percentage index, table 37. This plant is subject to poor seed yields when growing conditions are unfavorable, such as occurred in 1938 and 1939. In those years, it was represented in only about 1 per cent of the total organic contents of the duck gizzards examined, but in 1940, a year in which beds were abundant and luxuriant, its volume increased to 8.18 per cent. The puddle ducks, especially the mallard, pintail, and both teals, used this plant. It was not uncommon to find 40,000 seeds in a mallard gizzard, or 25,000 to 30,000 in a pintail or teal gizzard. Only the seeds and seed heads of this plant were used.

Water-hemp seeds or seed heads, found in 695 gizzards, table 38, made up 2.52 per cent of the total organic contents of all gizzards included in this study. Appar-

ently, the usage of this food plant throughout the fall changed little as long as the seeds were accessible. An early freeze would probably have lessened its use, but the 1938–1940 study did not indicate any decrease in percentage of use as the season progressed. Water-hemp can be considered a good all-fall food for most species of dabbling ducks.

Nodding Smartweed *Polygonum lapathifolium*

Nodding smartweed, fig. 12, grew abundantly along the margins of most Illinois rivers and bottomland lakes in 1938–1940. Gizzard analyses showed that most of the important species of waterfowl fed on the seeds in significant amounts. Seed, produced in abundance, seemed to serve principally as a supplemental food, as it never constituted a complete feeding.

Seeds of nodding smartweed, present in 1,145 gizzards, table 38, constituted 0.92 per cent of the total organic contents of all gizzards examined. The period of



Fig. 12.—Nodding smartweed (*Polygonum lapathifolium*). The long, drooping, densely flowered spikes distinguish this plant from other smartweeds.

greatest consumption occurred the latter half of October; during the fall the proportion of these seeds in the gizzards dropped from 1.62 per cent to 0.56 per cent of the plant foods.

This smartweed can be considered only a fair source of all-fall food, except lo-



Fig. 13.—Large-seeded smartweed (*Polygonum pennsylvanicum*), known also as Pennsylvania smartweed. A moist-soil plant, this smartweed ranked below marsh smartweed and nodding smartweed as an Illinois duck food in the years of this study.

cally where the plant is easily accessible. It ranked ninth in the occurrence-percentage index, table 37.

Buttonbush

Cephalanthus occidentalis

This shrub is very abundant in the valleys of both the Illinois and the Mississippi rivers. Even though its seeds are a fair duck food, the buttonbush is not a desirable plant to have in a waterfowl habitat,

as it tends to crowd out more favorable duck food plants. However, this shrub is less undesirable in a waterfowl habitat than lotus or river bulrush, which have little value as duck food plants. Seeds of the buttonbush were found in small quantities in the gizzards of all important species of dabbling ducks.

Present in 690 gizzards, the seeds of the buttonbush represented 1.31 per cent of the total organic contents of all gizzards, table 38. Throughout the fall season, the percentage of seeds consumed varied very little from week to week. Buttonbush may be considered as a fair supplemental duck food plant, table 37.

Large-Seeded Smartweed

Polygonum pennsylvanicum

The large-seeded smartweed, fig. 13, ranked eleventh in the occurrence-percentage index, table 37. Utilization of this plant by ducks in Illinois was subject to change from year to year and place to place and was dependent principally on accessibility. For instance, along the Mississippi River, where this smartweed appeared to be easily accessible during the years of this study, it ranked first among native foods, table 38. The seed was the only part of this plant found in the duck gizzards examined.

Seeds of this smartweed, in 599 gizzards, table 38, made up 1.01 per cent of the entire organic contents of all gizzards. Apparently the seeds were eaten throughout the fall, but were more important in the diet during the latter part of November and December than at other times.

Nut-Grass

Cyperus strigosus

Like the red-rooted nut-grass, this species grows on certain mud flats and other moist areas. It ranked high among the important foods preferred by the pintail, blue-winged teal, and green-winged teal in the years of this study. Apparently both seeds and seed heads were avidly consumed. Some pintail and teal gizzards contained as many as 10,000 seeds each.

Structures of this plant, found in 384 gizzards, constituted 1.58 per cent of the total plant contents and 1.49 per cent of the total organic contents of the gizzards examined, table 38. Apparently heaviest



Fig. 14.—Chufa (*Cyperus esculentus*), one of several nut-grasses that grow on moist soil in Illinois. Ducks feed upon the seeds and tubers.

use of this plant occurred during November, when its principal consumers were most abundant.

As with most moist-soil plants, in years and in places in which the seed was present and accessible, this nut-grass was a good source of waterfowl food during the fall months. It ranked twelfth in the occurrence-percentage index, table 37.

Chufa

Cyperus esculentus

Chufa, fig. 14, occurred rather sporadically on mud flats, ditchbanks, and other moist ground in the areas from which gizzards were collected. It was a preferred food of the blue-winged teal, green-winged teal, and pintail, which consumed seeds, seed heads, and tubers. Several hundred seeds were taken from a few of the teal gizzards.

Structures of this plant were found in 385 gizzards and constituted 1.36 per cent of the total organic contents of the gizzards examined, table 38. As with the other moist-soil plants, chufa received the heaviest use during November. This nut-grass furnished good waterfowl food during the fall months when water conditions made the plants accessible. It ranked third

among nut-grasses in the occurrence-percentage index, table 37.

Walter's Millet

Echinochloa walteri

Although the seeds of Walter's millet, fig. 15, are much smaller than those of the wild millet, they were eagerly consumed by the ducks represented in this study. Walter's millet often volunteers in muck areas generally wetter than those containing wild millet. Seeds of Walter's millet were found in the gizzards of most puddle ducks—in relatively largest amounts in gizzards of the pintail, green-winged teal, and blue-winged teal. The fruit is more



Fig. 15.—Walter's millet (*Echinochloa walteri*), sometimes called corn grass. Its small seeds are consumed in considerable numbers by mallards, pintails, and teals.

persistent than that of the wild millet and is therefore available for waterfowl later in the season.

Walter's millet was represented in 243 stomachs, table 38, and constituted 2.09 per cent of the total organic contents of all gizzards. It is a good source of late-fall waterfowl food. It ranked fourteenth in the occurrence-percentage index, table 37.

Sago Pondweed

Potamogeton pectinatus

Sago pondweed, fig. 16, according to Martin & Uhler (1939) is one of the most important duck food plants in the United States. In 1938-1940, this plant appeared to be relatively unimportant in Illinois; here the plant was spotty in distribution and it produced very little seed (Bellrose 1941:266). Although sago ranked low among the important plants in the present study, table 37, most species of ducks, especially the divers, fed on the limited seed supply, tubers, and leaf structures.

Portions of the plant, found in 630 gizzards, represented only 0.64 per cent of

the total organic contents of all gizzards examined, table 38. In no half-month period did it vary considerably in volume or number of occurrences from the average.

If this plant had been more abundant and if it had produced more seed, it undoubtedly would have ranked much higher in the food preference list.

Duck-Potato

Sagittaria latifolia

The duck-potato, fig. 17, was shown by this study to rank low among the important duck food plants in Illinois, table 37. Although it occurred sparingly in the areas from which gizzards were collected in 1938-1940, it produced a moderate amount of seed (Low & Bellrose 1944:13). Analyses of gizzard contents showed that most species of waterfowl fed on the seeds and tender roots; however, only the large ducks were able to use the tubers. The usefulness of this plant seemed to be partly dependent upon accessibility—on water levels sufficiently high to allow the ducks to feed in the duck-potato beds.

Structures of this plant, found in 167 gizzards, comprised 1.31 per cent of the



Fig. 16.—Sago pondweed (*Potamogeton pectinatus*), known also as teal grass and eel grass. Ducks feed upon its seed, foliage, and tubers.



Fig. 17.—Duck-potato (*Sagittaria latifolia*), known also as arrowhead, wapato, or boot-jack. Ducks value it more for its seed than for its tubers.

total organic contents of the gizzards collected for examination, table 38. The plant apparently increased in duck food value as the fall season waned. In October, it represented less than 1 per cent of the plant contents of gizzards, but 3 per cent by December. This plant may be considered a fair duck food throughout the fall, increasing in importance as the season advances.

River-Bulrush

Scirpus fluviatilis

River-bulrush seeds occurred in about one-tenth of the duck gizzards collected in 1938–1940 from areas along the Illinois and Mississippi rivers, table 38. The total quantity of river-bulrush seeds was only 0.29 per cent of all the organic food.

The number of gizzards in which river-bulrush seeds were found (510) is considered large in view of the fact that seed production of this plant is poor in Illinois (Bellrose & Anderson 1943:430). Evidently the seeds are very palatable.

Teal Grass

Eragrostis hypnoides

Teal grass was found to be another moist-soil plant that ranked among the

important sources of duck food in the period of this study, table 37. Under certain conditions, when water levels were sufficiently high to flood the plants growing along ditchbanks and mud flats, it ranked much higher than when conditions were less favorable. It appeared among the important native foods because of large numbers of seeds consumed by a relatively small number of ducks. The green-winged teal, blue-winged teal, and pintail fed more upon this plant than did other species of ducks.

Seeds of teal grass, found in 114 gizzards, constituted 0.96 per cent of the total organic contents, table 38. After November 15, utilization of this plant rapidly decreased. The drop was due partly to ice fringes that prevented ducks from having access to the seeds and partly to a decrease in numbers of the ducks that were the principal consumers of these seeds. Teal grass may be considered a fair source of early-fall food but a poor source of late-fall food.

Giant Bur-Reed

Sparganium eurycarpum

Giant bur-reed occurred in small beds scattered among the bottomland lakes of the Illinois River valley in the years gizzards were collected for this study. Despite the very limited occurrence of giant bur-reed, a comparatively large number of gizzards, 286 from the Illinois River valley and 24 from the Mississippi River valley, contained seeds of this plant, table 38. The high rate of utilization indicates that ducks found the nutlike seeds of the giant bur-reed very palatable, but that the small quantity available limited the importance of giant bur-reed, which ranked last among the 19 most important plants, table 37.

ANIMAL FOODS

This study indicated that animal foods were not important in the diet of most species of waterfowl migrating through Illinois in the autumns of 1938, 1939, and 1940, although impressive numbers of animal groups were found in the gizzards collected. The lesser scaup duck, ring-necked duck, shoveler, blue-winged teal, and green-winged teal were among the

Table 39.—The most important animal foods of ducks taken along the Illinois River, Ottawa to Florence (4,505 gizzards), and along the Mississippi River, Rock Island to Quincy (472 gizzards), 1938–1940.

ANIMAL	ILLINOIS RIVER			MISSISSIPPI RIVER		
	Occurrence (Number of Gizzards)	Volume (Cubic Centi- meters)	Per Cent of Organic Contents	Occurrence (Number of Gizzards)	Volume (Cubic Centi- meters)	Per Cent of Organic Contents
TOTAL ANIMAL.....		941.57	5.18		143.24	9.64
BRYOZOA, moss animals.....	136	9.97	0.05			
MOLLUSCA						
GASTROPODA, snails						
<i>Stagnicola</i>	3	5.70	0.03			
<i>Planorbis</i>	2	1.50	0.01	2	t	
<i>Helisoma</i>	3	1.17	0.01			
<i>Gyraulus</i>	7	0.58	t			
<i>Carinifex</i>	1	0.40	t			
<i>Physa</i>	7	3.40	0.02	1	t	
<i>Viviparus</i>	2	4.90	0.03	1	0.20	0.01
<i>Campeloma</i>	26	34.20	0.19	9	11.80	0.79
<i>Lioplax</i>	8	3.25	0.02	2	1.80	0.12
<i>Amnicola</i>	45	43.15	0.24	10	13.80	0.93
<i>Flumicola</i>	4	5.50	0.03	3	3.10	0.21
<i>Somatogyrus</i>	3	0.90	t	1	0.80	0.05
<i>Pleurocera</i>	16	5.50	0.03	2	0.30	0.02
<i>Neritina</i>	2	2.50	0.01			
Unidentified Gastropoda.....	167	143.49	0.79	12	10.78	0.72
PELECYPODA, mussels						
Sphaeriidae						
<i>Pisidium</i>	15	17.70	0.10	4	5.90	0.40
<i>Musculium</i>	20	27.50	0.15	1	2.70	0.18
<i>Sphaerium</i>	45	94.50	0.52	11	16.20	1.09
Unidentified Sphaeriidae.....	6	23.30	0.13	4	13.70	0.92
Unionidae, fresh-water clams.....	9	10.80	0.06	9	4.89	0.33
Unidentified Pelecypoda.....	28	17.64	0.10	2	2.80	0.19
Unidentified Mollusca.....	81	48.94	0.27	13	18.50	1.24
ARTHROPODA						
CRUSTACEA						
Branchiopoda.....	3	1.40	0.01			
Copepoda.....	9	4.30	0.02			
Ostracoda.....	105	4.20	0.02			
Malacostraca.....	27	18.91	0.10	2	2.50	0.17
INSECTA						
Orthoptera.....	3	0.52	t	1	t	
Neuroptera, hellgrammites.....	1	0.50	t			
Ephemeroptera, mayflies						
<i>Hexagenia</i>	80	31.25	0.17	29	13.68	0.92
<i>Caenis</i>	2	0.10	t			
Odonata						
Anisoptera, dragonflies.....	9	2.80	0.02	4	2.10	0.14
Zygoptera, damselflies.....	17	14.00	0.08	1	t	
Unidentified Odonata.....	6	3.60	0.02			
Homoptera						
Cicadellidae, leafhoppers.....	3	0.20	t	1	t	
Hemiptera						
Corixidae, water boatmen.....	329	128.52	0.71	37	4.33	0.29
Notonectidae, backswimmers.....	2	0.30	t			
Nepidae, waterscorpions.....	2	0.80	t			
Belastomatidae, water bugs.....	22	17.73	0.10	1	0.12	0.01
Gerridae, water striders.....	2	0.20	t			
Miridae, <i>Lygus</i> , plant bugs.....	1	t		1	0.02	t
Lygaeidae, chinch bugs.....	1	t		1	0.03	t

Table 39.—Continued.

ANIMAL	ILLINOIS RIVER			MISSISSIPPI RIVER		
	Occurrence (Number of Gizzards)	Volume (Cubic Centimeters)	Per Cent of Organic Contents	Occurrence (Number of Gizzards)	Volume (Cubic Centimeters)	Per Cent of Organic Contents
Coreidae, squash bugs.....				1	0.12	0.01
Pentatomidae, stink bugs.....	3	0.40	t			
Unidentified Hemiptera.....	5	0.57	t			
Coleoptera						
Carabidae, ground beetles.....	46	1.32	0.01	8	0.12	0.01
<i>Omophron</i>				1	0.20	0.01
Halipidae.....	3	0.17	t			
Dytiscidae, diving beetles.....	227	23.97	0.13	8	0.35	0.02
Gyrinidae, whirligig beetles....	8	0.37	t	1	0.10	0.01
Hydrophilidae, water scavenger beetles.....	6	0.90	t	4	6.00	0.40
Staphylinidae, rove beetles....	6	0.29	t			
Puprestidae, fatheaded wood borers.....	1	t				
Dravididae.....	1	t				
Elmidae.....	2	t				
Scarabaeidae, scarab beetles....	6	0.86	t	3	0.27	0.02
Chrysomelidae, leaf beetles....	12	0.50	t			
Curculionidae, snout beetles....	17	2.90	0.02	3	0.20	0.01
Unidentified Coleoptera.....	6	0.55	t			
Trichoptera, caddisflies						
Hydroptilidae.....	132	5.99	0.03	1	t	
Hydropsychidae.....	13	11.66	0.06			
Unidentified Trichoptera.....	19	2.25	0.01			
Lepidoptera.....	4	0.39	t	1	0.09	0.01
Diptera, flies						
Chironomidae, midges.....	238	127.61	0.70	10	4.70	0.32
Tabanidae, horse flies.....	2	0.50	t			
Anthomyiidae.....	1	0.09	t	1	0.20	0.01
Unidentified Diptera.....	14	5.63	0.03	3	0.10	0.01
Hymenoptera						
Ichneumonidae, ichneumons....	3	0.05	t			
Tiphiidae, <i>Tiphia</i> , tiphiid wasps	2	0.10	t			
Formicidae, ants.....	6	0.10	t	2	0.08	t
Unidentified Hymenoptera.....	1	0.96	t			
Unidentified Insecta.....	15	5.09	0.03			
ARACHNIDA.....	21	0.72	t	7	0.14	0.01
ACARINA, water mites.....	75	0.37	t			
CHORDATA						
Pisces, fish.....	18	0.72	t	1	t	
AMPHIBIA, frogs.....	1	1.00	t			
UNIDENTIFIED ANIMAL.....	4	0.80	t	2	t	
NONFOOD						
PARASITIC WORMS.....	1	0.20	t			
FEATHERS.....	83	8.72	0.05	8	0.52	0.03

species that were the principal consumers of animal foods.

Animal parts constituted 5.52 per cent of the organic contents of all waterfowl gizzards collected in the years of the study. The two outstanding animal groups were mollusks and insects, table 39. The former comprised 55.66 per cent of the total

animal foods and the latter 39.32 per cent. Crustaceans comprised 2.89 per cent of the animal foods.

Mollusca

Snails comprised 49.47 per cent of the Mollusca and 27.54 per cent of the animal foods, while mussels constituted 39.36

per cent of the Mollusca and 21.90 per cent of the animal foods, table 39.

Fresh-water snails found in the largest numbers of duck gizzards were *Amnicola*, *Campeloma*, and *Pleurocera*. Fragments of a brackish water snail, *Neritina*, were found in two gizzards. The mussels identified were of no commercial use; most of them were small and thin shelled. Genera represented included *Sphaerium*, *Pisidium*, and *Musculium*.

Insecta

The insects represented 2.17 per cent of the total organic foods and 39.32 per cent of the total animal foods in the gizzards examined, table 39. Many species of insects were represented in gizzards collected prior to November 15, but after this date the volume and the number of species of insects decreased. This decrease was due in part to a decline in the populations of ducks that feed upon insects and in part to a decline in the number of insects available.

Among the insect material found in greatest volume in the duck gizzards were Odonata nymphs, midge larvae, mayfly nymphs, fig. 18, caddisfly larvae, and water boatmen.

Crustacea

In the duck gizzards collected, Crustacea constituted only a small portion of the animal foods, table 39; in greatest volume were the crayfish (Malacostraca). The minute forms appeared in many gizzards but in negligible volumes; among them were water fleas (Branchiopoda), amphipods and pillbugs (Malacostraca), and ostracods.

Bryozoa

These small animal forms appeared most often as traces in the duck gizzards collected. The winter buds or statoblasts of *Pectinatella* and *Plumatella* probably had been eaten along with other foods.

Amphibia

Frog bones appeared in only one gizzard.

Arachnida

A few spiders and water mites were found in the contents of the gizzards col-



Fig. 18.—Mayfly nymph of the genus *Hexagenia*. This is one of the animal foods consumed by ducks that migrate through Illinois in autumn.

lected; they were not considered important waterfowl foods.

Pisces

Fish vertebrae and scales were occasionally found in the duck gizzards collected. Mallards and black ducks have been known to feed extensively on gizzard shad, *Dorosoma cepedianum*.

GRIT

Generally grit is considered to have two functions in avian nutrition: (1) assisting the gizzard in the grinding of food and (2) furnishing necessary minerals for metabolism and reproduction (Nestler 1946: 137). Because grit invariably appeared in the gizzards examined in the present study, it seems reasonable to conclude that adequate supplies of hard, nonfriable particles were available to waterfowl in the Mississippi Flyway. Experiments with captive wild mallards have shown, moreover, that the grit demands of waterfowl may be low even in areas of grit abundance. When supplied with granite grit, each of 30 mallards under observation at the Havana laboratory of the Illinois Natural History Survey took an average of slightly less than one piece per day for a period of 14½

Table 40.—Grit contents of duck gizzards collected in Illinois, 1938–1940.

SPECIES	AVERAGE GIZZARD CAPACITY (CUBIC CENTIMETERS)	AVERAGE GRIT CONTENTS PER GIZZARD (CUBIC CENTIMETERS)	AVERAGE PER CENT OF GIZZARD CAPACITY OCCUPIED BY GRIT
Mallard.....	16.0	2.95	18.44
Pintail.....	14.0	2.31	16.50
Baldpate.....	13.0	2.87	22.08
Gadwall.....	14.0	3.85	27.50
Wood duck.....	9.0	1.91	21.22
Green-winged teal.....	3.5	0.83	23.71
Blue-winged teal.....	3.7	0.40	10.81
Shoveler.....	6.0	1.71	28.50
Canvasback.....	14.5	3.01	20.76
Redhead.....	14.0	2.78	19.86
Lesser scaup.....	5.7	1.00	11.76
Ring-necked duck.....	8.5	1.53	18.00

months. Though additional grit was easily available, some mallards retained the same particles for as long as 7½ months.

Evidence of the ability of ring-necked pheasants and bobwhites to retain grit in their gizzards for 6 weeks or more has been presented by Gerstell (1942:72–9) and Nestler (1946:141). Grit as a grinding agent in the gizzards of the bobwhite quail, *Colinus virginianus*, was not essential for growth, health, or reproduction, Nestler found.

In gizzards collected for the present study, grit occupied an average of 10.81 to 28.50 per cent of the gizzard capacity in the various species of ducks, table 40. The data indicate no correlation between amount of grit and size of duck, type of food (plant or animal), type of feeder (puddler or diver), or feeding habitat.

Grit in the gizzards collected for the present study was composed principally of rough, angular particles of quartz and chert and some limestone. Particles were

Table 41.—The number of ducks of various species represented by gizzards collected in Illinois in 1938–1940 and the number of these gizzards that contained lead shot pellets, some worn (ingested) and some unworn (embedded).

SPECIES	NUMBER OF GIZZARDS EXAMINED	NUMBER OF GIZZARDS WITH SHOT	NUMBER OF PELLETS		
			Worn	Unworn	Total
Mallard.....	2,825	250	404	140	544
Pintail.....	881	71	104	42	146
Baldpate.....	160	4	3	3	6
Gadwall.....	98	2	.....	2	2
Wood duck.....	26	.....	.....	.....	.....
Green-winged teal.....	393	5	66	4	70
Blue-winged teal.....	129	3	1	2	3
Shoveler.....	62	.....	.....	.....	.....
Canvasback.....	28	4	9	.....	9
Redhead.....	14	2	5	1	6
Lesser scaup.....	220	43	450	19	469
Ring-necked duck.....	120	22	129	19	148
Black duck.....	11	3	6	.....	6
Ruddy duck.....	5	.....	.....	.....	.....
Common goldeneye.....	3	.....	.....	.....	.....
Greater scaup.....	1	.....	.....	.....	.....
Oldsquaw.....	1	.....	.....	.....	.....
Total.....	4,977	409*	1,177	232	1,409

*Of these gizzards, 190 represented ducks in which shot had entered the gizzards at the time the birds were killed. The other 219 represented ducks that had ingested shot.

measured in millimeters across the widest dimension regardless of the shape. These varied from minute to 19 mm. in size; most of them were under 2 mm. Grit in mallard, pintail, ring-necked duck, and lesser scaup gizzards consisted mostly of stones over 3 mm. in size. Baldpate and gadwall gizzards seldom contained gritty material larger than sand particles. Teal and shoveler gizzards seldom contained stones over 2 mm.

The frequency with which sand occurred to the exclusion of stones in the baldpate and gadwall gizzards suggests a relationship between the food habits and physical composition of the grit ingested by these species. Baldpates and gadwalls generally feed on soft, leafy aquatic plants, which are likely to require little or no grinding during the digestive processes, and the sand recovered from the gizzards

of these ducks may have been taken only because it adhered to the food; or it may have been unintentionally taken during normal feeding activity.

Shell fragments, rather than stones, were found in the gizzards of many lesser scaups, ring-necked ducks, redheads, goldeneyes, and shovelers. Many other particles classified as inorganic material were found in the gizzards examined. Fossil fragments of crinoid stems, wood, coral, and brachiopod shells were not uncommon. Muskrat and fish teeth were numerous. Most of these items were rough and angular, serving as excellent grinding agents.

LEAD SHOT

Lead shot pellets were found in the gizzards of most of the species of ducks included in this study, table 41. Some of

Table 42.—The number of duck gizzards collected in Illinois in each of 3 years, the number and percentage of these that contained lead shot pellets, and the number of pellets per gizzard among the gizzards that contained lead.

YEAR	NUMBER OF GIZZARDS EXAMINED	NUMBER OF GIZZARDS WITH SHOT	PER CENT OF GIZZARDS WITH SHOT	TOTAL NUMBER OF PELLETS	NUMBER OF PELLETS PER GIZZARD WITH SHOT
1938.....	1,814	159	8.8	998	6.3
1939.....	2,291	191	8.3	332	1.7
1940.....	872	59	6.8	79	1.3
Total.....	4,977	409*	.....	1,409	.....

*Of these gizzards, 190 represented ducks in which shot had entered the gizzards at the time the birds were killed. The other 219 represented ducks that had ingested shot.

Table 43.—The number of duck gizzards collected in Illinois by 2-week periods, 1938–1940, the number and percentage of these that contained lead shot, and the number of worn (ingested) pellets per gizzard among the gizzards that contained lead.

PERIOD	NUMBER OF GIZZARDS EXAMINED	NUMBER OF GIZZARDS WITH SHOT	PER CENT OF GIZZARDS WITH SHOT	NUMBER OF WORN PELLETS	NUMBER OF WORN PELLETS PER GIZZARD WITH SHOT
October					
15–30.....	1,607	89	5.5	84	0.94
November					
1–15.....	1,466	101	6.9	297	2.9
November					
15–30.....	1,424	185	13.0	746	4.0
December					
1–15.....	480	34	7.1	50	1.5
Total.....	4,977	409*	.....	1,177	.....

*Of these gizzards, 190 represented ducks in which shot had entered the gizzards at the time the birds were killed. The other 219 represented ducks that had ingested shot.

these pellets had been ingested by ducks in their feeding and some had become lodged in the gizzards at the time the birds were killed.

The lining of many gizzards containing lead shot was dark green in color. Any duck from which a gizzard of this color had been taken was considered to have been sick before it was shot.

Water levels and firmness of lake or marsh bottoms are among the factors that determine the accessibility and availability of lead shot to waterfowl (Bellrose 1959: 249). Although the percentage of gizzards containing lead pellets did not vary greatly from year to year for the 3-year period of the study, the average number of pellets per gizzard changed materially, table 42.

Probably the lead shot was consumed in the season it was deposited rather than in a subsequent season (Bellrose 1959:266). The gizzard contents showed an increase in percentage of gizzards with lead shot as well as an increase in the number of pellets per gizzard as the autumn progressed, table 43.

SUMMARY

1. In the autumns of 1938, 1939, and 1940, duck gizzards totaling 4,977 were collected from hunting clubs and individual hunters at 21 sites along the Illinois River between Ottawa and Florence and 11 sites along the Mississippi River between Rock Island and Quincy. The following 17 duck species were represented: mallard, pintail, green-winged teal, blue-winged teal, baldpate, gadwall, shoveler, black duck, wood duck, lesser scaup, ring-necked duck, redhead, canvasback, ruddy duck, greater scaup, common goldeneye, and oldsquaw.

2. Analyses of the gizzard contents were made in accordance with the procedure instituted and followed by the U. S. Fish and Wildlife Service, Department of the Interior.

3. The analyses indicated that, during the fall, most species of ducks in Illinois are predominantly vegetarians, that most of them feed principally on native wild plants, and that the lesser scaup is the only species with a diet predominantly animal.

4. Corn made up nearly half of the organic contents of mallard gizzards. Native wild foods were present in relatively greater quantities in gizzards of the wood duck, pintail, redhead, baldpate, green-winged teal, and ring-necked duck, all of which included corn in their diets.

5. Of the 95 wild plants and 4 cultivated plants found in the gizzards and identified to species, the following 19 were most important: corn, rice cutgrass, marsh smartweed, coontail, wild millet, longleaf pondweed, red-rooted nut-grass, water-hemp, nodding smartweed, buttonbush, large-seeded smartweed, nut-grass, chufa, Walter's millet, sago pondweed, duck-potato, river-bulrush, teal grass, and giant bur-reed.

6. The relative positions of the important food plants changed from year to year as accessibility and availability varied.

7. The importance of a plant species to a species of duck depended on the size of the duck and the type of feeding habitat frequented by the duck.

8. The dabbling ducks fed primarily on emergent and moist-soil plants and the diving ducks more frequently on submergent plants. Animal foods were more important to diving ducks than to dabbling ducks.

9. Snails and mussels provided the largest animal food volume and occurred in the largest number of gizzards. Insects were second in volume and occurrence.

10. Grit constituted about 11 to 28 per cent of the gross contents of the gizzards of various duck species. Most of the stones were less than 2 mm. in size; the sizes ranged from minute to 19 mm. in size (largest dimension).

11. More than 200 of the gizzards examined contained lead shot pellets that had been ingested.

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