

FOOD HABITS OF CANVASBACKS, REDHEADS, AND LESSER SCAUP IN MANITOBA

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The purpose of this paper is to present information on food habits of 175 Canvasbacks (*Aythya valisineria*), 99 Redheads (*A. americana*), and 71 Lesser Scaup (*A. affinis*) collected in southwestern Manitoba during the late spring, summer, and early fall, from 1959 to 1964. Primary emphasis is on juveniles and spring- and summer-collected adults.

Studies of food habits lead to a better understanding of a species' environmental and nutritional requirements, its diseases caused by parasitic infestation and food poisoning, its role in the biological transportation or concentration of environmental contaminants, and its economic relationship with man. Relatively little waterfowl food-habit information is based upon juveniles and adults collected during the summer; most information of this type is based upon birds collected during either the hunting season, winter, or early spring.

Information on the food habits of adult Canvasbacks, Redheads, and Lesser Scaup on their breeding grounds is very limited. Cottam (1939) summarized food habits of many Canvasbacks, Redheads, and Lesser Scaup taken throughout the year, but sexual, seasonal, and regional differences could not always be evaluated. Yocom (1951:172-176) and Keith (1961:34) examined a combined total of 2 Canvasbacks, 12 Redheads, and 9 Lesser Scaup collected during the summer; however, they lumped these data in with data from other species and, in doing so, obscured possible interspecific differences. Specific data on foods of adults during spring and summer are available for 6 Canvasbacks, 1 Redhead, and 51 Lesser Scaup (Pirnie 1935:308, 310; Munro 1941:134-137; Erickson 1948:282; Rogers and Korschgen 1966:259-261). Published data on juveniles are available for 9 Canvasbacks, 8 Redheads, and 32 Lesser Scaup (Cottam 1939;

Munro 1941:135; Yocom 1951:174; Collias and Collias 1963:7).

Cottam (1939), in his presentation of the food habits of North American diving ducks, summarized the data accumulated by the Bureau of Biological Survey over many years. Much of the published information on food habits of Canvasbacks, Redheads, and Lesser Scaup has been based wholly or partly on these data (Phillips 1911, 1925; McAtee 1917, 1939; Preble and McAtee 1923; Kubichek 1933; Gabrielson and Jewett 1940; Martin et al. 1951).

COLLECTING AREAS IN SOUTHWESTERN MANITOBA

The ducks used in this study were collected primarily from the following areas in southwestern Manitoba.

Minnedosa-Erickson pothole area. Located mainly within the aspen parkland but extending into the prairies, the Minnedosa-Erickson area with its numerous potholes (kettle-hole ponds and lakes) and associated upland woods, pastures, and cereal crops provides some of the most productive, unmanaged, waterfowl nesting habitat remaining in North America. Canvasbacks, Redheads, and Lesser Scaup use this area primarily for breeding and nesting. None of the adults, both male and female, of these three species were known to have remained on the potholes during their postnuptial molt. Descriptions of this area and its use by waterfowl were given by Evans et al. (1952:2-16), Dzubin (1955:281), Kiel (1955:189-190), Rogers (1959:218), and Stoudt (1962-64). The general ecology of the aspen parkland was described by Bird (1961).

Delta-Lake Francis marshes. The two adjacent and somewhat similar marshes of Delta and Lake Francis are located between Lake Manitoba and the fertile agricultural lands of the Portage la Prairie plain. The Delta marsh is important to Canvasbacks, Redheads, and Lesser Scaup as a breeding area and a stopover during spring and fall migration, but it is relatively unimportant as a molting area (Hochbaum 1959). Hochbaum (1959:3-12) and Olsen (1959:40-41) described the general ecology of the Delta marsh, Löve and Löve (1954) described its emergent vegetation, and Collias and Collias (1963:9-13) presented

data on some invertebrates that were potential foods for waterfowl.

Lake Winnipegosis. Lake Winnipegosis is a large (5200 km²), shallow (6-m mean depth), eutrophic lake lying within the southern edge of the boreal forest. This lake is important to Canvasbacks, Redheads, and Lesser Scaup as a stopover during the spring and as both a stopover and a staging area during the fall; in July and August, Redheads use it as a molting area (Bartonek 1965:18-19). All three species nest here to a limited extent. The Manitoba Department of Mines and Natural Resources, the Wildlife Management Institute, the U.S. Fish and Wildlife Service (1948), and McLeod and Bondar (1953:2-4) described the lake; Bajkov (1930) listed its plankton and bottom fauna.

METHODS

Of the 345 ducks used in our analyses, 330 were shot and 15 were drowned in gill nets of commercial fishermen. Prior to 1963 we placed most of the birds, immediately after collecting, in ice until they were autopsied or could be frozen. In 1963 and 1964 we minimized the effects of post-mortem digestion of foods by either injecting digestive tracts with Formalin, or removing the tracts and placing them in Formalin immediately after collection. The various foods were identified, segregated, and volumetrically measured while wet by water-displacement. Grit was analyzed separately from foods. Because of biases resulting from food digesting at different rates in certain parts of the upper digestive tract, we analyzed the contents of the esophagus separately from that of the accompanying proventriculus and gizzard. Dillon (1958:114) recognized that "gullet material reflects recent consumption and stomach material may distort the importance of some hard seeded plants." We noted that data on certain invertebrates are similarly distorted and that the composition of most foods found in the esophagus is significantly different from the composition in either the proventriculus or gizzard. Because many of the earlier waterfowl food-habit studies included the proventriculus and gizzard in their analyses, the esophagus-proventriculus-gizzard data and the preferred esophageal data are presented for comparative purposes. "Per cent of volume" (the "aggregate volume method" of Martin et al. 1946) and "per cent of occurrence" are used in presenting these data. "Percentage of bulk method" data (the "aggregate percentage method" of Martin et al. 1946) were used to compare our findings with those of others who had used this method of analysis.

FOOD HABITS OF CANVASBACKS

The spring-summer food habits of Canvasbacks were determined from 120 juveniles collected between mid-June and the first of September and from 42 adults collected between May and the end of August. Fall food habits were determined from 13 birds collected in the last part of September and in October during the hunting season.

During summer, food habits of juvenile and adult female Canvasbacks were similar in their high percentages of invertebrates and differed appreciably from those of

adult males, which were high in plant material (table 1). Indexes of Similarity (Curtis 1959:82-83) were used to compare diets among the various groups of birds. An I S value of 1.00 would indicate that diets were identical, while a value of 0.00 would indicate that diets had nothing in common. We compared "per cent of volume" of the items in the esophageal material and obtained I S values of 0.32 for juveniles and female adults, 0.03 for juveniles and male adults, and 0.09 for female and male adults. Corresponding values determined from esophagus-proventriculus-gizzard contents were 0.52, 0.13, and 0.25. I S values are highest in this latter group of comparisons because these food materials contained items common in most ducks, i.e., hard-coated seeds that tend to be retained by the gizzard.

Mostly immature aquatic insects and various gastropods (Lymnaeidae, Physidae, and Planorbidae) formed 87 per cent of the volume of foods found in the esophagi of juvenile Canvasbacks (table 1). Trichoptera larvae and cases, Tendipedidae larvae, pupae and an occasional adult, and Ephemeroptera nymphs were the most abundant insects found in these young birds. Zygoptera and Anisoptera nymphs, Corixidae nymphs and adults, Haliplidae and Dytiscidae larvae and adults, Stratomyidae larvae, and an adult Mallophaga were the remaining insects, and totaled only one per cent. Other invertebrates (Hirudinea, cladoceran ehippia, ostrocods, arachnids, etc.) formed less than one per cent volume. Consumption of *Zannichellia palustris* nutlets by two flying juveniles accounted for 62 per cent of the plants found in esophageal material from the juvenile sample, and unduly influenced the values of both *Zannichellia* and the total plant material. Oögonia and vegetative branches of *Chara*, tubers and rootstalks of *Potamogeton pectinatus*, and seeds and vegetative parts from numerous emergent and sub-emergent species formed the remainder of the plant material in the esophagi.

As juvenile Canvasbacks grow older, they rely less and less upon animal food. By fall their diet and that of adults consist primarily of plant material (table 2). The percentage (aggregate percentage method) of animal material found in the esophageal contents of birds aged 0 to 5 weeks was 99 ± 1 (95% C.L.); at 5 to 9 weeks of age, 86 ± 11 ; and at flying time, but before the fall hunting season, only 38 ± 22 .

TABLE 1. Foods from Canvasbacks collected during the spring and summer in southwestern Manitoba.

Source of material Food item	Common name (part of type)	% occurrence			% aggregate vol.		
		Juvenile	Adult female	Adult male	Juvenile	Adult female	Adult male
Esophageal contents (n)		(86)	(16)	(13)	(86)	(16)	(13)
<i>Zannichellia</i> sp.	Horned pondweed (nutlets)	2			8		
<i>Chara</i> spp.	Muskgrass (oögonia, vegetative)	5	6		2	tr.	
<i>Potamogeton</i> spp.	Pondweeds (tubers)	12	44	62	1	7	95
Other plants	Various seeds	45	25	46	2	tr.	tr.
	Misc. vegetative parts	34	6	15	tr.	tr.	2
Total plant material		73	75	100	13	8	98
Trichoptera	Caddis flies (larvae, cases)	53	44		59	10	
Gastropoda	Pond snails	22	38		18	66	
Tendipedidae	Midges (larvae, pupae)	37	31	31	8	2	2
Ephemeroptera	Mayflies (nymphs)	6	6		1	13	
Misc. Insecta	Misc. aquatic insects	26	12		1	tr.	
Other animals	Other aquatic invertebrates	12			tr.		
Total animal material		79	88	31	87	92	2
Esophagus-proventriculus-gizzard contents (n)		(120)	(23)	(19)	(120)	(23)	(19)
<i>Potamogeton</i> spp.	Pondweeds (tubers, winter buds)	12	35	68	3	13	81
	Pondweeds (nutlets)	52	87	79	2	6	4
<i>Zannichellia</i> sp.	Horned pondweed (nutlets)	2			4		
<i>Chara</i> spp.	Muskgrass (oögonia, vegetative)	8	9		4	2	
<i>Scirpus</i> spp.	Bulrushes (achenes)	83	87	79	3	4	3
<i>Ceratophyllum</i> sp.	Coontail (nutlets)	11	17	16	3	tr.	tr.
<i>Carex</i> spp.	Sedges (achenes, perigynia)	32	35	63	1	tr.	2
<i>Myriophyllum</i> sp.	Water milfoil (nutlets)	43	87	79	tr.	1	1
<i>Chenopodium</i> sp.	Lamb's-quarter (utricles)	5	9	21	tr.	tr.	5
Miscellaneous	Various seeds	31	52	58	1	1	tr.
	Vegetation	33	17	32	tr.	tr.	tr.
Total plant material		98	100	100	21	27	96
Trichoptera	Caddis flies (larvae, cases)	72	61	37	61	24	1
Gastropoda	Pond snails	22	30		10	33	
Tendipedidae	Midges (larvae, pupae)	34	44	37	4	5	3
Odonata	Damselflies, Dragonflies (nymphs)	16	17		1	tr.	
Ephemeroptera	Mayflies (nymphs)	8	4		1	8	
Other animals	Misc. aquatic invertebrates	39	9	11	1	1	tr.
	Unidentified animal material	12	17		1	2	
Total animal material		91	91	58	79	73	4

Cottam (1939:30) examined eight juveniles from Alberta and Saskatchewan. Three older birds, taken in September but still flightless, had fed almost entirely upon *Potamogeton* and *Scirpus*, while animal material comprised 56 per cent of the food found in the five younger ducklings. Percentages of the more important food items found by Cottam were: *Potamogeton*, 37; *Scirpus*, 5; *Sparganium*, 7; *Myriophyllum* and *Hippuris*, 4; Trichoptera, 19; Corixidae, 8; Coleoptera, 4; and Tendipedidae larvae, 2. In comparing our data with Cottam's but excluding both miscellaneous and unidentified materials in the comparison, we obtained an I S value of 0.47. Yocom (1951:174) reported that a juvenile Canvasback collected at the end of July in Washington had fed entirely upon *Ruppia maritima* and *Potamogeton* spp.

Of food found in the esophagi of adult female Canvasbacks during spring-summer, 92

per cent was animal (table 1). Lymnaeidae snails formed 99 per cent of the gastropods. Immature forms of Trichoptera, Tendipedidae, Ephemeroptera, and Zygoptera comprised the remainder of the animal food and 26 per cent of the esophageal contents. Ehippia of cladocerans, corixids, Haliplidae adults and larvae, and arachnids were the "miscellaneous invertebrates" found in the esophagus-proventriculus-gizzard contents. *Potamogeton pectinatus* tubers were utilized by the females, but not as extensively as by the adult males. Miscellaneous plant items included *Lemma trisulca*, leaf segments of *Myriophyllum exalbescentis*, and the seeds of *Sparganium*, *Hordeum*, *Eleocharis*, *Rumex*, and *Ranunculus*. Apparently, animal material forms the bulk of the adult females' diets during nesting, incubation, and brood-rearing, but plant material later increases in importance.

Adult male Canvasbacks consumed pri-

TABLE 2. Foods from Canvasbacks collected in late September and early October during the hunting season in southwestern Manitoba.

Source of material Food item	Common name (part or type)	% occurrence	% aggregate vol.
Esophageal contents (<i>n</i>)		(7)	(7)
<i>Potamogeton</i> spp.	Pondweeds (tubers)	71	71
<i>Chara</i> spp.	Muskgrass (vegetative)	14	5
<i>Myriophyllum</i> sp.	Water milfoil (nutlets)	14	1
Other plants	Misc. vegetative parts and seeds	14	1
Total plant material		100	78
Ephemeroptera	Mayflies (nymphs)	14	18
Zygoptera	Damselflies (nymphs)	14	3
Other animals	Misc. aquatic invertebrates	29	1
Total animal material		29	22
Esophagus-proventriculus-gizzard contents (<i>n</i>)		(13)	(13)
<i>Potamogeton</i> spp.	Pondweeds (tubers, winter buds)	77	51
	Pondweeds (nutlets)	92	20
<i>Scirpus</i> spp.	Bulrushes (achenes)	62	4
<i>Chara</i> spp.	Muskgrass (vegetative)	15	4
<i>Myriophyllum</i> sp.	Water milfoil (nutlets, vegetative)	38	1
Other plants	Various seeds	23	1
	Unidentified vegetative parts	8	5
Total plant material		100	86
Ephemeroptera	Mayflies (nymphs)	8	12
Zygoptera	Damselflies (nymphs)	8	1
Other animals	Misc. aquatic invertebrates	15	1
Total animal material		15	14

marily (97 per cent) the vegetative parts and nutlets of *Potamogeton*, the tubers being mainly utilized (table 1). Although animal matter was found in four males, it comprised only two per cent of the esophageal food items.

Sexual differences in food habits, as observed between adult male and female Canvasbacks during summer, have not previously been reported. Only once before has this aspect of waterfowl food habits been examined, i.e. for the Mallard, *Anas platyrhynchos* (Perret 1962:38-39). Although the reason for this difference is unknown, a high protein diet simply may not be a necessity for the adult males.

The food found in Canvasbacks collected during the hunting season was similar to that in adult males collected during the spring and summer ($I S = 0.71$; table 2). Vegetative parts of aquatic plants, especially tubers of *Potamogeton pectinatus*, formed 77 per cent of the esophageal material. One juvenile male Canvasback, shot in late September on the Delta Marsh, contributed 21 of the total 22 per cent of animal material for esophageal contents and 13 of the 14 per cent of esophagus-proventriculus-gizzard contents.

Cottam (1939:24-29) found that animal matter comprised 21 per cent of the food consumed by birds collected during April, May, June, and September (48 "stomachs"). Insects, nearly two-thirds of which were Trichoptera

larvae and cases, were taken primarily during summer; mollusks were taken primarily during winter. Najadaceae (pondweeds) formed 33 per cent of the summer foods. Preble and McAtee (1923:47) reported that an adult male Canvasback, collected in the Pribilof Islands in May, had fed exclusively upon Trichoptera larvae and cases. Erickson (1948:282) examined six spring migrants that died from lead poisoning and found *Scirpus acutus* and *Potamogeton pectinatus* fruits in limited quantities.

If today's information on the food habits of Canvasbacks throughout their range had been available to Alexander Wilson, he might well have named them "*Anas potamogeton*" instead of "*A. valisineria*." The published reports, which are either reviewed subsequently or listed in table 3, indicate that potamogetons and other Najadaceae are more important to Canvasbacks than is the much acclaimed *Vallisneria americana*. Stewart (1962:51, 170-173) reported the food habits of 86 Canvasbacks taken from the Chesapeake region of Delaware and Maryland between October and March. Combining Stewart's findings from four different areas, the "percentages of occurrence" for Najadaceae species were: *Potamogeton* vegetative parts, 28, and fruit, 31; *Zostera marina* vegetative parts, 13; *Ruppia maritima* vegetative parts, 6, and fruit, 8; and *Najas* vegetative parts, 1. *Vallisneria*

TABLE 3. Quantities of *Potamogeton* spp., other Najadaceae, *Vallisneria americana*, and total plant material found in Canvasbacks (esophagus-proventriculus-gizzard content), as presented in reports involving 10 or more birds.

Location	N	Season	% vol. or (% occurrence)				Reference
			<i>Potamogeton</i>	Other Najadaceae	<i>Vallisneria</i>	Total plants	
26 states, 5 provinces	427	Sept.-June	18	1	9	81	Cottam (1939:25)
Mostly southern states	381 ^a	Winter-Spring	—18—		11	85	Phillips (1925:130-131)
Northeastern U. S.	71 ^a	Fall-Spring	10-25	tr.-2	25-20		Martin et al. (1951:68)
Southeastern U. S.	64 ^a	Winter	10-25	tr.-2			Martin et al. (1951:68)
Western U. S.	109 ^a	All seasons	53	2-5			Martin et al. (1951:68)
Oregon	12 ^a	Fall?	(62)	(8)		60	Gabrielson and Jewett (1940:157)
Minnesota	88	Fall?	(95)	tr.			Smith (1946:74)
Tennessee	38	Fall	38			74	Rawls ([1958]:65-66)
Illinois	28	Oct.-Dec.	46			65	Anderson (1959:320)
California	17	Oct.-April	16	3		19	Yocom and Keller (1961:48-49)
Missouri	10	Oct.-Dec.	45	1		95	Korschgen (1955:16)
Manitoba	175	April-Oct.	23	3		37	this study

^a These data are also incorporated into Cottam's (1939:25) data based upon 427 birds.

americana was found in 24 per cent of the birds. In four birds from Maryland, Warren (1890:43) found only vegetable substances that he "judged" to be "remains of *Vallisneria*." H. L. Skavlem found *Potamogeton* tubers to form 60 to 80 per cent of the Canvasbacks' food on Lake Koshkonong (McAtee 1917:14). He discredited the importance of *Vallisneria* as a food in Wisconsin by taking some of the alleged "wild-celery" buds from esophagi of Canvasbacks and growing them; in reality, they proved to be a *Potamogeton* (Kumlien and Hollister 1903:22). Zimmerman (1953:172) indicated that *Potamogeton* and *Vallisneria* were among the foods eaten by six birds examined in Wisconsin. Seven of eight birds collected by Pirnie (1935:307-308) in Michigan contained, in addition to other items, either the tubers, winter buds, or nutlets of potamogetons. Longcore and Cornwell (1964) successfully maintained Canvasbacks and Lesser Scaups in Michigan by feeding them "natural foods" which included 64 per cent (oven-dried weight) *Vallisneria*.

Additional references indicate that plants other than *Vallisneria* are extensively utilized by Canvasbacks. Nuttall (1834:431) claimed that in Massachusetts Bay the Canvasbacks' principal foods were *Zostera marina* and *Ruppia maritima* instead of *Vallisneria*. McAtee (1917:21) reported that the tubers of *Sagittaria platyphylla* were important in attracting large numbers of Canvasbacks into the Mississippi Delta in Louisiana. Grinnell et al. (1918:154), not mentioning any Najadaceae, reasoned that "in California the Canvasback

partakes of more animal food, for wild celery does not grow in this state."

The succulent leaves, stems, rootstalks, tubers, and to a lesser extent the fruits, of *Potamogeton* spp., *Ruppia maritima*, *Zostera marina*, *Vallisneria americana*, and *Sagittaria* spp. appear to be the plant foods most utilized by Canvasbacks. While the extent to which "preference" in the wild determines their relative utilization has not been studied, plant distribution provides a partial explanation for differences noted in utilization. *Potamogeton*, being more widely distributed in continental range than *Vallisneria* (Martin and Uhler 1939:25-35, 43), logically should form a greater proportion of Canvasbacks' diets, as it apparently does.

Most of the previously mentioned references on Canvasback food habits indicate that consumption of animal material is not uncommon. Additional references reporting Canvasbacks feeding extensively upon animal material are those of Dawson and Bowles (1909:793) in Washington, Trautman (1940:192) in Ohio, and Saunders (1964:257) in the coastal waters of México.

FOOD HABITS OF REDHEADS

The spring-summer food habits of Redheads were determined from 59 juveniles, collected between the end of June and the first week of September, and 24 adults collected between mid-May and late August. Information on fall food habits was provided by 2 juveniles and 14 adults shot during the hunting season.

Differences between the food habits of juveniles and adult females and those of adult

TABLE 4. Foods from Redheads collected during the spring and summer in southwestern Manitoba.

Source of material Food item	Common name (part or type)	% occurrence			% aggregate vol.		
		Juvenile	Adult female	Adult male	Juvenile	Adult female	Adult male
Esophageal contents (n)		(37)	(6)	(6)	(37)	(6)	(6)
<i>Chara</i> spp.	Muskgrass (oögonia)	8			16		
	Muskgrass (vegetative)	11			2		
<i>Scolochloa</i> sp.	Whitetop grass (grains)	16	17	17	17	tr.	tr.
Chlorophyceae	Green algae	19		17	8		tr.
<i>Ranunculus</i> spp.	Buttercups (achenes)	5			5		
<i>Scirpus</i> spp.	Bulrushes (achenes)	51	50	33	3	4	tr.
<i>Potamogeton</i> spp.	Pondweeds (winter-buds)	11	33	17	3	15	12
<i>Lemna</i> spp.	Duckweeds (vegetative)	11	17	17	2	tr.	tr.
Other plants	Misc. plants (seeds)	32	67	50	1	tr.	2
Total plant material		81	100	83	57	19	14
Trichoptera	Caddis flies (larvae, cases)	41	50	50	18	80	62
Gastropoda	Pond snails	11			11		
Cladocera	Water fleas (adults, ephippia)	16			7		
Tendipedidae	Midges (larvae, pupae)	24	17	17	1	tr.	22
Other animals	Invertebrate eggs	11			5		
	Misc. aquatic invertebrates	30	33	33	1	tr.	2
Total animal material		76	50	50	43	81	86
Esophagus-proventriculus-gizzard contents (n)		(59)	(10)	(14)	(59)	(10)	(14)
<i>Chara</i> spp.	Muskgrass (oögonia)	5			11		
	Muskgrass (vegetative)	10			1		
<i>Potamogeton</i> spp.	Pondweeds (winter buds)	8	30	43	7	19	50
	Pondweeds (nutlets)	44	60	33	3	1	tr.
<i>Scolochloa</i> sp.	Whitetop grass (grains)	10	10	7	7	2	9
<i>Scirpus</i> spp.	Bulrushes (achenes)	95	60	57	6	5	2
<i>Ranunculus</i> spp.	Buttercups (achenes)	19		7	5		tr.
Chlorophyceae	Green algae	17	10	7	5	tr.	tr.
Misc.	Various seeds and vegetative parts	51	80	57	2	tr.	2
Total plant material		97	100	100	46	27	64
Trichoptera	Caddis flies (larvae, cases)	64	50	50	36	72	33
Cladocera	Waterfleas (adults, ephippia)	14			5		
Gastropoda	Pond snails	7	10		4	tr.	
Tendipedidae	Midges (larvae, pupae)	24	20	7	1	1	3
Corixidae	Water boatmen (adults, nymphs)	20	10		1	tr.	
Other animals	Invertebrate eggs	7			5		
	Misc. aquatic invertebrates	44	30	29	tr.	tr.	tr.
Total animal material		85	70	57	54	73	36

males were not as great among Redheads as among Canvasbacks (table 4). I S values for esophageal contents were 0.21 for juveniles and female adults, 0.24 for juveniles and male adults, and 0.74 for female and male adults. Corresponding values determined from esophagus-proventriculus-gizzard data were 0.52, 0.52, and 0.57, respectively.

Various foods were consumed by juvenile Redheads and no particular item was utilized extensively by the entire group (table 4). The algae, Characeae and Chlorophyceae, comprised 26 per cent of the esophageal contents and were found in 12 of the 37 esophagi examined. Hard-coated seeds and Trichoptera larvae with their cases comprised a greater percentage of the foods in the esophagus-proventriculus-gizzard contents than in the esophageal contents. Zygotera nymphs, Haliplidae and Dytiscidae adults and larvae, Hydracarina, Chonchostraca, Ephemeroptera

nymphs, and eggs of various invertebrates formed the "miscellaneous invertebrates" in the esophagus.

The only other references on juvenile Redheads reported plant material to form the bulk of the foods. Cottam's (1939:13-14) three downy Redheads contained primarily *Potamogeton* (33 per cent), *Scirpus* (31 per cent), and animal material (31 per cent); of the latter group, Corixidae, Coleoptera, Orthoptera, and Odonata were most important. Collias and Collias (1963:7) reported that five one-week-old Redheads collected on the Delta marshes had eaten primarily the nutlets of *Potamogeton*.

Animal material found in our small samples of adult males and females comprised 86 and 81 per cent, respectively, of esophageal volumes (table 4). Trichoptera larvae and cases and Tendipedidae larvae and pupae comprised the bulk of animal foods consumed

TABLE 5. Foods from Redheads collected in late September and early October during the hunting season in southwestern Manitoba.

Source of material Food item	Common name (part or type)	% occurrence	% aggregate vol.
Esophageal contents (n)		(5)	(5)
<i>Chara</i> spp.	Muskgrass (vegetative)	80	99
<i>Hordeum</i> sp.	Squirrel-tail grass (grain)	20	tr.
Total plant material		100	100
Esophagus-proventriculus-gizzard contents (n)		(16)	(16)
<i>Chara</i> spp.	Muskgrass (vegetative)	88	96
<i>Potamogeton</i> spp.	Pondweeds (vegetative, nutlets)	12	1
Misc.	Various seeds	12	2
	Unidentified vegetative parts	6	1
Total plant material		100	100

by these adults. Zygoptera nymphs, Haliplidae and Dytiscidae adults and larvae, amphipods, and Sphaeridae were the "miscellaneous animal" foods eaten. Winter buds of *Potamogeton* were almost the exclusive item eaten by a group of 11 flightless adults drowned in gill nets during late August on Lake Winnipegosis. In addition to those plant items listed in table 4, fruits from the following plants were found in small quantities: *Myriophyllum*, *Chenopodium*, *Eleocharis*, *Sparganium*, *Ruppia*, *Hordeum*, and *Echinochloa*.

Chara, with its musky odor and limy incrustation, is at times an important food of Redheads. Vegetative branches of *Chara* were found in all 14 birds shot on Lake Winnipegosis during the hunting season (table 5). Both oögonia and, to a lesser extent, vegetative parts from these plants were eaten by six juveniles (table 4). Kubichek (1933:108) reported that *Chara* comprised 91 per cent of the food found in the "stomachs" of 83 Redheads collected at Okanagan Landing, British Columbia, during the winter. We disagree with Kubichek's conclusion that Redheads resort to *Chara* because other foods are scarce. Eleven Canvasbacks, also collected with the Redheads during the hunting season on Lake Winnipegosis, had fed primarily upon *Potamogeton* tubers and nutlets, suggesting to us that, although *Potamogeton* was available as a potential food for Redheads, *Chara* was preferred. Cottam (1939:10) also considered *Chara* to be an acceptable food in many areas where other excellent duck foods were available. At Swan Lake, British Columbia, Munro (1939:183), found *Chara's* vegetative branches and oöspores to comprise 31 and 17 per cent, respectively, of the foods found in eight Redheads collected in the fall. Cornwell and Cowan (1963:186), examining the same 14 birds from Lake Winnipegosis used in this study, noted a paucity of intestinal parasites

and suggested that *Chara* serves as a natural means to deworm the birds either mechanically or chemically.

Cottam (1939:7-13) considered Redheads to be predominantly vegetarians; plant material comprised 90 per cent of the "stomach" contents found in his 364 adults. Najadaceae (32 per cent) and Characeae (21 per cent) were the most important plant families represented in the foods consumed. Insects, including Orthoptera, Tendipedidae, and Trichoptera, and mollusks, including Gastropoda and Pelecypoda, comprised six and four per cent, respectively, of the total foods consumed. Animal material comprised 24 per cent of the food in June and 20 per cent in July; no adults were collected during May or August.

FOOD HABITS OF LESSER SCAUP

Data on spring and summer food habits of Lesser Scaup are based upon 47 juveniles collected during July, August, and the first week in September, and 24 adults collected in each month from May through August. We did not collect scaup during the hunting season.

Animal matter was more important than plants to duckling and adult Lesser Scaup; and, as was expected, animal food decreased in importance when material from proventriculi and gizzards were included with the contents of the esophagi (table 6). I S values for esophageal data were 0.61 for juveniles and female adults, 0.20 for juveniles and male adults, and 0.22 for female and male adults; corresponding values determined from esophagus-proventriculus-gizzard contents were 0.50, 0.34, and 0.46, respectively.

Amphipods, gastropods, and Tendipedidae larvae formed 96 per cent of the esophageal material found in 25 juvenile Lesser Scaup. The esophagus-proventriculus-gizzard contents of 47 juveniles increased the importance of such plants as *Myriophyllum* and *Scirpus*.

TABLE 6. Foods from Lesser Scaup collected during the spring and summer in southwestern Manitoba.

Source of material Food item	Common name (part or type)	% occurrence			% aggregate vol.		
		Juve- nile	Adult female	Adult male	Juve- nile	Adult female	Adult male
Esophageal contents (n)		(25)	(7)	(7)	(25)	(7)	(7)
Misc. plants.	Various seeds	16	29	29	tr.	tr.	tr.
	Misc. vegetative	32	43	29	tr.	1	tr.
Total plant material		40	57	57	tr.	2	tr.
Amphipoda	Scuds	52	43	29	49	46	8
Gastropoda	Pond snails	4	14	43	39	4	4
Tendipedidae	Midges (larvae, pupae)	20	43	29	8	41	6
Corixidae	Water boatmen (adults, nymphs)	40	14	14	2	2	1
Coleoptera	Aquatic beetles (adults, larvae)	8		29	tr.		2
Hirudinea	Leeches	4		14	tr.		61
Trichoptera	Caddis flies (larvae, cases)	8	14	29	tr.	2	16
Other animals	Misc. aquatic invertebrates	16	29	14	1	1	1
Total animal material		80	86	100	99	98	99
Esophagus-proventriculus-gizzard contents (n)		(47)	(12)	(12)	(47)	(12)	(12)
<i>Myriophyllum</i> sp.	Water milfoil (nutlets)	47	92	92	12	7	5
<i>Scirpus</i> spp.	Bulrushes (achenes)	92	100	100	6	4	7
Other plants	Various seeds	51	17	75	1	2	2
	Misc. vegetative parts	15	25	25	tr.	tr.	tr.
Total plant material		96	100	100	19	13	14
Amphipoda	Scuds	32	25	17	39	19	7
Gastropoda	Pond snails	2	17	33	20	2	3
Tendipedidae	Midges (larvae, pupae)	17	25	25	9	34	12
Corixidae	Water boatmen (adults, nymphs)	38	17	25	4	1	tr.
Coleoptera	Aquatic beetles (adult, larvae)	6	8	25	1	tr.	2
Trichoptera	Caddis flies (larvae, cases)	6	25	25	tr.	5	24
Hirudinea	Leeches	2	8	8	tr.	2	31
Misc. Crustacea	Misc. crustaceans	13	25	8	tr.	2	tr.
Misc. Insecta	Misc. aquatic insects	4	25	8	tr.	2	1
Unident. animals	Unidentified animal material	32	17	17	7	20	6
Total animal material		68	58	64	81	87	86

Chlorophyceae, *Potamogeton* vegetation and nutlets, and the fruits of *Ruppia*, *Sparganium*, *Scolochloa*, *Hordeum*, *Eleocharis*, *Carex*, *Rumex*, *Ceratophyllum*, *Ranunculus*, and *Sonchus* were among the group of "miscellaneous plants" that formed only one per cent of the total foods. Ehippia of cladocerans, ostracods, nymphs of Ephemeroptera and Zygoptera, and the larvae of Culicidae formed the "miscellaneous invertebrates."

Eighty-nine per cent of the "stomach" contents of 17 juvenile Lesser Scaup collected in the Prairie Provinces was animal material (Cottam 1939:45-46). Aquatic beetles, Tendipedidae larvae, Corixidae, and Odonata nymphs were the most important groups of animals eaten by this group. In spite of a preponderance of Dytiscidae beetles eaten by Cottam's birds and amphipods by ours, and I S value of 0.24 was obtained in a comparison of esophagus-proventriculus-gizzard data from the two groups.

We compared our findings based upon 20 adult Lesser Scaup collected in the pothole area with those of Rogers and Korschgen (1966:260) who collected 39 adults in the

same area. An I S value of 0.39 was obtained. In spite of using esophagus-proventriculus-gizzard contents which usually greatly inflate the importance of plant material, the percentages of animal material in both studies were high—86 per cent for ours and 91 per cent for theirs. Three of Rogers and Korschgen's birds ate *Daphnia*, which amounted to eight per cent of the foods. None of our scaup contained these mature cladocerans, but 7 of the 71 birds (47 juveniles and 24 adults) did contain trace amounts of their ehippia. Leeches were eaten by birds in both studies.

The amphipods, *Gammarus* and *Hyaella*, are important foods for many adult and juvenile Lesser Scaup in potholes and marshes of southwestern Manitoba. Of 71 scaup we examined, 20 contained these crustaceans (table 6). Rogers and Korschgen (1966:259-261) found 21 of 39 adults had eaten amphipods. Amphipods composed most of the food found by Munro (1941:134-137) in 10 juveniles and 9 adults taken during the summer in British Columbia. Cottam (1939:40-46), however, found them relatively unimportant in birds that he examined.

DISCUSSION

Cottam (1939:5, 53), whose information was based upon specimens collected largely from fall to spring, was probably justified in concluding that the food habits of *Aythya*, excepting those of the Greater Scaup (*A. marila*), are predominantly vegetarian. The present study during the spring and summer, however, shows that Canvasbacks (excepting adult males), Redheads, and Lesser Scaup in southwestern Manitoba consumed chiefly animal material. Other investigations tend to corroborate the importance of animal foods for diving ducks during summer. Martin et al. (1951:66, 68-69) reported percentages of animal material among summer-collected birds to be 37 for Canvasbacks, 21 for Redheads, and 52 for Lesser Scaup. Keith's (1961:34) data from Redheads, Lesser Scaup, Ruddy Ducks (*Oxyura jamaicensis*), and Canvasbacks taken during the spring and summer in Alberta showed that animal material comprised 59 percent of the foods found in 24 "stomachs." Rogers and Korschgen (1966:262-263), who presented seasonal data and reviewed studies following Cottam's (1939), concluded that the food habits of Lesser Scaup were more akin to those of Greater Scaup in that both consisted mainly of animal material.

During the summer, Canvasback and Redhead juveniles ate progressively less animal material as they became older. Lesser Scaup juveniles, however, maintained diets high in animal material. Chura (1961:124-126) noted that juvenile Mallards also consumed progressively less animal material as they became older. Perret (1962:61-62), however, did not find a similar change in the diets of the juvenile Mallards he examined. Mendall (1958:187) believed the diets of half-grown juvenile Ring-necked Ducks (*Aythya collaris*) were more similar to those of adults (more plant material) than to those of downy young (more animal material).

Studies in which "stomachs" or "gullets and gizzards" were used in analyses of food habits have probably over-estimated the importance of plant material because of the bias resulting from the inclusion of the proventriculus and gizzard contents in with the more meaningful esophageal contents. Some plant foods found in the ducks were probably ingested incidentally. Filamentous algae (Chlorophyceae) were frequently ingested when ducks fed upon amphipods, corixids, Tendipedidae larvae, and Trichoptera larvae, since these plants adhered to the invertebrates that were being eaten by the birds. The seeds of *Eleocharis*, *Scirpus*,

Carex, *Myriophyllum*, *Hippuris*, *Ranunculus*, *Chenopodium*, and *Rumex*, and the oogonia of *Chara*, and the vegetative parts of *Myriophyllum*, *Ceratophyllum*, and *Lemna* were frequently incorporated into the larval cases of Trichoptera, and were therefore incidentally ingested by those birds that fed upon the larvae. Of course seeds are eaten as a food or as a substitute for grit, but their importance as a summer food is often overrated.

Aquatic invertebrates formed the bulk of foods eaten by the Canvasbacks, Redheads, and Lesser Scaup during the spring and summer months in southwestern Manitoba. Trichoptera larvae with cases, Tendipedidae larvae, and gastropods were important items for all three species; amphipods were additionally important to scaup. Immature rather than adult insects were most frequently consumed. Although juvenile birds were occasionally seen chasing flying insects across the water, flying forms of insects were rarely encountered in the examination of food contents.

Potamogeton, with its tubers, winter buds, rootstalks, and nutlets, was the most important plant genus. *Chara* was often consumed in large quantities by particular groups of birds, but it was not found in a majority. *Scirpus* and *Myriophyllum* were found in most birds, but seldom in large quantities. With the possible exception of two birds feeding upon caryopses of *Scolochloa* that were still attached to this emergent, seeds were taken from the bottom of the pond.

There were greater similarities in food habits between ducks of all three species collected from potholes and marshes ($I S = 0.34$) than ducks from either potholes and lakes (0.13) or marshes and lakes (0.13). The fruits of upland and emergent vegetation such as *Scirpus*, *Carex*, *Eleocharis*, *Scolochloa*, *Hordeum*, *Ranunculus*, *Rumex*, *Chenopodium*, *Melilotus*, and *Senecio* were more frequently consumed by ducks from the potholes and marshes than by those from the lakes. Conversely, aquatic vegetation such as the vegetative branches and oogonia of *Chara* and the winter buds of *Potamogeton* was more frequently found in birds from the lakes than in those from either potholes or marshes. These differences may in part reflect the higher ratios of edge to open-water associated with potholes and marshes in comparison with lakes.

Use of foods, with respect to quantity and availability and interspecific relations of the food habits among diving ducks, will be discussed in a separate paper (Bartonek and Hickey, unpublished).

SUMMARY

Among 162 summer-collected Canvasbacks, animal material formed the bulk of esophageal contents in both juveniles (87 per cent) and adult females (92 per cent), but it was less important to both adult males (2 per cent) and 13 fall-collected birds (22 per cent). Trichoptera larvae with cases, Tendipedidae, Ephemeroptera nymphs, and gastropods were the animal items found in greatest quantities. Tubers of *Potamogeton* comprised 95 per cent of the esophageal contents of summer-collected adult males, and 71 per cent of the fall-collected birds. A review of literature on food habits indicated that *Potamogeton*, probably because of its continent-wide distribution, is a more important food of Canvasbacks than the often acclaimed *Vallisneria americana*.

The esophagi from 83 summer-collected juvenile and adult female and male Redheads contained, respectively, 43, 81, and 86 per cent animal material. Trichoptera larvae, Tendipedidae, Cladocera, and gastropods were the most abundant animal items. *Chara* oögonia and vegetative branches, Chlorophyceae, and the fruits of *Scolochloa*, *Ranunculus*, *Scirpus*, and *Potamogeton* were among the more important plant items consumed by these summer-collected birds. Vegetative branches of *Chara* were almost the only item found in 16 fall-collected Redheads.

Animal material formed 99, 98, and 99 per cent, respectively, of esophageal contents in 71 summer-collected juvenile and adult female and male Lesser Scaup. Amphipods were particularly important to these diving ducks, but gastropods, Tendipedidae and Trichoptera larvae, corixids, and leeches were also used.

With the possible exception of adult male Canvasbacks that fed mainly upon tubers of *Potamogeton*, the three species of *Aythya* used animal material extensively throughout the summer. By fall, however, plant material formed the bulk of the diets of Canvasbacks and Redheads. Lesser Scaup probably maintain a diet high in animal material throughout the year. Juvenile Canvasbacks and Redheads consumed progressively greater quantities of plant material as they became older.

Trichoptera larvae with cases, Tendipedidae larvae, pupae, and adults, gastropods, amphipods, Ephemeroptera and Odonata nymphs, and corixids were among the most important animal items consumed by the three species of birds. The vegetative parts and fruits of *Potamogeton* and *Chara* were the most frequently consumed plant items; fruits of *Scirpus*, *Myriophyllum*, *Scolochloa*, *Chene-*

podium, and *Carex* were occasionally important to this group of birds.

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