beak while she pecks at the ground during "tidbitting" (directing the young to a morsel of food). I have also seen chicks (of a female White Leghorn × male Red Junglefowl) peck at the red comb and wattles of the White Leghorn hen during the brooding period; this sometimes caused the young to be tossed into the air.

Pecking occurs frequently in newly-hatched chicks (see also Nice 1962, Kruijt 1964, Hogan 1971). The adaptive significance (if any) of earlobe-pecking is unknown, but it seems reasonable to speculate that it improves the accuracy with which the young subsequently peck at food (cf. Hess 1956, Hailman 1967) and the efficiency with which they grasp food objects. This problem is open to laboratory and field investigation (Miller 1977) and may provide insight into our knowledge of the development of pecking preferences and feeding behavior (Hogan 1973a, 1973b, 1975; Fischer et al. 1975).

I thank Gilbert Gottlieb for making his facilities available to me. Milton Crowther kindly provided the junglefowl eggs from which the birds in this study originated. I also thank Linda Lach Miller for making the line drawings in Fig. 2. This study was funded by Research Grant HD-00878 from the National Institute of Child Health and Human Development.

LITERATURE CITED

DAWKINS, M. 1971. Perceptual changes in chicks: Another look at the 'search image' concept. Anim. Behav. 19:566–574.

FISCHER, G. J., G. L. MORRIS, AND J. P. RUHSAM. 1975. Color pecking preferences in White Leghorn chicks. J. Comp. Physiol. Psychol. 88:402–406.

HAILMAN, J. P. 1967. The ontogeny of an instinct: The pecking response in chicks of the Laughing Gull (*Larus atricilla* L.) and related species. Behaviour, Suppl. 15.

HESS, E. H. 1956. Space perception in the chick. Sci. Am. 195:71–80.

HOGAN, J. A. 1971. The development of a hunger system in young chicks. Behaviour 39:128–201.

HOGAN, J. A. 1973a. Development of food recognition in young chicks: I. Maturation and nutrition. J. Comp. Physiol. Psychol. 83:355–366.

HOGAN, J. A. 1973b. Development of food recognition in young chicks: II. Learned associations over long delays. J. Comp. Physiol. Psychol. 83: 367–373.

HOGAN, J. A. 1975. Development of food recognition in young chicks: III. Discrimination. J. Comp. Physiol. Psychol. 89:95–104.

KRUIJT, J. P. 1964. Ontogeny of social behaviour in Burmese Red Junglefowl (*Gallus gallus spadiceus*). Behaviour, Suppl. 12.

MCBRIDE, G., I. P. PARER, AND F. FOENANDER. 1969. The social organization and behaviour of the feral domestic fowl. Anim. Behav. Monogr. 2:125–181.

MILLER, D. B. 1977. Roles of naturalistic observation in comparative psychology. Am. Psychol. 32:211–219.

NICE, M. M. 1962. Development of behavior in precocial birds. Trans. Linn. Soc. N.Y. 8:1–211.

STOKES, A. W. 1971. Parental and courtship feeding in Red Jungle Fowl. Auk 88:21–29.

Psychology Laboratory, North Carolina Department of Mental Health, Box 7595, Dorothea Dix Hospital, Raleigh, North Carolina 27611. Accepted for publication 16 March 1977.

FOODS OF JUVENILE, BROOD HEN, AND POST-BREEDING PINTAILS IN NORTH DAKOTA

GARY L. KRAPU

AND

GEORGE A. SWANSON

The Pintail (*Anas acuta*) is a common to abundant nesting species in North Dakota, becoming more numerous during years of favorable water conditions and less so during drought. Stewart and Kantrud (1974) estimated breeding populations of 304,000, 111,000 and 379,000 pairs in the Prairie Pothole Region of North Dakota during 1967–69, respectively. We studied food habits of juvenile and adult Pintails during the brood-rearing and post-breeding periods in North Dakota to learn their food requirements during these phases of the life cycle. Food habits of flightless juveniles have been studied in Alberta (Sugden 1973) and limited information on downy Pintail ducklings has been reported from the Soviet Union (Dement'ev and Gladkov 1967). Published information is lacking on food habits of fledged juveniles, brood hens, and post-breeding adults during the summer months on the breeding grounds. Food habits of breeding Pintails in North Dakota have been described by Krapu (1974a, 1974b).

We collected juveniles, brood hens, and post-breeding hens while they fed in prairie wetlands of Stutsman, Barnes, and Logan counties of eastern North Dakota from June through August of 1969, 1970, and 1971. Hens were considered post-breeders when occurring in flocks during late spring and summer. Additional Pintails were collected during October 1976 on a wetland staging area in western Stutsman Co. A shotgun was used to collect birds feeding in natural wetlands and a municipal sewage lagoon. The digestive tract of each bird was removed immediately after collection and esophageal contents were flushed into a glass bottle containing 80% ethanol to minimize postmortem digestion. Volumetric measurements are presented by the aggregate percent method (Martin et al. 1946) and frequency of occurrence is given for each food item. We identified invertebrates and plant material with the aid of guides by Pennak (1953), Ward and Whipple (1959), and Martin and Barkley (1961). Esophageal contents were measured volumetrically by water displacement.

Animal foods formed 66% of the diet of 23 juvenile Pintails; dipterans accounted for 42% of the animal matter consumed and larvae of the family Chironomidae formed 99% of the total. Other dipteran families identified were Ceratopogonidae and Anthomyiidae. Snails ranked second in percent aggregate volume;

TABLE 1. Esophageal contents of 23 juvenile Pintails collected in eastern North Dakota during 1969 and 1970. Tr = trace.

Food item		Flightless (8)		Flying (15)	
Scientific name	Common name	Percent occurrence	Percent volume	Percent occurrence	Percent volume
PLANT					
Chlorophyceae	Filamentous algae (vegetative)	0	0.0	13	0.4
Potamogeton sp.	Pondweed (achenes)	13	0.1	7	6.5
Ruppia maritima	Widgeongrass (seeds)	0	0.0	27	26.2
Scolochloa festucacea	Whitetop (caryopses)	13	11.7	7	1.9
Hordeum jubatum	Wild barley (caryopses)	0	0.0	7	0.1
Beckmannia sp.	Sloughgrass (caryopses)	0	0.0	7	6.0
Eleocharis sp.	Spikerush (achenes)	0	0.0	7	tr
Scirpus sp.	Bulrush (achenes)	25	0.1	13	0.5
Carex sp.	Sedge (achenes)	13	tr	0	0.0
Lemna sp.	Duckweed (vegetative)	13	0.1	0	0.0
Rumex crispus	Curled dock (achenes)	0	0.0	20	0.6
Polygonum sp.	Smartweed (achenes)	25	4.0	13	tr
Chenopodium album	Lambsquarters (utricles)	25	1.9	0	0.0
Potentilla sp.	Cinquefoil (utricles)	13	0.9	0	0.0
Unidentified		13	0.1	20	0.7
Total plant matter		63	18.9	87	42.9
ANIMAL					
Hirudinea	Leeches	13	tr	20	6.7
Notostraca	Tadpole shrimp	13	3.2	0	0.0
Conchostraca	Clam shrimp	25	5.2	7	tr
Cladocera	Water fleas	0	0.0	13	6.7
Copepoda	Copepods	13	tr	0	0.0
Ostracoda	Seed shrimp	13	tr	0	0.0
Amphipoda	Scuds	13	tr	13	tr
Hydracarina	Water mites	0	0.0	20	0.7
Ephemeroptera	Mayflies	25	0.1	13	0.1
Odonata	Dragonflies & damselflies	25	0.5	0	0.0
Hemiptera	Bugs	13	5.6	20	0.3
Trichoptera	Caddisflies	25	0.1	13	1.5
Coleoptera	Beetles	62	6.1	47	1.8
Diptera	Flies, midges	75	11.4	67	39.0
Gastropoda	Snails	63	48.9	33	0.3
Total animal matter		100	81.1	80	57.1

principal snail genera in the diet were *Lymnaea, Helisoma, Physa,* and *Gyraulus.*

Aquatic invertebrates formed 81% of the diet of eight flightless juveniles (Table 1). Snails and dipteran larvae were the principal food items and accounted for 49 and 11% of the diet, respectively. Our food habits data on flightless juveniles generally support the findings of Sugden (1973). In Alberta studies, he reported invertebrates formed 67% of the diet during the prefledging period (dry weight basis) with snails and dipteran larvae and pupae accounting for 36 and 16% of the total, respectively. In the Soviet Union, Dement'ev and Gladkov (1967) reported that animal matter formed 80% of the diet of downy Pintail ducklings, with snails, midge larvae, dragonfly larvae, and small crustaceans being the chief food items. The high incidence of animal foods during early growth increases protein content in the diet which, according to Marshall (1951), increases the rate of growth in birds. Rapid growth presumably is advantageous because it reduces the length of the flightless period and thereby lowers vulnerability to predation. Invertebrates are a prime source of highly digestible protein (Krapu and Swanson 1975). Scott (1973) stated "The nutritional requirements during the starting period are higher than for any other period throughout the life of the bird."

Food selection by juvenile Pintails diversifies with growth. Pintails feed primarily on surface invertebrates during the first five days (Sugden 1973) but increasingly forage on benthos and plant foods, particularly seeds in shallow wetlands. Dabbling and tipping become the commonest feeding positions as juveniles grow; both are often used for removing midge larvae from the detritus and sediments of pond bottoms. Although Pintails dive to obtain food under certain conditions (Chapman et al. 1959, Bourget and Chapdelaine 1975), we never saw adults or ducklings do so in natural habitat in North Dakota. Smith (1966) noted that breeding Pintails in Alberta did not dive during observations there.

Pintail brood observations were most frequent in flooded stands of whitetop (*Scolochloa festucacea*). Collias and Collias (1963) presented data showing that larvae of the family Tendipedidae (Chironomidae) were most abundant in stands of whitetop of eight genera of aquatic plants sampled at the Delta Waterfowl Research Station. Cladocera occurred only in esophageal samples from birds collected on the Jamestown municipal sewage lagoon. Both flightless and flying immature Pintails fed upon the abnormally high

TABLE 2. Esophageal contents of brood and post-breeding hens collected in eastern North Dakota during 1969–1971.

Food item		Brood (5)		Post-breeding (7)	
Scientific name	Common name	Percent occurrence	Percent volume	Percent occurrence	Percent volume
PLANT					
Sagittaria sp.	Arrowhead (seeds)	20	0.2	0	0.0
Glyceria sp.	Mannagrass (caryopses)	20	2.2	0	0.0
Scolochloa festucacea	Whitetop (caryopses)	20	0.5	0	0.0
Hordeum jubatum	Wild barley (caryopses)	20	14.0	14	0.3
Beckmannia syzigachne	Sloughgrass (caryopses)	20	5.9	0	0.0
Eleocharis sp.	Spikerush (achenes)	20	5.0	0	0.0
Scirpus sp.	Bulrush (achenes)	20	0.4	71	11.5
Carex sp.	Sedge (achenes)	20	0.6	14	0.0
Juncus sp.	Rush (achenes)	20	tr	0	0.0
Rumex crispus	Curled dock (achenes)	20	1.0	14	0.1
Ceratophyllum demersum	Coontail (achenes)	20	0.5	0	0.0
Distichlis stricta	Saltgrass (grains)	0	0.0	29	3.6
Ruppia maritima	Saltwater widgeongrass (seeds)	0	0.0	14	11.2
Chenopodium album	Lambsquarters (utricles)	0	0.0	14	tr
Phalaris arundinacea	Reed canarygrass (grains)	0	0.0	14	0.2
Zannichellia palustris	Horned pondweed (seeds)	0	0.0	14	0.5
Polygonum sp.	Smartweed (achenes)	0	0.0	14	tr
Echinochloa crusgalli	Wild millet (grains)	0	0.0	29	11.2
Ambrosia sp.	Ragweed (achenes)	0	0.0	14	tr
Triticum aestivum	Wheat (grains)	0	0.0	14	0.6
Setaria glauca	Yellow foxtail (grains)	0	0.0	14	2.5
Unidentified		0	0.0	29	12.1
Total plant matter		80	30.3	86	53.8
ANIMAL					
Hirudinea	Leeches	20	3.2	0	0.0
Hydracarina	Water mites	0	0.0	14	0.8
Conchostraca	Clam shrimp	20	1.7	43	12.3
Trichoptera	Caddisflies	0	0.0	14	0.1
Hemiptera	Bugs	20	0.3	0	0.0
Coleoptera	Beetles	60	3.0	43	4.4
Diptera	Flies, midges	80	33.3	43	14.6
Gastropoda	Snails	60	28.2	29	14.0
Total animal matter		100	69.7	86	46.2

densities of Cladocera occurring there during late summer and early autumn.

Immature Pintails that had reached flight stage consumed a diet of 57% animal matter (Table 1). Midge larvae (Chironomidae) were the chief animal food consumed; snail intake was insignificant. Widgeongrass (*Ruppia maritima*) was the principal plant food and formed 26% of the diet. Both flying immatures and adults fed principally on the seeds and seed stalks of this plant when foraging in saline wetlands. Saline wetlands with extensive beds of widgeongrass serve as important staging areas for this species from August to October. Widgeongrass formed 99% of the esophageal contents of six Pintails (five drakes, one hen) collected on a saline wetland staging area in south-central North Dakota in early October 1976; damselfly nymphs (Odonata) and water boatman (Hemiptera) formed the remaining 1%. Pintails commonly use saline wetlands during autumn. The presence of large subcutaneous and visceral lipid reserves in specimens collected while feeding in saline wetlands during early fall suggests that widgeongrass nourishes birds preparing for fall migration.

The diet of brood hens was similar to that of ducklings feeding in similar habitat. Animal foods formed approximately 70% of the esophageal contents of brood hens; snails and midge larvae accounted for 88% of the animal matter consumed (Table 2). The high proportion of animal matter in the diet may reflect, in part, high protein demands associated with feather replacement. All brood hens were in heavy body molt when collected. Because reproductive status was based upon association with a brood, these data would reflect only foods taken in brood habitat. The proportion of animal matter in the diet of Pintail brood hens was markedly above levels reported during the post-laying period when only 29% was of animal origin but was quite similar to the laying period when invertebrates comprised 77% of the diet based on data presented by Krapu (1974a).

Post-breeding hens consumed approximately equal proportions of plant and animal foods (Table 2). Consumption of bulrush (*Scirpus* sp.) achenes, widgeongrass seeds, wild millet (*Echinochloa crusgalli*) grains, and wheat (*Triticum aestivum*) grains reflect divergent habitat use. Post-breeding hens were collected in late May and June after apparent abandonment of nesting but prior to loss of flight feathers.

With the growth of cereal grain farming during the past century, the diet of post-breeding Pintails has changed markedly in North Dakota and elsewhere in the Prairie Pothole Region. Bossenmaier and Marshall (1958) cited information suggesting that field-feeding by Pintails and other waterfowl in southern Manitoba

first became intense during the 1920's as birds began to shift from aquatic habitat to cropland to feed. Wheat and other cereal grains are now an integral part of the diet of this species particularly during autumn. Agricultural tillage has also affected diet composition in wetland habitat. Krapu (1974b) reported that wild millet (barnyard grass) formed 71% of the diet of breeding Pintail hens feeding in tilled basins. This annual grass is a dominant species in annually tilled wetland basins. Grains of wild millet are eaten from spring through fall during periods when tilled basins are flooded.

We thank Mavis I. Meyer for assistance in preparing food habits data and Jerome R. Serie for critically reviewing the manuscript.

LITERATURE CITED

BOSSENMAIER, E. F., AND W. H. MARSHALL. 1958. Field-feeding by waterfowl in southwestern Manitoba. Wildl. Monogr. No. 1.

BOURGET, A., AND G. CHAPDELAINE. 1975. Diving by wintering puddle ducks. Wildfowl 26:55–57.

CHAPMAN, S., B. KING, AND N. WEBB. 1959. Pintails diving. Br. Birds 52:60.

COLLIAS, N. E., AND E. C. COLLIAS. 1963. Selective feeding by wild ducklings of different species. Wilson Bull. 75:6–14.

DEMENT'EV, G. P., AND N. A. GLADKOV [Eds.] 1967. Birds of the Soviet Union. Vol. 4. (Transl. from Russian). Israel Program for Sci. Transl. Jerusalem.

KRAPU, G. L. 1974a. Feeding ecology of pintail hens during reproduction. Auk 91:278–290.

KRAPU, G. L. 1974b. Foods of breeding pintails in North Dakota. J. Wildl. Manage. 38:408–417.

KRAPU, G. L., AND G. A. SWANSON. 1975. Some nutritional aspects of reproduction in prairie nesting pintails. J. Wildl. Manage. 39:156–162.

MARSHALL, A. J. 1951. Food availability as a timing factor in the sexual cycle of birds. Emu 50:267–282.

MARTIN, A. C., AND W. D. BARKLEY. 1961. Seed identification manual. Univ. Calif. Press, Berkeley.

MARTIN, A. C., R. H. GENSCH, AND C. P. BROWN. 1946. Alternative methods in upland gamebird food analysis. J. Wildl. Manage. 10:8–12.

PENNAK, R. W. 1953. Fresh-water invertebrates of the United States. Ronald Press, New York.

SCOTT, M. L. 1973. Nutrition in reproduction—direct effects and predictive functions, p. 46–59. *In* D. S. Farner [ed.], Breeding biology of birds. Natl. Acad. Sci., Washington, D.C.

SMITH, R. I. 1966. [Review of] *Handbook of Waterfowl Behavior* by Paul A. Johnsgard. Wilson Bull. 78:483–484.

STEWART, R. E., AND H. A. KANTRUD. 1974. Breeding waterfowl populations in the Prairie Pothole Region of North Dakota. Condor 76:70–79.

SUGDEN, L. G. 1973. Feeding ecology of pintail, gadwall, American widgeon and lesser scaup ducklings in southern Alberta. Can. Wildl. Serv. Rep. Ser. No. 24.

WARD, H. B., AND G. C. WHIPPLE. 1959. Fresh-water biology. W. Edmondson [ed.], John Wiley and Sons, New York.

U.S. Fish and Wildlife Service, Northern Prairie Wildlife Research Center, Jamestown, North Dakota 58401.
Accepted for publication 5 July 1977.

TICKS AS A FACTOR IN NEST DESERTION OF CALIFORNIA BROWN PELICANS

KIRKE A. KING
JAMES O. KEITH
CHRISTINE A. MITCHELL
AND
JAMES E. KEIRANS

In 1975, heavy infestations of ticks (*Ornithodoros capensis*) caused Brown Pelicans (*Pelecanus occidentalis*) in Texas to desert their nests and to abandon their colony (King et al. 1977). This finding stimulated us to investigate whether *Ornithodoros* ticks could also be affecting pelican reproduction at our other study area in the Gulf of California, where we have frequently observed nest desertion. We report here that *O. denmarki*, a species closely related to *O. capensis*, does infest Brown Pelicans on Isla San Lorenzo Norte, and may have contributed to nest desertion during 1976.

Isla San Lorenzo Norte is in the Gulf of California, Mexico (28°42'N, 112°56'W) between the islands of Salsipuedes and San Lorenzo. The Brown Pelican breeding colony there is one of the largest in North America: in 1970 we estimated that the colony contained 16,000 nests.

In 1974 and 1975, observers and crews banding young pelicans reported seeing ticks on the ground near nesting sites. Although no pelicans were thoroughly examined, ticks were not observed on the 7,340 young birds banded between 1970 and 1975. An intensive search for ticks in pelican nesting areas was not made until 1976, when ticks were collected between 5 and 15 April. In order not to disturb nesting pelicans, we searched for ticks only in canyons where pelicans had nested in previous years. We found adults and nymphs in every major canyon where pelicans had nested in 1975. They also were present in one canyon where birds had nested in 1974, but not in 1975 and 1976. Ticks were most easily collected from beneath the larger rocks near pelican nests, but were found also in pelican nest material and in litter beneath old nests. In previous seasons, tick numbers must have reached high levels in individual nests, as over 100 exoskeletons were present in the litter under many nests. Live ticks were most abundant in lower portions of drainages that emptied into the ocean; they were least numerous in the higher elevations of interior canyons.

Larvae raised from adult ticks collected from Isla San Lorenzo Norte were identified as *O. denmarki*. This species has been recorded in several areas along the Pacific Coast of North America including Islas Rasa and Calaveras, Gulf of California, Mexico (Kohls et al. 1965). A closely related species in the genus *Ornithodoros*, but not true *O. denmarki*, has been found at two locations in Oregon (Clifford et al. 1970, Radovsky et al. 1976) and in California (Marshall and