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FLIGHT RANGES AND LIPID DYNAMICS OF MALLARDS WINTERING ON THE SOUTHERN HIGH PLAINS OF TEXAS

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Abstract.—Lipid dynamics in Mallards (*Anas platyrhynchos*) wintering on the Southern High Plains of Texas were examined in relation to the energy demands of retreat flights that might be made during adverse local conditions (cold temperatures, food shortages, frozen water surfaces). We conclude that the endogenous lipid reserves offer sufficient energy for flights of at least 620 km for all Mallards and for flights of more than 1850 km for most Mallards wintering on our study area. These flight distances enable Mallards to reach alternative wintering habitat in Texas.

EXTENSIÓN DE LOS VUELOS Y DINÁMICA DE LOS LÍPIDOS DE PATOS INGLESES (*ANAS PLATYRHYNCHOS*) QUE PASAN EL INVIERNO EN SOUTHERN HIGH PLAINS, TEXAS

Resumen.—La dinámica de lípidos en patos ingleses (*Anas platyrhynchos*) que pasan el invierno en las planicies altas del sur de Texas, fueron examinados en relación a las demandas energéticas de vuelos de retroceso que pueden hacerse durante condiciones locales adversas (temperaturas frias, escasez de alimento, superficie de cuerpos de agua congelados). Se concluyó que reservas endógenas de lípidos, ofrecen suficiente energía a los patos para volar al menos 620 km y para la mayoría de las aves en vuelos de mas de 1850 km. Estas distancias permiten a los patos ingleses alcanzar con facilidad otros hábitats de invierno disponibles para estas aves en Texas.

Waterfowl wintering on the Southern High Plains of Texas apparently exhibit marked changes in flock composition and movements relative to prevailing cold weather and associated thermal stress (Alford and Bolen 1977, Bennett and Bolen 1978, Obenberger 1982). Mallards (*Anas platyrhynchos*) wintering on the Southern High Plains feed in fields on waste grain (Baldassarre et al. 1983, Baldassarre and Bolen 1984); the large winter population normally reaches peak numbers in November and February (Obenberger 1982). A good deal also is known about the body weights, energy reserves, and carcass-composition dynamics of Mallards wintering on the Southern High Plains (Whyte et al. 1986). In this paper, we estimate the flight ranges and associated lipid dynamics of Mallards, relative to the retreat flights Mallards might undertake when faced with cold fronts and local low temperatures, frozen lake surfaces and snow-covered feeding areas.

METHODS

Mallards were collected between October and March 1979–1980, 1980–1981, and 1981–1982. However, we present data only for those Mallards

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collected between 8 Jan. and 9 Feb., the period of coldest weather during each year of our study (Whyte 1983). Mean maximum and minimum temperatures during the period were 9° C (range: 23° to −12° C) and −7° C (range: 4° to −18° C), respectively. See Bolen and Guthery (1982) for a full description of playa lakes and the study area.

Birds were shot, aged using standard techniques (Hochbaum 1942, Krapu et al. 1979), plucked and frozen. The bill and feet were discarded from thawed birds and the carcass homogenized twice through a meat grinder using a 5-mm sieve plate. Lipid content of the homogenate was determined by a 4-h Soxhlet extraction using petroleum ether. Neutral lipids represent the major energy store of the body (Blem 1976) and measurement of those stores is an indicator of body condition. All Mallards were assigned to a Lipid Index Category = total body lipid (g)/wing length (mm), thus comparing body condition of birds within and between age-sex classes while accounting for structural variation.

Body weight was used to calculate Basal Metabolic Rate (BMR) using Prince's (1979) equation for Mallards ($BMR = 87.9W^{0.734}$). We determined Flight Energy Rate using Prince's (1979) calculation for Mallard flight costs = 12 × Basal Metabolic Rate. Similarly, Berger et al. (1971) estimated the metabolic rate of flight for Black Ducks (*Anas rubripes*), an anatid similar to the Mallard, as 14 times the resting metabolic rate. To determine Carcass Energy Reserves we multiplied the mean fat level by 9.0 kcal, the amount of energy yielded when 1 g avian lipid is oxidized (Ricklefs 1974). Next, we estimated Flight Hours by dividing Carcass Energy Reserves by Flight Energy Rate. Finally, Flight Range was determined by multiplying Flight Hours by the flight speed of a duck, 64 km/h (Tucker and Schmidt-Koenig 1971).

Our estimates of lipid loss associated with 500- and 1000-km flights were determined as follows: Flight Energy Rate was multiplied by the flight time to go 500 km (7.8 h) and 1000 km (15.6 h) at 64 km/h. This resulting product was divided by 9.0 to determine grams of lipid needed to fly each distance, respectively. The quotient was subtracted from the amount of original lipid, thus giving the lipid remaining upon arrival.

RESULTS AND DISCUSSION

Hypothetically, Mallards wintering on the Southern High Plains of Texas are capable of flying at least 600 km if in Poor–Fair condition, 1800 km in Good condition and 2400 km in Excellent condition (Table 1). Most Mallards thus have the lipid stores necessary for fairly lengthy flights to escape adverse conditions. Adult hens, with a low Basal Metabolic Rate and substantial lipid stores, showed the greatest ranges for each condition category. Presumably, only diseased individuals or those in the Poor–Fair category with extremely low endogenous lipids—less than 10 g lipid on a living Mallard has been reported (Whyte et al. 1986)—would not be able to fly very far. These flight ranges allowed us to establish the maximum distances Mallards in any of the three condition

TABLE 1. Mean body weights (g, ±SD), Basal Metabolic Rates (BMR, kcal/h), mean carcass lipid level (g, ±SD) and flight ranges (km) for Mallards classified by Lipid Index Categories.

Age-sex class and Lipid Index Category	*N*	Mean body weight (g)	Basal metabolic rate (kcal/h)	Mean carcass lipid level (g)	Flight range (km)
Adult drake					
Poor–Fair	12	1078 ± 87	3.87	56 ± 24	698
Good	48	1231 ± 84	4.26	164 ± 26	1856
Excellent	25	1314 ± 87	4.81	242 ± 25	2413
Adult hen					
Poor–Fair	5	922 ± 106	3.45	65 ± 30	902
Good	20	1066 ± 63	3.84	156 ± 20	1946
Excellent	16	1165 ± 76	4.09	225 ± 24	2637
Juvenile drake					
Poor–Fair	4	1094 ± 38	3.91	66 ± 39	813
Good	5	1132 ± 87	4.01	159 ± 11	1901
Excellent	9	1312 ± 69	4.46	225 ± 14	2419
Juvenile hen					
Poor–Fair	6	818 ± 61	3.16	41 ± 20	621
Good	8	1050 ± 46	3.79	152 ± 32	1920
Excellent	4	1145 ± 80	4.04	214 ± 19	2541

categories could fly before exhausting total body lipids, even though we assume these extremes rarely are approached by free-living Mallards.

We also determined the flight costs in terms of lipid depletion and the lipid reserves that would remain following flight distances of 500 and 1000 km (Table 2). These distances are realistic in relation to available wetland habitat for Mallards leaving the Southern High Plains and moving elsewhere. For example, the 500-km flight is representative of the distance to the flood-prevention lakes described by Hobaugh and Teer (1981). Similarly, the 1000-km distance represents a flight to the Texas Gulf Coast, a region of extensive wintering habitat (Bellrose 1976).

Mallards in each condition category are capable of flying 500 km to north-central Texas and having lipids remaining after the flight. In the case of Poor–Fair birds, lipid reserves would be low on arrival, but Mallards in other categories would have 100 g lipid or more to survive in their new habitat or continue farther. Based on estimates from endogenous lipids alone, none of the Poor–Fair Mallards could make the 1000-km trip to the Gulf Coast. Those in Good condition would arrive with adequate lipids for survival, about 75 g for each age-sex class. Those in Excellent condition could reach the coastal wetlands and still possess at least 130 g lipid.

Therefore, based on our sample of Mallards from the coldest time of

TABLE 2. Estimates of carcass lipid losses (g) after 500-km and 1000-km direct flights and the amount of lipid remaining (g) upon arrival for Mallards by Lipid Index Categories.

Age-sex class and lipid index category	Lipid loss during 500-km flight (g)	Remaining lipid (g)	Lipid loss during 1000-km flight (g)	Remaining lipid (g)
Adult drake				
Poor–Fair	40[a]	16	80[a]	−24
Good	44	124	88	76
Excellent	50	192	100	142
Adult hen				
Poor–Fair	36	29	72	−7
Good	40	116	80	76
Excellent	42	183	84	141
Juvenile drake				
Poor–Fair	41	25	82	−16
Good	42	117	84	75
Excellent	46	179	92	133
Juvenile hen				
Poor–Fair	33	8	66	−25
Good	39	113	78	74
Excellent	42	172	84	130

[a] Calculated from mean carcass lipid levels in Table 1.

the winter, 86% and 88% of adult drakes and hens, respectively, could leave the Southern High Plains and reach the coast in a single flight if necessary. Likewise, 76% and 67% of juvenile drakes and hens, respectively, could make the flight and arrive with adequate energy reserves. We believe these estimates for non-stop 500- and 1000-km flights are realistic, especially since Calverley and Boag (1977) calculated flight costs of pintails for a 1925-km non-stop flight from the Canadian parklands to the Arctic. Similarly, Vangilder et al. (1986) reported that Brant (*Branta bernicla*) experience an energetic cost of 323 g of fat during a migratory flight totalling 2820 km. The route and energetic costs for the brant were analyzed in three segments, but food resources are not available until the birds begin the last 1429 km of flight. The earlier segments included costs of 55 g of fat for 483 km and 104 g for 908 km of travel.

Cold fronts moving onto the Southern High Plains cause low ambient temperatures and freeze the surface of playa lakes, and accompanying snowstorms render waste corn unavailable to waterfowl (Baldassarre et al. 1986, Whyte and Bolen 1984). It is widely acknowledged that some individuals undergo retreat flights when faced with these conditions (Alford and Bolen 1977, Bennett and Bolen 1978, Obenberger 1982). Whereas Mallards tend to be less mobile than other species (Obenberger 1982), nevertheless some individuals do undertake retreat flights. Mean lipid levels for adult Mallards collected before and after a December 1980 cold front were 77 g and 32 g lower after the front for drakes and hens respectively (Whyte and Bolen 1984). Compared to the lipid loss during a 500-km flight, 40–50 g for adult drakes and 36–42 g for adult hens (Table 2), we suggest retreating 500 km or sitting out a cold front are energetically equivalent strategies. Movements of 1000 km south to the Texas coast would be energetically costly compared to sitting out adverse conditions and would probably be undertaken only in extreme circumstances.

In conclusion, Mallards wintering on the Southern High Plains of Texas during the coldest time of the year possess enough endogenous lipids for flights to other wetland habitat (e.g., at least to flood-prevention lakes in north-central Texas). Also, most of the wintering flock—those in Good or Excellent condition—have the energy stores necessary for longer flights (e.g., to Gulf Coast wetlands). When faced with cold, reduced food availability, or frozen surface water, the Mallards of the Southern High Plains can easily undergo retreat flights to wetlands elsewhere in Texas.

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ERRATUM

Parkes, K. C. 1988. A brown-eyed adult Red-eyed Vireo specimen. J. Field Ornithol. 59: 60–62.

The last sentence on page 60 should read: The symmetry of the rectrix molt in this bird, and its coincidence in timing with the molt of other tracts, indicated that the growing tail feathers did not represent replacement of adventitiously lost rectrices; such adventitious loss is seldom symmetrical unless all tail feathers are lost, in which case the regrowth is simultaneous rather than staggered.