

BODY COMPOSITION AND DIET OF BREEDING FEMALE COMMON CROWS¹

ANDREW D. YOUNG

*Ecology and Evolution Group, Department of Zoology, University of Western Ontario,
London, Ontario N6A 5B7, Canada*

Abstract. I collected female Common Crows (*Corvus brachyrhynchos*) during rapid follicle growth (RFG), egg-laying, incubation, and nestling periods to see whether they used stored nutrient reserves to supplement dietary intake during these stages. Body fat did not change systematically during RFG and laying. Body protein increased during RFG and decreased during laying. Female crows appeared to store fat during incubation and to use it during the brood-rearing period. Based on gizzard contents, female crows ate mostly wheat and small rodents throughout breeding.

Key words: *Corvus brachyrhynchos*; nutrition; diet; reserves; reproduction.

INTRODUCTION

Reproduction in birds imposes a nutritional cost above maintenance requirements in order to produce eggs and provide heat and food to developing offspring during incubation and brood rearing, respectively (Walsberg 1983). Birds can make more nutrients available for these activities by increasing dietary intake, reducing allocation to other activities, using stored nutrient reserves, or any combination of these mechanisms (Murphy and King 1985). Nutrient reserves can be built up in expectation of an increase in nutritional demand, or a decrease in food supply or time to acquire food. To produce eggs, birds may rely almost exclusively on stored nutrients (Ankney and MacInnes 1978), may obtain all nutrients from the diet (Ankney and Scott 1980) or use a combination of these mechanisms (Hails and Turner 1985). During incubation, precocial waterfowl utilize stored fat and protein reserves and sometimes leave the nest at hatching with very little of either (Ankney and MacInnes 1978). In contrast, altricial Red-billed Queleas (*Quelea quelea*) store fat during incubation and use it during the nestling period (Jones and Ward 1976).

I wanted to know if female Common Crows (*Corvus brachyrhynchos*; hereafter referred to as crows) used stored nutrients to compensate for the increased demands of reproduction. Nutrient reserves may be important to breeding crows. Hooded Crow (*Corvus corone cornix*) females in

good condition (heavy relative to their size) breed earlier than those in poor condition (Loman 1984).

STUDY AREA AND METHODS

Twenty breeding female crows were collected from 10 April to 29 May 1987 in southwestern Saskatchewan from an area west of Weyburn. Most of the land in this area was cultivated with wheat. Crows nested in small and patchily distributed woodlots separated by wide expanses of cultivated field. Birds were not collected in the same area twice to avoid resampling a local population. Females were killed with a shotgun while on or near the nest or by the roadside. Only birds in pairs were collected.

Freshly killed birds were weighed with a Pesola scale to the nearest 5 g. Ovaries were removed and placed in formalin. Any oviducal eggs or nest eggs were removed, hard boiled, and frozen. Esophagi were examined but none contained food. Carcasses were frozen for later analysis.

In the laboratory, I made four measurements on thawed carcasses to account for differences in structural size. Body length and wing chord were measured to the nearest mm with a ruler, and tarsus and keel length were taken to the nearest 0.1 mm with calipers. A principal components analysis of the variance-covariance matrix of these measures produced a first principal component axis that was a general size component as all loadings were positive ranging from 0.37 to 0.65 (Pimental 1979), explaining 52.5% of the variation in structural size. The scores from this axis were used as a dependent variable in all

¹ Received 9 December 1988. Final acceptance 27 April 1989.

regression models to remove variation due to structural size.

Contents of the gizzard were removed and later examined for food habits. Gizzard contents are biased towards finding hard tissue (Swanson and Bartonek 1970) and therefore can only be used as an index of food types (Ankney and Scott 1980). The oviduct was removed, dried to constant weight (90°C), and then discarded. The carcass was ground twice through a Hobart meat grinder. I took a ca. 130-g subsample and dried it to constant weight. This dried subsample was homogenized once more in the meat grinder. Two 3- to 5-g aliquots were then placed in separate cellulose extraction thimbles, and lipids were extracted for 6 hr using petroleum ether as a solvent in a modified Soxhlet apparatus. These lean dry samples were then ashed in a muffle furnace at 550°C for 6 hr, leaving the amount of ash in the sample. The percentage of fat, ash, and ash-free lean dry weight (hereafter referred to as body protein) in the sample was obtained by subtraction, and values for the separate thimble samples were averaged. Dry body weight was estimated by multiplying the ratio of dry tissue in the 130-g subsample by the weight of the ground carcass. The total grams of body fat, ash, and protein was obtained by multiplying the ratio of each component in the thimble sample by dry body weight.

I estimated the total number of days females had committed to reproduction (nest days) by assuming that they developed one ovarian follicle a day (Ricklefs 1974) and laid one egg per day. Days spent incubating were estimated by examining embryo development and applying waterfowl development rates (Caldwell and Snart 1974) to the 18-day incubation period of crows (Emlen 1942). Days spent rearing nestlings were estimated by relating the weight of the largest young to the growth curve of nestling Carrion Crows (*Corvus corone*; Yom-Tov 1974). Both species have similar adult body weights and nestling periods (Bent 1946).

During egg formation, body reserves may be used to form the fat, protein, and mineral components of eggs. In order to help evaluate the relationship between body components and egg components, I calculated the amount of fat, protein, and dry shell in ovary, oviduct, and oviducal eggs (after Alisauskas and Ankney 1985) using the same procedure as for body tissue except that the entire sample was used. For eggs laid, the amount of fat, protein, and shell in-

vested was estimated by multiplying the number of eggs laid (as determined by postovulatory follicles) by the average amount of these components calculated for 12 fresh eggs from nests.

I performed univariate linear and curvilinear regressions of body components on nest days for RFG and laying periods and the incubation and nestling periods separately. During the egg-formation stages, I also performed these same regressions using the corresponding reproductive tissue as an independent variable (e.g., body fat on reproductive fat) instead of nest days. Probability levels were those associated with type III sums of squares given for linear models for the dependent variable and for curvilinear models for the dependent variable and dependent variable squared. For cases where none of the dependent variable(s) explained a significant proportion of variation, I reported only the lowest probability, all others were higher. Coefficient of determination estimates were adjusted for structural size.

RESULTS

Dry body weight of female crows did not change significantly with nest days during egg formation, or incubation and nestling periods (P 's > 0.10; Fig. 1). There was no systematic change in body fat in relation to nest days ($P = 0.21$; Fig. 1) or reproductive fat ($P = 0.83$). The drop in body fat from RFG to laying was difficult to interpret. The two females with the least amount of body fat in Figure 1 were also the latest to begin laying. Both these females initiated RFG about 40 days after the first female had and 13 days after the next latest females (average initiation was day 20.5). There was no difference in the results of regression analyses with or without these females. Later nesting females may have initiated RFG with less body fat.

Females stored protein reserves during RFG when mostly fat was being added to the follicles and used this protein during egg laying when albumen (egg protein) was being laid down. There was a strong curvilinear relationship between body protein and nest days (Fig. 1; $r = 0.82$; $P = 0.01$; $P = 0.007$) and an even stronger relationship with reproductive protein ($r = 0.90$; $P = 0.002$; $P = 0.001$). Crows did not rely on stored calcium to form eggshells as there was no relationship between body ash and nest days or clutch shell (P 's > 0.20).

Regression models indicated that body fat and

protein did not change during incubation and brood-rearing periods (P 's > 0.17 ; Fig. 1). However the power of these tests was low due to a small sample size ($n = 10$). There was a trend of increasing body fat during incubation and a decrease during the nestling period (Fig. 1).

Of the 20 breeding crows collected, 17 had food in their gizzards, of which 13 contained either wheat (2), mice (2), or both (9). Contents of the remaining gizzards were: insects and wheat (2); egg, mice, and wheat (1); and egg and wheat (1). Female crows most commonly relied on a diet of wheat and mice.

DISCUSSION

Protein reserves are used during laying in some passerine species (Jones and Ward 1976, Fogden and Fogden 1979) while in others reserves are not used (Ankney and Scott 1980, Hails and Turner 1985, Krementz and Ankney 1988). When protein use has been documented, the pattern is one of a gradual decline from the beginning of RFG through laying. Crows are different because they store protein during RFG when little protein is being committed to eggs, and then use these reserves apparently to add albumen to eggs. Rodents are an excellent source of protein for crows so why do they store protein? Female crows may need to stay close to the nest once laying begins in order to guard their eggs, compromising their foraging range and ability to acquire protein with the specific amino acids needed to form eggs. Laying female Mallards (*Anas platyrhynchos*) need protein and the essential amino acids they provide to produce a normal-sized clutch of viable eggs (Eldridge and Krapu 1987).

During egg formation, body fat is not used to supplement a dietary intake of wheat (76% carbohydrate; Krapu 1979) and lipid-rich rodents (Millar 1987), apparently adequate sources of energy. Body fat may increase during RFG and decrease during laying in early nesting females but the sample size is too small. This type of cycle in body fat occurs in some passerines (Jones and Ward 1976, Fogden and Fogden 1979, Krementz and Ankney 1988) and if it occurs in early nesting crows, it could supplement dietary intake in a manner similar to protein reserves.

Female crows may store fat during incubation and deplete this store during the nestling period. This pattern occurs in Red-billed Queleas in Africa (Jones and Ward 1976). Male crows may help females put on body fat by incubating (Bent

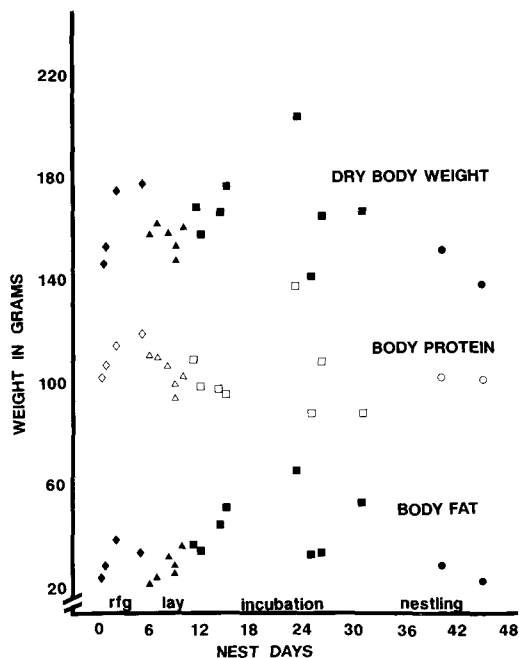


FIGURE 1. Changes in dry body weight, protein, and fat during breeding in female Common Crows. The observations extend only until the middle of the nestling period.

1946) and allowing females to forage, or by feeding females while they are incubating (Skutch 1962). The extent of body fat use is underestimated in this study because my data extend only to midway through the nestling period. Energy requirements of foraging adult crows increase during the nestling period and are greatly elevated during the last half of the period when nestling food requirements are highest (Yom-Tov 1974).

Rodent bones may provide the calcium needed to form eggshells. Sandpipers eat lemming bones, presumably for the same reason (Maclean 1974).

ACKNOWLEDGMENTS

I thank my wife Vicki for field assistance. Dave Ankney provided financial support through a Natural Sciences and Engineering Research Council of Canada grant and improved this note with helpful comments.

LITERATURE CITED

- ALISAUSKAS, R. T., AND C. D. ANKNEY. 1985. Nutrient reserves and the energetics of reproduction in American Coots. *Auk* 102:133-144.
- ANKNEY, C. D., AND C. D. MACINNES. 1978. Nutrient reserves and reproductive performance of female Lesser Snow Geese. *Auk* 95:459-471.
- ANKNEY, C. D., AND D. M. SCOTT. 1980. Changes in

- nutrient reserves and diet of breeding Brown-headed Cowbirds. *Auk* 97:684-696.
- BENT, A. C. 1946. Life histories of North American jays, crows and titmice. U.S. Natl. Mus. Bull. No. 191.
- CALDWELL, P. J., AND A. E. SNART. 1974. A photographic index for aging Mallard embryos. *J. Wildl. Manage.* 38:298-301.
- ELDRIDGE, J. L., AND G. L. KRAPU. 1987. The influence of diet quality on clutch size and laying pattern in Mallards. *Auk* 105:102-110.
- EMLEN, J. T. 1942. Notes on a nesting colony of Western Crows. *Bird-Banding* 13:143-154.
- FOGDEN, M.P.L., AND P. M. FOGDEN. 1979. The role of fat and protein reserves in the annual cycle of the Grey-backed Camaroptera in Uganda (Aves: Sylviidae). *J. Zool. (Lond.)* 189:233-258.
- HAILS, C. J., AND A. K. TURNER. 1985. The role of fat and protein during breeding in the White-bellied Swiftlet (*Collocalia esculenta*). *J. Zool. (Lond.)* 206:469-484.
- JONES, P. J., AND P. WARD. 1976. The level of reserve protein as the proximate factor controlling the timing of breeding and clutch-size in the Red-billed Quelea *Quelea quelea*. *Ibis* 118:547-574.
- KING, J. R., AND M. E. MURPHY. 1985. Periods of nutritional stress in the annual cycles of endotherms: Fact or fiction? *Am. Zool.* 25:955-964.
- KRAPU, G. L. 1979. Nutrition of female dabbling ducks during reproduction, p. 59-70. *In* T. A. Bookout [ed.], *Waterfowl and wetlands: an integrated review*. La Crosse Printing, La Crosse, WI.
- KREMENTZ, D. G., AND C. D. ANKNEY. 1988. Changes in the lipid and protein reserves and in diet of breeding House Sparrows. *Can. J. Zool.* 66:950-956.
- LOMAN, J. 1984. Breeding success in relation to parent size and experience in a population of the Hooded Crow. *Ornis. Scand.* 15:183-187.
- MACLEAN, S. F. 1974. Lemming bones as a source of calcium for Arctic Sandpipers (*Calidris* spp.). *Ibis* 116:552-557.
- MILLAR, J. S. 1987. Energy reserves in breeding small rodents. *Symp. Zool. Soc. (Lond.)* 57:231-240.
- PIMENTAL, R. A. 1979. *Morphometrics: the multivariate analysis of biological data*. Kendall and Hunt Publishing Company, Dubuque, IA.
- RICKLEFS, R. E. 1974. Energetics of reproduction in birds. *Nuttall Ornithol. Club Publ.* 15:152-292.
- SKUTCH, A. F. 1962. The constancy of incubation. *Wilson Bull.* 74:115-152.
- SWANSON, G. A., AND J. C. BARTONEK. 1970. Bias associated with food analysis in gizzards of Blue-winged Teal. *J. Wildl. Manage.* 34:739-746.
- WALSBERG, G. E. 1983. Avian ecological energetics, p. 161-220. *In* D. S. Farner, J. R. King, and K. C. Parkes [eds.], *Avian biology*. Vol. 7. Academic Press, New York.
- YOM-TOV, Y. 1974. The effect of food and predation on breeding density and success, clutch size and laying date of the Crow (*Corvus corone* L.). *J. Anim. Ecol.* 43:479-498.