A Safe and Accurate Method for Force-feeding Small Granivorous Birds

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Many questions in avian nutrition can be examined most effectively by experimentally restricting or enhancing food intake or the intake of specific nutrients. It is usually easy to restrict intake merely by rationing the diet. In many large birds or those with capacious crops it may also be easy to enhance the delivery of nutrients with an esophageal cannula or tube. The classical example of this is the fattening of domestic geese by force-feeding. Textbooks of veterinary medicine also often describe methods of esophageal intubation for the delivery of drugs or medicines (e.g. Cooper and Eley 1979, Stone 1982: fig. 17). If the apparatus is suitably scaled to the size of the bird, aqueous solutions in volumes up to 1 cm^3 can be administered accurately without harm to birds at least as small as a 34-g Budgerigar (*Melopsittacus undulatus;* Blackmore and Lucus 1965). The Budgerigar, however, has a relatively large, sacculate crop. Many other species of small-bodied experimental birds, such as fringillids, estrildids, and some emberizids, have simple fusiform crops (hardly more than a local expansion of the esophagus; Ziswiler and Farner 1972, McClelland 1979) that are not suited to large-capacity storage. One of these is the White-crowned Sparrow (*Zonotrichia leucophrys*), which we needed to feed measured amounts of food at specific times. We first tried esophageal intubation, which was unsatisfactory (see below) in all but a few conditions, and then turned to a new method using pelleted rations. We will describe briefly our results with esophageal tubes, mainly to caution others against the use of this method in species or conditions for which it is not suited, and to supply guidelines for a few conditions in which it is serviceable. Then we will relate in greater detail our method for force-feeding using pelleted rations. We tested each force-feeding method described below on groups of at least 12 White-crowned Sparrows (a 25-30-g granivore) in various stages of the annual cycle.

Intubation.—We tested the suitability of esophageal tubes made from ca. 2.5-cm lengths of three kinds of surgical tubing (latex rubber, polyethylene, Tygon) of several outer diameters (range: 1.7-4.5 mm) attached to a 5-cm^3 hypodermic syringe. Before each use we lubricated the tip of the tube with a 3:1 (v:v) solution of glycerol : water. In our initial trials we force-fed the birds an aqueous slurry (water to powder 1:1, v:w) of a powdered semisynthetic diet (Murphy and King 1982). The hydraulic resistance of small-diameter tubes of all three materials caused this food slurry to separate into solid and liquid phases when delivered under pressure, so that only a very dilute extract of unknown and variable composition was extruded. We succeeded in delivering known amounts of this slurry only when using relatively large-bore (outer diameter $\frac{3}{16}''$, inner diameter $\frac{1}{8}''$) rubber latex tubing, but at the same time we killed by esophageal perforation about half the birds in our trials. An additional hazard in the use of aqueous slurries is that fluid leakage during intubation, or regurgitation soon thereafter, may choke the bird to death.

To solve the problem of phase-separation of food slurries under pressure, we made a gel by mixing semisynthetic diet with a 3% agar solution (1:1, w:v) either in a syringe or in a petri dish for later use. Unlike an aqueous slurry, this gel could be pressed from a syringe through very small tubing, which reduced trauma and mortality almost to zero. The tubing that offered the best compromise between safety to the bird and the rate of food delivery was PE 205 polyethylene, 2.5 cm long, outer diameter 1.7 mm. Regardless of these improvements, intubation is still marred by two disadvantages: (1) the space occupied by the esophageal tube greatly reduces the already small volume of food that a bird such as the White-crowned Sparrow can accommodate per feeding bout; and (2) regurgitation, although less common in this method and less likely to suffocate the bird, is frequent enough (about 1 in 5 birds) to make predictably accurate delivery of food an elusive goal.

Force-feeding of pelleted food.—We devised a new method of force-feeding in which we placed pellets of food in a bird's pharynx with forceps, thereby triggering reflexive swallowing. This method averted esophageal trauma, and resulted in regurgitation only if the experimenter exceeded the rate of force-feeding that the bird can accommodate. Regurgitated pellets are much less likely to cause suffocation (we have no cases thus far in hundreds of bouts of force-feeding) than are liquified rations administered by intubation. White-crowned Sparrows force-fed pellets did not exhibit the behavioral peculiarities seen in sparrows force-fed by intubation (crouching on the cage floor, feather erection, dulled response to stimuli that normally cause movement). White-crowned Sparrows that were force-fed pellets at a rate near their voluntary rate of intake resumed their usual movement patterns soon after return to their cages. White-crowns that were stuffed to capacity by force-feeding of pellets tended to be quiescent, slowing their usual activity pattern for about 1 h before they resumed voluntary feeding.

Preparation of food pellets.—We tested the suitability of several foods for force-feeding as pellets: semisynthetic diet, chick-starter mash, and millet, flax, rape, and canary seeds. We made pellets of semisynthetic diet according to the method of Murphy and King (1982: 1:1 mixture of diet and 3% agar solution, w:v). For chick-starter mash and the various seeds (kernels only; mash or kernels ground through a No. 20 screen in a Wiley mill) we mixed 9 parts of dry food with 1 part of cellulose (Celufil Hydrolyzed, United States Biochemical Corp., Cleveland, Ohio) and added this combination to 15 parts of 3% agar solution (w:v). This mixture congeals into a doughlike texture after different intervals of time (minimum ca. 0.5 h) that must be ascertained by trial with each kind of food. During this phase the mixture should be refrigerated to reduce desiccation. If the dough becomes too dry, it usually can be restored by wetting and regelling. The dough is ready to be made into pellets when it is pliable but not sticky to the touch. The first stage of pellet making consists of forming long, thin strands of dough, either by rolling it flat like a pie crust and cutting strips from it, or by extruding strands from a plastic hypodermic syringe from which the tip has been cut. Small segments scaled to bird size are then cut one at a time from a strip or strand and rolled into a pellet. The best pellet diameter for White-crowned Sparrows is about 4 mm. Pellets in covered petri dishes remain usable for at least one week if refrigerated (5°C).

To ensure that we administered known quantities of food, we weighed out the amount of dry food needed in an experimental meal and used it all in making pellets. This quantified exactly how much food was consumed if all pellets were fed, or allowed a reliable estimate of food quantity per pellet if fewer than all were fed. This also allowed exact control of the specific activity of ingested radiolabeled components of the diet.

Force-feeding procedure.—White-crowned Sparrows were able to accommodate in one force-feeding bout ca. 1 cm^3 of gelled rations, or about 20 pellets. This is equivalent to about 0.65 g of dry semisynthetic diet. The dry-weight equivalents of other pelleted foods differ from this and must be measured for each type. A White-crowned Sparrow will accept 20 force-fed pellets in about 8 min without regurgitation. This can be repeated hourly for at least 6 h without inducing detectable behavioral aberrations in the birds.

We force-fed a bird while holding it in the left hand (the best arrangement for a right-handed person). We opened the bird's bill by inserting a fingernail of the right hand or a thin-bladed instrument beween the tomia and twisting. The gape may then be held open by the pressure of the left thumb and forefinger at the rictal commissure, while the bird's body is held firmly with the other three fingers of the left hand. While its bill is thus held agape, it is easy to place a food pellet in the bird's pharynx with the aid of forceps. The bird's tongue must be in a forward position, so that its caudad movement (the first phase of the swallowing reflex) will press the pellet further into the pharynx. If it has not already begun, the swallowing reflex can then be initiated by pressing the food pellet gently into the pharynx with forceps. The bird should then be allowed to close its bill and swallow without further interference. This sequence is repeated until the entire experimental meal has been ingested. White-crowned Sparrows when force-fed signal that the limits of their capacity are near by slowly flexing their crown feathers. Late in a force-feeding bout the bird's pharynx may become dry, and it will seem to gag while swallowing or attempting to swallow. Gagging can be alleviated by giving the bird a small amount of water. Water should not be dropped into its throat (which risks the aspiration of water into the trachea), but instead should be administered slowly from a hypodermic needle and syringe along the tomia of the closed bill. Water then moves readily into the bird's mouth, apparently by capillary action. Only enough water should be given to trigger a swallowing reflex. Excess water swells pellet size and reduces the number that a bird can consume per bout.

We have used the pellet-feeding method successfully in a variety of experiments that required, for instance, (1) timed administration of radiolabeled nutrients (for subsequent measurement of their utilization); (2) controlled administration of two different diets (each subadequate alone, but adequate together if nutrient complementation occurs); and (3) controlling daily periods of feeding and fasting relative to the light : dark cycle (in factoring out the roles of endogenous 24-h periodicities and of cycles of nutrient intake in relation to several metabolic rhythms). Similar applications of the method to questions in avian nutrition and nutritional ecology seem limited only by ingenuity.

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LITERATURE CITED

BLACKMORE, D. K., & J. F. LUCAS. 1965. A simple method for the accurate oral administration of drugs to Budgerigars. J. Small Anim. Practice 6: 27–29.

COOPER, J. E., & J. T. ELEY (Eds.). 1979. First aid and care of wild birds. London, David and Charles.

MCCLELLAND, J. 1979. Digestive system. Pp. 69–181 *in* Form and function in birds, vol. I (A. S. King and J. McClelland, Eds.). New York, Academic Press.

MURPHY, M. E., & J. R. KING. 1982. Semi-synthetic diets as a tool for nutritional ecology. Auk 99: 165–167.

STONE, R. M. 1982. Clinical examination and methods of treatment. Pp. 258–268 *in* Diseases of cage and aviary birds (M. L. Petrak, Ed.). Philadelphia, Lea and Febiger.

ZISWILER, V., & D. S. FARNER. 1972. Digestion and digestive system. Pp. 343–430 *in* Avian biology, vol. 2 (D. S. Farner and J. R. King, Eds.). New York, Academic Press.

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Philydor hylobius Wetmore and Phelps is a Synonym of *Automolus roraimae* Hellmayr

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Philydor hylobius Wetmore and Phelps (1956) was described on the basis of two specimens, a tail-less adult (type) and an "immature" (= juvenile), collected at 1,800 m on Cerro de la Neblina in extreme southern Venezuela in January 1956. The two specimens are numbers 461696 and 461697, respectively, in the collections of the U.S. National Museum of Natural History. On the same trip 13 adult and 2 juvenile *Automolus roraimae duidae* (= *Automolus albigularis duidae* in the published list of birds collected on Cerro de la Neblina, Phelps and Phelps 1956) were collected. Mayr (1971) followed the describers and noted *hylobius* to be "Similar to and related to *P. atricapillus.*" Mayr also cited a personal communication from C. Vaurie, who examined the two specimens of *hylobius,* and later wrote that it ". . . is only an isolated population of *P. atricapillus,* but not a distinct species" (Vaurie 1980). Note that the range of *P. atricapillus* along the southeastern coastal region of Brazil is approximately 2,700 km from Cerro de la Neblina!

In the ensuing years the Colección Ornithológica Phelps of Caracas obtained several additional collections from Cerro de la Neblina, but these included no new material of *P. hylobius.* During the period January 1984 to February 1985, eight ornithologists netted and collected extensively at elevations of over 1,200 m on Cerro de la Neblina. Twenty-three specimens of *A. roraimae* were obtained, but again, no additional specimens of *P. hylobius* were taken. In the field Barrowclough and Cannell noted that a juvenile *A. roraimae,* caught in the same mist net with its parent, resembled the description of *P. hylobius* in Meyer de Schauensee and Phelps (1978). Both specimens were collected and the juvenile matched well two juvenile specimens of *A. roraimae* in the collection of the American Museum of Natural History.

This renewed our interest in the original specimens, and Dickerman compared the three juvenile *A. roraimae* (including the above juvenile from Cerro de la Neblina) with the juvenile *P. hylobius* in the National Museum. The juvenile *P. hylobius* was found to be inseparable from them. It also differed markedly from every juvenile specimen of *Philydor* examined (see acknowledgments) in having weak dusky scalloped edgings on the ventral feathers. The juvenile plumage in all species of the genus *Philydor* is very similar to the basic plumage and lacks any ventral barring or scalloping.

The tail-less adult of *P. hylobius* was compared with an adult *A. roraimae.* They were inseparable in wing length, in bill shape, and in size of the tarsi and feet. We believe the type of *hylobius* is actually an erythristic specimen of *A. roraimae.* The description of the type exactly fits an adult *roraimae* except for the "tawny" rather than cream-colored superciliary line, and the "ochraceous-tawny" rather than creamy-buff throat. However, below the right eye of the type of *P. hylobius,* there is a small patch of pale feathers that matches the throat color of *A. roraimae.*

In the original description, the authors wrote that they considered the most closely related species to be *Philydor atricapillus,* but noted differences in the more slender bill and heavier feet of *hylobius.* Indeed, the tarsi and feet of *hylobius* are heavier than those of any species of *Philydor,* but match well species in the genus *Automolus.* Futhermore, the wing formula of both *A. roraimae* and the type of *P. hylobius* is $7 > 8 > 9 > 6 = 5 = 4 = 3 = 2 > 1 > 10$, while the wing formula of *P. atricapillus* is $6 > 7 > 8 > 9 > 5 > 4 > 3 = 2 = 1 > 10$. We also note that no species of *Philydor* has an all-dusky ear patch, as do *hylobius* and *roraimae,* without some pale feathers included within the dark auricular area.

Philydor hylobius Wetmore and Phelps should be considered a junior synonym of *Automolus roraimae* Hellmayr. With this action, Cerro de la Neblina has no endemic taxa of birds above the subspecific level.

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