ON THE FITTING OF EQUATIONS RELATING AVIAN STANDARD METABOLISM TO BODY WEIGHT

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A controversy has developed recently concerning the problem of fitting a regression line to data which are presumed to be related by the power function, $Y = aX^b$. The model commonly used as the relationship between avian standard metabolic rate (Y) and body weight (X) is such a situation. Most authors routinely transform the data logarithmically and then perform a least squares linear regression fit to the equation $\log Y = \log a + b \log X$; but the untransformed data may instead be fit directly by least squares (Zar, BioScience 18:1118–1120, 1968). As pointed out in the latter paper, as well as in Lasiewski and Dawson (Condor 71:335–336, 1969), these two methods are not statistically equivalent. Whereas the first method may be appropriate for certain sets of data, the second may be warranted for others, and the researcher is confronted with the need to choose objectively between them.

The crux of the matter, as stressed by Lasiewski and Dawson and by Zar, is whether the use of a particular model results in residuals whose variability is constant over the range of measurements. A residual is the difference between the observed Y and the Y predicted by the model, and constant variability of residuals is termed homoscedasticity. Glejser (J. Amer. Statist. Assoc. 64:316–323, 1969) has proposed an objective, easy to perform test as a criterion for the determination of heteroscedasticity (i.e., the lack of constant variability among the residuals). He suggests an examination of the linear regression, $E = a' + b'X$, where E is the absolute value of the residuals and X is the independent variable in the model being examined. In this regression, using the residuals from the untransformed fit, a slope (b') significantly greater than zero would indicate that the variability of the residuals increases with X, and the logarithmic transformation may be employed to try to achieve homoscedasticity. (A slope not significantly different from zero should rule out the employment of any transformation.) If, after the fitting of the logarithmic equation, the application of Glejser's regression yields a b' value not significantly different from zero, then the transformation might be deemed justifiable.

For the passerine data of Lasiewski and Dawson (Condor 69:13–23, 1967), such a regression of residuals applied after fitting the nontransformed power function yields a b' significantly greater than zero. The regression applied after fitting the logarithmic model (in this case E is the absolute difference between the log Y observed and the log Y predicted, and log X is used in place of X) results in a positive b' value not significantly different from zero. Thus, contrary to my previous suggestions (BioScience 18:1118–1120, 1968; Comp. Biochem. Physiol. 29:227–234, 1969), the logarithmic model is the more appropriate for this set of data. However, the fact that these data are better analyzed using the logarithmic transformation should not lead to a general rejection of the nontransformed model. Lasiewski and Dawson (Condor 71:335–336, 1969) suggest that graphical examination might aid subjectively in the choice of model. However, examination of the residuals, such as recommended above, is a far better procedure, as it can provide an objective justification for the use of the chosen model. It is of importance for the researcher not only to choose his model objectively, but also to submit to his readers ample justification of his choice.

NESTING OF KING VULTURE AND BLACK HAWK-EAGLE IN PANAMÁ

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Surprisingly little is known about any aspect of the breeding biology of some relatively common neotropical Falconiformes. The nesting of the King Vulture (*Sarcoramphus papa*) and the Black Hawk-Eagle (*Spizaetus tyrannus*), two large and conspicuous species which range over the lowlands from México to Argentina, has not been described previously. Here is an account of the finding of two nests of each species in the Republic of Panamá.

Sarcoramphus papa. The Penards (De Vogels van Guyana. Vol. 1, p. 357, Paramaribo, 1908) state simply that *Sarcoramphus* nests in a hollow tree or rock cavity but present no supporting data, and their statement was presumably hearsay (see Haverschmidt, Auk 66:56, 1949). Lundy (Anim. Kingd. 60:117, 1957) describes the finding by Carl Koford of a downy *Sarcoramphus* on the forest floor in January 1957 at Barro Colorado Island, Canal Zone, but the actual nest site was not located. *Sarcoramphus* has bred in captivity (Heck, Zool. Gart. 27(6):296, 1963).

On 27 February 1965 I found a *Sarcoramphus* incubating a single egg 0.3 m above the ground in a rotten tree stump on the Atlantic side of Panamá, 12.8 km SSW of Boca del Río Indio, western Colón Province. This site was 45 m from the west bank of the Río Indio in dense, wet, second-growth woods at 100 m altitude. The circular stump was lipped and canted so that the incubating vulture could be seen from only a narrow angle on one side. As I approached, it flew up and joined its mate which had been sitting in a tree 7.5 m from the ground. Both birds uttered low croaking noises and snapped their bills from crouched positions with their wings held open, and arched forward in an owl-like manner. The single, cream-white, spotless egg which rested on the floor of the stump measured 90 × 63 mm, much like the dimensions of eggs from captive individuals (Heck, op. cit.). Apparently the vultures had not modified this site, which appeared to be a perfectly natural cavity. The incubating vulture lacked three primary feathers on its right wing, while its mate's wing was fully feathered. When I returned on 5 March for the last time, the individual lacking wing feathers was soaring near the nest site while the other sat in the nest cavity. I did not disturb the incubating vulture and the fate of the egg or chick is unknown.

On 6 July 1966 I was shown another site by a local hunter, again on the Atlantic side, 5 km ESE

of the mouth of the Río Guanche, eastern Colón Province, in habitat much like the other, 75 m above sea level. A single, dull, dirty white egg (93 × 63 mm) rested on the forest floor near the base of a small spiny palm. Unlike the first site, here the vultures appeared to have made a scrape in the dirt and leaves. The behavior of the parents was like that of the others, and on two occasions, both approached hopping on the ground to within 3 m of me. The egg and the parents were not present on 18 July. I do not know the cause of the disappearance.

Thus, *Sarcoramphus* appears to be like *Coragyps* and *Cathartes* in placing its egg on or very near the ground, and making little or no modification of the site. But unlike *Coragyps* and *Cathartes*, the forest-dwelling *Sarcoramphus* lays a single egg, rather than a clutch of two or three, and its egg lacks the brown blotching found on the eggs of *Coragyps* and *Cathartes*, which breed in more open, brushy habitat.

Spizaetus tyrannus. During the periods of 1–18 February 1965 and 20–25 July 1968, I observed a nest site of *Spizaetus tyrannus* in the crown of a royal palm (*Roystonea* sp.), 13.5 m above the ground on military road K-15, near the west bank of the Panama Canal, in the southwestern Canal Zone. The nest was composed entirely of sticks and I estimated its measurements at 1.3 m in diameter and 0.45 m in depth. The *Spizaetus* did not use this site in 1966, and in 1967 the wind and rain had reduced the nest to but a few sticks. The 1968 nest was very similar to that built in 1965.

Two young were present in the nest during both periods; but those in February 1965 were small and covered with whitish down, while the July 1968 chicks were well feathered and hopped about in the nest flapping their wings. Although *S. tyrannus* is normally very vocal while soaring, the adults did not vocalize near the nest. Only when I approached the base of the tree did the parents swoop down, uttering a staccato, *ka, ka, ka*, a vocalization that I had never before heard from *Spizaetus*. Both parents fed the young. Through a 25 × telescope, food items identified with certainty were two *Iguana iguana*, each approximately 25 cm long, a vine snake (*Oxybelis* sp.), a Black-chested Jay (*Cyanocorax affinis*), and a squirrel (*Sciurus granatensis*). The success of the 1965 chicks is unknown, but the 1968 nest was empty on 19 August, and a single juvenile was perched not far from the nest tree.