SHORT COMMUNICATION

Body Size Variation in Baboons: A Reconsideration of Ecological Determinism

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ABSTRACT. POPP (1983) presented an intriguing argument regarding the covariation of body size in baboons and rainfall. However, a reanalysis of the data indicates that "Principle 2" of the model is not supported.

Key Words: *Papio*; Body size; Ecology; Climate.

INTRODUCTION

Body size is a fundamental component of an animal's adaptation, at once reflecting and determining a vast array of morphological and life history parameters (HUTCHINSON & MACARTHUR, 1959; SCHMIDT-NIELSEN, 1984).

POPP (1983) found a significant positive relationship between mean annual rainfall and body size in baboons (sexes analyzed separately). He suggested that the greater energy availability in habitats with more rainfall shifts the focus of inter-male competition from food resources to females. As rainfall increases, increasingly aggressive interactions select for an increasingly greater body size in males. A prediction of this model, as stated by POPP (1983), is *Principle 2: The degree of sexual dimorphism in body mass increases with increasing rainfall. Male body mass increases geometrically as a function of adult female body mass.* Although POPP's sexual selection hypothesis represents an interesting approach to integrating selective factors affecting behavior and morphology, his data and analyses require re-examination.

ANALYSES AND RESULTS

Table 1 of POPP (1983) lists the data for body weight and rainfall in the 13 baboon samples used for his analyses. The single sample representing mandrill males has a mean of 50.5 kg, based on two captive animals. This observation is as much as twice the mean weight reported by any other study (cf., STAMMBACH, 1986; DECHOW, 1980 for several sources) and, as it is based on captive animals, appears likely to be a substantial overestimate of the average body weight of wild mandrill males. Therefore, in the reanalysis conducted here, this sample is omitted.

Figure 2 (POPP, 1983), redrawn here as Figure 1, shows the regression of male against female mean body mass and depicts a power curve (dashed line) which "best described" the data and represents increasing sexual dimorphism with increasing body weight. Although not stated, calculations reveal that this curve can be determined by performing least squares

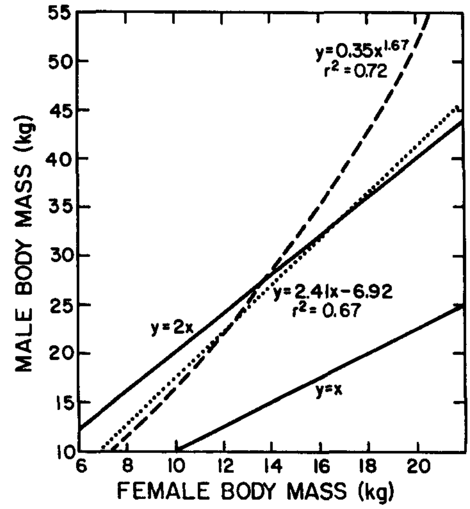

Fig. 1. Redrawn from POPP (1983) with additional analyses. Dashed line: antilog of observed linear regression of *ln*-transformed data including mandrill sample. This is the curve suggested by POPP. Solid lines: two models of constant sexual dimorphism; $y = x$ (male body size = female body size); $y = 2x$ (sexual dimorphism = 200%). Dotted line: observed linear regression without mandrill sample; slope is not significantly different from $y = 2x$.

linear regression of the natural log of male body mass against the similarly-transformed female mean body mass values; the antilog of the resulting linear equation gives this power equation.

POPP (1983) notes how "considerably different" this power curve is "from a simple linear 1:1 relationship between male and female body mass" (slope labeled $y = x$). True, but it has not been suggested that there is *no* sexual dimorphism in baboons; that is the meaning of $y = x$. Rather, the frequent observation has been that male baboons weigh about twice that of females; this relationship, a constant sexual dimorphism across all body weights of 200% (male/female × 100), is labeled $y = 2x$.

A linear regression of the mean body weight data, but excluding the mandrill sample, produces a line (labeled $y = 2.41x-6.92$) with a slope statistically indistinguishable from that of a constant dimorphism of 200% ($y = 2x$). This observed regression is highly significant ($p \leq 0.001$) and the r^2 (0.67) is comparable to that of POPP's power curve (0.72). In other words, about the same proportion of the variance is explained by a simple linear model of constant 200% dimorphism as by a power model of increasing dimorphism.

However, any linear regression of untransformed data will produce some non-geometric relationship. Following POPP's procedure of ln-transforming the mean body masses and then taking the antilog of the determined linear regression, a power curve of $y = 0.832x^{1.32}$ ($r^2 = 0.76$) is the best fit to the data; the linear regression of this ln-transformed data is $\ln y = 1.32 \ln x - 0.184$ (not drawn). This can be compared to an expected linear relationship of ln-transformed data if dimorphism is held constant at 200%, $\ln y = 1.0 \ln x + 0.693$. The two models are not significantly different (t-statistic = 1.33).

DISCUSSION AND CONCLUSIONS

In sum, the best-fit curves to the data (straight and ln-transformed) are not significantly different from models representing a constant dimorphism of 200% across increasing body weight. A sexual selection hypothesis that predicts increasing dimorphism is not supported by the data if the single mandrill sample is excluded. In fact, even linear regressions that do include this mandrill sample are not convincingly distinguishable ($0.10 \geq$ observed $p \geq 0.05$) from models of constant dimorphism. Similarly, PHILLIPS-CONROY and JOLLY (1981) found that sexual dimorphism in size did not increase with increasing body size in Awash Park anubis and hamadryas baboon troops.

However, a positive covariation of body size and rainfall is indicated by the data presented by POPP and corroborated by a study (VITZTHUM, 1986) of rainfall and odontometric variation (a correlate of body size). The basis of these observations requires further study. As greater rainfall generally signals increasing energy availability and since individual growth is dependent upon adequate nutrition (LEONARD, 1987), a smaller body size in drier habitats may reflect insufficient nutritional resources rather than a change in the magnitude of sexual selection.

The analyses and conclusions presented here do not negate the role of sexual selection in determining body size. Rather, the results suggest that there is a general framework of 200% body size dimorphism in baboons, probably selected in part as a result of inter-male competition. Within this framework, "fine tuning" of body size is in response to other proximate features of the environment to which an organism must adapt; in this case, perhaps the availability of food. Thus, undoubtedly, several selective factors including social interactions and energy availability contribute to body size adaptations. Continued rigorous collection and examination of appropriate data will eventually reveal how these selective factors interact.

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