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Redaksi : D. I. Hartoto, S. N. Prijono, A. S. Adhikerana

CAN BODY WEIGHT EXPLAIN CLUTCH SIZE ?

ASEP S. ADHIKERANA*)

ABSTRAK

DAPATKAH BERAT TUBUH MENUNJUKKAN JUMLAH TELUR DALAM SATU SARANG BURUNG? Beberapa ahli menyebutkan adanya hubungan fungsi matematika antara berat tubuh burung dengan jumlah telur dalam satu sarang, tetapi kerancuan-kerancuan masih ditemukan terutama tentang keabsahan hubungan kedua parameter biologis tersebut secara statistika. Tulisan ini mencoba menguji keabsahan korelasi kedua parameter dengan menggunakan data burung-burung dari kelompok passerine yang ada di Jawa dan Bali. Hasil analisis menunjukkan bahwa sesungguhnya kedua parameter sama sekali tidak memiliki korelasi yang tinggi, sehingga penggunaan berat badan seekor burung untuk menduga jumlah telur yang dieraminya selama musim berbiak adalah langkah yang keliru.

*) Puslitbang Biologi - LIPI, P.O. Box 110, Bogor 16122.

INTRODUCTION

It is widely accepted that there are relations between animal body size and the biological characteristics of the animal. Peters (1983) suggested that such relations play a central role in animal ecology. Calder & King (1974) have demonstrated a significant correlation between avian body mass and its energetics. Adhikerana & Prawiradilaga (1991) have used Calder & King's model to test the difference in basal metabolic rate between terrestrial and arboreal passerines. Other relations have also been demonstrated by many authors (see Peters, 1983), and one of them is the relationship between body weight and clutch size in birds. The common form of such relationship is in a logarithmic model such as follows:

$$y = ax^b$$

where y is biological characteristics, e.g. clutch size, and x is body weight, while a is intercept and b is the slope of such regression. Blueweiss *et al.* (1978) reported clutch size-body weight relation in such a form, but there seems to be a discrepancy in that the slope is zero. They, moreover, did not verify the significance of such a relationship. Later, Cabana *et al.* (1982) re-evaluated such a relationship and suggested the following equation:

$$\text{clutch size} = 4.15\ W^{1.18}$$

where clutch size is numbers of eggs in a clutch, and body weight (= W) is in kilogram. They had, however, a very low coefficient of determinism (r^2 = 0.10), suggesting a small degree of relationship between the two characters. This study seeks to further verify such correlation between avian clutch size and its body weight.

MATERIALS AND METHODS

This study concerns with only passerine birds from Jawa and Bali. A total of 1217 specimens disposed at the MZB (Balitbang Zoologi, Puslitbang Biologi, LIPI) were examined, and all provided body weight data written on their respective labels. They consisted of 95 passerine species. The mean body weight of each species was used in the analysis. Clutch size of each species was obtained from information described in Mackinnon (1988). All data were log-transformed and subjected to the least square regression analysis as described in Peters (1983).

RESULTS AND DISCUSSION

The mean body weight and clutch size of passerine species used in this analysis are listed in the Appendix 1, and the results of the least square regres-

Table 1. The results of least square regression analysis.

Equation :	$y = a\,x^b$
where,	y = clutch size, number of eggs
	x = body weight, gram.
Intercept (a) = 2.78	
Slope (b) = 0.89	
Coefficient of determinism (r^2) = 0.02	
Coefficient of correlation (r) = 0.13	
$F_{1, 93}$ = 1.01 (p = 0.32, not significant)	

sion analysis are shown in Table 1. There was a very small degree of probability that clutch size correlated with body weight. It is indicated that the clutch size cannot be explained merely by body weight.

Although Perrins & Birkhead (1983) suggest that smaller birds would have more eggs in their clutches than bigger ones, they reckon that there is no obvious relationship between clutch size and body weight. They also suggest that many other factors determine the clutch size. These include latitude, habitat, population density, time of breeding, and age of reproducing birds.

These factors can act together as a natural selection pressure upon the clutch size of birds. It is suggested that natural selection favours birds which produce clutches that leave the largest number of young in succeeding generations (Lack, 1948). This is known as Lack's hypothesis. The amount of food which parents could bring to the nest to feed the young is the most important factor affecting the clutch size. The more eggs are laid, the more young will hatch. But, because the parents should share the food among hatchlings, some individual young in larger broods will receive less food. This will increase the mortality rate of young, with the increase of the brood size. The optimum clutch size is, therefore, the one which gives the most surviving young.

Perrins & Birkhead (1983) indicated that clutch size might be influenced by body size, but the body size is affected by a wide range of factors, such as feeding ecology of a species, and intra-and/or inter-specific competition. There has also been a good evidence that characteristics such as egg size, adult body size, laying date, and clutch size are all inherited (Noordwijk *et al.*, 1980). The result of this study confirm these views where the clutch size cannot be simply indicated by body weight. Such mathematical models are, therefore, not appropriate for assessing the relationship between clutch size and body weight. As yet such a relationship has been demonstrated for only a group of passerine species from Jawa and Bali, but it seems likely that it will also hold true for others.

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Appendix 1. List of passerine birds from Jawa and Bali used in this study.

Species	Mean Body Weight (g)	Mean Clutch Size (eggs)
Eurylaimus javanicus	82.25	2
Pitta sordida	53.57	4
Pitta guajana	61.75	3
Mirarfa javanica	17.60	3
Hirundo rustica	14.86	2
Hirundo tahitica	13.93	2
Hemipus hirundinaceus	12.00	2
Coracina javensis	99.67	2
Coracina larvata	69.00	1
Coracina striata	101.67	2
Lalage nigra	22.40	2
Pericrocotus cinnamomeus	9.00	2
Pericrocotus flammeus	21.00	2
Aegithina tiphia	14.62	2
Chloropsis sonnerati	39.83	2
Chloropsis cochinchinensis	25.85	2
Pycnonotus atriceps	26.46	2
Pycnonotus aurigaster	37.50	2
Pycnonotus goiavier	33.25	2
Pycnonotus plumosus	31.32	2
Pycnonotus simplex	27.67	2
Pycnonotus bimaculatus	37.33	2
Hypsipetes virescens	30.67	2
Dicrurus macrocercus	44.33	2
Dicrurus leucophaeus	36.00	2
Dicrurus remifer	47.00	2
Dicrurus hottentottus	83.86	3
Dicrurus paradiseus	61.50	3
Oriolus xanthonotus	42.21	2
Oriolus chinensis	81.39	2
Irena puella	63.90	1
Corvus macrorhynchus	607.09	3
Sitta frontalis	17.00	3
Pellorneum capistratum	27.67	2
Trichastoma sepiarium	25.00	2
Trichastoma abbotti	27.60	2

Appendix 1. (continued).

Species	Mean Body Weight (g)	Mean Clutch Size (eggs)
Malacopteron cinereum	21.50	2
Pomatorhinus montanus	40.50	3
Stachyris melanothorax	17.00	2
Macronus flavicollis	13.11	2
Pteruthius aenobarbus	12.00	2
Alcippe pyrrhoptera	17.75	2
Brachypterix leucophrys	15.00	2
Copsychus saularis	41.00	3
Copsychus malabaricus	33.00	3
Cinclidium diana	21.40	2
Enicurus leschenaulti	46.00	2
Zoothera interpres	52.00	3
Zoothera citrina	53.50	3
Turdus obscurus	56.50	1
Gerygone sulphurea	6.10	2
Seicercus grammiceps	7.67	2
Phylloscopus borealis	9.00	2
Phylloscopus trivirgatus	7.75	2
Orthotomus sepium	9.00	2
Prinia familiaris	12.12	3
Prinia polychroa	18.00	2
Cisticola juncidis	8.17	4
Cisticola exilis	7.67	3
Cyornis banyumas	17.42	2
Cyornis rufigastra	18.50	4
Rhipidura phoenicura	15.50	2
Rhipidura javanica	16.33	2
Hypothymis azurea	11.75	2
Pachycephala cinerea	21.05	2
Artamus leucorhynchus	40.59	3
Lanius schah	34.67	3
Aplonis panayensis	50.55	3
Sturnus contra	77.83	3
Gracula religiosa	264.00	2
Lichmera indistincta	14.67	2
Anthreptes malacensis	11.53	2

Appendix 1. (continued).

Species	Mean Body Weight (g)	Mean Clutch Size (eggs)
Anthreptes singalensis	8.83	2
Nectarinia calcostetha	9.30	2
Nectarinia jugularis	7.38	2
Aethopyga siparaja	6.00	2
Aethopyga mystacalis	7.00	1
Arachnothera longirostra	14.78	2
Arachnothera affinis	27.33	2
Dicaeum trigonostigma	6.20	2
Dicaeum trochilum	7.52	2
Zosterops palpebrosa	8.50	3
Zosterops chloris	8.00	3
Passer montanus	17.25	4
Ploceus manyar	20.00	3
Ploceus philippinus	16.00	3
Amandava amandava	6.00	5
Erythryra prasina	11.83	5
Padda oryzivora	22.17	5
Lonchura leucogastra	11.00	4
Lonchura leucogastroides	10.25	4
Lonchura punctulata	10.50	5
Lonchura malacca	8.00	5
Lonchura maja	11.00	4
Lonchura molucca	10.37	5

THE EMBRYONIC SHELLS AND THE DEVELOPMENTAL STAGE OF *BROTIA* (FRESHWATER SNAILS : THIARIDAE)

Two species of freshwater snails, identified as *Brotia kuli* and *B. toradjarum,* were collected from Lake Poso, Central Sulawesi, and examined in this study. This was aimed for describing the embryonic shells and the developmental stage of these species. Ten adult specimens for each species were examined.

There were several embryonic shells, i.e. young snails, found inside the brood pouches. The number of embryonic shells, dimension of adult specimens, and number of whorls in each embryonic shells are shown in Table 1.

Table 1. Dimension of adult specimen, the number of embryonic, dimension of the embryonic, the number of whorl and the number of egg for each species.

Species	Adult specimen (always eroded)		Embryonic shell			Number of egg
	Length (mm)	Width (mm)	Number in brood pouch	Length (mm)	Number of whorl	
B. kuli	1) 48.30	13.41	2	1) 7.55	6	2
				2) 0.90	2	
	2) 56.65	15.16	1	1) 7.42	6	–
	3) 52.66	14.50	2	1) 9.19	6	–
				2) 3.48	4	
B. toradjarum	1) 43.40	14.30	4	1) 10.95	6	–
				2) 9.04	6	
				3) 7.31	6	
				4) 6.57	5	
	2) 41.05	12.88	1	1) 7.05	5	–
	3) 38.90	11.85	1	1) 4.56	5	–
	4) 38.89	11.34	1	1) 4.51	5	–
	5) 40.13	12.81	4	1) 8.15	6	–
				2) 6.84	6	
				3) 5.26	5	
				4) 3.88	4	
	6) 37.71	12.04	1	1) 8.69	6	–
	7) 32.51	9.81	1	1) 4.95	5	–

The embryonic shells of both species have fully formed with many whorls, and are provided with a step-like shoulder at the third whorl. The apex and the second whorl are smooth. The third to fifth whorl are sculptured with regular axial ribs. The sculpture of *B. toradjarum* differs from that of *B. kuli* in the presence of spiral lines crossing the axial ribs, which create fine granules which are prominent at the body whorl. Smaller embryonic shells are sometimes covered with thin layer of albumen, which is either transparent, brownish, or darkbrown.

Table 1 shown that only three adult specimens of *B. kuli* contained embryonic shells; three embryonic shells with six whorls, one specimen with four whorls and one with two whorls. Seven adult specimens of *B. toradjarum* contained several embryonic shells. Six specimens of embryonic shell with six whorls, six specimens with five whorls and only one specimen with four whorls.

Based on the number of embryonic shell that found in the adult specimens and the number of whorl at each embryonic shell, the proportion of the developmental stage of the *Brotia kuli* ranked as (6 whorl > 2-4 whorl) and for *B. toradjarum* was ranked as (5-6 whorl > 4 whorl). The proportion of both species is inverted to the proportion of *Melanoides tuberculata* which had ranked in abundance (5-6 whorl < 2-4 whorl < egg and 2 whorl) (Dudgeon, D. 1986. *Jour. Zool. Lond.* (A) 208: 37-53).

In the present study, *B. kuli* contained 1 to 2 embryonic shells and *B. toradjarum* contained 1 to 4 embryonic shells. Compared with the number of embryonic shell found inside the brood pouch of *M. tuberculata* (Dudgeon, 1986), *B. kuli* and *B. toradjarum* produced fewer embryonic shells. The variation in dimension and number of embryonic shell for each species and each individual might be explained by differences in the ecology of each species, and phylogenetic limitations may also be involved in this relationship (Calow, P. 1978. The Evolution of Life-Cycle Strategies in Freshwater Gastropods. *Malacologia* 17 (2): 351-364). The present study, however, gave the basic information on the number and the developmental stage of embryonic shells, especially for the genus *Brotia* from Sulawesi.

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RISTIYANTI M. MARWOTO. Balitbang Zoologi, Puslitbang Biologi-LIPI, Bogor.