

ON USE OF SIZE OF THE BURSA OF FABRICIUS AS AN INDEX OF AGE AND DEVELOPMENT

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Abstract.—I compared size of the bursa of Fabricius to gonadal dimensions, body weight, tarsus length, and wing length in four species of cormorants and three species of oystercatchers. No relationship was found except for female Rock Shags (*Stictocarbo magellanicus*) and only with ovary size and wing length. I conclude that bursa size should be used as an index to age or development only after chronological study of involution has been made for each species.

EL USO DEL TAMAÑO DE LA BOLSA DE FABRICIO COMO ÍNDICE DE DESARROLLO Y EDAD

Sinopsis.—Comparé el tamaño de la bolsa de Fabricio a dimensiones de la gónada, peso, largo del tarso y del ala en cuatro especies de cormoranes y tres especies de ostreros. No se encontró relación alguna, excepto en el tamaño del ovario y largo del ala, de hembras de *Stictocarbo magellanicus*. Concluyó que el tamaño de la bursa debe ser utilizado como índice de edad o desarrollo tan solo después que se hayan llevado a cabo estudios cronológicos de la involución de la bolsa para cada una de las especies.

Common techniques used to age birds include plumage development, degree of cranial pneumaticity, and size of bursa of Fabricius (see Gower 1939, Kirkpatrick 1944, Linduska 1943, McNeil and Burton 1972, Siegel-Causey 1989). The last is used often in game management studies since the measurements can be made quickly and unambiguously on live birds of many species (cf., Hanson 1949, Keith 1960).

The bursa of Fabricius ("bursa") is a dorsal diverticulum of the cloaca, has a lympho-epithelial origin, and functions as an early immunosuppressive organ (Glick 1983). In most species, growth of the bursa commences soon after hatching but embryonic development is reported for some birds and, depending upon the species, reaches maximum size in 14–16 wk. Involution occurs immediately after maximum development (Jolly 1915, Riddle 1928) and its decrease in size is nearly linear for most species studied. Thus, size of the bursa once involution has commenced should be a reliable index of early age. Furthermore, gonadal growth and bursa size during involution are usually inversely related and, therefore, the same measurement can also act as an index to sexual development (Kirkpatrick 1944). Study of the relation between bursa size, gonadal development, and overall body size are rare for nongame species. I report here results for four species of cormorants and three oystercatchers.

METHODS

All measurements were done on specimens soon after field collection in late austral summer. Species (and numbers examined) of Phalacrocoracidae (nomenclature follows Siegel-Causey 1988) and Haematopodidae are: Olivaceous Cormorant (*Hypoleucus brasilianus*: 29 ♂, 16 ♀), Imperial Shag (*Notocarbo atriceps*: 59 ♂, 99 ♀), Rock Shag (*Stictocarbo magellanicus*: 39 ♂, 54 ♀), Red-legged Shag (*S. gaimardi*: 26 ♂, 12 ♀), American Oystercatcher (*Haematopus palliatus*: 24 ♂, 22 ♀), Blackish Oystercatcher (*H. ater*: 33 ♂, 35 ♀), and Magellanic Oystercatcher (*H. leucopodus*: 20 ♂, 39 ♀). All birds were collected for other purposes and near natal colonies at various sites in Argentina and Chile; localities and data are available from the author. I measured body masses using Pesola scales. For bursa and gonad dimensions, I measured length and width using dial calipers and I measured wing lengths by centimeter ruler. Measurement of bursa thickness under field conditions was not accurate, so I approximated bursa size by the product of length and width only. I performed all analyses on log-transformed data using BMDP statistical programs (Dixon 1988); and assessed statistical significance using the sequential Bonferroni inequality (Holm 1979).

RESULTS

Of 507 specimens examined, 181 had bursae (Olivaceous Cormorant: 22; Imperial Shag: 59; Rock Shag: 47; Red-legged Shag: 19; American Oystercatcher: 8; Blackish Oystercatcher: 10; and Magellanic Oystercatcher: 16). Judging from plumage and molt, the total sample ranged in age from fledglings to full adults. With very few exceptions, only birds in juvenile or prebasic plumage had bursae. All bursae appeared mature, i.e., the bursa walls were not glandular and all appeared to have commenced involution.

When sexes were combined in the analyses, I found no relation between size of bursa and tarsus length (Fig. 1), body weight, gonadal dimensions, or wing length in Imperial Shags, or in any of the other six species. In addition, age of specimens (classed by plumage as juvenile, subadult, or adult) had no relation to bursa size (see Fig. 1). When sexes were analyzed separately, I found significant relationships only in female Rock Shags and only between bursa size and ovary size ($r = -0.508$, $F = 8.68$, $df = 1, 25$, $P = 0.007$), and between bursa size and wing-length ($r = -0.625$, $F = 16.02$, $df = 1, 25$, $P < 0.001$). All other comparisons were nonsignificant.

DISCUSSION

Lack of relationship between bursa size and various age-related measures has been found in other studies involving phalacrocoracids. Winkler (1987) assessed wing and tail molt in European Cormorants (*Phalacrocorax carbo*) and found no relationship between bursa size and age or bursa size and plumage development in 11 banded birds. I (Siegel-Causey

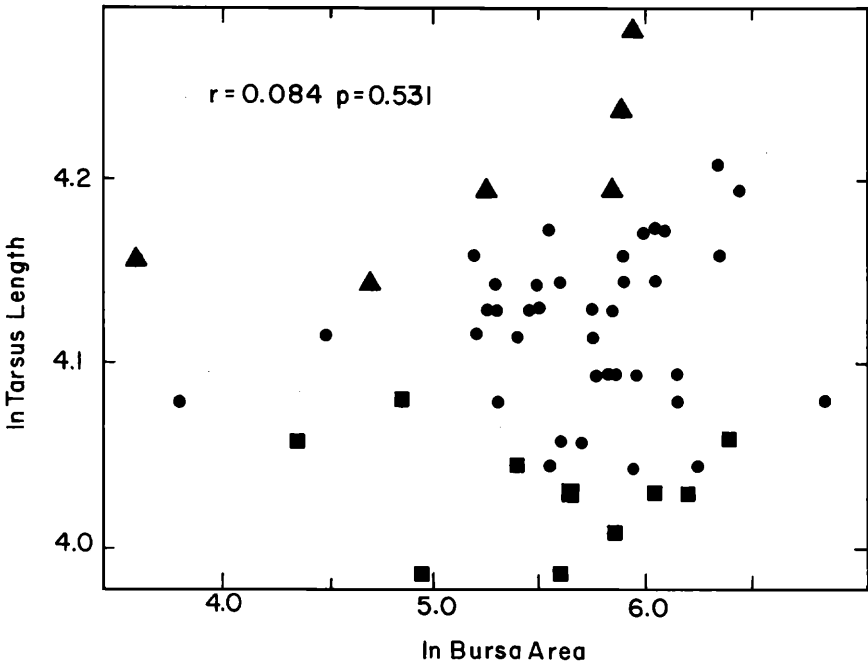


FIGURE 1. Relation between tarsus length and bursa size in Imperial Shags. Squares = juveniles, circles = subadults, triangles = adults. All values are log-transformed.

1989, 1990) found no relationship between bursa size and cranial dimensions, degree of cranial pneumaticity, or nasal gland size in four species.

Some of the shorebirds that McNeil and Burton (1972) studied showed a decrease in bursa size with time (e.g., *Charadrius semipalmatus*: $r = -0.844$, $P = 0.006$; *Totanus flavipes*: $r = -0.825$, $P = 0.025$; regression on means given in their Table 1). Most of their study species, however, showed no such relation using the same test, and instead were similar to the findings I report here for Fuegian oystercatchers. It should be noted that some of the tests failed because of small sample sizes, but in other species there were no trends at all. Because all of my specimens were old enough that bursas had begun involution, the relation between bursa size and age variables should have been linear or at least monotonic. With two exceptions, I found no such correlations.

Although I found significant correlations with bursa size in female Rock Shags, the magnitude of the residual variation (60–70%) precludes easy interpretation. Overall, my findings do not support the use of bursa size as a means of quantifying age in all birds, but the results may reflect yet undetermined variation in growth or development. For example, the data may indicate either that bursa involution is decoupled with age in Fuego-Patagonian oystercatchers, or that it is similar to that found for

other shorebirds and instead is unrelated to gonadal development, increase in body weight or wing length. Presence or absence of a bursa may be used as a tool to class individuals (e.g., juvenile, adult), but it is clear from these and other results that precise determination is not always possible. Chronological study of bursa involution in each species must be made before the size of the bursa of Fabricius is used to quantify specimen age.

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