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Pebbles in nests of Double-crested Cormorants.—While censusing Double-crested Cormorants (*Phalacrocorax auritus*) breeding on Lake Winnipegosis, Manitoba, in 1987 and 1988 (see McLeod and Bondar 1953 for a description of colonies), I discovered several nests that contained pebbles. Because birds nested on flat or gently sloping substrates and built nests with rims well above the ground, these pebbles could not have gotten into the nests accidentally. Instead, they were probably placed into nests by cormorants. Incorporating foreign objects within clutches or creating "artificial clutches" occurs rarely (geese: Hanson and Eberhardt 1971; Knight and Erickson 1977; penguins, gulls and murres: D. G. Ainley pers. comm.) and has not been reported in the Phalacrocoracidae.

From 4 August to 6 September 1987, I visited 37 colonies containing 35,191 cormorant nests. In 10 colonies, 47 of 12,784 nests contained only small pebbles. Pebbles averaged approximately 4 cm in diameter (range 0.5–10 cm) and "clutches" contained 4.7 ± 4.5 [SD] pebbles. Nests with pebbles were found in colonies both at the egg and chick stages and were observed on earlier visits to colonies by R. W. Knapton (pers. comm.). From 14 to 21 June 1988, 35 of these colonies were revisited. In 9 colonies 74 of 11,286 nests contained pebbles. Four of these colonies had nests with pebbles in 1987. However, unlike the previous year, 18 nests with pebbles also contained at least one egg ($\bar{x}$ = 1.1 ± 1.3 eggs/nest, range 0–4 eggs), and 6 contained one small chick. Nests with pebbles made up 0.1 to 2.5% and 0.1 to 6.2% of all nests at each colony in 1987 and 1988, respectively. In both years, all three of the nests containing pebbles were located on the periphery (i.e., within two nests of the outer edge) of subcolonies. Colonies were visited briefly to reduce disturbance, and so the age or breeding status of birds that constructed or attended these nests is not known.

Although pebble clutches occurred infrequently, the phenomenon may have been limited, in part, by the availability of suitable pebbles at colonies. Several empty nests occurred throughout the season but the substrates of these consisted typically of fine gravels; sand or compacted guano and small pebbles were seen rarely. The only colony with a pebble substrate recorded the highest frequency of nest with pebbles in 1988. It is possible that some of the smaller pebbles found in nests had been regurgitated (see Siegel-Causey 1986). Regurgitated boli were occasionally found in nests after birds had been disturbed from colonies. Since nests with pebbles were typically located on the periphery of colonies, and contained few if any eggs or young, they may have been attended by young or inexperienced birds (Siegel-Causey and Hunt 1986, Kharitonov and Siegel-Causey 1988). Construction of mock or ephemeral nests by subadult and adult cormorants has been reported (Van Tets 1959; Siegel-Causey and Hunt 1986). In younger birds, this behavior may contribute to the development of nesting skills, and the creation and attendance of pebble clutches may be an extension of this behavior.

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Cranial pneumatization in the Phalacrocoracidae.—In certain regions of the cranium in birds, air spaces separate inner and outer layers of dense, ossified bone. In many cases, these pneumatic areas ("ossified bone" [sic] of earlier studies—see Serventy et al. 1967) are contiguous with cranial air sacs, but precise functions are still being debated (Harrison 1957, Warneke and Stork 1977, Winkler 1979). Pneumatization occurs late in development and has been used to assess cranial maturation (Winkler 1979); its relationship with age, however, is not well understood, and its reliability as an age index is uncertain (cf. Serventy et al. 1967, McNeil and Burton 1972, Sugimori et al. 1985).

The relationship of the bursa of Fabricius with age has been well-documented, and its size is used regularly to assess chronological age (see Gower 1939, Linduska 1943, Kirkpatrick 1944). Davis (1947) and McNeil and Burton (1972) consequently examined the relationship between cranial ossification and bursa size, but found differing results. Davis qualitatively assessed bursa size and cranial ossification in 110 species in 31 families, and although he found widely varying results, he felt that degree of cranial ossification was directly correlated with age. McNeil and Burton found no such relationship among ossification, pneumatization, and age in 21 species of shorebirds, but determined that bursa size tracked chronological age as it did in other birds.

During the course of a phylogenetic study of the Phalacrocoracidae (Siegel-Causey 1988), I was able to obtain data on cranial pneumatization patterns in 15 taxa in the family. Where possible, I measured bursa size, extent of pneumatization, and various skull dimensions. I examine here the phylogenetic patterns of cranial pneumatization in the Phalacrocoracidae and the relationship between the extent of cranial pneumatization, bursa size (age), and body size.

Methods.—All skeletal measurements were done on museum specimens obtained from various collections. Species of Phalacrocoracidae used in this study and sample sizes are: Reed Cormorant (*Phalacrocorax africanus,* 15), Little Pied Cormorant (*P. melanoleucos,* 21), Brandt's Cormorant (*P. penicillatus,* 4), Black-faced Cormorant (*P. fuscescens,* 2), Olivaceous Cormorant (*P. olivaceus,* 50), Double-crested Cormorant (*P. auritus,* 57), Little