A guide to foraging methods used by marine birds in Antarctic and Subantarctic seas. BIOMASS Handbook 24:1–22.

KOOYMAN, G. L., Y. CHEREL, Y. LE MAHO, J. P. CROXALL, P. H. THORSON, V. RIDOUX, AND C. A. KOOYMAN. 1992. Diving behavior and energetics during foraging cycles in King Penguins. Ecol. Monogr. 62:143–163.

KURODA, M. 1954. On the classification and phylogeny of the Order Tubinaires, particularly the shearwaters (Puffinus). Herald Co., Tokyo.

PENNYCUICK, C. J. 1982. The flight of petrels and albatrosses (Procellariiformes), observed in South Georgia and its vicinity. Phil. Trans. Roy. Soc. Lond. B 300:75–106.

PENNYCUICK, C. J., J. P. CROXALL, AND P. A. PRINCE. 1984. Scaling of foraging radius and growth rate in petrels and albatrosses (Procellariiformes). Ornis Scand. 15:145–154.

PRINCE, P. A., AND M. JONES. 1992. Maximum dive depths attained by South Georgia Diving Petrel *Pelecanoides georgicus* at Bird Island, South Georgia. Antarct. Sci. 4:433–434.

PRINCE, P. A., N. HUIN, AND H. WEIMERSKIRCH. 1994. Diving depths of albatrosses at South Georgia and Macquarie Islands. Antarct. Sci. 6:353–354.

SKIRA, I. J. 1979. Underwater feeding by Short-tailed Shearwaters. Emu 79:43.

SWENNEN, C., AND P. DUIVEN. 1991. Diving speed and food-size selection in Common Guillemots *Uria aalge*. Neth. J. Sea Res. 27:191–196.

WANLESS, S., A. E. BURGER, AND M. P. HARRIS. 1991. Diving depths of Shags *Phalacrocorax aristotelis* breeding on the Isle of May. Ibis 133:37–42.

WILSON, R. P., AND M.-P. T. WILSON. 1988. Foraging behaviour in four sympatric cormorants. J. Anim. Ecol. 57:943–955.

WOOD, K. A. 1993. Feeding behaviour, offal preferences and tarsus shape of *Puffinus* shearwaters off central New South Wales. Notornis 40:123–127.

The Condor 96:1113–1114

MULTIPLE CASES OF POLYGYNY IN THE BLACK-CAPPED CHICKADEE: A POSSIBLE ADVANTAGE TO THE PRIMARY FEMALE[1]

JANINE R. CLEMMONS
Department of Zoology, University of Wisconsin, Madison, WI 53706

Key words: Polygamy; polygyny; Black-capped Chickadee; Parus atricapillus; *female choice.*

The Black-capped Chickadee, *Parus atricapillus,* is almost strictly monogamous with only one reported case of polygyny (Smith 1967, Smith 1991) and two reported cases of polyandry (Waterman et al. 1989, Howitz 1991). Here I report several cases of bigyny occurring during one breeding season within a small study area. The primary female was identified as the first female to nest on the territory.

In 1992, there were three cases in which female chickadees constructed nests on territories of mated pairs in the Picnic Point area of the University of Wisconsin–Madison. Two cases occurred in an area with about ten nesting pairs. The males assisted primary females with excavation of the nesting cavities, whereas secondary females excavated alone. Copulation with the secondary female while the primary female incubated was observed in one case. In the second case, although copulation with the secondary female was not observed, the male defended her nesting area, as demonstrated when he sang "*fee-bee*" in response to playbacks of *fee-bee* song within 20 m of her nesting cavity. In both cases, the nests of the primary females were depredated, and the primary females subsequently usurped the nests of the secondary females. Secondary females were not seen in the nesting area after usurpation. The third case was discovered in a nearby woods after the eggs of the secondary female were laid. This nest resided within the defended area of the male, as indicated by his response to playbacks of *fee-bee* song. The nest of the primary female fledged, and the nest of the secondary female was depredated after hatching.

The degree to which secondary females were tolerated on the territories was unclear, but they were probably excluded from the nest vicinity of the primary female. In one case the primary female was once observed to chase the secondary female a short distance from the nest but not completely off the territory. In another case, the two females and the male foraged together without aggression on the territory but away from the nest site of the primary female prior to egg laying. The primary female was once observed to supplant the secondary female who was peering into the primary female's nesting cavity. Aggression is also known to occur between resident females in polygynous species (Searcy 1988, Yasukawa et al. 1992).

Why polygyny was common in the Madison study area during the breeding season of 1992 is unclear. There were no other reported cases of polygyny in the previous three years of the study. In the related Blue

[1] Received 27 July 1994. Accepted 1 August 1994.

Tit (*Parus caeruleus*), polygyny may arise when there is a female-biased sex ratio (Kempenaers 1994). Other explanations for polygyny frequently invoke female choice for superior males (Verner 1964, Verner and Willson 1966, Orians 1969, Dhondt 1987). Although not necessarily the primary or only factor driving polygyny in the present observation, female choice may have been involved with the chickadees: in all three cases, secondary females occurred on territories of males in at least their second breeding season. It has also been suggested that being a secondary female might increase the probability of becoming a primary female the second year (Weatherhead and Robertson 1979). Accordingly, at least two of the three secondary females of the present report were in their first breeding season. The age of the third female was unknown. Two of the secondary females continued to associate with the males beyond the nesting season. One of these paired with the male in the subsequent breeding season. In the other case, the male disappeared, presumably died, before the next breeding season.

Few discussions consider the possible advantages that primary females receive by association with secondary females, and most of those focus on mutual benefits of the "co-wives" (Altmann et al. 1977, Picman et al. 1988, Yasukawa et al. 1992). Therefore, it may be worth noting the unique situation with the chickadees, where two of the three primary females appeared to benefit by having a new nest site ready to occupy in the event that the first nest was depredated. Black-capped Chickadees typically raise only one brood per year, renesting only if the first attempt fails early in the season. Finding and excavating a new nesting cavity is costly with respect to both time and energy, and chickadees rarely reuse failed nest sites or sites excavated in previous years. The primary females began laying within four days of losing their first nests, whereas another pair without a secondary female took 10 days before the first egg of the second clutch was laid. However, the benefits, if any, would not necessarily be mutual: the primary female appeared to benefit only if she lost her first nest and at the expense of the secondary female. The secondary female could benefit either way, by increasing her chance of becoming the primary female later in the season or subsequent year, or by having a chance to rear offspring during the season she is without a mate.

Thanks to Ken Yasukawa for discussion, to Jack P. Hailman and Christine Hurd for assistance in the field and key information, and to J. P. H., Jaroslav Picman, Susan M. Smith, Jared Verner and two anonymous reviewers for helpful comments on earlier drafts of the manuscript.

LITERATURE CITED

ALTMANN, S. A., S. S. WAGNER, AND S. LENINGTON. 1977. Two models for the evolution of polygyny. Behav. Ecol. Sociobiol. 2:397–410.

DHONDT, A. A. 1987. Polygynous Blue Tits and monogamous Great Tits: does the polygyny-threshold model hold? Am. Nat. 129:213–220.

HOWITZ, J. L. 1991. A case of polyandry in Black-capped Chickadees. Loon 63:152–154.

KEMPENAERS, B. 1994. Polygyny in the Blue Tit: unbalanced sex ratio and female aggression restrict mate choice. Anim. Behav. 47:943–957.

ORIANS, G. H. 1969. On the evolution of mating systems in birds and mammals. Am. Nat. 103: 589–603.

PICMAN, J., M. LEONARD, AND A. HORN. 1988. Antipredation role of clumped nesting by marsh-nesting Red-winged Blackbirds. Behav. Ecol. Sociobiol. 22:9–15.

SEARCY, W. A. 1988. Do female Red-winged Blackbirds limit their own breeding densities? Ecology 69:85–95.

SMITH, S. M. 1967. A case of polygamy in the Black-capped Chickadee. Auk 84:274.

SMITH, S. M. 1991. The Black-capped Chickadee: behavioral ecology and natural history. Comstock, Ithaca, NY, and London.

VERNER, J. 1964. Evolution of polygamy in the Long-billed Marsh Wren. Evolution 18:252–261.

VERNER, J., AND M. F. WILLSON. 1966. The influence of habitats on mating systems of North American passerine birds. Ecology 47:143–147.

WATERMAN, J., A. DESROCHERS, AND S. HANNON. 1989. A case of polyandry in the Black-capped Chickadee. Wilson Bull. 101:351–353.

WEATHERHEAD, P. J., AND R. J. ROBERTSON. 1979. Offspring quality and the polygyny threshold: "the sexy son hypothesis." Am. Nat. 113:201–208.

YASUKAWA, K., R. A. BOLEY, J. L. MC CLURE, AND J. ZANOCCO. 1992. Nest dispersion in the Red-winged Blackbird. Condor 94:775–777.