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Dissertation Abstract

Offspring Sex Ratio, Mortality and Relative Provisioning of Daughters and Sons in the Northern Harrier (*Circus cyaneus*)

Sex ratio theory has two main paradigms. The first, proposed by R.A. Fisher (1930, The genetical theory of natural selection, Clarendon Press, Oxford, U.K.), posits that natural selection will favor parents that invest equally in the sexes, such that the population sex ratio at the end of the period of parental care should be the inverse of the costs of producing individuals of each sex. The second paradigm supposes that whenever the genetic fitness benefits of producing daughters or sons vary predictably with ecological circumstances individual parents are expected to manipulate the sex ratio of their offspring so as to maximize the number of grandoffspring produced.

Offspring sex ratios were documented over 10 yr (1980–85, 1990–93) for a New Brunswick, Canada, population of the northern harrier (*Circus cyaneus*), a strongly size-dimorphic hawk. In contrast to a population in Orkney, Scotland, in which the sex ratio at fledging was female-biased (N. Picozzi 1984, *Ibis* 126: 356–365), sex ratios at hatching and at fledging did not deviate from parity in New Brunswick. However, in Scotland, the sex ratio at fledging became progressively less female-biased and eventually male-biased over a 30-yr period. In Orkney, but not in New Brunswick, there existed a shortage of males in the breeding population. Despite the larger size of females, daughters and sons were provisioned similar amounts of food during the period of parental care. This implies that the sexes similarly affect parent residual reproductive value, i.e., the expected contribution to the population through future offspring. These observations are consistent with the expectation of Fisher's principle of the evolution of population sex ratios, viz., parents should invest equally in daughters and sons, unless the reproductive values, or average expected fitnesses, of the sexes differ, in which case natural selection will favor parents that produce more of the rarer sex. A seasonal decline in sex proportion of males was evident among fledglings, but not hatchlings, implying a differential increase in mortality among male offspring as the breeding season progressed. Increased mortality among males relative to females was primarily due to an overall seasonal increase in nestling mortality, rather than to sex-specific differences in susceptibility to mortality.

I found little evidence of facultative parental manipulation of offspring sex ratios depending on ecological circumstances at the time of breeding. Sex ratios varied nonrandomly according to the egg-sequence within clutches. Overall, eggs laid first in the clutch were biased toward females, and second and third eggs laid were biased toward males; however, the proportion of females among eggs laid early increased with increasing clutch size. Regardless of clutch size, neither sex predominated in the last egg laid. I could not confirm that the nonrandom allocation of the sexes within clutches is adaptive; however, growth in females was more strongly negatively associated with correlates of reduced food consumption and increased mortality, including high precipitation, late birth date, and late positions within the laying sequence than was growth in males. Females began flying at an older age and developed flight skills more slowly than males. Furthermore, the ability of fledglings to secure food from parents was strongly influenced by the sequence in which siblings began flying. Thus, a skewing of the sex ratio of first-hatched offspring toward females may enhance the growth, competitive ability, and survival, and hence, fitness of daughters. Eggs hatched asynchronously; consequently, starvation increased with position in the laying sequence. Yet, the proportion of nestlings that died within broods did not increase with brood-size. I propose that the shift toward an even sex ratio among late-hatched eggs is an adaptive mechanism that limits the degree of sex-biased mortality and forestalls the development of a maladaptive sex ratio at the end of the period of parental care.—**R. Bruce MacWhirter. 1994. Ph.D. dissertation, Department of Zoology, The Ohio State University, Columbus OH, 43210 U.S.A. Present address: Department of Natural Resource Sciences, McGill University, 21 111 Lakeshore Road, Ste. Anne de Bellevue, QC H9X 3V9 Canada.**