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Brief report

Characteristics of maternal family lineages in a Common Goldeneye *Bucephala clangula* breeding population

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1. Introduction

Before their first breeding attempt, animals must decide whether to stay in their natal area or to disperse. Dispersing and colonising new areas is an essential life history trait and occurs when there is a chance that a new location will be more favourable than the one that is presently inhabited (Gadgil 1971). Remaining near the site of birth, natal philopatry, involves benefits like familiarity with and possible adaptation to the local area and its environment. Dispersing behaviour is female biased in most avian species, the family Anatidae being a well-known exception for female site fidelity and male dispersal (Greenwood 1980, Clarke et al. 1997). However, the evolutionary basis of philopatry suggests that Anatidae is not an exception because the sex defending resources is the philopatric one (Clarke et al. 1997).

Different rates of philopatry and dispersal by breeders determine the current structure of the breeding population (Greenwood 1980, Hewitt & Butlin 1997). In a given year, breeding individuals consist mainly of three different subgroups: (i) natally philopatric breeders that were born in the area and also began to breed there, (ii) individuals that were born outside the focal population and that have bred in the area before and (iii) immigrant breeders that were born outside the focal population, and have not bred there earlier.

The Common Goldeneye *Bucephala clangula* is a diving duck whose breeding range covers most of the northern coniferous forest (between 55° and 70°) in Europe, North Asia and North America (Dennis & Pöysä 1997). In Europe, about 80% of the goldeneye population breeds in Finland and Sweden, where extensive nestbox schemes may have increased the breeding population (Dennis & Pöysä 1997). Typical for Anatidae species, Common Goldeneye females are philopatric to their natal and breeding sites (Dow & Fredga 1983, Pöysä et al. 1997a). As a result of long lifespan and iteroparous breeding, closely related females may breed simultaneously in the same area (Pöysä et al. 1997a, Ruusila et al. 2000).

In this paper, we will use long-term ringing-recovery data to study the structure of the breeding population of female Common Goldeneyes. First, we document the family lineage pattern evolved from natal and breeding site philopatry. Second, we consider consequences of philopatry to relatedness of individuals and further, on structure of the breeding population (Greenwood & Harvey 1982, Anderson et al. 1992). We also briefly discuss factors essential to the development of the observed population structure.

2. Material and methods

This study is based on ringing-recovery data from Maaninka, central Finland (63°09´N, 27°17´E), during 1984–1998. The study area consists of 14 lakes and three bays of larger lakes surrounded mainly by agricultural land. The Common Goldeneye naturally breeds in old nests of Black Woodpecker *Dryocopus martius* or other tree cavities. Natural nest holes are however in a very limited supply because of active farming and forestry practices. The shores of most lakes are sparsely populated by farms and summer cottages. Nest boxes are ca. 50 cm high and made of hollow trunks or board, with an inside of 20 cm and flying hole of 10 cm in diameter. Some 10–15 cm thick filling of wood shavings is put on the bottom of the box, which seems to be of great importance for Goldeneyes' nesting success. Boxes are attached to trees 2–3.5 m above ground and within 10 meters of the shore line. Distance between boxes varied between 10–300 m on the shores and islands within the area.

We visited all nest boxes in the area at the onset of the breeding season in early May. To ensure that all breeding attempts were recorded, we made a second visit one to two weeks later to boxes unoccupied at the first visit. Between 1984–1989 the area was expanded to its current size, about 280 km^2. Until 1995 the number of nest boxes was ca. 250 (Pöysä et al. 1997a), and during 1996–1998 it has varied between 300–350 boxes.

The mean proportion of occupied nest boxes was 26.4% per year (range 18.3–35.5%). We ringed breeding females and hatched young every year, the latter with special wax-filled rings (Mihelsons & Blums 1976, Pöysä et al. 1997a). Females were caught by a net from the nest boxes during the last week of incubation and young were ringed within 48 hours after hatching.

During the study period, we caught 98.0% of successful broods (N = 612) and 99.0% of successfully breeding (at least one hatchling) females (N = 612). In this number, all females in every year are included, i.e. a female is counted every time she breeds. The proportion of unsuccessful clutches (no hatched young) was 24.7% (N = 815), and resulted mainly from desertion. Since almost all ducklings and all breeding females were caught and ringed, we were able to recognise family lineages and population structure every year. A female that had produced a daughter breeding in the population was considered the minimum unit of a family lineage. The first recruit returned to breed in the area in 1987, and during the study period, we recognised 24 family lineages (an example in Fig. 1). No males hatched in the area have been caught or seen returning to the site (Pöysä et al. 1997a and unpublished data).

3. Results

Only 13.4% of all ringed breeders (29/217) produced a recruit to the population at some stage. This number must be considered a low estimate, since it does not include recruits of new breeders from 1997 (the offspring are not mature in 1998) nor females that have bred earlier or are currently breeding, but whose recruits have not arrived yet or will be produced during later stages of life.

To date, 20 of the lineages have produced breeding females in two generations, 3 in three and 1 in four. On annual basis, an average of 18.4% (min 6.3%, max 40.0%) of controlled breeding females had one or more relatives breeding in the area (Fig. 2). The proportion of females with relatives in the area did not correlate with year (r_S = 0.084, P = 0.8, N = 12), number of breeding attempts (r_S = 0.225, P = 0.483, N = 12) or number of experienced breeders (r_S = 0.126, P = 0.696, N = 12). The most common kinship type was between mothers and daughters, 71.4% (N = 70). The remainder was made up by half-sisters (21.4%), sisters (5.7%) and grandmother–granddaughter (1.4%).

The number of new recruits per year varied between one and seven (mean 3.67 ± 1.87SD), representing a considerable proportion (mean 27%) of all new breeders in the area annually (Fig. 3). Mean annual proportion of all new breeders in the area was 32.6%; only years after the

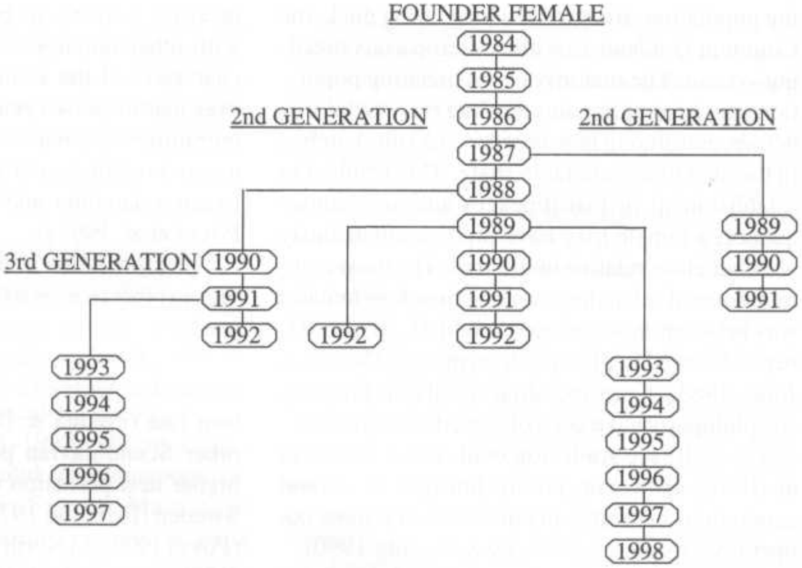

Fig. 1. An example of a matrilineal family lineage as a consequence of female natal philopatry. In this case the founder female started breeding in 1984 and has produced recruits to the population in three generations, having four daughters and one granddaughter. The breeding years of each female between 1984–1998 are indicated.

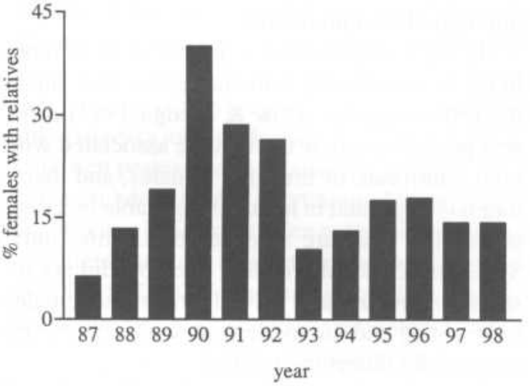

Fig. 2. Annual proportion of females with at least one breeding relative of captured breeders in the study population between 1987–1998. Number of lineages where related females have bred simultaneously is 16.

expansion of the study area (1990–1998) are included. The mean number of observed breeding years before a female produced her first recruit to the population was 2.62 ± 2.41SD (N = 29). The number of total breeding years of these females in the area was 5.76 ± 2.75SD (N = 29). This should be considered as a minimum value, since many females were already breeding or have possibly bred somewhere else prior to the onset of the study.

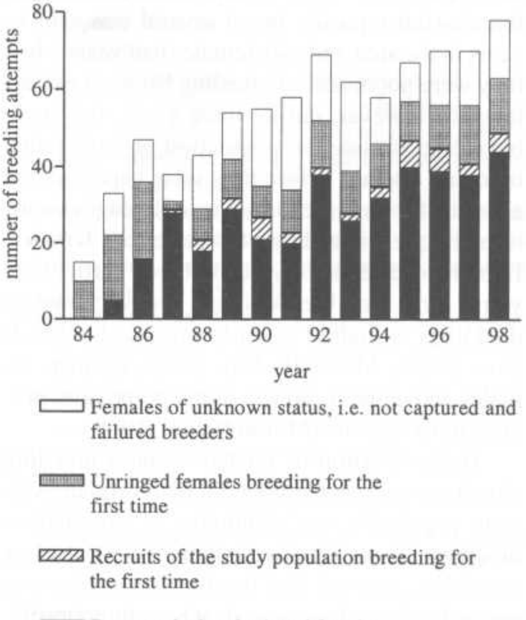

Fig. 3. Yearly population structure of breeding females. Each bar represents the number of initiated breeding attempts.

4. Discussion

In this study we documented consequences of female natal and breeding site philopatry on breeding population structure of a long living duck, the Common Goldeneye, with an iteroparous breeding system. The majority of the breeding population consisted of females that had bred in the area before, and among new breeders, recruits hatched in the area made a notable share. This resulted in establishment of matrilineages and as a consequence, a female may have bred simultaneously with her close relative in the area. The most common form of relatedness among breeding females was between mothers and daughters, as also has been observed in philopatric mammals (Waser & Jones 1983). Corresponding results on breeding site philopatry have been observed in other Anatidae as well (see Anderson et al. 1992, Clarke et al. 1997). However, family lineages in several generations are rarely documented (for some cooperative species, see Stacey & Koenig 1990).

Relatively few females produced daughters who returned to breed in their natal area. Those females did typically breed several consecutive years in the area; only six females had years when they were not observed breeding between two attempts. However, during these years, they may have bred outside the population or have failed breeding attempt before they were captured. An essential factor in the formation of lineages seems to be frequent breeding of experienced females. Experienced females typically breed earlier than young first time breeders, and recovery rate of ducklings is highest in early broods (Fredga & Dow 1984a, Milonoff et al. 1998). Further, females above the mean age of the population produce most recruits (Milonoff et al. 1998).

The proportion of related females breeding simultaneously in the area did not correlate with year, population size or number of experienced breeders. Instead, it fluctuated without a clear trend, and although new lineages emerged, some seemed to have disappeared, at least temporarily. However, continuous congregation of relatives in the area could increase the population density, intensify competition over nest sites and therefore increase the costs of philopatry (Anderson et al. 1992). For example in Snow Geese *Anser c. caerulescens* and Black Brant *Branta bernicla nigrans*, increasing colony size decreased the level of natal philopatry in females (Cooch et al. 1993, Lindberg et al. 1998, respectively).

Recruitment of females born in the area as breeders is likely to be reduced by competition with other females as well as some life history characters of the Common Goldeneye. Goldeneyes mature at two years of age, and this delay in recruitment decreases the likelihood of simultaneous breeding, and possible competition, between a daughter and her mother (Emlen 1997, Pöysä et al. 1997a).

Nest predation is the main cause of nest failures in birds (e.g. Martin 1988). Mean annual nest predation rate in our study area was 5.4% (range 0–15%). Corresponding results have been detected in Sweden, with 10% nest predation and 59% return rate (Fredga & Dow 1984b). Studies from other Scandinavian populations usually report higher nest predation rates, for example 38% in Sweden (Eriksson 1979) and 33–74% in Finland (Pöysä 1999). In North America, Savard and Eadie (1989) observed 29–45% return rate in Common Goldeneye nest recaptures, but do not give an estimation of nest predation.

If Goldeneye's nest is predated, it is more likely that the female will change her nest site in the following year (Dow & Fredga 1983). Low nest predation rate is likely to be associated with high return rate of breeding females, and therefore it is important in maintaining stable breeding population structure as observed in this study. Since unsuccessful breeding attempts did not result from predation, it is likely that these females were young and inexperienced, which in general more easily desert their clutch.

To summarize, we observed configuration of matrilineal family lineages based on natal and breeding site philopatry of Common Goldeneye females in our study population. Although new lineages were established, number of females with breeding relatives in the area did not increase with time. The prerequisite for the emergence of matrilineages and observed population structure seems to be repeated, successful breeding of females with earlier experience in the area. A low nest predation rate is likely to play a significant role by enticing females to remain in the area and in assuring good breeding success.

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Selostus: **Naarassukulinjojen esiintyminen telkän pesimäpopulaatiossa**

Vesilinnuille tyypillisesti naaraat ovat sekä synnyinpaikka- että pesäpaikkauskollisia myös telkällä. Tutkimme pesivien naaraiden ja pesäpoikasten rengastuksen avulla 1984–1998 välisenä aikana paikkauskollisuuden vaikutuksia pesimäpopulaation rakenteeseen Pohjois-Savossa Maaningan kunnassa. Noin 67% naaraista oli pesinyt alueella aikaisemmin, ja uusista pesijöistä 27% oli kuoriutunut tutkimusalueella ja palannut sinne pesimään. Populaatiorakenne pysyi hyvin samankaltaisena eri vuosien välillä. Pesimäpopulaatioon oli muodostunut yhteensä 24 naarassukulinjaa, joissa äitiä ja tyttäriä oli pesinyt alueella vähintään kahdessa sukupolvessa joko yhtäaikaa tai erikseen. Lähisukulaisten pesiessä yhtäaikaisesti tyypillisin sukulaisuussuhde oli äidin ja tyttären välinen. Toisilleen sukua olevien naaraiden määrä populaatiossa ei kuitenkaan kasvanut ajan myötä, vaan vaihteli 6–40% välillä. Keskeinen tekijä havaitun populaatiorakenteen ja naaraslinjojen syntymisen kannalta on todennäköisesti alhainen pesäpredaatio.

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