The heritability of tarsus-length in House Sparrows *Passer domesticus*

For several years, we have been studying a population of House Sparrows *Passer domesticus* that breeds around the farm buildings at a Nottinghamshire College of Agriculture. Adult birds are trapped and marked with coloured rings. Their breeding performance is monitored, and their young are weighed and measured at 10 days of age. A blood sample is taken from every individual on the first occasion that it is handled. This is used as a source of DNA for genetic fingerprinting (Wetton et al., 1987).

We can use our family data to determine the heritability of tarsus-length in the population. There are no gross discrepancies between years, but young sparrows have shorter legs if they come from larger clutches, and longer legs if they come from higher surviving broods. There is also a significant positive correlation between progeny mean and both male and female parent. Heritability can be estimated as twice the regression coefficient (Falconer 1960); that on the female parent is about 8% higher than on males.

Studies on other species (e.g. Pied Flycatcher *Ficedula hypoleuca*, Alatalo et al. 1984) have suggested that this is due to a proportion of the progeny not being the offspring of the attendant males, and thus being reared against the 'wrong' adult. When we eliminate progeny known from DNA fingerprinting to be extra-pair from the data set, the difference between male and female heritability disappears.

Following the method of Alatalo et al. (1984), we can estimate the degree of extra-pair fertilisation (epf) in the population. We know from the DNA fingerprinting that the female is always the true mother, so we can artificially create data sets with known amounts of 'epf' by randomly assigning females to progeny at that frequency. Calculation of female/progeny regression will give the relationship between heritability and 'epf' rate. Comparing the observed male/progeny heritability with this gives an estimate of 'epf' rate in nature. In fact, this comes out at 19.4%, which is close to the value of 14.6% derived directly from DNA fingerprinting.

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Alatalo, R.V., Gustafsson, L. & Lundberg, A. 1984. High frequency of cuckolodry in Pied and Collared Flycatchers. Oikos 42: 41-47.

Falconer, D.S. 1960. Introduction to Quantitative Genetics. Edinburgh: Oliver and Boyd.

Wetton, J.H., Carter, R.E., Parkin, D.T. & Walters, D. 1987. Demographic study of a wild house sparrow population by DNA fingerprinting. Nature 327: 147-149.

Long-term studies of American White Ibises *Eudocimus albus* breeding in coastal South Carolina

The numbers of American White Ibises *Eudocimus albus* breeding on Pumpkinseed Island at the North Inlet Estuary Long-Term Ecological Research site in coastal South Carolina, USA, have fluctuated between <2000 and >20,000 pairs during the past 11 years. Concurrent observations of ibises feeding in the estuary indicate that changes in the breeding population do not result from changes in the availability of estuarine prey. Rainfall during the 6-month period before hatching, however, is correlated with the number of ibises breeding at the site, and the amount of local rainfall, in turn, influences the availability of freshwater prey in flooded bottomland hardwood forest adjacent to the site. Results of experiments in which nestling ibises were hand-reared on either estuarine or freshwater prey reveal that freshwater prey is essential for the normal growth and development of nestlings. The results of these experiments indicate that even at estuarine sites, where adult ibises regularly feed on estuarine prey, nestling ibises require a diet of freshwater prey. Observations along flight lines, together with regurgitant samples collected at the colony site, show that as a result of this physiological bottleneck, ibises import considerable amounts of nitrogen and phosphorus from freshwater habitats into estuarine areas. For example, during some, but not all breeding seasons, the amounts of nitrogen and phosphorus imported into the North Inlet Estuary by White Ibises approach those transported by atmospheric processes. The results of our long-term studies demonstrate that avian-induced ecosystem processes in estuaries with large colonies of wading birds can vary considerably from year to year, and they suggest that estuaries with large colonies of nesting birds can experience different nutrient regimes than sites without such colonies.

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The dynamics of a cyclic predator-prey system: the Barn Owl *Tyto alba* and field vole *Microtus agrestis*

From 1979 to 1990 relationships between populations of Barn Owls *Tyto alba* and their prey were studied in two areas in south Scotland: the Esk/Liddie and the Dee river catchments. Field vole populations were cyclic with a 3-year periodicity. synchronised over the study areas. Common shrew *Sorex araneus* populations declined in synchrony with vole declines. Field voles *Microtus agrestis* were the owls' main prey by weight at all times but as voles declined, the owls switched more to shrews and, in lowland areas, to woodmouse *Apodemus sylvaticus*. All aspects of owl breeding biology, including laying dates, clutch-size, chick mortality, weights at fledging, number fledged and frequency of second broods, were cyclic, and synchronized with vole cycles. On average only 7% of pairs did not breed in low vole years. On 85% of birds dispersed less than 10 km between natal and breeding sites with no differences in relation to vole cycles. Mortality rates of breeding adults were cyclic with lowest...
levels at peak vole populations and highest levels in the year following the year of vole decline. Numbers recruited to the breeding population were related to vole abundance. The total pairs and the number of breeding pairs in the populations were cyclic. The decline phase was extended over two years following vole declines such that lowest owl numbers occurred one year later than the year of vole decline. Changes in owl numbers were not related to yearly changes in breeding output but to changes in mortality rates and recruitment rates.

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Population dynamics of breeding Grey Herons Ardea cinerea in Flanders, Belgium, during the period 1981–1989

Since 1981 a yearly census of the breeding population of Grey Herons Ardea cinerea has been organized in Flanders, northern Belgium. In the Wallonian region, breeding Grey Herons are rather scarce. Every year between 28 and 35 heronries were counted very precisely. The total number of occupied breeding sites (including solitary nests) per year varied between 35 and 39. The estimated total number of breeding pairs increased slowly between 1981 (1464 occupied nests) and 1983 (increase of 27%). Since 1983, a gradual decrease was recorded and in 1987 the population had decreased by 33%. It is tempting to speculate that the series of severe winters was largely responsible for this trend, although the decrease had already started in 1984, before the first hard winter. Probably other factors were involved. However, after the first warm winter of 1987–1988 numbers increased very quickly (49%), and after two extremely warm winter periods, the breeding population increased by 77%. The heron population reached an absolute maximum for this century in 1989, when 2183 pairs were recorded in 39 heronries. The mean number of breeding pairs per heronry showed a trend comparable with the total numbers counted.

Thus the recent fluctuations of the breeding population are expressed by changes in the number of occupied nests per colony, prior to changes in the number of colonies. Nest density for the whole of Flanders is very high: 1.48 pairs per 100 km². All colonies are established in trees: 57% of the nests are built in deciduous forests, 43% in larch and pine woods.

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Sex ratio and population dynamics of Great Bustards Otis tarda

In the Great Bustard Otis tarda, the sex ratio is usually slightly biased in favour of females (1:1.5–2:5; Gewalt 1959, Winkler & Dangel 1972, Winkler 1973, Triebl 1978, Farago 1982, Otero 1987). However, in populations with severe hunting, sex ratios of up to 1:5 and 1:10 or even more are found due to selective shooting of the males (e.g. Lukschanderl 1970, 1971, Fodor et al. 1971, Ferianc 1973, Litzbarski et al. 1987, Farago 1987). As in many species, the natural sex ratio is heavily affected either by direct impact (hunting) or by habitat deterioration.

Sex ratio and census data were calculated from Lukschanderl (1971), Winkler & Dangel (1972), Winkler (1973), Hutterer & Lütkens (1974), from 1978 onwards from censuses carried out by hunters’ associations and, from 1981 onwards, from our own data, for the Marchfeld, Austria.

Until the hunting ban in 1969 a sex ratio of 1:4–5 was reported. In 1971 it was still 1:3.3, and fell to 1:1.75–1:1.94 in 1980 (Fig. 1). Around 1981/82, the ratio changed to a slight preponderance of males and since then has varied around 1:0.7–0.8. In contrast to the former marked bias due to hunting, the present reverse effect can probably be explained by losses of breeding females caused by highly mechanized agricultural methods and/or by higher mortality rates among female young birds. Through habitat restoration measures, such as the setting up of managed plots ('bustard plots'; BP 1 & 2) since 1979, it is hoped to minimize these effects and to stop the decline of the population (Kollar 1983, 1988, 1989).

Numbers decreased from about 100 individuals in 1967 to 22 in 1987 and since then rose again to 28 in 1989 (Fig. 2). The hunting ban seemed to have only a short-lived effect on the recovery of the population. Subsequent habitat management measures probably contributed to the slowing down of the decline and to the supposed

Figure 1. Sex ratio of the Marchfeld (Austria) Great Bustard population.
stabilization during the last few years. At the same time, the sex ratio slowly seems to have returned to an approximately natural state.

The setting up of especially managed plots for Great Bustards, as well as similar habitat restoration measures in the intensively used agricultural landscape of the Marchfeld (and others), are thought to be the only promising long-term strategy for the preservation of the Great Bustard (and other species).

**KOLLAR, H.P. 1983. Der Einfluß von Trappenschutzfeldern auf den Hutterer.**

**KOLLAR, H.P. 1991. Zur Bestandsentwicklung der Großtrappe (Otis tarda L.).**

**KOLLAR, H.P. 1988. Arten- und Biotopschutz am Beispiel der Großtrappe. Umwelt. Grüne Reihe des Vereins für Ökologie und Umweltforschung 22, Vienna.**

**LIEBCHEN. L. 1970. Zur Bejagung der europäischen Großtrappe (Otis tarda L.). Zeitschr. f. Jagdwissenschaft 16: 75–89.**

**LOYER, M. 1973. Die Großtrappe (Otis tarda L.) in Osterreich.**

**PARAGI. S. 1982. A Hanság környéki tůzokállomány, éven Magyar-Osstrák szinkronfelvételek alapján. Allatani Közlemények 69: 75–84.**

**PARAGI. S. 1987. Der Großtrappenbestand (Otis tarda) Ungarns.**

**PARAGI. S. 1987. Osterreichisch-ungarische Trappenzählung 1970. Natur und Umwelt im Burgenland 1(2): 51–52.**

**PETRICK, S. 1987. Zur Okologie und zum Trappenbestand (Otis tarda L.).**

**PIECZYNSKI, W. 1969. Die Großtrappe (Otis tarda L.) im Bezirk Potsdam. Acta ornitho-oecol. Jena 1/3: 199–244.**

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**Changes in survival rates of Lesser Snow Geese**

We used data from a 20 year study of Lesser Snow Geese *Anser caerulescens caerulescens* nesting at La Pêrouse Bay, near Churchill, Manitoba, supplemented with data from other colonies in the same flyway, to describe the patterns of age-specific survival and estimate how these patterns change with time. We used various analysis techniques, based both on recoveries from hunters and live recaptures at the banding site.

Mortality rates of geese during their first year after fledging averaged about three times higher than those of adults. However, young geese were only twice as likely to be shot by hunters, indicating that they experience higher natural mortality. Yearlings were also more likely to be shot, and had slightly lower survival rates than adults, but older non-breeders and failed breeders were less likely to be shot than breeding adults. There was no evidence of any senescent decline in survival up to at least 12 years of age, although the sample sizes for older age classes were small.

Mean adult survival increased significantly over the course of the study from about 78% in 1970 to nearly 88% in 1987, corresponding to nearly a doubling of the expected mean life-span. This increase was related to a decline in the proportion of birds being shot, suggesting that variation in adult survival is strongly controlled by hunting pressure. In contrast, immature survival decreased significantly between 1970 and 1987, despite the lower hunting pressure. This appears to be due to a density-dependent decline in food availability on the breeding grounds. These results indicate that quite different factors can affect survival at each stage of the life cycle.

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**Arabian seabirds**

For over forty years the Royal Naval Bird-watching Society has been collecting reports of birds seen at sea around Arabia. A concentration
of southern species off south-east Arabia in the late summer was
studied by R. S. Bailey in 1963-64 and found to be due to a
proliferation of plankton and fish in local upwelling during the SW
monsoon (Ibis 108: 224–264). I visited the area in RFA Tidespring in
November 1987–February 1988 and August 1988 to examine the
tsituation inshore and at other seasons, when northern seabirds
appeared to concentrate in the Gulf of Oman and some of the larger
fish-eating birds, notably the abundant endemic Socotra Cormorants
Phalacrocorax nigrogularis and also the scarcer Red-billed Tropic-birds
Phaethon aethereus. Caspian Terns Sterna caspia and Ospreys Pandion
alinaetus breed in the autumn in the approaches to the Arabian Gulf.
It was found that as the upwelling died away in the Arabian Sea at
the end of the SW monsoon new concentrations of seabirds formed
first over fish-shoals moving out of the Arabian Gulf as the water
temperature fell in the autumn, and then over yellow streaks which
appeared along the edge of the continental shelf in the Gulf of Oman
in the new year, one of which was composed of fishes' eggs. The
species included Audubon's Shearwaters Puffinus lherminieri persicus,
Red-necked and Grey Phalaropes Phalaropus lobatus and P. fulicarius,
Black-headed and 'Heuglin's' Gulls Larus ridibundus and L. (heuglini:)
taimyrensis, and a few White-cheeked Terns Sterna repressa. As the
water temperature rose again in the spring some of these followed the
young fish back into the Gulf. Details will be published in Sea Swallow
40.

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