# SEX AND AGE DETERMINATION OF SHORT- EARED OWL NESTLINGS[1]

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*Abstract.*   We studied plumage patterns of known-sex nestling and juvenile Short-eared Owls (*Asio flammeus*) to develop a sexing technique for nestlings in the field. Markings on the secondaries varied according to sex, and differences were apparent from about 10–15 days of age. We also provide aging formulas based on mass for nestlings up to 15 days of age and on wing length for nestlings older than that age. Finally, we evaluate growth parameters according to sex. The asymptotes of body mass, wing length, and tarsus length growth curves were higher in females than males. The inflexion point was attained earlier by males than by females.

*Resumen.*   Hemos analizado los patrones de plumaje de pollos y jovenes de Lechuza Campestre (*Asio flammeus*) de sexo conocido, para determinar criterios que permitan sexar los pollos en el campo. La coloración de las secundarias difiere entre los dos sexos, y las diferencias son visibles a partir de los 10–15 días de edad. Proporcionamos también fórmulas que permiten calcular la edad de los pollos; los mejores estimadores de la edad son el peso hasta los 15 días, y la longitud del ala a partir de esa edad. Por último, analizamos los parámetros de crecimiento en función del sexo. Las asíntotas de las curvas de crecimiento del peso, la longitud del ala y del tarso, son más elevadas en las hembras que en los machos. El punto de inflexión se alcanza antes en los machos que en las hembras.

*Key words:   aging techniques, Asio flammeus, growth parameters, sexing technique, Short-eared Owl.*

No technique to determine the sex or age of nestling Short-eared Owls (*Asio flammeus*) has been described. Holt and Leasure (1993) described the plumage development of known-age nestlings. Thus, descriptive methods, such as the presence of first or secondary down, degree of development of body feathers, etc, may be used to estimate nestling age. However, such methods are relatively subjective, and are less precise than methods based on body measurements. Precise determination of both nestling age and sex is important for a variety of purposes (e.g., determination of nesting periods, nestling sex-ratio, sex-related variation in behavior, growth, or energetics).

Here, we present a field technique for sexing nestlings and a method to estimate nestling age at different times of the nestling period. We also present nestling growth curves up to 35 days of age according to sex, as published data on nestling growth is relatively limited and only include mass data of nestlings up to 15 days old (Gröndlund and Mikkola 1969, Holt et al. 1992). Finally, we analyze variation in growth parameters according to sex.

## METHODS

The study was carried out in the Département de Deux Sèvres, west-central France (46°11′N, 0°28′W). The study area covers 340 km² of agricultural habitat. Land use in the study area is a mixture of winter cereal crops (35% of the surface), rape-seed and peas (15%), spring-sown crops (sunflower and corn, 25%), other permanent or semipermanent crops (10%), and pasture land (5%). In 1996, between 13–19 pairs of Short-eared Owl were found breeding in the study area (De Cornulier et al. 1997). All pairs bred in crops, mainly cereal but also ryegrass. Nestlings in the field were measured, banded, and released at the same spot. When they were at risk from harvesting activities, however, we temporarily took nestlings to the lab and then released them at the original spot after harvesting. Average (± SD) length of stay in captivity was 7 ± 3 days (range 4–16, *n* = 12).

Plumage patterns were described in all nestlings handled, and photographs were taken of all nestlings temporarily removed from the field. We took a total of nine blood samples from nestlings, sexed using molecular techniques (Griffiths et al. 1998). Additionally, sex, determined by dissection, was indicated in the museum label of six specimens of juvenile and one nestling Short-eared Owls in the Museum of Natural History, Tring, United Kingdom. We evaluated plumage variation of these 16 known-sex chicks and juveniles (9 females and 7 males).

One clutch of seven eggs was found in a ryegrass field that was due for mowing. We collected the clutch and incubated the eggs artificially. One egg had already hatched and another one hatched the same day of collection; two others hatched sequentially at 2-day intervals, and the last one hatched at a 3-day interval. One egg did not hatch, and one nestling died two days after hatching. The remaining five nestlings were raised in captivity, fed ad libitum with 1-day-old chickens. These nestlings were weighed every other day. Tarsus length (measured from the intertarsal joint with vernier calipers), and flattened wing length (measured with a butted rule) were taken every 3–4 days. Aging formulas calculated from the five captive-reared chicks were used to age other nestlings in the field, for which
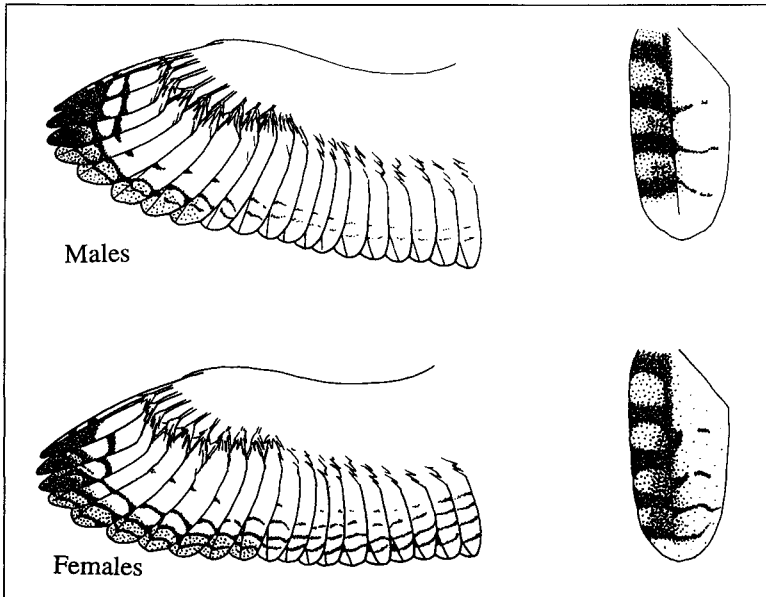
FIGURE 1.    Secondary pattern in male and female Short-eared Owl nestlings. Drawings of the outstretched wings show the ventral view of the wing. Single feather drawings show the dorsal view of a secondary feather. Note the overall paler secondaries in males, and the clear contrast in the dorsal side of the feathers between the pale bands of the outer web (which are ochre) and the inner web (which is pure white).

measurements were taken similarly. Data for the captive-reared nestlings and from nestlings measured in the field (totaling 142 measurements from 28 nestlings) were then combined and fitted to the Richards model of growth curve (Ricklefs 1983, Zach et al. 1984). The use of nonlinear least-square regression procedures assumes that residuals are randomly distributed independently of chick age (Zach et al. 1984). Richards general model of growth curve, with four parameters, was used because it provides a way to choose which kind of more simple model fits the data best (Zach et al. 1984); four models were compared (logistic, Gompertz, monomolecular, and von Bertalanfy). The best model is chosen according to the value of $m$ provided by Richards model, and the fit to the assumption described above with regard to the distribution of residuals. The value of parameter $m$ and inspection of the distribution of residuals using Richards model indicated that the Gompertz equation was most appropriate.

RESULTS

The pattern of markings on the secondaries differed between males and females (Fig. 1). On the upper (dorsal) side of the secondaries, males showed a clear contrast between the pale bands in the outer web (which were ochre) and the pure white of the inner web. Secondaries in females were overall darker in the inner web, which near the rachis had a color similar to that of the outer web (ochre) and which faded out toward dirty white near the edge of the feather (Fig. 1). The white tip on the upper side of the feathers was much larger in males than in females. On the under-

wing (ventral side of the feathers), male secondaries had significantly fewer dark transversale lines ($t$-test, $t_{13} = 3.99$, $P < 0.002$). Average number ($\pm$ SD) of transversal lines in males was $2.4 \pm 0.5$ (range = 2–3, $n = 7$), and in females $3.7 \pm 0.7$ (range = 3–5, $n = 9$). Furthermore, these transversale lines were thinner in males and did not reach the edge of the feather (Fig. 1). These patterns were visible in all secondaries, but were particularly marked in S1–S4. The secondary pattern criterion was applied to sex other nestlings in the field in our study area. A total of 21 nestlings was sexed in our study area in 1996. The sex ratio of these nestlings was 9 males:12 females, not significantly different from unity (binomial test, $P = 0.66$), and similar to that found in individuals sexed from blood samples (4 males:5 females).

Figure 2 shows the growth curves of the five captive-reared nestlings (2 males and 3 females). Mass increase up to the age of 15 days old was linear ($r^2 = 0.97$), and fitted the regression equation: mass = $18.2 \cdot$(age) $- 15.6$. Thus, mass was used as an aging character for young nestlings. After 15 days of age, the regression equation of wing length growth (wing length = $7.6 \cdot$(age) $- 30.1$, $r^2 = 0.92$) was used for aging.

We found sex-related differences in at least one growth parameter in all biometric variables considered. Asymptotic mass varied according to sex, and was on average 72 g higher in females than males (Table 1). In contrast, instantaneous mass growth rate and inflexion point were similar for males and females (Table 1). Growth of the tarsus and wing showed sex-related differences in asymptotic values and inflexion point,
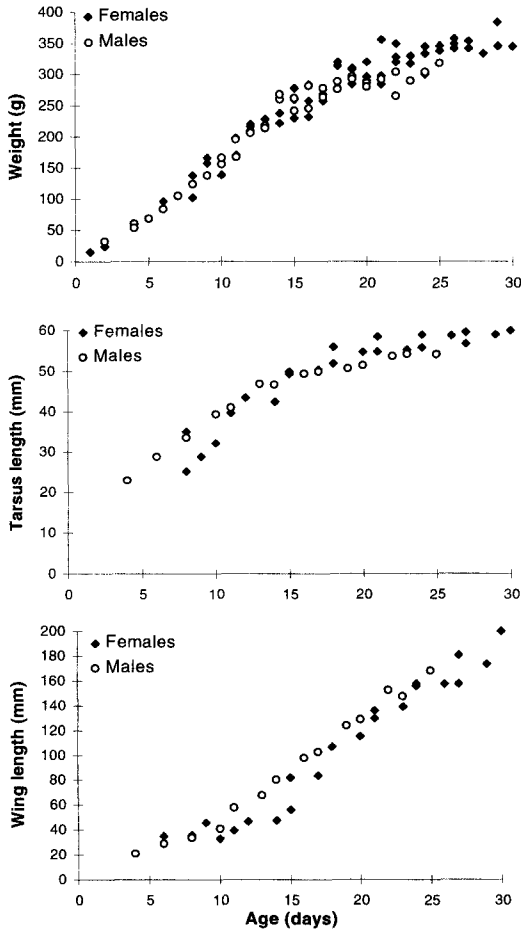
FIGURE 2. Growth curves of body mass, wing length, and tarsus length in five captive-reared nestling Short-eared Owls.

which was attained by males earlier than by females (Table 1).

## DISCUSSION

Sex determination of nestlings based on secondary pattern represented a reliable criterion (it matched 100%

of the 16 known-sexed birds) and, furthermore, was very simple to use in the field. The dimorphism was visible from about 12 days of age; thus, sexing was possible in all chicks trapped after that age. We believe that markings do not change with age, as the same pattern was found in the specimens of sexed juveniles (i.e., fledged nestlings killed from August to November). Therefore, the criterion is valid at least until the first complete molt. Other plumage characteristics (such as overall color or face markings) showed a higher degree of overlap between sexes, and are probably less reliable.

Holt et al. (1992) presented growth-model parameters for body mass, but they used logistic models and overall growth rate, so values of K are not easily comparable with ours. However, body masses at 15 days are identical between the two studies (225–260 g, Fig. 1 in Holt et al. 1992; and 225–270 g, this study) and also similar to that reported by Gröndlund and Mikkola (1969) in Finland. The differential asymptotic mass between sexes found in this study was expected, given the sexual size dimorphism found in adults (Cramp 1983, Mikkola 1983). The estimated asymptotic values in tarsus and wing found in this study were, however, much higher than those found in adult birds (Cramp 1983, Mikkola 1983), which is probably due to the fact that growth was not completed at 30 days (especially for wing length; Fig. 2), so asymptotic values are not correctly modeled.

The fact that sex differences in body mass growth were only related to asymptotic values means that body mass is a good aging criteria for nestlings up to 15 days old, regardless of sex. In contrast, because of the sex-related differences in wing length growth, calculating aging formulas for each sex separately would probably be more efficient. Indeed, in the linear increase period (after 15 days of age), wing length differed according to sex (ANCOVA, partial $F_{1,55} = 21.8$, $P = 0.001$). With our data set (for the five nestlings in captivity), wing length growth in females followed the equation WL = 7.9·(age) − 42.2, whereas in males it was WL = 7.9·(age) − 28.6. Nonetheless, a larger data set is needed to refine these equations.

TABLE 1. Growth model parameters of Short-eared Owl nestlings (142 measurements from 28 nestlings). Data were fitted to a Gompertz model (Zach et al. 1994). A is asymptotic value, K is the Gompertz instantaneous growth coefficient, and T is the age at inflexion of the S-shaped curve. The estimated value of each parameter is expressed ± SD.

| Character | Sex | A | K | T |
|---|---|---|---|---|
| Body mass | Males | 329 ± 8 | 0.17 | 7.5 ± 2.5 |
|  | Females | 401 ± 15 | 0.11 | 9.1 ± 0.6 |
| Wing length | Males | 330 ± 26 | 0.07 | 18.5 ± 1.3 |
|  | Females | 417 ± 41 | 0.05 | 24.6 ± 2.0 |
| Tarsus length | Males | 52.7 ± 1.2 | 0.18 | 3.1 ± 1.1 |
|  | Females | 50.5 ± 1.6 | 0.23 | 6.0 ± 0.8 |

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# POPULATION DECLINES OF KING AND COMMON EIDERS OF THE BEAUFORT SEA[1]

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*Abstract.* King (*Somateria spectabilis*) and Common Eiders (*S. mollissima v-nigra*) wintering off western North America migrate past Point Barrow, Alaska and across the Beaufort Sea to nest in northern Alaska and northwestern Canada. Migration counts were conducted by various researchers at Point Barrow during 1953, 1970, 1976, 1987, 1994, and 1996. We examined population trends by standardizing the analysis of the migration counts in all years. Based on this standardized procedure, the King Eider population appeared to remain stable between 1953 and 1976 but declined by 56% (or 3.9% year⁻¹) from approximately 802,556 birds in 1976 to about 350,835 in 1996. The Common Eider population declined by 53% (or 3.6% year⁻¹) from approximately 156,081 birds in 1976 to about 72,606 in 1996. Reasons for the declines are unknown.

*Key words: Beaufort Sea, Common Eider, King Eider, mortality, population trend,* Somateria mollissima v-nigra, Somateria spectabilis.

King (*Somateria spectabilis*) and Common Eiders (*S. mollissima v-nigra*) wintering in the Bering Sea and north Pacific Ocean migrate north to nesting areas in Russia, Alaska, and northwestern Canada. Most of the eiders that nest in Alaska and Canada migrate past Point Barrow, Alaska and across the Beaufort Sea.