

Table 1. Wing length, bill length and bill depth of Shags *Phalacrocorax aristotelis*. For nominate *aristotelis*, wing length combines data from Britain, Brittany and The Netherlands; bill measurements are from southwest England and Brittany. Data for *aristotelis* and *desmarestii* are from BWP, for Galician birds from Alberto Velando (see text). Figures show mean (range, sample size); all data in mm.

	<i>aristotelis</i> (northern Europe)	Galicia	<i>desmarestii</i>
Wing length (male)	271 (261-278, 12)	273.5 (262-280, 11)	258 (243-271, 12)
Wing length (female)	258 (251-269, 11)	260 (252-275, 17)	249 (240-265, 11)
Bill length (male)	55.7 (53-58, 6)	65.3 (62.2-72.1, 11)	60.9 (58-65, 6)
Bill length (female)	56.2 (55-58, 5)	63.9 (60.5-70.1, 17)	63.2 (61-65, 5)
Bill depth (male)	10.5 (10.2-11.0, 5)	16.5 (15.2-17.7, 10)	10 (9.7-10.6, 5)
Bill depth (female)	9.2 (8.3-10.4, 14)	14.4 (12.8-16.1, 16)	8.7 (8.2-9.3, 5)

should have a much shorter wing and a far less stout bill than Galician birds).

The peculiarities of these Galician Shags suggest that they might deserve a taxonomic reappraisal, since both their biometrics and their coloration appear to depart significantly from those of described forms. We suggest that this species' variability is worth a detailed study throughout its range, since a better understanding of phenotypic variation, particularly in adult birds, is surely a prerequisite for modifying subspecies boundaries.

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Ageing and sexing Short-toed Eagles

It has long been recognised that Short-toed Eagles *Circaetus gallicus* show considerable individual plumage variation. Most breeding adults show a dark brown head and upper breast, but a minority of birds in Europe appear distinctly paler, and have been variably described as 'white', 'pale' and 'intermediate' types. Currently, no parameters exist by which individual birds can be assigned to a particular type (or colour phase or morph). Three of the most frequently observed plumage types of 'pale' Short-toed Eagle are described as follows:

- Mantle ashy-grey, with white throat, breast and belly. Sparse grey-brown spotting on the underwing.
- Mantle pale grey, with white head, throat and breast. Completely white underwing.

- Mantle brown, with white throat, breast and belly. Sparse brown spotting on the underwing.

Factors such as distance, weather and light conditions, and background colour combine to affect observers' perception of plumage patterns and colours in the field. So that terms such as 'pale phase' or 'dark morph' can be quantified, it is essential that parameters are established by which individuals can be assigned clearly to one particular plumage class, and are not subject to the vagaries of individual perception.

Several authors have attempted to clarify and quantify the extent of this variability, but all have done so without demonstrating that their conclusions are based upon specific observations. For example, Martorelli (1895) described

Short-toed Eagle plumages and noted that males were paler; Boudoint *et al.* (1953) stated that pale coloration is typical of very old individuals; while Porter *et al.* (1976) speculated that pale individuals may be immatures, but added that there were no data available (at that time) to confirm this. Cattaneo & Petretti (1992) suggested that these paler birds might originate from eastern populations, while Cramp & Simmons (1980) stated: 'sexes similar, no seasonal variation, juveniles apparently unidentifiable in the field, plumage variation poorly understood but probably age-related'. More recently, following studies on populations in northwest Italy, Cattaneo (2001) and Campora (2002) established that the various colour phases are, in fact, distinct plumages related directly to age as well as to the sex of the birds. These conclusions are supported by the use of photographs and reference to museum specimens.

Study area and methods

Short-toed Eagles were studied at breeding sites in the western Alps and the Apennines, two distinct and widely separated regions of Italy which differ in their climate, altitude and habitat types. In total, 38 breeding pairs of Short-toed Eagles were studied over a period of 23 years. These observations were supported by assessment of over 400 photographs of birds taken at or near nests over a period of several years, enabling plumage changes in individual birds to be monitored. In addition, over 80 museum specimens in collections in Genoa, Turin and Milan were examined, along with those in the Natural History Museum, Tring (NHM). This enabled the plumage variation among age classes to be examined in detail; particular attention was given to establishing the age of each specimen. Each specimen was photographed to assist comparison of specimens among collections, while other data (including measurements, date and location) were also collected.

Observations of pale birds during the breeding season

In breeding pairs, adult females invariably show darker and more uniform breast feathering, while males have paler and more streaked breasts (Campora 1998, 2002). However, the proportion of pale individuals (as described above) in the breeding population is extremely

low (Cattaneo 1998, 2001). In France, M. Belaud (*in litt.*) found no pale birds among breeding pairs in Provence, while Joubert (2001) found only one such individual among 13 pairs in the Upper Loire region (over an unspecified time period). In northwest Italy, only two such pale birds, plus one further case involving a probable breeding pair, were recorded in over 150 broods studied. It should also be stressed that the few observations of pale individuals within breeding pairs were always limited to a single year; in all cases, both parents at the same nest-site showed typical coloration in the following year.

In Italy, records of Short-toed Eagles showing pale breast feathering generally relate to unpaired or wandering individuals (Campora 1998; Cattaneo 1998, pers. obs.). These paler individuals tend to appear later in the season, typically in April and May, and never in March, when established breeding pairs return to nesting territories (Campora unpubl.). This is further confirmed by observations at spring migration watchpoints, where pale individuals are generally observed after mid April only (Baghino pers. comm.; Toffoli pers. comm.). Spring migration in mainland Italy has received little attention, and the only regular watchpoint is at Arenzano, in the Ligurian Apennines, near Genoa. Unfortunately, the plumage patterns of migrating Short-toed Eagles are only occasionally recorded here. Baghino (pers. comm.) reported that, in April and May at Arenzano (when breeding pairs have already settled into their territories), there is a noticeable migration of 'very pale' Short-toed Eagles, with 40 of 65 birds observed there on 11th April 2003, 2 of 2 on 5th May 1993, and 6 of 7 on 25th April 1992 classed as this plumage-type.

Supporting evidence that reinforces the view that the palest birds are immature comes from personal observations of numerous breeding pairs in Italy, many of which we have photographed, over several years. Some of these individuals used the same perches over a period of years, suggesting that they were the same returning birds. Photographs of these individuals reveal a gradual but continuous change in plumage, progressively darkening over the years. Furthermore, a captive individual at a raptor recovery centre showed a rufous throat and breast, with white longitudinal streaks in 1999; by 2002, following a series of moults, this

same individual exhibited typical female plumage (MC pers. obs.). Although these observations cannot be considered as absolute proof that plumage darkness is age-related, they support the view that pale birds are in immature plumage.

Pale birds in the wintering areas

Not all immatures return to Europe in spring, with some remaining in their wintering areas throughout the year; others do return but later than adults. Examination of museum specimens revealed that the proportion of pale individuals increases in Africa (fig. 1), reinforcing the view that immatures have paler underparts. In fact, the palest individuals among the specimens examined were the only birds collected in Africa in March and April, when breeding pairs have already reached breeding territories in Europe and Asia. Many of these specimens retained rufous juvenile breast feathers, confirming their age as second-calendar-year birds.

Plumage variation due to the effects of moult

In juvenile plumage, all Short-toed Eagles are broadly similar, with a well-defined, uniform reddish-brown head and breast, and spots on

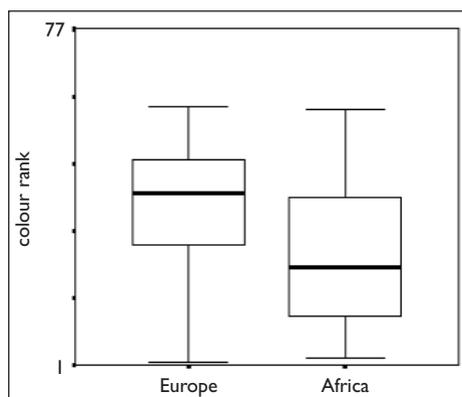


Fig. 1. Ranking of underpart colour (1 = palest, 77 = darkest) of 77 Short-toed Eagles *Circaetus gallicus* collected in Europe and Africa, and housed in the Genoa Museum and the NHM, Tring. The average ranking of European specimens is 47.2; that of African specimens is 33.8. This difference is statistically significant (Mann-Witney U-Test, $P = 0.01$).

the underparts and underwings that usually, but not always, appear paler and less well-defined than those of adults (plate 211). These birds can closely resemble some adults, and may be separable only at close range, and often only when seen directly alongside.

By their third or, in some cases, fourth



211. Juvenile Short-toed Eagle *Circaetus gallicus*, Natural History Museum of Genoa. At this age, the head and breast are uniform reddish-brown in both sexes.



212. Third- or fourth-calendar-year Short-toed Eagle *Circaetus gallicus*, Natural History Museum of Genoa. At this age, the uniform reddish-brown head and breast of juvenile plumage is replaced by paler feathering with dark shaft-streaks. The sexes remain inseparable at this age.

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213. Male Short-toed Eagle *Circaetus gallicus*, between four and six calendar-years of age, Natural History Museum of Genoa. Brown streaks appear on the paler head and breast, but are generally less extensive than those of females of a similar age.



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214. Female Short-toed Eagle *Circaetus gallicus*, between four and six calendar-years of age, Natural History Museum of Genoa. The female appears noticeably darker than males of the same age, but the heavily blotched and streaked breast separate it from adult females.

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215. Adult male Short-toed Eagle *Circaetus gallicus*, Natural History Museum of Genoa. In this plumage, acquired in the eighth or ninth calendar-year, the head is distinctly brown and the breast is heavily streaked. Confusion with younger females is possible.



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216. Adult female Short-toed Eagle *Circaetus gallicus*, Natural History Museum of Genoa. As with males, this plumage is attained in the eighth or ninth-calendar-year, but only adult females appear as dark and uniform on the head and breast as this individual.

calendar-year, Short-toed Eagles acquire a paler plumage in which the juvenile head, breast and upper mantle plumage is replaced with wholly pale feathering with darker shafts (plate 212). Although the dynamics and frequency of moults in juveniles and adults are still unclear (Cramp & Simmons 1980; Forsman 1999), immature Short-toed Eagles gradually acquire the darker head and streaked breast typical of older birds through subsequent moults in their fourth to sixth calendar-years. At this age, although the darker head and streaked breast become increasingly apparent in both sexes, on the female these are darker and generally better defined, making separation of the sexes possible in most instances (plates 213 & 214). Finally, as birds mature further, the plumage differences between the sexes become better defined, and dark colours more saturated, leading to the 'definitive adult plumage' (Campora 2002). This occurs typically in the eighth or ninth calendar-year. Plates 215 & 216 illustrate the extent of sexual dimorphism which Short-toed Eagles can exhibit in adult plumage.

In Europe, moult commences shortly after arrival from the wintering quarters, as demonstrated by the abundant feathers found beneath nests, and continues until September (Zebe 1935, 1936; Campora 1998; pers. obs.). Examination of specimens collected during the summer months confirmed that all birds had been in active moult. Birds collected during spring migration were not in active moult, but many showed signs of suspended or arrested primary moult, with new feathers, usually reaching to between P4 and P6 (measured descendantly), contrasting with retained old, worn primaries.

Conclusions

Brown & Amadon (1968) were correct to assume that all Short-toed Eagles undergo a series of moults which lead eventually to full adult plumage. It has now been established that Short-toed Eagles go through a transitional or 'white phase', in their third or possibly fourth calendar-year, when the sexes are inseparable in the field. Subsequently, as birds gradually acquire a darker coloration between their fourth and sixth calendar-year, sexual dimorphism becomes more evident: males tend to remain rather pale, especially on the throat and breast, while females acquire their characteristic brown breast.

During this transitional phase, Short-toed Eagles are still considered to be immature and incapable of breeding. Occasionally, for example upon the death of one member of a breeding pair, these paler individuals (which do not hold territories and have probably not yet reached sexual maturity) can take the unoccupied place (Campora pers. obs.). Such individuals occur more frequently in northern Italy, where immatures are expanding and establishing territories beyond the traditional range, and where a significant increase in Short-toed Eagle numbers is occurring. In France, following range expansion in the 1970s, the population is now considered stable, and pale individuals are observed less frequently.

In summary, our studies have established that the various plumage types of Short-toed Eagle are directly related to age, with the palest being immature birds in their third and fourth calendar-years. Many birds of this age remain in wintering areas during the northern breeding season, which accounts for their relative scarcity in Europe.

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217. Juvenile Short-toed Eagle *Circaetus gallicus*, Ligurian Apennines, Italy, July 1995. This individual is about to fledge and shows typical reddish-brown plumage.



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218. Female Short-toed Eagle *Circaetus gallicus*, Ligurian Apennines, Italy, July 2001. This bird, probably over eight years old, was photographed bringing a viper *Vipera aspis* to the young (which shows similar plumage to the adult female).

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218. Pale, unmated immature Short-toed Eagle *Circaetus gallicus*, Ligurian Apennines, Italy, July 2002.

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220. Short-toed Eagles *Circaetus gallicus*, Ligurian Apennines, Italy, August 2003. This adult male (right), probably over seven years old, is shown bringing prey to a fledged youngster.

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221. Juvenile Short-toed Eagle *Circaetus gallicus*, Ligurian Apennines, Italy, August 2003, showing heavy markings on the underwings.