First Symposium on Steller's and White-tailed Sea Eagles in East Asia pp. 11-16, 2000
UETA, M. & MCGRADY, M.J. (eds)

Aging by molt patterns of flight feathers of non adult Steller's Sea Eagle

Teruaki MORIOKA
1-41-17-103 Kamishakujii, Nerima-ku, Tokyo 177-0044, Japan.

INTRODUCTION

Accipitrid raptors have one molt unit in the primaries and four in the secondaries. Molt of the primaries begins with the first primary (P1) and proceeds outward. The molt proceeds from secondary 1 (S1) inward, from S5 inward and from S12 outward (Miller 1941, Jollie 1947, Stresemann & Stresemann 1960, Edelstam 1984). According to Miller (1941), the molt of the innermost secondaries proceeds from the innermost secondary (S16) outward, but according to Jollie (1947) and Edelstam (1984), it proceeds from S13 toward the innermost secondary (inward). In Steller's Sea Eagles, the molt of the innermost secondaries appears to proceed from S15 and inward and from S16 outward.

Large birds such as eagles do not complete the molt of all flight feathers in a single year. In a year, eagles molt about one-half to two-thirds of all feathers, usually one-fourth to one-third the flight feathers, and resume the sequent molt the next year. Before they have completed one cycle of molt especially in the primaries, they start the next molt cycle (Ginn & Melville 1983, Edelstam 1984); it is a serial molt. As serial molts occur, the flight feathers show several generation feathers.

MATERIALS AND METHODS

The molt sequence of the flight feathers and the wing pattern resulting from molt were investigated in seven skins specimens of Steller's Sea Eagles *Haliaeetus pelagicus* from the Yamashina Institute for Ornithology and about fifty photographs of Steller's Sea Eagles in flight taken in Hokkaido in winter.

Topology

In this paper, only the row of the upperwing-coverts just above the median coverts are called lesser coverts. The rows of the upperwing-coverts above the lesser coverts are called marginal coverts.

RESULTS AND DISCUSSION

Molt was arrested in Steller's Sea Eagles in winter. It is evident that they molt serially because three generations of feathers can be found in the primaries of older Steller's Sea

Eagles at the same time. Their molt sequence is the same as that of White-tailed Sea Eagles as described by Edelstam (1984). The age of eagles that have yet to pass through their third winter can be determined by examining the molt pattern in the flight feathers. Feathers of subsequent generations are distinguished from the juvenile feathers by being broader and uniformly black with rounded or flat tips, while juvenile feathers are dark brown and longer with pointed tips.

First Winter (1W; Fig. 1)

Flight feathers: All flight feathers are juvenile and homogeneous. The inner primaries and the secondaries are sharply pointed. The primaries are dark brown with whitish bases. The white is more extensive on the inner feathers and is less extensive or missing on outer feathers. The inner webs of the inner three primaries are mottled white and tipped dark brown. When a primary feather has a whitish base, the corresponding greater under primary covert has also a whitish base.

Other points: The median under primary and secondary coverts and the lesser under secondary coverts are white tipped or fringed dark brown. From a distance, these create white underwing stripes that run unbroken the length of the wing. The axillaries, the subhumerals and the subhumeral coverts, as well as the tail, are white fringed or sometimes tipped dark brown. The bill is brownish yellow with a blackish tip and ridge. The iris is dark brown. Some darker juveniles appear identical to second winter birds.

Second Winter (2W; Fig. 1)

Flight feathers: Inner three primaries (P1-P3) have been replaced by second generation feathers. These are similar to juvenile feathers but the dark tips are blacker and larger. Second generation flight feathers are broader with a flatter tip. In the outer secondaries, S1 and S5 often have molted into second generation feathers which are shorter and blacker with a flatter tip. In some individuals only one of these (S1 or S5) have been replaced by the second winter. More rarely, S5 and S6 are replaced, but not S1. In the inner secondaries, the innermost two or three secondaries have always molted. And so, birds of this age are distinguished by most secondaries being longer juvenile feathers with second generation feathers on both the inner and outer margins, or at least the inner margin of the secondary feather set.

Other points: Similar to the first winter birds, but the white areas of the axillaries, subhumerals and subhumeral coverts are often reduced.

Third Winter (3W; Fig. 1)

Flight feathers: P4-P7 have been replaced by second generation feathers which are almost all black, but sometimes with white frosting or whitish wash around the base of the inner web. P1 has molted into the third generation feather which is all black. Birds of this age can be distinguished by having reduced white patches on the primaries, which are usually confined

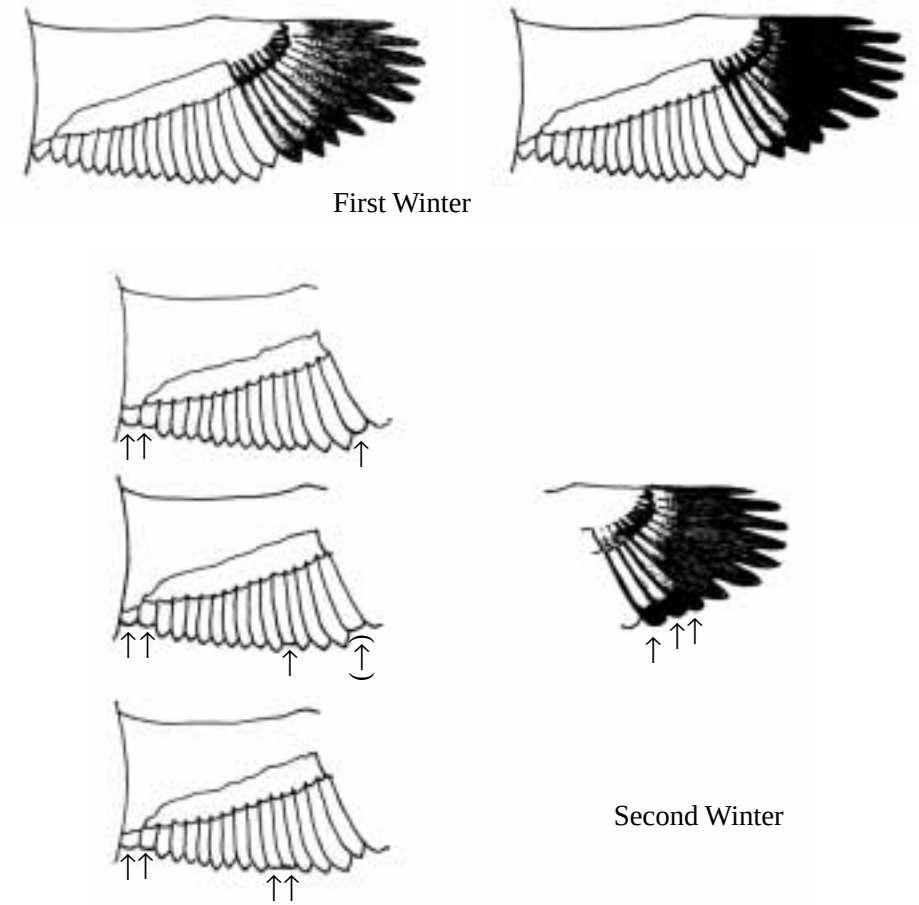

Fig. 1. The variation of the molt patterns of the flight feathers of Steller's Sea Eagle. The figures show the underwings. The primaries show the differences of the pattern as well as the molt sequence. A mark "←" shows the feather replaced during last molt cycle. In case the mark "(←)" is attached to an old feather, it shows that the feather is sometimes replaced, and in case it is attached to a new feather, sometimes not replaced.

First Winter
(Left): Underwing view with primaries displaying greatest extent of whitish area.
(Right): Underwing view with primaries with least extent of whitish area.
Second Winter
(Right): Underwing view with primaries with average extent of whitish area.

to P2 and P3 (although some have narrow whitish bases on the outer primaries P8-P10). Usually, S2-S3, S6-S8 and S13-S14 have been replaced by second generation feathers which are blacker and broader with a flatter tip. At this age S4 and S9-S12 are juvenile feathers and are typically worn and faded, but which are longer than the second generation secondary feathers. However, the molt of the secondaries is often irregular. In some individuals, S2-S3, S6-S8 and S11-S14 or S2-S4, S6-S7, S9 and S13-S14 have molted (thus

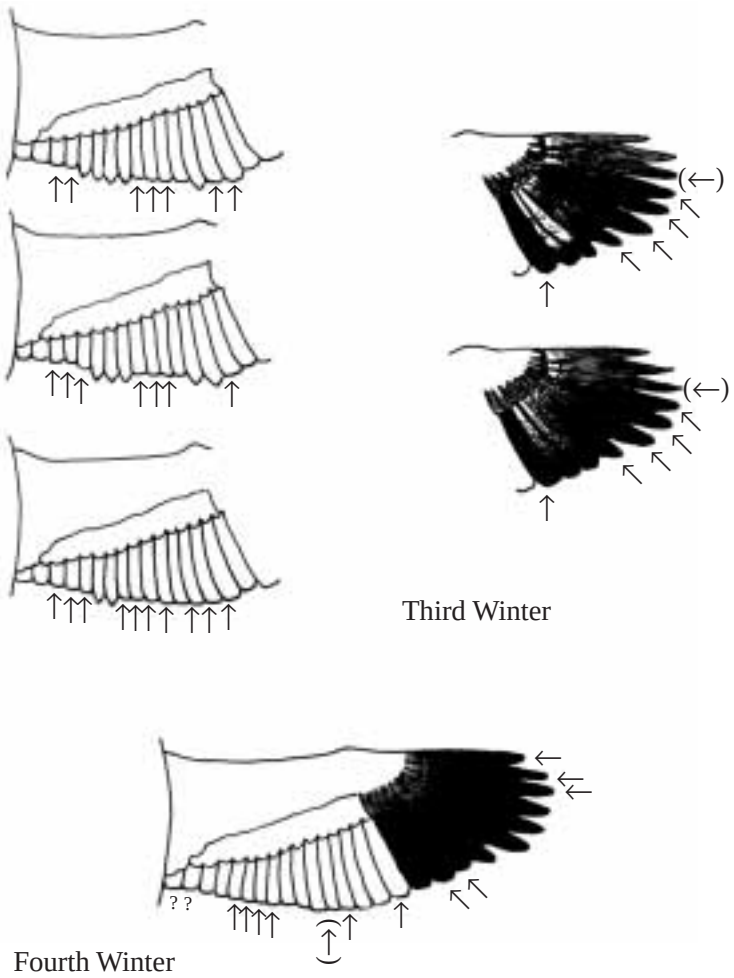

Fig. 1. continued.

Third Winter
(Left below): Underwing view showing the greatest extent to which molt occurs in birds of this age.

S4 and S9-S10, or S8 and S10-S12 juvenile), in others, S2-S4, S6-S9 and S12-S13 have replaced (thus S10-S11 juvenile). We have seen an individual of this age that retained a juvenile feather only at S10, and an individual that retained a juvenile feather only at S5. In any case, the birds of this age show one to four juvenile secondary feathers which project beyond the other secondary feathers.

Other points: White underwing bands formed by light markings on the lesser and median underwing-coverts are indistinct; they are divided into many white spots spaced irregularly along the length of the wing. In many individuals, the greater under primary coverts corresponding to P4-P7 are uniformly dark grey, but in some cases these are similar in color to juvenile feathers. The white areas of the axillaries, the subhumerals and the subhumeral

coverts are more reduced, but third winter birds cannot be reliably distinguished from first and second winter birds by the extent of white in the axillaries alone. In most birds of this age, the marginal coverts have a white frosting. The lower flanks, thighs, vent, undertail-coverts and tail are white mottled with dark brown. The amount of brown in the tail is variable, and birds which have extensive areas of dark brown on the tail can not be distinguished from first and second winter birds by the tail alone. In some individuals, the thighs and vent are dark brown. The bill is bright yellow with a blackish tip and sometimes a brownish ridge. The iris is dull yellow.

Fourth Winter (4W; Fig. 1)

Flight feathers: P8-P10 have been replaced by second generation feathers. At least, P2-P3 have molted into third generation feathers. Juvenile secondaries (usually S4 and S9-S12) which remained in the third winter, have been replaced by second generation feathers, and S1 and S5 have molted into third generation feathers. The molt of the innermost secondaries is less easy to characterize. After this molt, the primaries have no white patches, but some have white frosting around the bases of P4-P7. The trailing edges of the secondaries are even and smooth.

Other points: The marginal coverts are white, but some have dark brown speckling. The median under primary coverts corresponding to P4-P8 and some of the median under secondary coverts show white spots at the bases. The axillaries, the subhumerals and the subhumeral coverts are black, but the bases can remain whitish. The lower flanks, thighs, vent, undertail-coverts and the tail are white with a few dark brown speckles. The bill is bright yellow, but some have a brownish tint at the tip and the ridge. The iris is yellow.

Fifth Winter (5W)

Very similar to adult plumage.

Flight Feathers: Usually, P4-P6 have been replaced by third generation feathers. P1 is presumed to have molted into the fourth generation feather, but that has not yet been verified. S2-S3 and S6-S7 have been replaced by third generation feathers. Other secondary feathers can have molted. As the individual differences in molt have accumulated, the fixed molt sequence is not discernable. The molt of the innermost secondaries is not clear.

Other points: White speckles remain at the bases of some greater under primary and secondary coverts. The development of the white patch on the forehead shows individual variation: some third winter birds have it, but some birds of more than 5 1/2 years of age lack it.

ACKNOWLEDGEMENT

The author is most grateful to the staff at the Yamashina Institute for Ornithology for granting permission to study specimens and to review literature. The author also wishes to thank an anonymous

referee for valuable comments. Thanks to those who supplied the many photographs eagles used in this study.

LITERATURE CITED

Edelstam, C. 1984. Patterns of moult in large birds of prey. Ann. Zool. Fennici **21**: 271-276.

Ginn, H.B. & Melville, D.S. 1983. *Moult in Birds*. BTO, Tring.

Jollie, M. 1947. Plumage changes in the Golden Eagle. Auk **64**: 549-576.

Miller, A.H. 1941. The significance of molt centers among the secondary remiges in the *Falconiformes*. Condor **43**: 113-115.

Stresemann, V. & Stresemann, E. 1960. Die Handschwingenmauser der Tagraubvogel. J. Ornithol. **101**: 373-403. In German.