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THE PREFORMATIVE MOLT OF MARBLED MURRELETS

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Many aspects of the biology of the Marbled Murrelet (*Brachyramphus marmoratus*) are poorly understood, including habitat use, demography, physiology, breeding ecology and molt (Nelson 1997; Piatt and others 2007). While the general pattern of molts and plumages has been documented, many important details remain unknown, including the mechanism by which juvenile murrelets transition from overall dark plumage with a dark neck ring at fledging to whiter plumage with a partial or absent neck ring by late summer and early fall. Carter and Stein (1995) proposed 3 possible explanations for this plumage transition: 1) rapid wear of the thin, dark feather margins of the contour feathers from salt water exposure and at-sea activity following fledging; 2) juvenile murrelets have not yet obtained their full juvenal plumage at fledging and finish their prejuvenal molt at sea; and 3) some of the juvenal plumage is replaced in a preformative molt following fledging. Piatt and others (2007) and Pyle (2008) suggest that the neck ring and finely mottled barring of juvenile under parts are subject to wear and bleaching through September and March. Through the examination of museum specimens, Pyle (2008, 2009) also suggest that the prejuvenal molt is completed at the natal site, and that a preformative molt occurs between September and January. Based upon observations of juvenile Marbled Murrelets captured at sea and supplemented by museum specimens, we provide evidence to support the 3rd mechanism, whereby juveniles undergo a preformative molt following fledging, beginning as early as late-July.

Of 31 juvenile murrelets captured at sea in Desolation Sound, British Columbia (50° 58′ N, 124° 48′ W) in 2008 (see Janssen and others 2009 for details of capture methods), 6 were found with actively molting feather tracts on the breast (Table 1). It should be noted that these observations were made opportunistically during the collection of breast feathers for a different study (Janssen 2009) and due to the need for quick handling time and release, individuals were not examined thoroughly for molt, but only on the breast. No pinfeathers were observed, and all individuals with molt exhibited 6 or more intermediate (approximately half-sheathed), white (no dark margins) molts on the breast. The earliest juvenile murrelet was captured on 19 July without any signs of breast molt, and the 1st juvenile examined with actively molting feathers on the breast was captured on 30 July. The last 3 juveniles of the field season were captured on 28 August, and each exhibited extensive breast molt. The mean capture date of juveniles without molt was $\bar{x}$ = 2 August, s =

TABLE 1. Measurements of juvenile Marbled Murrelets captured at sea in Desolation Sound, British Columbia, in July and August 2008.

Breast molt	Bill length (mm)	Mass (g)	Egg teeth	Capture date
Y	13.0	195	0	30 July
Y	14.1	189	0	5 August
Y	15.1	228	0	17 August
Y	14.2	210	0	28 August
Y	14.0	209	0	28 August
Y	16.0	210	0	28 August
N	11.7	148	1	19 July
N	11.7	148	1	20 July
N	12.5	151	1	23 July
N	12.6	177	0	23 July
N	12.2	184	0	24 July
N	11.9	155	1	24 July
N	12.2	172	1	25 July
N	13.0	168	0	26 July
N	12.9	165	0	26 July
N	11.5	157	2	27 July
N	13.2	179	1	29 July
N	11.8	163	2	29 July
N	13.2	184	1	29 July
N	12.6	175	2	30 July
N	12.7	160	0	1 August
N	12.1	151	0	2 August
N	11.2	111	2	4 August
N	14.0	205	1	6 August
N	12.7	159	2	13 August
N	13.2	208	0	14 August
N	10.7	127	2	15 August
N	13.3	197	0	17 August
N	12.4	177	2	17 August
N	11.6	150	2	21 August
N	11.2	137	2	21 August

10.4 d, and of juveniles with molt was $\bar{x}$ = 17 August, s = 12.9 d.

At-sea observations were supplemented by the examination of museum specimens from the Cowan Museum Vertebrate Collection at the University of British Columbia and the Royal British Columbia Museum (RBCM), collected July through October, 1904 to 1969. Juvenile specimens were examined by lifting underside feathers with a dissecting needle to examine the surrounding skin for presence of pinfeathers and intermediate stages of feather growth. Of 17 specimens examined, 4 were found with white molt on the chin, neck, breast, and upper abdomen (Cowan #3062, 3063, 14788, RBCM#34), and 13 were found without evidence of molt (Cowan #1942, 13470, 10011, 478, RBCM #9118, 11820, 10555, 6165, 10735, 11643, 11644, 11706, 12915). The mean collection date of specimens without molt was $\bar{x}$ = 28 July, s = 22.1 d, and of specimens with molt was $\bar{x}$ = 17 September, s = 11.7 d. All examined specimens showing no sign of molt still exhibited a partial or complete neck ring with abundant dark-margined feathers on the underside; while those found to be actively molting when collected in early fall had faint or absent neck rings with fewer dark-margined feathers remaining.

Our observations of museum specimens and live juvenile murrelets captured at sea suggest that juveniles may replace many of the juvenal contour feathers at sea following fledging. Juveniles with molt were captured or collected significantly later in the breeding season than those without molt (capture date $t = -3.12$, $df = 29$, $P < 0.01$; collection date $t = -4.38$, $df = 15$, $P < 0.001$), and exhibited lighter plumage overall than those without molt. Unfortunately, asynchronous breeding and cryptic nesting behavior make it impossible to determine the amount of time passed between fledging and date of capture among juveniles captured at sea without directly tracking individuals. However, if the probability of capturing an individual that has been on the water for a long period of time increases with capture date, then a positive relationship between capture date and body components grown at sea would be expected. Wing and tarsus length of juvenile murrelets captured at sea were not related to capture date (Janssen 2009), suggesting that these body components are grown primarily in the nest, and thus were not used here. For body components whose growth is likely completed at sea following fledging, individual juveniles captured at sea with evidence of molt were significantly larger than those without molt. Juveniles with molt had larger bill lengths ($t = -4.36$, $df = 29$, $P = 0.0001$), were heavier ($t = -5.46$, $df = 29$, $P < 0.0001$), and had no egg teeth (Table 1), suggesting that individuals with molt were older than those not molting (Janssen 2009). The peak fledging date in Desolation Sound, British Columbia in 1999 and 2000 was estimated to be $\bar{x} = 31$ July, $s = 20$ d, with the earliest juveniles seen at sea on 30 June 1999 and 25 June 2000 (McFarlane Tranquilla and others 2003). The earliest juveniles in 2008 were seen on 6 July, with the earliest capture exhibiting molt occurring on 30 July. Taken together with our observations that individuals with molt were caught later in the fledging period and were significantly larger than those without molt, we suggest that the at-sea period before the onset of molt is approximately 1 mo following fledging, which can be as early as late July for some individuals. Therefore, it is unlikely that the transition from dark to light plumage occurs shortly following fledging during an extended off-the-nest phase of the prejuvenal molt, where the juvenal plumage generation is not acquired entirely in the nest (Carter and Stein 1995).

The plumage transition also includes the uniform dark brown to black feathers on the upper parts of juveniles being replaced with feathers edged with thick grey margins. Unfortunately, due to the nature of the fieldwork and the preparation of the museum study skins, we were not able to examine the upper parts for evidence of molt. It is possible, however, that these feathers are replaced in the partial body molt. We were also unable to determine if feather wear contributes to this plumage transition. Microscopic examination has previously led to the discovery of false conclusions regarding the molts and plumages of other species (for example Lawrence's Goldfinch, *Carduelis lawrencei*; Willoughby and others 2002). However, all molts observed in our study showed no evidence of dark margins at the tip, suggesting that the new feather generation would be white before wear or bleaching. Feather wear of the juvenal contour feathers, therefore, may play a role in the plumage transition of juvenile Marbled Murrelets, but we suggest it is minor relative to the lighter plumage acquired from the partial body molt following fledging.

Environmental and physiological constraints experienced throughout a species' life cycle could result in the development of inserted molts in addition to the basic molt cycle. Preformative molts of varying extents and timing have recently been documented in 17 species of Alcid (Pyle 2009). Marbled Murrelets devote much energy to secretive nesting behavior and cryptic adult and nestling plumage, presumably to avoid high predation risk at the nest (Nelson 1997; Piatt and others 2007). Perhaps it is not surprising then that juvenile Marbled Murrelets would invest energy in a transition from their camouflaged terrestrial juvenal plumage to a counter-shaded formative plumage more suitable for concealment from both predators and prey in the marine environment. Regardless of the adaptive purpose of this plumage transition, our findings lend support to the hypothesis that the transition from dark to light plumage in juvenile Marbled Murrelets occurs due to a preformative molt of at least the feathers of the chin, neck, breast, and upper abdomen. This finding contributes to the generally limited information on the biology of this secretive species, whose breeding habits and cryptic behavior make it a particularly challenging species to study.

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Literature Cited

Carter HR, Stein JL. 1995. Molts and plumages in the annual cycle of the Marbled Murrelet. In: Ralph CJ, Hunt GL, Raphael MG, Piatt JF, editors. Ecology and conservation of the Marbled Murrelet. Albany, CA: USDA Forest Service. General Technical Report PNW-152. p 99–109.

Janssen MH. 2009. Diet composition and breeding success in a threatened Pacific seabird, the Marbled Murrelet (*Brachyramphus marmoratus*) [thesis]. Guelph, ON: University of Guelph. 98 p.

Janssen MH, Arcese P, Kyser TK, Bertram DF, McFarlane-Tranquilla L, Williams TD, Norris DR. 2009. Pre-breeding diet, condition, and timing of breeding in a threatened seabird, the marbled murrelet *Brachyramphus marmoratus*. Marine Ornithology 37:33–40.

McFarlane-Tranquilla L, Williams T, Cooke F. 2003. Using vitellogenin to identify interannual variation in breeding chronology of marbled murrelets (*Brachyramphus marmoratus*). Auk 120:512–521.

Nelson SK. 1997. Marbled Murrelet (*Brachyramphus marmoratus*). In: Poole A, Gill F, editors. The Birds of North America. Washington, DC: Academy of Natural Sciences and American Ornithologist's Union. 32 p.

Piatt JF, Kuletz KJ, Burger AE, Hatch SA, Friesen VL, Birt TP, Arimitsu ML, Drew GS, Harding AMA, Bixler KS. 2007. Status Review of the Marbled Murrelet (*Brachyramphus marmoratus*) in Alaska and British Columbia. USGS Open-File Report 2006-138. 257 p.

Pyle P. 2008. Identification guide to North American birds: Part ii. Bolinas, CA: Slate Creek Press. 836 p.

Pyle P. 2009. Age determination and molt strategies in North American alcids. Marine Ornithology 37: 219–226.

Willoughby EJ, Murphy M, Gorton HL. 2002. Molt, plumage abrasion, and color change in Lawrence's Goldfinch. Wilson Bulletin 114:380–392.

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