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Molt in Burrowing Owls (*Athene cunicularia*)

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ABSTRACT

Molt sequence and timing were previously poorly described for the Burrowing Owl (Athene cunicularia). *We recorded molt when owls were in hand during long-term studies (1977-2011) during the breeding season in Canada and on the wintering grounds in Mexico and Texas. Definitive prebasic molt of flight feathers was complete in nearly all cases and begins with p3, moving proximally and distally, soon followed by secondary molt, which has at least two molt centers at s1 and s5. We provide evidence that wing and tail molt in some individuals is rapid, indicating flight could be compromised for short periods of time in late summer. Body molt is documented through the winter in wild and captive owls and is likely a resumption of the preformative and prebasic body molt after migration, but more study is suggested to determine if a partial prealternate molt occurs.*

INTRODUCTION

The general molt pattern of the Burrowing Owl (*Athene cunicularia*) has been classified as the Complex Basic Strategy (Howell et al. 2003), which is typical of most or all species of Strigidae. Young Burrowing Owls have juvenal (first basic) plumage replaced by a partial preformative molt in late summer to early autumn, whereby the distinctive juvenal brown and white body feathers are replaced with speckled brown and white formative feathers (that resemble subsequent basic feathers). Their flight feathers are retained until the following summer, when the second prebasic molt of second calendar-year (SY) individuals occurs late in the nesting season (generally July in prairie Canada). Based on museum specimens this molt appears to be complete (Pyle 1997).

The sequence of Burrowing Owl molt has not been well documented. This is likely because the majority of museum specimens are hatch-year birds (HY) and few researchers have the opportunity to handle Burrowing Owls when prebasic molt is underway. This occurs late in the breeding season when young are fledging and adults can be more difficult to locate and trap. Thomsen (1971) reported primaries 3 and 4 missing in one female trapped in mid-July in California while the mate had no molt. A simultaneous tail molt has been documented in some populations (Courser 1972, Mayr and Mayr 1954) but not in others (Thomsen 1971).

We provide observations of the sequence and timing of molt for Burrowing Owls in prairie Canada. This population is at the northern limit of its range and is highly migratory, wintering in Texas and Mexico (Holroyd et al. 2010). We describe winter body molt in wintering Burrowing Owls trapped in south Texas and Mexico. We follow Pyle's definition of flight feathers which, in the Burrowing Owl, consists of 10 primaries (p) and their coverts, 12 secondaries (s), 3 tertials, and 12 tail feathers or rectrices (r). We use remiges to include primaries, secondaries, and tertials (Roberts 1955).

METHODS

We trapped Burrowing Owls for telemetry and stable isotope studies during the summers (May–Aug 1998-2011) in Alberta and Saskatchewan, Canada, and during the winters (Nov–Feb 1997-2007) in Mexico and Texas (Holroyd et al. 2010, Duxbury 2004, Sissons 2003, Shyry 2005). We examined owls for flight and body molt and photographed wings in active molt. We received photographs of Burrowing Owl wings from other researchers in Canada and the US. We also gathered molt feathers regularly for seven molt cycles from three captive, non-breeding Burrowing

Owls. Finally, we collected molt feathers at nests throughout the breeding season and at winter roosts.

RESULTS

Prebasic Molt - We visited over 310 Burrowing Owl winter roosts in Mexico and over 160 in Texas (Nov–Feb, 1997-2010) but never found molted wing or tail feathers, as was common during the late summer in Canada. We trapped 94 Burrowing Owls in Texas and Mexico in the winter. We were unable to differentiate HY/SY birds from AHY/ASY in most cases, and all birds had fully grown tail and flight feathers, except for one owl trapped in Guanajuato on 19 Nov 1999. This bird was still growing s7-9 and s4. An additional 25 Burrowing Owls trapped in Texas by collaborators had no missing remiges or retrices, including a known-age bird from Canada that was trapped in its second winter (M.K. Skoruppa pers.comm.). Thus, we concluded that the Burrowing Owl had a complete second prebasic molt, replacing all remiges and rectrices on the summer grounds before migrating.

We examined over 100 breeding Burrowing Owls in the summer in southern Alberta and southern Saskatchewan (south of 50° N). The first primary molted (the molt center) during the prebasic molt was p3, proceeding quickly distally to p2 and p1 and proximally to p4-5 (n = 20). At times, three or more primaries among p1-5 were lost almost simultaneously, resulting in large gaps in the wing (see Fig. 1).

Replacement of the 12 secondaries started with molt centers at s1 and s5 (moving proximally) around the same time or just after p1 and p2 molted (N=9) and finished at or just after the outer primaries (p9-10) finished growing. Two wild owls examined late in secondary molt appeared to have a

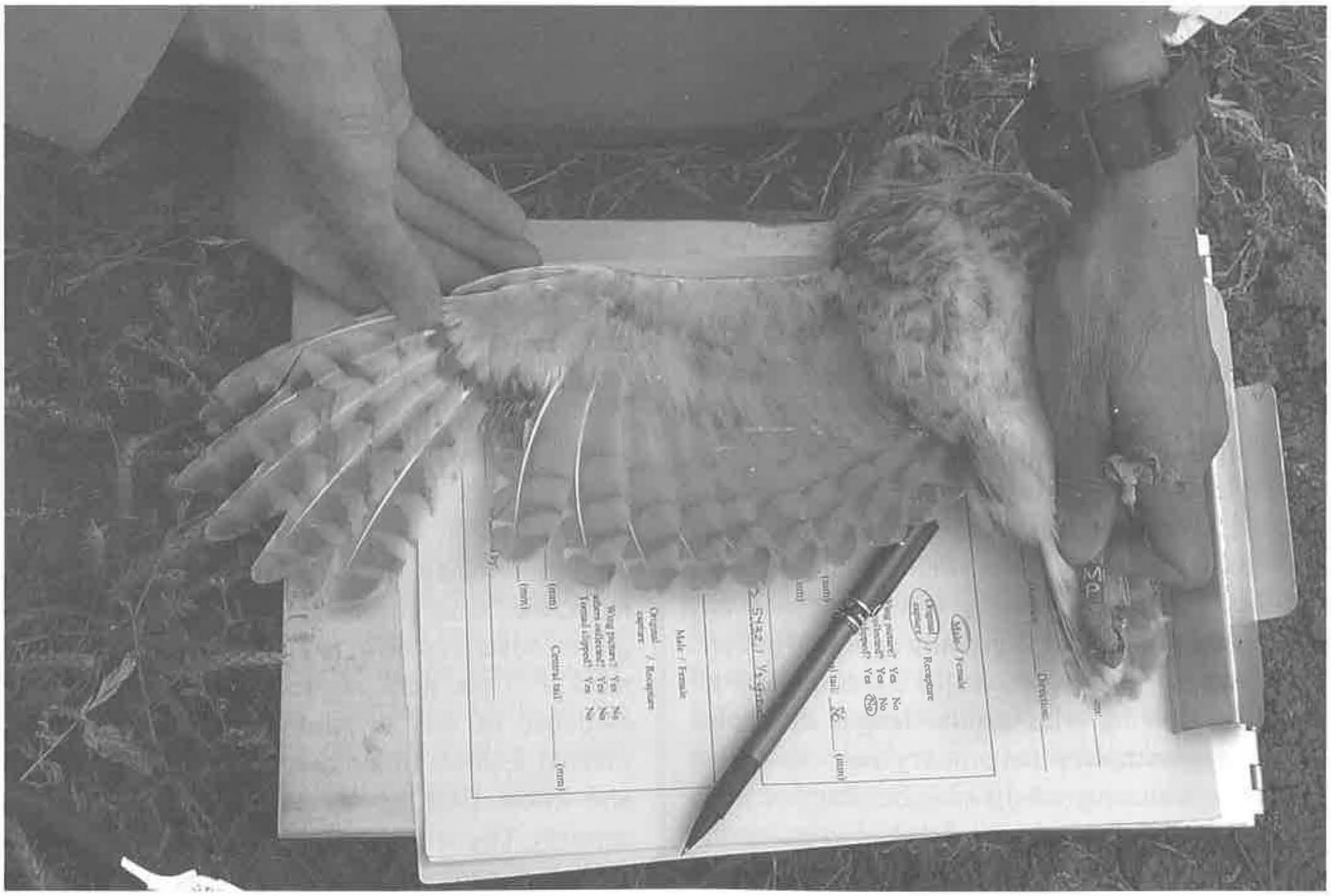

Fig. 1. Wing molt in a maleBurrowing Owl, 22 Jul 2004 in Alberta. Note p1-5 have all been lost, resulting in a large gap in the wing and near-flightlessness.

third wave that started distally from the tertials. We found an anomalous retained s1 on the right wing of one ASY male Burrowing Owl in June.

Captive, non-breeding Burrowing Owls held under natural light also molted all flight feathers, annually during the prebasic molt. Timing varied greatly. While a SY finished in less than two months (the first week of May to 18 Jun), others (N=6) were more consistent with breeding owls, starting in late Jun to Jul and finishing from late Aug to 1 Oct (the latest was a nine-year-old owl). The entire underwing exhibited a short-lived pinkish wash following the molt, as found in Northern Saw-whet Owls (*Aegolius acadicus*) (Evans and Rosenfield 1987).

Wild nesting females typically began the prebasic wing molt while on the nest with older chicks, before males. For example, a female trapped at a late nest with large chicks on 20 Jul was molting her last outer primaries (p9-10) and her secondaries were in advanced molt (s1-2 and s5-6 new, s3 and s9 half grown and s4, s7-8 in sheathed quills), while the male had just started molt, with p2-4 replaced. In general, primary molt started in July, with failed or early nesters and singles starting molt earliest. Photographs of Arizona Burrowing Owls in wing molt (N=6) suggest the timing is about a month earlier there, commencing in ~early June.

Tail molt was seldom documented in wild trapped owls, likely because it proceeds rapidly late in the breeding season and few owls are handled at this time. Rectrices were collected regularly in early August, along with numerous wing feathers at nest and roost burrows after the young fledged, indicating the tail was molted when wing molt was well underway. However, timing appeared to vary. For example, one male caught 31 Aug had all rectrices growing with similar length short pins (simultaneous molt) when primary molt was almost complete with only p8-10 old; but another male trapped 20 Jul had almost finished growing the outer tail feathers with one central feather missing (i.e., not simultaneous molt) with only p2-4 replaced. A captive male Burrowing Owl molted his tail simultaneously for nine consecutive years. One year he molted all rectrices within five days with only the central (r1) tail feathers lost on the final day; and primary molt was well underway (only p7-10 old). One wild Burrowing Owl was atypical with 13 rectrices instead of 12, a condition apparently not commonly noted in owls (Acker and Garcia 2010).

All primary and greater coverts as well as the alula were replaced in the captive Burrowing Owls, with no retention of coverts. The primary coverts molted in synchrony with the associated primaries, while the greater coverts were replaced more slowly than the associated secondaries.

Early in the breeding season (May) adjacent to nearly all active nest burrows we found a few small downy, gray body feathers, consistent in size and appearance and related to development of the female's brood patch. Although males did not incubate, they developed a small brood patch but it did not become vascularized. By early- to mid-July, body molt was observed on the ventral (brood patch area), spinal, and axillary tracts of females (N=6).

Preformative Molt - The preformative molt started shortly after fledging in July, and by September it was hard to differentiate juveniles from adults. When the wing and tail were fully grown, the back and neck were molted into the adult dark feathers with light spots. The lesser coverts were replaced first, then the primary coverts, followed by the greater coverts. Contrary to many bird species that molt the medians before the greater and lesser coverts (P. Pyle, pers. comm.), the medians molted last, thus losing the most reliable juvenal field mark, the "wing stripe." In other owls, some or all greater coverts could be retained during preformative molt (P. Pyle, pers. comm.) but we observed no evidence of this in Burrowing Owls. The last juvenal feathers to molt were the head, scapulars, and chest (starting on the sides and molting inward). The orbital feathers around the eyes were still growing in wild juveniles in September.

Winter Body Molt - We found evidence that Burrowing Owl body molt continued on the

wintering grounds in Texas and Mexico. For example, on 5 Dec 2001 we surveyed a field with a high density of migrant Burrowing Owls in Guanajuato, Mexico, and collected body molt feathers at 12 of 14 Burrowing Owl roosts. We did not identify which body feather tracts they originated from. On 25 Jan 2002, we found body feathers associated with 15 of 21 winter roosts in the same area. None of these roosts were suitable for nesting, and none of the owls remained to nest (E.Valdez-Gomez, pers. comm.).

We examined 41 winter-trapped Burrowing Owls for body molt, of which 15 were considered winter migrants and 26 were likely year-round residents (as determined by the evidence of nests, information from local inhabitants, paired owls, and behavior). About half (14 of 26) of the Mexican residents showed a small degree of body molt, usually represented by a few pin feathers, occurring in 1-3 ventral and dorsal tracts (capital, neck, breast, abdomen, axillary, spinal, crural, rump, and vent). We found molt in the majority of the migrant owls (12 of 15). We found pin feathers in 1-3 of the following tracts: capital, neck, breast, spinal, axillary, and crural. Since we were often handling birds in poor light conditions and were cognizant of reducing handling time, it is very likely we missed some body molt. We collected body molt feathers from two HY/SY captive owls over the winter (Nov-Mar) as well. The winter feathers identified were from the lesser or median coverts, scapular and ventral region. One captive SY owl was checked carefully for body molt, and while the Nov-Jan feathers corresponded to those above, in early March a more extensive molt occurred with new contour feathers growing in the spinal tract and around the neck, as well as single half grown pin feathers interspersed throughout the ventral tract. We saw no evidence of Burrowing Owls in the winter plumage having more extensive feather tracts and under-feathering (Coulombe 1970).

DISCUSSION

Our observations showed that migrant Burrowing Owls in Canada underwent a complete prebasic molt of flight feathers, in agreement with Pyle's (1997) observations from museum specimens collected primarily in California. This was likely driven by the need to replace feathers that received extensive wear while in the nesting burrows and by the sun in their open habitats before migrating in fall. The single exception was a Guanajuato Burrowing Owl finishing wing molt in November, likely an owl that nested nearby and at a very late date, thus delaying molt. For isotope studies this meant all primaries and rectrices in Burrowing Owls will be useful when examining links to the breeding ground. The closely related Little Owl (*Athene noctua*) in Europe also underwent a complete molt of flight feathers (Climent et al. 2002), but some SYs retained a few secondaries during the second prebasic molt, useful in ageing. This method cannot be used in Burrowing Owls.

Molt of retrices was simultaneous or nearly simultaneous in some cases and resulted in the complete loss of the tail before primary molt was finished. The tail molt of Little Owl was also simultaneous (Snow 1967). While Mayr and Mayr (1954) recorded a centrifugal replacement of tail feathers in one Burrowing Owl, the owls we observed most closely during tail molt displayed a "centripetal" molt with the outermost retrices (r6) molted and re-grown first.

The rapid molt of flight feathers resulted at times in gaps and an uneven edge to the wings, a condition documented to reduce lift in other raptors (Tucker 1991). Plumage condition alone can compromise flight in birds (Arent 1996) and damaged or molting primaries have been shown to reduce flight take-off speed and thus the ability to escape predators (Swaddle and Witter 1997, Swaddle et al. 1999). Rapid molt has been documented in other groups of birds to cause various stages of flightlessness. Passerines at northern latitudes are most likely to exhibit a rapid molt that compromises flight, especially when rapid wing molt is accompanied by a simultaneous tail molt (Haukioja 1971). Unlike other land birds, Burrowing Owls can rely on the safety of a burrow during heavy molt. We concur with Butts' (1973) observations that molting adults were usually inactive and seemed reluctant to fly,

some escaping disturbance by running into burrows rather than taking flight. At least some Burrowing Owls "staged" not far from their nesting grounds for up to a month prior to migration at a time when the wing and tail molt would be terminating, especially in males (G.L. Holroyd and H.E. Trefry, unpub. data). Insects are an important food supply in September (Shyry 2005) and would be easier to capture than small mammals during periods of heavy flight feather molt.

Owls are an unusual taxonomic group in that the initiation point of primary molt is so highly variable. For example, while primary molt started with p3 in Burrowing Owls, in the closely related Little Owl molt starts at p1, the same as in *Asio* owls (Climent et al. 2002). *Bubo* have a p7 molt center, Barn Owl (*Tyto alba*) p6, *Strix* are p5, while others are still unknown (e.g., *Otus* and *Scops*) and require further study (Snow 1967, Pyle 1997, Climent et al. 2002). Owls are considered diastataxic (Bostwick and Brady 2002), lacking the secondary feather that corresponds to the fifth greater covert. Diastataxic species typically molt proximally from centers at s1 and s5 (Pyle 2008), as we found in Burrowing Owl.

The body molt for AHY Burrowing Owls nearing the end of the breeding season (Jul-Aug) in Canada started on the upper part of the body (neck, brood patch, spinal tract), indicating a head-to-tail molt pattern similar to that in other birds (except we did not note the head molting at this time). It is likely that the winter body molt is a continuation of protracted and suspended prebasic and preformative molts. Additionally, a prealternate molt might occur, if some feathers were replaced twice. Although most or all other owls lack a prealternate molt (Pyle 1997), Thomsen (1971) mentions a partial prenuptial [prealternate] molt in California Burrowing Owls in both adults and young about mid-March that she speculated may contribute to the plumage differences between sexes. Other authors have noted that prealternate molts have been missed in museum specimens (Banks 1976, Lanyon 1975), since few birds are collected prior to the breeding season and pin feathers fall out of prepared museum specimens. Since researchers (including ourselves) almost never handled owls prior to the breeding season and our captive owls exhibited a body molt in March, further study is required to determine if this molt is a limited prealternate molt.

Although we were unable to age Burrowing Owls on the winter grounds, since the majority of roosts in Mexico had accumulated molted body feathers and the majority of trapped migrant owls showed body molt, we speculated that this winter molt included both AHY/ASY and HY/SY birds. The range of feather tracts molting in both the resident and migrant owls suggested a mixing of birds at different stages of molt (everything from head to crural and vent molt). This would be expected for a population of owls that vary by months as to where and when they might have bred. Stable isotope studies showed wintering Burrowing Owls in Mexico and Texas originated from across the entire Great Plains of North America as well as Mexico (Holroyd and Trefry 2011, Duxbury 2004). The partial body molt for HY/SY birds in the fall and winter has been found also in the Little Owl in Europe (Climent et al. 2002), affecting head, body, and some wing coverts.

The Little Owl, and some North American owl species, retained some inner greater coverts during their first fall (preformative) molts. This is useful in ageing SY and ASY birds (Pyle 1997) and, although it did not occur in our captive owls, we encourage others to watch for retained coverts in live known-age birds. Similarly, more observations on the molt sequence of the proximal secondaries and the tail are required. We especially encourage anyone handling Burrowing Owls early in the spring to examine contour feathers for evidence of a prealternate molt.

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Burrowing Owl
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