GENERAL NOTES

Molt-Breeding Overlap and Timing of Pre-Basic Molt in Texas Least Terns.—The plumages of Least Terns (*Sterna antillarum*) were most recently detailed by Massey and Atwood (1978); however, these authors speculated regarding molt sequences because they examined only a small number of specimens, and specimens were lacking outside of the breeding season. A partial fall molt and complete spring molt were surmised from field observations and feather replacement on museum specimens of juvenile, subadult, and adult terns. This schedule is similar to that suggested by Dwight (1901), but it does not account for the successive primary molt reported for this species by Stresemann and Stresemann (1966: *in* Ashmole 1968).

Nadler (1978:116) depicted apparent primary replacement by *S. albifrons* (≅*S. antillarum*) during mid-summer in Europe, intermediate to the molt periods suggested by Massey and Atwood. Primary molt during the breeding season has been described for several other larid species (Ashmole 1968, Harris 1971, Barth 1975, Verbeek 1977, 1979, Walters 1978). The coincidence of Nadler's observations and recognition of primary molt among other larids suggested the likelihood of a partial molt period not described by Massey and Atwood (1978) nor fully explored by the Stresemanns (op. cit.). Verification of such a molt sequence in Least Terns would add to the understanding of plumage patterns in this species and may supplement theoretical considerations of molt-breeding overlap as discussed by Lofts and Murton (1968), Payne (1972), and Foster (1975).

In this note, we present field data concerning primary molt overlapping with nesting in North American Least Terns. Additionally, we describe aspects of the late summer–early fall (pre-basic) molt that may lead to confusion in assignment of age categories to Least Terns observed in the field.

Field work was conducted on the Texas coast from May through September 1979 and 1980. Primary replacement was examined on both wings of 190 adult terns that were captured from April through July with nest traps (160) or cannon net (30) for banding and marking (cf. Brubeck et al. 1981). Breeding status was certain for those terns captured at nests; with 12 exceptions the terns caught with the cannon net were subsequently observed near active nests or with young. Those not subsequently observed nesting were included in the data set because of their timing of capture and similarity to data for known nesting individuals. Sex was not determined for any of the terns examined.

Plumage changes were observed throughout both breeding seasons on marked adults as well as juveniles that had been marked with patagial tags after capture in colonies when 12 to 20 days old. Notes also were made concerning evidence of molt on unmarked terns observed in the field, but not handled. Plumage classifications (adult, juvenile, subadult/basic) were recorded for Least Terns seen during 1-day counts on the entire Texas coast during early August of both years. All observers involved in these counts were provided with diagrammatic and narrative plumage descriptions excerpted from Massey and Atwood (1978). These plumage classifications were used to assess the proportion of Least Terns exhibiting distinctive plumages.

Primary molt began during the last 10 days of May and followed a regular sequence to molting of P5 by mid to late July (Table 1). The interval between molt of successive primaries was about 10 days as indicated by the relatively constant shifts in percentages among the 10-day periods presented in Table 1. Such a pattern was not discernible when these data were compiled for 5-, 7-, and 15-day periods. Although sample size is small after 20 July, replacement of P6 was timed similarly to or slightly slower than more proximal primaries as reported by Ashmole (1968). Molt of secondary remiges was not examined specifically, but one tern was replacing S1 on 10 July 1980 and the tern examined on 6 August 1980 had lost S2. This evidence that molt of secondaries was initiated when primary molt was about one-half complete corresponds to Ashmole's (1968) description of wing molt in other terns.

Although incubating terns comprised the bulk of the sample, primary molt appeared to be a function of season rather than breeding condition. This seasonal cue was apparent in that the terns replacing P4 and P5 while incubating eggs in early to late July (whether

TABLE 1. Timing or primary replacement by breeding Least Terns in Texas, 1979–80.

Time period[a]	n	Terns with recently molted or new primary (%)[b]					
		None	P1	P2	P3	P4	P5
<22 May	28	100.0	0	0	0	0	0
22–31 May	13	46.2	53.8	0	0	0	0
1–10 June	37	35.1	56.8	8.1	0	0	0
11–20 June	49	6.1	10.2	49.1	30.6	2.0	2.0
21–30 June	27	0	11.1	37.1	33.3	18.5	0
1–10 July	29	0	0	3.4	31.0	48.4	17.2
11–20 July	5	0	0	0	0	80.0	20.0

[a] One tern examined on 21 July 1980 and one examined on 6 August 1980 each had P6 new.

[b] Data are tabulated for the most distal primary in molt at the time of examination to illustrate progression. New growth of primaries was evident at the adjacent proximal loci on most terns examined.

original or renesting attempt) fit the molt schedule of terns captured on earlier nests (Table 1). Further, there was no indication that primary molt was interrupted during nesting as was described by Ashmole (1968) for the White Tern (*Gygis alba*), by Harris (1971) for gulls, and by Payne (1972) for a number of other species. In fact, a tern showing no molt when captured on 20 May 1980, subsequently hatched and raised a clutch and had replaced P2 by about 15–20 June when it was killed (apparently shot by vandals). Despite the apparent seasonal cue for the primary molt that we report, molt of other pterylae may be more strongly influenced by breeding condition as shown by head feather molt which tends to be more advanced in terns that fledge young earlier in the season (J. L. Atwood, Univ. California, Los Angeles, Calif. pers. comm.).

The breeding biology and behavior of Least Terns bear similarities to all of the hypothesized mechanisms for molt-breeding overlap as discussed by Foster (1975). Regarding resource exploitation based hypotheses, the size classes of food delivered to young chicks are critical for a relatively short period while adults and older juveniles exploit a food base of larger size that is abundant but may be seasonally limited. The availability of species typically eaten by Texas Least Terns (*Brevoortia patronus, Anchoa mitchilli, Membras martinica,* and *Leiostomus xanthurus*; unpublished data) may be limited by migration of the fish to deeper water or growth to unusable size classes by late summer (Hoese and Moore 1977, Landry 1977). In terms of reproductive efficiency hypotheses, Least Terns have a small clutch and a simple nest which are characteristic of many species with molt overlap. Also, the ability of chicks to hide and move about extensively soon after hatching may decrease their vulnerability and reduce the need for protective care from the parents, thereby making more energy available to molting adults. The generally extended nesting season of Least Terns within rather limited areas is consistent with the hypothesis that molt-breeding overlap may prolong the breeding season to increase the probability of success, although natural perturbations of the nesting areas probably are more important in extending breeding periods. The routine exposure of Least Terns' plumage, especially the primaries, to sand and shell during nesting is coincident with Payne's (1971) suggestion that excessive feather abrasion influences the timing of molt.

Despite the Least Terns' similarities to features of all the hypothesized mechanisms, exploitation of seasonally abundant food in concert with feather abrasion seem the most likely factors contributing to remex molt overlap with breeding in Least Terns. Keying molt to these factors would serve to use energy resources efficiently and would most enhance the condition of flight feathers prior to lengthy migration. The initiation and progression of primary molt independent of breeding condition that we observed is consistent with this hypothesis.

The pre-basic molt of body feathers and color change of soft parts in adults began in mid to late July. Adults observed during the last week in July of both years exhibited extensively mottled crowns, darkened bill and legs, and evidence of covert feather (=cubital bar: Massey and Atwood 1978) darkening. Nearly all adults were discernible from subadults during this time.

Body molt progressed rather rapidly after late July and basic-plumaged terns were commonly seen by early August when eggs or small chicks were still present at some colonies. Two marked adults seen on 2 August 1980 were in definitive basic plumage, and 10 of 51 terns examined on 7 August 1979 were in similar plumage, including a known adult. Most Least Terns on the Texas coast during September were in definitive basic plumage or at least were indistinguishable from intermediate plumages. Well-advanced molt was coincident with the peak migration period from mid-August through mid-September recorded by A. Amos (Marine Science Institute, Port Aransas, Texas, pers. comm.).

Plumage/age class relationships of some individuals became confusing by the first week in August. This confusion was evident during early August counts wherein all observers reported that 14.4% and 25.8% of 4695 and 2282 Least Terns examined during 1979 and 1980, respectively were in intermediate (=subadult) or basic plumage. Our careful classification of 1045 and 403 terns during the same counts revealed 2.7% and 4.5%, respectively in these plumage classes. Thus, less-experienced observers biased their classifications toward the "catch all" category, probably because of less familiarity with subtle distinguishing characters. However, changes in proportions between years were the same in either sample, indicating sensitivity by all observers to relative changes in abundance of terns that were either truly intermediate in plumage or well advanced in molt. Terns with intermediate plumages are not expected to represent more than 1 or 2% of such a sample.

The confusion in assignment of age classes based on plumage was primarily caused by similarity among the basic and intermediate plumages and the possibility that some subadult terns were also molting to the definitive basic plumage. However, some older juveniles were approaching their first basic plumage at the same time. A marked juvenile that fledged about 25 June 1980 (3.5 weeks later than the earliest fledging) showed a well advanced prebasic molt on 6 August and was in first basic plumage when seen on 18 September. Thus, at least the oldest juveniles attained basic plumage when near Texas breeding areas. Although subtle characteristics described by Massey and Atwood (1978) may have served to distinguish these various plumages "in hand," these plumages appeared similar under field conditions.

In summary, the Least Tern appears to be a theoretically interesting addition to the list of species exhibiting molt-breeding overlap. Further, the prebasic molt by Least Terns, at least in Texas, is well-advanced of previously described schedules. This earlier molt leads to confusion in the assignment of age categories to Least Terns seen in the field from early August on and is an important consideration if post-breeding age ratios are to be monitored during population studies of this species in the southern United States.

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Belly-soaking by Incubating and Brooding Common Terns.—Grant (J. Field Ornithol. 52:244, 1981) described belly-soaking behavior by individuals of 3 species of terns, including Common Terns (*Sterna hirundo*), at a colony in North Carolina. Mes et al. (Limosa 51:64, 1978) described an earlier case of belly-soaking by Common Terns in The Netherlands. This note reports 3 more cases of belly-soaking by Common Terns, and provides evidence for the context and function of this behavior.

The most striking case occurred on 9 July 1973, at a colony at Yarmouth, Massachusetts (41°43′N, 70°15′W), where I was conducting a detailed study of Common Terns (Nisbet, Condor 77:221–226, 1975). This was the hottest day I have experienced in 12 years' study of terns on Cape Cod. The official maximum temperature was 35°C (95°F) at Hyannis Airport, 6 km SW of the colony, but U.S. Coast Guard stations to the west, north, and east of the colony reported temperatures between 37° and 39°C (according to 3-h weather summaries broadcast by local NOAA radio stations). The heat was exacerbated by clear skies, intense insolation, windless conditions, and an early afternoon low tide which minimized the cooling influence of the sea. Although I could not measure the temperature of the sand surface, it was uncomfortable to walk on it even in rubber-soled sneakers. There was a massive fish kill in nearby Barnstable Harbor as the sand-flats heated up after low tide. Large numbers of American sand lance (*Ammodytes americanus*) which had burrowed into the sand on the falling tide emerged onto the hot sand surface or into shallow warm water, either dying within a few seconds or being eaten by Herring Gulls (*Larus argentatus*). By counting the rate at which representative gulls ate fish, I estimated that more than 400,000 sand lance were killed during the afternoon.