

on 29 March 1974. They measured  $22.4 \times 16$  mm,  $22.1 \times 15.5$  mm, and  $23 \times 15.9$  mm. The ground color of the eggs was medium olive-gray without gloss (based on the color key in M. L. Grossman and J. Hamlet, *Birds of prey of the world*, Bonanza Books, New York, 1964). All three eggs were spotted and streaked to some extent, one only slightly. The

markings were closest to olive-drab or olive-brown in color, and were almost solely around the larger end. The eggs were given to the American Museum of Natural History, New York.

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## THE ADAPTIVE SIGNIFICANCE OF DULL COLORATION IN YELLOW WARBLERS

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The Yellow Warbler (*Dendroica petechia*, *aestiva* group) breeds over a wide area in temperate North America ranging north to north-central Alaska, northern Yukon, northwestern and central Mackenzie, northern Manitoba, northern Ontario, north-central Quebec, central Labrador, and Newfoundland. Allied forms of the *petechia* and *erithachorides* groups occur in the tropics. The northernmost populations, comprising the races *rubiginosa* in southern Alaska and western British Columbia and *annicola*, widespread in northern Canada to north-central and interior Alaska, characteristically have dull olive coloration in the first winter (basic) plumage.

Recent observations of Yellow Warblers wintering in Panama suggest a possible source of selection favoring dull coloration in the first winter plumage of the immatures in these northernmost populations.

The Yellow Warbler is territorial on its wintering grounds (pers. obs.) and, like all warblers that are territorial in winter quarters, it retains the plumage color of the breeding season throughout the year (although not all non-territorial species become dull). Yellow Warblers arrive on wintering grounds very early; in Panama they are common from late August on (Eisenmann, in Groscom and Sprunt [eds.], *Warblers of North America*, Devin-Adair, New York, 1957). This early migration may be due to competition for winter territories, similar to the selective forces favoring early migration northward in species having rare nest sites (e.g., the cavity-nesting Purple Martin [*Progne subis*], Tree Swallow [*Iridoprocne bicolor*], Eastern Bluebird [*Sialia sialis*], and Prothonotary Warbler [*Protonotaria citrea*]).

Northernmost populations breed later than more southern populations and thus are at a disadvantage when they migrate south because southerly breeding birds already occupy much of the suitable wintering habitat. This is particularly true for immatures seeking wintering places for the first time.

Young northern birds may have solved the problem of not being on an equal competitive basis for winter territories by adopting a different wintering "strategy." My observations of immature Yellow Warblers of the dull northernmost races suggests that they

do not become territorial but join flocks of mixed species and wander. The extent to which immatures of more southerly races also wander in mixed flocks is unknown but at least some of them defend territories. One dull immature (probably *annicola*; E. Eisenmann, pers. comm.) collected on 14 December 1974 was with a flock consisting mainly of Tennessee Warblers (*Vermivora peregrina*) and Bay-breasted Warblers (*Dendroica castanea*), feeding on the nectar and pollen of a tree (*Inga* sp.) in second-growth woodland along a stream near the Chiva Chiva Road in the Panama Canal Zone. Its stomach contained 50% insects and 50% "yellow pulp" (pollen and nectar). This is my only Panama record of the Yellow Warbler eating non-insect food, but the other specimens were all territorial birds (9 stomachs, nearly 15 hours of observation combined over 17 wintering months). I also saw 3 immature dull green northern Yellow Warblers (one collected) in December occupying a single tree without showing aggressive behavior toward each other or eliciting aggression from a yellow territorial Yellow Warbler nearby.

These observations suggest that immature northern Yellow Warblers have acquired a dull, non-yellow plumage to avoid aggression by territorial Yellow Warblers, thereby increasing their chances for winter survival. They have lost the bright yellow color that releases aggressive behavior in territorial conspecifics. Adults of the northernmost forms are darker above than more southerly forms but are bright yellow below.

A further social adaptation is the tendency for the dull immature warblers to join mixed flocks. Hamilton and Barth (*Am. Nat.* 96:129-144, 1962) and Moynihan (*Smithson. Misc. Coll.* 143:1-140, 1962) proposed that dull plumage permits wintering birds to join flocks of mixed species more easily. This idea may hold for dull immature Yellow Warblers. But, the fact that the flocks sometimes pass near territorial Yellow Warblers argues strongly for dullness being favored by selection from intraspecific aggression.

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