Tracking Long-Distance Songbird Migration by Using Geolocators

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Until now it has been impossible to track migratory songbirds to their tropical wintering grounds. Songbirds are far too small for satellite tracking, and our current understanding of individual movements comes from brief snapshots of the journey via radar images, opportunistic recaptures of banded individuals, studies of migrants on the ground refueling, and an exceptional study that followed radio-tagged songbirds by airplane (*1*–*4*). We tracked songbird migration by mounting light-level geolocators (*5*, *6*) on 14 wood thrushes (*Hylocichla mustelina*) and 20 purple martins (*Progne subis*) breeding in northern Pennsylvania during 2007. The next summer we retrieved geolocators from five wood thrushes and two purple martins and analyzed sunrise and sunset times to reconstruct migration routes and estimate wintering locations (±300 km).

Rapid long-distance movement occurred in both species, and prolonged stopovers were common during fall migration (Fig. 1). Both purple martins flew south 2500 km to the Yucatan Peninsula in 5 days (500 km/day) and, on the basis of longitude estimates, then had a stopover of 3 to 4 weeks in the region (fig. S1). Four wood thrushes spent 1 to 2 weeks in the southeastern United States in late October before crossing the Gulf of Mexico (Fig. 1C), and two individuals stopped on the Yucatan Peninsula for 2 to 4 weeks before continuing migration (Fig. 1D).

Wood thrushes overwintered in a narrow band from 83.7° to 85.0°W (±1.4°) in Honduras or Nicaragua (Fig. 1), suggesting a level of connectivity not previously documented for migratory songbirds. Stable isotope analysis of black-throated blue warbler (*Dendroica carulescens*) feathers, for instance, showed that individuals wintering on western Caribbean islands originate from the northern portion of the breeding range, whereas those on easterly islands are from southern breeding areas (*7*).

Overall migration rate was 2 to 6 times more rapid in spring than in fall (table S1). One female martin (Fig. 1A) left the Amazon basin after the night of 12 April and flew about 7500 km in 13 days (577 km/day). Nine days involved migration flights, and 4 days were spent on stopover. Most wood thrushes returned to their breeding territory in only 13 to 15 days (233 to 271 km/day). One wood thrush did not cross the Gulf of Mexico on spring migration and took 29 days to complete the 4600-km overland route (Fig. 1D). Previous studies appear to greatly underestimate the true flight performance of migrating songbirds (*4*) because spring migration speed has typically been estimated at under 150 km/day.

Alarming long-term declines of migratory songbird species in North America and elsewhere heighten the urgency of mapping migration routes and wintering locations with far greater accuracy than is currently possible with stable isotope analysis (*8*). Tracking individuals to their wintering areas is essential for predicting the impact of tropical habitat loss and climate change (*7*, *9*). Survival estimates can now be obtained from regions where individuals from a specific breeding population overwinter, improving our understanding of how wintering versus breeding threats drive population fluctuations of migratory songbirds.

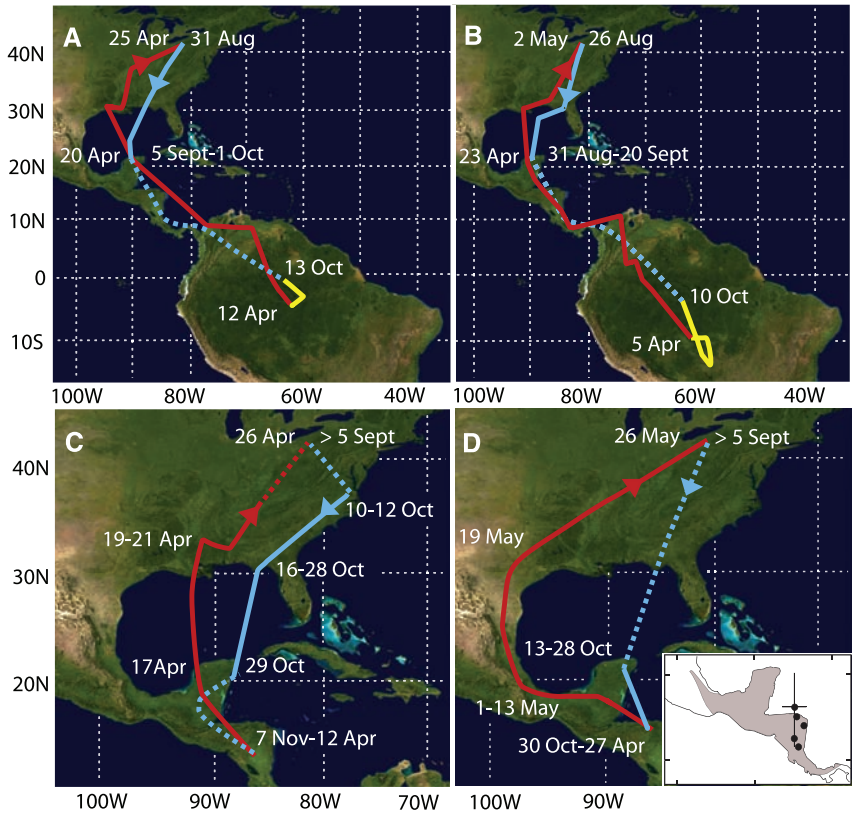

Fig. 1. Interpolated geolocation tracks of individual purple martins (**A** and **B**) and wood thrushes (**C** and **D**) that bred in northern Pennsylvania, USA (42°N, 80°W). Blue, fall migration; yellow, winter range movements; and red, spring migration. Dotted lines link locations when latitude could not be determined. Inset shows winter territory locations of wood thrush and species winter range (shaded); the standard deviation for one individual is shown.

References and Notes

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Supporting Online Material

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Materials and Methods
Fig. S1
Table S1
References

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