Oceanic Spawning Migration of the European Eel (*Anguilla anguilla*)

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European eels (*Anguilla anguilla*) undertake a ~5000-km spawning migration from Europe to the Sargasso Sea (*1*), although details of the migration remain unknown. Satellite tracking enables investigation of migratory behavior of large ocean-dwelling animals (*2*), but tag sizes have precluded tracking smaller animals like European eels. Here, we present information about the spawning migration of European eels based on a miniaturized pop-up satellite archival transmitter (PSAT). The experiment fell short of revealing the full migration to the Sargasso Sea, but the tags tracked eels up to 1300 km from release and provided unique behavioral insights.

Transmissions were received from 14 of 22 tagged silver eels released on the west coast of Ireland in October and November 2006 (table S1). Eels migrated southwest, suggesting a route against the prevailing shelf edge and Atlantic drift currents and toward the Canary and Azores current systems (Fig. 1A). The horizontal net migration speed varied from 5 to 25 km day^{-1} (mean of 13.8 km day^{-1}), much lower than required [35 km day^{-1} (*1*)] to reach the Sargasso Sea for spawning in April (table S1). This may reflect drag from the PSAT. However, the inferred speed corresponded to results from eels tagged with much smaller archival or acoustic tags in coastal areas (*1*) and to PSAT studies of much larger long-finned eels (*A. dieffenbachii*) in the Pacific Ocean (*3*). In consequence, our data are consistent with a hypothesis (*4*) suggesting that eels gain speed and increase travel efficiency by entering the south- and west-flowing currents that begin west of Africa and continue as part of the subtropical gyre system to the Caribbean.

The habitat use revealed by depth and temperature data showed that migrating eels encountered a diverse range of environments (fig. S1), consistent with ARGO data collected from the same region and time period (fig. S2). When eels moved into the mesopelagic zone they all undertook distinct diel vertical migrations (DVMs), predominantly between depths of 200 and 1000 m. DVM was typified by two tag records (Fig. 1B; all following results refer to these tags). During night, eels occupied shallow warm water (daily average = 282 ± 138 m, 11.68° ± 0.48°C). At dawn, eels made a steep dive into the cool disphotic zone (daily average = 564 ± 125 m, 10.12° ± 0.89°C, minimum observed = 7.1°C). At night, they ascended steeply back into the upper layer.

DVM allows pelagic organisms to avoid exposure to predators during the day and maximize feeding time at night (*5*). Predator avoidance may explain the deeper depths during the day, but eels do not feed during the spawning migration. We hypothesize that the observed DVM reflects thermoregulation. The daily ascent into shallower warm water may serve to maintain sufficiently high metabolism and swimming activity (*1*), whereas descent to deeper waters may permit the eels to keep their average temperature below 11°C, delaying gonadal development (*6*) until reaching the Sargasso Sea. This potential delay of the maturation may prove especially important when eels encounter higher surface temperatures during later stages of the migration.

Further technical improvements of PSAT tags render it realistic to record the entire spawning migration to the Sargasso Sea.

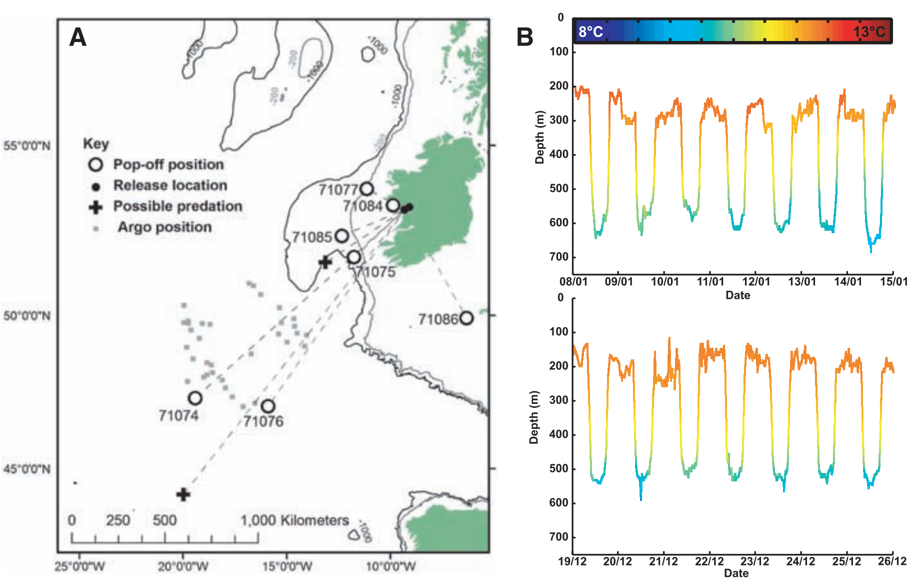

Fig. 1. (**A**) Map showing pop-up positions (± 1 km, determined by Doppler shift) and positions of data extractions from the ARGO database used as corroboration (*7*). Pop-up positions for 71077 and 71086 are unreliable because of extensive drift before being picked up by the satellites. (**B**) Oceanic diel vertical migration of two eels, 71074 and 71076. Data from tag 71074 (January 2007) are shown in the top graph, and data from tag 71076 (December 2006) are shown in the bottom graph. Depth values are colored by temperature, over a week-long period.

References and Notes

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7. Materials and methods are available as supporting material on *Science* Online.
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Supporting Online Material

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Materials and Methods
Figs. S1 to S3
Table S1

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