Plate 1. Common Tern *Sterna hirundo* feeding juvenile during the post-fledging period. Massachusetts, USA, 27 July 2007. © James Fenton.

Female Common Terns *Sterna hirundo* start autumn migration earlier than males

Nisbet, I. C. T.[1*], Szczys, P.[2], Mostello, C. S.[3] and Fox, J. W.[4,5]

**Correspondence author.*
E-mail: icnisbet@verizon.net
[1] *I. C. T. Nisbet & Company, 150 Alder Lane, North Falmouth, MA 02556, USA;* [2] *Eastern Connecticut State University, 83 Windham Street, Willimantic, CT 06226, USA;* [3] *Massachusetts Division of Fisheries and Wildlife, 1 Rabbit Hill Road, Westborough, MA 01581, USA;* [4] *British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET, UK. Present address:* [5] *Migrate Technology Ltd, P.O. Box 749, Coton, Cambridge CB1 0QY, UK.*

Abstract

We used geolocators to track Common Terns *Sterna hirundo* from a breeding colony in the northeastern USA. Seven females started autumn migration between 1 and 22 August (mean 9 August), whereas four males started between 12 August and 5 October (mean 6 September). Common Terns have prolonged post-fledging care and our findings support earlier inferences that males perform more of this care than females. This would result in higher costs for males.

Introduction

Most terns that nest in the temperate zones have a prolonged period of 1–3 months between completing breeding and starting autumn migration, during which they disperse within the breeding range, undergo a partial moult, and attend and feed juveniles (Nisbet 1976, 2002; Burger 1980; Gochfeld *et al*. 1998; Watson & Hatch 1999). In at least some species, post-fledging care continues for several months after autumn migration (Ashmole & Tovar 1968; Feare 1975; Barlow 1998; Gochfeld *et al*. 1998). Male and female terns perform parental care more or less equally until late in the chick-rearing period (Gochfeld *et al*. 1998; Nisbet 2002), but the relative contributions of the sexes after fledging are not known. Nisbet *et al*. (2010) described an event at Bermuda in which a hurricane on 5 September 2003 eliminated all the male Common Terns *Sterna hirundo*: most or all females survived and appear to

have left the island early, while the males had continued caring for juveniles until the day before the hurricane. Here we report direct measurements of autumn departure dates of male and female Common Terns from a post-breeding staging area around Cape Cod, Massachusetts, USA.

Methods

We used geolocators (light-level data loggers) to track Common Terns from a breeding colony at Bird Island (41°40'N 70°43'W), Massachusetts, USA. We attached 17 geolocators to Common Terns in 2007 and 2009, and retrieved 11 geolocators with year-round location data in 2008–2010. The birds that returned were sexed using DNA extracted from erythrocytes following methods described by Nisbet *et al*. (2007). Field methods, data processing and results for the first five birds were reported by Nisbet *et al*. (2011).

We measured colony productivity (mean number of chicks raised to fledging per pair) in 2007 and 2009, using field protocols codified by the Massachusetts Division of Fisheries and Wildlife, based on methods described by Tims *et al*. (2004). Using the same protocols, we determined the number of chicks raised to fledging by each of the geolocator birds in 2007. For 2009, we used the geolocator records to determine which birds had been raising chicks: the geolocators recorded many shading events every day up to 11 days after hatching, and occasional shading events up to day 17. These shading events occurred when the birds were incubating eggs or brooding small chicks, and subsequently when they entered cover to feed larger chicks (some of the birds were raising chicks among dense vegetation). We estimated fledging dates as 24 days after hatching. However, we did not verify fledging of any chicks in 2009 and we have no information on post-fledging survival in either year.

Following breeding, all birds remained in the area around and to the west of Cape Cod (39–42°N 69–73°W) for periods of 4–13 weeks in July–September. This is an important staging area for Common Terns in the post-breeding period (Trull *et al*. 1999). We identified 'departure date' for each bird as the date when estimates of both latitude and longitude started to change systematically by >1° per day for ≥ 3 days, so that estimated positions moved well outside the limits specified above. Nine of the 11 birds migrated directly from the post-breeding area to the eastern Caribbean Sea in the vicinity of Puerto Rico or the Dominican Republic (18–20°N 66–70°W). The remaining two birds staged in the vicinity of Cape Hatteras, North Carolina (35°N 75°W), for 3 and 48 days before crossing to the vicinity of Puerto Rico (Nisbet *et al*. 2011); we identified the date they left the post-breeding area as the departure date. For the two birds that departed after 31 August (i.e. within 21 days of the autumn equinox, when latitude estimates are unreliable), we relied on changes in longitude to identify departure date.

Results

Two Common Terns are known to have raised no young to fledging in the year of study. One other bird apparently failed to raise young, based on the geolocator record which showed no shading events after the second day after hatching. These birds are marked F in Figure 1. All other birds are believed to have raised one chick to fledging, based on colony productivity and the geolocator records which showed many shading events until days 4–11 of chick-raising and occasional shading events until days 8–17. Based on chick weights in 2007 and colony productivity in 2009, it is unlikely that any birds in this study raised two chicks to fledging.

Dates of departure are shown in Figure 1. Seven females departed between 1 and 22 August (mean 9 August) and four males departed between 12 August and 5 October (mean 6 September). Thus, females started migration approximately 28 days earlier than males: the difference was statistically significant (Mann-Whitney test, $U = 1$, $P = 0.012$). There were insufficient data to test for a difference between years, but dates overlapped in both sexes. There was only a slight

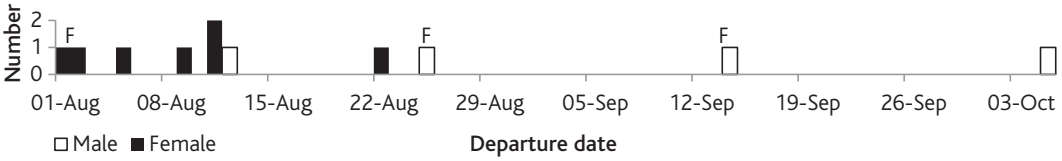

Figure 1. Departure dates of Common Terns *Sterna hirundo* from a post-breeding staging area around Cape Cod, Massachusetts, USA. Solid bars denote females and open bars denote males. F denotes birds known or thought to have failed to raise chicks.

tendency for birds that raised no chicks to depart earlier than those that raised chicks (Figure 1). Among birds that are thought to have raised chicks, six females departed 18–46 days and two males departed 42 and 93 days after their chicks fledged (Mann-Whitney test, U = 1, P = 0.096).

Discussion

Our data show that female Common Terns departed on autumn migration much earlier than males. In the staging areas around Cape Cod where these birds stayed during July–September, post-fledging care continues well after the average departure date of 9 August for the tracked females, and some birds continue feeding juveniles until at least 26 September (I. Nisbet, unpubl. data). We have no direct information on whether juvenile Common Terns migrate with their parents or when they migrate, but birds ringed as chicks in North America are rarely reported in the West Indies or northern South America in August of the same year (Hays *et al*. 1997). Among Common Terns ringed as chicks in Massachusetts, only one has been recovered in these areas in August (probably erroneously because it was reported in Guyana only nine days after fledging), versus seven in September and ten in October (I. Nisbet, unpubl. data). Thus, to complete their post-fledging growth and development (Schauroth & Becker 2008), juveniles appear to remain in the post-breeding area long after females leave. Hence, male Common Terns appear to perform all the post-fledging care, at least after mid August.

It should be noted that the five Common Terns fitted with geolocators in 2007 had lost body-mass and had shown chafing injuries to the legs when retrapped 10–13 days after attachment. However, all had improved when trapped again 3–6 days later, and three of them raised chicks to fledging (Nisbet *et al*. 2011). Short-term adverse effects on the six Common Terns fitted with geolocators in 2009 were much smaller (I. Nisbet & C. Mostello, unpubl. data). It is nevertheless possible that the geolocators impaired the birds' behaviour or performance during the post-breeding period, and such effects might hypothetically have been on greater on males than on females because the males were working harder to feed the juveniles. However, this would not explain why the females departed at such early dates, while the juveniles were still dependent on parental care.

Our findings are consistent with earlier data which had suggested that male Common Tern parents perform more post-fledging care than female parents (Nisbet *et al*. 2010). In Ospreys *Pandion haliaetus*, similarly, females depart soon after fledging and males do most of the post-fledging care (Hake *et al*. 2001; Martell *et al*. 2001). The biological significance of this difference is that males probably incur greater costs, either through the physiological costs of caring for fledglings or through greater risks encountered in the post-fledging period. In the study area around Cape Cod, male Common Terns migrate SSE from mid August to early October (Figure 1) and therefore have to cross the main track of North Atlantic hurricanes at the peak period of their occurrence, while female Common Terns migrate well in advance of the period of highest risk in September. The event at Bermuda in early September 2003, in which all the male Common Terns were eliminated by a hurricane and most or all of the females escaped (Nisbet *et al*. 2010), is a dramatic illustration of this differential risk. An earlier hurricane that passed through the main

staging area of Common and Roseate Terns *S. dougallii* around Cape Cod on 19 August 1991 eliminated many adult and most juvenile Roseate Terns from the regional population (Lebreton *et al*. 2003; Spendelow *et al*. 2008). We have no statistical information on the effects of the 1991 hurricane on Common Terns, but the data on departure dates in this paper suggest that most females would have escaped it, whereas most males would have experienced it.

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Figure 1. Newly hatched Common Eider *Somateria mollissima* chick in a Great Black-backed Gull *Larus marinus* nest, Er Valant Island, France, 20 May 2010. © *Arnaud Le Nevé*.

Interspecific brood parasitism by the Common Eider *Somateria mollissima* at Er Valant Island, Brittany, France

Le Nevé, A.[1*], Delord, K.[2], Barbraud, C.[2], Barbraud, J.-C.[3] & Fortin, M.[4]

**Correspondence author.*
Email: arnaud.le-neve@wanadoo.fr
[1] *Groupe Ornithologique Breton, BP 42, F-56110 Gourin, France;* [2] *CEBC-CNRS UPR 1934, F-79360 Villiers en Bois, France;* [3] *4 impasse du Vignaud, La Nougerée, F-17770 Bercloux, France;* [4] *Bretagne Vivante – SEPNB, Réserve naturelle des Marais de Séné, Brouël Kerbihan, F-56860 Séné, France.*

Interspecific brood parasitism (IBP) involves individuals of one species leaving the incubation and rearing of their brood to another species, while conspecific brood parasitism (CBP) involves a female laying its eggs in the nest of another of the same species (Robert & Sorci 2001; Lyon & Eadie 2008). CBP is a common reproductive tactic in Anatidae, found in 46% of species including the Common Eider *Somateria mollissima* (Yom-Tov 2001), while IBP is infrequent in precocial species such as Anatidae (Robertson 1998).

On 20 May 2010, we conducted a seabird population survey on the 300 m long Er Valant Island (île aux Chevaux; 47°21'N 2°58'W), Brittany, at the northern end of the Bay of Biscay. Species breeding on the island in 2010 included European Shag *Phalacrocorax aristotelis* (109 pairs), Lesser Black-backed Gull *Larus fuscus* (5 pairs),