

PRESUMED HYBRID ELEGANT × CABOT'S TERNS *THALASSEUS ELEGANS* × *T. ACUFLAVIDA* IN ISLA RASA, GULF OF CALIFORNIA, MEXICO

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SUMMARY

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Terns are more likely to hybridize than most bird species. Elegant (*Thalasseus elegans*) and Cabot's (*T. acuflavida*) Terns are not sympatric and have been considered sister species or members of a single superspecies. A few Cabot's Terns have been observed in Elegant Tern nesting colonies, including the colony on Isla Rasa, but few hybrids of these two species have been reported in the literature. Here we report 15 presumed Elegant × Cabot's Tern hybrids observed in Isla Rasa during the nesting seasons of 2010 and 2011, including three adults each escorting a chick, and a subadult. We used photographs of 10 adults to compare their general external anatomical characteristics with those of the presumed parental species. Elegant Tern is considered a Vulnerable species under Mexican environmental law. With the introduction of Cabot's Tern genes, Elegant Tern could be gaining genetic diversity and adaptability to more tropical conditions, particularly considering the possible future climatic effects of global warming.

Key Words: Elegant Tern, Gulf of California, hybrid terns, Isla Rasa, Cabot's Tern, *Thalasseus elegans*, *Thalasseus acuflavida*

RESUMEN

Los charranes se hibridizan mas que otras especies de aves. Los charranes elegante (*Thalasseus elegans*) y de Cabot (*T. acuflavida*) no son especies simpátricas y han sido consideradas como especies hermanas o pertenecientes a una misma superespecie. Algunos charranes de Cabot se han encontrado en colonias de anidación de charrán elegante, incluyendo la colonia en Isla Rasa, pero pocos híbridos de estas dos especies se han reportado en la literatura. En este trabajo reportamos haber visto quince presuntos híbridos de charrán elegante × charrán de Cabot en Isla Rasa, en las temporadas de anidación de 2010 y 2011, incluyendo a tres adultos escoltando sendos polluelos, y un subadulto. Con base en fotografías de diez de ellos, comparamos las características anatómicas generales de estos individuos con las de ambas presuntas especies parentales. El charrán elegante se considera como Vulnerable de acuerdo a la ley ambiental Mexicana. Esta especie podría estar adquiriendo una mayor diversidad genética y capacidad adaptativa con la introducción de genes de charrán de Cabot, que es una especie más tropical, particularmente considerando los posibles efectos climáticos futuros del calentamiento global.

INTRODUCTION

Elegant and Cabot's Terns (*Thalasseus elegans* and *T. sandvicensis acuflavidus* and *T. s. eurygnathus*) are closely related species sometimes classified as a single superspecies (AOU 1998), or sister species, distinct from *T. s. sandvicensis* (Efe *et al.* 2009). Their breeding distributions do not generally overlap, since Elegant Terns nest in the Pacific coast of North America and Cabot's Terns, along the Atlantic coast (Burness *et al.* 1999, Shealer 1999). However, Cabot's Terns have occasionally been observed in Elegant and Royal Tern colonies along the Pacific coast (Schaffner 1981, Collins 1997, Hamilton 2007), and some Elegant Terns have been recorded along the Atlantic coast of North America (AOU 1983, Boesman 1992 cited by Kwater 2001, Kwater 2001, Paul *et al.* 2003), and Europe (O'Sullivan & Smiddy 1988, Alstrom and Colston 1991), several of them paired with Cabot's or Sandwich Terns.

As no breeding colonies of Cabot's Tern occur on the Pacific coast, it is believed that all birds that winter there migrate from Atlantic

and Caribbean colonies (Ridgely 1981, Hilty & Brown 1986, Collins 1997, Ridgely & Greenfield 2001). In the Pacific, vagrants have been recorded in California and the Hawaiian Islands (AOU 1998, Hamilton *et al.* 2007). Between 1980 and 1995, there were four records of Cabot's Tern in California (Schaffner 1981, Collins 1997, Hamilton *et al.* 2007, www.californiabirds.org/cbrc_book/update.pdf), all during the breeding season, and recently two Cabot's Terns (one each in 1986 and 2008) were reported from Isla Rasa, in the Gulf of California (Velarde & Tordesillas 2009). Mixed pairs and presumed hybrids of these two species have been documented along the Pacific coast in several instances (Collins 1997, Singer & Terrill 2009, www.westernfieldornithologists.org/gallery). There are also several reports of mixed pairs and hybrid young in the north Atlantic, in North America (Shealer 1999, Paul *et al.* 2003).

These records suggest that there may be many more cases of Cabot's Terns along the Pacific coast, and Elegant Terns in the North Atlantic, and that they occasionally interbreed with Cabot's Terns

at several locations. This is not surprising, considering that almost 44% (10 of 23) of all North American and European tern species have been reported to hybridize (Hays 1975, Collins 1997, Whittam 1998 and references therein, Singer & Terril 2009); depending on the taxonomic authority used, even higher percentages have been reported (Efe *et al.* 2009). However, within the class Aves, this is a very high proportion, considering that only about 10% of all bird species hybridize (Grant & Grant 1992).

A single Cabot's Tern was observed on Isla Rasa, Gulf of California, Mexico, in 1986 and in 2008 (Velarde & Tordesillas 2009). There was no way to know whether these observations represented the same or different individuals, but it is unlikely they were the same, being 22 years apart. Observations on Isla Rasa were carried out in a mixed colony of Elegant and Royal Terns (*Thalasseus maximus*) that is established every year in this island. The Elegant Tern colony in this island is some 100 000 nests (constituting over 90% of the world population), while the Royal Tern colony has averaged some 7 000 nests in the last 30 years (Velarde & Anderson 1993, Velarde, *et al.* 2007). Here we report observations of 15 presumed Elegant × Cabot's Tern hybrids observed on Isla Rasa during the breeding seasons of 2010 and 2011.

METHODS

During regular field surveys, presumed Elegant × Cabot's Tern hybrids were observed on Isla Rasa during 2010 and 2011. Hybrids were first identified as showing most of the characteristics of an Elegant Tern, but with some dark areas in an orange bill; later, other mixed characteristics were also noted. Some of these individuals were photographed. The second author was able to photograph seven of the 14 individuals observed in 2011, using a Nikon D300s camera, with a Nikkor 200–400 mm lens and, in some instances, a 1.4× converter. In Appendix I (available on the Web site) we describe the conditions under which the observations were made, the individuals' activities during these observations, and the individuals seen and photographed in 2011 (Table 1, Fig. 1). We compare some of their characteristics with those of both Elegant and Cabot's Terns.

To estimate the possible contribution of Cabot's and Elegant Tern to each of the observed hybrids, we selected six characteristics (bill length, bill depth, estimated % of black on the bill, leg color, relative body size with respect to Elegant Terns nearby, and crest length) and assigned a numerical score to each of the characteristics with 1 = closest to pure Elegant and 4 = closest to pure Cabot's;

TABLE 1
Anatomical characteristics of the presumed hybrid terns observed in Isla Rasa, compared with Elegant and Cabot's Terns

Individual (Fig.) or species	Characteristic, description (and score)						Total score	Type
	Bill length	Bill depth	% black bill ^a	Leg color ^b	Body size	Crest		
1 ^c			<50	Black				
2			<50	Black				
3 ^d (1A)	Short (4)	Slender (4)	<50 (2)	N/e (3)	Smaller (2)	Shorter (3)	19	B1
4 ^d (1B)	Short (4)	Slender (4)	>50 (3)	Black (4)	Medium (2)	Medium (2)	19	B1
5 ^d (1C)	Medium/ large (2)	Medium/ thick (2)	<50 (2)	Black (4)	Smaller (3)	Long (1)	14	B3
6 ^d (1D)	Medium (3)	Medium (3)	>50 (3)	Black (4)	Smaller (3)	Medium (2)	18	B1
7 ^d (1E)	Short (4)	Slender (4)	<50 (2)	Orangish (1)	Medium (2)	Short (4)	17	B1
8 ^d (1F)	Medium/ large (2)	Medium/ thick (2)	<50 (2)	Black (4)	Smaller (3)	Long (1)	14	B3
9 ^d (chick in Fig. 1D)								
10	Medium (3)	Slender (3)	<50 (2)	Black (4)	Medium (2)	Medium (2)	16	B2
11	Medium (3)	Slender (3)	<50 (2)	Black (4)	Medium (2)	Medium (2)	16	B2
12 (chick)								
13 ^d	Medium/ large (2)	Medium/ thick (2)	<50 (2)	Black (4)	Smaller (3)	Medium (2)	15	B2
14 ^d	Long (1)	Medium/ thick (2)	<50 (2)	Black/ orange (3)	Medium (2)	Shorter (3)	13	B3
15 ^d (chick)								
Elegant	Long (1)	Thick (1)	0 (1)	Variable (1)	Large (1)	Long (1)	6	
Cabot's	Short (4)	Slender (4)	All but tip (4)	Black (4)	Small (4)	Short (4)	24	

^a Amount of black on the bill is estimated as a percentage according to the following categories: < 50% = 2, > 50% = 3.

^b n/e = Characteristic not evident in the photo.

^c Individual 1 was observed in 2010; all other individuals were seen in 2011.

^d Individual was photographed.

adding the scores then gives a “hybrid index” for each bird, ranging from 6 = pure Elegant to 24 = pure Cabot's. We classified the observed hybrids into three categories: 17–19 (closer to Cabot's), 15–16 (intermediate), and 13–14 (closer to Elegant), depending on the amount of Cabot's vs. Elegant characteristics observed. We refer to these categories as backcross 1, backcross 2 and backcross

3, respectively (Table 1), each of them displaying, successively, a larger proportion of Elegant Tern characteristics. After observing the first presumed hybrid individuals in the crèche areas, we started counting the numbers of terns, to estimate the proportion of individuals observed with presumed hybrid characteristics among the total Elegant Tern nesting population on Isla Rasa.



Fig. 1. Presumed Elegant × Cabot's Tern hybrids observed on Isla Rasa. Photo credit: Patricia Rojo. (A) 13 May 2011: Note smaller, more slender bill than that of the Elegant Tern in the foreground. (B) 13 May 2011: Note smaller size of the bird, and smaller, more slender bill than that of the Elegant Tern in the background. (C) 14 May 2011: Note small dark streak on mandible and long crest. (D) 14 May 2011: This individual was observed escorting and brooding a chick for over 1 h. Note large proportion of blackish coloration of the bill. The chick showed mostly Elegant Tern coloration of plumage and bill. (E) 14 May 2011: Based on plumage coloration characteristics (dark markings on secondaries and tertials), this individual was believed to be a subadult. Note blackish coloration around nostril and orangish legs. This individual could have a smaller component of Cabot's Tern than others shown in this study. (F) 14 May 2011: Note larger amount of dark coloration on top of bill, longer crest, and long bill.

RESULTS

In 2010, a tern that seemed to be a hybrid adult Elegant × Cabot's (formerly considered Sandwich) Tern was observed on Isla Rasa, but no photograph could be obtained at the time. This individual was assumed to be a hybrid because its bill was tinted orange, with some black diffuse markings or smudges. In 2011, also on Isla Rasa, we observed 10 adults and one subadult individual that seemed to be hybrids of these two species, two caring for half-grown chicks and one for a small chick. Consequently, these three chicks were also presumed to be hybrids. Images of seven of these individuals are shown in Figure 1. The other individuals were either not photographed or the images were of a low quality.

All seven individuals pictured, plus one that was not photographed, were observed on 13–14 May 2011, at the edge of one of the mixed Elegant–Royal Tern nesting colonies. The other six individuals (four adults and two chicks) were seen on 3 and 5 June at a crèche, when chicks were leaving the nesting area on their way to the island's edge. All adults and subadults observed during 2010 and 2011 presented slightly different degrees and patterns of black coloration on an orange bill, with a lighter (orange-yellow) tip, as well as differences in bill length and depth, crest length, body size relative to nearby standing Elegant Terns, and leg coloration (Table 1).

We counted 1 779 adult individuals in our observation areas, of which 10 (about 0.56% of the population) were presumed hybrids. The total nesting Elegant Tern population on Isla Rasa is close to 200 000 individuals. According to the relative proportion of presumed hybrids occurring in the observation areas, the random pairing of Elegant and hybrid terns would result in 99.4% of hybrids being paired with pure Elegant terns and only 0.6% being paired with another hybrid. However, from the total of 12 presumed adult hybrids observed during 2010 and 2011, only four (33.3%) were not associated with another hybrid, while seven (58.3%) were observed associated with one other hybrid, and one (8.3%) was observed associated with three other different hybrids, giving a total of 66.6% of the hybrids associated with other hybrids.

We list all encountered presumed hybrid individuals in Table 1, according to the order in which they were observed. This is based on the assumption that a hybrid (F₁ individual) will have a higher probability of mating with an Elegant, as opposed to another hybrid (but see previous paragraph). According to this classification, individuals 1A, 1B, 1D and 1E might be considered backcross 1; individuals 10, 11 and 13 (not shown in the Figure), backcross 2; and individuals 1C, 1F and 14 (the latter not shown in the Figure), backcross 3.

DISCUSSION

The Cabot's and Elegant Terns have recently been considered to belong to a single superspecies (AOU 1998) while, on the basis of genetic studies, Efe *et al.* (2009) proposed the Elegant Tern to be nested among the subspecies of the Cabot's Tern. Conversely, they proposed that the present European Sandwich Tern (*T. s. sandvicensis*) is a distinct species, further removed from both *T. elegans* and the Cabot's Tern (present *T. s. acuflavidus* and *T. s. eurygnathus*), the latter two being considered by these authors as a single species (*T. acuflavidus*) with *T. elegans* as a sister species. This conclusion is reinforced by the fact that both mitochondrial and nuclear DNA mean K2P pairwise percent

distances between *T. elegans* and *T. acuflavidus* are much smaller than those between either of these two species and *T. sandvicensis*, while MtDNA distances are quite similar between *T. elegans* and both *T. sandvicensis* and *T. maximus*, indicating that Elegant Tern is almost as distantly related from *T. sandvicensis* as it is from *T. maximus*. Also, while several instances of Elegant × Cabot's hybrids have been documented, no documentation of Elegant × Sandwich hybrids was found in the literature.

Cabot's Terns observed in Elegant and Royal Tern nesting colonies may be individuals caught up in the northwestward movement of the other two species during early spring, migrating with them to their breeding colonies in the Gulf of California and southern California, instead of following their usual northeasterly migration to breeding colonies in the Gulf of Mexico and southeastern United States. In 2009 Velarde and Tordesillas suggested that occurrence of Cabot's Terns (considered Sandwich Terns at that time) in the main colony of Elegant Terns on Isla Rasa could lead to sporadic hybridization and the appearance of variably intermediate birds throughout the range of the Elegant Tern. The observations reported here confirm this suggestion and lead us to believe that there must be a very small but constant flux of Cabot's Terns into the Elegant Tern nesting areas and some small degree of hybridization. The occurrence of fertile hybrids, as demonstrated by our observations of several individuals caring for what seemed to be mostly Elegant Tern chicks, reinforces the proposition that Elegant and Cabot's Terns are sister species or belong to a single superspecies.

Our results show that hybrids may be exerting a certain amount of attraction among themselves, and tend to associate. This could be the result of these hybrids having a greater affinity among themselves, or being closely related to each other. Hays (1975) found hybrid chicks in three nests in a mixed Common (*Sterna hirundo*) and Roseate (*S. dougallii*) Tern colony. She found that both mates in two of those three nests were hybrids, speculated about the high improbability of chance mating of four hybrid individuals with one another in such a large colony, and suggested some kind of specific elements in their courtship calls that might lead to this intra-hybrid attraction. Intermediate forms of some hereditary characteristics in hybrids, such as migratory direction, have been demonstrated for some species (Helbig 1991, Berthold *et al.* 1992, Helbig 1996). If vocalizations in these tern species follow a similar hereditary pattern, this would favor hybrid recognition through their calls. Just as Hays (1975) did, we suggest caution in these interpretations, and the need for analysis of the calls of both species as well as that of the hybrids, combined with field tests, before further speculation.

If the individual in the photo shown in the website www.westernfieldornithologists.org/gallery is a 50/50% (F₁) hybrid Elegant × Cabot's Tern, we could speculate that the individuals that we observed were all backcrosses, originating from successive matings of F₁ hybrids with Elegant Terns in this large Elegant Tern nesting colony. Although the scoring results in Table 1 are crude, and should be taken as such, they do suggest the value of future genetic studies of these hybrid individuals, in order to establish a more accurate record of the degree of genetic contribution of Cabot's Tern on Isla Rasa, the most important Elegant Tern nesting colony (Velarde *et al.* 2005).

The Elegant Tern is considered vulnerable under Mexican environmental law, owing mainly to the fact that a single colony, the one on Isla Rasa, holds about 90% of the breeding population of the

species. The conservation implications of the observed hybridization are hard to predict. Some authors have suggested detrimental effects of hybridization such as decreased survival of hybrids or difficulty in attracting potential mates (Berthold *et al.* 1992, Helbig 1991, 1996). On the other hand, considering the possible positive effects of selection on these hybrids, if we take into consideration the likelihood of global warming and other environmental changes, the integration of higher genetic variability, particularly of a more tropical species such as the Cabot's Tern into the gene pool of the Elegant Tern, could result in unforeseeable benefits.

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