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Short Note

First Stranding Record of Fin Whale (*Balaenoptera physalus*) in the Mexican Waters of the Gulf of Mexico

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Fin whales (*Balaenoptera physalus*; Linnaeus, 1758) exhibit a cosmopolitan distribution with higher concentrations of individuals in temperate and cold waters (Aguilar, 2009). The most distinctive identification feature is asymmetrical pigmentation: the right lower jaw is white, while the left jaw is mostly dark gray, with some right side baleen plates being lighter in color than those on the left. Most populations are migratory, feeding in higher latitudes during the summer and breeding during the winter temperate waters, with few exceptions of resident stocks (Jefferson et al., 2008; Edwards et al., 2015). Two main forms are recognized, *B. p. physalus* in the Northern Hemisphere and *B. p. quoyi* in the Southern Hemisphere (Rice, 1998). In the western North Atlantic, three separate populations have been described: a northern, a cold-adapted, and a southerly stock (Würsig et al., 2000). There are very few reports of fin whales sighted in the Gulf of Mexico where they are considered extralimital (Jefferson & Schiro, 1997). Indeed, fin whales are rare or absent from equatorial regions between 20° N and 20° S, and extensive surveys in the Gulf of Mexico from 1980 to 2012 resulted in just three sightings, all in U.S. waters (Würsig et al., 2000; Edwards et al., 2015). Herein, we describe the first stranding record of a fin whale in Mexican waters of the Gulf of Mexico and analyze the possible causes and origin.

In Yucatán, Mexico, the Universidad Autónoma de Yucatán's Marine Mammal Research and Conservation Program (PICMMY-UADY for its Spanish acronym) is an active participant of the local stranding network in collaboration with government and nongovernment agencies. On 28 February 2016, an unidentified cetacean was reported adrift to the east of Progreso, Yucatán, Mexico, about 5 km offshore (Figure 1). It was towed ashore and then pulled approximately 100 m above the high tide limit using heavy machinery. PICMMY personnel examined the carcass and performed a necropsy *in situ* (following Geraci & Lounsbury, 1993; Jefferson et al., 2008; Diario Oficial de la Federacíon [DOF], 2014).

To estimate the geographical location at the point of death, the proportion of the carcass above the waterline was estimated as well as the decomposition level. This information was used to estimate the number of days that the whale was adrift postmortem (Peltier et al., 2012, 2013). The drift track of the carcass (Putman & He, 2013; Naro-Maciel et al., 2017) was inferred from 500 independent simulations in which the advection of 25,000 particles along 500 m of coastline were modeled using the ICHTHYOP Program, a Lagrangian tool for particle tracking (Lett et al., 2008), with the outputs of the Global Hybrid Coordinate Ocean Model (HYCOM) (Chassignet et al., 2007). The HYCOM allows the representation of ocean circulation processes by using data obtained through satellite altimeter observations, as well as data obtained through a global series of disposable bathythermographs, anchored buoys, and vertical profiles of ARGO, CTD, and XBT floats; these together provide information such as temperature, salinity, surface sea elevation, heat flows, precipitation, river discharges, intensity, and wind direction. The model output contains the vector components of the sea current velocity fields with a resolution of ~0.08, between 6 and 9 km of grid length. This process calculated the position of the particles every 60 min by the number of days adrift, using a Runge-Kutta forth-order method in HYCOM, and finally inferring the

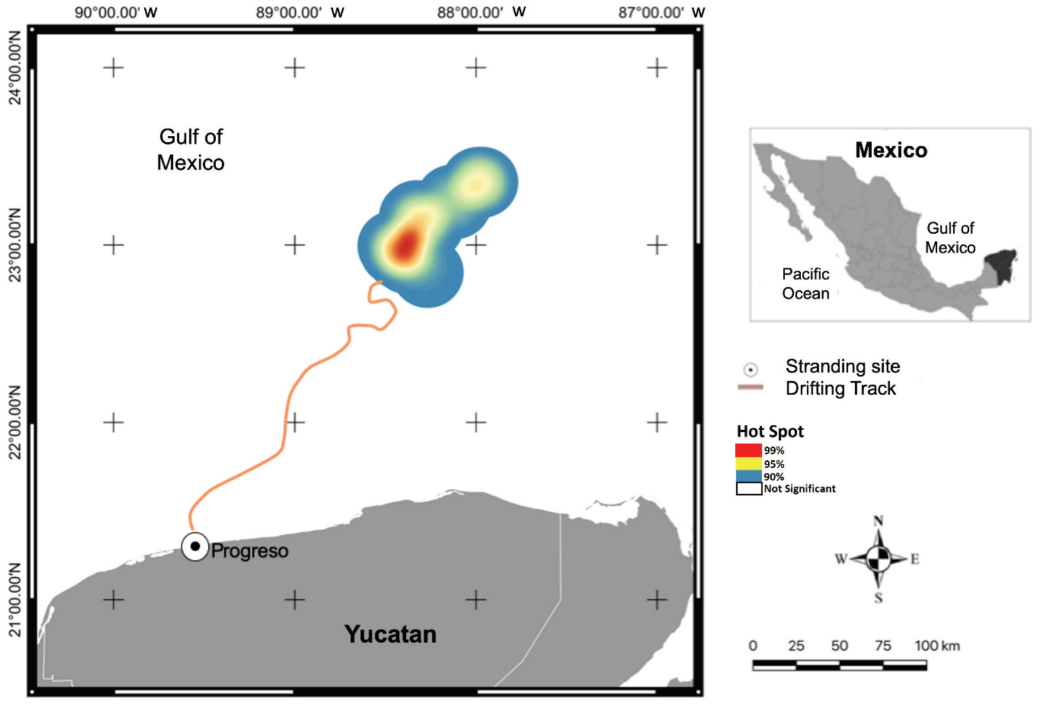

Figure 1. Stranding site in Progreso, Yucatán, Mexico, the estimated place of origin and drifting track of the fin whale (*Balaenoptera physalus*). The Hot Spot indicates the probability of the origin from the spatial dataset analyzed (Peltier et al., 2012).

area of origin. This spatial dataset was analyzed in the QGIS Program using two methods—Kernel Density and Hot Spot—indicating the probability of the origin (Peltier et al., 2012; Figure 1).

The whale was determined to be an immature male fin whale, 14.5 m in length (Figure 2). The height of the dorsal fin being about 2.5% of the body length, the ventral pleats extending beyond the navel, the presence of one ridge on the rostrum, and the presence of white baleen plates on the right side confirm the species identification (Jefferson et al., 2008). The body weight was estimated to be 15.6 t using the formula $Weight = 0.0015, Length^{3.46}$ (Aguilar, 2009). Age estimate was 1 to 2 years, following the observations of Aguilar & Lockyer (1987). No predation or human interaction signs were observed in the external examination. An ectoparasite in the caudal peduncle was identified as a *Pennella balaenoptera* copepod (Hogans, 1987). The necropsy revealed an empty stomach with multiple gastric ulcers consistent with prolonged perimortem fasting. No evidence of internal injuries was noted.

According to Peltier et al. (2012), the fin whale carcass was code 2: moderately decomposed, with an estimate of between 3 to 5 days from dying based on the 25% loss of epidermal tissue, which is equivalent to code 3 as stated by Geraci & Lounsbury (1993). Considering the body size, currents, and prevailing winds in the days before the stranding, the estimated place of origin (death) was at 23° 0' 14.6" N, 88° 23' 37.26" W (SD = 1.09 km radius), 227.5 km northeast of the stranding site (in a straight line). The place of origin was located on the continental shelf with a depth of 75 m, 162 km offshore, and 109 km from the closest shelf break. A 268.5-km drifting track was estimated; this was initially a little sinuous and then almost linear (Figure 1).

Skeletal remains were recovered, articulated, and displayed permanently in Progreso, Yucatán, Mexico (Figure 3). This exhibit represents the first of its kind throughout the Gulf of Mexico, both in the Mexican and U.S. parts.

This short note is the first stranding record of a fin whale in the Mexican waters of the Gulf of Mexico and the fourth confirmed record for this species in the Gulf (Würsig et al., 2000; Edwards et al., 2015). This event highlights the great importance of marine mammal diversity in the poorly

Figure 2. Stranded fin whale in Progreso, Yucatán, Mexico, on 28 February 2016 (*Photo credit:* Raúl E. Díaz-Gamboa)

Figure 3. Outdoor exhibition of the fin whale skeleton in Progreso, Yucatán, Mexico (*Photo credit:* Raúl E. Díaz-Gamboa)

explored southern Gulf of Mexico. Subsequently, in August 2018, another fin whale stranded alive in the Mexican Caribbean (García-Rivas et al., 2019), confirming the occasional presence of this species in the Gulf of Mexico (Edwards et al., 2015).

Aguilar (2009) observed that the fin whale density tends to be higher outside the continental slope than inside it. It is known that the edge of the continental shelf is a major point of aggregation of marine mammals due to the high productivity caused by upwelling and current systems, creating an ecotone between shallow and deep water (Davis et al., 1998; Würsig, 2009). Ramírez-León (2020) indicated that most sightings of cetaceans were restricted to the continental shelf and predicted that most abundance of cetaceans in the Gulf of Mexico should be found in the continental shelf break environments. However, the coast of Yucatán is characterized by an extended continental shelf, reaching up to 300 km from the coastline. This may suggest that the presence of large whales should be found around the continental slope of Yucatán.

The absence of food in the stomachs with multiple gastric ulcers indicated a lack of feeding for several days prior to death. In the western North Atlantic, fin whales feed in summer north of Long Island, New York, up to Newfoundland, and are thought to breed while fasting in winter off Florida and in the Caribbean Sea (Gambell, 1985; Rice, 1998). The mating period in this zone is from December to February, followed by 11 months of gestation, and weaning occurs 7 months after, when the calf is 11 to 13 m long (Aguilar, 2009), suggesting that this 14.5 m individual was recently weaned.

The presence of the ectoparasitic copepod, *Pennella* sp., is commonly observed on fin whales in the Mediterranean Sea (Notarbartolo di Sciara et al., 2003). However, there are no reports of *P. balaenoptera* on cetaceans of the Gulf of Mexico. Molecular analysis on the fin whale must be performed to determine if it is related to those in the Mediterranean Sea.

There are several studies that calculate the origin of floating objects, oil spills, and animals, from larvae to vertebrates; however, few have been applied to cetaceans (Haelters et al., 2006; Peltier et al., 2012, 2013). Herein, the place of origin was estimated with high accuracy and precision: within a radius of 1.09 km at 99% certainty. Peltier et al. (2012) found that errors of 8 to 16% in determining drift distance are related to variations in buoyancy during decay. In the present study, coastal currents were taken into account, in addition to the influence of oceanographic variables and the effect of wind and tide on the carcass, thereby reducing uncertainty.

The present study highlights the richness of species in the waters of Yucatán and the need to monitor the distribution and abundance of marine mammals there.

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