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Records of Southern elephant seals (*Mirounga leonina*) in the southern Mexican Pacific

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The Southern elephant seal (*Mirounga leonina*) has a generally circumpolar distribution in the Southern Hemisphere. Four populations are distinguished based on their genetic attributes. One inhabits Argentina and Chile, including the Valdés Peninsula, the Falkland Islands, the Strait of Magellan, and the Chilean Antarctic region (Capella et al., 2017); the second ranges in the Atlantic Ocean along South Georgia, South Orkney, South Shetland, Bouvetøya, and Gough islands; the third, in the Indian Ocean on the Kerguelen, Crozet, Heard, and Prince Edward islands; and the fourth, in the Pacific Ocean on Macquaire, Campbell, and Antipodes islands, near New Zealand (Slade et al., 1998). The total population size of this species has been estimated at approximately 750,000 individuals in the year 2000 (Hindell et al., 2016; Hindell, 2018) and the species is listed as "Least Concern" by the International Union for the Conservation of Nature (Hofmeyr, 2015).

The Southern elephant seal feeds mainly between 40° S and Antarctica (Hindell & McMahon, 2000; Hofmeyr, 2015). Most adult females feed in pelagic zones, while adult males feed in both pelagic and benthic zones (Hindell et al., 1991). The diet of this pinniped includes different species of fish and squid, with changes that are proportional according to the season and feeding areas (Bradshaw et al., 2003). Southern elephant seals perform long-range movements, coupled with the absence of oceanographic barriers and currents that could hinder their displacement. This has resulted in relatively frequent records on the Brazilian coasts, with almost 50 individuals observed between 1958 and 2008 (de Moura et al., 2010). There are records of this species toward northern latitudes, whose frequency has increased recently or has been documented for the first time (*e.g.*, Alava & Aurioles-Gamboa, 2017; Páez-Rosas et al., 2018; Elorriaga-Verplancken et al., 2020; de Vos, 2021; Alava et al., 2022). These unusually long-range movements by this species involve juvenile and subadult males, as these seem not to choose resting or hauling sites as selectively as older and more experienced animals (Mulaudzi et al., 2008). In this regard, the continental edge of the southeast Pacific is narrow and relatively close to the coast, which favors juveniles and subadults to move along this coast and its productive waters, heading to northern and distant latitudes (Acevedo et al., 2016).

This article reports the presence of two Southern elephant seals on the coasts of Chiapas and Oaxaca, Mexico. Both individuals were taxonomically identified based on the large size of the specimens, compared with animals of the same sex and age class as the Northern elephant seal (*M. angustirostris*). Other useful features for identification included a thick neck relative to head size, and proboscis length and size - which is shorter, smaller, and with nostrils tending to be more forward-facing compared to males of the Northern elephant seal, whose proboscis is much larger and rounded (Reeves et al., 2002; Páez-Rosas et al., 2018).

The first individual was observed on 15 December 2020 at Santuario Playa, Puerto Arista (SPPA), 2.9 km southeast of the Puerto Arista town (15°55'41.96" N, 93°48'10.02" W; Fig. 1). Its presence was reported by the staff of the local turtle camp. The individual, which was molting, had no external injuries nor evidence of interaction with human activities such as fishing.

Keywords:
extralimital records, *Mirounga*, negative sea surface temperature anomaly, climate change

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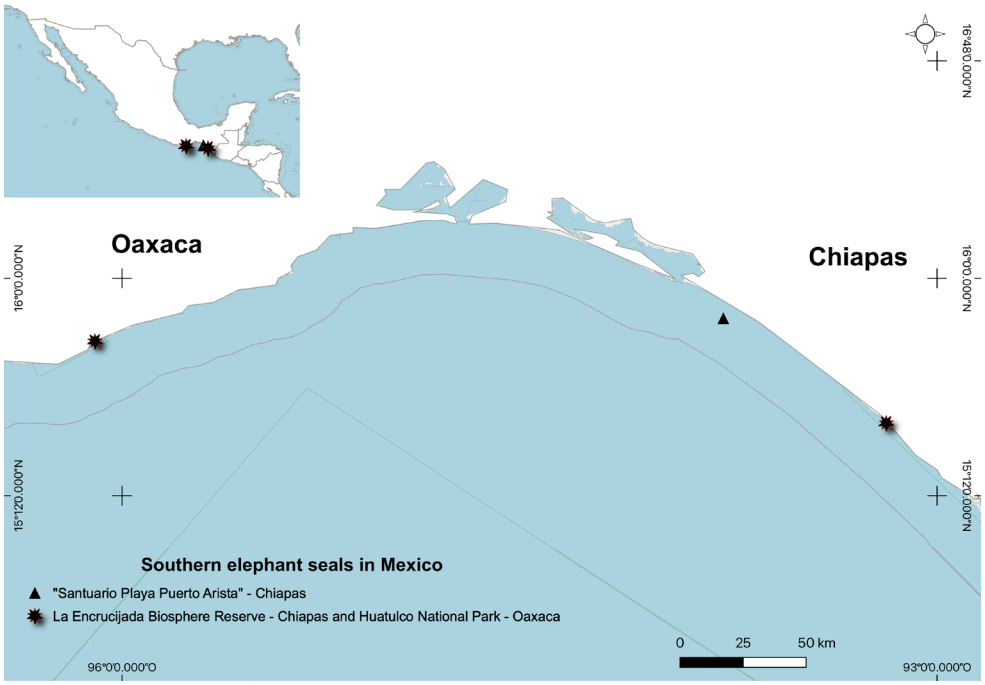

Figure 1. Location of two southern elephant seals on the coasts of Chiapas (15°55'41.96" N, 93°48'10.02" W first individual; 15°28'0.8" N, 93°11'13" W second individual) and Oaxaca (15°50'35.11" N, 95°53'32.68" W second individual), Mexico (Map created with QGIS 3.22 Biatowieza).

Videos and images indicated that it was a juvenile male measuring 2.8 m in total length (Fig. 2). It originally had a high number of epibionts in the mid-posterior part of its body but was free of them a few days after its arrival (Fig. 2). Between 16 and 31 December 2020, during the animal's stay on the coast of Chiapas, this individual went into and out of the sea daily, moving across approximately 41 km between the southeast end of Boca Barra de Paredón (15°59'16.8" N, 93°56'13.1" W) and 0.5 km northwest of El Madresal town. It was followed closely during this period, and 24-hour guards were conducted at the sites used by this phocid to rest. Between 01 and 06 January 2021, the individual was no longer observed in the area; on 07 January, it reappeared at the southeast end of Boca Barra de Paredón to the northwest of SPPA. Its body condition had deteriorated considerably, and it had a fishbone tacked inside its mouth (Fig. 3). The consensus of the specialists was that this condition could hinder its feeding ability. Therefore, with authorization from the Attorney's Office of Environmental Protection (PROFEPA), this individual was captured, the fishbone was removed, and it was released. It was last sighted on 10 January, once molting was completed, so it was assumed that it had returned to the sea to feed.

The second elephant seal was spotted on 26 January 2021 on the beach of the "El Palmarcito" town (15°28'0.8" N, 93°11'13" W; Fig. 1), municipality of Pijijiapan, in the northwest of La Encrucijada Biosphere Reserve (REBIEN), state of Chiapas. The local inhabitants of REBIEN and the local authorities reported its presence. It was followed up, and photographs and videos indicated that the species was another subadult male Southern elephant seal measuring 3.5 m in total length, also molting (Fig. 4). Contrasting with the previous individual, this one had no epibionts,

Figure 2. Southern elephant seal, *Mirounga leonina*, observed in Santuario Playa Puerto Arista and surrounding areas during its stay in Chiapas shores. The images show epibionts on its body (photos by Luis A. Álvarez).

Figure 3. Fishbone tacked inside the mouth of a Southern elephant seal *Mirounga leonina* (photo by Luis A. Álvarez).

Figure 4. Southern elephant seal, *Mirounga leonina*, observed on the coast of the La Encrucijada Biosphere Reserve and Santuario Playa Puerto Arista, Chiapas, and on the Huatulco National Park, Oaxaca (photo by Cristina Contreras).

and its body condition was better. Between 26 and 29 January, it moved to the northwest, being last observed in Chiapas at SPPA. On 02 February, a subadult male elephant seal was observed at Barra de la Cruz Beach, on the coast of Oaxaca, 24 km south of Huatulco (15°50'35.11" N, 95°53'32.68" W; Fig. 5); that same day, it was observed again within the Huatulco National Park (15°46'04.8" N, 96°05'59.3" W; Fig. 6). The photographs obtained confirmed that this individual was the same seal observed days before on the coast of Chiapas, based on the marks on the skin and hair in its ventral thoracic region (Fig. 5). The animal was still molting, so it was provided with a safe exclusion area, mounting guards, similar to the previous case. It remained in the area for another three days and then moved to the northwest until last observed on 05 February.

In both cases, these elephant seals were recorded flipping sand on their bodies as a thermoregulatory behavior while resting. They were also seen burying their proboscises in the sand. Frequently, local people and tourists approached these elephant seals to take pictures of them and aimed to "help them", thinking that these animals suffered from the heat. This approach also promoted the presence of dogs. In response to the presence of people and dogs, the elephant seal threatened those coming close by emitting grunts with its mouth open. This response made it necessary to ask people not to approach the seal and not to take their pets with them.

Figure 5. Subadult male of southern elephant seal *Mirounga leonina* at Barra de la Cruz Beach, Oaxaca, 02 February 2021 (photo by José Mattern García / Dron Huatulco).

Samples of hair, skin, and feces from both specimens were collected; besides, samples of epibionts were obtained from the first seal. These samples will be used to carry out studies on genetics, trophic ecology through stable isotopes, diet, and the potential presence of parasites.

Most likely, in terms of distance, these Southern elephant seals documented in the Mexican South Pacific came from populations inhabiting the coasts of islands of Chile and Argentina, where their numbers have increased in recent decades (Lewis et al., 1998; Galimberti et al., 2001; Capella et al., 2017). Particularly, incipient breeding sites have been recorded in southern Chile, suggesting an expansion of the distribution range of the species on the Pacific coast of South America (Acevedo et al., 2016; Capella et al., 2017). In this sense, the distance traveled by both individuals between the Chilean region of Bahia Mont and Tonalá, Chiapas could be ~5,000 km.

These are among the northernmost records of this species to date, although there are already other northerly records reported by Alava et al. (2022). Until 2016, the northernmost case of this species in the Pacific Ocean had been documented on Taboga Island (08°47'00" N, 79°33'36" W) in the Gulf of Panama (Redwood & Félix, 2018). The northernmost case in the Northern Hemisphere was recorded in 2019 in La Ribera (23°36'1.8" N, 109°34'33" W), southern Gulf of California, Mexico (Elorriaga-Verplancken et al., 2020), followed by a record in Sawqirah (18°07'00" N, 56°32'00" E) on the coast of the Arabian Sea in 1989 (Johnson, 1990). Additional unusual records have reached as far north as the Fernando de Noronha Archipelago in Brazil (03°51'00" S, 32º25'00") (Lodi & Siciliano, 1989; de Moura et al., 2010), the waters off the southern coast of Sri Lanka (de Vos, 2021), different localities in Ecuador (Alava & Carvajal, 2005; Páez-Rosas et al., 2018), Colombia (Ávila et al., 2019), Galapagos Islands, and the Eastern Pacific Ocean (Alava et al., 2022).

Our sightings in the Mexican South Pacific were related to periods of low sea surface temperatures (SST) in the region. As part of this phenomenon, from November 2020 to January 2021, negative SST anomalies were recorded, as indicated by El Niño Index (NOI) values of -1.2-1.3 (NOAA, 2021) throughout the region 3.4 (05° N–05° S, 120°–170° W). The unusual presence of Southern elephant seal individuals in the Pacific Ocean, in areas such as the Gulf of Panama (Redwood & Félix, 2018) and Ecuador (Alava & Carvajal, 2005; Páez-Rosas et al., 2018), was linked to negative SST anomalies (*e.g.*, NOI from -1.3 to -0.7), corresponding to La Niña in this region. The likely cause is that these oceanographic features allowed Southern elephant seals to feed along a cold, nutrient-rich area, which broadened because of these SST conditions and increased their food coverage toward northern latitudes.

The effect of these anomalous SST conditions (Alava & Carvajal, 2005; Páez-Rosas et al., 2018) and the growing population size of the Southern elephant seal in certain localities (Galimberti et al., 2001; Hofmeyr, 2015; Acevedo et al., 2016) are important factors that likely triggered these unusual records of the species. Proof of the above is that no records of the species had been documented in Mexico before 2019, while four cases were recorded from 2019 to 2022 (Elorriaga-Verplancken et al., 2020, and the Southern elephant seal reported in the present study), including a subadult male on the coast of Nayarit (Playa San Pancho, 20º54'11" N, 105º24'57.8" W) in the summer of 2020

Figure 6. Southern elephant seals *Mirounga leonina* recorded on the beaches of Chiapas and Oaxaca with skin and hair marks confirming that it was the same individual (photo above by Cristina Contreras and below by Salvador Neri).

(https://www.excelsior.com.mx/nacional/elefante-marino-descansa-en-playas-de-nayarit/1393007; Cerrillo-Espinosa et al., 2023). Additionally, the feeding habits of Southern elephant seals depend on ocean fronts, currents, and marginal areas of the ice edges (Hofmeyr, 2015; Hindell et al., 2016). Therefore, current, and future changes associated with climate change in these regions have potential effects on the habitat of that species and its ability to adapt to these environments (Constable et al., 2014). These cause atypical displacements in this species, which is capable to move over long distances, as observed under normal conditions, covering distances that can regularly range from 1,000 to 3,600 km (Campagna et al., 1998, 1999, 2007; Hindell & McMahon, 2000).

These records are ecologically relevant as they contribute to our knowledge about the status of pinniped populations in the Southern Hemisphere and their possible future trends. At the same time, they provide evidence of how anomalous oceanographic conditions, which are gradually becoming more persistent in recent decades (Freund et al., 2019), impact the movements of this species in particular, from high latitudes to temperate, subtropical, and tropical areas. The findings reported here regarding the displacement of these Southern elephant seal individuals, and those reported in other parts of the eastern central Pacific, may be related to the current climate change scenario (Capella et al., 2017; Alava et al., 2022).

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