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Off-seasonal copulation of South American sea lion *Otaria byronia* in the Chilean Central Coast

Cópula atemporal del león marino sudamericano *Otaria byronia* en la costa central de Chile

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The South American sea lion *Otaria byronia* inhabit almost continuously from Perú to southern Chile and Brazil to southern Argentina on the Pacific and Atlantic Oceans, respectively. It is an abundant species, with great vagility and reproductive success and, without conservation problems. Like all pinnipeds, *O. byronia* exhibits a reproduction, notedly seasonal and highly synchronized with slight interpopulation differences, being the description of an atemporal copulation the objective for this note. On September 2020 we carried out a field observation in a reproductive rookery of *O. byronia* through binoculars on a rock in the Chilean central Coast. Eight individuals of *O. byronia* were recorded; from them, a couple had courted each other by moving their heads and bodies in unison. Subsequently, the male (sub-adult) mounted the female and they copulated for approximately 20 minutes, after which, she unhurriedly jumped into the sea. During the courtship and copulation only the male emitted sounds, and no mutual aggressive behavior was observed, not even the female opposed to being copulated, nor the 6 other individuals interacted with both. Considering its reproduction during the austral summer, this off-seasonal copulation is unusual for *O. byronia*; unprecedented in Chilean populations and subcontinent, being aspects such as climatic, physiological to anthropogenic factors suggested as causes, or triggers for this event. The foregoing highlights the need to expand studies of marine mammals distributed on the Chilean coast and explore the link and impact of extrinsic factors on populations.

Key words: Distribution; Loanco Cove; mating; pinnipeds; seasonality.

El lobo marino común *Otaria byronia* se distribuye ampliamente en Sudamérica desde Perú pasando por Chile hasta Brasil en los océanos Pacífico y Atlántico, respectivamente. Es una especie abundante, muy vágil y sin problemas de conservación. Como todos los pinnípedos, exhibe una reproducción notablemente estacional y sincronizada con ligeras diferencias entre poblaciones, siendo una cópula atemporal el objetivo de esta nota. Durante septiembre de 2020 se realizó un censo de *O. byronia* en una lobera reproductiva de la costa de Chile central, cuyos individuos sobre una roca fueron observados con binoculares. Ocho individuos de *Otaria byronia* fueron registrados, de éstos, una pareja se cortejaba mutuamente moviendo sus cabezas, cuerpos y se desplazaban al unísono sobre la roca. Posteriormente el macho (un sub-adulto) montó a la hembra y copularon aproximadamente por 20 minutos tras lo cual, ella sin prisa salto al mar. Durante el cortejo, cópula e interacción, solo el macho emitió sonidos y no se observaron conductas agresivas mutuas, ni que la hembra se opusiera a ser copulada. Tampoco se observó que los otros individuos interactuaban con ellos. La reproducción de *O. byronia* ocurre durante el verano austral siendo esta cópula inusual para la temporada, sin precedentes en las poblaciones chilenas y en el subcontinente. Diversos aspectos como factores climáticos, fisiológicos o presión antropogénica se pueden sugerir como causas o detonantes de este evento. Lo anterior destaca la necesidad de ampliar los estudios en mamíferos marinos en la costa chilena, explorando el vínculo e impacto de los factores extrínsecos sobre las poblaciones.

Palabras clave: Caleta Loanco; cópula; estacionalidad; pinnípedos; reproducción.

Reproduction is one of the most relevant aspects of the life history of an organism, which is related in turn behavioral, physiological, and ecological features. For any mammal the reproduction is associated with its reproductive cycle defined as the normal time for a female to reproduce, *i.e.*, to complete the associated processes with the fertile oestrus, ovulation, conception, gestation, birth, and lactation (Pomeroy 2011). In pinnipeds, the female reproductive cycle is characterized by a period of delayed embryo implantation or diapause from 2 to 3 months with a gestation period of 9 months (Costa 1991). The period of delayed implantation confers flexibility of timing of parturition, due to evolutionary adaptations in response to the environment, nutrition, or social influences (Boyd *et al.* 1999; Pomeroy 2011). For the otariids, reproduction is characterized by polygyny strategy, where the breeding

animals congregate in colonies and dominant males mate with several females within a harem and keeping other males away to prevent access to the females (Heckel and Schramm 2021). This is the case of the South American sea lion *Otaria byronia* (de Blainville 1820), sin. *O. flavescens* (Shaw 1800), a species distributed almost continuously from Perú to southern Chile on the Pacific Ocean coast, and Brazil to southern Argentina on the Atlantic Ocean (King 1983; Sielfeld *et al.* 2018; Sepúlveda *et al.* 2011; Crespo *et al.* 2021). Like other otariids, the males arrive at the breeding sites earlier than females during the second half of December and they, establish territories or dominance hierarchies with other males (Crespo 1988). The females then arrive to these protected territories where to give birth about 2 or 3 days after their arrival, to then mate, generally with the dominant male (Sielfeld 1983). Mating occurs from January to the first days of March (Acevedo *et al.* 2003) with some day's variations between the Atlantic and Pacific populations (Campagna and Le Boeuf 1988; Acevedo *et al.* 2003; Pavés *et al.* 2005) that are recognized as distinct phylogenetic lineages or Evolutionarily Significant Units ESU (*e.g.*, Túnez *et al.* 2007; Artico *et al.* 2010; Weinberger 2013).

Regarding reproductive cycle of Pacific populations (Chile and Perú), differences have been reported in the timing of breeding season that can extend from 22 of December until May at Punta Negra rookery (20º 50′ S, 70º 10′ W) located in northern Chile, with a peak of newborn pups and mating late in January and mid-February (Acevedo *et al.* 2003) while, at Punta Lobería rookery (38º 39′ S, 73º 29′ W) in the central-south coast of Chile, the peak of births and mating occurs between the last week of January and mid-February (Pavés *et al.* 2005). Although the studies describing breeding times for the South American sea lion over their extensive geographical range, are relatively scarce on Pacific side, especially on Chilean coast (*e.g.*, Acevedo *et al.* 2003; Pavés *et al.* 2005; Pavés *et al.* 2011), the breeding behavior have extensively been studied on the Atlantic coast (*e.g.*, Hamilton 1934, 1939; Vaz Ferreira 1975, 1981, 1982; Ximénez 1975; Campagna 1985). However, no off-seasonal copulation data in the time ranges mentioned above, in both in reviews (*e.g.*, Sielfeld 1983, 1999; Muñoz-Pedreros and Yáñez 2000; Iriarte 2008; Crespo *et al.* 2021) and publications concerning this species in Chile (Aguayo and Maturana 1973; Acevedo *et al.* 2003; Pavés *et al.* 2005; Goetz *et al.* 2008; Sepúlveda *et al.* 2011). Consequently, based on a field record during 2020, we report an off-seasonal copulation for the South American sea lion *O. byronia* on central coast of Chile.

The observations were made in the breeding colony known as Cabo Carranza which includes the Santa Ana and Santos del Mar rookeries to the NW and SW, respectively, of the fisherman's cove of Loanco (35º 34′ 7.2″ S, 72º 37′ 91″W), near 40 km South of Constitución city, Maule Region, Chile (Figures 1 and 2). The individuals of *O. byronia* present in the study area, were assessed using visual count for 15 min with binoculars on a big rock (of approximately 500 m^2) distant of approximately 50 m from shore. There, we also recorded the copulation between a male and female by almost 1 hr from 13:00 to 14:00 hr. This sighting was recorded in September 2, 2020 and photographically captured (Figure 3), being part of more broadly seasonal and geographical monitoring for this species in the area (Guzmán, unpublished data).

On the breeding colony of Cabo Carranza (Figure 2) a group of at least 6 individuals of *O. byronia* (among females, sub-adult individual, and just one pup from the previous reproductive season) plus, a couple near them were observed. The couple displayed a courtship behavioral before the copulation, where male (sub-adult) and female caress each other mutually, while moved their heads and bodies back and forth and moved in unison from place to place on the rock (Figure 3). During the mating, the female stayed stationary under the male while he completes insemination. The copula lasted about 20 min and once they ended, the female went calmly to edge of the place and jumped into the sea. During the entire time, only the male vocalized, and we did not observe hostilities, neither that male blocking the free the passage or escape

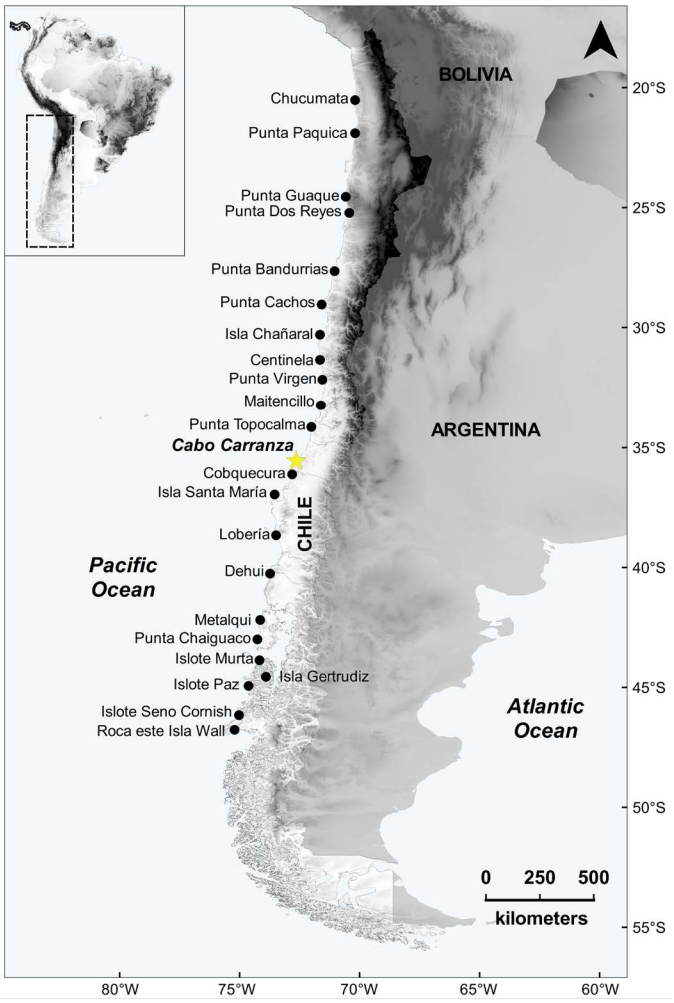

Figure 1. Location of the Cabo Carranza rookery, Región del Maule, Central Chile (star). Black dots indicate some (a few of them) breeding colonies of *Otaria byronia* along the Chilean coast (Appendix 1).

of the female, forcing copulation or, some physical assault between them. Besides this copulating couple the other individuals on the place did not interact with the couple or among themselves.

The scarce data for the reproductive time for Cabo Carranza shows that breeding takes place throughout the summer months, evidenced by offspring as well as adults in reproductive activity (Guzmán, unpublished data). In consequence, the described off-seasonal reproductive behavior is unusual for this species, unprecedented in Chilean populations and in the subcontinent same period (early September). For Cabo Carranza, censuses conducted from 2014 to 2022, are estimated a population between 28 and 6,000 animals with 1,248 individuals recorded for the winter period of 2020 (J. Guzmán per. obs.). In addition, the reproductive females reach 57.9 % of the total population size, with a birth rate of 3.6 %, a value considered below the average for Central Chile (DOPPLER 1996; Sepúlveda *et al.* 2007).

Pinnipeds have amphibious lifestyles with a combination of marine feeding and terrestrial reproduction. Regarding the above, the production is highly seasonal and synchronized with slight interpopulation differences, where climatic oscillations could influence variations of these stages and their noticeable seasonality (*e.g.*, El Niño Southern Oscillation - ENSO) which in turn impacts the food availability (*e.g.*, Sielfeld and Guzmán 2002; Oliveira 2011; Elorriaga-Verplancken *et al.* 2016), anthropogenic disturbances (including fishing activity) that modify population dynamics (*e.g.*, French *et al.* 2011; McHuron *et al.* 2017), or physiological factors (*e.g.*, Boyd 1991). In fact, during ENSO 1997/98 event Sielfeld and Guzmán (2002) reported at the breeding rookery of Punta Patache, numerous abortions, and premature birth since October 1997, with a maximum intensity during December 1997, and massive starvation of yearling and females in emaciated conditions, apparently caused by lack of anchovies, its main food item (Sielfeld *et al.* 2018).

Figure 2. A) "Cabo Carranza rookery" Región del Maule, Central Chile during September 2020; B) individuals (up) on the rock and the copulating couple (below). Photographs by J. A. Guzmán.

Aguayo and Maturana (1973 in Vaz Ferreira 1981) reported evidence for an earlier and probably longer pupping season than the ones on the Atlantic side. In fact, during a population census in October 1965, along the northern Chilean coast between Arica (18º 28' S, 70º 18' W) and Taltal (25º 24' S, 70º 28' W), they distinguished a newborn pup in 2 rookeries of Arica and Guaneras, indicating a possible calving season, in October 1965, a season that would be outside the normal calving and mating season for this species in January and February of each year (Acevedo *et al.* 2003). Other pups registered during that opportunity were yearlings from the previous breeding season: Punta Baquedano (15 to 20 pups), Punta Condell (30 pups), Punta Mejillones del Norte (140 to 150 pups), Punta Piedra (3 pups), Punta Lobitos (3 pups), Punta Baja (20 to 30 pups), Punta Lobería (70 to 100 pups), Punta Bandurria (20 to 30 pups; see Table 1 and 2 in Aguayo and Maturana 1973). The cause of an earlier reproductive event (calving prior to the summer season in this species) could be explained by an increase in environmental temperature, in this case by the presence of the ENSO event that in 1965/66 had a strong notation (NOAA/National Weather Service 2005). Today it is known that the ENSO events cause a decrease and absence of upwelling and a decrease of the productivity (Arntz and Tarazona 1990) which sustains the nekton, among others the anchovy (*Engraulis ringens*; Zuzunaga 1985; Arntz 1986) consumed by sea lions, birds and cetaceans and causing high mortality rates in these species (Duffy 1990; Limberger 1990). In this situation the females of the sea lions, especially the young females, eventually can advance ovulation and accept the males before the reproduction date in the austral summer. A similar condition with newborn pups on a rookery south of Valparaiso (33° 03' S, 71° 39' W) observed at the end of September 1975, also during an ENSO event of strong notation (NOAA/National Weather Service 2005), led Sielfeld (1983) to indicate the South America Sea Lion breeding season between September and March.

A possible hypothesis to explain the previous cases could be the independent or combined action of the mentioned factors on change of the foraging area, physiological and nutritional stress disturbing the timing of the reproductive cycles leading to delayed implantation, abort gestation, advancing the oestrus, or changes in other life history parameters. The mating reported in this note evidenced that the female was receptive to the male, suggesting that her oestrus cycle began earlier than usual. The interaction between the copulatory couple was like the dynamics observed during the reproductive season of this species, although without the competition and the frequent harassment from neighboring males. Since the South American sea lion reproduction takes place during the austral summer (*e.g.*, Pavés *et al.* 2005, 2011), especially during January and February, this reproductive behavior in early September is therefore unusual for this species. So, to fully understand whether this event is results of environmental, anthropogenic, physiological factors or combination of them, it is necessary to intensify the faunistic research for this species and other marine mammals of Chilean coastal and document every off-season event.

Figure 3. Record of the off-seasonal reproductive activity of *Otaria byronia* at Cabo Carranza rookery. From A to D courtship ritual prior to mating; E and F mating process (copulation) and G, end of copulation event. Photographs by J. A. Guzmán.

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Appendix 1

Geographical coordinates of some important breeding colonies (from literature) of the South American sea lion *Otaria byronia* along the Chilean coast.

Location	Latitude	Longitude
Chucumata	20.52 S	70.19 W
Punta Paquica	21.90 S	70.19 W
Punta Guaque	22.68 S	70.28 W
Punta Dos Reyes	24.55 S	70.57 W
Punta Bandurrias	25.22 S	70.43 W
Punta Cachos	27.65 S	71.04 W
Isla Chañaral	29.04 S	71.58 W
Centinela	30.30 S	71.65 W
Punta Virgen	31.35 S	71.65 W
Maintencillo	32.18 S	71.55 W
Punta Topocalma	34.14 S	72.01 W
Cobquecura	36.12 S	72.81 W
Isla Santa María	36.96 S	73.54 W
Lobería	38.66 S	73.48 W
Dehui	40.26 S	73.73 W
Metalqui	42.19 S	74.14 W
Punta Chaiguaco	43.00 S	74.26 W
Islote Murta	43.87 S	74.17 W
Isla Gertrudiz	44.56 S	73.90 W
Isla Paz	44.94 S	74.63 W
Islote Seno Cornish	46.16 S	75.03 W
Roca este Isla Wall	46.77 S	75.21 W