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Leopard Seal (*Hydrurga leptonyx*) Immature Male Play Behaviour

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Leopard seals (*Hydrurga leptonyx*) are known to migrate from their breeding grounds in the Antarctic to subantarctic waters for the austral winter (Rounsevell & Eberhard, 1980; Walker et al., 1998; Jessopp et al., 2004; Staniland et al., 2018). They are frequently considered solitary; however, observations are difficult to obtain throughout the majority of their range (Southwell et al., 2008; Rogers et al., 2013). At South Georgia, leopard seals are most frequently sighted after the breeding season (Hamilton, 1939), and they are sighted at Bird Island (54° 00' S, 38° 03' W) between April and November. Sighting numbers fluctuate from year to year, being driven by environmental factors and prey availability (Jessopp et al., 2004). The prey available to leopard seals at Bird Island is abundant and varied throughout these winter months, including but not limited to, Antarctic fur seals (*Arctocephalus gazella*), gentoo (*Pygoscelis papua*) and macaroni (*Eudyptes chrysolophus*) penguins, fish, and Antarctic krill (*Euphausia superba*) (Walker et al., 1998; Forcada et al., 2009). Studies of the winter leopard seal population at Bird Island have shown a combination of adult seals with high site fidelity, but most are transient young animals, gathering together to exploit the island's resources (Jessopp et al., 2004; Forcada & Robinson, 2006).

The abundance of prey, and its reliance on Bird Island's coastline, has provided the opportunity for the winter population of visiting leopard seals to be systematically monitored using identification tags (Walker et al., 1998) since 1993, and photo-identification through individual pelage patterns since 2005 (Forcada & Robinson, 2006). The intensive monitoring of individuals within and between winter seasons at Bird Island provides a unique opportunity to record behavioural observations, with a focus on individuals with assigned age based on measurements, as well as confirmed sex and site-fidelity details. An individual's age can be estimated by total straight-line length measurements, while sex can be determined by visually inspecting a seal's ventral area (Laws, 1957).

Herein, we present observations recorded in the 2019 season to describe social interactions of this "solitary" species. While observations of leopard seals in areas of high prey abundance have recorded kleptoparasitism (Krause et al., 2015) and prey-sharing (Hiruki et al., 1999; Robbins et al., 2019), this paper reports the social interactions, observed from the shoreline, between multiple immature male leopard seals without a prey item present. The behaviour observed, which could be interpreted as play and as part of the process of learning adult behaviour, has not been reported before in this species.

In the austral winter, daily systematic surveys of a 2 km section of the Bird Island, South Georgia, coastline are completed as part of a long-term monitoring programme by the British Antarctic Survey (see Jessopp et al., 2004). The 2019 observation season started on 24 April and concluded on 29 October. All observations of leopard seals were recorded, and individuals were catalogued. During observations, multiple digital photographs were collected of all sides of each animal, and they were identified following photo-identification methods in Forcada & Robinson (2006). Individual seals were recognised through their unique pelage patterns and then monitored during opportunistic observations. Each seal's presence and behaviour were recorded on land and in the water from observer vantage points on the shoreline.

Where possible, if a seal was hauled out, its sex was noted if the ventrum was observed, total body length was measured, and the individual would receive an identification tag. These identification tags are coloured cattle tags placed into the inter-digit webbing of the rear flippers with a unique four-digit number printed on both sides, with possible matching tags placed in both flippers. Seals were classified into an age category depending on standard length (nose to tail length): pups (up to 200 cm), immature (from 200 to 285 cm for females and to 275 cm for males), or adults

(longer than 285 cm for females and 275 cm for males) following Laws (1957).

Images and videos were collected to illustrate behaviours displayed and to construct a timeline during observations (see Supplemental Video; supplemental material for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147). Relevant interactions and predations were noted daily with the corresponding individual seal or seals observed and identified where possible.

Combining the age and sex information obtained from such resources as the long-term dataset at Bird Island with these opportunistic observations of group behaviour such as this example could be invaluable to understanding the development, learning, and potential sociality of leopard seals.

A range of behaviours and interactions between individuals were observed during the surveys throughout the season. A descriptive account of interactions that took place during a 5-d period (8 to 12 August 2019) is presented herein. The social interactions observed involved up to five different photo-identified individuals, which were classified as immature with length measurements obtained in the season and whose sex was visually confirmed, with one individual seal recorded in a previous season visiting the island as a pup (Table 1). The four male individuals without previous season sightings can be estimated as immature, approximated as 3 y old; according to the curve in McLaren (1993), all were shorter than 275 cm and therefore immature (McLaren, 1993; Rodgers, 2009). Individual 2014007 was first recorded in 2014, which meant he was at least 5 y old at these observations.

Over the 5-d period, the leopard seals were seen swimming in proximity close enough to each other to be touching; they would follow each other in the water and then twist at the surface, swimming over each other, occasionally lightly biting each other's backs and holding each other using their front flippers (Figure 1A-G & Supplemental Appendix). This type of behaviour was observed multiple times during the observation days, with the groups of individual seals interacting for at least 1 to 2 h within the observable range of the shallow bays and kelp. Observations were limited to when the seals were in an area of water which could be observed. They ceased when the animals left the bay and visual contact was lost, and they continued when spotted in the observable area again. On several occasions, the observations started as the group of seals were seen following in close proximity, swimming at the surface along the shoreline before entering the shallow inlet. On all occasions when leaving the observable area, it was noted that all the seals in the group were travelling in the same direction along the coast, following in close proximity again while swimming at the surface. There did not seem to be an obvious cue for the group to stop the interactions and leave the bay.

The behaviour described above was first observed on 8 August at 1215 h involving two immature males: 2019002 and 2019010. Both were recorded daily for the five consecutive days close interactions were observed: on 8 August at 1215 h and again at 1700 h, on 9 August at 1400 and 1700 h, on 10 August at 1445 h, and on 12 August at 1320 and 1700 h. On 12 August, individual 2019010 had an erect penis (Figure 1H). Individuals 2019002 and 2019010 were also recorded hauled out in close proximity (< 5 m) on the beach on 11 August at 1130 h with a third immature female 2019024. Individual 2019010 left the beach at 1210 h after an attempt to apply an identification tag, while individual 2019002

Table 1. Details of the six individuals involved in the observations. J = immature, M = male, and F = female. In the column listing identification tag numbers, tag placements in the left or right webbing of the seals' rear flippers are shown by the slash (/). The number before the slash indicates a tag placed in the left flipper, and the number after the slash indicates a tag placed in the right flipper. "B" indicates that the tag was blue in colour.

Identification code (ID)	First sighting in 2019	Last sighting in 2019	Length (cm)	Age class	Sex	Identification tag number	Additional season sightings
2014007	8 Aug.	4 Sept.	246	J	M	B4967/	Yes: 2014, 2017, 2021
2019002	19 May	12 Aug.	267	J	M	B4964/B4964	No
2019008	28 June	7 Sept.	272	J	M	/B4957	No
2019010	22 June	30 Aug.	270	J	M	None	Yes: 2020, 2021
2019023	5 Aug.	21 Aug.	250	J	M	B4968/B4968	No
2019024	11 Aug.	31 Aug.	277	J	F	B4966/B4966	No

Figure 1. Images illustrating the following observed behaviours: (A) following behaviour, (B) close contact swimming, (C) twisting, (D) holding with front flippers, (E) biting, (F) group interactions, (G) group interactions, and (H) erect penis (*Photo credit:* Claire Stainfield)

remained on the beach until 1500 h, and individual 2019024 remained on the beach until 1600 h.

On 10 August at 1220 h, the behaviour was observed involving a group of five leopard seals: 2014007, 2019008, 2019023, 2019002, and 2019010. All these seals were confirmed as immature males. From the shoreline vantage, the group appeared as a mass of twisting bodies, all touching and swimming over each other at the surface of the water. Seals could be seen fore-flipper holding within the group, and individual 2019010 presented an erect penis during the interaction. Visual contact was lost at 1330 h as the group of five seals left the shallow cove swimming in close proximity to each other in the same direction. This was the only occasion during the 5-d period that this activity involved more than just two animals. As mentioned above, individuals 2019002 and 2019010 returned to the area later that day at 1445 h and continued to interact with each other without the rest of the group present.

There were individual seals sighted during the observation that were not interacting with the playing animals. A total of three individuals were photo identified on 8 August, two on 9 August, six on 10 August, 11 on 11 August, and four on 12 August.

Play has been recognised as a functional behaviour for building strength in muscles, improving coordination, and bonding in social species. It is often associated with developmental milestones in some species (Renouf & Lawson, 1986; Harcourt, 1991). In birds and mammals, play is associated with juveniles, with relatively few records of adult animals exhibiting the behaviour (Bekoff & Byers, 1981). Burghardt (2005) proposed a set of criteria to classify behaviour as play, suggesting that it should be performed by healthy individuals, should be repeated and rewarding, and should appear nonfunctioning in the short term or be modified from its original function. To understand these criteria in context, we can first explore the common example of play in pinniped species: the locomotive play of porpoising (Harcourt, 1991). The function of this behaviour is to be able to travel fast and change direction rapidly, which is useful for predator avoidance (Harcourt, 1991; Williams, 2001). This behaviour is often demonstrated by healthy pups as they learn to swim, with the reward of building up coordination, muscle development, and physical fitness (Renouf & Lawson, 1986; Harcourt, 1991). In the short term, the behaviour is not necessary for pups as they are dependent on their mother's milk to survive (Nagel et al., 2021), and it should be modified from its original function as it can be performed in shallow waters in the absence of predators (Harcourt, 1991).

The immature male leopard seal behaviour described in this paper meets the same play behaviour criteria. All individuals appeared healthy, and the behaviour was repeated not only in the same observation period but multiple times over the duration of a single day and over the five consecutive days. The behaviour described has similarities to "play copulation" and "play fighting" such as holding with fore flippers and light biting at the base of the neck as documented in harbour seals (*Phoca vitulina*; Renouf & Lawson, 1986) and South American fur seals (*Arctocephalus australis*; Harcourt, 1991). The adult consequence of this behaviour displayed in terms of function would most likely be with the goal of a successful mate/territory being determined and a resulting copulation. The group displaying the behaviour was comprised of only immature males that were approaching sexual maturity. The behaviour would be considered non-functioning in the short term and was modified from its original function as the interaction involved all males and therefore no mating copulation would have taken place. The play fighting also did not result in injury or escalate to a territory being held or defended.

One theory of the reward of performing this "play" behaviour is that it aids in individual development by allowing the individual to practice motor skills requisite for adulthood. Another theory is that the "play" behaviour was bonding behaviour strengthening a male group alliance. Male alliances have been documented in other mammal species (Olson & Blumstein, 2009), including bottlenose dolphins (*Tursiops truncatus*; Wiszniewski et al., 2012), and has been shown to increase foraging success in river otters (*Lontra canadensis*; Blundell et al., 2004). Leopard seals have a large, diverse foraging range (Staniland et al., 2018), and it is unknown how much of this range the species travels alone. It would be an understandable incentive for younger animals to maximize socializing opportunities during high density congregations. Evidence of leopard seals' group prey processing, while suggested as rare, has been documented in South Georgia waters (Robbins et al., 2019), supporting social interactions in this species.

The play behaviour displayed by the immature male leopard seals has not been documented in literature for this species. Whether these interactions were typical and potentially influenced by seal individuality or a result of a higher than usual congregation of leopard seals in 2019, potentially in response to particular environmental influences at Bird Island, remains unknown. We hypothesize that the winter population of leopard seals at Bird Island and the longer residency times of some individuals facilitate social interaction. Whether sociality in leopard seals might be related to sex and age differences as well as to tolerance

to conspecifics, spatial distancing, and sharing resources requires further exploration.

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