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Note

First account of apparent alloparental care of a long-finned pilot whale calf (*Globicephala melas*) by a female killer whale (*Orcinus orca*)

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Abstract

Interactions between killer whales (*Orcinus orca* (Linnaeus, 1758)) and long-finned pilot whales (*Globicephala melas* (Traill, 1809)) have been documented on numerous occasions, usually involving predation events and pursuits. Here, the first documented account of a long-finned pilot whale calf seen in echelon position with one killer whale in a group of three killer whales is described, along with one further interaction of the same killer whale group with other long-finned pilot whales. Behavioral, locational, and photographic data were recorded and analyzed for killer whales between 2011 and 2022 and for long-finned pilot whales between 2019 and 2022 off West Iceland. The data were used to obtain background information on the killer whale group involved in the apparent alloparental behavior. The described event also presents the first documented account of epimeletic behavior of a killer whale toward a non-conspecific. The movements of the same killer whale group in conjunction with other killer whales during a subsequent interaction with a group of long-finned pilot whales do not fit any previously observed behavioral patterns described for interactions between these species and may represent an active effort to obtain another long-finned pilot whale calf. Long-finned pilot whale and killer whale interactions might be more complex than previously thought and influenced by multiple drivers.

Key words: killer whale, *Orcinus orca*, long-finned pilot whale, *Globicephala melas*, Iceland, interspecies interaction, epimeletic behavior, allocare, echelon position, delphinids

Killer whales (*Orcinus orca* (Linnaeus, 1758)) have been documented living in matrilineal units with strong long-term associations between the mother and the offspring (Bigg et al. 1990; Baird and Whitehead 2000; Beck et al. 2012). Long-finned pilot whales (*Globicephala melas* (Traill, 1809); further also referred to as "pilot whales") have been thought to form long-term matrilineal associations within units similar to killer whales (Amos et al. 1991; Ottensmeyer and Whitehead 2003; De Stephanis et al. 2008), but whether these units are strictly matrilineal across their range is not certain (Augusto 2017). Natal group philopatry, where neither male nor female offspring disperse from the natal group, has been found in killer whales and suggested for pilot whales (Bigg et al. 1990; Ottensmeyer and Whitehead 2003). These two species appear to share similarities in their individual mother–offspring relationships. However, the rigidity of these relationships across populations varies, and there are several populations for which basic social structure is not yet or only partly understood. A multilevel social structure without clear hierarchical tiers has been suggested for the Icelandic herring-eating killer whale population (Tavares et al. 2017), but no information is available on the social structure of long-finned pilot whales off Iceland.

Interactions between killer whales and long-finned pilot whales have previously been documented in the North Atlantic, including both predation events and pursuits. Off southwest Greenland, along the northeast coast of the United States, and in Faroese waters, killer whales reportedly chased or successfully attacked pilot whales on several occasions (Bloch and Lockyer 1988; Heide-Jorgensen 1988; Jefferson et al. 1991). Off Iceland, only one predatory record of killer whales attacking pilot whales exists in the scientific literature (Donovan and Gunnlaugsson 1988).

Antagonistic behavior of long-finned pilot whales toward killer whales has been documented in the Norwegian Sea, the Strait of Gibraltar, and the waters south and west of Iceland, with pilot whales moving toward and pursuing killer whales but never reaching them. In these encounters, the killer whales involved regularly exhibited nonaggressive avoidance behavior (De Stephanis et al. 2014; Selbmann et al. 2022). The avoidance behavior of the killer whales to the approach of pilot whales in Iceland could be divided into two categories—

regular avoidance where killer whales moved away at low to moderate speeds with minorly evasive behavior and high-speed avoidance where killer whales porpoised out of the water as they were pursued by pilot whales in a chase (Selbmann et al. 2022). The proposed drivers of these interactions are resource competition, with both species exploiting similar resources (in Iceland possibly Atlantic herring, *Clupea harengus* Linnaeus 1758, or Atlantic mackerel, *Scomber scombrus* Linnaeus 1758) or anti-predatory strategies of the pilot whales toward the perceived threat presented by the presence of killer whales (Curé et al. 2012; De Stephanis et al. 2014; Selbmann et al. 2022).

Here, we describe the first documented account of a group of killer whales with a lone long-finned pilot whale calf and one further interaction of the same killer whale group with other long-finned pilot whales. Behavioral, locational, and photographic data were recorded of killer whales between 2011 and 2022 and of long-finned pilot whales between 2019 and 2022 from an opportunistic platform aboard whale-watching tours, as well as dedicated surveys in the southern part of Breiðafjörður Bay and along the Snæfellsnes Peninsula, West Iceland. For all observations, experienced observers were present to document the behavior of individuals, and data were obtained under strict compliance with the IceWhale Code of Conduct for Responsible Whale Watching (IceWhale 2015). The killer whales present in the encounter with the pilot whale calf were photo-identified (Bigg 1982) from a database of 987 individuals cataloged for West Iceland (Mrusczok 2022). All encounters with these individuals in the period 2012–2022 were then examined for female–calf associations and size of the dorsal fins of the individuals to determine their sex and approximate age (Olesiuk et al. 1990; Ford et al. 2000). The body conditions of the pilot whale calf and of the individual killer whales were categorized with the Body Condition Score system for delphinids by Joblon et al. (2014). The approximate age of the pilot whale calf was determined from photographs and according to the presence of fetal folds on the body (Auger-Méthé and Whitehead 2007; Augusto et al. 2017). Echelon swimming was defined via the description in Weihs (2004).

On 12 August 2021, a long-finned pilot whale calf was recorded in the company of three individual killer whales west of the Snæfellsnes Peninsula, West Iceland (Table 1). The observation period for this encounter lasted 21 min, and no other cetaceans were detected in the area throughout the observation. The body condition of all the three killer whales was considered "normal" (mesomorphic), and the individuals were identified as adult females SN0092 "Dragonfly" and SN0540 "Sædís" and adult male SN0089 "Zale". This group, henceforth also referred to as the 92s, has been documented feeding on Atlantic herring and has been observed on a total of 21 occasions between 2012 and 2022 (Table 1). During 19 of these occasions, all 3 members were present, showing a stable group structure over time and indicating a social unit of likely related individuals (Table 1). All individuals were adults when first documented in 2012, and SN0540 has not been recorded with a calf of her own during our long-term study (2012–2022). The pilot whale calf was classified as a newborn and its body condition as "emaciated" (Fig. 1). The pilot whale calf was observed in echelon position with SN0540 for the whole duration of the encounter (Fig. 1)—with the exception of two surfacings where the calf surfaced several meters away from SN0540. There were no visible interactions between the other group members (SN0089 and SN0092) and the pilot whale calf. The 92s displayed foraging behavior (Table 1) throughout the encounter, which continued as the boat left the scene. The next confirmed sighting of the 92s was in March 2022, and the pilot whale calf was not observed to be present (Table 1).

On 19 July 2022, the 92s were observed as part of an association of 10 killer whales that interacted with a group of approximately 40 long-finned pilot whales (Table 1). The observation period lasted 26 min, and the pilot whales were observed pursuing the killer whales southwest. In this encounter, a lone white-beaked dolphin (*Lagenorhynchus albirostris* (Gray, 1846)) was sighted among the pilot whales and was observed porpoising with them toward the killer whales during the initial chase before disappearing from view during the subsequent part of the encounter. The killer whales exhibited non-aggressive avoidance behavior and moved away from the pilot whales in a tight formation at moderate speed. The pilot whales stopped at a distance of approximately 200 m from the killer whales and turned back toward northeast. As the pilot whales turned northeast, the killer whales also turned northeast and slowly moved toward the pilot whales, maintaining a tight formation. The pilot whales then turned southwest and started chasing the killer whales again, who reacted by also turning southwest. This chain of behaviors repeated itself twice more in the same way during the observation period. The group of killer whales included one killer whale calf (not associated with the individuals that had formerly been seen with the pilot whale calf), and the pilot whale group included several conspecific calves of various ages. Observations ended when the boat left as the killer whales were moving toward the pilot whales for the third time.

Social and reproductive advantages provide possible explanations for why a newborn pilot whale calf was observed in association with killer whales on 12 August 2021. The behavior of SN0540 toward the pilot whale calf could represent a form of interspecific alloparental care. Alloparental care toward conspecifics has been documented in both killer whales and long-finned pilot whales (Ford et al. 2000; Augusto et al. 2017). In mammalian species, it is thought that individuals caring for non-descendant young may acquire selective advantages such as parental experience or reciprocal altruism (Riedman 1982). As SN0540 has never been observed with any confirmed calves of her own, she might gain valuable knowledge regarding calf care while attempting to look after the pilot whale calf as a substitute for a calf of her own. SN0540 may have shortly before had a late-term miscarriage or lost a newborn and may have been lactating at the time of this encounter, but given the lack of evidence of this individual having calves during the previous eight years, the lack of documentation of offspring in other encounters shortly before this observation, and the poor body condition of the associated newborn pilot whale with its subsequent disappearance, there is no data available to

Table 1. Sightings of the focal group of killer whales (*Orcinus orca*) in the southern part of Breiðafjörður Bay and along the Snæfellsnes Peninsula, West Iceland.

Date	Time	SN0540	SN0092	SN0089	Ind. total	Special remarks on foraging/feeding behavior	Number of pilot whales (*Globicephala melas*) on scene
11.02.2012	N/A	1	1	1	N/A	None	0
23.02.2012	N/A	1	1	1	N/A	None	0
11.02.2013	N/A	1	1	1	N/A	Probable carousel feeding[a]	0
24.02.2013	N/A	1	1	1	N/A	None	0
16.03.2013	N/A	1	1	1	N/A	None	0
30.03.2013	N/A	N/A	1	1	N/A	None	0
17.01.2014	14:20–15:42	1	1	1	30 (est.)	None	0
16.04.2018	14:54–15:30	1	1	1	15	None	0
02.08.2018	10:57–11:58	1	1	1	20 (est.)	None	0
15.03.2019	12:13–12:32	1	1	1	5	None	0
15.03.2019	15:04–15:47	1	1	1	20	Probable carousel feeding[a]	0
25.03.2019	14:49–15:17	1	1	1	45 (est.)	Probable carousel feeding[a]	0
23.06.2021	16:10–16:23	N/A	N/A	1	15 (est.)	None	0
12.08.2021	16:19–16:40	1	1	1	3	Foraging[b]	1
20.03.2022	12:03–12:25	1	1	1	3	Foraging[b]	0
20.03.2022	15:27–16:24	1	1	1	9	Carousel feeding on herring[c]	0
19.07.2022	11:47–12:13	1	1	1	10	None	40 (est.)
22.07.2022	11:29–11:51	1	1	1	7	Foraging[b]	0
23.07.2022	11:46–12:16	1	1	1	10	None	0
25.07.2022	15:28–15:47	1	1	1	5	None	0
26.07.2022	11:04–11:39	1	1	1	10	Foraging[b]	0

Note: Ind. total refers to the total number of individuals recorded during the encounter. N/A marks where data were not available. Est. means an estimate of the total number of individuals. Estimates were given when not all individuals could be photographed due to weather conditions or brevity of the encounter on a public whale-watching tour.

[a] "Probable carousel feeding": sea birds were observed taking whole Atlantic herring (*Clupea harengus*) close to the surfacing killer whales, and the characteristics common for killer whales' carousel feeding on Atlantic herring were documented (Similä and Ugarte 1993; Similä 1997).

[b] "Foraging": individuals moved in a non-directional manner in a loose constellation, with birds hovering over, but no prey species was observed.

[c] "Carousel feeding on herring": a group member was observed consuming an Atlantic herring, whole herring was afloat on the water surface, and the characteristics common for killer whales' carousel feeding on Atlantic herring were documented (Similä and Ugarte 1993; Similä 1997).

support this idea. Alloparental care between killer whales and pilot whales may be possible because of the similar long-term cooperative group structure and mother–offspring relationships in both species (Bigg et al. 1990; Baird and Whitehead 2000; Ottensmeyer and Whitehead 2003; De Stephanis et al. 2008; Beck et al. 2012). Interspecific alloparental care has previously been noted for several delphinid species, including short-beaked common dolphins (*Delphinus delphis* Linnaeus, 1758), common bottlenose dolphins (*Tursiops truncatus* (Montagu, 1821)), Indian Ocean humpback dolphins (*Sousa plumbea* (G. Cuvier, 1829)), and Indo-Pacific humpback dolphins (*Sousa chinensis* (Osbeck, 1765)) (Bearzi 1996; Carzon et al. 2019; Conry et al. 2022). In one case study, a common bottlenose dolphin female was documented fostering and nursing a melon-headed whale (*Peponocephala electra* (Gray, 1846)) calf while at the same time also mothering its presumed biological offspring (Carzon et al. 2019). This association persisted even after the disappearance of the presumed biological calf of the common bottlenose dolphin female (Carzon et al. 2019). In another case study, a female Indian ocean humpback dolphin was observed to be an allocarer for a newborn Indo-Pacific bottlenose dolphin (*Tursiops aduncus* (Ehrenberg, 1833)) calf on one occasion and for a newborn short-beaked common dolphin calf during a subsequent event while also swimming with her presumed biological offspring during both events (Conry et al. 2022). Given the frequency of alloparental care events associated with this individual, it was thought possible that she could be stealing calves (Conry et al. 2022).

In the case presented here, the observation of the echelon formation between the adult female killer whale SN0540 and the pilot whale calf should be given special consideration, even though the pilot whale calf was not observed nursing. The echelon position allows a calf to make fewer tail fluke movements than when swimming on its own and overcome physical limitations during high-speed travel, as it is closely "drafting" alongside an individual, carried by the pressure wave created by the adult's larger body (Weihs 2004; Noren and Edwards 2007). As a form of aquatic infant-carrying behavior, echelon swimming is considered one of the most

Fig. 1. Killer whale (*Orcinus orca* (Linnaeus 1758)) female SN0540 in echelon formation with a long-finned pilot whale (*Globicephala melas* (Traill, 1809)) calf. The pilot whale calf displayed clear signs of emaciation via a deep depression posterior to the blowhole and a narrowed trunk, indicating poor body condition and nutritional status (Joblon et al. 2014). The strong fetal folds, indicating that the calf was newborn (Auger-Méthé and Whitehead 2007; Augusto et al. 2017), are clearly visible on both sides of the body. All images were taken on 12 August 2021 (upper two images by M.-T. Mrusczok and lower image by S. Rodríguez Ramallo).

energy-intensive forms of parental care after lactation and may impact energy budgets, predator evasion, and foraging efficiency (Noren 2008).

The observation of SN0540 keeping the pilot whale calf in echelon position can also be seen as a form of epimeletic or nurturant behavior. This typically refers to a healthy adult caring for a dead or impaired individual (Bearzi et al. 2017), in this case a healthy adult killer whale female caring for an emaciated, weak, and possibly lost or orphaned pilot whale calf. Epimeletic behavior of killer whales toward conspecifics has previously been documented on several occasions (Reggente et al. 2016; Bearzi et al. 2018; Shedd et al. 2020). A female killer whale from the Icelandic population has previously been observed displaying epimeletic behavior toward her dying (and later dead) calf for five consecutive days, with the female carrying the killer whale calf on the rostrum (Mrusczok et al. 2022). Epimeletic behavior of killer whales toward non-conspecifics has not been previously documented.

Long-finned pilot whale calves are frequently observed traveling alongside other pilot whale adults and juveniles, both males and females, in echelon position (Augusto et al. 2017). These allocaring individuals have been found to be from outside the calf's social unit, and pilot whale calves have been observed to switch between allocarers regularly (Augusto et al. 2017). It is a possible explanation that the calves themselves may initiate some of these allocare relationships, which might make it easier for a killer whale to either intercept or adopt a newborn pilot whale calf. SN0540 may have also initiated the contact and deliberately, at least temporarily, adopted the pilot whale calf, considering the high-energy investment of caregiving. During the observation, SN0089 and SN0092 tolerated the presence of the pilot whale calf, but it is unknown how these individuals related to the calf specifically, as no interaction was documented.

Even though the 92s were observed foraging in the vicinity of the pilot whale calf, foraging benefits are unlikely to occur for the killer whales in this specific interspecies association, as the calf was a newborn and would still have to be nursed (Augusto et al. 2017; Soto et al. 2017). Given the poor body condition of the pilot whale calf and the lack of nursing killer whale calves in the group at the time of observation, it is unlikely that the pilot whale calf received any nourishment.

While we do not know how the observed relationship between SN0540 and the pilot whale calf started, it does suggest a possible novel explanation for the regularly observed killer whale chasing behavior from long-finned pilot whales in Icelandic waters. The movements of the 92s in conjunction with other killer whales during the subsequent interaction between them and the pilot whale group on 19 July 2022 do not fit any formerly observed behavioral patterns described for these antagonistic interactions (De Stephanis et al. 2014; Selbmann et al. 2022). It is possible that the movements of the killer whale group as a whole could have been influenced by an active effort of SN0540 to obtain another pilot whale calf through an approach of the pilot whale group, and the pilot whales may have reacted with a chase as a preventative measure to protect their young.

SN0540 with the newborn pilot whale is the first documented account of a long-finned pilot whale calf seen in echelon position with a killer whale. This observation also presents the first documented account of epimeletic and possible alloparental behavior of a killer whale toward a non-conspecific. Whether the attraction between SN0540 and the pilot whale calf was mutual or one-sided is not known, nor is the duration of the association, or how it started and ended.

We suggest that pilot whales and killer whales in Iceland may display repeated or long-term interactions on the basis of multiple drivers. More research on pilot whale–killer whale interactions, including on how pilot whale calves become associated with killer whale groups in the first place, is necessary to understand the complex interplay of these two delphinid species.

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