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First Observations of Parturition and Postpartum Behavior in the Mediterranean Monk Seal (*Monachus monachus*) in the Eastern Mediterranean

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Abstract

Understanding reproductive behavior, especially the circumstances surrounding parturition and the events following the first days postpartum, is essential in developing effective conservation strategies for endangered pinnipeds. In the case of the critically endangered Mediterranean monk seal (*Monachus monachus*), difficulties in documenting events such as parturition are compounded by the very low population numbers and the inaccessibility of the habitat occupied by the species. In this study, the authors report the first observations of parturition for the species from the central Aegean Sea, Greece, in the eastern Mediterranean Sea. Using a state-of-the-art infrared remote-monitoring system, two births were documented, and important information on the total duration of the events; the total duration of attempted suckling; as well as information on the presentation of the pups, their sex, and habitat were recorded. This new information on the reproductive biology of the species in this part of its range outline the importance of suitable reproductive caves for the conservation of the species and the urgency of protecting them. In addition, considering the high cost and logistics of the study, monitoring the species on a large scale to effectively protect it will require the development of new, low-cost, and time-efficient methodologies.

Key Words: Mediterranean monk seal, *Monachus monachus*, conservation, endangered species, Greece, non-invasive monitoring, parturition

Introduction

Parturition and postpartum behavior has been recorded in numerous species of pinnipeds—for example, Antarctic fur seal (*Arctocephalus gazella*) (Acevedo et al., 2008), Northern fur seal (*Callorhinus ursinus*) (Boltnev & York, 2001),

Hawaiian monk seal (*Monachus schauinslandi*) (Eliason et al., 1990), and grey seal (*Halichoerus grypus*) (Pomeroy et al., 2005). Such information has been used to understand pinniped maternal behavior (Haller et al., 1996), mating strategies (Van Parijs et al., 2001), population dynamics (Wickens & York, 1997), and to define conservation strategies (Antonelis et al., 2006). However, documenting such events for pinnipeds that give birth to pups that swim shortly after parturition is difficult, especially during the pupping season when parturient females are extremely sensitive to disturbance (Lawson & Renouf, 1985).

In the case of the critically endangered Mediterranean monk seal (*Monachus monachus*), these difficulties are compounded by the low population density of the species, its critical conservation status, and the inaccessibility of the habitat occupied. World population estimates for the species currently number less than 600 individuals, distributed over isolated subpopulations in the Archipelago of Madeira and the Cabo Blanco region in Mauritania / Morocco in the Atlantic Sea and the eastern Mediterranean Sea (Johnson et al., 2006). General information on the reproductive biology of the species is available only from the colony at Cabo Blanco (Layna et al., 1999; Gazo et al., 2000a, 2000b; Cedenilla et al., 2009); this information, however, might not necessarily be directly applicable to the other two areas of the species' distribution due to significant differences in habitat occupied (Karamanlidis et al., 2004), female reproductive strategies, and population structure (Dendrinis et al., 2007b). Monk seals in Greece generally inhabit small coastal caves, often close to human populated areas that offer only limited land area, exposing newborns to the danger of being washed-out to the open sea by storms early in life.

To obtain information that will be used in the effective conservation of the species, a study was initiated in 2007 with the goal to collect

information on the parturition and postpartum behavior of the Mediterranean monk seal in this part of its distribution. Herein, the first observations of parturition events in the Mediterranean monk seal from the eastern Mediterranean are reported. The parturition event was defined as the time span between the last entry of a parturient female into the cave before giving birth and the actual parturition up until the first (unforced) departure, with or without the newborn pup, from the cave used for reproduction (i.e., being absent for more than an hour from the cave).

Materials and Methods

As part of a wider study of the reproductive biology and activity patterns of the Mediterranean monk seal, a monitoring system was installed in one of the main reproductive caves of the species at the island of Kimolos at the southwestern Cyclades islands (Figure 1a). This population of seals has been continuously monitored since 1997 and is considered one of the most important of the species in the eastern Mediterranean (MOM,

2007). The monitoring system was installed in a cave at the northeastern part of the island (Cave code: KIM1, $36^{\circ} 49' N$, $24^{\circ} 36' E$; Figure 1b), with an entrance facing to the east that led through a 35-m-long corridor and an approximately 100 m^2 pool to two beaches with sand, pebbles, and boulders. The total size of the beaches depended on the state of the sea and varied between the beaches being totally washed-out by the sea during storms and a maximum of approximately 50 m^2 of dry surface during calm weather conditions (Figure 1c). The monitoring system was installed in July when sea conditions were best for working in the cave, but most importantly, when cave use by Mediterranean monk seals in the eastern Mediterranean Sea is lowest (Dendrinos *et al.*, 1994). Therefore, no seals were disturbed during the installation of the system.

The monitoring system consisted of one remote-controlled (AU-G70, VIDO Electronics Vertriebs G.m.b.H.) and one standard (RA-25PT, RAS Electronics limited) digital video camera, supported by two infrared light beams (140 W), which provided 24-h monitoring. The system was

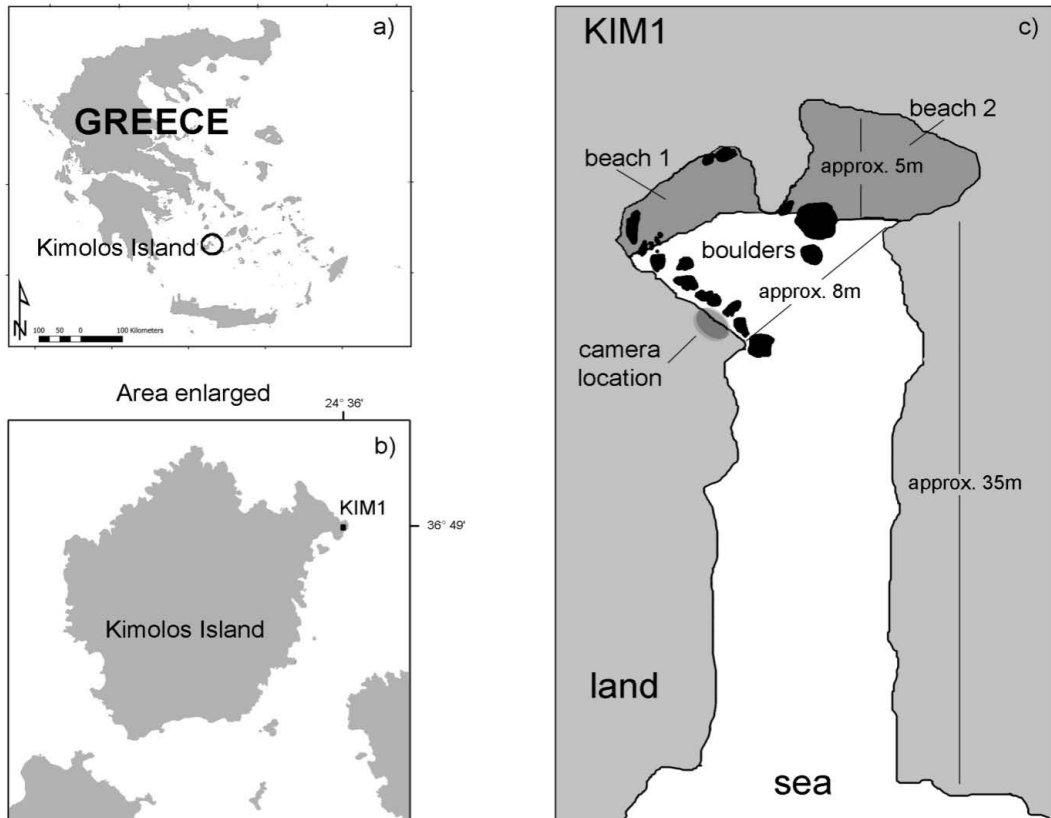


Figure 1. (a) Map of Greece indicating the study area, (b) map of the island of Kimolos indicating the location of the study site, and (c) drawing of cave KIM1 indicating the main topographic features of the cave; the drawing is not to scale.

powered by 12 solar panels (1,400 W), which generated power for charging a set of four car batteries which ensured system operation during the night and in the winter. Monitoring data was stored locally, but also remotely via satellite internet connection. Internet connection enabled remote control of one camera. The approximate cost of this monitoring system was €35,000.

Results

The first parturient female (Fem1) entered the cave on 18 September 2007 at 2211 h and positioned herself on the left beach (beach 1; Figure 1c), parallel to the shore, lying on her belly. Until parturition, Fem1 appeared very restless; she made frequent 180° reorientation movements and movements around her axis. When lying on her ventrum, she often slightly arched her lower pelvic area while spreading her hind flippers. Until parturition, this behavior was accompanied by frequent scratching and scooping of sand with the fore flippers onto the back ($n = 11$) and digging of the muzzle in the sand. Respiration rate during this time, which was determined by counting the times the nostrils opened, was six breaths per minute. Parturition, as defined by the crowning of the pup, started on 19 September at 0404 h when weather conditions were good. Presentation of the pup was caudal (Table 1), and during the initial stages of parturition, Fem1 vocalized and turned constantly around her axis. Five minutes into parturition, Fem1 went into the water and out of sight of the monitoring system. At 0414 h, she reappeared from the sea accompanied by a female pup (Pup1) as determined by the ventral patch pattern (Badosa et al., 1998). For the next 20 min, Fem1 was active in an apparent attempt to lead her newborn pup onto the beach. These efforts were characterized by the vocalizations of parturient Mediterranean monk seals (Dendrinis & Karamanlidis, 2008) and constant nuzzling. When on land, the two animals remained in direct

body contact until 19 September at 1919 h when Pup1 moved more than one adult body length away from her mother. On 20 September at 1542 h, Pup1 went for the first time on her own into the sea. The first attempted lactation occurred approximately 6 h postpartum (1000 h); from the time of birth until being left for the first time by its mother, Pup1 tried to suckle at least 27 times, approximately every 4 h (Table 1).

On 21 September 2007, weather conditions deteriorated, with the waves washing-out the entire cave. The pup was repeatedly washed away from her mother, and Fem1 lunged several times towards her pup and led it with her body back to safety. She often placed her body in position to act as a wave breaker against the incoming waves. On one occasion, while trying to bring Pup1 back to safety, Fem1 showed extreme agility and climbed a 1.2-m-high boulder (Figure 2a). On 23 September, the mother-pup pair was approached by another female; however, no aggressive interaction was recorded. The event ended on the same day at 2050 h, when Fem1 left the cave, leaving the pup alone, only to return after approximately 9 h. The first parturition event lasted a total of 119 h.

The second parturition event started on 2 October 2007 at 1754 h and lasted until 7 October 2007 at 0708 h when the second female (Fem2) left the cave used for pupping for the first time on her own (total duration of the event: 109 h). At the time Fem2 approached the beach positioned to the left of the cave, Pup1 and, later on, Fem1 were also in the cave on the right beach. However, no interactions between them were recorded. Until 2 October at 2054 h, Fem2 was lying on her belly, parallel to the seashore, exhibiting no discernible signs of activity. At this point, an obvious dilation of the vaginal aperture was recorded, and at 2059 h, parturition started. Fem2 turned constantly around her axis while laboring. Presentation of the pup was cephalic (Figure 2b). Parturition ended at 2104 h with a single strong thrust which resulted

Table 1. Summary of events recorded during the parturition events of two Mediterranean monk seals (*Monachus monachus*) in the eastern Mediterranean Sea; in calculating the total duration of events for Female 2, the time she was absent from the cave after being scared away by a human was included.

Event	Female 1	Female 2
Cave entrance – birth	~6 h	~3 h 10 min
Parturition presentation	Caudal	Cephalic
Pup sex	Female	Male
Time to first nursing	6 h	~2 h 10 min
Frequency of nursing	Approximately every 4 h 6 min	Approximately every 5 h 20 min
First entrance of pup into the sea	1.5 d postpartum	4 d postpartum
Total duration of suckling	310 min ($n = 27$)	340 min ($n = 20$)
Cave entrance – female first leaves the pup	119 h	109 h

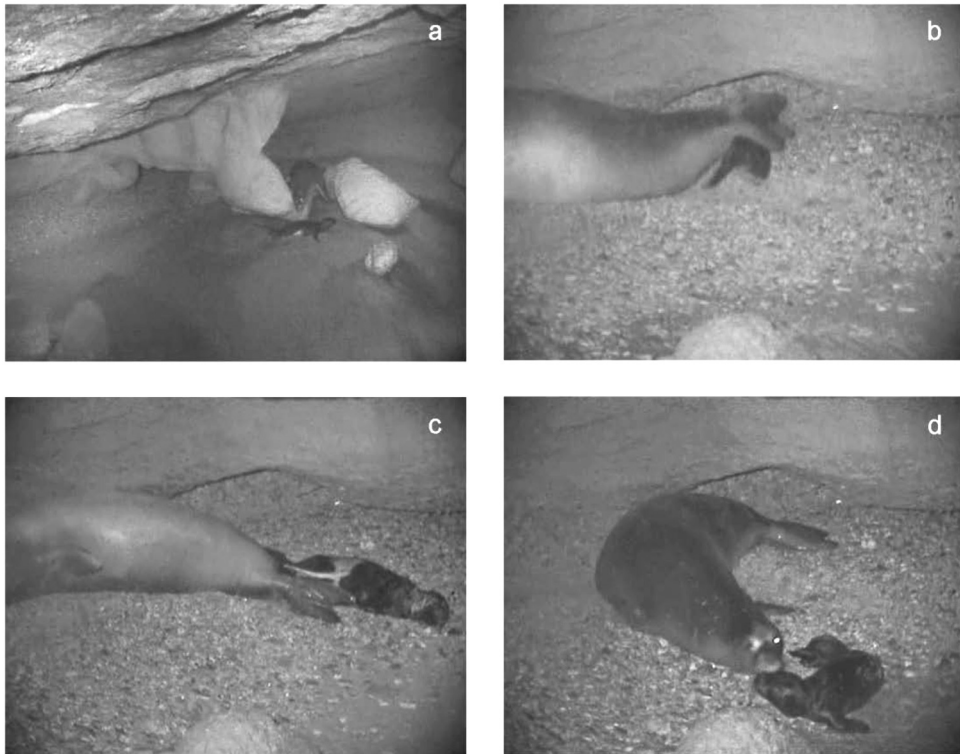


Figure 2. Sequence of images from an automatic infrared monitoring system installed in a coastal cave at the island of Kimolos, Greece, to monitor Mediterranean monk seals (*M. monachus*): (a) while trying to prevent her pup from being washed away by waves, a female Mediterranean monk seal climbs over a 1.2-m-high boulder; (b) presentation of the second pup was cephalic; (c) moments after the birth of a male pup, the umbilical cord was broken; and (d) seconds after parturition, the mother-pup pair engaged in intense nuzzling.

also in the breaking of the umbilical cord (Figure 2c). Just seconds after parturition, the mother-pup pair engaged in intense nuzzling and vocalizations (Figure 2d). Approximately 2 h after parturition (2315 h), the first attempted suckling of Pup2 was recorded; and on 6 October, Pup2 entered the sea on its own for the first time (Table 1).

Until 4 October 2007 at 1026 h, the mother-pup pair rested on the left beach in direct body contact. At this point, the parturition event was interrupted by an unidentified human who entered the cave and scared Fem2 away, leaving Pup2 alone in the cave. In her attempt to get into the water, Fem2 trampled over her newborn pup; the pup was not injured. Upon Fem2's return to the cave approximately 7 h later (1737 h), she was initially approached by Pup1 that was at that moment by itself in the cave; intense nuzzling and vocalizing took place. Moving towards her own pup, Fem2 was followed by Pup1 that tried to suckle. Fem2 pushed it away with her muzzle. Upon insisting, Fem2 bit Pup1 and then actively chased it away into the water. During the parturition event,

another three aggressive behaviors from Fem2 towards Pup1 were recorded. No aggressive interactions between Pup1 and Pup2 were recorded.

Throughout both parturition events, the females remained close to their pups, mostly in body contact. They prevented their pups from moving beyond their reach by "restraining" them and resting their head on the pups' hind flippers. No interactions between the two females were recorded during the two pupping events.

Discussion

Understanding Mediterranean monk seal reproductive biology, especially the circumstances surrounding parturition and the events following the first days postpartum, is essential in the effective protection of this critically endangered species. Israëls (1992) suggested that human disturbance during parturition or the lactation period might lead to the abandonment of unweaned pups or even the abortion of unborn ones (Johnson & Lavigne, 1999). While this might not have been the case in

this study, the temporary abandonment of the pup observed during this study in conjunction with bad weather conditions could have led to mother-pup separation and the eventual death of the pup. Natural mortality related to bad weather conditions has been the sole cause of death recorded for this age class among Mediterranean monk seals in Greece (Androukaki et al., 1999) and has also been associated with the low pup survival rates at the colony at Cabo Blanco (Gazo et al., 2000b). Identifying the most important pupping sites of the species in the country and effectively protecting them is considered therefore one of the outstanding conservation priorities for *M. monachus* in Greece (Notarbartolo di Sciarra et al., 2009).

The general pattern of the parturition events recorded during this study is consistent with the information available from the species (Layna et al., 1999) and the closely related Hawaiian monk seal (Eliason et al., 1990). Some differences were recorded, however, such as the cephalic presentation of one pup, the potential birth of a pup in shallow waters, the lack of aggressive interactions between adult females, and the presence of aggressive interactions between parturient females and non-filial pups. Clearly, additional research is required to understand the reproductive biology of the species in this particular type of habitat and distribution. The methodology applied in this study can provide detailed information on specific aspects of the species' biology and behavior and is an invaluable tool in public education and awareness. Considering, however, the high cost and logistics of this and similar studies (Dendrinis et al., 2007a) and the high number of caves used for reproduction in Greece (MOM, 2007), monitoring the Mediterranean monk seal population in Greece on a national level using this methodology is not realistic. Developing low-cost and time-efficient remote methodologies to obtain the biological information that will promote the effective conservation of the species is therefore of utmost importance.

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