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Short Note

Birth of a *Halichoerus grypus atlantica* (Nehring, 1866) Pup at the Biotechnical Aquacomplex of MMBI RAS

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This short note describes the first successful birth of an Atlantic gray seal (*Halichoerus grypus atlantica*; Nehring, 1866) pup in managed care with near-natural conditions at the eastern periphery of their North Atlantic habitat. Its weight and size changes during nursing, postnatal molting, and initial stages of solid food consumption are presented as well as its mother's weight changes during the prenatal, postpartum, and lactation periods. Herein, we describe the pup's delivery conditions that were created for seals kept in a floating open-water enclosure. A peculiar case of a managed-care female seal inseminated by a wild gray seal male is also described.

Gray seals (*Halichoerus grypus*; Fabricius, 1791) are successfully kept in zoos and aquariums around the world, and their births in managed care are not uncommon (Kastelein & Wiepkema, 1988, 1990; Grande et al., 2020). Gray seals are not threatened or endangered in terms of their global habitat (Bowen, 2016); however, in various countries, the subspecies are often included in local lists of protected species due to their non-uniform distribution (e.g., including in *The Red Data Book of the Murmansk Region*; Kavtsevich & Erokhina, 2014). Anthropogenic factors are the most common cause of concern for the state of various local populations (Woodley & Lavigne, 1991; Harding & Härkönen, 1999; Kavtsevich & Erokhina, 2014).

The Murmansk Marine Biology Institute of the Russian Academy of Science (MMBI RAS) is one of the few research institutes in Russia that has a scientific and experimental facility allowing the study of seals year-round in conditions as close to natural as possible (Erokhina & Kavtsevich, 2007). Two available stationary facilities located on the coast of the Kola Bay give us an opportunity to gain data on keeping and adapting Arctic seal species in managed care (Mishin & Kavtsevich, 2001; Kavtsevich & Erokhina, 2007; Matishov et al., 2007). Over the years, various species were kept in the biotechnological aquatic facilities of MMBI in the towns of Gadzhievo and Polyarny, including the ringed seal (*Pusa hispida*; Schreber, 1775), the harp seal (*Pagophilus groenlandicus*; Erxleben, 1777), and the gray seal. Past studies have shown that gray seals are highly adaptable to life in managed care (Kondakov, 2008; Matishov et al., 2015); therefore, this factor, along with their high degree of trainability, made this species the best choice to be involved in the experimental studies performed by MMBI (Yakovlev et al., 2016).

In this short note, we present details about Atlantic gray seals in an MMBI enclosure located in Polyarny (Kola Bay, Barents Sea) that contained eight individuals—four females were captured as whitecoat pups after the end of nursing in 2005, and three females and one male were also captured as whitecoat pups after the end of nursing in 2016. All adult animals were trained with the basic skills necessary for research activities in open water areas (including swimming in harnesses with a leash, transportation in and out of a crate, and following the boat). The enclosure is a floating structure consisting of several interconnected blocks (Figure 1). The submerged base of the blocks is made of HDPE pipes hermetically sealed on both ends on top of which a wooden flooring is laid. Net cages with mesh cell size of 40 to 60 mm are placed inside the blocks. Cages are connected to a guard rail that is also made of HDPE pipes and is 1 m high. The cage bottoms are equipped with a metal frame that works as a tensioner for the net. Cage tops are also covered with netting to prevent seals from leaving. The enclosure is located 30 m offshore. Each seal is contained in an individual cage; and each cage is 2 m in width, 4 m in length, and 3 m deep underwater with 1 m height above the water.

All sexually mature gray seals kept in the MMBI enclosure are females, which is why we were extremely surprised when on 8 January 2017 a pup carcass was found floating in the water in one of the cages. Having examined the enclosure and the seal (called "Veta") inside, we were sure that this pup was born here and had not come from somewhere outside of the enclosure. We estimated that mating occurred sometime in the winter of 2016, which correlates to the normal period of mating for gray seals in this area. As all seals at the facility were sexually mature females in separate cages, both a pregnancy and a pup birth were unexpected. We concluded that the sire of this pup was one of the wild gray seals (male) periodically observed in the water around the enclosure as we do not have a mature male gray seal in our managed care. Initially, the circumstances of fertilization were unknown, but the assumption was that mating occurred in the water through the net of the cage where the female was kept. This assumption was subsequently confirmed.

After such a negative, unanticipated experience (pup death), we took measures to prepare the enclosures of all four sexually mature females for possible future births. Cage modifications made throughout 2017 included an increase of the haul-out areas for each female, as well as removable partitions to isolate each female and pup from the water and to divide a single cage into two equal sections in case we needed to isolate the mother from her pup (Figure 1).

We did not take any measures to prevent mating between wild seals and captive ones as gray seals

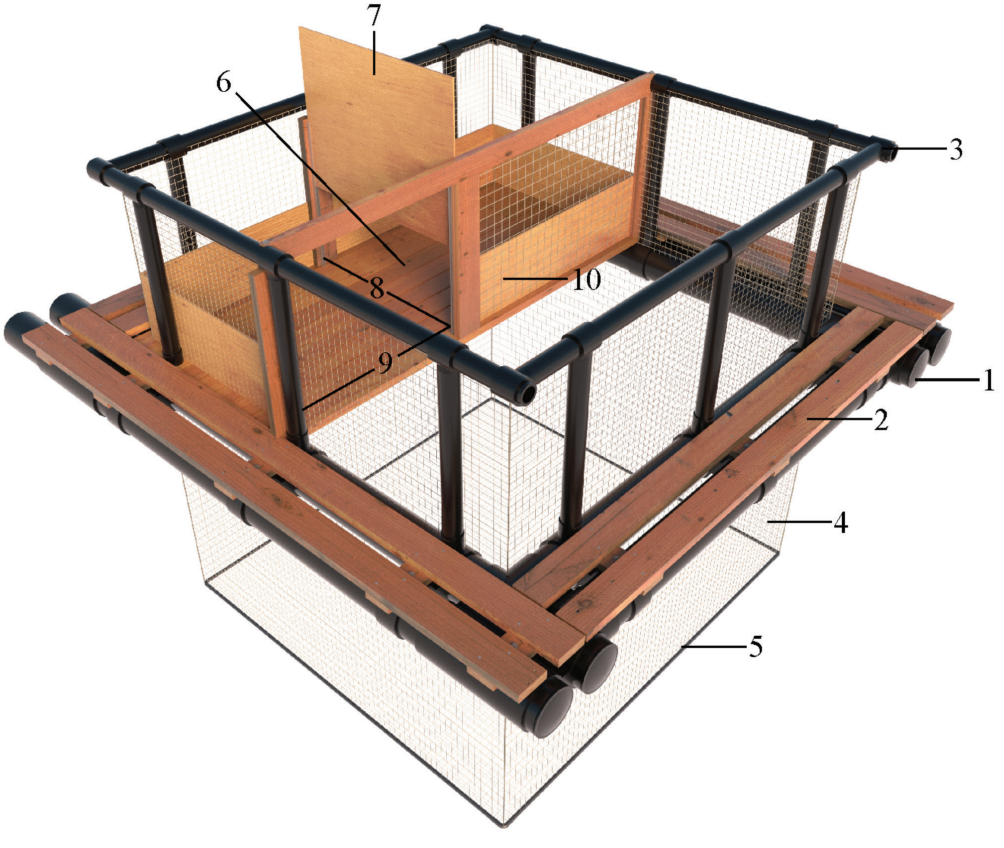

Figure 1. Scheme of an enclosure complex block, suited for a seal to give birth inside. The labeled sections include (1) floating base of enclosure made of HDPE tubes; (2) wooden flooring; (3) guarding railing made of HDPE tubes, which also offers an attachment location for netting canvas; (4) netting canvas; (5) a tensioner made of metal frame; (6) haul-out area of the enclosure; (7) moveable wooden screen; (8) jamb to hold mobile wooden screen, which is used to separate mother and offspring; (9) jamb to hold mobile wooden screen used to separate animals from the water area; and (10) fence around the perimeter of netting wall to protect the pup from a wild gray seal (*Halichoerus grypus atlantica*) male.

are listed in *The Red Data Book of the Murmansk Region* and, thus, one of the points of research of captive gray seals was to observe the possibility of mating, facilitating the birth of gray seals in captivity.

A pup that we called "Tim" (male) was born at 1500 h on 9 December 2019 (Figure 2), which corresponded to the second half of the gray seal birth season in the Barents Sea (Vishnevskaya et al., 1990; Kondakov, 1999). Unfortunately, the actual birth was not recorded on camera. The female, called "Buzya," was primiparous. We closed access to the water from inside the enclosure with a mobile screen to prevent the pup from falling into the water. For a time period immediately after the birth, the mother and pup were not disturbed. Buzya showed no signs of aggression when a person approached the enclosure, reacting only when an employee attempted to perform some activities inside her cage. The pup was not weighed on Day 1 to facilitate the mother–offspring bond, though the platform was cleaned of afterbirth and soiled snow 4 h after the pup's birth. Fresh snow was added to their cage twice a day to maintain clean conditions in the enclosure and to fulfill the seals' freshwater needs during lactation (Stewart et al., 2014). The pup began to nurse on Day 1 as the mother tried to take the position and show her nipples to the pup each feeding time. The mother did not stop eating fish even while lactating (the weight of food consumed per day was 4 to 5 kg; Table 1). The diet included Atlantic herring (*Clupea harengus*) and blue whiting (*Micromesistius poutassou*). The female was fed twice a day in compliance with the standard schedule, and feeding took place in the water area of her cage. This was done to prevent aggression from the mother during enclosure cleaning and pup handling if needed. After the mother left the haul-out area, the pup was kept from exiting to the water by the mobile screen.

On Day 2, 10 December 2019, after we managed to attract the female into the water using fish, the cage was again cleaned, and the level of the platform was raised. This was done to have a larger dry haul-out area for the mother–pup pair. Also, the pup's weight was collected (9 kg). Given the daily weight gain documented for this pup at the end of the nursing period (Table 1), we can assume this pup weighed ~7 kg at birth. We discovered that the pup was rather small compared to those pups presented in the literature: gray seal pups have a normal weight range of 10 to 20 kg in the wild (Hall, 2002; Hauksson, 2007). At the Harderwijk Marine Mammal Park, newborn pups weighed around 15 to 17 kg in different years (Kastelein & Wiepkema, 1988, 1990; Kastelein et al., 1991). This pup's small weight can be explained by the small size of its mother:

Figure 2. Newborn Atlantic gray seal (*Halichoerus grypus atlantica*) pup, Tim, inside the enclosure

Table 1. Weight change of the pup and his mother over ~6 mo (NA = Not applicable)

Date (d/mo/y)	Event	Days from birth	Pup weight (kg)	Weight of consumed fish by pup (kg)	Weight of mother (kg)
24/10/19	Routine weight collected prior to pup's birth				126.5
10/12/19	Second day after birth, first weight	2	9.0	NA	109.0
27/12/19	End of nursing*	18	49.5	NA	98.5
30/12/20	Beginning of postnatal molt	21	49.0	NA	96.0
7/1/20	Routine weighing	29	43.5	NA	91.5
17/1/20	Routine weighing	39	36.1	NA	**
2/2/20	Beginning of solid food feeding	55	33.5	0.7***	87.0
23/2/20	End of postnatal molt	76	38.0	1.6	92.0
02/3/20	Release into water	84	40.8	1.7	92.0
18/3/20	Current data	100	41.5	1.8	105.5

*We did not collect any weights until the end of the nursing period to avoid adding excessive stress to the pup and mother.
**We were unable to weigh the mother due to equipment malfunction.
***Pup was in a post-weaning fast from 27 December 2019 to 2 February 2020, so no weight data are available during the pup's postnatal molt.

her length from front flipper to tail tip was 121 cm, and she weighed 126.5 kg prior to birth. This being her first pup also might have been a factor. For comparison, three other female gray seals of the same age that we kept weighed 140 to 160 kg, and their lengths ranged from 130 to 140 cm (Bonner, 1981; Kovacs & Lavigne, 1986; Hauksson, 2007). The pup's umbilical cord fell off on Day 5, 14 December 2019, which corresponds to the estimated time for umbilicus loss in the wild (Kondakov, 1999).

The constant presence of the presumed father was an unpleasant fact as were his attempts to enter into the cage where the mother and the pup were placed. Such behavior may have been caused by the expectation to mate with the nursing female. As the cage is made of net, in certain conditions the male could mutilate the young pup as it is known that there are cases of cannibalism against young seals (Kovacs et al., 1996; Brownlow et al., 2016; van Neer et al., 2019). Therefore, we took measures to close the walls of the cage around the perimeter for the pup's protection (Figure 1).

We did not collect any weights during the nursing period to avoid adding excessive stress to the pup and mother. The pup was quite active during the days after birth and often moved from place to place inside the cage. Sometimes we observed its playful behavior as the pup tried to nibble its mother's flippers and whiskers. Its physical activity decreased as the pup gained weight; it did not move around the cage much on Days 17 and 18, mostly lying in the same place.

On Day 18, 27 December 2019, the mother was transferred to the water part of the enclosure during feeding; her willingness to do so was noted, although it had been difficult to transfer this gray seal to the water previously. As she went to the water, the female ignored the offered fish and went straight to the netting wall where the male was waiting for her. The mating process began shortly after her arrival. This observation confirmed our assumption that mating takes place in the water. Mating occurred as follows: the female turned her rear flippers to the netting wall while the male was in a vertical position, having hold of the netting wall with his front flippers.

Usually nursing lasts 18 d in gray seals. Once estrus starts, females go into the water to mate with males (Kondakov, 1999; Hall, 2002). For this reason, we decided to isolate the pup from his mother. The pup was isolated by a wooden screen installed in the dry part of the haul-out area with no access to water, while the mother was located in the other half of the haul-out area with access to water. Interestingly, the other female (Veta) that gave birth in 2017 refused to feed after the birth of the pup until the end of nursing (i.e., during the

period when the male was near the enclosures). The behavior of Veta during this period was significantly different as the animal spent more time actively swimming underwater and rarely went ashore. As only one female out of four gave birth, it is fair to assume that in 2018, mating happened only with the female called Buzya or that it at least was unsuccessful with the other females. The reasons for this male's apparent selectivity remain unclear as this apparent behavior does not correspond to the polygyny common for this species (Bishop et al., 2017).

At the end of nursing (18 d after birth), Tim's (the pup's) weight was 49.5 kg, and his body length from the base of his neck to the tip of his tail was 67 cm, which suggests that Tim gained 42.5 kg or seven times his initial weight. Despite this pup's relatively low birth weight, by the end of nursing, he had gained weight comparable to what we found in the scientific reports. For example, a pup that was born in 1987 at Harderwijk Marine Mammal Park weighed 42 kg at Day 20 after birth with an initial weight of 17 kg (Kastelein & Wiepkema, 1988).

Tim's behavior did not change after separation from his mother. He was mostly lying in the same place, occasionally showing some playful behavior. His activity increased as his weight decreased. We observed him moving around his cage exploring it. We also observed him eating fresh snow that we added after we cleaned his cage. The pup began molting on Day 21, 20 December 2019, and his molt lasted the entire period of fasting; however, a small area of embryonic fur was observed on the ventral side after the pup went into the water on 3 February 2020. Postnatal molt is a very variable period for gray seals as they may be born partially molted (Kondakov, 1999) or they may start molting a few days after the end of nursing (Kastelein et al., 1991). The postnatal molt speed may be strongly affected by a pup's motion and activity (Kondakov, 1999).

Tim's fasting period lasted about 5 wks from 27 December 2019 to 2 February 2020. After the fasting period, the pup's weight was 33.5 kg with a body length of 78 cm (Table 1). He lost 16 kg during this period—on average 0.4 kg per day. We found that postnatal fasts last from 10 to 28 d in the wild (Hall, 2002), although this period varies under human care (Kastelein & Wiepkema, 1988, 1990; Kastelein et al., 1991; Zaytsev et al., 2018). The mother's weight was 98.5 kg at the end of nursing and kept decreasing during the following month despite the feeding she continued during lactation (Table 1).

The pup's complementary fish feeding was carried out without the use of coercive measures. First attempts to offer defrosted fish slices were conducted at Week 4. Tim began biting pieces of snow later and showed his interest in objects lying on the snow, including fucus algae seaweed and slices of fish that we put there. When we tried to feed him directly with fish slices, he turned away or tried to push away the employee's hand with his flippers. It is worth noting that this animal did not demonstrate any active defensive reaction during feeding attempts unlike the gray seal pups that were wild caught in 2005 and 2016 (Zaytsev et al., 2018).

The gray seal birth described herein is our first experience of this kind and the first case of a *H. g. atlantica* birth in captivity in Russia. Despite that, most of the information covers the events earlier described by other authors; the peculiar details of our results expand the existing knowledge about the early stages of gray seals' ontogenesis. This short note shows that a pup can weigh comparably similar to individuals of his species after nursing despite an initial weight of two times smaller as compared to the average weight for its species, although this may be a sign of catch-up growth (McLaughlin et al., 2020). Apparently, the feeding activity of the mother during lactation is of high importance (Grande et al., 2020). The geographical location of the birthplace is at the eastern border of the North Atlantic habitat of this species. These particular living conditions allowed us to obtain data expanding the existing knowledge on reproduction of *H. grypus* in captivity. The circumstances under which the pup was conceived let us suggest that an enclosure with flexible netting can be used for breeding gray seals in captivity. The need for such isolation is stipulated by the aggressiveness of this species' males during mating. We know of some incidents when a male caused serious damage to his partner's body when trying to mate. The use of netting in this case may prevent the female from contacting the male until the female is ready for mating.

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accordance with "Permit for keeping and breeding in semi-free conditions and artificially created habitat of wildlife objects listed in the *Red Book* of the Russian Federation," Nos. 78, 79, 80, and 82 from 20 April 2020, all issued by the Federal Service for Environmental Supervision of the Russian Federation. The newborn gray seal is kept in accordance with the "Permit for keeping and breeding in semi-free conditions and artificially created habitat of wildlife objects listed in the *Red Book* of the Russian Federation," No. 86 from 20 April 2020, issued by the Federal Service for Environmental Supervision of the Russian Federation. All animals are managed in accordance to laws of the Russian Federation for containing and breeding of species listed in the *Red Book* of the Russian Federation and are monitored to maintain appropriate conditions by the Murmansk branch of the Russian Federation's Federal Service for Environmental Supervision.

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