Short Note

Ethogram of Two Captive Mother-Calf Dyads of Bottlenose Dolphins (*Tursiops truncatus*): Comparison with Field Ethograms

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The first and strongest bond bottlenose dolphins (Tursiops truncatus) encounter during their lives is the mother-calf-relationship (Wells, 1991). The calves are generally nursed for 3 to 6 y (Mann & Smuts, 1999) and associate strongly with their mothers for the first few years (Wells et al., 1987; Smolker et al., 1992). In the last decades, the study of bottlenose dolphin mother-calf behaviour concentrated on quantitative aspects of suckling behaviour (Eastcott & Dickinson, 1987; Cockcroft & Ross, 1990; Peddemors et al., 1992; Reid et al., 1995; Triossi et al., 1998; Mello et al., 2005) and spatial relations (Reid et al., 1995; Gubbins et al., 1999; Mann & Smuts, 1999). Detailed field ethograms were presented by Mann & Smuts (1999) for wild bottlenose dolphin mother-calf dyads in the calves' first 10 wks and by Miles & Herzing (2003) for wild Atlantic spotted dolphin (Stenella frontalis) mother-calf dyads. In the present study, the first detailed ethogram of captive mother-calf dyads was established. Fifty-one behavioural patterns of two bottlenose dolphin mothercalf dyads in the calves' first year were defined. The ethogram comprised aspects of suckling behaviour, swimming positions, mother-calf interactions, solitary behaviour, and play behaviour and contributes to a better understanding of the diversity of bottlenose dolphin mother-calf behaviour. This, in turn, can potentially lead to improvements in the housing and breeding of captive dolphins as well as the rehabilitation of stranded or otherwise injured mother-calf pairs. To assess how the captive dyads' behavioural repertoire corresponded to that of wild dolphins, the ethogram was compared to Mann & Smuts (1999) and Miles & Herzing (2003).

The observations were conducted in the dolphinarium II of the zoological garden in Nuernberg, Germany, established especially for breeding and research and not open to the public. It consists of two circular tanks connected by two channels (Figure 1).



Figure 1. Plan of the dolphinarium II; the diameter of tank A is 15 m and the diameter of tank B is 12 m. Water depth is 3.55 m. The tanks are connected by two channels with two gates each. Tank A is divided into two sections by a net (dotted lines). The wall of tank B is coated with a net for the calf's safety (dotted line). The dolphins living in the tanks during the calves' first year are indicated. Before the calves' births, Moby and Eva were housed in the greater section of tank A. Emy and Nemo (Eva's 7-y-old son) occupied the smaller section of tank A, the upper channel, and tank B.

Both females in this study were wild-caught. Eva was 25 and Emy 13 y old. The two calves were born within 5 d of each other in November 1993. Noah was Eva's third son and Neike was Emy's first surviving calf. To prevent aggression by Emy towards Eva and her calf, the two females were housed in separate tanks with the gates in the channels closed (Figure 1). Moby, the calves' father, had access to Eva and Noah from Noah's 23rd week, and to Emy and Neike from Neike's 33rd week. The gates in the channels were opened after this study concluded, when the calves were about $1\frac{1}{2}$ y old. All animals were in good health throughout the study. Observations were made from a platform which allowed good views over the whole facility. To avoid disturbances by people, the observations were conducted without trainers present (1200 to 1300 h and 1700 to 1800 h) when the observer was the only person in the dolphinarium. Each dyad was observed twice at noon and twice in the evening per week throughout the calves' first year.

Preliminary observations of the two pregnant females started in August 1993. At that time, Eva and Moby were housed in the larger section of tank A (Figure 1). The gates in the channel connecting the smaller section of tank A with tank B were open. Emy shared these sections of the dolphinarium with Eva's 7-y-old son Nemo. Two observers established an ethogram of the two females. As the ethogram also served as a basis for quantitative analyses of selected categories (in preparation), only behavioural patterns that were clearly visible and measurable from the observation platform were incorporated. The ethogram contained 18 behavioural categories. To verify the accuracies of the definitions and measurements, an inter-observer-reliability-test was conducted. Twelve hours of observation of Eva and 20 of Emy were carried out and analyzed independently by the two observers. Observation techniques were focal animal sampling and continuous recording

(Altmann, 1974). *Events* and *states* were distinguished (Martin & Bateson, 1993). *Events* are behaviour patterns of short duration for which only the frequency is measured. *States* can last for seconds or minutes, and their duration is measured as well. For each hour of observation, the observers recorded the beginning and end of the behavioural categories and calculated the frequencies of the events and the total duration of the states/h. The Spearman rank correlation coefficient was used to test the two datasets for correspondence. Correspondence was high for all behavioural categories (Table 1).

After the calves' births, all mother-calf behaviour and behavioural patterns of the calves that were clearly visible and measurable from the observation platform were added to the ethogram by one observer.

In total, 51 behavioural categories were defined (Table 2). Comparison with the two field ethograms revealed that 18 of these categories were also described by Mann & Smuts (1999) and 22 by Miles & Herzing (2003). Fourteen categories were described by all three ethograms, and 25 only in the captive study.

The ethogram demonstrated a high diversity of mother-calf interactions, solitary behaviour, and play behaviour. It contained behavioural patterns

Table 1. Results of the inter-observer-reliability-test between the datasets of two independent observers, measuring the behaviour of the two pregnant females; the Spearman rank correlation coefficient (Rs) for each behavioural category is given. Emy showed a higher diversity in behaviour (18 categories) than Eva (5 categories), which might be due to differences in age (13 vs 25 y) and temperament. Sample size is 20 h of observation for Emy and 12 h for Eva. See ethogram (Table 2) for definitions of the behavioural categories.

Behavioural category	Rs, Eva	Rs, Emy
Events		
Breathing	0, 85	0, 98
Bend back	0, 82	0, 87
Belly-flop		1, 0
Tail-slap		1, 0
Tail-slap with belly up		1, 0
Draw fluke into the water		0, 87
Draw fluke into the water with belly up		0, 87
Cough		0, 96
Ram gate with melon		0, 96
Ram gate with fluke		0, 86
States		
Steady swim	0, 99	0, 99
Rest	0,95	0, 99
Rub	1, 0	0, 98
Speed swim		0, 78
Social play (with Nemo)		0, 99
Swim together (with Nemo)		0, 93
Rest together (with Nemo)		0, 87
Mother-calf-position (with Nemo) 0, 82		0, 82

Behavioural category	Definition
A Suchling bab suiter	Demitton
A. Suckling benaviour	
Suckling +*	Calf swims under the mother and holds its rostrum to her mammary slit for more than 2 s. It lies on its side, the fluke slightly bent towards the belly. Usually the calf performs two or three suckling events in quick succession.
Side presentation *	Mother stops her swimming movements, roles onto her side, and turns her mammary region towards the calf.
B. Swimming positions States	
Echelon-position +*	Mother and calf swim very close together. The calf's head is next to the mother's fin and its body slightly above the mother, touching or nearly touching the mother's body. The mother's swimming movements are strong; the calf's are weak or absent.
Mother-calf-position +*	Calf swims under the mother, its head touching her mammary region.
Mother swims under calf	Mother-calf-position with reversed roles.
C. Mother-calf interactions <i>Events</i>	
Push up	Calf sinks to the bottom and mother gently pushes him to the surface with her rostrum or head. Only seen between Eva and Noah in the first weeks.
Lift	Mother swims on her back under the calf so that it lies on her chin. She lifts it out of the water. Only seen in the first months.
Push away	Mother pushes calf away from the tank wall, a net, or an object. Only seen in the first months.
Mother brings calf to her side	Mother passes the calf closely, thus bringing it to her side in her wake. Only seen in the first months.
Approach +*	Dolphin swims towards another dolphin. Followed by an interaction.
Leave +*	Dolphin swims away from another dolphin after an interaction.
States	
Mother follows calf	When the calf leaves, the mother turns on her side, uttering loud whistles and snarling sounds. First, she stays at one spot, always turning her rostrum towards the calf. Then she chases the calf and brings it to her side. Only seen in the first weeks.
Swim together +*	Two dolphins swim in steady circles through the tank; the distance between them is less than one body-length.
Rest together	Two dolphins lie at a spot within a distance of a maximum of one body-length.
Flipper-rub +*	While swimming together, the calf rubs parts of its body or the whole body on its mother's pectoral fins. It turns different parts of its body towards the mother's pectoral fins, thus swimming sometimes on its side or its back. The mother remains horizontal. She sometimes sticks her pectoral fins towards the calf and moves them up and down.
Body-rub +*	Calf rubs parts of its body on its mother's head or body.
Calf observes mother *	Calf is close to its mother (< one body-length) and orients its rostrum towards the mother. Sometimes it circles the mother slowly and moves its head up and down as if observing its mother's activity—in most cases, object play or exploratory behaviour.
Calf twirls around mother	While the mother rests or swims slowly, the calf crosses or leaps in front of her, lies on its side in front of her, nudges her, glides over her head, leaps onto her head, slaps its tail towards her, or jumps and falls onto her with its back. It seems as if it wants to catch her attention or play with her.
Calf nibbles at mother	Calf nibbles at mother's fluke or, very rarely, at her head or body.
Mother moves calf	Mother moves calf with her rostrum. The calf lies motionless on its side. The mother's rostrum is placed at the calf's fluke, genital region, or belly.
Rostrum to genital region +*	Dolphin touches the genital region of another dolphin with its rostrum.
Present genital region *	Dolphin turns genital region towards another dolphin.
Belly to belly *	I wo doipning swim belly to belly.

Table 2. Ethogram of two captive mother-calf dyads of bottlenose dolphins in the calves' first year

Mount + Only seen in Noah. He turns his genital region towards Eva's genital region, sometimes having an erection. Eva remains passive. D. Solitary behaviour Events Sink Calf sinks to the bottom of the tank. Only seen in Noah in the first weeks. Jump * Dolphin leaves the water with the whole body and dives in head first. Belly flop + Dolphin leaves the water with the whole body or up to the fluke and falls on its side, back, or belly. Tail-slap Dolphin isses fluke into the air and gently pulls i back into the water without splashing. Draw fluke into the water Dolphin isses fluke into the air and gently pulls i back into the water without splashing. Cough White swimming on its back, dolphin raises fluke into the air and gently pulls ii back into the water without splashing. Cough Vehement expiration. Bend back * Dolphin heads head and fluke downwards, compressing the belly region. Ram gate with fluke Dolphin heads head and fluke downwards, compressing the belly region. Ram gate with fluke Dolphin swims in steady circles without changing direction or speed. Stead swim ** Dolphin inswims at high speed. Make waves Dolphin being bead out of the water in one spot, either by rocking up and down or by jumping. Rub Dolphin inswims at high speed. Make waves Dolphin brings head out of the water in one spot, either by rocking up and down or by jumping. Rus	Behavioural category	Definition
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	Play with fish +*	Dolphin picks up pieces of fish from the bottom of the tank and gnaws at them. Only seen in the calves.

+ The category was described by Mann & Smuts (1999) for wild bottlenose dolphins (*Tursiops truncatus*).
* The category was described by Miles & Herzing (2003) for wild Atlantic spotted dolphins (*Stenella frontalis*).

that were not described by Mann & Smuts (1999) or Miles & Herzing (2003), thus contributing to the knowledge of the variability of dolphin mothercalf behaviour as well as to the ongoing discussions comparing wild vs captive behaviours. The differences among the ethograms could be due to various factors—for example, captivity, species, methodology, observing techniques, or study site. The details of mother-calf behaviour obtained in this study might be valuable for the housing and breeding of dolphins in dolphinaria as well as for the rehabilitation of injured or stranded mothercalf dyads.

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