ALLOPARENTAL CARE IN *TURSIOPS TRUNCATUS*: A CASE REPORT

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INTRODUCTION. In the majority of mammal species mothers provide virtually all of the care for their young alone, even more rarely non-parental animals provide care (Riedman, 1982). Recently, many researchers have become interested in the interactions between newborns and individuals other than mothers (Mann & Smuts, 1998). Among captive bottlenose dolphins (*Tursiops truncatus*) the mother is often assisted by another female during parturition and neonatal care (Caldwell & Caldwell, 1964, 1966; Tavolga, 1966), and such behaviour which benefits the young is defined alloparental. Conflicting opinions have been expressed about the adaptive significance of such interaction and several functions have been proposed. The babysitting function, referred to remaining with the young during the absence of the mother, seems to benefit the mother by releasing her for more efficient foraging, which may represent one instance of apparent "altruism" that has evolutionary significance in terms of kin selection theory (Riedman, 1982). On the other hand, some authors have regarded the interactions as selfish behaviour on the part of the allomother, e.g. "learning to mother" to develop maternal skill by the allomother (Lancaster, 1971).
Quantitative observations on the mother's and allomother's responses in such interactions in relation to the infant in the natural environment tend to be very difficult, especially in sea environments. Captive colonies could provide a basis for this approach. Aim of this study is to investigate the development of an alloparental relationship occurred in bottlenose dolphins in captivity conditions. The birth of a calf at Rimini's Aquarium provided the opportunity for studies of mother-calf and aunt-calf interactions observing detailed behaviour sequences.

METHODS. ***Animals and environment*.** Subjects of the study were one newborn female bottlenose dolphin named **Luna**, its own mother **Alfa**, and an unrelated female (defined as "aunt") **Beta**. Luna was born in the pool on May 12, 1995 (see TAB. 1 for details on dolphins housed at Rimini's Aquarium).

TAB. 1

Name	Sex	Age/Birth Date	Provenience	Residence in captivity (years)
Speedy	m	25 years (adult)	Adriatic Sea	17
Alfa	f	16 years (adult)	Gulf of Mexico	9
Beta	f	14 years (adult)	Gulf of Mexico	9
Sole	m	05/03/1993 (juvenile)	Rimini's Aquarium	captive-born (Alfa x Speedy)
Luna	f	05/12/1995 (infant)	Rimini's Aquarium	captive-born (Alfa x Speedy)

Observations has been carried out at the Rimini's Aquarium, whose open-air pool (20x20 m; capacity of 1400 m^3; surface of 314 m^2; maximum height of 5.5 m) is equipped with four underwater windows (80x80 cm).
Hygienic conditions were controlled by means of a close-circuit water system, and a chemical conditioning process monitored the intake of sodium hypoclorite-based disinfectants (range 0.2-0.8 ppm). The water was weekly checked for the presence of bacteria (*Colibacilluses* < 20 colonies/100 ml), pH was kept between 7.6 and 7.8 and water temperature oscillated, according to the season, between 13 and 27 °C.

Data collection and Analysis. Mother-calf pair and the aunt were constantly observed from birth to 52 weeks of age (i.e. from May 1995 to May 1996) in order to monitor maternal and allomaternal relationships in controlled conditions.
"Focal animal sampling" (Altmann, 1974) observational sessions lasting 30 minutes were carried out for the calf according to a decreasing temporal scheduling (from week 1 to week 26: 4 sessions/2 times a week; from week 27 to week 52: 4 sessions/1 time a week). Sessions were randomly distributed in four time periods lasting three hours (from 08:00am to 08:00pm) and counterbalanced in order to equate, as much as possible, the representation of the different days (within each week) and of the different times of day (within each day).
A list of behavioural categories was first set up and then used for the systematic observations. Two main groups were selected from the catalogue and analyzed for this specific study: locomotory behaviour and interactions. While the first one included 10 behavioural patterns of relatively long duration (TAB. 2), the second one was characterized by 5 short time behaviours mainly related to touches (TAB. 3).
The following parameters were scored for the calf, by means of a video camera and a specific computer program for behavioural studies (Observer 3.0; Noldus, 1997):

a) hourly mean duration of locomotory behaviours (mainly swimming) with the mother, or the aunt, or both, or alone;
b) hourly mean frequency of interactions (mainly contacts) with the mother or the aunt; the indication of the calf's active/passive situation and the part of the body involved in the contact were also measured. In this respect, **active state** indicates a condition in which the calf clearly approaches the mother or the aunt to begin interacting (i.e. given contacts), and **passive state** is referred to a situation in which the calf is clearly approached by the mother or the aunt to undergo the interaction (i.e. received contacts).

Mean duration and frequencies were analysed by Student's *t*-test for correlated measures.

RESULTS. A total number of 312 sessions, corresponding to 156 hours of observation, was recorded. A typical formation with the calf kept in a central position between mother's and aunt's sides was observed immediately after birth, and this close association in locomotory behaviour was maintained particularly over the next four months ($p<0.05$) (see FIG. 1). Moreover, the aunt seemed to show a babysitting function - remaining with the young during the absence of the mother - particularly during the first month, while this close proximity was maintained at lower level over the following months. Finally, the calf association in swimming with its mother only showed a non-monotonic trend, with two maximum values reached at the fifth and tenth month, while a constant increasing in time spent in locomotory behaviour alone was seen. Significant changes in the time spent in each association were observed comparing the first six months of the calf's life with the next months of the studied period (see FIGs. 2a and 2b).
Contact behaviours were the most frequent interaction seen (78%). In fact, the calf showed an higher frequency of given (**active state**) and received (**passive state**) contacts with the

aunt during the first month ($p<0.05$), reaching very low levels after the second one until the end of the studied year (see FIGs. 3a and 3b). Both given and received contacts with the mother increased after the first month until the forth, declined over the following four months and raised again during the last three ($p<0.05$). Behavioural patterns including yielded touches through pectoral fins and received contacts on the trunk were the most frequent calf's interactions seen during all the studied period [see Tab. 4 (active state) and 5 (passive state) for details on hourly mean frequency of calf's contacts involving different body portions with the mother and the aunt].

DISCUSSION. The aunt role of the unrelated female was clear since the first stage of calf's life. In fact, Beta's babysitting function in swimming and providing assistance with the infant was particularly evident during the mother's leavings. The cares of another's young by the inexperienced female and the apparent benefit of such behaviour, points to allomothering as a prerequisite for successfully raising its own future offspring due to the fact that first time mother are initially inept at handling calves, but gradually gain competence in maternal skills with maturity and experience (Hrdy, 1976). One important point of this "learning to mother" argument is the existence of a disparity in maternal competence between primiparous and multiparous mothers which may be lessened by aunting experiences prior to motherhood. Interactions between infants and individuals other than mother undoubtedly represent a complex phenomenon and the hypothesis concerning the function and the evolution of infant handling are even more numerous the terms to which this phenomenon has been referred (see Tab. 1 in Mastripieri, 1994).
The Beta's care-giving "training" activity seemed to be particularly relevant during the first month of the calf's life, as also documented by the high frequency of aunt-infant contact behaviours. Touch signals can be varied in many ways to increase their information content, including how produced, where touched, and the intensity of contact (Herman & Tavolga, 1980). Extensive contact with pectorals, flukes or trunk during affiliative relationships is common among dolphins, giving evidence of strong social bonding between the mother-calf and aunt-calf pairs, which may be in part developed and maintained through touch. In addition, the apparent variation in the occurrence of mother's and aunt's cares, suggests that individual differences may play a role in the quality of "sitting" but this is a difficult topic on which to gather information. Nevertheless, distinctive features of mother-calf and aunt-calf interactions were observed and different spatial location in their occurrence were recorded. In fact, the young animal maintained a position at the aunt's side never showing some typical mother-calf actions (e.g. swim beneath the mother, bump the mammary area with the top of the head, attempt to suckle), suggesting the development of a specific differential recognition made by the calf.
The aunt female gave birth to its first own calf on June 1997. A parallel study is going on, in order to verify if the benefits of altruistic behaviours (Hamilton, 1963; Trivers, 1971; Connor & Norris, 1982), such as alloparental care and babysitting, may have been instrumental in the evolution of sociality in female bottlenose dolphins in a situation where it has the opportunity to receive a future increase of fitness via reciprocity. Preliminary data seems to confirm the Hrdy (1976) hypothesis of babysitting as a way to gain experience ("learning to mother") for the primiparous animal (Beta) since the older and experienced female (Alfa) did not show an evident babysitting function. This captivity observation suggests a possible environmental influence in the occurrence and development of allomaternal behaviour since in the wild the aunt role is often played by experienced females (Norris & Pryor, 1991)

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REFERENCES

Altmann, J. 1974. Observational study of behavior: Sampling methods. *Behaviour* **49**: 227-267.

Axelrod, R. & Hamilton, W.D. 1981. The evolution of social cooperation. *Science* **211**: 1390-1396.

Caldwell, D.K. & Caldwell, M.C. 1964. Experimental studies on factors involved in care-giving behaviour in three species of the cetacean family Delphinidae. *Bulletin of the Southern California Academy of Sciences* **63**: 1-19.

Caldwell, D.K. & Caldwell, M.C. 1966. Epimeletic (care-giving) behavior in Cetacea. In *Whales, Dolphins and Porpoises* (K.S. Norris ed.) Univ.of California Press. Berkley, pp. 755-789

Connor, R.C. & Norris, K.S. 1982. Are dolphins reciprocal altruist? *American Naturalist* **119**: 358-374.

Gould, L. 1992. Alloparental Care in Free-Ranging *Lemur catta* at Berenty Reserve, Madagascar. *Folia Primatologica* **58**: 72-83.

Hamilton, W.D. 1963. The evolution of altruistic behavior. *American Naturalist* **97**: 354-356.

Hrdy, S.B. (1976). Care and exploitation of nonhuman primate infants by conspecifics other than the mother. In *Advanced in the study of behavior* (Rosenblatt J.S., Hinde R.A., Shaw E. & Bier C, eds.). Academic Press, New York, Vol 6: 101-158.

Herman, L.M. & Tavolga, W.N. 1980. The communication systems of Cetaceans. In *Cetacean Behavior: Mechanisms and Functions* (L.M. Herman, ed.), J. Whiley and sons, New York, pp. 148-209.

Herzing D. L. 1995. An ethogram of underwater behaviours of the Atlantic Spotted Dolphins (*Stenella frontalis*). Behavioral Ethogram Workshop, 9th European Cetacean Society Annual Conference, Lugano February 9-11.

Mann J. & Smuts B.B. 1998. Natal attraction: allomaternal care and mother-infant separations in wild bottlenose dolphins. *Anim. Behav.* **55:** 1097-1113.

Mastripieri D. 1994. Social structure, infant handling and mothering styles in group-living old world monkeys. *Int. J. Primatol.* **15(4):** 531-553.

Maynard Smith, J. 1964. Group Selection and Kin-Selection. *Nature* **14**: 1145-1147.

Nelson D. L. & Lien J. 1994. Behaviour patterns of two captive Atlantic white-sided dolphins, *Lagenorhynchus acutus*. *Aquatic Mammals* **(20)1:** 1-10.

Norris, K.S. & Pryor, K. 1991. Some Throughts on Grandmothers. In *Dolphin societies: Discoveries and Puzzles* (K.S. Norris & K. Pryor, eds.), Berkeley: University of California Press, pp. 287-289.

Norris K. S., Wursig B., Wells R. S. 1994. Aerial Behavior. In *The Hawaiian Spinner Dolphin*. (Norris K. S., Wursig B., Wells R. S., Wursig M., eds), Univ. of California Press, Berkeley and Los Angeles, pp.103-121

Quiatt, B. 1979. Aunts and Mothers: adaptative implications of allomaternal behavior of nonhuman primates. *American Anthropologist* **81**: 310-319.

Renjun L., Gewalt W., Neurohr B. & Winkler A. 1994. Comparative studies on the behaviour of *Inia geoffrensis* and *Lipotes vexillifer* in artificial environments. *Aquatic Mammals* **20(1):** 39-45.

Riedman, M.L. 1982. The evolution of Alloparental Care and Adoption in mammals and birds. *The Quarterly Review of Behavior* **57(4):** 405-435.

Sobel N., Supin A. Ya. & Myslobodsky 1994. Rotational swimming tendencies in the dolphin (*Tursiops truncatus*). *Behavioural Brain Research* **65:** 41-45.

Stanford, C. B. 1992. Costs and benefits of allomathering in wild capped langurs (*Presbytis pileata*). *Behavioral Ecology Sociobiology* **30**: 29-34.

Tavolga, M.C. 1966. Behavior of bottlenose dolphins (*Tursiops truncatus*): social interaction in a captive colony. In *Whales, Dolphins and Porpoises* (K.S. Norris ed.) Univ.of California Press. Berkley, pp.718-730.

Trivers, R.L. 1971. The evolution of reciprocal altruism. *The Quarterly Rewiev of Biology* **46**: 35-57.

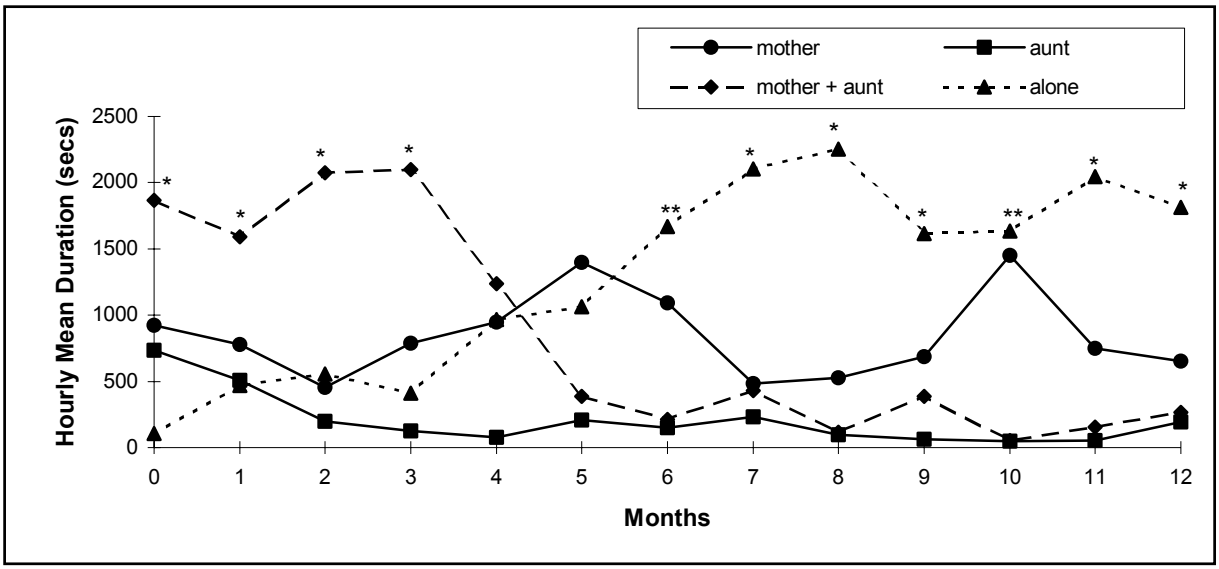
Whitehead, H. 1996. Baby-sitting , dive sinchronicity and indication of alloparental care in Sperm Whale. *Behavioral Ecology and Sociobiology* **38(4):** 237-244.

TAB. 2. LOCOMOTORY/RESTING BEHAVIOURS

CATEGORY	CODE	TYPE	DESCRIPTION	REFERENCE
swim normal posture	SNR	state	The usual mode of swimming or normal swimming posture	Renjun L., Gewalt W., Neurohr B. & Winkler A. (1994), Aq. Mamm. 20(1), 39-45
swim b-up	SBU	state	Dolphin is swimming inverted	Herzing D. L. (1995), 9th European Cetacean Society annual Conference, Lugano February 9-11.
swim left side/ swim right side	SLS-SRS	state	The dolphin swam on its side	Nelson D. L. & Lien J. (1994), Aq. Mamm. (20)1, 1-10
swim random	SRD	state	Random swimming	Sobel N., Supin A. Ya. & Myslobodsky (1994), Behav. Brain Res. 65, 41-45
exploratory behaviour	EXP	state	Scanning horizontal/perpendicular to the bottom	Herzing D. L. (1995), 9th European Cetacean Society annual Conference, Lugano February 9-11.
bottom rub	BTR	state	Dolphin is rubbing side/ventral, back area on bottom	Herzing D. L. (1995), 9th European Cetacean Society annual Conference, Lugano February 9-11.
bottom lying	BTL	state	Dolphin is lying on bottom, motionless	Herzing D. L. (1995), 9th European Cetacean Society annual Conference, Lugano February 9-11.
vertical stand	VST	state	Dolphin hangs vertically, head towards bottom/surface	Herzing D. L. (1995), 9th European Cetacean Society annual Conference, Lugano February 9-11.
rest	RST	state	The animals floated at the surface of the water without any body movements, the blowhole only was exposed to the air, the breathing frequency was reduced and the small eyes appeared to be closed	Renjun L., Gewalt W., Neurohr B. & Winkler A. (1994), Aq. Mamm. 20(1), 39-45
fluke out	FKO	state	Dolphin may literally surface vertically tail-first, thrusting the tail stock and flukes into the air before subsiding again. Dolphins may emerge to the level of the umbilicus and hold still or wriggle the tail in the air for up to 8 sec	Norris K. S., Wursig B. & Wells R. S. (1994), in The Hawaiian Spinner Dolphin. Univ. of California Press, Berkeley and Los Angeles, pp.103-121

TAB. 3. INTERACTIONS

CATEGORY	CODE	TYPE	DESCRIPTION	REFERENCE
bonding	BND	state	One dolphin swims pec to body with another	Herzing D. L. (1995), 9th European Cetacean Society annual Conference, Lugano February 9-11.
push	PUS	state	One dolphin pushes another with rostrum	Herzing D. L. (1995), 9th European Cetacean Society annual Conference, Lugano February 9-11.
rubbing	RUB	event	One dolphin is rubbing ventral area, flank, head or pectoral fin of another dolphin with pectoral fin	Herzing D. L. (1995), 9th European Cetacean Society annual Conference, Lugano February 9-11.
contact	CNT	event	Any behaviour which involved physical contact between two animals; a "bout" of interaction began when one dolphin touched the other and continued until they moved greater than one body length apart	Nelson D. L. & Lien J. (1994), Aq. Mamm. (20)1, 1-10
chase	CHS	state	One dolphin, or group of dolphins chasing each other in fast, medium, or slow chase	Herzing D. L. (1995), 9th European Cetacean Society annual Conference, Lugano February 9-11.



* p<0.05 vs "mother", "aunt" and "alone"
** p<0.05 vs "mother+aunt" and "aunt"

FIG. 1. Hourly mean duration of calf's association with the mother, the aunt, both or alone during locomotory behaviours.

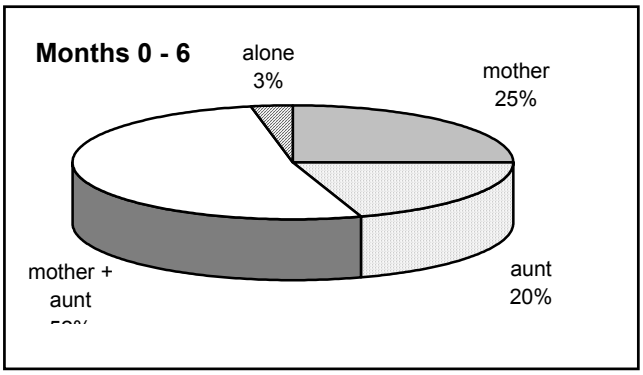


FIG. 2a. Time spent by the calf in locomotory behaviours in association with the mother, the aunt, both or alone (months 0 - 6).

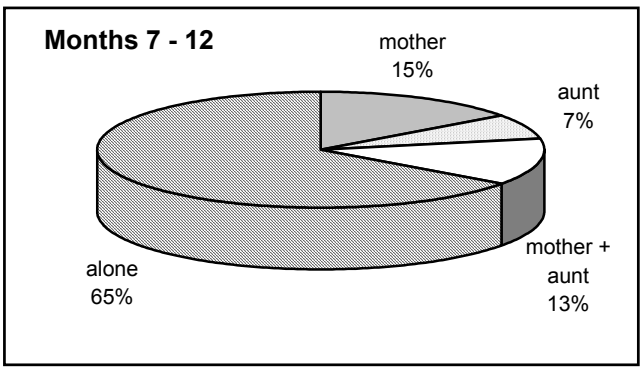


FIG. 2b. Time spent by the calf in locomotory behaviours in association with the mother, the aunt, both or alone (months 7 - 12).

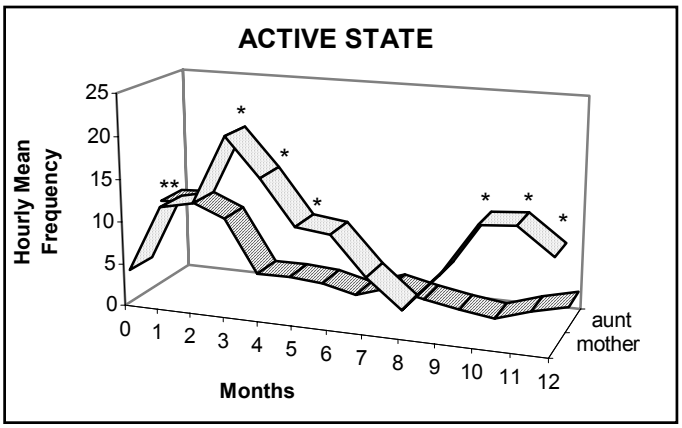


FIG. 3a. Hourly mean frequency of calf's contact behaviours (**active state**) with the mother and the aunt.

* p<0.05 "mother" vs "aunt"
** p<0.05 "aunt" vs "mother"

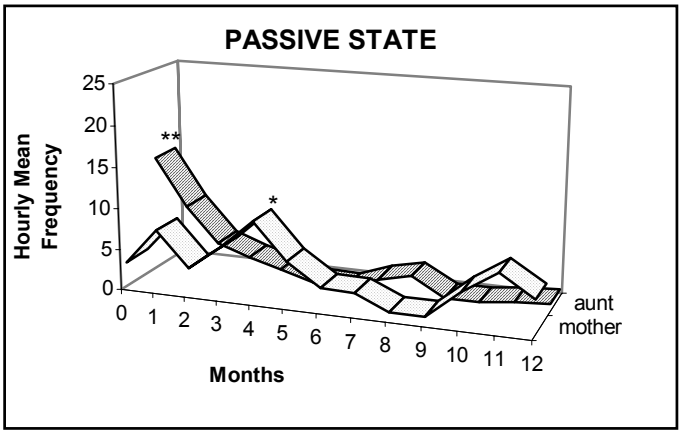


FIG. 3b. Hourly mean frequency of calf's contact behaviours (**passive state**) with the mother and the aunt.

* p<0.05 "mother" vs "aunt"
** p<0.05 "aunt" vs "mother"

TAB. 4. Hourly mean frequency of calf's given (active state) contact behaviours related to the mother and the aunt body portions

MONTHS	HEAD		BACK		SIDE		BELLY		PECT FINS		DORS FINS		TAIL	
	MOTHER	AUNT	MOTHER	AUNT	MOTHER	AUNT	MOTHER	AUNT	MOTHER	AUNT	MOTHER	AUNT	MOTHER	AUNT
0	0,87	1,48	0,78	0,26	0,26	1,74	0,00	0,17	1,74	5,91*	0,00	0,00	0,17	0,26
1	2,73	1,53	2,60	0,13	0,73	1,13	0,47	0,13	3,60	7,07*	0,80	0,07	1,33	0,20
2	2,36	1,07	2,29	0,43	1,07	0,93	0,50	0,21	4,93	5,36	0,71	0,00	0,36	0,07
3	4,71*	0,21	5,21*	0,07	1,29	0,14	0,64	0,00	6,36*	1,71	2,00*	0,00	0,21	0,07
4	3,79*	0,29	4,64*	0,21	1,21	0,14	0,79	0,00	4,29*	1,64	0,93	0,00	0,93	0,00
5	2,43	0,07	1,71	0,07	0,93	0,21	0,43	0,07	4,79*	1,50	0,71	0,00	0,07	0,07
6	3,30*	0,40	0,90	0,10	0,90	0,10	0,70	0,20	3,30*	0,20	0,30	0,00	0,20	0,00
7	0,67	0,33	2,00*	0,00	1,17	0,33	0,00	0,17	1,83	1,00	0,17	0,00	0,50	0,17
8	0,71	0,14	0,86	0,14	0,43	0,43	0,00	0,00	0,71	0,71	0,14	0,00	0,00	0,00
9	2,43*	0,00	1,14	0,00	0,57	0,14	0,29	0,00	2,14	0,43	0,29	0,00	0,00	0,00
10	2,00	0,17	2,83*	0,00	1,00	0,00	0,17	0,00	2,00*	0,00	0,17	0,00	0,33	0,00
11	1,83	0,33	0,83	0,00	1,17	0,17	0,33	0,00	2,70	1,00	0,50	0,00	0,67	0,00
12	1,20	0,67	2,53	0,40	1,87	0,53	1,60	0,00	2,27	2,00	0,00	0,00	1,07	1,07

* p<0.05

TAB. 5. Hourly mean frequency of calf's received (passive state) contact behaviours related to the mother and aunt body portions.

MONTHS	HEAD		BACK		SIDE		BELLY		PECT FINS		DORS FINS		TAIL	
	MOTHER	AUNT	MOTHER	AUNT	MOTHER	AUNT	MOTHER	AUNT	MOTHER	AUNT	MOTHER	AUNT	MOTHER	AUNT
0	0,26	0,96	0,52	1,30	0,87	4,87	0,96	4,35*	0,00	0,87	0,00	0,00	0,26	1,65
1	1,80	1,20	0,80	1,27	2,07	1,13	1,73	1,00	0,33	1,13	0,27	0,27	0,80	0,73
2	0,64	0,71	0,43	0,57	1,07	1,36	0,50	0,43	0,29	0,29	0,00	0,07	0,21	0,36
3	1,29	0,14	0,29	0,14	2,00	0,64	0,93	0,57	0,93	0,14	0,07	0,00	0,50	0,50
4	1,36	0,07	1,29	0,00	2,71	0,71	2,14*	0,29	0,64	0,14	0,21	0,07	1,21	0,00
5	0,93	0,00	0,57	0,00	2,00*	0,07	1,14	0,00	0,43	0,00	0,21	0,07	0,29	0,00
6	0,30	0,10	0,70	0,00	0,80	0,00	0,40	0,00	0,20	0,00	0,20	0,00	0,20	0,00
7	0,33	0,17	0,17	0,17	0,33	0,67	0,50	0,00	0,17	0,17	0,17	0,00	0,67	0,17
8	0,14	0,57	0,14	0,14	0,29	0,43	0,29	0,00	0,14	0,00	0,00	0,00	0,00	1,00
9	0,14	0,00	0,43	0,00	0,14	0,14	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
10	0,33	0,00	0,50	0,00	1,50	0,00	0,50	0,00	0,00	0,17	0,00	0,00	0,67	0,00
11	1,67	0,17	0,83	0,17	1,33	0,00	2,00	0,17	0,00	0,00	0,00	0,00	1,00	0,17
12	0,53	0,00	0,40	0,00	1,47	0,40	1,07	0,00	0,13	0,00	0,00	0,00	0,27	0,00

* $p<0.05$