

# PREGNANCY IN BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*): BEHAVIOURAL AND RESPIRATORY ASPECTS

R. Tizzi<sup>1,3</sup>, M. Gabaldo<sup>2</sup> and D. S. Pace<sup>3</sup>

<sup>1</sup>*Delphinario Rimini, Lungomare Tintori 2, 47900 Rimini, Italy (raftizzi@tin.it)*

<sup>2</sup>*Dip. Biologia Evoluzionistica Sperimentale, Università degli Studi di Bologna, 40131 Bologna, Italy*

<sup>3</sup>*OCEANOMARE, Via delle Gondole 109, 00121 Roma, Italy (dp Pace@telethon.it)*

**INTRODUCTION** Since 1995, a behavioural research program on pregnancy and mother-calf relationship in bottlenose dolphin has been conducted in the Rimini Delphinarium, Italy.

Given that detailed quantitative behavioural aspects of gestation and parturition in dolphins have been rarely described in reproductive reports, the objective of this study was to systematically investigate behavioural patterns and respiratory activity during the last quarter of pregnancy, in order to assess specific trends while approaching parturition.

**METHODS** Subject of the study was “BETA”, a pregnant female of bottlenose dolphins (*Tursiops truncatus*), 16 years old, who gave birth her first calf in the Rimini Delphinarium on June 26<sup>th</sup>, 1997. She was housed in the same pool with other two wild adults (a male and a female) and two captive born calves (a male and a female).

A specific ethogram including 52 different displays organized into five main categories (Locomotion & Postural, Social, Play, Aerial Behaviour and Bubbles) was first set up and then used for the data collection. Focal animal (Altmann, 1974) sessions lasting 30 minutes were carried out to systematically monitorize the patterns during last quarter of gestation. Total and weekly frequency and duration were scored by means of a videocamera and Observer 3.0 software. Respiratory rates [“Dive times” and “Roll intervals” as defined by Watson and Gaskin (1983)] were also collected during dedicated sessions lasting 15 minutes each. Both behavioural and respiratory observations were randomized among 3-hr periods and balanced for equal representation within a week and at different times of the day (observational phase: from 08:00am to 08:00 pm). Data were analyzed by mixed-model factorial ANOVA.

**RESULTS AND DISCUSSION** A total number of 92 h of behavioural observations (corresponding to 184 sessions) and 24 h of respiratory monitoring activity (corresponding to 96 sessions) were performed over the study period.

“Locomotion & Postural” patterns were the most relevant activities seen, both in frequency (81.6%) and duration (97.3%) (Fig. 1). “Social” displays were also considerably represented (frequency=10.7%; duration=2.5%) as well as “Bubbles” (frequency=6.6%). As for behavioural categories weekly trend (Fig. 2), significant variations within “Social” ( $F=3,10$ ;  $df=11$ ;  $P<0.0001$ ) and “Bubbles” ( $F=2,80$ ;  $df=11$ ;  $P<0.0057$ ) groups were seen, both showing a steadily decrease during the last four weeks of pregnancy. According to McBride and Kriztler (1951) this result could be related to the tendency of the pregnant female of withdrawing from association with other animals as term of delivery approach.

The total frequency and duration of behavioural displays is presented in Table 1. Among “Locomotion & Postural” category, “swim normal” display was highly exhibited by the studied subject (total duration > 70%) as a possible result of her segregation during the last four weeks of pregnancy (see Fig. 1). However, the isolation showed by BETA did not exclude the manifestation of some remarkable “Social” displays such as “contact”, “chase” and “body slam”. As reported by Kinoshita *et al.* (1999) and Joseph *et al.* (1999), these behavioural aspects are typically displayed in nervousness and discomfort contexts related to gestation. Furthermore, the last week of pregnancy was characterised by an expected and impressive increase of “flexion” and “ventral arch”, confirming both the trouble state of the female and the parturition approach (Tavolga and Essapian, 1957; Krames and Krames, 1996). Finally, as already reported by Kinoshita *et al.* (1999), our data confirmed that aerial behaviours such as “breacking” were clearly related to delivery in light of its peak few days before parturition.

As for respiratory activity weekly trend (Fig. 3), the subject showed clear changes in rates ( $F=1,70$ ;  $df=91$ ;  $P<0.0001$ ), whose mean apneustic plateau values increase from 26-28 secs up to 33-35 secs during the last three weeks before delivery. This result seems to be similar to what described by Joseph *et al.* (1999), even if they just reported a general no quantified “irregular breathing” related to the parturition.

The high mean values showed during the last three weeks before parturition appeared to be connected with the slow “swim normal” activity seen. In fact, the female seems to save energy in her movements in order to maintain both cardiac and respiratory rhythm similar to the level recorded during rest (see Williams *et al.*, 1992 for details).

**CONCLUSIONS** It is readily apparent that a considerable percentage of *Tursiops truncatus* pregnancies fail to produce a live calf (Van Bonn, 1999). Moreover, since captive studies on pregnancy seem mainly focused on both physiological and veterinarian reports, a better understanding of the behavioural aspects of gestation - as those described in this work - could possibly drive to a multidisciplinary approach addressed to find out the highest risks of loss of births.

Finally, learning about specific periods of the pregnancy could improve our knowledge on the reproductive behaviour of dolphins females, as well as mother-calf interaction, which is crucial to develop useful models of social evolution, socio-ecology, social behaviour, or population dynamics (Whitehead and Mann, 2000).

**ACKNOWLEDGMENTS** We thank the owners and trainers of the Rimini’s Delphinarium. Special thanks to Cristiana Balducci, Tiziana Chieruzzi and Alexandre Castellano for their help in collecting data.

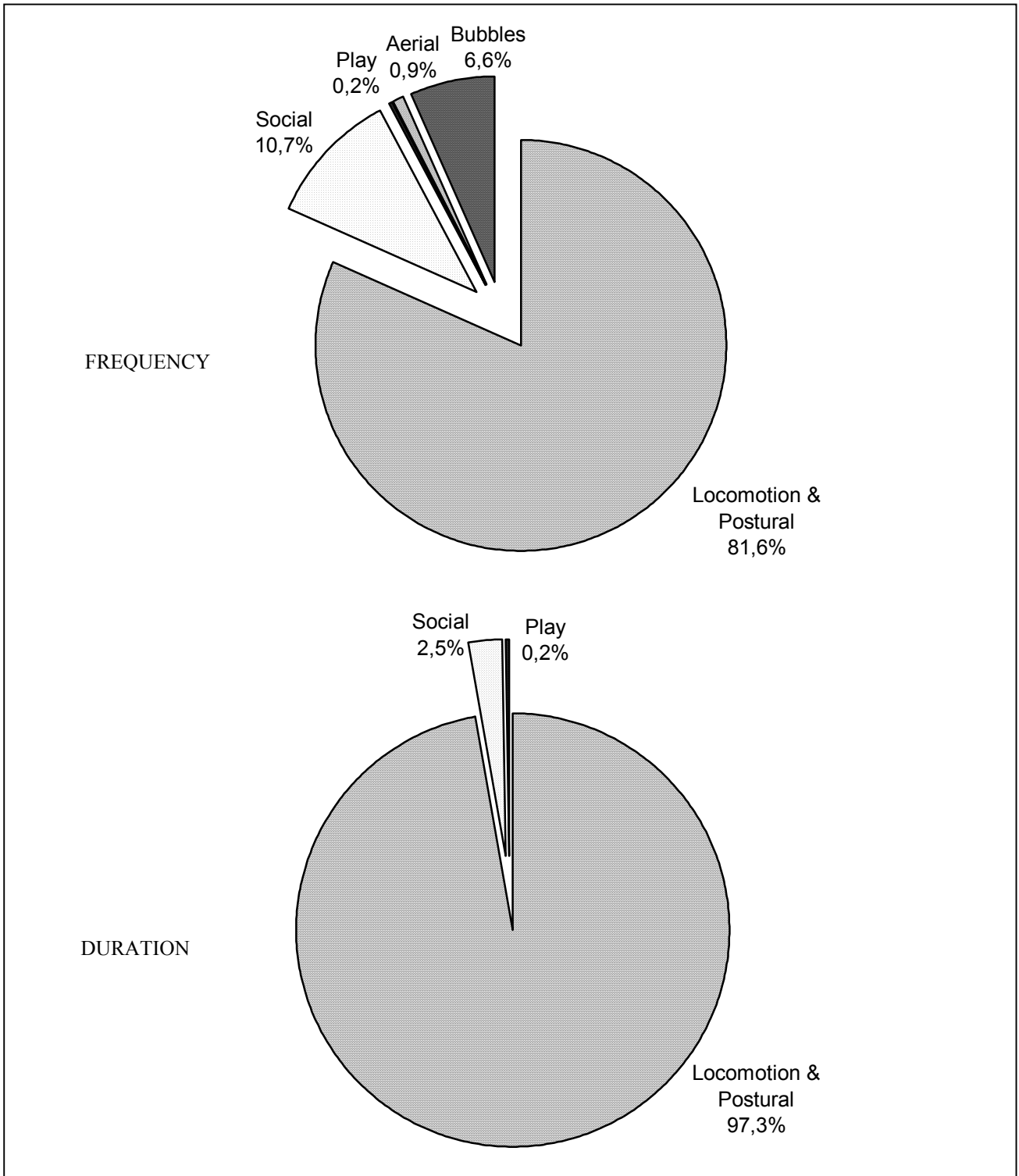
## REFERENCES

- Altmann, J. 1974. Observational study of behavior: sampling methods. *Behaviour*, 49: 227-265.
- Anonimous at Monkey Mia, Australia 1995. Ethogram. *Workshop on Behavioural Ethograms*, 9<sup>th</sup> ECS Ann. Conf, 8 February 1995, Lugano.
- Joseph, B., Duffield, D. and Robeck T. 1999. Summary data on reproduction of bottlenose dolphins in controlled environment. Pp. 42-56. In *Bottlenose Dolphin Reproduction Workshop*, San Diego, California, 3-6 June 1999 (Eds. D. Duffield and T. Robeck). 376pp.
- Herzing, D. L. 1996. An ethogram of underwater behaviors of the Atlantic Spotted dolphin, *Stenella frontalis*. Pp. 60-61. In *European Research on Cetaceans*, Proc. 9<sup>th</sup> Ann. Conf. ECS, Lugano, 9-11 February 1995 (Eds. P. G. H. Evans and H. Nice). 226pp.
- Kinoshita, R., Rayner, C. and Brook, F. 1999. A managed reproduction program for *Tursiops truncatus aduncus*. Pp. 16-26. In *Bottlenose Dolphin Reproduction Workshop*, San Diego, California, 3-6 June 1999 (Eds. D. Duffield and T. Robeck). 376pp.
- Krames, B. and Krames, J. 1996. Pre-natal care and post-natal observation of four *Tursiops truncatus* first-time mothers. *Mar. Mamm.*, 2(1): 10-23.
- Martinez, D. R. and Klinghammer, E. 1995. Partial ethogram of the killer whale (*Orcinus orca*, L.). *Workshop on Behavioural Ethograms*, 9<sup>th</sup> ECS Ann. Conf, 8 February 1995, Lugano.
- McBride, A. F. and Krizler, H. 1951. Observations on pregnancy, parturition and post-natal behavior in the bottlenose dolphin. *J. Mammal.*, 32: 251-256.
- Nelson, D. L. and Lien, J. 1994. Behaviour patterns of two captive Atlantic white-sided dolphins, *Lagenorhynchus acutus*. *Aq. Mamm.*, 20(1): 1-10.
- Norris, K. N., Würsig, B., Wells, R. S. and Würsig M. 1994. The Hawaiian Spinner Dolphin. Univ. of Calif. Press, Berkley. 408pp.
- Pace, D. S. 2000. Fluke-made bubble rings as toys in bottlenose dolphin calves (*Tursiops truncatus*). *Aq. Mamm.*, 26(1): 57-64.
- Pilleri, G. 1986. Ecology and behaviour of the Narwhal. Pp. 131-138. In *Investigation on Cetacea*, Switzerland (Eds. G. Pilleri).

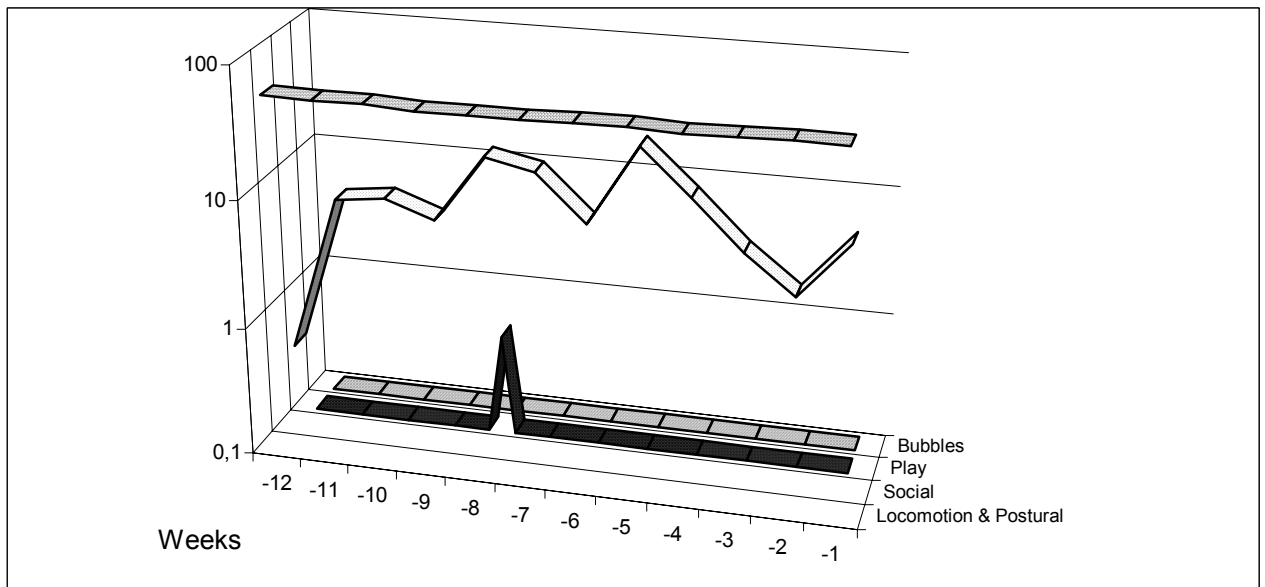
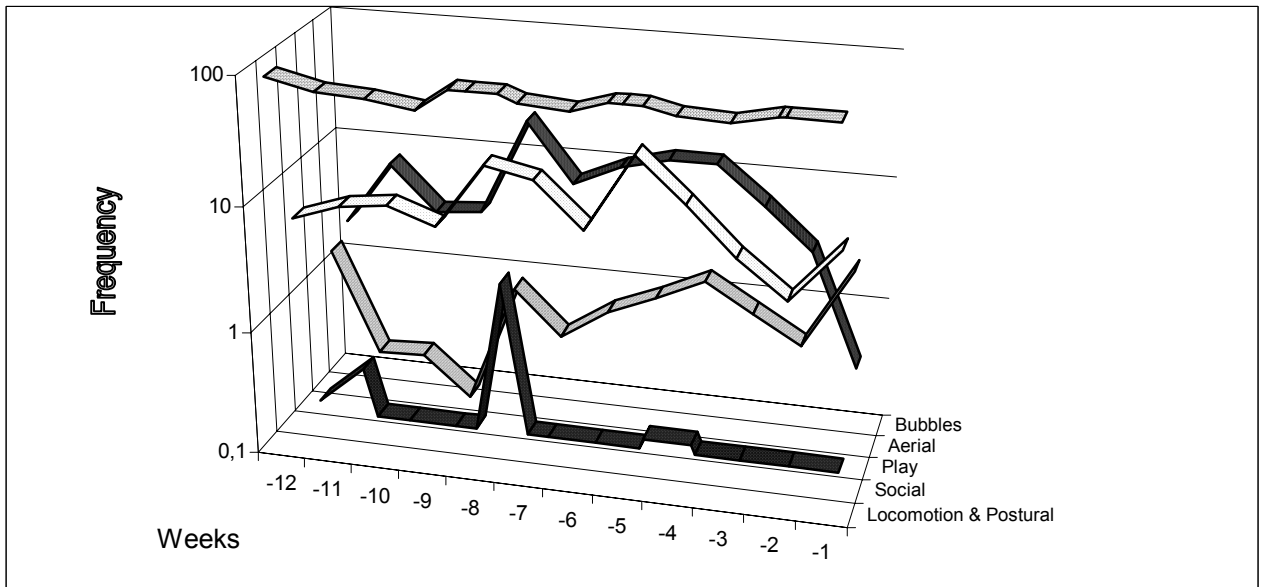
- Renjun, L., Gewalt, W., Neurohr, B. and Winkler, A. 1994. Comparative studies on the behaviour of *Inia geoffrensis* and *Lipotes vexillifer* in artificial environments. *Aq. Mamm.*, 20(1): 39-45.
- Saayman, G. S., Tayler, C. K. and Bower, D. 1973. Diurnal activity cycles in captive and free-ranging Indian Ocean Bottlenose Dolphin (*Tursiops aduncus ehrenburg*). *Behav.*, 44: 212-233.
- Shane, S. H. 1990. Behaviour and ecology of bottlenose dolphin at Sanibel Island, Florida. Pp. 245-265. In *The Bottlenose Dolphin*, San Diego, Academic Press (Eds. S. Leatherwood and R. R. Reeves). 653pp.
- Sobel, N., supin, A. Ya. And Myslobodsky, M. S. 1994. Rotational swimming tendencies in the dolphin (*Tursiops truncatus*). *Behav. Brain Res.*, 65:41-45.
- Tavolga, M. and Essapian, F. S. 1957. The behavior of the Bottlenose dolphin (*Tursiops truncatus*): mating, pregnancy, parturition and mother-infant behavior. *Zool.*, 42(2): 11-31.
- Tizzi, R. 1995. Comportamento di due coppie madre-piccolo in *Tursiops truncatus* (Cetacea, Odontoceta): studio comparativo durante il primo anno di vita in condizioni di cattività. Unpublished Thesis, University of Bologna, Italy.
- Van Bonn, W. 1999. Infectious diseases and late term abortions. Pp. 279-287. In *Bottlenose Dolphin Reproduction Workshop*, San Diego, California, 3-6 June 1999 (Eds. D. Duffield and T. Robeck). 376pp.
- von Streit, C. and von Fersen, L. 1996. Mother-calf relationship and behavioural development of two newborn bottlenose dolphins (*Tursiops truncatus*). Pp. 195-198. In *European Research on Cetaceans*, Proc. 9<sup>th</sup> Ann. Conf. ECS, Lugano, 9-11 February 1995 (Eds. P. G. H. Evans and H. Nice). 226pp.
- Watson, A. P. and Gaskin, D. E. 1983. Observation on the ventilation cycle of the harbour porpoise *Phocoena phocoena* in coastal waters of the Bay of Fundy. *Can. J. Zool.*, 61: 126-132.
- Whitehead, H. and Mann, J. 2000. Female reproductive strategies of cetaceans. Pp. 219-246. In *Cetacean Societies* (Eds. J. Mann, R. C. Connor, P. L. Tyack and H. Whitehead). The University of Chicago Press, Chicago and London. 433pp.
- Williams, T. M., Friedl, W. A., Fong, M. L., Yamada, R. M., Sedivy, P. and Haun, J. E. 1992. Travel at low energetic cost by swimming and wave-riding Bottlenose Dolphin. *Nature*, 355:821-823.

**Table 1.** Behavioural Displays - Total Frequency and Duration

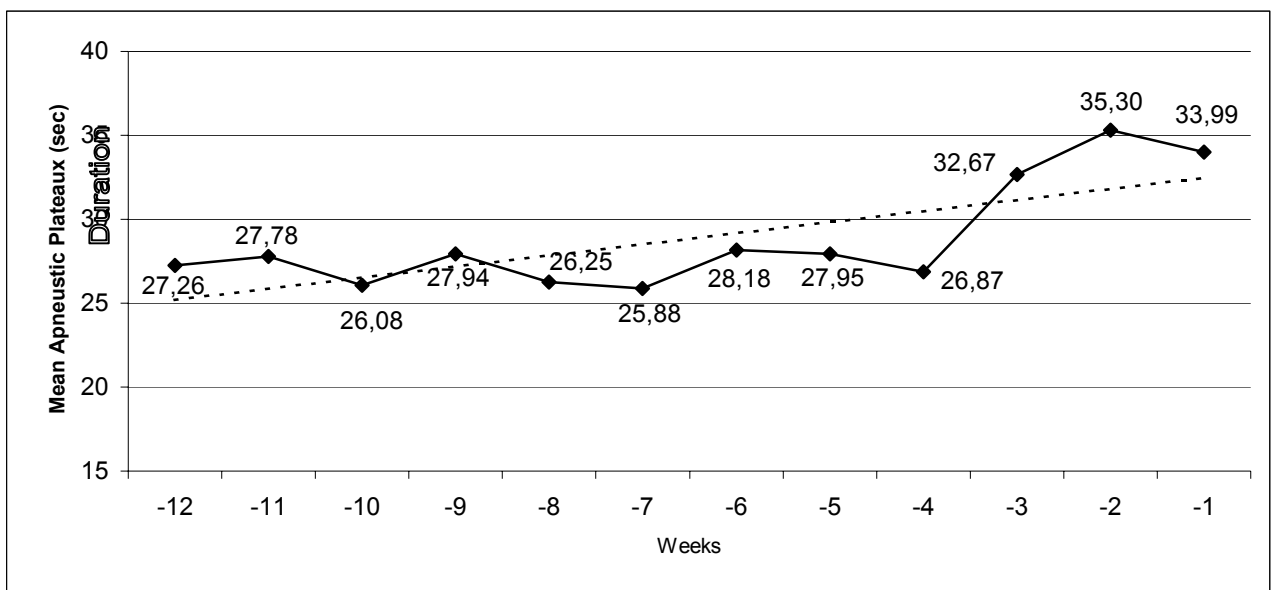
| DEFINITION AND REFERENCE                                  | FREQUENCY        |                  | DURATION         |                  |
|---|------------------|------------------|------------------|------------------|
|   | % total ethogram | % intra-category | % total ethogram | % intra-category |
| <b>LOCOMOTION &amp; POSTURAL</b>                          | <b>81,6%</b>     | <b>100%</b>      | <b>97,3%</b>     | <b>100%</b>      |
| Swim normal posture (Renjun <i>et al.</i> , 1994)         | 32,2             | 39,5             | 72,7             | 74,8             |
| Swim open mouth (Martinez and Klinghammer, 1995)          | 8,1              | 9,9              | -                | -                |
| Pool rub (Herzing, 1996)                                  | 7,4              | 9,1              | 4,2              | 4,3              |
| Rest (Renjun <i>et al.</i> , 1994)                        | 6,3              | 7,7              | 5,4              | 5,6              |
| Swim side (Nelson and Lien, 1994)                         | 5,3              | 6,5              | 2,4              | 2,5              |
| Exploratory behavior (Herzing, 1996)                      | 3,8              | 4,7              | 2,5              | 2,6              |
| Swim random (Sobel <i>et al.</i> , 1994)                  | 3,1              | 3,8              | 4,2              | 4,3              |
| Porthole stand (Tizzi, 1995)                              | 2,3              | 2,8              | 2,4              | 2,4              |
| Swim belly-up (Shane, 1990)                               | 1,8              | 2,2              | 1,4              | 1,4              |
| Shaking flipper (von Streit and von Fersen, 1996)         | 1,5              | 1,8              | -                | -                |
| Roll (Renjun, 1994)                                       | 1,4              | 1,7              | -                | -                |
| Lying (Herzing, 1996)                                     | 1,4              | 1,7              | 1,3              | 1,3              |
| Approach (Herzing, 1996)                                  | 1,4              | 1,7              | -                | -                |
| Sommersault (Anonymous at Monkey Mia, Australia 1995)     | 1,2              | 1,5              | -                | -                |
| Vertical stand (Herzing, 1996)                            | 1,1              | 1,3              | 0,8              | 0,8              |
| Flex (Tavolga and Essapian, 1957)                         | 0,8              | 0,9              | -                | -                |
| Loop (Martinez and Klinghammer, 1995)                     | 0,7              | 0,8              | -                | -                |
| Ventral arch (von Streit and von Fersen, 1996)            | 0,7              | 0,8              | -                | -                |
| Head jerk (Herzing, 1996)                                 | 0,6              | 0,8              | -                | -                |
| Spy hop (Shane, 1990)                                     | 0,4              | 0,6              | -                | -                |
| Dorsal arch (von Streit and von Fersen, 1996)             | 0,1              | 0,2              | -                | -                |
| Stop (Anonymous at Monkey Mia, Australia 1995)            | 0                | 0                | -                | -                |
| Jerk (Nelson and Lien, 1994)                              | 0                | 0                | -                | -                |
| Fluke out (Norris <i>et al.</i> , 1994)                   | 0                | 0                | -                | -                |
| <b>SOCIAL</b>   | <b>10,7%</b>     | <b>100%</b>      | <b>2,5%</b>      | <b>100%</b>      |
| Contact (Nelson and Lien, 1994)                           | 4,7              | 43,9             | -                | -                |
| Chase (Saayman <i>et al.</i> , 1973)                      | 1,2              | 11,3             | 1,0              | 41,6             |
| Body slam (Anonymous at Monkey Mia, Australia 1995)       | 1,2              | 11,3             | -                | -                |
| Rubbing (Tavolga and Essapian, 1957)                      | 1,0              | 9,3              | -                | -                |
| Tail hit (Anonymous at Monkey Mia, Australia 1995)        | 0,7              | 6,5              | -                | -                |
| Bonding (Anonymous at Monkey Mia, Australia 1995)         | 0,7              | 6,5              | 1,1              | 42,5             |
| Rostrum hit (Anonymous at Monkey Mia, Australia 1995)     | 0,2              | 1,9              | -                | -                |
| Push (Pilleri, 1986)                                      | 0,2              | 1,9              | 0,2              | 9,8              |
| Directed open mouth (Herzing, 1996)                       | 0,2              | 1,9              | 0,2              | 6,1              |
| Bite (Saayman <i>et al.</i> , 1973)                       | 0,2              | 1,9              | -                | -                |
| Tail slap (Shane, 1990)                                   | 0,1              | 0,9              | -                | -                |
| Nibbling (von Streit and von Fersen, 1996)                | 0,1              | 0,9              | -                | -                |
| Jaw clap (Tavolga and Essapian, 1957)                     | 0,1              | 0,9              | -                | -                |
| Squeeze (Anonymous at Monkey Mia, Australia 1995)         | 0,1              | 0,9              | -                | -                |
| Flipper slap (Shane, 1990)                                | 0                | 0                | -                | -                |
| Belly presentation (Saayman <i>et al.</i> , 1973)         | 0                | 0                | -                | -                |
| Homosexual behavior (Renjun, 1994)                        | 0                | 0                | 0                | 0                |
| Attempting mate (Anonymous at Monkey Mia, Australia 1995) | 0                | 0                | 0                | 0                |
| <b>PLAY</b>   | <b>0,2%</b>      | <b>100%</b>      | <b>0,2%</b>      | <b>100%</b>      |
| Play with objects (Renjun, 1994)                          | 0,2%             | 100%             | 0,2%             | 100%             |
| <b>AERIAL BEHAVIOUR</b>                                   | <b>0,9%</b>      | <b>100%</b>      | <b>-</b>         | <b>-</b>         |
| Breacking (Pilleri, 1986)                                 | 0,5              | 55,6             | -                | -                |
| Leap (Shane, 1990)  | 0,3              | 33,3             | -                | -                |
| Slap (Martinez and Klinghammer, 1995)                     | 0,1              | 11,1             | -                | -                |
| <b>BUBBLES</b>  | <b>6,6%</b>      | <b>100%</b>      | <b>0%</b>        | <b>100%</b>      |
| Bubble (von Streit and von Fersen, 1996)                  | 4,0              | 60,7             | -                | -                |
| Bubble stream (Anonymous at Monkey Mia, Australia 1995)   | 2,1              | 31,8             | -                | -                |
| Torus (Herzing, 1996)                                     | 0,5              | 7,6              | -                | -                |
| Bubble interest (Pace, 2000)                              | 0                | 0                | 0                | 0                |
| Bubble contact (Pace, 2000)                               | 0                | 0                | 0                | 0                |
| Tail-made bubble ring (Pace, 2000)                        | 0                | 0                | -                | -                |



**Fig. 1.** Behavioural Categories Distribution (Total Frequency and Duration)



**Fig. 2.** Behavioural Categories Weekly Trend (Hourly Frequency and Duration)



**Fig. 3.** Respiratory Activity Weekly Trend