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Observations of rest behaviours in captive bottlenose dolphins (*Tursiops truncatus*)

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Abstract

Sleep in marine mammals has been investigated mainly by Russian scientists. Mukhametov (1985) first described unihemispheric slow-wave sleep in the bottlenose dolphin (*Tursiops truncatus*). From his work, we know that dolphins never sleep with both hemispheres simultaneously and never show paradoxical (REM) sleep. During his experiments, Mukhametov determined whether the animals were in a 'unihemispheric sleep state' through EEG. During our research, we identified at least two behavioural patterns which should be considered resting behaviour. We did not look for electrical brain activity in dolphins, and our considerations are based only on visual and acoustic recordings. Nevertheless, some elements commonly associated with resting behaviour, such as partial or total reduction of movement, absence of sound production, poor attention toward the environment, are easily recognisable. However, resting behaviour should not be confused with sleep, even if resting includes sleeping episodes. We called the first resting category 'rest swimming' and the second 'rest at the surface'. It is notable that during 'rest swimming' animals tend to pair-off, slowly swimming in strong synchrony. In such a state, they typically close one eye and co-ordinate with the partner which eye is open. If they invert their position they also change which eye is open. On the contrary, during 'rest at the surface', dolphins stop swimming and float at the surface with the blowhole emerged. According to our experience, dolphins choose between these two resting solutions, depending on water movement and availability of a co-operative partner. 'Rest at the surface' was never observed in young dolphins, whereas 'rest swimming', in association with the mother, was the only resting behaviour observed.

Key words: *Tursiops*, sleep, rest, bottlenose dolphin.

Introduction

In 1964, John Lilly first observed that an important feature of sleeping behaviour in *Tursiops truncatus* was that they keep their eyelids closed alternately, so he suggested the concept of unilateral sleep in dolphins. Investigations on brain electrical activity showed that in sleeping bottlenose dolphins, EEG presents an unihemispheric slow-wave sleep (the orthodox or non-REM sleep) i.e., a state of the brain in which slow-wave EEG patterns are recorded in one hemisphere (alternately in the right or in the left), while EEG-desynchronisation (typical of the waking stage) is recorded in the other hemisphere. Apparently, there is no strict correlation between alternating which eye is open and which brain hemisphere is sleeping. The open eye performs a sentinel function, regardless of whether the controlateral or ipsilateral hemisphere of the brain is asleep or awake (Mukhametov, 1985). This is even more notable considering that a complete decussation of optic nerve fibres was demonstrated in the bottlenose dolphin (Jacobs *et al.*, 1975).

Unilateral sleep apparently arose from the dolphin's need to move constantly and breath at the surface.

It can be assumed that muscle hypotonia and hyporeflexia, which are characteristic of the normal slow-wave sleep in terrestrial mammals, are impermissible conditions for dolphins and therefore, the two hemispheres enter the state of slow-wave sleep alternately. Probably the same cause accounts for the absence of paradoxical sleep (the REM sleep). In fact, in terrestrial mammals, paradoxical sleep follows the slow-wave (othodox) stage in a sleep cycle and is accompanied by even more

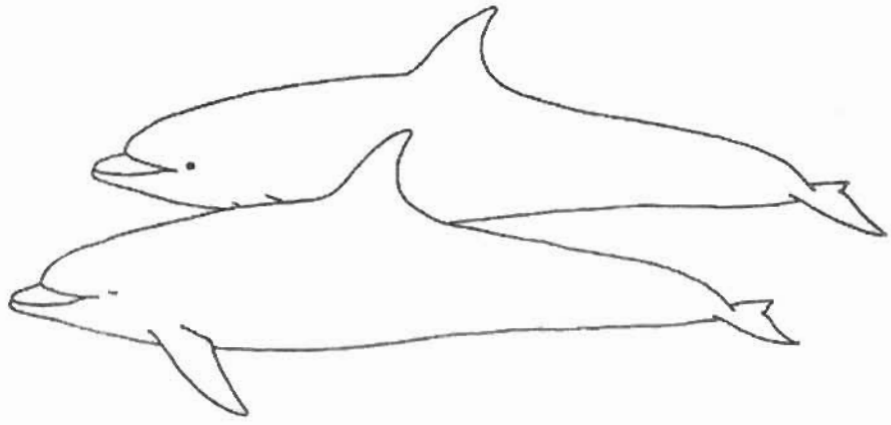

Figure 1. The side-by-side position of two adult bottlenose dolphins while rest swimming as a pair. Each individual keeps the open eye directed to the partner.

profound hypotonia and hyporeflexia. The main objective of this study was to describe two behavioural patterns which we believe should be considered as two different resting options in captive bottlenose dolphins. Some hypotheses about environmental conditions which could influence the decision of the animal in relationship to these two resting solutions are discussed.

Materials and Methods

Our presentation about sleeping and resting behaviour in the bottlenose dolphin is not the result of one single specific study, but arises from observations during various behavioural research projects with different purposes at the Genoa Aquarium.

In 1994 night observations were carried-out to foresee the delivery of a calf to 'Bonnie', a bottlenose dolphin female, by behavioural changes during the last period of the pregnancy. At that time, Bonnie was housed together with a young bottlenose male called 'Micha'. Dolphins were observed during nighttime from 00:00 to 06:00h for 7 months. For approximately 2 months, 22 June to 4 September, attention was focused on the resting behaviour of Bonnie and Micha when swimming in a pair. Since birth, the behaviour of Bonnie and her calf was monitored during the daytime for 1 year using both video and acoustic techniques. Recordings took place on Monday and Wednesday during four, 15-min. periods, starting at 09:00, 11:00, 14:00 and 17:00 h each week for the first six months and one week out of two for the second half of the first year, for a total of 76 h (Benoldi *et al.*, 1996).

In 1996–1997, a new research project was carried-out to investigate the welfare of Bonnie and Cleo, (Bonnie's daughter born in 1994). The behaviour of the two individuals was monitored during day time from 08:00 to 18:00 h through different periods of the year, for a total of about 220 h (Fognani, 1998).

Results

The description of the two different resting behaviours observed in our dolphins ('rest swimming' and 'rest at the surface') follows:

Rest swimming

During rest swimming, the dolphin swims slowly following a regular trajectory, surfacing only to breathe. The animal shows no interest toward the environment and produces no sounds. Most of the time, one eye is closed while the other performs a sentinel function. Rest swimming can be displayed by a single individual, but more often two dolphins pair-off and rest together. In this case, the two dolphins swim side-by-side and move in strong synchrony. Each one keeps one eye open while the other is closed; notably the open eye is constantly the eye directed to the partner, so that if they invert their position, they also change which eye is open (Fig. 1–2).

Since delivery occurred, the mother was observed resting only in association with the calf. The position of the calf close to the mother's body can change from the usual side-by-side position to a 'ventro-caudal' position. When resting in this formation, the mother and calf still keep only one eye open, different for each individual, so that they could look at both sides, and check each other's position with easy lateral movements. Body contacts often were observed, with the calf touching the mammary area of the mother (Fig. 3). Initially, the mother and new born spent a lot of time resting

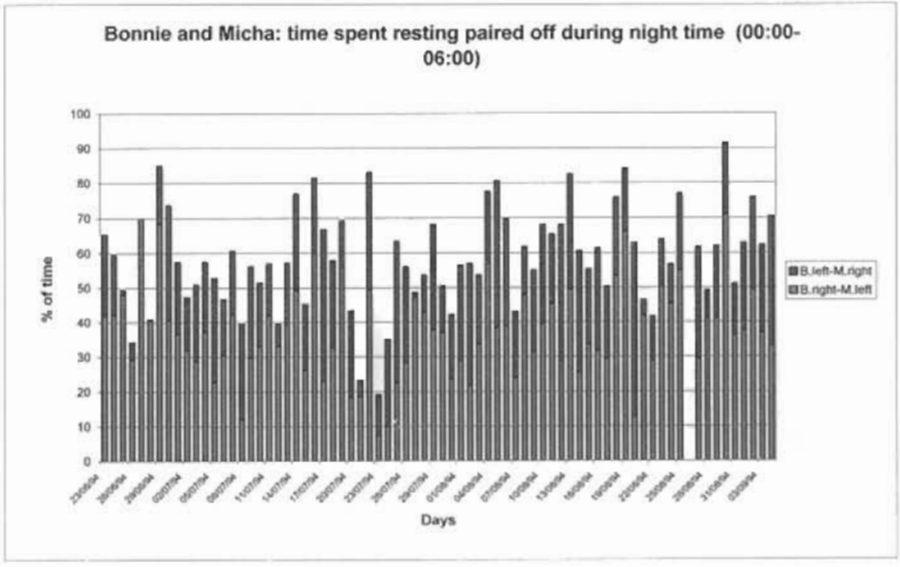

Figure 2. Percent of time Bonnie and Micha spent resting as a pair during night time observations. Both animals always had only one eye open (the interior one). The formation with Bonnie on the left and Micha on the right, was predominant ($z=7.9$; $P=0.01$).

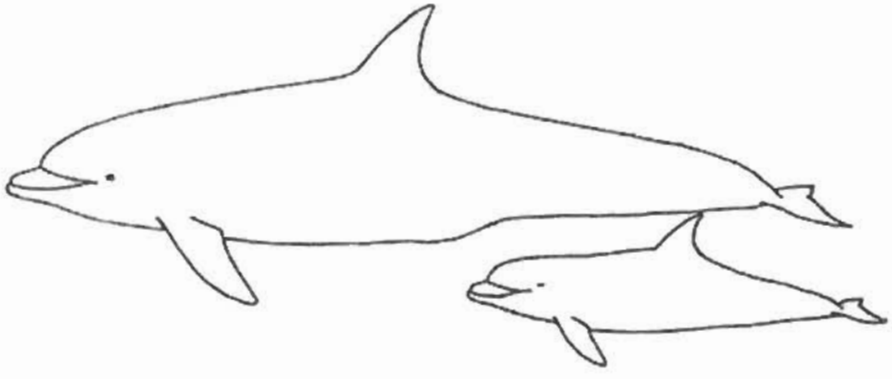

Figure 3. The 'ventro-caudal' position of a bottlenose dolphin calf close to the mother's body. Both dolphins keep a different eye open and check each other's position with gentle lateral movements. Body contacts often were observed.

together, but this diminished in the first year, at least during daytime (Fig. 4) (Benoldi *et al.*, 1996).

Rest at the surface

During rest at the surface, the dolphin hangs at the water surface, keeping the blowhole out of the water. No active swimming is observed, but the animal still has to balance to keep the position. The dolphin shows no interest toward the environment and produces no sounds (Fig. 5). Rest at the surface takes place in a few precise areas of the pool. Animals can 'hang' at the surface together, close to each other, but we observed this behaviour more often displayed by one single animal.

During our observations, the resting position of the dolphin did not allow us to observe both eyes simultaneously, so it was impossible to check for an eventual alternation of the open eye, as observed during 'rest swimming'.

Rest at the surface was never observed in the calf, so rest swimming, in association with the mother, seemed the only resting solution available to the calf.

Discussion

Rest at the surface has never been described in wild bottlenose dolphins. It was suggested that 'hanging'

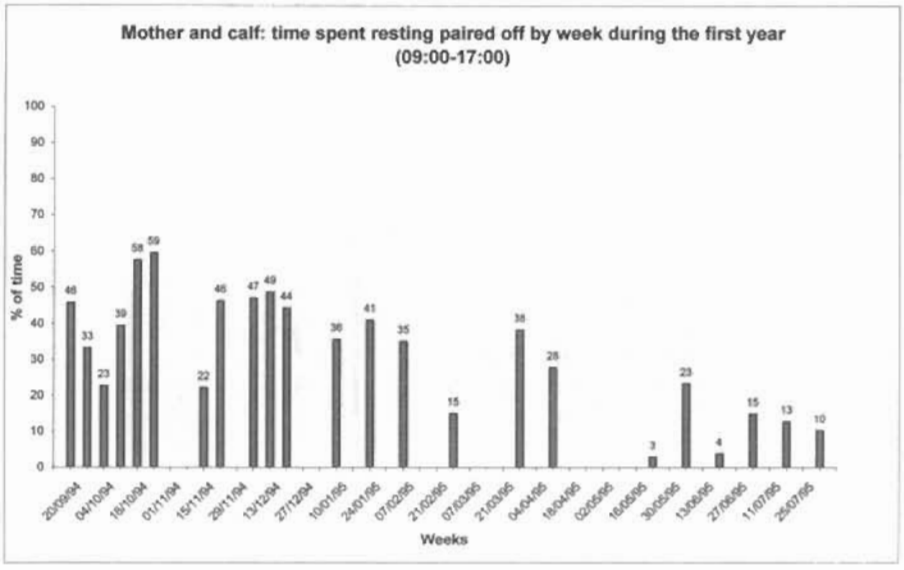

Figure 4. Percent of time the mother and the calf spent resting as a pair by week during the first year (on Monday's and Wednesday's during four 15-min periods, starting at 09:00, 11:00, 14:00 and 17:00 h, each week for the first six months and every other week for the second half of the year, for a total of 76 h). Both animals always had only one eye open. The attitude of the mother-calf pair to rest swimming as a pair was very strong immediately after the birth, but decreased during the first year, at least during daytime (n=24; Spearman rank test= -0.715; $P=0.01$) (Benoldi *et al.*, 1996).

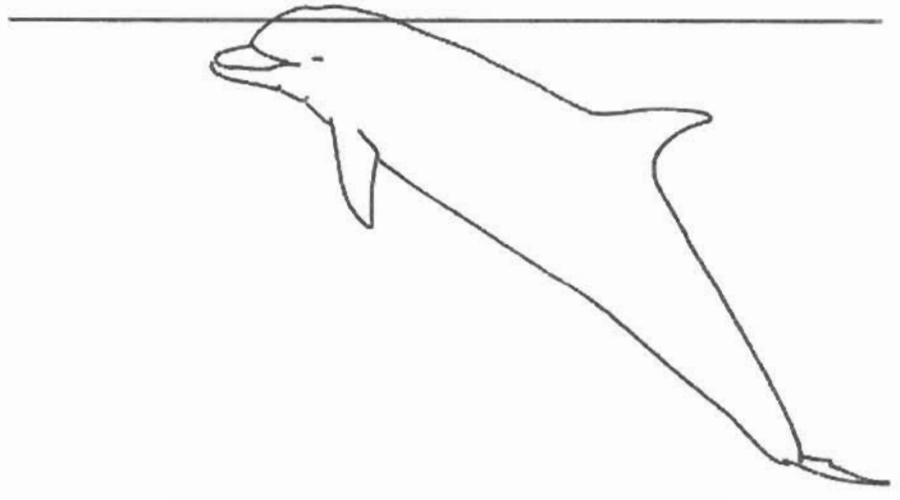

Figure 5. An adult bottlenose dolphin resting at the surface.

at the surface is partially a by-product of captivity (Gnone, 1991). Other delphinids species (i.e., *Globicephala sp.*, *Feresa attenuata*, *Peponocephala electra*, *Steno bredanensis*) show a so called *logging* behaviour which resembles the resting behaviour we describe. *Logging* usually is displayed by many individuals resting together at the water surface. It is difficult to believe that resting at the surface could be an exclusive behaviour of captive bottlenose dolphins, but the rate at which it appears in some captive individuals could be unusual. Rest swimming was frequent in the mother-calf pair and for a long time was the only rest behaviour displayed. During the weaning period, we observed a decreasing tendency of the calf to rest swimming with the mother (at least during daytime), with more time

dedicated to playful and exploratory activities. Such change in the calf's behaviour coincided with an increasing tendency of the mother to rest at the water surface. An increase in water movement seemed to discourage resting at the surface and promote rest swimming behaviour.

Relative to the costs and benefits of the two forms of rest, it seems like rest swimming is preferred whenever a partner is available, but if this is not the case, then rest at the surface could be more profitable, especially when the environmental conditions allow stationing without disturbances. This hypothesis is reinforced by the fact that rest at the surface is observed only occasionally in pools housing a large number of dolphins (Gnone, 1991; Fognani, 1998), but this also could be due to the fact that in such a situation it is harder to find a quite area to rest at the surface without disturbance from conspecifics. The huge amount of time the mother and new born spend in rest swimming together suggests that this behaviour is typical of the mother-calf relationship. Adults seem to re-enact such behaviour to save energy and maintain a good vigilance state during resting.

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