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Comparative studies on the behaviour of *Inia geoffrensis* and *Lipotes vexillifer* in artificial environments

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Summary

This paper compares behavioural patterns among the Amazon river dolphin (*Inia geoffrensis*) and the Chinese river dolphin (*Lipotes vexillifer*) within different captive environments. Differences between the two species are recorded in relation to the various styles of swimming, and to variations in diving, resting, play, and sexual behaviour patterns. Differences in the daily 24 hour activity patterns are also discussed. It is argued that the two species have evolved different behavioural patterns in response to differences in their respective natural habitats within the Amazon and Orinoko river systems in South America and the Changjiang River in China. Within the captive environment, pool size, shape and structure are considered to be important in influencing the behaviour of these dolphins.

Introduction

Behavioural observations on cetaceans have largely been concentrated upon marine dolphins and whales, while freshwater or river dolphins (family Platanistidae) have received only scant attention in the past (but see Layne, 1958; Layne & Caldwell, 1964; Caldwell, Caldwell & Evans, 1966; Pilleri, 1969; Gewalt, 1978, 1979, 1989; Lin, Liu & Chen, 1985; Perrin *et al.*, 1989). Most of the above studies on river dolphins have been conducted upon individuals kept in zoos and dolphinaria, while detailed behavioural observations in the wild have been rare (Layne, 1958; Pilleri, 1969; Chen *et al.*, 1980). Of the five distinct species of river dolphins, only two species are presently kept in human care—Amazon river dolphin (*Inia geoffrensis*) and the Chinese river dolphin or baiji (*Lipotes vexillifer*). Our present day knowledge about the life and behaviour of platanistid dolphins is largely based upon scientific observations on these two species.

The objective of this study was to evaluate differences in the behavioural patterns of the Amazon river dolphin and the Chinese river dolphin within captive environments, using the body of information gathered during earlier behavioural studies on these two species (Layne & Caldwell, 1964; Caldwell, Caldwell & Evans, 1966; Gewalt, 1978, 1979, 1989; Liu, Klinowska & Harrison, 1985; Caldwell, Caldwell & Brill, 1989; Chen & Liu, 1989; Liu & Wang, 1989), together with data collected during additional observations.

Observations on the Chinese river dolphin were undertaken at the Institute of Hydrobiology in Wuhan, China. During the 1980s four dolphins were brought into this institution from the wild. Two of these animals were studied in detail. The male dolphin 'QiQi', which was captured in 1980, is kept in an elliptical concrete pool measuring $20 \times 15 \times 14$ m in size. The female dolphin 'Zhen-Zhen, which survived for almost three years after capture in 1986, was kept in two adjoining round pools of $15 \times 15 \times 5$ m and $20 \times 20 \times 3$ m in size, respectively. Observations at Wuhan were carried out on two days and nights per month since the arrival of the first animal in 1980. Additional behavioural observations were carried out by Gewalt and Neurohr during visits in 1985 and 1989.

Amazon river dolphins were studied at Zoo Duisburg in Germany, where two males dolphins ('Vater' and 'Baby') are kept, which have been captured in the Rio Apure in Venezuela during 1975, together with a female dolphin which died in 1981. Both animals are kept together permanently in a square pool measuring $7 \times 5.5 \times 2$ m in size. Behavioural observations have been undertaken at irregular intervals since the dolphin's arrival in

1975. During 1991 Liu conducted additional one hour observations every four hours on a daily basis, for a period of two months.

Behavioural observations

Swimming

Several distinct swimming postures were observed during the studies: (i) normal swimming posture, (ii) side swimming posture, (iii) belly-up posture, and (iv) 'rolling' swimming posture, where the body is rotated through 360° on the longitudinal axis to either side of the dolphin.

For both river dolphin species, the normal swimming posture was the usual mode of swimming. Side swimming was observed occasionally among the baiji near the surface of the water, after feeding or during periods of excitement. Among the Amazon river dolphins side swimming was observed regularly at any depth of the water, in particular during times when the dolphins circled the pool.

Belly-up swimming occurred infrequently among baiji, and was seen only during fast swimming modes, while playing, or while circling the pool. The duration of belly-up swimming was always short. Among the Amazon river dolphins belly-up swimming was commonly observed. The two animals at Zoo Duisburg engaged in different patterns of belly-up swimming, with either both dolphins swimming in belly-up posture, or with the upper dolphin swimming in normal posture, while the lower dolphin adopted the belly-up position, thus forming a belly to belly swimming posture among the two dolphins.

Rolling swimming was regularly seen among the baiji 'QiQi' in the elliptical pool. In the round pools, however, this posture seldom occurred. The two Amazon river dolphins often showed the rolling swimming mode, in particular during play and while circling the pool. On occasions they rolled over for up to five times without moving forward. In addition, Amazon river dolphins have also been recorded to swim backwards. This swimming behaviour has never been observed among the baiji.

Swimming was always slow and lethargic among both river dolphin species at a speed of 1.5–3.0 km/h. However, the baiji regularly demonstrated short bursts of fast swimming actions.

Occasionally the baiji stopped swimming to raise the upper parts of their bodies out of the water in order to scan the surrounding area, similar to spy-hopping among marine dolphins and whales. Liu and Wang (1988) termed this behaviour pattern 'standing behaviour', which was regularly observed among the baiji at Wuhan. No form of 'standing behaviour' occurred among the Amazon river dolphins at Duisburg.

The direction of swimming of the dolphins in all of the pools under observation were either clockwise or counterclockwise. Both directions of swimming occurred at equal parts among the baiji in the different pools at Wuhan. The Amazon river dolphins at Zoo Duisburg usually swam counterclockwise.

Diving

The baiji were observed to dive on average for about 20 seconds, with range of 5 to 135 seconds. Longer dives were always followed by two to three shorter ones. Respiratory intervals among the Amazon river dolphins were regular at 60 to 100 seconds. Dives were shorter when the animals were active (25 to 60 seconds), and longer when the animals were resting at the bottom of the pool (up to 150 seconds).

Play

Both the baiji and the Amazon river dolphin demonstrated elaborate forms of play action with a number of different toys, including plastic balls and rings, rubber tubes, brushes, rugby balls, etc. All of these toys were either carried in the mouth of underneath a flipper, balanced on the rostrum, or thrown above the surface of the water. In addition, both species regularly used permanently fixed tools to rub their bodies against. Thus, the baijis often rubbed their bodies against water inlet pipes or even against the pool walls. In the pool of the Amazon river dolphins at Zoo Duisburg, a standing concrete circle of 100 cm in diameter is positioned at the bottom of the pool, with a series of brushes fixed on the inside of the circle. The dolphins regularly swam through the circle rubbing their bodies against these brushes. Other rubbing behaviour was not observed. Tool-using was also noted among the Amazon river dolphins, with one dolphin using a brush to rub its companion, or to create water bubbles for both animals to play with. Even without toys the Amazon river dolphins showed numerous play actions, such as gently biting each other, bending their bodies, and creating water bubbles to swim through or to lay in.

Resting

Resting behaviour among the baiji mainly occurred at night. The animals floated at the surface of the water without any body movement. The blowhole only was exposed to the air, the breathing frequency was reduced, and the small eyes appeared to be closed. Resting behaviour of the Amazon river dolphin also occurred mainly at night. These animals swam counterclockwise at slow speed in the middle or the lower water levels of the pool, usually surfacing every 1 to 2 minutes to breathe. Occasionally they were lying at the bottom of the pool, often

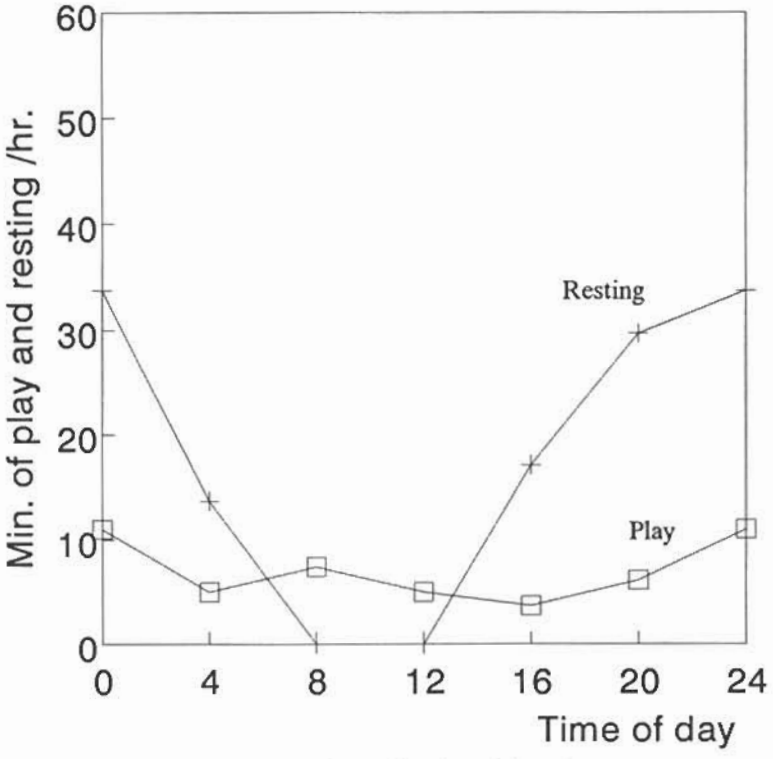

Figure 1. Amount of time spent play and resting during the 24 hr. cycle by the Chinese river dolphin at the Institute of Hydrobiology in Wuhan, China.

in an upside down position, eyes closed, coming to surface at more than 2 minute intervals.

Sexual behaviour

In spite of being kept on its own for most parts of the study, the male baiji did show sexual behaviour, more often during the periods of spring and autumn than at any other time of the year. During these periods 'QiQi' extended its penis to touch the surrounding pool walls. The two male Amazon river dolphins demonstrated homosexual behaviour throughout the entire year. Both animals were commonly seen to extend their penis. They often used them as probes to touch every part of each others body, even to extend the penis into each others blowhole. In addition, it was observed for one dolphin to insert its penis into the other dolphin's anus. This behaviour usually lasted for one minute, after which the passive animal always excreted a large amount of faeces. The passive dolphin was always swimming in normal posture on the surface of the pool, while the other dolphin was underneath in a belly-up posture with its penis fully extended in search of the other dolphin's anus. Most sexual activities were initiated by the older dolphin 'Vater'.

Feeding

Feeding behaviour among the baiji and the Amazon river dolphins was found to be similar. Both species feed on fish, which are grabbed with their anterior teeth, before being swallowed head first. Larger fish are torn to pieces before swallowing, with the dolphin firmly shaking its head from side to side to sever the fish.

Grouping behaviour

When the two pools of the male baiji 'QiQi' and the female 'ZhenZhen' were connected by a channel of one meter in width, the two dolphins initially avoided each other and remained in their own pools. As time went on and the degree of familiarity increased they gradually swam and played together. On occasions the younger dolphin 'ZhenZhen' bit the adult male 'QiQi', resulting in scars on 'QiQi's' body. The two Amazon river dolphins 'Vater' and 'Baby' shared one pool permanently, and stayed and swam together for

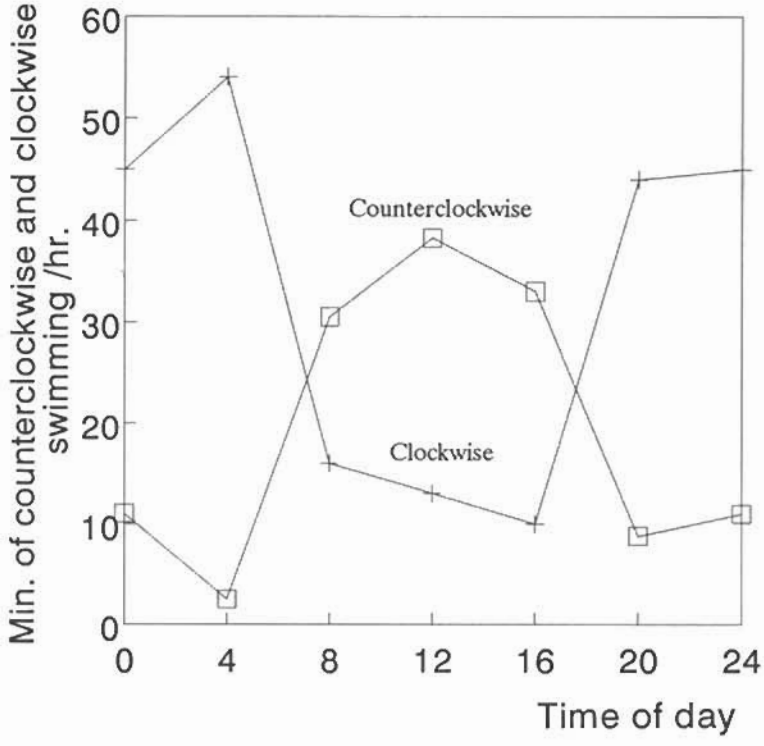

Figure 2. Amount of time spent swimming counterclockwise and clockwise during 24 hours cycle by the Chinese River dolphin at the Institute of Hydrobiology in Wuhan, China.

70–90% of all the observation periods. The two animals rarely showed any sign of aggressive behaviour towards each other.

Daily activity patterns

Daily activity patterns revealed that the baiji were most active during the day, while resting periods occurred at night (Fig. 1). During the day time the baiji usually swam counterclockwise with fast swimming modes prior to feeding times. Clockwise swimming occurred more regularly during night-time hours than during the day (Fig. 2). All sexual activities were recorded during the day only. Amazon river dolphins were also found to be more active during the day, with most resting periods occurring at night (Fig. 3). Prior to feeding fast counterclockwise swimming was recorded, followed by regular play behaviour after feeding time (Fig. 4). Sexual activities occurred during day-times only.

Conclusions

The studies demonstrated that individual behaviour patterns were similar for the two dolphin species. Differences which occurred largely in relation to the various modes of swimming were possibly due to differences in pool size and shape. Thus, it is argued that side swimming, which was commonly observed among the Amazon river dolphins, largely occurred due to the more restricted size of the square pool at Duisburg Zoo. This mode of swimming was notably more convenient for the dolphins in view of the small turning radius when circling the pool. In the larger pools at Wuhan, in contrast, the baiji could circle their pools in a normal swimming posture. The larger pool size at Wuhan also allowed the baiji to swim faster than the Amazon river dolphins in Duisburg. Leaping forward out of the water could also be attributed to pool size, since this behaviour pattern regularly occurred among the baiji, but was never observed among the Amazon river dolphins at Duisburg. Backward swimming, which was observed only among the Amazon river dolphins, could have also occurred in reflection of the smaller pool size at Duisburg. Similarly, standing behaviour was never observed among the Amazon river dolphins, possibly due to the more shallow depth of the water at Duisburg Zoo in relation to Wuhan.

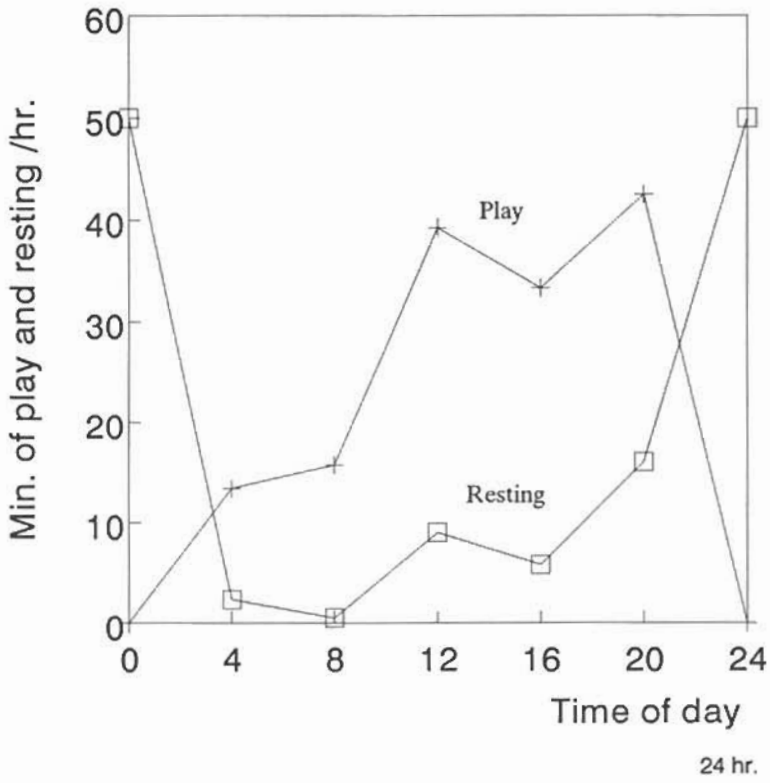

Figure 3. Amount of time spent play and resting during the 24 hr. cycle by the two Amazon river dolphins at Zoo Duisburg.

However, the differences in behaviour between the two river dolphin species could have also been related to the dolphins adaptations to differences in their respective natural habitats, rather than to restrictions in pool size alone. Thus, baiji, which occur in the deep waters of the Changjiang river, have evolved a fast and powerful mode of swimming in response to the strong currents of this river. As a result, anterior flukes are streamlined and small in size to allow for fast swimming actions. Amazon river dolphins, in contrast, which largely inhabit the shallow and calm tributaries and swamps of the vast Amazon and Orinoko river systems, have evolved disproportionately large anterior flippers, as an adaptation to turn quickly and to balance their bodies in the shallow waters (see also Table 1). As a result, Amazon river dolphins are commonly observed to swim at a very slow speed of less than 3 km/h.

Other behavioural patterns might have also evolved in response to differences in the natural environments of these dolphins. Thus, side swimming, commonly observed among the Amazon river dolphins at Duisburg Zoo, might have evolved as an adaptation for the dolphins to turn and manoeuvre themselves in the narrow river beds and swamps of the Amazon and Orinoko tributaries. Similarly, backward swimming, unique to the Amazon river dolphin, could be seen as an adaptation for the dolphins to turn in the narrow stretches of these rivers. Hence, this mode of swimming does not occur among baijis, since manoeuvrability is not restricted in the wide and deep waters of the Changjiang river.

Similarly, standing behaviour among baiji might have evolved for these dolphins to scan the surrounding area in the deep and turbulent waters of the Changjiang River. Among the Amazon river dolphins, however, this behaviour pattern does not occur in the wild, possibly due to the shallow depth of water of the calm and narrow tributaries of the Amazon and Orinoko rivers. Instead, these animals have been observed to only raise their heads above the surface of the water, while their bodies remain in a horizontal position (Layne, 1958). The shallowness of these waters might also account for the belly-up swimming among Amazon river dolphins, since this swimming posture within shallow waters

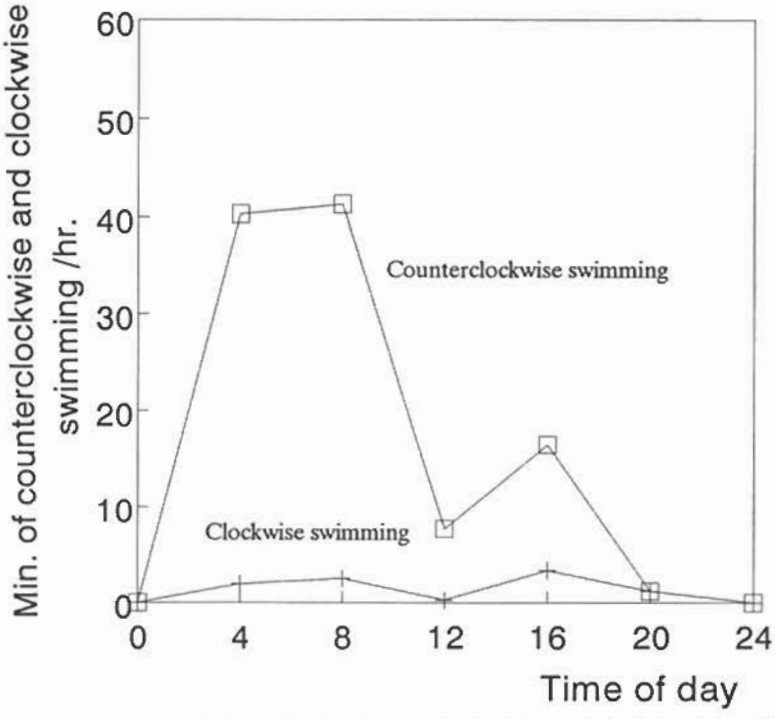

Figure 4. Amount of time spent swimming counterclockwise and clockwise during 24 hours cycle by the two Amazon river dolphins at Zoo Duisburg.

Table 1. Comparative body measurements of Chinese river dolphin at the Institute of Hydrobiology in Wuhan, and of Amazon river dolphin at Zoo Duisburg.

Positions of measurements	Lipotes vexillifer QiQi (cm)	Inia geoffrensis	
		Vater (cm)	Baby (cm)
Snout to notch	220	232	212
Girth at axilla	113.5	0.90	0.87
Maximum girth	125.5	114	111
Girth at anus	70	64	76
Girth midway anus to fluke notch	34.5		56
Height, same place	17.5	30	
Fluke width	55.5	48	56
Fluke depth	15.5	22	20
Flipper length (anterior)	29	50	48
Flipper length (posterior)	22	38	39
Flipper width, maximum	14.5	25	22

apparently allows these dolphins to use their sonar systems more effectively than when swimming in normal posture (see also Herald, 1969).

These observations thus suggest that differences in behaviour between the two river dolphin species have evolved in response to differences in their respective natural habitats. Pool size and shape, however, are nevertheless likely to influence certain behavioural patterns of the dolphins within the captive environment.

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