The Chinese river dolphin, *Lipotes vexillifer*

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The river dolphins, of which there are now five species, are among the world's most endangered animals. This article describes the steps that have been taken – based on systematic study of its anatomy, ecology, and breeding and behavioural habits – to preserve the rare Chinese river dolphin. This is now limited to about 300 individuals in the middle and lower reaches of the Changjiang River.

There are now five species of freshwater dolphin in the world (figure 1), namely *Inia geoffrensis* which is mainly distributed in the Amazon River system of South America; *Platanista gangetica* in the Ganges River system of the India subcontinent; *Platanista indi* in the Indus River system of Pakistan; *Pontoporia blainvillii* in the coastal waters of the Atlantic Ocean along the eastern shore of Brazil, Uruguay, and Argentina; and *Lipotes vexillifer* in the middle and lower reaches of the Changjiang (Yangtze) River in China. The future prospects of all freshwater dolphins are not good, especially *Lipotes vexillifer* which is the least numerous among them. It is listed as one of the endangered animals of the world, and heads the list of protected animals in China (figure 2). Although *Lipotes* is now a scarce and valued aquatic mammal native to China, it was a widely distributed species in the Miocene and Pliocene epochs. The book 'Er-ya' published 2000 years ago described the morphological features and life habitats of the dolphin. Up to the 1970s, however, there were only some accounts of it, limited to its distribution and taxonomy. More active and wider research began when the Chinese Academy of Sciences organized the Cooperative research group for Baiji biology in 1978. Since then, studies have been carried out on *Lipotes* anatomy, ecology, breeding, behavioural biology, bioacoustics, etc. Although this research has only comparatively recently been started, much work has been done [2, 3].

**Distribution and natural habitat**

Because of the differences in the geomorphologic features of the upper middle, and lower reaches, the Three Gorges of the Changjiang River forms a geographical barrier for the dolphin’s activity. The natural distribution range of *Lipotes* is limited to the mainstream of the middle and lower reaches of the Changjiang River covering a distance of about 1600 km from Yi Du, Hubei provinces to Liuhekou, Jiangsu province. The current in the section known as the Three Gorges is torrential and the velocity can be as high as 7 m s⁻¹. Below the Three Gorges, the River enters an alluvial plain, with a broadened channel and gentle slope. The current velocity there is generally about 1–2 m s⁻¹. There are many sandbars and tributaries draining into the main stream, as well as many lakes of varied size connecting with the main stream. The upstream and downstream areas of the sandbars are exposed during the dry season of the year, forming flots on which a luxuriant growth of reeds and weeds occurs naturally, but they are inundated completely during the flood season. Aquatic organisms which may serve as fish food therefore proliferate in these areas. These are the places where the dolphins feed. There are some regularities in the dolphins' activity. They like to move about within slow-current regions near bars and banks, and especially to linger within the big return-current areas which have certain characteristic features of hydrology and geography. The big return current areas change regularly along with changes in current velocity, state of the water, and topographic features of the river bed. Great changes take place during the flood season and the dolphins migrate in step with these changes. The changes occur very much less during the dry season and the activity of the dolphins is correspondingly more stable [5].

**Population size**

Since 1978, an ecology survey group organized by the Institute of Hydrobiology, Academia Sinica, has made regular annual surveys of *Lipotes* in the middle and lower reaches of the Changjiang River. Sometimes it made two surveys each year, covering the whole of the middle and lower reaches. Sometimes, it concentrated on the section where the dolphins were seen most often. We also made some improvements in the survey method. Originally, there was only a single ship on the river, so that surveyors could observe from only a single angle. Since 1984, we have used a big ship as mother ship, with 6–8 small motor boats (4.5 hp) to carry out searches. The angle of search was thus much wider, and the chances of finding the dolphins correspondingly increased. This made it possible to estimate the numbers of dolphins more precisely.

The survey results showed that the standing stock of *Lipotes* is about 300 individuals, divided into 42 groups. We also analyzed the population structure according to dolphin size and external appearance, and found that the proportion of young dolphins was very low. This warns us that the future will not be easy for the dolphins [6, 7].

**Structure and function of the organ system**

Systematic studies have been made of the anatomical and histological aspects of *Lipotes* in recent years. Careful observations have been made of the respiratory system, especially nares,
nasal sac, and larynx which are related to emission of sound. It has been verified that Lipotes has only false vocal cords. These data have provided a scientific basis for research on the dolphin’s sound production region [8]. From study of the skeletal system, the systematic growth and taxonomic position of Lipotes has been established, and some new views have been put forward [9]. A relatively clear understanding of the structure of the cochlea has been reached by examination of both graphic representations and computer-aided three-dimensional reconstruction methods.

These observations reveal that the sonar system of Lipotes is rather underdeveloped in comparison to those of Tursiops and Neophocaena. Observation of the microscopic and submicroscopic structures of the eye and optic nerve of Lipotes show that Lipotes should have some optic function, but very poor [10].

Biological features
The colouring of Lipotes is relatively simple. Its back is light blue-grey, and the belly is white. White streaks are apparent on the nape of the neck and the tail. The dolphins eat fish: the length of the ingested fish is mostly about 25 cm, the weight below 100 g. However, big individuals can eat fish as much as 30 cm in length and 1.2 kg in weight. The age of the dolphin can be determined from their teeth. By analysing the state of growth of teeth we find that the females grow a little faster than males after four years old. Consequently, females of the same age as males are longer and heavier. From the specimens we obtained, females had a body length of 250 cm at age 13, and males 216 cm at age 14. From the observation of the histology of dolphins’ sex glands we found that those of females reached maturity at the age of 6, and male at the age of 4. The mating season for Lipotes has two peaks: from March to May in spring and August to October in autumn [11].

Behavioural features
Under natural conditions, the behaviour of Lipotes has been carefully observed and recorded. In general, up to ten adult dolphins form a group within which immature and baby dolphins can also be found. Dolphins like to swim, play, and chase each other in the slow-current areas where fish are plentiful. They sometimes swim on the side, sometimes on the belly, and sometimes roll. Before storms come, dolphins seem restless and even jump out of the water.

The process of feeding can be divided into three steps: chasing, catching, and resting. As might be expected, dolphins congregate where fish are rich and follow the shoals as they migrate. Adults are often seen protecting their young. In general, a grown dolphin carries a baby with his (or her) flipper while swimming.
Sometimes, however, the young dolphin swims close behind a parent. We have also observed the behaviour of *Lipotes* in captivity. From the recording and analysing of ten behavioural patterns (i.e. clockwise swimming, anticlockwise swimming, side swimming, belly swimming, rolling swimming, upright positioning, playing, sexual behaviour, fish catching, and resting), we conclude that *Lipotes* has obvious circadian and seasonal rhythms. The circadian resting behaviour occurs at night, with two peaks in winter and summer. Sexual behaviour shows two peaks, during April–May and August–September [5, 12–14].

**Bio-acoustics**

Since 1983, we have recorded acoustic signals from three *Lipotes* in captivity. The results showed that *Lipotes* probably has two main kinds of signals: communication signals and echo-location signals. The communication signals fall into several categories. All of them are continuous signals; their frequency band-width is narrow and their energy mainly in the ultrasonic region. We have made a preliminary study of the relationship between sound and behaviour, as well as adaptation to environment. It has been found that *Lipotes* is capable of simultaneously emitting as many as three entirely different series of pulses. Some interpreted this as meaning that there might be three independent sources of vibration, possibly related to the three pairs of air sacs [15].

The function of the melon, which is one of the important components of the sonar system (*Lipotes*), has been studied by several scientists. Some considered that it can narrow the width of the main beam of the wave bundle, while simultaneously considerably inhibiting the side lobe of the beam, enabling the main axis of the beam to be directed more to the anterior. Others found two sound transmission paths with lower attenuation in the melan, in which the ultrasonic attenuation was either very small, zero, or even negative. They considered also that the melon possesses good properties of sound transmission and serves to generate a sonar beam. The directional pattern of the ‘clicks’ of *Lipotes* has been described. In general, the horizontal and vertical 3 dB beam widths are 13° and 9°, respectively. The angle of elevation for the major axis of the beam is 7.5°. An audiogram was obtained for frequencies between 1 kHz and 200 kHz for a male adult *Lipotes* in captivity. The dolphin was most sensitive to tones between 16 and 48 kHz. The sensitivity threshold in this area was ~38 to ~44 dB (re 1 μbar). The upper limit of hearing was above 200 kHz, the lower limit below 1 kHz [16].

**Rearing**

Since 1980, we have reared four *Lipotes* among which one male, named ‘Qi Qi’ has been in captivity for over eight years and is still healthy. This is the longest recorded success of the survival of *Lipotes* in captivity. In the spring of 1986, we caught a young female dolphin named ‘Zhen Zhen’ as a result of our long-term study of the ecology of *Lipotes*. ‘Zhen Zhen’ has stayed in captivity for more than two years and has gradually adapted to the artificial environment. Much work has been done in the rearing of these two dolphins [17].

**Prevention and cure of diseases**

‘Qi Qi’ was badly injured during capture. The gaff used made two holes in the nape of its neck both 4 cm in diameter and 8 cm in depth. We treated this by a continuation of Chinese and western medicine, treating partly in water and partly out. The wounds healed after seven months. This set up a world record for curing serious external wounds of dolphins in captivity. Meanwhile, we have studied skin diseases of the dolphin very carefully, and generally speaking can now eliminate these [18, 19].

**Health studies**

There are two important factors for keeping dolphins healthy in captivity. The first is the water quality. Through the observation of the relationship between the water quality of the pool and the health of the dolphin, we can tell when the condition of the water is on the point of being detrimental to health. The second factor is the food. Studies have been made of preferred fish species, eating capacity, and feeding times. Feeding standards and food allocation have been laid down. Through regular analysis of the blood we have devised an index indicative of good health.

**Proposals for protection**

The population size of *Lipotes* is the smallest among freshwater dolphins, and the species is on the brink of extinction. This raises the question of what must be done to protect this animal, so highly valued in China. The following are the proposals put forward by us.

1. Protective areas for *Lipotes* must be established in the parts of the river which they most frequent. Two such areas exist in Honghu section in the middle reaches and in Anqing section in the lower reaches. There are about four groups and 38 individuals in Honghu section and about four groups and 34 individuals in Anqing section. Protection laws must be promulgated and enforced by monitoring with patrol boats.

2. To establish favourable breeding areas for *Lipotes*. There are many ox-bows in the mainstream of the Changjiang River where conditions are favourable for dolphins’ activities. It would be sensible to move some dolphins into these ox-bows, and reduce human interferences as much as possible, so that they can live and reproduce undisturbed. From the results of surveys, we consider that the Tannezon ox-bow at Shishou, in the middle reaches, is an ideal base. Tongling, in the lower reaches, is also preparing to construct a semi-natural reserve for *Lipotes*.

3. To intensify the studies of reproduction of *Lipotes* in captivity. If all these measures are carried out effectively, we are confident the numbers of *Lipotes* will gradually increase and that the species’ long-term future will be assured [7].

**References**