

Study on the regularity of reproduction in *Lipotes*

Liu Renjun

Institute of Hydrobiology, Academia Sinica, Wuhan

Abstract

Examination of the uteri, ovaries and the status of pregnancy and lactation of 13 specimens of female *Lipotes* which were collected from 1974 to 1986 from the Changjiang River, allows preliminary estimation of parameters for reproduction in this species. The mature age of female dolphins is about 8 years old. Among 13 female specimens, the mature dolphins belonging to elderly age (upward of 8 years old) constitutes 84.6%, the pregnant *Lipotes* is about 30% of all female specimens. It is known that *Lipotes* is an endangered species. The calving season is around February. The gestation period is 10-11 months. The calf size at birth is about 80 cm. According to the research on the behaviour of *Lipotes* in captivity and in the wild, the animal has two sexual peaks, one in spring and one in fall, but this has not been proved from collected specimens. The pregnancy of *Lipotes* is once every second year, and one foetus is born each time. In the light of shape of uterus, the decidualization in the endometrium, the structure of corpus luteum and corpora albicantia on the ovary, and the condition of mild secretion, *Lipotes* probably conceives two foetuses each time.

The characteristics of reproduction and reproductive organs of three species of freshwater dolphins, *Inia geoffrensis*, *Pontoporia blainvillei*, and *Platanista gangetica*, have been studied by Best (1984), Brownell (1972, 1975), Harrison, Boice & Brownell (1969). Chen Peixun, Lui Renjun & Lin Kejie (1984), reported the morphological and histological characteristics of reproduction and reproductive organs of *Lipotes* and preliminarily studied its reproductive behaviour. In order to develop the protection work and to carry out the reproduction research, the regularity of reproduction in *Lipotes* must be understood better. The present paper goes further into this subject.

Materials and Methods

According to the anatomical data from thirteen specimens of female dolphins obtained between 1974

and 1986, the author carefully observed the morphological and structural characteristics of uteri and ovaries as well as the status of the pregnancy and lactation. Histological observation was also carried out. The ovary was cut into serial sections of 1.5 to 2 mm thickness so that the number of corpora albicantia on the ovary might be correctly calculated and the maturity of *Lipotes* might be determined. Then, the reproductive regularities of *Lipotes* was comprehensively analysed by combining the behaviour of *Lipotes* in the wild and in captivity, and then the corresponding result was obtained.

Results

A. Maturity index

Thirteen female specimens of *Lipotes* were collected and anatomized from 1974 to 1986 (see Table 1).

Each pregnant individual of cetacea has a gestational corpus luteum on its ovary; so does *Lipotes*. The corpus luteum is surrounded by a thick membrane of connective tissue and is divided into numerous small areas full of growing granulosa lutein cells which are plump and polyhedral in appearance. After the baby animal is born, corpus luteum collapses rapidly and becomes corpus albicans, which is not absorbed, but persists.

Therefore, if there were corpora lutea or corpora albicantia or both of them on the ovary, we considered that the animal was mature, if both of them are absent, the animal was immature. Moreover, there is a nipple on each side of *Lipotes*' genital slit and there are two large mammary glands in the adipose layer of the nipple areas. If a slight gentle pressing of the nipple area causes white sticky milk to flow out from the nipple, the individual is identified as a nursing one.

It may be seen from Table 1 that the mature age of *Lipotes* is about 8 years old with a body length of 184.5 cm. Specimen No. 83-1 is eight years old and its body length is 226.1 cm. Since there are no corpora lutea or corpora albicantia on its ovary, there

Table 1. Status of maturity of female *Lipotes*

Specimens	Date	Body length (cm)	Body weight (kg)	Age	Status of maturity
84-2	29.3.84	90.3	6.75		Immature
80-3	11.1.80	184.5	63.5	4	Immature
83-1	28.2.83	226.1	165.0	8	Nonpregnant
86-1	2.12.86	237.4	161.25		Pregnant
80-7	15.2.80	226.0	166.5	9	Mature, nonpregnant
79-2	25.1.79	234.0	142.5	10	Mature, nonpregnant
83-2	18.3.83	231.0	141.0	9	Mature, nursing
83-3	6.10.83	240.0	120.0	11	Mature, nonpregnant
82-1	1.2.82	232.0	152.9	8	Pregnant
80-8	8.3.80	239.0	116.5	8	Nonpregnant, nursing
74-1	21.1.74	250.0	224.0		Pregnant
74-2	21.1.74	253.0	237.0		Pregnant
82-2	24.9.82	259.0	163.5	12	Nonpregnant, nursing

are two possibilities for this specimen. One is that it is immature. Second is that it might be mature but not pregnant in as much as other individuals being 8 years old are all mature. Among 13 specimens collected, 11 individuals are mature, accounting for 84.6% of the total; among them, four are pregnant, accounting to 36.36% of the mature individuals and 30% of the total females. Three animals are nursing but not pregnant which account to 27% of the mature individuals. Four mature animals are neither pregnant nor nursing. According to our observation on the behaviour of male *Lipotes* under rearing condition and the fact that newborn animals can be seen in spring and in autumn in the Changjiang River, *Lipotes* has two peaks of sexual activities in spring and autumn. Among four mature but not pregnant individuals, two were obtained in spring and the remaining two, in autumn. Therefore, they would have become pregnant during that year. From the nursing individuals No. 80-8 and 83-2 which were obtained in the middle of March, parturition in all probability would have taken place around February. From three pregnant dolphins which were obtained at the end of January and in the beginning of February, their foetuses were in the stage of birth and, thus, would probably be born in February. Specimen No. 86-1 was obtained on 2 December 1986 and its foetus was 35 cm in length. From the extent of embryonic development, it was about eight months in age, therefore, it would have been born in February, too. Thus, analysing as a whole, the parturition time of *Lipotes* is around February. Among the specimens collected so far, there has been no indication of autumnal parturition.

B. Foetus

Since 1974 up to now, we have obtained four foetal and newborn specimens (see Table 2). One can see

from the Table, the body lengths of two foetuses obtained on 21 January 1974 were 54.5 cm and 73 cm, respectively. The foetus obtained on 2 December 1986 was 34.5 cm in body length. The newborn animal obtained on 29 May 1979 was 95 cm in body length. According to the deduction that parturition of *Lipotes* takes place in February, the body length of *Lipotes* at the time of birth should be about 80 cm. According to Chen Peixun's report that the mating time of *Lipotes* occurs in April to May, the gestation duration should be 10 to 11 months. Based on the gestation regularity of mammals in general, the growth of foetus can be expressed by the exponential equation: $Y = a \cdot b^X$.

According to the above index, when logarithmic separation for the months of gestation and body length 80 cm at birth is made, one can obtain theoretical correlational expression between gestation month and foetal body length ($Y = \text{body length}$; $X = \text{gestation month}$).

$$Y = a \cdot b^X$$

For *Lipotes*, this expression is:

$$Y = 1.4894^X$$

By shifting the above expression, one may obtain

$$X = \text{Lg } Y / \text{Lg } 1.4894 \quad X = 5.7803 \cdot \text{Lg } Y$$

Accordingly, the gestation duration of the foetuses in the Table 2 can be calculated (see Table 2). The above equation is also used for the newborn.

C. Ovary

Chen Peixun *et al.* made detailed studies on the morphological character and histological structure of *Lipotes*' ovary. The ovarian specimens collected from 1974 to 1986 are listed in Table 3, from which

Table 2. Status of foetuses and newborn of *Lipotes*

Date	Sex	Body length (cm)	Body weight (kg)	Note	Calculated gestation (months)
2 Dec 1986	M	34.5	0.85	Foet.	8.89
21 Jan 1974	M	54.5	2.5	Foet.	10.04
21 Jan 1974	F	73.0	4.8	Foet.	10.77
29 May 1979	F	95.0	9.5	Newborn	11.43

Table 3. Measurements of ovary of *Lipotes*

No.	Date of death	Body length (cm)	Body weight (kg)	Ovary				Status of mature (cm)
				Size (cm)		Weight (g)		
				Left	Right	Left	Right	
83-3	11.1.80	184.5	63.5	1.6 × 0.6 × 0.3	1.6 × 0.4 × 0.4	0.3	0.3	Immature
83-1	28.2.83	226.1	165.0	3.0 × 2.1 × 1.6	3.6 × 2.0 × 1.6	10.0	8.0	Immature
80-7	15.2.80	226.0	166.5	3.65 × 1.9 × 0.9	3.4 × 1.9 × 1.2	3.6	4.3	Left: Corpora albicantia 0.8 × 0.4 (1) Right: Corpora albicantia 0.8 × 0.7 (1)
86-1	2.12.86	237.4	161.3	3.4 × 2.6 × 1.9	3.7 × 2.7 × 2.8	15.0	20.0	Left: Corpora albicantia 0.5 × 0.3 (1) Collapsing corpus luteum 1.9 × 1.4 (1) Right: Corpus luteum 3.1 × 2.5 Corpora albicantia 0.5 × 0.5 (2)
79-2	25.1.79	234.0	142.5	2.6 × 1.8 × 0.9	2.7 × 1.8 × 0.9	1.3	2.0	Left: Corpora albicantia 0.7 × 0.7 (5) Right: Corpora albicantia 0.7 × 0.8 (1)
74-1	21.1.74	250.0	224.0	5.2 × 3.2 × 1.8	3.1 × 1.8 × 1.0	16.0	2.7	Left: foetus 73 cm Corpus luteum 4.55 × 3.2 × 1.8 (1) Corpora albicantia 0.6 × 0.5 (1) Right: Corpora albicantia 1.0 × 0.6 (1)
74-2	21.1.74	253.0	237.0	5.7 × 3.2 × 1.2	3.6 × 2.1 × 1.3	13.5	5.8	Left: foetus 54.5 cm Corpus luteum 3.9 × 3.1 × 1.1 (1) Corpora albicantia 0.75 × 0.6 (2) Right: Corpora albicantia 1.0 × 0.8 (5)

Table 4. Measurement of uterus of *Lipotes* (in cm)

No.	Body length	Length of vagina	Length of cervix	Left horn	Right horn	Status of pregnancy
80-3	192.0	8.0	3.0	7.4 × 3.0	5.5 × 2.9	Immature
86-1	237.4	13.6	14.9	30.5 × 54.5	40.8 × 27.5	Foetus in right horn
79-2	245.0	14.4	5.0	14.0 × 3.5	12.6 × 4.0	Mature
74-1	250.0	18.0	12.7	70.0 × 20	19.0 × 15	Foetus in left horn
74-2	253.0	22.0	12.8	52.0 × 18	49.0 × 16	Foetus in left horn
80-8	250.6	14.6	12.1	13.7 × (L)	14.5 × (L)	Mature

one can see that *Lipotes*' ovary is relatively small as compared with its body weight. However, when the animal is pregnant, its ovary will double and redouble its volume since corpus luteum graviditatis forms after ovulation and fertilization. The corpus luteum graviditatis of *Lipotes* is like that of *Neophocaena phocaenoides* and other cetaceans in that soon after giving birth, the corpus luteum will contract quickly and become a corpus albicans which is very small in size, with diameter of less than 1 cm.

Cysts were found in the ovary of specimen 86-1, and the cyst in the left ovary was larger, with a diameter of 1.5 cm, and the one in the right ovary was smaller, with a diameter of 0.5 cm. The cysts were full of white liquid. Such a case has never been reported in *Lipotes* or *Neophocaena phocaenoides*. It was a pathological phenomenon. Unlike the cysts of human beings that occur in ovarian cortex, these two cysts all presented at the basal part of the ovarian membrana.

C. Uterus

Table 4 shows the measurement of six uteri.

Lipotes' uterus is bicornute and asymmetrical. A septum divides the cavum uteri into two cornua uteri. However, the septum disappears near to the uterine cervix where left and right cornual uteri are connected. From Table 4, we can see that the size of uterus of the mature individuals is twice that of immature individuals. The size of the left horn of the non-pregnant female is similar to that of the right, usually very small. In Specimen 74-1, the size of the left pregnant horn is 70 × 20 cm and the right non-pregnant horn dilates to a certain extent but smaller than the left. In Specimen 74-2, the left pregnant horn expands greatly and the right nonpregnant horn also expands but smaller than the left horn. However, in Specimen 86-1, the left nonpregnant horn is larger than the right pregnant horn.

The uterus consists of endometrium, lamina muscularis and serosa. Its histological structure was described in our previous paper (see Chen Peixun *et al.*, 1982). According to the present study, in

Specimen 86-1 which is mature, the decidualization in the endometrium was not found in the left non-pregnant horn, nor in the right pregnant horn. In the mature but nonpregnant individual, there was decidualization in the endometrium.

Discussion

The above result shows that the mature age of *Lipotes* is about 8 years. The birth takes place around February. The newborn calf is about 80 cm long, and the gestation duration is 10 to 11 months. According to the result of behaviour study made under rearing condition and field observation, *Lipotes* has two peaks of sexual activities. However, from our collected specimens, this generalization cannot be substantiated and, thus, more data should be obtained for further verification.

Among thirteen female specimens, immature individuals make up 15% of the total female specimens. That means the amount of supplementary reproductive population of *Lipotes* is very small. It further shows that *Lipotes* is indeed an endangered species. From 1974 to 1986, we obtained 31 specimens of *Lipotes* in total, among which 18 are male and 13 are female, the sexual ratio being 1.38 : 1. However, there are only four pregnant females, the pregnant rate being 30%. If the present population of *Lipotes* in the Changjiang River is calculated at 300 among which 126 individuals are female, 38 females would be pregnant every year. Because the mating, pregnant, parturition and nursing of *Lipotes* take place in the Changjiang River where the geographical and hydrological situation is complicated, the mortality rate is likely to be relatively high and only half of newborn animals could be expected to survive. Therefore, only 20 newborn animals supplement the population each year. In addition, the mortality may be also caused by accidental catching and killing. *Lipotes* would soon become extinct if protection measures were not strengthened. In other words, if the protective measures are efficient, the restoration of *Lipotes*' population in the Changjiang River will be promising, although it will be a relatively slow process.

Lipotes usually has one foetus each time. According to the fact that the left horn of Specimen 74-2 was pregnant and its right horn also expanded, Chen I-Yu *et al.* suggested that this specimen had twins. Through our studies on this specimen, we consider that their suggestion, based solely on the size of horns, is not very convincing. Although the left and right horns are separated by a septum, they are still connected near the uterine cervix and they are not mutually independent. The foetus of this specimen was about to be born and, therefore, not only the left horn was full of amniotic fluid, but also the right nonpregnant horn, which dilated correspondingly. So the expansion of the right horn does not constitute an unequivocal evidence for the bearing of twins. Besides, from the condition of ovary, the corpus luteum graviditatis was only found on the left ovary, and no corpus luteum graviditatis or atrophied corpus luteum existed on the right ovary. There was no milk secretion found during the dissection of the specimen. These indications show that the animal did not seem to have twin embryos.

After all, can *Lipotes* be pregnant with twins? This is really a very interesting question because there has been no report that cetacean animals can be pregnant with twins. According to our recent data obtained from Specimen 86-1, it is probably that this animal was pregnant with twins. The evidence is as follows:

a. The anatomy of a number of *Neophocaena phocaenoides* and *Lipotes* specimens shows that pregnancy usually occurs in one horn while the other horn expands correspondingly to a certain extent. The non-pregnant horn may greatly expand at the period of birth, but it cannot be larger than the pregnant horn. For example, though Specimen 74-1 was about to give birth, the nonpregnant right horn was much smaller than the pregnant left horn. Even in Specimen 74-2, the nonpregnant right horn was still much smaller than the pregnant left horn. However, the non-pregnant right horn of Specimen 86-1, on the contrary, was much larger than the pregnant left horn.

b. The cervix uteri of the specimen which was pregnant but did not give birth was relatively small, with a diameter of 2-3 cm. Even for the specimen near parturition, the expansion of cervix uteri was only 5 cm. That is because the foetus' head is always oriented toward the bottom of the uterus and its tail, toward the uterine cervix. During parturition, the tail emerging first is the natural condition and the head emerging first is the difficult labour. This is contrary to that of human beings. The uterine cervix could actually expand to a great extent just after giving birth, but, after three days or so it resumes its normal size. Specimen 86-1 had a foetus in the right horn but not about to give birth, its uterine cervix attained a diameter of 20.5 cm. Therefore, it may be said that it was just after giving birth from the right horn.

c. There were a large corpus luteum in the right ovary and an atrophied corpus luteum in the left ovary of Specimen 86-1. Judged from the anatomical observation of a number of ovaries, corpora lutea atrophied soon after giving birth and became corpora albicantes with a diameter less than 1 cm. However, the size of the atrophied corpus luteum in the left ovary of Specimen 86-1 was about 3.1×2.5 cm, apparently it was in the transitional period from corpus luteum to corpus albicans.

d. In the histological analysis, if one horn of the uterus is pregnant, then the decidualization in the endometrium could not occur; decidualization does occur in the nonpregnant horn of uterus, in preparation for setting of a fertilized egg. No decidualization in the endometrium could be found either in the left or in the right horn of the uterus of Specimen 86-1. This shows that both horns of the uterus had been pregnant in the past.

e. There was no indication of milk secretion in all specimens of pregnant *Lipotes* and *Neophocaena phocaenoides* when they were dissected. Even for the pregnant dolphin which was about to give birth, only a very little amount of thin milk could be squeezed when one pressed the mammary gland. For example, Specimens 74-1 and 74-2 were about to give birth, but no milk secretion was found during dissection. A copious amount of white, sticky milk emerged from Specimen 86-1 upon dissection, which shows that this animal had given birth previously.

According to the above analysis, Specimen 86-1 probably had twins. In the light of general regularity of mammals, most fertilizations of twins occurred simultaneously and very few occurred several days apart. It seems impossible that one foetus is about to be born while the other is to be born several months later. Therefore, Specimen 86-1 possibly has one foetus aborted. Anatomically, we found that Specimen 86-1 was in good health without external injury, and its internal organs had no pathological changes except for its lung. Therefore, abortion might be one of the causes of its death. Cases of death due to parturition in captivity are not infrequent in marine dolphins abroad.

References

- Best, R. C. and da Silva, V. M. F. (1984). Preliminary analysis of reproductive parameters of the bottu, *Inia geoffrensis*, and the tucuxi, *Sotalia fluviatilis*, in the Amazon River system. *Reproduction in Whales, Dolphins and Porpoises* pp 361-369. Ed. W. F. Perrin, Report of the International Whaling Commission, Special Issue 6, Cambridge University Press.
- Brownell, R. L. (1975). Progress report on the biology of the Franciscana dolphin, *Pontoporia blainvillei*, in Uruguayan waters. *J. Fish. Res. Bd. Can.* **32**, 1073-1078.
- Brownell, R. L. and Herald, E. S. (1972). *Lipotes vexillifer*. *Mamm. Species*, **10**, 1-4. Amer. Soc. Mamm.

- Chen Peixun, Liu Renjun and Lin Kejie (1982). Reproduction and reproductive system of *Lipotes vexillifer*. *Oceanol. Limnol. Sin.* **13**(4), 331-337 (in Chinese).
- Chen Peixun, Liu Renjun and Lin Kejie, (1984). Reproduction and reproductive system in the Beiji, *Lipotes vexillifer*. *Reproduction in Whales, Dolphins and Porpoises*, pp. 445-450. Ed. W. F. Perrin, Report of the International Whaling Commission, Special Issue 6, Cambridge University Press.
- Chen, I-Yu and Chen Wei, (1975). Notes on some morphological and anatomical features of the white-flag dolphin, *Lipotes vexillifer* Miller. *Acta Hydrob. Sinica*, 360-370 (in Chinese).
- Harrison, R. J., Boice, R. C. and Brownell, R. L. (1989). Reproduction in wild and in captive dolphins. *Nature* **222**(5199), 1143-1146.
- Harrison, R. J. and Brownell, R. L. (1971). The gonads of the South American dolphins, *Inia geoffrensis*, *Pontoporia blainvillei* and *Sotalia fluviatilis*. *J. Mammal.* **52**, 413-419.
- Harrison, R. J., Boice, R. C. and Brownell, R. L. (1972). Reproduction and gonadal appearances in some Odontocetes. *Functional Anatomy of Marine Mammals*, Academic Press, London and New York, **1**, 361-429.
- Harrison, R. J. (1972). Reproduction and reproductive organs in *Platanista gangetica*. *Investigations on Cetacea* **4**, 71-82. Publ. G. Pilleri.
- Harrison, R. J. and McBrearty, D. A. (1973). Reproduction and gonads of the black finless porpoise *Neophocaena phocaenoides*. *Investigations on Cetacea* **5**, 225-230. Publ. G. Pilleri.
- Pilleri, G. and Bhatti, N. U. (1978). Status of the Indus dolphin population (*Platanista indi* Blyth, 1959). *Investigations on Cetacea* **9**, 25-38. Publ. G. Pilleri.
- Pilleri, G. and Gahr, M. (1977). Observations on the Bolivian (*Inia geoffrensis* de Blainville, 1871) with a description of a new subspecies (*Inia geoffrensis humboldtiana*). *Investigations on Cetacea* **8**, 11-76. Publ. G. Pilleri.