

## OVARIAN APPEARANCES IN CAPTIVE DELPHINIDS (*TURSIOPS* AND *LAGENORHYNCHUS*)

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### *Introduction*

HARRISON, BOICE and BROWNELL (1969) gave the first account of the appearances of the ovaries of delphinids that had died in captivity.

HARRISON and RIDGWAY (1971) and HARRISON, BROWNELL and BOICE (1972) have added more details as additional specimens became available. *Tursiops truncatus* has become the species most commonly, and the most easily, kept in captivity but there still remains a lack of knowledge of its basic reproductive pattern and of how that may be modified in captivity. In an endeavour to share the available information, a "Tursiops Breeding Workshop" was held at San Diego Zoo, California from 8th - 9th December, 1975. Those proceedings added only slightly to the published reports and little guidance emerged for the successful breeding of delphinids. It was agreed, however, that (a) it was essential to acquire accurate details about reproductive events in captive delphinids (b) the need to encourage breeding programmes was imperative. The reasons for supporting proposal (a) are obvious: those for advocating (b) are less compelling while it is still possible to take delphinids from the wild, whether or not they are used to establish breeding stocks.

### *Materials and Methods*

The specimens described came from delphinids maintained in captivity for varying periods under essentially similar basic conditions with regard to being in tanks but under quite different ones as regards environment, "social" and "in captivity" conditions. The lack of knowledge regarding the optimum conditions for breeding became apparent at the Workshop mentioned above. As much information as possible was obtained about the reproductive history of each female as far as the well known difficulties allowed in this respect. The ovaries, genital tract, endocrine organs and mammary glands were examined personally whenever possible. Teeth were extracted for aging, and the skeletal characteristics noted, but it is suspected that conclusions based on such criteria must be vitiated by even relatively short periods in captivity. Tissues available were examined by standard histological and special methods to endeavour to isolate differences in function and maturity. Essential measurements were taken, often by persons thanked in the Acknowledgements to whom we are much indebted.

### *Ovarian appearances*

The following animals died after varying periods in captivity and some details of their reproductive activities are available.

MM. 128 *T. truncatus* 193 cm. Taken off Florida in 1971, this female had been in captivity for five years when it died suddenly in S. California in May, 1976, from pneumonia. It had been in contact with males for three years and constant "sexual activity" had been observed.

The right ovary (5.05 g) and the left (5.36 g) were similar in appearance. No corpora were present. There were numerous follicles up to 1.5 mm in both ovaries but no large ones. The lack of corpora and large follicles suggests that this female was not sexually active.

MM. 150 *T. truncatus* 230 cm. Transferred from Florida to England where it died in January, 1977, with ulceration of the oesophagus and stomach probably related to candidiasis. There is no other past history except that the animal had not been pregnant and was considered to be about ten years old.

The right ovary (2.4 g) and the left (2.9 g) were similar in that they lacked corpora and no large follicles were present.

MM. 140 *T. truncatus*. This female had been in captivity in S. California for five years. The ovaries weighed 5.7 and 2.8 g and were similar in that they contained neither corpora nor large follicles.

MM. 136 *T. truncatus* 238 cm. This female was taken off Florida in 1972 and died after four years in captivity in S. California in November, 1976, from a sudden onset obstructive hepatitis. It had been in different pools with males and at the time of death was the "number two" female in a social group of five animals containing males. "Semi-active" sexual behaviour had been observed.

The right ovary (3.94 g) and left (4.94 g) ovary were similar in appearance and lacked corpora. Both contained many small follicles up to 2 mm in diameter and the left ovary had several follicles 3 - 4 mm in diameter. The general appearances were those of inactive gonads, and there was no evidence of past activity in that there were no corpora albicantia.

MM. 114 *T. truncatus* 239 cm. This female was transferred from Texas to South Africa where it died from massive gastric ulceration and enteritis in January, 1976. Nothing else is known about its past history.

The right ovary (2.4 g) and the left (2.4 g) were similar. No corpora and no large follicles were present. The ovaries are remarkably small and inactive considering the length of the animal.

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- Fig. 1. The left ovary of MM. 121 *Tursiops truncatus*.  
Fig. 2. The same ovary opened to show the two large corpora lutea.  
Fig. 3. MM. 113 *Tursiops truncatus* shows a right ovary with two corpora lutea and a left ovary without corpora.  
Fig. 4. MM. 162 *Tursiops truncatus* left and right ovaries. The left has nine corpora albicantia whilst the right ovary is composed almost entirely of two large follicles and one corpus albicans seen at lower left.  
Fig. 5. A series of slices cut through the right ovary of MM. 113 shows the two corpora lutea and the five obvious corpora albicantia.

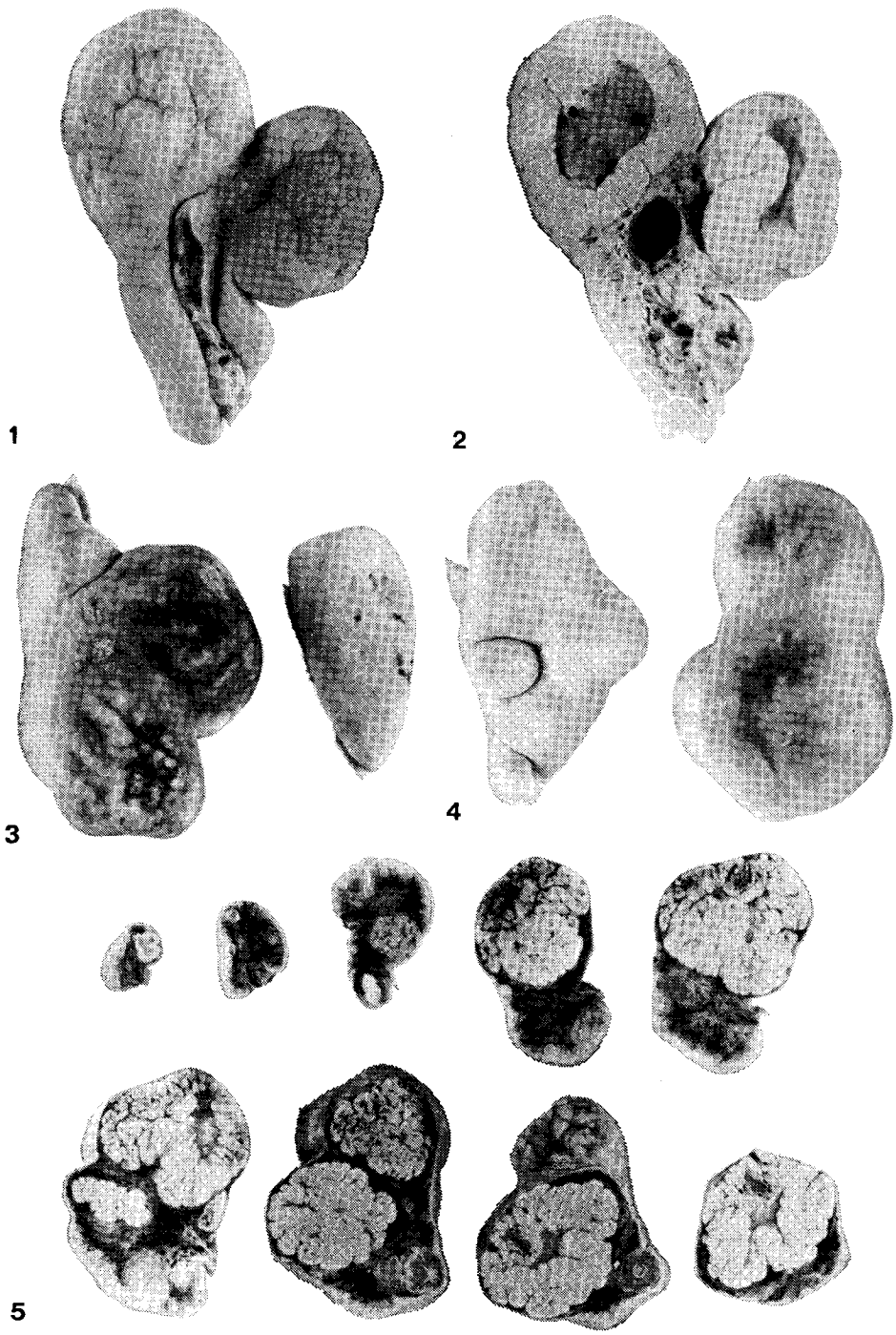


Plate 1.

MM. 121 *T. truncatus* 219 cm. Captured off the Bahamas in the summer of 1974, this female gave birth in S. Europe on the 26th December, 1974, and died of pulmonary fibrosis and congestive heart failure eighteen months later in June, 1976. It had been with two immature males before death and much "sexual activity" had been observed but it is not known if copulation took place.

The right ovary (4.5 g) lacked corpora but contained several follicles up to 6 mm in diameter. The left ovary (13.5 g) possessed two corpora lutea (23 x 21 x 19, 22 x 17 x 16 mm) with central cavities and two corpora albicantia both 4 x 4 x 3 mm. There was also a cystic follicle 8 mm in diameter and several healthy follicles up to 6 mm in diameter.

MM. 151 *T. truncatus* 228 mm. Taken off the Bahamas in the summer of 1974, this female died in February 1977, after two and half years in captivity in S. Europe. The cause of death was heart failure due to pulmonary fibrosis from lungworm infestation. It had not been pregnant in captivity and had been violently attacked by two immature males on many occasions. "Sexual activity" was also observed. It had been maintained on low level corticosteroid therapy (5-10 mg betamethasone daily) for twelve months before death. At post mortem the anus was found to open caudal to the urogenital slit, and there were severe superficial bite wounds.

The right ovary (4.5 g) contained two corpora albicantia (9 x 8 x 7, 7 x 7 x 6 mm) and a small follicle (7 x 5 x 5 mm) and two bright orange bodies (4 x 3 x 3, 3 x 2 x 2) which exhibited a form of lipophanerosis.

"Wave", *T. truncatus* 228 cm. Captured off Florida, this female was transferred to S. California in 1960 (PRESCOTT, 1975) along with another in 1961. The two females gave birth to three calves from 1962 - 1967, and probably a fourth, but its exact parentage is unknown. "Wave" became pregnant in 1968 (PRESCOTT, 1975) but died in August 1969 after the birth of a 124 cm male calf.

The right ovary (7.1 g) contained no corpora nor any large follicles. The left ovary (22.4 g) possessed a corpus luteum (26 x 26 x 26 mm) and four small scars of corpora albicantia (each 3 x 3 x 3) but one of these was very likely the remnants of a lutealized follicle. J. H. Prescott has expressed to one of us his opinion that "Wave" probably had four young in captivity. This would fit with the ovarian appearances in that there were one corpus luteum, and three definite small corpora albicantia which could therefore be between seven and three years old.

MM. 113 *T. truncatus* 230 cm. This female had been in captivity in S. Europe for twenty months having been caught off the Bahamas in 1974. It had died on the 31st January, 1976, from mycotic pneumonia. It had received low doses of steroids; at post mortem there was evidence of hypothyroidism and adrenal atrophy. While in captivity it had been in contact with immature males. It had not become pregnant during captivity.

The right ovary (16.3 g) contained two large corpora lutea (26 x 20 x 20 and 23 x 21 x 21 mm) and five obvious corpora albicantia (9 x 6 x 7, 8 x 8 x 7, 7 x 6 x 4, 8 x 5 x 5, 5 x 4 x 4) as well as five other more superficial scars, presumably corpora albicantia (5 x 6 x 3, 5 x 6 x 3, 3 x 3 x 2, 6 x 2 x 2, 1 x 1 x 2). No large follicles were present, a few small ones up to 2 mm were scattered throughout the cortex. The left ovary (3.4 g) was small, lacked corpora, and exhibited only a few follicles up to 2 mm in diameter. The two corpora lutea had similar macroscopic appearances in that there was a small central cavity in each and the luteal tissue was arranged in lobules separated by narrow connective tissue septa.

MM. 162 *T. truncatus* 231.5 cm. Taken from the Gulf of Mexico and transported to England where it died from bronchopneumonia in May, 1977, after ten days in captivity. The mammary glands showed histological evidence of recent activity but most of the gland tissue had retrogressed.

The right ovary (22.5 g) possessed two large follicles (30 x 28 x 27, 24 x 21 x 20) which both appeared healthy and were lined by several layers of granulosa cells. A large corpus albicans (20 x 12 x 10) still possessed patent blood vessels containing red cells and appeared to be one of the youngest in our collection. The left ovary (9.9 g) had nine corpora albicantia (15 x 14 x 10, 13 x 10 x 9, 9 x 8 x 7, 9 x 7 x 6, 9 x 7 x 6 and four more about 7 x 6 x 6). There were several small follicles 2 - 3 mm in diameter, a few atretic pigmented follicles but no large follicles.

Although nothing is known of the past history of this female, whether or not it was accompanied by a calf at sea, nor how long it was held before being transported, the findings suggest that it had recently ceased suckling and had developed two large follicles. The size of the largest corpus albicans, compared with those in other females, suggests that it is related to a recently terminated pregnancy, which could have terminated a month or two previously.

MM. 116 *T. truncatus* 234 cm. Taken off Florida in October, 1975, this female was in captivity in S. California for two months during which time it lost 20 kg in weight and was emaciated at death in late December. It was not pregnant.

The right ovary (9.3 g) contained a retrogressing papilliform luteum (14 x 13 x 11) and five obvious corpora albicantia (12 x 12 x 10, 11 x 10 x 9, 10 x 9 x 7, 6 x 6 x 5 mm). No large follicles were present. The left ovary (3.4 g) lacked corpora and no follicles were visible.

MM. 124 *T. truncatus*. Taken off Florida this mature female had been in captivity in England for some years and was said to have had four stillborn young. It died of systemic candidiasis in August, 1976 : its tail stock was severely kinked so that its length could not be measured.

The right ovary (8.2 g) contained one corpus albicans (13 x 13 x 13 mm) but no large follicles. The left ovary contained five corpora albicantia (10 x 10 x 9, 10 x 8 x 7, 9 x 8 x 7, 9 x 6 x 5, 7 x 5 x 5) but no large follicles. A large cyst 45 mm in diameter was present in the left mesovarium.

MM. 68 *T. truncatus* 235 cm. This female was captured off Mississippi in August, 1971, and was for fourteen months in a tank in S. California with a mature male. It probably became pregnant in January or February, 1972, and died in labour in January, 1973.

The right ovary (3.7 g) contained eight structures resembling corpora albicantia (11 x 8 x 5, 9 x 9 x 5, 10 x 8 x 5, 4 x 3 x 3, 3 x 3 x 3, 5 x 4 x 4, 3 x 2 x 2, 3 x 2 x 2) and a corpus atreticum (14 x 7 x 5) which was distinguished as a body consisting only of an aggregation of disorganised thecal cells without vascularization. The left ovary contained a large corpus luteum (31 x 30 x 24 mm), an accessory corpus luteum (12 x 10 x 6) and three corpora albicantia (12 x 10 x 8, 16 x 9 x 6, 6 x 3 x 3). The corpora luteum must be related to the pregnancy, and therefore the largest corpus albicans (16 x 9 x 6) could have been related to a previous ovulation before the female was taken and is therefore at least one year old, unless of course it were the result of an infertile ovulation just before it became pregnant in January, 1972, in which case it was about thirteen months old (but this is unlikely, see p. 66).

MM. 57 *T. truncatus* 235 cm. This female was taken off Florida in June, 1970 and gave birth in September, 1970 to a 103 cm foetus, but died in June, 1971, in captivity in S. California.

The right ovary (5.35 g) contained four corpora albicantia (16 x 14 x 14, 15 x 14 x 13, 10 x 10 x 9, 8 x 8 x 7). The left ovary (5.75 g) also contained four corpora albicantia (11 x 10 x 8, 10 x 8 x 8, 9 x 9 x 6, 7 x 7 x 7). There were no large follicles in either ovary. The largest corpus albicans could be the one related to the birth in September, 1970; it would then be at least eight months old at death, but one or more of the larger ones could be the result of postpartum ovulations.

MM. 93 *T. truncatus* 247 cm. Taken off Florida, this female gave birth in S. California in November, 1970, and died from haemorrhagic pneumonia in February, 1974. It did not become pregnant after the birth in 1970. From its tooth count it was considered to be about 23 years old.

The right ovary (9.4 g) contained seven corpora albicantia (9 x 9 x 9, 9 x 8 x 7, 8 x 5 x 7 x 8.5, 8 x 7 x 7, 8 x 6 x 5, 6 x 5 x 6, 3 x 3 x 3 mm). There were no large follicles. The left ovary (3.9 g) did not have any corpora and lacked large follicles. It could be argued that the largest corpus albicans is about three years old.

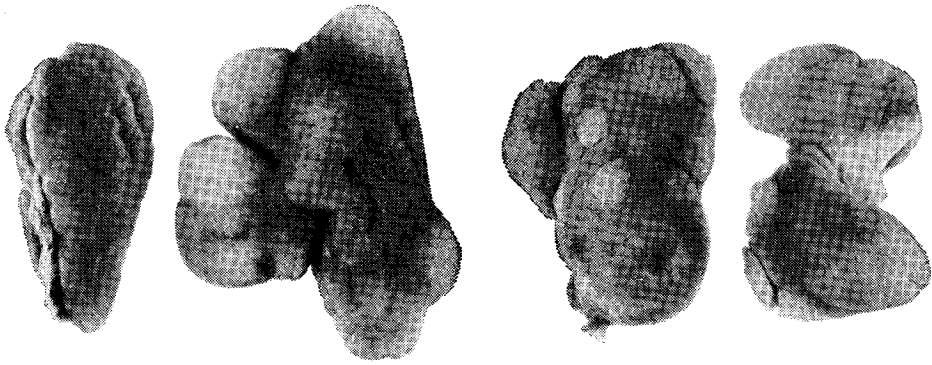
MM. 78 *T. truncatus* 249 cm. Captured off Gulfport, Mississippi in July, 1971, this female was in a tank in S. California with an active male and gave birth in October, 1972. The female suckled the calf until it died in April, 1973, after which the female deteriorated and died in August, 1973.

The right ovary (9.3 g) contained twelve corpora albicantia of which the largest was 14 x 14 x 13 mm and the others were 13 x 12 x 12, 12 x 11 x 10, 10 x 10 x 7, 9 x 8 x 4.5, 8 x 8 x 6.5, 9 x 8 x 4, 9 x 8 x 3, 9 x 7 x 3.5, 7 x 5 x 4, 6 x 5 x 3, 5 x 3 x 3 mm. No large follicles were present but there were some small masses (2 - 3 mm) of lutealized tissue. The left ovary (1.6 g) was small and lacked both corpora and large follicles. It could be maintained that the largest corpus albicans was ten months old.

MM. 109 *T. truncatus* 258 cm. This female had been a 'feeder' animal in S. California until transferred to England in February, 1975, where it died fourteen months later in June, 1976, from myocardial fibrosis and heart failure. It had not been pregnant and no definite evidence of association with males could be elicited. Low dose steroid therapy had been administered for some months.

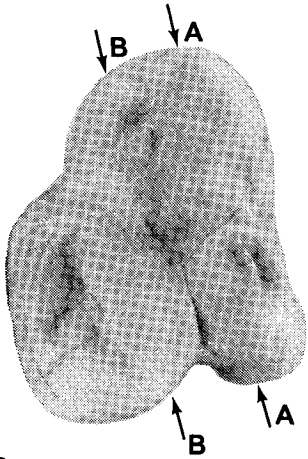
The right ovary (5.9 g) possessed a follicle 8 mm in diameter and several up to 5 mm.

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- Fig. 6. The ovaries of MM. 116 *Tursiops truncatus* showing corpora albicantia only in the right ovary.
- Fig. 7. MM. 57 *Tursiops truncatus* showing corpora albicantia in both ovaries.
- Fig. 8. MM. 109 *Tursiops truncatus* left ovary cut through at A and B to show the four unruptured follicles and some of the many corpora albicantia.
- Fig. 9. MM. 118 *Tursiops aduncus* showing a corpus luteum of pregnancy in the left ovary.
- Fig. 10. MM. 137 *Langenorhynchus obliquidens* showing the packed corpora albicantia at one pole in the left ovary, and two isolated corpora albicantia in the right ovary.

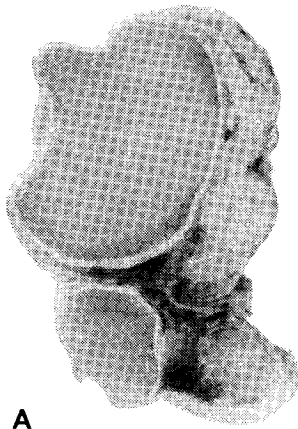


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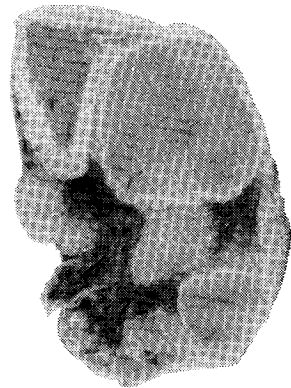
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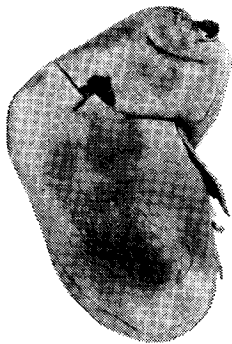
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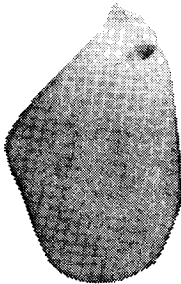
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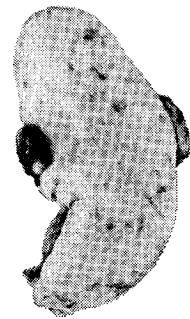


Plate 2.

The left ovary (51.9 g) contained four large unruptured follicles from 20 to 32 mm in diameter the walls of which all showed varying degrees of lutealization. There were thirteen corpora albicantia varying from 15 x 12 x 10, 13 x 10 x 11, 11 x 10 x 10, 10 x 9 x 7, 9 x 8 x 7, 9 x 8 x 7, 9 x 6 x 6 to 8 x 8 x 5, 7 x 7 x 5, 7 x 6 x 6, 6 x 5 x 4, 5 x 5 x 5, 6 x 4 x 4 mm.

MM.118 *T. aduncus* 190 cm. Ovaries from a female captured near Indonesia in July, 1975, that died after birth of a 60.3 cm foetus sixteen days later have been provided by J. F. Allen.

The right ovary (4.5 g) contained two corpora albicantia (8 x 8 x 7, 7 x 7 x 5) and a follicle 10 x 8 x 8 mm. The left ovary possessed a corpus luteum 23 x 20 x 17 mm.

MM. 141 *T. gilli* 307 cm. This female was taken in August, 1969, and gave birth to a stillborn calf at full term in April, 1973, and to another also at full term in May, 1975. It died in September, 1976, having exhibited mating behaviour throughout captivity.

One ovary was small and lacked corpora and large follicles. The other ovary contained six corpora albicantia (12 x 9 x 6, 8 x 6 x 5, 7 x 7 x 7, 7 x 6 x 5, 5 x 5 x 4). There were no large follicles but there were several small orange atretic follicles. From the history of this animal, and if the pregnancies and corpora are related, then the largest could be sixteen months old and the next largest would then be three years and four months old.

MM. 137 *L. obliquidens* 216 cm. This female was taken off S. California in February, 1972. A stillborn foetus of 101.6 cm was delivered in May, 1974, and another 109.2 cm in July, 1975. The female was isolated with the same male at various times during the four year captivity period. It died from injuries received after a fight with a *T. gilli* in August, 1976. There had not been any sexual behaviour during the period before death.

The right ovary (4.32 g) contained two corpora albicantia (10 x 8 x 6, 9 x 7 x 6), they were the largest and were presumably related to the pregnancies in 1975 and 1974. The left ovary (5.45 g) contained twelve corpora albicantia so closely packed at one pole of the ovary that it was impossible to measure them accurately in more than two dimensions (8 x 8, 8 x 7, 7 x 7, 8 x 6, 7 x 5, 7 x 6, 6 x 6, 6 x 5, 4 x 4, 5 x 4, 4 x 3).

MM. 126 *L. obliquidens* 213 cm. This female was taken off S. California in October, 1970, and was in captivity for nearly six years until it died from septicemia in July, 1976. It had been with males known to be fertile off and on over this period and mating had been observed many times. There is no record of a pregnancy.

The right ovary (2.7 g) contained one corpus albicans (5 x 5 x 5) and the left (6.78) possessed five (3 x 10 x 10, 10 x 8 x 6, 11 x 10 x 6, 10 x 10 x 7, 10 x 9 x 6). No large follicles were present in either ovary. The corpora in the left ovary looked more recent than those in MM. 137 and are thus considered to have been formed during captivity.

#### Discussion

There is considerable variation in the length of *T. truncatus* females brought into captivity at the time of onset of ovarian activity. Females of 193, 230, 238 and 239 cm in length had inactive ovaries even though their curators had observed much "sexual



activity" by some of them. On the other hand, several females from 219 to 228 cm had already established a considerable reproductive past history. Undoubtedly the population of origin has significance as regards state of physical development but other factors must also be involved in determining the length at puberty. Clearly it would be foolish to ignore the origin of any delphinid brought into captivity.

The apparently seasonal display of "sexual behaviour" of captive delphinids has led to a suspicion that *Tursiops* is seasonally polyoestrous. Indeed, HARRISON and RIDGWAY (1971) reported that births in captivity of this species took place either in the period March to May or from August to November, which implies a mating season over these two periods. If captive *Tursiops* were polyoestrous, even for short periods, this would mean a succession of regularly spaced spontaneous ovulations unless the female became pregnant at the first ovulation of each period of seasonal activity. If this were not to happen there should be a display of the successive stages of maturing follicles, corpora lutea of the cycle, retrogressing corpora lutea and all the associated reproductive phenomena in organs such as the uterus and vagina. These have not yet been demonstrated and there is not all that much evidence in this albeit limited series of it happening as a regular occurrence. Indeed, the most striking feature of this series is the lack of evidence of follicular activity, a finding that makes one question whether there is some factor in captivity that suppresses follicular activity.

The interpretation of ovarian appearances in captive *Tursiops*, as in other cetaceans, has to be based on certain assumptions. Firstly, it is assumed that every corpus luteum, however it may be formed, persists as a corpus albicans which shrinks gradually in size but remains in the ovary until death. Secondly it is assumed that there is no difference between corpora albicantia whatever their origin. Efforts have been made to distinguish corpora albicantia of the cycle or of pseudopregnancy and of pregnancy but so far with little success (HARRISON, BROWNELL and BOICE, 1972). These findings suggest that in captivity some mature *Tursiops* kept with immature males exhibit infertile ovulations with the formation of well developed corpora lutea. These seem to be the result of induced ovulation, not of a regular cycle, possibly also stimulated by the steroids administered therapeutically. Also, accessory corpora lutea (lutealized follicles) can accompany corpora lutea of pregnancy, corpora atretica can occur as well as other forms of atretic follicles resembling the "orange bodies" found in larger cetaceans (LAWS, 1957). If these types of corpora lutea become persistent corpora albicantia, then it will be all the more difficult to interpret the past reproductive history from their number and size.

The corpus luteum of *T. truncatus* at parturition has a volume of about 9200 - 11900 mm<sup>3</sup>, this means with an average diameter of between about 26 and 28 mm. The most reliable evidence from the material investigated suggests that after eight months the corpus albicans could have shrunk to about 1650 mm<sup>3</sup> (av. diam. 14.6 mm), after ten months to 1330 mm<sup>3</sup> (av. diam. 13.6) after one year to 577 mm<sup>3</sup> (av. diam. 10.3 mm), after three years to 380 mm<sup>3</sup> (av. diam. 9 mm), and after seven years to as small as 14 mm<sup>3</sup> (av. diam. 3 mm). KASUYA, MIYAZAKI and DAWBIN (1974) after examining a much greater number of wild *Stenella attenuata* found that from a mean diameter of the corpus luteum of 22.08 mm, the corpus albicans shrinks rapidly to about 7 mm after eight months, more slowly to 6 mm after some eighteen months to two years, and reaches a final diameter of 2 - 3 mm after seven years and may stay in the ovary until the female reaches an age of more than forty years. While the corpora albicantia in *T. truncatus* do not seem to regress as fast as in *S. attenuata* it must be emphasized that (a) many young born in captivity are stillborn or do not survive for

long (b) that a postpartum ovulation could have occurred and its corpus albicans could have been confused with that relating to the previous pregnancy. MM. 68, however, died in labour and presumably its largest corpus albicans (10.3 mm) will be at least a year and a month or two old. In other female *T. truncatus*, not in the above series, one died a year after giving birth and had corpora albicantia of 7.7, 6.7, 6.3, and 4.6 and 4.3 mm; another died just over four months after parturition and had corpora albicantia 10.6, 8.7 and 8.7 mm, another died a few weeks after parturition with a single retrogressing corpus of 18.7 mm, and two died in labour at full term with corpora albicantia of 7.7 and 7.3 mm, and 6.7 and 4.3 respectively in addition of course to the corpora lutea of the pregnancies. These findings at least confirm that a corpus albicans in *Tursiops* could shrink to 10 mm in diameter, or even less, in one year.

#### *Acknowledgements*

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