ON THE FORMATION AND REGRESSION OF CORPUS LUTEUM IN THE NORTHERN FUR SEAL OVARIES

KAZUMOTO YOSHIDA, NORIHISA BABA

Far Seas Fisheries Research Laboratory, Shimizu

MACHIKO OYA AND KAZUHIRO MIZUE

Ocean Research Institute, University of Tokyo, Tokyo

ABSTRACT

Corpus luteum and the process of its formation in fur seal ovary, collected around the Robben Island in the Okhotsk Sea, were studied. The regressive phases of follicle and courpus luteum were examined histologically. There are two kinds of corpus luteum, one is formed inside the vesicular follicle after ovulation, the other is formed outside the follicle without ovulation. The former is the true corpus luteum and the latter is the accessory corpus luteum or corpus atreticum. The function of corpus luteum graviditatis degenerates in the last stage of pregnancy. Corpus albicans originated from the true corpus luteum is distinguished from the corpus atreticum clearly. The former exists for about two years in the ovary and then disappears, but the latter vanishes shortly.

INTRODUCTION

There are many informations about the mammalian ovaries including human race. Since the fur seal is a kind of marine mammal but goes ashore during some months once a year for reproduction, its sexual cycle, age and growth were made clear by various authors. But microanatomical studies of the reproductive tracts are still rather scanty. Craig (1964), Enders *et al.* (1946), and Pearson and Enders (1951) report ovarian cycle for seals taken in the eastern Pacific and on the Pribilof Islands respectively. However, there is no report on the microanalisis of reproductive organs on the Robben and Commander fur seals.

In the field observation of fur seals for the purpose of the stock assessment, numbers of corpus luteum and corpus albicans are counted, but the disappearing process of corpus luteum and corpus albicans can not be followed sufficiently by this method and further the corpus albicans can not be identified from corpus atreticum by macroscopical observation. The disappearing processes of corpus luteum and corpus albicans were not treated sufficiently in the aforesaid reports.

We report in this paper on the corporal cycle in the fur seal ovaries taken in the seas around Robben Island between July and October 1975.

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MATERIAL AND METHOD

The Fur Seal Section of the Far Seas Fisheries Research Laboratory, Japanese Fisheries Agency, took fur seals in the seas around Robben Island in 1975 for the purpose of stock assessment and their reproductive tracts were preserved in 10% formalin after field biological investigation. We have sampled randomly 117 pairs of ovaries from these, which consisted of ovaries from 11 immature females, 11 ovulated females for the first time this year, 29 nonpregnant females but ovulated in preceding breeding season, 23 ovulated females this year but non-ovulated in preceding breeding season, and 43 pregnant females. These ovaries were weighed their weight, then sliced to the thickness of about 2 mm, and measured the diameter of corpus luteum in three dimensions, counted the number of corpus albicans, and measured the diameter of the largest Graafian folicle. And then all ovaries were further sliced into thin sections, embedded in paraffin, and these sections were stained by compound stain method of Mayer's haematoxylin and eosin, and then observed. Age of these fur seals was determined by annual rings in the upper and lower cuspids.

OBSERVATION AND RESULT

(1) *Regression of follicle*

Section of the pup ovary of about three months after birth is indicated in Plate I-1 which contains many small follicles. Very few follicles among them develop to large size and finally ovulated, but many other follicles would be regressed, because it can be seen that there are many corpora atretica and follicles in process of degeneration and contraction. Plate I-2 shows ovary of 2 years of age, immature female, which contains many large follicles and this specimen was collected in the middle of October. In this investigation mature females had no large follicle in the ovaries at this time of the season, owing to their functional corpus luteum, but in the ovaries of immature females, a number of comparatively large follicles are present, due to the fact that they have no functional corpus. Plate I-3 shows matured ovary of 14 years of age. A functional corpus luteum caused by ovulation of this reproductive season exist in this section. Since this specimen was collected towards the end of July, it is not clear whether this is corpus luteum graviditatis or corpus luteum of without gravidity. (Craig, 1964; Enders *et al.*, 1946; Pearson and Enders, 1951). In addition there are corpus albicans and corpora atretica resulted from Graafian follicles in this figure.

Enlarged follicle figure in the process of regression existed in pup ovary of Plate I-1 is shown in Plate I-4. Oocyte is actualized in this figure but stratum granulosum begins to degenerate, and in antrum folliculi, a sort of phagocyte which is usefull for exhaustion are observed in abundance, and the basement membrane transformed to glassy membrane by distortion and increase of thickness. The former term of vesicular follicle in the progress of development which is similar to that of the other mammals is shown in Plate II-1. Contraction of the vesicular

follicle, the stratum granulosum degeneration in the first place, and then in oocyte are shown in Plate II-2. In corpus atreticum distortion has occurred and thickened glassy membrane, and in Plate II-3, there are no oocyte and stratum granulosum. This corpus atreticum existed abundantly in ovary and it can be distinguished from corpus albicans resulted from corpus luteum distinctly and it seems that these corpora atretica vanishes rapidly.

The figure of large vesicular follicle which contracted already is shown in Plate II-4. The glassy membrane in this figure thicken increasingly than the former, but it is the same in fundamental structure as corpus atreticum.

(2) *Corpus luteum and its degeneration*

The aspect just ruptured to release an ovum from a ripened vesicular follicle is shown in Plate III-1. In this figure, liquor folliculi and blood are still exist in antrum folliculi, stratum granulosum along interna of theca folliculi increases the thickness exceedingly and follicular epithelial cells formed stratum granulosum begin to expand and change to lutein cell in the enlarged figure. It is thought that fur seal corpus luteum is originated mainly from the cells of stratum granulosum and not from theca interna of folliculi.

TABLE 1. CORPUS LUTEUM DIAMETERS IN mm AFTER OVULATION BY MONTHS

	Vertical diameter	Lateral diameter	Height
July	8.0	7.4	8.5
August	10.0	8.7	9.7
September	11.3	10.4	10.5
October	14.0	12.7	13.5

The corpus luteum resulted from an ovulation about two months before is shown in Plate III-2, a specimen from mid September. In the fur seal corpus luteum is contained within the ovary like in many other mammals, though in whales it is usually protruded from the ovary. Other corpus luteum constituted around the outside of vesicular follicle, beside formal corpus luteum, is observed in Plate III-2. Such corpus luteum is not rare in fur seal ovary, like in ovaries of whales (Harrison *et al.* 1972). It seems that the lutein cells of such corpus luteum are originated from theca follicular cells and perform the same function as formal one besides suppressing the development of its inside follicle. The lutein cells in formal corpus luteum resulted from an ovulation of about three months before are enlarged in Plate III-3, a specimen from mid October. This figure shows the most active appearance of lutein cells and there are many secretions in the protoplasm of these cells and around them. The lutein cells in corpus luteum formed around vesicular follicle show the same histological appearance in this season too.

In Table 1 corpus luteum measurements in three dimensions are arranged in the order from July to October. The corpus luteum which was formed in early

July by ovulation increases its size during the progress of month and increases its function gradually, as shown in Table 1 clearly. And no difference in the size of corpus luteum by ages, from three to twenty years, is noted.

After fur seals went ashore for reproduction and delivered a calf, the ovulation is taken place within one week. Consequently it might be necessary that the regression of the lutein cells should begin towards the latter of the pregnancy. Craig (1964) describes that the corpus luteum graviditatis of the fur seal in the eastern Pacific is functional until February and begins to degenerate after that. His description agrees with ours. The histological figure of corpus luteum graviditatis of pregnant animal prior to delivery caught on 10 July is indicated in Plate III-4. In this figure lutein cells are almost degraded or fallen off and remains are small and not in complete phase. It is distinct that the aspect of this corpus luteum graviditatis does not perform the secretion, unlikely from the lutein cells in Plate III-3, and has the connective tissue penetrating into the structure of corpus luteum arborescently. As we have only specimens for four months, from July to October, we can not conclude definitly about the cycle of corpus luteum, but it is thought that the same pattern of corporal cycle of Robben seal, as reported by Craig (1964), would be followed by the eastern Pacific stock of the fur seal.

Table 2 shows the process of regression of the corpus luteum graviditatis, in diameters in three dimensions, from just before delivery to after birth. In spite of

TABLE 2. THE AVERAGE DIAMETER OF CORPUS LUTEUM IN mm BEFORE AND AFTER PARTURITION

		Vertical diameter	Lateral diameter	Height
Corpus luteum just before parturition		18.9	14.2	15.5
Corpus luteum after parturition	July	11.2	10.4	13.0
(corpus albicans)	August	10.6	8.7	10.9
	September	8.7	8.5	8.9
	October	8.6	7.3	8.5

the unfunctional lutein cells, the size of this corpus luteum is larger than that shown in Table 1, so it is concluded that the corpus luteum enlarges continuously since ovulation. Fur seal fertilized ovum remains free in the lumen of uterine horns and does not implant for about four months and placentation is established after implantation (Craig, 1964; Enders *et al.*, 1946; Pearson and Enders, 1951). It seems possible that this phenomenon occurs not only in fur seal but also in all Pinniped animals (Matthews and Harrison, 1949). The corpus luteum without pregnancy, or in the case of unfertilization or unimplantation it does not contract rapidly, unlikely to whales, because it has enough time for contraction until next reproductive season and contractive process is thought to be same to that of corpus luteum graviditatis. Pearson and Enders (1951) describes that the fur seal corpus luteum which has not accompanied by a pregnancy follows even in the latter part of March same phase of corpus luteum graviditatis and this is similar to our result. The corpus albicans originated from corpus luteum without pregnancy in the

preceding breeding season, and from an animal caught in 6 August, is shown in Plate IV-2. The size and the stage of degeneration of this corpus albicans is same to that of Plate IV-1. From Table 2, the corpus luteum graviditatis contracts rapidly just after whelping, but the pace of contraction become slow after that.

The corpus albicans two months later from the parturition is indicated in Plate IV-1, in which no lutein cell is observed naturally. And this is a typical corpus albicans originated from the true corpus luteum and it shows quite different phase, compared with the accessory corpus luteum or corpus atreticum originated from vesicular follicle. Laws (1958) discusses about the differences between the corpus albicans resulted from corpus luteum graviditatis and that without pregnancy in whales, but in the fur seal, there is no difference between both corpora albicantia from the starting points of ovulations.

(3) *Corpus albicans and its degeneration*

The corpus albicans disappears within a comparatively short span of time in most mammals, but in whales the corpus albicans persists in the ovaries throughout the life. This is thought to be based on the fact that their ovaries are large enough for admiting the persistence of all corpora albicantia, but in the fur seal, the ovary is small and has no core in the center of corpus albicans, unlikely to whales. Accordingly, the disappearing period of corpus albicans is not short in the fur seal, compared with other mammals. It does not remain, however, in the ovary throughout the life.

A contracted figure of corpus albicans after one year since parturition is shown in Plate IV-3. Its surrounding parts are torn to pieces and has disappeared and became smaller. There are many ovaries in our specimens which have such a corpus albicans, collected from animals one year after parturition, in which twenty percent have vanished within one year, and this rate is higher in younger animals than older. Plate IV-4 shows corpus albicans of an animal taken two years after parturition. Such an old corpus albicans which existed such long time is very seldom in the fur seal. According to our investigations, it is concluded that in the fur seal corpus albicans vanishes within three years after ovulation, though there are some individual variations. That is different from the finding of Pearson and Enders (1951) who describe that it disappears before the next ovulation from the same ovary, which means that the corpus albicans disappears within one year after parturition.

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EXPLANATION OF PLATES

PLATE I

Fig. 1. ×11.4, Histological section of fur seal pup ovary after three months from birth. Caught 11 October, 1975.

Fig. 2. ×5.7, Histological section of immature fur seal ovary, two years old. Caught 13 October, 1975.

Fig. 3. ×5.7, Histological section of mature fur seal ovary, 14 years old. Caught 31 July, 1975. It contains one functional corpus luteum resulted from this ovulation, one corpus albicans originated from corpus luteum and eight corpora atretica originated from vesicular follicle.

Fig. 4. ×380, Histological figure of small follicle in the progress of degeneration. The same ovary of Fig. 1.

PLATE II

Fig. 1. ×380, Early stage of vesicular follicle in the process of development, three years old. Caught 3 September, 1975.

Fig. 2. ×155, Degrading vesicular follicle, five years old. Caught 15 July, 1975. There is no stratum granulosum already and oocyte is degenerating.

Fig. 3. ×155, Corpus atreticum originated from vesicular follicle, from the same specimen shown in Fig. 2.

Fig. 4. ×51, Corpus atreticum originated from large vesicular follicle, eighteen years old. Caught 6 August, 1975.

PLATE III

Fig. 1. ×11.4, Ovulated follicle, four years old. Caught 29 July, 1975.

Fig. 2. ×5.7, Mature ovary, nineteen years old. Caught 14 September, 1975. In this section there are two kinds of corpus luteum, one is the formal by ovulation, the other is formed around the outside of vesicular follicle.

Fig. 3. ×760, Functional lutein cells, fourteen years old. Caught 11 October, 1975.

Fig. 4. ×155, Histological figure of corpus luteum graviditatis just before delivery. Fourteen years old. Caught 10 July, 1975. It is in the process of degeneration.

PLATE IV

Fig. 1. ×51, Corpus albicans after about two months from parturition. Seven years old. Caught 13 September, 1975.

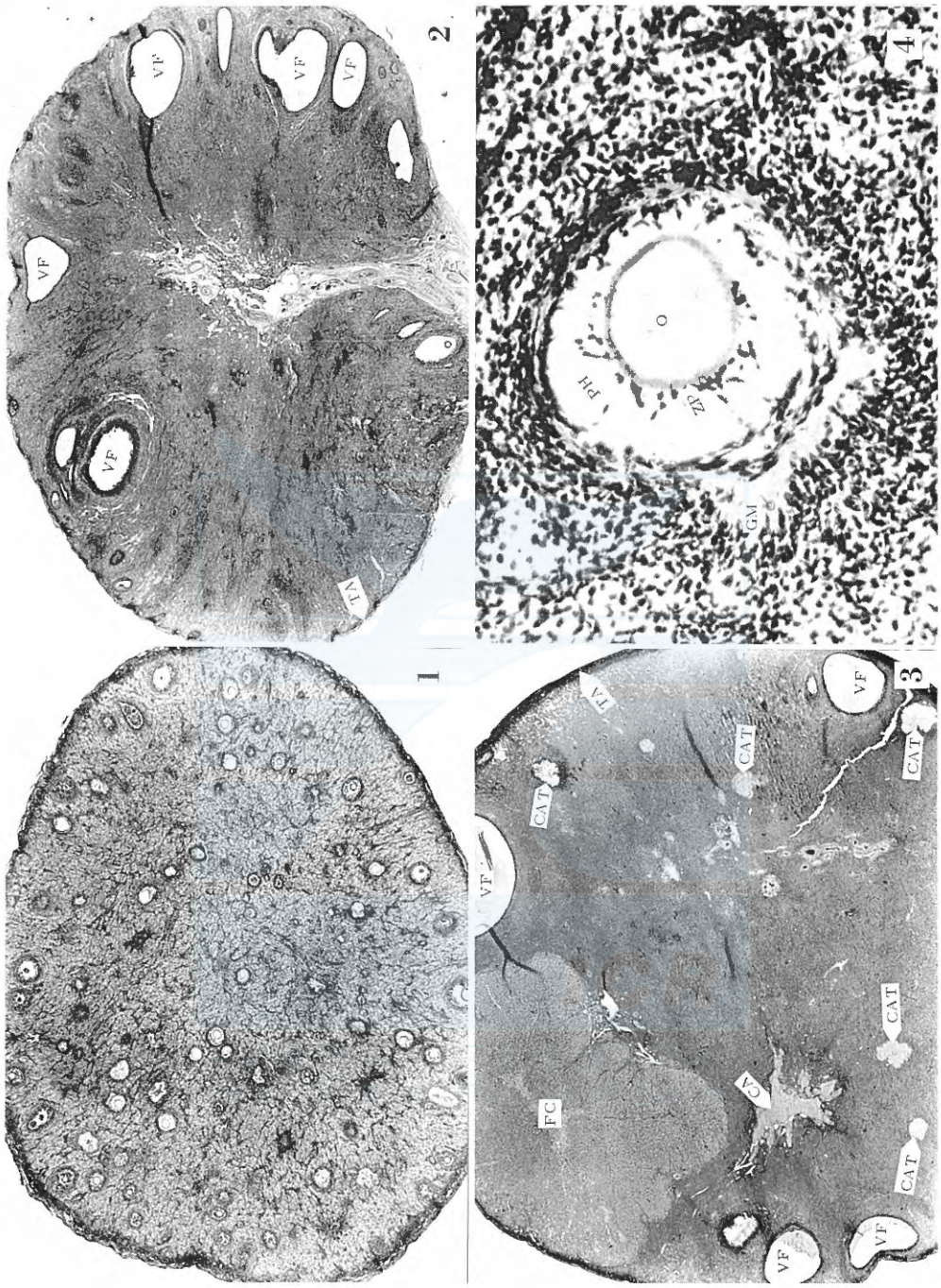
Fig. 2. ×51, Corpus albicans not accompanied by pregnancy passed about thirteen months after ovulation. Eighteen years old. Caught 6 August, 1975.

Fig. 3. ×51, Corpus albicans originated from corpus luteum graviditatis of about fourteen months after parturition. Six years old. Caught 28 September, 1975.

Fig. 4. ×51, Corpus albicans of about two years after parturition. Fifteen years old. Caught 3 July, 1975.

EXPLANATION OF SYMBOLS IN PLATES

AF	Antrum folliculi
BM	Basement membrane
CA	Corpus albicans
CAT	Corpus atreticum
CLF	Corpus luteum formed around the follicle
CO	Cumulus oophorus
FC	Functional corpus luteum
GM	Glassy membrane
LC	Lutein cell
LF	Liquor folliculi
N	Nucleus
O	Oocyte
P	Protoplasm
PH	Phagocyte
S	Secretion
SG	Stratum granulosum
TA	Tunica albuginea
TF	Theca folliculi
VF	Vesicular follicle
ZP	Zona pellucida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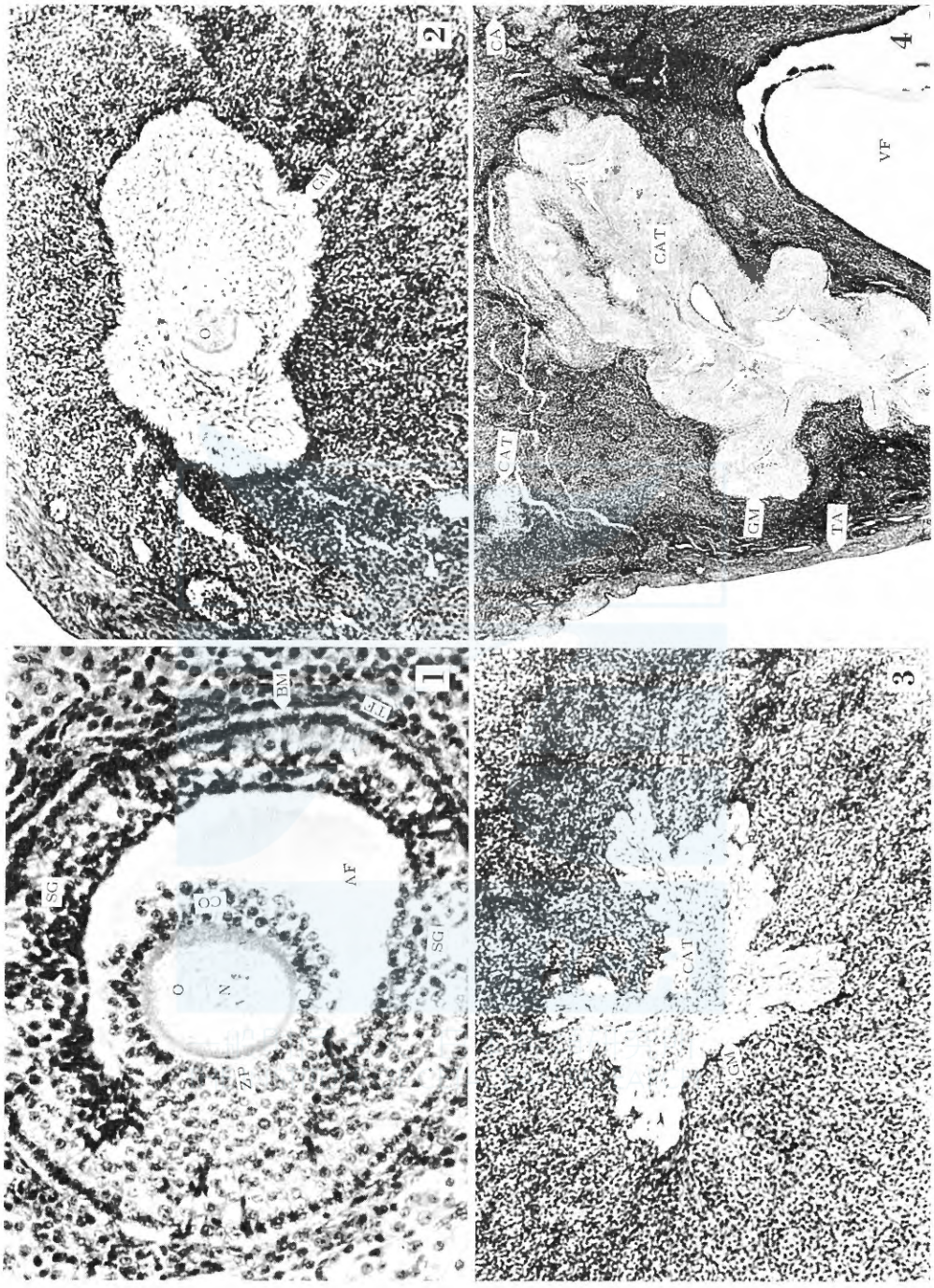
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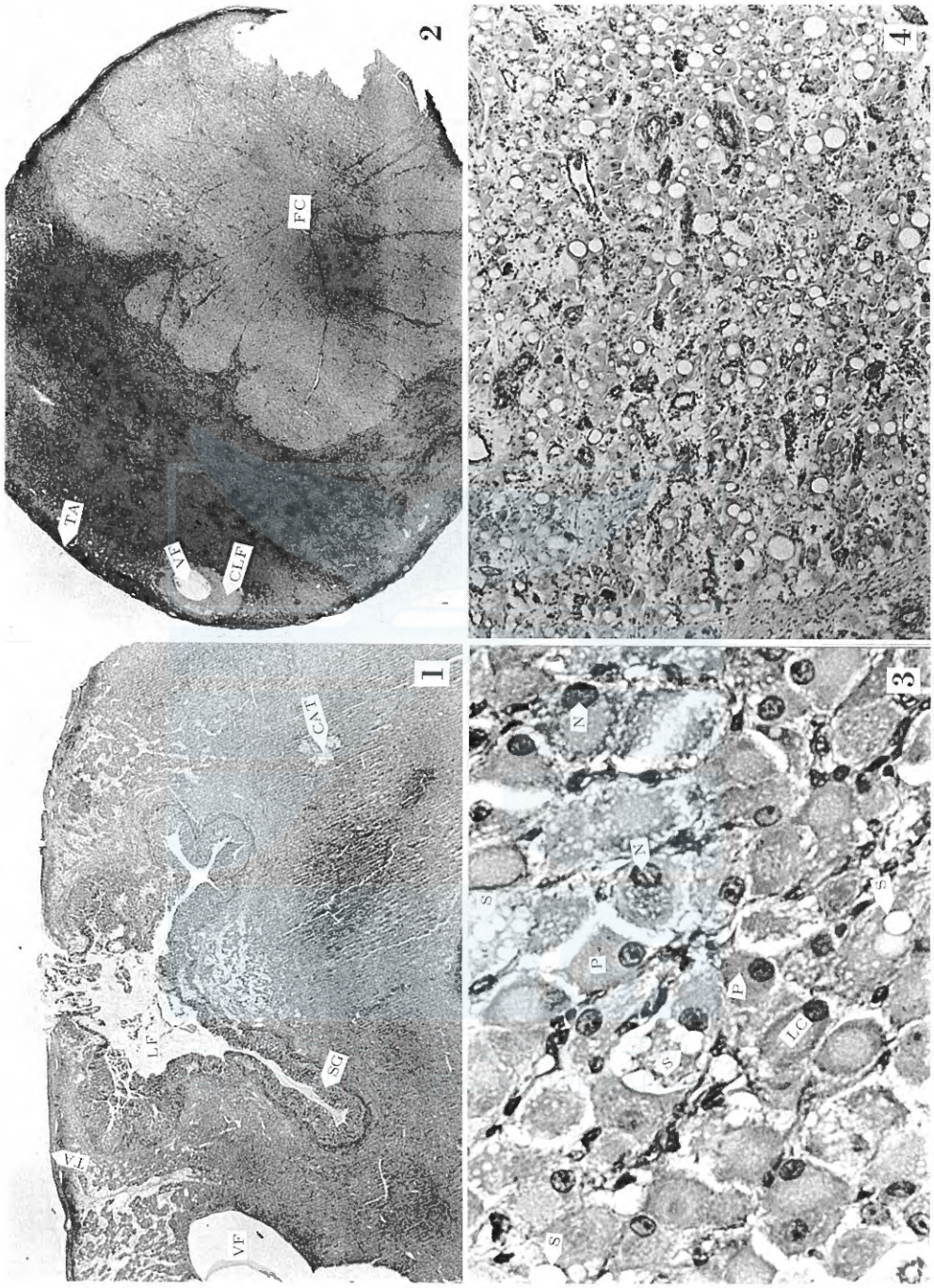
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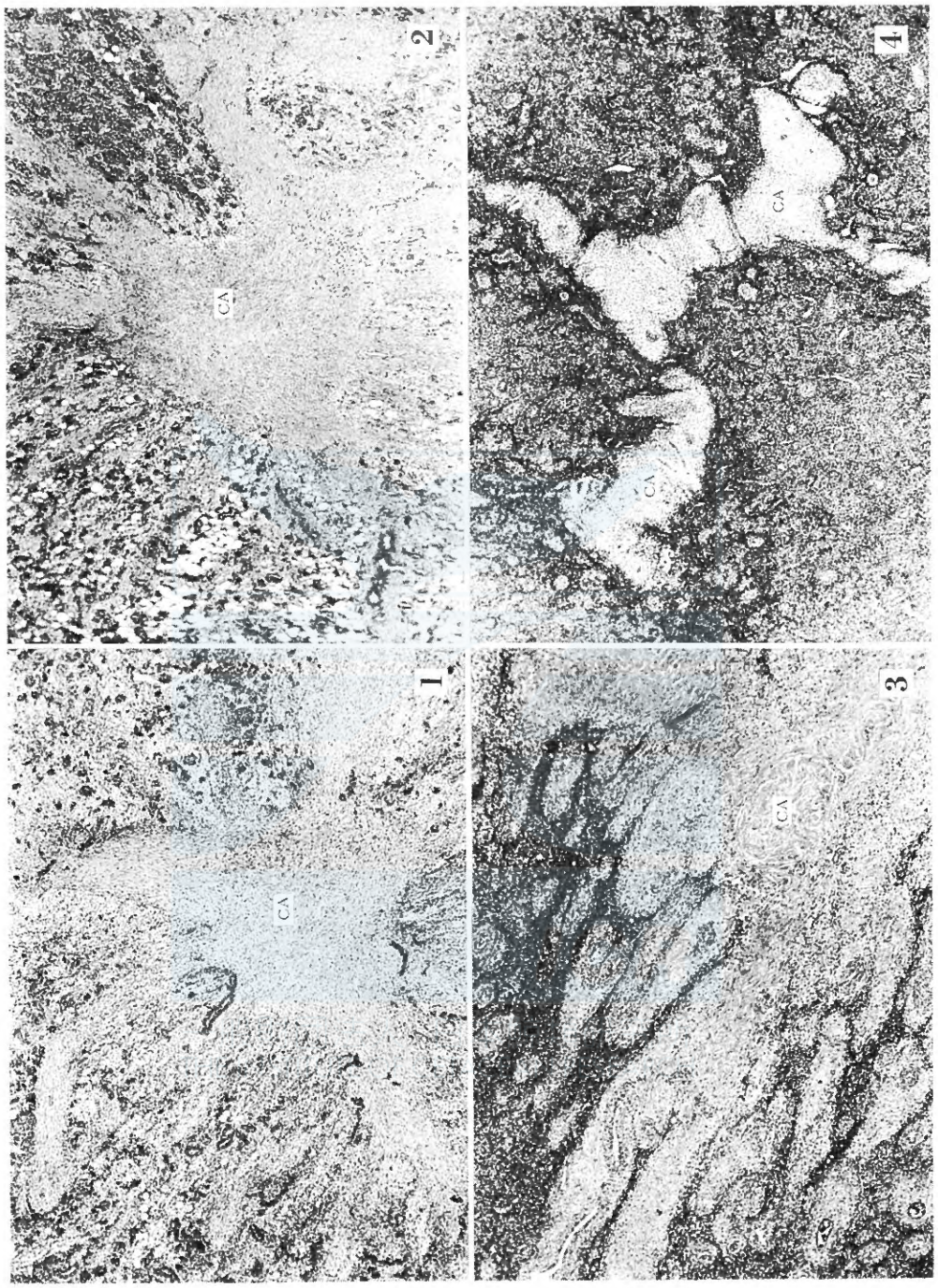
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