

OVARIAN DEVELOPMENTAL RHYTHM OF THE FORMOSAN RED SCAD, *DECAPTERUS KURROIDES* *AKAADSI ABE* IN TAIWAN

WEN-LUNG WU and KUN-HSIUNG CHANG

*Institute of Zoology, Academia Sinica, Taipei,
Taiwan, Republic of China*

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Wen-Lung Wu and Kun-Hsiung Chang (1979) Ovarian developmental rhythm of the Formosan red scad, *Decapterus kurroides akaadsi* Abe in Taiwan. *Bull. Inst. Zool., Academia Sinica* 18(1): 39-44. The maturation of the Formosan red scad was studied histologically. Oogenesis was divided into five stages: chromatin-nucleolus, perinucleolus, yolk-vesicle, yolk and mature stage. Based on the change of the monthly gonad index, it was inferred that the Formosan red scad had a long spawning season from February to August. The authors also divided the reproductive cycle of female red scad into three periods: prespawning period—almost all of the ova are at the perinucleolus stage and a few at the yolk-vesicle stage; spawning period—more visible ova can be seen and some of them are at yolk and mature stage; postspawning period—the oocytes are at chromatin-nucleolus and perinucleolus stage.

Food habit^(1,8), age and growth⁽²⁾, morphometry⁽⁷⁾ and maturity⁽⁴⁾ of the red scad (*Decapterus kurroides akaadsi* Abe) found in the Taiwan area were discussed in previous papers. Accurate distinction of mature and immature fish is one of the most important problems in the study of the ecological and life history of a fish species, particularly when the reproduction of the species was considered. In order to obtain more information about the reproductive cycle of the Formosan red scad, histological studies were made in this report.

MATERIALS AND METHODS

The fish were sampled monthly from hand-liner caught from 1972 to 1974 at Nanfangao and Kaohsiung. Body length, body weight and gonad weight were recorded. Small fragments of posterior tip of the left ovary were fixed with the Bouin's fixative. Paraffin series section of 5-7 μ were stained with haematoxylin-eosin.

The gonad index is expressed as:

$$\text{Gonad index} = \frac{\text{Gonad weight}}{\text{Body weight}} \times 100$$

RESULTS AND DISCUSSION

Annual change in weight and external feature of ovary

The red scad has a paired ovaries which are almost equal in size and each attaches separately to the dorsal wall of the coelmic cavity with a thick mesovarium. The monthly change in gonad index is shown in Fig. 1. In general, the monthly gonad index is increasing from January to April, and reaches its maximum from May to June.

Before early February, the ovaries of the red scad are very small and no ovum can be seen with naked eyes. From February to June, the size of the ovary is enlarged, visible ova are increased in number, so are the diameters of the ova. During this period, the spent ovary has been observed. Between June and

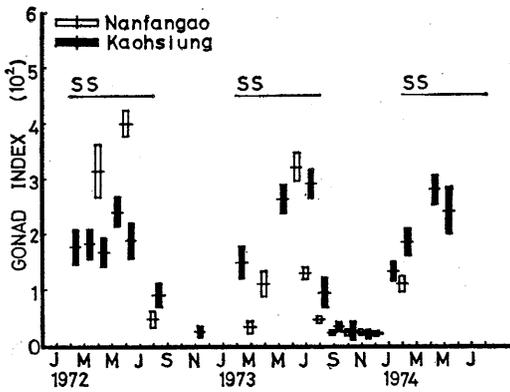


Fig. 1. Monthly fluctuation of the Formosan red scad's gonad index.

□: Mean \pm 2 S.E.

SS: Spawning season.

August, the diameters of the ova are decreased and the number of visible ova is diminished in some spent fish. After September, the size of ovary becomes very small.

Development of oocytes

It was reported that ova in various maturation stages were evenly distributed in the ovary⁽⁴⁾. In this paper, the posterior tip of the left ovary was examined. The maturational development of oocytes was divided into five stages: chromatin-nucleolus, perinucleolus, yolk-vesicle, yolk and mature stage.

1) Chromatin-nucleolus stage: Throughout the year, very small oocytes about 15μ were found sparsely in the ovaries. They had a large nucleus about $4-8\mu$ which surrounded with a thin layer of the cytoplasm. The nucleus was lightly stained by haematoxylin.

More or less than 10 nucleolei were distributed in nucleus. The color of nucleolei was deeper than that of other parts of nucleus. The oocytes of this stage with more advanced development might grow up to 20μ and their nuclei were about $12-15\mu$, (Plate I-A).

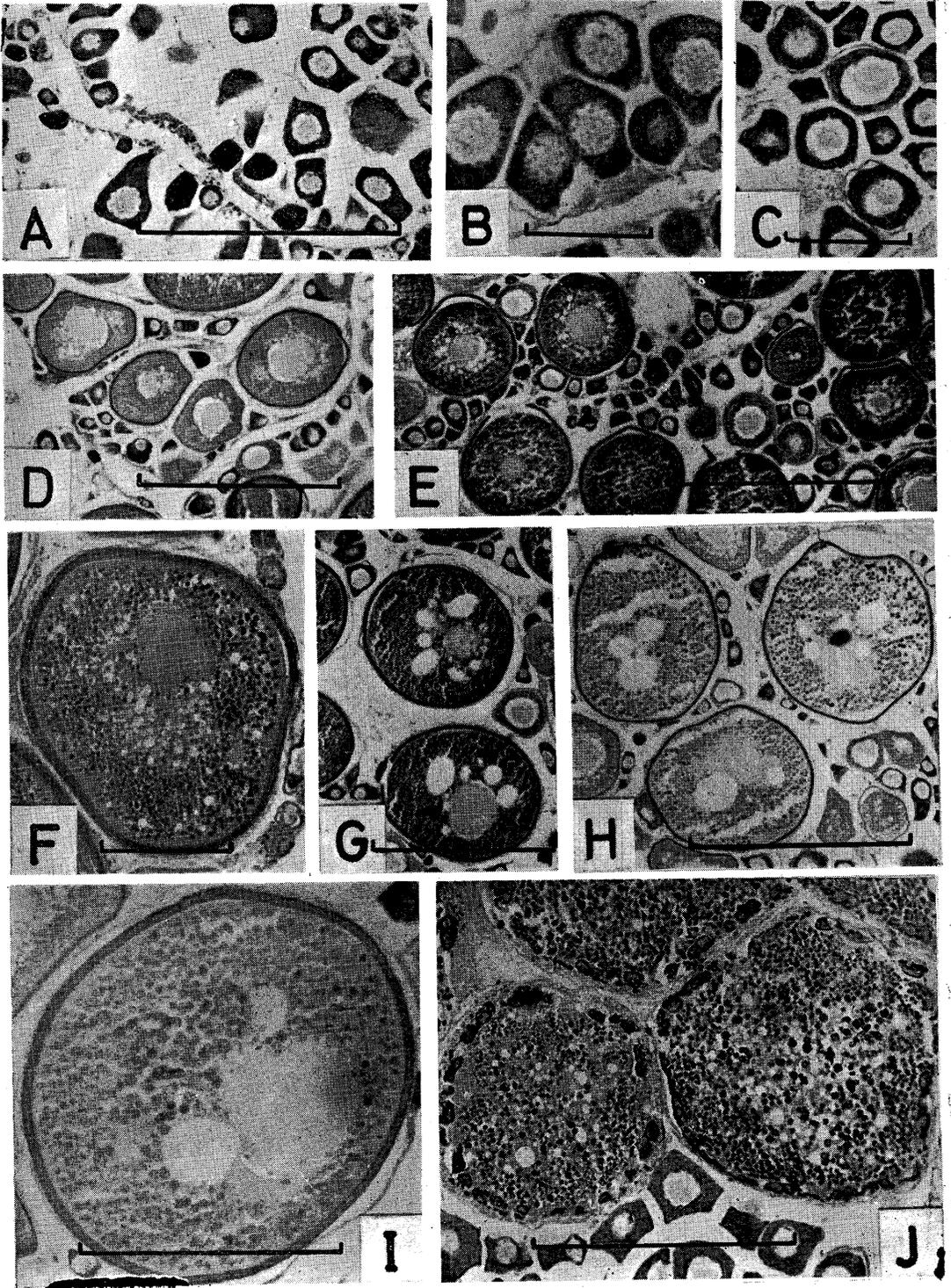
2) Perinucleolus stage: Perinucleolus ova were $25-75\mu$ in diameter, they had a large nucleus about $20-45\mu$ and with many peripherally arranged nucleolei. The chromatin threads became freely distributed in the nucleus. The volume of cytoplasm was increased and stained deeply by haematoxylin (Plate I-B). When they reached $87-100\mu$, the nucleoli gradually disappeared. A thin layer of follicular cells was now discernible at the periphery of the ovum (Plate I-C).

3) Yolk-vesicle stage: The yolk-vesicle oocyte ranged from $90-200\mu$ in diameter. When the oocytes grew to about 90μ , the yolk substance made its first appearance in the cortex of the ooplasm. Fat globules of $10-15\mu$ in diameter appeared in the inner part of ooplasm. Both of them increased in number and size as maturation progressed (Plate I-D). The circular or elliptical nucleus was located in the central part of oocyte. Zona radiata made its appearance between the follicular layer and oocyte.

4) Yolk stage: The oocyte was about $0.5-0.6$ mm in diameter. Some yolk globules made their first appearance at the periphery of the ooplasm and gradually increased in number and size. They were distributed all over the ooplasm and fused into spherical masses eventually (Plate I-E). The egg membrane increased in

Plate I. Development of the Formosan red scad's oocytes.

- A. Chromatin-nucleolus stage, scale is 0.5 mm.
- B. Perinucleolus stage, scale is 0.12 mm.
- C. Early phase of yolk-vesicle stage, scale is 0.25 mm.
- D. Yolk-vesicle stage, scale is 1.0 mm.
- E. Yolk stage, scale is 1.0 mm.
- F. Yolk stage, scale is 0.25 mm.
- G. Later yolk stage, scale is 1.0 mm.
- H. Early mature stage, scale is 1.0 mm.
- I. Migratory nucleus stage enlarged, scale is 0.5 mm.
- J. Later mature stage, scale is 0.5 mm.



thickness (Plate I-F). In the advanced yolk stage, oocytes grew about 0.6–0.7 mm in diameter. Nuclei were almost the same in form, size and location as in the previous stage (Plate I-G).

5) Mature stage: In the beginning of this stage, the nucleus migrated toward the animal pole (Plate I-H, I). The size of oocytes in this stage was the same or slightly large as the yolk stage. When the nucleus arrived at the animal pole, the nuclear membrane disappeared. However, the clear nucleoplasm stood out markedly in the granular ooplasm (Plate I-J).

Reproductive cycle of female red scad

From Fig. 1 the reproductive cycle of female red scad could be divided into three periods, namely: prespawning, spawning, and postspawning period.

1) Prespawning period (January to February): In January, the gonads of this species were very small and no visible ovum could be seen. Almost all of the ovum were at the perinucleolus stage and a few at the yolk-vesicle stage (Plate II-A). Some of the ova of adult might develop into the yolk-vesicle stage (Plate II-B).

2) Spawning period (February to August): The period from February to August was the spawning season of the red scad in Taiwan.

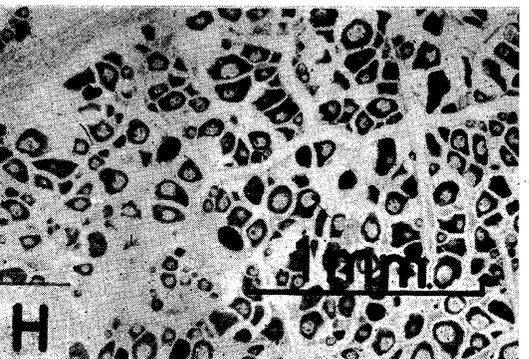
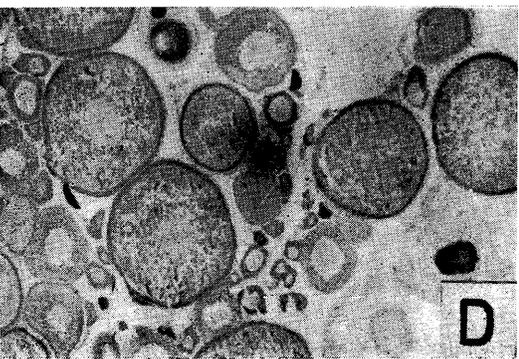
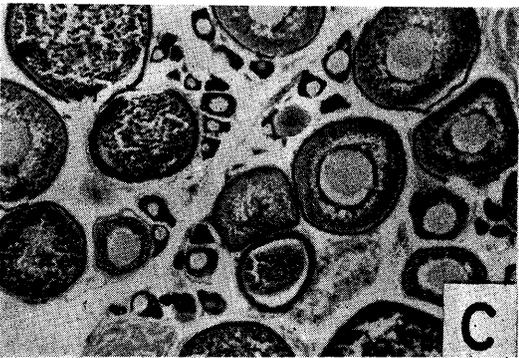
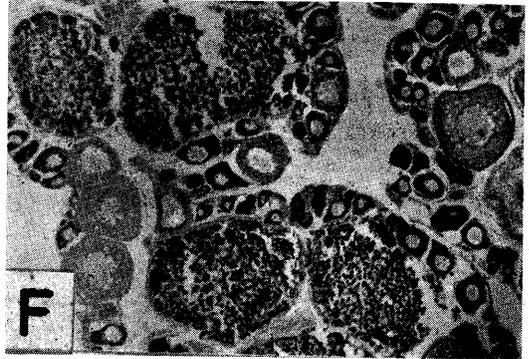
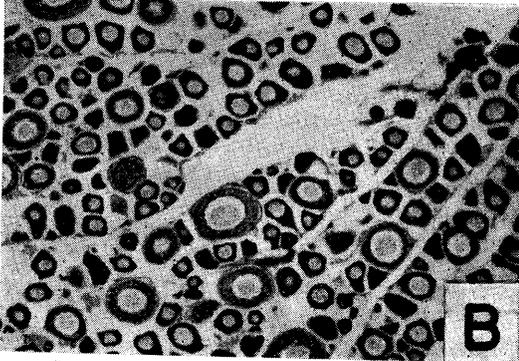
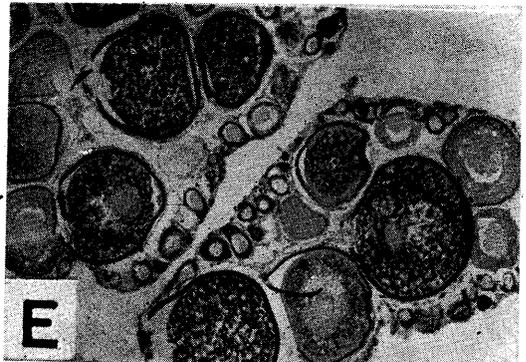
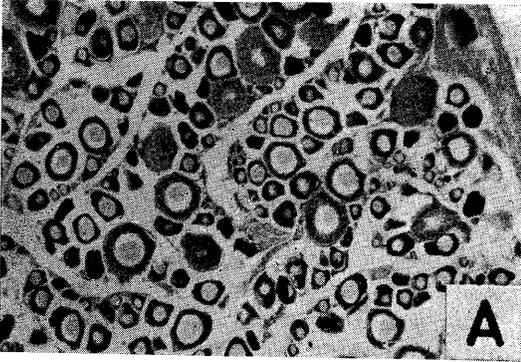
The rate of ovarian development was very fast in this period. Both the size and weight of gonad were increased rapidly. Some of the ova could develop into yolk stage (Plate II-C). In March, the number of ova in yolk stage was more than that in February (Plate II-D). From April to July, the gonads of the red scad became larger, and more visible ova could be seen. Some of them were at the mature stage (Plate II-E, F).

3) Postspawning period (August to December): The red Scad had spent before September. From August to December, the female was almost in resting period. From Plate II-G and H, the gonads were very small and no visible ova could be seen, and the stages to which oocytes belonged were the chromatin-nucleolus and the perinucleolus stage.

Marza (1938)⁽⁵⁾ has classified the developmental rhythm of fish oocytes into three types: (1) total synchronism, (2) group synchronism, and (3) asynchronism. Since the spawning Formosan red scad have all types of developing oocytes in their ovaries and a long-lasting spawning period, it is suggested that the Formosan red scad, similar to sardines (Ishida, 1959)⁽³⁾ and red sea bream (Mio, 1962)⁽⁶⁾, displays asynchronous type of development. This is in agreement with Lee's conclusion⁽⁴⁾.

Plate II. The ovarian structure of the Formosan red scad at different time.

- A. The specimen (Gonad weight 4.30 g, body length 266 mm) was sampled on Jan. 14, 1974 in Kaohsiung. The oocytes were predominant at chromatin-nucleolus and perinucleolus stage.
- B. The specimen (Gonad weight 2.20 g, body length 245 mm) was sampled on Feb. 18, 1974 in Nanfangao. The oocytes were predominant at chromatin-nucleolus and perinucleolus stage.
- C. The specimen (Gonad weight 3.50 g, body length 245 mm) was sampled on Feb. 18, 1974 in Nanfangao. The oocytes were predominant at yolk-vesicle and yolk stage.
- D. The specimen (Gonad weight 6.60 g, body length 262 mm) was sampled on Mar. 23, 1974 in Kaohsiung. The oocytes were predominant at yolk-vesicle and yolk stage.
- E. The specimen (Gonad weight 14.00 g, body length 324 mm) was sampled on July 27, 1974 in Kaohsiung. The oocytes were predominant at yolk and a few at yolk-vesicle stage.
- F. The specimen (Gonad weight 9.80 g, body length 312 mm) was sampled on July 27, 1974 in Kaohsiung. The oocytes were predominant at mature, yolk, yolk-vesicle and perinucleolus stage.
- G. The specimen (Gonad weight 0.35 g, body length 265 mm) was sampled on Nov. 7, 1973 in Nanfangao. The oocytes were predominant at chromatin-nucleolus and perinucleolus stage.
- H. The specimen (Gonad weight 0.20 g, body length 300 mm) was sampled on Oct. 2, 1973 in Nanfangao. The oocytes were predominant at chromatin-nucleolus and perinucleolus stage.



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臺灣產扁紅鯷卵細胞的發育及其生殖周期變化

巫文隆 張崑雄

利用卵巢的組織切片技術，將扁紅鯷卵細胞的發育過程分為五個階段，染色質絲及核仁期，周邊核仁期、卵黃期及成熟期。由扁紅鯷的生殖腺指數，發現其產卵期甚長，由組織切片發現扁紅鯷卵細胞的發育情形，係屬於非同時發生型。

在產卵前期，最成熟的卵，只發育到卵黃泡期而已，而產卵期則有各型的卵細胞存在，而以成熟卵占大部份，在產卵後期，生殖腺進入復原及休止狀態，此時期之卵細胞幾乎全是在周邊核仁期附近。