MFR PAPER 1072

Shrimp maturity can be determined by color of ovaries.

Color Changes in the Ovaries of Penaeid Shrimp as a Determinant of Their Maturity

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ABSTRACT

The maturation sequence of penaeid shrimp is presented as pictorial illustrations. The major color changes occurring in the ovary are shown. The stages presented include the undeveloped, developing, and the early ripe to ripe stages.

INTRODUCTION

It has been observed that ovaries of penaeid shrimp progress through a series of color changes from immaturity to maturity (King, 1948; Cummings, 1961). These color changes have enabled biologists to determine when penaeid shrimp were sufficiently mature for spawning, for the ripe ovary is easily recognized. The eggs are carried internally, but the ovarian lobes are visible dorsally along the abdomen or tail. Ripe ovaries of the pink shrimp (*Penaeus duorarum*) and brown shrimp (*Penaeus aztecus*) appear olive green and those of the white shrimp (*Penaeus setiferus*) olive brown (Cook and Murphy, 1969). Ripe and early ripe shrimp cannot be separated by gross observations, but the increased "greenness" of the ovaries does indicate that the shrimp has reached the early ripe condition (Cummings, 1961).

The reproductive system of female penaeid shrimp consists of paired ovaries, oviducts, and a single thelycum. The ovaries are partly fused, bilaterally symmetrical bodies extending in the mature animal for nearly its entire length, usually from the cardiac region of the stomach to the telson. In the cephalothoracic region each organ bears a slender anterior lobe and in most cases seven or eight finger-like projections. A pair of lobes, one from each ovary, extend the length of the abdomen (King, 1948; Eldred, 1958).

The ability to determine when shrimp are mature is very important when the expense of gathering shrimp for brood stock is considered. This paper is intended to eliminate some of the errors in selecting gravid shrimp for rearing experiments in aquaculture.

MATERIALS AND METHODS

All shrimp examined in this study were collected offshore on board a commercial trawler. After collection, the live shrimp were kept in ice chests with constant aeration provided by portable aerators. Approximately 8 to 10 shrimp exhibiting various stages of ovarian development were placed in each ice chest. These animals were further culled prior to photographing.

The shrimp were photographed as soon as possible, with attention focused primarily on those animals ready for spawning. However, for contrast, other developmental stages were included. The stages of primary importance in the opinion of the authors consist of the undeveloped, developing, and the early ripe to ripe stages.

The shrimp were photographed with a Polaroid MP-3[1] camera and a 2¼ × 2¼ inch role film holder. Two light banks of three number one photofloods placed at a 45° angle were used. Kodak Ektachrome-X, daylight-type film, was used. The lens was a Rodenstock-Ysaron 5-inch (127-mm) with an 80B conversion filter (A.S.A. rating of 20). Exposures were 1/60 of a second at *f*/8.

STAGES OF OVARIAN DEVELOPMENT

The three developmental stages considered in this paper are the undeveloped (transparent, small ovaries); the developing (larger, yellowish, with increasing pigmentation); and early ripe to ripe stages (intense green color with a further increase in size).

Undeveloped Ovaries

Cummings (1961) and King (1948), working with the pink shrimp and white shrimp, respectively, characterized the ovaries in this stage as small, translucent, flaccid, difficult to remove, and invisible through the exoskeleton (Figs. 1 and 2). It can be

[1]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Figure 1.—*Penaeus aztecus*, left, with undeveloped ovaries.

Figure 2.—*Penaeus setiferus*, right, with undeveloped ovaries.

Figure 5.—*Penaeus setiferus*, left, with ovaries exposed showing increased melaophores associated with the yellow developing phase of the ovaries.

Figure 6.—*Penaeus aztecus*, right, showing increase in size of ovaries and apparent red melanophores.

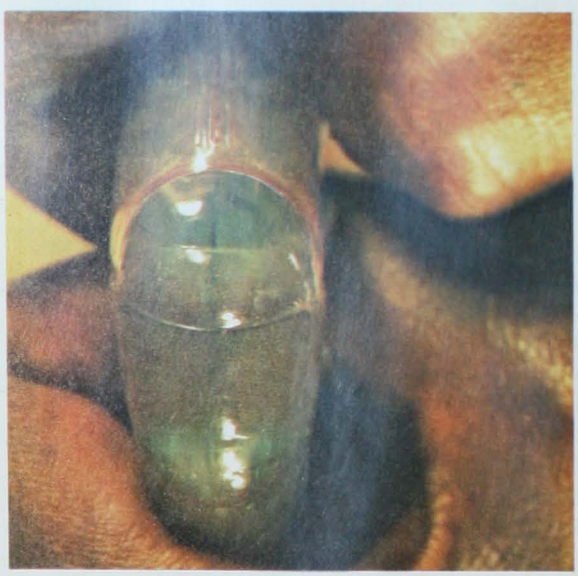

Figure 9.—"Greenness" of the ovaries of *P. aztecus*, left, during ripe or early ripe stages.

Figure 10.—Darker green color mature *P. aztecus*, right.

Figure 3.—*Penaeus setiferus*, left, with developing ovaries.

Figure 4.—*Penaeus setiferus*, right, with developing ovaries exposed.

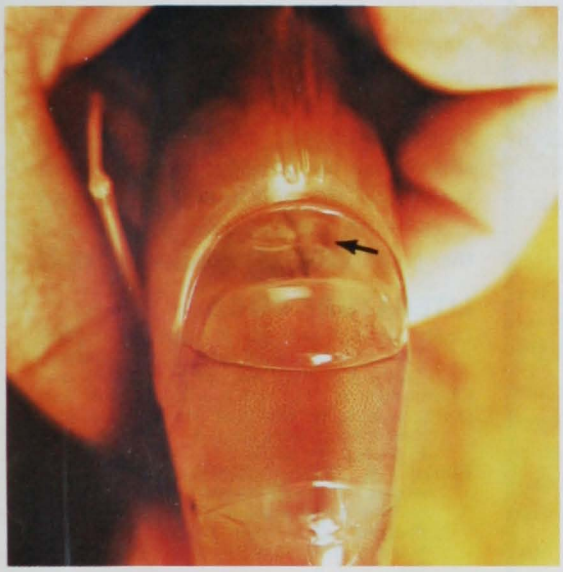

Figure 7.—*Penaeus aztecus*, left, with concentration of red melanophores immediately underneath the posterior end of the carapace.

Figure 8.—"Greenness" of the ovaries of *P. aztecus*, right, during ripe or early ripe stages.

A B C

Figure 11.—A, B, C. Abdominal and anterior segments of the ovary of *P. aztecus*, left.

A B C

Figure 12.—A, B, C. Three of the most important stages in the maturation of *P. aztecus*, right.

seen from observing the photographs that there is little difference between the brown shrimp and the white shrimp except possibly the natural coloration of the animals, the lighter colored of the two being the white shrimp.

Developing or Yellow Ovaries

This stage in ovarian development in the white shrimp has been characterized by an increase in the size of the ovaries and a darkening color dorsally due to scattered melanophores (Figs. 3, 4, and 5).

The darker coloration of the ovaries in the white shrimp might cause them to be mistaken for the ripe or early ripe ovaries. Upon closer examination on the ventral surface of the ovary, however, a yellow color will be detected that is indicative of the developing stage of the ovaries.

In the brown shrimp this stage is generally the same as in the white shrimp with a possible difference being in the color of melanophores. The melanophores in the brown shrimp appear pink to red in color (Figs. 6 and 7) instead of the dark green color of the melanophores in the white shrimp. The pinkish red color of the ovaries of the brown shrimp during this stage makes it virtually impossible to confuse it with the "green color" of the early ripe or ripe shrimp.

Ripe or Nearly Ripe Ovaries

Unfortunately, during the time that shrimp were being collected for this paper, we were unable to catch any white shrimp that properly illustrate the ripe stage of ovarian development.

Cummings (1961), working with the pink shrimp, characterized the ripe or nearly ripe ovaries as having a glaucous color which is darker in more mature ovaries. This is essentially true for the brown shrimp, in which the ovaries are green to dark green in fresh specimens (Figs. 8 and 9). In the more advanced stages of maturity, the ovaries in the brown shrimp take on an even darker green color (Fig. 10). This particular coloration (see also Fig. 11) is the color or stage of choice for spawning. The ovaries have increased in size and the anterior lateral projections are quite evident. These projections are dissected out in the brown shrimp (Figs. 11B and 11C) to illustrate the profuse nature of the projections. The abdominal lobes have also been exposed (Fig. 11A) to illustrate their bilateral nature.

For a comparison of the three more important stages, a photograph was taken (Fig. 12) in which the undeveloped (A), developing (B), and early ripe to ripe (C) are included. The size and transparency of the undeveloped ovaries are noteworthy. The developing stage again shows the increased growth of the ovary but the yellowish color remains, characteristic of the developing stage. The ovaries of the early ripe to ripe stages are more turgid, darker green in color, and larger in size than those in both the undeveloped and developing stages.

DISCUSSION

During transit from offshore to the laboratory, noticeable color changes have been noted in the integument of the shrimp. These superficial color changes may be caused in part by the increase in illumination from the time of capture (night) to the time of their arrival at the laboratory (daylight) (Fingerman, 1970). Apparently, the integumental color changes do not affect the spawning activity of the shrimp.

In the process of gathering mature white shrimp for spawning and rearing experiments, a certain degree of caution must be exercised in the determination of maturity. The developing stage of the white shrimp superficially resembles the mature stage. In contrast, however, there is little chance that a developing stage of the brown shrimp can be mistaken for the mature because of the pinkish red color associated with the developing stage and the green color of the mature stage.

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MFR Paper 1072. From Marine Fisheries Review, *Vol. 36, No. 7, July 1974. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.*