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FIRST RECORD OF A SECOND MATING AND SPAWNING OF THE SPOT PRAWN, *PANDALUS PLATYCEROS*, IN CAPTIVITY

The spot prawn, *Pandalus platyceros* Brandt, is the largest species of the family Pandalidae. It supports a minor fishery within its range of San Diego to the Bering Strait, Korea, and Japan in depths to 532 m (Butler 1964). The prawn is being studied at the National Marine Fisheries Service (NMFS) Aquaculture Research Station, Manchester, Wash., as a possible companion crop to Pacific salmon reared in floating net pens (Mahnken 1975; Prentice 1975). One phase of this work is to investigate the reproductive potential of the prawn in captivity.

The prawn is a protandric hermaphrodite, i.e., an individual matures first as a male (at age 1.5 yr), breeds one or more times as a male, passes through a transitional phase (at age 2.5 yr), and becomes a functional female (at age 3.5 yr) (Butler 1964). In studies of natural populations in southern British Columbia, Butler (1964) found that few if any females breed more than once and suggested that the females die soon after spawning.

At the Aquaculture Research Station, prawn culture and breeding experiments have been carried out since 1973. The matings reported in this study were made with laboratory-cultured males and captured, wild females. The females were captured in ovigerous condition in 1974 from Hood Canal, Wash., and their eggs hatched in the laboratory during February and March 1975. Therefore, we know these females have spawned at least once, and since their prior history is unknown, there is the possibility that some or all may have spawned more than once.

The spawned females (103) were held from March to August at the Aquaculture Research Station in floating net pens or in benthic cages 10 m beneath floating net pens containing salmon. The postspawning survival was 100% through August 1975 for both groups. All prawns in the net pens were maintained on a diet of frozen clam meat, *Panope generosa*, and salmon mortalities. The benthic cage group did not receive any supplemental food.

In August varying densities of spawned females and cultured males (Table 1) were placed either in three net pens, eight laboratory tanks, or in a benthic cage. The net pens were constructed of 18-mm mesh (stretch measure) knotless nylon with 6.8 m² of substrate per pen available to the prawns. The top of each pen was covered with black plastic sheeting. Each laboratory tank had 0.24 m² of available substrate. All water entering the tanks was sand filtered and not recycled. The single benthic cage was constructed of vinyl-coated wire mesh (9.0-mm stretched measure) and had 2.6 m² of substrate available to the prawns. All test groups were fed the clam–salmon diet with the exception of those in the benthic cage which received no supplemental food. A continuous low-level mortality was observed among the females from August to early October 1975 which reduced their survival to 39.8%.

Survival of the female prawns was not dependent upon stocking density; however, survival was significantly greater in the benthic cage and laboratory tanks than in the net pens (Table 1).

TABLE 1.—Survival (percent in parentheses) and second spawning of female *Pandalus platyceros* in three seawater systems.

Container type	No. of prawns per container: Female	No. of prawns per container: Male	Density of prawns[1]	Survival of previously spawned females	Survivors spawning a second time
Benthic cage (9 m deep)	5	5	3.8	4 (80.0)	3 (75.0)
Net pen 1	29	56	12.5	12 (44.8)	10 (84.6)
Net pen 2	24	43	9.9	6 (25.0)	4 (66.7)
Net pen 3	29	89	17.4	6 (20.7)	5 (83.3)
Laboratory tanks[2]	2	2	16.7	12 (75.0)	12 (100.0)

[1]Prawns per square meter of available substrate.
[2]A total of eight laboratory tanks.

Females held in the bottom cage or in the laboratory tanks were subject to less ambient light, more stable temperatures, and water below the photosynthetic zone. The laboratory water system utilizes water pumped from an area 2 m above the sea floor, thereby approximating the water available to the bottom caged prawns. Previous work has shown that juvenile and yearling prawns are sensitive to rapidly fluctuating water temperature, light, and plankton blooms (Rensel and Prentice[1]).

A second spawning was recorded for 85.4% of the surviving females. The average carapace length of these spawners was 39.2 mm (SD = 1.31). Eggs developed normally, producing viable larvae, but the fecundity was low, ranging from 10 to 1,000 eggs. The fecundity of wild bred stocks is 2,000–5,000 eggs per female. The reduced fecundity in the female prawns spawning for the second time may be due to nutritional or environmental factors. However, in some instances the female prawns were observed actively removing eggs from their own abdomens, using the second pereiopod. In other cases, we observed egg losses during the holding period due to abrasion on the nets and tanks.

Multiple breeding and spawning are common in other families of caridean shrimps, but among the Pandalidae only *P. montagui* Leach in the northeastern Atlantic Ocean has been known to spawn for two consecutive years (Allen 1963). This study shows that female spot prawns can also successfully breed, spawn, and hatch eggs for a second time. This is important to both the aquaculturist and the field biologist. If multiple breeding also takes place in wild populations, then estimates of year-class recruitment based on single spawning populations are in error.

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[1]Rensel, J. E., and E. F. Prentice. A comparison of growth and survival of cultured spot prawns, *Pandalus platyceros* Brandt, at two salmon farming sites in Puget Sound. Unpubl. Manuscr., 25 p. Northwest and Alaska Fish. Cent., Natl. Mar. Fish. Serv., NOAA, Seattle, Wash.

EFFECT OF DISSOLVED OXYGEN CONCENTRATION AND SALINITY ON SWIMMING SPEED OF TWO SPECIES OF TUNAS

Studies on captive skipjack tuna, *Katsuwonus pelamis*, have determined three physiological parameters that may operate to delimit oceanic distribution of this fish. If 1) a lower temperature limit of 18°C, 2) a size-dependent upper temperature limit, and 3) a lower oxygen limit of 5 ppm are mapped onto the temperature and oxygen levels of the central Pacific area, the resulting model is consistent with many of the peculiar features of the geographical distribution of the skipjack tuna (Barkley et al.[1]). In particular, the exclusion of adult skipjack tuna from warm, oxygen-poor waters of the eastern tropical Pacific Ocean is explained.

But the physiological parameters used in the model were either speculative—upper temperature limits—or based upon acute and stressful experimental conditions—lower oxygen and temperature limits. Gooding and Neill[2] determined the lower oxygen limit by introducing tunas into a small tank (1.8 × 2.4 × 0.6 m oval) containing

[1]Barkley, R. A., W. H. Neill, and R. M. Gooding. Skipjack tuna habitat based on temperature and oxygen requirements. Manusc. in prep. Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96812. (Material presented at 26th Tuna Conference, Lake Arrowhead, Calif., 29 Sept.-1 Oct. 1975.)

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