

counterpart in paddy cultivation, in the same field and for more or less the same period of time. In West Bengal, of total export value of 43 crores, up to 25 crores is realized by farmers for their production of shrimp through culture reflecting better unit return for their raw material than that realized by the processor/exporter of the end-product. Therefore, bringing additional areas under shrimp culture will directly affect the socio-economic status of the rural people employing an average of 5 persons/ha, and indirectly affect no less than 15,000 casual workers in the seafood processing industry by additional utilization of manpower and working hours.

As productivity from capture appears bleak, brackish-water shrimp culture has been accorded top priority in India's national developmental programmes for more harvest from aquatic sources otherwise termed the "Blue Revolution."

Larval Growth and Survival Optima for Four Species of Penaeids from Australia, as Indicated by their Distribution and Abundance in the Field

Peter C. Rothlisberg and Christopher J. Jackson

CSIRO Marine Laboratories
P.O. Box 120, Cleveland, Qld. 4163
Australia

Prawn catches from tropical northern Australia are dominated by four species of prawns: *Penaeus merguensis*, *P. semisulcatus*, *P. esculentus* and *P. latisulcatus*. Three of the species (*P. merguensis*, *P. semisulcatus* and *P. latisulcatus*) are widespread throughout the Indo-Pacific, while *P. esculentus* is endemic to northern and eastern Australia. The species appear, however, to have well defined and limited distribution on a smaller scale. Surveys of the larvae in the Gulf of Carpentaria, northern Australia, have shown both spatial and temporal heterogeneity in the abundance of all four of these species.

Assessing the temperatures and salinities in which the larvae were caught may be a realistic indicator of conditions suitable for reproduction, as well as growth and survival of the larvae. Means of these distributions may be deemed optima and ranges indicate tolerances.

Most of the larvae of all four species are found in water above 26°C and 31 ppt. However, the mean temperatures and salinities vary significantly between species. *P. merguensis* has the lowest salinity optimum (31.8 ppt) and the highest temperature optimum (29.0°C). The other three species are similar for both temperature and salinity optima. *P. latisulcatus* has the lowest temperature optimum of 27.4°C compared with *P. semisulcatus* at 27.9°C and *P. esculentus* at 28.5°C. The salinity optima for these three species are almost identical at approximately 33.2 ppt.

While the ranges of temperatures of all four species are similar (21.5-30.6°C), the ranges of salinities in which the lar-

vae are found coincide with the size of the biogeographic distribution of the species. The three widespread species have large salinity ranges: *P. merguensis*, 26.2-34.9 ppt; *P. semisulcatus*, 27.8-34.9 ppt; and *P. latisulcatus*, 28.6-34.9 ppt. The Australian endemic, *P. esculentus*, has the smallest and highest range, 30.1-34.6 ppt. This apparent inability of *P. esculentus* to tolerate low salinity water may restrict dispersal during the larval stages.

Description of the Embryonic Stages of *Penaeus notialis* and the Influence of Some Abiotic Factors on the Species

Isis Fernandez and Mario Oliva

Centra de Investigaciones Marinas, Universidad de la Habana
Ave. Ira No. 2808, Miramar
Ciudad Habana, Cuba

The embryonic development of the shrimp *Penaeus notialis* Farfante, 1967 is studied. The duration from spawning to hatching of the nauplii was 14-16 hr. As soon as spawning occurs, a sequence of transformations is observed in the characteristic cell mitosis up to the formation of the embryo which breaks the membrane and emerges as the first naupliar stage. The process of development is very similar to other penaeids and the duration of each stage is characteristic of the species. The influence of salinity and pH on spawning, hatching rate and survival, and the optimal values for each factor were determined.

Thermal Tolerance of Larval Greentail Prawn *Metapenaeus bennettiae* (Racek and Dall) — A Comparison with School Prawn *Metapenaeus macleayi*

Tadashi Murai

School of Zoology, University of New South Wales
P.O. Box 1, Kensington, 2033 N.S.W.
Australia

The thermal tolerance of four larval stages of *Metapenaeus bennettiae* was studied in the laboratory. Critical Thermal Maximum (CTM), One hour Median Lethal Temperature (1hLT50), and Median Resistance Time (MRT) were measured. Moulting rate of larvae and hatching rate of embryos were also monitored to study the delayed effect of thermal stress.

Thermal tolerance was shown to be strongly dependent on acclimation temperature (TA) at all larval stages, which