J. mar. biol. Ass. India, 1987, **29** (1 & 2) : 104-107

INFLUENCE OF INITIAL STARVATION ON THE LARVAL DEVELOPMENT OF THE BRACKISHWATER CRAB *METAPLAX DISTINCTA* H. MILNE EDWARDS, 1852

T. KRISHNAN AND T. KANNUPANDI

Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai-608 502, Tamil Nadu

ABSTRACT

The present study depicts the effects of early lack of food on later survival and development duration in the brackishwater crab *Metaplax distincta*. Initial feeding of 2 d suffices for all the Z-I to moult successfully to Z-II without further feeding and Point of Reserve Saturation for 50% of individuals (PRS $_{50}$) is *ca.* 1.3 d. Starvation periods beginning right after hatching of Z-I prolongs the instar and Point-of-No-Return for 50% of individuals (PNR $_{50}$) is 1.2 d. It is suggested that initial feeding is paramount important for the successful development and survival of crab larvae.

INTRODUCTION

PREVIOUS studies on the effects of early starvation in crab larvae of temperate waters indicate that initial starvation reduces survival and delays development (Yatsuzuka, 1962 ; Anger and Nair, 1979 ; Kon, 1979 ; Cronin and Forward, 1980 ; Anger and Dawirs, 1981, 1982 ; Anger *et al.*, 1981 ; Storch and Anger, 1983 ; Anger, 1984). Similar studies have not been carried out in tropical waters and hence the current investigation is an attempt to depict the effects of early starvation periods on the zoeal development of the brackishwater crab *Metaplax distincta*.

Thanks are due to Dr. K. Krishnamurthy, Director for facilities and to C.S.I.R., New Delhi for the award of Senior Research Fellowship to Mr. T. Krishnan.

MATERIAL AND METHODS

'Sponge' bearing females of *M. distincta* were collected from Pitchavaram mangroves (11°29′ N ; 79°47′ E) on October 24, 1985 and held in plastic troughs containing aerated filtered water of salinity 15 ± 1‰, temperature 25 ± 1°C and photoperiod 12 : 12 L : D until hatching occurred in the early hours on October 28, 1985.

Freshly hatched larvae were transferred to numbered glass bowls with 50 ml water of salinity 15 ± 1‰. All larvae used in the experiment originated from the same brood and they were reared individually to prevent cannibalism or necrophagy (Anger and Nair, 1979). Larvae were fed (where applicable) freshly hatched Brazilian strain of *Artemia* sp. nauplii *ad libitum*. Water and food were changed and moults or mortality were noted everyday. Experiment was terminated when all larvae had either died or metamorphosed to megalopa. Ontogeny of *M. distincta* comprises 5 zoeal stages and takes 11 d to reach megalopa (Krishnan and Kannupandi, MS).

Experimental design followed was that of Anger and Dawirs (1981). Experiment consisted of six subexperiments of 25 larvae each. Each subexperiment had a different feeding

regimen. (1) Food was offered only during the first 1 d following hatching. The larvae were then transferred to clean bowls and no further feeding was done until a larvae moulted to the Z-II. (2) Same as (1), but initial feeding period 2 d. (3) Fed control (No starvation). (4) Starvation only during first 1 d after hatching; then feeding. (5) Same as (4), but initial starvation period 2 d. (6) Starved control (No feeding).

Point of reserve saturation (PRS) and Point-of-no-return (PNR) were calculated following the method of Anger and Dawirs (1981), The abbreviations Z-I, Z-II, etc. denote zoeal stages I, II, etc.

Results

Only 10 Z-I moulted to Z-II after 2.80± 1.23 d in the group of larvae offered food for only 1 d. 7 larvae successfully moulted to megalopa after passing through 5-Z stages, of these 1 Z-V moulted to Z-VI which lasted 2 d.

After 2 d of feeding, there was no influence of starvation on survival of Z-I through megalopa and the development of Z-I took 2.32± 0.48 d. In the fed control group also, there was no mortality, which moulted to Z-II in 2.04±0.20 d. PRS_{50} (the minimum time necessary for 50% of larvae to accumulate enough reserves for reaching next instar, independent of further food supply) value was ca. 1.3 d.

Prey deprivation directly in the beginning of larval life delayed development when compared to the control fed larvae. The delay was 1.46 d in 1 d starved group and 1.96 d in 2 d starved larvae. Survival was minimal in 2 d starved larvae and none of them survived beyond Z-IV. The control starved (unfed) larvae died at the end of third day. PNR_{50} the time when 50% of the starved larvae could not recover when being re-fed) value was *ca* 1.2 d.

Development and mortality rates of Z-I and Z-II are provided in Fig. 1. Data for subsequent zoeae are listed in Table 1. Starved control group of larvae was omitted because no larvae reached the Z-II.

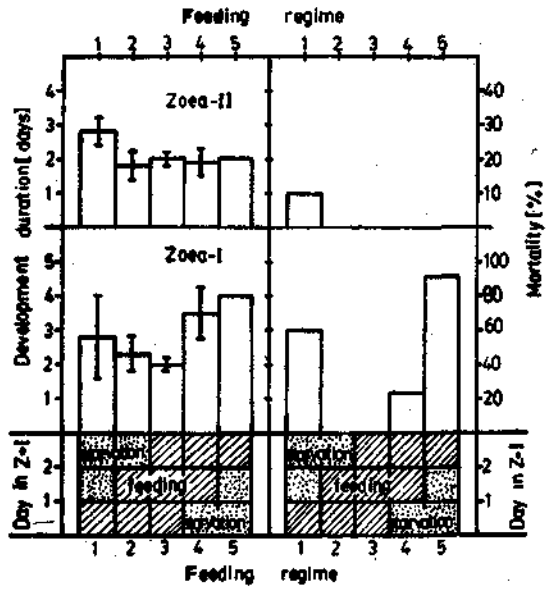

FIG. 1. Development duration in days (mean±standard deviation) and mortality (%) in the Z-I and Z-II of *M. distincta* under different feeding/starvation schedule during the Z-I stage.

Discussion

In *M. distincta*, after initial feeding, short starvation in all regimen at the Z-I prolongs the instar. On the other hand, studies on the larvae of temperate crabs viz. *Menippe mercenaria, Panopeus herbstii, Neopanope sayi, Sesarma cinereum, Libinia emarginata* (Anger *et al.*, 1981) and *Hyas araneus* (Anger and Dawirs, 1981) show that starvation at the end of Z-I has no effect or shortens the stage I.

PRS_{50} in *M. distincta* is ca. 1.3 d, which is <1 d in *L. emarginata*, between 1 and 2 d in *M. mercenaria, P. herbsti, N. sayi, S. cinereum* (Anger *et al.*, 1981) and ca. 3 d in *H. araneus* (Anger and Dawirs, 1981).

In 1 d fed group 1 Z-V moulted to Z-VI, which moulted to megalopa after 2 d. Appearance of more number of larval stages in tropics is due to scarcity of food, which leads to slower growth or higher temperatures, which quicken catabolism of cuticle. In the Arctic and Antarctic low temperatures result in slower growth, thereby more number of larval stages (Heegaard, 1971).

Starvation commencing towards the end of the Z-I in *M. distincta* shortens Z-II and III and delays Z-IV and V ; total zoeal development is prolonged and survival is 100%. But, starvation delays Z-II and following zoeal stages, and also total zoeal development is prolonged in temperate waters (Anger and Dawirs, 1981 ; Anger *et al.*, 1981).

Starvation period at the beginning of Z-I of *M. distincta* prolongs this stage as reported by earlier workers. (Kon, 1979 ; Anger and Dawirs, 1981 ; Anger *et al.*, 1981). They have shown that the delay in moulting is approximately equivalent to the duration of the starvation period in Z-I larva, same holds good only for the 2 d starved Z-I of *M. distincta*.

PNR_{50} in *M. distincta* is ca. 1. 2 d, that of five species of crab larvae (Anger *et al.*, 1981) is ca. 1-2 d and in *H. araneus* < 8 d. The influence of starvation immediately following hatching in *M. distincta* is stronger than where a feeding period precedes starvation as suggested by Anger *et al.* (1981).

Owing to initial starvation in *M. distincta*, Z-II and III are shortened and Z-IV and V are prolonged ; ultimately total zoeal development is delayed. Initial lack of prey lengthens development of Z-II in *P. herbstii*, *S. cinereum* and *L. emarginata* and shortens in *M. mercenaria*, *N. sayi* (Anger *et al.*, 1981) and *H. araneus* (Anger and Dawirs, 1981). The subsequent zoeal stages are prolonged in all species except *H. araneus*.

In view of this, it appears that there is a critical period in the beginning of larval development of *M. distincta* as reported by Kon (1979), Anger and Dawirs (1981) and Anger *et al.* (1981). Except for chitin synthesis, development processes await the starting signal given by first feeding (Anger and Nair, 1979). When prey is available during intermoult,

TABLE 1. *Duration of zoeal stages in days (mean ± standard deviation) and mortality (%) of* M. distincta *under different feeding regimens (see text for conditions of regimes).*

Stage	Feeding regimen																	
	1			2			3			4			5			6		
	days			days			days			days			days			days		
	$\bar{\times}$	±	%	$\bar{\times}$	±	%	$\bar{\times}$	±	%	$\bar{\times}$	±	%	$\bar{\times}$	±	%	$\bar{\times}$	±	%
Z-I	2.80	1.23	60	2.32	0.48	0	2.04	0.20	0	3.50	0.77	24	4.00	0	92			100
Z-II	2.80	0.44	4	1.80	0.41	0	2.04	0.20	0	1.90	0.40	0	2.00	0	0			
Z-III	1.88	0.35	4	1.20	0.41	0	2.08	0.28	0	1.90	0.24	4	2.00	0	0			
Z-IV	1.86	0.38	4	2.56	0.65	0	2.12	0.33	0	2.50	0.51	4			8			
Z-V	3.14	0.38	0	2.76	0.44	0	2.16	0.37	0	2.50	0.51	0						
Z-VI	2.00	0	0															

tissue growth and accumulation of organic reserves take place (Yamaoka and Scheer, 1979). If starvation precedes or interrupts phase C, it will last longer, because protein losses have to be compensated for (Anger and Dawirs, 1981). Sterols present in the first feed are the precursors of B-ecdysone, which initiates premoult and ecdysis independent of further food availability (Anger and Dawirs, 1981). Lipid pools formed during PRS, are necessary precursors for chitin synthesis in the Z-II (Holland, 1978).

The delay in Z-I, which are starved initially and their inability to moult to Z-II, may be due to an irreversible damage to some hormonal or enzymatic system controlling moulting (Anger and Dawirs, 1981); catabolism of proteins (Anger and Nair, 1979); lipid degradation during final premortal period (Anger and Dawirs, 1982); aminoacid catabolism (Munday and Poat, 1971); ultrastructural alterations in R-cells of hepatopancreas, (in freshly hatched zoeae) which are stuffed with libid inclusions representing yolk reserves (Stock and Anger, 1983); irreversibility of tissue atrophy in the epidermis and muscle surface when the PNR has been exceeded (Anger, 1984). Further studies on biochemical, histological and physiological changes during starvation of tropical larvae will throw light on probable causative factor. Perhaps the larvae may have maximum starvation resistance as an ecological adaptation.

References

ANGER, K. AND K. K. C. NAIR 1979. Laboratory experiments on the larval development of *Hyas araneus* (Decapoda, Majidae). *Helgolander Wiss. Meeresunters*, **32** : 36-54.

——— AND R. R. DAWIRS 1981. Influence of starvation on the larval development of *Hyas araneus* (Decapoda, Majidae). *Helgolander Meeresuntersuchungen*, **34** : 287-311.

———, R. R. DAWIRS, V. ANGER AND J. D. COSTLOW 1981. Effects of early starvation periods on zoeal development of Brachyuran crabs. *Biol. Bull.*, **161** : 199-212.

——— AND R. R. DAWIRS 1982. Elemental composition (C. N. H) and energy in growing and starving larvae of *Hyas araneus* (Decapoda, Majidae). *Fish. Bull.*, **80** : 419-433.

——— 1984. Influence of starvation on moult cycle and morphogenesis of *Hyas araneus* larvae (Decapoda, Majidae). *Helgolander Meeresunters*, **38** : 21-33.

CRONIN, T. W. AND R. B. FORWARD, JR. 1980. The effects of starvation on phototaxis and swimming of larvae of the crab *Rhithropanopeus harrisii*. *Biol. Bull.*, **158** : 283-294.

HEEGAARD, P. 1971. Larval stages and growth in the decapods. *Videnskabelige Meddeleser Fra Dansk Naturhirstorisk Forening*, **134** : 119-126.

HOLLAND, D. L. 1978. Lipid reserves and energy metabolism in the larvae of benthic marine invertebrates. In: D. C. Malins and J. R. Sargent (Ed.) *Biochemical and biophysical perspectives in marine biology*. Academic Press, London, **4** : 85-123.

KON, T. 1979. Ecological studies on larvae of the crabs belonging to the genus *Chionoecetes* I. The influence of starvation on the survival and growth of the Zuwai crab. *Bull. Jap. soc. Sci. Fish.*, **45** : 7-9.

KRISHNAN, T. AND T. KANNUPANDI MS. Laboratory cultured zoeae, megalopa and first crab of *Metaplax distincta* H. Milne Edwards, 1852 (Brachyura: Sesarminae). *Communicated to Journal of Plankton Research.*

MUNDAY, K. A. AND P. C. POAT 1971. Respiration and energy metabolism in Crustacea. In: M. Florkin and B. T. Scheer (Ed.). *Chemical Zoology*: Arthropoda. Academic Press, New York, **6** : 191-211.

STORCH, V. AND K. ANGER 1983. Influence of starvation and feeding on the hepatopancreas of larval *Hyas araneus* (Decapoda, Majidae). *Helgolander Meeresuntersuchungen*, **36** : 67-75.

YAMAOKA, L. H. AND B. T. SCHEER 1979. Chemistry of growth and development in crustaceans. In: M. Florkin and B. T. Sheer (Ed.) *Chemical Zoology*: Arthropoda. Academic Press, Inc., New York, **5** : 321-341.

YATSUZUKA, K. 1962. Studies on the artificial rearing of the larval brachyura especially of the larval blue crab, *Neptunus pelagicus* Linnaeus. *Rep. Usa mar. biol. Stn. Kochi Univ.*, **9** : 1-88.