CHARACTERIZATION OF MOULT STAGES OF *PENAEUS INDICUS* BASED ON DEVELOPING UROPOD SETAE AND SOME CLOSELY ALLIED STRUCTURES

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ABSTRACT

The characters of the different moult stages of *Penaeus indicus* H. Milne Edwards, through a complete moult cycle, based on the successive stages of development of the setae and closely allied structures in the uropod are described so as to serve as a key.

The early attempts to decide the physiological stages of decapod crustaceans were based on gross apparent changes occurring prior to, during and just after ecdysis (Baumberger and Olmsted 1928). Later, the concept of moult cycle as a well-defined sequence of stages was originated by Drach (1939) in his classical studies on the brachyurans *Cancer* and *Maia*. This study was based mainly on the integumental changes of the cuticle. After his subsequent work

(Drach 1944) on the natantian *Leander serratus*, in which he modified the method by adopting setal development as a diagonstic factor, this method found application in many more crustatceans including prawns and crabs (Stevenson 1972, Longmuir 1983).

In the present investigation, the moult stages of *P. indicus* were determined based on the changing morphology of the uropod setae alone as, in this prawn, the study in the live condition has been easier of the uropod.

Live *P. indicus* were periodically collected from the ponds of the Prawn Culture Labortory of CMFRI at Narakkal. A few prawns in the premoult condition were maintained in the laboratory to note the changes in the setal morphology occurring immediately after moulting. The rest were sacrificed for studying the changes in the setal morphology of the different moult stages that the sample contained. The setal characters of the stage immediately after moulting were determined from the animals maintained in the laboratory as soon as they had moulted. Keeping this observed morphology as the character of the first moulting stage, other stages were arbitrarily fixed assigning the progressive setal changes found in the rest of the sample. Any lack of continuity in stages was filled by further samplings. This way a complete picture of all moulting stages was gained.

The microscopic study was by mounting parts of uropod in sea water on a slide and examining under both low and high power magnifications. For classification of the moult stages the morphological changes of the setae were mainly used, a criterion originally proposed by Drach (1944) and later modified by Scheer (1960), Drach and Tchernigovtzeff (1967), Schafer (1968) and Cognie (1969).

The following five clearly demarcated moult stages, A to E, were determined. The division of stage D into the substages was based on the developmental stages of new setae and the stages of reorganization of the new epidermis. The determinative characters of the various stages as observed are as follows:

Moult stage A: This is the premoult stage immediately after ecdysis. Translucent matrix visibly extends through out the setae. The internal cones are absent. With the advancement of stage A, however, there is gradual retraction of the setal matrix from the distal end (Plate I, 1 and 2).

Moult stage B: With the onset of stage B, the matrix is greatly retracted and is visible only at the basal end. Formation of cone-shaped structures begins at the base of the setae with the advancement of stage B. No. pigment retraction is seen (Plate I, 3).

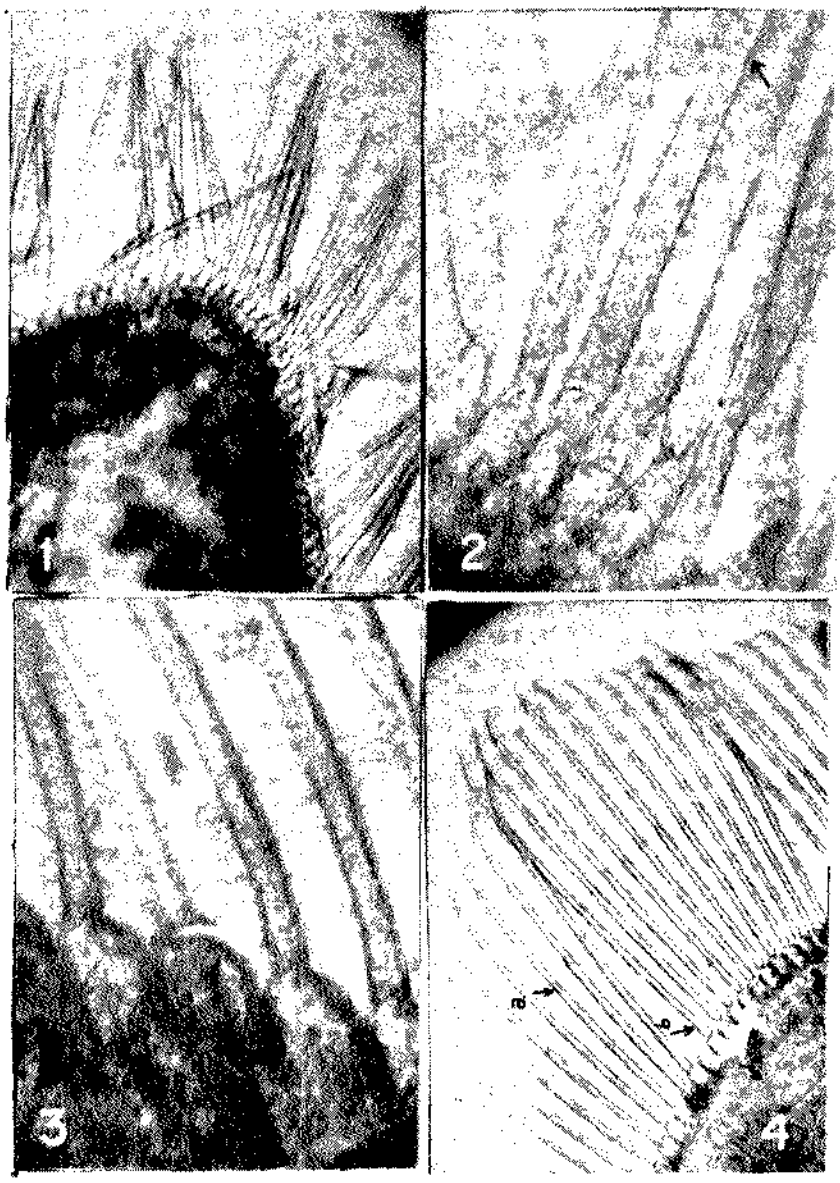

PLATE I FIG. 1 Moult stage early A, showing the delicate condition of the uropod setae, 100X. 2. Moult stage late A, arrow indicating the gradual retraction of matrix in uropod setae, 400X. 3. Moult stage early B, showing the absence of basal cone and concentration of matrix in uropod setae, 400X. 4. Moult stage C, showing (a) fully formed internal cone; (b) well-shaped basal cone, 100X.

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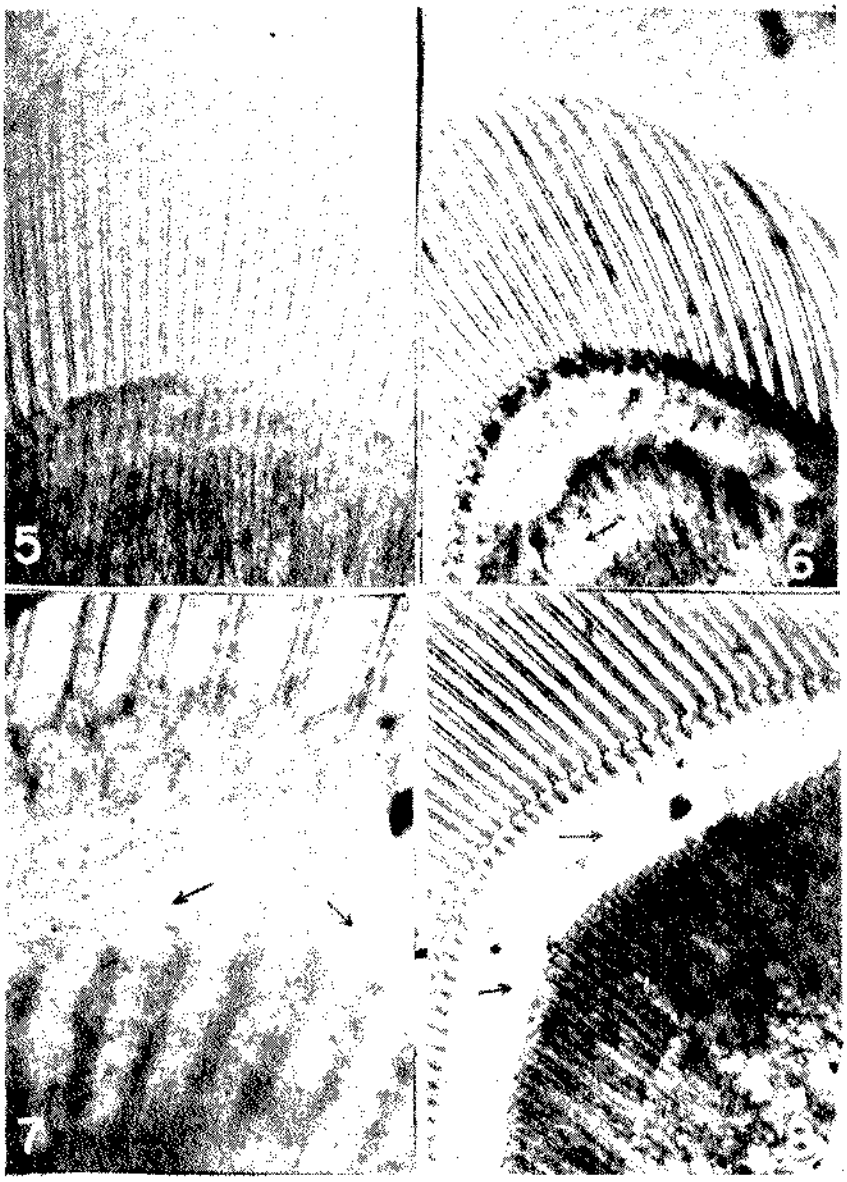

PLATE II FIG. 5. Moult stage advanced D, showing the heavy pigment retraction in uropod. 100X. 6. Moult stage early D1, arrow indicating the invagination process during the new setal development. 100X. 7. Moult stage D1", arrow indicating the evagination of new setae. 400X. 8. Moult stage D4, arrow indicating the fully formed and bushy nature of new setae, evaginating from epidermis gradually, 100X.

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Moult stage C: This is the intermoult stage, in which a thick conical structure appears at the setal base. This structure undergoes marked development during the course of this stage. The setae are now totally devoid of matrix. The prominent internal base-cone is the most diagnostic feature of this stage (Plate I, 4).

Moult stage D: The premoult stage D, covering a course of changes from the beginning of the retraction of the epidermis from the cuticle to the animal's becoming ready to rid of the old cuticle, comprises many setal and epidermal changes, based on which it is subdivided into stages D1 to D4. In stage D, to begin with, there is heavy pigment retraction in the uropod (Plate II, 5). The newly developing setae are discernible at the base of the epidermis on the borders of the uropod. D1' to D1''' are further substages of D1 distinguished based on the development of the newly forming setae.

*Moult stage D*1' - This is characterized by the very slender invaginations in the epidermis forerunning the new setae (Plate II, 6).

*Moult stage D*1'' - The setal invaginations continue more deeply and clearly. The epidermal surface proceeds to reorganize.

*Moult stage D*1''' - The reorganization of the epidermis is complpete and the new setae are very prominent (Plate II, 7). The formation of the barbules begins at the tip of the new setae.

*Moult stage D*2 - A clear cuticular layer is present but no visible change in the setal morphology is seen, indicating that the formation of setae is complete.

*Moult stage D*3 - Heavy pigmentation of the cuticular layer is prominent. Barbule formation has extended towards the basal part of the new setae.

*Moult stage D*4 - The new setae are fully developed. The setae, appearing as very fragile structures, begin to evert. The new setae get accomodated between the old cuticle and the new by evenly folding on themselves without penetrating the old setae (Plate II, 8).

Moult stage E: The shedding of the old cuticle takes place at this stage, and, with the cuticle shed, the new setae unfold and become promient, though the greater part of them are still embedded in the epidermis. During the postmoult period immediately follows, the new setae completely extend out of the uropod.

The changes in the setal morphology among the different moult stages were clearly distinct in *P. indicus*. That the matrix, which was in full extent in the setae in stage A, was almost completely retracted when the animal passed on to stage B is in conformity with the criterion set forth by Drach (1939) for fixing stage B while classifying the natantian moult stages. So also, that the

appearance of the basal cone in stage C agrees with the observations made by Drach (1944) and later confirmed by Schafer (1968), Mills and Lake (1975) and Peebler (1977).

The onset of the premoult stage D in *P. indicus* was characterized by the beginning of the retraction of the epidermis from the cuticle at the base of the setae. In most of the decopod crustacea, in fact, this has been accepted as the identifying character of stage D (Drach and Techernigvtzeff 1967, Aiken 1973). The setal invaginations in the epidermis as the character of stage D1 has also been observed by others. The process of the formation of setae during stage D1 both in natantia (Scheer 1960) and in brachyura (Drach 1944) was also as invaginations of the retracted epidermis. Later Drach and Tchernigovtzeff (1967) have found this as the process common in all the decapod groups.

The clearly developed cuticular layer in stage D2 observed in *P. indicus* has been like in other decapods (Scheer 1960, Yamoka and Scheer 1970), too. Stevenson (1972) has noted that the setae in the crayfish *Orconectes* look bushy at this stage because of the emergence of many hairs. In *Homarus americanus* too barbules are reported to become visible at this stage (Aiken 1973). The kind of increasing setal invaginations in D3-D4 stages of *P. indicus* were also seen in *P. tasmanicus* (Mills and Lake 1975).

Therefore, keeping these well-differentiated characters based mainly on the setal development on the uropod as an index it may be possible to segregate the different moult phases without difficulty.

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References

Aiken, D. E. 1973. *J. Fish. Res. Board Can.*, 30: 1337-1344.

Baumberger, J. P. and J. M. D. Olmsted. 1928. *Physiol. Zool.* 1: 531-544.

Cognie, D. 1966. *These de Specialite, Universite d'dix, Marsielle.*

Drach, P. 1939. *Ann. Inst. Oceanogr. Monaco.* 19: 103-391.

Drach, *P.* 1944. *Bull. Biol.* 78: 40-62.

Drach, P. and C. Tchernigovtzeff. 1967. *Vie Milieu, Ser.* A. 18: 595-610.

Longmuir, E. 1983. *Marine Biology.* 77(2): 183.

MILLS, B. J. AND P. S. LAKE. 1975. *Aust. J. Mar. Freshwat. Res.* 26: 103-107.

PEEBLES, J. B. 1977. *Aquaculture*, 12: 173-180.

SCHAFER, H. W. 1968. *FAO Fish. Rep.* 57: 381-391.

SCHEER, B. T. 1960. *Comp. Biochem. Physiol* 1: 3-18.

STEVENSON, J. R. 1972. *Am. Zool.* 12: 373-380.

YAMAOKA, L. H. AND B. T. SCHEER. 1970. *Chemical Zoology* (Eds. Florkin, M. and Scheer, B. T.) Academic Press. New York. 321-341.