SCI. MAR., 68 (3): 373-384 SCIENTIA MARINA 2004

Abbreviated larval development of *Tunicotheres moseri* (Rathbun, 1918) (Decapoda: Pinnotheridae), a rare case of parental care among brachyuran crabs*

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SUMMARY: *Tunicotheres moseri* (Rathbun, 1918) presents a rare case of post-hatching parental care not recorded previously among brachyuran decapods. The complete larval development takes place within a brooding enclosure of the parental female, formed by flexure of the broad abdomen against the sternum. The first crab instar is the earliest stage observed to leave this enclosure, doing so without active help from the parental female. The development of stages preceding the first crab was investigated by *in vitro* culture of eggs obtained from ovigerous crabs inhabiting the atrial cavity of the tunicate *Phallusia nigra* Savigny, 1816, in Venezuela. Eggs were hatched in the laboratory and reared through two zoeal stages and the megalopa. Additional samples of the larval stages were obtained directly from abdominal enclosures of aquarium-held females. All larval stages were described and illustrated in detail. Morphological comparisons were made between larvae from two different populations. Comparisons were also made with other previously described larvae of Pinnotherinae, which led us to conclude that *Tunicotheres* should not be assigned to the Pinnotherinae *sensu stricto*. Relationships between the three known disjunct populations assigned to *T. moseri* remain questionable, especially since the potential for larval dispersal appears to be very limited.

Key words: *Tunicotheres moseri*, Pinnotheridae, larval morphology, parental care, zoea, megalopa, population, systematics.

RESUMEN: DESARROLLO LARVAL ABREVIADO DE *TUNICOTHERES MOSERI* (RATHBUN, 1918) (DECAPODA: PINNOTHERIDAE), UN CASO RARO DE CUIDADO PARENTAL EN CANGREJOS BRAQUIUROS. – *Tunicotheres moseri* (Rathbun, 1918) representa un caso raro de cuidado parental de los estadios posteriores a la eclosión larval, que no ha sido documentado con anterioridad en decápodos braquiuros. Todo el desarrollo larval transcurre en la cavidad comprendida entre el abdomen y la placa esternal de la hembra. El primer estadio juvenil es el primero que abandona la cavidad, y lo hace sin ayuda de un movimiento activo del abdomen por parte de la hembra. El desarrollo de los estadios previos al primer juvenil fue estudiado mediante cultivo *in vitro* de huevos extraídos de hembras ovígeras que habitan la cavidad atrial del tunicado *Phallusia nigra* Savigny, 1816, en Venezuela. Los huevos eclosionaron en el laboratorio y se obtuvieron dos estadios zoea y una megalopa. Muestras adicionales de todos los estadios larvales fueron obtenidas directamente de las cavidades formadas por el abdomen de hembras mantenidas en acuarios en el laboratorio. Todos los estadios larvales son descritos e ilustrados en detalle. La morfología de las larvas de dos diferentes poblaciones de esta especie fue comparada. También se hicieron comparaciones morfológicas con las larvas de otros Pinnotherinae previamente descritos, lo que nos permite concluir que *Tunicotheres* no debería ser asignado a los Pinnotherinae *sensu stricto*. Queda en cuestión que exista relación entre las tres poblaciones aisladas, reconocidas como pertenecientes a la especie *T. moseri*, debido especialmente a que su potencial para la dispersión larvaria parece ser muy limitado.

Palabras clave: *Tunicotheres moseri*, Pinnotheridae, morfología larval, cuidado parental, zoea, megalopa, población, sistemàtica.

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*Received April 15, 2003. Accepted March 8, 2004.

INTRODUCTION

The family Pinnotheridae de Haan, 1833 is a somewhat heterogeneous group of small crabs living as symbionts with other invertebrates. In the last ten years this family has been the object of several studies based upon larval and adult morphology (Marques and Pohle, 1995; Campos, 1996, 1999; Števčić, 1996; Pohle and Marques, 1998, Campos and Manning, 2000). More recently, two of the present authors have focused efforts on combining molecular genetic data with findings from comparisons of larval and adult morphology in the course of a broad-based study of systematics and phylogeny within the Pinnotheridae (Cuesta *et al*., 2001, 2002, Cuesta and Felder, in prep.). The preliminary results of these projects underscore the polyphyletic nature of the family Pinnotheridae as presently composed and make clear the need for a revised classification based on both molecular analysis and re-evaluations of larval and adult morphology.

The genus *Tunicotheres* was erected by Campos (1996) for a single species, *Pinnotheres moseri* Rathbun, 1918, originally described on the basis of female specimens from Jamaica (type locality) and Florida. The apparent male of this species was found recently in Laguna La Restinga (Isla de Margarita, Venezuela) inside the black tunicate, *Phallusia nigra*, as reported by Hernández and Bolaños (1995). As is now known, the distribution of this species is believed to be restricted to Jamaica, the west coast of Florida and Isla de Margarita (Venezuela). Specimens have been found living as commensals within the ascidians *Phallusia nigra* Savigny, *Molgula occidentalis* Traustedt, 1882, *Polycarpa spongiabilis* Traustedt, 1883, and *Styela plicata* (Lesueur, 1823) (Goodbody, 1960; Roberts, 1975; K. Strasser, University of Tampa, pers. comm.).

This species presents a rare case of post-hatching parental care in a marine decapod crustacean. All larval stages are contained within the space delimited by the flexed abdomen and sternum of the female, hereafter termed the abdominal enclosure. The megalopa moults to the first crab stage while still contained within the abdominal enclosure, and the first crab is the first instar to leave the abdomen of the female and exit the atrial cavity of the host, thereafter potentially dispersing to a new host.

In the present study, the complete larval development of *T. moseri* from Isla de Margarita (Venezuela) is described and fully illustrated. Where possible, comparisons are made with developmental stages described by Goodbody (1960) for a Jamaican population of the species. Interspecific comparisons are made with known larvae of other Pinnotherinae.

MATERIAL AND METHODS

Thirty-two ovigerous females were collected between 1995 and 2001, all from the atrial cavity of the host tunicate, *Phallusia nigra*, in Laguna La Restinga, Isla de Margarita, Venezuela. The females were transferred live to the Laboratory of Carcinology, Universidad de Oriente, Boca del Río (Isla Margarita, Venezuela). The egg masses were removed from nine ovigerous females and cultured *in vitro*. The remaining ovigerous females were maintained in aerated aquaria at 23-27°C and 36-38 psu salinity, so development of the eggs could proceed while egg masses remained intact in the abdominal enclosures of the females. Larvae hatched from *in vitro* egg cultures were reared at 23-27°C and 36-38 psu salinity in gently aerated beakers (120 ml, ca. 10 larvae per beaker). Water was changed and freshly hatched nauplii of *Artemia* were added (*ad libitum*) after each daily examination of cultures for mortalities and evidence of moulting. Control groups of larvae were reared under exactly the same conditions, but without feeding, to ascertain any effects of starvation. Samples of larvae and exuviae were fixed in a 4% neutralised solution of formaldehyde in seawater.

The two zoeal stages, the megalopa and first crab were also harvested from the abdominal enclosures of the aquarium-held females for comparison with the stages reared from *in vitro* egg cultures. Different larval stages, along with the first crab stage, were sometimes taken simultaneously from the same female.

Dissections were made under a Leika MZ8 binocular dissecting microscope. Drawings and measurements were made using an Olympus BH-2 compound microscope equipped with a *camera lucida*. Semi-permanent and permanent slide mounts in polyvinyl lactophenol were made of whole larvae and dissected appendages. All measurements were made with an ocular micrometer. Drawings were based on examinations of no less than 5 larvae for each feature, but more than 20 larvae of each stage were dissected and examined to determine setal variability. Size measurements were based on 10 larvae per stage from 3 different hatches. For zoeal

stages, rostro-dorsal length (rdl) was measured from the tip of the rostral spine to the highest point on the carapace; carapace length (cl) was measured from the base of the rostrum to the posterior margin of the carapace; and carapace width (cw) was measured as the greatest distance across the carapace. In the megalopa stage, carapace length (cl) was measured from the base of the rostrum to the posterior margin of the carapace, and carapace width (cw) was measured as the maximum width of the carapace.

The long setae on the distal exopod segments of the first and second maxillipeds were drawn truncated. Descriptions and figures were arranged according to the standards proposed by Clark *et al*. (1998). Samples of all larval stages and one parental female of *Tunicotheres moseri* from the Venezuelan population were deposited at the Smithsonian Institution National Museum of Natural History, Washington, D.C. (USNM 1020583) and at the University of Louisiana-Lafayette Zoological Collection (ULLZ 5578).

TABLE 1. – Dimensions (rostro-dorsal length, rdl, carapace width, cw, and carapace length, cl; mean ± SD in mm) for zoeae and megalopa of *Tumidotheres moseri*, along with day of first appearance (F) and duration of each stage (D) in days.

	rdl	cw	cl	F	D
Zoea I	0.70 ± 0.02	0.53 ± 0.01	0.64 ± 0.01	1	1-2
Zoea II	0.94 ± 0.02	0.55 ± 0.04	0.81 ± 0.02	2	1-3
Megalopa	-	0.59 ± 0.03	0.68 ± 0.04	3	1-2

RESULTS

Hatching of the eggs cultured *in vitro* was followed by two morphologically distinct zoeal stages and a megalopa (Table 1). Development to the megalopa was completed in a minimum of 3 days from hatching. All zoea I stages appeared to moult to zoea II, with no evidence of direct moulting from zoea I to the megalopa. The first crab stage was reached at a minimum of 4 days after hatching. No observations were possible on the duration of devel-

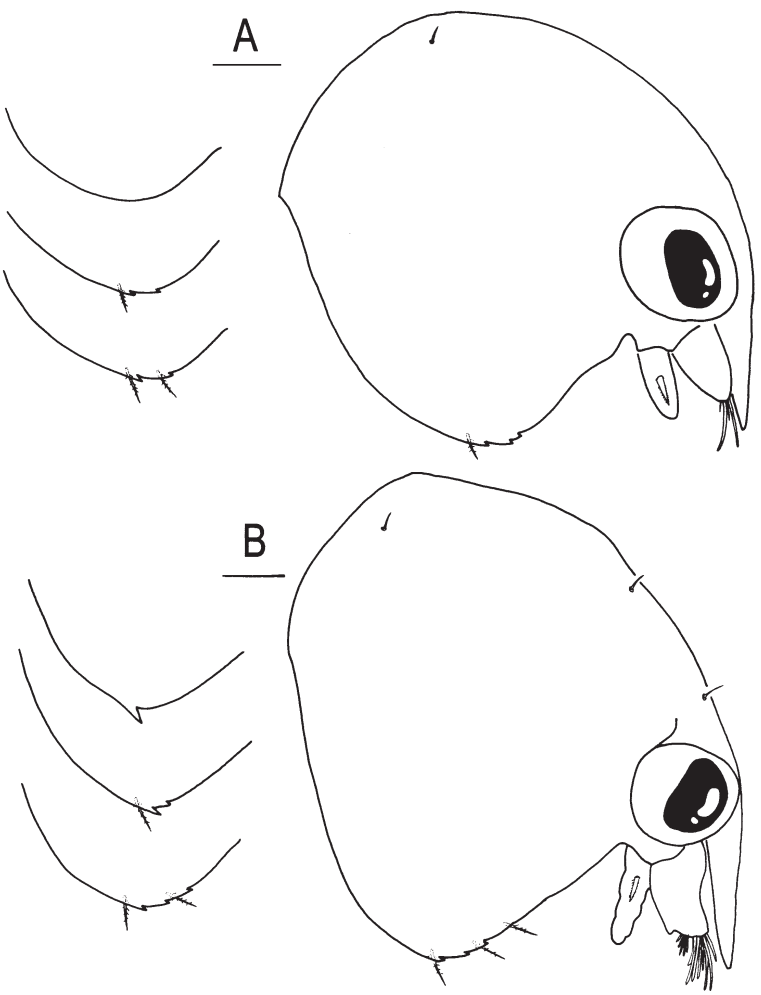

FIG. 1. – *Tunicotheres moseri* (Rathbun, 1918): Carapace, lateral view and magnification of the ventrolateral margin from different specimens; A, zoea I. B, zoea II. Scale bars = 0.1 mm.

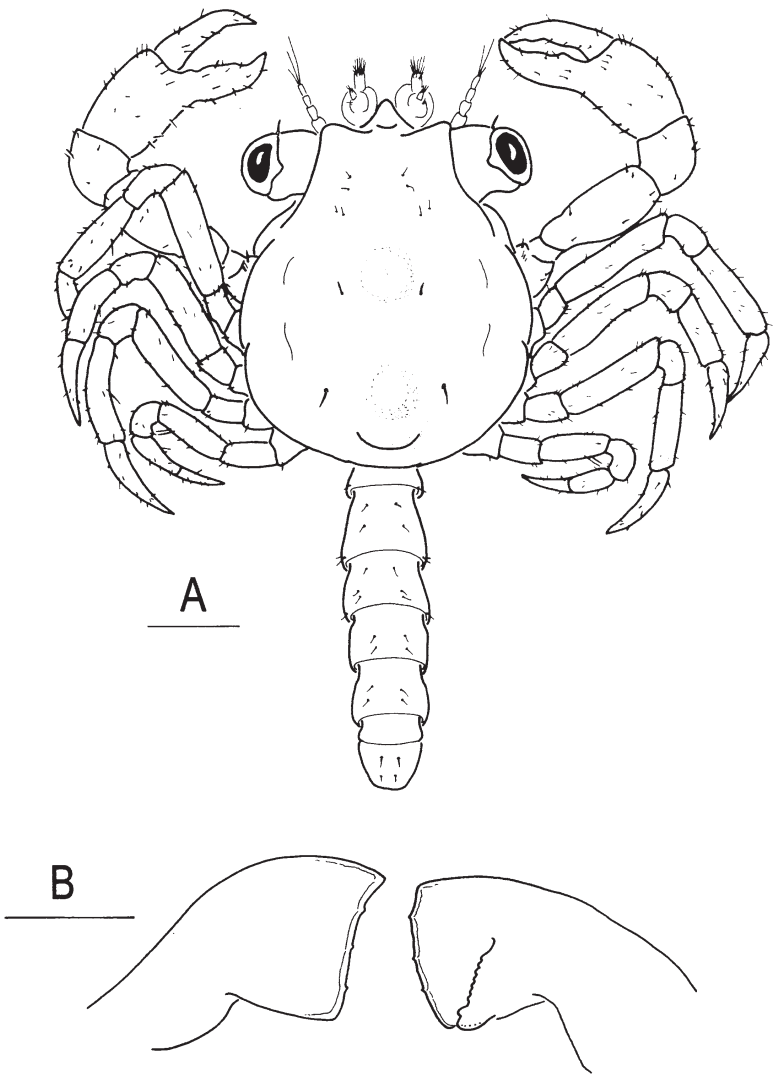

FIG. 2. – *Tunicotheres moseri* (Rathbun, 1918): Megalopa: A, dorsal view. B, mandible, anterior and posterior view. Scale bars : A = 0.1 mm, B = 0.05 mm.

opmental stages reared within the abdominal enclosure of females.

There were no differences in survival or stage durations between larvae cultured under starvation and those fed nauplii of *Artemia*. Larvae appeared to carry large masses of yolk in all stages. There was no evidence of a source of food for larvae developing in the abdominal enclosure of females. It thus appeared that the larval stages were either non-feeding or at least facultatively lecithotrophic.

Ovigerous females maintained in aquaria never released larvae into the water column, as none of these stages were ever observed within the tanks. The first crab instar was the only stage observed in the aquaria.

The first zoeal stage of *Tunicotheres moseri* was described completely, whereas only differences were described in detail for subsequent stages. Morphological differences were not found between larvae cultured *in vitro* and those obtained from female abdominal enclosures. For some larval appendages the number of setae varied. In these cases, the typical number was illustrated, but ranges were indicated in the text.

Description of zoeae and megalopa

Tunicotheres moseri (Rathbun, 1918)
(Figs 1-7)

Zoea I

Previous description: Goodbody (1960): 704, fig. 1.

Carapace (Fig. 1A): Globose, smooth and without tubercles. Dorsal and lateral spines absent. Ros-

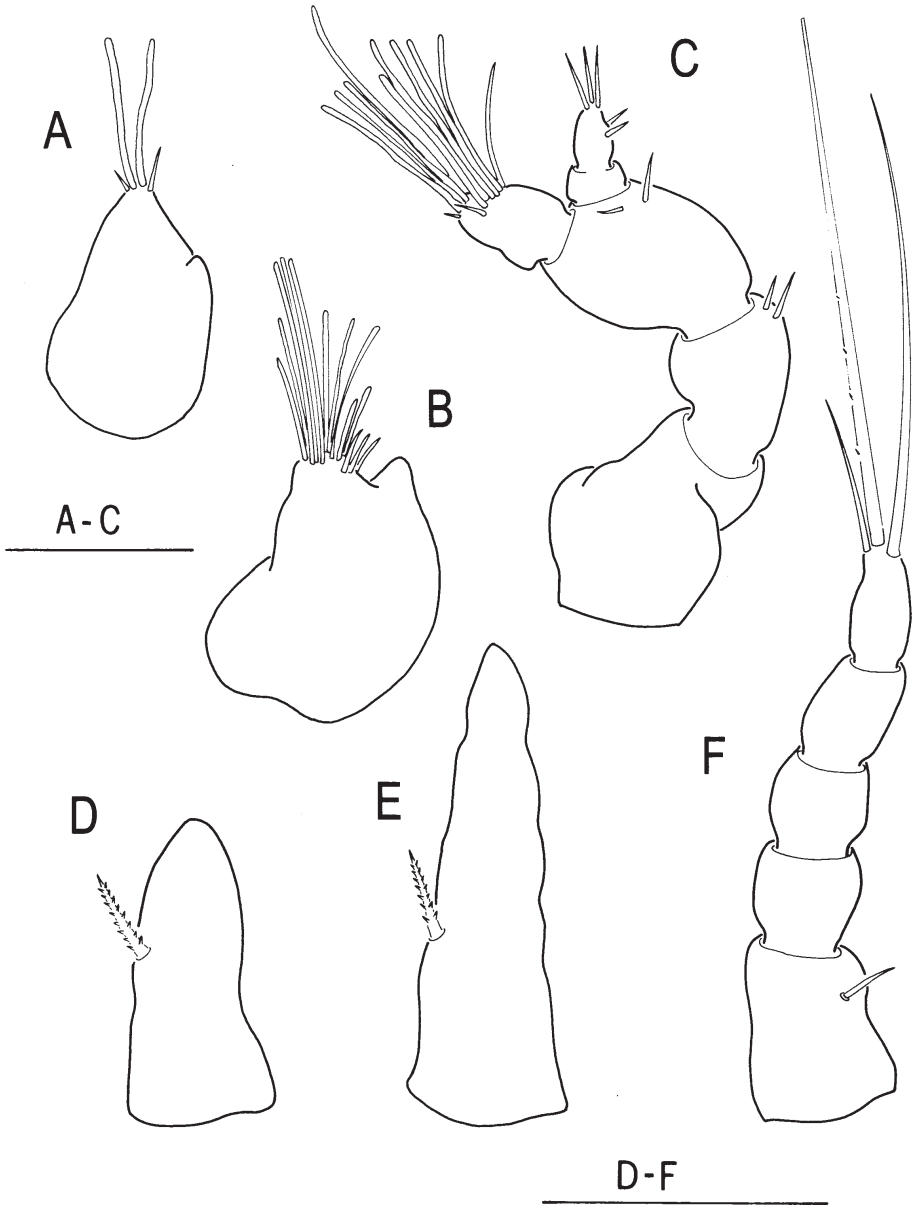

FIG. 3. – *Tunicotheres moseri* (Rathbun, 1918): Antennule: A, zoea I. B, zoea II. C, megalopa. Antenna: D, zoea I. E, zoea II. F, megalopa. Scale bars = 0.1 mm.

tral spine present, straight and slightly longer than antennular exopod. A pair of posterodorsal simple setae. Posterior margin without setae. One to 3 spines and 0-2 plumodenticulate setae on ventral margin. Eyes sessile.

Antennule (Fig. 3A): Biramous. Endopod present as a small bud. Exopod unsegmented with 2 short aesthetascs and 2 simple setae (1 minute), all terminal.

Antenna (Fig. 3D): Small protopod bearing 2 rows of spinules. Exopod absent. Endopod well developed, unsegmented, longer than protopod.

Mandible: Small, with molar and incisor processes differentiated. Endopod palp absent.

Maxillule (Fig. 4A): Coxal endite with 1 plumose seta and 0-1 terminal spines. Basial endite with 5 setae (2 plumodenticulate cuspidate, 3 plumodenticulate). Endopod 2-segmented, proximal segment unarmed, terminal plumodenticulate seta on distal segment. Exopod seta absent.

Maxilla (Fig. 4D): Coxal endite with 1-2 plumose setae. Basial endite bilobed with 4-5 + 3-4 plumodenticulate setae. Endopod simple (not bilobed) unsegmented, 1 long plumodenticulate terminal seta. Scaphognathite with 5-6 plumose marginal setae and a long setose posterior process.

First Maxilliped (Fig. 5A): Coxa without setae. Basis with 5-6 medial simple setae arranged 1-2, 2,

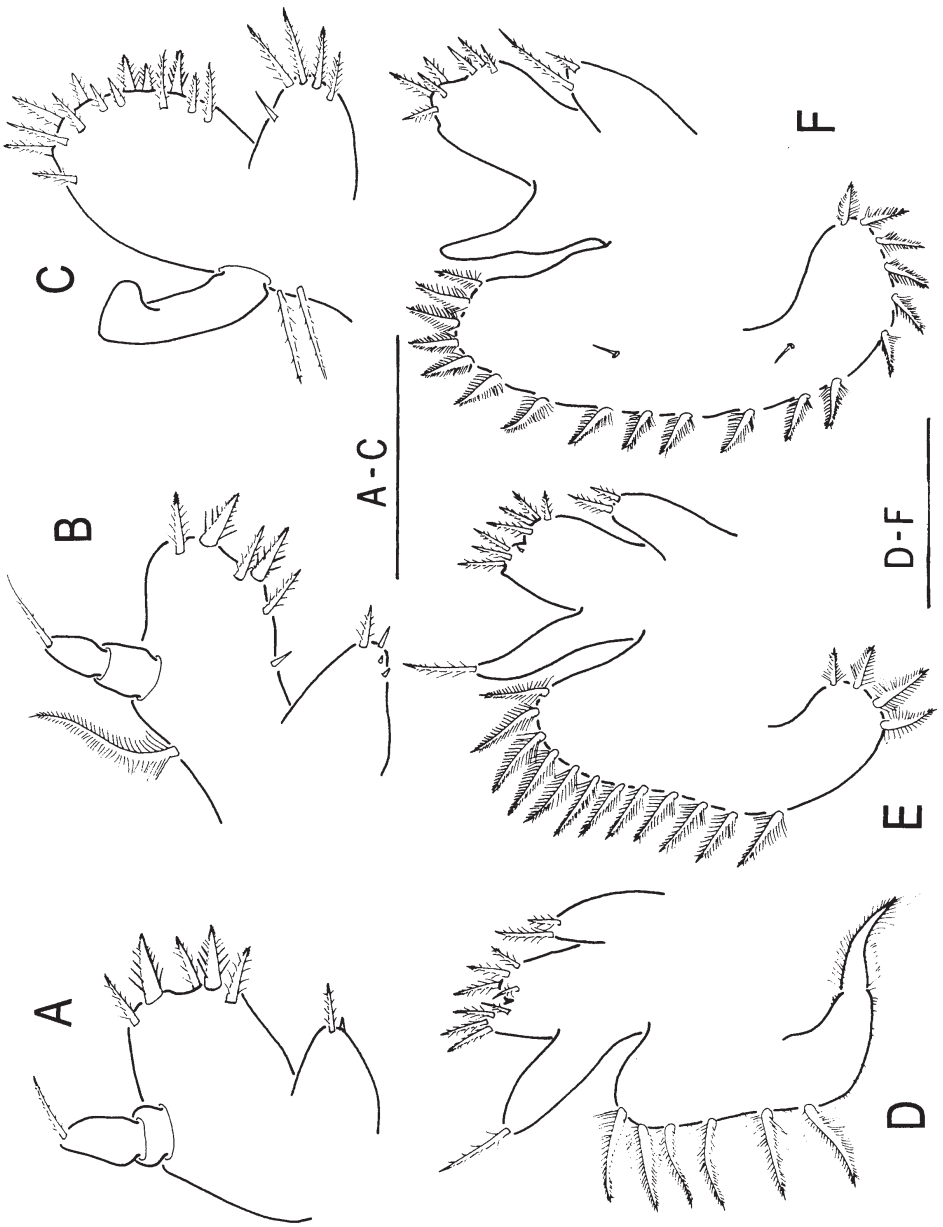

FIG. 4. – *Tunicotheres moseri* (Rathbun, 1918): Maxillule: A, zoea I. B, zoea II. C, megalopa. Maxilla: D, zoea I. E, zoea II. F, megalopa. Scale bars = 0.1 mm.

2. Endopod 5-segmented with 0, 0, 1 plumodenticulate, 2 plumodenticulate, 4 (1 plumodenticulate subterminal + 2 plumodenticulate and 1 simple terminal) setae. Exopod unsegmented, with 4 long terminal plumose setae.

Second Maxilliped (Fig. 5D): Coxa without setae. Basis with 0-1 small simple seta. Endopod 2-segmented with 0, 3-4 (1 subterminal + 2-3 terminal) plumodenticulate setae. Exopod unsegmented, with 4 long terminal plumose setae.

Third Maxilliped (Fig. 5G): Biramous. Endopod, exopod and epipodite present as 3 undifferentiated buds.

Pereiopods (Fig. 6A): Present as undifferentiated buds. First pair chelate.

Abdomen (Fig. 7A,B): Five abdominal somites. Somites 2-3 with pair of dorsolateral processes. Somites 2-5 with a pair of posterodorsal simple setae, and a pair of pleopods, present as undifferentiated buds, with rudiments of endopods.

Telson (Fig. 7A,B): Telson bifurcated with 3 pairs of short serrulate setae on posterior margin. Telson base, proximal to bifurcation, 2.5 times longer than furcal branches. Each furcal branch with small dorsal spine proximally and covered with spinules distally.

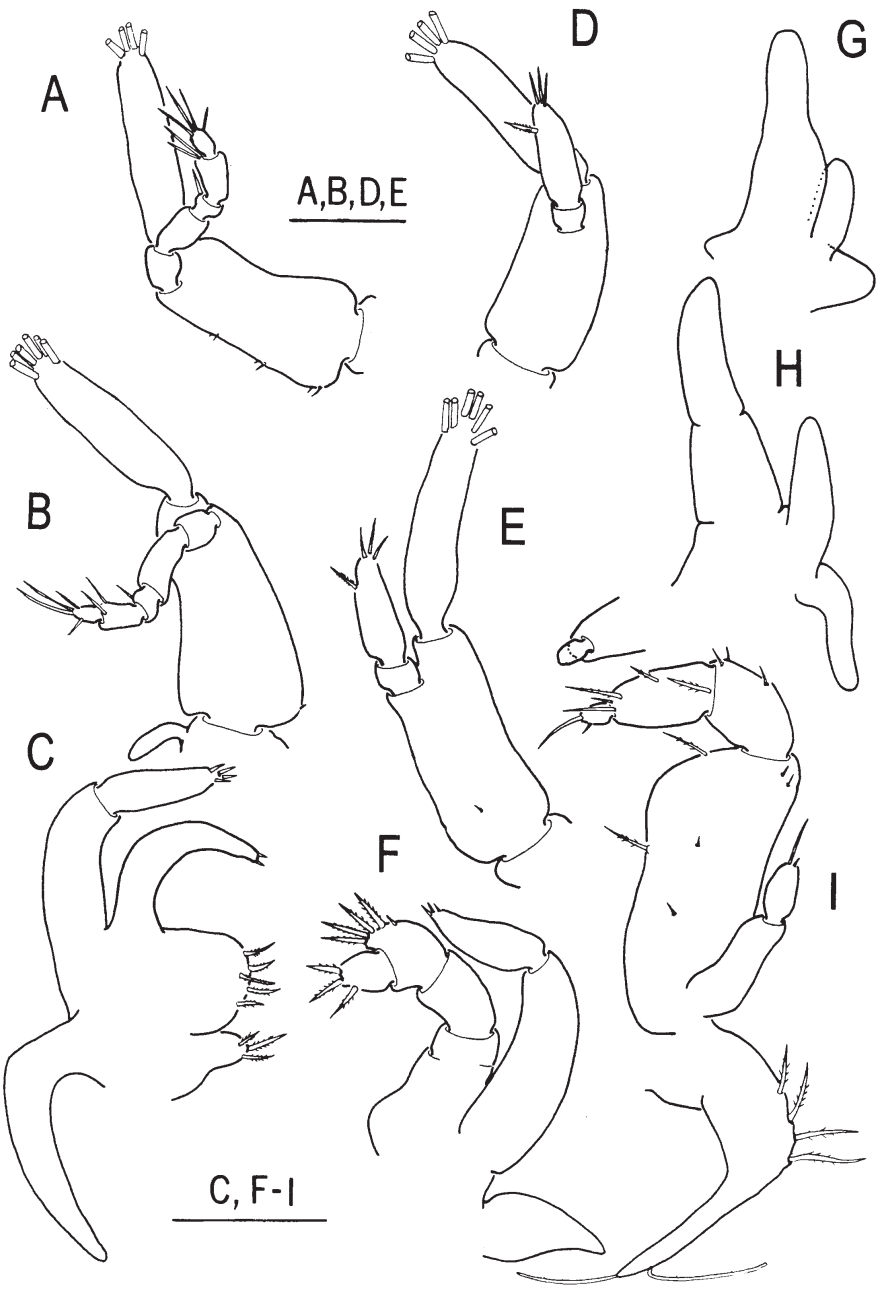

FIG. 5. – *Tunicotheres moseri* (Rathbun, 1918): First maxilliped: A, zoea I. B, zoea II. C, megalopa. Second maxilliped: D, zoea I. E, zoea II. F, megalopa. Third maxilliped: G, zoea I. H, zoea II. I, megalopa. Scale bars = 0.1 mm.

Zoea II

Carapace (Fig. 1B): Two pairs of anterodorsal simple setae. Ventral margin with 0-3 plumodenticulate setae and 1-3 spines. Eyes stalked.

Antennule (Fig. 3B): Exopod with 10 aesthetascs (2 subterminal, 8 terminal), and 3 subterminal simple setae. Endopod bud elongated.

Antenna (Fig. 3E): Endopod bud elongated.

Maxillule (Fig. 4B): Coxal endite with 1-2 plumose and 1 simple setae, and 1-2 terminal small spines . Basial endite with 6 setae (2 plumodenticulate cuspidate, 3 plumodenticulate, 1 simple). Exopod present as a long plumose marginal seta.

Maxilla (Fig. 4E): Basial endite bilobed with 3-4 plumodenticulate setae on the inner lobe and 3 plumodenticulate and 1 small simple setae, and 1 minute spine on the outer lobe. Scaphognathite with 12-16 plumose marginal setae.

First Maxilliped (Fig. 5B): Epipod present as small bud. Basis with 1 proximal simple seta. Endopod 5-segmented with 0, 0, 0-1, 2, 4 (1 subterminal

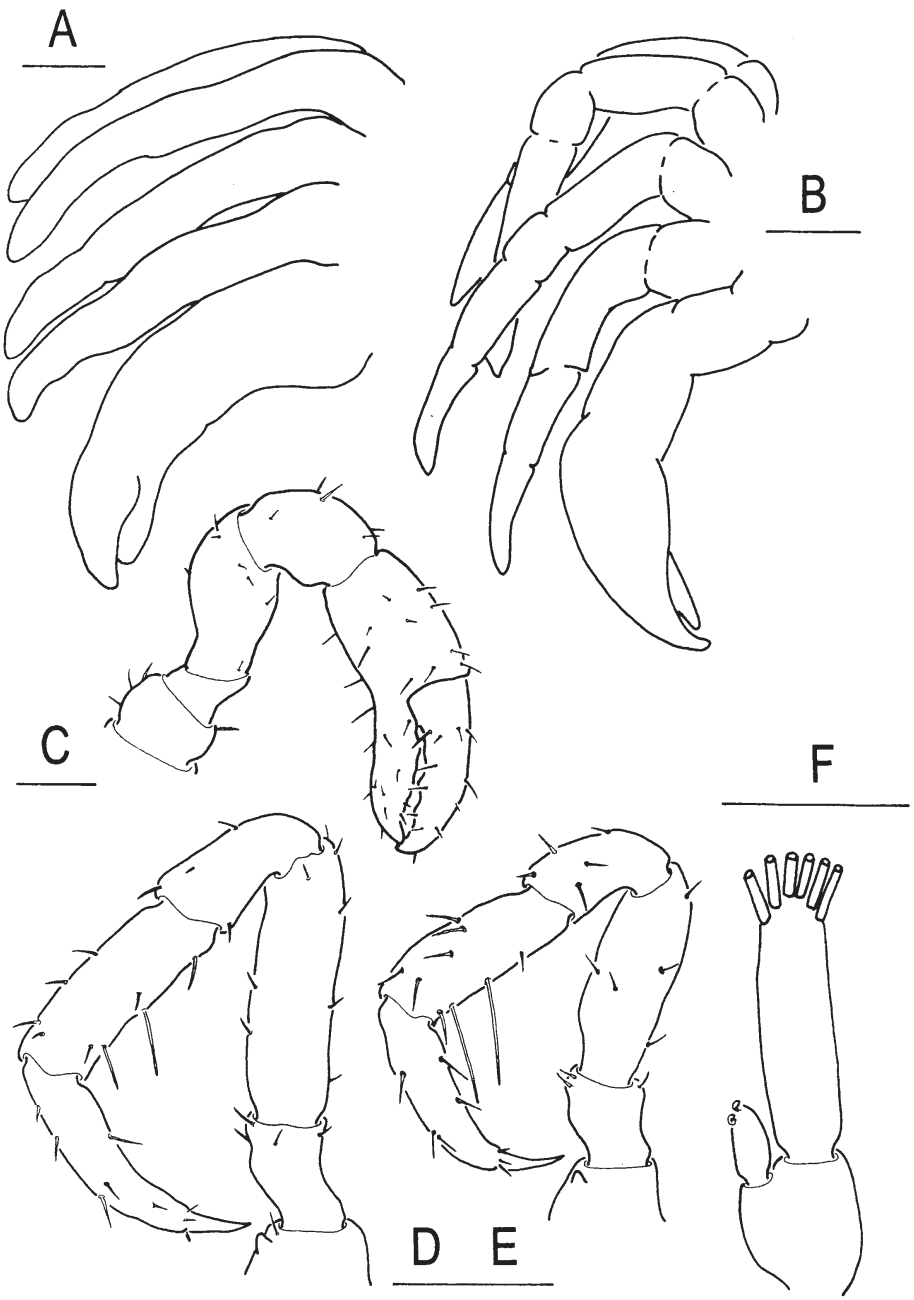

FIG. 6. – *Tunicotheres moseri* (Rathbun, 1918): Pereiopods: A, zoea I. B, zoea II. Megalopa, C, cheliped. D, third pereiopod. E, fifth pereiopod. F, third pleopod. Scale bars = 0.1 mm.

+ 3 terminal) plumodenticulate setae, respectively. Exopod unsegmented with 6 long terminal plumose setae.

Second Maxilliped (Fig. 5E): Exopod unsegmented with 6 long terminal plumose setae.

Third Maxilliped (Fig. 5H): Buds elongated, endopod incompletely segmented.

Pereiopods (Fig. 6B): Buds elongated, segmentation apparent.

Abdomen (Fig. 7C): One mid-dorsal plumodenticulate seta on first somite. Pleopods buds elongated.

Megalopa

Carapace (Fig. 2A): Longer than broad. Rostrum ventrally deflected (approximately 60º), with median longitudinal depression. Gastric, cardiac and mid-posterior tubercles present. Setal arrangement as figured. Eyes stalked with simple seta on outer margin.

Antennule (Fig. 3C): Peduncle 3-segmented with 0, 2, 2 simple setae respectively. Endopod 2-segmented, proximal segment unarmed, distal segment

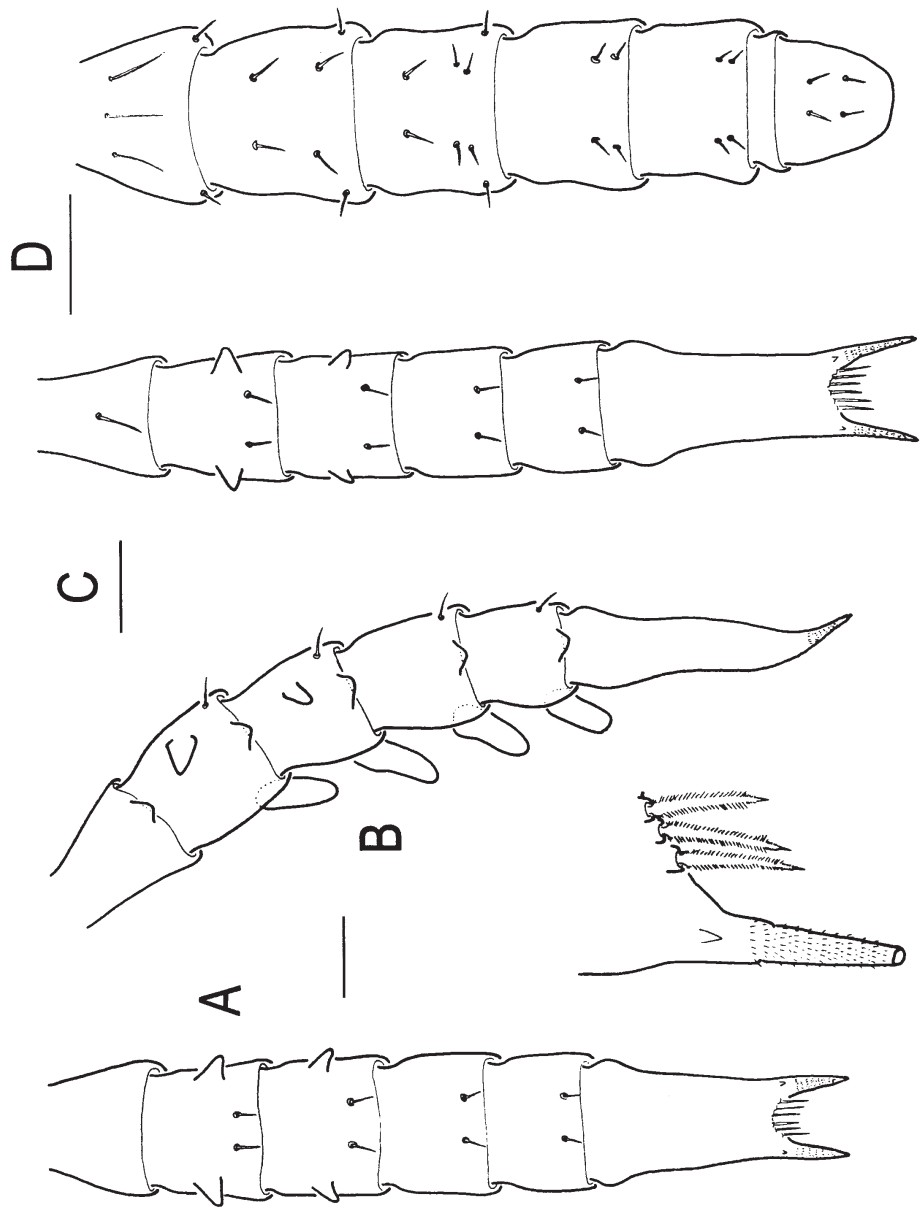

FIG. 7. – *Tunicotheres moseri* (Rathbun, 1918): Abdomen, A, zoea I, dorsal view and telson magnification. B, zoea I, lateral view. C, zoea II, dorsal view. D, megalopa, dorsal view. Scale bars = 0.1 mm.

with 2 subterminal and 3 terminal simple setae. Exopod unsegmented with two groups of 6 and 4 aesthetascs, with small simple seta each.

Antenna (Fig. 3F): Peduncle 3-segmented with 1, 0, 0 simple setae respectively. The first segment in some specimens retains modified protopod. Flagellum 2-segmented, proximal segment unarmed, distal segment with 3 unequal sized long setae (1 plumodenticulate, 2 simple).

Mandible (Fig. 2B): Scoop-shaped, smooth incisor process with thin cutting edge, molar process very reduced with only 1 tooth well-developed. Endopod palp absent.

Maxillule (Fig. 4C): Coxal endite with 5 setae (4 plumose, 1 simple). Basial endite with 13-14 plumodenticulate setae. Endopod unarmed. Epipod seta present.

Maxilla (Fig. 4F): Coxal endite with 2-3 setae (1-2 plumose, 1 plumodenticulate). Basial endite slightly bilobed with 3-4 + 4-5 plumodenticulate setae. Scaphognathite with 18-19 plumose marginal setae, and 1 anterior and 1 posterior lateral simple seta.

First Maxilliped (Fig. 5C): Coxal endite with 3 plumodenticulate setae. Basial endite with 5 plumodenticulate setae. Endopod unsegmented,

with 2 terminal small simple setae. Exopod 2-segmented, proximal segment unarmed, distal segment with 4 terminal small simple setae. Epipodite of triangular shape, unarmed.

Second Maxilliped (Fig. 5F): Coxa and basis not differentiated, without setae. Endopod 4-segmented with 0, 0, 3-5 and 3-4 plumodenticulate setae respectively. Exopod 2-segmented, proximal segment with 0-1 distal simple seta, and distal segment with 3 terminal small simple setae. Epipodite of triangular shape, unarmed.

Third Maxilliped (Fig. 5I): Coxa and basis not differentiated, without setae. Endopod 4-segmented, fused ischium-merus, carpus, propodus and dactylus with 6 (2 plumodenticulate, 4 simple), 3 simple, 5 (4 plumodenticulate, 1 simple), and 2 (1 plumodenticulate, 1 simple) setae respectively. Dactylus inserted subterminally on propodus. Exopod 2-segmented, proximal segment unarmed, distal segment with 2 short terminal simple setae. Epipod elongated with 3-5 medial plumodenticulate setae and 1-2 long terminal plumodenticulate setae.

Pereiopods (Fig. 6C-E): All segments well differentiated and with plumodenticulate, simple and pappose setae as figured. Propodus of pereiopod 2-5 with long modified simple setae resembling aesthetascs. Coxa of pereiopods 2-5 with a remarkable distal bud.

Abdomen (Fig. 7D): Six somites present. Somite 1 with 3 mid-dorsal setae. Somites 1-3 with pair of simple lateral setae. Somites 2, 4, 5 with 2 pairs of mid-dorsal simple setae. Somite 3 with 3 pairs of mid-dorsal simple setae. Somites 2-5 with one pair of biramous pleopods (Fig. 6F), each one with an unsegmented endopod with 2 terminal cincinnuli, and an unsegmented exopod with 6 long marginal plumose setae. Uropods absent.

Telson (Fig. 7D): Square-shaped, rounded posterior margin, with 2 pairs of mid-dorsal simple setae.

DISCUSSION

Tunicotheres moseri exhibits highly abbreviated larval development in terms of both the number of zoeal stages and the duration of development. The number of zoeal stages for pinnotherid species described to date ranges from 3-5, with 3-4 zoeae being typical of species in the subfamily Pinnotherinae. The shortened larval history, together with the peculiar retention of all larval stages by the female and the presence of a large yolk mass in all larval stages, strongly suggest that these larvae are lecithotrophic. As previously noted by Goodbody (1960), this type of abbreviated development and parental care in an obligate commensal of ascidians probably represents an advantageous strategy to avoid dispersing too far from host populations.

The mouthpart appendages of the larvae are not well-developed, much as in the case of other lecithotrophic species of brachyurans (Hartnoll, 1964; Soh, 1969; Rabalais and Cameron, 1983; Taishaku and Konishi, 2001), and this may also explain the unusually great variability in setal formulae for these appendages. Therefore, it is difficult to compare the setal patterns of anterior appendages of *T. moseri* with those in larvae of other Pinnotheridae. However, characters of the antenna and telson suggest that *T. moseri* does not belong within the Pinnotherinae. In the zoeal stages of Pinnotherinae *s.s.* (*sensu stricto*, as per Cuesta *et al.*, 2001), the antenna is absent or reduced to small setae, whereas in *T. moseri* it is present as a small but well-developed protopod with two rows of spinules. The zoeal telson in *T. moseri* differs very strikingly from Pinnotherinae *s.s.* in that it is furcate and bears two small dorsal spines instead of the peculiar trilobate trapezoidal shape that typifies zoeae of the Pinnotherinae. These two zoeal characters place *T. moseri* close to the genera *Calyptraeotheres*, *Clypeasterophilus*, *Dissodactylus*, *Pinnaxodes*, and *Tumidotheres*, composing an intermediate group between Pinnotherinae *s.s.* and Pinnothereliinae. Campos (2000) has, on the basis of adult morphology, also rediagnosed the subfamily Pinnotherinae and concluded that the genera *Calyptraeotheres*, *Clypeasterophilus*, *Dissodactylus*, *Fabia*, *Holothuriophilus*, *Juxtafabia*, *Ophistopus*, *Parapinnixa*, *Pinnaxodes* and *Tumidotheres* do not belong there. We find that *Tunicotheres moseri* likewise does not exhibit the complete set of adult characters proposed by Campos (2000) for defining the true Pinnotherinae, *viz*: soft carapace, slender and atrophied walking legs, the ischium and merus of third maxilliped indistinguishably fused and the presence of a tubercle on the basal antennal segment. Finally, preliminary comparisons of mitochondrial DNA sequences support removal of *T. moseri* from the Pinnotherinae *s.s.* and clarify its relationship with some other Pinnotherinae genera, as will be addressed in a forthcoming paper (Cuesta and Felder, in prep.).

A comparison of the present larval description of *T. moseri* with the first brief larval description of this species by Goodbody (1960) shows two distinct dif-

ferences. Goodbody described only a single zoeal stage, while we found two zoeal stages, both in larvae we cultured *in vitro* and among specimens removed directly from the abdominal enclosures of the females. Goodbody (1960) also described hatching processes and natatory behaviours in the first zoea that were never seen in the present study. We never observed hatching, and facultative swimming was observed only in those larvae hatched from eggs cultured *in vitro*. Despite the apparent adaptation of early development to the confines of the parental female's abdominal enclosure and thus limited area for locomotion, the larvae did not lose natatory capacity. How this swimming behaviour might be inhibited or initiated in larvae that hatch and develop inside the abdominal enclosure is unknown at present.

The duration of the zoeal stage described by Goodbody (1960) falls into the range recorded for the first zoeal stage in the present study, between 24 and 36 h. The zoea I illustrated by Goodbody (1960: 471, Fig.1) exhibits characters typical of a last zoeal stage, similar to those of the zoea II described in the present paper, but appears to have only four natatory setae characteristic of a zoea I. The latter pattern at least suggests that no preceding stage was overlooked by Goodbody (1960), but could also indicate that the previously described larvae exhibit a different pattern in natatory setae during zoeal development. Unfortunately, these earlier larval descriptions are not detailed for any stage, and no further comparisons can be made. We cannot exclude the possibility that the specimens described by Goodbody (1960) from Jamaica could in fact represent a different species from populations reported in the present paper, especially given the limited potential for larval dispersal and thus apparent high potential for endemism.

Preliminary comparisons of mtDNA sequences for specimens of putative *T. moseri* taken in Venezuela and Florida suggest that at least these two are in fact different species (Cuesta and Felder, in prep.), but it remains to be determined whether either of these two populations is conspecific with topotypes from Jamaica. Sequencing of mtDNA from Jamaican specimens of *T. moseri*, along with further studies of larval morphology for both the Florida and Jamaican populations, should do much to clarify the relationships of these three possibly isolated populations.

The possibility of yet another unrecorded population of *T. moseri* could be inferred from the direct development described for "*Pinnotheres* sp." by Kurata (1970: 229). According to Kurata (1970) a first young stage "emerged from the brood pouch of the female", and the brief description of this stage and the illustration clearly match the first crab of *T. moseri*. The ovigerous female was collected at Sponge Reef off Sapelo Island (Georgia, US), but no data are provided regarding the host. Unfortunately the material is no longer extant (R. Heard, pers. comm.) and we therefore cannot identify the parental female. We conclude that this record must represent either another population of *T. moseri* or a population of another closely related species with a similar larval history.

ACKNOWLEDGEMENTS

Sincere thanks are extended to Karen Strasser for kindly sending specimens of *T. moseri* from Tampa Bay for comparative examination and DNA analysis, and to Gerhard Pohle and Paul Clark for their comments and criticism as reviewers of the manuscript. Research was partly funded by the U.S. Department of Energy grant no. DE-FG02-97ER12220 and National Science Foundation grant no. DEB-0315995 to D. L. Felder, grants from the 'Consejo de Investigaciones' (Universidad de Oriente, Venezuela) to Juan Bolaños and Gonzalo Hernández, and a postdoctoral grant from the 'Ministerio de Educación, Cultura y Deportes', Spain to J. A. Cuesta.

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Scient. ed.: C. Zeng