THE LARVAL DEVELOPMENT OF *CRANGON SEPTEMSPINOSA* (SAY)[1, 2]
(Crustacea: Decapoda)

CHARLSIE ANN TESMER[3] AND A. C. BROAD
Department of Zoology and Entomology, The Ohio State University, Columbus 10

Larvae of several species of crangonids, *Crangon vulgaris*, *C. allmani*, *Philocheras bispinosus*, and *Pontiphilas spinosus* were described by G. O. Sars (1890). Gurney (1903, 1903a) added accounts of the larvae of *Philocheras fasciatus* and *P. trispinosus*. A generalization of crangonid development that ascribed five larval stages to the development of members of the family was formulated by Lebour (1931).

Needler (1941) obtained from plankton in the vicinity of Prince Edward Island five types of crangonid larvae, one of which was identical to larvae she obtained from eggs of adult *Crangon septemspinosa* in the laboratory. The five larval forms, which differed from Lebour's generalized plan of postembryonic development only in the lack of an anal spine in the fourth stage, were considered a reconstruction of the complete development of this species.

In April, 1957, larvae which hatched from eggs carried by three ovigerous female *Crangon septemspinosa* were reared through metamorphosis at the Duke University Marine Laboratory in Beaufort, North Carolina. The mode of larval development observed in the laboratory differed in several respects from Needler's description of larvae of Prince Edward Island *C. septemspinosa* and from other accounts of crangonid development. Growth, molting, and the sequence of larval forms of *C. septemspinosa* observed in the laboratory are presented in this paper.

We are grateful to Dr. C. G. Bookhout, Director of the Duke University Marine Laboratory, for space and equipment and to Dr. T. R. Rice of the U. S. Fish and Wildlife Service, Beaufort, N. C., for unialgal cultures of *Chlamydomonas* sp. and *Skeletonema* sp. which were fed to the larvae. We also express our thanks to Mr. Russell Skavaril for advice on statistical treatment of the data.

METHODS

Adult shrimp were obtained by dredging in the Newport River estuary, Carteret County, N. C. Ovigerous females were held separately in bowls of sea water until the eggs hatched. One hundred sibling larvae (designated hereafter as culture 103) were reared individually in 4-inch, stacking finger bowls. One hundred-fifty other larvae (culture 102) from the same female were divided equally among 15 similar bowls. Larvae from the remaining two females (cultures 104 and 105) were reared in large aquaria. The data on growth and molting were obtained from culture 103. Those on diet and survival are from culture 102. Preserved specimens on which figures and descriptions are based were obtained from cultures 104 and 105.

One third of the larvae in culture 102 was fed *Chlamydomonas*. One-third of this group was fed only the diatom, *Skeletonema*. The remaining 50 larvae were fed day-old, living *Artemia* nauplii. All other larvae were fed a mixture of *Skeletonema* and *Artemia* nauplii.

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[2]Manuscript received June 22, 1963.

[3]Present address: North High School, Bakersfield, California.

Except on the second and third days after hatching when samples of the larvae were examined, each individual in cultures 102 and 103 was inspected daily under a low power, stereoscopic microscope (6× to 60×). For inspection, the larvae were removed to watch glasses and examined individually. Those in culture 103 were measured (total length to the nearest hundredth millimeter) with an ocular micrometer. The form of all larvae in cultures 102 and 103 and the presence or absence of exuviae in the bowls were noted following which the sea water was changed and fresh food added. Cultures 104 and 105 were sampled daily by removing some individuals for examination under the microscope. The presence of shed skins was noted and fresh food added daily, but the water in the large aquaria used in mass rearing was changed infrequently or not at all.

Camera lucida drawings were made of entire larvae (killed in 10 per cent sea water formalin and preserved in 70 per cent alcohol) and of individual appendages removed from preserved specimens.

RESULTS

About 2,000 larvae hatched from eggs carried by the parent shrimp of cultures 102 and 103. A few unhatched eggs remained on the pleopods when she was preserved. This shrimp was 61 mm long (rostrum to tip of telson) after preservation. Price (1962) counted more than 3,500 eggs carried by an ovigerous *C. septemspinosa* of comparable length. The preserved eggs were from 0.4 to 0.5 mm wide and from 0.6 to 0.7 mm long. The broods reared in cultures 104 and 105 were considerably smaller, as were the parent shrimp.

Seven different forms were noted frequently among the larvae reared in the laboratory. An eighth type (form III) was seen three times, and a ninth (form IX) once. The larvae hatch from the eggs as protozoeae but, shedding the protozoeal cuticle at the first molt, become zoeae in the second and all subsequent larval intermolts. The enumeration of forms given in Roman numerals below is in accordance with the sequence in which they appeared in development but does not imply a relationship between present and previous form, molting history, or age of the individual.

Form I, The Protozoea.—(Pl. I, fig. 1–9) Length about 1.9 mm. Eyes sessile. Antennule (fig. 2) uniramous; peduncle unsegmented, tipped by a stout seta and a slightly subterminal,

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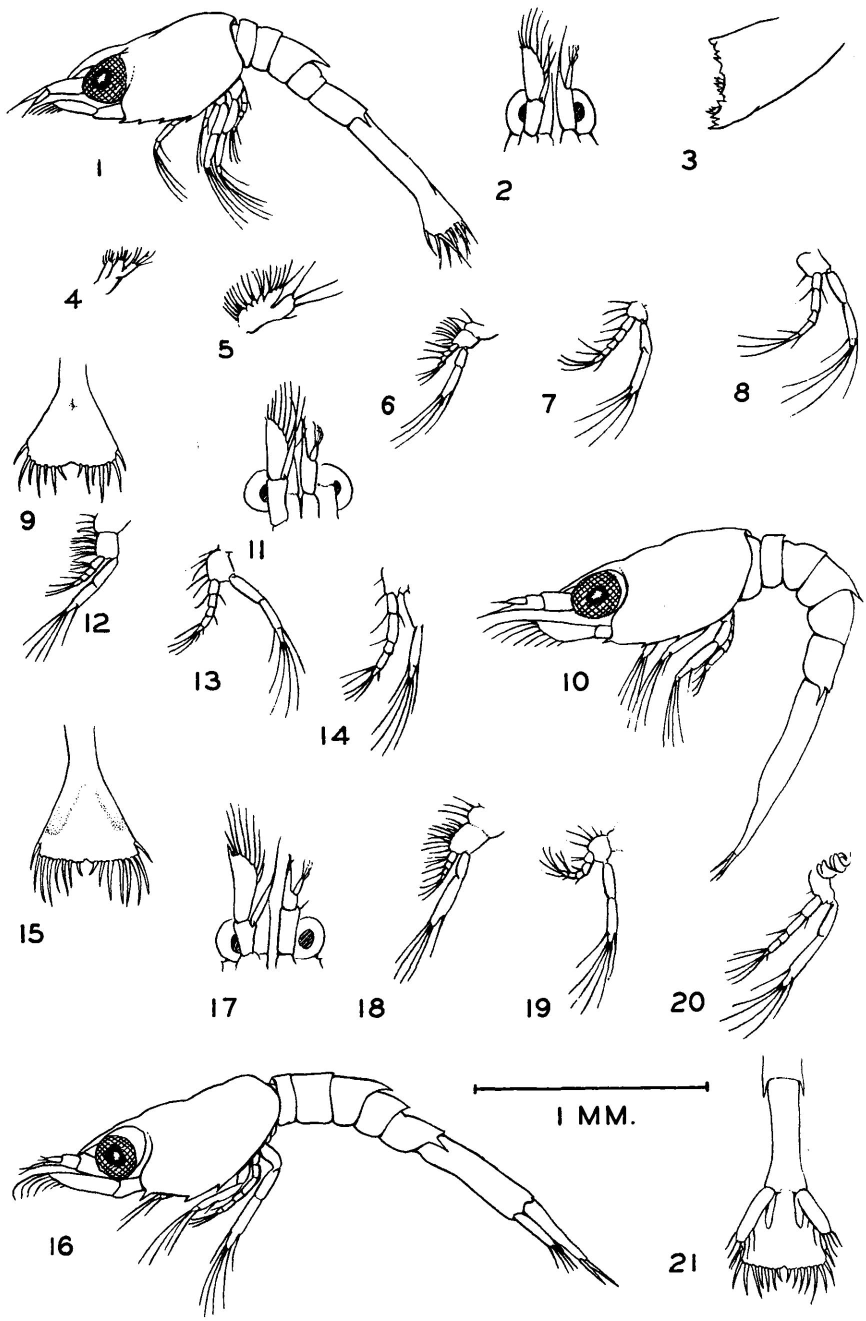
EXPLANATION OF FIGURES

Forms I, II and IV larvae of *Crangon septemspinosa*

FIGURE 1. Entire larva, form I.
FIGURE 2. Antennule and antenna, form I.
FIGURE 3. Mandible, form I, greatly enlarged.
FIGURE 4. Maxillule, form I.
FIGURE 5. Maxilla, form I.
FIGURE 6. First maxilliped, form I.
FIGURE 7. Second Maxilliped, form I.
FIGURE 8. Third maxilliped, form I.
FIGURE 9. Telson, form I.
FIGURE 10. Entire larva, form II.
FIGURE 11. Antennule and antenna, form II.
FIGURE 12. First maxilliped, form II.
FIGURE 13. Second maxilliped, form II.
FIGURE 14. Third maxilliped, form II.
FIGURE 15. Telson, form II.
FIGURE 16. Entire larva, form IV.
FIGURE 17. Antennule and antenna, form IV.
FIGURE 18. First maxilliped, form IV.
FIGURE 19. Second maxilliped, form IV.
FIGURE 20. Third maxilliped, form IV.
FIGURE 21. Telson and uropods, form IV.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unsegmented flagellum with four aesthetes. Antenna biramous; basis unsegmented with a small spine on the ventral side at the base of the flagellum; flagellum less than half the length of the scale, with a long terminal seta; scale of one segment with 8 setae on anterior margin.

Mandible (fig. 3) well formed with molar and incisor processes. First maxilla (fig. 4) with 2-segmented gnathobase and a short palp of one article tipped with long setae. Second maxilla (fig. 5) plate-like, biramous; protopod 4-lobed, armed with about 12 setae; endopod unsegmented, 4-lobed, with 6 setae; exopod a flattened unsegmented gill bailer bearing 3 anterior and one lateral setae.

First maxilliped (fig. 6) biramous; basis of two articles with about 10 medially directed setae; endopod of 4 segments, each of the first 3 with a seta, and the fourth with 3 stout terminal setae; exopod longer than endopod, of 2 segments, bearing 3 terminal and one subterminal setae. Second maxilliped (fig. 7) biramous; endopod of 5 segments with 3 stout terminal setae; exopod longer than endopod, of 2 segments bearing 3 terminal and 2 subterminal setae. Third maxilliped (fig. 8) biramous, similar to second but larger; endopod of 5 segments with 3 terminal and 2 subterminal setae; exopod larger than endopod, of 2 segments, with 3 terminal and 2 subterminal setae.

Third abdominal segment with dorsal spine directed posteriorly. Fifth abdominal segment with a pair of lateral spines. Telson (fig. 9) with 7 pairs of terminal spines. Carapace with a pterygostomian and 3 marginal spines.

Pereiopods absent.

The protozoea is easily distinguished from all subsequent larvae by its sessile eyes. All of the larvae emerged from the egg in the protozoeal form and none retained this form after the first molt.

Form II.—(Pl. I, fig. 10–15) Length about 2.3 mm. Differs from previous larva mainly in the following: Seta on tip of antennule (fig. 11) short, stout, barbed. Antennal scale with 1 short and 8 long setae; endopod almost the length of scale. Eyes stalked.

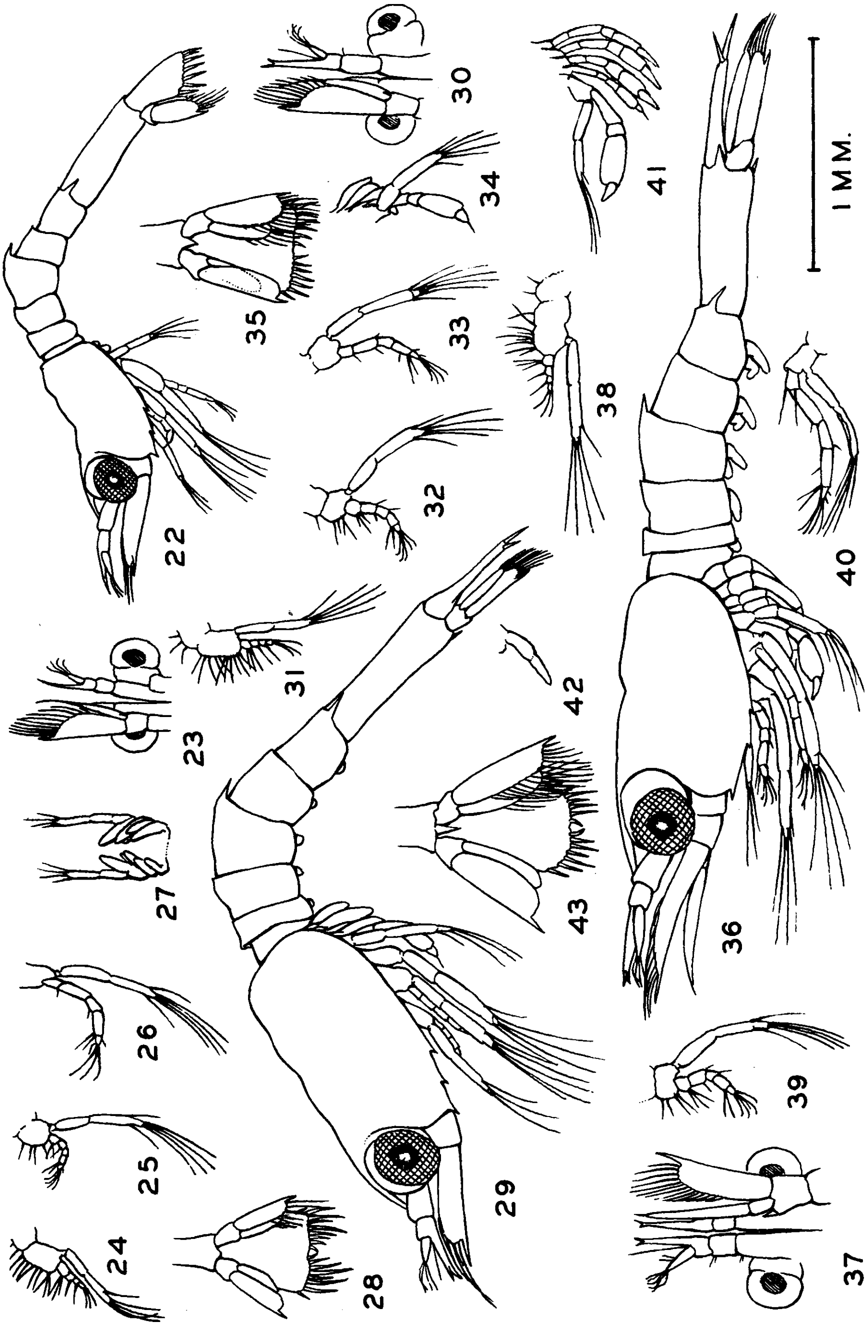
Exopod of first maxilliped (fig. 12) with 4 terminal and 1 subterminal setae. Second maxilliped (fig. 13) basis with 5 setae; first article of endopod bears 2 setae; exopod bears 4 long terminal and 2 subterminal setae. Third maxilliped (fig. 14) basis bears 2 setae; exopod bears 4 terminal and 2 subterminal setae.

Telson (fig. 15) with 8 pairs of terminal spines. Uropod rudiments often observable through exoskeleton.

EXPLANATION OF FIGURES

Forms V, VI, and VII larvae of *Crangon septemspinosa*

FIGURE 22. Entire larva, form V.
FIGURE 23. Antennule and antenna, form V.
FIGURE 24. First maxilliped, form V.
FIGURE 25. Second maxilliped, form V.
FIGURE 26. Third maxilliped, form V.
FIGURE 27. Pereiopods, ventral view, form V.
FIGURE 28. Uropods and telson, form V.
FIGURE 29. Entire larva, form VI.
FIGURE 30. Antennule and antenna, form VI.
FIGURE 31. First maxilliped, form VI.
FIGURE 32. Second maxilliped, form VI.
FIGURE 33. Third maxilliped, form VI.
FIGURE 34. Pereiopods, form VI.
FIGURE 35. Uropods and telson, form VI.
FIGURE 36. Entire larva, form VII.
FIGURE 37. Antennule and antenna, form VII.
FIGURE 38. First maxilliped, form VII.
FIGURE 39. Second Maxilliped, form VII.
FIGURE 40. Third maxilliped, form VII.
FIGURE 41. Pereiopods, form VII.
FIGURE 42. Pleopod, form VII.
FIGURE 43. Uropods and telson, form VII.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Form II and all subsequent larvae differ from the protozoea in having stalked eyes which stand free of the carapace and rostrum. All form II larvae had molted only once.

Form III.—Length about 2.3 mm. Differs from previous larva in having free uropods as in the form IV larva, but lacks the pereiopod rudiments of form IV.

Larval form III was observed only in three individuals from culture 103. All had molted twice.

Form IV.—(Pl. I, fig. 16–21) Length about 2.6 mm. Differs from previous larva in the following: Sixth abdominal somite separate from telson (fig. 21); uropods biramous, outer ramus with 6 or 7 short setae; inner ramus rudimentary, not setose.

First pereiopod (fig. 20) biramous, rudimentary, other pereiopods uniramous buds. Antennular peduncle (fig. 17) of 2 segments. Antennal scale with spine and 1 short, 8 or 9 long setae.

The form IV larvae are distinguished from previous larvae by the uropods and by the presence of the rudiments of pereiopods. Most larvae that had molted twice were in form IV, but four individuals that had molted three times retained this form in the fourth intermolt.

Form V.—(Pl. II, fig. 22–28) Length about 2.8 mm. Differs from previous larva as follows: Antennular peduncle of 3 segments (fig. 23). Antennal scale with 10 setae.

First pereiopod (fig. 27) with exopod of 2 segments, bearing 2 terminal and 2 subterminal setae; endopod rudimentary. Second, third, and fourth pereiopod rudiments uniramous.

Uropods segmented (fig. 28), with definite basal article; outer ramus longer than inner, with spine on postero-lateral margin and 3 long and 3 short setae; inner ramus bears 5 short setae. Telson slightly narrower than in previous larva.

Form V larvae are characterized by the unfolding of the first pereiopod as a functional appendage with a setose, natatory exopod. More than half of the fourth intermolt larvae were in form V but many were form VI after three molts. A few individuals retained form V in the fifth intermolt.

Form VI.—(Pl. II, fig. 29–35) Length about 3.0 mm. Differs from form V larvae as follows: Antennular flagellum (Fig. 30) longer. Antennal scale with 1 short, 10 long setae.

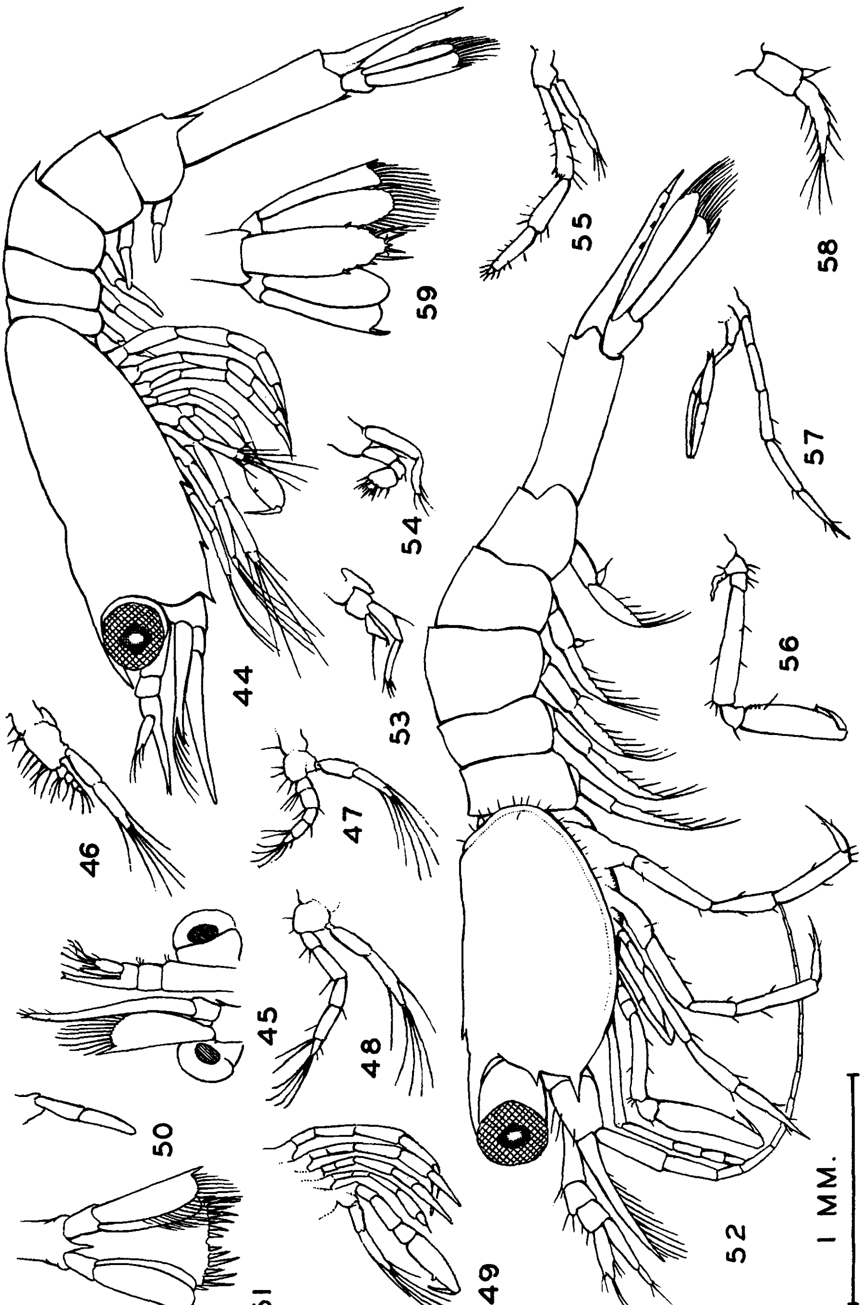
First pereiopod (fig. 34) with endopod of 4 articles; propodus large, bulbous; dactylus a small protuberance with a terminal seta (rudiment of sub-chela); exopod with 4 terminal and 2 subterminal setae. Second, third, fourth and fifth pereiopod buds uniramous. Pleopods represented by small, knobby buds.

Uropod (fig. 35) exopod bears 11 setae; endopod with 10 setae. Telson with 7 pairs of terminal spines; narrower than before. A small ventral (anal) spine at posterior margin of sixth abdominal somite.

EXPLANATION OF FIGURES

Larval form VIII and the first postlarva, form X, of *Crangon septemspinosa*

FIGURE 44. Entire larva, form VIII.
FIGURE 45. Antennule and antenna, form VIII.
FIGURE 46. First maxilliped, form VIII.
FIGURE 47. Second Maxilliped, form VIII.
FIGURE 48. Third maxilliped, form VIII.
FIGURE 49. Pereiopods, form VIII.
FIGURE 50. Pleopod, form VIII.
FIGURE 51. Uropods and telson, form VIII.
FIGURE 52. Entire postlarva, form X.
FIGURE 53. First maxilliped, form X.
FIGURE 54. Second maxilliped, form X.
FIGURE 55. Third maxilliped, form X.
FIGURE 56. First pereiopod, form X.
FIGURE 57. Second and third pereiopods, form X.
FIGURE 58. Pleopod, form X.
FIGURE 59. Uropods and telson, form X.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The form VI larva is readily recognized by the presence of pleopod buds. Form VI larvae were in either the fourth, fifth or even the sixth intermolt, having molted either three, four or five times.

Form VII.—(Pl. II, fig. 36–43) Length about 3.4 mm. Form VII differs from form VI in the following: Antennal scale (fig. 37) bears 13 setae. Antennal flagellum of one basal and one long segment; flagellum extends beyond blade.

First pereiopod endopod (fig. 41) bears developing sub-chelate process without seta. Second through fifth pereiopod endopods with 5 articles. Second pereiopod slender, shorter than others, with terminal seta on dactylus.

Pleopods (fig. 42) uniramous, of 2 articles. Uropod exopod (fig. 43) with about 14, endopod with 12 or 13 setae. Telson narrower than before with 14 terminal spines.

Form VII larvae are characterized by the possession of elongate pleopod rudiments, by the initial appearance of sub-chelae on the first pereiopods, and by the unfolding of the remaining pereiopods. Larvae in form VII had molted either four, five or six times and were in the fifth, sixth, or seventh intermolt.

Form VIII.—(Pl. III, fig. 44–51) Length about 3.7 mm. Differs from previous larva as follows: Antennular peduncle (fig. 45) with short setae at anterior margin of each segment. Antennal scale with 14 setae; flagellum almost twice the length of blade with short terminal setae.

First pereiopod (fig. 49) sub-chelate, of five articles. Pleopods (fig. 50) elongate; second segment flattened, non-setose. Uropod (fig. 51) exopod with about 20, endopod with 17 or 18 setae.

Form VIII was usually the final larval form. It is characterized by the presence of long, functional but non-setose pleopods. Form VIII was reached by larvae in the fifth, sixth, seventh or eighth intermolt.

Form IX.—Length 3.30 mm. Differs from form VIII in having setose pleopods.

Form IX, a larva having the post-larval characteristic of setose pleopods, was observed only once. One individual that had molted six times was in form IX in the seventh intermolt but died without further molting.

Form X, The Postlarva.—(Pl. III, fig. 52–59) Length about 3.8 mm. Rostrum does not extend beyond eyes. Antennule with outer flagellum of 1 segment bearing 4 terminal and 2 lateral aesthetes; inner flagellum of 2 segments, bearing 4 aesthetes; peduncle of 3 segments; 2 setae at anterior margin of each segment. Antenna biramous; blade of one segment bearing a spine and more than 20 setae; flagellum long, segmented entirely, bearing 3 terminal setae.

Maxillipeds reduced. First maxilliped (fig. 53) small, biramous; endopod armed with 2 very small terminal and one long, strong lateral setae; exopod similar; epipod a flat lobe. Second maxilliped (fig. 54) biramous; endopod of 4 articles, the last two with many stout setae; exopod of 2 segments armed with short terminal setae. Third maxilliped (fig. 55) biramous; exopod of 2 segments bearing short terminal setae; endopod long of 5 articles with many short setae; merus with 3 short terminal teeth.

First pereiopod (fig. 56) sub-chelate, stouter than second, with many setae and 3 tooth-like processes at proximal end of propodus; exopod may persist as a rudiment. Second pereiopod (fig. 57) slender, chelate. Third to fifth pereiopods typical walking legs.

Pleopods (fig. 58) biramous, with long, wide base; endopod a rounded protuberance with a terminal seta; exopod of one segment bearing long setae. Uropods (fig. 59) biramous; exopod with short outer spine, movable tooth, and many terminal setae; endopod slightly longer than exopod, bearing many setae. Telson same length as exopod, 3 times longer than wide, bearing posteriorly 3 pairs of small stout lateral spines, 2 long subterminal spines, and 3 terminal spines, the middle spine very small.

Carapace with single dorsal rostral, suborbital and pterygostomian spines. Cardiac and branchial margins bear small setae. Pleurae of abdominal somites rounded. No anal spine. Stout seta on dorsal distal area of sixth abdominal somite.

Post larvae are readily distinguished from all larval forms by the lack of natatory exopodites and by behavior typical of a benthic rather than a planktonic organism. Metamorphosis to the postlarva occurred at the fifth, sixth or seventh molt. Two individuals that were eighth intermolt form VIII larvae died without metamorphosing but, presumably, might have done so at the eighth molt.

A summation of the growth and development of larvae in culture 103 is presented in table 1. The first molt cycle was assumed to start on the day of hatching and ended with the first ecdysis two to four days later. All data on duration of molt cycles are in whole days because molting occurred only at night. The statistics in columns six and seven are calculated from the frequency of observed data. No records of postlarval molting were kept.

TABLE 1

Summary of molting, growth and form of Crangon septemspinosa *larvae reared in culture 103*[1]

Relationship between form and molt cycles				Duration of molt cycle in days			Total length in mm		
Molt cycle no.	No. larvae	Form	No. after molt	Range	Mean	Std. dev.	No. measured	Mean	Std. dev.
1	100	I	99	2–4	2.79	0.41	35	1.94	0.05
2	99	II	96	1–3	2.17	0.37	72	2.26	0.08
3	3	III	2	3	—	—	3	2.27	—
3	93	IV	90	2–3	2.31	0.46	90	2.58	0.10
4	4	IV	4	2–3	—	—	4	2.56	—
4	53	V	52	2–4	2.37	0.54	53	2.77	0.12
4	35	VI	33	2–4	2.33	0.53	35	2.98	0.08
5	5	V	5	2–3	—	—	5	2.88	—
5	42	VI	40	1–4	2.33	0.61	42	3.05	0.15
5	39	VII	38	1–4	2.11	0.72	39	3.30	0.12
5	3	VIII	3	2–4	—	—	3	3.57	—
6	3	VI	3	2–3	—	—	3	3.23	—
6	32	VII	29	2–4	2.31	0.53	32	3.37	0.18
6	49	VIII	46	1–4	3.11	0.67	49	3.71	0.14
6	2	X	—	—	—	—	2	3.65	—
7	3	VII	2	2	—	—	3	3.50	—
7	32	VIII	25	1–3	2.72	0.53	32	3.76	0.22
7	1	IX	0	—	—	—	1	3.30	—
7	42	X	—	—	—	—	42	3.77	0.16
8	2	VIII	0	—	—	—	2	3.70	—
8	25	X	—	—	—	—	25	3.76	0.24

[1]Data on first and second molt cycles are based on 19 and 18 individuals respectively.

Data on survival of larvae fed three different diets in culture 102 are summarized in table 2. None of the larvae fed only *Chlamydomonas* survived more

TABLE 2

Survival of larvae of Crangon septemspinosa (*Culture 102*) *at the start of each molt cycle*

	No. of of larvae surviving		
Molt cycle no.	*Chlamydomonas* diet	*Skeletonema* diet	*Artemia* diet
1	50	50	50
2	30	33	46
3	14	26	35
4	0	19	34
5		11	22
6		4	18
7		0	13

than two molts. None of the larvae fed only *Skeletonema* survived through metamorphosis. Twelve of the fifty larvae fed *Artemia* nauplii metamorphosed in the laboratory.

Sixty-nine of the 100 larvae in culture 103 survived metamorphosis. The mean duration of the larval phase was 16 days, but metamorphosis occurred as early as the 13th day and as late as the 19th day after hatching. The larvae were reared at room temperature (mostly 18 to 20 C). Since this was considerably warmer than the water in the Newport River estuary in April (usually 10 to 15 C), development probably proceeded more rapidly in the laboratory than in nature.

DISCUSSION

The first two larval stages described by Needler (1941) correspond fairly closely to our forms I and II in total length and, generally, in stage of development, although certain differences are noteworthy. The endopods of the first and second maxillipeds of the North Carolina larvae are segmented upon hatching. Those of the Prince Edward Island material are unsegmented prior to stage two. Needler's second stage has a free spine on the antennal scale and rudiments of three pairs of pereiopods. The spine of the antennal scale is first evident in our form III or form IV larvae; pereiopod rudiments in our form IV. Minor differences in setation occur both in early and later larvae.

Following Needler's stage two or, presumably, second intermolt larvae, there is no clear correspondence between her material and ours. The third stage larvae from Prince Edward Island bear free uropods, as do our third intermolt larvae (forms III and IV), but are larger and otherwise more advanced. The pereiopods most nearly resemble those of our form IV, but pleopod buds, which first appear in our form VI, are evident in "many specimens" of Needler's third stage. In total length, this stage corresponds to our form VI.

Stage four in the development of Prince Edward Island *Crangon septemspinosa* is about 3.5 mm long. The pereiopods resemble those of our form VI larvae, but the pleopods are long rudiments as in our form VII.

Needler's fifth stage, at a length of 3.8 mm, resembles our form VIII anatomically and in total length. The anal spine, which first appears in the fifth or final stage, is evident in our forms VI, VII, VIII and IX.

The postlarvae reared in the laboratory are usually smaller than those obtained from plankton by Needler but generally similar to them.

The number of larval intermolts that may be deduced from Needler's reconstruction is five. The fifth molt marks the metamorphosis to the postlarva. Two of our larvae actually metamorphosed at the fifth molt. These individuals passed through a sequence of forms I, II, IV, VI, VIII, and X (postlarva) which corresponds fairly closely to Needler's sequence of stages. The majority of those postlarvae reared in the laboratory, however, underwent six or seven larval intermolts each represented by one of the forms described above.

Differing modes of larval development in the same species of crustaceans have been discussed by Gurney (1942) by Broad (1957) and by Provenzano and Dobkin (1962). Gurney considers "extra stages" to be "abnormal," but Broad, and Broad and Hubschman (1962, 1963) have pointed out that variation in larval form in *Palaemonetes* may result from independence of rate of development and periodicity of ecdysis, as has been shown in euphausid furcilia stages by Fraser (1936) and Boden (1950, 1951) and inferred in *Penaeus* by Heegaard (1953). In *Crangon* there seems to be another example of the independence of molting and development during the larval phase.

An analysis of the data from table 1 provides evidence in support of the notion that the form of an individual larva is a function of the degree of development indicated by its total length rather than by its age or by the number of molt cycles previously completed. The model of the problem is

$$X_{ij} = \mu + a_i + e_{ij}$$

where X_{ij} is the length of the jth individual of the ith class; μ is the over all population mean; a_i is a random variable associated with the ith class; and e_{ij} is a random element from a normally distributed population with zero mean and standard deviation σ.

Two null hypotheses may be tested: that the mean lengths of larvae of the same form, irrespective of previous molting history, are equal; and that the mean lengths of larvae of the same molting history, regardless of form, are equal. Algebraically, for both null hypotheses,

$$H_o: \quad \mu_1 = \mu_2 = \ . \ . \ . \ \mu_k$$

where μ_i is the mean of each of the a_i classes, and $i = 1, 2, \ . \ . \ . \ k$. In the first hypothesis the classes are the molt cycle numbers of the larvae of each of the several forms. The classes of the second hypothesis are the forms of the larvae of each of the several molt cycles. The two hypotheses may be tested independently by one way analyses of variance.

Concerning the first null hypothesis, more than one class (intermolt number) exists for forms IV, V, VI, VII, VIII, and X. The F values (followed by the degrees of freedom in parentheses) for these forms are: 0 (1, 92); 3.53 (1, 56); 7.12** (2, 77); 3.12 (2, 71); 1.24 (3, 82); and 0.36 (2, 66) respectively. The F values for forms IV and X suggest that some other source of variation exists in those forms. The data in the two classes (intermolts) of form IV are 90 individuals in intermolt three and four in intermolt four, at best an unrealistic basis for comparison. The data in the three classes of form X are sufficiently numerous and equally enough distributed among at least two of the three intermolts for the test. The F value of less than unity probably casts doubt on the model for those classes, or it may represent a consequence of sample size. Postlarvae have just undergone metamorphosis, a time of extensive anatomical, physiological and behavioral reorganization. It is possible that, due to factors involved in metamorphosis, the assumption of a mean length related to form does not obtain for postlarvae.

Of the remaining F values only that for form VI is significant at the one per cent level. If the three members of class (intermolt) six are omitted from this calculation, an F value of 6.35 with 1 and 74 degrees of freedom is obtained. Thus, if three form VI sixth intermolt larvae are excluded from consideration, analysis permits acceptance of the null hypothesis. The total lengths of larvae of the same form are members of the same normal population.

When we consider the second null hypothesis, more than one class (larval form) exists among those larvae in intermolts 3, 4, 5, 6, 7, and 8. Because of the discrepancy between the number of individuals of the two classes (forms III and IV) of third molt cycle larvae, no analysis was attempted. For the remaining molt cycles F values (and degrees of freedom) are: 24.31** (2, 89); 50.15** (3, 85); 28.83** (3, 82); 3.27 (3, 74); and 0.09 (1, 25) respectively. Except for those F values for the seventh and eighth molt cycles (the latter of which is meaningless), all are highly significant and justify rejection of the null hypothesis. The mean lengths of larvae of the same molting history but of different form are not equal. The F values for the seventh and eighth molt cycles are derived from a comparison of the lengths of both larvae and postlarvae. For reasons pointed out above, there is probably no valid basis for this comparison.

SUMMARY

1. Larvae obtained from three ovigerous female *Crangon septemspinosa* in North Carolina and reared in the laboratory passed through a sequence of from five to eight morphologically distinct larval forms and metamorphosed after

five, six, or seven molts. A ninth larval form was observed once, but this individual did not survive.

2. Larvae survived through metamorphosis if fed *Artemia* nauplii, but did not do so on a diet of either *Chlamydomonas* or *Skeletonema.*

3. Metamorphosis occurred from 13 to 19 days after hatching.

4. A relationship between larval form and the total length of individuals is demonstrated. There is no relationship between larval form and age or molting history.

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