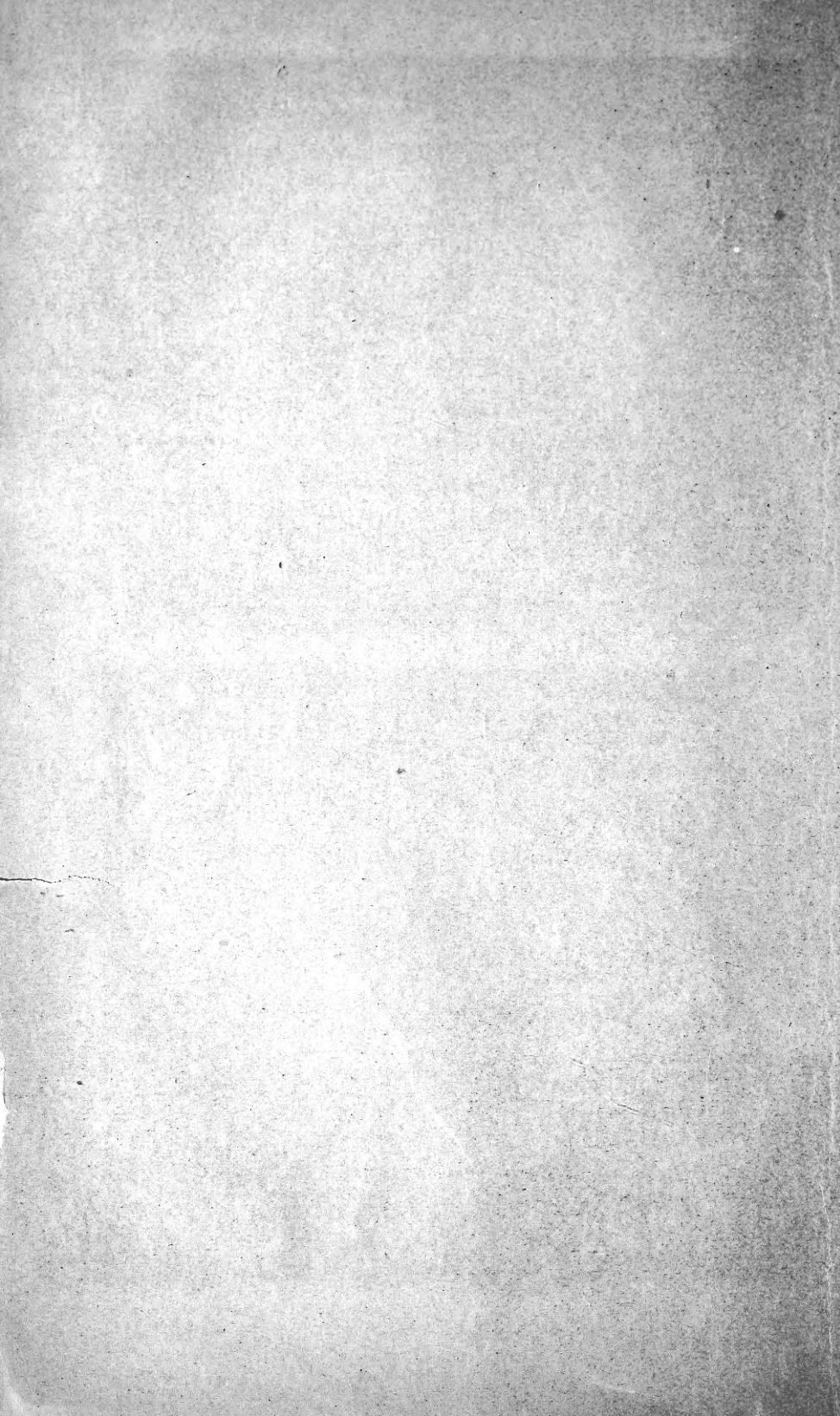


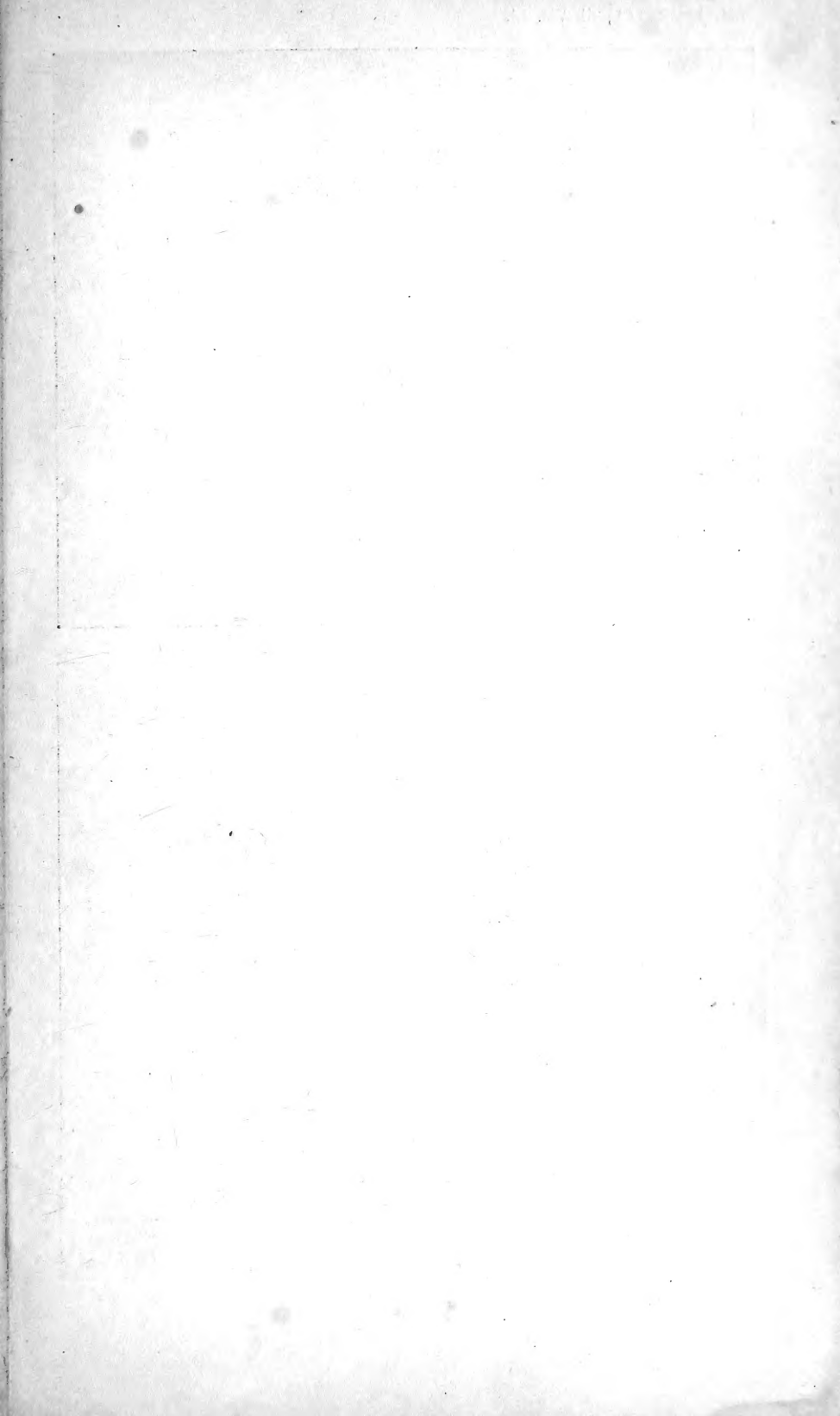
To Mr Rathbun, Aug. 1900

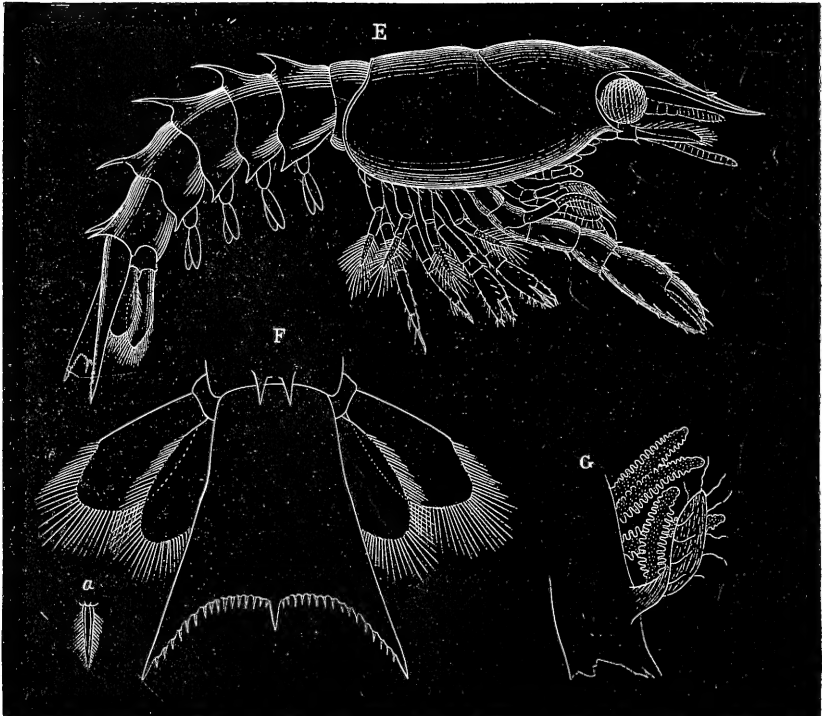
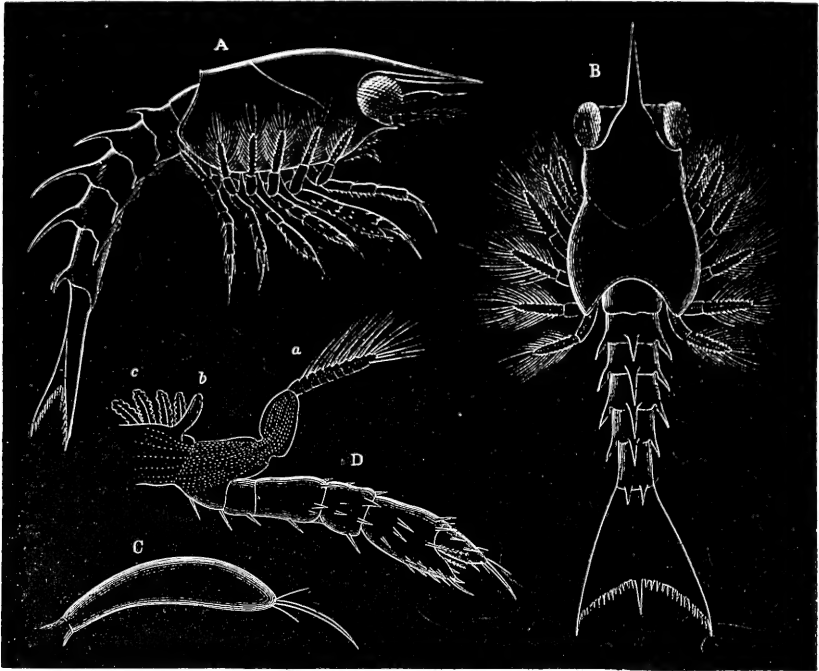
EARLY STAGES OF THE AMERICAN LOBSTER
(*Homarus Americanus* Edwards).

By SIDNEY I. SMITH.

[FROM THE AMERICAN JOURNAL OF SCIENCE AND ARTS, VOL. III, JUNE, 1872.]







S. I. S. from nature.

Brief Contributions to Zoölogy from the Museum of Yale College.

No. XXI.

THE EARLY STAGES OF THE AMERICAN LOBSTER
(*HOMARUS AMERICANUS* Edwards); by S. I. SMITH.

THE majority of the published observations on the development of the higher crustacea have been confined to the changes taking place in the embryo within the egg, or immediately after leaving it. Of the later stages, which connect the newly hatched young with the adult, little is known. So far as the published accounts are known to me, this is the case in the history of the common lobster of Europe. On the development of the lobster of our own coast nothing has been published. The investigation, of which this article is a short notice, was undertaken to supply this deficiency in the history of the later development of the lobster, and is one of the results obtained through the facilities for collecting and studying our marine animals, offered last summer by the U. S. Commissioner of the Fisheries, Professor Baird.

The specimens were all obtained in Vineyard Sound, or the adjacent waters, during July, and were mostly taken at the surface in the day-time, either with the towing or hand net. They present three quite different stages in the true larval condition, besides a later stage approaching closely the adult. The exact age of the larvæ of the first stage was not ascertained, but was probably only a few days, and they had, most likely, moulted not more than once, perhaps not at all. Between the third stage, here described, and the last, there is probably an intermediate form wanting. The descriptions and figures have

all been drawn from specimens preserved in alcohol, as there was no opportunity for studying them while alive.

First Stage.—The larvæ of the first stage observed were frequently taken at the surface, and were obtained from the well of a lobster smack, where they were swimming in great abundance near the surface of the water. In this stage (pl. IX, figs. A, B, C, D) they are free-swimming Schizopods, about a third of an inch (7.8 to 8.0^{mm}) in length, without abdominal appendages, and with six pairs of pediform cephalothoracic appendages, each with the exopodus* developed into a powerful swimming organ. The general appearance is represented in the figures. The eyes are bright blue: the anterior portion and the lower margin of the carapax and the bases of the legs are speckled with orange; the lower margin, the whole of the penultimate, and the basal portion of the ultimate segment of the abdomen, are brilliant reddish orange. They are very active, swimming about very much like the species of *Mysis* and *Thysanopoda*.

The antennulæ (fig. C) are short and sack-like, with a single articulation at the base and three setæ at the tip. The antennæ have large well-developed scales, furnished along the inner margin with long plumose hairs, but the flagellum is shorter than the scale, not divided into segments, and with three plumose setæ at tip. The mandibles are unlike on the two sides; the inferior edges are armed with acute teeth, except at the posterior angle, where there is a small molar area; the palpi are very small and the three segments just indicated. The exognathus in both pairs of maxillæ is composed of only one article, and is furnished with several setæ at tip. In the first maxillipeds, the exognathus is an unarticulated process, furnished with short plumose hairs on the outer side. The second maxillipeds have the principal branch cylindrical, not flattened and appressed to the inner mouth organs as in the adult; the exognathus is short and as yet scarcely flabelliform; and the epignathus is a simple process, with not even the rudiment of a branchia. The external maxillipeds are pediform, the endognathus as long as and much resembling the endopodi of the posterior legs, while the exognathus is like the exopodi of all the legs, being half as long as the endognathus, and the terminal portion furnished along the edges with long plumose hairs. The epignathus and the branchiæ are very rudimentary, represented by minute sack-like processes. The anterior thoracic legs, which in the adult develop into the big claws, are exactly alike, and no

* To prevent confusion the terms here used are those proposed by Milne Edwards to designate the different branches of the cephalic and thoracic appendages: *endopodus*, for the main branch of a leg; *exopodus*, for the accessory branch (a in fig. D); *epipodus*, for the flabelliform appendage (b); and *endognathus*, *exognathus*, and *epignathus*, for the corresponding branches of the mouth organs.

longer than the external maxillipeds. The pediform branch is, however, somewhat stouter than in the outer legs, and subcheliform. The legs of the second and third pairs (fig. *D*) are similar to the first but not as stout. The legs of the fourth and fifth pairs are still more slender, and styloform at the extremity as in the adult.

The exopodal branches of all the legs and of the external maxillipeds are quite similar, and differ very little in size. In life, while the animal is poised at rest in the water, they are carried horizontally, as represented in figure *B*, or are curved up over the carapax, sometimes so as almost to cover it. The blood circulates rapidly in these appendages, and they undoubtedly serve, to a certain extent, as respiratory organs, as well as for locomotion. By careful examination, small processes were found representing the normal number of branchiæ to each leg.* These rudimentary branchiæ, however, differ somewhat in different specimens, being very small, and scarcely distinguishable, in what appear to be younger individuals, from the rudimentary epipodi, while in others, apparently older, they are farther developed, being larger, more cellular in structure than the epipodi, and even showing an approach to crenulation in the margins, as in figure *D*.

The abdomen is slender, the second to the fifth segments each armed with a large dorsal spine curved backward, and with the lateral angles produced into long spines, and the sixth segment with two dorsal spines. The proportional size and the outline of the last segment is shown in figure *B*; its posterior margin is armed with a long and stout central spine, and each side with fourteen or fifteen plumose spines or setæ, which are articulated to the margin.

Second Stage.—In the next stage the larvæ have increased somewhat in size, and the abdominal legs of the second to the fifth segments have appeared. The rostrum is much broader, and there are several teeth along the edges. The basal segments of the antennulæ have become defined, and the secondary flagellum has appeared but is not subdivided into segments. The antennæ and mouth organs have undergone but slight changes. The first thoracic legs are proportionately larger and stouter

* The number of branchiæ, or branchial pyramids, in the American lobster is twenty on each side: a single small one upon the second maxilliped, three well-developed ones upon the external maxilliped, three upon the first thoracic leg, four each upon the second, third and fourth, and one upon the fifth. This number is perhaps different in the European species. De Haan (*Fauna Japonica*, Crustacea, p. 146) gives the number, for the genus *Homarus*, as nineteen on each side, giving only two for the external maxilliped, while Owen (*Lectures on the Anatomy of the Invertebrate Animals*, 2d ed., p. 322) and Edwards (*Hist. nat. des Crust.*, i, 86) give the whole number on each side as twenty-two, although Edwards in the second volume of the same work, under *Homarus*, p. 333, gives twenty as the number.

than in the first stage, and have become truly cheliform. The succeeding legs have changed little. The epipodi of all the legs and of the external maxillipeds have increased in size, and the branchial processes are distinctly lobed along the edges, and have begun to assume the form of true branchiæ. The segments of the abdomen have the same number of spines but they are relatively somewhat smaller, and the last segment is relatively smaller and broader at base. The appendages of the second to the fifth segments differ considerably in size in different specimens, but are nearly as long as the segments themselves; their terminal lamellæ, however, are represented only by simple sack-like appendages, without sign of segmentation, or clothing of hairs or setæ. The penultimate segment is still without appendages.

Third Stage.—In the third stage (pl. IX, figs. *E*, *F*, *G*) the larvæ are about half an inch (12 to 13^{mm}) in length, and the integument is of a much firmer consistency than in the earlier stages. The antennulæ are still rudimentary, and considerably shorter than the rostrum, although the secondary flagellum has increased in length, and begins to show division into numerous segments. The antennæ retain the most marked feature of the early stages—the large size of the scale—but the flagellum is much longer than the scale, and begins to show division into segments. The mandibles, maxillæ, and first and second maxillipeds have changed very little, although in the second maxillipeds, the extremity of the exognathus begins to assume a flagelliform character, and the branchia is represented by a small process upon the side of the epignathus. The maxillipeds have begun to lose their pediform character. The anterior legs have increased enormously in size, and those of the second and third pairs have become truly chelate, while the swimming exopodal branches of all the legs, as well as of the external maxillipeds, are relatively much smaller and more unimportant. The epipodi (fig. *D*) are furnished with hairs along the edges, and begin to assume the characters of these appendages in the adult. The branchiæ (fig. *D*) have developed rapidly, and have a single series of well-marked lobes along each side. The abdomen still has the spines characteristic of the earlier stages, though all of them are much reduced in size. The appendages of the second to the fifth segments have become conspicuous, their lamellæ have more than doubled in length, and the margins of the terminal half are furnished with very short ciliated setæ. The appendages of the penultimate segment (fig. *F*) are well developed, although quite different from those in the adult. The outer lamella wants wholly the transverse articulation near its extremity, and both are margined, except the outer edge of the outer lamella, with long plumose

hairs. The last segment is relatively smaller and more quadrangular in outline, and the spines of the posterior margin are much smaller.

Fourth Stage.—In the next stage observed, the animal, about three fifths of an inch (14 to 17^{mm}) long, has lost all its schizopodal characters, and has assumed the more important features of the adult lobster. It still retains, however, the free-swimming habit of the true larval forms, and was frequently taken at the surface, both in the towing and hand net. Although resembling the adult in many features, it differs so much that, were it an adult form, it would undoubtedly be regarded as a distinct genus. The rostrum is bifid at tip, and armed with three or four teeth on each side toward the base, and in some specimens with a minute additional spine, on one or both sides, close to the tip. The flagella of the antennulæ extend scarcely beyond the tip of the rostrum. The antennal scale is very much reduced in size, but is still conspicuous and furnished with long plumose hairs along the inner margin, while the flagellum is as long as the carapax. The palpi of the mandibles have assumed the adult character, but the mandibles themselves have not acquired the massive molar character which they have in the older animal. The other mouth organs have nearly the adult form. The anterior legs, although quite large, are still slender and just alike on the two sides, while all the thoracic legs retain a distinct process in place of the swimming exopodi of the larva.

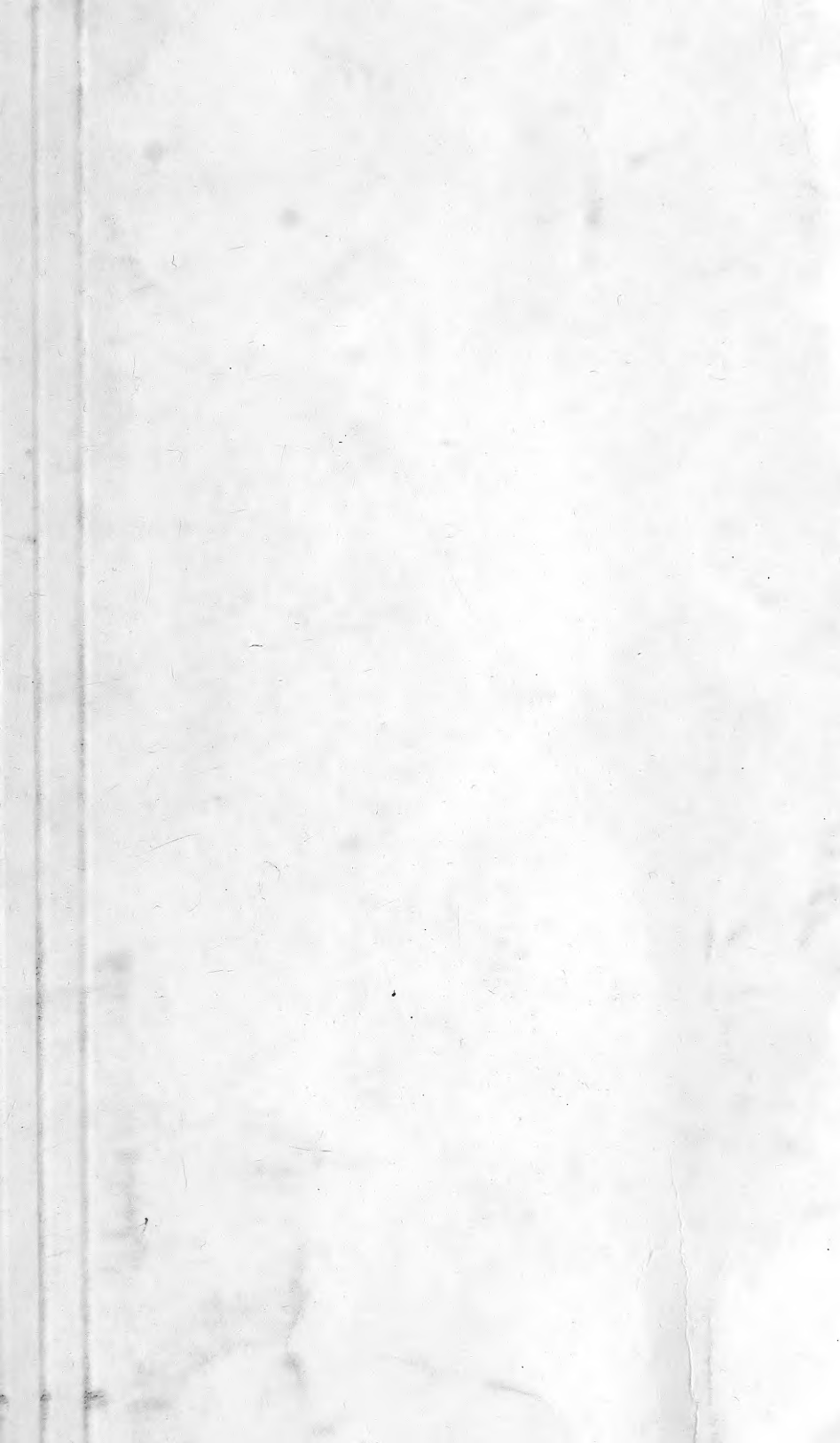
The lateral angles of the second to the fifth abdominal segments are prolonged downward into long spiniform teeth, the appendages of these segments are proportionately much longer than in the adult, and the margins of their terminal lamellæ are furnished with very long plumose hairs. The lamellæ of the appendages of the penultimate segment are oval, and margined with long plumose hairs. The terminal segment is nearly quadrangular, as wide at the extremity as at the base, the posterior margin arcuate, but not extending beyond the prominent lateral angles, and furnished with hairs like those on the margins of the lamellæ of the appendages of the penultimate segment.

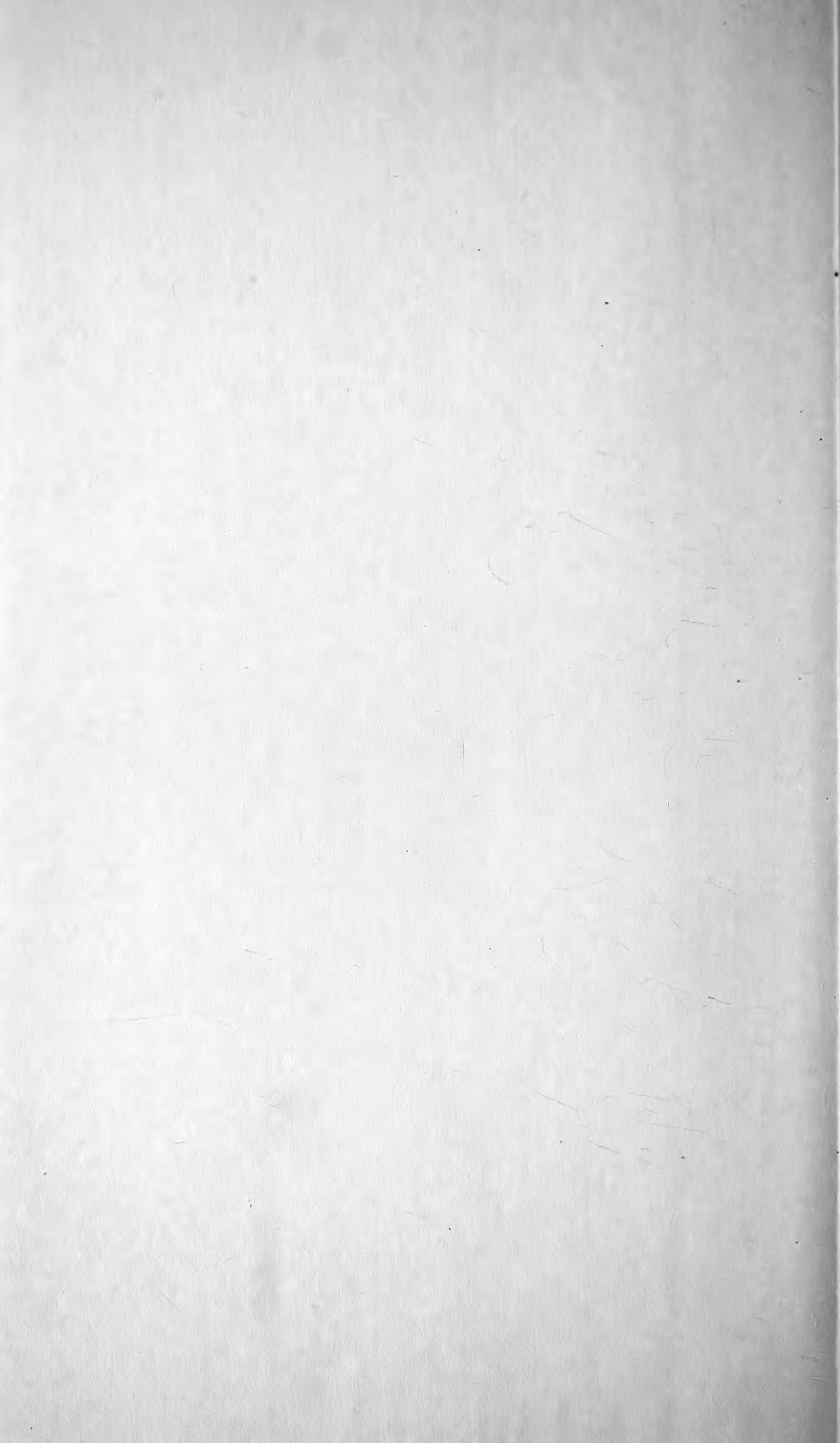
In this last stage, the young lobsters swim very rapidly by means of the abdominal legs, and dart backward, when disturbed, with the caudal appendages, frequently jumping out of the water in this way like shrimp, which their movements in the water much resemble. They appear to be truly surface animals as in the earlier stages.

From the dates at which the different forms were taken, it is probable that they pass through all the stages here described in the course of a single season. How late the young, after reaching the lobster-like form, retain their free-swimming habit was not ascertained.

EXPLANATION OF PLATE IX.

- Figure *A*. Lateral view of the larval young in the first stage observed, enlarged 10 diameters.
- “ *B*. The same in a dorsal view, the abdomen held horizontally.
- “ *C*. Antennula, enlarged 20 diameters.
- “ *D*. One of the thoracic legs of the second pair, enlarged 20 diameters; *a*, exopodus; *b*, epipodus; *c* branchiæ.
- “ *E*. Lateral view of the larval young in the third stage, enlarged 8 diameters.
- “ *F*. Terminal portion of the abdomen seen from above, enlarged 15 diameters; *a*, one of the small spines of the posterior margin of the terminal segment, enlarged 75 diameters.
- “ *G*. Basal portion of one of the legs of the second pair, showing the epipodus and branchiæ, enlarged 20 diameters.





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