constituting the type of a new genus, which was proposed to be called *Eupathistonia*. Of the New Zealand species treated of 16 were described as new, and the new generic term *Trachyleberis* was proposed for the reception of *Cythere scabrocuneata*, Brady.

This paper will be published in full in the 'Transactions.'

The following papers were read:—

1. On the Early Post-larval Stages of the Common Crab (*Cancer pagurus*), and on the Affinity of that Species with *Atelecyclus heterodon*. By J. T. Cunningham, M.A.[1]

[Received February 15, 1898.]

(Plate XXI.)

A complete account of the natural history of the common Edible Crab is not in existence, and the naturalist who endeavours to construct a life-history of the species from the separate observations recorded in zoological literature will find that direct observations on this particular species are very scarce. A general knowledge of the development of Brachyura has been obtained from the partial study of various species, but the systematic investigation of the diagnostic characters of the larval and immature stages in the various divisions of the suborder has yet much to accomplish. With regard to this species neither the Zoæa, nor the Megalopa, nor the earliest post-larval form has yet been figured and described in sufficient detail.

The paper by R. Q. Couch in the Report of the Falmouth Polytechnic Society for 1843 contains a brief description of the Zoæa of this species, with a figure in the illustrating plate. A special paper on the development of the Edible Crab was published by the same author in the Reports of the Penzance Natural History Society for 1853–4–5. This paper is based on observations made in 1852. The Zoæa is here again mentioned, and reference is made to a figure of it as plate i. fig. 1; but I have been unable to find any plate or figure in the volume. The Megalopa and the earliest post-larval stage are also described, but as it is not my intention in the present paper to consider the larval stages, I need only refer to the description of the first post-larval stage, into which the Megalopa changes after ecdysis. It is stated that in this stage the margin of the carapace was much more waved than in the Megalopa; the animal was now unlike any previous state, but not at all like the adult. The lateral rim was indented as in the adult, but instead of the oval form it was almost quadrangular; the sides, instead of being rounded off as in the adult, were perpendicular.

Prof. S. I. Smith, in 'The Invertebrate Fauna of Vineyard Sound,'

[1] Communicated by F. E. Beddard, F.R.S.

U.S. Fish. Comm. Rep. 1871–72, published in 1873, gives some observations on the early stages of the American species *Cancer irroratus*. He states that Zoæas of the species were taken abundantly in Vineyard Sound from June 23rd till late in August. Megalopas were also taken, and that the change of the Megalopa into the first crab-form was observed in aquaria. In this early stage the young Crab was quite different from the adult. The carapace was about 3 mm. long and slightly less in breadth. The front was much more prominent than in the adult. The antero-lateral margin was much more longitudinal than in the adult, and was armed with 5 normal teeth, which were long and acute, and 4 much smaller secondary teeth alternating with these. Young Crabs in this stage were once or twice taken in the tow-net. Figures of the Zoæa and Megalopa are given, but none of the first crab-form. The most important part of this description in relation to my own observations is that concerning the teeth on the antero-lateral margin.

During last summer, while engaged in presenting to Cornish crab-fishermen the known facts concerning the natural history of the animals it is their business to capture, I endeavoured, when leisure and opportunity allowed, to trace the successive stages of the Edible Crab in the littoral waters. Having failed to identify any of the stages in the produce of the tow-net, or to obtain any stages later than the Zoæa hatched directly from the ovum, I began to search the shore at low tide in the hope of finding the earliest ambulatory stages derived from the swimming larvæ hatched some weeks earlier. This search was also for a time unsuccessful, but at the Laboratory of the Marine Biological Association at Plymouth I obtained on Sept. 28th the specimens which form the subject of the present paper. They were found among a quantity of coralline growth collected on the shore at Wembury Bay and were examined in the Laboratory, and my possession of them is due entirely to the exertions made by the Director and his assistants on my behalf.

The specimens were ten in number, the smallest 2·5 mm. across the carapace, the largest 7 mm. The largest specimen was quite similar to the adult *Cancer pagurus*. Two or three of the smallest specimens had the characters shown in fig. 1 (Plate XXI.), while the rest were in a condition intermediate between this and the ordinary condition of *Cancer pagurus*. One of the most typical of these intermediate conditions is shown in fig. 2 (Plate XXI.), drawn from a specimen 4 mm. in breadth of carapace.

For a time it seemed doubtful whether the smallest specimens as represented in fig. 1 were the young of *Cancer pagurus* or of *Atelecyclus heterodon*, as the antero-lateral teeth of the carapace are so similar to those in the adult condition of the latter species. The specimens seemed, however, to belong to the same series, and the facts that the outline of the carapace is not so regularly circular in the smallest specimens as in *Atelecyclus*, and that no more advanced specimens of that species were found in the

collection, seem to exclude the possibility that any of the specimens belong to that species. Further, as we have seen, the characters of these small specimens agree with the brief description given by S. I. Smith of the earliest ambulatory form of an American species of *Cancer*.

A minute examination of the specimen represented in fig. 1 reveals the following peculiarities:—The anterior portion of the carapace between the eyes is much more prominent than in the adult *Cancer*. It consists, as in the latter, of five principal projections or teeth, each of which carries secondary pointed teeth of different sizes. The eyes are much larger in proportion than in the adult, and on the anterior border of each eye-stalk is a tooth. The margin of the orbit carries minute teeth. The antero-lateral margin of the carapace bears altogether 10 teeth, five larger and 5 smaller alternating with each other. As seen in the quotation given above, Prof. S. I. Smith states that the number of teeth in the first crab-form of *Cancer irroratus* is only 9, 5 "normal," and 4 smaller alternating with them; but it seems to me probable that he omitted to notice the last small tooth behind the fifth large tooth. In any case this tooth is undoubtedly present in my specimens, and, as I shall show, its presence is of some importance. The larger teeth and some of the smaller exhibit secondary teeth on their hinder margins, and on these margins there are also some setæ. From the tenth tooth there extends backward a granulated ridge corresponding to a similar ridge in the adult *Cancer*.

The antennæ are relatively longer than in the adult. The ambulatory legs or pereiopods are similar in shape to those of the adult, but the anterior pair or chelipeds differ in the possession of rows of pointed tubercles on the carpus and propodus, and a few smaller tubercles are visible also on the dactylus. On all the pereiopods and on the antennæ there are a considerable number of setæ.

The length of the carapace in these smallest specimens is about 3 mm.; the breadth is only 2·5 mm. We may conclude therefore, both from size and characters as compared with those given by S. I. Smith in reference to *Cancer irroratus*, that these specimens are in the first crab-stage, and are derived directly from the Megalopa stage. The length of the carapace in this stage is thus somewhat greater than the breadth, while in the adult it is much less; even in the largest specimen in the collection here considered the breadth of the carapace is 7 mm., while the length is only 5 mm.

The intermediate stage seen in fig. 2 shows how the transition to the adult form is effected. This stage is probably derived directly from the former by a single ecdysis. In it the carapace is 4 mm. in breadth and slightly less in length. The anterior or rostral portion of the carapace now projects less, and the teeth both here and on the antero-lateral margin have become broader and rounder, while the secondary teeth on their margins have become regular rounded crenations. In this condition the antero-

lateral teeth approach to the form of the quadrate lobes in the same position in the adult, the notches between them in the earlier stage having been filled up by their increase in breadth. In the adult the crenated margin becomes much smoother, the crenations becoming so minute as to be all but obsolete. The tubercles on the outer surface of the chelipeds are in the second stage relatively smaller, but still distinct, and their arrangement in longitudinal rows is more evident. In both stages there are numerous small scattered tubercles on the surface of the carapace, more prominent in the first stage than in the second; in the adult these are reduced to minute granulations.

It is quite obvious that the second stage, represented in fig. 2, could not possibly belong to *Atelecyclus*, or indeed to any other species than *Cancer pagurus*, and I think there is no doubt that this form is derived from the first stage shown in fig. 1. But the evident similarity of the form shown in fig. 1 to *Atelecyclus* at once suggests that the two genera are closely allied, and I was led by this resemblance to compare the two British species more carefully. As a result of this study I have come to the conclusion that *Atelecyclus* properly belongs to the family Cancridæ, and should be placed in close proximity to the genus *Cancer*, not in the place hitherto assigned to it, in the family Corystidæ.

The points of resemblance between *Atelecyclus heterodon* and *Cancer pagurus* are numerous and obvious. In both the anterior margin of the carapace is quinquedentate, one of the teeth being median, and the two external forming the inner boundaries of the orbits. The antero-lateral teeth require a detailed examination. I have had for this purpose three specimens of *Atelecyclus*, two males 3·7 cm. in diameter, one female 2·4 cm. I find there are really 10 of these teeth in all, as in *Cancer pagurus*. The last or 10th, counting that which forms the outer boundary of the orbit as the first, is at the anterior extremity of the granulated ridge which borders the dorsal surface of the carapace posteriorly. This tooth is sometimes defined behind by a distinct indentation as well as in front. This is the case on both sides of one of the males, on the right side only in the other; in the female the indentation is not very distinct on either side. In *Cancer pagurus* the tenth lateral lobe or tooth, although much less marked than the rest and situated on the postero-lateral margin, is defined posteriorly by a distinct indentation.

In *Atelecyclus heterodon* the 1st, 3rd, 5th, 7th, and 9th teeth are larger, the rest smaller. In my two male specimens the 2nd and 4th teeth are very small, almost rudimentary. Montagu, who first defined the species, called it *septemdentatus*, and Stebbing ('Crustacea,' Internal. Sci. Ser. 1893) states that there are 9 teeth on the antero-lateral margin, and suggests that Montagu did not include the point at each extremity of the series. It seems to me more probable that Montagu omitted the 2nd and 4th on account of their slight development, and also the 10th tooth, which might be regarded as the extremity of the posterior granulated ridge.

In reckoning 9 teeth on the antero-lateral margin, Stebbing follows Thomas Bell ('British Crustacea,' 1853), and, I believe, all other writers who have described the species. Whether the 10th tooth should be counted or not may be considered a matter of opinion if the description of the species is considered apart from its relations to other species; but my own observation has convinced me that the teeth correspond exactly to the broad teeth or lobes of *Cancer pagurus*, and in both species there is a 10th tooth at the posterior end of the series. Thomas Bell noticed this 10th tooth in *Cancer pagurus*, giving as one of the specific characters "latero-anterior margin ten-lobed;" and when, as in his work, only 9 teeth are attributed to *Atelecyclus* the homology of the teeth in the two species is obscured.

It is stated as a peculiarity of the legion Corystinea, containing the single family Corystidæ, that the third pair of maxillipeds do not usually make a complete closure of the mouth-cavity, and are extended over the anterior margin of its frame. But it is mentioned as an exception that in *Atelecyclus* the third maxillipeds do make a complete closure of the mouth-cavity. The real significance of this exception is that in *Atelecyclus* as in *Cancer* the inner edges of the third maxillipeds meet in the middle line.

The form and proportional size of the chelipeds, and of the other legs, are very similar in *Atelecyclus* and in *Cancer*. In *Atelecyclus* there are 7 longitudinal rows of tubercles on the propodus of the chelipeds. In the adult *Cancer* there are no prominent tubercles, but it is easy to verify the fact that the five lower rows are represented by granulated ridges, while the upper two are obsolete. On the preceding segment, or carpus, in *Atelecyclus* there are 4 rows of tubercles, of which the uppermost bifurcates anteriorly. These are likewise represented in *Cancer* by ridges, but the bifurcation of the uppermost is not visible. In the young stages of *Cancer pagurus* which I have figured and described in this paper the rows of tubercles on both the segments mentioned are very similar to those in the adult *Atelecyclus*.

In all the points mentioned in which *Atelecyclus heterodon* approaches to *Cancer pagurus* it differs from *Corystes cassivelaunus*. The form of the carapace in the latter is quite different; it is much longer than broad, and its sides are almost straight and parallel to the antero-posterior axis. There is no median tooth to the rostrum, the extremity of which forms two divergent teeth, and the sides of which slope outward to the orbits without any projecting tooth, but with only a slight rounded prominence at the inner boundary of each orbit. Instead of 10 teeth on the antero-lateral margin, there are 4 widely-separated lateral teeth, with a blunt projection between the 2nd and 3rd. The maxillipeds of the 3rd pair are long and narrow, and their inner edges do not meet in the middle line.

The chelipeds of *Corystes*, instead of being short and robust as in *Atelecyclus* and *Cancer*, are, especially in the male, long, and slender, with long segments, and the rows of tubercles mentioned above

are not represented. In *Corystes* also the tail extends forward only to the sternum of the 3rd pereiopods, while in *Cancer* and *Atelecyclus* it extends to the sternum belonging to the chelipeds.

I think it will be agreed that the evidence I have detailed is abundantly sufficient to prove that *Atelecyclus* has no claim to a position in the family Corystidæ and that its proper position is in the Cancridæ next to *Cancer*. The resemblances of the adults are enough to establish this proposition, while at the same time it is confirmed by the greater resemblances between the young *Cancer* and the adult *Atelecyclus*. The peculiarities of the 1st crab-form of *Cancer* thus indicate that the latter in its evolution has diverged from an ancestral form closely similar to *Atelecyclus*, and that in the adult condition of *Cancer* several features which *Atelecyclus* retains throughout life have been considerably modified.

Mr. Walter Garstang (Journ. Mar. Biol. Assoc. vol. iv. no. 3) has recently described the respiratory adaptations in *Corystes cassivelaunus*, in which the antennæ form a tube conveying an anterior afferent current of water to the branchial cavities, and remarks that a similar reversal of the respiratory current occurs in the allied form *Atelecyclus heterodon*. Now, in accordance with this remark, I find that there is a certain degree of similarity between the arrangement of the antennæ and parts surrounding the anterior apertures of the respiratory cavities in the two forms. The antennæ in *Atelecyclus* are not more than one-third the length of those of *Corystes*, but they are provided each with a dorsal and ventral fringe of hairs which by their apposition would form a tube as in *Corystes*. The anterior edges of the external maxillipeds (2nd segment) are also fringed with long hairs which form a ventral floor to the water-channel as in *Corystes*. But the second joint of the peduncle of the antennæ is not flexed on the first in *Atelecyclus* as it is in *Corystes*. The first joint of the antenna is fixed in *Atelecyclus* while it is movable in *Corystes*, and in the former there is a thick fringe of long hairs, extending across the base of the second joint or segment of the external maxillipeds and along the ventral surface of the carapace, which is entirely wanting in *Corystes*. It is evident therefore that the differences, even in the parts here considered, between the two forms are greater than the resemblances, and all that can be said is that there is a slight adaptive similarity in the two cases. In other words, we find in *Atelecyclus* a slight development of a structural adaptation for respiratory purposes, which is much more complete in *Corystes*. The condition of the parts in question in *Atelecyclus* is not such as to indicate any close affinity between the two genera.

DESCRIPTION OF PLATE XXI.

Fig. 1. Early crab-form of *Cancer pagurus*, the Edible Crab. Actual size of specimen 2·5 mm. across carapace. Drawn with Zeiss oc. 3, obj. a_3, without camera lucida.

2. Transition stage of *Cancer pagurus*; from a specimen 4 mm. across carapace. Drawn under the same conditions as fig. 1.