

ART. XXXI.—*The systematic position of Crangopsis vermiformis (Meek), from the Subcarboniferous rocks of Kentucky; by ARNOLD E. ORTMANN, Ph.D.*

IN 1872 and 1875 F. B. Meek described* a peculiar Crustacean from the lowermost Subcarboniferous rocks (base of Waverly series) near Danville, Ky., under the name of *Archæocaris vermiformis*, but owing to the imperfect condition of his specimens he did not express any opinion as to the systematic position of this fossil. The Museum of Geology of Princeton University possesses quite a number of specimens of this form, which were collected by M. Fischer at or near the same locality (Boyle Co., Ky.), and which are also for the most part poorly preserved. Yet a few specimens are better, and one of them shows clearly a peculiar feature which enables us to make out its approximate systematic position.

Previously, Crustacean remains closely resembling Meek's species have been reported by Salter† from the Subcarboniferous (Mountain Limestone) of Scotland under the name *Palæocrangon socialis*, the generic name being subsequently changed into *Crangopsis* Salter,‡ in order to prevent confusion with *Palæocrangon* Schauroth. Salter places his fossils among the Macrurus Decapods, considering the presence of a carapace, of seven distinct abdominal segments, and of caudal swimmerts as conclusive. These three characters are all that is known of *Crangopsis*, and *Archæocaris* of Meek shows exactly the same; there is nothing that should induce us to separate generically the American from the Scotch fossil. Accordingly, we should consider *Archæocaris* as a synonym of *Crangopsis*, and the American species should be called *Crangopsis vermiformis* (Meek). The three characters which induced Salter to place his genus among the Decapods are not sufficient to warrant the correctness of this position. On the contrary, these three characters are present, among the Malacostraca, in the same combination also in the living orders of the *Stomatopoda*, *Euphausiacea*, and *Mysidacea*,§ and we cannot make out the proper position of these fossils according to our present knowledge. From one specimen however in the Princeton collection (Mus. No. 1597^c) we learn another very important character.

* Proc. Acad. Philad., 1872, p. 335; Geol. Surv. Ohio, Palæont., ii, 1875, p. 321, pl. 18, fig. 1.

† Trans. Roy. Soc. Edinburgh, xxii, p. 394; Quart. Journ. Geol. Soc. London, xvii, 1861, p. 533, fig. 8.

‡ See Zittel, Handb. Palæont., ii, 1885, p. 682.

§ Compare Boas, in Morpholog. Jahrb., viii, 1883.

Of this specimen the body is complete, showing the carapace and the whole abdomen preserved *in situ*. Fortunately, the hinder and upper part of the carapace is broken away, thus enabling us to see that in addition to the seven abdominal segments exposed in specimens with unbroken carapace, there are, in front of them, *four* other segments present, originally covered by the hinder expansion of the carapace, and these four (thoracic) segments are dorsally perfectly closed, smooth, and uninjured, thus proving that they were not connected and anchylosed with the carapace, but free dorsally. These free thoracic segments are exhibited in a few other specimens (Mus. No. 1597^d), but since in the latter the abdomen is not complete, their exact number cannot be determined.

This character clearly shows that *Crangopsis vermiformis* cannot be a *Decapod*. In the Decapods all the thoracic segments are firmly united dorsally with the carapace. Neither can *Crangopsis* belong to the *Euphausiacea*, because in this order only the last (fifth) thoracic segment is dorsally free, while all the others are united with the carapace. In the *Stomatopoda* the five thoracic segments are free, but they are not covered by the carapace; only in the *Mysidacea* we have the same condition as shown by *Crangopsis*. Thus, according to this character, this genus should be placed in the order of *Mysidacea*, and it is the *first fossil form* assigned to this group.

I think, however, it would be a little rash to assume positively that *Crangopsis* belongs to that group of *recent* animals designated as the order *Mysidacea*, since we know nothing of the other characters of this form. It is true, the character mentioned is present, among the living Malacostraca, only in the order of *Mysidacea*, but it is a mere secondary one, the principal characters being drawn from the differentiation of the appendages of the body. In the fossil *Crangopsis* only faint traces of limbs have been discovered, but their number, their shape and differentiation are entirely unknown, and accordingly we are at a loss to recognize the typical characters of any particular order of the Malacostraca; we may even imagine that *Crangopsis* possessed in the conformation of the thorax the characters of *Mysidacea*, while the limbs were developed according to the Decapod-type, a condition which is not altogether impossible. Since *Crangopsis* belongs to the earliest forms of Malacostraca, we are to expect that it belongs to a primitive group, perhaps to that group which forms the original stock from which all the now living Malacostraca originated. But the presence of a carapace covering entirely the thorax indicates that this genus belongs to the *Thoracostraca*, and further, the fact that the four last thoracic segments are dor-

sally free, shows that closer relations exist to the *Mysidacea* than to any other order.

There is no doubt that the Carboniferous and Permian fossils designated by Brocchi* as a new family (*Nectotelsonidæ*) of the order Amphipoda belong to that primitive group of Malacostraca which gave origin to the different now living orders. This family contains the genera *Palæocaris* Meek and Worthen, *Uronectes* Bronn (= *Gampsonyx* Jordan), and *Nectotelson* Brocchi, but its position among the Amphipods, as maintained by Brocchi, is certainly erroneous. The *Nectotelsonidæ* show a number of characters common to all Malacostraca, but no typical characters of any of the orders of this subclass; they represent a mere collective type of different Malacostracous orders.

The general characters of all Malacostraca are the following: Body with a limited number of segments; the number of the anterior segment is somewhat doubtful, but there are certainly eight segments of the "cormus" bearing the cormopods, and seven of the abdomen or pleon, six of which bear pleopods, the last one forming with the telson a caudal fin. A differentiation between the appendages of the cormus and the pleon is present. This primitive type of Malacostraca is divided into two large sections: the *Thoracostraca*, having a carapace developed and stalked eyes, and the *Arthrostraca* having no carapace and sessile eyes.† The first section is farther characterized by the prevailing presence of the caudal fin (which is reduced only in the Decapoda Brachyura); of the second section only a part of the Isopods retains the caudal fin. In the Thoracostraca the legs are either differentiated in the primitive manner into cormopods and pleopods, or the former are again divided (Decapoda) into three maxillipeds and five pereopods (thoracic legs). In the Arthrostraca, there is never a differentiation of maxillipeds and pereopods, but often (Amphipoda) the pleopods are divided into swimming (anterior) and jumping (posterior) feet.

The *Nectotelsonidæ* of Brocchi show on the one hand the primitive characters of the Malacostraca; they have a limited number of body-segments, divided according to the appendages into a cormus and a pleon with a caudal fin. On the other hand no carapace is developed and stalked eyes are present.‡ The latter character, and the shape of the antennæ, and the gill-like appendages on the bases of the cormopods separate this group from the Arthrostraca, and Jordan and Meyer were perfectly right in so far as giving *Uronectes* a position inter-

* Bull. Soc. Geol. France, iii, 8, 1880.

† I disregard the *Cumacea*, which are intermediate between both in this respect.

‡ The details of structure given here are best known in *Uronectes* (= *Gampsonyx*). Compare Jordan and Meyer, Palæontographica, iv, 1, 1854, p. 1, ff. pl. 1.

mediate between the Arthrostraca and Thoracostraca: but in pointing to the resemblance to the Amphipods they were wrong, since there are no closer relations present to that order. The other genera referred by Brocchi to the *Nectotelsonidæ* are only incompletely known, but their general appearance strongly favors the opinion that they really belong to the relatives of *Uronectes*. The description of the genus *Nectotelson* of the Permian of Autun, France, is very poor and contradictory. Brocchi gives it seven thoracic segments (p. 6) and four abdominal segments, but his figures show nothing that might warrant this number, and fig. 1 (pl. 1), indeed, shows clearly that the number *four* for the abdominal segments is incorrect. Further, he says (p. 7) that probably the eyes were small and sessile: but the specimens did not show any traces of these organs! He did not discover in his specimens an appendage of the antennæ: these characters and the much smaller size are the only differences of *Nectotelson* and *Uronectes*. The limbs of *Nectotelson* (pl. 1, fig. 2) are badly preserved, but they resemble apparently those of *Uronectes*.*

As regards the genera *Palæocaris* and *Acanthotelson* of Meek and Worthen,† I refer only to the descriptions and restorations given by Packard‡ from which it is apparent that both are closely related to *Uronectes*.

In order to get an approximate idea of the systematic position of Brocchi's *Nectotelsonidæ*, we may rely upon a combination of the characters of these three or four genera, and if we consider these characters as conclusive for this family, we may say that the *Nectotelsonidæ* show the typical characters of the subclassis Malacostraca; but further on they unite characters of the Arthrostraca (the missing carapace) with those of the Thoracostraca (stalked eyes), thus proving to be a primitive group from which the former as well as the latter might be derived.

I may add here that Packard creates the *suborder Syncarida* for these genera,§ which thus consists of Brocchi's *family Nectotelsonidæ*.

* It is astonishing that Brocchi in comparing *Nectotelson* with *Uronectes* did not consult the paper of Jordan and Meyer quoted above, and that he describes a very bad figure that we possess of *Gampsonyx* (he gives a copy pl. 1, fig. 7), while *Gampsonyx* (*Uronectes*) is known as completely as we might expect to know a Palæozoic Crustacean.

† *Palæocaris typus*, Coal Measures of Illinois (Proc. Acad. Philad., 1865, p. 49, and Geol. Surv. Ill., ii, 1866, p. 405; iii, 1868, p. 552). *Acanthocaris*, three species from the Coal Measures of Illinois (ibid.). A second species of *Palæocaris* has been described by Woodward from the Coal Measures of England (Geol. Magaz., 1881, p. 533).

‡ Mem. Nat. Acad. Sci., Washington, iii, 1886, and Proc. Boston Soc. N. H., xxiv, 1889.

§ Compare Calman, 1896, p. 801, footnote 1.

This fossil group of Crustaceans has become the more interesting, since very recently a peculiar living species has been discovered in fresh-water pools of the mountains of Tasmania, which was first described by G. M. Thomson* under the generic name of *Anaspides*, and of which W. T. Calman† gives a more detailed investigation, especially with reference to its relation to the fossil forms here under discussion. *Anaspides*, indeed, is the most important discovery among the recent higher Crustaceans, and it is no doubt *a living form belonging to the group Syncarida*. Calman has shown conclusively that the characters of *Anaspides* are a combination of the Podophthalmate type (Thoracostraca) with a completely segmented body and the lack of a carapace, i. e. with Edriophthalmate type (Arthrostraca). But, on the other hand, the details of structure in *Anaspides* point to a closer connection with the "Schizopoda" of the Euphausiid-type as well as of the Mysid-type.‡

I think, however, it is best to regard the *Syncarida* of Packard, including the recent genus *Anaspides*, as a group of equal rank with the other chief divisions of the subclass Malacostraca, namely as an *order*, and, indeed, as the most primitive order from which all the others are to be derived: there is no doubt about the genetic relation of the Euphausiacea, Mysidacea, and Decapoda to the Syncarida, but I am convinced that further study will show that also the other orders of Malacostraca, Squillacea, Cumacea, Isopoda, and Amphipoda are to be connected directly or indirectly with this primitive order.

The chief characteristics of the order *Syncarida* (Packard) derived from the morphological features displayed by the recent *Anaspides* would be the following:

Body with a limited number of distinct segments, differentiated into a "cormus" and a "pleon." No carapace developed. Stalked eyes present. Antennæ with a scale. Cormopods on the coxal joints with "branchial lamellæ," and on the basal joints with an "exopodite." Penultimate segment of the pleon with two well developed appendages forming with the telson a caudal fin.

Comparing *Crangopsis* with the *Syncarida* we see at once that it is distinguished by the presence of a carapace, thus coming clearly under the subdivision *Thoracostraca*. As we have seen above, we may assign it to a particular order, *Mysidacea*, but we must bear in mind that the typical characters of this order drawn from the appendages of the body are not

* Trans. Linn. Soc. Zool. (2), vol. vi, 1894.

† Trans. Roy. Soc. Edinburgh. vol. xxxviii, part 4, 1896.

‡ Compare Calman, l. c. p. 795 and 801.

recognizable, and therefore its position among the Mysidacea is not beyond doubt. Indeed, I do not believe that *Crangopsis* really belongs to the order Mysidacea, but that it is related to the Syncarida. At present, however, we are at a loss to ascertain its true position, since the morphology of the appendages of the body is unknown: yet there is much probability that *Crangopsis* may be a transitional form from the true Syncarida to one of the more specialized groups of Thoracostraca, namely the Mysidacea. Whether we shall connect it systematically with the latter group or with the Syncarida, depends on the knowledge of the other details of structure. In the latter case, the synopsis of the Syncarida ought to be changed as to include this form provided with a carapace.

I may be permitted here to direct attention to a few other Malacostracous Crustaceans found in Palæozoic strata, the position of which with *Crangopsis* is likely more correct than with the Decapoda.

The oldest form referred to the Decapoda, *Palæopalæmon newberryi*,* from the Upper Devonian of Ohio, has been placed by J. Hall among the "*Carididæ*;" but certainly it does not belong to the typical forms of this group, as the name might suggest, which are now called *Eucyphidæ*. Zittel† places this genus among the *Penæidæ*. Although there is no character known which contradicts this position, there is, on the other hand, none which seems to warrant it. On the contrary, no characters are present at all which stamp this fossil as a Decapod: it may belong equally well among the Euphausiacea or Mysidacea. Indeed, in the figure of the only known specimen the carapace appears posteriorly elevated over the abdomen as if separated from the trunk, a feature which suggests a condition similar to that of the Mysidacea or Euphausiacea. But, of course, we cannot judge from this character, as it might be due as well to fossilization.

In the Coal Measures of England a peculiar Crustacean has been found, described by Huxley under the name *Pygocephalus cooperi*.‡ Huxley considers this form to come near to the recent *Mysis*, but to possess some relations to the *Stomatopods*, while Zittel places it among the Decapod-group *Penæidæ*. I should like to endorse the opinion of Huxley in so far as the wanting chelæ, the non-differentiation of maxillipeds and pereopods, and the presence of exopodites are strongly against its

* Whitfield, this Journal (3), vol. xix, 1880, p. 41, and Ann. N. Y. Acad. Sci., vol. v, 1891, p. 571, pl. 12, figs. 19-21. Hall, Pal. N. Y., vol. vii, 1888, p. 203, pl. 30, figs. 20-23.

† Handbuch d. Palæont., ii, 1885, p. 683.

‡ Quart. Journ. Geol. Soc., London, xiii, 1857, p. 363, pl. 13 and 18, 1862, p. 420.

affinity with the Decapods. *Pygocephalus* may belong to the "Schizopods"* in the old sense, which comprise the Euphausiacea and Mysidacea of recent systems, but we are at a loss to say to which of the two latter orders it may be referred.

In conclusion I may add that no Palæozoic Crustacean is known in which Decapod-characters have been observed.† The only genus *Anthrapalæmon*‡ of the Coal Measures of Scotland and Illinois, which has been referred to the Decapods from the appearance of the external form of the body, has incompletely preserved legs, so that its true position remains doubtful. It may be well to remember that true Decapods, i. e. Crustaceans in which typical Decapod-characters are evident, are not found until the Triassic period, and that it may be possible that they did not exist at all in Palæozoic times. On the other hand, it is sure that upwards from the Upper Devonian period, through the Subcarboniferous, Carboniferous and Permian, Malacostraca have been found, which represent either a mere collective type of this subclass or show even some tendency to become more specialized: at least a differentiation of Thoracostraca and Arthrostraca took place probably in the earliest Subcarboniferous or Upper Devonian period. Remains of this primitive group, which may be conveniently called *Syn-carida* (Packard), have not yet been found in Mesozoic or Tertiary strata, *but this group is still represented by the genus Anaspides, living in fresh water on the mountains of Tasmania.*

Princeton University, January, 1897.

* Huxley unites the Schizopods with the Decapods, and, accordingly, he calls *Pygocephalus* a Decapod: but he expressly states its nearer relation to "Mysis," a Schizopod.

† Even an alleged abdomen of a Brachyurous Decapod, *Brachypyge carbonis*, has been described from the Coal Measures of Belgium (Woodward, Geol. Magaz., 1878, p. 433, pl. 11, and de Kœninck, Bull. Acad. Roy. Belg. (2), lxx, 1878, p. 83, figs. 1, 2). It is extremely unintelligible why this fossil should belong to a Crustacean at all, and whoever has seen the abdomen of a living crab, cannot doubt that this fossil is no such thing. Probably *Brachypyge* belongs to the Arachnoidea (compare the Carboniferous *Anthracomarti*).

‡ Salter, Quart. Journ. Geol. Soc., London, xvii, 1861, p. 529, figs. 1-7. Meek and Worthen, Geol. Surv. Ill., ii, 1866, p. 407, pl. 32, fig. 4, and iii, 1868, p. 554. Etheridge, Quart. Journ. Geol. Soc., London, xxxv, 1879, p. 404, pl. 23.

AM. JOUR. SCI.—FOURTH SERIES, VOL. IV, No. 22.—OCT., 1897.