XII NOTES ON DECAPODA IN THE INDIAN MUSEUM

IV.—Observations on the primitive Atyidae with special reference to the genus *Xiphocaridina*.

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For the last few years efforts have been made to improve the collection of Atyidae in the Indian Museum and, thanks to the energy displayed by numerous correspondents, the series will, it is hoped, shortly become thoroughly representative of this important part of the Indian freshwater fauna. In course of time a full report on this family and on the Palaemonidae will be issued, forming a part of the Museum Catalogue of Indian Decapod crustacea.

The Atyid fauna of the Indian Empire comprises, so far as is at present known, only three genera, *Atya*, *Caridina* and *Xiphocaridina*. *Ortmannia* (*Atyoida*) does not seem to occur, and this, in view of Bouvier's theory of the mutational origin of that genus and of *Atya*, is a most unfortunate circumstance. It is, however, still hoped that specimens will be found which will provide material for some further consideration of this interesting question.

Atya appears to be very scarce. A few specimens from the Andamans are the only Indian representatives of the genus in the collection, while in addition there is a single example from Ceylon. *Caridina*, the prevalent genus, occurs in great abundance in every suitable locality, inhabiting both fresh and brackish water and ascending to altitudes of at least 6,000 ft. Of *Xiphocaridina* a single species only is known, obtained at Tezpur, on the north bank of the Brahmaputra R. in Assam, and in the native state of Manipur further to the east. It is with this last form that the present note is concerned.

The Atyidae as a whole must be regarded as a very primitive family of Caridea, in spite of the fact that the peculiarly modified chelae indicate a considerable degree of specialization. *Xiphocaridina* is one of the most primitive of the known genera, and it is through such forms as this and *Xiphocaris* that the common ancestry of the Atyidae and the deep-sea pelagic shrimps of the family Hoplophoridae has been traced. Bouvier (1909*a*), following Ortmann (1895), has laid great stress on this interesting feature of Caridean evolution, and his careful researches leave no room for doubt on the point.

The most conspicuously primitive feature of the genera *Xiphocaris* and *Xiphocaridina* is the possession of well-formed exopods on all the peraeopods, a schizopod-like character which they share with one other Atyid genus, *Palaemonias*, Hay, from the mammoth cave of Kentucky. In three other genera, *Syncaris*, *Troglocaris* and *Atyaëphya*, exopods are also found on certain thoracic legs, but never on all, while they are uniformly absent from *Atya*, *Caridina* and *Ortmannia*, genera which comprise the large majority of known species of the family, and from *Limnocaridina*, *Caridella* and *Atyella* that constitute the peculiar Atyid fauna of lake Tanganyika.

Until comparatively recently the distinctions between *Xiphocaris* and *Xiphocaridina* were not recognized; but Bouvier (1909*a*) had pointed out that the West Indian *X. elongata*, the type of the former genus, differs from its supposed congeners in New Zealand, China and Australia in several important structural features. He consequently created for the latter species a new genus, *Xiphocaridina*.

Xiphocaridina is distinguished from *Xiphocaris* by the presence of supra-orbital spines on the carapace, by the anteriorly excavate carpus of the first peraeopods, by the presence of tufts of hairs on the tips of the fingers of the chelae (a character found in all Atyidae with the exception of *Xiphocaris*) and by the absence of arthrobranchs at the base of the first four peraeopods.

From a consideration of these characters it is evident that *Xiphocaridina* has proceeded on a line of specialization similar to that which has resulted in the evolution of *Caridina* and this fact determined Bouvier in his choice of its name. *Xiphocaris*, as at present understood, is the most primitive genus in the family; except for the complete suppression of the mandibular palp, it bears a very close resemblance to the Hoplophoridae.

Palaemonias, Hay (1902, p. 226), is distinguished from both the preceding genera by the distal excavation of the carpus of the second pair of peraeopods and by the unpigmented and non-facetted eyes. It appears to resemble *Xiphocaris* in the absence of a supra-orbital spine and *Xiphocaridina* in the reduction of its branchial system.[1]

Up to the present time only the following species of Atyidae with the full number of exopods on the thoracic limbs have been described :—

Xiphocaris elongata (Guérin).
Cuba; Hayti; Dominica; St. Domingo.

Xiphocaridina compressa (De Haan).
Yokohama; Tokio; Flores; Queensland; Victoria; New South Wales; Norfolk Is.

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1 Hay states (p. 229) that "the gills seem to be only four in number, on each side attached to the first four peraeopods, but there may be a rudiment on the fifth." In *Xiphocaridina* there are seven gills (one rudimentary) on either side and twelve (one rudimentary) in *Xiphocaris*.

Xiphocaridina curvirostris (Heller).
New Zealand; Chatham Is.

Palaemonias ganteri (Hay).
Mammoth cave, Kentucky.

It is consequently a matter of some considerable interest that one of these primitive Atyidae still persists in India, and the identification of this species with *Xiphocaridina curvirostris*, hitherto known only from New Zealand, presents a difficult problem in geographical distribution.

The material available consists of the following specimens:—

Tezpur, Darrang District, Assam. Col. H. H. Godwin-Austen. Twenty-four specimens, two of which are ovigerous females, ranging in length from 24 to 42 mm.

Manipur Hills, Manipur state. Col. H. H. Godwin-Austen. Three specimens (none ovigerous) from 24·5 to 28 mm. in length.

These examples were found many years since and it must, I think, be the case that the species is very strictly localised. On a visit to Assam a year ago I had ample opportunities of collecting freshwater crustacea at Mangaldai in the Darrang District and on the neighbouring Assam-Bhutan frontier, localities at no great distance from Tezpur. Special efforts were made to rediscover *Xiphocaridina*; but the search proved quite unavailing, although several interesting species of *Caridina* were obtained in abundance in the tributaries of the Brahmaputra.

For assistance in the identification of the specimens collected by Col. Godwin-Austen I am under considerable obligation to Prof. E. L. Bouvier, who was kind enough to forward me a transcript of one of his papers on Atyid evolution that had not at that time been received in our Calcutta libraries. He also furnished me with several references which afforded valuable information and spared me from his small series in the Paris museum a specimen of *X. curvirostris* from New Zealand for comparison with the Assam examples.

Subsequently, Dr. C. Chilton, to whom I wish to convey my sincere thanks, furnished me with a considerable number of specimens, obtained in the R. Avon at Christchurch, New Zealand.

I have thus been able to make a careful comparison of Indian and New Zealand examples and no doubt whatever remains in my mind of the complete identity of the two forms. Inasmuch, however, as this determination raises questions of geographical distribution of no little importance a mere statement of fact would not perhaps be acceptable and in searching for some standard of comparison between the two forms it has seemed best to adopt the somewhat laborious method of measurements, as employed by de Man (1908) in the discrimination of varieties of *Caridina nilotica*. The figures are shown in the tables on pp. 116—117 and it will be seen that, judged by this criterion, there is no room for doubt regarding the identity of the forms from the two localities. In the proportions of the antennular peduncle and antennal scale, in the

Measurements of *Xiphocaridina curvirostris* (Heller).[1]

	Tezpur, Assam.					R. Avon, New Zealand.				
Sex	♀	♀	♀	♀	♂	♀	♀	♀	♂	♂
Total length ..	37·5	35	33	29	31	43	39·5	37	34·5	*ca.* 29
Length of rostrum ..	7·0	8·0	?	6·1	6·4	7·7	7·1	6·6	7·1	5·9
Length of carapace ..	8·3	7·8	7·1	5·8	6·0	9·2	8·2	8·0	6·8	5·5
Length of antennal scale	6·0	5·7	5·2	4·5	5·0	6·5	5·8	5·7	5·4	4·6
First peraeopod—										
Length of carpus	1·42	1·44	1·43	1·05	1·28	1·79	1·57	1·53	1·40	1·16
Breadth of carpus	·83	·73	·73	·53	·53	·91	·84	·78	·58	·52
Carpus: length ÷ breadth ..	**1·71**	**1·97**	**1·96**	**2·00**	**2·41**	**1·97**	**1·87**	**1·96**	**2·41**	**2·23**
Length of chela	2·12	2·06	1·90	1·65	1·58	2·48	2·23	2·12	1·84	1·31
Breadth of chela	·76	·74	·74	·56	·55	·87	·85	·77	·60	·56
Chela: length ÷ breadth	**2·80**	**2·78**	**2·57**	**2·95**	**2·87**	**2·85**	**2·62**	**2·75**	**3·07**	**2·34**
Length of dactylus ..	1·0	·90	·91	·77	·72	1·09	96	·84	·89	·62
Chela-length ÷ carpus-length	**1·49**	**1·43**	**1·33**	**1·56**	**1·23**	**1·37**	**1·42**	**1·39**	**1·31**	**1·13**
Second peraeopod—										
Length of carpus ..	3·45	3·12	2·88	2·24	2·63	3·51	3·16	3·02	2·19	2·25
Breadth of carpus ..	·56	·51	·45	·38	·39	·56	·49	·49	·44	·35
Carpus: length ÷ breadth	**6·16**	**6·12**	**6·40**	**5·89**	**6·74**	**6·27**	**6·45**	**6·16**	**5·00**	**6·43**
Length of chela ..	2·00	1·90	1·79	1·53	1·53	2·20	1·95	1·88	1·67	1·30
Breadth of chela ..	·58	·56	·53	·45	·44	·64	·59	·58	·50	·45
Chela: length ÷ breadth	**3·58**	**3·39**	**3·38**	**3·40**	**3·48**	**3·44**	**3·31**	**3·24**	**3·34**	**2·89**
Length of dactylus .	1·23	1·07	1·05	·91	·91	1·18	·95	1·02	·91	·77
Carpus-length ÷ chela length	**1·72**	**1·64**	**1·61**	**1·46**	**1·72**	**1·60**	**1·62**	**1·61**	**1·31**	**1·73**
Third peraeopod—										
Length of propodus	3·67	3·58	3·17	2·77	3·02	4·28	3·77	3·59	3·19	2·77
Length of dactylus ..	1·03	·91	·91	·77	1·14	1·14	1·08	1·0	1·27	·92
Propodus length ÷ dactylus-length ..	**3·56**	**3·93**	**3·48**	**3·60**	**2·65**	**3·75**	**3·49**	**3·59**	**2·51**	**3·01**
Breadth of dactylus	·28	·25	·22	·18	·23	·29	·25	·25	·24	·20
No. of dactylar spines	10	10	10	8	16	11	10	11	17	13
Fifth peraeopod—										
Length of propodus	4·17	3·43	3·58	3·06	3·51	4·84	4·37	4·05	3·81	2·93
Length of dactylus	1·21	1·10	1·08	·82	1·05	1·35	1·21	1·20	1·25	·93
Propodus-length ÷ dactylus-length	**3·45**	**3·30**	**3·31**	**3·73**	**3·34**	**3·60**	**3·61**	**3·37**	**3·05**	**3·15**
Breadth of dactylus	·31	·26	·26	·24	·21	·33	·24	·30	·24	·22
No. of dactylar spines	66	59	63	46	65	70	65	71	70	62
Ova—										
Length ..	..	·40	·40		..	..	·45	·43		..
Breadth		·25	·25	..	..	..	·26	·26	..	..

[1] The measurements of total length are only approximate. Those of the rostrum, carapace and antennal scale are given to the nearest tenth of a millimetre. As regards the dimensions of the eggs the average of six measurements is entered in the case of each ovigerous female examined.

Proportional lengths of segments of peraeopods in *Xiphocaridina curvirostris*.

(FEMALES ONLY.)

	Tezpur, Assam.			R. Avon, New Zealand.		
	Minimum	Average.	Maximum	Minimum.	Average.	Maximum.
First peraeopod—						
Carpus: length ÷ breadth ..	1·71	**1·9**	2·00	1·87	**1·9**	1·97
Chela: length ÷ breadth	2·57	**2·8**	2·95	2·62	**2·7**	2·85
Chela-length ÷ carpus-length	1·33	**1·5**	1·56	1·37	**1·4**	1·42
Second peraeopod—						
Carpus: length ÷ breadth ..	5·89	**6·1**	6·40	6·16	**6·3**	6·45
Chela: length ÷ breadth ..	3·38	**3·4**	3·58	3·24	**3·3**	3·44
Chela-length ÷ carpus-length ..	1·46	**1·6**	1·72	1·60	**1·6**	1·62
Third peraeopod—						
Propodus-length ÷ dactylus-length ..	3·48	**3·4**	3·93	3·49	**3·6**	3·75
Fifth peraeopod—						
Propodus-length ÷ dactylus-length	3·30	**3·4**	3·73	3·37	**3·5**	3·61

Rostral formulae[1] of *Xiphocaridina curvirostris*.

Tezpur Assam

3)3+6+7 / 5	2)2+4+2+3 / 4	7)3+4+1+2+? / 4	2)2+6+1+4 / 4
2)2+5+1+5 / 3	3)3+7+2+5 / 5	2)2+5+1+5 / 4	2)2+8+2+4 / 6
2)2+4+1+4 / 4	2)2+4+1+1+4 / 5	2)2+6+1+? / 4	2)2+6+4 / 4
2)2+5+1+1+4 / 4	2)2+5+1+4 / 3	2)2+6+4 / 4	2)2+4+1+3 / 4
3)3+4+1+1+? / 4	2)2+5+1+1+? / 5	2)2+6+2+4 / 3	

Manipur.

2)2+4+1+1+5 / 4	2)2+4+4 / 4	3)3+5+1+1+5 / 4

R. Avon, Christchurch, New Zealand.

3)3+5+1+4 / 3	2)2+5+1+3 / 5	2)2+5+1+4 / 5	3)3+2+1+1+6 / 8
2)2+4+1+4 / 4	3)3+4+1+? / 4	2)2+5+1+4 / 5	2)2+4+1+1+4 / 6
2)2+4+1+4 / 4	2)2+5+1+4 / 5	2)2+5+1+6 / 4	2)2+5+1+5 / 4
3)3+5+1+4 / 4	3)3+7+6 / 4		

[1] The numbers of dorsal teeth are given above and those of the ventral below the horizontal line. In the case of the dorsal series, the full number is shown to the right of the bracket, the plus signs indicating gaps between individual teeth or series of teeth. The figure on the left, separated by the bracket, represents the number of teeth situated on the carapace behind the orbital notch. In the present species it will be noticed that these teeth invariably form a distinct series, isolated by a toothless space from those further out on the limb of the rostrum.

characters of the mouth parts, in the relative length of the peraeopods and the spinulation of their meral and carpal segments, in the branchial formula and in the armature of the telson there appears to be the closest possible resemblance between the two forms.

In point of fact, the sole difference that I have been able to discover is one of colour. In the majority of the New Zealand specimens received from Dr. Chilton the proximal part of each of the setae which fringe the antennal scale and uropods is bright purple and the same coloration is found on the terminal spinules of the telson. This curious pigmentation undoubtedly vanishes in alcohol and, although it is well shown in most of Dr. Chilton's specimens, which were collected in 1910, it could hardly be expected to have persisted in the examples from Assam which have been lying in alcohol for many years.

Xiphocaridina curvirostris was first described by Heller (1862) as a species of *Caridina* from specimens obtained at Auckland. A fuller account by the same author appeared in 1865 and in 1876. Miers included it, also under the genus *Caridina*, in his Catalogue of New Zealand Crustacea. Three years later (1879) Thomson described it as a new species of Palaemonidae, *Leander fluviatilis*; but in 1903 he realized his mistake and gave a fresh account of it[1] under the name *Xiphocaris curvirostris*. In Ortmann's revision of the Atyidae (1895) it appears as *Caridina curvirostris* with a note to the effect that it probably belongs to the genus *Xiphocaris*. Bouvier does not refer to the species in his valuable paper published in 1905; but he mentions it subsequently—using Thomson's name, *fluviatilis*—as a member of his new genus *Xiphocaridina* (1909, *a*, *b*).

The curious distribution of *Xiphocaridina curvirostris* does not, I believe, find any exact parallel among other freshwater Crustacea.

Perhaps its most peculiar feature is that the other species of the genus, *X. compressa*, which inhabits S. Australia, Flores, China, Korea and Japan appears to extend in a band completely separating the two localities in which it is known to exist. But in the present state of our knowledge it is impossible to lay any emphasis on this point, for it may well be that *X. curvirostris* still remains to be discovered in many other localities.

On turning to Ortmann's work on "The geographical distribution of freshwater Decapods and its bearing on Ancient Geography" (1902) it is at once seen from the maps illustrating the hypothetical distribution of land and sea in past geologic periods that, according to this author's views, no direct land connection between New Zealand and Assam has existed in any recent epoch. In the Lower Cretaceous, however, when a land-bridge connected S. India with Madagascar and S. Africa, and when the whole of Northern India was submerged and formed the eastern limit of the

[1] The figures given on Pl. xxix are poor.

great central sea now represented by the N. Atlantic and the Mediterranean, there existed a 'Sino-Australian' continent. This involved Eastern Asia, the Indo-Malaysian Archipelago and Australia, extending southwards to the Antarctic regions and from it a tongue of land reached out to New Zealand by way of New Guinea and Norfolk Island. During Upper Cretaceous times the 'Sino-Australian' continent was divided by a neck of water extending across the region now occupied by Sumatra and Celebes and the land extension from Madagascar to S. India reached north to the northern or Asiatic part of that continent. In Lower and Upper Tertiary times New Zealand was completely isolated as it remains at the present day; in the former period India was merely an island, an eastern sea-connection between the 'Mediterranean' and Indo-Pacific extending across Assam and Burma, while in the latter it approaches the shape which it at present bears.

On these theories the explanation of the discontinuous distribution of *X. curvirostris* is possible, though it can hardly be said to be very convincing. We must assume that *Xiphocaridina curvirostris* evolved from some unknown marine or freshwater ancestor in early Cretaceous or pre-Cretaceous times and remained unchanged until the present day. In the Lower Cretaceous period it would have opportunities of spreading to New Zealand on the one hand and to Lower Burma on the other. Subsequently, while becoming isolated in New Zealand it must have persisted in Burma or in the country existing to the west of it until Assam reappeared during the Upper Tertiary period.

The existence of *Xiphocaridina compressa* both in China and Japan and in Australia seems to show that this species also, according to Ortmann's theories, must have remained without sensible modification for almost as long a period. Every zoologist will readily call to mind other instances tending to a similar conclusion.

Although no exactly parallel case of geographical distribution seems to be known among freshwater Crustacea, the Megascolecid Oligochaeta of the sub-family Octochaetinae afford an instance of a closely similar nature. According to Michaelsen (1909) this sub-family is found only in India and New Zealand [1] and although no species appear to be common to the two, two genera, *Octochaetus* and *Hoplochaetella*, occur in both localities.

Michaelsen holds that the only possible interpretation of these facts is that at one period a direct land connection existed between India and New Zealand. He remarks (p. 203): "I need not explain to any zoo-geographer that the discontinuation of these two regions of distribution in the Octochaetinae is quite a common matter in geographical distribution, the two regions, New Zealand and India, perhaps together with a third region, Madagascar, the home of *Howascolex*, representing the peripheral parts

[1] Michaelsen mentions that another genus, *Howascolex*, known only from Madagascar, might perhaps also be regarded as a member of this sub-family.

of a circular distribution, the internal parts of which have been obliterated by the mighty development of younger and stronger forms, in this case the vigorous genus *Pheretima*, which, from Burma to New Hebrides in one direction and Japan in another, has suppressed and partly exterminated all other genera of earthworms, those of its own phylum or sub-family as well as those of other tribes."

It is, however, difficult to bring the case of *X. curvirostris* in line with this view. There is no evidence that *X. compressa* represents a young and vigorous type which has exterminated its near ally in localities lying between Assam and New Zealand; on the contrary it would rather seem that both species are archaic forms that must have arisen almost simultaneously and, while it is by no means impossible that *Caridina* may have suppressed *X. curvirostris* in Eastern Asia, it is difficult to see why the same cause should not have effected its destruction in Assam.

The genus *Xiphocaridina* is unquestionably a very primitive one and it may be predicted that such forms are less liable to evolve varieties, local races or other species than those exhibiting a greater degree of specialization.[1] That this is so is indeed self-evident, for a primitive form, if it be primitive, must necessarily have existed without considerable modification for a prolonged period and the mere fact that it has done this is an indication that it is less likely to adapt itself to any altered conditions of its environment than is a form which by its very specialization showed that in the past it had given a more ready response to such changes.

The full significance of the unchanged condition of *X. curvirostris* is, indeed, only realized when the great range of variation in certain other Atyidae is considered. *Caridina nilotica* is a species of wide African and Asiatic distribution. Specimens found in Bengal differ in certain measurable features from the type which occurs in Egypt and Dr. de Man has distinguished them under the name of *C. nilotica* var. *bengalensis*. Among other varieties of the same species it agrees most nearly with var. *gracilipes* found in Celebes and Salayer Is. Even within the limits of India and Ceylon, however, the form exhibits a most remarkable tendency to split into races, and series of specimens from Calcutta, Madras, Tuticorin, Ceylon and the Andamans each seem to possess its own particular characteristics.

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[1] Pocock (1889) has described several species very closely allied to *Xiphocaris elongata*; but subsequent authors have preferred to regard them merely as varieties. I am, however, of the opinion that these forms are not deserving even of varietal recognition and believe that the suggestion which Pocock himself made, that they only represent stages in the growth of a single species, is likely to prove true. The rostra of large specimens of *Xiphocaridina curvirostris* are as a rule relatively shorter than in smaller examples, and this is also the case with several species of *Caridina*. In these instances, however, the variation has not nearly so great a range as in *X. elongata*. On the other hand there appears to be some evidence that two distinct races of *X. compressa* exist on Norfolk Is. (see Thomson 1903, p. 449, and Grant and McCulloch, 1907, p. 151).

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