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To Dr F. A. Chace
With the author's
Compliments

I. GORDON

1. Redescription of *Alpheopsis monodi* SOLLAUD, a rare freshwater prawn from Sénégal.

2. The function of the *linea impressa* in the *Alpheidae*.

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1. Redescription of *Alpheopsis monodi* SOLLAUD, a rare freshwater prawn from Sénégal. 2. The function of the *linea impressa* in the *Alpheidae*

by ISABELLA GORDON.

1. REDESCRIPTION OF *ALPHEOPSIS MONODI* SOLLAUD, A RARE FRESHWATER PRAWN FROM SÉNÉGAL.

In July 1939 Dr Th. MONOD collected in Senegal a number of small freshwater shrimps (*Caridea*) which at first sight appeared to be Hippolytids. As Dr MONOD was uncertain as to the family and knew of no freshwater *Hippolytidae* from the African continent, he sent part of the material to the late Dr R. GURNEY for examination. Gurney was also puzzled by the specimens and sent them to me at the British Museum, since he did not feel competent to deal with them. In his covering letter he wrote « If they are Hippolytids they must be a new genus since there is none with these characters. So far as I know only *Lysmata* has a split antennular flagellum ? I suppose it might be an Alpheid, but I do not know any genus which it could fit into ». Dr MONOD then sent me the rest of his material and in January, 1940, I made some preliminary notes and sketches and decided that, although the specimens were in many ways surprisingly like Hippolytids, they must belong to the family *Alpheidae*. At that time I did not recall any freshwater species of Alpheids but a search through the Zoological Record showed that in fact two such species had been recorded from the African continent namely, *Alpheopsis haugi* COUTIÈRE 1906 and *A. monodi* SOLLAUD 1932. In 1940, however, I had not access to the requisite literature and the specimens were set aside as *Alpheo-*

psis sp. Some years later the specimens were thought to have been destroyed by enemy action but eventually they were rediscovered and proved to agree quite well with SOLLAUD's species *A. monodi*.

Unfortunately the descriptions of these interesting freshwater Alpheids are rather inadequate. COUTIÈRE had at his disposal only three ovigerous females of *A. haugi* from Gabon and the species has not again been found. SOLLAUD's material comprised six specimens, five of which did not exceed 10 mm. in length. Now that an adequate sample of both sexes is available, a fuller description of *Alpheopsis monodi* is given below. Although both the known localities are near to the sea, the water in which *A. monodi* lives along with large Palaemonid River Prawns, etc. is 'parfaitement douce' and *A. haugi* was found at Ngômô, Gabon 'dans un petit lac qui se déverse dans l'Ogooué, à plus de 200 km. de la mer'.

Alpheopsis monodi SOLLAUD.

SOLLAUD, E. 1932. *Bull. Soc. Zool. Fr.* 57 (4) : 375-386, 2 fig.

Material. Ruisseau de Néma, eau douce, entre Toubakouta et Messira, Sénégal. Collected at night by Dr Th. MONOD, 9-VII-39, 40 males and 15 females (three ovigerous, one of these minus carapace and anterior appendages). The specimens range from 7.5 to 18.5 mm. in total body length.

Previously recorded from the Cameroons in streams not far from the coast, in the region of Manoka Bay.

Description of female. The largest specimen in this excellent sample measures 18.5 mm. in length and is represented in lateral aspect in fig. 1. The *carapace*, which measures 6 mm. from the anterior margin of the cornea to the posterior dorsal edge, is smooth except for the three anterior spines. The median of these, the short rostrum, is concealed by the fully exposed cornea of the eye (*cf.* fig. 15) ; in dorsal aspect it is carinate and rather shorter than the eyestalk. The latter has a row of setae on the antero-internal lobule as described and figured by SOLLAUD (1932, p. 377, fig. 1). On either side of the rostrum is a distinct extra-corneal spine : the rounded pterygostomial angle is unarmed and bears a few fine short setae. When the eye, antennule and antenna are removed, as in the male represented in fig. 15, a minute infraorbital lobule is apparent near the extra-corneal spine.

The *abdomen* like the carapace is entirely smooth. The first and fifth somites are rather shorter than the others which are about

equal. The pleura of the first two somites are wide and deep and form the brood chamber which is closed posteriorly by the fourth pair of pleopods. The posterolateral angles of the third and fourth pleura are rounded while that of the fifth pleuron is acute. The sixth pleuron is a movably articulated triangular plate.

The *telson*, which is longer than the sixth abdominal somite, is of almost uniform diameter throughout its length ; the apex is

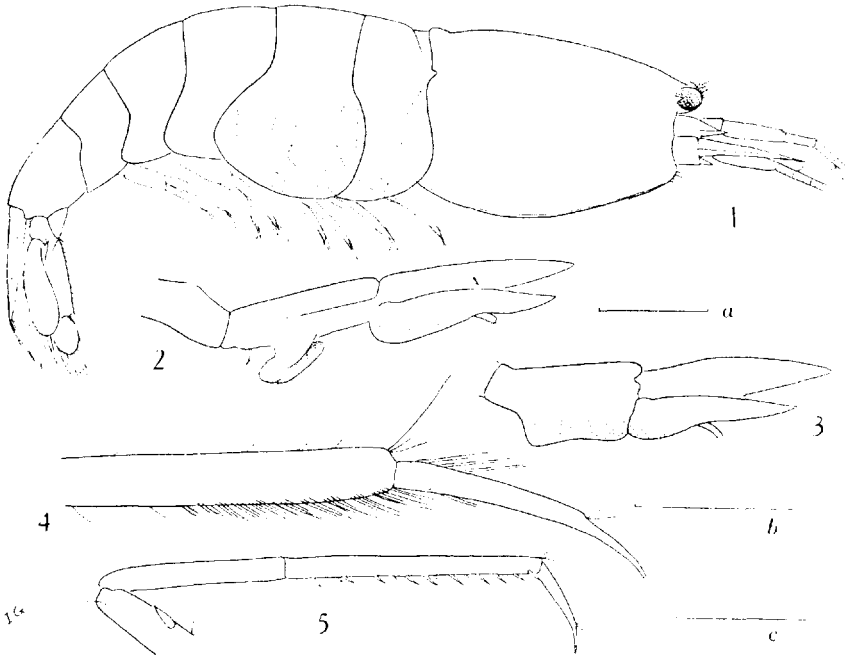

FIG. 1-5. — *Alpheopsis nanodi* SOLLAUD, largest female from Senegal. — Fig. 1. In lateral aspect, most of the appendages omitted (l = 18,5 mm.). — Fig. 2 and 3. Right second and fourth pleopod respectively, at scale a = 1 mm. — Fig. 4. Tip of left peracopod V showing rows of setae on ventral margin of propodus, at scale b = 0,5 mm. — Fig. 5. Carpus, propodus and dactylus of right peracopod III, at scale c = 1 mm.

uniformly convex and, in addition to the usual two pairs of short lateral spines, bears some 20-24 long setae each with a short shaft and a long finely plumose distal portion (fig. 19). The *uropod* is represented in fig. 20 but the long setae are omitted and the details of the suture line or diaeresis on the exopod are shown at a higher magnification.

Antennule. The peduncle is at least half as long as the carapace

and is rather more robust than that of a smaller male represented in fig. 16 (see fig. 1). The slender, pointed stylocerite extends slightly beyond the distal articulation of the first segment : the statocyst appears to contain several sand grains. The second segment is rather longer than the first, and twice as long as the third segment. The two flagella are long, each exceeding half the body length : the shorter ramus of the outer flagellum is fused to the longer throughout the greater part of its length ; the fused portion comprises 13 or 14 segments and the free portion appears to have 2 or 3 segments but here the segmentation is indistinct (fig. 17). The accessory flagellum is almost as long as the peduncle, and bears many bundles of olfactory setae in large specimens : in young specimens there may be only 6-8 bundles.

Antenna. The scaphocerite is long and narrow, but little contracted distally and the spine just fails to reach the distal articulation of the third segment of the antennular peduncle. There is a spine on the basicerite below the base of the scale. The flagellum is slender and very long (equal to or longer than the body).

Mouthparts. Those from the right side of the largest female are represented, all at the same magnification, in fig. 6-11. The small arthrobranch at the base of the third maxilliped is adhering to the appendage.

Peraeopods. The first pair are symmetrical and, though rather more robust than any of the others, are remarkably slender for an Alpheid. As Sollaud says they are 'fort peu alphéidiens' and the carpus is unusually long and narrow ; when extended they reach the middle of the scaphocerite (fig. 13). The dactylus is nearly as long as the palm and the cutting edge of the fingers is unarmed except for a tooth at the extreme tip as figured by SOLLAUD (1932, p. 281, fig. 2 B). On the inner surface of the carpus there is a longitudinal series of 6 or 7 comb-like rows of setae (fig. 12). The second and subsequent pairs of peraeopods are very slender. The second right peraeopod of the largest female is represented in fig. 14 and the left one is similar. The carpus is the longest segment and is composed of five subsegments ; merus plus ischium : carpus as 5 : 4. When extended this peraeopod exceeds the scaphocerite by the dactylus and the last subsegment. The first subsegment is the longest, the second and fourth the shortest. The third peraeopod, the distal segments of which are represented in fig. 5, surpasses the scaphocerite by its dactylus which is just over one-third of the propodus. The ventral margin of the latter is armed with a series of spines. The merus is rather longer, and

considerably stouter than the propodus and armed with two stout spines on the ventral margin (Coutière, 1932, fig. 2 C). There is one similar spine on the ischium. The fourth pair of peraeopods is very similar to the third. The fifth pair is appreciably longer, exceeding the scaphocerite by at least half of the dactylus. The carpus and propodus together are longer than the merus plus

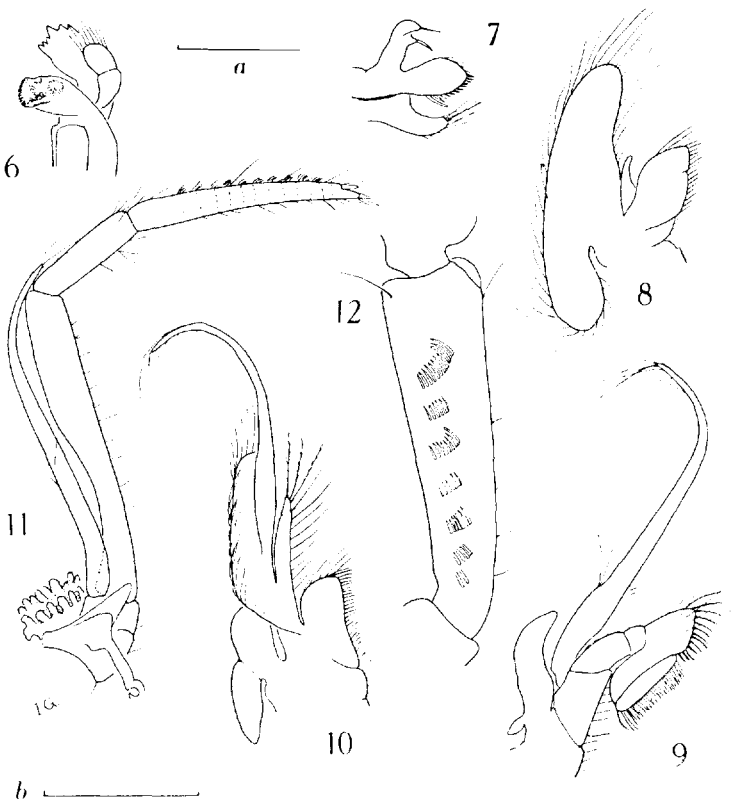

Fig. 6-12. — *Alpheopsis monodi* Sollaud, largest female from Senegal. — Fig. 6-11. Mouthparts, all at scale a = 1 mm. — Fig. 12. Carpus of right first peraeopod, greatly enlarged (scale b = 0,5 mm.), to show comb-like rows of setae on inner surface.

ischium (in the third pair they are equal) ; the distal third of the propodus has comb-like rows of setae on the ventral margin and a number of long terminal setae (fig. 4).

Branchial formula. There are five pleurobranchs, one to each peraeopod, in addition to the arthrobranch on the third maxilli-

ped. An epipodite is present on all but the last of the thoracic appendages and there is a setobranch on each of the five peraeopods.

Pleopods. The pleopods of the largest female are indicated rather

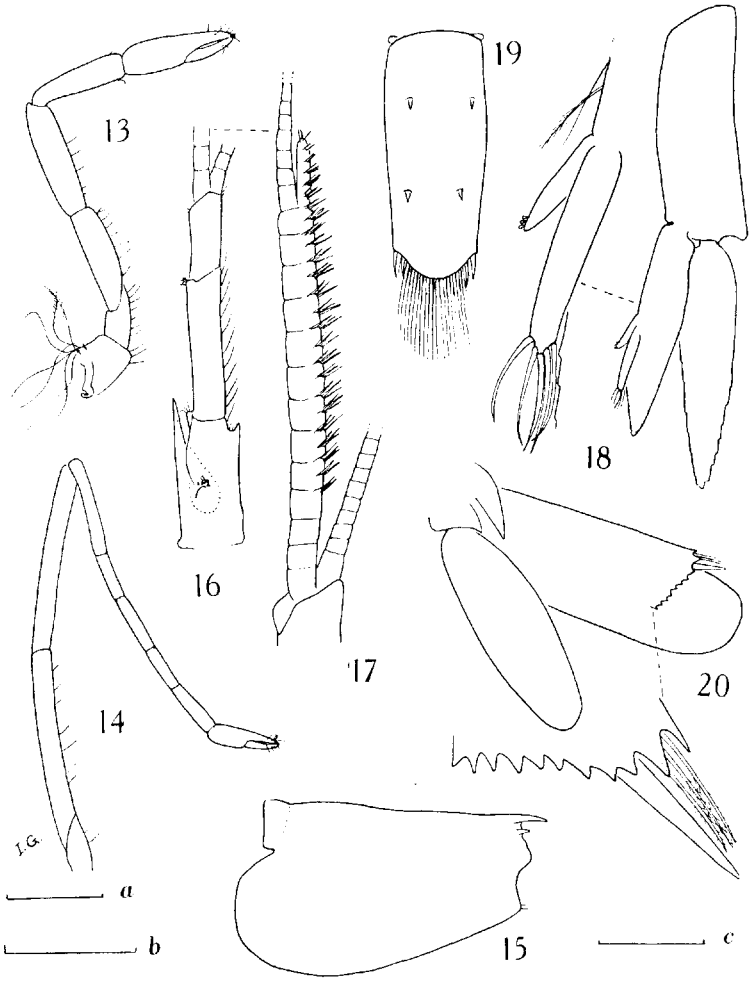

FIG. 13-20. — *Alpheopsis monodi* SOLLAUD. — Fig. 13 and 14. Right peraeopod I and II respectively of largest female, at scale *a* = 1 mm. — Fig. 15. Carapace of male measuring 14 mm. in body length; eye, antennule and antenna removed. — Fig. 16. Peduncle of right antennule of same male, in ventral aspect. — Fig. 17. Proximal portion of external flagellum of antennule, more highly magnified, showing accessory flagellum and olfactory setae. — Fig. 18. Second pleopod of male, setae omitted, with appendix masculina and appendix interna more highly magnified. — Fig. 19. Telson of male. — Fig. 20. Right uropod of male, with diaeresis more highly magnified. — Fig. 19 and 20 at scale *b* = 1 mm. — Fig. 17 and 18 at scale *c* = 0,5 mm.

sketchily in fig. 1 ; the first three pairs are long and — the small endopod of the first pair excepted — very similar : each has a prominent lobe on the inner margin of the basis as shown in fig. 2. In this specimen, which had presumably recently produced a brood, nearly all the ovigerous setae are wanting. The right fourth pleopods is as represented in fig. 3. In the three ovigerous specimens the ova are attached chiefly to the first three pairs of pleopods, but a few may adhere to the fourth pair which, as already stated, closes the brood chamber posteriorly. The pleopods of the larger non-ovigerous females agree with those described by Sollaud (1932, p. 382, fig. 2 D). The stippled parts of basis and endopod of pleopod 3 are thin and membranous and some ovigerous setae are present ; in pleopods 1 and 2 the median third of the inner margin of the basis is a thin membranous lobe with thickened apical border.

The *ova* are small and rather numerous : each is oval and the longer axis measures on an average 0.5 mm. the shorter 0.42 mm.

The *males* greatly outnumber the females in Dr Monod's samples which were collected at night. They vary in length from 7.5 to 15 mm. and are so similar to the small and the non-ovigerous females that some care is required in separating the sexes. However, the appendix masculina on the endopod of pleopod 2 is long and armed with 5 long terminal spines and is easily seen (fig. 18). The males and smaller females are more slender than the large females — compare the carapace represented in fig. 15 with that of fig. 1. Sollaud mentions only six rows of olfactory setae in the type specimens. In our specimens only the smallest have from six to eight rows on the accessory antennular flagellum, but the number of such rows increases rapidly with age (see fig. 17).

Habitat. Dr Monod informs me that the specimens were caught at night in the vegetation of a stream together with one, or perhaps two, species of River Prawns belonging to the genus *Macrobrachium*. Although the locality was but a short distance from Bandiala, a marine mangrove with *Rhizophora*, the water was perfectly fresh ; Sollaud states that the type locality was also near the coast. *Alpheopsis haugi*, on the other hand, was found at a distance of over 200 km. from the sea.

Remarks. To date, as far as I know, fourteen species have been referred to the genus *Alpheopsis*, some only tentatively since the chelipeds are unknown in five of them and the material was sometimes inadequate. Of the twelve littoral marine species one is West African, one Chilean, one West Indian and the rest are from

the Indo-Westpacific. Those in which the chelipeds are known fall roughly into two groups ; in one the chela is smooth and entire as in the genus *Athanas*, the other is « extrêmement remarquable par la présence sur les pinces de la première paire des sillons et des lobes 'alpheopsidiens' dont on pourra trouver la trace dans toute l'étendue du genre *Alpheus* » (COUTIÈRE, 1906, p. 377). To this latter group belongs *Alpheopsis africanus* HOLTHUIS (1952, p. 45, fig. 11 and COUTIÈRE 1899, p. 193, fig. 228-231 as *A. trispinosus*). The chelipeds may be equal or unequal, but in all these species the carpus is far shorter than the chela and, as a rule, much expanded distally. *A. chalciope* de MAN (1911, p. 179 and 1915, pl. V, fig. 17 *a-e*) is an exception in that the short carpus is scarcely expanded distally.

The two freshwater species from the African continent are related to the first group with entire smooth chela. SOLLAUD has compared the two species as far as one can until more specimens of *A. haugi* are available and here it is only necessary to mention that the equal chelipeds are much more robust in *A. haugi* than in *A. monodi* ; moreover the carpus is far shorter than the chela and distinctly enlarged distally while the palm is at least three times as long as the dactylus. *A. monodi* is exceptional in having the first peraeopods very slender, with small chela and long narrow carpus and it is this, together with the slender peraeopods II to V and the fully exposed cornea, that gives the species its strong superficial resemblance to an Hippolytid.

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2. THE FUNCTION OF THE *LINEA IMPRESSA* IN THE *ALPHEIDAE*.

COUTIÈRE, in his monograph on the *Alpheidae*, has described in minute detail the progressive elaboration of the chelae of the first pair of peraeopods within the family and has introduced a special terminology for the furrows, crests and lobes which attain their maximum development in certain species of the genus *Alpheus* [*Crangon*] (COUTIÈRE, 1899, p. 194 and fig. 230 and 232 ; p. 223, fig. 270 and 271, etc.). One feature seems to have puzzled him namely, the *linea impressa* which in the genus *Alpheus* is « complète et fermée, limitant sur la face inférieure et une partie de la face externe palmaire une aire triangulaire à côtés courbes » (p. 210). « Il est difficile d'expliquer la signification de la '*linea*

impressa' ; au sillon externe qui la constitue correspond un sillon interne tout aussi net, de sorte que le trajet de cette ligne est marqué par un double amincissement de l'épaisse paroi palmaire. Ce trajet ne paraît nullement correspondre à une aire d'insertion musculaire ; c'est sans doute une formation de même ordre que la '*linea thalassinica*' non calcifiée de la carapace des Callianasses et des Gébies » (Coutière, 1899, p. 211).

I take this opportunity, therefore, of placing on record an observation which I made in April, 1954 and which demonstrates clearly the significance of the *linea impressa*. Miss P. J. Wortley sent me two living specimens of *Alpheus macrocheles* (Hailstone) which had been caught in a crevice at Church Reef, Wembury on 9-VI-54 by Mr G. M. Spooner of the Marine Biological Laboratory, Plymouth. The larger specimen died in transit but the smaller one lived for a time in the very small amount of sea water in which the specimens had travelled. During the night of 13-14th April the specimen underwent a moult which it survived although, unfor-

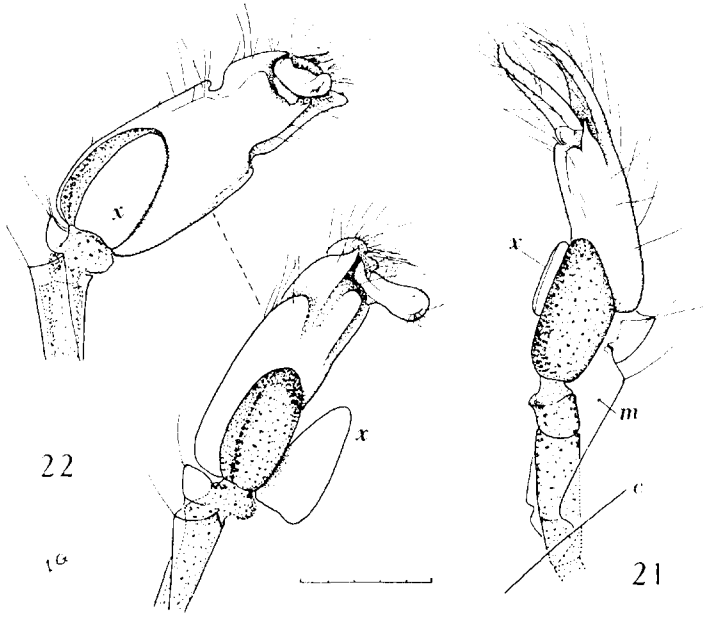

Fig. 21-22. — *Alpheus macrocheles* (Hailstone), ♂. — Fig. 21, Smaller cheliped partially withdrawn from the old cuticle at a moult. — Fig. 22, Larger cheliped of same specimen, in two different aspects, showing commencement of withdrawal of the flesh. *c*, Edge of moulted carapace. *m*, Longitudinally split cuticle of merus. *x*, Plate bounded by the *linea impressa*, displaced by the partial withdrawal of the propodus from the old cuticle. Scale 5 mm.

tunately, it failed to withdraw its chelipeds (peraeopods I) and cast them with its old cuticle. I examined the moult on April 14th. and made some camera lucida sketches of the chelipeds which I coloured as a record (the specimens had been sent so that I might make some sketches of the colour in life). From these sketches it is clear that the *linea impressa* is a line of resorption and that the chela can be withdrawn without distortion through the gap which results when plate *x* is loosened. The smaller cheliped had been almost freed from the old cuticle ; the cuticle of the more proximal segments had been split longitudinally so that the carpus, merus and ischium projected (fig. 21 ; *c* is the margin of the cast carapace). In the case of the larger cheliped, the so-called hammer claw, withdrawal had just commenced ; the palm bulged slightly through the gap caused by the displacement of the triangular plate *x* — COUTIÈRE's 'aire triangulaire' — and the carpus was partially freed but had been damaged and soon showed signs of disintegration (fig. 22). When the appendage was turned over to obtain the view represented in the lower sketch, the triangular plate fell away from the protruding proximal portion of the palm. When captured this specimen, the male, was 'pale golden brown, with darker chelipeds' but after the moult these chelipeds were plentifully supplied with red spots as indicated in fig. 21 and 22.

HERRICK (1909, p. 207) refers briefly to moulting in a specimen of *Alpheus dentipes* (GUÉRIN) observed at Naples on November 13th, 1896 ; he writes : « In this case the muscular mass of the claw was withdrawn through a crack which extended along the outer margin of the propodus. The cleft was continuous with a small fissure involving the proximal segments of the cheliped and extending through the basal ring. The great muscular mass of the hammer claw was thus withdrawn without distortion. This fissure was assumed to correspond to a linear absorption area, but I have not been able to repeat the observation ». It would be erroneous, he adds, to infer that all Macrura in moulting withdraw the flesh of their large chelipeds through the 'draw plates' of the basal segment of the limb as does *Homarus*. Since then much experimental work has been done on factors influencing moulting, and on reversal of the chelipeds, in Alpheids and large numbers have been kept through a number of successive moults (*e. g.* HESS, 1941, p. 215 mentions 136 specimens of *Crangon* [*Alpheus*] *armillatus*). DARBY (1938, p. 78) in an abstract of a paper read before the American Association for the Advancement of Science writes : « The method of breaking the exo-skeleton at the time of moulting was investi-

gated. Preparatory to moulting the carapace [= cuticle] is reduced in thickness. Preformed lines of fissure, observable at all times, are then ruptured by hydrostatic pressure which develops within each joint. The puncture of a single joint (without injury to the nerve) so that no pressure could be built up within it resulted in failure to break that particular segment of the shell, even though the rest of the carapace [= cuticle] was shed without difficulty ». The observation which I made in 1954 must therefore be quite commonplace to a number of experimentalists. The *linea impressa* is one of the preformed lines of fissure to which Darby refers and is a special adaptation in the Alpheids with large chelipeds to enable the chelae to be withdrawn without distortion at the moult. Coutière does not show the *linea impressa* in his earlier illustrations of the large chelipeds of *Ogyris*, *Athanas*, *Arete*, etc. (1899, fig. 203 to 206) ; and from his remarks on p. 194-195, I formed the impression that the said *linea impressa* first appeared in *Alpheopsis* in a simple form, becoming much more pronounced in *Synalpheus* and above all in *Alpheus* (fig. 229, 230, 232, 245, 270 and 271 and later figures in Coutière, 1899). However, in July, 1955 I found by chance a cheliped of a male *Athanas laevirhinchus* (Risso) that had been shed during a moult, in much the same way as the chelipeds of *Alpheus macrocheles*. This cheliped was found in material dredged in shallow water at Cadaqués in Spain and the plate *x* can be seen detached for the most part from the palm of the chela. It is a relatively small, more narrowly triangular, plate and the *linea impressa* may not be so apparent in *Athanas* as in *Synalpheus minor* Say, for example (Coutière, 1899, p. 200, fig. 245) or as in species of the genus *Alpheus*. The *linea impressa* may well be absent in those Alpheids with small non-specialised chelae, especially such a species as *Alpheopsis monodi* (see fig. 13 of the present paper). It would be interesting to know whether or not there is any special adaptation to facilitate withdrawal of the enlarged and curiously modified chela of one of the second pair of peraeopods in the rare genus *Leontocaris* (Stebbing, 1905, p. 99, plate XXVI ; Kemp, 1910, p. 113, plate XVII, fig. 1, 10 and 11).

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