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A NEW *PASIPHAEA* (CRUSTACEA, DECAPODA,  
NATANTIA) FROM SOUTHERN  
CALIFORNIAN WATERS<sup>1</sup>

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Since 1949, members of the Allan Hancock Foundation and of the Department of Biology, University of Southern California, have undertaken an increasingly intensive study of the fauna and ecology of the mid-waters of the deep basins, especially the San Pedro Basin, off the coast of Southern California. During the course of this work several new or unusual species of macrurous decapod Crustacea (shrimps and shrimp-like forms) have been obtained. The bulk of the collections made before September 1960 had already been examined and identified by Dr. John S. Garth of the Hancock Foundation, and specimens of the *Pasiphaea* described here had been sent to Dr. Fenner A. Chace, Jr., of the U.S. National Museum and had been recognized by him as a new species, though not described. Thus it has been my privilege, while working on these deep-water Crustacea during 1960-61, to describe this *Pasiphaea* in the first of a series of studies on this interesting material.

The San Pedro Basin, lying between San Pedro and Santa Catalina Island, has an area of about 655 square kilometres and a maximum depth of about 912 metres, while the sill depth (the depth of the lowest point on its rim) is about 737 metres. The new *Pasiphaea* has been taken as shallow as about 300 metres over this basin, as well as in nets that have touched the basin floor (actual depth of capture unknown), but it does occur in abundance, at least during daylight, at depths of about 550 to 700 metres. It has almost always been associated with *Sergestes similis* Hansen and appears to occur in a shallower zone than that in which the larger, more intensely pigmented, *Pasiphaea emarginata* Rathbun is usually taken.

Though occurring in numerous hauls in the San Pedro Basin, as well as in the deeper Catalina and San Nicolas Basins further offshore, the new *Pasiphaea* is recorded here from only four selected stations as its

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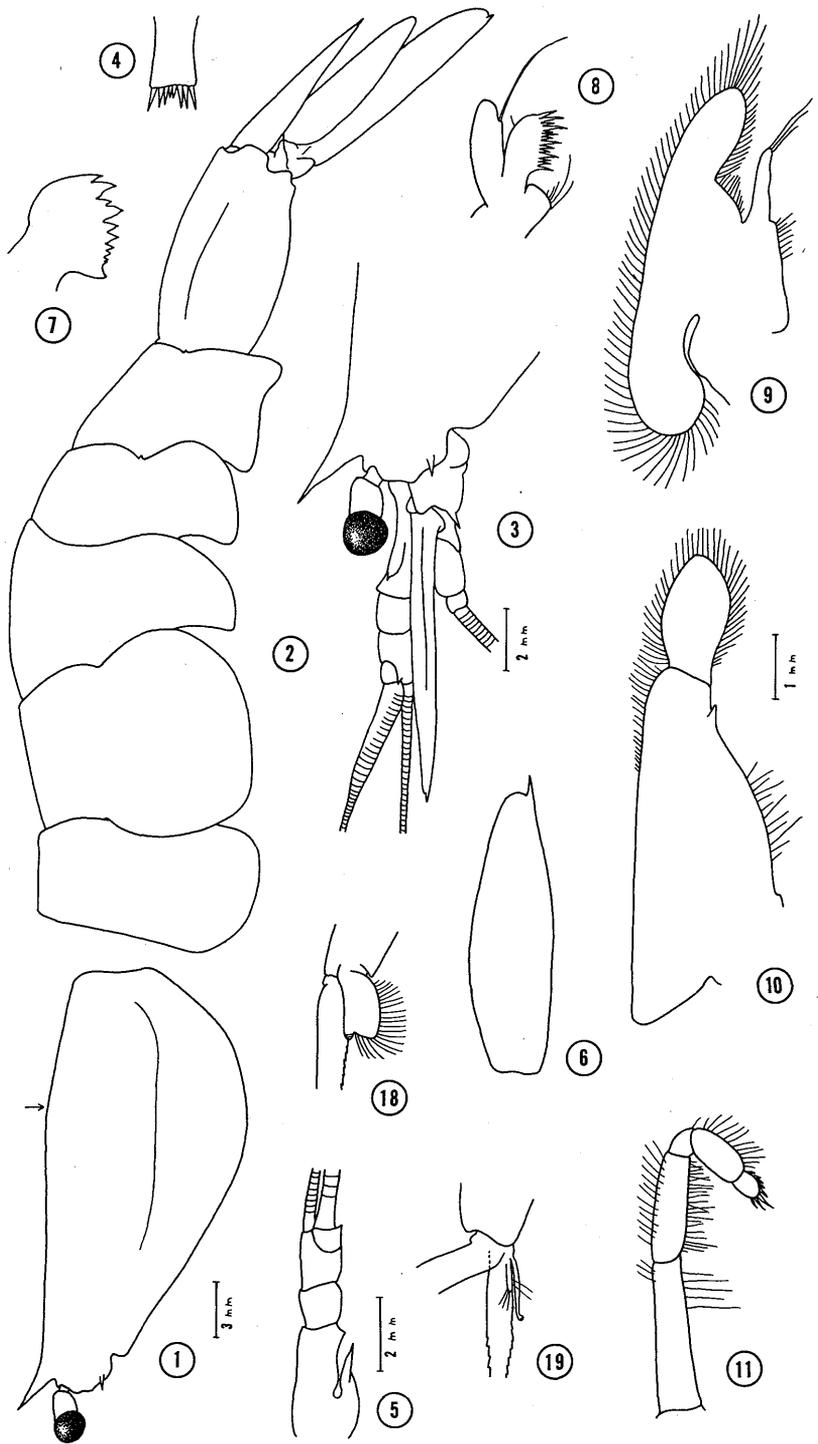
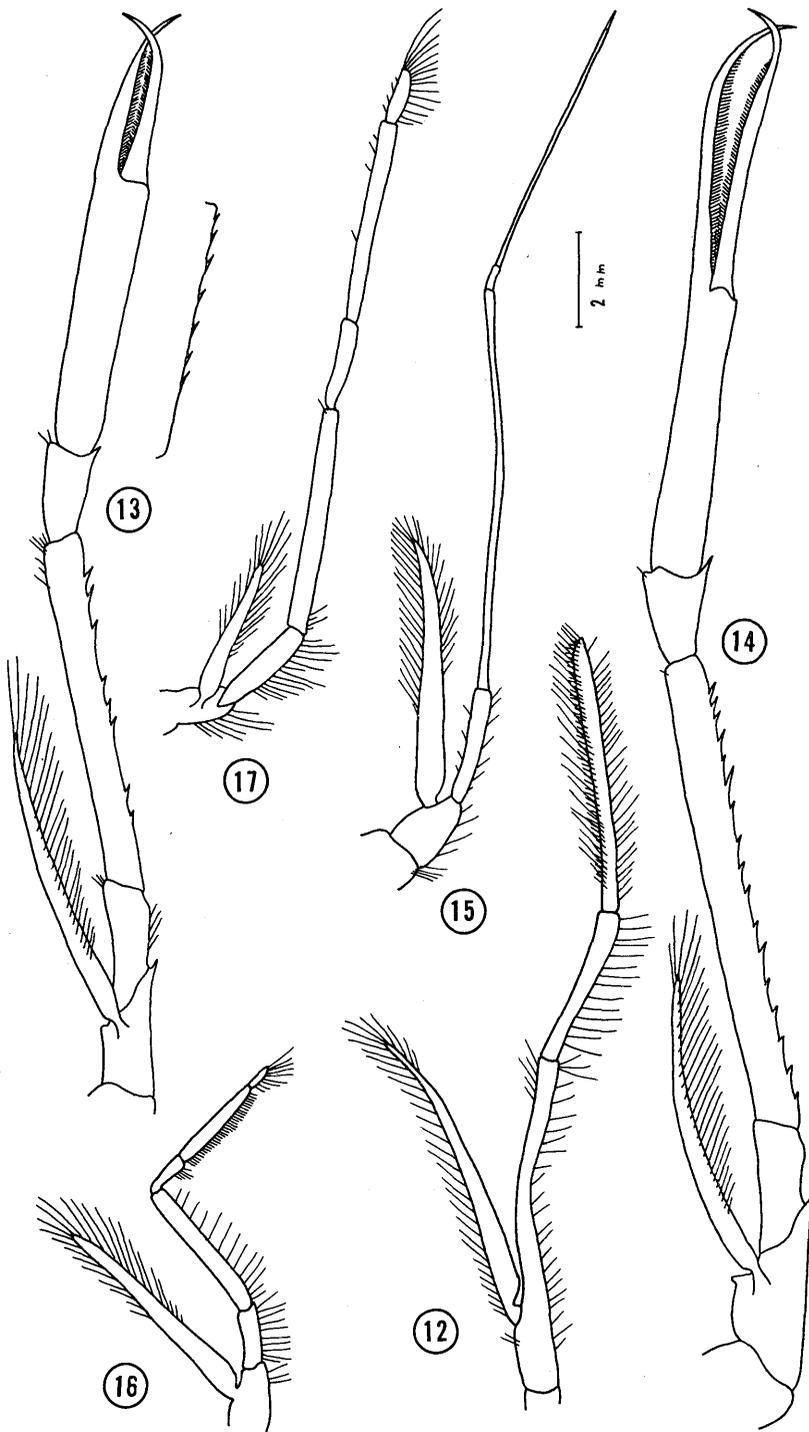


Fig. 1, lateral view carapace (arrow indicates extent of dorsal carina); fig. 2, lateral view abdomen; fig. 3, lateral view anterior part of carapace; fig. 4, dorsal view tip of telson; fig. 5, antennule; fig. 6, scaphocerite; fig. 7, mandible; fig. 8, 1st maxilla; fig. 9, 2nd maxilla; fig. 10, 1st maxilliped; fig. 11, 2nd maxilliped; fig. 12, 3rd maxilliped; fig. 13, 1st pereopod; fig. 14, 2nd pereopod; fig. 15, 3rd



pereiopod; fig. 16, 4th pereiopod; fig. 17, 5th pereiopod; fig. 18, male 1st pleopod; fig. 19, male 2nd pleopod. Figs. 1 to 17 from holotype, 18 and 19 from paratype, carapace length 17mm. Figs. 5 to 19 of right appendage. Figs. 1 and 2 to same scale; figs. 4, 7 to 11, 18 and 19 to same scale; figs. 5 and 6 to same scale; figs. 12 to 17 to same scale.

occurrence and bathymetric distribution will be discussed in detail in a future paper on the bathypelagic natant decapod Crustacea taken by the *Velero IV* off Southern California.

TABLE 1

Selected Allan Hancock Foundation stations in the San Pedro Basin from which *Pasiphaea chacei* n.sp. was obtained. All the specimens from these four stations are to be regarded as type material.

Sta. No.	Date	Position	Net Down		Net Up		Remarks
			Time	Fms	Position	Time	
7186-60	Oct. 28	33-36-11	1035	475	33-30-52		2 metre net hit bottom during 1½ hours at depth.
	1960	118-32-13			118-22-48		
7221-60	Dec. 9	33-37-36	1008	463	33-27-13	1510	Isaacs-Kidd Mid-Water Trawl at 1931 ft. by gauge; 4 hours at depth.
	1960	118-32-28			118-17-24	461	
7273-61	Jan. 23	33-39-07	1015	458	33-27-47	1503	IKMWT at 1986 ft. by gauge; 3½ hours at depth.
	1961	118-31-02			118-16-06		
7299-61	Feb. 24	33-38-03	1005	468	33-25-48	1510	IKMWT at 2341 ft. by gauge; 4 hours at depth.
	1961	118-32-39			118-16-48	458	

## SECTION CARIDEA

## Family PASIPHAEIDAE

Genus *Pasiphaea* Savigny, 1816***Pasiphaea chacei*** new species

*Types*: Holotype, female, carapace length 19mm. from Station 7186-60 (Allan Hancock Foundation Catalogue No. 601). Paratypes, 1 female 11mm.<sup>3</sup> from Station 7186-60; 2 males 12 to 17mm., 30 females and immature 6 to 15mm., 2 ovigerous females 19mm., from Station 7221-60; 10 males 10.5 to 15mm., 24 females and immature 7.5 to 20mm.

<sup>3</sup>The carapace length, in mm., is used as the standard length throughout.

(including 1 ovigerous 20mm.) from Station 7273-61, and 190 specimens, of which a sample of 50 consisted of 19 males 11.5 to 19.5mm. and 31 females 9.5 to 22mm. (3 ovigerous 19 to 21mm.), from Station 7299-61.

*Diagnosis:* Telson truncate distally. Carapace dorsally carinate, with a characteristic, slender, acute rostrum projecting anterodorsally at least as far as cornea. Abdomen smooth, not carinate. 1st pereopod with 0 to 12 meral spines, 2nd with 6 to 23 meral spines. Fingers of 2nd pereopod subequal with palm.

*Description:* Rostrum (gastric spine of some authors) prominent, relatively long and slender, acute, directed obliquely dorsally, without a curve, to extend anteriorly at least as far as cornea. Carapace with a distinct carina on anterior  $\frac{2}{3}$  of dorsal surface, posterior third smooth and rounded. Lateral surface of carapace with suprabranchial carina. Anterior margin produced dorsally into a blunt, convex lobe, not extending as far anteriorly as the broadly rounded lower orbital angle; this angle continuing ventrally into a weakly concave emargination, which in turn passes through a broadly rounded angle to trend obliquely posteroventrally into a concave emargination at level of branchiostegal spine, then into the deep branchiostegal sinus. Branchiostegal spine prominent, arising behind, and projecting beyond, anterior margin.

Abdomen smooth, all segments dorsally rounded and unarmed; 6th strongly compressed dorsally but not carinate. Pleura of 1st and 2nd broadly rounded; pleura of 3rd to 5th produced somewhat anteroventrally, 5th with concave ventral margin. 6th half as long again as 5th, with weak dorsolateral carina. Telson a little shorter than 6th segment, with a broad, longitudinal groove dorsally and a truncate distal margin armed with four pairs of spinules graded in size from a short median pair to a relatively long lateral pair.

Eyes well developed, cornea rounded, well-pigmented and broader than ocular peduncle.

Antennular peduncle with first segment reaching with less than  $\frac{1}{3}$  its length beyond eyes. Stylocerite narrow in dorsal view and relatively widely separated from first antennular segment proper; in lateral view dorsal margin forming an acute point distally which passes ventrally into the rounded anterior margin of the broad ventral portion of the stylocerite. Two antennular flagella present, dorsolateral flagella with about 13 enlarged basal segments in female, about 17 in male; enlarged basal section in male considerably broader and more abruptly passing into the flagellum proper than in the female; this character is especially

useful for sexual differentiation. Antennal peduncle reaching to about midpoint of antennular peduncle, basal segment with strong, obliquely directed spine. Scaphocerite reaching distally beyond antennular peduncle to about last enlarged flagellar segment; outer margin weakly convex, produced into a strong distal tooth projecting full length beyond lamella, which is  $3\frac{1}{2}$  times as long as wide.

Mandible consisting of toothed incisor process only, palp absent. 1st maxilla with small, rounded proximal endite, strongly toothed distal endite and long, simple endopod armed with a single stout seta. 2nd maxilla with no endites visible, simple, well developed endopod and large scaphognathite. 1st maxilliped reduced to large elongate lamella, articulated distally. 2nd maxilliped simple, with distal segment articulated normally with penultimate, no epipod or exopod. 3rd maxilliped reaching a little beyond scaphocerite, ultimate segment long and slender, somewhat less than twice length of penultimate and shorter than antepenultimate, exopod well developed.

All pereopods with well developed exopods, but no epipods. 1st pereopod reaching with fingers and half palm beyond scaphocerite. Fingers slender, cutting edges toothed, tips curved and capable of crossing one another,  $\frac{2}{3}$  length of elongate, parallel-sided palm. Palm with medioventral row of about 5 to 7 slender, movable spines, as shown alongside fig. 13. Carpus  $\frac{1}{3}$  palm, armed with distoventral spine. Merus  $\frac{5}{4}$  palm, armed ventrally with from 0 to 12 (usually 2 to 9) unevenly sized and irregularly placed spines. Ischium about  $\frac{1}{3}$  length merus, unarmed. Basis with strong, distoventral spine. 2nd pereopod reaching with fingers and half palm beyond scaphocerite. Fingers elongate, slender, cutting edge toothed, tips curved and capable of crossing one another, subequal in length to elongate palm, which is somewhat narrower distally than proximally. Carpus a little less than  $\frac{1}{3}$  palm, armed with strong distoventral spine. Merus  $\frac{5}{3}$  length palm, armed with from 6 to 23 (usually 14 to 21) unevenly sized spines spaced relatively evenly along entire ventral margin. Ischium about  $\frac{1}{4}$  length of merus, unarmed. Basis with distoventral spine. 3rd pereopod slender, attenuated, reaching to distal end of antennal peduncle, dactyl subequal to carpus and about  $\frac{1}{10}$  propodus which is  $\frac{2}{3}$  merus. Ischium a little less than  $\frac{1}{3}$  merus, all segments unarmed. 4th pereopod short, reaching to basoischial articulation of 2nd pereopod, dactyl  $\frac{1}{4}$  propodus, carpus about  $\frac{1}{2}$  propodus, merus equal to carpus and propodus combined, ischium to  $\frac{1}{3}$  carpus, propodus and dactyl combined. 5th pereopod distinctly longer than 4th, reaching a little beyond ischiomerall articulation of 1st pereopod. Dactyl relatively broad, and

rounded distally, a little more than  $\frac{1}{4}$  propodus and a little more than  $\frac{1}{2}$  carpus, carpus subequal to ischium and  $\frac{2}{5}$  merus.

First pleopod male and female with broadly ovate endopod and short appendix interna bearing some hooks distally. 2nd to 5th pleopods male and female with slender appendix interna, 2nd pleopod male with in addition a slender and shorter appendix masculina. Uropods elongate, exopod longer than endopod, exopod with lateral margin produced into distal spine reaching beyond distal margin of lamella.

Eggs large and relatively few in number, measuring after preservation,  $1.79$  to  $1.88 \times 1.26$  to  $1.38$  mm.

TABLE 2

Branchial Formula.	Maxillipeds			Pereiopods				
	1st	2nd	3rd	1st	2nd	3rd	4th	5th
Pleurobranchiae	.	.	.	1	1	1	1	1
Arthrobranchiae	.	.	.	1	1	1	.	.
Podobranchiae	.	.	.	.	.	.	.	.
Epipodites	.	.	.	.	.	.	.	.
Exopodites	.	.	1	1	1	1	1	1

*Color in Life:* The body and appendages are mainly transparent, while the eyes are dark golden brown. There is an irregular scattering of large, stellate, red chromatophores on the body and appendages, differing greatly in concentration with the size of the specimen. Small specimens are almost colorless, while in larger specimens the carapace at least appears pink, the fingers are very red with the curved tips grey-black in color. Eggs in an early stage of development are colorless. The viscera appears through the carapace as a dark mass anteriorly and yellow gonads posterodorsally (in mature specimens).

In comparison with *Pasiphaea emarginata*, taken in the same area, *P. chacei* is considerably less pigmented, especially on the carapace, the pereiopods and the anterior segments of the abdomen.

*Maturity and Sexual Differentiation:* The smallest ovigerous female examined in the material available had a carapace length of 19mm., however, some females at a carapace length of 15mm. had a small, but quite distinct, ovary, containing ova, clearly visible posterodorsally through the transparent cuticle of the carapace. Males with a carapace

length of 15mm. or less had an extremely small appendix masculina, which at a carapace length of 12mm. and below was usually not discernible. The difference in width of the enlarged basal segments of the antennular flagella, as described above, is, however, a clear sexual distinction at all sizes down to at least a carapace length of 10mm., and in larger specimens can be easily used for "in hand" sexing without magnification.

The size at maturity then is a carapace length of about 15 to 16mm., with all males above this size bearing a well developed appendix masculina and all females above this size with a clearly visible, developing ovary.

*Variation in Meral Spinulation:* The number of spines on the meri of the 1st and 2nd pereopods has been widely used in this genus as a systematic character. Considerable variation within a species has been recorded previously (e.g. in *Pasiphaea sivado* by Stephensen, 1923), but the extent of this variation both within a species and between the right and left members of a pair of limbs in the same individual is often not fully appreciated. Fifty specimens selected at random from Station 7299-61 gave the following figures. (Data for 2nd pereopods in parenthesis.)

The spines on the merus of the 1st pereopod (2nd pereopod) varied from 0 to 12 (6 to 23), with 90% (80%) of the sample having from 2 to 9 (14 to 21) on the right member. Sexually mature specimens tended to have more than immature specimens. Thus the variation in the 23 mature specimens was from 2 to 12 (15 to 23) with an average of a little more than 6 (18), while in the 27 immatures the variation was from 0 to 9 (6 to 19) with an average of a little more than 3 (a little less than 14). The difference in the number of spines between the right and left member of the 1st pereopods (2nd pereopods) varied from 0 to 3 with an exceptional 5 (0 to 4); in 38% (28%) there was no difference between the right and left member, in 40% (38%) there was a difference of one, and in 18% (18%) a difference of 2, one specimen had a difference of 3 and one of 5 (five specimens had a difference of 3 and three a difference of 4).

In a general way the greater the number of spines on the 1st pereopod the greater the number on the 2nd. The ratio of the number of meral spines on the right 1st to the number on the right 2nd in the sample varied from 1:1.6 to 1:9 (96%) with one at 1:12 and one at 1:16. The difference between the number of spines on the right 1st and the number on the right 2nd varied from 4 to 17 with 76% between 10 and 14 and the average at a little over 11.

Finally it should be stated that there is a great variation in the size of the meral spines present, and that all recognizable spines have been counted no matter how small. Sexual significance in variation was tested for, but no correlation could be made.

*Systematic Position:* The carinate carapace, the smooth abdomen and the distally truncate telson clearly distinguish this species from all but five of the approximately 34 described and recognized species and forms of the genus *Pasiphaea*. These five species are as follows: *P. sivado* (Risso, 1816) from the North Atlantic, Mediterranean and Indo-West Pacific; *P. unispinosa* Wood-Mason, 1893, from the Indian Ocean; *P. magna* of Rathbun, 1904 (only questionably identified by Rathbun as *P. magna* Faxon, 1893) from Californian waters; *P. flagellata* Rathbun, 1906, from Hawaiian waters, and *Pasiphaea* sp. oc. de Man, 1920, from Indonesian waters.

*Pasiphaea chacei* differs from *P. sivado* (first adequately described by Zariquiey, 1957) in that the latter has the carapace compressed but not actually carinate and a small but distinct spine posterodorsally on the 6th abdominal segment (personal observation from Mediterranean material); it differs from *P. unispina* in which the condition of the abdomen is undescribed, in the number of spines on the meri of the 1st and 2nd pereopods, only 0 and 1 respectively in the latter species; it differs from *P. magna* of Rathbun (which I am convinced is conspecific with *P. magna* Faxon) in that Rathbun's specimens have the 2nd to 5th abdominal segments carinate (personal observation from Rathbun's original material); it differs from *P. flagellata*, in which the condition of the dorsal surface of the carapace is undescribed in the literature, in that the carapace is non-carinate in the latter (personal observation from Rathbun's original material), and finally *P. chacei* differs from *Pasiphaea* sp. oc of de Man in that the carapace in the latter is compressed, but not actually carinate dorsally, and the number of spines on the meri of the 1st and 2nd pereopods is, as in *P. unispina*, 0 and 1 respectively. In addition to the above differences the characteristic, slender, prominent rostrum, extending beyond the anterodorsal margin of the carapace, clearly distinguishes *P. chacei* at a glance from these and other similar species.

*Comparison with Pasiphaea emarginata Rathbun:* The only other species of *Pasiphaea* taken commonly in the San Pedro Basin is *P. emarginata* Rathbun (*P. pacifica* Rathbun, with a deeply forked telson, occurs very rarely). Though *P. emarginata* has a carinate abdomen and a weakly, but distinctly, distally-emarginate telson in adult stages, in juveniles these features are not at all apparent and may, especially in

damaged material, be impossible to make out. It has been found, however, that in juvenile *P. emarginata* (at carapace lengths of less than 11 mm.), though the telson may be apparently distally truncate, there are always at least 5 pairs of spines on the distal margin of the telson and often a small medial spine as well, while in *P. chacei* (juveniles and adults) there are almost always only 4 pairs of distal spines. In the rare cases where more than 4 pairs are present, identification must be made from rostral shape, strength of branchiostegal spine and depth of branchiostegal sinus.

In general *P. emarginata*, in contrast to *P. chacei*, is usually bigger, specimens with a carapace length up to about 45mm. are quite common from San Pedro Basin (compared to a maximum of about 22mm. in *P. chacei*), and more brightly colored; in *P. emarginata* the carapace appears deeper anteriorly as the posterior margin of the branchiostegal sinus is longer; the front (the anterodorsal margin of the carapace) is more prominent and reaches as far as the suborbital angle; the rostrum does not extend up to the front and is separated from the front (in lateral view) by a much less acute angle or more often a smooth curve (in juveniles the rostrum may extend almost vertically); the branchiostegal spine is considerably shorter and does not extend much beyond the anterolateral margin of the carapace; there is a distinct, submarginal, low carina around the dorsal portion of the branchiostegal sinus; the dorsal carina of the carapace extends nearly to the posterior margin and the 2nd to 5th abdominal somites are distinctly carinate.

*Remarks:* It gives me great pleasure to name this species for Dr. Fenner A. Chace, Jr., whose work on Crustacea, especially Western Atlantic Caridea, is so well known, and to memorialize his name, along with those of other eminent carcinologists—Alcock, Doflein, Faxon and Rathbun—in the wide-ranging and typically bathypelagic genus, *Pasiphaea*.

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