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**ALPHEUS SAXIDOMUS NEW SPECIES, A ROCK BORING
SNAPPING SHRIMP FROM THE PACIFIC COAST OF,
COSTA RICA, WITH NOTES ON *ALPHEUS SIMUS*
GUÉRIN-MÉNEVILLE, 1856**

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With 2 text-figures

Recently, Professor Dr. Rudolf Fischer, Institut für Geologie und Paläontologie, Philipps-Universität, Marburg, F. R. Germany, submitted for identification some material of an Alpheid shrimp, which was found to be responsible for a considerable erosion of part of a rocky shore on the Pacific coast of Costa Rica. The species proved to be new to science, while also the rock-boring activities seem hitherto to be unknown for the Alpheidae, or, for that matter, for Decapod Crustacea as a whole. The new species proves to be closely related to *Alpheus simus* Guérin-Méneville from the Caribbean area, but it shows minor, but evidently constant differences.

It is a great pleasure to thank Professor Fischer for his kindness in allowing me to study this material and for the permission to cite here his observations on these interesting shrimps.

The material is preserved in the collection of the Rijksmuseum van Natuurlijke Historie, Leiden.

Some notes on *Alpheus simus* are added, as there proves to be a confusion about its nomenclatural and taxonomic status.

***Alpheus saxidomus* new species**

Playa Tamarindo, Nicoya Peninsula, Pacific coast of Costa Rica, about 10°19'N 85°53'W; boring in basaltic rock in the surf zone; October 1978; R. Fischer. — 11 specimens (7 ovigerous females). Holotype is the largest ovigerous female (RMNH Crust. no. D. 32108); the other specimens are paratypes (RMNH Crust. no. D. 32109).

Size. — The carapace length of the specimens varies between 4 and 7 mm, of the ovigerous females it is 6 to 7 mm. The rather numerous eggs are

0.8 to 1.0 mm in diameter, those in which the young are practically ready for hatching measure 1.1 to 1.6 mm.

The carapace shows no trace of a rostrum; the anterior margin between the two orbital hoods is deeply concave and rounded. The ocular hoods themselves are unarmed, they are rounded anteriorly, and the carapace between them is flat dorsally, being hollowed out in the extreme distal part only, and then only slightly so. No antennal or other spines are visible on the carapace. The posterior margin of the carapace shows no, or at least no distinct, cardiac notch.

The abdomen is smooth. The pleura of the first five somites are rounded; that of the sixth somite is bluntly triangular and shows no movable plate; the posterolateral angle of the sixth somite is rounded. The somite itself is as long as or slightly longer than the fifth, and somewhat shorter than the telson. The dorsal surface of the telson bears two pairs of exceedingly small spines, which are placed slightly closer to the lateral margin of the telson than to its midline. The anterior pair of these spines lies in or slightly before the middle of the telson, the posterior pair lies slightly closer to the posterior margin of the telson than to the anterior pair. Sometimes one or both spines of the anterior pair are absent, while also sometimes one of the posterior spines may be missing. The posterior margin of the telson is narrow and truncated; at each corner it bears two short spines, the rest of the margin is provided with hairs. In several specimens some of the spines and hairs are missing. The width of the posterior margin is less than $1/3$ of that of the anterior margin of the telson.

The eyes are well pigmented; dorsally and partly anteriorly they are covered by the orbital hoods.

The antennula has the first segment about half as long as the second. The stylocerite is short and blunt and fails to reach to the middle of the visible part of the segment. The third segment is distinctly less than half as long as the second.

The antenna is unarmed. The scaphocerite is elongate triangular and shows no division in spine and lamella; it reaches about $2/3$ of the length of the carpocerite. The carpocerite reaches to or slightly beyond the middle of the second segment of the antennular peduncle.

The mandible has the incisor process normal and ending in about 6 distinct, rather short teeth. The molar process is blunt and carries numerous short setae. The palp consists of two broad segments. The maxillula has the lower lacinia very slender, tapering to a narrow tip; the upper lacinia is broadly truncated distally; the palp is deeply bilobed, with a strong seta on the tip of the lower lobe. The maxilla has the upper lacinia cleft, the lower consists

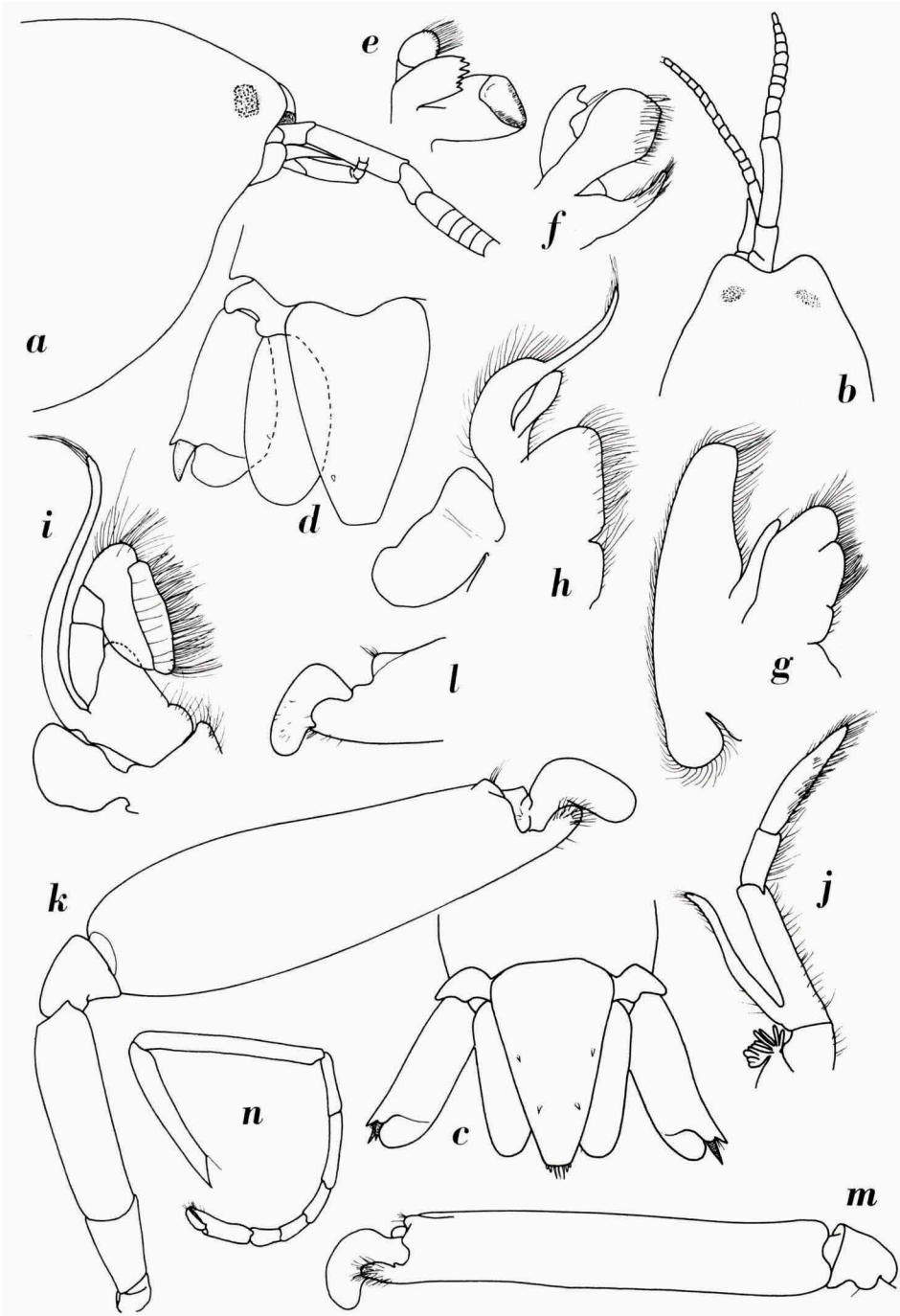


Fig. 1. *Alpheus saxidomus* new species. a, anterior part of carapace, and antennae, lateral view; b, the same, dorsal view; c, telson and uropods of female; d, telson and uropod of male; e, mandible; f, maxillula; g, maxilla; h, first maxilliped; i, second maxilliped; j, third maxilliped; k, larger first pereiopod of female, inside view; l, fingers of the same, outside; m, larger first pereiopod of male; n, second pereiopod. a-d, j-m, $\times 10$; e-i, $\times 20$; n, $\times 5$.

of a single lobe; the palp is slender and well developed; the scaphognathite is large, being rounded below. The first maxilliped has the two laciniae separated by a distinct notch; the palp is large and wide, ending in a blunt top; the exopod is well developed with a long flagellum and a distinct caridean lobe; the epipod has the upper part truncate and shorter than the lower part. The second maxilliped has the usual shape; the last segment lies with its longer side against the penultimate segment; the exopod is well developed with a long flagellum; a large epipod, but no podobranch, is present. The third maxilliped reaches, when stretched forward, to the end of the antennular peduncle; its distal segment is twice as long as the penultimate and bears many transverse rows of stiff hairs; the antepenultimate segment is slightly longer than the ultimate; the exopod ends in a long flagellum; an arthrobranch is present, but no pleurobranch was observed.

The branchial formula is as follows:

| | maxillipeds | | | pereiopods | | | | |
|---------------|-------------|---|---|------------|---|---|---|---|
| pleurobranchs | — | — | — | I | I | I | I | I |
| arthrobranchs | — | — | I | — | — | — | — | — |
| podobranchs | — | — | — | — | — | — | — | — |
| epipods | I | I | I | I | I | I | I | — |
| exopods | I | I | I | — | — | — | — | — |

All pereiopods bear a pleurobranch, while epipods are present on the first four of them.

The left and right first pereiopods are very unequal. Both reach with the chela or carpus beyond the end of the antennular peduncle. In the larger leg the dactylus is strongly bent and hammer-shaped, it ends in a blunt rounded apex, which is directed down over the tip of the fixed finger. The fixed finger is much shorter than (about half as long as) the dactylus; it is also blunt, but straight and it bears numerous long and rather stiff setae. In the female the palm is about 3.5 times as long as the dactylus and three times as long as its greatest height; the greatest height is in the proximal third of the palm, which gradually narrows anteriorly, the height at the base of the fingers being about $\frac{2}{3}$ the greatest height. In the male the chela is relatively more slender and more cylindrical; the dactylus is as in the female, but the palm is about 5 times as long as the dactylus and almost six times as long as its greatest height; the height is practically the same over the full length of the palm, which is not swollen in the basal part as it is in the female. In other respects there are no conspicuous differences in the large chelipeds of the two sexes. The carpus is short and cupshaped being $\frac{1}{5}$ (in the female) or $\frac{1}{6}$ (in the male) of the length of the palm, less than half as long as the merus and about as long as the ischium. No spines or teeth are visible on any of the segments of the chelipeds.

The smaller first leg has the chela normal. The fingers are slender, of the same length and measure about half the length of the palm. The tips of the fingers are sharp and curved; the cutting edge shows no teeth. The fingers in neither sex has a "Balaeniceps" structure. The palm is cylindrical, without any teeth or grooves, it is about 5 times as long as high. The carpus is somewhat more than $1/4$ as long as the palm; it is cup-shaped. The merus is about $4/5$ shorter than the palm. The ischium is very short. None of the segments shows any teeth or spines.

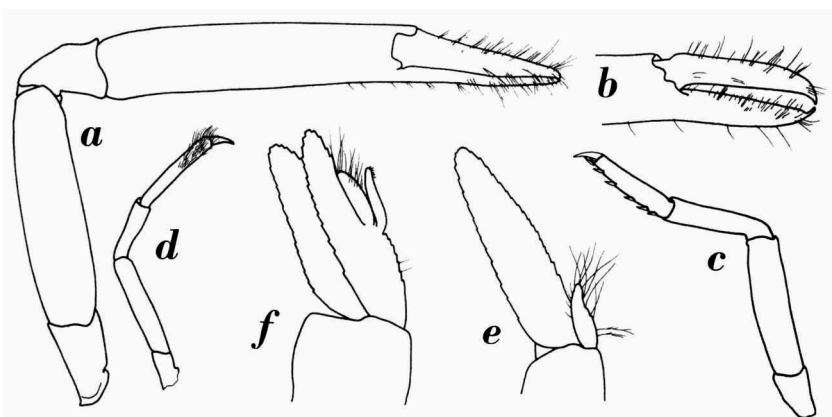


Fig. 2. *Alpheus saxidomus* new species. a, smaller first pereiopod of female; b, fingers of the same; c, third pereiopod; d, fifth pereiopod; e, first pleopod of male; f, second pleopod of male. a, b, $\times 10$; c, d, $\times 5$; e, f, $\times 20$.

The second pereiopods are very long and slender, they reach with a large part of the merus beyond the antennular peduncle. The fingers are short, rather high and blunt, they are about $2/3$ as long as the elongate palm. The carpus is about three times as long as the chela and consists of 5 segments; the basal segment is about $4/5$ as long as the second segment, which is the longest of the five; the third segment is shorter than the first and the two distal segments are again shorter than the third. The merus is about 2.5 times as long as the chela. The ischium is somewhat shorter than the merus.

The third leg reaches with the propodus beyond the antennular peduncle. The dactylus is slender and simple, it is not scoop-shaped. The propodus is about three times as long as the dactylus and bears 6 or 7 strong spines, evenly distributed, on the posterior margin; next to the distal of these spines a second spine is implanted on the anterior margin of the propodus. The carpus is slightly longer than the propodus. The merus is 1.5 times as long as the propodus, and has no ventro-distal tooth. The ischium is very short.

No spines are present on carpus, merus, or ischium. The fourth leg is very similar to the third.

The fifth pereopod is shorter and more slender than either the third or the fourth leg. It reaches with the dactylus beyond the antennular peduncle. The dactylus is simple, and similar to that of the third leg. The propodus is about three times as long as the dactylus; it bears no large posterior spines, but in its distal part there are numerous transverse rows of setae. The carpus is about $2/3$ as long as the propodus. The merus is only slightly longer than the propodus. The segments are more slender and narrower than in the fourth and third legs, and show no spines.

The endopod of the first pleopod of the male is small and tapers to a rather narrow blunt point. The second male pleopod has the appendix masculina rather broad; it is longer than the appendix interna and is provided with numerous stiff setae.

The uropods are slender. The protopod ends in two blunt lobes over the bases of the exo- and endopods. The outer margin of the exopod is slightly convex proximally, slightly concave distally; it ends in a strong tooth which at its inner side has one (sometimes two) strong dark-coloured spines. A diaeresis is present in both sexes, although it is not very distinct. In the female the uropods are narrower and more slender than in the male, and the dark spine is broader in the male.

Biology. — The most remarkable feature of this species is its ability to bore in rock, and in this way it adds considerably to the erosion of the coastal rock in Costa Rica. Professor Fischer gave the following details: "The main importance of *Alpheus saxidomus* lies in the destruction of non-calcareous rocks, in which it works with an unusual intensity. The Alpheids are found in a horizontal zone of the steep rocky slope in the lower part of the tidal region. This zone is characterized as "red zone", because the entire rocky substrate there is covered with a red or purplish-red crust of calcareous algae. The flora and fauna in this zone are very rich. The flora consists of encrusting red algae, of *Lithothamnion* and *Halimeda* (both in protected niches), of other green algae and several Phaeophyceae, which remain rather short (being only a few cm high, 10 cm at the most). The fauna consists of sessile and mobile molluscs, serpulid worms, very many Brachyura, and, in protected areas, sponges, to mention only the most important groups. Of great interest are the boring organisms which live in the rocky substrate (the present new *Alpheus*, the echinoids *Diadema* and *Cidaris*, three species of Polychaeta, probably belonging to the genera *Morphysa* and *Eunice*, and Sipunculida), or in the calcareous crust formed by calcareous algae and by the shells of sessile invertebrates (Sipunculida, Polychaeta, the bivalve mollusc *Lithophaga aris-*

tata (Dillwyn), and the sponge *Cliona*). *Alpheus saxidomus*, like the echinoids, penetrates into the rocks for a depth of about 10 cm, forming mine-like cavities and destroying up to 70% of the rock volume. In basaltic rocks there are areas where 98% of the boring damage is caused by *Alpheus*; usually the shrimps are responsible for about 40% of the total damage, another 50% results from the boring of echinoids, while the destruction caused by Polychaeta and Sipunculida is relatively insignificant. The new *Alpheus* species prefers to live in rocks that are directly exposed to the surf; in more protected areas the species is practically absent. Likewise it does not seem to like surf channels, where in non-calcareous rocks the echinoids are the only active borers. The shrimps also seem to avoid water of a high turbidity". A more detailed account by prof. Fischer is in preparation.

I have been unable to find in the literature any positive record of rock-boring activities by Decapod Crustacea. There are, it is true, several reports that Alpheids inhabit rock cavities made by other animals. So, Graeffe (1900: 35) remarked about *Alpheus dentipes* Guérin from the Gulf of Trieste, Italy, that this species "findet man meist in den Höhlungen im Meere liegender Steine und Klippen, besonders in solchen, die von den Bohrmuscheln hervorgebracht werden. Wenn das Muschelthier abgestorben und ausgewittert ist, nimmt der Krebs Besitz von dem schützenden Raum". Volz (1938: 291) remarked about the same species (*Alpheus dentipes* from Rovinj, Jugoslavia): "Regelmässig findet man ihn bei Rovigno in den vertret am Grunde liegenden, zerfressenen Kalksteinen; die von abgestorbenen Meerdatteln (*Lithodomus lithophagus*) herrührenden Bohrlöcher sind sein bevorzugter Aufenthaltsort". Coutière (1899: 507) had similar observations about *Alpheus malleodigitus* Bate in the Gulf of Aden near Jibuti: "l'espèce habite les tubes cylindriques creusés dans la roche calcaire par les Mollusques ou les Annélides, et dont les parois sont enduites d'une mince couche de vase lisse et polie". Numerous species of *Alpheus* have been reported from holes and crevices in dead or living coral, but I did not find any indication that these holes were made by the shrimps themselves; but see below for the habitat of *Alpheus simus*.

Distribution. — *Alpheus saxidomus* was observed by professor Fischer all along the Pacific coast of Costa Rica in suitable habitats.

Relationship. — The new species is very close to *Alpheus simus* Guérin-Méneville, and can justifiably be considered the Pacific counterpart of that Atlantic species.

The differences between the two species are the following:

1. The second segment of the antennular peduncle is distinctly longer and narrower in *A. simus* than in *A. saxidomus*.

2. The third and fourth pereopods in *A. simus* are more slender and the propodus has fewer posterior spines (3 or 4 instead of 5 or 6; not included in this count is the distal pair) than in *A. saxidomus*.

3. The movable spine to the inside of the distal tooth of the uropodal exopod is uncoloured in *A. simus*, while it is dark brown or black in *A. saxidomus*.

4. The exopod of the uropod does not show a diaeresis in *A. simus*, while such a diaeresis is present in *A. saxidomus*.

5. In the females of *A. simus* the posterior margin of the blade of the uropodal exopod slopes inward and forward and is not produced back as far as the end of the final tooth of the uropod. In *A. saxidomus* the posterior margin of the blade of the uropodal exopod is strongly convex and reaches to or slightly beyond the final tooth at the outer margin of the exopod.

***Alpheus simus* Guérin-Méneville, 1856**

Alpheus Simus Guérin-Méneville, 1856: xix, pl. 2 fig. 11; Guérin-Méneville, 1857: li, pl. 2 fig. 11; Valdés Ragués, 1909: 181.

Alpheus simus — Kingsley, 1883: 123; Coutière, 1899: 18; Chace & Forest, 1970: 1468, 1473; Chace, 1972: 57, 73.

Crangon rathbunae Schmitt, 1924: 74, pl. 1; Holthuis, 1955: 92.

Thunor rathbunae — Armstrong, 1949: 13, figs. 3, 4 A-J, L; Holthuis, 1955: 92, fig. 62a; Banner, 1956: 365, 366; Chace, 1972: 104, fig. 39.

Alpheus rathbunae — Banner & Banner, 1966: 172, 173, 175.

not *Alpheus Rathbuni* Coutière, 1900: 356 (nom. nud.).

not *Amphibetaeus simus* — Verrill, 1922: 123, pl. 25 fig. 5.

Outer bay of Piscadera Bay, south-west coast of Curaçao near Willemstad, Netherlands Antilles; from hole in dead coral; 24 February 1972; J. C. den Hartog. — 1 male, 1 female.

Alpheus simus has usually been considered an enigmatic or dubious species, and, since its original description in 1856, it has never been recognized with certainty. It was very briefly described by Guérin-Méneville in 1856 (in Spanish) and in 1857 (in French; the French text evidently is the original and the 1856 Spanish text a literal translation); both descriptions were accompanied by the same, rather unsatisfactory, figure. Most following authors mentioning the species, did not add any new information, just listing it (Kingsley, 1883; Valdés Ragués, 1909; Chace & Forest, 1970). Coutière (1899) considered it to probably be “un individu anomal voisin de *A. crinitus*, Dana, ou de *A. rostratipes*, Pocock [= *Metalpheus rostratipes*]”. Verrill (1922) identified an Alpheid specimen from Dominica with Guérin's species and placed it in the genus *Amphibetaeus*; as pointed out by Chace (1972: 73), Verrill's specimen more likely is a *Leptalpheus*. Verrill's (1922: pl. 25 fig. 5)

figure of "*Amphibetaeus simus*", although said to be "after Guérin", bears very little resemblance to Guérin's pl. 2 fig. 11, and is either entirely new or only very partly based on Guérin's illustration. However this may be, it is clear that Verrill's "*Amphibetaeus simus*" is incorrectly identified, being a species quite different from Guérin's *Alpheus simus*. According to Chace (1972: 73), *Alpheus simus* "has probably not been found again since it was described from Cuba".

Guérin's original description of *Alpheus simus* is as follows (the French version is cited here): "Cette espèce (pl. 2, f. 11) est très-distincte de l'*A. emarginatus* de M. Edwards, t. II, p. 357 [= *Betaeus emarginatus* (H. Milne Edwards)], parce que le second article de ses antennes supérieures est très-long et non *gros et très-court*. Dans cette espèce, la pièce basilaire des antennes externes n'offre qu'une faible saillie anguleuse et non une épine; la lame spiniforme de la base des antennes supérieures est très-courte, ne dépassant pas l'extrémité du premier article de ces antennes — De Cuba". The figure on Guérin's pl. 2 fig. 11 is rather crude, but it, and the short description, make it likely in my opinion, that *Alpheus simus* is identical with the species that Schmitt (1924) later described as *Crangon rathbunae*. Guérin's figure shows the peculiar front with the rounded orbital hoods, between which the anterior margin of the carapace is concave, without a trace of a rostrum, a feature, among the western Atlantic *Alpheus* only found in the present species. The antennulae as shown in Guérin's figure, however, do not resemble those of *Crangon rathbunae*, as they show the stylocerite too large and the second peduncular segment too short. That the figure must be inaccurate in these two respects is shown by the description, which, although short, lays a special emphasis on those two characters, mentioning the second segment of the antennular peduncle as "très-long" and the stylocerite as "très-courte". The very long second peduncular segment of the antennula indeed is one of the striking features of the species, as well as the undersized stylocerite. The absence of a spine from the antennal peduncle, mentioned in Guérin's description, also is a feature found in *Crangon rathbunae*. Guérin's figure shows the scaphocerite with a distinct lamella and a distal spine, while in *C. rathbunae* the scaphocerite is a simple triangular appendage, not divided in spine and lamella; it is possible that the artist was inaccurate also in this respect. As Guérin's description of *Alpheus simus* fits *Crangon rathbunae* perfectly and as the features in his figure that are different from those of *Crangon rathbunae* are either contradicted by the description or not mentioned at all, while all other West Indian species of *Alpheus* are entirely different, the only acceptable conclusion is that *Alpheus simus* and *Crangon rathbunae* are synonyms. Unfortunately no type material of *Alpheus simus* exists any-

more, so that a positive proof is impossible. It might be best therefore to select a neotype for *Alpheus simus* Guérin, 1856.

Coutière (1930: 356) in his paper "Sur quelques Alpheidae des côtes Américaines (Collection de l'U.S. National Museum, Washington)" mentioned that in this collection he discovered two new species of *Alpheus*, "La première, *A. Rathbuni* H. C., recueillie par l'Albatross sur les côtes de la Floride (St. 2409), est voisine de l'espèce *A. intrinsecus* Sp. Bate (Challenger) de la même région atlantique". So far as I know Coutière never did describe the species and the above cited mention of *A. Rathbuni* gives not enough details of the species to make the name available, it has to be considered a nomen nudum. Even if the name were available, it could not invalidate *Alpheus rathbunae* (Schmitt), as the spelling *rathbuni* cannot be proved to be an error for *rathbunae*: the species might have been named for Richard Rathbun, at that time director of the United States National Museum, and not for his sister the famous carcinologist Mary Jane Rathbun. As Dr. Fenner A. Chace, Jr. of the National Museum of Natural History, Washington, D.C., kindly informed me, the type of *Alpheus rathbuni* cannot be found in the collections of the National Museum, neither is there any specimen of *Alpheus intrinsecus* Bate, 1888, or of the closely related *Alpheus armatus* Rathbun, 1901 from "Albatross" Sta. 2409, and the name is not included in the catalogue entries covering the return of the major loan of Alpheids made by the U.S. National Museum to Henri Coutière. Therefore, although the identity of *Alpheus rathbuni* Coutière with *A. armatus* Rathbun, 1901, seems most probable, this cannot be definitely proved.

Biology. — Of the biology of *Alpheus simus* little is known. Schmitt (1924: 74) reported the types of *Crangon rathbunae* from "coral rock" and "coral heads". Other records are from "the crevices of dead coral fragments in the quiet water behind the Piedra Prieta Reef" (Armstrong, 1949: 14), while Chace (1972: 104) found that "most of these specimens were apparently living in cavities in dead coral". The above listed specimens from Curaçao were provided with a field note by Mr. den Hartog stating that the pair was found in a cavity in coral rock, the opening of which was so small that neither of the animals could pass through. Although there is thus clear evidence that the animals live in crevices in rock (especially coral rock), there is no direct indication that the species is a burrower. The situation in which the Curaçao specimens were found may be an indication that the young settle in pairs in small holes, which they enlarge when growing up, but that the opening is left as it was; there also is the possibility that the opening of the cavity is partly filled through some action of the shrimps. More observations, both in the field and in the laboratory are highly desirable.

Distribution. — The species seems to be widely distributed throughout the Caribbean region: Bahía de la Asención and Bahía del Espíritu Santo, Yucatan, Mexico (Chace, 1972), Cuba (type locality of *Alpheus simus*; Guérin-Ménéville, 1856, 1857), Key West, Florida, U.S.A. (Chace, 1972), Barahona Harbor, Dominican Republic (Armstrong, 1949), Virgin Gorda, Virgin Islands, U.S.A. (Chace, 1972), Antigua (Chace, 1972), Saint Lucia (Chace, 1972), Okra Reef and Needham's Point, Barbados (type localities of *Crangon rathbunae*; Schmitt, 1924), Piscadera Bay, Curaçao (present publication).

Generic affiliation of *Alpheus simus* and *A. saxidomus*. — Armstrong (1949) erected the new genus *Thunor* with *Crangon rathbunae* as type and only species. Later, Banner (1956: 365) discussed the status of the genus *Thunor*, to which he assigned also *Alpheus idiocheles* Coutière and *Thunor* species 1, but he expressed doubt as to the validity of the genus, which according to him possibly had to be placed in the synonymy of *Alpheus* Fabricius, 1798. Still later, Banner & Banner (1966: 175) definitely sank *Thunor* as a synonym of *Alpheus*. Chace (1972: 54, 104) agreed with most of the Banners' arguments, but nevertheless kept *Thunor* provisionally as a good genus, as in the western Atlantic the species *A. rathbunae* occupies a quite isolated position within the genus *Alpheus* s.l., being strongly different from all other species. *Alpheus saxidomus* is so close to *A. rathbunae* [= *A. simus*] that, if the genus *Thunor* be recognized, it should be placed in that genus.

Banner (1956) showed that most of the characters that Armstrong (1949) considered to be typical for *Thunor* are variable within the genus *Alpheus*, and in his opinion (Banner, 1956: 366) only two characters could be seen as distinguishing the two genera, viz., the presence or absence of anal tubercles, and the presence or absence of a diaeresis on the uropod. The character of the anal tubercles was later shown by Banner & Banner (1966) to be too variable to be used as a generic character, while the one of the presence or absence of the diaeresis is shown by the present material to be unusable to distinguish the genus *Thunor* from *Alpheus*. Therefore I follow here, for the time being at least, Banner & Banner (1966) in synonymizing the two genera. However, Chace may be right that in the future the unwieldy large genus *Alpheus* has to be split up on the basis of other characters, and that in that event the name *Thunor* might well become available again for one of the components. In that case the present species will become known as *Thunor saxidomus* and *Thunor simus*.

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ADDENDUM

After the present note had been sent to the printers, I received, through the kindness of Mr. Michael Türkay, Senckenberg Museum, Frankfurt, Germany, some additional material of *Alpheus saxidomus* preserved in the Senckenberg Museum, and collected in Costa Rica by Professor R. Fischer: Punta Pelada near Nosara, 9°56'N 85°41'W, 5 specimens (cl. 4-6 mm; including 3 ovigerous females with cl. 5.5-6 mm). Isla Bejuco, Gulf of Nicoya, 10°0'N 85°02'W, 1 male (cl. 4.5 mm), 1 ovigerous female (cl. 6 mm). Punta San Francisco, Playa Tamarindo, 10°18'N 85°52'W, 1 specimen (cl. 5 mm).