

On the Identity of Snapping Shrimp Described and Identified by W. N. Lockington, 1878

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Abstract.—W. N. Lockington (1878) wrote the first key and guide to the snapping shrimp of North America. Many records came from the eastern Pacific Ocean, from California to Panama. His paper includes 10 species recognizable today, one record that probably includes more than one species under the same name, and reports and descriptions of another six species that are unrecognizable or questionable. The five species described as new by Lockington probably are variants of species that have been described since 1878; if so, Lockington's species names may be available as senior synonyms. The identities of some of these species are likely to remain uncertain because the original descriptions were brief and without illustrations, the types have been lost and the range of variation within most alpheid species is unknown.

The first attempt to prepare a summary and key to the snapping shrimp (family Alpheidae) of North America was that of W. N. Lockington of the California Academy of Sciences. In 1878, he published "Remarks on some new Alpheii, with a synopsis of North American Species," which presented 18 species. Most of these came from the Pacific Ocean, including the Gulf of California. The paper included species described by Lockington as well as others previously described by Say (1818) and Kingsley (1878a). Lockington considered all of the species to belong either to *Alpheus* or *Betaeus*.

In comparing Lockington's account with modern works on alpheid shrimp, one is surprised by the small number of species. The modern reader should remember that extensive collections had yet to be made in much of the United States and Mexico. Like many curators of the time, Lockington relied upon amateur collectors and fishermen to send specimens to him for examination. The majority of the species known in 1878 were either intertidal species or shallow subtidal species that could be collected in holdfasts or rocks cast ashore after storms.

As was customary at the time, Lockington presented brief descriptions of new species without illustrations. New species were compared with known species, with important morphological differences emphasized. The features presented by Lockington (1878) in many cases only allow the modern reader to determine the genus to which the animal belongs. Features such as presence or absence of epipods, shape of the dactyls of the walking legs, and many of the ridges, grooves and spines of the chelae were not included or were described in general terms. Although locations for the species were given, no type locality was designated if

specimens came from more than one collecting site, nor was a particular specimen mentioned in the text as being a holotype.

Lockington's type material was deposited at the California Academy of Sciences. A few duplicate or exchange specimens seem to have been sent to the Smithsonian Institution or European museums, but as yet, no alpheid specimens have been located. In 1906, almost all of the specimens of the Academy as well as much of the building housing them were destroyed by the fire following the major earthquake in San Francisco. (See Bronson 1959 for an account of how a few of the Academy's specimens were rescued.) No invertebrate specimens are known to have been saved; indeed, being preserved in alcohol, the crustaceans probably were among the first specimens to catch fire.

As part of an ongoing attempt to prepare a master species list of carideans of the tropical eastern Pacific Ocean, M. E. Hendrickx (Estacion Mazatlan, Universidad Autonoma de Mexico) and I have been examining historic records of shrimp of the area. Despite the uncertainty of identification of some of the species, the records given by Lockington are useful for comparison of modern and historic distributions of alpheid species. Kim and Abele (1988) considered five of Lockington's species of *Alpheus* to be valid, but noted that three of the supposed species were unreported since Lockington's report. However, most of Lockington's names have been ignored for over 50 years, and, if found to be senior synonyms of other names, could be suppressed (International Commission on Zoological Nomenclature Article 79c, 1985). This paper provides the modern identification, when known, of Lockington's species of 1878 and attempts to identify the species that remain unrecognized.

Methods

In the account of the species, the name used by Lockington and the page on which it appears is provided, along with the localities as given in the paper of 1878. Localities are given in quotations if they are vague or questionable in the original text. However, Lockington himself was inconsistent in giving localities, giving localities as "Port Escondido, Gulf of California," which can be interpreted either as Port Escondido in the Gulf of California or Port Escondido as well as the rest of the Gulf of California. (Probably the former interpretation is correct.) Species described prior to 1878 and their current taxonomic status and known range are given first. Species described in the paper are discussed later, with clues to their current identification.

Many of Lockington's specimens came from "Port Escondido" on the Gulf of California (now Puerto Escondido, Baja California Sur, Mexico; 25°50'N, 111°19'W). More recent collecting has been carried out there by the University of Southern California. I examined published records of alpheids collected at Puerto Escondido during the trips of the *Velero III* and later expeditions (Wicksten 1983; Kim and Abele 1988), as well as unpublished records in the card catalogue of the Hancock collections at the Natural History Museum of Los Angeles County. The alpheids from these collections have not been completely identified to species and catalogued by station. However, the existing records give some indication of what species might occur there and therefore might be the same as some of Lockington's species.

Alpheid Species Reported by Lockington (1878)

1. Species Described Prior to 1878:

Alpheus affinis Kingsley, 1878a: Panama (p. 476).

Status: Now *Alpheus normanni* Kingsley, 1878b. (*Alpheus affinis* Kingsley, 1878a is a homonym of *A. affinis* Guise, 1854; see Kim and Abele 1988.) Western Atlantic Ocean from Virginia to São Paulo, Brazil and eastern Pacific Ocean from Gulf of California to Galapagos Islands (Kim and Abele 1988).

Alpheus bellimanus Lockington, 1877a: San Diego (California) (p. 470).

Status: Valid species; Monterey Bay, California to Galapagos Islands (Wicksten 1983; Kim and Abele 1988).

Alpheus clamator Lockington, 1877b: Santa Barbara "Islands," California and San Bartolme Bay, Baja California (p. 469).

Status: Valid species; Dark Gulch, Mendocino County, California (T. Chess, U.S. National Marine Fisheries, personal communication, range extension) to San Bartholome Bay, Baja California Sur (Wicksten 1984).

Alpheus cylindricus Kingsley, 1878a: Pearl Island, Bay of Panama (p. 478).

Status: Valid species; eastern and western Atlantic Ocean from Islands of Principe, São Tome and Annobon; Bimini, Bahamas, Bermudas and Florida through Barbados to Bahia, Brazil; Flower Gardens Reefs off Texas; eastern Pacific Ocean from Gulf of California to Galapagos Islands (Kim and Abele 1988).

Alpheus aequidactylus Lockington, 1877b: Monterey, California (p. 472).

Status: Now *Alpheopsis equidactylus*; Monterey Bay to Cortez Bank, California (Wicksten 1984).

Alpheus floridanus Kingsley, 1878a: Fort Jefferson, Florida (p. 476).

Status: Valid species; eastern and western Atlantic Ocean from Guinea to Congo and Principe Island; Gulf of Mexico to Bahia, Brazil; eastern Pacific Ocean from Gulf of California to Ecuador (Kim and Abele 1988).

Alpheus heterochaelis Say, 1818: La Paz, San José Island, Amortiguado Bay, Mulege Bay and Port Escondido, west side of Gulf of California; Magdalena Bay, Baja California (p. 475).

Status: Although *A. heterochaelis* is a valid species, it is considered to inhabit only the western Atlantic (Christoffersen 1984).

Remarks: Kim and Abele (1988) reported that records of *A. heterochaelis* from the eastern Pacific Ocean by Kingsley (1878a) and Rathbun (1900) included in part *A. bouvieri* A. Milne Edwards, 1878. However, it is unclear how they came to this identification, for they did not indicate that they examined the specimens on which the records of *A. heterochaelis* were based. Lockington's specimens may have included *A. californiensis* Holmes, 1900 which has been collected at Magdalena Bay, and other species of the "Edwardsii" group of *Alpheus*, which resemble *A. heterochaelis*. Lockington noted that his larger specimens "showed traces of a varied coloration," which suggests that he had more than one species.

Alpheus minor Say, 1818: no locality given by Lockington (p. 472). Say reported it from the "coasts of the southern states, and of East Florida."

Status: Now *Synalpheus minus* (Say, 1818); Bermuda and North Carolina to Alagoas, Brazil (Chace 1972).

Alpheus panamensis Kingsley, 1878a: Acajutla, "Central America" (now Pacific coast of El Salvador) and Panama (p. 473).

Status: Valid species; eastern Pacific Ocean from Costa Rica to Peru (Kim and Abele 1988).

Alpheus parvimanus Kingsley, 1878a: Panama (p. 477).

Status: Identity unknown.

Remarks: Kingsley's description suggests that the species belonged to the diverse "Edwardsi" group, but, other than mentioning that the larger chela had "a constriction of both margins posterior to the articulation of the dactylus," there are too few details to compare the shrimp with those described more recently.

Alpheus sulcatus Kingsley, 1878a: Bay of Panama, Zorritas, Peru (p. 475). Kingsley did not designate a type locality.

Status: Valid species; circumtropical except western Atlantic Ocean, eastern Pacific Ocean from Gulf of California to Peru (Wicksten 1983; Kim and Abele 1988).

Betaeus aequalis (Kingsley, 1878a): Catalina Island, California (p. 478).

Status: Synonym of *Betaeus harfordi* (Kingsley, 1878a); Fort Bragg, California to Magdalena Bay, Baja California Sur (Hart 1964).

Betaeus longidactylus Lockington, 1877a: San Diego, California (p. 480).

Status: Valid species; Elkhorn Slough, California to Baja California Norte; also northern Gulf of California to Tepoca Bay, Sonora, Mexico (Hart 1964).

2. Species Described as New in Paper of 1878:

Alpheus barbara Lockington, 1878: Santa Barbara, California (p. 471).

Status: Probably a damaged or malformed specimen of *Alpheus clamator* Lockington, 1877b (Wicksten 1990).

Remarks: Lockington differentiated the supposed new species from *A. clamator* by the absence of a spine on the "basal joint of the antennae" (the basicerite), "different proportions of the carpal joints of the second pair," and the "want of meral spines on the posterior pairs" (of pereopods). However, about 2% of specimens of *A. clamator* lack a spine on at least one basicerite. The "different" proportions of the carpal joints are so close to those of a typical *A. clamator* as to be nearly indistinguishable. Specimens of *A. clamator* usually have a strong spine at the distal end of the merus of the third pereopod, but this could be missing in an animal regenerating a limb. (Kingsley [1878a] and Lockington [1878] both mentioned that the unique holotype of *A. barbara* was "damaged"). Examination of over 1000 specimens collected throughout the range of *A. clamator* failed to locate any animals matching Lockington's description. The type locality of *A. barbara*, Santa Barbara, California, is inhabited by *A. clamator*.

Alpheus fasciatus Lockington, 1878: "Port Escondido, Gulf of California" (p. 478).

Status: Kim and Abele (1988) treated *A. fasciatus* as a distinct and valid species "until more information about this species is available."

Remarks: Kim and Abele (1988) believed that *A. fasciatus* was distinct from *A. paracrinitus* Miers, 1881 on the basis of the length of the stylocerite, which, according to Lockington's description, was "longer than the first segment of the peduncle." Otherwise, Lockington's description is almost identical to that of

A. paracrinitus. According to Lockington, *A. fasciatus* had “no ocular spines, rostrum about equal to diameter of eye, surface between rostrum and eyes slightly depressed but with no distinct sulcus, small spine on basal joint of antennae below, larger hand smooth, nearly cylindrical, dactylus works vertically, smaller hand small, smooth, cylindrical and slender.”

The name “*fasciatus*,” meaning banded, gives a clue to the species’ modern identity. Lockington described the color as “carapax (sic) and abdomen alternately banded with bright red and white; larger hand red, with marblings of white in some cases.” This color pattern is common in *A. paracrinitus*. *Alpheus paracrinitus* has been collected in the southern Gulf of California, where *A. fasciatus* also was reported. *Alpheus paracrinitus* is reported to be circumtropical, in the eastern and western Atlantic Oceans, the Gulf of Mexico, tropical Indo-West Pacific to Hawaii, and eastern Pacific Ocean from the Gulf of California to the Galapagos Islands (Kim and Abele 1988).

Coutière (1897) reported *A. fasciatus* as occurring at Djibouti in the Red Sea. He mentioned seeing specimens of the species from Baja California, collected by Leon Diguet. However, Banner and Banner (1981) noted that the specimens from the Red Sea probably were *A. alpheopsides* Coutière, 1905, which has been collected there recently. Coutière’s specimens of *A. fasciatus* have not been located at the Muséum National d’Histoire Naturelle in Paris, but, should they exist, they would be very useful for comparison with other specimens in determining the modern identity of *A. fasciatus*.

Knowlton and Mills (1992) compared color patterns of specimens of *A. paracrinitus* from the Pacific coast of Panama with those of specimens from the Caribbean coast, and found that three different color patterns existed. Specimens from the Caribbean coast showed two discrete patterns that were different from those of the Pacific population. At present, it is not known whether or not these color patterns correspond to separate species or to within-species variation in *A. paracrinitus*. If the color patterns are shown to be related to morphological or enzymatic differences in the shrimp, it may be useful to distinguish the eastern Pacific population by a different species name. Further study may indicate that *A. fasciatus* Lockington is an available senior synonym for the eastern Pacific species.

Alpheus laeviusculus Lockington, 1878: Port Escondido, Mulege Bay, and other points on the “Californian” shore of the Gulf of California (p. 474).

Status: Probably a synonym of *Synalpheus digueti* Coutière, 1909.

Remarks: Lockington’s choice of the trivial name was poor from the start, for *A. leviusculus* Dana, 1852 is a homonym. However, the description indicates that Lockington’s specimen probably belonged to the genus *Synalpheus*. The description states that the front was “trispinose, the ocular spines triangular, almost equal in length to the triangular rostrum, which is not divided from the eye-shields by a rostrum,” the chelipeds were “very unequal” in size, and the posterior pereopods had “dactyli bifid at tip, the upper spine longer than the lower.”

Coutière (1909) recognized that Lockington’s species was a *Synalpheus* and attempted to redescribe and rename it. However, Coutière’s new specimens came from off San Nicolas Island in southern California, not the Gulf of California. The new specimens, named *S. lockingtoni*, probably did not belong to

Lockington's original species. In *S. lockingtoni*, the rostrum is longer than the orbital spines, not almost equal to their length. The upper spine of the basicerite is shorter than the lower, but is noticeable; Lockington described this spine as "small" for his species. In *S. lockingtoni*, the stylocerite is shorter than the first segment of the antennular peduncle; in Lockington's species, the stylocerite was described as reaching the middle of the second segment of the antennular peduncle.

Lockington's description could belong to *Synalpheus digueti* Coutière, 1909. In the species, the rostrum is the same length as the orbital spines. The scaphocerite does not reach to the end to the antennular peduncle, the merus of the larger cheliped bears a small spine, and the fingers of the chelae bear dark tips. These features, mentioned by Lockington, occur in specimens of *S. digueti*. *Synalpheus digueti* is a common intertidal species of the southern Gulf of California, and has been collected at Puerto Escondido (Jens Knudsen station K121, collections of Allan Hancock Foundation). It ranges from Guaymas, Gulf of California to the Galapagos Islands (Wicksten 1983).

Alpheus spinicaudatus Lockington, 1878: Port Escondido (p. 477).

Status: Kim and Abele (1988) considered *A. spinicaudatus* to be a valid species.

Remarks: Kim and Abele (1988) considered *A. spinicaudatus* to be a distinct species on the basis of the movable finger of the major chela moving obliquely. However, Lockington's description otherwise resembles that of *A. hebes* Kim and Abele, 1988 or a related species of the "Edwardsi" group. The rostrum is described by Lockington as "very short, continued backward between the eyeshields as a low carina, no ocular spine." According to the description by Lockington, the stylocerite was as long as the first segment of the antennular peduncle, the spine of the scaphocerite was longer than the blade or antennular peduncle. The major chela lacked a spine on the merus, the hand bore "constrictions" on the upper and lower surfaces and a sulcus running "backward" longitudinally at right angles to the upper constriction. The smaller chela was rounded and smooth, with the fingertips sharp and curved inwards, crossing each other. The carpus of the second pereopod had 5 articles, the merus of the third to fifth pereopods lacked a spine, the telson was elongate with tapering sides and 2 pairs spinules on the upper surface as well as a pair of posterior spines.

Alpheus hebes, which most closely resembles the description of *A. spinicaudatus*, has a short rostrum and no noticeable eyeshields. It ranges from Ensenada de San Francisco, Sonora, Gulf of California to the Galapagos Islands, and has been collected at Puerto Escondido (*Velero III* sta. 670-37) (Kim and Abele 1988). Although *A. hebes* is described as having the movable finger of the major chela closing vertically, Banner and Banner (1982, fig. 83) showed that the shape and angle of the finger varied in *A. edwardsi* within the species. Whether or not similar variation occurs in *A. hebes* is unknown.

Alpheus tenuimanus Lockington, 1878: Port Escondido, Gulf of California (p. 473).

Status: Coutière (1899) tentatively identified this as a species of *Synalpheus*.

Remarks: Lockington described this species as "arched in profile, much higher in the centre (sic)." The front was "trispinose, rostrum much longer than ocular

spines, reaching middle of second joint of peduncle of antennulae," the ocular spines were "slender, projecting from the centre of the convex front of the eyeshields." The stylocerite reached beyond the first segment of the antennular peduncle, the basicerite bore a spine and the scaphocerite reached the end of the antennular peduncle. The first pereopods bore a spine at the distal end of the merus. The major chela was elongated and smooth, rounded above and below, with a shallow sulcus and a shorter one "above" extending obliquely upward from the carpal articulation on the inner side of the hand. The smaller chela had a similar merus and an elongated, smooth, cylindrical chela. The second pereopod had a 5-jointed carpus, the third to fifth pereopods were without spines or spinules. The telson was elongate, slightly tapering, with 2 pairs of spinules on the dorsal surface and a spine on each posterolateral border.

Lockington's mention of the "hands" (of the chelipeds) "equal in length, not greatly differing size, dissimilar" casts some doubt on the identification of *A. tenuimanus* as a species of *Synalpheus*, for in the latter genus, the hands differ greatly in size. In species of the eastern Pacific Ocean, it is easy to distinguish between a major and a minor chela; the major chela is not "elongated." The ocular spines were described as "projecting from the centre of the convex front of the eyeshields," rather than "triangular," which suggests that the species belonged to *Alpheus*, not *Synalpheus*.

Two other "trispinose" genera of alpheids occur in the Gulf of California: *Alpheopsis* and *Salmoneus*. However, Lockington himself commented on the "triangular projection on each side of the base of the telson" in the description of *A. aequidactylus* and yet made no mention of such a feature in the description of *Alpheus tenuimanus*. Species of *Salmoneus* have peculiar chelipeds and a very broad rostrum, easily distinguished from that of species of *Alpheus*. It seems most likely that *A. tenuimanus* was a species of *Alpheus*.

Most of the description of *A. tenuimanus* suggests a species of the "Sulcatus" group. Of the species known in the eastern Pacific Ocean, *A. panamensis* Kingsley, *A. felgenhaueri* Kim and Abele and *A. splendidus* Coutière are the most similar. All have a rostrum at least as long as the first segment of the antennular peduncle; the major chela neither has spinules on the merus or characteristic spines, notches or bumps, and there are no large sulci adjacent to the rostrum. However, Lockington stated that the posterior pairs (of pereopods) were "without spines or spinules on any of the joints."

Alpheus exilis Kim and Abele, 1988, described from specimens without chelipeds, may be found to be a synonym of *A. tenuimanus*. Both descriptions mention the ocular spines; in both, the third pereopod lacks spines and spinules. However, the rostrum and stylocerite are reported to be shorter than the first segment of the antennular peduncle in *A. exilis*. Length of the rostrum, however, has been found to be variable in at least two species of *Alpheus* (Banner and Banner 1982, figs. 20, 43). *Alpheus exilis* has been taken at Puerto Escondido (*Velero III* sta. 667-37) and Sullivan Bay, Galapagos Islands (Kim and Abele 1988). One hopes that, in the future, a series of specimens with chelipeds can be collected and compared with both descriptions to determine whether or not there are one or two species agreeing substantially with the two descriptions.

Discussion

Unless Lockington's original specimens are found, identification of many of his species is likely to remain uncertain. Even if some of his specimens are located, identification of the species may remain questionable because, even today, the range of morphological variation within a single species of alpheid shrimp is likely to be unknown. Banner and Banner (1982), in a lengthy study of species of *Alpheus*, contrasted the great variation in features such as length of the rostrum and details of the movable finger of the major chela in various species, while other features remained uniform over a range of the entire Indo-Pacific region. Features such as length of the rostrum and shape of the dactyls of the pereopods in at least two species were found to vary with age and maturity of the animal. Kim and Abele (1988) used features such as rows of setae, spinules of the chelipeds, shape of the ridges and grooves of the major chela and relative lengths of the stylocerite, rostrum and segments of the first antenna to distinguish between species. To date, no one has compared these features among large series of hundreds of animals along the entire eastern Pacific coast. Color patterns of most species are unknown. Some species are known from less than 10 specimens. The dispersal capabilities of eastern Pacific alpheids larvae also are unknown.

In instances in which Lockington's species can be recognized, the species occur today in the localities from which he had specimens. The unidentifiable or questionable species at least are similar to species that still occur in the areas from which Lockington's material came. Lockington's records indicate that at least a few alpheids have occupied the same areas for over 115 years.

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