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The Alpheidae from China Seas

Crustacea: Decapoda: Caridea

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Contents

Instruction

1

As one of the most diverse groups of marine decapod crustaceans, the Alpheidae contain more than 700 species within 48 established genera (e.g. De Grave & Fransen, 2011; Komai & Fujita, 2018). Alpheid shrimps represent one of the most abundant decapods in tropical and subtropical areas, which are commonly found in shallow-waters, especially on coral reefs (e.g. Banner & Banner, 1966; Felder & Chaney, 1979; Liu & Lan, 1980). Few alpheids are also found in hypohaline environments, such as mangrove and estuary. About 16 species within Alpheidae were also reported living in freshwater, brackish or marine cave and anchialine pools (Anker, 2008; Komai & Fujita, 2018). Moreover, small number of species of genus *Alpheopsis* and *Alpheus* live in deep-waters (Anker, 2017; Komai & Ohtomi, 2018; Ramos-Tafur, 2018). Most alpheids are permanent association with sessile marine invertebrates, particularly sponges, corals and crinoids, and gobiid fishes (e.g. Banner & Banner, 1975; Bruce, 1976; Duffy, 1992; Karplus & Thompson, 2011). Social monogamy is the common mating system employed by many crustaceans in order to defend and share a specific microhabitat or refuge (Correa & Thiel, 2003; Thiel & Baeza, 2001), which is also frequently observed among alpheid shrimps (Pescinelli et al., 2018). Interestingly, Duffy (1996) reported the first case of eusociality in a sponge-dwelling shrimp, *Synalpheus regalis* Duffy, 1996. That shrimp colonies consist of only one to few reproductive females and tens to hundreds of cohabiting genetically related, non-breeding colony males (Duffy & Macdonald, 1999). The cooperative colonies are always competition for sponge hosts (Duffy, 2003), and the major chela is a powerful weapon, which is used in communication and combat (Nolan & Salmon, 1970; Duffy et al., 2002). When the snapping shrimps rapidly close their claws, they direct a powerful water jet at a nearby opponent and generate a loud noise (Knowlton & Moulton, 1963; Versluis et al., 2000). The biological noises of oceans are also caused by the snapping shrimp, except for the fish, dolphins and whales (Versluis et al., 2000). Moreover, some of the alpheid shrimps, such as *Alpheus japonicus* Miers, 1879 and *Alpheus digitalis* De Haan, 1844, also have economic values (Liu & Lan, 1980). As one of the most species-rich groups, the Alpheidae present a particular challenge for taxonomists. The alpheid shrimps often contain cryptic taxa that are difficult to be identified using traditional, morphology-based criteria (Knowlton, 1986, 1993, 2000; Hebert et al., 2003; Witt et al., 2006; Barber & Boyce, 2006; Mathews, 2006). Within the 48 established genera, *Alpheus* is the most species-rich genus followed by *Synalpheus*, and the other genera of Alpheidae are consisted of not more than 60 species (e.g. De Grave & Fransen, 2011). Both *Alpheus* and *Synalpheus* are divided into several different taxonomic groups (e.g. Coutière, 1899, 1905; Banner & Banner, 1975; Ríos & Duffy,

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2007; Anker & De Grave, 2008). The history of taxonomic research on the Alpheidae is listed as following.

Alpheus Fabricius, 1798 contains 311 described species now (updated by Komai & Ohtomi, 2018). *Alpheus* was ever confused with *Crangon* Fabricius, 1798 for many decades, until the International Commission officially accepted the name *Alpheus* and the family name Alpheidae in 1955 (see detail in Banner & Banner, 1982). Coutière (1899) divided *Alpheus* into five species groups (*A. brevirostris*, *A. crinitus*, *A. edwardsii*, *A. macrochirus* and *A. megacheles*), then the species group *A. crinitus* was further divided into three subgroups: *A. crinitus*, *A. insignis* and *A. obesomanus* by Coutière (1905). However, with more and more species being discovered, the redefinition of the groups was requested. Banner & Banner (1966) elevated the above three subgroups to the status of group, and re-divided the *Alpheus* into the following 7 species groups: *A. brevirostris*, *A. crinitus*, *A. diadema*, *A. edwardsii*, *A. macrochirus*, *A. megacheles* and *A. obesomanus* with accepting the suggestion of De Man (1911). Presently, the redefined species groups (*A. brevirostris*, *A. crinitus*, *A. diadema*, *A. edwardsii*, *A. macrocheles*, *A. obesomanus* and *A. sulcatus*) have be well-accepted (e.g. Banner & Banner, 1982, 1985; Chace, 1988; Bruce, 1990), which are also adopted herein. Same as *Alpheus*, *Synalpheus* was also divided into six species groups: *S. brevicarpus*, *S. biunguiculatus* (later changed to *S. coutierei*), *S. comatularum*, *S. Laevimanus* (later changed to *S. gambarelloides*), *S. neomeris*, and *S. paulsoni* by Coutière (1908, 1909) and Banner & Banner (1975). However, only three of these traditionally recognized morphology-based species group (*S. brevicarpus*, *S. comatularum*, and *S. gambarelloides* groups) were supported as monophyletic using molecular analyses (Hultgren et al., 2014). Therefore, the *Synalpheus* is not divided into species groups in the present report.

The anatomical parts used to identify of the alpheid shrimps in this study are shown in Figs. 1.1 and 1.2 and discussed as following. **The anterior part of carapace:** the rostrum is present or absent, if present it's usually unarmed with serrated teeth both on dorsal and ventral margins (species in *Salmoneus* sometime bearing apical teeth on ventral margin); the rostral carina is well-developed in some species and lacking in the other species; the eyes are usually covered by the carapace or part of them are visible in dorsal and lateral view, but species in *Automate*, *Bermudacaris* and *Stenalpheops* with the eyes are exposed completely; Not all alpheid shrimps have the orbital tooth; the extra-corneal and supra-corneal tooth develop in some species of *Arete*, *Athanas* and *Rugathanas*; the pterygostomian tooth is present or absent. **The antennular peduncle:** it consists of three segments; the basal segment has a shield, the stylocerite, which is usually not overreaching the end margin of the second antennular segment. **The antennae:** the basicerite is visible both in dorsal and lateral view, and bearing strong distodorsal or distolateral tooth; the scaphocerite with strong lateral teeth distally is usually well-developed and beyond the antennular peduncle; the length of the cylindrical carpocerite is often an aid in diagnosis. **The mouth parts:** The mandible usually consists of molar process, incisor process and two-segmented palp, but the palp is lacking in the *Batella* and both the molar process and palp are lacking in the *Prionalpheus*; the remaining parts of the mouth are not showing distinctly differences between alpheid shrimps. **The first pereiopods (chelipeds):** the chelipeds are larger and stronger than the following four pairs of pereiopod, and most alpheid shrimps, especially species of *Alpheus* and *Athanas* with the chelipeds vary with age and sex; chelipeds are usually asymmetrical in size and shape except the species in genus *Stenalpheops* and *Thuylamea*, which have subequal and symmetrical chelipeds; the chela is often carrying the dactylus dorsally, but the dactylus of species in *Aretopsis* and *Bermudacaris* are situated ventrally; The chelipeds, especially the major cheliped, are probably carrying the most important single character for the identification of alpheid shrimps. **The second pereiopod:** they are chelate; the carpus often consists of 3–5 segments, and the ratio of these segments is taxonomic significance. **The following three**

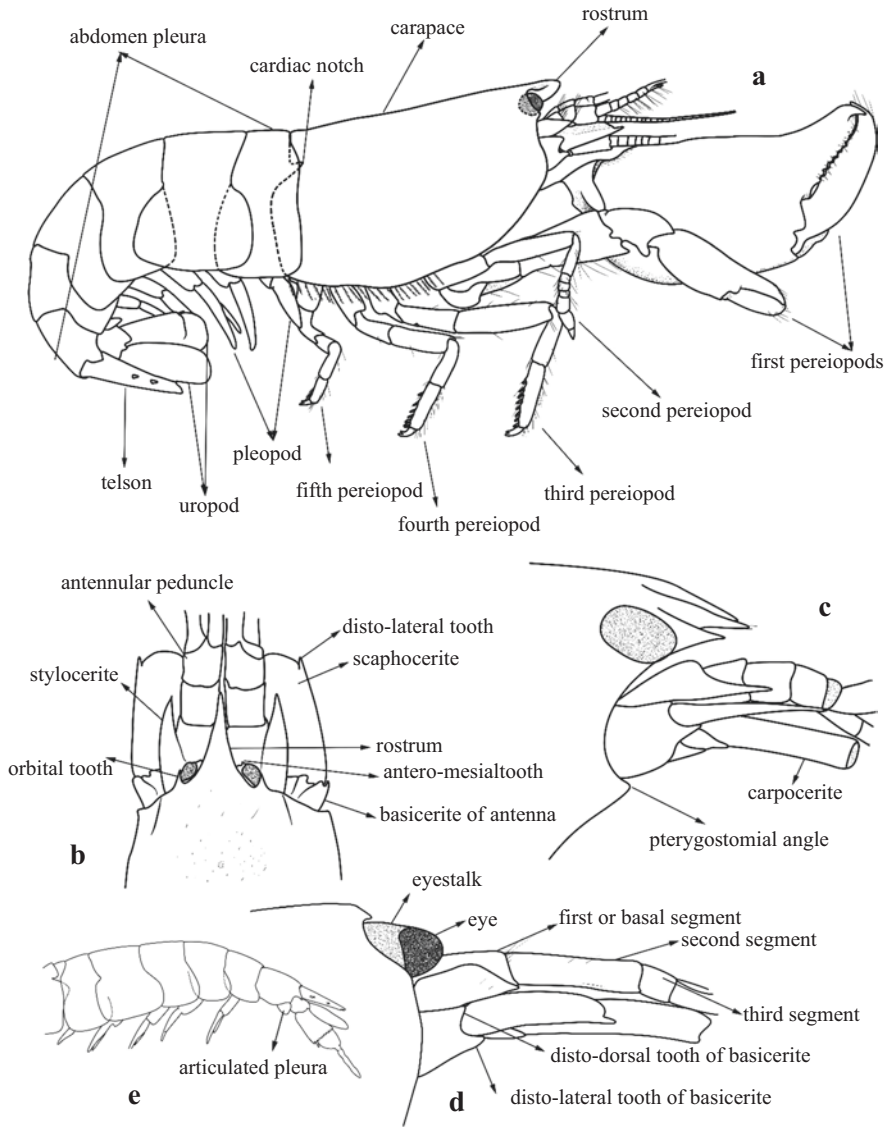

Fig. 1.1 Schematic drawing of alpheid shrimp: (**a**) entire animal in lateral view; (**b**) anterior part of carapace in dorsal view; (**c**) and (**d**) anterior part of carapace in lateral view; (**e**) abdomen pleura in lateral view

pereiopods: third pereiopods are not chelate; the dactylus is simple or biunguiculate or even triunguiculate, and is an important identified character; the proportions of each articles and all spines or teeth situated on each articles are taxonomic significant. The fourth and fifth pereiopods are both similar to third pereiopod, and are not ordinarily used in definition of the species. The branchial formula is useful at the generic level in alpheid shrimps. **The abdominal segments:** the sixth abdominal segment bearing triangular articulate plate is one of most important characters in generic level's definition. **The pleopods:** the endopod of second pleopod is often bearing appendix interna and masculina in males while appendix interna only in females. However, species of *Synalpheus* and *Automate* are only bearing appendix interna both in males and females and some species of *Salmoneus* have appendix interna and mascu-

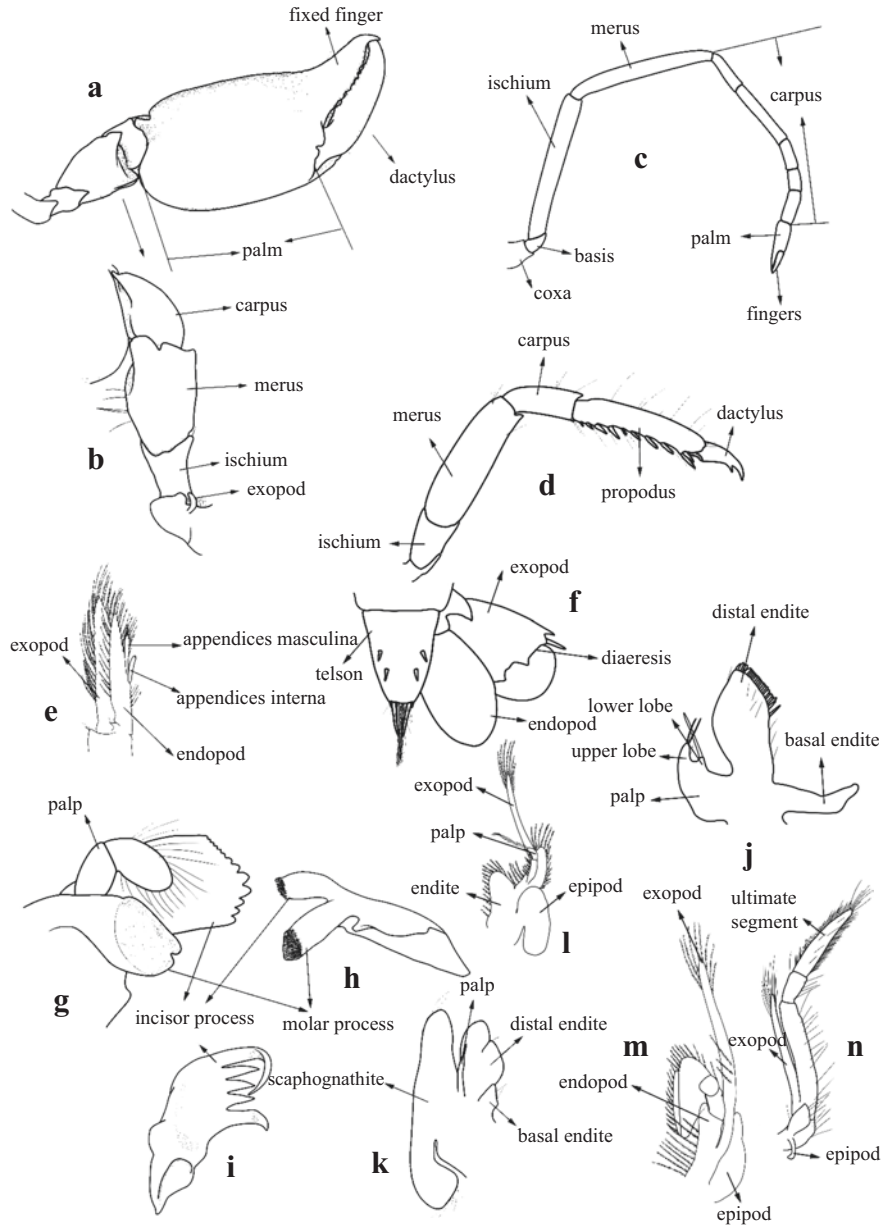

Fig. 1.2 Schematic drawing of alpheid shrimp: (**a**) and (**b**) major cheliped; (**c**) second pereiopod; (**d**) third pereiopod; (**e**) second pleopod; (**f**) telson and right uropod; (**g**–**i**) mandible; (**j**) maxillule; (**k**) maxilla; (**l**) first maxilliped; (**m**) second maxilliped; (**n**) third maxilliped

lina in both males and females. **Uropods:** the exopod is articulated, and is extending as a tooth laterally and bearing a contiguous spine; the endopod is rounded; the uropods are usually less taxonomic significant. **The telson:** the telson is subtriangular and truncate distally; dorsal surface has two pairs of spines; posterior margin is armed with two pairs of posterolateral spines, and is straight, convex or notched between those posterolateral spines; the location of the dorsal spines and the shape of the posterior margin are important characters to define species.

Since the twentieth century, there are lots of taxonomic works on alpheid shrimps that has been done. Coutière (e.g. 1899, 1905, 1908, 1909) who established many genera and described many species, made great contribution to Alpheidae. De Man (1910, 1911) reported the alpheid shrimps of Indonesia through the Siboga Expedition, and described many species. Banner & Banner (e.g. 1966, 1975) has done a series of regional works from the West-Pacific and Indian Oceans, and also recorded the habitats of the shrimps. Miyake (1998) and Miya (e.g. 1997) reported the alpheids from Japan waters. Recently, Komai (e.g. 2009, 2011, 2015) and Anker (e.g. 2000, 2001, 2007, 2008, 2010, 2011a, 2011b, 2012, 2017) did great contribution to the Alpheidae for establishing many genera and describing many species. Furthermore, the taxonomic works of the Alpheidae from China seas are listed as following. Yu (1935) described 6 species of the genus *Alpheus* and two of them were new to science. Liu (1995) reported 4 species of the genus *Alpheus*. Liu & Lan (1980) described and illustrated 18 species of the genus *Alpheus* from Xisha Islands. Jeng & Chang (1985) and Jeng (1997) reported the alpheid shrimps from Taiwan. Bruce (1990) reported the alpheid shrimps from Hong Kong. Sha & Liu (2007, 2008) recorded the species of *Athanas* and *Arete*. Cui & Sha (2014) described one newly recorded species of *Alpheus* from Beibu Gulf. Wang & Sha (2015–2017) did some works of the *Automate*, *Salmoneus*, *Stenalpheops*, *Synalpheus* and *Thuylamea*. However, a systematic morphological research on the Alpheidae is needed. Based on more than 2000 specimens collected from China seas, 145 species belonging to 16 genera of the Alpheidae are described and illustrated herein.

1.1 Material and Methods

The present more than 2000 specimens were collected from China seas, including the Bohai Sea, the Yellow Sea, the East and South China Sea mainly by Agassiz trawl. Specimens were collected by the National Comprehensive Oceanographic Survey (1958–1960), the China-Vietnam Comprehensive Oceanographic Survey of the Tonkin Gulf (1959–1960, 1962), the China-Japan Joint Investigation of the Hainan Island (1997), the China-Germany Joint Investigation of the Hainan Island (1990, 1992), the CAS Xisha Islands Marine Biological Investigation (1956–1985), the CAS Nansha Islands Multi-disciplinary Investigation (1985, 1987–2000), and so on. The specimens were immediately fixed in 10% formalin and then deposited in the Marine Biological Museum, Chinese Academy of Sciences (MBMCAS), Qingdao, China, and preserved in the 75% ethanol now. Specimens were examined and dissected under a stereomicroscope (Nikon SMZ1500, Japan). Line drawings were completed in the Adobe Photoshop CS6 with graphics tablet. Carapace length (CL) was measured from the posterior margin of the orbit to the posterior margin of the carapace and is used herein as an indication of specimen size. All measurements are in millimeters (mm).

1.2 Zoogeographic Summary

145 species within 16 genera of the Alpheidae from the China seas are descripted in the present report, including 3 species within 2 genera in the Bohai Sea; 21 species within 4 genera in the Yellow Sea; 23 species within 6 genera in the East China Sea; 132 species within 13 genera in the South China Sea and 27 species within 8 genera in Taiwan (Fig. 1.3).

The Bohai and Yellow Sea: is a marginal sea in the northwestern Pacific Ocean, semi-enclosed by China and the peninsula of Korea. The Bohai and Yellow Sea are each with an average depth of 18 and 45.3 m, respectively. The macro faunal communities in this area are affected by several factors such as: Several large rivers flowing into this area, The Yellow Sea Cold Water Mass, the Yellow Sea Warm Current, etc.

The East China Sea: has the most extensive continental shelf in the northwestern Pacific

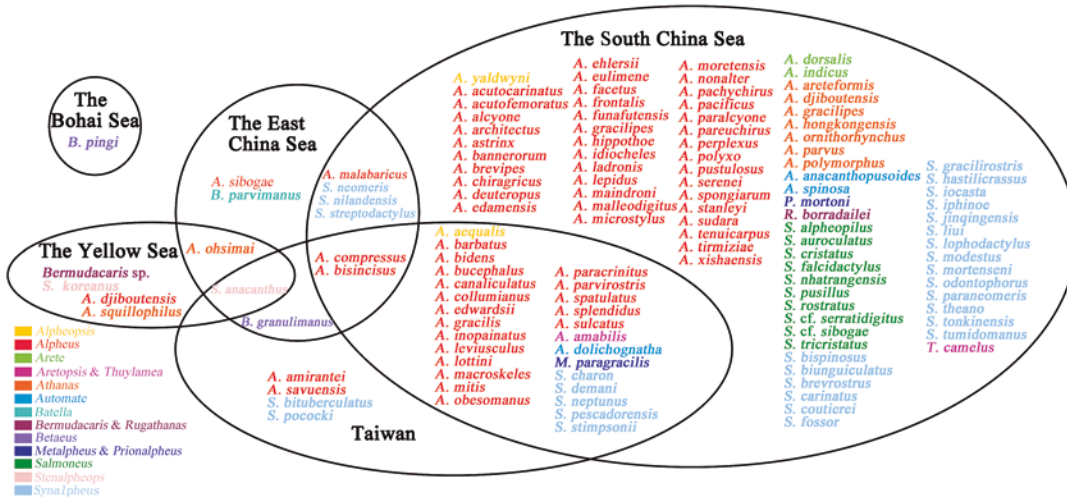

Fig. 1.3 The alpheid shrimps in each part of China seas, except for the following 15 species: *Alpheus brevicristatus* and *Alpheus digitalis* found from the whole China seas; *Alpheus euphrosyne, Alpheus hoplocheles* and *Alpheus strenuus strenuus* found from the whole China seas except the Bohai Sea; *Alpheus balaenodigitus, Alpheus diadema, Alpheus leptocheles, Alpheus pacificus, Athanas dimorphus* and *Athanas japonicus* found from both the Yellow Sea and the South China Sea; *Alpheus japonicus, Alpheus malabaricus* and *Alpheus rapacida* found from the Yellow Sea, the East and South China Sea; *Alpheus lobidens* found from the Yellow Sea, the South China Sea and Taiwan

Ocean and covers an area of 7.7 × 10 km^2. Its hydrological characteristics are mainly influenced by the coastal water, the Yangtze River-diluted water and the Kuroshio Current.

The South China Sea: is the largest marginal sea of the northwest Pacific Ocean, with an average depth of 1212 m and a maximum depth of 5377 m.

Taiwan: the north part of it belongs to the East China Sea, and the south part of it belongs to the South China Sea according to the Scheme of the World Maine Biogeographic Regions shown in Liu (2008).

The Sampling stations of each alpheid genus are shown in Fig. 1.4.

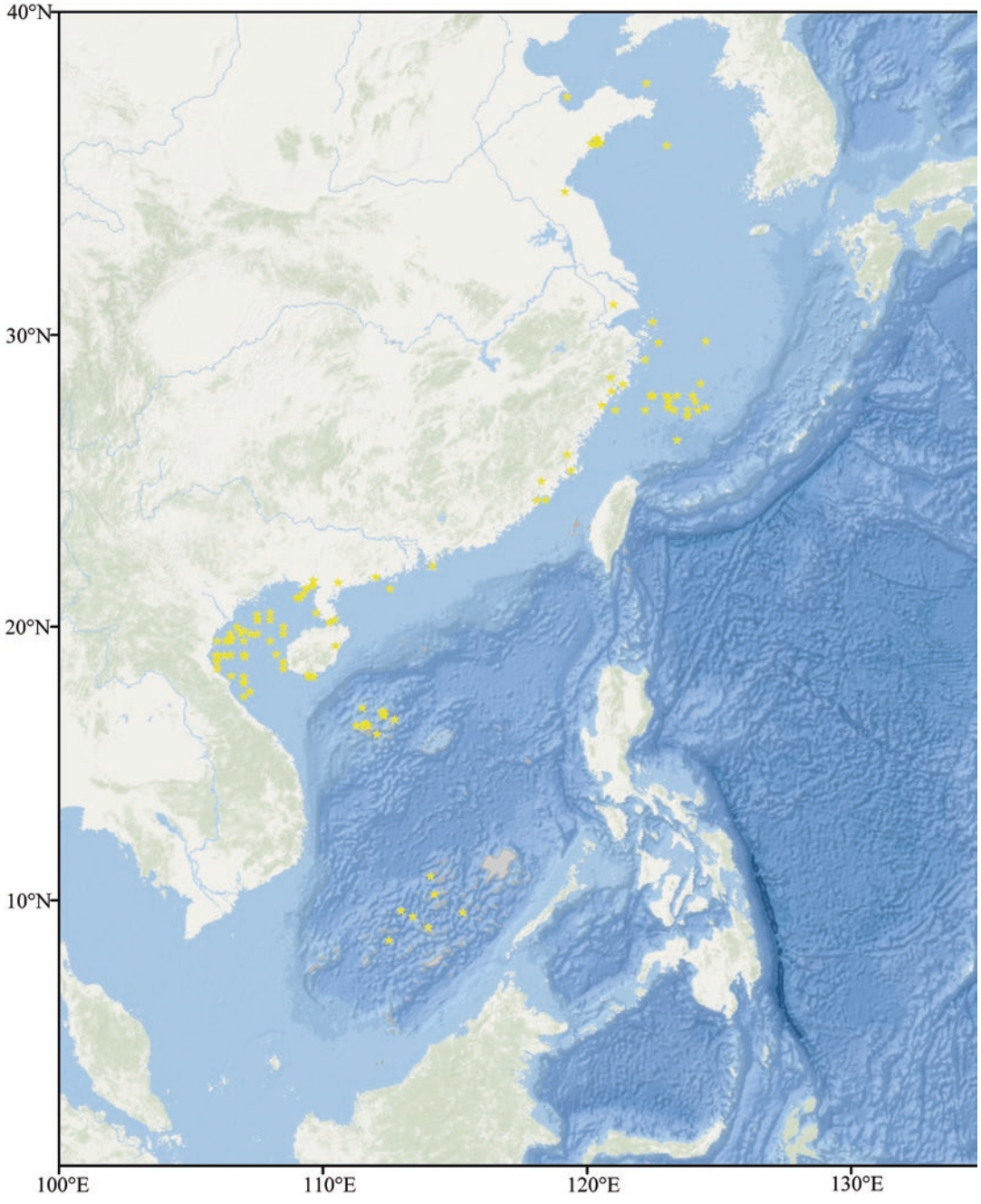

Fig. 1.4 Location map of the sampling sites of the Alpheidae from China seas

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Taxonomy of Alpheidae from China Seas

2

Key to genus of Alpheidae from China seas

1. Carapace with ventral margins bearing one large notch on each side ..... *Stenalpheops*
-. Carapace with ventral margins not bearing one notch on each side 2
2. Posterior surface of carapace bearing one backwards large tooth medially ..... *Thuylamea*
-. Posterior surface of carapace smooth, without large tooth 3
3. Mandible without 2-segmented palp 4
-. Mandible with 2-segmented palp 5
4. Mandible with molar process absent ..... *Prionalpheus*
-. Mandible with molar process present ..... *Batella*
5. Sixth abdominal segment with articulate plate on posterolateral margin 6
-. Sixth abdominal segment without articulate plate on posterolateral margin 11
6. Chelipeds with dactylus situated ventrally ..... *Aretopsis*
-. Chelipeds with dactylus situated dorsally 7
7. Carapace with rostrum and orbital teeth both absent on anterior margin ..... *Betaeus*
-. Carapace at least with rostrum present on anterior margin 8
8. Eyes covered by carapace ..... *Alpheopsis*
-. Eyes visible in dorsal and lateral view 9
9. Major chela in male with margins of palm rugged ..... *Rugathanas*
-. Major chela in male with margins of palm smooth or bearing tubercles 10
10. Second pereiopod with carpus 4-segmented ..... *Arete*
-. Second pereiopod with carpus 5-segmented ..... *Athanas*
11. Second pleopod without appendix masculina in male 12
-. Second pleopod with appendix masculina in male 13
12. Carapace without orbital teeth and pterygostomial teeth ..... *Automate*
-. Carapace with orbital teeth and pterygostomial teeth ..... *Synalpheus*
13. Eyestalk visible in dorsal and lateral view ..... *Bermudacaris*
-. Eyestalk invisible in dorsal and lateral view 14
14. Mandible with incisor process expand, bearing distally more than 10 irregular teeth ..... *Metalpheus*
-. Mandible with incisor process not expand, bearing distally not more than 10 irregular teeth 15
15. Major chela with cutting edges of dactylus bearing plunger ..... *Alpheus*
-. Major chela with cutting edges of dactylus not bearing plunger ..... *Salmoneus*

Z.-l. Sha et al., *The Alpheidae from China Seas*,
https://doi.org/10.1007/978-981-15-0648-2_2

2.1 Genus *Alpheopsis* Coutière, 1897

Diagnosis Rostrum present. Orbital teeth present or absent. Cornea of eyes always visible in dorsal and lateral view. Antennular peduncle short and stout. Scaphocerite usually broad, lateral tooth usually longer than blade. First pereiopod asymmetry, Fingers compressed, cutting edges without teeth or with simple arrangement of exactly fitting teeth; palm subcylindrical or with lines and depressions; carpus cup-shaped; merus roughly triangular. Second pereiopod with carpus composed by 3–5 segments. Third to fifth pereiopods robust, dactylus simple or biunguiculate; merus without spines on ventral margin. Sixth abdominal segment without articulated plate. Posterior margin of telson convex (Banner & Banner, 1953).

Key to species of the genus of *Alpheopsis* from China seas

1. Major chela subcylindrical; Stylocerite not reaching to end margin of second antennular segment .....*A. aequalis*
-. Major chela with mesial face flattened, lateral face rounded; Stylocerite reaching to end margin of third antennular segment .....*A. yaldwyni*

2.1.1 *Alpheopsis aequalis* Coutière, 1897 (Figs. 2.1 and 2.2)

Alpheopsis aequalis Coutière, 1897b: 382; Wang & Sha, 2016a: 1100, figs. 1, 2.
Alpheopsis equalis –. Banner, 1953: 15, fig. 4a–o; Banner AH & Banner DM, 1966b: 33, fig. 6; Banner DM & Banner AH, 1973: 342, fig. 16.
Alpheopsis equalis var. *truncatus* Coutière, 1903: 89, Figs 37–38.
Alpheopsis consobrinus De Man, 1910: 305.

Material Examined MBM 284426, 1 ovigerous♀, CL 3.9 mm, TL 9.7 mm, Chenhang (Dengqing) Island, Xisha Islands, Xu Jie-shan & Fan Zhen-gang Coll., 4 May 1958; MBM 158597, 1♂, CL 4.1 mm, TL 10.2 mm, 1♀, CL 2.7 mm, TL 7.6 mm, Yongshu Reef, Nansha Islands, Li Xin-zheng Coll., 18 May 1993.

Description Carapace smooth, glabrous. Rostrum acute, reaching about 1/2 length of visible part of first segment of antennular peduncle, about as long as wide at base, termination in lateral view acute. Orbital teeth absent. Pterygostomial angle produced into acute tooth. Cardiac notch well developed. Eyes well developed, cornea invisible dorsally, partly visible laterally.

Endopod of second pleopod with appendices interna and masculina in male, appendix interna only in female. Telson about 1.7 times as long as wide at base dorsal surface with two pair of spines (as show in Fig. 1l, left side with 3 spines was unusual) situated at some distance from lateral margin, anterior and posterior pair situate about 2/5 and 7/10 length of telson, respectively; posterior margin rounded, bearing two pairs of slender posterolateral spines, mesial about twice as long as lateral; anal tubercles absent. Uropods slightly exceeding telson; diaeresis with one strong acute spine; distolateral spine long, slender, reaching posterior margin of exopod.

Antennular peduncle moderately slender; first segment longest; second segment slightly longer than wide; stylocerite reaching about 3/4 length of second segment of antennular peduncle, acute distally; lateral flagellum biramous, shorter ramus composed of at least three segments bearing tufts of aesthetascs; proximal fused portion composed of at least four segments. Basicerite bearing strong ventrolateral tooth; scaphocerite oval, anterior margin of blade rounded; distolateral tooth strong, acute, reaching beyond anterior margin of blade, reaching about end of third segment of antennular peduncle; carpocerite moderately slender, overreaching end of third segment of antennular peduncle.

Mandible with incisor process bearing distally 10 rounded irregular teeth, with fourth and fifth larger than others, molar process typical for genus. Maxillule with two endites, distal endite with numerous large spine-like setae on inner margin, basal endite with long setae on distal margins; palp bilobed, lower lobe with one robust plumatus seta, upper lobe rounded. First and

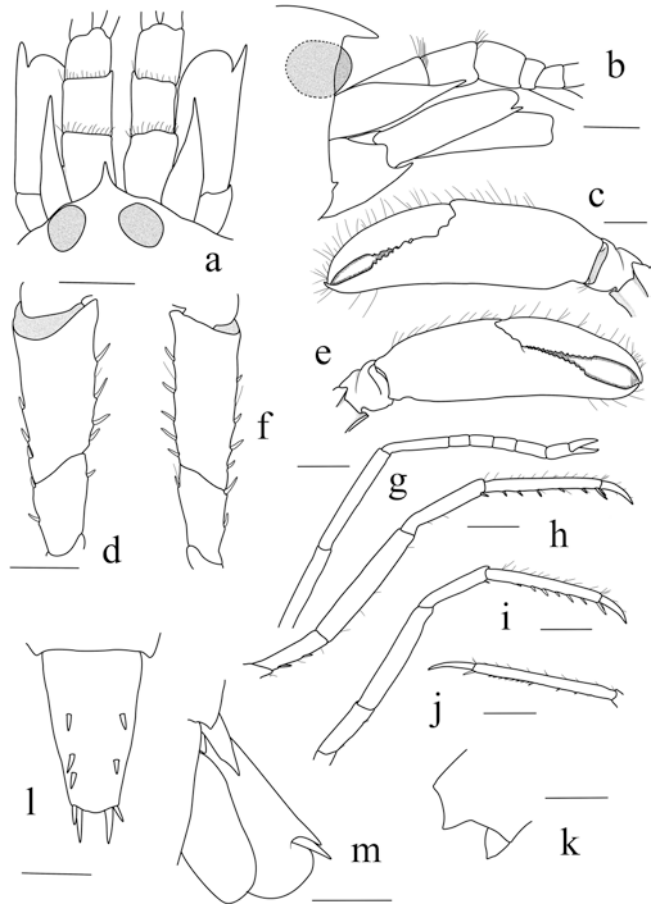

Fig. 2.1 *Alpheopsis aequalis* Coutière, 1897. MBM 158597, male, CL 4.1 mm, **a**, anterior region, dorsal view; **b**, anterior region, lateral view; **c**, major chela; **d**, same, merus and ischium; **e**, minor chela, **f**, same, merus and ischium; **g**, right second pereiopod; **h**, right third pereiopod; **i**, left fourth pereiopod; **j**, dactylus and propodus of left fifth pereiopod; **k**, articulated pleura of sixth abdominal segment; **l,** telson; **m**, right uropod (scale bar = 0.5 mm. **c** and **e** same scale bar; **d** and **f** same scale bar)

second maxilliped normal. Third maxilliped moderately stout; ultimate segment very setose, distally tapering, bearing 2 subapical spines; arthrobranch normally developed.

First chelipeds nearly symmetrical in shape and size. Chela subcylindrical, without grooves on surface; cutting edge of dactylus and pollex bearing teeth on about 3/5 length, distal 2/5 length without teeth, stiff setae along full length of cutting edge of fingers, fingers tips corneous, crossing when closed; palm nearly as long as fingers. Carpus with outstanding flange into which proximal end of propodus fit, with slight constriction before this flange. Merus with ventromesial margin bearing 4 or 5 large spines, and dorsal margin bearing 3 or 4 spines. Ischium with ventral margin bearing 1 spine, and dorsal margin bearing 1 distal spine and 1 medial spine.

Second pereiopod slender, fingers slightly longer than palm. Carpus 5-segmented, length ratio subequal to 2: 0.6: 0.7: 0.7: 1.

Third pereiopod slender, with dactylus simple, gradually curved, about 0.3 times as long as propodus, with setae. Propodus slightly shorter than merus, armed with 5 spines along ventral margin, and distally one pair spines. Carpus about 3/4 length of merus, with distal 1 spine on ventral margin. Merus more than twice length of ischium, unarmed, about 8 times as long as wide at base. Ischium armed with 2 spines on ventrolateral margin

Fourth and fifth pereiopod similar to third pereiopod, bur more slender. Fifth pereiopod

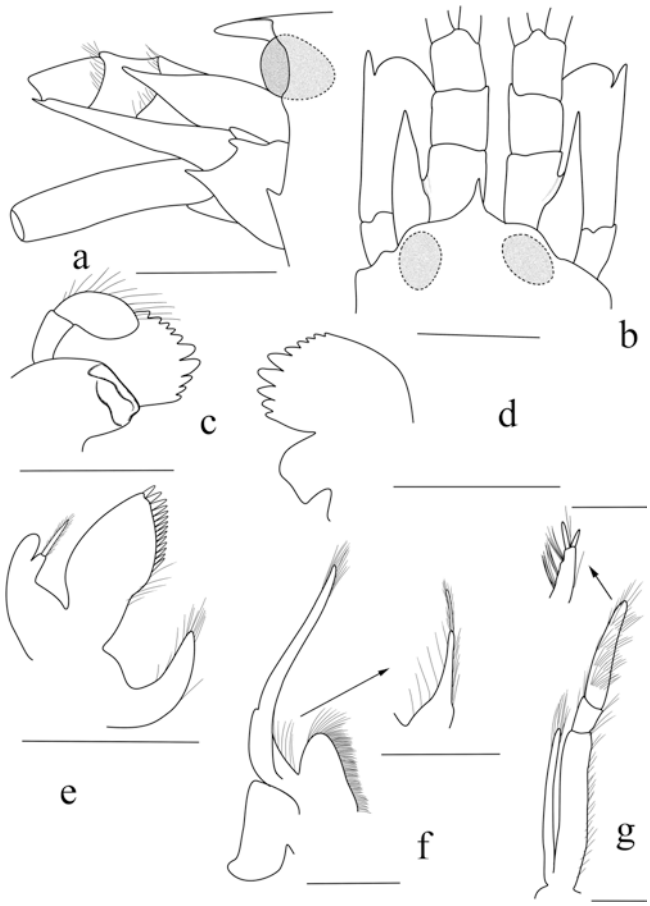

Fig. 2.2 *Alpheopsis aequalis* Coutière, 1897. MBM 158597, female, CL 2.7 mm, **a**, anterior region, lateral view; **b**, same, dorsal view. MBM 158597, male, CL 4.1 mm, **c**, **d**, left mandible; **e**, left maxillule; **f**, left first maxilliped; **g**, left third maxilliped (scale bar = 0.5 mm)

with dactylus more slender than that of third and fourth pereiopods. Propodus with 3 small spine and at least 8 rows of short setae along ventral margin.

Remarks *Alpheopsis aequalis* is originally described by Coutière (1897b) in a very brief way and without illustrations. Coutière (1903) illustrated the anterior part of the carapace. Wide variation has found in its morphological characters (De Man, 1910; Armstrong, 1941; Banner, 1953; Banner & Banner, 1973). Therefore, Anker et al. (2005) stated that *A. aequalis* might be a species complex, but the present material is not enough to prove it. However, the type-specimens have gone missing from the Paris museum. The neotype should be selected and described from the type locality for the wide variation of this species. The present specimens are morphologically similar to each other, and are more similar to the descriptions of De Man (1910) and Banner & Banner (1966b) than to other re-descriptions. Additionally, the differences between the present material and the descriptions published previously (Banner, 1953; Banner & Banner, 1966b, 1973) are listed below: the longer rostrum shown by Banner & Banner (1973, fig. 16f) not found in the present specimens, and the rostrum not overreaching end margin of the first antennular segment in the present material; the longer stylocerite shown by Banner & Banner (1973, fig. 16a) not found in the present specimens, and the stylocerite of the present specimens not overreaching end margin of the second antennular segment; the pterygostomial angle well developed into an

acute tooth in the present specimens. Additionally, Armstrong (1941) discusses the variation of the pterygostomial angle. The rounded pterygostomial angle as figured by Armstrong (1941) and Banner (1953) is not found in the present specimens. Moreover, the mouthparts of the species are now dissected and illustrated. There are some differences found between this species and other species of the genus (Chace, 1972; Anker et al., 2005). The incisor process bears 10 rounded irregular teeth distally, while it only bears 6 teeth in *A. labis* Chace, 1972 (cf. Chace, 1972, fig. 15g), and 7 teeth in *A. azorica* Anker, d'Udekem d'Acoz & Poddoubtchenko, 2005a and *A. africana* Holthuis, 1952 (cf. Anker et al., 2005). The palp of the mandible is usually 2-segmented in the genus, while it is described as 3-segmented (Chace, 1972, fig. 15g) in *A. labis* (with broadly rounded distal segment). Considering the fact that molecular evidence is not available, the present specimens are treated as *A. aequalis*.

Distribution Xisha Islands and Nansha Islands, the South China Sea; from Red Sea and Eastern Africa to Hawaii; Society Islands (Bora Bora, Tahiti); Easter Island; Savaii, eastern reef. intertidal to 80 m depth.

2.1.2 *Alpheopsis yaldwyni* Banner and Banner, 1973 (Figs. 2.3, 2.4, and 2.5)

Alpheopsis yaldwyni Banner DM & Banner AH, 1973: 344–346, fig. 17; 1985: 9, fig. 1; Wang & Sha, 2016a: 1105, figs. 3–5.

Material Examined MBM 284428, 1♂, CL 4.6 mm, TL 11.4 mm, Chenhang (Dengqing) Island, Xisha Islands, Fan Zhen-gang & Xu Jie-shan Coll., 16 April 1958; MBM 158631, 1♂, CL 6.1 mm, TL 15.1 mm, Jinqing Island, Xisha Islands, 30 April 1958; MBM 158003, 2♀ (1 ovigerous), CL 4.6, 7.2 mm, TL 12.2, 16.5 mm, Yongxing (Wude) Island, Xisha Islands, 12–13 June 1958; MBM 284427, 1♀, CL 5.1 mm, TL 11.3 mm, Chenhang (Dengqing) Island, Xisha Islands, Fan Zhen-gang & Xu Jie-shan Coll., 4 May 1958.

Description Carapace smooth, glabrous. Rostrum acute, reaching from slightly beyond end of first segment to end of second segment of antennular peduncle, about as long wide at base or distinctly wider at base than long. Orbital teeth absent. Pterygostomial angle produced into acute tooth. Cardiac notch well developed. Eyes well developed, cornea invisible dorsally, partly visible or totally invisible laterally.

Endopod of second pleopod with appendices interna and masculina in male, appendix interna only in female; appendix masculina with distally long setae slightly longer than appendix interna. Telson about 1.3 times as long as wide at base; dorsal surface with two pairs of spines situated at some distance from lateral margin, anterior and posterior pair of spine inserted about 1/2 and 3/4 length of telson, respectively; posterior margin rounded, bearing two pair of slender posterolateral spines, mesial about 3 times as long as lateral. Uropods exceeding telson; diaeresis with two subacute teeth, one on each side of distolateral spine; distolateral spine long, slender, not reaching posterior margin of exopod.

Antennular peduncle moderately stout; first segment longest; second segment slightly wider than long; third segment near as long as second; stylocerite reaching near end of third segment of antennular peduncle, acute distally; lateral flagellum biramous, shorter ramus composed of at least three segments bearing tufts of aesthetascs; proximal fused portion composed of at least four segments. Basicerite bearing strong distolateral tooth, and rounded distodorsal tooth, shorter than distolateral tooth; scaphocerite oval, anterior margin of blade rounded; distolateral tooth strong, acute, reaching far beyond anterior margin of blade, slightly longer than end of third segment of antennular peduncle; carpocerite moderately slender, far overreaching end of third segment of antennular peduncle; flagellum relatively slender.

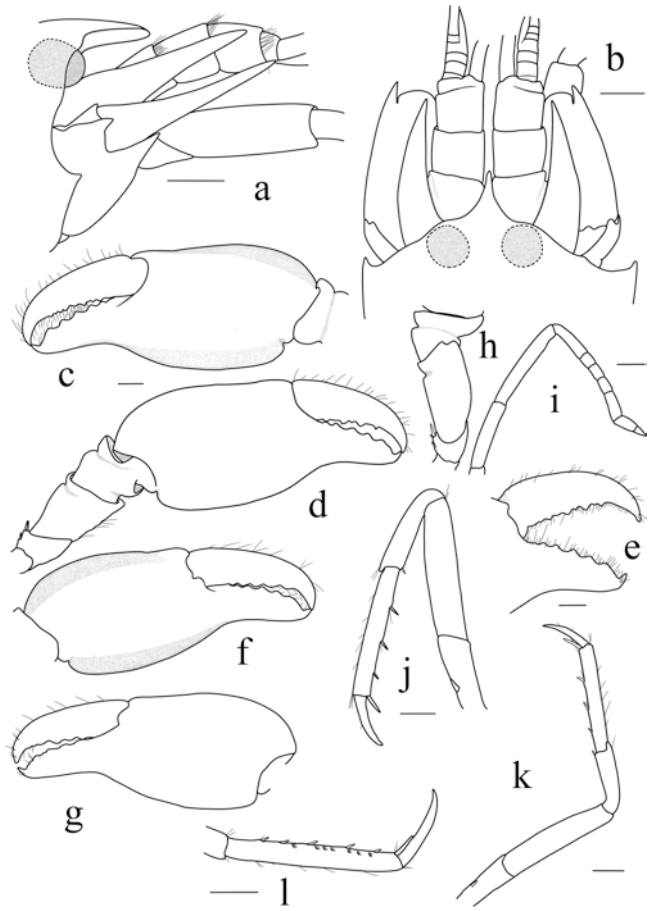

Fig. 2.3 *Alpheopsis yaldwyni* Banner & Banner, 1973. MBM 158631, male, CL 6.1 mm, **a**, anterior region, lateral view; **b**, same, dorsal view; **c**, major chela, outer face; **d**, same, inner face; **e**, fingers of major chela; **f**, minor chela, outer face; **g**, same, inner face; **h**, carpus, merus and ischium; **i**, right second pereiopod; **j**, right third pereiopod; **k**, left fourth pereiopod; **l**, dactylus and propodus of left fifth pereiopod (scale bar = 0.5 mm. **c**, **d**, **f**, **g** and **h** same scale)

Mandible with incisor process bearing distally 13 rounded irregular teeth, with sixth and seventh larger than others, molar process typical for genus. Maxillule with two endites, distal endite with numerous large spine-like setae on inner margin, basal endite with long setae on distal margins; palp bilobed, lower lobe with one robust plumatus seta, upper lobe rounded. Maxilla with two endites, distal endite bilobed, both lobes with moderately short setae on inner margin; basal endite smaller, bearing long setae distally. First and second maxilliped normal. Third maxilliped moderately stout; ultimate segment very setose, distally tapering, tip bearing 2 spines; arthrobranch normally developed.

Frist cheliped only slightly asymmetrical in shape, but minor cheliped smaller than major cheliped in size. Major cheliped with fingers about 0.7 length of palm, cutting edges armed with irregular, not exactly fitting teeth, and densely short setae; tips corneous, crossing when closed. Palm without grooves, lateral face convex; mesial face completely flat; superior margin rounded. Carpus heavy, wider than long, distally bearing superior transverse constriction or groove and expanding into collar around base of palm. Merus stout, unarmed. Ischium stout, dorsal margin bearing 1 medial spine and one pair of spines. Minor cheliped with fingers about 0.7 length of palm, cutting edge armed with regular, exactly

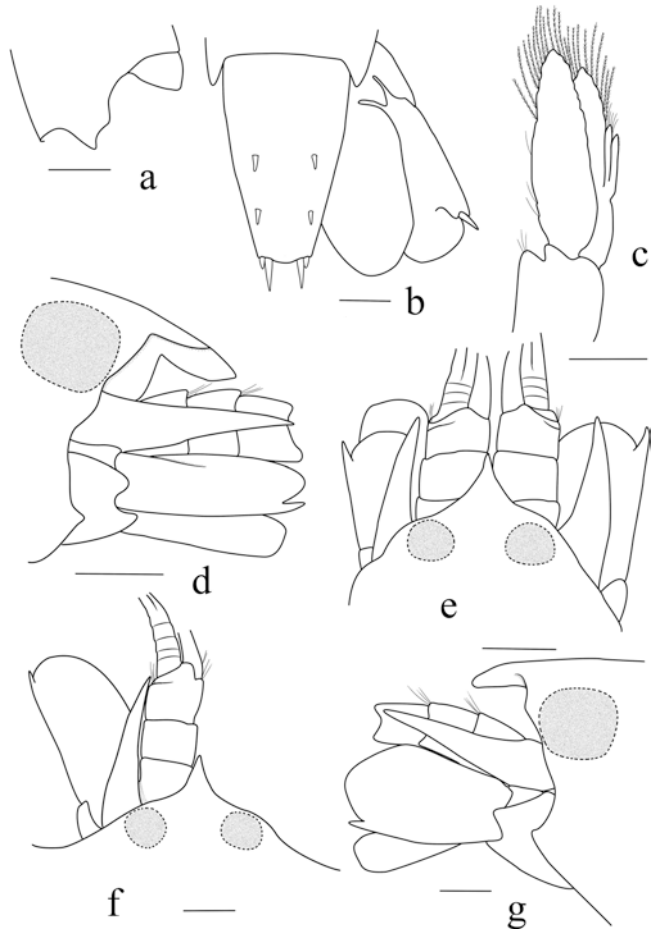

Fig. 2.4 *Alpheopsis yaldwyni* Banner & Banner, 1973. MBM 158631, male, CL 6.1 mm, **a**, articulated pleura of sixth abdominal; **b**, telson and right uropod; **c**, left second pleopod. MBM 158003, female, CL 4.6 mm, **d**, anterior region, lateral view; **e**, same, dorsal view. MBM 158003, ovigerous female, CL 7.2 mm, **f**, anterior region, dorsal view; **g**, same, lateral view (scale bar = 0.5 mm)

fitting teeth, tips corneous, crossing when closed. Merus similar to that of major cheliped, but more slender. Ischium and carpus like that of major cheliped.

Second pereiopod with chela simple, palm slightly longer than fingers. Carpus 5-segmented, with length ratio subequal to 1.2: 0.4: 0.5: 0.5: 0.9. Ischium distinctly shorter than merus.

Third pereiopod with dactylus about 2/5 length of propodus, simple, slender, gradually curved, with short setae on superior margin. Propodus nearly as long as merus, armed with 3 smaller spines and one pair distal larger spines on ventral margin. Carpus slightly longer than 1/2 length of merus, distal inferior margin armed with usually 1 spine. Merus about 4.2 times as long as wide at base, unarmed. Ischium armed with 1 spine on ventral margin.

Fourth and pereiopod similar to third pereiopod, but fifth pereiopod more slender; dactylus about 1/2 length of propodus. Propodus armed with 5 smaller spines and distally one pair larger spines, and distal 2/3 length with at least 7 rows of short setae.

Remarks *A. yaldwyni* is a newly recorded species from China seas. This species is originally described by Banner & Banner (1973) from Australia. De Grave & Fransen (2011) and Anker et al. (2015) provide a colorful photograph of the

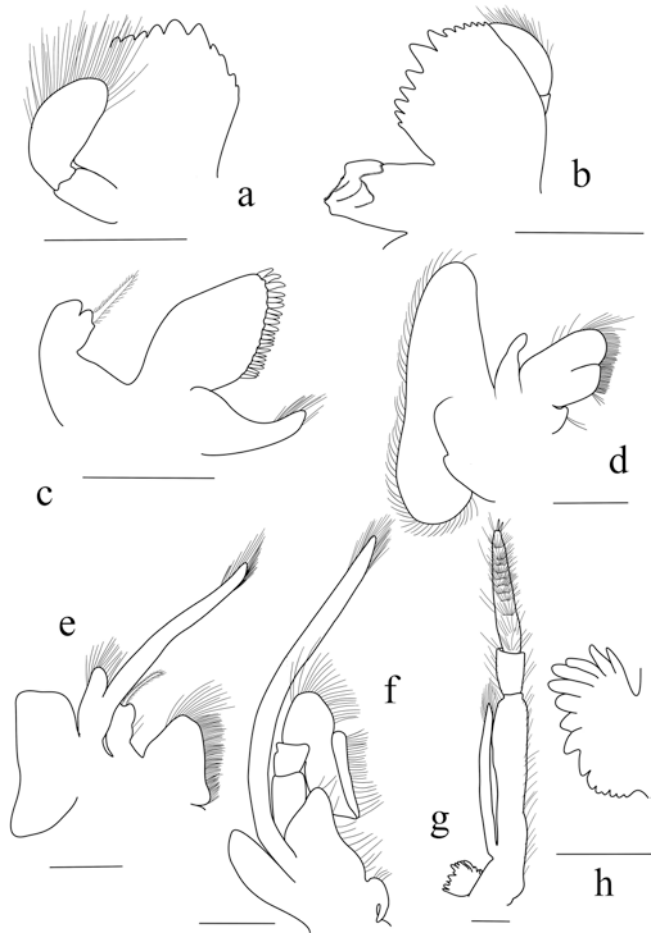

Fig. 2.5 *Alpheopsis yaldwyni* Banner & Banner, 1973. MBM 158631, male, CL 6.1 mm, **a** & **b**, left mandible; **c**, left maxillule; **d**, left maxilla; **e**, left first maxilliped; **f**, left second maxilliped; **g**, third maxilliped; **h**, arthrobranch (scale bar = 0.5 mm)

species. The present specimens are generally agreed with the original description, except for the following characters: the rostrum varying from slightly overreaching the end of the first antennular segment to the end of the second antennular segment in the present specimens, while the rostrum only slightly beyond end margin of the first antennular segment in Banner & Banner (1973, fig. 17a, b), or only reached half-length of the second antennular segment in Banner & Banner (1985, fig. 1a); the rostrum nearly as long as wide at base in the present specimens, while the rostrum 1.5 times as long as wide at base in Banner & Banner (1973, fig. 17a); the basicerite of the antenna bearing a strong distodorsal tooth in the present specimens, while the basicerite not bearing distodorsal tooth in Banner & Banner (1973, fig. 17b; 1985, fig. 1a). *A. yaldwyni* is most similar to *A. aequalis* in *Alpheopsis*, but can readily be distinguished from *A. aequalis* by the following characters: the incisor process of the mandible bearing 13 rounded irregular teeth distally rather than 10 in *A. aequalis*; the rostrum slightly overreaching the end of the first segment of the antennular peduncle, while it not reaching that end in *A. aequalis*; the stylocerite reaching almost to end margin of the antennular peduncle, while the stylocerite not reaching end margin of the second antennular segment in *A. aequalis*; the mesial face of the major chela flattened, while the

major chela sub-cylindrical in *A. aequalis*; the merus of the first chelipeds bearing no spines in all margins, while both the ventral and dorsal margin of the merus of the first chelipeds bearing moderately large spines in *A. aequalis*.

Distribution Xisha Islands, the South China Sea; Ambon (Rumah Tiga), Indonesia; Micronesia; Japan; Australia.

2.2 Genus *Alpheus* Fabricius, 1798

Diagnosis Rostrum usually present, triangular. Orbital hoods frequently with spiniform apex and usually demarked from rostral base by more or less pronounced depressions. Carapace with at least slight rostral carina; pterygostomian angle rounded. Eyes are completely enclosed by orbital hoods except on ventral side. Antennules usually with basal peduncular segment and stylocerite reduced. Antennal scale with blade frequently shorter than lateral spine. First chelipeds very asymmetrical. Large chela variable form, surfaces smooth or with grooves; dactylus usually with pistonlike process, which fits into cavity on fixed finger; carpus hemispherical; merus triangular in section. Small chela sometimes showing marked sexual dimorphism. Second pereiopods having carpus composed of five segments. Third to five pereiopods similar in shape; dactylus simple or biunguiculate. Sixth abdominal somite without articulated plate. Telson usually having the dorsal surface with two pair spines, with posterior margin convex (Banner & Banner, 1966).

Key to species groups of the genus *Alpheus*

1. Dorsal surface of palm of large chela with transverse groove near distally, which extending into triangular and rectangular depressions on the mesial and lateral face of the palm, respectively.....Edwardsii Group
-. Dorsal surface of palm of large chela with or without transverse groove near distally, if with, the groove not extending into triangular and rectangular depressions on the mesial and lateral face of the palm, respectively 2
2. Palm of large chela twisted, and with 3 heavy longitudinal ridges and grooves..... .....Macrocheles Group
-. Palm of large chela without 3 heavy longitudinal ridges and grooves 3
3. Large chela having palm only with slightly longitudinal groove, and dactylus of the form of a single to double-headed hammer; Second pereiopods at times asymmetrical development .....Obesomanus Group
-. Large chela having palm with or without groove, and dactylus without single or double-headed hammer; Second pereiopods symmetrical development.....4
4. Large chela always distinctively compressed.....Brevirostris Group
-. Large chela not distinctively compressed 5
5. Palm of large chela smooth, without grooves .....Crinitus Group
-. Palm of large chela with grooves 6
6. Longitudinal grooves absent on the palm of large chela .....Diadema Group
-. Transverse grooves absent on the palm of lager chela.....Sulcatus Group

Brevirostris Group (Fig. 2.6)

Orbital teeth absent. Large chela always compressed, more or less quadrangular in section; dorsal face of palm with or without transverse groove proximal to dactylus. Dactylus of third pereiopod always not biunguiculate; merus usually unarmed (Banner & Banner, 1982).