Revision of the Pelagic Amphipod Genus *Primno* (Hyperiidea: Phrosinidae)

THOMAS E. BOWMAN

SMITHSONIAN CONTRIBUTIONS TO ZOOLOGY · NUMBER 275

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ABSTRACT

Bowman, Thomas E. Revision of the Pelagic Amphipod Genus *Primno* (Hyperiidea: Phrosinidae). *Smithsonian Contributions to Zoology,* number 275, 23 pages, 13 figures, 1978.—Four species are recognized in the genus *Primno,* previously considered to be monotypic. These species, which are all described and illustrated in detail, are *Primno macropa* Guerin-Meneville, 1836 (the type-species), *P. latreillei* Stebbing, 1888, and 2 new species, *P. brevidens* and *P. johnsoni*. A key to the species is given. The 2 new species are confined to tropical and subtropical waters; *P. brevidens* inhabits cooler water, and the large *P. macropa* is found only at still higher latitudes. Brief discussions are given of associations with siphonophores, food, parasites, and the conspicuous gland in the basipod of pereopod 2.

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Revision of the Pelagic Amphipod Genus *Primno* (Hyperiidea: Phrosinidae)

Thomas E. Bowman

Introduction

The genus *Primno* was proposed by Guérin-Méneville* (1836) for a single new species, *Primno macropa*. A second nominal species, *P. guerinii* White (1847), was a nomen nudum, and *P. macropa* remained the only species in the genus until Stebbing (1888) described 3 new species: *P. antarctica, P. latreillei,* and *P. menevillei*. Stebbing's species were short-lived, being reduced to synonyms of *P. macropa* the following year by Bovallius (1889), and since that time *Primno* has been considered a monotypic genus, although Monod (1926) recognized *P. macropa* var. *menevillei*. Recently Thurston (1976) expressed doubts about the monotypy of *Primno* and suggested the possible existence of a series of physiological races or a group of sibling species. I believe that Thurston's doubts were well founded, and that for 88 years 4 species of *Primno* have been lumped as *P. macropa*.

The present study is based largely on the following collections: (1) From CalCOFI cruises 1, 5, 9, and 20, off the North American west coast from the Columbia River to the southern tip of Baja California (Figures 4, 8, 10). At the stations occupied oblique tows were made from about 70–0 m (Cruises 1, 5, 9) or about 140–0 m (Cruise 20). (2) Specimens from the Climax I Project in the North Pacific Central Gyre (28°N, 155°W), sent to me by Dr. Eric Shulenberger. (3) Collections from the SOND Expedition, near the Canary Islands, sent to me by Dr. Michael Thurston. (4) Collections from the *Ombango* cruises in the Gulf of Guinea, sent to me by Dr. S. Frontier. (5) Specimens from the Bermuda Oceanographic Expeditions, 1931, led by Dr. William Beebe. In addition to these 5 major collections, I have examined samples in collections of the Smithsonian Institution from various localities.

These collections do not give adequate worldwide coverage for a definitive revision of *Primno*. Only the North Pacific can be claimed to be reasonably well covered; the South Pacific and Indian Oceans are barely represented. Despite these shortcomings, the present revision is offered as a step toward better understanding of the taxonomy and distribution of the species of *Primno*, now obscured by the long-

* Guérin modified his name to Guérin-Méneville, and both versions are cited in the zoological literature without regard to the date of the change. Standard reference works usually cite only Guérin-Méneville (e.g., Larousse's *Grand Dictionnaire Universal du XIX^e Siècle, Catalog of the Library of the British Museum (Natural History), Library of Congress* (catalog of printed cards), a practice that is followed herein.

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standing universal misconception that *Primno* is monotypic.

Of the 4 species of *Primno* that I have been able to distinguish, one, which agrees in body length and structure of pereopod 5 with Guérin-Méneville's account, appears to be *P. macropa*. I have not been able to confirm this by comparison with Guérin-Méneville's type-material, since the latter is not in the collections of the Muséum National d'Histoire Naturelle, Paris, and must be considered lost (J. Forest, in litt., 1 July 1976). Efforts to obtain specimens from the type-locality, "les mers du Chile," have been unsuccessful. Thus the designation of *Primno macropa* given herein is not altogether certain.

Because *Primno* is so abundant and widespread, there are more than 50 references to it in the scientific literature. In the majority of these references it is impossible to determine which of the 4 species is referred to; hence accurate and full synonymies cannot be given here. The synonymies given for each species include only those references in which descriptions and/or illustrations contain sufficient information to identify with reasonable assurance the species referred to. The indeterminable references are given as the synonymy of *Primno* incertae sedis.

ACKNOWLEDGMENTS.—For making available collections that were essential to this study, I wish to thank Drs. S. Frontier, Eric Shulenberger, and Michael Thurston. Dr. Shulenberger and Dr. Frank Ferrari searched thru plankton samples from Pacific South American waters in unsuccessful attempts to obtain topotypes of *Primno macropa;* their efforts are much appreciated. The manuscript benefited from a careful review by Ms. Anne Cohen. My drawings were arranged and mounted by Ms. Martina Picciano.

PHROSINIDAE

Primno Guérin-Méneville

Primno Guérin-Méneville, 1836:2–3. [Type-species, by monotypy, *Primno macropa* Guérin.]
Euprimno Bovallius, 1889:397.
Euprimnus Fraser, 1961:43 [lapsus calami].

ETYMOLOGY.—"Nymphe, fille de l'Océan" (Guérin-Méneville, 1836). Gender feminine. Bovallius (1889:397) proposed changing the name to *Euprimno,* "because *Primno* was previously applied to a genus of Crustacea by Rafinesque-Schmaltz in 1814." However, as Stebbing (1888) pointed out, Rafinesque's *Primno* was a nomen nudem, one of 11 names simply listed without further information in a paragraph that began, "Obs. Voici les noms des autres N. G. et N. Esp. des Familles Aselotia et Oniscia." Thus Bovallius' action was invalid, and the correct name of the genus is *Primno.*

DIAGNOSIS.—Head produced into single very short rostrum. Pereonites 1 and 2 separate. Pereonite 7 and pleonites 1 and 2 produced posteriorly into middorsal spines. Posteroventral corner of pleonite 3 produced posteriorly into spine. Telson much narrower than urosome. Antenna 1 of ♀ longer than head. Antenna 2 of ♀ reduced to a tubercle. Pereopod 1 basis with large gland with duct running from center of gland to tip of dactyl. Pereopods 3, 4, and 6 simple with some teeth on margin of carpus. Pereopod 5 prehensile, entire anterior margin of carpus dentate, with several long teeth separated by groups of short teeth; propus shorter than carpus. Pereopod 7 with all segments present; dactyl digitiform, with ring of spinules at apex in ♀. Uropods pointed; uropods 2 and 3 with teeth on outer margins. Gills without folds. (Modified from Bowman and Gruner, 1973:40.)

Key to the Species of *Primno*

1. Longer teeth on anterior margin of carpus of pereopod 5 about ⅓ or less width of carpus..... ***P. brevidens,*** new species
   These teeth nearly as long as width of carpus 2
2. Proximal tooth on anterior margin of carpus of pereopod 5 short. Posterior margin of propus of pereopod 6 with clearly visible setae ..... ***P. macropa***
   Proximal tooth on anterior margin of carpus of pereopod 5 long. Posterior margin of propus of pereopod 6 apparently smooth (minute setae visible under high magnification) 3
3. Basis of pereopod 7 about 1.2 × length of remaining segments combined. Total length of adult ♀ up to 8.0 mm ..... ***P. johnsoni,*** new species
   Basis of pereopod 7 more than 1.5 × length of remaining segments combined. Total length of adult ♀ up to 6.5 mm ..... ***P. latreillei***

Primno macropa Guérin-Méneville

FIGURES 1–2, 3*a–c*, 4

Primno macropa Guérin-Méneville, 1836:4, pl. 17: fig. 1a–f.—Bovallius, 1887:28.—?Spandl, 1927:168–169.—Barnard, 1930: 424–425 [at least larger specimens—up to 12 mm]; 1932: 287–288 [except 6 and 7 mm ovig. ♀], pl. 1: fig. 8.—Mackintosh, 1934, passim.—Hardy and Gunther, 1935, passim.—Thorsteinson, 1941:93–94, figs. 98–102.—Hurley, 1955:172–174, figs. 219–235; 1969:33, map 7.—Vinogradov, 1956:209; 1962:22.—Yoo, 1971a:59 [part]; 1971b: passim; 1972a: passim [part]; 1972b:174–175 [part.].—Sanger, 1973:20; 1974:7.—Lorz and Pearcy, 1975: 1445–1446.

Primno menevillei Stebbing, 1888:1447–1448, pl. 179, B.

Primno antarctica Stebbing, 1888:1448–1451, pl. 209, B.

Euprimno macropus (Guérin-Méneville).—Bovallius, 1889:400–407 [part].—Walker, 1907:9.—Wailes, 1929:161; 1931:41; 1933:9.—Behning, 1939:363.

Euprimno abyssalis Bowman.—Fulton, 1968:104, 109.

Euprimno macropa Guérin-Méneville var. *menevillei* Stebbing.—Monod, 1926:50–51, fig. 49.

ETYMOLOGY.—From Guérin-Méneville's center heading, "P. à grands pieds. *P. Macropa.* Guérin," it is clear that the specific name "macropa" is composed of μαχροσ (large) and ποδσ (foot), and should have been transliterated as *macropus*. Guérin-Méneville apparently changed its ending from *-us* to *-a* to make it agree in gender with the feminine *Primno*. Bovallius (1889) was linguistically correct in changing *macropa* to *macropus,* but subsequent authors continued to use *macropa,* perhaps intimidated by Stebbing's (1904) admonition "that *macropus* is a more scholarly form than *macropa* must be admitted, but the practice of polishing and improving the names which our scientific ancestors invented has to my mind the same effect as daylight upon Melrose Abbey, where the rays of the sun 'gild but to flout the ruins grey.'"

Stebbing's view is supported by Article 32(a)(ii) of the *International Code of Zoological Nomenclature,* which prohibits correction of an original spelling because of incorrect transliteration. Guérin-Méneville's spelling is therefore the "correct original spelling" as defined by Article 32(a).

DIAGNOSIS.—Body narrow, up to 21 mm in length. Rostrum truncate in dorsal view. Pereon about 3.3× as long as head, slightly longer than pleon. Middorsal spines and posteroventral spine of pleonite 3 sharper and more pronounced than in other species of *Primno*. Antenna 1 slightly longer than head. Buccal mass about ⅔ height of head. Pereopod 5 basis nearly 3× as long as broad; carpus slightly longer than basis, proximal 1–2 teeth short, long teeth slightly shorter than width of carpus; short teeth about as long as width of gently curved propus. Peropod 6 basis slightly more than ⅓ as wide as long, narrowed proximately, proximal part of anterior margin concave; ischium, merus and carpus narrower than in other species of *Primno;* propus armed with spinules on anterior and posterior margins. Pereopod 7 basis about as long as remaining segments combined. Uropod 3 with well developed medial shoulder.

REMARKS.—The large size, short proximal teeth on the carpus of pereopod 5, and the spinulose margins of the propus of pereopod 6 make identification of *P. macropa* relatively simple. None of the other species reaches more than 9 mm in length, and most are considerably shorter. The usual length of ovigerous females of *P. macropa* in the North Pacific is 12–15 mm. The greatest length reported is 21 mm (Vinogradov, 1956) for females from the western Bering Sea. Guérin-Méneville (1836) reported a length of 12–14 mm for his specimen(s).

The shape of its uropod 3 shows that *Primno antarctica* ("three twentieths of an inch" = 3.8 mm) is clearly juvenile. Uropod 3 of juvenile *Primno* are narrow with sharp apices, in contrast to the broad shape in mature individuals. This difference was pointed out by Bovallius (1889:400) and confirmed by Stebbing (1904). Stebbing illustrated a juvenile, only 1.4 mm in length, with an articulated process on the lateral margin of uropod 3 that he interpreted as an outer ramus since a muscle was inserted on it. A juvenile *P. johnsoni* from Bermuda, removed from its maternal marsupium, has uropods closely matching those of Stebbing's juvenile (Figure 13*i*). A later developmental stage is shown in a 2.3 mm *P. brevidens* (Figure 7*e*). It resembles Stebbing's *P. antarctica* in having a narrow pointed uropod 3 with a tooth on the lateral margin. As Stebbing (1904) suggested, this tooth may represent the outer ramus, now coalesced.

The short proximal teeth of the pereopod 5 carpus of *P. antarctica* (Figure 3*k*) places it in *P. macropa*. Whether the proximal teeth are long or short is apparent in very young stages, although marsupial young have a smooth carpus except for a pair of distal teeth (Figure 13*e*). Stebbing's (1904) 1.4 mm *Primno* had only 3 long teeth, and Bovallius (1899) recorded a 1.5 mm specimen in which the right pereopod 5 has 4 long teeth and the left

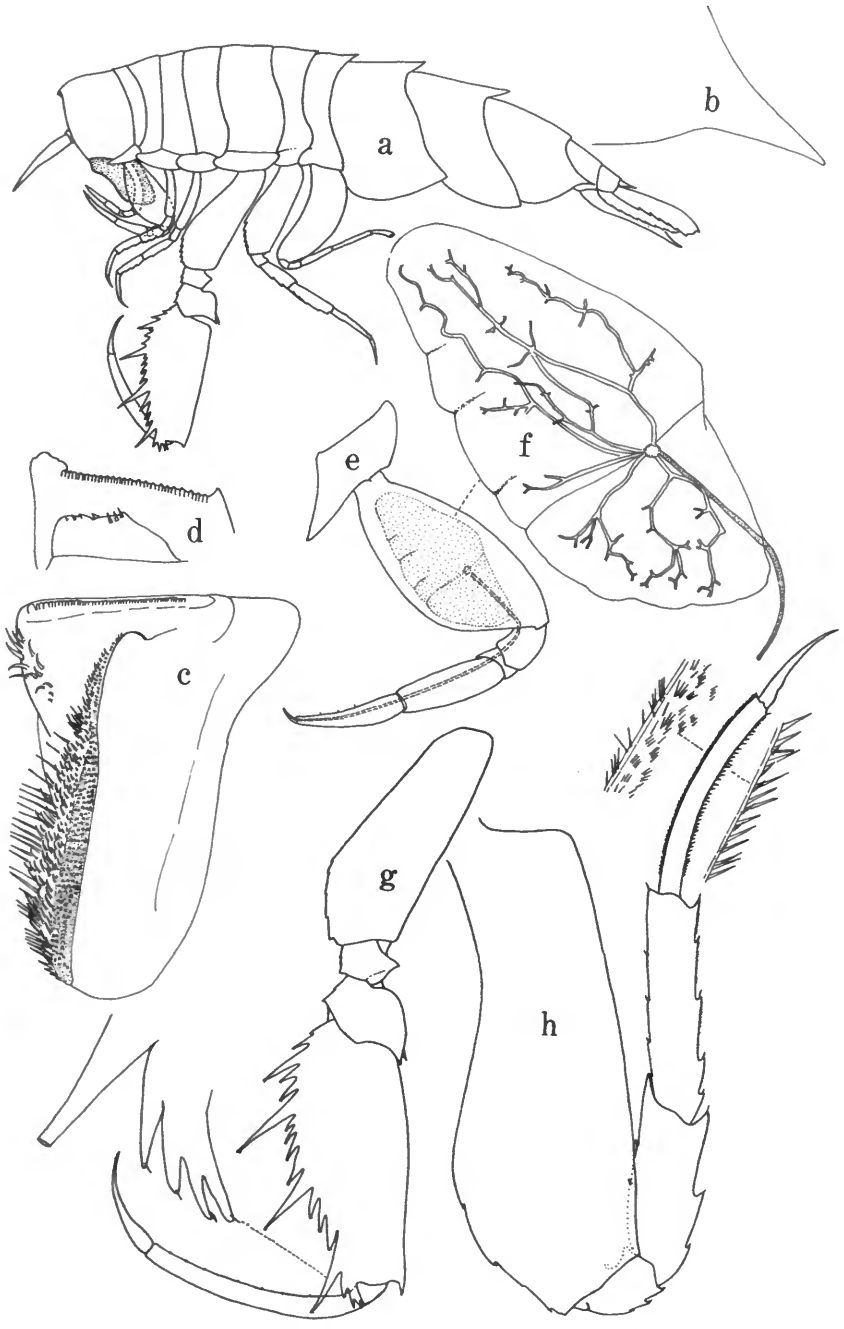

FIGURE 1.—*Primno macropa*, ♀: *a*, habitus, lateral; *b*, posteroventral corner of pleonite 3; *c*, right mandible; *d*, incisor and lacinia of left mandible; *e*, pereopod 2; *f*, gland in basis of pereopod 2; *g*, pereopod 5; *h*, pereopod 6.

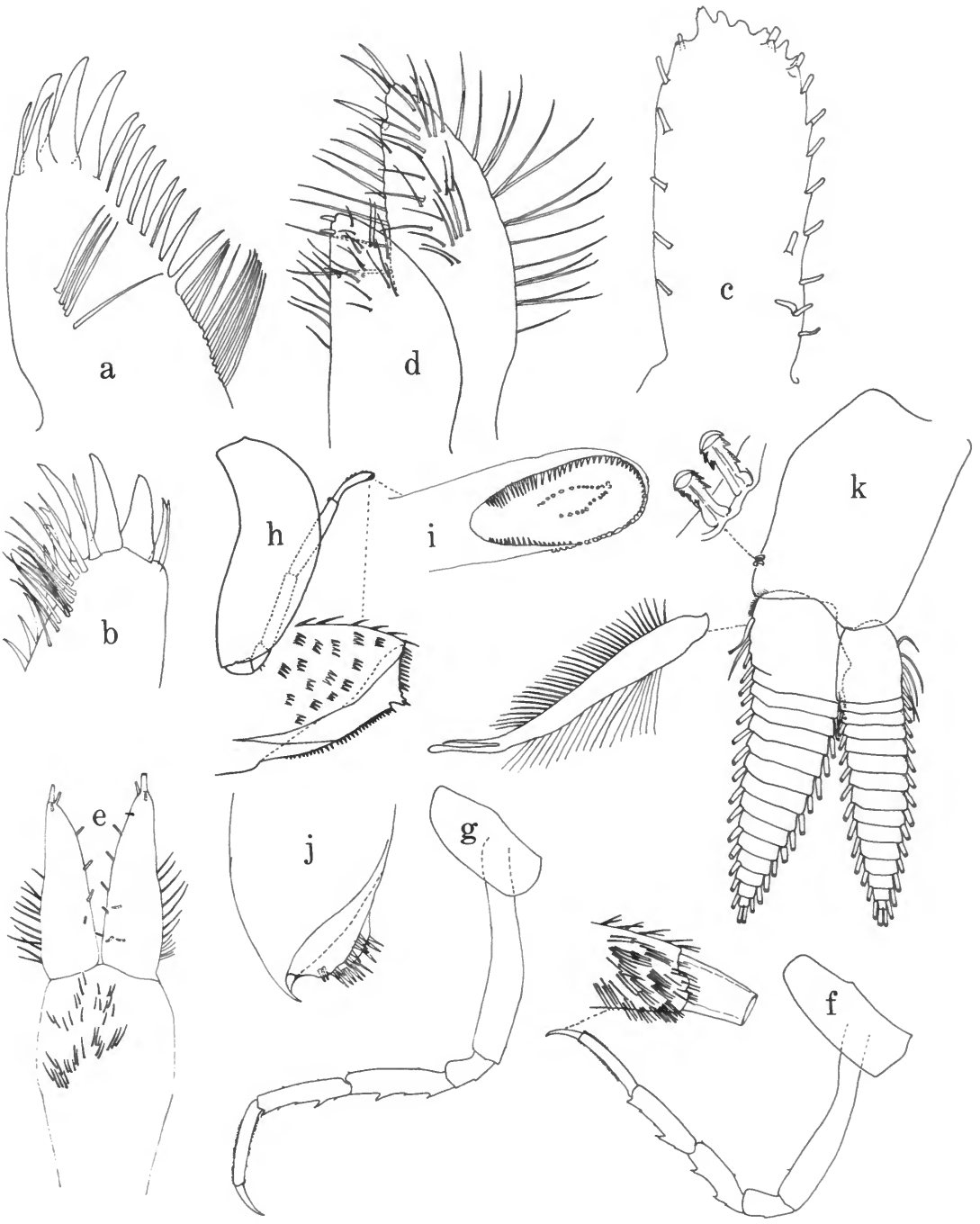

FIGURE 2.—*Primno macropa*, ♀: *a*, maxilla 1, outer lobe, anterior; *b*, same, posterior; *c*, maxilla 1, palp; *d*, maxilla 2; *e*, maxilliped (inner lobe omitted); *f*, pereopod 3; *g*, pereopod 4; *h*, pereopod 7; *i*, *j*, same, apex of dactyl; *k*, pleopod 3, anterior.

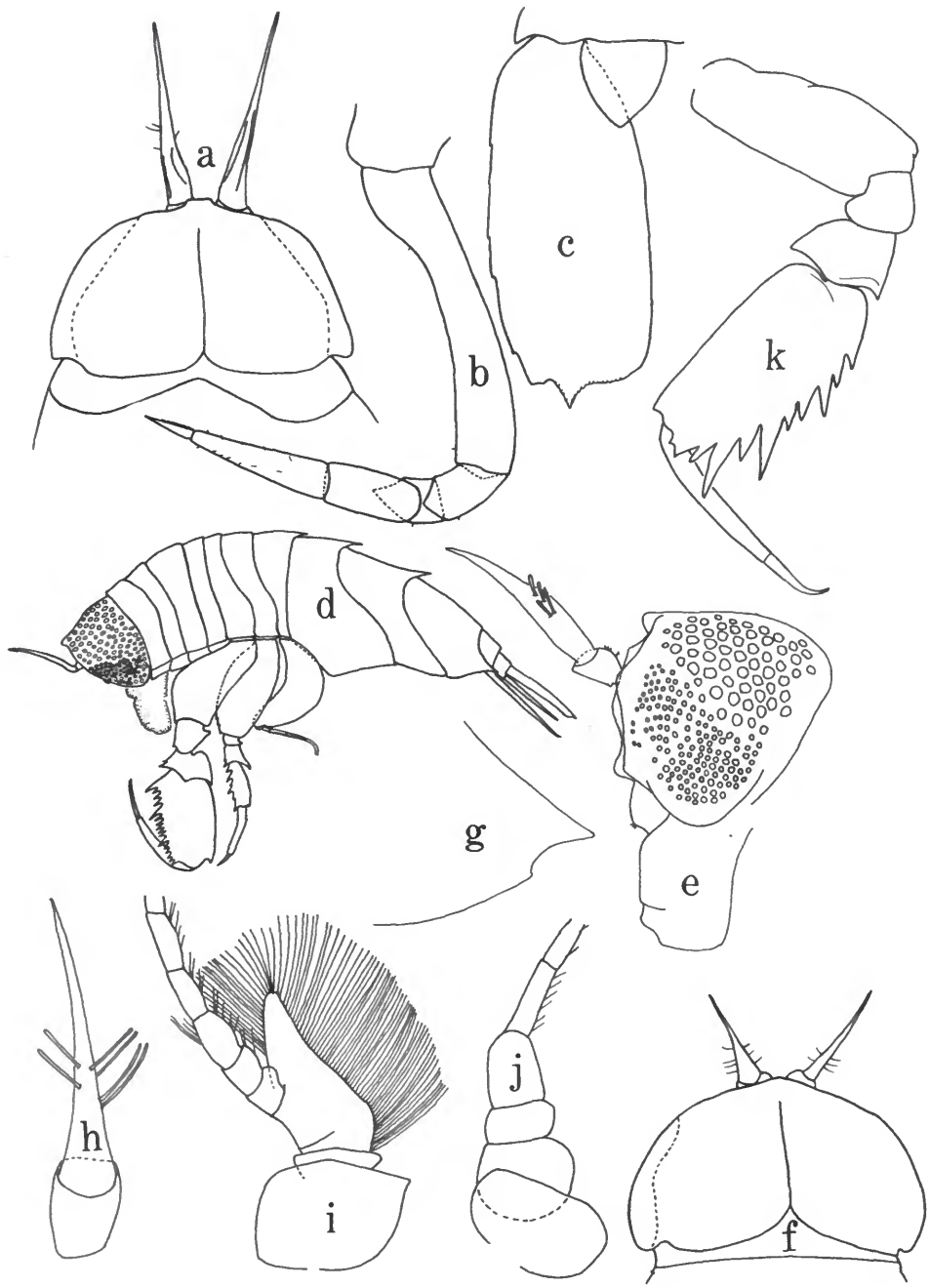

FIGURE 3.—*Primno macropa*, ♀: *a*, head, dorsal; *b*, pereopod 1; *c*, telson and uropod 3. *Primno brevidens: d*, ♀ habitus, lateral; *e*, ♀ head, lateral; *f*, same, dorsal; *g*, posteroventral corner of pleonite 3; *h*, ♀ antenna 1, dorsal; *i*, ♂ antenna 1, proximal segments, lateral; *j*, ♂ antenna 2, proximal segments, lateral. *Primno antarctica*, ♀ syntype: *k*, pereopod 5.

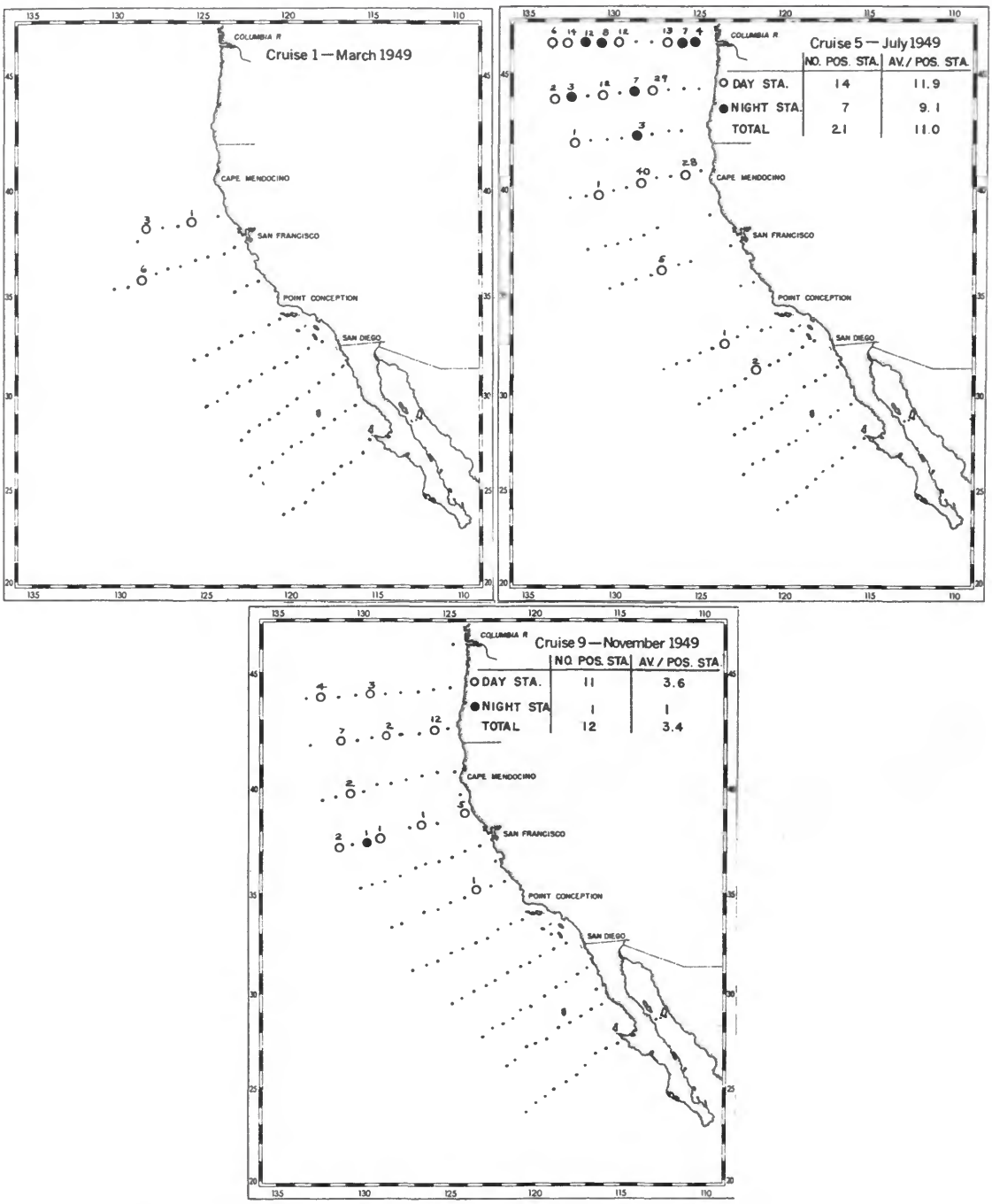

FIGURE 4.—Distribution of *Primno macropa* on 3 CalCOFI cruises, showing numbers of specimens per 1000 m³ of water filtered.

pereopod 5 has a short proximal tooth followed by 3 long teeth. It appears that the long teeth are the first to be discernible as such, but the short teeth soon follow. Figure 5*j* shows the pereopod 5 of a 2.3 mm female *P. brevidens;* as in the adult the proximal spine is long.

In *P. menevillei* the short proximal tooth of the pereopod 5 carpus and the shape of the uropod 3 apex reinforces Bovallius' opinion that this species is identical with *P. macropa.*

At the time I was preparing my doctoral thesis (Bowman, 1953), I had not seen Guérin-Méneville's original account of *P. macropa* and based my concept of this species on Stebbing's (1886) description and illustrations of the species herein referred to *P. brevidens.* I considered the large *Primno* to be a new species, and gave it the name *Euprimno abyssalis.* Plans to publish the present review were delayed, and the inevitable happened; Fulton (1968) made the name *abyssalis* available by quoting from my thesis to the effect that Thorsteinson's (1941) figures of *P. macropa* were referable to *E. abyssalis.* This action makes *E. abyssalis* a junior synonym of *P. macropa.*

DISTRIBUTION.—South Atlantic, S of 44°32'S (Barnard, 1932); Antarctic (Barnard, 1930); S of Australia, 48°18'S (Stebbing, 1888); New Zealand (Hurley, 1955); Chile (Guérin-Méneville, 1836); Japan, Okhotsk and Bering Seas (Behning, 1939); western Bering Sea (Vinogradov, 1956); SE Bering Sea (Sanger, 1974); Gulf of Alaska and off Nanaimo, B.C. (Thorsteinson, 1941); Strait of Georgia, British Columbia (Fulton, 1968); British Columbia (Wailes, 1929, 1931, 1933); British Columbia and Washington (Sanger, 1973); Oregon (Lorz and Pearcy, 1975).

In the CalCOFI area *P. macropa* was not taken on Cruise 20, which did not extend north of Point Conception. In the other cruises it occurred almost entirely north of Point Conception and was most abundant at the northern stations. Only 3 adults, all females, were taken on these CalCOFI cruises; the remaining specimens were juveniles, 3–7 mm long. The adult population presumably lives at greater depths than the 70–0 m layer sampled.

The collections of the Smithsonian Institution contain a ♀ from *Eltanin* station 138, N of the South Shetland Islands (ca. 62°S, 61°W). The head is missing, and the body length without the head is about 16 mm.

Primno brevidens, new species

FIGURES 3*d–j,* 5–8

Primno macropa Guérin-Méneville.—Stebbing, 1888:1441–1445, pl. 178.

ETYMOLOGY.—From the Latin "brevis" (short) plus "dens" (tooth), alluding to the relative shortness of the carpal teeth on pereopod 5.

DIAGNOSIS.—Body rather stout, up to 9 mm in length. Rostrum very short, rounded in dorsal view. Pereon 2.5–3× as long as head, subequal in length to pleon. Antenna 1 about as long as head. Buccal mass about half height of head. Pereopod 5 basis slightly more than twice as long as broad; carpus subequal in length to basis, proximal tooth long, long teeth ⅓ or less as long as width of carpus, short teeth about half as long as width of curved propus. Pereopod 6 basis about twice as long as wide, anterior margin convex throughout; posterior margin of propus apparently bare, but with minute spinules visible only under high magnification. Pereopod 7 basis about as long as remaining segments combined. Uropod 3 apex less abruptly pointed than in *P. macropa.*

TYPES.—All from CalCOFI Cruise 5, Station 901, off San Diego, California, 32°39'N, 118°09'W, 1 Jul 1949, 0035 hrs PST, oblique tow 68.3–0 m. Female holotype USNM 170203; 12♀, 6♂ paratypes USNM 170204.

DISTRIBUTION.—*Challenger* station 287, South Pacific, 36°32'S, 132°52'W. In addition to its occurrence in the CalCOFI area (discussed below) I have identified it in collections of the *Ombango* in the SE Gulf of Guinea.

P. brevidens is one of the most abundant amphipods in the CalCOFI area, with the largest numbers tending to occur at the inner stations. In the 1949 cruises the southern boundaries roughly paralleled 30 m isotherms: 15°C in March, 18°C in July, and 20°C in November (Figure 8). In November 1950, however, it extended into much warmer water, more than 26°C at 2 stations. The greater southern penetration might be explained by the greater depth sampled in 1950, about 140–0 m, in contrast to about 70–0 m in 1949. It is likely that *P. brevidens* frequents deeper and colder water in the southern part of its range.

P. brevidens was much more abundant in July

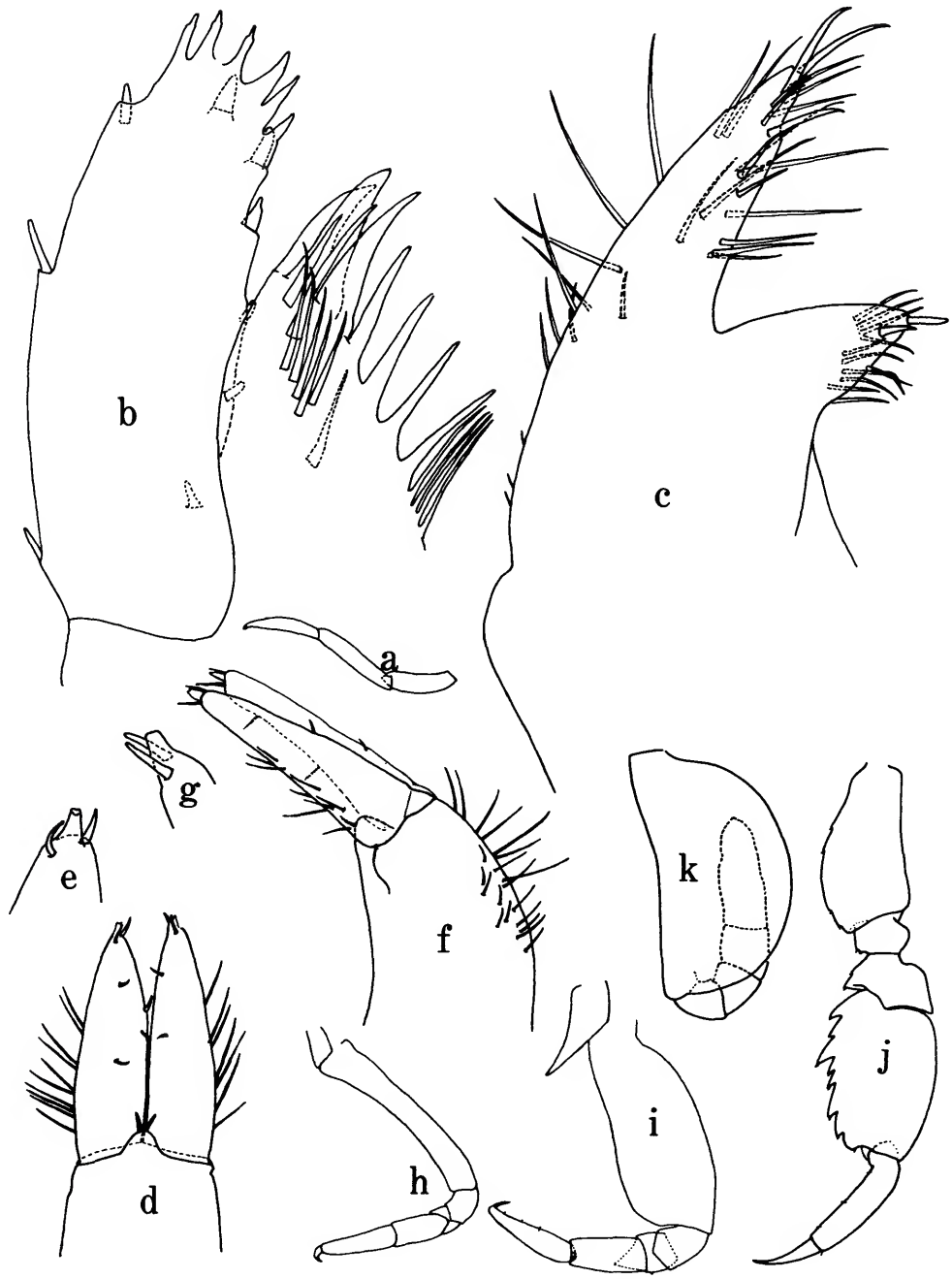

FIGURE 5.—*Primno brevidens*, ♂: *a*, palp of mandible. ♀: *b*, maxilla 1; *c*, maxilla 2; *d*, maxilliped, anterior; *e*, same, lateral; *f–g*, anterior and lateral aspects of apex of maxilliped outer lobe; *h*, pereopod 1; *i*, pereopod 2; *j*, pereopod 5 of juvenile, 2.3 mm; *k*, pereopod 7 of same juvenile.

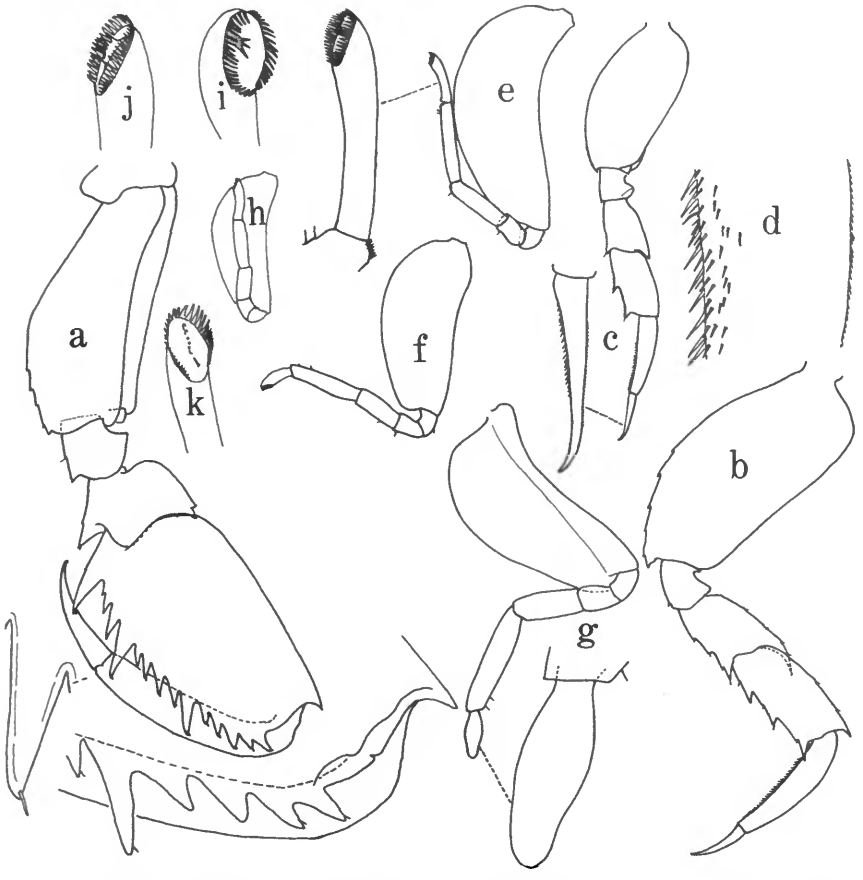

FIGURE 6.—*Primno brevidens*: *a*, ♀ pereopod 5; *b*, ♀ pereopod 6; *c*, ♂ pereopod 6; *d*, same enlarged section of propus; *e*, ♀ pereopod 7; *f*, subadult ♂ pereopod 7; *g*, adult ♂ pereopod 7; *h*, juvenile ♀ pereopod 7; *i–k*, ♀ pereopod 7, spinulose ring of dactyl of 3 different specimens.

(61.2 per positive station) than in March (18.0) or November (18.5). A possible explanation is afforded by the change in vertical distribution. In both March and November the average number per positive station was about twice as great for the night stations as for the day stations. Hence at least during the day much of the population was below the depth sampled. In July the average number per positive station was about the same for day and night stations. Either the population had increased in numbers, was distributed over the same depth range, and had ceased vertical movements; or it had migrated closer to the surface so that most of it was being sampled in both day and night net tows. The latter interpretation seems more reasonable.

Primno latreillei Stebbing

FIGURES 9–10

Primno latreillei Stebbing, 1888:1445–1447, pl. 179A.

ETYMOLOGY.—"The specific name is given in honour of the celebrated French naturalist, Latreille" (Stebbing, 1888:1447).

DIAGNOSIS.—Body slender, length of ovigerous ♀ 3.7–6.5 mm. Rostrum short, pointed. Pereon about

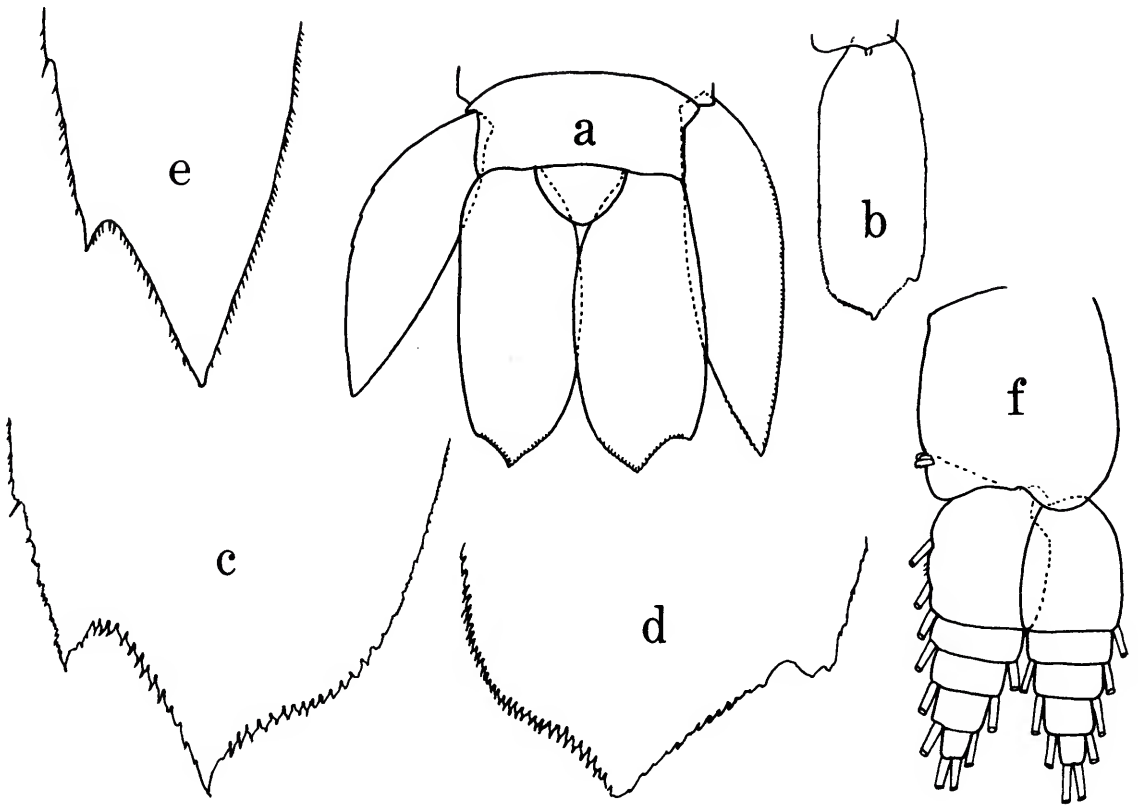

FIGURE 7.—*Primno brevidens*, ♀: *a*, telson and uropods; *b*, uropod 3; *c–d*, apex of right and left uropod 3 (from different individuals); *e*, apex of left uropod 3, juvenile, 2.3 mm; *f*, pleopod 3 of same juvenile.

3.5× as long as head, about as long as pleon. Female antenna 1 about ⅓ longer than head. Buccal mass about half height of head. Pereopod 5 basis slightly less than 3× as long as broad; carpus subequal in length to basis, proximal tooth long, long teeth nearly as long as width of carpus, short teeth subequal in length to width of nearly straight propus. Pereopod 6 like that of *P. brevidens*. Female pereopod 7 basis more than 1.5× length of remaining segments combined; ♂ basis about equal to remaining segments combined. Uropod 3 similar to that of *P. brevidens*.

TYPES.—Syntypes, British Museum (Natural History) 89–5–15–243, mounted on 4 slides as follows: ♂ head; ♂ pleon; ♂ gnathopods 1–2 and pereopods 1–5; ♀. These are the remains of Stebbing's 2 ♂ and 1 ♀ from Challenger station 164D, off Sidney, Australia, 34°3'S, 152°20'E, surface temperature 67.5°F.

REMARKS.—Identification of my material with Stebbing's *P. latreillei* is not altogether satisfactory. Stebbing's description and illustrations are based almost entirely on the 2 immature ♂ syntypes, and most of the information given is of little help at the specific level. Stebbing seemed to attach most importance to the structure of pereopods 5 and 7. Pereopod 5 of *P. latreillei* agrees closely with those of my specimens, but in pereopod 7 illustrated by Stebbing the basis is only about ¼ longer than the remaining segments combined, whereas in my specimens it is more than ½ longer. This discrepancy might favor identifying *P. latreillei* with the larger species described herein as *P. johnsoni*, but the shape of the pereopod 7 basis of *P. latreillei* is quite

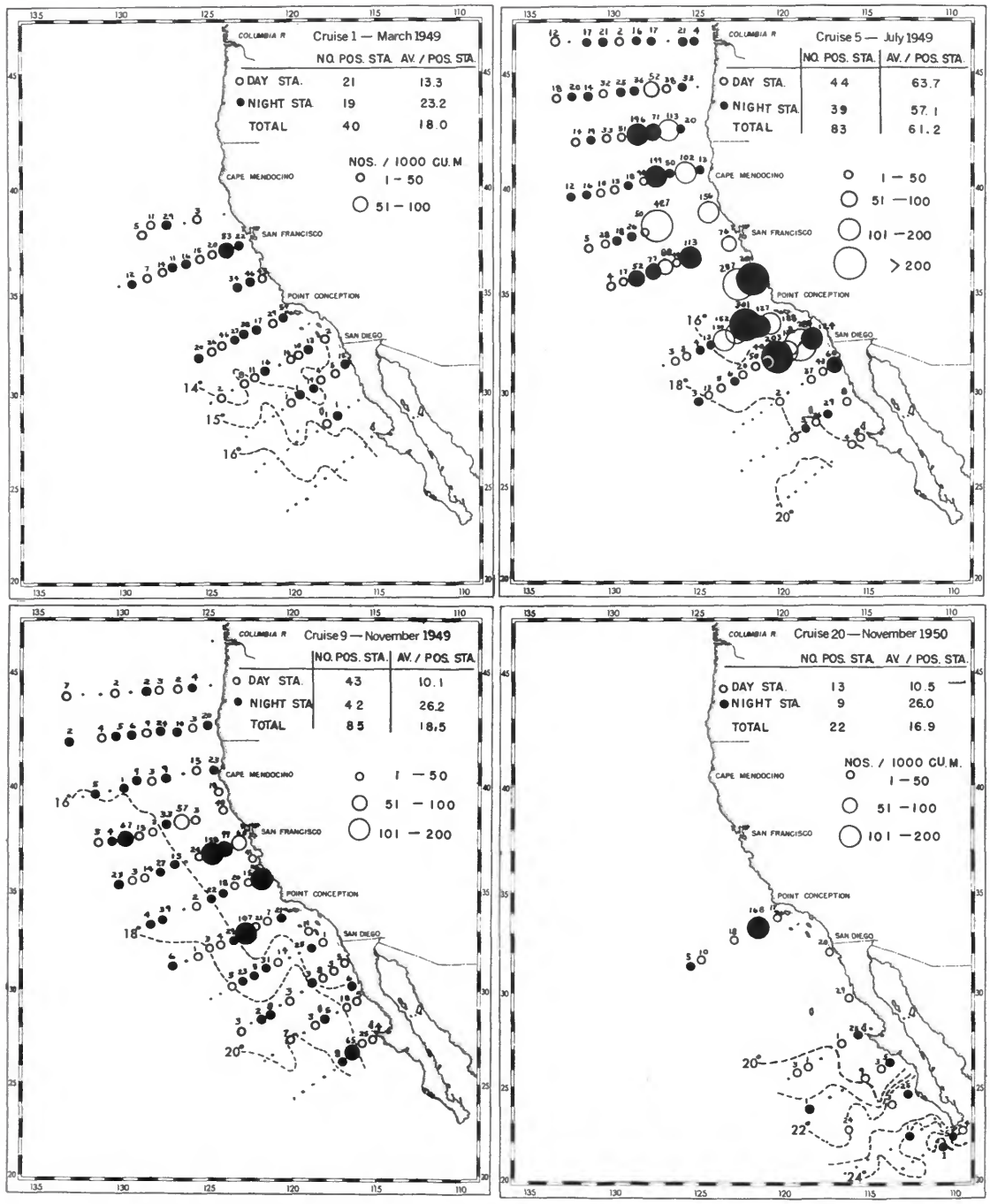

FIGURE 8.—Distribution of *Primno brevidens* on 4 CalCOFI cruises, showing numbers of specimens per 1000 m³ of water filtered. Some isotherms at depth of 30 m are shown.

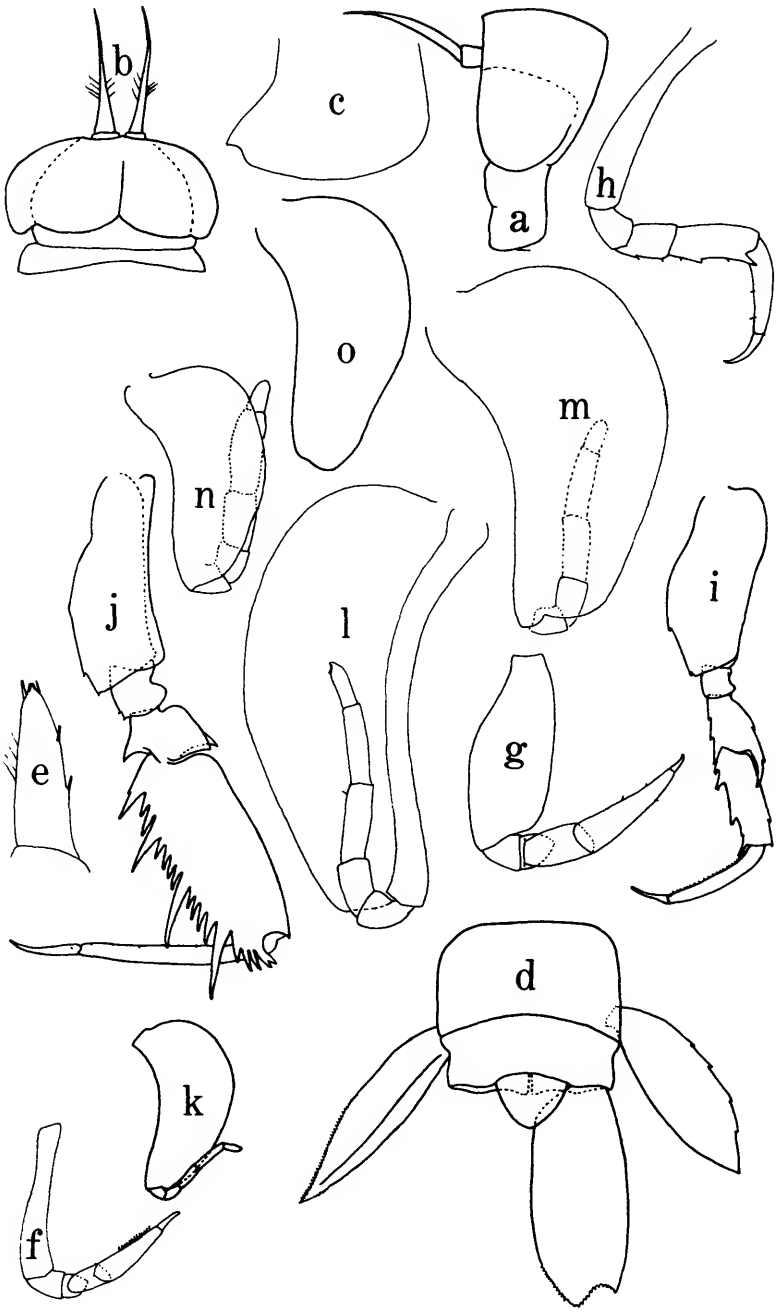

FIGURE 9.—*Primno latreillei*, ♀: *a–b*, head, lateral and dorsal; *c*, posteroventral corner of pleonite 3; *d*, telson and uropods; *e*, maxilliped, outer lobe; *f*, pereopod 1; *g*, pereopod 2; *h*, pereopod 3; *i*, pereopod 6; *j*, pereopod 5; *k*, pereopod 7 (California); *l–m*, pereopod 7 (Gulf of Guinea). ♂: *n*, pereopod 7, juvenile (3.3 mm) (Gulf of Guinea). ♀: *o*, pereopod 7, basipod, syntype, *Challenger* station 164D (E of Australia).

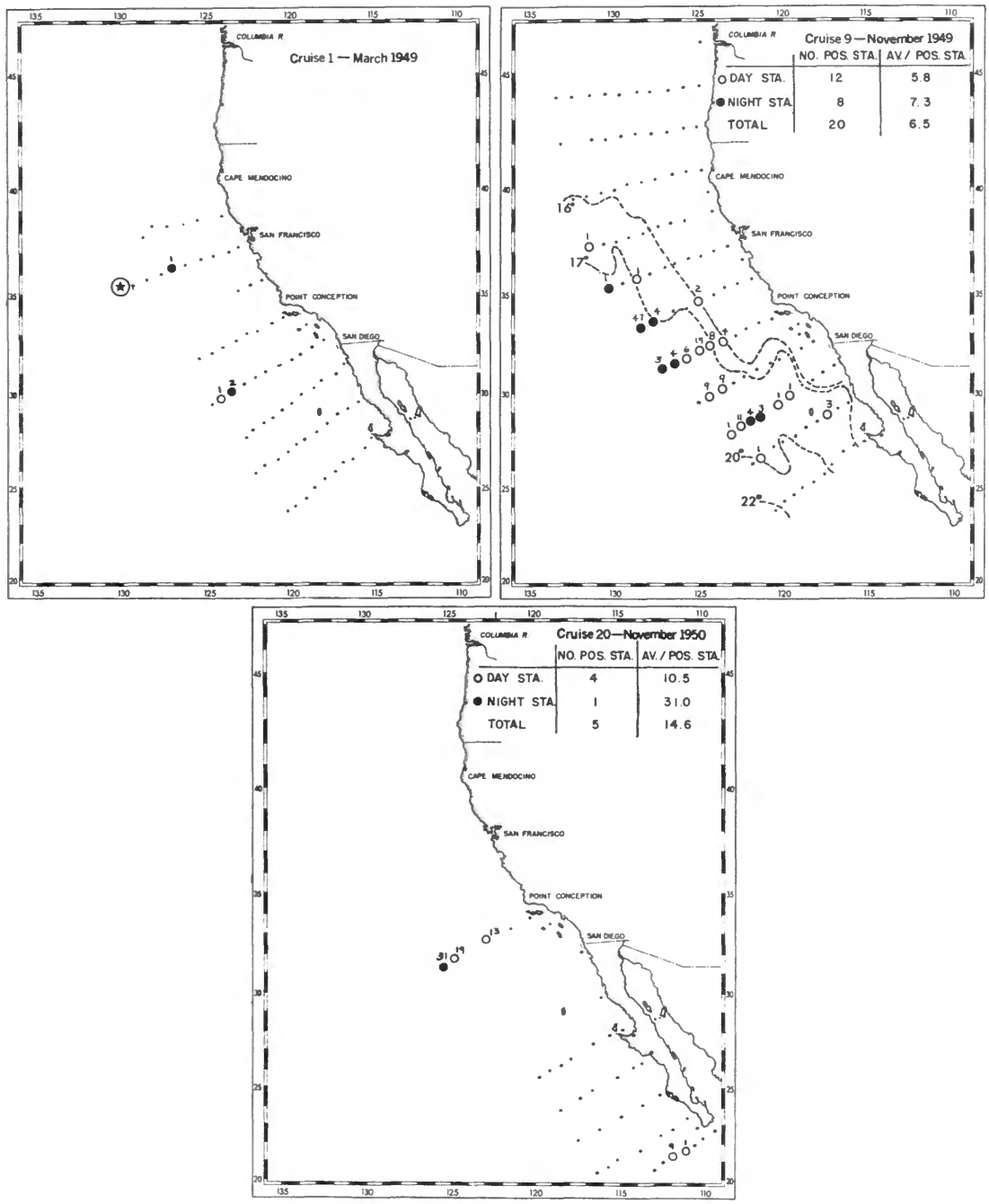

FIGURE 10.—Distribution of *Primno latreillei* on 4 CalCOFI cruises, showing numbers of specimens per 1000 m³ of water filtered. Some isotherms at depth of 30 m are shown for Cruise 9. Star on Cruise 1 map shows Cruise 5 (July) station where *P. latreillei* was collected.

unlike the pyriform basis in *P. johnsoni*. In my opinion the shape of the basis is less likely to vary than the combined length of the remaining segments, hence I have assigned the smaller species to *P. latreillei*.

I borrowed the type-material of *P. latreillei* from the British Museum (Natural History) through the kindness of Dr. Roger J. Lincoln. The mountant had deteriorated so badly that I could not make out clearly the details of the mounted appendages, but I was able to confirm the shape of the pereopod 7 basis (Figure 9o).

DISTRIBUTION.—Off Sydney, Australia. In addition to its occurrence in the CalCOFI area (discussed below) I have identified it in collections of the *Ombango* in the southeast Gulf of Guinea, and in collections made by the Hebrew University of Jerusalem in the eastern Mediterranean and the Red Sea.

In the CalCOFI area *P. latreillei* occurred in limited numbers on all 4 cruises studied. It was never abundant, and generally occurred well offshore. In Cruise 5 (July) it occurred at only 1 station, but in Cruise 9 (November) it was taken at 20 stations, and its northern boundary roughly paralleled the 17°C isotherm at 30 m (Figure 10).

Only a small part of the *P. latreillei* population extends into the CalCOFI area, but its distribution there is consistent with that of a "Central" species (Brinton, 1962; McGowan, 1971, 1974). Additional evidence that *P. latreillei* is a Central species is given by its abundance in the North Pacific Central Gyre, where it is one of the most numerous hyperiids (Shulenberger, 1977).

Primno johnsoni, new species

FIGURES 11–13

Primno macropa Guérin-Méneville.—Dakin and Colefax, 1940: 123, fig. 210.—Shoemaker, 1945:234, 236.—Thurston, 1976: 427–431.

Euprimno macropus (Guérin-Méneville).—Chevreux and Fage, 1925:416–417, fig. 411.

ETYMOLOGY.—Named for Dr. Martin W. Johnson, in recognition of his many significant contributions to our knowledge of zooplankton.

DIAGNOSIS.—Closely resembling *P. latreillei* in almost all respects, but larger, up to 9 mm. Female pereopod 7 basis broader proximally, hence more pyriform in shape; about 1.2× length of remaining segments combined. Uropod 3 distal end with well developed medial shoulder.

TYPES.—All from Beebe's "cylinder," an area about 8 mi in diameter located about 5 mi SE of Bermuda (Beebe, 1931); collections made during Bermuda Oceanographic Expeditions, 1931, led by William Beebe. Holotype: USNM 170234 ovigerous ♀, 7.8 mm, net 1249, 1 Sep 1931, towed at 1280 m. Paratypes: Net 1249, 2 ♀ (USNM 170235); Net 1072, 10 Jul 1931, 549 m, 6 ♀ (USNM 170236); Net 1088, 15 Jul 1931, 549 m, 17 ♀ (USNM 170237); Net 1218, 24 Aug 1931, 1280 m, 2 ♀ (USNM 170238); Net 1247, 1 Sep 1931, 914 m, 17 ♀, 2 ♂ (USNM 170238); Net 1248, 1 Sep 1931, 1097 m, 2 ♀, 1 ♂ (USNM 170240); Net 1312, 16 Sep 1931, 732 m, 19 ♀, 2 ♂ (USNM 170241) (data from Beebe, 1932).

REMARKS.—*P. johnsoni* is very close to *P. latreillei*. If adequate material eventually shows a continuum in the characters used to separate them, it will be necessary to combine them under *P. latreillei*. At present it seems best to keep them separate to prevent a possible loss of zoogeographic information such as has resulted in the past from lumping all forms of *Primno* under *P. macropa*. I have had available only the Beebe Bermuda material (Shoemaker, 1945) in the collections of the Smithsonian Institution, and a large series from the SOND Cruise, 1965, kindly loaned to me by Dr. Michael H. Thurston.

DISTRIBUTION.—Off New South Wales, Australia (Dakin and Colefax, 1940); Bermuda (Shoemaker, 1945); Canary Islands (Thurston, 1976).

Primno incertae sedis

Primno macropa Guérin-Méneville—Stebbing, 1904:38–40, figs. 1–2.—Tattersall, 1906:25.—Stewart, 1913:258.—Spandl, 1924a:25; 1924b:266–267; 1927:168–169.—Barnard, 1925:375; 1931:128; 1937a:187; 1937b:4.—Pirlot, 1939:40.—Hurley, 1956:17–18; 1960a:113; 1960b:280.—Bogorov, 1958:156.—Bary, 1959: passim.—Irie, 1959:32.—Ruffo, 1959:34.—Kane, 1962:307–309, fig. 5.—Siegfried, 1963:9.—Pillai, 1966:216–218, fig. 9.—Brusca, 1967a:386–387; 1967b:450–451; 1973:17.—Dick, 1970:63, fig. 9.—Bradford, 1972:68.—Repelin, 1972: passim.—Tashiro and Jossi, 1972:9, 19, 31.

Euprimno macropus (Guérin-Méneville).—Chevreux, 1900:148.—Lo Bianco, 1902:419, 423, 425, 426, 447; 1903:198.—Vosseler, 1901:87–88, pl. 8, fig. 21.—Chilton, 1921:234.—Stephensen, 1924:143–146, chart 22; 1947:77.—Schellenberg, 1927: 643–644, fig. 46.—Pirlot, 1929:130–131; 1930:22.—Bulycheva, 1955:1048.—Hure, 1955:50–51; 1961:34.—Hure, Scotto di Carlo, and Basile, 1971: passim.—Reid, 1955:23.—Vives, 1966:96; 1968:460.—Vives, Santamaria, and Trepat, 1975: 58–59.—Jossi, 1972:120, fig. 12.—Daniel, 1973: passim.

Euprimno macropa (Guérin-Méneville).—Walker, 1909:52.

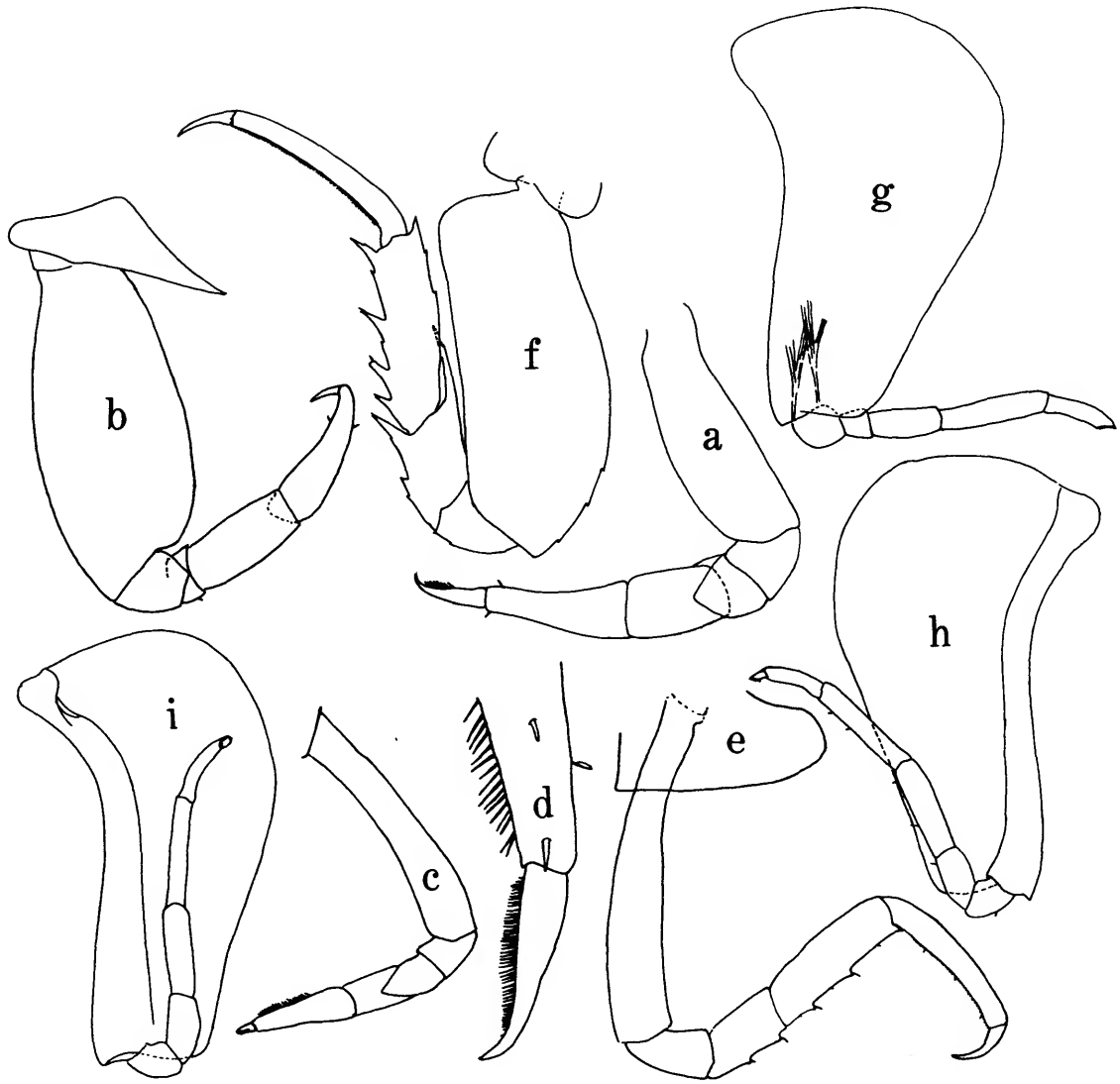

FIGURE 11.—*Primno johnsoni*, ♀: *a*, pereopod 1 (Bermuda); *b*, pereopod 2 (Bermuda); *c*, pereopod 1 (Canary Is.); *d*, apex of same, slightly flattened under cover glass; *e*, pereopod 3 (Canary Is.); *f*, pereopod 6 (Bermuda); *g–h*, pereopod 7 (Canary Is.), lateral and medial; *i*, pereopod 7 (Bermuda).

Primno macropus Guérin-Méneville.—Chevreux, 1935:181–182.—Gamulin, 1948:179.

Euprimnus macropus (Guérin-Méneville).—Fraser, 1961:43 [lapsus calami].

REMARKS.—The widespread distribution of *Primno* in the world oceans, except the Arctic and the Atlantic north of about 60°N, is well documented, but the majority of published records of *Primno* do not give information that will permit specific identification. Consequently, distributions of the 4 species of *Primno* are poorly known. *P. macropa* lives at higher latitudes and in cooler waters than the other species, being found in subarctic and subantarctic parts of the Pacific and in

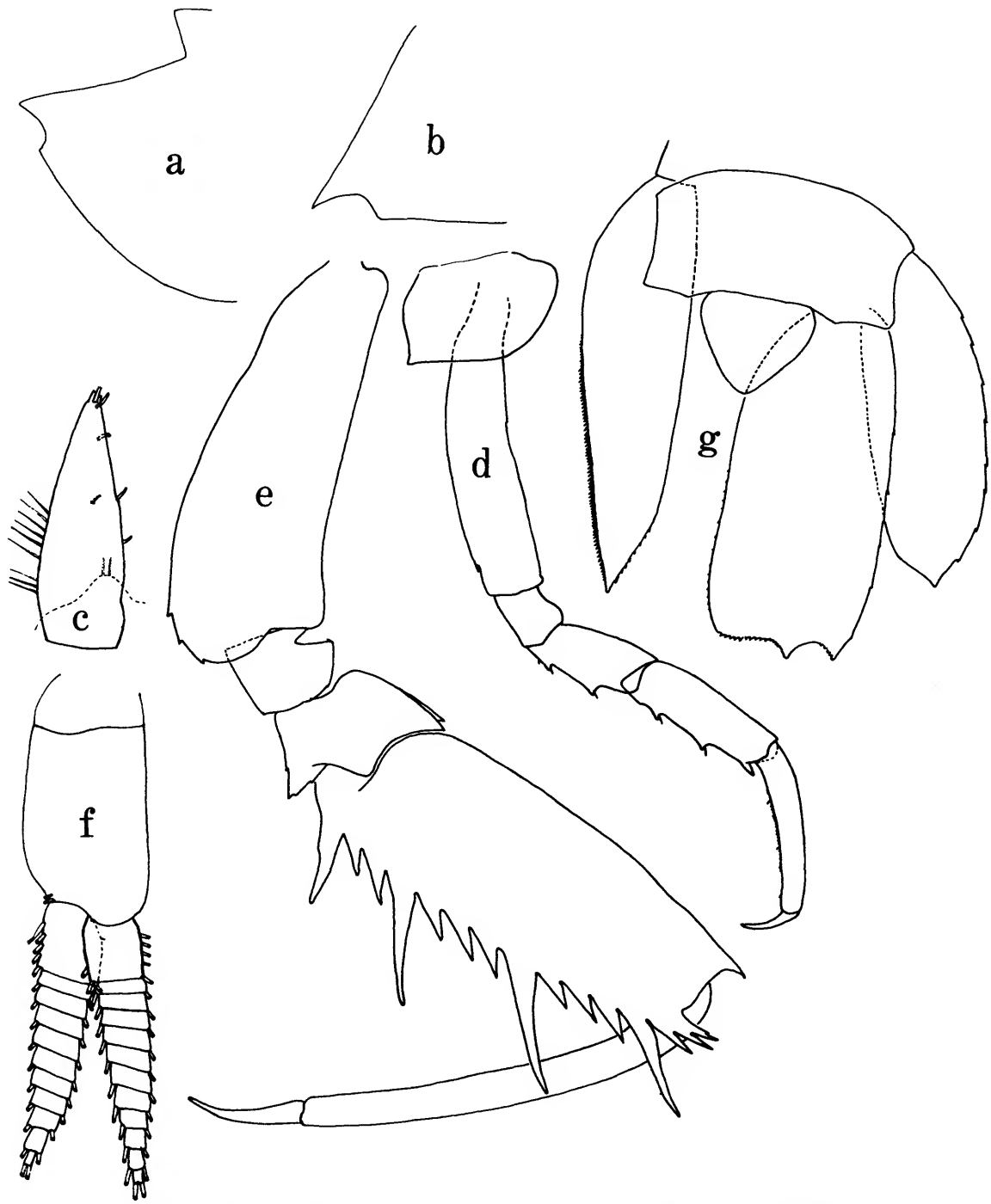

FIGURE 12.—*Primno johnsoni*, ♀: *a–b*, posteroventral corner of pleonite 3; *c*, maxilliped; *d*, pereopod 4; *e*, pereopod 5; *f*, pleopod 1; *g*, telson and uropods.

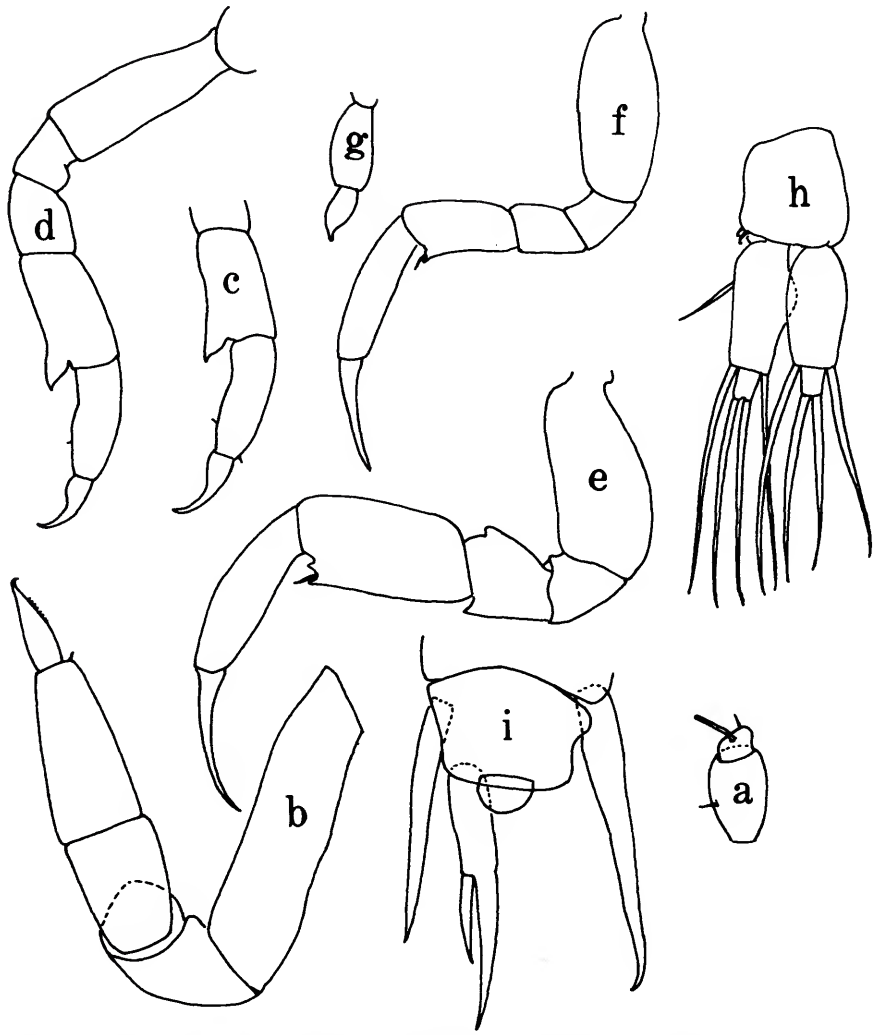

FIGURE 13.—*Primno johnsoni*, young from marsupium: *a*, antenna 1; *b*, pereopod 1; *c*, pereopod 3; *d*, pereopod 4; *e*, pereopod 5; *f*, pereopod 6; *g*, pereopod 7; *h*, pleopod 1; *i*, telson and uropods.

the Antarctic. It is absent from the Indian Ocean, and has not been found north of 44°32'S in the Atlantic. *P. brevidens* inhabits warmer water than *P. macropa*, but, unlike *P. latreillei* and *P. johnsoni*, is not limited to tropical and subtropical regions. *P. latreillei* is probably circumtropical-subtropical, but *P. johnsoni* is thus far known with certainty only from the Atlantic.

I have given above, in the form of a synonymy, references to *Primno* that I cannot assign to species. Doubtless some records in the voluminous literature on marine plankton have escaped my attention, but I believe the listing above is reasonably complete back to Bovallius (1889). References prior to 1889 are given in detail by Bovallius, and are not repeated here.

The Canadian literature contains a number of reports that may or may not be considered publications under the provisions of the *International Code of Zoological Nomenclature*. Since the provisions of

the ICZN as to what constitutes publication are undergoing revision, I am not including these "gray area" reports in my synonymies or bibliography. Most of them can be found in Shih, Figueira, and Grainger (1971).

Natural History of *Primno*

ASSOCIATIONS.—Recent observations by Madin and Harbison (1977) and Harbison, Biggs, and Madin (1977) support the view that most hyperiids spend at least part of their lives in association with gelatinous zooplankton. The only report known to me of such an association for *Primno* is that of Daniel (1973), who found *"Euprimno macropus"* within the posterior nectophores of the siphonophores *Abylopsis tetragona* (Otto) and *Sulculeolaria chuni* (Lens and Van Riemdijk).

FOOD.—I have examined the contents of the midguts of 8 specimens of *P. brevidens*. Most of the contents consisted of unrecognizable granules, but there were some remains of crustaceans: parts of copepods, crystalline cones from compound eyes, pereopods of a small hyperiid (*Parathemisto pacifica*), and pereopods of an unidentified platysceloid amphipod.

PARASITES.—In 4 of the 8 midguts examined, there were from one to many unidentified gregarines. No gregarines have been reported from *Primno*, but from *Phrosina semilunata* (a member of the same family, Phrosinidae) the gregarine *Cephaloidophora phrosinae* was recently described by Théodoridès and Desportes (1975).

GLANDS.—In all species of *Primno* a conspicuous gland occupies most of the basis of pereopod 2. The gland is composed of larger proximal and smaller distal parts. At the juncture of these parts is a vesicle from which collecting ducts radiate throughout the gland. An efferent duct runs from the central vesicle thru the distal segments and opens at the tip of the dactyl.

The function of the gland is unknown. Similar glands were found in pereopods 5–7 of *Phronimella* by Mayer (1878), who suggested they might be poison glands, but Laval (1968), in observations on living *Phronima curvipes*, found no evidence to support Mayer's hypothesis.

Glands have been reported from the pereopod 1 basis of several members of the gammaridean family Lysianassidae, e.g., *Eucallisoma glandulosa* Barnard, 1961. Their function is unknown; possible uses for the glandular secretions suggested by Barnard—paralysis, digestion, excretion of toxic wastes—remain to be tested.

PEREOPOD 7.—The differences in structure between the male and female pereopod 7 appear to have been overlooked in the past. In the female the dactyl is slightly expanded at its apex into an oblique oval surface that is ringed by spinules. A few additional spinules are situated in the center of the oval surface. In the adult male the segments distal to the basis are longer than in the female, and the digitiform dactyl lacks the spinulose ring. Young males, however, may have the spinulose ring.

The function of the specialized pereopod 7 is unknown, but it seems likely that it may play a role similar to that in *Vibilia*, which also has a digitiform pereopod 7 dactyl with a ring of spinules. In *Vibilia*, Laval (1963) observed that toward the end of the incubation period of about 20 days, the larvae begin to move about in the marsupium. The mother then reaches into the marsupium with the very flexible 7th pereopods, grasps a larva between the dactyls, and deposits it on the surface of a salp. The larva enters the salp's interior through a siphon and develops there, feeding on the salp's tissues.

VERTICAL DISTRIBUTION.—The most informative study of vertical distribution in *Primno* is that of Thurston (1976) on *P. johnsoni* (identified as *P. macropa*). Thurston found that the habits of vertical migration are complex, with differences in behavior associated with sex and maturity. During the day adult males occurred at depths of 450–940 m, with a mean depth of 647 m. At night they ranged between 100 and 830 m, with a mean depth of 616 m. Thus vertical migration was insignificant. Adult females and immature and juvenile males and females were found at lesser depths than adult males and moved upward at night for distances of 110 m (adult females), 350 and 222 m (immature males and females), and 114 and 204 m (juvenile males and females), based on mean depths. Juveniles not identified to sex were found almost exclusively in the shallowest samples and moved slightly downward at night.

Other studies of the vertical distribution of *Primno* are summarized by Thurston (1976) and need not be discussed here. Most of these studies are of limited usefulness, either because non-closing nets were used, or because the species involved is uncertain.

Literature Cited

Barnard, J. L.

1961. Gammaridean Amphipoda from Depths of 400 to 6000 Meters. *Galathea Reports,* 5:23–128.

Barnard, K. H.

1925. Contributions to the Crustacean Fauna of South Africa, 8: Further Additions to the List of Amphipoda. *Annals of the South African Museum,* 20:319–380, plate 34.

1930. Amphipoda. *British Antarctic (Terra Nova) Expedition, 1910, Natural History Report, Zoology,* 8(4): 307–454, 63 figures.

1931. Amphipoda. *Great Barrier Reef Expedition, 1928–29, Scientific Reports,* 4(4):111–135.

1932. Amphipoda. *Discovery Reports,* 5: 326 pages, 174 figures, 1 plate.

1937a. Amphipoda. *The John Murray Expedition 1933–34, Scientific Reports,* 4(6):131–201.

1937b. Amphipoda Hyperiidea. *Australasian Antarctic Expedition 1911–14, Scientific Reports,* series C (Zoology and Botany), 2(5):1–4.

Bary, B. M.

1959. Ecology and Distribution of Some Pelagic Hyperiidea (Crustacea: Amphipoda) from New Zealand Waters. *Pacific Science,* 13(4):317–334.

Beebe, William

1931. Bermuda Oceanographic Expeditions 1929–1930: Introduction. *Zoologica, Scientific Contributions of the New York Zoological Society,* 13(1):1–14.

1932. Bermuda Oceanographic Expeditions 1931: Individual Nets and Data. *Zoologica, Scientific Contributions of the New York Zoological Society,* 13(3):37–45.

Behning, A. L.

1939. Die Amphipoda-Hyperiidea der den Fernen Osten der UdSSR. umgrenzenden Meere. *Internationale Revue der gesamten Hydrobiologie und Hydrographie,* 38:353–367.

Bogorov, B. G.

1958. Biogeographical Regions of the Plankton of the North-western Pacific Ocean and Their Influence on the Deep-Sea. *Deep-Sea Research,* 5(2):149–161.

Bovallius, Carl

1887. Systematical List of the Amphipoda Hyperiidea. *Bihang till Kungliga Vetenskapsakademiens Handlingar,* 11(16):1–50.

1889. Contributions to a Monograph of the Amphipoda Hyperiidea, Part I: 2, The Families Cyllopodidae, Paraphronimidae, Thaumatopsidae, Mimonectidae, Hyperiidae, Phronimidae, and Anchylomeridae. *Kongliga Svenska Vetenskapsakademiens Handlingar,* 22(7):1–434, plates 1–18.

Bowman, Thomas E.

1953. *The Systematics and Distribution of Pelagic Amphipods of the Families Vibiliidae, Paraphronimidae, Hyperiidae, Dairellidae, and Phrosinidae from the Northeastern Pacific.* 430 pages. Ph.D. Thesis, University of California, Los Angeles.

Bowman, Thomas E., and Hans-Eckhard Gruner

1973. The Families and Genera of Hyperiidea (Crustacea: Amphipoda). *Smithsonian Contributions to Zoology,* 146:1–64.

Bradford, Janet M.

1972. Systematics and Ecology of New Zealand Central East Coast Plankton Sampled at Kaikoura. *Bulletin of the New Zealand Department of Scientific and Industrial Research,* 207:1–87.

Brinton, Edward

1962. The Distribution of Pacific Euphausiids. *Bulletin of the Scripps Institution of Oceanography of the University of California,* 8(2):51–270.

Brusca, Gary J.

1967a. The Ecology of Pelagic Amphipoda, I: Species Accounts, Vertical Zonation and Migration of Amphipods from the Waters off Southern California. *Pacific Science,* 21(3):382–393.

1967b. The Ecology of Pelagic Amphipoda, II: Observations on the Reproductive Cycles of Several Pelagic Amphipods from the Waters off Southern California. *Pacific Science,* 21(4):449–456.

1973. Pelagic Amphipods from the Waters near Oahu, Hawaii, Excluding the Family Scinidae. *Pacific Science,* 27(1):8–27.

Bulycheva, A. I.

1955. Hyperiids (Amphipoda-Hyperiidea) of the Northwestern Part of the Pacific Ocean. *Doklady Akademii Nauk SSSR,* 102(5):1047–1050. [In Russian.]

Chevreux, Édouard

1900. Amphipodes Provenant des Campagnes de *l'Hirondelle. Résultats des Campagnes Scientifiques Accomplies sur son Yacht par Albert Ier, Prince Souverain de Monaco,* 16: i–iv + 1–195, plates 1–18.

1935. Amphipodes Provenant des Campagnes Scientifiques du Prince Albert Ier, de Monaco. *Résultats des Campagnes Scientifiques Accomplies sur son Yacht par Albert Ier, Prince Souverain de Monaco,* 90: 1–214, plates 1–16 (1 color).

Chevreux, Édouard, and Louis Fage

1925. Amphipodes. *Faune de France,* 9:1–488.

Chilton, Charles

1921. Some New Zealand Amphipoda, No. 2. *Transactions of the New Zealand Institute,* 53:220–234.

Dakin, William J., and Alan N. Colefax
1940. The Plankton of the Australian Coastal Waters off New South Wales, Part I. *Publications of the University of Sydney Department of Zoology*, 1:1–215, plates 1–4.

Daniel, Ruby
1973. Siphonophores and Their Commensals in the Indian Ocean. *Journal of the Marine Biological Association of India*, 15(1):354–358.

Dick, R. I.
1970. Hyperiidea (Crustacea: Amphipoda), Keys to South African Genera and Species, and a Distribution List. *Annals of the South African Museum*, 57(3):25–86.

Fraser, J. H.
1961. The Oceanic and Bathypelagic Plankton of the North-East Atlantic and Its Possible Significance to Fisheries. *Marine Research, Department of Agriculture and Fisheries for Scotland*, 1961(4):1–48.

Fulton, John
1968. A Laboratory Manual for the Identification of British Columbia Marine Zooplankton. *Fisheries Research Board of Canada Technical Report*, 55:iii + 141 pp.

Gamulin, T.
1948. Prilog Pozynavanju Zooplanktona Srednjedalmatinskog Otočnog Područja. *Acta Adriatica*, 3(7):159–194.

Guérin-Méneville, F.-E.
1836. Description de quelques genres nouveaux de Crustacés appartenant à la famille des Hypérines. *Magasin de Zoologie*, 6(7):1–10, plates 17, 18.

Harbison, G. R., D. C. Biggs, and L. P. Madin
1977. The Associations of Amphipoda Hyperiidea with Gelatinous Zooplankton, II: Association with Cnidaria, Ctenophora, and Radiolaria. *Deep-Sea Research*, 24:465–488.

Hardy, A. C., and E. R. Gunther
1935. The Plankton of the South Georgia Whaling Grounds and Adjacent Waters, 1926–1927. *Discovery Reports*, 11:1–456.

Hure, Jure
1955. Distribution Annuelle Verticale du Zooplancton sur une Station de l'Adriatique Méridionale. *Acta Adriatice*, 7(7):1–72.
1961. Dnevna Migracija i Sezonska Vertikalna Raspodjela Zooplanktona Dubljeg Mora. *Acta Adriatica*, 9(6):1–59.

Hure, Jure, Bruno Scotto di Carlo, and Antonio Basile
1971. Comparazione tra lo Zooplancton del Golfo di Napoli e dell' Adriatico Meridionale presso Dubrovnik, II: Amphipoda (Hyperiidea). *Pubblicazioni della Stazione Zoologica di Napoli*, 37:599–609.

Hurley, Desmond E.
1955. Pelagic Amphipods of the Sub-Order *Hyperiidea* in New Zealand Waters, I: Systematics. *Transactions of the Royal Society of New Zealand*, 83(1):119–194.
1956. Bathypelagic and Other Hyperiidea from Californian Waters. *Allan Hancock Foundation Publications Occasional Paper* 18:1–25.
1960a. Amphipoda Hyperiidea. *B.A.N.Z. Antarctic Research Expedition 1929–1931 Reports*, series B (Zoology and Botany), 8(5):107–114.
1960b. Pelagic Amphipods of the N.Z.O.I. Pacific Cruise, March 1958. *New Zealand Journal of Science*, 3(2):274–289.
1969. Amphipoda Hyperiidea. *Antarctic Map Folio Series*, Folio 11: *Distribution of Selected Groups of Marine Invertibrates in Waters South of 35°S Latitude*, pages 52–54, sheets 1, 2. American Geographical Society.

Irie, Haruhiko
1959. Studies on Pelagic Amphipods in the Adjacent Seas of Japan. *Bulletin of the Faculty of Fisheries, Nagasaki University*, 8:20–42.

Jossi, Jack W.
1972. Distribution and Abundance of Pelagic Amphipoda in the Arabian Sea, Java Sea, and Indian Ocean with Notes on Their Contribution to the Total Zooplankton. *Journal of the Marine Biological Association of India*, 14(1):115–138.

Kane, Jasmine E.
1962. Amphipoda from Waters South of New Zealand. *New Zealand Journal of Science*, 5(3):295–315.

Laval, Philippe
1963. Sur la biologie et les larves de *Vibilia armata* Bov. et de *V. propinqua* Stebb., Amphipodes Hypérides. *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences* (Paris), 257(6):1389–1392.
1968. Observations sur la biologie de *Phronima curvipes* Voss. (Amphipode Hypéride) et description du mâle adulte. *Cahiers de Biologie Marine*, 9:347–362.

Lo Bianco, Salvatore
1902. Le pesche pelagiche abissali eseguite dal maia nelle vicinanze di Capri. *Mittheilungen aus der Zoologischen Station zu Neapel*, 15(3):413–482, plate 19.
1903. Le pesche abissali eseguite da F.A. Krupp col yacht *Puritan* nelle adiacenze di Capri ed in altre localita del Mediterraneo. *Mittheilungen aus der Zoologischen Station zu Neapel*, 16(1–2):109–278, plates 7–9, 1 table [folded].

Lorz, H. (Van Arsdale), and W. G. Pearcy
1975. Distribution of Hyperiid Amphipods off the Oregon Coast. *Journal of the Fisheries Research Board of Canada*, 32(8):1442–1447.

Mackintosh, N. A.
1934. Distribution of the Macroplankton in the Atlantic Sector of the Antarctic. *Discovery Reports*, 9:65–160.

Madin, L. P., and G. R. Harbison
1977. The Associations of Amphipoda Hyperiidea with Gelatinous Zooplankton, I: Associations with Salpidae. *Deep-Sea Research*, 24:449–463.

Mayer, P.
1878. Carcinologische Mittheilungen, I et II. *Mittheilungen aus der Zoologische Station zu Neapel*, 1:40–48, pl. 1.

McGowan, John A.
1971. Oceanic Biogeography of the Pacific. *In* B. M. Funnell and W. R. Riedel, editors, *The Micro-*

paleontology of Oceans, pages 3–74. Cambridge: Cambridge University Press.

1974. The Nature of Oceanic Ecosystems. *In* Charles B. Miller, editor, *The Biology of the Oceanic Pacfiic*, pages 9–28. Corvallis: Oregon State University Press.

Monod, Théodore

1926. Tanaidacés, Isopodes et Amphipodes. *Expédition Antarctique Belge, Résultats du Voyage de la Belgica en 1897–99, Rapports Scientifiques, Zoologie*, 67 pages, 61 figures.

Pillai, N. Krishna

1966. Pelagic Amphipods in the Collections of the Central Marine Fisheries Research Institute, India, Part II: Excluding Oxycephalidae. *Proceedings of the Symposium on Crustacea Held at Ernakulam from January* 12–15, 1965, part 1:205–232.

Pirlot, Jean-M.

1929. Résultats zoologiques de la croisière atlantique de l'*Armauer Hansen* (Mai-Juin 1922), 1: Les Amphipodes Hypérides. *Mémoires de la Société Royale des Sciences de Liége* (3) 15(2):1–196.

1930. Les Amphipodes de l'expédition du *Siboga*, Première Partie: Les Amphipodes Hypérides (à l'exception des Thaumatopsidae et des Oxycephalidae). *Siboga-Expeditie*, 33a:1–55.

1939. Sur des Amphipodes Hypérides provenant des croisières du Prince Albert 1er de Monaco. *Résultats des Campagnes Scientifiques Accomplies sur son Yacht par Albert 1er, Prince Souverain de Monaco*, 102:1–63, plates 1, 2.

Rafinesque, C. S.

1814. *Précis des découvertes et travaux Somiologiques entre 1800 et 1814, ou choix raisonné de ses principales Découvertes en Zoologie et en Botanique, pour servir d'introduction à ses ouvrages futurs*. 55 pages. Palermo.

Reid, Douglas M.

1955. Amphipoda (Hyperiidea) of the Coast of Tropical West Africa. *Atlantide Report*, 3:7–40.

Repelin, Robert

1972. Étude préliminaire des Amphipodes du Bol Alimentaire de Poissons pélagiques provenant de Pêches à la longue ligne. *Cahiers O.R.S.T.O.M., Série Océanographie*, 10(1):47–55.

Ruffo, S.

1959. Contributions to the Knowledge of the Red Sea (Contributo alla conoscenza degli anfipodi del Mar Rosso), 13: Materiali raccolti a Ghardaqa e nel Golfo di Aqaba. *Sea Fisheries Research Station, Haifa, Bulletin*, 20:11–36.

Sanger, Gerald A.

1973. Epipelagic Amphipods (Crustacea) off Washington and British Columbia, October-November 1971. *Northwest Fisheries Center MARMAP Survey I, Report*, 8: 29 pages. Seattle, Wash.: National Marine Fisheries Service, Northwest Fisheries Center. [Multilith.]

1974. Pelagic Amphipod Crustaceans from the Southeastern Bering Sea, June 1971. *NOAA Technical Report National Marine Fisheries Service, Special Scientific Report, Fisheries*, 680:1–8.

Schellenberg, A.

1927. Amphipoda des Nordischen Plankton. *Nordisches Plankton*, 6(20):589–722. Kiel.

Shih, Chang-Tai, A.J.G. Figueira, and E. H. Grainger

1971. A Synopsis of Canadian Marine Zooplankton. *Fisheries Research Board of Canada Bulletin*, 176:264 pages.

Shoemaker, Clarence R.

1945. The Amphipoda of the Bermuda Oceanographic Expeditions, 1929–1931. *Zoologica, Scientific Contributions of the New York Zoological Society*, 30(4):185–266.

Shulenberger, Eric

1977. Hyperiid Amphipods from the Zooplankton Community of the North Pacific Central Gyre. *Marine Biology*, 42(4):375–385.

Siegfried, W. R.

1963. The Hyperiidea (Amphipoda) off the West Coast of Southern Africa. *Union of South Africa, Department of Commerce and Industries, Division of Fisheries, Investigational Report*, 48:1–2.

Spandl, Hermann

1924a. Expeditionen S. M. Schiff *Pola* in das Rote Meer, Nördliche und Südliche Hälfte, 1895/96–1897/98, Zoologische Ergebnisse, 35: Die Amphipoden des Roten Meeres. *Denkschriften Akademie der Wissenschaften in Wien, Mathematisch-Naturwissenschaftliche Klasse*, 99:19–73.

1924b. 3, Amphipoda Hyperiidea aus der Adria. *Zoologischer Anzeiger*, 58:261–272.

1927. Die Hyperiiden (exkl. Hyperiidea Gammaroidea und Phrominidae) der Deutsche Südpolar-Expedition 1901–1903. *Deutsche Südpolar-Expedition 1901–1903*, 19(Zoologie)(11):145–287, plate 10.

Stebbing, T.R.R.

1888. Report on the Amphipoda Collected by H.M.S. *Challenger* during the years 1873–76. *Report on the Scientific Results of the Voyage of H.M.S. Challenger during the Years 1873–76, Zoology*, 29: xxiv + 1713 pages, 210 plates [in 3 volumes].

1904. Biscayan Plankton Collected during a Cruise of H.M.S. *Research*, 1900, Part II: The Amphipoda and Cladocera, with Notes on a Larval Thyrostracan. *Transactions of the Linnean Society of London*, series 2 (Zoology), 10(2):13–45, plates 2, 3.

Stewart, Dorothy A.

1913. A Report on the Extra-Antarctic Amphipod Hyperiidea Collected by the *Discovery*. *Annals and Magazine of Natural History*, series 8, 12:245–265, plates 4–7.

Stephensen, K.

1924. Hyperiidea—Amphipoda, part 2: Paraphronimidae, Hyperiidae, Dairellidae, Phrominidae, Anchylomeridae. *Report on the Danish Oceanographical Expeditions 1908–1910 to the Mediterranean and Adjacent Seas*, 2,D(4):71–149.

1947. Tanaidacea, Isopoda, Amphipoda, and Pycnogonida. *Scientific Results of the Norwegian Antarctic Expedition 1927–1928*, 27:1–90.

Tashiro, Joseph E., and Jack W. Jossi
1972. Amphipoda (Hyperiidea) Distribution and Abundance off the Coast of Central West Africa. *NOAA, National Marine Fisheries Service, Seattle, Washington, Data Report,* 76: 38 pages.

Tattersall, Walter M.
1906. Pelagic Amphipoda of the Irish Atlantic Slope. *Department of Agriculture and Technical Instruction for Ireland, Fisheries Branch, Scientific Investigations,* 1905(4):1–39, plates 1–5.

Théodoridès, Jean, and Isabelle Deportes
1975. Sporozoaires d'invertébrés pélagiques de Villefranche-sur-Mer (Étude descriptive et faunistique). *Protistologia,* 11(2):205–220.

Thorsteinson, Elsa D.
1941. New or Noteworthy Amphipods from the North Pacific Coast. *University of Washington Publications in Oceanography,* 4(2):50–96.

Thurston, Michael H.
1976. The Vertical Distribution and Diurnal Migration of the Crustacea Amphipoda Collected during the SOND Cruise, 1965, II: The Hyperiidea and General Discussion. *Journal of the Marine Biological Association of the United Kingdom,* 56:383–470.

Vinogradov, M. E.
1956. Hyperiids (Amphipoda – Hyperiidea) of the Western Bering Sea. *Zoologicheskii Zhurnal,* 35 (2):194–218. [In Russian.]
1962. Hyperiids (Amphipoda, Hyperiidea) Collected by the Soviet Antarctic Expedition on M/V *Ob* South of 40°S. *In* Studies of Marine Fauna (IX). *Biological Results of the Soviet Antarctic Expedition (1955–1958),* 1:5–35. Zoological Institute, Akademiya Nauk SSSR. [In Russian; English translation by Israel Program for Scientific Translations published in 1966.]

Vives, Francisco
1966. Zooplancton Nerítico de las Aguas de Castellón (Mediterráneo Occidental). *Investigacion Pesquera,* 30:49–166.
1968. Sur les Malacostracés Planctoniques des Mers Tyrrhénienne et Catalane. *Rapports et Procès-Verbaux des Réunions, Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée,* 19(3):459–461.

Vives, Francisco, G. Santamaría, and I. Trepat
1975. El zooplancton de los alrededores del estrecho de Gibraltar en junio-julio de 1972. *Resultados Expediciones Cientificas del Buque Oceanografico "Cornide de Saavedra,"* 4:7–100.

Vosseler, J.
1901. Die Amphipoden der Plankton-Expedition, I Theil: Hyperiidea 1. *Ergebnisse der Plankton-Expedition der Humboldt Stiftung,* 2(G,e):i-viii + 1–129, plates 1–13.

Wailes, G. H.
1929. The Marine Zoo-Plankton of British Columbia. *Vancouver, B.C. Art, Historical, and Scientific Association, Museum and Art Notes,* 4:159–165.
1931. Amphipoda from British Columbia, Part II. *Vancouver, B.C., Art, Historical, and Scientific Association, Museum and Art Notes,* 6:40–41.
1933. The Plankton of the West Coast of Vancouver Island, British Columbia. *Vancouver, B.C., Art, Historical, and Scientific Association, Museum and Art Notes,* 7(supplement 9):1–11.

Walker, Alfred O.
1907. Crustacea, III: Amphipoda. *National Antarctic Expedition, British Museum (Natural History)* 3:1–39, plates 1–13.
1909. Amphipoda Hyperiidea of the *Sealark* Expedition to the Indian Ocean. *Transactions of the Linnaean Society of London,* series 2, Zoology, 13(1):49–55.

White, Adam
1874. *List of the Specimens of Crustacea in the Collection of the British Museum.* viii + 143 pages. London.

Yoo, Kwang Il
1971a. Pelagic Hyperiids (Amphipod-Hyperiidea) of the Western North Pacific Ocean. *Journal of the National Academy of Sciences, Republic of Korea, Natural Sciences Series,* 10:39–89.
1971b. The Biology of the Pelagic Amphipod, *Primno macropa* Guér., in the Western North Pacific, 1: Systematics. *Korean Journal of Zoology,* 14(3):132–138.
1972a. The Biology of the Pelagic Amphipod, *Primno macropa* Guér., in the Western North Pacific, 2: Geographical Distribution and Vertical Distributional Pattern. *Korean Journal of Zoology,* 15(2): 87–91.
1972b. Faunal Studies on the Amphipods in Korea. *Floral Studies on Some Taxa of Plants and Faunal Studies on Some Taxa of Animals in Korea,* R–72–82: 163–181. Ministry of Science and Technology.

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