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Pelagic Amphipoda from the Waters near Oahu, Hawaii, Excluding the Family Scinidae[1]

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ABSTRACT: This paper reports a study conducted on pelagic Amphipoda collected from the waters near Oahu, Hawaii. Included here are species accounts for all of the amphipods except the hyperiid family Scinidae. The specimens discussed here represent 35 species belonging to 12 families of gammarid and hyperiid amphipods. Data and remarks on the systematics, vertical distribution and migration, and reproductive activities are presented, together with geographic distributions.

DURING THE SUMMER of 1971 Dr. Thomas Clarke of the Hawaii Institute of Marine Biology, University of Hawaii, made available to this author a number of midwater samples from the waters southwest of Oahu, Hawaii (about lat 21° N, long 158° 20′ W). The water depth in this sampling area ranged from 1,850 to 3,700 meters. This paper concerns the amphipod crustaceans sorted from those samples with the exclusion of the hyperiid family Scinidae which is still under investigation. Included with the species account are notes on vertical distribution and migration, reproductive conditions, and geographical distributions.

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METHODS AND MATERIALS

All of the samples considered here were taken during June 1971, on the R.V. *El Pescadero IV*, utilizing a 10-foot Issacs-Kidd midwater trawl (Issacs and Kidd, 1953). Although this type of trawl has the quality of obtaining large amounts of material, it has the disadvantages of being somewhat unstable in terms of maintaining its fishing depth (Aron et al., 1964; Brusca, 1967*a*) and, since the mouth is always open, of capturing large numbers of organisms when the net is being lowered and raised. Both of these problems, of course, are most serious when fishing at great depths. Two particular samples included here are used to illustrate and partially account for the latter difficulty. Stations 71-6-28 and 71-6-30 were "bounce tows," during which the net was lowered to a depth of 425 meters and immediately retrieved.

Table 1 lists the species of amphipods taken from the Hawaiian samples and Table 2 lists the station numbers and corresponding data for the samples discussed in this study. Unfortunately, no tows were taken during the daylight hours at depths of less than 400 meters and, thus, where negative data are predicted and needed to analyze vertical distributions during the daytime, none are available.

The samples were initially preserved in 10-percent formalin solution, and the amphipods were later transferred to 70-percent alcohol.

SPECIES ACCOUNTS

Suborder GAMMARIDEA

Family LYSIANASSIDAE

Genus *Erythenes* Smith

Eurythenes obesus (Chevreux).

Katius obesus Chevreux, 1905*b*: 1–5, fig. 1–3; Stephensen, 1924–1925: 126–127; Schellenberg, 1926: 217–218, fig. 26*d*; K. H.

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TABLE 1

SPECIES LIST OF AMPHIPODS (EXCLUDING THE FAMILY SCINIDAE) FROM THE HAWAIIAN SAMPLES

TAXON	TOTAL NUMBER COLLECTED	NUMBER OF POSITIVE SAMPLES	DEPTH RANGE (m) OF POSITIVE SAMPLES
Suborder Gammaridea			
Family Lysianassidae			
Eurythenes obesus	5	4	260–1,275
Cyphocaris anonyx	22	9	425–1,065
C. richardi	8	4	630–930
C. faurei	14	10	260–1,065
Suborder Hyperiidea			
Family Vibiliidae			
Vibilia armata	120	10	15–1,065
V. viatrix	19	9	15–1,065
Family Cystisomidae			
Cystisoma fabricii	35	11	330–1,065
C. pellucidum	4	3	330–690
C. latipes?	2	2	850–1,275
Family Phronimidae			
Phronima sedentaria	40	13	15–775
P. atlantica	16	8	15–975
P. colletti?	1	1	80–85
Phronimella elongata	7	5	15–1,065
Family Paraphronimidae			
Paraphronima gracilus	2	2	100–570
P. crassipes	2	2	15–775
Family Lanceolidae			
Scypholanceola vanhoeffeni	10	6	450–1,275
Family Phrosinidae			
Primno macropa	19	7	100–620
Phrosina semilunata	37	11	15–1,275
Family Hyperiidae			
Hyperia luzoni	36	9	15–975
H. bengalensis	350	11	15–975
Family Pronoidae			
Eupronoë minuta	45	11	15–775
Parapronoë crustulum	12	7	260–930
Family Brachyscelidae			
Brachyscelus crusculum	4	2	330–620
B. rapacoides?	2	2	580–1,275
Family Platyscelidae			
Platyscelus armatus	6	6	260–930
P. serratulus	19	8	15–1,065
Tetrathyrus arafurae?	1	1	850–975
Paratyphis spinosus?	1	1	0–425 (bounce tow)
Family Oxycephalidae			
Streetsia challengeri	12	6	50–425
Oxycephalus clausi	11	4	15–1,275
O. piscator	17	6	15–690
Calamorhynchus pellucidus	2	2	100–425
Rhabdosoma whitei	17	5	15–975
R. minor	1	1	100
R. armatum?	2	2	100–625
Total number of individuals	908		

TABLE 2

STATION DATA FOR SAMPLES ANALYZED, JUNE 1971

STATION NO.	DATE	TIME	WIRE OUT (m)	DEPTH (m)	*A–B–C*
71-6-1	8	2009–0027	2,500–2,700	850–975	21–179–58
71-6-2	9	0121–0500	1,125–1,325	450–600	14–175–30
71-6-3	9	0730–1010	1,200	425	20–125–15
71-6-4	9	1032–1325	1,500	600–625	18–120–35
71-6-5	9	1338–1705	2,100	725–775*	22–120–65
71-6-6	9	2000–2400	1,500–1,700	640–750	18–117–45
71-6-7	10	0052–0600	3,000–3,300	1,100–1,275	38–195–75
71-6-8	10	0721–1014	1,650–1,700	580–620	26–120–37
71-6-9	10	1034–1310	1,350	540–590	11–118–27
71-6-11	10	2036–2300	650	260	17–112–15
71-6-16	15	1957–2203	250	100	03–119–04
71-6-18	16	0303–0520	400	160–170	04–123–10
71-6-19	16	0804–1100	1,400	450–570	32–119–25
71-6-21	16	1510–1818	1,600	630–690	28–135–28
71-6-24	17	0049–0253	100	50	02–119–03
71-6-25	17	0303–0515	150	80–85	03–124–05
71-6-27	17	1200–1625	2,550	900–930	33–177–55
71-6-28	17	2002–2040	1,000	0–425	17–000–21
71-6-30	17	2301–2341	1,000	0–425	17–000–23
71-6-32	18	0803–1240	2,800	1,025–1,065	37–180–60
71-6-34	18	2005–2235	850	330–340	09–123–18
71-6-35†	18	2248–0051	40	15–20	02–120–01

NOTE: *A*, time (minutes) to pay out cable and adjust depth; *B*, time (minutes) at depth; *C*, time (minutes) for retrieval.

* Malfunction in time-depth recorder; depth from telemeter reading.

† Towed at about 5 knots, all others at about 4 knots; 71-6-28 and 71-6-30 were bounce tows (see Methods and Materials).

Barnard, 1932: 56–58, fig. 21, pl. 1, fig. 1; Chevreux, 1935: 63–65, pl. 10, fig. 4–6, pl. 11, fig. 10.

Eurythenes obesus Shoemaker, 1956: 177–178; J. L. Barnard, 1961: 38–39, fig. 8; Brusca, 1967*a*: 384.

Station 71-6-1: 1 female (52 mm); 850–975 m.

Station 71-6-7: 2 females (35, 44 mm); 1,100–1,275 m.

Station 71-6-11: 1 male (?), (20 mm); 260 m.

Station 71-6-27: 1 male (?), (10.5 mm); 900–930 m.

Remarks

J. L. Barnard (1961) reported the distribution of this species as cosmopolitan between the polar circles at depths of from 500 to 5,610 meters, and suggested demersal habits. The question of vertical movement and distribution was further complicated by Brusca (1967*a*: 384) reporting specimens captured some 500 to 600 meters off the bottom, the guts of which contained what appeared to be siliceous sponge spicules. The water depth in the area of sampling for this present study was from 1,850 to 3,700 meters, so all of these individuals were collected some distance from the bottom, especially the one taken at 260 meters. On the basis of these data it seems reasonable to assume that not all of the population of *E. obesus* is moving to and from the bottom on any regular schedule. Unfortunately, this species is rarely taken in high enough numbers to permit accurate analysis of its vertical distribution or migratory activity. It should be noted, however, that three of the four positive samples were obtained during the dark hours; the small (10.5 mm) specimen was collected in the daytime.

Genus *Cyphocaris* Boeck

Three species of the genus *Cyphocaris* were recovered from these Hawaiian samples. They are easily distinguished from one another by examining the basis of the third peraeopod. The key (modified from Schellenberg, 1926: 206) below includes the three species discussed in this paper, plus *C. challengeri* which has previously been reported from tropical Pacific waters.

1. Posterior lobe of basis of peraeopod 3 greatly produced into a smooth or serrated spine; rostral spine absent or bluntly produced 2
1. Posterior lobe of basis of peraeopod 3 only moderately produced as a convex serrated edge; rostral spine usually very long and pointed ..... *C. richardi*
2. Ventral margin of posterior lobe of peraeopod 3 smooth 3
2. Ventral margin of posterior lobe of peraeopod 3 toothed ..... *C. anonyx*
3. Posterior surface of basis of peraeopod 3 smooth above spine; spine shorter than remainder of leg ..... *C. faurei*
3. Posterior surface of basis of peraeopod 3 toothed above spine; spine as long or nearly as long as remainder of leg ... *C. challengeri*

Cyphocaris anonyx Boeck.

Cyphocaris micrononyx Stebbing, 1888: 656, pl. 16.

Cyphocaris anonyx Boeck, 1871: 104–105; Schellenberg, 1926: 202–206, fig. 2*b*, 210–212, fig. 5*a–b*, pl. 5, fig. 2; K. H. Barnard, 1932: 36; Waterman et al., 1939: 256–279; Shoemaker, 1945: 187, fig. 1*a–b*; J. L. Barnard, 1954: 53; Brusca, 1967*a*: 385; Brusca, 1967*b*: 450, table 2.

Station 71-6-1: 2 females (10.5, 13 mm); 1 male (8 mm); 850–975 m.
Station 71-6-3: 3 females (6, 7.5, 10 mm); 3 males (8, 8, 13 mm); 425 m.
Station 71-6-6: 1 female (13.5 mm); 1 male (damaged); 640–740 m.
Station 71-6-8: 1 female (11.5 mm); 580–620 m.
Station 71-6-9: 1 male (9 mm); 540–590 m.
Station 71-6-21: 1 male (12 mm); 630–690 m.
Station 71-6-27: 1 female (11 mm–ovigerous); 900–930 m.
Station 71-6-30: 1 male (12 mm); 0–425 m.
Station 71-6-32: 6 females (12.5–14.5 mm, 3 were ovigerous); 1,025–1,065 m.

Remarks

Vertical migration by this cosmopolitan species has been reported by Waterman et al. (1939: 268) and suggested by Brusca (1967*a*: 385). Although only 22 specimens were taken in this present study, they were collected at various times of the day and night, scattered in no apparent pattern at depths of from about 425 to 1,065 meters. One specimen was obtained in a bounce tow from 0 to 425 meters at night but, based on the other collecting data, this individual was most likely inhabiting the lower levels of that range.

As can be seen from the station data above, less than 30 percent of the females were carrying ova in June. Brusca (1967*b*: 450) reported that the highest reproductive activity off the coast of southern California occurred in May, June, and July.

Cyphocaris richardi Chevreux.

Cyphocaris Richardi Chevreux, 1905*a*: 1–5, fig. 1–2.

Cyphocaris richardi Schellenberg, 1926: 204–209, fig. 2*a*, 3*a–e*, 4*a–d*, pl. 5, fig. 1; K. H. Barnard, 1932: 35; Stephensen, 1933: 4–5; Shoemaker, 1945: 187–189, fig. 1*d*; J. L. Barnard, 1954: 54, pl. 2–3; J. L. Barnard, 1961: 32; J. L. Barnard, 1962: 24; Bernstein and Vinogradov, 1955: 212–213, fig. 2–3; Bernstein and Vinogradov, 1958: 221; Brusca, 1967*a*: 385–386, table 5; Brusca, 1967*b*: 450–451, table 3.

Station 71-6-5: 5 females (23.5–25 mm); 725–775 m.
Station 71-6-6: 1 female (22.5 mm); 640–750 m.
Station 71-6-21: 1 female (23.5 mm, ovigerous); 630–690 m.
Station 71-6-27: 1 female (25 mm); 900–930 m.

Remarks

Because of the low number of positive samples for this species, little can be concluded con-

cerning its vertical distribution. The fact that specimens were only taken at depths of greater than 600 meters emphasizes the relatively deep pelagic nature of *C. richardi*. J. L. Barnard (1954) indicated a cosmopolitan distribution at depths of from 2,000 to 4,000 meters, whereas in this present study and that of Brusca (1967*a*) all of the individuals were collected at depths of 1,200 meters or less.

Cyphocaris faurei Barnard.

Cyphocaris alicei Strauss, 1909: 67.

Cyphocaris faurei K. H. Barnard, 1916: 117–120, pl. 26, fig. 4; Schellenberg, 1926: 215–216, fig. 2*e*, 11, 12, pl. 5, fig. 4; Schellenberg, 1929: 195; K. H. Barnard, 1932: 36–37; Pirlot, 1933: 128; K. H. Barnard, 1937: 141–142; J. L. Barnard, 1961: 31–32.

Station 71-6-2: 1 female (9 mm); 450–600 m.
Station 71-6-3: 1 female (22 mm); 425 m.
Station 71-6-6: 1 female (23 mm—carrying young); 640–750 m.
Station 71-6-8: 1 male (14.5 mm); 580–620 m.
Station 71-6-9: 1 female (8.5 mm—ovigerous); 540–590 m.
Station 71-6-11: 1 female (12 mm—carrying young); 260 m.
Station 71-6-19: 1 female (8 mm); 450–570 m.
Station 71-6-21: 1 female (23 mm—carrying young), 2 males (18.5, 19 mm), 2 juveniles (4.5, 5 mm); 630–690 m.
Station 71-6-32: 1 female (17 mm); 1,025–1,065 m.
Station 71-6-34: 1 female (12.5 mm—ovigerous); 330–340 m.

Remarks

This species has been reported by Barnard (1961) as cosmopolitan bathypelagic ranging in depth from 175 to 2,800 meters. Although only 14 specimens were collected during this present study there is some evidence of a vertical migration toward the surface at night. Of the 10 samples in which *C. faurei* occurred, the deepest (71-6-32) was taken in the daytime while the two shallowest (71-6-11, 71-6-34) were taken at night. However, because of the low number of specimens and the rather scattered distribution of the rest of the positive samples between about 400 and 750 meters at various times, no definite conclusions can be drawn.

Reproductive activity was apparent in these June samples in that five of the nine mature females collected were either ovigerous or carrying young in their brood pouches.

Suborder HYPERIIDEA

Family VIBILIIDAE

Genus *Vibilia* Milne Edwards

Hurley (1955: 125) offers a key to members of this genus which includes the two species obtained in this present study.

The two representatives discussed here are easily distinguished from one another by the shape of the first antennae:

Antennae lanceolate ..... *V. armata*
Antennae blunt ..... *V. viatrix*

Sex determination is difficult in this genus and, therefore, is designated only for females carrying ova or young.

Vibilia armata Bovallius.

Vibilia armata Chevreux & Fage, 1925: 387–388, fig. 391; Pirlot, 1929: 100–101; Pirlot, 1930: 11; K. H. Barnard, 1930: 104; K. H. Barnard, 1932: 264–265; Hurley, 1956: 10–11; Brusca, 1967*a*: 388–389, table 10.

Station 71-6-6: 1? (6.5 mm); 640–750 m.
Station 71-6-8: 1 female (6.5 mm—carrying young), 8? (7–8 mm); 580–620 m.
Station 71-6-9: 2 females (6, 6.5 mm—carrying young), 22? (6–8 mm); 540–590 m.
Station 71-6-18: 1? (7 mm); 160–170 m.
Station 71-6-19: 15? (5.5–8.5 mm); 450–570 m.
Station 71-6-24: 24? (5–9 mm); 50 m.
Station 71-6-25: 2? (6, 8 mm); 80–85 m.
Station 71-6-32: 2? (7, 7.5 mm); 1,025 1,065 m.
Station 71-6-34: 1? (7 mm); 330–340 m.
Station 71-6-35: 10 females (6–8 mm—ovigerous), 31? (5.5–8 mm); 15–20 m.

Remarks

Vertical movement toward the surface at night has been previously reported for *V. armata* (Brusca, 1967*a*: 389), and is suggested by the concentrations in positive samples presented here. Individuals were collected in relatively high numbers near the surface at night.

Females carrying either eggs or young con-

stituted about 10 percent of the total population during June. This figure corresponds favorably with 13 percent recorded by Brusca (1967*b*: 453), for summer populations off the coast of southern California. However, most of those females were carrying young, whereas most of those in this present study were ovigerous.

Vibilia viatrix Bovallius.

Vibilia californica Holmes, 1908: 490–492, fig. 1–2.

Vibilia viatrix Stephensen, 1918: 41–43, fig. 13; Chevreux and Fage, 1925: 385–386, fig. 390; Pirlot, 1929: 95–96; K. H. Barnard, 1930: 403; Pirlot, 1930: 10–11; K. H. Barnard, 1932: 262–263; Shoemaker, 1945: 234; Hurley, 1956: 11; Brusca, 1967*a*: 389–390, table 11; Brusca, 1967*b*: 453–454, table 9.

Station 71-6-1: 1 ♀ (6 mm); 850–975 m.
Station 71-6-2: 1 ♀ (7 mm); 450–600 m.
Station 71-6-3: 1 ♀ (5.5 mm); 425 m.
Station 71-6-8: 1 ♀ (8 mm); 580–620 m.
Station 71-6-9: 1 female (12 mm, carrying young), 6 ♀ (6–7 mm); 540–590 m.
Station 71-6-19: 1 ♀ (8 mm); 450–570 m.
Station 71-6-30: 1 ♀ (6 mm); 0–425 m.
Station 71-6-32: 2 ♀ (6, 9 mm); 1,025–1,065 m.
Station 71-6-35: 2 females (7, 7.5 mm—ovigerous), 2 ♀ (4.5, 6 mm); 15–20 m.

Remarks

The paucity of specimens prohibits much speculation on the true vertical distribution of *V. viatrix* in Hawaiian waters. Individuals occurred in only one sample (71-6-35) shallower than 400 meters and that one was taken at night. Brusca (1967*b*), working with much larger numbers, found this species at the surface at all hours and noted that only the lower limit of the distribution changed.

Family CYSTISOMIDAE

Genus *Cystisoma* Guérin

Barnard (1932: 270–271) gives a key and set of definitions for the members of this genus. Distinguishing traits are given for each of the three species presented below.

Most of the specimens listed here were damaged to varying degrees. Those which consisted of whole animals all appeared to be females, but absolute sex determination was not made.

Cystisoma fabricii Stebbing.

Thaumatops fabricii Stephensen, 1918: 63–64, fig. 22–23; Pirlot, 1929: 89.

Cystisoma fabricii Stebbing, 1888: 1333; K. H. Barnard, 1932: 272–273; Hurley, 1956: 10; Brusca, 1967*a*: 387.

Station 71-6-2: 6 (one badly damaged, 44, 44, 60, 60, 75 mm); 450–600 m.
Station 71-6-3: 9 whole (33, 41, 45, 47, 47, 59, 62, 64, 77 mm); 2 heads (15, 20 mm); 425 m.
Station 71-6-4: 1 (32 mm); 600–625 m.
Station 71-6-6: 2 (75, 90 mm); 640–750 m.
Station 71-6-8: 1 (45 mm); 580–620 m.
Station 71-6-9: 5 (40, 43, 52, 85, 94 mm), 1 (13.5 m "larva," see below); 540–590 m.
Station 71-6-19: 1 (65 mm); 450–570 m.
Station 71-6-21: 1 (55 mm); 630–690 m.
Station 71-6-28: 1 (50 mm); 0–425 m.
Station 71-6-32: 1 (67 mm); 1,025–1,065 m.
Station 71-6-34: 4 (39, 51, 62, 73 mm); 330–340 m.

Remarks

Cystisoma fabricii was certainly the most common member of its genus in the samples examined. It is also the most prevalent *Cystisoma* in the waters of the northeastern Pacific as recorded by previous workers (Hurley, 1956; Brusca, 1967*a*).

This species is characterized by the following traits (from K. H. Barnard, 1932: 270): "1 mandibular spine; 2 pairs ventral [head] spines; antennae arise close together, about equal to the length of head."

This species has been previously recorded from the north Atlantic and Indo-Pacific by K. H. Barnard (1932), and from the Pacific coast of North America by Hurley (1956) and Brusca (1967*a*). Depth ranges for *C. fabricii* have been reported as from 275 to 2,200 meters, and only scant evidence of any vertical migration can be drawn.

Specimens in the Hawaiian samples were taken at all hours of the day and night and were

TABLE 3

DISTINGUISHING CHARACTERISTICS OF *Phronima sedentaria* AND *Phronima atlantica*

SPECIES	MALES	FEMALES
P. sedentaria	antennae 2 rudimentary	1st pleon segment as long as 7th peraeon segment.
P. atlantica	antennae 2 well developed	1st pleon segment distinctly shorter than 7th peraeon segment.

Note: Data based on Stephensen, 1924.

scattered over a depth range of from 330 to 750 meters, with a single individual recorded from more than 1,000 meters.

The "larva" listed above from station 71-6-9 fits well with that figured by Spandl (1927: 174) as *Thaumatops* larva. The specimen reported here corresponds with the diagnostic features of *Cystisoma fabricii*.

Cystisoma pellucidum (W. Suhm).

Thaumatops pellucida Stephensen, 1918: 64–66, fig. 19, 24–27; Spandl, 1927: 172–173, fig. 10.

Cystisoma pellucidum K. H. Barnard, 1932: 272; Thorsteinson, 1941: 92–93; Hurley, 1956: 10; Brusca, 1967*a*: 387.

Station 71-6-3: 1 head (~25 mm); 425 m.
Station 71-6-21: 2 (124, 125 mm); 630–690 m.
Station 71-6-34: 1 (135 mm); 330–340 m.

Remarks

C. pellucidum has been previously reported from various regions of the Atlantic and Pacific oceans. It is characterized as follows (from Barnard, 1932: 270): "1 mandibular spine, (4) 5–6 (7) pairs ventral [head] spines; antennae arising far apart about equal to head."

Cystisoma latipes? (Stephensen).

Cystisoma latipes K. H. Barnard, 1932: 270–271.

Station 71-6-4: 1 (54 mm); 850–975 m.
Station 71-6-7: 1 (58 mm); 1,100–1,275 m.

Remarks

K. H. Barnard (1932: 271) characterized *C. latipes* as follows: "2 mandibular spines; 5–6 pairs of ventral [head] spines; antennae close together, longer than head; 2nd (1st free) joint of peraeopod 7 markedly pyriform."

The two specimens collected during this present study have been tentatively assigned to this species based upon head spination and the shape of peraeopod seven. However, they appear to possess only a single mandibular spine. It is hoped that a larger number of undamaged individuals will help clarify this contradiction.

Family PHRONIMIDAE

Genus *Phronima* Latreille

The systematics of this genus were reviewed by Shih (1969) with some modification presented by Laval (1970). The two common species (*P. sedentaria* and *P. atlantica*) are easily separated from one another (see Table 3).

A third species (*P. colletti*) was represented by a single specimen.

Phronima sedentaria (Forskål).

Phronima sedenteria Holmes, 1908: 490; Stephensen, 1924: 114–121, fig. 50–51, chart 15; Chevreux and Fage, 1925: 393–395, fig. 396; Pirlot, 1929: 110–112; K. H. Barnard, 1930: 422; Pirlot, 1930: 12–14; K. H. Barnard, 1932: 283–284; Hurley, 1955: 166–171, fig. 12–13; Hurley, 1956: 16; Brusca, 1967*a*: 389–390, table 12; Brusca, 1967*b*: 454, table 10; Shih, 1969: 10–14, fig. 1.

Station 71-6-5: 1 female (20 mm); 725–775 m.
Station 71-6-9: 3 females (19, 20, 34 mm); 540–590 m.
Station 71-6-11: 3 females (33 mm—ovigerous, 18, 26 mm); 260 m.

Station 71-6-16: 1 female (25 mm); 100 m.
Station 71-6-19: 1 female (29 mm—ovigerous); 450–570 m.
Station 71-6-24: 1 male? (5 mm); 50 m.
Station 71-6-28: 1 female (8 mm); 1 male? (5 mm); 0–425 m.
Station 71-6-30: 1 male (8.5 mm); 0–425 m.
Station 71-6-30: 1 female (14.5 mm); 330–340 m.
Station 71-6-35: 1 female (19 mm); 15–20 m.

Remarks

Phronima sedentaria is a common representative of pelagic samples from around the world between the polar circles. Its distribution is mapped by Shih (1969: 55).

This species has been shown to undergo consistent vertical migrations upward at night and down in the daytime (Brusca, 1967*a*). This present study demonstrates that the animals are at depths of less than 100 m during the dark hours.

Only two ovigerous females were taken (about 5½ percent of the adult females examined). Brusca (1967*a*) reported over 70 percent of the summer females as either ovigerous or with young off the coast of southern California. Stephensen (1924–1925) indicated that *P. sedentaria* shows highest reproductive activity during the summer and fall months in northern waters, and in the winter and early spring elsewhere.

Phronima atlantica Guérin.

Phronima atlantica Vosseler, 1901: 21, pl. ii, fig. 1–10; Stephensen, 1924–1925: 121, chart 16; Mogk, 1927: 131, chart 2; K. H. Barnard, 1932: 258; Hurley, 1955: 166; Shih, 1969: 14–16, fig. 2.

Station 71-6-1: 1 female (12.5 mm); 850–975 m.
Station 71-6-5: 3 females (12, 15, 22 mm); 725–775 m.
Station 71-6-6: 1 female (11 mm); 640–750 m.
Station 71-6-9: 1 female (15 mm); 540–590 m.
Station 71-6-28: 1 female (19 mm); 0–425 m.
Station 71-6-30: 1 female (9 mm—ovigerous), 2 males? (6.5, 7 mm); 0–425 m.
Station 71-6-34: 1 female (28 mm); 330–340 m.
Station 71-6-35: 5 females (11, 13, 13, 14.5, 15 mm); 15–20 m.

Remarks

P. atlantica has been reported from various areas of the world and appears to be nearly cosmopolitan except for Arctic waters. Shih (1969: 57) mapped this species distribution as it was known at that time.

From analyzing depth records from this and other studies, there is little doubt that *P. atlantica* occurs near the surface at night, and probably to depths of 1,000 m or more during the daylight hours. The presence of specimens in samples from Station 71-6-35 (night, 15–20 m) and in the two "bounce tows" at night supports the former statement. The regularity of any migration is still questionable, but is suspected to be similar to *P. sedentaria*.

Only a single ovigerous female was taken in this present study. Early work (Vosseler, 1901) suggests the possibility of two breeding seasons (summer and winter) for *P. atlantica*, but data are too scant for anything more than speculation.

Phronima colletti? Bovallius.

Phronima colletti Stephensen, 1924–1925: 127–130, chart 18; Chevreux and Fage, 1925: 396–397, fig. 395, 398; Pirlot, 1929: 114–115; K. H. Barnard, 1932: 286; Shoemaker, 1945: 236; Hurley, 1956: 17; Hurley, 1960: 280; Shih, 1969: 21–25, fig. 5; Laval, 1970: 47–57, fig. 1, 2, 5.

Station 71-6-25: 1 female (12 mm); 80–85 m.

Remarks

The single individual recovered in this study fits reasonably well with the description given by Laval (1970) of the Indo-West-Pacific form of *P. colletti* but absence of comparative specimens prevents this author from making an absolute identification.

Genus *Phronimella* Claus

Phronimella elongata Claus.

Phronimella elongata Chevreux and Fage, 1925: 398–399, fig. 400; Barnard, 1932:

286; Shoemaker, 1945: 236–238; Hurley, 1955: 1970; Hurley, 1960: 280, 284, table 2; Shih, 1969: 30–32, fig. 8.

Station 71-6-24: 1 male (8 mm); 50 m.
Station 71-6-28: 2 female (9, 13 mm); 1 male (8.5 mm); 0–425 m.
Station 71-6-32: 1 female? (16 mm—damaged); 1,025–1,065 m.
Station 71-6-34: 1 female (10.5 mm); 330–340 m.
Station 71-6-35: 1 female (13.5 mm); 15–20 m.

Remarks

Barnard (1932) recorded *P. elongata* from the Mediterranean, North and South Atlantic, Indo-Pacific, and Antarctic. Hurley (1955, 1960) reported this species from New Zealand waters, and Shih (1969: 61) mapped the distribution.

This species is certainly near the surface at night, but too few positive samples were obtained for any analysis of vertical movement.

Family PARAPHRONIMIDAE

Genus *Paraphronima* Claus

The two species of *Paraphronima* are distinguished from one another on the following bases:

Peraeopods 1–5 with numerous spines on posterior margins; adult size range about 5–16 mm ..... *P. gracilus*
Peraeopods 1–5 lacking obvious spines, adult size range about 10–28 mm ..... *P. crassipes*

Paraphronima gracilus Claus.

Paraphronima gracilus Stephensen, 1924–1925: 75–77; Chevreux and Fage, 1925: 391, fig. 394; Spandl, 1927: 165–166, fig. 6; Pirlot, 1929: 105–106; K. H. Barnard, 1932: 267; Hurley, 1956: 12–13; Brusca, 1967*a*: 390–391, table 13; Brusca, 1967*b*: 454–455, table 11.

Station 71-6-16: 1 male (6.5 mm); 100 m.
Station 71-6-19: 1 male (8 mm); 450–470 m.

Paraphronima crassipes Claus.

Paraphronima crassipes Stephensen, 1924-1925: 77–78; Chevreux and Fage, 1925: 390–391, fig. 393–394; Spandl, 1927: 166; Pirlot, 1929: 105–106; K. H. Barnard, 1932: 267–268; Shoemaker, 1945: 234; Hurley, 1955: 136; Hurley, 1956: 13; Hurley, 1960: 280; Brusca, 1967*a*: 391, table 14; Brusca, 1967*b*: 455, table 12.

Station 71-6-5: 1 female (18 mm); 725–775 m.
Station 71-6-35: 1 female (12 mm); 15–20 m.

Remarks

Vertical migration upwards at night has been shown to occur in both species of *Paraphronima* (Brusca, 1967*a*).

Family LANCEOLIDAE

Genus *Scypholanceola* Woltereck

Scypholanceola vanhoeffeni Woltereck.

Scypholanceola richardi Chevreux, 1920: 8, fig. 4–6; Pirlot, 1929: 45.
Scypholanceola vanhoeffeni Woltereck, 1909: 161, 167, pl. vii, fig. 24*a*, *b*; Woltereck, 1927: 65–67, fig. 5, 9; K. H. Barnard, 1916: 290; K. H. Barnard, 1932: 257.

Station 71-6-1: 1 (35 mm—damaged); 850–975 m.
Station 71-6-2: 1 male? (15 mm); 450–600 m.
Station 71-6-5: 3 damaged plus one part (20, 20, 28 mm); 725–775 m.
Station 71-6-7: 1 female (20 mm); 1,100–1,275 m.
Station 71-6-27: 2 females? (14, 15 mm); 900–930 m.
Station 71-6-32: 1 male? (24 mm); 1,025–1,065 m.

Remarks

Although most of the specimens were somewhat damaged, they seem to agree with Woltereck's (1909, 1927) descriptions of *S. vanhoeffeni*. Work on this species since K. H. Barnard (1932) has not been encountered by this author and these Hawaiian samples may represent an extension of range. Barnard reported it from the Atlantic and Indian oceans, and from Antarctic waters.

From this present study and others, *S. vanhoeffeni* appears to be restricted to depths of more than about 450 meters, and probably undergoes little or no regular vertical migration.

Family PHROSINIDAE

Genus *Primno* Guérin

Primno macropa Guérin.

Euprimno macropus Bovallius, 1889: 400–407, pl. xvii, fig. 23–40, pl. xviii, fig. 1–2; Chevreux and Fage, 1925: 416, fig. 411; Pirlot, 1929: 130–131; Pirlot, 1930: 22.

Primno macropa K. H. Barnard, 1930: 424–425; K. H. Barnard, 1932: 287–288; Thorsteinson, 1941: 93–94, pl. 9, fig. 98–102; Mackintosh, 1934: 90, fig. 20; Shoemaker, 1945: 234–236; Hurley, 1955: 172–174, fig. 219–235; Hurley, 1956: 17–18; Brusca, 1967*a*: 386–387, table 7; Brusca, 1967*b*: 450–451, table 5.

Station 71-6-8: 1 female (5 mm), 1 male (5 mm); 580–620 m.
Station 71-6-16: 2 females (5, 5.5 mm); 100 m.
Station 71-6-18: 4 females (4, 4.5, 6—carrying young, 5 mm); 160–170 m.
Station 71-6-19: 2 females (5, 5.5 mm); 450–570 m.
Station 71-6-28: 2 females (6, 7 mm); 0–425 m.
Station 71-6-30: 1 female (4 mm), 1 male (5 mm); 0–425 m.
Station 71-6-34: 5 females (4, 6, 7—ovigerous, 7, 7.5 mm); 330–340 m.

Remarks

Primno macropa has been previously collected from the Mediterranean, Atlantic (lat 47° N to lat 36° S), Indian, and North and South Pacific oceans and the Antarctic (K. H. Barnard, 1932; Hurley, 1955). Although previously thought to be a deepwater species by Barnard and Hurley, more recent work (Brusca, 1967*a*) and this present study indicate a typical vertical migration toward the surface at night to depths of 100 meters or less.

Genus *Phrosina* Risso

Phrosina semilunata Risso.

Phrosina semilunata Bovallius, 1889: 426, pl. xviii, fig. 3–30; Stephensen, 1924: 138, chart 21; Chevreux and Fage, 1925: 413, fig. 409; Spandl, 1927: 168, 282, fig. 60–61; K. H. Barnard, 1930: 424; K. H. Barnard, 1932: 287; Hurley, 1955: 174; Hurley, 1956: 18; Hurley, 1960: 281.

Station 71-6-1: 1 female (8 mm); 850–975 m.
Station 71-6-6: 1 female (8 mm); 640–750 m.
Station 71-6-7: 1 female (7 mm); 1,100–1,275 m.
Station 71-6-9: 1 female (10 mm); 540–590 m.
Station 71-6-11: 6 females (12.5 mm—carrying young, 13 mm—carrying young, 17.5 mm—carrying young, 18, 19, 22 mm—ovigerous); 260 m.
Station 71-6-16: 8 females (7, 7, 7.5, 7.5, 8, 10, 11 mm); 100 m.
Station 71-6-18: 5 females (20—ovigerous, 12, 13, 15, 15 mm); 160–170 m.
Station 71-6-19: 1 female (19 mm—ovigerous); 450–570 m.
Station 71-6-28: 1 female (6, 7 mm); 0–425 m.
Station 71-6-30: 10 females (6, 6, 7.5, 11, 15 mm—ovigerous, 19 mm—ovigerous, 20, 20).
Station 71-6-35: 1 female (5.5 mm); 15–20 m.

Remarks

From analyzing records of previous studies, I find that this species appears to be nearly cosmopolitan except for Arctic seas.

Of the 37 specimens taken in these Hawaiian samples, only two were found in daytime trawls. At night, however, several were captured at depths of 100 meters or less, indicating a migration toward the surface during the dark hours.

Family HYPERIIDAE

Genus *Hyperia* Latreille

The tremendous amount of taxonomic confusion which has accompanied this genus makes positive identification difficult. There is, without doubt, much intraspecific variation geographically. The specimens listed here as *Hyperia luzoni* compare well with Stebbing's (1888) description of that species, and with Hurley's (1955) key to the New Zealand members of the genus *Hyperia*.

The other species, *H. bengalensis*, agrees on most points with Hurley's (1955) description

and figures for the males. Some of the systematic problems have been reviewed by Hurley (1956).

Hyperia luzoni Stebbing.

Hyperia luzoni Stebbing 1888: 1,384–1,385, pl. clxvi; K. H. Barnard, 1930: 410; Pirlot, 1939: 35; Hurley, 1955: 137; Hurley, 1960: 279.

Station 71-6-1: 2 females (2.5 mm—ovigerous, 2.5 mm); 850–975 m.
Station 71-6-5: 2 females (4 mm—ovigerous, 4.5 mm); 725–775 m.
Station 71-6-16: 4 females (2, 2.5, 3, 4 mm); 100 m.
Station 71-6-18: 1 male (3.5 mm); 160–170 m.
Station 71-6-24: 5 females (1.5, 2, 3, 3, 3.5 mm—ovigerous), 5 males (2.5, 3, 3, 3, 4 mm); 50 m.
Station 71-6-25: 2 females (2, 2.5 mm), 2 males (2, 2.5 mm); 80–85 m.
Station 71-6-28: 3 females (2, 2.5, 3 mm); 0–425 m.
Station 71-6-34: 1 male (3 mm); 330–340 m.
Station 71-6-35: 4 females (3 mm—ovigerous, 3.5, 3.5, 4 mm), 5 males (3, 3.5, 4, 4, 4.5 mm); 15–20 m.

Remarks

The data accumulated here demonstrate that *H. luzoni* is concentrated in the upper 100 to 150 meters during the dark hours. Only four specimens were taken at depths of more than 425 meters and those could have been a result of contamination from higher levels. Four of the mature females collected in June were noted to be carrying ova.

Hyperia bengalensis (Giles).

Lestregonus bengalensis Giles, 1887: 224, pl. 6, fig. 1–10, pl. 7, fig. 1–9.
Hyperia bengalensis Shoemaker, 1942: 49; Shoemaker, 1945: 238; Hurley, 1955: 137–140, fig. 70–82; Hurley, 1956: 14–15; Hurley, 1960: 279; Brusca, 1967*a*: 388; Brusca 1967*b*: 452. (Other synonomies are given by Hurley, 1955.)

Station 71-6-1: 6 females (2.5–3.5 mm), 9 males (2–4.5 mm); 850–975 m.
Station 71-6-6: 1 male (3 mm); 640–750 m.
Station 71-6-8: 1 male (4.5 mm); 580–620 m.
Station 71-6-16: 83 females (10 ovigerous, 4 carrying young, 2–4.5 mm), 39 males (3–4.4 mm); 100 m.
Station 71-6-18: 6 females (3–4 mm), 18 males (3–5 mm); 160–170 m.
Station 71-6-24: 47 females (4 ovigerous, 1 carrying young, 3–4.5 mm), 44 males (3–5 mm); 50 m.
Station 71-6-25: 47 females (9 ovigerous, 2 carrying young, 1.5–4.5 mm), 12 males (3–4.5 mm); 80–85 m.
Station 71-6-28: 5 females (2–3.5 mm), 5 males (2.5–4.5 mm); 0–425 m.
Station 71-6-30: 4 females (2–4 mm), 3 males (2.5–3 mm); 0–425 m.
Station 71-6-34: 1 male (3 mm); 330–340 m.
Station 71-6-35: 7 females (2.5–4.5 mm), 12 males (3.5–5 mm); 15–20 m.

Remarks

Hurley (1955) gave the geographic distribution of *H. bengalensis* as being the North and South Atlantic, Mediterranean, Arabian Sea, South Pacific (off Cape Howe), Australia, New Zealand, Bermuda, and New South Wales. Hurley (1956) and Brusca (1967*a*) reported this species from off the southern California coast.

The evidence presented by Brusca (1967*a*) that this species undergoes nightly migration toward the surface is further supported by the distribution of position samples and by the numbers of individuals collected in the present study. Note the high concentrations of specimens in the shallow, nighttime stations.

Family PRONOIDAE

Genus *Eupronoë* Claus

Eupronoë minuta Claus.

Eupronoë minuta Stephensen, 1924-1925: 160–161, fig. 55–56; Chevreux and Fage, 1925: 425–426, fig. 417; Pirlot, 1929: 148–149; K. H. Barnard, 1930: 426; Pirlot, 1930: 34–35; K. H. Barnard, 1932: 289; Shoemaker, 1945: 245–246; Hurley, 1955: 175; Hurley, 1956: 19; Hurley, 1960: 281; Brusca, 1967*a*: 386, table 6; Brusca 1967*b*: 450–451, table 4.

Station 71-6-1: 1 female (3.5 mm), 2 males (4, 4.5 mm); 850–975 m.

Station 71-6-3: 1 female (3.5 mm); 425 m.
Station 71-6-5: 1 female (4 mm); 725–775 m.
Station 71-6-9: 1 male (3 mm); 540–590 m.
Station 71-6-16: 1 female (3.5 mm), 4 males (3–4 mm); 100 m.
Station 71-6-18: 2 females (3.5, 4 mm), 4 males (3.5, 4, 4, damaged); 160–170 m.
Station 71-6-24: 5 females (2.5, 3, 3, 3.5, 4.5—ovigerous), 12 males (3–4.5 mm); 50 m.
Station 71-6-25: 2 females (2, 2.5 mm), 3 males (2.5, 3, 3.5 mm); 80–85 m.
Station 71-6-28: 1 female (3 mm); 0–425 m.
Station 71-6-30: 1 female? (2.5 mm); 0–425 m.
Station 71-6-35: 1 female (5 mm), 3 males (4, 4, 5 mm); 15–20 m.

Remarks

E. minuta has been reported previously from the Mediterranean, North Atlantic, Canaries and Azores, and the South Pacific by Barnard (1932) and from New Zealand (Hurley, 1955), and off the coast of California (Hurley, 1956, Brusca, 1967*a*).

The confusion regarding vertical migration by this species (Brusca, 1967*a*) cannot be cleared up by this present study because of the absence of shallow daytime tows. It appears, however, that individuals are more concentrated near the surface at night than they are in deep water.

Genus *Parapronoë* Claus

Parapronoë crustulum Claus.

Parapronoë crustulum Stebbing, 1888: 1,530, pl. cxciii, fig. *A*; Stephensen, 1924–1925: 165; Spandl, 1927: 220–221, fig. 39, 40; K. H. Barnard, 1932: 290; Hurley, 1960: 281.

Station 71-6-2: 1 female (18.5 mm—carrying young); 450–600 m.
Station 71-6-3: 1 female (21 mm); 425 m.
Station 71-6-9: 2 females (14, 19 mm); 540–590 m.
Station 71-6-11: 4 females (16.5, 18 mm—ovigerous, 22 mm—ovigerous, 22.5 mm); 260 m.
Station 71-6-21: 1 female (18.5 mm—ovigerous); 630–690 m.
Station 71-6-27: 2 females (14 mm—carrying young, 16 mm—carrying young); 900–930 m.
Station 71-6-28: 1 female (17 mm); 0–425 m.

Remarks

K. H. Barnard (1932) recorded this species from the Atlantic (lat 47° to 17° N), and the Indo-Pacific Ocean. Hurley (1960) listed *P. crustulum* from stations in the Pacific south of Fiji (lat 17° to 23° S).

Family BRACHYSCELIDAE

Genus *Brachyscelus* Bate

Brachyscelus crusculum Bate.

Brachyscelus crusculum Holmes, 1908: 490; Shoemaker, 1925: 45–46; Chevreux and Fage, 1925: 427, fig. 418; Spandl, 1927: 210; K. H. Barnard, 1932: 292; Shoemaker, 1945: 242; Hurley, 1955: 181; Hurley, 1960: 282.

Station 71-6-8: 2 females (7.5, 8 mm—ovigerous); 580–620 m.
Station 71-6-34: 2 males? (3 mm, one damaged); 330–340 m.

Remarks

This species has been previously reported from the Mediterranean, Atlantic, and North Pacific (K. H. Barnard, 1932); and from the North and South Pacific by Hurley (1955, 1956, 1960).

Brachyscelus rapacoides? Stephensen, 1925.

Station 71-6-7: 1 (damaged, ~7 mm); 1,100–1,275 m.
Station 71-6-8: 1 (damaged, ~7 mm); 580–620 m.

The two specimens appear to be assignable to *B. rapacoides* based primarily on the key given by Hurley (1955) which separates *B. crustulum* from *B. rapacoides*. Until more and better individuals are obtained from Hawaiian waters, this identification must remain questionable.

Family PLATYSCELIDAE

Genus *Platyscelus* Bate

The two species of *Platyscelus* taken off Hawaii are easily separated from one another. When

viewed from above, *P. armatus* displays very distinct, sharp, lateral epimeral projections; these processes are not evident in *P. serratulus*. Also, the size range for *P. armatus* is about 10 to 18 mm, whereas individuals of *P. serratulus* rarely exceed 5 or 6 mm.

Platyscelus armatus (Claus).

Platyscelus armatus Claus, 1887: 36, pl. ii, fig. 3–15; Spandl, 1927: 229, fig. 45; K. H. Barnard, 1932: 298.

Station 71-6-2: 1 female (13 mm); 450–600 m.
Station 71-6-3: 1 female (11 mm); 425 m.
Station 71-6-6: 1 female (17.5 mm—ovigerous); 640–750 m.
Station 71-6-9: 1 female (12 mm); 540–590 m.
Station 71-6-11: 1 female (16 mm); 260 m.
Station 71-6-27: 1 female (15 mm); 900–930 m.

Remarks

The distribution of this species is given as "warm seas" by Spandl (1927). Most of the early records are from the Atlantic Ocean. There is no evidence of vertical movement by *P. armatus*, but data are too scant to be conclusive.

Platyscelus serratulus Stebbing.

Platyscelus serratulus Stebbing, 1888: 1,470; Stephensen, 1924–1925: 215–218, chart 31; Chevreux and Fage, 1925: 422, fig. 414; K. H. Barnard, 1930: 437; Pirlot, 1930: 37; K. H. Barnard, 1932: 298; Shoemaker, 1945: 259; Hurley, 1955: 189; Hurley, 1956: 21–22; Hurley, 1960: 283; Brusca, 1967*a*: 385–386; Brusca, 1967*b*: 450.

Station 71-6-2: 1 female (5 mm); 450–600 m.
Station 71-6-3: 1 female (6 mm); 425 m.
Station 71-6-16: 5 females (3.5–5 mm); 100 m.
Station 71-6-25: 6 females (3–6 mm—one ovigerous); 80–85 m.
Station 71-6-28: 1 female (3 mm); 0–425 m.
Station 71-6-32: 2 females (6.5, 7 mm); 1,025–1,065 m.
Station 71-6-35: 2 females (3, 4.5 mm); 15–20 m.

Remarks

Aggregation near the surface at night by *P. serratulus* has been previously reported by Stephensen (1924–1925) and Brusca (1967*a*).

The distribution of positive samples in this present study supports these reports. During the dark hours individuals were more concentrated above 150 m than they were at greater depths. The single specimens in the samples around 400 to 500 meters at night may well have been captured as the trawl was being lowered or raised.

Since this species is rarely taken in great numbers, little information is available on its reproductive cycle.

Genus *Tetrathyrus* Claus

Tetrathyrus arafurae? Stebbing.

Tetrathyrus arafurae Stebbing, 1888: 1483; Spandl, 1927: 243.

Station 71-6-1: 1 female (5 mm); 850–975 m.

Remarks

This single individual has been questionably assigned to *T. arafurae* based upon Spandl's (1927) key and Stebbing's (1888) description. Without comparative specimens, the identification remains tentative.

Genus *Paratyphis* Claus

Paratyphis spinosus? Spandl.

Paratyphis spinosus Spandl, 1927: 245–246; Hurley, 1955: 188.

Station 71-6-30: 1 female (damaged, approximately 2.5 mm—ovigerous); 0–425 m.

Remarks

Although damaged, the specimen reported here fits Spandl's (1927) key and description, and Hurley's (1955) key.

Family OXYCEPHALIDAE

Four genera represented this family in the Hawaiian samples. They may be separated with the following key.

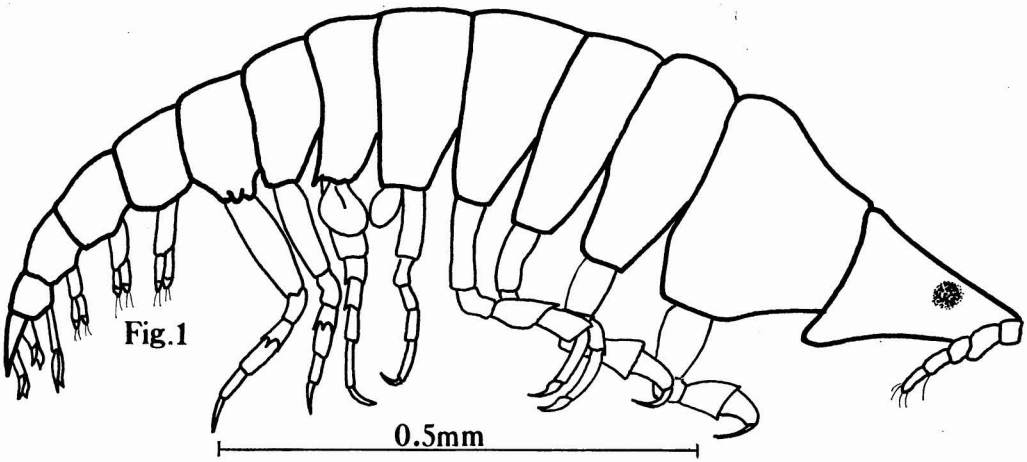

FIG. 1. *Streetsia challengeri*: 1-mm-long young removed from brood pouch of 15-mm female.

KEY TO THE GENERA *Rhabdosoma*, *Calamorhynchus*, *Oxycephalus*, AND *Streetsia*

1. Body very long and slender; rostrum styliform and fragile; uropods extremely elongate ..... *Rhabdosoma*
1. Head may be somewhat elongate; body and uropods normal 2
2. Head flattened dorsoventrally producing lateral expansions; inner ramus or uropod 3 fused with peduncle, other uropod rami free ..... *Calamorhynchus*
2. Head not dorsoventrally flattened; uropods otherwise 3
3. Inner rami of uropods 2 and 3 with peduncles; eye-bearing portion of head distinctly shorter than peraeon ..... *Oxycephalus*
3. Inner rami of all uropods free; eye-bearing portion of head relatively long, narrow, often as long as, or nearly as long as, peraeon ..... *Streetsia*

Genus *Streetsia* Stebbing

Streetsia challengeri Stebbing.

Streetsia pronoides Bovallius, 1890: 34, pl. III, fig. 7–12, p. 23, fig. 9, p. 35, fig. 62; Pirlot, 1938: 369; Hurley, 1956: 18–19.

Streetsia challengeri Stebbing, 1888: 1603–1606, pl. 207; Stephensen, 1924–1925: 194–199, fig. 75; Pirlot, 1929: 164–165; K. H. Barnard, 1930: 435; K. H. Barnard, 1932: 295; Shoemaker, 1945: 255; Hurley, 1955: 183; Fage, 1960: 51–63, fig. 36–43; Brusca, 1967*a*: 387–388, table 8; Brusca, 1967*b*: 452, table 6.

Station 71-6-3: 1 female (36 mm—ovigerous); 425 m.

Station 71-6-11: 5 females (18, 20, 24, 30 mm—ovigerous, 33 mm); 260 m.

Station 71-6-24: 1 female (12.5 mm); 50 m.

Station 71-6-24: 1 female (12.5 mm); 50 m.

Station 71-6-25: 1 female (17 mm); 80–85 m.

Station 71-6-28: 1 female (21 mm); 0–425 m.

Station 71-6-30: 3 females (15 mm—carrying young, 15 mm—carrying young, 22 mm); 0–425 m.

Remarks

A compilation of past records for *S. challengeri* indicates that it is probably cosmopolitan between the polar circles.

Previous works (Hurley, 1956; Fage, 1960; and Brusca, 1967*a*) indicate that this species undergoes nightly migrations toward the surface and retreats to deeper waters during the daytime.

This present study revealed specimens in the upper 100 meters at night, but other data are too scant for adding any definite conclusion to the already established pattern of vertical movement.

Two females with eggs and two carrying well-developed young were recovered in this present study. Figure 1 pictures a 1-mm juvenile

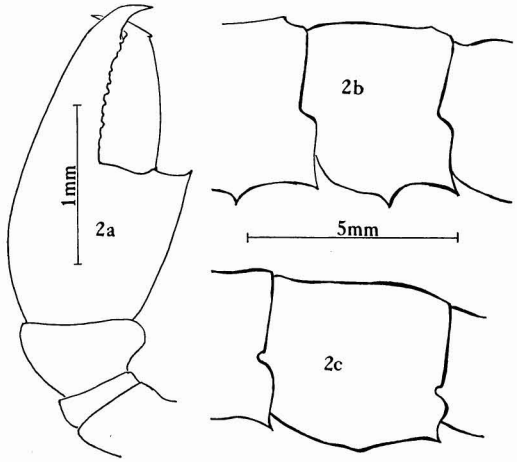

Fig.2

FIG. 2. *a–b*, *Oxycephalus clausi*: *a*, second gnathopod showing produced anterior border of carpus; *b*, metasomal epimera showing median ventral point; *c*, *Oxycephalus piscator*, metasomal epimera showing absence of median ventral point.

removed from the brood pouch of a 15-mm female (Station 71-6-30). It is interesting to note that the first pair of true thoracic legs is markedly subchelate, as is the second, while the third pair is simple and resembles the rest of the legs which will eventually be the adult peraeopods.

In subsequent growth, then, the first pair must be transformed into the maxillipeds, while the second (subchelate) and third (simple) must become the complexly chelate gnathopods. With the acquisition of more specimens, it is hoped that these developmental changes may be described.

Genus *Oxycephalus* Milne-Edwards

The two species of *Oxycephalus* taken in this study may be separated on the following traits (compiled from Fage, 1960; figures drawn from Hawaiian specimens):

Anterior, distal border of carpus of gnathopods produced (Fig. 2*a*); metasomal epemerae with median, ventral points (Fig. 2*b*) ..... *O. clausi*

Anterior, distal border of carpus of gnathopods not produced; metasomal epemerae lacking median ventral points (Fig. 2*a*) ..... *O. piscator*

Oxycephalus clausi Bovallius.

Oxycephalus clausi Bovallius, 1890: 60, fig. 4, 7, 8, 22, 54, 65, pl. i, fig. 19–24, pl. ii, fig. I; Stephensen, 1924–1925: 188, chart 27; K. H. Barnard, 1930: 433; K. H. Barnard, 1932: 294; Fage, 1960: 20–26, fig. 11–16; Brusca, 1967*a*: 387.

Station 71-6-3: 2 females (32, 35 mm); 425 m.
Station 71-6-7: 1 male (21 mm); 1,100–1,275 m.
Station 71-6-25: 1 female (34 mm); 80–85 m.
Station 71-6-35: 7 females (17, 18, 19, 20, 24, 26, 26 mm); 15–20 m.

Remarks

This species has been reported from temperate and tropical waters of the Atlantic, Pacific, and Indian oceans, and the Mediterranean. There is little doubt that *O. clausi* concentrates near the surface during the dark hours, but data showing its daytime distribution are scant and not conclusive.

Oxycephalus piscator Milne-Edwards.

Oxycephalus piscator Bovallius, 1890: 56, fig. 33, 35–37, 41, 42, 66, 68, 69, 75, pl. i, fig. 8–16; Stephensen, 1924–1925: 186, chart. 27; Spandl, 1927: 180, fig. 13*a–d*; K. H. Barnard, 1930: 433; K. H. Barnard, 1932: 294–295; Hurley, 1955: 182; Fage, 1960: 14–20, fig. 4–10.

Station 71-6-8: 1 female (12 mm—ovigerous), 1 male (14 mm); 580–620 m.
Station 71-6-18: 1 male (15 mm); 160–170 m.
Station 71-6-21: 1 female (19 mm); 630–690 m.
Station 71-6-24: 3 females (9, 5, 11, 13.5 mm); 50 m.
Station 71-6-25: 4 females (21, 5, 24 mm, <20 mm—damaged, <20 mm—damaged); 80–85 m.
Station 71-6-35: 3 females (10, 11, 23 mm), 3 males (11 mm, 12 mm—damaged); 15–20 m.

Remarks

O. piscator is reported by Fage (1960) from the tropical and temperate waters of the Atlan-

tic, Pacific, and Indian oceans, and the Mediterranean Sea.

The distribution of positive samples in this study suggests a migratory pattern toward the surface at night. Again, the absence of shallow daytime samples prevents absolute determination of the pattern of vertical movement.

Genus *Calamorhynchus* Streets

Calamorhynchus pellucidus Streets.

Calamorhynchus rigidus Stebbing, 1888: 1,000, pl. 206; Bovallius, 1890: 74; Stephensen, 1924–1925: 189–191.

Calamorhynchus pellucidus Bovallius, 1890: 73–74, pl. 2, fig. 14–15; Hurley, 1955: 182; Fage, 1960: 31–37, fig. 19–20; Brusca, 1967*a*: 387.

Station 71-6-16: 1 female (11 mm); 100 m.

Station 71-6-28: 1 female (17.5 mm—carrying young); 0–425 m.

Remarks

The two specimens noted in this study were taken in nighttime samples.

Genus *Rhabdosoma* Adams & White

Rhabdosoma whitei Bate.

Rhabdosoma whitei Stephensen, 1924–1925: 207; Spandl, 1927: 208–210, fig. 31; K. H. Barnard, 1930: 436; K. H. Barnard, 1932: 296–297; Shoemaker, 1945: 255; Hurley, 1960: 282; Fage, 1960: 97–103, fig. 71–75.

Station 71-6-1: 1 male (~55 mm—telson broken); 850–975 m.

Station 71-6-18: 1 female (65 mm—carrying young); 160–170 m.

Station 71-6-27: 1 female (67 mm—carrying young); 900–930 m.

Station 71-6-28: 2 females (~47 mm—rostrum broken, 52 mm); 0–425 m.

Station 71-6-35: 9 females (58, 60, 68, 70 mm, plus five damaged—all nine specimens carrying young); 2 males ?—damaged; 15–20 m.

Remarks

Fage (1960, fig. 76) mapped the distribution of R. *whitei* as being in nearly all waters from about lat 40° N to lat 20°–30° S.

This species was by far the commonest representative of the genus *Rhabdosoma* in these Hawaiian samples, and showed a clustering near the surface at night. Eleven of the 13 females were carrying well-developed young. A 0.8-mm embryo taken from a large female from Station 71-6-35 is shown in fig. 3. Oddly, the head appendage shown there (presumably the developing first antenna) was only present on the right side of each specimen examined.

Rhabdosoma minor Fage.

Rhabdosoma minor Fage, 1960: 107–110, fig. 79.

Station 71-6-16: 1 female (17 mm—rostrum missing); 100 m.

Remarks

Only one specimen of this species was recorded in the present study. Fage (1960, fig. 79) shows the geographic distribution as from about lat 30° N–10° S in the Pacific Ocean, lat 0°–lat 35° S in the Indian Ocean, and a few records in the Atlantic Ocean from above lat 60° N to lat 10° S.

Rhabdosoma armatum? Milne-Edwards.

Rhabdosoma armatum Spandl, 1927: 210; K. H. Barnard, 1930: 436; K. H. Barnard, 1932: 197; Fage, 1960: 88–96, fig. 58–70.

Station 71-6-4: 1 male (badly damaged, 46 mm without telson and most of rostrum, uropods broken); 600–625 m.

Station 71-6-16: 1 male (~60 mm—badly damaged); 100 m.

Remarks

These two specimens are tentatively assigned to R. *armatum* based upon the key given by Fage (1960), but both were badly damaged during collecting.

DISCUSSION AND CONCLUSIONS

A total of 908 individuals was considered in this study from the complete sorting of 22 samples. These specimens represent 35 species belonging to 12 families (see Table 1). The most abundant species in terms of total numbers collected were, in decreasing order: *Hyperia bengalensis*, *Vibilia armata*, *Eupronoë minuta*,

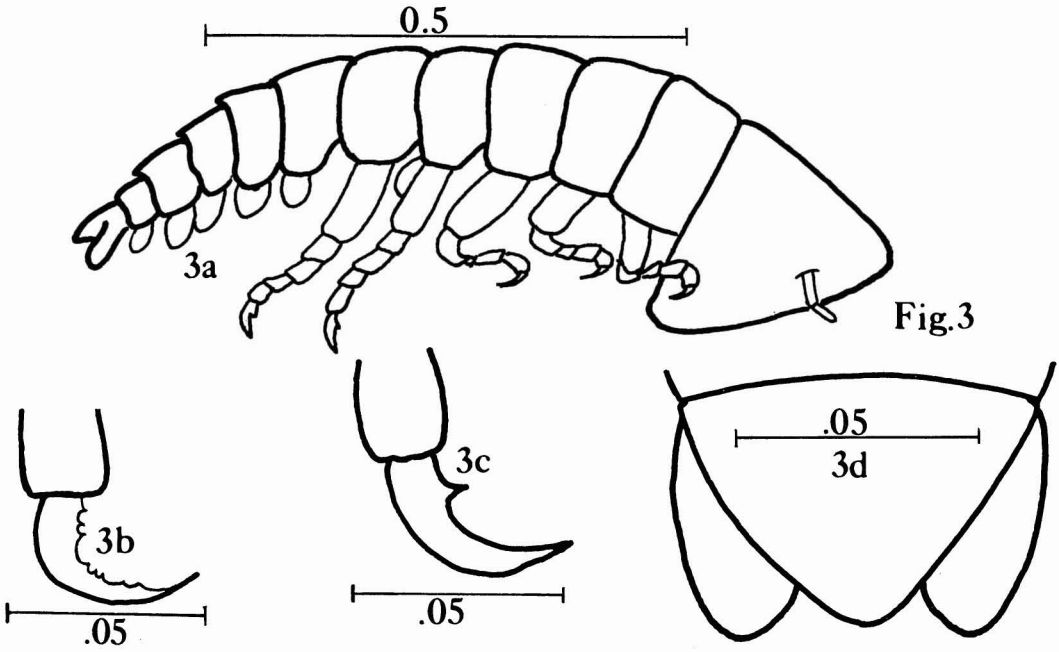

Fig. 3. *a–d, Rhabdosoma whitei*: *a*, 0.8-mm-long young removed from brood pouch of adult female; *b*, details of dactylus of most posterior peraeopod; *c*, details of dactylus of 4th peraeopod; *d*, dorsal view of posterior end. (*b–d* drawn from individual shown in *a*.) (All scales in millimeters.)

TABLE 4

A Comparison of Numbers of Species and Numbers of Individuals Taken from Various Depths during the Day and Night at about Lat 21° N, Long 158° 20′ W

DEPTH RANGE IN METERS	TOTAL TIME AT DEPTH IN MINUTES	TOTAL NO. SPECIES	NO. SPECIES PER HOUR TRAWLING TIME	NO. INDIVIDUALS PER HOUR TRAWLING TIME
		NIGHT		
0–50	239	15	3–4	49
>50–100	243	16	4	~61
>100–300	235	14	3–4	16
>300–600	298	16	~3	~7
>600–800	117	9	~4	6
>800	374	20	~3	~6
bounce tows				
0–425	78 down and up	17	~13	~46
		DAY		
0–400		no samples		
>400–600	482	21	2–3	17
>600–900	375	16	2–3	6–7
>900	357	13	~2	~4

and *Phronima sedentaria*. All other species were represented by less than 40 individuals. In terms of numbers of samples in which each species occurred, the following were encountered in 10 or more of the 22 samples: *Phronima sedentaria* (highest, with 13), *Cyphocaris faurei*, *Vibilia armata*, *Cystisoma fabricii*, *Phrosina semilunata*, *Hyperia bengalensis*, and *Eupronoë minuta*.

As mentioned earlier, the members of the family Scinidae are still being studied. It should be noted that a comparatively high number of specimens of this group was obtained and will add considerably to the total.

There is no doubt that many of the amphipods discussed in this paper are concentrated in the upper 100 meters or so of water during the dark hours. It is suspected that most of these particular species undergo regular vertical migrations toward the surface at night, and deeper in the daytime; but the absence of shallow, daytime samples makes accuracy impossible. Table 4 shows the vertical distribution of the total amphipod population based on the samples studied here. The differences in numbers of individuals taken in shallow versus deep tows at night are probably really greater than shown there, based on the high suspected contamination as the net is being lowered and raised (note the high number in the "bounce tows"). It also appears that most of the individuals are concentrated above 600 meters even during the daylight hours.

Accurate descriptions of the vertical movements of animals such as these pelagic amphipods and many others will ultimately depend upon more discreet sampling methods employing precise opening and closing devices. The use of such gear is presently limited by availability and expense.

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