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Faunal Associates of an Undescribed Species of *Chrysaora* (Cnidaria, Scyphozoa) in the Southern California Bight, with Notes on Unusual Occurrences of Other Warm Water Species in the Area

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Abstract.—A large, undescribed species of scyphomedusa (Cnidaria, Scyphozoa) was sighted offshore, in bays, and washed up in large numbers on beaches of Southern California and northern Baja California, México, during the summer of 1989. Invertebrate associates, taken from two living but damaged medusae lacking tentacles and oral arms, included a pycnogonid sea spider and two species of mysidacean shrimp not previously reported associated with scyphozoans. These species probably became attached as the moribund medusae contacted the seafloor prior to washing ashore. Previously reported scyphozoan associates included a hyperiid amphipod and larval (megalopal) and juvenile brachyuran crabs of the genus *Cancer*. Photographs and video footage of living scyphomedusae allowed observations of the natural history of the medusae and of the behavior of juvenile crabs. The unique occurrence of this scyphozoan and its faunal associates is described and discussed along with other unusual local occurrences of species from other, mostly tropical, regions.

From July 7 through early September 1989, unidentified dark purple scyphozoan medusae were sighted along the eastern Pacific coast from at least as far south as Isla San Martin, off San Quentín, Baja California, México, north to Santa Monica Beach, California. The medusae were found in greatest numbers washed ashore on sand beaches and in the surf zone within 100 m from shore but were also sighted from boats traveling in bays and to approximately 1 nautical mile offshore (Table 1). Offshore medusae were all observed at the surface with the exception of one sighting at a depth of 21 m (above the wreck of the *Olympic* off Long Beach, California, Table 1) and the medusae filmed off the Islas de Los Coronados (see below). Most medusae in the above sightings were approximately 20 to 40 cm in bell diameter. Additionally, photographs and video footage (provided by Howard Hall and Mark Conlin, of Howard Hall Productions) showed a "school" of larger specimens (estimated bell diameter up to 1 m; Figs. 1, 2) from Coronodo Norte, Islas de Los Coronados, Baja California, México.

Distinguishing characteristics of those scyphomedusae washed ashore or observed nearshore include a light brown to tan reticulated pattern about 3 to 8 cm wide surrounding the dorsal perimeter of the bell (Figs. 1A, B), a dark purple mesoglea, a dark red-brown mucous that is produced when the medusae are handled (see Shanks and Graham 1988, for description of mucous production as a defensive mechanism in living scyphomedusae), and a mild sting. Living spec-

Table 1. Collecting (*) and sighting localities of undescribed species of *Chrysaora* (Cnidaria, Scyphozoa) in 1989. Medusae that harbored invertebrate associates (**). Abbreviations under "Proximity to Shore" are: O = offshore; B = bay; I = inshore (near shore); S = stranded (onshore).

Locality	Proximity to shore	Date
Isla San Martin, San Quentin, Baja California, Mexico		
D. Montagne	O	07 July 1989
Coronado Norte, Islas de Los Coronados, Baja California, Mexico		
H. Hall and M. Conlin	O/I	09, 26, 31 July 1989
Los Angeles Breakwater Light, Long Beach, CA**		
M. Curtis	O	15 July 1989
Desmond Bridge, Long Beach, CA		
E. Mastro and T. Deckel	B	27 July 1989
Desmond Bridge, Long Beach, CA*		
E. Mastro and T. Deckel	B	28 July 1989
Santa Monica Beach, CA		
J. Seigel	S	12 August 1989
Dana Point, CA		
B. Ormsby	B	15 August 1989
Venice Beach, CA**		
B. Hogue and D. Golles	I	20 August 1989
Venice Beach, CA*		
J. Martin and H. Kuck	I/S	25 August 1989
Venice Beach, CA**		
R. Feeney et al.	I	25 August 1989
San Diego, CA		
D. Pasko and D. Zmarzly	B	30 August 1989
Venice Beach, CA		
T. Rudnick	I/S	late August 1989
Venice Beach, CA*		
R. Fay	I	late August 1989
Estero Beach, Ensenada, Baja California, Mexico		
R. Fox	I	late August 1989
La Jolla, CA		
R. McConnaughey	O	early September 1989
Scripps Inst. of Oceanography Pier, La Jolla, CA*		
R. Snodgrass	I	early September 1989
Torrey Pines Fish & Game Reef, La Jolla, CA		
R. Snodgrass	O	early September 1989

imens, found mostly offshore, additionally have delicate tentacles and thick oral arms extending approximately 6 m (estimated from photographs and video footage, Figs. 1, 2). The tentacles and oral arms were missing from specimens that were sighted near shore or had washed ashore, with the exception of one specimen sighted but not collected off Long Beach, California (Table 1). The phenomenon was discussed with regional biologists and local residents, none of whom had seen this species before. Dr. Ron Larson, Harbor Beach Oceanographic Institution, Inc., Fort Pierce, Florida, determined, after examination of our specimens, other specimens, and the video footage of living animals, that the scyphomedusa is an undescribed species of the semaeostome genus *Chrysaora* (Larson 1990 and in preparation). In this paper we discuss the invertebrates and fish seen or collected

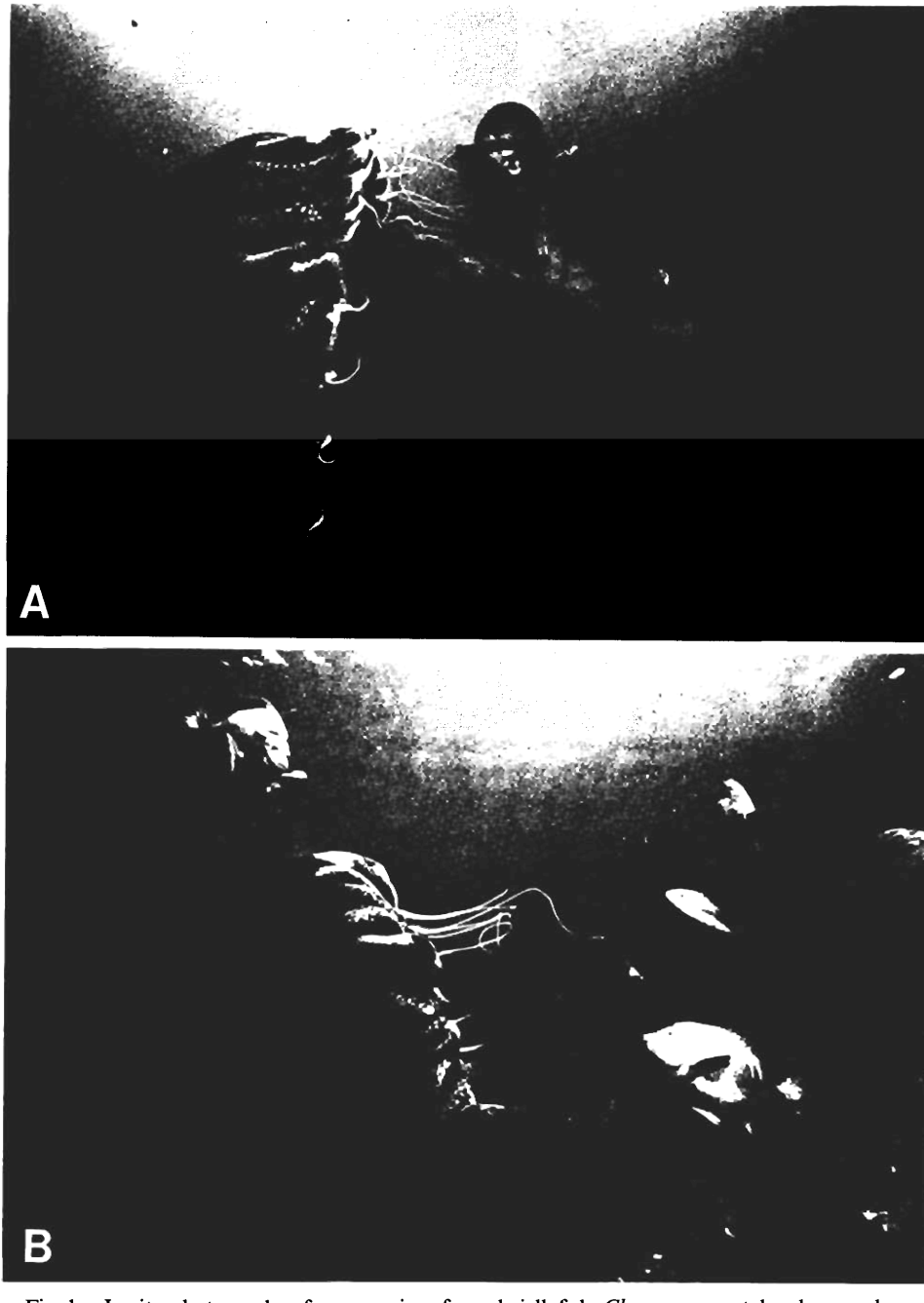

Fig. 1. In situ photographs of new species of purple jellyfish, *Chrysaora* sp., taken by members of Howard Hall film crew off Coronado Norte, Islas de Los Coronados, northern Baja California, México, July, 1989. A, intact medusa in front of diver; bell diameter estimated at 1 m. Note length of tentacles and especially oral arms, estimated to 6 m, which trail to bottom right of photograph (and terminate beyond frame of photograph). B, medusa with damaged tentacles and oral arms near seafloor. Note garibaldis and senoritas possibly feeding on oral arms and tentacles, probably explaining in part why only the bell exists in stranded specimens.

Fig. 2. Photograph of "school" of medusae, taken from video monitor, showing density of the jellyfish off Coronado Norte, Islas de Los Coronados, Baja California, México, July, 1989. At least 7 animals are in the field of view, 3 on either side of central largest (closest) animal.

in association with this new species. Additionally, we discuss this unusual occurrence in light of other unusual species occurrences in the area.

Materials and Methods

The first scyphomedusa specimen seen by us was collected on 20 August 1989 by B. T. Hogue and D. Golles, both lifeguards at Venice Beach with over 43 years combined experience (8 Hogue, 35 Golles) in the area without having seen this species. This large (approximately 23 cm bell diameter) living medusa was collected approximately 100 m offshore of Venice Beach, California. The medusa was donated to the Natural History Museum of Los Angeles County (LACM) and was brought to our attention because of the number of juvenile brachyuran crabs found on the manubrium (oral arms) and subumbrellar surface of the bell; it was subsequently catalogued as LACM 89-206.1 An additional live specimen (LACM 89-205.1, bell diameter approximately 25 cm) was collected on 25 August 1989 by the LACM Ichthyology Section just north of the Marina del Ray jetty, Venice, California. The authors counted another 24 dead specimens washed ashore along Venice Beach on 25 August 1989 and collected one dead specimen (LACM 89-26.1, bell diameter approximately 24 cm) floating on the surface in the surf zone. Another dead specimen (bell diameter approximately 22 cm) was collected by staff members of the Cabrillo Marine Museum near Long Beach, California (Table

1). The two live specimens and the two dead specimens were washed with warm tap water over a sieve (U.S. Standard #10; 0.5 mm mesh size), and invertebrates were collected from the washings. Three of the above specimens, and all collected invertebrate associates, were deposited at LACM; the fourth is housed at the Cabrillo Marine Museum, San Pedro , California (CMM Acc. No. 89.28.1). Additional observations of living medusae and associated fish were gleaned from video footage supplied by Howard Hall Productions.

Results

Invertebrate Associates

Neither of the dead medusae harbored any invertebrate associates. The two living medusa, both from off Venice Beach, Venice, California, harbored a variety of invertebrates, listed below. Because all of the symbionts were washed off in order to collect them we could not determine where on the medusa they were originally located.

Pycnogonida
Family Callipallenidae
Anoropallene palpida (Hilton, 1939)

One female with swollen femorae containing eggs, total length (tip of proboscis to end of abdomen) 2.6 mm, leg span 7.2 mm (LACM 89-205.4).

Remarks: This species is fairly common from Southern California south to Panama (Brusca 1980) but has never been reported in association with a scyphozoan or other cnidarian host, nor has it been found in a parasitic association with any other species (C. Allan Child, pers. comm.). Child (pers. comm.) has collected in Panama "over 100 of this species [*A. palpida*] from a sterile-appearing mud substrate with almost no epifauna on which they could feed." In fact there are very few reports of any association between pycnogonids and pelagic cnidarians, although benthic cnidarians are common prey items (Mauchline 1984; Child and Harbison 1986). The appendages do not appear to be specialized for clinging to a cnidarian host (compared to, for example, the appendages of species of the genus *Pallenopsis*; C. Allan Child, pers. comm.), and it is possible that this specimen attached itself to the jellyfish as the weakened medusa came in contact with the seafloor.

Crustacea, Amphipoda
Family Hyperiidae
Hyperia medusarum (Muller, 1776)

One female, total length 8.1 mm (LACM 89-206.2).

Remarks: Hyperiids are common associates of planktonic medusae and were reviewed by Thurston (1977), Harbison et al. (1977), and Laval (1980). Almost all reported hosts for the genus *Hyperia* are scyphozoan medusae, with the exceptions being ctenophores and one "dubious report" with a salp (Laval 1980: 15, see also Madin and Harbison 1977) and at least some hydromedusae (Pasko 1987). Laval (1980) questioned the reliability of records of associations with ctenophores; it is likely that species of *Hyperia* occur only on scyphozoan and hydrozoan medusae (Pasko 1987). There are 8 or 9 currently recognized species in the genus, depending upon whether the two "forms" of *H. medusarum, hystrix*

form and *medusarum* form, are treated as subspecies of *H. medusarum* or are recognized as distinct species (Bowman 1973). In Southern California the *hystrix* form is most commonly encountered (Bowman 1973), although the form we collected was *medusarum* (Gary Brusca, pers. comm.). Records of *H. medusarum* as associates of medusae in Southern California are numerous, and it is not surprising to encounter this species on any large scyphozoan host (Thurston 1977; Laval 1980; Pasko 1987; Gary Brusca, pers. comm.).

Crustacea, Mysidacea
Family Mysidae
Metamysidopsis elongata (Holmes, 1895)

2 adult males, total length of both approximately 4.7 mm (LACM 89-205.2).

Mysidopsis cathengelae Gleye, 1982

1 adult male, total length 10.5 mm; carapace length 2.8 mm (LACM 89-205.3)

Remarks: *Metamysidopsis elongata* is common in Southern California waters, and was the most abundant nearshore (to 36 m depth) mysid encountered in studies off San Onofre, California (Linda Gleye, unpub. data). Off La Jolla, California, the species can be "so abundant immediately above the bottom that vision of divers is obscured" (Clarke 1971). *Mysidopsis cathengelae* was described in 1982 from San Onofre State Beach, California, and is morphologically similar to *Mysidopsis californica* (Gleye 1982).

Although several mysid species are associated with benthic cnidarians, such as the mysid *Heteromysis actiniae* on the sea anemone *Bartholomea annulata* (Clarke 1955), we are not aware of any previous reportings of mysids as associates of scyphozoans (Linda Gleye and Ron Larson, pers. comm.). Because both species are abundant near shore and particularly near the bottom for *M. elongata,* it seems likely that these mysids became associated with the medusae only as the latter approached shore.

Crustacea, Brachyura
Family Cancridae
Cancer sp. (cf. *C. antennarius* Stimpson, 1856)

Twelve juveniles, all apparently belonging to the same species, ranging in size from carapace width (CW) of 3.1 to 22.1 mm. Eleven larvae (megalopae), from CW of 1.6 to 2.8 mm (LACM 89-206.3, 8 juveniles and 4 megalopae, from medusa LACM 89-206.1; LACM 89-205.5, 4 juveniles and 7 megalopae, from medusa LACM 89-205.1).

Remarks: The largest and most numerous associates of the jellyfish were juvenile crabs of the genus *Cancer.* The largest of these (CW 22.1 mm) was a male. The other 11 juvenile specimens ranged from CW of 3.1 mm to 18.1 mm; three were males, one was female, and the other seven specimens were too small to allow assessment of sex. Of the latter, two specimens of about 8.0 mm CW had sexual characteristics of both sexes (i.e., gonopores on the third abdominal sternites and two pairs of gonopods). A crab was seen but not collected on the medusa sighted at 21 m depth off Long Beach, California (Table 1), and also on at least one of the medusae photographed by the Howard Hall film crew off Islas de Los Coronados, Baja California, México (Fig. 3).

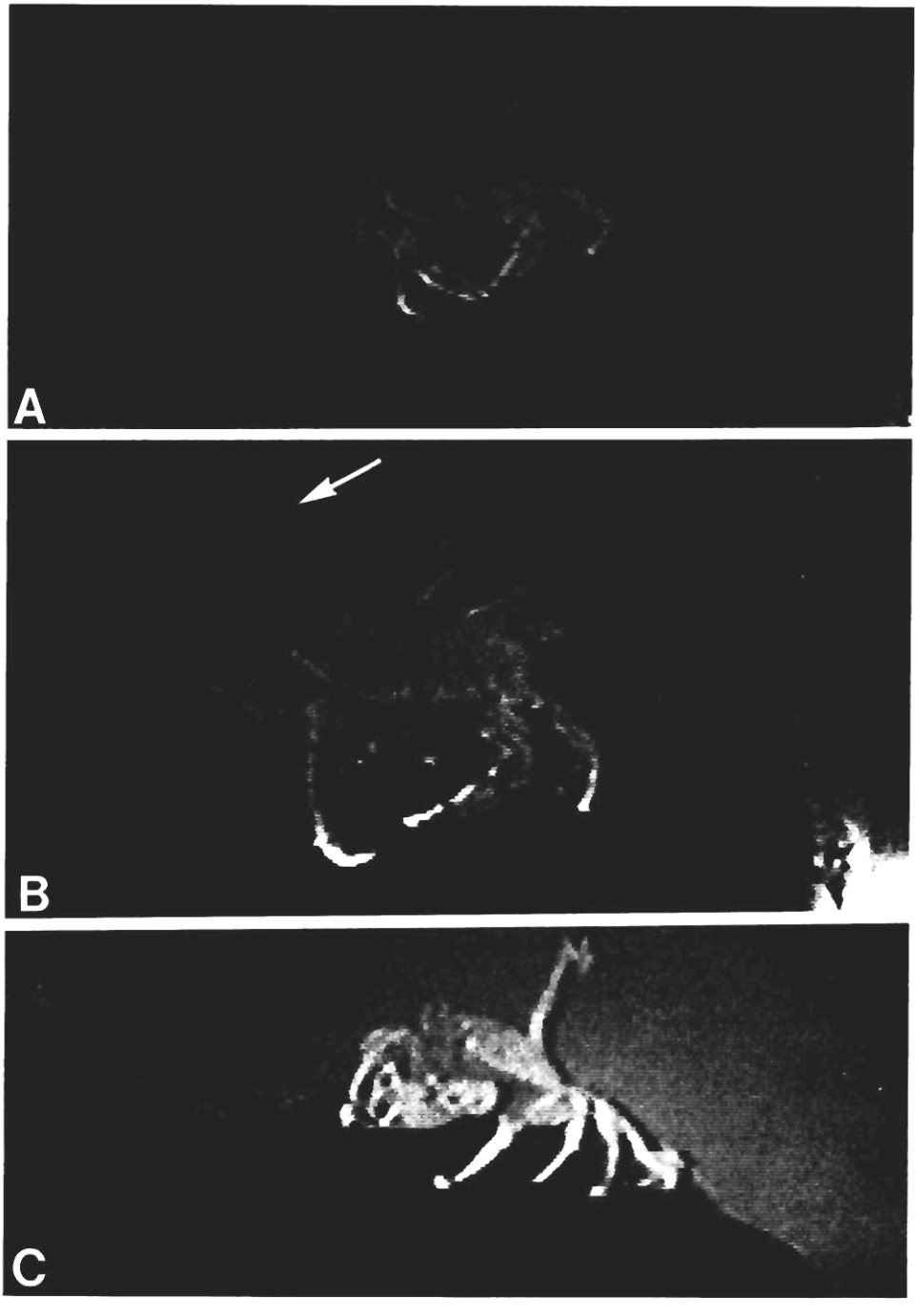

Fig. 3. Large specimen of juvenile or subadult *Cancer* sp. on medusa (photographs taken from video monitor). A, crab on exumbrellar surface of bell. B, slightly higher magnification of same animal showing clusters of foreign material (white arrow) adhering to dactylus of both fifth pereiopods; note also dactylus of other perpiopods embedded in medusa. C, side view of same animal in A and B showing elevated fifth pereiopod on right side (arrow) during a "shaking bout" (see Discussion).

There are approximately 14 species of *Cancer* known from the west coasts of North and South America (Nations 1975; Carvacho 1989a, b). Only 6 of these—*C. amphioetus, C. antennarius, C. anthonyi, C. branneri, C. gracilis,* and *C. jordani*—are common in Southern California (Nations 1975). However, if these medusae originated in more southern waters, as we suspect (see Discussion), then the crab associates could belong to a more southern species, such as *C. porteri* or *C. johngarthi* from México and Central America (see Carvacho 1989a, b). Nations (1975) divided extant and fossil species of *Cancer* into 4 subgenera based primarily on characters of the carapace. Following his subgeneric diagnoses the largest specimen of ours can be placed in the subgenus *Romaleon* (based on the development, curvature, and spination of the anterolateral teeth of the carapace), to which only 3 of the above-mentioned species—*C. branneri, C. antennarius,* and *C. jordani*—belong. Using Nation's (1975) characters, which were based on adult morphology, we tentatively identified these juveniles as belonging to *C. antennarius* Stimpson, 1856. However, little is known concerning ontogenetic changes of the characters of the carapace, and *C. gracilis* is more commonly known as a medusa associate (W. M. Graham, pers. comm.), so our identification of juveniles as *C. antennarius* should be accepted with caution.

In addition to the juveniles, there were several megalopae, also attributable to the genus *Cancer.* The megalopae bear well developed spines on the ischium of the cheliped and on the coxa of the second walking leg; in this respect the megalopae are similar to those of several other species of the genus (Quintana and Saelzer 1986; DeBrosse et al. 1990), but are not attributable to *C. gracilis* according to the recent key to megalopal stages of species of *Cancer* by DeBrosse et al. (1990). That key is restricted to 4 northwest coast species and does not include *C. antennarius.* However, the table of characters presented by Quintana and Saelzer (1986), for which information on *C. antennarius* was taken from the description by Roesijadi (1976), is useful for identifying megalopae in Southern California. The megalopae taken from the medusae differ from those tabulated in Quintana and Saelzer (1986: 294) in that they are slightly smaller and less setose on some of the mouthparts.

The size of one of the *Cancer* crabs seen in the video footage (not collected), and its behavior, are worth noting. The crab appears to be larger than any of the specimens we collected and is probably a subadult. Attached to the dactyli of the fifth pereiopods (walking legs) are clusters of foreign matter that are conspicuous even at low video resolution (Fig. 3) (see Discussion).

Vertebrate Associates

Osteichthyes
Family Stromateidae
Peprilus simillimus (Ayres, 1860)
(Pacific butterfish)

Several specimens, apparently adults, estimated size 10-15 cm, observed on video footage only.

Remarks: This was the only fish species observed in association with the medusae while they were healthy and offshore. All butterfish were observed swimming rapidly behind the bell and in close proximity to the oral arms, and they maintained this position throughout the video segment. Once the medusae began to

weaken and drag across the sea floor, other fish were evident from the video footage (Fig. 1B). Garibaldi (*Hypsypops rubicundus*) apparently were feeding on the now-disintegrating jellyfish, or possibly on plankton on the tentacles and oral arms (W. and P. Hamner, pers. comm.), although proximity of the scyphomedusae to the seafloor also may have evoked a territorial response in the adult males (R. Lavenberg, pers. comm.). Other fish, such as senorita (*Oxyjulis californica*) and blacksmith (*Chromis punctipinnis*), also were seen in the vicinity of the disintegrating medusae and may have been feeding on associates of the medusae or on small pieces of the oral arms.

Discussion

Although the scyphozoan medusae that appeared in 1989 belong to an undescribed species, these sightings are not the first. According to R. Larson (pers. comm.), a photograph of what is undoubtedly the same species appeared in the August, 1926, issue of National Geographic (Crowder 1926: 190). The photograph was labelled only "black jellyfish" and had no indication of where it was taken. Another photograph of this species appeared in Halstead (1965, vol. 1: plate XLIII); however, the species was incorrectly identified as *Cyanea capillata* and the photograph was attributed to the western Atlantic (Florida) rather than the Pacific, which is possibly an error. It is also possible that the new species has occurred in waters off Southern California before but was overlooked or was misidentified as *Pelagia colorata,* although this seems unlikely in light of the differences in color patterns (Larson 1990: fig. 3C). The new scyphomedusa is the fourth known species of *Chrysaora* from the eastern Pacific (Larson 1990).

Several observations suggest that the medusae originated from waters to the south of the area where they came ashore. The first confirmed sightings (early July, 1989; Table 1) were from northern Baja California, México, and it was not until later that month that the first records were made further north, in Southern California. Additionally, the video footage that showed large numbers of living medusae (Fig. 2) indicates that both numbers and condition declined as the medusae came inshore. It is likely that as the medusae came northward and into shallower waters, fish and macroinvertebrates began to remove portions of the oral arms and tentacles, with the result that only the bell was intact in the two living animals seen by us and in the many stranded specimens encountered along Southern California beaches.

Scyphozoan medusae are known to undergo long-term population fluctuations. The best documented case is that of *Pelagia noctiluca* in the western Mediterranean Sea, where records extending back 200 years show population blooms approximately every 12 years (Goy et al. 1989). It is doubtful that the appearance of the dark purple medusae in 1989 along Southern California beaches reflects a bloom of a species that is otherwise rare. That this species has not been reported from Southern California despite the fact that these beaches are so heavily populated and relatively well known biologically suggests that the medusa does not normally occur in this geographic area.

There have been other unusual occurrences along California beaches of species not normally encountered in this geographic area. Humboldt squid (*Dosidicus gigas*) occasionally come ashore (approximately every 35 to 40 yr; Kerstitch 1989) in large numbers during the grunion (*Leuresthes tenuis*) breeding months, and

have become stranded on Southern California beaches at least twice in the mid to late 1970s (Suzanne Lawrenz-Miller, pers. comm. and Kerstitch 1989); a large "squid slick" inundated the beaches at Dana Point and Laguna Beach, California, as this paper was being prepared, and the story was carried by local newspapers (The Orange Coast Daily Pilot, 4 August 1990; and Orange County edition of the Los Angeles Times, 3 and 4 August, 1990). There has been at least one stranding of another cnidarian, the siphonophore *Velella velella,* which came ashore in large numbers during the mid to late 1970s (Wickham 1976; Charles Galt, pers. comm.). *Velella* has been reported to harbor megalopal stages of at least two species of *Cancer* (*C. magister* and another unidentified species; see Wickham 1976). Perhaps the best documented large scale influx of any species in Southern California involves the red galatheid squat lobster, *Pleuroncodes planipes,* which occurs in great numbers during or immediately following an El Niño event (Glynn 1961; Boyd 1967; T. Parker, pers. comm.).

The spectacular 1982–1983 El Niño event was the strongest recorded for this century. Sea surface temperatures were as much as 8°C above normal in the western Pacific; the Pacific Equatorial Current reversed direction and extended eastward for 8000 miles to the coasts of North, Central and South America (Canby 1984; Wooster and Fluharty 1985). Among the unusual faunal distributions resulting from this oceanic-atmospheric phenomenon were reports of barracudas off the coast of Oregon, loss of cold-water salmon in the Pacific northwest, and tropical vertebrates and invertebrates along western coasts of North and South America. It would seem unlikely that the occurrence in 1989 of previously unseen medusae could result from an El Niño event 6 years earlier. There is also a possibility that this occurrence might be a harbinger of an upcoming El Niño event; one precursor of El Niño in Chile is the occurrence of large numbers of a related jellyfish (*Chrysaora plocamia*; see Soto 1985), but as of early 1991 there has been no indication of a forthcoming El Niño event.

The invertebrate associates of the scyphozoan can be grouped into two categories. The hyperiid amphipod, and the megalopal and juvenile stages of the brachyuran crabs, often have been reported as associates of pelagic medusae, and their presence on the new scyphozoan is not surprising. It is perhaps surprising that only one hyperiid and so few crabs were found on four rather large medusae, but the four specimens we sampled, only two of which were still living at the time, were in poor condition. It seems reasonable to expect more hyperiids on a healthy specimen with tentacles and oral arms intact. The pycnogonid and the two mysids are more interesting finds. There are no previous reports of these species on pelagic medusae, and there are no morphological specializations of the pycnogonid that would suggest an association with a medusa (C. Allan Child, pers. comm.). These taxa probably can be considered "accidentals," most likely having become associated with the scyphozoans after the latter began to come ashore. Future sampling of intact medusae would help to answer this question.

The range in size of the juvenile crabs and the presence of megalopal stages suggest that there are no discrete size classes as have been found in other scyphozoan/crab associations (W. M. Graham, pers. comm.). The presence of these larvae and juveniles also suggests that the crabs are dispersing via the jellyfish, as has been found in northern populations of *Cancer* on a congeneric species of scyphozoan, *Chrysaora fuscescens* (in Graham 1989, as *C. melanaster*). The oc-

currence of decapod Crustacea on medusae is not unprecedented and indeed there are larval forms among the Decapoda that have been hypothesized to be modified just for such an existence (e.g., the phyllosoma stages of spiny lobsters: Shojima 1963; Thomas 1963; Herrnkind et al. 1976). Association with pelagic organisms is only one of several behaviors exhibited by decapod larvae to facilitate dispersal (e.g., see Shanks 1986).

The behavior of the brachyuran crab in the video footage (Fig. 3) is curious. As previously noted, there were clusters of foreign matter on the dactyli of the posterior (fifth) pereiopods. The crab appeared to hold these appendages off the dorsal surface of the bell at the same time that all other pereiopods had their dactyli slightly embedded into the bell for grasping. From time to time the crab shook these back legs (Fig. 3C), but whether this behavior was for balance or was an attempt to dislodge the foreign matter on the dactylus, or served some other purpose, was not clear. We also do not know the nature of these clusters of material, although they appear in texture to be similar to the more flocculent borders of the jellyfish's oral arms and may be no more than adhering mucous balls from that part of the medusa. Another suggestion is that the foreign matter on the dactyli are clusters of nematocyst-bearing tissue from the oral arms of the medusa (W. and P. Hamner, pers. comm.). If so, there is the possibility that some defensive benefit to the crab exists, and the behavior may have been elicited by the presence of the photographer. We can not yet speculate as to the significance of the "shaking bouts" that the crab displays. Other crabs were seen on the video to actively ingest strands of detritous-laden mucous from the oral arms of the jellyfish, so that at least one benefit to the crab of the association seems to be nourishment.

As far as we know, there were no abnormal conditions of temperature, salinity, air pressure, upwellings, or other physical factors in the summer of 1989 (D. Pasko, pers. comm., and Climate Diagnostics Bulletin (NOAA), February–October 1989). As of this writing (February 1991), we know of no further sightings of the medusae along Southern California or Baja California, México.

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Addendum

The following publication, which contains a synopsis of scyphomedusae from the waters of California and mentions the *Chrysaora* n. sp. upon which the present paper is based, came to our attention too late to be incorporated into the text.

Larson, R.J. and A.C. Arneson. 1990. Two medusae new to the coast of California: *Carybdea marsupialis* (Linnaeus, 1758), a cubomedusa and *Phyllorhiza punctata* von Lendenfeld, 1884, a rhizostome scyphomedusa. Bull. S. Calif. Acad. Sci., 89(3):130–136.

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