SIZE DISTRIBUTIONS AND SEX RATIOS OF RIDGEBACK PRAWNS (*SICYONIA INGENTIS*) IN THE SANTA BARBARA CHANNEL (1979-1981)

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ABSTRACT

Ridgeback prawns (*Sicyonia ingentis*) were sampled monthly over two years (1979-81) at offshore stations, and less frequently onshore. Size distribution and sex ratios of samples were determined. Data from the offshore station indicate a unimodal size distribution (23-47 mm CL), from which age structure could not be discerned. Data from onshore samples provided evidence that prawns enter the fishery at age 1. The sex ratio of monthly samples fluctuated during 1981, in contrast to 1980, when a 1:1 ratio was observed in all months except during the fall.

RESUMEN

Durante más de dos años (1979-81) se realizaron muestreos mensuales del langostino *Sicyonia ingentis* en estaciones alejadas de la costa y, menos frecuentemente, en estaciones costeras. Se determinaron la distribución de tallas y las proporciones de sexos. Los datos de las estaciones alejadas de la costa indicaron una distribución de tallas unimodal (longitud del caparazón: 23.47 mm), de la cual no pudo discernirse la estructura de edades. Los datos de las estaciones costeras aportaron evidencias de que los langostinos comienzan a participar de la pesquería a la edad 1. En 1981 la relación de sexos en las muestras mensuales fue fluctuante, a diferencia de 1980, cuando se observó una relación de 1:1 durante todos los meses, excepto en el otoño.

INTRODUCTION

A small commercial fishery for the ridgeback prawn (*Sicyonia ingentis*) has recently developed in the Santa Barbara Channel, and a concomitant increase in oil and gas exploration in the channel has produced a need for information about the prawn's life history. This species is also of general interest because there are few abundant free-spawning crustaceans on the west coast of the United States. Only a few studies of this species have been conducted since its description by Burkenroad (1938). Herkelrath (1977) examined some aspects of *S. ingentis*, including growth, but field observations were few. Herkelrath (1977) also examined salinity and temperature tolerance of these prawns. Wicksten (1980) recorded distributional notes on *S. ingentis*, and Frey (1971) indicated that the ridgeback prawn had the potential to support a fishery. More recently, commercial landings, catch-effort data, and size distributions were examined by Sunada (1984). He found a declining catch per unit of effort (CPUE) from a high of 60 kg/hr in 1979, the first year of heavy fishing, to 20 kg/hr in 1982. He concluded from the size distribution data that individuals were recruited at age 1; the catch consisted mainly of ages 2 and 3, with a maximum at age 4.

Molt and reproductive periodicity in populations of *S. ingentis* in the Santa Barbara Channel from 1979 to 1982 are described by Anderson et al. (1985). They found that females (26-44 mm CL) did not molt in the summer but rather progressed synchronously through a single molt cycle with a peak of activity in late fall. Another such peak occurs in April. Females were capable of repeated spawning throughout the spawning season from July through September (Anderson et al. 1984; Anderson et al. 1985).

The purpose of this paper is to document findings on size distributions and sex ratios of *S. ingentis* in the Santa Barbara Channel from 1979 to 1981. These data provide important baseline information on the ridgeback prawn during a critical period of increasing exploitation, and they provide new information for preliminary estimation of growth rates during certain life stages.

MATERIALS AND METHODS

Monthly samples were collected using shrimp semiballoon trawl gear at one fixed station in the Santa Barbara Channel off Santa Barbara, California (Figure 1). Occasionally, additional samples were taken at random trawl sites. Nets used were approximately 30 m long and 7 m wide at the mouth, with 11.5-cm mesh (diagonal, not stretched) on the cod end and a 2.5-cm mesh on the belly. Trawls made at the harbor station (Figure 1) used a 2.5-cm mesh net. Carapace length (CL) was measured from the posterior margin of the orbit to the posterior border of the carapace.

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[Manuscript received February 2, 1985.]

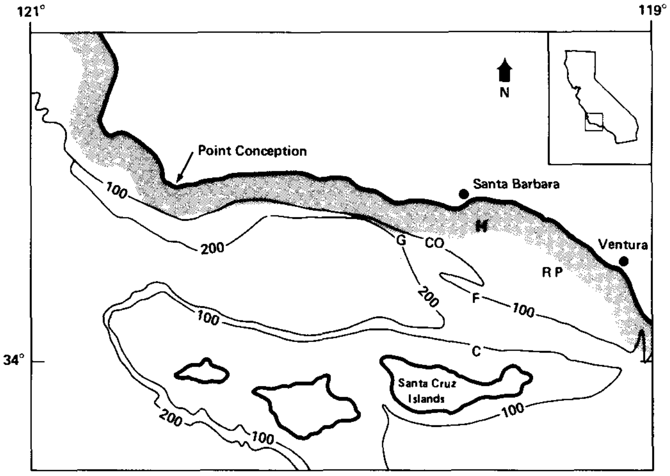

Figure 1. Map of the study area in the Santa Barbara Channel. Inset shows the location of the Santa Barbara Channel along the coast of California. Depths are in meters. The three-mile limit is indicated by shading. F = fixed station (34°18′N × 119°43′W); R = Rincon Point (34°17′N × 119°32′W); P = Pitas Point (34°18′N × 119°34′W); G = Gaviota area (34°23′N × 120°08′W); CO = Coal Oil Point (34°21′N × 119°52′W); C = China Cove (34°06′N × 119°40′W); H = harbor area (34°22′N × 119°42′W).

Males were distinguished from females by the presence of a petasma in the former.

Molt increments were measured in the laboratory for prawns collected in November 1982. We judged prawns to be in advanced premolt (stage D_2-D_4) at the time of collection (Anderson et al. 1985). They were kept in individual compartments in troughs containing running seawater of 12° to 15°C. Ecdysis occurred from 6 to 13 days after collection. We measured premolt CL on the cast exoskeleton. Postmolt CL was measured approximately 24 hours after ecdysis.

RESULTS

Size Distributions

Size distributions of prawns varied with sex and depth. Monthly sampling of prawns at 145-m depth over 2 years revealed a narrow size range (23-47 mm CL) offshore (Figures 2 and 3). The maximum size of females was consistently greater than the maximum size of males. Size composition of the catch at the deep station did not change markedly throughout the sampling period (Figure 2), and few individuals were collected that were smaller than 25 mm CL (Figure 3). In contrast, samples taken at 60-m depth contained more prawns in smaller size classes of approximately 25 mm CL and below (Figure 4). Sampling at 40 m yielded the smallest prawns observed in this study (Figure 5). For animals collected at that depth in December 1982, we observed a unimodal peak over the range of 6 mm CL to 15 mm CL (Figure 5). Samples at some onshore stations in May 1983 showed a unimodal peak (Figure 5) at a slightly larger size—10 to 27 mm CL; the maximum size of females was greater than the maximum size of males.

Molt increments were measured in laboratory in late fall because *S. ingentis* populations undergo a synchronous molt at this time (Anderson et al. 1985); thus it was relatively easy to obtain field specimens in late premolt. Molt increments measured in the laboratory were small (Table 1) and variable. The change between premolt CL and postmolt CL ranged from 1% to 8%, with means of 4.1% for females and 4.6% for males. Prawns examined measured from 21.2 to 24.6 mm CL for males and 25.7 to 28.4 mm CL for females.

Sex Ratios

Sex ratios during the two years of study showed two different patterns (Figure 6). In 1979 to 1980, ratios were consistently 1:1 until the spawning season, when females were more numerous in the trawl. In 1980 to 1981, sex ratios fluctuated throughout the year.

DISCUSSION

Although the data presented do not permit a definitive discussion of growth rates for *S. ingentis*, some preliminary estimates are possible. The 6-mm-CL-to-15-mm-CL prawns collected in December 1982 (Figure 5) are probably the annual cohort of juveniles. This compares favorably with the identification by Kennedy et al. (1977) of 4-to-5-mm *S. brevirostris* as the smallest juvenile recruits. If the sample taken in May 1983 (with a mode between 14 mm CL and 21 mm CL) also represents the year class that settled in the fall of 1982, growth between December and May was slightly greater than 1 mm/mo. Since prawns collected in trawls at 145 m were as small as 23 mm, it appears possible that individuals enter the fishery one year after settlement. Although the lowest age can be approximately established, it is not possible to determine the number of age classes present in the catch. Growth in crustaceans depends on molt frequency and molt increment. Both of these factors may be affected by sex, and usually decline with age (Hartnoll 1982). Effects of variability in molt increment and molt frequency on size distributions have been examined recently (Hartnoll 1982; Botsford, in press). In general, small increments together with variability in increment or period tend to obscure age-class modes in size distributions. For *S. ingentis*, apparent offshore movement (Figures 2-4) and small, variable molt increments in the laboratory (Table 1) make it difficult to follow distinct age-classes. Variability in molt frequency throughout the year and

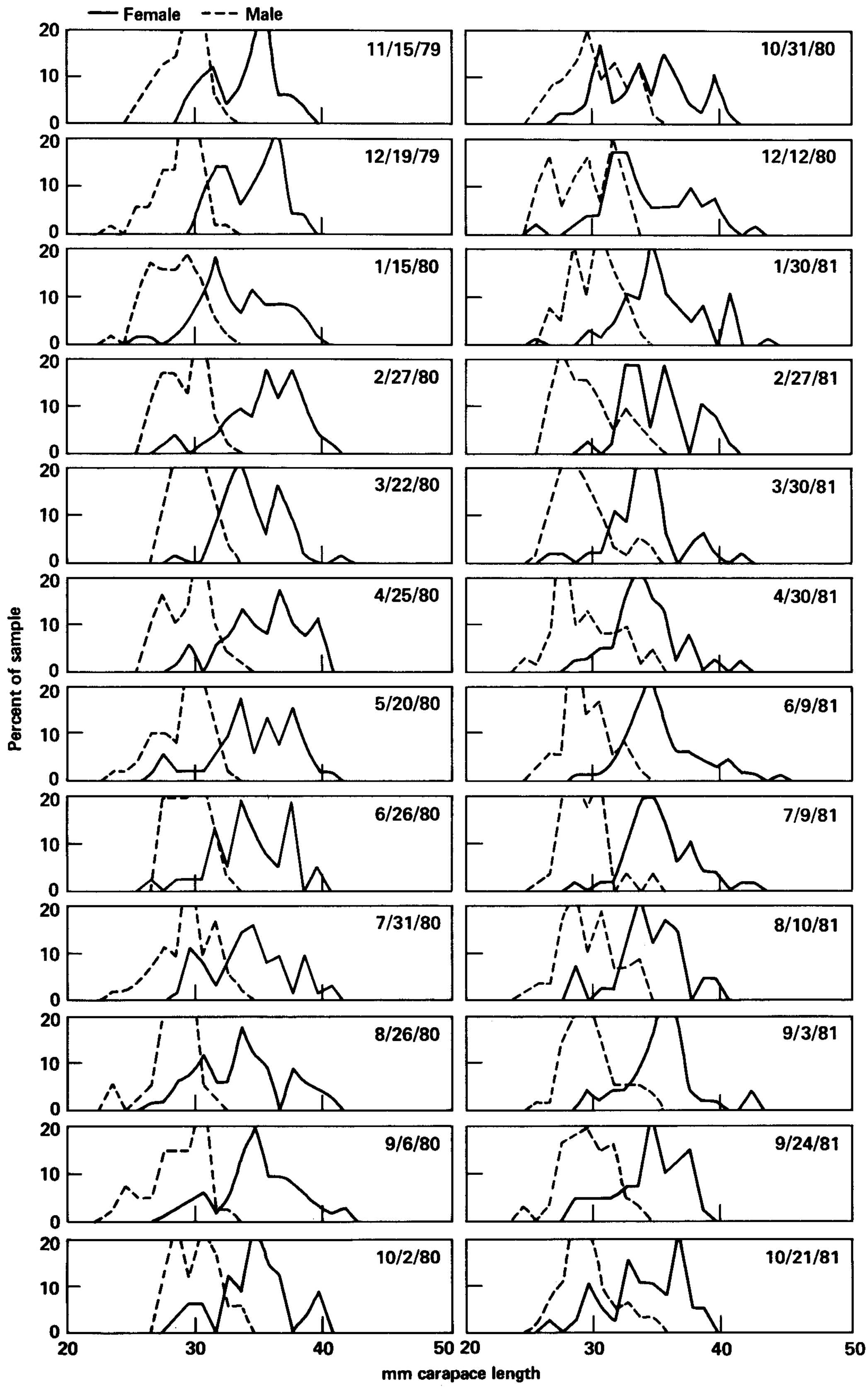

Figure 2. Size-class distribution of *S. ingentis* males and females in 24 monthly trawls at one fixed station (145-m depth). The range in number of animals observed was 50 to 118. The number observed in any single trawl is given in Figure 6.

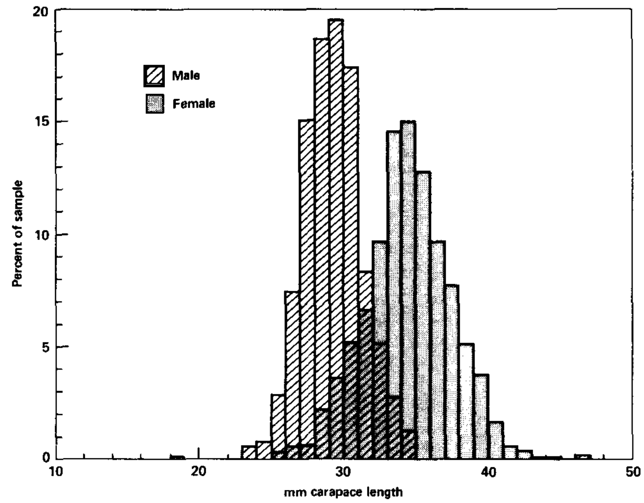

Figure 3. Size-class distribution of male and female *S. ingentis* in all monthly trawls combined for two years at one fixed station (145 m). n = 2452.

between sexes (Anderson et al. 1985) may also affect our ability to distinguish age-classes.

An estimate of crustacean growth patterns can usually be obtained from knowledge of the molt increment and frequency. The laboratory molt increment data reported here were taken for this purpose; however, the fact that molt increments were small leads to suspicion that they do not represent true natural molt increments. They may be a laboratory artifact or may be small because they were measured in November following the reproductive season. Use of these low increments would lead to a high maximum age in the fishery. For example, if these molt increments were the natural molt increments, and molting occurred a minimum of twice per year (Anderson et al. 1985),

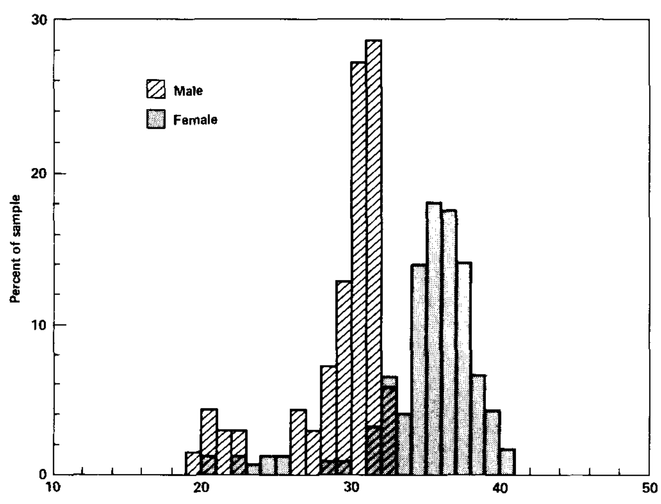

Figure 4. Size-class distribution of male and female *S. ingentis* in a representative trawl at 60 m (Rincon Point, 9/10/79). n = 191.

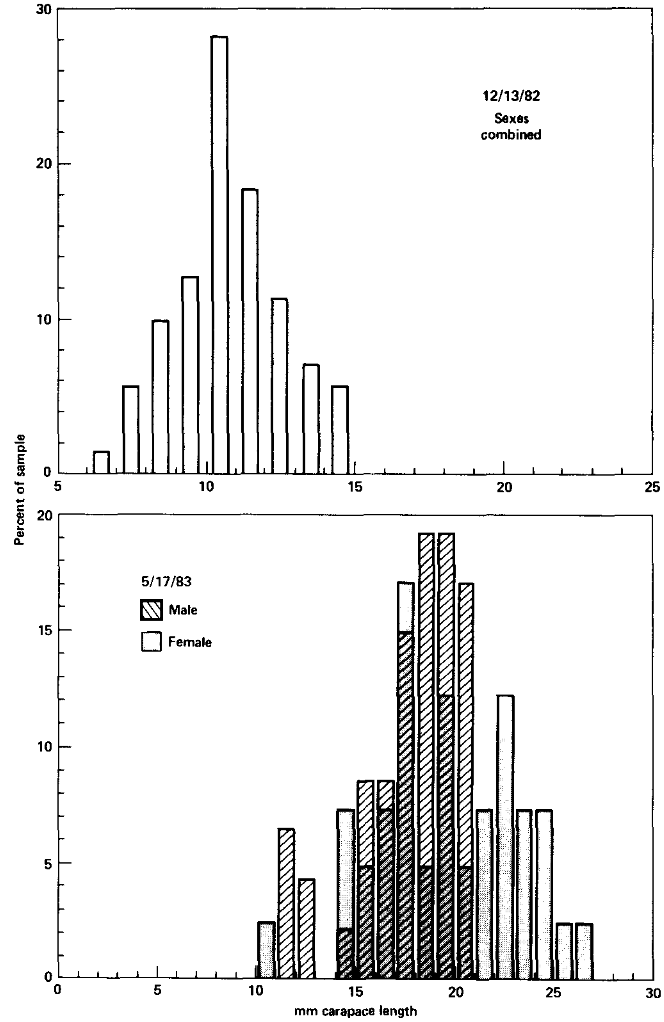

Figure 5. Size-class distribution of juvenile and small adult *S. ingentis* taken on 12/13/82 (n = 71) and 5/17/83 (n = 87). Sexes are combined on 12/13/82 because sexual differentiation as evidenced by the presence of a petasma was noted in only a few of the larger animals. Trawls were made in approximately 40 m of water due west of Santa Barbara Harbor (site H in Figure 1).

it would take 14 molts or 7 years to grow from a size of 25 mm to a size of 45 mm, growing at 1.041 mm per molt—the average of the measured increments for females (Table 1). Since 25 mm is near the size at age one, and 45 mm is near the maximum size of females in the trawls, this would imply a maximum age of 8 years. More reasonable estimates will require measurement of natural increments and molting frequencies. This information reflects natural mortality rate, and hence is critical for management of this fishery.

Kennedy et al. (1977) observed distinct modal progressions of size classes in populations of *S. brevirostris* from eastern Florida. They found that 8-to-10-mm-CL recruits grew to approximately 22 mm CL in 6 months after recruitment. This is twice the growth

TABLE 1
Molt Increments of Adult Ridgeback Prawns, Taken at the Fall Molt

Females				Males			
Initial CL (mm)	CL after molt (mm)	Difference (mm)	Percent change	Initial CL (mm)	CL after molt (mm)	Difference (mm)	Percent change
25.7	26.9	1.2	5	21.2	21.5	0.3	1
25.8	27.6	1.8	7	21.4	21.8	0.4	2
26.6	26.8	0.2	1	22.1	23.8	1.7	8
26.6	27.3	0.7	3	22.2	23.2	1.0	5
26.9	27.6	0.7	3	22.4	24.3	1.9	8
27.9	29.2	1.3	5	22.5	23.4	0.9	4
28.4	29.7	1.3	5	22.5	23.3	0.8	4
			$\bar{x} = 4.1$	22.8	24.2	1.4	6
			$\sigma = 1.95$	23.4	24.3	0.9	4
				23.6	24.1	0.6	3
				23.9	25.1	1.2	5
				24.2	25.5	1.3	5
				24.2	25.3	1.1	5
				24.4	25.4	1.0	4
				24.4	26.1	1.7	7
				24.4	25.0	0.6	2
				24.4	25.3	0.9	4
				24.6	26.2	1.6	7
							$\bar{x} = 4.6$
							$\sigma = 2.06$

rate we observed for *S. ingentis* at the same age. In agreement with our data on *S. ingentis*, male *S. brevirostris* appeared to grow slightly slower, and they reached a smaller maximum size (30 mm for males versus 38 mm for females). The maximum lifespan of *S. brevirostris* is 22 months (Kennedy et al. 1977).

Kennedy et al. (1977) and Cobb et al. (1973) showed seasonal cycles in prawn abundance at various stations. Kennedy et al. demonstrated a seasonal offshore migration of *S. brevirostris*. Recruitment occurs at 26 m. In June and July, highest CPUE occurs at 40 m and then shifts to 60 m by October. A similar migration pattern may occur in *S. ingentis* populations.

To date, there is no explanation for the variability we observed in sex ratio. It may be due to the fact that fishery exploitation was in its third heavy year, but there is no direct evidence as yet. Sex-ratio changes may well reflect different migration patterns in the two years studied. Sex ratios in *S. brevirostris* populations are close to unity, but females are slightly more numerous (Cobb et al. 1973; Kennedy et al. 1977). In each of these studies, it is not known whether sex ratios in the catch reflect the true sex ratio of the population or sex-specific differences in catch rate.

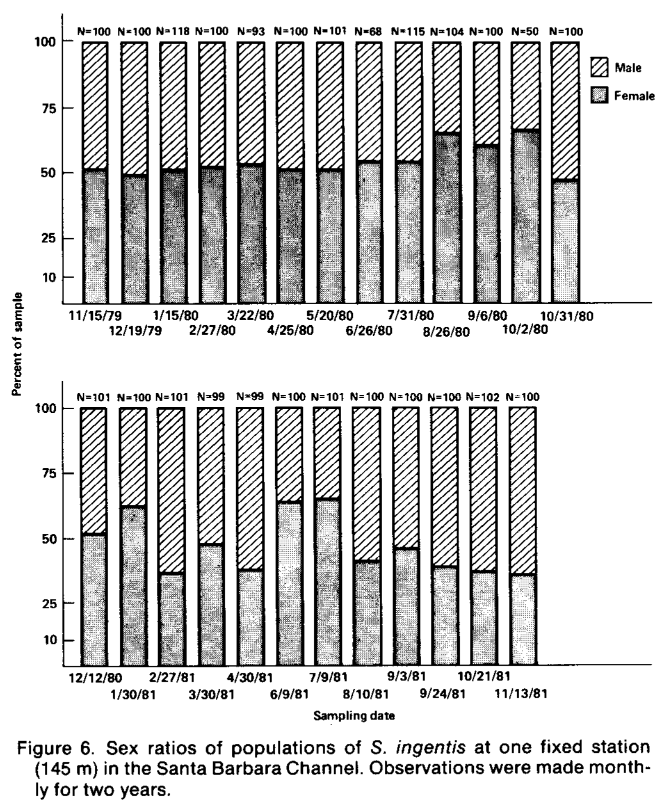

Figure 6. Sex ratios of populations of *S. ingentis* at one fixed station (145 m) in the Santa Barbara Channel. Observations were made monthly for two years.

Further studies are required for a complete understanding of recruitment, growth rates, and population movement for *S. ingentis*. Such studies would be important not only because this species is of local interest, but because very little is known about growth and recruitment of any free-spawning crustacean on the west coast of the United States. Perhaps one of the most significant factors influencing *S. ingentis* distribution is the presence of closed gyral circulations in the Southern California Bight. North of Point Conception, strong upwelling throughout most of the year results in strong offshore surface transport. This would cause tremendous loss of larvae for a free-spawning species with a long pelagic phase. Circulation patterns in the bight minimize loss of epipelagic fish larvae, and many migrating species apparently have increased spawning success in the bight for this reason (Parrish et al. 1981). Eggs of *S. ingentis* are demersal or neutrally buoyant if agitated slightly (personal observation); this means that deep currents may also play an important role in recruitment. Very little is known about deepwater currents in the Santa Barbara Channel, but it has been shown that some Penaeidae larvae and postlarvae actively discriminate between currents and current directions (Hughes 1972).

ACKNOWLEDGMENTS

Our gratitude is extended to R. Hazard, R. Hobbs, and S. (Shane) Anderson. Angie Fountain typed the manuscript and translated the abstract, and Kim Van-Dyke Smith drew the graphs. This work was supported by a grant from the Lerner-Gray Fund, and by NOAA, National Sea Grant College Program, Department of Commerce, under grant number NA80AA-D-00120, project number R/A-45, through the California Sea Grant College Program. The U.S. government is authorized to produce and distribute reprints for governmental purposes.

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