Distribution and abundance of stomatopods (Crustacea: Haplocarida) in Southern Sinaloa, Mexico*

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Abstract: Samples of benthic macrofauna were collected by trawl and grab-dredge during seasonal cruises along three transects on the coastal shelf of Southern Sinaloa, Mexico (SIPCO cruises) from 27 to 117 m and included 6 species of stomatopods. *Squilla biformis* Bigelow and *S. parva* Bigelow were the most abundant species. All species were found in shallow water (31-75 m) except *Squilla biformis* which occurred mostly below 100 m, where dissolved oxygen concentration was lower than 0.6 m/L. Other species found are: *Squilla panamensis* Bigelow, *S. hancocki* Schmitt, *Meiosquilla swetti* (Schmitt) and *Eurysquilla veleronis* (Schmitt).

Stomatopods of the Eastern Pacific Region are well-known and up to 46 species or subspecies are presently recognized in this geographical area. A large series of publications, most of them by Raymond B. Manning, of the Smithsonian Institution, have recently been produced and have provided a very valuable and long awaited taxonomic and phylogenetic reorganization of this group of crustaceans (Manning, 1961; 1963; 1968; 1970; 1971; 1972a; 1972b; 1972c; 1974; 1976; Reaka and Manning, 1980; 1981).

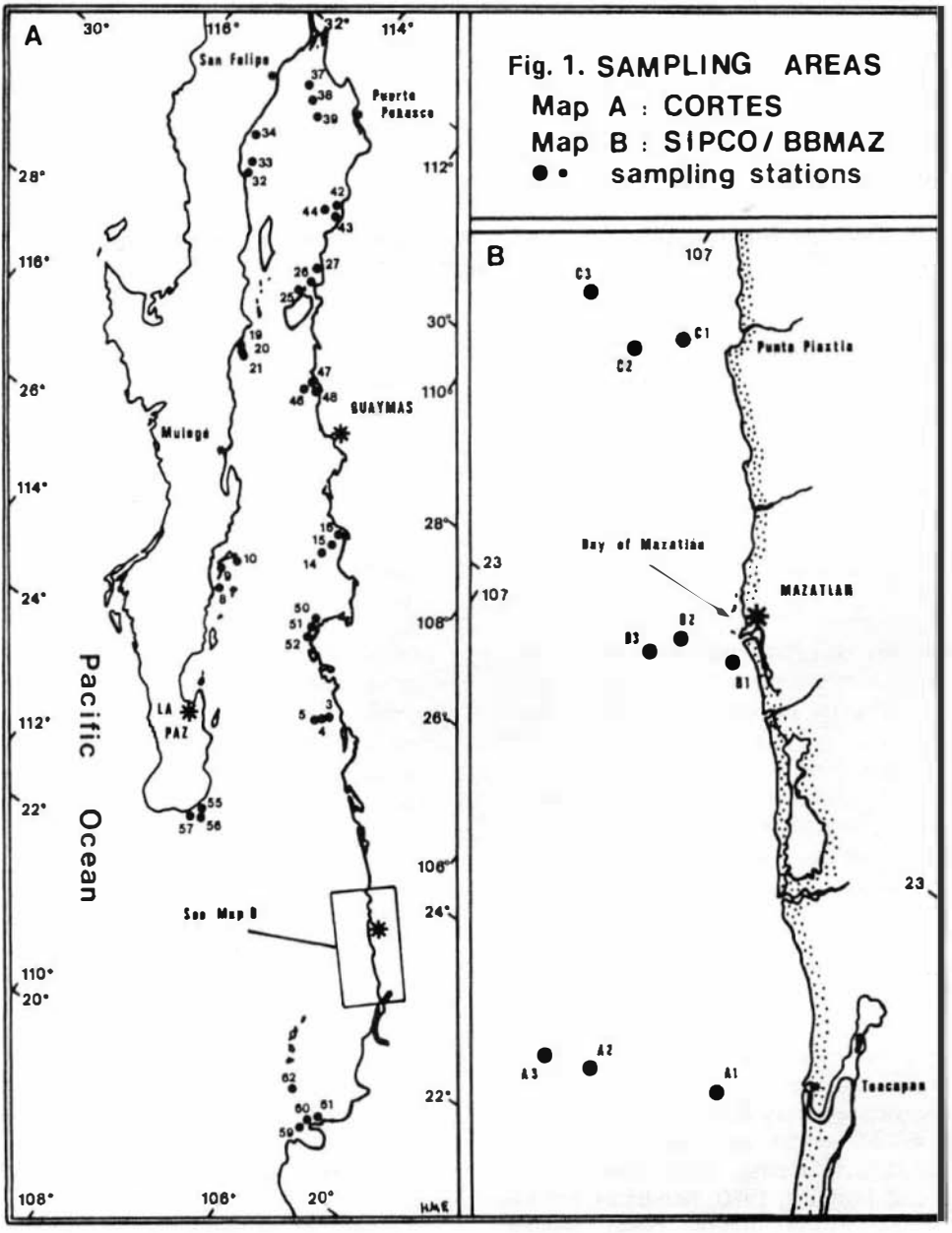
Stomatopods, commonly known as mantis shrimp ("catalina de mar" in México), represent an important group of species in the Gulf of California, and this for many reasons. First, they constitute a very diversified group and as many as 24 species are currently reported for this area (Manning, 1974; Brusca, 1980; Reaka and Manning, 1980; Hendrickx and van der Heiden, 1983a, 1983b, 1984). Second, stomatopods are voracious organisms which are able to prey on large crustaceans and small or medium-size fishes, and therefore probably play an important role in the trophic relationships of the continental platform community in the Eastern Gulf, where several large species of mantis shrimp occur. And thrid, there is still a considerable lack of adequate information regarding the ecology and the geographic distribution of many species, despite the fact that the taxonomy of the group is presently well documented. The SIPCO Project ("Sinaloa, Continental Platform") was initiated in 1980 as a first step towards a complete survey of the Gulf of California, and was later continued as an exploratory sampling program in the entire gulf (Cortés Project in 1982) (Hendrickx, 1984). The aim of this paper is to present information on stomatopods gathered during the sampling program along the coast of Southern Sinaloa, Mexico.

This is the ninth contribution arising from the SIPCO Project aboard the B/O "El Puma".

MATERIAL AND METHODS

A total of 24 trawls and 27 Van Veen grab samples were obtained along three transects on the Continental Platform of Southern Sinaloa, in April and August 1981 and in January 1982, off Punta Piaxtla (Transect C), off Mazatlán (Transect B) and off Teacapan (Transect A) (Fig. 1). Samples were collected with an 11.6 m otter trawl (6.5 cm stretched mesh with a 2.5 cm bar mesh inner cod-end bag) operating at depths between 27 and 114 m (Table 1) at a speed of 1.5 to 2 knots and with a grab of 40 L capacity at depths between 29

* Results of the SIPCO cruises (Southern Sinaloa, México) aboard the B/O "El Puma". Contribution 405 of the Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México.



and 114 m. All trawling operations were made by day aboard the B/O "El Puma" of the Instituto de Ciencias del Mar y Limnología, of the Universidad Nacional Autónoma de México, and lasted between 20 and 35 minutes. Samples were sorted immediately onboard; stomatopods were kept separately and fixed in 8% formaldehyde solution. Identification and counting were performed upon return to the laboratory.

Information on environmental conditions (temperature, dissolved oxygen and sediments) were taken from Hendrickx *et al.* (1984). Length of specimens was measured from the tip of the rostrum to the tip of the telson (Total length: T.L.) For each species, the following information is given: author and date of each

TABLE 1

Sampling stations of the SIPCO Project

Transect	Station	Date	Initial time	Duration of trawl	Position	Depth (m)
A	A_1	23/ IV /81	11:29	18'	22.24.3 N – 105.54.4 0	35 – 36
		22/ VIII /81	09:11	20'	22.24.8 N – 105.56.0 0	35
		15/ I /82	08:34	30'	22.24.2 N – 105.54.4 0	40
	A_2	23/ IV /81	17:49	31'	22.17.6 N – 106.10.9 0	61 – 62
		22/ VIII /81	13:20	22'	22.18.7 N – 106.10.3 0	66
		15/ I /82	12:29	31'	22.17.4 N – 106.11.0 0	74
	A_3	22/ VIII /81	17:49	20'	22.14.8 N – 106.16.1 0	115 – 104
		15/ I /82	16:42	31'	22.15.7 N – 106.16.6 0	114
B	B_1	25/ IV /81	15:10	15'	23.08.8 N – 106.25.4 0	27 – 27
		24/ VIII /81	14:21	30'	23.11.5 N – 106.29.0 0	34 – 32
		17/ I /82	14:40	31'	23.08.8 N – 106.16.6 0	31
	B_2	25/ IV /81	10:24	17'	23.08.4 N – 106.32.5 0	71 - 71
		24/ VIII /81	11:24	31'	23.08.7 N – 106.32.8 0	78
		17/ I /82	11:11	30'	23.07.6 N – 106.33.0 0	72
	B_3	24/ VIII /81	08:16	30'	23.06.0 N – 106.36.0 0	113 – 117
		17/ I /82	08:25	30'	23.03.5 N – 106.35.0 0	109 – 112
C	C_1	24/ IV /81	10:26	22'	23.37.5 N – 106.56.0 0	40 – 41
		23/ VIII /81	07:49	30'	23.37.6 N – 106.54.5 0	40
		16/ I /82	09:20	20'	23.27.2 N – 106.55.9 0	45
	C_2	24/ IV /81	16:00	17'	23.34.0 N – 106.57.5 0	66 – 66
		23/ VIII /81	11:08	31'	23.36.0 N – 107.02.2 0	72
		16/ I /82	12:31	26'	23.32.6 N – 106.59.10 0	76
	C_3	23/ VIII /81	14:35	30'	23.35.0 N – 107.05.8 0	104
		16/ I /82	16:10	30'	23.35.8 N – 107.08.9 0	111 – 107

specific name; original references providing they were accompanied by illustrations; material that was available for examination; general observations about each species; type locality and the distribution range as it is currently recognized.

RESULTS

Species composition: Three genera of stomatopods were found during the sampling program of the SIPCO cruises, including a total of 6 species: *Eurysquilla veleronis* (Schmitt, 1940); *Meiosquilla swetti* (Schmitt, 1940); *Squilla biformis* Bigelow, 1891; *S. hancocki* Schmitt, 1940; *S. panamensis* Bigelow, 1891; and *S. parva* Bigelow, 1891.

Superfamily Gonodactyloidea
Family Eurysquillidae
Genus *Eurysquilla* Manning, 1963

The family Eurysquillidae was erected by Manning (1977) to accommodate five genera

TABLE 2

Stomatopods collected during the SIPCO Project (three cruises combined)
(T = Trawl; V = Van Veen grab)

Species	Cruise	Station	Method	Date	No. Specimens ♂	No. Specimens ♀	Total Length (mm) ♂	Total Length (mm) ♀	Depth (m)
Eurysquilla veleronis	SIPCO I	A1	T	23 April 1981	1	1	33	28	35 - 36
	SIPCO I	A1	V	23 April 1981	1	–	20	–	38
	SIPCO II	C1	V	24 August 1981	–	1	–	19	75
	SIPCO III	B1	V	17 January 1982	–	1	–	31	31
Meiosquilla swetti	SIPCO II	A1	V	22 August 1981	1	–	27	–	35
	SIPCO II	B1	V	24 August 1981	– (1)*	1	–	19	32 - 34
Squilla biformis	SIPCO I	A2	T	23 April 1981	1	–	171	–	61-62
	SIPCO II	A3	T	22 August 1981	5	11	185 - 208	143 - 172	115 - 104
	SIPCO II	B3	T	24 August 1981	1	1	175	172	113 - 117
	SIPCO II	C3	T	23 August 1981	1	2	180	161 - 166	104
	SIPCO III	B3	T	11 January 1982	1	–	78	–	109 - 112
Squilla hancoki	SIPCO II	A1	T	22 August 1981	3	1	78 - 88	87	35
	SIPCO II	C1	T	23 August 1981	–	1	–	73	40
	SIPCO III	B2	T	17 January 1982	1	1	54	61	72
Squilla panamensis	SIPCO II	A1	T	22 August 1981	1	1	66	79	35
Squilla parva	SIPCO II	A1	V	22 August 1981	–	1	–	37	35
	SIPCO II	A1	T	22 August 1981	1	–	36	–	35
	SIPCO II	C1	T	23 August 1981	10	2	39 - 59	29 - 35	40

* sex indeterminable

of which only one occurs in the Eastern Pacific Region (Manning, 1980) where it is represented by *Eurysquilla veleronis*. *Eurysquilla solari* Manning, 1970, the other East Pacific species, has so far been reported only once (type locality) in Peru (09°24'S-79°28'W) (Manning, 1970) and its zoogeographical affinities will not be clearly defined until further localities are reported for this species.

Eurysquilla veleronis (Schmitt, 1940)
Pseudosquilla veleronis Schmitt, 1940, p. 176-180, Fig. 17

Material examined: A total of five specimens were collected, by trawl (SIPCO 1, Station A1) and the rest in Van Veen samples, during the SIPCO I, II and III; Stations A1, C1 and B1 (Table 2).

Observations: *Eurysquilla veleronis* was transferred from the genus *Pseudosquilla* by Manning (1963). It is a small species that has been reported only once from the Gulf of California. Because of its small size, it might be able to pass through fishing gear normally in use during trawling activities. It was found in 3 out of the 11 shallow Van Veen samples (from 29 to 45 m) obtained during this survey (Tables 1 and 2). The maximum size reported for *E. veleronis* is 40 mm (T.L.) for female specimens (the type specimen) and 35 mm (T.L.(for males (Schmitt, 1940).

Type locality: Off Bahía Petatlán, Oaxaca, México.

Distribution: In the Gulf of California, from Bahía de Los Angeles, Baja California Norte, and off Punta Piaxtla, Sinaloa (present survey), South to Islas Perlas, Panamá (Schmitt, 1940; Manning, 1974).

Superfamily Squilloidea
Family Squillidae
Genus *Meiosquilla* Manning, 1968

The genus *Meiosquilla* belongs to the most diversified of stomatopod families, which

include as many as 24 genera, 6 of them occurring along the Pacific coast of America (*Clorida; Cloridopsos; Meiosquilla; Pterygosquilla; Schmittius; Squilla*). In the Eastern Pacific Region, *Meiosquilla* is represented by 3 species, all endemic: *Meiosquilla swetti, M. dawsoni* Manning, 1970 (from Guaymas, Sonora, México, to Balboa, Panamá), and *M. oculinova* (Glassell, 1942) (from Bahía Chametla, Jalisco, México, to Isla La Plata, Ecuador) (Manning, 1972a; 1974; 1980; Reaka and Manning, 1980).

Meioquilla swetti (Schmitt, 1940)

Squilla swetti Schmitt 1940, p. 146-149, Fig. 3

Material examined: A male specimen obtained from a Van Veen grab (SIPCO II, Station A1); a female and a damaged specimen (sex indeterminable) from a Van Veen grab sample; SIPCO II, Station B1 (Table 2).

Observations: This species was transferred from the genus *Squilla* by Manning (1968). It is not a common species and was not known from the Gulf of California. The size of the male captured falls within the range of previously collected specimens (19 to 42 mm T. L.) (Reaka and Manning, 1980).

Type locality: Bahía de Petatlán, Guerrero, México.

Distribution: Off Teacapán, Sinaloa, México, South to Isla Taboguilla, Panamá (Hendrickx and van der Heiden, 1983). The material obtained off Mazatlán (Station B1) represents a slight range extension for this species.

Squilla Fabricus, 1787

The genus *Squilla* is represented in the Eastern Pacific Region by 8 species, all of which have been reported for the Gulf of California.

Squilla biformis Bigelow, 1891

Squilla biformis Bigelow, 1891, p. 94.
Squilla biformis, Bigelow, 1894, p. 532-534, Fig. 20, pl. 21.
Squilla biformis, Schmitt, 1940, p. 165-166, Fig. 12.

Material examined: A total of 23 specimens (9 ♂ and 14 ♀) from SIPCO I (Station A1), SIPCO II (Stations A3, B3 and C3) and SIPCO III (Station B3); all in trawls.

Observations: Together with *Squilla mantoidea* Bigelow, which also occurs off Southern Sinaloa and in the Bay of Mazatlán (Paul and Hendrickx, 1980; Hendrickx *et al.*, 1982), *S. biformis* is one of the largest species of stomatopods to be found in the Eastern Pacific region. Another large species, *Hemisquilla ensigera californiensis* Stephenson (Hemisquillidae), is known from the entire Gulf of California (Manning, 1972a) but was not collected during this survey. *Squilla biformis* had not been previously reported from off the coast of Southern Sinaloa.

Type locality: Off La Paz Harbor, Bahía de La Paz (205 m deep).

Distribution: From Bahía de La Paz, Baja California Sur, and Punta Piaxtla, Sinaloa (present survey), México, South to Taboguilla, Panamá (Manning, 1974).

Squilla hancocki Schmitt, 1940

Squilla hancocki Schmitt, 1940, p. 160-163, Fig. 10.

Material examined: Seven specimens (4 ♂ and 3 ♀) collected during the SIPCO II (Station A1 and C1) and SIPCO III (Station B2). All collected in trawls (Table 2).

Observations: Until recently, this species was not known from the Gulf of California (Hendickx and van der Heiden, 1983a). It is not a frequent species in the Gulf and it can be easily confused with other species of the genus *Squilla*, such as *S. panamensis* and *S. tiburonensis* Schmitt, the latter a species endemic to the Gulf of California that was not collected during the SIPCO survey.

Type locality: Bahía Petatlán, Guerrero, México.

Distribution: From Bahía de San Ignacio, Sinaloa (25°30'N – 109°W), South to Paita, Perú (Hendrickx and van der Heiden, 1983a).

Squilla panamensis Bigelow, 1891

Squilla panamensis Bigelow, 1891, p. 94

Squilla panamensis Bigelow, 1894, p. 526-530, Fig. 17-18.

Squilla panamensis Schmitt, 1940, p. 166-168, Fig. 13 (from Bigelow, 1894).

Material examined: One male and one female from a single station (A1, SIPCO II), obtained by trawling (Table 2).

Observations: This species was not reported from the Gulf of California until recently (Paul and Hendrickx, 1980; Reaka and Manning, 1980) and represents one of the four species of stomatopods frequently collected in the Bay of Mazatlán (Hendrickx *et al.*, 1982).

Type locality: Bahía de Panamá.

Distribution: From Southern Sinaloa (off Mazatlán and in the Bay of Mazatlán), South to Tumbes, Perú (Reaka and Manning, 1980; Hendrickx *et al.*, 1982).

Squilla parva Bigelow, 1891

Squilla parva Bigelow, 1891, p. 94.

Squilla parva Bigelow, 1894, p. 518-520, Fig. 11-12.

Squilla parva Schmitt, 1940, p. 168-169, Fig. 14 (in part from Bigelow, 1894).

Material examined: A total of 14 specimens (11 males and 3 females), all from SIPCO II (Stations A1 and C1); in Van Veen grab (one specimen) and by trawling (Table 2).

Observations: Recently reported as a member of the Gulf of California stomatopod fauna, *Squilla parva* is a common species in Southern Sinaloa, where it is frequently caught as part of the shrimp by-catch. It is the dominant stomatopod species in the Bay of Mazatlán (Hendrickx *et al.*, 1982). The record from off Punta Piaxtla is a slight range extension for this species.

Type locality: Bahía de Panamá.

Distribution: From off Punta Piaxtla, Sinaloa (present study), South to Cabo San Francisco, Ecuador (Hendrickx and van der Heiden, 1984).

Abundance and distribution. A total of 54 specimens of stomatopods were collected during the SIPCO Project. The most abundant species were *Squilla biformis* (23 specimens) and *S. parva* (14 specimens). Stomatopods are known to be dwelling crustaceans that live in holes in hard substrates (coral rubble and rocks) or in burrows dug in soft sediments (mud and sand, sometimes mixed with gravel or shell fragments) (Reaka and Manning, 1981). There is little evidence as to whether stomatopods that live on subtidal soft substrates reduce their activity outside burrows during night-time, or act indiscriminately, wandering around by day or night. The SIPCO specimens were all collected between 08:16 A.M. and 05:49 P.M.; specimens caught in trawl (i. e. with a non excavating device) account for more than 88% of the total, and this could indicate that some activity outside burrows occurs during the day. However, one can not dispel the possibility that the approach of the oncoming trawl might induce a stress reaction and their subsequent escape from their hiding-places.

Most specimens were found off Teacapan (54% in Transect A) and off Punta Piaxtla (31% in Transect C). Station A1 was particularly rich in species (5 out of 6), although not so in number of specimens (only 12 out of 54).

Of the six species that were collected, five were found in shallow water (54% of specimens at 31-41 m; 59% at 31-75 m). With the exception of one specimen caught at 61 m, *Squilla biformis* was obtained from the deepest trawls, between 104 and 117 m, where no other species were found. Comparison of environmental data obtained during the survey (Hendrickx *et al.*, 1984) indicates that dissolved oxygen at bottom level at the time *Squilla biformis* were captured oscillated between 0.37 and 0.55 ml/L (water temperature 13.6 to 15.6 °C), while with other species obtained from much shallower water, it never went under 1.47 ml/L except in one case (0.39 ml/L; *Eurysquilla veleronis*, SIPCO, A1) and most specimens were found at stations where oxygen values were close to ml/L (Table 3 and 4).

Squilla biformis occurred on muddy bottoms (silt and clay) in most cases, although

TABLE 3

Sampling conditions and number of specimens of Squilla biformis *captured during the SIPCO project (trawls)*

Number of specimens	Cruise	Station	Depth (m)	Temperature (° C)	Dissolved oxygen (ml/L)	Sediments (%)		
						Sand	Silt	Clay
1	SIPCO I	A_2	61 - 62	14.5	0.44	29	30	41
16	SIPCO II	A_3	104 - 115	15.0	0.42	77	10	13
2	SIPCO II	B_3	113 - 117	15.3	0.55	01	57	42
3	SIPCO II	C_3	104	15.6	0.37	09	51	40
1	SIPCO III	B_3	109 - 112	13.6	0.55	00	58	42

TABLE 4

Comparative sampling conditions for the species of stomatopods captured during the SIPCO Project (all stations combined)

Species	Depth range (m)	Temperature range (° C)	Disolved o_2 range (ml/L)	Sediments Dominant/Secondary
Eurysquilla veleronis	35 - 75	16.2 - 27.0	0.39 - 4.10	Silty sand/sandy silt
Meiosquilla swetti	32 - 35	26.4 - 27.2	3.87 - 4.14	Sand/sandy silt
Squilla biformis	41 - 117	13.6 - 15.6	0.37 - 0.55	Silt on clay/sand
Squilla hancocki	35 - 72	13.4 - 27.0	4.10 - 4.13	Sand/silt
Squilla panamensis	35	26.4	4.13	Sand
Squilla parva	35 - 40	26.4 - 27.0	4.10 - 4.13	Sand

the biggest catch came from sandy bottoms off Teacapan. Other species of *Squilla* also came predominantly for sandy bottoms (66 to 99% sand). *Eurysquilla veleronis* and *Meiosquilla swetti* were both found on sandy bottoms, usually mixed with a high fraction of silt (Tables 3 and 4).

DISCUSSION

Among the 20 species of stomatopods known to occur in the Gulf of California, 9 species have been found in the shrimp by-catch from off the coasts of Sonora, Sinaloa and Nayarit, where the bulk of the northwest area fishing fleet operates. These include all species of the genus *Squilla* known from the Gulf (*Squilla biformis, S. bigelowi* Schmitt, *S. mantoidea, S. panamensis, S. parva, S. tiburonensis, S. hancocki* and *S. aculeata* Bigelow) and *Hemisquilla ensigera californiensis* (Paul and Hendrickx, 1980; Brusca, 1980; Hendrickx, unpublished data). The other species have apparently never been reported from commercial trawling, probably because of their small size (they escape the net or they are crushed and overlooked) or because they live in habitats not sampled by fishing gear.

Of the six species collected during the SIPCO cruises, *Squilla biformis* and *Eurysquilla veleronis* had not been previously reported from the eastern coast of the Gulf of California and two other species (*Squilla parva* and *Meiosquilla swetti*) slightly extended their northern distribution to Punta Piaxtla.

Although the total number of specimens obtained during the SIPCO survey is rather reduced, some information was obtained regarding the bathymetric distribution of the species. Thus, *Squilla biformis* was predominantly found below 100 m, where dissolved oxygen levels are very low, while other species were predominantly found between 31 and 41 m. *Squilla biformis* has been reported from

depths of 28 to 518 m and seems to be a deep water species (Brusca, 1980). In the Southern Sinaloa area, *Squilla parva* is the dominant shallow water species, also collected between 9 and 27 m in Bahía de Mazatlán (Hendrickx *et al.*, 1982).

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RESUMEN

Muestras de la macrofauna bentónica de la plataforma continental del sur de Sinaloa, México, fueron obtenidas en arrastres y dragados efectuados en tres transectos perpendiculares a la costa (Campañas SIPCO). Las muestras fueron colectadas en tres períodos del año, entre 27 y 117 m de profundidad y se obtuvo un total de seis especies de estomatópodos. Las especies más abundantes fueron *Squilla biformis* Bigelow y *Squilla parva* Bigelow. Todas las especies fueron colectadas entre 31 y 75 m, con la excepción de *Squilla biformis* que apareció principalmente abajo de los 100 m de profundidad, en una zona donde las concentraciones de oxígeno no rebasaron 0,6 ml/L. *Squilla panamensis* Bigelow, *S. hancocki* Schmitt, *Meiosquilla swetti* (Schmitt) y *Eurysquilla veleronis* (Schmitt) son las otras especies que fueron colectadas.

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