

## Temperature related distribution of *Lucifer typus* (Crustacea: Decapoda) in the Gulf of California

Michel E. Hendrickx and Flor D. Estrada-Navarrete

Universidad Nacional Autónoma de México, Instituto de Ciencias del Mar y Limnología, Estación Mazatán, A.P. 811, Mazatlán, 82000, Sinaloa, México.

(Rec. 13-IV-1993. Acep. 14-III-1994)

**Abstract.** Specimens of the pelagic shrimp *Lucifer typus* H. Milne Edwards were captured during three cruises in the Gulf of California, Mexico. The distribution of this species is compared with data of water temperature obtained at the surface and 50 m depth. These data suggest that the penetration of *L. typus* in the Gulf of California is limited by both the surface 20-21°C and the 50 m depth 18-19°C isotherms, although in the Northern Gulf, shallow water and high turbidity might limit the occurrence of this oceanic species.

**Key words:** *Lucifer typus*, distribution, water temperature, Gulf of California.

Zooplankton studies in the Gulf of California are scarce and most are limited to analyses of biomass, occurrence and abundance of selected groups of species (see Brinton *et al.* 1986). Pelagic shrimps of the Gulf of California are also little known, and since the contributions of Burkenroad (1937, 1938), very little has been published on the subject (Hendrickx and Estrada-Navarrete 1989a).

Seven species of *Lucifer* Thompson, a small-size pelagic shrimp, are currently recognized, mostly from tropical and subtropical waters of the world oceans (Bowman 1967, Omori 1974, 1977, 1992). Typically epipelagic, they commonly occur in the surface layers of tropical water and are rarely found below 150 m. Two species have been reported in the East Pacific: *Lucifer typus* H. Milne Edwards, 1837, and *Lucifer orientalis* Hansen, 1919 (Omori 1974, 1992). Prior to this study, the only published record of *L. typus* in the Gulf of California was the one by Burkenroad (1937) (off Arena Bank, 23°27'N -108°49'W). The material collected during the present study allows us to confirm the presence of *L. typus*

well within the Gulf of California, and to relate its distribution to surface and sub-surface water temperatures.

### MATERIAL AND METHODS

Zooplankton samples were obtained during the CORTES cruises in the Gulf of California (Table 1) aboard the R/V "El Puma" of the Instituto de Ciencias del Mar y Limnología, UNAM. Oblique tows were performed between surface and 200 m using a bongo frame (60 cm diameter, 3 m length) equipped with 505 µm mesh size nets. Sampling depths and time were estimated using a Benthos automatic time/depth recorder fixed 1 m above the bongo frame, on the towing cable. Samples were obtained at a minimum depth collection of 0-121 m and a maximum of 0-220 m, at stations where total depth ranged from 424 to 3,080 m (Table 1).

A total of 77 samples were obtained from as many sampling localities (CORTES 1, 24 stations; CORTES 2, 27 stations; CORTES 3, 26

TABLE 1

Number of specimens of *Lucifer typus* obtained at each sampling station. Sampling depth ranges of the Bongo frame and total depth at each stations are provided for comparative purposes

Cruise	station	Depth (m) Sampling/total	Position	Date	Number of specimens	
					(♂)	(♀)
CORTES 1	54	0-121/2100	23 <sup>0</sup> 47'N - 109 <sup>0</sup> 27'W	13/V/82	71	57
CORTES 1	58	0-180/3080	22 <sup>0</sup> 45'N - 108 <sup>0</sup> 55'W	13/V/82	18	30
CORTES 2	53	0-200/1332	24 <sup>0</sup> 29'N - 109 <sup>0</sup> 39'W	20/III/85	0	1
CORTES 2	54	0-220/1000	23 <sup>0</sup> 48'N - 109 <sup>0</sup> 28'W	21/III/85	2	12
CORTES 2	58	0-190/2500	22 <sup>0</sup> 45'N - 108 <sup>0</sup> 55'W	22/III/85	1	2
CORTES 2	58B	0-210/2600	22 <sup>0</sup> 12'N - 107 <sup>0</sup> 28'W	22/III/85	1	5
CORTES 3	7	0-202/1300	27 <sup>0</sup> 05'N - 110 <sup>0</sup> 58'W	08/VIII/85	0	2
CORTES 3	12	0-190/2450	26 <sup>0</sup> 14'N - 110 <sup>0</sup> 36'W	31/VII/85	1	0
CORTES 3	13	0-190/1080	26 <sup>0</sup> 33'N - 110 <sup>0</sup> 16'W	31/VII/85	2	1
CORTES 3	23	0-200/424	28 <sup>0</sup> 44'N - 112 <sup>0</sup> 43'W	01/VII/85	3	4
CORTES 3	54	0-210/2150	23 <sup>0</sup> 47'N - 109 <sup>0</sup> 28'W	30/VII/85	8	7
CORTES 3	58B	0-195/2600	22 <sup>0</sup> 12'N - 107 <sup>0</sup> 28'W	29/VII/85	1	5

stations) (Fig. 1). A few stations were not visited during all three cruises due to adverse weather conditions. Water temperatures were measured immediately before towing at sub-surface (2-5 m) and at 50 m depth using reversible thermometers and data were plotted on maps in order to define isotherms.

## RESULTS AND DISCUSSION

From March to July-August, water temperatures gradually increased at both sub-surface and 50 m depth. At the entrance of the Gulf, surface temperatures range from 20° to 22°C in March (Fig. 2A), from 23° to 26°C in May (Fig. 2B) and reach 28° to 29°C in July-August (Fig. 2C). The 20°C surface isotherm shifts from its southern Gulf position to central Gulf between March and May, and in July-August the lowest surface temperatures throughout the Gulf are mostly within the 27° to 29°C range (locally > 30°C). Temperatures at the 50 m depth are relatively similar in May and March (Figs. 2D and E), although the water across the mouth was warmer in March. Central Gulf waters are always well below 20°C (13-17°C in March and 15-17°C in May); in the upper Gulf, water temperature is more homogeneous at this depth (range is 14.5-15.8°C). In July-August, water at 50 m depth get much warmer, and the upper-Gulf is 6-7°C warmer than the southwestern Gulf (Fig. 2F) with maximum of

27.2°C. In the summer, the 50 m-temperature distribution pattern in central-southern Gulf is complex. Local mixing processes might occur close to the eastern shelf. In summer, a warm water-coastal current, flowing north from the southeastern entrance (Wyllie 1966, Bray and Robles 1991), probably influences surface temperature as far as the upper central Gulf (28.0° to 29.0°C) and might also result in warmer water at higher depth on the west side of the Gulf (19.2° to 22.0°C) (Fig. 2F). At 50 m, temperatures below 20°C were registered up to about 28°N, along a tongue of cool water in the center of the Gulf (Fig. 2F). Temperature patterns observed in this study are quite similar to those reported by Badan-Dagon *et al.* (1985) and Alvarez-Borrego (1983).

Specimens of *L. typus* were found in 12 out of the 77 samples that were analyzed (Table 1), totalizing 234 specimens (108♂ and 126♀). Most of them (75%) were collected during the CORTES 1 cruise (May 1982), although during this cruise the species appeared only at two stations, at the western entrance of the Gulf (Fig. 3B). In March 1985, during CORTES 2, the species was found at 4 stations across the mouth of the Gulf and way up north, off Cerralvo Island (Fig. 3A), but only 24 specimens (10% of the total) were captured. During the summer cruise of July-August 1985 (CORTES 3), *L. typus* was found at 6 stations, from the mouth up to SW of Tiburon Island (Fig. 3C). However, fewer

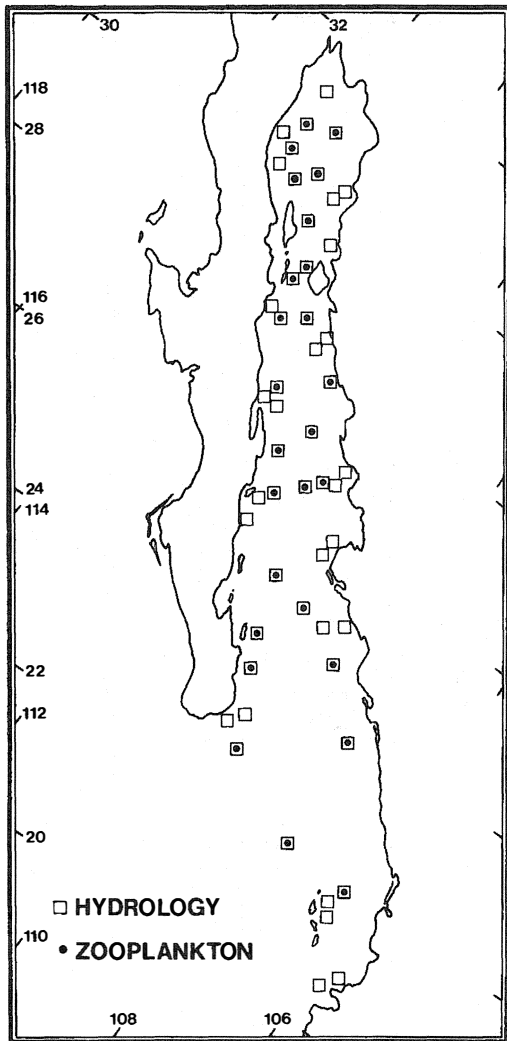


Fig. 1. Sampling stations during the cruises CORTES 1, 2 and 3 in the Gulf of California, Mexico.

specimens were obtained in each sample (from 1 to 15) (Table 1).

Species of *Lucifer* are typically epipelagic and they sometimes become a major component of surface-dwelling plankters (Omori 1992). They often represent an important part of the neuston over the continental shelf (Omori 1977). They are also found in very shallow-water, close to shore. *Lucifer typus*, however, has been considered an inhabitant of offshore waters, and in the western North Atlantic for instance, it is replaced, close to

shore, by the neritic species *L. faxoni* (Bowman and McCain 1967). In the present study, *L. typus* was collected mostly in localities where total depth exceed 400 m (once) or 1000 m (11 times), but often very close to shore. The penetration of *L. typus* in the Gulf of California during the CORTES cruises confirms the observation made by Burkenroad (1938) and extend the known distribution of this species up to 28°44'N within the Gulf. Temperature data registered at the time of sampling indicate that its presence is apparently related to water temperature. Bowman and McCain (1967) came to the conclusion that in the Florida Current, *L. typus* avoids the cooler Carolina coastal water that overlies the continental shelf and is predominantly associated with surface waters of 22 to 29°C. Examination of CalCOFI and EASTROPIC samples by Omori (1992) indicates that the northern distribution limit of *L. typus* in the California Current coincides with the 20°C surface isotherm. Our data indicate that the specimens of *L. typus* obtained during this study were sampled at stations with surface water temperatures of about 20°C or more, combined with temperatures of 18 to 19°C or more at 50 m depth. Indeed, in March 1985, *L. typus* penetrated the southern Gulf along the Baja California coast (Fig. 3A), where surface temperatures reached from about 20° to 21°C and 50 m depth temperatures were within the 18-19°C range (Figs. 2A and 2D). It did not extended so far north, however, in May 1982, when surface temperatures were much higher (23 to 24°C) than in March 1985, but 50 m depth temperatures were about 18°C or less (Fig. 2B and 2E). In the summer of 1985, 50 m depth temperatures of 17.6 to 19.9°C (Fig. 2F) and surface temperatures of well over the 20°C mark were observed throughout the Gulf (Fig. 2C) and coincide with the penetration of *L. typus* up to the northern part of Central Gulf (Fig. 3C). Absence of this species in the northern Gulf, where temperatures at 50 m depth are warmer (Fig. 2F), might be due to the shallowness (generally much less than 200 m) and turbidity in this part of the Gulf, two features that *L. typus*, a predominantly oceanic species, might not tolerate.

#### ACKNOWLEDGEMENTS

Part of this study was supported by CONACYT, Mexico (ICECXNA-021996). The

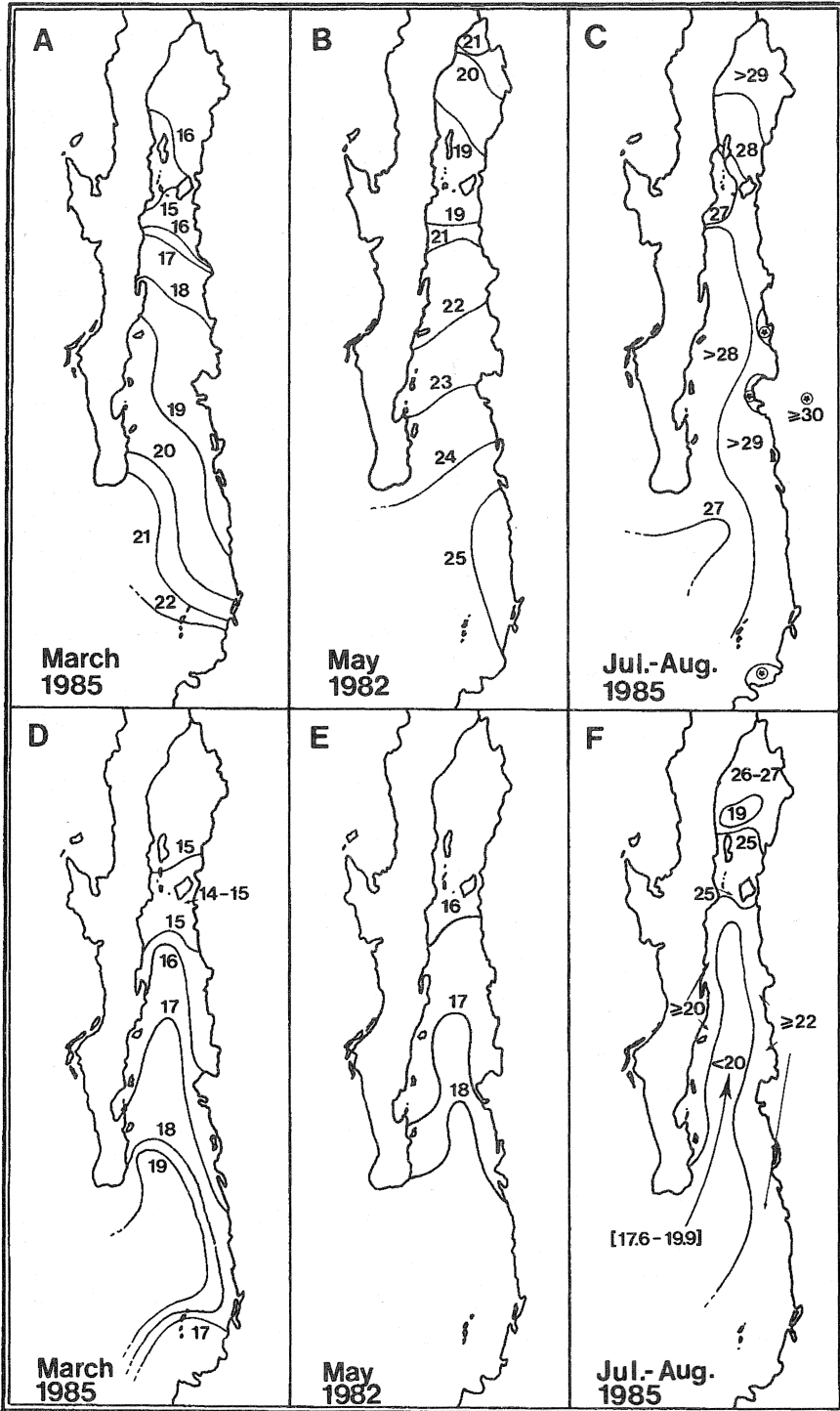


Fig. 2. Temperature contours ( $^{\circ}\text{C}$ ) for three periods of the year (March 1985, CORTES 2; May 1982, CORTES 1; July-August 1985, CORTES 3). A-C, at surface level (2-5 m); D-F, at 50 m depth.

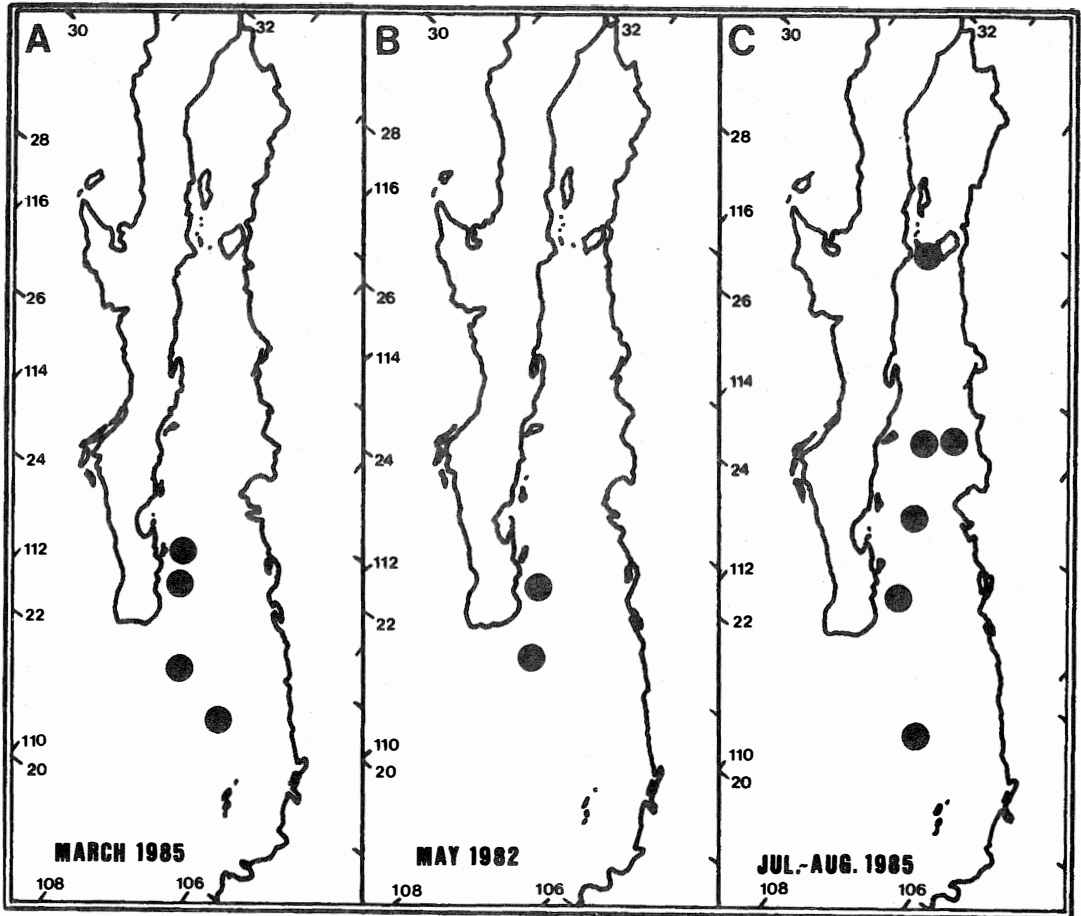


Fig. 3. Collecting stations of *Lucifer typus* in the Gulf of California for three periods of the year. A. March 1985, CORTES 2; B. May 1982, CORTES 1; C. July-August 1985, CORTES 3.

authors thank José Pelaez who provided valuable comments to the manuscript, Clara Ramirez J. for running a bibliographic search, Mercedes Cordero R. for typing the manuscript, and all scientists, students and crew members of the R/V "El Puma" who took an active part in the obtention of data and samples.

#### RESUMEN

Ejemplares del camarón pelágico *Lucifer typus* H. Milne Edwards, fueron capturados durante tres cruceros en el golfo de California, México. La distribución de esta especie en el Golfo fue comparada con los patrones de distribución de la temperatura del agua en la

superficie y a los 50 m de profundidad. Estos datos sugieren que la penetración de *L. typus* en el golfo de California está limitada por las isotermas de 20-21°C en la superficie y de 18-19°C a los 50 m, salvo en el Alto Golfo donde las pocas profundidades y la alta turbidez del agua podrían limitar la presencia de esta especie oceánica.

#### REFERENCES

- Alvarez-Borrego, S. 1983. Gulf of California. p. 427-449. In: B.H. Ketchum (ed.). Ecosystems of the world 26. Estuaries and enclosed seas. Elsevier Amsterdam.
- Badan-Dagon, A., C.J. Koblinsky & T. Baumgartner. 1985. Spring and summer in the Gulf of California: observa-

- tions of surface thermal patterns. *Oceanol. Acta* 8: 13-22.
- Bowman, T.E. 1967. The planktonic shrimp *Lucifer chacei* sp. nov. (Sergestidae: Luciferinae), the Pacific twin of the Atlantic *Lucifer faxoni*. *Pacif. Sci.* 21: 266-271.
- Bowman, T.E. & J.C. McCain. 1967. Distribution of the planktonic shrimps *Lucifer* in the western North Atlantic. *Bull. Mar. Sci.* 17: 660-671.
- Bray, N.A. & J.M. Robles. 1991. Physical oceanography of the Gulf of California, p. 511-553. In J.P. Dauphin & B.R.T. Simoneit (eds.). *The Gulf and Peninsular Province of the Californias*. AAPG Memoir 47. Am. Assoc. Petroleum Geol. Tulsa, Oklahoma.
- Brinton, E., A. Fleminger & D. Siegel-Causey. 1986. The temperate and tropical planktonic biotas of the Gulf of California. *CalCOFI Rep.* 27: 228-266.
- Burkenroad, M.D. 1937. The Templeton Crocker Expedition. XII. Sergestidae (Crustacea: Decapoda) from the Lower California region, with descriptions of two new species and some remarks on the organs of Pesta in *Sergestes*. *Zoologica* 22: 315-329.
- Burkenroad, M.D. 1938. The Templeton Crocker Expedition. XIII. Penaeidae from the region of Lower California and Clarion Island, with descriptions of four new species. *Zoologica* 23: 59-91.
- Hendrickx, M.E. & F.D. Estrada-Navarrete. 1989a. *Processa pippinae* Wicksten and Méndez, 1985: a pelagic processid shrimp from the Gulf of California. *Rev. Biol. Trop.* 83: 343-345.
- Hendrickx, M.E. & F.D. Estrada-Navarrete. 1989b. A checklist of the species of pelagic shrimps (Penaeoidea and Caridea) from the eastern Pacific with notes on their zoogeography and depth distribution. *CalCOFI Rep.* 30: 104-121.
- Omori, M. 1974. The biology of pelagic shrimps in the ocean. *Adv. Mar. Biol.* 12: 233-324.
- Omori, M. 1977. Distribution of warm water epiplanktonic shrimps of the genera *Leucifer* and *Acetes* (Macrura, Penaeoidea, Sergestidae). *Proc. Symp. Warm. Water. Zool. spl. Publ. UNESCO/N.* 10: 1-12.
- Omori, M. 1992. Occurrence of two species of *Lucifer* (Dendrobranchiata: Sergestoidea: Luciferidae) off the pacific coast of America. *J. Crust. Biol.* 12: 104-110.
- Wyllie, J.G. 1966. Geostrophic flow of the California Current at the surface and at 200 meters. *CalCOFI ATLAS.* 4: 288.