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Space-Temporal Presence of the Cirripede Parasite *Loxothylacus texanus* in the Lagoon-Estuarine Subsystem of Alvarado, Veracruz, México

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Abstract: The rhizocephalan *Loxothylacus texanus*, parasite of the crabs *Callinectes sapidus* and *C. rathbunae*, appears mainly in the Gulf of Mexico where important economic losses have been attributed to this parasite. The main objective of this study was to explain parasite-host relationship in time and space. A total of 756 organisms were collected, from which there were obtained 545 healthy crabs (72%), 32 feminized males (4.23%), 51 with virgin externa (6.74%), 31 with immature externa (4.1%) and 97 organisms with mature externa (12.8%). It was calculated a sexual proportion of the healthy organisms of 54.86% (299) for the males and 45.14% (246) for the females (sex ratio 1.2:1.0). For the parasitized organisms it was calculated a proportion of 50.24% (106 crabs) for the males and 49.76% (105 crabs) for the females (sex ratio 1.0:1.0). It can be concluded that *L. texanus* is persistent in time and space in the lagunar subsystem of Alvarado, Veracruz. Its prevalence is greater in dry seasons and in salinities higher than 8, but lower than 24‰. *L. texanus* is distributed in an isolated manner inside the lagoon, which allows that the zones with salinities other than 8-24‰ can serve as refuges to the megalopas and the early stages of *C. rathbunae* from this rhizocephalan. *L. texanus* is not selective in regard to the host's sex. The degree of development of the externa affects the osmoregulatory capacity of the host on benefit of the parasite.

Key words: Rhizocephala, *Loxothylacus texanus*, *Callinectes rathbunae*, parasitism

INTRODUCTION

The rhizocephalans' distribution is discontinuous through the intervals of distribution of their hosts and may appear in more than one species of host, parasitizing in most cases groups of related species and of the same genus (Nielsen, 1970; Høeg and Lützen, 1985; Alvarez, 1993).

The rhizocephalans are widely distributed in or on their respective hosts. They can be found in the deep ocean (Lützen, 1985; Rybakov and Høeg, 1992), in continental slopes and in the coastline (Andersen *et al*., 1990).

The superorder Rhizocephala includes seven families which differ noticeably in their metamorphosis process and in their sexual system (Høeg and Lützen, 1985). The members of the Peltogasteridae, Lernaeodiscidae and Sacculinidae families have a gonochoristic life cycle (separate sexes). This is reflected initially since the larvae phase.

The Sacculinidae family includes six types (like *Sacculina* and *Loxothylacus*) and 173 species approximately (Høeg, 1995).

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The rhizocephalan *Loxothylacus texanus*, parasite of the blue crab (*Callinectes sapidus*), appears mainly in the Gulf of Mexico. Even though the presence of *L. texanus*, has been recognized by local fisherman in Mexican waters of the Gulf of Mexico since a long time ago, only recently the affected populations have begun to be studied (Lázaro-Chávez *et al*., 1996; Alvarez and Calderón, 1996; Alvarez *et al*., 1999), where important economic losses have been attributed to *L. texanus* (Daugtherty, 1952; Christmas, 1969; Park, 1969; Adkins, 1972; Ragan and Matherne, 1974; Wardle and Tirpak, 1991; Hochberg *et al*., 1992).

It has been observed that *L. texanus* also affects in great measure the crab populations of the *Callinectes rathbunae* species, mostly in the coastlines of Veracruz and Campeche, Mexico, where an important blue crab fishery exists (Alvarez and Calderón, 1996; Alvarez *et al*., 1999; Vázquez-López *et al*., 2006).

The main objective of this study was to explain parasite-host relationship in time and space.

MATERIALS AND METHODS

Study Area

The Alvarado Lagoonal System (ALS) comprises the Alvarado, Tlalixcoyan, Buen País and Camaronera subsystems. The system is classified, according to its origin, as an estuary of a waterlogged river with a barrier (Lankford, 1977, in Contreras, 1985). It is located between the 18° 42° 30° N and 18° 52° 15° N and the 95° 42° 20° W and 95° 57° 32° W (Contreras, 1985), is separated from the Gulf of Mexico by a sandy bar. The Alvarado subsystem communicates with the marine environment through the Papaloapan river, while the Camaronera lagoon presents an artificial communication (Fig. 1). The rainfall regime is characteristic of the southwest region of the Gulf of Mexico, with a dry season that extends from March to May, a rainy season that extends from June

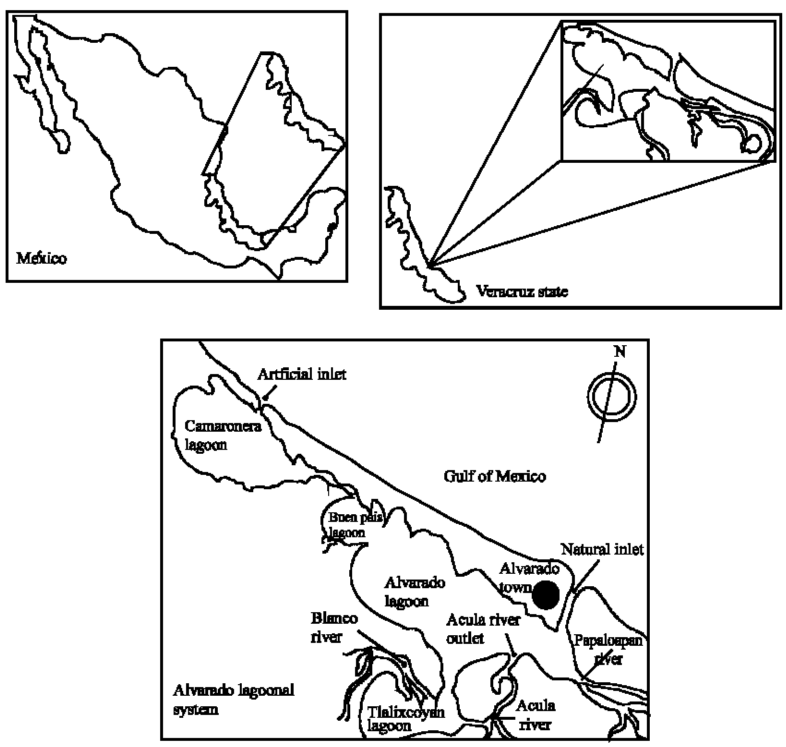

Fig. 1: Alvarado lagoonal system. Sampling area

to October and another cold season dominated by northward winds (*nortes*) that extends from November to February. In the subsystems of Alvarado and Tlalixcoyan, flow the Papaloapan, Acula and Blanco rivers, existing a marked heterogeneity of the salinity in time and space. The subsystem is surrounded almost in its totality by the mangroves *Rhizophora mangle*, *Avicennia nitida*, *Laguncularia racemosa* and *Conocarpus erectus* (Contreras, 1985; Morán-Silva *et al*., 1996, 2005). Vegetation comprises halophyte grass, palm trees and trees from the swampy jungle. The aquatic vegetation includes the grass *Ruppia maritima* L., red algae of the *Gracillaria* type and Clorophyta filamentous algae of local distribution. In the rainy season aquatic lily *Eichhornia crassipes* invades the Alvarado and Tlalixcoyan subsystems (Contreras, 1985; Morán-Silva *et al*., 1996, 2005).

Seven sampling points were established in the lagunar subsystem of Alvarado, Veracruz (Fig. 2), with the intention of capturing crabs of the *Callinectes rathbunae* species parasitized with the rhizocephalan *Loxothylacus texanus*. The points were selected taking into account the saline gradient, following Vázquez (2000) criteria. From March of 2001 to June of 2002, a series of periodical samplings were performed (every 45 days) in that body of water. *Aros jaiberos* (crab hoops), a local fishery gear, were thrown in the selected points. The captures were performed using 30 hoops, since there is no criteria established, the number of these varies between the fishermen dedicated to capture *jaibas* (In Mexico, the crabs of the *Callinectes* type are commonly known as *jaibas*). All the organisms captured were sexed and measured. The parasitized organisms were classified primarily according to the degree of parasitization and the number of externae. The categories that were established are: Feminized, virgin externa, immature externa and mature externa, following the criteria of Wardle and Tirpak (1991), Alvarez and Calderón (1996) and Werner (2001).

We considered feminized the males in which the externa had not emerged yet and those that presented an expanded abdomen (first in a triangular shape) and atrophied pleopods; we considered as virgins the externae that have not been fecundated and present a rounded shape and a creamy color, immature the externae that present a compacted shape and a pale yellow color and the mature externae are the parasites that have been fecundated and present a bright yellow to brown color and are ready to produce new parasites. The organisms that presented mature externae were transported to the Laboratory of the National Collection of Crustaceans of the Universidad Nacional Autónoma de México (CNCR, UNAM) so that the externae could spawn and to obtain larvae of the parasite (published data aside). At the same time of the captures, the salinity (‰) was measured with a YSI model 33 salinometer.

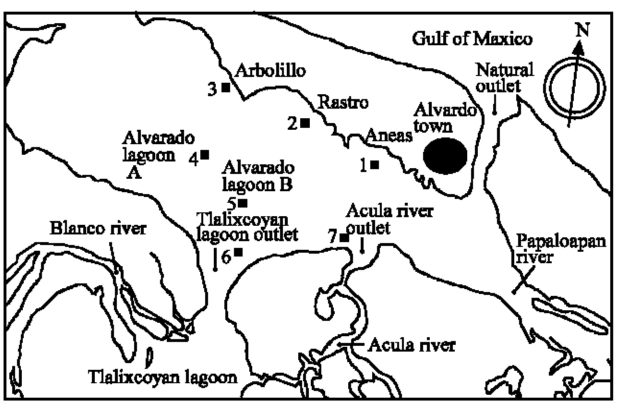

Fig. 2: Alvarado subsystem. ■ Sampling sites

RESULTS

A total of 756 organisms were collected, from which were obtained 545 healthy crabs (72%), 32 feminized males (4.23%), 51 with virgin externa (6.74%), 31 with immature externa (4.1%) and 97 organisms with mature externa (12.8%).

Sizes of the Organisms

Healthy Organisms

A minimum width of shell of 3 cm. for the males and 4 cm. for the females was registered, whereas the maximum sizes were 13.8 and 11.5 cm respectively.

Parasitized Organisms

The minimum sizes registered were of 4 cm for both sexes, the maximum sizes were of 13 cm for the males and 11 cm for the females. The most common sizes were of 7 to 8.9 cm for the males and 7 to 8.7 cm for the females.

Sex Ratios

It was calculated a sexual proportion of the healthy organisms of 54.86% (299) for the males and 45.14% (246) for the females (relation 1.2:1.0). For the parasitized organisms it was calculated a proportion of 50.24% (106 crabs) for the males and 49.76% (105 crabs) for the females (relation 1.0:1.0). The parasitized organisms that presented externae were regrouped in 12 categories with respect to the number of externae found per host and the degree of maturity (Table 1).

Two hundred and twelve parasitized organisms were captured; however, a female was discarded (first sampling, station 3) with a shell width of 5.4 cm for presenting 5 externae (virgins), since this category had not been contemplated because it was not reported in bibliography.

Distribution of the Organisms

The distribution per sampling station is showed in Fig. 3.

In Table 2-5 showed the distribution of the parasites by sampling and by degree of development.

Table 1: The organisms were accommodated in 14 categories, including the healthy and feminized organisms

	Sampling sites								
Host´s category	1 (Aneas)	2 (Rastro)	3 (Arbolillo)	4 (Alvarado lagoon A)	5 (Alvarado lagoon B)	6 (Tlalixcoyan lagoon outlet)	7 (Acula river outlet)	Hosts per category	Percentage
Healthy	80	86	88	64	87	75	65	545	72.00
Feminised	6	0	1	9	1	6	9	32	4.24
1virext	4	3	4	2	1	1	3	18	2.38
2virext	4	0	2	1	0	0	1	8	1.06
3virext	8	5	1	0	0	0	0	14	1.85
4virext	3	2	6	0	0	0	0	11	1.45
1immaext	0	1	4	6	0	0	0	11	1.45
2immaext	3	3	3	0	0	0	0	9	1.19
3immaext	1	0	3	0	0	0	0	4	0.53
4immaext	0	1	5	1	0	0	0	7	0.93
1maext	5	13	15	24	0	0	0	57	7.53
2maext	2	6	6	4	0	0	0	18	2.38
3maext	0	0	6	5	0	0	0	11	1.45
4maext	0	3	8	0	0	0	0	11	1.45
Hosts per sampling site	116	123	152	116	89	82	78	756	
								N = 756	

Virext = Virgin externa, immaext = immature externa and maext = mature externa. The numbers 1-4 indicate the number of externae per host

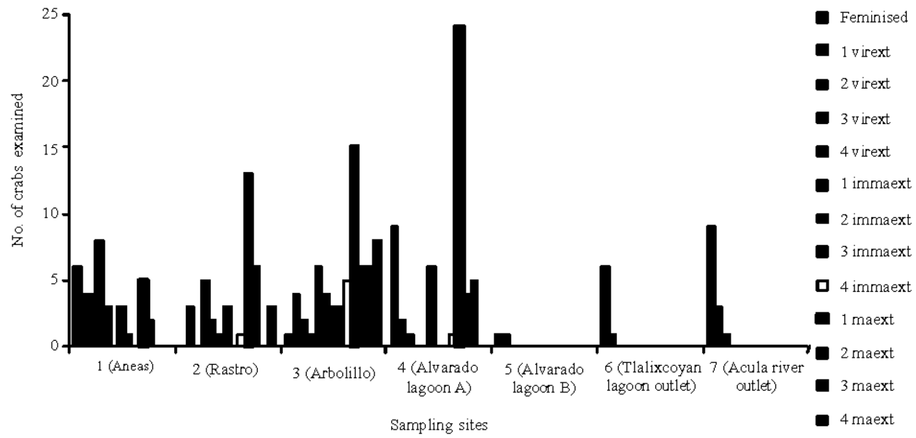

Fig. 3: Distribution of the parasitized crabs by category and by station. The feminized organisms are included

Table 2: Distribution of the feminized crabs by sampling

Sampling sites	Sampling date 16/03/2001	27/04/2001	06/07/2001	08/09/2001	26/10/2001	26/01/2002	04/04/2002	01/06/2002	Total per sampling site
1	3	2	0	0	0	0	1	0	6
2	0	0	0	0	0	0	0	0	0
3	1	0	0	0	0	0	0	0	1
4	3	0	1	1	2	1	1	0	9
5	0	1	0	0	0	0	0	0	1
6	3	1	0	0	0	1	1	0	6
7	1	0	1	1	1	3	1	1	9
	11	4	2	2	3	5	4	1	32

Table 3: Distribution of the crabs with virgin externa by sampling

Sampling sites	Sampling date 16/03/2001	27/04/2001	06/07/2001	08/09/2001	26/10/2001	26/01/2002	04/04/2002	01/06/2002	Total per sampling site
1	9	5	2	0	0	0	1	2	19
2	2	3	2	0	0	0	0	3	10
3	4	3	1	1	1	0	0	3	13
4	2	0	0	0	1	0	0	0	3
5	0	0	0	0	0	1	0	0	1
6	1	0	0	0	0	0	0	0	1
7	2	2	0	0	0	0	0	0	4
	20	13	5	1	2	1	1	8	51

Table 4: Distribution of the crabs with immature externa by sampling

Sampling sites	Sampling date 16/03/2001	27/04/2001	06/07/2001	08/09/2001	26/10/2001	26/01/2002	04/04/2002	01/06/2002	Total per sampling site
1	0	0	0	0	0	0	0	4	4
2	1	0	0	0	0	0	1	3	5
3	1	1	0	1	0	0	5	7	15
4	2	0	0	1	3	0	1	0	7
5	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0
	4	1	0	2	3	0	7	14	31

Table 5: Distribution of the crabs with mature externa by sampling

Sampling sites	Sampling date 16/03/2001	27/04/2001	06/07/2001	08/09/2001	26/10/2001	26/01/2002	04/04/2002	01/06/2002	Total per sampling site
1	3	2	1	0	0	0	1	0	7
2	11	5	0	0	0	2	2	2	22
3	9	6	8	0	4	1	5	2	35
4	6	8	0	2	4	1	1	11	33
5	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0
	29	21	9	2	8	4	9	15	97

Table 6: Salinities per sampling for each collecting station

Sampling sites	Salinity (‰) Sampling date 16/03/2001	27/04/2001	06/07/2001	08/09/2001	26/10/2001	26/01/2002	04/04/2002	01/06/2002
1	26	35	0	0	0.3	11	22	8
2	25	35	0	0	0.4	16	18	10
3	12	35	0	0	0.7	20	13	10
4	7	23	0	0	0.3	11	7	17
5	8	30	0	0	0.0	10	9	11
6	14	5	0	0	0.3	9	8	10
7	5	7	0	0	0.5	9.1	4	10

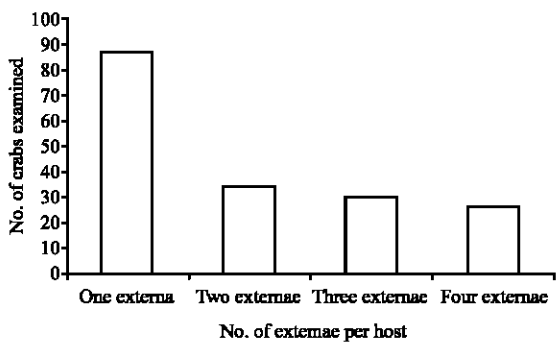

Fig. 4: No. of externae present per host

No. of Externae Per Host

The most common were the crabs with one externa (48.60%), then the ones that presented two (19.55), three (16.76) and finally, the less common were the crabs with four externae (15.09). A chi-square test was applied (Sokal and Rohlf, 1981) to know if there were differences between the observed frequencies concerning the number of externae per host, finding a significant difference ($\chi^2 = 53.91$, $\chi^2_{0.05}$, 3 gL = 0.352) (Fig. 4).

The average deepness of the capture stations was of 1.7 m, the lowest temperature (21.4°C) was registered in January, 2001, whereas the highest temperature (33.5°C) was observed in September, 2002.

Salinity

The salinity (‰) registered in each station for each sampling is presented in Table 6.

The captured crabs were also regrouped according to salinity (Fig. 5).

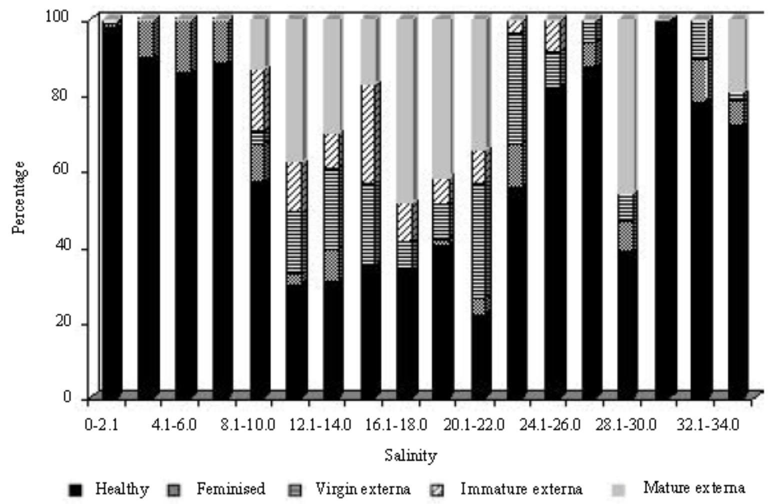

Fig. 5: Distribution of the captured crabs according to salinity

DISCUSSION

The low number of published papers about *C. rathbunae* biology didn´t allow a deep comparation of our findings; most information is focused in *C. sapidus*. Regarding to the sizes, Román-Contreras (1984) found that 85.7% of the healthy organisms captured in Términos lagoon, Campeche, which correspond to the *Callinectes* genus, was comprised in an interval of 1 to 9 cm of shell width; he also found that the rest corresponded to greater sizes. In this study, we found minimum sizes of 3 and 4 cm for healthy males and females respectively, discarding minor sizes because commercial fisheries were employed and these types of fisheries allow the escape of small organisms. The maximum sizes found (13.8 and 11.5 cm) correspond to healthy organisms of commercial size. Rocha-Ramírez *et al.* (1992) found small and medium sizes of healthy crabs *C. rathbunae* comprised in an interval of 3.1 to 9 cm in Tamiahua lagoon, Veracruz.

For the parasitized organisms, it was found a minimum size of 4 cm for both sexes; the maximum sizes were of 13 cm for males and 11 cm for females with averages of 8.43±0.33 and 7.46±0.25 cm, respectively. Alvarez and Calderón (1996) reported an average size of 8.78±1.04 cm for *C. sapidus* in Pueblo Viejo lagoon and 12.3±0.37 cm for the same species in Tamiahua lagoon. The same authors recorded an average size of 8.19±0.33 cm for *C. rathbunae* in Términos lagoon, Campeche and 12.02±0.72 cm for the same species in Mandinga lagoon, Veracruz. Similarly, Lázaro-Chávez *et al.* (1996) found that parasitized organisms of the species *C. sapidus* in the Tamiahua lagoon, Veracruz were within a size interval of 4.5 to 11.5 cm with an average of 7.72±0.26 cm.

Regarding the sexual proportion, Rocha-Ramírez *et al.* (1992) calculated a sex ratio of 1.4:1.0 in autumn and winter and of 1.0:1.0 in spring and summer for healthy crabs of the species *C. rathbunae* in Tamiahua lagoon. Alvarez *et al.* (1999) reported 1.46 healthy females for each male of *C. rathbunae* in the Alvarado lagoon. These results are similar to the results reported in this study (1.2 males for each female).

Regarding the parasitized organisms, in the present study it was calculated a proportion of 1.0:1.0; On the other hand, Wardle and Tirpak (1991) found a sexual proportion of 1.0:1.0 for *C. sapidus* parasitized with *L. texanus* in the Galveston bay in Texas. Alvarez and Calderón (1996) reported a relation of 1.0:1.0 for *C. rathbunae* parasitized with *L. texanus* in coastal lagoons of the southwestern Gulf of Mexico. Lázaro-Chávez *et al*. (1996) observed a relation of 1.68 females for each male; Vázquez-López *et al*. (2006) found a relation of 1.7 females for each male for *C. rathbunae*, even though the organisms collected were few. With respect to other species of rhizocephalans, Sloan (1984) found a relation of 1.0:1.0 for *Lithodes aequispina* crabs parasitized with *Briarossacus callosus*.

In previous reports there are only tree categories reported for the parasitized crabs; feminized, with virgin externa and with mature externa (Wardle and Tirpak, 1991; Høeg, 1995; Høeg and Lützen, 1995; Alvarez and Calderón, 1996; Alvarez *et al*., 1999) so that leaves out an intermediate phase that is immature (externae that have been fecundated but have not produced new parasites (Alvarez, Personal communication). Just recently, Vázquez- López *et al*. (2006) have mentioned this intermediate phase (Table 1).

Parasitized organisms were captured in all the stations (at least one crab) (Table 1 and Fig. 3). Wardle and Tirpak (1991) mention that the places in which they did not find parasitized crabs were the most superficial stations, where they probable are depredated by birds and other animals, since these crabs loose the ability to bury themselves like the healthy organisms do, whereby they can be visible to depredator organisms. Regarding to this, Høeg and Lützen, 1995; Vázquez-López *et al*., 2006 mention that the crabs with mature externa loose the ability to burry themselves and present a placid behavior, perhaps because they do not want to hurt their externae. According to Høeg and Lützen (1995), a regeneration of the externa has not been observed once it is lost. This could have repercussions in the prevalence of the parasite. Vázquez-López *et al*. (2006) observed that crabs from the species *C. rathbunae* with mature externae are less aggressive than healthy crabs of the same species and that the aggressiveness decreases with the growth of the externa. This could explain the absence of this type of crabs in shallow zones. In a greater scale, Alvarez and Calderón (1996) sampled 14 bodies of water in the southwestern Gulf of Mexico and registered the presence of *L. texanus* in the species *C. sapidus* and *C. rathbunae* in all sampling points, even though the greater incidence was registered in crabs of the species *C. rathbunae*.

In Table 2-5, we can observe that the prevalence of *L. texanus* is persistent in most part of the year. In the third sampling (06/07/2001) organisms with immature externa were not collected. Alvarez *et al*. (1999) did not capture parasitized crabs (*C. rathbunae* and *C. sapidus*) during March in Alvarado lagoon, Veracruz, but this is attributed to significant variations in the prevalence during the annual cycle, probably because of the variation in the intensity of hosts enrollment; even though, according to Román-Contreras (1984) and Rocha-Ramírez *et al*. (1992) the recruitment of *C. rathbunae* and *C. sapidus* to the lagoons is performed en high salinities and March belongs to the dry season, when high salinities are registered (Morán-Silva *et al*., 2005).

Regarding the number of externae per host, it was observed that the crabs with one externa (48.60%) are the most common, followed by those who present two externae (19.55) and three externae (16.76); the less common are the crabs that present four externae (15.09). A chi-square test was applied to find out the existence of any difference between the observed frequencies with respect to the number of externae per host, finding that a significant difference exists ($\chi^2 = 53.91$, $\chi^2_{0.05}$, 3 gL = 0.352) (Fig. 4). Høeg (1995) and Høeg and Lützen (1995) pointed out that one externa corresponds to one parasite, so it can be assumed that crabs of the *Callinectes* gene can be attacked by more than one parasite at the same time. Wardle and Tirpak (1991) registered 1 to 4 externae in *C. sapidus* crabs in Galveston bay in Texas and the most common were the hosts with one externa (n = 196), followed by those who presented two externae (n = 76), three (n = 12) and four externae (n = 1). Alvarez and Calderón (1996) found the same trend in *C. rathbunae* in different bodies of water in the southwestern Gulf of Mexico; 1 to 4 externae, where the crabs with one externa were the most common (50), with two (20), with three externae (11) and the less common were those who presented four externae (2). The same authors reported one to three externae (32, 5 and 1, respectively) per host in crabs of the *C. sapidus* species in the same bodies of water. On the other hand, Lázaro-Chávez *et al.* (1996) found one to four externae in *C. sapidus* in Tamiahua lagoon, Veracruz, with the same tendency (38, 10, 2 and 1 externae, respectively). Alvarez *et al.* (1999) reported the same number of externae and the same trend in *C. rathbunae* in Alvarado lagoon, in Veracruz. Vázquez-López *et al.* (2006) reported the same trend and one to four externae in *C. rathbunae* collected in Alvarado lagoon in Veracruz. No author had reported an organism with five externae. If the crab hoops are increased during the collection, it is possible to obtain more crabs with five externae; although in this case, this type of crab represents a 0.19 of 212 captured crabs, so its prevalence is very low.

Regarding the salinity, it was observed that parasitized organisms can be found mainly in a saline interval of 8.1 to 24‰. In Fig. 5 it can be appreciated that healthy organisms are found in a wide saline interval (0 to 36‰) and according to the externae's growth, the interval is narrowed, which may indicate that the externa plays a very important role in the hosts' physiology with respect to salinity. In Fig. 5 and Table 6, it can be appreciated that in samplings 3 to 5, the salinities found are smaller than 5‰ and correspond to the rainy season (Contreras, 1985; Morán-Silva *et al.*, 1996; Morán-Silva *et al.*, 2005); in Fig. 5 we can see that in salinities lower than 5, only healthy and feminized organisms can be captured, even though the latter are also found in all the saline interval, which can support this asseveration. Alvarez *et al.* (2002) observed that healthy *C. rathbunae* crabs presented a greater osmolality of the hemolymph than those of the same species parasitized with *L. texanus* in different salinities and concluded that *L. texanus* affects significantly the osmoregulation in *C. rathbunae* when these are exposed to different salinities. This can explain why healthy organisms were captured during the whole saline interval. Findley *et al.* (1978) exponed *C. sapidus* organisms and mollusks of the species *Thais haemastoma* to different salinities and measured the corresponding respiration rates; they observed that crabs suffer small changes in their respiration rates, but not the mollusks, since they noticed great changes in their respiration rates. They concluded that *C. sapidus* is capable of regulate their extracellular fluids and their ionic composition. On the other hand, Robles *et al.* (2002) observed that healthy crabs from the species *C. rathbunae* decreased their respiratory rate when the salinity was increased (25‰) while the organisms parasitized with *L. texanus* consumed more oxygen in lower salinities (5‰); they also found that crabs with mature externae present higher respiratory rates in lower salinities (5‰) than the hosts with virgin externae and with internal parasites in the same salinity. They mention that *C. rathbunae* presents a strong ability to osmoregulate in lower salinities (healthy organisms). They concluded that the presence of mature externae represents an extra metabolic load for the crabs. This would explain why most of the crabs with mature externae were captured in salinities higher than 5‰ and why the feminized hosts and with virgin externa were captured in a more wide saline interval (Fig. 5). Vázquez-López *et al.* (2006) showed that the larvae development of *L. texanus* is successfully accomplished in a saline interval of 12 to 24‰ (in Laboratory conditions); they observed that the development is not successful in other saline intervals. The same authors also observed that outside the mentioned saline interval, the larvae mortality is high (unpublished data). This can explain why most of the parasitized crabs concentrate in a saline interval ranging from 8.1 to 22‰ (Fig. 5). This saline interval was present in stations 1 to 3; which, according to Maldonado (1986) (quoted in Reguero and García-Cubas, 1989) are within an area recognized as a salinity gradient, where a mixture of fresh and marine waters exists and where horizontal gradients and stratification are present most of the year; he also mentions that this area includes the Alvarado and Buen País lagoons and the entrance of the Papaloapan river. The same author considers an area of fresh water influence with horizontal gradients and a predominant fresh water influence, without stratification and includes in it the Tlalixcoyan lagoon. Station 5 is located in this area. Regarding the samplings, it can be observed that most of the parasitized crabs were captured in the dry season that extends from March to June (Morán-Silva *et al.*, 2005), when the salinity increases. In Table 6 it can be observed that the samplings 3 to 5 correspond to the rainy season (Morán-Silva *et al.*, 2005). In Table 4 it can be appreciated that crabs with immature externae were not captured in sampling 3 and Table 5 shows that in sampling 4 only organisms with mature externae were captured in station 4. Both samplings correspond to the rainy season, so that implies that a dilution in the lagunar system occurs (Flores-Coto and Méndez, 1981; Reguero and García-Cubas, 1989).

It can be concluded that *L. texanus* is persistent in time and space in the lagunar subsystem of Alvarado, Veracruz. Its prevalence is greater in dry seasons and in salinities higher than 8‰, but lower than 24‰. *L. texanus* is distributed in an isolated manner inside the lagoon, which allows that the zones with salinities other tan 8-24‰ can serve as refuges to the megalopas and the early stages of *C. rathbunae* from this rhizocephalan. *L. texanus* is not selective in regard to the host's sex. The degree of development of the externa affect the osmoregulatory capacity of the host on benefit of the parasite.

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