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Distribution of *Loxothylacus texanus* (Cirripedia: Rhizocephala) Parasitizing Crabs of the Genus *Callinectes* in the Southwestern Gulf of Mexico

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DISTRIBUTION OF *LOXOTHYLACUS TEXANUS* (CIRRIPEDIA: RHIZOCEPHALA) PARASITIZING CRABS OF THE GENUS *CALLINECTES* IN THE SOUTHWESTERN GULF OF MEXICO

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ABSTRACT A preliminary study on the interaction between the parasitic barnacle *Loxothylacus texanus* and two of its host species, the blue crab *Callinectes sapidus* and the dark blue crab *C. rathbunae*, in the Gulf of Mexico is presented. Data were obtained from 923 crabs, 162 *C. sapidus* and 761 *C. rathbunae*, deposited in the Colección de Crustáceos, Instituto de Biología, Universidad Nacional Autónoma de México (UNAM), that were collected in 14 coastal lagoons and sites along the Mexican coast of the Gulf of Mexico. The distribution of *L. texanus* parasitizing each one of the host species, mean host size variation, distribution of number of parasite externae per host, and morphological modifications of the abdomen of the hosts are analyzed.

Introduction

The crabs of the genus *Callinectes*, mainly the blue crab *C. sapidus* Rathbun, and the dark blue crab *C. rathbunae* Contreras, support one of the most important commercial fisheries, both in terms of volume and value, within the Gulf of Mexico (Anonymous 1994). Of the biotic factors that affect blue crab populations negatively in the Gulf of Mexico, the parasitism by rhizocephalan barnacles may be one of the most important, periodically reaching very high prevalences (Wardle and Tirpak 1991; Lorán et al. 1993).

Rhizocephalan barnacles parasitize susceptible shrimps and crabs through a planktonic larval stage from which an endoparasitic phase originates, a phase that is not evident unless the host is examined histologically. During the internal phase of the parasite, the host external morphology changes; the male abdomen becomes broader through a process that has been called feminization (Reinhard 1950). The emergence of a reproductive body called "externa" follows the endoparasitic phase. The externa emerges through the internal surface of the abdomen of the host after molting, while the host exoskeleton is still soft. In host species parasitized by the rhizocephalan family Sacculinidae, hosts will not molt once the externa has appeared and the mean size of parasitized hosts is usually significantly less than that of unparasitized hosts (Reinhard 1956; O'Brien and Van Wyk 1984). However, the most important effect caused by this parasitism is that host gonads do not mature (parasitic castration *sensu* O'Brien and Van Wyk 1984). The effects of the parasitism by rhizocephalans at the population level are: a) parasitized individuals are not removed by the commercial fishery from the population because they do not attain legal size, and b) the parasitized fraction, which does not reproduce, competes with unparasitized individuals for food and space.

Studies have been carried out on the distribution of rhizocephalans (Hochberg et al. 1992), host size distribution (Christmas 1969; Adkins 1972; Ragan and Matherne 1974), changes in prevalence during outbreaks (Christmas 1969; Park 1969; Wardle and Tirpak 1991), the relationship between parasite size (externa size) and host size (Reinhard 1950; Wardle and Tirpak 1991), and the morphological changes that parasitized crabs undergo (Reinhard 1950; Hochberg et al. 1992). In spite of the great economic importance of the blue crab fishery in Mexico, only two studies have recorded data on the prevalence of *Loxothylacus texanus* Boschma, its seasonal variation, and host size variation: Lorán et al. (1993), who analyzed the crab populations of Alvarado lagoon and Lázaro-Chávez et al. (in press), who studied parasitized crabs in Tamiahua lagoon. The objective of this study is to present additional records of parasitized crabs of the genus *Callinectes* within the Gulf of Mexico in order to update the known distribution of *L. texanus*, to determine what host species are being parasitized, to establish the host size range, and to present figures of the most common type of morphological variations of parasitized crabs.

Materials and Methods

Data on parasitized blue crabs from the southwestern Gulf of Mexico were obtained through the examination of all the *C. sapidus* and *C. rathbunae* from the Gulf of Mexico deposited in the Colección de Crustáceos, Instituto de Biología, Universidad Nacional Autónoma de México (UNAM).

Fourteen localities were represented in these samples, including coastal areas and coastal lagoons (Altamira, Chairel, Pueblo Viejo, Tamiahua, Casitas, La Mancha, Mandinga, Alvarado, Sontecomapan, Coatzacoalcos, Machona, Atasta, Términos, and Champotón) as depicted in Figure 1. Detailed descriptions of these coastal lagoons and sites can be found elsewhere in a number of papers (Contreras 1985; Yáñez-Arancibia and Day 1988; Rosas 1989). Each crab was identified and examined for the presence of rhizocephalan externae. All crabs were sexed and the shape of the abdomen recorded; sex was determined through the inspection of gonopods and genital pores. In this way, feminized crabs (crabs that are parasitized but which do not yet show the parasite externa) were also found. The internal surface of the abdomen of all crabs was examined in search of small externae or scars of *Loxothylacus texanus* and the number of externae per crab was recorded. The distribution of number of parasite externae per host was compared to a Poisson (random) distribution with a chi-square test. The most common types of abdomens of parasitized male crabs were identified (triangular and rounded) and parasitized individuals were classified accordingly by species. A G-test of independence was used on a 2 x 2 contingency table, to test if triangular abdomens were equally frequent in males of both host species, and a Student's t-test was used to compare their mean sizes. The two types of abdomens for parasitized males and the extra broad abdomen of parasitized females were figured to aid in their identification in the field. Crab sizes correspond to carapace width in millimeters (mm), and mean values are followed ± one standard error.

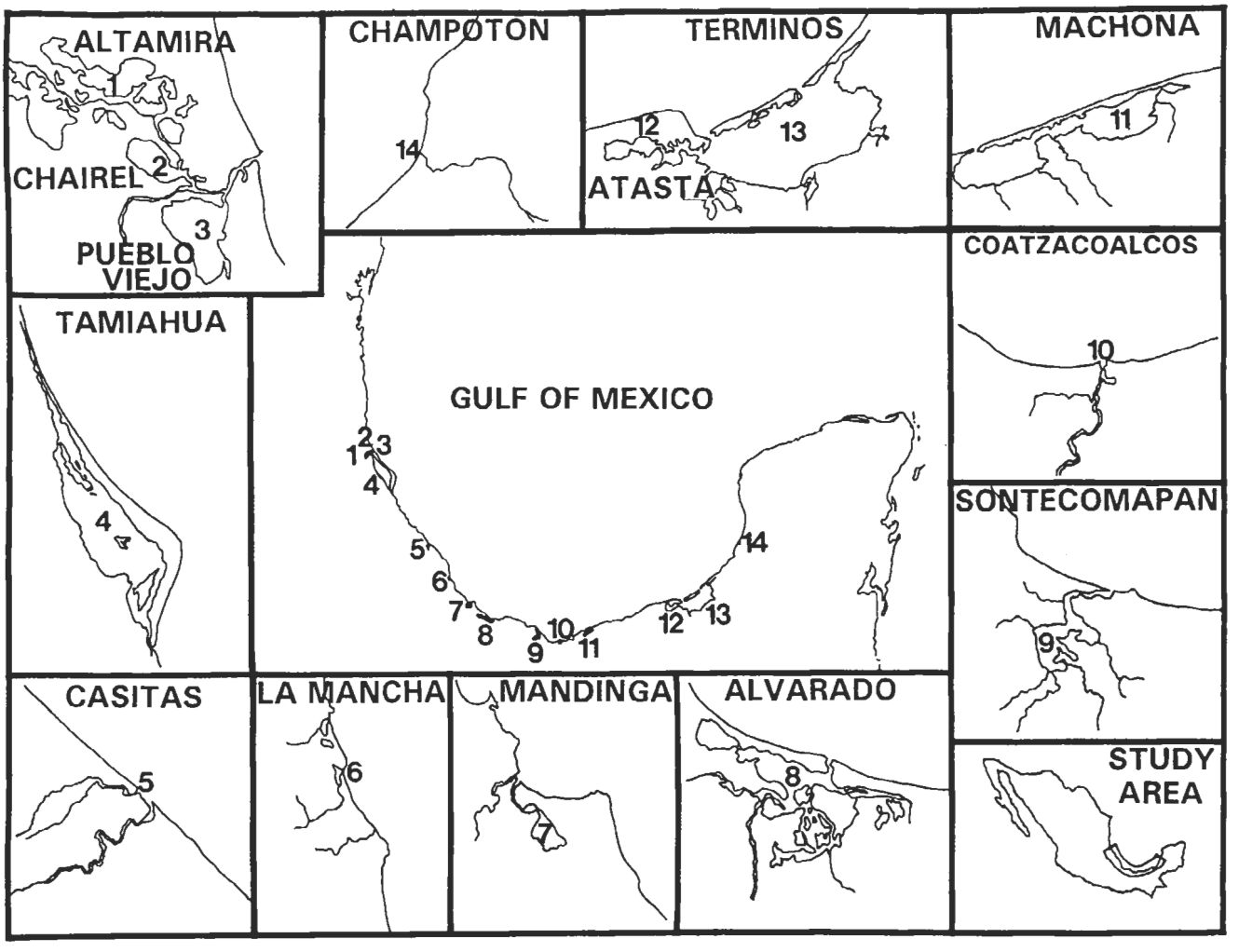

Figure 1. Collection sites in the Gulf of Mexico of *Callinectes sapidus* and *C. rathbunae*.

TABLE 1

Samples of crabs examined by species and locality within the Gulf of Mexico. Values represent number of parasitized crabs/ number of unparasitized crabs, and mean host size/mean size of unparasitized crabs, followed by ± one standard error. Asterisks represent significant differences between means. All material is deposited in the Instituto de Biología, UNAM.

	Callinectes sapidus		*Callinectes rathbunae*	
Altamira, Tamaulipas	0/9			
Chairel, Veracruz			0/21	
Pueblo Vicjo, Veracruz	5/1	87.8 ± 10.4	0/90	
Tamiahua, Veracruz	9/53	123.0 ± 3.7 / 116.4 ± 2.5	0/289	
Casitas, Veracruz			1/4	101.4
La Mancha, Veracruz	0/13		0/5	
Mandinga, Veracruz	0/5		6/123	120.2 ± 7.2 / 109.9 ± 1.5
Alvarado, Veracruz	0/4		0/112	
Sontecomapan, Veracruz	24/32	91.6 ± 1.9 / 111.2 ± 3.0*	67/26	86.0 ± 1.6 / 104 ± 3.3*
Coatzacoalcos, Veracruz			0/2	
Machona, Tabasco			1/0	94.3
Atasta, Campeche			1/0	75.2
Términos, Campeche	0/7		7/5	81.9 ± 3.3 / 113.5 ± 3.8*
Champotón, Campeche			0/1	

* P< 0.001

RESULTS

A total of 923 crabs, 162 *C. sapidus* and 761 *C. rathbunae*, was examined; from this total, 38 *C. sapidus* (23.5%) and 83 *C. rathbunae* (10.9%) were parasitized (Table 1). Parasitized crabs were found in eight of the 14 coastal lagoons and sites that were examined (Pueblo Viejo, Tamiahua, Casitas, Mandinga, Sontecomapan, Machona, Atasta, and Términos) as shown in Table 1.

In our samples, *C. sapidus* was parasitized in Pueblo Viejo, Tamiahua, and Sontecomapan lagoons, Veracruz. The mean size of parasitized *C. sapidus* ranged from 87.8 ± 10.4 mm in Pueblo Viejo lagoon to 123.0 ± 3.7 mm in Tamiahua lagoon; the range of sizes of parasitized *C. sapidus* was from 70.0 to 134.6 mm, both from Tamiahua lagoon, Veracruz. *C. rathbunae* was parasitized in Casitas and the coastal lagoons of Mandinga and Sontecomapan, Veracruz; Machona lagoon, Tabasco; and Atasta and Términos lagoons, Campeche. The mean size of parasitized *C. rathbunae* ranged from 81.9 ± 3.3 mm in Términos lagoon, Campeche, to 120.2 ± 7.2 mm in Mandinga lagoon, Veracruz; the range of sizes of parasitized *C. rathbunae* went from 45.3 mm in Sontecomapan lagoon, Veracruz, to 144.1 mm in Mandinga lagoon, Veracruz. In Términos lagoon, parasitized *C. rathbunae* and parasitized crabs of both species in Sontecomapan lagoon were significantly smaller than unparasitized crabs; while there were no significant differences in the rest of the localities.

The number of parasite externae in *C. sapidus* varied from one to three; 32 crabs had one externa (84.2%), five had two (13.2%), and one had three (2.6%). In turn, in *C. rathbunae*, the number of parasite externae ranged from one to four; 50 crabs had one parasite externa (60.2%), 20 had two (24.7%), 11 had three (13.6%), and two had four(2.5%). Assuming that the distribution of parasites is the result of similar processes in all the sites studied and since these distributions depart considerably from normality, the distribution of number of externae per host was analyzed only by species and not by locality. In *C. sapidus*, the distribution of externae corresponds to a random distribution (Table 2), while in *C. rathbunae*, the distribution departs considerably from random and approaches a contagious one, with a larger proportion of hosts having multiple externae (Table 3).

Out of 38 parasitized *C. sapidus*, 11 (28.9%) were males and 27 (71.1%) were females; while in *C. rathbunae*, there were 41 parasitized males and 42 parasitized females. In *C. sapidus*, three of 11 males (27.3%) had a triangular abdomen, while the remaining eight had a broad abdomen. For *C. rathbunae*, nine out of 41 crabs (22%) had a triangular abdomen (Figure 2). The frequency of appearance of triangular abdomens was independent of the host species

TABLE 2

Distribution of externae of *Loxothylacus texanus* on 162 *Callinectes sapidus*. Observed frequencies are compared (Chi-square test) to the expected frequencies of a Poisson (random) distribution.

No. externae per host	Observed frequencies	Expected frequencies	$(O-E)^2/E$
0	124	122.72	0.013
1	32	34.11	0.130
2	5	4.74	0.014
3	1	0.44	0.712
Total	162	162.01	χ^2=0.869, P>0.05

TABLE 3

Distribution of externae of *Loxothylacus texanus* on 761 *Callinectes rathbunae*. Observed frequencies are compared (Chi-square test) to the expected frequencies of a Poisson (random) distribution.

No. externae per host	Observed frequencies	Expected frequencies	$(O-E)^2/E$
0	678	640.57	2.18
1	50	110.17	32.86
2	20	9.47	11.70
3	11	0.54	202.61
4	2	0.02	169.93
Total	761	760.77	χ^2=419.30, P<0.0001

(χ^2[1]=1.83, P > 0.05); in other words, triangular abdomens are equally frequent in both host species. Mean host sizes for males with triangular abdomen were 83.76 ± 8.29 mm (range 67.2 to 92.7 mm) for *C. sapidus* and 82.25 ± 6.53 mm (range 45.3 to 115.8 mm) for *C. rathbunae*; no significant differences were found between the two mean values (t-test, t[10]=0.121, P>0.05).

DISCUSSION

Two species of the genus *Callinectes*, *C. sapidus* and *C. rathbunae*, are parasitized by *Loxothylacus texanus* in the southwestern Gulf of Mexico. *C. sapidus* is parasitized, as indicated by the records presented here and complemented with the information provided by Lorán et al. (1993), throughout the coast of the State of Veracruz from Tamiahua lagoon south to Alvarado and Sontecomapan lagoons. No clear pattern of variation of host size can be discerned in *C. sapidus* along the Mexican coast, contrary to what Hochberg et al. (1992) found for the northern and eastern Gulf of Mexico.

While in one previous report (Lorán et al., 1993) *C. rathbunae* was found to be a second host for *L. texanus*, no information on the extent of the distribution of this association was available prior to this report. *C. rathbunae* is an endemic of the Gulf of Mexico, occurring south from the United States-Mexico border to probably Términos lagoon, Campeche (Williams 1974); however, it is parasitized only southwards from Casitas, Veracruz, to Campeche. It is relevant to note that although very large samples of *C. rathbunae* have been obtained from Tamiahua lagoon (Lázaro-Chávez et al. in press), this species has never been found parasitized in that area, confirming that it is parasitized only in the southern portion of its range. The size range of parasitized *C. rathbunae* (45.3 to 144.1 mm) is greater than that for *C. sapidus* (70.0 to 134.6 mm), and no defined pattern of host size variation along a geographic gradient is evident with the available data.

The number of *L. texanus* externae appearing in the two host species differed statistically. In *C. sapidus*, the occurrence of externae was not significantly different from a random distribution, indicating that the chances of becoming parasitized are the same for all individuals. However, in *C. rathbunae*, the number of externae per host approached a contagious distribution, suggesting that this species may occur naturally in a more aggregated pattern that may favor multiple infections (Hoeg 1982).

The recognition of parasitized crabs in the field is based on the presence of externae of the parasite and on the identification of aberrant forms of the abdomen. In this study, two types of abdomens were recognized for parasitized males: rounded, similar to a mature female abdomen, and triangular, such as those of immature females. The recognition of the two types of abdomens for parasitized males was first made by Reinhard (1950) with blue crabs from Galveston Bay, Texas. Parasitized males with triangular abdomens may not occur in all populations, as the existence of two morphologies for abdomens of parasitized males was not discussed in an investigation of parasitized blue crabs from the west coast of Florida (Hochberg et al. 1992). The frequency of appearance of both forms in males and mean size of crabs bearing a triangular abdomen did not differ significantly between host species. The origin of the triangular abdomen may be related to the number of times an infected host molts between the time of infection and the time of emergence of the externa (Alvarez 1993), so the extent of feminization would be related to the duration of the internal phase of the parasite. Consequently, the appearance of the two types of abdomens could vary seasonally and geographically.

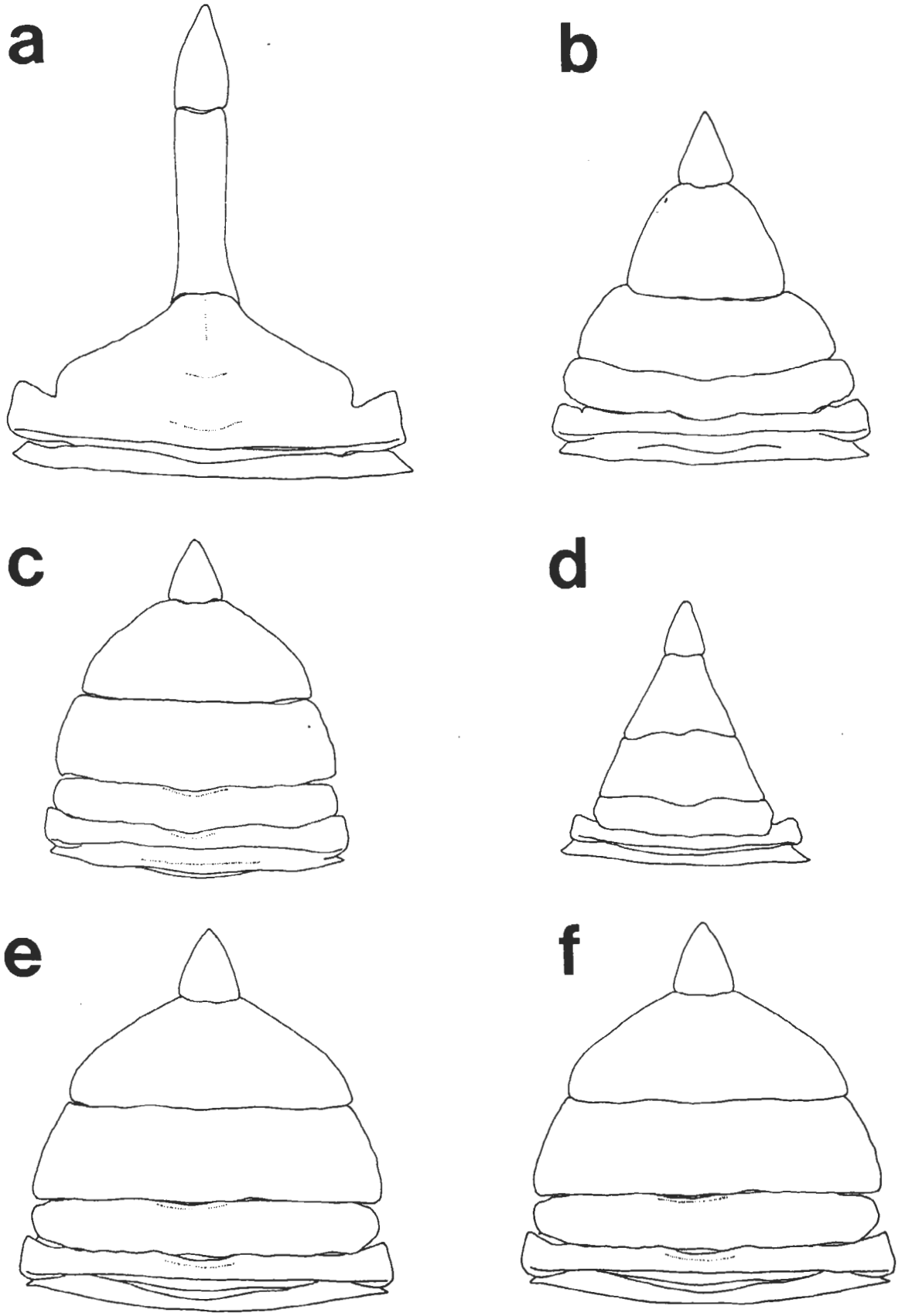

Figure 2. Abdomens of *Callinectes rathbunae*: a) normal male, b) parasitized male with triangular abdomen, c) parasitized male with rounded abdomen, d) immature female, e) normal mature female, and f) parasitized female.

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