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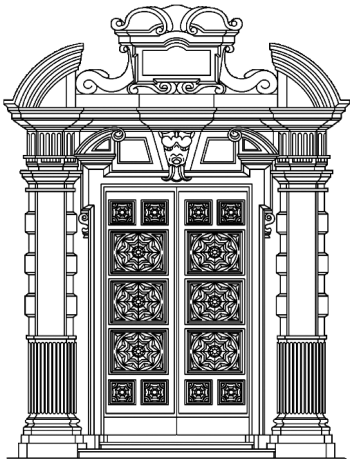

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Gianna INNOCENTI [1], Bella S. GALIL[2]

Observations on parasite and epibiont prevalence in the Levantine population of the Erythrean alien portunid *Charybdis longicollis* Leene

ABSTRACT

The swimming crab *Charybdis longicollis*, found in the Red Sea, the Persian Gulf and Madagascar, was first recorded in the Mediterranean in 1954. Soon after, its populations underwent an exponential growth stage and nowadays it occurs all along the Levant, from Egypt to Rhodes, being common on sandy-mud bottoms at 25-60 m, where it may form as much as 70% of the benthic biomass. In 1992 it was first found to be parasitized by the rhizocephalan *Heterosaccus dollfusi*, an Erythrean alien as well. The parasite causes sterilization and prevents moult in its host. The prevalence of the parasite has been monitored from September 2005 to October 2007 off Palmahim (Israel). Seasonal variations in infection range from 42.9% to 69.8% of the sample with a relatively high number of multiple externae per host. In 2007 the epibionts were noted as well – the serpulid *Hydroides operculatus* which were mostly observed on the thoracic sternites, and the barnacle *Chelonibia patula*. No correlation was found between the presence of encrusting serpulids/balanids and rhizocephalan parasitation or the number of externae per host. Crabs smaller than a certain size bore no epibionts.

Keywords: *Charybdis longicollis*, *Heterosaccus dollfusi*, alien, epibionts, parasite, Mediterranean Sea.

INTRODUCTION

The swimming crab *Charybdis longicollis* Leene is an invasive species originating in the Red Sea, very common on sandy-mud bottoms at 25-60 m, and present to depths of 90 m, along the Levant coast from Egypt to Turkey. In 1992 it was first found to be parasitized by the rhizocephalan *Heterosaccus dollfusi* Boschma, also an alien species originating in the Red Sea (Galil & Lützen,

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1995). The parasite causes sterilization, morphological and behavioural feminization, and cessation of moulting and hence growth, in its host (Innocenti *et al*., 1998; Galil & Innocenti, 1999; Innocenti & Galil, 2007). Both unparasitized and parasitized crabs have been noted to bear epibionts: the Erythrean alien serpulid *Hydroides operculatus* (Treadwell, 1929) (Galil & Lützen, 1995), and the cirripede *Balanus trigonus* Darwin, 1854, borne by 48 of 908 externa-bearing crabs collected in Haifa Bay, Israel (Galil & Innocenti, 1999). However, no further data were collected. This study reports the prevalence of the parasite (2005-2007) and epibionts (2007), and their occurrence is discussed.

MATERIAL AND METHODS

The crabs were collected off Palmahim (31°55'N 34°38'E, Israel) in 2005 (September), 2006 (May and September) and 2007 (May and October) with a 1.15 m wide beam trawl, at depths of 30-40 m.

A total of 6038 specimens were examined. Carapace width (CW), sex, presence of the parasite and number of its externae, and the presence and number of epibionts in the 2007 samples, were noted.

	September 2005		May 2006		September 2006		May 2007		October 2007	
	tot	%	tot	%	tot	%	tot	%	tot	%
					Uninfected					
M	81	15.5	143	21.2	340	26.2	428	14.8	162	25.1
F+FOV	98	18.7	139	20.7	342	26.4	447	15.4	206	31.9
Tot	179		282		682		875		368	
					Infected					
MI+ME	225	42.9	267	39.7	375	28.9	1367	47.1	164	25.4
FI+FE	120	22.9	124	18.4	239	18.4	658	22.7	113	17.5
Tot	345		391		614		2025		277	
Parasite ratio (parasite/tot)	65.8		58.1		47.4		69.8		42.9	
Total N of crabs	524		673		1296		2900		645	

Tab. I - The state of infection between sexes in *Charybdis longicollis*. M, F and FOV: respectively uninfected males, females and ovigerous females, MI and FI: males and females with internal infection; ME and FE: males and females with *externa*.

	September 2005		May 2006		September 2006		May 2007		October 2007	
N. ext.	tot	%	tot	%	tot	%	tot	%	tot	%
0	179	41.3	282	54.8	682	55.7	875	46.0	368	59.4
1	130	30.0	111	21.6	476	38.9	405	21.3	235	37.9
2	52	12.0	69	13.4	60	4.9	247	13.0	16	2.6
3	32	7.4	41	8.0	6	0.5	190	10.0	0	0.0
4	18	4.2	9	1.7	1	0.1	109	5.7	0	0.0
5	11	2.5	2	0.4	0	0.0	45	2.4	0	0.0
6	7	1.6	1	0.2	0	0.0	24	1.3	0	0.0
7	3	0.7	0	0.0	0	0.0	4	0.2	0	0.0
8	1	0.2	0	0.0	0	0.0	2	0.1	0	0.0

Tab. II - The distribution of *externae* of *Heterosaccus dollfusi* on *Charybdis longicollis*. As it is not known how many *interna* are in a internally infected crab, we excluded the categories MI and FI, the sexes are pooled.

		tot	with epibionts	%	S	Ba	Oth	preference dorsal	preference ventral
				May 2007					
	M	428	51	11.9	398	6	-	131	267
Uninfected	F+FOV	447	8	0.4	22	-	-	13	9
	tot		59	12.4					
	MI	689	0	0.0	-	-	-	-	-
	ME	678	12	1.8	208	-	1	71	137
Infected	FI	310	0	0.0	-	-	-	-	-
	FE	348	7	2.0	40	-	-	14	26
	tot		19	3.8				85	163
				October 2007					
	M	162	3	1.9	3	-	-	2	1
Uninfected	F+FOV	206	1	0.5	1	-	-	1	-
	tot		4	2.3				3	1
	MI	13	0	0.0	-	-	-	-	-
	ME	151	52	34.4	136	6	-	23	113
Infected	FI	12	0	0.0	-	-	-	-	-
	FE	101	34	33.7	88	1	-	17	71
	tot		86	68.1				40	184

Tab. III - Palmahim 2007 – Presence and number of epibionts on uninfected and infected *Charybdis longicollis*. S=serpulid, *Hydroides operculatus*; Ba=Balanomorpha, *Chelonibia patula* and *Balanus trigonus*; Oth=other, undetermined bryozoans.

		"Load" of epibionts		
		1	2	3
	Categories			
May	M + F	20	10	29
	ME + FE	3	4	12
October	M + F	4	0	0
	ME + FE	53	20	13

Tab. IV - Scoring the "load" of epibionts (1=up to 2, 2= up to 5, 3=over 5 epibionts), separated in sex categories and months (Spring and Fall catches).

		Average CW	SD	t	df	P
May	M	40.45	11.4	6.642	426	0.01
	M_{epi}	51.08	3.3			
	F	32.54	5.4	2.923	445	0.01
	F_{epi}	38.15	1.7			
	ME	33.43	5.8	5.732	676	0.01
	ME_{epi}	43.05	3.4			
	FE	33.77	5.2	2.499	346	0.02
	FE_{epi}	38.68	3.3			
October	M	45.27	5.4	1.702	160	ns
	M_{epi}	50.61	7.3			
	F	34.92	2.6	0.964	204	ns
	F_{epi}	37.43	-			
	ME	39.34	3.1	3.336	149	0.01
	ME_{epi}	37.54	3.2			
	FE	37.07	3.0	0.155	99	ns
	FE_{epi}	36.98	2.6			

Tab. V - Correlation among CW and presence of epibionts in May and October 2007 (M, F: respectively uninfected males and females; ME and FE: males and females with *externa*, $_{epi}$=with epibionts).

RESULTS

Presence of Heterosaccus dollfusi

The prevalence of the rhizocephalan differs greatly between the sexes (G=288.852, df=4, P<.001) (Tab. I). The percentage of infected crabs ranges from 42.9% (October 2007) to 69.8% (May 2007). The higher the percentage of infection, the higher the number of externae per host - in May 2007 (prevalence 69.8%), 9.7% of the infected crabs bore 4 or more externae, in September 2005 (prevalence 65.8%) 9.2% (G=17.827, df=4, P<0.01). The comparison of the externae distribution among the years is significant (G=731.232, df=16 P<.001) as well (Tab. II).

Presence of the epibionts

The crabs collected during 2007 bore serpulids identified as the Erythrean alien *Hydroides operculatus,* the barnacle *Chelonibia patula* (Ranzani, 1818), a single *Balanus trigonus*, and unidentified bryozoans (Fig. 1). The frequency of epibionts was low in both uninfected and infected crabs in May 2007, whereas in October 2007, 68% of infected crabs bore serpulids. The serpulids occurred most frequently on the crabs' thoracic sternites (G=7.063, df=1, P<0.01) (Tab. III). When the "load" of epibionts was scored (as follows: 1=up to 2, 2= up to 5, 3=over 5 epibionts), it became apparent that though in October the number of epibiont-bearing crabs was higher, the proportion of crabs bearing over 5 epibiotic specimens was higher in May (χ^2=92.779, df=5, P<0.001) (Tab. IV). Infected crabs with CW smaller than 30.9 mm and uninfected crabs smaller than 37.4 mm bore no epibionts.

A positive correlation was found between CW and presence of epibionts of both sexes, infected and uninfected in May 2007, but results are less consistent in October 2007 (Tab. V).

DISCUSSION

Our findings confirm the continued high infection levels of the SE Levantine populations of *C. longicollis* by the sacculinid *H. dollfusi* (Innocenti & Galil, 2007). The results confirm that the occurrence of multiple externae increases sharply when the incidence of infection rises above 50%. It seems that the parasite avoids settling on an already infected host when uninfected crabs are plentiful, and only does so when the chances of encountering an uninfected host are greatly reduced, as reported for *Lithodes aequispina* (Benedict, 1894) parasitized by *Briarosaccus callosus* Boschma, 1930 (Sloan, 1984), and for the blue crabs *Callinectes ssp.* infected by *Loxothylacus texanus* Boschma, 1933 (Alvarez *et al*., 2001; Alvarez & Calderon, 1996; see also Høeg, 1995).

The presence of epibionts is determined by moult interval, behaviour pat-

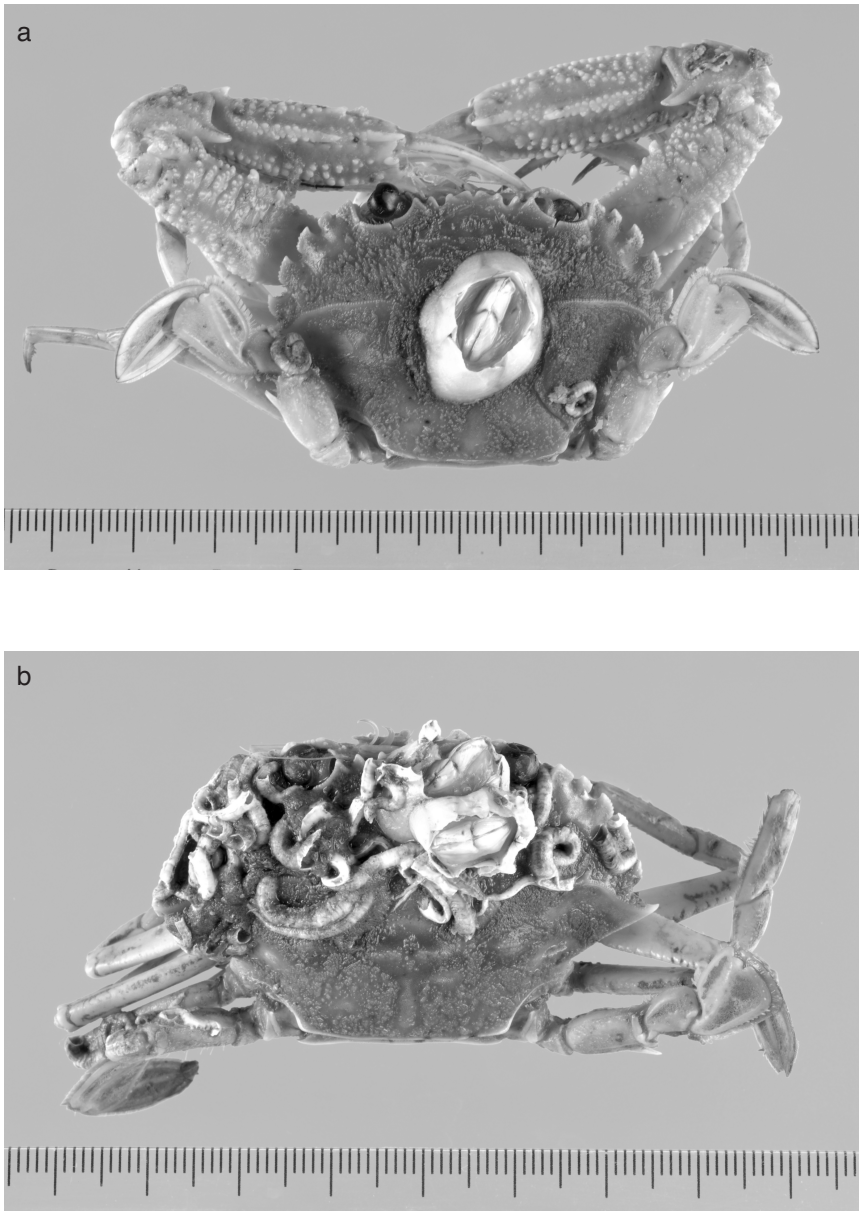

Fig. 1 - An uninfected male a) and an infected male b) of *Charybdis longicollis* covered with the serpulid *Hydroides operculatus* and the barnacle *Chelonibia patula* (photos by S. Bambi).

tern of the host and energy cost to the host (Phillips & Cannon, 1978; Bishop & Cannon, 1979; Abello *et al*., 1990, Miller *et al*., 2006). Epibionts burden their host by hampering movement thus increasing its vulnerability to predation (Overstreet, 1983), because moulting and burying protect against fouling epibionts, infected crabs are expected to bear more epibionts than uninfected ones (Gili *et al*., 1993). Moreover it has been observed that infected crabs bearing more epibionts spend more time in grooming (Bishop & Cannon, 1979). According to Miller *et al*. (2006), 85.4% of the *Charybdis japonica* (A. Milne Edwards, 1861) individuals collected in spring were fouled by large numbers of serpulid polychaetes, the fouling more abundant in males than females. They argued that more epibionts could be expected in larger specimens because their intermolt period is longer. Similar results were reported by for *Lithodes ferox* Filhol 1885, where most female specimens with carapace longer than 70 mm bore the cirripedes *Poecilasma kaempferi* Darwin, 1852 and the hydroid *Stegopoma plicatile* (Sars, 1863) (Abello & Macpherson, 1992), and for *Carcinus maenas* (Linnaeus, 1758) where the prevalence of barnacles and the serpulid polychaete *Pomatoceros triqueter* (Linnaeus, 1767) on sacculinized crabs was higher than on uninfected ones (Mouritsen & Jensen, 2006).

Our results support the significance of host size and parazitation for epibionts: year-old uninfected males (May 2007) bear a higher load of epibionts than uninfected females, probably reflecting size differentials (CW 52 vs 38 mm) and possibly moult differentials. The highly infected (70%) males and females in the May sample have a lower prevalence of epibionts. It may be that the energy cost of bearing epibionts in addition to multiple externae is too large, and such burdened individuals are more likely to perish. The epibiont load of uninfected crabs in the October sample is low and probably reflects the short moult interval, whereas the infected crabs have a high epibiont prevalence (68%) that reflects the rhizocephalan-influenced behavioural changes in the host in limiting grooming and burying. Similar results were found by Gaddes & Sumpton (2004) in *Portunus pelagicus* (Linnaeus, 1758) in specimens not infected and infected by *Sacculina granifera* Boschma, 1973 and the barnacle *Octolasmis* ssp.

Our results on epibiosis are preliminary, based on samples collected in May and October of 2007. We intend to continue the examination of both rhizocephalan infection and epibiont prevalence in the *C. longicollis* population off the Israeli coast.

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RIASSUNTO

Il granchio portunide *Charybdis longicollis*, presente in Mar Rosso, Golfo Persico e Madagascar, è stato raccolto per la prima volta nel Mediterraneo nel 1954. In poco tempo la sua popolazione ha avuto una crescita esponenziale e attualmente si ritrova nel Mediterraneo orientale, dall'Egitto a Rodi, comunemente su fondali sabbiosi tra i 25 e i 60 m, dove forma oltre il 70% della biomassa bentonica. Nel 1992 sono stati ritrovati esemplari parassitati dal rizocefalo *Heterosaccus dollfusi*, anch'esso una specie proveniente dal Mar Rosso. Il parassita provoca la sterilizzazione e il blocco della muta nel suo ospite. La presenza del parassita è stata monitorata da Settembre 2005 a Ottobre 2007 fuori Palmahim (Israele). Le variazioni stagionali nel tasso di infezione variano dal 42.9% al 69.8 %, con, in alcuni casi, un riguardevole numero di externae multiple per ospite. Nelle raccolte del 2007 sono stati osservati anche eventuali epibionti – il serpulide *Hydroides operculatus*, osservato soprattutto sugli sterniti toracici, e il balano *Chelonibia patula*. Non è stata trovata alcuna correlazione tra la presenza dei serpulidi o dei balanidi incrostanti e la presenza o il numero di rizocefali per ospite. I granchi al di sotto di una particolare taglia non portano mai epibionti.

Parole chiave: *Charybdis longicollis*, *Heterosaccus dollfusi*, alieni, epibionti, parassiti, Mediterraneo.

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