Species Composition and Diversity of Xanthoid Crabs (Decapoda: Xanthoidea) Among Dead Corals in Nhatrang Bay, South Central Vietnam

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Abstract A total of 847 xanthoid crabs were obtained from 82 dead coral samples collected in coral reefs of Nhatrang Bay during a biodiversity survey from 22 August to 22 September 2003. Areas sampled included southern and northern Mun Island, Mieu Island, Bai Bang Island, Cau Island and Tam Islan. The material consisted of 72 species among 4 families and 32 genera. Xanthidae was the most diverse and abundant family, representing 71% of all species and 92.1% of all specimens, with Chlorodiella the most dominant taxon. While the two most dominant species, *Chlorodiella corallicola* and *C laevissima*, made up only 3% of all species, they represented 54% of the total number of individuals. The Shannon index of species diversity for xanthoid crabs ranged from 2.29 to 4.21. Other indices confirm that Cau Island is the most favorable and the northern site of Mun Island the least favorable in terms of overall xanthoid diversity. The similarity of species composition among all coral reefs was about 40%. The xanthoid community structure of reef-flats among different reefs was more similar than when comparing each reef-flat with the reef-slope of the same coral reefs.

Key words: Xanthoid crabs, species composition, diversity, Nhatrang Bay, Vietnam

Introduction

Xanthoid crabs (superfamily Xanthoidea) are a group of Brachyura rich in genera and species within the Indo-West Pacific (Serène, 1984). While found in various types of habitats, most xanthoid crabs live subtidally among dead coral. Some of these crabs have been noted as indicators of coral reef conditions (Abele and Patton, 1976; Austin *et al*., 1980). Xanthoids crab taxonomy and distribution have been investigated in Vietnam since the mid 20th century (Dawydoff, 1952; Serène and Bui Thi Lang, 1959; Serène and Nguyen Van Luom, 1958, 1959, 1960; Serène, 1962).

Nhatrang Bay (12°08´-12°18´ N to 109°10´-109°24´ E) is located in the southern coast of Central Vietnam and includes many islands and coral reefs. This area is excellent for studies on marine diversity because it is relatively undisturbed and relatively rich in biodiversity. Given these circumstances, the aims of this study were to provide information on the distribution and diversity of xanthoids crabs among dead corals in the reefs of Nhatrang Bay, and to contribute to the literature of faunal community structure of coral reefs. This study is a part of a project investigating the biodiversity of Nhatrang Bay, Vietnam.

Materials and Methods

Xanthoid crabs were collected at six coral reefs in Nhatrang Bay in South Central Vietnam. The location of the reefs is as follows (Fig. 1): 1, Cau Island (12°17´06´´N, 109°22´05´´E); 2, Bai Bang (12°13´17´´N, 109°19´27´´E); 3, northern Mun Island (12°10´15´´N, 109°17´59´´E); 4, southern Mun Island (12°10´02´´N, 109°17´47´´E); 5, Tam Island (12°10´18´´N, 109°13´30´´E); 6, Mieu Island (12°10´58´´N, 109°14´00´´E). At each of the six study sites, two 100-meter-long transect tapes were laid on the reefs parallel with the seashore, one on the reef plateau (shallow transect, from 1 - 5 m) and

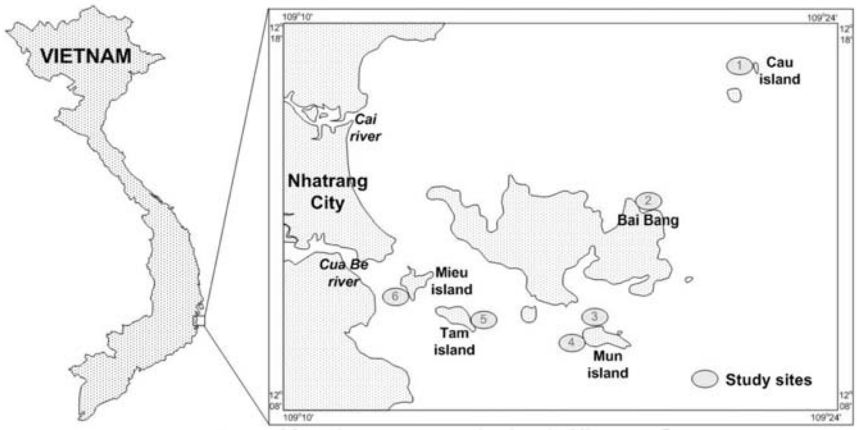

Fig.1. Map showing the study sites in Nhatrang Bay.

the other on the reef slope (deep transect, from 5-12m). A diver used a $0.1m^2$ benthic frame to collect samples along transects, at approximately 15m intervals; the collected layer of dead coral was about 5-10cm deep. On each transect, seven samples were collected, except from the deep transects on the northern and southern sites of Mun Island where only 6 samples were collected. In total 82 samples were collected. Crabs sorted out from collected samples were preserved in 75% alcohol. Xanthoid species were identified following Sakai (1976), Serène (1984) and Dai Ai-yun and Yang Si-liang (1991).

Sanders (1960) utilized a rating system to provide a "biological index" which was adopted for the present study. The index value of a species is determined by ranking the taxon from 1 to 10 based on relative abundance within each sample. The most abundant species is given a rank of 1 and a value of ten points; the species with rank 2, nine points; rank 3, eight points, etc. Thus a species ranked first in all 82 samples would have 820 points, the highest possible score. Relative dominance and commonality can be measured by examining the biological index and the frequency of occurrence for each species.

As a measure of biodiversity pattern, similarities in the species composition between study sites and sampling transects were estimated by the Bray-Curtis index. These study sites and sampling transects were clustered on the basis of the index. The species diversity was estimated using the Shannon and Wiener index (H'), species dominance by the Simpson index (C) and species evenness by the Pielou index (J'). Calculations of indices and cluster analysis were performed with PRIMER 5 (Primer-E Ltd.), while the statistic tests were done using Excel (Microsoft).

Results

Species composition

The material collected from coral reefs in Nhatrang Bay consisted of 847 specimens of xanthoid crabs identified from 82 dead coral samples. These taxa included 72 species among 32 genera and 4 families (Table 1). Among the four families found, the most abundant was Xanthidae with 780 individuals, representing over 90% of the total xanthoid abundance. The Xanthidae found included 51 species among 21 genera, representing circa 71% of all xanthoid species found. Conversely, only one carpiliid crab was found during the survey. Pilumnidae had 58 individuals including 16 species among 8 genera and there was 8 trapezid crabs including 4 species between 2 genera. On shallow transects xanthoid crabs were represented by 574 individuals, compared to 273 on deep transects. Xanthidae

Table 1. Xanthoidea found among dead coral of Nhatrang Bay in August-September 2003.

Family	Individuals		Transect		Genera		Species	
	Total	%	shallow	deep	Total	%	Total	%
Xanthidae	780	92.1	539	241	21	65.6	51	70.8
Pilumnidae	58	6.8	5	3	8	25.0	16	22.2
Trapezidae	8	0.9	29	29	2	6.3	4	5.6
Carpiliidae	1	0.1	1	0	1	3.1	1	1.4
Total	**847**		**574**	**273**	**32**		**72**	

Table 2. Top ten abundance-ranked species of xanthoid crabs, based on biological index, found in dead coral at studied coral reefs.

Species	Rank by biol. index	Biological index value							Frequency as one of ten most common species										Frequency	
		Total	Bai Bang	Cau Island	Northern Mun Island	Southern Mun Island	Tam Island	Mieu Island	1	2	3	4	5	6	7	8	9	10	No.	(%)
Chlorodiella corallicola	1	463	85	78	100	96	46	58	34	7	5	2	1						49	60
Chlorodiella laevissima	2	378	56	71	51	101	52	47	16	15	7	3	1						42	51
Psaumis cavipes	3	204	24	52	25	51	25	27	2	9	1	1	1	2					16	30
Etisus ohdneri	4	172	50	41	9	33	22	17	5	6	3	2	5						21	26
Etisus armatus	5	127	0	0	38	0	52	37	6	5	1	2							14	17
Chlorodiella nigra	6	79	0	0	10	8	33	28	4		4	1							9	11
Pilodius sp.	7	77	10	17	0	18	23	9	2	5		1		1					9	11
Actumnus setifer	8	71	43	0	0	9	19	0	2	4	1	1							8	10
Paramedaeus noelensis	9	67	27	40	0	0	0	0	2	2	2	1	1						8	10
Nanocassiope alcocki	10	63	9	21	10	23	0	0	1	2	2	1	2						8	10

was the most abundant family in both shallow and deep transects. There were 6 xanthoid species found, representing 1.3% of all individuals that are considered symbionts of living corals. They were the xanthids *Lybia leptochelis*, *Lybia tessellata*, and the trapeziids *Tetralia heterodactyla fusca, Trapezia cymodoce, Trapezia flavopunctata, Trapezia guttata* (see Appendix).

Dominant species

The biological index value and the frequency of a given species appearing as one of the 10 most abundant species are presented in Table 2. Among the top ten ranked species, *Chlorodiella corallicola* and *Chlorodiella laevissima* dominate, each of these species being represented among the ten most common species in 50% or more of the samples. A separate analysis for deep (Table 3) and shallow

Table 3. Top ten abundance-ranked species of xanthoid crabs from deep transects.

Species	Rank by bio. index	Biological index value	Frequency as one of ten most common species										Frequency	
			1	2	3	4	5	6	7	8	9	10	No.	(%)
Chlorodiella corallicola	1	171	13	3	1		1						18	45
Chlorodiella laevissima	2	155	7	6	3	1							17	43
Psaumis cavipes	3	75		4	4	1							9	23
Etisus ohdneri	4	74	3	4	1								8	20
Paramedaeus noelensis	5	57	1	2	2	1	1						7	18
Actumnus setifer	6	54	2	3		1							6	15
Etisus armatus	7	47	2	3									5	13
Chlorodiella nigra	8	38	3		1								4	10
Nanocassiope alcocki	9	32		2	1		1						4	10
Heteropilumnus sp.	10	29	2	1									3	8

Table 4. Top ten abundance-ranked species of xanthoid crabs from shallow transects.

Species	Rank by bio. index	Biological index value	Times as one of ten most common species										Frequency	
			1	2	3	4	5	6	7	8	9	10	No.	(%)
Chlorodiella corallicola	1	292	21	4	4	2							31	74
Chlorodiella laevissima	2	223	9	9	4	2	1						25	60
Psaumis cavipes	3	129	2	5	6		1	2					16	38
Etisus ohdneri	4	98	2	2	2	2	5						13	31
Etisus armatus	5	80	4	2	1	2							9	21
Etisus goldeffroyi	6	52	2	3				1					6	14
Pilodius sp.	7	50	2	2		1		1					6	14
Chlorodiella nigra	8	41	1		3	1							5	12
Nanocassiope alcocki	9	32		2	1		1						4	10
Heteropilumnus sp.	10	29	2	1									3	7

Table 5. Ecological indices of xanthoid crabs of surveyed coral reefs of Nhatrang Bay.

Parameter	Cau Island	Bai Bang	Northern Mun Island	Southern Mun Island	Tam Island	Mieu Island
No. of species (S)	29	17	22	30	26	19
No. of individuals	120	123	141	234	142	87
Density (ind./m2) (D)	92	95	108	180	109	67
Species diversity index (H')	4,24	3,09	2,29	2,74	3,69	3,52
Species evenness index (J')	0,87	0,75	0,51	0,56	0,78	0,83
Species dominance index (C)	0,07	0,17	0,43	0,27	0,12	0,12

transects (Table 4) show similar results. Other species with high-ranking scores are *Psaumis cavipes* and *Etisus ohdneri* but fewer individuals were found and they did not rank high as often. A comparison of these four species along the shallow and deep transects shows that they are more abundant in shallow areas, the difference being especially pronounced for *C. corallicola* and *C. laevissima*. *Paramedaeus noelensis* and *Actumnus setifer* were not among the top ten ranking taxa in shallow transects, nor were *Etisus goldeffroyi* and *Pilodius* sp. ranked highly in deep transects.

Diversity analysis

Table 5 lists the number of species (S), abundance, density (D), and species diversity (H'), species evenness (J'), and dominance (C) indices of xanthoid crabs living among dead coral of Nhatrang Bay study sites. While the southern site of Mun Island had the highest number of species, the species diversity index was highest in Cau Island, decreasing for Tam Island, Mieu Island, Bai Bang, southern Mun Island, and lowest at northern Mun Island with a value about half that of Cau Island. The species evenness values in Cau Island, Mieu Island, Tam Island and Bai Bang are similar (from 0.75 to 0.87) but considerably lower southern and northern sites of Mun Island (0.51 - 0.56). The species dominance index, on the other hand, indicates highest values for both Mun Island sites, but especially noticeable in the northern part of the island.

Similarity of species composition between study sites and among sampling transects

Using the Bray-Curtis similarity co-efficient on square root transformed abundance data; cluster analysis resulted in the study sites being classified into two groups at a similarity level of greater than 40% (Fig. 2). The first group includes the xanthoid groups of Mieu Island, Tam Island and northern Mun Island. Among that group, species compositions of the near shore sites of Mieu Island and Tam Island have the greatest similarity. The second cluster comprises the xanthoid groups of Cau Island, Bai Bang and southern Mun Island. Among these, the offshore sites of Cau Island and Bai Bang have the greatest similarity. Results show that there are two distinct groups of xanthoids representing nearshore (Mieu Island, Tam Island) and of offshore sites (Cau Island, Bai Bang), with southern and northern Mun Island sites representing an intermediate region.

The results of similarity indices of species composition in sampling transects (Fig. 3) are more complex. With the exception of Cau Island, where deep and shallow transects (1D, 1S), are similar, other study sites show a distinct difference between deep and shallow transects. For shallow transects, the community structure of xanthoid crabs of Mieu Island and northern Mun Island (6L, 3L), and southern Mun Island and Tam Island (4L, 5L) form a separate and distinct group with greater than 50% similarity. Among deep transects, northern Mun Island and Mieu Island (3D, 6D) and southern Mun Island and Bai Bang (4D, 2D) form distinct clusters at greater than 50% similarity. The results

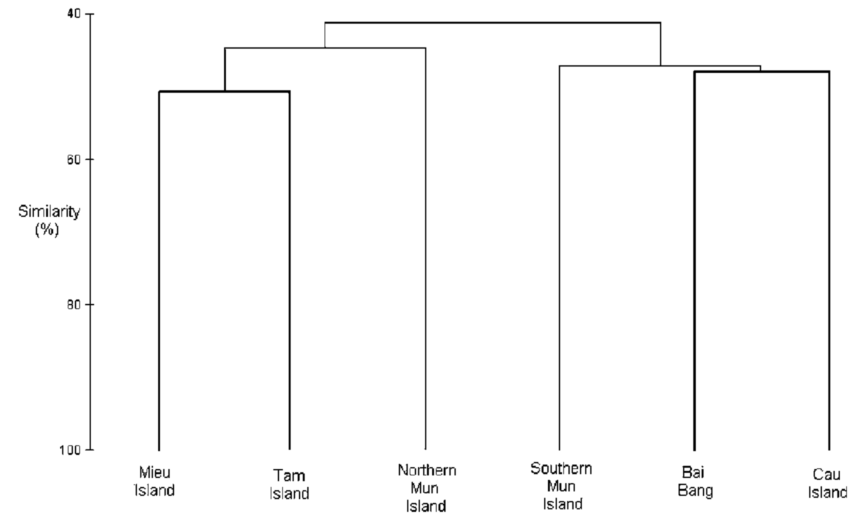

Fig.2. Cluster analysis of similarity indices showing xanthoid crab groupings of Nhatrang coral reefs.

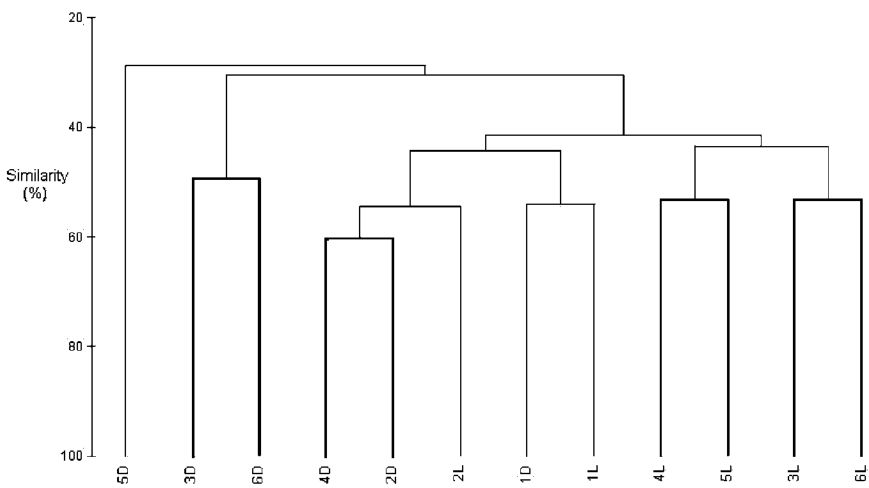

Fig.3. Cluster analysis of similarity indices showing xanthoid crab groupings of sampling transect. 1: Cau Island, 2: Bai Bang, 3: northern Mun Island Mun, 4: southern Mun Island, 5: Tam Island, 6: Mieu Island, L: shallow transect, D: deep transect

indicate that in these coral reefs, the species composition of xanthoid crabs among flat parts of the reef, i.e. shallow transects, are more similar than flat and slope, or deep transects of the reef.

Discussion

The present study found 72 species among 32 genera and 4 families of xanthoid crabs in six coral reefs of Nhatrang Bay. This represents a disproportionate number when compared to the recorded 114 species among 40 genera of xanthoid crabs recorded for all of Vietnam (Nguyen *et al.,* 1978). In Nhatrang Bay two species of Chlorodiella; *C. corallicola* and *C. laevissima* comprised more than half of all collected specimens and thus represent the dominant taxa among dead coral. The relatively low abundance of species of Trapezia (*T. cymodoce, T. flavopunctata, T. guttata*), Tetralia (*T. heterodactyla fusca*) and Lybia (*L. leptochelis, L. tessellata*), which are considered to be symbionts of living corals, is likely due to are few living corals mixed in with the collected material.

The lower species dominance of xanthoid crabs in Cau Island, Mieu Island, Tam Island and Bai Bang (0.07-0.17), combined with higher diversity index values (3.09-4.24), indicate that conditions, such as habitat diversity, may be more favourable for xanthoid crabs in those locations. Conversely, low species diversity and evenness indices, and a relatively high species dominance index were observed at Mun Island, especially at the northern site. Conditions at this island thus are less favorable for xanthoids in general but quite tolerable for the two species of Chlorodiella, that were very abundant in both northern and southern sites of Mun Island and made up at least 70% of all individuals. The similarity at species level in the study sites was about 40% and there was difference between near shore sites (Mieu Island - Tam Island) and offshore sites (Cau Island - Bai Bang) from the intermediate region Mun Island. The xanthoid community structure of reef-flats among different reefs was a more similar to each other than when comparing each reef-flat with the reef-slope within the same coral reef. This indicates that environment and habitat, such as depth and coral reef morphology, are key components determining the distribution of these crabs.

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Appendix:

Species list of xanthoid crabs found among dead coral of Nhatrang Bay in August-September 2003.

Family	Species	No. of ind.	Study sites						Transect	
			Northern Mun Island	Bai Bang	Cau Island	Mieu Island	Tam Island	Southern Mun Island	Shallow	Deep
Carpiliidae	Carpilius convexus	1				1			1	
Total Carpiliidae							1			1
Pilumnidae	*Actumnus dorsipes*	2			2					2
	Actumnus intermedius	1				1			1	
	Actumnus setifer	11		7			3	1	4	7
	Actumnus squamosus	8			7		1		3	5
	Actumnus tomentosus	1			1					1
	Glabropilumnus sp.	5				3	2		1	4
	Globopilumnus globosus	1						1	1	
	Heteropilumnus ciliatus	1		1						1
	Heteropilumnus sp.	3	1			2				3
	Parapilumnus coralliophilus	3		3					3	
	Parapilumnus sp.	1					1			1
	Pilumnopeus marginatus	3					3		3	
	Pilumnus minutus	5					3	2	5	
	Pilumnus sp.	5					4	1	5	
	Pilumnus vespertilio	2				2				2
	Planopilumnus labirinthius	6					6		3	3
Total Pilumnidae		29	1	11	10	8	23	5		29
Trapezidae	*Tetralia heterodactyla fusca*	2		1		1				2
	Trapezia cymodoce	1						1	1	
	Trapezia flavopunctata	3						3	3	
	Trapezia guttata	2			2				1	1
Total Trapezidae		3		1	2	1		4		5
Xanthidae	*Actaea perspinosa*	6			1		1	4	4	2
	Actaea sp.	1	1						1	
	Actaeodes areolata	1						1	1	
	Chlorodiella corallicola	278	91	25	18	20	22	102	219	59
	Chlorodiella laevissima	177	8	39	18	13	35	64	109	68
	Chlorodiella nigra	35	3			10	21	1	23	12
	Etisus albus	3	2			1			3	
	Etisus anaglyptus	2						2	2	
	Etisus armatus	32	11			10	11		26	6
	Etisus demani	1			1					1
	Etisus electra	1	1							1
	Etisus frontalis	2	2							2
	Etisus goldeffroyi	13		5		8			13	
	Etisus ohdneri	41	1	17	9	2	5	7	24	17
	Etisus sakai	1		1					1	
	Etisus sp.	9	5		4				6	3
	Etisus sp.A	4	2			1		1	1	3

Family	Species	No. of ind.	Study sites						Transect	
			Northern Mun Island	Bai Bang	Cau Island	Mieu Island	Tam Island	Southern Mun Island	Shallow	Deep
Xanthidae	*Euxanthus* sp.	1	1							1
	Hypocolpus granulata	5		2		1		2	3	2
	Leptodius gracilis	2	1		1				1	1
	Liocarpilodes armiger	8	2		5			1	2	6
	Liomera caelata	4					3	1	4	
	Liomera laevis	1				1				1
	Liomera monticulosa	1					1			1
	Liomera pediger	2			1		1			2
	Liomera rugata	1			1					1
	Lybia leptochelis	1					1			1
	Lybia tessellata	3			2			1	2	1
	Medaeops granulosus	1						1	1	
	Metaxanthops acutus	1					1			1
	Nanocassiope alcocki	9	1	1	3			4	5	4
	Paractaea rufopunctata f. intermedia	1					1			1
	Paramedaeus noelensis	11			6	5			1	10
	Paramedaeus sp.	2		1	1				2	
	Paraxanthias notatus	1							1	1
	Paraxanthodes sp.	2		1			1		1	1
	Pilodius aff. Spinipes	1						1		1
	Pilodius flavus	5	1		2		1	1	4	1
	Pilodius melanospinis	7	1	2	3			1	4	3
	Pilodius pilumnoides	1	1						1	
	Pilodius pugil	2			2				2	
	Pilodius sp.	20		5	4	3	5	3	15	5
	Pilodius sp.1	6			2		1	3	2	4
	Pilodius sp.2	8			7				1	8
	Pilodius sp.3	2			2					2
	Pilodius spinipes	6			6					6
	Psaumis cavipes	44	3	6	8	5	4	18	32	12
	Pseudoliomera variolosa	10	1		1	1	4	3	9	1
	Xanthias aff. Maculatus	2				2				2
	Xanthias lamarcki	1							1	1
	Xanthias maculata	1	1							1
Total Xanthidae		780	140	111	108	78	118	225	539	241
Total Xanthoidea		847	141	123	120	87	142	234	574	273