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Diversity and Abundance of Intertidal Crabs at the East Swamp-Managed Areas in Segara-Anakan Cilacap, Central Java, Indonesia

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Abstract

Mangrove forests possess a high diversity and abundance of crabs in Central Java. The conservation of mangrove forests into prawn ponds causes depletion of supply of river sediments and loss of property. The main objective of this study is to compare the diversity and abundance of intertidal crabs in undisturbed, crab hunting, logging and prawn pond areas that were different in percent mangrove canopy covers and percent sediment textures. In each area, two transect lines were installed to analyse the percent mangrove canopy cover, and also the percent sediment texture comparing to trilinier plot.
In total, 16,353 intertidal crab individuals in 13 species were sampled. Differences in observed number and estimated number of species (ACE, Chao1), as well as number of individuals, diversity indices and evenness between the four studied mangrove areas were all highly significant. Monthly fluctuation of intertidal crab diversity was more constant in the undisturbed area with a high mangrove coverage (90%) compared to the crab hunting, the logging and the prawn pond area with a coverage of 89%, 33% and 0%, respectively. Intertidal crab abundance was equal in the undisturbed, the crab hunting and the logging area, but significantly lower in the completely deforested prawn pond area.
These results underline the necessity for a combination of economic and natural resource management. Silvofishery leading to the complete clear-cutting of mangrove trees (as in the prawn pond area) leads to a highly impoverished crab community both in terms of crab individuals and species. Furthermore, the maintenance of the undisturbed area should be a primary objective for the management, since it represents a more constant crab diversity and highest abundance, and sustains the protection of rare species such as *Neosermatium sp*.

Introduction

Mangrove forests possess a high diversity of benthos habitats (ALONGI, 1990) and grow in the tropics with shallow waters in a continental shelf or penetrating river banks (TOMLINSON, 1999). In Segara-Anakan Cilacap, Central Java, Indonesia, mangrove forests grow in river banks and harbour crabs such as *Scylla serrata*, *S. paramamosain*, *S. olivacea*, *Thalamita crenata*, *Myomenippe hardwickii, Metaplax elegans*, *Metopotograpsus frontalis*, *Neosermatium sp*., *Perisesarma sp*., *Macrophthalmus crinitus*, *Uca bellator*, *U.*

chlorophthalmus, *U. coarctata*, *U. demani*, *U. dussumieri*, *U. rosea*, *U. triangularis* and *U. vocans*. Some of these are intertidal crabs such as the last thirteen species.

Unfortunately, ongoing destruction and deforestation of mangroves leads to decreases in mangrove coverage at the east swamp-managed areas. There are many human activities such as crab hunting (e.g. *Scylla olivacea*, *S. paramamosain* and *S. serrata*). Historically, local people tend to choose sand silty clay for crab hunting areas because the sediment is harder than silty clay. Characteristic for the crab hunting area is mounting sediment resulting from digging crustacean such as *Thalassina anomala.* Other activities such as illegal logging (fuel wood, charcoal and building material) and installing ponds (prawns and crabs) are equally carried out by the "Kampung Laut" people living in Segara-Anakan Cilacap.

Because of destruction and deforestation, Segara-Anakan Cilacap management areas have been divided into two sectors: the west swamp-managed and the east swamp-managed area. To conserve mangrove as a habitat for species, the Cilacap Government installed swamp-protected areas in the east swamp-managed area. In the west swamp-managed areas, there are prawn pond areas of 470 ha in size (HANLEY, 2000). HANLEY (2000) recommended a rehabilitation program including a silvofishery approach, and proposed that mangrove forest is established in the centre of ponds without clear ownership. Even so, the State Forest Corporation followed this approach and have a program of rehabilitation of degraded areas in the west swamp-managed and east swamp-managed areas where *Bruguiera gymnorrhiza* and *Rhizophora apiculata* are planted.

SUCGANG (1994) illustrated that the conversion of mangrove forest into prawn ponds causes coastal erosion, wet inundated lands, intrusion, depletion of supply of river sediments, flooding, damages to infrastructure and loss of property. Moreover, owing to the continued increase in installing prawn ponds, organic and inorganic material accumulation into sediment and water will take place. After harvesting, sediments remain on the ground of the pond. In addition, polluted water is discharged directly to surrounding waters (SANSANAYUTH ET AL., 1996). Loss of biodiversity is regularly identified as one of the greatest environmental risks facing mankind as a result of anthropogenic disturbances. Legislation has been proposed to preserve biodiversity and governments have been urged to approach this issue. An international treaty for the conservation of biodiversity has been negotiated (JUTRO, 1993).

The main objective of this study is to compare the diversity and abundance of intertidal crabs in the undisturbed, the crab hunting, the logging and the prawn pond area. They were different in the percent mangrove canopy cover and the sediment texture.

Study area and methods

In Segara-Anakan Cilacap management areas, the number of mangrove forests is highest in the east swamp-managed area (4,905 ha), followed by the west swamp-managed area (202 ha) and the Nusa Kambangan area (26 ha). Even though, the west swamp-managed area cover a larger area (9,565 ha) than the east swamp-managed areas (4,905 ha). The total are covered by the Nusa Kambangan Island area is largest (11,016 ha), and these areas are dominated by primary forests (9,934 ha) because it serves as Prison Authority. Overall the east swamp-managed area has a highest number of mangrove forest coverage (95%), mainly located in the swamp-protected areas (3,666 ha or 75%).

In the east swamp-managed areas, this research was done at swamp-protected and swamp-production areas. The undisturbed and the crab hunting area were located in the swamp-protected area, whereas the logging and the prawn pond area were in the swamp-production area. Then, two transects were installed per area (Figure 1).

Samples were taken monthly from October 2000 to January 2002. In these periods, intertidal crabs were collected when they acted on the surface only during periods of tidal emersion (low tide), during daylight hours, and burrows tend to contain only a single individual (WARREN, 1990). Intertidal crab samples were taken at random by digging out one-ninth of a square metre (0.33 m²) to a depth of about 20 cm with a spade. The block of sediment was then dug out and examined carefully. Twenty samples (1 transect x 20 samples) were taken (SASEKUMAR, 1974).

Intertidal crabs were preserved using a suitable fixative of 70% alcohol and identified (CANNICCI ET AL., 2000; CARPENTER AND NIEM, 1998; CRANE, 1975; DAI AND YANG, 1991; DAVIE, 1994; HARMINTO, 1988; TWEEDIE, 1936; TWEEDIE, 1937; TWEEDIE, 1940; TWEEDIE, 1948; AND TWEEDIE, 1950). All samples were verified at the Raffles Museum of Biodiversity Research, the National University of Singapore from 21st to 27th February 2001 and analysed by the program "EstimateS" 6.0b1a to get information on diversity indices (COLWELL, 2000).

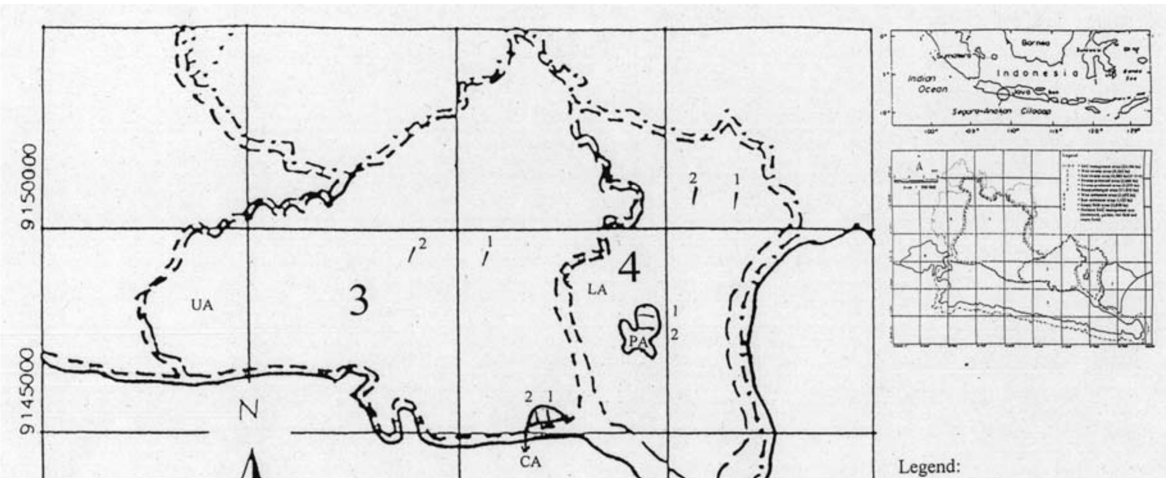

Figure 1: Location of the study area in SAC management areas, especially in the swamp-protected and the swamp-production areas, and schematic map of the total study plot (4,905 ha).

In each area, a total of two transect lines were installed to analyse the percent mangrove canopy cover (WOOD, 1988). Sediment samples were collected by sediment cores (MURDOCH ET AL., 1997) and analysed by wet sieving for determining sediment composition (KRAMER ET AL., 1994). The sediment composition (in percentage) was compared to a trilinier plot to get information on the sediment texture (RAO and SARMA, 1993).

Result and discussions

In total, 16,353 intertidal crab individuals in 13 species were sampled in all areas: *Metaplax elegans*, *Metopotograpsus frontalis*, *Neosermatium sp*., *Perisesarma sp*., *Macrophthalmus crinitus*, *Uca bellator*, *U. chlorophthalmus*, *U. coarctata*, *U. demani*, *U. dussumieri*, *U. rosea*, *U. triangularis* and *U. vocans*. Nine species were captured in the undisturbed area, 13 species in the crab hunting and 10 species in the logging and the prawn pond areas. Of the 13 intertidal crab species recorded, 4 (the first four species list above) belonged to family Grapsidae (31%) and 9 species (the following nine species) belonged to family Ocypodidae (69%). Of the 9 Ocypodid species recorded, 8 belonged to the dominant genus *Uca* (89%, see also Table 1).

Table 1: Intertidal crab (burrowing crabs live in sediments) composition represent *Metaplax elegans* as dominant species in undisturbed and logging areas. This dominant species drives *Neosermatium sp.* in the undisturbed area. *Macrophthalmus crinitus* as a dominant species in the crab hunting area may influences *Neosermatium sp.* and *Uca chlorophthalmus*. *Metopograpsus frontalis* is not a rare species because this species only lives in mangrove trees as climbing crabs. Number of samples is 2,560 units (20 sampling unit x 4 areas x 2 transects x 16 months).

Species	Local name	Undisturbed areas	Crab hunting areas	Logging areas	Prawn pond areas	Total abundance
Metaplax elegans	Yuyu	3,338	394	3,384	330	7,446
Metopograpsus frontalis	Yuyu	0	2	0	0	2
Neosermatium sp.	Yuyu	9	2	0	0	11
Perisesarma sp.	Yuyu	185	192	74	330	781
Macrophthalmus crinitus	Yuyu	0	2,031	4	9	2,044
Uca bellator	Yuyu	964	782	724	652	3,122
Uca chlorophthalmus	Yuyu	0	4	0	0	4
Uca coarctata	Yuyu	176	385	243	258	1,062
Uca demani	Yuyu	172	324	253	190	939
Uca dussumieri	Yuyu	57	48	44	61	210
Uca rosea	Yuyu	52	102	26	16	196
Uca triangularis	Yuyu	0	120	1	3	124
Uca vocans	Yuyu	125	52	167	68	412
Total abundance		5,078	4,438	4,920	1,917	16,353
Total species		9	13	10	10	13

Of the13 intertidal crab species collected, 2 could be classified as dominant species: *Metaplax elegans* and *Macrophthalmus crinitus*. The first dominant species drives *Neosermatium sp*. in the undisturbed area (Table 1). *Metaplax elegans* as a dominant species has characteristic as described in Robinowitz's three-way classification of rarity (Magurran, 1988) such as a wide geographic distribution, a restricted habitat specifity and a large local population size. *Neosermatium sp*. gives the classification as a rare species, because of its narrow geographic distribution, a restricted habitat specifity and a small local population size (Table 2), especially in the undisturbed area (Table 1). Both species share the same habitat specifity. Hence, *Metaplax elegans* may drives *Neosermatium sp*. in the undisturbed area. Possibly, the sediment may play a role as an appropriate habitat for the dominant species *Metaplax elegans* because the sediment of the undisturbed and the logging area are both silty clay in the mangrove and shore sediment, whereas the crab hunting and the prawn pond area are sand silty clay in the mangrove sediment and clayey sand in the shore sediment.

Table 2: The Robinowitz's three-way classification of rarity. There are three rare species at the study sites: *Neosermatium sp*., *Uca chlorophthalmus* and *Metopograpsus frontalis*.

Geographic distribution	Wide		Narrow	
Habitat specifity	Broad	Restricted	Broad	Restricted
Local population size:				
Somewhere large	*Uca bellator*	*Metaplax elegans* *Macrophthalmus crinitus*	*Perisesarma* sp. *Uca coarctata* *Uca demani* *Uca dussumieri* *Uca rosea* *Uca vocans* *Uca triangularis*	
Everywhere small	_	_	_	*Neosarmatium sp.* *Uca chlorophthalmus* *Metopograpsus frontalis*

Differences in observed number and estimated number of species (ACE, Chao1), as well as number of individuals, diversity indices and evenness between the four studied mangrove areas were all highly significant (ANOVA, $F_{1,2}(3,124) > 14.05$ and $p < 0.000$). Monthly fluctuation of intertidal crab diversity (Figure 3) was more constant in the undisturbed area with a high mangrove coverage (90%) compared to the crab hunting, the logging and the prawn pond area with a coverage of 89%, 33% and 0%, respectively. Intertidal crab abundance (Figure 3) was equal in three areas (Tukeys HSD-test, $p > 0.2$ in all cases), but significantly lower in the completely deforested prawn pond area (Tukeys HSD-test, $p < 0.000$ in all cases) (Figure 4). This negative trend can be reversed if a model of silvofishery can be established which contributes to the conservation of mangroves (ecological perspective) and to culturing fish products (economic perspective) at the same time (SASTRANEGARA and ROSYADI, 2003). Unfortunately, silvofishery leading to the complete clear-cutting of mangrove trees (as in the prawn pond area) leads to a highly impoverished crab community both in terms of crab individuals and species.

Conclusion and recommendation

These results underline the necessity for a combination of economic and natural resource management. Silvofishery leading to the complete clear-cutting of mangrove trees (as in the prawn pond areas) leads to a highly impoverished crab community both in terms of crab individuals and species. Furthermore, the maintenance of the undisturbed area should be a primary objective for the management, since it represents a more constant crab diversity and highest abundance, and sustains the protection of rare species such as *Neosermatium sp*.

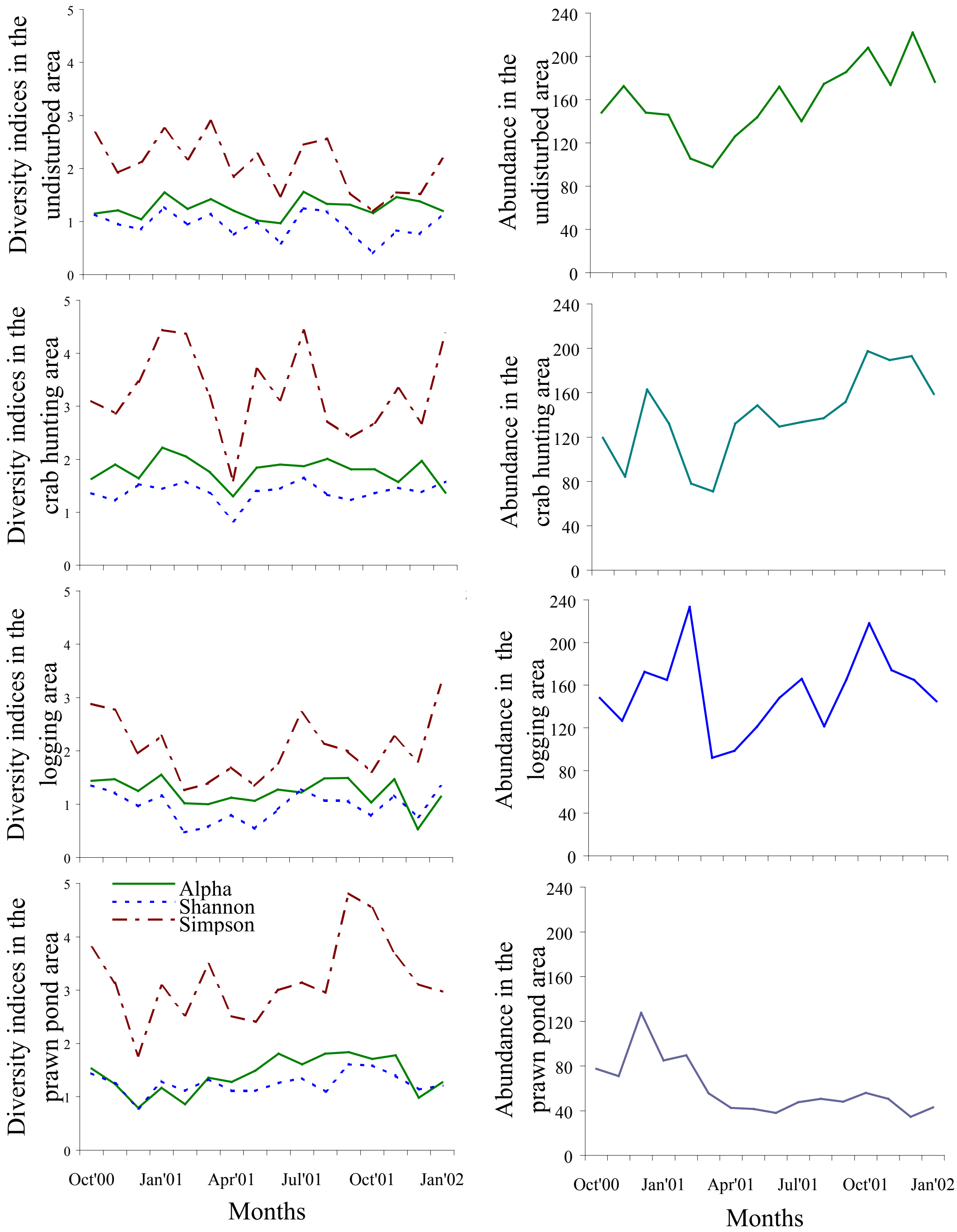

Figure 3: Intertidal crab diversity (left) and abundance (right). Diversity was more constant in the undisturbed area compared to the others, and its abundance was highest. Number of samples is 16 in each area as time series.

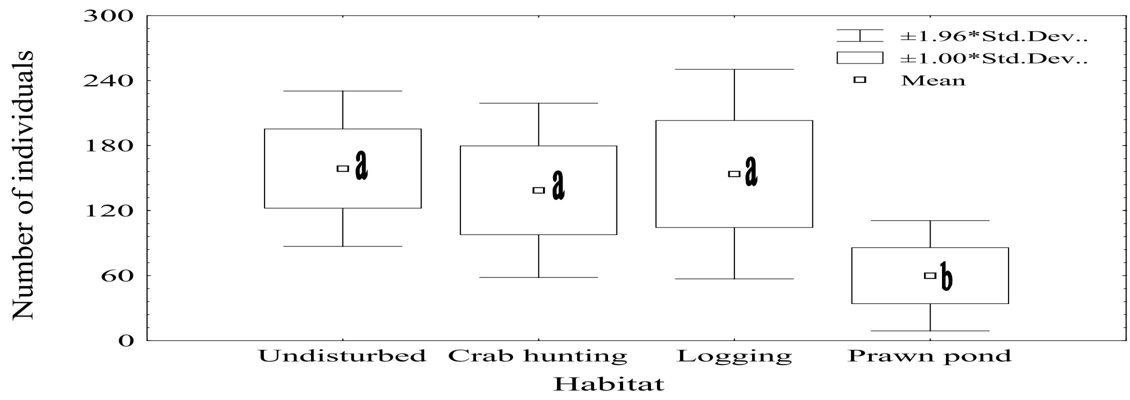

Figure 4: Box-Whisker-Plot with Tukeys HSD-test information on number of individuals in the undisturbed, crab hunting and logging areas relatively having the same number, whereas prawn pond area has significantly lower number compared to the first three areas. Number of samples is 32 in each area.

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