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INFLUENCES OF WAVE ACTION ON SHELL SHAPE OF MARINE SNAIL *NERITA PLICATA* AND OIL SPILL ON MARINE COASTAL ENVIRONMENTS

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Abstract

Influences of wave action on shell shape of marine intertidal snail *Nerita plicata* and oil spill on marine coastal environments were investigated in Ulithi Atoll, Yap State, Federation of States of Micronesia. Twenty species of marine snails were observed in the intertidal areas in Ulithi Atoll. Aperture mouth size of *N. plicata*, which was the most common snail in Ulithi Atoll was significantly different between smaller and larger snails but not between wave exposed area and sheltered area. However shell shape was significantly different between smaller and larger snails and between exposed area and sheltered area. These results suggested that shell shape and aperture size of *N. plicata* were affected by different factors.

Six Polycyclic Aromatic Hydrocarbons (PAHs) components (fluorine, phenanthrene, anthracene, fluoranthene, pyrene and chrysene) in surface seawater, sand and marine snails *N. plicata* in Ulithi Atoll where oil spill had happened from a sunken ship in August 2001 showed lower value. Although concentration of benzo (a) pyren in surface seawater and sand showed lower value, that of marine snails showed about six times higher concentration than snails in not-polluted area. I discussed the possibility of the influences by oil spill to the lives in coastal area.

Keywords: benzo (a) pyren, Micronesia, *Nerita plicata*, oil spill, Ulithi Atoll, wave action

Introduction

Many environmental conditions in intertidal area are rapidly changing in a short period. Therefore, this is one of harsh area for animals and plants to inhabit. However, many animals and plants adapted to these environmental conditions very much and much number of them inhabited in this area. Many researchers have studied the mechanisms and systems of their adaptation on these environment conditions such as wave action, predator, temperature, desiccation, light, etc (ex. LITTLE and KITCHING 1996; RAFFAELLI and HAWKINS 1996). Wave action was one of the important factors to influence on shell shape of the snails and shell shape was highly correlated to strength of wave force (ex. ETTER 1988).

Recently environmental pollution by oil spill became a big problem in the world (ex. PETERSON 1993). Oil spill has happened from a sunken oil tanker in August 2001 near Falalop Island, Ulithi Atoll, Micronesia (SALAS 2001). The ship was sunken by Japanese submarine "Kaiten" in World War II. The leaking point of sunken ship was soon filled up but some amount of oil was leaking to Atoll. Two weeks later, most of the oil spill from the ship was gone through to open sea beside Asor and Falalop Islands. But there is not any research about influence of oil

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leaking on the animals.

There are three purposes on this paper: 1) to investigate species of marine snails in intertidal area in Ulithi Atoll, 2) to study the influence of wave action on the shell shape and aperture mouth of *N. plicata*, which is the most common species in the intertidal areas, and 3) to investigate the concentration of oil in the seawater, sand, and marine snail *N. plicata*.

Materials and Methods

The research was carried out in intertidal areas in Ulithi Atoll, Yap State, Federation of States of Micronesia from 18 October to 24 October 2001. To study sort of marine snails in the intertidal areas, I walked along seaside in Mogmog, Asor, Falalop, and Fassarai Islands, to record the species name of all kind of the observed snails and take unknown species into laboratory to know species name.

I decided that *Nerita plicata* was a target species to study, because this was the most common snail in these areas (see Result). Thirty smaller (shell length < 15 mm) and 30 larger (shell length > 15 mm) *N. plicata* were collected from wave exposed and sheltered areas of Mogmog, Asor, Falalop, and Fassarai Islands, respectively. I assumed that the open seaside of atoll was exposed area and inside of atoll was sheltered area. In the laboratory, I measured the shell length, shell width, aperture length, and aperture width of the all snails (Fig. 1) and calculate following 2 indices: 1) Relative Aperture Index (RAI) = (aperture length) × (aperture width) / (shell length)^2, and 2) Relative Shell Shape Index (RSSI) = (shell length) / (shell width). RAI is an index of size of aperture mouth and higher value of the index means that size of the aperture is bigger. RSSI is an index showing shell shape.

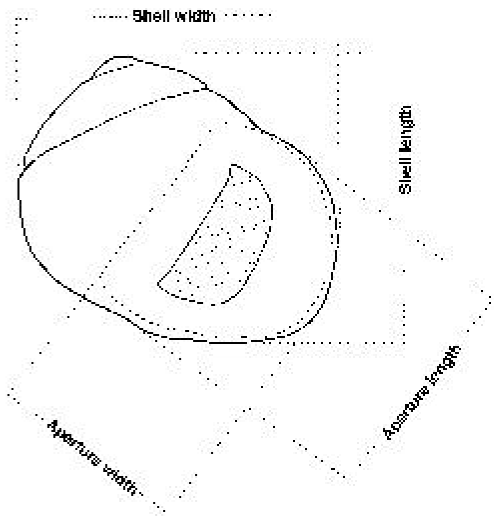

Fig. 1. Measuring method of two indices: 1) Relative Aperture Index (RAI) = (aperture length) x (aperture width) / (shell length)^2, and 2) Relative Shell Shape Index (RSSI) = (shell length) / (shell width).

To study state of the pollution, I studied 7 Polycyclic Aromatic Hydrocarbons (PAHs) components (fluorine, phenanthrene, anthracene, fluoranthene, pyrene, benzo (a) pyren and chrysene) in seawater, sand, and marine snail *N. plicata* in Asor Islands. Three litter of surface seawater was sampled near the shore. Two thousands and seven hundred cm^3 of sand was collected form 5 cm depth under the ground surface. Ten *N. plicata* were collected from sheltered shore. I commissioned Japan Frozen Foods Inspection Corporation to analysis these samples.

Results and Discussion

Shell Shape

Twenty species of marine snails were observed in the intertidal areas in Ulithi Atoll (Table 1). *Nerita plicata* and *Littorina undulata* were the two most common snails in this area. I adopted *N. plicata* as a target species of the study, because the density was higher than the other snails (personal observation).

Table 1. Species name which observed in intertidal area in Mogmog Island, Asor Island, Falalap Island, and Fassarai Island. ○ indicates that the snail was observed in the island.

Species	Mogmog	Asor	Falalap	Fassarai
Nerita plicata	○	○	○	○
Cerithium nodulosum	○			
Littoraria undulata	○	○	○	○
Cypraea tigris	○			
Cypraea moneta				○
Thais marginatra		○		
Thais savignyi	○			○
Drupa ricinus	○			
Drupa ebraeus				○
Drupa grossularia				○
Mancinella hippocastanus		○		
Coralliophila neritoides				○
Vasum ceramicum	○			○
Eugina mendicaria				○
Strigatella paupercula				○
Conus ebraeus				○
Muricidae A	○			
Muricidae B				○
Muricidae C				○
Mitridae A				○

Average RSSI of larger snails was significantly lower than that of smaller snails (two way ANOVA, $P < 0.001$) and average RSSI of snails in exposed area was significantly higher than that in sheltered area (two way ANOVA, $P < 0.001$) (Fig. 2, Table 2). There was an interaction effect between snail size and shore type on RSSI (two way ANOVA, $P < 0.05$). These suggested that there was significantly difference between exposed and sheltered area in smaller snail and no significant difference in larger snail. Larger and smaller snails inhabited in same area (personal observation), therefore both group received the same strength of wave force but shell shape showed different. There are two possible explanations on this. Firstly, sensitivity for selection force by wave force might be different between smaller and larger snails. Secondly, this was result of interaction between environmental factor and genetics.

Average RAI of larger snails showed significantly lower than that of smaller snail (two way ANOVA, $P < 0.001$) (Fig.3, Table 3). But there was no significant difference between shore

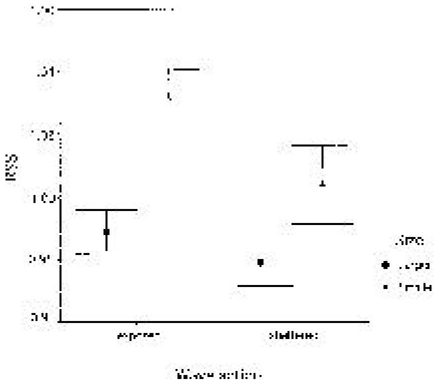

Fig. 2. Mean (± SE) relative aperture index (RSSI) of larger and smaller snails in exposed and sheltered areas

Table 2. Results of ANOVA on the effects of shore type and size of snail on RSSI

Source	d.f	SS	MS	F	P
Shore type	1	0.027	0.027	17.105	0.001
Snail size	1	0.086	0.086	55.447	0.001
Interaction	1	0.006	0.006	3.961	0.047
Residual	331	0.515	0.002		

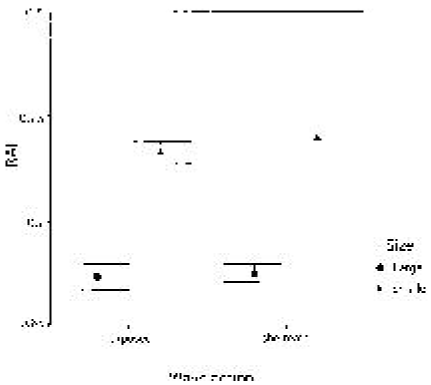

Fig. 3. Mean (± SE) relative shell shape index (RAI) of larger and smaller snails in exposed and sheltered areas

Table 3. Results of ANOVA on the effects of shore type and size of snail on RAI

Source	d.f	SS	MS	F	P
Shore type	1	0.005	0.005	1.938	0.165
Snail size	1	1.162	1.162	422.525	0.001
Interaction	1	0.002	0.002	0.727	0.395
Residual	331	0.91	0.003		

types (two way ANOVA, $P > 0.05$). Wave action did not influence aperture size but smaller snails had bigger size of aperture mouth than larger ones. It suggested that aperture size might be ontogenetically decided.

Both results suggested that shell shape and aperture size were affected by different factors, although I need more studies to confirm on these.

Oil Spill

Results of PAHs components in seawater, sand, and marine snails showed in Table 4. PAHs components in sands showed lower than these in seawater and snails. Most of PAHs components in seawater, sand, marine snail, except benzo (a) pyren in marine snail in this research were similar value to not-polluted ordinal beach in Japan but benzo (a) pyren in *N. plicata* showed about six times higher concentration than snail in not-polluted area (FUJIMOTO 1998). Another research suggested that benzo (a) pyren concentration of snails and mussels showed high in oil-polluted area (NOREA-BARROSO et al. 1999), suggesting the snails were affected by oil pollution. But source of the pollution was not clear in this area, although oil spill has happened from a sunken ship in August 2001 in Ulithi Atoll. There were two possibilities for source of the pollution. First possibility is oil spill from a sunken ship in August 2001 in Ulithi Atoll. Second one is oil leaking from boats, which were used general life.

Table 4. Results of PAHs analysis of seawater, sand, snails

	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Chrysene	Benzo (a) pyrene
Seawater (ng / g)	< 0.1	3.8	< 0.1	1.4	1	< 0.1	< 0.1
Sand (ng / g)	< 0.1	0.5	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Snails (ng / g)	3	15	< 1	2	3	< 1	7

Benzo (a) pyren may be a chemical to develop cancer (SMOLAREK 1988) and has negative effect on mate reproduction in the mouse (REVEL et al. 2001). Concentration of benzo (a) pyren in snail was high in Asor Island, suggesting a possibility that many coastal animals might develop cancer by benzo (a) pyren. Moreover, many marine animals are food for the local people. Therefore, there is a possibility to affect the health of local people by oil pollution.

To find out source(s) of the pollution to the snails and continuous monitoring of the concentration of PAHs are important for conservation of the marine ecosystem and for health of the local people in this area.

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