

Damages of epoxy anti-rust coating on marine structures observed under existence of sea urchins and its protection

Ichiro Katsuyama Seiji Kobayashi Japan NUS Co., Ltd.

Introduction

Divers engaged in maintenance and management observed that surface coating of marine structures was damaged by sea urchins. There have been no previous reports regarding such damages. Therefore, a survey was performed on the survival of sea urchins on marine structures and the damage they afflict on the surface coating.

E. molaris 'tawasi-uni' that are frequently observed on the coating surface, in most cases, stay in holes dug in rock beds along sea coasts and eat sea weeds that flow into the holes. Since they cannot dig holes on metal structures, it is thought that they crawl on the surface of marine structures, foraging for sea weeds and barnacles. During feeding, their hard teeth may damage the coating. The survey showed that a high frequency of coating damage was observed at points where *E. molaris* 'tawasi-uni' individuals were found.

In order to protect coating layer of marine structures from damage by the sea urchins, we prepared test plates with different coating hardness, exposed these plates to sea urchins for three months and observed damage conditions of anti-rust coating layers.

Results

Appearance of sea urchins on surveyed place

Survey place	Coating material	Numbers of points observed	Number of sea urchins per unit area (m ²)	Sea urchin species composition (in percent)			
				<i>Echinostrephus molaris</i>	<i>Anthocidaris crassispina</i>	<i>Echinometra sp.</i>	<i>Diadema setosum</i>
Marine structure	Tar epoxy or epoxy coating	6	5~7	44	44	5	7
Floating bank	Tar epoxy coating	5	10~16				

Echinostrephus molaris 'tawasi-uni'



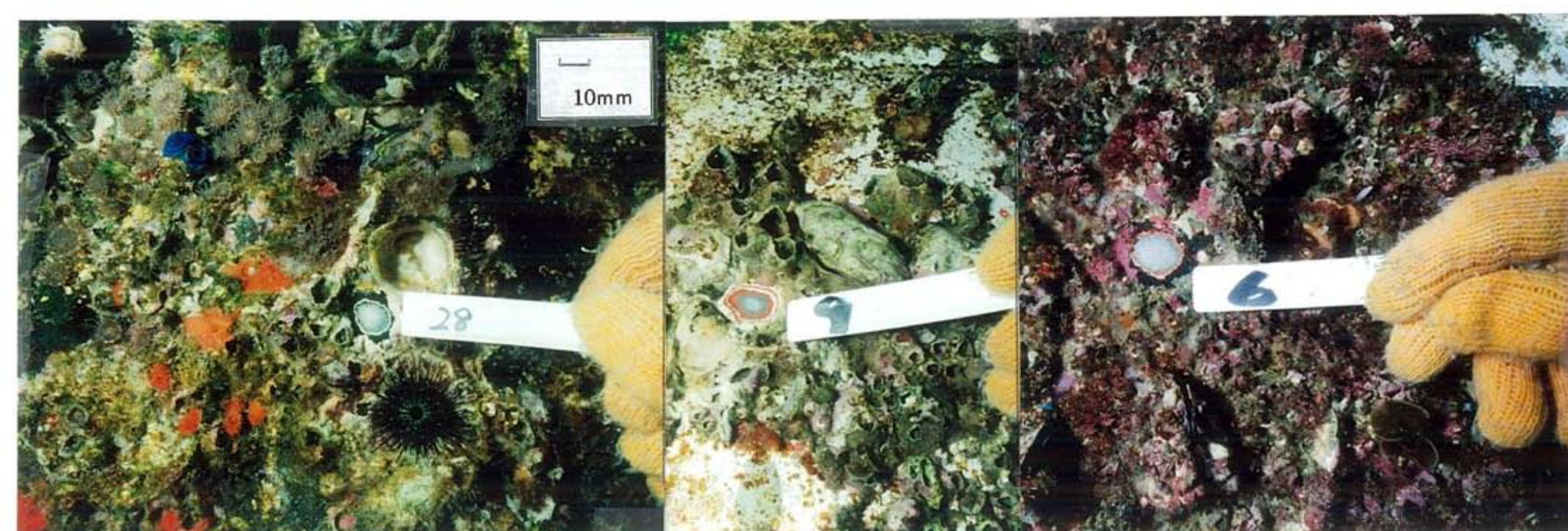
Micro vickers hardness of test coating materials.

	Tar epoxy	Epoxy	Epoxy glass flake (I)	Epoxy glass flake (II)
Width of coating layer (μm)	400	430	430	440
Micro vickers hardness (MVH)	10.1	18.1	29.6	32.6
	M±S.D.(n)	±0.68(20)	±5.97(20)	±6.49(20)

Occurrence (in percent) of damaged coating of the test plate with the sea urchin *E. molaris*.

Values are taken after 3 months from the start of the test.

Coating material	Number of points	Percentage	Coating type	Number of points	Percentage
Tar epoxy coating	5/9	56%	Epoxy glass flake coating (I)	2/15	13%
Epoxy coating	7/15	47%	Epoxy glass flake coating (II)	2/13	15%



Damage of coating at the place sea urchin (*Echinostrephus molaris*) was found.

Examples of tar epoxy coating (left and right) and epoxy coating (center). Damage shown on the right was observed within 72 hours after sea urchins arrived.



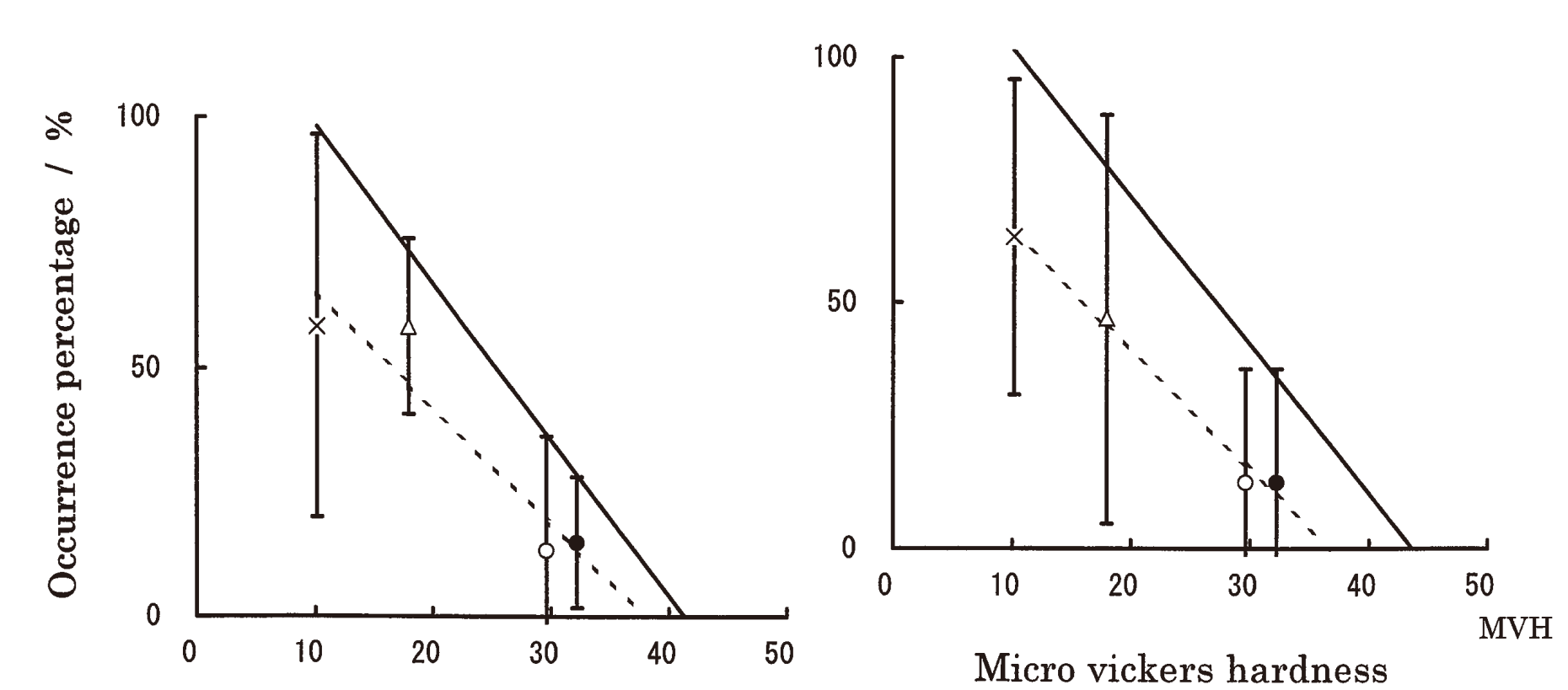
Damage on the coating of the test plate with the sea urchin *E. molaris*.

A: Tar epoxy coating, B: Epoxy coating, C: Epoxy glass flake coating (I), D: Epoxy glass flake coating (II)

Occurrence of damage on the coating of marine structure beneath sea urchins

	<i>Echinostrephus molaris</i>	<i>Anthocidaris crassispina</i>	<i>Echinometra sp.</i>	<i>Diadema setosum</i>
Occurrence of damage on points observed (in percent)	13~100	0~9	0~40	0
Average occurrence of damage (in percent)	50	2	7	-
Min. and max. Shell diameter (mm)	7~29	22~36	23~27	-

Teeth of *Echinostrephus molaris* 'tawasi-uni'



Relationship between damage on coating of the test plate with sea urchin (*E. molaris*) and micro vickers hardness of coating materials.

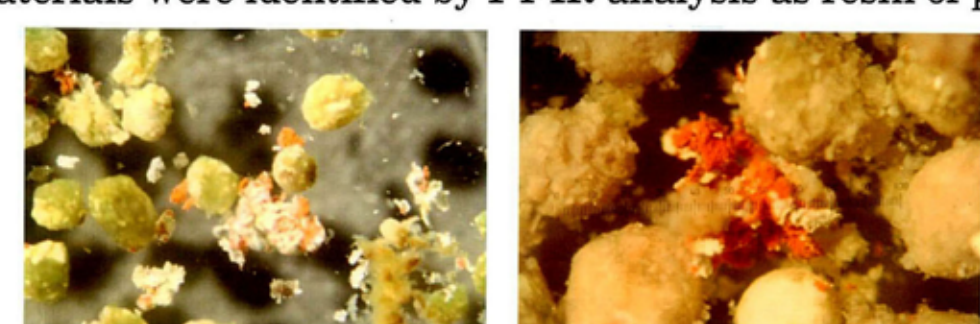
Left graph shows values after one month and the right shows those after three months from the start of the test. Occurrence (in percent) : numbers of sea urchins that produced damage / numbers of sea urchins observed. × : Tar epoxy coating, △ : Epoxy coating, ○ : Epoxy glass flake coating (I), ● : Epoxy glass flake coating (II).

Micro Vickers hardness of coating materials and teeth of sea urchin

	Load(g)	Numbers of measurement	Average values	Min. ~ Max.
Tar epoxy coating	10	20	6.0	5.3~7.2
Epoxy coating	10	30	13.7	12.2~15.4
Teeth of <i>E. molaris</i>	300	3	208.3	176.0~248.0

Rusty red and grayish materials, which seem to be pieces of the coating, were observed in the digestive canals of sea urchins (*E. molaris*).

These materials were identified by FT-IR analysis as resin of paint.



Conclusion

- High frequency of coating damage was observed at points where *E. molaris* ('tawasi-uni') were found.
- Their hard teeth may have damaged the surface coating.
- Epoxy-glass-flake paint effectively protected surface coating but this paint was expensive.
- Sea urchins could not damage the coating layer when the MVH was about 40.