Development of sustainable bivalve aquaculture technology adapted to tropical monsoon region

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Dr. YURIMOTO Tatsuya has been a Senior Researcher of the Fisheries Division at JIRCAS, from 2010 to 2016 and from 2020. He graduated with a master's degree from Kitasato University and a doctorate degree from Nagasaki University (Ph.D. in Fisheries Science). He had been a Researcher and a Senior Researcher at Seikai National Fisheries Research Institute, from 1999 to 2010 and from 2016 to 2020, respectively. His main research subject is coastal environment and bivalve biology.

ABSTRACT

Blood cockle (*Tegillarca granosa*) farming on the west coast of Peninsular Malaysia is carried out by collecting naturally occurring young spats in mud flats and sowing them to management farming plots owned by farmers. Since it is non-feeding extensive simple aquaculture, the farming materials and costs are less than those for hanging aquaculture, and small-scale farmers can easily start farming even with a small budget. However, this aquaculture has the drawback of being susceptible to changes in the natural environment[1,2]. First, the occurrence of planktonic larvae depends on the biomass of the adult cockles and natural conditions such as coastal topography, ocean currents, weather etc. In the case of this species, the full-grown larva does not settle to adhering substance during the transformation from planktonic to benthic stages, and starts benthic life directly on the surface sediment of the muddy bottom. For this reason, its distribution is easily affected by currents even in the benthic stage, and it is suggested that the early spats move and accumulate in the low current area with the fine mud. However, this spats collection site is not necessarily a suitable habitat environment (too soft bottom, high turbidity etc.) for the subsequent survival of the cockles. The early spats are raked up by farmers, transplanted to suitable bottom-condition plots, and cultivated with favorable growth and survival rates. In addition, as cultured cockles grow, organic matters are ingested in their bodies and CO_2 is fixed as calcium carbonate in shells, and these substances are also transported to land upon harvesting. Therefore, the activities of farmers play an important part in the substance cycle of coastal ecosystems.

Considering the above, it can be said that blood cockle farming can be an environmentally friendly sustainable aquaculture. However, there are still problems to be solved to realize its sustainability, and it is important to sustain the reproductive adult population of blood cockles and to maintain not only the coastal but also the terrestrial environments such as rivers. To realize this, it is important to have an organizational community for farmers to work together, and a system for environmental management from land to coastal areas based on mutual agreement and cooperation between fishermen, government, researchers and citizens. In recent years, the Malaysian Fishermen's Community (myKP) has been organized and has begun efforts to scientifically evaluate and redefine farming plots set up by the government. In addition, through joint research of JIRCAS and the Fisheries Research Institute Malaysia (FRI), a method has been developed that allows fishermen to rapidly evaluate the habitat conditions of the blood cockles during the aquaculture process using simple tools (calliper, scale)[3]. In addition, as part of coastal environmental management, activities for marine litter countermeasures have been started in cooperation with citizens. These activities are also in line with the "Sato-umi" concept that spread from Japan and are expected to lead to the realization of sustainable aquaculture in the tropical monsoon region[4].

[1] Yurimoto, T. et al. (2014) *Int. Aquat. Res.* **6**, 177-186.
[2] Yurimoto, T. et al. (2021) *Fish. Aquat. Life* **29**, 230-238.
[3] Saito, H. & Wooi, T.H. (2020) *Malaysian Fish. J.* **19**, 21-46.
[4] Yurimoto, T. (2020) *Malaysian Fish. J.* **19**, 1-20.

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Fisheries Division, JIRCAS
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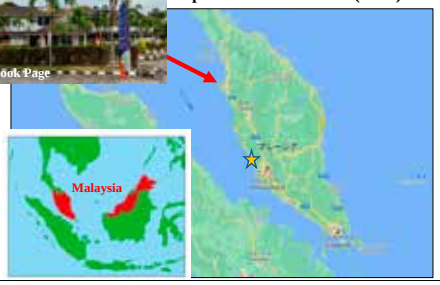
Locations of fisheries research institute and main research site about the blood cockle survey in Malaysia

Fisheries Research Institute (FRI), Department of Fisheries (DOF)



2

Blood cockle: *Tegillarca granosa* (Linnaeus,1758)

Morphology

- The shell is elliptical, thick, and well-inflated.
- There are about 18 ribs and many nodules on the shell surface.

(Encyclopedia of shellfish)

Distribution

- Main distribution in Southeast Asia.
- Inhabiting muddy bottoms from the intertidal zone to 10 m depth.

(Encyclopedia of shellfish)

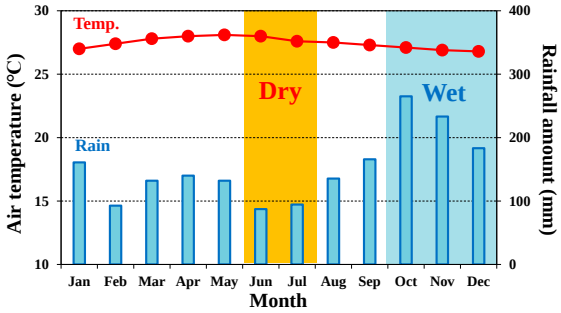
3

Blood cockle farms in west coast of Peninsular

FRI (2010)

4

Changes of monthly average values in air temperature and rainfall amount in Perak (Northern Selangor)



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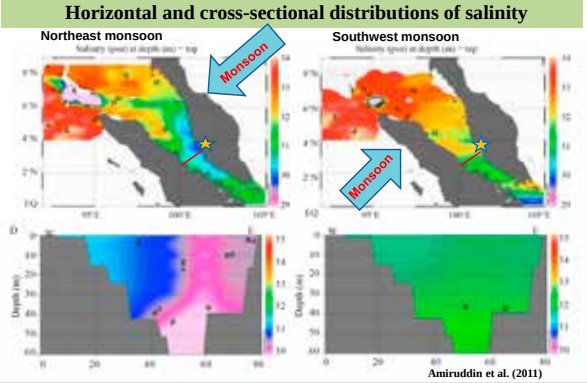
Horizontal and cross-sectional distributions of salinity



Amiruddin et al. (2011)

6

Sowing aquaculture of the blood cockle in Selangor

This harvest also means transferring organic matter and calcium carbonate to the ground.

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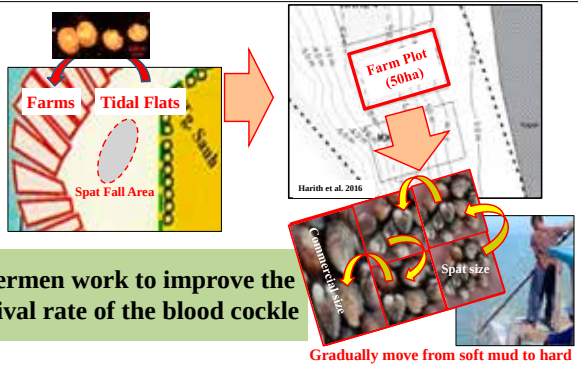

Fishermen work to improve the survival rate of the blood cockle

Gradually move from soft mud to hard mud depend on the growth size.

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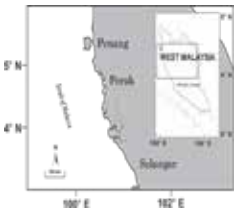
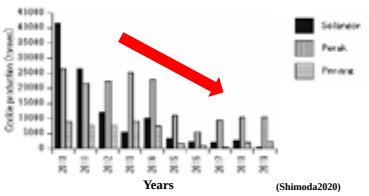
Blood cockle production on the west coast, Peninsular Malaysia





Cockle production in Selangor, Perak and Penang

- What is the reason for the decrease?
- What are the countermeasures?
- Environmental and biological surveys are important.

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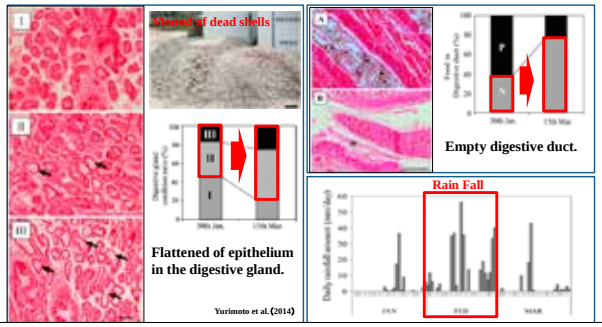
Occurrence of mass mortality event of the blood cockle in southern Selangor, 2012



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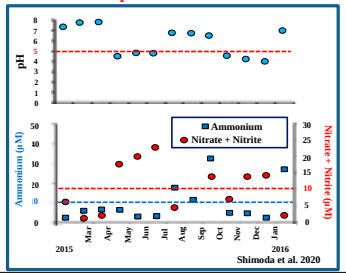
Water quality survey around Selangor coast

- Peat swamp forests exist on the west coast.
- It is called "black water" from its color, it is low pH, low dissolved oxygen, and rich in tannins.
- Black water easily flows into rivers due to the development of farms and urbanization.



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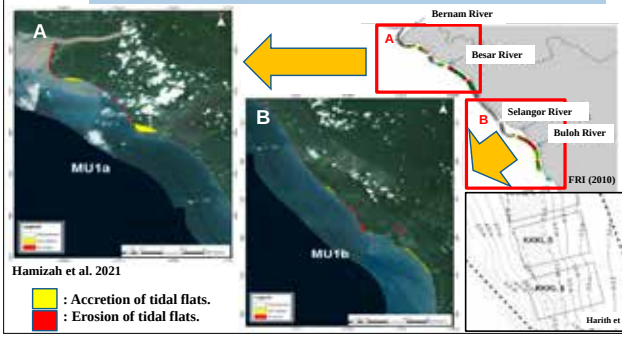
Difference in coastal topography from a comparison of the 1984 topographic map and the 2013 satellite image



Hamizah et al. 2021

: Accretion of tidal flats.
: Erosion of tidal flats.

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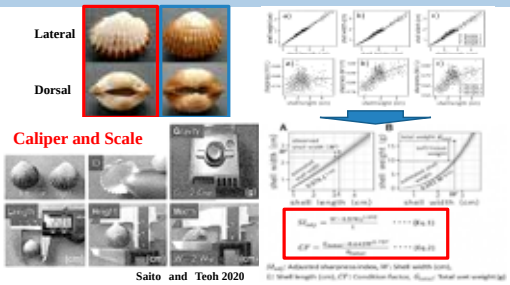
Simple evaluation index for the blood cockle physiological condition



Saito and Teoh 2020

➢An easy estimation method without destroying the shells to estimate the growth and physiological condition.

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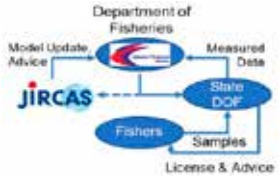
Additionally

➢Simple tools and methods which fishermen can use and evaluate.

➢This index is used for identifying a suitable farming area.

This method will lead to fishing ground management for stabilizing blood cockle farming.

Study meeting on blood cockle farming with local fishermen and FRI



Collaboration system for the evaluation

Saito and Teoh 2020

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Online News Paper (Mar.2020)

Revival plans

➢DOF plans to rearrange the farming plots to revive blood cockle farming.

➢Through the survey, DOF will identify the spat abundant areas and the suitable aquaculture sites.

➢To raise awareness of coastal litter, the DOF works with fishermen's associations (myKPs), primary school pupils, Forestry Department, and the Fisheries Development Authority to implement a nationwide program of action.

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Thank you for your attention.

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