Ecotechnology for Restoration of Water Environment

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Contents

1. What is Ecotechnology?
   -Low Impact Development towards Sustainable Society
2. Ecotechnology for Water Purification
   -Wetland System
3. Ecotechnology for Sediment Control
   -Relation between Sediment and Flow
4. Ecotechnology for Biodiversity
   -From Ecology To Ecotechnology

What is Ecotechnology？

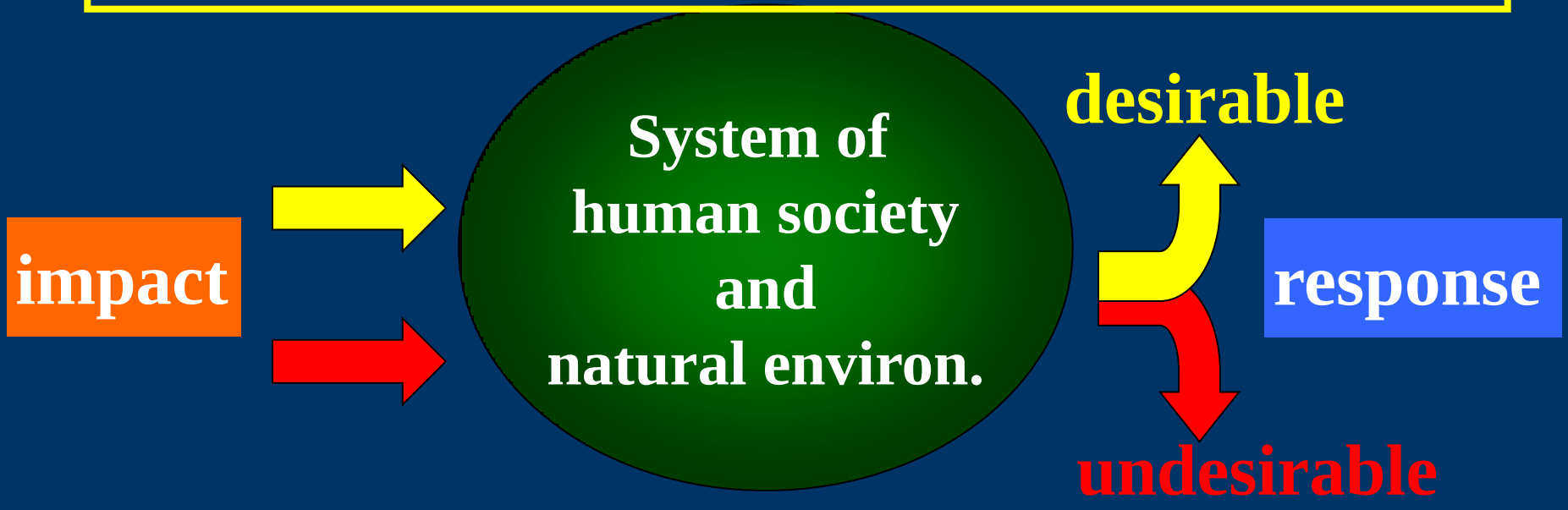
The design of human society with its natural environment for the benefit of both. (Mitsch, 1988)

Environmental Ecotechnology

It is the technology to restore destroyed environment by using the function of ecosystem. (Sudo, 2000)

Principal of Environmental Ecotechnology

Environmental Ecotechnology：impact is given to the system to obtain desirable response



Environmental Assessment：impact is controlled to avoid undesirable response

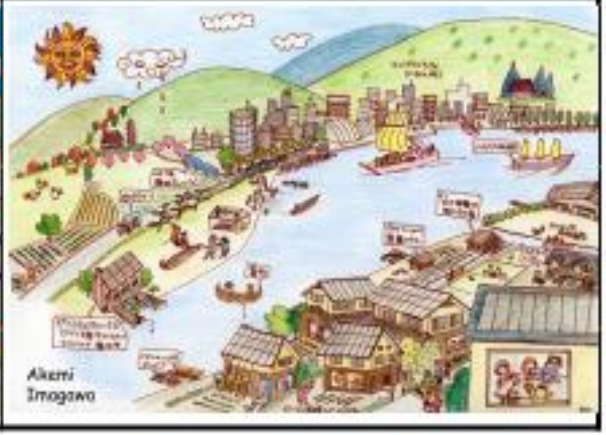
Why Ecotechnology?

- The basic principle of Ecotechnology is Ecology.

- In order to develop a low carbon, recycling-oriented society, and a society in harmony with nature we can and must learn from natural ecosystem how it has developed and sustained itself over billions of years.

Slide: Courtesy Dr. Junichi Fujino, NIES, Tsukuba, Japan

As for LCS visions, we prepared two different but likely future societies

Vision A "Doraemon"	Vision B "Satsuki and Mei"
Vivid, Technology-driven	Slow, Natural-oriented
Urban/Personal	Decentralized/Community
Technology breakthrough Centralized production /recycle	Self-sufficient Produce locally, consume locally
Comfortable and Convenient	Social and Cultural Values
2%/yr GDP per capita growth	1%/yr GDP per capita growth
	

Doraemon is a Japanese comic series created by Fujiko F. Fujio. The series is about a robotic cat named Doraemon, who travels back in time from the 22nd century. He has a pocket, which connects to the fourth dimension and acts like a wormhole.

Satsuki and Mei's House reproduced in the 2005 World Expo. Satsuki and Mei are daughters in the film "My Neighbor Totoro". They lived an old house in rural Japan, near which many curious and magical creatures inhabited.

The targets of Japan towards a low carbon society

2008～2012 (2010)		6％ from 1990
Kyoto Protocol		
by 2020		25％ from 1990
Prime Minister Hatoyama		
by 2050		60～80％ from the present
Prime Minister Fukuda		

Local government		
Saitama Pref.	by 2020	25％ from 2005
Shiga Pref.	by 2030	50％ from 1990
Sendai City	by 2020	25％ from 2005

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Present status of water environment in Japan

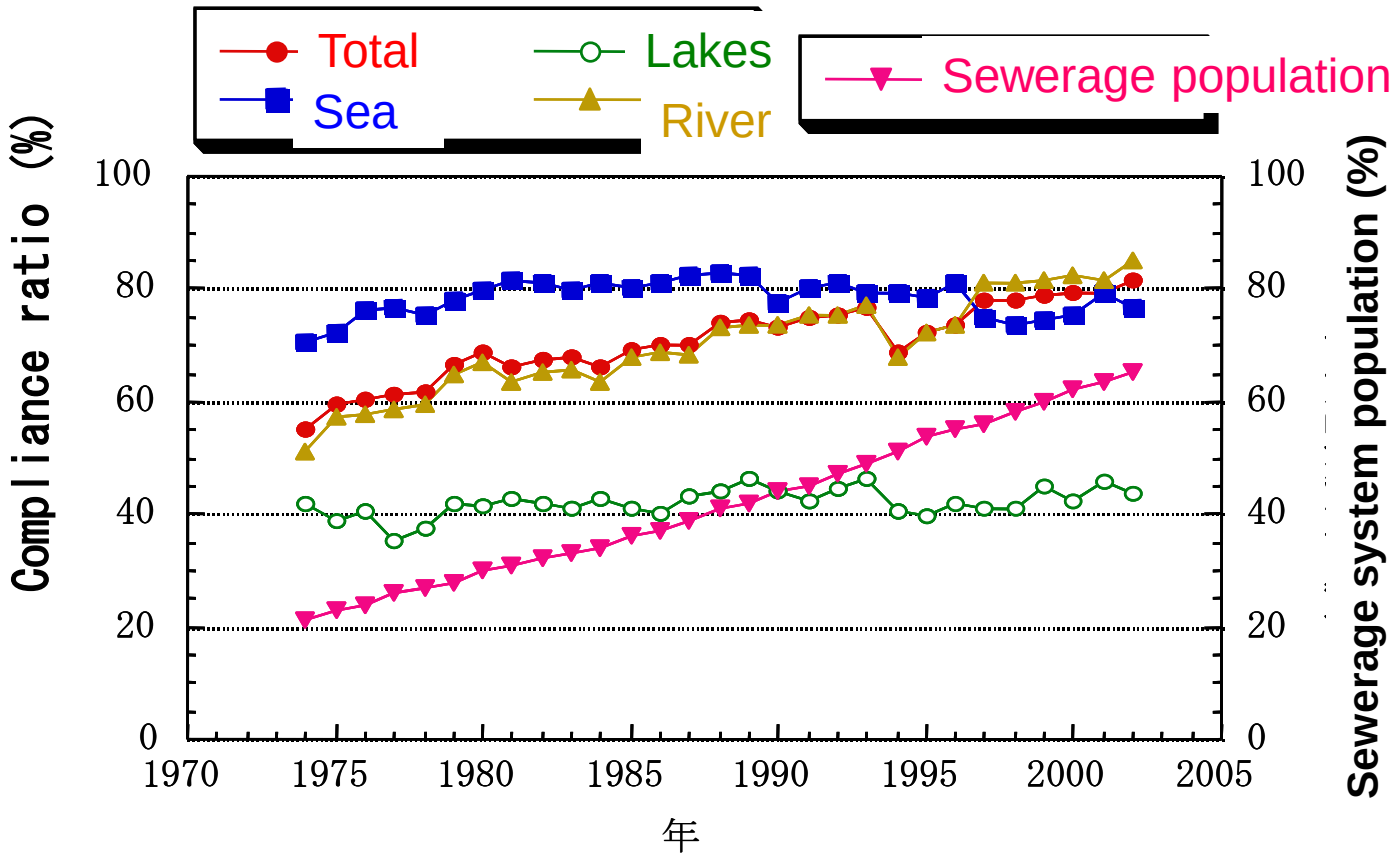
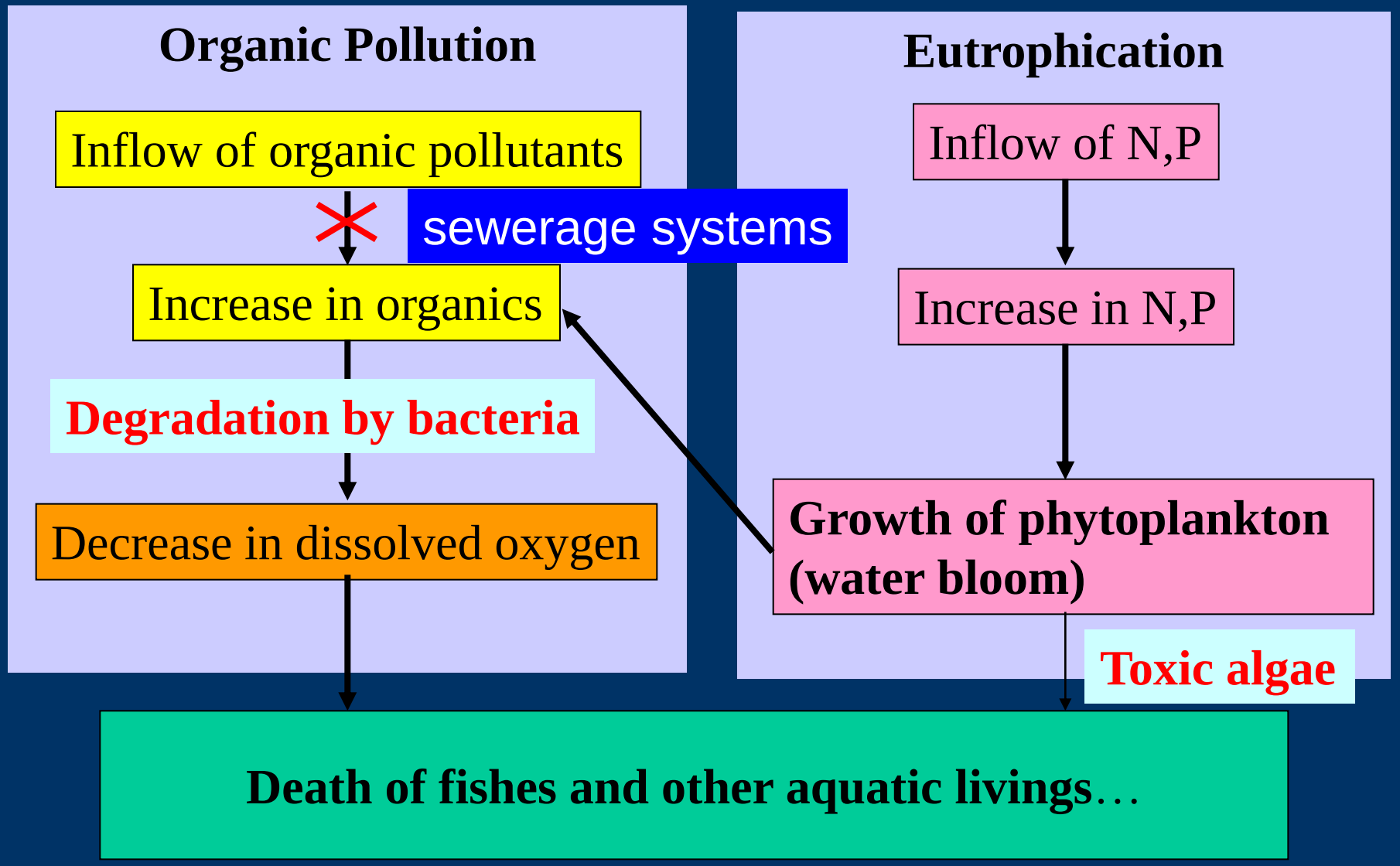


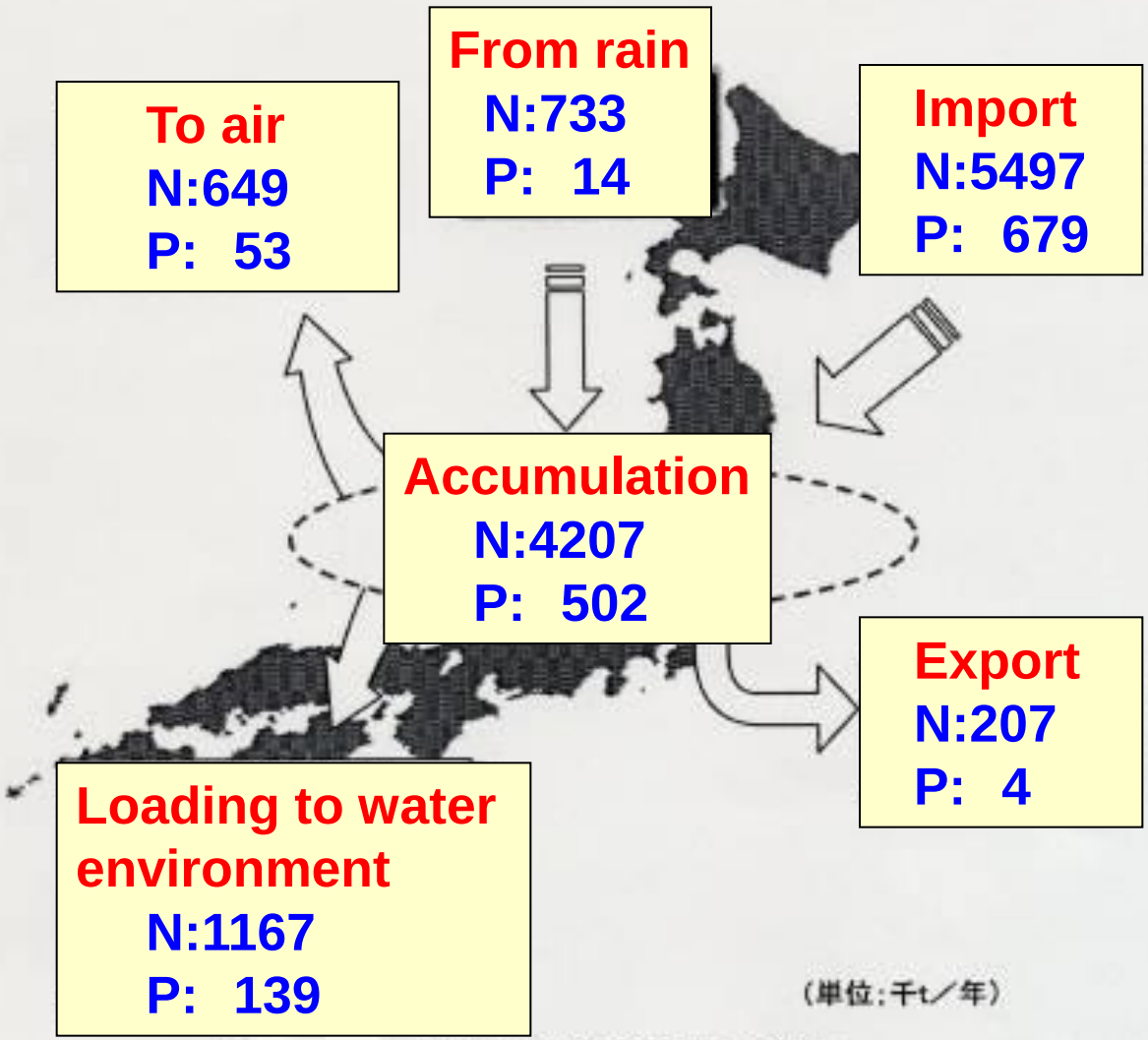
Fig. Percent compliance for the environmental quality standards (COD for lakes and estuaries, BOD for rivers) and sewerage population in Japan

Water quality of rivers has been improved, while those of lakes and seas have not improved.

Organic Pollution and Eutrophication



Fundamental problem is nutrients mass balance



(unit: thousands t/Year)

Excessive import of foods and livestock feed

Accumulation and excessive load to environments

Occurrence of eutrophication and groundwater pollution by nitrate nitorogen

Introduction of advanced treatment is wa

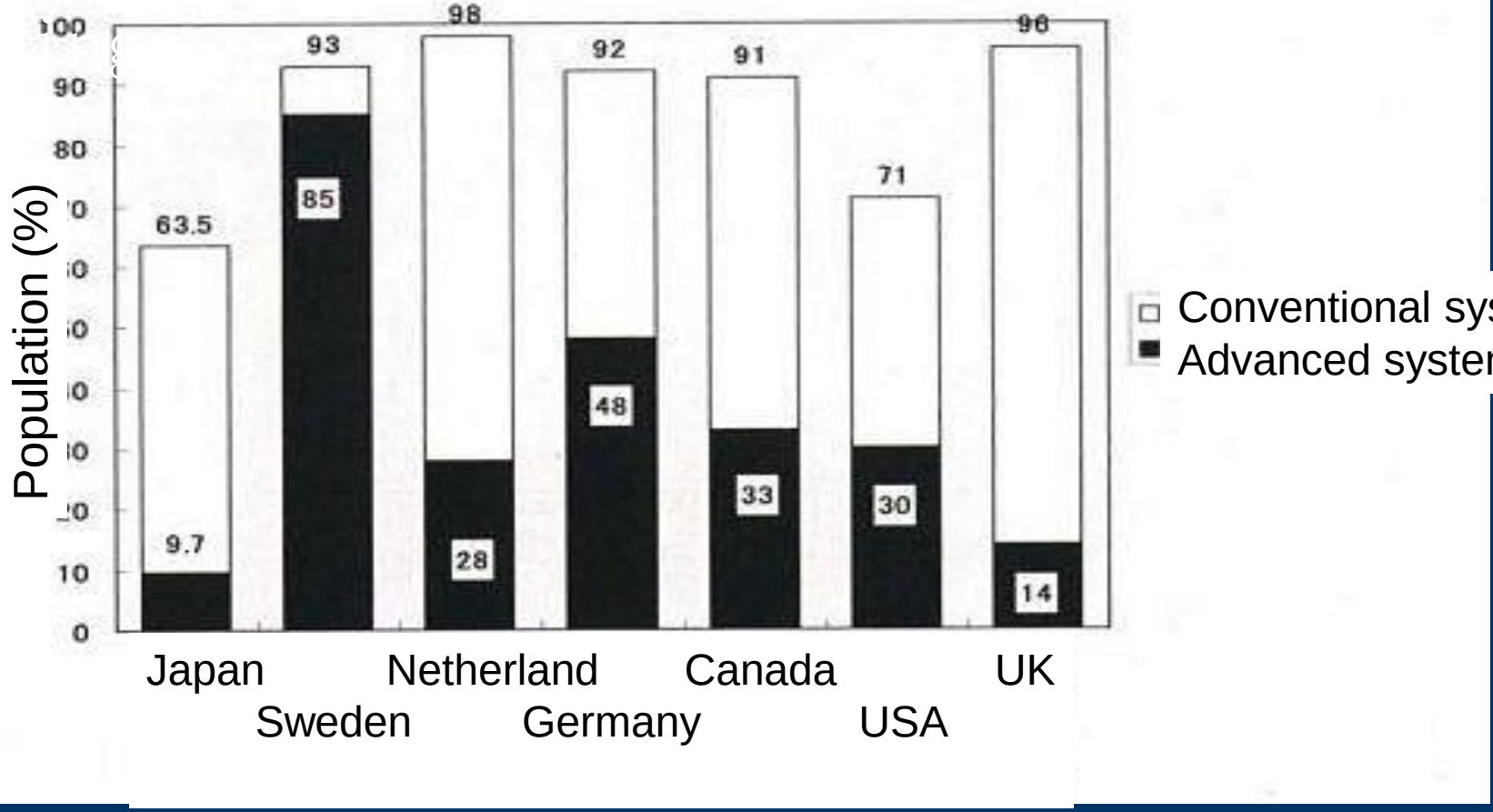
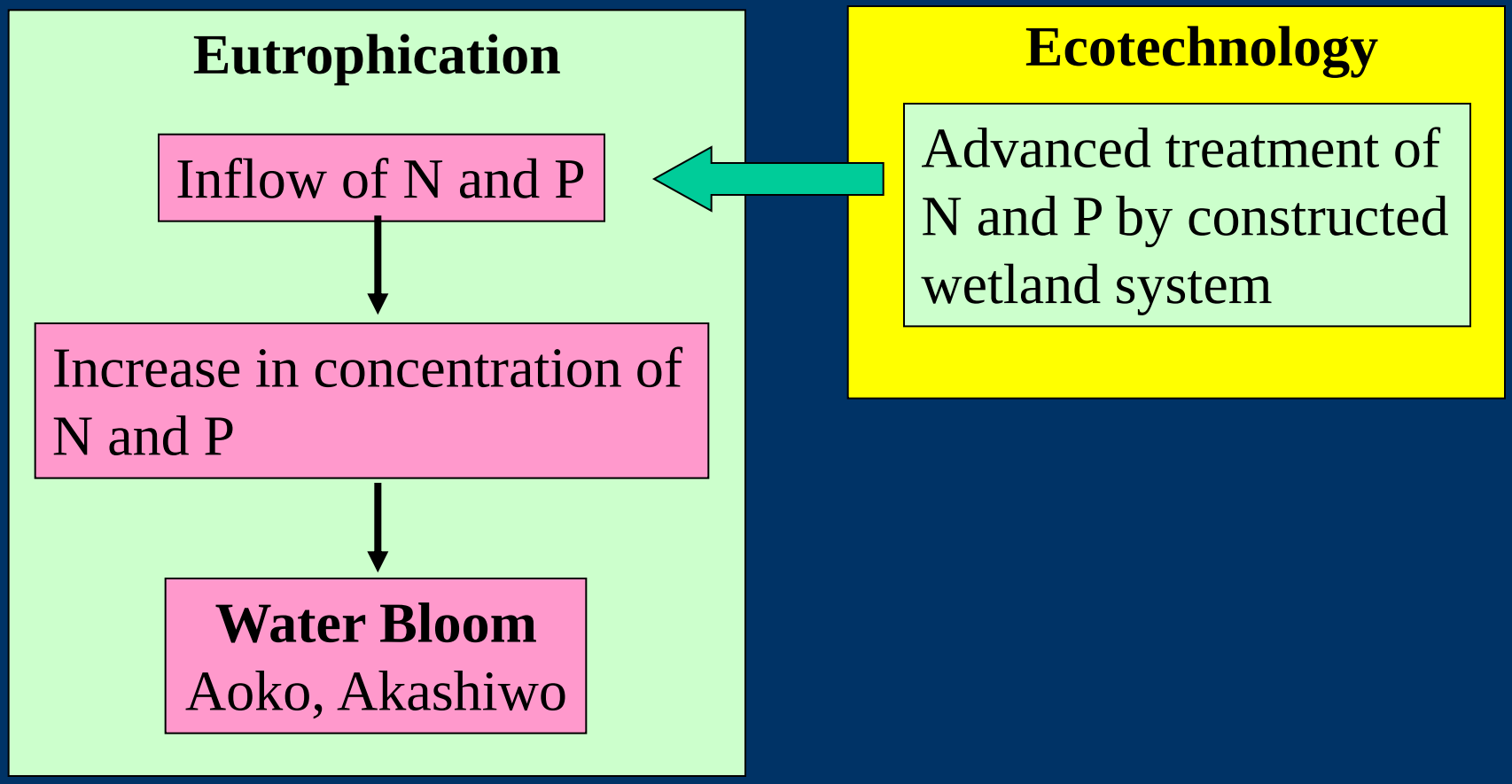


Fig. Population of conventional sewage system and advanced system

Installment of advanced system will take long time. Thus, some alternatives to prevent eutrophication is required.

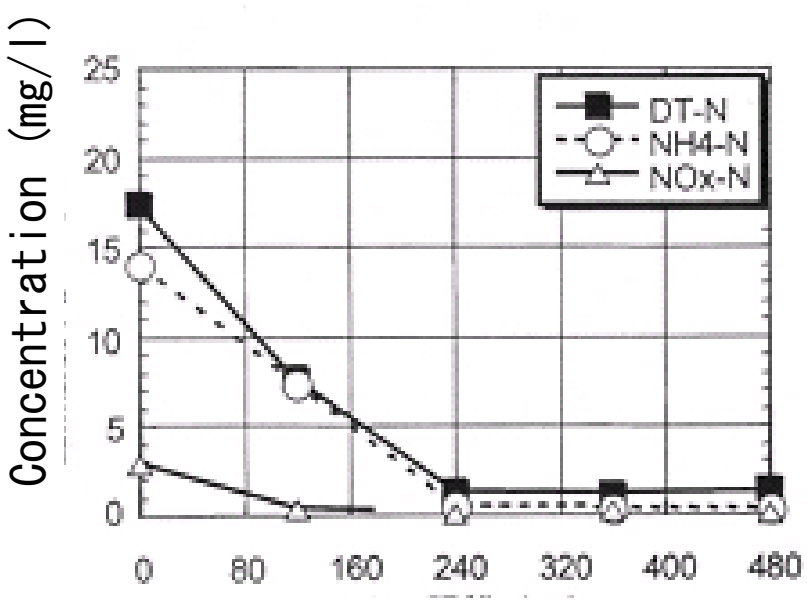
Constructed Wetland may substitute.

Countermeasure for eutrophication control by ecotechnology

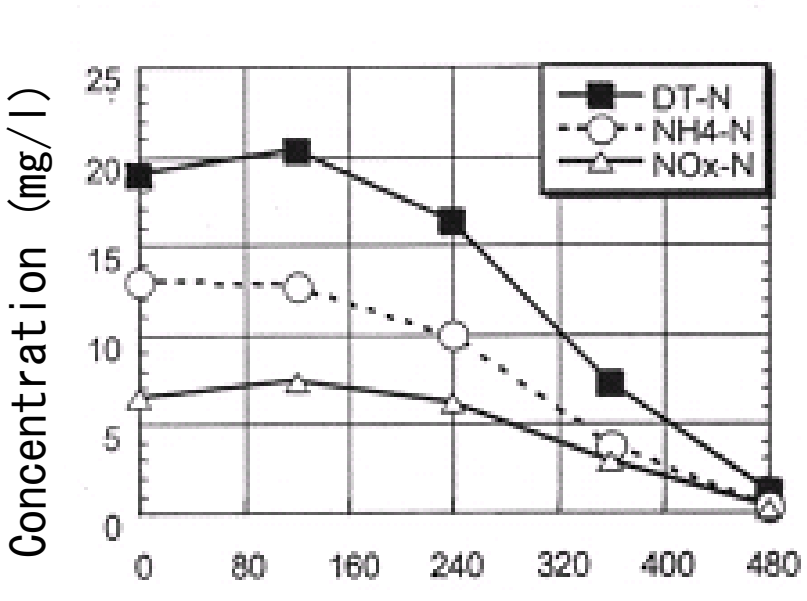


Advanced treatment of secondary effluent by reed wetland

Nitrogen removal by reed wetland.



August

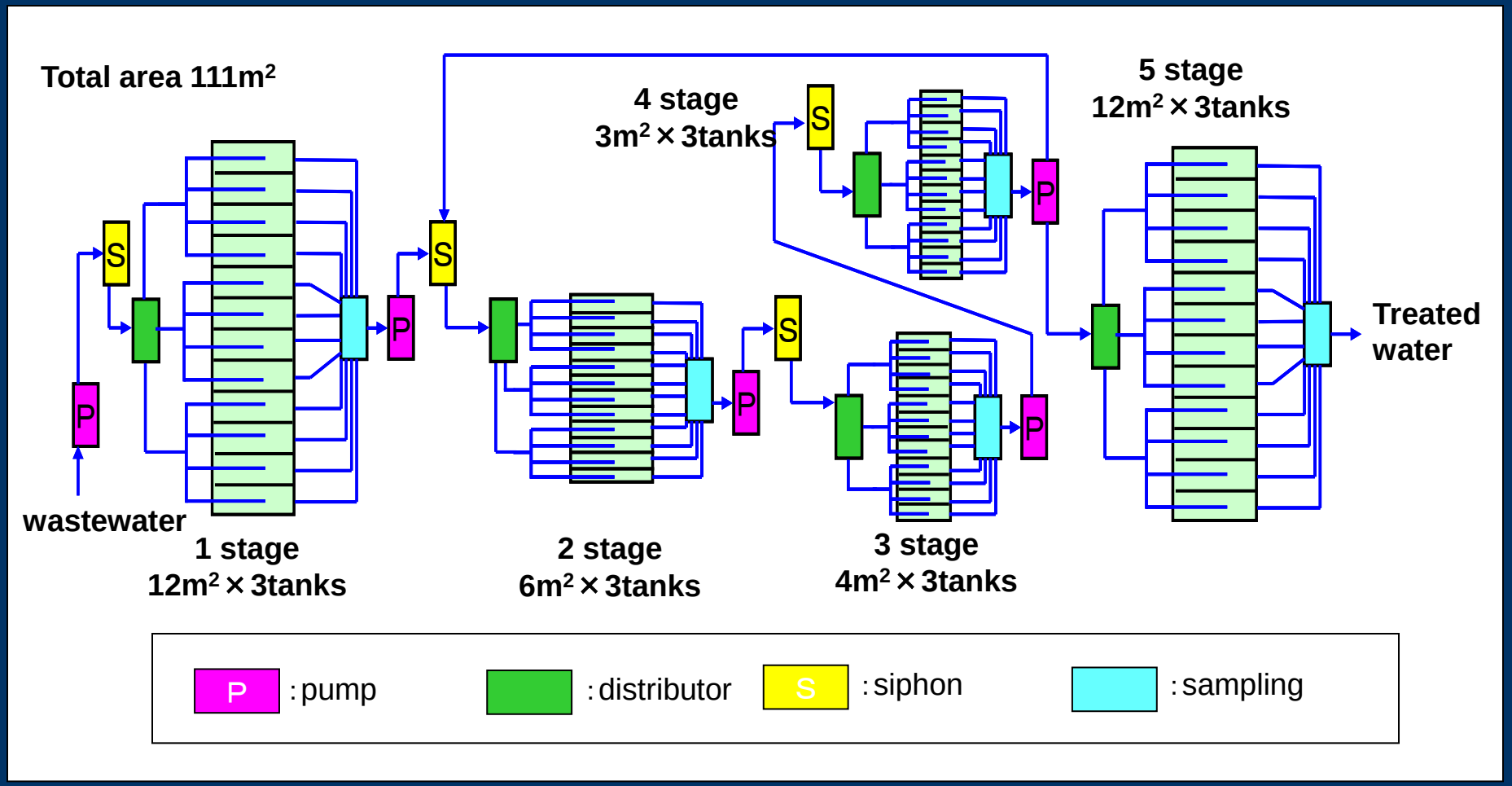


December

Fig Nitrogen removal by reed wetland (Water surface loading: 0.23m・day^{-1})

Constructed wetland for livestock wastewater treatment

Outline of constructed wetland system



Constructed wetland made on slope

Wastewater distribution system

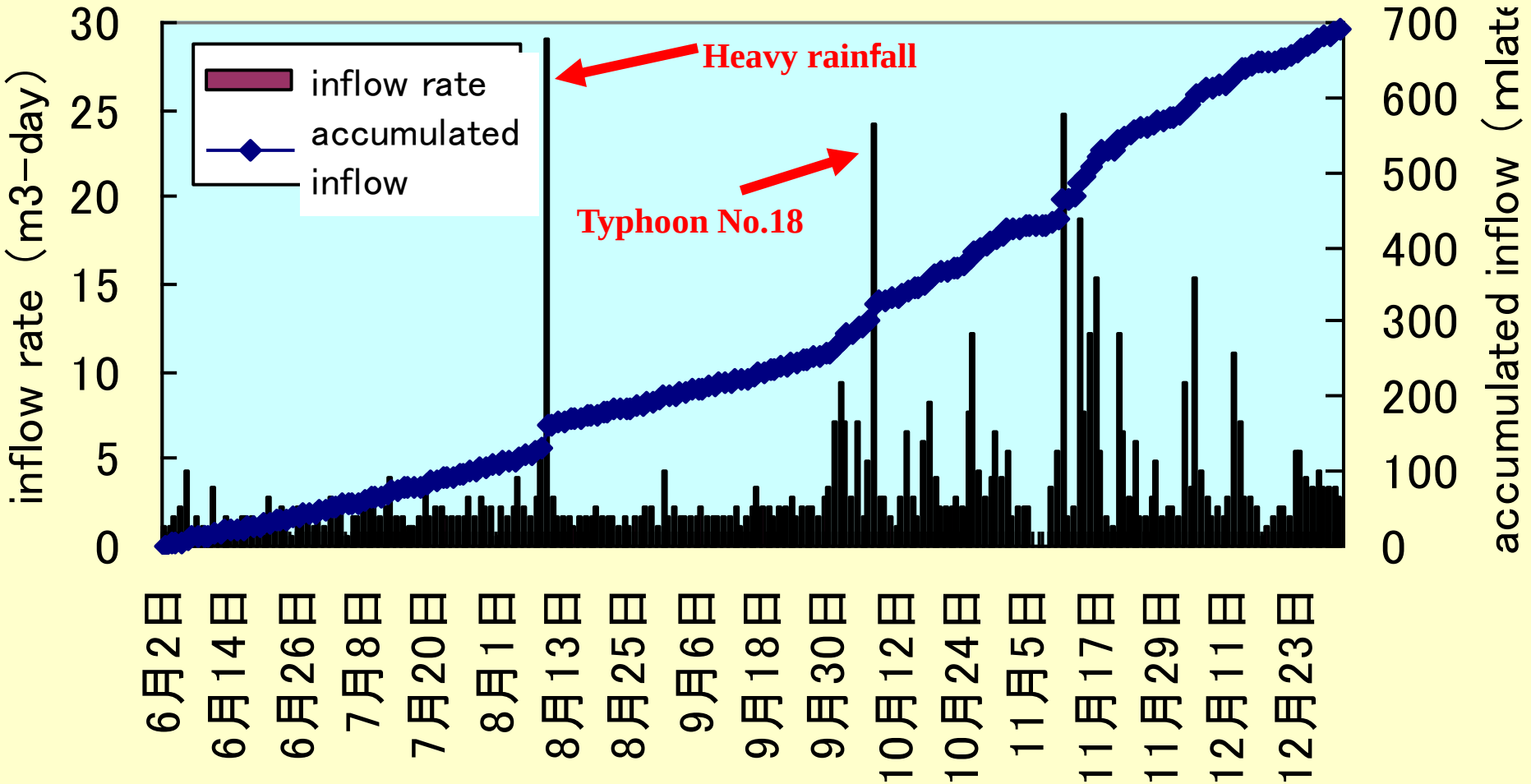
Water quality of effluent in each stage

	COD_{Cr}		BOD		SS		NH_4		NO_3		PO_4	
	Conc. (mg/L)	RR (%)	Conc. (mg/L)	RR (%)	Conc. (mg/L)	RR (%)	Conc. (mg/L)	RR (%)	Conc. (mg/L)	RR (%)	Conc. (mg/L)	RR (%)
Raw	2740		1552		859		61.3		0		15.3	
1	390	85.8	211	86.4	305	64.5	13.6	77.9	0	—	1.8	88.5
2	102	96.3	18	98.8	231	73.1	5.3	91.4	0.05	—	0.17	98.9
3	28	99.0	4.4	99.7	25	97.1	0.03	99.96	10.3	—	0.09	99.4
4	25	99.1	1.6	99.9	18	97.9	0.03	99.96	10.5	—	0.24	98.4

Aug. 2009

Jan. 2010

Change of inflow rate (June －Dec., 2009)



Constructed wetland is subject to the effect of weather like natural river and lake.

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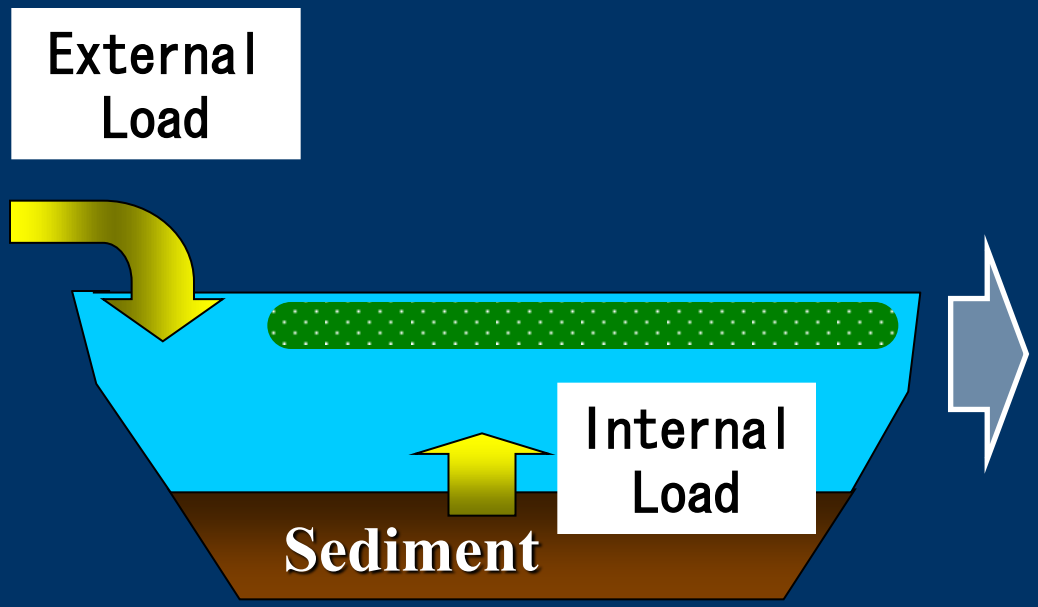
Internal load of N and P from sediment



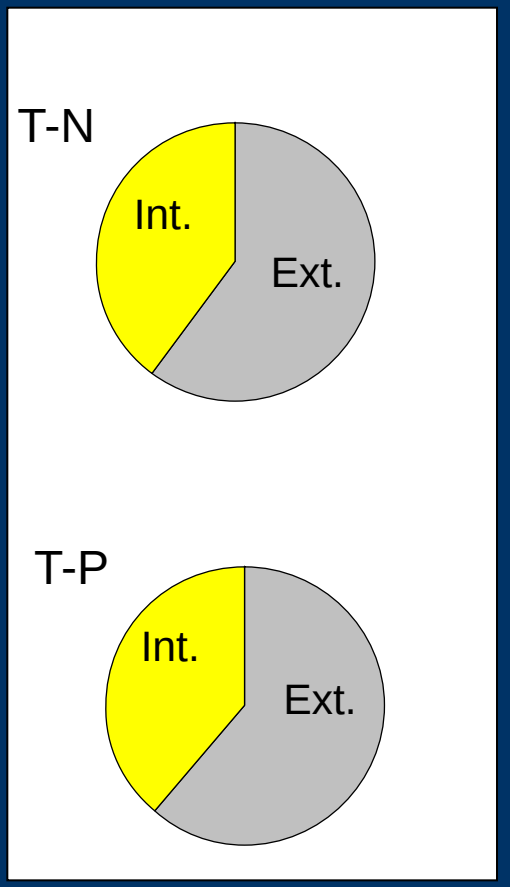
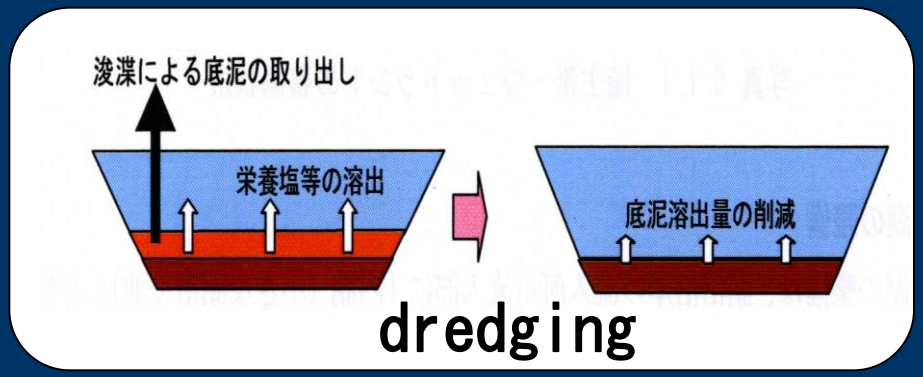


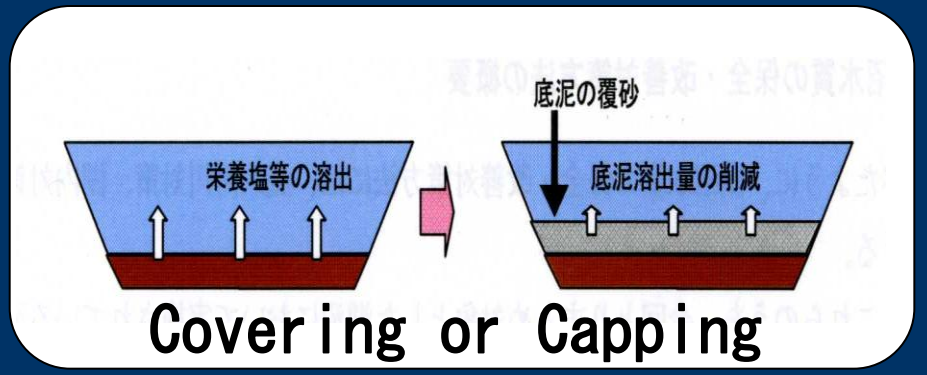
Fig N and P Loads to Lake Kasumigaura

国土交通省HP

The necessity to establish a new technology to improve sediment organic matter



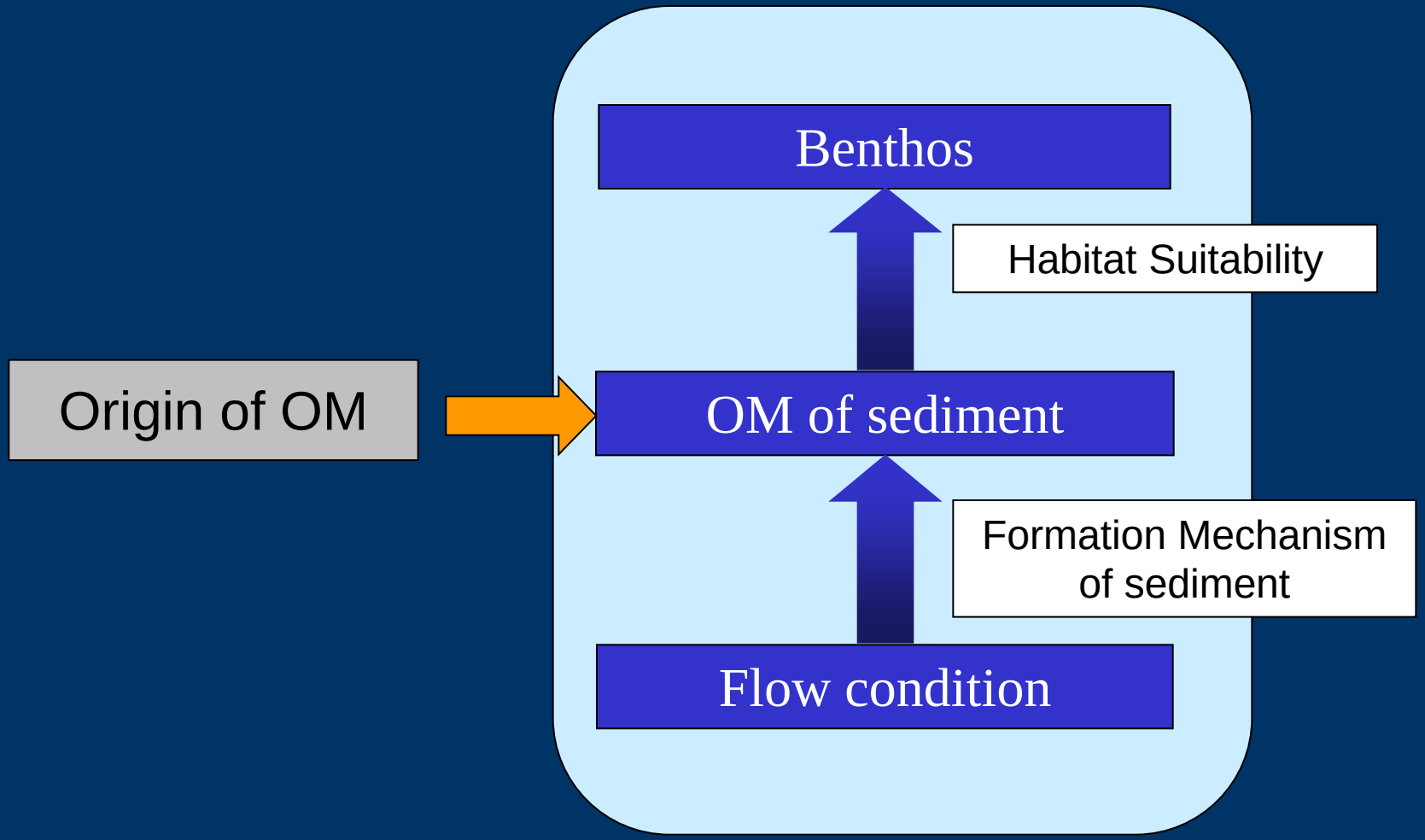
dredging



Covering or Capping

- Problem on the sustainability of effect
- Adverse effect to benthos

Hypothesis: OM of sediment is controlled by flow condition.



Lake Izunuma was designated as an internationally important wetland in 1985 by Ramsar Convention.

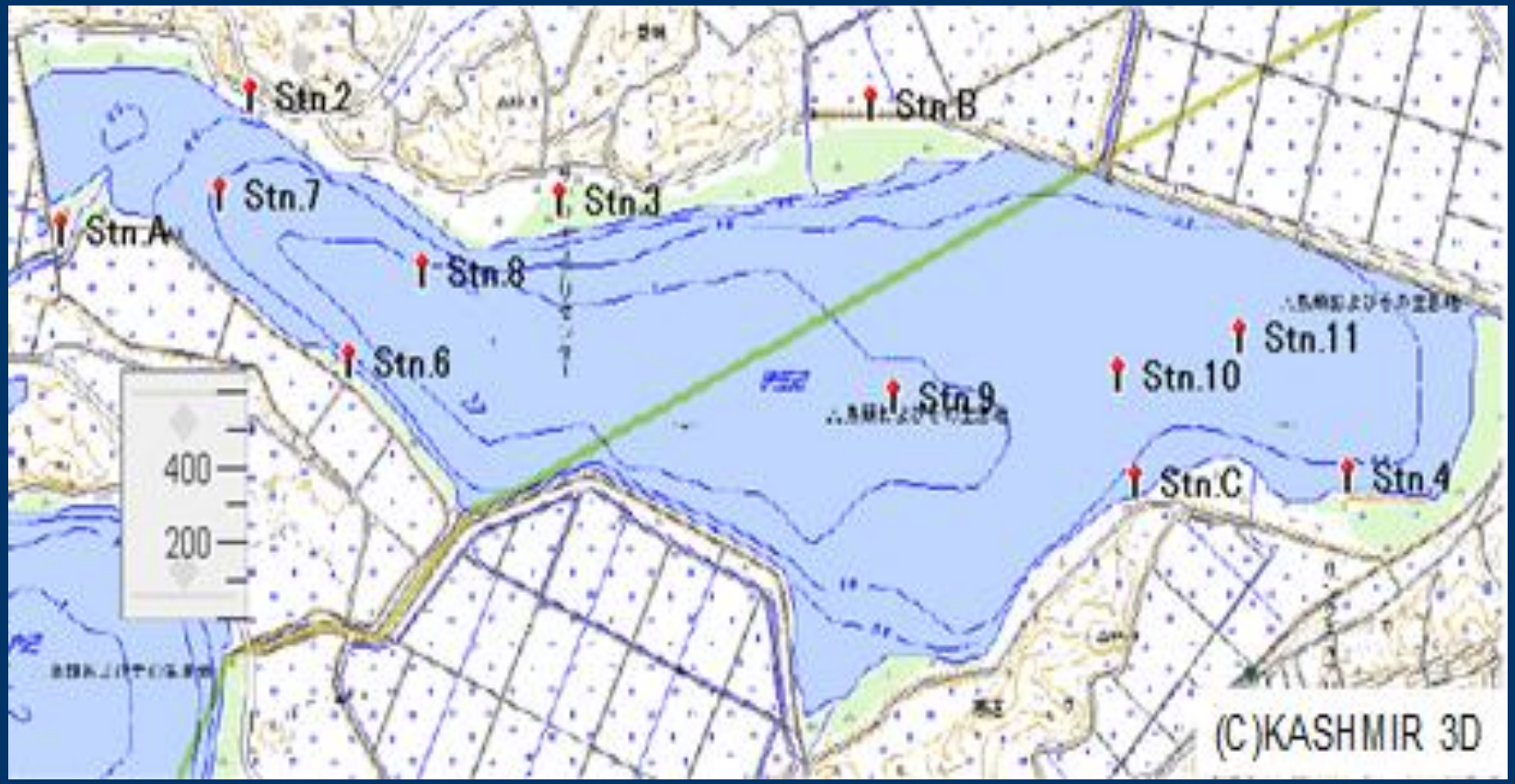


Fig. Sampling points of Lake Izunuma, Miyagi Pref. Japan

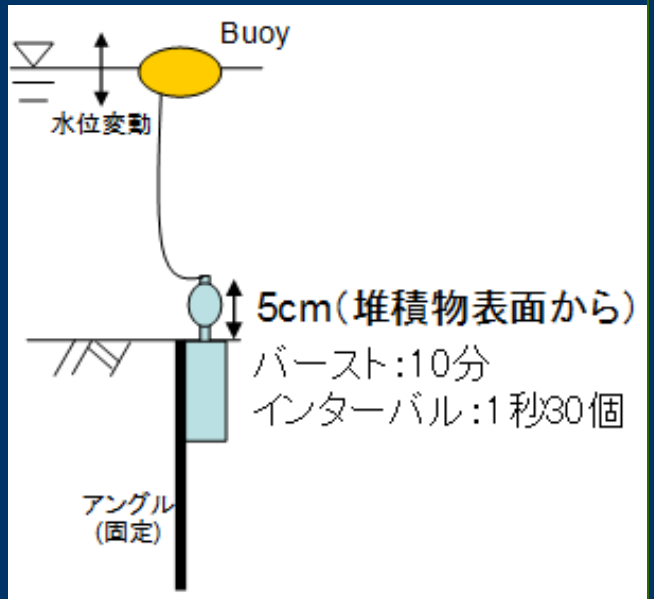

伊豆沼Stn.A


伊豆沼Stn.B

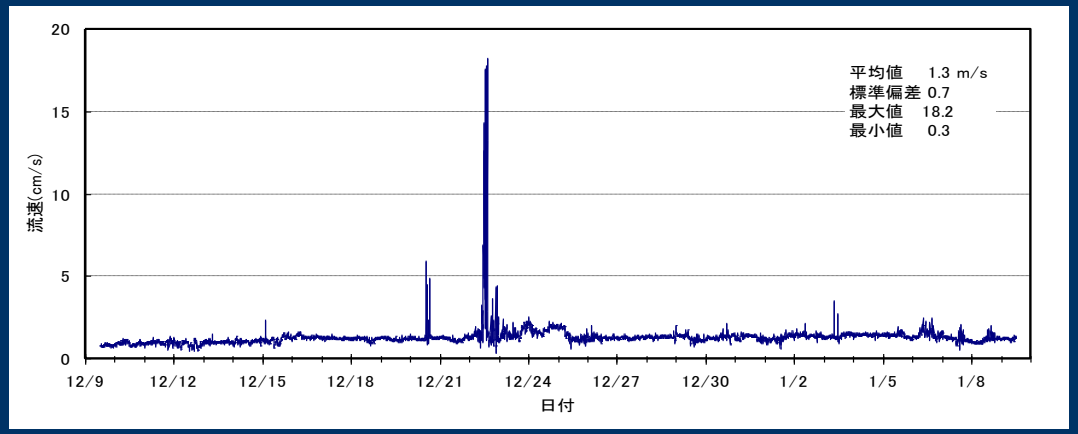

伊豆沼Stn.C

Sediment sampling method

Analysis method of flow velocity

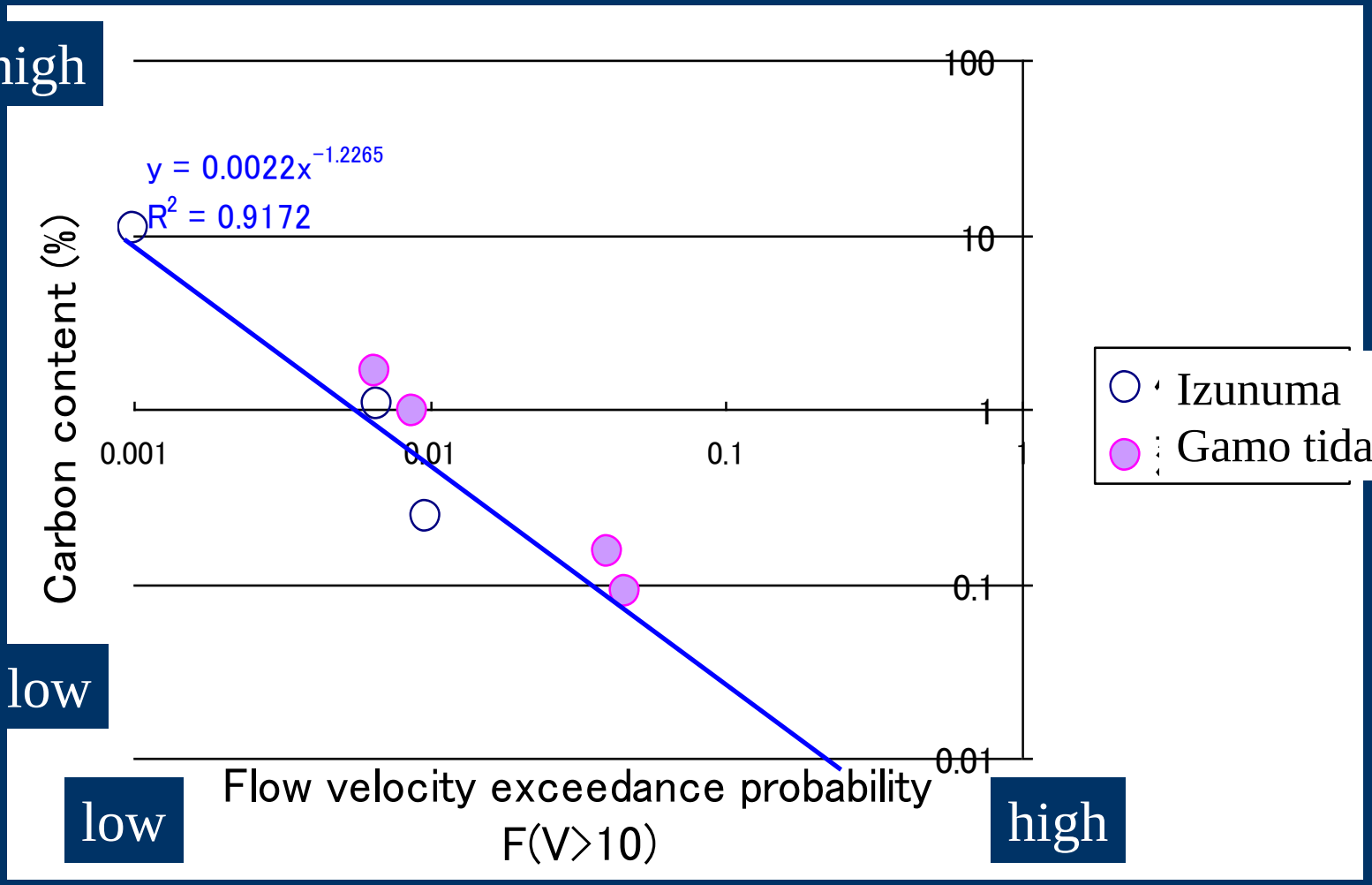


Flow meter was set at the 5cm above the sediment surface

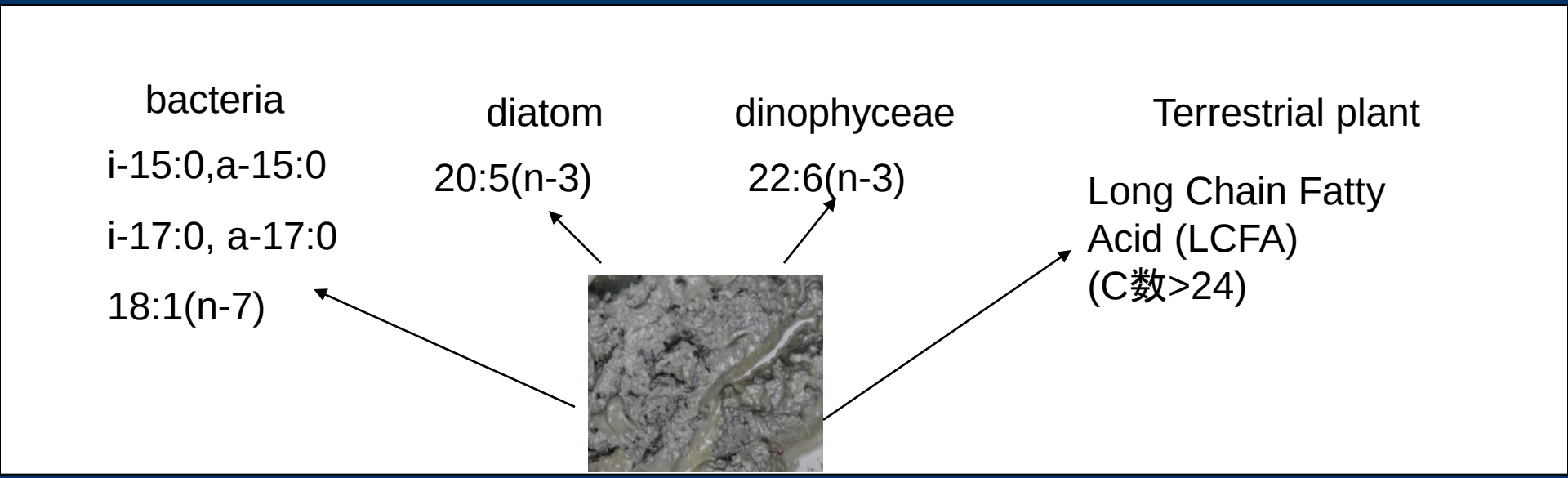


Flow velocity exceedance probability $F(V \geqq Vc) = \dfrac{\text{No. of Data} > Vc\,(cm/s)}{\text{Total No. of Data}}$

Relation between F and organic carbon content of sediment

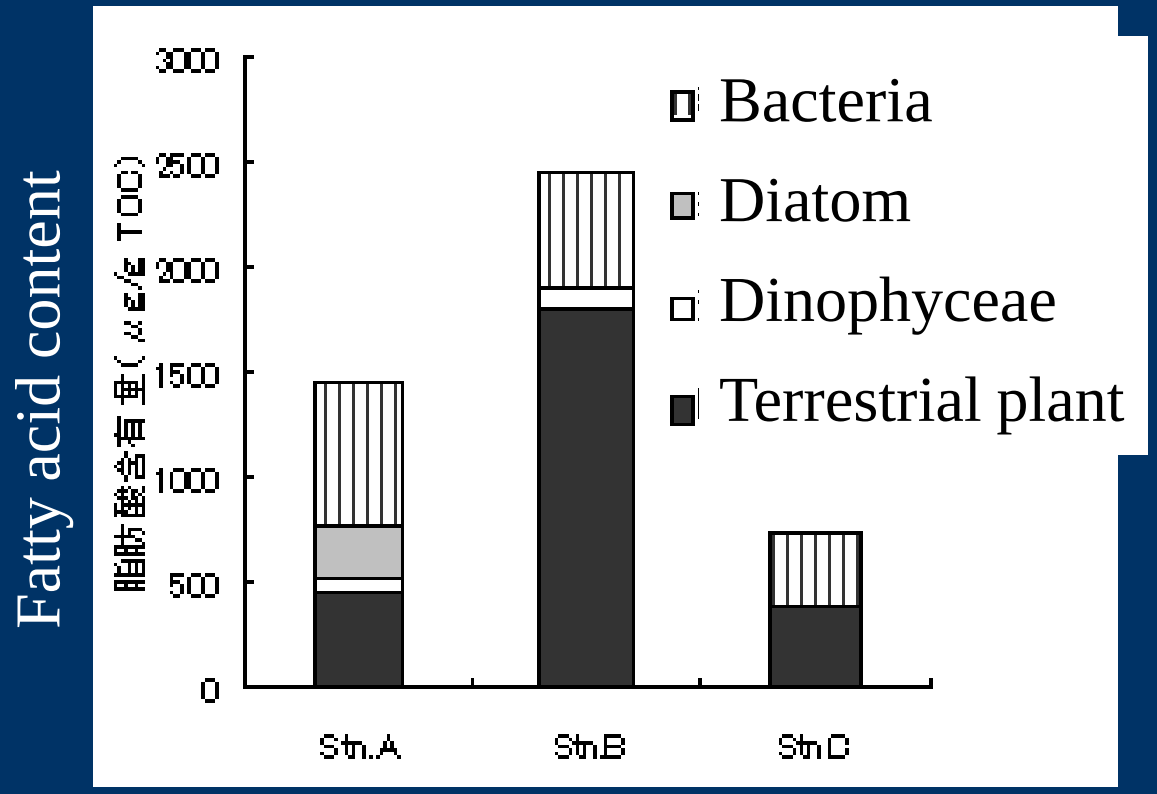


Fatty acid analysis

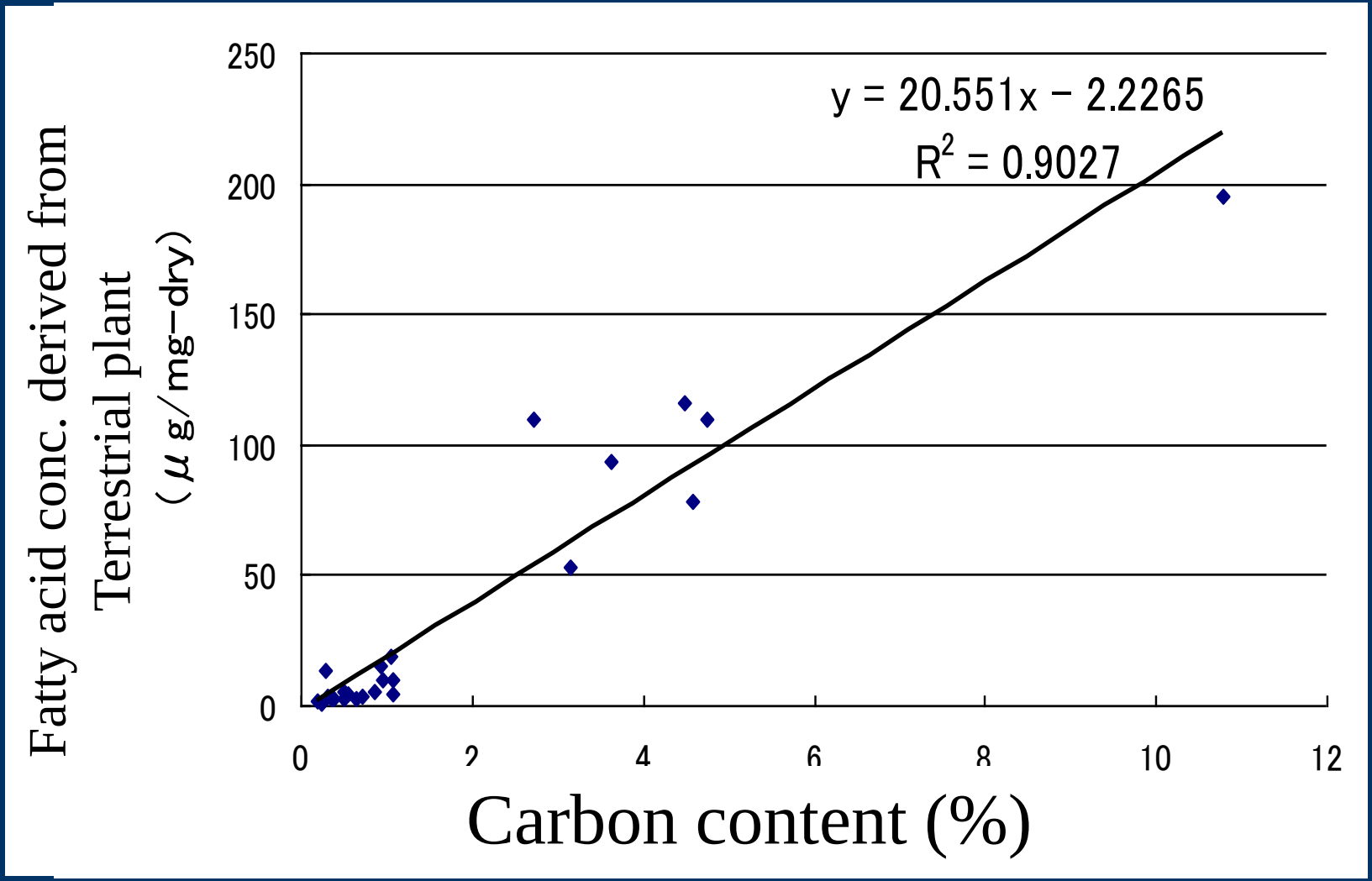


Fatty-acid biomarkers are frequently used for the identification of the origin of organic carbon of sediment.

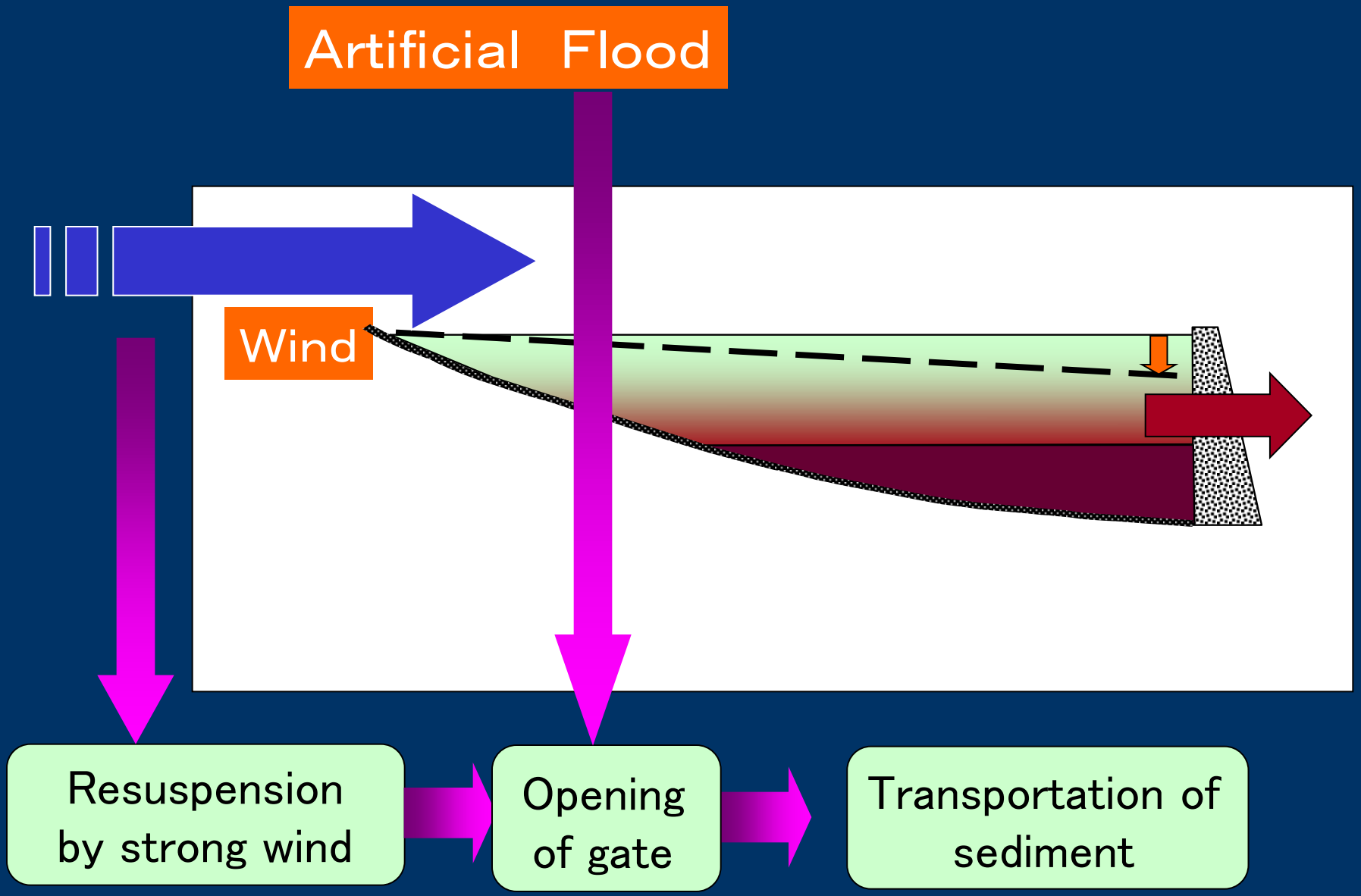
Origin of OM deposited in sediment



Organic content vs. Fatty acid concentration derived from Terrestrial plant



Ecotechnology to improve sediment quality



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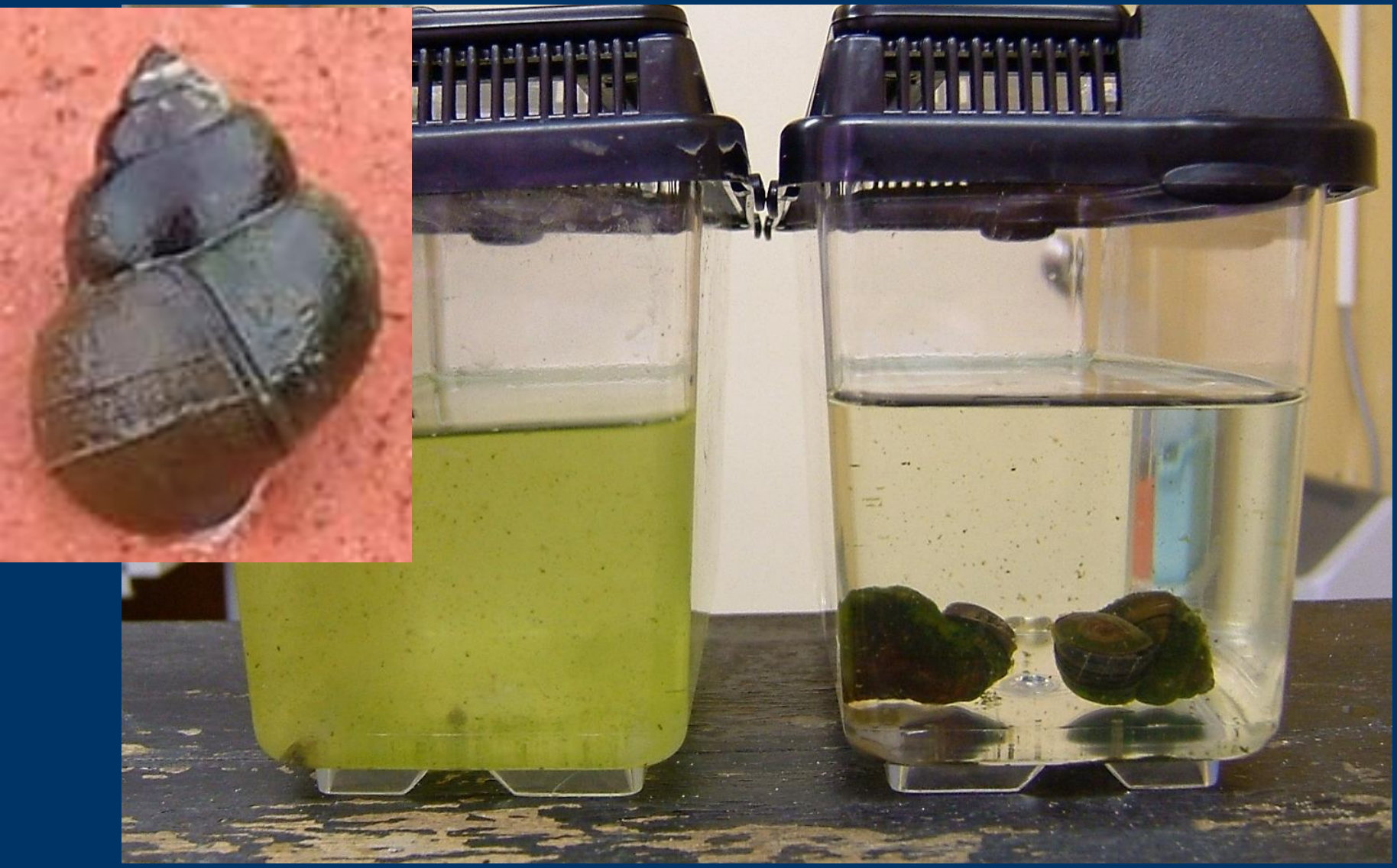
Experiment of filtration activity of pond snail, *Bellamya chinensis*



A mechanism of filtration

For branchial respiration, snail take in water with algae

↓

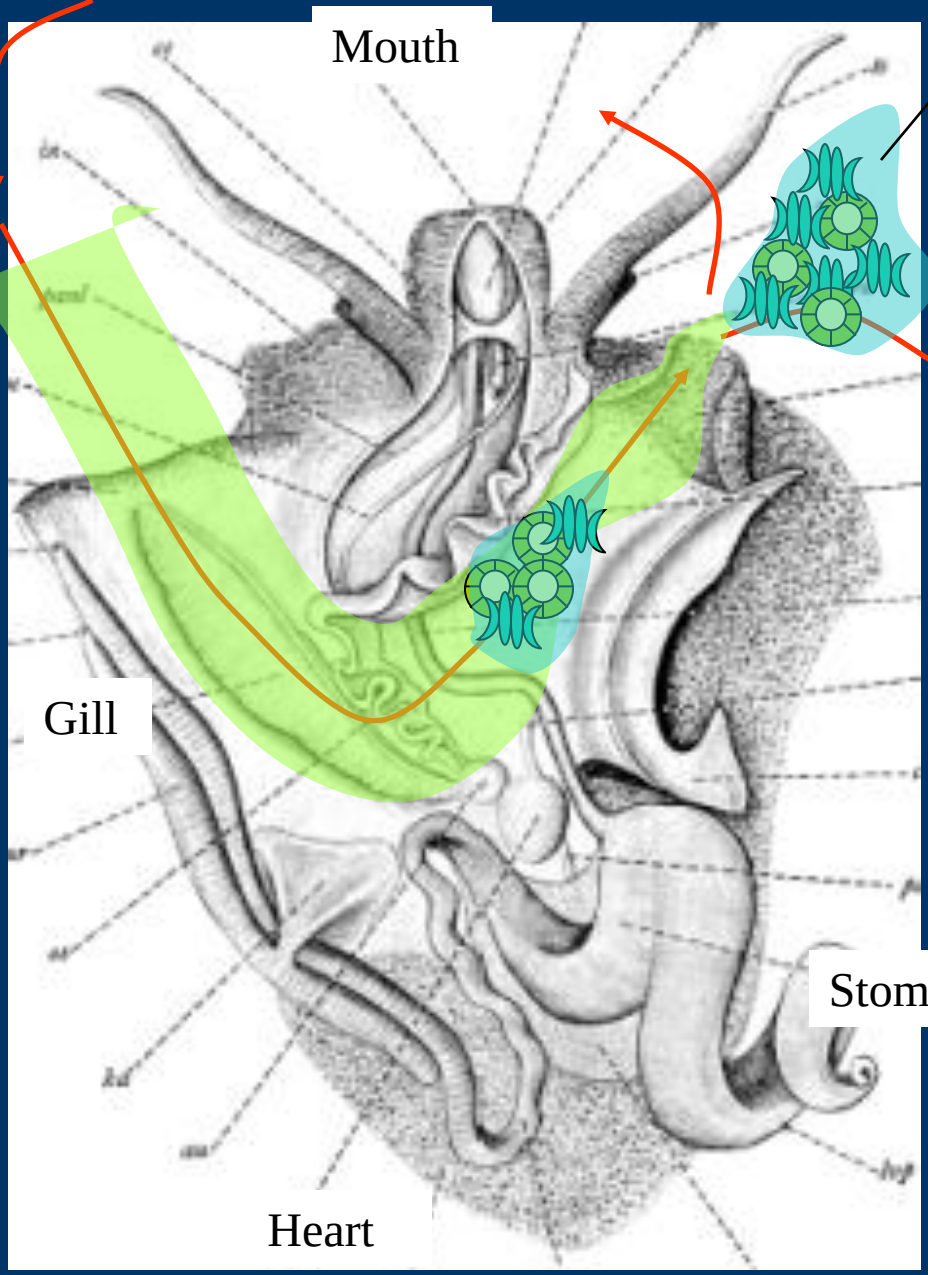
However, the case of snail gill doesn't connect digestive gland

↓

Snail have to eject phytoplankton as pseudofeces with mucus

↓

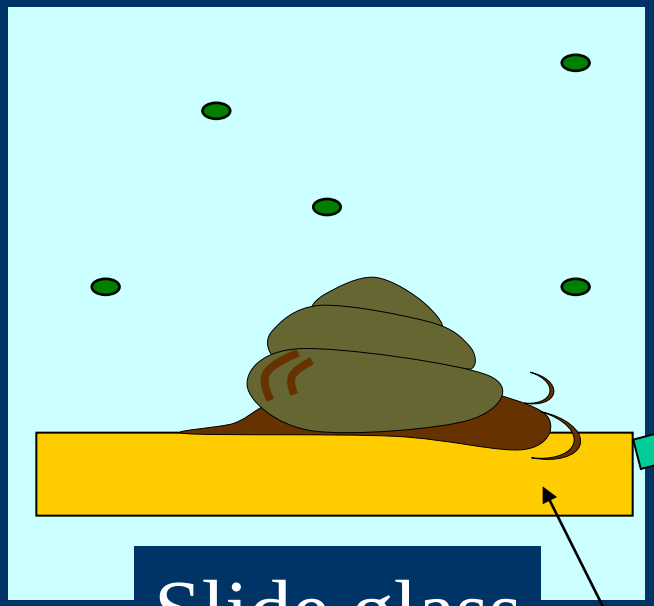
Energy is lost



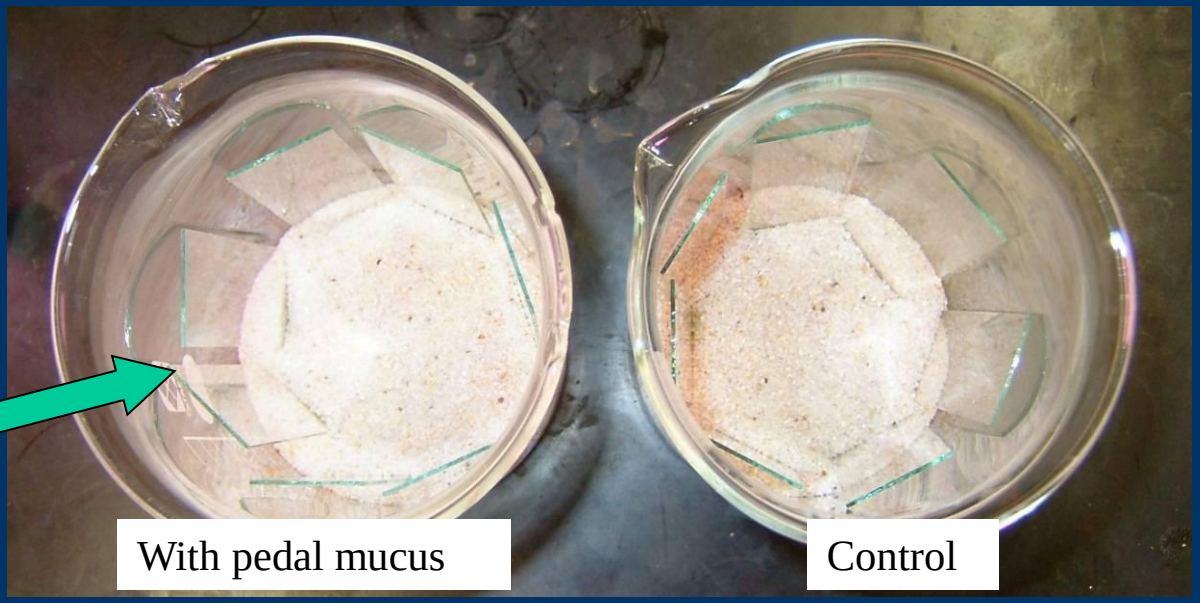
An anatomical chart of *B.chinensis* Taki,1933

The effect of pedal mucus of *B. chinensis* on algal growth

Natural lake water including algae was added



Slide glass



Pedal mucus was coated on slide glass

Slide glasses were used as substrate for attached algae

Pedal mucus stimulated growth of attached algae, which repressed growth of phytoplankton.

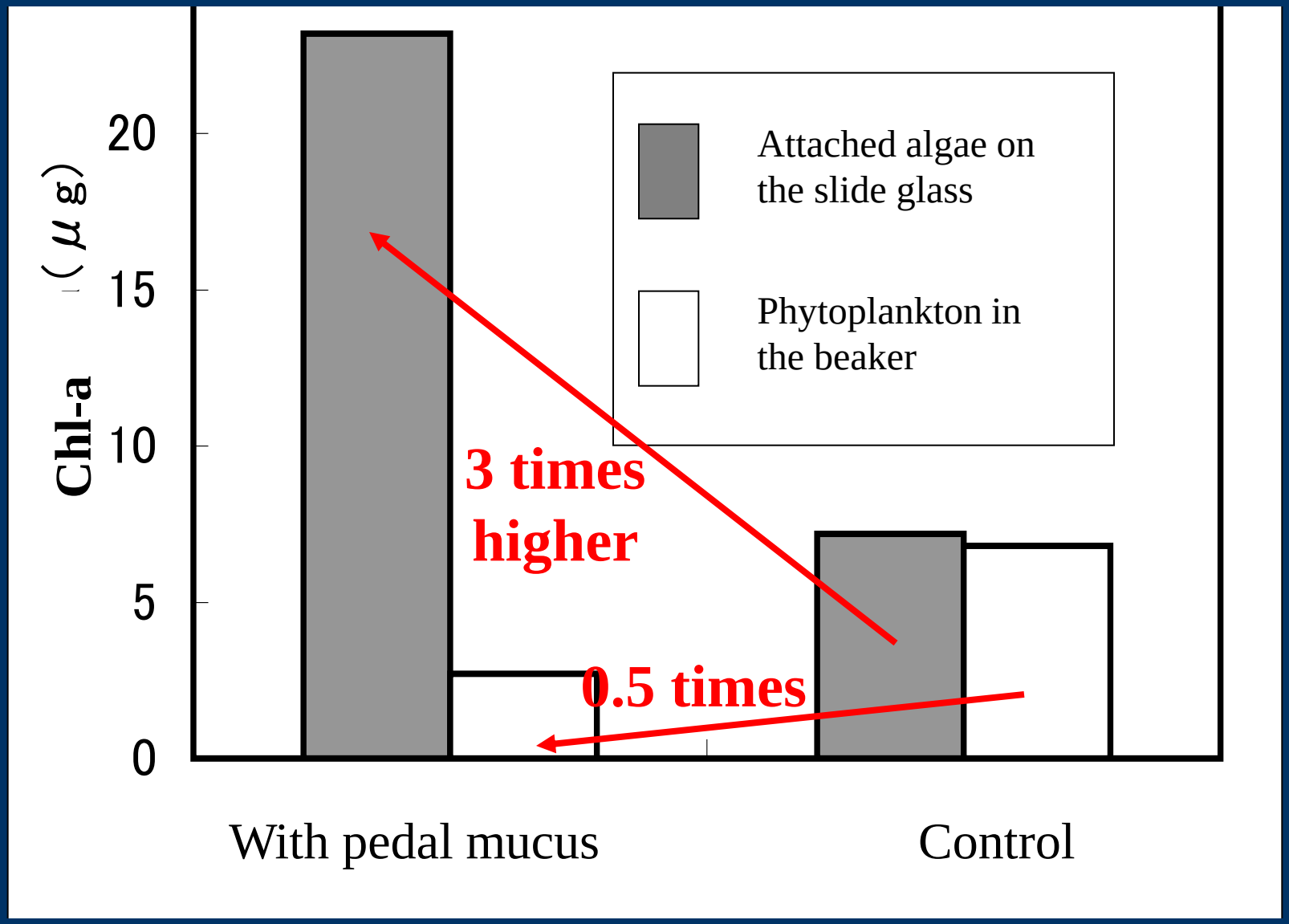


Fig. Abundance of both attached algae and phytoplankton

A mechanism of algal stimulation

・There were a lot of bacteria on the slide glass coated by pedal mucus.

→It is well known that microbe play a key role to develop attached algae on substrates.

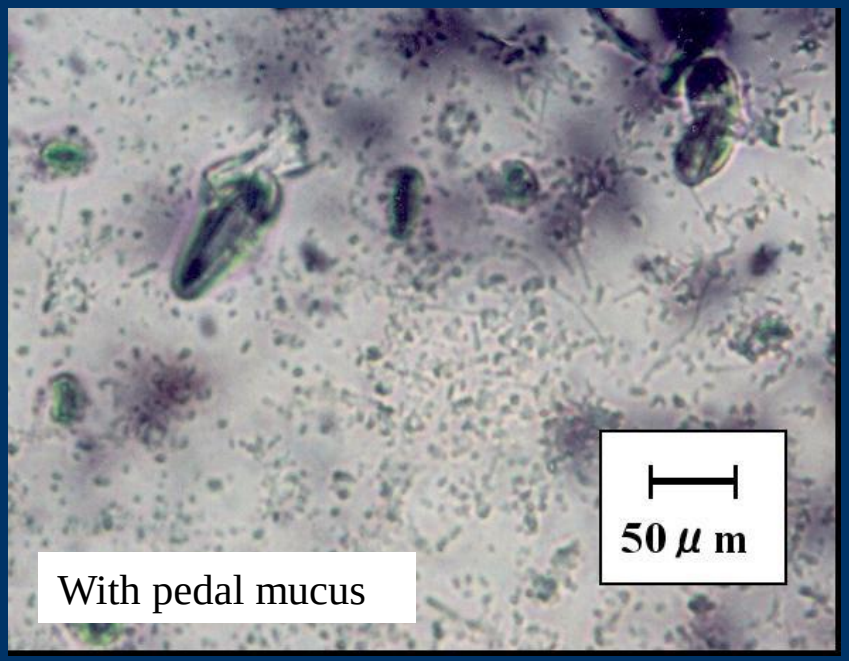


Photo Surface of slide glass with pedal mucus

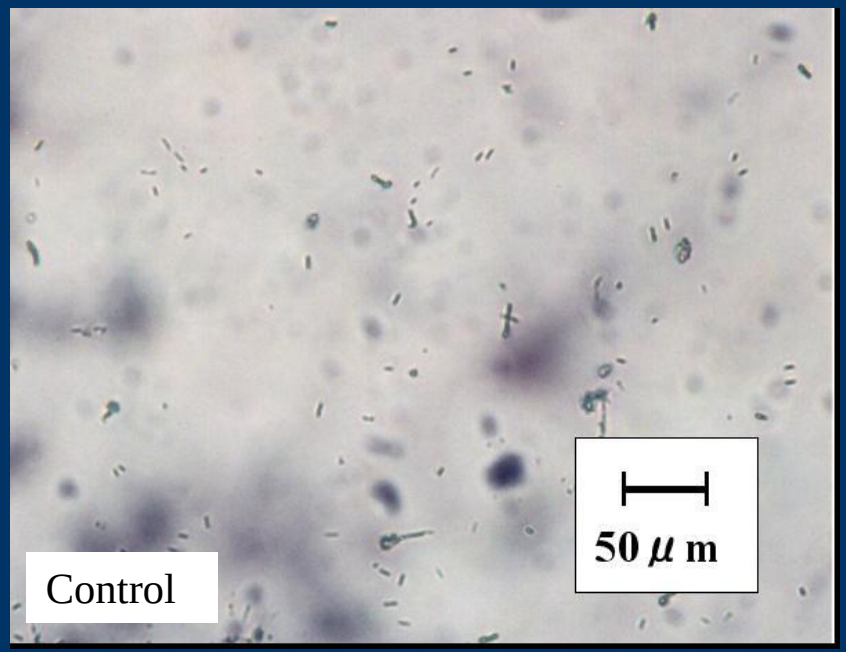


Photo Surface of slide glass without pedal mucus

Relationship between *B. chinensis* and other animals, 1 Tadpole

wikipedia

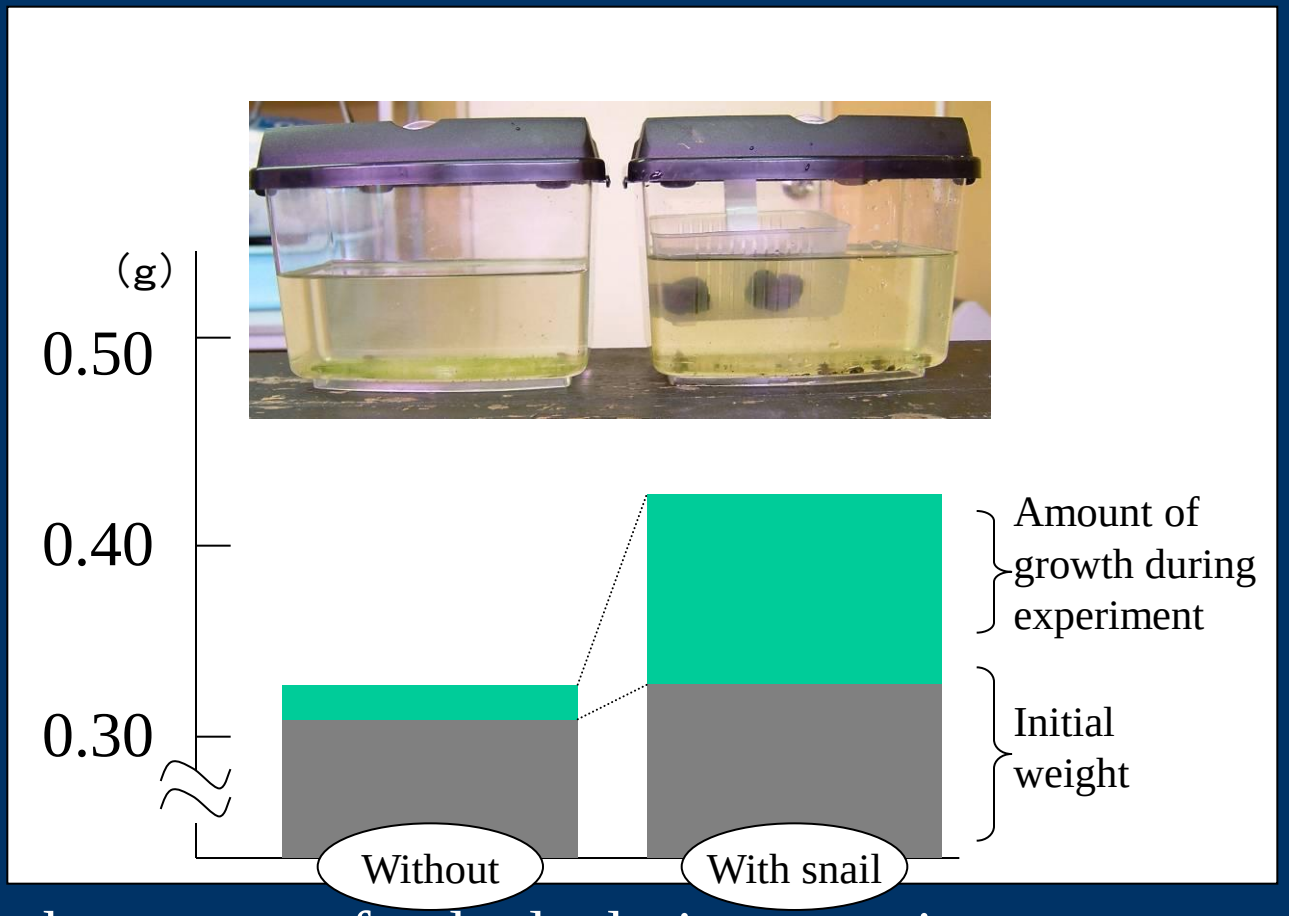
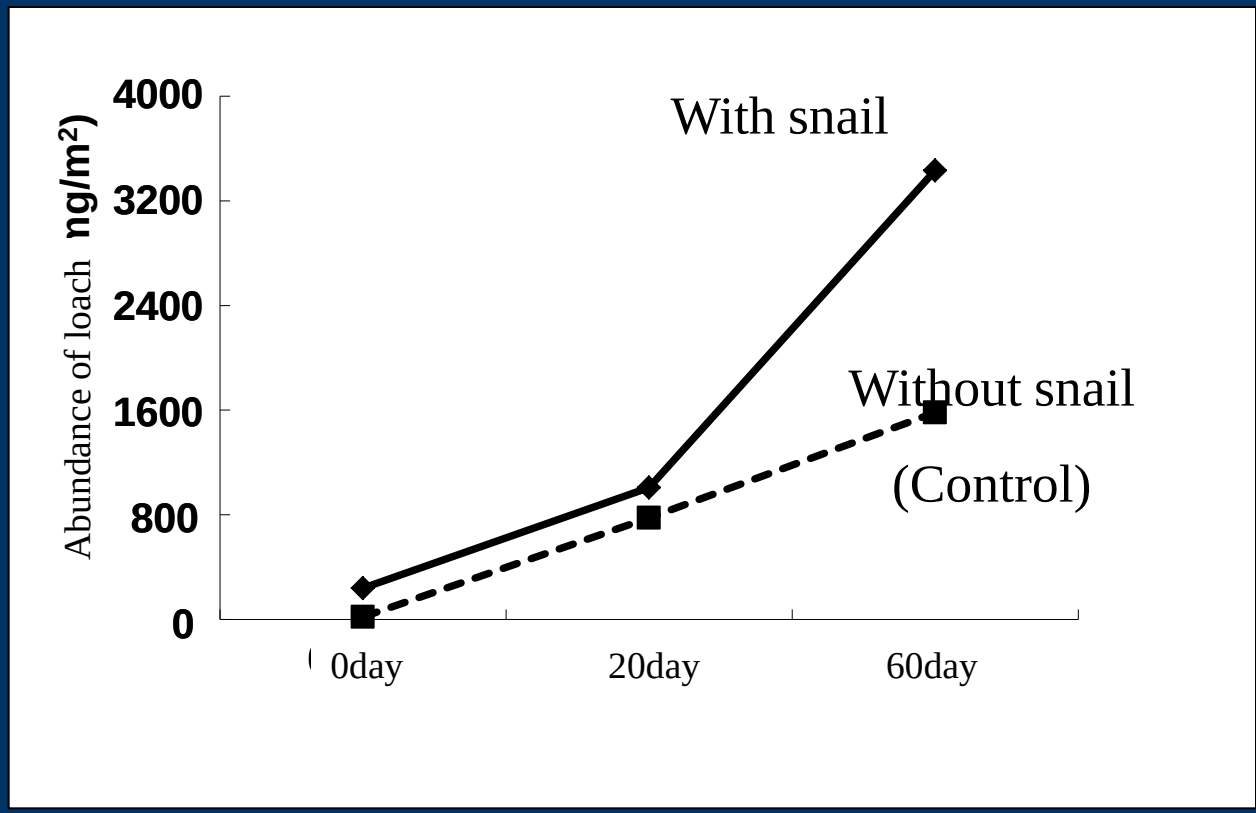


Fig. Growth **amount** of tadpole during experiment

The growth rate of tadpole was improved when tadpole and snails were co-occurrence ($p < 0.05$)

Relationship between *B. chinensis* and other animals, 2. Loach

wikipedia



While loach is considered a competitor for snail, abundance of loach was higher in co-occurrence with snail than control

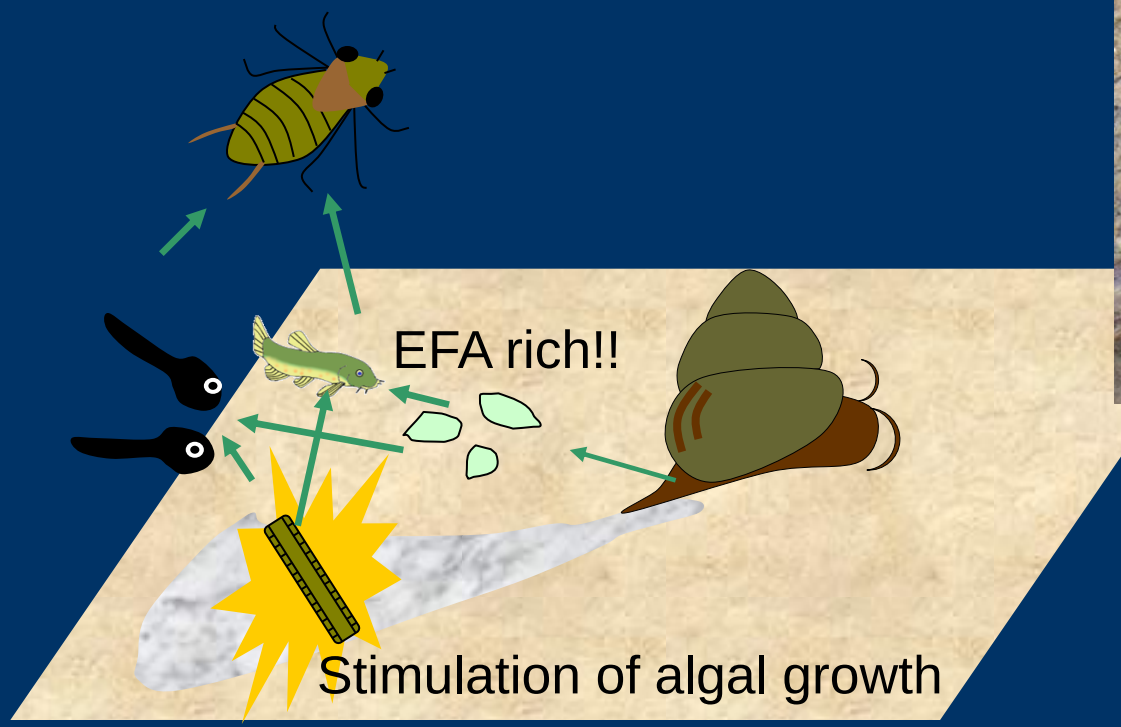
Possible mechanisms of animal growth stimulation

◆Algal stimulation by pedal mucus

→Quantity of food sources for animals is increased.

◆The role of feces of *B. chinensis* as Essential fatty acids (EFA) producer

→Quality of food sources for animals is enhanced



The feces of *B. chinensis* can be easily confirmed by the naked eye at paddy fields

Conclusion

The system of human society and natural environment is very complicated. We have to study more about the impact response of the system.

References

Wetland system

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