APPENDIX V

3. Testing Certificate For Shipboard Test

시 험 성 적 서
Testing Certificate

Korea Marine Equipment Research Institute
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시험성적서 번호
Certificate No. :
KOMERI-GTA-11T511

■ 접수일자 : 2011. 5. 24
Date of Receipt

■ 접수번호 : 11T511
Receipt No.

■ 신 청 자 : SAMKUN CENTURY Co., Ltd.
Applicant

■ 주 소 : Samhangoldenview B/D 11F, Hwamyeong-dong, Busan, Korea
Address

■ 시 료 명 : ARA PLASMA BWTS
Name of Product

■ 모 델 : ARA-250
Model

■ 일련번호 : ARA-001
Serial No.

■ 시험규격 : The Provisional Regulation for Type Approval of Ballast Water Management System by the Ministry of Land, Transport and Maritime Affairs (PR. No. 2011-342, Annex 5 and Annex 6) and Guidelines 8 (IMO Res. MEPC. 174(58), Annex, PART 2, 2.2)
Test Standard

■ 성적서 용도 : Type Approval by the Ministry of Land, Transport and Maritime Affair(Shipboard test)
Purpose of Testing Certificate

■ 시험기간 : 2011. 8. 12 ~ 2012. 3. 18
Test Period

■ 시험환경 : 온도 (20.1 ± 1.0) ℃ , 습도 (40 ± 5) % R.H
Environment Temperature Humidity

■ 시험결과 : **Conformity**
Test Result

본 시험성적서의 시험결과는 신청인이 제공한 시험대상품에 한하며, 한국조선해양기자재연구원장의 사전 서면 승인 없이 성적서의 전부 또는 일부를 복사하여 사용할 수 없음.
The test results are valid only for the test sample(s) provided by the applicant, and cannot be reproduced in full or in part without the prior written consent of the KOMERI

2012. 4. 19

시험원 *Tested by* 성명 *Name*	Jun-Hak Lee (서명)	기술책임자 *Technical Manager* 성명 *Name*	Young-soo Kim (서명)

(재)한국조선해양기자재연구원장 (인)

The President of Korea Marine Equipment Research Institute

TABLE OF CONTENTS

■ GENERAL ····· 3

1. SHIPBOARD TEST ····· 4

ATTACHMENT I. DRAWING ····· 9
ATTACHMENT II. PROCEDURES OF SHIPBOARD TEST ····· 10
ATTACHMENT III. TEST RESULT DETAILS ····· 11
ATTACHMENT IV. ANALYZED SAMPLE PICTURES ····· 17

GENERAL

■ MANUFACTURER

☑ Same as the Applicant

Company Name : SAMKUN CENTURY Co., Ltd.

Address : Samhangoldenview B/D 11F, Hwamyeong-dong, Busan, Korea

■ ADDITIONAL TEST INFORMATION

Treatment Rated Capacity : 250 m^3/hr

Rated : AC 440/380 V, 60 Hz, 43 A

■ TEST SUMMARY

No.	Test Item	Test Standard	Result
1	Shipboard test	The Provisional Regulation for Type Approval of Ballast Water Management System by the Ministry of Land, Transport and Maritime Affairs (PR. No. 2011-342, Annex 5 and Annex 6) and Guidelines 8 (IMO Res. MEPC. 174(58), Annex, PART 2, 2.2)	Conformity

1. SHIPBOARD TEST

1.1 TEST ENVIRONMENT

· Ambient temperature (20.1 ± 1.0) °C

· Relative Humidity (40 ± 5) % R.H.

1.2 TEST STANDARD

· Test standards are The Provisional Regulation for Type Approval of Ballast Water Management System by the Ministry of Land, Transport and Maritime Affairs (PR. No. 2011-342, Annex 5 and Annex 6) and Guidelines 8 (IMO Res. MEPC. 174(58), Annex, PART 2, 2.2), and details as below;

	Item	Test standard	Remark
◆	Water temperature	APHA Standard Method 2550:2012	Measurement with Electrode multiprobe (Hydrolab, USA)
◆	pH	APHA Standard Method 4500 H^+ B:2012	
◆	ORP	APHA Standard Method 2580:2012	
◆	Salinity	APHA Standard Method 2520 B:2012	
◆	DO	ASTM Standard Method D888-09 C:2010	
◆	Turbidity	APHA Standard Method 2130 B:2012	Measurement with Turbidity meter (Hach, 2100 P)
◆	TSS	APHA Standard Method 2540 D:2012	-
◆	DOC/POC	ISO 8245:1999	-
◆	Viable organisms (≥ 50 μm)	Fleming & Coughlan, 1978, US EPA 600/R-10/146:2010, APHA Standard Method 10200 C:2012	Staining with Neutral Red, Touch with the point of a fine dissecting needle, Concentration techniques
◆	Viable organisms (≥ 10 - 50 μm)	Anja et al., 2005, APHA Standard Method 10200 C:2012	Fluorescence dyeing with 5-CFDA AM, Concentration techniques
◆	Heterotrophic bacteria	APHA Standard Method 9215:2012	-
◆	Total coliform	APHA Standard Method 9222 B:2012	-
◆	*Escherichia coli*	US EPA 1603:2009	-
◆	Intestinal Enterococci	US EPA 1600:2009	
◆	Toxicogenic *Vibrio cholerae* (O1, O139)	APHA Standard Method 9260 H:2012 and/or API 20E kit (BioMerieux, Inc.)	

1.3 TEST EQUIPMENT

	Description	Manufacturer	Model Number	Calibration Due
◆	Fluorescent microscope	Olympus	CFX41-33FL	-
◆	Sedgewick-Rafter chamber	Pyser-SGI	-	-
◆	Stereo-microscope	Olympus	SZ40	-
◆	Bogorov counting chamber	DH Sci.	-	-
◆	Multiprobe (Hydrolab)	Hach company	Hydrolab DS5	-
◆	Portable cleanbooth	DS Tech.	-	-
◆	Turbidity meter	Hach company	2100 P	-
◆	Digital imaging	BAUMER	TDI DMC3	-
◆	Digital imaging	Olympus	JUJAK 5.5	-
◆	Standard sieve	Sefar	30 μm (diagonal)	~ 2012. 12. 05
◆	Standard sieve	Sefar	10 μm (diagonal)	-
◆	Plankton net	SA Sci.	conical type (30 μm, diagonal)	-
◆	Auto pipette	Labnet International, inc.	BP-10000	~ 2012. 12. 06
◆	Micro (Pasteur) pipette	Hilgenberg	31 501 02	-
◆	Auto pipette	Labnet International, inc.	BP-1000	~ 2012. 12. 06
◆	Auto pipette	Labnet International, inc.	BP-200	~ 2012. 12. 06
◆	Filtration system	Nalgene	350 mL	-
◆	Vacuum pump	THOMAS	-	-
◆	Mass cylinder	Witeg	100 mL	~ 2015. 06. 04
◆	Portable incubators	CAIS	KC2500	-

1.4 TEST SET-UP

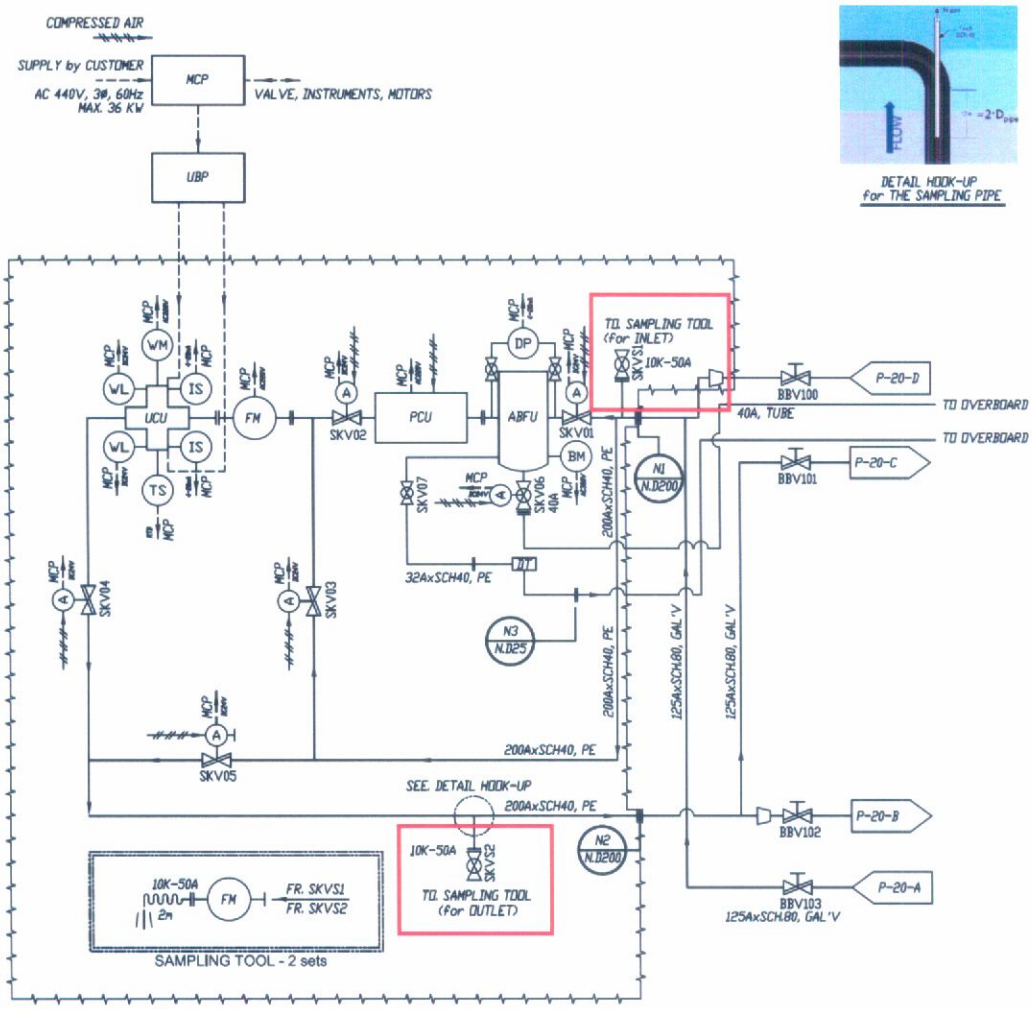


Figure 1. Diagram of the shipboard test facility of the ARA PLASMA BWTS

1.5 TEST PROCEDURE

· See Appendix II. PROCEDURES OF SHIPBOARD TEST.

1.6 TEST SCHEDULE

Test cycle	Test date and location	
	Ballasting	de-Ballasting
1st	2011. 08. 12 Saganoseki port/Japan	2011. 08. 17 Fukuyama port/Japan
2nd	2011. 11. 21 Dalian port/China	2011. 11. 25 Dalian port/China
3rd	2012. 03. 12 Hongkong port/China	2012. 03. 18 Gwangyang port/Korea

1.7 TEST RESULTS

1.7.1 Assessment of valid tests

(1) Viable organisms of influent water

Test cycle	≥ 50 μm organisms (inds./m^3)	≥ 10 - 50 μm organisms (inds./mL)	Remarks
1st	30 506	125	Conformity
2nd	27 150	158	Conformity
3rd	2 027	128	Conformity
Valid requirement	**> 100**	**> 100**	-

※ Data indicates an arithmetic mean.

(2) Viable organisms of discharge control water

Test cycle	≥ 50 μm organisms (inds./m^3)	≥ 10 - 50 μm organisms (inds./mL)	Remarks
1st	2 548	15	Conformity
2nd	15 034	22	Conformity
3rd	1 674	27	Conformity
Valid requirement	**> 10**	**> 10**	-

※ Data indicates an arithmetic mean.

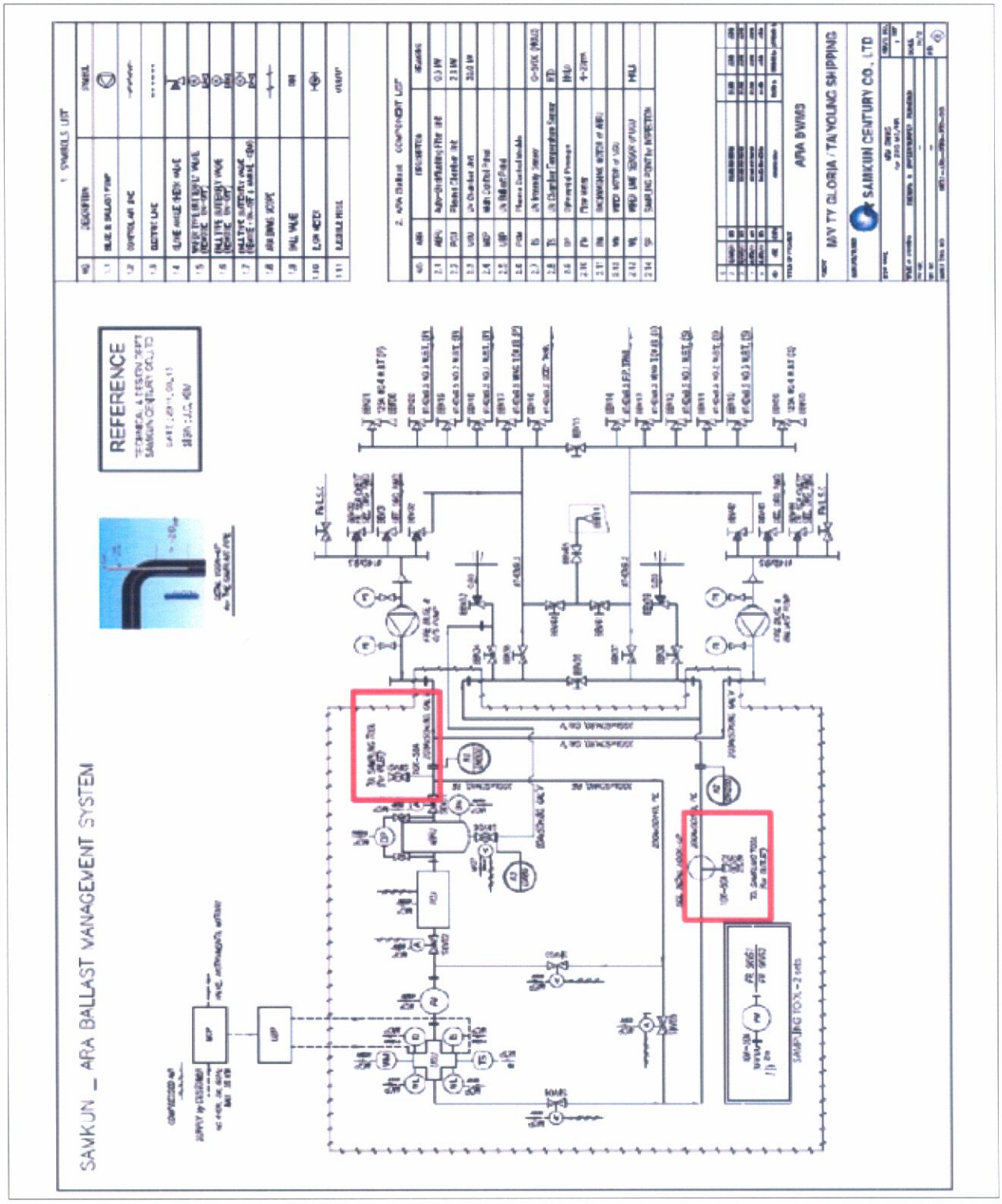
1.7.2 Assessment of discharge treated water

Test cycle	≥ 50 μm organisms (inds./m^3)	≥ 10 - 50 μm organisms (inds./mL)	*Escherichia coli* (cfu/100 mL)	Intestinal Enterococci (cfu/100 mL)	Toxicogenic *Vibrio cholerae* (O1, O139) (cfu/100 mL)	Remarks
1st	6	0	1	1	0	Conformity
2nd	2	0	0	0	0	Conformity
3rd	1	1	0	0	0	Conformity
Discharge requirement	< 10	< 10	< 250	< 100	< 1	-

※ Data indicates an arithmetic mean.

ATTACHMENT

I. DRAWING

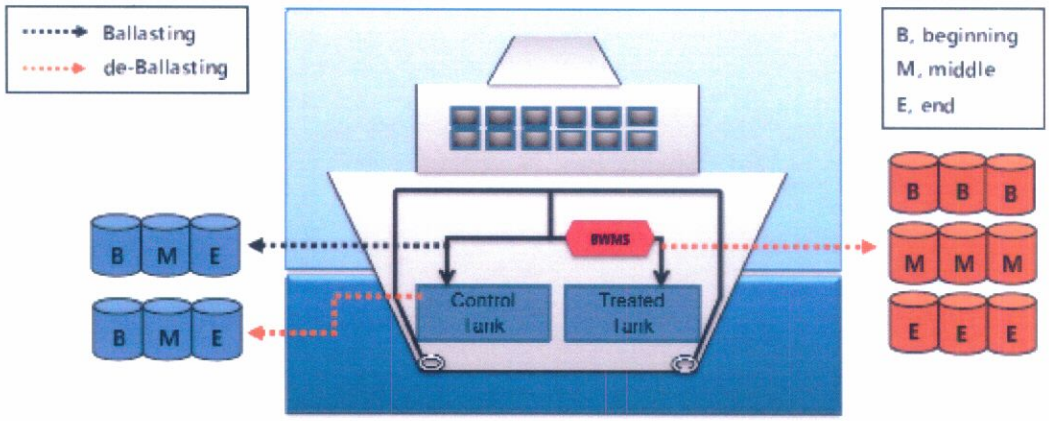


II. PROCEDURES OF SHIPBOARD TEST

KOMERI SOP BWMS 02
Rev. 2.0 May 2011

BWMS Test Procedure on Shipboard Test

The test cycles including invalid and unsuccessful test cycles are to span a trial period of not less than six months

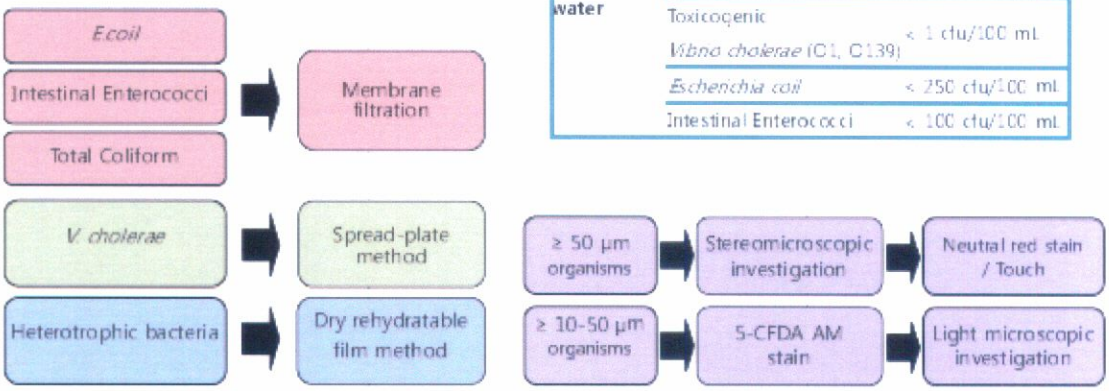


Sample volume			
Ballasting	Influent water	≥ 50 μm organisms	1 m³ × 3
		≥ 10-50 μm organisms	1 L × 3
		Bacteria	500 mL × 3
de-Ballasting	Discharge control water	≥ 50 μm organisms	1 m³ × 3
		≥ 10-50 μm organisms	1 L × 3
	Discharge Treated water	≥ 50 μm organisms	1 m³ × 9
		≥ 10-50 μm organisms	1 L × 9
		Bacteria	500 mL × 9

<Standard for valid test>

Ballasting		
Influent water	≥ 50 μm organisms	> 100 inds./m³
	≥ 10-50 μm organisms	> 100 inds./mL

de-Ballasting		
Discharge Control water	≥ 50 μm organisms	> 10 inds./m³
	≥ 10-50 μm organisms	> 10 inds./mL
Discharge Treated water	≥ 50 μm organisms	< 10 inds./m³
	≥ 10-50 μm organisms	< 10 inds./mL
	Toxicogenic *Vibrio cholerae* (O1, O139)	< 1 cfu/100 mL
	Escherichia coli	< 250 cfu/100 mL
	Intestinal Enterococci	< 100 cfu/100 mL



III. TEST RESULT DETAILS

· Ballasting (1st cycle : 2011. 08. 12, Saganoseki port)

Test Item	Ballasting			
	Source water	Influent water		
		B[1]	M[2]	E[3]
Water temperature (°C)	25.67	24.89	25.66	25.91
pH	8.48	8.42	8.48	8.48
ORP (mV)	265	276	266	264
Salinity (psu)	33.72	33.94	33.72	33.63
DO (mg/L)	6.80	6.71	6.80	6.80
Turbidity (NTU)	1.14	1.14	1.12	1.02
TSS (mg/L)	10.50	-	-	-
DOC (mg/L)	1.27	-	-	-
POC (mg/L)	0.14	-	-	-
≥ 50 μm organisms (inds./m^3)	-	39 800	29 834	21 844
≥ 10 - 50 μm organisms (inds./mL)	-	116	140	117
Heterotrophic bacteria (cells/mL)	-	TNTC[4]	TNTC	TNTC
Total Coliform (cfu/100 mL)	-	23	672	580
Escherichia coli (cfu/100 mL)	-	73	113	80
Intestinal Enterococci (cfu/100 mL)	-	0	0	0
Toxicogenic *Vibrio cholerae* (O1, O139) (cfu/100 mL)	-	0	0	0

[1]Beginning, [2]Middle, [3]End, [4]Too Numerous To Count.

· **de-Ballasting (1st cycle : 2011. 08. 17, Fukuyama port)**

Test Item	de-Ballasting											
	Discharge control water			Discharge treated water								
	B[1]	M[2]	E[3]	B1	B2	B3	M1	M2	M3	E1	E2	E3
Water temperature (°C)	28.88	28.90	28.84	28.88	28.75	28.80	28.78	28.79	28.79	28.88	28.93	29.04
pH	8.31	8.31	8.31	8.30	8.38	8.39	8.38	8.38	8.38	8.37	8.38	8.30
ORP (mV)	227	228	227	260	250	246	248	249	238	251	230	227
Salinity (psu)	34.01	34.00	33.99	33.45	33.50	33.46	33.44	33.48	33.49	33.50	33.50	33.50
DO (mg/L)	5.49	5.55	5.55	5.70	5.86	5.86	6.01	6.01	6.03	5.94	5.92	5.98
Turbidity (NTU)	0.74	0.90	2.26	1.26	1.10	1.12	0.70	0.97	1.24	1.19	0.87	0.55
≥ 50 μm organisms (inds./m^3)	875	3 634	3 134	6	4	4	3	2	6	10	7	7
≥ 10 - 50 μm organisms (inds./mL)	15	14	15	0	0	0	0	0	0	0	0	0
Heterotrophic bacteria (cells/mL)	-	-	-	TNTC[4]	98	138	72	118	98	96	79	TNTC
Total Coliform (cfu/100 mL)	-	-	-	1	0	0	0	0	0	0	0	0
Escherichia coli(cfu/100 mL)	-	-	-	1	0	0	0	2	0	0	0	0
Intestinal Enterococci (cfu/100 mL)	-	-	-	1	0	0	0	0	0	0	0	0
Toxicogenic *Vibrio cholerae* (O1, O139) (cfu/100 mL)	-	-	-	0	0	0	0	0	0	0	0	0

[1]Beginning, [2]Middle, [3]End, [4]Too Numerous To Count.

· **Ballasting (2nd cycle : 2011. 11. 21, Dalian port)**

Test Item	Ballasting			
	Source water	Influent water		
		B[1]	M[2]	E[3]
Water temperature (°C)	12.03	12.53	25.66	25.91
pH	7.72	8.03	8.48	8.48
ORP (mV)	355	382	266	264
Salinity (psu)	30.90	31.11	33.72	33.63
DO (mg/L)	6.58	8.31	6.80	6.80
Turbidity (NTU)	1.95	2.87	1.12	1.02
TSS (mg/L)	9.20	-	-	-
DOC (mg/L)	2.02	-	-	-
POC (mg/L)	0.03	-	-	-
≥ 50 μm organisms (inds./m^3)	-	29 650	25 850	25 950
≥ 10 - 50 μm organisms (inds./mL)	-	156	133	185
Heterotrophic bacteria (cells/mL)	-	TNTC[4]	TNTC	TNTC
Total Coliform (cfu/100 mL)	-	TNTC	TNTC	TNTC
Escherichia coli (cfu/100 mL)	-	TNTC	TNTC	TNTC
Intestinal Enterococci (cfu/100 mL)	-	TNTC	TNTC	TNTC
Toxicogenic *Vibrio cholerae* (O1, O139) (cfu/100 mL)	-	0	0	0

[1]Beginning, [2]Middle, [3]End, [4]Too Numerous To Count.

· **de-Ballasting (2nd cycle : 2011. 11. 25, Dalian port)**

Test Item	de-Ballasting											
	Discharge control water			Discharge treated water								
	B[1]	M[2]	E[3]	B1	B2	B3	M1	M2	M3	E1	E2	E3
Water temperature (°C)	12.83	12.02	12.19	12.33	12.31	12.33	12.35	12.48	12.59	12.25	12.39	12.20
pH	7.87	8.01	8.00	8.05	8.10	8.06	8.07	8.08	8.10	8.08	8.07	8.08
ORP (mV)	376	367	348	352	344	342	342	337	335	335	331	332
Salinity (psu)	31.25	31.20	31.17	31.21	30.98	30.42	31.10	31.00	31.03	31.05	31.03	31.09
DO (mg/L)	7.69	7.78	8.03	7.45	7.03	6.96	7.32	7.26	7.23	7.54	7.16	7.45
Turbidity (NTU)	3.10	3.37	1.09	1.88	2.69	1.88	1.78	1.84	1.90	1.84	1.90	1.26
≥ 50 μm organisms (inds./m^3)	15 750	14 250	15 100	2	1	2	0	0	1	2	1	1
≥ 10 - 50 μm organisms (inds./mL)	19	21	24	0	0	0	0	0	0	0	0	0
Heterotrophic bacteria (cells/mL)	-	-	-	TNTC[4]	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC
Total Coliform (cfu/100 mL)	-	-	-	0	0	0	0	0	0	0	0	0
Escherichia coli(cfu/100 mL)	-	-	-	0	0	0	0	0	0	0	0	0
Intestinal Enterococci (cfu/100 mL)	-	-	-	0	0	0	0	0	0	0	0	0
Toxicogenic *Vibrio cholerae* (O1, O139) (cfu/100 mL)	-	-	-	0	0	0	0	0	0	0	0	0

[1]Beginning, [2]Middle, [3]End, [4]Too Numerous To Count.

· **Ballasting (3rd cycle : 2012. 03. 12, Hongkong port)**

Test Item	Ballasting			
	Source water	Influent water		
		B[1]	M[2]	E[3]
Water temperature (°C)	17.18	17.06	17.18	17.12
pH	8.13	8.40	8.40	8.39
ORP (mV)	318	276	265	259
Salinity (psu)	33.02	33.26	33.16	32.97
DO (mg/L)	7.48	7.56	7.59	7.54
Turbidity (NTU)	4.48	4.36	3.56	3.04
TSS (mg/L)	12.40	-	-	-
DOC (mg/L)	1.10	-	-	-
POC (mg/L)	0.06	-	-	-
≥ 50 μm organisms (inds./m^3)	-	2 114	2 147	1 820
≥ 10 - 50 μm organisms (inds./mL)	-	111	122	150
Heterotrophic bacteria (cells/mL)	-	59	74	83
Total Coliform (cfu/100 mL)	-	240	150	190
Escherichia coli (cfu/100 mL)	-	28	41	22
Intestinal Enterococci (cfu/100 mL)	-	12	5	12
Toxicogenic *Vibrio cholerae* (O1, O139) (cfu/100 mL)	-	0	0	0

[1]Beginning, [2]Middle, [3]End.

· **de-Ballasting (3rd cycle : 2012. 03. 18, Gwangyang port)**

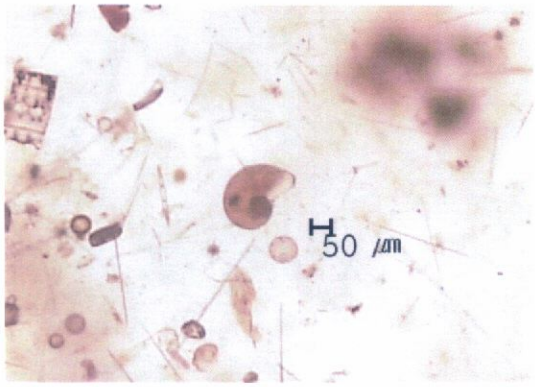
Test Item	de-Ballasting											
	Discharge control water			Discharge treated water								
	B[1]	M[2]	E[3]	B1	B2	B3	M1	M2	M3	E1	E2	E3
Water temperature (°C)	12.34	12.35	12.52	11.98	12.07	12.04	12.19	12.10	12.17	12.20	12.28	12.31
pH	8.08	8.32	8.32	8.37	8.37	8.37	8.36	8.35	8.37	8.34	8.37	8.37
ORP (mV)	327	285	282	278	276	275	274	273	272	271	270	269
Salinity (psu)	33.11	32.94	33.03	33.18	33.14	33.19	33.21	33.21	33.22	33.20	33.24	33.22
DO (mg/L)	7.67	7.52	7.74	8.06	8.05	8.11	8.11	8.13	8.20	8.07	8.21	8.19
Turbidity (NTU)	2.37	2.52	1.97	3.76	2.90	2.73	2.56	3.09	2.85	2.97	2.33	2.56
≥ 50 μm organisms (inds./m^3)	1 654	1 647	1 720	0	0	1	0	0	0	0	0	0
≥ 10 - 50 μm organisms (inds./mL)	36	25	20	1	0	0	0	0	0	0	1	0
Heterotrophic bacteria (cells/mL)	-	-	-	5	2	6	5	2	5	1	0	3
Total Coliform (cfu/100 mL)	-	-	-	0	0	0	0	0	0	0	0	0
Escherichia coli(cfu/100 mL)	-	-	-	0	0	0	0	0	0	0	0	0
Intestinal Enterococci (cfu/100 mL)	-	-	-	0	0	0	0	0	0	0	0	0
Toxicogenic *Vibrio cholerae* (O1, O139) (cfu/100 mL)	-	-	-	0	0	0	0	0	0	0	0	0

[1]Beginning, [2]Middle, [3]End.

IV. ANALYZED SAMPLE PICTURES

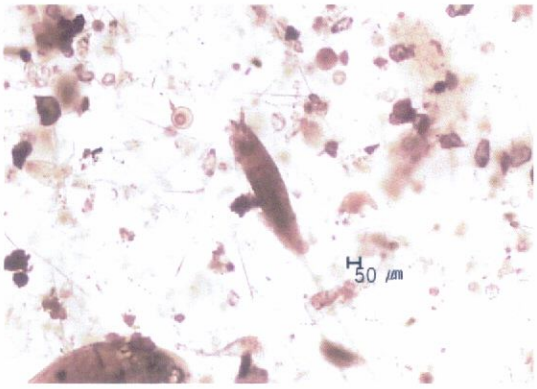
1. ≥ 50 μm organisms

· **Ballasting (1st cycle : 2011. 08. 12, Saganoseki port)**

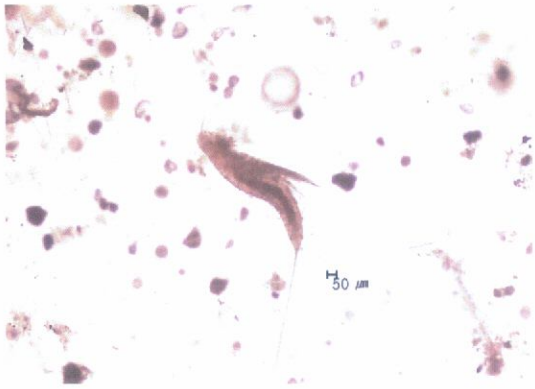


Gastropod larva (Influent water)

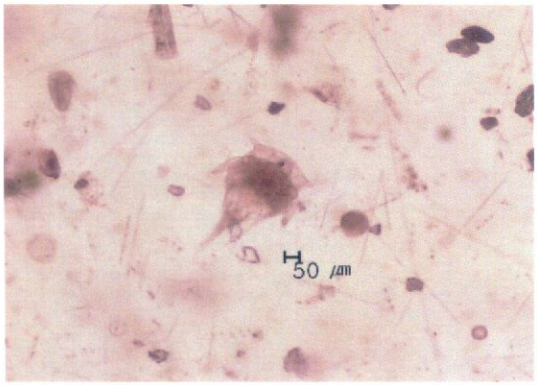
Cyprid larva (Influent water)



Harpacticoida (Influent water)



Harpacticoida (Influent water)



Balanus larva (Influent water)

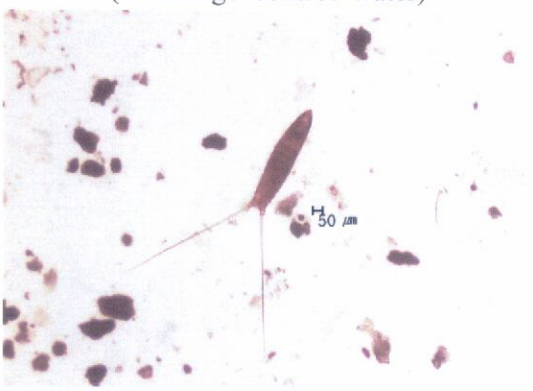
Paracalanus sp. (Influent water)

1. To be continued

· de-Ballasting (1st cycle : 2011. 08. 17, Fukuyama port)

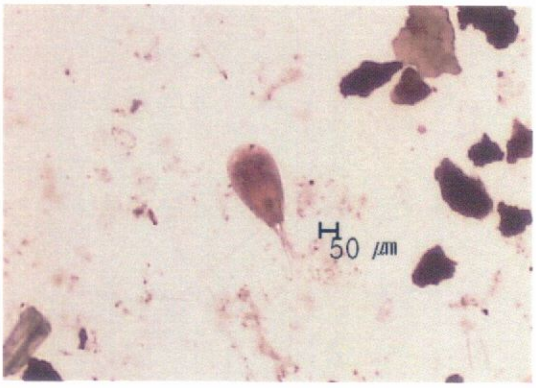
Polychaeta larva
(Discharge control water)

Harpacticoida
(Viable, Discharge treated water)

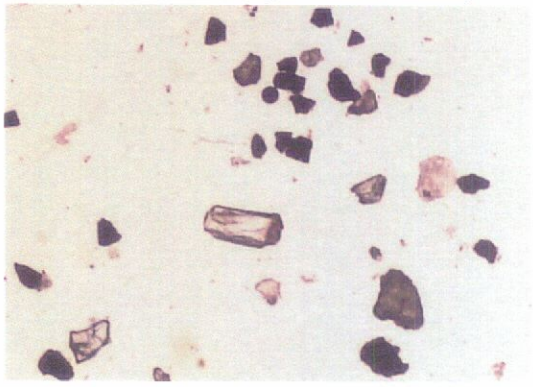


Harpacticoida
(Discharge control water)

Harpacticoida
(Viable, Discharge treated water)



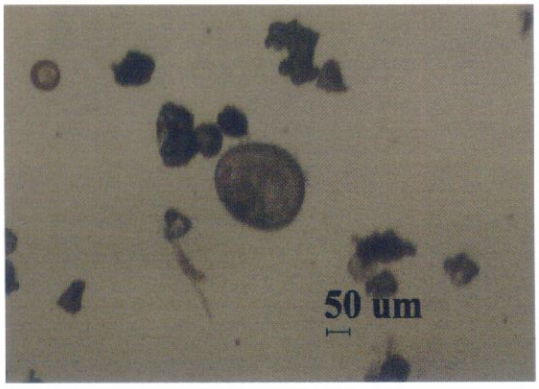
Oncaea sp.
(Discharge control water)



Debris
(Discharge treated water)

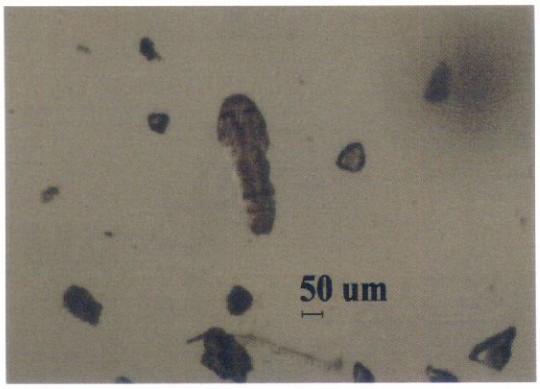
1. To be continued

· **Ballasting (2nd cycle : 2011. 11. 21, Dalian port)**

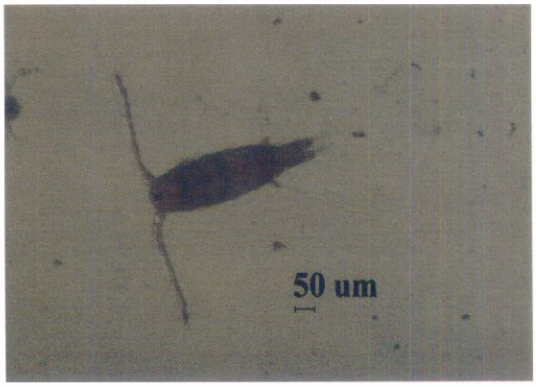


Bivalve larva (Influent water)

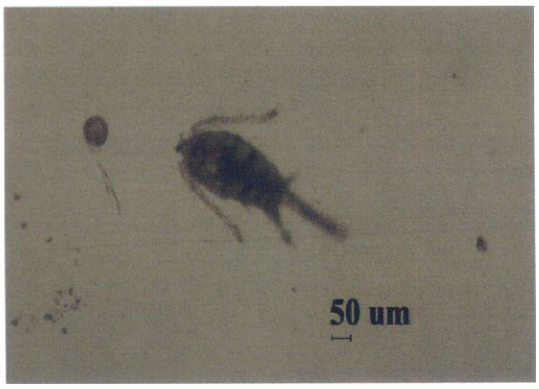
Oithona sp. (Influent water)



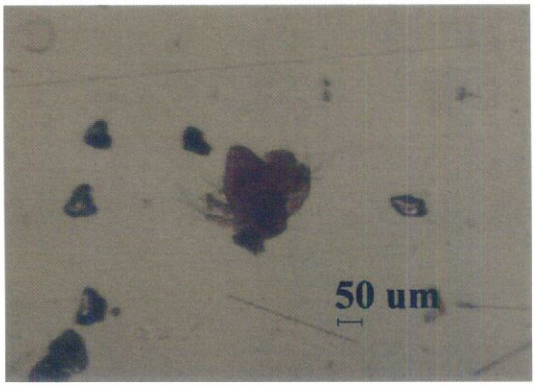
Polychaeta larva (Influent water)



Calanoida copepodite (Influent water)



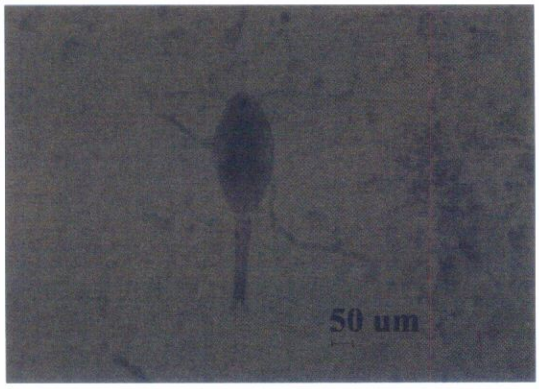
Oithona sp. (Influent water)



Copepod nauplius (Influent water)

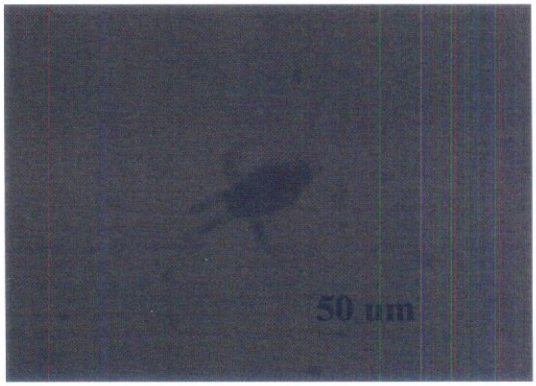
1. To be continued

· de-Ballasting (2nd cycle : 2011. 11. 25, Dalian port)



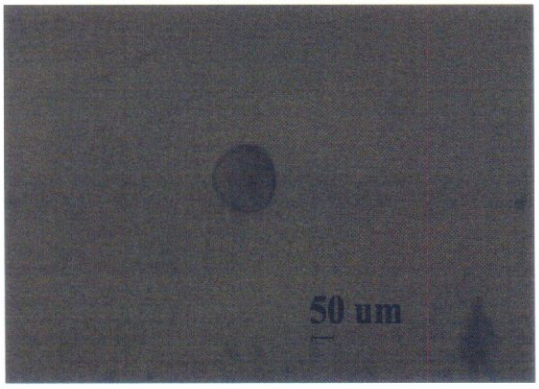
Oithona sp.

(Discharge control water)



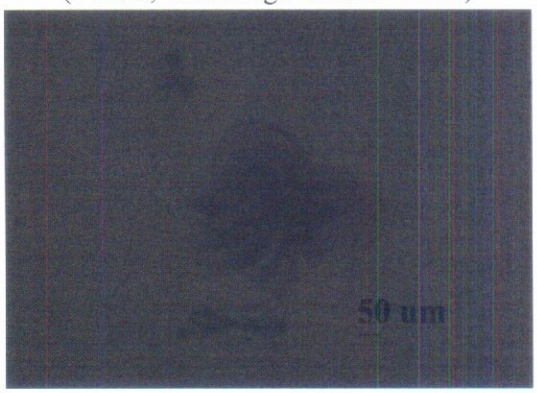
Copepod nauplius

(Viable, Discharge treated water)



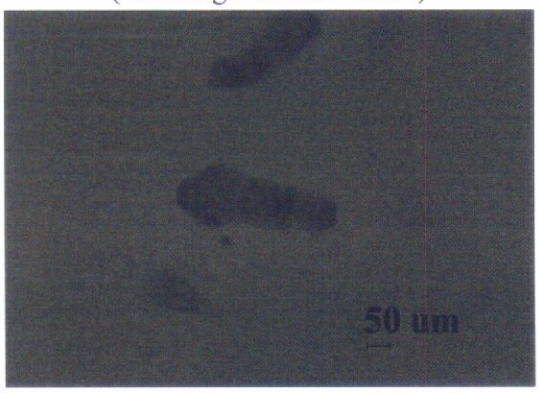
Bivalve larva

(Discharge control water)



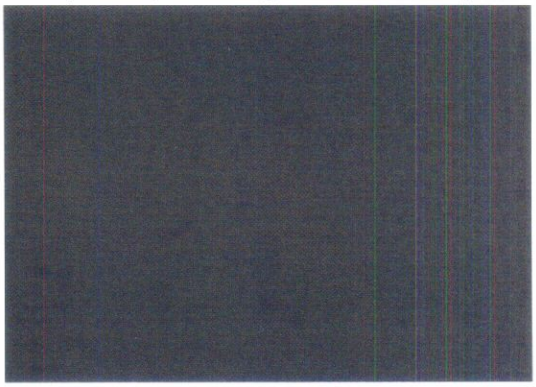
Podon sp.

(Viable, Discharge treated water)



Polychaeta larva

(Discharge control water)

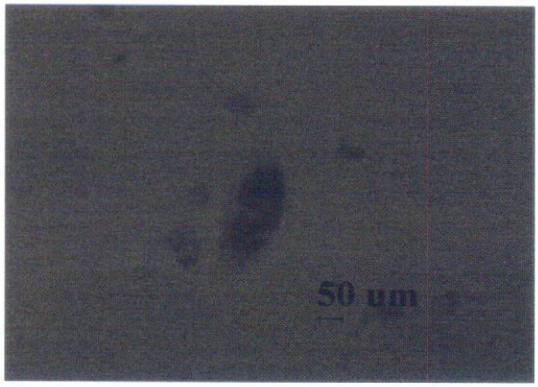


Debris

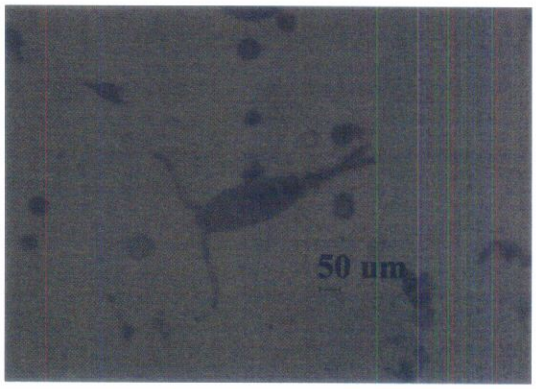
(Discharge treated water)

1. To be continued

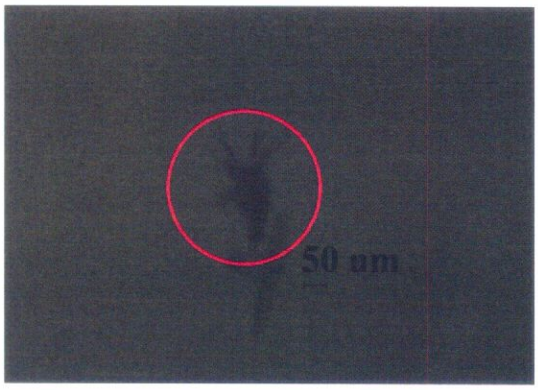
· Ballasting (3rd cycle : 2012. 03. 12, Hongkong port)



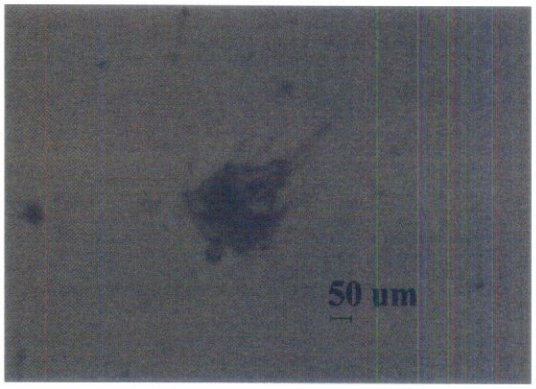
Tintinnopsis sp. (Influent water)



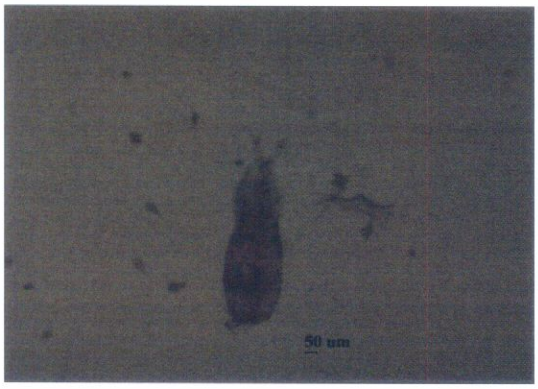
Oithona sp. (Influent water)



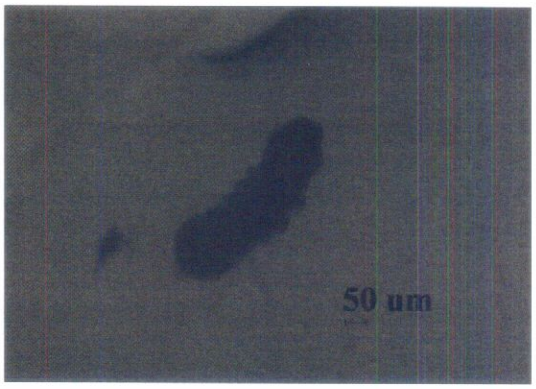
Copepod nauplius (Influent water)



Balanus larva (Influent water)



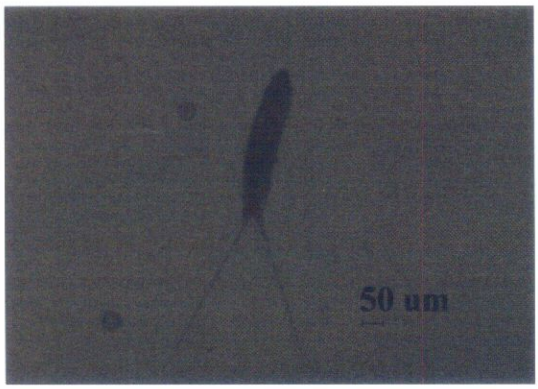
Corycaeus affinis (Influent water)



Polychaeta larva (Influent water)

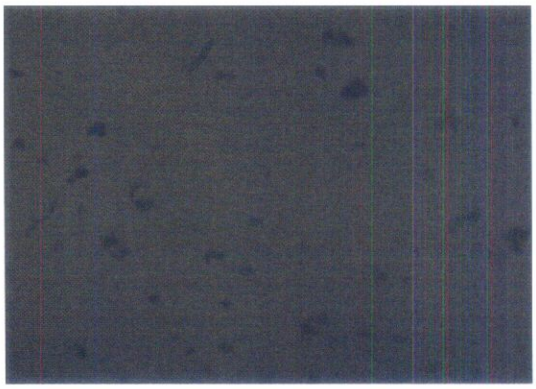
1. To be continued

· de-Ballasting (3rd cycle : 2012. 03. 18, Gwangyang port)



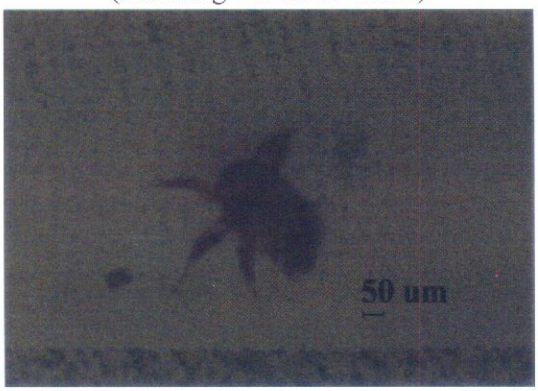
Harpacticoida

(Discharge control water)



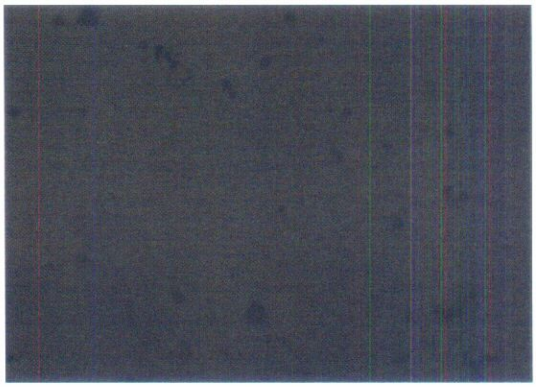
Debris

(Discharge treated water)



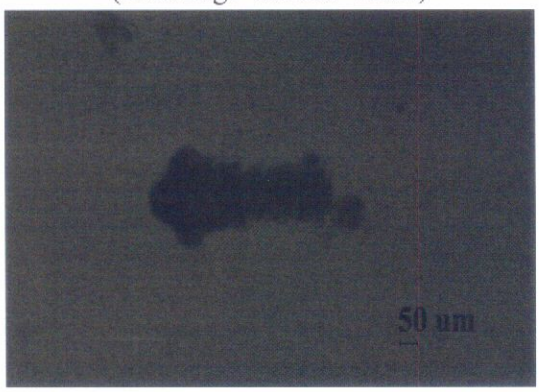
Copepod nauplius

(Discharge control water)



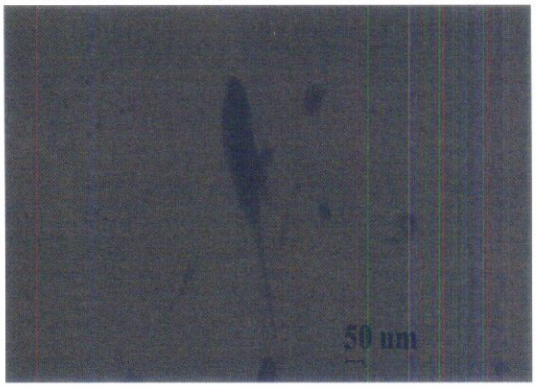
Debris

(Discharge treated water)



Polychaeta larva

(Discharge control water)

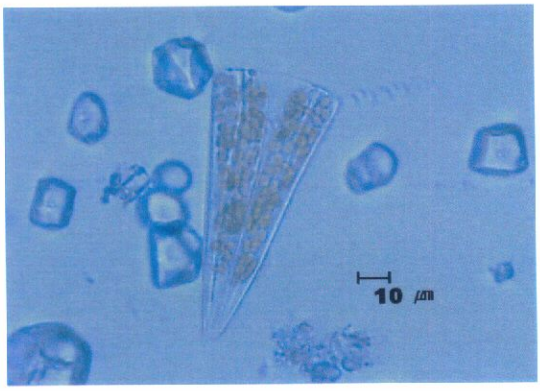


Harpacticoida

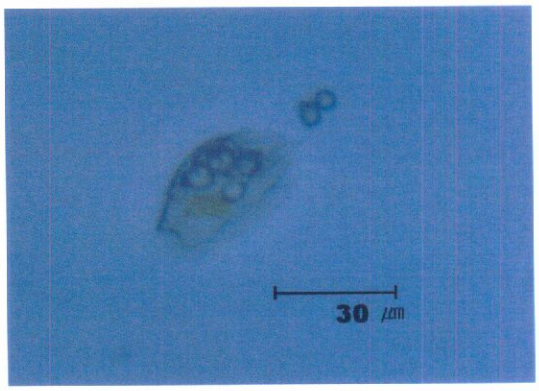
(Viable, Discharge treated water)

2. ≥ 10 - 50 μm organisms

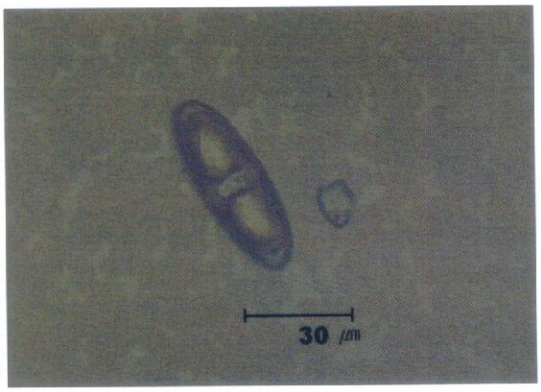
· **Ballasting (1st cycle : 2011. 08. 12, Saganoseki port)**



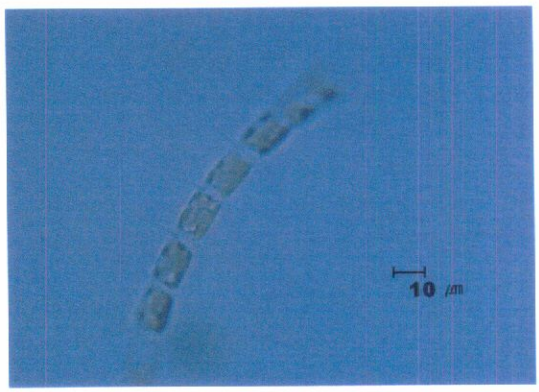
Licmophora sp. (Influent water)



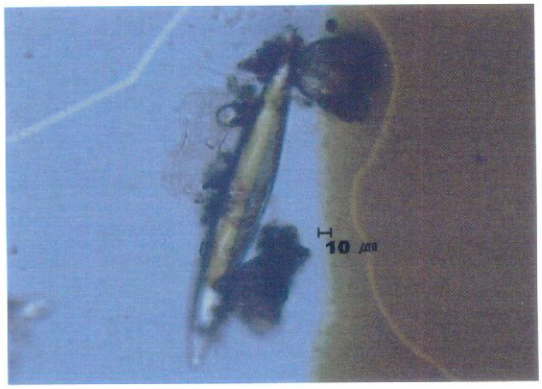
Protozoa (Influent water)



Navicula sp. (Influent water)



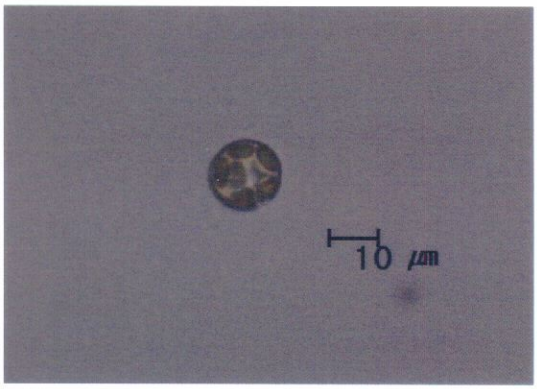
Chaetoceros sp. (Influent water)



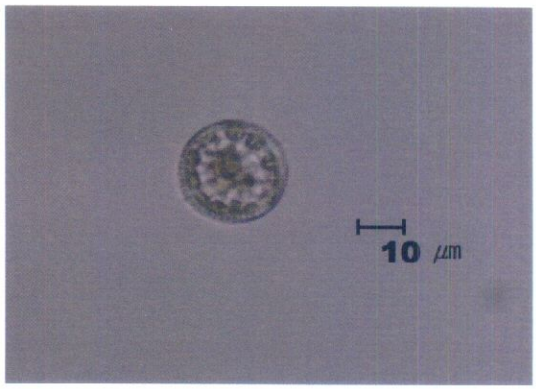
Pleurosigma sp. (Influent water)

2. To be continued

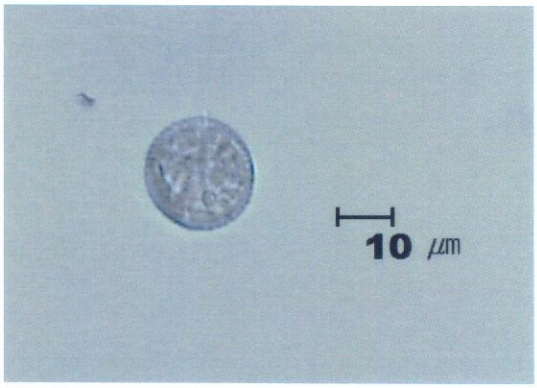
· de-Ballasting (1st cycle : 2011. 08. 17, Fukuyama port)



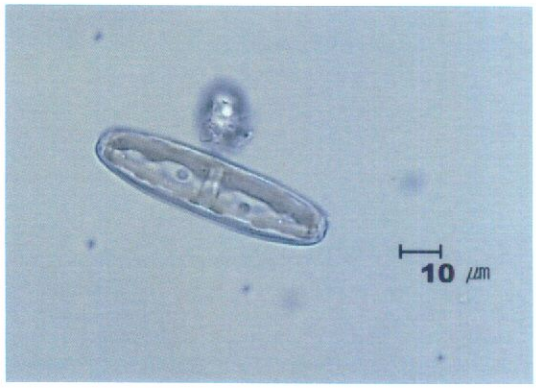
Thalassiosira sp. (Discharge control water)



Thalassiosira sp. (Discharge control water)



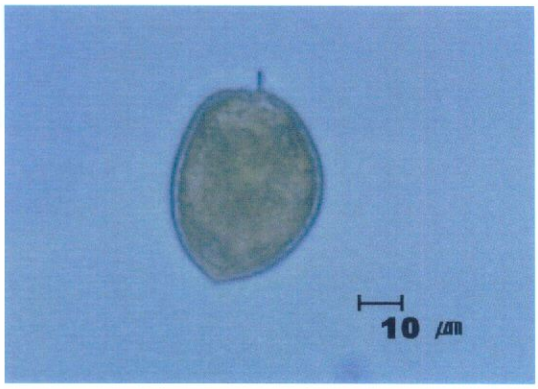
Thalassiosira sp. (Discharge control water)



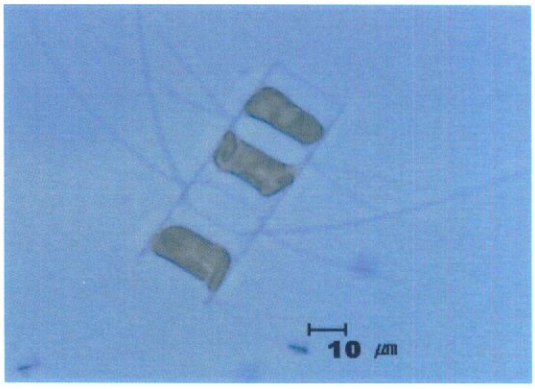
Pinnularia sp. (Discharge control water)

2. To be continued

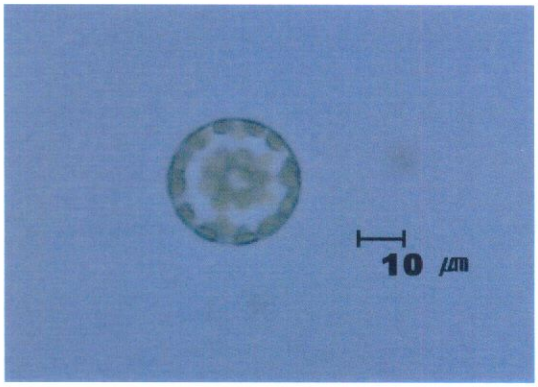
· **Ballasting (2nd cycle : 2011. 11. 21, Dalian port)**



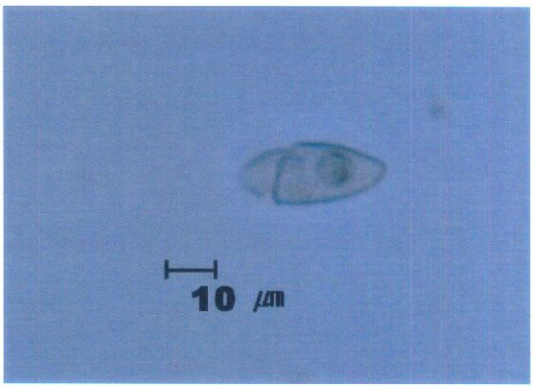
Prorocentrum sp. (Influent water)



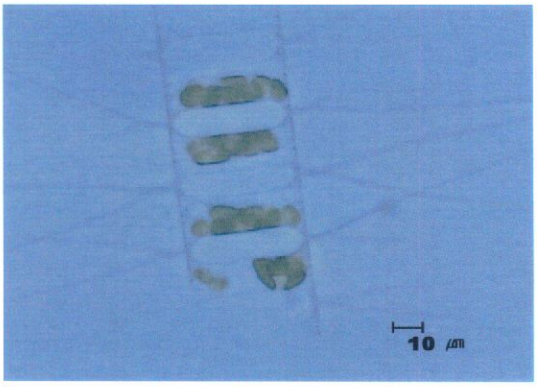
Chaetoceros sp. (Influent water)



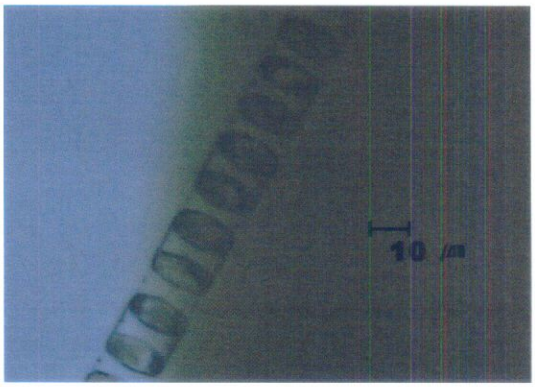
Thalassiosira sp. (Influent water)



Katodinium sp. (Influent water)



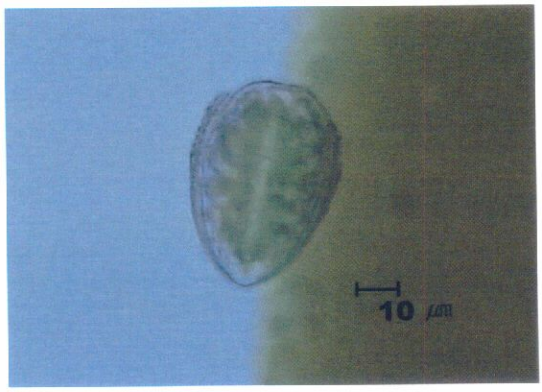
Chaetoceros sp. (Influent water)



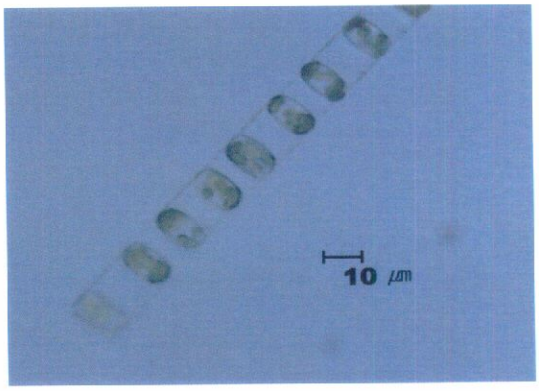
Skeletonema sp. (Influent water)

2. To be continued

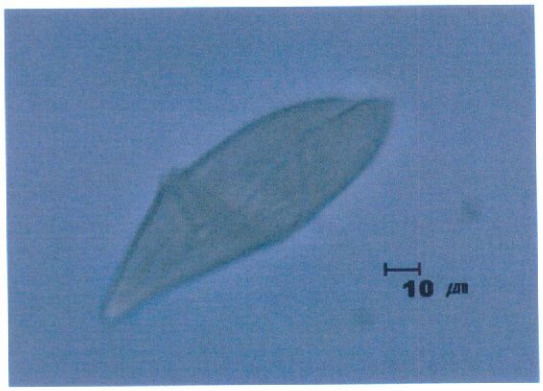
· de-Ballasting (2nd cycle : 2011. 11. 25, Dalian port)



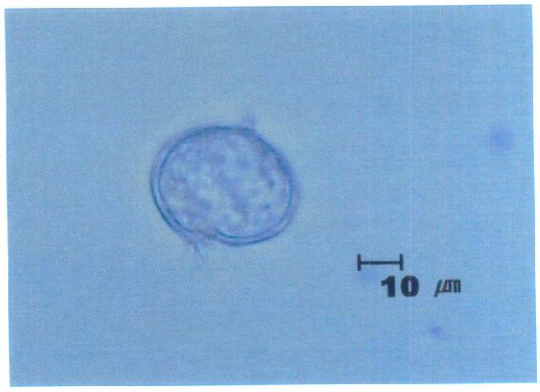
Prorocentrum sp. (Discharge control water)



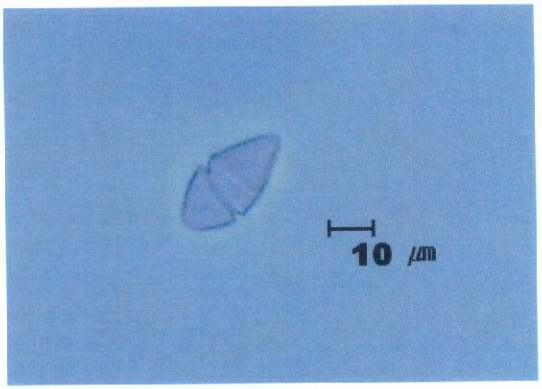
Skeletonema sp. (Discharge control water)



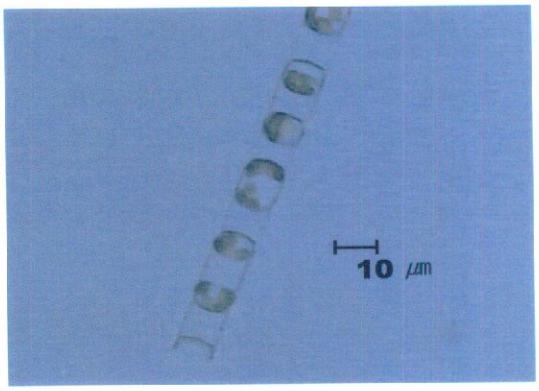
Gyrodinium sp. (Discharge control water)



Protoperidinium sp. (Discharge control water)



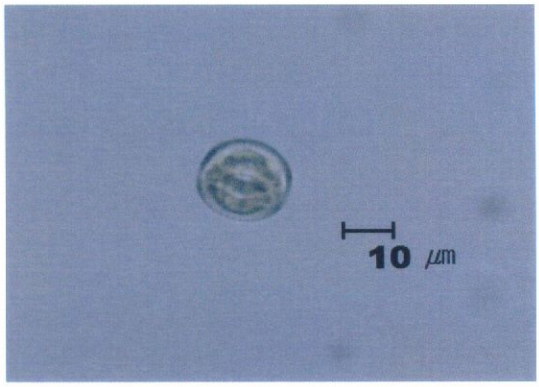
Gyrodinium sp. (Discharge control water)



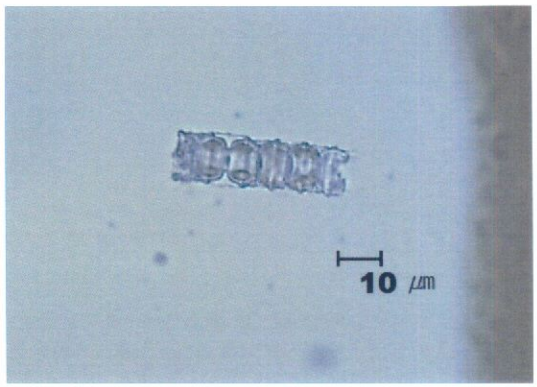
Skeletonema sp. (Discharge control water)

2. To be continued

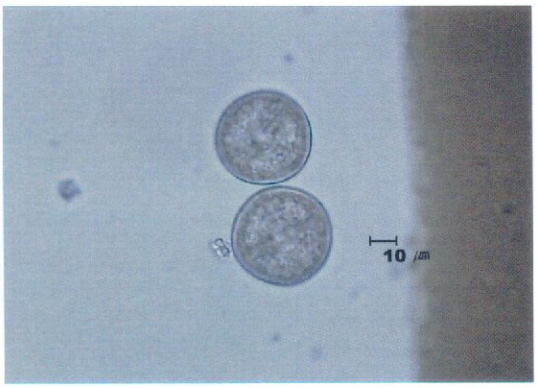
· **Ballasting (3rd cycle : 2012. 03. 12, Hongkong port)**

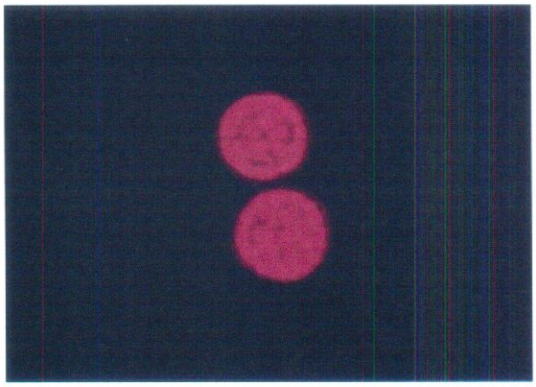


Thalassiosira sp. (Influent water)



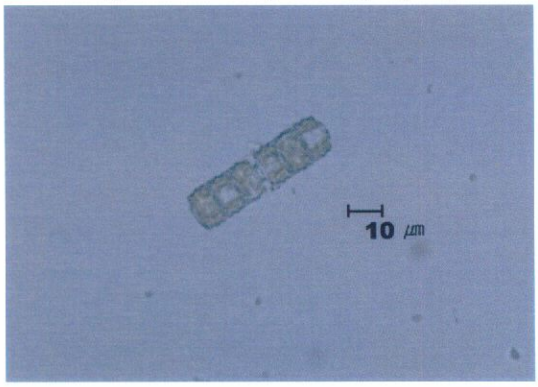
Paralia sp. (Influent water)

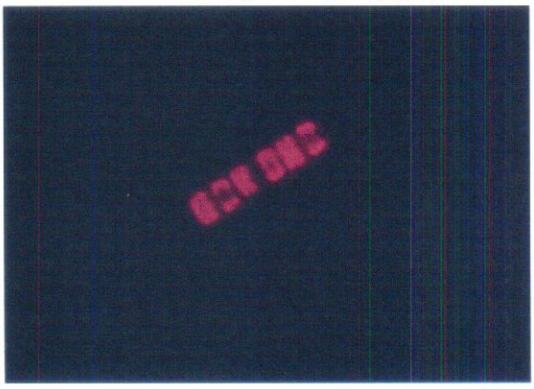




Thalassiosira sp. (Influent water)

Light microscope image (left) and auto-fluorescence microscope image (right).



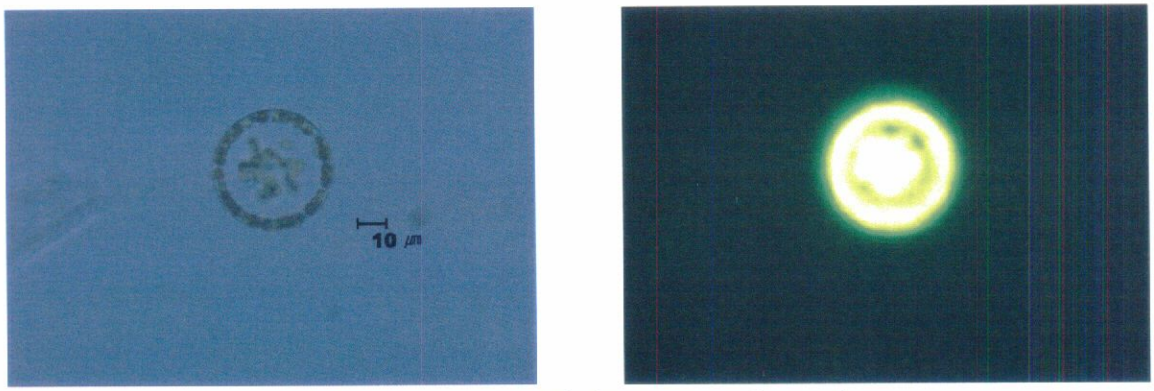


Paralia sp. (Influent water)

Light microscope image (left) and auto-fluorescence microscope image (right).

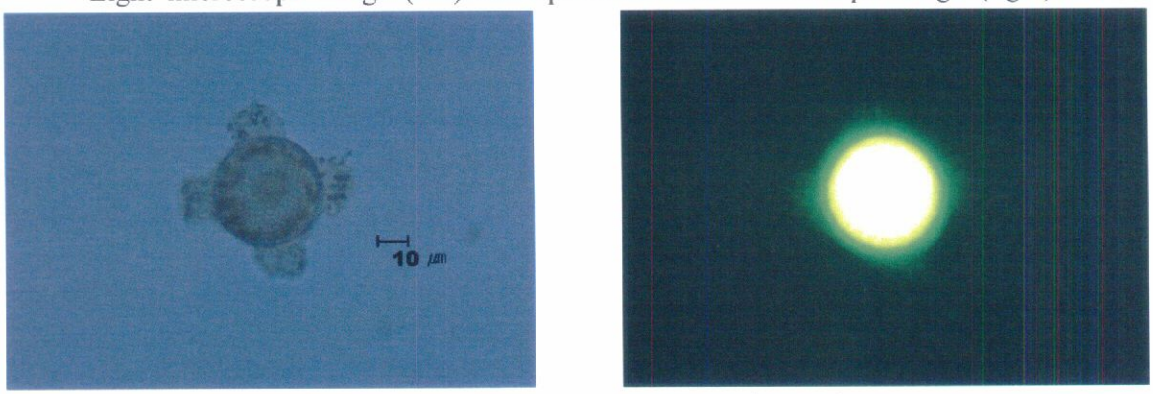
2. To be continued

· de-Ballasting (3rd cycle : 2012. 03. 18, Gwangyang port)



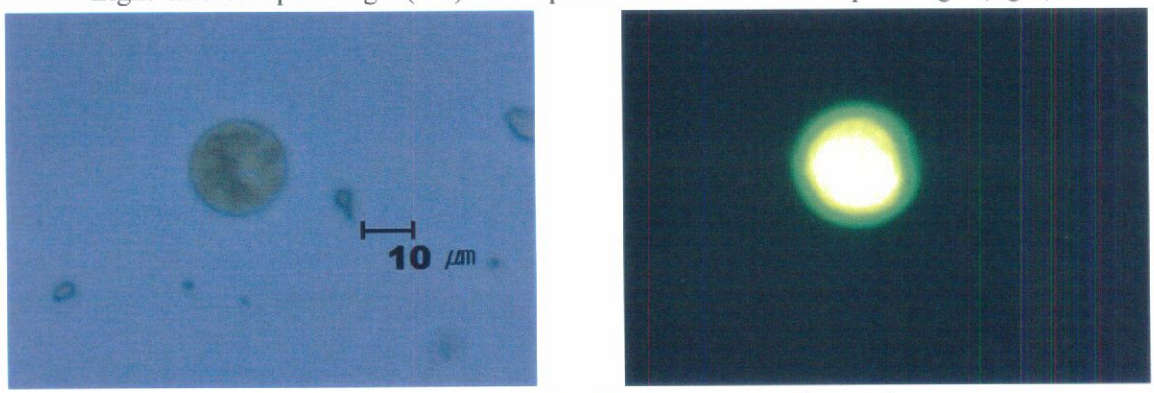
Thalassiosira sp. (Discharge control water)

Light microscope image (left) and epi-fluorescence microscope image (right).



Thalassiosira sp. (Discharge control water)

Light microscope image (left) and epi-fluorescence microscope image (right).

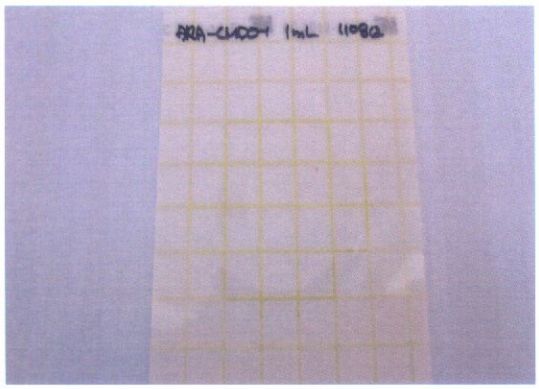


Thalassiosira sp. (Viable, Discharge treated water)

Light microscope image (left) and epi-fluorescence microscope image (right).

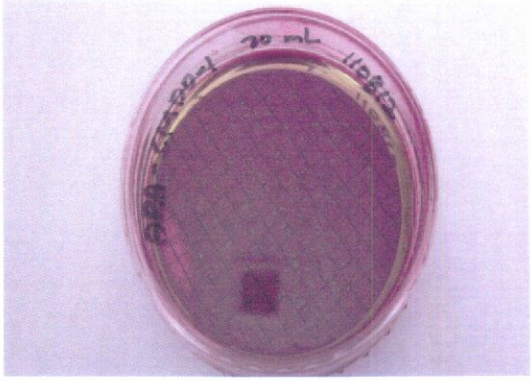
3. Bacteria

· **Ballasting (1st cycle : 2011. 08. 12, Saganoseki port)**



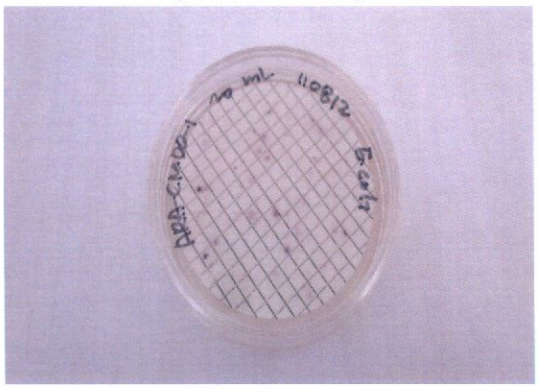
Heterotrophic bacteria

(Influent water)



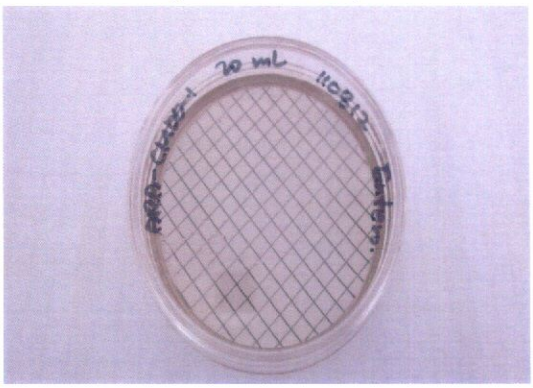
Total coliform

(Influent water)



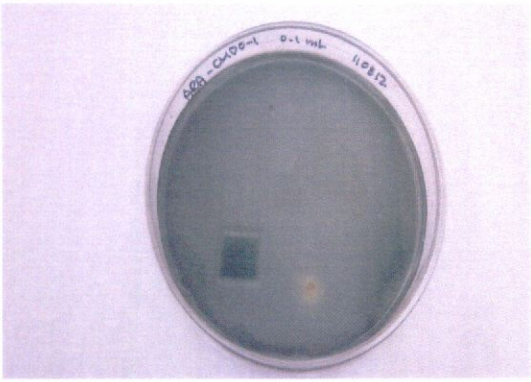
Escherichia coli

(Influent water)



Intestinal Enterococci

(Influent water)

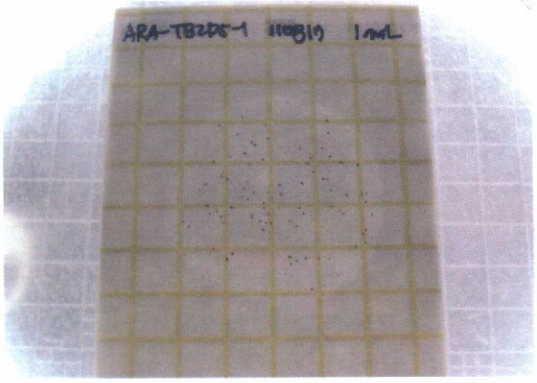


Toxicogenic *V. cholerae* (O1, O139)

(Influent water)

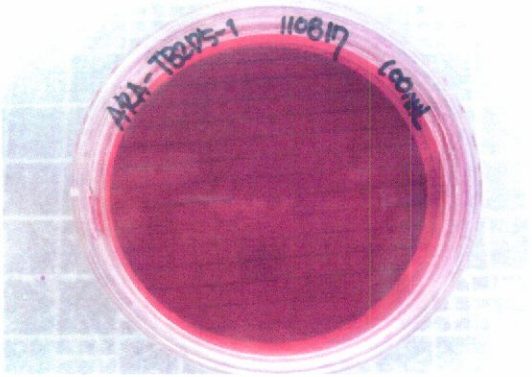
3. To be continued

· de-Ballasting (1st cycle : 2011. 08. 17, Fukuyama port)



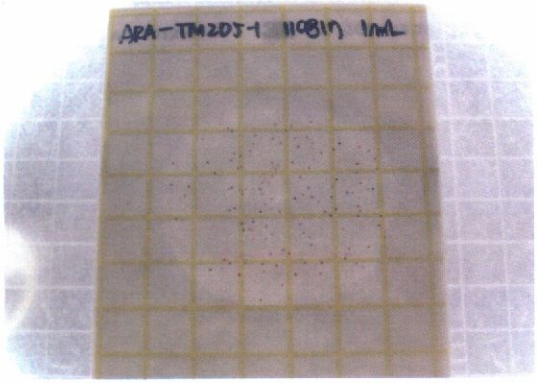
Heterotrophic bacteria

(Beginning, Discharge treated water)



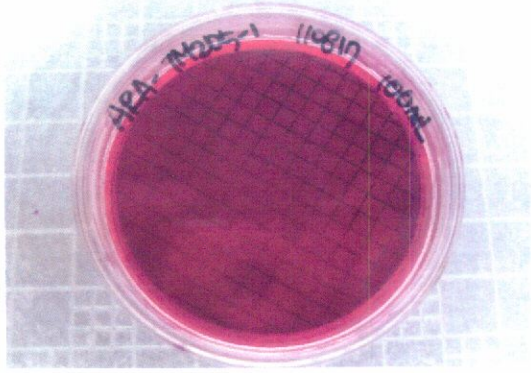
Total coliform

(Beginning, Discharge treated water)



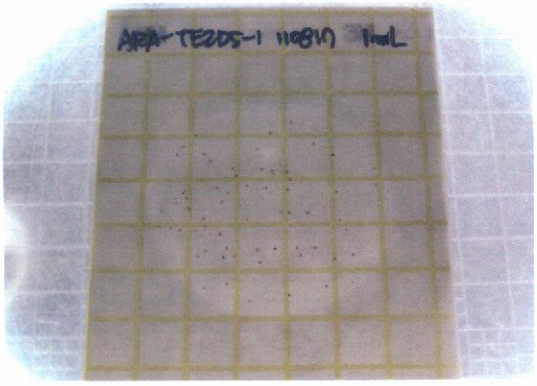
Heterotrophic bacteria

(Middle, Discharge treated water)



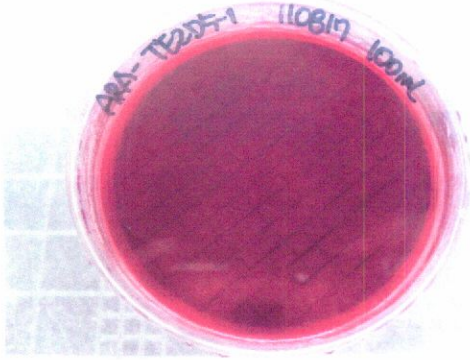
Total coliform

(Middle, Discharge treated water)



Heterotrophic bacteria

(End, Discharge treated water)

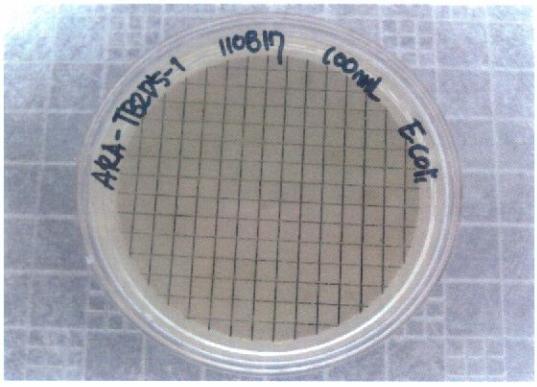


Total coliform

(End, Discharge treated water)

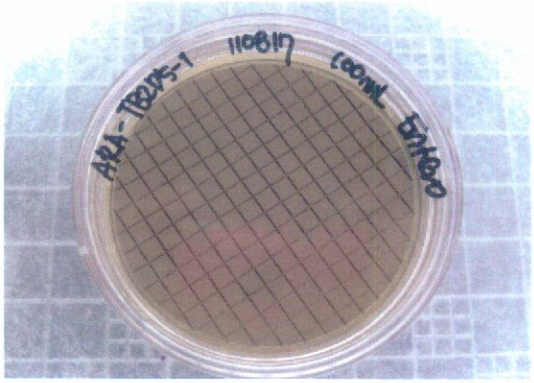
3. To be continued

· de-Ballasting (1st cycle : 2011. 08. 17, Fukuyama port)



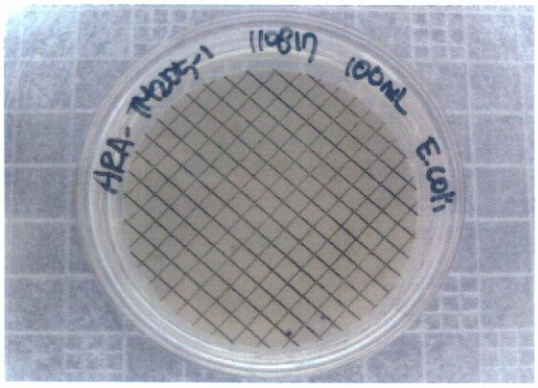
Escherichia coli

(Beginning, Discharge treated water)



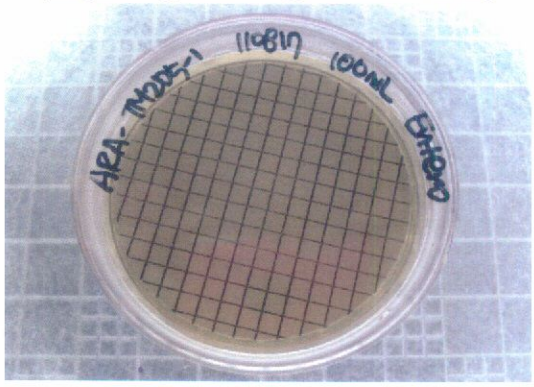
Intestinal Enterococci

(Beginning, Discharge treated water)



Escherichia coli

(Middle, Discharge treated water)



Intestinal Enterococci

(Middle, Discharge treated water)

Escherichia coli

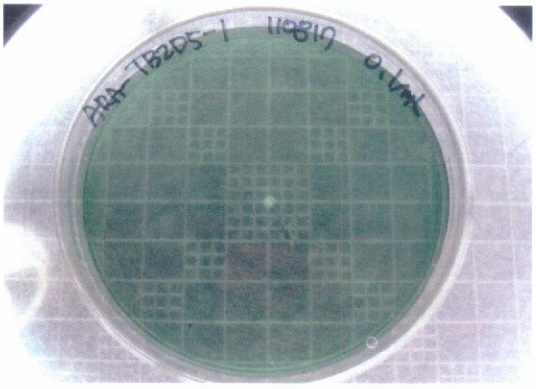
(End, Discharge treated water)

Intestinal Enterococci

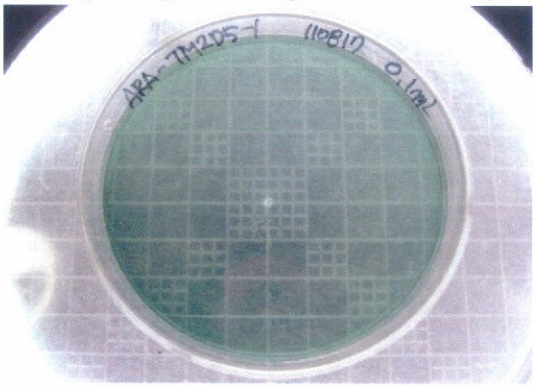
(End, Discharge treated water)

3. To be continued

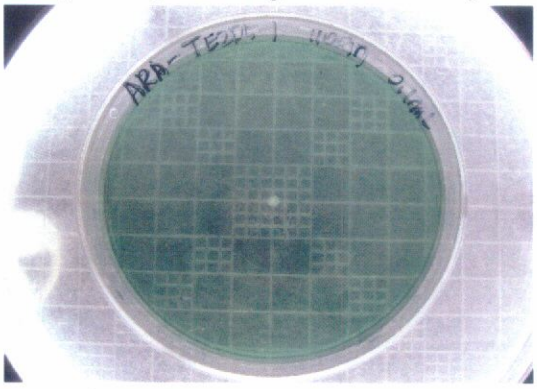
· de-Ballasting (1st cycle : 2011. 08. 17, Fukuyama port)



Toxicogenic *V. cholerae* (O1, O139)
(Beginning, Discharge treated water)



Toxicogenic *V. cholerae* (O1, O139)
(Middle, Discharge treated water)



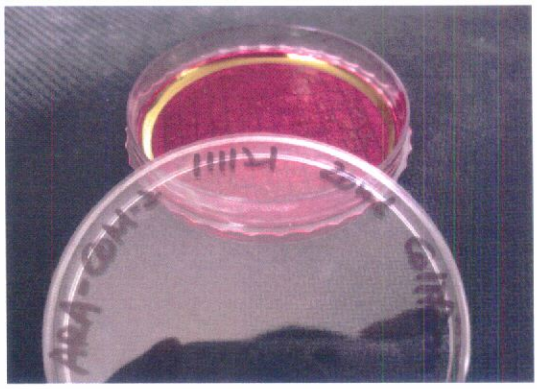
Toxicogenic *V. cholerae* (O1, O139)
(End, Discharge treated water)

3. To be continued

· **Ballasting (2nd cycle : 2011. 11. 21, Dalian port)**

Heterotrophic bacteria

(Influent water)

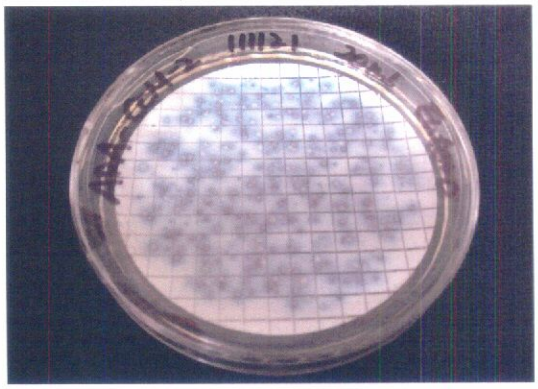


Total coliform

(Influent water)

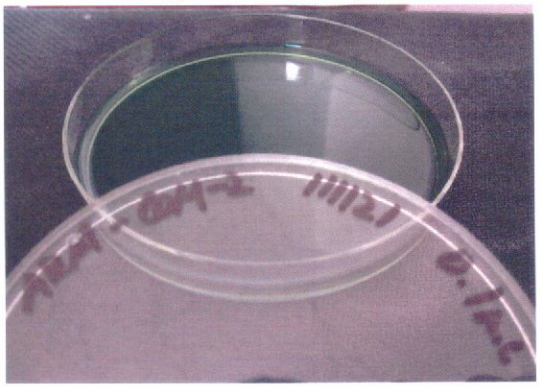
Escherichia coli

(Influent water)



Intestinal Enterococci

(Influent water)

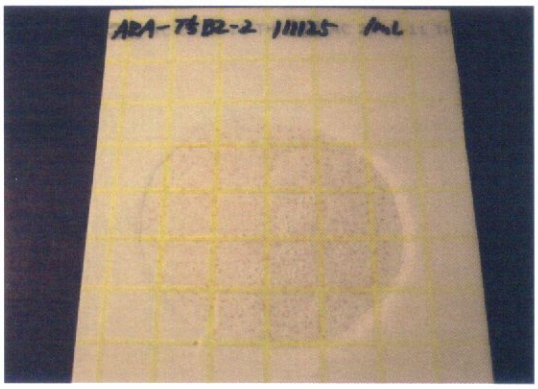


Toxicogenic *V. cholerae* (O1, O139)

(Influent water)

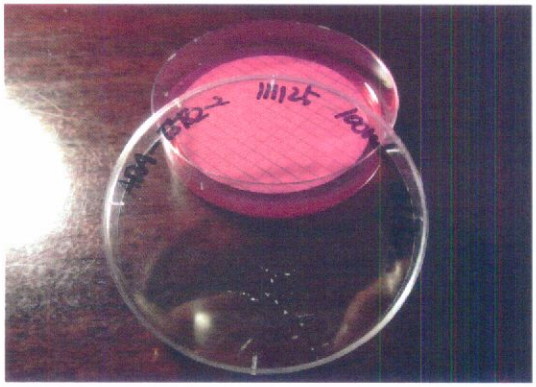
3. To be continued

· **de-Ballasting (2nd cycle : 2011. 11. 25, Dalian port)**



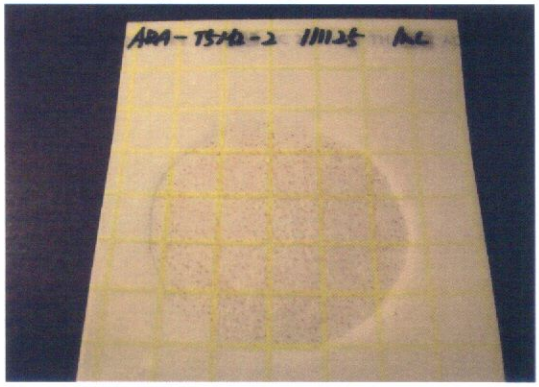
Heterotrophic bacteria

(Beginning, Discharge treated water)



Total coliform

(Beginning, Discharge treated water)

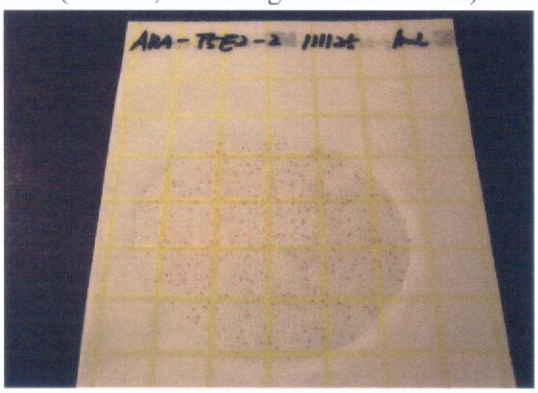


Heterotrophic bacteria

(Middle, Discharge treated water)

Total coliform

(Middle, Discharge treated water)



Heterotrophic bacteria

(End, Discharge treated water)

Total coliform

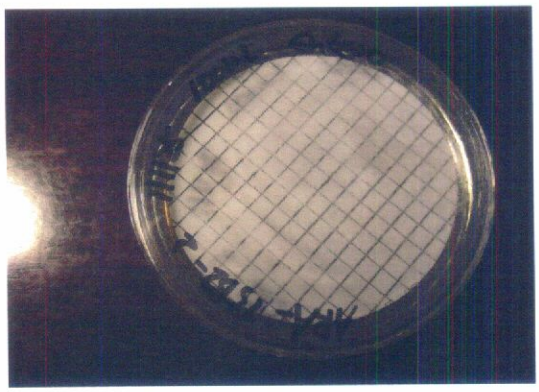
(End, Discharge treated water)

3. To be continued

· de-Ballasting (2nd cycle : 2011. 11. 25, Dalian port)

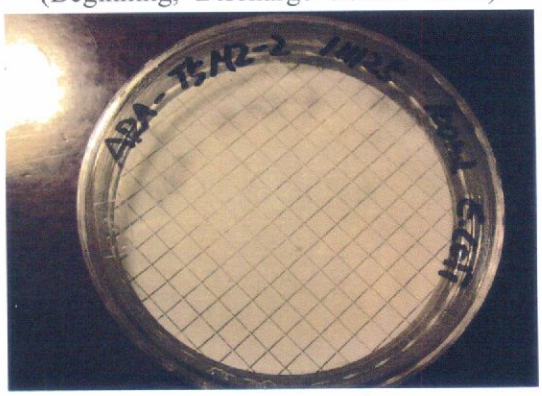
Escherichia coli

(Beginning, Discharge treated water)



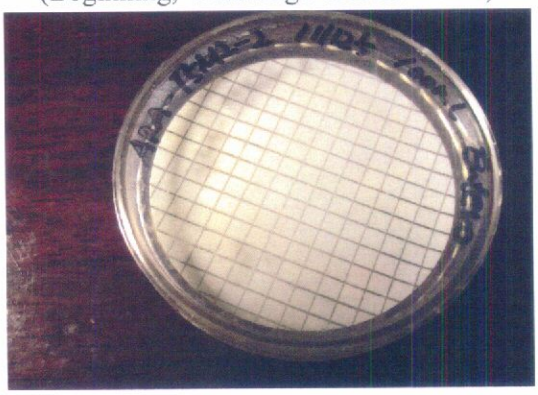
Intestinal Enterococci

(Beginning, Discharge treated water)



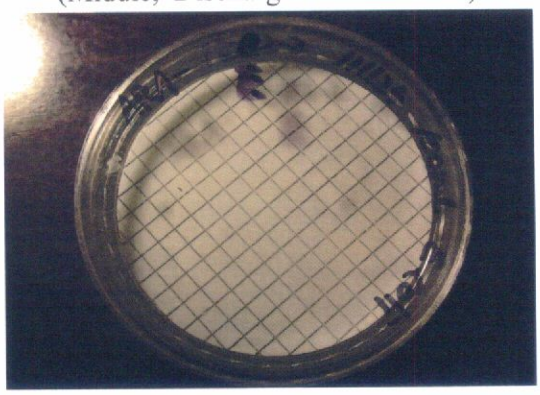
Escherichia coli

(Middle, Discharge treated water)



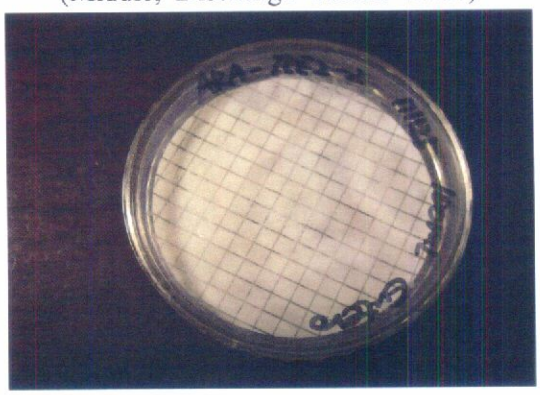
Intestinal Enterococci

(Middle, Discharge treated water)



Escherichia coli

(End, Discharge treated water)



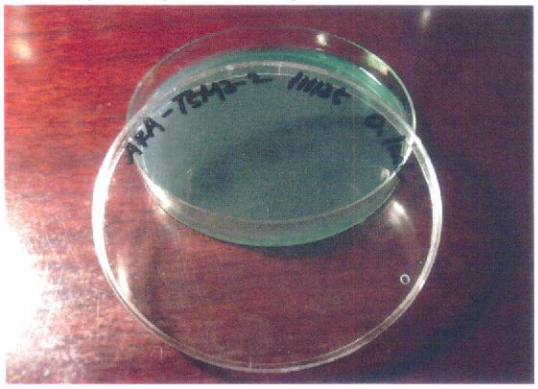
Intestinal Enterococci

(End, Discharge treated water)

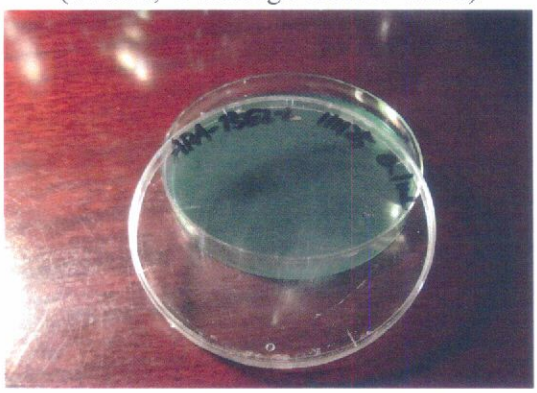
3. To be continued

· de-Ballasting (2nd cycle : 2011. 11. 25, Dalian port)

Toxicogenic *V. cholerae* (O1, O139)
(Beginning, Discharge treated water)



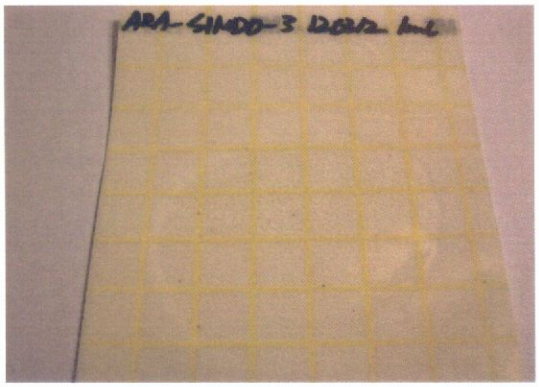
Toxicogenic *V. cholerae* (O1, O139)
(Middle, Discharge treated water)



Toxicogenic *V. cholerae* (O1, O139)
(End, Discharge treated water)

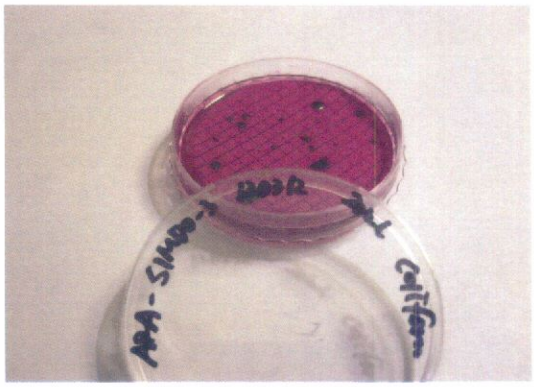
3. To be continued

· **Ballasting (3rd cycle : 2012. 03. 12, Hongkong port)**



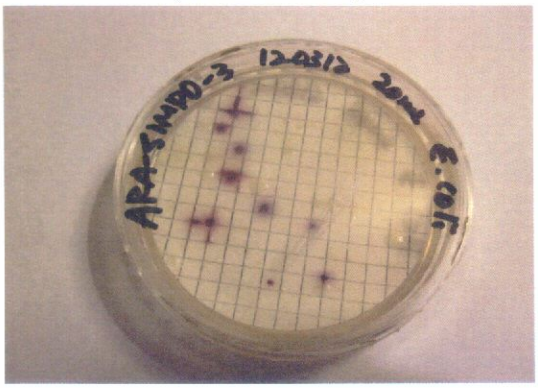
Heterotrophic bacteria

(Influent water)



Total coliform

(Influent water)

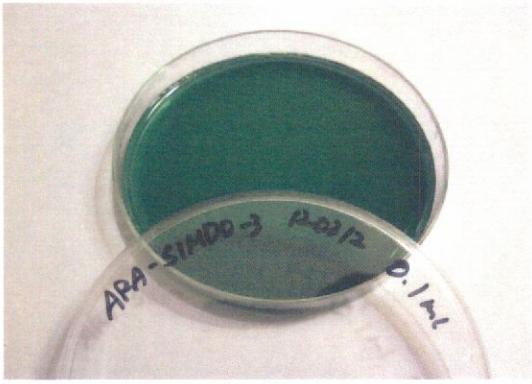


Escherichia coli

(Influent water)

Intestinal Enterococci

(Influent water)



Toxicogenic *V. cholerae* (O1, O139)

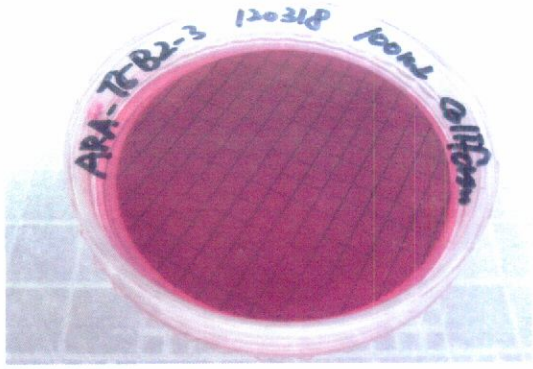
(Influent water)

3. To be continued

· de-Ballasting (3rd cycle : 2012. 03. 18, Gwangyang port)

Heterotrophic bacteria

(Beginning, Discharge treated water)

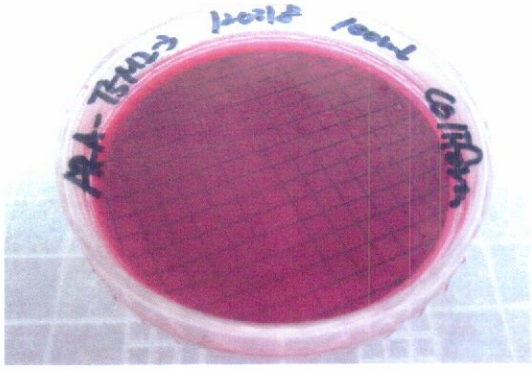


Total coliform

(Beginning, Discharge treated water)

Heterotrophic bacteria

(Middle, Discharge treated water)

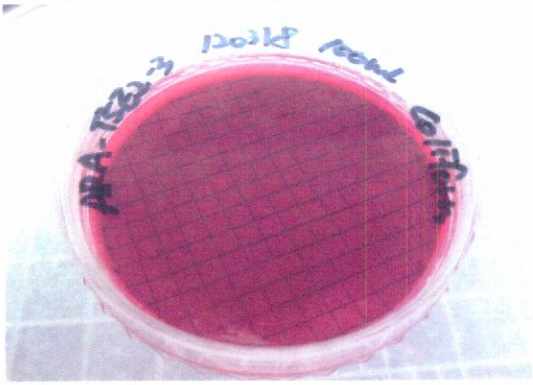


Total coliform

(Middle, Discharge treated water)

Heterotrophic bacteria

(End, Discharge treated water)

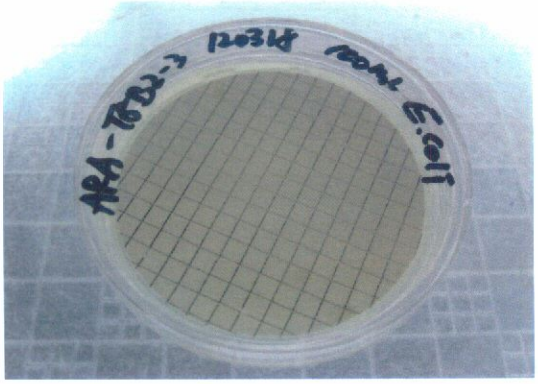


Total coliform

(End, Discharge treated water)

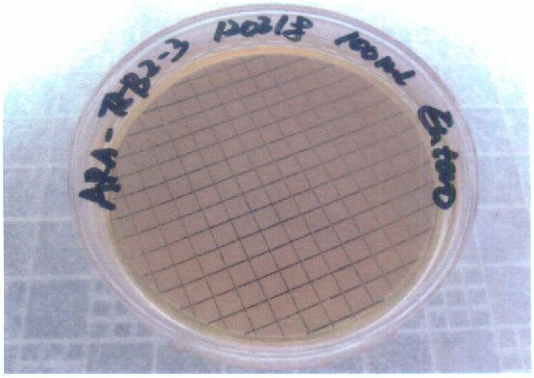
3. To be continued

· de-Ballasting (3rd cycle : 2012. 03. 18, Gwangyang port)



Escherichia coli

(Beginning, Discharge treated water)

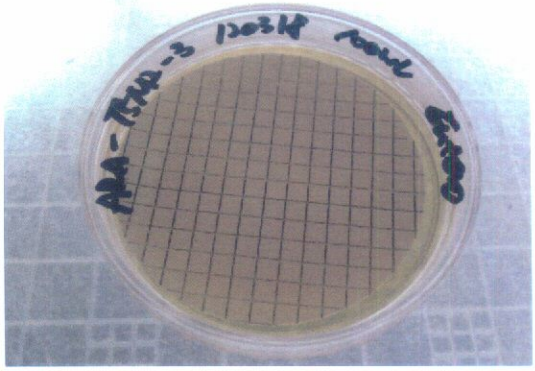


Intestinal Enterococci

(Beginning, Discharge treated water)

Escherichia coli

(Middle, Discharge treated water)

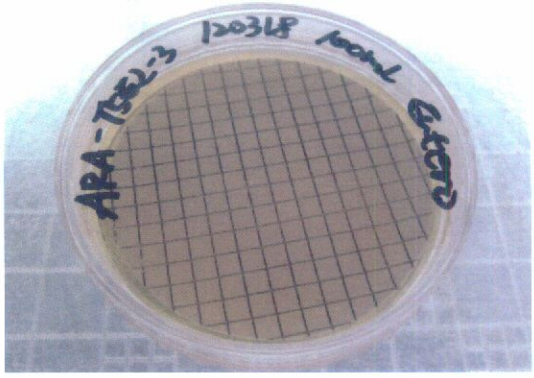


Intestinal Enterococci

(Middle, Discharge treated water)

Escherichia coli

(End, Discharge treated water)

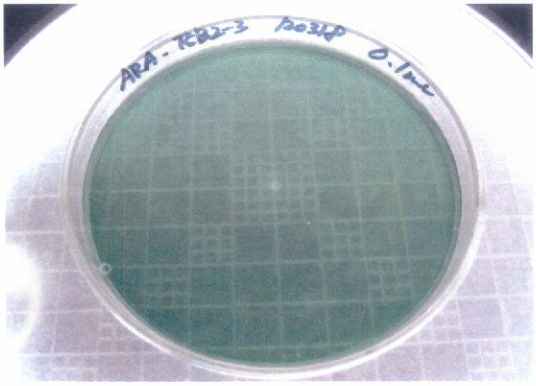


Intestinal Enterococci

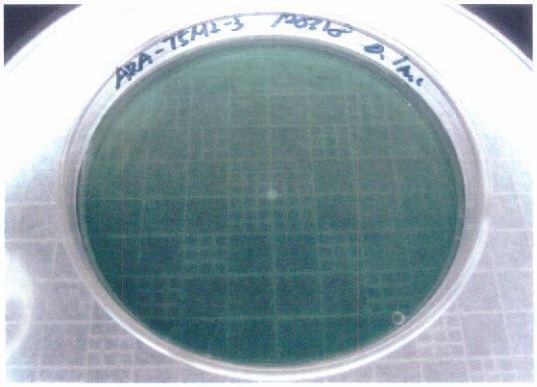
(End, Discharge treated water)

3. To be continued

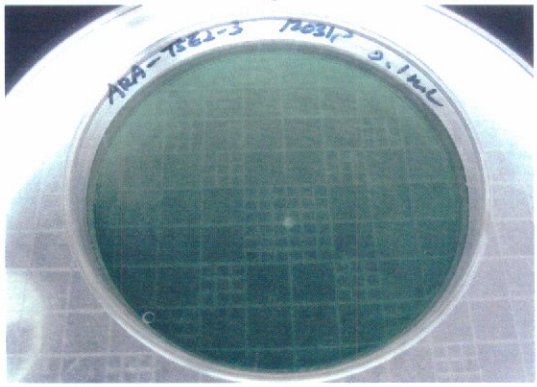
· de-Ballasting (3rd cycle : 2012. 03. 18, Gwangyang port)



Toxicogenic *V. cholerae* (O1, O139)
(Beginning, Discharge treated water)



Toxicogenic *V. cholerae* (O1, O139)
(Middle, Discharge treated water)



Toxicogenic *V. cholerae* (O1, O139)
(End, Discharge treated water)