

Bioassay Data for Marine Pollution Using Sea Urchin Eggs, 1984 to 1989

1984

Four experiments were made as follows.

- I. Winter season, January 21, using *Hemicentrotus pulcherrimus* eggs, see Table 1.
- II. Spring season, April 3, using *H. pulcherrimus* eggs, see Table 2.
- III. Summer season, June 23, using *Anthocardis crassispina* eggs, see Table 3.
- IV. Autumn season, September 4, using *A. crassispina* eggs, see Table 4.

(Notes common to all tables: Fertilization membrane formation examined 3 min. after fertilization; minutes and hours in parentheses respectively after First cleavage, Gastrulation and Pluteus indiate the time after insemination; the maturation state of gonads used was nearly ripe to full ripe; For the 5 mins. old sperm and 3-6 hrs. old eggs, Degree of inhibitory effect 0 show the non-inhibition, 1 the slight inhibition, 2 the weak, 3 the moderate, 4 the strong and 5 the violent inhibition state of the sea water tested (see Ranking III, Publ. Seto Mar. Biol. Lab., Vol. 30, No. 4/6, p. 224, Table 6, 1985))

1985

Four experiments were made as follows.

- I. Winter season, January 24, using *Hemicentrotus pulcherrimus* eggs, see Table 5.
- II. Spring season, March 23, using *H. pulcherrimus* eggs, see Table 6.
- III. Summer season, July 18, using *Anthocardis crassispina* eggs, see Table 7.
- IV. Autumn season, August 28, using *A. crassispina* eggs, see Table 8.

(Notes common to all tables: See the notes mentioned above.)

1986

Three experiments were made as follows.

- I. Winter season, January 23, using *Hemicentrotus pulcherrimus* eggs, see Table 9.
- II. Spring season, March 28, using *H. pulcherrimus* eggs, see Table 10.
- III. Autumn season, September 4, using *Anthocardis crassispina* eggs, see Table 11.

(Notes common to all tables: See the notes mentioned above.)

1987

Four experiments were made as follows.

- I. Winter season, January 17, using *Hemicentrotus pulcherrimus* eggs, see Table 12.
- II. Spring season, March 19, *H. pulcherrimus* eggs, see Table 13.
- III. Summer season, June 10, using *Anthocardis crassispina* eggs, see Table 14.

IV. Autumn season, August 28, using *A. crassispina* eggs, see Table 15.
(Notes common to all tables: See the notes mentoined above.)

1988

Four experiments were made as follows.

I. Spring season, March 29, using *Hemicentrotus pulcherrimus* eggs, see Table 16 and May 30, using *Anthocardis crassispina* eggs, see Table 17.

II. Summer season, July 19 and August 19, using *A. crassispina* eggs, see Tables 18 and 19.

(Notes common to all tables: See the notes mentioned above; For the 0 mins. old sperm and 0 hrs. old eggs, Degree of inhibitory effect 0 show the no inhibition, 1 the weak, 2 the moderate and 3 the strong inhibition state of the sea water tested (see Ranking IV, Publ. Seto Mar. Biol. Lab., Vol. 34, Nos. 4/6, p. 235, Table 8, 1990))

1989

Four experiments were made as follows.

I. Winter season, February 21, using *Hemicentrotus pulcherrimus* eggs, see Table 20.

II. Spring season, April 5, using *H. pulcherrimus* eggs, see Table 21.

III. Summer season, July 5, using *Anthocardis crassispina* eggs, see Table 22.

IV. Autumn season, August 30, using *A. crassispina* eggs, see Table 23.

(Notes common to all tables: See the notes mentioned above.)

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Table 1. Results of the Jan. 21, 1984 experiment with eggs of *Hemicentrotus pulcherrimus*.
Wind; 0, Test water temperature; 18°C, 5 mins. old sperms, 6 hrs. old eggs. Ranking III 1985.

Location (depth)	Time after insemination									Degree of inhibitory effect
	3 mins.		75 mins.		22 hrs.			45 hrs.		
	fert. memb. formation (%)	1-cell state (%)	2-cell stage normal (%)	multi-cell polyspermy (%)	permanent blastula (%)	normal gastrula (%)	exo- gastrula (%)	abnormal pluteus (%)	normal pluteus (%)	
(m)										
Running sea water of Laboratory	99.5	0.5	99.5	0	0.5	99.5	0	1.0	99.0	0
	98.5	1.0	99.0	0	1.0	99.0	0	1.5	98.5	
	99.0	1.0	99.0	0	0.5	99.5	0	1.5	98.5	
Water from open sea side of Hatakejima Surface	99.0	1.0	99.0	0	0.5	99.5	0	1.0	99.0	0
	99.5	0.5	99.5	0	0.5	99.5	0	0.5	99.5	
	99.5	1.0	99.0	0	1.0	99.0	0	1.5	98.5	
Water from land side of Hatakejima Surface	96.5	4.0	96.0	0	3.5	96.5	0	5.5	94.5	1
	98.0	2.5	97.5	0	2.5	97.5	0	6.0	94.0	
	97.0	3.5	96.5	0	3.0	97.0	0	4.5	95.5	
Bottom (7)	95.0	6.0	94.0	0	3.5	96.5	0	5.5	94.5	1
	98.0	2.5	97.5	0	4.0	96.0	0	6.5	93.5	
	96.0	5.0	95.0	0	3.0	97.0	0	5.0	95.0	
Sea water from Tsunashirazu cove Surface	92.0	9.0	91.0	0	56.5	43.5	0	29.5	70.5	5
	96.5	4.5	95.5	0	52.0	48.0	0	27.0	73.0	
	94.0	6.5	93.5	0	50.5	49.5	0	24.0	76.0	
Bottom (5)	94.5	7.0	93.0	0	22.0	78.0	0	22.0	78.0	4
	96.0	5.5	94.5	0	19.0	81.0	0	21.0	79.0	
	93.0	7.5	92.5	0	18.0	82.0	0	24.5	75.5	

Table 2. Results of the Apr. 3, 1984 experiment with eggs of *Hemicentrotus pulcherrimus*.
Wind; 0, Test water temperature; 18°C, 5 mins. old sperms, 6 hrs. old eggs. Ranking III 1985.

Location (depth)	Time after insemination									Degree of inhibitory effect	
	3 mins.		75 mins.			24 hrs.			48 hrs.		
	fert. memb. formation (%)	1-cell state (%)	2-cell stage normal (%)	multi-cell polyspermy (%)	permanent blastula (%)	normal gastrula (%)	exo- gastrula (%)	abnormal pluteus (%)	normal pluteus (%)		
(m)											
Running sea water of Laboratory	99.0	1.5	98.5	0	0.5	99.5	0	1.5	98.5	0	
	99.5	1.0	99.0	0	1.0	99.0	0	1.0	99.0		
	98.0	2.0	98.0	0	0.5	99.5	0	1.5	98.5		
Water from open sea side of Hatakejima Surface	99.5	1.0	99.0	0	0.5	99.5	0	1.0	99.0	0	
	99.0	1.5	98.5	0	0.5	99.5	0	0.5	99.5		
	98.0	2.0	98.0	0	1.0	99.0	0	1.5	98.5		
Water from land side of Hatakejima Surface	97.5	3.0	97.0	0	1.0	99.0	0	1.5	98.5	0	
	97.0	3.5	96.5	0	1.5	98.5	0	1.0	99.0		
	98.5	2.0	98.0	0	3.5	96.5	0	2.5	97.5		
Bottom (7)	97.0	4.0	96.0	0	1.5	98.5	0	2.0	98.0	0	
	96.0	4.5	95.5	0	3.0	97.0	0	2.5	97.5		
	98.0	3.0	97.0	0	2.5	97.5	0	4.0	96.0		
Sea water from Tsunashirazu cove Surface	98.0	2.5	97.5	0	1.5	98.5	0	6.0	94.0	1	
	97.0	4.5	95.5	0	3.0	97.0	0	5.5	94.5		
	96.5	4.0	96.0	0	2.0	98.0	0	7.0	93.0		
Bottom (5)	96.0	4.0	96.0	0	2.5	97.5	0	8.0	92.0	1	
	97.5	5.0	95.0	0	3.5	96.5	0	7.5	92.5		
	97.0	3.5	96.5	0	2.0	98.0	0	6.0	94.0		

Table 3. Results of the June 23, 1984, experiment with eggs of *Anthocardis crassispina*.
Wind; 0, Test water temperature; 26°C, 5 mins. old sperms, 3 hrs. old eggs. Ranking III 1985.

Location (depth)	Time after insemination									Degree of inhibitory effect
	3 mins.	60 mins.			16 hrs.			26 hrs.		
	fert. memb. formation (%)	1-cell state (%)	2-cell stage normal (%)	multi-cell polyspermy (%)	permanent blastula (%)	normal gastrula (%)	exo- gastrula (%)	abnormal pluteus (%)	normal pluteus (%)	
(m)										
Running sea water of Laboratory	99.0 99.5 98.5	1.5 1.0 2.0	98.5 99.0 98.0	0 0 0	0.5 0 1.0	99.5 100 99.0	0 0 0	1.0 0.5 1.0	99.0 99.5 99.0	0
Water from open sea side of Hatakejima Surface	98.5 99.0 99.5	1.5 1.0 1.0	98.5 99.0 99.0	0 0 0	0.5 1.0 0.5	99.5 99.0 99.5	0 0 0	0.5 1.5 1.0	99.5 98.5 99.0	0
Bottom (15)	77.0 76.5 71.0	24.5 26.0 30.0	75.5 74.0 70.0	0 0 0	14.5 12.5 13.0	85.5 87.5 87.0	0 0 0	14.5 16.0 13.0	85.5 84.0 87.0	3
Water from land side of Hatakejima Surface	76.5 78.0 72.0	26.0 25.0 30.0	74.0 75.0 70.0	0 0 0	14.0 11.0 15.5	86.0 89.0 84.5	0 0 0	16.0 17.0 13.0	84.0 83.0 87.0	3
Bottom (7)	81.0 79.0 75.5	19.5 23.5 27.0	80.5 76.5 73.0	0 0 0	1.0 4.0 4.5	99.0 96.0 95.5	0 0 0	3.0 3.5 6.5	97.0 96.6 93.5	2
Sea water from Tsunashirazu cove Surface	78.5 73.0 71.5	24.0 28.0 31.5	76.0 72.0 68.5	0 0 0	11.0 16.5 13.0	89.0 83.5 87.0	0 0 0	15.0 15.5 17.0	85.0 84.5 83.0	3
Bottom (5)	76.0 70.0 68.5	25.0 32.0 33.0	75.0 68.0 67.0	0 0 0	13.0 18.5 16.0	87.0 81.5 84.0	0 0 0	16.0 13.5 19.0	84.0 86.5 81.0	3

Table 4. Results of the Sep. 4, 1984, experiment with eggs of *Anthocidaris crassispina*.
Wind; 0, Test water temperature; 27°C, 5 mins. old sperms, 3 hrs. old eggs. Ranking III 1985.

Location (depth) (m)	Time after insemination									Degree of inhibitory effect
	3 mins.			60 mins.			15 hrs.		24 hrs.	
	fert. memb. formation (%)	1-cell state (%)	2-cell stage normal (%)	multi-cell polyspermy (%)	permanent blastula (%)	normal gastrula (%)	exo- gastrula (%)	abnormal pulteus (%)	normal pulteus (%)	
Running sea water of Laboratory	99.5 99.0 99.0	1.0 1.5 1.0	99.0 98.5 99.0	0 0 0	0.5 1.0 1.0	99.5 99.0 99.0	0 0 0	1.0 0.5 2.0	99.0 99.5 98.0	0
Water from open sea side of Hatakejima Surface	98.0 99.5 99.0	2.0 1.5 2.0	98.0 98.5 98.0	0 0 0	2.0 2.5 1.5	98.0 97.5 98.5	0 0 0	4.0 3.5 6.0	96.0 96.5 94.0	1
Bottom (15)	98.0 99.0 98.0	2.5 1.5 2.0	97.5 98.5 98.0	0 0 0	1.0 2.5 1.0	99.0 97.5 99.0	0 0 0	1.5 2.0 1.5	98.5 98.0 98.5	0
Water from land side of Hatakejima Surface	98.5 98.0 98.0	2.0 2.5 3.0	98.0 97.5 97.0	0 0 0	1.5 2.0 1.0	98.5 98.0 99.0	0 0 0	2.0 1.5 2.5	98.0 98.5 97.5	0
Bottom (7)	98.0 98.0 97.5	2.5 2.0 3.0	97.5 98.0 97.0	0 0 0	2.0 2.5 2.0	98.0 97.5 98.0	0 0 0	5.5 4.0 3.5	94.5 96.0 96.5	1
Sea water from Tsunashirazu cove Surface	99.0 98.0 96.5	2.0 2.5 5.0	98.0 97.5 95.0	0 0 0	1.5 2.0 1.0	98.5 98.0 99.0	0 0 0	1.5 2.0 3.5	98.5 98.0 96.5	0
Bottom (5)	93.0 87.0 89.0	8.0 13.5 12.0	92.0 86.5 88.0	0 0 0	1.5 3.0 4.0	98.5 97.0 96.0	0 0 0	10.5 8.5 12.0	89.5 91.5 88.0	2

Table 5. Results of the Jan. 24, 1985 experiment with eggs of *Hemicentrotus pulcherrimus*.
Wind; NW1, Test water temperature; 18°C, 5 mins. old sperms, 6 hrs. old eggs. Ranking III 1985.

Location (depth)	Time after insemination										Degree of inhibitory effect
	3 mins.		75 mins.			23 hrs.			45 hrs.		
	fert. memb. formation (%)	1-cell state (%)	2-cell stage normal (%)	multi-cell polyspermy (%)	permanent blastula (%)	normal gastrula (%)	exo- gastrula (%)	abnormal pluteus (%)	normal pluteus (%)		
(m)											
Running sea water of Laboratory	98.5	2.0	98.0	0	0.5	99.5	0	1.5	98.5		
	99.0	1.5	98.5	0	0.5	99.5	0	0.5	99.5	0	
Water from open sea side of Hatakejima Surface	99.0	2.0	98.0	0	0	100	0	1.0	99.0		
	98.0	1.5	98.5	0	0.5	99.5	0	0.5	99.5	0	
Water from land side of Hatakejima Surface	97.0	3.0	97.0	0	1.5	98.5	0	2.5	97.5		
	98.0	3.5	96.5	0	1.0	99.0	0	2.0	98.0	0	
Bottom (7)	96.5	4.0	96.0	0	3.0	97.0	0	7.5	92.5		
	97.0	5.0	95.0	0	2.0	98.0	0	6.5	93.5	1	
Sea water from Tsunashirazu cove Surface	98.0	3.5	96.5	0	2.0	98.0	0	8.0	92.0		
	97.5	4.0	96.0	0	1.5	98.5	0	5.5	94.5	1	
Bottom (5)	93.0	9.0	90.5	0.5	52.5	47.5	0	83.5	16.5		
	92.5	8.5	90.5	1.0	60.5	39.5	0	58.0	42.0	5	

Table 6. Results of the Mar. 23, 1985 experiment with eggs of *Hemicentrotus pulcherrimus*.
Wind; 0, Test water temperature; 17°C, 5 mins. old sperms, 6 hrs. old eggs. Ranking III 1995.

Location (depth)	Time after insemination									Degree of inhibitory effect	
	3 mins.		75 mins.			24 hrs.			48 hrs.		
	fert. memb. formation (%)	1-cell state (%)	2-cell stage normal (%)	multi-cell polyspermy (%)	permanent blastula (%)	normal gastrula (%)	exo- gastrula (%)	abnormal pluteus (%)	normal pluteus (%)		
(m)											
Running sea water of Laboratory	96.5	4.5	95.0	0.5	1.0	99.0	0	0.5	99.5	0	
	94.5	6.0	94.0	0	0.5	99.5	0	0.5	99.5		
	98.0	2.0	98.0	0	0.5	99.5	0	1.0	99.0		
Water from open sea side of Hatakejima Surface	96.0	5.0	94.5	0.5	1.5	98.5	0	1.0	99.0	0	
	94.0	6.0	94.0	0	0.5	99.5	0	0.5	99.5		
	98.5	2.0	98.0	0	1.0	99.0	0	0.5	99.5		
Water from land side of Hatakejima Surface	88.5	13.5	86.5	0	7.5	92.5	0	73.0	27.0	5	
	91.0	9.5	90.5	0	4.5	95.5	0	68.5	31.5		
	90.5	10.0	90.0	0	6.5	93.5	0	71.0	29.0		
Bottom (7)	91.5	9.5	90.5	0	6.5	93.5	0	3.0	97.0	2	
	90.0	10.0	84.0	6.0	4.5	95.5	0	2.5	97.5		
	94.0	7.0	93.0	0	4.0	96.0	0	3.0	97.0		
Sea water from Tsunashirazu cove Surface	96.0	5.0	95.0	0	3.5	96.5	0	3.5	96.5	2	
	93.0	8.0	92.0	0	5.0	95.0	0	2.0	98.0		
	91.5	10.0	90.0	0	6.0	94.0	0	3.0	97.0		
Bottom (5)	94.0	6.5	93.5	0	5.5	94.5	0	6.0	94.0	2	
	94.0	7.0	93.0	0	4.0	96.0	0	4.5	95.5		
	92.0	9.0	91.0	0	6.0	94.0	0	3.5	96.5		

Table 7. Results of the July 18, 1985 experiment with eggs of *Anthocardis crassispina*.
Wind; 0, Test water temperature; 27°C, 5 mins. old sperms, 3 hrs. old eggs. Ranking III 1985.

Location (depth)	Time after insemination									Degree of inhibitory effect
	3 mins.		60 mins.			16 hrs.		27 hrs.		
	fert. memb. formation (%)	1-cell state (%)	2-cell stage normal (%)	multi-cell polyspermy (%)	permanent blastula (%)	normal gastrula (%)	exo- gastrula (%)	abnormal pluteus (%)	normal pluteus (%)	
(m)										
Running sea water of Laboratory	98.0	1.5	98.5	0	0.5	99.5	0	1.0	99.0	0
	98.0	2.0	98.0	0	0.5	99.5	0	0.5	99.5	
	99.0	2.0	98.0	0	0	100	0	1.0	99.0	
Water from open sea side of Hatakejima Surface	98.0	2.0	98.0	0	0	100	0	0.5	99.5	0
	99.0	1.5	98.5	0	0.5	99.5	0	0.5	99.5	
	99.5	1.0	99.0	0	0.5	99.5	0	0.5	99.5	
Bottom (15)	97.5	3.0	97.0	0	1.0	99.0	0	2.5	97.5	0
	98.0	2.5	97.5	0	0.5	99.5	0	3.0	97.0	
	97.0	3.5	95.5	1.0	0.5	99.5	0	2.0	98.0	
Water from land side of Hatakejima Surface	98.0	2.5	97.5	0	0.5	99.5	0	3.5	96.5	1
	98.5	3.0	96.0	1.0	1.0	99.0	0	5.5	94.5	
	97.0	3.5	95.0	1.5	2.0	98.0	0	3.0	97.0	
Bottom (7)	95.5	5.0	93.0	2.0	1.5	98.5	0	4.0	96.0	1
	95.0	6.0	93.5	0.5	2.0	98.0	0	6.5	93.5	
	93.0	7.5	90.0	2.5	3.0	97.0	0	5.0	95.0	
Sea water from Tsunashirazu cove Surface	92.5	8.0	80.5	11.5	12.5	87.5	0	24.5	75.5	4
	94.0	6.5	80.5	13.0	11.0	89.0	0	19.5	80.5	
	93.0	7.5	78.5	14.0	9.5	90.5	0	21.0	79.0	
Bottom (5)	94.0	6.5	90.5	3.0	1.5	98.5	0	6.0	94.0	1
	95.0	6.0	92.0	2.0	2.5	97.5	0	7.0	93.0	
	95.5	5.0	93.5	1.5	2.0	98.0	0	8.5	91.5	

Table 8. Results of the Aug. 28, 1985 experiment with eggs of *Anthocidaris crassispina*.
Wind; 0, Test water temperature; 27°C, 5 mins. old sperms, 3 hrs. old eggs. Ranking III 1985.

Location (depth)	Time after insemination									Degree of inhibitory effect
	3 mins.		60 mins.			15 hrs.		24 hrs.		
	fert. memb. formation (%)	1-cell state (%)	2-cell stage normal (%)	multi-cell polyspermy (%)	permanent blastula (%)	normal gastrula (%)	exo- gastrula (%)	abnormal pluteus (%)	normal pluteus (%)	
(m)										
Running sea water of Laboratory	99.0	1.5	98.5	0	1.0	99.0	0	0.5	99.5	0
	99.5	1.0	99.0	0	0.5	99.5	0	1.0	99.0	
	99.0	1.0	99.0	0	1.0	99.0	0	1.0	99.0	
Water from open sea side of Hatakejima Surface	99.5	1.0	99.0	0	0	100	0	1.0	99.0	0
	99.5	0.5	99.5	0	0.5	99.5	0	0.5	99.5	
	98.5	2.0	98.0	0	1.5	98.5	0	1.5	98.5	
Bottom (15)	99.0	1.0	99.0	0	0.5	99.5	0	0.5	99.5	0
	98.0	2.5	97.5	0	1.0	99.0	0	1.0	99.0	
	98.0	2.0	98.0	0	1.5	98.5	0	2.0	98.0	
Water from land side of Hatakejima Surface	98.0	2.5	97.5	0	1.0	99.0	0	1.5	98.5	0
	96.5	4.5	95.5	0	1.5	98.5	0	2.5	97.5	
	97.0	3.5	96.5	0	2.0	98.0	0	2.0	98.0	
Bottom (7)	97.0	3.5	96.5	0	1.5	98.5	0	2.5	97.5	0
	94.5	7.0	93.0	0	2.0	98.0	0	3.5	96.5	
	96.0	4.5	95.5	0	3.0	97.0	0	3.0	97.0	
Sea water from Tsunashirazu cove Surface	56.5	45.5	54.5	0	6.0	94.0	0	5.0	95.0	4
	63.5	39.0	61.0	0	4.5	95.5	0	4.5	95.5	
	58.0	43.0	57.0	0	8.5	91.5	0	7.5	92.5	
Bottom (5)	81.5	19.5	77.0	3.5	1.0	99.0	0	2.5	97.5	2
	78.0	24.0	75.0	1.0	3.5	96.5	0	3.5	96.5	
	75.5	25.5	72.5	2.0	4.0	96.0	0	4.0	96.0	

Table 9. Results of the Jan. 23, 1986 experiment with eggs of *Hemicentrotus pulcherrimus*.
Wind; NW1, Test water temperature; 19°C, 5 mins. old sperms, 6 hrs. old eggs. Ranking III 1985.

Location (depth)	Time after insemination									Degree of inhibitory effect
	3 mins.		65 mins.		24 hrs.			48 hrs.		
(m)	fert. memb. formation (%)	1-cell state (%)	2-cell stage normal (%)	multi-cell polyspermy (%)	permanent blastula (%)	normal gastrula (%)	exo- gastrula (%)	abnormal pluteus (%)	normal pluteus (%)	
Running sea water of Laboratory	99.0	1.5	98.5	0	0.5	99.5	0	1.0	99.0	0
	100	0.5	99.5	0	1.0	99.0	0	0.5	99.5	
	99.5	2.0	98.0	0	1.5	98.5	0	1.0	99.0	
Water from land side of Hatakejima Surface	93.0	8.0	92.0	0	4.5	95.5	0	2.5	97.5	1
	99.5	1.0	99.0	0	3.5	96.5	0	1.5	98.5	
	92.0	9.5	90.5	0	2.5	97.5	0	1.0	99.0	
Bottom (7)	85.5	18.5	81.5	0	11.0	89.0	0	18.5	81.5	5
	91.0	9.5	90.5	0	7.5	92.5	0	27.5	72.5	
	88.5	14.0	86.0	0	18.0	82.0	0	23.0	77.0	
Sea water from Tsunashirazu cove Surface	90.5	10.5	89.5	0	6.0	94.0	0	8.5	91.5	2
	94.0	8.0	92.0	0	3.5	96.5	0	13.0	87.0	
	91.5	10.0	90.0	0	7.5	92.5	0	7.0	93.0	
Bottom (5)	96.0	5.0	95.0	0	7.0	93.0	0	16.0	84.0	3
	97.5	3.0	97.0	0	4.0	96.0	0	15.5	84.5	
	90.0	11.5	88.5	0	8.5	91.5	0	9.5	90.5	

Table 10. Results of the Mar. 28, 1986 experiment with eggs of *Hemicentrotus pulcherrimus*.
Wind; 0, Test water temperature; 19°C, 5 mins. old sperms, 6 hrs. old eggs. Ranking III 1985.

Location (depth)	Time after insemination									Degree of inhibitory effect
	3 mins.	65 mins.			24 hrs.			48 hrs.		
(m)	fert. memb. formation (%)	1-cell state (%)	2-cell stage normal (%)	multi-cell polyspermy (%)	permanent blastula (%)	normal gastrula (%)	exo- gastrula (%)	abnormal pluteus (%)	normal pluteus (%)	
Running sea water of Laboratory	96.5	4.5	95.5	0	1.5	98.5	0	0.5	99.5	0
	97.5	4.0	96.0	0	1.0	99.0	0	1.5	98.5	
	98.0	2.5	97.5	0	0.5	99.5	0	1.5	98.5	
Water from open sea side of Hatakejima Surface	96.5	4.5	95.5	0	1.0	99.0	0	76.5	23.5	5
	97.0	4.0	96.0	0	1.0	99.0	0	100	0	
	98.5	2.0	98.0	0	0.5	99.5	0	100	0	
Water from land side of Hatakejima Surface	96.5	4.5	95.5	0	3.5	96.5	0	16.5	83.5	5
	96.5	5.0	95.0	0	2.5	97.5	0	100	0	
	97.5	3.0	97.0	0	2.0	98.0	0	100	0	
Bottom (7)	96.0	5.5	94.5	0	2.5	97.5	0	7.0	93.0	5
	94.0	6.0	94.0	0	2.0	98.0	0	25.5	74.5	
	97.5	3.0	97.0	0	1.5	98.5	0	19.0	81.0	
Sea water from Tsunashirazu cove Surface	96.0	5.0	95.0	0	4.5	95.5	0	26.5	73.5	5
	95.0	5.5	94.5	0	5.0	95.0	0	53.5	46.5	
	98.5	3.0	97.0	0	3.0	97.0	0	63.5	36.5	
Bottom (5)	95.5	5.5	94.5	0	6.5	93.5	0	3.5	96.5	1
	96.6	5.0	95.0	0	5.5	94.5	0	4.0	96.0	
	97.0	3.0	97.0	0	3.5	96.5	0	3.0	97.0	

Table 11. Results of the Sep. 4, 1986 experiment with eggs of *Anthocidaris crassispina*.
Wind; 0, Test water temperature; 27°C, 5 mins. old sperms, 3 hrs. old eggs. Ranking III 1985.

Location (depth)	Time after insemination									Degree of inhibitory effect	
	3 mins.		60 mins.			18 hrs.			30 hrs.		
	fert. memb. formation (%)	1-cell state (%)	2-cell stage normal (%)	multi-cell polyspermy (%)	permanent blastula (%)	normal gastrula (%)	exo- gastrula (%)	abnormal pluteus (%)	normal pluteus (%)		
(m)											
Running sea water of Laboratory	99.5	0.5	99.5	0	0.5	99.5	0	0.5	99.5	0	
	99.0	1.0	99.0	0	0.5	99.5	0	1.0	99.0		
	98.0	2.5	97.5	0	1.0	99.0	0	0.5	99.5		
Water from open sea side of Hatakejima Surface	99.0	1.0	98.0	1.0	1.0	99.0	0	2.0	98.0	0	
	98.5	1.5	97.0	1.5	1.5	98.5	0	1.5	98.5		
	98.0	1.5	97.0	1.5	1.5	98.5	0	0.5	99.5		
Bottom (15)	98.5	1.0	98.5	0.5	2.0	98.0	0	3.0	97.0	0	
	98.0	2.0	97.0	1.0	2.0	98.0	0	2.5	97.5		
	97.0	3.0	96.0	1.0	1.5	98.5	0	1.5	98.5		
Water from land side of Hatakejima Surface	97.0	3.0	95.5	1.5	3.5	96.5	0	3.5	96.5	1	
	96.0	4.0	94.0	2.0	5.0	95.0	0	2.5	97.5		
	96.0	4.0	95.0	1.0	4.5	95.5	0	3.0	97.0		
Bottom (7)	96.0	3.0	93.0	4.0	4.5	95.5	0	4.5	95.5	1	
	93.0	7.0	91.0	2.0	5.0	95.0	0	3.0	97.0		
	94.0	6.0	93.0	1.0	4.5	95.5	0	2.5	97.5		
Sea water from Tsunashirazu cove Surface	18.5	84.0	16.0	0	100	0	0			5	
	15.0	86.0	14.0	0	100	0	0				
	26.0	75.0	25.0	0	100	0	0				
Bottom (5)	81.5	21.0	74.5	4.5	4.0	96.0	0	5.0	95.0	2	
	80.0	20.0	78.0	2.0	4.5	95.5	0	4.5	95.5		
	77.5	21.0	76.0	3.0	4.5	95.5	0	6.0	94.0		

Table 12. Results of the Jan. 17, 1987 experiment with eggs of *Hemicentrotus pulcherrimus*.
Wind; 0, Test water temperature; 19°C, 5 mins. old sperms, 6 hrs. old eggs. Ranking III 1985.

Location (depth)	Time after insemination									Degree of inhibitory effect
	3 mins.		75 mins.			22 hrs.			45 hrs.	
(m)	fert. memb. formation (%)	1-cell state (%)	2-cell stage normal (%)	multi-cell polyspermy (%)	permanent blastula (%)	normal gastrula (%)	exo- gastrula (%)	abnormal pultes (%)	normal pluteus (%)	
Running sea water of Laboratory	98.0 99.5 83.0	3.0 1.0 18.0	97.0 99.0 82.0	0 0 0	0 1.0 1.5	100 99.0 98.5	0 0 0	1.0 0.5 0.5	99.0 99.5 99.5	1
Water from open sea side of Hatakejima Surface	98.5 99.5 87.5	1.5 1.0 12.5	98.0 99.0 87.0	0.5 0 0.5	0.5 1.0 1.5	99.5 99.0 98.5	0 0 0	0 0.5 1.0	100 99.5 99.0	1
Water from land side of Hatakejima Surface	98.0 99.0 83.5	2.5 2.0 17.0	97.0 98.0 82.5	0.5 0 0.5	3.5 3.0 5.0	96.5 97.0 95.0	0 0 0	1.0 1.5 1.0	99.0 98.5 99.0	1
Bottom (7)	81.0 83.5 73.0	20.0 17.0 28.0	79.0 82.0 70.0	1.0 1.0 2.0	11.0 10.5 16.5	89.0 89.5 83.5	0 0 0	2.0 2.5 1.5	98.0 97.5 98.5	3
Sea water from Tsunashirazu cove Surface	85.0 87.5 79.5	32.5 35.0 31.0	65.0 61.0 66.0	2.5 4.0 3.0	19.5 19.0 22.0	80.5 81.0 78.0	0 0 0	2.0 2.5 3.0	98.0 97.5 97.0	4
Bottom (5)	62.0 78.0 75.0	39.0 40.5 36.0	59.0 54.5 60.0	2.0 5.0 4.0	21.5 24.0 29.0	78.5 76.0 71.0	0 0 0	2.0 3.0 2.5	98.0 97.0 97.5	5

Table 13. Results of the Mar. 19, 1987 experiment with eggs of *Hemicentrotus pulcherrimus*.
Wind; 0., Test water temperature; 19°C, 5 mins. old sperms, 6 hrs. old eggs. Ranking III 1985.

Location (depth)	Time after insemination									Degree of inhibitory effect
	3 mins.		75 mins.		24 hrs.			48 hrs.		
	fert. memb. formation (%)	1-cell state (%)	2-cell stage normal (%)	multi-cell polyspermy (%)	permanent blastula (%)	normal gastrula (%)	exo- gastrula (%)	abnormal pluteus (%)	normal pluteus (%)	
(m)										
Running sea water of Laboratory	98.5	2.5	97.5	0	1.0	99.0	0	1.0	99.0	
	99.0	1.5	98.5	0	0.5	99.5	0	1.5	98.5	0
	98.5	2.0	97.0	1.0	1.5	98.5	0	0.5	99.5	
Water from open sea side of Hatakejima Surface	99.0	1.5	98.5	0	1.0	99.0	0	1.0	99.0	
	99.5	1.0	99.0	0	0.5	99.5	0	1.0	99.0	0
	98.5	1.5	97.0	1.5	2.0	98.0	0	1.5	98.5	
Water from land side of Hatakejima Surface	96.0	4.0	95.0	1.0	2.0	98.0	0	1.5	98.5	
	97.0	3.5	92.0	4.5	2.5	97.5	0	1.5	98.5	1
	96.5	7.5	89.0	3.5	3.0	97.0	0	2.0	98.0	
	97.0	10.0	72.5	17.5	8.5	91.5	0	100	0	
Bottom (7)	98.0	8.0	71.0	21.0	10.0	90.0	0	65.0	35.0	5
	97.0	11.0	65.5	23.5	13.0	87.0	0	100	0	
Sea water from Tsunashirazu cove Surface	8.0	93.0	7.0	0						
	7.0	93.5	6.5	0						5
	5.5	95.0	5.0	0						
	94.0	15.0	61.5	23.5	13.5	86.5	0	100	0	
Bottom (5)	95.0	7.5	64.5	28.0	16.5	83.5	0	100	0	5
	93.0	11.5	57.5	31.0	83.0	17.0	0	100	0	

Table 14. Results of the June 10, 1987 experiment with eggs of *Anthocardis crassispina*.
Wind; 0, Test water temperature; 25°C, 5 mins. old sperms, 3 hrs. old eggs. Ranking III 1985.

Location (depth)	Time after insemination									Degree of inhibitory effect
	3 mins.	70 mins.			15 hrs.			24 hrs.		
(m)	fert. memb. formation (%)	1-cell state (%)	2-cell stage normal (%)	multi-cell polyspermy (%)	permanent blastula (%)	normal gastrula (%)	exo- gastrula (%)	abnormal pluteus (%)	normal pluteus (%)	
Running sea water of Laboratory	99.5	1.0	99.0	0	0.5	99.5	0	1.0	99.0	0
	99.0	1.0	99.0	0	0	100	0	2.0	98.0	
	98.0	2.5	97.5	0	1.0	99.0	0	1.5	98.5	
Water from open sea side of Hatakejima Surface	99.5	1.0	99.0	0	1.0	99.0	0	1.5	98.5	0
	99.5	0.5	99.5	0	0.5	99.5	0	1.5	98.5	
	98.5	2.0	98.0	0	0.5	99.5	0	2.0	98.0	
Bottom (15)	98.0	3.0	97.0	0	1.5	98.5	0	2.0	98.0	0
	98.5	2.0	98.0	0	2.0	98.0	0	1.5	98.5	
	99.0	2.5	97.5	0	1.0	99.0	0	2.5	97.5	
Water from Land side of Hatakejima Surface	97.0	4.0	95.0	1.0	4.0	96.0	0	3.5	96.5	1
	98.5	2.0	97.5	0.5	3.5	96.5	0	4.5	95.5	
	97.5	2.5	97.0	0.5	4.5	95.5	0	5.0	95.0	
Bottom (7)	98.5	2.0	97.0	1.0	4.0	96.0	0	9.5	90.5	2
	98.0	2.5	96.0	1.5	5.0	95.0	0	9.0	91.0	
	96.5	4.0	94.0	2.0	3.5	96.5	0	9.5	90.5	
Sea water from Tsunashirazu cove Surface	98.0	3.0	96.0	1.0	4.0	96.0	0	4.5	95.5	1
	97.5	3.5	96.0	0.5	3.0	97.0	0	5.0	95.0	
	96.0	5.0	94.0	1.0	3.5	96.5	0	4.0	96.0	
Bottom (5)	95.0	5.5	92.5	2.0	4.5	95.5	0	10.5	89.5	2
	96.0	3.5	94.0	2.5	6.0	94.0	0	9.0	91.0	
	94.0	6.5	90.0	3.5	5.0	95.0	0	10.0	90.0	

Table 15. Results of the Aug. 11, 1987 experiment with eggs of *Anthocardis crassispina*.
Wind; 0, Test water temperature; 27°C, 5 mins. old sperms, 3 hrs. old eggs. Ranking III 1985.

Location (depth)	Time after insemination									Degree of inhibitory effect
	3 mins.	60 mins.			18 hrs.			24 hrs.		
	fert. memb. formation (%)	1-cell state (%)	2-cell stage normal (%)	multi-cell polyspermy (%)	permanent blastula (%)	normal gastrula (%)	exo- gastrula (%)	abnormal pluteus (%)	normal pluteus (%)	
(m)										
Running sea water of Laboratory	93.5 9.95 99.0	7.0 1.0 1.5	93.0 99.0 98.5	0 0 0	0.5 1.0 1.0	99.5 99.0 99.0	0 0 0	0.5 1.0 1.0	99.5 99.0 99.0	0
Water from open sea side of Hatakejima Surface	94.5 99.5 99.0	5.5 0.5 1.0	94.5 99.5 99.0	0 0 0	1.0 0.5 0.5	99.0 99.5 99.5	0 0 0	0.5 0.5 1.0	99.5 99.5 99.0	0
Bottom (15)	94.5 98.5 98.0	6.0 2.0 2.5	94.0 98.0 97.5	0 0 0	0.5 1.0 1.0	99.5 99.0 99.0	0 0 0	1.0 1.5 2.0	99.0 98.5 98.0	0
Water from land side of Hatakejima Surface	93.5 98.0 97.5	7.0 2.5 3.0	93.0 97.5 97.0	0 0 0	1.5 2.0 1.5	98.5 98.0 98.5	0 0 0	2.0 5.0 5.5	98.0 95.0 94.5	1
Bottom (7)	93.0 98.5 98.5	6.5 3.0 2.0	93.5 97.0 98.0	0 0 0	2.0 2.0 2.5	98.0 98.0 97.5	0 0 0	10.0 11.0 12.0	90.0 89.0 88.0	2
Sea water from Tsunashirazu cove Surface	92.0 96.5 97.0	8.0 4.0 4.5	90.5 94.0 92.5	1.5 2.0 3.0	1.5 2.5 3.0	98.5 97.5 97.0	0 0 0	11.0 13.0 10.5	89.0 87.0 89.5	2
Bottom (5)	93.0 95.0 95.5	8.0 6.0 5.0	92.0 94.0 95.0	0 0 0	2.0 3.0 3.0	98.0 97.0 97.0	0 0 0	9.5 12.5 14.0	90.5 87.5 86.0	2

Table 16. Results of the Mar. 29, 1988 experiment with eggs of *Hemicentrotus pulcherrimus*.
 Wind; 0, Test water temperature; 19°C, 5 mins. old sperms, 6 hrs.. old eggs. Ranking III 1985.

Location (depth)	Time after insemination									Degree of inhibitory effect	
	3 mins.		75 mins.			24 hrs.			48 hrs.		
	fert. memb. formation (%)	1-cell state (%)	2-cell stage normal (%)	multi-cell polyspermy (%)	permanent blastula (%)	normal gastrula (%)	exo- gastrula (%)	abnormal pluteus (%)	normal pluteus (%)		
(m)											
Running sea water of Laboratory	100	1.0	99.0	0	0.5	99.5	0	0.5	99.5		
	99.5	1.0	99.0	0	1.0	99.0	0	1.0	99.0	0	
	98.0	3.5	96.5	0	1.5	98.5	0	1.0	99.0		
Water from open sea side of Hatakejima Surface	99.5	0.5	99.5	0	0.5	99.5	0	1.5	98.5		
	100	1.0	98.0	1.0	0.5	99.5	0	1.5	98.5	0	
	97.0	5.0	95.0	0	1.0	99.0	0	3.0	97.0		
	99.0	6.0	94.0	0	1.0	99.0	0	4.5	95.5		
Bottom (15)	99.5	5.5	94.5	0	0.5	99.5	0	5.0	95.0	1	
	95.0	17.5	82.5	0	2.5	97.5	0	7.5	92.5		
Water from land side of Hatakejima Surface	99.0	1.0	99.0	0	1.0	99.0	0	2.5	97.5		
	98.5	2.0	97.5	0.5	2.0	98.0	0	2.0	98.0	0	
	99.5	7.0	93.0	0	4.0	96.0	0	3.5	96.5		
	99.0	1.5	98.0	0.5	2.0	98.0	0	3.0	97.0		
Bottom (7)	99.5	2.0	97.5	0.5	1.5	98.5	0	2.5	97.5	1	
	93.0	12.0	87.0	1.0	3.5	96.5	0	4.5	95.9		
Sea water from Tsunashirazu cove Surface	99.0	1.5	98.5	0	1.5	98.5	0	5.0	95.0		
	98.0	2.0	97.5	0.5	2.0	98.0	0	6.0	94.0	1	
	94.0	10.0	89.5	0.5	3.0	97.0	0	7.5	92.5		
	98.0	4.0	96.0	0	2.5	97.5	0	2.0	98.0		
Bottom (5)	99.0	2.0	96.5	1.5	3.0	97.0	0	1.5	98.5	1	
	92.0	18.0	81.0	1.0	4.0	96.0	0	4.0	96.0		

Ranking IV

Location	1st cleavage (75 m)			Pluteus formation (48 h)					Remarks grade
	normal	1 cell	multi- cell	normal	retard	mal- form	pre- pluteus	dead embryo	
(depth)	(polyspermy)			N	R	P ₁	P ₂	D	
(m)	%	%	%	%	%	%	%	%	
Running sea water of Laboratory	99.5	0.5		97.5		2.5			0
	99.0	1.0		97.0		3.0			
	97.0	3.0		96.0		4.0			
Water from open sea side of Hatakejima Surface	99.5		0.5	93.5	1.0	5.5			1
	99.5	0.5		94.5	2.0	3.0	0.5		
	97.0	3.0		92.5	0.5	7.0			
Bottom (15)	95.0	4.0	1.0	87.0	1.0	12.0			1
	95.0	5.0		78.0		21.5	0.5		
	84.0	16.0		69.0	4.0	25.5	1.5		
Water from land side of Hatakejima Surface	98.5	1.0	0.5	96.5	0.5	2.5	0.5		1
	98.5	1.5		97.5		2.0	0.5		
	94.5	5.5		91.5	0.5	6.0	2.0		
Bottom (7)	98.5	1.5		96.0		4.0			1
	99.0	1.0		93.5		6.5			
	89.5	10.5		85.0	1.5	12.0	1.5		
Sea water from Tsunashirazu cove Surface	97.5	1.0	1.5	84.0	1.0	14.5	0.5		1
	98.5	1.5		82.0	2.0	16.0			
	90.5	9.5		83.0	6.5	9.5	1.0		
Bottom (5)	96.5	3.5		94.5		5.0	0.5		1
	98.0	1.0	1.0	95.0	0.5	4.5			
	86.0	14.0		83.0	3.0	12.0	2.0		

Table 17. Results of the May 30, 1988 experiment with eggs of *Anthocidaris erassispina*.
 Wind; 0, Test water temperature; 22°C, 5 mins. old sperms 3.5 hrs. old eggs. Ranking III 1985.

Location (depth)	Time after insemination									Degree of inhibitory effect	
	3 mins.			60 mins.			20 hrs.		36 hrs.		
	fert. memb. formation (%)	1-cell state (%)	2-cell stage normal (%)	multi-cell polyspermy (%)	permanent blastula (%)	normal gastrula (%)	exo- gastrula (%)	abnormal pluteus (%)	normal pluteus (%)		
(m)											
Running sea water of Laboratory	94.5	6.0	93.0	1.0	1.5	98.5	0	2.5	97.5	0	
	92.0	9.0	91.0	0	1.0	99.0	0	3.0	97.0		
	93.0	8.0	92.0	0	1.5	98.5	0	1.5	98.5		
Water from open sea side of Hatakejima Surface	91.5	8.5	90.0	1.5	2.5	97.5	0	2.5	97.5	0	
	92.0	8.5	91.5	0	1.0	99.0	0	1.5	98.5		
	93.0	7.5	92.5	0	1.5	98.5	0	1.5	98.5		
Bottom (15)	87.0	13.5	86.5	0	3.5	96.5	0	1.5	98.5	1	
	88.0	13.0	87.0	0	5.5	94.5	0	3.0	97.0		
	90.0	11.0	89.0	0	5.0	95.0	0	2.0	98.0		
Water from land side of Hatakejima Surface	86.5	16.0	84.0	0	4.0	96.0	0	2.5	97.5	1	
	86.0	15.0	85.0	0	3.5	96.5	0	3.0	97.0		
	85.0	16.5	83.5	0	2.5	97.5	0	3.5	96.5		
Bottom (7)	80.5	21.5	78.5	0	7.0	93.0	0	3.5	96.5	1	
	83.0	18.5	81.5	0	3.5	96.5	0	4.0	96.0		
	81.5	20.0	80.0	0	3.0	97.0	0	4.5	95.5		
Sea water from Tsunashirazu cove Surface	84.0	16.5	83.5	0	2.0	98.0	0	3.0	97.0	1	
	85.5	16.0	84.0	0	6.0	94.0	0	3.5	96.6		
	83.0	17.5	82.5	0	6.5	83.5	0	5.0	95.0		
Bottom (5)	80.0	25.0	75.0	0	8.5	91.5	0	3.5	96.5	1	
	81.5	20.0	80.0	0	6.5	93.5	0	4.5	95.5		
	79.5	21.5	78.5	0	6.0	94.0	0	6.0	94.0		

Ranking IV

Location (depth)	1st cleavage (60 m)			Pluteus formation (36 h)					Remarks grade
	normal	1 cell	multi-cell (polyspermy)	normal N	ratard R	mal-form P ₁	pre-pluteus P ₂	dead embryo D	
(m)	%	%	%	%	%	%	%	%	
Running sea water of Laboratory	95.5	4.0	0.5	96.0	3.5			0.5	0
	96.5	3.5		98.0	1.0	1.0			
	97.0	3.0		96.5	1.5	1.0	0.5	0.5	
Water from open sea side of Hatakejima Surface	93.5	6.0	0.5	97.0	1.5	1.5			0
	93.5	6.5		97.0	0.5	1.5		1.0	
	92.0	7.5	0.5	96.5	0.5	1.0	0.5	1.5	
Bottom (15)	92.0	8.0		95.0	0.5	2.0	1.5	1.0	1
	93.0	7.0		92.0	2.5	2.5	2.0	1.0	
	93.5	6.0	0.5	88.0	0.5	5.5	3.0	3.0	
Water from land side of Hatakejima Surface	91.0	8.5	0.5	92.0	1.5	4.0		2.5	1
	90.0	9.5	0.5	90.0	5.0	2.0	3.0		
	84.5	14.0	1.5	93.0	5.5		1.0	0.5	
Bottom (7)	87.5	12.0	0.5	90.5	6.5	2.0	1.0		1
	85.5	13.5	1.0	92.5	5.0	2.0		0.5	
	86.0	13.0	1.0	91.0	5.0	3.5		0.5	
Sea water from Tsunashira cove Surface	90.5	7.5	2.0	85.5	3.0	5.5	3.0	3.0	1
	89.5	9.0	1.5	86.5	4.0	6.0	2.0	1.5	
	86.5	12.5	1.0	93.5	1.0	2.0	2.0	1.5	
Bottom (5)	84.5	14.5	1.0	90.5	3.5	5.0	0.5	0.5	1
	83.0	16.5	0.5	88.5	6.5	4.5		0.5	
	87.5	11.5	1.0	86.0	8.5	4.0	1.0	0.5	

Table 18. Results of the July 19, 1988 experiment with eggs of *Anthocidaris crassispina*.
Wind; 0, Test water temperature; 26° C, 5 mins. old sperms, 3 hrs. old eggs. Ranking III 1985.

Location (depth)	Time after insemination									Degree of inhibitory effect	
	3 mins.		60 mins.			18 hrs.			36 hrs.		
	fert. memb. formation (%)	1-cell state (%)	2-cell stage normal (%)	multi-cell polyspermy (%)	permanent blastula (%)	normal gastrula (%)	exo- gastrula (%)	abnormal pluteus (%)	normal pluteus (%)		
(m)											
Running sea water of Laboratory	97.0	3.5	96.5	0	0.5	99.5	0	0	100		
	99.5	1.0	99.0	0	0.5	99.5	0	0.5	99.5	0	
	99.0	1.5	98.5	0	0	100	0	0.5	99.5		
Water from open sea side of Hatakejima Surface	98.5	2.0	98.0	0	0	100	0	0.5	99.5		
	98.5	1.5	98.5	0	0.5	99.5	0	0.5	99.5	0	
	98.5	1.5	98.0	0	0.5	99.5	0	0.5	99.5		
Bottom (15)	96.5	4.0	96.0	0	1.5	98.5	0	1.0	99.0		
	98.0	2.0	98.0	0	1.0	99.0	0	1.5	98.5	0	
	98.0	2.5	97.5	0	1.0	99.0	0	2.0	98.0		
Water from land side of Hatakejima Surface	98.5	2.0	98.0	0	4.5	95.5	0	7.0	93.0		
	99.0	1.5	98.5	0	8.5	91.5	0	10.5	89.5	1	
	98.0	2.5	97.5	0	7.0	93.0	0	9.5	90.5		
Bottom (7)	98.0	2.5	97.5	0.5	3.0	97.0	0	2.5	97.5		
	98.0	2.0	98.0	0	3.5	96.5	0	3.0	97.0	0	
	98.5	2.5	97.5	0	2.5	97.5	0	3.0	97.0		
Sea water from Tsunashirazu cove Surface	95.0	8.5	91.5	0	2.5	97.5	0	3.0	97.0		
	98.5	3.0	97.0	0	5.0	95.0	0	4.5	95.5	1	
	97.5	3.5	96.5	0	4.0	96.0	0	4.0	96.0		
Bottom (5)	98.0	2.0	98.0	0	3.5	96.5	0	3.5	96.5		
	98.0	2.5	97.5	0	4.0	96.0	0	3.0	97.0	1	
	95.0	6.5	93.5	0	5.5	94.5	0	4.0	96.0		

Ranking IV

Location (depth)	1st cleavage (60 m)			Pluteus formation (36 h)				Remarks grade
	normal	1 cell	multi-cell (polyspermy)	normal N	retard R	mal-form P ₁	pre-pluteus P ₂	
(m)	%	%	%	%	%	%	%	
Running sea water of Laboratory	98.0	2.0		99.0	1.0			
	99.0	0.5	0.5	99.5	0.5			0
	99.5	0.5		99.0		1.0		
Water from open sea side of Hatakejima Surface	98.5	1.5		96.0		2.0	2.0	
	98.5	0.5	1.0	98.5		1.5		0
	99.0	1.0		99.5		0.5		
Bottom (15)	96.5	3.5		96.5	0.5	3.0		
	97.0	2.0	1.0	96.5	1.5	2.0		0
	98.5	1.5		98.0	1.0	1.0		
Water from land side of Hatakejima Surface	98.0	2.0		86.5	4.0	9.5		
	98.5	1.5		93.0	1.0	6.0		1
	98.0	2.0		91.0	1.5	7.5		
Bottom (7)	99.0	1.0		96.5	3.0	0.5		
	98.0	1.5	0.5	95.0	0.5	4.0	0.5	0
	99.0	1.0		95.5	4.0	0.5		
Sea water from Tsunashirazu cove Surface	98.0	2.0		90.5	1.0	4.5	4.0	
	96.5	3.0	0.5	88.5	4.5	3.5	3.5	1
	98.0	2.0		90.0	2.0	4.0	4.0	
Bottom (5)	98.0	2.0		90.0	4.0	3.0	3.0	
	98.0	2.0		89.0	4.0	3.5	3.5	1
	96.0	3.5	0.5	90.0	3.5	4.5	2.0	

Table 19. Results of the Aug. 19, 1988 experiment with eggs of *Anthocidaris crassispina*.
 Wind; 0, Test water temperature; 27°C, 5 mins. old sperms, 3 hrs. old eggs. Ranking III 1985.

Location (depth)	Time after insemination									Degree of inhibitory effect
	3 mins.			60 mins.			18 hrs.			
	fert. memb. formation (%)	1-cell state (%)	2-cell stage normal (%)	multi-cell polyspermy (%)	permanent blastula (%)	normal gastrula (%)	exo- gastrula (%)	abnormal pluteus (%)	normal pluteus (%)	
Running sea water of Laboratory	97.5	3.5	96.5	0	1.0	99.0	0	2.0	98.0	0
	96.5	5.0	95.0	0	1.5	98.5	0	2.0	98.0	
	98.0	3.0	97.0	0	1.5	98.5	0	1.5	98.5	
Water from open sea side of Hatakejima Surface	96.0	4.5	95.5	0	1.0	99.0	0	2.0	98.0	0
	97.0	4.0	96.0	0	1.0	99.0	0	1.0	99.0	
	98.0	3.5	96.5	0	1.5	98.5	0	1.0	99.0	
Bottom (15)	92.5	9.0	91.0	0	2.0	98.0	0	3.5	96.5	0
	91.0	10.5	89.5	0	2.5	97.5	0	2.0	98.0	
	93.0	9.5	90.5	0	2.5	97.5	0	3.5	96.5	
Water from land side of Hatakejima Surface	91.0	10.5	89.5	0	5.0	95.0	0	8.5	91.5	1
	89.5	12.0	88.0	0	6.0	94.0	0	8.0	92.0	
	88.0	13.5	86.5	0	4.0	96.0	0	7.0	93.0	
Bottom (7)	85.5	17.0	83.0	0	3.5	96.5	0	12.5	87.5	2
	83.0	18.5	81.5	0	6.0	94.0	0	13.5	96.5	
	81.5	20.0	80.0	0	5.0	95.0	0	12.0	88.0	
Sea water from Tsunashirazu cove Surface	41.0	60.0	40.0	0						5
	40.0	60.5	39.5	0						
	38.5	63.5	36.5	0						
Bottom (5)	69.5	31.5	68.5	0	7.0	93.0	0	9.0	91.0	1
	69.0	33.0	67.0	0	4.0	96.0	0	7.5	92.5	
	73.5	29.0	71.0	0	7.5	92.5	0	7.0	93.0	

Ranking IV									
Location	1st cleavage (60 m)			Pluteus formation (36 h)					Remarks grade
	normal	1 cell	multi- cell	normal	retard	mal- form	pre- pluteus	dead embryo	
(depth)	(polyspermy)			N	R	P ₁	P ₂	D	
(m)	%	%	%	%	%	%	%	%	
Running sea water of Laboratory	97.5	2.5		96.5	2.5	1.0			
	99.5	0.5		96.0	2.5	1.5			0
	99.0	1.0		97.0	2.5	0.5			
Water from open sea side of Hatakejima Surface	98.5	1.0	0.5	97.0	1.0	2.0			
	97.0	3.0		98.0	1.5	0.5			0
	96.5	3.5		97.5	1.0	1.5			
Bottom (15)	97.0	3.0		96.0	3.0	1.0			
	94.5	5.5		95.5	4.0	0.5			0
	93.5	6.5		95.5	3.0	1.5			
Water from land side of Hatakejima Surface	95.0	5.0		86.0	14.0				
	95.5	4.5		86.5	12.5	1.0			1
	93.0	7.0		81.0	16.5	2.5			
Bottom (7)	92.5	7.5		63.5	28.0	8.5			
	87.0	13.0		72.0	21.0	7.0			2
	84.5	15.5		71.5	23.0	5.5			
Sea water from Tsunashirazu cove Surface	46.5	53.5							
	39.0	61.0							3
	42.5	57.5							
Bottom (5)	71.5	28.5		82.0	11.0	7.0			
	79.0	21.0		87.5	7.5	5.0			1
	76.5	23.5		87.0	8.5	4.5			

Table 20. Results of the Feb. 21, 1989 experiment with eggs of *Hemicentrotus pulcherrimus*.
Wind; 0. Test water temperature; 18°C. Ranking IV

Location (depth)	1st cleavage (75 m)			Pluteus formation (48 h)					Remarks grade	
	normal	1 cell	multi-cell	normal	retard	mal-form	pre-pluteus	dead embryo		
			(polyspermy)	N	R	P ₁	P ₂	D		
(m)	%	%	%	%	%	%	%	%		
Running sea water of Laboratory	99.5	0.5		96.5	2.5	1.0				0
	99.0	1.0		93.5	3.5	3.0				
	99.5	0.5		93.5	4.0	2.5				
Water from open sea side of Hatakejima Surface	97.5	2.0	0.5	94.5	3.0	2.5				0
	99.5	0.5		94.0	3.5	2.5				
	99.0	1.0		93.0	4.0	3.0				
Water from land side of Hatakejima Surface	97.0	3.0		92.0	3.5	3.0	1.5			1
	99.0	1.0		94.0	3.0	2.5	0.5			
	98.5	1.5		91.0	4.0	3.5	1.5			
Bottom (7)	97.5	2.5		88.5	6.0	4.5	1.0			1
	97.5	2.5		87.5	5.5	6.5	0.5			
	99.0	1.0		84.5	7.5	7.0	1.0			
Sea water from Tsunashirazu cove Surface	96.5	3.5		89.0	4.5	5.5	1.0			1
	98.0	2.0		85.0	6.5	7.0	1.5			
	98.5	1.5		83.0	7.0	8.5	1.5			
Bottom (5)	96.5	3.5		84.5	7.0	6.0	2.5			1
	97.5	2.5		84.0	6.5	7.5	2.0			
	99.0	1.0		82.0	7.5	8.5	2.0			

Table 21. Results of the Apr. 5, 1989 experiment with eggs of *Hemicentrotus pulcherrimus*.

Wind; 0. Test water temperature; 17°C.

Ranking IV

Location (depth)	1st cleavage (75 m)			Pluteus formation (48 h)					Remarks grade
	normal	1 cell	multi-cell (polyspermy)	normal N	retard R	mal-form P ₁	pre-pluteus P ₂	dead embryo D	
(m)	%	%	%	%	%	%	%	%	
Running sea water of Laboratory	99.5	0.5		99.0	1.0				0
	99.5	0.5		99.5	0.5				
	99.0	1.0		98.5	1.5				
Water from open sea side of Hatakejima Surface	99.0	1.0		98.5	1.5				0
	99.5	0.5		97.0	2.0	1.0			
	98.5	1.0	0.5	98.0	1.0	1.0			
Water from land side of Hatakejima Surface	99.0	1.0		97.0	3.0				0
	98.5	1.5		95.0	2.0	3.0			
	98.5	1.0	0.5	96.0	2.0	2.0			
Bottom (7)	99.0	1.0		95.0	5.0				1
	99.0	0.5	0.5	94.5	3.0	2.5			
	98.0	1.5	0.5	91.5	6.5	2.0			
Sea water from Tsunashirazu cove Surface	99.0	1.0		93.5	6.5				1
	98.5	1.5		94.0	4.5	1.5			
	98.0	1.5	0.5	92.5	6.5	1.0			
Bottom (5)	96.5	2.5	1.0		31.5		45.5	23.0	3
	95.5	3.0	1.5		48.5		32.0	19.5	
	96.0	3.5	0.5		44.0	1.5	33.5	21.0	

Table 22. Results of the July 5, 1989 experiment with eggs of *Anthocardis crassispira*.

Wind; ; 0. Test water temperature; 25°C.

Ranking IV

Location (depth)	1st cleavage (60 m)			Pluteus formation (36 h)					Remarks grade
	normal	1 cell	multi-cell (polyspermy)	normal N	retard R	mal- form P ₁	pre- pluteus P ₂	dead embryo D	
(m)	%	%	%	%	%	%	%	%	
Running sea water of Laboratory	97.0	3.0		98.0	2.0				
	94.0	6.0		96.0	3.5		0.5	0	
	98.0	2.0		99.0	1.0				
Water from open sea side of Hatakejima Surface	99.5	0.5		99.5	0.5				
	95.0	5.0		97.0	2.5		0.5	0	
	99.0	1.0		98.5	1.5				
Bottom (15)	97.5	2.5		98.0	2.0				
	92.0	8.0		97.0	2.0		1.0	0	
	96.0	4.0		97.0	3.0				
Water from land side of Hatakejima Surface	96.0	4.0		97.0	2.0		1.0		
	91.5	8.5		95.0	3.0	1.0	1.0	0	
	95.5	4.5		96.0	2.5	0.5	1.0		
Bottom (7)	91.0	9.0		96.0	3.0	0.5	0.5		
	90.0	10.0		93.0	4.0	1.0	2.0	1	
	95.0	5.0		95.0	3.5	0.5	1.0		
Sea water from Tsunashirazu cove Surface	90.0	10.0		94.5	5.0		0.5		
	86.5	13.5		90.0	6.5	1.0	2.5	1	
	94.0	6.0		93.0	5.5	0.5	1.0		
Bottom (5)	91.0	9.0		88.0	10.0	0.5	1.5		
	85.0	15.0		83.0	12.0	1.5	3.5	1	
	93.0	7.0		87.0	11.0		2.0		

Table 23. Results of the Aug. 30, 1989 experiment with eggs of *Anthocidaris crassispina*.

Wind; 0. Test water temperature; 27°C.

Ranking IV

Location (depth)	1st cleavage (50 m)			Pluteus formation (32 h)					Remarks grade
	normal	1 cell	multi-cell (polyspermy)	normal N	retard R	mal-form P ₁	pre-pluteus P ₂	dead embryo D	
(m)	%	%	%	%	%	%	%	%	
Running sea water of Laboratory	97.0	3.0		98.0	1.0	0.5	0.5		0
	98.5	1.5		99.0	0.5	0.5			
	98.0	2.0		97.5	1.5	1.0			
Water from open sea side of Hatakejima Surface	95.5	4.5		93.0	2.5	2.5	2.0		1
	94.0	6.0		94.0	4.0	1.0	1.0		
	96.5	3.5		93.5	3.0	3.0	0.5		
Bottom (15)	96.5	3.5		97.0	2.5	0.5			0
	97.5	2.5		98.0	1.0	1.0			
	99.0	1.0		97.5	2.0	0.5			
Water from land side of Hatakejima Surface	92.5	7.5		96.0	1.0	1.5	1.5		1
	96.0	4.0		94.0	3.0	2.0	1.0		
	93.5	6.5		94.5	3.5	1.0	1.0		
Bottom (7)	92.5	7.5		96.0	3.0	1.0			1
	95.0	5.0		93.0	4.0	1.5	1.5		
Sea water from Tsunashirazu cove Surface	91.5	8.5		92.5	3.5	2.5	1.5		1
	92.0	8.0		95.5	2.0	2.0	0.5		
	93.5	6.5		92.0	4.5	1.5	2.0		
Bottom (5)	93.0	7.0		93.5	4.0	1.5	1.0		1
	93.5	6.5		93.0	4.0	2.0	1.0		
	91.0	9.0		90.5	8.0	1.0	0.5		
	92.0	8.0		89.0	10.0	0.5	0.5		