Table S1. Fish information of all females for the series of artificial fertilization

Trial	Date	Age	Fork length (cm)	Body weight (g)	Ovulation	Gonadal weight (g)	Ovulated eggs weight (g)	Female No.
1	4 August 2021	2+	53.0	2,213	Yes	172.39	91.75	Female 1
		2+	51.8	2,715	Yes	285.74	169.38	Female 2
		2+	49.7	2,117	Yes	110.59	33.55*	–
2	6 August 2021	2+	51.9	2,923	Yes	369.20	175.10	Female 3
		2+	54.9	3,164	Yes	210.92	94.77	Female 4
		2+	53.1	2,522	Yes	130.44	No data	Female 5
3	11 August 2021	2+	56.5	3,546	No	153.09	0.00	–
		2+	47.8	1,798	No	44.64	0.00	–
4	16 August 2021	2+	54.5	2,915	No	111.45	0.00	–
		2+	57.2	3,248	No	98.13	0.00	–
		2+	55.6	2,828	No	146.09	0.00	–
5	23 August 2021	2+	55.7	2,934	Yes	140.42	88.00	Female 6
		2+	52.8	2,500	No	113.79	0.00	–
		2+	55.2	3,016	No	127.20	0.00	–
6	25 August 2021	2+	54.8	2,953	No	1.26	0.00	–
		2+	54.3	2,829	No	73.37	0.00	–
7	2 September 2021	2+	No data	3,048	Yes	250.73	146.69	Female 7
		2+	50.5	2,614	Yes	166.37	82.66	Female 8
8	7 September 2021	2+	52.8	2,689	Yes	276.80	193.00	Female 9

		2+	56.4	2,702	Yes	201.98	101.21	Female 10
9	10 September 2021	2+	55.2	3,127	Yes	213.33	123.52	Female 11
		4+	59.3	3,248	No	102.61	0.00	–
10	14 September 2021	2+	No data	2,532	Yes	200.20	124.50	Female 12
		2+	No data	3,159	No	103.47	0.00	–

*Artificial fertilization could not be performed because the number of ovulated eggs from this female was low.

Table S2. Fish information of males used for artificial fertilization

Date	Males No.	Age	Fork length (cm)	Body weight (g)	Gonadal weight (g)	Inseminated females No.
4 August 2021	1	2+	55.3	2,816	144.43	Female 1 and 2
	2	2+	50.6	2,147	128.05	
6 August 2021	3	2+	53.4	2,800	177.60	Female 3, 4, and 5
	4	2+	54.3	2,982	165.37	
23 August 2021	5	2+	55.7	3,225	298.99	Female 6
	6	2+	56.5	3,233	249.01	
2 September 2021	7	3+	54.6	3,316	277.58	Female 7 and 8
	8	2+	51.1	2,777	168.54	
	9	2+	52.1	2,717	164.37	
7 September 2021	10	2+	54.3	2,455	137.86	Female 9 and 10
	11	2+	No data	2,889	142.35	
10 September 2021	12	2+	54.5	2,885	107.42	Female 11
	13	2+	56.0	3,261	133.53	
14 September 2021	14	3+	56.9	3,846	290.39	Female 12
	15	2+	55.2	2,962	153.58	

Table S3. Precipitation and daylight hours of the Misho area [33] from 3 August 2021 to 15 September 2021.

Date	3 Aug	4	5	6	7	8	9	10	11	12	13
Precipitation (mm)	0.0	0.0	0.0	8.0	0.0	**61.5**	16.0	0.0	**45.5**	**63.5**	**69.0**
Daylight hours (h)	11.7	8.5	11.4	4.5	8.2	5.2	1.8	7.5	0.0	0.0	0.0
Artificial fertilization	–	Trial 1	–	Trial 2	–	–	–	–	Trial 3	–	–
Ovulation rate (%)	–	100.0	–	100.0	–	–	–	–	0.0	–	–
Date	14 Aug	15	16	17	18	19	20	21	22	23	24
Precipitation (mm)	15.5	25.0	16.0	24.5	**51.5**	**100.0**	**55.5**	1.0	0.0	0.0	0.0
Daylight hours (h)	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.2	1.5	4.9	0.0
Artificial fertilization	–	–	Trial 4	–	–	–	–	–	–	Trial 5	–
Ovulation rate (%)	–	–	0.0	–	–	–	–	–	–	33.3	–
Date	25 Aug	26	27	28	29	30	31	Sep 1	2	3	4
Precipitation (mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Daylight hours (h)	3.0	8.1	11.5	12.3	12.3	12.3	12.1	3.4	1.4	1.4	9.5
Artificial fertilization	Trial 6	–	–	–	–	–	–	–	Trial 7	–	–
Ovulation rate (%)	0.0	–	–	–	–	–	–	–	100.0	–	–
Date	5 Sep	6	7	8	9	10	11	12	13	14	15
Precipitation (mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.5	13.0	4.0
Daylight hours (h)	3.4	4.6	0.6	7.6	10.7	9.0	5.6	0.1	0.0	0.0	0.0
Artificial fertilization	–	–	Trial 8	–	–	Trial 9	–	–	–	Trial 10	–
Ovulation rate (%)	–	–	100.0	–	–	50.0	–	–	–	33.3	–

Table S4. Developmental efficiency after preservation of ovulated eggs in different solution.

	Preservation solution	Preservation time				
		0 h (Initial)	1 h	3 h	5 h	12 h
Fertilization (%)	Control	99.1 ± 0.3	98.9 ± 0.3	89.2 ± 3.4	81.6 ± 4.9[a]	64.1 ± 4.8
	Hanks'	99.2 ± 0.2	99.1 ± 0.2	95.8 ± 1.4	72.5 ± 9.8[ab]	54.9 ± 9.5
	L-15	98.5 ± 0.7	98.5 ± 0.3	82.0 ± 4.8	60.6 ± 6.3[b]	36.5 ± 8.2
	Ringer's	98.6 ± 0.7	98.7 ± 0.3	96.3 ± 0.9	80.1 ± 5.8[ab]	45.1 ± 6.0
Hatching (%)	Control	93.8 ± 2.3	93.0 ± 1.2	81.9 ± 5.4	75.8 ± 3.7[a]	20.2 ± 5.7
	Hanks'	93.5 ± 2.6	90.6 ± 1.8	82.2 ± 7.3	41.5 ± 8.6[b]	5.9 ± 3.3
	L-15	91.2 ± 3.6	91.4 ± 4.0	73.2 ± 9.0	33.7 ± 9.6[b]	9.4 ± 2.5
	Ringer's	94.8 ± 1.4	90.6 ± 2.2	84.1 ± 3.8	51.6 ± 6.9[ab]	7.5 ± 3.1
Normal larvae (%)	Control	91.2 ± 3.3	90.5 ± 1.3	78.5 ± 5.3	69.8 ± 3.4[a]	12.1 ± 3.4
	Hanks'	92.3 ± 2.7	89.4 ± 1.8	75.9 ± 7.2	33.9 ± 7.9[b]	4.6 ± 2.8
	L-15	89.2 ± 3.9	89.8 ± 3.9	68.0 ± 9.5	29.6 ± 8.3[b]	4.9 ± 1.4
	Ringer's	93.3 ± 1.6	87.6 ± 2.4	78.9 ± 4.0	43.1 ± 5.1[b]	3.5 ± 1.5

Each value is the mean ± SE of the twelve replicates using ovulated eggs from six females.

Different superscript letters in the column of 5 h preservation indicate significant differences as determined by the Steel–Dwass test ($p < 0.05$).

There is a significant difference between "a" and "b". There is no significant difference between "a" and "ab" or "b" and "ab".

Table S5. Developmental capacity after preservation of ovulated eggs in different temperatures.

		Control				Hanks' solution			
	Preservation temperature	Preservation time				Preservation time			
		0 h (Initial)	1 h	3 h	5 h	0 h (Initial)	1 h	3 h	5 h
Fertilization (%)	15℃		87.5 ± 4.1	83.5 ± 5.3	53.3 ± 10.3		84.5 ± 7.0	88.6 ± 5.0	83.3 ± 6.3
	20℃	88.5 ± 4.6	92.1 ± 2.3	87.6 ± 4.4	72.4 ± 9.1	91.8 ± 2.7	90.6 ± 4.6	93.9 ± 2.0	78.1 ± 8.1
	25℃		83.8 ± 6.3	76.0 ± 6.1	63.0 ± 9.5		74.8 ± 8.5	70.2 ± 7.1	45.8 ± 7.6
Hatching (%)	15℃		71.6 ± 5.6	54.3 ± 7.6	41.5 ± 5.9		67.0 ± 9.6	61.1 ± 4.4	42.2 ± 5.6
	20℃	66.4 ± 7.3	71.7 ± 7.7	66.3 ± 6.9	58.2 ± 6.0	76.8 ± 5.8	75.7 ± 8.9	75.6 ± 5.1	52.6 ± 6.5
	25℃		57.6 ± 9.9	55.6 ± 8.1	35.4 ± 7.6		62.8 ± 9.6	37.5 ± 9.6	10.8 ± 3.9

Each value is the mean ± SE of the eleven replicates.

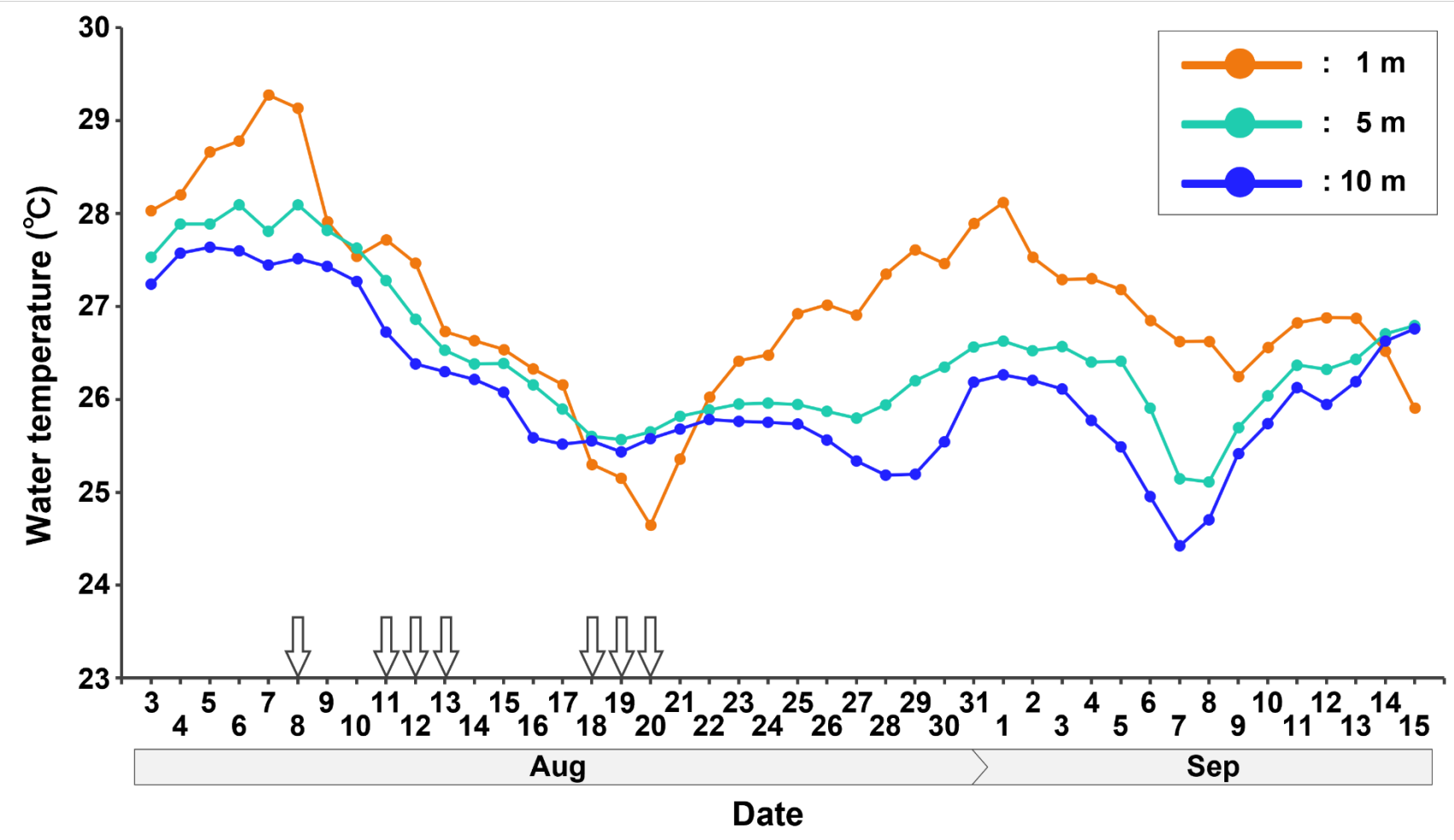

Figure S1. Water temperature at the depth of 1 m, 5 m, and 10 m in the experiment period from 3 August 2021 to 15 September 2021 at the rearing site [30]. White arrows indicate the days which recorded more than 40 mm of precipitation.

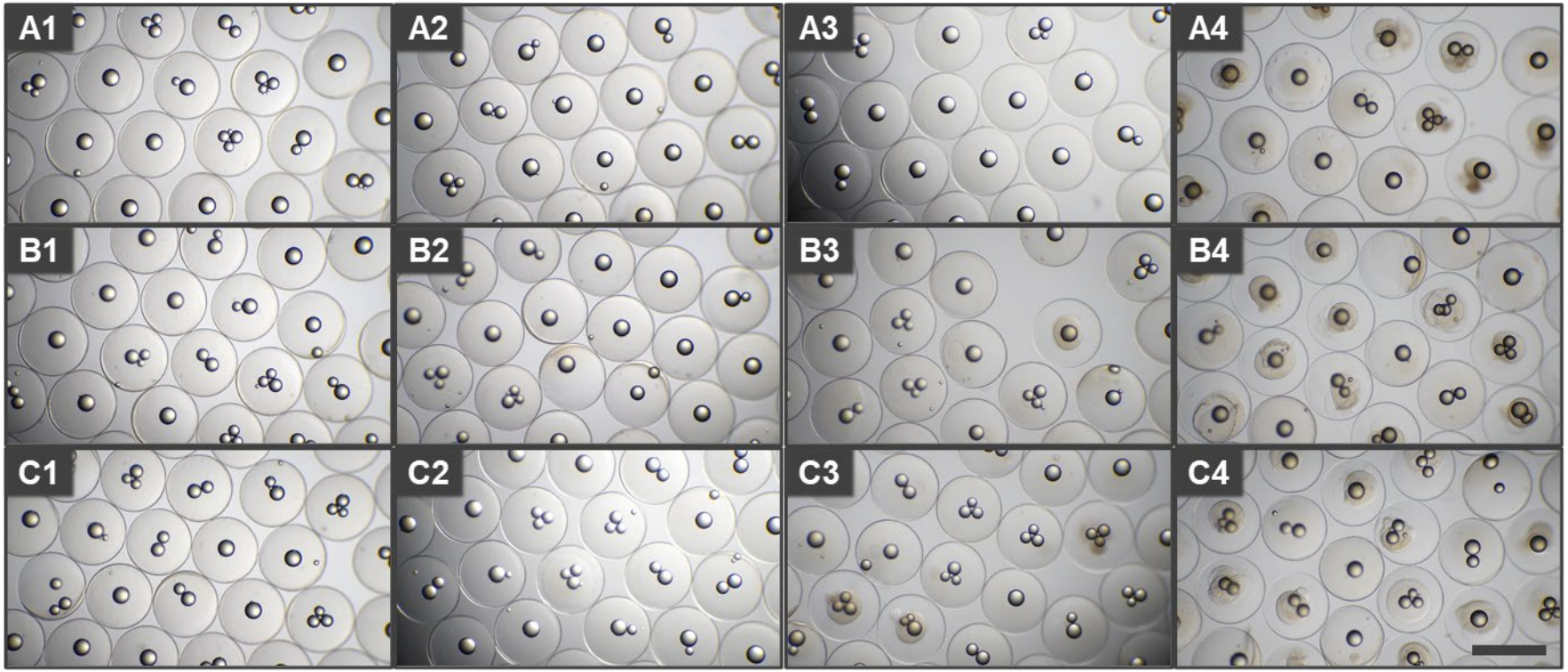

Figure S2. Ovulated eggs of kawakawa *Euthynnus affinis* after preservation in different solutions.

(A) Preservation in the Hanks' solution, (B) in the L-15 medium, and (C) in the Ringer's solution for marine teleost. Column 1: 1 h preservation, Column 2: 3 h preservation, Column 3: 5 h preservation, Column 4: 12 h preservation. Scale bar denotes 1 mm.