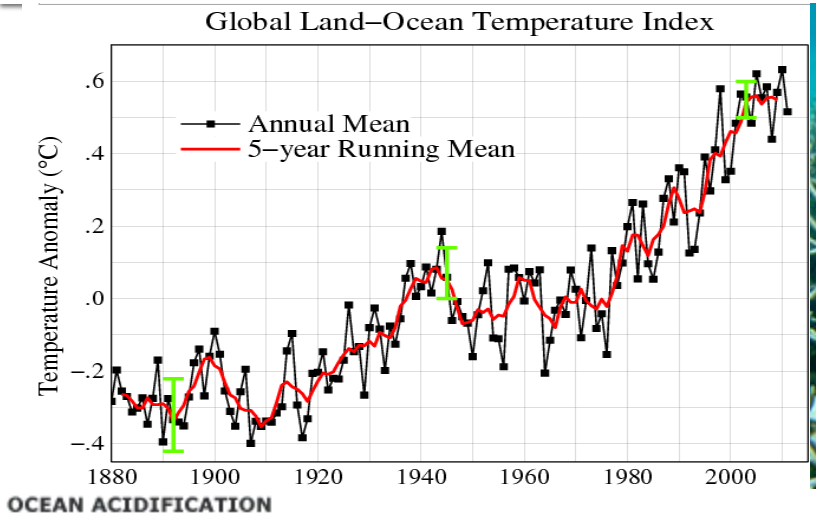
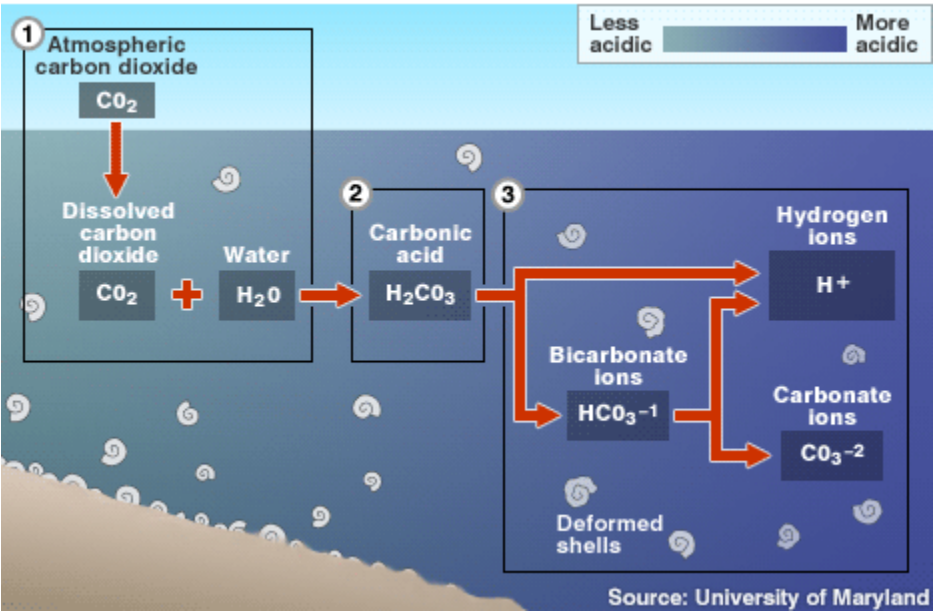
The combined effects of elevated CO_2 and temperature on the physiological conditions of olive flounder larvae, *Paralichthys olivaceus*

Kyung-Su Kim

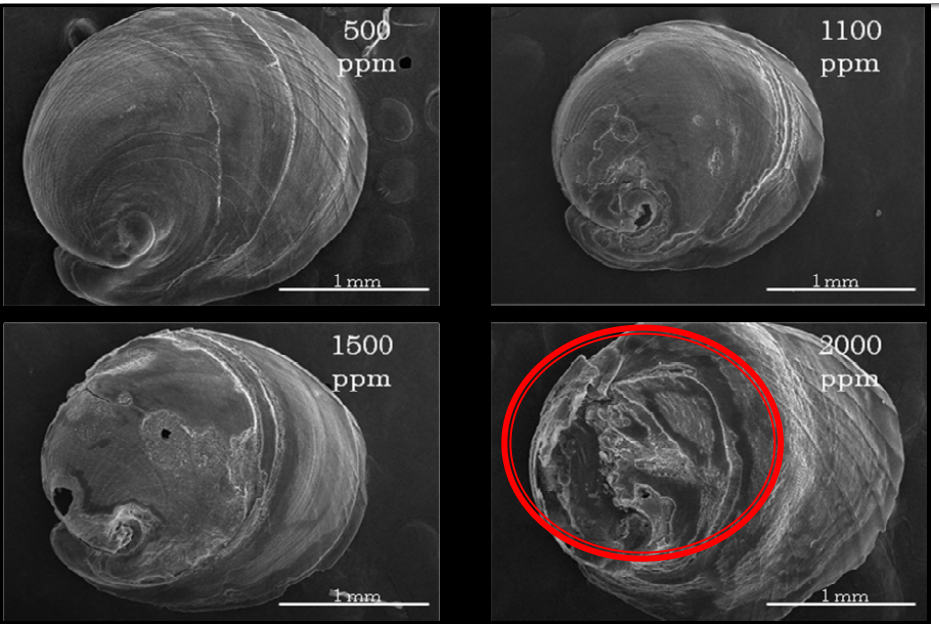
Pukyong National University, Busan, Korea

Climate change : GW and OA

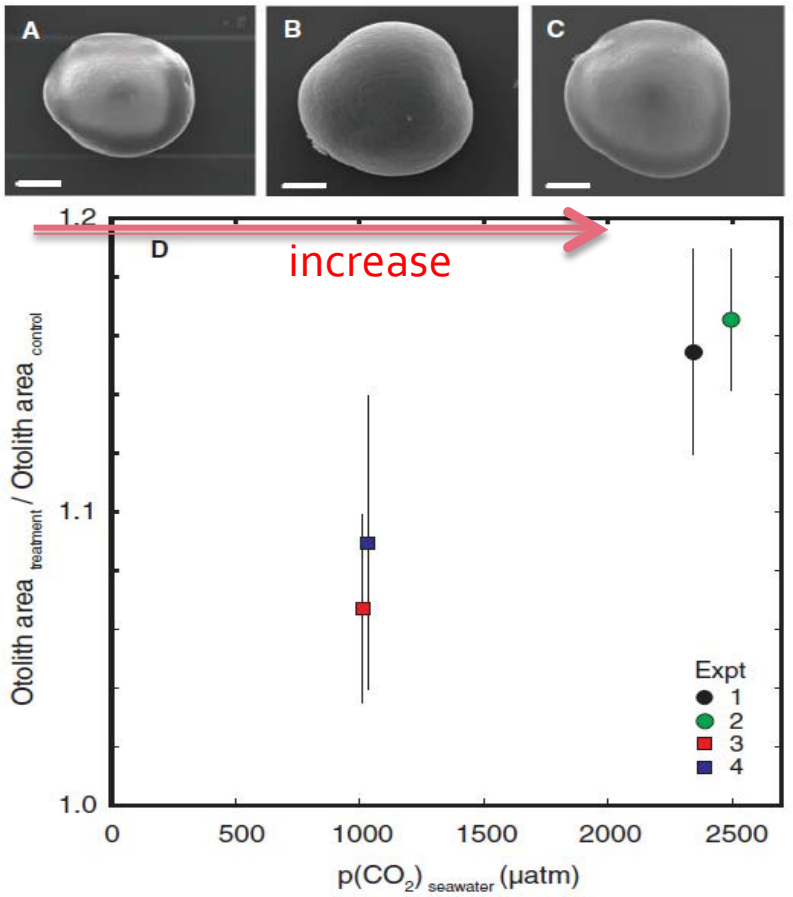




Related researches



Post-larval Ezo abalone *Haliotis discus hannai* were reared under different pCO2 concentrations for 30 days from just after metamorphosis.
(Takami et al., 2010)



Dorsal view of sagittal otoliths of 7-day-old white sea bass grown. (Checkley et al., 2009)

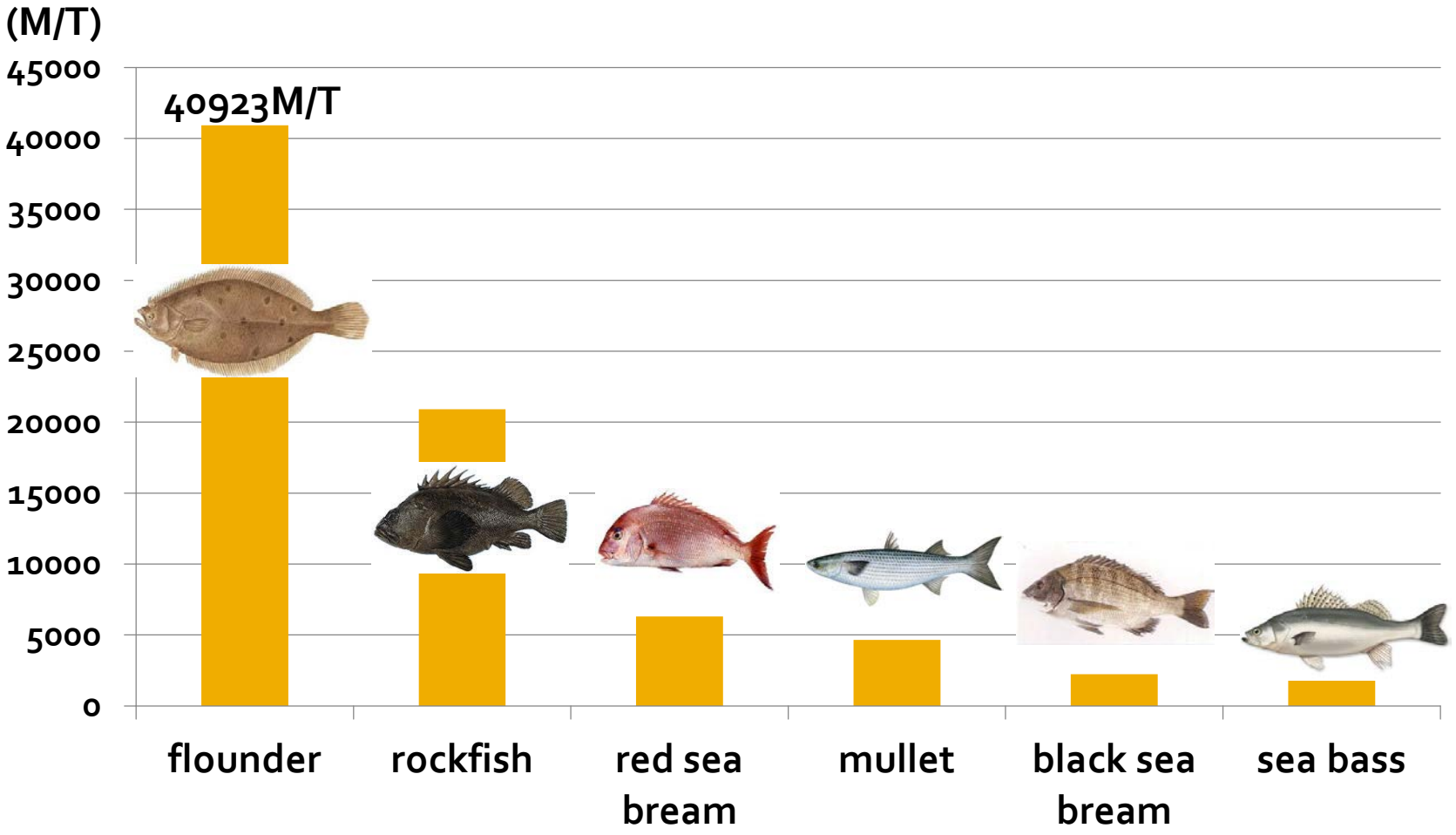
Olive flounder

- Important commercial species in Korea
  (main aquaculture species)

- their growth and survival during the early life history will response to a new environment :
  seawater warming and
  ocean acidification

Olive flounder

Aquaculture production of commercial species in 2010

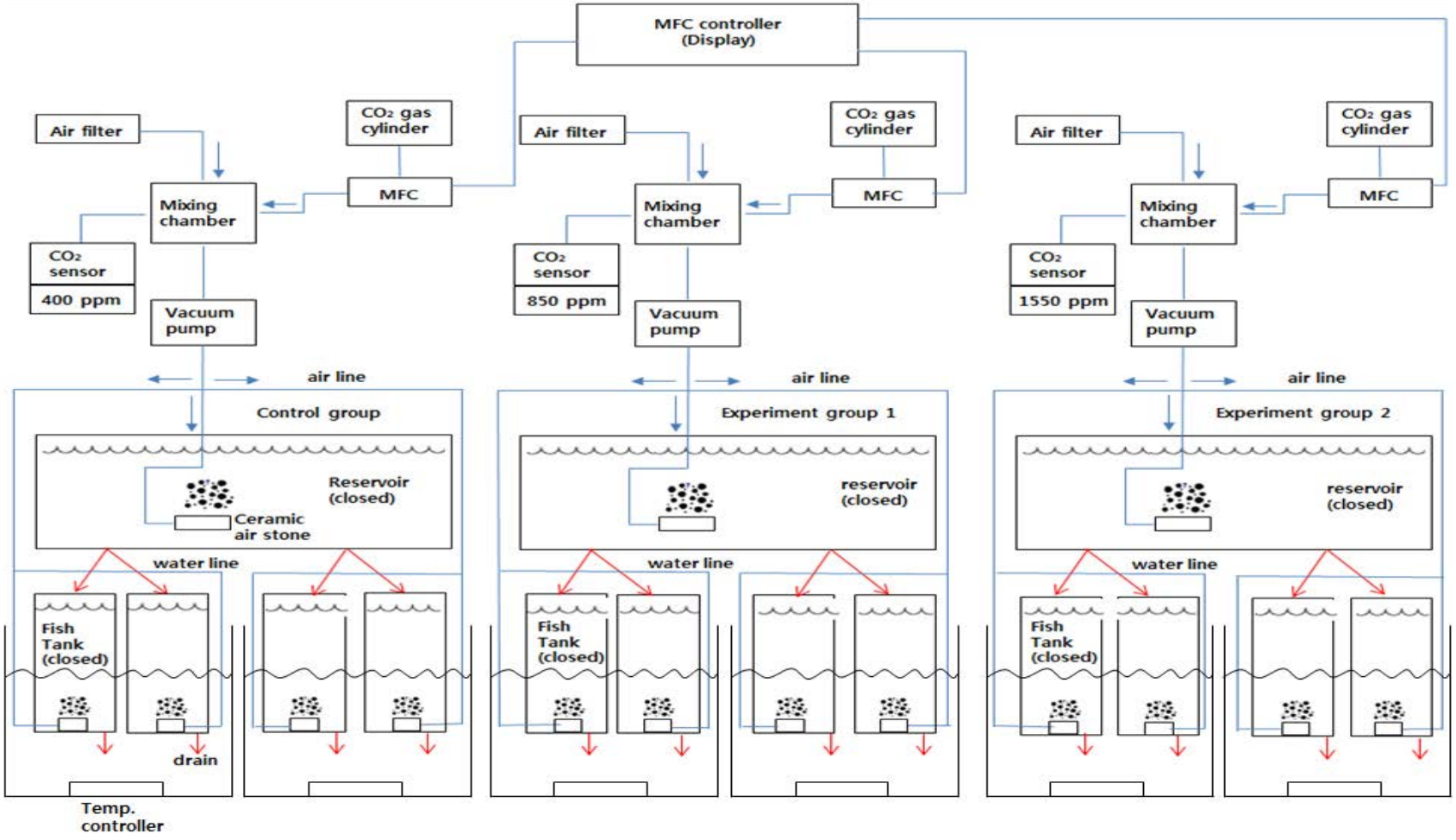


Purpose of this study

To evaluate the combined effects of ocean acidification and global warming on early development stage of olive flounder.

Experimental setting

- Artificial condition



Experimental setting

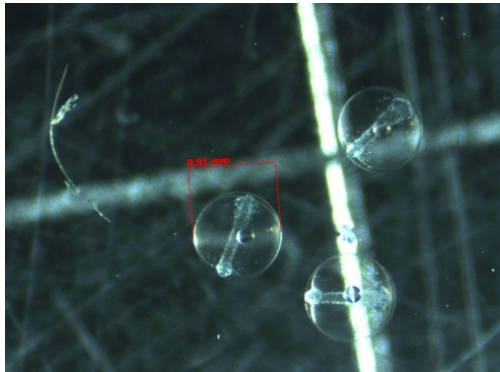
- 3 different CO_2 concentrations
  -400 ppm-current day
  - 850 ppm-mild emission (2100)
  - 1550 ppm-strong emission (2100)

- 2 different temperatures
  -18℃-mean temp. of southern coast area in Korea
  -22℃-forecast temp. of southern coast area in Korea at 2100(KORDI, 2004)

Rearing and feeding

- Rearing : from fertilized eggs to metamorphosis (approximately 28 days)

- Feeding : from hatching to 14 days : fed rotifer & chlorella
  - 14 ~ 21 days : rotifer and artemia
  - 21 ~ 28 days : artemia only



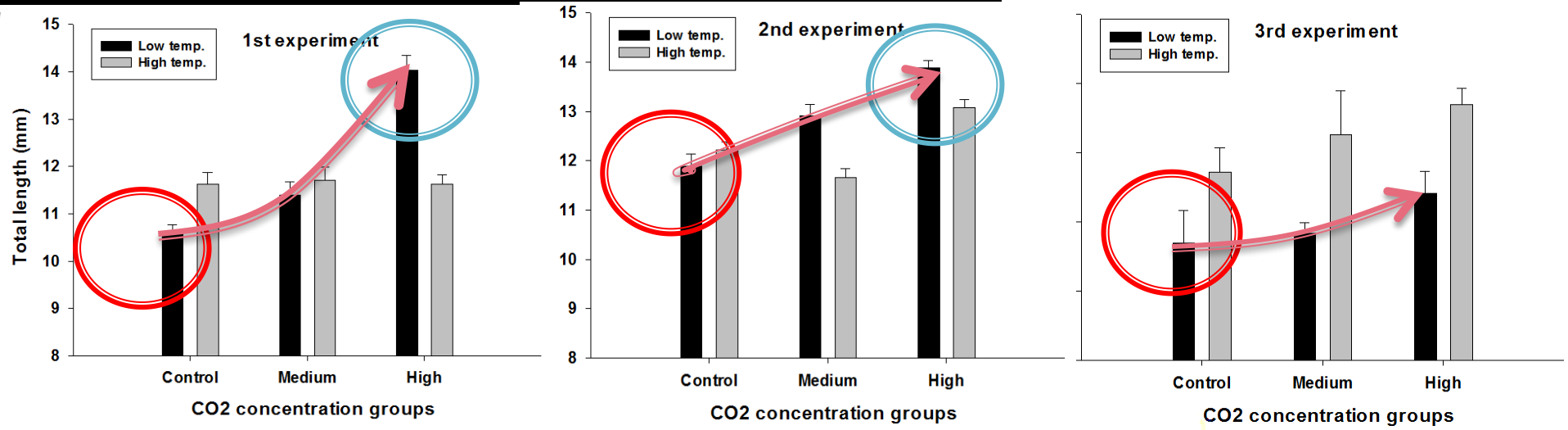
Sampling and measurement

- Sampling : 10 ind/tank every 3~5days (measuring length)
- At 28th day : All live fishes were preserved in alcohol after measuring length and weight
- Skeleton malformation check
- Whole body section-histomorphology

Statistic analysis

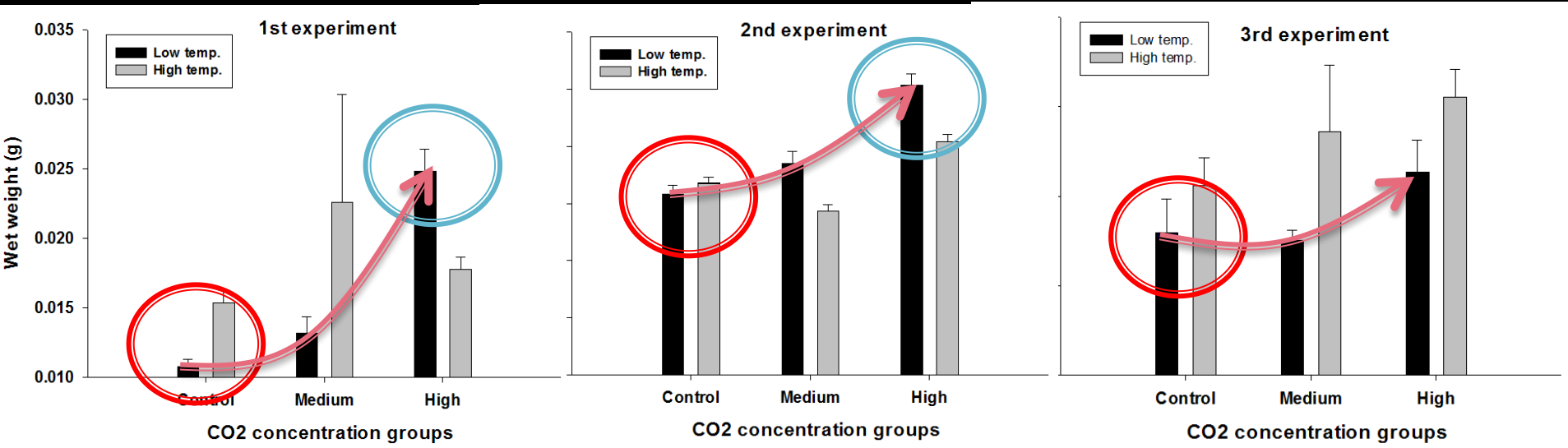
- all sample data – test of normality.
- One way ANOVA and Two way ANOVA. (Tool : minitab 16)

Results(1)- length



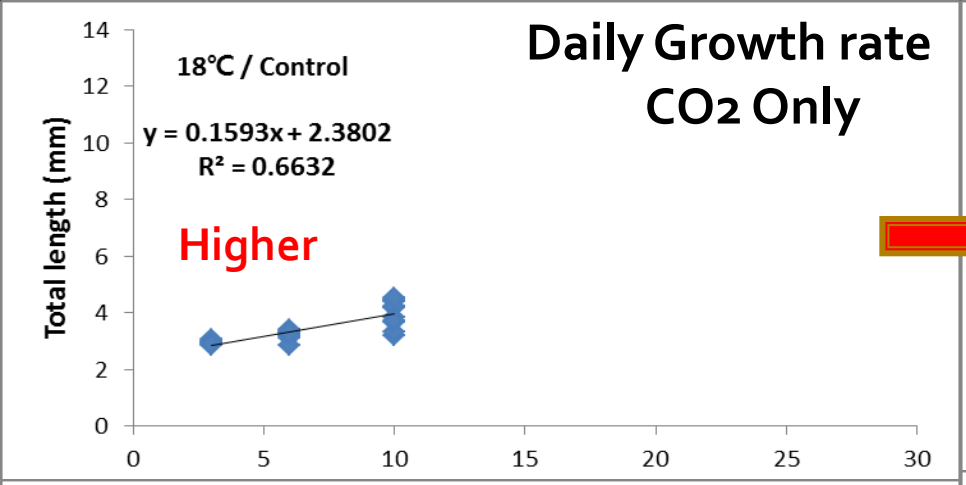
- At normal CO_2 condition- High > Low ($p<0.05$)
- However, High CO_2 condition- High < Low ($p<0.05$)
- CO_2, temp. Interaction- $p<0.01$

Results(2)- weight

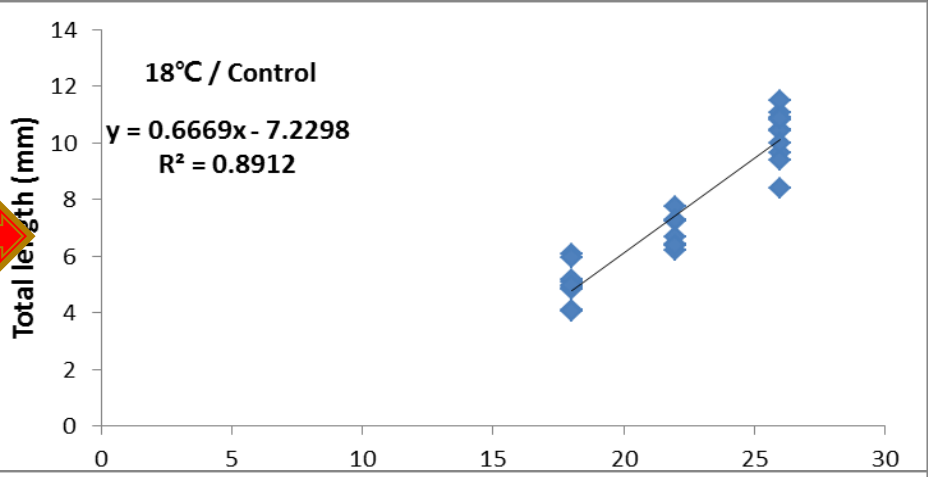


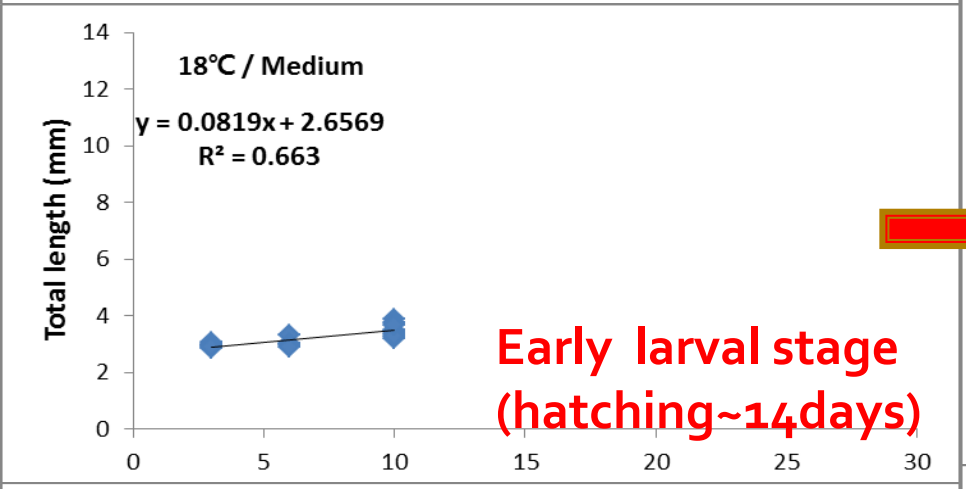
- At normal CO_2 condition- High > Low ($p<0.05$)
- However, High CO_2 condition- High < Low ($p<0.05$)
- CO_2, temp. Interaction- $p<0.05$

Daily Growth rate
CO_2 Only

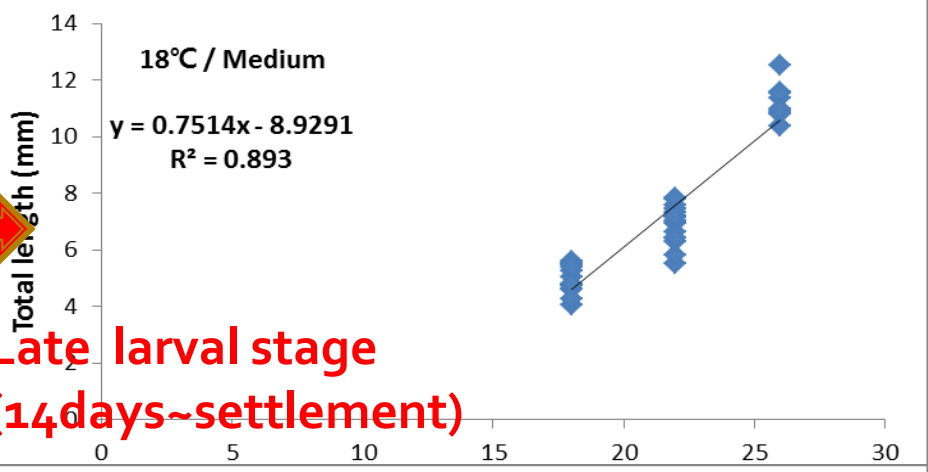


Higher

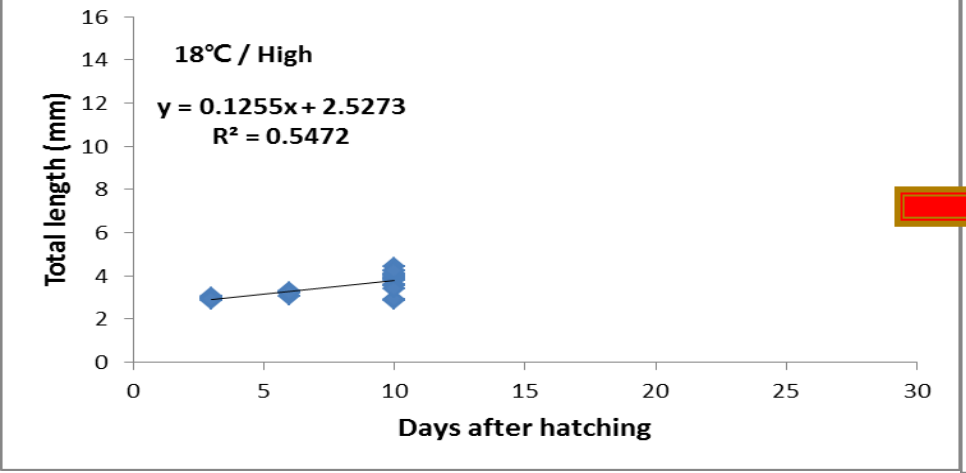


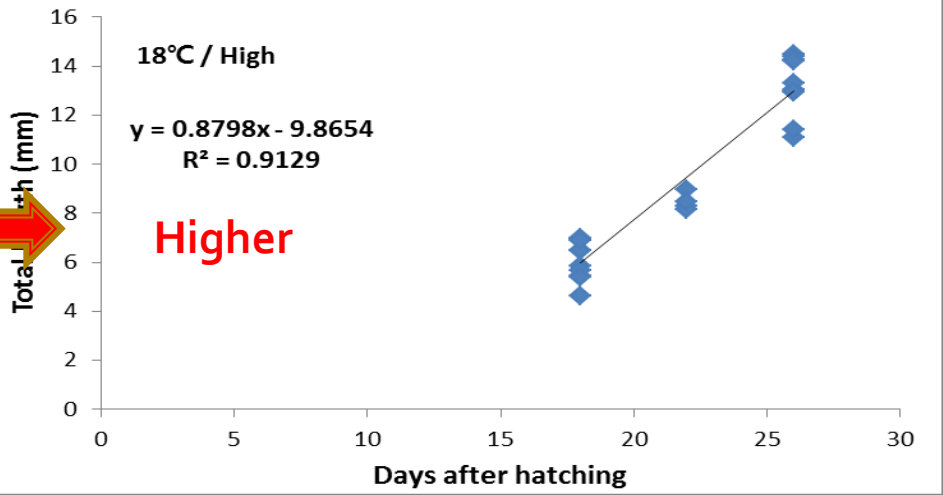


Early larval stage
(hatching~14days)



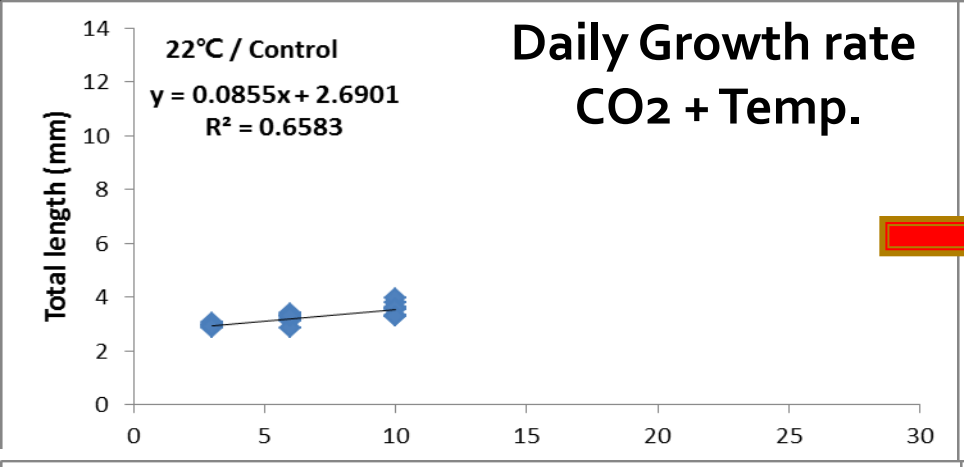
Late larval stage
(14days~settlement)

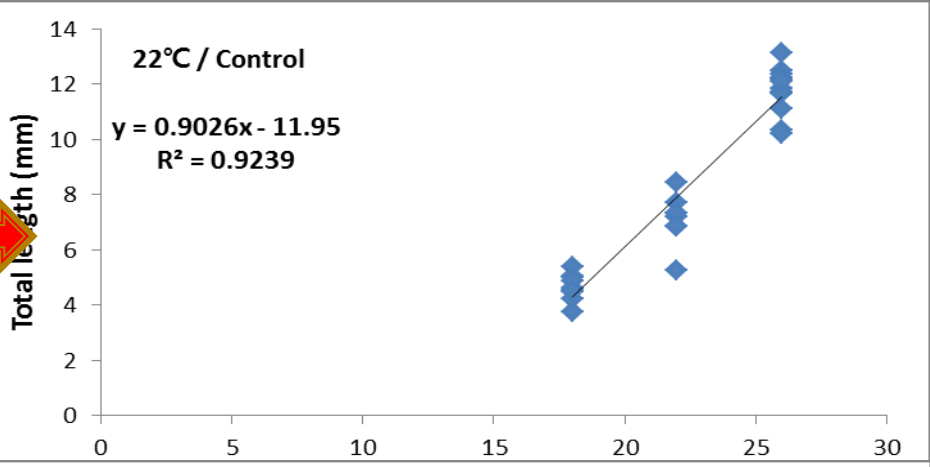


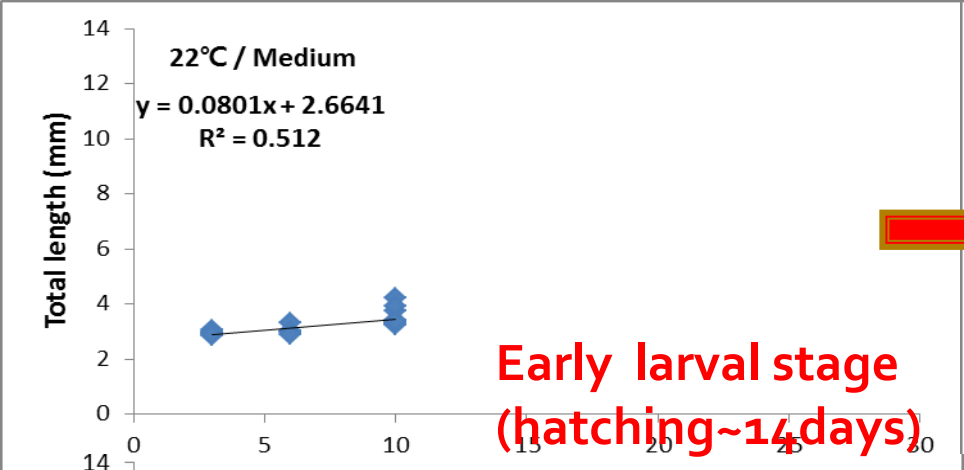


Higher

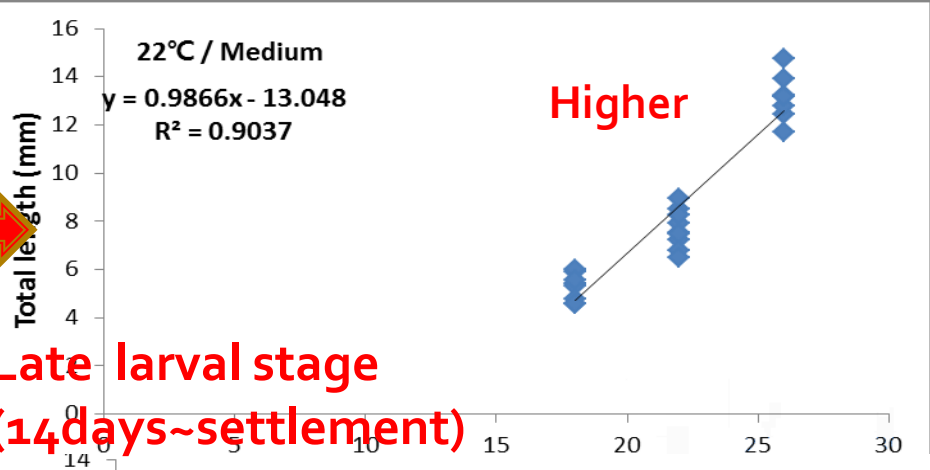
Daily Growth rate
CO_2 + Temp.





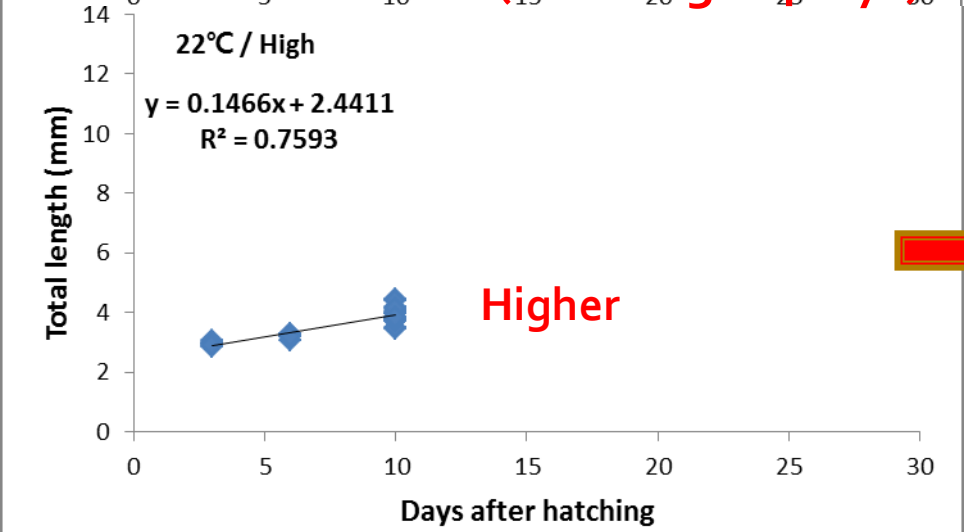


Early larval stage
(hatching~14days)

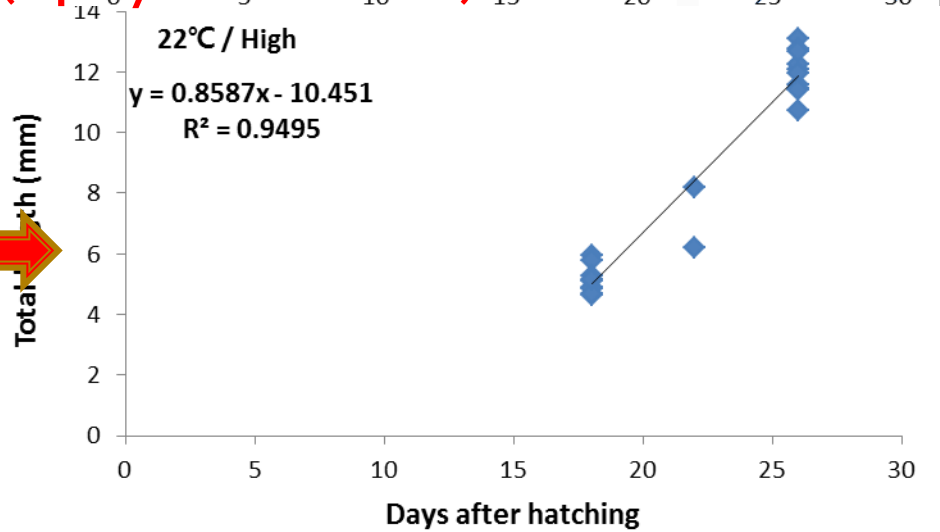


Higher

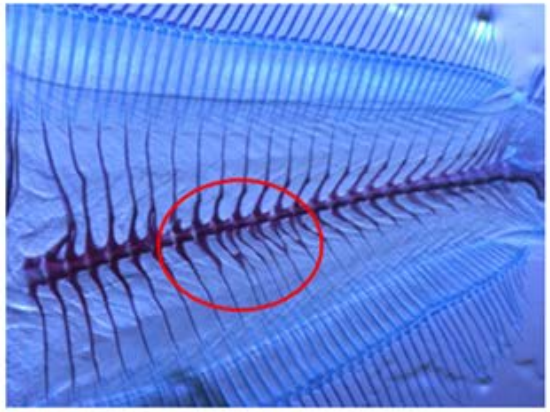
Late larval stage
(14days~settlement)

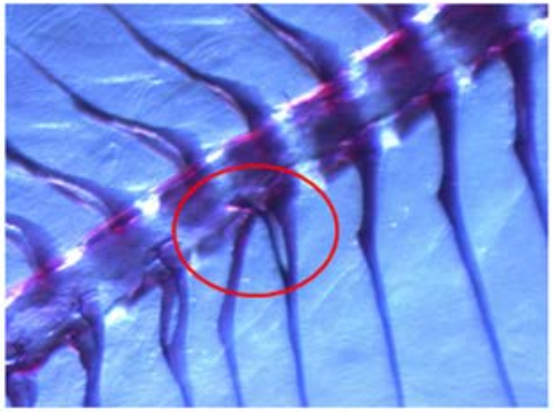


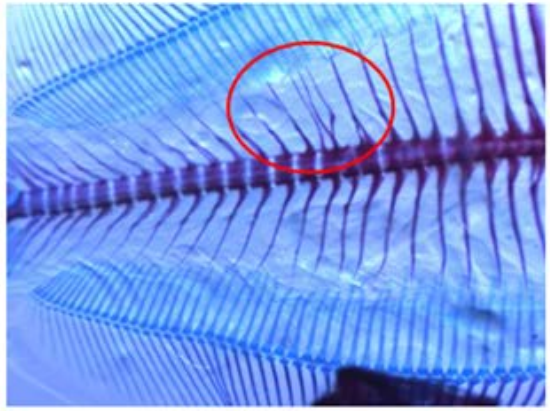
Higher

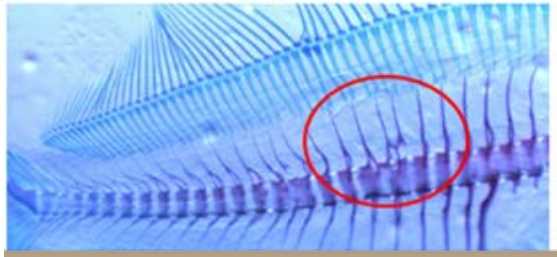


Results(4)- skeleton malformation





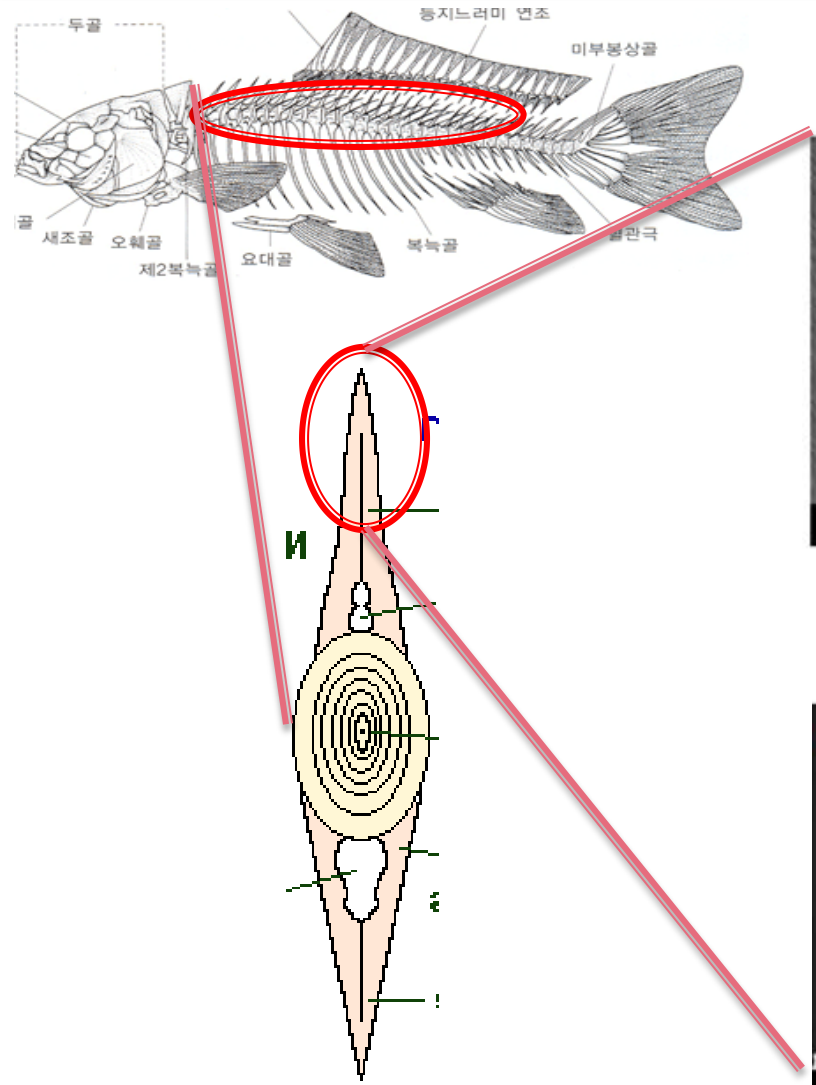




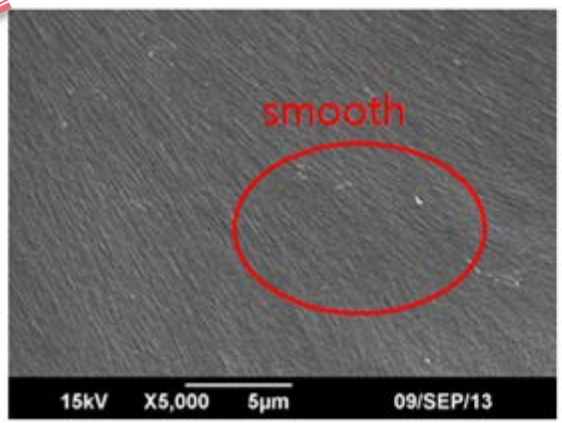
- Temp. 22℃
- 1st experiment

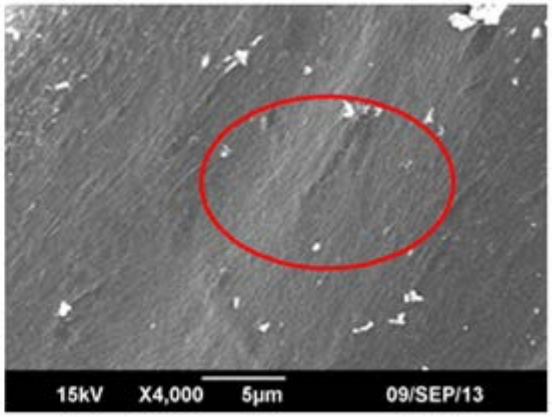
Concentration	Total sample size	Frequency of malformation	Malformation ind.
400ppm	4 ind.	0~1	2
850ppm	4 ind.	2~3	3
1550ppm	4 ind.	2~5	3

Results(5)- skeleton SEM photography

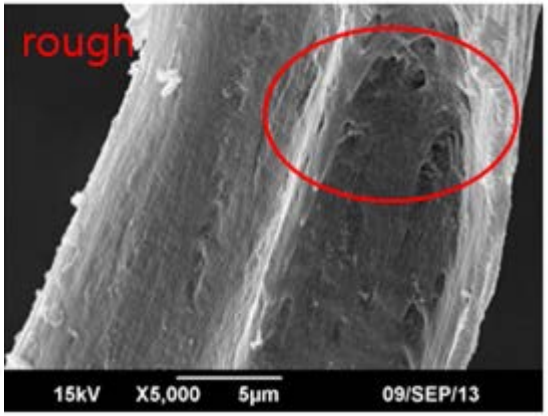


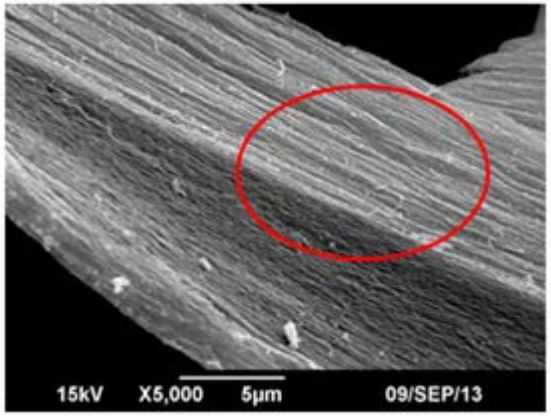
- Normal CO_2 condition



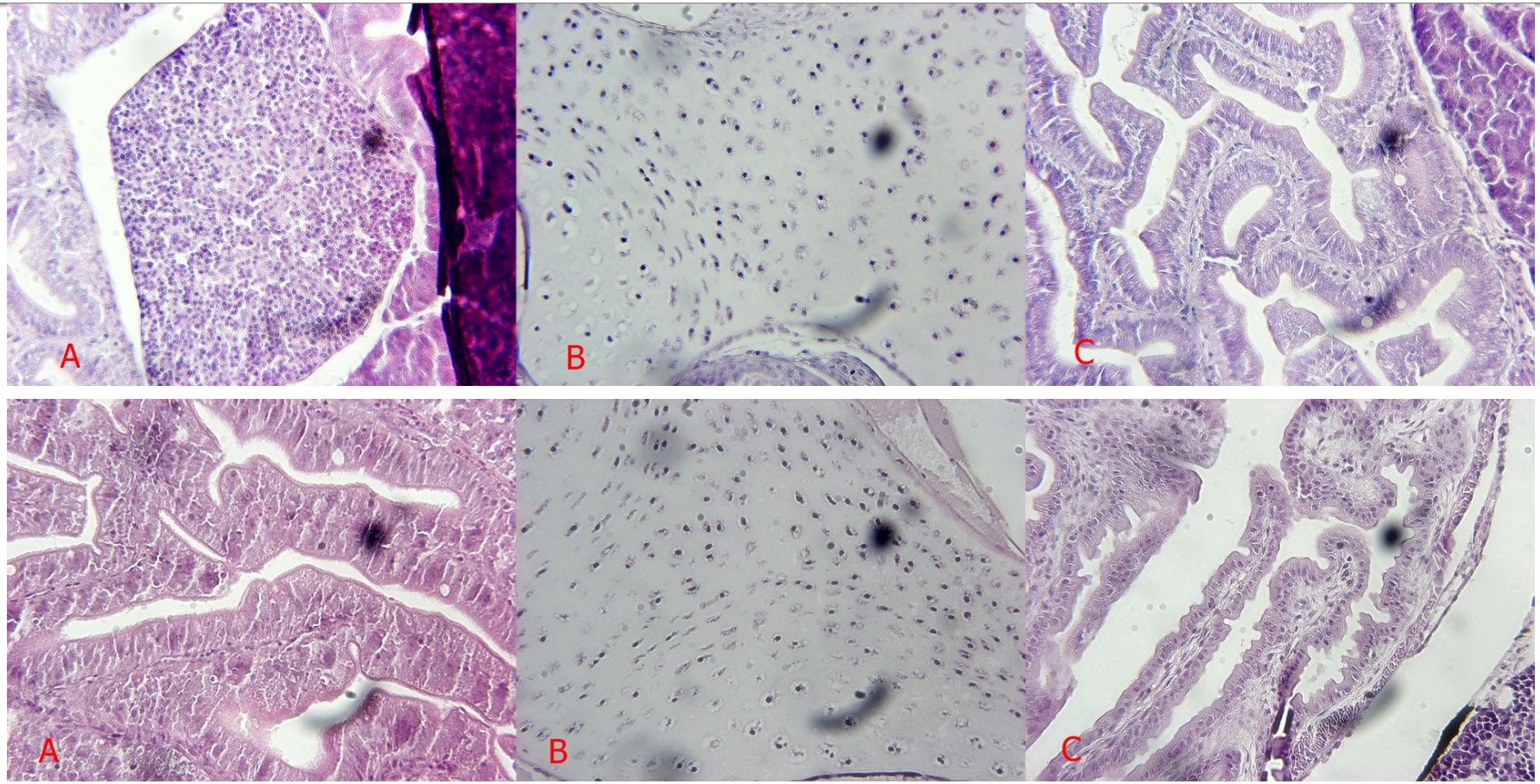


- High CO_2 condition





Results(6)- histomorphology



A: liver B: skeleton C: intestine

Results(7)- rearing condition

- *p*CO2 of each seawater were different.

CO2(ppm)	pH	Temp.	TA	Sal.	pCO2
400	8.05	22.0	2278.9	32.4	573.6
850	7.84	22.0	2275.4	32.4	987.9
1550	7.73	22.0	2267.4	32.4	1296.7

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	START	START	START	START	START	START	START	START	START	START	START	START	START
2	INPUT CONDITIONS					OUTPUT CONDITIONS		DATA (leave empty if no data)					SCA
3	Salinity	t(oC)	P (dbars)	Total P (µmol/kgSW)	Total Si (µmol/kgSW)	t(oC)	P (dbars)	TA (µmol/kgSW)	TCO2 (µmol/kgSW)	pH (Chosen Scale)	fCO2 (µatm)	pCO2 (µatm)	Clear Data <---
4	32.4	22	0	0.5	5	22	0	2278.87		8.05			
5	32.4	22	0	0.5	5	22	0	2281.57		8.05			
6	32.4	22	0	0.5	5	22	0	2275.42		7.84			
7	32.4	22	0	0.5	5	22	0	2275.93		7.84			
8	32.4	22	0	0.5	5	22	0	2265.74		7.73			
9	32.4	22	0	0.5	5	22	0	2267.37		7.73			Clear Results --->
10													
11													
12													

Discussion- temperature

- Usually, temperature impact on fish physiology (Brett, 1969).

- Marine organism growth was increase with increasing temperature within range of optimum temperature(Pörtner and Farrell, 2008).

Discussion- CO_2

- As our results, some study suggest fishes were affected positively by increased CO_2 concentration in rearing water (Munday et al., 2009).
- But, other study suggest fishes were affected negatively by increased CO_2(Baumann et al., 2011).

- Most invertebrate were affected negatively by increased CO_2 concentration in rearing water(Wittmann et al., 2013)

Discussion

- Depending on species, CO_2 and temperature can affect (positively or negatively) their growth, survival and several physiological factors.

- In this study, olive flounder was affected by both factors of temperature and CO_2 (positive- growth, negative-bone density)

Summery

- Dissolved CO_2 positively affect olive flounder larvae growth(length, weight) at normal temperature(18℃)
- But, skeleton formation and density were affected negatively by decreased pH(both temperature).
- High temperature(22℃) positively affect growth of larvae at the normal CO_2 condition(400 ppm)

Thank you for your attention.