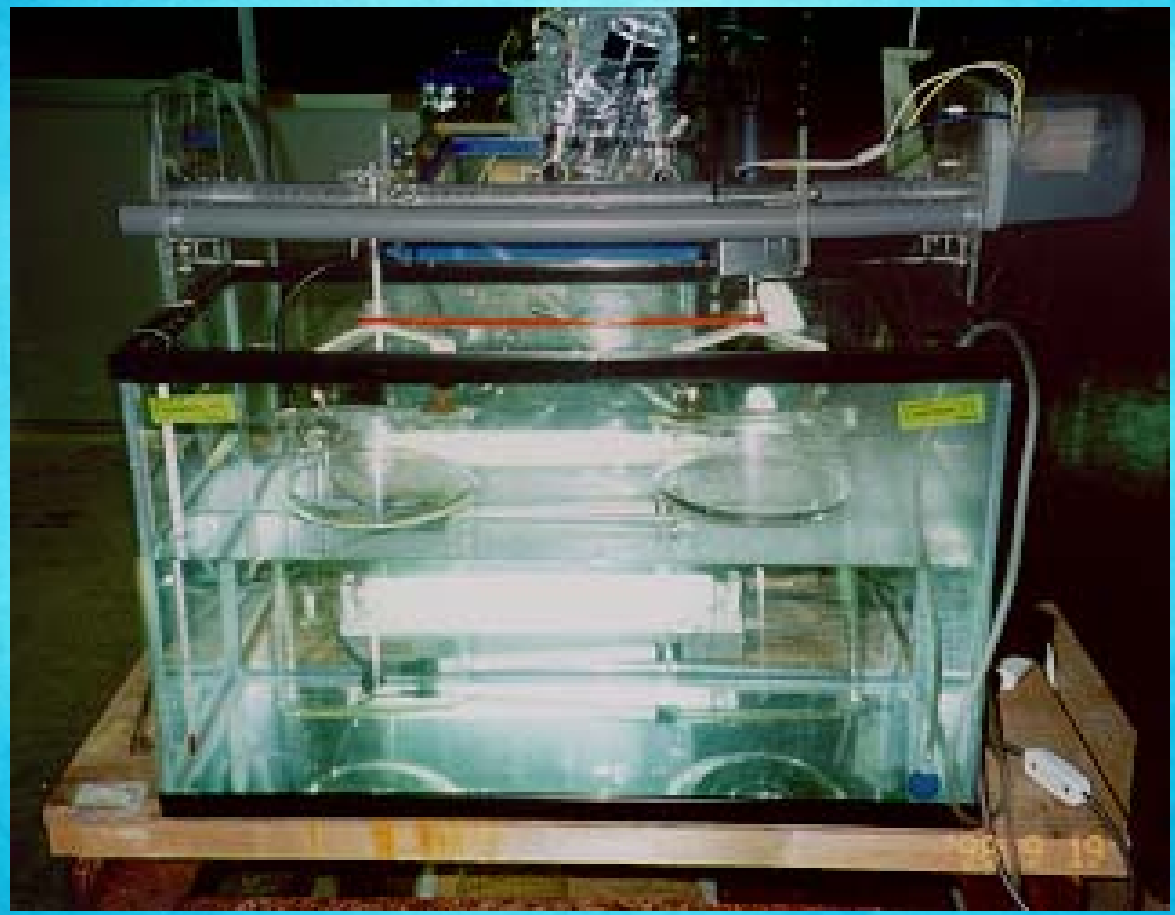
Experimental Study of Appendicularians



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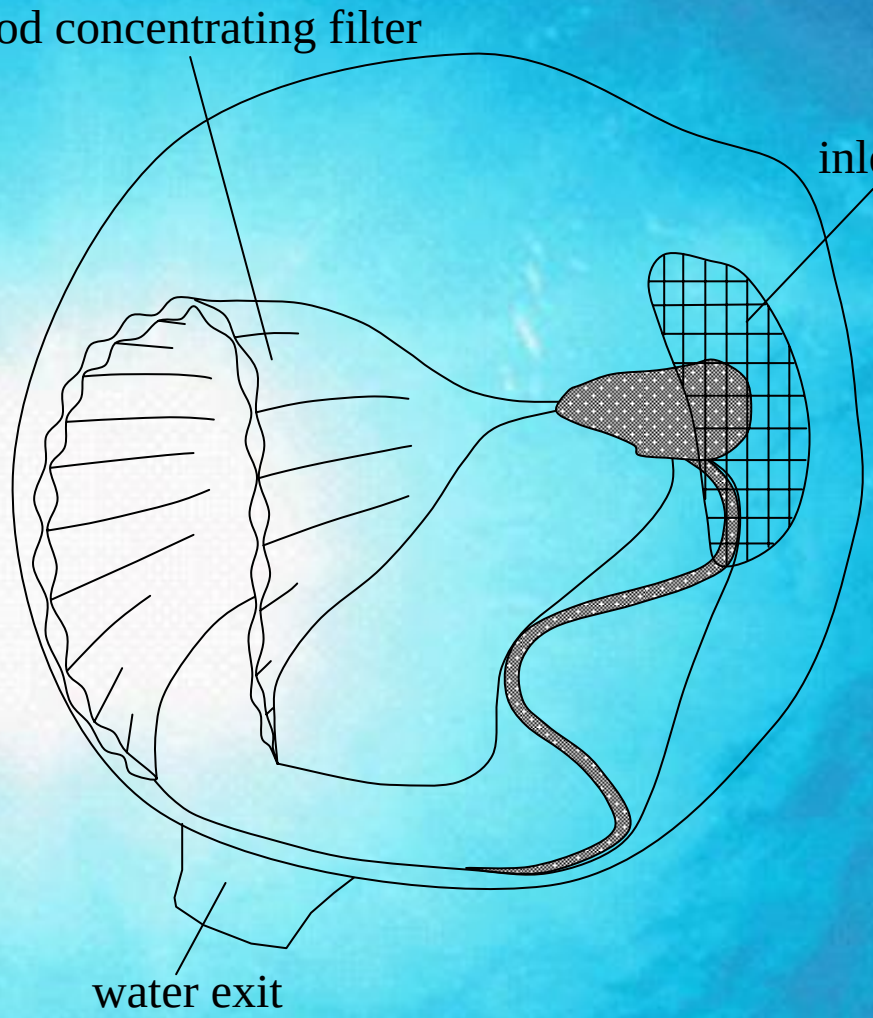
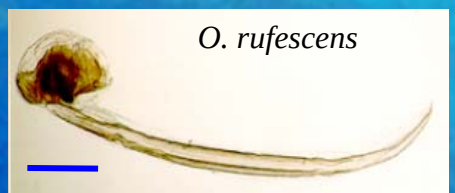
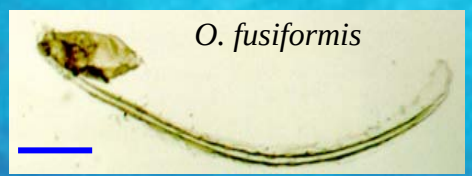
Oikopleura dioica.

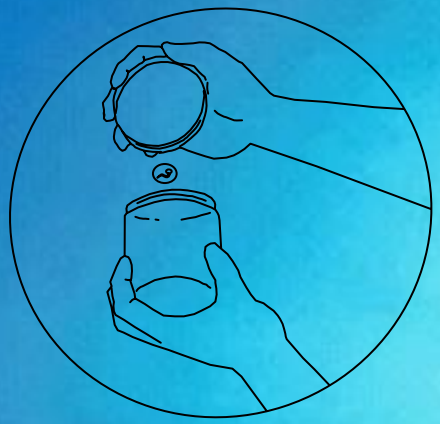


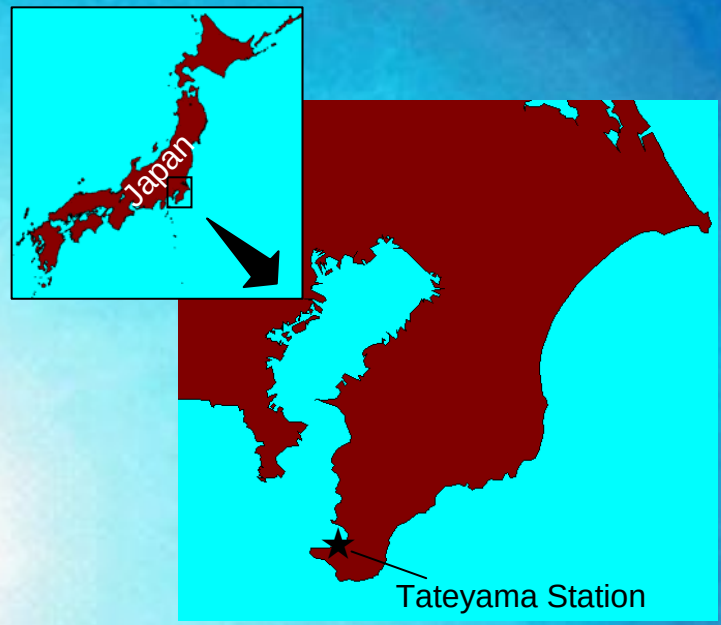
Schematic diagram of typical form of house of oikopleurid appendicularian.

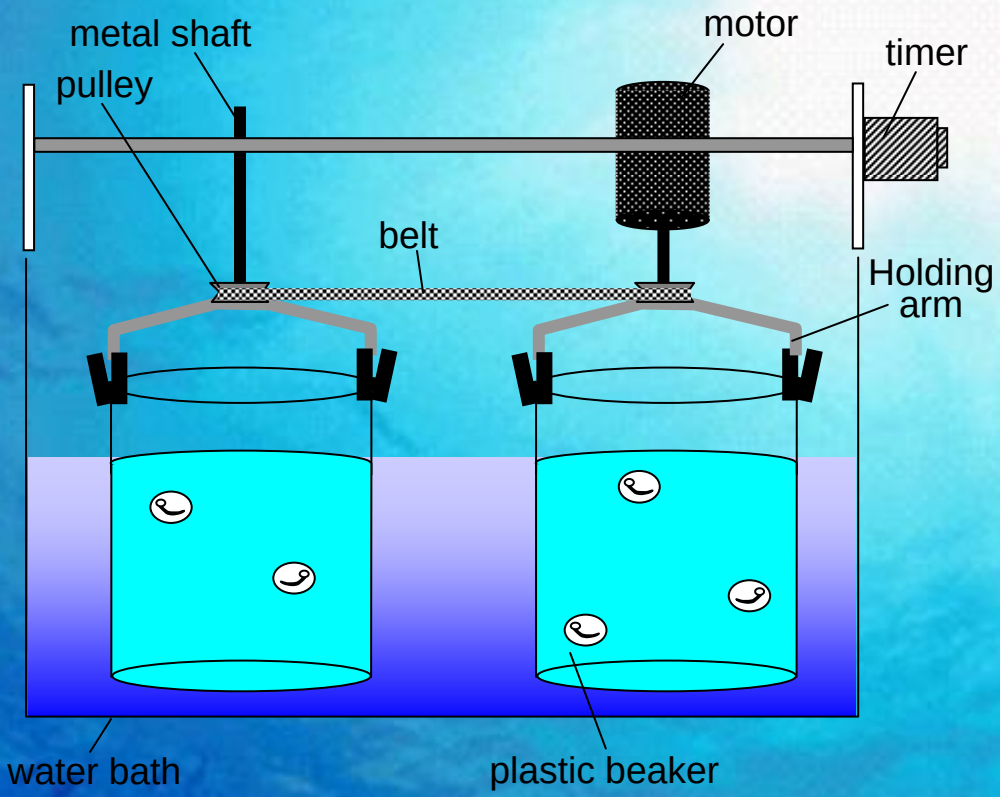




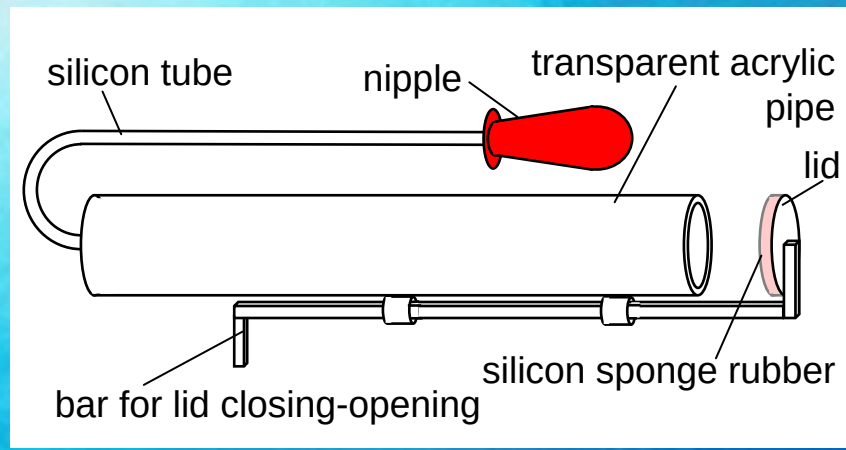
Blue bars indicate 500 µm.







Cultivating apparatus for appendicularians.



Transfer device.

List of appendicularian species cultivated up to the present by author. ◎: cultivated through full life cycle. ○: spawned but second generation did not grow. △: not reached maturation.

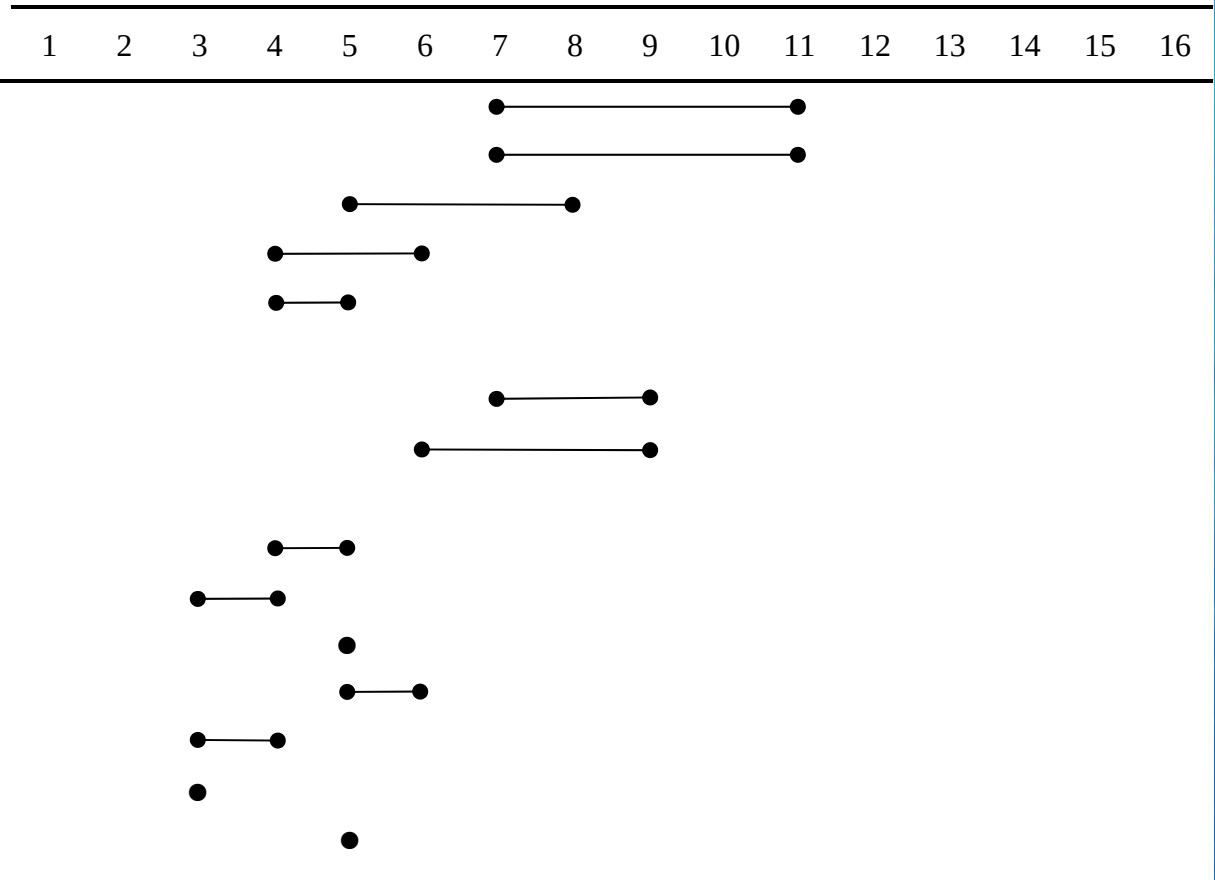
Family	Species	Level of cultivation	Filial generation number
Oikopleuridae	*Oikopleura dioica*	◎	54
	O. longicauda	◎	14
	O. fusiformis	◎	10 <
	O. rufescens	◎	3 <
	O. cornutogastra	○	
	O. cophocerca	○	
	O. intermedia	△	
	Megalocercus huxleyi	◎	1
	Stegosoma magnum	◎	1
Fritillariidae	*Appendicularia sicula*	◎	4
	Fritillaria formica digitata	◎	3
	F. pellucida	◎	1
	F. haplostoma	△	
	F. sp.	◎	8
	Tectillaria fertilis	△	
Kowalevskiidae	*Kowalevskia tenuis*	○	

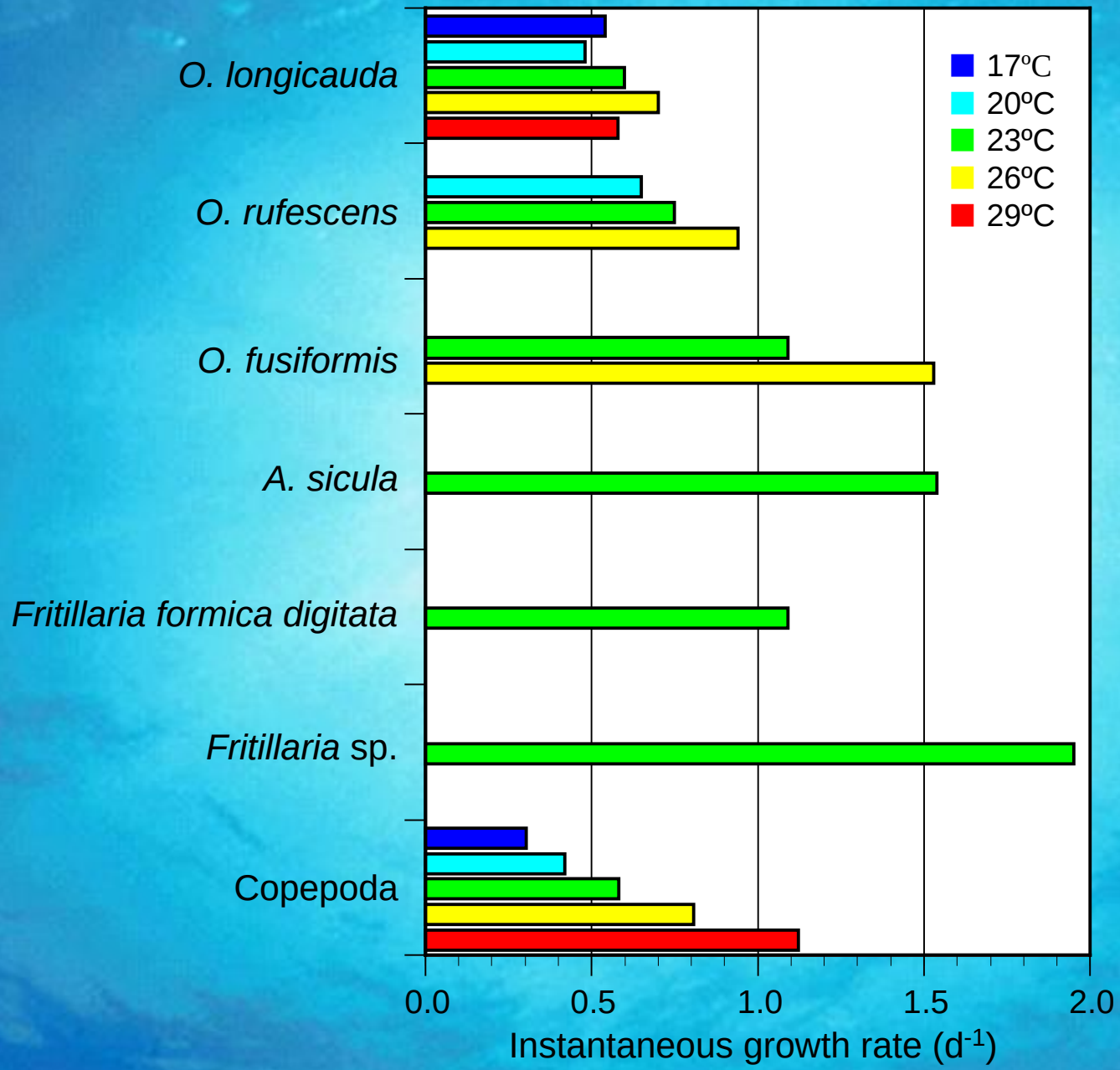

Megarocercus huxleyi


Fritillaria sp.

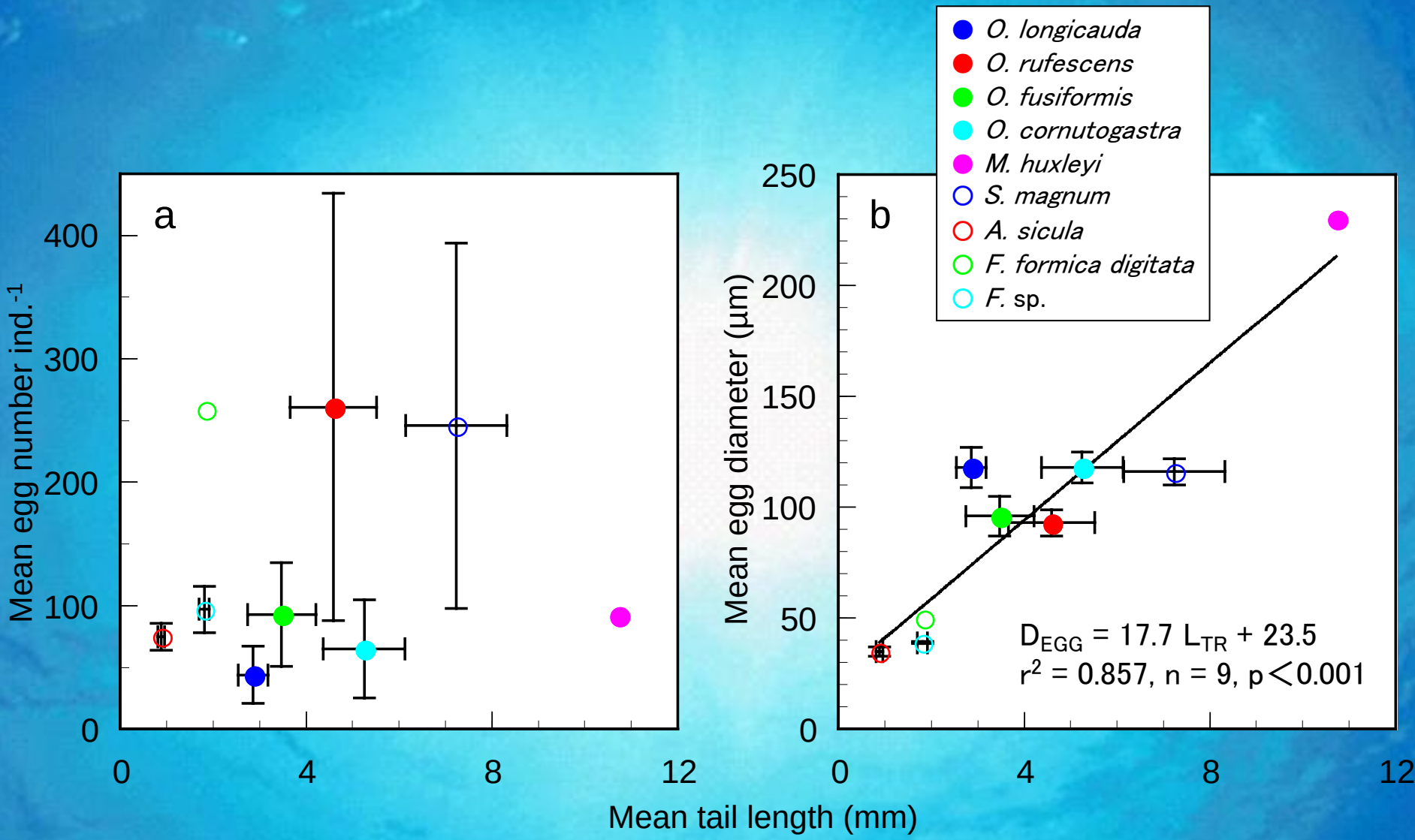
Generation time of appendicularian species. ×: not survived.

Species	Temperature (℃)	Day after fertilization
Oikopleura longicauda	17	
	20	
	23	
	26	
	29	
O. rufescens	20	×
	23	
	26	
O. fusiformis	20	×
	23	
	26	
Megalocercus huxleyi	23	
Stegosoma magnum	26	
Appendicularia sicula	23	
***Fritillaria* sp.**	23	
F. formica digitata	23	

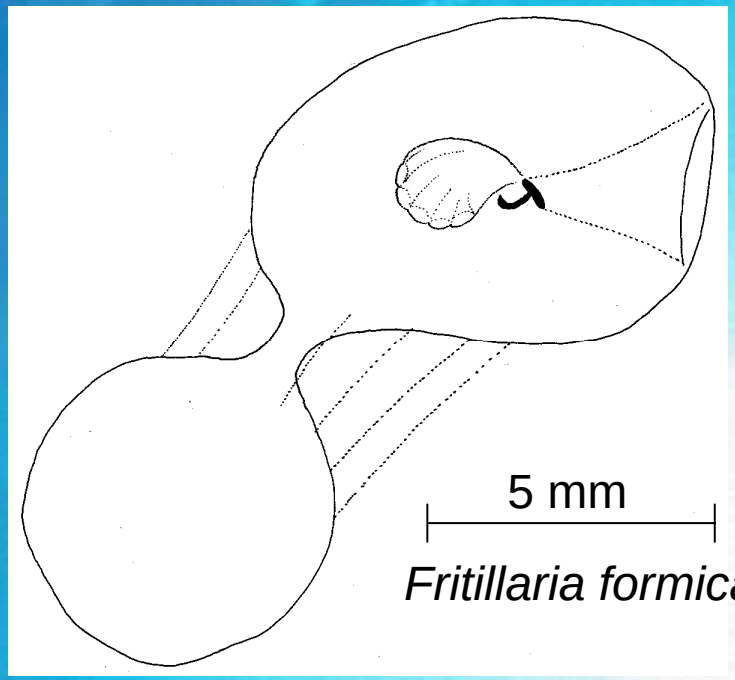




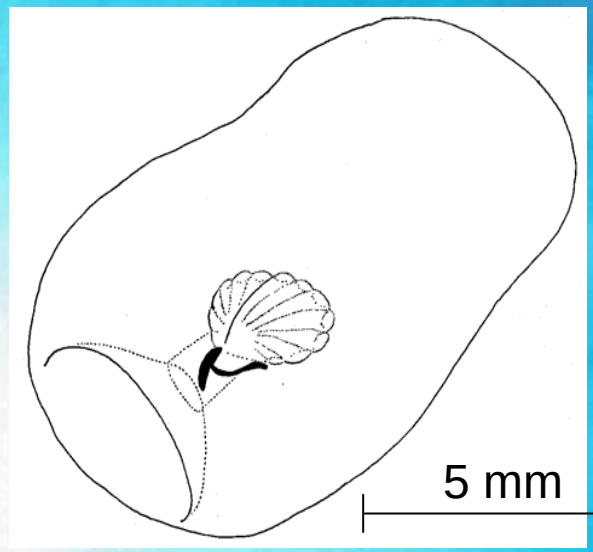
Instantaneous growth rate of appendicularian species and Copepoda. Values of Copepoda are calculated from growth rate (g) - temperature (T) relationship, $g = 0.0445\ e^{0.111T}$ obtained by Huntley & Lopez (1992).



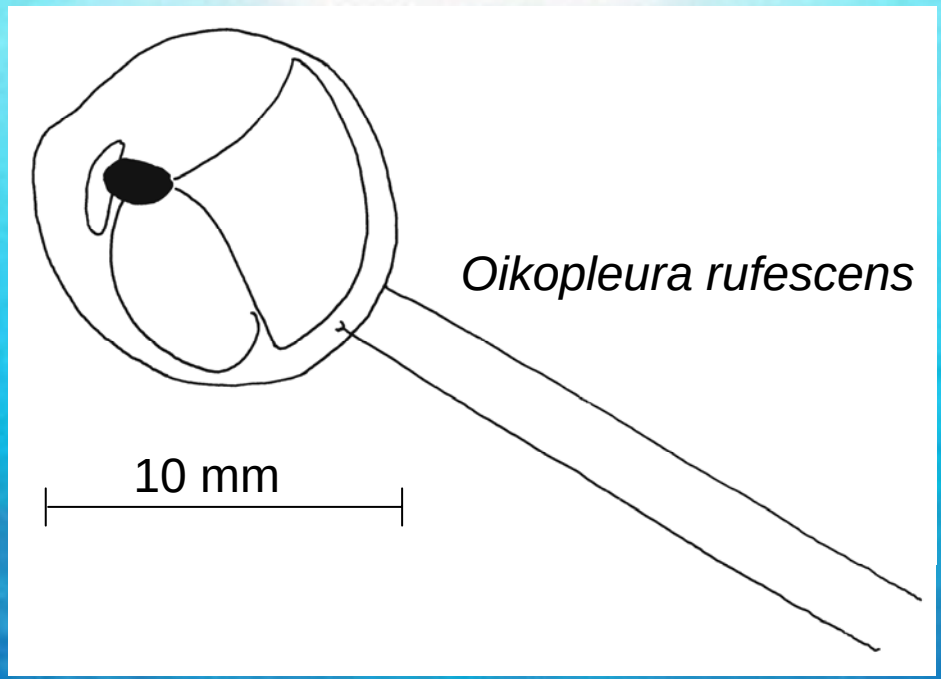
Relationships between mean tail length (L_{TR}) and (a) mean egg number per individual and (b) mean egg diameter (D_{EGG}) of appendicularian species. Bars are standard deviations.



Fritillaria formica digitata



Fritillaria sp.

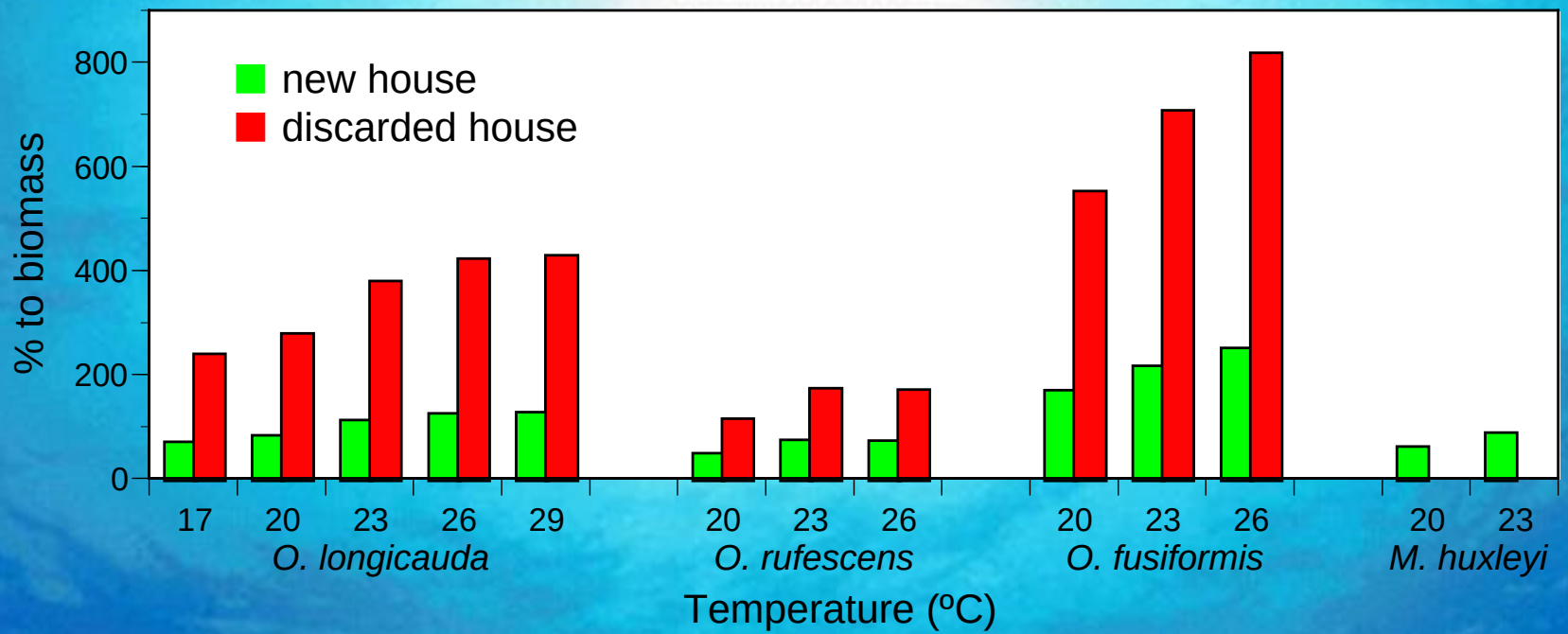


House renewal rate of appendicularian species at various temperature.

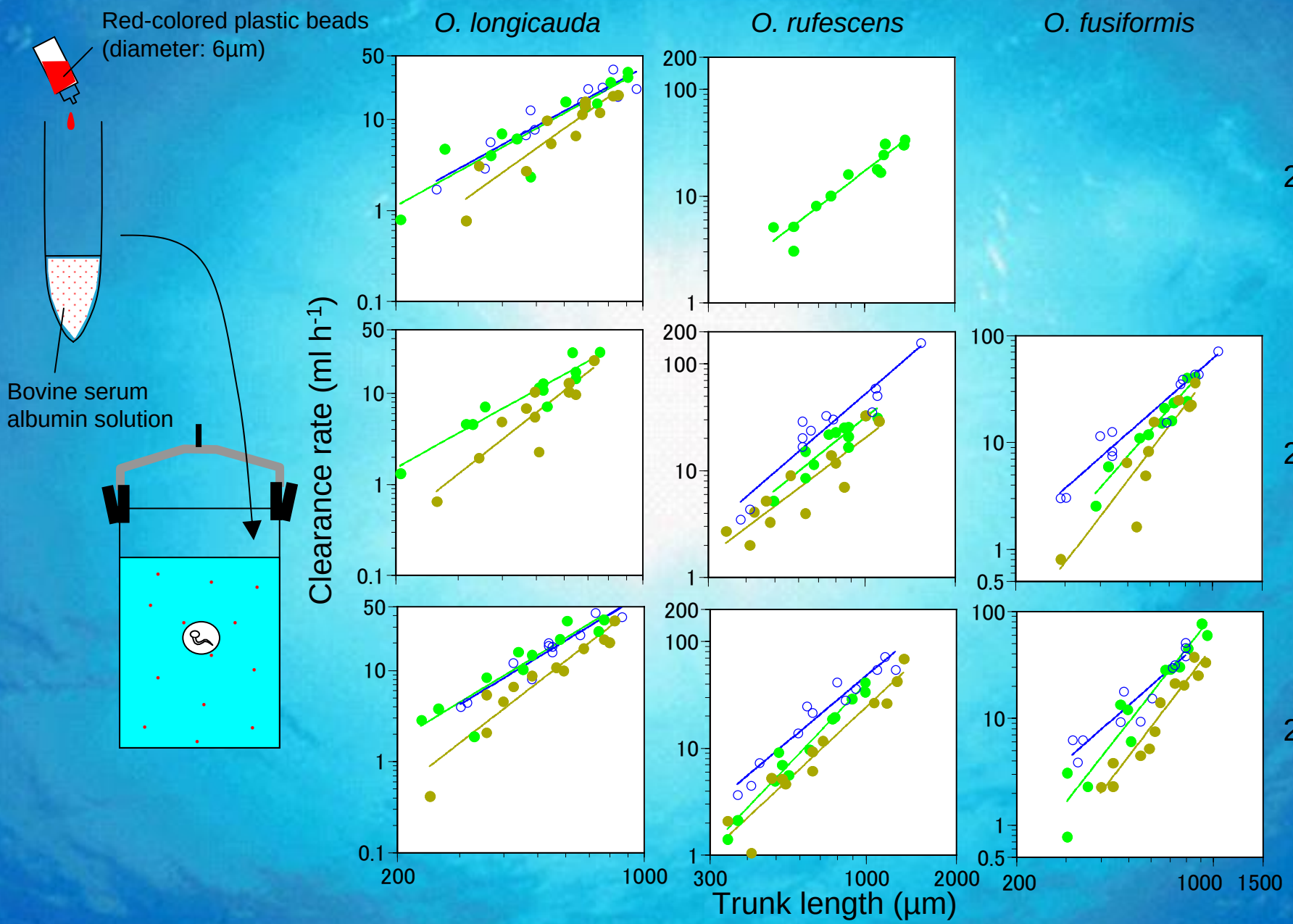
Species	Temperature (℃)	House renewal rate (houses d^{-1})	ind. number examined
Oikopleura longicauda	17	13.4 ± 1.0	20
	20	15.6 ± 0.8	20
	23	21.2 ± 1.9	20
	26	23.6 ± 1.0	20
	29	24	8
O. fusiformis	20	18.4 ± 2.2	9
	23	23.6 ± 2.4	9
	26	27.3 ± 3.5	11
O. rufescens	20	3.5 ± 0.9	8
	23	5.3 ± 1.0	17
	26	5.2 ± 1.0	28
O. intermedia	20	8	1
	23	8	1
O. cornutogastra	23	20	1
O. cophocerca	20	2	1
Megalocercus huxleyi	20	6.0 ± 1.6	4
	23	8.6 ± 0.9	5
Stegosoma magnum	23	8	2
Fritillaria formica digitata	23	40	2
Fritillaria sp.	23	30	10
Kowalevskia tenuis	20	6	2

Carbon contents of new house and discarded house and house carbon / body carbon ratios of appendicularian species.

Species	New house carbon (µg house^{-1})	Discarded house carbon (µg house^{-1})	Ratio of house C / body C (%)	
			New house	Discarded house
Oikopleura longicauda	0.16	0.68 ± 0.15	5.3	17.9 ± 8.4
O. rufescens	1.6 ± 0.6	3.9 ± 1.1	14.1 ± 2.8	32.8 ± 4.4
O. fusiformis	0.48 ± 0.01	1.2 ± 0.26	9.2 ± 0.6	30.0 ± 6.6
Megalocercus huxleyi	8.8 ± 2.2	–	10.3 ± 2.0	–



Percentage of daily house production and daily discard of old house of appendicularian species to their boimass on carbon basis at various temperature.

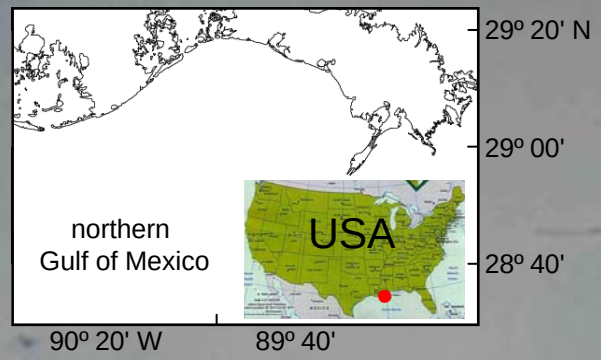


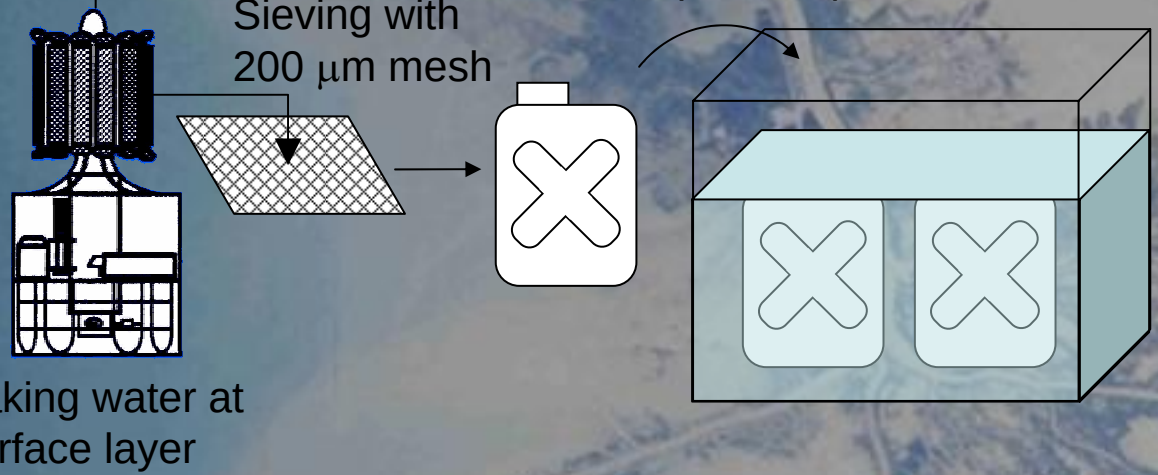
Relationships between trunk length and clearance rate of appendicularian species in various temperature and food concentrations. Blue open circles: diluted 30 μm mesh-screened seawater. Green filled circles: 30 μm mesh-screened seawater. Dark green filled circles: 30 μm mesh-screened seawater with *Isochrysis galbana*.

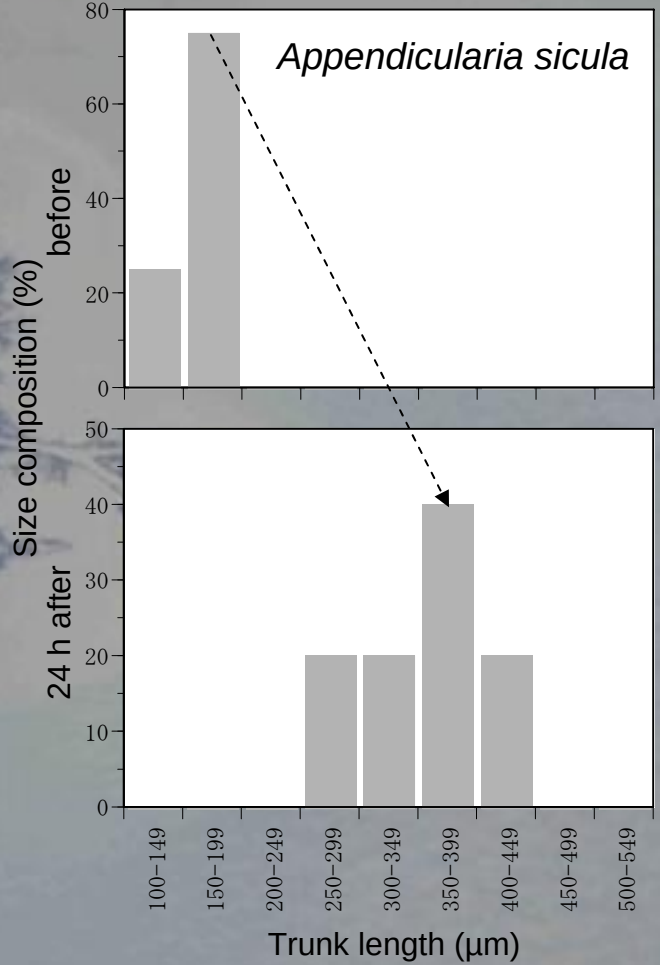
Carbon based weight-specific clearance rates of planktonic herbivorous crustaceans and pelagic tunicates (modified from Alldredge and Madin, 1982)

Group or species	Carbon weight (µg)	Weight-specific clearance rate (ml µgC^{-1} h^{-1})
COPEPODA	3 - 94	0.1 - 0.8
EUPHAUSIACEA		
Euphausia pacifica	1806	0.02
DOLIOLIDA		
Dolioletta gegenbauri	2.4 - 35	0.5 - 1.2
SALPIDA	14 - 4720	0.1 - 4.1
APPENDICULARIA		
Oikopleura dioica	10	0.6 - 1.8
O. vanhoeffeni	10	1.5 - 2.0
Stegosoma magnum	10	5.9
O. longicauda	10	2.7 - 6.2
O. rufescens	10	1.9 - 5.0
O. fusiformis	5	6.3 - 12.9

Incubation experiments for growth rate measurement







Change of trunk length of *A. sicula* during on deck incubation.

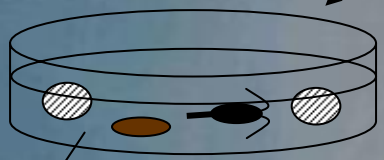
Instantaneous growth rates of appendicularian species measured by on deck incubation experiments in northern Gulf of Mexico in August 2004.

Species	Instantaneous growth rate (d^{-1})	n
Oikopleura longicauda	1.81 ± 0.29	4
Oikopleura dioica	1.91 ± 0.42	4
Appendicularia sicula	1.71 ± 0.52	3

Copepod feeding on discarded house

Discarded house and fecal pellet of *Oikopleura dioica*

Oncaea venusta



Seawater with *Dunaliella* sp.

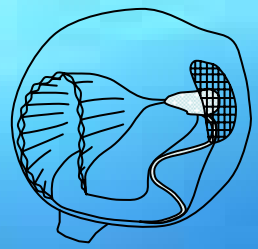
Counting number and measuring volume of house and pellet

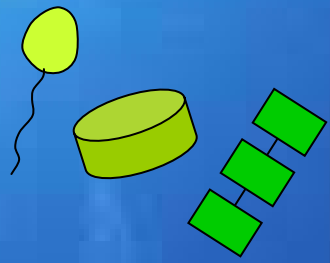
Grazing rate of *Oncaea venusta* on discarded houses.

Ingested house number (houses ind^{-1} d^{-1})	Ingested house carbon (µg ind^{-1} d^{-1})	Copepod number
4.4 ± 1.5	1.6 ± 0.22	11

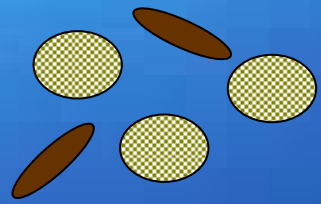
High growth rate

Generation time is short: 3 - 11 days.
Instantaneous growth rates are higher than those of copepods.



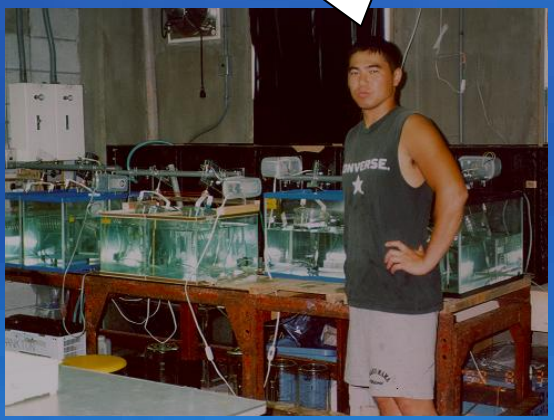


I could confirm these important characteristics for many appendicularian species by experiments.



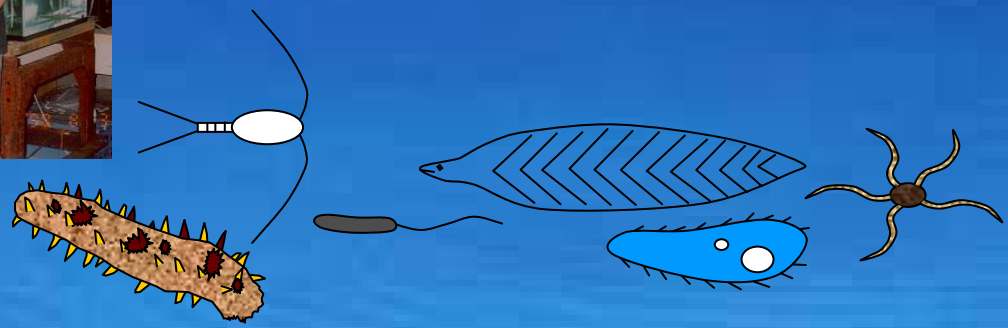
Hi clearance rate

Weight-specific clearance rates are higher than those of planktonic crustaceans and even other pelagic tunicates.



Significant producer of sinking particles

Up to 40 houses are produced per day.
Discarded house productivity can be severalfold of their own biomass.

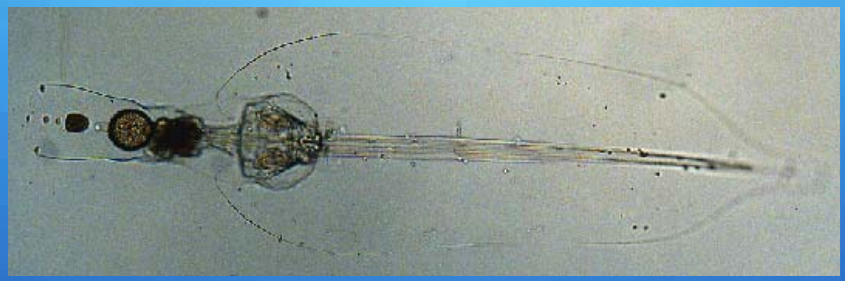


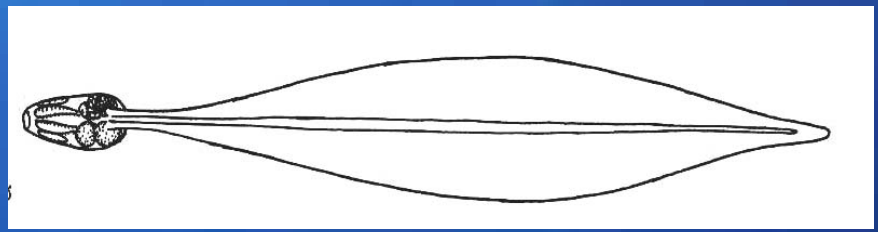
Important supplier of food for other groups

Appendicularians are very unique animals!!

But there is still a lot of unknowns for appendicularians.

⌘ Fritillariid and Kowalevskiid species





⌘ Cold water and deep water species

http://perezyvan.free.fr/Gabriel_Neve/galarie.htm

http://montereybay.noaa.gov/sitechar/pelagic4.html

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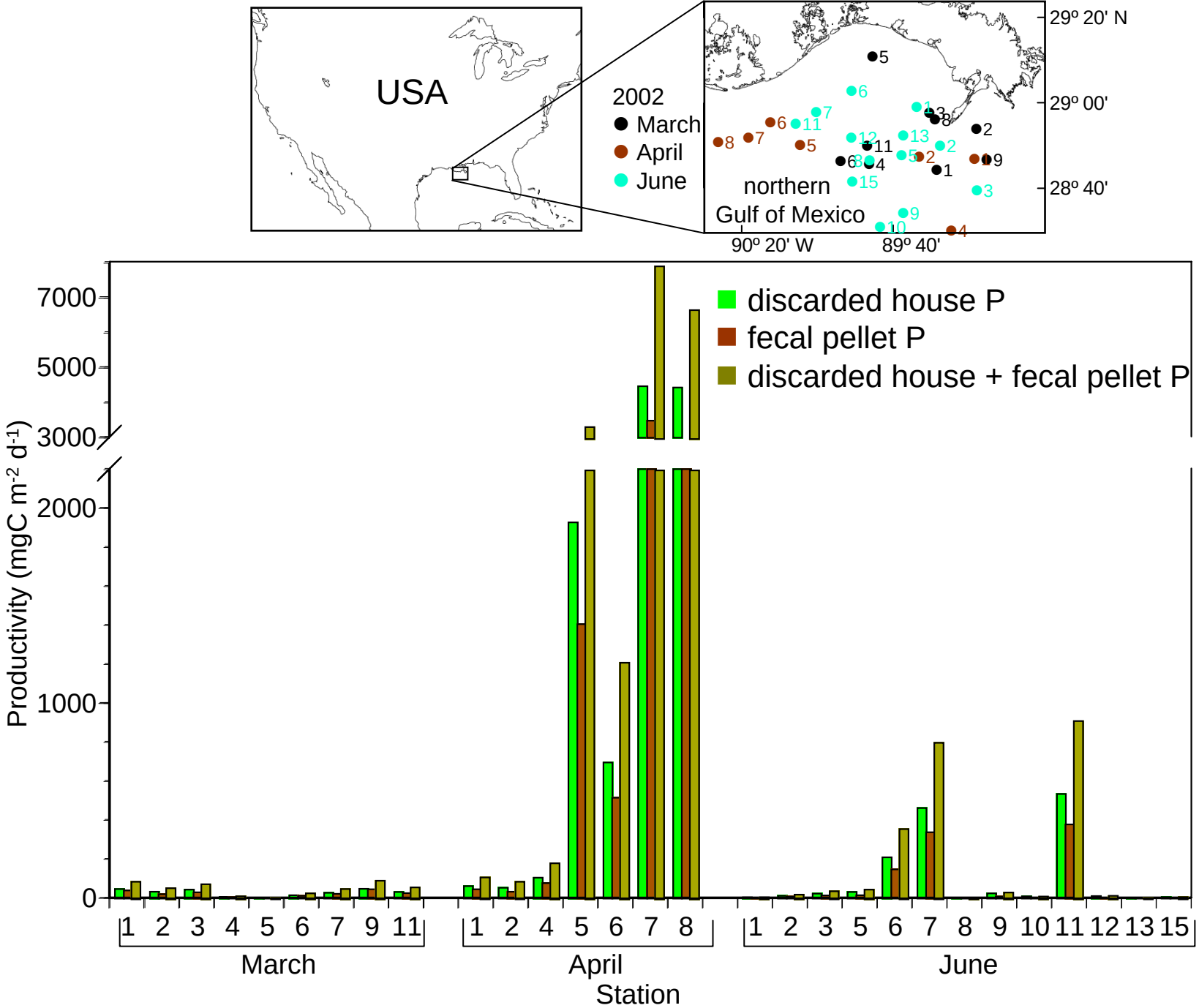

Discarded house and fecal pellet productivity by appendicularians in the northern Gulf of Mexico.