Russian Federal Research Institute of Fisheries and Oceanography (VNIRO), Moscow

Feeding strategies for early life stages of red king crab *(Paralithodes camtschaticus)* and giant freshwater prawn *(Macrobrachium rosenbergii)* under artificial conditions

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Introduction

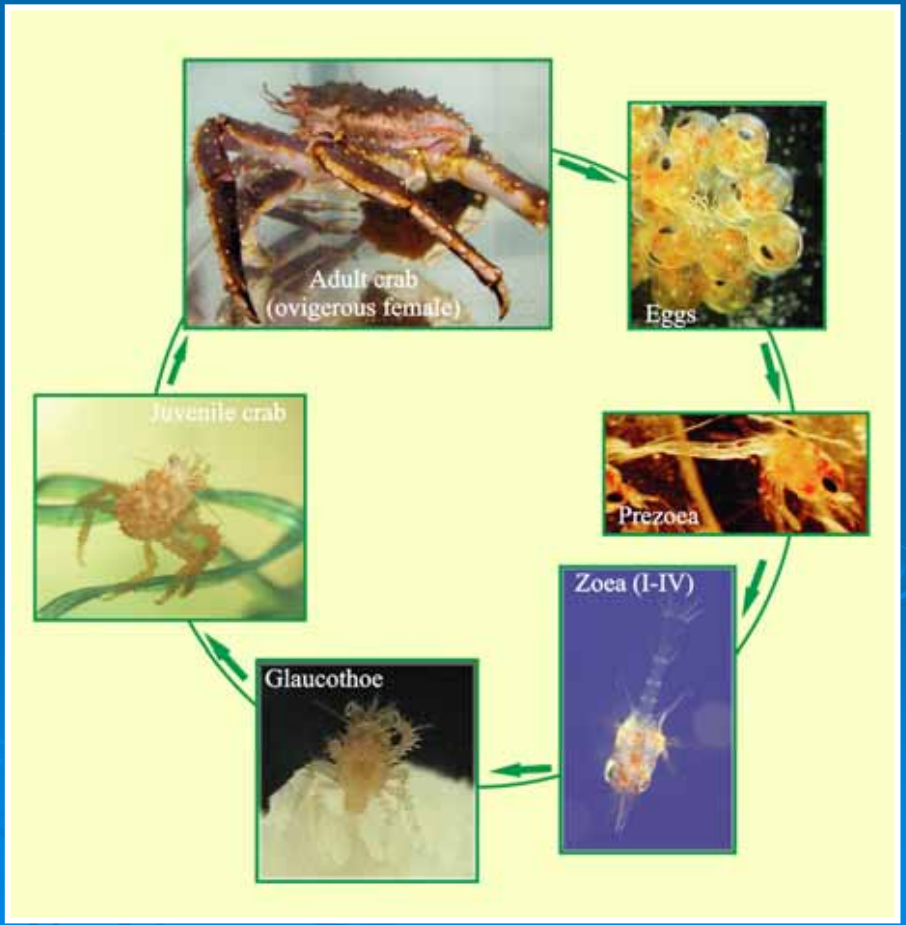
- In recent years, the cultivation of crustaceans is an important direction for aqua-culture in East and Central Europe, and particularly Russia.
- This is important both for preservation of species variety, maintenance of natural population size of commercially valuable species (red king crab), and increase of production and diversity of delicacy hydrobionts (giant freshwater prawn).

Red king crab larval culture

Program of VNIRO (Moscow)

"Elaboration of Normative and Methodical Bases for Artificial Reproduction of the Red King Crab in order to Restore its Natural Populations"

The technology of obtaining and rearing the larvae up to viable juvenile stage under controlled conditions



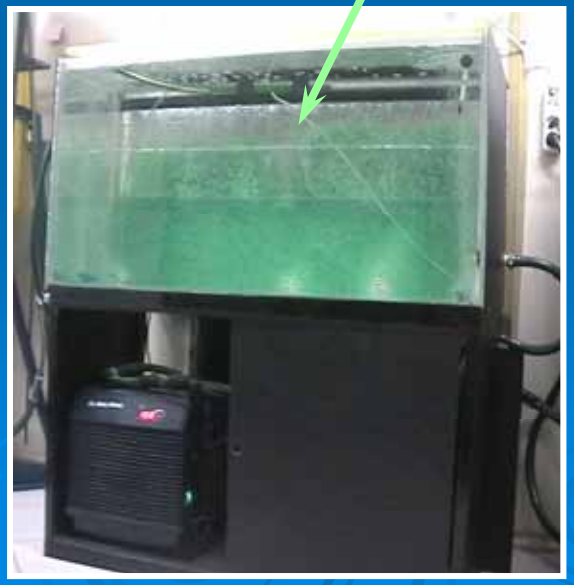
Object and tasks

The important elements in the feeding strategy for crustaceans at their early stages are:

- determine daily rations;
- selection of optimal feed;
- development of a feeding regime;
- optimization of feeding procedure

The experiments were held (2002-2008) in the Laboratory of Crustacean Reproduction and cultivation (VNIRO, Moscow)

Recirculation water system (Moscow): 1 – Holding tank; 2 – Biofilter; 3 – Chiller.



water temperature - 6-8°C,
water salinity - 32 – 35 g L-1.

Red king crab early life stages

prezoea – duration 1 h after hatching - non-feeding, non-active stage

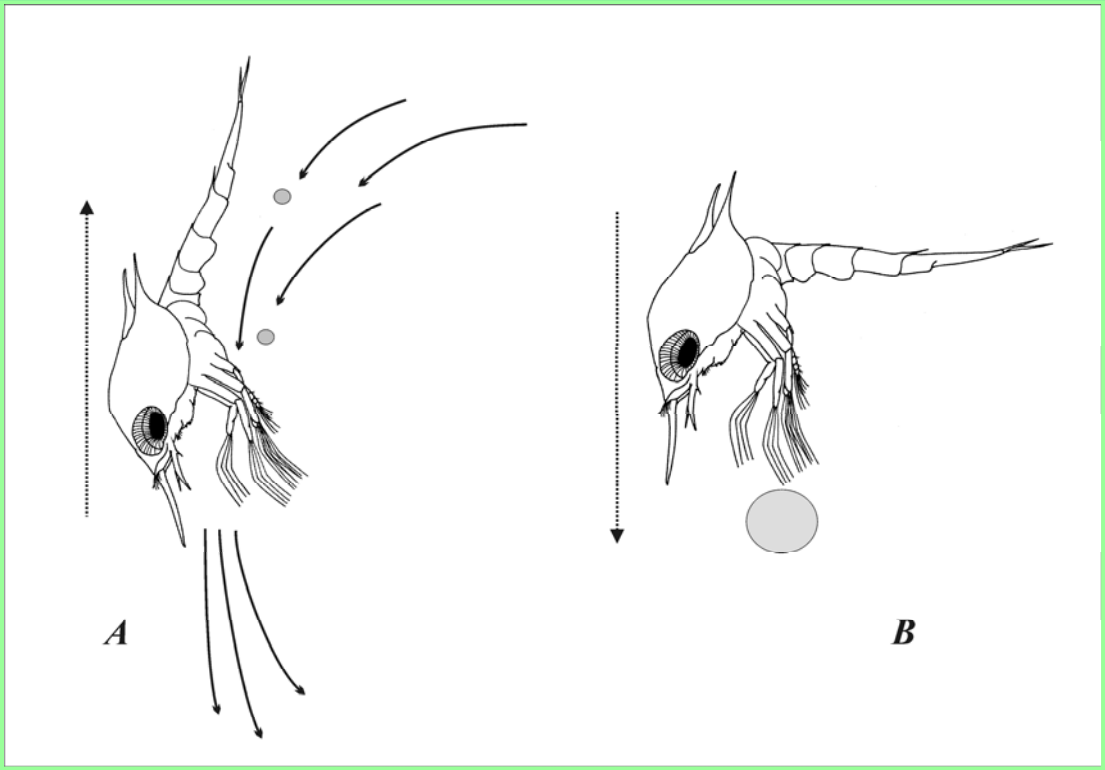
Larvae – planktonic zoeal stages (I-IV)

Zoea I - 8-10 days 56-70 degree-days	Zoea II – 7-8 days 56-64 degree-days	Zoea III – 9-10 days 72-80 degree-days	Zoea IV - 11-12 days 88-96 degree-days

The post larval stage – glaucothoe non-feeding stage (18 - 20 days)

Early Juveniles

Feeding Mode



Two modes of prey cupture:
A – "active" (solid lines show the feeding current),
B – "passive"

- *feed by capturing material suspended in the water column;*
- *by collecting food objects from the substratum.*

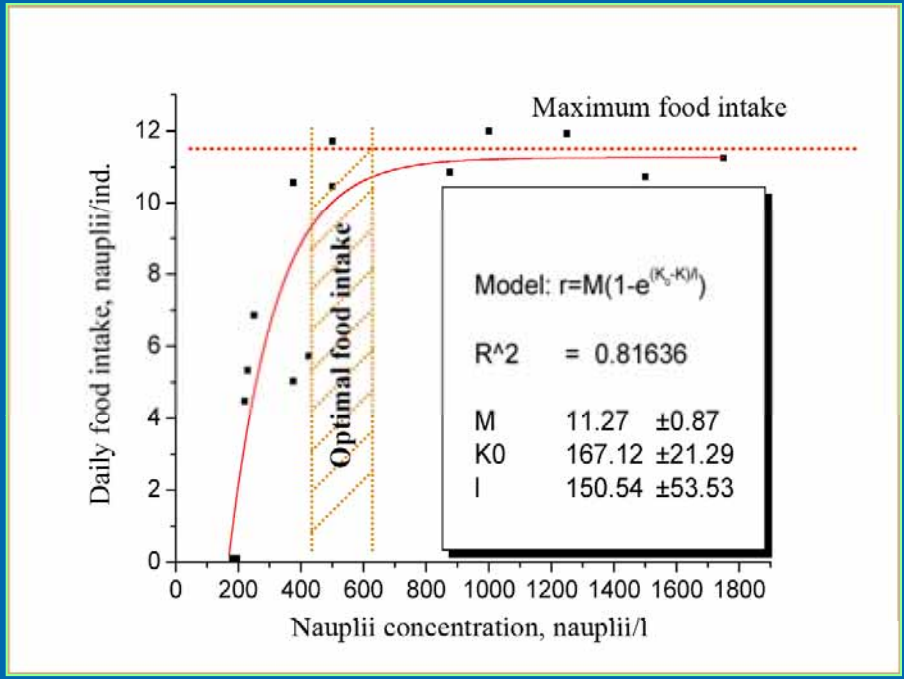
zoeae are good swimmers and have well developed eyes, but, they do not use sight in locating and capturing the prey.

minimum non-consumable food concentration is 160 nauplii/L-*1* /per larvae

Epelbaum, Kovatcheva, 2005; Kovatcheva N.P. et al., 2006.

Daily food intake of zoea

Main food – freshly hatched nauplii of *Artemia* sp.



Daily food intake of zoeae I-IV at 8ºC.

Zoeal stage	Daily food intake (M)		
	nauplii/ ind	mg (wwt)/ ind	µg (dwt)/ ind
I	11.3	0.294	47.46
II	22.4	0.582	94.08
III	33.2	0.863	139.44
IV	41.8	1.087	175.56

dwt – dry weight, wwt – wet weight.

r=M[1-e(Ko-K)/l]
r - daily food intake (nauplii/ind per day),
K - nauplii concentration (nauplii/L),
M, ***l*** and ***K0*** - constants.

Epelbaum, Kovatcheva, 2005;
Kovatcheva N.P. et al., 2006.

Optimal initial *Artemia* nauplii concentrations for feeding zoeae I-IV constitute:
I-400-600,
II-600-800,
III-800-1000
IV-1000-1200 nauplii/L

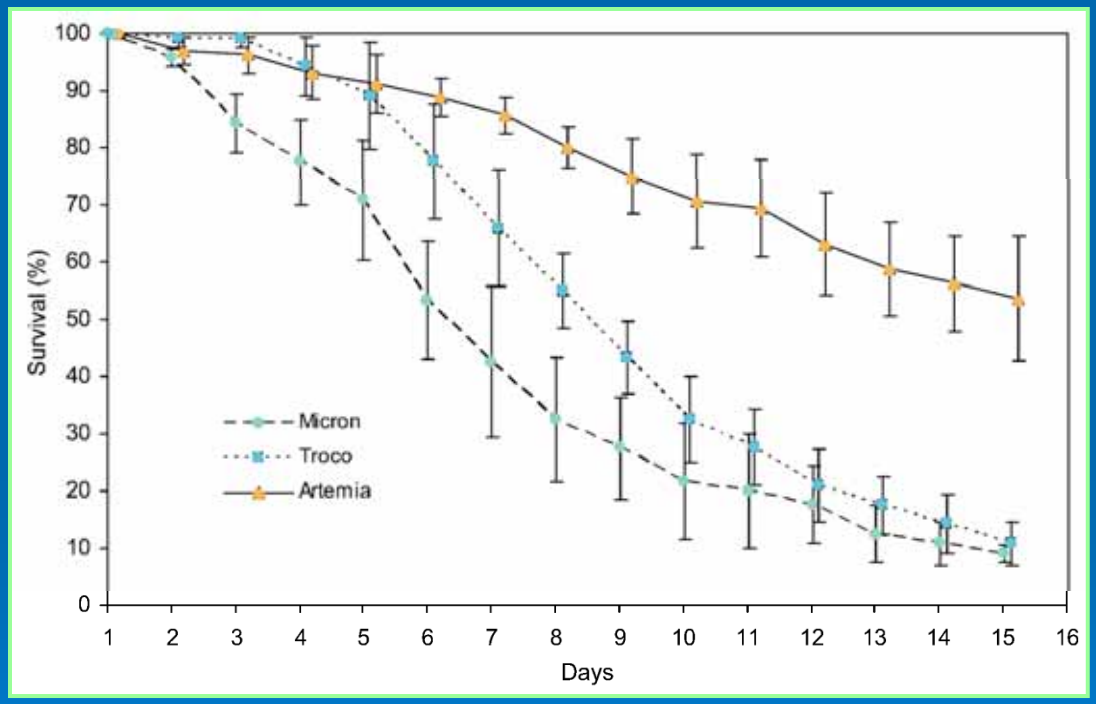
Testing of various feeds

Biochemical composition of the used feeds

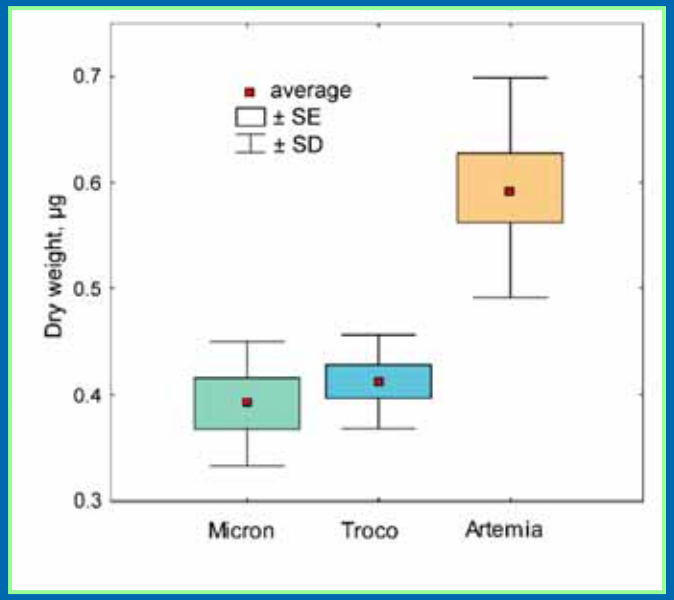
Subject	Feeds	Chemical composition			
		Proteins	Fats	Carbohydrate	Ash
Larvae	*Artemia* *	41,6	23,1	22,7	6,56
	Micron (Sera)	50,2	8,1	4,2	11,9
	Troco (Coppens)	63,0	15,0	0,3	10,0
Juveniles	**Tetra Wafer Mix**	45,0	6,0	2,0	11,0
	Ecostart 17 (BioMar, The Netherlands)	47,0	20,0	0,8	9,5
	squid**	85,28	4,06	-	7,36
	bloodworm ***	62,79	3,1	29,46	4,65
	mussel ******	51,43	7,71	-	-

Selection of optimal feed

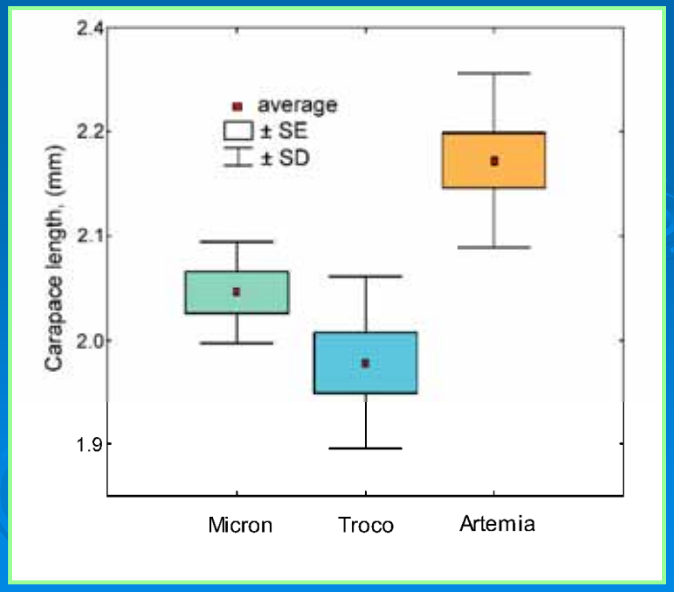
Survival rates of larvae feeding by various feeds.



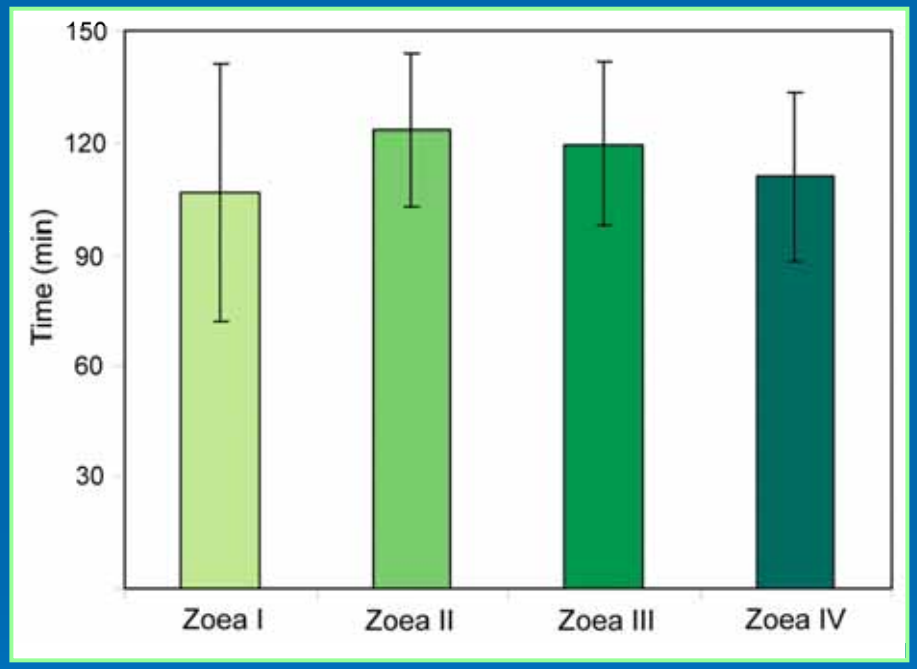
Dry weight of larvae feeding by various feeds.



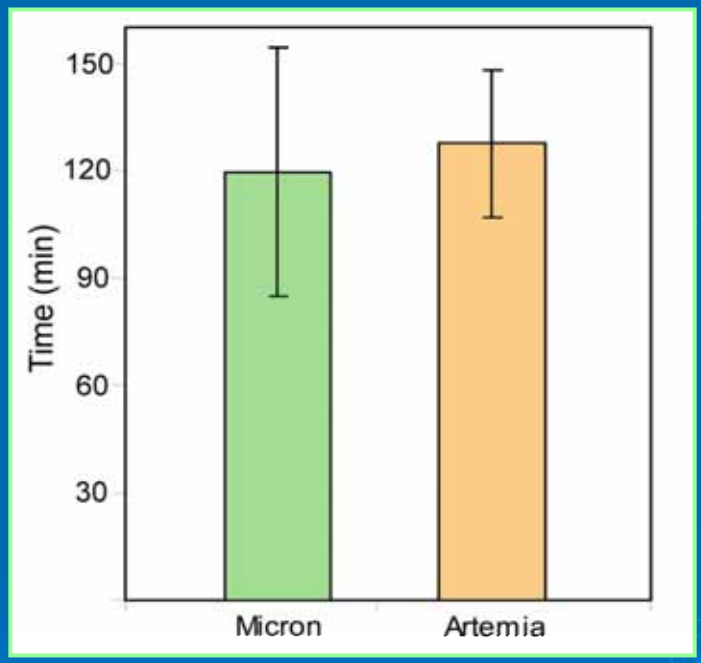
Carapace length of larvae feeding by various feeds



Duration of the food passing through the gastrointestinal tract



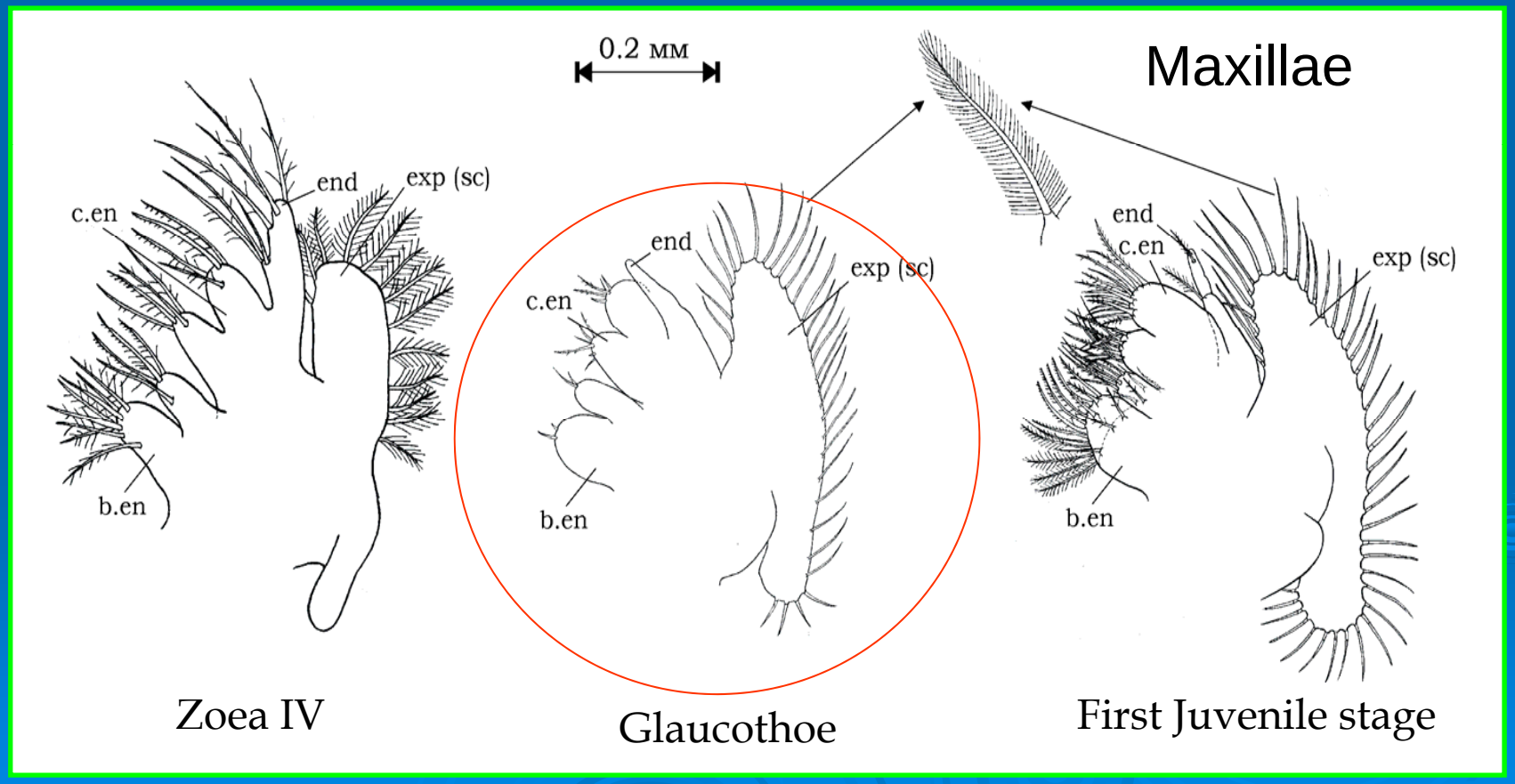
Variations in duration of the food passing through the gastrointestinal tract at different larval stages.



Variations in duration of the food passing through the gastrointestinal tract (zoea III) depending on the food type.

Post larval stage – glaucothoe (non feeding period)

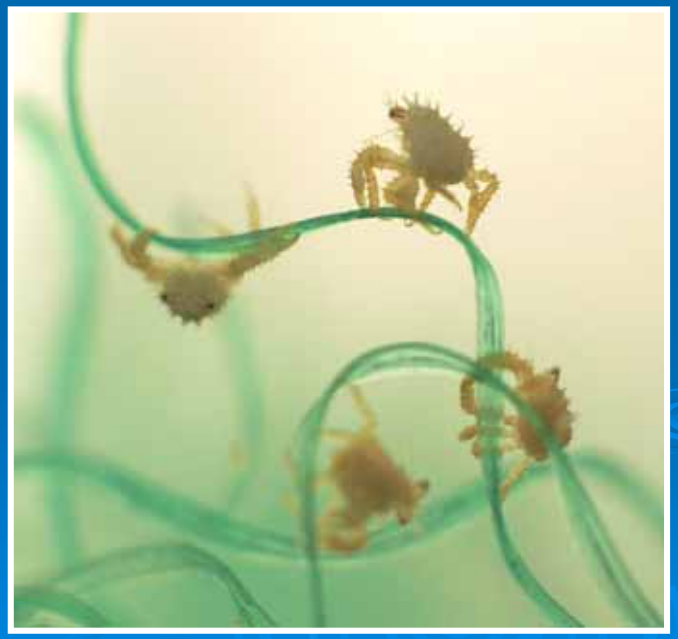
Reduction of the glaucothoe oral appendages



Early juvenile phase

The juveniles grasp and tear food items using chelipeds and process it using maxillipeds and oral appendages.

Requirements for potential feeds for red king crab juveniles :



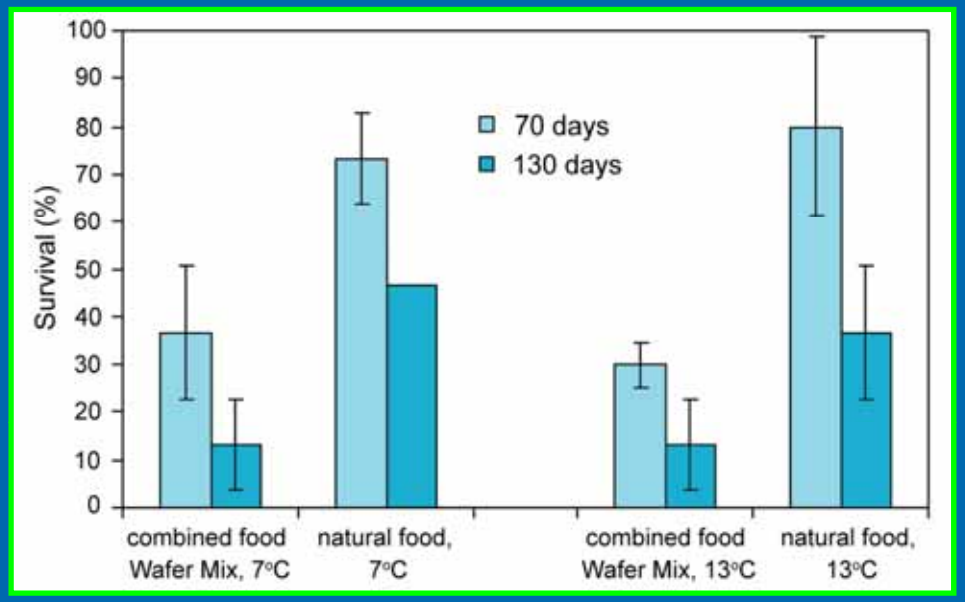
- Be appropriate in size for the juveniles of a certain age and meet their nutritional requirements;
- Have negative buoyancy;
- Remain stable in seawater for at least 12 h and not alter water quality significantly.

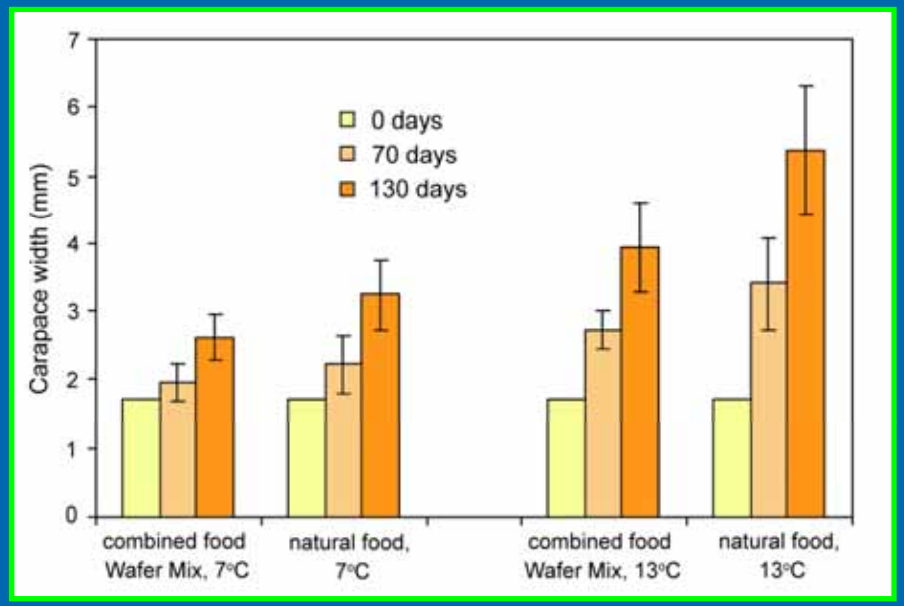
Early juvenile phase

Molting process

Blocks with experimental vessels for juveniles rearing

Selection of optimal rearing conditions





Survival of juveniles dependent on temperature and the feed type.

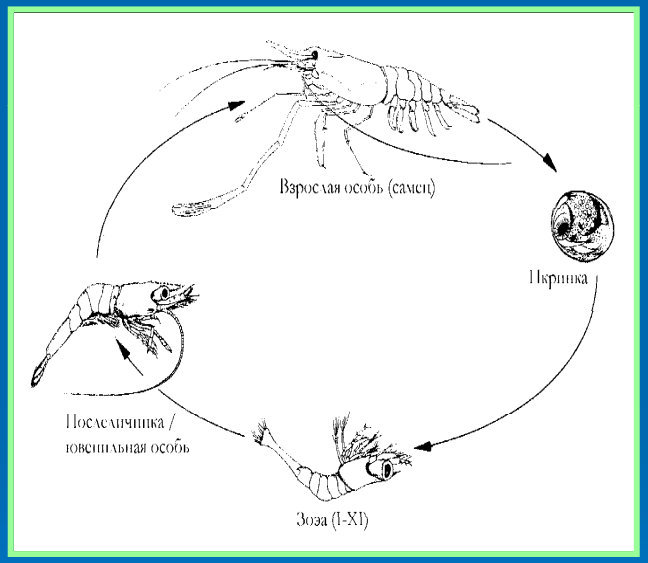
Carapace width of the juveniles depending on the temperature and the type of feed.

The principal cause of juvenile mortality is cannibalism

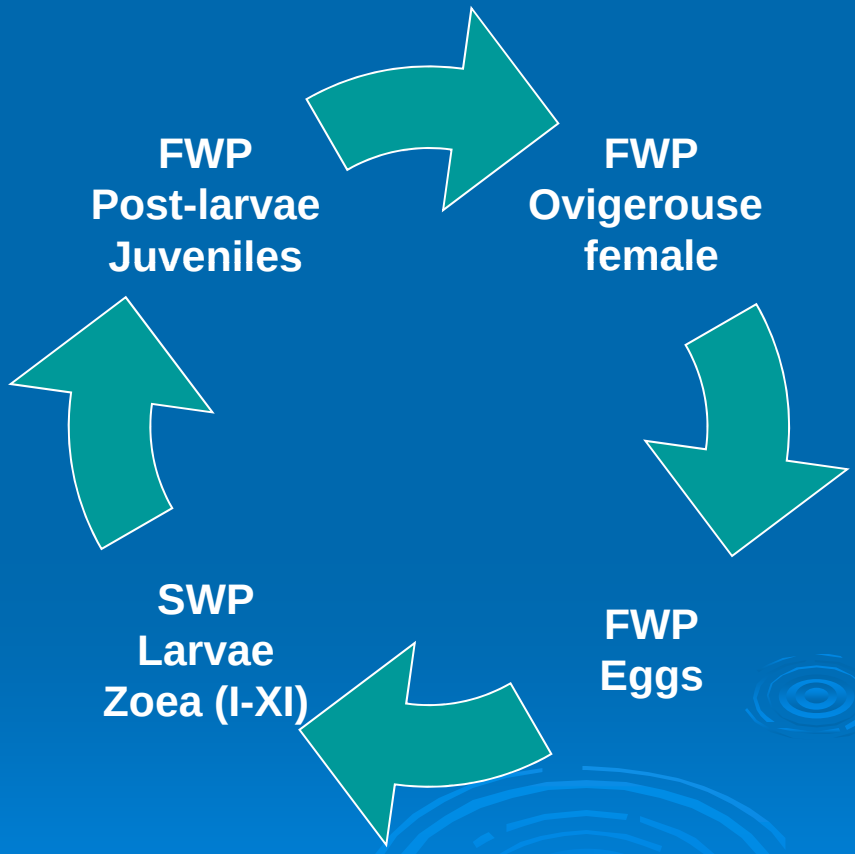
Duration of the food passing through the gastrointestinal tract

Minimum duration of the food passing through the gastrointestinal tract is 2-2.5 hours. The entire digestion process took more than 24 hours.

Giant freshwater prawn
Macrobrachium rosenbergii



Life cycle of *M.rosenbergii*



FWP – freshwater period (benthick behaviour)

SWP – salt water period (planktonic behaviour)

Larvae culture conditions (CRWS, VNIRO)

- water temperature – 28 - 31°C
- salinity - 12 – 14 g L-*1*;
- differential feeding;
- stock density 80-120 ind./l;

Life cycle of *M.rosenbergii* duration of all phases in culture conditions

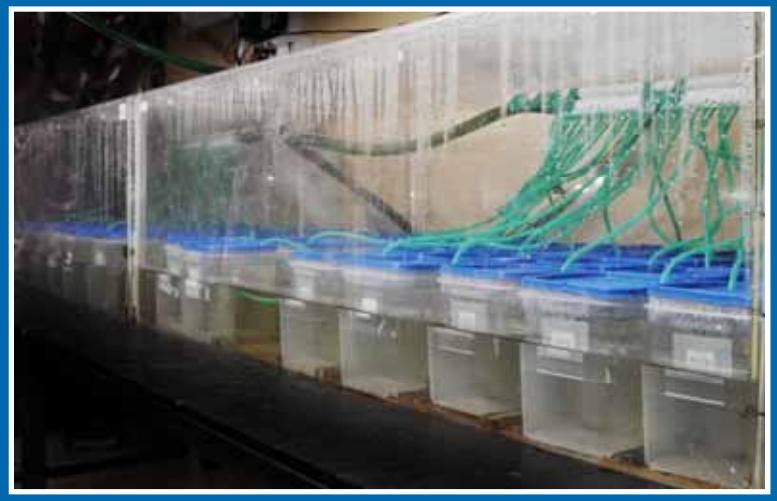
eggs	– 14 days;
larvae	– 27 – 35 days;
post-larvae	– 14 days;
juveniles until maturity	– 90 days

survival rate	- 45-60 % (Z-XI)
Z-XI length	- 7.2 - 8.5 mm;
Z-XI weight	- 6.6 - 7.4 mg.

Duration of *M. rosenbergii* larvae stages and their synchronism

Days after hatching	Stage	Larvae rate on each stage of development, %
1	1	100
2	1; 2	40; 60
4	2; 3	40; 60
6	4; 5	70; 30
8	4; 5	20; 80
11	5; 6; 7; 8	4; 61; 26; 9
14	7; 8	87; 13
17	8; 9	80; 20
22	8; 9; 10	6; 87; 7
27	8; 9; 10; 11; PL*	4; 32; 47; 13; 4
31	9; 10; 11; PL*	20; 40; 36; 4
34	9; 10; 11; PL*	4; 14; 68; 14
36	10; 11; PL*	2; 18; 80

Experimental design (feeding experiments)



The scheme of differential feeding of *M.rosenbergii* larvae

Larvae stage	nauplii *Artemia sp.*, items per larvae	eggs mixture, мg/ind.	size of the eggs mixture particles, µm	feeding shedule	
				Artemia sp. times/day	eggs mixture
II	50	-	-	4	-
III – V	100	0,5-2,5	300-500	3	1
VI – VIII	150	2,5-4,5	500-700	2	2
IX–post-larvae	200	4,5-12,0	900-1200	3	2

Conclusions

- Giant freshwater prawn larvae are more active in search and uptake of food. It took them 10-15 minutes to uptake and consume food.
- The minimum duration of the feed passing trough the gastrointestinal tract in GFP is 20-23 minutes on average, which is 4-5 times less than in the RKC larvae.
- Daily feeding frequency is 2 times for RKC larvae and 4-5 times for GFP.
- The size of food particles available to the RKC and GFP larvae could be comparable with that of the larvae themselves.

- *Artemia sp.* nauplii is the type of feed for RKC larvae which fully meets the physiological demands of larvae.

- The optimized ration for the first stages of young red king crab includes alternation of minced mollusk meat, mixed feed and nauplii of Artemia sp.

- Daily ration has to increase in the larvae period: for RKC from 11.3 to 41.8 and for GFP from 50 to 200 nauplii *Artemia sp.*/ind with additional egg mixture for GFP.

- The feeding strategies developed by us in the process of RKC and GFP cultivation, in combination with other technological methods, have become the basis of Biotechnical requirements of crustacean mass-culture method in Russia.

THANK YOU FOR YOUR ATTENTION!