Effect of different microalgae diets on *Apocyclops panamensis* (Marsh, 1913) as live feed for fish larval rearing

Laura Ballesteros-Redondo[a,*], Harry W. Palm[a], Hanno Bährs[b] and Adrian A. Bischoff[a]

[a]University of Rostock, Faculty of Agricultural and Environmental Sciences, Department of Aquaculture and Sea-Ranching, Justus-von-Liebig-Weg 6, 18059 Rostock, Germany.
laura.redondo@uni-rostock.de, adrian.bischoff-lang@uni-rostock.de, harry.palm@uni-rostock.de

[b]Aquacopa GmbH, Hoher Damm 25, 17194 Jabel, Germany.
baehrs@aquacopa.de

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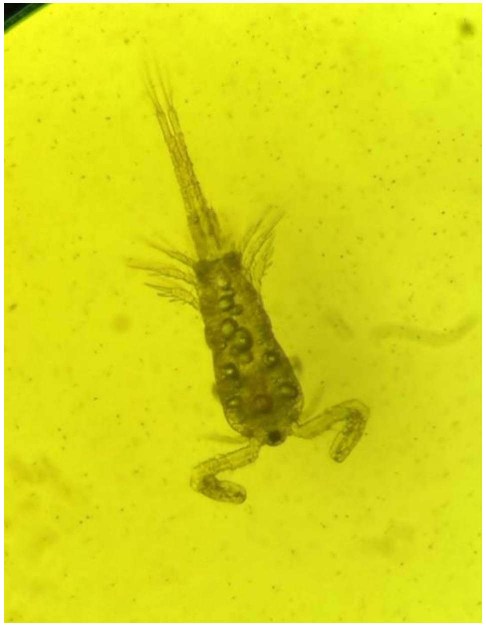
- The effort done in aquaculture to rear fish larvae has increased in the past years

- Copepods seem to be promising candidates because of their size, swimming behaviour and nutritional composition

- One candidate is *Apocyclops panamensis*

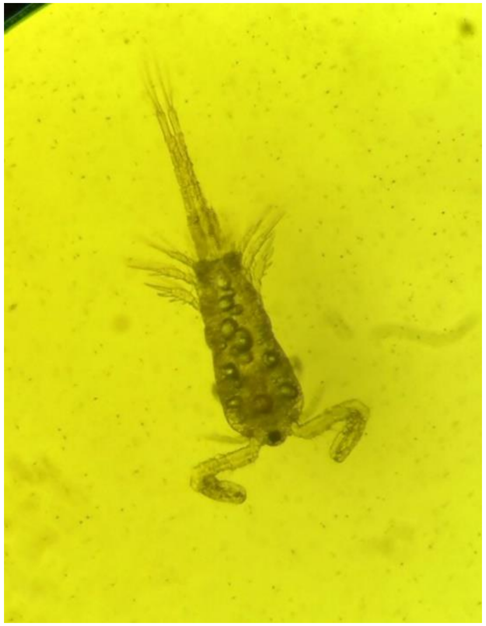


- Cyclopoid copepod
- Candidate for **intensive culture**
- **Smaller size** than other copepods could have an advantages for the small pikeperch larvae
- But we still do not know if *A. panamensis* can fill the **nutritional requirements** of the fish larvae

- Our aim was to investigate the potential use of *A. panamensis* as a live food for fish larvae

- For this purpose, we tested three diets (see next slide) in three independent experiments at different nauplii stocking densities (4, 8 and 34 nauplii*ml^{-1})

- We filtered the original culture through a net of 100 µm to remove copepodites and adults and through another net of 50 µm to collect the nauplie



- Three diets:
  - **N100%** (*Nannochloropsis* sp. at 200.000 cells*mL^{-1}*day^{-1})
  - **ISO100%** (*I. galbana* at 100.000 cells*mL^{-1}*day^{-1})
  - **N+I** (*Nannochloropsis* sp. at 100.000 cells*mL^{-1}*day^{-1} + *I. galbana* at 50.000 cells*mL^{-1}*day^{-1})

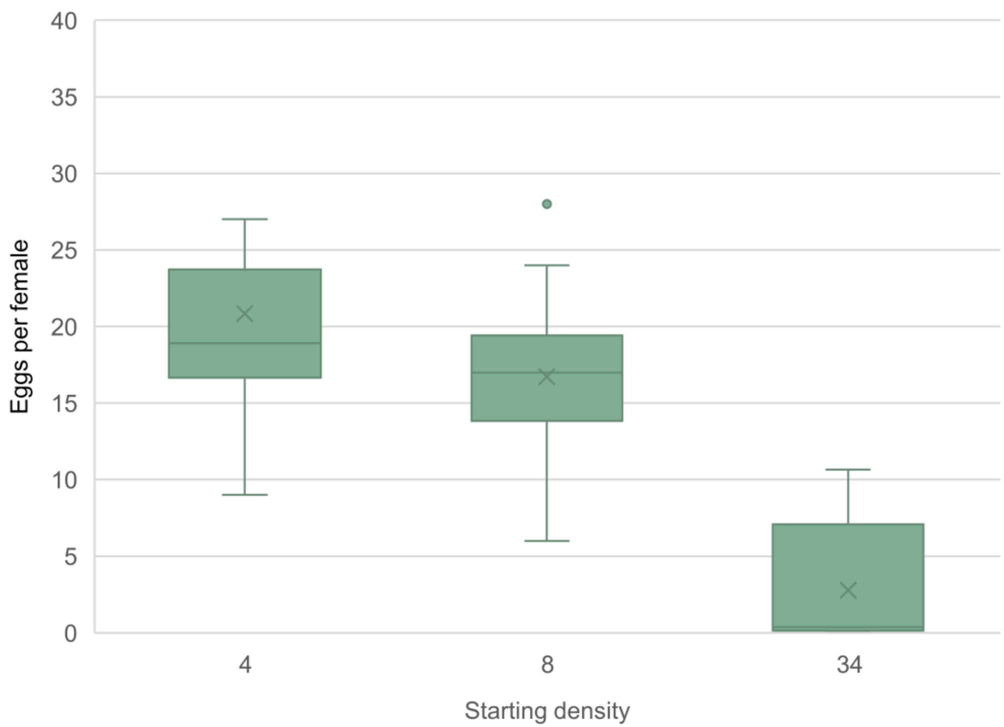
- The microalgae were culture to be in the exponential phase while feeding the copepods

All the experiments consisted in the analysis of the **effect** of the **initial stocking density** and the **three diets** on the:

- Total density (specimens*ml^{-1})
- Density of each group (groups are nauplie, copepodites, males and females)
- Population structure (% of each group)
- Size of each group
- Some reproduction parameters: eggs per females, total number of eggs and ratio male:female

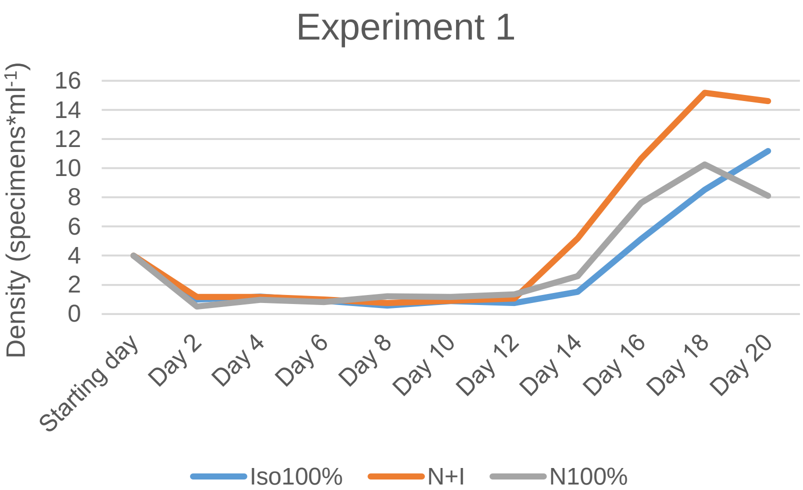
Effect of the initial **stocking density**

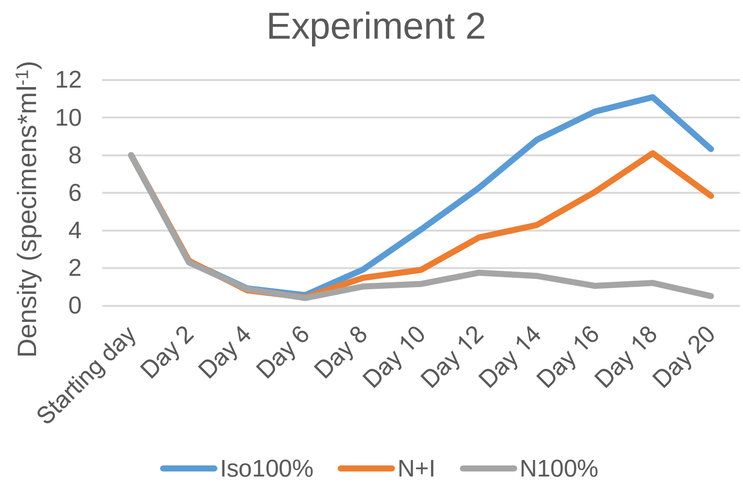
The main difference between the three experiments or initial stocking densities was the amount of eggs per females, being this number the highest in experiment 1 (4 nauplie*ml^{-1}) and the lowest in experiment 3 (34 nauplie*ml^{-1}) (Kruskal-Wallis test p=0.00)

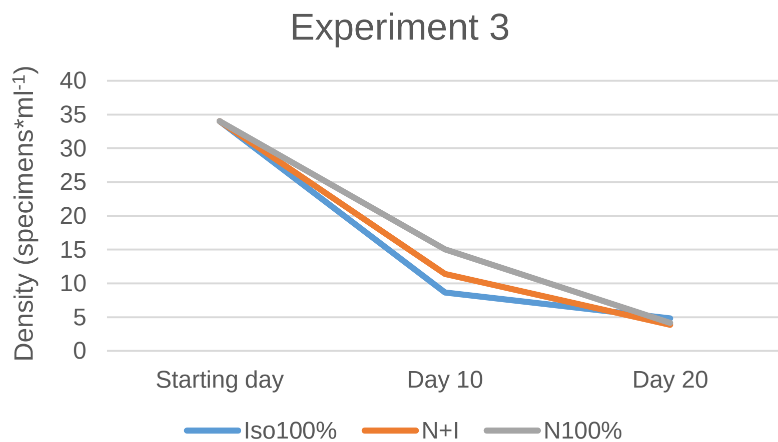


Effect of the **diets**

- There were **statistical differences** between diets in relation the **total density** (Kruskal-Wallis test $p=0.017$)
- The total density in experiments 1 and 2 (4 and 8 nauplie*ml^{-1} respectively) showed a similar pattern. The initial stocking density decreased until around 1 nauplii*ml^{-1} and then, there is an increase, when the reproduction started. At the end of both experiments we could see that the lowest total density was the culture fed only *Nannochloropsis* sp. (see next slide)
- During the experiment 3 (34 nauplie*ml^{-1}), the total density always decreased

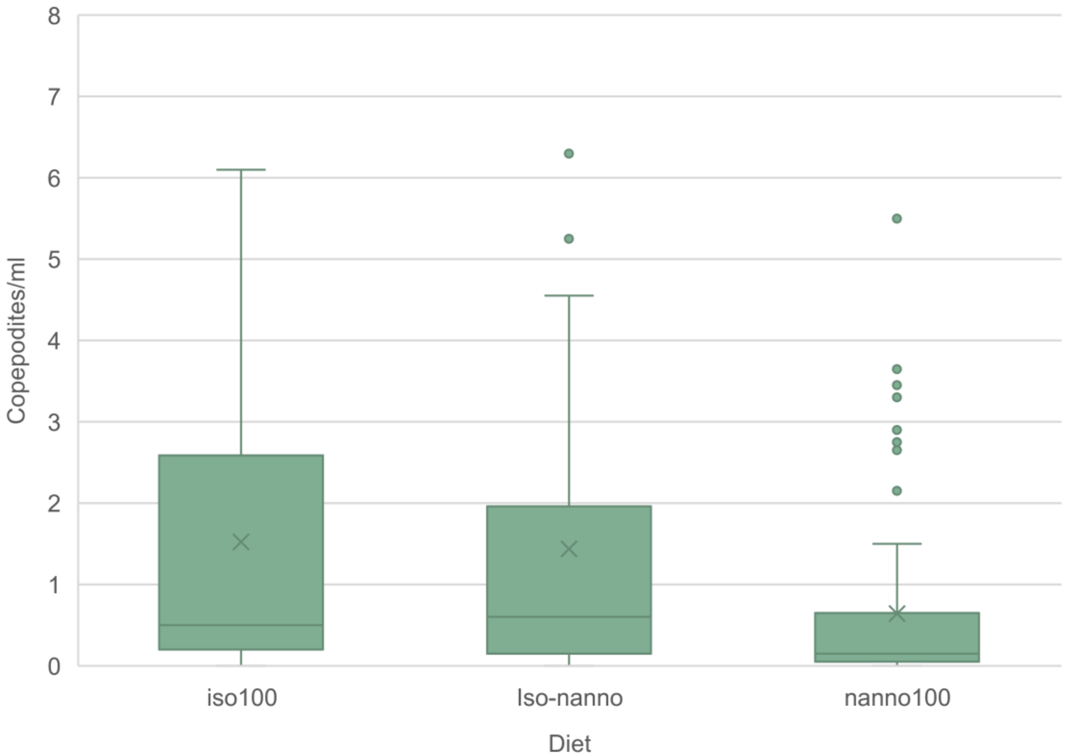

Experiment 1
Density (specimens*ml^{-1})
16
14
12
10
8
6
4
2
0
Starting day
Day 2
Day 4
Day 6
Day 8
Day 10
Day 12
Day 14
Day 16
Day 18
Day 20
Iso100%
N+I
N100%


Experiment 2
Density (specimens*ml^{-1})
12
10
8
6
4
2
0
Starting day
Day 2
Day 4
Day 6
Day 8
Day 10
Day 12
Day 14
Day 16
Day 18
Day 20
Iso100%
N+I
N100%


Experiment 3
Density (specimens*ml^{-1})
40
35
30
25
20
15
10
5
0
Starting day
Day 10
Day 20
Iso100%
N+I
N100%

Effect of the **diets**

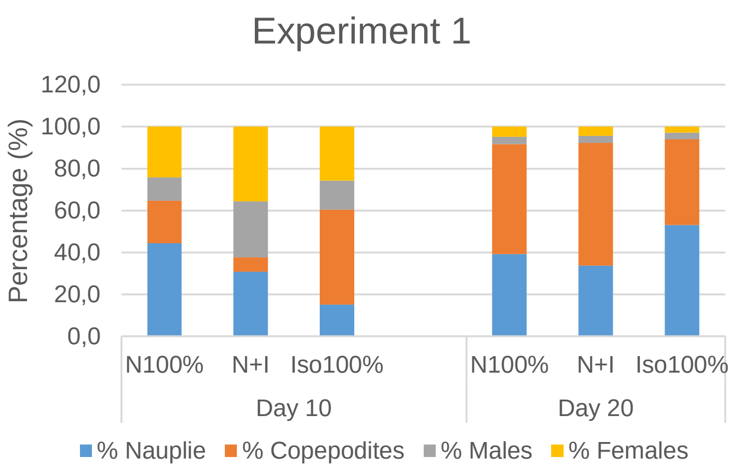
- There were only **significant differences** between diets in relation the **copepodites density** and not in the rest of the groups (Kruskal-Wallis test p=0.001)
- Pairwise comparison showed that the difference is between N100% and the other two diets for both, total and copepodite density

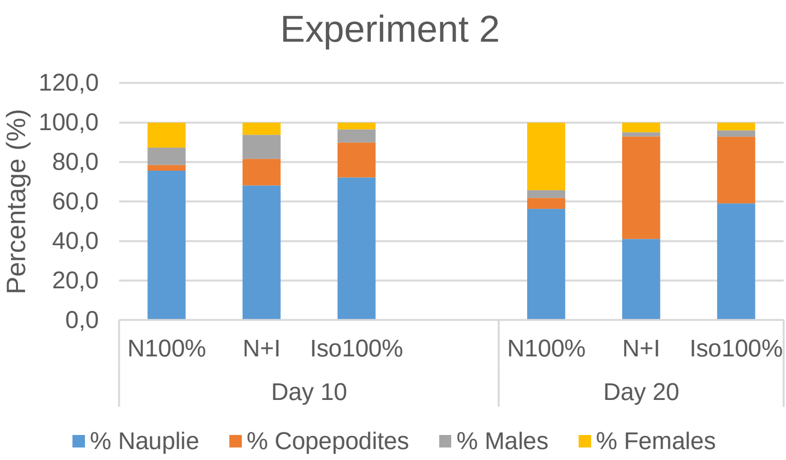


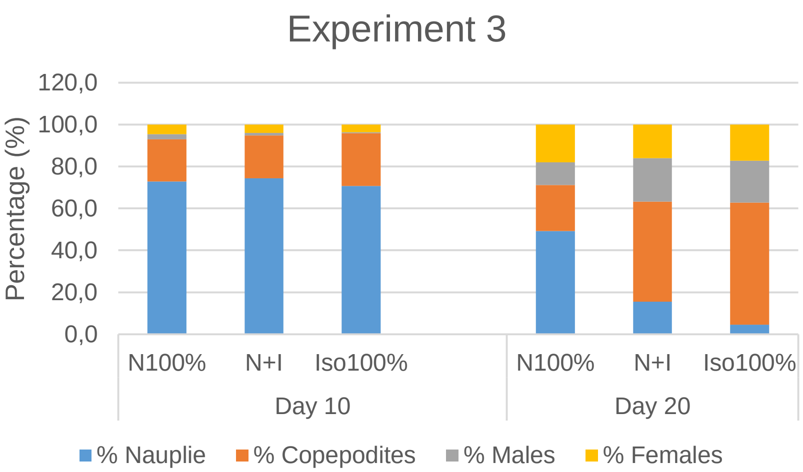
Effect of the **diets**

- There were **statistical differences** between diets in relation the **proportion of nauplii** (ANOVA p=0.036) and the **proportion of copepodites** (Kruskal-Wallis test p=0.001)
- As we already saw previously, there are differences in the density of the copepodites. Thus, the differences in the percentage of copepodites are logic. The proportion of nauplii also varies with the diet. (See next slide)
- There are no differences in percentage of males and females, ration male:female, total number of eggs and eggs per females in relation to the diets

Introduction | Material & Methods | **Results** | Discussion

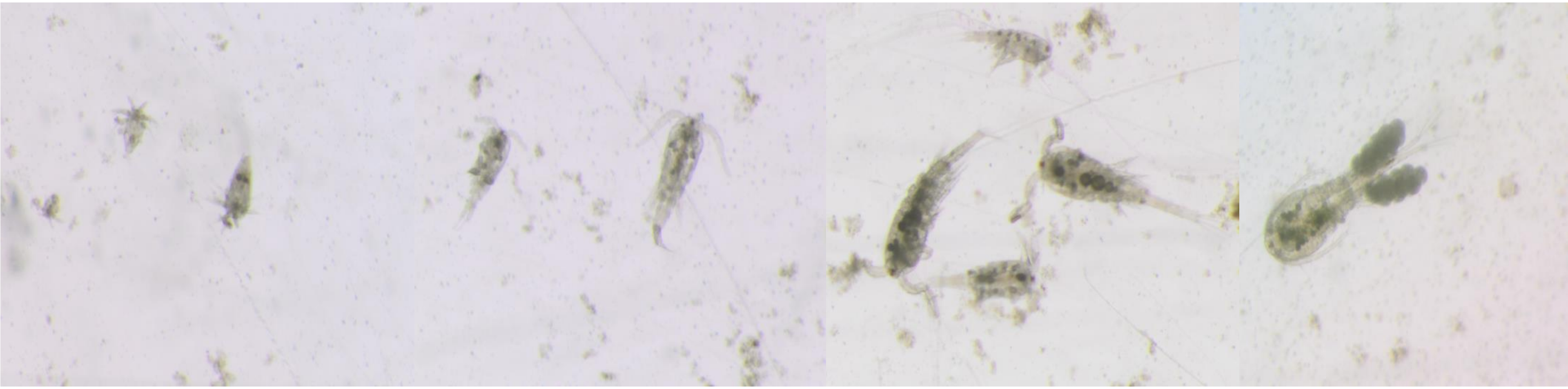


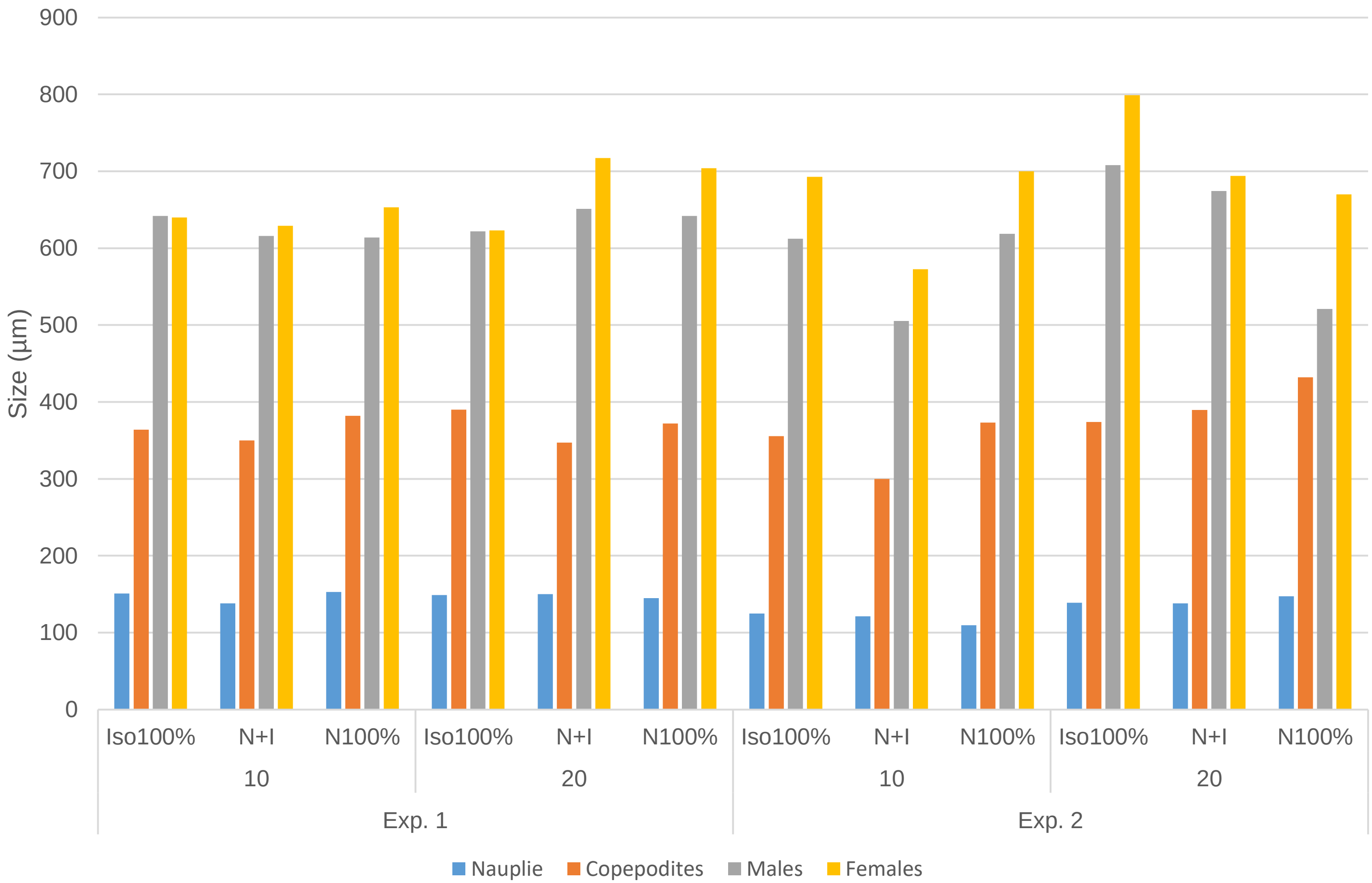




Effect of the **diets**

- There was **no effect** of the **diets** in relation to **the size of each group**
- Furthermore, no differences were found in relation to the initial **stocking density** and neither along time (See next slide)




900
800
700
600
500
400
300
200
100
0
Size (µm)
Iso100%
N+I
N100%
Iso100%
N+I
N100%
Iso100%
N+I
N100%
Iso100%
N+I
N100%
10
20
10
20
Exp. 1
Exp. 2
Nauplie
Copepodites
Males
Females

As we saw before, the diet containing only *Nannochloropsis* sp. got the lowest density at the end of the experiment. Moreover, this diet had more proportion of nauplie over copepodites (but less total number of copepods). This could mean that a lower proportion of nauplie survived to reach the next stage in comparison to the other diets. Therefore:

- ✓ *I. galbana* seems to be the best diet and 50. – 100.000 cells*ml^{-1} looks to be enough to have densities between 6 and 14 *A. panamensis**ml^{-1}

The highest densities at the end of the experiment were found during the first experiment, with a stocking density of 4 nauplie*ml^{-1}. This fact can be explained by the amount of food available for each copepod, which was higher in the first experiment. And of course, could be the same for the females, which could produce more eggs. Therefore:

- ✓ Food availability can influence the survival of the copepods and the production of eggs by females

Diets seems to have no effect on **size** of *A. panamensis.* As showed in previous graphics, adults are over 500 µm. Thus, we have the posibility to filter the culture at 350-400 µm :

- ✓ to keep the adults for reproduction and some copepodites to become adults and therefore, **maintain the culture**
- ✓ To extract nauplie and smaller copepodites to **feed fish larvae** covering also like this, a wide range in case of high fish size variability

We can conclude that *A. panamensis* is a good candidate for aquaculture:

- Relative **high culture density** (between 6-14*ml^{-1}) with 50. – 100.000 cells*ml^{-1} per day
- **Stable length** (posibility to filter per size) for feeding fish larvae and for maintenance
- Research about the **nutritional composition** should be done

Thanks for your attention