Copepods as live food organisms for marine fish larvae

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First feeding of marine fish larvae using copepods

Stolt Sea Farm AS,
Rubbestadneset
Bømlo, Norway

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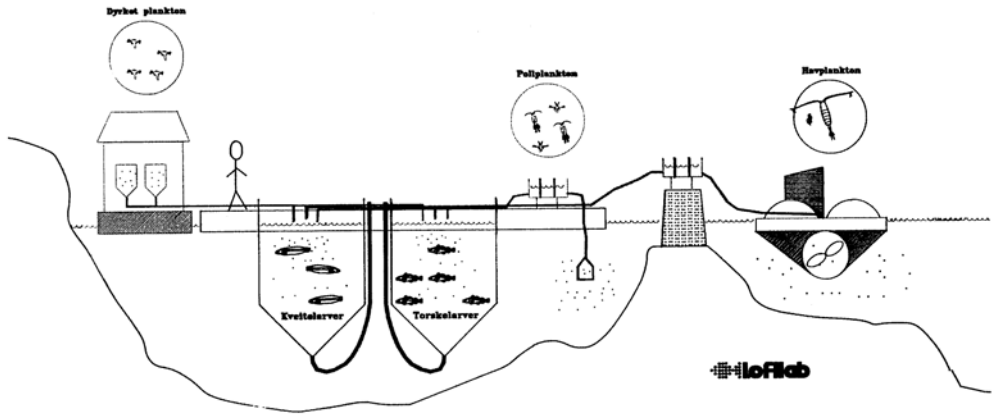
Semi-intensive production of cod (*Gadus morhua* L.) and halibut (*Hippoglossus hippoglossus* L.) larvae

Lofilab AS,
Lofoten, Norway

Meøypollen in Lofoten, Norway



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Wide range of zooplankton species, size and developmental stages

- Early spring dominated by nauplii and copopodid stages
- Late spring and summer - higher numbers of adult stages
- Chemical composition is variable

Photo: Tora Bardal, NTNU

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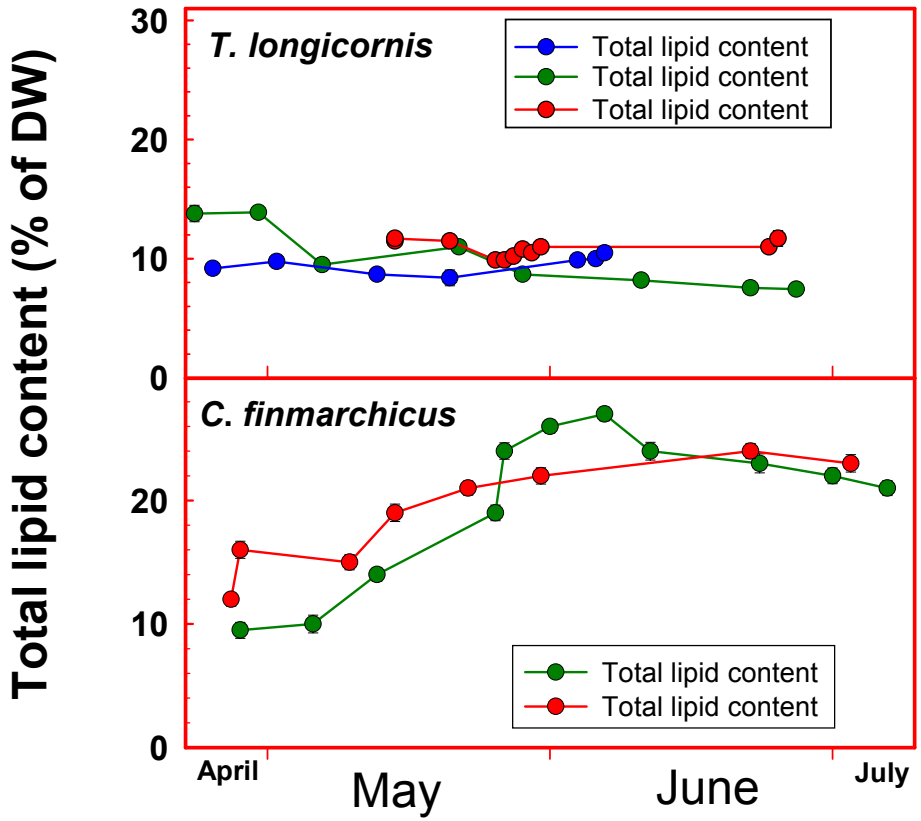
Total lipid content in *Temora longicornis* and *Calanus finmarchicus* from late April until late June – early July

(data from different years)

Photo: Tora Bardal, NTNU



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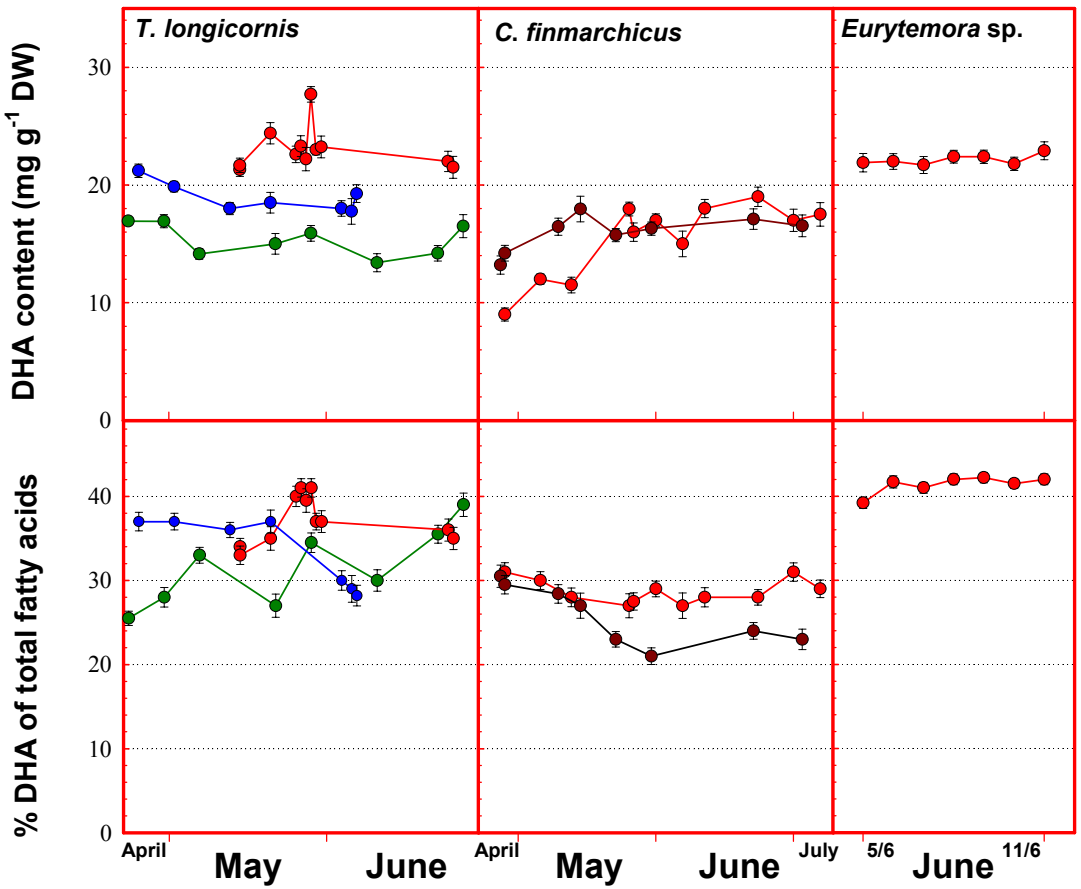
Absolute and relative content of DHA in *T. longicornis*, *C. finmarchicus* and *Eurytemora* sp.

Major fatty acid in the copepods:
DHA,
EPA,
16:0



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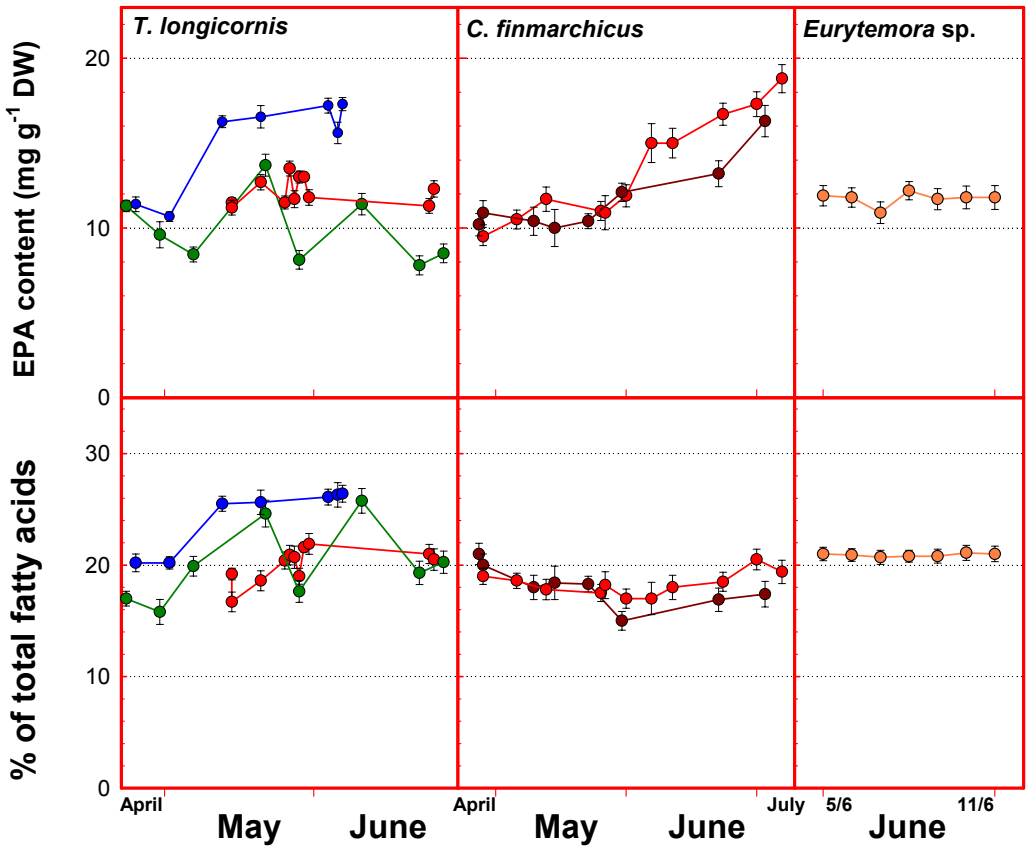
Absolute and relative content of EPA in *T. longicornis*, *C. finmarchicus* and *Eurytemora* sp.



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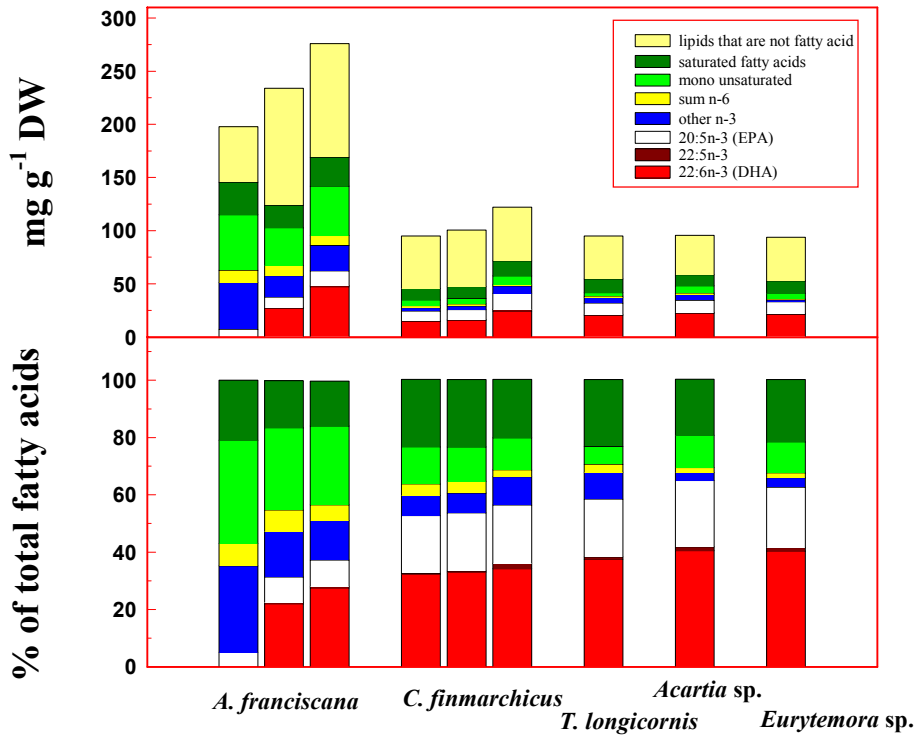
Fatty acid profiles of different live food organisms

Artemia franciscana **nauplii (newly hatched) and after enrichment with two enrichment diets**

Common copepods from northern coastal waters



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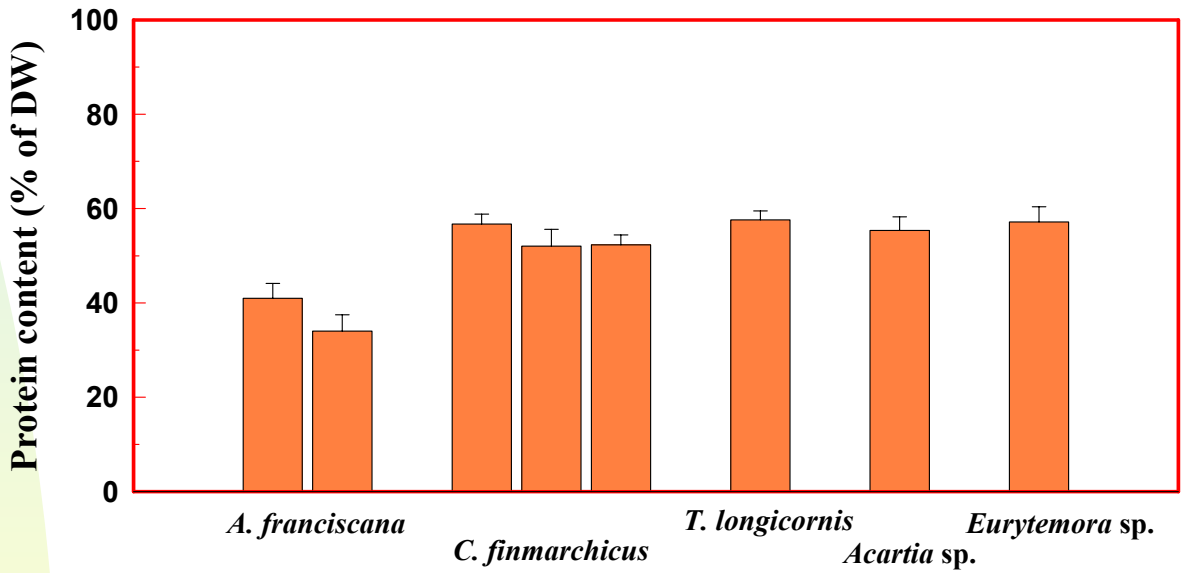
Protein content in different live food organisms

A. franciscans nauplii (newly hatched) and after enrichment

Common copepods from northern coastal waters



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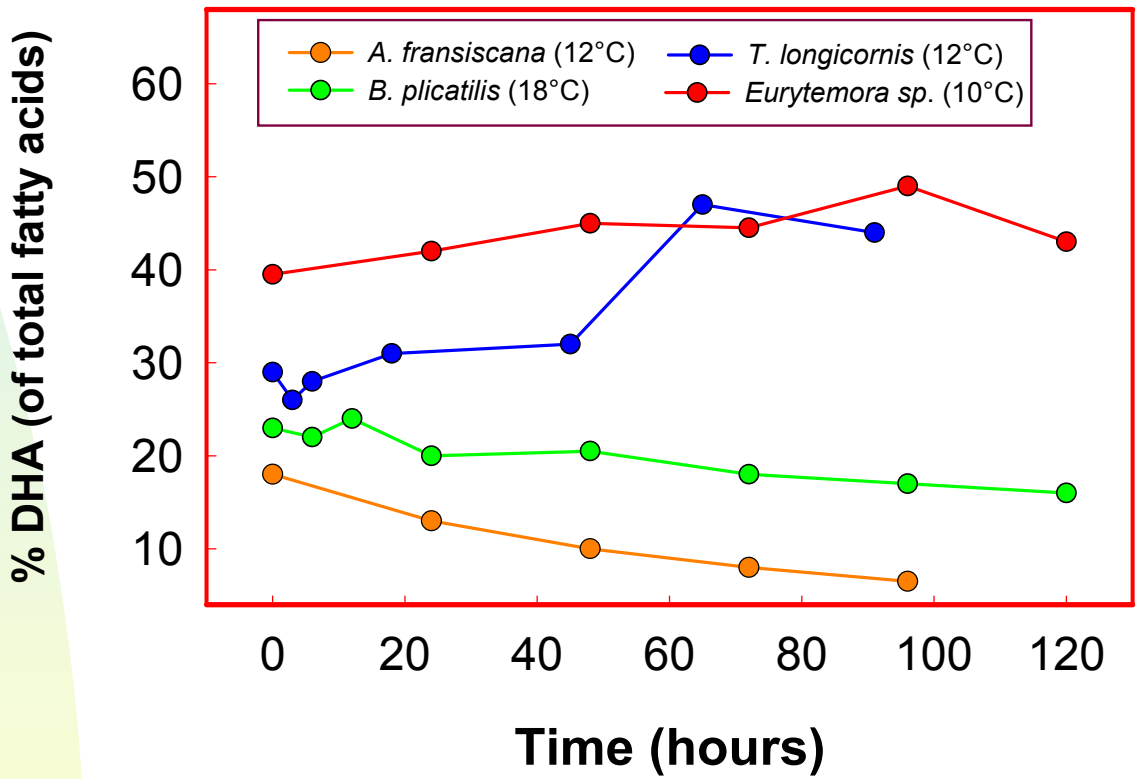
DHA content in cultivated and wild live food organisms during starving conditions



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Lossrate of total lipid content, EPA and DHA during starving conditions in various live food organisms

Loss rate expressed as % reduction day^{-1} of different lipid components in *T. longicornis*, *Eurytemora* sp. and *A. franciscana* during starvation at 12.5°C ± 1

	Loss rate (% day^{-1})		
	T. longicornis	***Eurytemora* sp.**	***A. franciscana***
Total lipid content	18	12	11
EPA	26	17	15
DHA	14	10	51

$SLR = \ln(Q_t / Q_0)/t$

$\%LR = (e^{SLR} - 1) \cdot 100$

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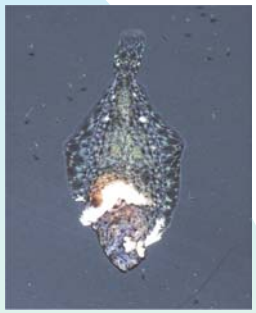
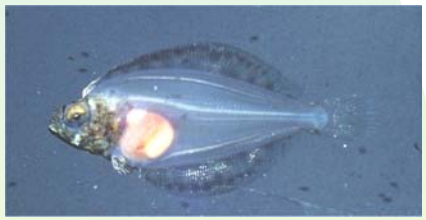
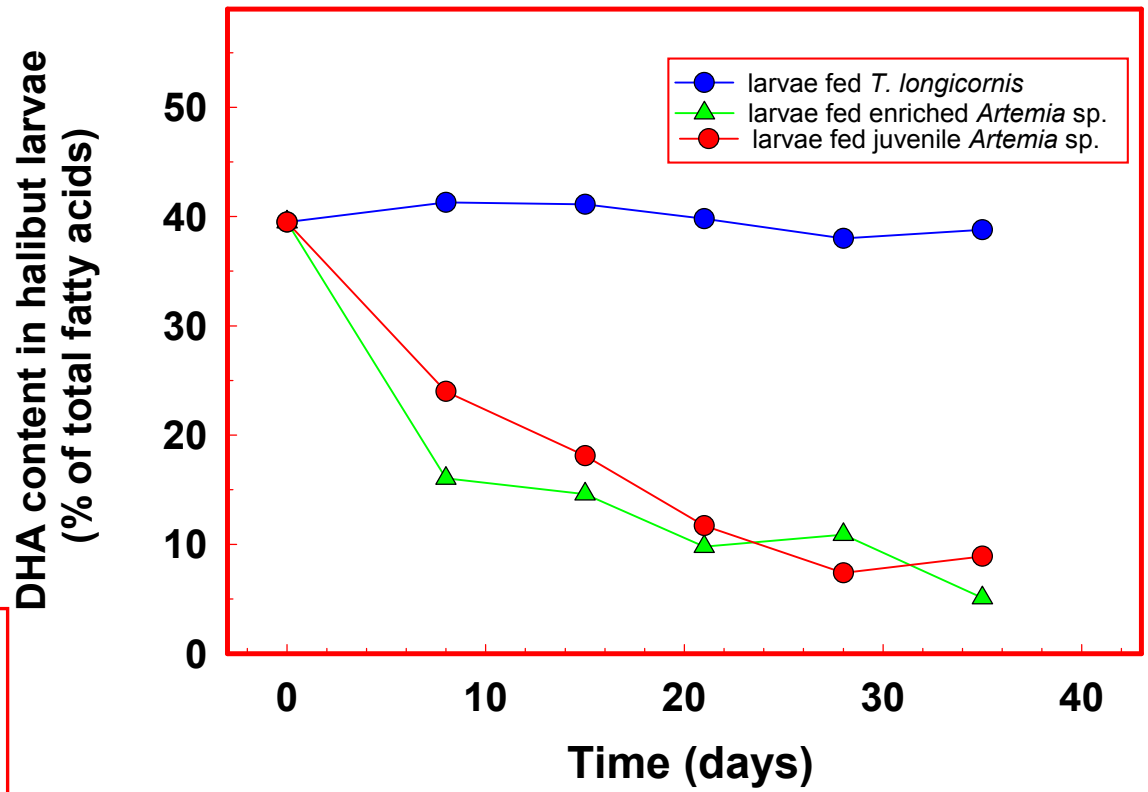
Why are copepods superior to enriched *Artemia* sp. in first feeding of halibut larvae?





DHA content in halibut larvae (*H. hippoglossus*) fed *Artemia* sp. and *T. longicornis*



DHA content in live food organisms:

T. longicornis	38% of tot. FA
Enriched *Artemia sp.*	15% of tot. FA
Juvenile *Artemia sp.*	16% of tot. FA

Photo: Institute of Marine Research, Bergen

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Relationship between the DHA content (% of total fatty acids) in different live food organisms and in halibut larvae (*H. hippoglossus*)

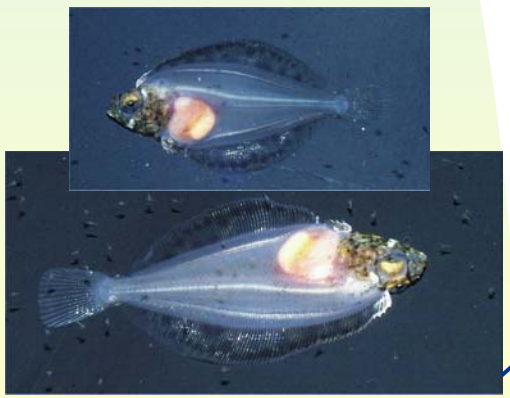
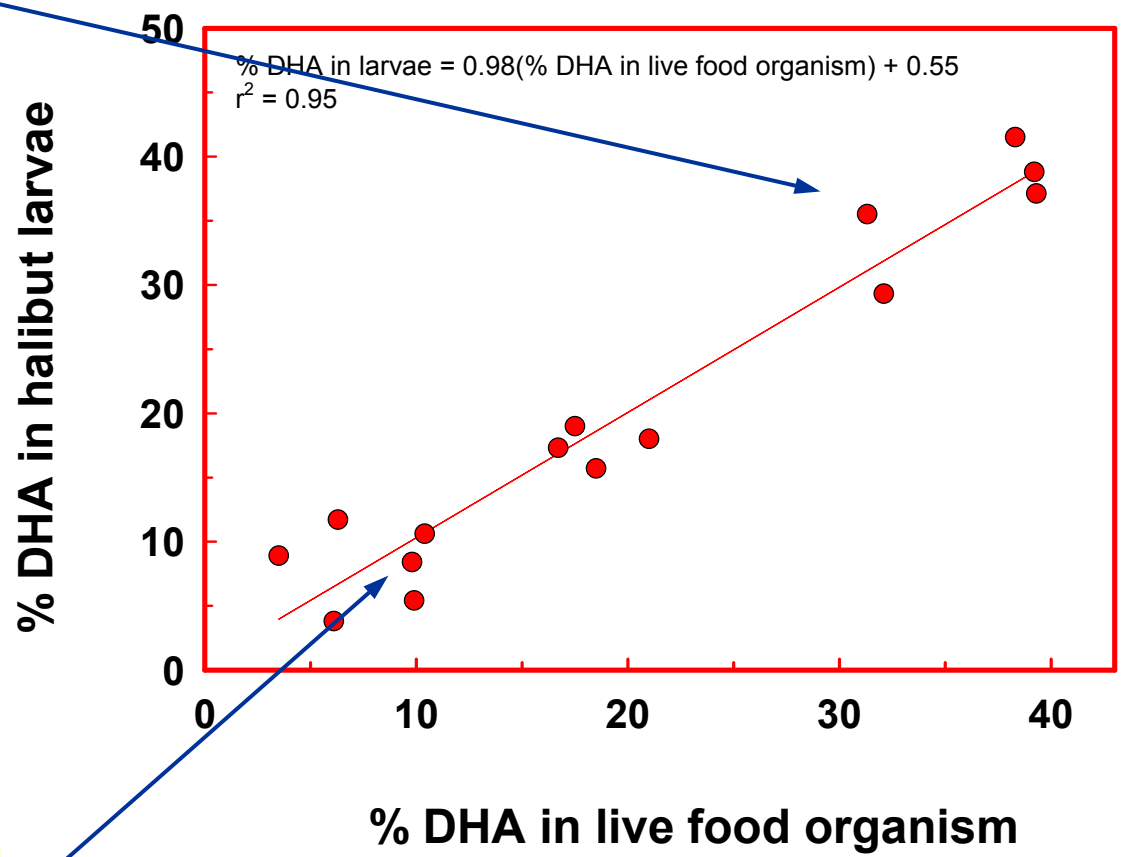


Photo: Institute of Marine Research, Bergen



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Lessons learned after 10 years use of marine copepods in Norwegian marine larvaeculture

- Nutritional quality of copepods are considered as optimal
  - Lipid and fatty acid content
  - Protein content
  - vitamins and minerals
- Availability (restricted to 4 months)
  - density and species composition are highly variable
- Production number of fish fry (200 000 - 800 000 year $^{-1}$)
- To obtain profitable whole year production of fish fry intensively produced live food organisms must be recommended

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Intensive production of live food organisms

- **Copepods might be used as a supplement during certain periods of the year**
- **Production of *Artemia* sp. and rotifers must be given high priority**

- **Develop new enrichment diets for marine cold water fish species**
  - establish a main reference from copepod analysis and further develop intensive live food production (*Artemia* sp. and *B. plicatilis*)

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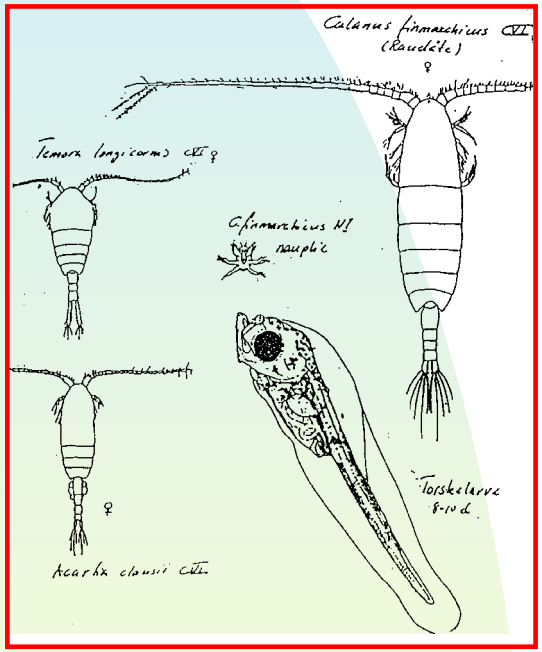
Conclusions



***T. longicornis, Acartia* sp. and *Eurytemora* sp. had a total lipid content close to 10%**

HUFA level ranging from 55% to 62% of total lipid content

The dominant fatty acids were DHA (25.5 - 42%), EPA (15.1 - 24%) and 16:0 (8.4 – 12%)

In variuos stages of *C. finmarchicus* the dominant fatty acids were DHA (17 - 31%), EPA (17 - 23%) and 16:0 (9 - 16%)

During early spring the lipid content increased more than 50% and adult stages had a total lipid content close to 25% of DW

Size and species composition can be highly variable

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Conclusions

In the copepods the protein content varied between 52.4 and 57.6% of DW, and is significantly higher than in *A. franciscana* ($p < 0.005$)

There is a close relationship between the percent DHA content in the halibut larvae and in different live food organisms fed to the larvae. High DHA content in the live food organism was reflected by a high DHA content in the larvae and vice versa

There are significant differences in the lipid content and the distribution of fatty acids in the marine copepods examined and enriched *A. franciscana*. The copepods are characterised by a relatively low lipid content and a high n-3 HUFA content.

Through proper enrichment diets the nutritional value of cultivated live food organisms will reach the requirements of the larvae

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Further perspectives

- **Ongoing research programme ”Calanus” (2001 - 2005)**
- **Harvesting and use of zooplankton as a bio-resource for fish feed and industrial raw material**
  - **Copepod - oil for *Artemia* sp. and rotifer enrichment**

- **In the Norwegian Sea it is estimated 200 mill ton of *Euphausids*, *C. finmarchicus* and *Amphipods*. If 0.5% of the biomass is harvested (1 mill ton) this is the same amount of biomass used for fish meal and oil in Norway today**

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