EUPHAUSIIDS from the Far-Eastern Russian waters: composition, distribution, seasonal dynamics

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Russia

Subphylum Crustacea
Class Malocostrata
Order Euphausiacea
Family Euphausiidae
Genus Thysanoessa
Euphausia

Euphausiids (= krill)
are shrimp-like in appearance
Exclusively marine crustaceans living
in the pelagic zone from 0 to 5000 m

Role in ecosystems:

- inhabit all the oceans, more abundant – in the cold waters,
- the richest source of protein and vitamin A,
- the most important food for marine animals (mainly – for whales), birds and almost all pelagic fish and squids,

- used as food for marine farms,
- used for making sauces

MATERIALS:

1985-2010 years

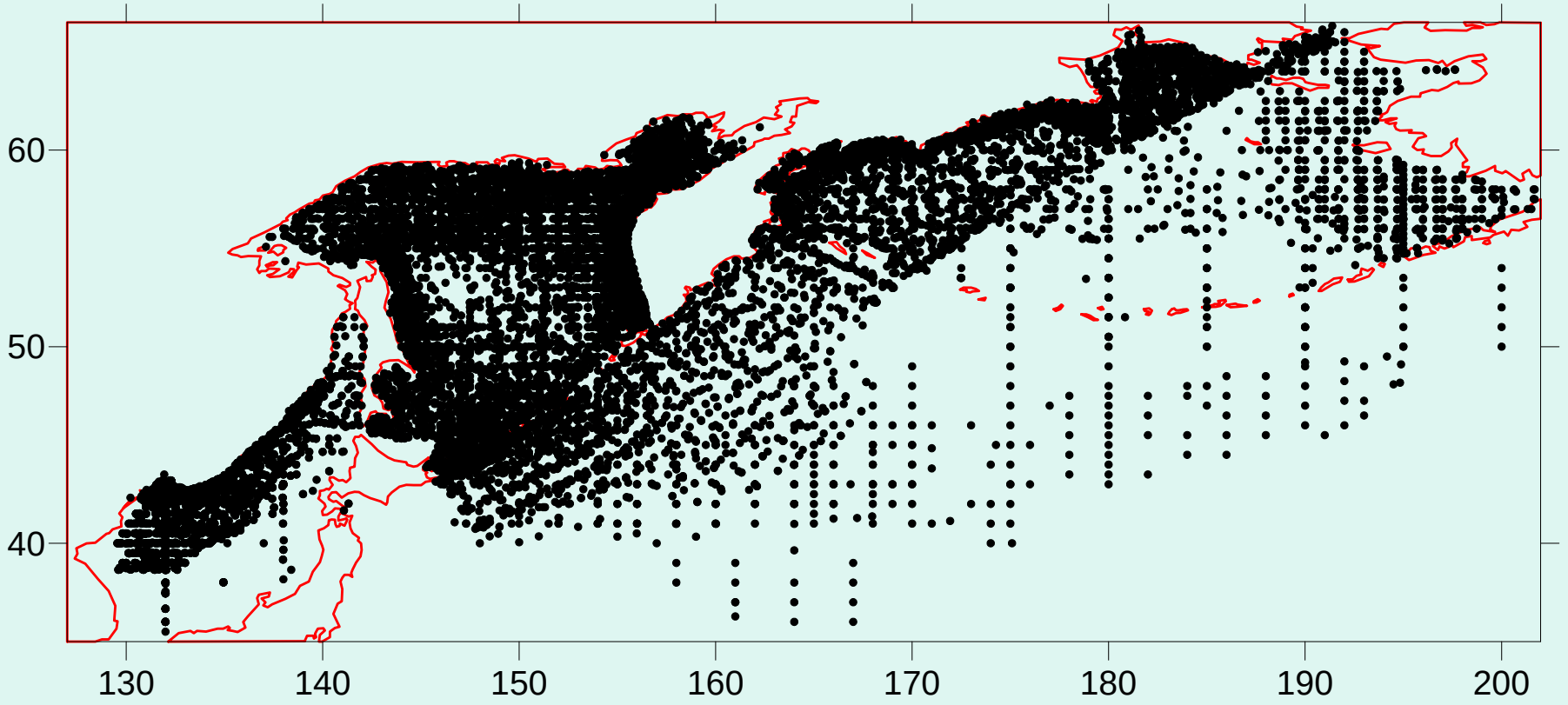
-more than 100 expeditions
- 25 thousand of trawls
- 250 thousand of stomachs
- 20 thous. of plankton samples

the ship is named the same as our Institute

As a result, due to perform regular surveys on the vast waters, using the standard methods of data collection and processing, the large-scale monitoring of the status and dynamics of pelagic communities was organized in the area about 6 million km^2.

MATERIALS:

Planktonic stations in 1985 - 2010



Winter – 2054
Spring – 4338
Summer – 8650
Autumn - 5246

20288 samples

GOAL:

- Comparative analysis of qualitative and quantitative characteristics of euphausiids in the Far East region

- Spatial distribution of mass species, their spawning areas

- Seasonal and interannual dynamics of their abundance

- Stock euphausiids in the Russian Far-Eastern waters

- The role of euphausiids in the pelagic food web

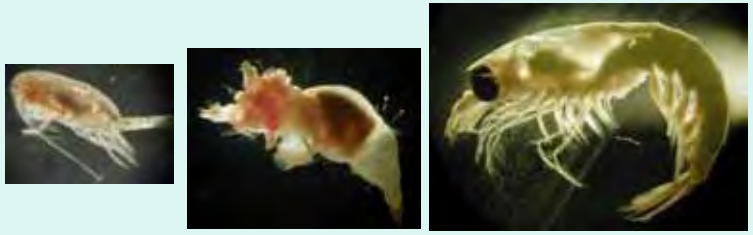
METHODS:

This method provides us with rapid processing of samples even on a board of RV

Division of samples into 3 size fractions (small, medium and large) with straining through the 3 differeent sieve with mesh size: 1,2 mm, 0,5 mm and 0,168 mm.

SF – animals with body length 0,6 to 1,2 mm,
MF - 1,2-3,2 mm
LF - more 3,2 mm.

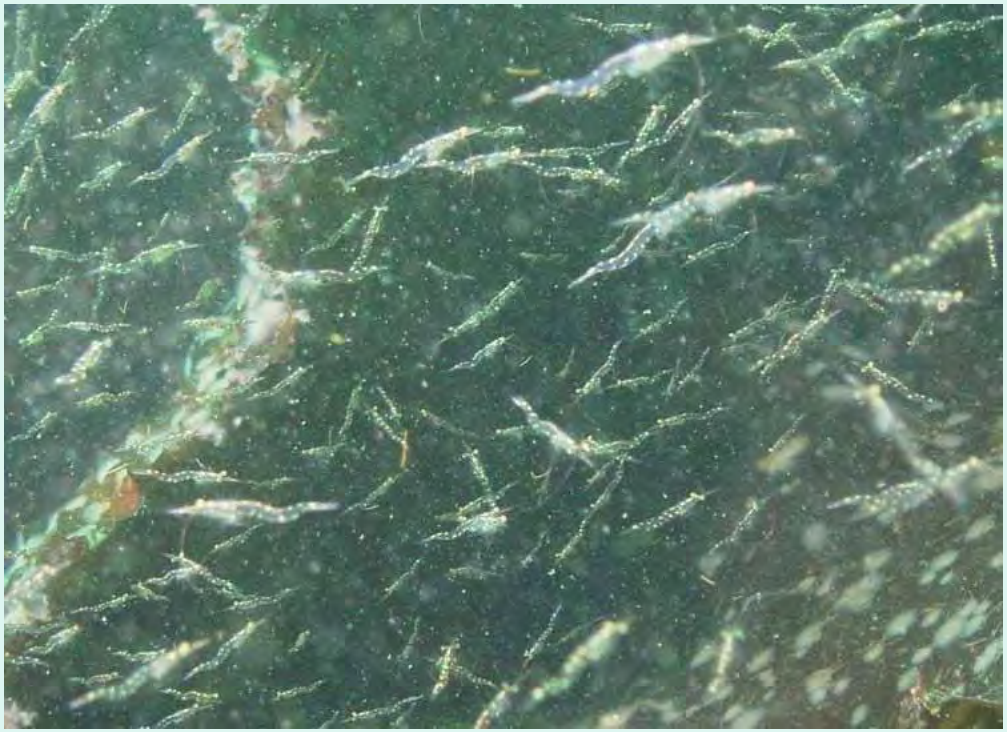
the next step –processing of each fraction separately



Which net is better?

We harvested the same layer of water at the same time by trawl and by plankton net…

During our expeditions we often noticed large concentrations of euphausiids in surface layer, especially in offshore



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We harvested the same layer of water at the same time by trawl and by plankton net…

As a result - very large-size euphausiids (Thysanoessa inermis 40-45 mm) were often caught by trawl, but not by net!

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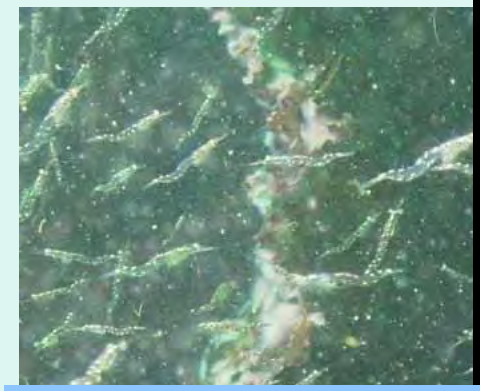
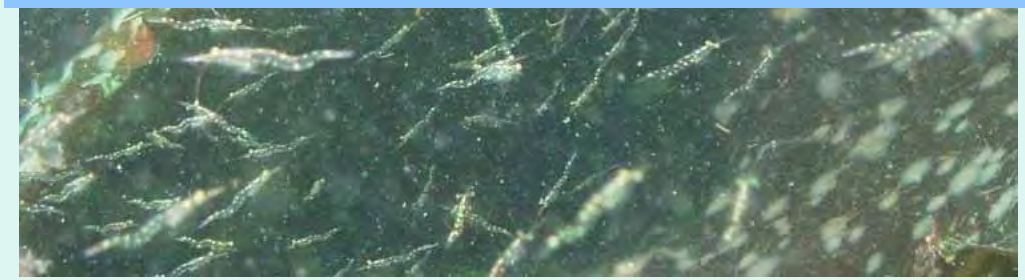
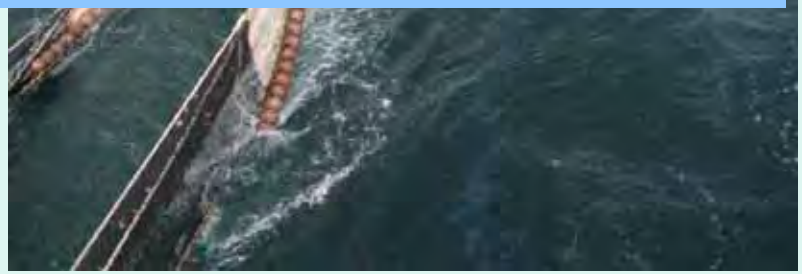


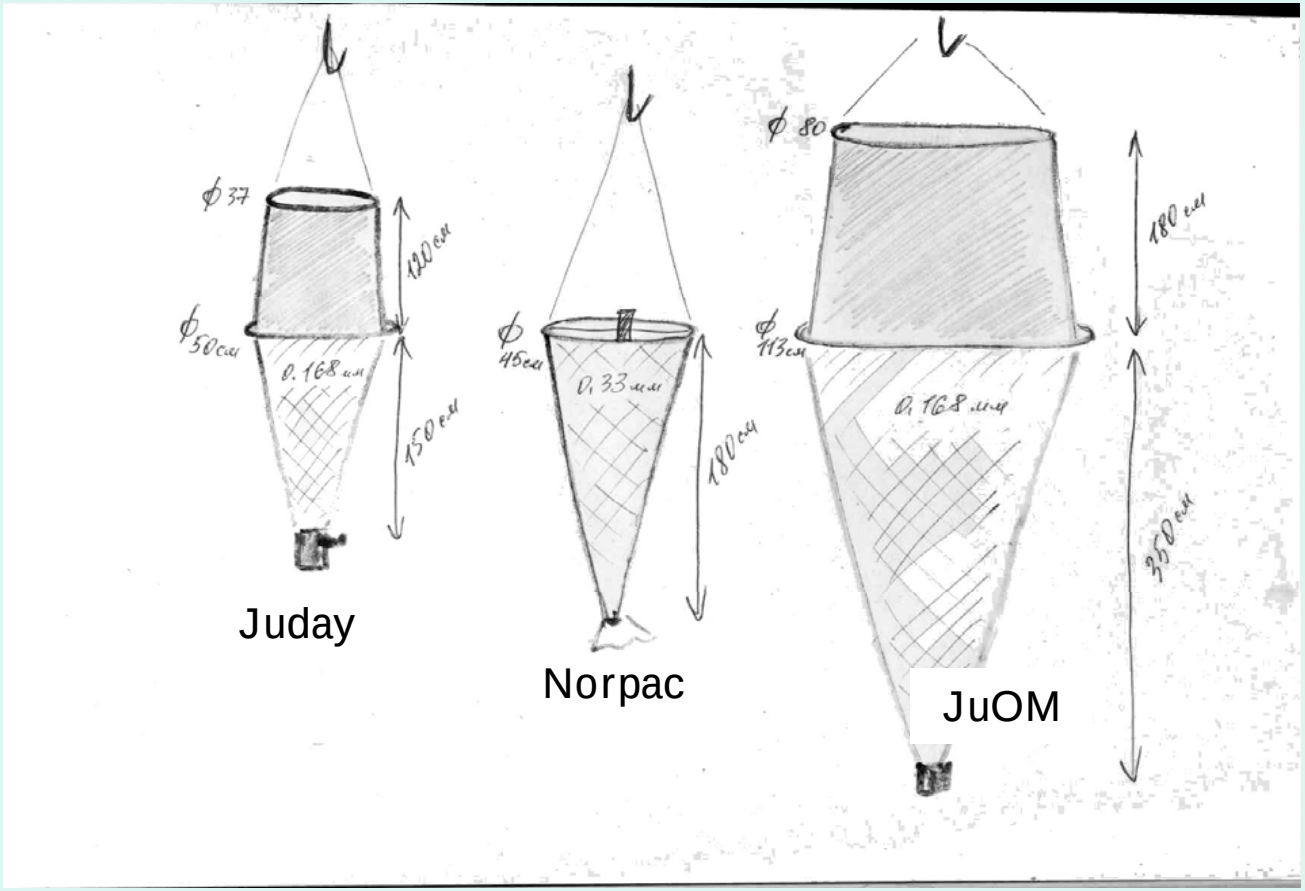
thus, it is clear that euphausiids are able to avoid falling into the plankton nets





PLANKTON NETS:

All the filtering plankton nets are not able to give a reasonable estimate the number of plankton for two reasons:
1 - the smallest animals pass through the mesh,
2 - the largest and most mobile animals actively avoid falling into the net.



We have performed an experimental work - catchability comparison of different nets

Translation coefficients (ratio of zooplankton biomass from Juday net to other nets)

	Juday/ JuOM	Juday/ Norpac	Juday/ Bongo	Juday/ WP- 2
TOTAL BIOMASS	**1,3**	**1,5**	**0,4**	**0,9**
Small fraction	1,5	4,5	45,8	1,0
Middle fraction	1,2	1,3	0,5	0,9
Large fraction:	1,2	1,3	0,5	0,9
Copepoda	1,8	1,5	0,5	1,0
Amphipoda	1,0	1,8	0,6	1,0
Euphausiacea	0,7	0,7	0,3	0,7
Chaetognatha	0,7	1,8	0,6	0,8
Medusae	1,7	1,0	1,5	1,2
Salpa	1,7	2,3	-	-
Decapoda- larva	0,5	-	0,5	0,8
Others	0,4	0,5	0,4	0,9

Gorbatenko, Dolganova,

Izv.TINRO, 2006

Some description of different tipes of plankton nets

	Juday	JuOM	Norpac	Bongo	WP-2
Mouth square, m^2	0,1	0,5	0,16	0,2826	0,25
Mouth diameter, sm	38/50	80/113	45	60	56
Total net length, sm	235	530	180-200	310	280
Mesh size, mm	0,168	0,168	0,33	0,5	0,33
Масса балласта, кг	50	75-100	25	25	50

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SF are much better represented in the Juday net

Gorbatenko, Dolganova,

Thus, the Juday net is the most suitable for capturing and quantifying the majority of plankton animals (excluding euphausiids and decapods).

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Before applying the catchability coefficients there was an improbable relationship between stocks of euphausiids in the sea and their consumption by nekton.

This problem was resolved (but not completely!) with using coefficients for Juday net:

Proposed by Dr. A.F.Volkov (1986, 1996):

- Ova, nauplii, Calyptopis - 1.0
- Furcilia < 5 mm - 1.5
- Euphausiacea 5-10 mm - 2.0
- 10-20 mm- 5.0
- > 20 mm - 10.0

Coefficient increases with body size increasing

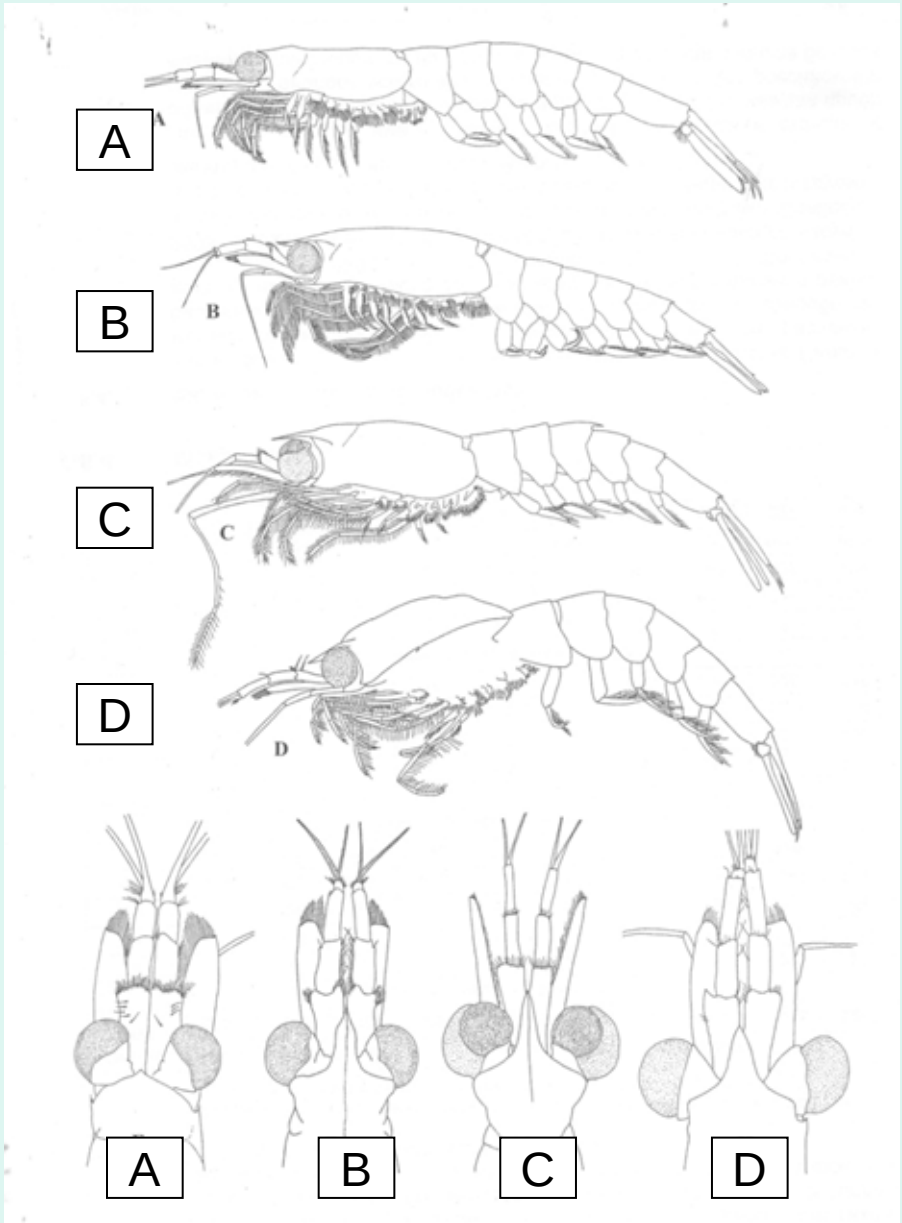
4 major species – 93,3% :

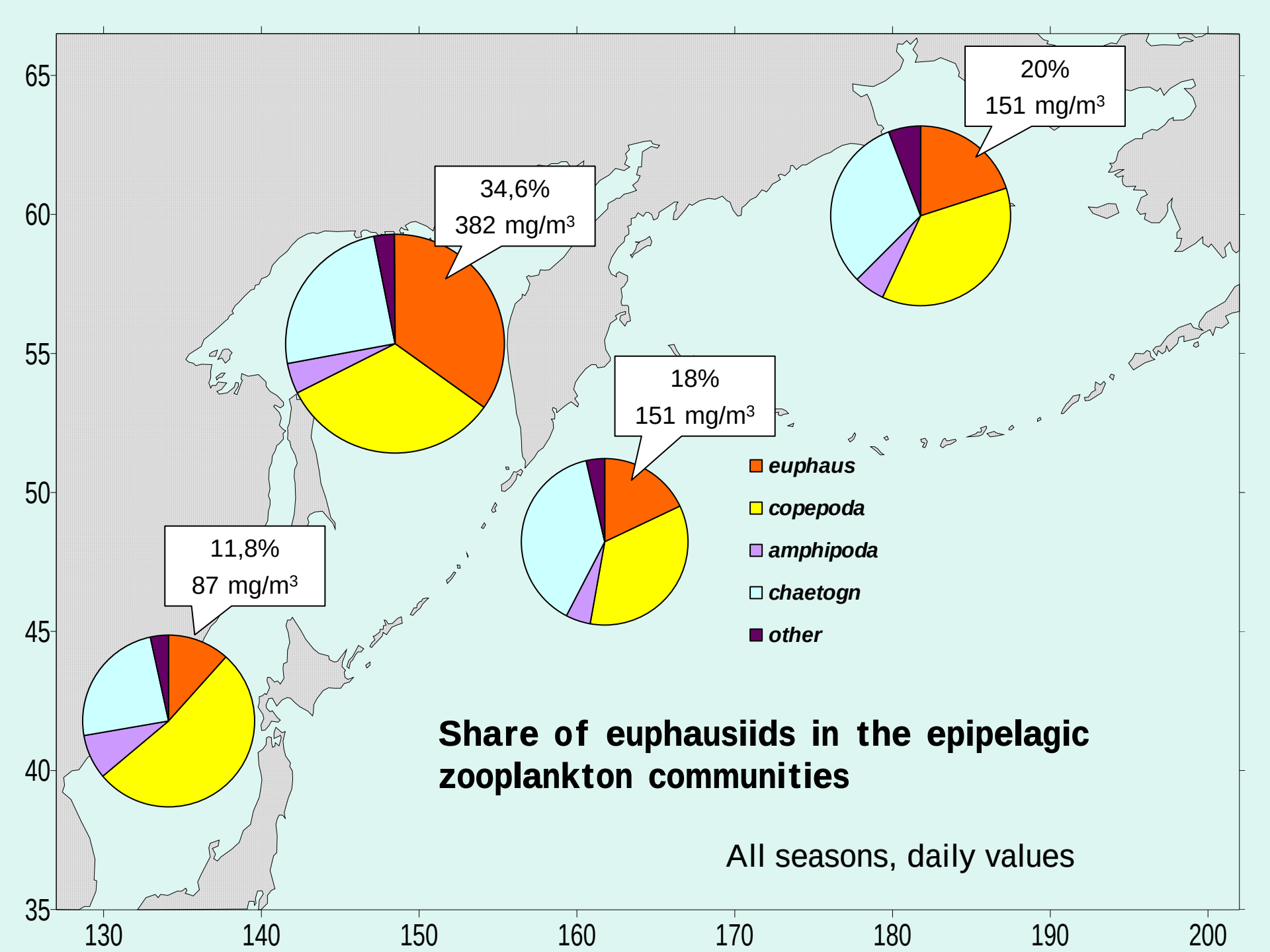
A – *Euphausia pacifica*

B – *Thysanoessa inermis*

B – *Thysanoessa longipes*

B – *Thysanoessa raschii*





Share of euphausiids in the epipelagic zooplankton communities

All seasons, daily values

Life cycle

During the breeding season krill form huge spawning aggregations in the surface layer.
In the Far-eastern Seas spawning of euphausiids takes place mainly in offshore waters.

stages:

Ova - nauplii - metanauplii – calyptopis - furcilia – juveniles

Life cycle

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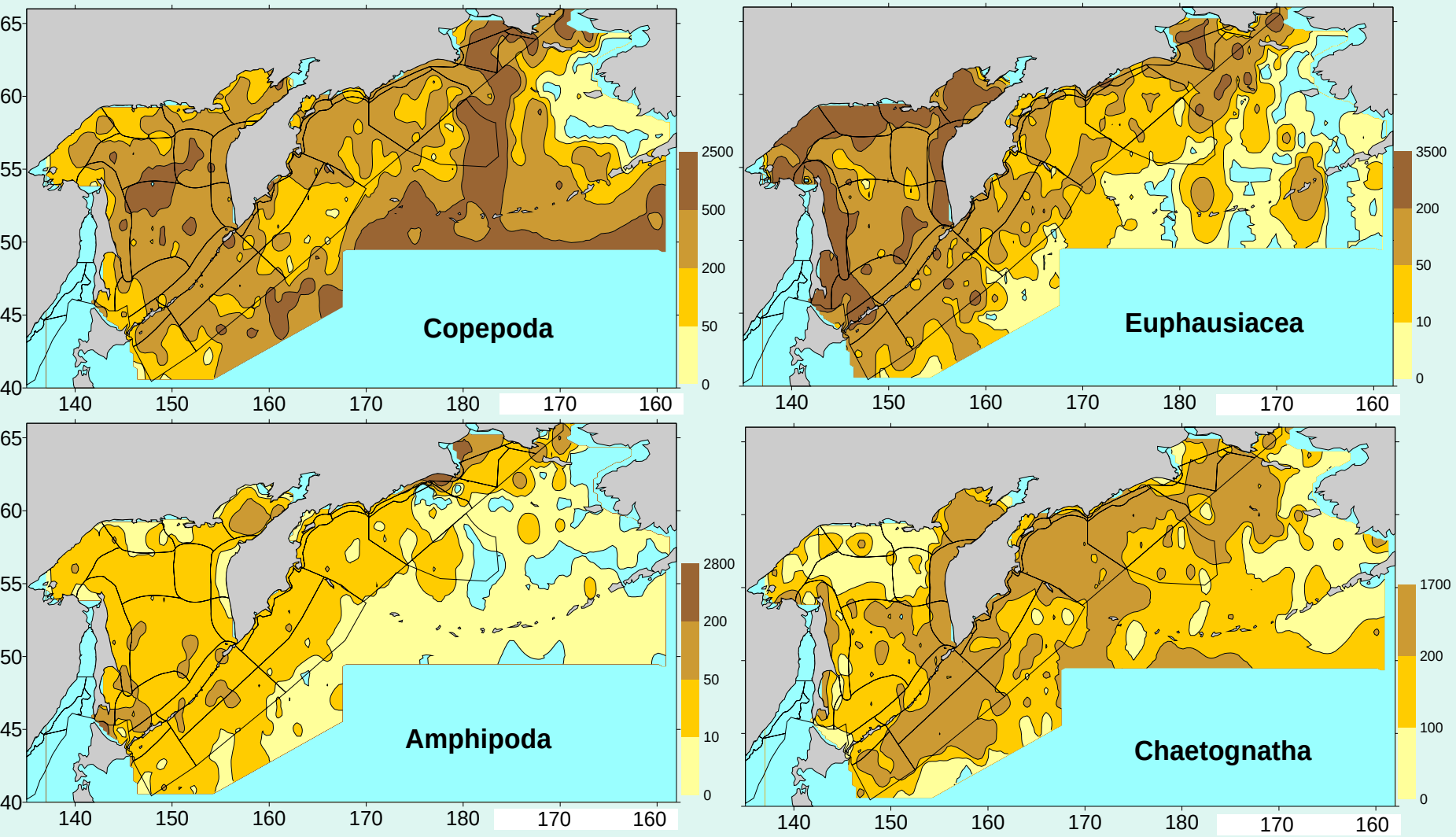
stages:

Ova - nauplii - metanauplii – calyptopis - furcilia – juveniles → 45-70 days

adult – at the age of 1 year

life cycle – mainly 2 years

Spatial distribution of macroplankton biomass (mg/m³)



In the most productive Okhotsk Sea euphausiids is **dominant** group in zooplankton community, - in average 45% of **macroplankton** biomass. In other regions euphausiids is **third** group – after copepods and chaetognaths,
- from 16% in the Sea of Japan till 25% in the Bering Sea.

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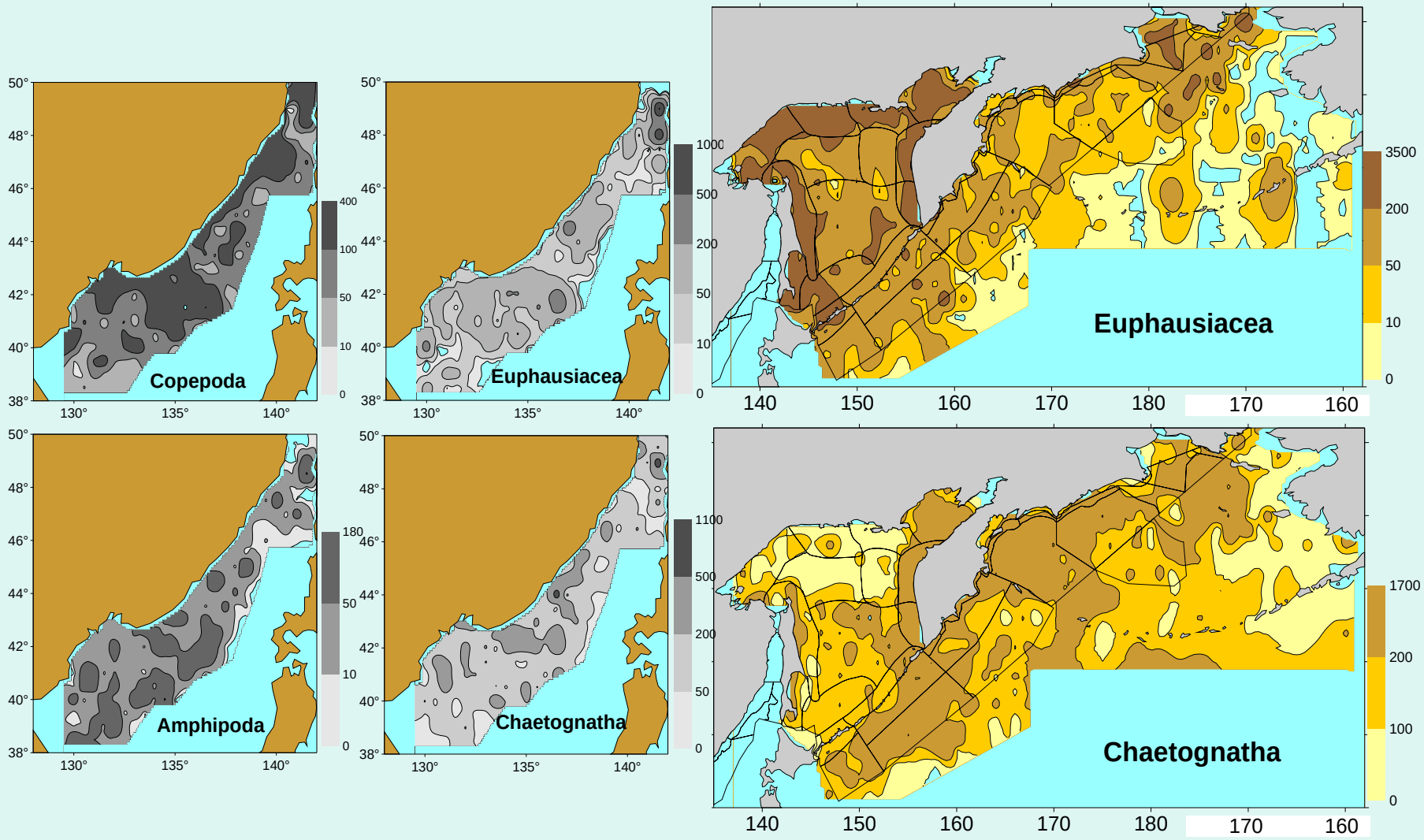

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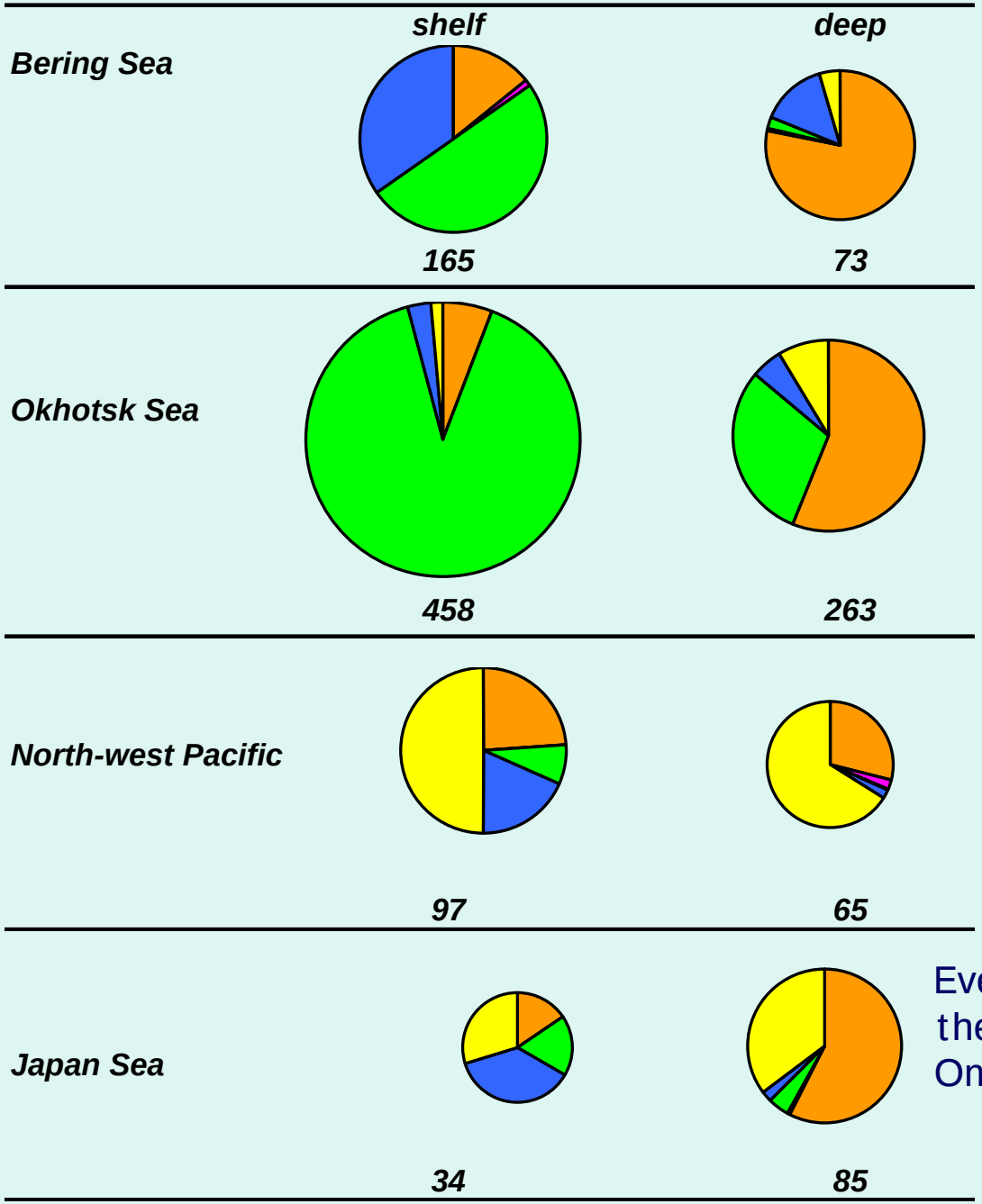


Species composition

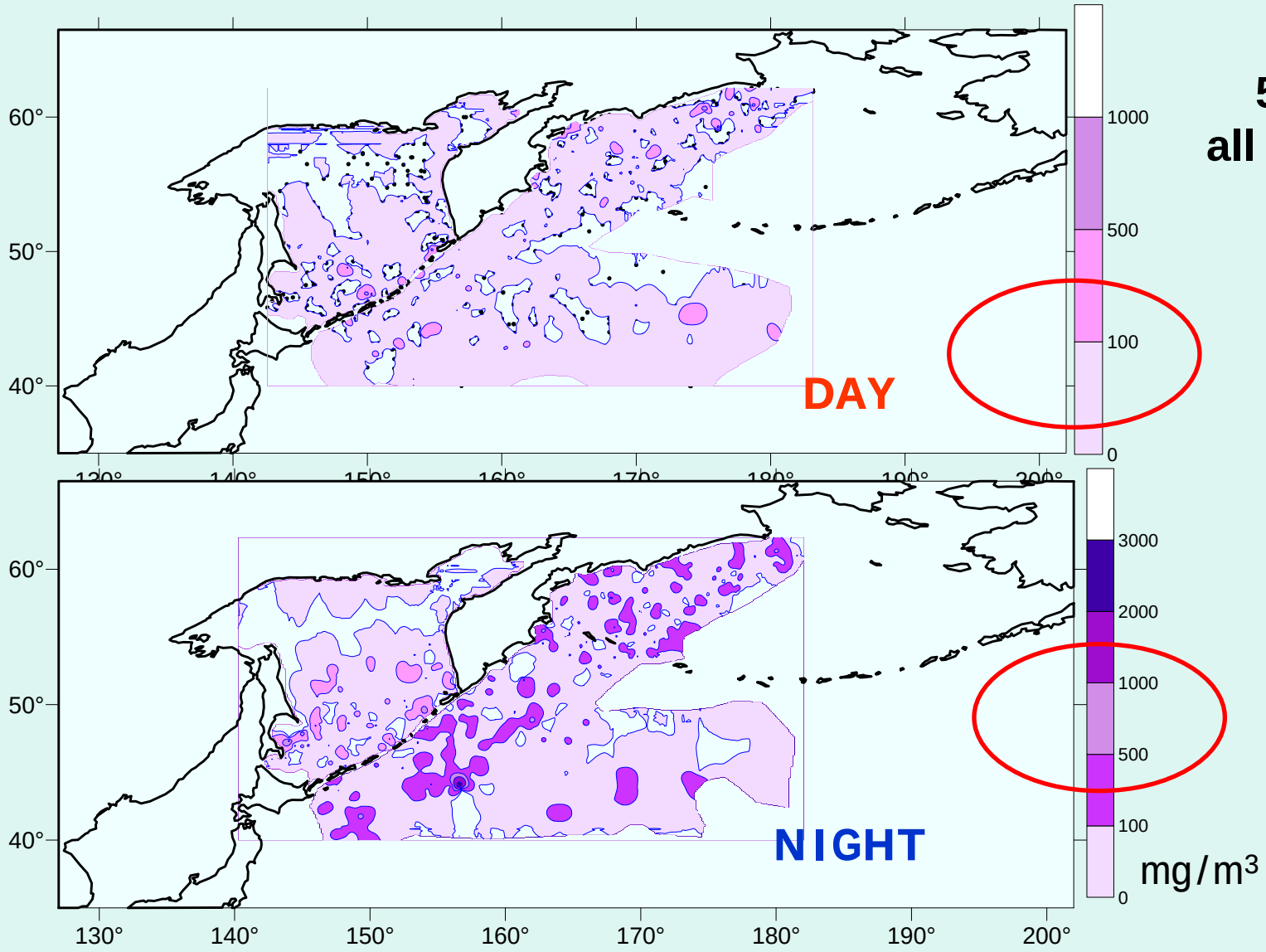
- Thysanoessa longipes
- Thysanoessa inspinata
- Thysanoessa raschii
- Thysanoessa inermis
- Euphausia pacifica

Everywhere dominated a couple of species

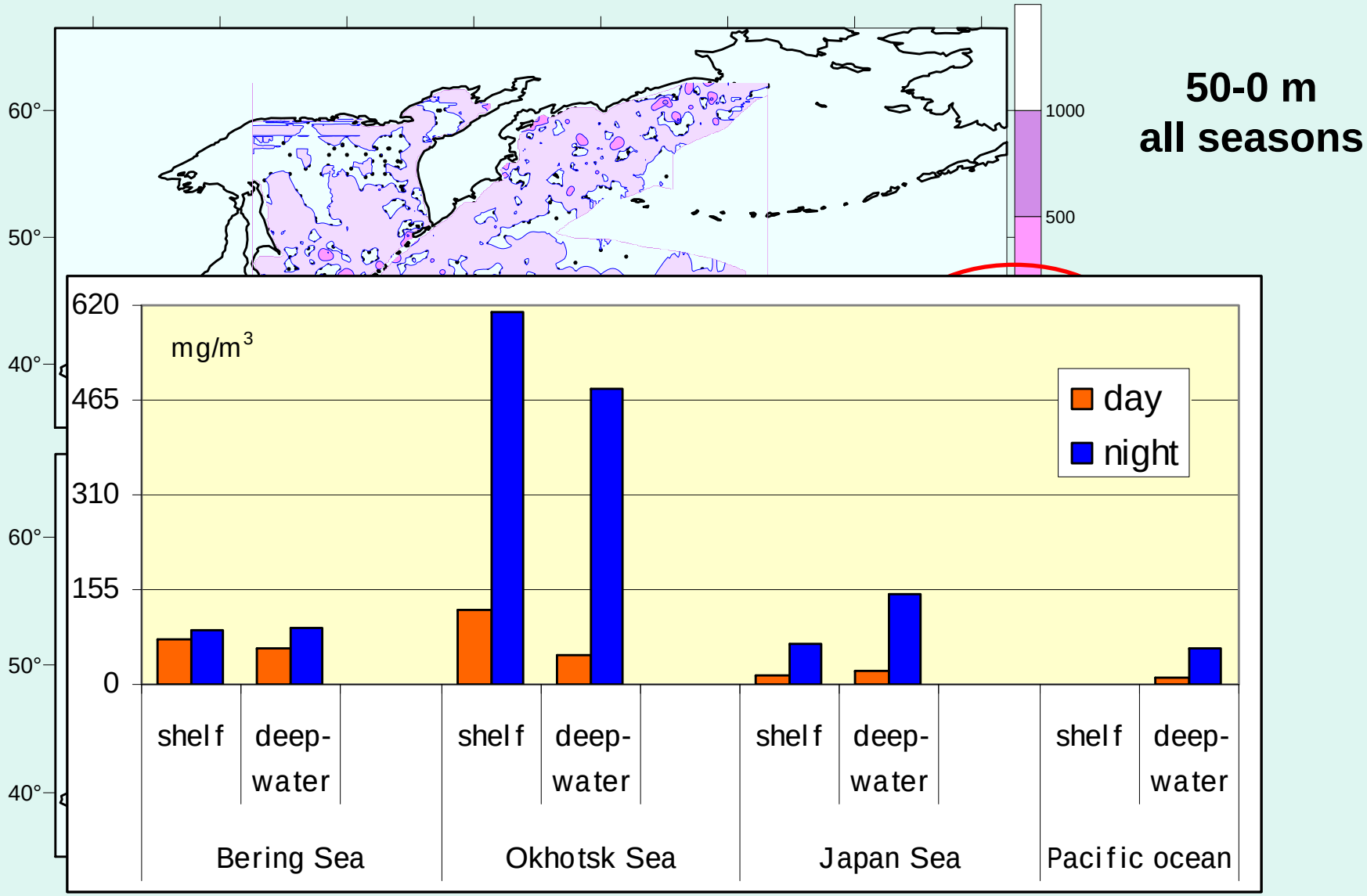
more over: there is Th.longipes - in each couple.

Everywhere except the Sea of Japan the largest biomass is in the shelf zone. On contrary – in the Sea of Japan.

night-time biomass (mg/m^3)



Due to the dayly vertical migration, night-time concentration of euphausiids in the epipelagial is significantly higher than in day-time. So, a more correct estimation of euphausiids abundance is in night-time collection.



50-0 m
all seasons

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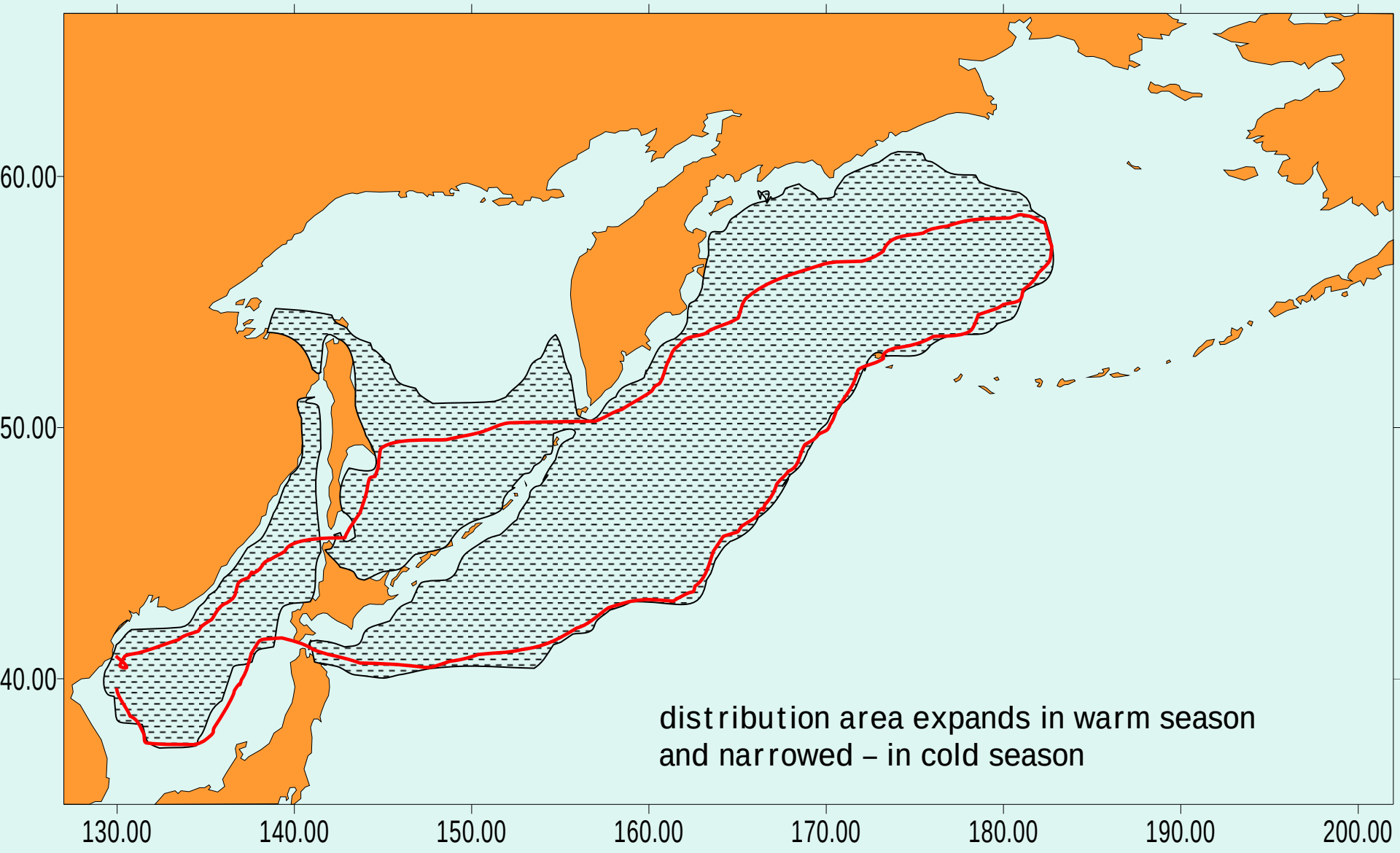
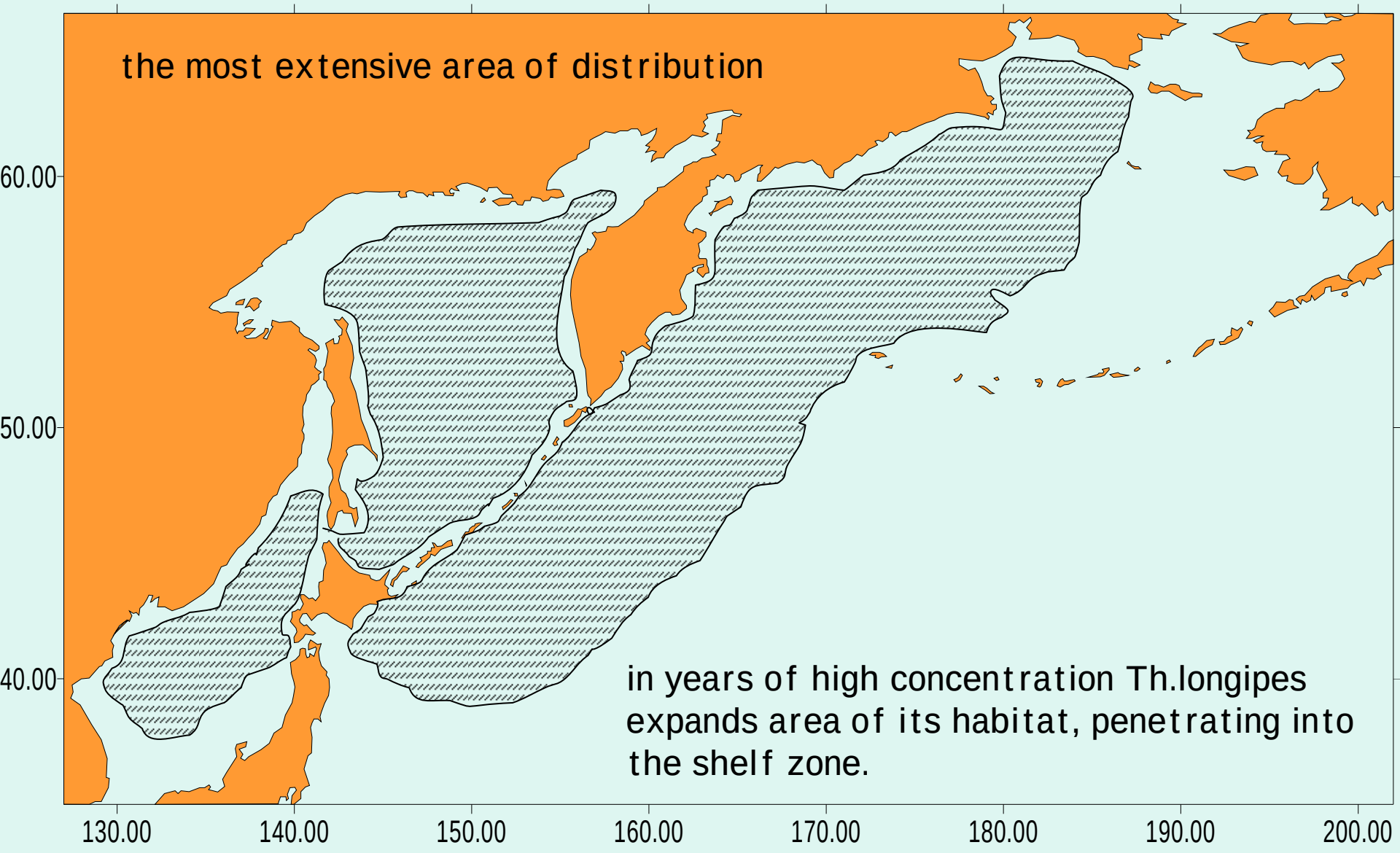
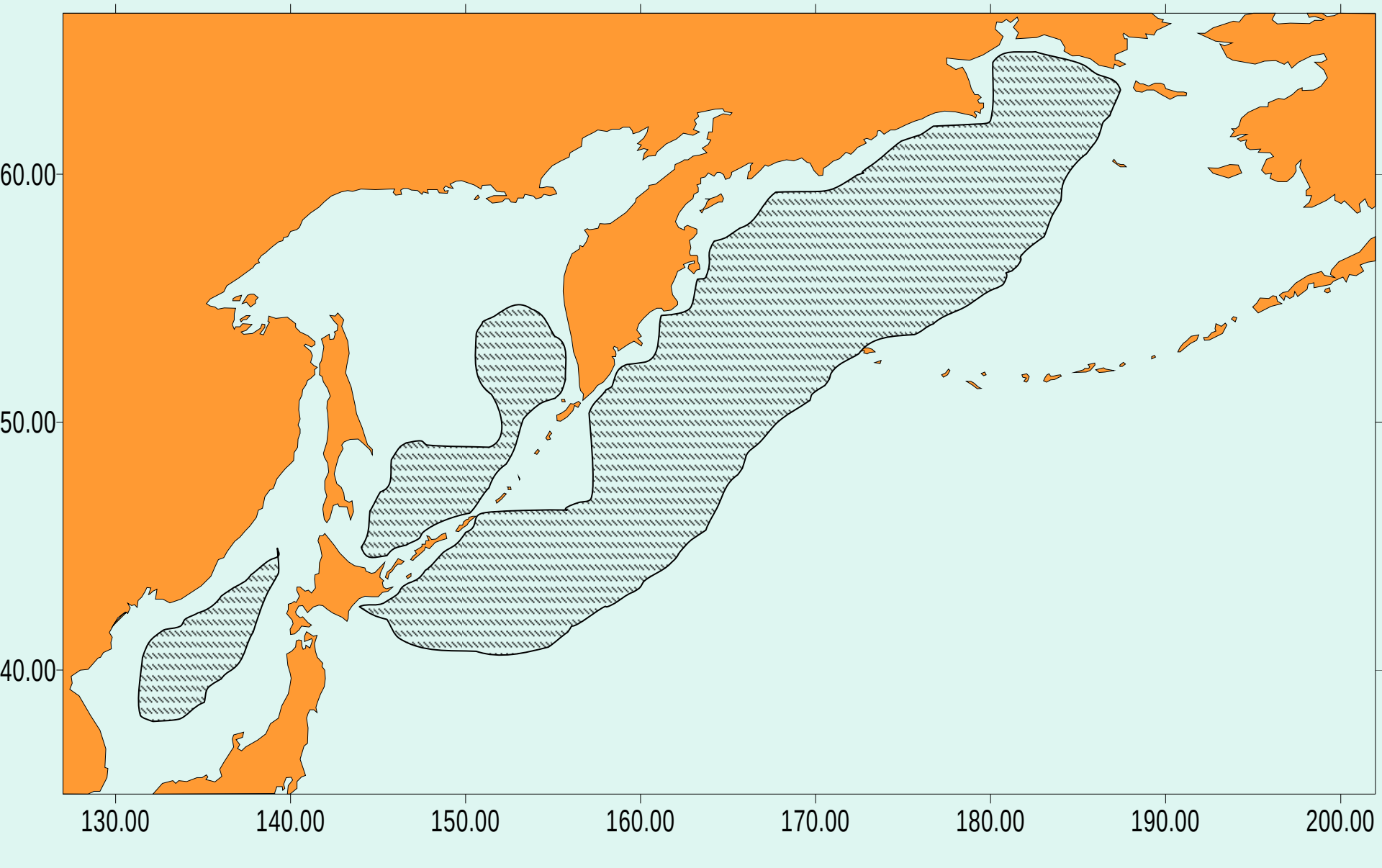
Area of distribution of Euphausia pacifica



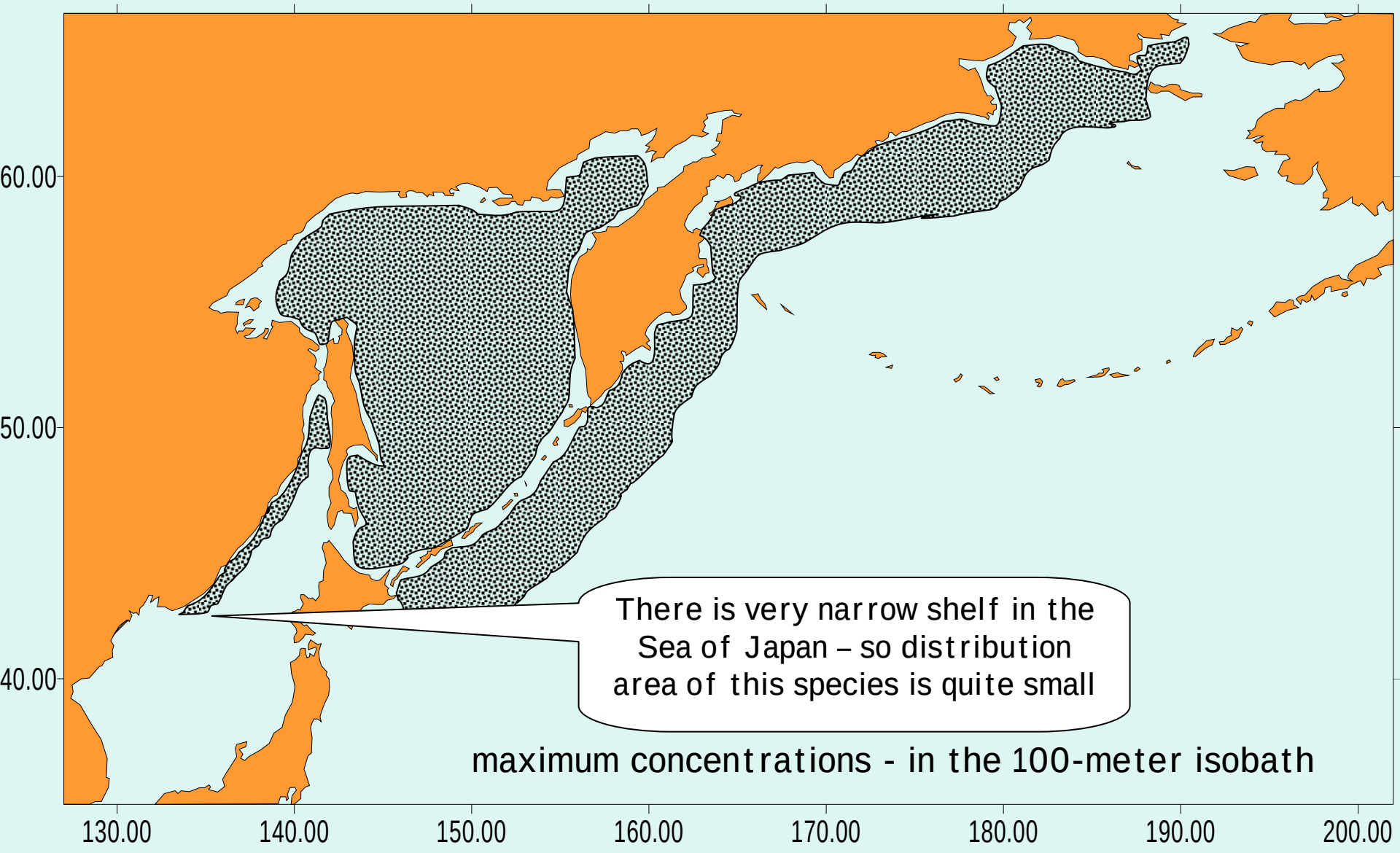
Area of distribution of Thysanoessa longipes



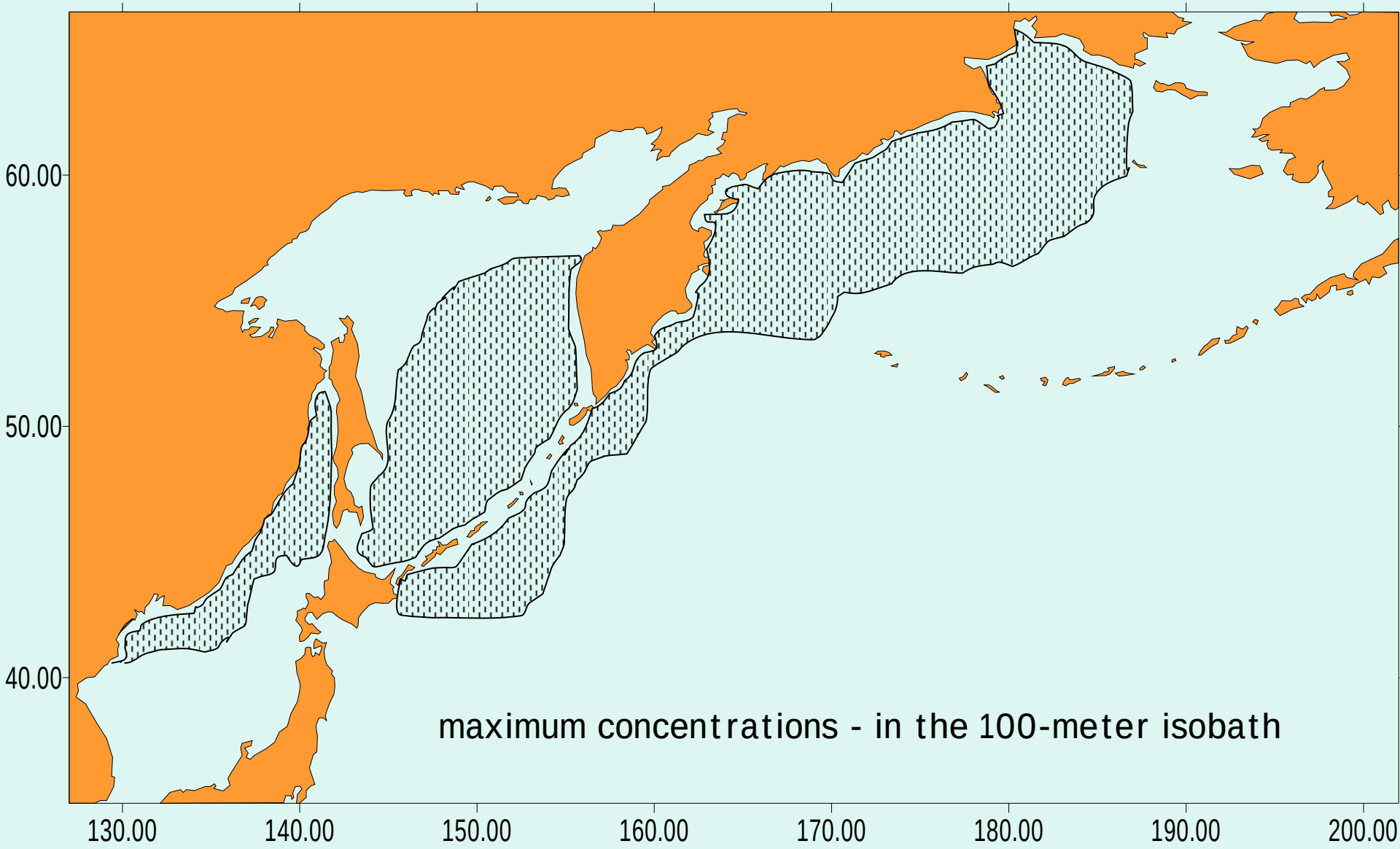
Area of distribution of Thysanoessa inspinata



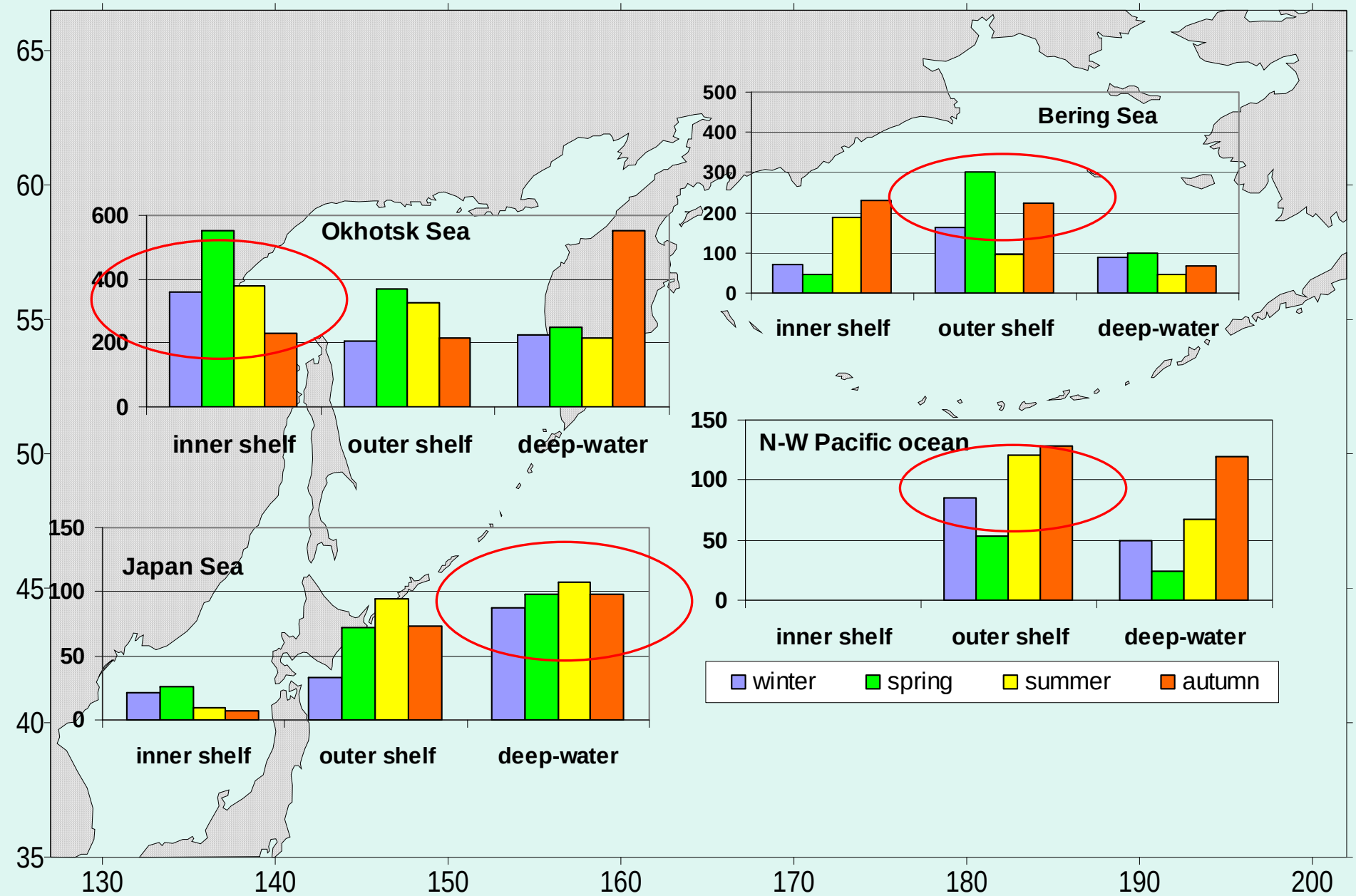
Area of distribution of Thysanoessa raschii



Area of distribution of Thysanoessa inermis



Seasonal dynamic of euphausiids abundance (mg/m³)



Trophical role in the Far-eastern pelagial

phytoplankton, detritus, microplankton, small-size copepods




EUPHAUSIIDS- food for fish and squid

random food:

1-9%

of diet

- Coryphaen.cinereus
- Malacocottus zonurus
- Gadus macrocephalus
- Oncorhynchus kisutch
- Liparis marmoratus
- Salvelinus malma
- Limanda sakhalinensis
- Lepidopsetta polyxystra
- Lampanuctus fetivus
- Myzopsetta proboscidea
- Pleurogram.monopteryg.
- Scomber australasicus
- Gonatopsis kamtschatic
- Brama japonica
- Cololabis saira
- Oncorhynchus keta
- Ammodytes hexapterus
- Leuroglossus schmidti
- Gymnocanthus detrisus
- Sardinops melanostictus

not major food:

Share

10-20%

of diet

- Gonatus pyros
- Clupea palasii
- Sebastes trivittatus
- Osmerus mordax dentex
- Podothecus sturioides
- Trichodon trichodon
- Pleurogrammus azonus
- Oncorhynchus nerka
- Boreogadus saida
- Scomber japonicus
- Lipolagus ochotensis
- Hyppoglos.elassodon
- Sebastes minor
- Engraulis japonicus
- Eleginus gracilis
- Gonatopsis borealis
- Triglops forficatus

major food:

20-50%

- Gonatopsis japonicus
- Oncorhync.gorbuscha
- Theragra chalcogramma
- Gonatopsis octopedatus
- Oncorhync.tschawyscha
- Stenobrach.leucopsarus
- Mallotus villosus
- Triglops scepticus
- Watassenia scintillans
- Todarodes pacificus
- Sebastes alutus
- Laemonema longipes
- Berryteus magister

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phytoplankton, detritus, microplankton, small-size copepods




EUPHAUSIIDS- food for fish and squid

random food:
1-9%
of diet

- Cod
- Greenling
- Mackerel
- Chum salmon
- Sea bram
- Saury
- Flounder

not major food:
Share
10-20%
of diet

- Herring
- Red salmon
- Smelt
- Mackerel
- Armhook squid
- Anchovy

major food:
20-50%

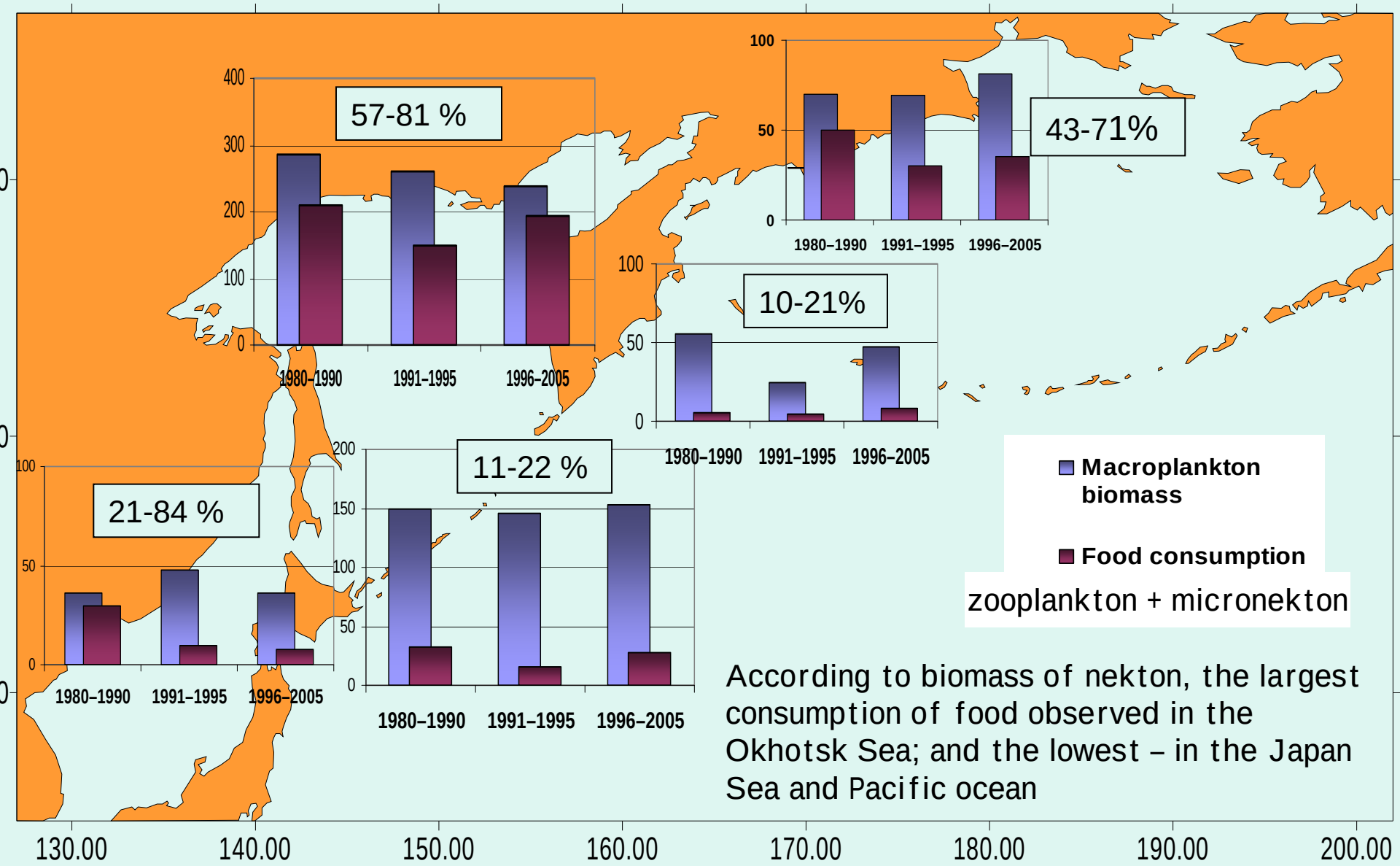
- Pink salmon
- Pollock
- Chinook salmon
- Capelin
- Flying squid
- Sparkling squid

a huge amount of inhabitants of the Ocean consume euphausiids all their life

Spotted (< 5 month)- up to 3 kg of euphausiids/ per 1 individual

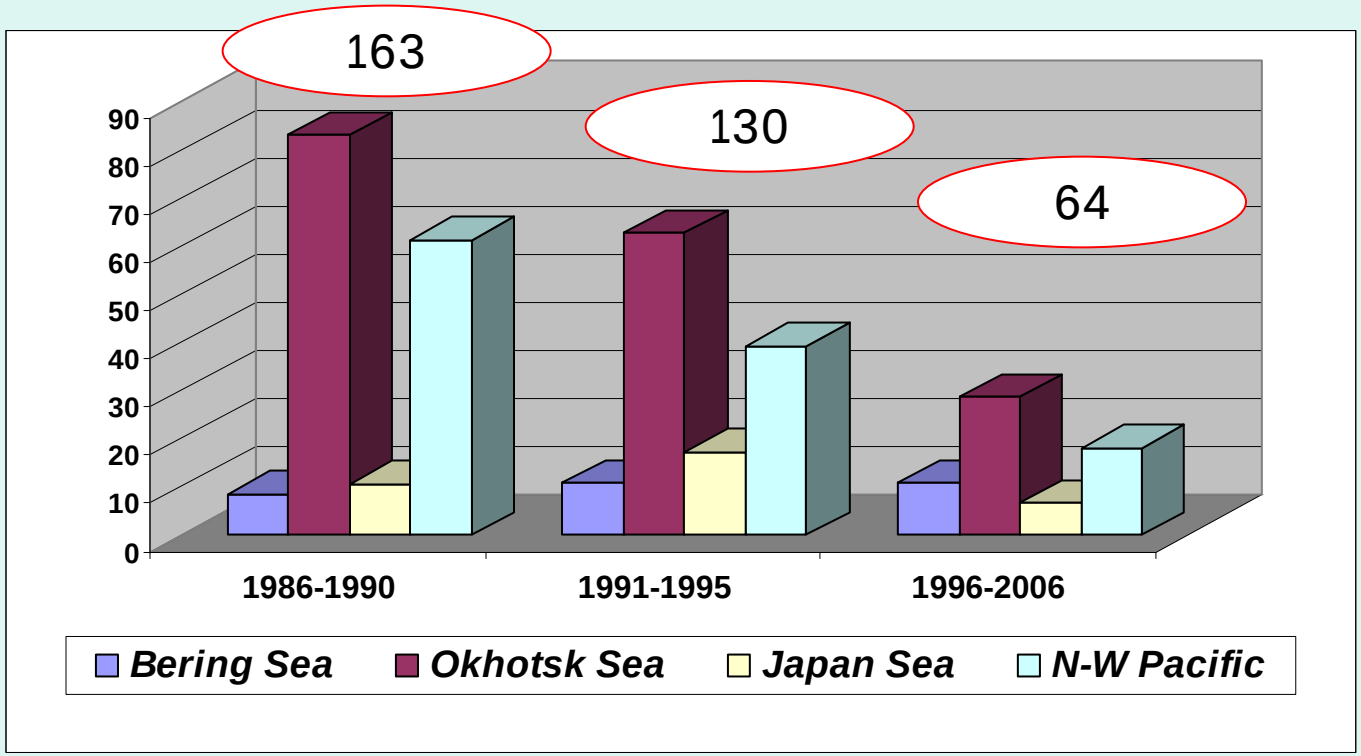
Whales- up to 360 kg of euphausiids/ per 1 individual

Overall abundance and consumption of zooplankton by nekton (mln. t) in the upper 200-m layer of the Far Eastern Seas



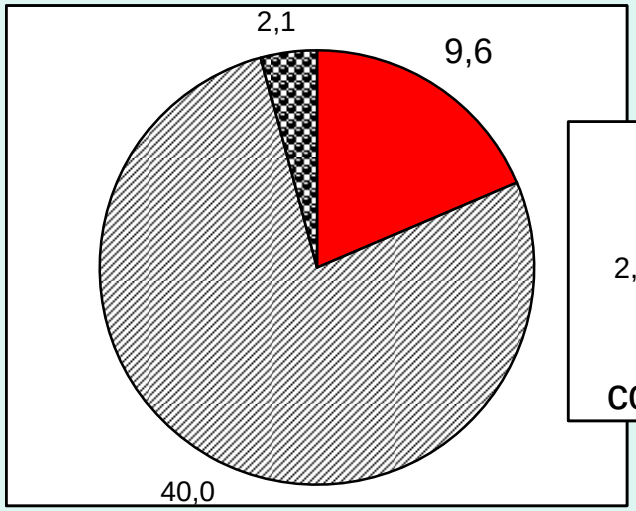
According to biomass of nekton, the largest consumption of food observed in the Okhotsk Sea; and the lowest – in the Japan Sea and Pacific ocean

Long-term variability of **euphausiid**'s stock (mln.tonn) in the pelagial



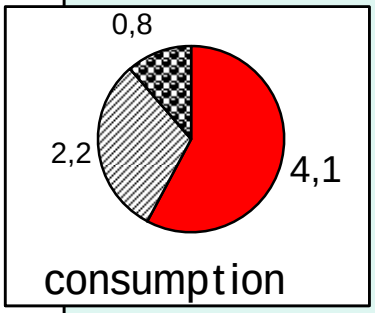
The gradual decrease of euphausiids stock in the Sea of Okhotsk and the Pacific ocean, but stable stocks - in the Japan Sea and Bering Sea

Stock and consumption of **euphausiids** by nekton in the western Bering Sea



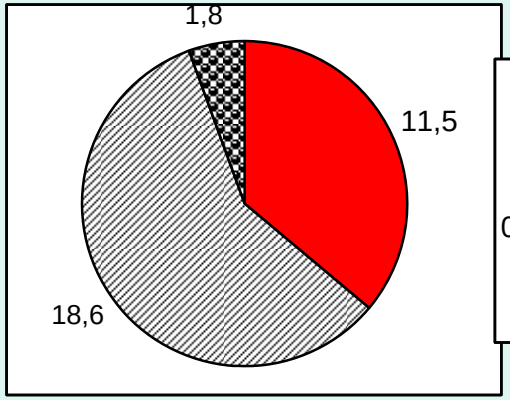
stock

Autumn
2002-2003



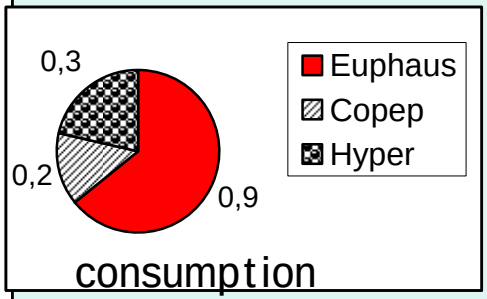
43% of stock

Ratio of stocks and consumption indicated the favor of euphausiids



stock

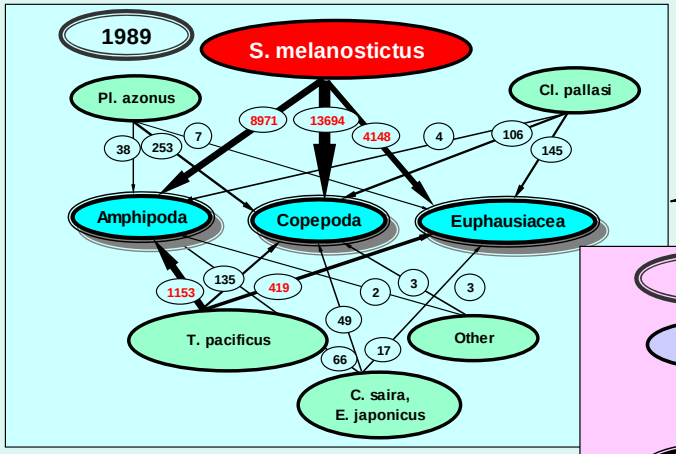
Autumn
2004-2006



8% of stock

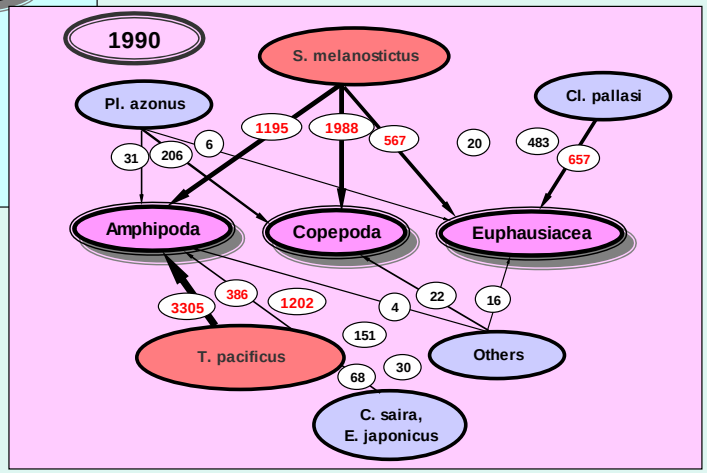
And also - a very small amount of consumption

Interannual variability of zooplankton consumption (thous.tonn) by the mass nekton species in N-W Japan Sea



1985-1989
maximal consumption of
euphausiids – almost 5 mln.tonn

60% of stock

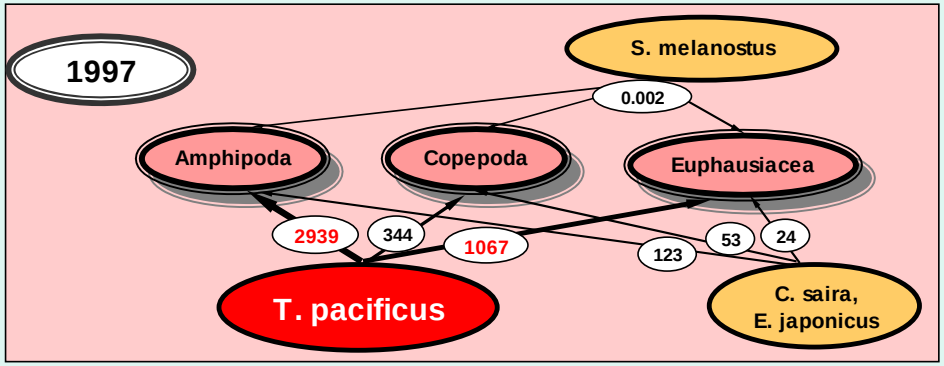


In the mid-1990-s
consumption decreased by
70% - up to 1.46 mln.tonn

22% of stock

**30-50%
of stock**

in the late-1990-s- our days
consumption has decreased
by 10% - up to 1.02 mln.tonn



The low level of consumption indicates under-utilization of plankton resources due to low abundance of nekton.

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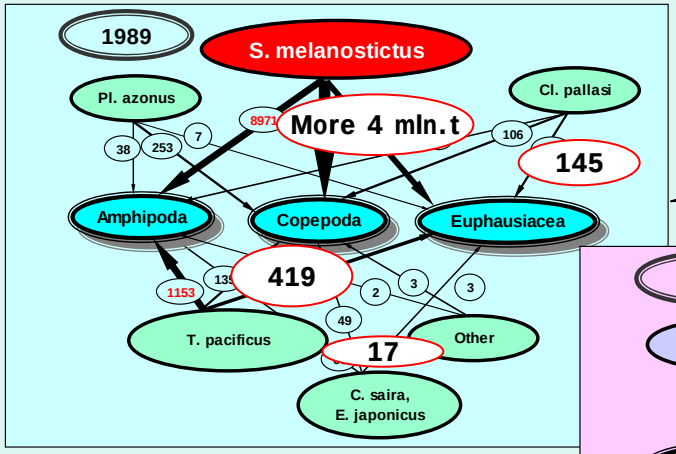

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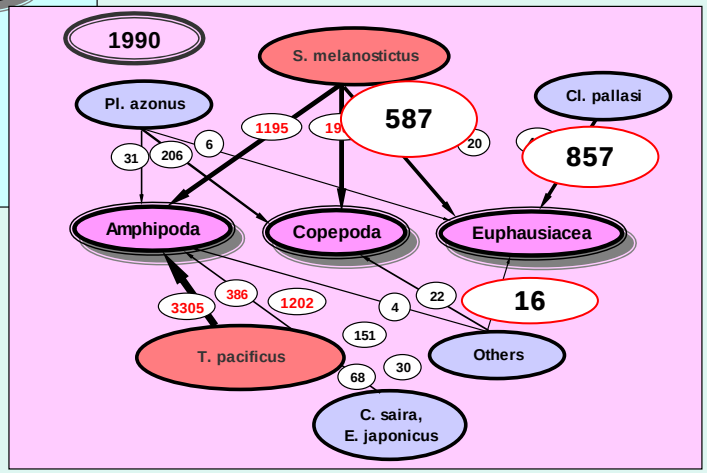

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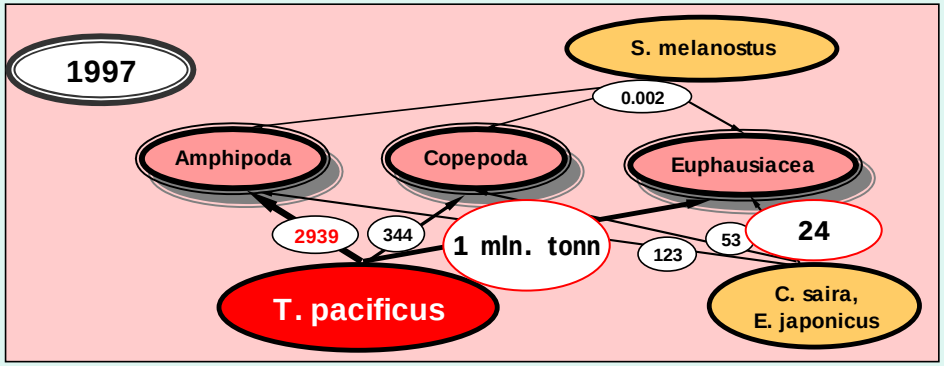
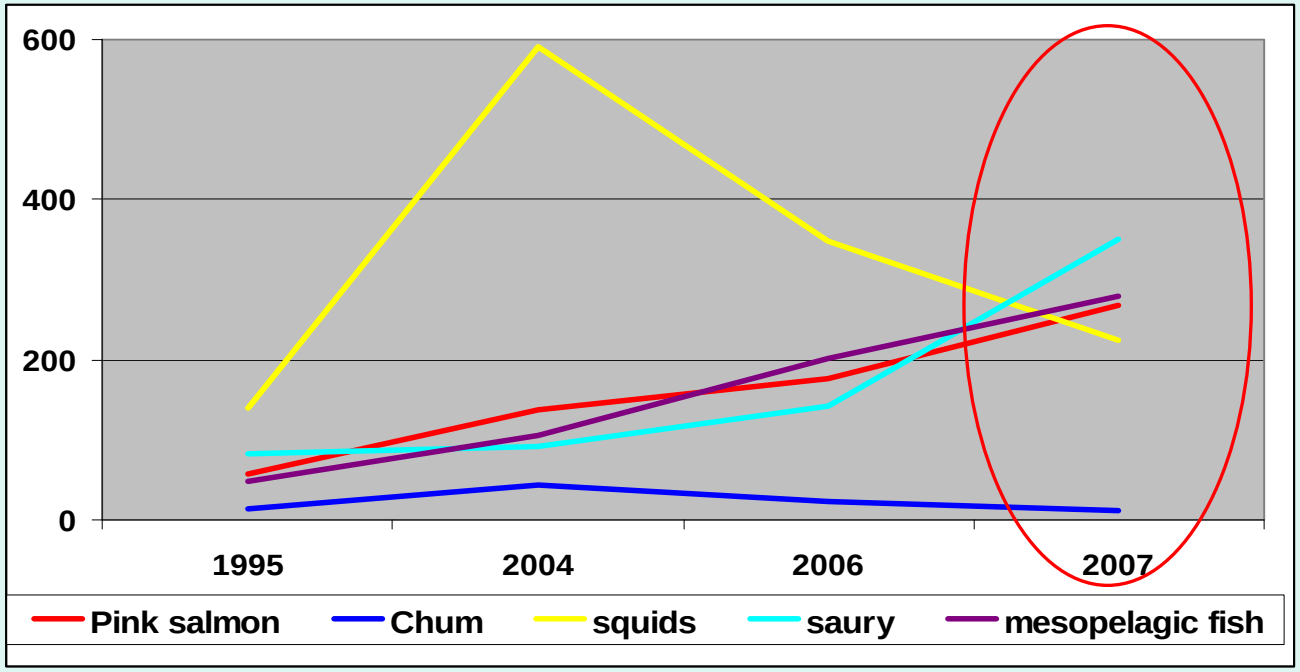
by 10% - up to 1.02 mln.tonn



The low level of consumption indicates under-utilization of plankton resources due to low abundance of nekton.

Interannual variability of euphausiids consumption (thous.tonn) in the epipelagial of N-W Pacific in summer

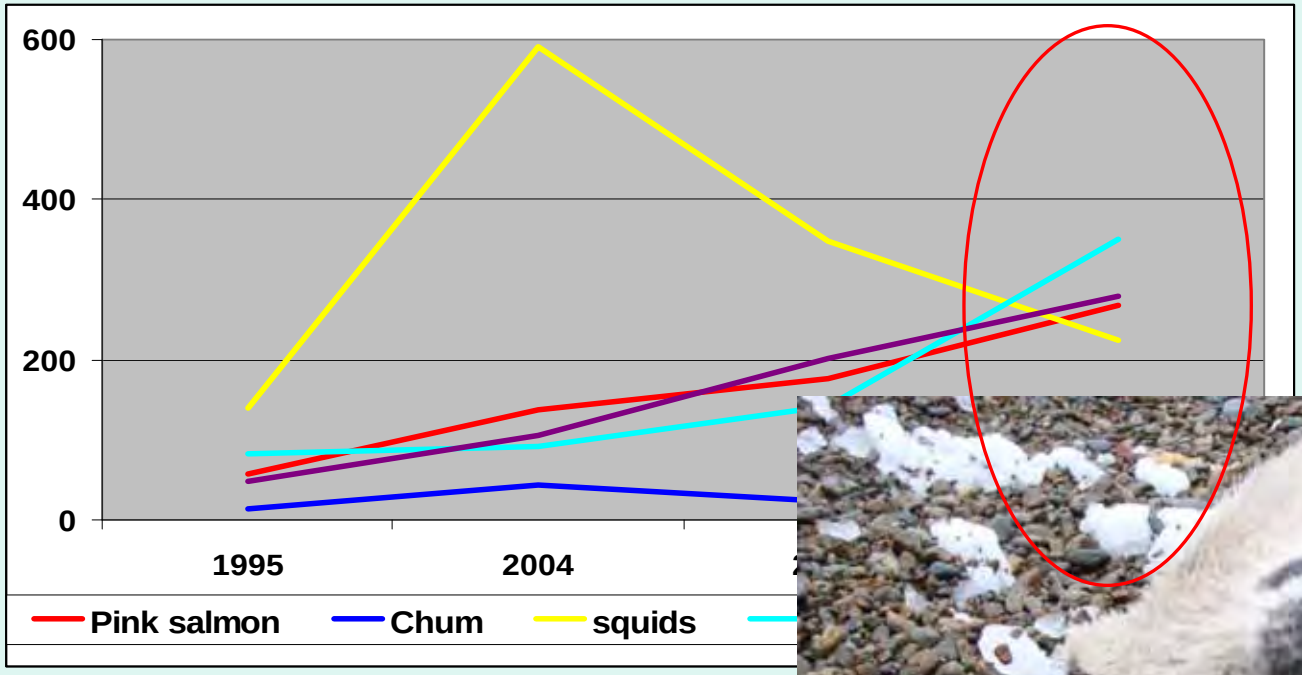


In summer of 2007 all species of nekton consumed about 1400 tons of euphausiids (=1/8 of their stock)

In the Far Eastern Seas and the North Pacific every-year stocks of euphausiids estimated at 180 million tons in average.
Fish and squid consume about 50% of these reserves.

Marine mammals consume about 10% of the reserves.

Interannual variability of euphausiids consumption (thous.tonn) in the epipelagial of N-W Pacific in summer



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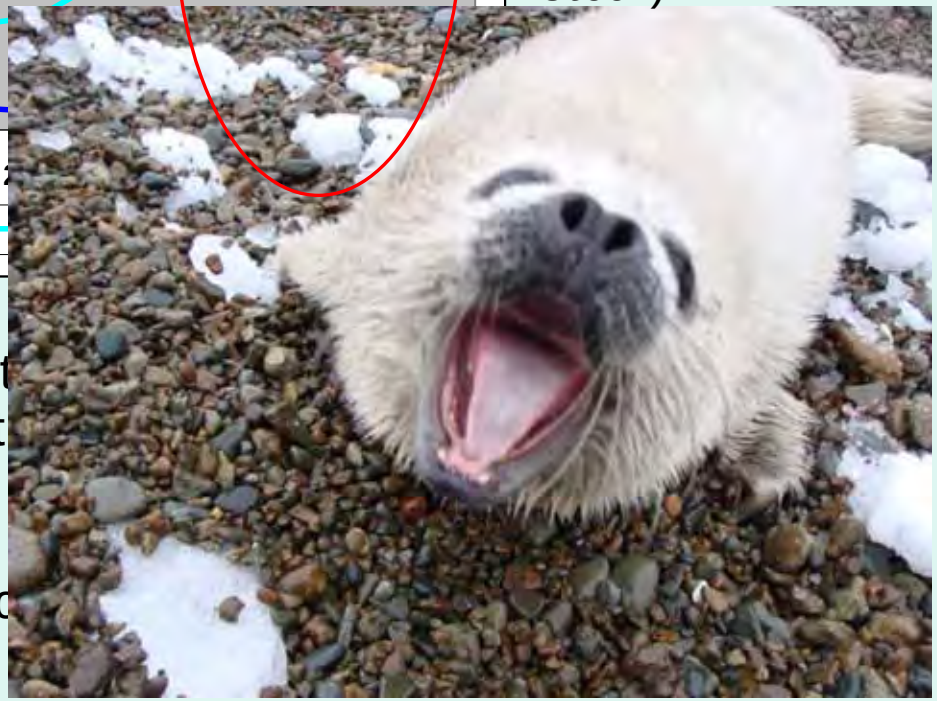

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Conclusions:

-For more improbable estimation of euphausiids quantity it is nessesary to use catchability coefficients

- Except *Th.longipes* there is one more dominant species in every sea: *Th.inermis* – in the Bering Sea, *Th.raschii* – in Okhotsk Sea, *E.pacifica* – in the Sea of Japan and Pacific ocean.

- *Th.longipes* characterized by bigest area of spreading, then with reduction are following *E.pacifica, Th.raschii, Th.inermis, Th.inspinata*

- The largest share of euphausiids in the pelagic plankton communities (35%) is in Okhotsk Sea, making the total zooplankton biomass in 2-3 times higher than in other areas, - 1100 mg/m^3 in average.

-Last 20 years stock of euphausiids in the epipelagial decreased in the Sea of Okhotsk and Pacific ocean in 5 time. At the same time their stock in the Bering and Japan Sea stay rather stable.

-Consumption of euphausiids decreased everywhere almost in 5 times, due to significant reduction in nekton biomass