Euphausia mucronata, a central link in the Humboldt Current food web.

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Structure of the talk: the role and implications

- Evidences of E. m as a primary herbivore and its adaptations to Humboldt Current
- Evidences as a primary prey of fish
- Description of food webs resulting from shifts in predator abundances

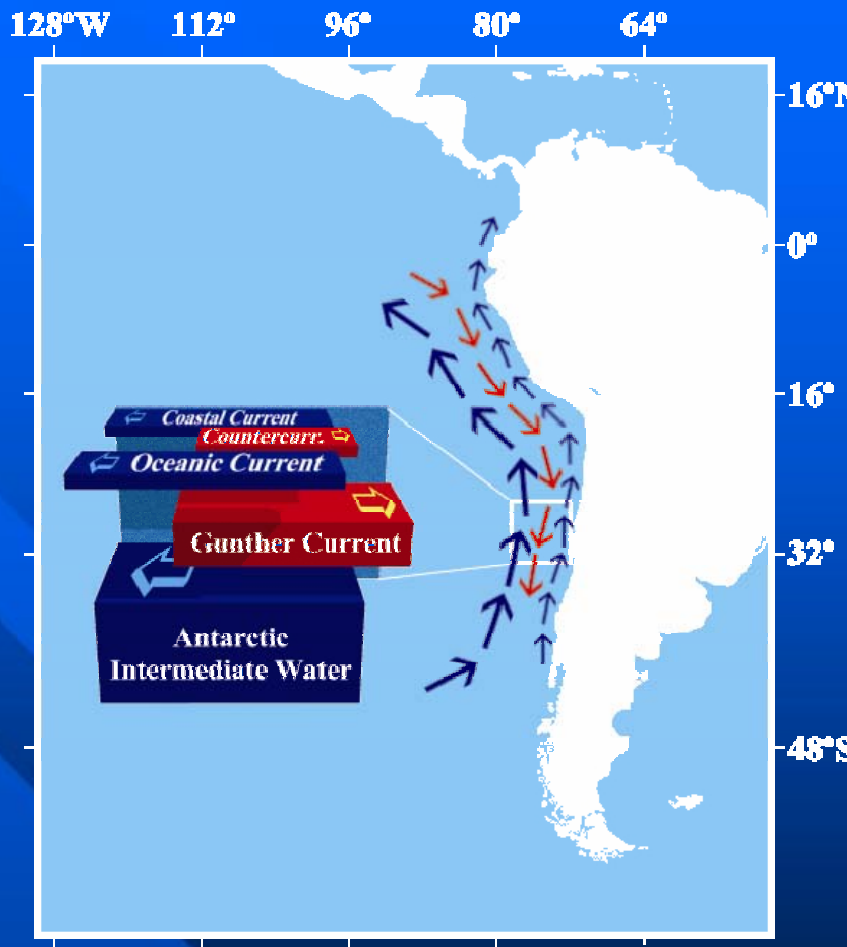
The Humboldt Current:

- A system of merging polar & equatorward currents.

- Coastal upwellings

- Productivity: plankton and fish

- A subsurface 02 Minimum Layer

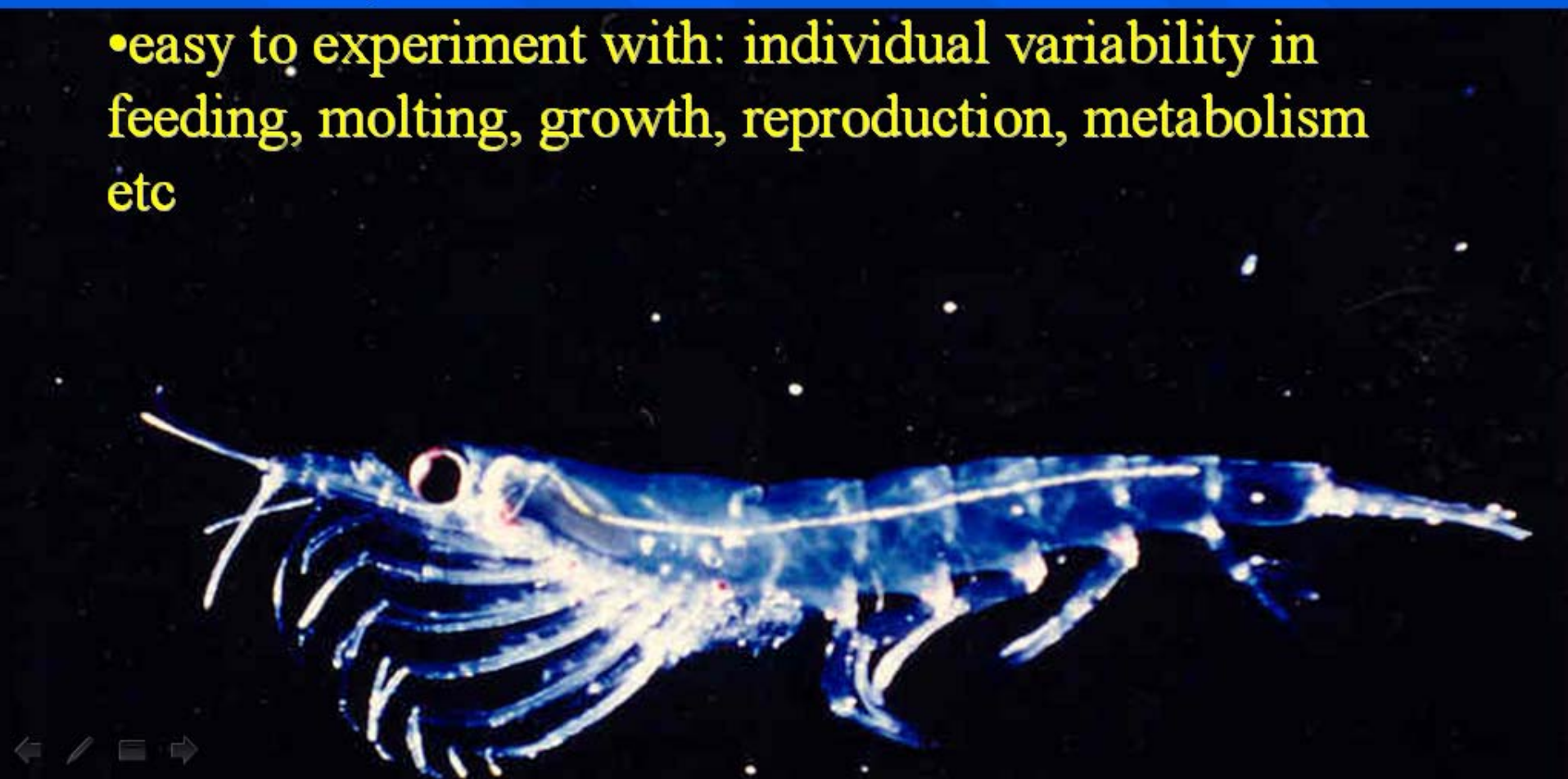


Variability is not well documented along the ca. 2400 nm latitudinal range

Gunther, 1936; Brandhorst, 1958; Antezana, 1978

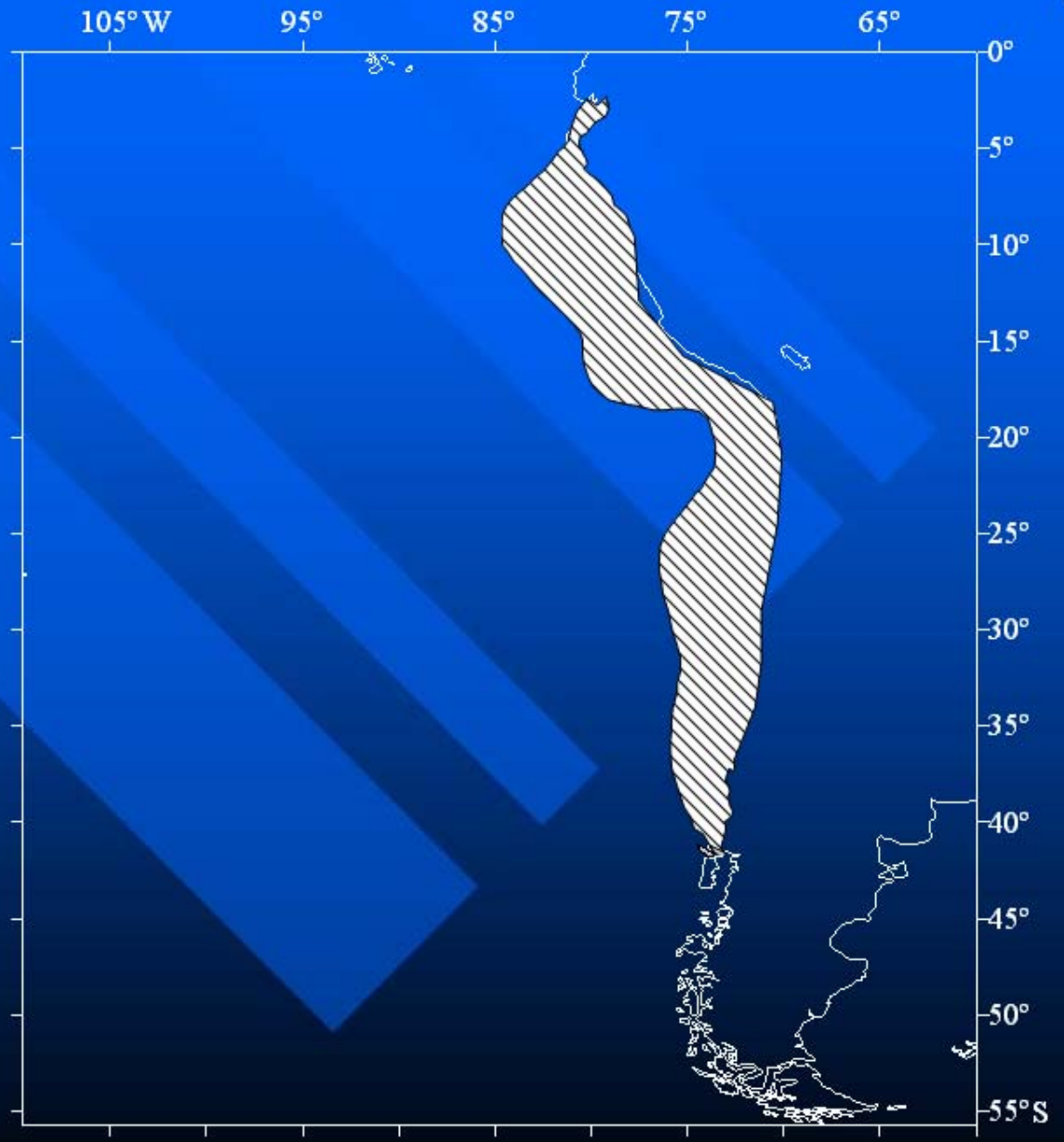
E. mucronata

- large, abundant, swarming (schooling?) planktonic crustacean,
- easy to experiment with: individual variability in feeding, molting, growth, reproduction, metabolism etc



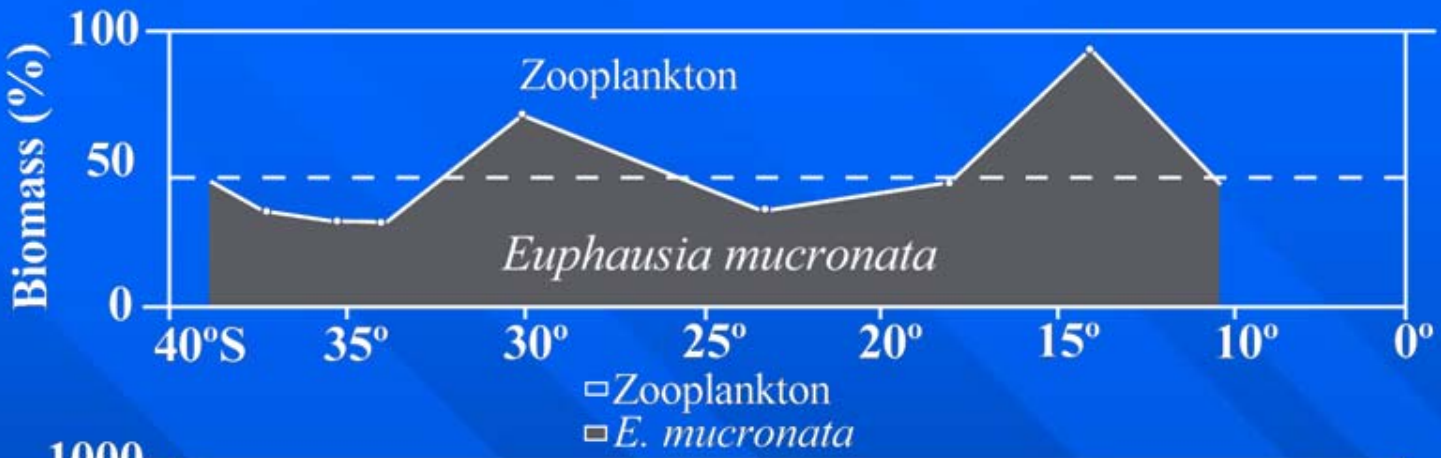
Geographic Distribution of *E. mucronata*

- Endemic to Humboldt Current
- Coastal and associated with upwelling centers
- Dominant in the zooplankton



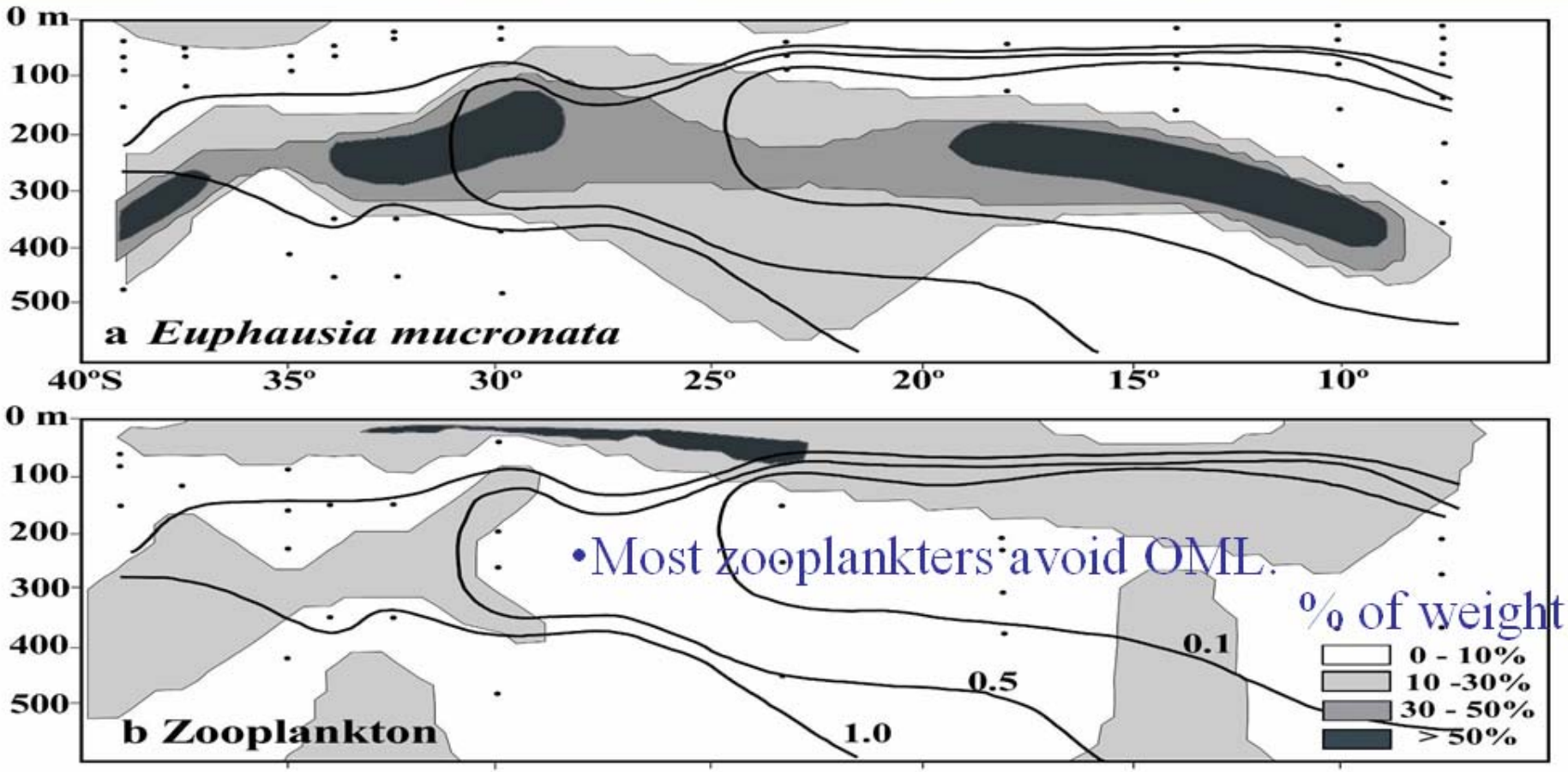
Sars, 1885; Gunther, 1936; Brinton, 1962; Antezana, 1970; 1978; 1981

Dominance of krill in the Humboldt Current



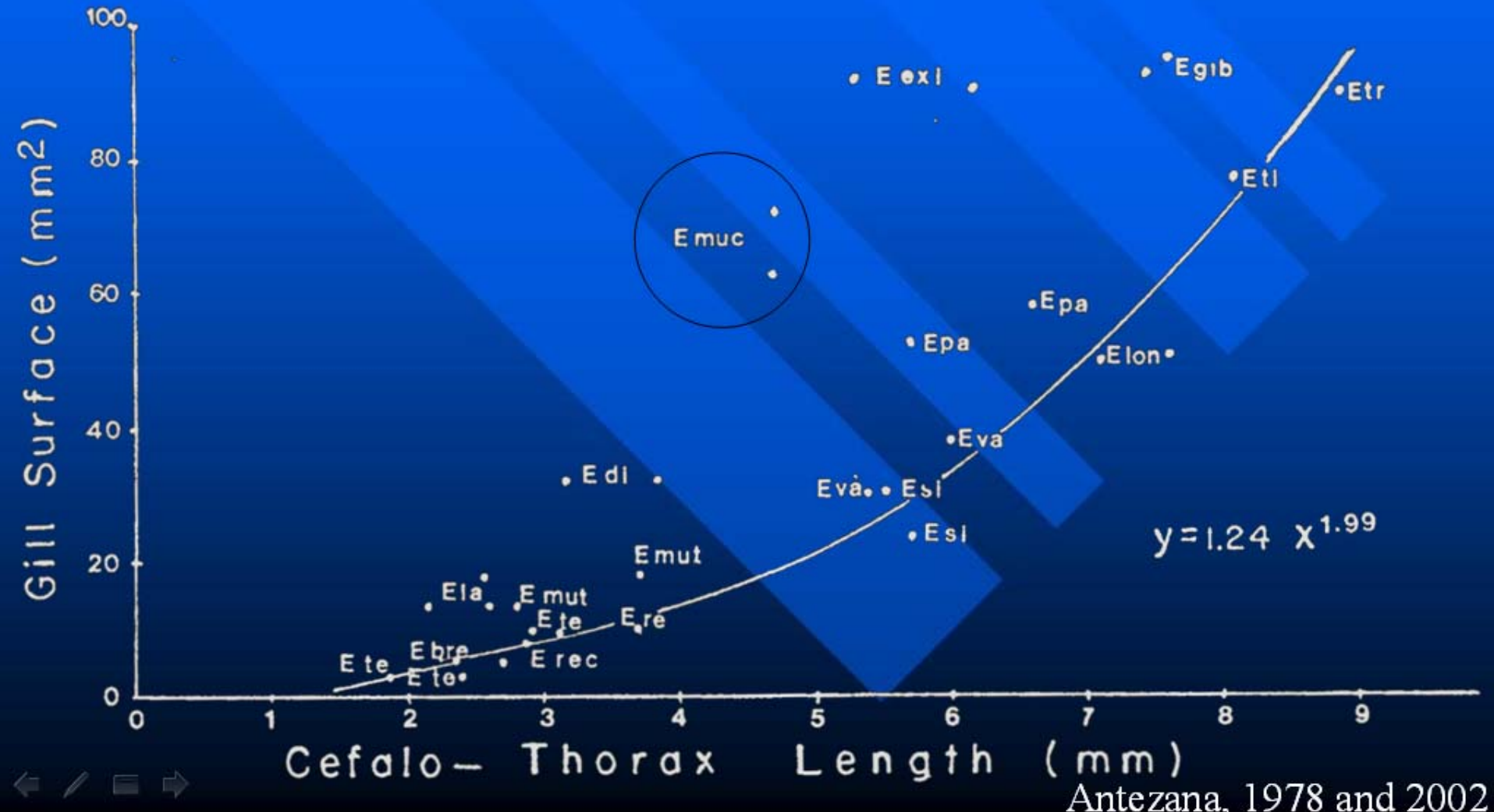
A diurnal dweller of the Oxygen Minimum Layer: all along the HC

S Central Chile……N Peru



Morphological adaptations

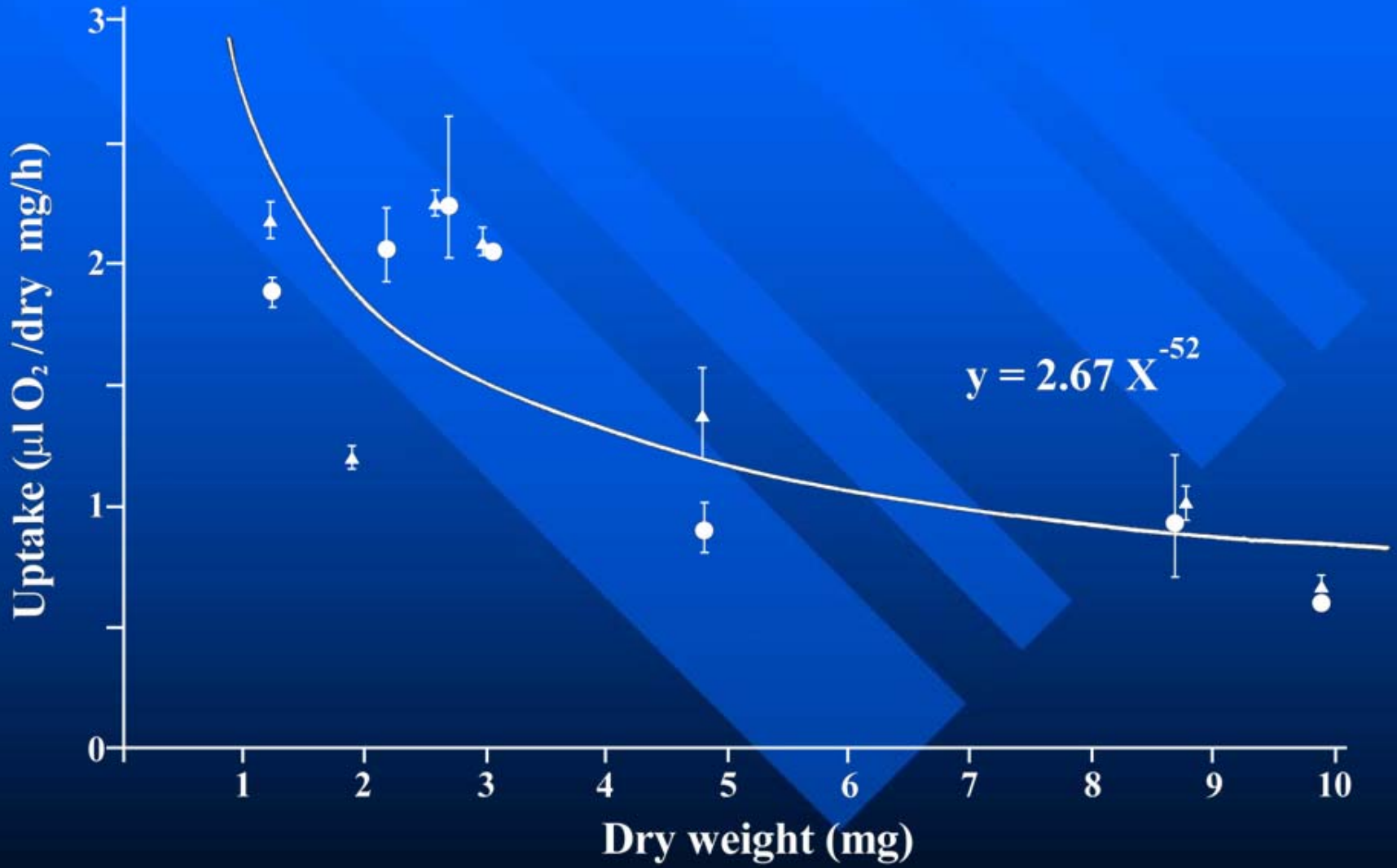
Larger gills than most *Euphausia* species



Antezana, 1978 and 2002

Respiratory adaptations

Similar Respiratory rates in and out of OML



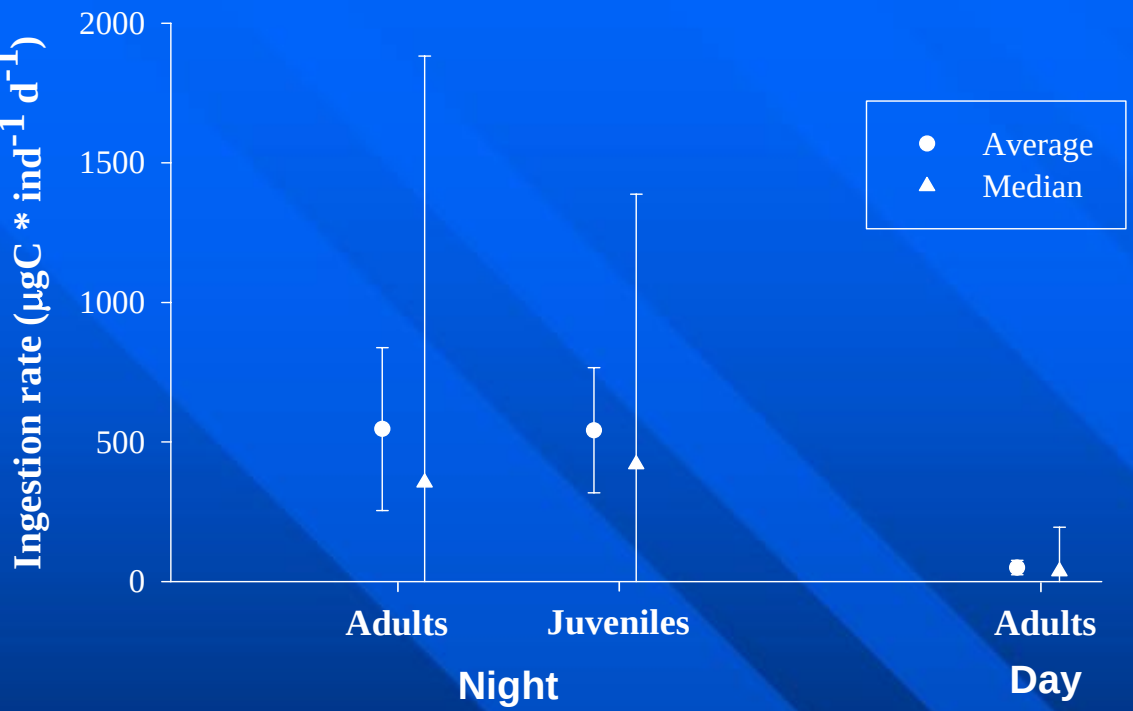
In vitro experiments: Antezana, 1978 and 2002

Plastic Feeding behavior:

- *Primarily Herbivorous*
  in the photic zone at night,
- *Raptorial, carnívorous, scavenger*
  in the Oxygen Minimum Layer in daytime.

Evidence: *Contingeny tables of item occurrence in stomach contents*: Antezana, 1978; 2002

STOMACH CONTENT AND INGESTION RATES



- Higher estimates at night than in daytime
- High variation between individuals d
- High evacuation rates: 2.8 /hr;

  Retention: 20 min.

Evacuation experiments and stomach content analysis; Antezana, 1978 and 2002

Stomach Contents and Ingestion Rates

(Stomach clearance rate = 2.8/hr, feeding period =12 hr at night; C:Chl ratio = 50).

Body length	Wet W	Dry W	Stomach content		Ingestion rate	Ration / BW
						%
mm	G	g	µg Chl-eq. /ind.	µg C/ind	µg C/ind.* d	% µg C / µg C
20	0.05	0.01	0.316	15.8	523	13

Population Consumption and Impact upon phytoplankton production at average and swarm densities

*(Swarm density as reviewed by Ritz (1994) for other euphausiids . Depth of integration for average densities :0-50 m and for swarm densities :0-10 m. Average ingestion rate: 10.45 µg Chl -eq/ ind. Chl:C ratio: 50. Primary production: 3 g C/m^2 * d from Walsh (1981)).*

	Biomass wet	Density		Population Consumption	Impact on Pri. Prod.
Density	g/1000 m^3	#/m^3	#/m^2	g C/m^2*d	%
Average	0.1	2	100	0.952	30
Swarming	500	10,000	100,000	52.25	173

Conclusions as a primary consumer

- Dominant item of zooplankton biomass (50%)

- It migrates daily into the O2 Minimum layer:
  Herbivore at night at the mixed layer &
  Omnivore in daytime at the O2 Min. Layer.

- High ingestion rate explains high biomass &
  high molting frerquency (10%C every 4-5 d)

E. mucronata a main prey item of vertebrantes in the H Current

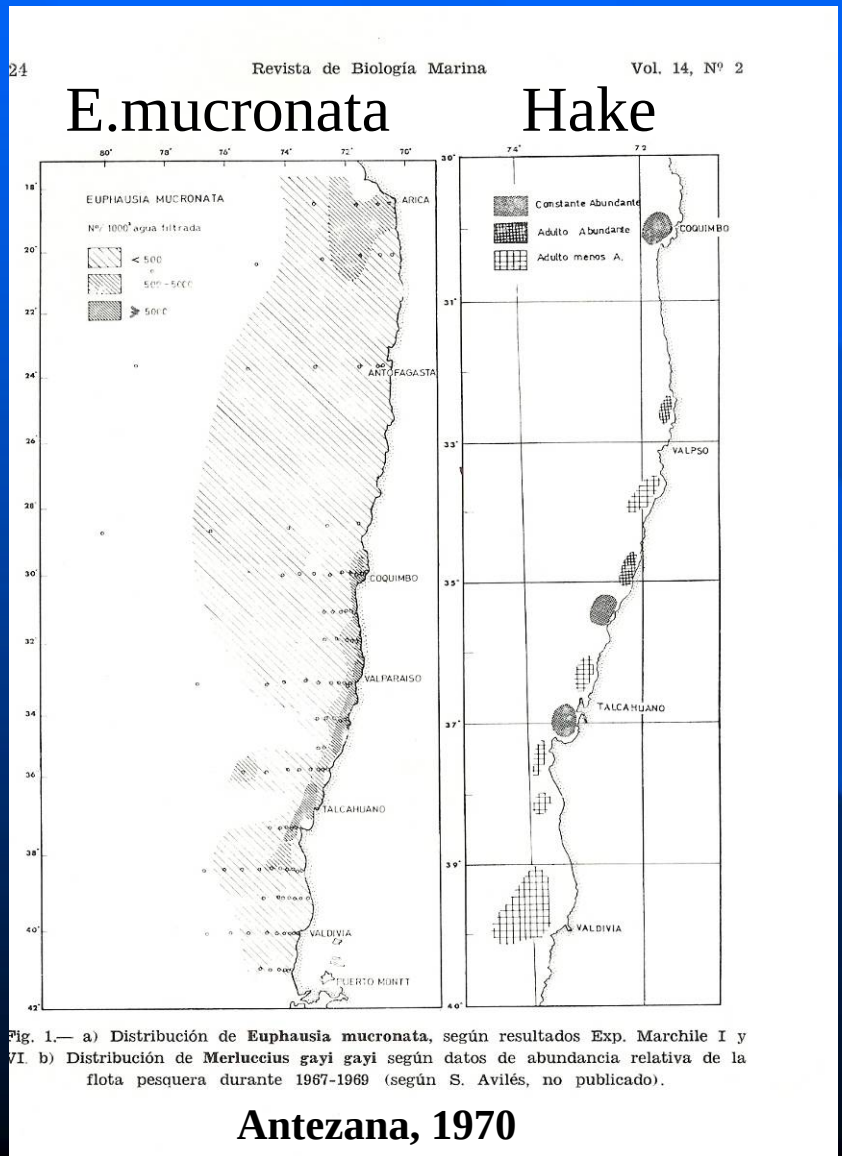
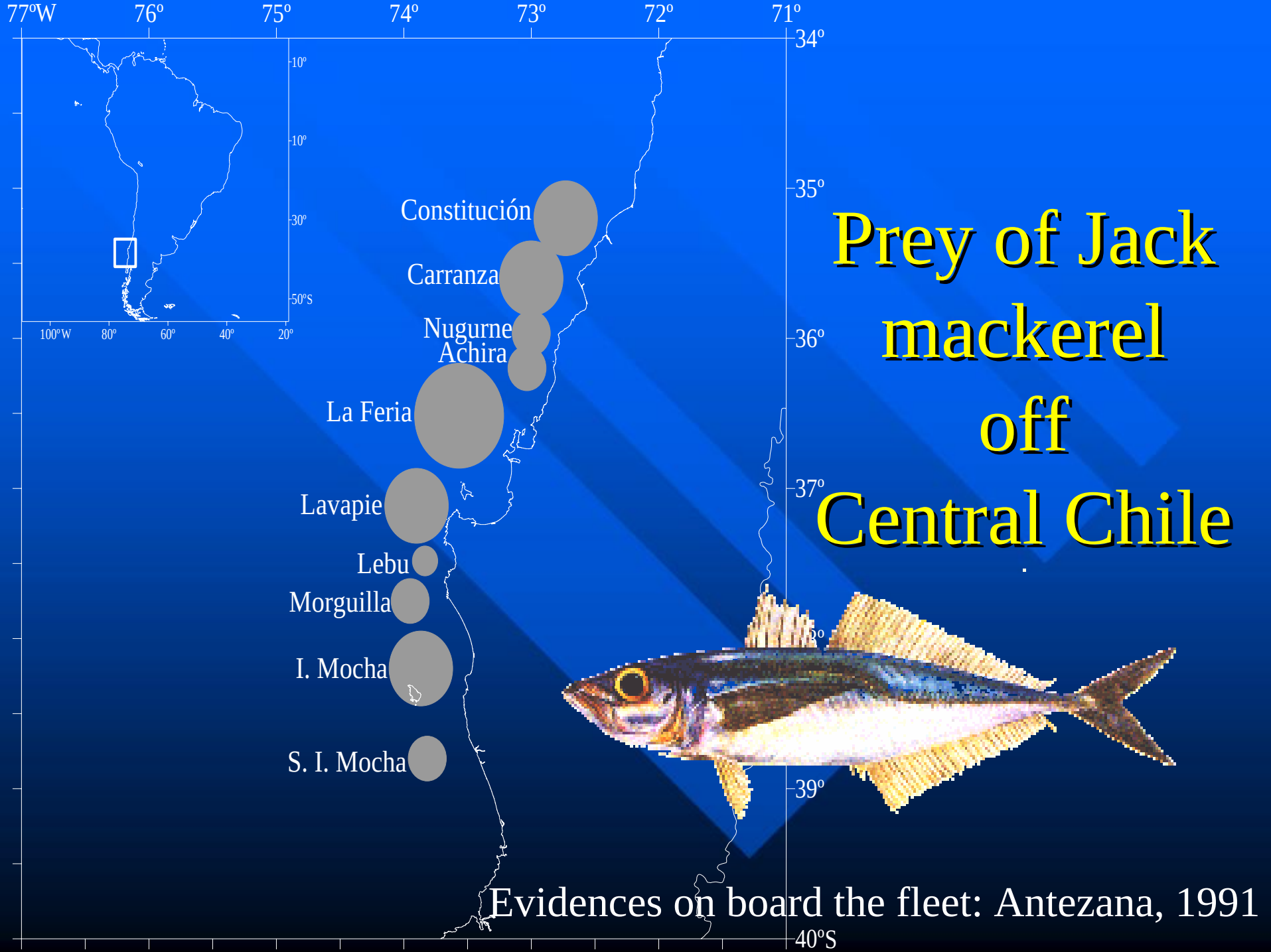


Fig. 1.— a) Distribución de **Euphausia mucronata,** según resultados Exp. Marchile I y VI. b) Distribución de **Merluccius gayi gayi** según datos de abundancia relativa de la flota pesquera durante 1967-1969 (según S. Avilés, no publicado).

Antezana, 1970

Also:
Snoek (sierra)
Baleen whales
Other spp

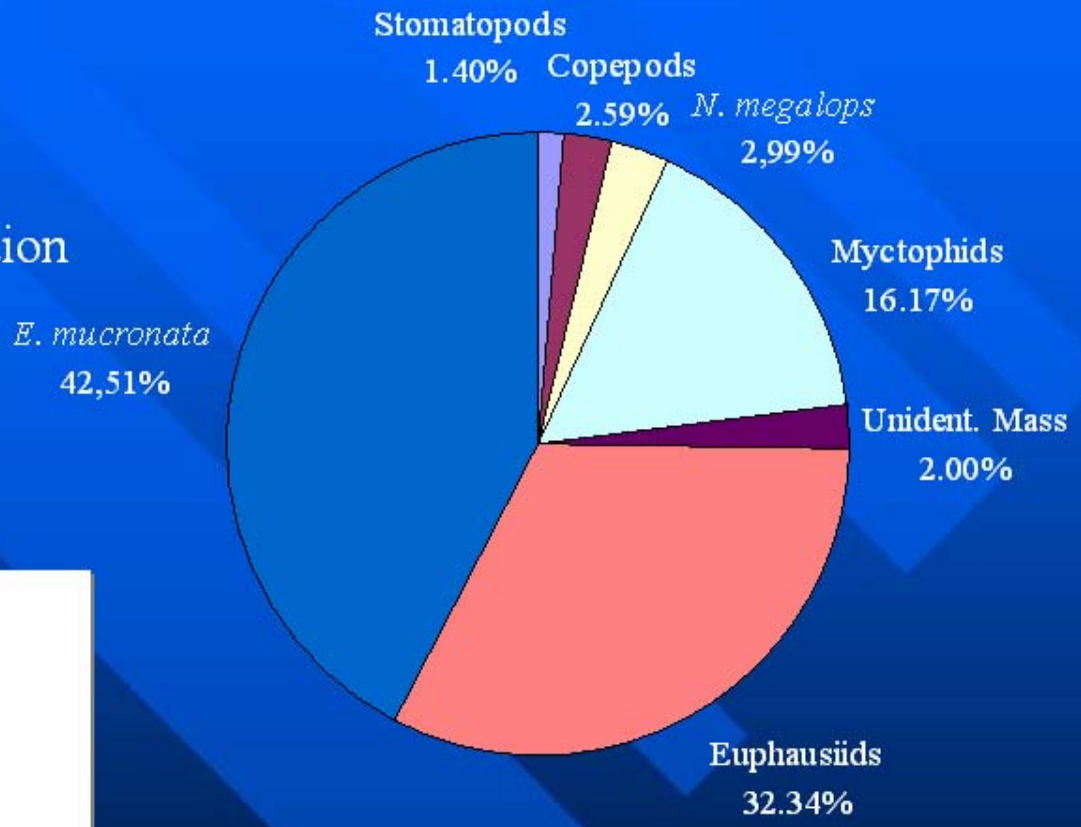
Prey of Jack mackerel off Central Chile



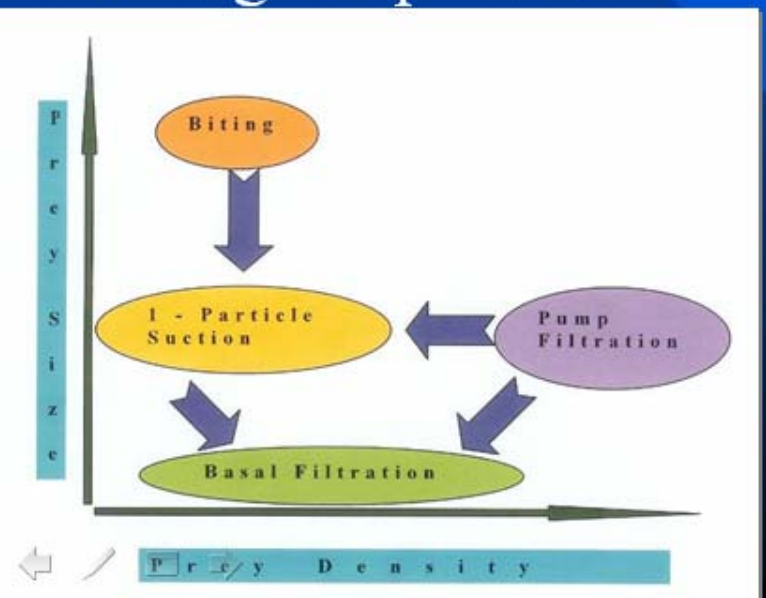
Evidences on board the fleet: Antezana, 1991

Diet of Jack Mackerel of Central Chile (overall mean % of wet weight)

Main item
Euphausia mucronata
in several stages of digestion



Secondary items:
Feeding adaptations



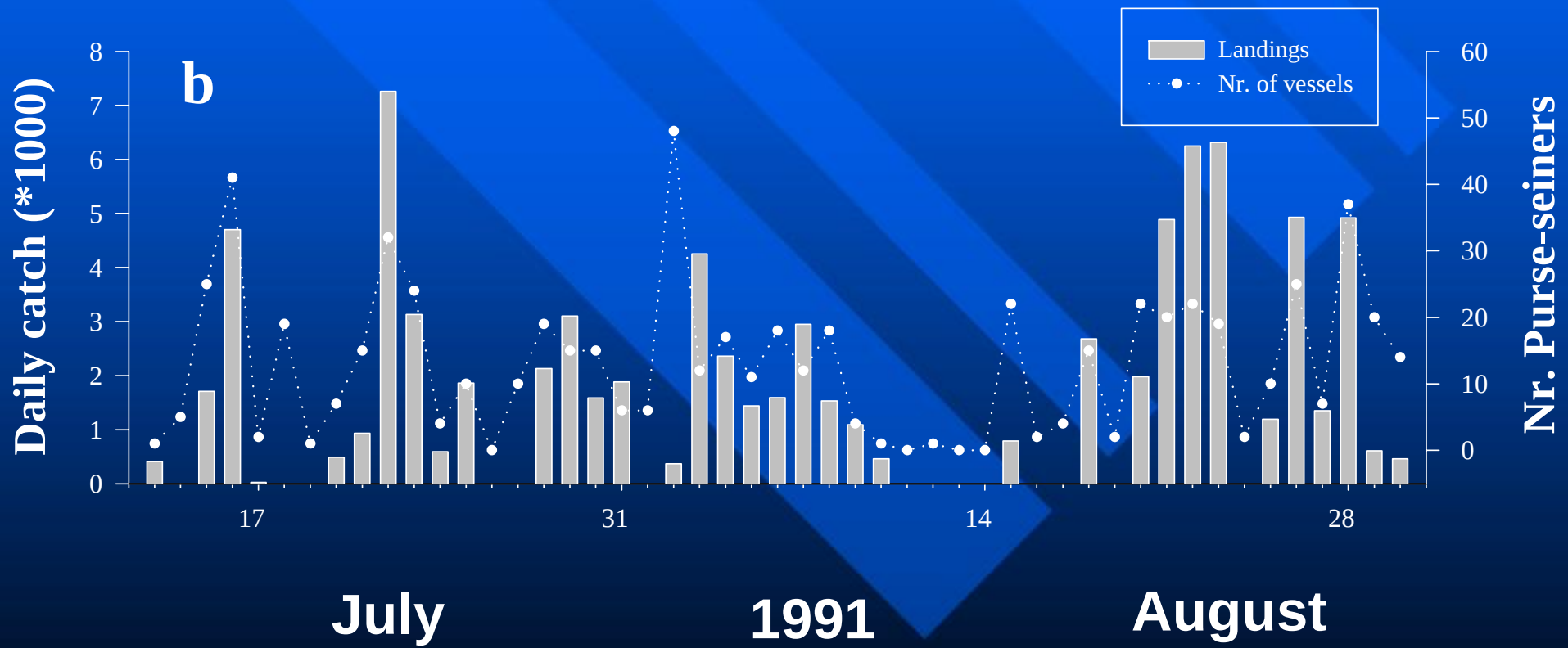
Antezana, MS

Prey consumption in 2 fishing events in the same fishing ground: 50 d day variability

Fish Stomach content

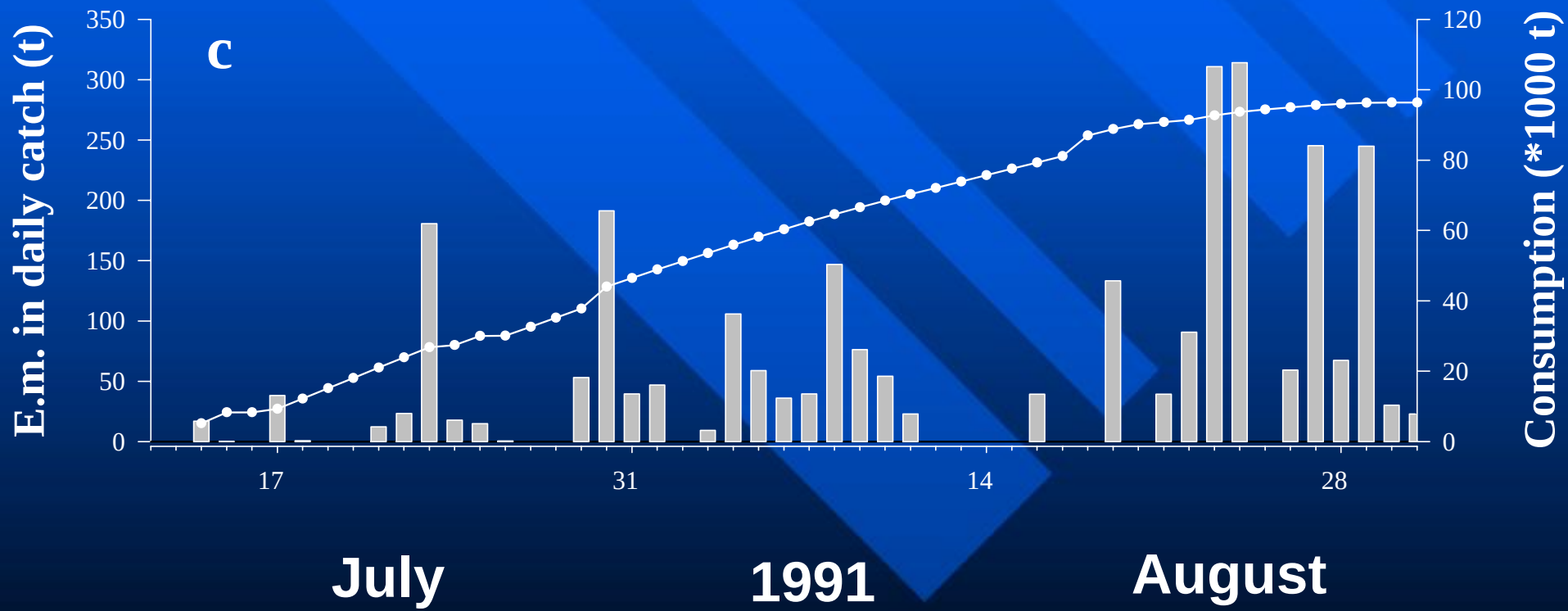
Prey consumption in 2 fishing events in the same fishing ground: 50 d day variability

Catch and fishing effort



Prey consumption in 2 fishing events in the same fishing ground: 50 d day variability

Consumption of *E. mucronata*



Consumption of krill in 50 d by J-Mackerel off Chile

Cumulative:

Landing = 125 000 ton

Krill consumption = 1 500 ton/d

R/B ca. 1 % of fish weight/d

(Underestimated?)

Annual consumption of *E. mucronata* by jack mackerel in the Talcahuano-Coronel fishing region.

Fish size: 40 cm, 700 g. Clearance rate: 5.28/d from Pillar and Barange (1998). Total and virtual population size from Arancibia et al., (1995)

		Sto. content / 1 fish	Daily ration	Daily ration on *E.mucronata*		Consumption of *E. mucronata* *by* landed fish	
	annual	wet weight	Clearance Rate	75 % of *E. m* in Sto.W	28 % non feeding fish	12 months	9 months
	*1000 t	g / fish	g / fish*d	g / kg fish	kg / t fish	(*1000 t)	
Catch 91	2 330	2.71	14.3	15.3	11.0	9 200	6 900
Virtual 91	6 825	”	”	”	”	27 100	20 300
Virtual 94	8300	”	”	”	”	39 700	29 800
Catch 94	4 150	”	”	”	”	16 500	12 400
Catch 06	1 150 ?	”	”	”	”	4 500	3 500

Other predator on Euphausiids in the HC

South Central Chile

- 10 mill ton whip tail hake
- 3 mill ton hake
- 7 mill mesopelagic fish
- ?? Snoek;
- ?? Baleen whales
- ?? Birds

No quantitative data available

Off Peru :

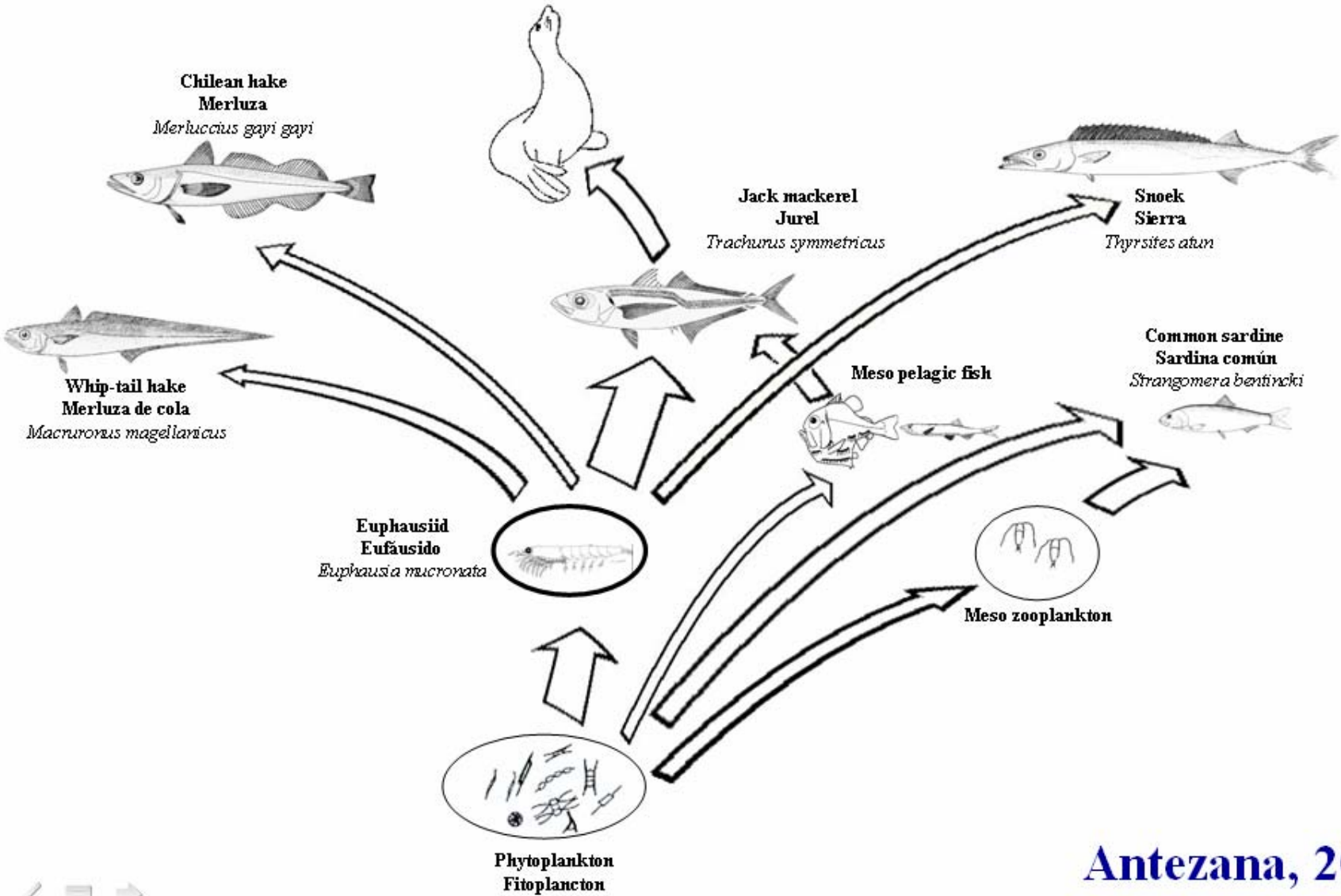
- Jack Mackerel
- Chub mackerel
- Hake

E. mucronata consumption is ignored or merged with meso zooplankton items

Conclusions: on krill as prey

- *E.mucronata* makes ca. 60% of diet of Jack-mackerel off Central Chile.
- It is a main item of diet of other fishes and whales
- It may be limiting prey , and partitioned among population stocks of predators.
- Then a conceptual food web is depicted and its shifts deduced

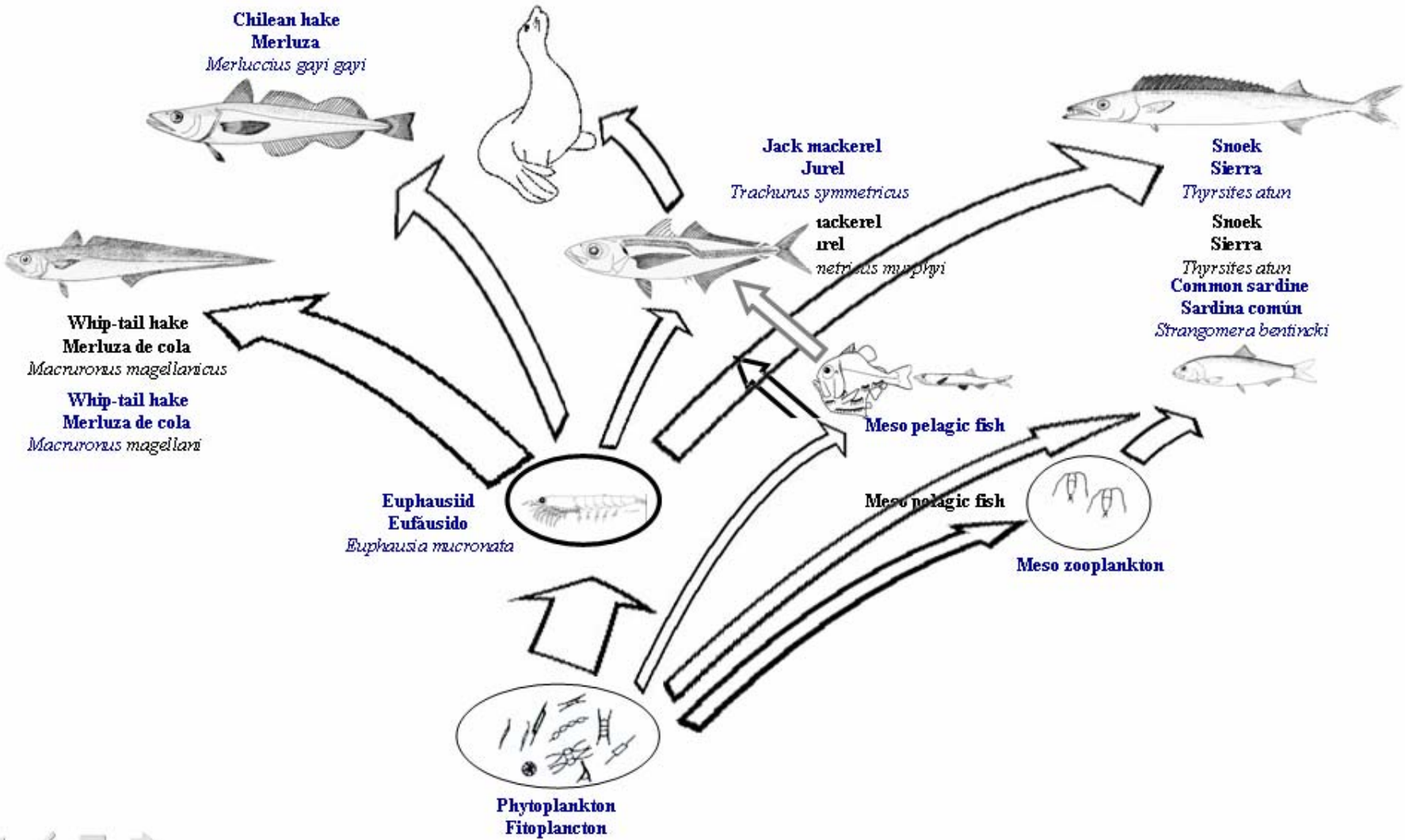
Food Web off Central Chile.
Phytoplankton..Krill...Jack-Mackerel..... Sea Lion



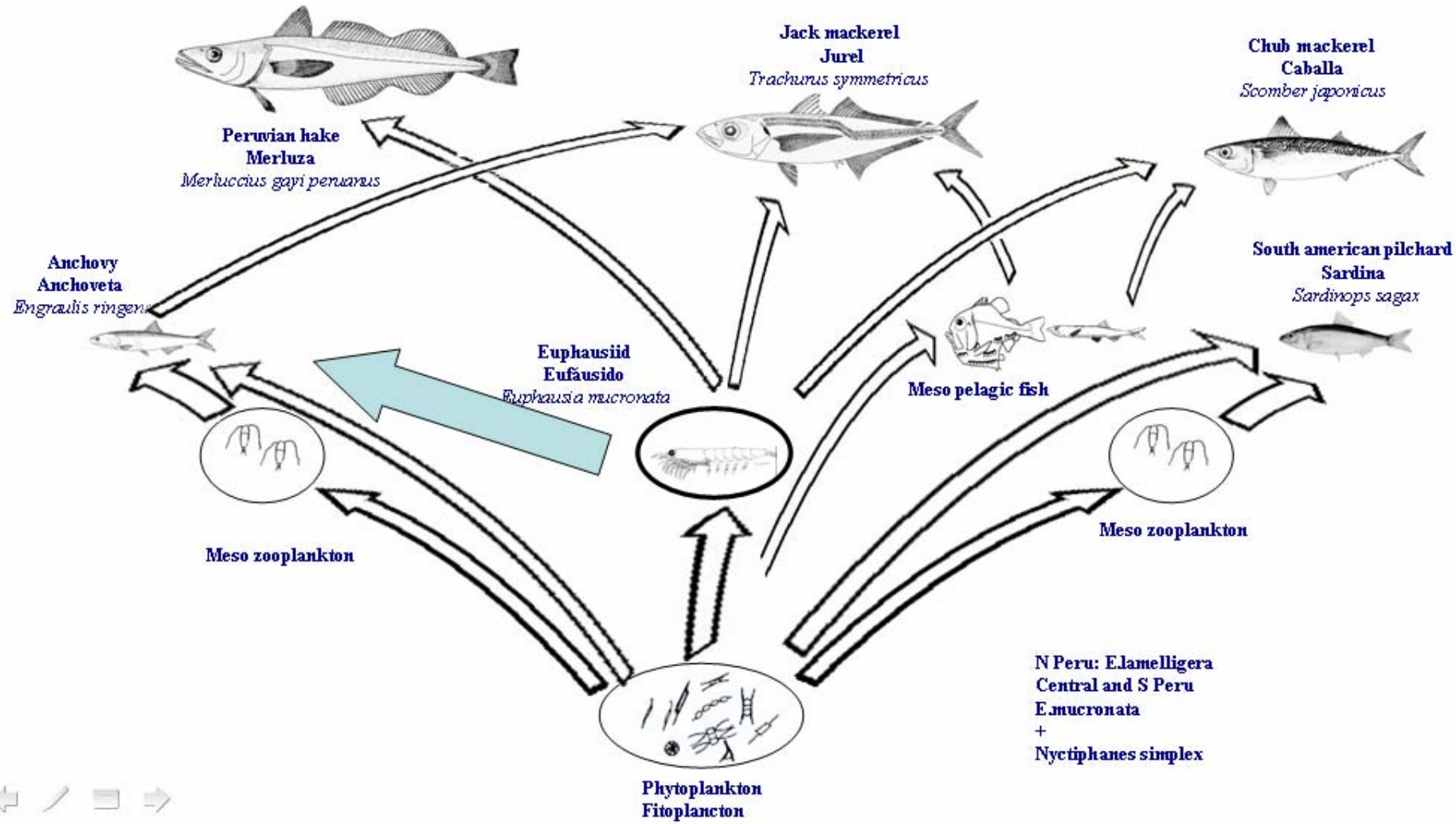
Antezana, 2001.

LOW JACK MACKEREL POPULATION YEAR

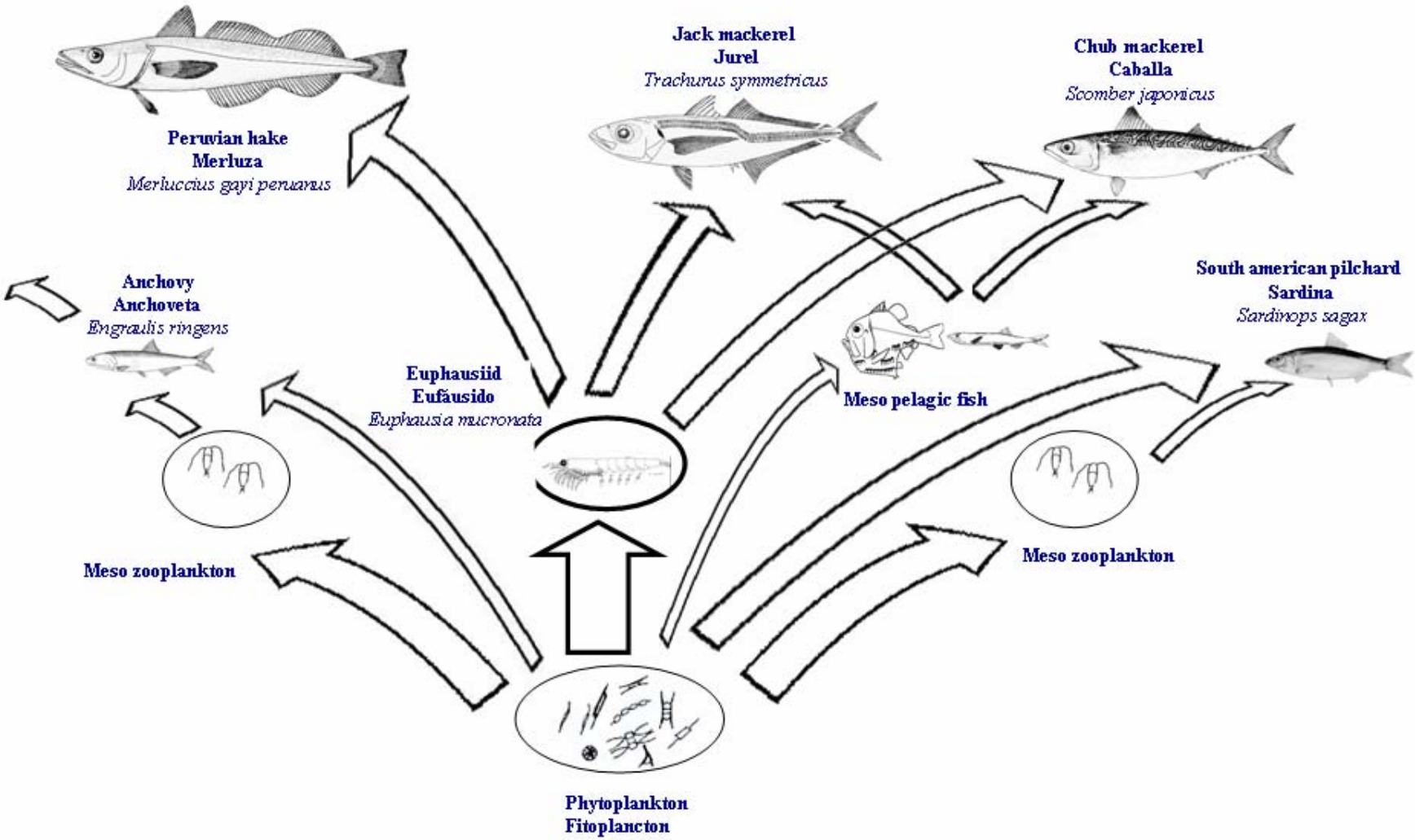
Low Jack-Mackerel Population Year



High Anchovy Population Year



Low Anchovy Population Year



Conclusions on E. mucronata role in HC

- *E. mucronata* is competetively adapted to dominate in the HC
- It takes a significant portion of Primary Production
- It is a crucial prey for Jack-mackerel, and a main item of the diet of other fishes and whales: total consumption is underestimated
- Its role in food web may be crucial to explain regime shifts.