# PICES – 2011 S3

# Structural and functional aspects of nektonic squid food and parasite relations in the World Ocean ecosystems

**Chingis Nigmatullin**
**AtlantNIRO, Kaliningrad, Russia**
**E-mail: squid@atlant.baltnet.ru**

# Introduction

-The terminology and theory of the general ecology now is relatively developed. But there is clear signs of crisis in its theory and accordingly – in its notion apparatus.

- In particular the evidence of this crisis is minimal contacts between two most important lines of ecological investigations: population ecology and synecology – whose development goes mostly independently.

- Other indirect evidence of this situation is the fact that despite very wide amount of literature discussing main fundamental ecological notions as **population, its life cycle, ecological niche, life form and community of organisms**, there are not clear idea on theirs systematic coordination.

**The aim of this communication is attempt of system synthesis of above-listed main ecological notions and demonstration obtained results on the conceptions of trophic-parasite webs structure in the pelagic communities of Tropical Atlantic with orangeback squid *Sthenoteuthis pteropus* and East-Pacific with Jumbo squid *Dosidicus gigas* as key-species.**

This theoretical study based on generalize data of the trophic-parasite relations of 24 species of abundant nektonic squids of the World Ocean, which together represent approximately **90**% of total squid biomass (about **60 million** tons), annual production about **450** million tons and an annual consumption rate **more one billion** tons of prey.

The model most studied species were four oceanic ommastrephids ***Dosidicus gigas, Ommastrephes bartramii, Sthenoteuthis pteropus*** and ***S. oualaniensis***.

All studied nektonic squids make both active and passive ontogenetic migrations up to 1000-1500 miles as a part of their life cycles. When migrating squid travel through the diversity of vertical water layers, climatic zones and ecosystems. They are an important element of migratory “rigid” framework that integrates local ecosystems into ecosystems of the next, higher level and eventually into the whole ecosystem of the World Ocean. Thus they are important **inter-ecosystem integrators and transporters**! Owing to the unique combination of such parameters as high abundance, biomass, production, food consumption, total and active metabolism, short life cycle and highly diversified trophic relations, nektonic squids plays the role of “accelerators” of the biogeocenological processes, they are some kind of specific **“ecosystem enzymes”!**

## Multistage life cycle as whole

In ecological notion apparatus there are following fundamental ecological notions: **population, its life cycle, ecological niche, life form, community of organisms and ecosystem**. All other notions - about some hundreds - are derived from theirs. I think that we all well know about this terms.

May be need only defined un detail two notions – ecological niche and what is real functional unit in ecosystems.

## Functional unit

In synecology as structural-functional unit used such groups of organisms as **life form** in the broad sense of the term, **trophic level** or **groups**, **functional groups** and **species**. The parameters of these units as rule used by characteristics of adults, or more rarely as separate and opposable each other ecologically specific stages of species life cycles.

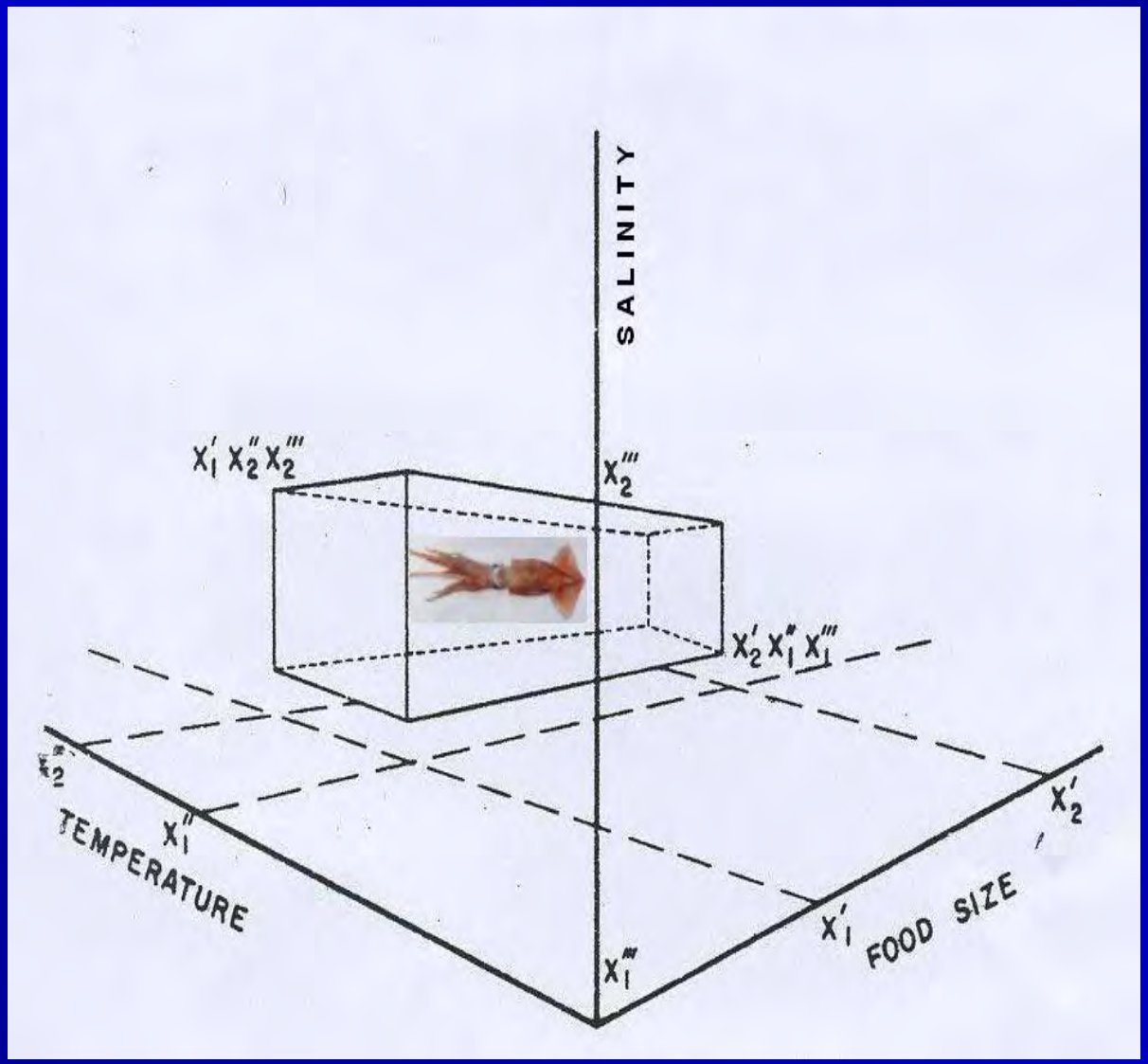
Theirs using is correct for certain type of ecological investigation, firstly on initial descriptive stage of cognition, but they enable only very preliminary and generalized idea on the community structure and its functioning.

But in ecosystems and in biosphere as whole the elementary functional unit is population in its life cycle. That is why for achievement realistic idea we must use as functional unit only population life cycle with accentuates on interacting populations' interfacing in time-space.

- **The ecological niche (EN)**

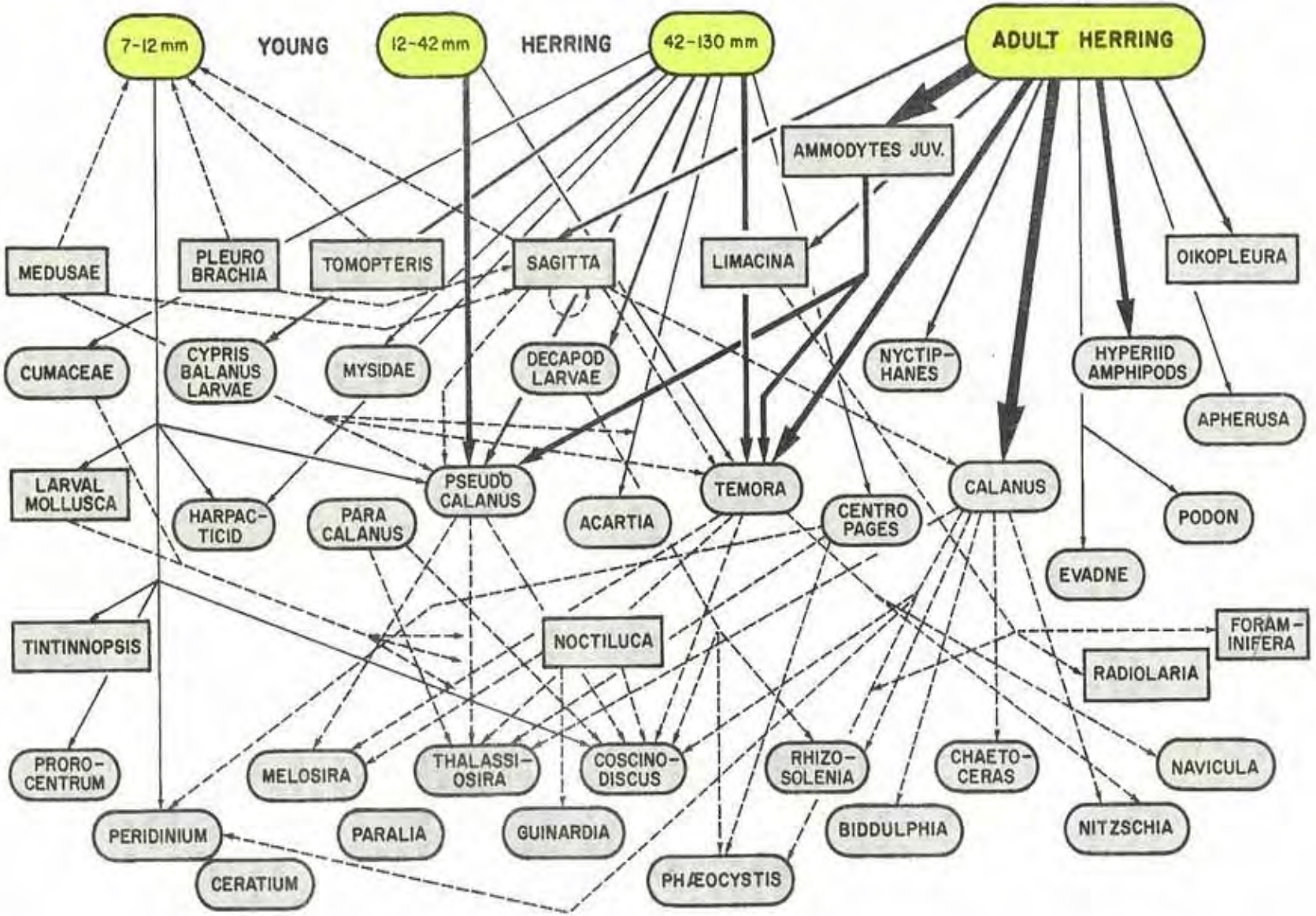
- **George Evelyn Hutchinson** (1944, 1957, 1978) developed formal notion of ecological niche as a hypervolume, a concept which is the base of present niche theory. Each point in this multidimensional space describes states of the environmental variables which a suitable for the survival of given species. Ecological niche is an expression of the location and function of a species in habit as a hypervolume.

# G.E. Hutchinson's model of multidimensional ecological niche (here – three-dimensional)




**Ecological niche is an attribute of population!**

- Population life cycle of most animals is multistage but as whole life cycle has holistic nature. This problem is not developed in literature from theoretical position. In the modern niche theory, the each population life cycle stage has ***own separate ecological niche***. However then we lose sight of the fundamental characteristic of population and its life cycle - its holistic nature.
- In most animal life cycle, the situation is complicated by presence of multiple changes of habitats and characteristics of trophic and other ecological relations. The niche notion for multistage life cycle has intricate hierarchic character and it not developed in framework of modern hypervolume niche concept of Hutchinson (1957, 1978) .

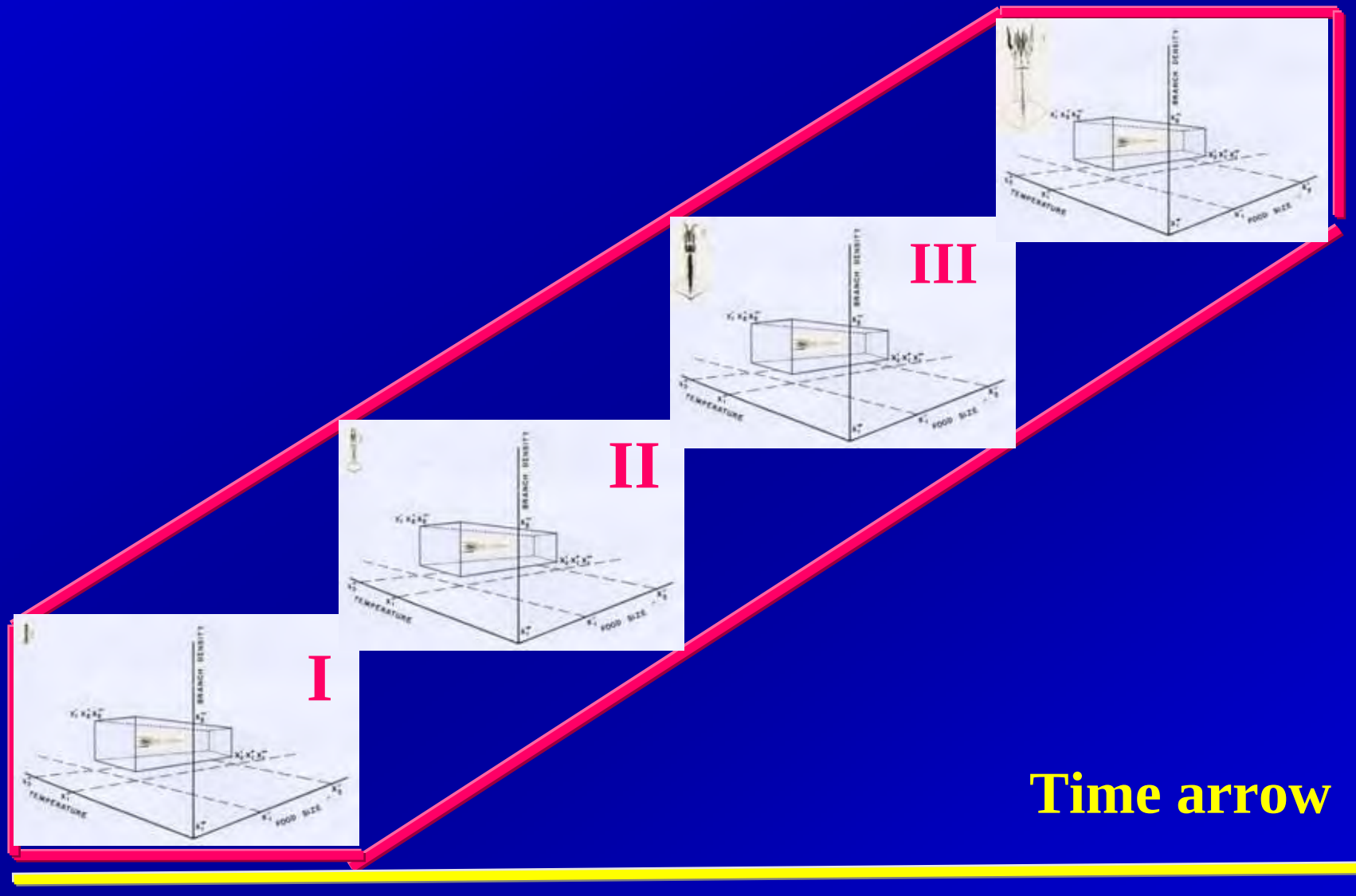



The feeding relations of four ontogenetic stages of herring in the North Sea (by Hardy, 1924)

I propose for system synthesis of main ecological notions, establish noncontradictory notion apparatus and solution the problem of correct relation between multistage life cycle and ecological niche exercise simple procedure:

- in Hutchinson's model of ecological niche incorporate the time scale!
- In this case **the ecological niche** means - **multidimensional space of environmental factors where realized life cycle of population in time scale.**
- **Ecological niche is an attribute of population!**

# Model of multidimensional population ecological niche with stage subniches (I-IV) that integrated in population life cycle

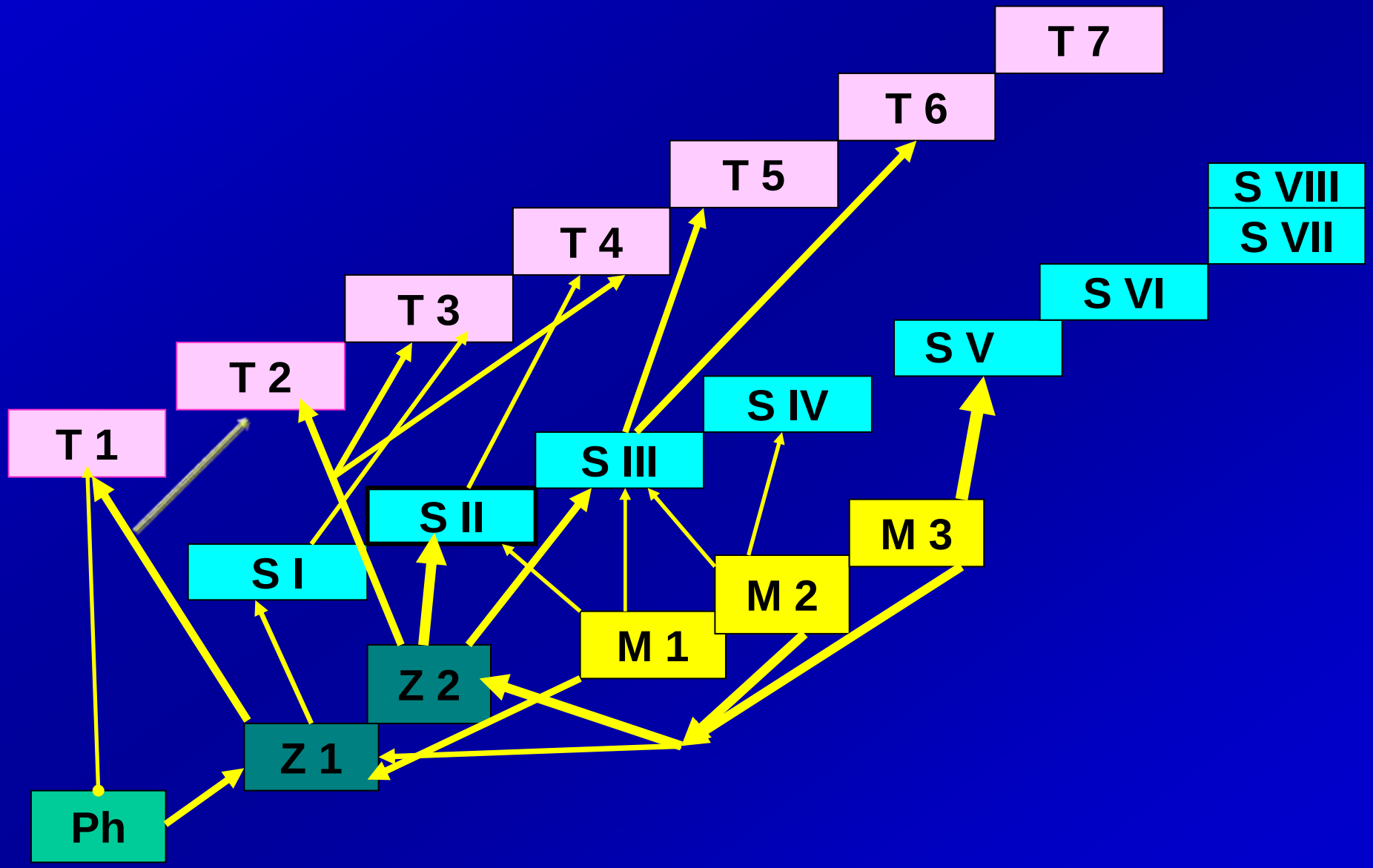


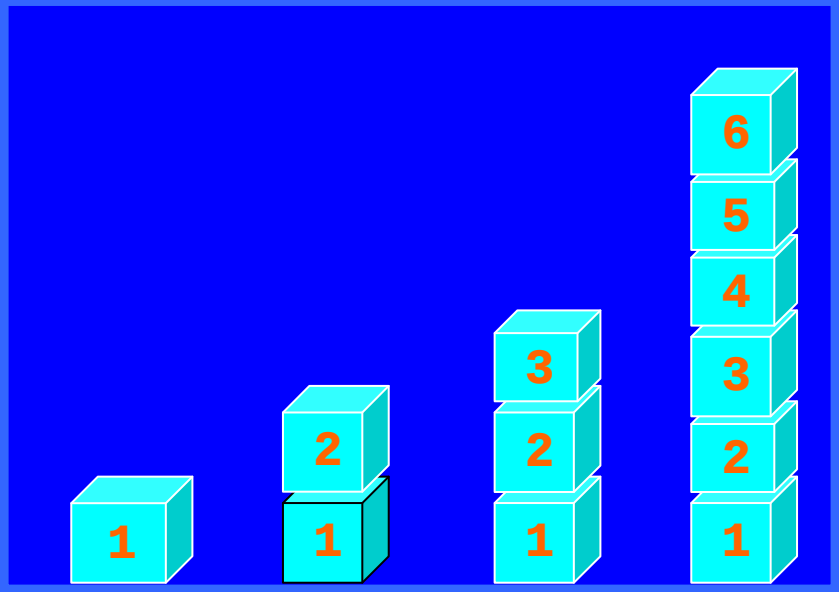
It is first step of this synthesis. The important premise of it is following. The final goal of **population life cycle** is optimal reproduction, and it is elementary unit of selection, evolution and functioning in ecosystem i.e. it is a single whole.

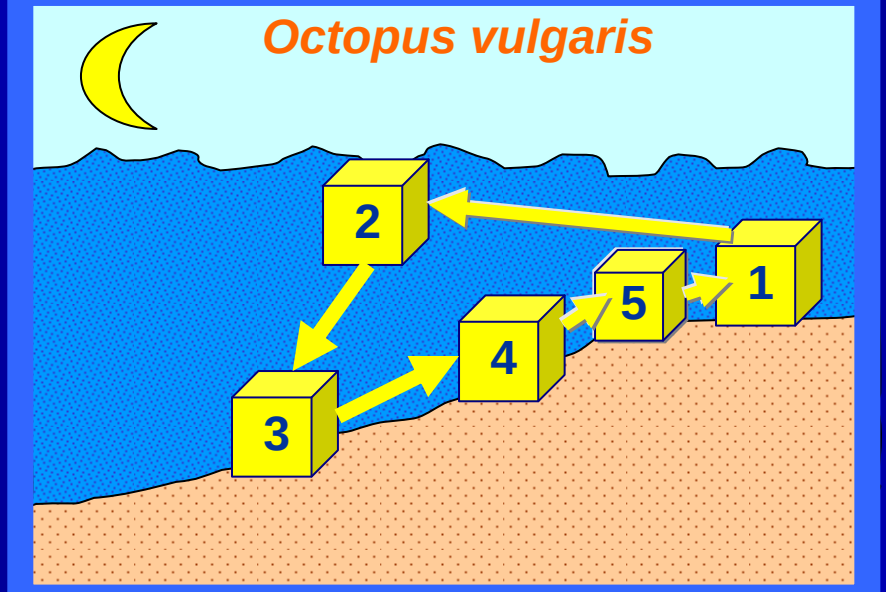
At the same time the multistage life cycle includes some morpho-ecological specific stages that inhabit sometimes very different habitats. Every of these stages is elementary functional and adaptive **subunits**, elementary **life forms** and realized own special role in the “chain” of life cycle.

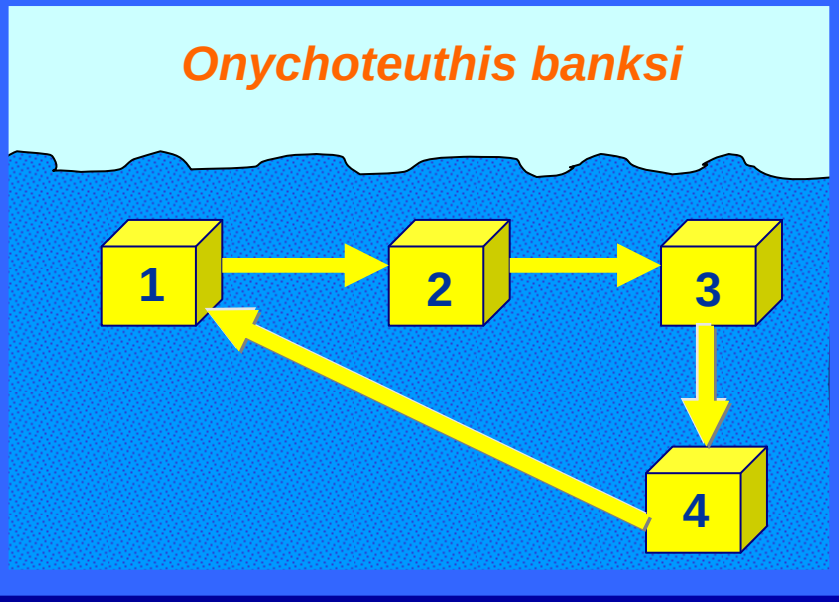
- The holistic population interpretation of niche notion is proposed for consistent system synthesis of basic ecological notions. It is the multidimensional space of environmental factors at what population life cycle is realized in time scale.
- In this case the **population niche** is characterized by its extension during life cycle, which determines the degree and character of genetic and phenotypic determinated variations of niche parameters during life cycle. The number of life cycle stages, and accordingly - the specific parts (levels) of population niche's "channel" is its integral parameter. Therefore each stage has own subniche in total population niche "channel".
- **The community** is considered within the space of environmental factors as system of population niches that at every instant interacting and conjugated on the level of stage subniches.

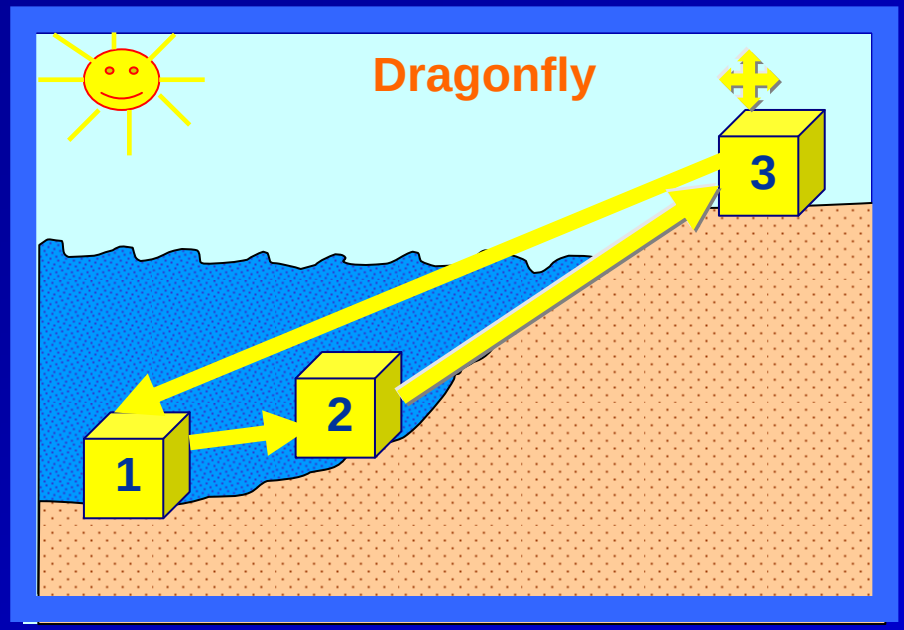
# Ontogenetic evolvent of trophic relations of tuna (T), squid (S), myctophids (M), zooplankton (Z) and phytoplankton (Ph)

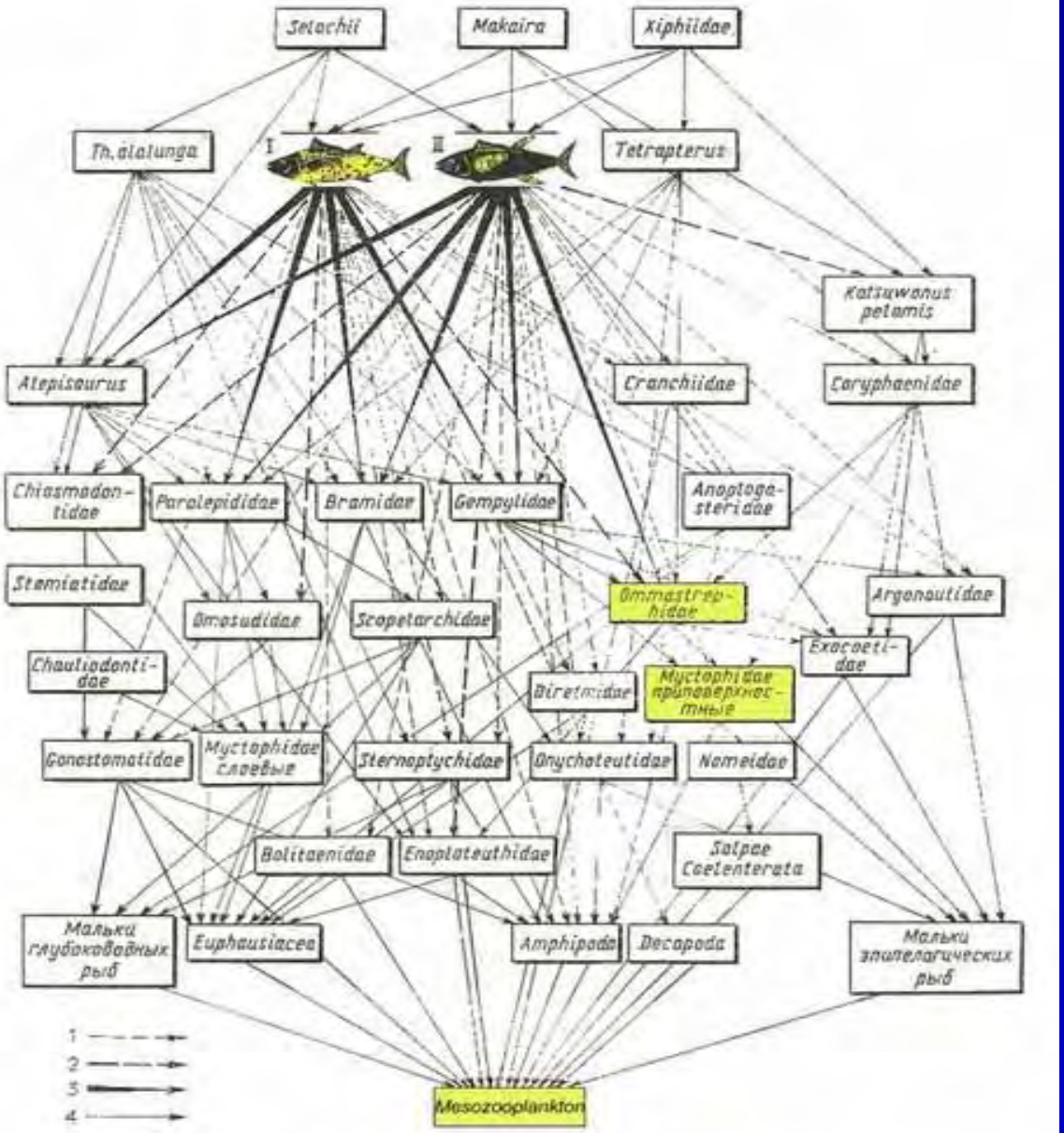



1
2
1
3
2
1
6
5
4
3
2
1


Octopus vulgaris
2
1
5
4
3

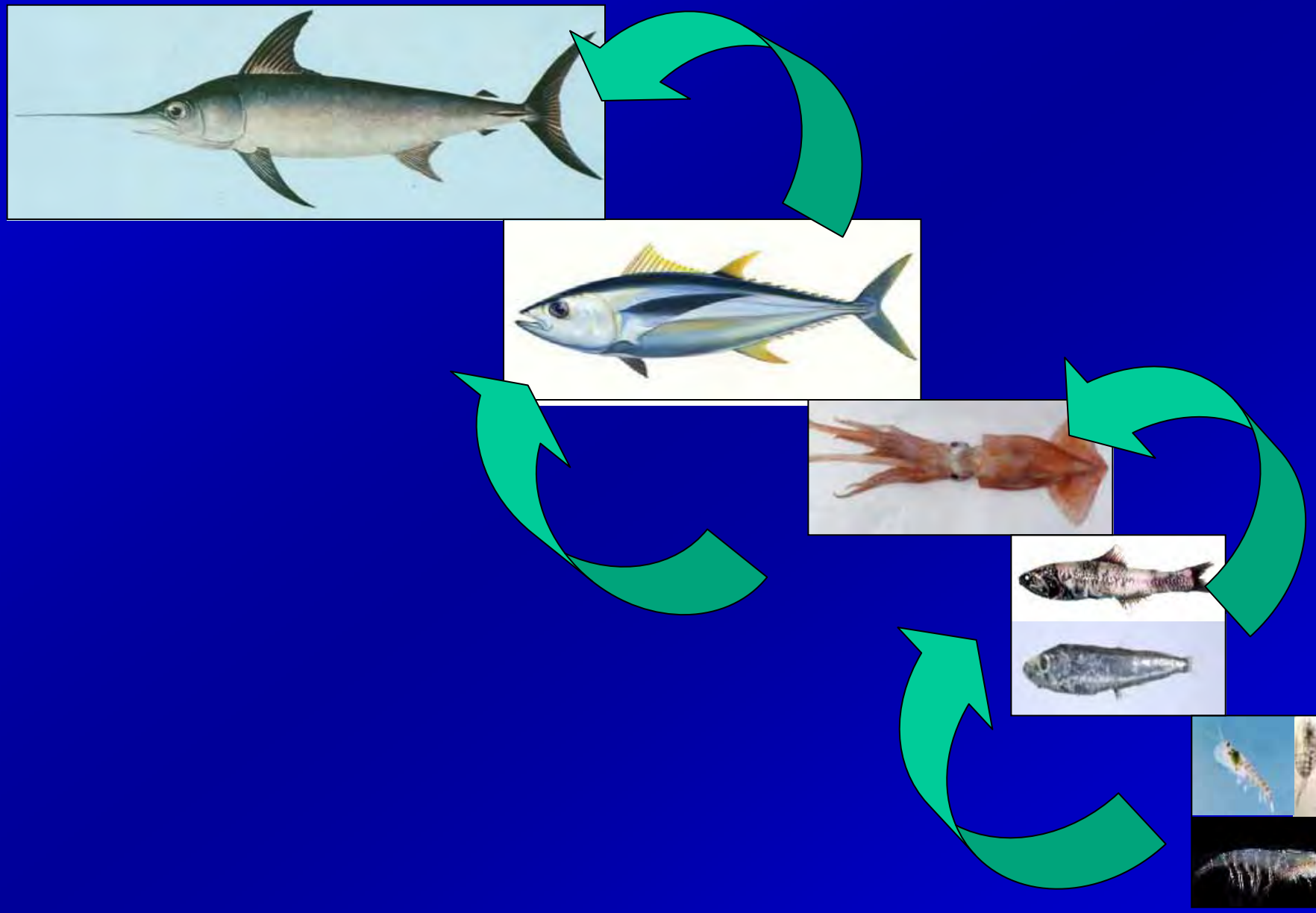

Onychoteuthis banksi
1
2
3
4


Dragonfly
3
2
1

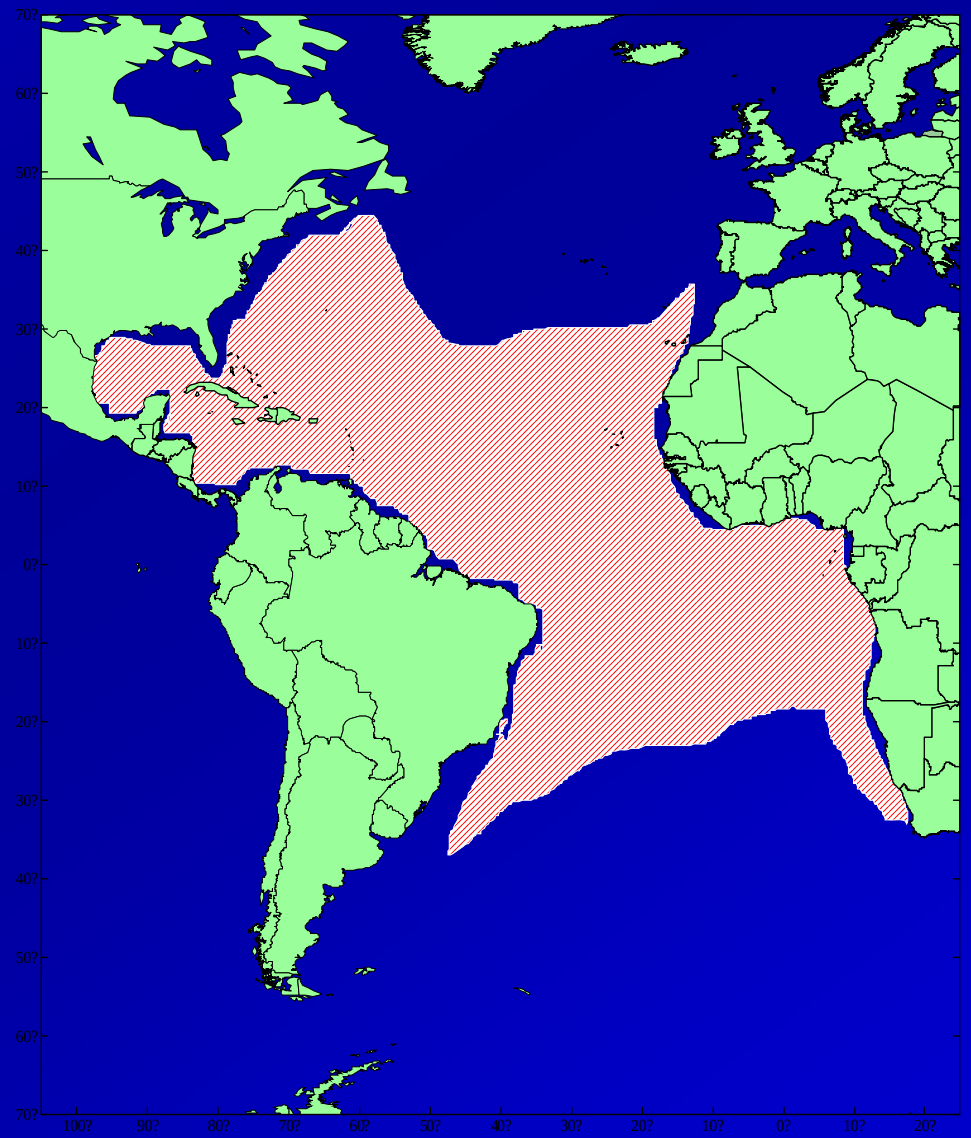



Food web of the community in the open waters of Tropical Atlantic (by Parin, Timonin, 1985)

# Main direction of energy flow from zooplankton to top-predators in epipelagic oceanic communities (by Parin, 1988)

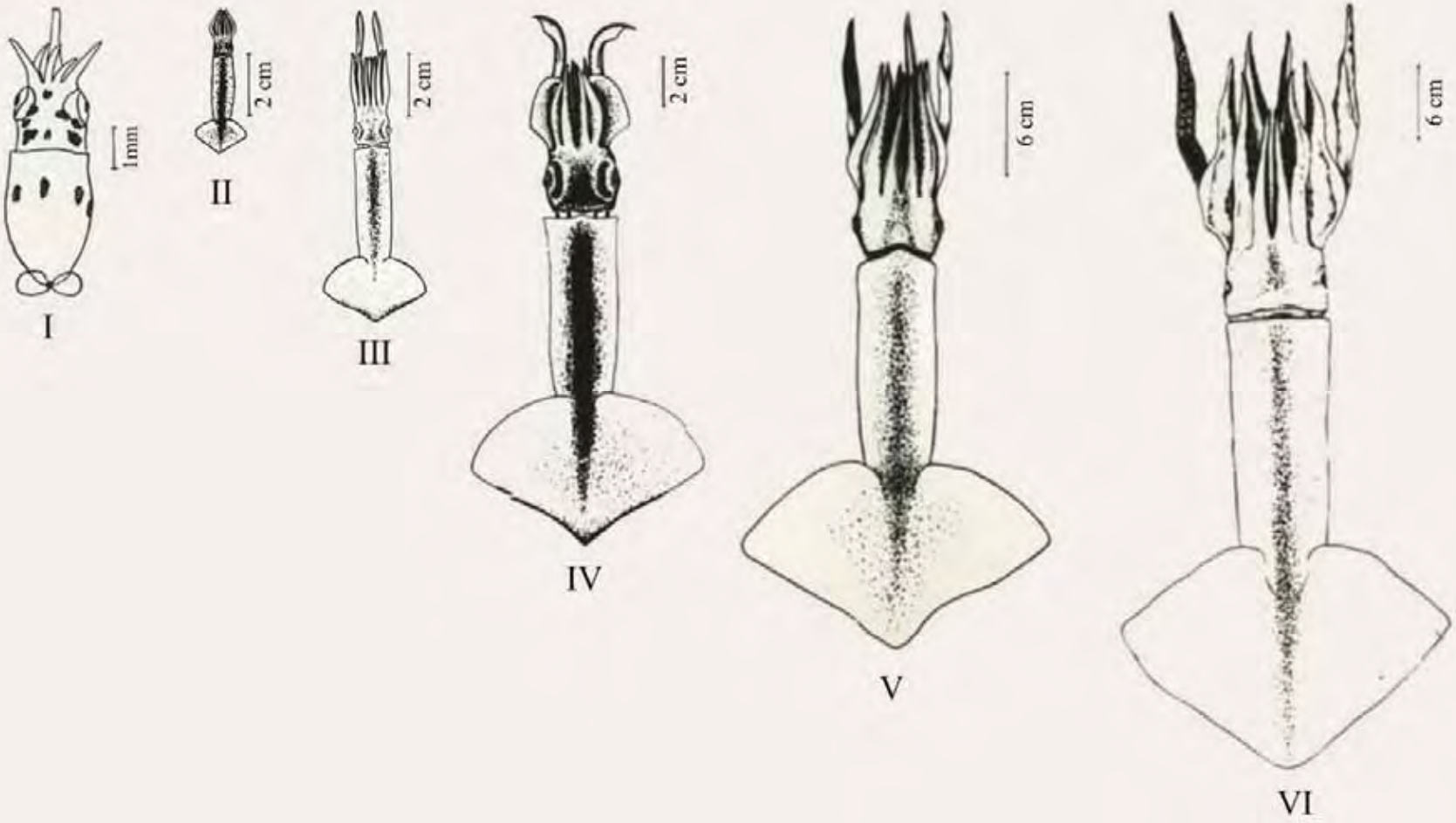


# Orangeback squid *Sthenoteuthis pteropus*

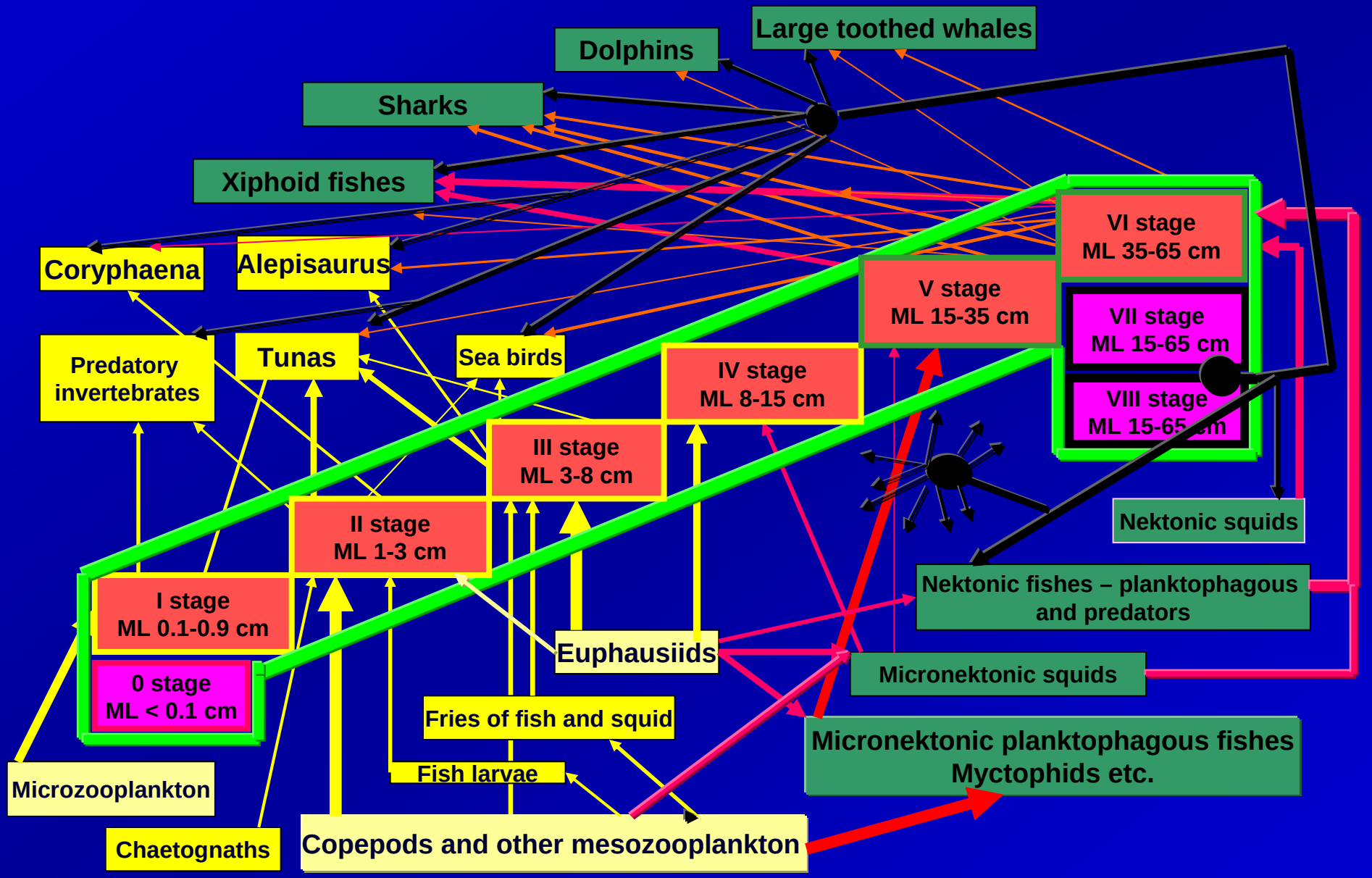


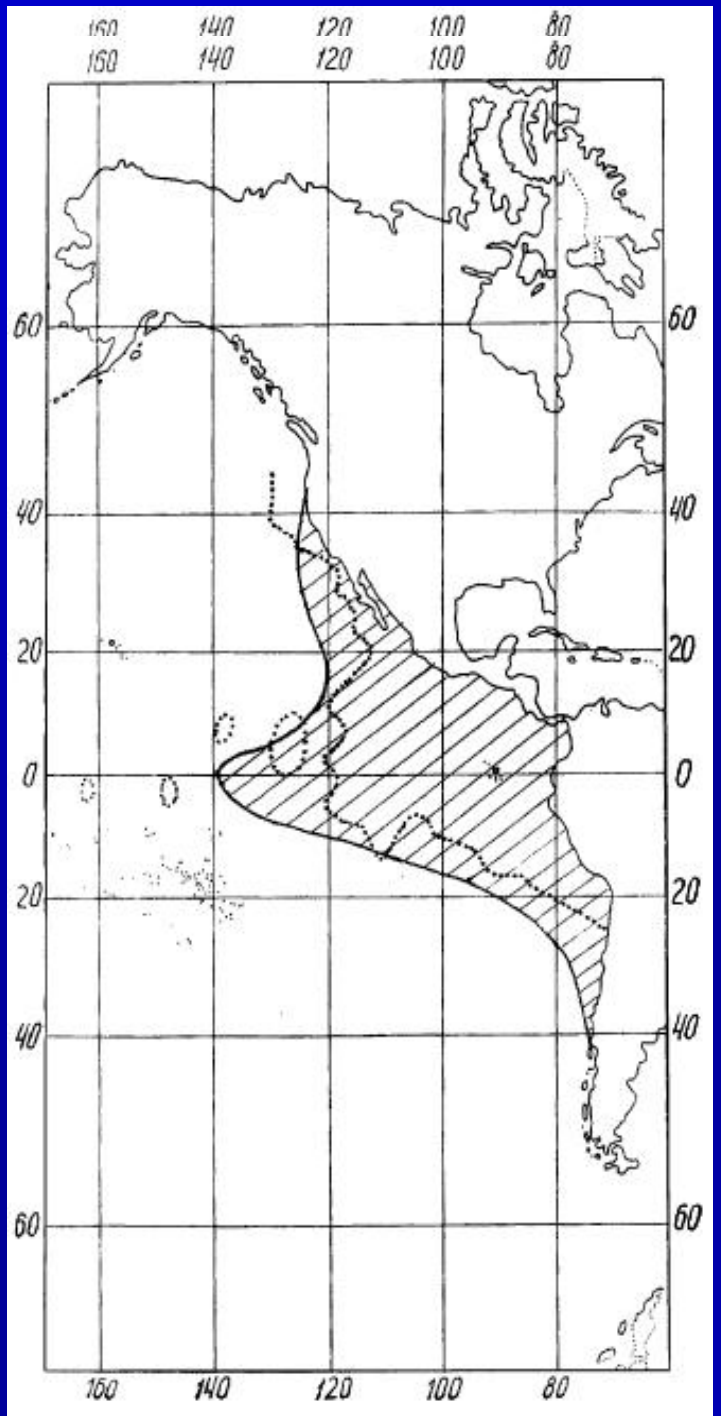

- **Instantaneous biomass 4,2-6,5 million tons Annual production about 34-52 million tons**

# Habitus of the orangeback squid's different ontogenetic stages



# Four directions of energy flow from zooplankton to top-predators via orangeback squid

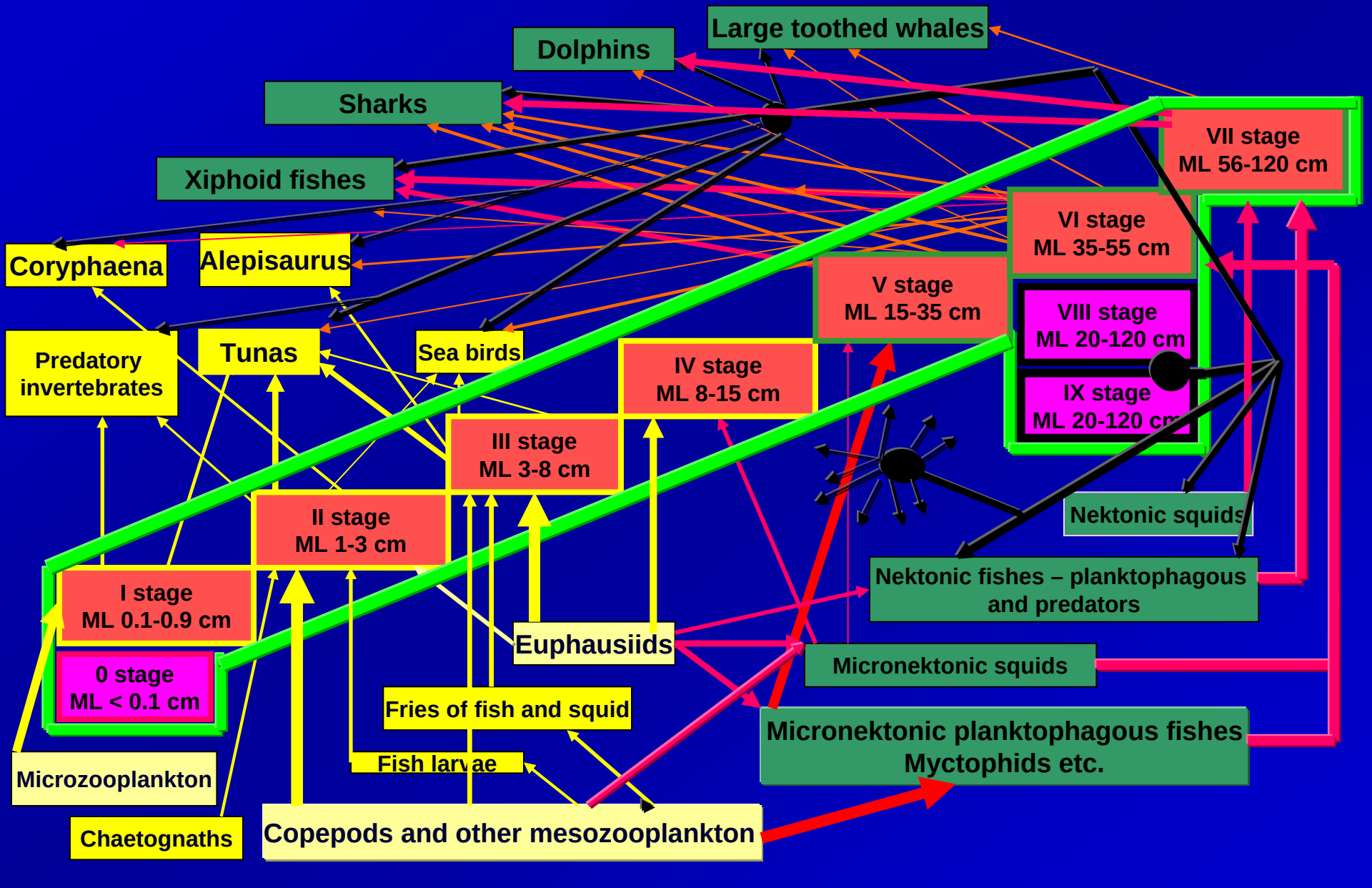




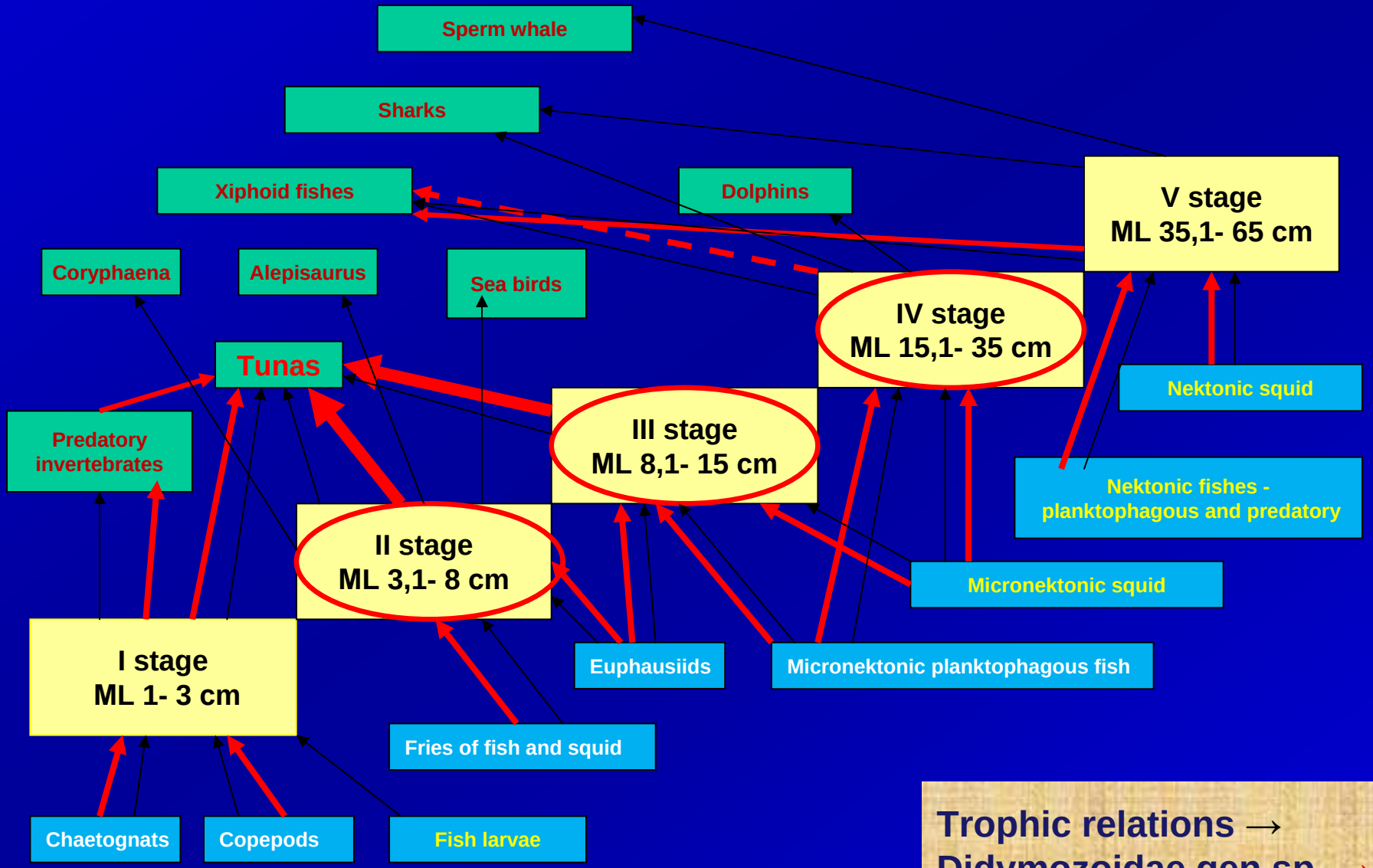

# Range of Jumbo squid

.It is one of the largest and abundant nektonic squid with a mean standing biomass estimated to be on the order of 8-12 million tons. It is one of the key species in ecosystems of tropical and subtropical Eastern Pacific.

# Four directions of energy flow from zooplankton to top-predators via Jumbo squid

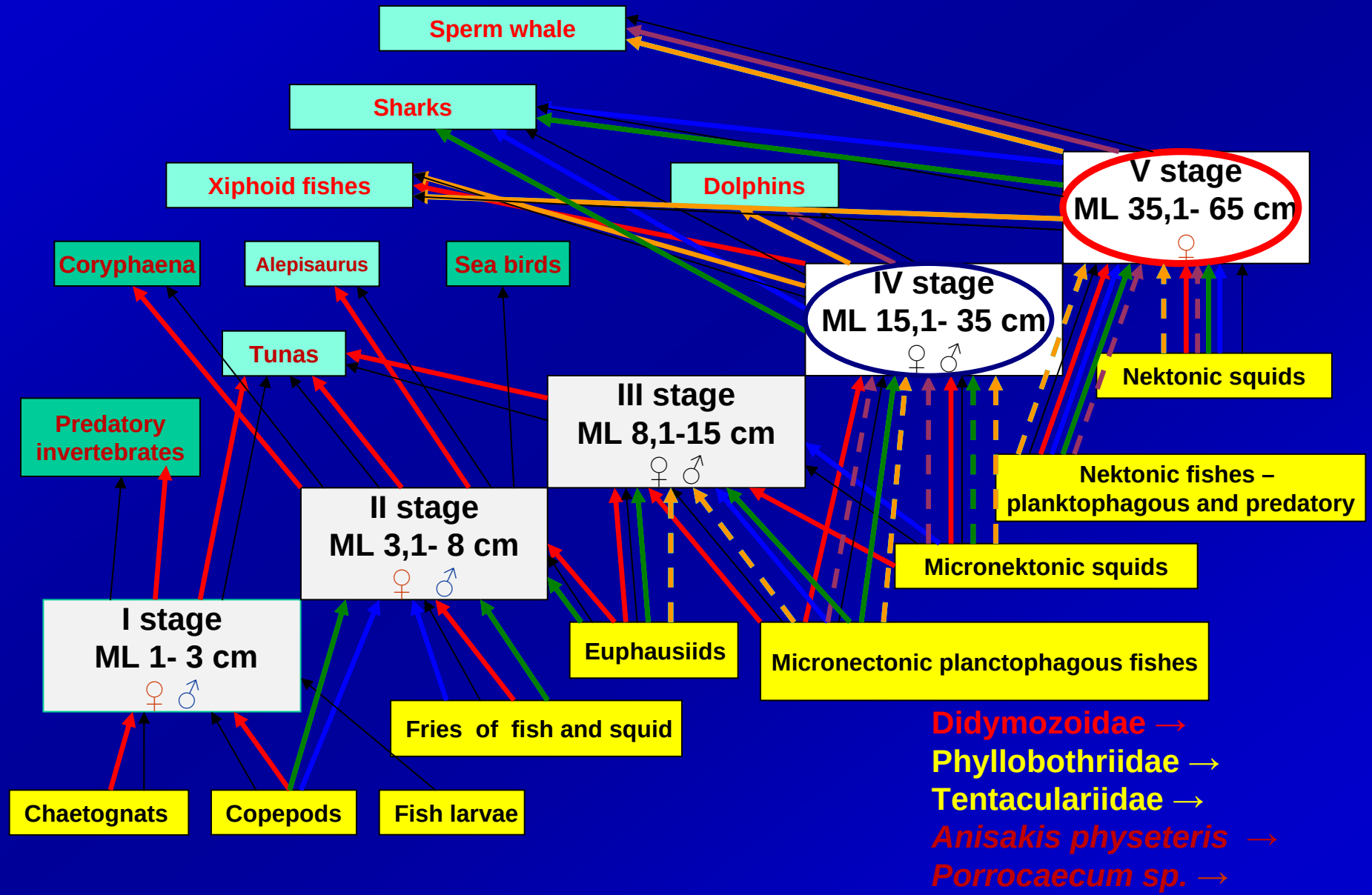


# Trophic relations of oceanic nektonic squids and ways of life cycle realization of trematodes family Didymozoidae

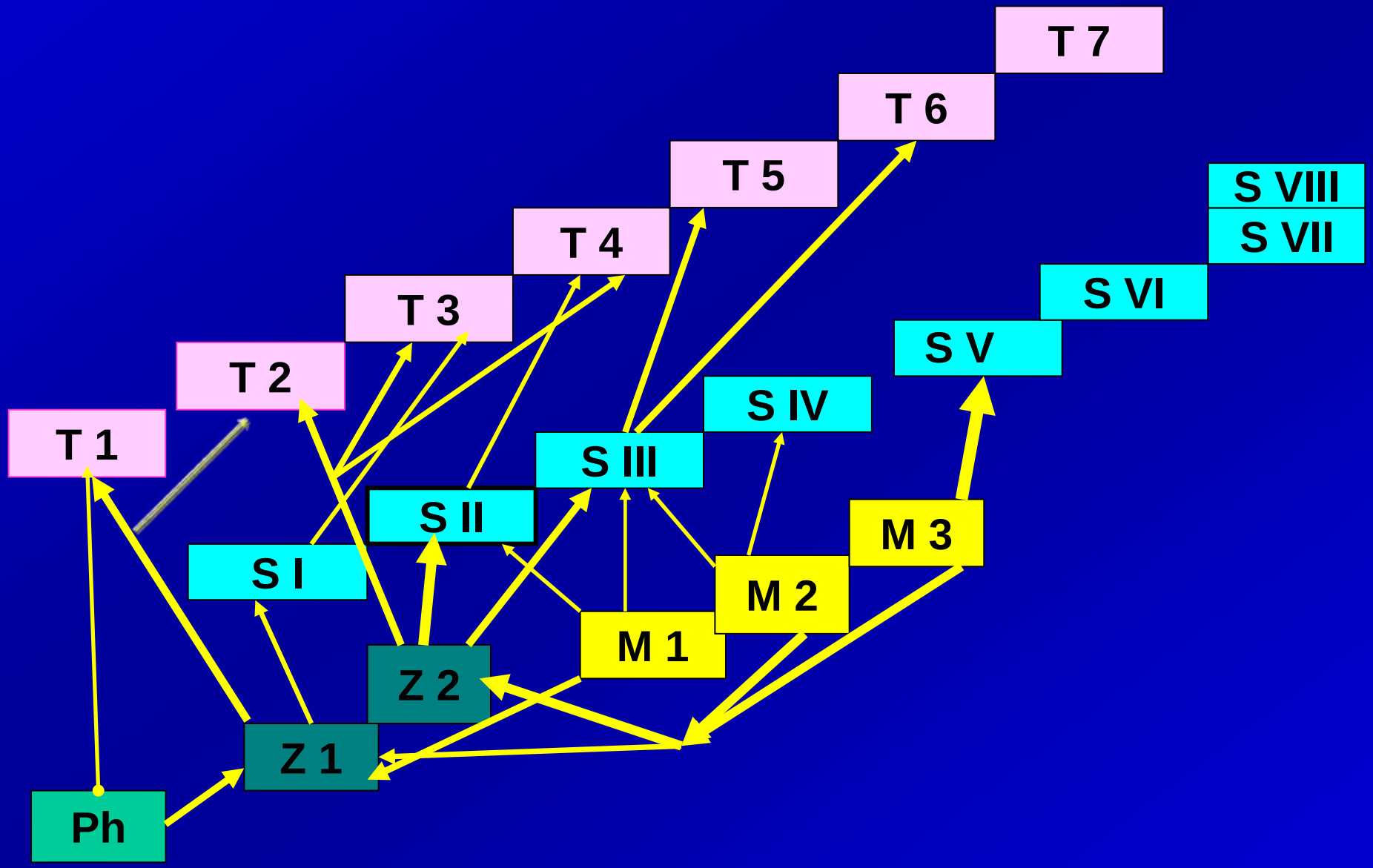



Trophic relations →
Didymozoidae gen.sp. →

# Trophic and parasite relations in oceanic nektonic orangeback squid *Sthenoteuthis pteropus*



# Ontogenetic evolvent of trophic relations of tuna (T), squid (S), myctophids (M), zooplankton (Z) and phytoplankton (Ph)



In conclusion need to stress that the signs of crisis in ecological theory were sensed in the 1940-1950s by outstanding ecologists - Danish **Gunnar Thorson** and Russian **Vladimir Beklemishev**.

They both independently see the main direction of progressive development of ecological theory in study of interfacing of interacting population life cycles!

This approach give real possibility for that.

**This approach may optimize the cognition of real structure and functioning of communities, real populations life cycle structure, their evolution and comprehend its real results in synecological context.**

**And this approach make it possible for convergence and productive relationships of population biology and synecology.**

- **This approach may be effective for planning population and synecological investigations.**
- **But realization in life of this approach is very difficult and takes vast and detail field and laboratory efforts with parallel study of different life cycle stages.**
- **But I think that here is the potential “growing point” for disaffiliation with crisis of theory of ecology, and in particular population biology, synecology and modelling of communities.**