Feeding ecology of larval and juvenile black snake mackerel (*Nealotus tripes*, Gempylidae) and their roles in the fish communities of the Kuroshio Extension Region

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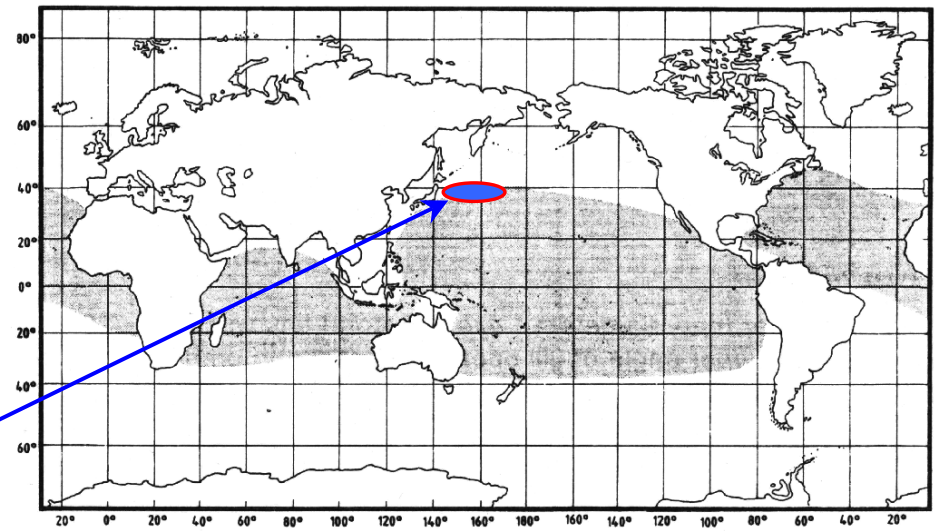
Ecological Feature (1)

Black Snake Mackerel (*Nealotus tripes*)

Geographic Distribution: Tropical and temperate waters of Indo-Pacific and Atlantic oceans.

Biomass: Unknown, but larvae and juveniles (ca. <40 mm) **sometimes dominants thirdly to Japanese anchovy and myctophids in the Kuroshio Extension Region** (Kubota *et al*., 2001).



Geographical distribution of black snake mackerels (Nakamura and Parin, 1993)

Ecological Feature (2)

Vertical distribution:

Larvae and Juveniles (ca. <40mm):

Epipelagic. Mostly live in upper 30 m depth. The pattern is **similar to that of Japanese anchovy**.

Feeding Habit:

Adults and Young:

Mainly euphausiid and myctophid.

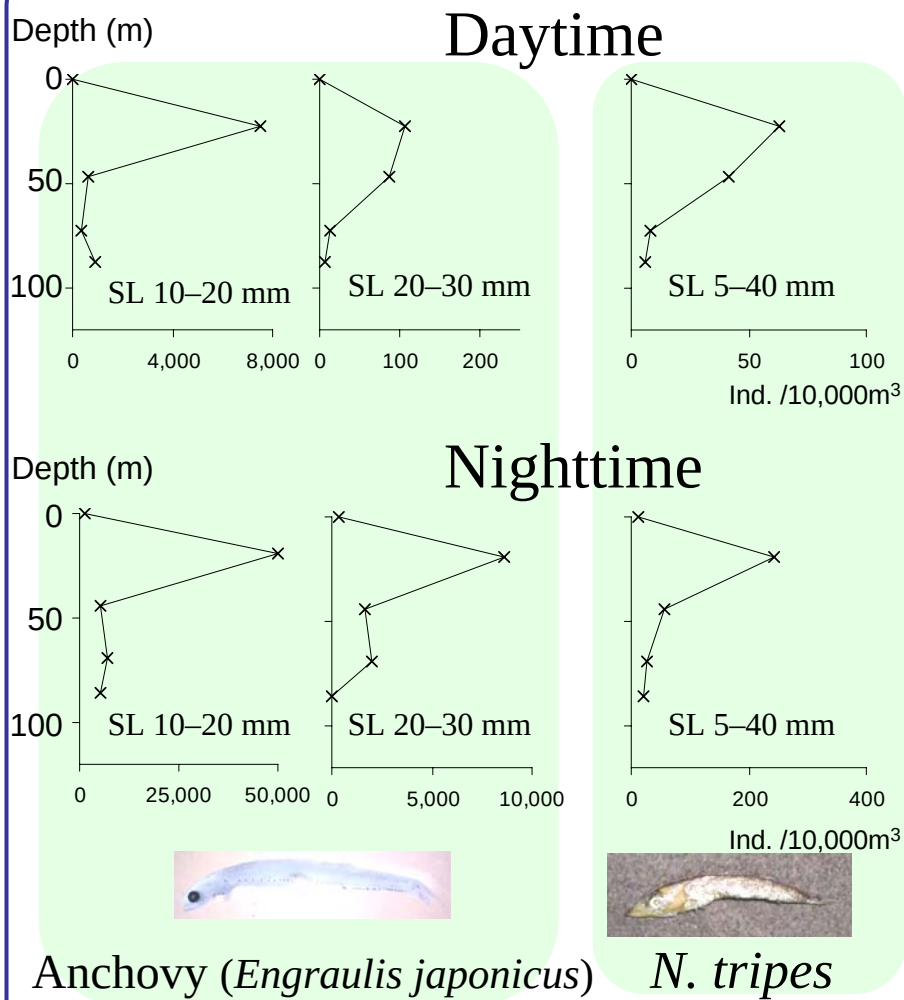
Also feed on squids, larval anchovy and crustaceans (Yamashita and Yatsu, 2005).

Early larvae (ca. <7 mm) :

Mainly copepods (Matsuzaki and Ozawa, 1997).

Juveniles :

unknown, but assumed gradually change to **picsivorous**.



Vertical distribution of anchovy and black snake mackerels (larvae and juveniles) in Kuroshio Extension in May, 2000. (Kubota *et al.*, 2002)

Juveniles of black snake mackerel are...

(1) One of the major species in Kuroshio Extension.

(2) Probably piscivorous.

(3) Living in similar layer to anchovy larvae.

Important as one of predators of anchovy larvae?

The objectives of this study are...

(1) To clarify the feeding habit of black snake mackerel juveniles.

(2) To estimate how much they feed on anchovy larvae.

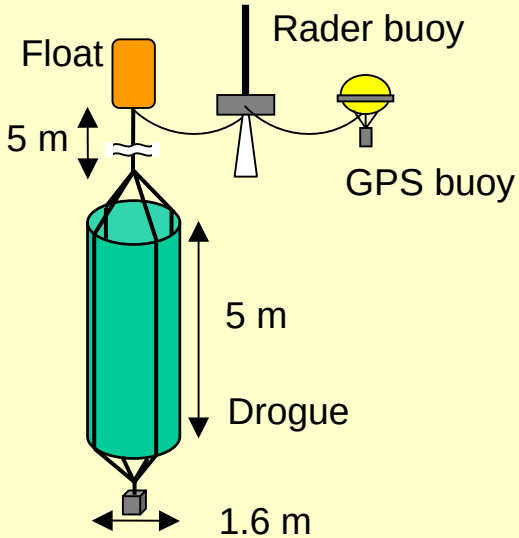
Study Area and Sampling Procedure

Kuroshio Extension Region
May 14th-15th, 2001, R.V. Soyo-Maru

Requirements for sampling procedures

Feeding rhythm
Daily consumption
← 24 hour sampling in short time interval

Different densities depending on the oceanographic structures
← Need to find dense area of pelagic larvae

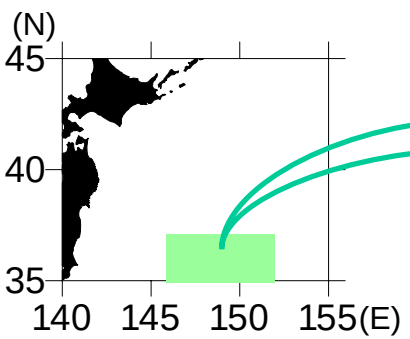


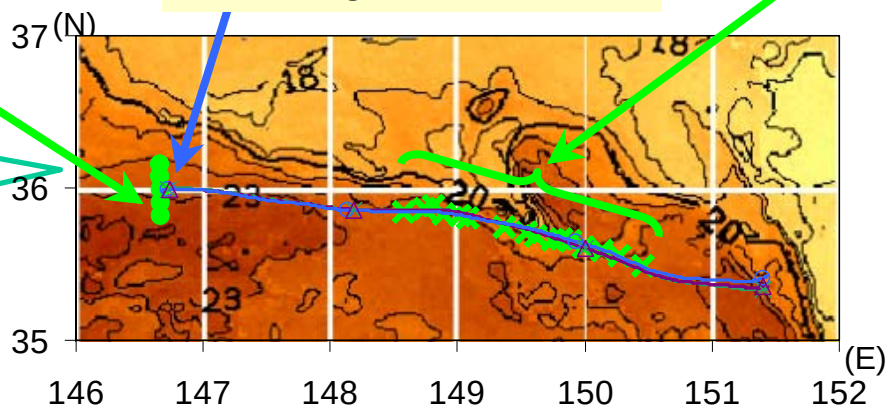
Found dense area

Obtained 16 samples in the 24 hours.

Exploratory research

Deployed 3 buoys with drogue at 5 m

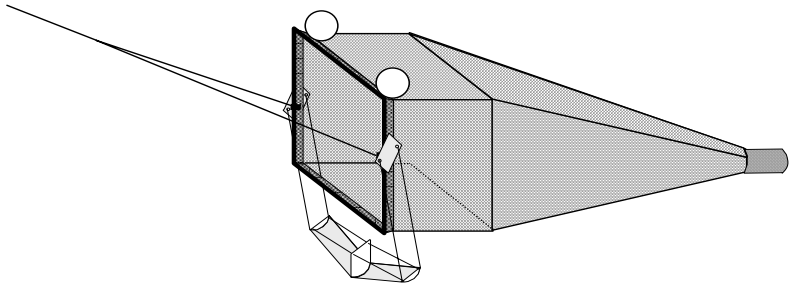




Sampling Gear

Newly Developed Frame Trawl for Larvae and Juvenile Sampling (Oozeki *et al*., 2004)

Net opening: 5 m^2 (2.24 x 2.24 m)
Mesh size: 1.6 mm square
Net length: 12 m
Mouth / mesh opening area ratio: 8.8



Stomach Contents Analysis

71 individuals were analyzed.

Measured Sections

>Standard length (SL, mm)

Dry body weight (mg)

>Stomach fullness index

(Qualitatively ranked as none, none to half, half to full)

Hole stomach contents volume

>Every contents volume

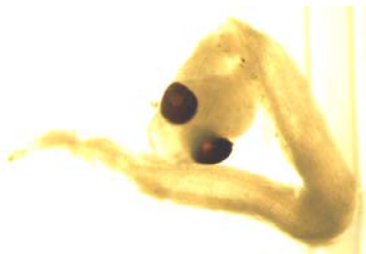
(from body length and width of items)

Relative stomach contents weight

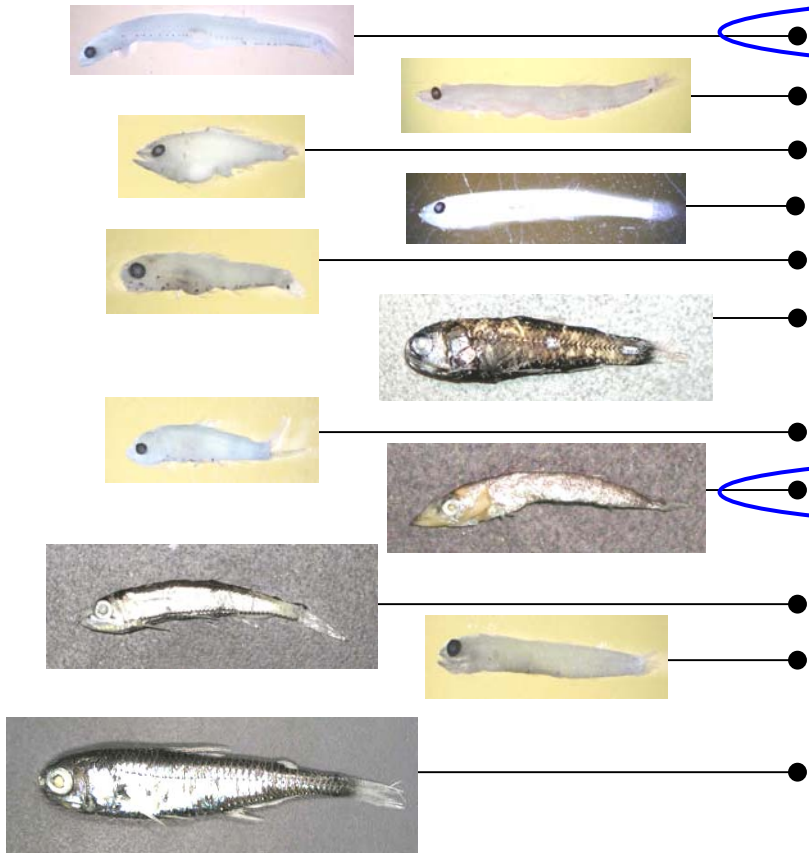
(= 100 x contents dry w / body dry w)

>Volumetric ratios of contents

>Daily food consumption (two methods)



Total Fish Caught by the Frame Trawl



Species	Stage	Density	%
Engraulis japonicus	L	176	16.6
Vinciguerria nimbaria	L	174	16.4
Myctophum asperum	L	75	7.1
Sigmops gracile	L	75	7.1
Diaphus kuroshio	L	71	6.7
Diaphus kuroshio	J	46	4.3
Lampanyctus spp.	L	42	4.0
Diaphus garmani	L	42	4.0
Nealotus tripes	**L-J**	**40**	**3.8**
Scopelosaurus spp.	L	38	3.6
Vinciguerria nimbaria	J	38	3.6
Ceratoscopelus warmingii	L	24	2.3
Vinciguerria attenuata	L	17	1.6
Myctophum asperum	J	15	1.4
Other fish		189	17.8
Total		1062	1.0

Major fish caught by the total 16 frame trawl tows at the station.

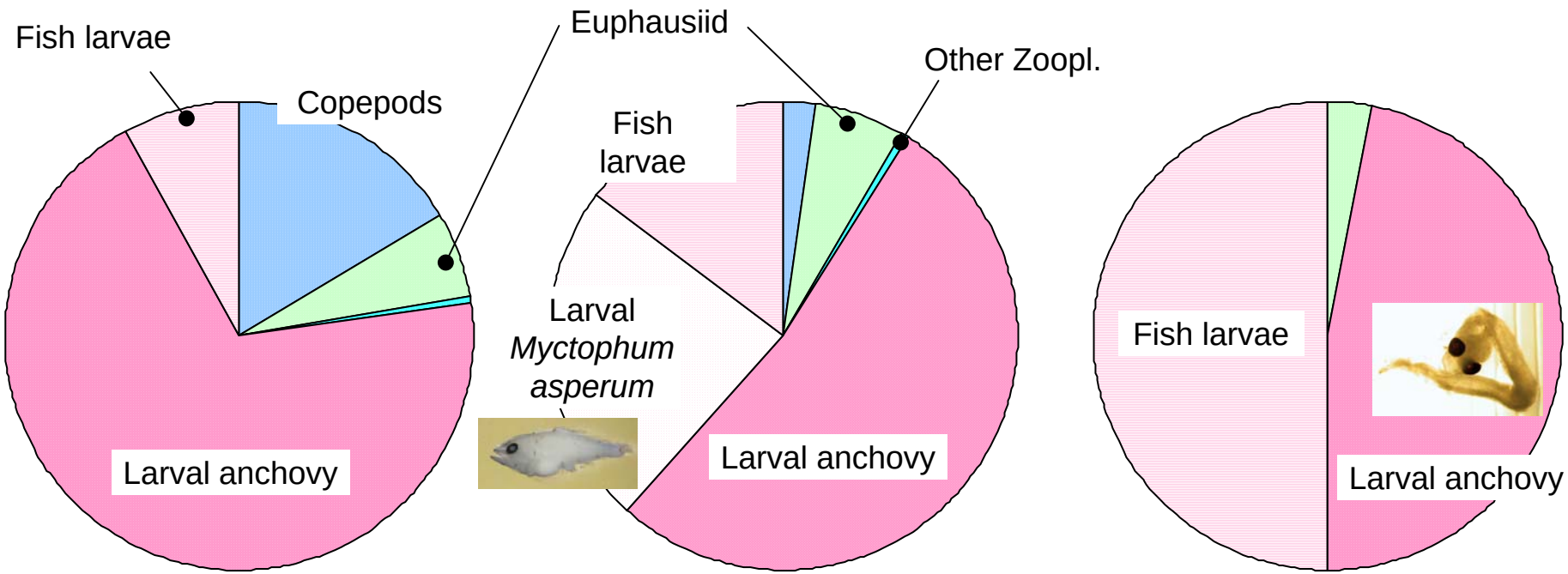
Larvae (L) and Juveniles (J) were treated separately for Micronekton. Density; individuals per 10,000 m^3.

- **Larval anchovy was less than the other years (ca.50-80% of total).**
- **Black snake mackerels consisted of about 4 % of total fish density.**

Size Frequency Distribution

Frequency distribution of standard length of black snake mackerel

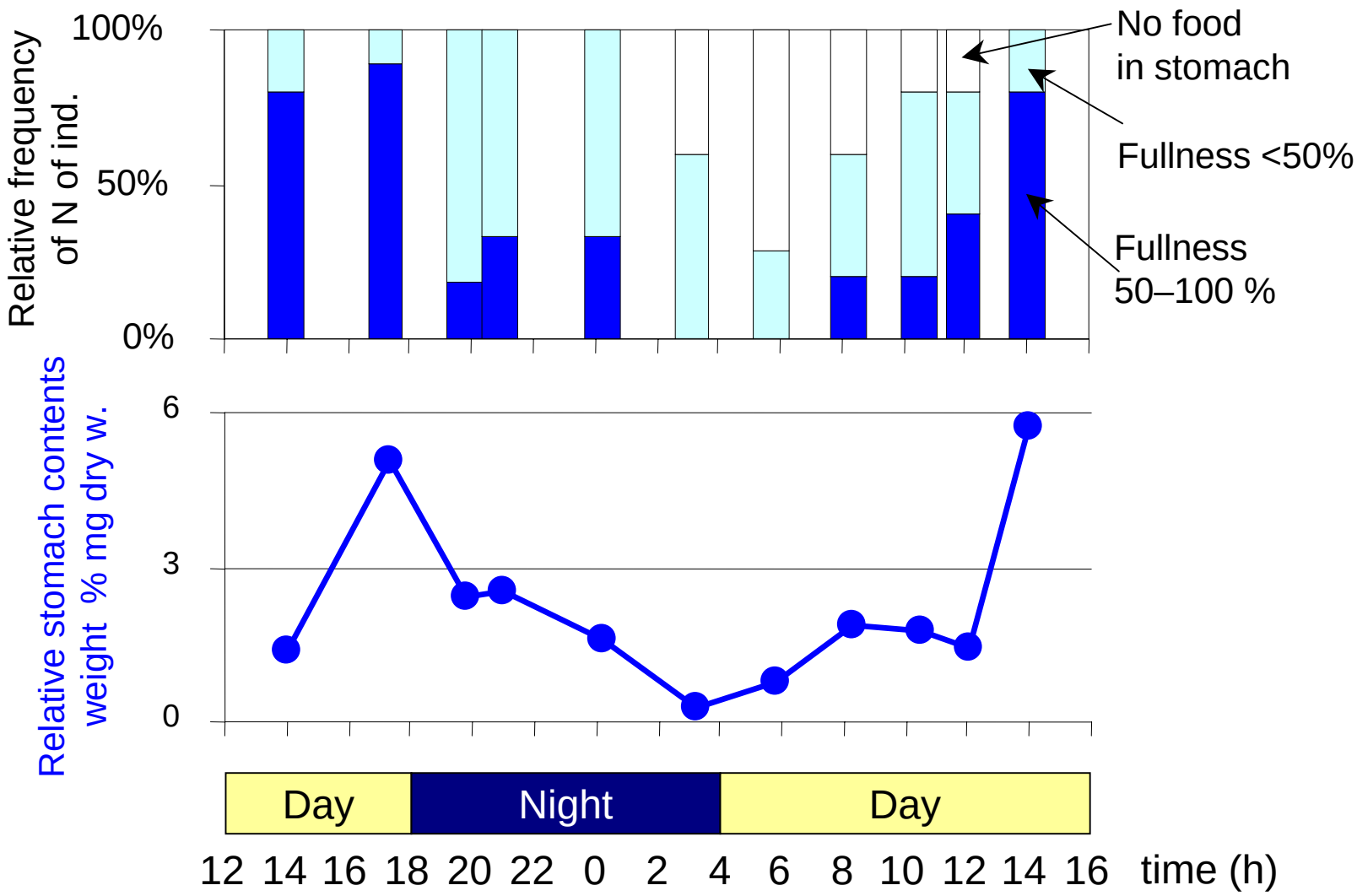
Prey Composition



Volumetric ratio of stomach contents of black snake mackerel.

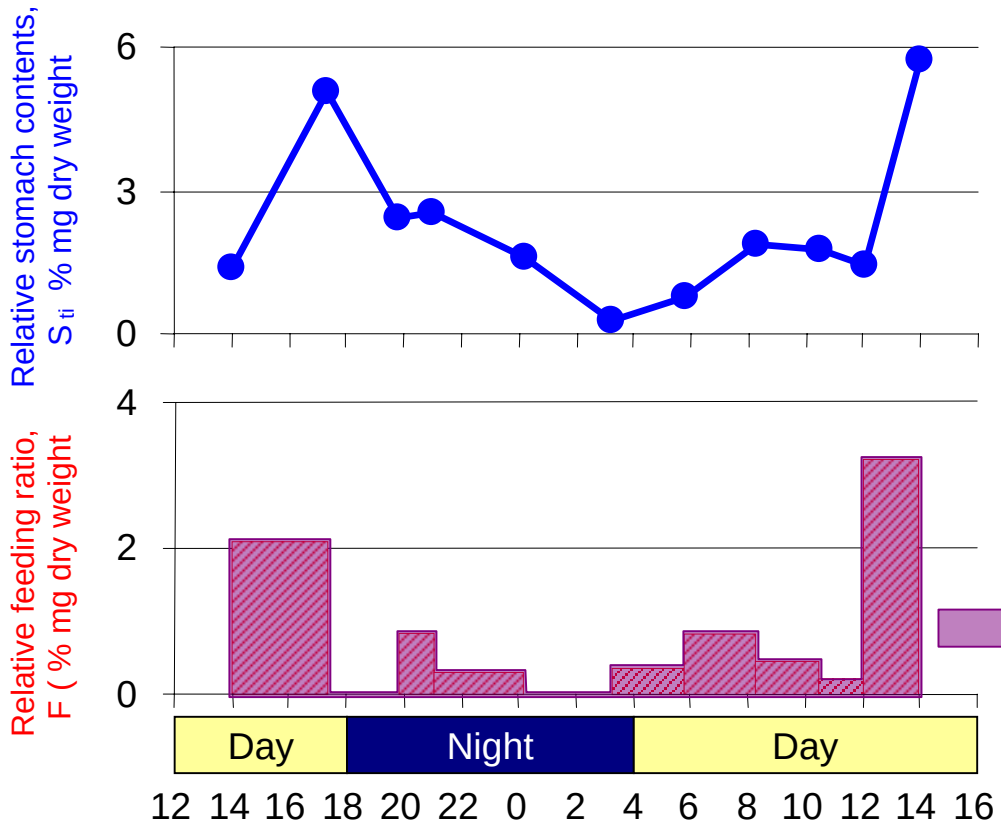
- **Start feeding on fish before metamorphosis to juvenile (12–13 mm in SL).**
- **Larval anchovy from stomach were 3.5–12.5 mm in SL.**

Feeding Rhythm



Feed on mostly at daytime

Daily Food Consumption (Method 1)



Based on the method of Elliott and Persson (1978)

$$F = \frac{\left(S_{t_i} - S_{t_{i-1}} e^{-R(t_i - t_{i-1})}\right)}{1 - e^{-R(t_i - t_{i-1})}} R$$

$$C_{t_i - t_{i-1}} = F(t_i - t_{i-1})$$

Daily food consumption rate $= \sum_{i=1}^{n} C_{t_i - t_{i-1}} =$ **19.6**

R : Gastric evacuation rate = 0.286 .Estimated from decreasing curve of relative stomach contents weight at nighttime)

F : Relative feeding ratio in a hour

$C_{t_i - t_{i-1}}$: Relative food consumption between C_{ti-1} and C_{ti}.

S_{ti} : Relative stomach contents weight at time t_i.

Feed 19.6 % of body weight per day.

Daily Food Consumption (Method 2)

Based on the bioenergetics

Daily food consumption ratio $_{(mg/mg/day)}$ = (G+R)/A

(G; Growth ratio, R; Respiration ratio, A; Assimilation ratio)

Weight specific growth rate = -0.0036 + 0.0094 x T (T = Water temperature ^{o}C)

$G_{(mg/mg/day)}$ = exp(Weight specific growth ratio) - 1

$R_{.mg/mg/day.}$ = 24 x Q_{O_2} x Q_{OX} / Calorie of preys

A = 0.641 (Assimilation ratio of larvae at 20 ^{o}C)

Q_{O_2} (μLO_2/mg/h) = 2.3553 . 0.2209 x .. **(Houde 1989)**

Q_{OX} ($cal/\mu LO_2$) = 0.00463 (Brett and Groves 1979)

Calorie of preys = 5.4 cal/mg (Northern Anchovy (*E. mordax*).Theilacker 1987)

T: = median depth temperature of vertical distribution (20.75 ^{o}C)

Feed 55.2 % of body weight per day.

Discussion

How much anchovy larvae fed by black snake mackerel?

(1) Daily food consumption ratio: **19.6 to 55.2 %**.

(2) Ratio of larvae in the stomach of black snake mackerel: **91.2 %**.

(3) Larval anchovy biomass (<15 mm SL): **3.0 mg/m^2 in d.w**.

(Estimated from a 1/4 m^2 MOCNESS sample towed at the station at night)

(4) Black snake mackerel biomass (<40 mm SL): **1.42 mg/m^2 in d.w.**

(Estimated from 5 m^2 frame trawl samples towed at the station at night)

Larval anchovy was fed 8.4 - 23.8 % by black snake mackerel juveniles.

Summary

Feeding habit:

Feed at **daytime**. Start feeding larval anchovy from late larval stage, and mostly **piscivorous at juvenile stage**.

Daily Food Consumption:

Between **19.6 - 55.2 %** per dry body weight.

Impact on the mortality of anchovy larvae:

Estimated as **8.4 to 23.8 % of the larval anchovy (< 15 mm) will be fed** in a day. It will be **not negligible** for larval anchovy survival in the case of our study.

For More Studies:

Studies coupled with the **interannual variations of abundances** of larval anchovy and black snake mackerel will be needed to evaluate how its feeding impact affect on the anchovy resource dynamics.