Reproductive biology of *Benthosema pterotum* (Myctophidae) in the shelf region of the East China Sea

Chiyuki SASSA, Seiji OHSIMO, Hiroshige TANAKA, and Youichi TSUKAMOTO

Seikai National Fisheries Research Institute, Fisheries Research Agency, 1551-8 Taira-machi, Nagasaki 851-2213, Japan, csassa@fa.afrrc.go.jp

1. Introduction – biology of *B. pterotum*

Distribution and biomass

Myctophid fishes are one of the most abundant and widespread mesopelagic fish groups in the world oceans, being key species in ecosystems. Of these, some species occur associated with submerged bottom features such as islands, seamounts, and continental edge-shape regions (so-called pseudofaeces species). *Benthosema pterotum* is a typical pseudofaeces myctophid, and dense distributions were observed in the ECS shelf (mainly 40–90 m depth) in all seasons. The biomass was estimated in the order of several thousands to 14,000 tonnes in April to July, and declined during August to December, indicating storage of energy for reproduction.

Trophic position in the food web

*B. pterotum* occurs in the epipelagic layer at night, and shifts down to the benthopelagic layer during the daytime to form dense aggregations. The prey items of *B. pterotum* are mainly composed of zooplankton. *B. pterotum* forms a major prey item for both pelagic and demersal fishes, including many commercially important species in the shelf region of the ECS. Therefore, this species is a key species acting as an important link between secondary producers and upper trophic levels.

2. Sample collection & general biological data

*B. pterotum* were collected during 31 cruises in the shelf region of the ECS and its adjacent area in 1899 and from 2004 to 2009. A total of 3,065 specimens ranging from 10.7 to 54.8 mm standard length (SL) were used in this study.

The SL, body weight (BW), gonad weight (GW) and liver weight (LW) were measured and sex was determined for all specimens. Gonadosomatic index (GSI) and hepatosomatic index (HSI) were calculated using the following equations:

\[ \text{GSI} = \frac{\text{GW}}{\text{BW} \times 100} \]
\[ \text{HSI} = \frac{\text{LW}}{\text{BW} \times 100} \]

3. Sex ratio

In fish >74 mm SL, it was possible to distinguish between the sexes. Between 14 and 30 mm SL, the ratio of females to males was ca. 50%, it increased with SL and all individuals >24 mm SL were females.

The preponderance of females over males was significant throughout the year, i.e. there were more females than males.

4. GSI vs. developmental stages of gonad

(a) The GSI was positively correlated with gonad stages in both sexes.

(b) The GSI at 50% sexual maturity (GSI50) of females and males was 3.91 and 8.24, respectively, based on fitting to a logistic function.

(c) The GSI in males was much lower than females, as reported for several other myctophid species.

5. GSI vs. body length – size at maturity

Based on the GSI-body length relationships and GSI50, females and males can mature at sizes larger than 28 mm and 24 mm SL, respectively.

Males mature at smaller sizes than females, as in some other reported myctophid species.

6. Monthly changes in GSI and HSI

Mean GSI of females (≥28 mm SL) peaked sharply during August to September. Mean GSI of males (≥24 mm SL) was high during May to September, showing an earlier and longer peak than that of females. In both sexes, mean HSI peaked during April to July, and declined during August to September, indicating storage of energy for reproduction.

7. Seasonal change of body size distribution

Based on data from seasonal bottom trawl surveys, small individuals of *B. pterotum* began to occur abundantly from autumn, and sexual body lengths increased progressively during spring–summer, corresponding with the above reproductive seasonality.

8. Size-frequency distribution of oocytes

The size of all the oocytes in a cohort gradually increased in synchrony with ovarian development. As an advanced group of the oocytes reached the secondary yolk stage, they form a clear separate mode that is distinct from adjacent groups of smaller oocytes.

9. Egg size and batch fecundity (BF)

Egg size of *B. pterotum* at the hydration stage ranged from 0.55 to 0.85 mm. In many other myctophids, the egg size ranges from 0.45 to 0.8 mm 1/5. I.e. that of *B. pterotum* appears to be slightly larger than these reports.

BF was positively correlated with SL, ranging from 253–1,942 eggs in fish from 30.1–54.8 mm SL. This fell within the reported ranges on other myctophids of similar-sized species. To determine BF, specimens having ovaries containing terminal yolk, migratory nucleus, and hydrated oocytes were used. We counted the number of oocytes in the most advanced mode.

Considering that *B. pterotum* produces slightly larger and a similar number of eggs compared to other myctophid species, they might have higher energetic costs for reproduction.

10. Conclusions

- There were more females than males, and the ratio of females to males increased with SL.
- GSI of females and males was 3.91 and 8.24, respectively, and the GSI in males was much lower than females.
- Females and males can mature larger than 28 mm and 24 mm SL, respectively.
- *B. pterotum* are multiple spawners within a spawning season, and the primary spawning period is during August to September.
- Egg size ranged from 0.55–0.85 mm and batch fecundity ranged from 253–1,942 eggs.