# On the Early Life History of Gunnel (*Enedrias fangi*)

Jae Myung Yoo, Woong - Seo Kim, Sung Kim, and Eun Kyung LEE
Div. of Biological Oceanography, Korea Ocean Research & Development Institute,
Ansan P.O. Box 29. Seoul 425 - 600, Korea

The larval fish, which had been previously identified or classified as *Enedrias (Pholis) nebulosus*, *Enedrias* spp., *Pholis taczanowskii*, and unidentified species belonging to Protosalanginae, were revealed as that of a gunnel, *Enedrias fangi*. This species has been known as a cold water species mainly caught in the Yellow Sea.

Larval *E. fangi* showed peak abundances in the coastal waters off Chonlla Province in March, Chungnam Province in April, and Kyunggi Province in May and June. The primary spawning season of *E. fangi* seemed to be winter (November to January), and the eggs hatched after 60 days from spawning. The average growth rate of larval fish was about 0.33mm/day. The larval fish of 40mm in body length began to move to the bottom, and stayed in the bottom cold water mass when their body length was greater than 60 - 70mm.

The average annual catches of larval *E. fangi* from 1985 to 1991 were 5,000M/T in the Yellow Sea, which were more than 99 % of the total gunnel catches around Korean waters. The peak season of catches was from March or April to July in Chungnam Province, and from May to July in Kyunggi Province.

## Introduction

Gunnel in larval stage is an economically important fish caught in the coastal waters of the Yellow Sea. Therefore, lots of studies have been conducted on this species of larval stage(KORDI, 1980 ; KORDI, 1981 ; KORDI, 1982 ; Hur and Yoo, 1983 ; Hur *et al.*, 1984a ; Kim *et al.*, 1985 ; Yoo, 1985 ; Hwang, 1989). Previous studies, however, reported the gunnel(*Enedrias fangi*) as many different names. *Enedrias(Pholis) fangi* belongs to Class Osteichthyes, Order Perciformes, Family Pholidae, and Genus *Enedrias*. It had been known as *Pholis taczanowskii* (KORDI, 1980), *Enedrias nebulosus* (KORDI, 1981), and *Enedrias* spp.(Kim, 1982 ; Kim, 1983 ; Hur and Yoo, 1984 ; Hur *et al.*, 1984a ; Hur *et al.*, 1984b) before Yoo(1985) identified them as *E. fangi*. This species was also mis - identified by fishermen. According to the fisheries statistics(MAFF, 1987), *E. fangi* was considered such the fish belonging to Family Salangidae as *Salangichthys microdon*, *Neosalanx hubbsi*, *N. jordani*, which are also economically important fish.

The previous studies(references are in Table

1) on the early life history, distribution and seasonal variations of larval *E. fangi* were reviewed in this paper. Most of the previous studies were conducted in the coastal waters of the Yellow Sea(Fig. 1).

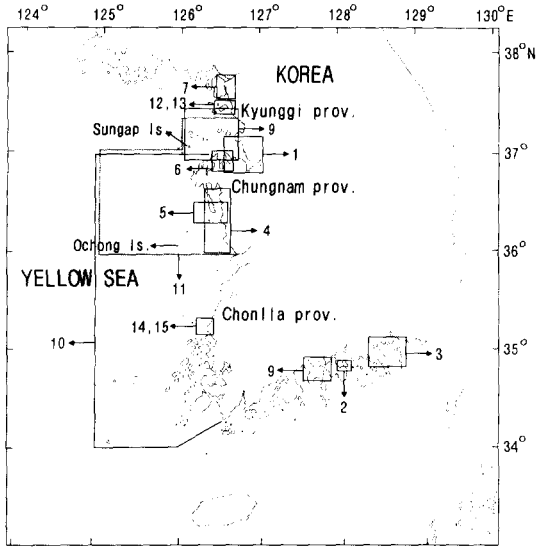


Fig. 1. A map showing the study area. Numbers in the map designate the location number of the study area in Table 1.

## Distribution

The larval fish of *Enedrias fangi* occurred from December to July in the coastal waters of the Yellow Sea(Table 1). It was found in Garolim Bay from December to July(KORDI, 1981), in Kyunggi Bay from February to July(Yoo *et al.*, 1987), in the coastal waters of the Yellow Sea(Kim, 1982 ; Hur and Yoo, 1984), and in Chonsu Bay and estuarine waters of the Keum River from December to May(Cha, 1986). In the southern sea, larval *E. fangi* was found in the Kwangyang bay in February(Park, 1993), in the Changson Channel from December to March(Kim, 1983) and in Chinhae Bay in January and April(Yoo *et al.*, 1992).

Water temperature ranged widely from 0.2 to 24.2℃ when the larval *E. fangi* was found during the period of December to July(Table 2). Larval gunnel, however, was most abundant when the temperature was between 2 to 6℃ (KORDI, 1981 ; Kim, 1982 ; Cha, 1986). The highest water temperature at which larval gunnel was found was 24.2 ℃ in Garolim Bay.

**Table 1. Months that larval gunnels were found at each study area.**

| Location\Month | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Asan Bay(1) | * | | | * | | | | - | | - | | | KORDI, 1993 |
| Changson Channel(2) | * | * | * | - | - | - | - | - | - | - | - | * | Kim, 1983 |
| Chinhae Aay(3) | * | - | | * | | - | - | - | | - | | - | Yoo *et al.*, 1992 |
| Chonsu Bay - | * | * | * | * | * | - | - | - | - | - | | * | Cha, 1986 |
| Keum River estuaruy(4) | | | | | | | | | | | | | |
| Daechon coastal waters(5) | | * | * | * | * | * | | | | | | | Hwang, 1989 |
| Garolim Bay(6) | * | * | * | * | * | * | * | - | - | - | - | * | KORDI, 1981 |
| Han River estuary(7) | | * | | | * | | | - | | - | | | Park, 1990 |
| Kwangyang Bay(8) | | * | | | | | | | | | | | Park, 1993 |
| Kyunggi Bay(9) | | * | * | | * | * | * | - | - | | - | | Yoo *et al.*, 1987 |
| Western waters of Korea(10) | | | * | * | * | * | | | | | | | Kim, 1982 |
| Western waters of Korea(11) | | * | * | * | * | * | - | - | | | | | Hur and Yoo, 1984 |
| Youngjong Island(12) | | | | * | * | | - | - | | - | | | MOT, 1993 |
| Youngjong Island(13) | * | | | * | | | - | | | - | | | KORDI, 1992 |
| Youngkwang coastal waters(14) | * | | | * | | | - | | | - | | | Han, 1987 |
| Youngkwang coastal waters(15) | * | | | - | | | | - | - | | - | | KOPEC, 1992 |

* : Presence
\- : Absence

**Table 2. Water temperature at each study area when larval gunnel were found.**

| Location\Month | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chinhae Bay | 4.5 | | | 11.0 | | | | | | | | | Yoo *et al.*, 1992 |
| Chonsu Bay | 3.2 | 2.2 | 4.5 | 7.5 | 12.0 | | | | | | | 4.3 | Cha, 1986 |
| Keum Rivers estuary | 1.0 | 2.3 | 7.7 | 12.3 | 11.3 | 17.2 | 24.2 | | | | | | KORDI, 1981 |
| Garolim Bay | | | | | | | | | | | | | |
| Han River estuary | | 3.8 | | | 15.0 | | | | | | | | Park, 1990 |
| Kwangyang Bay | | 5.6 | | | | | | | | | | | Park, 1993 |
| Kyunggi Bay | | 0.2 | 1.0 | | 11.1 | 16.1 | 18.4 | | | | | | Yoo *et al.*, 1987 |
| Western waters of Korea | 4.4 | 5.4 | 7.7 | 11.6 | 16.8 | | | | | | | | Hur and Yoo, 1984 |
| Youngjong Island | 3.5 | | 9.1 | | | | | | | | | | KORDI, 1992 |
| Youngkwang coastal waters | 2.5 | | 9.5 | | | | | | | | | | Han, 1987 |
| Youngkwang coastal waters | 6.1 | | | | | | | | | | | | KOPEC, 1992 |

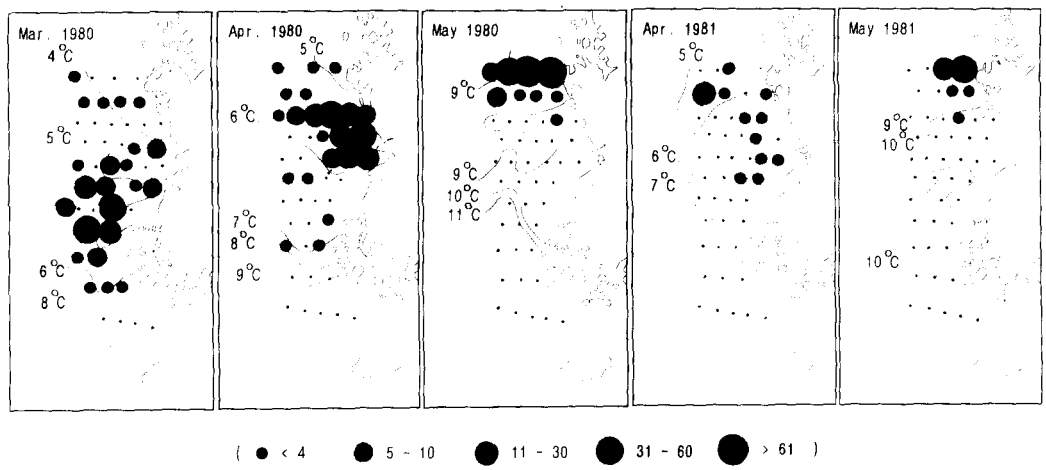


Fig. 2. Distributional patterns of *Enedrias fangi* and temperature at the 20-m depth in the western waters of Korea(Kim, 1982).

As shown in Fig. 2, the distributional patterns of larval gunnel showed a trend that gunnel moved up to north as times went by. It was found most abundantly between 35 and 36° N in March, 36 and 36° 30′ N in April, and near 37° N in May. Similar results were obtained in another study(Hur *et al.*, 1984a). It suggested that water temperature play an important role in determining the distributional pattern of larval gunnel.

## Spawning

The early life history of gunnel including spawning season and hatching period has not been known in detail. A couple of trials were made to estimate the spawning season of gunnel. Hwang(1989) estimated that the spawning season of gunnel was in October and November from the otolith data under the assumption of 60 - day hatching period. Hur *et al.*(1984a) estimated that it was in December to March based on the monthly abundance data of larval fish. However, it might be reasonable that its spawning season would be from November to January, because larval fish less than 10mm in body length occurred abundantly from January to March and estimated hatching period was

about 2 months(Hwang, 1989). The spawning ground seemed to be around Ochong and Sungap Islands(see Fig. 1), based on the distributional patterns of larval fish(Hur *et al.*, 1984b). However, the whole korean coastal waters of the Yellow sea seem to as a spawning ground referring to the distribution pattern(Fig. 2)

## Growth

The developmental stages of larval fish were divided into 3 stages such as postlarval stage, young stage and immature stage depending on the body length and shape(Yoo, 1985), and pictures of each stage are shown in Fig. 3. Gunnel in a postlarval stage grew up to be a young stage when its body length became about 30 mm, and body shape changed. The young stage changed to immature stage when the body length was about 94mm, and looked like an adult fish. Average growth rate was 0.33 mm/day(Hwang, 1989).

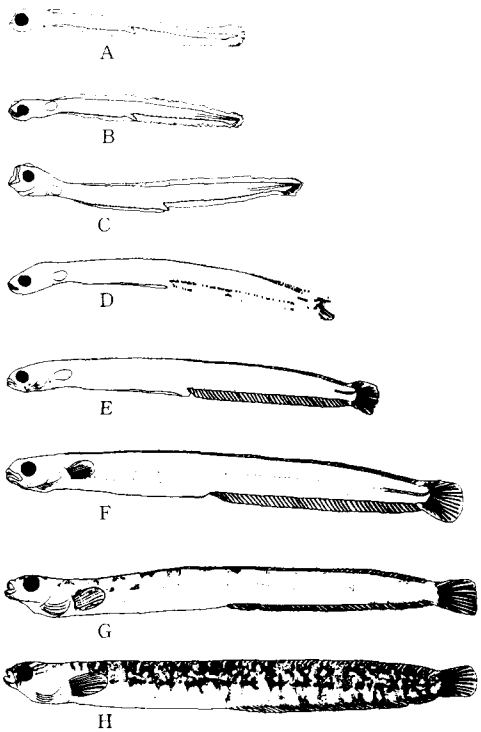


Fig. 3. Developmental stages of *Enedrias fangi*(Yoo, 1985).
Postlarval stage : A(14mm), B(18mm), C(24mm)
Young stage : D(31mm), E(40mm), F(50mm), G(60mm)
Immature stage : H(94mm)

Figure 4 shows an increase of the body length of gunnel in each month from January to July. The bar describes the range of the body length of the total gunnel population in mm unit, which was from 8.0 to 72.7mm. The ranges of body length were 8.0 to 18.0mm in December and January, 8.0 to 26.0mm in February, 9.0 to 37.2mm in March, 15.0 to 47.5 mm in April, 28.0 to 55.5mm in May, 43.0 to 67.7mm in June and 53.0 to 72.7mm in July. Gunnels in postlarval stage were usually found in the surface layer. As they grew up to be about 30mm in body length, gunnels began to migrate downward(KORDI, 1982). Until their body length reached 40 mm, they stayed in the bottom layer(Cha, 1986). They seemed to migrate to the feeding ground of adult fish when they were 60~70mm in body length(KORDI, 1981).

## Catches

Gunnels were usually caught in the waters

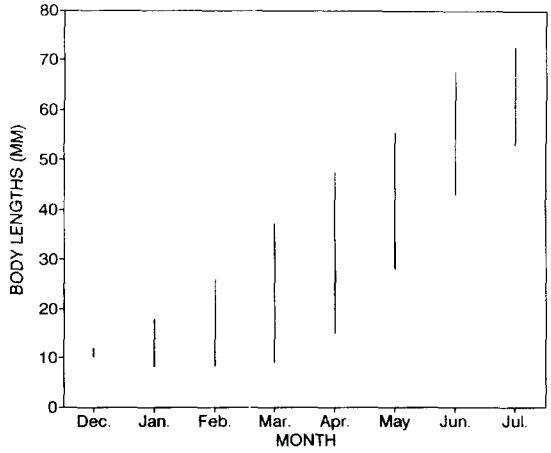


Fig. 4. Ranges of body length(mm) of gunnels in each month.

off Kyunggi and Chungnam Provinces. The average annual catches from 1985 to 1991 were 4,000M/T in Chungnam Province and 6,343M/T in Kyunggi Province(MAFF, 1985 - 1991). The average monthly catches of larval gunnels in the coastal waters off Chungnam and Kyunggi Provinces from 1985 to 1991 are in Fig. 5. The peak of catches was found earlier in Chungnam Province than in Kyunggi Province. Differences in catching season between them may be due to water temperature. Chungnam Province was located in further south than Kyunggi Province, which indicated that water temperature was higher in Chungnam Province than Kyunggi Province. This high - temperature possibly affected reproduction, resulting in early catches in Chungnam Province. Catching season started in February and April in Chungnam and Kyunggi, respectively. Catches were almost four times higher in Kyunggi than in Chungnam. Figure 6 shows annual variations in total catches of the larval gunnels in the coastal waters of Korea from 1962 to 1991. Catches were continuously increasing even though there were fluctuation.

## Schematic models

Gunnels occurred widely in the coastal waters and bays in the Yellow Sea. As mentioned before, however, they had a tendency to migrate to the higher latitute as they grew up (Kim, 1982), which is represented as a schematic

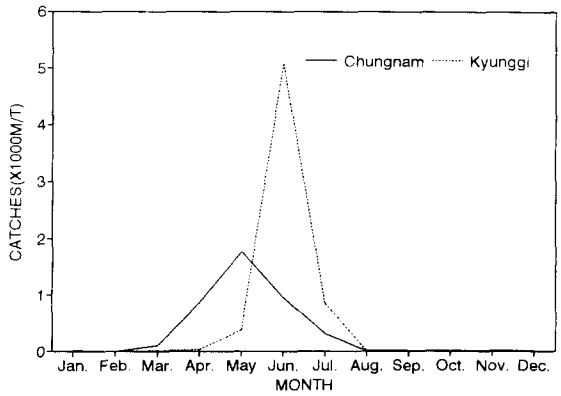


Fig. 5. The average monthly catches of gunnels in the coastal waters off Chungnam and Kyunggi Province from 1985 to 1991(MAFF, 1986 - 1992).

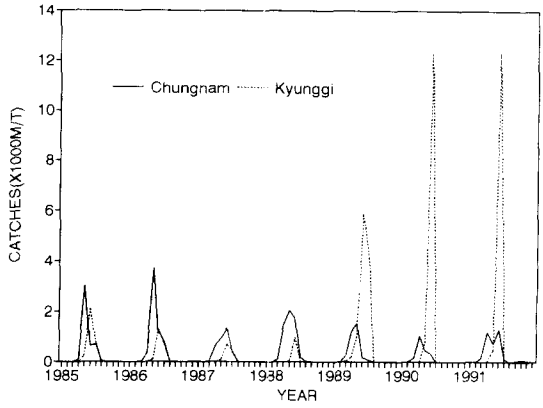


Fig. 6. The annual variations of total catches of larval gunnels in the coastal waters of Korea from 1962 to 1991.

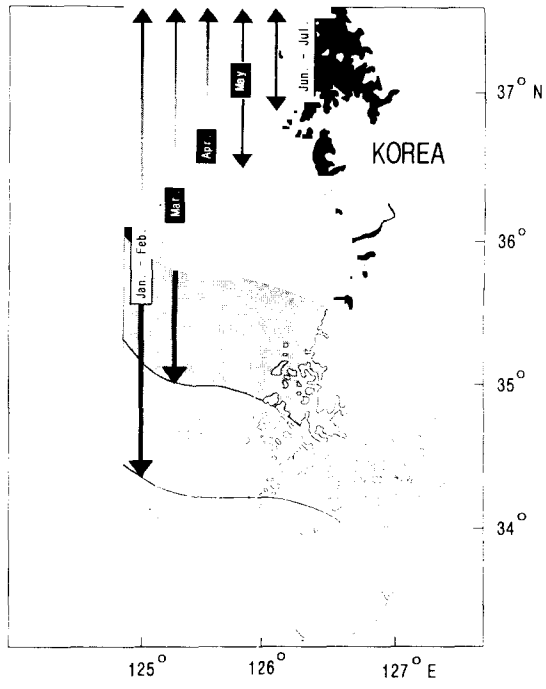


Fig. 7. A schematic model on the distributional pattern of *Enedrias fangi*. Arrows show the distribution range of *Enedrias fangi*.

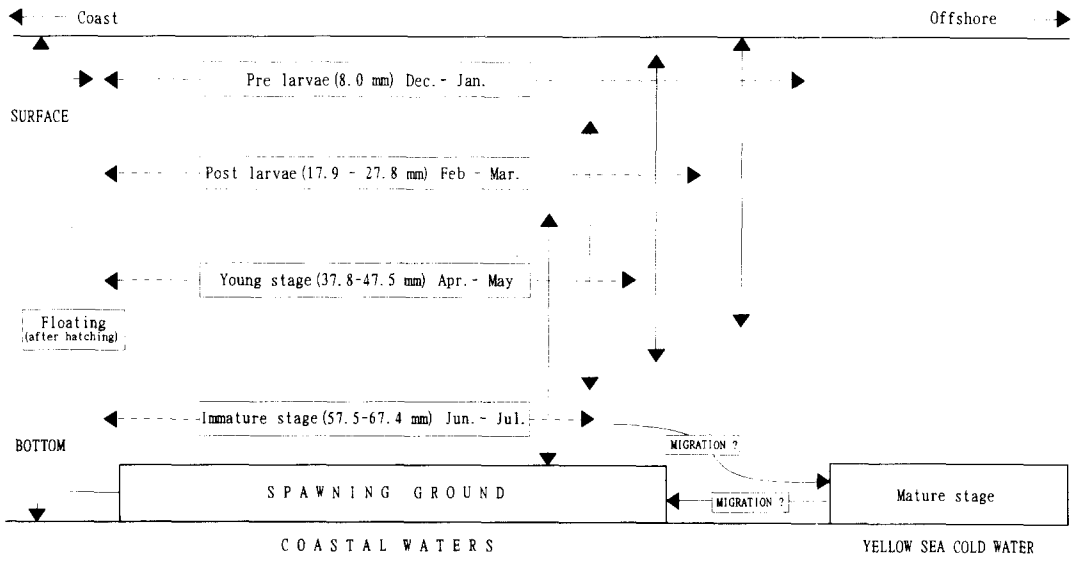


Fig. 8. A schematic model on the life history of *Enedrias fangi* in the Yellow Sea.
The X - direction represents relative geographical distance and the Y - direction represents the relative depth from the surface to the bottom. Vertical solid lines and horizontal dashed lines represent the relative vertical and horizontal distribution ranges, respectively.

model(Fig. 7). Kim also suggested that they migrate to the north following an optimal water temperature. Considering their swimming ability, it would be impossible for them to migrate by themselves such a long distance. Therefore, they seemed to use the northward current pattern for a ride to the north(see the current pattern in MST, 1992).

The schematic model on the life history of gunnel in the Yellow Sea was proposed based on the previous studies(KORDI, 1981 ; KORDI, 1982 ; Cha, 1986 ; Hwang, 1989 ; KORDI, 1992 ; MOT, 1993). As gunnel grew up, they moved down to the bottom and went out to the offshore waters(Fig. 8). Adult gunnel seemed to stay in the Yellow Sea Cold Water and migrate to the coastal waters for spawning.

## References

Cha, S. S. 1986. A study on the ichthyoplankton community in the Mid - east Coastal waters of the Yellow Sea. Ph. D. Thesis. Seoul National Univ. 144p.

Han, K. N. 1987. An ecological study on the ichthyoplankton in the sout - west coastal waters of Korea, Yellow Sea. M. S. Thesis. Inha Univ. 58p.

Hur, S. B., and J. M. Yoo. 1993. Notes on external morphology of Enedrias nebulosus and E. fangi in Korean Waters. Bull. Korean Fish Soc. 16(2) : 97~102.

Hur, S. B., and J. M. Yoo. 1984. Distribution of fish eggs and larvae in the Western waters of Korea. Bull. Korean Fish. Soc. 17(6) : 536~542.

Hur, S. B., D. Y. Kim, and J. M. Yoo. 1984a. Larval stock of *Enedrias* in the Yellow Sea. Bull. Nat. Fish. Univ. Pusan 24(1) : 69~79.

Hur, S. B., J. M. Kim, and J. M. Yoo. 1984b. Fisheries resources in Garolim bay. Bull. Korean Fish. Soc. 17(1) : 69~80.

Hwang, S-D. 1989. Early life history of the gunnel, Enedrias fangi, as indicated by microstructures in otolith. M., S. Thesis. Chungnam National Univ. 61p.

Kim, J. M., D. Y. Kim, J. M. Yoo, and H. T. Huh. 1985. Food of the larvae gunnel, *Enedrias fangi*.

Bull. Korean Fish. Soc. 18(5) : 484~490.

Kim, Y. U. 1983. Fish larvae of Changson channel in Namhae, Korea. Bull. Korean Fish. Soc. 16(3) : 163~180.

Kim. J. Y. 1982. A study on the distribution of fish larvae in the western waters of Korea in spring. Bull. Fish. Res. Dev. Agency. 30 : 65~71.

KORDI. 1981. Studies on the useful fisheries resources in Grolim Bay : Larval stock of the gunnels, *Enedrias* species. KORDI report BSPE 00030 - 55 - 3. 81p.

KORDI. 1982. Studies on the development of the useful fisheries resources in the Yellow Sea. KORDI Report BSPE 00045 - 67 - 3. 97p.

Ministry of Agriculture, Forestry and Fisheries. 1978 - 1991. Statistical yearbook of agriculture, forestry and fisheries.

MST. 1993. The exploitation research of marine resources on the Yellow Sea. The Ministry of Science and Technology. 999p.

Park, K. J. 1993. Distribution of the ichthyoplankton and first feeding ecology in Kwangyang Bay. M. S. Thesis. Chonnam National Univ. 49p.

Park, K. S. 1990. A study on the fish community in the lower Han river and Han river estrary. M. S. Thesis. Inha Univ. 63p.

Yoo, J. M. 1985. A study on the morphological and skeletal development of larvae and juveniles of *Enedrias fangi*(Wang and Wang). M. S. Thesis of Pusan Univ. 48p.

Yoo, J. M., J. M. Kim, H. T. Huh, and S. S. Cha 1987. Distribution of fish larvae in Kyonggibay. Ocean Research. 9 : 15~23.

KOPEC, 1992. 영광원자력발전소 주변 해양환경조사보고서 329p.

KORDI, 1980. 가로림만의 유용 및 미이용 생물자원 개발에 관한 연구. 해양개발연구소 보고서 BSPE 00025 - 44 - 3, 206p.

KORDI, 1992. 수도권 신 국제공항 건설로 인한 어업권 피해 영향조사 및 보상액 산정. 한국해양연구소 보고서 BSPI00149 - 1 - 505 - 3. 523p.

KORDI, 1993. 화옹지구 간척매립에 따른 어업피해조사연구. 한국해양연구소 보고서 BSPI0014 - 523 - 7. 497p.

MOT, 1993. 1993년도 수도권 신 공항 고속도로 연륙교 건설공사 수산업 관련 조사 연구. 교통부. 194p.

# 흰베도라치(*Enedrias fangi*)의 초기생활사에 관하여

유재명 · 김웅서 · 김 성 · 이은경
한국해양연구소

서해의 겨울철 우점종인 흰베도라치(*Enedrias* (*Pholis*) *fangi*) 치자어는 베도라치(*Enedrias nebulosus*), 베도라치류(*Enedrias* spp.), 황줄베도라치(*Pholis taczanowskii*), 뱅어류(Protosalanginae) 등으로 분류되었다. 이 종들의 치자어의 대부분은 흰베도라치(*Enedrias fangi*)로 밝혀졌다. 이 종의 치자어는 서해 전해역에 분포하는데, 3월경에는 전남북 근해, 4월에는 충남 연근해, 5, 6월에는 경기 연근해에 주로 분포한다. 이 종의 주 산란기는 겨울철인 11～1월, 산란은 서해 전역에서 이루어지는 것으로 추정된다. 치자어의 평균 성장률은 0.33/일, 전자어기에서 치어기 중기까지는 부유생활을 하며 체장이 40mm 이상이 되는 치어 후기부터 저층에서 서식하기 시작하는 것으로 보이며 체장이 60～70mm정도로 성장한 후 황해 저층냉수역으로 회유하는 것으로 추정된다. 서해 연근해에서 1985～1991년에 어획된 흰베도라치 치어자원의 어획량은 연평균 5,000M/T으로 우리 나라 전체 흰베도라치 치자어 어획량의 99% 이상이며, 주 어획시기는 충남이 5월, 경기 연근해에서는 6월로 나타났다.