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Distribution and Abundance of Planktonic Shrimps in the Southern Sea of Korea during 1987-1991

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Distribution and abundance of planktonic shrimps were studied in the southern sea of Korea from 1987 to 1991. Nine species of five genera belonging to three families were identified. Of these, *Leptochela sydniensis* and *Lucifer intermedius* were predominant species and *Lucifer penicilifer* and *Lucifer typus* were common species. Remaining five species, *Acetes chinensis*, *Leptochela gracilis*, *Lucifer chacei*, *Process wheeleri* and *Sergestes similis* occurred sporadically and rarely. The distribution pattern of planktonic shrimps varied with species and sampling periods. *L. intermedius* occurred abundantly along inshore waters. *L. penicilifer* and *L. typus* appeared in both inshore and offshore waters, but more abundantly in offshore waters under influence of the Tsushima Current. In conclusion, the distribution patterns of planktonic shrimps may be related with hydrographic characteristics and seasonality in the southern sea of Korea.

Key words: Planktonic shrimp, *Acetes*, *Leptochela*, *Lucifer*, The southern sea of Korea, Tsushima Current

Introduction

The southern sea of Korea is bordered by the Yellow Sea to the west and by the East China Sea to the south. Most of the southern sea is a continental shelf shallower than 200 m in depth (Uda, 1966) with thousands of small islands. The sea is influenced by the Korean and Chinese coastal waters, the Yellow Sea Cold water and the Kuroshio warm current (Kondo, 1985). The sea is utilized by various commercially important fish and shellfish as nurseries, permanent habitats and migration routes (NFRDI, 2005).

Planktonic shrimps are small crustaceans, and their swarming behaviors drag them into important fisheries in Asia and eastern African countries (Omori, 1975; Nurul Amin et al., 2009). They also play an important role in pelagic ecosystems as a trophic connecter, consuming green algae and being preyed by carnivores, as other zooplankton species (Parson et al., 1984; Xiao and Greenwood, 1993).

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Despite the importance of planktonic shrimp in fisheries and marine ecosystem in the southern sea of Korea, little information on their distributions is available. Lack of knowledge on their distribution may hinder planning relevant management strategies for the shrimps, and understanding the entire marine ecology in the southern sea of Korea.

The present research is to investigate the distribution of planktonic shrimps in the southern sea of Korea, and to understand relationship between hydrographic characteristics and the distribution of planktonic shrimp in the southern sea of Korea.

Materials and Methods

Zooplankton were collected at 46 stations arrayed along five transects (01, 03, 05, 07 and 09) distributed between 123°30′E-128°30′E and 32°00′-34°30′N during five sampling periods between 1987 and 1991: October 1987, July 1988, March 1989 and 1990, and May 1991 (Fig. 1; Table 1). Sampling stations varied with the sampling periods: 42 stations

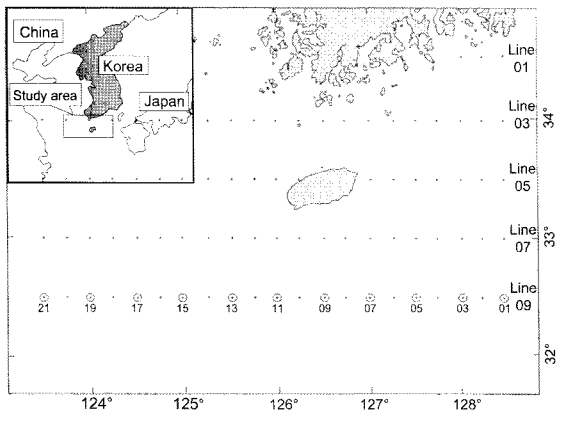

Fig. 1. Sampling stations.

in October 1987, 44 stations in August 1988, 29 stations in March 1989, 28 stations in March 1990 and 30 stations in May 1991 (Table 1). At each station, a 60 cm diameter bongo net with 505 and 303 μm mesh was deployed once 5-10 m above the bottom, with a double oblique tow. We included samples collected with the 303 μm mesh net in our analysis. A flow meter was equipped inside the nets to measure the filtered water volumes. Zooplankton samples were preserved in 5% buffered formalin aboard the vessel and transported to the laboratory. All planktonic shrimps were sorted and identified to species following Yoo (1995), and Chihara and Murano (1997). Hydrograhic features of the sampling area (Fig. 2) were referred with "A study on the atlas of marine resources in the adjacent seas to Korea" conducted by the Korea Ocean Research Development Institute (KORDI) (KORDI, 1987, 1988, 1989, 1990, 1991). The densities of planktonic shrimps were calculated as individuals per 1000 m^3 based on the filtered water volumes.

Results and Discussion

During the sampling period, nine species of five genera belonging to three families were collected: *Lucifer intermedius*, *L. typus*, *L. penicilifer*, *L. chacei*, *Sergestes similes*, *Acetes chinensis*, *Leptochela gracilis* and *L. sydniensis* and *Process wheeleri*.

L. intermedius was collected predominantly in October 1987 and July 1988 (Fig. 3). In particular, the species was collected most abundantly at the station 03 on the line 01 in October 1987 (1,630.8 inds. per 1,000 m^3) and in July 1988 (597.2 inds. per 1,000 m^3) (Fig. 3). During the sampling periods, *L. intermedius* was less abundant in the Yellow Sea cold water and Tsushima warm water areas (refer Fig. 2). However, in March 1989 and 1990, and May in 1991, *L. intermedius* was collected only at the stations in the Tsushima warm water with a low density. During the sampling periods, *L. intermedius* was not collected in the Yellow Sea cold water and Chinese coastal water regions (refer Fig. 2). During cold seasons, such as March 1989 and 1990 and May 1991, *L. intermedius* was found in the water mass of Tsushina warm water. *L. intermedius* is a warm water species (Zhang, 1995). The distribution of *L. intermedius*

Table 1. Sampling stations of planktonic shrimps during 1987-1991 in the southern sea of Korea

Date	Line	Sampling stations
October 18 - November 4, 1987	01	01 03
	03	01 03 05 07 09 11 13 15 17 19
	05	01 03 05 07 09 11 13 15 17 19 21
	07	03 05 07 09 11 13 15 17 19 21
	09	05 07 09 11 13 15 17 19 21
August 16-27, 1988	01	01 03
	03	01 03 05 07 09 11 13 15 17 19 21
	05	01 03 05 07 09 11 13 15 17 19 21
	07	03 05 07 09 11 13 15 17 19 21
	09	01 03 05 07 09 11 13 15 17 19
April 17-26, 1989	01	01 03
	03	01 03 05 07 09 11 13 15 17 19 21
	05	01 03 05 07 09 11 13 15 17 19 21
	07	03 05 07 09 11
March 13-27, 1990	05	01 03 05 07 09 11 13 15
	07	03 05 07 09 11 13 15 17 19 21
	09	03 05 07 09 11 13 15 17 19 21
May 13-23, 1991	03	07 09 11 13 15 17
	05	01 03 05 07 09 11 13 15 17
	07	03 05 07 09 11 13 15 17
	09	05 07 09 11 13 15 17

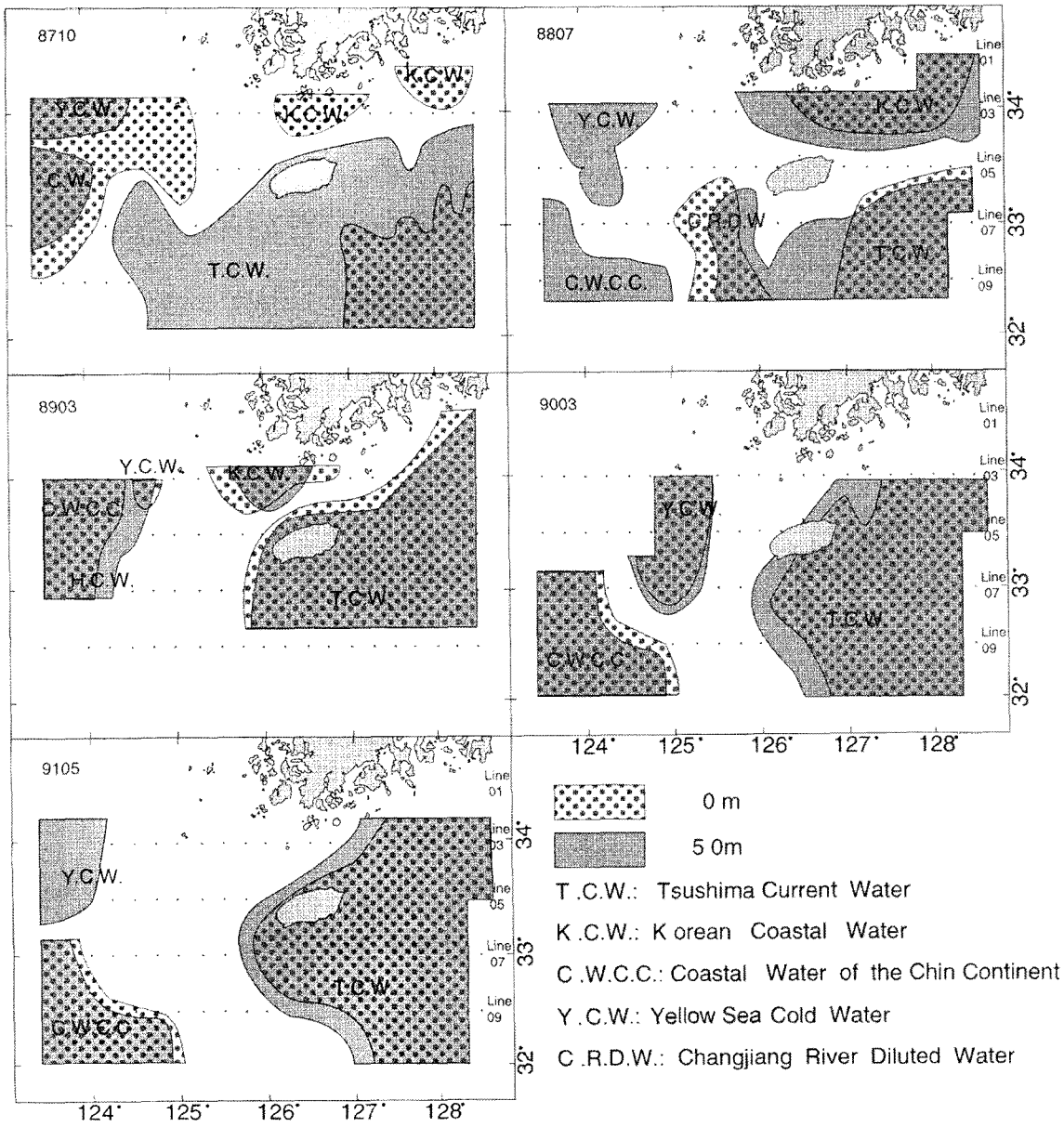

Fig. 2. Hydrographic features during the sampling periods. Hydrographic features were adopted from KORDI (1987, 1988, 1989, 1990, 1991).

may be related with the seasonal meandering of Tsushima warm water in the southern sea.

The density of *L. typus* was generally very low (less than 5 inds. per 1,000 m^3) at every stations during the entire sampling periods (Fig. 4). The highest density of the species was found at the station 05 on the line 07 in May 1987 (4.9 inds. per 1,000 m^3). The density of *L. typus* was relatively higher in the Tsushima warm water regions, particularly at the stations near Jeju-do in October 1987 and May 1990 (Refer Fig. 2) because *L. typus* is a warm water species (Zhang, 1995). We speculate that they were exclusively collected in areas under the influence of the Tsushima warm current although the densities were very low.

L. penicilifer was collected with low densities during the entire sampling periods (Fig. 5). None of *L. penicilifer* was collected in March 1989 and May 1991. In July 1988, the densities of *L. penicilifer* were relatively higher than other years at the western part of sampling stations (Fig. 5). In October 1987 and March 1990, densities of *L. penicilifer* at all sampling stations were 0 or less than 5 inds. per 1,000 m^3. Despite low density, we speculate that the

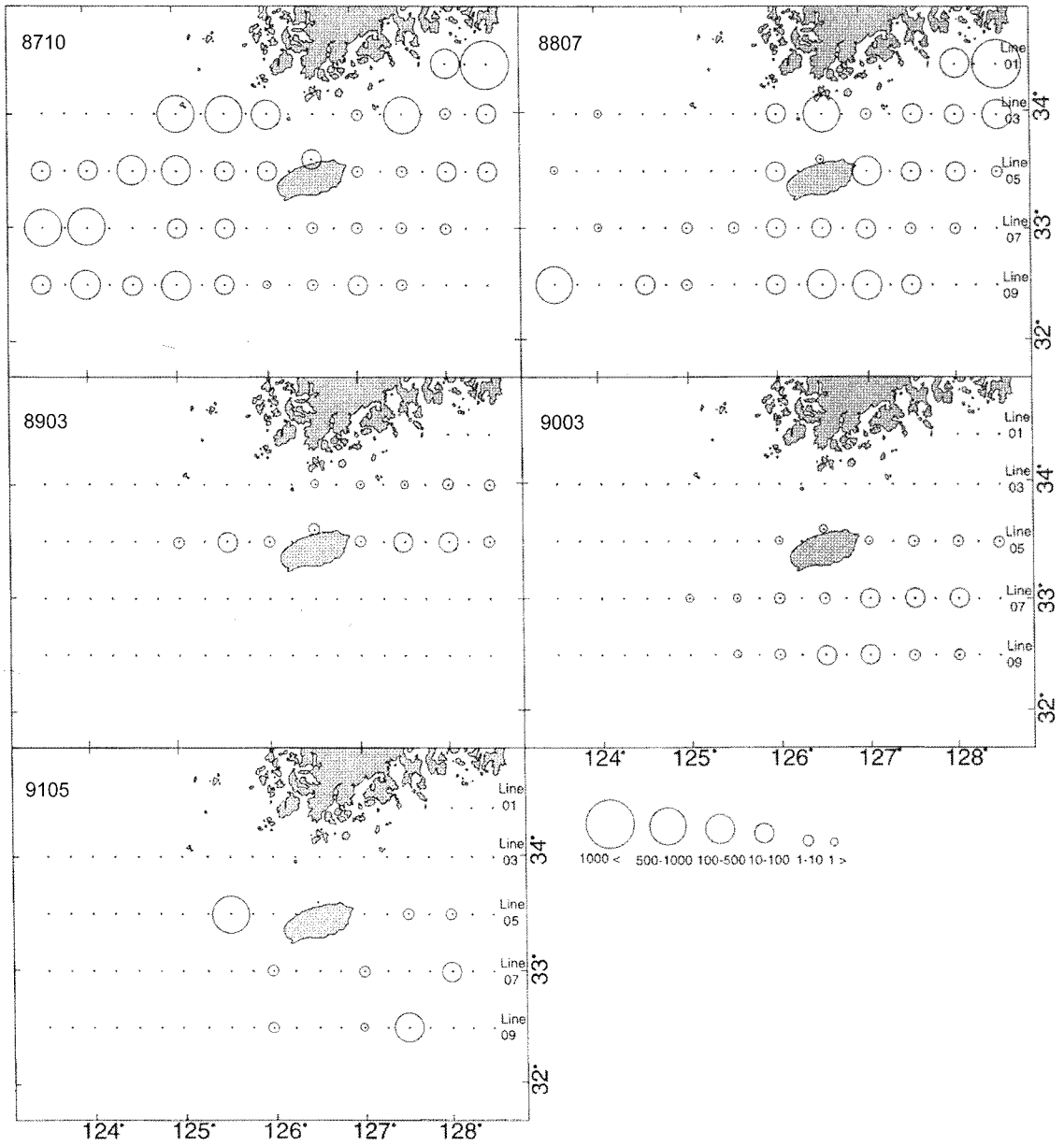

Fig. 3. Distribution and abundance of *Lucifer intermedius* in the southern sea of Korea during 1987-1991. Ranges in the legends indicate individuals per 1,000 m^3.

distribution of *L. penicilifer* may be related with the Tsushima warm current because they were collected exclusively along the area of the Tsushima warm current (refer Fig. 2).

L. chacei was collected only at the station 07 on the line 05 in October 1987 and March 1990 (both 0.5 inds. per 1,000 m^3) (Fig. 6). Among the species belonging to the genus *Lucifer*, *L. chacei* showed lowest density for the entire sampling periods.

Relative densities of *Lucifer* spp. were higher in October while they were lower in other seasons. Kang (1986) reported that Luciferinae in the southern sea of Korea were relatively abundant in October, following by December. Our results are coincided with Kang (1986) in that density of *Lucifer* spp. in October in the southern sea of Korea is highest.

L. sydniensis appeared at most stations in October 1987 (Fig. 7). The density of *L. sydniensis* was the highest in October 1987. *L. sydniensis* was present at eastern and southern stations of Jeju-do in July 1988. In other sampling periods, *L. sydniensis* occurred with low densities. The highest densities of *L. sydniensis* were at the station 17 on the line in October 1987 (50 inds. per 1,000 m^3) and at the station

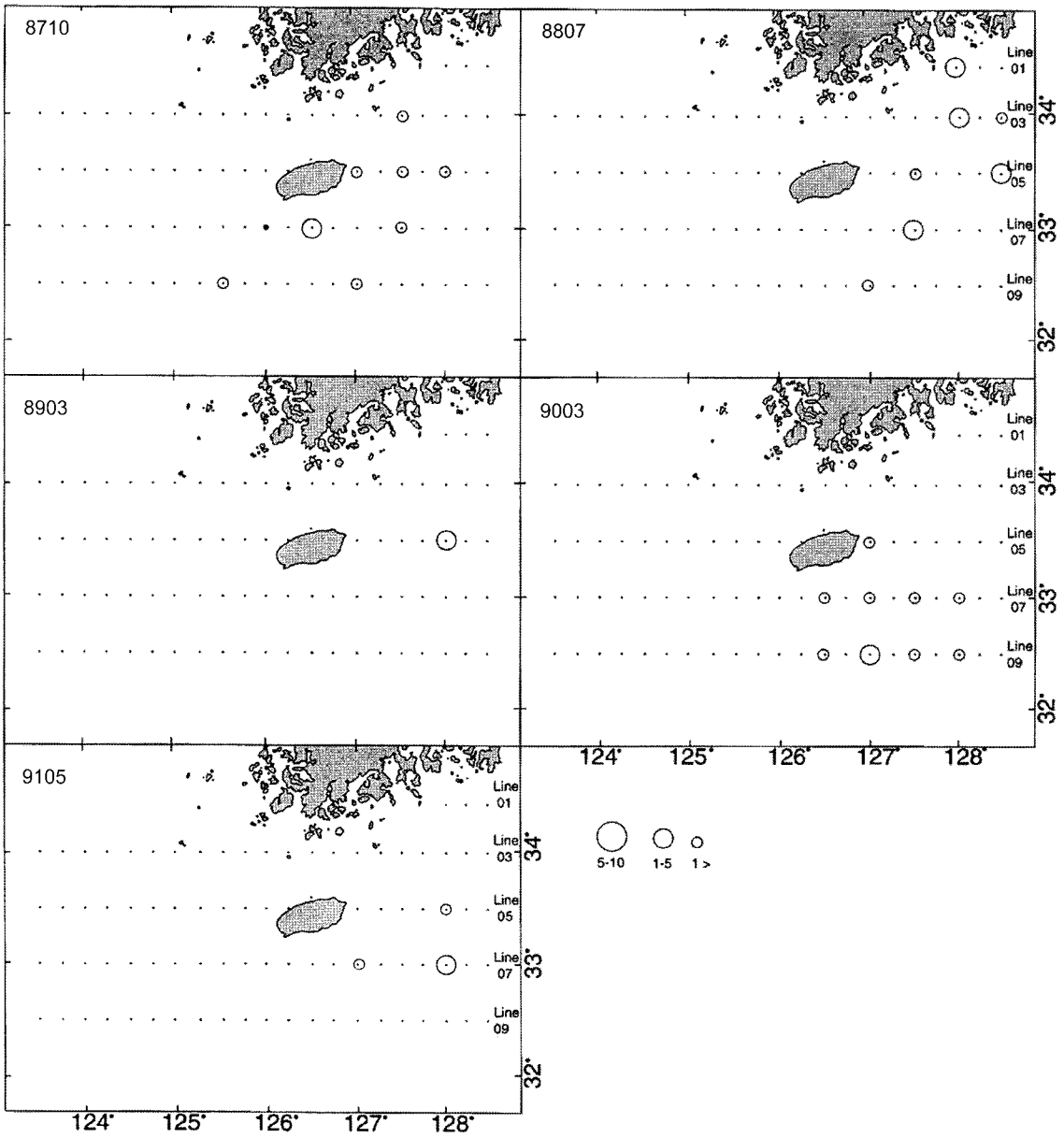

Fig. 4. Distribution and abundance of *Lucifer typus* in the southern sea of Korea during 1987-1991. Ranges in the legends indicate individuals per 1,000 m^3.

13 on the line 05 in May 1991 (64.1 inds. per 1,000 m^3). In other stations and sampling periods, the densities of *L. sydniensis* were lower than 30 inds. per 1,000 m^3. We did not find any relationship between the distribution of *L. sydniensis* and hydrographic characteristics (refer Fig. 3). Rather, *L. sydniensis* was collected more abundantly and from wider areas in July and October than March and May. This may indicate their seasonal changes in occurrence in thesouthern sea of Korea. *L. gracilis* was found with a low number in October 1987 and March 1990 (Fig. 6). *L. gracilis* was collected at the station 12 on the line 07 (1.7 inds. per 1,000 m^3) in October 1987 and at the stations 15, 17 and 19 on the line 09 in March 1990 (1.7, 0.1 and 0.2 inds. per 1,000 m^3, respectively.

A. chinensis was rarely collected during the entire sampling periods (Fig. 6). Densities were lower than 2 inds. per 1,000 m^3. *A. chinensis* was collected at the stations 19 on the line 05 (1.4 inds. per 1,000 m^3) and 21 on the line 07 (0.7 inds. per 1,000 m^3) in October 1987. The species was also collected at the stations 17 (2.4 inds. per 1,000 m^3), 19 (1.5 inds. per 1,000 m^3) and 21 (3.7 inds. per 1,000 m^3) on the line 09 in March 1990. *P. wheeleri* and *S. similes* were rarely

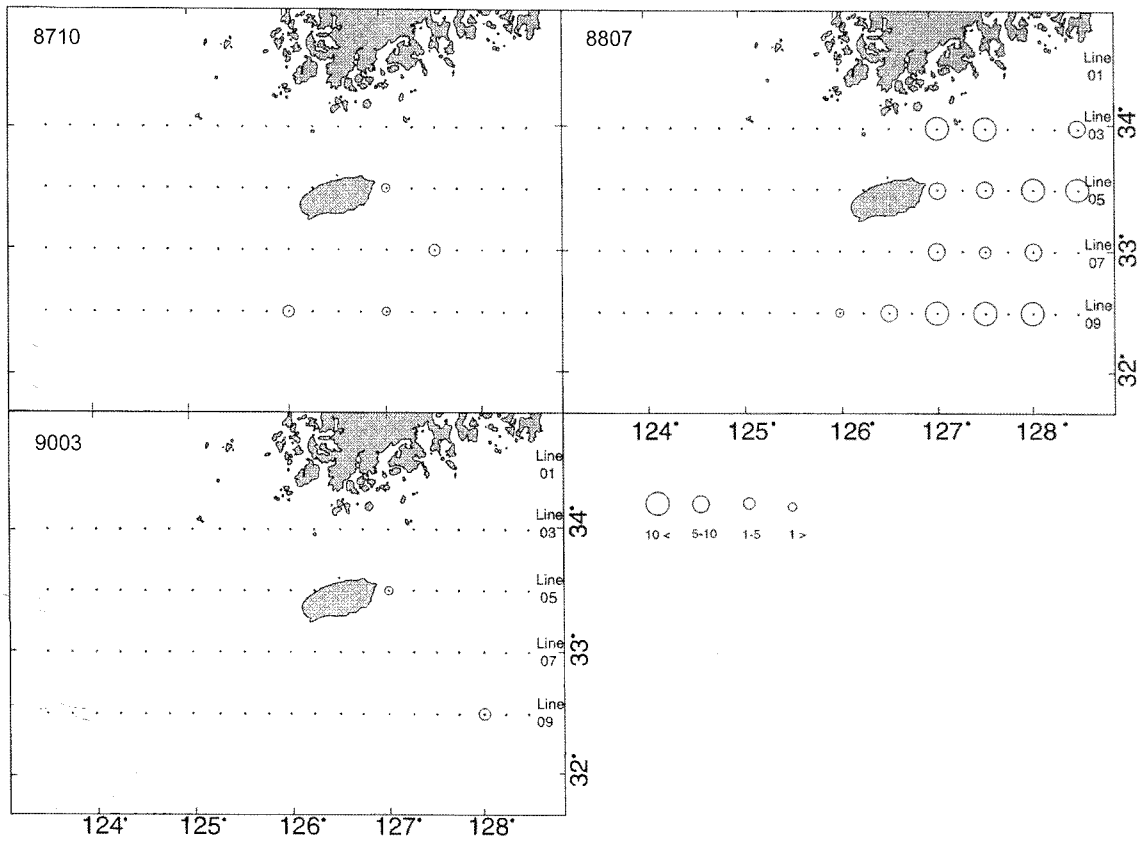

Fig. 5. Distribution and abundance of *Lucifer penicilifer* in the southern sea of Korea during 1987-1991. Ranges in the legends indicate individuals per 1,000 m^3.

found (Fig. 8). These two species were rarely collected in the southern area of Jeju-do.

Many planktonic shrimps distribute below 150 m in depth (Omori, 1974). Genera *Acetes* and *Lucifer* are epipelagic planktonic shrimps, which distribute inshore, neritic and oceanic in the subtropical and tropical seas (Omori, 1974). In our study, most shrimp species distributed at areas along the Tsushima warm current. Omori (1974) also reported that these species occurred in warm water regions such as East China Sea region and southeast Asian countries. Among *Lucifer* species, *L. typus* is a typical oceanic species (Bowman and McKain, 1967). In our study, *L. typus* was collected mostly in oceanic areas rather than in coastal, nearshore areas. The distribution pattern of *L. typus* was also suggested by Bowman and McKain (1967). On the other hand, *L. intermedius* and *L. penicilifer* were collected in both nearshore and oceanic areas, as Yoo and Nam (1997) previously reported.

In summary, the distribution pattern and abundance of planktonic shrimps varied seasonally and annually. Species with low densities may not indicate seasonality or relationship with hyderography in the current study, but species of higher densities may indicate it. *L. intermedius*, *L. typus* and *L. penicilifer* were collected only at the stations in the Tsushima warm water but not in the Yellow Sea cold water and Chinese coastal water regions, suggesting that *L. intermedius* may be a warm water species. *L. sydniensis* did not show relationship with hydrographic features, but showed seasonal differences in distribution and abundance. Our results suggest planktonic shrimps may be an indicator of hydrographic features or seasonality in the region.

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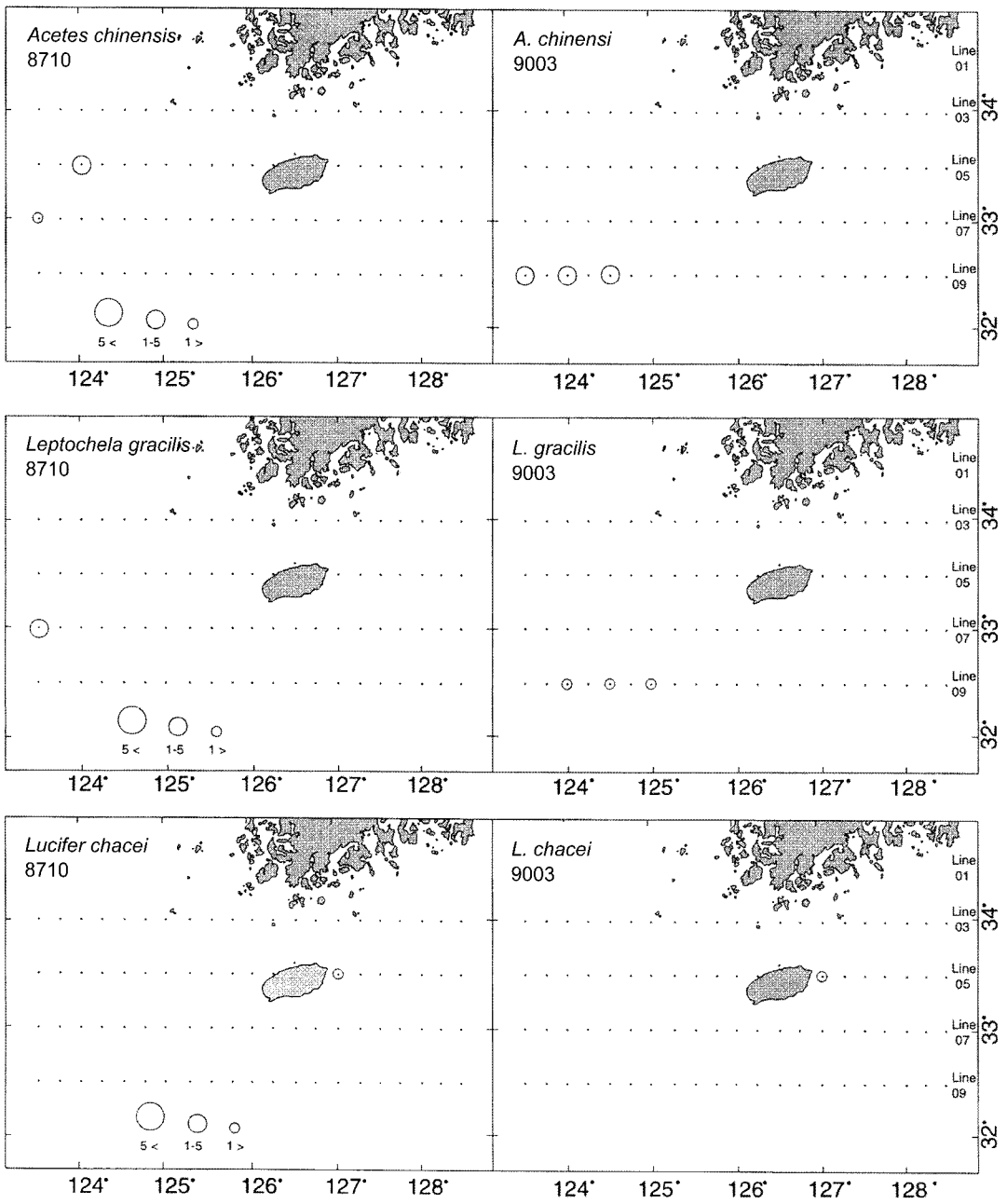

Fig. 6. Distribution and abundance of *Acetes chacei*, *Leptochela gracilis* and *Lucifer penicilifer* in the southern sea of Korea during 1987-1991. Ranges in the legends indicate individuals per 1,000 m^3.

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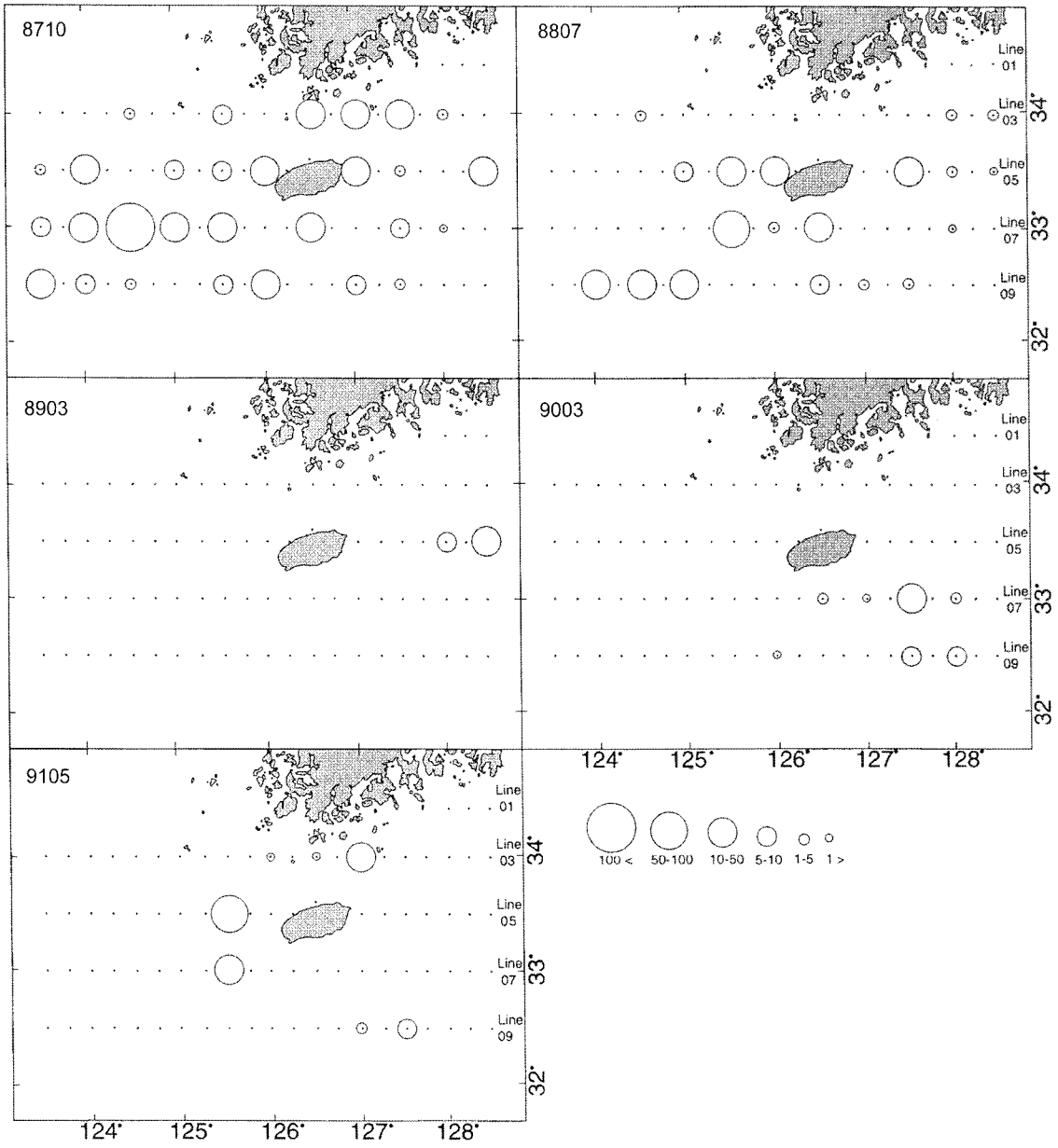

Fig. 7. Distribution and abundance of *Leptochela sydniensis* in the southern sea of Korea during 1987-1991. Ranges in the legends indicate individuals per 1,000 m^3.

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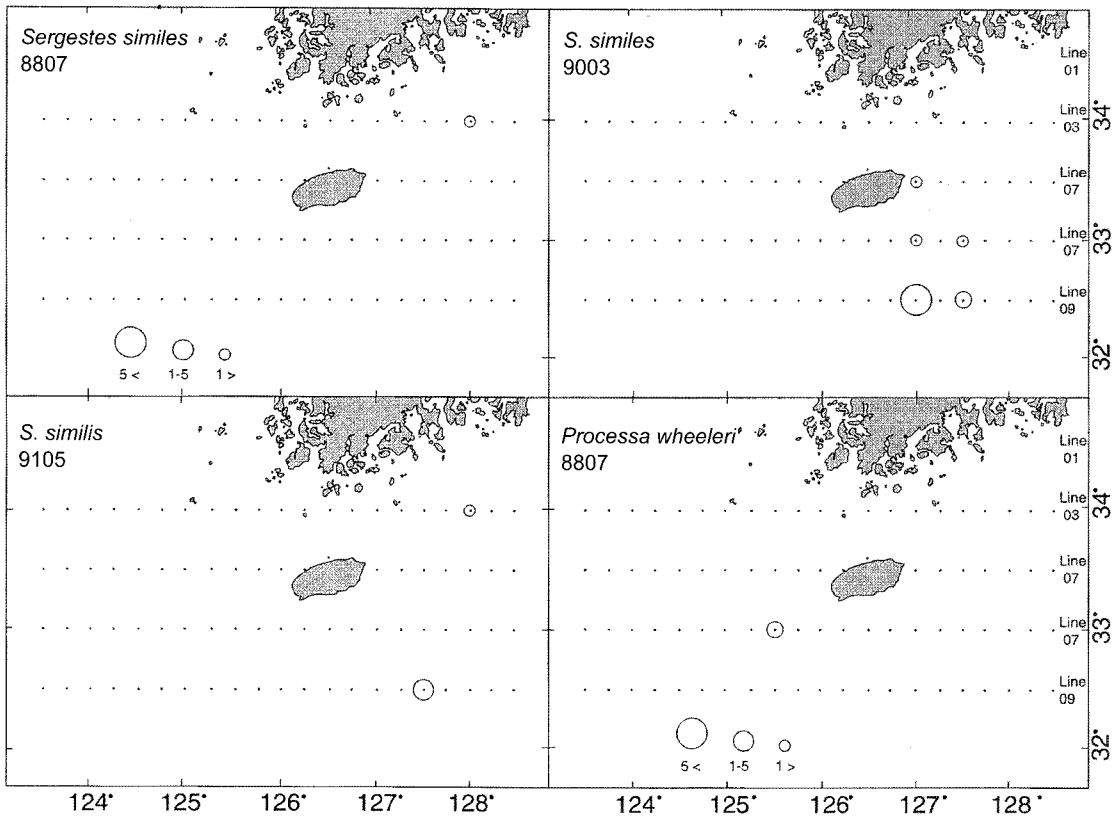

Fig. 8. Distribution and abundance of *Sergestes similis and Processa wheeleri* in the southern sea of Korea during 1987-1991. Ranges in the legends indicate individuals per 1,000 m^3.

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