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Catch distribution of diamond squid (*Thysanoteuthis rhombus*) off Hyogo Prefecture in the western Sea of Japan and its relationship with seawater temperature

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This paper describes the distribution of catches of diamond squid (*Thysanoteuthis rhombus*) off Hyogo Prefecture in the western Sea of Japan, and the relationship between the fishing condition and seawater temperature based on the catch-location and catch-amount data collected from the logbooks of seven vertical longline fishing boats in 1999–2005. Catches generally occurred south of 36°15′N, but in September–October of 2003 and 2005, when a cold water mass occurred on the fishing ground, catches were concentrated near shore south of 35°45′N. Good catches occurred where seawater temperatures at 50 and 100 m depths were >19°C and >14–15°C, respectively, from late August through early November in 1999–2005. The mean water temperature at 100 m depth at six oceanographic observation sites off Hyogo Prefecture was related to the mean latitude of catch locations weighted by catch amount, which suggests that this index can be used to forecast the location of the fishing grounds.

Key words: diamond squid, *Thysanoteuthis rhombus*, Sea of Japan, fishing condition

Introduction

The diamond squid (*Thysanoteuthis rhombus*) is an epipelagic oceanic squid found in tropical and subtropical regions of the world's oceans, and at higher latitudes in temperate waters associated with warm currents. It is now one of the most abundant and commercially important squids in the Sea of Japan, where it has been fished since the early 1960s with vertical longline gear called "*taru-nagashi* (drifting barrel)" (Nazumi, 1975a; Miyahara and Takeda, 2005; Bower and Miyahara, 2005). *Thysanoteuthis rhombus* in the Sea of Japan hatches from January to September with a peak in February–March at the spawning grounds, which are thought to extend from the southwest Pacific to the East China Sea (Miyahara *et al.*, 2006b). After hatching, the young stages occur near the surface (Miyahara *et al.*, 2006a) and are transported northward through the Tsushima Strait into the Sea of Japan (Nishimura, 1966; Nazumi, 1975b). Recruitment into the fishery in the western Sea of Japan in the peak fishing season (=September–November) is positively related to seawater temperatures 600 km upstream in the Tsushima Strait in June, and several models incorporating environmental indices near the strait have been shown to accurately predict the annual CPUE in the fishery (Miyahara *et al.*, 2005). Miyahara and Gorie (2005) also showed inner-annual fluctuations of abundance using several CPUE (catch per unit effort) values, but the spatial distribution and abundance of the squid during the fishing season have not been examined in detail.

The fishing grounds of *T. rhombus* in the Sea of Japan generally occur over bottom depths of 100–500 m, and catches occur at 75–100 m depths during the daytime and 0–50 m depths at night (Takeda and Tanda, 1998; Bower and Miyahara, 2005). Off Hyogo Prefecture, where the largest catch in the Sea of Japan is landed every year (Bower and Miyahara, 2005), the fishing grounds occur during late summer to early winter in areas where the temperature at 100 m depth is >15–17°C (Nazumi 1975a; Tamaki 1987). Seasonal changes of seawater temperatures at >50 m depth in the western Sea of Japan generally peak in September–November (Watanabe *et al.*, 2003), but are greatly influenced by a cold water mass called "*Sanin-Wakasa Oki Reisui*" that sometimes occurs in nearshore areas off Hyogo and neighboring prefectures (Naganuma, 2000). The effect of this water mass on several commercially important species has been examined in previous studies (Ito *et al.* 1967; Hara 1990; Hashimoto 1998) but has not been examined on *T. rhombus*.

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The present study describes the catch distribution of *T. rhombus* in the western Sea of Japan during 1999–2005 by using data recorded in the logbooks of vertical longline fishers. Seawater temperatures were examined to discuss the relationships between oceanographic and fishing conditions in the area and to consider possible indices for forecasting fishing conditions. Recently, numerical modeling has been used to simulate future oceanographic conditions in the Sea of Japan, such as temperature and current velocity (by the RIAM ocean circulation Model, Hirose and Yoon, 1998; Lee *et al.*, 2003; Hirose, 2003) and is now also used to accurately predict environmental-dependent fishing conditions (e.g., for the Japanese common squid *Todarodes pacificus*; Fujii *et al.*, 2004). An exploratory forecast of horizontal distribution of water temperature was also tried using the RIAM model to forecast the fishing conditions of *T. rhombus* off Hyogo Prefecture.

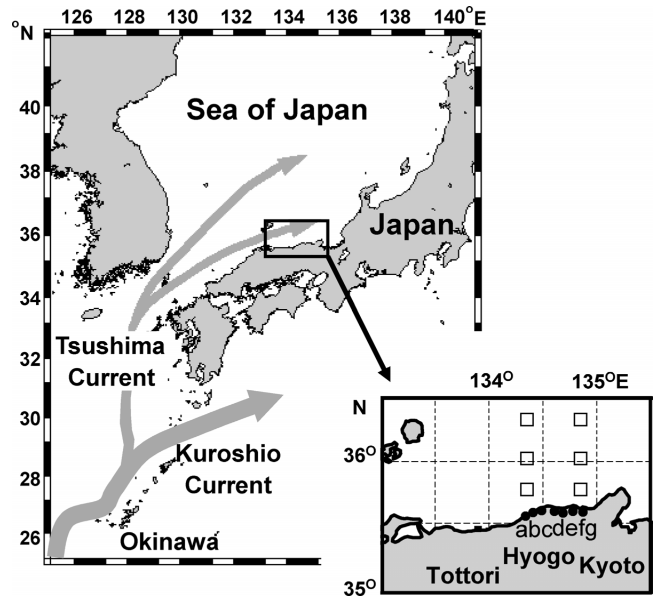

Figure 1. Map of study area in the present study. Open squares show the six observation sites off Hyogo Prefecture. Closed circles indicate the fisheries cooperative associations/branches from which logbook data of monitored fishing boats were collected; **a**: Igumi, **b**: Moroyose, **c**: Hamasaka, **d**: Kasumi, **e**: Shibayama, **f**: Takeno, **g**: Tsuiyama.

Materials and Methods

Daily fishing data of catch number (C_N) and boat location (latitude and longitude) were collected from the logbooks of seven vertical longline fishing boats (sampled from each fisheries cooperative association/branch in Hyogo Prefecture in 1999–2005 (Fig. 1). The catch amount (W_i, $kg \cdot day^{-1} \cdot boat^{-1}$) of each boat was estimated by multiplying C_N by the mean body weights during 10-day periods in September–December of each year in the corresponding season (the mean body-weight data during 1999–2004 were published in Miyahara and Gorie (2005), and these data in 2005 were obtained in the present study).

To outline the ambient oceanographic conditions near the fishing ground, contour drawings of seawater temperatures at 0, 50 and 100 m depths in the western Sea of Japan were derived from the oceanographic database of the Japan Sea National Fisheries Research Institute (http://jsnf.affrc.go.jp/Physical/newindex.html), which is based on the data collected monthly by prefectural fishery research institutes. The mean seawater temperatures at 100 m depth at six observation sites off Hyogo Prefecture (Fig. 1) were used to determine whether a cold water mass occurred near the fishing ground, and compared with weighted means of the catch locations (L_{wav}) during the period between five days before and five days after each oceanographic observation. In the present study, L_{wav} is given by

$$L_{wav} = \sum W_i L_i \,/ \sum W_i$$

where L_i is the catch location at which the catch of W_i occurs. A linear regression of the mean seawater temperature was run on the L_{wav} (latitude and longitude, respectively) using the least squares method. Data of late November 2002, September 2004, and September 2005 were excluded for the analysis because of lack of the oceanographic observations or the less logbook data.

Operational forecasts of water temperature in the potential fishing ground were made with the RIAM model, which is now accessible on the Internet (http://jes.riam.kyushu-u.ac.jp/). In the present study, a horizontal distribution of water temperature at 100 m depth in early October 2005 off Hyogo Prefecture was preliminarily simulated two months earlier (in August 2005).

Results

The horizontal distributions of catches and water temperatures between late August and early November in 1999–2005 are shown in Figs. 2–4. The sea surface temperature (SST) declined during the fishing season from 24–28°C in early September to 18–22°C in early November. The temperatures at 50 and 100 m depths did not show such clear seasonal changes, and generally ranged from 22–24°C at near shore to 16–22°C at 36°30′N (at 50 m depth) and 16–20°C at near shore to 12–16°C at 36°30′N (at 100 m depth), respectively. In September–October of 2003 and 2005, a cold water mass (with <12°C at 100 m depth) occurred on the fishing ground.

The distribution of catches showed no clear changes despite of decreased SST through the fishing season. Catches occurred ubiquitously south of 36°15′N, and from

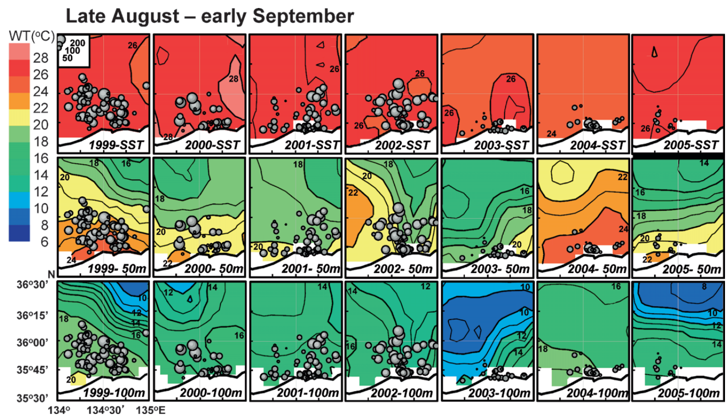

Figure 2. Horizontal distributions of *T. rhombus* catch amount (kg·day^{-1}·boat^{-1}, bubble circles) during late August–early September and water temperature of 0, 50 and 100 m depths in early September off Hyogo Prefecture in the western Sea of Japan. Contour drawings of the seawater temperatures were derived from the oceanographic database of the Japan Sea National Fisheries Research Institute (http://www.jsnf.affrc.go.jp/Physical/newindex.html).

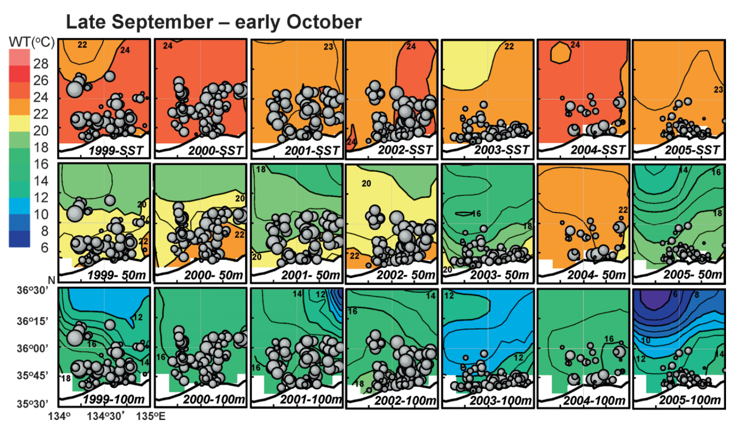

Figure 3. Horizontal distributions of *T. rhombus* catch amount (kg·day^{-1}·boat^{-1}, bubble circles) during late Septembe–early October and water temperature of 0, 50 and 100 m depths in early October off Hyogo Prefecture in the western Sea of Japan. Contour drawings of the seawater temperatures were derived from the same database as Fig. 2.

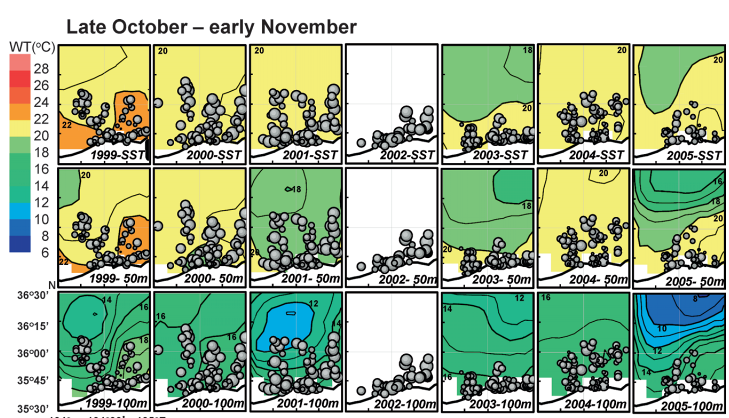

Figure 4. Horizontal distributions of *T. rhombus* catch amount (kg·day^{-1}·boat^{-1}, bubble circles) during late October–early November and water temperature of 0, 50 and 100 m depths in early November off Hyogo Prefecture in the western Sea of Japan. Contour drawings of the seawater temperatures were derived from the same database as Fig. 2.

134°10′E to 135°00′E except for 2003 and 2005. In 2003 and 2005, catches were concentrated nearshore south of the cold water. Good catches occurred in warm areas where the temperatures at 50- and 100 m depths were >19°C and >14–15°C, respectively.

The mean seawater temperatures at 100 m depth at the six fixed observation sites off Hyogo Prefecture ranged from 10.7 to 16.7°C during late August through late October in 1999–2005 (Fig. 5). The mean seawater temperature showed a positive linear relationship with the weighted mean latitude of the catch ($r=0.78$, $P<0.01$), but no clear relationship with the mean longitude. A simulated horizontal distribution of water temperature at 100 m depth off Hyogo Prefecture was very similar to the actual observations two months later (Fig. 6).

Discussion

Squid populations are generally unstable and strongly affected by environmental conditions (Bakun and Csirke, 1998; Dawe *et al.*, 2000; Rodhouse, 2001). As a result, environmental indices are often used to predict squid abundance (e.g., Pierce *et al.*, 1998; Robin and Denis, 1999; Agnew *et al.*, 2002; Denis *et al.*, 2002). Annual changes of *T. rhombus* abundance in the Sea of Japan have been discussed in accordance with environmental indices, especially water temperature in the Tsushima Strait two months before the start of the fishery (Miyahara *et al.*, 2005). The results of the present study showed that the distribution and abundance of catches were also related to seawater temperatures on the fishing ground.

The main fishing grounds off Hyogo Prefecture generally occurred at the south of 36°15′N (Figs. 2–4). This is presumably due to the limited cruising range of the fishing boats, which operate during the day and must return to port before night. In 2003 and 2005, however, the fishing ground occurred much closer to shore, south of 35°45′N. The relationship between water temperature in the fishing ground and weighted mean latitude of the catch suggests that the catches were strongly influenced by the occurrence of cold water masses in the region (Fig. 5). In the Sea of Japan, similar cold water masses often occur in several nearshore areas as well (Naganuma, 2000), and the influences of these cold masses have been studied on the fishery biological characteristics of several important species. For example, few eggs and larvae of sardines and squids were collected in the cold water areas, and no spawning there was suggested (Ito *et al.*, 1967). Cold water mass at bottom is closely related to the migration and fishing condition of swordtip squid (*Photololigo edulis*) off Shimane Prefecture (Moriwaki, 1994). Location of the cold water masses and related oceanographic conditions of the Tsushima Current can also deflect the routes of broad-scale migration of the Japanese amberjack (*Seriola quinqueradiata*) in the Sea of Japan (Ogawa, 1976; Hara, 1990; Hashimoto, 1998).

Catches occurred where the seawater temperature at 100 m depth was >14–15°C, which is similar to the results of Tamaki (1987), who reported catches where the temperature at this depth was >15°C. High catches in warm areas are presumably due to a biological characteristic of *T. rhombus* as a warm water species, but future studies need to clarify how such fishing areas form. Direct tracking of the squid using ultrasonic telemetry (Iizuka, 1990; Nakamura, 1993; Yatsu *et al.*, 1999; Yano *et al.*, 2000) or data-recording tags (Gilly *et al.*, 2006) will make it feasible to obtain swimming speed and depth information corresponding to ambient oceanographic conditions, which will help improve

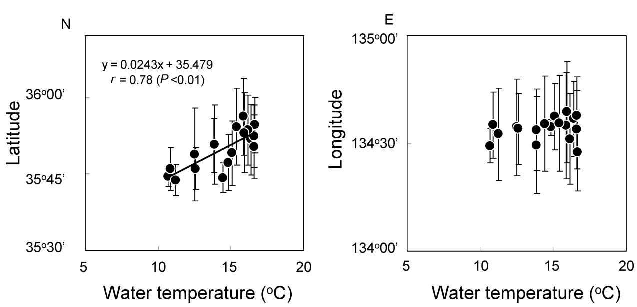

Figure 5. Relationship between mean water temperature (100 m depth) of the six observation sites off Hyogo Prefecture and weighted means of the catch locations (latitude and longitude) of the monitored fishing boats. The weighted means of the catch locations were calculated using catch data collected during the period between five days before and five days after each oceanographic observation. Bars show ±SD.

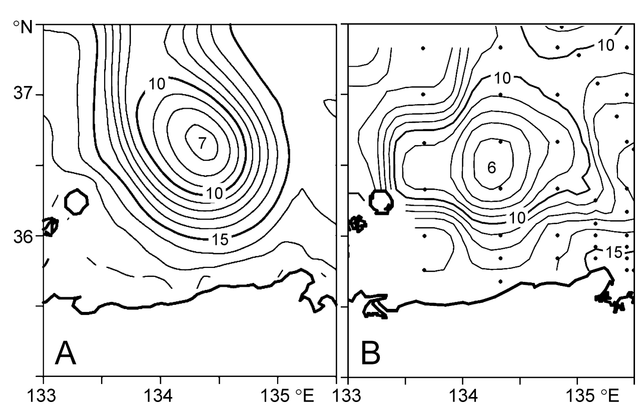

Figure 6. Simulated and actual horizontal distributions of water temperature at 100 m depth in early October 2005 off Hyogo Prefecture in the western Sea of Japan. **A**: operational fo recast made in August 2005 using the RIAM ocean circulation model (http://jes.riam.kyushu-u.ac.jp/), **B**: actual temperature data from the database of the Japan Sea National Fisheries Research Institute (http://jsnf.affrc.go.jp/Physical/newindex.html).

forecasting models.

The mean seawater temperature at 100 m depth at the six observation sites off Hyogo Prefecture was a good index for identifying the location of the fishing ground. A linear regression of the mean latitude of boats on seawater temperature suggests that seawater temperature data can be used to quickly forecast the location of the fishing grounds (Fig. 5). The vertical distribution of *T. rhombus* adults in the Sea of Japan (50–150 m during the day, 0–50 m during the night; Iizuka, 1990; Miyahara *et al.*, unpublished) also supports the validity of using this depth's data. When seawater temperatures at this depth are examined throughout the Sea of Japan, the estimated potential fishing grounds extend from coastal areas off Yamaguchi Prefecture to Niigata Prefecture (Watanabe *et al.*, 2003), which closely coincides with where fishery occurs (Bower and Miyahara, 2005).

Operational forecasts made with the RIAM model suggests that a simulated horizontal distribution of water temperature could be available to forecast oceanographic conditions enough before the start of fishing season (Fig. 6). The results of the present study will improve our ability to forecast future fishing conditions by simulating the detailed horizontal spread of water temperatures and identifying areas with appropriate seawater temperatures.

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References

Agnew, D. J., J. R. Beddington and S. L. Hill (2002) The potential use of environmental information to manage squid stocks. Can. J. Fish. Aqua. Sci., **59**, 1851–1857.

Bakun, A. and J. Csirke (1998) Environmental processes and recruitment variability. In. Squid Recruitment Dynamics. The Genus *Illex* as a Model. The Commercial *Illex* Species. Influences on Variability, ed. P. G. Rodhouse, E. G. Dawe and R. K. O'Dor, FAO Fisheries Technical Paper No. **376**, FAO, Rome, 105–124.

Bower, J. R. and K. Miyahara (2005) The diamond squid (*Thysanoteuthis rhombus*): a review of the fishery and recent research in Japan. Fish. Res., **73**, 1–11.

Dawe, E. G., E. B. Colbourne and K. F. Drinkwater (2000) Environmental effects on recruitment of short-finned squid *Illex illecebrosus.* ICES J. Mar. Sci., **57**, 1002–1013.

Denis, V., J. Lejeune and J. P. Robin (2002) Spatio-temporal analysis of commercial trawler data using General Additive models: patterns of loliginid squid abundance in the North-east Atlantic. ICES J. Mar. Sci., **59**, 633–648.

Fujii, Y., N. Hirose, T. Watanabe and H. Kidokoro (2004) Numerical simulation of the transport for eggs and larvae of *Todarodes pacificus* Steenstrup (Surume-ika) in the Japan Sea. J. Mar. Meteo. Soc., **80**, 9–17 (in Japanese with English abstract).

Gilly, W. F., U. Markaida, C. H. Baxter, B. A. Block, A. Boustany, L. Zeidberg, K. Reisenbichler, B. Robison, G. Bazzino and C. Salinas (2006) Vertical and horizontal migrations by the jumbo squid *Dosidicus gigas* revealed by electronic tagging. Mar. Ecol. Prog. Ser., **324**, 1–17.

Hara, N. (1990) Yearly fluctuations of yellowtail catch in set net fishery along the coastal area of the Sea of Japan. Nippon Suisan Gakkaishi, **56**, 25–30 (in Japanese with English abstract).

Hashimoto, H. (1998) Relationship between current, distribution of water temperature, and *Seriola quiqueradiata* catches. Contrib. Fish. Res. Japan Sea Block, **38**, 101–125 (in Japanese).

Hirose, N. (2003) Reanalysis of the Japan Sea circulation using approximate smoother. Rep. Res. Inst. Appl. Mech., **124**, 29–37 (in Japanese with English abstract).

Hirose, N. and J. H. Yoon (1998) A numerical model for ocean circulation, material transport and fisheries environment in the Japan Sea. *Kaiyo Monthly*, **30**, 490–497 (in Japanese).

Iizuka, S. (1990) Considerations on the swimming ecology and fishing-ground formation of *Thysanoteuthis rhombus*. In. Report of the 1989 Meeting on Squid Resources, and Fishing and Oceanographic Conditions, Tohoku National Fisheries Research Institute, Hachinohe, 63–69 (in Japanese).

Ito, S., S. Kasahara and K. Ikehara (1967) Influence of the cold water regions on the reproduction of important fishery resources. In. Japan Sea Report on the influence of the cold water regions on the distribution of fishery resources, Japan Sea National Fisheries Research Institute, Niigata, 13–36 (in Japanese).

Lee, H. J., J. H. Yoon, H. Kawamura and H. W. Kang (2003) Comparison of RIAMON and MOM in modeling the East Sea/Japan Sea circulation. Ocea. Pol. Res., **25**, 287–302.

Miyahara, K. and Gorie S (2005) Comparison of CPUEs in the diamond squid angling fishery off Hyogo Prefecture, the Sea of Japan. Bull. Hyogo Pref. Tech. Cent. Agri. Forest. Fish. (Fisheries Section), **38**, 15–23 (in Japanese with English abstract).

Miyahara, K. and R. Takeda (2005) Changes of angling methods for the diamond squid fishery in Hyogo Prefecture. Bull. Hyogo Pref. Tech. Cent. Agri. Forest. Fish. (Fisheries Section), **38**, 25–29 (in Japanese with English abstract).

Miyahara, K., T. Ota, N. Kohno, Y. Ueta and J. R. Bower (2005) Catch fluctuations of the diamond squid *Thysanoteuthis rhombus* in the Sea of Japan and models to forecast CPUE based on analysis of environmental factors. Fish. Res., **72**, 71–79.

Miyahara, K., K. Fukui, T. Ota and T. Minami (2006a) Laboratory observations on the early life stages of the diamond squid *Thysanoteuthis rhombus*. J. Mollus. Stud., **72**, 199–205.
Miyahara, K., T. Ota, T. Goto and S. Gorie (2006b) Age, growth and hatching season of the diamond squid *Thysanoteuthis rhombus* estimated from statolith analysis and catch data in the western Sea of Japan. Fish. Res., **80**, 211–220.
Moriwaki, S. (1994) Ecology and fishing condition of Kensaki-squid, *Photololigo edulis*, in the southwestern Japan Sea. Bull. Shimane Pref. Fish. Exp. Stat., **8**, 1–111 (in Japanese with English abstract).
Naganuma, K. (2000) The Sea of Japan as the natural environment of marine organisms. Bull. Japan Sea Natl. Fish. Res. Inst., **50**, 1–42 (in Japanese with English abstract).
Nakamura, Y. (1993) Vertical and Horizontal Movements of mature females of *Ommastrephes bartramii* observed by ultrasonic telemetry. In. Recent Advances in Cephalopod Fisheries Biology, ed. T. Okutani, R. K. O'Dor RK and T. Kubodera, Tokai Univ. Press, Tokyo, 331–336.
Nazumi, T. (1975a) Notes on the fishery and the ecology of the squid, *Thysanoteuthis rhonbus* [sic] TROSCHEL in the east San'in water. Bull. Hyogo Pref. Fish. Exp. Stat., **15**, 15–34 (in Japanese).
Nazumi, T. (1975b) Notes on the species of squid, collected in the Tajima region of the Japan Sea, 1974. Bull. Hyogo Pref. Fish. Exp. Stat., **15**, 9–13 (in Japanese).
Nishimura, S. (1966) Notes on the occurrence and biology of the oceanic squid, *Thysanoteuthis rhombus* Troschel, in Japan. Publ. Seto Mar. Biol. Lab., **14**, 327–349.
Ogawa, Y. (1976) Interrelationship between changes of location of a cold-water mass off Shimane and fishing condition of yellowtail shore-net. Bull. Jpn. Soc. Fish. Oceanogr., **29**, 1–6 (in Japanese with English abstract).
Pierce, G. J., N. Bailey, Y. Stratoudakis and A. Newton (1998) Distribution and abundance of the fished population of *Loligo forbesi* in Scottish waters: analysis of research cruise data. ICES J. Mar. Sci., **55**, 14–33.
Robin, J. P. and V. Denis (1999) Squid stock fluctuations and water temperature: temporal analysis of English Channel Loliginidae. J. Appl. Ecol., **36**, 101–110.
Rodhouse, P. G. (2001) Managing and forecasting squid fisheries in variable environments. Fish. Res., **54**, 3–8.
Takeda, R. and M. Tanda (1998) Fishing and migration of *Thysanoteuthis rhombus* Troschel in the Japan Sea. In. Contributed papers to international symposium on large pelagic squids, ed. T. Okutani, Japan Marine Fishery Resources Research Center, Tokyo, 191–198.
Tamaki, T. (1987) Fishing condition of *Thysanoteuthis rhombus* in the Tajima region in 1985. Contrib. Fish. Res. Japan Sea Block, **9**, 99–104 (in Japanese).
Watanabe, T., M. Ichihashi, H. Yamada and O. Katoh (2003) Mean water temperature in the Sea of Japan (1971–2000). Contrib. Fish. Res. Japan Sea Block, **41**, 1–112 (in Japanese).
Yano, K., Y. Ochi, H. Shimizu, T. Kosuge (2000) Diurnal swimming patterns of the diamondback squid as observed by ultrasonic telemetry. In. Biotelemetry 15. Proceedings of the 15th International Symposium on Biotelemetry, ed. J. H. Elier, D. J. Alcorn and M. R. Neuman, International Society on Biotelemetry, Wageningen, Netherlands, 108–116.
Yatsu, A., K. Yamanaka and C. Yamashiro (1999) Tracking experiments of the jumbo flying squid, *Dosidicus gigas*, with an ultrasonic telemetry system in the eastern Pacific Ocean. Bull. Natl. Res. Inst. Far Seas Fish., **36**, 55–60.

日本海西部兵庫県沖におけるソデイカ漁獲の分布と水温との関係

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日本海西部の兵庫県沖海域において，7隻の樽流し立縄漁業標本船操業日誌資料を用いて1999年から2005年のソデイカ *Thysanoteuthis rhombus* の漁獲位置や漁獲量の水平分布について調査するとともに，漁場周辺の水温環境との関係について解析した．兵庫県沖の漁場は概して北緯36°15′以南，東経134°10′から135°の範囲に形成されていたが，冷水域（山陰・若狭沖冷水）の接岸が確認された2003年と2005年には，より沿岸部寄りの北緯35°459以南に形成された．好漁場の指標水温は，水深50 m，100 m深でそれぞれ19°C，14–15 ℃以上と考えられた．兵庫県沖の観測定点（6箇所）の100 m深の平均水温は，漁獲量で重み付けした平均漁獲緯度と相関しており，漁場形成位置の指標になると考えられた．

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