

抄 録

Catch fluctuations of the diamond squid *Thysanoteuthis rhombus* in the Sea of Japan and models to forecast CPUE based on analysis of environmental factors

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Fisheries Research, 2005, 72, (1), 71-79.

This paper describes recent catch fluctuations of the diamond squid *Thysanoteuthis rhombus* in the Sea of Japan and the development of models used to forecast catch per unit effort (CPUE) off Hyogo Prefecture based on statistical analyses of environmental indices measured 600 km upstream in the Tsushima Current. Annual catches during 1989–2002 fluctuated widely, and prefectural annual catches were closely related to each other, especially among the western prefectures. Four indices in June were closely related with CPUE during the fishing season (September–November) off Hyogo: (1) water temperature in the Tsushima Strait, (2) salinity in the Tsushima Strait, (3) sea level at Izuhara (Tsushima Island) and (4) sea level difference between Izuhara and Hakata (Kyushu Island). Using these indices as independent variables, simple and multiple regression analyses were conducted, and CPUE was accurately estimated by both regression and extrapolation, indicating that the CPUE off Hyogo can be forecasted 2 months before the fishery starts using the described models. The strong correlation among catches in different prefectures suggests the indices discussed here affect the catches over a large area.

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抄 録

計量魚群探知機を用いた日本海隠岐諸島周辺海域におけるキュウリエソの音響散乱層の識別

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日本水産学会誌, 2005, 71, (6), 947-956.

計量魚群探知機により観察されるキュウリエソの音響散乱層を識別することを目的として, 日本海隠岐諸島周辺海域において, 従来推奨されてきた方法と季節毎に変化する SV の下限閾値を利用した方法を比較検討した。この結果, 信号毎に深度 10 m より海底までのデータの水柱中の最大 SV を抽出し, 各最大 SV (体積後方散乱強度) を調査ラインに沿って平均した値から 10 dB 差し引いた値を下限閾値に設定して, 散乱層を識別する方法がトロールによるキュウリエソの採集結果と良く一致した。この方法はキュウリエソの集群密度の変化に対応し, 散乱層の輪郭を的確に捉えている。

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抄 録

Environmental effect on diet, fecundity and condition of an endangered fish *Neosalanx reganius* (*Osmeriformes*) in the Chikugo Estuary, in the upper Ariake Bay, Japan

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Aquat. Living Resour.,2006,19,(1), 59-68.

Neosalanx reganius is a poorly studied salangid fish restricted to the upper reaches of the Chikugo and the Midori River flowing into the Ariake Bay, Kyushu, Japan. Samples of *N. reganius* were collected from brackish water areas of the Chikugo River by eight cruises in 1998-2004 to characterize the distribution pattern, feeding ecology in relation to ambient prey concentrations, fecundity and condition of the fish. A total of 244 specimens were collected, 36 to 71 mm total length, and 111 to 1301 mg body weight. The catch per unit of effort (CPUE; number of fish collected by towing a larva net for 20 min) correlated positively with turbidity and negatively with salinity. *N. reganius* is a planktivorous fish, fed on a single calanoid copepod species *Sinocalanus sinensis*, which was the single most dominant prey item in all stations during all cruises, contributing as high as 97.0% of the total diet of the fish; the other prey items (other calanoids and cyclopoids, *Daphnia* sp. and decapod mysid) together contributed only 3%. *S. sinensis* also dominated in the environmental copepod composition. The CPUE showed significant correlation with copepod dry biomass which increased upstream ($r = 0.90$; $p < 0.05$). Fecundity ranged 347-995 (mean) oocytes individual⁻¹ and relative fecundities ranged 6.8-15.6 (mean) oocytes mm⁻¹ TL and 0.8-2.5 (mean) oocytes mg⁻¹ of net body weight (weight taken after gonad extraction). Fecundity showed significant positive relationship with fish length and body weight. GSI ranged 29.4-58.8% (mean %) and had significant relationship with fish length and body weight. Spawning individuals had higher allometry coefficient (b) and condition factor (K) than the non-spawning individuals. The oligohaline upper Chikugo estuary provides important feeding and spawning grounds for the fish with sufficient prey abundance and turbidity maximum that seemed advantageous for feeding and spawning of *N. reganius* in the Chikugo estuary. We suggest that future research should emphasize on the spawning and early life ecology of the fish in order to formulate effective conservation action.

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抄 録

Age, growth and hatching season of the diamond squid *Thysanoteuthis rhombus* estimated from statolith analysis and catch data in the western Sea of Japan

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Fisheries Research, 2006, 80, (2), 211-220.

Age, growth and hatching season were estimated for the diamond squid (*Thysanoteuthis rhombus*) migrating into the Sea of Japan based on analyses of statolith growth increments and length–frequency data of the catch in 1999–2004. Growth rates did not differ significantly between the sexes. The oldest squid was 306 days old, which provides further evidence that *T. rhombus* has a 1-year life span. The hatching season extended from January to September, with a peak in February–March, and the spawning grounds were suggested to extend from the far southwestern Pacific to the East China Sea. Using aging results from statolith analysis, growth was well described by a logistic formula, which also closely corresponded with the sequential progress of the mean mantle length in size–frequency distribution of the catch. Growth rates varied depending on the time of hatching; earlier-hatched squid grew faster than later-hatched ones, suggesting that the former hatched in warmer upper-stream areas of the Tsushima Current or the Kuroshio region and the latter hatched in colder mid- or downstream areas of the Tsushima Current.

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抄 録

Laboratory observations on the early life stages of the diamond squid *Thysanoteuthis rhombus*

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Journal Molluscan Studies, 2006, 72, (2), 199-205.

The early life stages of the diamond squid *Thysanoteuthis rhombus* from early embryogenesis to post-hatching (0–7 days old) were observed through laboratory incubation using egg masses collected in the southern Sea of Japan. The egg diameter and mantle length increased during embryonic development through hatching. Mantle-length growth was linear over time, and the growth rate was significantly higher at 25°C than at 20°C. The inner yolk was located on the dorsal side of the mantle cavity and increased in volume through hatching. Immediately after they hatched, the hatchlings remained on the bottom of culture plates with their ventral sides facing up, but 2–3 days after hatching they began to swim with their dorsal sides facing up. Feeding experiments were conducted, but none of the hatchlings fed. Statolith growth increments were shown to form daily. Ontogenetic changes that occur from fertilization through post-hatching are discussed.

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抄 録

Diel and tidal changes in the distribution and feeding habits of Japanese temperate bass *Lateolabrax japonicus* juveniles in the surf zone of Ariake Bay

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Ichthyological Research, 2006, 53, (2), 129-136.

Japanese temperate bass *Lateolabrax japonicus* juveniles recruit to the surf zone and grow by feeding on commonly occurring coastal copepods. However, little is known about diel and tidal patterns in their migration and feeding habits. We sampled wild juveniles during the neap and spring tides, over periods of 24 h, with small seine nets in the sand flat of the eastern part of Ariake Bay, Kyushu, western Japan. In both the neap and spring tides, abundance of juveniles significantly increased during the daytime, being highest around the time of high tide. The relative gut fullness indices of juveniles drastically increased in the morning (0700–0900) and during the flood tide in the daytime, while major prey copepod (*Paracalanus spp.*) density in the ambient water was relatively constant. We summarized that *L. japonicus* juveniles would migrate to the surf zone after sunrise to feed on copepods, and then emigrate from the surf zone after sunset. The migratory behavior of *L. japonicus* juveniles would be influenced by light (daytime) and feeding activity influenced by both light (morning) and tidal condition (flood tide). The intertidal region of the tidal flat was recognized to be one of the important habitats for *L. japonicus* during their early life history.

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抄 録

Long-term patterns in the diets of Japanese temperate bass *Lateolabrax japonicus* larvae and juveniles in Chikugo estuarine nursery ground in Ariake Bay, Japan

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Estuaries and Coasts, 2006, 29, (3), 519-529.

Larval and juvenile Japanese temperate bass (*Lateolabrax japonicus*) samples were collected from a wide range of spatial gradients (covering a distance of approximately 30 km) in Chikugo estuary, Ariake Bay, Japan over a period of 8 yr (1997–2004) in order to observe changes in diet. Gut contents were studied by separating, identifying, counting, and estimating the dry weight of prey organisms. Copepod samples were collected during each cruise to observe the numerical composition, abundance, and biomass in the estuary. Considerable spatial and temporal variations were observed in copepod distributions in ambient water and the diets of the fish. Two distinctly different copepod assemblages were identified in the estuary: One in the upper estuarine turbidity maximum (ETM), dominated by a single species *Sinocalanus sinensis* and the other in the lower estuary consisting of a multispecies assemblage, dominated by *Oithona davisae*, *Acartia omorii*, *Paracalanus parvus*, and *Calanus sinicus*. The gut content composition of the fish in the upper estuary was dominated by *S. sinensis*, while in the lower estuary, it consisted of *P. parvus*, *O. davisae*, and *A. omorii*. Within the size group analyzed (13.0–27.0 mm SL), the smaller individuals were found to feed on a mixed diet composed of smaller prey. The diets gradually shifted to bigger prey composed predominantly of *S. sinensis* for larger size groups. Greater proportions of empty guts were recorded in the smaller individuals and dropped with increasing fish size. Higher dry biomass of copepods in the environment, as well as higher dry weights of gut contents, were recorded in the upper estuary, indicating that the upper estuarine ETM areas are important nursery grounds for the early life stages of the Japanese temperate bass. The early life stages of the Japanese temperate bass are adapted to use the upstream nursery grounds and ascending to the nursery areas to use *S. sinensis* is one of the key survival strategies of the Japanese temperate bass in the Chikugo estuary.

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抄 録

Vertical distribution of *Todarodes pacificus*(Cephalopoda:Ommastrephidae) paralarvae near the Oki Islands,southwestern Sea of Japan

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Marine Biology ,2007, 153,7–13

The diel vertical distribution patterns of Japanese common squid, *Todarodes pacificus*, paralarvae were examined using a Multiple Opening Closing Net and Environmental Sensing System (MOCNESS) in the southwest Sea of Japan near the Oki Islands (Japan) during Wve lateautumn surveys in 1998–2002. A total of 1,511 paralarvae ranging in mantle length (ML) from 0.7 to 7.3 mm were collected at 63 of the 68 stations surveyed. Most (84%) were collected above 75 m depth and in the mixed layer.

The vertical distribution patterns varied little between day and night. Hatchling-sized (<1.0 mm ML) paralarvae were abundant at 0–25 m depth, and paralarval ML increased with increasing sampling depth. Our results suggest that *T.pacificus* paralarvae do not exhibit large diel vertical migration patterns, but as they increase in size, paralarvae gradually descend in the water column and the variability in depth increases with ontogeny.

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抄 録

理論モデルによるエチゼンクラゲ *Nemopilema nomurai* のターゲットストレングス推定
に必要な生体密度および生体内音速の測定

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海洋音響学会誌,2007, 34,(2),109-118.

The jellyfish *Nemopilema nomurai*, which reaches up to 2 m in diameter and 200 kg in weight, has appeared in large numbers in the Sea of Japan during the last several years and has had a negative effect on coastal fisheries in this region. Data on the abundance and distribution of these jellyfish are needed to forecast when and where they will occur in coastal areas. Acoustic techniques are commonly used to study the distribution and abundance of fish and zooplankton because these techniques can survey large areas relatively quickly. Before such surveys can be conducted, the acoustic characteristics of the target species must be known. In this study, the density and speed-of-sound in live jellyfish were measured in order to clarify their acoustic characteristics using a theoretical scattering model. The density of the jellyfish was measured using the dual-density method, while the speed of sound was measured using the time-of-flight method. Their acoustic characteristics were estimated with the distorted-wave Born approximation (DWBA) model using these material properties and the shape of free-swimming jellyfish. The results demonstrate the feasibility of investigating the abundance and distribution of jellyfish using acoustic methods.

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抄 録

**Transportation of organic matter to the sea floor by carrion falls of the giant jellyfish
Nemopilema nomurai in the Sea of Japan**

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Marine Biolog,2007,153,(3), 311-317.

The fate of the giant jellyfish *Nemopilema nomurai* after death was examined in the southwest Sea of Japan. The density of dead jellyfish was greater than that of live animals. The dead animals are heavier than the Japan Sea Proper Water which occurs deeper than 200 m, suggesting that dead jellyfish sink to the sea floor. The sea floor survey, conducted with a towed video tape recorder (VTR) monitoring system between mid September and mid October, observed a total of 138 jellyfish during 28 of 29 operations. The density of carrion ranged between 0.2 and 5.1 individuals/1,000 m² (mean \pm SE = 1.1 \pm 0.2). Ophiuroids occurred abundantly at 23 jellyfish carcasses and a sea anemone was observed attached to five carcasses. The VTR surveys confirmed that carrion sinks to the sea floor not only during the winter, the normal end of life for medusae, but also during the fall. A trap survey baited with medusae was also employed, and four different species were sampled with the traps: the snow crab (*Chionoecetes opilio*), a shrimp (*Pandalopsis japonica*), the ivory shell (*Buccinum striatissimum*) and an ophiuroid (*Ophiura sarsii*). Much of the trap bait remained (49–68% weight-mean = 60.3%) during the 23 h soak-time, and the reduction in weight was greater than that observed by bacterial decomposition, suggesting benthic animals consume dead organisms. The present study indicates that dead *N. nomurai* sink to the sea floor continuously and were subsequently consumed by benthic scavengers.

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抄 録

Distribution of Japanese temperate bass, *Lateolabrax japonicus* , eggs and pelagic larvae in Ariake Bay

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Ichthyological Research,2007,54,(4), 367-373.

We collected eggs and larvae of the Japanese temperate bass, *Lateolabrax japonicus*, and present horizontal and temporal changes of distribution relative to development and growth during the species pelagic life history in Ariake Bay. Sampling was conducted from the inner to central region (11 sampling stations) of Ariake Bay using a plankton net (80 cm diameter, 0.5-mm mesh) from November 2000 to February 2001. Both eggs and larvae were collected most abundantly in mid-December. The CPUE of eggs in the surface layer was higher than the middle layer, which is in contrast to that at the larval stage. Most eggs were collected around the central and western regions of the bay. The distribution of eggs shifted vertically to the middle layer with development. Yolk-sac larvae were collected in the central region of the bay, and preflexion and flexion larvae were more abundantly collected in the inner region of the bay. The body length of larvae around the inner bay was larger than in the central region. The pelagic life history can be summarized as follows: eggs are distributed around the central region of the bay and eggs and larvae expand their distribution to the inner and shallower waters with growth. We conclude that the shift of vertical distribution in pelagic stages and the hydrographic features of the middle layer form one of the mechanisms enabling the inshore migration of *L. japonicus*.

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抄 録

稚魚期を有明海灣奥部河口域で過ごしたスズキの成長

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海洋と生物,2007,168,(29),33-39.

Annual larva-net collections in the Chikugo River estuary located in the unner part of Ariake Bay showed that freshwater area is one of the important nursery grounds for the early juvenile period as the local population of Japanese temperate bass *Lateolabrax japonicas*. Analyses of otolith microincrements and strontium / calcium (Sr/Ca) ratios were conducted for clarifying their upstream migration and maintaining mechanism of amphidromous migration. Compared growth in early juveniles between fresh, brackish and marine waters around Chikugo River estuary based on microincrements analyses, fish which inhabited lower salinity area tended to have high growth. In particular, fish immigrating to the freshwater area had the highest growth. Otolith Sr/Ca ratio trajectories of 0-age bass showed their fresh-water entry during the early juvenile period. In addition, size of the individuals immigrating to freshwater area tended to be larger than non-immigrants.

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抄 録

春季の日本海鳥取沖におけるカタクチイワシの成熟と産卵
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水産海洋研究,2008,72,(2),101-106.

The purpose of this study was to clarify the characteristics of maturation and spawning of the Japanese anchovy, *Engraulis japonicus*, off Tottori, Sea of Japan during spring. The research was based on histological analysis of ovaries and gonadosomatic index (GSI) of female anchovies caught by purse seine fisheries off Tottori and landed at the Sakaiminato harbor in 2003 and 2004. In addition, the frequency of anchovy eggs collected during 1995 and 2004 using a NORPAC-net off Tottori by the Tottori Prefectural Fisheries Experimental Station was assessed. Female GSI was positively correlated with body length from April to May, and yolked stage or more matured stage oocytes were found in ovaries of females ≥ 4.7 in GSI and ≥ 11.9 cm in body length. Females with migratory nucleus stage oocytes were 18% of total females in March. More than 90% of total females had nucleus stage or more matured stage oocytes in April and May. Frequency of matured females increased rapidly when the sea surface temperature increased to about 12°C in spring. Anchovy eggs were collected where the SST was between 11.8 and 19.4°C from April to June. This study found that anchovy can spawn in low temperature area off Tottori in spring.

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抄 録

Migration of Japanese temperate bass *Lateolabrax japonicus* juveniles within the Chikugo River estuary revealed by $\delta^{13}\text{C}$ analysis

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Marine Ecology Progress Series, 2008, 358, 245-256.

With conventional techniques it is difficult to evaluate the nursery value for migratory juveniles of Japanese temperate bass *Lateolabrax japonicus* within the Chikugo River estuary in Japan, especially in lower salinity areas where highly abundant prey organisms are distributed. In the present study stable carbon isotope ratios ($\delta^{13}\text{C}$) were used as a migration tracer within the estuary. Based on preparatory information from diet-switch experiments and field observations of prey organisms, the ranges on which tissue $\delta^{13}\text{C}$ values of juveniles should converge (convergence range) were determined in lower and higher salinity areas (LSA salinity < 10, HSA salinity > 10). For early juveniles, muscle $\delta^{13}\text{C}$ values were analyzed and ages were determined by otolith increment counts. For more developed juveniles $\delta^{13}\text{C}$ values were analyzed in muscle and liver, whose half-life values were 11.4 and 2.9 d, respectively. Temporal patterns of migration were estimated by comparing $\delta^{13}\text{C}$ values in muscle and liver with the convergence ranges of both LSA and HSA. Early juveniles aggregated around the river mouth in March 2003 and the majority gradually ascended the river to LSA by April. Most of them stayed in LSA until August, while some began to expand their home ranges to HSA after July. In addition, it is suggested that the timing of ascent influenced the early growth of juveniles. Consequently, the potential importance of LSA was demonstrated during the first growth season of Japanese temperate bass in the estuary.

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抄 録

Prevalence and intensity of *Phrixocephalus umbellatus* (Copepoda: *Siphonostomatoida*: *Pennellidae*) parasitic on *Paralichthys olivaceus* in the western part of the Sea of Japan

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Fisheries Science, 2009, 73(1), 214-216.

No Abstract

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抄 録

日本海南西海域における中層トロールと面積密度法を用いたマアジ当歳魚の現存量推定手法の開発

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日本水産学会誌,2009,75,(6), 1042-1050.

マアジは日本周辺の沿岸域に広く分布する産業重要種である。マアジ対馬暖流系群の資源量はVPA法で推定されているが、この手法では当歳魚の資源量が推定されるのは加入から数年後であるため、当歳魚の資源評価の精度が低いという欠点がある。そこで、漁期前に中層トロールで当歳魚を採集して、面積密度法によって現存量指標値を推定する方法を開発した。マアジの分布は水塊配置によって東西や南北方向に偏った。面積密度法によって水温分布を考慮し4海域に区分することで、正確な現存量指標値を推定することができた。

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抄 録

Numerical simulation of the migration and distribution of diamond squid (*Thysanoteuthis rhombus*) in the southwest Sea of Japan

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Fisheries Oceanography, 2009, 19, (1), 63-75.

To elucidate the effects of hydrographic conditions on the migration and distribution of diamond squid (*Thysanoteuthis rhombus*) in the Sea of Japan, two numerical experiments were conducted using a Lagrangian particle-tracking model. First, Lagrangian simulations with different horizontal swimming speeds were conducted in the area off the San-in coast, the southwest Sea of Japan. The comparison results of simulations and experimental tagging records from 2003 suggest that horizontal movement of diamond squid over a few days is influenced by individual swimming, but long-term migration over more than about 10 days is dependent on the ambient current field. Secondly, further Lagrangian simulations with biological processes, forced by different hydrographic conditions in 2003–2005, were conducted. Temporal variations in distributions and sizes calculated by the model corresponded approximately to those of catch data. A large number of particles simulating squid were distributed over the nearshore region from the San-in coast to the Noto Peninsula during September–November every year. Differences in the migration route and distribution of particles among years were closely related to differences in hydrographic conditions such as the position of the main stream of the Tsushima Warm Current. Prediction of the catch off the San-in coast might be improved by considering hydrographic conditions in the southwest Sea of Japan.

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