

PICES XIII BIO_P-1835 Oral

Use of otoliths to determine the age and growth of two subtropical flatfishes, *Cyclopsetta querna* and *Cyclopsetta panamensis* (Pleuronectiformes: Paralichthyidae), off the southeast coast of the Gulf of California, México

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Sagittal otoliths were used to determine the age and growth of *Cyclopsetta querna* and *Cyclopsetta panamensis* caught off the southeast coast of the Gulf of California with commercial trawls. In total, 245 individuals of *C. querna* and 172 individuals of *C. panamensis* were examined. For both species, the marginal growth increments indicated that the bands were formed yearly, the hyaline bands were formed during the summer and the opaque bands were formed during the winter. Four hyaline bands and three opaque bands were recognized, representing ages from 0.5 to 4.5 years. The von Bertalanffy growth parameters for the entire population were $L_{\infty}=66.171\text{cm}$; $k=0.214/\text{yr}$; $t_0=0.404\text{ yr}$ for *C. querna*, and $L_{\infty}=60.024\text{cm}$; $k=0.177/\text{yr}$; $t_0=0.26\text{ yr}$, for *C. panamensis*. No significant differences in length-at-age were found between sexes for any species. The life span of these species is short, about 5 years. The use of otoliths to determine the age and growth of these species is an adequate method, notwithstanding the usual paradigm that determining the age of species of warmer climates is difficult because there are no clear annual rings in the otoliths.

PICES XIII BIO_P-1781 Poster

Productivity of pelagic communities and distribution patterns of benthos on the continental shelf and slope of the Okhotsk Sea along NE Sakhalin Island

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An expedition in August of 2003 on the continental shelf and slope of the Okhotsk Sea along NE Sakhalin Island obtained new data on productivity of pelagic communities and abundance and distribution patterns of benthos. Water and sediment samples were taken at 20 stations along 5 transects between 52° and 54°N at a depth from 20 to 1500 m.

Concentrations of Chl *a* in the photic layer varied from 0.13 to 11.79 mg/m³ (mean = 1.76 mg/m³). Primary production varied from 0 to 7.30 mgC/m³ day (mean = 1.40 mgC/m³ day). As a rule, the highest Chl *a* concentration and primary productivity was observed at layer of 10-20 m near the shore. The diatom microalgae community with the highest abundance, Chl *a* concentration and productivity level was observed in the coastal waters. Areas of high productivity of pelagic communities in 2003 were concentrated in zones of local cyclonic eddies.

The benthos abundance pattern in 2003 corresponded to data obtained in the 1990s, indicating that the highest biomass (>1000 g/m²) and densities (>16,000 ind/m²) were observed at the depth range 30-100 m due to strong aggregations of suspension-feeders: sea urchins, amphipods and cumaceans. This zone encompasses the area of coastal upwelling. Maximum species abundance was registered at the depth range 100-200 m.

PICES XIII BIO_P-1980 Poster

PCR-based assays for detecting ichthyotoxic *Cochlodinium polykrikoides* (Gymnodiniales, Dinophyceae) in the South Sea of Korea

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Rapid detection of the harmful dinoflagellate *Cochlodinium polykrikoides* is necessary for effective monitoring in Korean coastal waters. Recently, the DNA ITS (Internal Transcribed Spacers) region has been identified as a suitable means for the identification of *C. polykrikoides*. This study is the first to design specific DNA primers and to evaluate their specificity and sensitivity in a PCR assay on cultures. Oligonucleotide primers Cocho 1F and Cocho 5R were designed to amplify an approximately 500 base pair fragment, comprising sections of the rDNA ITS of *C. polykrikoides*. PCR products of predicted size were produced for 4 isolates from Narodo and Daeyeon, Korea, and from the Yatsushiro Sea of Kumarr and Inokushi Bay, Japan. No PCR products were amplified when the primers were tested against *Heterosigma akashiwo*, *Gymnodinium impudicum*, *Alexandrium tamarense*, *Prorocentrum micans*, *Akashiwo sanguineum*, *Chaetoceros affinis*, *Scrippsiella trochoidea*, and *Chlamydomonas* sp. In cultures of *C. polykrikoides*, the limit of detection was 10 cells l⁻¹. This PCR assay directly detected *C. polykrikoides* in the ocean at Dolsan (St. 1) in June, where it existed at approximately 10 cells l⁻¹ (determined by light microscope). However, neither PCR-positive products nor detection by light microscope was seen during March, April, May, or June in any locations, except for Dolsan on June. During the period of study, fluctuations in environmental conditions, nutrients, and the ratio of DIN/DIP were similar regardless of sampling sites. The cause of the outbreak of *C. polykrikoides* at Dolsan did not appear to be associated with environmental characteristics. These specific primers will be a useful tool in simple, rapid, and accurate assessment of *C. polykrikoides* in natural samples.

PICES XIII BIO_P-1812 Oral

On the fluctuations of sardine-*iwashi* abundance

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The sardine-*iwashi* (*Sardinops melanosticta*) has shown prominent periodic fluctuations in its abundance, similar to other species of the genus *Sardinops*. Both the stock of this species and value of the catch change in a hundred-fold or more times in 25-30 years. This fluctuation is among the highest of any fish population in the North Pacific. After 30-years of depressed abundances, a sardine generation with high abundance appeared in 1972, and in 1976 an active seine fishery began in the Japan Sea, with a value reaching 370,000 MT in Russian EEZ alone in 1982. The total biomass of sardines in the Northwest Pacific was about 20 MMT in that period. The fishery was unlimited and the total catch of sardines by all Asian-Pacific countries was 4.5 MMT – higher than the catch of Alaska walleye pollock. We hypothesize that changes in solar activity are the primary factor behind climate changes and large-scale reconstructions of marine ecosystems, including the fluctuations of sardine abundance. Regional climate-oceanographic environments provide the starting conditions for sardine stock growth, but when it reaches a high value, mechanisms of population density regulation are switched on, and environmental control terminates. Independent of environmental factors, density factors can lead the population to an inevitable depression.

PICES XIII BIO_P-1912 Poster

Spatial distribution of fish larvae in relation to hydrographic conditions in the waters around Taiwan

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The purpose of this study is to investigate the species composition and distribution of fish larvae in relation to hydrographic conditions in the waters around Taiwan collected during a R/V FRI cruise in February 2003. Samples

were collected from 28 stations by oblique tows from 200 m depth (or 10 m from bottom at stations with shallower depth) to the surface using an ORI net, with 1.6 m mouth diameter and 330 μ m mesh. Two hundred and twenty-nine taxa of fish larvae belonging to 126 genera and 70 families were recognized. Of these, 96 taxa were identified to family or genus level, and the rest to species. The ten most dominant taxa were *Engraulis japonicus*, *Auxis rochei*, *Diaphus* spp., *Benthoosema pterotum*, *Carangoides ferdau*, *Embolichthys mitsukurii*, *Maurolicus* sp., *Gonostoma gracile*, Myctophidae gen.sp. and *Trichiurus lepturus*; together they constituted 68% of the total fish larvae. The winter hydrographic conditions in the waters around Taiwan were mainly influenced by the China Coastal Waters (CCW) and the Kuroshio Current (KC). The distribution of fish larvae showed apparent association with water masses. Higher abundance was observed in the northwestern Taiwan where CCW was located and lower in KC, but the reverse was true for species number and diversity. Based on the results of cluster analysis, three seasonal groups were distinguished and are discussed.

PICES XIII BIO_P-1778 Oral

Monitoring biological effects of contamination in fat greenling *Hexagrammos otakii* along the Dalian coast by measurement of EROD activity

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There have been many efforts to find suitable biological parameters for pollution monitoring programmes in the past 20 to 30 years. The monooxygenase (MO)-activity of fish has been shown to be useful as an 'early warning' system for environmental contamination caused by polycyclic aromatic hydrocarbons (PAH), polychlorinated dibenzodioxins (PCDD) and certain PCB (polychlorobiphenyl). Ethoxyresorufin-O-deethylase (EROD) is one of the model reactions of the cytochrome P-450-1A1 mediated monooxygenase system. In this study, EROD activity, measured by kinetics fluorescence spectrophotometry, was selected as an indicator of PAH and PCB effects in benthic fishes. EROD induction in fish liver exposed to organic contamination demonstrated the ability of this technique to be an available and efficient marker of exposure to specific pollutants. After it was determined that there existed a dose/effect relationship between EROD activities and specific pollutant concentrations, an initial assessment of biological effects on fat greenling *Hexagrammos otakii* was carried out in well-chosen stations of the coasts along Dalian. It was proved to be feasible that EROD activity can be used to assess specific contamination through combination with other analysis of PCB data. It should be noted that multiple factors may have an effect on EROD activities in organisms. Therefore, a regular biological effects monitoring had been carried out for three years along Changhai area of Dalian by measurement of EROD activities in fish, to determine the feasibility of studying such parameters in the field and the optimal conditions for analysis of EROD activity are discussed. Moreover, a much faster and simpler method for measuring hepatic EROD activities of fish, using a fluorescence plate-reader, was introduced and discussed.

PICES XIII BIO_P-2101 Poster

Acoustic visualization of the relationship between ocean structure and the vertical distribution of biota in the Kuroshio-Oyashio Transition Zone (KOTZ)

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The Kuroshio-Oyashio Transition Zone (KOTZ) is well known as a region where a complex ecosystem forms because of the mixing of warm and cold water. Especially in the spring, remarkable biological production is observed because of the increase of primary productivity and the resulting phytoplankton bloom. It is important to examine how the environmental conditions in the KOTZ affect the horizontal and vertical distribution pattern of

marine organisms. Acoustic methods are an effective way to examine vertical distribution patterns of biota. The aim of this study is to clarify the relationship between oceanographic conditions and the horizontal and vertical distribution pattern of biota in the KOTZ using a quantitative echosounder system. Acoustic, net sampling and oceanographic data were obtained during a survey of prey preference of baleen whales conducted in April 2003 off the Pacific coast of northeastern Japan. Acoustic backscattering from Japanese anchovy (*Engraulis japonicus*) was frequently seen in the surface layer of the warm water region and from zooplankton such as euphausiids and copepods in the cold water region. Two kinds of water mass structure occurred in Sendai Bay, which was located in the mixed water region, and the distribution of marine organisms was divided according to the water layers. These results suggest that the acoustic method can visualize how strongly biota of the complex region are distributed according to ocean structure.

PICES XIII BIO_P-1888 Poster

Metabolic characteristics of meso- and bathypelagic copepods in the Oyashio region, western North Pacific Ocean

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Copepods living in the 500-1000, 1000-2000, and 2000-3000m depth strata in the Oyashio region were retrieved by vertical hauls with closing nets, and their oxygen consumption rates were determined on board ship at near *in situ* oxygen concentrations (2-3.5 mlO₂ l⁻¹) and temperatures (1.5-3°C) by using a sealed-chamber method. Oxygen consumption rates thus obtained on a total of 64 copepod species were standardized to body nitrogen to examine the effect of body size (nitrogen), temperature, depth of occurrence, and ambient oxygen concentration. Stepwise-multiple regression analyses on these data, combined with information on epipelagic copepods inhabiting similar thermal regimes in the Arctic and Antarctic, revealed that, in addition to body size and temperature, the depth of occurrence is a factor affecting the oxygen consumption rates of deep-sea copepods. Typically, the oxygen consumption rates of bathypelagic copepods were 1/3-1/4 of the rates of epipelagic ones. Possible artifacts caused by the sampling process are unlikely as simultaneous determinations of ETS-activities of these copepods exhibited the same depth effect (F. Sano *et al.*, unpublished data). Thus, our results do not support the standing view that the metabolic activity of pelagic copepods is not affected by the depth of their occurrence in the ocean.

PICES XIII BIO_P-2064 Oral

Molecular population structure of the euphausiid *Pseudeuphausia sinica* from the Northeastern Asia

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The euphausiid *Pseudeuphausia sinica* (Crustacea, Euphausiacea), is abundant in the coastal regions of the South and East China Sea all the year round, and was first reported from the southwestern coastal region in Korean waters in November 1989. However, it has recently also been found in Gwangyang Bay in the southern region of Korea. DNA sequences for a 610bp region of mitochondrial cytochrome oxidase I (mtCOI) were determined to examine the relationships of 23 specimens from three coastal regions of Korea and China (southwestern coastal region of Korea; Gwangyang Bay, southern Korea; and the mouth of the Changjiang (Yangtze) River, China). Alleles from the three sample regions formed paraphyletic groups. In Gwangyang Bay more than 91% of specimens collected in October were classified into the same clade as the China population, while the other specimen and one collected on July formed an independent clade. Specimens collected from the southwestern coastal region of Korea and the mouth of the Changjiang of China in May and July were classified into three clades: Southwestern and southern Korean populations and a Chinese one. Beardsely *et al.* (1992) showed that in summer the southern coastal waters of Korea could be affected by Changjiang River water ca. two months after discharge. This suggests that the Chinese

population of *P. sinica* predominating in the coastal regions of China below 34°N could be continuously transported to Korean waters.

PICES XIII BIO_P-1958 Poster

The distribution of modern dinoflagellate cysts in the Yellow Sea

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Approximately 30 species of modern dinoflagellate cysts were identified in surface sediments in the Yellow Sea with a total abundance of 100~12,830 cysts/g. The predominant order was Gonyaulacales, accounted for 87% to total modern dinoflagellate cysts and followed by Peridinales (9%) and Gymnodinales (4%). The dominant species of Gonyaulacales were *Alexandrium tamarense*, *Gonyaulax scrippsae*, *G. spinifera*, and *G. verior*; those of Peridinales were *Diplopsalis lenticula* and *Protoperidinium conicum*; and those of Gymnodinales were *Pheopolykrikos hartmannii* and *Gynodinium catenatum*. The overall distributional patterns of modern flagellate cysts showed high densities in the central part of the Yellow Sea where Gonyaulacales was 30~400 cysts/g and Peridinales with 10~1,500 cysts/g and showed decreasing densities in the coastal areas of Korea and China. In the coastal areas, it was relatively higher in Korea than in China except for Gymnodinales which showed higher abundances of 20~850 cysts/g in waters near China side than near Korea. *Alexandrium tamarense* and *Gynodinium catenatum*, well-known toxic dinoflagellate species, were dominant taxa collected with densities of 10~8,000 cysts/g and 5~170 cysts/g, respectively.

PICES XIII BIO_P-1965 Poster

Study of macrobenthos communities in Peter the Great Bay using an underwater vehicle

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Underwater vehicles are being increasingly used to monitor aquatic ecosystems. The underwater vehicle created for this study is equipped with a system of sensors for video recording of benthic communities. To test this technology, video recordings of benthic communities in Peter the Great Bay have been compared to data simultaneously collected by a diving method in October, 2000. One hundred and twenty eight pictures taken from the underwater vehicle and 40 pictures from divers were analyzed. The density of aquatic organisms was determined for the 9 most abundant species in pictures: 1. *Aphelasterias japonica*; 2. *Asterias amurensis*; 3. *Patiria pectinifera*; 4. *Strongylocentrotus intermedius*; 5. *Strongylocentrotus nudus*; 6. *Stichopus japonicus*; 7. *Glycymeris yessoensis*; 8. *Crenomytilus grayanus*; 9. *Halocynthia roretzi*. From these, the most common species (2, 3, 5, 8) in this area are chosen for improvement of techniques of quantitative analysis. The average density of each of these species was determined from the 128 pictures: 5.03 ± 0.47 ; 0.039 ± 0.002 ; 0.25 ± 0.04 ; 0.64 ± 0.07 individuals m^{-2} . Comparison of these results from the underwater vehicle with data from the diving method indicates the underwater vehicle can be reliably used to monitor aquatic systems.

PICES XIII BIO_P-1840 Oral

Seasonality in the oncaeid copepods in the epipelagic layers of the subtropical water off Kuroshio

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Seasonality in the biomass, distribution and production of oncaeid copepods, one of the main food organisms for pelagic fish larvae, was investigated in the epipelagic layer of the subtropical water off Kuroshio. Oncaeids occupied about 15% of

the total copepod biomass through the four seasons. More than 30 species of oncaeid copepods appeared in the upper 200m, and showed vertical zonation. Although the mean depth of distribution for each species was shallower in the stratified seasons than in the mixing season, the orders of the species in the zonation were similar during both seasons. The egg productivities of the surface dominated oncaeids were high in the surface layers as compared with chlorophyll maximum layers, and were positively related with the biomass of the microbial food web members such as bacteria and HNF. On the other hand, the egg productivities of the species whose peak biomass occurred in the chlorophyll maximum layers were positively related with the phytoplankton biomass. The vertical zonation, productivity and composition of the oncaeid copepods seemed to be largely affected by the biomass and the composition of phytoplankton and the microbial group members.

PICES XIII BIO_P-2078 Oral

Abundance dynamics of pacific saury (*Cololabis saira*) in the northwestern Pacific Ocean

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Pacific saury is one of the common commercial epipelagic fishes in the northwestern Pacific. Numbers and biomass of saury were estimated based on data from trawl surveys of the northwestern Pacific that have been conducted since the 1980s.

Pacific saury biomass in the Transition region outside of the Russian EEZ over last twenty years fluctuated between 328,000 and 846,000 tons, with the minimal indices during 1980s. Some increase of saury abundance in this region was observed after 1990. According to our estimation, in summer of 2002 the saury was the second most abundant species by biomass within the nekton community of the epipelagic layer. In contrast, abundance and biomass of species that are usually dominant, Japanese sardine, Pacific mackerel and Japanese anchovy, were low at this time. According to the available data, biomass of Pacific saury near the Kuril Islands fluctuated from less than a few tons to 450,000 tons, with the minimal level seen during the 1990s. Since 2000 the saury, salmon and myctophids have made up the basis of the fish community in the upper epipelagic layer in this region.

The distribution of the fishing ground of Pacific saury is closely related to oceanographic processes such as the thermal regime of waters and the course and velocities of the main currents. The increase of saury biomass after 2000 may be connected with changes of migration routes in these years.

PICES XIII BIO_P-1844 Poster

Relatively high chlorophyll *a* spots in the offshore subarctic North Pacific in summer

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High-Nutrient and Low-Chlorophyll (HNLC) conditions occupy the majority of the offshore North Pacific. Chlorophyll *a* (chl *a*) concentration in the HNLC regime is generally accepted as being less than 1 mg m⁻³. However, SeaWiFS chl *a* images of mesoscale features often show zones of 1 mg m⁻³ or greater in the offshore subarctic North Pacific.

Chl *a* concentration was investigated between 165°E and 145°W along 48°N from late August through early September 2000, by ship and satellite observation. Mesoscale, relatively high chl *a* zones of 1 mg m⁻³ and greater were observed in the upper 30 m near 165°E, between 178°W and 170°W, and between 168°W and 157°W. Inflow of near-shore water was inferred to play an important part in the formation of these high chl *a* zones. Large sized phytoplankton (> 10 µm) as well as small sized phytoplankton (< 2 µm or 2-10 µm) contributed to the high chl *a* zones in cases of strong influence by near-shore water. In addition, high chl *a* zones were considered to be a

summertime phenomenon in the offshore subarctic North Pacific, based on the SeaWiFS chl *a* images from 1998-2001.

PICES XIII BIO_P-2059 Oral

Site-specific factors affecting productivity of an upper trophic level marine predator: Bottom-up, top-down, and mismatch effects on reproduction in a colonial seabird

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We report on a broad-scale, integrated study of a piscivorous, colonial-nesting seabird, the black-legged kittiwake *Rissa tridactyla*, and its prey in Prince William Sound, Alaska. Our study spanned five breeding seasons (1995 – 1999) and focused on three primary colonies that differed in size (~ 250 to over 7,000 breeding pairs) and proximity to a variety of marine habitats. The diversity of marine habitats and physical and biological coupling between the Gulf of Alaska and Prince William Sound created a complex foraging environment for breeding kittiwakes. The abundance of three primary prey species for kittiwakes (Pacific herring *Clupea pallasii*, Pacific sand lance *Ammodytes hexapterus*, and capelin *Mallotus villosus*) varied both annually and regionally, with little uniformity among years or regions. We found that bottom-up, top-down, timing mismatch, and colony-specific effects were all important to kittiwake nesting success. Although bottom-up effects appeared to be strongest, they were not evident in some cases until other factors were accounted for. Important factors influencing kittiwake reproductive success were not only total prey abundance and the rate at which energy was provisioned to nestlings, but also species, age-class, and chronology of prey occurrence (match/mismatch of timing with critical brood-rearing periods). All of these effects varied among colonies and years. Top-down effects from egg and nest predators (independent of prey abundance) confounded seabird-forage fish relationships. Ultimately, when confounding factors were controlled for, non-linear relationships were identified between kittiwakes and their prey, with the asymptotic threshold of effects on kittiwake nesting success at a fish school surface area density of ~ 5 m²/km².

PICES XIII BIO_P-2128 Oral

Structure and trophic ecology of the micronektonic crustacean assemblage in the subarctic Pacific and Bering Sea

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The vertical distribution, assemblage structure, and diet of dominant micronektonic crustacea (pelagic decapods and mysids) in the subarctic North Pacific and Bering Sea were examined at four stations: the western subarctic Pacific (WSA), central subarctic Pacific (CSA), eastern subarctic Pacific (ESA), and the Bering Sea (BS). Results were compared to literature reports for euphausiid diet and mesozooplankton biomass concurrently sampled with the micronekton. Diel distribution patterns were highly variable ranging from strong vertical migration in the epipelagic zone to absence of any migration for species residing in the mesopelagic zone. The biomass and abundance of the epipelagic zone was dominated by euphausiids, while mysids dominated the biomass and abundance of the mesopelagic zone. Decapods were a significant, but smaller fraction of the mesopelagic biomass and abundance than mysids. Decapods were the most diverse taxa (17 sp.), followed by euphausiids (13 sp.), and mysids (5 sp.). Dominance within each taxon was represented by 3 species (both in abundance and biomass) across the study area. Daily ration estimates for the micronektonic crustacea and their impact on mesozooplankton production in the subarctic Pacific and Bering Sea are presented, and implications for their trophic positioning in the subarctic Pacific food web are discussed.

Community structure of zooplankton in the East China Sea and the Yellow Sea

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Community structure and indicator species of zooplankton in the East China Sea and the Yellow Sea were examined using multivariate methods. Seasonal variations in zooplankton were described in detail with respect to abundance, biomass and species composition, and vertical distribution in the southern part of the Yellow Sea. Zooplankton indicators of Yellow Sea Warm Current (YSWC), the main hydrographic phenomena in winter in this region, were also analyzed.

Zooplankton showed higher diversity in the lower latitudes and thermophilic species occurred mainly south of 31°N. Five communities were distinguished based on results of TWINSpan with the following species composition and environmental characteristics: Yellow Sea neritic community (F) with indicator species of *Labidocera euchaeta* in autumn and *Centropages mcmurrici* in spring; Yellow Sea central community (HC) with indicator species of *Themisto gracilipes*, *Calanus sinicus* and *Euphausia pacifica*, the latter two species only in spring; East China Sea continental shelf mixed water community (K) with indicator species of *Rhincalanus cornutus* and *Pterosagitta draco* which were limited in waters with high temperature and salinity; Yellow Sea and East China Sea mixed water community (HE) and East China Sea inshore mixed water community (M), both of which were made of species belonging to diverse ecotypes, but temperate species showed more preference in HE while wide-distributed warm species occurred more in M. From multiple regression analyses, temperature and salinity in surface water were the most important environmental factors related to zooplankton distribution and communities divisions. In the southern part of the Yellow Sea, zooplankton showed decadal changes with the abundance, biomass and diversity of zooplankton, and the ratio of abundance of *Calanus sinicus* to that of *Sagitta crassa* all increasing compared to corresponding data from 1959. The distribution patterns of warm water species clearly showed that the YSWC flows beneath the surface northwards into the Yellow Sea along the Yellow Sea Trough. The northern limit to where the YSWC can penetrate was about 35-36°N and the intrusion of the warm water took place mainly in the middle layer. Temperature was the main determinative factor for zooplankton vertical distribution according to Canonical Correlation Analysis (CCA). The seasonal variations in vertical distribution of *C. sinicus* and *T. gracilipes*, provided evidence that Yellow Sea Bottom Cold Water served as an over-summering site by some temperate species which generally live in waters with relative low temperature.