PICES XIV W2-2623 Oral

Tests of a ballast water treatment system onboard an ocean-going vessel and hints on a new sampling device for larger volumes of water

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Several ballast water treatment systems are currently in a testing phase with the aim to meet the ballast water discharge standards as set forth by the IMO Ballast Water Management Convention. A new ballast water treatment system, developed by the Norwegian vendor OceanSaver, was installed onboard of a car carrier after detailed land-based tests were completed. Onboard tests of the system started in June 2005 and are ongoing since. Results from the first onboard tests are presented. One challenge when testing ballast water treatment systems is to sample large volumes of ballast water to evaluate the systems performance regarding larger organisms (above 50 microns). To solve this problem a new sampling device was developed in cooperation with a German vendor of scientific sampling gear. The prototype was successfully tested onboard and details of this method will be introduced.

PICES XIV W2-2603 Oral

Importance of inputs from scientists to effective implementation of ballast water management convention

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Several important guidelines in support of the Ballast Water Management Convention were established at MEPC 53 in July 2005. Evaluation of potential treatment systems to terminate organisms in ballast water will be commenced according to the guidelines. Now scientists are requested to develop techniques to measure < 10 individuals of organisms of a size > 50 μ in one m^3 of water with judging their viability and minimum dimension. Not only for evaluation of performance of treatment systems, but also for evaluation of implementation, i.e. quantification of organisms in discharging ballast water, above mentioned technology is one of the most important factors. Preparation of test water for development of treatment system is also difficult task of plankton scientists. According to the guidelines, 400m^3 water containing 10^3 ind/ml of organisms ranging between 10 and 50 micrometer is necessary. Such water must be prepared at least 5 times with approximately one-week interval. These are some examples of issues where planktologists must provide substantial operational solutions.

PICES XIV W2-2574 Oral

Overview on introduced aquatic species in Europe – With focus on ICES Member Countries

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Regions considered in this overview range from Arctic to the Mediterranean Sea and Irish waters to the Black Sea. In total more than 1,000 non-indigenous aquatic species have been recorded from European coastal and adjacent waters. The majority has been first recorded since 1950s. More than 500 taxa (range from unicellular algae to vertebrates) are established with self-sustaining populations. The dominating group of exotic species across all seas are zoobenthos organisms. Species movements for aquaculture purposes and shipping (ballast water and hull fouling) are the major introducing vectors.

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Efforts of IMO to avoid secondary toxicity risk on the marine environment by chemical treatment of Ballast Water Management System

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IMO's International Convention for the Control and Management of Ships Ballast Water and Sediments (hereafter referred to as the Convention) permits ships to use approved chemicals or products, if they want to treat their ballast water with chemicals for disinfections of invasive species. Chemical treatment is essential to achieve the discharge standards set by the Convention, especially the criteria for phytoplankton and bacteria. The chemical treatment system shall be approved by the IMO. The approval procedure by IMO is much stricter than that for physical and/or mechanical treatment systems, which requires only a Member State's approval. Because ballast water after chemical treatment includes some residues and byproducts, and this ballast water has higher risks than that treated physically and mechanically. According to chemical manufacturers, their treatment techniques (such as hypochlorite, hydrogen peroxide and peracetic acid) are widely used for disinfecting drinking water; the techniques for ballast water are under development at the moment. Their potential risks such as chronic toxicity, the rate of degradation, and the byproducts are not yet well characterized in real sea conditions. Early 2005, the IMO is going to commence the evaluation of these chemicals.

PICES XIV W2-2565 Oral

Phylogeny and geographical distribution of *Cochlodinium polykrikoides* population (Gymnodiniales, Dinophyceae) collected from Japanese and Korean coasts

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An unarmored dinoflagellate *Cochlodinium polykrikoides* has often caused mass fish mortalities in East and Southeast Asian countries. In Japanese and Korean coastal waters, blooms of this species have occurred every summer of the last decade, however, the local habitation of their seed population is still obscure. It is suspected that the seed population is transferred from offshore; a small number of motile cells was in fact found off the coasts of the East China Sea. On the other hand, putative resting cysts of *C. polykrikoides* were also found in this area. To clarify the intraspecific variety and distribution, SSU rDNA sequences of *Cochlodinium polykrikoides* strains from Japan, Korea, Philippines and Malaysia were analysed. In the phylogenetic tree inferred from gamma weighted neighbor-joining method, all strains formed a well-supported monophyletic group and branched out near the basal position of dinoflagellates. Sequence divergences between all Korean and most of Japanese strains were identical, while other strains had several substitutions. This indicates that the dominant population of *C. polykrikoides* in Japanese and Korean waters could be distinguished from other populations inhabiting Southeast Asian countries. Two *Cochlodinium* strains collected from Sumatra and the East China Sea near Nagasaki Peninsula resemble *C. polykrikoides* in appearance, because of the cingulum encircling the cell twice, the presence of the pigmented body in the dorsal side of the epicone, and formation of cell-chains. However, the larger cell size, position of the sulcus and shape of chloroplasts differentiate this species from *C. polykrikoides*. This species closely related to *C. polykrikoides* among dinoflagellates in the phylogenetic tree, but clearly distinguished from it based on their morphology and SSU rDNA sequences.

PICES XIV W2-2429 Oral

Marine and estuarine non-indigenous species in the Strait of Georgia, British Columbia, Canada

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The Strait of Georgia is an important inland sea for seafood production, recreational activity, and maritime industry. Based on the literature and authoritative personal communications, we estimate that as of 2000, the following number of non-indigenous species (NIS) have established populations in the Strait or along its shoreline: algae - 22; vascular plants - 22; invertebrates - 65; fish - 3; birds - one; mammals - one. Some species' records may only represent range extensions and other species may be cryptogenic, and all records do not necessarily indicate continued species presence today. They may have been records of a small population that only sustained itself for a limited time period, during which it happened to be observed. Because of the lack of ecological surveys and monitoring in the Strait there is uncertainty about when most of the NIS arrived in the Strait, modes of introduction, and ecological impact. However, many species arrived accidentally with intentionally introduced species for culture from both the western Atlantic and Pacific Oceans. Other species may have arrived via ballast water, ship fouling, releases of live food organisms, the plant nursery and aquarium trade, and research and teaching activities. Because of the multiple pathways available for NIS to spread into the Strait, it is proving difficult to implement comprehensive effective control mechanisms to minimize or prevent further introductions. Current programs in place include quarantine procedures, ballast water control and management, and public education, and it is hoped these measures will reduce the rate of further introductions.

PICES XIV W2-2600 Oral

Macroalgal diversity of hull communities on trans-ocean coal carriers

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To elucidate the processes contributing to intercontinental introductions of marine macro-algae, we studied the biodiversity of the biota on the hulls of bulk carriers, and investigated the genetic diversity of taxa that are representative of introduced species in international port areas of Japan and overseas. We found more than 10 macro-algae and more than 50 benthic animals on the hulls of coal carriers operating between Osaka Bay and Australian/Indonesian ports. The richness of attached organisms differed depending on the location on the hull: they occurred more frequently near the ladder, sea-chests, and screws. The most dominant seaweeds were membranous/filamentous algae such as *Ulva* spp. and *Enteromorpha* spp. (green algae), and ectocarpalean brown algae. They showed apparently close genetic relationships with the natural populations in the ports of call of the coal carriers, which suggests frequent introductions of taxa by means of ship transportation.

PICES XIV W2-2606 Oral

Some non-indigenous marine invertebrates of Korea

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The invasion of non-indigenous marine invertebrates into Korean waters has been very poorly noticed up to now. However, there are at least six invertebrates that are well known invaders: *Mytilus edulis* Linne, *Balanus amphitrite* Darwin, *Balanus improvisus* Darwin, *Balanus eburneus* Gould, *Ciona intestinalis* (L.), and *Styela plicata* (Lesueur). *Mytilus edulis* is certainly the first invading animal to be observed all around Korean coasts. *Balanus amphitrite*, *B. improvisus* and *B. eburneus* were first noticed in 1970s and are now widely distributed along the south and east coast. *Ciona intestinalis* and *Stylela plicata* are uncertain for their first invasions. These tunicates and *M. edulis* occur very frequently in harbor areas and are problematic for the mariculture industry, although some of them (*S. plicata* and *M. edulis*) are used for food. These species occupied barren areas at first, but expanded their habitats and some of them are competing with native animals. Many more non-indigenous species are considered to have invaded Korean coasts, especially into the harbors.

PICES XIV W2-2532 Invited
Vectors and processes involved in biological invasions

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Over this last century a wide range of powerful and previously non-operating vectors became active in transmitting species over varying distances. Yet evidence for the arrival of a species is often unclear, as there are many arrivals of species not easily explained. Yet a good knowledge of species life-modes and of nearby human activities have implicated their arrival via some likely vector that may have involved a series of movements relayed from overlapping activities. Over time the power of a vector transmission may cease or become taken-up by a different transferral process. One of the main recent changes is speed of transmission. Formerly shipping journeys between Europe and eastern Asia took some ten or more weeks during which the carried species were subject to varying challenges that reduced their potency for founding populations on arrival. Aircraft presently distribute aquaculture stock, aquarium species and living foods to most world regions within a day and this will include the many accompanying biota, including diseases. New shipping and airline routes also provide new opportunities for species expansions. One notable area of concern is the new shipping routes likely to evolve through the Arctic Sea following climate warming during this century. This would provide the first cold-water direct passage between the North Pacific and Atlantic Oceans. Over the last thirty years many new leisure pursuits have evolved or expanded involving trade of plants and fishes for ornamental ponds (as well as their associated biota), sport fishing and aquaria and transmissions by fouling on leisure craft. Such movements usually involve small volumes of biota that can become widely distributed and may escape or become released. Many of these species are nurtured while in transit and so they and their associated biota are provided special advantages for survival. The size required to form a founder population and occasions when colonization is possible is an important gap in our understanding. Further, the capability of natural vectors may not be so completely understood, rare or infrequent meteorological or earth crust events or natural alterations to climate may all have some future consequence. Management requires these complexities to be unraveled so that a practical targeted action is possible and appropriate according to the expansion in the range of an impacting species. Preventive actions are best but not all invasive species can be predicted and some following arrival may be cryptic for some years before expansion. Should a species be identified at an early stage there is a possibility of eradication, otherwise mitigation methods may provide the only appropriate cost-effective approach. Unless regular monitoring of consignments and of likely arrival sites, with the knowledge of likely routes and assessment of the vectors involved, are undertaken we will find invasions taking place without our knowledge until some impact is revealed. In addition it is helpful to undertake a shared responsibility using recent knowledge with all stakeholders, including those that may be involved in production and transmission, from source to destination. There is also a need to strengthen working links between Pacific and Atlantic biologists in formulating risk assessments for known impacting species moving to and from the North Pacific.

PICES XIV W2-2562 Invited
Xenodiversity versus biodiversity: Invasive alien species in European coastal marine ecosystems

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Evolutionary separation and specialisation of coastal marine life over millions of years created much of the biogeographical peculiarities of Europe. These peculiarities, in great extent, have been lost during the last five hundred years because of different human activities. Often beginning of marine bioinvasions is attributed to the 19th century; however the scale of invasions that must have occurred prior to appearance of first inventories of world flora and fauna is practically unknown. Since the time of early overseas voyages, ships were transporting organisms on and in their hulls as well as in rock and sand ballast. That process inevitably had to result in establishment of hundreds of coastal species that are now regarded as “naturally cosmopolitan”, in fact being early introductions of the 16th – 18th centuries. In the beginning of the 3rd millennium, due to globalisation of human activities, the number and variety of available invasion corridors is rapidly growing. Results of this global exchange of species are evident in most marine coastal areas of Europe. Much of its present structural and functional diversity is of foreign origin. This human-mediated addition of non-native species was termed “xenodiversity” (Gr. xenos - strange) to indicate the diversity caused by nonindigenous (alien, exotic, introduced) species (Leppäkoski & Olenin 2000). The xenodiversity might be traced at different hierarchical levels: genetic

(hybridization and addition of genetically modified organisms); species (addition of alien species, elimination of native species); functional/community (emergence of novel or unusual functions, changes in community structure, alterations of food webs and ecosystem functioning) and, even habitat/landscape (habitat engineering, encrusting of solid objects, and changes in bottom micro-topography). The study of invasions in coastal marine systems, now being a rapidly growing ecological discipline only really began a little more than two decades ago. The scientific interest is in great deal driven by practical needs due to serious ecological and economical consequences of bioinvasions. In fact, the problem of biological pollution, became multidisciplinary, involving not only biological/ecological (genetics, ecophysiology, biogeography, *etc.*) but also technical and socio-economic aspects.

PICES XIV W2-2570 Oral

Effect of mid-ocean exchange of ballast water on bacterial community in ballast tanks

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This research was planned to clarify the change of bacterial community in ballast water tanks before and after mid-ocean exchange, and also during a voyage. Live and total bacteria numbers were observed using the spread plate method and the direct count method, respectively. DGGE (Denaturing Gradient Gel Electrophoresis) structure analysis was used to observe the composition. Samples were collected from the ballast tanks of a coal cargo ship *Shinchi-maru* by pumping up through a manhole and a sounding pipe as the vessel traveled between Soma, Japan and Newcastle, Australia. The results of live and total counts showed that bacteria numbers decreased after the mid-ocean exchange of ballast water. It suggested that the number of bacteria discharged at the loading port could be reduced by conducting a mid-ocean exchange. Results of DGGE structure analysis revealed that sub-clusters in band patterns were distinctively different before and after the mid-ocean exchange, and DGGE patterns from multidimensional scaling analysis showed that the bacterial composition was changing along with the duration of storage in ballast tanks. It is clear that the decrease of cell numbers and the change of composition in bacteria community occurred abruptly after the mid-ocean exchange, and also the composition was gradually changed during the voyage.

PICES XIV W2-2563 Oral

Marine introduced species in China seas and action plans

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The China seas are located in the north-western part of the Pacific Ocean and consist of Bohai Sea, Huanghai (Yellow) Sea, East China Sea and South China Sea, covering three climatic zones (warm-temperate, subtropical and tropical). Diverse habitats are easily influenced by different alien species. It is estimated that there are one hundred and thirty-seven marine alien species in China. They have been introduced either intentionally for marine aquaculture and marine aquarium, or unintentionally by ships' hulls and ballast water. For example, 26 alien species had been introduced to China for marine aquaculture by 2001, including ten fish, two shrimps, nine shellfish, one echinoderm and four algae. In recent years, 16 cryptogenic HAB species have been found in the coastal seas of China; perhaps they were introduced by ballast water. Up to now, three marine alien species, including *Spartina alterniflora, Mytilosis sallei* and *Crepidula onyx*, have caused great damage of ecology and social economy of coastal China so the Chinese government is consistently paying more attention to invasive species. The Ministry of Agriculture was directed to coordinate a national strategy and plan to address the growing environmental and economic threat from invasive species, and further, to use their authority to prevent the introduction of invasive species and to restore native species.

PICES XIV W2-2581 Oral

Introduction of species into the northwestern Sea of Japan

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Studies conducted by the Institute of Marine Biology of ship fouling began in 1975. Data on fouling of 600 ships in a various modes of operation in different regions of World Ocean has been assembled. It has revealed that 17 exotic species have been introduced to the northwestern Sea of Japan as a result of ship fouling and/or ballast waters. The location of the Sea of Japan at the border between two biogeographic provinces with different temperature regimes affects the natural distribution of species. The northwestern part of the sea might be inhabited by widely-boreal, subtropical and subtropical-low-boreal species living together. Using a scheme of Zenkevich (1940), we distinguished four groups of introduced species, which are now at different stages of acclimation.

(1) Introduced species that cannot adapt to new conditions even in harbor waters, where free ecological niches are usually available. This group includes two species of barnacle, *Balanus eburneus* and *B. trigonus*, which primarily have been found on foreign-going ships. They are extremely rare on cabotage ships, do not reproduce and are absent in bottom communities.
(2) Potential invaders are species that are in the first stage of introduction and have small-scale developments. This group includes *Gonothyrea loveni, Laomedea flexuosa, L. calceolifera, Polydora limicola, and Bugula californica.* They show greater ecological plasticity than the species of the first group and relatively frequently are responsible for the fouling of harbors. It is still not known whether the species of this group could naturalize in the Sea of Japan.
(3) Species that are at the stage of ecological explosion. This group is comprised of four species, *B. amphitrite, Hydroides elegans, Molgula manhattensis, and Ciona savignyi.* They demonstrate great qualitative characteristics in the fouling of ships and experimental plates.
(4) Naturalized species are a group of species that have been found not only in fouling communities, but also in the benthic community of the upper subtidal zone. These are *B. improvisus, Pseudopotamilla occelata, Corophium acherusicum, Campanularia johnstoni, Conopeum seurati* and *Schizoporella unicornis*.