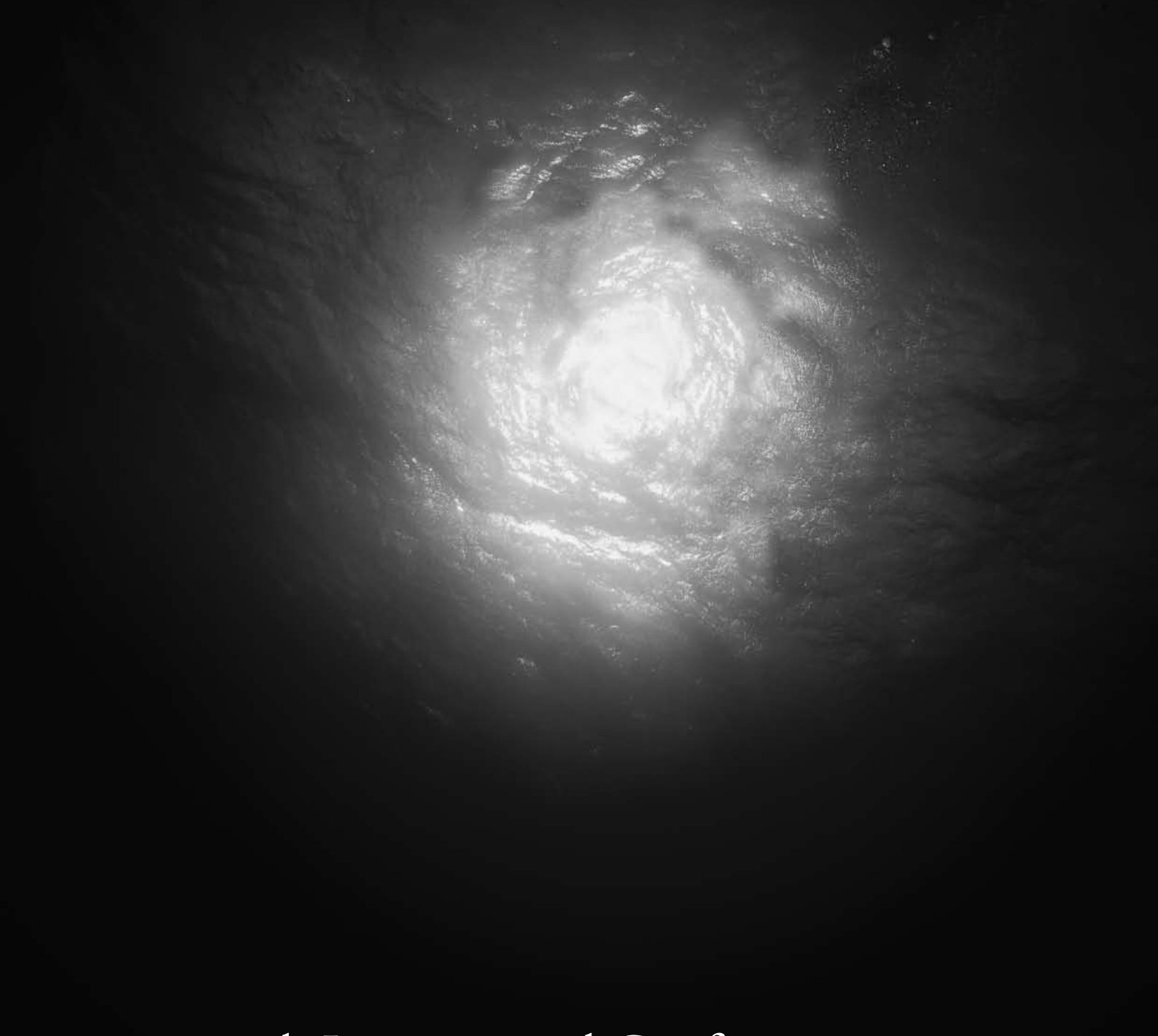

7th International Conference on

Marine Bioinvasions

Abstract Book

August 23 - 25, 2011, CosmoCaixa. Barcelona, Spain

7th International Conference on Marine Bioinvasions

Dear Conference Participant:

On behalf of the Scientific Steering Committee (SSC) and our sponsors, we would like to extend you a warm welcome to Barcelona for the 7th International Conference on Marine Bioinvasions. Barcelona is a city historically known for embracing people of different cultures and participating actively in the construction of an accessible, multicultural society.

We are grateful for the efforts by the SSC and student interns to organize the conference as well as for the support of our sponsors: CosmoCaixa, for providing the venue; The North Pacific Marine Science Organization (PICES), for providing travel awards to early career scientists; and the National Oceanographic and Atmospheric Administration (NOAA) and Fundació "La Caixa" for donating additional funds. Most of all, we appreciate your participation and willingness to share your ideas and expertise here.

We believe you will find the conference program most stimulating and your attendance at this conference most worthwhile. This year's program is full of interesting papers, posters, and plenary talks, and we are confident all will generate spirited discussions, new connections, and future collaborations. Finally, we hope you will develop a greater awareness of the recent progress that has been made in the field of marine and coastal invasions and the challenges we still face.

Once again, welcome to the 7th International Conference on Marine Bioinvasions and we send our best wishes for a stimulating and rewarding experience. Enjoy the conference, enjoy Barcelona!

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WWF Mediterranean Programme Office, Spain
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List of presenters

Alphabetical order by last name

Developing Science Based, Numeric Ballast Water Limits under the United States Clean Water Act

Oral presentation
symposiumtheme1: -
symposiumtheme2: -
Contributed

abstract

As a result of a 2006 U.S. court order, all non-recreational, non-military vessels must have a Clean Water Act National Pollutant Discharge Elimination System (NPDES) permit to legally discharge ballast water in waters of the United States. Most vessels meet these requirements by obtaining coverage under the U.S. Environmental Protection Agency's Vessel General Permit (VGP). NPDES permits establish two kinds of limits: Technology Based Effluent Limits (TBELs) and Water Quality Based Effluent Limits (WQBELs). TBELs are established based upon such factors as the efficacy, availability, and cost of ballast water treatment systems. WQBELs are established based on what is necessary to achieve water quality standards (e.g., protection of aquatic ecosystems). The 2008 VGP does not include national numeric discharge standards for ballast water. At the time of that permit's issuance, EPA determined it was infeasible to calculate numeric WQBELs, and found that technologies were not sufficiently available to establish numeric TBELs.

EPA plans to propose the next VGP by November 30, 2011, and issue a final permit by November 2012. The proposed permit will contain numeric concentration-based ballast water limits. Partnering with the United States Coast Guard, EPA has commissioned studies from two independent expert panels to help provide a more rigorous scientific basis for what limits EPA might establish. The first study was led by the National Academy of Science National Research Council (NAS). The NAS assessed methods to evaluate the risk of invasive species introductions associated with ballast water discharges. The second study was led by EPA's Science Advisory Board (SAB). The SAB evaluated the status of existing and potential shipboard ballast water treatment technologies and whether it is reasonable to assume that a given system is capable of meeting different discharge standards. This presentation will discuss the findings of those studies and how they might inform development of the next VGP.

In 2009, the Coast Guard proposed numeric ballast water discharge standards under the National Invasive Species Act (NANPCA/NISA); as of April 2011, the Coast Guard plans to finalize those regulations in the near future. EPA has continued its work with the Coast Guard so that any final U.S. government standards are consistent to the maximum extent possible.

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Long-distance dispersal by small vessels

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: *Ship Biofouling: Vector Characterization and Management Strategies*
Contributed

abstract

There is increasing evidence that hull-fouling of small vessels (recreational and fishing boats) contributes to the secondary spread of invasive species, yet there have been few quantitative analyses of this vector. Using the west coast of North America as a study area, we demonstrate that small vessels may be significant vectors for the secondary spread of NIS. Two critical components to assess introduction risk are the level of connectivity provided by small vessels, and the degree of biofouling associated with these vessels. We used boater questionnaires and records of boat movements to assess the level of connectivity along the coastline by small vessels. Questionnaire responses indicate that less than 20 % of vessels leave their home bays, but in a region with more than 1 million registered boats, that means over 10,000 small vessels may transit between bays annually. Vessels traveling long distances pose the greatest threat for transfers of NIS and we targeted transient vessels for in-water hull surveys of biofouling extent and diversity. Both measures varied greatly among vessels, with invertebrate diversity estimates ranging between zero and over 30 species, and abundance estimates reaching over 100,000 individuals per vessel. Both known and novel NIS were identified among hull-fouling communities. Using information from questionnaires, we were also able to assess the ability to predict fouling-risk level using information regarding the vessels (e.g., voyage history, hull maintenance history). While obvious outliers can be distinguished using historical information, the predictive capabilities are low. Current international marine NIS management proposals are focused on commercial vessels while small private vessels continue to navigate largely unchecked. Our results indicate that these vessels are responsible for transporting diverse assemblages of organisms over long distances, and will continue to operate even if introductions by larger vessels are curbed.

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Developing Augmentative Biocontrol Tools for Marine Fouling Assemblages

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: *Eradication/management of invasive species*
Contributed

abstract

Despite being a frequent practice in terrestrial and freshwater systems, there is a lack of research investigating the feasibility of augmentative biocontrol agents (i.e. biocontrol that relies on indigenous agents) for the management of non-indigenous species in marine habitats. Critical to any biological control programme is the selection of appropriate biological control agents. We developed a theoretical framework for the justification of this selection based on a range of biological traits that an ideal biocontrol agent should fulfill before its successful application. Some of these traits included feeding preferences, consumption rates, reproductive strategy, growth rates, longevity, distribution, conservation status, resilience to changing environmental conditions, enhancement potential and risk of non-target effects. We used a caging experiment to determine the potential of four different native grazers and predatory species to control fouling assemblages on artificial structures in marinas, which included several co-occurring non-indigenous species. Treatments were applied both to mature fouling and pre-cleaned substrata, to target both response and maintenance biocontrol management strategies, respectively. A second field experiment tested the concept of space pre-emption using an indigenous anemone considered a 'benign fouler', as a mean to prevent colonization by non-indigenous species. Preliminary results will be presented and contrasted with the developed theoretical framework for the selection of successful biocontrol agents.

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A geo-referenced database for not native Mediterranean sea fishes

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: *New species in an ancient sea: the Mediterranean cross road*
Invited

abstract

Here we present a database on not native fish species recorded so far in the Mediterranean sea. Data were collated on the basis of published and unpublished sources, from 1896 to 2011. Our list embraces 150 alien fishes of different status and origin, including questionable and cryptogenic species. Overall, more than 700 records of distribution were geo-referenced using ArcGIS 9.3 as Geographical Information System (GIS). Other available information on the distribution of these species was also geo-referenced within a grid of resolution of 0.1° of longitude and latitude.

For each species the database provides also biological, ecological and taxonomic information; introduction pathways; bibliographic references and other relevant data. Cartographic outputs shows a time integrated summary of the invasion and depict sub-regional differences in dominant pathways. Due to differences in research efforts, available information is not evenly distributed among the Mediterranean and a geographic gap in our knowledge was apparent for large parts of north African coasts where little published information exists. Initial analyses consisted of calculations of linear rates of spread for both single species and major invasive pathways. The current data holdings represent a comprehensive collection of information on Mediterranean alien fish species and offers a powerful tool to explore patterns and processes of marine bio-invasions.

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Risk assessment for ship-mediated introductions to Canada

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -
Contributed

abstract

In order to predict and to efficiently manage aquatic invasions, risk assessments must be conducted to evaluate probabilities of success and potential impact at each stage of the invasion process. While there have been a number of highly useful species-specific risk assessments that consider a variety of vectors for a single species of interest, vector-based risk assessments that consider a variety of species moved by a single vector are urgently needed to manage an overwhelming number of potential invaders as well as unknown (or unpredicted) species.

We conducted a semi-quantitative, risk assessment of two shipping vectors (hull fouling and ballast water) to Canadian ports by three different pathways (transoceanic, coastal and domestic shipping). This assessment evaluated the probability of introduction (arrival and survival) of an aquatic nonindigenous species and associated potential consequences (impacts) to determine risk. A comprehensive database of vessel arrivals and volume of ballast water discharged at Canadian ports was utilized to estimate the probability of arrival. Environmental similarity between source and recipient ports was then used to estimate the probability of survival after arrival. We used the number of high impact aquatic nonindigenous species reported from the donor ecoregion(s) to estimate the potential magnitude of consequences. This methodology enabled identification of ports at highest risk for ship-mediated invasion and will direct future research and management efforts.

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Sargassum muticum vs. *Cystoseira* spp. inputs on exposed sandy beaches: Shifting subsidies from rocky to sandy shores in NW coast of Spain

Poster presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -

abstract

Sargassum muticum is an invasive macroalgae widely distributed along the Atlantic coast of Europe. Its distribution has spread in most of the intertidal rocky shores in the Galician coast since 1986, when it was first observed.

Once detached by wave and currents, all macroalgae can potentially be exported toward neighbor ecosystems. These materials are of paramount relevance in exposed sandy beaches, where autochthonous primary production is low. Allochthonous inputs of organic matter, mainly stranded macroalgae (also called wrack), provide food and habitat for a number of primary consumers. Then, through a cascade effect, secondary production is translated from wrack macrofauna toward higher trophic levels.

Differential effects between *S. muticum* and native macroalgae on faunal assemblages on sandy beaches have been previously studied. The main goal of this study was to quantify the biomass of *S. muticum* stranded in two intermediate exposed beaches throughout the year. In addition to assess the annual pattern of deposition of the invasive species, we also were interested in comparing this data with the inputs of the native macroalgae *Cystoseira* spp., the most abundant native algal wrack in this area.

The average monthly biomass provided by *Cystoseira* spp. and *S. muticum* represented the 76 % (S.D ± 14) of the total wrack material in the studied beaches. The annual biomass of *S. muticum* was lower than that of *Cystoseira* spp. (18 and 58 % respectively). The amounts of both algae differed significantly over time. The highest biomass of *S. muticum* and the lowest biomass of *Cystoseira* spp. were recorded between March and July. Difference in temporal contribution is consistent with the life-cycle traits of each macroalga: *Cystoseira* spp. show a summer and a winter phase with similar growth rates, while *S. muticum* has a winter phase with slow growth rate and a faster growth rate during spring. Different live traits produce dissimilar stocks of live macroalgae in the rocky habitat, which once detached by wave and currents differentially subsidize exposed sandy beaches.

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Sargassum muticum deposition on sandy beaches: effect of wave exposure.

Poster presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -

abstract

Food webs dynamics and community structure are determined by the resource availability. The transfer of nutrients and organic matter between ecosystems may influence these processes. This effect is supposed to be increased at greater differences in productivity between the donor and recipient systems. This is the case of exposed sandy beaches characterized by a low in situ primary production, where allochthonous subsidies of macroalgae are of paramount importance in the ecosystem processes. Changes in wrack composition due to the increasing arrival of invasive macroalgae to new areas could have important ecological implications

In this study we quantified the arrival of *Sargassum muticum*, the most common invasive alga in exposed sandy beaches of Galicia, in three exposed locations subjected to different wave action. Samples were taken monthly throughout a year.

The highest biomass of *S. muticum* (441 gm^{-1} ± 219 S.D) was registered in the beach less affected by the wave action (Abra), contrary to the highest wave environment beach (Balieiros) where the lowest amount (2.6 ± 2 S.D) was measured. This pattern is consistent with the distribution of S. muticum in the rocky shores which mainly occupies sheltered and semi-exposed habitats. However, the relative contribution of this alga to the total biomass stranded in each beach did not follow the same trend. The highest proportion of *S. muticum* was found in the more wave exposed beaches. These results suggest that deposition process of *S. muticum* in the more wave exposed beaches could be favored over other algae. In addition to the proximity of the rocky shore, other factors as for example the buoyancy properties of each alga could increase the probabilities of being driven ashore. The presence of air bladders in *S. muticum* could increase its buoyancy and enhance the transport to more distant habitats.

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The Impacts of the Indo-Pacific (*P. volitans* and *P. miles*) on Fish Assemblages in Near Shore Benthic Reef Habitats of the Central and Southern Bahamas

Oral presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: *Factors promoting the establishment and spread of marine invaders post-arrival*
Contributed

abstract

Since the first recorded sightings of the Indo-Pacific Lionfish (*P. volitans* and *P. miles*) in the 1990s, this invasive mid-level predator has become a common member in a wide range of benthic fish habitats throughout the Tropical Western Atlantic. Although the origins of this cryptic invasion are unknown, the success of lionfish, specifically in the near shore waters of The Bahamas, has been documented through increased abundance in the number of benthic habitats utilized since 2005. Long term impacts of lionfish on near shore fish assemblages in the wider Caribbean is not known, but invasive species management planning requires some information on changes in the abundance and diversity of reef fishes, especially species exploited In commercial fisheries. This large synoptic survey of fish assemblages from reef habitats on two islands in The Bahamas examines how the presence of lionfish is altering established fish assemblages. Patch, hard bottom, fringing and channel reefs adjacent to the islands of Great Exuma (Central Bahamas) and Great Inagua (Southern Bahamas) were evaluated via a rapid assessment methodology. Roving diver fish surveys, benthic epifauna and macro-algal assessments were conducted with a coastal assessment of anthropogenic impacts (ranking) from development and/or fishing pressure. Univariate and Multivariate statistics were used to determine if the presence of lionfish is significantly altering the recorded fish assemblages when compared to sites absent of lionfish. This protocol of characterization can be applied to help understand how lionfish may affect near shore ecology, and ultimately the production of commercially important fisheries species.

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Habitat and reproductive biology of *Chaetopleura angulata* (Spengler, 1797), an old invader in Galicia

Oral presentation
symposiumtheme1: *Other topics*
symposiumtheme2: -
Contributed

abstract

Chaetopleura angulata (Spengler, 1797) is a poliplacophoran mollusc whose current distribution comprises two Atlantic areas: from Cabo Frio (Brazil) to Cape Horn in South America and on the Atlantic European coasts of the Iberian Peninsula. The most widely spread opinion about the European invasion is the one holding that it was transported in the past, adhered to the hull of Spanish and Portuguese ships due to the intense commercial and militar trade with South America.

As regards its European distribution, it is especially abundant on the coasts of Galicia, where its most typical habitat are bottoms of muddy shelly-gravel or sandy mud, stretching from the beginning of the infralittoral area to the circalittoral area, from 50 to 60 m deep. On these bottoms, it lives adhered to empty shells of Bivalvia and small stones, but it can also be found, but less frequently, among *Mytilus galloprovincialis*. Its greatest abundance is present on bottoms of the middle areas of the 'rias', but it can also be found outside them on deeper bottoms less affected by the swell dashing.

Ría de Ferrol is the location where *Chaetopleura angulata* is most abundant. Different aspects of its reproductive biology have been studied by means of specimens from these bottoms, which are also presented in this paper. Fertilization is external; its sexual cells are laid in sea water. Spermatozoids and ovules are expelled simultaneously in streams, driven by the regular movement of the peripedal ventolatory current.

All the process, which lasts around 15 days, has been followed in the laboratorium, from the obtaining of eggs, hatching, several stages of larval development and final metamorphosis. The first hatching occurred 22 hours after the egg-laying and the last after 39 hours. The egg capsule presents a special ornamentation in the shape of maces. The larva swims by means of the movements of its prototroch, always turning clockwise.

Two days after hatching, the larvae get longer and longer and the first hints of sclerites start to be observed, still very faint. The whole formation of the foot, expelling movements, appearance of the eyes, spines of the aculifera mantle and formation of the plates are described. The plates can already be observed; seven hints of the future plates of the shell can be observed in detail when they are 8 days old.

In the present paper, both the habitat and the reproductive biology of this interesting species are described in detail, which was first quoted in Europe at the 'rias' of Vigo and A Coruña, about the middle of the 19th century (MacAndrew, 1850; MacAndrew & Woodward, 1864).

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18

Propagule pressure mediates diversity-colonization relationship: Implications for marine bio-invasion.

Poster presentation
symposiumtheme1: *Drivers of invasibility*
symposiumtheme2: -
Contributed

abstract

Recent evidence from terrestrial systems suggests high levels of genetic diversity may facilitate settlement and colonisation in new environments. This has obvious applications to the study of invasive species. Some invading populations, or the larval cohorts of exotic species arriving in new areas, may have high levels of genetic diversity as a result of transport from multiple source locations. We predict, however, that the number or rate of arriving propagules can alter this relationship. Increasing propagule pressure may increase the chance of 'selecting' propagules better able to colonise and survive new environments (a sampling effect), or may increase the strength of biological interactions between genetically distinct larval cohorts (biological interaction, such as facilitation or competition).

We examined this hypothesis with a model organism, the Australian bi-valve *Saccostrea glomerata*. We simulated larval arrival into new areas in both the laboratory and into field based sessile invertebrate communities. We first test whether settlement, mortality, and growth in this species do differ between genetically distinct larval cohorts, and how propagule pressure may alter these patterns. We then factorially manipulate both propagule pressure and intra-specific diversity and test for differences in colonisation ability in this model species.

We find dramatic increases in the ability of *S.glomerata* to colonise in treatments that had higher intra-specific diversity. As predicted we find this pattern only existed when propagule pressure was high. Rather than simple sampling effects, we find that this pattern is due to a biological interaction between larval cohorts in high intra-specific diversity treatments. We also find that settlement and colonisation between genetically distinct larval cohorts differs according to cohort identity and with differing propagule pressure, however we find no interaction between these two factors. We conclude that invasive ability may in fact be mediated by genetic identity, propagule pressure and intra-specific diversity.

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Combined effects of salinity and temperature on survival of two populations of autochthonous brine shrimp *Artemia parthenogenetica* under invasive pressure in Portugal

Oral presentation
symposiumtheme1: *Drivers of invasibility*
symposiumtheme2: -
Contributed

abstract

Artemia (Branchiopoda, Anostraca) is a crustacean that is distributed over all continents except Antarctica. There are nine reproductively isolated species described, with sexual and parthenogenetic reproduction. The Iberian Peninsula comprises two native species, *Artemia salina* with bisexual reproduction and *Artemia parthenogenetica* with asexual reproduction, some populations were found with the presence of *Artemia franciscana*, native from the American continent. In the Iberian Peninsula almost all types of biotopes described and colonized by the *Artemia* genus are present, including coastal and inland saltworks, which differ in ionic composition. One of the problems that the *Artemia* genus faces relates to the loss of biodiversity that has occurred in the Iberian saltmines due to introduction of exotic species of *Artemia* and loss of habitat. In Portugal there are only two places referenced with the presence of parthenogenetic *Artemia* strains: the Rio Maior saltworks and the Troncalhada saltworks in Aveiro, which are quite distinct in terms of the ionic composition of their water. Parthenogenetic strains have a wide variation in response to physiological stress caused by the combined effect of temperature and salinity. The aim of this study was to estimate the combined effect of different temperatures and salinities on the survival of these two strains, in order to understand the impact of different environmental stressors in the permanence of native Portuguese populations. In this study we found a different physiological response in the two strains caused by the stress of the combined effect of temperature and salinity. These results show that, although belonging to the same strain, these two populations respond differently to different environmental conditions. This may be an important factor to consider in the current efforts to try preventing the disappearance of native strains of *Artemia* from the Western Mediterranean Region.

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Situation actuelle des mollusques exotiques de la côte libanaise. Current status of exotic molluscs of the Lebanese coast.

Oral presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: *Management issues and bioinvasions science dialogue*
Contributed

abstract

Depuis l'ouverture du Canal de Suez le nombre d'espèces exotiques venant de l'océan indo-pacifique vers la côte libanaise ne cesse d'augmenter. Au Liban, la faune des invertébrés marins compte environ 934 espèces dont 104 sont exotiques. La liste de mollusques révèle 355 espèces dont 43 sont exotiques. Ces dernières se répartissent en 31 gastéropodes et 12 Bivalves. Ces espèces et en particulier celles de substrat dur sont bien établies et plusieurs d'entres elles sont devenues envahissantes et contribuent à la restructuration des habitats marins. L'impact de ces espèces ainsi que celui du réchauffement climatique sur la faune locale sont discutés.

Current status of exotic molluscs of the Lebanese coast.
Since the opening of the Suez Canal, the number of exotic species coming from the Indo-Pacific Ocean toward the Lebanese coast didn't cease from increasing. In Lebanon, the fauna of marine invertebrates encompasses about 934 species, 104 of which are exotic. The list of molluscs reveals the presence of 355 species, including 43 exotic species. The latter comprise 31 gastropods and 12 bivalves. These species, especially those of hard substrate are well established and many of them have become invasive and contribute to the restructuring of marine habitats. The impact of these species as well as that of global warming on the local fauna are discussed.

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Genetic evidence corroborates dispersal histories of two North Atlantic intertidal species

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: *Application of genetic methods for reconstructing invasion histories*
Invited

abstract

Knowledge of phylogeographic patterns of marine species has been very useful in resolving ecological and invasion histories of organisms with broad geographic distributions. Specific to the North Atlantic, numerous intertidal organisms show trans-Atlantic ranges; yet it is not always clear whether those distributions represent natural dispersal in the past or more recent human-mediated dispersal. Two North Atlantic gastropods, *Littorina saxatilis* (rough periwinkle) and *Littorina littorea* (common periwinkle), are both found in the eastern and western Atlantic; *L. saxatilis* additionally exists on several North Atlantic islands (e.g., Faeroes, Iceland, Greenland). Past evidence suggests highly different dispersal histories for the two littorines: *L. saxatilis* is believed to have naturally moved across the North Atlantic via North Atlantic islands; whereas, *L. littorea* is suspected of being a recent anthropogenic introduction to North America from Europe. Although molecular evidence exists for both species, a comparative phylogeographic study between the species has not yet been investigated to further understand their dispersal histories. As such, we compiled an extensive genetic (mitochondrial DNA) dataset across the North Atlantic, and based on multiple genetic analyses, we found considerable differences between the two species. In particular, for *L. saxatilis*, we uncovered long-term separation between the eastern and western Atlantic, the existence of glacial refugia, and a connection across North Atlantic islands. In contrast, for *L. littorea*, we found signatures of a close connection and recent separation between populations in the eastern and western Atlantic. In addition, due to *L. littorea*'s absence from North Atlantic islands, a natural stepping stone migration is unlikely for this species. Furthermore, the two species have very different reproductive strategies (*L. littorea* broadcast spawns; *L. saxatilis* broods), which has further influenced their differing phylogeographic patterns within and across regions. Altogether, our genetic work corroborates historical, ecological, and parasite evidence, confirming the long held belief that *L. saxatilis*' trans-Atlantic distribution was likely the result of stepping stone migration in the distant past, and that North American populations of *L. littorea* are the result of a recent anthropogenic introduction from Europe.

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The roles of larval supply, habitat selection and post-settlement mortality in controlling adult distributions of the invasive gastropod *Crepidula fornicata*

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -
Contributed

abstract

Understanding the processes that drive the recruitment of populations of invasive non-native species is of critical importance in evaluating their potential to colonise previously unoccupied habitats. The slipper limpet *Crepidula fornicata* has become a common component of the fauna along the east, south and south west coasts of the UK since its first introduction in the 1870s. The Milford Haven Waterway in Wales supports a well established population with locally high densities but no indication of a range extension beyond its boundaries. It is suggested that the observed patchy distributions of the species at other European study sites may be due to a highly variable supply of larvae, both temporally and spatially. In this study, we tested a series of existing models to quantitatively investigate the roles of larval supply, larval habitat selection and post-settlement mortality to explain the highly variable densities of *C. fornicata* within the Milford Haven Waterway. Between 2009 and 2011, data were collected on intertidal and subtidal adult densities, settlement rates and larval abundances. Whilst larval abundances were found to be very high during the peak reproductive season with maximum densities of > 1200 larvae. m^{-3}, settlement and recruitment were overall low. No relationship was observed between juvenile settlement rates and adult densities; in fact, highest settlement rates often occurred in areas with the lowest numbers of adults. Our data suggest that the distribution of adults in intertidal populations of *C. fornicata* is mainly a result of differential post-settlement mortality following initial settlement. Further work is currently being undertaken to identify the biotic and abiotic factors causing differential post-settlement mortality and to evaluate the importance of active larval habitat selection during the settlement process. Developing an integrative approach is important in trying to predict the risks that a potentially harmful invader such as *C. fornicata* might impose on native species in recently invaded areas.

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Adding positive species interactions into the melting pot of biological invasions: emerging perspectives and future research directions

Plenary talk

abstract

Current ecological theories aiming to explain and predict community invasibility are grounded on the assumption that natural communities are largely structured by competitive interactions and that the effects of native species on invaders are predominantly negative. Apart from the concept of invasional meltdown, the role of positive species interactions (e.g. mutualism and facilitation) has been overlooked in the context of biological invasions. This is at odds with reports of positive effects of native species on invaders rapidly accumulating in both terrestrial and marine environments. Recent theoretical models, taking into account potential positive effects of resident species on invaders, could help reconciling contrasting evidence generated by empirical studied in support or against competition-based models (e.g. the biotic resistance and fluctuating resource hypotheses). For instance, increasing levels of native species richness are thought to provide a barrier against invasion by enabling a more effective exploitation of resources (due to complementarity and sampling mechanisms). On the other hand, greater availability of life-history traits within the native pool can also increase the probability of exhibiting traits able to facilitate the establishment or spread of exotic species. Thus, re-balancing our attention between competition/predation and facilitation might foster our understanding of the mechanisms underlying variations in community invasibility. Importantly, facilitation of invaders by native species can occur via an amelioration of harsh physical conditions or the provision of refugees from consumers. Framing research into the conceptual context of switches in the sign and intensity of species interactions (i.e. from competition to facilitation and vice versa) along gradients of physical stress or consumer pressure (i.e. the Stress Gradient Hypothesis) could, therefore, advance our ability to predict how community susceptibility to invasion will be altered by forecasted global climate changes and species loss.

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Productivity changes of *Zostera noltii* meadows invaded by the drift seaweed *Gracilaria vermiculophylla*

Poster presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -
Contributed

abstract

Seagrasses are important habitat-formers and facilitator species that form the basis of complex ecosystems in estuaries throughout the world. Seagrasses supply habitat and food for a wide variety of organisms, filter suspended matter and land derived nutrients and pollution, stabilizes soft sediments and protect coastlines from erosions. However, seagrass beds are under a siege derived from different anthropogenic causes, and, in addition, these systems have to cope with invading seaweeds that threaten to displace the seagrasses and change the ecosystem function. This study aims to accurately evaluate how the invasive drift seaweed *Gracilaria vermiculophylla* alters seagrass assemblage performance by comparing the assemblage functioning of invaded and non-invaded *Zostera noltii* meadows. Moreover, we estimate the total productivity of both kinds of meadows across an extensive range of one of the largest estuaries of Portugal, Ria de Aveiro, where a general decline in *Z. noltii* meadows have been reported. Assemblage functioning was assessed as the metabolic state of the system based on carbon dioxide (low tide productivity) and oxygen (high tide productivity) fluxes. We calculated the total productivity carried out by marginal seagrass in different parts of the ria using abundance data derived from field samplings carried out in summer, coinciding with maximum seaweed densities.

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Patterns of spatial variation in macroalgal assemblages of Iberian rockpools invaded by *Sargassum muticum*

Poster presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -
Contributed

abstract

Intertidal rock-pools of coastal shores of the Cantabrian and Atlantic coasts of the Iberian Peninsula are frequently invaded by *Sargassum muticum*, which alter the composition and functioning of the native communities. This brown seaweed was firstly recorded at the Iberian Peninsula in the Basque Country. Here we followed a fully hierarchical design to examine the degree of invasion of rock-pools across the Atlantic Iberian Peninsula, including areas from Asturias (Spain) to Vicentine Coast (Portugal). Following a design including 4 spatially nested factors, we investigated the patterns of invasion by *S.muticum* and its relationship with native macroalgal richness and diversity of these systems at different spatial scales, ranging from distances of meters to shores hundreds of km apart. We hypothesize that *S. muticum* abundance is higher in those areas with an older invasion time and on those areas with lower diversity at local scales, and discuss about the possible importance of the involved processes, such as temperature.

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What social and cultural values are impacted by introduced marine species? A case study focussing on Guam, Palau and Saipan

Oral presentation
symposiumtheme1: *Other topics*
symposiumtheme2: -
Contributed

abstract

It is recognised that introduced marine species pose a threat to both environment and economic values, but the threats to social and cultural values remain nebulous. As such, little work has been attempted to elucidate the impact introduced marine species may have on these values despite their large influence on individuals and their willingness to support the costs associated with biosecurity outcomes such as long term management or eradication. Similarly, values influence behaviours (behavioural intent) and consequently a person's ability to self-manage their behaviours, such as inadvertently moving species into a region. To address this lack of knowledge about social and cultural values, we investigated social and cultural values associated with the potential to be impacted by introduced marine species into Micronesia; specifically Guam, Palau, and Saipan. Social and cultural values were defined as things that were important to people either from a social or cultural perspective. Environmental and economic values were also collected but are not presented here. A preliminary assessment was undertaken that involved an initial series of face-to-face meetings with individuals in government, industry, and tourism. These interviews and meetings elucidated a number of values for the different regions. A follow-up electronic survey based on choice-modelling, was then used for additional values to be captured and to assess if respondents felt if a value would change if an introduced marine species arrived in the region. We present the preliminary outcomes of this research.

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Are recreational users a hazard to marine environmental health? Vectors of non-indigenous marine species into Marine Protected Areas

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -
Contributed

abstract

The management of Marine Protected Areas (MPAs) is often devolved to the individual through public education and outreach programs that tell users what should and should not occur in MPAs, with limited enforcement potentially occurring. Similarly, the detection of non-indigenous marine species (NIMS) is often devolved to the public with people being encouraged to report a pest or to keep vigilant about the cleanliness equipment to reduce the possibility of become a vector or pathway for a pest. The aim of these public education and outreach programs is to influence (and hopefully improve) an individual's capability and their behaviour. In the instance of MPAs, the aim is that people will use the area and respect the objectives of the park. In a biosecurity context, the aim is to inform people of NIMS, the impacts that NIMS can have, and to provide information about how to inform management if a suspected NIMS incident occurs (i.e., 'if you see this pest call this number'). It's argued that through the devolution or sharing of the responsibility to manage these issues management operating costs will be reduced thus freeing up more funds for emergency situations. It's also argued that education and outreach will result in better buy-in and compliance by stakeholders and the public, as they become aware of issues (raise awareness) and develop a sense of empowerment (they are able to help, or to make responsible judgements). Yet, what happens when stakeholders are informed but the message doesn't get through?

We undertook a study to determine if recreational users at a number of MPAs and surrounding areas in Tasmania, Australia, were aware of NIMS and thus would they be theoretically able to ensure that they did not transfer NIMS from place to place (secondary transfer of NIMS). We placed this into an MPA context due to the conservation focus of MPAs and thus the apparent urgency of efficient management in these areas. We investigated marine users' perceptions of NIMS, their self-proclaimed awareness of NIMS and the accuracy of this awareness. This was done using a survey tool (questionnaire) that was administered face-to-face to individuals that were seen to be participating in recreational marine activities at six MPAs and six control sites (areas close to an MPA). The majority (70.45 %) of respondents believe that they are aware of NIMS in Tasmania, with accuracy of awareness being variable but ranging from low to fair, in some instances (e.g., <10 % to 54.95 % for identifying four well established NIMS). Accuracy was not affected by the recreational activities that people undertake. Thus, we identified that marine users in Tasmania are partially informed about NIMS, but they are not knowledgeable about NIMS. This suggests that NIMS education and outreach in Tasmania has only been partially successful, with work still needing to occur to ensure that marine recreational users do not become vectors of NIMS in Tasmanian waters.

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Biosecurity risk assessment of introduced species on the Port of Jakarta, Indonesia

Oral presentation
symposiumtheme1: New tools for identification, monitoring, risk assessment, and management
symposiumtheme2: -
Contributed

abstract

A marine biosecurity risk assessment was conducted for the Port of Tanjung Priok, Indonesia, an active port within the Great Jakarta Bay Ecosystem. Two methods were used to examine the pathway of species introduction to the Great Jakarta Bay Ecosystem: 1) a bioregion based pathway analysis provided information on which bioregions are more likely to be the source of species introduction; and 2) an exposure to introduced species analysis provided information on which species are most likely to arrive in the Great Jakarta Bay Ecosystem. Both risk assessment models provide an estimate of risk yet they focus on different aspects of invasion, the pathway, and the species, and hence may give similar or different management outcomes. An 11-year dataset of ship traffic into the Port of Tanjung was used to analyse both pathway and the species risk factors, with a global introduced species database also being used to assess species risk factors. The two methods were compared to determine which would provide effective management measures of species introduction in Great Jakarta Bay Ecosystem.

Outcomes of the bioregion based pathway analysis suggest that the Port Authority should be concerned with the threats that come from within the East Asian Seas bioregion (the same bioregion that the Great Jakarta Bay Ecosystem occurs within). This outcome is based on the strength of the pathway; with no other bioregions having a significant likelihood to be potential donors of introduced species. A further outcome of this analysis was the development of a hub-and-spoke model to examine the pathway strengths from Jakarta Bay to other Indonesian ports (presented in another paper at this conference).

Outcomes of the species exposure analysis suggest that 357 species can be introduced in many or most circumstances, to the Great Jakarta Bay Ecosystem. The impact of the 357 potential species that are likely to be introduced to Great Jakarta Bay Ecosystem was further assessed using consequence matrices to derive a measure of risk that might be posed. Based on this analysis, there are 52 species that posed a threat ranging from extreme to moderate risk. We suggest that these 52 species be proposed as targeted species for border and post-border management of introduced species in Great Jakarta Bay Ecosystem. Thus, both risk assessment models provide different management outcomes and illustrate the need for risk assessment models to be inclusive of species and pathways to provide a more thorough pattern analysis.

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Using a hub and spoke model to assess internal marine biosecurity risk patterns within Indonesia

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -
Contributed

abstract

Little introduced marine species research has occurred in Indonesia, yet the issue of introduced marine species is recognised and needs to be regulated. Our recent research (presented elsewhere at this conference) indicates that based on exposure to international shipping patterns and hence exposure to likely introduced marine species associated with that international shipping the East Asian Seas bioregion poses a biosecurity threat to Indonesia. This risk is driven by the major shipping hub of Singapore being present in this bioregion. Our previous risk research also indicates that there are at least 52 introduced marine species that can establish within the Port of Tanjung Priok (Jakarta Bay) that pose a moderate to extreme risk to Indonesia and should be targeted for border and post-border management initiatives. Furthermore, Indonesia is an archipelagic country consisting of more than 17,000 islands that are interconnected by domestic and inter-island shipping. Based on these factors and to aid the biosecurity management process we developed a hub-and-spoke model to examine the potential secondary transfer patterns of introduced marine species from the Port of Tanjung Priok (Jakarta hub) to the 32 Indonesian provinces (spokes), and to assess the loss of potential values in these regions.

We analysed more than 51,000 port of call records for an 11-year period (1999-2009) and identified that seven provinces (~22 %) received the greatest domestic trade volume (number of ship visits) from Jakarta Bay. The urban provinces of East Java, Central Java, North Sumatera and South Sulawesi all experience a strong transport pressure/linkage to the Port of Tanjung Priok. To assess the values that may be impacted, we grouped the top 15 provinces (based on trade volume) into three regions based on their locations and their shared values. Region 1 consisted of provinces with coastal areas associated with extensive aquaculture and mariculture activities and associated economic benefits. Region 2 was categorised based on biodiversity hotspots, where protection of biodiversity is recognised and regulated. The final region was a 'catch all' categorisation that included areas mined for natural resources, tourist sites and to a lesser extent aquaculture and mariculture areas. A comparison of impacts on these values was then undertaken. We present the results of this research and based on these results provide some biosecurity recommendations for the region.

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Protecting high-value areas from introduced marine species: theoretical and realised risk assessment models

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -
Contributed

abstract

Marine introductions threaten various environmental, economic, social and cultural values in coastal zones throughout the world. Introductions initially occur at entry points such as ports, marinas and aquaculture farms, but natural dispersal and human mediated secondary transfer will spread these species to adjacent coastal regions, including protected or high-value areas (HVAs). High-value areas exist in most coastal zones and are frequently established as marine protected areas in an effort to protect and conserve biodiversity and contribute to the sustainable management of natural resources. To manage both marine biosecurity issues and high-value area protection requires effective management, with decisions relying on best available information. But what happens when information is lacking or conflicting?

To test this, we have used *Undaria* invasions in New Zealand as a model system to assess the use of a theoretical risk system that is then built upon with the use of a realised risk model. The theoretical risk assessment was implemented via a 5-step risk assessment process through a focus group setting (group interviews) where experts were asked to share knowledge, discuss concepts, test theories, and run scenarios. This process re-assessed the potential impacts of *Undaria* on values associated with a set of New Zealand high-value areas. In this setting, *Undaria* was found to pose an extreme risk to a majority of subcomponent values in all evaluated HVAs.

The next step in the process of delineating the risk *Undaria* poses to New Zealand HVAs was to analyse the realised risk. To do this we developed a combined pathway/vector model equation that assessed each HVA's exposure to *Undaria* (multiple variables), propagule strength risk factors (multiple variables), and mitigation factors. This model uses quantitative vessel and propagule strength data to examine secondary transfers into HVAs.

Undaria is an introduced species in more than nine countries with risk models such as these being applicable to other regions and to other species. The risk models we present can be used as either individual stand-alone models (theoretical and realised) or combined risk models. Currently, the model focuses on biofouling, as this is thought to be the main transfer mechanism for *Undaria*. However, the realised risk model equation can be easily manipulated to include, or exclude, variables that are applicable to other vector mechanisms such as ballast water or the aquarium trade.

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Non-native Marine Species and Climate Change: the 'Caribbean Creep' Hits the Reset Button

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -

abstract

New marine invasions have been recorded in increasing numbers along the world's coasts due, in part, to the global warming of the oceans and the ability of many successful invasive marine species to tolerate a broader thermal range than similar native species. Several marine invertebrate species have invaded the U.S. southern and mid-Atlantic coast from the Caribbean this poleward range expansion has been coined 'Caribbean Creep'. While models have predicted the continued decline of global biodiversity over the next 100 years due to global climate change, few studies have examined the episodic impacts of prolonged cold events that could impact species range expansions. A pronounced cold spell occurred in January 2010 in the U.S. southern and mid-Atlantic coast and resulted in the mortality of several terrestrial and marine species. To experimentally test whether cold-water temperatures may have caused the disappearance of one species of the 'Caribbean Creep' we exposed the non-native crab Petrolisthes armatus to different thermal treatments that mimicked normal and severe winter temperatures. Our findings indicate that Petrolisthes armatus cannot tolerate prolonged and extreme cold temperatures (4-6 °C) and suggest that aperiodic cold winters may be a critical "reset" mechanism that will limit the range expansion of other 'Caribbean Creep' species. Temperature 'aberrations' such as 'cold snaps' are also an important, and often overlooked, part of global climate change. These climate fluctuations should be accounted for in future studies, particularly with reference to introduced tropical species and attempts to predict both rates of invasion and rates of unidirectional geographic expansion.

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Optimizing the allocation of surveillance effort for defending marine protected areas from introduced species

Oral presentation
symposiumtheme1: *Other topics*
symposiumtheme2: -

abstract

The majority of non-indigenous marine species in Australia are found in ports or surrounding areas, having been introduced via international shipping. The potential for these species to spread beyond port areas to other parts of the coast is a growing concern, particularly for those areas set aside for the protection of biodiversity. When considering such secondary incursions, vectors other than international shipping take on greater importance. Aquaculture operations, ocean-going yachts, coastal fishing and trading vessels, small recreational boats and the aquarium trade are all potential vectors, in addition to transport via natural means. Victoria, Australia, provides a useful case study for considering secondary incursions for several reasons: 1) Port Phillip Bay contains two major ports and at least 99 introduced and 61 cryptogenic species. It is thus particularly important as a potential source for secondary inoculation of other locations along the coast. 2) The southern coast of Australia is notable for its biodiversity, having high levels of endemicity in its marine flora and fauna. 3) Victoria has a highly protected system of 13 marine national parks and 11 marine sanctuaries dating from 2002.

To assist in management of the risk of introduced species in Victorian MPAs, we have developed a Bayesian network to prioritize species for surveillance from the suite of those known to be present in Port Phillip Bay. Prioritization is important because the management agency, Parks Victoria, has limited resources with which to tackle the problem of introduced species in its MPAs. The prioritization is based on habitat preferences, estimated probabilities of species arriving in parks via a variety of vectors including recreational boating and natural dispersion, and the likely impacts of the target species on valued attributes of the MPAs. During the course of this project, spread of the introduced alga *Undaria pinnatifida* to a secondary port outside Port Phillip Bay and close to a marine sanctuary, provided an unexpected opportunity to apply our Bayes net to the prioritization of surveillance sites with a view to preventing further spread.

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Effects of the non-native Asian mussel (*Musculista senhousia*) on resilience of eelgrass (*Zostera marina*) to disturbance

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Oral presentation
symposiumtheme1: *Drivers of invasibility*
symposiumtheme2: -
Contributed

abstract

Disturbance can facilitate colonization by non-native species, but the establishment of introduced species and subsequent interactions with native species are rarely studied within a disturbance framework. We investigated the effects of the non-native Asian mussel *Musculista senhousia* (Benson in Cantor, 1842) on recovery dynamics of eelgrass *Zostera marina* L., a native marine angiosperm, following disturbance. Previous work suggests that Asian mussels may suppress the clonal growth of eelgrass, a propagation mechanism critical for resilience, by altering the physical structure of the benthos or modifying sediment and porewater chemistry. We conducted field surveys to quantify the spatial relationship between these two species and sediment characteristics in Mission Bay, San Diego, California, USA. To determine how Asian mussels may influence resilience of eelgrass to disturbance, we simulated small-scale disturbances to eelgrass habitat and compared recovery dynamics between treatments with live mussels and treatments with structural mimics of mussels and their byssal mats. Preliminary findings suggest that mussels may impact eelgrass recovery through a combination of autogenic and allogenic mechanisms. This project represents a novel contribution to our understanding of the interplay between native species, introduced ecosystem engineers, and disturbance.

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Role of native species richness on invasibility of Mediterranean rocky

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: *Factors promoting the establishment and spread of marine invaders post-arrival*
Contributed

abstract

It is widely accepted that biological invasions are threatening biodiversity and ecosystems functioning worldwide. Actually, one of the important goals for ecologist is to understand why and how successful invasions occur. Specifically, native biodiversity is claimed to be a determining factor for the invasion success of an invasive species on a new assemblage (invasibility). Recent studies indicate that relationships between native species richness (NSR) and susceptibility to invasion are scale dependent, being positive at large scales and negative at smaller. However, here we hypothesize that these relationships are also time dependent, shifting from positive to negative with time. *Lophocladia lallemandii* is a filamentous marine red alga, which is currently invading several areas of the Mediterranean Sea. Although *L. lallemandi* is able to grow in different algal assemblages, there are no studies on the susceptibility of different habitats to be invaded according to their species composition and richness. Here, we explore the relationship between *L. lallemandii* invasion and species richness of its hosting native habitats in order to elucidate if most diverse habitats are more susceptible to be invaded, or whether, in contrast, biodiversity prevents *L. lallemandii* invasion, and how this may change with time since invasion. We performed a correlational approach to study the relationships between NSR and *L. lallemandii* invasibility at a large and small spatial scales and at different time phases of the invasion as well as a short-term field experiment designed to examine / assess if native biodiversity assemblage and structural complexity layers of Mediterranean native macroalgal assemblage promote the successful spread of *Lophocladia lallemandii*.

Our study shows that even though the relationships between NSR and invasibility by *L. lallemandii* are generally scale dependent (i.e. positive at large scales and negative at small scales), they can be also positive at smaller spatial scales, as long as no resource limitation exists. In addition, we further demonstrate a clear shift from a positive to negative relationship through time considering the same habitat and scale, suggesting that the observed pattern at different scales might be a main consequence of the invasion process itself.

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The effects of the spread of the invasive seaweed *Caulerpa racemosa* into disturbed *Posidonia oceanica* beds

Oral presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -
Contributed

abstract

Human disturbances, such as anchoring and dredging can cause physical removal of seagrass rhizomes and shoots, leading to the fragmentation of meadows, reducing habitat complexity and, thus, species diversity. The invasive green alga *Caulerpa racemosa* is widely spread in the North-West Mediterranean, where it has established both on sandy and rocky bottoms down to about 70 m of depth. Although *C. racemosa* can establish in both degraded and pristine environments, its ability to become a dominant component of macroalgal assemblages seems greater in the former. The aim of this work was to estimate whether the spread of *C. racemosa* in disturbed *Posidonia oceanica* meadows can change the recovery patterns of benthic understorey assemblages. A field experiment was started in July 2010 when habitat complexity of a *P. oceanica* about 5 m deep was manipulated simulating effects of a mechanical human disturbance (canopy removed CR, canopy re-growing CRG and undisturbed UN). Disturbance was applied within plots of different size (40x40 cm and 80x80 cm), both at the margins and inside a *P. oceanica* meadow, according to an orthogonal multifactorial design. Since then, the spread of *Caulerpa racemosa* in the experimental units has been allowed or impeded depending on the *Caulerpa* treatment (spreading vs not spreading). Response variables analysed included the cover of species colonizing either the primary substratum or the rhizomes.The spread of *C. racemosa* was significantly higher at the edge of the seagrass meadow rather than inside and was highly dependent on the disturbance level. The assemblage of taxa covering the substrate and *P. oceanica* rhizomes were both differently affected by the disturbance depending on the position within the meadow. Further, the size of disturbance seemed to interact with the presence of *C. racemosa* in shaping the structure of understorey assemblages. These results suggest that different effects of the colonization by *C. racemosa* will vary according to the position within the meadow, as the cover of the invasive alga was much higher at the margin of *P. oceanica*. Large differences in the recovery of assemblages among treatments are expected to occur through time, as the invasion of the alga proceeds.

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Current status of marine non-indigenous species in the Western Pacific region

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -
Contributed

abstract

Recently, UNESCO/IOC Sub-Commission for the Western Pacific (WESTPAC) project on the 'Coastal Marine Biodiversity and Conservation' had organized three regional workshops related to marine non-indigenous species, and published a report on current status of marine non-indigenous species in the Western Pacific region. This report aimed to consolidate the available information on the current status and list of marine non-indigenous as of 2010 in nine countries; China, Indonesia, Japan, Republic of Korea, Malaysia, Philippines, Singapore, Thailand, and Vietnam. The report also attempted to provide a general review of on-going research and management in each country. Since there were still some difficulties to identify whether a species was native or non-native species, the information provided in this report were focused primarily on macroorganisms. The information from this report can serve as a baseline data for further research on marine non-indigenous species in the region. This presentation will give an overview of current status, pathways, and list of marine non-indigenous species found in the region.

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Can propagule pressure really explain intertidal non-indigenous species establishment in Canadian oceanic ports?

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: *Factors promoting the establishment and spread of marine invaders post-arrival*

abstract

The establishment of non-indigenous species in natural ecosystems is a growing concern at global, national, and regional scales. Over 100 known marine non-indigenous species (NIS) are found along the Pacific and Atlantic coasts of Canada. It is widely believed that commercial shipping activities associated with international ports (eg. ballast water discharge, hull fouling...) could expose native communities to a variety of NIS. Thus, harbours are recognized as critical entry points for NIS and, pending establishment can serve as an invasion hub for secondary dispersal vectors (e.g. recreational boats). Although, harbours are believed to be critical invasion locations, relatively few studies have examined the relationship between propagule pressure from commercial shipping and actual NIS establishment in port communities. During 2007 and 2008, extensive intertidal surveys were conducted to examine spatial patterns of abiotic variables and the intertidal community structure in Canadian ports. Sixteen major international ports, eight along the Pacific coast and eight along the Atlantic coast were surveyed for richness and abundance of both native and non-indigenous marine intertidal species. In addition, twelve abiotic variables: both anthropogenic (ballast water discharge, ship arrivals, etc) and environmental (sea surface temperature, salinity, etc.) were recorded at each port. Our findings showed a significant correlation between total intertidal species richness and three environmental variables: latitude, sea surface salinity, and temperature. For established non-indigenous intertidal species, additional anthropogenic variables also were important. These included human population size and aquaculture on the Pacific coast, as well as the distance away from shipping berths on the Atlantic coast. Our findings suggest that: (a) Total species richness in intertidal communities of Canadian coastal ports seem to be associated with only environmental variables and are almost unaffected by anthropogenic activities; and (b) NIS richness across intertidal communities in Canadian coastal ports was related to anthropogenic variables, but propagule pressure from ballast water and other commercial shipping activities were not responsible for the observed patterns. Programs for conservation and management of invaded communities should consider including the risk posed by other anthropogenic activities in addition to marine commercial shipping when characterizing invasion dynamics.

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Intrinsic time-dependence in the diversity-invasibility relationship

Oral presentation
symposiumtheme1: *Development and tests of invasion theory*
symposiumtheme2: -
Contributed

abstract

Contradictory patterns in the diversity-invasibility relationship have intrigued ecologists for many years. Experiments testing the relationship generally find it to be negative, but field surveys usually find it to be positive. This conundrum has become known as the invasion paradox, and several explanations have been offered. Most propose that the paradox is driven by differences in spatial scale, since experiments are conducted at small scales and surveys usually at large. The effects of diversity are thought to occur at small scales only, but this is challenged by field surveys that find a positive relationship across all spatial scales. Here we propose that the invasion paradox may be partially driven by differences in temporal scale, since experiments generally consider invasion on shorter time scales than surveys. We present a conceptual model of how temporal scale may affect the diversity-invasibility relationship, and test the logic with simulation models. Results show that the relationship begins negative and moves to positive under a wide range of scenarios, providing an alternate explanation for the invasion paradox.

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Copper tolerance allows invaders to take advantage of polluted areas

Oral presentation
symposiumtheme1: *Drivers of invasibility*
symposiumtheme2: *Factors promoting the establishment and spread of marine invaders post-arrival*
Contributed

abstract

Copper is one of the most toxic pollutants to marine invertebrates. However, some species can acquire tolerance through localized induction of tolerance mechanisms, localised evolution of resistance, or from the selection of resistant genotypes during the transport phase of introduction (e.g. on hulls of vessels coated in copper anti-fouling paint). We tested for effects of copper on the development of sessile invertebrate assemblages at 121 sites, across 7 estuaries on the east coast of Australia. We concurrently measured background copper contamination at each site by analysing metal loads in benthic sediments and sediment traps, and bioaccumulation in experimentally deployed oysters. Copper tolerance in some non-indigenous species (NIS) increased with background levels of contamination, which gave them a competitive advantage in contaminated areas. This suggests that copper tolerance may be a key trait in the invasiveness of some NIS.

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Disentangling the patterns and drivers of marine invasion: a northern temperate case study

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -
Contributed

abstract

Vectors of primary introduction may be very different from those responsible for secondary spread. Commercial shipping and aquaculture-related transfers have been responsible for many initial introductions but secondary, regional spread likely occurs via a different suite of vectors. Here we use a large northern hemisphere temperate marine region to explore patterns and infer possible causes of both introduction and spread of aquatic invasions. Empirical results show that the incidence of nonindigenous species (NIS) on recreational boats in British Columbia (BC), Canada is surprisingly high: one in four boats surveyed had NIS attached or entangled. This suggests that the recreational boating vector may be the most significant vector of secondary spread, transporting NIS within BC waters. To test the relative importance of this vector, NIS spatial and temporal distribution data for BC were compiled, based on extensive biological surveys of marinas and aquaculture facilities. To gain insights into both past and present vectors of invasion, we evaluated potential relationships between anthropogenic activity patterns and NIS distributions. We compared the relative contribution of recreational boating with commercial shipping, aquaculture, and population census data in predicting the distribution of NIS in BC marinas. The present study will support the efficient prioritization of research and management of marine NIS, improving vector management, monitoring and outreach efforts for stakeholders and the public.

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NIS Interactions: negative impacts of an invasive caprellid amphipod on an invasive tunicate

Oral presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: *Factors promoting the establishment and spread of marine invaders post-arrival*
Contributed

abstract

As the number of introductions of non-indigenous species (NIS) continues to rise, ecologists are faced with new and unique opportunities to observe interactions between species that do not naturally co-exist. These interactions can be important in determining whether NIS become successful invaders, with widespread and dominant populations, or fail to establish themselves and disappear. Many studies to date have focused on interactions between NIS and native species, but few have looked at the direct interactions between NIS. In some cases these interactions can facilitate the invasion process of both species, but factors such as competition for resources or predation can lead to the advancement of one species and the demise of the other. The recent introduction of the vase tunicate, *Ciona intestinalis*, in Prince Edward Island (Canada) has created problems for the mussel aquaculture via heavy biofouling of equipment and mussels. However, two species of caprellid amphipods, *Caprella linearis* and *C. mutica*, are also present, the second of which is a non-indigenous species. Although considered an opportunistic feeder in their native habitat, *C. mutica* is found to feed predominantly on diatoms and detritus. However, through a broad estuary-wide survey and smaller experimental studies on caprellid abundance, we have found *Ciona* recruitment is negatively correlated with caprellid abundance. Although *C. mutica* has been proposed as a potential method for controlling invasive tunicates, our data definitively show their presence reduces tunicate recruitment. In contrast to the popular notion of invasion meltdowns, this study provides a striking example of an invasive species having a negative impact on another invasive species.

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Assessing ballast treatment standards for effect on rate of establishment with a stochastic model of the green crab

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: *Ship Biofouling: Vector Characterization and Management Strategies*
Contributed

abstract

Understanding the likelihood that a non indigenous species (NIS) could become established is a critical gap in our ability to manage NIS introduction via ballast water discharge. This limitation severely restricts our ability to ensure the efficacy of current and proposed numeric based ballast water discharge standards. This paper describes a stochastic model used to characterize the probability/risk of NIS establishment from ship's ballast water discharges. Establishment is defined as the existence of sufficient numbers of a species to provide for a sustained population of the organism. The inherent variability in population dynamics of organisms in their native or established environments is generally difficult to quantify. Much qualitative information is known about organism life cycles and biotic and abiotic environmental pressures on the population, but generally little quantitative data exists to develop a mechanistic model of populations in such complex environments. Moreover, there is little quantitative data to characterize the stochastic fluctuations of population size over time even without accounting for systematic responses to biotic and abiotic pressures. This research applies an approach using life-stage density and fecundity measures reported in research to determine a stochastic model of an organism's population dynamics. The model is illustrated with data from research studies on the green crab that span a range of habitats of the established organism and collected over some years to represent a range of time-varying biotic and abiotic conditions that are expected to exist in many receiving environments. This model is applied to introductions of NIS at the IMO D-2 and United States Coast Guard's proposed Phase Two U.S. ballast water discharge standard levels. Under a representative range of ballast volumes discharged at U.S. ports, the average rate of establishment of green crabs for ballast waters treated to the IMO-D2 concentration standard (<10 organisms/m^3) is predicted to be reduced to about a third the average rate from untreated ballast water discharge. The longevity of populations from the untreated ballast water discharges is expected to be reduced by about 90 % by treatment to the IMO-D2 concentration standard. This research was support by USCG Contact GS-23F-8167H/HSCG23-09-F-MSR105 (March 17, 2010).

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Change in tropical rocky shore communities due to an alien coral invasion

Poster presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -
Contributed

abstract

To determine how benthic tropical rocky shore communities were affected by the invasive corals *Tubastraea coccinea* and *Tubastraea tagusensis* eight sites were studied during two years on rocky shores in the southwest Atlantic (Brazil) using both fixed and random sampling techniques. Overall, mean cover of *T. tagusensis* was 0.65 % and *T. coccinea* 0.37 %, (the eleventh and sixteenth most abundant taxons, respectively throughout the sites). Forty-two major space occupying taxons were registered. In fixed quadrats there was a 76.6 % a year increase in density of *Tubastraea* spp. over time. For percent cover no significant difference in cover over time was detected for *T. coccinea* but for *T. tagusensis* and overall (both species) cover increased significantly. The random quadrats data showed subtle differences from the fixed quadrats: there was an increase in density of *Tubastraea* spp. through time (67.8 % a year). In random samples the density of *T. coccinea* increased during the study but *T. tagusensis* did not. The cover of both corals also increased over time. The sites where *Tubastraea* spp were most abundant possessed higher diversity, evenness and richness of species. Sites where *Tubastraea* was present tended to group in ordination. The presence of *Tubastraea* in the communities caused a mean 4.81 % dissimilarity in the invaded communities. A strong positive relationship between invader cover and change in community structure was found which suggested complete (100 %) community dissimilarity at an invader cover of 45 %. The negative effects are sufficient to disturb the native benthic rocky shore communities throughout the tropical Atlantic.
Sponsorship: Petrobras
Grants: FAPERJ, CNPq

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Quantitative protocols for long-term monitoring of invasive corals *Tubastraea* spp. (Cnidaria, Scleractinia): Sun-Coral Project

Poster presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -
Contributed

abstract

The methodology used for the extensive Brazilian monitoring program consisted of semi-quantitive large-scale mapping of the distribution of two invasive corals *Tubastraea coccinea* and *T. tagusensis*. At each site two divers using snorkel swam in opposite directions parallel to the rocky shore, in five one-minute transects (approximately 25 m in length per minute). In each transect the divers estimated the density of coverage of each species of *Tubastraea*, assigning a DAFOR scale and values for classes of relative abundance: Dominant = extremely obvious populations forming many essentially monospecific patches 1m^2 diameter at least one depth level, with very frequent isolated colonies and/ or smaller patches spread throughout the substratum (score = 10); Abundant = frequently occurring essentially monospecific patches of 50-100 cm diameter, with frequent isolated colonies and/or small patches spread throughout the substratum (score = 8); Frequent = isolated colonies and/or small patches observed to be spread constantly throughout the substratum, with occasional occurrence of patches 10-50 cm in diameter (score = 6); Occasional: less than 10 colonies or small groups but more than 5 colonies per minute dive (score = 4); Rare = between 1 and 5 colonies found during a 1 minute dive (score = 2); Absent (score = 0). The intensive monitoring study aimed to quantify change in the native benthic community structure due to the invasive corals *Tubastraea* spp. Eight sites has to be initially selected based on extensive monitoring data that previously reported differences in the abundance of *Tubastraea*: Two sites without *Tubastraea*; two sites with low relative abundance; two sites with medium relative abundance; two sites with high relative abundance. Abundance and percent cover of the sessile macrobenthic species is estimated over years. This is achieved by using SCUBA and 0.25 m^2 quadrats which are placed onto permanently marked 50 m transects previously placed at each site parallel to the coast in 1-3 m depth onto which were placed 15 fixed position and 15 random positioned quadrats. A mixed approach of random quadrats allowed temporal independence and fixed position (but randomly initially determined) quadrats was used to test whether fixed quadrats maximized sensibility to temporal change. In each quadrat divers estimated the cover of the major space occupying taxons or functional groups in each of 25 10 x 10 cm sub-quadrats. This method focused attention on the dominant space occupying organisms in the community. The density of the two alien corals is also estimated by counting individuals (colonies) in each quadrat.
Sponsorship: Petrobras-Programa Petrobras Ambiental
Financial support: FAPERJ, CNPQ, CAPES 'Ciências do Mar' 1137/2010

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Ten years monitoring *Tubastraea* spp. in Brazil: lessons learned

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -
Contributed

abstract

The genus *Tubastraea* is an ahermatypic scleractinian nonindigenous to south-western Atlantic, which probably arrived on a ship's hull or oil platform in the late 1980's. This genus was first reported for Brazil by 2001. However, in 2004 it was realized that the introduction was of two species *Tubastraea tagusensis* and *Tubastraea coccinea* at Ilha Grande, south of Rio de Janeiro. The Sun-Coral Project was launched in 2006 with extensive long-term monitoring. For brazilian waters it provides the first real opportunity to address the question of whether the tropical benthic community's rock shores are changing due to these invasions. The aims of this study are to show the current status of the invasive corals *Tubastraea* spp on the Brazilian coast. These reports were produced using semi-quantitative data and compiled information since 2000 and literature and personal communications. To map the general distribution and relative abundance of *Tubastraea* spp, a semi-quantitative method was used at 37 locations (genus level) during 2000, 71 locations during 2004, and 207 locations during 2010, 144 sites at Ilha Grande Bay and 63 at São Paulo. At each location, two snorkel divers spent five periods of 1 min underwater, evaluating the relative abundance of *Tubastraea*, which was classified as: Dominant > Abundant > Frequent > Occasional > Rare > or Absent. A relative abundance index was created by scoring these categories as 10, 8, 6, 4, 2 and zero, respectively. Based on this method we observed in 2000, the genus *Tubastraea* was found over a substantial geographical range on the rocky shores in Ilha Grande: 83.8 % of monitored locations showed the presence of the corals. The double-species occurrence was recorded from 2004, 43.7 % of sites found *T. coccinea* and 49.3 % *T. tagusensis*, and for 2010 45.1 % *T. coccinea* and 51.38 % *T. tagusensis* for Ilha Grande Bay. Comparing data from 2000 and 2004, the numbers of locations were *Tubastraea* spp. was not found decreased from 10.3 % to 3.4 %, while the number of sites with the highest abundance of these corals increased from 3.4 % to 13.8 %. In 10 years monitoring, the percentage of sites were the corals were dominant increased almost 14 times. On the other hand, the north of São Paulo state (SP) registered only 6.3 % of sites with *T. tagusensis* and 4.5 % *T. coccinea*, indicating that it is currently under invasion. These corals showed a significant increase in abundance and spatial distribution throughout southwestward and northward of Brazil. The current range expansion of *Tubastraea* offers a rare opportunity to compile information on the insertion of this exotic coral into a tropical rocky shore community.
Sponsorship: Petrobras - Programa Petrobras Ambiental
Financial support: FAPERJ, CNPQ

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Invader distribution and the Intermediate Disturbance Hypothesis

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: *Factors promoting the establishment and spread of marine invaders post-arrival*
Invited

abstract

Ecosystems vary greatly in the degree to which they have been invaded by exotic species, but one relatively consistent observation is that polluted or degraded areas tend to be more invaded than pristine sites. Although the role of environmental factors alone in producing this pattern has been difficult to isolate (because the supply of potential invaders is confounded with conditions thought make systems more vulnerable to invasion), a growing body of work is demonstrating that increasing disturbance can directly benefit invasive species. Despite this mounting evidence for a positive relationship between invasion and disturbance, one ecological theory - the intermediate disturbance hypothesis - predicts that species richness should in fact show a unimodal relationship along a disturbance gradient, with declining diversity away from some peak of richness. This theory has received considerable attention in the general ecological literature, with some support but also some lack of fit. Where the pattern holds, however, one might expect peaks of native and exotic richness to occur in different locations, with exotics skewed toward the disturbed end of the spectrum. A review of the invasion literature reveals that this question has not often been explicitly addressed, but there are several instances where observed patterns match with this prediction. More testing of this pattern should be carried out, both experimentally and with descriptive studies. Potentially substantial obstacles in accomplishing this work include the definition and interpretation of disturbance, manifestation of a full range of disturbance regimes, and the availability of pools of invasive and native species.

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Minimizing the potential transport of non-native aquatic invasive species by boats: The role of hull coatings

Oral presentation
symposiumtheme1: *Other topics*
symposiumtheme2: *Eradication/management of invasive species*
Contributed

abstract

Boats are a primary vector for the spread of non-native aquatic invasive species (AIS). Use of toxic copper-based antifouling paints for control of hull fouling organisms, including AIS, is under increased scrutiny due to high copper levels in harbors, and the associated negative impacts on water quality and native species. As a result, a ban on the use of these toxic antifouling paints is being considered in California and elsewhere. While such bans may improve water quality, less effective coatings may increase the risk of transporting AIS.

To inform these discussions, we experimentally tested two related hypotheses in harbors: 1) hull coating type affects the recruitment of fouling organisms, and 2) non-native species settle sooner and occupy more space over time than native species on surfaces coated with toxic copper-based antifouling paint. We deployed fiberglass experimental panels with different coatings at Santa Barbara Harbor (SBH), Santa Barbara, and/or Shelter Island Yacht Basin (SIYB), San Diego, California. Treatments included one toxic and two non-toxic hull coatings, and three deployment periods (3, 6, 12 months). Recruitment was evaluated using percent cover and counts, measured over one-month or longer (3-12 months) periods.

For one-month deployments, virtually no fouling organisms recruited to panels with toxic copper-based coating in either harbor. However, for non-toxic coatings, patterns of recruitment varied with location. Recruitment was similar among treatments and controls at SBH. In contrast, recruitment of three fouling organisms at SIYB - the bryozoans, *Watersipora subtorquata* and *Membranipora* sp., and the tubeworm, *Hydroides* spp. - was significantly affected by the type of non-toxic coating, with patterns differing among the three taxa. Over longer time periods non-native species appeared sooner than native species at both locations on panels with the copper-based coating, and percent cover increased over time.

Our findings indicate that the potential for spreading non-native AIS via boats may be higher for non-toxic hull coatings, but risks also exist for copper-based antifouling paints especially over longer time periods (> 6 months). More broadly our results support the need for companion practices, such as hull cleaning, for all boats regardless of hull coating, to reduce the potential spread of non-native AIS.

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Strategies for minimizing the transport of marine invasive species by recreational boats: Effective hull cleaning practices

Oral presentation
symposiumtheme1: *Other topics*
symposiumtheme2: *Eradication/management of invasive species*
Contributed

abstract

Recreational boats are a primary pathway for transporting non-native aquatic invasive species (AIS) among marine habitats. While various hull coatings are used to deter the recruitment of fouling organisms on boats, additional strategies are needed to more effectively minimize the potential spread of AIS. In California, the hull cleaning industry has developed best management practices (BMPs) that specify frequent in-water cleaning of boat hulls. The use of these BMPs may soon be mandated in some areas, yet questions about the efficacy of the BMPs and their broad applicability to other regions remain. In particular, concerns that hull cleaning may stimulate fouling by disturbing the fouling community and altering the surface have been raised. Additionally, it may be possible to reduce the frequency of cleaning for some locations and times when rates of fouling are low.

To investigate these issues we conducted two field studies at harbors in Santa Barbara (SB) and San Diego (SD), California. For the first study, we assessed the biomass of fouling organisms accumulating on experimental panels with toxic and non-toxic coatings that underwent three treatments; new (not cleaned), cleaned once or continually cleaned using the California BMPs. For the second study, we evaluated monthly recruitment of fouling organisms among locations and over time on similar panels for one year. Recruitment to experimental panels was assessed using point contact methods and counts.

We found that the accumulation of fouling biomass was not significantly affected by cleaning treatment, with similar biomass for all panels. In contrast, panels with toxic coatings accumulated significantly less fouling than panels with non-toxic coatings. Location also mattered with significantly less fouling at the northern SB locations as compared to the southern SD locations. Seasonal patterns of recruitment were also evident, with lower fouling rates in the winter. However, while some hull fouling species exhibited strong pulses of recruitment during certain months, others recruited year round.

Our findings indicate that California in-water hull cleaning BMPs provide an effective companion method to use with hull coatings for managing fouling on boats and minimizing transport of AIS. Further, our results support the use of different cleaning frequencies for hulls with certain coatings. Current hull cleaning intervals, however, should be adjusted depending on the coastal area where the boat is kept and the time of year.

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Investigating the invasibility of artificial structures and shallow reef

Oral presentation
symposiumtheme1: *Other topics*
symposiumtheme2: *Factors promoting the establishment and spread of marine invaders post-arrival*
Invited

abstract

Artificial structures differ from natural rocky reefs due to their physical characteristics. Most jetties and pontoons present large areas of vertical substrata and are relatively shaded, which reduces competition from many algal species and allows the development of assemblages dominated by sessile invertebrates. They are also regularly disturbed by cleaning and maintenance and this may play a role in providing a foothold for arriving invaders. In contrast, natural habitats are thought to provide barriers to invasion through the biotic resistance of native residents.

We compared hard-substrate assemblages on the vertical surfaces of pilings, pontoons and rocky reef in Sydney Harbour, Australia. We found greater non-indigenous diversity and dominance on piers and pilings relative to rocky reef. However, some non-indigenous invertebrates and algae were present on the reef. We tested the hypothesis that the ability to invade natural rocky reef is influenced by shading and resident assemblage. Experiments were deployed simultaneously at two rocky reef areas in Sydney Harbour. Sandstone plates were subjected to shading treatments and were positioned vertically. Half the plates were bare at deployment and half had 1-year old assemblages present (65-90 % cover of *Sargassum* sp.). The plates were deployed for seven months and then algal canopy was removed and weighed, and the remaining assemblage censused live. Exotic species were better able to invade bare plates and showed inconsistent effects of shading. These findings suggest that management efforts should be targeting reefs where vertical walls are prevalent and areas exposed to high levels of physical disturbance.

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Antifouling strategies: History and regulation, ecological impacts and mitigation

Oral presentation
symposiumtheme1: *Other topics*
symposiumtheme2: *Ship Biofouling: Vector Characterization and Management Strategies*
Contributed

abstract

Vessel hull fouling is an important vector for the transport of non-indigenous species (NIS) and antifouling (AF) technologies incorporating biocides (e.g. copper and tributyltin (TBT)) have been developed to prevent settlement of organisms on vessels. The widespread use of AF paints has introduced high levels of contamination into the environment and raised concerns about their toxic effects on marine communities. We present results from recent laboratory and field studies examining metal tolerance in non-indigenous and native sessile invertebrates. In laboratory assays on adult colonies, NIS showed remarkable tolerance to copper, with strong post-exposure recovery and growth. In contrast, native species displayed negative growth and reduced feeding efficiency across most exposure levels. Field transplant experiments supported laboratory findings, with NIS growing faster under copper conditions. Large-scale field surveys also provide evidence that metal pollution and physico-chemical variables have the potential to be important factors in the establishment of non-indigenous species. A nested hierarchical design was employed to investigate variation in sessile invertebrate diversity at the scales of site (1-3 km apart) and estuary (40-180 km) apart. Background heavy metals loads were assessed using bioaccumulation in experimentally deployed oysters and other physico-chemical variables were measured with a water quality probe. Individual species distributions were strongly related to metal contamination, temperature, turbidity and pH. The development of heavy metal tolerance in non-indigenous fouling species is identified as an important contributor to their transport and establishment in new regions.

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Assessing aquatic nonindigenous species consequence despite gaps in impact data: how uncertainty effects expert decision-making processes

Poster presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -

abstract

Uncertainty pervades the understanding of many environmental issues, including the threat posed by aquatic nonindigenous species (ANS) to environmental, economic, social, cultural and human health values. Given these uncertainties, ANS risk assessments often use expert judgement to determine consequence (impact) and ultimately risk estimates. To understand how uncertainty may affect expert decision-making, we explored the presence and effects of uncertainty on ANS scientist and manager consequence assessment for 10 ANS. In the absence of information, experts could choose to predict an impact may occur (in keeping with a 'guilty until proven innocent' approach) or predict an impact will not occur (in keeping with a 'innocent until proven guilty' approach). Decision Theory posits that individuals should maximize utility via the maximin principle (i.e., choose the alternative that produces the best of the 'worst' outcomes). In a biosecurity context, this means assuming an impact will occur (a 'worst' outcome) and consequently preventative action should be taken.

The outcomes of this study showed a significant negative correlation between consequence and uncertainty for all groups (correlation of -0.42 to -0.56). Experts tended to assume (and assign) lower consequence when faced with knowledge gaps and other forms of uncertainty. Based on these outcomes, participants appear to make decisions in violation of both the maximin principle and precaution. Descriptive heuristics (i.e., judgemental shortcuts used in the presence of uncertainty) may offer an alternative explanation for these outcomes.

Norms in specialist fields often run deep and may create a filter through which the individual perceives risk, consciously or unconsciously. One of the earliest and most important norms learned and incorporated by scientists is null hypothesis significance testing, which assumes no difference between treatments. In impact assessment, this means assuming that no impact is associated with an activity or species unless the probability of a Type I error is sufficiently low. This focus on Type I errors (at the expense of Type II errors) translates into an 'innocent until proven guilty' mindset, which we refer to as a 'hindsight heuristic'. This heuristic also fits additional characteristics identified by the literature as likely to contribute to a heuristic's use (e.g., relatedness, relevance, frequent historic use and ease of recall).

These outcomes have implications for the identification and management of uncertainty within risk assessment. The consistent use of the hindsight heuristic (in which Type II errors are more common than Type I errors) may create a bias against protecting environmental and other values from ANS impacts. Some potential strategies to address the influence of uncertainty and related heuristic processes in a consequence or risk assessment context, as well as integrating precaution in a transparent and flexible manner are also presented.

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Power Analysis for Studies on Nonindigenous Algal and Crustacean Species' Impacts on Abundance

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -
Contributed

abstract

Uncertainty is a fundamental aspect of scientific research, and of particular importance to research informing aquatic non-indigenous species (ANS) risk assessment due to its potential influence on management decisions. One source of research-based uncertainty within risk assessment stems from the process of assessing statistical and biological significance (null hypothesis significance testing, NHST). NHST ignores effect size, and can lead to low power (and greater rates of Type II errors) resulting in misinterpretation of results (e.g., equating statistical nonsignificance with no effect). In an ANS impact assessment context, the implications of these issues are significant and can result in a decision not to manage a potentially hazardous species. As such, calculation of post hoc power and effect size is important for nonsignificant findings.

Given the common occurrence of low power in ecological studies, with repeated calls for identifying and addressing this problem, we use ANS research as a case study to review power and effect size via post hoc power analysis for 25 impact studies focusing on algal and crustacean ANS effects on the abundance of other species in the community that reported nonsignificant results. We were able to calculate power and effect size for 31 different nonsignificant analyses. The results demonstrate consistent low power resulting in a bias against Type II error rates 5.6 to 19 times greater than Type I error rates (despite moderate effect sizes), as well as a positive correlation between power and effect size (ralgae=0.89, rcrustacea=0.84).

These results suggest that assessments reporting nonsignificant impact of ANS species (specifically crustacean and algae) may potentially have large impacts, but due to high variation or small sample sizes, are not 'picked up' by statistical analyses. Based on these findings, we recommend that ANS studies should focus on the effect size (or, for impact assessment, the maximum acceptable impact); deciding on a multiplier to determine acceptable rates of Type I (Î±) and Type II (Î²) errors based on the relative importance and costs of each error; and choosing a sample size necessary to realize these values (given the interdependence of Î±, Î², effect size, sample size and design).

The benefits of this shift in statistical approach include early prioritization of impacts to core values and agreement on the associated impact threshold(s) that trigger management action. In addition, as managers improve the communication of their needs to researchers, researchers will be better able to produce data that is both scientifically valid and increasingly useful to management of the pervasive issue. This improved communication and relationship between science and policy will result in increased effectiveness of aquatic biosecurity risk assessment and policy.

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Genetic admixture dynamics in a coastal marine invasion

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: *Application of genetic methods for reconstructing invasion histories*
Contributed

abstract

A number of recent studies have recognized the important roles that multiple introductions and intraspecific genetic admixture may play in determining the success of biological invasions. What is less widely recognized is that study of these phenomena can prove extremely useful for understanding the dispersal processes driving population expansion. Here we describe detailed genetic study of a paradigmatic case of multiple introductions, the invasion of European green crabs (*Carcinus maenas*) to the northwest Atlantic. Using both mitochondrial and nuclear genetic datasets collected over multiple years, we demonstrate that populations in the region of overlap between two distinct invasion fronts reveal unique genetic signatures reflecting intraspecific admixture. The resulting admixture zone exhibits temporal dynamics consistent with advective current patterns and predicted larval dispersal in the region. We take advantage of significant observed differences in genetic introgression patterns associated with nuclear and mitochondrial genomes to explore specific hypotheses regarding expected admixture dynamics in marine invasive systems. In addition, using genetic data and information drawn from the observational record, we develop a spatially explicit model of admixture dynamics in the system, and employ simulated datasets to discriminate between alternative invasion scenarios and their associated demographic parameters. The results of these analyses provide valuable insights into both the invasion history of *Carcinus* in the northwest Atlantic and the behavior of presumably neutral alleles in an admixed coastal marine system subject to advective currents.

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Effects of the invasive algae *Womersleyella setacea* on sponge reproduction: compromising the viability of future populations

Oral presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -

abstract

In marine ecosystems, the effects of invasive species on native fauna are understudied, even though their consequences should be taken into consideration for the proper conservation and management of marine systems. Therefore, the aim of this study was to investigate the effects of invasive algae (*W. setacea*) overgrowth on sponge reproduction, a key process, which may determine possible long-term effect on sponge assemblages. Reproduction effort was studied by comparing the presence of reproductive elements (oocytes, embryos, spermatic cysts, and larvae) in sponges covered by a thick carpet of the invasive algae and in sponges dwelling in the same habitats but without the invasive algae. *W. setacea* had a strong negative effect on sponge reproduction, demonstrated by the lower and even nil reproductive structures on the sponges subjected to the algae overgrowth. Considering that the persistence of most sponge populations rely on the recruitment of new colonies, a significant reduction of the reproductive effort may compromise their viability and future trends on those benthic systems.

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Field trials of molecular tools for the detection of marine pests in Australia

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -
Contributed

abstract

The Australian National System for the Prevention and Management of Marine Pest Incursions requires that 18 priority ports are surveyed for listed pest species every two years to assess the risks associated with domestic shipping that carries ballast water. These surveys inform a risk mitigation system that will be used to determine if ships are required to exchange ballast at sea or treat their ballast water to prevent the spread of marine pests. Traditional surveys are developed using The Australian Marine Pest Monitoring Manual, sample adult organisms directly and rely on traditional taxonomy to identify them. These surveys are labour intensive, require broad expertise and are expensive. We have developed quantitative polymerase chain reaction (qPCR)-based detection tools for eight of the most important listed marine pests. Surveys using these tools detect all life history stages, are quicker, use more readily available expertise and are less expensive than traditional surveys. Here we present the results of surveys of The Port of Adelaide and around Kangaroo Island, South Australia, the Ports of Christmas Island, Fremantle, Dampier and Port Hedland, Western Australia, where both molecular and traditional survey methods were conducted in parallel.

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Alien and native fish assemblages in the eastern Mediterranean: A parasitological viewpoint

Oral presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: *New species in an ancient sea: the Mediterranean cross road*
Invited

abstract

Red Sea alien fish are establishing in mounting numbers in the eastern Mediterranean, blending into local fish communities and creating new species assemblages with virtually no past or contemporary counterparts. Such novel biocenoses promote new predator-prey interactions and create fresh opportunities for parasite transmission and subject susceptible species to newly encountered parasites. This presumably promotes host-switching events, expands parasite dispersal boundaries and is likely to modify existing infection patters.

In a recent survey of over 600 individual fish belonging to 13 alien and 7 native fish species from the Israeli and Turkish Mediterranean coasts, we examined parasites from the gills and alimentary tracts. The encountered taxa included the ectoparasitic Monogenea (15.3 % prevalence), Copepoda (7.3 %) and Isopoda (4.5 %) and endoparasitic Nematoda (25.5 %), Cestoda (18.7 %) and Digenea (11.9 %). No significant differences were noted between similar parasite taxon prevalences in the alien and native hosts.

In native tropical marine ecosystems, co-evolving fish and parasites are thought to be well-established in regional food webs, and both partners will have developed a resilience to withstand environmental instabilities. For such species, the eastern Mediterranean comprises a new, dynamic arena, impacted by numerous anthropogenic activities such as intense fishing efforts, pollution and coastal habitat degradation, and in recent years, also climate change. Aliens are likely to encounter here a variety of stressors that presumably, must entail appropriate adaptation. The newly formed predator-prey and host-parasite interactions are likely to modify the existing food webs and are predicted to rapidly change a growing number of eastern Mediterranean marine coastal communities. Red Sea aliens - being thermophilic species - are in all likelihood pre-adapted to the warming surface waters encountered in the Mediterranean. Indigenous species are, on the other hand, increasingly confronted with a warming temperature regime, an ambience gradually departing from the temperate environment in which they evolved. In the newly formed mixed species assemblages, both alien and indigenous host and parasite populations must adapt to a rapidly changing Mediterranean.

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Detecting the impacts of notorious invaders: experiments vs. observations in the invasion of eelgrass meadows by the green seaweed *Codium fragile*

Oral presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -
Contributed

abstract

The impact of biological invasions on indigenous communities varies greatly and predicting impacts for a given system is difficult. In coastal marine ecosystems, the green seaweed *Codium fragile* ssp. *fragile* (*Codium*) is a notorious invader. However, its reputation is largely based on studies done on rocky shores. *Codium* has recently invaded soft-bottom eelgrass communities by attaching epiphytically to eelgrass (*Zostera marina*) rhizomes, raising concerns that it may impact these important coastal structural species through competition or disturbance. We investigated how *Codium* affects various aspects of eelgrass performance (shoot density and length, shoot growth, above- and below-ground biomass, and carbohydrate storage) using both small-scale manipulative and large-scale observational experiments. Manipulative experiments that varied *Codium* abundance demonstrated clear negative effects on eelgrass shoot density and carbohydrate reserves over a 4 month period, but only for the highest *Codium* biomass evaluated. The precise mechanism for these effects is unknown but likely involves shading of young eelgrass shoots by the algal canopy. In contrast, these effects were either not detected or very weak when examined correlatively with field surveys done at larger spatial scales, even in sites that had been invaded for 4+ years. The generalization of this species' impact on eelgrass communities is thus premature and further efforts are required to assess the long-term threats that this invader poses to this ecosystem. This study demonstrates the need to investigate impacts of invasions over multiple scales, especially those that incorporate the temporal variability and spatial heterogeneity of the invader's abundance.

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Mapping dispersal patterns during the early stages of invasion: implications for invasive species management

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -
Contributed

abstract

The variation of dispersal processes of non-indigenous species (NIS) across various scales is largely misunderstood. A clear understanding of these mechanics can provide key information for optimizing monitoring strategies and ultimately increase the probability of eradication. Dispersal studies to date have typically focused on modeling terrestrial NIS dispersal over large spatial scales (10-100 km). The ability to predict marine dispersal on fine spatial scales has of yet not been rigorously examined. In 2008 we studied a small, recently discovered population of *Ciona intestinalis*, an invasive species of tunicate in Boughton bay, Prince Edward Island (PEI). We collected a suite of spatial data on the adult population and larval settlement in Boughton bay on an extensive 85-station grid - 4 times per summer - for the summers of 2008 and 2009. We found a significant increase in adult and larval abundance between 2008 and 2009. This population explosion yielded heterogeneous settlement patterns in the bay, the dynamics of which seemed to shift through the early stages of invasion before reaching apparent equilibrium. We fit a Weibull family dispersal kernel to the adult/juvenile patterns in 2008, but the strength of the relationship between adult populations and settlement degraded in 2009 and no apparent relationship between adult locations and settlement could be found. This suggests that distance from the adult population was influential during the very early stages of dispersal but with time and population expansion distance from adults became a poor predictor of dispersal.

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Invasion ecology of the brown seaweed *Sargassum muticum*.

Oral presentation
symposiumtheme1: *Development and tests of invasion theory*
symposiumtheme2: *Factors promoting the establishment and spread of marine invaders post-arrival*
Contributed

abstract

Four stages of biological invasion can be considered: transport, colonization, establishment and landscape spread. We investigated the processes behind local colonization and establishment of the brown seaweed *Sargassum muticum*. Our results, from a wide variety of field and laboratory studies, show that colonization is benefiting from the semi-lunar periodicity of gamete release, but microrecuit survival is not clearly affected by lunar phase and not different from that of the native brown seaweed *Cystoseira humilis*. Population growth rates increased and stabilized as the species became established and dominant. In this respect especially the persistence of non reproductive adults is of importance, both during the colonization and the establishment phases. Fauna associated with *S. muticum* differed in the native and introduced range as well as from fauna on competing seaweeds in both ranges. Multiple food choice experiments showed that meso-herbivores in Portugal prefer native seaweeds as food sources rather than the invader, but this is not due to chemical defenses. On the contrary, waterborne cues released by the grazing of *S. muticum* induces chemical defense in closely related brown seaweeds. *S. muticum* benefits from high growth rates and relatively low grazing pressure which increase its competitiveness. This invader, can be typified as an aggressive space grabber that relies on a combination of r- and (mainly) K-traits and benefits from food preference of meso-herbivores and the consequential need for perennial competitors to allocate energy to defense against grazing.

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The impact of zooplankton migration and stratification on estimating concentrations in ballast water discharge: When is the best time to sample zooplankton in ballast water?

Oral presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -
Contributed

abstract

Ballast water is recognized as an important source of invasive and nuisance species. The proposed US and international discharge limits, which attempt to reduce the introduction of non-indigenous species, set limits for living organisms 50 µm in minimum dimension (nominally, zooplankton) and allow very low concentrations in discharged ballast water (<10 organisms m^{-3}). To measure this sparse concentration with suitable statistical confidence requires the sampling of large volumes of water. The goal of this study was to determine if sampling different portions of the discharge period would yield disparate concentrations of living zooplankton. Ballast tank fill and discharge trials were conducted at the land-based ballast water facility in Key West, Florida, USA. A slurry of organic and inorganic materials was injecting during the tank fill water stream to mimic the concentration of dissolved material and suspended solids of port environments, and trials with one-day tank hold times (n=3) and five-day hold times (n=3) were conducted from January - April, 2011. Zooplankton were collected from a specialized filter housing array with removable 35 µm mesh filter bags (a filter skid). Water flow could be isolated to half of the eight-housing array, allowing filter bags to be replaced while the other housings continuously sampled the discharge stream. Segmentation of the discharge sampling occurred in three periods (beginning, middle, end); each segment lasted approximately 25 min and sampled approximately 3.5 m^3. Importantly, the three zooplankton samples were representative subsamples of the discharge, i.e., they were collected in series in a flow-averaged manner over the entire discharge. Sedimentation was evident in five-day hold trials: the beginning segment had the highest concentrations of total solids retained in the filter bags. Concentrations of living zooplankton were, in most cases, significantly greater in the last segment of the discharge period (up to 2 fold greater; ANOVA, $p < 0.05$, $n = 3$). This disparity between the discharge segment samples may be a function of zooplankton vertical migrations driven by unfavorable conditions in tank bottom water (e.g., low light, oxygen depletion). Stratification may also occur in ships' ballast water if tanks do not experience agitation and mixing. These results suggest tank stratification could lead to an underestimation of total zooplankton concentration if the last segment of the discharge event is undersampled.

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Foul friends or foe? The impact of invasive hydroids in commercial mussel culture

Oral presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: *Factors promoting the establishment and spread of marine invaders post-arrival*
Invited

abstract

Hydroids (Cnidaria:Hydrozoa) are an important, and frequently abundant component of marine sessile communities associated with natural and artificial habitats. Many non-indigenous hydroids are known to exhibit 'invasive' behaviour and have the potential for economic impacts through extensive fouling of wharf piles, floating pontoons, vessel hulls and aquaculture facilities. Port Phillip Bay (PPB), located in temperate southern Australia, is considered to contain more invasive marine species than any other ecosystem in the Southern Hemisphere. Several non-indigenous hydroid species are resident in PPB, believed to have been introduced almost certainly by shipping. The extensive, clean waters of PPB have supported a thriving marine aquaculture industry for over 20 years, cultivating the blue mussel *Mytilus galloprovincialis*. Filamentous materials such as hydroids are known to provide an attractive settlement surface for juvenile mussels. In this study, the presence of the non-indigenous hydroid *Obelia dichotoma* on mussel ropes in the bay greatly facilitates mussel recruitment. In contrast, another non-indigenous hydroid has recently expanded its distribution in PPB to establish and spread throughout the farms, but is rapidly become problematic by heavily fouling mussel ropes and the shells of adult mussel stock. *Ectopleura crocea* deters mussel recruitment, preys upon mussel larvae and impedes mussel growth and condition. These effects cause substantial economic losses for mussel growers, prompting the search for methods to avoid, prevent and treat biofouling outbreaks of this hydroid, and other fouling species in PPB. This research represents the first documented assessment of the range of impacts of invasive hydroids in longline mussel culture, providing basic but valuable information for commercial mussel growers on the nature of the relationship between hydroids and juvenile/adult mussels, and their ecology and role as fouling and aquatic invasive species.

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Impacts of the colonial ascidian *Didemnum vexillum* on commercial aquaculture of the New Zealand green-lipped mussel (*Perna canaliculus*)

Oral presentation
symposiumtheme1: Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species
symposiumtheme2: -

abstract

Biofouling poses a significant threat to aquaculture, as fouling organisms are often strong spatial competitors that are able to reach a very high density or biomass in relatively short time frames. The solitary ascidians *Ciona intestinalis* and *Styela clava* have had considerable impacts on cultured mussel and oyster industries around the world; this can include increased costs of production and processing, and negative impacts on growth rates and meat yields due to competition for space and food resources. Although the potential impacts of the colonial ascidian *Didemnum vexillum* are recognised in New Zealand, actual effects have not been quantified; knowledge that is required to decide whether and to what extent management is needed. Here we describe the results of a field-based experiment which investigated the competitive interaction between *D. vexillum* and cultured New Zealand green-lipped mussels (*Perna canaliculus*). Three size classes of mussels (small 20 - 40 mm, medium 40 - 60 mm, large 60 - 80 mm), on replicate 4 metre experimental lines were assigned to one of three treatments: (a) fouling from ambient recruitment of *D. vexillum* larvae; (b) fouling from *D. vexillum* fragment inoculation in addition to ambient recruitment; and (c) control lines which were kept free of *D. vexillum* and other fouling. The experimental lines were maintained for 15 months after which 0.5 metre sub-sections were harvested and mussels transported to the lab for analysis. A range of measurements were taken for individual mussels to determine the potential effects of *D. vexillum* overgrowth on condition and growth. Results indicated that *D. vexillum* presence did not directly affect mussel condition or growth. However, small mussels (20 - 40 mm) were displaced by *D. vexillum* hence may be at more risk. This information will assist managers in the implementation of management procedures as it provides increased understanding of *D. vexillum* effects at different stages of mussel production.

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Sensitivity and efficacy of settlement collectors for early detection of invasive marine species

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -
Contributed

abstract

Passive collectors, such as settlement plates, have been used extensively to monitor early life stages of marine organisms. They have also been used for surveillance of non-indigenous marine species in several global locations. They are cheap to construct and sample, but their effectiveness for detecting small populations has never been examined formally. This project used a combination of field experiments and modelling to evaluate the efficacy of 'settlement arrays' - consisting of a range of artificial substrata - for detecting new incursions of non-indigenous fouling species. Four species were considered in the study: the ascidians *Styela clava* and *Ciona intestinalis*, the sabellid polychaete *Sabella spallanzanii* and the kelp *Undaria pinnatifida*. For each species we estimated the rate at which dispersive life-stages (larvae or spores) released by populations of different sizes were likely to encounter the arrays. The volume of water sampled by each array was estimated by calibrating a 3 D hydrodynamic model of the study area with detailed measurements of current speeds and shear stress. The volume of water passing each array over a standard time was determined from outputs of the model. Data on the reproductive biology of each species was used to estimate concentrations of larvae (or spores) likely to be released into the water column from adult populations of different sizes. To determine the attractiveness of the arrays to settling larvae (or spores) we carried out 'dosing' experiments in which known numbers of larvae of each species were exposed to the surfaces *in situ*. The number of settlers that had recruited and survived was determined after 8 weeks of deployment. Data from each component of the study were combined using stochastic scenario tree models to calculate the probabilities of detecting at least one recruit of the target species for a range of resident population sizes and given deployment of different numbers of settlement arrays. The cost-effectiveness of the settlement arrays was evaluated against other sampling methods (e.g. dive surveys) to determine whether the inclusion of settlement arrays as a sampling method would add value to New Zealand's ongoing national marine pest surveillance programme.

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Differential survival rates of environmental abiotic factors may drive non-native parasite prevalance in native mud crab populations in the Chesapeake Bay

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -

abstract

Although parasites are important contributors to population and community level dynamics in marine systems, their basic biological, physiological, and ecological roles are often overlooked. One such non-native parasitic sacculinid castrating barnacle *Loxothylacus panopaei* infects native populations of the xanthid white-fingered mud crab *Rhithropanopeus harrisii* along the western Atlantic. While *L. panopaei* is native to the Gulf of Mexico and Florida, it was presumably introduced with infected mud crabs associated with oysters transplanted from the Gulf over the past 50 years. As a rhizocephalan barnacle, *L. panopaei* has a highly modified life cycle with only two larval stages, the nauplius and cypris, and a gonochoristic adult form. The female cypris larva infects a crab (usually a recently molted individual) and develops as an endoparasite (internal phase). After a variable time period, the reproductive body (externa) of *L. panopaei* emerges through the abdomen of the crab, usually after the crab molts. After fertilization by a male cypris larva, the externa matures and produces several broods of thousands of naupli each. From the moment of initial infection to the formation of a virgin externa, the crab undergoes a series of physiological and morphological changes, including complete castration and growth cessation. Although *L. panopaei* has been present along the US Atlantic coast for the past 50 years, relatively little is known about the overall impacts of this parasite on crab demography or physiology. Data collected over the past eight years show interesting interactions between salinity and water temperature and parasite prevalence in *R. harrisii* populations both spatially and temporally. However, it is not known how the life cycles of both parasite and host are influenced by either of these environmental factors. We attempt to answer several of these questions examining the impact of temperature and salinity on the physiology of both *L. panopaei* and *R. harrisii*.

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Is biotic resistance stronger in the tropics than the temperate zone? Effects of predation on post-arrival invasion dynamics across latitude

Oral presentation
symposiumtheme1: *Drivers of invasibility*
symposiumtheme2: *Factors promoting the establishment and spread of marine invaders post-arrival*
Invited

abstract

Latitudinal patterns in non-native species richness of terrestrial plants, birds, and mammals suggest fewer successful invasions in the tropics, relative to temperate regions. Stronger biotic resistance in the tropics has been proposed to explain this difference, but this prediction has not been experimentally tested. Predation in particular can have significant impacts on the establishment and spread of non-native marine species. Since predation on marine epifaunal communities is stronger at lower latitudes, the effectiveness of predation as a biotic resistance mechanism may also be greater in tropical than temperate regions in this system. We conducted three-month predator exclusion experiments on marine epifaunal communities in four regions, ranging from the temperate zone to the tropics, in the western Atlantic Ocean and Caribbean Sea. These communities developed in situ in the presence or absence of predators. Non-native tunicates were among the species most affected by predation at our highest and lowest latitude regions. In temperate Long Island Sound (Connecticut, USA, 41°N), non-native tunicate species, *Ascidiella aspera* and *Diplosoma listerianum*, were abundant in the absence of predators. While predation reduced the average abundances of these species, complete exclusion of native or non-native species by predators was uncommon. Species richness among predation treatments did not differ. In tropical Bocas del Toro (Panama, 9 °N), non-native tunicate species, *Ascidia sydneiensis* and *Didemnum psammathodes*, were also abundant in the absence of predators. However, these species, along with many other species, were commonly excluded by predators, resulting in lower species richness at both local and regional scales when predators were present. Additional experiments in Panama demonstrated that adult individuals of *A. sydneiensis* and *D. psammathodes* also underwent significant reductions in abundance and often complete exclusion when exposed to predation for only a few days. Therefore, while predation can limit non-native species establishment and spread at both temperate and tropical latitudes, this limitation may be stronger in the tropics. However, the interaction between predation pressure and other factors, particularly propagule supply, is still unknown.

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Impact of the invasive red king crab (*Paralithodes camtschaticus*) on soft bottom infauna, Porsangerfjord, Norway

Poster presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -
Contributed

abstract

The introduction of the red king crab *Paralithodes camtschaticus* to the Barents sea in 1960s and 70s resulted in a relatively fast spreading of this species along the Norwegian Finnmark coast. The crab is an omnivore predator on benthic epi- and infauna and the availability of food is estimated to be the most important factor in limiting the distribution in its new environment. Adult crabs are found inhabiting deeper soft bottoms during most of the year and current research suggests that dominant epifauna at soft bottom habitats are most affected by predation. Our study addresses a knowledge gap on the impact of this species on benthic macrofauna of a high latitude fjord, which has been invaded in 2006 and inhabits now an established population of red king crabs. The fjord is believed to have a unique fauna assemblage in the deep inner fjord basin with low average temperatures. Grab samples were taken in 2008 and 2010 covering more less the entire fjord. The benthic community was analyzed on a functional and taxonomic level, indicating a reduction in prey species (like Echinodermata and larger Molluscs), as well as a change in size structure, i.e. smaller species or individuals constitute to the present benthic biomass.

This presentation summarizes the preliminary results from our study and possible implications for the benthic community at mid-project.

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The changeable Sea -gaps in understanding marine bioinvasions in the Mediterranean

Plenary talk

abstract

The anthropization of the Mediterranean marine environment has accelerated in the past 500 years as a consequence of the demographic rise and technological and societal changes. But only recently was bioinvasion recognized as one of the major environmental pressures that helped create the present anthropic ecosystem. In the late 20th century the evidence was already indisputable - sudden declines in abundance, even local extirpations, of native species, concurrent with proliferation of aliens had been recorded throughout the Sea. About 670 multicellular alien species are recognized at present, yet the scale of invasion is profoundly underestimated. The gaps in our knowledge stem from sampling, systematic, and historic biases. The data is most accurate for large, conspicuous species for which taxonomic expertise is readily available, occurring along frequently sampled coasts, whereas data is entirely absent for many of the smaller-sized invertebrate phyla, and for vast stretches of the sea. Earlier introductions, mostly those which took place between the 1500s and 1900s, by shipping or mariculture, have largely escaped recognition, and only the recent application of molecular tools has brought to light some such cases. With the exception of documented intentional introductions, rarely are the means and route of invasion known from direct evidence - as a rule they are deduced from the biology and ecology of the species, the habitats and locales it occupies in both native and introduced range, and its pattern of dispersal. Information is lacking concerning the life histories and characteristics of most recorded aliens, the temporal and spatial shifting of vectors and corridors, and the susceptibility of habitats to invasion. Though invasive aliens have been identified as threats to native biodiversity, few qualitative, quantitative, or experimental studies have been conducted to determine their ecological and economical impacts. Taxonomic research of the understudied or overlooked smaller invertebrate taxa, underpinning recognition of alien and native species, together with robust sampling programs of both benthic and pelagic habitats are needed for a comprehensive baseline knowledge of the Mediterranean biota. Last, research is needed into the spatial and temporal evolution of invasions as potential signals of significant environmental changes.

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89 Pattern of distribution of invasive mussel *Xenostrobus securis* along an horizontal gradient in the Ria of Vigo (NW Spain).

Poster presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -
Contributed

abstract

Estuaries are one of the most common areas in marine environment where invasive species are increasing. The progressive increase of a variety of artificial structures in shallow coastal waters, such as breakwaters, or seawalls, has raised concern about their effects on invasion. The invasive mussel *Xenostrobus securis*, a small brown mussel endemic to the brackish waters of New Zealand and Australia, has been reported for the fist time in the Ria de Vigo (Galicia, NW Spain). Its distribution is overlapped with that of the native mussel species *Mytilus galloprovincialis* along intertidal shores in the inner part of the ria. We carried out an observational study to assess the patterns of distribution of the two mussel species along the shared horizontal gradient. The hypotheses tested were that (1) there is variation in the abundance of invasive species over this gradient, and (2) there are differences in the patterns of distribution between natural and artificial substrates. From the inner part to the middle part of the ria, we sampled 11 locations in which both natural and artificial rocky shores were present. In each location and type of substrate, we sampled 30 quadrants of 20 x 20 cm equidistantly spaced on a 30 m long transect line parallel to the coastline and located on the middle shore. Percentage cover and abundance of both mussel species, percentage cover of algae, and number of mobile invertebrates were determined in each quadrant. In addition, physical parameters (i.e. temperature, salinity and pH) were measured (n=3). Previous results showed a gradient of abundance of invasive mussel from the river, where it reached the largest abundances, to the middle part of the ria where the smallest abundances were found. However, an opposite pattern of abundance was found for the native mussel species. In addition, significant differences in abundance of both species between natural and artificial rocky shores were found. In most locations, the invasive species was more abundant on artificial substrates than on natural rocky shores, whereas the abundance of the native mussel followed an opposite trend. The distribution of both species might be explained in part by a gradient of variation of physical factors. In particular, salinity provided the best correlation with patterns of distribution, explaining 61 % of variance. Biotic interactions (i.e. competence, facilitation or predation) could also play an important role in establishment and expansion of invasive species in the ria. Furthermore, the presence of numerous artificial structures in the ria seem to be an important factor favouring its spread.

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Macrofauna associated with mussel aggregation: does invasive species make a difference?

Poster presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -
Contributed

abstract

Mussel beds are one of the most prominent and well researched features of rocky shores and are frequently an informal human resource. Mussel beds are intrinsically complex, in terms of their demography, physical structure, associated biota and interactions. The black-pygmy mussel *Xenostrobus securis* is an invasive species that is in expansion along the Galician coast (NW Spain). At present, it shares distribution with the native species *Mytilus galloprovincialis*, forming mixed beds on natural and artificial rocky intertidal shores in the inner part of the Ria de Vigo. Here, we analysed the macrofauna associated with mussel aggregations. We tested the hypotheses that (1) there are differences in composition and structure of assemblages associated with the two mussel species, and (2) both type of aggregations show differences in structural complexity, and such differences may explain most of variability of macrofaunal assemblages associated, and (3) pattern of variability of associated macrofauna differs between types of substrate. We collected 3 types of aggregations: aggregations of *X. securis*, aggregations of *M. galloprovincialis* and mixed aggregations (i.e. the two mussel species) on both artificial substrate and natural rocky shores at 3 locations. Structural complexity was measure using the chain and tape method. Diversity and abundance of individuals varied among types of aggregations. In general, the diversity was greater in aggregations of the invasive species than that found in the native species or mixed aggregations. In contrast, there were more individuals in aggregations of the native species and mixed aggregations than in aggregations of the invasive species. Structure and composition of macrofaunal assemblages varied among aggregations and between types of substrate. Assemblages associated with aggregations of *M. galloprovincialis* differed from those associated with the other two aggregations, whereas mixed aggregations and aggregations of the invasive species did harbour similar macrofauna. Aggregations of the invasive species tended to be more complex although such differences were not significant, and therefore, complexity could not explain much of variability of macrofaunal assemblages.

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Minimizing the risk of introducing nuisance species: the Shellfish Import Monitoring Protocol of The Netherlands

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -

abstract

In the Netherlands shellfish form an important industry, part of which is dependent on the import of shellfish from countries like the UK, Ireland and Denmark. To minimize the risk that 'new' invasive species are imported from these countries with shellfish that are placed in outer water after arrival, in 2009-2010, a shellfish import monitoring protocol was developed for the Dutch importers . Regardless of its name the new protocol does not only describe how the monitoring has to be conducted. Following the advice of the Invasive Alien Species Team of the Dutch Ministry of Agriculture, Nature and Food Quality, the protocol is much more extended. To start with it acts as a continuous rapid detection system and includes a description of the mandatory Shellfish Associated Species Inventory (SASI) in each export area. The number of samples that has to be taken during a SASI is depended on the number of new species that is found in each consecutive sample. To calculate this, a species accumulation curve is made and a theoretical maximum species number is estimated. Next to a SASI a continuous monitoring effort is obliged upon arrival of the shellfish in The Netherlands. As some species may die during fishing, some may die during transport and a selected few can survive the trip to the Netherland, two species lists are kept updated for each export area: [1] A list of species that live on or in between the shellfish in the export area, and [2] A list of species that have arrived alive from that area in The Netherlands together with shellfish. On the basis of these two lists, nine parameters are calculated. These parameters include absolute values like the number of non-native species in a monitoring action, but also values that take prior monitoring results into consideration like the number of species that are new to an area. As a direct consequence of such a parameter the protocol may demand that the monitoring effort has to be intensified. This intensification will remain mandatory for that export area until the species diversity in the area is better known. Next to the monitoring effort, the newly developed protocol also describes obliged management actions when species are found that are not present in the import area and may form a potential nuisance. In such a case, all shellfish imported from that area have to be quarantined upon arrival, and sometimes a complete import area needs to be fished clean to the best of the abilities of the importer.

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Do the zoogeographical affinities of Lessepsian migrant fish correlate with successful colonization?

Oral presentation
symposiumtheme1: -
symposiumtheme2: *New species in an ancient sea: the Mediterranean cross road*
Contributed

abstract

It has been hypothesized that species with a wide distribution range can be predicted to become successful colonizers. In order to check the validity of this hypothesis, vis-à-vis Red Sea fishes that have colonized the Mediterranean via the Suez Canal (Lessepsian migrants), Lessepsian fish species were divided according to five zoogeographical categories, from the narrowest range (Red Sea endemic) to wide Indo-Pacific distribution. Their rate of success in the Mediterranean was categorized according to their current abundance and westward spread in their new habitat. No significant difference was found between the frequency of zoogeographical affinities between the entire Red Sea and the Lessepsian migrants. No correlation was found between wide distribution range and success in colonization of the Mediterranean. Recent molecular studies have revealed that an increasing number of species, that are currently considered to be the Red Sea populations of a species with a wide Indo-Pacific distribution, actually constitute distinct taxons of endemic species. This finding will further weaken the hypothesis concerning a correlation between wide distribution range and probable success in colonization of Red Sea fish migrants. Other more significant factors promoting success in colonization of Lessepsian migrant fish in the Mediterranean have been suggested but not yet conclusively established.

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Patterns and predictions: making the most of genetic data

Oral presentation
symposiumtheme1: Patterns of invasion and spread at local, regional, and global scales
symposiumtheme2: -
Contributed

abstract

Numerous genetic studies have focused on patterns of neutral genetic variation to track vector pathways and regional spread of marine bioinvasions. These studies often result in less resolute data than is required to support management decisions and eradication of invasive species, or to reconstruct invasion pathways. The large amount of data assembled from these studies across multiple taxa now enables us to move beyond genetic patterns and use advanced tools to test specific hypotheses of bioinvasions. We have used a modified Approximate Bayesian Computation approach to test alternate invasion scenarios for the sea squirt Styela clava, recently introduced to New Zealand. In addition, we assess the application of standard genetic tools to reconstruct invasion pathways at different spatial and temporal scales integrating simulations and standard genetic analyses on empirical data.

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Sampling to proof compliance with the standards of the IMO Ballast Water Management Convention?

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: *Management issues and bioinvasions science dialogue*
Contributed

abstract

The IMO Ballast Water Management Convention was developed with the overall objective to reduce the introduction of aquatic alien species to new regions. During intensive debates and negotiations the relevant IMO working groups agreed on measures to minimize organism transport with ballast water. This may be done by two different approaches (a) exchange of coastal ballast water in high seas or (2) by reducing the numbers of living organism in the ballast water to be discharged. The Convention also includes provisions to take samples from ships to assess whether or not the ballast water is in compliance with these two approaches. However, compliance control sampling seems to be much more challenging than anticipated. This presentation will evaluate which parameters may be checked to confirm a water exchange in high seas. To proof compliance with the above mentioned organism standard a representative ballast water sample needs to be taken. The authors sampled ballast water of more than 250 vessels also including onboard performance tests of ballast water treatment systems and sampling voyages to support the development of representative ballast water sampling methods. Results from these studies will be reviewed and possible sampling strategies will be discussed also addressing the weakness of the methods.

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Phenolic content of two species of macroalgal wrack on estuarine beaches: *Sargassum muticum* vs *Cystoseira* spp.

Poster presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -
Contributed

abstract

Beach consumers are supported primarily by allochthonous inputs of macroalgal wrack and seagrasses. These deposits at the supra littoral zone undergo dehydration, aging and finally are usually covered by wind-blown sand. One of the main characteristic changes in chemical composition during wrack decay is the lost of phenolic compounds, i.e., secondary metabolites present in macroalgae and seagrasses whose functions include deterring feeding by herbivores. In the Galician beaches the largest biomass of macroalgal wrack is supplied by *Cystoseira* spp. and the invasive *Sargassum muticum*. Previous studies have pointed out differential effects of native and invasive algae on macrofaunal assemblage which could be related with the phenolic content.

The aim of this work was to examine the phenolic content in fresh and aged tissues of *S. muticum* and *Cystoseira* spp. stranded on the beach face. In addition, seasonality differences between both species were assessed throughout the year.

The study was carried out in four estuarine beaches on the NW coast of Spain (Galicia). Field sampling were carried out during spring low tides. Wrack samples were collected at one-month intervals over a period of thirteen months (from January 2009 to January 2010) on one shore-parallel transect located on the drift-line. Triplicates samples of *S. muticum* and *Cystoseira* spp. were collected, transported to the laboratory and kept at -30º C for later analyses. We measured phenolic content with a modified Folin-Ciocalteu method.

The phenolic content in fresh tissue was significantly higher than in attached macroalgae. In addition, the trend in phenolic loss did not differed significantly between species. Temporal data showed that the highest phenolic content for stranded *S. muticum* over time was obtained on spring months. However, values in *Cystoseira* spp. were stable throughout the year. Despite of this seasonality variation, there were not significant differences in phenolic content between both algae over time. Results suggest similar inhibitory features of native and invasive algae species on consuming activity of beach herbivores.

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Influence of macroalgal morphology on the spatial distribution of wrack deposits in a mesotidal beach in the NW coast of Spain

Poster presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -
Contributed

abstract

On sandy beaches, macroalgae and seagrasses strand throughout the intertidal range after being transported by waves and currents. Previous studies demonstrated that aging process, macrofaunal utilization and bacteria decay depends on the spatial distribution, amount and species composition of wrack debris along the beach face. The arrival of invasive macroalgae to new coastal areas has become an increasing phenomenon during the last decades. Despite of this, little attention has been addressed to the role of invasive algal wrack in providing food and habitat to macrofaunal species in sandy beaches.

Due to the relevant ecological implications of wrack distribution across the beach (zonation), the main objective of the present study was to evaluate the observed differences in deposit distribution of two invasive macroalgae along the intertidal beach.

The study was carried out on an estuarine beach of the northwest coast of Spain (Galicia). Two zones were identified: a steep upper foreshore zone (UP) and a broad, flat low-tide terrace (LO). All wrack present along six one-meter wide transects perpendicular to the shore was collected to assess specific composition and biomass.

A total of 24 taxa of macroalgae were recorded throughout the year. Two invasive species were found: *Sargassum muticum* (Yendo) Fensholt and *Gracilaria vermiculophylla* (Ohmi) Papenfuss. Results showed that the spatial pattern of deposition for both species differed significantly. The relative biomass of *S. muticum* showed the highest values on the upper zone of the beach (93.31 %) while *G. vermiculophylla* reached the highest amounts on low-tide terrace (96.78 %). The different distribution of wrack deposits of both species could be related to the buoyancy properties of each one. The presence of air-bladders could enhance floating *S. muticum* at the water surface favouring the deposition on the upper beach level. However, the transport of *G. vermiculophylla* could be conditioned by the lower buoyant characteristics.

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Eastern Mediterranean: Old Sea - New Biodiversity

Oral presentation
symposiumtheme1: *Other topics*
symposiumtheme2: *New species in an ancient sea: the Mediterranean cross road*
Invited

abstract

The continuous invasion of biota through the Suez Canal, combined with the sea warming and heavy fishery activity, have altered the biodiversity of the Eastern Mediterranean. In order to document and quantify these changes, we carried out a study on the status of alien species along a temperature gradient in the eastern Levant basin, as well as at descending depths off the Israeli coast.

This study revealed a gradual decrease in the proportions of alien species (number of species, individuals and biomass) between Ashdod (Israel), Iskenderun, and Antalya (Turkey). In addition, during the research period we observed major changes in the biodiversity of this region. These changes are expressed in both the increased proportions and range of alien species. Alien dominancy of depth increased within one year from 30 m to 60 m, with once rare aliens having now become common. We also followed the population explosion of certain alien species, such as *Nemipterus randalli*, *Plotosus lineatus* and *Apogon smithi* along the Israeli coast. Analysis of the diet of the most abundant fish species revealed a clear competition for food between the alien and the native species.

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Current status of the invasion of two species of the *Hemigrapsus* genus on the French coast of the English Channel

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -

abstract

Hemigrapsus takanoi (Asakura & Watanabe, 2005) and *Hemigrapsus sanguineus* (de Haan, 1835) were observed in France for the first time in 1994 at La Rochelle, and in 1999 at Le Havre, respectively. These species, native from the northwestern Pacific, were most probably introduced on the European coast via ballast waters. A survey of the spread of the two species along the French coast of the English Channel was initiated in April 2008. More than 50 sites were monitored and the presence of introduced species was detected from the south-west of Cotentin up to Dunkerque on the Opale Coast, through Calvados. The individual size ranged from 2.40 to 42.6 mm for males and from 5.9 to 35.1 mm for females of *H. sanguineus*. Individuals of *H. takanoi* were smaller, with males ranging from 3.08 to 27.5 mm and females from 7 to 22.4 mm. The sex ratio was 0.62-0.96 for *H. takanoi* and between 0.67 and 2.05 for *H. sanguineus*. Interestingly enough, the presence of ovigerous female (13-31 mm; from March to November) was detected in 2008 in the Cotentin and since 2010 on the Opale Coast, indicating that both species can reproduce on the French coast and could thus be considered as naturalized. The annual surveys performed in the Cotentin and on the Opale Coast highlighted the increase of these species populations and the colonization of new sites (Senequet and Carteret in the Cotentin and Grand Fort-Philippe on the Opale Coast were colonized in 2009). The first results of a monthly study (2010-2011) on the abundance of the two *Hemigrapsus* species and the indigeneous *Carcinus maenas* at five sites showed strong seasonal variations of crab densities (e.g. in Dunkerque 43 ind.m^{-2} *H. takanoi* in March vs 110 ind.m^{-2} in October ; La Hougue 54 ind.m^{-2} *H. sanguineus* in August vs 70 ind.m^{-2} in October). The overall densities of the two species ranged from 1 ind.m^{-2} (Grand Fort-Philippe, April 2010) to 70 ind.m^{-2} (la Hougue, October 2010) for *H. sanguineus* and from 1 ind.m^{-2} (Lion-sur-Mer, April 2011) to 110 ind.m^{-2} (Dunkerque Port, October 2010) for *H. takanoi*. Nevertheless, these densities are low compared to those observed on the east coast of USA for *H. sanguineus* (up to 350 ind.m^{-2} in Long Island) but are, to date, the highest reported in Europe for both species. It appears to be important to organise a French and European survey of colonisation of both species in European waters.

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The Tasmanian distribution and density of the introduced New Zealand porcelain crab *Petrolisthes elongatus*

Poster presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -

abstract

Non-indigenous species (NIS) are an increasing threat to native biodiversity worldwide. The receiving ecosystems play a role in determining NIS invasion success. Absence of biotic elements in recipient communities such as direct competitors, parasites and predators can contribute to the successful establishment and subsequent spread of NIS. Favourable abiotic conditions (suitable habitat) also play a role in invasion success and in some cases can be even more important than biotic factors to the point that if the habitat is appropriate for the NIS, invasion success is highly probable, the biotic factors having very low or no influence. We explored how biotic factors (two native grapsid crab species, *Paragrapsus quadridentatus* and *Paragrapsus laevis*) and abiotic factors (substrate type, exposure to wind and wave energy) affect the distribution and density of *Petrolisthes elongatus* around Tasmania.

The New Zealand porcelain crab *P. elongatus* was introduced into southern Tasmania (Australia) in the early 1900's. Since then, it has expanded its distribution to the east and north coasts of Tasmania, probably via hitchhiking on commercial and recreational vessels and propagule dispersal. The lack of aggressiveness observed in this species makes it difficult to determine the impacts they have on native ecosystems and biodiversity, however high densities of this species can potentially over-populate and remove native species from their niche habitats.

The preliminary results of this study showed higher densities of *P. elongatus* within southern Tasmanian locations (>75 individuals m^{-2}) compared to that of east and north locations (<38 individuals m^{-2}). The two native grapsid crabs were most abundant in areas where *P. elongatus* was present, however a negative correlation (although not statistically significant) between introduced and native crabs was found at both site and quadrat scale (Ï = -0.207; Ï = -0.051; both p>0.05). Furthermore, abiotic factors including wind exposure and wave energy play a role in determining the invasion success of *P. elongatus* within Tasmanian coastlines. Coastal zones exposed to high wind and wave energy do not support *P. elongatus* populations probably as a result of the increased sediment in the water (affecting the efficiency of filter feeding), removal of food sources and displacement of shelter. Substrate type preference including small to medium sized rocks, rocky cobble, coarse sand and mud (characteristics of sheltered to estuarine coastal environments) were also found to determine *P. elongatus* distribution.

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Untangling the contrasting impacts of invasive species among different ecological levels

Oral presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -

abstract

Habitat-forming invasive species commonly have strong impacts on native biota because of the large effects they have on the abiotic environment, particularly in soft-sediment environments. To date, studies have focused on describing either positive or negative community level effects, with few studies addressing individual level responses. Here I highlight research that myself and colleagues have been conducting on the impacts of the invasive green alga *Caulerpa taxifolia* on biota in southeastern Australia. As for other habitat-forming invasive species, at the community level *Caulerpa* directly facilitates native epibiota by providing a surface for colonization and a refuge from predation in otherwise unvegetated habitat. However, fitness-related life-history traits (condition, growth and reproduction) of an abundant infaunal bivalve that recruits to *Caulerpa* and adults resident within sediments are reduced compared to uninvaded habitat suggesting that recruitment to *Caulerpa* is maladaptive. In addition, negative impacts on infauna are dependent on *Caulerpa*'s biomass, and there are important non-linear thresholds of biomass that induce sublethal and lethal effects on native biota. We suggest that, on their own community-level studies can be misleading and may be underestimating the impacts of habitat-forming invasive species. There is an urgent need to integrate studies across all levels of ecological organisation.

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The evidence for biotic resistance and the consequences for invasions in coastal ecosystems.

Oral presentation
symposiumtheme1: *Drivers of invasibility*
symposiumtheme2: *Factors promoting the establishment and spread of marine invaders post-arrival*
Invited

abstract

A wide variety of processes have been shown to influence non-native species upon arrival into a novel range. Among the many forces that may influence subsequent establishment and spread is biotic resistance. Despite the ubiquity of predators, competitors and diseases that comprise biotic resistance and the many studies demonstrating biotic resistance in terrestrial systems, the evidence for biotic resistance in marine and estuarine systems is comparatively thin. As part of a larger review, I use examples from my own work involving invasive plants and invertebrates in western North American estuaries as well as other recent studies to examine the evidence supporting biotic resistance in coastal systems. I compare these results with similar evidence from terrestrial and aquatic habitats to explore differences in biotic resistance among systems. I discuss how this informs our understanding of post-arrival invasion patterns as well as invasion processes more generally in marine and estuarine systems.

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Invasive potential of the introduced sponge *Paraleucilla magna* in the Iberian Mediterranean based on population dynamics and genetics studies.

Poster presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -

abstract

The introduced calcareous sponge *Paraleucilla magna* has proliferated in the western Mediterranean during the last decade, where it shows a highly patchy distribution. The species populations are dense in zones close to sea-farms and slightly contaminated marinas, and sparse in well-preserved areas. To gain knowledge about its proliferative capacity in the newly colonized areas, we studied the growth dynamics and the spatial and temporal genetic differentiation of three close populations of *P. magna* at the NE of the Iberian Peninsula, in three successive years (2006-2008). The species life span was unambiguously annual and showed a clear seasonal cycle. Reproduction started in March. Embryo development lasted from May to June. The amphiblastula larvae were released in June. The adult population disappeared totally in late July-early August. New recruits resulting from settled larvae were conspicuous at a size of 3 +/-1.3 mm in September. Mature individuals reached 15.2 +/-10 mm in March, and then they pursuit growing up to a maximum size of 30.1 +/-13 mm in June. Populations were genotyped for nine microsatellite markers. Spatial genetic structure was found in the three populations of 2006, one population disappeared in 2007 and the other two remained differentiated, while the three populations were in place again in 2008 and showed non-significant genetic differentiation. Low but statistically significant differentiation occurred among years for any to the three populations. Results showed high allele diversity, but heterozygote deficit and allele instability in the populations over the three years, which are consistent with a recent establishment of the populations in the study area. The whole population descriptors indicated that the species is a good opportunistic colonizer, but highly sensitive to stochastic events in particular those affecting recruitment. Thus, we can predict a low-medium impact on native well-preserved communities, and a higher impact on eutrophized zones.

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Stress resistance: Both a precondition for and a consequence of seaweed invasion

Oral presentation
symposiumtheme1: *Development and tests of invasion theory*
symposiumtheme2: -
Contributed

abstract

Originating from East Asia, the red macroalga *Gracilaria vermiculophylla* is a successful invader that appears in several temperate areas of the Northern hemisphere since approximately 1995. Recent genetic studies hint at a most interesting point: Phylogenies of the marker gene cox1 indicate that the Sea of Japan/ East Sea is the donor region of all non-native *G. vermiculophylla* populations worldwide, despite there being several other native populations all along the East Asian coast (Kim *et al.* 2010 in J. Phycol).

This raises the question why those populations are particularly successful. Are the populations from the Sea of Japan in comparison to the other natives more resistant towards abiotic and biotic stress that goes along with the invasion process? Is stress-resistance even a precondition for the invasion or is it rather developed in the course of the invasion process?

We tested stress resistance of *G. vermiculophylla* from six native populations inside and outside of the Sea of Japan and compared it to eight invasive populations from Europe and NW-Mexico. *Gracilaria* individuals were, in short-term experiments, exposed to I. heat shock, II. UV-radiation and III. elevated copper concentrations in the water. In a limitation experiment the seaweed had to cope with darkness in combination with low temperature and dryness for several months. Further, in order to compare the resistance against herbivory individuals of native and invasive *G. vermiculophylla* populations were fed to snails from the native (*Littorina brevicula*) and the invasive (*Littorina littorea*) range.

During long-term limitation stress not only all invasives, but also native populations from the Sea of Japan had better survival rates than native populations from other areas. A similar pattern was also detected for resistance toward herbivory: in tendency invasive and native populations from the Sea of Japan were less palatable than native populations from other areas. Thus, specimens from the Sea of Japan may have been successful invaders due to their resistance toward limitation stress and herbivory. In contrast, in the case of the heat shock experiment all natives - irrespective of the area of origin - showed a considerably poorer performance than all invasives, which suggests that heat shock resistance may have been selected early during the process of invasion. No clear difference was detected with respect to resistance toward UV-radiation and copper, which seems to point at a relatively specific selection for heat shock resistance.

We thus conclude that some stress resistance traits may be a precondition for successful invasion, while others evolve in the course of the invasion process.

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Disentangling invasive propagule pressure effects: Frequency of introduction more important than intensity?

Oral presentation
symposiumtheme1: *Other topics*
symposiumtheme2: *Factors promoting the establishment and spread of marine invaders post-arrival*
Invited

abstract

Detailed experimental studies of propagule pressure effects are essential to our ability to predict and prevent non-indigenous species colonisation at the earliest stages of the invasion pathway. Theoretical models now posit that the frequency and intensity (or size) size of invasive propagule inoculations, rather than total propagule pressure, are key predictors of invasion success. Currently there exists little experimental evidence of frequency or size effects, despite the theoretical importance of each to the success of invasive species in most ecological systems.

In a series of factorial field experiments, we used a newly developed technique to quantitatively alter the size and frequency of propagule arrival. We manipulated these intrinsic elements of propagule pressure using larvae of the marine invasive Pacific Oyster, *Crassostrea gigas*. I will discuss how the frequency of larval introduction had a dramatically (>65 %) greater effect on invader colonization in this sub-tidal system. Surprisingly, we show that the effects of arrival frequency, rather than inoculation size, were still observed several months after larval introduction.

With this new empirical data, our findings may help explain patterns of ballast water and hull fouling introductions, as ports and harbours that receive frequent exposure to invasive propagules from the same source location will be at greater risk of invasion.

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A Risk-Based Predictive Tool to Prevent Accidental Introductions of Marine Invasive Species by Navy Activities

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -
Contributed

abstract

Long port residence times and lack of hull husbandry result in the accumulation of dense fouling assemblages on the hulls of inactive Navy vessels (i.e., those destined for final disposal). Movement of inactive vessels to their final destination is therefore a potential vector for the transportation of invasive species. While the Navy has taken the first and critical step in environmental planning by monitoring hulls of these ships for the presence of invasive species, a risk analysis would enable characterization of the potential risk of invasive species transfer and establishment associated with transporting inactive vessels, and allow for recommendation of mitigation or management measures. A modified risk analysis process is proposed to identify inactive vessels that have the greatest potential to transfer invasive species from one area to another, and to examine the potential environmental and economic risks associated with that transfer. The risk process requires identification of port of origin, destination port, travel history, hull material, age of antifouling paint, type of hull husbandry, and time since last cleaning in order to identify those ships that have the greatest potential for accumulation of biofouling. The risk process also characterizes the potential for survival, reproduction, spread, and potential impacts associated with an introduction. This risk analysis process will serve as a basis for Navy environmental planners tasked with making decisions about management, control, or mitigation of invasive species. The eventual planned displacement of an inactive aircraft carrier from its current location will be used as a case study.

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Quo vadis *Celtodoryx ciocalyptoides*? On the traces of an invasive sponge-status and perspectives

Oral presentation
symposiumtheme1: *Drivers of invasibility*
symposiumtheme2: -
Contributed

abstract

Asian waters are considered to be a potential source for non-indigenous species due to expanded transportation and the use of Asian species in aquaculture facilities worldwide. The latter is especially true for *Crassostrea gigas*. Thus, in 2002 Reise *et al.* assumed that the occurrence of 32 alien species in the North Sea is directly related to the introduction of the oyster to the NE Atlantic Ocean.
In general, investigations of invasive sponge species are rare. This is surprising since sponges are one of the most important megafaunal benthic components in terms of diversity and abundance. A probable reason for the lack of records of sponge invaders may be due to difficulties in sponge identification. Nevertheless, 15 sponge species are known as invaders to the Dutch inshore waters (Van Soest *et al.*, 2007), including a sponge that was firstly recorded in a well studied area in the Ria of Etel, Brittany, France in 1996. It was later described as a new species and genus, *Celtodoryx girardae* by Perez *et al.* (2006), who assumed its invasive nature, but without having a clue about the area of its origin. Within several years this sponge was found to occur successively in the Gulf of Morbihan, France, and Oosterschelde estuary, Netherlands. It is characterized by an extensive spatial spreading, and therewith it rates today among the dominant benthic megafauna component in the shallow waters of the Gulf of Morbihan and Dutch inshore waters (Perez *et al.*, 2006; Van Soest *et al.*, 2007). Furthermore, it was observed to compete successfully with macrobenthic organisms, such as octocorals and other poriferan species (Perez *et al.*, 2006). It is assumed, that this sponge is distributed in a much wider range than it has been recorded so far (Van Soest, pers. comm.).
Recent records of that sponge from the Chinese Yellow Sea, NW Pacific Ocean confirmed the assumption about its invasive nature as it was found that both Chinese and European sponges are in fact conspecific with *Cornulum ciocalyptoides* recorded by Burton (1935) from the Sea of Japan, NW Pacific Ocean (Henkel & Janussen, 2011). Our findings confirm the hypothesis that the aquaculture of the Pacific oyster *C. gigas* is the most likely source for the invasion of *C. ciocalyptoides* to European waters.
We present *Celtodoryx ciocalyptoides* (Burton, 1935) as the first 'non-cosmopolitan' sponge species that was verifiably transferred from one World Ocean into another by human activity. Its variability regarding morphology and population structure from both oceans is discussed with respect to differences in ecology and seasonal variations.

References

Burton M. (1935) Some sponges from the Okhotsk Sea and the Sea of Japan. Exploration des Mers de l'URSS 22, 61-79.
Perez T., Perrin B., Carteron S., Vacelet J. and Boury-Esnault, N. (2006) Celtodoryx girardae gen. nov. sp. nov., a new sponge species (Poecilosclerida: Demospongiae) invading the Gulf of Morbihan (North East Atlantic, France). Cahier de Biologie Marine 47, 205-214.
Van Soest R.W.M., de Kluijver M.J., van Bragt P.H., Faasse M., Nijland R., Beglinger E.J., de Weerdt W.H., de Voogd N.J. (2007) Sponge invaders in Dutch coastal waters. Journal of the Marine Biological Association of the United Kingdom 87(6), 1733-1748.
Henkel, D. and Janussen, D. 2011. Redescription and new records of Celtodoryx ciocalyptoides (Demospongiae: Poecilosclerida) - A sponge invader in the North East Atlantic Ocean of Asian origin? Journal of the Marine Biological Association of the United Kingdom, 91(2): 347-355. doi:10.1017/S0025315410001487

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Macroinvertebrate larvae and phytoplankton establishment risk: A stochastic model assessment of ballast water treatment standards

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -
Contributed

abstract

The efficacy of reducing organism concentrations in ships' ballast water discharge to lessen the probability of invasive species establishment is subject to much research and uncertainty. A benchmark approach to address the relative effectiveness of proposed ballast water discharge standards involved development of a stochastic stage-structured matrix model for organisms representative of two size classes of the IMO D-2 standard (e.g., > 50 µm and 10-50 µm). Crustacean and mollusk larval forms are representative of the former while most phytoplankton species are found in the latter size class. The model results of four organisms, the green crab and the zebra mussel, dinoflagellates (generically across taxa) and diatoms (also generically across diatom taxa) are considered. The model development derived vital rate probability distributions from key observations recorded in published research. The quality of the available data to model the larger size of organisms was more definitive than the data available to specify the dynamics of the smaller organisms due to the high complexity of physical and biological processes that characterize phytoplankton communities. The population dynamic model results suggested that increased stringency in ballast water standards would be more effective in reducing the risk of establishment from smaller organisms than for larger ones. Between the two larger organisms, the results suggested that the risk of establishment of the more fecund organism (zebra mussel) would be more difficult to control. This research was support by USCG Contact GS-23F-8167H/HSCG23-09-F-MSR105.

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Harnessing Allee effects to eradicate marine pest populations - how low do we have to go? A case study of the effects of population reduction on the reproductive success of *Sabella spallanzanii*.

Oral presentation
symposiumtheme1: *Other topics*
symposiumtheme2: *Eradication/management of invasive species*
Contributed

abstract

Although eradication is often conceived as destruction of every individual of a pest population, most eradication attempts are, in fact, efforts to reduce the density or size of the population below a level that is self-sustaining. This is the point at which stochastic and/or Allee effects contribute to decline in the remaining population. Because these effects occur only when populations are very small they are difficult to measure in natural populations and difficult to predict theoretically.

Mate limitation is the Allee effect most commonly identified in small marine populations. For gonochoric species that broadcast their gametes, fertilization success depends on the rate of encounter of sperm and eggs which is often a function of the proximity of fertile adults and the synchrony of spawning. We describe the effects of harvesting by commercial divers on the demography and spatial distribution of a population of the Mediterranean fan worm, *Sabella spallanzanii* in the Port of Lyttelton, New Zealand. A fertilization kinetics model was used to evaluate the impact of the campaign on likely reproductive success within the population. Outputs from the fertilization model were then used with other life-history information to parameterise a stochastic life-stage model of the population.

Over the 15 months of the harvesting programme, divers reduced the fan-worm population to < 4 % of its initial density. The proportion of reproductively mature individuals in the harvested population declined from 89 % to < 36 % and the average nearest neighbour distance between mature males and females increased from < 8 m to > 54 m. Results of the modelling suggested that, at the start of the campaign, around 80 % of eggs produced within the population were likely to have been fertilised, resulting in over 1 million larvae. On cessation of the campaign < 0.2 % were likely to be fertilised with a modelled output of < 200 larvae from the remaining population. Population projections suggested strong potential for extinction of the residual population. There is, however, large uncertainty in the projections associated with limited information on the mating strategy and early life stages of *Sabella spallanzanii*. Many marine organisms have mechanisms that appear designed to enhance fertilization success (e.g. gregarious settlement, sperm packaging and storage, etc) and may be adapted to persist at very low population densities.

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The supply side of marine invasions – stochastic and demographic influences on establishment success

Plenary talk

abstract

Predicting the identity of invaders and the circumstances in which they are likely to be successful remain important (but elusive) goals of invasion biology. Propagule supply (i.e. the number of individuals introduced to a specific area) has emerged as our best correlate of establishment success, but we are still some way from being able to use it in a predictive framework for marine invaders. To become established, a species that has been introduced outside its natural range must arrive at a time and place where it is able to reproduce and then negotiate the perils of small initial population size that include environmental and demographic stochasticity, founder and Allee effects. Delivery of large initial inocula is thought to help overcome the demographic impediments to establishment, but there is increasing evidence that variation in the rate and timing of propagule supply is as important to the chances of success as is the total number of individuals delivered.

I review recent research into the dynamics of transportation of marine species by shipping and discuss the role that initial population size plays in successful establishment. Modern global shipping networks are inherently complex with high levels of connectivity among widely separated locations. This complexity imposes a strong stochastic element on the sample of species and numbers of individuals that are transported and released in time and space. Species that are widely distributed within the transportation network and which have traits that allow them to be transported frequently will have greater opportunities for success.

There is growing evidence from studies of the population genetics of marine invaders that multiple, independent introductions appear to be more common than previously suspected and that founder effects and loss of genetic diversity may be less severe. Doubt has also been cast on how frequently Allee effects might be expected in marine populations, given that many marine species exhibit apparent life-history adaptations to cope with local rarity, such as mechanisms for sperm capture and storage, high fecundity, gregarious settlement and synchronous spawning. Indeed, local rarity is much more common than abundance in most benthic marine assemblages. A consequence is that introduced marine species may be better equipped to overcome small initial population sizes than birds, mammals or even insects. A better understanding of this relationship between initial population size and likely persistence will help us make better choices about which battles to fight when evaluating eradication and control strategies for marine invaders. This is likely to be a fertile area for future research in marine invasion biology.

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Live and let live: Erythrean invasive host and parasite in the Levantine basin

Oral presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: *New species in an ancient sea: the Mediterranean cross road*
Contributed

abstract

The Levantine populations of Erythrean invasive swimming crab *Charybdis longicollis* have been parasitized by the rhizocephalan *Heterosaccus dollfusi*, itself an Erythrean alien, since 1992. The parasite affects the host morphology, moulting, behaviour, causes its sterilization, and induces mortality. The high prevalence of *H. dollfusi* can be ascribed to the dense population of the host, the year-round reproduction of the parasite that promotes recurrent re-infection, and the recruitment dynamics that likely permit the synchronous development of both host and parasite. After 19 years, despite the high prevalence of the parasite and its injurious impact on the host reproduction, the invasive host-parasite pair has reached an apparent *modus vivendi*, with no evident reduction in the host population and with recurrent seasonal high rates of parasitization and multiple externae.

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A potential bioinvasion by population of *Ulva prolifera* (Ulvales, Chlorophyta)----the causative species of the Yellow Sea green tide

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -
Contributed

abstract

From 2007 to 2010, the largest green tide ever recorded has occurred in successive summers in the Yellow Sea, which drew most attention in 2008 during Olympic sailing competition in Qingdao city. The causative species has been identified as *Ulva* (=*Enteromorpha*) *prolifera* (Ulvales, Chlorophyta) by both morphological and ITS (ribosomal DNA internal transcribed spacers)-based molecular investigation. Since *U. prolifera* was a cosmopolitan species, especially with record of wide distribution along China coast, ISSR (inter-simple sequence repeat) method was applied to genetic analysis on population level to track these blooms. Totally seven floating and six attached *U. prolifera* samples collected from the north of Yellow Sea to the south of East Sea were analyzed, and lower genetic diversity among floating samples was detected than that of attached samples. The UPGM and PCoA results suggested that floating *U. prolifera* samples in Yellow Sea in successive three years had a closely genetic relationship, and separated from all the attached samples. According to the ISSR result, a SCAR (sequence characterized amplified region) marker specific to the floating population has been developed. Adding the fact that attachment of this population has not been detected up to now at least in the north Yellow Sea coast, it was strongly implied that Yellow Sea green tide was caused by a potential bioinvasion of single population of *U. prolifera* . Further approach on both origin tracing and evaluation of effects on marine ecosystems must be considered in light of the ongoing global climate change situation.

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Anthropogenic factors promoting the establishment and spread of non-indigenous species post-arrival

Oral presentation
symposiumtheme1: *Drivers of invasibility*
symposiumtheme2: *Factors promoting the establishment and spread of marine invaders post-arrival*
Invited

abstract

When a non-indigenous species (NIS) reaches a new location, multiple biotic and abiotic factors influence its establishment and spread. Biotic processes such as competition, facilitation, predation and disease can either limit or promote invasion, as can emergent community-level traits such as species diversity. Abiotic factors are also important, as disturbances regulate resource availability and environmental conditions determine the suitability of an invader to a new environment. Complexities arise when biotic and abiotic factors are influenced by anthropogenic activities such as those associated with coastal urbanisation and industrialisation. The rate and spatial pattern of post-establishment spread of a NIS is particularly influenced by the availability of anthropogenic transport mechanisms and the species' affinity to these. A mechanistic understanding of the role of anthropogenic activity in driving invasion is vital to the development of management responses. This presentation presents a review of the major anthropogenic factors that increase the success of non-indigenous species post-arrival. We prioritise the factors in terms of their ecological importance and present an overview of potential management solutions.

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Mapping Coastal Values in a Biosecurity Context: Anticipating Impacts, Managing Responses

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -
Contributed

abstract

The ability to manage marine bioinvasion risks can be significantly hampered by a lack of information on those values we wish to protect. Questions such as 'Which life history characteristics of non-native species are of greatest concern?', 'Where should surveillance monies be concentrated?', and 'Which incursions can or must we respond to?' require a knowledge base of values and likely impacts. To this end, MAF Biosecurity New Zealand and New Zealand's Department of Conservation have coordinated a 'value mapping' research program for New Zealand's coastal marine environment to determine what value is, how it is measured, and where it exists. A Delphic process was used to 1) identify subcomponents of environmental, economic, and social values, 2) determine publicly available data sources with spatially explicit information on the subcomponents, and 3) identify valuation methods for the subcomponents. Through the collation of existing datasets and expert knowledge, a spatially-explicit database of coastal marine values was created. Using a Geographic Information System, this data set allows New Zealand's coastline to be examined as components of environmental (e.g., habitat types, protected areas, species distributions), economic (e.g. coastal industry employment and productivity, commercial fishery catch data), and social value (e.g., amenity distributions, patterns of recreational use). Although this project has a focus on marine biosecurity, it also provides opportunities for broader applications by establishing a comprehensive database of locations and characteristics of marine resources that can be applied to a variety of coastal zone impacts. In this way, the project has wide benefits to coastal resource managers, including central and local government, scientists, researchers and environmental decision-makers. Here, we present results of the mapping efforts and demonstrate different scenarios of how these data can be applied towards the management and mitigation of biosecurity risks.

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Environmental factors influencing establishment of Pacific oysters: a combined approach using coordinated sampling, modelling and experimentation

Oral presentation
symposiumtheme1: -
symposiumtheme2: *Factors promoting the establishment and spread of marine invaders post-arrival*
Invited

abstract

Population data from the early stages of marine invasion are rarely available in the literature but are important for understanding and managing the invasion process. Pacific oysters *Crassostrea gigas* are invasive in many parts of the world but have been farmed for over 30 years in Ireland without becoming established in the wild. However, our extensive sampling programme in 2009 revealed small and moderate numbers of oyster individuals outside aquaculture. This programme was designed to be cost-effective and repeatable and to enable assessment of factors associated with establishment of the oysters. It involved close cooperation among a number of state agencies and universities. Based upon the data gathered, a logistic model was applied. It demonstrated that oysters were more likely to be found in proximity to aquaculture, on hard substrata and in large intertidal areas and were less likely to be found in the presence of macrophytes. Subsequently, an experimental study with a 2-factor, fully crossed design, was set up in the lower intertidal on a macrophyte-dominated shore to discern the effect of macrophytes and predation on post-recruitment oyster survival and growth. Predation had a strong negative effect on oyster survival and might play a role in restricting establishment at particular sites. In the presence of macrophytes, growth and survival were slightly enhanced, however, the results were not significant. The findings will be used to improve prediction of the further spread of oysters and to directly inform management actions.

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The evidence shipping and boating network from boat surveys and molecular data

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -
Contributed

abstract

Shipping and boating activities are often suggested to be the most important vectors for the dispersal of marine invasive species. We examined the role of human maritime vectors for the primary introduction and secondary spread of the invasive colonial tunicate, *Botryllus schlosseri*, in eastern Canada. We (i) used molecular tools to determine the relative importance of commercial ships and recreational boats on the frequency of coastal introduction events, (ii) quantified boat infection and (iii) showed how the local patterns of boating activity may alter the spread of aquatic invasive species. The mitochondrial DNA cytochrome oxidase subunit I gene (COI) and 10 microsatellite markers were used to determine the genetic structure and diversity of *B. schlosseri* from 5 populations exposed to shipping activities (i.e. ports) and 21 to boating activities (i.e. marinas) in Nova Scotia, Canada. We quantified boat infection of *B. schlosseri* using an underwater video camera on 223 boats at 29 marinas in Nova Scotia. The variability of boating activity between regions was evaluated from questionnaires completed by talking with boat owners in eastern Canada (N = 374) and central New Zealand (N = 116). Both genetic markers indicated that multiple invasions occurred in Nova Scotia and a loss of genetic diversity showed a founder effect from ports to marinas, demonstrating a stronger influence from ships than from small boats in primary coastal introductions. Overall, 8 % of Canadian boats were infected in high boating season and 48 % of boats in low boating season. Among infected boats, 64 % boats sailed between marinas. Boat maintenance was lower in New Zealand than in Canada, increasing the risk of hull biofouling. The strength of boating networks was greater in Canada than in New Zealand, increasing the risk of both hull biofouling and spread. We conclude that in eastern Canada frequent introductions arise from ships and secondary spread progressively occurs around each individual commercial port facilitated via recreational boating. We extrapolate our conclusions by showing how local patterns of boating activity may alter the spread of aquatic invasive species.

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Records of Alien Species Along the algerian coast

Poster presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -
Contributed

abstract

Several surveys; carried out, on foot, by boating, snorkeling or diving in the central region of the Algerian coast; have highlighted the presence of introduced invasive species: the alga *Caulerpa racemosa*, the cnidarian *Oculina patagonica*, the crustacean *Percon gibbesi* and the mollusk *Bursatella leachii*.Their distribution in the area is presented and their extensions over time and vectors of introduction discussed .

Keyword: introduced species, distribution, Algeria.

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Managing tunicate infestation in Prince Edward Island Canada: the role of science.

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: *Management issues and bioinvasions science dialogue*
Contributed

abstract

The recent establishment of four invasive tunicates on Prince Edward Island (PEI) has severely impacted the important mussel aquaculture industry and associated ecosystems. These invasive tunicates compete with mussels and associated fauna for space and food, potentially decreasing the growth rates and meat yields of cultured mussels. The main impact, however, is the disruption in the ecological function of the estuaries with the potential lost of productivity and biodiversity.
Science has played an important role in providing key knowledge and advice to identify the management options (based on relevant environmental, economic, social, and cultural values) to mitigate the tunicates effects. Hazard Analysis and Critical Control Points (HACCP) principles have been used to identify critical control points and potential control measures. Current knowledge of the biological adaptation of these tunicate species in their new environment is essential to develop effective management strategies. New mitigation technologies and methodologies are being investigated to achieve the most effective response to these invasions, from an environmental and ecological perspective.

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Invasive barnacle modifies the effect of fertilization on benthic algal and herbivore communities

Poster presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -
Contributed

abstract

Eutrophication and biological invasions are the two potentially interacting anthropogenic pressure factors in the Baltic Sea. Bay barnacle (*Balanus improvisus*) is a successful invader in the NE Baltic Sea. The impact of bay barnacles on benthic primary producers and herbivorous invertebrates was studied in a factorial field experiment at fertilized and unfertilized conditions. The diversity of macroalgae was higher in the presence of barnacles compared to control treatments. Neither fertilizer nor barnacles affected the biomass of macroalgae. But barnacles affected the abundance, biomass, and community structure of herbivores. In addition, an interactive effect of barnacles and fertilizer was found both on the abundance and biomass of herbivores. To conclude, the presence of an invader may locally modify the biological effect of nutrient loading. This finding also emphasizes the complexity and importance of species-specific traits in community patterns as a possible source of uncertainty in predictions of the consequences of invasions.

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Settlement preference of native and non indigenous epibionts.

Poster presentation
symposiumtheme1: *Drivers of invasibility*
symposiumtheme2: -

abstract

Factors that facilitate non-indigenous species (NIS) successful invasions are hypothesised to be controlled by a complex interplay of environmental and biological factors, including predator release, human mediated disturbance and vacant niches. Although the transfer of species beyond their natural geographical boundaries is frequent, most NIS fail to establish within new recipient regions and knowledge of the causes remains limited. This restricts the ability to predict which invaders will succeed after an inoculation.

Marine fouling communities are often densely populated, with space being a limiting resource. As a consequence, any natural or artificial substrates quickly become colonised by an organic layer of microfoulers (mainly bacteria, protozoa, algae and fungi) that then potentially promote settlement and growth of macrofoulers such as invertebrate larvae and microalgae spores. This settlement is not limited to inanimate substrate, but also includes the living surfaces of marine biota. The growth of one organism (epibiont) on another one that acts as substrate (basibiont) is called epibiosis. Epibiosis is a recognised mode of life for many NIS which allows them to exploit other species as primary space, thus eliminating the need to find uncolonised, bare substrate or relying on an event to release this resource (disturbance). Nevertheless, an ability to colonise both living and inanimate substrate has been relatively unexplored as a factor of successful establishment.

The published literature on epibiosis is vast, but it rarely distinguishes between native and NIS status when looking at epibionts and basibionts. We undertook a meta-analysis of 114 individual case studies and combined this information with a species status (native/NIS), to provide insights into global patterns of settlement.
Our data shows that settlement of native and NIS epibionts was statistically dependent on the native/NIS status of basibiont. Further outcomes suggest that native basibionts experience greater fouling pressure from both native and NIS epibiont. In contrast fouling by NIS and native epibionts on NIS basibiont is less prevalent. The implications of these findings will be discussed in this poster presentation.

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Understanding (marine) invasions through the application of a comprehensive framework

Oral presentation
symposiumtheme1: *Development and tests of invasion theory*
symposiumtheme2: -
Contributed

abstract

Different invasion theories include varied stages, transitions, factors and terminology explaining the failure or success of an invasion process. This study presents a comprehensive framework consisting of three stages, each preceded by a transition. Successful invaders pass these transitions which are influenced by factors like propagule pressure, invasiveness, and invasibility. A meta-analysis was conducted in a marine approach to test the developed framework. By the comparison of case studies this study revealed that ecological drivers determine the success of an invader, regardless of taxonomy. This holistic framework provides a new insight into invasion theory especially for marine environments and valuable management options to deal with harmful marine invaders.

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AFORO: an automatic online tool to identify fish otoliths of not native species

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -
Contributed

abstract

AFORO (http://aforo.cmima.csic.es) is an interactive system for shape analysis of fish otoliths. It is a classification tool based on the unique characteristics of the otolith shape of different species. The system allows users to classify their own sample interactively by simply uploading an unknown otolith image as a query instead of as alphanumeric information. The user can obtain the classification output either by e-mail or at the web page, where an image is plotted showing the nine most similar otoliths in the database in order of greatest contour similarity. Also the system is complemented with a database of image. Here we used the otoliths of 21 Lessepsian fish species to test the usefulness of AFORO in the identification of not native species. Lessepsian fishes have entered the Mediterranean from the Red Sea through the Suez Canal. In relation to others native species inhabiting the Mediterranean Sea the automatized identification system of AFORO resulted extremely accurate to determine the Lessepsian species. The total percentage of correctly classification attained 92.5 %, showing that these not native fishes have otoliths clearly distinguishable from native ones.

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Molecular discrimination of native and exotic *Paralia* (Bacillariophyta) in ballast and open water samples in Canada

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -
Contributed

abstract

Paralia Heiberg is arguably one of the most recognizable, widely distributed, and commonly reported diatoms from contemporary coastal marine environments and in ship ballast waters. In three trans-Atlantic voyages (TAVs) from Europe to Canada, *Paralia* comprised the majority of diatoms encountered (up to 94 %) in ballast water samples and showed no relationship to any of the physicochemical properties of the tank environment tested. In addition, it was the only diatom recovered live from the last day in each of the three TAVs. We determined the morphological and genetic profile of *Paralia* from these TAVs and 184 monoclonal cultures of *Paralia* from 76 sites from Europe, the east and west coast of Canada and others worldwide. The isolates were sequenced for a fragment of the RuBisCo large subunit (rbcL) gene, and the internal transcribed spacer (ITS) and 18S regions of nuclear encoded ribosomal RNA. In total 6 phylotypes were found with 5 of the molecular variants corresponding to new *Paralia* species, most of them cryptic. Species of *Paralia* resolved included, largely endemic at this time, *Paralia* 'Mexico Pacific', *Paralia* 'Caribbean' from Jamaica and Panama, *Paralia* 'Europe' (formerly *P. sulcata* sensu Crawford, 1979) which was also present in samples from Uruguay and New Zealand, *Paralia* 'north-northwest Pacific' from Vancouver Island and Washington State, and *Paralia* 'pan-Canada 1' and *Paralia* 'pan-Canada 2' from both the Atlantic and Pacific coasts of Canada and the United States. All sequences recovered from TAVs corresponded to *Paralia* 'Europe'. Despite the number of *Paralia* 'Europe' cells arriving to eastern Canadian waters in ships' ballast, likely for decades, it was only detected at one site, Cheticamp, Nova Scotia. In addition, our results show the existence of two genetic hotspots for *Paralia* in Canada; Vancouver Island, British Columbia and Cape Breton Island, Nova Scotia as each harbours at least three *Paralia* species. If the propagule pressure of *Paralia* 'Europe' continues to arrive at the same or at an increased rate, native Canadian *Paralia* diversity could conceivably be most affected in these two hotspots. In addition, this study is one of the first to use molecular means to identify diatom taxa in the ballast water of ships and represents a method for the detection of cryptic, potentially non-native diatom species arriving at a receiving port.

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102 Considering science in species management: a case study of the non-native seagrass, *Zostera japonica*, in the Northeast Pacific

Oral presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: *Management issues and bioinvasions science dialogue*
Contributed

abstract

Management of non-native species can be difficult as the relevant science needed to inform policy decisions often lags behind the occurrence and expansion of species introductions. As efforts to control or regulate non-native species transitions from a single-species focus to an ecosystem-based approach, research on the new community interactions is necessary to inform management decisions. This approach also requires resource managers to have the appropriate access to research on the species they manage. As a case study we examined some of the barriers to effectively manage a non-native species through a comprehensive bibliometric analysis of research on the Japanese seagrass, *Zostera japonica*.

This species was introduced to the Northeast Pacific more than 60 years ago and currently resource agencies in Washington State, USA differ widely in management approach toward *Z. japonica*. Programs range from requiring mitigation to proposing to list *Z. japonica* as a noxious invasive weed, a decision whose outcome may entail considerable economic costs. The majority (52 %) of studies on *Z. japonica* in its introduced range were executed in only two estuaries in Washington and a quarter of papers (19 of 74) were reviews of other studies. Our meta-analysis of those papers to test the impact of *Z. japonica* on species in the native community (8 studies), revealed that while the majority of its interaction effects were negative, species that were studied were primarily infaunal invertebrates, a factor that most likely biased our results. No studies have investigated the influence of *Z. japonica* expansion on migrating finfish populations or epifaunal invertebrates that are now found within the canopy, which might be positively affected by the presence of *Z. japonica*. We suggest, therefore, that science on *Z. japonica* in its introduced range is extremely limited and management of this species should consider the paucity and bias current research when managing this species. There is an increasing need to determine the ecosystem role of introduced species to inform management. We suggest that our approach be considered in other locations were the scientific investigation of non-native species impacts, or lack thereof, has not been adequately factored into resource management programs.

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Ship hull fouling as a vector of introduction of nonindigenous species to Canada's coastal ecosystems

Oral presentation
symposiumtheme1: *Drivers of invasibility*
symposiumtheme2: *Ship Biofouling: Vector Characterization and Management Strategies*
Contributed

abstract

The most effective way to manage nonindigenous species and their impacts is to prevent their introduction via vector regulation. While ships' ballast water is very well studied and this vector is actively managed, hull fouling has received far less attention and regulations are only now being considered despite its importance for introductions to coastal, marine systems. We conducted comprehensive in situ sampling and video recording of hulls of 40 transoceanic vessels to assess propagule and colonization pressure in Vancouver and Halifax, the two dominant coastal ports in Canada. Concomitant sampling was conducted of harbour fouling communities to compare hull and port communities as part of a vector risk assessment. Although this vector has been operational for a long time, hull and harbour communities were highly divergent, with mean Sørensen's similarity values of 0.03 in Halifax and 0.01 in Vancouver, suggesting invasion risk is high. Propagule pressure (up to 600,000 ind. ship^{-1}) and colonization pressure (up to 156 species ship^{-1}) were high and varied significantly between ports, with Vancouver receiving much higher abundances and diversity of potential invaders. The higher risk of fouling introductions in Vancouver is consistent with historical patterns of successful hull fouling invasions in that port. We modeled the extent of hull fouling using a variety of ship history predictors. Propagule pressure increased with time spent in previous ports-of-call and with time since last application of antifouling paint, whereas colonization pressure increased with time since last painting and with the number of regions visited by the ship. Both propagule and colonization pressure were negatively related to the time spent at sea and the latitude of ports visited.

Our study revealed that hull fouling has a strong potential for introduction of many novel nonindigenous species to coastal, marine habitats in Canada, and that management should be considered. Simple variables related to the vessels' hull husbandry, voyage, and sailing patterns were useful predictors of hull fouling intensity.

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Impact of the invasive ctenophore *Mnemiopsis leidyi* in the NW Mediterranean Sea

Oral presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -
Contributed

abstract

The ctenophore *Mnemiopsis leidyi*, native species from estuaries and coastal regions of the eastern coast of America, was introduced in European waters in the 1980s probably via ballast water, and within three decades it has spread to almost all European waters with dramatic effects. In 2009 it was reported for the first time in the northwestern Mediterranean coast, and in 2010 continuous reports throughout the year about its presence along the Catalan coast in Spain, suggested a probable establishment of the species at least in a particular area of the Ebro River Delta. Due to several reports about the potential predatory impact of this species and the devastating effect over the marine ecosystems invaded and the zooplanktonic communities associated, a pressing study about the species was considered necessary, in order to estimate the impact of this ctenophore in the new invaded area. Therefore, the present study covers the eco-physiological aspects of the species, regarding respiration, feeding, reproduction, and larval growth rates, determined under laboratory conditions. Estimated respiration rates of *M. leidyi* in this study showed high metabolic demands, as well as feeding rates revealed high predatory efficiency as a carnivore predator of diverse zooplankton components, similar to previous studies that suggest that this species is capable of exert important pressure over the zooplanktonic communities. Likewise, high reproduction and larval growth rates state the potential of this invader to be responsible of sudden population outbursts in optimal invaded ecosystems. Moreover, the elemental and proximate composition analysis of the species was assessed to discern the biomass and nutritional state of this ctenophore in the studied areas, in order to couple this with the metabolic parameters, allowing the monitoring and control of field populations. Meanwhile, the determination of the abundance, distribution and population dynamics assessments trough monthly samples and monitoring from the field, were carried out during 2010 and 2011 in the Ebro River Delta, in the Catalan coast. Preliminary results suggest a successful establishment of the ctenophore in the studied area, revealing its presence during the whole year, alternating periods of high reproductive rates with dominance of larvae and small size class, with blooms of large size classes exerting high pressure in the associated environment. Consequently, herein we present a broad study about the composition and physiological features of this invasive ctenophore, along with monitoring the population dynamic and abundance in situ, evidencing *Mnemiopsis leidyi*'s expanding distribution range in the Mediterranean basin and its potential effects in this recently invaded ecosystem in the Catalan coast, NW Mediterranean Sea.

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Phytoplankton, tunicates and invasions in the Bay of Fundy, Atlantic Canada

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: *Management issues and bioinvasions science dialogue*
Contributed

abstract

A monitoring programme was initiated in 1987 to study phytoplankton populations in the Western Isles region of the Bay of Fundy, southwest New Brunswick (Atlantic Canada). Results revealed a number of new phytoplankton species previously absent or non-indigenous observed suggesting the introduction of new species or species unknown to the area. New species include the following: (dinoflagellates) *Alexandrium pseudogonyaulax, Amphidinium carterae, Amphidinium sphenoides, Ceratium macroceros, Polykrikos schwartzii, Preperidinium meunieri, Protoperidinium crassipes*, and *Pyrocystis lunata*, and (diatoms) *Attheya septentrionalis, Attheya longicornis, Chaetoceros radicans, Cylindrotheca gracilis, Grammatophora serpentina, Lithodesmium undulatum, Mediopyxis helysia, Membraneis challengeri, Neodenticula seminae, Odontella sinensis, Proboscia eumorpha, Pseudo-nitzschia subpacifica, Pseudo-nitzschia fraudulenta* and *Thalassiosira punctigera*.

Additionally, a monitoring programme was initiated in Atlantic Canada for invasive tunicates in 2006 to concentrate on the detection of *Ciona intestinalis, Botryllus schlosseri, Didemnum vexillum, Botrylloides violaceus* and *Styela clava*. Results from collectors deployed in the southern New Brunswick portion of the Bay of Fundy from 2006-2009 show a large inter-annual variability between years and sites. *C. intestinalis* was detected through much of the southwest New Brunswick area. *B. schlosseri* was observed to be concentrated in specific areas with greatest settlement observed in 2009. During the study period, *B. violaceus* was first detected in 2009 and at only one location. S. clava and *D. vexillum* have not been detected from our sampling collectors to date. As the invasive colonial tunicate, *D. vexillum*, has rapidly extended its range in the northeast US to areas very close to Canada, rapid assessments have been conducted in Canadian waters during late September of 2009 and 2010. Divers, underwater video cameras and scallop drags did not detect any *D. vexillum* colonies.

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Assessing the risk of transporting non native species to Scotland via biofouling on vessels.

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: *Ship Biofouling: Vector Characterization and Management Strategies*
Contributed

abstract

Marine Scotland - Science is undertaking a research project to assess the biofouling on vessels arriving in Scottish waters. The overall aim of the project is to obtain information regarding which species are being transported via biofouling and whether particular vessels e.g. recreational or commercial, or voyages e.g. UK based or international, pose a higher risk of introducing non native species.

The Scottish Government funded Biofouling project has involved the collection of samples from commercial vessels by visiting dry docks to sample the hulls and other areas of vessels that are subject to reduced water flow e.g. sea chests, propellers, rudders. The docks are visited immediately the dock has been drained i.e. prior to the vessel being washed down, and Marine Scotland staff use a cherry-picker lift to access the hull and protected 'niche' areas of fouling. These areas are photographed, ranked in terms of the level of fouling and samples of all the different types of fouling taken by using a paint scraper. To date, one dry dock in Aberdeen has been visited on several occasions to collect samples and there are plans to visit other dry docks in Scotland in order to obtain samples from as wide a variety of vessels as possible.

The second aspect of the project involves using the Marine Scotland - Science dive team to take samples from vessels that trade in Scottish ports but would be too large to use the dry docks. The dive team aim to use a series of in water methods (e.g. video cameras, small suction devices and scrapers) to record and sample biofouling on vessels. The combination of these methods will enable samples to be collected from a variety of vessels from different origins.

The sample analysis is ongoing and to date no new non native species have been detected. The results of the biological analysis will be combined with information on vessel type and usual voyage pattern to assess whether it is possible to assign levels of risk for introducing non native species.

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Mitigation and control of two Aquatic Invasive Species in Newfoundland, Canada: Case studies on the violet tunicate, *Botrylloides violaceus* and the European green crab, *Carcinus maenas*

Oral presentation
symposiumtheme1: -
symposiumtheme2: *Eradication/management of invasive species*
Contributed

abstract

Two highly invasive aquatic species have been detected through early monitoring programs in Newfoundland, Canada, the violet tunicate *Botrylloides violaceus* and the European green crab, *Carcinus maenas*. Once these species had been detected and their distribution established, actions regarding their mitigation and control began to be implemented based on the Canadian Aquatic Invasive Species Rapid Response framework. In October 2007, during an aquatic invasive species (AIS) dive survey on the southern coast of Newfoundland, the colonial violet tunicate, *B. violaceus*, was detected on a small area of the government wharf and attached to three vessels in Belleoram Harbour, Fortune Bay. Belleoram is a very active, multi-use harbour and an important area for commercial fishing, and finfish and shellfish aquaculture. Following the discovery of *B. violaceus*, concern was expressed by industries based in the area regarding the risk to aquaculture and the potential spread and rapid growth of this colonial tunicate. Several mitigation methods, modified from New Zealand treatment trials for *Didemnum vexillum* infestations, were used (2008-2010) to control the spread of this species. To date *B. violaceus* has not spread beyond the wharf where it was initially detected. The European green crab, *C. maenas*, was discovered in northern areas of Placentia Bay, in August 2007. Several mitigation methods were attempted in the summer and fall of 2008 to 2010. These methods included developing and issuing experimental green crab licenses, a targeted harvest effort in North Harbour, Placentia Bay (the area of greatest green crab concentration) and experiments on catch effort in several areas of Placentia Bay by volunteer fish harvesters. In 2008, over 25,000 pounds (est. 350,000 green crabs) were harvested from this 2 km2 area. In 2009 and 2010, 7,000 and 6,500 pounds, respectively, were harvested from the same area. Catch rate declined over time in each focused mitigation trial, in each area and between years. In areas where the invasive green crab was significantly reduced, the native rock crab, *Cancer irroratus*, returned. Research is ongoing to provide additional scientific information on more effective control methods for colonial tunicates and green crab. Mitigation and control is a management decision; however, the AIS Rapid Response Framework provides the guideline for scientific inquiry that directs the advice on impacts and effectiveness which managers need to make decisions regarding control of AIS in Canada.

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Bigger, better, stronger and more invasive: evolution with heavy metal pollution.

Oral presentation
symposiumtheme1: -
symposiumtheme2: *Factors promoting the establishment and spread of marine invaders post-arrival*
Invited

abstract

Marine ecosystems are increasingly threatened by anthropogenic stressors such as non-indigenous species and pollution. Previous evidence suggests that non-indigenous species introduced via hull fouling may gain an ecological advantage in metal-polluted environments. Such an advantage depends on the evolutionary potential of these species to adapt to anthropogenic stressors. Using laboratory and field experiments we investigated the tolerance of the non-indigenous bryozoan *Watersipora subtorquata* to copper. To assess individual tolerance, offspring from individual colonies were exposed to a range of copper concentrations. Successful recruitment was significantly reduced by the highest copper concentration. In a genotype by environment design using cloned colonies, individuals were exposed to a gradient of copper concentrations and their growth monitored. Overall both experiments found tolerance to vary considerably on an individual basis. A recruitment study in the field then investigated the settlement preferences of *W. subtorquata* in ambient and elevated copper conditions. Recruitment was significantly greater in elevated copper conditions despite greater mortality, suggesting that despite higher costs larvae are actively selecting and surviving in the contaminated environment. Morphological traits were also affected in elevated copper, such as reduced ancestrula length. The positive effect of heavy metals on recruitment effectively increased the propagule pressure of this bryozoan. The high level of variation in copper tolerance between colonies and recruitment preferences of larvae suggests that there is considerable potential within populations to adapt to elevated copper levels. This ability to rapidly adapt, resulting in high tolerance to copper, has no doubt enhanced the spread and establishment of this species in polluted environments.

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Gauging Invasion Opportunity According to Geographic Diversity of Ballast Water Delivery

Oral presentation
symposiumtheme1: New tools for identification, monitoring, risk assessment, and management
symposiumtheme2: -
Contributed

abstract

Using data from the United States National Ballast Information Clearinghouse, we analyzed all ship arrivals and ballast water (BW) discharges to U.S. waters for a three year period. Under current U.S. federal law, all overseas arrivals to the U.S. are required to perform open-ocean ballast exchange prior to BW discharge; however, depending on the voyage type, BW exchange frequently takes place in coastal waters, likely reducing the effectiveness of exchange for reducing BW-borne invasions. Data were analyzed geographically, based on global biogeographic regions of BW source and discharge. For each recipient biogeographic region of the coterminous 48 United States, the geographic sources and volumes of BW were determined in order to calculate a BW diversity index (H'). Higher diversity indices suggest greater opportunity for invasion either due to high numbers of source regions sampled, high volumetric evenness among source regions, or both. Results indicate that U.S. biogeographic regions vary with respect to likely invasion risk when analyzed in three ways: 1) total BW discharged, 2) un-exchanged BW only, 3) open-ocean + coastal exchanged BW. Results highlight significant differences in potential invasion opportunity when different management actions are applied.

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Estimating observer bias during surveys for the invasive marine seastar, *Asterias amurensis*

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -
Contributed

abstract

Asterias amurensis
Our ability to manage introduced marine species is often impeded by the lack of information, limited resources and the imperfect detection of the target species. Extensive survey programs have been undertaken globally to detect spreading introduced marine species. A common sampling error when monitoring for a species is the failure to detect an individual when present during a survey. Inferences of population abundance and distribution that overlook accounting for imperfect detection can be inaccurate and misleading. Few marine studies have empirically tested the ability of observers to detect a spreading introduced species. This study aimed to assess the relationship between factors influencing detection of the northern Pacific seastar, *Asterias amurensis* in Victoria, Australia. *Asterias amuernsis* is a conspicuous species that poses a threat to southern Australia's endemic marine species and fishery industry. Parameters assessed in this study include observer experience, search effort, local spatial aggregation and false negative observations. Using a novel approach, artificial mimics of the target species were placed along a 50 m survey transect to create a known population density. Observers independently survey the transect and record search effort and the number of individuals detected. Participants involved in the study came from a wide background of experience and skill including government agency staff, community volunteers and marine consultants. Regression modelling was used to examine the relationship between detection probability, search effort, observer experience and environmental conditions. The findings suggest that detection probabilities declined with (i) increasing habitat cover and (ii) decreasing water visibility and search effort. Detection probabilities on average were higher for an experienced observer compared with an inexperienced observer. This study provides a powerful tool in addressing the overall efficiency of detection during surveys for spreading introduced marine species. Additionally, this information can be incorporated into the framework for decision analysis under the National Control Plan for this species.

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Invasibility of salt marsh by mangroves: Predicting how environmental fluctuations facilitate recruitment across gradients of abiotic stress

Oral presentation
symposiumtheme1: *Drivers of invasibility*
symposiumtheme2: -
Contributed

abstract

Surveys in estuaries of southeast Australia have revealed a decline in the area occupied by salt marsh and a concurrent 'invasion' of these marshes by the native mangrove *Avicennia marina*. A leading explanation for this invasion is that environmental change, particularly increased run-off of nutrients and freshwater due to human modification of the coastal landscape, has reduced stressful abiotic conditions of salt marshes and facilitated the recruitment of *A. marina*, allowing competitive displacement of the species of plants that characteristically dominate the marsh. To examine this explanation, in a series of field experiments I manipulated salt marsh vegetation and nutrients along tidal elevation gradients dominated by different species of plants, supplied mangrove propagules to these areas, and monitored the establishment and growth of seedlings. Seedling establishment was universally poor in areas without marsh vegetation, but varied in the presence of marsh vegetation. Marsh vegetation facilitated mangrove recruitment at low tidal elevations dominated by the chenopod *Sarcocornia quinqueflora*, but largely precluded recruitment at high tidal elevations dominated by the larger rush *Juncus kraussii*. Nutrients had no influence on seedling establishment. Nevertheless, a multiyear, field experiment where I manipulated nutrient load surrounding mangrove seedlings already established in the marsh revealed that nutrients reduced the physiological stress (as determined by chlorophyll fluorescence) of seedlings and catalyzed the demographic transition from seedling to sapling, with some individuals flowering after only two years. The amelioration of harsh abiotic conditions by the presence of marsh vegetation and nutrients clearly has the potential to facilitate the establishment and spread of mangroves within coastal salt marshes. The key to predicting future patterns of mangrove invasion will be an understanding of the processes that promote recruitment, particularly those that break down barriers to propagule dispersal and facilitate seedling establishment and early growth. Given that the southeast coast of Australia is predicted to be one of the most influenced by environmental change over the next century, due to a combination of increased population growth and warming under climate change, understanding the ecological processes responsible for mangrove invasion will help to predict distributional shifts from seaward to landward and with latitude.

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Oceans under threat: A study of ballast water stowaways entering a Jamaican port

Poster presentation
symposiumtheme1: *Other topics*
symposiumtheme2: *Eradication/management of invasive species*
Contributed

abstract

Although the worldwide impact of bioinvasions via ballast water transfer has been documented, no research has been done in the Caribbean region, including Jamaica, to investigate the nature and possible impacts of ballast water introductions. Ballast water tanks of bulk cargo vessels entering a Jamaican port were sampled during the period January 28, 2010 and August 17, 2010. Thirty samples of preserved zooplankton and 22 live samples were obtained during this period with the use of a diaphragm pump, an in-line flow meter and a cod-end fitted with a 50 µm mesh, in replicates of two. Information concerning the vessel, tank and ballast water management protocols was also obtained from each vessel. More than 19 groups of zooplankton were found. The three most species-diverse adult groups, in descending order from the most to least diverse were, Copepods > Tintinnids > Rotifers. A similar ranking of abundance was obtained for adults and juveniles (sub-adults): Tintinnids > Rotifers > Copepodites and Copepodites > Lamellibranch Larvae > Veliger Larvae, respectively. When both adults and juveniles counts were combined, Tintinnids were the only group more abundant than copepods. From previous studies, the most abundant group within the bay enclosing the port were copepods (Webber *et al.* 2005). 4.8 % of the replicate live samples in the ballast water could be considered to have not complied with the Standard Regulation D-2 of the International Convention for the Control and Management of Ship's Ballast Water and Sediment. The two 'non-compliant' replicates contained 31.67 individuals m^{-3} and 16.75 individuals m^{-3} of viable organisms. Both samples came from ships that did not conduct mid-ocean exchange. 43 % of the vessels sampled did not conduct mid-ocean exchange; all of these arrived from a freshwater port. This study has generated useful baseline data which captures the nature of the biotic composition, as well as the ratio of vessels that conduct mid-ocean exchange, of ballast water that is being discharged into a Jamaican port.

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112 The likely effects of climate change on the success of potential invaders: the effect of freezing air temperatures on the non-native Chilean oyster, *Tiostrea chilensis* (Philippi 1845) in the Menai Strait and Conwy Bay Special Area of Conservation (UK)

Poster presentation
symposiumtheme1: *Other topics*
symposiumtheme2: *Factors promoting the establishment and spread of marine invaders post-arrival*
Contributed

abstract

'Biological invasions' and 'climate change' are considered to be amongst the most prevalent threats to the preservation of global biodiversity and ecosystem functioning. The likelihood that introduced species become invasive within their novel environment is dependent on a number of factors, including a suitable temperature range. By way of environmental changes related to climate change (e.g. increase in extreme events such as freezing UK winters), the potential economic and environmental damage potential associated with currently 'innocuous' introduced species are likely to change in the near future. The present investigation investigated the effects of winter air temperatures on the survival of a non-native oyster (*Tiostrea chilensis*); a species which has only recently reached high densities in several areas of the Menai Strait and Conwy Bay Special Area of Conservation (North Wales, UK). By exposing three size groups of oysters (small: 20-35 mm, medium: 40-55 mm, large: 60-75 mm) to either a single or 3 consecutive daily periods (2h each) of freezing air temperatures (-2, -6, -10 °C), oyster survival rate was shown to be significantly lower with decreasing temperature. Small oysters (i.e. those likely to be exposed to their first winter) cooled and thawed as much as 3 times quicker than their Large counterparts (4+ years old), and were also subjected to longer periods of tissue ice formation. However, no significant difference was observed between oyster survival rate and size class, suggesting that younger, smaller oysters are relatively more tolerant to freezing conditions than larger conspecifics. Such a pattern was mirrored in field surveys, conducted pre- and post-winter of 2010-2011. Our findings are discussed in relation to the successful proliferation of a non-native species in a designated Special Area of Conservation, and the likely threats to the native biodiversity.

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Capricious bioinvasions versus rigid management strategies: how the most unlikely invaders can prosper under current UK legislation

Poster presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -

abstract

Biological invasions in coastal waters are known to be highly unpredictable and context-specific, thus highlighting the critical nature of the formation and implication of effective management strategies. Using the recent spread of the Chilean oyster, *Tiostrea chilensis* (Philippi 1845), within a designated marine Special Area of Conservation (SAC), we demonstrate what can happen when an apparently 'innocuous' non-native species is introduced and no active regular monitoring and management of their abundance and spread is undertaken. Following over 30 years of relative containment at Tal y Foel (Anglesey, Wales, UK), the Chilean oyster, a species with a very low natural dispersal potential, has now spread over a range of more than 30 km along the Menai Strait. It is suggested that anthropogenically-mediated movements and rafting are the likely means that have facilitated the long-distance dispersal of *T. chilensis* away from the site of original introduction. High oyster densities (maximum = 232 oysters m^{-2}) have become established both close to and at distances away from the original site of introduction and the presence of up to 7 and 9 year classes in intertidal and subtidal oyster populations respectively confirms the regular annual recruitment in the area. As well as providing valuable, up-to-date information on the recent spread of this non-indigenous species within a designated marine SAC, our study also highlights the current discrepancies in both UK legislation and management strategies concerning non-native marine species. We advocate the urgent need for a more proactive and far-sighted approach to the management of non-native species, including the continuous and careful monitoring of even the most inconspicuous species.

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114 Eight years of targetted surveillance for non-indigenous marine species in New Zealand

Oral presentation
symposiumtheme1: *Other topics*
symposiumtheme2: -
Contributed

abstract

New Zealand introduced a programme of targetted surveillance for marine non-indigenous species (NIS) in 2002 and it has run more or less continuously ever since, funded by the Ministry of Agriculture and Forestry Biosecurity New Zealand and carried out under contract by the National Institute for Water and Atmospheric Research. The programme surveys 11 high-risk ports of first entry for a target suite of high-risk primary species not yet present in New Zealand. Sampling effort is focussed on habitats within each port where the target species are most likely to occur (based on habitat modelling and propagule dispersion studies). Several sampling methods are used, appropriate to target species and habitats but also capable of detecting other, non-target NIS and requiring minimal post-processing to allow maximal sampling intensity with the resources available. During its eight years of operation the programme has detected first incursions of one primary target species (the polychaete *Sabella spallanzanii*) and several non-target species, and recorded range extensions of these and several other NIS already present in New Zealand. This presentation presents an overview of the programme, its results to date and future directions.

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Linosa island (Central Mediterranean Sea): a key study site for understanding climate-driven pathways of alien species invasion in the Mediterranean Sea.

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: *New species in an ancient sea: the Mediterranean cross road*
Invited

abstract

Linosa is a small volcanic island of the 'Pelagie archipelago', a Marine Protected Area located in the Central Mediterranean Sea (Sicily Channel - Italy). Despite the very low anthropogenic impact (i.e. no industries, agriculture, low tourism), and the reduced importance of ship traffic and aquaculture, Linosa is recognized as one of the main hotspots of introduction of non-native species in Italy.
The origin of these alien species is mainly from the Indo Pacific region and they had been previously reported in the eastern Mediterranean having entered through the Suez canal, whereas a few fish species of tropical Atlantic origin could have entered through the Strait of Gibraltar.
Due to its location at the biogeographical boundary between the western and eastern Mediterranean, Linosa island may act as a stepping stone for secondary dispersal of non-native species from west to east or vice versa. Moreover, it represents a meeting point of Atlantic-derived species with those originating from the Red Sea and Indo-Pacific, providing an interesting opportunity for studying the interactions of non-native species of different biogeographic affinity.
A 'people science' survey has been conducted during the last two summers by students under the guidance of researchers of the Universities of Pavia and Genova participating in the education project For-Mare (www.for-mare.eu). These activities provided a comprehensive set of data on alien species distribution, abundance and impact on the island. The whole perimeter of Linosa island was surveyed by visual census, both scuba diving and snorkeling observations, in a depth range of 0-20 m. Results showed the acclimation of five non-native species along the island's coastline: the green alga *Caulerpa racemosa*, the crab *Percnon gibbesi*, the red alga *Asparagopsis armata*, the fish *Siganus luridus* and the opistobranch *Aplysia dactylomela*. Data were used to inform the scientific community and raise awareness about the changes in natural littoral communities, making use of biopollution index (sensu Olenin *et al.*, 2007) showing that *Caulerpa racemosa* and *Percnon gibbesi* are the major impacting species in the area. The study provides further evidence of the ongoing acclimation of non-native thermophilic species in the Mediterranean sea, which are widening their biogeographical range thanks also to global warming.

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Changes in fish diversity in the central-western Mediterranean: monitoring exotic species in Sardinian waters

Poster presentation
symposiumtheme1: -
symposiumtheme2: *New species in an ancient sea: the Mediterranean cross road*
Contributed

abstract

The composition of fish assemblages in central-western Mediterranean has undergone significant changes in recent years. An increasing number of Mediterranean thermophilic fish species have been recorded north of their original geographical distribution. Moreover, the invasion by exotic species of Atlantic Ocean origin and Lessepsian migrants represents a continuous process which seems to have accelerated in the last decades.
The aim of this paper is to provide an update check-list of new species in Sardinian waters on the basis of exiting data source, and analyse the presence and distribution of exotic fishes

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International open-access journal '*Aquatic Invasions*': an important part of the developing European information and early warning system on aquatic invasive species

Poster presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -
Contributed

abstract

Aquatic Invasions is an open access, peer-reviewed international journal focusing on biological invasions in both inland and coastal waters of Europe, North America and other regions. The journal provides authors with protective rights concerning primary geo-referenced records, biological monitoring and surveys as well as timely publication of reports concerning first alien species records. This contributes to rapid information dissemination, risk assessment procedures and early warning systems on invasive alien species (IAS). Currently *Aquatic Invasions* is playing an important specific role in the development of a network of internet-based global, regional and national databases on IAS, serving as a cost-effective tool for collecting and transferring essential primary information on aquatic invasive species to the level of decision-makers, general public and other interested stakeholders. The first 5 volumes of *Aquatic Invasions* were published during 2006-2010, totaling 20 issues, and are freely available on-line (http://www.aquaticinvasions.net). They include 350 research articles and short communications with more than 4000 new geo-referenced records of aquatic alien species in European inland and coastal waters. Manuscript publication, including a comprehensive review process, takes on average less than two months, thereby reducing the publication time lag typical of many peer review international journals and furthermore provides a cost-effective early warning service, specifically for European countries. Information transfer is specifically timely in the case of *Aquatic Invasions* Records papers to be published in the electronic journal supplements (see for example the 5th journal volume supplement at http://www.aquaticinvasions.net/2010/supplement1.html). The fast and comprehensive review process of manuscripts serves as an effective data quality insurance mechanism, which is generally lacking in most open IAS databases. Currently we are working on the development of additional web services for contributing authors, including online interfaces for automated upload of IAS record data series and the provision of online management for these datasets. *Aquatic Invasions* is published on behalf of the European Research and management Network on Aquatic Invasive Species (ERNAIS) with partial support from the European Commission Seventh Framework Programme collaborative project *enviroGRIDS* (http://www.envirogrids.net).

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Towards a Decision Support System for Management of Invasive Aquatic Species in the Black Sea Basin

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -
Contributed

abstract

During previous decades, introductions of invasive aquatic species (IAS) in the Black Sea basin have been greatly facilitated by increasing shipping, development of inland waterways and by other pathways. As a result, a large number of IAS have been established in the basin severely affecting biodiversity and ecosystem services. The current invasion corridors and increasing human activities may further facilitate IAS introductions into the region and their transfer within the region. Appropriate risk assessment-based management options are required to address risks posed by human-mediated introductions of these species. This presentation will discuss the ongoing activities within the European Commission FP7 collaborative project *enviroGRIDS* (http://www.envirogrids.net) in developing online applications, which use Decision Support System (DSS) technology to aid development of effective management options on IAS on the national and regional levels. Demo versions of these online applications are currently available at the Regional Euro-Asian Biological Invasions Centre information system (REABIC) website (http://www.reabic.net) and include: 1). a searchable experts database (http://www.reabic.net/dbExp.html); 2). a searchable information system on IAS *AquaInvader* (http://www.reabic.net/Aquainv.aspx) and 3). an interactive GIS on IAS records in the Black Sea basin (http://www.reabic.net/GIS_black.html). Furthermore, online DSS will include a module on assessment of risk-based indicators on IAS within the DPSIR framework, including a system for assessment of non-native species invasiveness and biological contamination indices for invaded habitats. Also, online DSS will include an early warning component, and currently we are working on mechanisms for the more effective transfer of scientific information from publications in the open access journal *Aquatic Invasions* (http://www.aquaticinvasions.net) upwards to the level of decision-making, by focusing on the Black Sea basin as a model region.

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Drivers of marine invasions: integrating key environmental and biotic factors that facilitate nonnative species invasions in Maine estuaries.

Oral presentation
symposiumtheme1: *Drivers of invasibility*
symposiumtheme2: -
Contributed

abstract

Invasive species are rapidly changing the structure and functions of native ecosystems. Coastal Maine has changed due to introduced mobile species such as *Littorina littorea* and the green crab, *Carcinus maenas* (both introduced centuries ago). However recently, nonnative colonial invertebrates have been increasing in abundance along the coast of Maine. We used three estuaries (Kennebec, Sheepscot and Damariscotta) as a laboratory to tests several theories about what drives the inoculation process of such invasions in this region of the Western North Atlantic. Specifically, we considered the coastal migration, ship vector and aquaculture vectors theories. We deployed more than 400 hundreds settlement plates at 1 m depth at different sites along each river where average salinity and thermal aspects of the river were similar. We found the highest diversity and abundance of non-native species midway up the Damariscotta river, especially colonial (i.e *B. violaceus*, *B. schlosseri*, *D. vexillum*) and solitary ascidians (*S. clava*, *A. aspersa*, *C. intestinalis*). There were no differences among rivers on the outer coastal stations suggesting that coastal migration did not cause the pike in this river. The ship traffic in the Kennebec River was by far the greatest and the Damariscotta river has the lowest so the pattern we observed was not likely ship-vector related. We are left with the hypotheses that either aquaculture operations over the decades and/or the Damariscotta River's benign freshwater flows inoculated and nurtured the distribution, abundance and diversity of non-native species in the Damariscotta river.

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Biomass of Non-Native Species in New England

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -
Contributed

abstract

Rapid Assessment Surveys of native and non-native species on pontoons in the Northeastern coast of the U.S. have been conducted periodically for ten years. The surveys record presence/absence of species, which fails to take into account abundance or biomass of non-native species. During the summer of 2011, the Rapid Assessment Team addressed two questions: are non-native species present in natural substrate (low rocky shores) and what is the biomass of non-native species compared to native species on pontoons? Biomass samples were collected from 16 marinas to compare non-native species to native species. Wet weight analysis indicated that the sea anemone biomass was 4 times that of non-native species (primarily sea squirts) or mussels (corrected for wet tissue weight), and five times the weight of others. Non-native biomass ranged from a few percent at several locations to over 40 % at one location with an average wet weight of 15 %. Although no biomass samples were collected from natural substrate locations, the average number of native, non-native and cryptogenic species was comparable between the pontoons and rocky subtidal areas. The variability of species present and absent at sites that have been visited multiple times during the surveys suggests populations respond to environmental variables.

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Assessment of Methods to Prevent Biofouling by Invasive Species in Narragansett Bay, Rhode Island

Oral presentation
symposiumtheme1: -
symposiumtheme2: *Eradication/management of invasive species*
Contributed

abstract

Biofouling is a significant issue for Navy ships, underwater fixed test gear, and sensors deployed in Narragansett Bay, Rhode Island because it can compromise the operations of these systems, as well as delay Navy missions. A heavily fouled vessel also incurs increased costs due to excessive fuel consumption associated with increased drag. Although much attention has focused on antifouling methods, these are frequently ineffective, costly, and pose a risk to the environment (e.g., chemically active coatings or heavy metals). Complicating this issue is that fact that invasive species (a major component of the fouling communities in Narragansett Bay) have increased in occurrence in the last decade, and they may have more severe impacts than their native counterparts. Didemnum vexillum is one such species that has colonized natural and artificial substrates within New England waters. This species is an aggressive colonizer that has proven difficult to control with traditional antifouling methods. The objectives of this research are to evaluate a range of existing (i.e., paints SeaGuard and Intersleek) and novel antifouling techniques (i.e., aeration) on test panels and a model boat hull in Narragansett Bay; and to determine which method maximizes efficacy against biofouling by invasive species, while minimizing cost and environmental risk. Percent coverage of biofouling of native and invasive species on the test panels and model hull was sampled monthly during the four-month study. Results from this study will add new findings to the pool of limited data from previous studies that investigated aeration as an effective and environmentally friendly antifoulant. The implications of this finding are significant considering the worldwide ban of tri-butyl tin antifoulants.

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A threat around the corner? Assessing the invasive potential and biogeographic boundaries of an introduced ascidian

Oral presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -

abstract

There is a thin line between introduced and invasive species. However, since their invasive potential is uncertain, introduced species commonly receive less attention. The aim of this study was to use an integrative approach to assess the invasive potential and biogeography of marine introduced species. For this, we used as a model organism the solitary ascidian *Styela plicata* (Lesueur, 1823), a species that is present in harbours and on submerged structures around the world. Nevertheless, this species is not considered invasive, as there are few demonstrations of introduced populations outcompeting native species. Demographic and biological parameters were studied using four different approaches: 1) A global phylogeography using two genetic markers; 2) An assessment of the *S. plicata* reproductive cycle in two Mediterranean populations over a 2-year period; 3) An assessment of the susceptibility of *S. plicata* to changes in salinity, pollutant concentration, and temperature; and 4) An assessment of the stress response of *S. plicata* to natural environmental fluctuations over time, through quantification of hsp70 gene expression. The results of the phylogeographic study showed that *S. plicata* has been present in all the studied oceans for a long time, and that its populations have been shaped by recurrent and ongoing colonization events through ship traffic. The study assessing the reproductive cycle of this species showed that *S. plicata* has a protracted reproductive period and rapid growth. Experiments using embryos and larvae showed that early life-history stages of this species were highly tolerant to a common pollutant (copper), while low salinities (as found in estuarine conditions) and high temperatures seriously impaired larval development. Finally, low salinities and high temperatures in the field significantly increased hsp70 gene expression in this species. Taken together, our results indicate that the present distribution of this species appears to be regulated by low salinity and high temperature events in estuaries, while it shows high tolerance of pollution in harbours and marinas. Considering that many potentially suitable coastal areas remain to be colonized, our results suggest that *S. plicata* has the potential to proliferate and extend beyond its current boundaries. This study highlights the importance of multidisciplinary approaches for understanding the interaction among the many factors shaping the invasive potential of introduced species.

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Through the Eastern Gate: taxonomic survey of benthic invertebrates along the shallow Mediterranean rocky coasts of Israel

Oral presentation
symposiumtheme1: *Other topics*
symposiumtheme2: *New species in an ancient sea: the Mediterranean cross road*
Invited

abstract

The invertebrate fauna of Mediterranean shallow rocky bottoms is one of the world's best studied faunas. However, the largest part of its knowledge comes from the central and northwestern areas of the basin. Available information from the Levantine Sea still derives from scattered and usually taxon-specific observations. Within the framework of the 2007-2010 Italy-Israeli Cooperation Programme, supported by the Italian Ministry of Environment, the Euro-Mediterranean Centre for Climate Change (CMCC) launched the project 'The impacts of biological invasions and climate change on the biodiversity of the Mediterranean'. In this framework, we carried out a multi-taxon inventory of the benthic communities of the Israeli Mediterranean shallow rocky bottoms from Tel Aviv to Rosh Hanikra, a marine protected area bordering Lebanon waters. Qualitative and quantitative samplings were carried out in two periods (June 2009; February 2010) by SCUBA diving on vertical transects from surface to 25 m depth at five stations. Qualitative samplings of the hydroid community were carried out by visually oriented collections. Quantitative samplings on the whole benthic invertebrate community were also carried out in June 2009 by combined scraping and suction using a man-operated hood device on replicate standard areas (400 cm^2). We report here the inventories of hydroid and mollusc species recorded in the five transects. The hydroid collection represents the first inventory made along the Israeli Mediterranean coast, with the collection of 58 taxa (42 Leptomedusae, 16 Anthomedusae). Three invasive alien species from the Red Sea were identified: *Macrorhynchia philippina*, *Dynamena quadridentata*, and *Campanularia morgansi*, the latter species as the first record in the Mediterranean Sea. *Macrorhynchia philippina* is now a dominant species throughout the year and its bushy morphology qualifies it as a structural species, hosting a number of epibionts and therefore enhancing the biodiversity of benthic communities. For molluscs, the quantitative samplings led to the identification of 2730 specimens belonging to 45 species, 25 of them already known as exotic species. Among them, the large bivalves *Spondylus spinosus* and *Chama pacifica* are known as habitat-formers, creating extended shallow reefs at all sampled sites. A further species, belonging to the bivalve genus *Musculus*, never reported for the Mediterranean, is still under taxonomic consideration.

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First report of the occurrence of *Caprella scaura* Templeton, 1836 *sensu lato* (Amphipoda: Caprellidae) in the Mar Piccolo of Taranto (Ionian sea, Mediterranean sea).

Poster presentation
symposiumtheme1: *Other topics*
symposiumtheme2: *New species in an ancient sea: the Mediterranean cross road*
Contributed

abstract

Alien species continuously increase in numbers in the Mediterranean waters. *Caprella scaura* is a crustacean amphipoda of the Caprellidae family (Suborder Caprellidaea) worldwide distributed. It was originally described from Mauritius in the Indian Ocean (Templeton, 1836). The first record of *C. scaura* in the Mediterranean Sea dates back to 1994 from the lagoon Venice, in the northern Adriatic sea. Further records were from the Gulf of Amvrakikos, Greece in 2002, in the Ravenna harbour, Italy in 2004, in the Tyrrhenian sea at Livorno, in 2004, in eastern Sicily in 2004 and in the Iberian Peninsula in the 2005.

The first occurrence of *C. scaura* in the Mar Piccolo lagoon (Southern Italy, Ionian Sea) is reported in this note, the specimens discovered are in good agreement with Indo-Pacific descriptions.

The study site is located on the eastern part of the Mediterranean sea in Mar Piccolo of Taranto (40° 28' N; 17° 15' E). Mar Piccolo is an inner, semi-enclosed basin located on the North of Taranto town showing lagoon features. It has a surface area of 20.72 km^2 and is divided by two rocky promontories into two inlets, First and Second Inlet which have a maximum depth of 13 and 8 m, respectively. It is subject to urbanization, industry, agriculture, aquaculture and commercial fishing: the main problems of environmental impact are due to the presence of a water scooping machine of the still industry catches seawater of the basin for cooling plans, the largest mussel farm (ca. 30,000 tons $y^{-1}$of mussels), furthermore until few years ago, the most important Italian navy base was located in the First Inlet. A total of 4 sampling stations were allocated in the study area, two of them in the first Inlet (Station 1 and 2) and two in the second Inlet (Stations 3 and 4). Sampling was performed every month during one year, from October 2007 to September 2008 in shallow waters of the basin. Samples were taken at a depth of about 0.5m using a square metal box (50 X 50 cm). Individuals of *C. scaura* were counted and measured using a steremicroscope with a graduated eyepiece. A total of 442 individuals were collected, during whole period of study.

The greatest densities were estimated in the second Inlet among *Chaetomorpha linum, Gracilaria bursa-pastoris* and *Hypnea cornuta* beds which seem to play an important role in the settlement of this invader species. The length of largest male was 23 mm while the largest female was 9.68 mm. The minimum size of an ovigerous female was 5.64 mm with 5 eggs, whereas the maximum brood size observed was 72 for a female of 7.89 mm.

According to our data, as well as taking into the consideration previous investigations, the recent introductions of *Caprella scaura* to Mar Piccolo should give rise to concern. There is an urgent need to monitor this environment in order to determine the status of native species and possible impact of non-indigenous taxa.

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126 Phenology of the introduced kelp *Undaria pinnatifida* in Blairgowrie (Australia) and management implications

Oral presentation
symposiumtheme1: -
symposiumtheme2: *Eradication/management of invasive species*
Contributed

abstract

Undaria pinnatifida is an invasive kelp native to the northwest Pacific that is quickly attaining cosmopolitan distribution. It has known environmental, economic and social impacts, and therefore it is important to understand this invasive species in order to control its spread and avoid new introductions. Furthermore, different populations have demonstrated differing autecological characteristics depending on the location of study; hence each population needs to be studied separately. Phenological studies were undertaken in Blairgowrie (Victoria, Australia), including the variation of growth and spore release rates with age and throughout the growing season, and the variation of spore motility throughout the growing season. Maximum growth occurred in August (austral winter) with maximum spore release rates in May and October (austral autumn and spring respectively). Neither growth nor sporulation rates showed a significant correlation with sea surface temperature. Spore motility (which influences dispersal rates) showed a significant correlation with sea surface temperature. Multiple sporophyte generations occur during the year, with sporulation occurring year round. The sporophyll appears within 1-2 months of sporophyte growth and spore release generally starts in the same month, so once the sporophyll has developed, sporulation is almost a certain event. Considering the obtained results, the prevention of spread should be centered on transport vectors rather than on the kelp itself, at least until more is known about its life cycle. Community education and engagement is needed to aid vector management. Surveillance of surrounding areas should not be forgotten since natural spread over short distances is also possible.

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Synthesis of marine invasion history for the Iberian Peninsula: Patterns and predictions

Oral presentation
symposiumtheme1: -
symposiumtheme2: *New species in an ancient sea: the Mediterranean cross road*
Invited

abstract

Non indigenous species (NIS) have been colonizing marine and brackish habitats of the Iberian Peninsula since the XV century. For some taxonomic groups, such as the algae, research has been advanced. But for the majority, studies are lacking. To address this gap, we compiled NIS records from research papers, biota inventories and surveys and ecological studies. Our goals were to (a) characterize the current state of knowledge, (b) examine spatial, temporal and taxonomic patterns of invasion, and (c) stimulate research. We have documented over 230 NIS introduced in the Iberian Peninsula coastal marine waters; most of them (80 %) in the North Atlantic and Mediterranean regions of Spain. In particular, in the Mediterranean region of Spain over 60 NIS have been recorded. We predict that these low numbers result from differences in search effort, as many additional species are found from nearby regions.

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Reciprocal invasions of two *Boccardia* species (Annelida, Spionidae) in North and South America

Oral presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -
Contributed

abstract

Spionid polychaete, mudworm *Boccardia proboscidea* Hartman, 1940 was originally described from California and later widely reported from the Pacific side of North America from British Columbia south to California, and also in Japan, Korea, China, Australia, Tasmania and New Zealand. During the last decade it was reported as an introduced species in Hawaii and South Africa; it was also suggested to be invasive in the Bay of Biscay, northern Spain and England, but never reported from South America. In 2008, an explosive development of *B. proboscidea* was found near the sewage outfall of Mar del Plata city, Buenos Aires Province, Argentina; the dense sand tubes of these worms (up to 650.000 ind m^{-2}) rapidly formed large biogenic reefs in sewage-impacted intertidal area (Jaubet *et al*., 2010). Dense intertidal populations of this species were also found all along the coast of northern Patagonia in Argentina in 2010. The Patagonian worms bored into mud- and limestone and greatly affected the associated native communities. Progressive invasions of *B. proboscidea* in Argentina are accompanied by extinction of its close relative, *Boccardia claparedei* (Kinberg, 1866), which occupies the same ecological niche and is considered to be native in South America. During the Rapid Assessment Survey provided by the PICES Working Group 21 (financially supported by the Ministry of Agriculture, Forestry and Fisheries of Japan, MAFF) on the Pacific side of North America, Oregon, in October 2010, an established dense colony of *B. claparedei* was discovered in a salt-water drain channel coming from the aquarium of the Hatfield Marine Science Center in Newport. Additional *B. claparedei* were found adjacent to the Marine Science Center in Yaquina Bay, where the native *B. proboscidea* was abundant. *Boccardia claparedei* is known in South America from Chile and Argentina (Radashevsky, unpublished), but was unknown previously from North America. *Boccardia proboscidea* has not been reported from the Atlantic coast of North America, and is likely to have been transported to Argentina as larvae in ballast water. The vector of transportation of *B. claparedei* to Oregon remains unknown. Individual behavior and reproductive biology of these two spionid polychaetes are discussed in relation to their invading populations.

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Differences in the phenological recruitment patterns between native and non-native species: Past work and future agenda

Poster presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -
Contributed

abstract

The timing of life history events, including the timing of recruitment of marine organisms, can have a large influence over individuals or populations. For example, species-specific seasonal differences in timing of recruitment can be an important factor determining the nature and strength of competitive interactions, population growth rates and reproductive success.
Using a 19 year recruitment record we have been able to observe distinct differences in the phenological patterns of resident and non-native species recruitment in the New England (USA) marine epifaunal community. In this presentation we will review differences in native and non-native phenological recruitment patterns and present new data utilizing null and regression models. Our results suggest that there are different controls on the timing of recruitment for native and non-native species. Our preliminary results, however, leave more questions than answers and have us wondering what are the potential causes for these patterns? Ultimately, we wish to gain a better understanding of the characteristics and processes of invasive species recruitment that allow them to establish new populations and stably persist. These differences have given us insight and have helped to develop hypothesis regarding specific mechanisms of invasion and expansion into new habitats.
Here I will present data illustrating differences in the patterns of native and non-native species phenological patterns to form the basis of a research agenda. This future line of work will utilize theoretical models, field experiments and studies to investigate adaptive mechanisms of recruitment timing in marine epifaunal species. This research will improve our understanding of the fundamental mechanisms of species invasion as well as informing our basic understanding of community ecology.

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Multivariate approaches to predict invasion success: a novel conceptual framework

Oral presentation
symposiumtheme1: *Development and tests of invasion theory*
symposiumtheme2: -
Contributed

abstract

Invasion success of non-native species has typically focused on identifying a single rather than a suite of related attributes. We examined attributes of extant non-native species for the Chesapeake Bay both individually and collectively, as predictors of invasion success. Data cover fish, plants and molluscs. The degree to which three categories: (1) biological traits, (2) environment characteristics and (3) introduction event properties contribute to establishment were investigated via a conceptual diagram. Multivariate approaches (e.g. PCA, GLM) were used to quantify the contribution of these three categories to observed success of establishment.

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Indo-Pacific invaders dominate Levant subtidal rocky reef communities

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: *New species in an ancient sea: the Mediterranean cross road*
Invited

abstract

It is a well-known fact that the Levant shores are a major hotspot of bioinvasions. However, so far, quantitative data on the extent of this invasion beyond list of species is very limited, especially on hard bottom environments, and definitely for invertebrates. In a recent extensive survey (> 20 sites in waters 3-20 m deep) along 30 m long transects in the north of Israel (Haifa) I found that Indo-pacific species dominate or nearly dominate many components of the macro-benthos. In benthic fish assemblages (excluding cryptic species such as gobies, blennies and scorpeanids) 52 % of all individuals were invasive. The most numerically dominant species were herbivores (two Red Sea siganid species long established along the shore) while the only native, true, herbivore (*Sarpa salpa*) was very rare (0.1 %). Invasive species composed 40 % of the bivalve individuals; however the largest bivalve, the invasive *Spondylus spinosus* is a massive species that in some sites forms extensive 3-D reefs. The only visible echinoderm was the large Indo-Pacific sea cucumber, *Synaptula reciprocans*, occurring mostly below 10 m depth, with densities > 1.4 individuals per m^2 in some deep transects. Sea urchins, that were once abundant along the coast, were not detected at all in our surveys and only 4 individual where observed in shallow waters outside the transects. The most profound result so far is the total domination of gastropods by invasive species - 97 % of all individuals were IndoPacific. The two most dominant species are the Arabian Gulf snail, *Conomurex persicus*, and the Red Sea cerithid *Cerithium scabridum* (in very shallow waters). Several transects were dominated (30-90 % cover) by a recent Indo-Pacific invasive red algae, *Galaxaura rugosa*. There is no doubt that this profound domination of the ecosystem by invasive species is having considerable effects on its function in various ways. The siganids, for example, are decimating all erect algae, leaving mostly corallines on the rocks in most places, and the *Spondylus*, by increasing habitat complexity, surely serves as an important ecosystem engineer for other species. Further work is planned to try to test these interactions in order to unfold the extent of ecosystem shifts in this highly invaded system.

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Facing the complexity of marine scenarios using genetic data

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: *Application of genetic methods for reconstructing invasion histories*
Invited

abstract

A critical step for developing strategies to prevent and control biological invasions is to understand the pathways and historical processes by which non-indigenous species become introduced into novel ecosystems. Over the past two decades, enormous progress has been made through the implementation of molecular data to the study of biological invasions, greatly improving our ability to understand the invasion process, as well as assisting with untangling cryptic biodiversity and clarifying the origin of cryptogenic species. In the field of population genetics, we are now able to use well-established procedures to compare the genetic composition of populations from introduced and native ranges, assess the level of genetic diversity and differentiation among populations, or detect the most likely source of introduced populations. Despite these recent advances, most current analytical methods of genetic data are still unable to resolve complex routes of invasion. This is especially critical for marine bioinvasions, as these are most-often extremely complex due to the high prevalence of multiple sources and non-independent introductions. However, new analytical tools such as the approximate Bayesian computation methods overcome certain limitations of more traditional methods, thereby enabling researchers to determine the most likely introduction histories and, ultimately, reconstruct routes of invasion. For instance, such methods can help untangle whether these introductions are a result of independent or non-independent colonization events, resolve the most likely geographic sequence for multiple introductions, and determine whether introductions were as a result of an isolated event from a single source or occurred as a result of admixture events. Although the use of approximate Bayesian computation methods represents a substantial advance for invasion genetics, these methods have their own analytical limitations, especially when facing recurrent and/or recent introductions, or when migration exists among introduced regions. Here I present some factual examples to show how different analytical tools used for genetic data can help us untangle complex marine scenarios

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Do temperature and light determine expansion and distribution of *Womersleyella setacea* in the mediterranean sea?

Oral presentation
symposiumtheme1: *Other topics*
symposiumtheme2: *Factors promoting the establishment and spread of marine invaders post-arrival*
Contributed

abstract

Since its introduction in the Mediterranean in late's 80, the tropical red alga *Womersleyella setacea* (Rhodomelaceae) has colonised most Mediterranean areas. This invasive behaviour is causing increasing concern, but the mechanism underlying the acclimatization of this species to the Mediterranean and the invasion process remains unknown. Thus, we studied the bathymetric distribution and seasonal biomass patterns of *W. setacea* populations at two localities of the Scandola Regional Park, Corsica, France, and related them with irradiance and temperature values recorded in situ. Moreover to experimentally determine if *W. setacea* tolerance to different light and temperature conditions can explain its colonization success through the Mediterranean, as well as its bathymetrical distribution, laboratory experiments were set up to study survival and growth at short (1 month), mid (3 months) and long term (1 year). Results showed that, in the studied area bathymetric distribution on *W. setacea* is restricted to a narrow horizon between 25 and 40 m deep, reaching maximum values at 30 m depth with biomass values up to 125.75 g DW m^{-2}. *Womersleyella setacea* did not show a clear seasonal pattern, though minimum values were reported in spring. In concordance, at mid and long term, *W. setacea* presented restricted dim light and low temperature requirements, although at short term, it was able to survive and grow in a large range of environmental conditions. Therefore, NW Mediterranean spread, bathymetric distribution and absence of biomass cycle of *W. setacea* at the study area can be mostly explained by its temperature and light requirements.

This work was supported by an EU Reintegration grant (ERG-2009-248252) and a grant from the Spanish Ministry of Science and Technology (CGL2004-05556-C02-01).

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Regional differences in foraging behaviour and morphology of invasive green crab (*Carcinus maenas*) populations in Atlantic Canada

Oral presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -
Contributed

abstract

Invasive green crab populations initially established in Canada within the Bay of Fundy, New Brunswick in the 1950's and spread to all four Atlantic provinces by 2007. Genetic evidence suggests that the Atlantic Canadian populations originated from two separate introductions with differences in time of establishment among regions and possible population-level behavioural differences. In this study, we examine intraspecific foraging behaviour among crabs from different populations, differences in crab claw size, and interspecific foraging competition between genetically similar crabs and juvenile lobsters. Both sets of foraging experiments involved competition for a limited food source over a one-hour period. In intraspecific match-ups, recent invaders from Newfoundland (NL) were significantly superior foragers than long established invaders from Nova Scotia (NS) and New Brunswick (NB) populations; however, we found no differences between NL and Prince Edward Island (PE) invaders. PE crabs were better competitors than those from NS and NB, but these differences were not significant. Interspecific competition experiments indicated that the feeding behaviour of recent invaders (NL) and genetically similar but long-established invaders (NS) differed in the presence of juvenile lobsters. Examination of claw sizes revealed no relationship with genetic variability or competitive dominance. Our study documents striking behavioural differences among populations of green crab from a small geographic region, which may reflect a combination of both genetic differences and time since establishment. These differences may result in varying impacts on newly invaded habitats.

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Monitoring of two alien caprellids (crustacea: amphipoda) in southern Spain. A threat to native wildlife

Poster presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -
Contributed

abstract

In order to monitor the population and impact of two non-native crustacean caprellids, the seasonal fluctuations of the caprellid fauna were studied from summer 2010 to spring 2011 at the harbour of Cádiz, Southern Spain. Three caprellid species, the non-native species *Caprella scaura* and *Paracaprella pusilla* and the native *C. equilibra*, were found associated to the hydroid *Eudendrium racemosum* and the bryozoans *Bugula neritina*, *Zoobotryon verticillatum* and the recent invader *Tricellaria inopinata*. *Caprella scaura* was the dominant species in all the substrates during the whole year, in spite of the differences measured in water temperature, salinity and turbidity among seasons. On the other hand, *Caprella equilibra*, very common in other nearby harbours, was scarcely represented in the harbour of Cádiz, probably due to the presence of the invasive *C. scaura*, which shows a very aggressive behaviour and is spreading very fast across the Mediterranean and Atlantic coast. The tropical species *P. pusilla*, which is recorded for the first time in European waters in the present study, was only present in *Z. verticillatum* and *E. racemosum* in summer months, probably due to a higher water temperature during this period. The presence of this species in Southern Spain (temperate area) could be related to climatic change. This study reveals how arborescent substrates such as bryozoans and hydroids, which are present in the pontoon systems, can be suitable habitat for non-native species. These results should be taken into account for an adequate management and monitoring of harbours to avoid new invasions.

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Recovery of invasive and native macroalgae after being removed.

Poster presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: *Eradication/management of invasive species*
Contributed

abstract

The present study evaluates the capability of spread and recovery of well established populations of invasive macroalgae (*Caulerpa racemosa* and *Lophocladia lallemandii*) after being removed on Mediterranean rocky bottom assemblages.
In order to account for changes in a depth gradient, a manipulative experiment was performed at different depths to compare the evolution of (1) *C. racemosa*, (2) *L. lallemandii* and (3) native species in areas where (1), (2) or (3) were actively removed with other control areas were (1), (2),(3) remained untouched. The experiment lasted two years, and independently of the depth, temporal evolution of invasive and native algae was similar in both treatments (previously deprived and untouched). In fact, in only three months no significant differences were detected on *L. lallemandii, C. racemosa* and native algae coverage between treatments, demonstrating that the rapid expansion and high abundance of the invasive species were underpinned by vegetative growth and high recruitment rates. Our results may help to evaluate the futility of removing the studied species as a control strategy. Probably, both species would be slowed more by the removal of small emerging populations (nascent foci) than by a similar or even greater reduction in area of well-established monocultures.

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Barricades and Brick Walls: understanding selective filters on biofouling survivorship during translocation.

Poster presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -
Contributed

abstract

The spread of invasive marine species via vessel biofouling involves multiple successive stages: (1) colonisation of the hull at a source location, (2) translocation to a recipient destination, (3) transfer from the hull to the recipient environment (introduction), (4) colonisation of local habitat/s and (5) establishment. Various selective filters act during each event and dictate which organisms move through to the next stage in the sequence. These filters include: level of hull hygiene, location on hull colonised by the organisms, morphology of the organisms, vessel speed, voyage duration, en route environmental conditions, residence time and environmental conditions at destination, and post-journey fitness of arriving organisms. Despite recent studies aiming to elucidate the relative importance of some of these factors, important knowledge gaps still remain, such as the influence of life-history stage (e.g. post-settlement, juvenile or adult stage) on the survivorship and post-journey fitness of fouling taxa. We aim to address these gaps through manipulative experiments and the synthesis of existing information to provide better tools for the management and prevention of species introductions via vessel biofouling. This work is pertinent in New Zealand where management of invasive species is focused on pre-border control (i.e., the initial colonisation and translocation events), and where the management of marine invasive species and conservation of the marine environment is a high priority.

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Expansion of an alien coral species in the NW Mediterranean

Poster presentation
symposiumtheme1: Patterns of invasion and spread at local, regional, and global scales
symposiumtheme2: -
Contributed

abstract

Climate change and the introduction of alien species are among the main global environmental threats affecting the Mediterranean. The invasive species *Oculina patagonica* is the first alien scleractinian coral that have invaded the Mediterranean. Currently it has been documented to be increasing its abundance. In this study we periodically assessed occurrence of the species on 223 locations distributed along the 400 km coastline of the Catalan coast (40º 31'N - 42º 26'N; latitude). On this basis, we examined the dynamics of the species along 19 years. The species inhabits the shallow infralittoral rocky coast on both natural and artificial habitats. The species was first detected in the southernmost location in 1992 (40º 31'N). By 2010, the species was present in 19 % of the total assessed locations and up to 42º 14'N. Then, *O. patagonica* displayed a mean northward expansion of 22 km/year over the study period. This is consistent with the pattern of south to north decrease in species occurrence, abundance, and maximum colony size. The cumulative number of locations where the species have been observed since first detection characterized by a lag phase of 9 years and an steady increase since year 2001. However, this pattern differed between the two distinct habitats in which the species dwells. The duration of the lag phase on natural habitat was about twice of that on artificial habitat. Over the whole period of invasion of the species the slope on artificial substrate was slightly higher than that on natural substrate. This effect accentuated in the exponential phase in which the slope on artificial substrata was more than two-folds higher than that on natural substrata. Therefore, the species is spreading faster on the artificial habitat than on the natural one. We address the main factors that may have contributed to the pattern of increase abundance and northward expansion of the alien coral species in the NW Mediterranean.

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Discovery and response to colonial tunicate *Didemnum vexillum* infestation in Alaska

Poster presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -
Contributed

abstract

The colonial tunicate, *Didemnum vexillum*, Kott 2002, has a known history of invading and overgrowing marine communities. The species can colonize and dominate remarkably large areas of benthic habitat, including coastal bays and outer coastal areas, causing concerns about potential long-term effects on community structure, critical habitats, and fisheries resources. We report here the occurrence of *D. vexillum* in southeast Alaska, representing a dramatic 1000 km northward extension of this non-native species along western North America. The species was detected as part of a 'bioblitz', engaging citizen scientists to survey local biota and detect non-native marine species incursions. Following detection, the identity of *D. vexillum* was confirmed with robust genetic methods. Although invasions have been relatively rare in Alaskan waters to date, it is now clear that *D. vexillum* is established in at least one harbor. Given the explosive growth and spread of this species in other global regions, and its potential for significant impacts across diverse habitats in Alaska, current efforts are underway to evaluate its full distribution and potential options to eradicate or control the species. We highlight the discovery of *D. vexillum* in Alaska and response actions to date.

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Evidence for loss of genetic diversity during colonization of New Zealand by a Northern Hemisphere solitary ascidian, *Ciona savignyi*

Poster presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -

abstract

Recently, mitochondrial cytochrome oxidase I (COI) gene sequencing lead to the first record of the solitary ascidian *Ciona savignyi* in the southern hemisphere (Nelson, New Zealand, April 2010). To pursue this finding we sought to quantify *C. savignyi* COI genetic diversity within New Zealand and to compare this with *C. savignyi* COI genetic diversity within its native geographical range (i.e. north-west Pacific). Ciona savignyi were collected from the two New Zealand sites where visual surveys had indicated it to be present: Nelson marina and Port Lyttelton. In Japan *C. savignyi* were collected from three sites: Shizugawa Bay, Mutsu Bay and Nabeta Bay. COI sequences (595 bp) were amplified using the PCR. A total of 12 haplotypes were recovered, with the unique: shared haplotype ratios being: Japan 8:2, Nelson 0:2 and Lyttelton 2:2. In general, *C. savignyi* populations from Japan were found to have higher haplotype and nucleotide diversity when compared with both Nelson and Lyttelton. The relative paucity of COI genetic variation in the two New Zealand *C. savignyi* populations is consistent with a founder effect associated loss of genetic diversity. Using the COI sequences we also designed a PCR assay to distinguish *C. savignyi* from the morphologically similar *C. intestinalis*.

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Increased inter-colony fusion is associated with reduced haplotype diversity in an invasive colonial ascidian *Didemnum vexillum*

Oral presentation
symposiumtheme1: *Other topics*
symposiumtheme2: -

abstract

Considerable progress in our understanding of the population genetics of biological invasions has occurred over the past decade. Using selectively neutral loci, it has been established that a reduction in genetic diversity, reflecting a founder effect, has been observed in some invasive populations. However, some colonial organisms may actually gain an ecological advantage from reduced genetic diversity because of the associated reduction in inter-colony conflict. Here we report mitochondrial cytochrome oxidase I (COI) and 18S ribosomal DNA (rDNA) sequence data, as well as inter-colony fusion experiments of the highly invasive colonial ascidian, *Didemnum vexillum*. Phylogenetic analyses of the COI data revealed two distinct clades. One clade appears to be restricted to its probable native region (north-west Pacific Ocean), while the other clade is present in Japan, New Zealand and other temperate coastal areas around the world. This division was supported by the 18S rDNA data, which revealed a one base-pair difference between the two clades. Recently established populations of *Didemnum vexillum* in New Zealand have reduced genetic diversity when compared with populations within Japan. In association with this reduction in genetic diversity was a significantly higher rate inter-colony fusion between New Zealand colonies when compared to colonies from Japan. This study adds to growing evidence that, for colonial organisms with genetically-based inter-colony recognition systems, reductions in genetic diversity may actually enhance invasiveness.

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Comparative responses of xenobiotic metabolism between the invasive species *Solea senegalensis* and the native *Solea solea* from the NW Mediterranean. Is the invasive one more likely to succeed in a climate change context?

Poster presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -

abstract

Solea senegalensis (Kaup, 1858) is considered an invasive species in the Mediterranean. It originates from Tropical Atlantic waters and it has been reported as well established in the Western Mediterranean. Although its presence is recognised since 1920, at present, there is no reliable data on its abundance in respect to the common *S. solea*.

To search into the adaptability of both species to anthropogenic chemicals, and in a context of global water temperature increases, a contrast of the enzymes involved in xenobiotic biotransformation was carried out between the invasive *S. senegalensis* and the native *S. solea*.

For the species comparison, juveniles of both species were sampled in February 2011 from the Ebro Delta region (NW Mediterranean); and the selected enzymes acetylcholinesterase (AChE), carboxylesterase (CbE), ethoxyresorufin O-deethylase (EROD) and glutathione S-transferase (GST) were determined in specific tissues (muscle, gills, gonads, liver and kidney) and, in plasma, lipid peroxidation (LP) was measured as an indicator of oxidative stress damage. Moreover, in vitro responses to the organophosphorous pesticides dichlorvos, malathion and its more toxic metabolite malaoxon were contrasted analysing AChE activity (as indicator of neurotoxicity) in muscle, kidney, gonad, and CbE activity in liver (esterases inhibition). The selection of theses pesticides was made on basis to their use in aquaculture for fish pest control (dichlorvos) and in rice crops (malathion) in the region.

Overall, enzymatic activities were similar in both fish species except for AChE in gills and liver, and for CbE in liver. The reason for this could be partly attributed to a negative effect due to fish size. The conjugation metabolism capacity measured as GST activity was significantly ($p<0.05$) greater in *S. senegalensis* gill and kidney but not in liver. However, as hepatic EROD activity was lower in *S. senegalensis* ($p<0.05$), the biotransformation index (BTI =EROD/GST) was, in the invasive species, half of the value of the native one, revealing a higher detoxication rate in the Senegal sole. Furthermore, in vitro exposures to the three pesticides showed that S. solea was more sensitive to all three pesticides, and confirmed the oxon form as more toxic. These observations suggest a greater adaptability of the invasive species over the native one.

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Long-term incubation experiments as testing tool for ballast water treatment and risk management

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -

abstract

Ballast water is the main vector for marine bioinvasions. To minimize the spread of non-indigenous species and thus possibilities for introducing invaders the International Maritime Organization (IMO) adopted the Ballast Water Management Convention which will come into force within the next months. Ballast water treatment systems using techniques like filtration, Ultra-Violet radiation and chemical disinfection were tested in long-term incubation experiments. During these experiments it was shown that different organism groups survive treatment and re-grow in numbers. Application of flow cytometry, microscopy and DNA-sequencing to these incubation samples gives an indication of the zooplankton, phytoplankton and bacteria species which might be able to get introduced by ballast water discharge - despite treatment. Testing according to IMO guidelines does not give complete insight into the overall effectiveness of ballast water treatment systems, long-term incubation experiments are therefore recommended as an additional testing tool. These experiments are able to point out possible future invaders and should be considered in risk assessment and management strategies.

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Studies on Biofouling in different substratum and characterisation of exopolysaccharide from biofilm bacterium *Bacillus cereus* JBS10 GU812900 in estuarine environment

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: *Ship Biofouling: Vector Characterization and Management Strategies*
Contributed

abstract

The aim of the present study is to compare the fouling communities (micro and macrofouling) between the test panels and to study the main factors that may be controlling these communities. This comparison is based on monthly durations of panel immersion. By using three different test panels (16x10 cmX1mm), monthly samples of marine fouling were collected from the Vellar estuary during November 2008 to December 2009. The deployed test panels when analysed a direct relationship between the rate of corrosion and the concentration of EPS i.e. the rate of corrosion increased with an increase in the concentration of EPS and the period of immersion. The remarkable variation in number and diversity of macrofouling communities in found test panels. Totally 10 species of macrofouling organism were recorded. This data was considering with Primer ver.5.0 software and make a species diversity, richness, evenness and dominance of macrofouling organism. The minimum diversities were recorded during the studies of monsoon season (1.45, 1.38 and 0.96 wood, fibre glass and aluminium test panels respectively) while the maximum diversity, 2.68 (Feb.2009), 2.74 (Jan., 2009) and 2.63 (Feb.2009) was achieved during the study. Moreover, a small shift among the two dominant groups (Polychaete and Barnacles) was noted in all three test panels. The present study indicated that many factors may contribute to fouling, of which nutrient enrichment and salinity is the most important and the nature of the applied test panel. Total heterotrophic bacterial population density also recorded from test panels. In wooden panels, the density of micro fouling bacteria varied between 5.4 X 103 CFU ml^{-1} (November, 2008) and 6.3 X 103 CFU ml^{-1} (October, 2009). In Fiber panels, the microfouling bacteria density recorded from 4.6 X 103 CFU ml^{-1} (November, 2008) to 5.6 X 103 CFU ml^{-1} (October, 2008). With respect to Aluminium panels, the micro fouling bacterial density varied from 4.5 X103 CFU ml^{-1} (November, 2008) to 5.1 X 103 CFU ml^{-1} (October, 2009). 13 biofilm forming bacteria, *Escherichia* sp., *Pseudomonas* sp., *Klebsiella* sp., *Salmonella* sp., *Staphylococcus* sp., *Bacillus* sp., *Bacillus* sp.1, *Streptococcus* sp., *Micrococcus* sp.1, *Micrococcus* sp.2, *Micrococcus* sp.3, *Pseudomonas* sp.1 and *Pseudomonas* sp.2 were isolated and identified. A few bacterial isolates were isolated from the test panels and screened for EPS production and particular strain which showed high amount of EPS was further cultured and identified as *Bacillus cereus* which was confirmed up to species level by 16S rRNA partial gene sequencing. The sequenced product (1498 bp) was recorded in NCBS and an accession number GU812900 was availed. Production, isolation and characterization of the exopolysaccharides produced by the bacterium were evaluated. EPS was produced in all stages of growth but was found to be high during the stationary phase thus revealing it to be a secondary metabolite. The EPS production was influenced by carbon, nitrogen and phosphate concentrations in the growth medium. FTIR analysis revealed the functional groups of the EPS.

KEYWORDS: Biofilm, EPS, Corrosion, Sequencing, GU812900, Secondary metabolite, Characterization, FTIR analysis.

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Assessing control options for the invasive tunicate *Didemnum vexillum*: recommendations for shellfish aquaculture

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: *Eradication/management of invasive species*
Contributed

abstract

Globally, invasive tunicates continue to plague shellfish aquaculture operations by fouling both cultured bivalves and cultivation gear. Recently, in British Columbia, Canada the colonial tunicate *Didemnum vexillum* has become established at various Pacific oyster (*Crassostrea gigas*) aquaculture sites and at some locations it is the dominant fouling species. In the present study we examined potential chemical (4 % hydrated lime exposure), mechanical (removal via scrubbing), and biological treatments (10 green sea urchins, *Strongylocentrotus droebachiensis*, per tray) to control *D. vexillum* fouling oysters grown in suspended tray culture. Both chemical and mechanical treatments reduced *D. vexillum* fouling on oysters by 85 to 96 % while urchins did not reduce fouling substantially. Our results suggest that both lime and mechanical treatments may be viable options for controlling D. vexillum fouling on Pacific oysters, although a decrease in percent survival was observed for lime-treated oysters, suggesting that the concentration and duration of exposure should be investigated further. In a subsequent experiment we explored the efficacy of lime treatments relative to freshwater, brine, and acetic acid (vinegar) treatments by manipulating chemical concentrations and dip durations in an effort to identify the most appropriate combination to utilize at shellfish production sites. Interestingly, the reduction in D. vexillum fouling created free space that allowed botryllid tunicate (*Botrylloides violaceus* and *Botryllus schlosseri*) fouling to increase suggesting a holistic management plan will be required to mitigate invasive tunicate impacts on shellfish aquaculture operations.

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Fugitives into the wild: aquaculture and introduced fish in Canary Islands

Oral presentation
symposiumtheme1: *Other topics*
symposiumtheme2: -
Contributed

abstract

The introduction of species has become an issue of major concern as it is identified as one of the main causes of the biodiversity loss. Different impacts induced by non-native fish such as hybridization, competition and predation on native species have been recorded in fresh and marine waters. Aquaculture is one of the main vectors for the introduction of fish in aquatic environments and thus there is a need for experimental studies that highlight the possible risks of introducing species for this activity.

Canary Islands have turn into a natural laboratory to study the consequences of the introduction of marine fish by aquaculture. European sea bass (*Dicentrachus labrax*) and sea bream (*Sparus aurata*) have been introduced in three out of the seven islands, and translocated in one of them. Meagre (*Argyrosomus regius*) has been introduced in two of the islands. Taking into account this scenario our study deals with the biogeography of cultured fish in the archipelago, causes of escapes and magnitude of escape events. A compilation of published and non published data on the role that escaped fish are playing in shallow coastal habitats are also presented putting it in relation to general ecological theories and discussing the implications for other areas were these species are cultured. Recommendations on management policies are given to avoid and mitigate possible damages to the environment.

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Invasive species and trophic interactions: what do native predators prefer? An experimental test with invasive ascidians

Oral presentation
symposiumtheme1: -
symposiumtheme2: -
Contributed

abstract

Understanding the mechanisms that limit species invasions is a major concern for conservation. The Enemy Release Hypothesis (ERH) predicts that and introduced species will successfully spread in a new environment where it lacks its natural predators, while the Biotic Resistance Hypothesis (BRH) suggests that introduced species are constrained by competence with native species and predation from native predators. Numerous studies confirm both hypotheses in terrestrial and freshwater systems, while the role of native enemies in regulating marine invasions is still poorly understood. In addition, some authors have argued that the phylogenetic relationship between invasive and native species can be a predictive tool to forecast invasions, and that exotic plants that are closely related to native species are more vulnerable to native herbivores since they are more likely to be functionally similar to their native 'pairs'. Introduced ascidians are an increasing concern in marine systems, where they can have important ecological and economical impacts. In this work we used a series of paired-choice feeding experiments to ask: 1) Do native generalist predators prefer native to introduced species)? and 2) Is feeding behaviour of native predators influenced by the phylogenetic relationship between native and introduced species? We found support for BRH, with sea stars often preferring the exotic species to the native ones. In addition, no clear relationship was observed between degree of relatedness and susceptibility to native enemies. Predation can stronly determine the structure and composition of fouling communities, and our results suggest it could also contribute to limiting tunicate invasions.

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Tropical fish in temperate systems: phase shifts in Eastern Mediterranean benthic communities

Poster presentation
symposiumtheme1: -
symposiumtheme2: *New species in an ancient sea: the Mediterranean cross road*
Contributed

abstract

Biological invasions are an increasing threat to the conservation of biodiversity. Mediterranean shallow subtidal habitats are typically dominated by diverse algal beds and seagrass meadows and have low diversity and abundance of herbivorous fish, with only one species (*Sarpa salpa*) being widespread along the entire Mediterranean basin. This situation, however, is changing in the Eastern Mediterranean, where two tropical herbivorous fish (*Siganus rivulatus* and *S. luridus*) have been introduced from the Red Sea. We assessed the potential community-wide effects of these exotic tropical species on shallow rocky habitats along a gradient of distance to the Suez Canal. We found that abundance and composition of herbivores strongly changed with distance from the channel, shifting from relatively low abundance of temperate native herbivores in Greece to high abundance and dominance of exotic herbivores of tropical origins in east Turkey. In areas with high abundances of exotic fish (but not of sea urchins) we also observed large areas denuded of algal cover. In the context of global warming, termophilic species are expected to expand their distributions into temperate areas. In the case of tropical herbivorous fish, which are generally characterized by high razing rates, their expansion into low herbivory regions could have devastating consequences for native algal systems.

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Comparing marine invasions across the Panama Canal

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -
Contributed

abstract

Panama is an important focal point for the study of ship-mediated marine and coastal invasions and provides the opportunity to evaluate hypotheses about invasion dynamics. The Panama Canal serves as an aquatic corridor between the Atlantic and Pacific oceans. Since its opening in 1914, approximately 800,000 ocean-going commercial vessels have passed through the Canal. Recently, the annual number of commercial ship transits exceeded twice the number of ship arrivals in the largest U.S. ports. This suggests that the potential supply of organisms associated with ships may be relatively high, yet reports of marine invasions are limited in this tropical region. Current efforts for expanding the capacity of the Panama Canal and Panama's ports will increase shipping and the potential for invasions beginning in 2014. To develop a preliminary baseline of current introduced marine invertebrates in Panama and to compare faunal similarity between the Atlantic and Pacific entrances of the Panama Canal we used standardized collectors to characterize sessile invertebrate communities from 2007-2010.

We found a greater proportion of introduced species in the Pacific compared to the Atlantic. In total, over a 3 year period, we encountered 82 sessile invertebrate species in our Atlantic collections, of which 18 % were known introduced species. In contrast, we encountered only 62 species in our Pacific collections, of which 28 % were considered introduced. For both coasts, approximately 50 % of the species encountered were either cryptogenic or unresolved. Using a combination of data from our surveys, literature, reports and museum collections, a total of 62 introduced marine species are currently reported from Panama's Pacific Coast and 29 are reported from Panama's Atlantic Coast. There is noticeable asymmetry in biotic exchange, with 33 species (50 % of total) introduced to the Pacific are of Atlantic origin but only 9 species (<30 % of total) in the Atlantic are of Pacific origin.

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Do we care about non-indigenous species in Marine Protected Areas?

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -

abstract

Western Australia's marine environment ranges from pristine, isolated reefs to local beaches, popular for family holidays. Many areas of this unique coastline are protected through the establishment of Marine Protected Areas (MPAs). However, the marine environment and protected areas are vulnerable to impacts such as non-indigenous species (NIS). Of concern is that the level of protection granted to an MPA can also extend to NIS once NIS are within the boundary of the protected area. To effectively prevent impacts from NIS within MPAs, management plans governing these areas must be flexible and allow for a rapid response to a NIS incursion. With this in mind, we undertook a study to investigate the perception of ecological risks associated with NIS and people's support for controlling NIS impacts on the marine environment. This study was implemented at three locations in Western Australia that ranged from iconic international destinations to family friendly holiday locations. Our aim was to try and understand characteristics, such as demographics, that influence risk perceptions related to NIS as this information can be useful for targeted, educational initiatives to reduce the likelihood of NIS incursions.

To do this, we developed a questionnaire to collect data onsite, administered through face-to-face interviews. Our results indicate that gender and age influenced respondents' perception of risk of NIS, yet knowledge of NIS, education level, and income level had no influence. Survey respondents had a high level of self-rated knowledge of NIS and they also indicated a willingness to support management interventions to prevent or control the spread of NIS in Western Australia. This information begins to smooth the way for management to proactively develop and implement policies that are necessary to more fully protect the Western Australian marine environment. It also leads to potential management directions (via targeted education and outreach) that may be useful for the management of NIS in other high-value or protected areas in Australia and elsewhere.

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Morphological and molecular identification of rare and thermophilic species in the central Tyrrhenian sea

Poster presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: *Eradication/management of invasive species*
Contributed

abstract

In this study, we present morphological and molecular data of six interesting species captured in the Tyrrhenian Sea. Two of these, the crustacean *Marsupenaeus japonicus* (Bate 1888) and the fish *Fistularia commersoni* (Rüppell, 1835) are allochthonous species penetrated into the Mediterranean through Suez Canal (Red Sea). The fish *Pomadasys incisus* (Bowdich, 1825) is autochthonous but basically restricted to the southern parts of the Mediterranean. The others fishes, *Galeus melastomus* (Rafinesque, 1810), *Phycis chesteri* (Goode & Bean, 1878) and *Sudis hyalina* (Rafinesque, 1810) are all autochthonous species interesting because of sporadic occurrence. Analyses of the mitochondrial gene 12S mt-rRNA confirms all morphological identifications, documents for the first time its sequence for *Galeus melastomus*, *Sudis hyalina* and *Pomadasys incisus* as new entries in GenBank and permits the improving of the Mediterranean rare and thermophilic species knowledge. Furthermore, the potential molecular identification role of in a systematic monitoring program on the tropicalization and meridionalization impacts across the basin will be reported.

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Coming and going: Temporal genetic variability of the introduced sea squirt *Styela plicata*

Poster presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: *Application of genetic methods for reconstructing invasion histories*
Contributed

abstract

Introduced species may have an important impact on the natural ecosystem, disrupting ecological processes such as succession and species composition. *Styela plicata* is a solitary ascidian commonly found in harbors and marinas from tropical and temperate waters. This species is believed to have spread worldwide travelling on ship hulls. In this study, we determined the temporal genetic structure between and within cohorts of S. plicata. Samples were collected from the decks of the Center for Marine Science (UNC Wilmington, USA) between February 2007 and July 2009. We used the 454 Genome Sequencer GS-FLX next-generation sequencing platform to obtain 159,832 genomic reads averaging 278 bp. These sequences were then analyzed for repeat motives using Phobos v 3.3.12. We obtained over 100 potential microsatellite regions and from these, we isolated 8 polymorphic microsatellites. Our results showed that there were genetic differences among cohorts during the 2.5 years of study. In addition, there was a clear shift in the genetic structure of the population between May and July. This shift may be due to the high mortality event recorded every June, followed by the arrival of new recruits in July. Our results suggest that the dispersion and re-colonization of *Styela plicata* in coastal waters of North Carolina is an ongoing process. The most parsimonious explanation is an arrival of new recruits carried by the many ships that cross the Intracostal Waterway, which runs parallel to the coast from New Jersey to Texas.

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Assessment a\secondary Biofouling Patternsin Gorgon Project construction vessels operating in a marine protected ara

Oral presentation
symposiumtheme1: -
symposiumtheme2: -
Contributed

abstract

The Gorgon Liquefied Natural Gas (LNG) Project is the largest infrastructure development in Australia's history. When completed Gorgon will ship 15 million tonnes per annum from an LNG plant at Barrow Island in northern Western Australia. The project includes the development of major infrastructure for shipment of LNG by vessels. As the operator, Chevron Australia recognises the substantial environmental values of the marine and terrestrial environments of the region and is committed to maintaining these values. A key commitment is that no marine pests be introduced to island waters. A comprehensive marine pest strategy has been developed to initiate quarantine barriers to prevent arrivals, monitor for any penetrate the barriers, and respond to any penetrations. The present talk deals only with vessel inspections. During the current construction phase all vessels mobilising to Barrow Island must be free of secondary biofouling. To ensure this, there is an extensive inspection program of premobilisation inspections with vessels cleaned if necessary. The key question: 'How long can vessels remain in water and still be considered free of secondary biofouling?' is ecologically and economically important. To address this, results of a series of inspections were analysed, including both vessels commencing and departing from Gorgon service. Most of the commencing vessels had a fresh antifouling coating. Topsides, internal seawater systems, and open hull surfaces were largely free of secondary biofouling, which was concentrated in niche areas such as bow thrusters, seachests, anodes, grates, propellers, rudders, etc. Barnacles, particularly acorn barnacles, dominated; 13 species were found. Seventeen species of molluscs were identified, mostly juvenile bivalves, and also filamentous algae and serpulid polychaetes. Four vessels detected with marine pests (Asian green mussels and barnacles) were dry-docked and cleaned. These results will be combined with other data such as areas of operation, presence/absence of marine pests in the originating port, species tolerances and monitoring results to determine how long vessels can be left before being reinspected and, if necessary, cleaned.

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Response of Macroalgae Assemblages to an Invasion and Climate Change Scenario

Oral presentation
symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: -
Contributed

abstract

There is a general consensus that non-indigenous species and climate change are amongst the most serious environmental threats in marine systems, however experimental evidence is limited. Through an experimental study in mesocosms we investigated the effects of two climate-driven stressors (temperature and CO_2 increase), and their interactions with invasive species on the functioning of marine macroalgal assemblages. The experimental set up included two levels of temperature (15 versus 20 ºC) and CO_2 conditions (ambient levels and average values of 1000 ppmv (IPCC scenario in 2100)). We used synthetic macroalgal assemblages as model communities, and we used combinations of 4 morpho-functional groups to obtain different levels of functional richness. Within the canopy forming functional group we included both, native species (*Cystoseira tamariscifolia*) and the invasive *Sargassum muticum*. In total, we used 128 artificial assemblages arranged in eight different tanks with the environmental conditions orthogonally applied. Community assemblages were monitored during the experiment and four ecosystem-function parameters were measured: biomass, productivity, respiration and photosynthetic efficiency (PAM). Results suggest that while the structure (identity & diversity) of our assemblages was not the key driver of the reaction of assemblages to stress, unexpected interactions among physical stressors may difficult our capacity to predict the consequences of climate change.

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Alien Macrophytes In The Mediterranean Sea: Towards Homogenisation Of Biota

Oral presentation
symposiumtheme1: -
symposiumtheme2: *New species in an ancient sea: the Mediterranean cross road*
Invited

abstract

The Mediterranean Sea is a hotspot for species diversity (12 % of the worldwide macrophyte flora for 0.8 % of the ocean surface area) but also for seascape diversity owing to a high, low-scale, spatial heterogeneity of benthic assemblages. Two other important characteristics of most Mediterranean marine macrophytes are a small size (very few exceed 10-20 cm height) and a high seasonality. Small size, seasonality, and high species diversity are weaknesses in the face of biological invasions, and when coupled to several different sources of introduction (Suez Canal, aquaculture, ballast waters, fouling...) make the Mediterranean Sea a hotspot for marine species introduction. A total of 125 alien macrophytes have been listed to date in the Mediterranean Sea. Among them, 21 taxa are invasive or potentially invasive, that is they are able to impact native assemblages, ecosystem functioning and economic activities. They are either relatively big size species (e.g. *Asparagopsis* spp., *Caulerpa* spp., *Stypopodium schimperi*), or small filamentous species (e.g. *Acrothamnion preissii*, *Lophocladia lallemandii*, *Womersleyella setacea*) but all of them are able to constitute dense and extensive populations. Their number decreases from west to east: western Mediterranean (16), Adriatic Sea (14), central Mediterranean (13), and eastern Mediterranean (11). Only 7 species are known from the four basins: *Asparagopsis taxiformis*, *Caulerpa racemosa* var. *cylindracea*, *Caulerpa taxifolia*, *Codium fragile*, *Halophila stipulacea*, *L. lallemandii* and *W. setacea*. In coastal lagoons harboring shellfish farming, the alien flora has dramatically disrupted the ecosystem; e.g. in Thau Lagoon (France), alien species contributes to 32 % of the flora and up to 99 % of macrophyte biomass on hard substrates. In open sea, invasive macrophytes can constitute permanent and dense populations. Among them *A. preissii*, *Caulerpa* spp. and *W. setacea* are probably the most aggressive alien macrophytes. They monopolize space, reduce native species abundance and change species and habitat diversity, competition and energy flow (e.g. *A. preissii* and *W. setacea* in Coralligenous bioconstructions and *Posidonia oceanica* meadows). In the same way, *Caulerpa racemosa* var. *cylindracea* and *C. taxifolia* are able to invade most Mediterranean habitats from the sea surface to 40-60 m depth. A worrying homogenisation of biota is on-going: the highly diverse Mediterranean seascapes are progressively giving way to species-poor benthic assemblages dominated by a few invasive species. This change is driving the Mediterranean Sea into uncharted territories, and human interactions with marine life will probably be drastically changed.

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Native and Invasive Populations of the slipper limpet *Crepidula fornicata* Differ in their Tolerance to Abiotic Stress

Poster presentation
symposiumtheme1: *Development and tests of invasion theory*
symposiumtheme2: -
Contributed

abstract

To prevent future invasions or to mitigate their impacts, it is important to understand the factors that make species successful invaders. One trait considered crucial for invasion success - especially during early stages of the invasion process - is stress tolerance, i.e. the ability to endure unfavourable fluctuations in environmental parameters. Previous studies compared stress tolerance in native and non-native benthic marine invertebrates that share the same habitat or that are phylogenetically similar. The majority of them showed that invasive species generally exhibit a higher stress tolerance. However, so far no studies in the marine environment examined whether native and non-native populations of the same species differ in physiological robustness. To fill this gap, we investigated the effects of a common abiotic stressor on an invasive marine mollusc. We exposed specimens from one native (Connecticut, USA) and two invasive (Washington State, USA and Wales, UK) populations of the American slipper limpet *Crepidula fornicata* to hyposalinity (17 PSU) for seven days and compared survival rates between populations after this period. The invasive population from Wales was more tolerant to hyposalinity than the native, while the one from the North-American West Coast was not. Even though our results are ambiguous, they suggest that tolerance to abiotic stress is not only a species-specific trait but can also vary between populations from the native and the invasive range of the same species. Increased stress tolerance in invasive populations could result from the selection for stress tolerant genotypes during the invasion process or from the release from predators, pathogens, parasites or competitors in the new habitats.

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Monitoring for Introduced Marine Pests for the Gorgon LNG Project

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -
Contributed

abstract

As the operator of the Gorgon Project, Chevron Australia Pty Ltd is constructing a major gas processing plant at Barrow Island, WA. Along with the widely known terrestrial environmental values of Barrow Island there are also substantial marine environmental values. Chevron has adopted an extensive, proactive program to protect the Barrow Island marine environment from introduced marine pests, including mechanisms to prevent their arrival, a monitoring program to detect any IMP that do arrive and action plans should a pest species be detected. A monitoring strategy based on the Australian national IMP monitoring protocols has been developed for Barrow Island. Remote Operated Vehicle (ROV) transects are made at six monthly intervals at a combination of sites offshore of the island within and outside operational areas. The ROV surveys are supplemented by sampling by beam trawl of biota in sandy areas. Grab samples are used to collect sediment for analysis for dinoflagellate cysts. Quarterly monitoring occurs at five sites along the east coast of Barrow Island, using a combination of shoreline visual searches, settlement plates and sediment cores for toxic dinoflagellates. A similar quarterly sampling program has been established at the major Gorgon supply bases at Henderson, south of Perth, and Dampier to provide early warning should an IMP be detected in either locality. The monitoring program began in April 2010, so the first full year of data are available. To date, no potential marine pest species have been detected except for the European fanworm *Sabella spallanzanii* in the temperate marine environment at Henderson. This species is widespread in southern Australia. It has been known in Western Australia since 1964, and in the Henderson region since at least since 1995. The European fanworm has not extended its range northward and is considered unlikely to be able to survive the tropical temperatures of Barrow Island.

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Biological traits favouring the occurrence and spread of Atlantic thermophilic fish species in the Mediterranean sea

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: *New species in an ancient sea: the Mediterranean cross road*

abstract

In the last decades an increasing number of species have exceeded their geographical limits reaching Mediterranean waters by two principal entrances: Suez channel - lessepsian species with Red Sea or Indopacific origin, and Gibraltar Strait, with Atlantic origin. Fifty-seven out of 75 Atlantic thermophilic species known to have reached the Mediterranean, for whose biological data that could be related with the capability of dispersal was available, were considered in this work. The effect of quantitative variables of species (maximum length, depth range, number of related taxa and geographical distribution limits) and other variables related with dispersal success (antiquity and distance travelled) were analysed using multiple linear regression. On the other hand, the effect of factors climate affinity, eggs type, mobility, shoaling, trophic and spatial categories and resiliency over antiquity was evaluated using ANOVA. At last a correspondence analysis was applied to investigate the relation between species and their biological and ecological characteristics. The 57 species analysed were distributed in 27 families, with 12 % of fish species belonging to Sparidae and 20 % to the order Perciform. Acanthuridae and Polynemidae were new family registers for Mediterranean waters. Geographical distribution was significant related with antiquity and could explain partially species variation. Species showing more septentrional distribution limits were found at a longer time than species with meridional distribution range. This fact could be directly linked with global warming, and if so, it would be expected that the thermophilic species record will increase in the next decades. Under this view, specific methods for measure and detection should be adopted instead of species record haphazardly obtained and subsequently published. The establishment of a coordinated system is needed in order to properly investigate the causes and effects of thermophilic species range shift in Mediterranean waters.

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Factors affecting distribution and abundance of *Percnon gibbesi* (H. Milne-Edwards, 1853) in Cabo de Palos - Islas Hormigas marine reserve and adjacent areas

Poster presentation

symposiumtheme1: *Impact of bioinvasions on ecosystem structure and function, including the biology and ecology of invasive species*
symposiumtheme2: *New species in an ancient sea: the Mediterranean cross road*

abstract

The abundance of the allochtonous crab *Percnon gibbesi* and its relationships with structural habitat, protection status, isolation, and the abundance of other benthic invertebrate species was assessed using a visual census technique in Cabo de Palos - Islas Hormigas marine reserve and adjacent unprotected sites in SW Mediterranean. Neither protection measures nor isolation degree exerted a significant influence on the abundance of the studied species, although a non-significant trend to lower densities in both protected and insular sites was evident; in addition, a significant spatial variability was detected at finer spatial scale (among sites), likely due to spatial variations of habitat at this scale. The presence of small holes, incrusting algae and low slope favor the abundance of this crustacean. The abundance of *P. gibbesi* appeared to be similar to potentially competing native species, although some species (e.g. *Pachygrapsus marmoratus*) showed lower values of abundance in those sites were *P. gibbesi* was more abundant.

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The effect of vessel sound on larval settlement

Oral presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: *Ship Biofouling: Vector Characterization and Management Strategies*
Contributed

abstract

Recent research indicates that underwater sound plays an important ecological role in the settlement behaviour of many coastal organisms. Laboratory and field experiments have shown that sound triggers a more rapid settlement response in a wide range of species, culminating in physiologically induced earlier settlement and metamorphosis. Large steel hulled vessels are well known to be a major source of underwater sound in the oceans. Large steel hulled vessels are also noted for their propensity to accumulate marine fouling, mostly from the settlement of invertebrates such as crustaceans (barnacles), cnidarians (anemones), ascidians (sea squirts) and algae. Many millions are spent each year on methods attempting to control the fouling on commercial marine vessels.

The basis of this research was to test the hypothesis that the fouling of vessels by marine invertebrates was greatly enhanced by the underwater sound the vessels emit while in port. In the laboratory, several larval species were exposed to vessel noise pre-recorded from large steel hulled ships. In addition, settlement plates were deployed in a harbour (free of vessel traffic) and subjected to pre-recorded noise.

Preliminary results have indicated there is a significant increase in settlement and metamorphosis of larvae when subjected to vessel noise. This research is the first of its kind to test this hypothesis and the results may have global significance and wide ranging implications for biosecurity and vessel-mediated spread of invasive species.

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Development of a real-time PCR assay for the detection of the invasive clam, *Corbula amurensis*, in environmental samples

Poster presentation
symposiumtheme1: *New tools for identification, monitoring, risk assessment, and management*
symposiumtheme2: -
Contributed

abstract

The detection of invasive species soon after an incursion, when the population is confined to a small area and at a low density maximizes the probability of successful eradication. As such, a number of sensitive molecular methods have been developed for identifying the larvae of marine invertebrate pests at low concentrations. In this study we developed a real-time PCR assay targeting the 18S ribosomal DNA for the rapid and accurate identification of *Corbula amurensis* in environmental samples. Larvae of *C. amurensis* were spiked into commonly encountered sampling matrices including benthic assemblages, biofilms, sediment grabs and plankton net hauls, and the sensitivity of the assay was assessed. The assay can detect one larva in up to 10 g of sediment and five larvae in 10 g of benthic invertebrate and macro-algal assemblages. Seawater and benthic assemblages samples were collected from four major ports around New Zealand and all were negative for *C. amurensis*. This assay has the potential to enhance current monitoring methods, especially with regards to the detection of early life-stages which are difficult to identify morphologically. Real-time PCR can be used in high through-put platforms and is extremely sensitive, allowing for the detection of marine pests at the initial stages of incursions.

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Why didn't we notice them earlier? The invasive fish *Carassius gibelio* (gibel carp) identified by genetic methods in Swedish waters.

Poster presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -
Contributed

abstract

In Europe, some of the most successful invasive fish species belong to the genus *Carassius* (Cypriniformes, Cyprinidae, Cyprininae). Gibel carp (*Carassius gibelio*) and goldfish (*Carassius auratus*) have been introduced and are widely distributed in Europe. Especially gibel carp (also called Prussian or silver carp) has shown a rapid increase in abundance in certain areas, e.g. coastal waters of Estonia, which has had impacts on the ecosystem, affecting the indigenous ichthyofauna. Gibel carp has also had a major impact on freshwater habitats such as the Dyje River in the Czech Republic. The native and closely related crucian carp (*Carassius carassius*) has reportedly suffered when in contact with gibel carp. In addition to competition for space and food, the species hybridize frequently. Despite the presence of gibel carp in the southern and south-eastern parts of the Baltic Sea coast, no recordings of the species have been done in Sweden. The short distance (approximately 150 km) between the most eastern part of Sweden, the island of Gotland, and the eastern coast of the Baltic, should not be an insuperable barrier. Indeed, here we present the first data of gibel carp and hybrids with crucian carp in Swedish waters. We studied two localities on the island of Gotland and one on the mainland, close to the city of Kalmar, and in all three sampling sites, hybrids where found. This shows that the presence of gibel carp, hybrids especially, could be substantial and highly underestimated. The genetic analyses, both mtDNA and microsatellites, reveal a complex genetic diversity in the fishes, suggestive of more than one immigration or introduction.

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Response to the invasion of the Asian kelp *Undaria pinnatifida* in a major port: 1.5 years of management efforts in San Francisco Bay

Oral presentation
symposiumtheme1: -
symposiumtheme2: *Eradication/management of invasive species*
Contributed

abstract

In May 2009, we found the Asian kelp *Undaria pinnatifida* at two marinas in San Francisco Bay and at Pillar Point Harbor, in Half Moon Bay, 35 km to the south. While *Undaria* was reported from the California coast in 2000, Monterey Harbor (170 km south) had been its northernmost extent since 2001. San Francisco Bay is major commercial shipping and fishing port; if *Undaria* were to become widespread in the Bay, the risk of further vessel-mediated spread would dramatically increase. Here we report on efforts to map and control the spread of *Undaria* over the past 1.5 years.

We surveyed 60 marinas and waterfront sites in SF Bay, some of these multiple times. We removed *Undaria* monthly at two marinas in SF Bay and at Pillar Point. We also tested freshwater and dilute acetic acid as killing agents in the laboratory. We removed ~7,000 thalli (500 kilos) of *Undaria* from target marinas. Effects of hand removals were mixed and proportional to the size of the population and marina area: at Pillar Point, the smallest initial population, *Undaria* decreased to the point where we did not detect any for five months, although individuals later appeared at 'hot spots,' including an abandoned vessel. At SF Marina, mean size and number of reproductive individuals decreased. At South Beach Marina, a large marina with the biggest population of *Undaria*, we were only able to regularly remove from two docks, and we did not see a decrease in population, mean size or number of reproductive individuals.

Hand removals require long-term commitment and will not be effective in situations where some (unknown) critical percentage of the population cannot be detected or removed. Acetic acid and freshwater were effective in killing *Undaria*. These or other treatments that could target all potential substrate and kill gametophytes and sporophytes are likely to be more effective and cost-efficient over the long haul.

Undaria was found at 10 sites, many of which are contiguous to one another. As of early 2011, *Undaria* appeared to be limited to the SF waterfront and not spreading rapidly between marinas. However, dock renovations at SF Marina resulted in over 100 resident boats dispersing to other marinas in March 2011. There was no agency with the authority to require cleaning before departure and no way to track the fate of the vessels leaving the marina. Despite attempts by individual harbormasters, and one city, to limit exposure by requiring boats from SF Marina to haul out before arrival, this event is likely to increase the rate of spread of *Undaria* within the Bay.

We are developing an eradication plan for SF Bay that could serve as a model for use in other locations and an early-detection/rapid response network for the coast north of the Bay; however both efforts are seriously underfunded. Lack of authority to control infested vessels, or any central agency to which boaters report movements are additional stumbling blocks to attempts to control and eradicate this invader.

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Native biota colonization by its lessepsian counterpart (Gulf of Tunis, northTunisia).

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: *New species in an ancient sea: the Mediterranean cross road*
Contributed

abstract

Subtidal rocky biotope monitoring of the North Coast of the Tunis Gulf (West side of Cap Bon, February 2011) allowed us to discover the recent colonization of an intertidal biocenosis of lessepsian origin that included the gastropods *Cellana rota* Gmelin1791 and *Monodonta nebulosa* Forsskal in Niebuhr, 1775, the Brachyura Hymenosomatidae *Elamena matheoi* (Desmarest, 1823) and the Majidae Epialthidae *Menaethius monoceros* Latreille, 1825.
The Nacellidae *Cellana rota* already present in Tunisia in the area of Zarzis (south Tunisia, Zaouali & Coll., 2007) cohabits in Cap Bon (north Tunisia) with *Patella caerulea* (average ratio 1/7); the Trochidae *Monodonta nebulosa*, never reported before in the Mediterranean Sea, cohabits (Cap Bon) with *Osilinus turbinatus* (average ratio 1/20). The presence of the Brachyura *Elemena matheoi* was previously unknown for the Mediterranean Sea, whilst *Menaethius monoceros* was cited only in the Tyrrhenian Sea.
As it was already observed in Tripoli (Libya) and Zarzis (Tunisia) the association of these Lessepsian species looks like the indigenous biota (Zaouali & Coll., 2007). What was the driver of this joint transfer? According to our study, the most likely cause of this invasion was the 'stabulation' of mollusks from the indo-Pacific area.

Bibliography

Zaouali J., ben Souissi J., Sthor. S., d'Udekeim d'Acoz C. and ben Abdallah A., 2007. Contribution à l'étude des peuplements actuels des substrats solides de l'étage médiolittoral de la Méditerranée orientale. Rapp. Comm. int. Mer Médit. 38: 639.

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Invasion genetics of the *Ciona intestinalis* species complex: from regional endemism to global homogeneity

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -
Contributed

abstract

Determining the degree of population connectivity and investigating factors driving genetic exchange at various geographic scales is essential to understanding population dynamics and spread potential of invasive species. Here we explore these issues in the highly invasive vase tunicate, *Ciona intestinalis*, a species whose invasion history has been obscured by its poorly understood taxonomy and population genetics. Recent phylogenetic and comparative genomic studies suggest that *C. intestinalis* is a cryptic species complex consisting of at least three species. We reconstructed phylogenies based on both mitochondrial (cytochrome c oxidase subunit 3 - NADH dehydrogenase subunit 1 region and NADH dehydrogenase subunit 4 gene) and nuclear (internal transcribed spacer 1) sequences, results of which support four major phylogroups corresponding to the previously reported spA, spB, and C. spp (spC) as well as an undescribed cryptic species (spD). While spC and spD remain restricted to their native ranges in the Mediterranean Sea and Black Sea, respectively, the highly invasive species (spA and spB) have disjunct global distributions. Despite extensive interspecific divergences, we identified low phylogeographic structure within these two invasive species. Haplotype network analyses revealed comparatively limited mutation steps among haplotypes within each species. Population genetic analyses based on two mtDNA fragments and eight unlinked microsatellites illustrated relatively low population differentiation and high population connectivity at both regional and continental scales in the two invasive species. Human-mediated dispersal coupled with a high potential for natural dispersal are likely responsible for the observed genetic homogeneity.

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Spatial distribution and temporal trends of soft-bottom marine benthic alien species in the Basque coast (N of Spain)

Oral presentation
symposiumtheme1: *Patterns of invasion and spread at local, regional, and global scales*
symposiumtheme2: -
Contributed

abstract

Introduction of alien species is a growing environmental issue world-wide since it represents one of the most important causes of biodiversity loss. The aim of the present study is to analyse the spatial distribution and temporal trends of soft-bottom marine benthic alien species in the Basque coast and in the Nervión estuary, a heavily hydromorphologically modified and historically contaminated water body located in the Basque country, north of Spain. The evaluation of marine benthic alien species was accomplished by using data obtained from 1989 to 2010 in different projects carried out by AZTI-Tecnalia. For the evaluation, a total of 39,195 records were analysed and crossed against a list containing 217 alien species identified in the Bay of Biscay. Results indicate that the percentage of exotic species with respect to native species was 2.8 in the Basque coast and 3.3 in the Nervión estuary, suggesting that the introduction of species could be related to maritime transport activities (input of ballast water, biofouling, etc.). In overall, alien species identified in the study belonged to phyla annelida, arthropoda, mollusca and cnidaria. The most abundant alien species, both in the Basque coast and the Nervión estuary, was the polychaete *Pseudoplydora paucibranchiata*, representing a 24.8 % and 33.7 % of the total of the cases respectively. Due to its opportunistic strategy and capacity to survive in reduced sediments and hypoxic conditions, *P. paucibranchiata* was a dominant species at the most contaminated sites such as ports. Besides, in the Nervión estuary, this polychaete was predominant in the intermediate part of the estuary, where, historically, the activities of the port of Bilbao were located. Apparently, ports seem to be highly affected by the presence of alien species, suggesting that maritime traffic activities could be the main sources of introduction. However, as the alien species identified in this study are not invasive, and no clear temporal trends are observed, there is no evidence of great risk for native biodiversity to be threatened.

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