

Marine Science Review – 239

Introduced Species

In this review:

- A. Recent articles – no abstract available
- B. Recent articles with abstracts

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MacPhee, B. **Hitchhikers' guide to the Ballast Water Management Convention: An analysis of legal mechanisms to address the issue of alien invasive species.** *Journal of International Wildlife Law and Policy* 10(1): 29-54, 2007.

Wagner, D. and Kahng, S. E. **New report of nudibranch predators of the invasive octocoral *Carijoa riisei* in the Main Hawaiian Islands.** *Coral Reefs* 26(2): 411, 2007.

Moore, A. and Ndobe, S. **Discovery of an introduced banggai cardinalfish population in Palu Bay, Central Sulawesi, Indonesia.** *Coral Reefs* 26(3): 569, 2007.

B. Recent articles with abstracts

Karlson, A.M.L., Almqvist, G., Skora, K.E., and Appelberg, M. **Indications of competition between non-indigenous round goby and native flounder in the Baltic Sea.** *ICES Journal of Marine Science* 64(3): 479-486, 2007.

Notes: The Ponto-Caspian round goby (*Neogobius melanostomus*) was introduced to the Gulf of Gdansk, southern Baltic Sea, in the late 1980s, and it has now become the dominant demersal fish species in shallow water. This study aimed to assess diet preferences and the degree of diet overlap between the round goby and the native flounder (*Platichthys flesus*). Results from time-series of stomach contents and stable isotope analyses of wild-caught fish, together with prey preference experiments carried out in the laboratory, showed that the two species consumed similar species and sizes of prey. The similarities in diet suggest potential for food competition. Catch data showed both reverse depth distributions of round goby and flounder when round gobies were abundant and that the abundances of the two species were negatively correlated. The diet overlap between small flounders and round gobies was greatest when goby abundance was least, suggesting that abundance of round gobies may restrict flounder habitat utilization and, therefore, also food availability to the latter. Therefore, round gobies may have a negative influence on the commercially important flounder.

Humphreys, J., Caldwell, R.W.G., McGrorty, S., West, A.D., and Jensen, A.C. **Population dynamics of naturalised Manila clams *Ruditapes philippinarum* in British coastal waters.** *Marine Biology* 151(6): 2255-2270, 2007.

Notes: The Manila clam *Ruditapes philippinarum* was introduced to Poole Harbour (lat 50°N) on the south coast of England in 1988 as a novel species for aquaculture. Contrary to expectations, this species naturalised. We report on individual growth patterns, recruitment, mortality and production within this population. On the intertidal mudflats the abundance of clams (> 5 mm in length) varied seasonally between 18 and 56 individuals m². There appear to be two recruitment events per year and there were 6 year classes in the population. A mid-summer decline in abundance was partly due to increased mortality but probably also a result of down-shore migration in response to high water temperatures and the development of anoxic conditions. A winter fishery removes c 75% of clams of fishable size (maximum shell length ≥ 40 mm) and c 20% of the

annual production. The fishery depresses the maximum age and size attained by the clams but appears to be sustainable. Clam mortality due to factors other than fishing is highest in late-winter to early spring. The growth of the clams is intermediate in comparison with many published studies but remarkably good given their intertidal position. As on the coasts of the Adriatic Sea, where the clam is also non-native, the Manila clam has thrived in a shallow, eutrophic, lagoon-like system on the English coast. While the Poole Harbour population is currently Europe's most northerly reported self-sustaining, naturalised population, given forecasts of increasing air and sea temperatures it might be expected that this species will eventually spread to more sites around the coasts of Northern Europe with associated economic and ecological consequences.

Kruse, I. and Hare, M.P. **Genetic diversity and expanding nonindigenous range of the rhizocephalan *Loxothylacus panopaei* parasitizing mud crabs in the western North Atlantic.** *Journal of Parasitology* 93(3): 575-582, 2007.

Notes: Nonindigenous parasite introductions and range expansions have become a major concern because of their potential to restructure communities and impact fisheries. Molecular markers provide an important tool for reconstructing the pattern of introduction. The parasitic castrator *Loxothylacus panopaei*, a rhizocephalan barnacle, infects estuarine mud crabs in the Gulf of Mexico and southeastern Florida. A similar parasite introduced into Chesapeake Bay before 1964, presumably via infected crabs associated with oysters from the Gulf of Mexico, was identified as *L. panopaei*. Our samples of this species during 2004 and 2005 show that the introduced range has expanded as far south as Edgewater, Florida, just north of the northern endemic range limit. The nonindigenous range expanded southward at a rate of up to 165 km/yr with relatively high prevalence, ranging from 30 to 93%. Mitochondrial DNA sequences from the cytochrome oxidase 1 gene showed that these nonindigenous *L. panopaei* are genetically distinct from the endemic parasites in southeastern Florida and the eastern Gulf of Mexico. The genetic difference was also associated with distinct host spectra. These results are incompatible with an eastern Gulf source population, but suggest that unrecognized genetic and phenotypic population structure may occur among Gulf of Mexico populations of *Loxothylacus*.

Kraemer, G.P., Sellberg, M., Gordon, A., and Main, J. **Eight-year record of *Hemigrapsus sanguineus* (Asian shore crab) invasion in western Long Island sound estuary.** *Northeastern Naturalist* 14(2): 207-224, 2007.

Notes: *Hemigrapsus sanguineus* (Asian shore crab) first arrived at Rye, NY in 1994. The intertidal abundances of *H. sanguineus*, *Carcinus maenas* (green crab), and the native crabs *Eurypanopeus depressus* (flatback mud crab), *Cancer irroratus* (Atlantic rock crab), and *Libinia emarginata* (spider crab) were censused from 1998-2005. Asian shore crab densities (estimated in June) increased from 1998-2001 to ca. 120 crabs m⁻², and then declined to 80 crabs m⁻² from 2002-2005. The flatback mud crab declined in abundance by about 95%. Decreases in the abundances of Atlantic rock crabs, green crabs, and spider crabs may also have occurred, though these species were uncommon at the outset of the study. The lower intertidal density of the gastropod *Littorina littorea* (common periwinkle) decreased by about 80%, and the decline was coincident with the expansion of the Asian shore crab population. In June, small Asian shore crabs were disproportionately more abundant in the upper intertidal zone compared with lower zones, where large crabs were more abundant. January intertidal populations were dominated by small Asian shore crabs, and these were restricted to the lower half of the intertidal zone.

Gunnarsson, B., Asgeirsson, P.H., and Ingolfsson, A. **The rapid colonization by *Crangon crangon* (Linnaeus, 1758) (Eucarida, Caridea, Crangonidae) of Icelandic coastal waters.** *Crustaceana* 80(6): 747-753, 2007.

Notes: The European brown shrimp, *Crangon crangon* (L., 1758) has colonized the intertidal zones of Iceland and spread rapidly to many coastal areas. The first confirmed record dates from 2003, and by 2006 the species had colonized the west and south coasts, while not being recorded on the north and east coasts. Densities as high as 6700 animals 100 m⁻² were measured. The absence of the brown shrimp from Iceland until recently is interesting in the light of its occurrence in Arctic waters, especially off northern Norway and Russia. It seems most likely that it was brought to Iceland by ballast water. The present records substantially extend the known geographical range of this species.

Reaser, J.K., Meyerson, L.A., Cronk, Q., De Poorter, M., Eldrege, L.G., Green, E., Kairo, M., Latasi, P., Mack, R.N., Mauremootoo, J., O'Dowd, D., Orapa, W., Sastroutomo, S., Saunders, A., Shine, C., Thrainsson, S., and Vaiutu, L.

Ecological and socioeconomic impacts of invasive alien species in island ecosystems. *Environmental Conservation* 34(2): 98-111, 2007.

Notes: Minimizing the impact of invasive alien species (IAS) on islands and elsewhere requires researchers to provide cogent information on the environmental and socioeconomic consequences of IAS to the public and policy makers. Unfortunately, this information has not been readily available owing to a paucity of scientific research and the failure of the scientific community to make their findings readily available to decision makers. This review explores the vulnerability of islands to biological invasion, reports on environmental and socioeconomic impacts of IAS on islands and provides guidance and information on technical resources that can help minimize the effects of IAS in island ecosystems. This assessment is intended to provide a holistic perspective on island-IAS dynamics, enable biologists and social scientists to identify information gaps that warrant further research and serve as a primer for policy makers seeking to minimize the impact of IAS on island systems. Case studies have been selected to reflect the most scientifically-reliable information on the impacts of IAS on islands. Sufficient evidence has emerged to conclude that IAS are the most significant drivers of population declines and species extinctions in island ecosystems worldwide. Clearly, IAS can also have significant socioeconomic impacts directly (for example human health) and indirectly through their effects on ecosystem goods and services. These impacts are manifest at all ecological levels and affect the poorest, as well as richest, island nations. The measures needed to prevent and minimize the impacts of IAS on island ecosystems are generally known. However, many island nations and territories lack the scientific and technical information, infrastructure and human and financial resources necessary to adequately address the problems caused by IAS. Because every nation is an exporter and importer of goods and services, every nation is also a facilitator and victim of the invasion of alien species. Wealthy nations therefore need to help raise the capacity of island nations and territories to minimize the spread and impact of IAS.

Hernandez, J., Prado, V., Torres, D., Waldenstrom, J., Haemig, P.D., and Olsen, B. **Enteropathogenic *Escherichia coli* (EPEC) in Antarctic fur seals *Arctocephalus gazella*.** *Polar Biology* 30(10): 1227-1229, 2007.

Notes: Rectal swabs were collected from Antarctic fur seal pups *Arctocephalus gazella* at Cape Shirreff, South Shetland Islands, and analyzed for the presence of anthropogenic pathogens. Two of the 33 pups tested positive for enteropathogenic *Escherichia coli* (EPEC). These samples are the first records of EPEC in Antarctic wildlife and suggest that more needs to be done to protect the Antarctic fauna from exotic anthropogenic pathogens.

Mineur, F., Belsher, T., Johnson, M.P., Maggs, C.A., and Verlaque, M. **Experimental assessment of oyster transfers as a vector for macroalgal introductions.** *Biological Conservation* 137(2): 237-247, 2007.

Notes: Introduction of non-indigenous species can alter marine communities and ecosystems. In shellfish farming, transfer of livestock, especially oysters, is a common practice and potentially constitutes a pathway for non-indigenous introductions. Many species of seaweeds are believed to have been accidentally introduced in association with these transfers, but there is little direct evidence. We experimentally simulated the transfer of oysters from the Thau Lagoon (France). These transfers involved increasing periods of aerial emersion and additional brine and hot water treatments. The brine and hot water treatments were evaluated as a means of reducing the probability of algal introductions with oyster transfers. Shells were cultured for 40 days in experimental tanks to identify the macroalgae likely to be introduced with any oyster transfer. A total of 57 macroalgal taxa, including 16 taxa not indigenous to the Thau Lagoon, were recorded across all treatments and experiments. The abundance of some species increased in several cases following aerial emersion. Elimination treatments (immersion in brine or hot water) significantly reduced algal diversity, with hot water treatments resulting in no species or only tubular *Ulva* spp. present. The results support the hypothesis that oyster transfers are effective as primary and secondary vectors of macroalgal introductions. Relatively simple changes to the transfer practice (particularly hot water treatments) are suggested as a means of reducing the risk of non-indigenous algal introductions.

Drury, K.L.S., Drake, J.M., Lodge, D.M., and Dwyer, G. **Immigration events dispersed in space and time: Factors affecting invasion success.** *Ecological Modelling* 206(1-2): 63-78, 2007.

Notes: Classical models of biological invasions generally assume that introductions consist of single releases of organisms, whereas in nature successful invasions are usually the result of repeated immigration events. A straightforward consequence of such repeated events is that they are likely to increase invasion success. In this article, we consider a less-obvious consequence, namely how repeated immigration events interact with the spatial dispersion of immigration. We construct a spatially explicit model that includes Allee effects and population diffusion, so that repeated introductions must be concentrated in order for the population to exceed the Allee threshold over a critical minimum area and successfully invade. We use this model to show that the spatial dispersion of immigration events is of key importance in determining invasion success. Specifically, invasion risks decline when immigration events are dispersed more widely. Because of this effect, immigration events that occur close to habitat boundaries are likely to lead to higher invasion risks, as dispersing organisms are forced back towards the source of immigrants. These results have important implications for efforts to reduce the risk of aquatic invasions due to discharges of ballast-water by commercial ships. When ballast discharge occurs either far from port, and thus far from habitat boundaries, or far from other ballast discharge events, and thus with wider dispersion, then invasion risks should be greatly reduced. Our work demonstrates the importance of spatial structure for understanding ecological problems, and shows how mathematical models can be useful in guiding environmental management.

Coutts, A.D.M. and Dodgshun, T.J. **The nature and extent of organisms in vessel sea-chests: A protected mechanism for marine bioinvasions.** *Marine Pollution Bulletin* 54(7): 875-886, 2007.

Notes: A total of 150 different organisms, including one plant species and 12 animal phyla were identified from sea-chests of 42 vessels visiting or operating in New Zealand between May 2000 and November 2004. Forty-nine percent of organisms were sessile, 42% mobile adults and the remaining 9% sedentary. Decapods were the most represented group with 19 species present among 79% of vessels. Forty percent of organisms were indigenous to New Zealand, 15% introduced, 10% non-indigenous, and 35% of unknown origin. Sea-chests have the potential to (1) transfer non-indigenous organisms between countries across oceanic boundaries; and (2) disperse both indigenous and introduced organisms domestically. The occurrence of adult mobile organisms is particularly significant and indicates that sea-chests may be of greater importance than ballast water or hull fouling for dispersing certain marine species. These findings emphasise the need to assess and manage biosecurity risks for entire vessels rather than different mechanisms (i.e., ballast water, hull fouling, sea-chests, etc.) in isolation.

Hoppenrath, M., Elbrachter, M., Halliger, H., Koeman, R.P.T., Krakhmalnyy, A., Surek, B., Erler, K., and Luckas, B. **First records of the benthic, bloom-forming, non-toxic dinoflagellate *Thecadinium yashimaense* (Dinophyceae) in Europe: with special emphasis on the invasion in the North Sea.** *Helgoland Marine Research* 61(3): 157-165, 2007.

Notes: *Thecadinium yashimaense* was recorded for the first time in France, Great Britain, The Netherlands, and Germany. The invasion and establishment of the species in the German Bight was documented reliably and is presented here. The geographic expansion of the species from the North Pacific to the North Atlantic Ocean is discussed. This bloom-forming, marine, sand-dwelling dinoflagellate was shown to be non-toxic. Also *Thecadinium kofoidii*, the type species of the genus, was analyzed for potential toxin production and turned out to be non-toxic as well.

Fowler, A.J., Lodge, D.M., and Hsia, J.F. **Failure of the Lacey Act to protect US ecosystems against animal invasions.** *Frontiers in Ecology and Environment* 5(7): 353-359, 2007.

Notes: Harmful non-indigenous species may be introduced, either accidentally or intentionally, into the US through commerce, and may subsequently drive reductions in abundances of native species and changes in ecosystem function. The "injurious wildlife provision" of the Lacey Act (1900) is the primary legal tool protecting US non-agricultural ecosystems against the introduction and spread of invasive animal species. We evaluated the efficacy of this provision at disrupting the invasion processes involved in transport, introduction, establishment, and spread, and found that the wildlife provision prohibits importation of only 17 taxa. While the Lacey Act may have been somewhat effective at preventing transport into the country of the few taxa listed prior to their introduction, over half of listed taxa were already present in the US when listed,

and most taxa already established in the wild continued to spread after listing. Currently, five taxa are being considered for listing. Mean time for a petitioned listing has increased to over 4 years, and only one species has been added by petition in the past decade. If the goals of the provision are to be met in the face of increasing international trade in live organisms, then revision or replacement of the provision is required.

Baker, P., Fajans, J.S., Arnold, W.S., Ingraio, D.A., Marelli, D.C., and Baker, S.M. **Range and dispersal of a tropical marine invader, the Asian green mussel, *Perna viridis*, in subtropical waters of the southeastern United States.** *Journal of Shellfish Research* 26(2): 345-355, 2007.

Notes: The tropical Asian green mussel, *Perna viridis* (Bivalvia: Mytilidae) is a recent invader of the Caribbean Basin, including the subtropical southeastern United States. In this study we examined the (1) range of *P. viridis* in the southeastern United States. (2) relative abundance of *P. viridis* across habitats and (3) density of *P. viridis* in Tampa Bay, FL. The invasion and spread of *P. viridis* in the southeastern United States was estimated by a combination of first-hand qualitative sampling and second-hand observations. There were apparently at least two discrete introductions, each followed by natural dispersal. The initial invasion was discovered in Tampa Bay in 1999, and was followed by rapid spread of *P. viridis* south as far as Marco Island, FL, but limited spread northward. In 2002, a second invasion occurred in northeast Florida, separated from the west Florida population by 650 km of coastline. On the east coast, *P. viridis* appeared to be distributed discontinuously between South Carolina and the Indian River Lagoon, FL by 2007. The literature concerning native distribution, habitat use and invasion history, and vectors of *P. viridis* is also reviewed.

Roman, J. and Darling, J.A. **Paradox lost: genetic diversity and the success of aquatic invasions.** *Trends in Ecology and Evolution* 22(9): 454-464, 2007.

Notes: There is mounting evidence that reduced genetic diversity in invasive populations is not as commonplace as expected. Recent studies indicate that high propagule vectors, such as ballast water and shellfish transplantations, and multiple introductions contribute to the elimination of founder effects in the majority of successful aquatic invasions. Multiple introductions, in particular, can promote range expansion of introduced populations through both genetic and demographic mechanisms. Closely related to vectors and corridors of introduction, propagule pressure can play an important role in determining the genetic outcome of introduction events. Even low-diversity introductions have numerous means of avoiding the negative impact of diversity loss. The interaction of high propagule vectors and multiple introductions reveal important patterns associated with invasion success and deserve closer scrutiny.

Sax, D.F., Stachowicz, J.J., Brown, J.H., Bruno, J.F., Dawson, M.N., Gaines, S.D., Grosberg, R.K., Hastings, A., Holt, R.D., Mayfield, M.M., O'Connor, M.I., and Rice, W.R. **Ecological and evolutionary insights from species invasions.** *Trends in Ecology and Evolution* 22(9): 465-471, 2007.

Notes: Species invasions provide numerous unplanned and frequently, but imperfectly, replicated experiments that can be used to better understand the natural world. Classic studies by Darwin, Grinnell, Elton and others on these species-invasion experiments provided invaluable insights for ecology and evolutionary biology. Recent studies of invasions have resulted in additional insights, six of which we discuss here; these insights highlight the utility of using exotic species as 'model organisms'. We also discuss a nascent hypothesis that might provide a more general, predictive understanding of invasions and community assembly. Finally, we emphasize how the study of invasions can help to inform our understanding of applied problems, such as extinction, ecosystem function and the response of species to climate change.

Desprez-Loustau, M.L., Robin, C., Buee, M., Courtecuisse, R., Garbaye, J., Suffert, F., Sache, I., and Rizz, D.M. **The fungal dimension of biological invasions.** *Trends in Ecology and Evolution* 22(9): 472-480, 2007.

Notes: Fungi represent an essential component of biodiversity, not only because of the large number of species, but also for their ecological, evolutionary and socio-economic significance. Yet, until recently, fungi received scant consideration in

ecology, especially invasion ecology. Their under-representation is largely the result of a lack of scientific knowledge of fungal biodiversity and ecology. With the exception of pathogenic fungi, which cause emergent infectious diseases, the impact of fungal invasions is often difficult to quantify owing to limited baseline data on fungal communities. Here, we aim to raise awareness among mycologists and ecologists of the fungal dimension of invasions and of the need to intensify research in fungal ecology to address issues of future introductions.

Vellend, M., Harmon, L.J., Lockwood, J.L., Mayfield, M.M., Hughes, A.R., Wares, J.P., and Sax, D.F. **Effects of exotic species on evolutionary diversification.** *Trends in Ecology and Evolution* 22(9): 481-488, 2007.

Notes: Exotic species invasions create almost ideal conditions for promoting evolutionary diversification: establishment of allopatric populations in new environmental conditions; altered ecological opportunities for native species; and new opportunities for hybridization between previously allopatric taxa. Here, we review recent studies of the evolutionary consequences of species invasions, revealing abundant and widespread examples of exotic species promoting evolutionary diversification via increased genetic differentiation among populations of both exotic and native species and the creation of new hybrid lineages. Our review indicates that, although the well-documented reductions to biodiversity caused by exotic species might outweigh the increases resulting from diversification, a complete understanding of the net effects of exotic species on biodiversity in the long term will require consideration of both.

Miller, K.A., Engle, J.M., Uwai, S., and Kawai, H. **First report of the Asian seaweed *Sargassum filicinum* Harvey (Fucales) in California, USA.** *Biological Invasions* 9(5): 609-613, 2007.

Notes: We report the occurrence of the brown seaweed *Sargassum filicinum* Harvey in southern California. *Sargassum filicinum* is native to Japan and Korea. It is monoecious, a trait that increases its chance of establishment. In October 2003, *Sargassum filicinum* was collected in Long Beach Harbor. In April 2006, we discovered three populations of this species on the leeward west end of Santa Catalina Island. Many of the individuals were large, reproductive and senescent; a few were small, young but precociously reproductive. We compared the sequences of the mitochondrial *cox3* gene for 6 individuals from the 3 sites at Catalina with 3 samples from 3 sites in the Seto Inland Sea, Japan region. The 9 sequences (469 bp in length) were identical. *Sargassum filicinum* may have been introduced through shipping to Long Beach; it may have spread to Catalina via pleasure boats from the mainland.

Zabin, C.J., Zardus, J., Pitombo, F.B., Fread, V., and Hadfield, M.G. **A tale of three seas: consistency of natural history traits in a Caribbean-Atlantic barnacle introduced to Hawaii.** *Biological Invasions* 9(5): 523-544, 2007.

Notes: Predictive models in invasion biology rely on knowledge of the life history and ecological role of invading species. However, species may change in key traits as they invade a new region, making prediction difficult. For marine invertebrate invaders there have been too few comparative studies to determine whether change in key traits is the exception or the rule. Here we examined populations of the intertidal barnacle *Chthamalus protens* in three locations in its native range in the Caribbean and Atlantic, and in the Hawaiian Islands, where it has recently invaded, as a model system for such comparative studies. We measured body size, fecundity, population density and vertical distribution, compared habitat use and investigated aspects of the barnacle's ecological role in Curacao, Panama and Brazil and the main Hawaiian Islands. In terms of these measures, the barnacle has undergone little change in its invasion of Hawaii. Thus, if this barnacle had been studied in its native range, predictions about its spread in Hawaii could have been made. As little was known about this barnacle in either its native range or Hawaii, we also carried out studies of its larval life history, fecundity, growth, and mortality. Based on this work, we predict that this barnacle will continue to spread, aided by vessel traffic, throughout the Hawaiian Islands and elsewhere in the Pacific.

Pratt, M.C. and Grason, E.W. **Invasive species as a new food source: does a nudibranch predator prefer eating an invasive bryozoan?** *Biological Invasions* 9(6): 645-655, 2007.

Notes: *Membranipora membranacea* is an invasive bryozoan that was first found in the Gulf of Maine in 1987 and within two years became the dominant organism living on kelps. *Membranipora* may have become dominant so quickly because it had little competition in a relatively unoccupied niche; however, lack of predation has also probably played a major role. Where *Membranipora* is native, there is usually a specialist nudibranch predator that keeps the population in check. For example, in European populations, the nudibranch *Polycera quadrilineata* prefers *Membranipora* while *Onchidoris muricata* is known to prefer another bryozoan, *Electra pilosa*. *Electra*, *Membranipora*, and *Onchidoris* are all now found in the Gulf of Maine while *Polycera* is not. We tested whether *Onchidoris* would (1) eat *Membranipora* at all, (2) eat *Membranipora* and *Electra* at different rates, and (3) show a preference for eating *Membranipora* or *Electra* when given a choice. We found that *Onchidoris* does eat *Membranipora*, and it generally eats *Membranipora* faster than *Electra*. However, when given a choice, *Onchidoris* prefers *Electra*. *Onchidoris* typically reproduces in the spring and grows over the fall and winter, but has recently been found reproducing in the winter in New Hampshire. Although it does not survive the winter as well as *Electra*, *Membranipora* is the dominant organism living on many macroalgae in the late summer and fall. Thus, the large *Membranipora* food source now available in the summer and fall may allow *Onchidoris* to reproduce earlier.

Chapman, J.W., Carlton, J.T., Bellinger, M.R., and Blakeslee, A.M.H. **Premature refutation of a human-mediated marine species introduction: the case history of the marine snail *Littorina littorea* in the northwestern Atlantic.** *Biological Invasions* 9(6): 737-750, 2007.

Notes: The European periwinkle snail, *Littorina littorea* was discovered in Pictou, NS, Canada in 1840. This snail's subsequent rapid, conspicuous spread south from Pictou along the Canadian maritime coast and then along the New England and mid-Atlantic coast to New Jersey, its virtual absence in pre-European contact deposits, and its close association with human mechanisms of transport from Europe are among the clearest evidence for a human-mediated introduction. However, molecular genetic data have been proposed as evidence that *L. littorea*'s occurrence in North America was not the result of a human introduction by Wares *et al.* (*Ecol Lett* 5:577-584, 2002). Reexamination of these genetic data and reexamination of all other data available reveal that a human-mediated introduction of *L. littorea* is the simplest explanation of its occurrence in North America. The refutation of the human-mediated introduction of *L. littorea* was premature.

Hollebone, A.L. and Hay, M.E. **Population dynamics of the non-native crab *Petrolisthes armatus* invading the South Atlantic Bight at densities of thousands m².** *Marine Ecology Progress Series* 336: 211-223, 2007.

Notes: The green porcelain crab *Petrolisthes armatus* recently invaded oyster reefs of the South Atlantic Bight. In 2 estuaries of coastal Georgia, USA, crab densities reached peak densities of 4000 to 11000 crabs m⁻² in some periods and locations. Densities generally were higher in the low versus the high intertidal and in the lower versus upper regions of the estuaries. In warmer months, 20 to 90% of adult females were gravid, recruits were dense, and population levels were high. In colder months, densities dropped by 64 to > 99 %. Male:female ratios were near 1:1 across times and locations. Maximum mean densities of *P. armatus* in Georgia were 37 times the highest densities recorded in the presumptive native range. Crabs in the new range reproduced at a smaller size, and the percentage of gravid females was similar between the old and new range. Thus, population fecundity in Georgia exceeds that of the native range by more than 1 order of magnitude. Densities of native mud crabs in the genera *Panopeus* and *Eurypanopeus* were unrelated to, or positively correlated with, densities of the exotic crabs; correlations were never significantly negative. The impact of *Petrolisthes armatus* on native communities is unclear, but could be considerable if this filter-feeding crab impacts oysters, which are the foundation species of inshore reefs.

Lee, J.E. and Chown, S.L. ***Mytilus* on the move: transport of an invasive bivalve to the Antarctic.** *Marine Ecology Progress Series* 339: 307-310, 2007.

Notes: Increasing numbers of scientific and tourist vessels are entering the Antarctic region and have the potential to bring with them a range of organisms that are not currently found in the region. Little is known about the frequency of such introductions or the identity and survivorship of the species associated with them. In this study, we report the findings of an inspection of the sea chests of the South African National Antarctic Programme supply vessel, the SA 'Agulhas', while the vessel was in dry dock in June 2006. Large populations of a known invasive mussel, *Mytilus galloprovincialis* (Lamarck), were found. By extrapolating from shell length, the age of individuals was estimated, the results of which suggest that some

specimens have survived transportation to the Antarctic region on multiple occasions. These findings are cause for concern and demonstrate that Antarctic research and supply vessels are important vectors for marine non-indigenous species into the region.

Robinson, T.B., Branch, G.M., Griffiths, C.L., Govender, A., and Hockey, P.A.R. **Changes in South African rocky intertidal invertebrate community structure associated with the invasion of the mussel *Mytilus galloprovincialis*.** *Marine Ecology Progress Series* 340: 163-171, 2007.

Notes: Since the establishment of the alien mussel *Mytilus galloprovincialis* in South Africa, several authors have studied its interactions with individual indigenous species. However, the broader implications of this invasion on the intertidal zone remain undocumented. This paper analyses the impacts of this mussel on the rocky-shore invertebrate community structure at Marcus Island on the west coast of South Africa. The effects of the invasion were linked to 3 key elements and were not consistently spread across the intertidal zone, but were focused within the mid-to-low shore. Firstly, physical stress in the mid-intertidal zones was ameliorated by the presence of *M. galloprovincialis* beds. Secondly, habitat complexity was increased where *M. galloprovincialis* replaced bare rock or less complex secondary habitat. Thirdly, habitat became less patchy as mussel beds blanketed the shore. Consequently, invertebrate density and species richness increased substantially, and community composition changed significantly in the mid-shore. Lower on the shore, significant changes in invertebrate community structure were driven by a switch from mono-layered beds of the small indigenous mussel *Anulacomya ater* to multilayered beds of *M. galloprovincialis*, despite no change in total species richness.

Hollebone, A.L. and Hay, M.E. **Propagule pressure of an invasive crab overwhelms native biotic resistance.** *Marine Ecology Progress Series* 342: 191-196, 2007.

Notes: Over the last decade, the porcelain crab *Petrolisthes armatus* invaded oyster reefs of Georgia, USA, at mean densities of up to 11000 adults m⁻². Interactions affecting the invasion are undocumented. We tested the effects of native species richness and composition on invasibility by constructing isolated reef communities with 0, 2, or 4 of the most common native species, by seeding adult *P. armatus* into a subset of the 4 native species communities and by constructing communities with and without native, predatory mud crabs. At 4 wk, recruitment of *P. armatus* juveniles to oyster shells lacking native species was 2.75 times greater than to the 2 native species treatment and 3.75 times greater than to the 4 native species treatment. The biotic resistance produced by 2 species of native filter feeders may have occurred due to competition with, or predation on, the settling juveniles of the filter feeding invasive crab. Adding adult porcelain crabs to communities with 4 native species enhanced recruitment by a significant 3-fold, and countered the effects of native biotic resistance. Differences in recruitment at Week 4 were lost by Weeks 8 and 12, when densities of recent recruits reached similar to 17 000 to 34 000 crabs m⁻² across all treatments. Thus, native species richness slows initial invasion, but early colonists stimulate settlement by later ones and produce tremendous propagule pressure that overwhelms the effects of biotic resistance.

Panov, V.E., Rodionova, N.V., Bolshagin, P.V., and Bychek, E.A. **Invasion biology of Ponto-Caspian onychopod cladocerans (Crustacea: Cladocera: Onychopoda).** *Hydrobiologia* 590: 3-14, 2007.

Notes: We review the patterns of recent range expansions and the biology of the invasive Ponto-Caspian predatory onychopod cladocerans: *Cercopagis pengoi*, *Evadne anonyx*, *Podonevadne trigona*, *Cornigerius maeoticus* and *Cornigerius bicornis*. Recent invasions of *C. pengoi*, *E. anonyx* and *C. maeoticus* into the Baltic Sea can be attributed to the climate change, facilitating invasibility of the eastern Baltic Sea coastal ecosystems by the warm water Ponto-Caspian species and intensive shipping activities via the Volga-Baltic waterway (European "northern invasion corridor"). All three species can be considered to be established in pelagic communities of the eastern Gulf of Finland. Only one onychopod species, *C. pengoi* has invaded the North American Great Lakes via an existing invasion corridor between the eastern Baltic and the Great Lakes. Invasive onychopods may possess adaptive life cycles, switching to early gamogenetic reproduction which enables their establishment in recipient ecosystems and further dispersal. Analysis of temperature and salinity ranges of the Ponto-Caspian onychopod species in native and invaded habitats, indicates that they are potentially able to form populations in a wide range of inland and coastal water ecosystems in temperate zones. Ponto-Caspian onychopods can be considered as "high risk" invasive species, in terms of their potential for range expansion and impact on recipient ecosystems.

Berezina, N.A. **Invasions of alien amphipods (Amphipoda: Gammaridea) in aquatic ecosystems of North-Western Russia: pathways and consequences.** *Hydrobiologia* 590: 15-29, 2007.

Notes: Since the middle of the 20th century, six species of Ponto-Caspian amphipods (*Chaetogammarus ischnus*, *C. warpachowskyi*, *Chelicorophium curvispinum*, *Dikerogammarus haemobaphes*, *Obesogammarus crassus*, *Pontogammarus robustoides*), one Baikalian amphipod *Gmelinooides fasciatus* and one amphipod of Atlantic origin *Gammarus tigrinus* have expanded in Russia and adjacent regions. A wide variety of human mediated vectors such as deliberate and accidental introductions, natural migration via constructed inland waterways and high rates of spread, survival and reproduction in these species have facilitated rapid dispersal and successful establishment of these alien species. Causes of successful establishment of these invaders and potential consequences of the invasions including extinctions of native species in rivers, lakes and estuaries of north-western Russia are discussed.

Ashton, G.V., Willis, K.J., Cook, E.J., and Burrows, M. **Distribution of the introduced amphipod, *Caprella mutica* Schurin, 1935 (Amphipoda: Caprellida: Caprellidae) on the west coast of Scotland and a review of its global distribution.** *Hydrobiologia* 590: 31-41, 2007.

Notes: *Caprella mutica* Schurin, 1935 was first described from sub-boreal areas of north-east Asia. In less than 40 years *C. mutica* has spread throughout the northern hemisphere and the first recorded sighting in the southern hemisphere is reported here. *Caprella mutica* has been introduced to temperate oceanic coasts between latitudes of 25 and 70°N. Outside its native range, *C. mutica* has only been found in areas of human activity, including ports, aquaculture facilities and an oilrig; the species has not yet been found in natural habitats. Shipping and aquaculture transfers are the most likely long distance vectors; recreational boating and drifting weed are the most likely short distance vectors. Temperature and salinity do not explain the small-scale distribution of *C. mutica* on the west coast of Scotland; globally its annual temperature range is 0-22°C. This suggests that the local scale distribution of *C. Mutica* is potentially limited by the availability of suitable transportation vectors during the dispersal phase rather than by physical environmental factors following release.

Jorgensen, L.L. and Primicerio, R. **Impact scenario for the invasive red king crab *Paralithodes camtschaticus* (Tilesius, 1815) (Reptantia, Lithodidae) on Norwegian, native, epibenthic prey.** *Hydrobiologia* 590: 47-54, 2007.

Notes: Large invasive predators like the king crab, *Paralithodes camtschaticus*, deserve particular attention due to their potential for catastrophic ecological impact on recipient communities. Conspicuous, epibenthic prey species, such as the slow growing commercial scallop *Chlamys islandica*, are particularly exposed to the risk of local extinction. A research program integrating experiments and field monitoring is attempting to predict and track the impact of invasive king crab on scallop beds and associated fauna along the north Norwegian coast. The claw gape of the crab shows no limitations in handling the flat-bodied scallop. However, the potential impact of the crab on scallop may depend on the availability of other calcified prey associated with scallop beds, such as the sea star, sea urchin, and blue mussel, all species recorded in the diet of *P. camtschaticus*. To address this issue, a laboratory experiment on foraging behaviour of *P. camtschaticus* was conducted. The experimental results show that all size classes of red king crab prefer scallops, but small juveniles and medium sized crabs demonstrate active selection for starfish (*Asterias rubens*) that equals or surpasses the electivity of the large crab. The selection of sea urchin (*Strongylocentrotus droebachiensis*) and blue mussel (*Mytilus edulis*) is slightly positive or neutral for the three crab size classes. These results suggest that scallop beds with a rich associated fauna are less vulnerable to red king crabs predation and possibly more resilient than beds with few associated species. Also, crab size distribution is likely relevant for invasion impact, with increasing abundance of small and medium sized crabs being detrimental for alternative calcified prey associated with scallop beds. Successive stages of crab invasion will see an acceleration of scallop mortality rates associated with (i) decreasing availability of alternative prey, due to protracted predation pressure intensified by recruitment of juvenile crabs, and (ii) increased number of large crabs. Estimates of crab density and intake rates suggest that the accelerated loss rates will eventually endanger scallop beds persistence.

Jorstad, K.E., Prodohl, P.A., Agnalt, A.L., Hughes, M., Farestveit, E., and Ferguson, A.F. **Comparison of genetic and morphological methods to detect the presence of American lobsters, *Homarus americanus* H. Milne Edwards, 1837 (Astacidea: Nephropidae) in Norwegian waters.** *Hydrobiologia* 590: 103-114, 2007.

Notes: American lobsters (*Homarus americanus* H. Milne Edwards, 1837) are imported live to Europe and should according regulations be kept in land-based tanks until sold. In spite of the strict regulations aimed specifically at preventing the introduction of this species into the NE Atlantic, several specimens of *H. americanus* have been captured in the wild, especially in Oslofjord, Norway since 1999. One of the great concerns is interbreeding between the introduced American species and the local European lobster, *H. gammarus* (Linnaeus, 1758). For this reason an awareness campaign was launched in 2000 focusing on morphologically "unusual" lobsters caught in local waters. Morphological characters have been based on colour and sub-ventral spines on the rostrum. Two samples of *H. americanus* were used for comparisons, as well as samples of European lobster from Oslofjord collected in 1992. Previous genetic analyses (allozymes, mtDNA and microsatellite DNA) have demonstrated that the American lobster is distinct from its European counterpart, with several additional alleles at many loci in addition to different allelic frequency distribution of alleles of "shared" alleles. During the present study, thirteen microsatellite loci were tested in the initial screening, and the three most discriminating loci (*Hgam98*, *Hgam197b* and *Hgam47b*) were used in a detailed comparison between the two species. A total of 45 unusual lobsters were reported captured from Ålesund (west) to Oslofjord (southeast) from 2001 to 2005 and these were analysed for the three microsatellite loci. Nine specimens were identified as American lobsters. Comparisons between morphological and genetic characteristics revealed that morphological differences are not reliable in discrimination the two species, or to identify hybrids. Further, some loci display almost no overlapping in allele frequency distribution for the reference samples analysed, thus providing a reliable tool to identify hybrids.
