KEEPING PESTS IN THEIR OWN BAY

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A new technology to better manage the risk of marine pest transfer is emerging. It is a method of genetically fingerprinting ships' ballast water to reveal exactly which marine pests are present and which are not.

The method offers cost savings to ship owners who face the prospect that the IMO Convention *"Ballast Water Management For Ships"* will set up a stringent compliance system. Ship owners' self interested motivations in tackling the problem fall into two categories; the care and maintenance of their own ships and their continued access to ports.

Blacked Striped Mussel

On the care and maintenance issue, consider the fact that, in the absence of natural marine predators, concentrations of the invasive Black Striped Mussel, for example, has been measured at densities of up to 10,000 mussels per square metre. This pest is spreading in Asian ports right now and this is alarming port authorities and ship owners alike. A visit to an infested port can result in an infested ship with mussels taking hold in the water inlets, pipes and pumps at a rate of 10,000m2.

When it comes to port access, the Port of Darwin was found to have an early stage infestation of Black Striped Mussels in 1999. The cost eradication AUD$2.3 million. In future port authorities are not likely to tolerate repeated bouts of cleaning marine pests if they can, instead, stop infested ships from calling at the port in the first place. The level of port refusals on the basis of pest threat water may be low now but, with the IMO Convention taking effect, may become more common.

The old technology

The fundamental challenge in controlling pest transfer is to detect when pests are there and when they are not. In the current technology – the 'old' technology – there is no way of knowing and solutions depend on broadbrush measures such as sea exchange on every voyage.

At first sight sea exchange might appear a simple and easy way of shedding pests acquired in one port before arriving at the next. But once it gets down to the detail it becomes much more complicated.

Practical difficulty of sea exchange

In a recent submission by Japan to the IMO International Conference on Ballast Water Management for Ships dated 30th January 2004, the Japanese delegation demonstrated the practical difficulties of achieving sea exchange even on long voyages.

The current draft convention Sub paragraphs 4.1 and 4.2 of regulation B-3 require that ballast water exchange be carried out 'at least 200 nautical miles' from the nearest land

and ‘at least 50 nautical miles from the nearest land respectively. The difference in distance relates to differing conditions of water depth.

The Japanese submission demonstrated that, even on a long ocean passage, sea exchange could be difficult because most of the sea transits were close to land. In an entire voyage there were only a few stages where the relevant criteria could be met.

The Japanese case study compared the transit time for ships through these ‘available’ areas with the ships’ ballast pumping capacity. The practical result appears bizarre because it shows that, even on a long voyage, sea exchange can be difficult without causing major time delay or detour.

Three routes and three ship types were used to support the Japanese contention; Far East to the Gulf, Europe to the Gulf and Far East to Western Australia.

In each route the method was to identify the stretch of ocean that fitted the distance criteria and then, using the service speed of the ship, calculate the time the ship would take to cross that sea distance in normal circumstances. Once the available time was calculated, this was compared with the hourly pumping capacity of the vessel. Matching the two figures would show if the exchange could be completed within the time available

The results highlighted that sea exchange is not as simple as it sounds. The implication is that if it is difficult on long passages, it may be impossible on short hops.

A risk based approach

The ‘out’ provided by various governments is the adoption of a risk based policy where ship owners only have to sea exchange if the presence of the pest is confirmed. If the pest is not present, these governments will not require ballast exchange at sea.

The race is therefore on for a diagnostic tool to identify marine pests in the ballast water.

Genetic ‘fingerprinting’ of ballast water

Using techniques of genetic ‘fingerprinting’ of the ballast water, the Australian research agency, CSIRO, together with the Australian Ship Owners Association has developed a tool which will have wide application all over Asia.

Dr. Nicolas Bax, a Senior CSIRO Research Scientist says, “Exotic species are spreading in Asian ports. The Black Striped Mussel is a classic case. Our genetics based approach will provide a tool to identify such pests and shortcut the need for sea exchange.”

Apart from the limited opportunities for sea exchange on many routes, owners have other problems sea exchange. The new technology addresses these. For a start, most existing ships are not designed to exchange at sea. They can do it but it is not an efficient process.

Secondly, it is unsafe to empty a ballast tank in the open sea while underway. Doing this could lead to the ship breaking up – even in calm conditions. The compromise is to run the pumps long enough to pump through the volume of water two or three times. Statistically, a ‘three-times’ pump through should result in a water exchange of greater than 95%. But what if a few larval stages of the pest still remain in the diluted 5%? At the moment there is no solution to this scenario.

Analysing DNA

The only guaranteed method of knowing whether pests are present is to analyse the DNA in the water. To do this we have researched the genetic profile of three target species to show that the method can work. The scientific knowledge to be able to do this has only become known recently and the technology to do it is right at the leading edge of development today. The detection method developed by CSIRO is a genetic probe.

Dr Jahawah Patel, Research Scientist with the project says, “Within the pest species we have identified small sequences of their DNA that are unique. This special portion of the DNA sequence becomes a unique identifier for the species. When we use our sampling techniques, this is the identifier we are looking for.

“We have developed a sampling or ‘bracketing’ method to exclude non target species from the genetic ‘soup’ of the sample. This allows us to zero in on the likely culprit. This process is called a Sequential Process of Amplification. The first step is to look for a broader range – longer DNA sequences – than just the pest target. In the second stage we can shorten the DNA sequence in our search to refine the target. In most cases we should be able to complete the bracketing in two stages,” he says.

This method it can tell with 100% accuracy that water either contains a pest or is free from it. There is no problem with the residual 5% of water and the technology works with the pest even in its larval stage.

The long term solution proposed by the IMO Convention is that every ship will have to be fitted – or retro fitted – with the necessary pumps, pipes and processes to treat all the ballast water during the voyage.

When these plants become the norm the advantage created by genetic fingerprinting is to enable scientific analysis of ballast upon leaving port. This may mean that the treatment plant may not have to be run at all.

The savings will be enormous – either avoiding the need to detour to deeper water for the sea exchange or avoiding the need to run the treatment plant at all. This will be particularly significant on short sea passages such as from Singapore to Penang, Taiwan to South Korea or Japan to Hong Kong.

The technology is proven but not yet deployed.

The IMO rules move on

Things are moving forward from the international law point of view. The IMO draft convention has been finalised in recent months but it is not yet ratified. Under this convention sea exchange, mandatory in the near future, will only be the first step. The ultimate plan to install treatment processes in all ships. The deadlines by which treatment plants are required will be phased in between 2009 and 2016.

The new convention will have enormous ramifications for ship owners, both in the way they run their ships now and in the way they operate in the future. Genetic fingerprinting will play a positive role in this.

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Cost of cleaning Darwin Harbour 1999

(This was the first ever successful repelling of an invasion of a harbour by a marine pest and may be one of the reasons behind the current push to move the International Convention on Ballast Water Management for Ships towards ratification. The Darwin example showed that we don’t need to roll over and die when a pest infestation occurs – effective action can be taken. This philosophy underpins the whole management strategy.}

170 tonnes Sodium Hypochlorite
3 tonnes Copper Sulphate
280 people
All vessels surveyed
Nationwide monitoring
$AUD 2.3 million and rising.

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<Side box 2 starts>

CASE 1

Is sea exchange achievable?

Far East to The Gulf

Case 1. Ship details

Navigation Route	Far East to The Gulf
Ship type	Crude Oil Tanker
Deadweight	250,000 D/W
Ballast water on board	100,000 tons
Service speed	15 knots
Ballast pump capacity	3000 ton/hour, 2 units

Case 1. Distance within the defined Ballast Water Exchange area

In the case of ‘at least 200 nautical miles’	835 miles
In the case of ‘at least 50 nautical miles’	3335 miles

Case 1. Times available in the transit of the Ballast Water Exchange area

(Distance divided by speed)

In the case of 'at least 200 nautical miles'	56 hours
In the case of 'at least 50 nautical miles'	222 hours

Case 1. Times required to conduct the Ballast Exchange

(**Sequential method** is ballast tonage divided by pump working capacity with two complete water rotations.

Flow through method is ballast tonage divided by pump working capacity with three complete water rotations)

Sequential method	72 hours
Flow through method	122 hours

Case 1. Practicality of sea exchange on this route

a. In the case of at least 200nm
   Sequential method **– unavailable** due to 16 hour time deficiency.
   Flow through method **– unavailable** due to 122 hour time deficiency
b. In the case of at least 50nm.
   Sequential method **– available** due to 122 hour time surplus
   Flow through method **– available** due to 144 hour time surplus

CASE 2

Is sea exchange achievable?

Europe to The Gulf

Case 2. Ship details

Navigation Route	Europe to The Gulf
Ship type	Crude Oil Tanker
Deadweight	100,000 D/W
Ballast water on board	40,000 tons
Service speed	15 knots
Ballast pump capacity	1700 ton/hour, 2 units

Case 2. Distance within the defined Ballast Water Exchange area

In the case of 'at least 200 nautical miles'	Nil miles
In the case of 'at least 50 nautical miles'	970 miles

Case 2. Times available in the transit of the Ballast Water Exchange area

(Distance divided by speed)

In the case of 'at least 200 nautical miles'	Nil hours
In the case of 'at least 50 nautical miles'	65 hours

Case 2. Times required to conduct the Ballast Exchange

(**Sequential method** is ballast tonage divided by pump working capacity with two complete water rotations.
Flow through method is ballast tonage divided by pump working capacity with three complete water rotations)

Sequential method	53 hours
Flow through method	80 hours

Case 2. Practicality of sea exchange on this route

c. In the case of at least 200nm
   Sequential method **– unavailable** due to 53 hour time deficiency.
   Flow through method **– unavailable** due to 80 hour time deficiency
d. In the case of at least 50nm.
   Sequential method **– available** due to 12 hour time surplus
   Flow through method **– unavailable** due to 15 hour time deficiency

Notes on pump use.

1. The working rate of the pump is usually assumed to be 80% of its full capacity.
2. It is desirable to suspend pumping work for 12 hours after a continuous 12 hours work.

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