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# BALLAST AND UNBALLAST OPERATIONS IN OIL TANKERS: PLANKTONIC ORGANISMS THAT CAN TRAVEL WITH THE BALLAST WATER

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## ABSTRACT

**At the beginning of the 20th century, the presence of non autochthonous species in ballast water was admitted. However, it was not until the decade of the 70s that it was considered a problem, for more non autochthonous species all over the world were introduced and watched during the decade of 80s. Canada and Australia, two of the countries which suffered from this kind of problem, exposed their worries to the Marine Environment Protection Commitee (MEPC) at the end of that decade.**

**In February 2004 the IMO adopted the International Convention for the Control and Management of Ships' Ballast Water and Sediments, which would be compulsory to fulfilling the approved standards between 2009 and 2016. Such standards comprise the year of construction of dead weight tank ship and the capacity of their ballast tanks.**

**Between July and December 2002, tests were carried out in an oceanic station (28° 30′ N and 16° 06′ W), with vertical tows of 50 meters long until surface, to register taxons present of the mesozooplanktonic community. The findings show average values of 313.06 density ind./m$^3$. With regard to the percentage composi-**

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**tion by taxonomic groups and for the same bathymetry, it stands out the community of copepods with an average value of 64.33%, followed by eggs of invertebrates and fish (18.32%), and appendicularians (5.86%). On the other hand, the remaining groups under study did not surpass the 2% of stocking.**

**Keywords:** Ballast, unballasts, oil tankers, mesozooplakcton, exotic species.

## INTRODUCTION

Nowadays, the widespread globalization in our planet, in which the distances are shorter and the communication among regions is faster, affects not only the social and cultural environment, but also the biological one.

In general, the carrier (bulk carriers, ore carries and tankers between others) need big volumes of ballast water when the ship sails without cargo (with ballast). The water warps before undertaking the voyage with the empty ship, which is an essential element for the navigation because it improves the ship stability. Moreover, without the load weight, her gravity centre can remain above the waterline and makes them list. This causes a reshuffle of around ten thousand million tons of dead weight water every year between several parts of the world.

When the ballast tanks are segregated and they only carry sea water and the ship travels without load, with ballast water weight one allochthonous organisms generally of small size, can load as "stowaways", belonging to the planktonic community. The ballast water sockets are situated in the ship helmet bottom.

Around 3,000 species of animals and plants are estimated to travel in this way every day (IMO, 1998). Besides, the ship displacement speed is another factor that favours the prosperity of these organisms, because many would not survive in the darkness of the ballast tanks for a long period of time.

There are a lot of cases of these unexpected ones, and sometimes undesired, stowaways along the story. Three hundred and sixty seven marine organisms of the Japanese fauna were detected in a bay in Oregon (EEUU) four years after some boats coming from this country released the water from dead weight in this bay (UNESCO). A planktonic algae that reproduces very easily, *Odontella sinensis*, invaded the North Sea in 1903. The dinoflagellata, *Pfiesteria piscicida*, of which twenty-four different forms exist, was discovered in 1988 in North Carolina, after having being introduced in the ballast waters. Some of these organisms produce a series of innocuous toxins for the human being, but they are responsible for injuries and a high death rate of fish (pitches).

Not only are there planktonic beings: the European green crab (*Carcinus maenas*) is a crustacean of approximately eight centimetres of length (in adult state), voracious enough and practically omnivorous, that has been introduced by the ballast waters in Hawaii, both coasts of United States, Panama, Madagascar, the Red Sea, India, Australia and Tasmania (HIDRITEC).

It is also necessary to consider that the invading species not only affect marine ecosystems. For example, in the short stretch of the Guadalquivir an exotic species has been located, the Chinese mitten crab (*Eriocheir sinensis*). He probably arrived in larval state in the water of dead weight of some cargo ship that drained into the port of Seville; he was in the estuary of the Guadalquivir between 1997 and 2002 (Cuesta et, 2006); from March 2005 until June 2006 more than 240 units have been capturated (Ortega and Ceballos, 2006). This crab is a catadromous species, that is to say, he combines freshwater ecosystems and salted ones, depending on age; the adults are reproduced in salted water and the young ones go to sweet waters where they stay for three to five years (Díaz Muñoz, 2006). This species has been introduced in other European, western coasts, in the Baltic Sea and also in the western coasts of North America (IMO, 2004).

In the United Nations Conference on Environment and Development (UNCED) celebrated in Rio de Janeiro in 1992, a complete chapter of the Program 21 was devoted to the Protection of the oceans as well as of the seas. Later, between 1993 and 1997, the International Maritime Organization (IMO) dictated directives to prevent the transfer of aquatic organisms and pathogenic unwanted agents proceeding from the ballast waters and sediment unloading of the ships. The problem is, however, that, unlike the spillages of hydrocarbons and other forms of polluting the sea originated by the maritime traffic, the marine species and exotic organisms are very difficult to eliminate. The resolution A.868 (20), approved on November 27, 1997 as annexe of the agreement MARPOL, is concerned with "Directives for the Control and Management of Ballast Waters in ships, in order to reduce the transfer of harmful aquatic organisms and pathogenic agents". The main objective of this resolution is to achieve that the whole world fleet sterilizes the waters of ballast as soon as possible. It also demands the governments to stimulate urgent averages to apply such directives and to spread them in the shipping sector.

On February 13, 2004 the IMO adopted the International Convention for the Control and Management of Ships' Ballast Water and Sediments. Nevertheless, the compulsory nature of the fulfillment of the approved standards will change between 2009 and 2016, depending on the year of construction of the craft and of the capacity of its ballast tanks.

Therefore, the vessels should be equipped with a plan of management of the specific ballast water, included in the documentation regarding their operations.

## OBJECT AND METHOD OF THE BALLAST AND UNBALLAST IN OIL TANKERS

The operations of ballast and unballast are carried out to keep, at every moment, the best conditions of a ship stability, efforts and navigability; in order to achieve this, the ballast tanks with which the ship is equipped are used (Fig. 1).

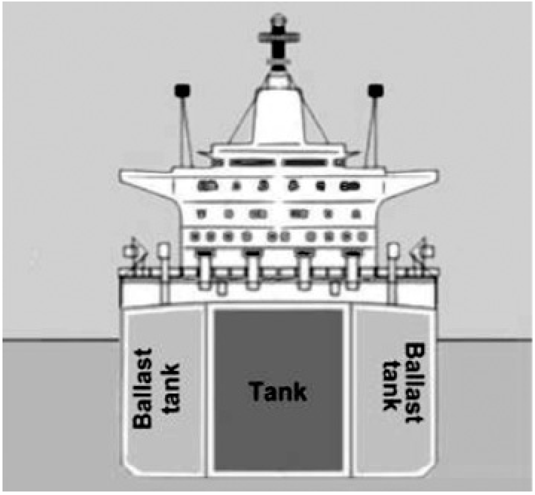



**Figure 1.** Scheme of the position of the tanks of ballast tanks in oil tankers.

Generally, tankers have twenty tanks of load, apart from their size, ten lateral (five to port and five starboard) and ten head-quarters, whose capacity is double than that of the lateral ones (Fig. 2); they are classified in terms of their load capacity:

—ULCC (*Ultra Large Crude Carrier*), more than 300.000 tons.
—VLCC (*Very Large Crude Carrier*), more than 200.000 tons.
—Suezmax (ships capable of fitting through the Canal de Suez), between 125.000 and 200.000 tons.
—Aframax (*American Freight Rate Association*), between 80.000 and 125.000 tons.
—Panamax (ships capable of fitting through the Panama Canal), between 50.000 and 79.000 tons.

An oil tanker of 60.000 tons takes approximately 25.000 tons of ballast water in a trip with swell; since 1m$^3$ of water of the sea weighs 1.020 kg, 25.000 tons equal approximately 24.509.804 m$^3$.

In Spain, when oil tankers need to realize operations of ballast, they have to comply with the directives exposed in the chapter II-1 of the International Agreement SINGLE, Rules 22. Likewise, the operations have to respond to the Booklet of Stability, taking into consideration the own conditions of stability of the ship in question, to the ISGOTT, and to the recommendations of the Spanish Administration (January 15, 2002).

When the vessel must sail in ballast, the situation of the same specified in the Notebook of Information about Stability that is kept in the Captain's power will adopt one. The tanks in which dead weight is introduced, if possible, will get one full to the 100 percent of their capacity. Moreover, it would avoid moving dead weights in the sea, above all in the run tanks of false bottom.

In deballasting operations the seawater contained in slops and other tanks must be pumped ashore once a check list of ship – tanks operations is done be the vessel's officer and the terminal segregated. The operations must take in to account the stresses on the yeses'.

With regard to the water contained in the tanks of ballast segregated, it will disburden bearing in mind the following considerations:

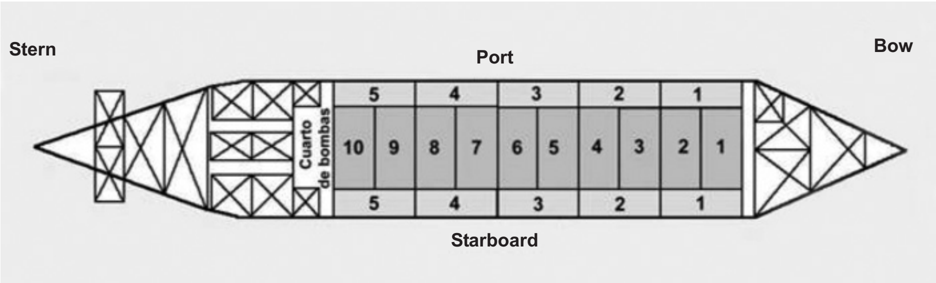



**Figure 2.** Central and lateral tanks distribution.

— Before beginning the operations of unballasts of the tanks of ballast segregated to the sea, some will verify that traces of hydrocarbons do not exist in the water contained in the indexed tanks, by means of the capture of samples and measurement of the gas concentration of hydrocarbons. The records of the realized operations will take form of a document.
— To support the ship with enough trim by the stern, but in no case superior to 4.0 meters, so that the tanks of continuous ballasts of double fund could remain dry.
— A lot of care must be taken so as not to exceed the soaked maximum allowed for mooring.
— To support the ship with a fret that allows manoeuvring at any time, in an emergency, for example, to stop moor.
— Combine it with the load operations so that excessive efforts in the ship helmet structure avoid one.
— In the moment of starting the operations of unballasts of the tanks of ballast segregated to the sea, in the ships where the above mentioned operation is feasible, a visual inspection of the water contained in the same ones must be carried out, or, if it is not feasible, from the water exhaust to the sea, stopping the operations if indications of pollution were observed.

As for the management of the ballast water, the Dirección General de la Marina Mercante (DGMM), has established that given the implications that the current skill of change of ballast during the navigation has for the safety and stability, it is not considered to be prudent to demand to the ships of Spanish flag the fulfillment of the A.868 Resolution: consults on the Plan of Management of the Ballast Water for ships (Ref. 04/JV, of January 15, 2002).

If the ships travel to foreign ports, the Plan of Management of the Ballast Water for ships can be demanded by the Authorities of the Governing State of the Port, and in this case, the following considerations should be born in mind:

— When the Port authorities consider fit to deballast a versel that has ballasted in a port in which the water is known to be contaminated, the deballasting has to be done offshove, in depths of move than 2.000 meters overflowing the ship`s tank.

— In this case, it will be sent to the Consignee the confirmation of the change of ballast, leaving witness of it in the Logbook.
— To avoid possible claims of pollution of the water of the port, the Captain will warn the Person in charge of the Terminus that he is going to unballast the ballast contained in the segregated ballast tanks, if he decides to send a person who recognizes the cleanliness of the water contained in them, leaving written witness of the request in the Logbook of the ship.

The Protocol of 1978 (MARPOL 73/78) introduces a series of modifications in the Annexe I of the Agreement. For example, it prescribes ballast tanks separated for all the new ships-tanks of dead weight equal or superior to 20.000 tons, whereas in the original Agreement, the above mentioned tanks were prescribed only for the new ships-tanks of dead weight equal or superior to 70.000 tons. The Protocol also arranges that the tanks of separated ballast are placed in such a way that they help to protect the tanks of load in case of boarding or launching. Besides, following the Rule 20 of the Annexe I of the International Agreement to anticipate the pollution by the ships (1973), in their form modified by the Protocol of 1978 (MARPOL 73/78), the operations of ballast-unballast of the oil tankers of brute arching equal or superior to 150 tons, will have to record in the Book Record of Hydrocarbons (Part II).

The management of that spoils of unballasts in a refinery is a professional speciality, for the pipeline bayout in a refinery is complex, the handling of ballast water must be done with extreme caution. Every refinery must have two water systems:

In them, terminals of clearance he must have poured installed teams to be the water about unballasts of the oil ones, avoiding that of hydrocarbons the being given back to the sea.

In the own refinery, because the volume of unballasts water is only surpassed in quantity by that of the own crude.

## PLANKTONIC COMMUNITY IN AN OCEANIC ZONE

The quantity and diversity of beings that constitute the planktonic community depends on a lot of factors: the latitude, the season of the year, and the bathymetric level amongst others.

Since the ballast water is taken from the low part of the hull of a nose, and since the change of ballasts, it is known the existence of the distribution in spots that the zooplankton experiences in the natural way (Steele and Frost, 1977).

The material studied in this piece of research comes from the tows fullfilled from July to December 2002, on a station placed in the North-East of the island of Tenerife, Canary Islands (28° 30' N and 16° 06' W), to 5 miles of the coast with a depth of probe of 1.200 m (Fig. 3). The anchorage of ships is habitual in the zones nearby.

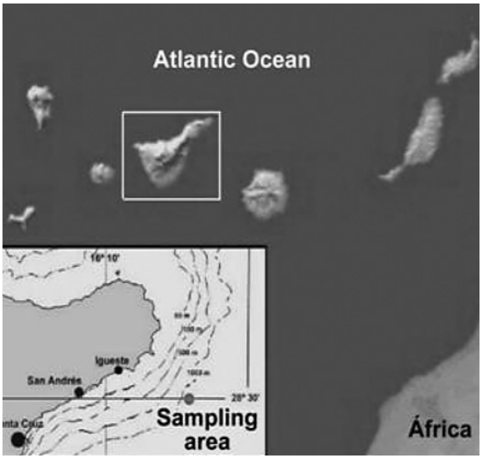



**Figure 3.** Situation of the sampling station.

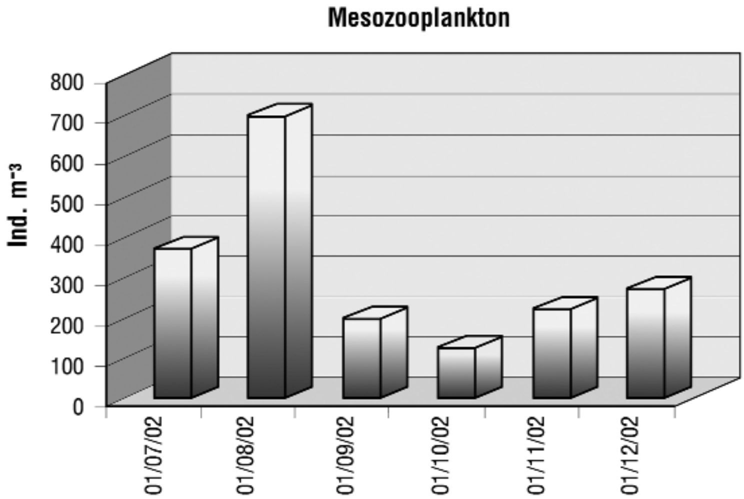
Vertical tows of 50 metre of length samplings were carried out until surface. The samples one harvested with a Juday-Bogorov net of 56 cm in diameter (0.246 $m^2$) and 250 µ mesh, obtaining a volume of filtered water of 12.3 $m^3$. Given the available net mesh light the collected units belong, by his size, to the mesozooplankton (0.2 – 20 mm.)

The samples were preserved with formalin at 4% on board, previously buffered with sodium borate (borax), labeled and stored for his posterior study in the laboratory.

Table 1 shows the results of the counts conducted with indication of ind.$m^{-3}$ and its percentage in each one of the considered taxonomical groups. In Fig 4, one population averages indicate the density data.

| TAXA | DATE (d/m/y) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30/07/02 | | 27/08/02 | | 24/09/02 | | 29/10/02 | | 28/11/02 | | 27/12/02 | |
| | Ind.$m^{-3}$ | % | Ind.$m^{-3}$ | % | Ind.$m^{-3}$ | % | Ind.$m^{-3}$ | % | Ind.$m^{-3}$ | % | Ind.$m^{-3}$ | % |
| Copepods | 136,26 | 37,18 | 476,43 | 68,32 | 152,20 | 77,74 | 103,09 | 81,49 | 133,66 | 60,71 | 163,58 | 60,53 |
| Cladocers | – | – | 1,95 | 0,28 | 0,65 | 0,33 | 0,33 | 0,26 | – | – | – | – |
| Ostracods | 0,98 | 0,27 | 3,58 | 0,51 | 3,58 | 1,83 | 6,18 | 4,88 | 5,85 | 2,66 | 1,63 | 0,60 |
| Mysidacea | – | – | – | – | – | – | – | – | 0,33 | 0,15 | 0,33 | 0,12 |
| Euphausiids | – | – | – | – | – | – | | – | – | – | – | – |
| Amphipods | 0,65 | 0,18 | 1,63 | 0,23 | – | – | 0,33 | 0,26 | 0,33 | 0,15 | 0,33 | 0,12 |
| Crustacea Larvae | 9,43 | 2,57 | 9,76 | 1,40 | 2,28 | 1,16 | 0,98 | 0,77 | 0,33 | 0,15 | 0,98 | 0,36 |
| Chaetognaths | 11,71 | 3,19 | 20,81 | 2,98 | 8,13 | 4,15 | 0,98 | 0,77 | 3,90 | 1,77 | 5,85 | 2,17 |
| Appendicularians | 13,33 | 3,64 | 66,34 | 9,49 | 7,48 | 3,82 | 6,50 | 5,14 | 1,95 | 0,89 | 32,85 | 12,15 |
| Pteropods | 4,55 | 1,24 | 2,93 | 0,42 | 0,65 | 0,33 | 0,33 | 0,26 | 7,15 | 3,25 | 1,30 | 0,48 |
| Siphonophores | 9,43 | 2,57 | 17,89 | 2,56 | 0,98 | 0,50 | 0,98 | 0,77 | 4,23 | 1,92 | 5,85 | 2,17 |
| Salps | 11,38 | 3,11 | 0,98 | 0,14 | – | – | – | – | – | – | – | – |
| Doliolids | 3,90 | 1,06 | 9,11 | 1,30 | 1,30 | 0,66 | 0,33 | 0,26 | 1,63 | 0,74 | 1,30 | 0,48 |
| Hydromedusae | 5,53 | 1,51 | 6,83 | 0,98 | 0,98 | 0,50 | 0,33 | 0,26 | 0,33 | 0,15 | 1,63 | 0,60 |
| Eggs | 154,15 | 42,06 | 61,14 | 8,74 | 16,26 | 8,31 | 6,18 | 4,88 | 59,84 | 27,18 | 50,73 | 18,77 |
| Fish Larvae | – | – | 1,30 | 0,19 | – | – | – | – | – | – | – | – |
| Polychaetes | 3,90 | 1,06 | 6,83 | 0,98 | 1,30 | 0,66 | – | – | 0,65 | 0,30 | 2,60 | 0,96 |
| Polychaetes Larvae | – | – | – | – | – | – | – | – | – | – | 0,33 | 0,12 |
| Mollusca Larvae | – | – | 0,65 | 0,09 | – | – | – | – | – | – | 0,33 | 0,12 |
| Echinodermata Larvae | 1,30 | 0,35 | 10,73 | 1,53 | – | – | – | – | – | – | 0,65 | 0,24 |
| Total | **366,5** | --- | **699,19** | --- | **195,77** | --- | **126,5** | --- | **220,16** | --- | **270,24** | --- |

**Table 1.** Density of population (ind.$m^{-3}$) and percentage (%) of the mesozooplancton taxonomic groups collected in tows 50 - 0 m.




| | 30/07/02 | 27/08/02 | 24/09/02 | 29/10/02 | 28/11/02 | 27/12/02 |
|---|---|---|---|---|---|---|
| Ind. –3 | 366,5 | 669,19 | 195,77 | 126,5 | 220,16 | 270,24 |

**Figure 4.** Half population densities.

The found half densities for the sampling period he was 313.06 ind.m$^{-3}$. The values of maximum (699.19 ind.m$^{-3}$) and minimum (126.5 ind.m$^{-3}$) density were registered during the months of August and October.

## TREATMENTS FOR THE STERILIZATION OF THE SEA WATER

Out of the different treatments known to sterilize the sea water, three of them can be basically distinguished:

— Chemical
— Mechanics
— Physical

Within the physical methods, the ultraviolet radiation is one of the most used and effective, although it has the disadvantage that it is the treatment of mechanical type that must be used in ideal conditions. The treatment with heat is another physical method; in this case the energy of the boilers inseeld/makes use? of increasing the temperature of the water, causing the death of the organisms. Nevertheless, a relatively complicated design is necessary and it is less effective than the treatment with ultraviolet radiation. A treatment for ultrasound also exists although it is still in an experimental phase.

Amongst the mechanical methods, the treatment for filtration eliminates any solid one or organism whose size overcomes the pore of the filter, but it allows stepping in of small organisms/,for example, small organisms to go through (virus, bacteria). Something slightly similar happens with the method of centrifugation; when the water centrifuges in a hydrociclon the particles and organisms with a bigger density than the water are dragged to the external part of the device and, thus, they are easily eliminated. However, the particles and organisms that have a similar or minor density to that of the sea water escape, and therefore they cannot be eliminated.

As for the chemical treatments, there are disinfectant products and biocides, generally oxidizers of the organic matter (as the chlorine that is used to make consumption water drinkable); a great disadvantage is that the waters treated this way preserve certain biocide character that can later affect other species. Also, on certain occasions, they give place to organochloride compounds of toxic and carcinogenic nature. Therefore, other substances are being investigated with limited biocide effects that do not put in danger other species, as well as the use of copper and other metals that are toxic for the microorganisms, though it can transport the problem of which certain metals, which in some cases are accumulative, enter the trophies chains. Nevertheless, these systems are not completely effective if not all the zones have been covered of the ballast tank and have left dead spaces without treating.

In the chemical measurements other possibilities as the treatment with ozone, electrolysis or variations in the acidity grade of the water have been proposed, but they have been discarded because of their high cost and because they can bring new, environmental problems.

Therefore, the management of the ballast waters worldwide needs an effective and economic method, but taking a lot of care not to damage the ecosystem of the zone or region where the unballast is realized, because, otherwise "prevention will be better than cure".

## CONCLUSIONS

Although nowadays oil tankers of new construction tend to have segregated tanks for the transport of the load and of the water of ballast, this separation in the tanks does not p revent that multiple organisms are moved every day from one zone to another around the planet, with the consequent problem of the introduction of exotic species in an ecosystem.

In the period recollected/analysed, an average density in the mesozooplankton of 313.06 ind.m-3 has been found, in spite of the fact that the sampling reported upon has been carried out in the North-East of the island of Tenerife (Canary Islands), which is a zone considered like oligotrophic, in comparison with the density that other zones and other latitudes can have, and that is the reason why an oil tanker that sucks 24.000.000 $m^3$ of ballast water can gather, approximately, 7.512 million organisms belonging to this one community.

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# OPERANCIONES DE LASTRES Y DESLASTRE EN BUQUES PETROLEROS: ORGANISMOS PLANCTÓNICOS QUE PUEDEN VIAJAR EN EL AGUA DE LASTRE


## RESUMEN

**A principios del siglo XX se reconoció la presencia de especies no autóctonas en el agua de lastre, pero no fue hasta la década de los 70 cuando realmente se vio como un problema. Durante la década de los 80, se introdujeron y observaron cada vez más especies no autóctonas en todo el mundo, y a finales de dicha década, Canadá y Australia, dos de los países que sufrían problemas de éste tipo, expusieron sus preocupaciones al Comité de Protección del Medio Marino (CPMM).**

**En febrero de 2004 la OMI adoptó el Convenio Internacional para el Control y Gestión del Agua de Lastre y Sedimentos de Embarcaciones, y será obligatorio cumplir los estándares aprobados entre 2009 y 2016, según el año de construcción del buque y la capacidad de sus tanques de lastres.**

**Durante el periodo julio - diciembre de 2002, se realizaron, en una estación oceánica (28° 30´ N y 16° 06´ W), muestreos verticales, de 50 metros hasta superficie, para registrar los taxones presentes de la comunidad mesozooplanctónica, encontrando valores medio de densidad de 313,06 ejem./m$^3$. Con referencia a la composición porcentual por grupos taxonómicos y para la misma batimetría, destacó la dominancia de los copépodos con un valor medio de 64,33%, seguido de huevos de invertebrados y peces (18,32%,) y apendiculariáceos (5,86%) mientras que el resto de grupos estudiados no superó el 2% de media.**


**Palabras clave:** Lastre, deslastre, petroleros, mesozooplancton, especies alóctonas.

## METODOLOGÍA

Los buques cargueros, necesitan grandes volúmenes de agua de lastre cuando el buque navega sin cargamento (en lastre). El agua se bombea antes de emprender el viaje con el buque vacío, y es un elemento imprescindible para la navegación ya que mejora la estabilidad del buque. Esto ocasiona un trasiego de unos diez mil millones de toneladas de agua de lastre cada año entre diversas partes del mundo. Con ese agua de lastre se pueden embarcar organismos alóctonos, generalmente de pequeño tamaño, pertenecientes a la comunidad planctónica.

Se estima en unas 3.000 especies los animales y plantas que diariamente viajan de ésta forma (OMI, 1998). Además, la rapidez de desplazamientos de los buques actualmente, es otro factor que favorece la prosperidad de estos organismos, ya que muchos no sobrevivirían un largo periodo de tiempo en la oscuridad de los tanques de lastre. La Organización Marítima Internacional (OMI) dictó, entre 1993 y 1997, directrices para impedir la transferencia de organismos acuáticos y agentes patógenos indeseados procedentes de las aguas de lastre y descargas de sedimentos de los buques, pero el problema es que, a diferencia de los derrames de hidrocarburos y otras formas de contaminación del mar originadas por el tráfico marítimo, las especies marinas y organismos exóticos son muy difíciles de eliminar. La resolución A.868(20), aprobada el 27 de noviembre de 1997 como anexo del convenio MARPOL, lleva por título "Directrices para el control y la gestión de las aguas de lastre de los buques a fin de reducir al mínimo la transferencia de organismos acuáticos perjudiciales y agentes patógenos", y su objetivo es lograr que toda la flota mundial esterilice las aguas de lastre en el menor plazo posible.

El material estudiado en este trabajo procede de los arrastres realizados desde julio a diciembre de 2002, en una estación situada en el noreste de la isla de Tenerife (28° 30´ N y 16° 06´ W), a 5 millas de la costa con una profundidad de sonda de 1200 m (Fig. 3). En zonas próximas, es habitual el fondeo de buques.

Se realizaron muestreos verticales de 50 metros hasta superficie. Las muestras se recolectaron con una red Juday-Bogorov de 56 cm de diámetro de boca (0,246 $m^2$) y malla de 250 μ, obteniéndose un volumen de agua filtrada de 12,3 $m^3$. Dada la luz de malla de la red disponible, los ejemplares recolectados pertenecen, por su tamaño, al mesozooplancton (0,2 – 20 mm).

Las muestras fueron fijadas a bordo con formol al 4%, previamente neutralizado con tetraborato de sodio (bórax), etiquetadas y almacenadas para su posterior estudio en el laboratorio.

A continuación, se procedió a la subdivisión de las muestras hasta el nivel 4 de fraccionamiento (16 submuestras) con un subdivisor Folsom, realizándose el recuento total de 4 de las submuestras sobre placas de recuento del tipo Bogorov bajo microscopía estereoscópica. Los datos obtenidos fueron sometidos al cálculo dado por HORWOOD & DRIVER (1976) expresando los resultados en número de ejemplares por $m^3$ y porcentaje. Los resultados obtenidos se expresan teniendo en cuenta a los 19 grupos taxonómicos encontrados, incluidos dentro del holoplancton o plancton permanente (copépodos, cladóceros, ostrácodos, misidáceos, eufausiáceos, anfípodos, quetognatos, sifonóforos, hidromedusas, pterópodos, poliquetos, apendiculariáceos, sálpidos y doliólidos) y meroplancton o plancton estacional (huevos de invertebrados y peces, y larvas de crustáceos, poliquetos, moluscos, equinodermos y peces).

## CONCLUSIONES

Aunque actualmente se tienda a que los petroleros de nueva construcción tengan tanques segregados para el transporte de la carga y del agua de lastre, ésta separación en los tanques no impide que múltiples organismos sean trasladados diariamente de una zona a otra del planeta, con el consiguiente problema de la introducción de especies alóctonas en un ecosistema.

En el periodo de tiempo muestreado, se ha encontrado una densidad media en el mesozooplancton de 313,06 ejem./$m^3$, a pesar de que dicho muestreo se ha realizado en el noreste de la isla de Tenerife, zona considerada como oligotrófica, en comparación con la densidad que puede encontrarse en otras zonas y otras latitudes, por lo que si un petrolero succiona 24.000.000 $m^3$ de agua para lastre, puede recoger unos 7.512 millones de organismos pertenecientes a ésta comunidad.