LIFE beneath the ocean is dwindling. While some species are falling prey to overfishing and habitat destruction, others are invaded due to anthropogenic vectors. Human activities have also accelerated the ecological imbalance.

More than 90% of the world trade and commerce is carried out by shipping. These huge fleets cause dispersal of organisms which are attached to their hulls or carried in ballast water. The exchange of organisms results in invasions of the native ones thus compromising the integrity of the marine ecosystem.

Studies reveal that over 7000 species can be exchanged through ballast tanks at any one time. A survey has cited the occurrence of a new invader every week for the past five years in the Mediterranean. Marine bio-invasion is of growing concern as it can be costly in terms of ecological and economic damages.

Ships float with three-fourths of their body underwater and one-fourth above it. In order to float it should displace an amount of water equal to its weight. Cargo ships have a specialised compartment called the Ballast tank that holds water for the purpose of providing adequate stability to the cargo vessels at sea. This water is designated as “Ballast water”. These ballast tanks are connected to pumps which can pump water in or out.

It is estimated that every year nearly 12 billion tonnes of ballast water is filled at one port and dispensed at other ports causing an imbalance in the ecosystem. Various vectors have been identified. Some are intentional for aquaculture improvement, are not harmful and can be controlled while others are unintentional like ballast water exchange and industrial discharge. These unintentional vectors change the biodiversity and cause the restructuring of the food web.

Ballast Water – Bio-invasion Vector

Ballast water contains multitude of organisms ranging from microscopic bacteria and algae to macroscopic starfish and mussels. Due to conditions like less light and low air supply, incubation occurs favourably. Stagnant environment curtails ventilation in the ballast tank.

So, organisms already residing in the ballast tank take up all the oxygen thus leading to oxygen depletion. Scarcity of oxygen leads to accumulation of organisms in particulate form. They form sediments with inorganic colloid. This condition is favourable for proliferation of various bacteria/virus that can tolerate extreme physicochemical environment. Thus they thrive happily. Also some cysts start growing. This way the fresh ballast turns into aged ballast till they reach the destination port.

When the Ballast water is emptied at another port, the harmful effects
come in the form of various diseases
and introduction of foreign organisms
that have no higher trophic levels. They
flourish and alter the integrity of the
ecosystem preying upon and competing
with the native species for food and
space.

The entry of foreign organisms
inflicts adverse impacts on aquaculture
and fisheries production. Bio-fouling
reduces economy and efficiency of
shipping, as a result the entire coastal
infrastructure is affected. Recreational
and tourism activities also shut down
thus affecting the economy of that
region.

Quite a handful of invasive species
have been recorded as particularly
harmful to the ecology and economy of
the regions they have invaded.

**Zebra mussels** (*Dreissena polymorpha*) are small aquatic molluscs
native to the Black Sea of Eastern
Europe and were introduced to Western,
Northern Europe, and Eastern half of
North America (Great lakes). In their
native environment their population is
controlled by 36 species of birds and 15
species of fish that are found in the Black
sea region. Moreover, attached mussels
are preyed upon by local rodents,
crayfish and leeches.

However, in the Lake ecosystem,
due to absence of predators, they
proliferate to a harmful extent. Their
voracious filter feeding habits tend
to create an imbalance in the lake
ecosystem and create lesser provisions
for larval and young fishes that hold up
fisheries. Industrial discharges in water
bodies are deposited in their tissues and
faeces which can have a negative impact
on the ecosystem. When other fishes eat
the contaminated zebra mussels, they too
become infected with chemicals. These
fishes when harvested and sold may
create a perilous situation for humans.

**Green Crab** (*Carcinus maenas*)
hail from North East Atlantic Ocean
and Baltic Sea and were introduced
to Australia, South Africa and South
America. Predators of green crab include
fishes, birds and larger decapods which
are local to their native place. Their
dearth in areas where green crabs are
introduced let them flourish. They
have an exceptionally strong potential
for destroying marine ecosystems and
fisheries on a worldwide basis. Its recent
invasion of the Washington state through
ballast water exchange has created havoc
in the biodiversity of that region.

Green crabs eat a vast assortment
of organisms from 104 families and 158
genera. These include molluscs (bivalve
and periwinkles), crustaceans, clams
like manila clam, oysters and shells. It
is slowly but steadily monopolising the
entire marine ecosystem.
The Algal Bloom is a phenomenon where an uncontrolled increase of algae in a particular water body. Some algal blooms that are known to be particularly lethal are usually members of the genus *Alexandrium* and *Karenia*. Such blooms usually take on a reddish brown tinge and are colloquially called red tides. It is a fast spreading menace that has invaded innumerable coastal areas all over the world due to coastal upwelling and through ship’s ballast water.

The marine ecosystem has been significantly affected due to the production of toxins by these algae, for example cyanotoxins, saxitoxin, domoic acid and brevetoxin. They cause hepato-pancreatic, digestive, neurological and immunological impairment in marine organisms who feed on them. Bottlenose dolphins and Atlantic Right whales have been reported to face extinction due to this menace. This problem has also proved to be costly in terms of economy and human health.

**Global Response**

The Australian Quarantine and Inspection Service (AQIS) has made it mandatory to maintain the records of ballast water and prohibit the discharge of “High risk ballast water”. It also stipulates exchange of ballast water at a minimum of 3 nm offshore. Likewise, Canada introduced regulation which includes exchange of ballast water more than 200 nm from land and submitted a “Ballast Water Report Form”.

Complexity and trans-boundary nature of ballast water control and management led the International Maritime Organisation (IMO) to propose the “International convention for the control and management of ship’s ballast water and sediments”. It stipulates the roles of coastal, port and flag states as well as shipping industries in protecting the maritime environment by embracing effective ballast water management measures.

It is estimated that every year nearly 12 billion tonnes of ballast water is filled at one port and dispensed at other ports causing an imbalance in the ecosystem.

According to IMO’s guidelines ships should exchange ballast water at sea before entering the port. Mid-water exchange has been proposed so that the port areas are not affected with organisms. However, mid-water exchange is seldom monitored. A few institutes including the CSIR-National Institute of Oceanography have addressed this issue. By applying molecular detection techniques, documenting and proving the invasion events are done. Six countries namely Brazil, China, India, Iran, South Africa and Ukraine are included in the Global Ballast Water Management programme (GloBallast). Mumbai has been chosen as a demonstration site.

In spite of such vigorous efforts in trying to eradicate the effects of bio-invasion, the methodologies of invasion management are yet to be developed properly and effectively.

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