OIL BIODEGRADATION AND BIOREMEDIATION

Oil spills are one of the most discussed environmental problems of our age: every year, due to the leak of petroleum in the sea, caused by oil tanker accidents, serious damages occur both to wildlife and to our environment.

Free image on: https://www.worldwildlife.org/stories/five-years-after-deepwater-horizon-spill

Many controversies have raised about which new technology performs the best result in oil remediation, but in recent years a new method involving the use of bacteria caught on.

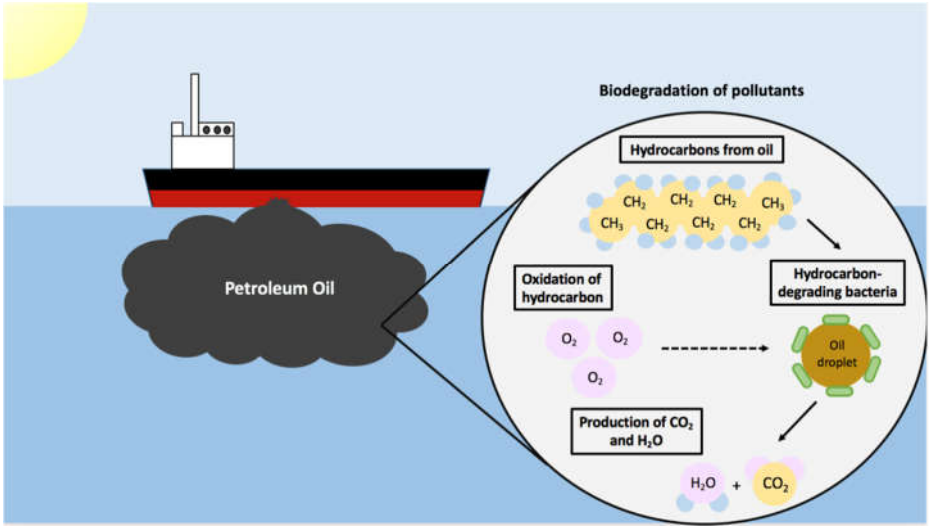
Indeed petroleum hydrocarbons contained in crude oils are natural products derived from algae laid down 100-200 million years ago, that constantly input small amounts of aliphatic and aromatic hydrocarbons as waste products. Therefore we can say that crude oils are naturally a part of all marine environments. Because of this, a huge number of aquatic microorganisms have evolved the capability of turning hydrocarbons into carbon dioxide and energy; in other words they are able to use what we commonly call "pollutant compounds" as source for their growth. The use of microorganisms in order to degrade contaminants, such as oil, is called "bioremediation".

In particular, in order to find out more about these microorganisms' metabolism, biologists have analyzed two different bacteria: *Alcanivorax borkumensis* and *Oleispira antarctica.* Both of them are called hydrocarbonoclastic, which literally means "able to break hydrocarbons".

Alcanivorax borkumensis

Alcanivorax is a marine bacterium which naturally propagates in seawater containing crude oil. Its genome encodes for a wide spectrum of efficient oil-degrading enzymes that can be used in bioremediation of spills.

Not very much is known about the exact method used by *Alcanivorax* to biodegrade oil, but some hypothesis seem to be very close to the real mechanism. Oil leakage into aquatic environments causes an increase in phosphorus and nitrogen, natural nutrient of this bacterium. The increased nutrient availability causes *Alcanivorax* to grow faster and population to increase. Each bacteria forms a biosurfactant, an extra layer along the cell membrane. The substances that make up these layers can reduce the surface tension of water and have a function of emulsifiers, which help to break up oil into droplets. *Alcanivorax* creates a biofilm around oil droplets. In the end, two important enzymes (AlkB1 and AlkB2) are used to oxidize alkanes and obtain carbon dioxide and water, necessary for the bacteria's growth.



Free image on: https://commons.wikimedia.org/wiki/File:Biodegradation_of_Pollutants.png

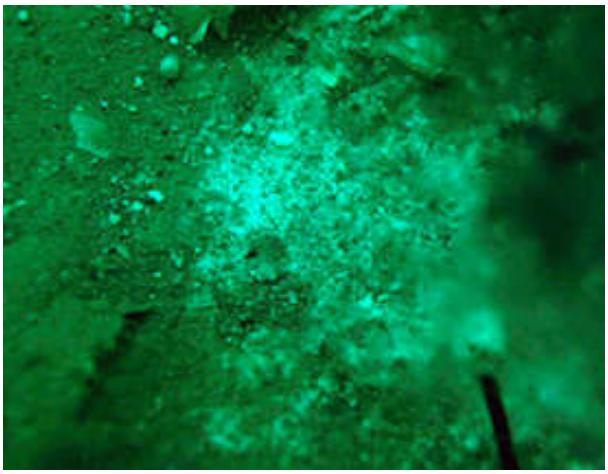
Alcanivorax's genome also codes for several defensive mechanisms. It flourishes almost only on or near to surface of water thanks to its mechanism of protection against UV radiation.

Oleispira Antarctica

Oleispira Antarctica is an aerobic marine bacterium and, just like *Alcanivorax,* has shown to play a significant role in biological removal of petroleum hydrocarbons from polluted waters.

Its name derives from the place where has been isolated for the first time: the Ross Sea in Antarctica. Indeed, *Oleispira* is a cold marine species, which means that is able to perform remediation of oil even in cold and deep water, where *Alcanivorax* can't live. Some gene clones belonging to *Oleispira* were found to be very common in samples obtained from deep underwater depths at the *Deepwater Horizon* oil spill in 2010.

This bacterium's metabolisms has shown to be very similar to *Alcanivorax*'s, but *Oleispira* can live in anaerobic conditions too, even if with some difficulties.



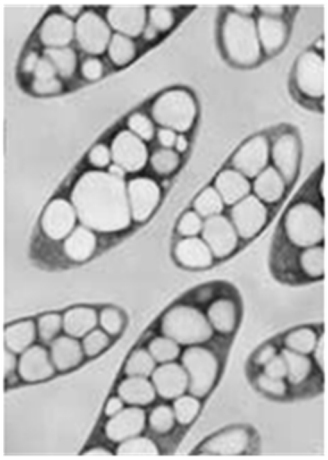
Free image on: https://en.wikipedia.org/wiki/Biofilm#/media/File:Screen_Shot_2017-12-13_at_1.40.19_PM.png

Minerv Biorecovery

As we said, hydrocarbonoclastic bacteria can survive only under specific oxygen and temperature conditions. Oil spills sometimes reach zones in the sea where bacteria can't live and because of this biologists tried to find out a way to create advantageous environments for them to grow.

Italian startup *Bio-on* developed a new project called *Minerv Biorecovery* which concerns the use of a special bioplastic able to eliminate, in natural ways, the pollution derived from hydrocarbons.

Minerv Biorecovery is a technique based on bioplastic (PHAs) powders, with a size of few microns, which form porous structure suitable to host bacteria. Bioplastic components act as nourishment for the colony and make it grow and strengthen to attack the oil. *Minerv Biorecovery* offers a home to microorganisms that are naturally present in the sea and help bioremediation process to get faster. This bioplastic is obtained from renewable plants sources and causes no problems in the food chain.



Free image on: https://commons.wikimedia.org/wiki/File:PHAs.png

In conclusion, oil spill are a major issue of our age and scientists are always looking for new technology to provide a solution. We know that a natural and sustainable way to solve this problem already exists, but certainly more in-depth studies and a higher interest by the press and the citizens would help research to gain support and progress more easily.

Sources:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3155281/

https://en.wikipedia.org/wiki/Alcanivorax

https://microbewiki.kenyon.edu/index.php/Alcanivorax_borkumensis#Ecology_and_Significance

https://www.ncbi.nlm.nih.gov/pubmed/17493798

https://www.ncbi.nlm.nih.gov/pubmed/12807200

https://en.wikipedia.org/wiki/Oleispira_antarctica

https://www.wired.it/attualita/ambiente/2017/06/06/minerv-biorecovery-bioplastica-mangia-petrolio/

http://www.minerv.it/indexEng.php

http://www.repubblica.it/ambiente/2017/06/05/news/azienda_bolognese_crea_una_tecnologia_per_pulire_il_mare-167319462/