Jellyfish replacing fish in over-exploited areas

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Moon jellyfish, Gijon Aquarium. Courtesy of José Luis Acuña and Julio Arrontes, University of Ontario

(PhysOrg.com) -- Over-fished commercial stocks of plankton-eating fish have been replaced in several locations by jellyfish species. This appears to be something of a paradox because fish move quickly and can see their prey, which suggests their capture of prey should be much more efficient than for jellyfish that move slowly and have to make contact with their prey to know they are present. Now a team of scientists in Spain and the US have discovered he jellyfishes' success is partly based on their large body size and its energy efficiency.

The team studied previously published data on jellyfish species and found that their relatively large body size, long tentacles, and their habit

of pulsing their bodies to draw plankton-laden water past their tentacles, all increase the chances of capturing nearby prey, and this body design enables them to compete successfully with the plankton-eating fish such as anchovies and sardines, even though a larger body size is less efficient for swimming.

The study, published in the journal *Science*, compared mathematical models of factors such as energy efficiency, speed, and size for over 600 species of fish and jellyfish. The researchers, led by ecologist José Acuña of the Universidad de Ovied in Spain, found that their size and speed did not give fish as much of an advantage as previously assumed, when features such as the type of body, and a reliance on light were factored in.

The jellyfish swimming style is slow but turns out to be highly efficient in terms of energy expended, and since most jellyfish species are blind, they can continue to feed regardless of the light conditions. These factors enable jellyfish to closely compete with the fish, and when fish numbers are in decline, they can become the dominant species.

The type of body also had an effect on their success. The large, gelatinous jellyfish bodies are composed of around 96% water, and therefore contain disproportionately less carbon than fish bodies, which are made up of compact organic matter. When this was taken into account the researchers found jellyfish could clear the water of plankton to produce energy at a similar rate to the fish. Having a low-carbon body (and stinging cells on the tentacles of some species) also make jellyfish a less appetizing meal for predators than do their competitors.

In some areas where fish stocks are declining, often through over-fishing or pollution, jellyfish are becoming the dominant species. These areas include coastal waters off Japan, Northeastern US, the Black Sea, and the Mediterranean. The increasing numbers could change the nature of

marine ecosystems, and in some areas, such as Japanese coastal areas, it is already causing problems for human beach-goers. In Japan, Scotland, and Israel, nuclear power plants drawing water from the sea have also experienced problems and have had to shut down at times through an over-abundance of jellyfish clogging water intake filters.

More information: Faking Giants: The Evolution of High Prey Clearance Rates in Jellyfishes, Science 16 September 2011: Vol. 333 no. 6049 pp. 1627-1629. DOI: 10.1126/science.1205134

ABSTRACT
Jellyfishes have functionally replaced several overexploited commercial stocks of planktivorous fishes. This is paradoxical, because they use a primitive prey capture mechanism requiring direct contact with the prey, whereas fishes use more efficient visual detection. We have compiled published data to show that, in spite of their primitive life-style, jellyfishes exhibit similar instantaneous prey clearance and respiration rates as their fish competitors and similar potential for growth and reproduction. To achieve this production, they have evolved large, water-laden bodies that increase prey contact rates. Although larger bodies are less efficient for swimming, optimization analysis reveals that large collectors are advantageous if they move through the water sufficiently slowly.