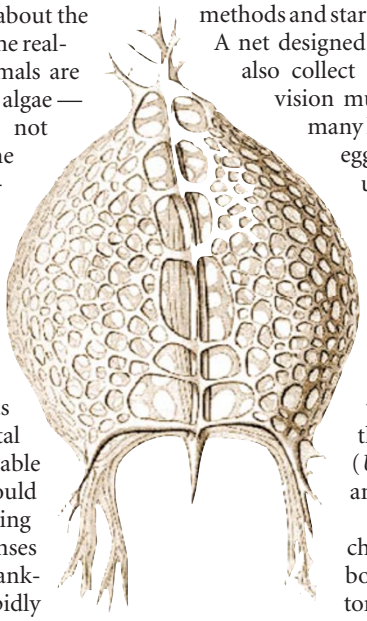
Revolution in the ocean

Victor Hensen realized that in the sea the very small feed the very large.

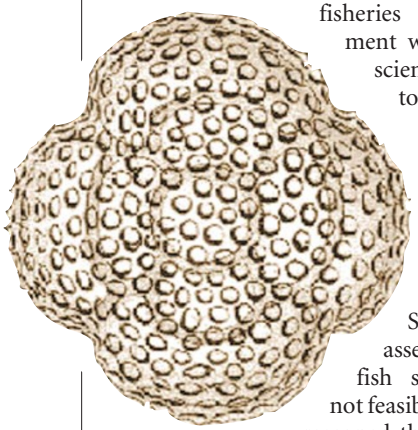
Victor Smetacek

Plants dominate life on land, but in the sea they are outweighed by animals. The ocean contains less than one per cent of plant biomass, but the proportion for animals is much larger. Yet the annual production of organic matter is about the same on land and in water. The realization that the ocean's animals are fed by a thin soup of minute algae — the phytoplankton — did not emerge gradually but was the inspiration of one man, Victor Hensen, who published his revolutionary thoughts in 1887.



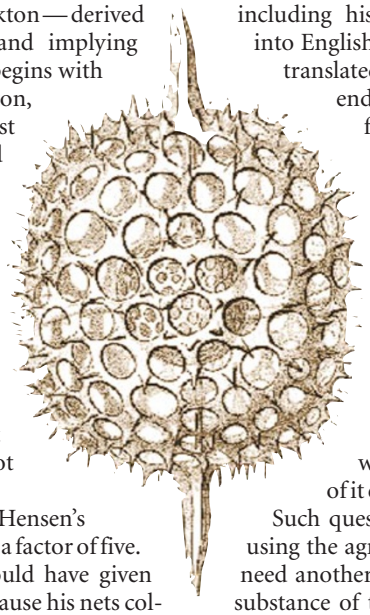
The study of planktonic organisms had begun 50 years earlier, but scientists believed that the food supply for all the ocean's animals was provided by rivers and coastal vegetation. They seemed unable to conceive that the small could feed the large. Hensen's thinking was revolutionary in both senses of the word: he thought of planktonic populations as rapidly revolving links in a food-chain leading from the very small to the very large and he applied this conceptual framework, which he called the "metabolism of the sea", to the quantitative study of ocean biology. This upset received wisdom, and launched a new discipline. The ridicule heaped upon him by leading scientists of the day testifies to the novelty of his thinking.

Hensen, a professor of medical physiology at Kiel University, was drawn to the study of the sea by the plight of the German fisheries, reeling under fluctuating fish stocks. His aim was to provide fisheries management with a true scientific basis; to him the clear first step was a reliable estimate of the "yield of the sea". Since direct assessment of fish stocks was not feasible, Hensen reasoned that the distribution and abundance of fish eggs, provided that they were dispersed uniformly by the currents, should provide a measure of population size. Hensen observed dispersion rates by following glass floats, and convinced himself that the eggs would indeed be distributed uniformly. So he designed some quantitative sampling methods and started counting eggs.

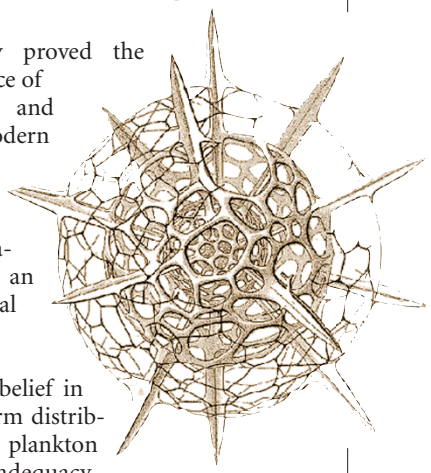


A net designed to sample fish eggs will also collect plankton, and Hensen's vision must have emerged in the many hours spent searching for eggs in thickets of plankton under the microscope. Unlike his predecessors, he looked beyond the trees, saw the forest, and developed his grand view of how oceans function. The time was ripe for a quantitative investigation of the primary food (*Urnahrung*) of the marine animals.

Hensen braved the choppy Baltic in small boats and counted plankton in rough weather. His first publication on the subject was a 105-page monograph intended to present methods and preliminary results. In it he coins the term plankton — derived from Homer's *Odyssey* and implying aimless drifting. Hensen begins with the statement that plankton, as well as being "of interest for its systematics and anatomy", was "without doubt of great importance for the entire metabolism of the sea". In the last few pages he compared his estimates of plankton production per square metre with that of agricultural fields and conjectured that plankton was equally, if not more, productive.



We now know that Hensen's conjecture was too high by a factor of five. Further, his methods should have given much lower estimates, because his nets collected only a fraction of the total plankton. Added to this, phytoplankton blooms (when his catches were large) were restricted to only a number of weeks in the year. Clearly he had made up his mind before acquiring the data. The school established by Hensen at Kiel University proved the importance of plankton and based modern biological and chemical oceanography on an agricultural model. Although Hensen's belief in the uniform distribution of plankton and the adequacy of his methods was disproved by his colleagues, he defended them right up to his last paper, published posthumously in 1926. He was forced onto the defensive by biologists working on systematics and anatomy, with Ernst Haeckel, the formidable Darwinian and meticulous draughtsman of plankton (as seen in the drawings in this article), at the forefront .



Haeckel seems to have believed that small is beautiful, but not important, and his mentor Johannes Müller, who launched the study of plankton in the 1830s, jokingly called it "philosophical dirt".

Haeckel attacked Hensen's methods, data and "quantifications". Haeckel's works, including his attacks, were translated into English. Hensen's works were not translated, and Haeckel's name has endured while Hensen's has faded.

Fisheries still reel from fluctuating fish stocks and the causes are still being debated, although we have a fairly accurate estimate of production from the ocean and of yield from the sea. The ratio of these is about 600:1 — so where is all the production going, and what determines how much of it enters the fish pool?

Such questions cannot be answered using the agricultural model. So do we need another revolution? Whatever the substance of the research in the future, Hensen's revolution will persist: plankton is indeed the provider. ■

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