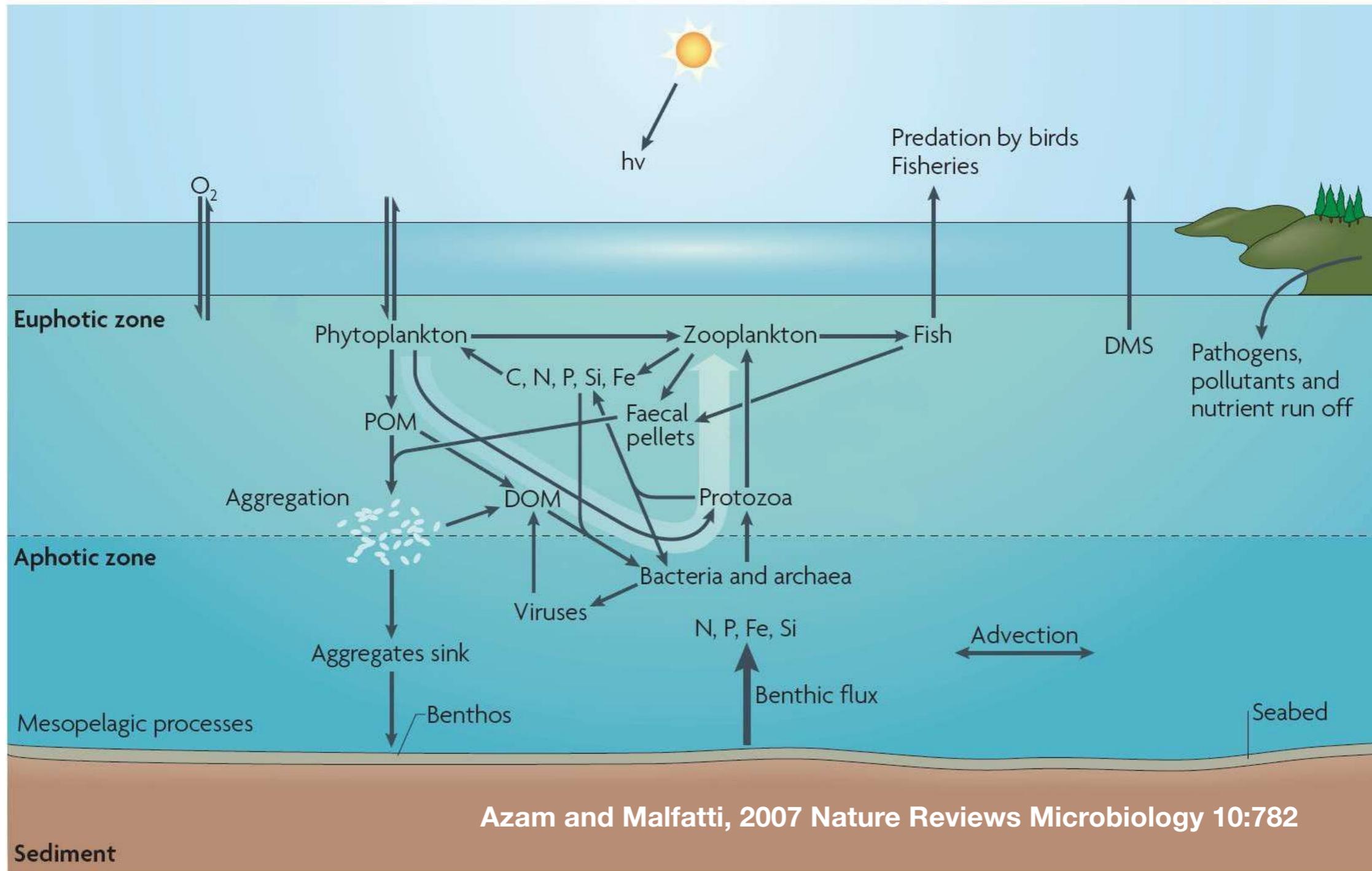
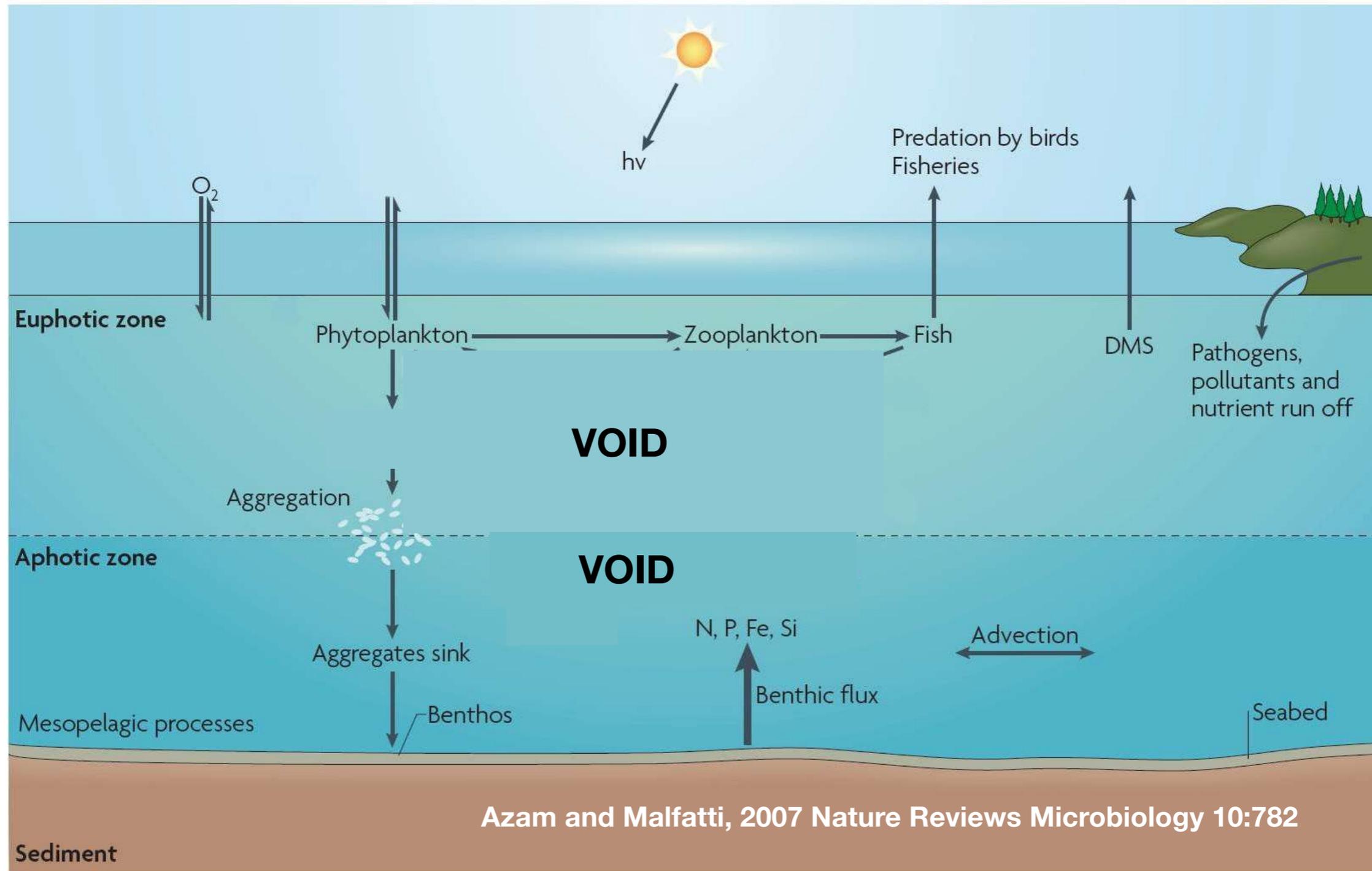


Microbes as central forces in biogeochemical cycles

Current knowledge

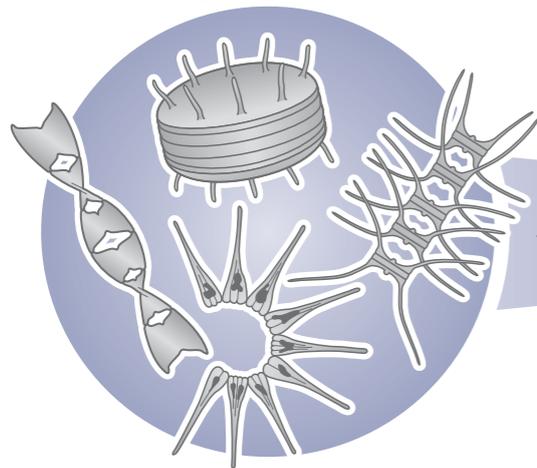


Old days..... only NPZ

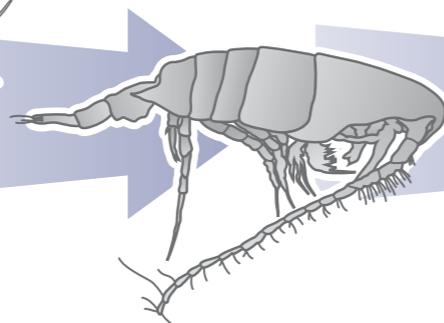


Age of discovery

Phytoplankton
(Primary Production)

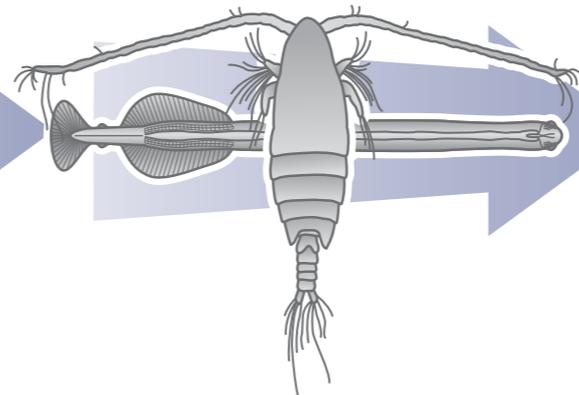


(herbivores)

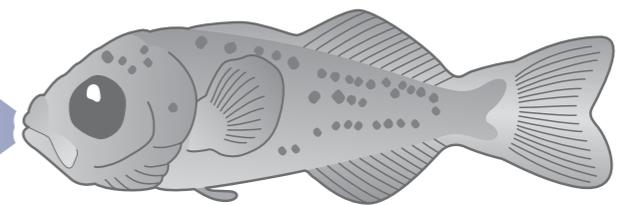


Zooplankton

(carnivores)

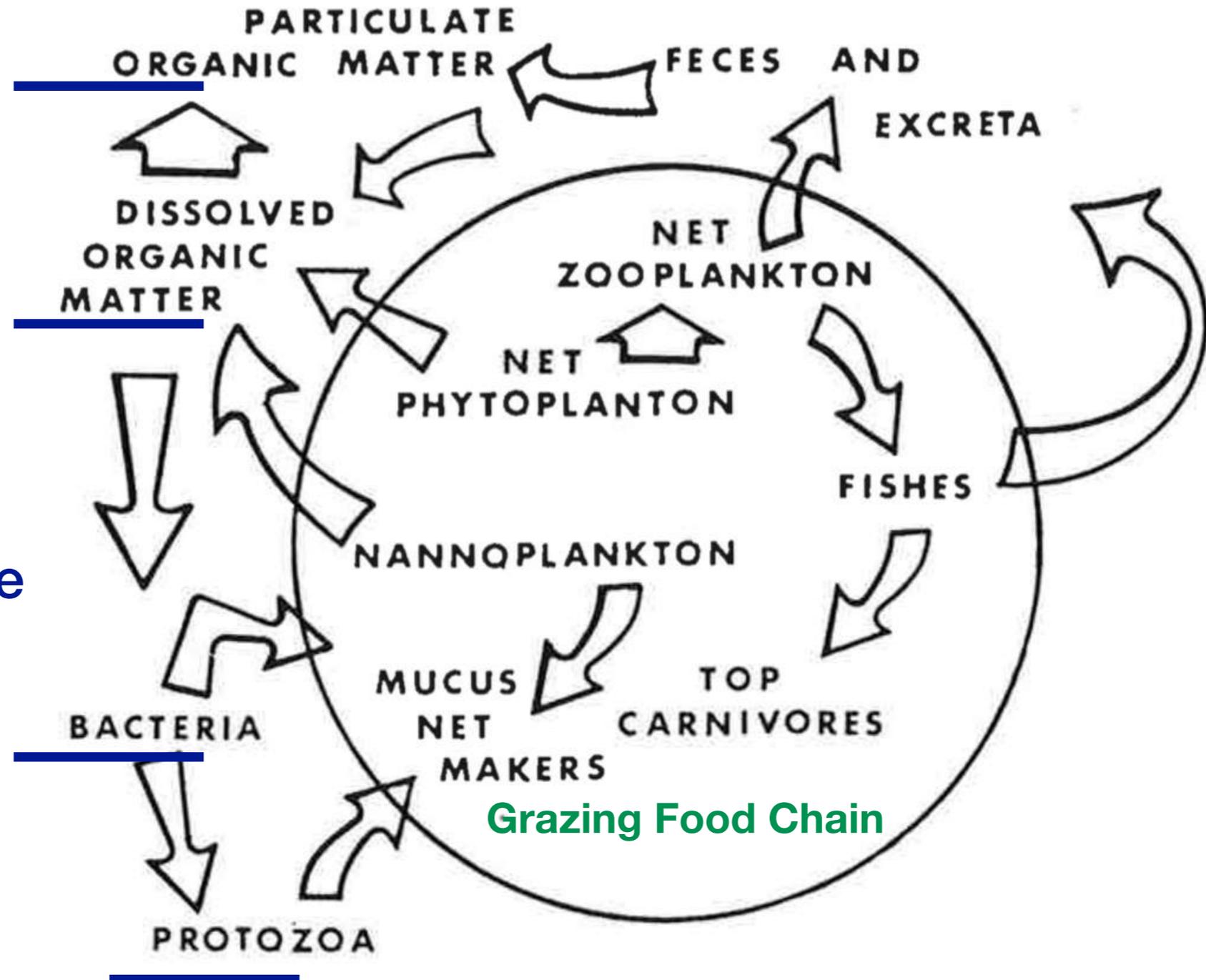


Fishes



Grazing Food Chain

The Ocean's Food Web, A Changing Paradigm



“Unseen strands in the food web”

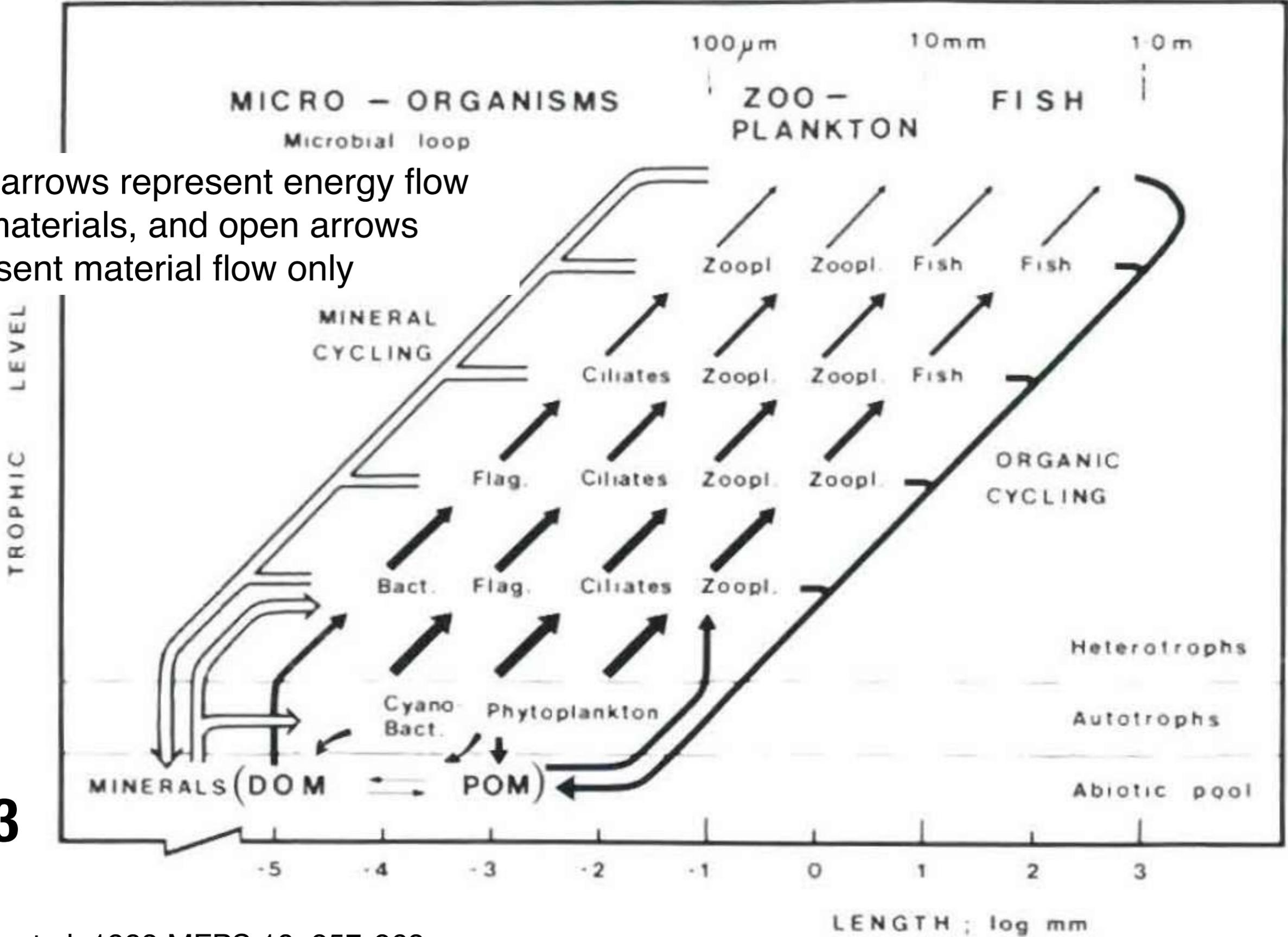
“New paradigm” are outside the circle

1974

Pomeroy 1974 BioScience 24 (9): 499-504

The Ecological Role of Water-Column Microbes in the Sea

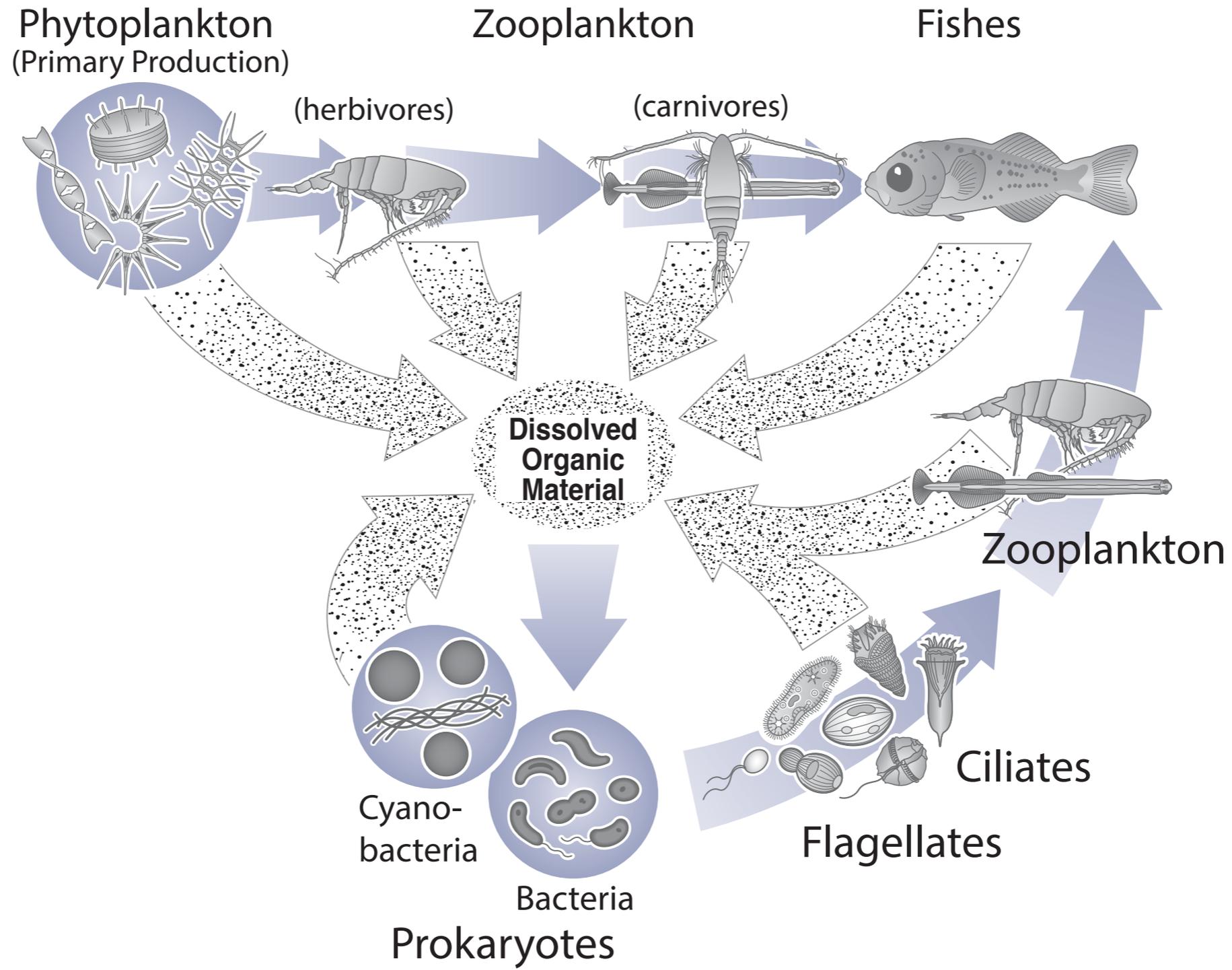
Solid arrows represent energy flow and materials, and open arrows represent material flow only



From Grieg Steward • University of Hawaii

1983

The Invisible Web



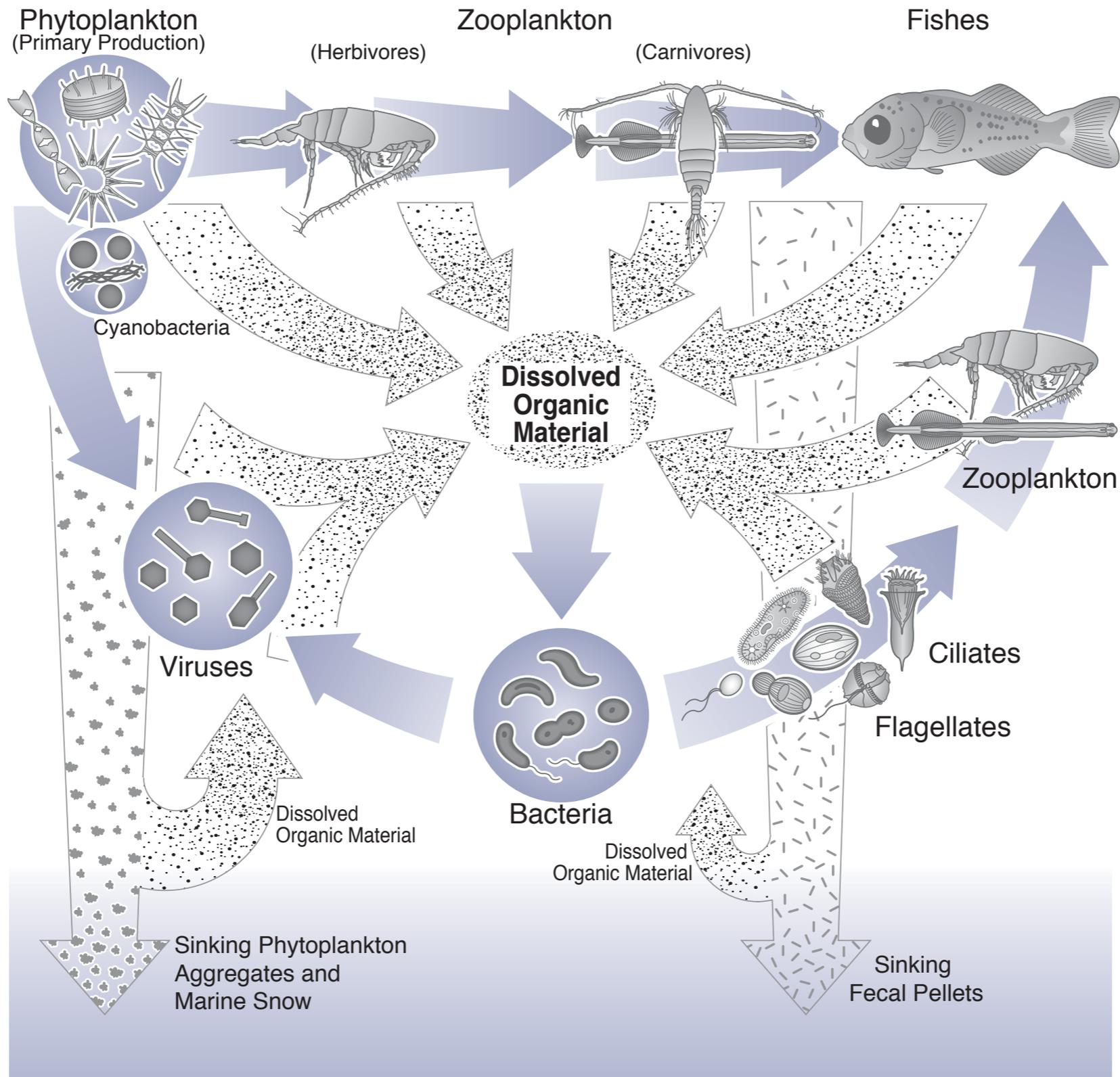
From **Grieg Steward** • University of Hawaii

1996

Howard et al. 1996 *Explorations* 3(2): 18-25

Illustration modified from original by Steve Cook, Scripps Institution of Oceanography *Explorations*

The Invisible Web



From **Grieg Steward** • University of Hawaii

1996

Howard et al. 1996 *Explorations* 3(2): 18-25

Illustration modified from original by Steve Cook, Scripps Institution of Oceanography *Explorations*

Microbial loop as a salvage pathway of OM

