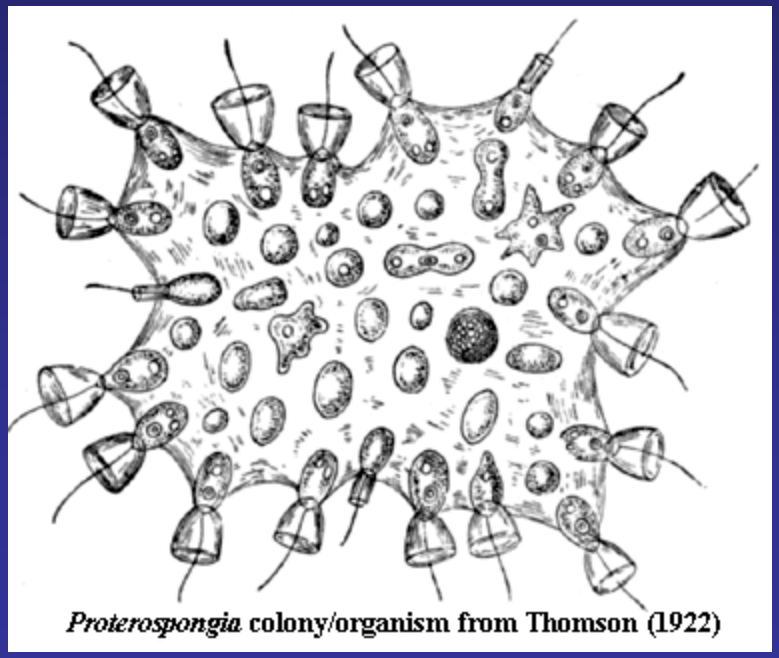
BIG IDEAS IN BIOLOGY

Six Big Ideas that shape the way biologists think about the world of life

http://cas.bellarmine.edu/tietjen/Ec&Ev_Distance_learning/MultiCelled/choanoflagellate.jpg



http://www.palaeos.com/Invertebrates/Porifera/Images/Proterospongia.gif

Passing Storm over the Sierra Nevadas **1870 Albert Bierstadt (1830–1902) Oil on canvas, 36 ½ x 55 in. (93 x 140 cm.) San Antonio Museum of Art, purchased with funds from the Robert J. and Helen C. Kleberg Foundation**

Tower Creek, 1871 Thomas Moran
19.7 x 26.8 cm (7 3/4 x 10 9/16 in)
Yellowstone NP, YELL 8528

The Six Big Ideas in Biology*:

(1) The origin of eukaryotic cells

(2) The origin of multi-cellularity

(3) The concept of an emergent property

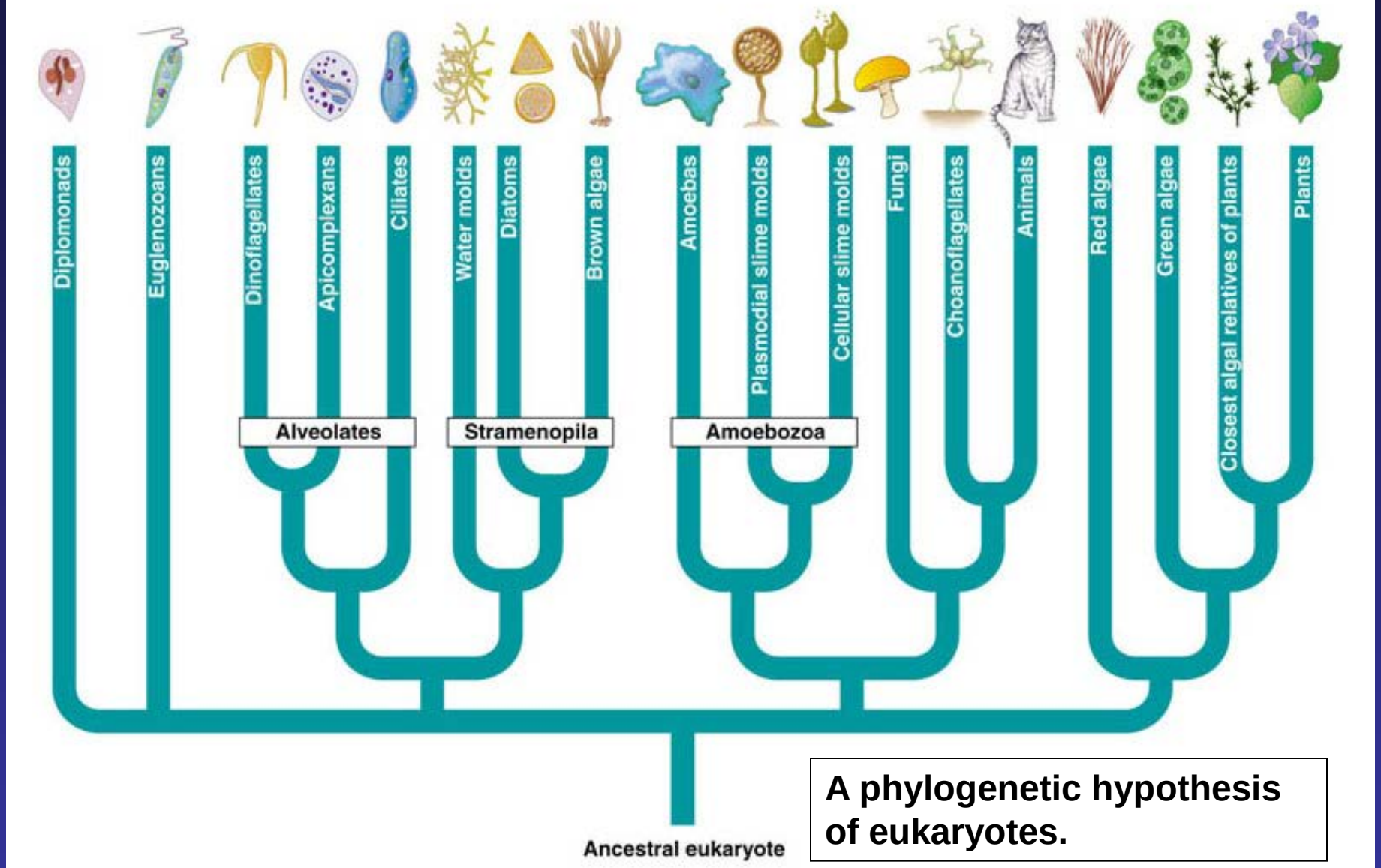
(4) Earth as an organism

(5) Infectivity and symbiosis

(6) Irreversible change as a constant

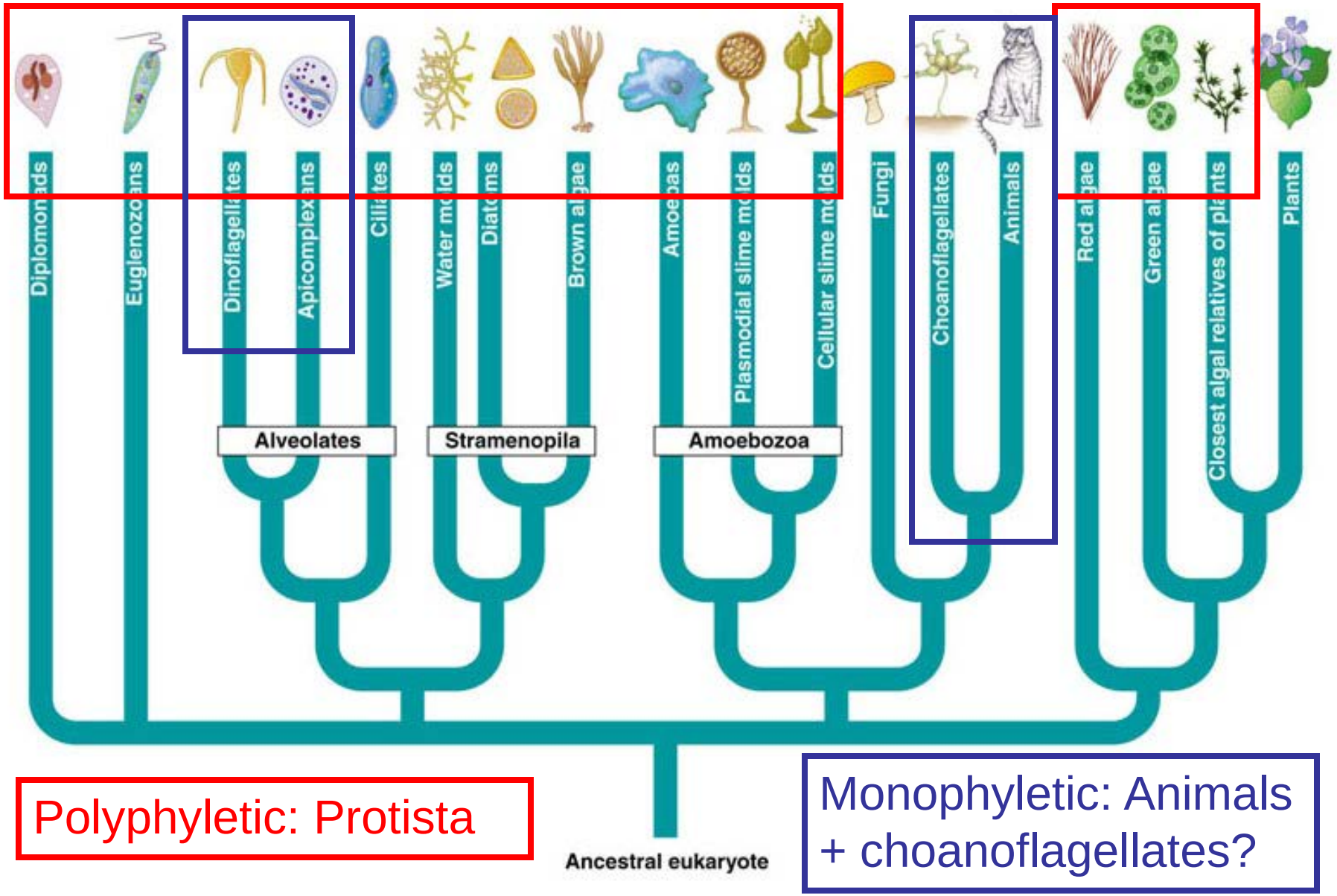
*Not all biologists would pick these six.

Big Idea #2: The origin of multicellularity



A phylogenetic hypothesis of eukaryotes.

Fig. 16.13

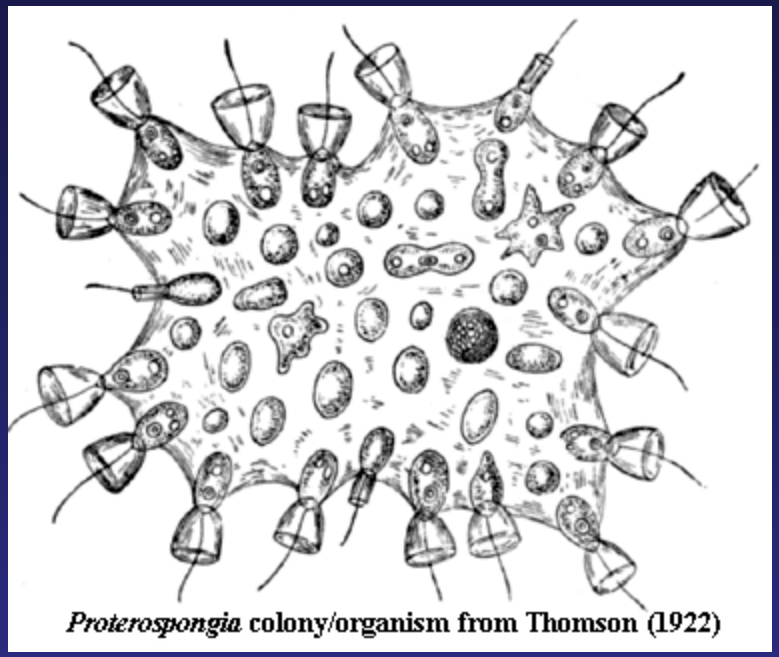


Polyphyletic: Protista

Monophyletic: Animals + choanoflagellates?

Fig. 16.13

http://cas.bellarmine.edu/tietjen/Ec&Ev_Distance_learning/MultiCelled/choanoflagellate.jpg



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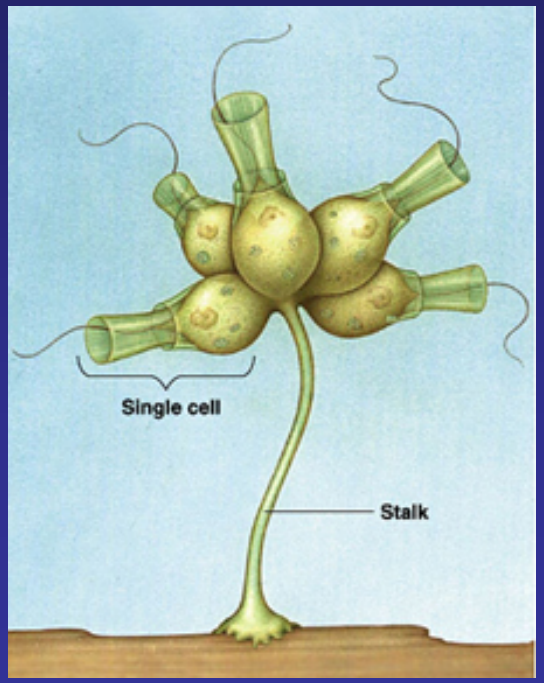

http://monado.files.wordpress.com/2008/03/choanoflagellate.jpg

What is a choanoflagellate?

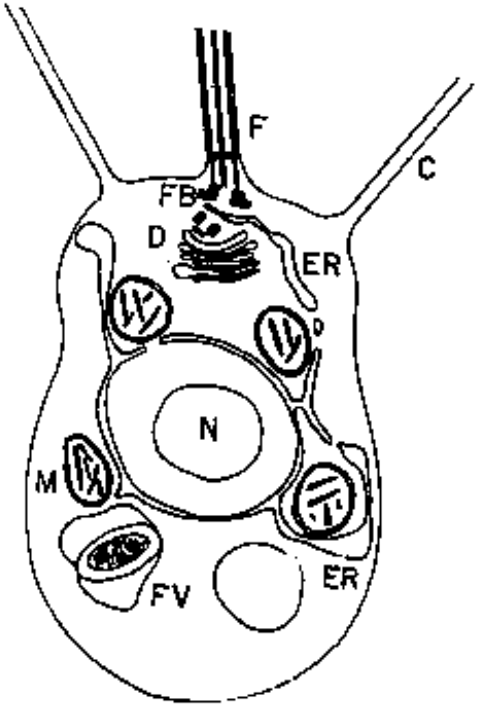

Fig. 2 Drawing of protoplast showing characteristic internal organelles X13,000 (drawing taken from electron micrograph). Flagellum, F; collar, C; flagellar base, FB; endoplasmic reticulum, ER; dictyosome, D; nucleus, N; mitochondrion, M; food vacuole, FV.

From Lee et al., 2000. *Illustrated guide to the protozoa*. Society of Protozoologists, Lawrence, KS

TI: LIFE HISTORY AND ULTRASTRUCTURE OF A NEW MARINE SPECIES OF PROTEROSPONGIA CHOANOFLAGELLIDA
AU: LEADBEATER-B-S-C [Reprint-author]
AD: DEPARTMENT OF PLANT BIOLOGY, UNIVERSITY OF BIRMINGHAM, P O BOX 363, BIRMINGHAM, B15 2TT, UK
SO: Journal-of-the-Marine-Biological-Association-of-the-United-Kingdom. 1983; 63(1): 135-160
AB: The morphology and microanatomy of 2 different phases in the life history of a single new marine choanoflagellate (*Proterospongia choanojuncta* sp. nov.) were documented and described with the aid of light microscopy and EM of whole mounts and sections of material in clonal culture. Completion of the life-cycle was repeatedly achieved in cultures established from single cells, regardless of which phase is used as a starting point. One phase is colonial and motile (the Proterospongia phase) and the other unicellular and sedentary (the Choanoeca phase). Taxonomic, nomenclatural and developmental problems are summarized and discussed.

(Love Library, QH92 M3)

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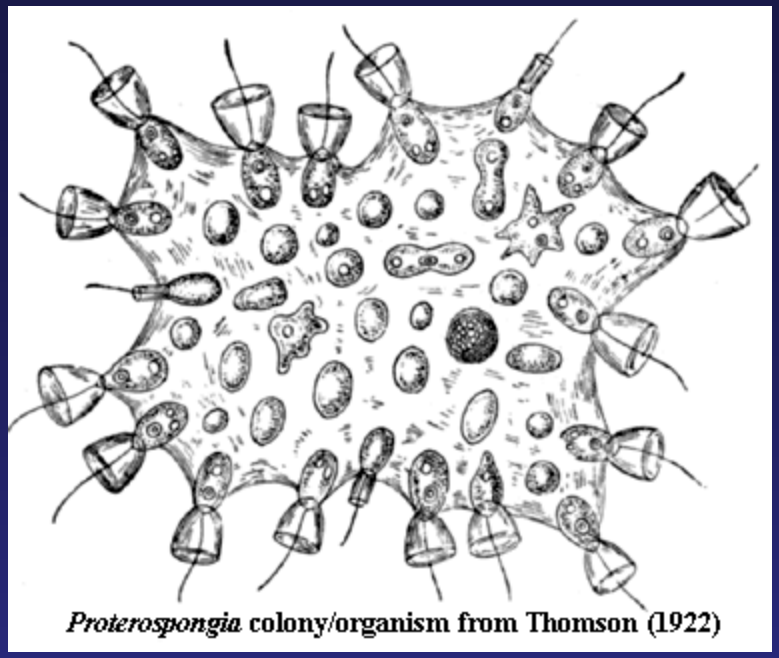

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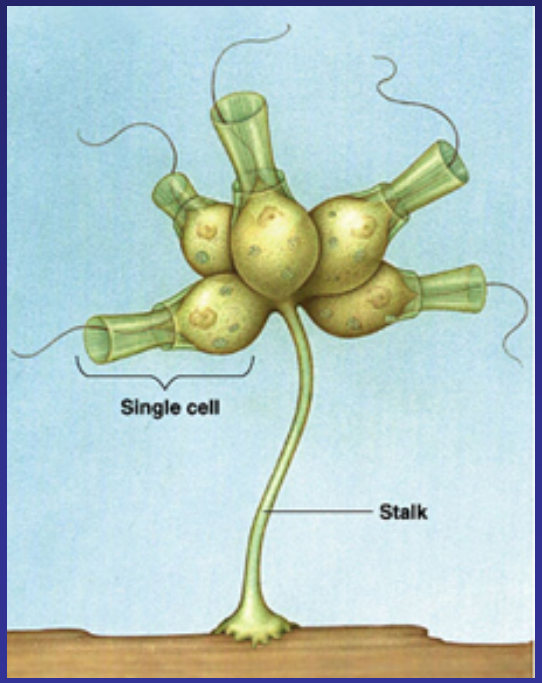
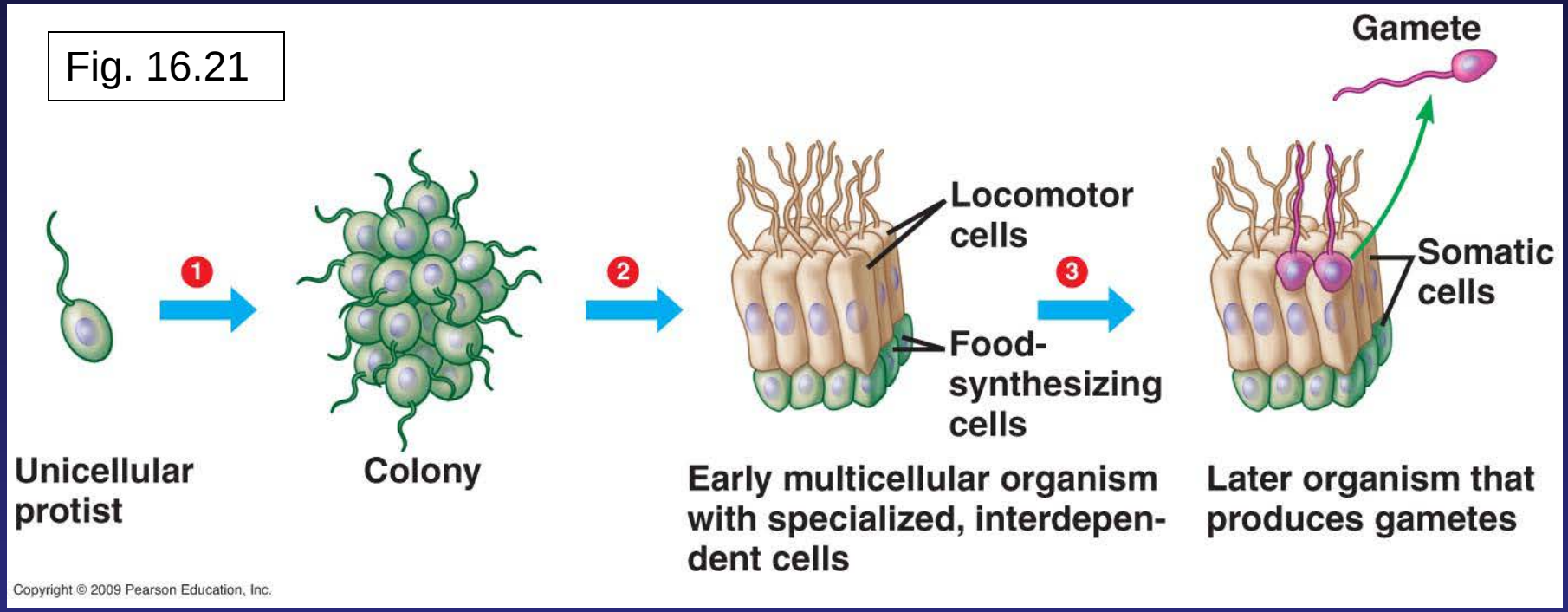


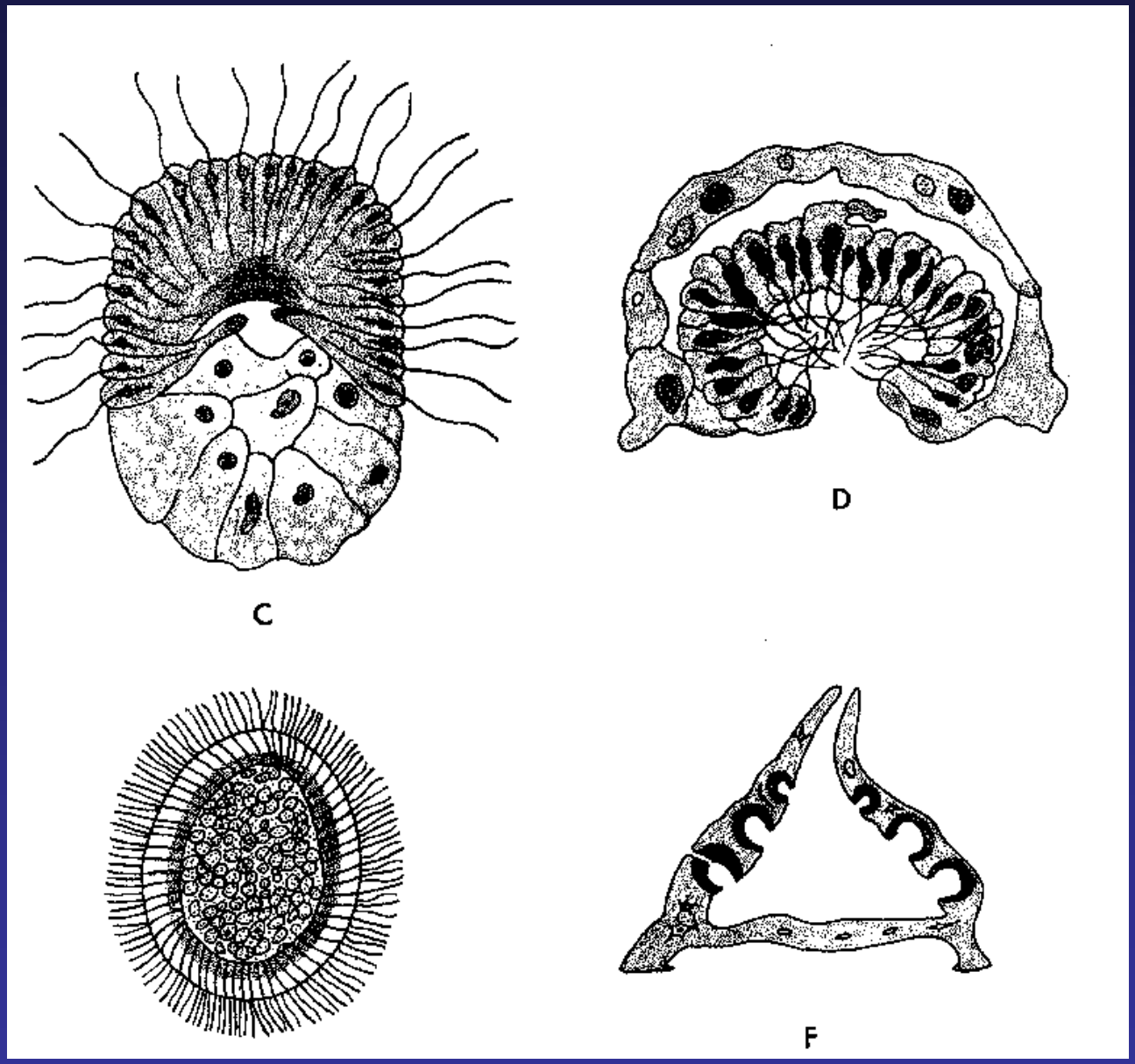
http://monado.files.wordpress.com/2008/03/choanoflagellate.jpg

Choanoflagellates are protists that have a “collar” that is made of microvilli and surrounds one or more flagella. These flagellates exhibit a variety of colony forms and degrees of cellular specialization.



Q: Do these kinds of events happen regularly in nature, e.g., during the life cycles of various organisms?

A: Yes



Typical sponge larvae showing differentiation of cell types and in-folding of amphiblastula.

From Barnes' *Invertebrate Zoology*

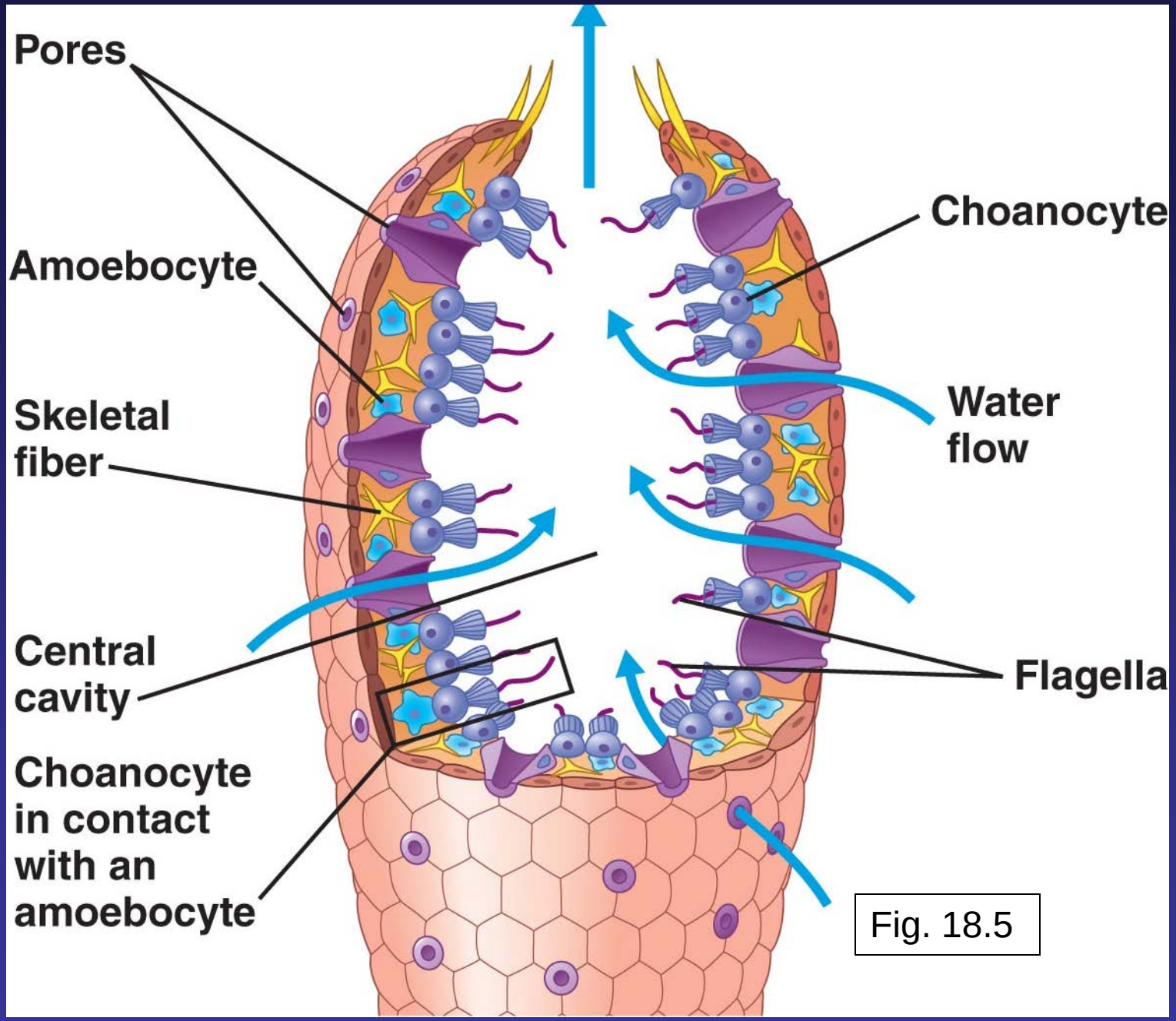
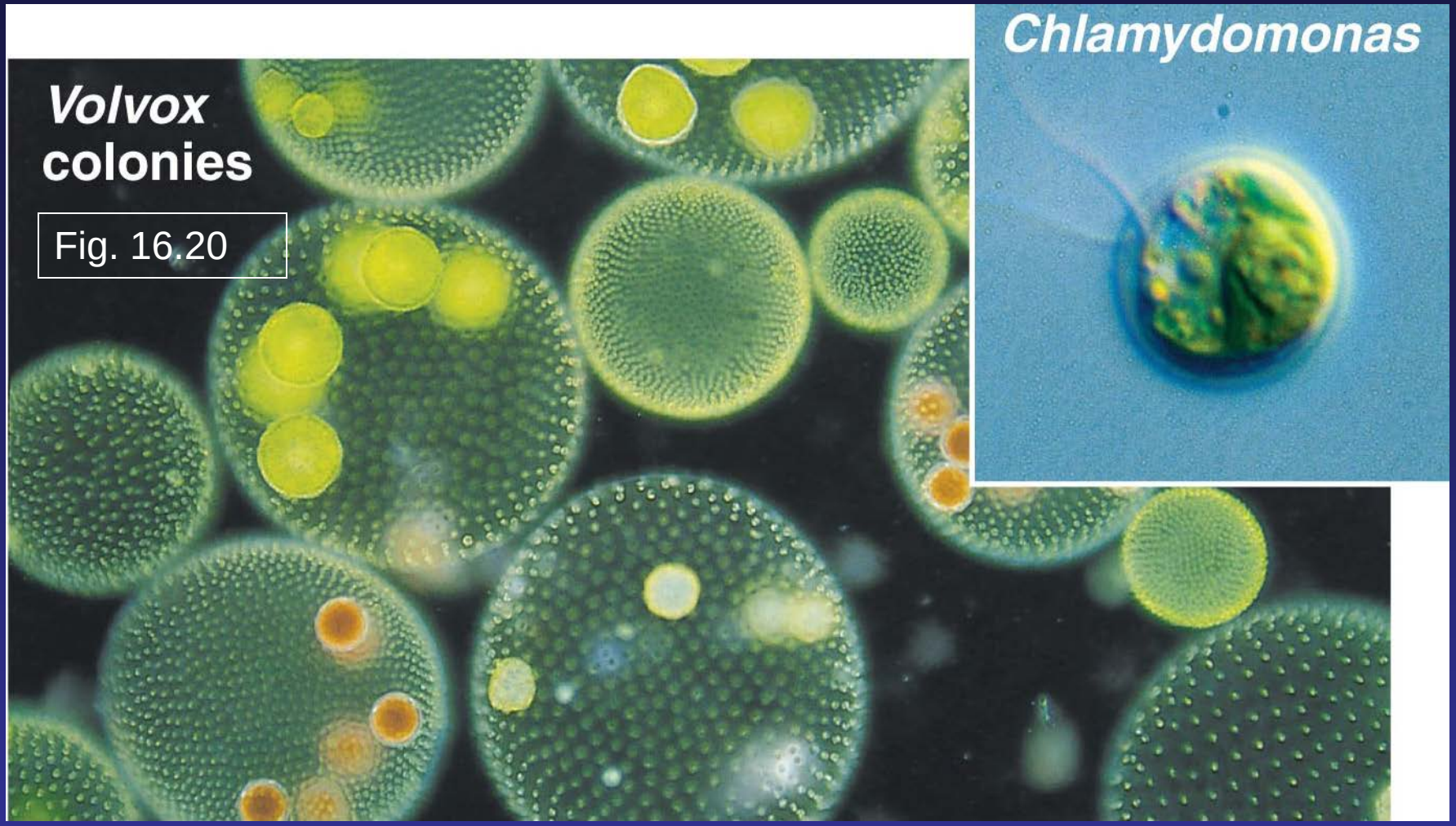

Pores
Amoebocyte
Skeletal fiber
Central cavity
Choanocyte in contact with an amoebocyte
Choanocyte
Water flow
Flagella

Fig. 18.5

Multicellular organism properties exhibited by sponges:

- Cellular specialization
- Cell-to-cell interactions
- Skeletal structures
- Complex (sort of) life cycles with larval stages
- Sexuality and differentiation of reproductive cells
- Surprising diversity; ecological niches



Volvox species (algae) exhibit these same general kinds of features.

Fig. 16.20 – *Ulva* sp. Life cycle

Mitosis

Male gametophyte

Spores

Mitosis

Gametes

Female gametophyte

Meiosis

Fusion of gametes

Sporophyte

Zygote

Mitosis

Key

Haploid (*n*)

Diploid (2*n*)

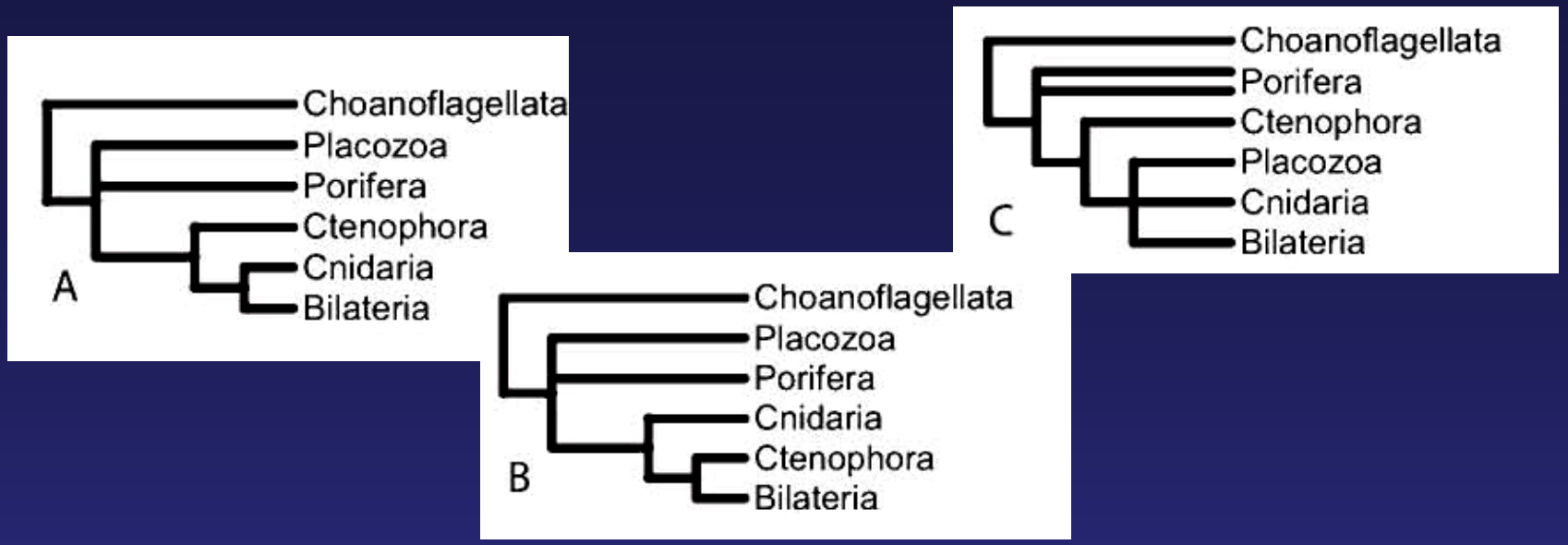


Fig. 1 Hypotheses of early animal phylogeny based on (**A**) the scenario by Salvini-Plawen (1978); (**B**) cladistic analyses by Schram (1991), Nielsen et al. (1996), Zrzavy' et al. (1998), and Peterson and Eernisse (2001); and (**C**) typical 18S rRNA analyses (Collins 1998; Kim et al. 1999). From Collins et al. 2005 ICB 45:585–594 with permission from SICB.

Can we ever identify the Urmetazoan?

Bernd Schierwater[1,*,†] and Rob DeSalle[†]

*ITZ, Ecology & Evolution, TiHo Hannover, Bünteweg 17d, D-30559 Hannover, Germany; [†]American Museum of Natural History, Division of Invertebrate Zoology 79 St. at Central Park West, New York, NY 10024, USA

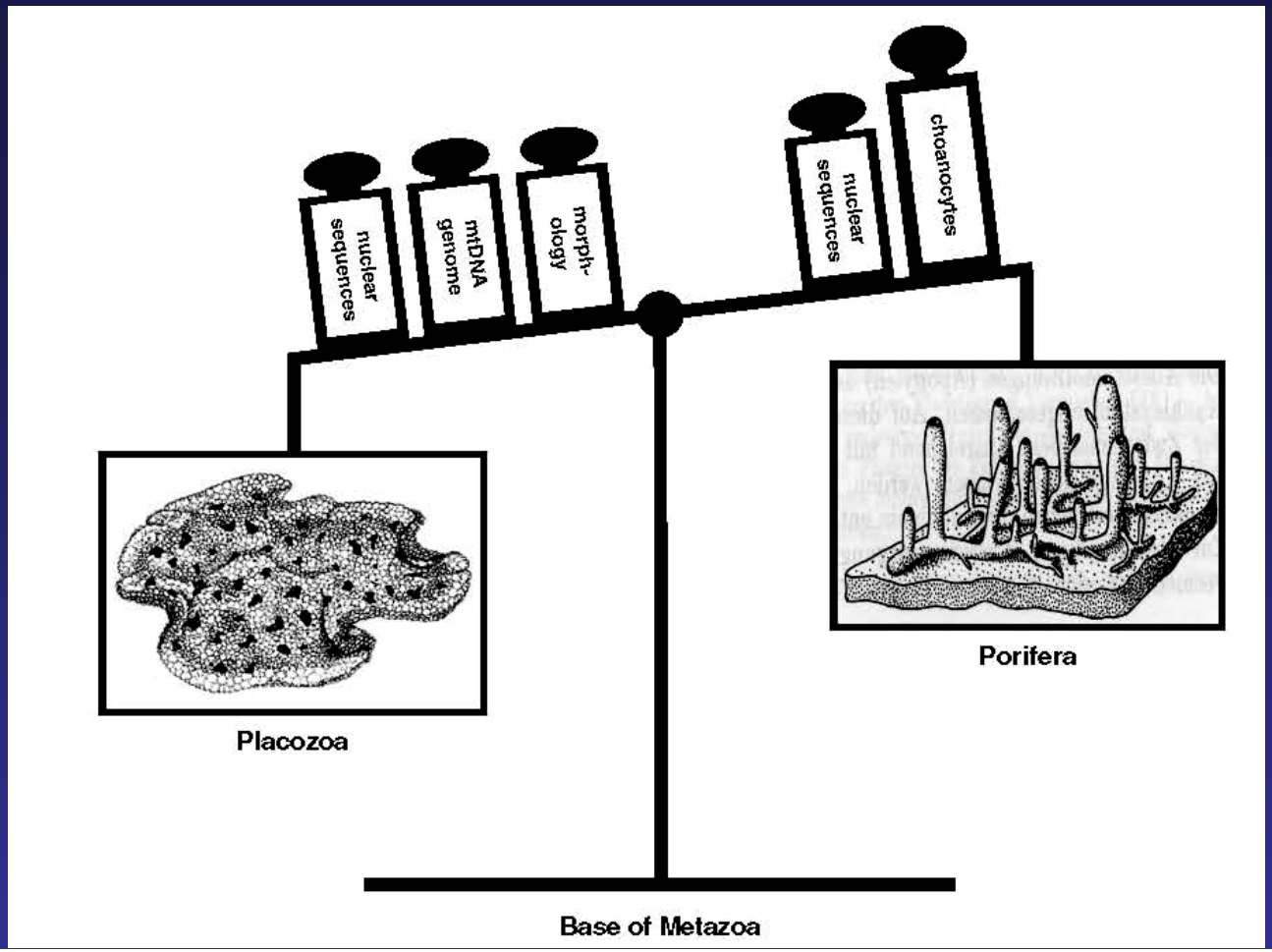


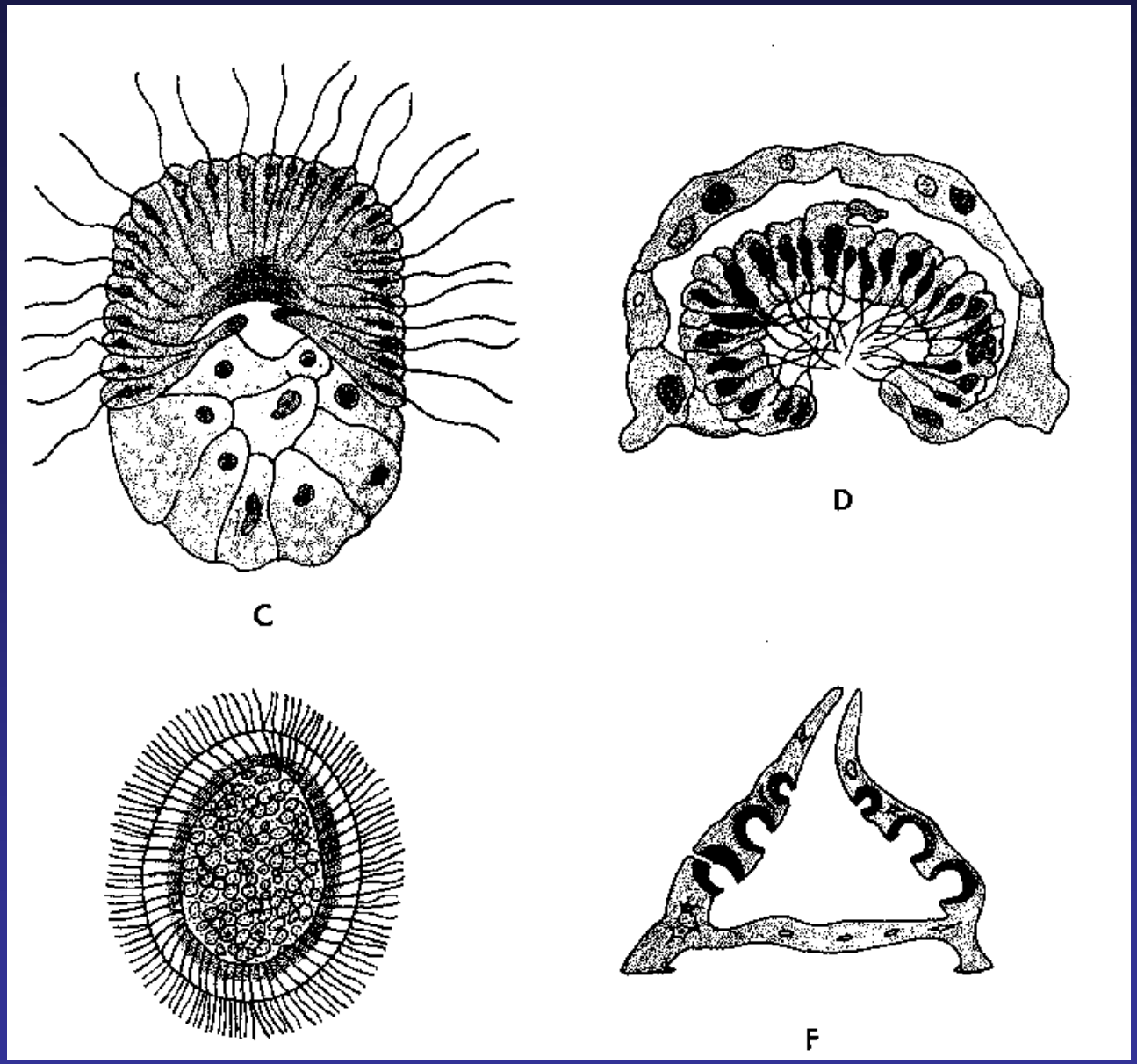
Fig. 3 The balance can never be objective. The researcher decides the weights. Researchers on Porifera seem to have a tendency to feel the weights on the right as heavy, while placozoan researchers might feel the opposite. The load of the weights seems to be influenced by one or more of the problems discussed in the text.

Placozoa – a phylum with a single species, *Trichoplax adhaerens.*

Big Idea #1: The origin of multicellularity

A tiny sample of sponge diversity

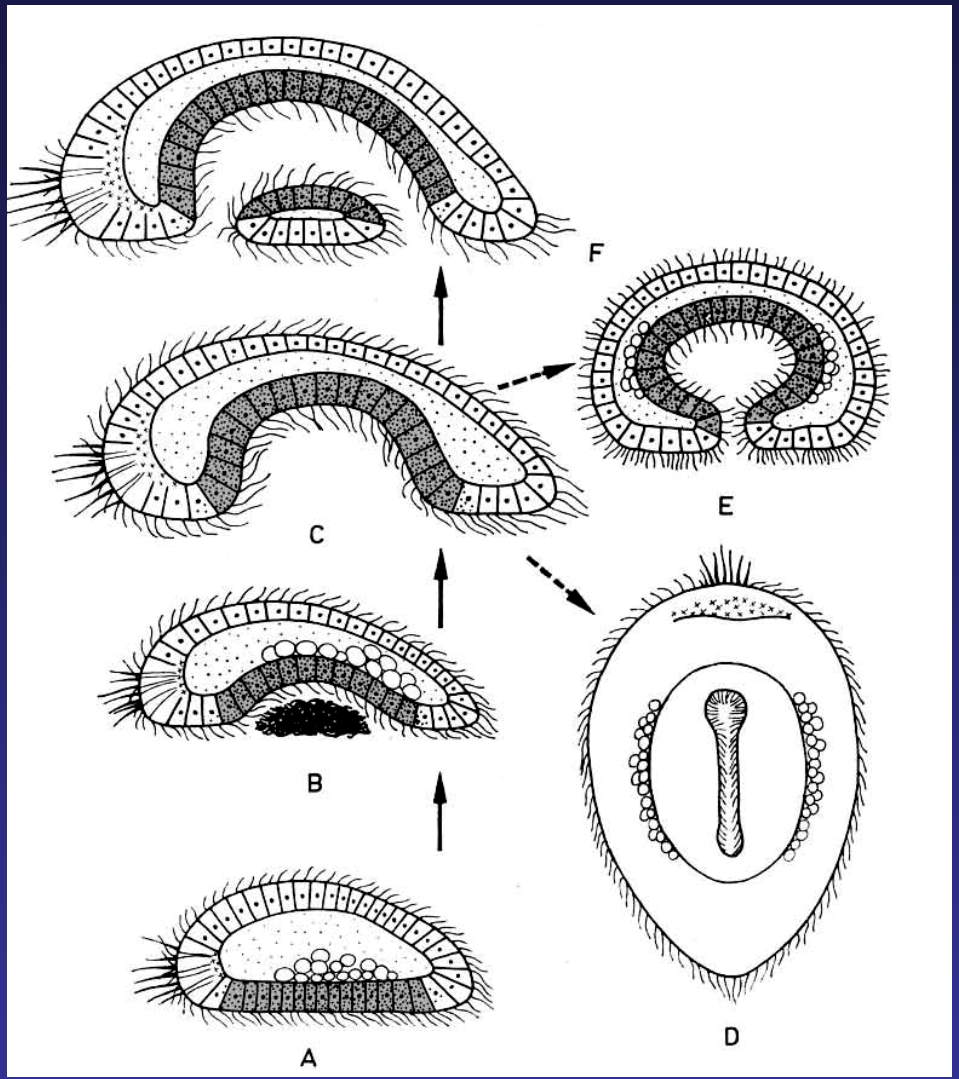
www.nortonprocleaning.com



Typical sponge larvae showing differentiation of cell types and in-folding of amphiblastula.

Q: Where and how did bilaterally symmetrical animals originate?

From Barnes' *Invertebrate Zoology*



Attempts to develop testable hypotheses regarding origins of multi-cellular organisms, especially bilaterally symmetrical ones (such as *Homo sapiens*).

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Fig. 2 Placula-hypothesis and Bilaterogastraea-hypothesis of metazoan evolution according to Jägersten (1955, 1959) and Bütschli (1884): a "benthoblastaea"-stage that looks similar to a placozoan *Bauplan* gives rise to the "bilaterogastraea" with a through-gut. Then polarity, specialized lower epithelium and an inner gastric cavity develop (D: transverse section showing "oral slit"). In this scenario, the vagile benthoblastaea has already developed an A/P-axis and bilateral symmetry and the presumed entoderm of the benthoblastaea (orange color) is homologous to the nutritive lower epithelium of *Trichoplax*. From Syed T, Schierwater B (2002a) with permission from Vie et Milieu.

Take-home messages:

- Scientists look for events and processes that demonstrate plausibility.
- Among present-day organisms, many events and processes exist that suggest avenues for the origin of multicellularity.
- Molecular technology allows for the test of hypotheses regarding origins and relationships.

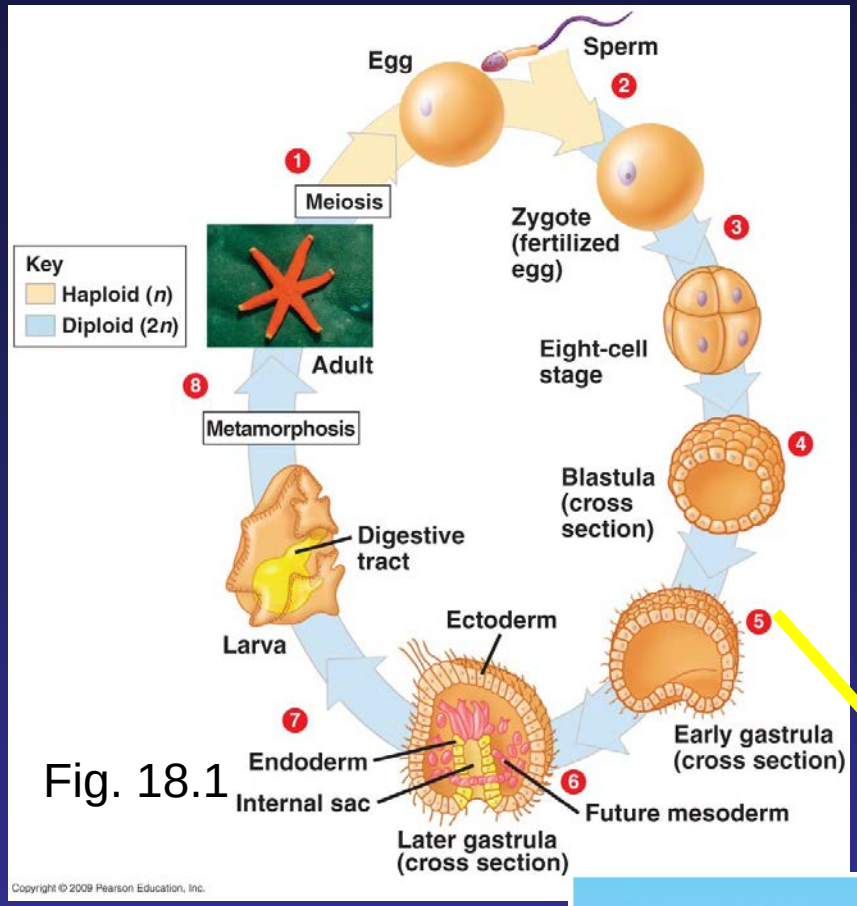

Fig. 18.1

Big idea: Truly new and innovative events and processes most often are produced by the immature stages.