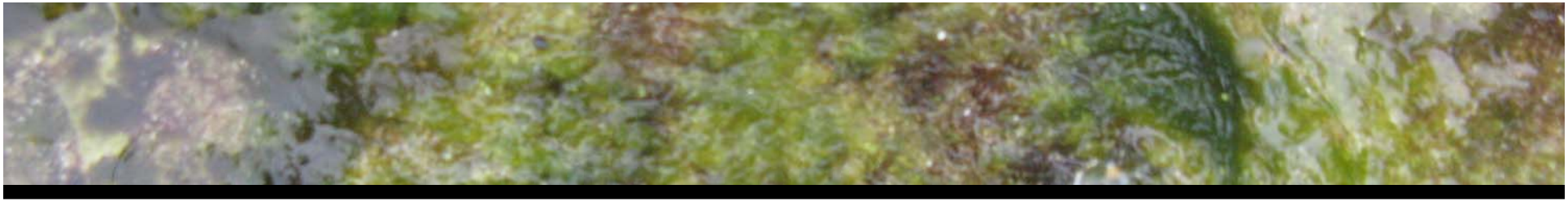

# *Introduction to Turf Algae*

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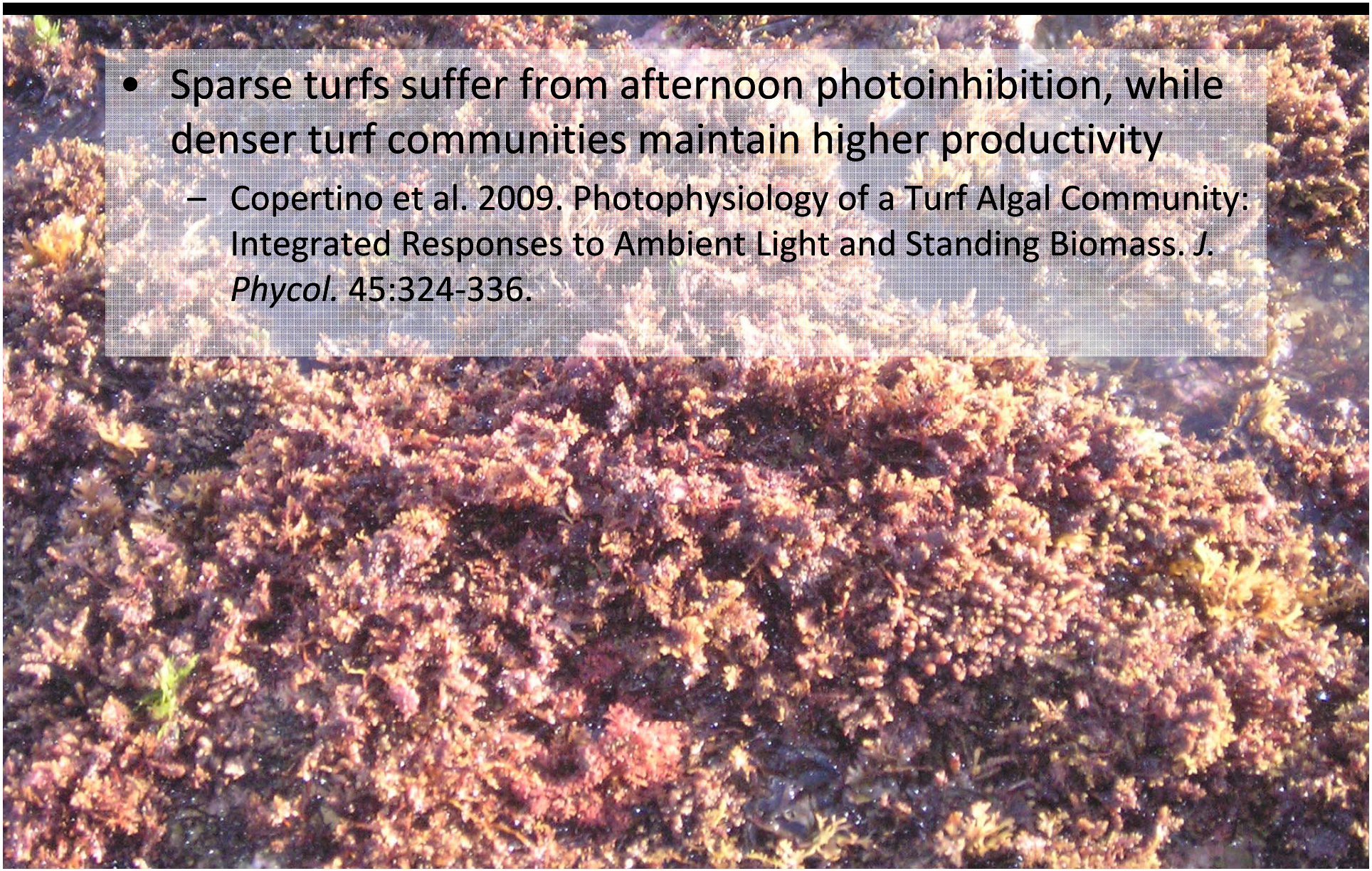
Pan-American Advanced Studies Institute
Advanced Methods in Tropical Phycology

# Algal Turfs

- common, multi-specific assemblages of green, red and brown seaweeds in intertidal (and subtidal) habitats worldwide
  - Stephenson & Stephenson 1972

- frequently, the dominant algal constituents in shallow coral reef ecosystems
  - Odum & Odum 1955, Wanders 1976, Morissey 1980, Adey & Steneck 1985, Klumpp et al. 1987, Klumpp & McKinnon 1989, Jompaa & McCook 2003a, b

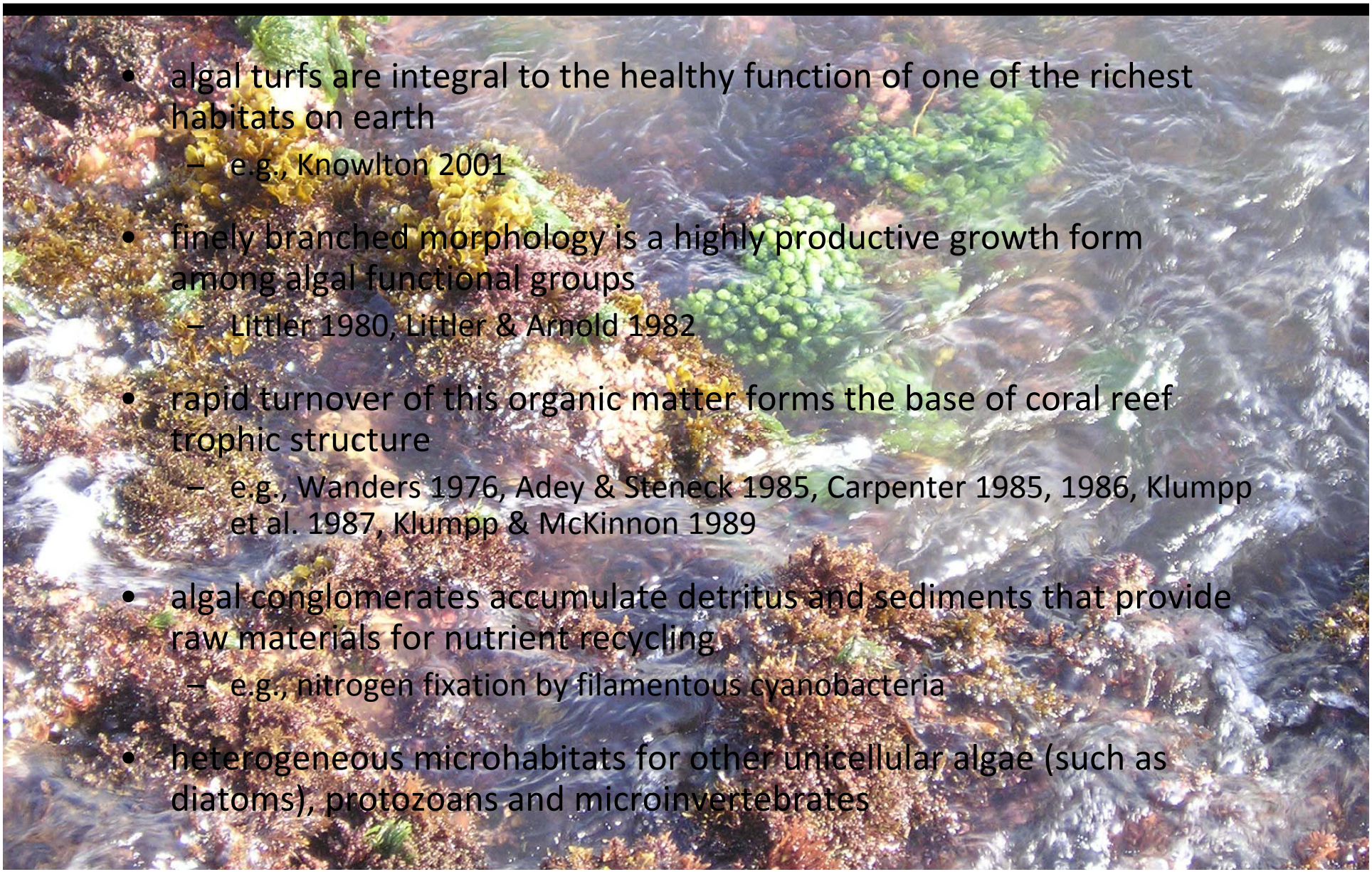
# Lush Algal Turf, Flat Rock Beach, BdT



- Sparse turfs suffer from afternoon photoinhibition, while denser turf communities maintain higher productivity
  - Copertino et al. 2009. Photophysiology of a Turf Algal Community: Integrated Responses to Ambient Light and Standing Biomass. *J. Phycol.* 45:324-336.

# Lush Algal Turf, Flat Rock Beach, BdT

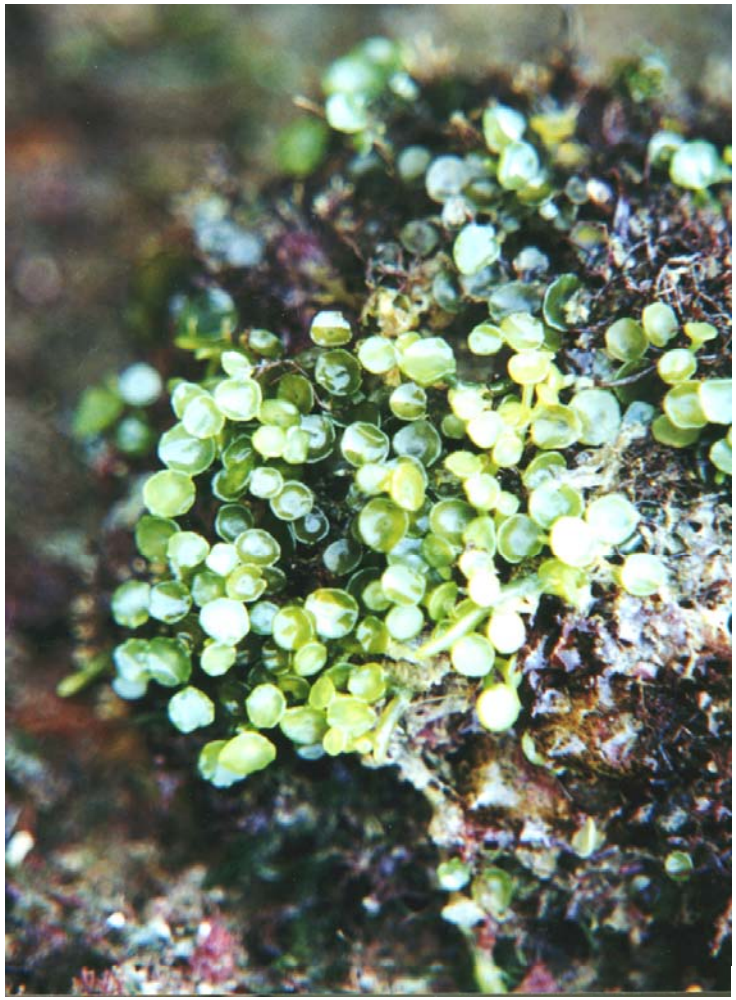
# Algal Turfs: Ecological Importance



- algal turfs are integral to the healthy function of one of the richest habitats on earth
  - e.g., Knowlton 2001
- finely branched morphology is a highly productive growth form among algal functional groups
  - Littler 1980, Littler & Arnold 1982
- rapid turnover of this organic matter forms the base of coral reef trophic structure
  - e.g., Wanders 1976, Adey & Steneck 1985, Carpenter 1985, 1986, Klumpp et al. 1987, Klumpp & McKinnon 1989
- algal conglomerates accumulate detritus and sediments that provide raw materials for nutrient recycling
  - e.g., nitrogen fixation by filamentous cyanobacteria
- heterogeneous microhabitats for other unicellular algae (such as diatoms), protozoans and microinvertebrates

# Algal Turfs: Ecological Importance

- In intertidal regions, turf communities can temper environmental stressors by retaining water and providing shade among densely packed filaments
  - Hunt & Denny. 2008.
- benefit of shading has been shown to be advantageous to some corals which resist bleaching when inhabited by endolithic algae
  - Shashar et al. 1997
- Some corals recover from bleaching episodes (loss of zooxanthellae) better when green-algal derived photoassimilates are incorporated into coral tissue
  - Fine & Loya 2002



# Algal Turfs: Ecological Importance

- Mixed algal assemblages serve as refuge for crab species in intertidal regions
- Tall turfs are used as frequently as rock crevices
  - Wieters et al. 2009.

# Algal Turfs: Ecological Problems

- sedimentation among turf species can also lead to coral degradation
  - Potts 1977, Knowlton 2001
  - Aka: TAS mats, Turf algal-sediment mats
- Sedimentation can lead to reduced herbivory rates
  - Bellwood & Fulton. 2008.

# Algal Turfs: Ecological Problems

- Roy 2004
  - Akumal Reef, Quintano Roo, MX
  - 37 corals lost an average of 70 ±13.2 $cm^2$ of live tissues/ coral/year
  - Roy. 2004. Akumal 's reefs:Stony coral communities along the developing Mexican Caribbean coastline. Revista de Biología Tropical, 52.

- TAS mats seldom develop when algal grazers are common, but once established,the sediment that is bound by algal turfs may deter herbivorous fishes
  - Purcell 2000

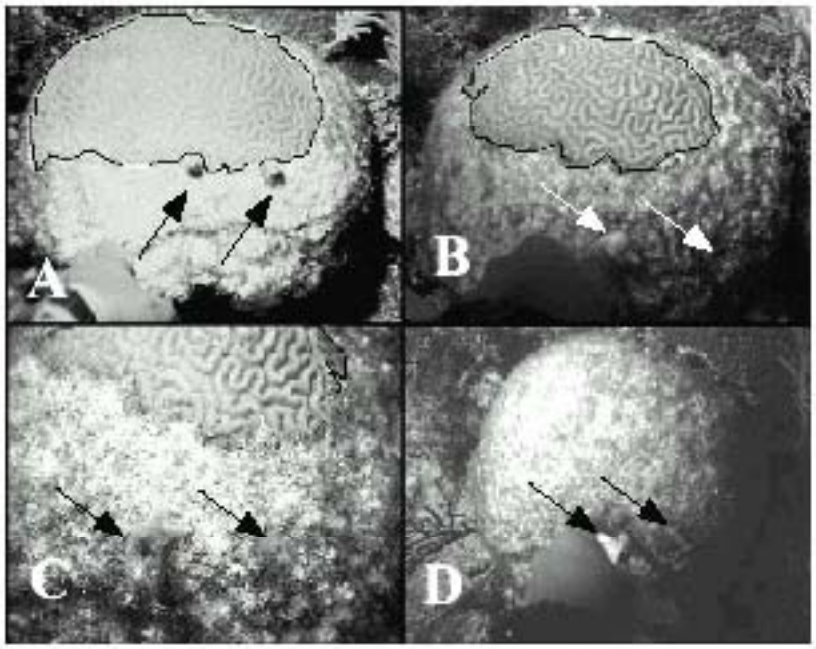
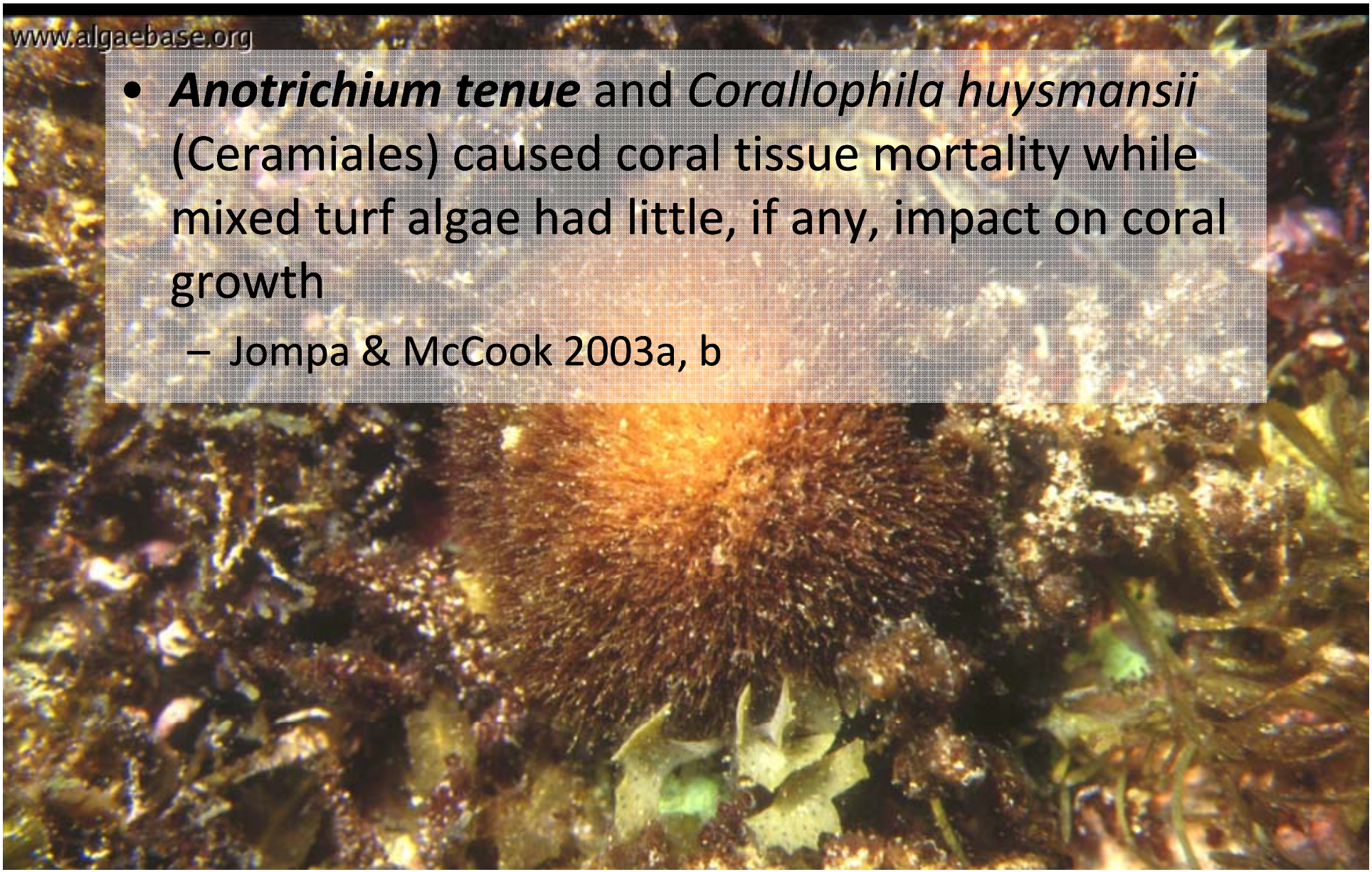



Fig. 3. Time series photography of a colony of *Diploria strigosa* (tag#78) at LR13, the live tissues of which were completely surrounded by a turf-algal/sediment (TAS) mat; nails shown by arrows; border of live tissues outlined in A and B. A Nails in TAS mat, 5cm apart from each other and 1 cm from the live tissue, July 1998; B Nails are now 4.4-4.5 cm from the live tissues, July 1999; C Close-up of sediment bound in turf-algal filaments, stretching across live tissue, August 1999; D whole colony has died and is now completely covered by the TAS mat, March 2000.

# Algal Turfs: Ecological Problems



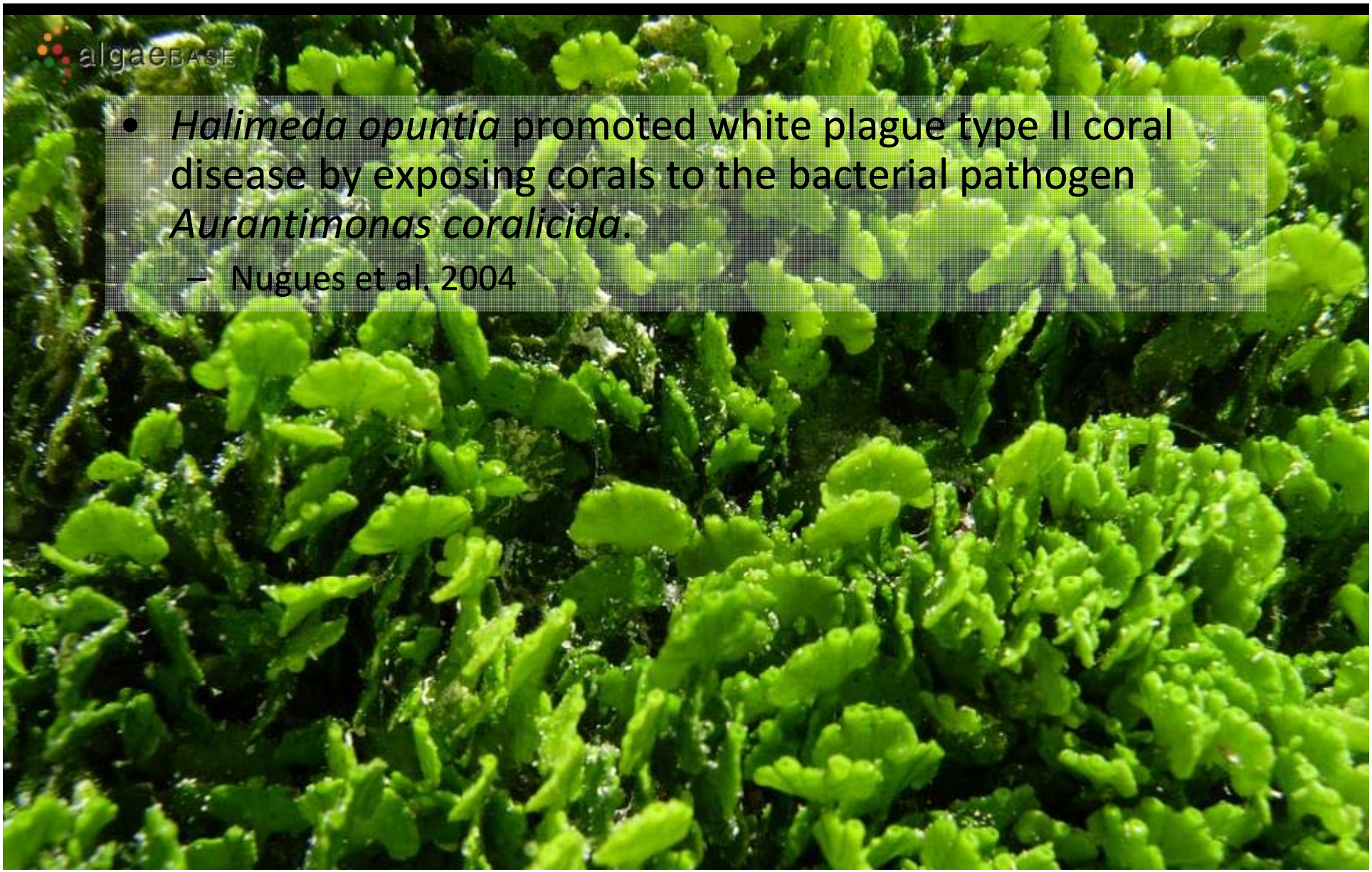

- ***Anotrichium tenue*** and *Corallophila huysmansii* (Ceramiales) caused coral tissue mortality while mixed turf algae had little, if any, impact on coral growth
  - Jompa & McCook 2003a, b

# Algal Turfs: Ecological Problems

- *Dasyopsis spinuligera* cause coral tissue mortality
  - Littler & Littler 1997

- Dissolved compounds produced by marine algae can indirectly affect corals by promoting microbial activity
  - Smith et al. 2006

# Algal Turfs: Ecological Problems




- *Halimeda opuntia* promoted white plague type II coral disease by exposing corals to the bacterial pathogen *Aurantimonas coralicida*.
  - Nugues et al. 2004

# Algal Turfs: Diversity

- Despite important ecological roles (both positive and negative), turf algal assemblages are rarely characterized by their constituent species

- Functional group characterization is insufficient for many coral reef ecology studies
  - species-specific coral-algal interactions

# Diversity of Algal Turfs: Caribbean Colombia

- More than 55 macroalgal species co-occur in an area of ca 600 $m^2$.
- How can so many species co-exist at the same time and location, exploiting the same resources (competitive exclusion principle)?
- Intermediate physical disturbance and herbivory have been suggested as factors promoting species diversity in rocky shores (Sousa 1984, 1985; Dean and Connell, 1987; Mengue and Branch, 2001).
  - sand intrusions disturb the algal community on a regular basis,
  - Represents intermediate disturbance force promoting high diversity.
  - Sand deposited over the macroalgal community is then washed out and rocky substrate becomes available again for algal colonization, thus avoiding dominance by few species.


- GARCIA, Camilo B. y PULIDO, Guillermo Díaz. DYNAMICS OF A MACROALGAL ROCKY INTERTIDAL COMMUNITY IN THE COLOMBIAN CARIBBEAN . bol. invemar, ene./dic. 2006, vol.35, no.1, p.7-18. ISSN 0122-9761.


Figure. 4. Photograph of the study area showing the intertidal communicty and sand. Some macroalgae rae bleached due to desiccation and previous intrusions.

# Algal Turfs: Challenges

- Identification is difficult
  - LRGTs: Little Round Green Things
  - GATGORE: Green Algae That Grow on Rocks Everywhere
  - Endo/epi-phytes

# Algal Turfs: Challenges

- Identification is difficult
  - stressful conditions of grazing and self-shading in turf species (Hay 1981) may remove or inhibit the development of diagnostic reproductive or vegetative features that facilitate accurate species determinations
  - morphological plasticity is common
    - e.g., Lewis et al. 1987: *Padina* vs. *Dictyerpa*

# Algal Turfs: Challenges

- morphologically different alternate life stages of free-living species are common components of algal assemblages
  - many examples, but
  - in many cases life history data may be unavailable to link the multiple stages of a single life history.

# Algal Turfs: Challenges

- '*Ralfsia*' stage of *Colpomenia* (Phaeophyceae)

# Algal Turfs: Challenges

- '*Falkenbergia*' stage of *Asparagopsis* (Rhodophyta)


# Algal Turfs: Challenges

- '*Halicystis*' stage of *Derbesia* (Chlorophyta)

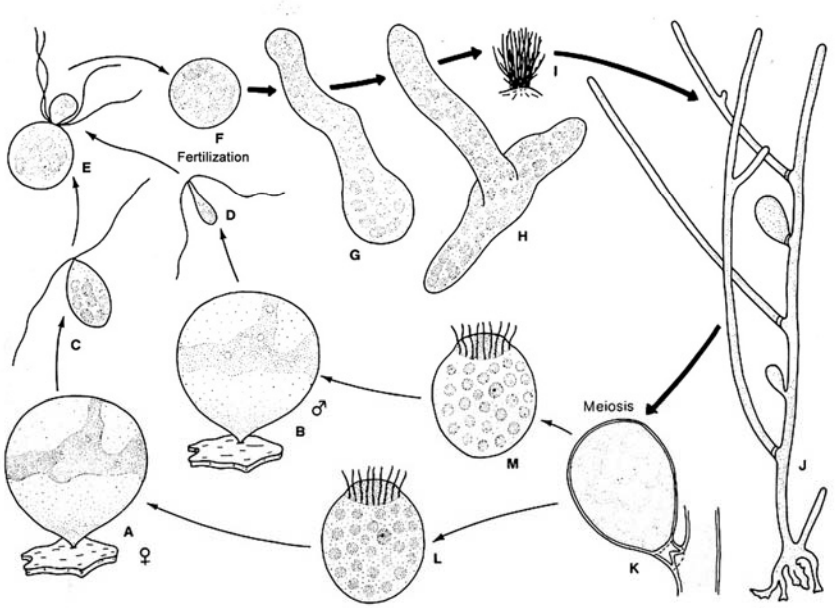
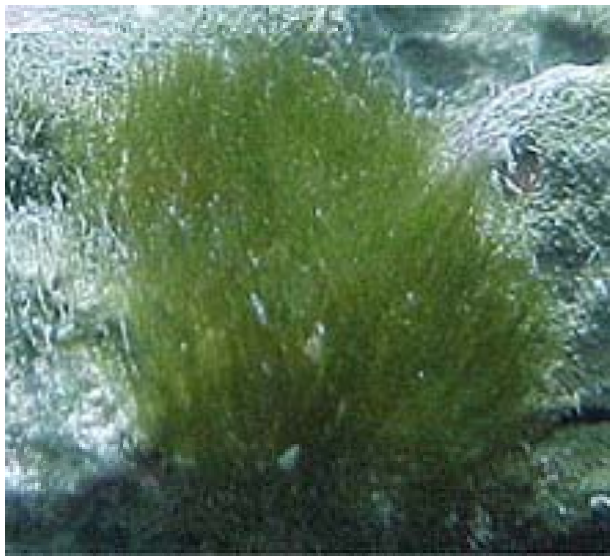
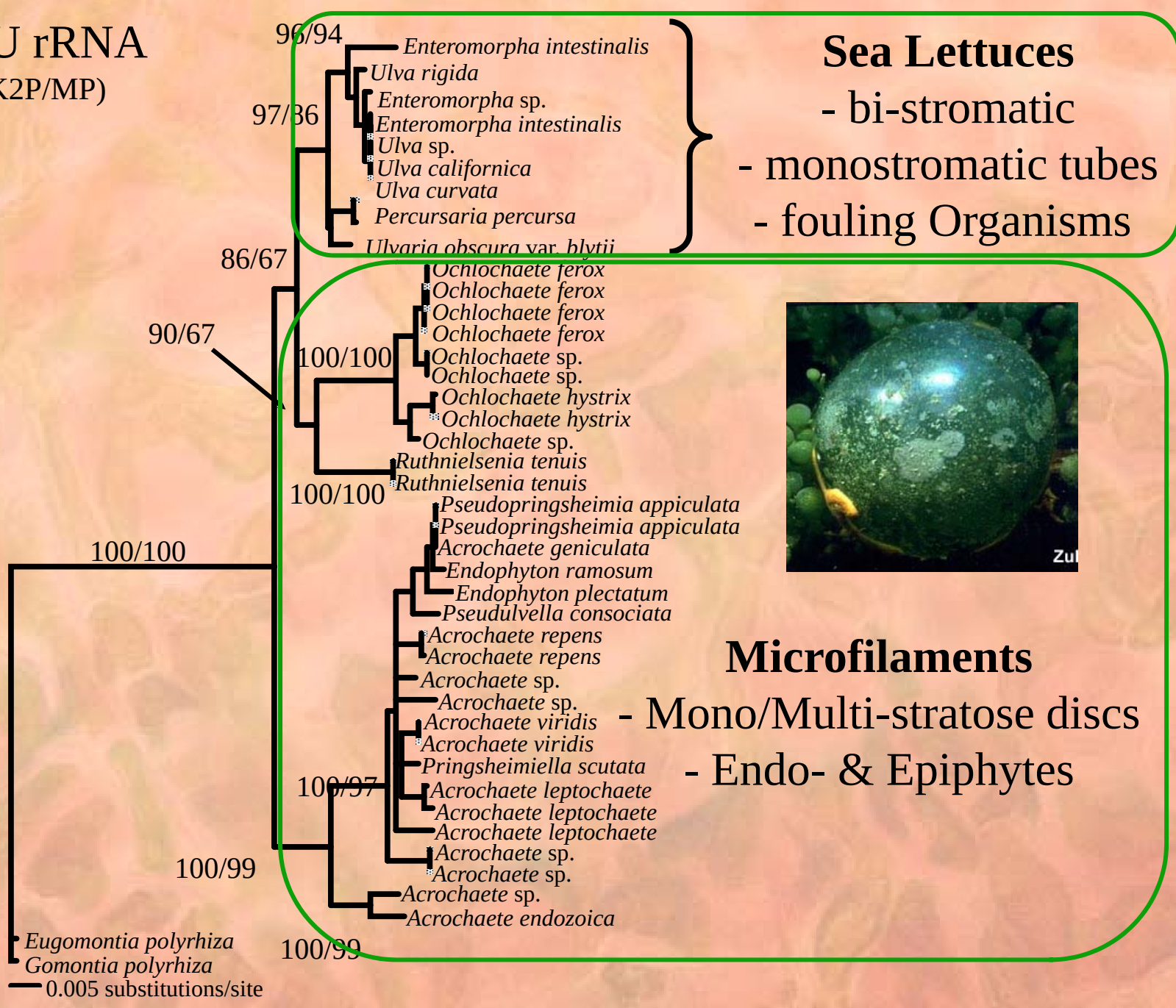



**Figure 7-23** Life history of *Derbesia* sp. (Codiales) with alternation of heteromorphic phases (*thin lines* indicate haploid phase, *thick lines* indicate diploid phase). **A, B,** globose, coenocytic stage: **A,** mature female gametophyte; **B,** mature male gametophyte. **C, D,** biflagellated gametes (produced by mitosis). **E,** fusion of anisogametes (fertilization). **F,** zygote. **G, H,** coenocytic juvenile sporophyte. **I,** habit of mature sporophyte. **J,** mature coenocytic sporophyte with two meiosporangia. **K,** mature meiosporangium. **L, M,** multiflagellated zoospores (produced by meiosis).

Scagel et al. 1984



SSU rRNA
(K2P/MP)

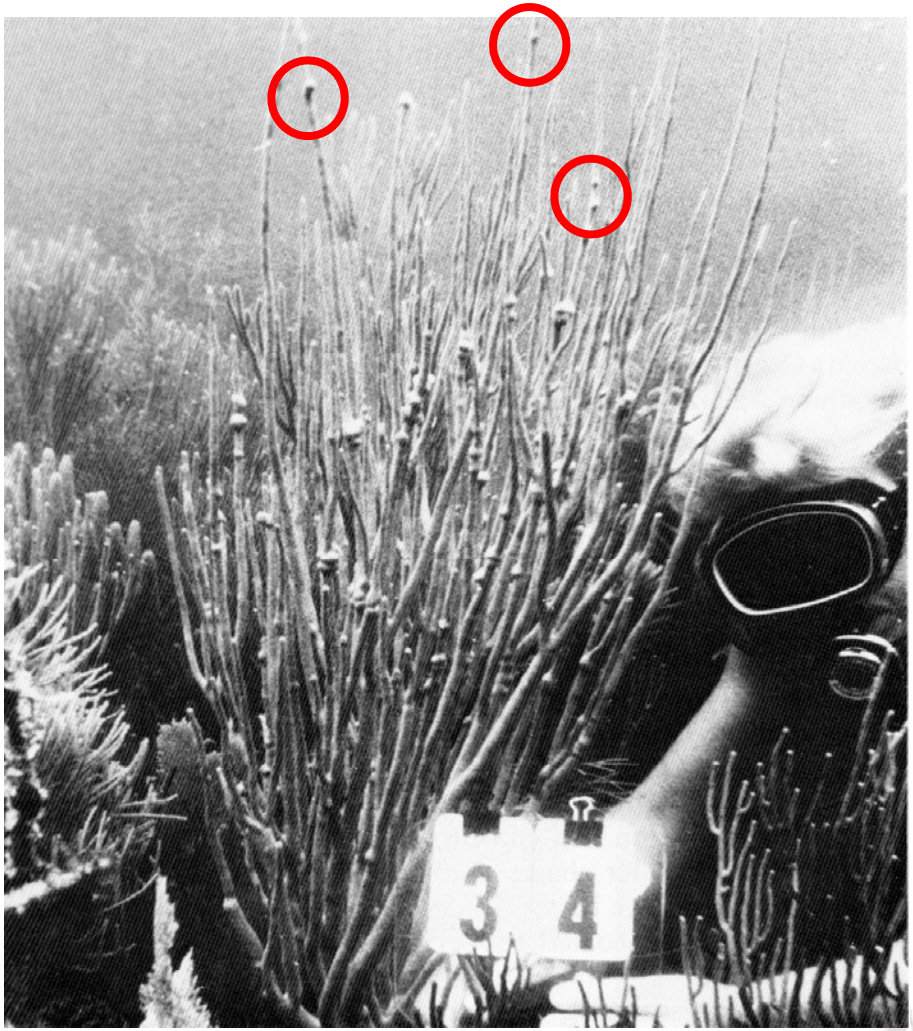



**Sea Lettuces**
- bi-stromatic
- monostromatic tubes
- fouling Organisms



**Microfilaments**
- Mono/Multi-stratose discs
- Endo- & Epiphytes

# Algal Turfs: Conservation




- *Acrochaete endozoica* is pathogenic in the gorgonian coral, Pseudoplexaura spp., which forms nodules in response to algal infection (Goldberg et al. 1984).
- The sister species to A. endozoica is an endophyte of Polysiphonia (Wysor & O'Kelly unpublished),
- Thus it is conceivable that A. endozoica or related species with similar pathogenic effects may occur among algal turfs
- The increased incidence of disease among corals (Barber et al. 2001, McClanahan 2002; Voss & Richardson 2006) may make them more susceptible to algal infection than in the past.

# Algal Turfs: Conservation

- Elucidation of species richness patterns across diverse spatial and temporal scales is essential for monitoring changes in coral reef ecosystems and will contribute to conservation goals that seek to minimize biodiversity losses (e.g., Mora et al. 2006).

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