PART A. MULTIPLE CHOICE QUESTIONS [CHOOSE ONE] 每題 5 分

1. Definition of ecosystem is:

a) The community of organisms together with the environment in which they live
b) The abiotic component of a habitat
c) The part of the earth and its atmosphere which inhibits living organisms
d) A community of organisms interacting with one other

2. What best describes the meiofauna?

a) Meiofauna are photosynthetic dinoflagellates living in symbiosis with corals
b) Meiofauna are sediment-associated organisms intermediate in size between the microbes and macrofauna
c) Meiofauna are planktonic organisms living in the water column
d) Meiofauna are microscopic organisms living in the gut of marine vertebrates

3. Sea urchins are classified under:

a) Foraminifera
b) Mollusks
c) Brachiopods
d) Echinodermata

4. Which of the following fishes do not have a swim bladder?

a) Parrotfish
b) Clownfish
c) Shark
d) Surgeonfish

5. Algae are photosynthetic organisms. What is the correct equation of photosynthesis reaction:

a) $6CO_2 + 6H_20 \rightarrow C_6H_{12}O_6 + 6O_2$
b) $Ca^{2+} + HCO_3^- \rightarrow H^+ + CaCO_3$
c) $6CO_2 + 12H_2S \rightarrow C_6H_{12}O_6 + 6H_2O + 12S$
d) $CO_2 + H_20 \rightarrow H_2CO_3$

6. The relationship between organisms that strive for the same resources in the same place is defined as:

a) Competition
b) Commensalism
c) Mutualism
d) Protocooperation

7. The possibility for the ecosystems to exist under multiples "states" refer to the theory of:

a) Alternative stable states
b) Intermediate disturbance
c) Changes
d) Evolution

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8. An inshore reef near a highly-populated area experienced increased levels of coastal runoff. The long-term reduction in coral cover experienced by the reef was most likely caused by an increase of the:

a) Availability of light
b) Population of macroalgae
c) Frequency of coral disease
d) Frequency of bleaching susceptibility

9. Select the direct consequences of ocean acidification for coral reef systems.

a) Bleaching of corals
b) Decreased algal production
c) Reduced dispersal of coral larvae
d) Reduce calcification and increase dissolution

10. Select the most relevant list of criteria to design marine protected areas.

a) Production, fish biomass, fishing
b) Connectivity, coverage, enforcement
c) Aesthetic values, recreational activities, fishing
d) Convenience, inexpensive, practical

PART B. SCIENTIFIC REASONING 每題 10 分

Coral Reef Ecosystems: Peter J. Mumby and collaborators (2007) analyzed and modeled mechanisms causing the contemporary decline of Caribbean corals. They showed that macroalgal growth has a negative effect on coral growth and that the growth of macroalgae is, itself, controlled by herbivores such as urchins (*Diadema*) and parrotfishes. Authors modeled the system at high and low levels of grazing (Figure 1).

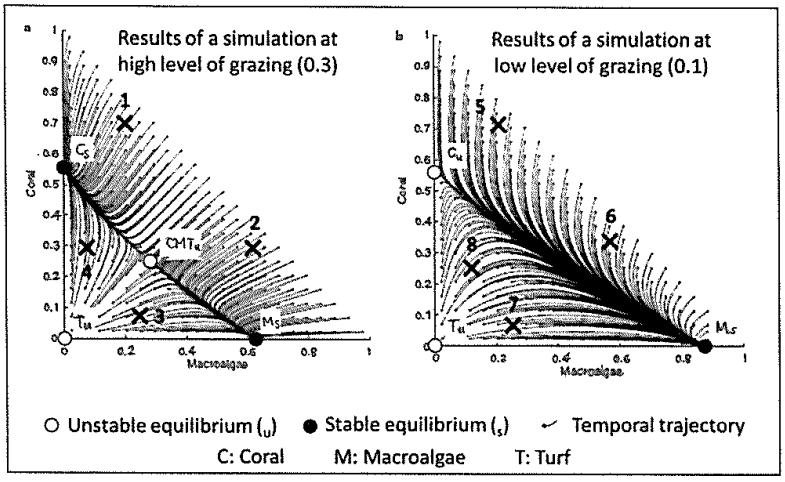

Figure 1. Phase planes showing equilibrium covers of macroalgae and corals and trajectories over time for simulations at a high level of grazing (a) or a low level of grazing (b). Adapted from Mumby et al. (2007).

The same model allows representing the % of coral cover as a function of the grazing (Figure 2). The trajectory of reefs in Jamaica such as observed between the 1970s and the 1990s is overlapped using blue arrows in the figure.

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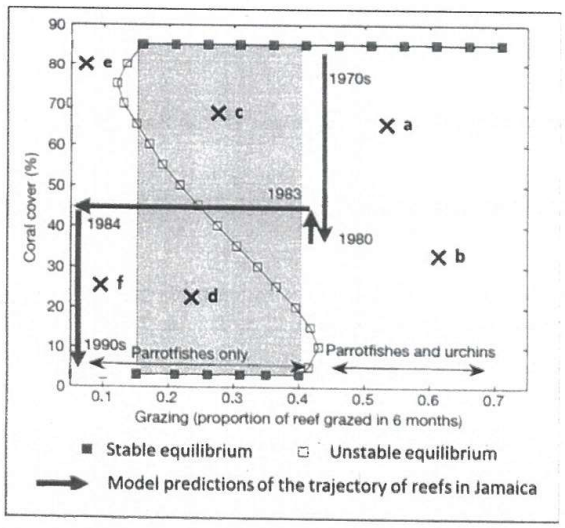

Figure 2. Stable and unstable equilibria for Caribbean coral reefs. *Stable and unstable equilibria are denoted by solid and open squares, respectively. Blue lines, marked with appropriate dates, represent model predictions of the trajectory of reefs in Jamaica (see also Figure 3). Adapted from Mumby et al. (2007).*

Figure 3 represents the changes in coral cover (%) since the 1970s with the indication of the events that could have influenced those changes.

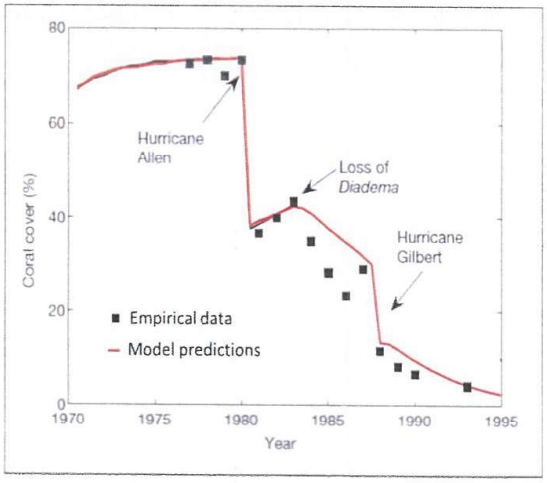

Figure 3. *Comparison between model predictions and empirical data for the trajectory of structurally complex forereefs in Jamaica at a depth of 10 m. The model was run with an algal–coral overgrowth rate of 14 $cm^2\ yr^{-1}$. Diadema is a genus of sea urchin and an important grazer on Caribbean reefs. Adapted from Mumby et al. (2007).*

Reference: Mumby PJ, Hastings A, Edwards, HJ (2007) Thresholds and the resilience of Caribbean coral reefs. Nature 450, 98-101. https://doi.org/10.1038/nature06252

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QUESTIONS

1) According to your knowledge, why is it important to maintain coral reefs in good conditions?

2) In a dynamical system, what is an equilibrium? A stable equilibrium? An unstable equilibrium?

3) Copy the figure 1 (or use Figure 1-1 without the trajectories in red), and represent schematically the trajectories of the system starting at points **1**, **2**, **3**, **4**, **5**, **6**, **7**, **8**. What is the effect of reducing herbivory (grazing)?

4) Copy the figure 2 (or use Figure 2-1 without the model predictions of the reefs in Jamaica) and represent the change in coral cover starting at points **a**, **b**, **c**, **d**, **e**, **f**.

What is the particularity of cases **c** and **d** (within the grey area)? How do we call this situation?

What's happen when we increase or decrease the grazing?

5) Combining the information in figures 2 and 3, describe the changes in coral cover and the suggested causes of those changes. What will you suggest to increase coral cover?

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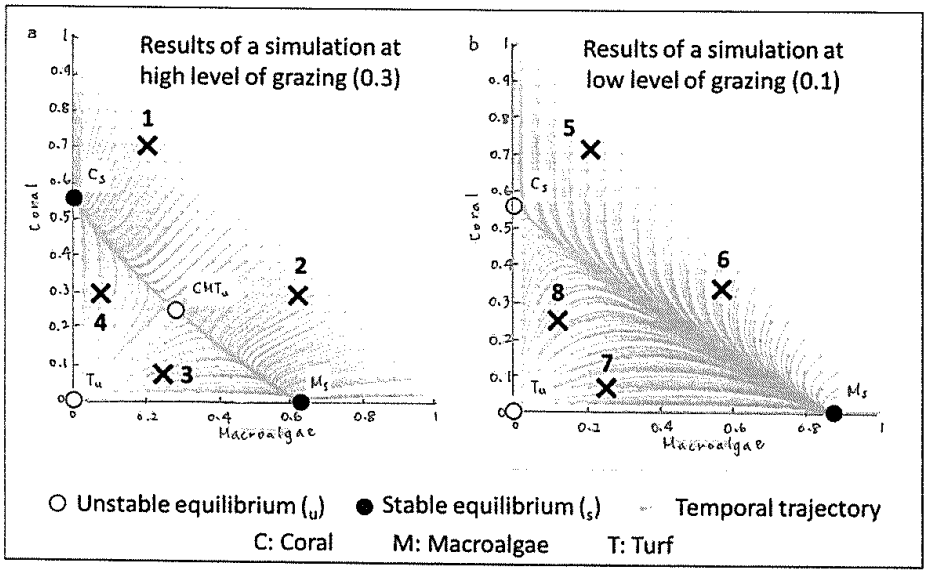

Figure 1-1

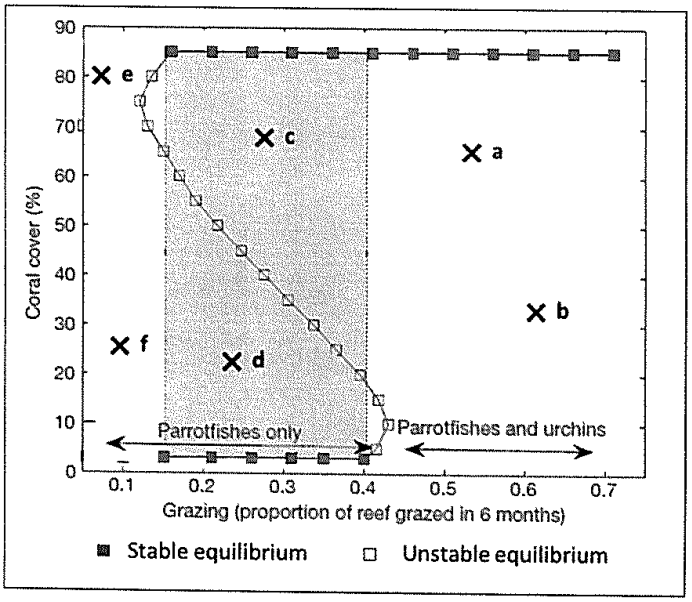

Figure 2-1

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