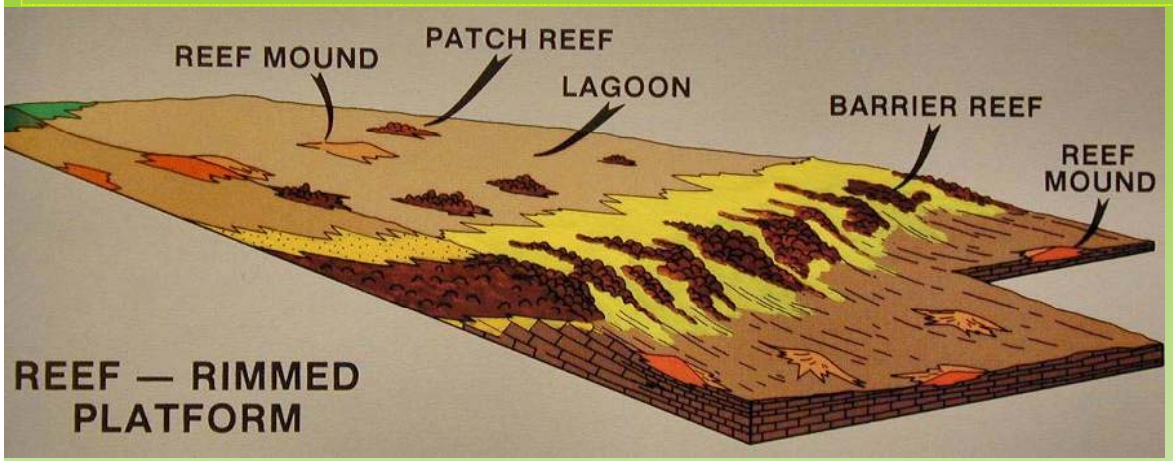
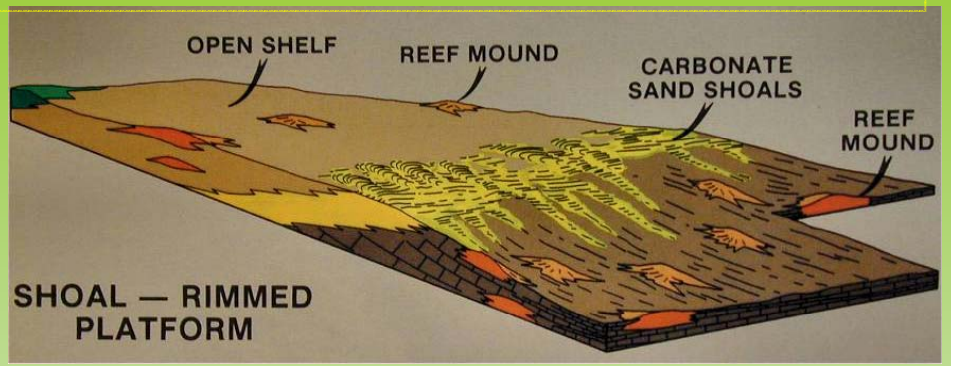
Le facies biocostruite della piattaforma carbonatica





I due margini di piattaforma:

-Controllati biologicamente oppure

- dall'accumulo di shoals sabbiosi

Un reef è un accumulo di carbonati biologicamente influenzati da organismi e con evidente rilievo morfologico

I reef attuali non sono comparabili con quelli del record geologico, solo quelli dell'Oligocene-Pliocene presentano caratteristiche del tutto comparabili.

Classificazione dei reef:

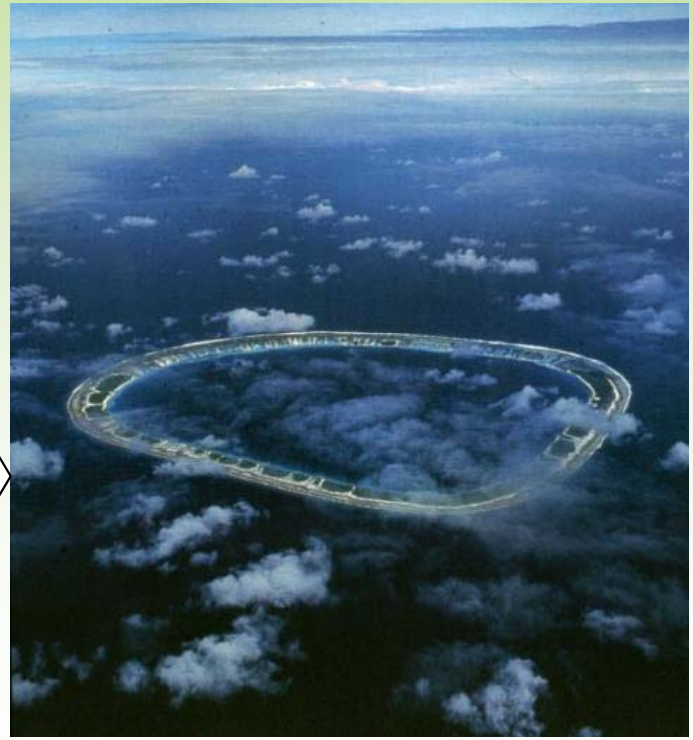
1. **dominati da organismi** :. coral reef, stromatoporoid-coral reefs (Devonian), microbial sponge boundstone reef (Permian), rudist reef (Cretaceo), algal reef mounds ecc.
2. in base alla **morfologia:** barrier reef, fringing reef, atoll, patch reef.
3. In base alla natura e accumulo biologico: reef and mud mounds vs. frame-built reefs

Classificazione morfologica dei reef

Fringing reef: discontinui, senza parti emerse e lagune di back reef)

Le tre situazioni raffigurate documentano la tipica evoluzione degli atolli dell'oceano Pacifico

Barrier reef: barriera continua che protegge una laguna costiera.



Atollo

Wright and Burchette, 1996

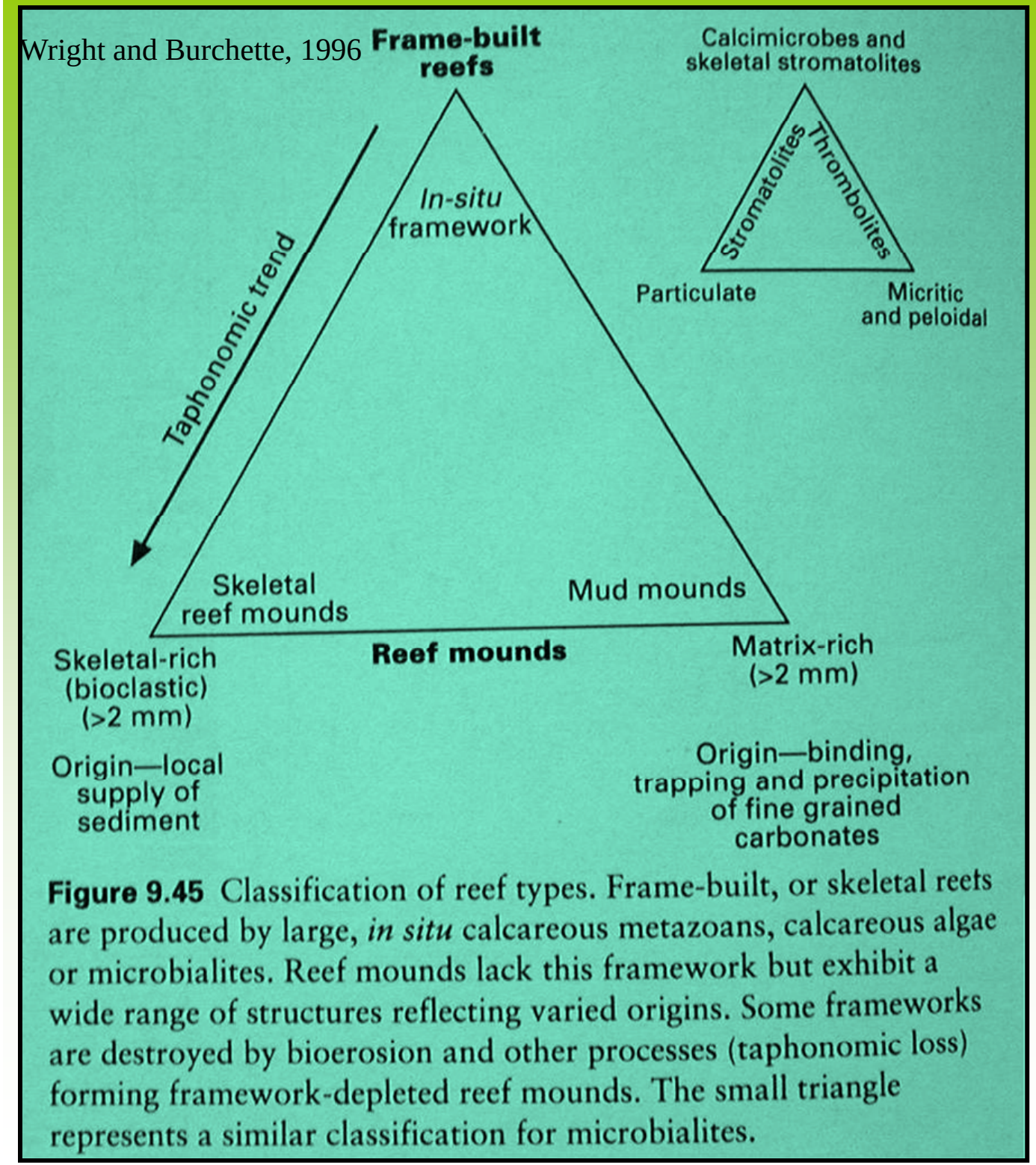


Figure 9.45 Classification of reef types. Frame-built, or skeletal reefs are produced by large, *in situ* calcareous metazoans, calcareous algae or microbialites. Reef mounds lack this framework but exhibit a wide range of structures reflecting varied origins. Some frameworks are destroyed by bioerosion and other processes (taphonomic loss) forming framework-depleted reef mounds. The small triangle represents a similar classification for microbialites.

La classificazione dei reef:

In funzione della predominanza di organismi costruttori che forniscono:
1)una struttura rigida in sito (**frame build reef**)

bioclastica (**skeletal reef mound**)

reef costituiti da prevalente matrice (**mud mounds)**

Distinzione tra :
stromatoliti (costituite da calcari microbici o con particelle)

e **tromboliti** (calcari microbici con prevalente micrite e peloidi).

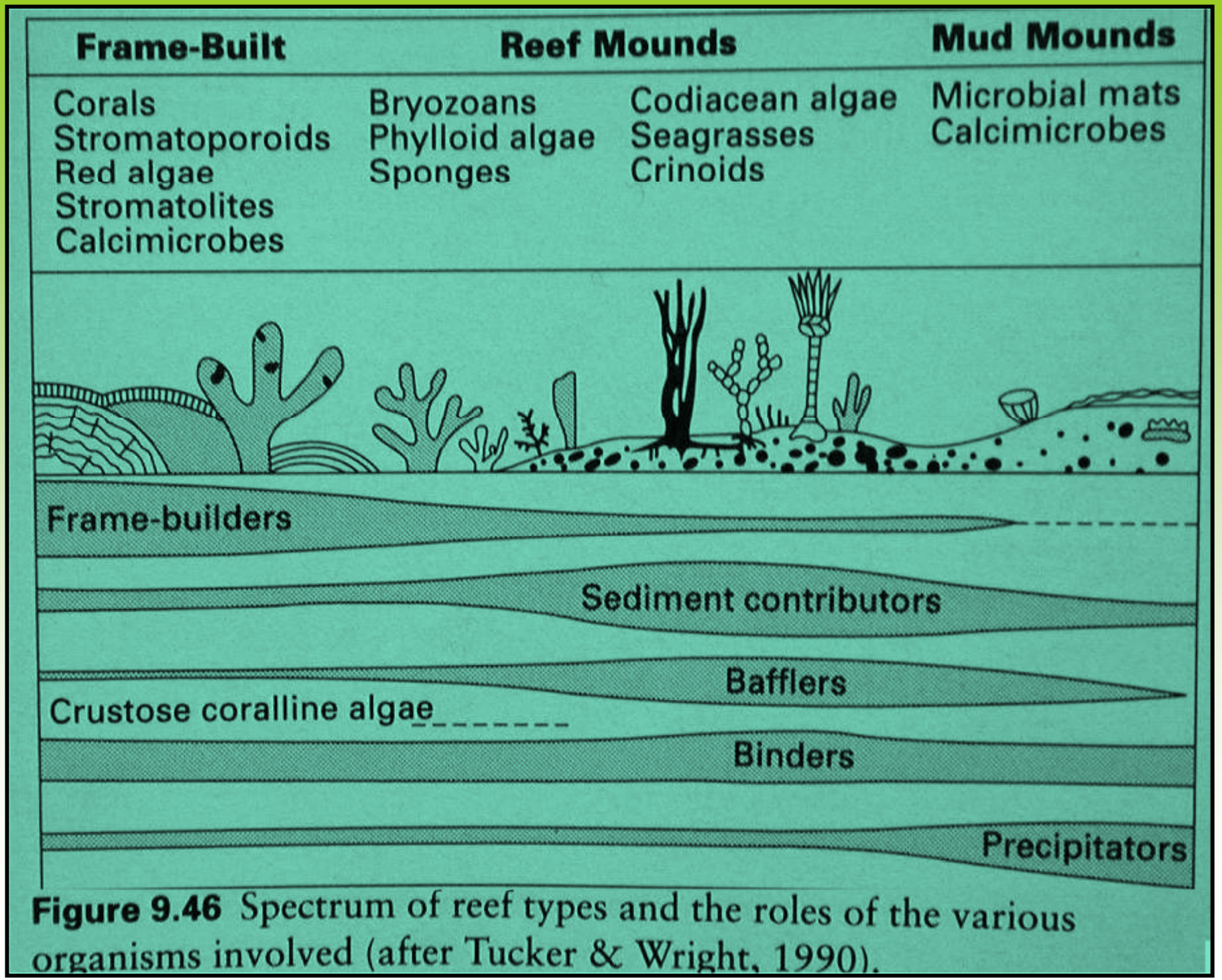
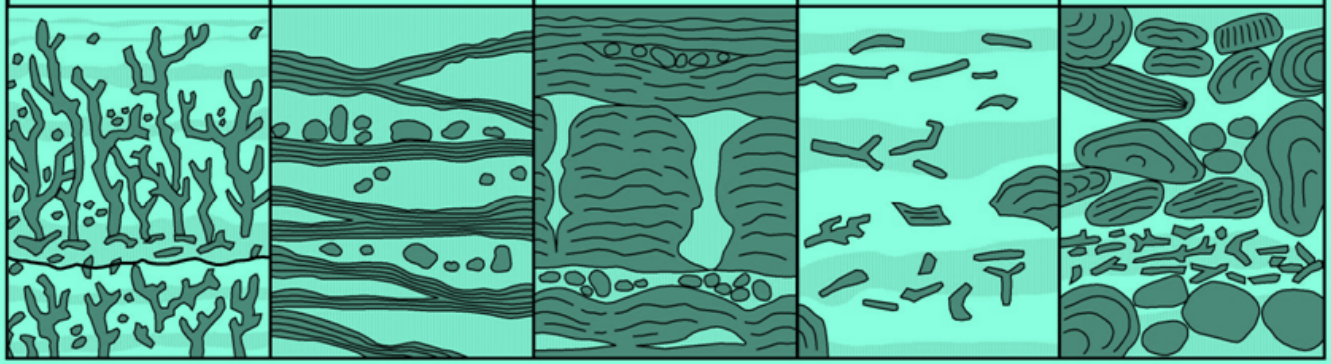


Figure 9.46 Spectrum of reef types and the roles of the various organisms involved (after Tucker & Wright, 1990).

CLASSIFICATION OF CARBONATE ROCKS ACCORDING TO DEPOSITIONAL TEXTURE

(after Dunham, 1962, modified by Embry & Klovan, 1971)

Original components were bound together during deposition			Original components not bound together during deposition	
			More than 10 percent *larger* grains (rudite size)	
Organisms act as sediment bafflers (e.g. dendroid corals)	Organisms act as sediment binders (e.g. algal mats)	Organisms act as frame builders (e.g. intergrown reef corals)	Contains mud (micrite matrix)	Lacks mud (sparite matrix)
B o u n d s t o n e			Matrix supported	Grain supported
Bafflestone	*Bindstone*	*Framestone*	*Floatstone*	*Rudstone*



Profilo del reef:

1. **Fore Reef (parte verso il mare aperto): reef front e reef crest**

- Si innalza morfologicamente sino a lambire la superficie del mare.

- E' la maggiore sorgente di frammenti scheletrici carbonatici
- Può essere interessato da digitazioni- canali che si aprono verso il mare aperto (spurs)

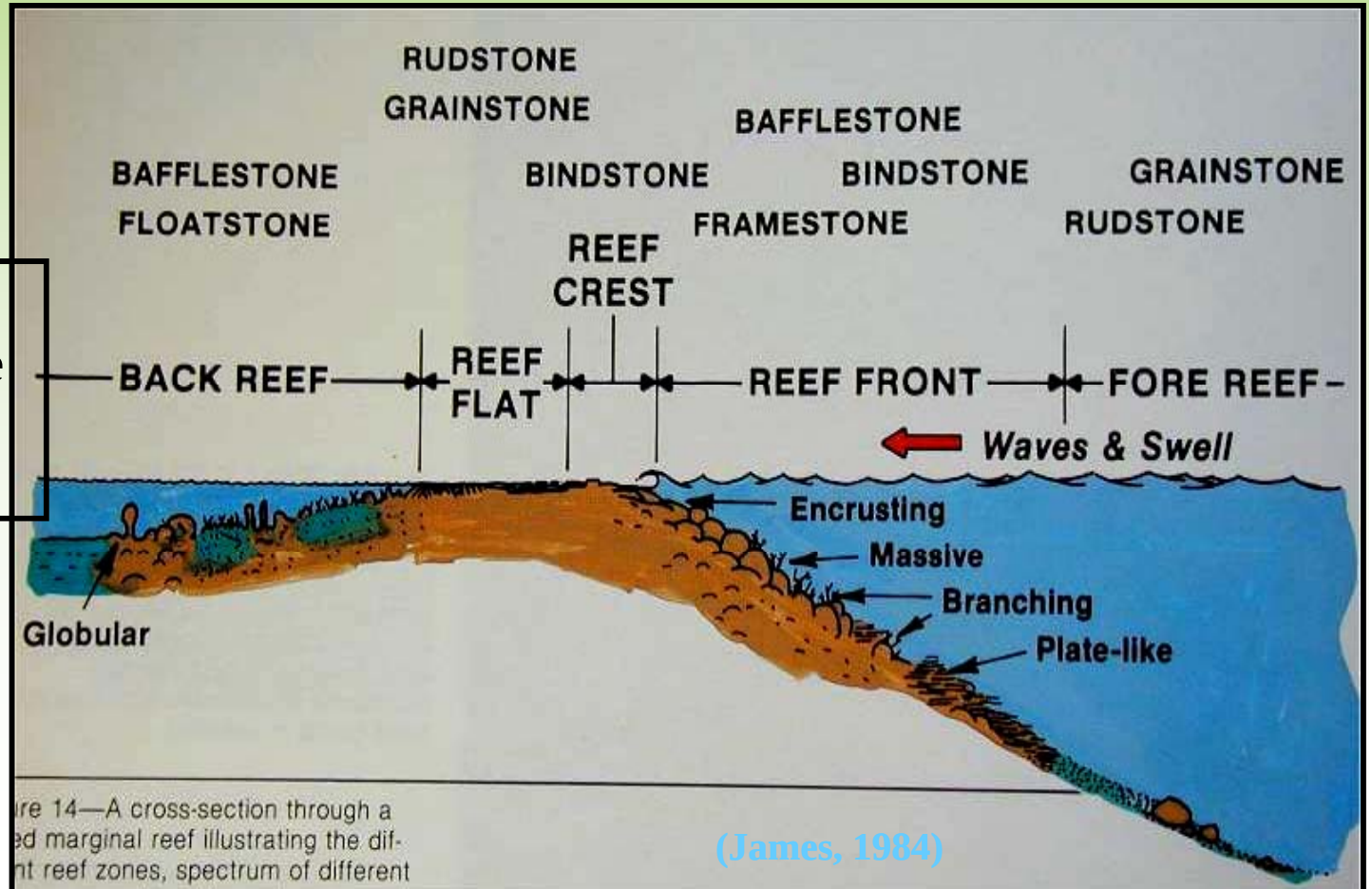
2 Back reef (parte verso terra: Reef flat e laguna)

- E' caratterizzato da ambienti protetti e di energia non molto elevata

- Sono presenti colonie di coralli , sabbie bioclastiche, praterie algali e patch a coralli

- **Si possono sviluppare anche piccole pozze-piane intertidali.**

Subambienti del reef e tipologia degli organismi che colonizzano il reef front (Isola di Andros, James, 1984)



re 14—A cross-section through a
ed marginal reef illustrating the dif-
nt reef zones, spectrum of different

(James, 1984)

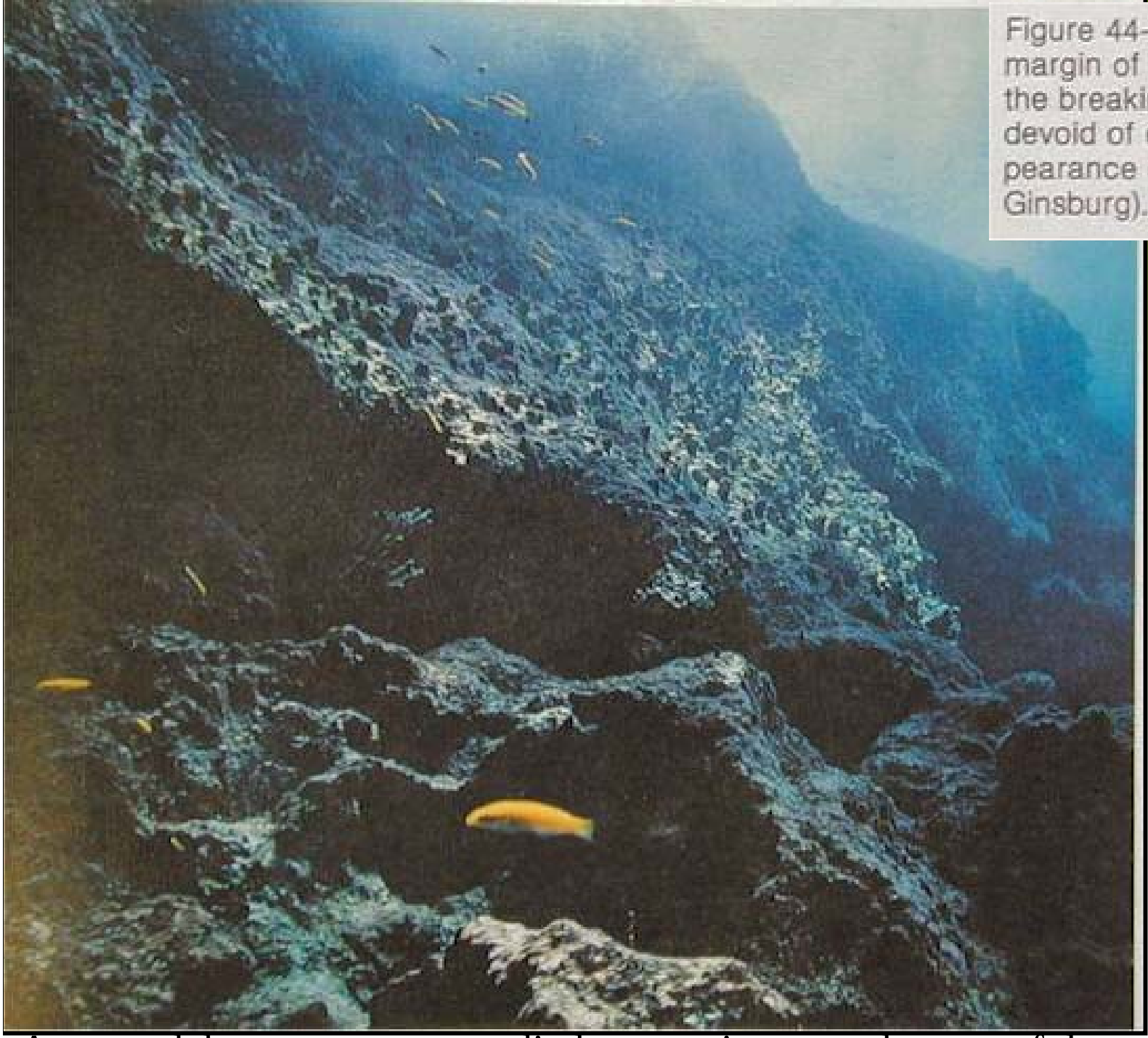
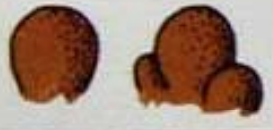


Figure 44—An underwater view of the margin of a cup reef looking up toward the breaking surf. The reef is generally devoid of coral growth and has the appearance of bare rock (photo R. N. Ginsburg).

Aspetto del versante esterno di alta energia un moderno reef dove si infrangono le onde (surf zone) e dove i coralli non possono svilupparsi.

GROWTH FORM AND ENVIRONMENT OF REEF BUILDING SKELETAL METAZOA

GROWTH FORM		ENVIRONMENT	
		Wave Energy	Sedimentation
	Delicate, branching	low	high
	Thin, delicate, plate-like	low	low
	Globular, bulbous, columnar	moderate	high
	Robust, dendroid, branching	mod-high	moderate
	Hemispherical, domal irregular, massive	mod-high	low
	Encrusting	intense	low
	Tabular	moderate	low

Relazioni tra le morfologie degli organismi costruttori e le caratteristiche dei subambienti del reef.

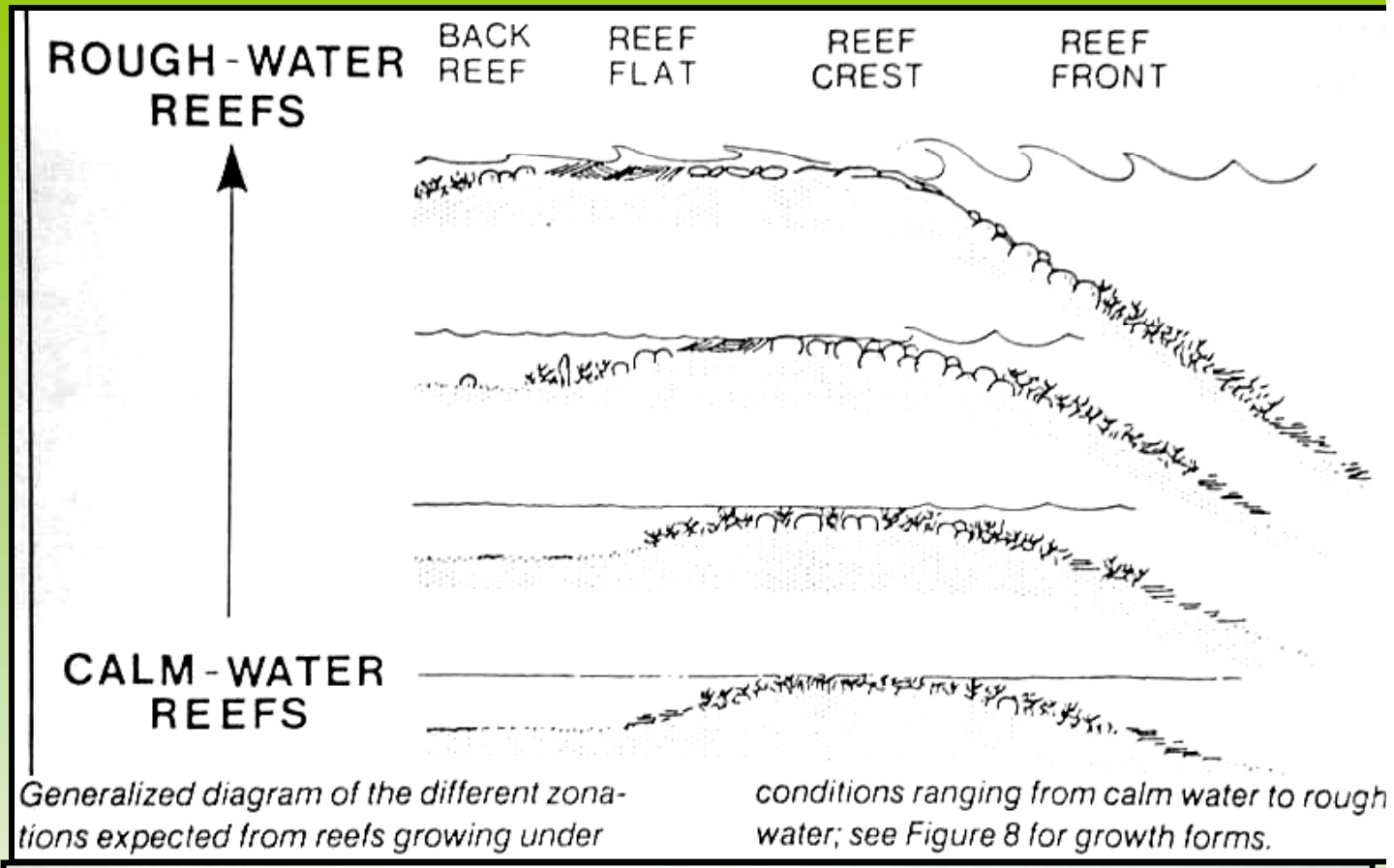
La crescita e la diversificazione di un reef dipende da molti fattori:

a) *profondità,*

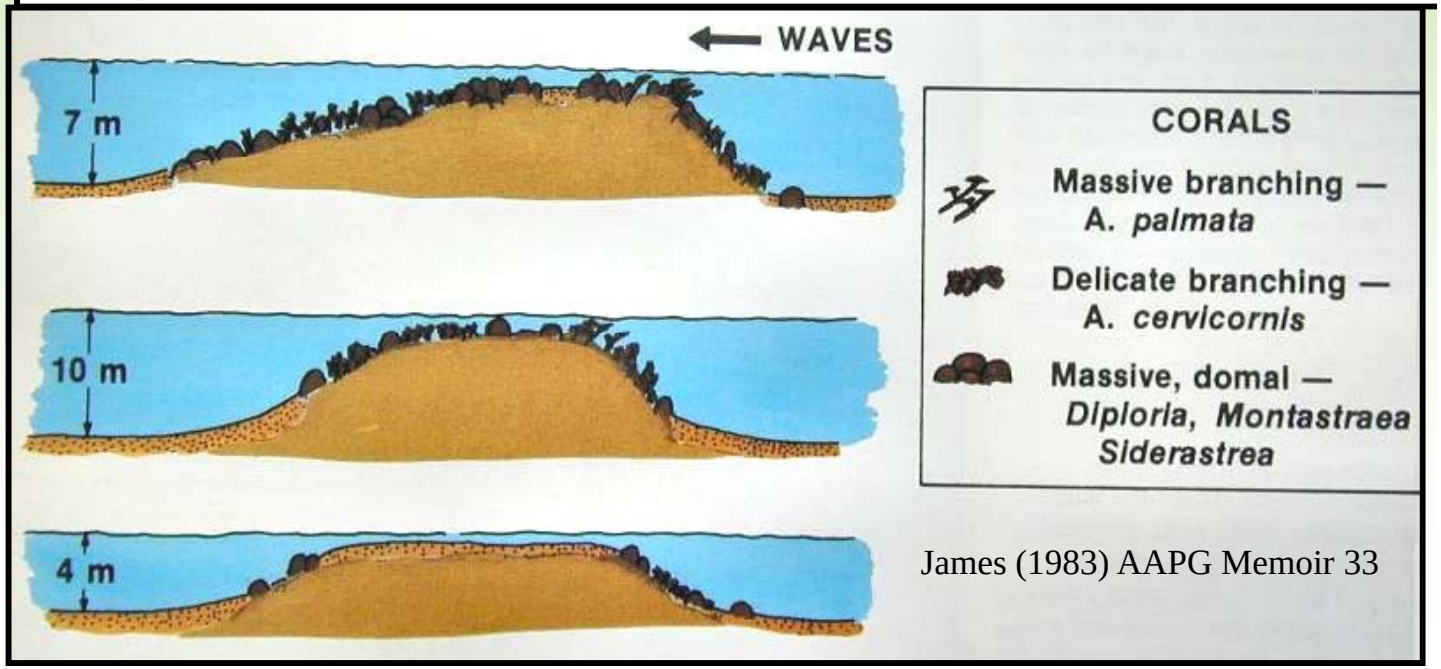
b) *orientazione rispetto alle onde (margine sotto corrente e sopracorrente),*

c) *energia dell'ambiente,*

d) *tipi di organismi a disposizione (variano in relazione ai periodi geologici).*



Generalized diagram of the different zonations expected from reefs growing under conditions ranging from calm water to rough water; see Figure 8 for growth forms.

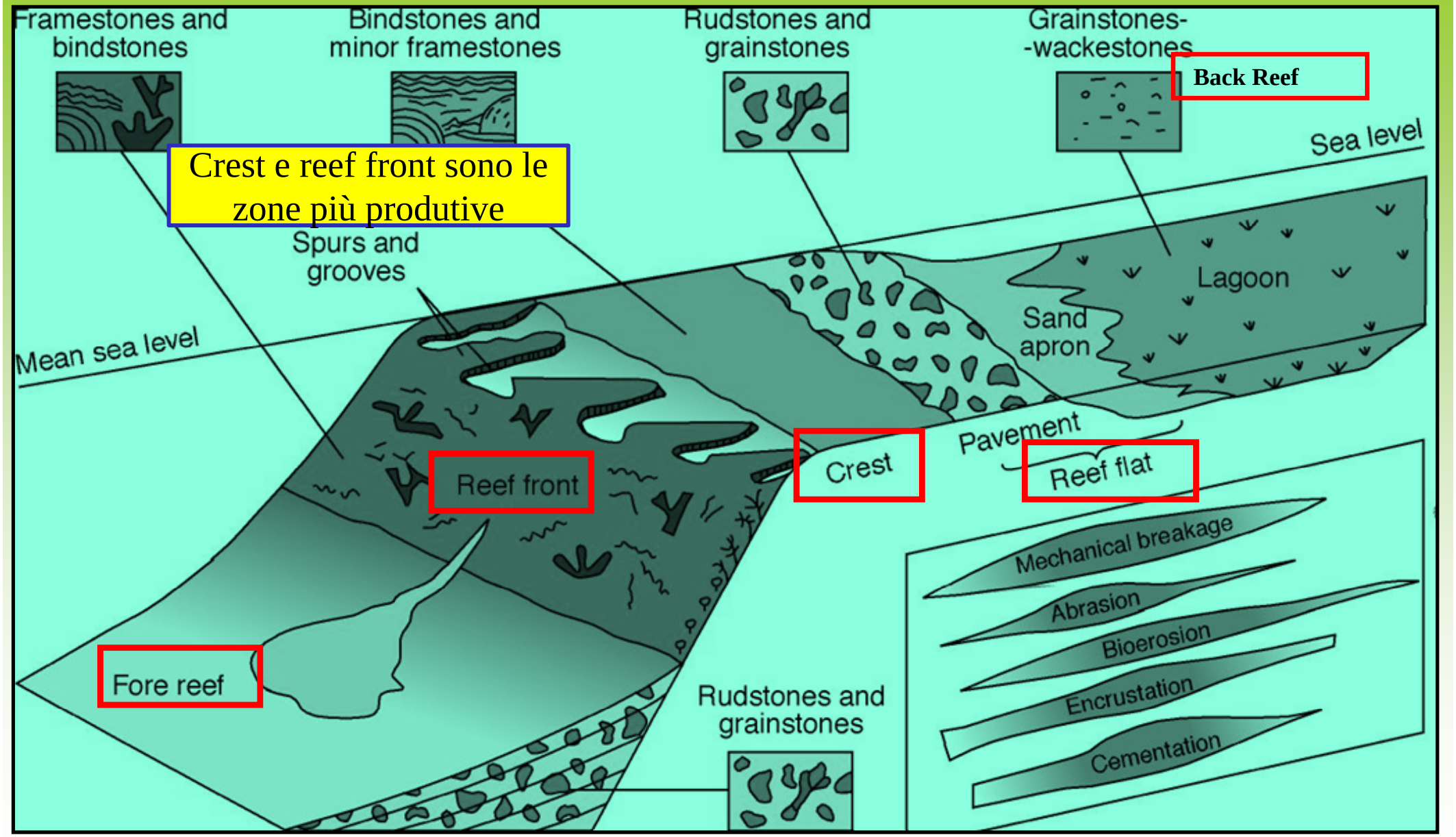


James (1983) AAPG Memoir 33

Profili in patch reef a coralli

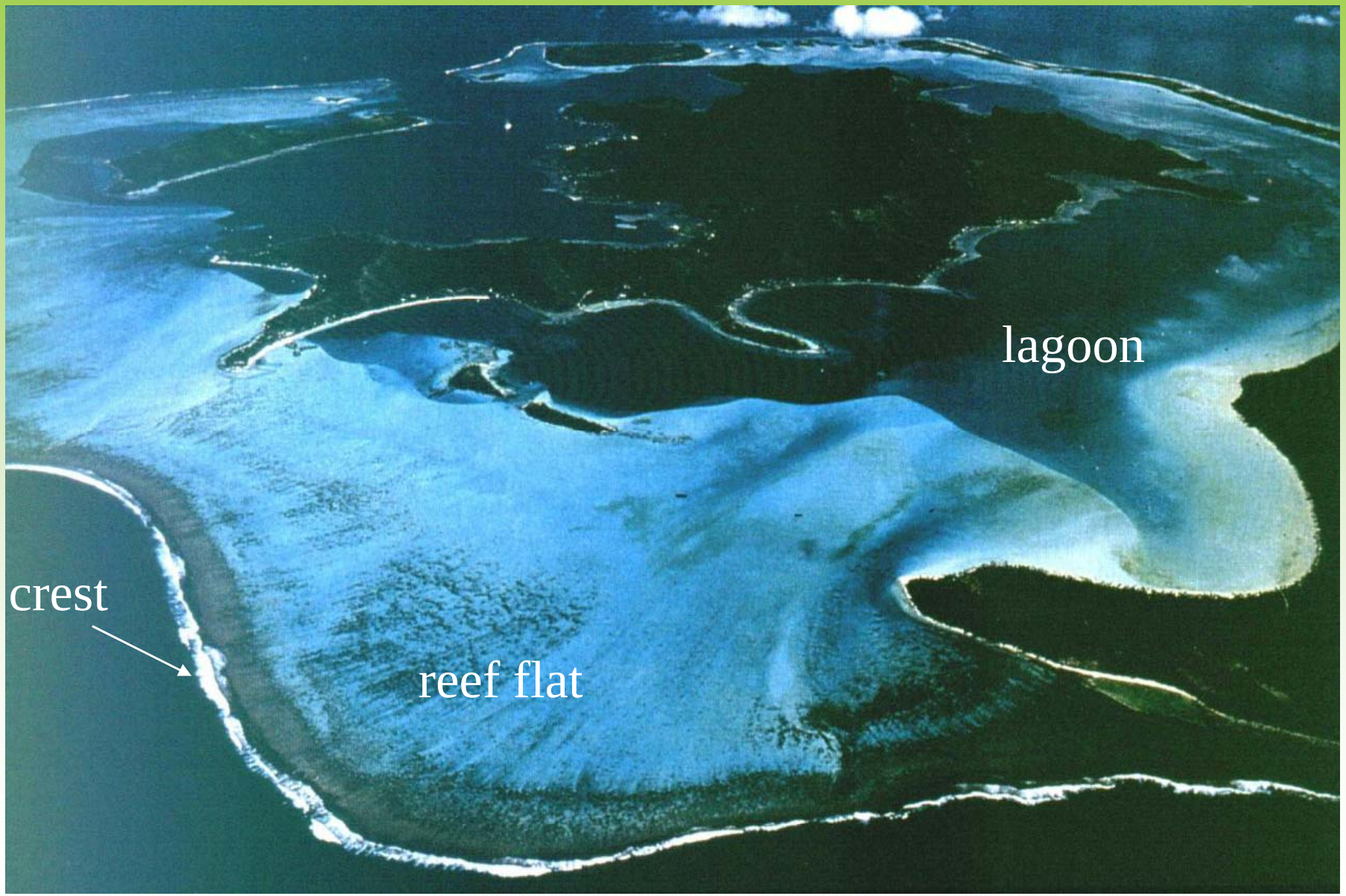
Le associazioni tessiturali delle litofacies del Reef Complex :

Fore Reef, Reef Front, Reef Crest, Reef Flat, Back Reef



I reef complex possono delimitare in modo continuo la piattaforma carbonatica per centinaia di km, la ampiezza del reef front –creste reef flat è invece limitata a decine\centinaia di metri

1. The **reef crest** is exposed to continuous wave action and even periodic exposure, so that the degree of breakage, abrasion, bioerosion and cementation is highest in this environment.

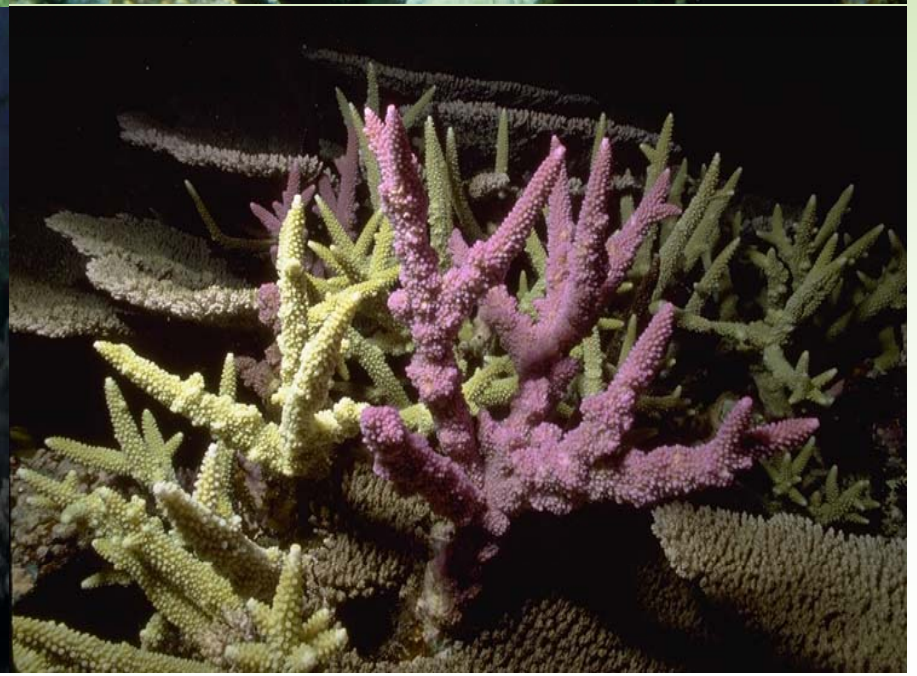


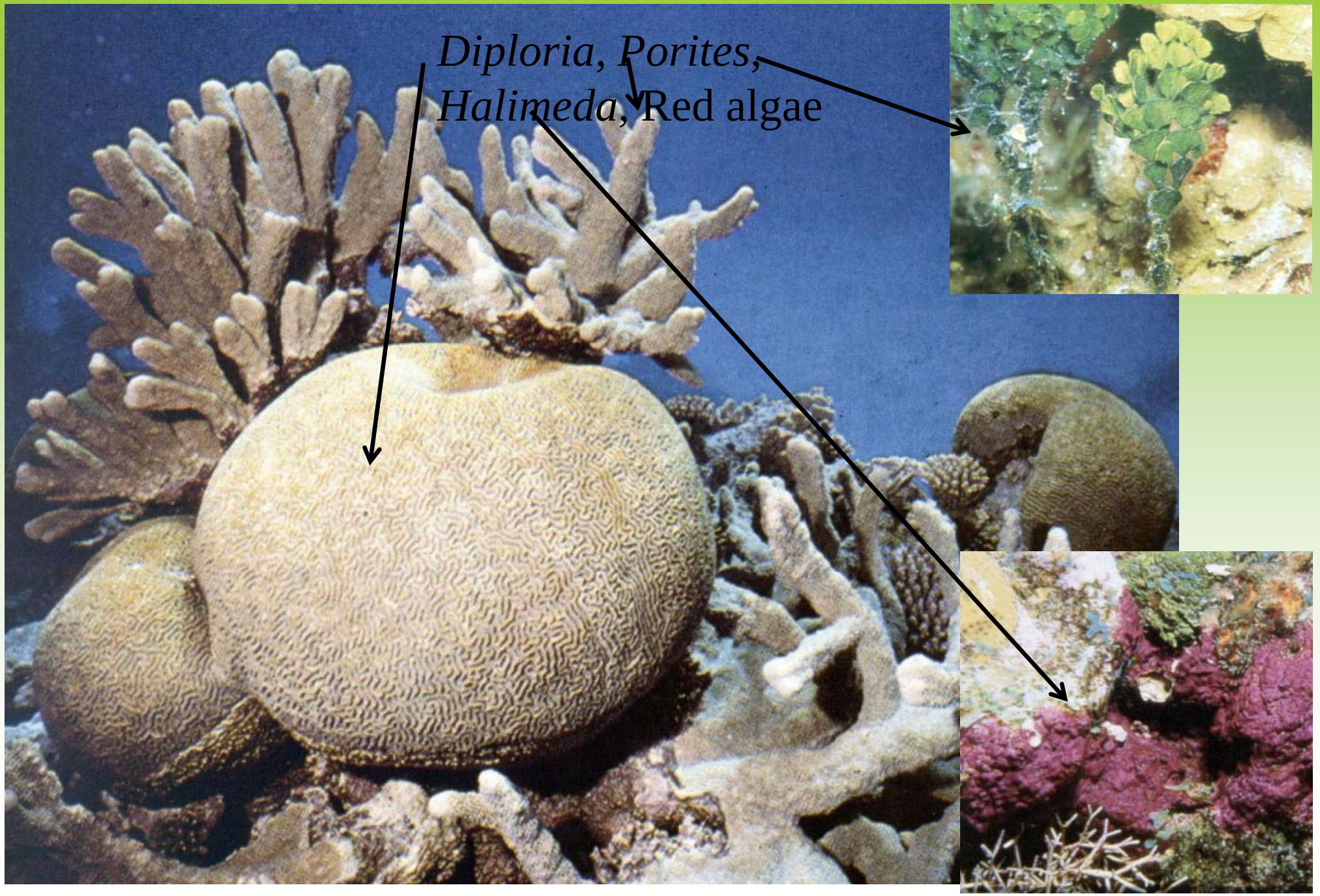
ANDROS BARRIER REEF – Coral REEF BUILDERS

Acropora palmata (branches 20 cm in diameter) on the crest, highest energy

Acropora cervicornis (branches 1-5 cm in diameter), up to 1 m high, also in lagoon

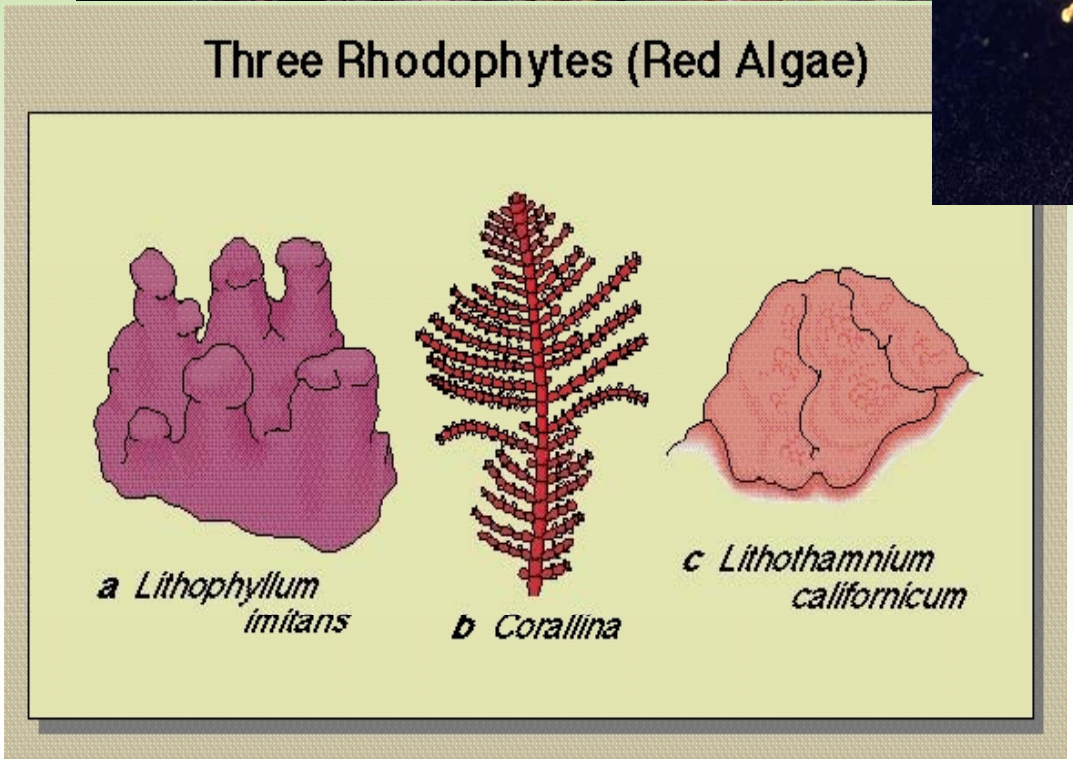
CORALS




Diploria, Porites,
Halimeda, Red algae

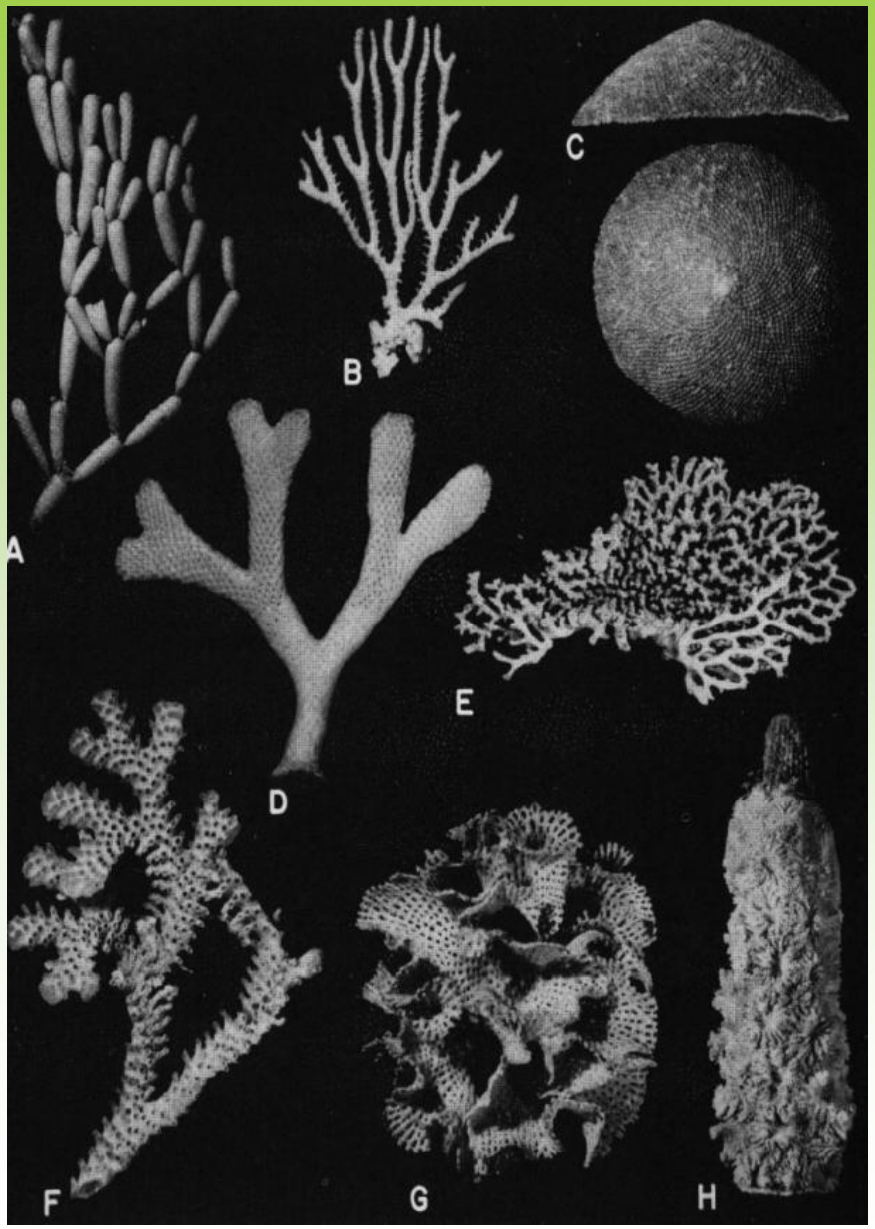
RED ALGAE

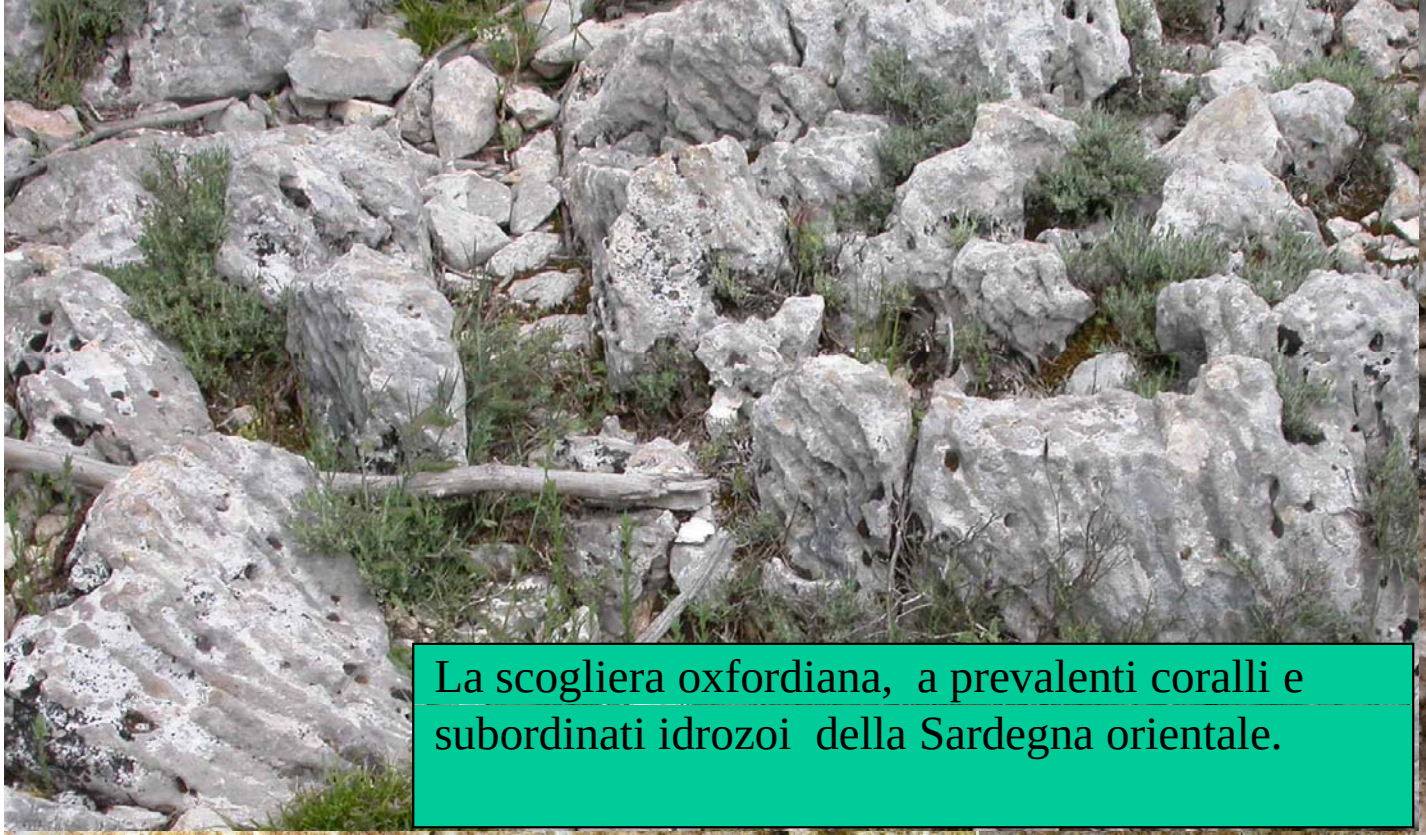
Goniolithon



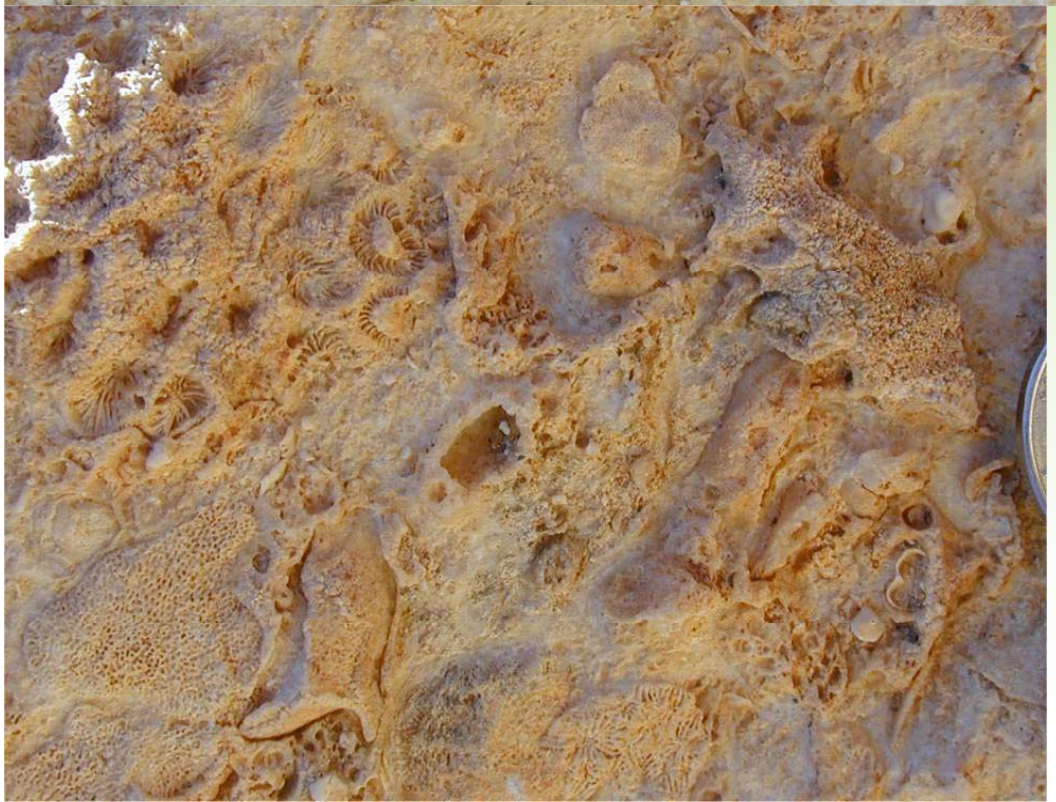
SPONGES

BRYOZOA





La scogliera oxfordiana, a prevalenti coralli e subordinati idrozoi della Sardegna orientale.




Radioli claviformi di
echinodermi


Idrozoi (ellipsactinia)


nerineidi

I processi dinamici nei reefs sono principalmente costruttivi ma ne esistono anche di distruttivi :

-sedimentazione-
costruzione del reef

- erosione
(meccanica, bioerosione)

- stabilizzazione-
consolidamento
(cementazione inorganica e indotta biologicamente-microbialica)

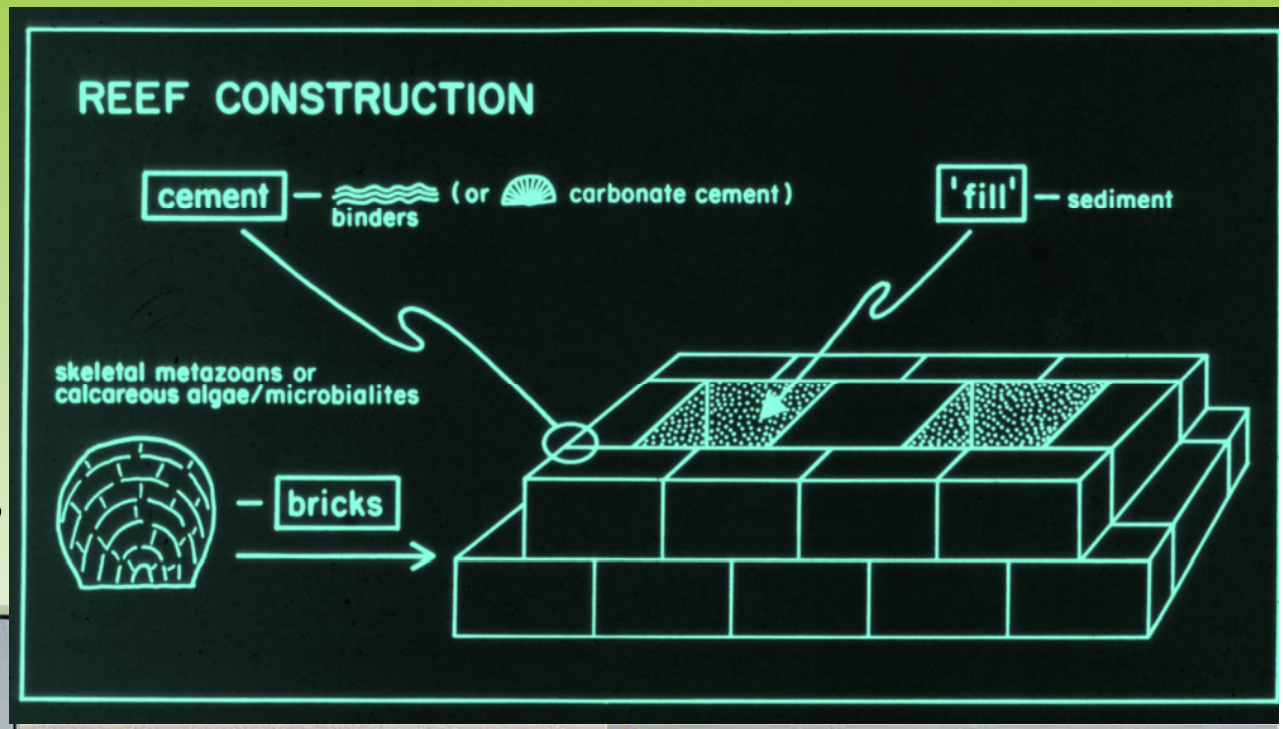


Figure 3—A sketch illustrating the different aspects of the organism/sediment mosaic that is a reef (after James, 1979, with permission of Geol. Assoc. Canada).

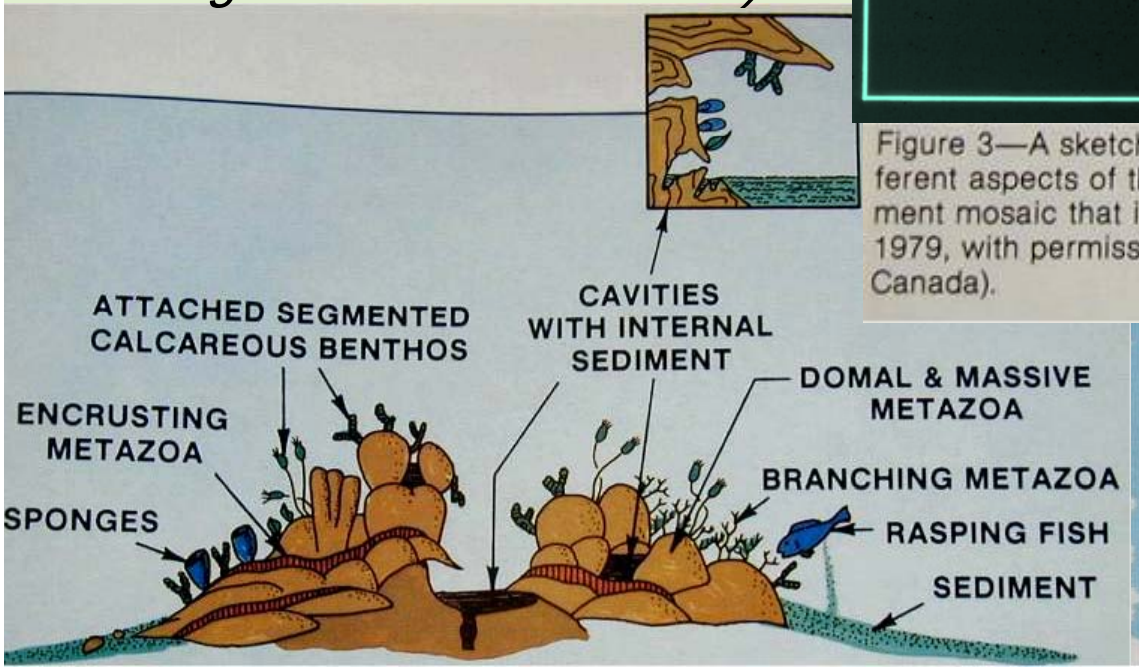
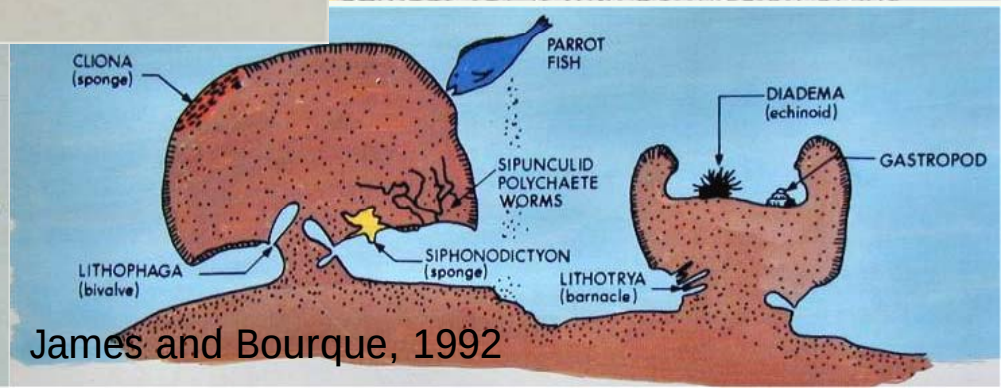


Figure 4—A sketch of two coral heads and some of the organisms responsible for bioerosion (after Ginsburg and James, 1974, with permission of the



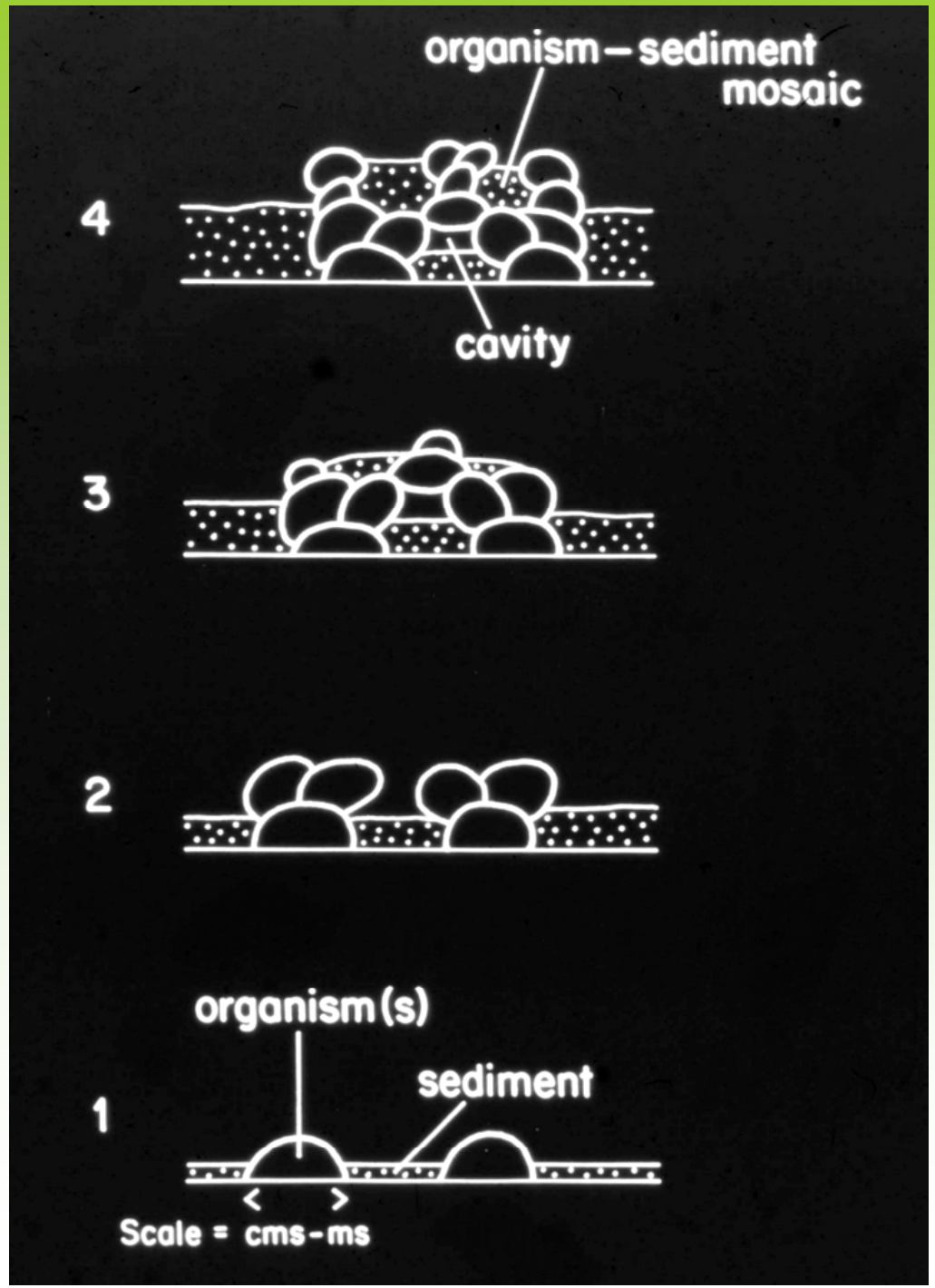
James and Bourque, 1992

Sedimentatione e cementatione

a) I sedimenti includono anche i prodotti della distruzione fisica e biologica della struttura del reef da parte di altri organismi bentonici che vivevano nel reef.

Il trasporto attivo dei sedimenti tra le biocostruzioni e nella consistente porosità primaria del reef avviene per opere di onde, tempeste, attività delle maree tidali

b) La cementazione precoce è un processo pervasivo comune a tutti i carbonati di scogliera dove esiste una attiva circolazione di acque marine che si muovono attaverso la porosità primaria.



Dettaglio di una colonia di organismi di reef pleistocenico con elevata porosità, presenza di sedimenti interni (più chiari), di bioturbazione associata ad ossidi di Fe.

Le trasformazioni dovute agli organismi ed alla cementazione nei reef

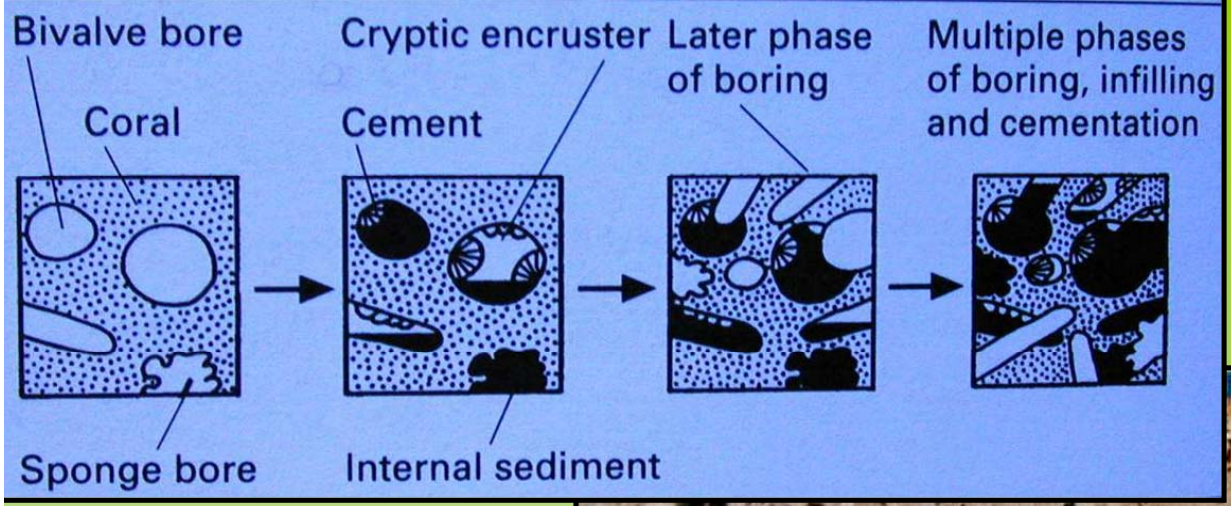


Figure 39—A polished slab of reef wall limestone (circa 9,000 years old) from the Belize barrier reef. This was originally a coral (*Montastraea annularis*) which has been subject to several generations of sediment infill, lithification and boring by sponges. The original coral skeleton can just be seen at the center. In this sample there are several different types of fine-grained sediment infill (light brown and dark brown) as well as different types of sponge borings (tiny holes at the lower right, medium-size galleries at the top, and large irregular voids in the center). The process of sponge boring sediment infill and early lithification repeated many times has almost completely altered this coral to a skeletal wackestone.

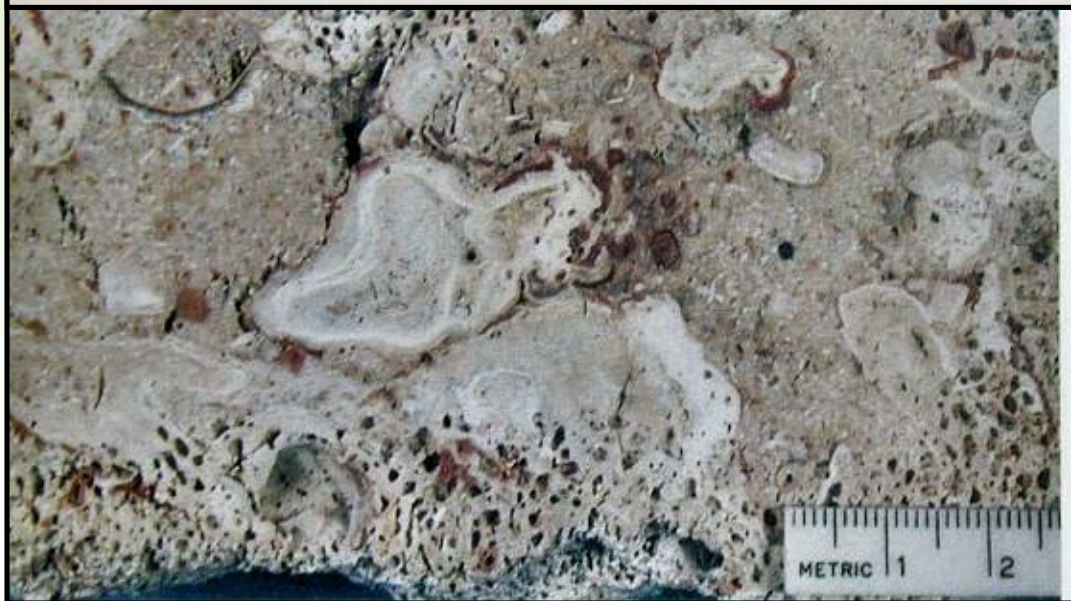


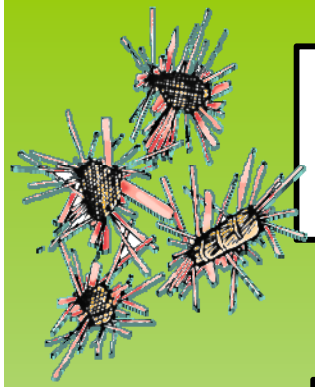
Figure 27—A slabbed and polished piece of reef limestone from a shall coral spur in 2 m of water on the eastern ocean-facing reef front of Glovers Atoll, Belize. The rock is co posed of branches of the hydrozoar *Millepora* (center) which are encru by the red foraminifer *Homotrema rubrum*. The sediment between the branches is a submarine cemented skeletal grainstone (see thin sectio photograph in Fig. 29). The holes a edge of the sample are excavated boring sponges, with holes cutting skeletal elements and cemented se ment.

Il ruolo della cementazione.

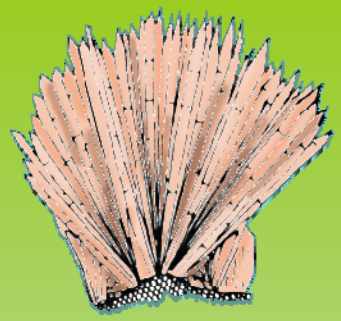
Il consolidamento e la rigidità delle biocostruzioni derivano da cementazioni precoci

I più comuni cementi dei reef attuali sono aragonitici e Mg calcitici e si sono deposti in contesti diagenetici molto precoci di ambiente marino freatico

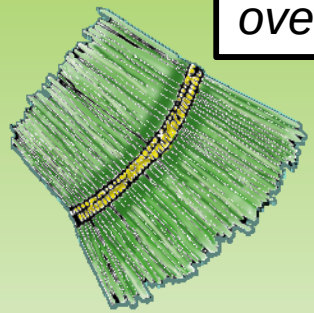
(James & Ginsburg, 1979)



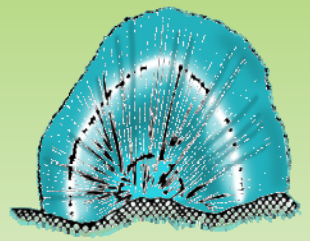
A mesh of aragonite needles



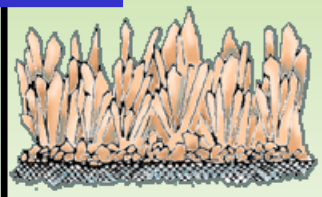
Epitaxial overgrowths

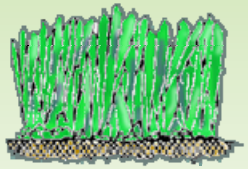


Botryoidal aragonite



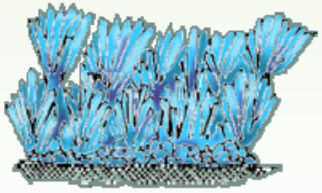
Reef ARAGONITE CEMENTS



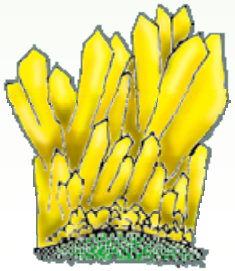


Elongate Blades

Small Spherulites



"Stubby"



Bladed Spar

(James & Ginsburg, 1979)

Reef MG-CALCITE CEMENTS

REEF CEMENTS

Cementation is an important factor in stabilising the reef framework at the platform margin.

Present day reef cements are aragonite and High Mg calcite cements

Holocene Belize barrier reef cement with spherulitic growth of botryoidal aragonite.
James (1983) AAPG Memoir 33

Middle Permian reef cement
In calcareous sponge-microbial reef (cf. lecture about Microbial Factory on 22/10/09 Capitan Reef, Texas)

Figure 120—A polished slab of *Stachyoids* (white)-*Renalcis* (speckled) reef framestone with a large cavity infilled with banded fibrous cement and red pelleted mud, which is in turn covered with geopetal sediment and finally equant blocky spar; Upper Devonian of the Canning Basin, Western Australia

Oltre agli organismi costruttori sono molto importanti nel consolidamento e stabilizzazione della biocostruzione del reef i cementi nelle cavità primarie (inter-intragranulari) o secondarie].

In alcuni reef antichi la cementazione *(reef cements)* alla fine dei processi diagenetici risulta dominante rispetto agli organismi biocostruttori originari.

Si ritiene che la precipitazione di molti di questi cementi possa essere controllata da fattori biologici (batteri e altri microrganismi che colonizzavano le varie cavità primarie e secondarie del reef)

NB Per dettagli sulla cementazione dei reef si rimanda alla presentazione sulle litofacies ed evoluzione delle piattaforme triassiche lombarde.

Figure 51—A close view of a plastic-impregnated and slabbed core through the seaward rim of Rodriguez Key Bank. The branching corals are *Porites porites* and almost all of the platey algal skeletons are from the green alga *Halimeda*. This sediment would be classified as a coral-platey algal floatstone to rudstone with a skeletal packstone matrix.

Aspetto macroscopico del sedimento, in gran parte organogeno e bioclastico, di un reef attuale.

Figure 52—A close view of the plastic-impregnated and slabbed core through the *Porites-Goniolithon* zone just in the lee of the seaward rim of Rodriguez Key Bank. The corals are *Porites porites*, the white rod-like skeletons are the branching coralline alga *Goniolithon* and between these major components are bivalve shells, small gastropods and the platey alga *Halimeda*. This sediment would be classified as a coral-coralline alga rudstone with a skeletal packstone to grainstone matrix.

“Patch reef“

Edifici di dimensioni più ridotte (da metriche a decametriche) sono i osservabili entro lagune o in altre aree caratterizzate da acque basse.

Una simile varietà esiste anche per quanto riguarda i depositi antichi. Il riconoscimento delle strutture maggiori richiede accurati rilevamenti geologici regionali o esposizioni di ampiezza eccezionale. Scogliere di piccole dimensioni possono essere individuate in cave o su scarpate naturali.

"reef mounds“ e mud mounds”.

Lenti a forma spesso emisferoidale, a fianchi più o meno inclinati (reef mounds), costituite principalmente da fango carbonatico contenente subordinate percentuali di resti di organismi (a volte non ben riconoscibili o preservati nei “mud mound” antichi) capaci di intrappolare sedimento (bafflestone e bindstones).

Tromboliti

Piccole costruzioni costituite dalla sovrapposizione di più croste e laminazioni di fango micritico e peloidale di forma a cupola, sono connesse all’attività di prevalenti batteri. Sono molto diffuse nel Paleozoico e Proterozoico associate con le stromatoliti (allora colonizzavano la maggior parte degli ambienti marini).

Esempio di crescita di un moderno patch reef

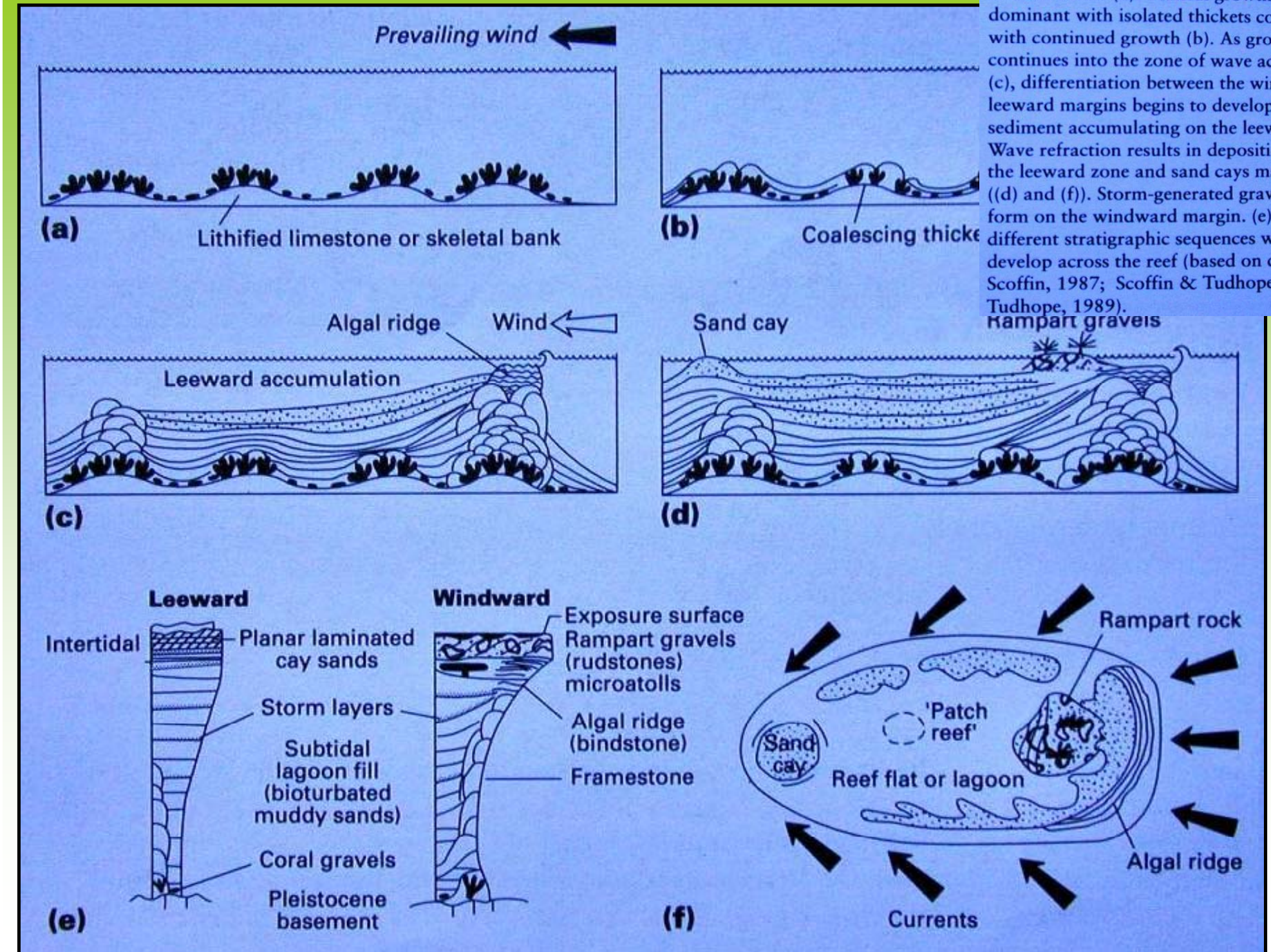
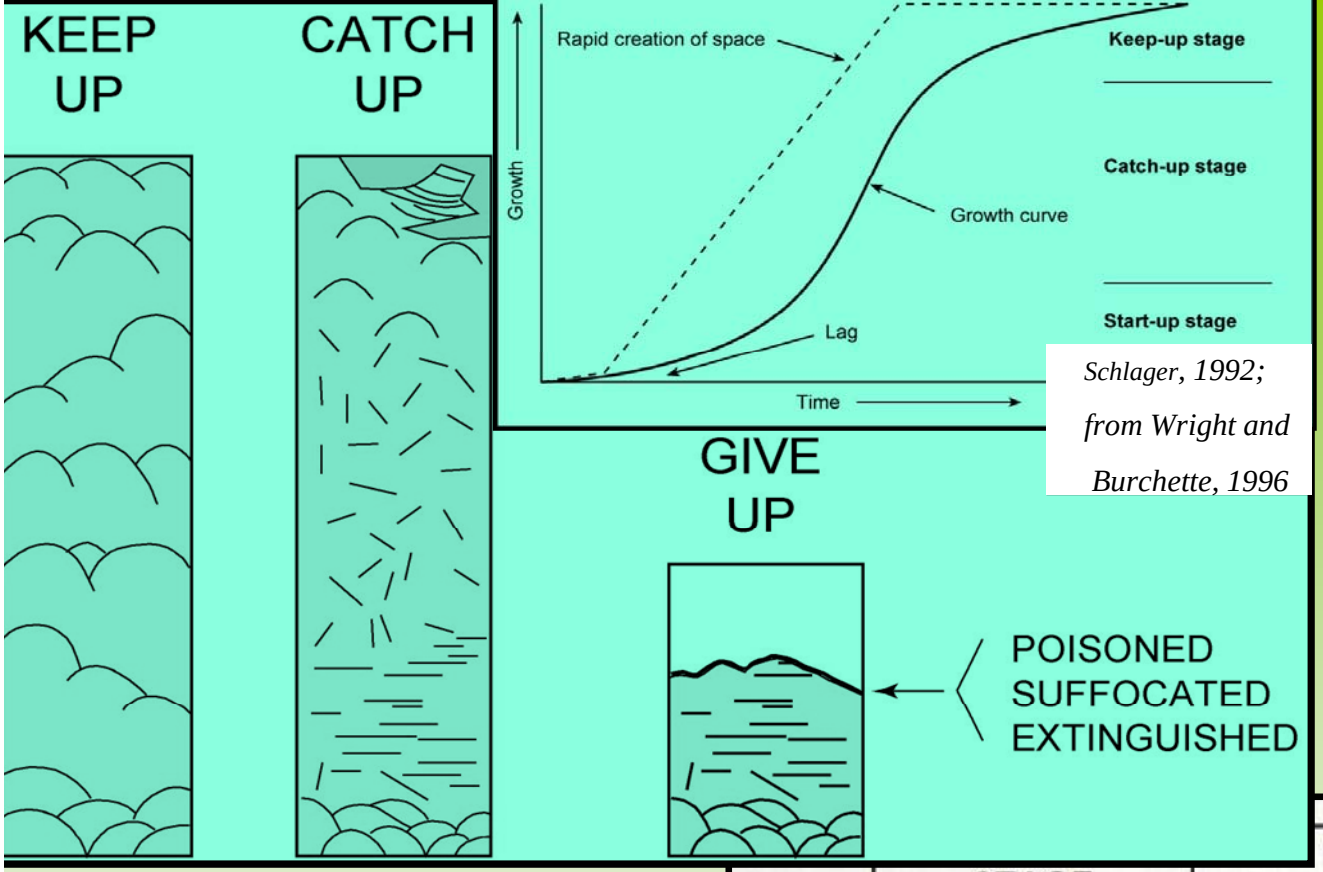


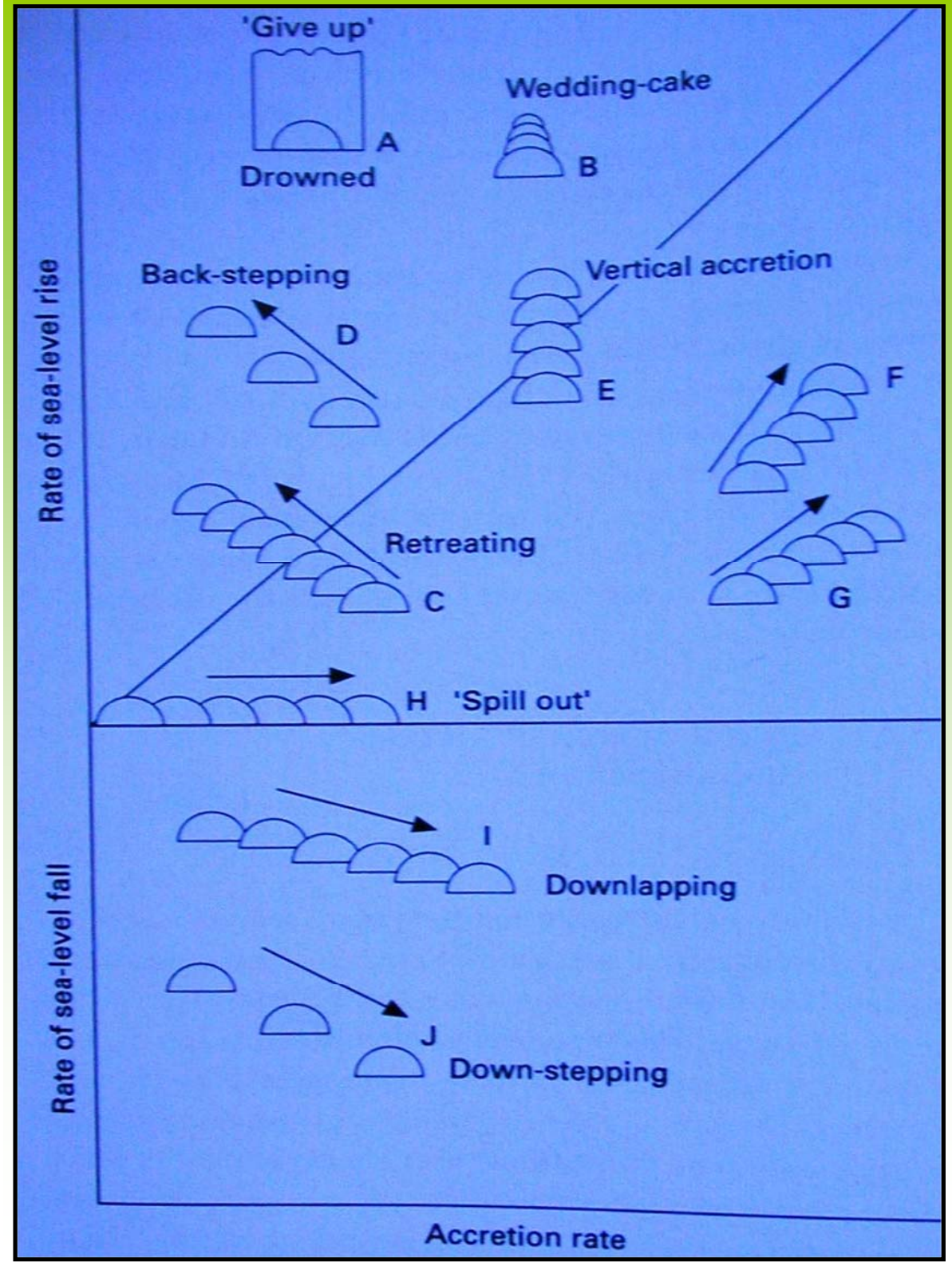
Figure 9.52 Growth of modern patch reefs. Growth begins on lithified Pleistocene or skeletal banks (a). Vertical growth is dominant with isolated thickets coalescing with continued growth (b). As growth continues into the zone of wave action (c), differentiation between the windward and leeward margins begins to develop with sediment accumulating on the leeward side. Wave refraction results in deposition around the leeward zone and sand cays may develop ((d) and (f)). Storm-generated gravels may form on the windward margin. (e) Shows different stratigraphic sequences which develop across the reef (based on data in Scoffin, 1987; Scoffin & Tudhope, 1988; Tudhope, 1989).



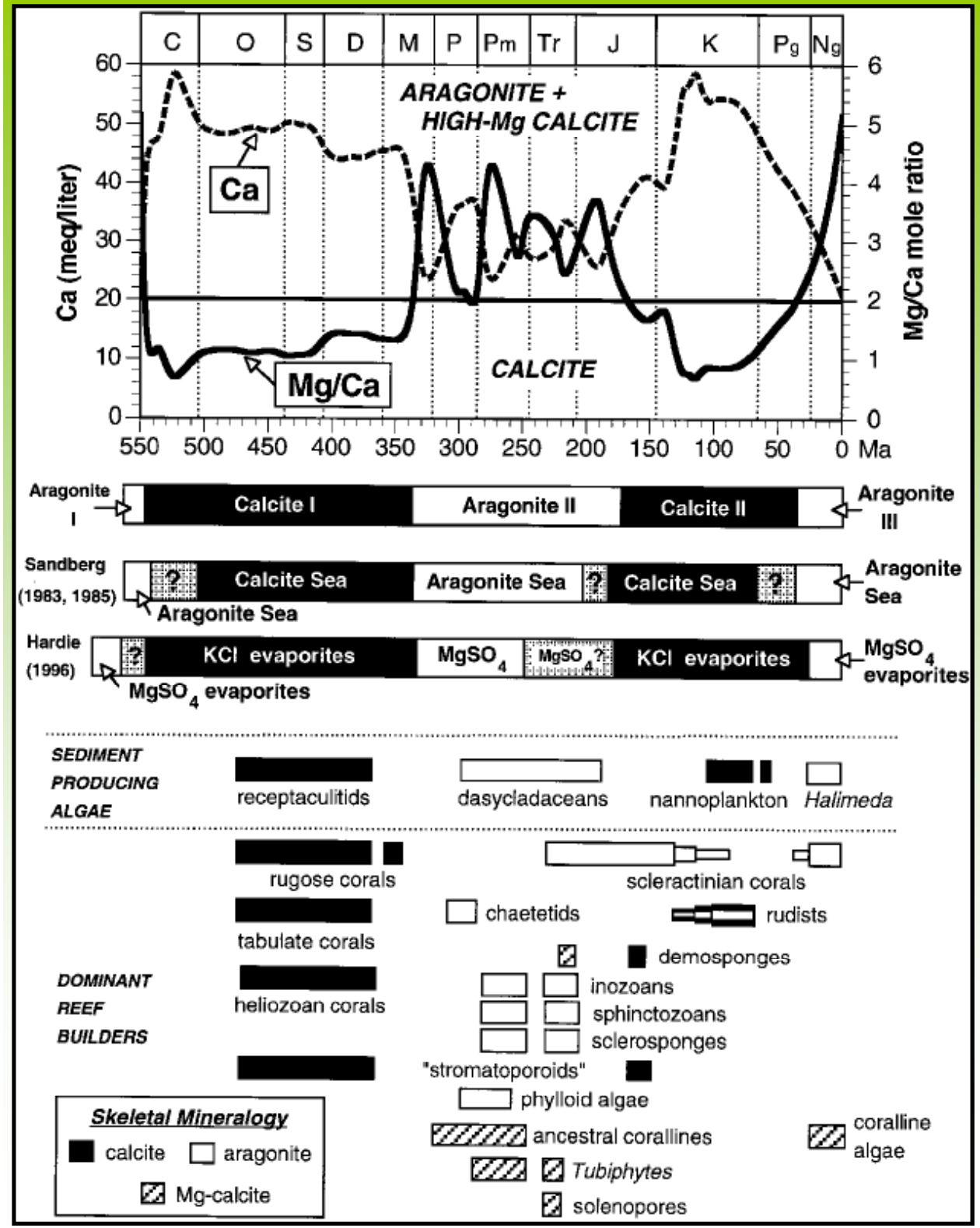
Schlager, 1992; from Wright and Burchette, 1996

Accumulo, stili di crescita delle biocostruzioni e diversificazione del reef

STAGE	TYPE OF LIMESTONE	SPECIES DIVERSITY	SHAPE OF REEF BUILDERS
DOMINATION	bindstone to framestone	low to moderate	Laminate encrusting
DIVERSIFICATION	framestone (bindstone) mudstone to wackestone matrix	high	domal massive lamellar branching encrusting
COLONIZATION	bafflestone to floatstone (bindstone) with a mud stone to wackestone matrix	low	branching lamellar encrusting
STABILIZATION	grainstone to rudstone (packstone to wackestone)	low	skeletal debris



Nomenclatura delle tipologie di espansione laterale e accrescimento (aggradazioni, progradazioni, retrogradazioni) di reef o singoli mounds osservabili in successioni di carbonati di margine-pendio con trend trasgressivo oppure regressivo.



La distribuzione nel tempo del rapporto Mg/Ca, della Calcite , aragonite-High Mg calcite. Si possono osservare dei periodi in cui prevale la calcite (Paleoz.- Cretacico) mentre in altri prevale l'aragonite-High Mg calcite (Trias-Giura inf.)