

Thematic index

Presentation

9

Oceans and seas

13

1. The salt-water kingdom

15

1.1 The continent and the content

[R. Margalef]

17

1.1.1 The imprint of history

17

The lithosphere and the hydrosphere

18

The oceans of the past

18

1.1.2 Seawater

20

The sea, a product of the land

20

Elements whose relative proportions remain constant

20

1.1.3 Seawater and life

22

Hydrographic structures

22

Descending and rising waters

22

Marine environments

23

1.2 Marine dynamics

[R. Margalef and J. Flos]

25

1.2.1 The displacement of water masses

[R. Margalef]

25

Geostrophic circulation

25

Density and vertical circulation

27

Winds and ocean currents

28

Circulation in secondary basins

29

1.2.2 The ebb and flow of the tides

[J. Flos]

32

Tidal dynamics

32

The moon and the tides

33

The influence of the Sun

34

The prediction of tides

35

1.2.3 Other more or less regular movements

[R. Margalef]

35

Surface waves

35

Internal waves and thermoclines

36

Fluctuations in upwellings

36

• The El Niño phenomenon

[R. Margalef]

40

2. Pelagic life

45

2.1 The bases of the pelagic system: plankton, nekton and pleuston

[R. Margalef]

47

2.1.1 Life in the pelagic space

47

From plankton to nekton

47

A question of size

47

2.1.2 The movements of pelagic organisms

48

Moving at will or drifting

49

Neither plankton or nekton

50

Making sure of permanence

51

• Microscopic jewelery

[R. Margalef]

52

2.2 Primary producers: the phytoplankton	[R. Margalef]	56
2.2.1 Phytoplankton organisms		56
Cyanobacteria and protochlorophytes		56
Dinophyta		57
Cryptophytes		59
Chrysophyta or chromophytes		60
The prasinophytes		63
The euglenoids and raphidophytes		63
Symbionts with simplified organization		63
2.2.2 Phytoplankton distribution and diversity		64
Low diversity, wide distribution		64
Planktonic ecosystems		64
Diversity and production		66
2.2.3 The primary production of phytoplankton		67
The photosynthetic pigments		67
The role of nutrients		68
New production and recycled production		71
2.2.4 The dynamics of phytoplankton production		73
Variations in production in space and time		74
Production and upwelling areas		74
The water column model		75
Heterogeneities and asymmetries		75
2.2.5 The processes of succession and biological types		77
Succession in phytoplankton		77
Swimming strategies		79
Regularities and variations		80
2.3 The primary consumers: the zooplankton	[J.M. Gili]	82
2.3.1 The organisms of the zooplankton		82
Meroplankton and holoplankton		82
Seasonal variations		84
Support systems		85
2.3.2 The distribution of zooplankton		87
Oceanic-scale distribution		88
Intermediate-scale distribution		88
Small-scale distribution		92
2.3.3 Vertical displacements of zooplankton		93
Migratory movements		94
Migratory strategies		96
2.3.4 Interspecific zooplankton relationships		96
Trophic relations		97
Biological and physical processes		97
• Whale food	[J.M. Gili]	98
Deep-water zooplankton		102
2.4 Secondary and tertiary consumers: large invertebrates and vertebrates	[D. Lluch Belda]	103
2.4.1 A bountiful but dangerous environment		103
Survival strategies		104
Productivity in pelagic systems		105
• Migratory fish	[R. Folch]	106
Production cycles		110
Exploitability of the pelagic environment		110
2.4.2 Typical pelagic consumers		111
Fish and small crustaceans		111
Medium-sized fish		115
Bathypelagic fish		116
Squid and cuttlefish		117
Large fish		118
2.4.3 Allochthonous pelagic consumers		118
Marine turtles		118
Marine mammals		119
Seabirds		120
• Seabirds	[R. Folch]	122
• Shark!	[R. Folch]	126

3. Life on the ocean bottom	133
3.1 The benthic system. [E. Ballesteros]	135
3.1.1 Life at the bottom of the sea.	135
Primary producers: bacteria, algae, and sea grasses	135
Consumers and decomposers: animals, fungi, and bacteria	135
3.1.2 Environmental factors	137
The physical substrate.	138
Light.	138
Hydrodynamism	139
Nutrients and organic material	139
Temperature	140
Disturbances.	140
Salinity and sedimentation.	141
3.1.3 Relationships between organisms	141
Predation	142
Competition	143
Parasitism, symbiosis, commensalism, and mutualism	145
Other interactions	145
3.1.4 The benthic landscape.	146
Evolutionary history	146
Bathymetric zonation.	147
Zones and levels	148
Some examples.	148
3.2 Seaweeds that are not seaweeds, and meadows that are not meadows [E. Ballesteros and J. Romero]	151
3.2.1 Underwater meadows [J. Romero]	151
Marine phanerogams	151
Organisms of the <i>Posidonia</i> meadows	153
Production in <i>Posidonia</i> meadows	154
Meadows in the littoral ecosystem	155
3.2.2 Kelp "forests" [E. Ballesteros]	157
Biomass and production	157
Structure and stratification.	158
Stability and persistence	159
3.3 Hard and soft seafloors. [E. Ballesteros]	160
3.3.1 Communities of suspensivores on rocky substrates	160
Structure and stratification.	160
Cycles and disturbances	161
Some examples.	161
3.3.2 Soft-floor platform communities	162
Structure and organization.	163
Ecological strategies and seasonal cycles	163
Some case studies	164
3.3.3 The communities of the deep soft seafloor	165
Environmental conditions at depth	165
Ecological strategies	166
The exaltation of biodiversity	166
3.4 Coral reefs [Z. Dubinsky]	167
3.4.1 Jungles in the ocean	167
The different types of coral reef	167
Geographical distribution.	168
Environmental conditions and the availability of nutrients	169
Specific diversity and coral behavior	170
Distribution by depth.	171
3.4.2 The coral reef ecosystem.	171
Complexity and relationships	171
Natural catastrophes	173

3.4.3 The organisms of the coral reefs	174
Corals or anthozoans	175
The zooxanthellae	178
Other coelenterates	179
Polychaetes	180
Mollusks	180
Echinoderms	182
Crustaceans	185
Fish	187
Turtles and dugongs	193
• Clownfish and other artists	[A. de Sostoa and X. Ferrer] 194
3.5 The dark abyss	[J. Ros] 198
3.5.1 The biotic conditions of the abyssal zone	198
The presence of life in the depths	198
The zonation of the deep sea	198
3.5.2 Abyssal organisms	199
The adaptations of the abyssal fauna	199
Abyssal communities	201
• The dream of the Piccards	[J.M. Camarasa] 202
Hydrothermal oases	206
Chemotrophic bacteria on seafloor without oxygen	206
4. Humans and the sea	209
4.1 The old sea routes	[J.M. Camarasa] 211
4.1.1 Wind and sail	211
Tracing the earliest navigators	211
Wind energy, oar power	212
The discovery of the sea	217
From three oceans to just one	220
• Never lose track of the north	[R. Folch] 222
4.1.2 Steam and empires, oil, and democracies	226
The first steam ships and the last sailing ships	226
Major technological innovations	228
War and know-how	230
From steam to nuclear power	232
4.1.3 Health and illness at sea	233
Seasickness	233
• Crossing the Atlantic	[J.M. Camarasa and R. Folch] 234
Illnesses related to malnutrition, scurvy	238
Food poisoning by fish or seafood; ciguatera fish poisoning and mollusk filter-feeders that contaminate	239
Epidemics and quarantine	239
4.2 The exploitation of living resources	[E. Hoyt and M.J. Uriz] 241
4.2.1 Artisanal fishing	[E. Hoyt] 241
From shellfishing to deep-sea fishing	241
Fishing nets and tackle	241
Traditional fishing today	246
4.2.2 Industrial fishing	[E. Hoyt] 247
• From canoe fishing to factory ships	[E. Hoyt] 248
Herring fisheries	253
Fishing of Peruvian anchoveta and other anchovies	255
Fishing for tuna and tuna-like species	256
Cod fishing	257
4.2.3 The hunt for cetaceans	[E. Hoyt] 259
Basque whalers	259
The Yankee whalers	263
Modern whaling	265

4.2.4	Seafood, sponges, and coral fishing	[E. Hoyt]	266
	Shellfish fisheries		266
	Sponge, coral, and pearl fishing		270
	New resources for emerging biotechnology	[M.J. Uriz]	271
	• Jewels from the sea	[R. Folch]	274
4.3	Management conflicts and environmental problems	[R.H. Borrourghs, Z. Dubinsky, E. Hoyt and J. Romero]	278
4.3.1	The world's sewer or buffer against devastation?	[R.H. Borrourghs]	278
	The impact of sewage		278
	Bioaccumulation and biomagnification		280
	Impacts of conservative pollutants and assimilative capacity		281
	The impact of supertankers and oilrigs	[E. Hoyt]	282
	The impact of waste from new technologies		283
4.3.2	Overfishing and bad fishery management	[E. Hoyt]	284
	The status of marine fisheries today		284
	The problem of drift nets		288
	The hunt for cetaceans		288
4.3.3	The degradation of coral reefs	[Z. Dubinsky]	290
	Abusive fishing		290
	Destruction of corals		291
	The difficulty of conservation		291
4.3.4	The destruction of <i>Posidonia</i> meadows	[J. Romero]	292
	Disturbances		292
	Recolonization		294
4.3.5	Geostrategic keys to management of oceans and their resources	[R.H. Borrourghs]	294
	From permissiveness to sense		294
	Regional management—the example of the Mediterranean		295
	Conditions for integrated action		296
	• From Captain Ahab to Commander Cousteau	[E. Hoyt]	298
4.3.6	The protection of submerged spaces	[J. Romero, A. Ramos and M.A. Ribera]	302
	The example of the Mediterranean		304

The frontiers between oceans and continents

305

1.	Between the land and the sea		307
1.1	The geographic space of coastal systems	[J. Flos]	309
1.1.1	The changing coastline		309
	The sea's memory		309
	Between the sea and the continent		310
	Coastal landforms		312
1.1.2	A sea that rises and falls		312
	Tidal oscillations		313
	Catastrophic variations in sea level		314
1.1.3	The boundaries between land and sea		315
	The coast, a frontier area		315
	The relatively arbitrary nature of the delimitation		316
1.1.4	Ecological criteria for classifying coastal systems		317
	Production and productivity		317
	Stability		317
	Exploitability		319
	• The fractal coastline	[J. Flos]	320
	The coastline, a conflictive space		324

1.2 The great planetary river	[R. Margalef]	325
1.2.1 The flowing waters		325
Rivers in the water cycle		325
Relief and the river network		326
Flows under river beds and underground water		327
1.2.2 The river system		328
River dynamics		328
From the clouds to the great planetary river		329
Interactions between rivers and their surroundings		331
1.3 Coastal bacterial landscapes	[L. Margulis, R. Guerrero and D. Sagan]	333
1.3.1 Water, land, and bacteria		333
Planets without seas		333
The interfaces of life		333
Energy sources		334
1.3.2 Bacteria as a geological force		335
The types of coastal bacterial communities		335
Bacterial mats		335
2. Life on coastlines with tides		341
2.1 Rocky coastlines: the intertidal zone		343
2.1.1 To the rhythm of the tides	[X. Niell]	343
Surviving in a changing environment		343
Intertidal levels and horizons		344
Production and feeding strategies		345
2.1.2 The variability of the intertidal system		346
Vertical zonation factors		347
Factors affecting horizontal diversification		348
Variability in time		349
2.1.3 The lichen, seaweed, and animal population		350
Lichens and cyanobacteria		350
Small grazing snails and colonial crustaceans		350
Seaweeds		351
2.1.4 The intertidal zone in the world's different seas		351
Tropical coasts		352
Temperate Atlantic European coasts		352
The Pacific coasts		354
The polar coasts		355
2.2 Low coasts: beaches, mangrove swamps, and estuaries	[P. Moreno, A. de Sostoa, X. Ferrer and J.M. Camarasa]	356
2.2.1 On the edge of the ocean	[P. Moreno and J.M. Camarasa]	356
Fresh and salt waters		356
Warm and cold waters		356
The colonization of coastal space		357
2.2.2 Beaches and coastal dunes	[P. Moreno]	358
The origin and nature of sandy beaches		358
The process of dune formation		359
Soil structure and nutrient availability		360
Strategies for the biological colonization of beaches		361
Strategies for the biological occupation of dunes		362
The flora and the vegetation		363
The fauna and animal communities		368
2.2.3 Mangroves	[P. Moreno, A. de Sostoa and X. Ferrer]	371
Physical factors		371
Mangrove organisms		373
American mangroves		378
The types of mangrove swamp and their distribution		380
• Ghost crabs and fishes in trees	[P. Moreno]	382
Natural disturbances and constructive dynamics		386

2.2.4. Estuaries	[P. Moreno]	387
The formative process		387
Types of estuaries		387
Circulatory flows		388
Nutrients and productivity		389
Diversity and ecotones		390
3. Life on tideless coastlines		391
3.1 Rocky coasts: where the waves pound	[J.M. Gili]	393
3.1.1 The breaking of the waves		393
The transition zone		393
Communities and sea level		393
Ecological conditions		396
3.1.2 Biological strategies		396
Attachment to the substrate		398
Feeding		398
Reproduction		398
Territoriality		399
3.2 Low-lying coasts: beaches, marshes, and deltas	[F. Mesléard, P. Grillas and F. Giró]	400
3.2.1 Habitat distribution	[F. Mesléard and P. Grillas]	400
Beaches and coastal dune belts		400
Inner dunes		401
Coastal lagoons		401
Saltmarshes		402
Dry salt meadows		403
Seasonal marshes		404
Forest formations		406
3.2.2 Adaptation to fluctuating environments	[F. Mesléard and P. Grillas]	406
Plant strategies		406
Animal strategies		408
3.2.3 The biological wealth of coastal wetlands	[F. Giró]	410
The abundance of pasture and food		410
Concentrations of large predators		412
Refuges for fauna		413
3.2.4 Marsh birds	[F. Giró]	413
Open waters		414
Stagnant waters		415
• Webfeet and waders	[F. Giró]	416
Muddy margins		420
Large herbaceous communities		420
4. Humans in coastal systems		421
4.1 Human settlement of coastal areas	[J.M. Camarasa]	423
4.1.1 Human colonization of the coastline		423
Lower Mesopotamia		423
Lower Egypt		424
The Lower Yangtze and the Jiangsu plains		425
The great Indian deltas		426
4.1.2 Modern coastal settlement		426
Primitive sedentary hunters and gatherers		426
Intensive farmers in delta areas		428
Marsh cities		429
• Venice, Queen of the Adriatic, and the unfortunate city of Dhaka	[R. Carvajal]	430
4.2 The use of plant resources	[J.A. Juanes]	434
4.2.1 The seaweed larder		434
Gastronomic and nutritional value		434
Husbandry uses		435
Industrial uses		436
The cultivation of algae and cyanobacteria		438

4.2.2	Reedbeds and marshland cultivation	440
	Harvesting without planting	440
	Beach and marsh cultivation	442
	• Fields of salt	[R. Folch] 444
4.3	The use of animal resources	[X. Ferrer and A. de Sostoa] 449
4.3.1	Hunting	449
	Hunting for food	449
	Skins, furs, and feathers	450
	The collection of eggs	451
4.3.2	Fishing and shellfish gathering	452
	The exploitation of rocky coasts	452
	The exploitation of deltas and estuaries	452
	The exploitation of tropical lagoons and mangrove swamps	454
4.3.3	Stock-raising and aquaculture	455
	Mariculture	455
	Stock-raising in marshes	456
4.3.4	Zoological tourism	457
	Mad about birds	457
	• Caviar	[R. Folch] 458
	Watching larger animals	462
4.4	Management conflicts and environmental problems	[J.M. Camarasa, H.F. Saeijs, P. Moreno and J.M. Gili] 463
4.4.1	Human pressure and pollution	[J.M. Camarasa, P. Moreno and J.M. Gili] 463
	Excessive demographic concentration	463
	The eutrophication of coastal waters	464
	The loss of the mangrove swamps	464
4.4.2	Wetland drainage and silting up: the case of the Netherlands	[J.M. Camarasa and H.F. Saeijs] 466
	The Zuiderzee Project	466
	The Deltaplan Project	468
	The lessons from this experience	472
5.	Protected areas and biosphere reserves in the littoral zone	[J.M. Camarasa, J. Harrison, D. Gordon and C. Sharpe] 475
5.1	Protected coastal systems	[J.M. Camarasa and J. Harrison] 477
5.1.1	The historical process of protection of coastal zones	477
	The protection of wetlands	477
	Protection of rocky coasts	480
5.1.2	International cooperation	480
5.2	Coastal UNESCO MAB biosphere reserves	481
5.2.1	General considerations	[D. Gordon] 481
	Natural values and conditioning factors	481
	Management problems	482
5.2.2	Biosphere reserves affected relatively little by humans	[C. Sharpe] 482
	The Sian Ka'an Biosphere Reserve	482
	The Bañados del Este Biosphere Reserve	488
	The case of the Doñana Biosphere Reserve	491
5.2.3	Biosphere reserves greatly modified by human action	[C. Sharpe] 496
	The case of the Wadden Sea Biosphere Reserve	496
	Bibliography	505
	Indexes	509
	Species' index	510
	Thematic index	519