Rivista Italiana di Paleontologia e Stratigrafia	volume 103	numero 1	pagine 3-14	Aprile 1997

ENVIRONMENTAL EVOLUTION OF THE LONGARINI AND CUBA LAGOONS (SOUTHEASTERN SICILY)

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Key-words: Lagoonal environment, Paleoecology, Italy, Southeastern Sicily.

Riassunto. I pantani Longarini e Cuba rappresentano le maggiori superfici umide del sistema retrostante la Costa dell'Ambra nella Sicilia sudorientale: la loro evoluzione è stata ricostruita mediante lo studio comparato delle caratteristiche tessiturali, composizionali e faunistiche dei sedimenti, evidenziando facies lagunari a diverso grado di "confinamento". I piani più antichi sono caratterizzati da un ambiente lagunare con sedimenti prevalentemente pelitici e con associazioni faunistiche riconducibili alla zonazione biologica proposta per gli ambienti paralici attuali da Guelorget & Perthuisot (1983). Nei piani più recenti si ha un'accentuazione delle caratteristiche lagunari, legata anche alla maggiore influenza degli apporti solidi provenienti dal retrostante bacino idrografico.

Abstract. The Longarini and Cuba lagoons are the largest wetlands in a system of lagoons located inland of the Ambra Coast in southeastern Sicily. A reconstruction of their evolution through a comparative study of textural, compositional and faunal data, showed facies of a lagoonal system influenced differently and in varying degrees by rivers and sea. The oldest layers are made of lagoonal pelitic sediments containing faunal assemblages (mixed biocenoses) referable to the zonal classification of the paralic environment proposed by Guelorget & Perthuisot (1983). In the more recent layers an environmental change is recorded, showing an increase in lagoonal characteristics and a decrease in "mixed" biocenoses, due to a greater input of solid materials from the adjacent hydrographic basin.

Introduction.

Research on the Sicilian paralic environments has been conducted since 1991 (Amore et al. 1991, 1994). The present study focuses on the lagoons of the Ambra coast between the towns of Pachino and Ispica.

The coastal lagoons of southeastern Sicily represent an important element from a social and naturalistic asset. They are located adjacent to a densely populated area rich in tourist facilities and are surrounded by vineyards and vegetable gardens. In particular, together with the nearby Vendicari lagoons, they provide a regular stopping-place for birds migrating from northern Europe to north Africa.

Only the Longarini and Cuba lagoons have been studied among the many wetlands ("Pantani") developed along the Ambra coast (Fig. 1). The Longarini lagoon (3 km^2 surface and 20 cm deep) communicates with the sea through two partially occluded artificial canals. The Cuba lagoon (0.7 km^2 surface and 1 m deep) is completely separated from the sea by a 5 m high ridge of dunes. The two lagoons are located on the southeastern edge of the Hyblean calcareous plateau.

The hydrographic basins of the Longarini and Cuba lagoons encompass the following Miocene-Quaternary formations: Middle-Upper Miocene marls of the Tellaro Formation, the Lower Pliocene marls of Trubi, calcarenites, Middle Pliocene calcirudites and marls, Lower Pleistocene calcarenites and sands, Middle-Upper Pleistocene sands, biocalcarenites and conglomerates, and Holocene fluvial, marsh and coastal deposits.

As a consequence, the solid input (Fig. 2) consists of: 1) pelitic granulometries due to predominantly marly-muddy deposits of Middle-Upper Miocene (Tellaro Formation), of Lower Pliocene (Trubi) and of Middle Pliocene, and holocenic alluvial sediments, and 2) sandy-ruditic granulometries due to alternations of Lower-Pleistocene calcarenites-sands and middle to Upper Pleistocene sands-calcarenites and conglomerates.

The solid input occurs prevalently during the autumnal-winter rains, following the hot dry mediterranean summers. In this area, winds blow from the West and North-East; and the mean air temperatures range from 12°C in January and December to 26°C in July and August. The mean annual precipitation averages 385 mm, ranging from as little as 0 mm per month from June to August to as much as 60 mm per month from October to January (Istat, 1988), with consequent seasonal variations of water levels in the lagoons.

The hydrological characteristics of the water reflect the predominant carbonate composition of the

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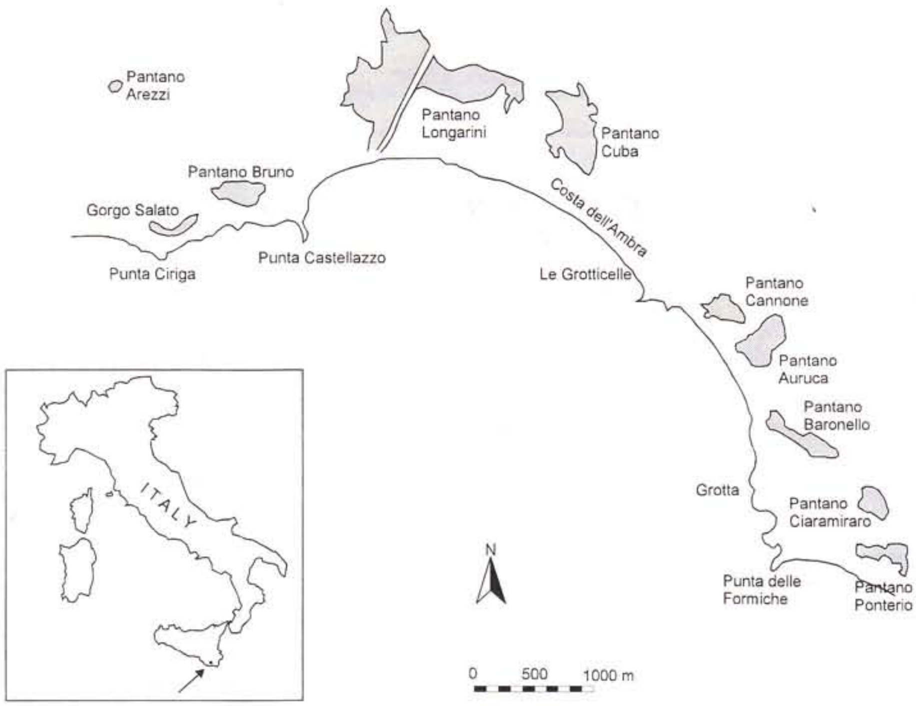


Fig. 1 - The lagoonal system of southeastern Sicily.

rocks exposed in the hydrographic basins: the *ph* is basic and the total salinity ranges between 7‰ in December and 189‰ in August, strictly related to rainfall and evaporation.

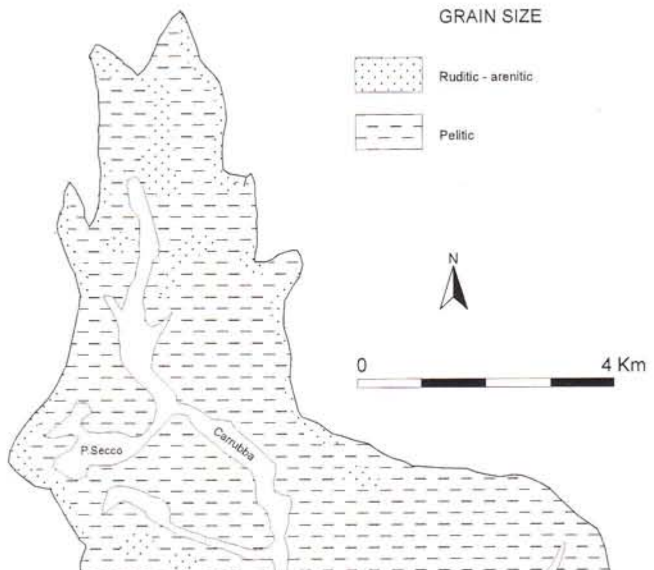


Fig. 2 - Solid inputs of the hydrographic basin.

Superficial samples (111) and cores (57) about 1 m deep were taken in spring 1994. On the basis of both sedimentological and faunal characteristics, and markers containing particular organic components connected with different sedimentary-environmental phases, four layers were identified at the following depths from the surface: -120/-100, -90/-80, -60/-40 and -10/0 cm.

To establish the evolution of these two lagoons, the lithology of the hydrographic basin, including grain texture and morphoscopy, were considered following the models and techniques proposed by Amore & Randazzo (1996), Amore et al. (1994), Randazzo (1991), Randazzo & Stanley (1992). In addition, the sandy fraction was analysed for its mineralogical, faunal and floral composition.

Variations of the faunal assemblage were defined in volumetric samples (250 cc) taken from 11 cores recovered from the two lagoons.

An ecologic horizontal zonation of the benthic mollusc assemblages in the different areas was identified (Kinne & Pérès, 1982). It is controlled by several environmental factors (nature of the substrate, water mass movement) that depend on sea-water trophic inputs from the pelagic areas. This zonation was compared with the "confinement" theory proposed for paralic environments by Guelorget & Perthuisot (1983).

Pantano Longarini.

The study documents the progressive isolation of the lagoons, represented by four easily recognizable layers (Fig. 3-4).

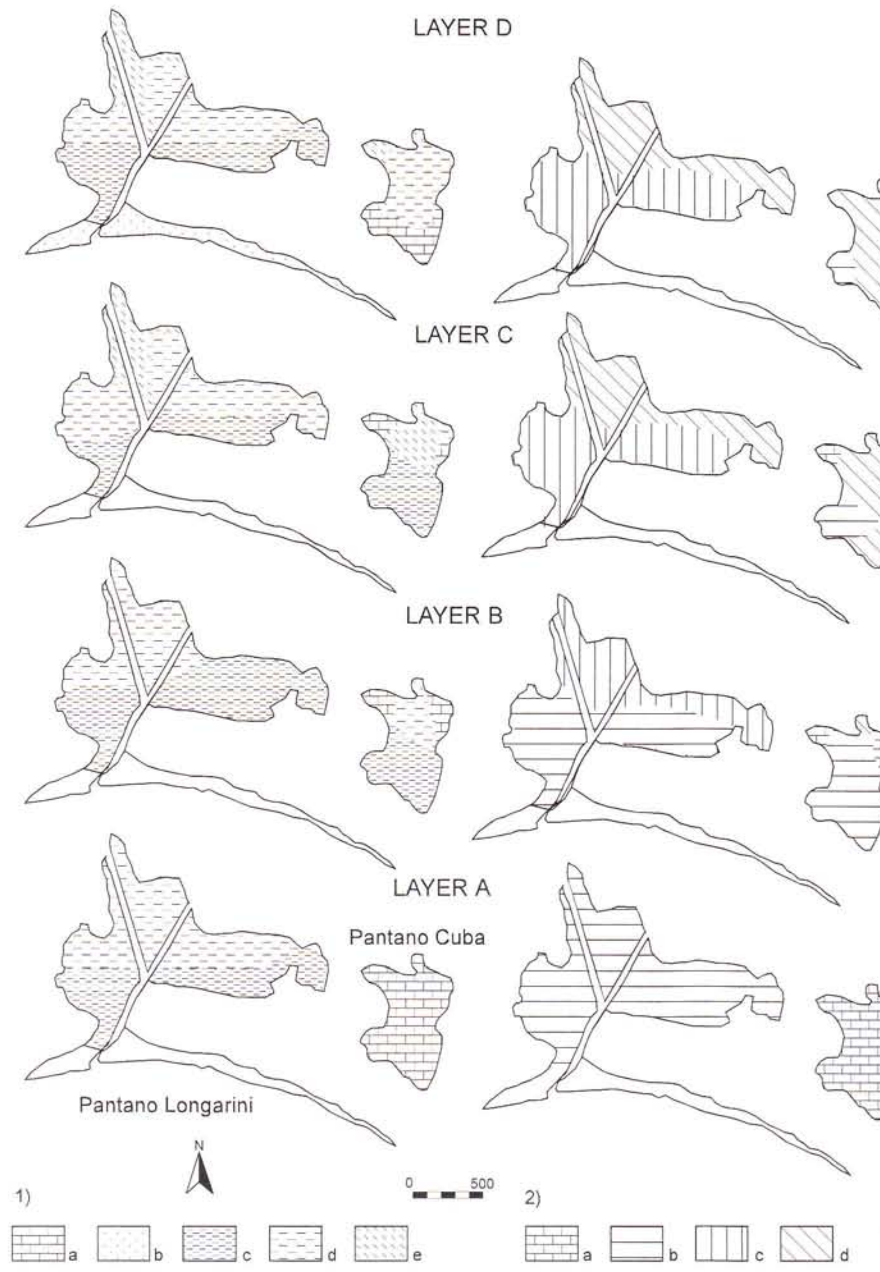


Fig. 3 - Grain-size of sediments and horizontal zonation of faunal assemblages. 1) Grain size distributions of sediments: a=substrate; b=well sorted fine and very fine sand; c=poorly sorted very fine sand, with mud; d=poorly sorted silt with clay and sand; e=poorly sorted clay with silt and sand; 2) Horizontal zonation of faunal assemblage: a=substrate; b=Zone III-IV; c=Zone IV; d=Zone IV-V.

Layer A is characterized by poorly sorted, fine to very fine sands with finely skewed distributions in the southern sector and by poorly sorted silts in the northern sector. Furthermore, in the southern sector a parallel or slightly oblique lamination is present, typical of facies originating in lagoonal and back-dune areas. Among the inorganic components, the carbonate grains always represent less than 45%, while quartz clasts account for more than 50% of the total and are more frequent in the eastern sector. This distribution conforms to the eolic nature of the lagoonal edge sediments, as quartz grains are of allocton origin when compared to the rocks of the hydrographic basin (Amore & Randazzo, 1996).

Compositional and textural elements present in this layer correspond to the sedimentologic characteristics of the lagoonal facies recognized in the Manzala lagoon in Egypt by Randazzo & Stanley (1992) and Randazzo (1992). The sedimentation pattern shows a meteo-marine dominance in the sector most proximal to the sea, indicated by a large amount of well-sorted quartz sands (eolian coastal sands facies). Poorly sorted silts, rich in carbonates eroded from the hydrographic basin, are prevalent in the most internal sector (silty sands facies of the central lagoon, influenced by rivers).

Within layer A, the mollusc assemblage is characterized by a relative abundance of characteristic species, exclusive to the biocenotic stock of eurythermal and euryhaline lagoons LEE (Pérès, 1967), ranging from 77% to 83% (Tables 1-3). The stock of the biocenosis of superficial muddy sands in sheltered SVMC areas (Pérès, 1967) constitutes a lower percentage, ranging between 9% and 14%. The biocoenotic stocks related to the ma-

	Layer A				Layer B						Layer C						Layer D			
	III-IV			III-IV			IV			IV			IV-V			IV			IV-V	
Samples	**18A**	**23A**	**18B**	**21B**	**23B**	**9B**	**25B**	**3B**	**18C**	**21C**	**23C**	**9C**	**25C**	**3C**	**18D**	**21D**	**23D**	**9D**	**25D**	**3D**
LDL																				
Truncatella subcylindrica (Linneo)		1																		
LEE																				
Hydrobia ventrosa (Montagu)	426	621	311	529	495	145	160	132	35	55	59	126	123	111	36	78	59	303	695	159
Cerastoderma glaucum (Poiret)	176	363	469	403	355	122	129	28	64	126	70	27	35	42	6	52	71		23	29
Abra ovata (Philippi)													15		2		1			
Mytilaster marioni (Locard)	2	4	7							1						2				
SVMC																				
Loripes lacteus (Linneo)	54	140	78		138	4		3		5	11	1	4		1	13	4			
Cerithium vulgatum (Bruguière)	7	24	34	11	3				1							2				
Pirenella conica (Blainville)	2	19	2	1	8											1				
Venerupis aurea (Gmelin)	1	1		1																
Nassarius corniculus (Olivi)	1	1														1				
SFBC																				
Venus gallina Linneo		4	7	1			2				2									
Donax venustus Poli	7	4	4	3		2	1				8	1								
Cylicnina umbilicata (Montagu)	1		1		1															
Glycymeris violacescens (Lamarck)		1	1	1																
Divaricella divaricata (Linneo)	1																			
Tellina nitida Poli	1																			
AP																				
Tornus subcarinatus (Montagu)				1																
Musculus costulatus (Risso)	1																			
Gibbula turbinoides (Deshayes)	1	1																		
AP - HP																				
Pusillina radiata (Philippi)		2		1																
Pusillina dolium (Nyst)		1																		
Rissoa similis Scacchi	3	4	4	2	8				2						1	1				
Rissoa auriscalpium Linneo		1			2															
Rissoa ventricosa Desmarest		1																		
Alvania lineata Risso	1	1																		
Tricolia tenuis (Michaud)	1	2																		
Tricolia speciosa (von Muhlfeldt)		1																		
Jujubinus striatus (Linneo)					1															
Smaragdia viridis (Linneo)		2																		
DC																				
Pitar rudis (Poli)									1											
DC - DE																				
Timoclea ovata (Pennant)		1																		
lre																				
Striarca lactea (Linneo)				1																
Bittium lacteum (Philippi)	3			5																
Bittium reticulatum (Da Costa)	30	74	31	48	30	2	2	3	3	1	1				1	4				
Rhyzorus acuminatus (Bruguière)				1																
sspr																				
Alvania cancellata (Da Costa)		3			1															
Lunatia sp.	1																			
Chrysallida sp.																1				
Totals	720	1277	1042	1009	1042	949	293	167	106	188	151	155	177	153	47	156	135	303	718	188

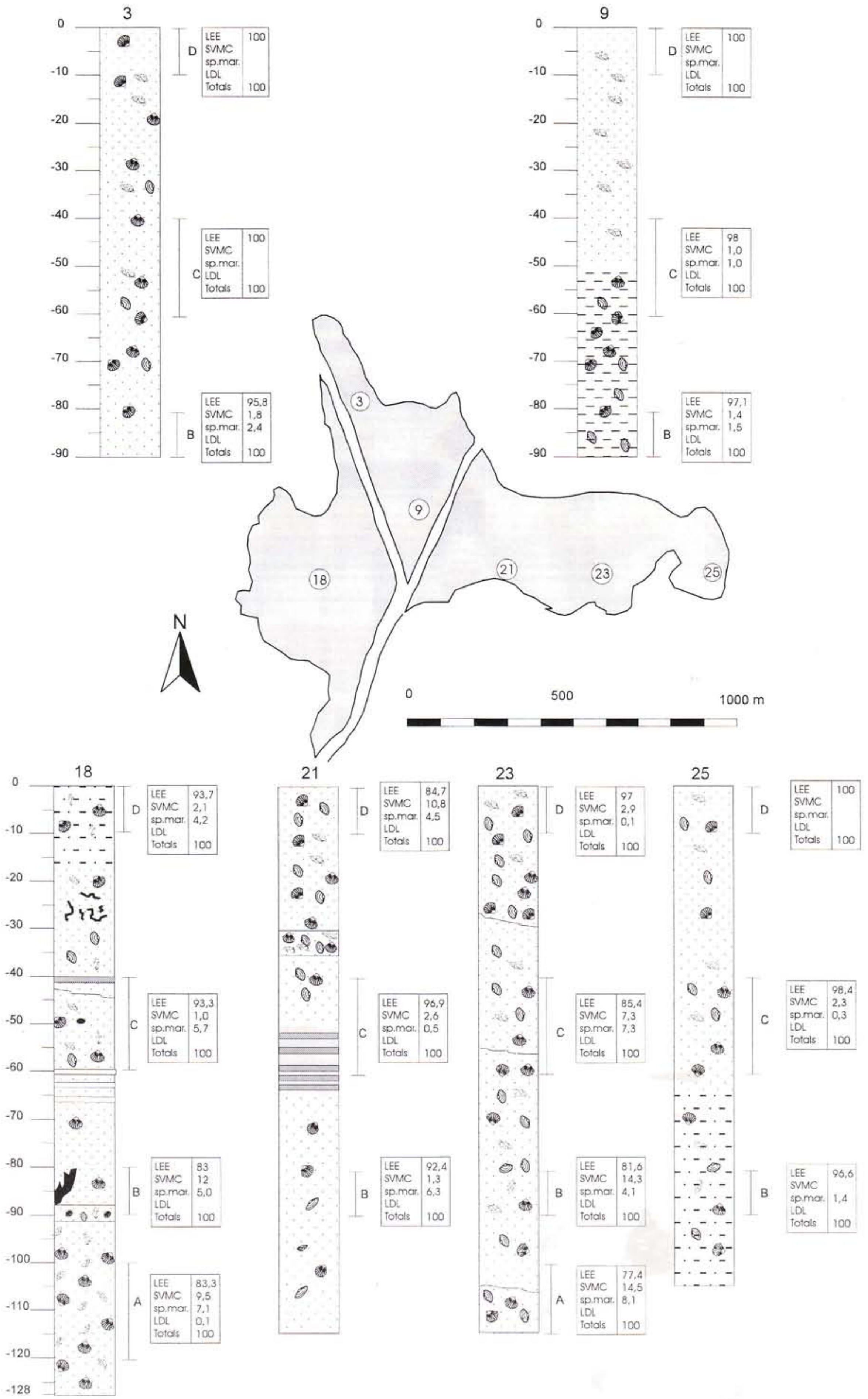
Tab. 1 - Bionomic distribution and abundance of the molluscs species in the volumetric samples of the Pantano Longarini; biocoenosis nomenclature after Pérès & Picard (1964) and Pérès (1967): LDL=Biocoenosis of the slowly-drying wracks; LEE=Euryhaline and eurythermal biocoenosis in brackish waters; SVMC = Biocoenosis of the superficial muddy sands in sheltered areas; SFBC=Biocoenosis of fine well-sorted sands; AP=Biocoenosis of photophilic algae; HP=Biocoenosis of Posidonia meadows; DC=Biocoenosis of the muddy detritic bottoms; Lre=species with wide ecological distribution; Sspr.=species without a definite ecological significance.

rine environment, such as those of fine well-sorted sands (SFBC), photophilic algae (AP) and *Posidonia* meadows (HP) are scarce (1%). It is worth mentioning the presence of a high number of adult specimens of *Hydrobia ventrosa*, a small grazing gastropod typical of lagoons with vegetation growing on soft bottoms and limited direct contact with the sea (Graham, 1988). In contrast, *Cerastoderma glaucum* is mostly represented by juvenile specimens. This setting, characterized by low diversity and very low equitability is favored by opportunistic species with an *r-selected* life strategy (Dodd & Stanton, 1981).

The presence of marine and stenohaline organisms (sponge spicules, littoral benthic and planktonic foraminifera, echinoderm fragments and *Posidonia* leaves) is probably due to occasional storms.

Following the model of Guelorget & Perthuisot (1983), this lagoonal assemblage can be related to "confinement" zone III/IV.

Fig. 4 - Core logs of lithological and faunal characteristics of P. Longarini.


3
9
18
21
23
25
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-128
A
B
C
D
LEE
SVMC
sp.mar.
LDL
Totals
N
0
500
1000 m

	Layer A				Layer B						Layer C						Layer D			
	III-	IV		III-IV			IV			IV			IV-V			IV			IV-V	
Samples	**18A**	**23A**	**18B**	**21B**	**23B**	**9B**	**25B**	**3B**	**18C**	**21C**	**23C**	**9C**	**25C**	**3C**	**18D**	**21D**	**23D**	**9D**	**25D**	**3D**
LDL																				
Truncatella subcylindrica (Linneo)		0.1																		
LEE																				
Hydrobia ventrosa (Montagu)	58.8	49.4	32.8	52.4	47.5	52.7	54.6	79.0	33.0	29.3	39.1	81.3	69.5	72.5	76.6	50.3	43.7	100	96.8	84.6
Cerastoderma glaucum (Poiret)	24.4	27.7	49.5	40.0	34.0	44.4	44.0	16.8	60.3	67.0	46.4	17.5	19.8	27.5	12.8	33.6	52.6		3.2	15.4
Abra ovata (Philippi)													8.5		4.3		0.7			
Mytilaster marioni (Locard)	0.3	0.3	0.7							0.5						1.3				
SVMC																				
Loripes lacteus (Linneo)	7.6	10.9	8.2		13.2	1.5		1.8		2.7	7.3	0.6	2.2		2.1	8.4	3.0			
Cerithium vulgatum (Bruguière)	0.9	1.8	3.6	1.1	0.3				1.0							1.3				
Pirenella conica (Blainville)	1.0	1.4	0.2	0.1	0.8											0.6				
Venerupis aurea (Gmelin)	0.1	0.1		0.1																
Nassarius corniculus (Olivi)	0.1	0.1														0.6				
SFBC																				
Venus gallina Linneo		0.3	0.7	0.1		0.7	0.7				1.3									
Donax venustus Poli	1.0	0.3	0.4	0.3				0.6			5.3	0.6								
Cylicnina umbilicata (Montagu)	0.1		0.1		0.1															
Glycymeris violacescens (Lamarck)		0.1	0.1	0.1																
Divaricella divaricata (Linneo)	0.1																			
Tellina nitida Poli	0.1																			
AP																				
Tornus subcarinatus (Montagu)				0.1																
Musculus costulatus (Risso)	0.1																			
Gibbula turbinoides (Deshayes)	0.1																			
AP - HP																				
Pusillina radiata (Philippi)		0.1		0.1																
Pusillina dolium (Nyst)		0.1																		
Rissoa similis Scacchi	0.4	0.3	0.4	0.2	0.8				1.9						2.1	0.6				
Rissoa auriscalpium Linneo		0.1			0.2															
Rissoa ventricosa Desmarest		0.1																		
Alvania lineata Risso	0.1	0.1																		
Tricolia tenuis (Michaud)	0.1	0.2																		
Tricolia speciosa (von Muhfeldt)		0.1																		
Jujubinus striatus (Linneo)		0.2			0.1															
Smaragdia viridis (Linneo)		0.1																		
DC																				
Pitar rudis (Poli)									1.0											
DC - DE																				
Timoclea ovata (Pennant)		0.1																		
lre																				
Striarca lactea (Linneo)				0.1																
Bittium lacteum (Philippi)	0.4			0.5																
Bittium reticulatum (Da Costa)	4.2	5.8	3.3	4.7	2.9	0.7	0.7	1.8	2.8	0.5	0.6				2.1	2.6				
Rhyzorus acuminatus (Bruguière)				0.1																
sspr.																				
Alvania cancellata (Da Costa)		0.2			0.1															
Lunatia sp.	0.1																			
Chrysallida sp.																0.6				
Totals	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Tab. 2 - Bionomic distribution and relative abundance (%) of the molluscs species found in the volumetric samples of the Pantano Longarini.

Layer B is characterized by poorly sorted, fine to very fine sands with fine skewed distributions in the southern and central sectors and by poorly sorted silts in the northern sector. Sedimentary structures are not evident in this layer.

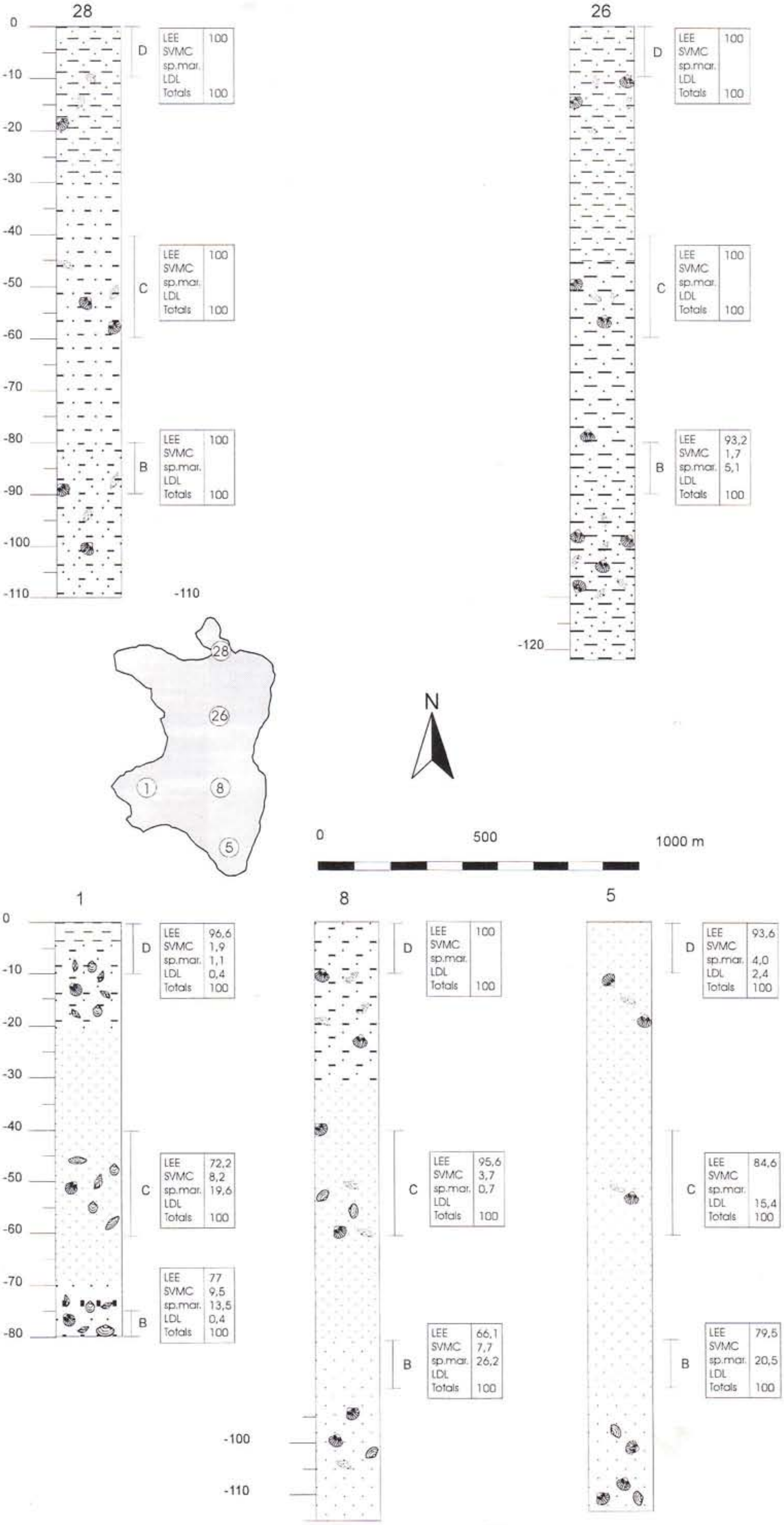
Quartz grains, mainly present in the southern sector, reach maximum values higher than 70%, while carbonate grains are always less than 30%. The more severely skewed distribution of the sands, absence of sedimentary structures and dominance of quartz, together with high percentages of carbonates,suggest a higher degree of isolation than underlying layer A. This hypothesis is confirmed by the distribution of the faunal assemblage (Tables 1-3) that shows a further decrease in mollusc abundance in the more southern sector.

Marine and "mixed" species (*sensu* Guelorget & Perthuisot, 1983) are much less frequent and the relative abundance of typical LEE species, always more than 82%, is increasing. This dominance could be related to zone IV of Guelorget & Perthuisot (1983). This interpretation is fully confirmed by the presence of *Ammonia beccarii tepida*, a typical lagoonal species, and the presence of *oogonia* of Characeae.

It is noteworthy that the marine species are more abundant in the southern than in the northern sector.

It is difficult to establish whether the rare specimens of the SVMC stock indicate a short episode of colonization or if, more probably, they are the result of *post-mortem* transport.

Fig. 5 - Core logs of lithological and faunal characteristics of P. Cuba.


28
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
D
LEE 100
SVMC
sp.mar.
LDL
Totals 100
C
LEE 100
SVMC
sp.mar.
LDL
Totals 100
B
LEE 100
SVMC
sp.mar.
LDL
Totals 100
-110
26
D
LEE 100
SVMC
sp.mar.
LDL
Totals 100
C
LEE 100
SVMC
sp.mar.
LDL
Totals 100
B
LEE 93,2
SVMC 1,7
sp.mar. 5,1
LDL
Totals 100
-120
28
26
1
8
5
N
0
500
1000 m
1
0
-10
-20
-30
-40
-50
-60
-70
-80
D
LEE 96,6
SVMC 1,9
sp.mar. 1,1
LDL 0,4
Totals 100
C
LEE 72,2
SVMC 8,2
sp.mar. 19,6
LDL
Totals 100
B
LEE 77
SVMC 9,5
sp.mar. 13,5
LDL 0,4
Totals 100
8
D
LEE 100
SVMC
sp.mar.
LDL
Totals 100
C
LEE 95,6
SVMC 3,7
sp.mar. 0,7
LDL
Totals 100
B
LEE 66,1
SVMC 7,7
sp.mar. 26,2
LDL
Totals 100
-100
-110
5
D
LEE 93,6
SVMC
sp.mar. 4,0
LDL 2,4
Totals 100
C
LEE 84,6
SVMC
sp.mar.
LDL 15,4
Totals 100
B
LEE 79,5
SVMC
sp.mar. 20,5
LDL
Totals 100

	Layer	A			Layer B						Layer C						Layer D			
	III -	IV		III-IV			IV			IV			V			IV			V	
Samples	18A	23A	18B	21B	23B	9B	25B	3B	18C	21C	23C	9C	25C	3C	18D	21D	23D	9D	25D	3D
LDL		0.1																		
LEE	83.5	77.4	83.0	92.4	81.6	97.1	98.6	95.8	93.3	96.8	85.5	98.8	97.8	100	93.7	85.2	97.0	100	100	100
SVMC	9.7	14.3	12.0	1.3	14.3	1.5		1.8	1.0	2.7	7.3	0.6	2.2		2.1	10.9	3.0			
SFBC	1.3	0.7	1.3	0.5	0.1	0.73	0.7	0.6			6.3	0.6								
AP	0.2			0.1																
AP-HP	0.6	1.4	0.4	0.3	1.0				1.9						2.1	0.6				
DC									1.0											
DC-DE		0.1																		
Lre	4.6	5.8	3.3	5.4	2.9	0.7	0.7	1.8	2.8	0.5	0.6				2.1	2.6				
Sspr.	0.1	0.2			0.1											0.6				
Totals	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Tab. 3 - Composition and relative abundance (%) of the molluscs bionomic stocks found in the volumetric samples of the Pantano Longarini.

Layer C is characterized by poorly sorted, fine to very fine sands with fine skewed distributions along the southern border, by poorly sorted silts in the central sector and by poorly sorted muds with silts and sands in the very northern sector. Rare laminar structures are present.

Carbonate grains are uniformly distributed with percentages of nearly 40%, while quartz grains decrease to 50% in the southern and to 30% in the northern sectors, respectively, demonstrating a trend reversal, switching towards increasing solid input from the basin.

The marine mollusc taxa (Tables 1-3) disappear almost completely and the presence of characteristic lagoonal species confirms the further reduction of the exchange of water between the sea and the lagoon. Foraminifera are more abundant in the central and southern areas and *oogonia* of Characeae occur everywhere, indicating phases of decreased water salinity.

In conclusion, this situation is referable to zone IV of Guelorget & Perthuisot (1983) in the southernmost sector and to zones IV-V in the northernmost area.

Layer D represents the recent sediments and is characterized, like layer C, by poorly sorted, fine to very fine sands with fine skewed distributions along the southern border, by poorly sorted silts in the central sector and by poorly sorted muds with silts and sands in the very northern sector.

Carbonate grains are still present, in percentages decreasing from the northern to the southern sectors. Quartz grains are also present, with increasing percentages towards the southern edges.

Coastal sediments along the beaches bordering the lagoon on the seaward side are formed by well-sorted fine sands with coarse skewed distributions, completely different from those detected inside the lagoons providing evidence of an exclusively intraparalic lagoonal evolution.

The frequency ratio between *Hydrobia ventrosa* and *Cerastoderma glaucum* shows a direct correlation with the marine inputs: *Hydrobia ventrosa* is dominant in both the northern and western sectors, while *Cerastoderma glaucum* is dominant in the southernmost area. Consequently, we hypothesize that sporadic communication with the sea occurred in the central-southern sector. This hypothesis is fully confirmed by the presence, in this sector, of sporadic "mixed" species. The central-southern area is referred to zone IV of the model of Guelorget & Perthuisot (1983) and the other sectors are referred to zones IV-V (Tables 1-3).

Pantano Cuba.

Examination of sediments and fauna revealed three layers lying on a marly substrate cropping out along the banks from bottom to top (Fig. 3-5; Tab. 4-6).

Layer A is characterized by a marly substrate cropping out along the banks.This indicates that Pantano Cuba likely formed more recently than Pantano Longarini. The lagoon sedimentation facies, found in the upper layers, occurred probably as a result of a periodic flooding by rainfall of hydrographic network defining the basin.

Layer B is characterized by poorly sorted, fine and very fine sands with fine skewed distributions in the central-southern sector, by poorly sorted silts in the central-northern sector and by poorly sorted muds with silts and sands in the very northern sector.

Rare laminar structures are present. Carbonate grains amount to more than 60% in the northern sector with values decreasing to 10-25% in the southern sector, while quartz grains present an opposite trend, with percentages increasing towards the south.

The LEE biocenotic stock is dominant. The presence of sporadic specimens of "mixed" and marine spe-

	Layer B					Layer C					Layer D				
	III - IV				IV-V	III-IV	IV-V				III-IV	IV-V			
Samples	**1B**	**8B**	**5B**	**26B**	**28B**	**1C**	**8C**	**5C**	**26C**	**28C**	**1D**	**8D**	**5D**	**26D**	**28D**
LDL															
Truncatella subcylindrica (Linneo)								20					3		
Ovatella myosotis (Montagu)											1				
LEE															
Hydrobia ventrosa (Montagu)	54	35	36	307	198	55	78	59	344	441	159	113	65	352	552
Cerastoderma glaucum (Poiret)	59	51	53	126	130	104	53	51	112	107	102	71	51	101	115
Abra ovata (Philippi)				13											
SVMC															
Cerithium vulgatum (Bruguière)	9			7							1				
Loripes lacteus (Linneo)		10				15	5				3				
Venerupis aurea (Gmelin)	1														
Pirenella conica (Blainville)	4					3					1				
Nassarius corniculus (Olivi)				1											
SFHN															
Donax trunculus Linneo							1								
SFBC															
Donax venustus Poli		8	9			4									
Venus gallina (Linneo)		9				12									
AP-HP															
Pusillina radiata (Philippi)				1											
Rissoa similis Scacchi				9		12					1				
Rissoa auriscalpium (Linneo)			3												
Gibbula ardens (von Salis)			11	5											
Pseudochama griphyna Linneo	1														
DC - C															
Cerithiopsis tubercularis (Montagu)						1									
Lre															
Bittium reticulatum (Da Costa)	19	17		9		14					2				
Sspr.															
Vitreolina sp.													5		
Totals	147	130	112	478	328	220	137	130	456	548	270	184	124	453	667

Tab. 4 - Bionomic distribution and abundance of the molluscs species in the volumetric samples of the Pantano Cuba; biocoenosis nomenclature after Pérès & Picard (1964) and Pérès (1967): LDL=Biocoenosis of the slowly-drying wracks; LEE=Euryhaline and eurythermal biocoenosis in brackish waters; SVMC=Biocoenosis of the superficial muddy sands in sheltered areas; SFHN=Biocoenosis of the fine sands in very shallow waters; SFBC=Biocoenosis of fine well-sorted sands; AP=Biocoenosis of photophilic algae; HP=Biocoenosis of the *Posidonia* meadows; DC=Biocoenosis of the coastal detritic; C=Coralligenous biocoenosis; Lre=species with wide ecological distribution; Sspr.=species without a definite ecological significance.

cies (zone III/IV) may be noted in the whole area, with the exception of the northern sector, which is referred to zones IV-V of Guelorget & Perthuisot (1983). Therefore a direct marine interconnection is likely.

The occurrence of lagoonal ostracods, benthic foraminifera and *oogonia* of Characeae is rare.

The sedimentation facies differs from layer B in Pantano Longarini due to its distance from the sea which favours both the concentration of carbonate grains, and the high relative abundance of brackish water biocenoses. In conclusion, it is possible to assume that the Cuba lagoon only rarely came into contact with the sea and that flooding, probably only for more or less limited periods, allowed it to come into contact only with the nearby Longarini lagoon.

Layer C is characterized by poorly sorted, fine to very fine sands with fine skewed distributions in the central-southern sector, by poorly sorted silts in the northeastern sector and by poorly sorted muds with silts and sands in the northern belt.

Carbonate grains decrease from 60% in the northeastern sector to 15% in the southwestern sector; quartz grains have an opposite trend, with increasing values towards the southwestern sector, to a maximum of 65%.

Evidence of an expanding lagoonal environment is provided by the presence of a wider central and northern sector, in which only species characteristic of brackish water euryhaline and eurythermal biocenoses are present. These biocenoses are referable to zones IV/V by Guelorget & Perthuisot (1983), while the fauna in a small creek in the southern sector is still diversified and referable to zones III/IV.

Layer D represents the recent sediments and is characterized by poorly sorted, fine to very fine sands with fine skewed distributions in the very southern sector and by poorly sorted silts in the remaining part of the lagoon. The northwestern sector is an exception, and is characterized by poorly sorted muds with silts and sands.

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Received August 29, 1996; accepted February 27, 1997