

**FIP MEETING AT LISBON**

**GEOBOTANICAL JOURNEY**

**SKETCH OF THE VEGETATION AND LANDSCAPE**

**AT "TROIA" AND "SERRA DA ARRÁBIDA"**

**21/11/1999**

# **RÉUNION DE LA FIP À LISBONNE**

## **19 à 22 Novembre**

### **19 novembre 1999**

Arrivée des plusieurs présidents des différents associations de Phytosociologie.

20 h Réunion dans l'Hôtel Nacional, Rua Castilho 34, Lisbonne

21 h Dîner de travail

### **20 novembre 1999**

9 h Réunion de travail dans la salle du Conseil Scientifique du "Instituto Superior de Agronomia" à l'invitation du Vice-Président du Conseil Scientifique (Prof. Dra. Manuela Chaves), qui donnera les bienvenues au group de présidents. et début de la réunion.

11 - 11 h 15 Pause pour café

11 h 15 Continuation de la réunion de travail

13 h 30 Déjeuné

15 h Recommencement de la réunion de travail

17 - 17h 15 Pause pour café

18 h 30 Conclusions et fin de la réunion

20 h Dîner (dans un restaurant typique)

### **21 novembre 1999**

Excursion géobotanique à la Montagne d'Arrábida et aux dunes au sud de Tróia

8 h Sortie de l'Hôtel Nacional

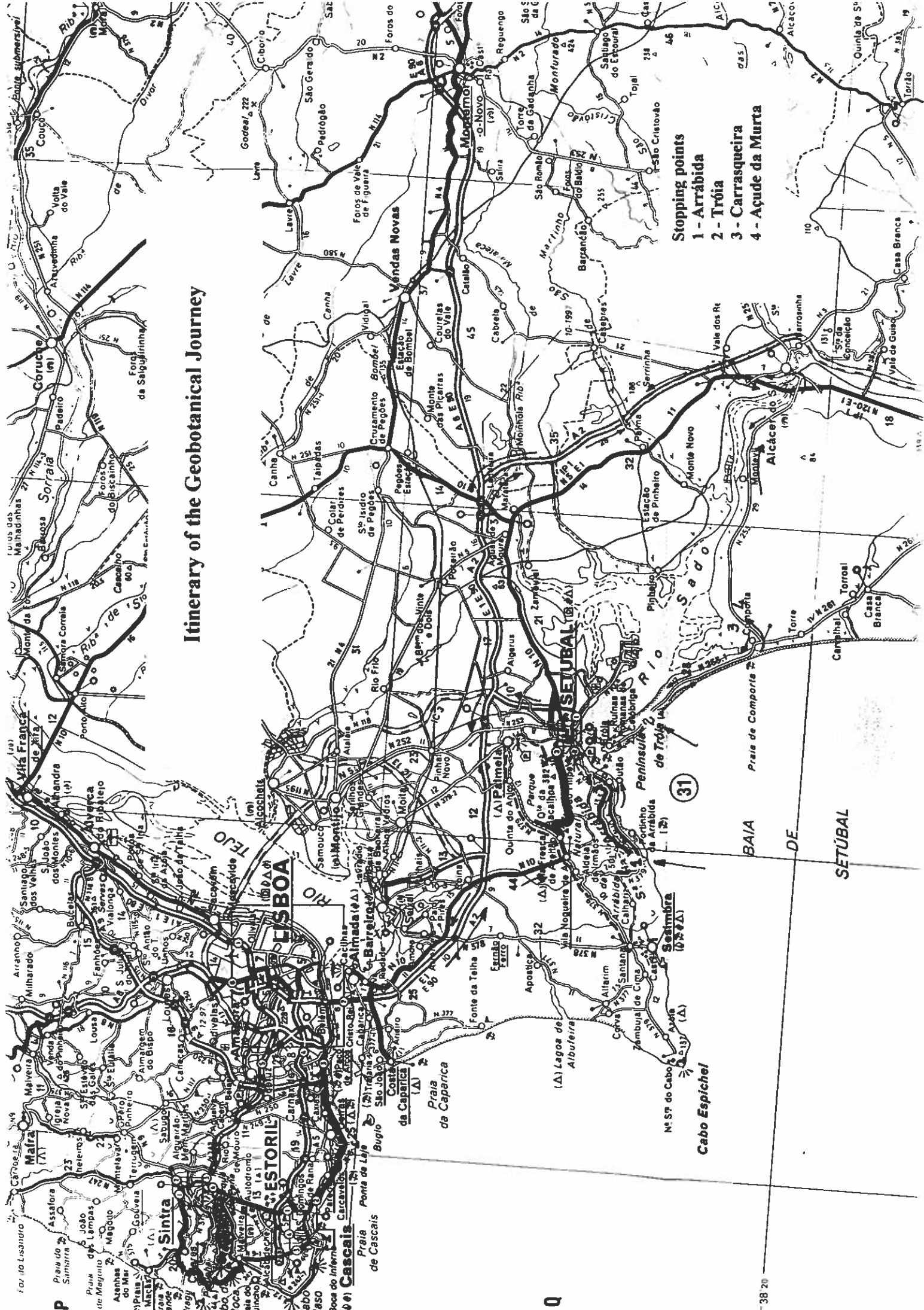
Itinéraire: Lisbonne - Pont 25 Avril - Autoroute vers le sud - Arrábida - Autoroute vers l'Algarve - Comporta - Tróia - Carrasqueira (Déjeuné - 13 h) - (Açude da Murta - Autoroute - Pont 25 Avril - Lisbonne)

14 h 30 -Retour à Lisbonne

16 h Arrivé à Lisbonne et nuit libre

### **22 novembre 1999**

Sortie des plusieurs participants pour leurs pays.



**Itinerary of the Geobotanical Journey**

- Stopping points**
- 1 - Arrábida
  - 2 - Tróia
  - 3 - Carrasqueira
  - 4 - Açude da Murta

## SKETCH OF THE VEGETATION AND LANDSCAPE AT “TROIA” AND “SERRA DA ARRÁBIDA”

José Carlos Costa\*, Jorge Capelo\*\*, Mário Lousã \* & Carlos Neto\*\*\*

\* Superior Institute of Agronomy. Technical University of Lisbon; \*\* National Forestry Research Station. National Institute of Agricultural Research.. Lisbon; \*\*\*Center of Geographical Studies. University of Lisbon.

\*, \*\* & \*\*\* Lusitanian Association of Phytosociology

### 1. The plant communities and landscape of “Serra da Arrábida”

The “Serra da Arrábida” is a small limestone outcrop, mostly of Jurassic origin, where the dominant soils are derived of hard calcium carbonate rocks some of with dolomitical character. It is placed on the thermomediterranean, upper sub-humid stage and biogeographically stands as a Superdistrict (Arrabidense) within the Tagano-Sadense Subsector. It shares a large proportion of its flora and vegetation with the larger calcareous unit –Portuguese divisory Sector - found north of the Tagus river.

Its vegetation has a relictual character due to the wealth of paleo-tropical and paleo-mediterranean *taxa* and vegetation structures still found there. Although similar to the limestone territories of Algarve, its higher precipitations allow the development of an original combination of vegetation series. The climatophyllous woodland vegetation is composed of micro-mesoforests dominated by tree-quermes oak - *Quercus coccifera* - , which in normal conditions never reaches the eight and physiognomy of a tree (here up to *ca.* 14 meters) – *Viburno tini-Quercetum cocciferae* (*Quercu-Oleion*, *Quercetalia ilicis*, *Quercetea ilicis*). This special feature lead some authors to admit the possibility that a taxon distinct of *Quercus coccifera* L. should be considered for these tree-kermes oaks. This woodlands occupy the mid-slope in well drained deep soils in the valleys of Arrábida. The existence of these tree-quermes oak woodlands is due to the rate Ca/Mg be low and the excess of magnesium in the soil be damaging for *Quercus rotundifolia*. The *Cheirolophus sempervirens* clearing community (*Leucanthemo sylvatici-Cheirolophetum sempervirentis*, *Trifolio-Geranietea*) is also a striking feature of these forest ecosystems.

Its substitution stage is an *Arbutus unedo-Quercus coccifera* community which in its primary positions can be considered as *Phillyreo angustifoliae-Arbutetum unedonis viburnetosum tini* variant of *Coronilla valentina* subsp. *glauca*.

Nevertheless, some parts of the valleys are covered with a secondary forest, which can be ascribed to the later association, but on which *Quercus coccifera* is co-dominant and even some plants of *Juniperus turbinata* subsp. *turbinata* can be found. As a second substitution stage the *Cistus albidus* dominated community *Phlomidio purpureae-Cistetum albidi* is found within the scope of this series. It's a low-scrub community found in deep clay-rich soils that suffered erosion of its top horizons.

In the bottom of valleys, where an intermitent stream is found during the winter months, deep clay-rich soils are exposed to a temporary water-table which compensates slightly the summer drought. In these partially edaphohigrophyllous biotopes another forest community is found: *Arisaro clusii-Querceto broteroi* , where the beech-oak –*Quercus faginea* subsp. *broteroi* is dominant. Normally a mesophytic

### PICTURE 23

Locality: Mata do Solitário, Serra da Arrábida. Portugal.

Altitude: 180 m

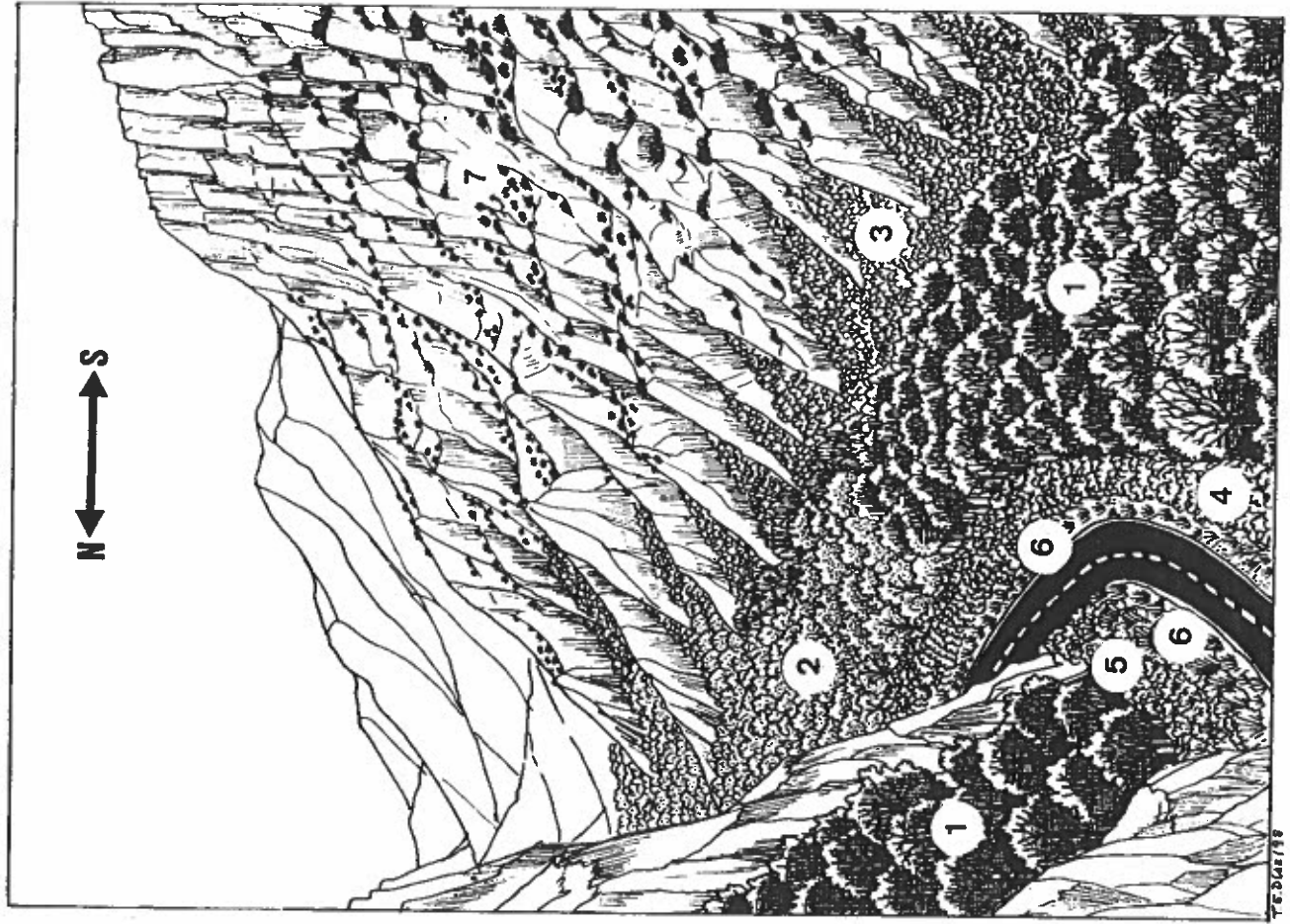
Date: 17-VII-1999

Biogeography: Superdisitrito Arrabidense superdistrict; Sadense sector

Bioclimatic belt: Thermomediterranean, upper subhumid to humid

Lithology: Limestone-Dolomite; soil with forestal mull (chromic luvisol).

1. Arboreal coscojar (*Viburno tini-Quercetum cocciferae*).
2. Quejigar of depressions (*Arisaro-Quercetum broteroi*).
3. Arbutus shrubland (*Phillyreo-Arbutetum*).
4. Mesophytic Arbutus shrubland with *Bupleurum fruticosum* (*Phillyreo-Arbutetum*).
5. Xerophytic Arbutus shrubland with *Coronilla glauca* (*Phillyreo-Arbutetum*).
6. Community of *Cheirolophus sempervirens*.
7. Juniper woodland (*Quercococciferae-Juniperetum turbinatae jasminetosum fruticantis*).



## PICTURE 24

Locality: Mata do Solitário, Serra da Arrábida, Portugal.

Altitude: 180 m

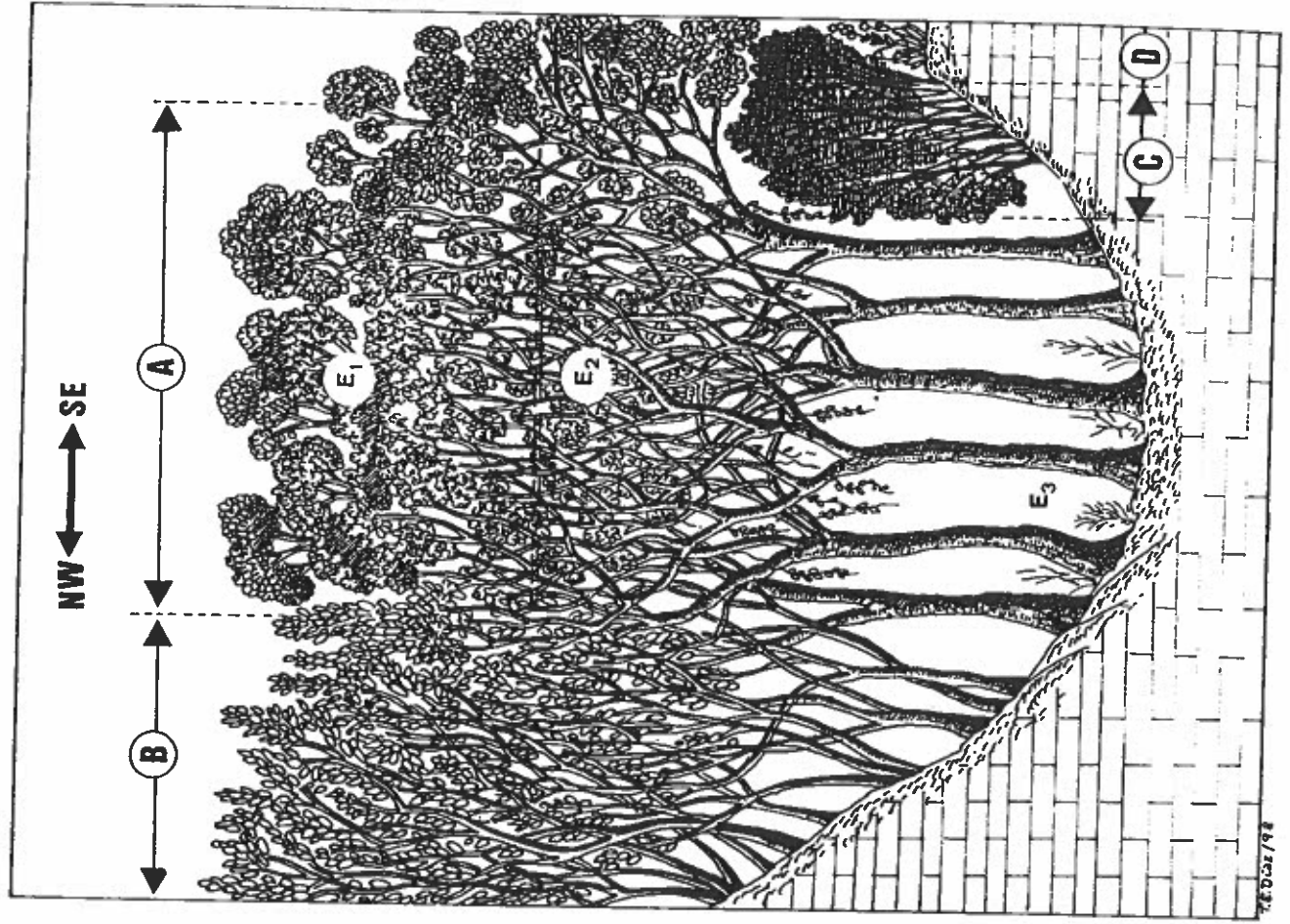
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- A. Arboreal coscojar (*Viburno ini-Quercetum cocciferae*).  
 B. Arbutus shrubland (*Phillyreo-Arbutetum*).  
 C. Mesophytic Arbutus shrubland with *Bupleurum fruticosum*.  
 D. Herbaceous community of *Cheirolophus sempervirens* (*Origanion virentis*).  
 E<sub>1</sub>: *Quercus coccifera*, *Olea europaea* var. *sylvestris*, *Phillyrea latifolia* subsp. *media*, *Ceratonia siliqua*.  
 E<sub>2</sub>: *Arbutus unedo*, *Pistacia lentiscus*, *Viburnum tinus*, *Myrtus communis*, *Sorbus domestica*, *Smilax aspera* var. *altissima*, *Rubia peregriana*, *Rosa sempervirens*, *Tamus communis*.  
 E<sub>3</sub>: *Asplenium obovatis*, *Lonicera implexa*, *Erica arborea*, *Crataegus monogyna*, *Arisarum vulgare*, *Rhamnus oleoides*, *Coronilla glauca*.



Synthetic table of Arrabida Communities

	A	B	C	D	E	F	G	H	I	J
<i>Quercus coccifera</i> (tree)	V									
<i>Bupleurum fruticosum</i>	III			X						
<i>Gemmaria diphylla</i>	+	I							X	
<i>Osyris quadripartita</i>	+	I								
<i>Rhamnus oleoides</i>	+	V		X			III			
<i>Viburnum tinus</i>	V		V	X						
<i>Asplenium onopteris</i>	IV		IV							
<i>Deschampsia stricta</i>	III		I							
<i>Erica arborea</i>	+		III	X						
<i>Paeonia broteroi</i>	+		II							
<i>Pistacia lentiscus</i>	V	V	III	X			II			
<i>Smilax aspera</i> var. <i>nigra</i>	V	III	V	X			II			
<i>Arisarum vulgare</i> var. <i>clusii</i>	V	IV	V	X	X	X			X	
<i>Arbutus unedo</i>	V	III	IV	X						
<i>Phillyrea latifolia</i>	V	II	III							
<i>Ruscus aculeatus</i>	V	II	V	X						
<i>Rubia peregrina</i> var. <i>longifolia</i>	IV	III	IV	X			II			
<i>Phillyrea media</i>	IV	III	III	X						
<i>Hyacinthoides hispanica</i>	III	I	III						X	
<i>Olea europaea</i> var. <i>sylvestris</i>	III	IV	I				I			
<i>Myrtus communis</i>	II	II	II	X						
<i>Coronilla glauca</i>	II	+	II	X						
<i>Lonicera implexa</i>	I	V	II	X			I			
<i>Phillyrea angustifolia</i>	I	IV	II	X			I			
<i>Carex distachya</i>	I	III	IV							
<i>Daphne gnidium</i>	+	II	II	X		X	V			
<i>Asparagus aphyllus</i>	+	I	I	X			IV	X		
<i>Vinca difformis</i>	II	I	III		X					
<i>Jasminum fruticans</i>	+	IV	II	X						
<i>Rhamnus alaternus</i>	+	I	I	X						
<i>Quercus coccifera</i>	III	V	III	X		X	II			
<i>Juniperus turbinata</i>		V		X			II			
<i>Ceratonia siliqua</i>		III								
<i>Asparagus albus</i>		II								
<i>Anemone palmata</i>		II	I	X		X				
<i>Bupleurum rigidum</i> ssp. <i>paniculatum</i>		I	II	X			IV	X		
<i>Asparagus acutifolius</i>		+	I							
<i>Euphorbia characias</i>		+	II							
<i>Quercus faginea</i> ssp. <i>broteroi</i>	I		V	X						
<i>Lonicera etrusca</i>			III	X						
<i>Genista tournefortii</i>			III				II			
<i>Acer monspessulanum</i>			I							
<i>Selaginella denticulata</i>			III							
<i>Laurus nobilis</i>			II							
<i>Cephalanthera longifolia</i>			I							
<i>Melica arrecta</i>			I							
<i>Cheirolophus sempervirens</i>			II		X					
<i>Origanum virens</i>			II		X			X		
<i>Geranium purpureum</i>	I	I	IV	X	X					
<i>Teucrium scorodonia</i>	I		III	X	X					
<i>Calamintha baetica</i>			III	X	X					
<i>Brachypodium sylvaticum</i>			III		X					
<i>Picris spinifera</i>					X					
<i>Campannula rapunculus</i>					X					
<i>Clinopodium vulgare</i> ssp. <i>arundanum</i>					X			X		
<i>Stachys germanica</i> ssp. <i>lusitanica</i>					X					
<i>Sedum forsteranum</i>					X					
<i>Silene latifolia</i>					X					
<i>Agrimonia eupatoria</i>		I			X					
<i>Rubus ulmifolius</i>	IV		V	X						
<i>Tamus communis</i>	IV		IV	X						
<i>Aristolochia paucimervis</i>		I	I							
<i>Lonicera periclymenum</i> ssp. <i>hispanica</i>			II							
<i>Narcissus calcicola</i>		I	I						X	X
<i>Calendula suffruticosa</i> ssp. <i>algarbiensis</i>		I							X	
<i>Iris foetidissima</i>			III							
<i>Pulicaria odora</i>			I	X			I	X		
<i>Erica scoparia</i>				X						
<i>Luzula forsteri</i> ssp. <i>baetica</i>					X					
<i>Cistus albidus</i>	I	II				X	II			
<i>Phlomis purpurea</i>						X	II			

Synthetic table of Arrabida Communities

<i>Cistus monspeliensis</i>		III		X		X	III		
<i>Cistus salvifolius</i>	I	II	III	X		X	IV		
<i>Lavandula luisieri</i>		I				X	IV		
<i>Astragalus lusitanicus</i>		III				X	II		X
<i>Thymus mastichina</i>						X			
<i>Cistus crispus</i>						X	II		
<i>Asphodelus aestivus</i>		I				X			X
<i>Ulex densus</i>							V		
<i>Thymus zygis ssp. silvestris</i>							V		
<i>Sideritis hirsuta var. hirtula</i>							IV		
<i>Serratula baetica ssp. lusitanica</i>							III		
<i>Serratula estremadurensis</i>							I		
<i>Anthyllis vulneraria ssp. maura</i>							II	X	
<i>Stachelina dubia</i>		II				X	IV		
<i>Rosmarinus officinalis</i>		IV				X	V		X
<i>Coridothymus capitatus</i>							II		
<i>Bartsia aspera</i>							I		
<i>Micromeria graeca ssp. micrantha</i>							I		
<i>Avenula occidentalis</i>							II		
<i>Carex hallerana</i>							IV	X	
<i>Phagnalon rupestre</i>							II		
<i>Fumana thymifolia</i>							II		
<i>Valeriana tuberosa</i>							I		
<i>Cistus x pulverulentus</i>							I		
<i>Daucus crinitus</i>							II	X	
<i>Eryngium dilatatum</i>							IV	X	
<i>Salvia sclareoides</i>		I	II		X		V	X	
<i>Brachypodium phoenicoides</i>	I	I	I	X			V	X	
<i>Phlomis lychnitis</i>							+	X	
<i>Asphodelus ramosus</i>		I						X	
<i>Plantago serraria var. hispanica</i>							+	X	
<i>Plantago lanceolata</i>								X	
<i>Ophrys lutea ssp. murbekii</i>								X	
<i>Lathyrus amphicarpos</i>								X	
<i>Allium roseum</i>								X	
<i>Dactylis glomerata ssp. hispanica</i>							III	X	X
<i>Stipa offneri</i>		I							X
<i>Iberis procumbens ssp. microcarpa</i>		+							X
<i>Sedum sediforme</i>									X
<i>Phagnalon saxatile</i>						X	+		X
<i>Brachypodium retusum</i>									X
<i>Ornithogalum concinnum</i>									X
<i>Gladiolus reuteri</i>									X
<i>Stipa gigantea</i>						X		X	
<i>Hyparrhenia hirta</i>							II		X
<i>Antirrhinum linkianum</i>									X
<i>Silene longicilia</i>									X
<i>Biscutella lusitanica</i>									X
<i>Calendula suffruticosa ssp. lusitanica</i>									X
<i>Sanguisorba multicaulis</i>									X
<i>Psoralea bituminosa</i>					X		+		X
<i>Sedum album var. micranthum</i>									X
<i>Euphorbia portlantica</i>							III		
<i>Narcissus bulbocodium ssp. obovatus</i>							II	X	
<i>Convolvulus althaeoides</i>							I	X	
<i>Urginea maritima</i>							I	X	X
<i>Scabiosa arthropurpurea</i>							+	X	
<i>Cynara humilis</i>								X	
<i>Cynodon dactylon</i>								X	
<i>Centaureum erythraea ssp. grandiflorum</i>							IV	X	
<i>Helichrysum stoechas</i>							II		

A *Viburno tini-Quercetum cocciferae* (Rivas-Martinez et al. 1990, Capelo & Almeida, 1993); B *Quercus cocciferae-Juniperetum turbinatae* (Rivas-Martinez et al. 1990); C *Arisaro-Quercetum broteroi* (Br.-Bl. et al. 1956, Pinto da Silva & Teles, 1972, Capelo & Almeida 1993); D *Phillyreo-Arbutetum viburnetosum tini* (Capelo & Almeida, 1993); E *Leucanthemo sylvatici-Cheirolophetum sempervirentis* (Capelo, 1996); F *Phlomido purpureo-Cistetum albidi* (Capelo & Almeida, 1993); G *Salvia sclareoides-Ulicetum densi thymetosum silvestris* (Capelo et al. 1993); H *Phlomido lychnitidis-Brachypodietum phoenicoides* (Capelo & Almeida, 1993); I *Iberido microcarpa-Stipetum offneri* (Rivas-Martinez et al. 1990); J *Sileno longiciliae-Antirrhinetum linkiani* (Ladero et al. 1991)



*Arbutus unedo* –*Bupleurum fruticosum* community is found (*Phillyreo-Arbutetum unedonis* variant of *Bupleurum fruticosum*) as its substitution stage. The rocky steep cliffs of the valleys are, in most cases, deprived of well-developed soils. Moreover, the presence of karst also contributes to the shortage of water *in situ*. Although receiving the same amount of rain, these biotopes are short on water available to plant communities. Therefore, a edaphoxerophyllous permanent high-scrub juniper community is interpreted as the climax: *Quercococciferae-Juniperetum turbinatae*. The strongly xeric character of this vegetation is testified by the co-dominance of *Olea europaea* var. *sylvestris*, *Asparagus albus* and ecologically similar taxa in some of these biotopes. Normally, primary positions of the *Querc-Juniperetum* have a perennial grass community as a substitution stage: *Iberido microcarpae-Stipetum offneri* (*Lygeo-Stipetea*).

The secondary versions of the *Querc-Juniperetum turbinatae* have a strong fire-adapted character and are, in most cases, in very eroded rocky, thinner soils, although in more or less flat topographical positions. In these cases, the soil mosaic was eroded in patches which determine a vegetation mosaic: *Querc-Juniperetum* in deeper soils; a tall-grass *Brachypodium phoenicoides* dominated community (*Phlomidolychnitidis-Brachypodietum phoenicoidis*, *Festuco-Brometea erecti*) and in the rocky eroded positions a community dominated by *Ulex densus* and *Thymus zygis* subsp. *sylvestris* (*Salvio sclareoidis-Ulicetum densi thymetosum sylvestris*). This endemic gorse can also be found as a substitution stage in the series *Arisaro-Querceto broteroi sigmetum* in marle-derived soils or even in low-carbonate soils within the scope of the *Viburno-Querceto cocciferae sigmetum*. In some cliffs exposed to the sea winds the *Salvio-Ulicetum densi thymetosum sylvestris* also seems to have a permanent character or as a substitution stage of the *Querc-Juniperetum turbinatae* variant of *Euphorbia pedroi* (a spurge of the grex “*dendroides*” endemic to Arrábida).

The surroundings of Serra da Arrábida belong to the cork-oak vegetation series on sand *Oleo sylvestris-Quercetum suberis*.

## 2. An overview of plant communities and landscape of Troia dune ecosystems.

The whole of the Sado basin (Sadense superdistrict) is included in the thermomediterranean stage where the *Oleo sylvestris-Querceto suberis sigmetum* develops on pleistocenic and holocenic sands. The artificial park structure (montados) still maintain some remanent tree cover of cork-oak, while its substitution stages dominate the landscape. An important dune system and aquatic vegetation (both freshwater and saltmarsh) is also well represented in the area. In the *Oleo-Querceto suberis sigmetum* series, the most outstanding subseral stages are the *Asparago aphylli-Myrtetum communis* (high-scrub) and the low-scrub, *Thymo capitellati-Stauracanthetum genistoidis*. A large amount of endemics are found in the later community: *Thymus capitellatus*, *Armeria rouyana*, *Malcomia lacera* subsp. *gracilima*. In biotopes where the miocenic harder level approaches the surface another low-scrub appears: *Erico umbellatae-Ulicetum welwitschiani* (*Calluno-Ulicetea*, *Ericion umbellatae*) where the gorse *Ulex australis* subsp. *welwitschianus* is dominant. In the clearings, the annual community *Anachorto-Arenarietum algarbiensis* (*Anthylido-Malcomion*) is found. A community dominated by nitrophyllous shrubs appears in the soils that suffered ancient agricultural activity. It is dominated by the endemic *Santolina impressa* and *Artemisia campestre* subsp. *campestre* (*Santolinetum impressae*, *Pegano-Salsoletea*).

Since most of the territory is found on the dry ombic stage, the appearance of the *Oleo-Querceto suberis sigmetum* series is only possible by the presence of the water table near the surface in a short part of the year. That fact arises from the underlying hard miocenic layer under the sand *strata*. In places where the soil is formed on deeper paleo-dunes (formed during the würmian regression of the coast) the water table never compensates summer draught and the cork-oak series never reaches its full development. Thus, an high-scrub community dominated the endemic juniper *Juniperus navicularis* appears as permanent climax vegetation (*Daphno gnidii-Juniperetum navicularis*).

Another original feature of this area is the peat-bog vegetation which appears in depressions that accumulate fresh water all year round, formed in the sand levels reaching the hard miocenic strata. The class *Alnetea glutinosae* is present by means of an *Salix atrocinnerea* community (*Carici lusitanicae-Salicetum atrocinnereae*) which includes the southernmost localities of *Myrica gale* and *Thelypteris palustris*, for instance. Peat-bog low scrub of gorse (*Ulex minor*) is also found: *Cirsio welwitschii-Ericetum ciliaris* (*Calluno-Ulicetea*, *Genistion micrantho-anglicae*). In these relictual peat-bogs the vegetation of the classes *Scheuzerio-Caricetea fuscae* and *Littoreletea uniflorae* can also be found (*Utriculario gibbae-Sphagnetum auriculatae* and *Hyperico elodis-Rhynchosporium rugosae* respectively).

Three main ecological factors seem to control the spatial distribution of saltmarsh communities in the Sadense Superdistrict: salinity, the level of the water-table and the submersion period. The later is strongly in relation to the microtopography of the biotopes. In relation to sodium chloride in soil solution, the higher positions of the saltmarsh have the higher contents due to greater distance to the water table. Progressively, a decreasing salt gradient follows towards the sea. Under the water surface, the first community in the saltmarsh *catena* is the

*Cymodoceetum nodosae* (*Halodulo-Thalassietea*). In higher positions, occupying the first mud band of the low tides the *Zosteretum noltii* appears (*Zosteretea marinae*). The first truly emerged plant community is the *Spartinetum maritimae*, which has a pioneer character in the saltmarsh ecosystem. In the same biotopes the annual community *Salicornietum fragilis* is also found. The greater extent of the lower part of the saltmarsh is occupied by the *Sarcocornio perennis-Puccinelieta convolutae* (*Salicornietea fruticosae*) being under submersion with sea-water twice a day. It is dominated by *Sarcocornia perennis* subsp. *perennis* and *Limonium vulgare*. The next higher community is the *Halimiono portulacoidis-Sarcocornietum alpini* (*Salicornietea fruticosae*). The later is dominated by *Sarcocornia perennis* subsp. *alpini*. In the banks of the saltmarsh canals another community appears: *Cistancho phelypaeae-Arthrocnemetum fruticosae* which is dominated by the nanophanerophyte *Sarcocornia fruticosa*. The clearings of this community are frequently occupied during the summer and autumn by the *Halimiono portulacoidis-Salicornietum patulae* (*Thero-Suaedetea*). In turn, in higher positions, the *Inulo crithmoidis-Arthrocnemetum glauci* (*Salicornietea fruticosae*), dominated by *Arthrocnemum macrostachyum*, *Limonium algarvense*, *Halimione portulacoides*, etc. only is covered by the highest tides. Other communities include: *Cistancho phelypaeae-Suaedetum verae* (biotopes rich in organic debris left by exceptionally high tides).

The halo-nitrophyllous vegetation has also a great development in Sado saltmarshes. The *Frankenio laevis-Salsoletum vermiculatae* (*Pegano-Salsolietea*) and the *Inulo crithmoidis-Limonietum ferulacei*. The later occurs mostly by animal grazing of the saltmarsh. Other associated communities to the saltmarsh are: *Arthrocnemo glauci-Juncetum subulati* (*Salicornietea fruticosi*) is of brackish low – salt waters that dry up during the summer months; *Polygono equisetiformis-Juncetum maritimi* which is frequent as a pioneer stage of abandoned agricultural practices within the saltmarsh influence; *Polygono equisetiformis-Tamaricetum africanae* (*Nerio-Tamaricetea*) in the margin of freshwater streams with some influence of salt in its water table. Also in freshwaters near the saltmarsh, the *Scirpetum compacto-littoralis* can also be found. A large wealth of annual communities can also be found in the saltmarsh surroundings during the spring, namely: *Parapholido incurvae-Frankenietum pulverulentae* (*Saginetea maritimae*), *Polypogo maritimae-Hordeetum marinae* which in the summer are replaced by the *Suaedo splendentis-Salicornietum patulae* (*Thero-Suaedetea*) or by the *Damasonio alismae-Crypsietum aculeatae* (*Isoeto-Nanojuncetea*). In more nithrophyllous spots the *Spergulario bocconeii-Mesembryanthemetum nodiflori* (*Stellarietea*) media is found.

In sadense territories the dune ecosystems have a great wealth of plant communities which, in short, are described here. In the first band closer to the sea the annual community *Salsolo kali-Cakiletum maritimae* is found in the short nitrified band where organic remains accumulate. The following band of very mobile sand is occupied by the *Euphorbio paraliae-Agropyretum junceiformis* dominated by the grass *Elymus farctus* subsp. *boreali-atlanticus*. In turn, in the mobile crests of dunes the *Loto cretici-Ammophilletum australis* is found. The stabilized sand biotopes are occupied by the chamaephytic community *Artemisio chrithmifoliae-Armerietum pungentis*. In the clearings of the former low-scrub the psamophyllous annual association *Linario pedunculatae-Ononidetum variegatae* (*Helianthemetea, Malcomietalia, Linarion pedunculatae*) appears. The somewhat anthropic character of the later formation is also testified by the semi-nitrophyllous grass community

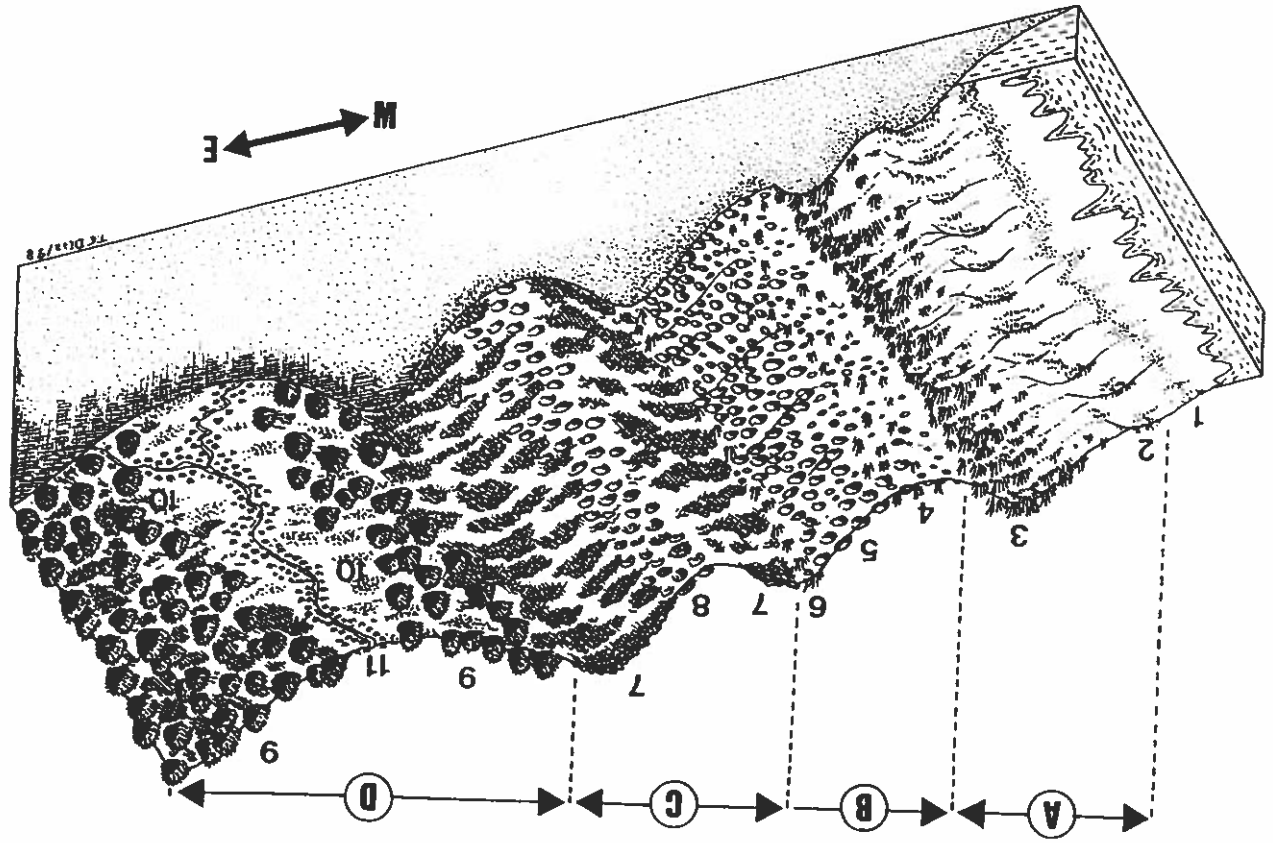
## PICTURE 21

Locality: Tróia Peninsula, Estuário do Sado Nature Reserve, Portugal.  
 Altitude: 1-20 m  
 Date: 17-VII-1999

Biogeography: Sadense superdistrict; Sadense sector  
 Bioclimatic belt: Lower thermomediterranean, dry.  
 Lithology: Dunes

1. Halo-nitrophilous therophytic community (*Salsoleo kali-Cakiletum maritimae*)
2. Perennial grass community of embryonary dunes (*Euphorbio-Agrophyretum junceifor-mis*).
3. Dune-crest community (*Loto cretici-Ammophiletum australis*)
4. Secondary *Ammophiletum*.
5. Chamaephytic community of grey dunes (*Artemisio crithmifoliae-Armerietum pungentis linarietosum lamareckii*).
6. Residual *Ammophiletum*.
7. Fixed dunes community with *Coremia album* (*Rubio longifoliae-Coremetum albi*) alternating with ephemeral dune therophyte community (facing the sea)
8. Secondary *Artemisio crithmifoliae-Armerietum pungentis* community on inalterd dunes (*Herniario algarvicae-Linarietum sicallhoanae*).
9. Juniper woodland of litoral fixed dunes influenced by the sea wind (*Osyrio-Juniperetum turbinatae*) with mantle of *Rubio-Coremetum albi* and scionitrophilous communities of *Scrophularia sublyrata*.
10. *Stauracantho-Halimietalia* communities, alternating with therophytic vegetation of *Linaron pedunculatae* and terricolous lichen communities of *Cladonietum mediterraneum*.
11. Subnitrophilous community of the roadsides on disturbed soils with *Santolina impressa* (*Santolinetum impressae*).

Potential Natural Vegetation: A. *Loto-Ammophiletum*; B. *Artemisio crithmifoliae-Armerietum pungentis*; C. *Rubio-Coremetum albi*; D. *Osyrio-Juniperetum turbinatae*



## PICTURE 22

Locality: Tróia Peninsula, Estuário do Sado Nature Reserve, Portugal.

Altitude: 1-20 m

Date: 17-VII-1999

Biogeography: Sadense superdistrict; Sadense sector

Bioclimatic belt: Lower thermomediterranean, dry.

Lithology: Dunes

1. Juniper woodland of litoral fixed dunes influenced by the sea wind (*Osyrio-Juniperetum turbinatae*).
2. Mantle of *Rubio-Coremetum albi*.
3. Communities of *Stauracantho-Halimietalia*.
4. Lichen community (*Cladonietum mediterraneum*).
5. Ephemeral therophytic community of *Herniario-Linarietum ficalhoanae* (*Linarion pedunculatae*).
6. Scionitrophilous community of the juniper woodland with *Scrophularia sublyrata*.
7. Subnitrophilous community of the roadsides on disturbed soils with *Santolina impressa* (*Santolinietum impressae*).



*Chamaemelo mixti-Vulpium alopecuris* (*Stellarietea mediae*, *Bromenalia rubentictori*, *Linario-Vulpium alopecuris*). In the depressions between dunes, where the water-table is frequently near the surface, two rush-communities can be found. The *Holoschoeno-Juncetum acuti* and the *Galio palustris-Juncetum maritimi* (both belong to *Molinio-Arrhatheretea*, *Holoschoenalia*, *Molino-Holoschoenion*). The later association is of biotopes where the water content of soil is higher and permanent throughout the year. When grazed these rush communities give rise to the *Trifolio resupinatae-Caricetum chaetophyllae* (*Molinio-Arrhatheretea*, *Plantaginetalia majoris*, *Trifolio-Cynodontion*).

The natural potential vegetation of dunes is represented by a juniper community: *Osyrio quadripartitae-Juniperetum turbinatae*. Probably most of the stands of this *Juniperus turbinata* subsp. *turbinata* dominated community have disappeared due to human activity.

The community sequence of dune ecosystems is basically: *Salsolo kali-Cakiletum maritimae*; *Euphorbio paraliae-Agropyretum junceiformis*; *Loto cretici-Amophylletum australis*; *Artemisio chrithmifoliae-Armerietum pungentis*. In the clearings of the later association, a vicariant annual community appears: *Herniario algarvicarum-Linarietum ficulneoideae*. The potential woody vegetation of dunes has in the Sadense Superdistrict its optimum: *Osyrio quadripartitae-Juniperetum turbinatae*. These juniper formations have also a wealth of other thermomediterranean taxa of the *Quercetea ilicis* class: *Rhamnus oleoides* subsp. *oleoides*, *Asparagus aphyllus*, etc. Its natural edge is formed by the *Empetraceae* - *Corema album* (*Rubio longifoliae-Coremetum albi*) includable in the same vegetation class.

Synthetic table of dune communities of Sadense Superdistrict

	A	B	C	D	E	F	G	H	I	J	K
<i>Cakile maritima</i> ssp. <i>maritima</i>	V	II	.	.	.	.	.	.	.	.	.
<i>Salsola kali</i>	IV	+	.	.	.	.	.	.	.	.	.
<i>Polygonum maritimum</i>	+	+	I	.	.	.	.	.	.	.	.
<i>Elymus farctus</i> ssp. <i>boreali-atlanticus</i>	.	V	III	.	.	.	.	.	.	.	.
<i>Eryngium maritimum</i>	.	IV	III	.	.	.	.	.	.	.	.
<i>Otanthus maritimus</i>	.	III	III	+	.	.	.	.	.	.	.
<i>Euphorbia paralias</i>	.	II	II	.	.	.	.	.	.	.	.
<i>Calystegia soldanella</i>	.	II	II	II	.	.	.	.	.	.	.
<i>Medicago marina</i>	.	II	II	I	.	.	.	.	.	.	.
<i>Ammophila arenaria</i> ssp. <i>australis</i>	.	I	V	III	.	I	.	.	.	.	.
<i>Pancratium maritimum</i>	.	III	III	III	.	.	.	.	.	.	.
<i>Lotus creticus</i>	.	.	IV	V	I	III	I	.	.	.	.
<i>Crucianella maritima</i>	.	.	III	V	.	III	.	.	.	.	.
<i>Armeria pungens</i>	.	.	III	V	.	IV	III	.	.	.	.
<i>Artemisia crithmifolia</i>	.	.	II	IV	.	.	.	.	.	.	.
<i>Cyperus capitatus</i>	.	.	+	II	.	.	.	.	.	.	.
<i>Malcolmia littorea</i>	.	.	II	IV	.	III	.	.	.	.	II
<i>Helichrysum picardi</i> var. <i>picardi</i>	.	.	II	IV	.	II	III	.	.	.	II
<i>Scrophularia frutescens</i>	.	.	I	II	.	.	.	.	+	.	I
<i>Ononis natrix</i> ssp. <i>ramosissima</i>	.	.	I	V	.	III	II	.	+	.	.
<i>Thymus camosus</i>	.	.	.	V	.	I	I	.	.	.	.
<i>Linaria lamarckii</i>	.	.	.	III	.	.	.	.	.	.	.
<i>Hemiaria maritima</i>	.	.	.	III	.	.	.	.	.	.	.
<i>Euphorbia portlandica</i>	.	.	.	III	.	.	I	.	.	.	.
<i>Anagallis monelli</i> var. <i>microphylla</i>	.	.	.	III	.	.	.	.	+	.	I
<i>Aetheorhiza bulbosa</i>	.	.	.	I	.	.	.	.	.	.	.
<i>Carpobrotus edulis</i>	.	.	II	III	.	II	III	.	II	.	.
<i>Calendula suffruticosa</i> ssp. <i>algarbiensis</i>	.	.	II	III	.	.	I	.	.	.	I
<i>Reichardia gaditana</i>	.	.	I	III	II	.	.	.	.	.	.
<i>Anchusa calcarea</i>	.	.	I	III	II	.	.	.	.	.	I
<i>Verbascum litigiosum</i>	.	.	I	I	.	.	.	.	.	.	II
<i>Sedum sediforme</i>	.	.	.	III	.	.	II	II	III	.	I
<i>Corynephorus canescens</i> var. <i>maritimus</i>	.	.	.	II	I	.	.	.	+	.	III
<i>Pimpinella villosa</i>	.	.	.	II	.	.	I	.	I	.	II
<i>Vulpia alopecurus</i>	.	.	.	II	II	.	.	.	.	.	.
<i>Centaurea sphaerocephala</i>	.	.	.	+	.	+	.	.	I	I	.
<i>Linaria ficalhoana</i>	.	.	.	.	V	.	.	.	.	.	.
<i>Silene littorea</i>	.	.	.	.	V	.	.	.	.	.	.
<i>Polycarpon alsinifolium</i>	.	.	.	.	V	.	.	.	.	.	.
<i>Medicago littoralis</i>	.	.	.	.	V	.	.	.	.	.	.
<i>Hedypnois arenaria</i>	.	.	.	.	V	.	.	.	.	.	.
<i>Erodium aethiopicum</i> ssp. <i>pilosum</i>	.	.	.	.	IV	.	.	.	.	.	.
<i>Cutandia maritima</i>	.	.	.	.	IV	.	.	.	.	.	.
<i>Pseudorhiza minuscula</i>	.	.	.	.	III	.	.	.	.	.	.
<i>Rumex bucephalophrus</i> ssp. <i>gallicus</i>	.	.	.	.	III	.	.	.	.	.	.
<i>Tuberaria guttata</i>	.	.	.	.	II	.	.	.	.	.	.
<i>Ornithopus pinnatus</i>	.	.	.	.	II	.	.	.	.	.	.
<i>Senecio gallicus</i>	.	.	.	.	I	.	.	.	.	.	.
<i>Papaver setigerum</i>	.	.	.	.	IV	.	.	.	.	.	.
<i>Centranthus calcitrapae</i>	.	.	.	.	III	.	.	.	.	.	.
<i>Silene colorata</i>	.	.	.	.	II	.	.	.	.	.	.
<i>Smilax aspera</i> var. <i>nigra</i>	.	.	.	.	II	.	.	.	.	.	.
<i>Osyris quadripartita</i>	.	.	.	.	.	I	II	.	.	.	.
<i>Rhamnus oleoides</i>	.	.	.	.	.	III	III	.	.	.	.
<i>Antirrhinum cirriferum</i>	.	.	.	II	.	V	IV	.	.	.	.
<i>Corema album</i>	.	.	.	II	.	V	IV	II	IV	.	I
<i>Pistacia lentiscus</i>	.	.	.	.	.	III	V	II	.	.	.
<i>Rubia peregrina</i> var. <i>longifolia</i>	.	.	.	.	.	III	I	+	.	.	.
<i>Asparagus aphyllus</i>	.	.	.	.	.	III	III	II	I	I	.
<i>Daphne gnidium</i>	.	.	.	.	.	II	II	V	II	III	.
<i>Phillyrea angustifolia</i>	.	.	.	.	.	II	II	III	+	I	.
<i>Juniperus turbinata</i>	.	.	.	.	.	V	I	.	.	.	.

Synthetic table of dune communities of Sadense Superdistrict

<i>Rhamnus alaternus</i>						II			
<i>Olea europaea</i> var. <i>sylvestris</i>						II		+	
<i>Lonicera implexa</i>						I			
<i>Quercus coccifera</i>						I	III		
<i>Juniperus navicularis</i>							V		I
<i>Anemone palmata</i>							II	II	I
<i>Scilla monophyllos</i>							I	I	
<i>Anagyris foetida</i>								+	
<i>Scrophularia sublyrata</i>							I		
<i>Cistus salvifolius</i>	III	III	IV	III	IV	II			
<i>Iberis limifolia</i> ssp. <i>welwitschii</i>	III	I	II	II					I
<i>Halimium halimifolium</i>	II	I	IV	V	V	+			
<i>Halimium calycinum</i>	I	II	IV	V	II	II			
<i>Thymus capitellatus</i>	I		IV	V	II	III			
<i>Lavandula sampsona</i> ssp. <i>lusitanica</i>	+	I	IV	IV	I	II			
<i>Thapsia villosa</i>		II		II					
<i>Helichrysum picardii</i> var. <i>virescens</i>				II	III				IV
<i>Lavandula luisieri</i>				I	I	III			
<i>Cistus crispus</i>				I	I	III			
<i>Armeria rouyana</i>				II	IV				I
<i>Stauracanthus genistoides</i>				II	V				I
<i>Dianthus hinoxianus</i>				I	II				
<i>Cistus libanotis</i>					I				
<i>Malcolmia lacera</i> ssp. <i>gracilima</i>					II				II
<i>Helianthemum stoechadifolium</i>					II				
<i>Lithodora prostrata</i> ssp. <i>lusitanica</i>					III	II			
<i>Euphorbia baetica</i>					I				
<i>Asphodelus ramosus</i>					I	II			
<i>Stipa gigantea</i>					I	I	I		
<i>Ulex australis</i> ssp. <i>welwitschianus</i>				IV	III	V	II		
<i>Calluna vulgaris</i>				II	+	IV			
<i>Erica umbellata</i>				I	I	IV			
<i>Tuberaria lignosa</i>					I	II			
<i>Cistus psilosepalus</i>					+	II			
<i>Genista triacanthos</i>					+	V			
<i>Chamaespartium tridentatum</i>						IV			
<i>Erica scoparia</i>						IV			
<i>Erica australis</i>						IV			
<i>Agrostis curtisii</i>						II			
<i>Simethis mattiazi</i>						II			
<i>Thymus villosus</i>						II			
<i>Erica erigena</i>						+			
<i>Pulicaria odora</i>						III			
<i>Cistus ladanifer</i>						III			
<i>Rosmarinus officinalis</i>						II			
<i>Santolina impressa</i>					II				V
<i>Scrophularia canina</i>									II
<i>Ononis natrix</i> ssp. <i>hispanica</i>									II
<i>Artemisia campestris</i> ssp. <i>campestris</i>									I
<i>Solanum sodomaeum</i>									I
<i>Euphorbia terracina</i>									IV
<i>Dittrichia viscosa</i> ssp. <i>viscosa</i>									III
<i>Verbascum thapsus</i> ssp. <i>crassifolium</i>									II
<i>Arrhenatherum album</i>						III	II		I
<i>Cytisus grandiflorus</i>						I			
<i>Carlina corymbosa</i>						I			II

A *Salsolo Kali-Cakiletum maritima* (Costa et al. 1994b); B *Euphorbio paraliue-Agropyretum juceiformis* (Costa et al. 1994b)  
 C *Loto cretici-Ammophiletum australis* (Costa et al. 1994b); D *Artemisio crithmifoliae-Armerietum pungentis* (Diez Garretas  
 1984, Costa et al. 1994b); E *Herniario algarvicae-Linarietum ficalthoanae* (Diez Garretas 1984, Costa et al. 1994b);  
 F *Rubio longifoliae-Coremetum albi* (Costa et al. 1994b); G *Osyrio quadripartitae-Juniperetum turbinatae* (Costa et al. 1994a,b);  
 H *Daphno gnidii-Juniperetum navicularis* (Rivas-Martinez et al. 1990, Costa et al. 1994a); I *Thymo capitellati-Stauracanthetum  
 genistoidis* (Rivas-Martinez et al. 1990); J *Erico umbellatae-Ulicetum welwitschianii* (Costa et al. 1997); K *Santolinetum impressae*  
 (Costa et al. 1999)



Synthetic table of salt-marshes communities of Sado river

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
<i>Cymodocea nodosa</i>	V																		
<i>Zostera noltii</i>		V																	
<i>Spartina maritima</i>			V	III	II	II									I	II			
<i>Limonium vulgare</i>			III	III	III	II									I	I			
<i>Sarcocornia perennis</i>			III	V	II	II									I	II			
<i>Puccinellia convoluta</i>			II	IV	II	I										II			
<i>Halimione portulacoides</i>			III	III	V	V	V	IV	IV	III	II		I			II			
<i>Sarcocornia alpini</i>				III	V	I	IV	II		II						II			
<i>Sarcocornia fruticosa</i>			I	I	III	V	II	II		II	III		II				III		
<i>Cistanche phelypaea</i>				I	III	IV	III	I		IV									
<i>Triglochin bulbosa</i> ssp. <i>barrelieri</i>				I	II	+	II	II	+		II								
<i>Spergularia maritima</i>					III	I	II	I											
<i>Puccinellia foucaudii</i>					II	II	III		I	+									
<i>Arthrocnemum macrostachyum</i>					II	+	V	V		V		I	I			II			
<i>Limonium ferulaceum</i>					II	II	III	III	V	I	II					I	III		
<i>Inula crithmoides</i>					II	I	III	III	III	I	III	+							
<i>Artemisia caerulescens</i>					I	I	IV		III										
<i>Limonium lanceolatum</i>					I		III		II										
<i>Juncus subulatus</i>								III						I			II		
<i>Suaeda vera</i>						J	III	III	+	V	II	IV							
<i>Polygonum equisetiforme</i>							I	II	+	+	IV	I	I						
<i>Elymus elongatus</i>							I			I	II								+
<i>Juncus maritimus</i>					I	II		IV	I		V		V						
<i>Juncus acutus</i>					I			II	I		V		II						
<i>Carex extensa</i>											II								
<i>Spergularia salina</i>					I				III		IV								
<i>Centaurium spicatum</i>											III						II		I
<i>Centaurium tenuiflorum</i>											II						II		
<i>Lactuca saligna</i>							I				II								
<i>Sonchus maritimus</i>											I								
<i>Oenanthe lachenalli</i>											I								
<i>Aster tripolium</i> ssp. <i>pannonicus</i>											I								
<i>Apium graveolens</i>											I								
<i>Scirpus maritimus</i> var. <i>compactus</i>											I								
<i>Phragmites australis</i>							+				II		V					II	
<i>Typha domingensis</i>													I						
<i>Frankenia laevis</i>								II	IV	I	III	V				I	IV	I	V
<i>Salsola vermiculata</i>										+		V							
<i>Atriplex halimus</i>												III							
<i>Beta vulgaris</i> ssp. <i>maritima</i>												II							V
<i>Plantago coronopus</i> ssp. <i>ceratophylla</i>										+		III	IV						IV
<i>Salicornia lutescens</i>			I											V	II				
<i>Salicornia patula</i>			I	II	I	I								III	V	V		III	
<i>Suaeda maritima</i>			III	III	III	II	III	II		II				I	IV	II			
<i>Suaeda splendens</i>																II	II	II	II
<i>Salsola soxla</i>													II			II	I		I
<i>Parapholis filiformis</i>							II	I	IV	+	III	II				II	V		III
<i>Hordeum maritimum</i>							I	I	II		II	II	I			II	V	III	IV
<i>Polypogon maritimus</i>							+	II	II		III	I	I			III	V	V	
<i>Parapholis incurva</i>									II							II	II		III
<i>Crypsis aculeata</i>													II			III	II	V	
<i>Juncus hybridus</i>																IV	V		
<i>Cressa cretica</i>											+					I	II		
<i>Juncus bufonius</i>																		III	
<i>Isolepis pseudosetacea</i>																		II	
<i>Spergularia boecknei</i>							+		II		I	I			III	V			IV
<i>Mesembryanthemum nodiflorum</i>							+										I		V
<i>Atriplex prostrata</i>								+	II		V	I	III		II	II			II
<i>Sonchus tenerrimus</i>												III							V
<i>Oxalis pes-caprae</i>																			II
<i>Hedypnois cretica</i>												+				II			II

# Synthetic table of salt-marshes communities of Sado river

<i>Avena barbata</i>	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	II	.	III	
<i>Cotula coronopifolia</i>	.	.	.	.	.	.	.	.	.	.	.	.	III	.	II	.	.	II	II	.	III
<i>Melilotus messanensis</i>	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	I	.	I	
<i>Hordeum leporinum</i>	.	.	.	.	.	.	.	.	.	.	.	.	+	I	.	.	.	.	.	.	
<i>Anacyclus radiatus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	.	.	.	
<i>Piptatherum miliaceum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	II	
<i>Phalaris paradoxa</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	I	.	II

A *Cymodoceetum nodosae*; B *Zosteretum noltii*; C *Spartinetum maritimae*; D *Sarcocornio perennis-Puccinellietum convolutae*; E *Halimiono portulacoidis-Sarcocornietum alpinii*; F *Cistancho phelypaeae-Arthrocnemetum fruticosae*; G *Inulo crühmoidis-Arthrocnemetum glauci*; H *Arthrocnemo glauci-Juncetum subulati*; I *Inulo crühmoidis-Limonietum ferulacei*; J *Cistancho phelypaeae-Suaedetum verae*; K *Polygono equisetiformis-Juncetum maritimi*; L *Frankenio laevis-Salsoletum vermiculatae*; M *Scirpetum compacto-littoralis*; N *Salicornietum fragilis*; O *Halimiono portulacoidis-Salicornietum patulae*; P *Suaedo splendentis-Salicornietum patulae*; Q *Polypogo maritimi-Hordeetum marini*; R *Damasonio alismae-Crypsietum aculeatae*; S *Spergulario bocconei-Mesembryanthemetum nodiflori*;

Figura 5 - Transecto fitossociológico realizado no Açude da Murta.

