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THE CASSARINA PROJECT (ERBIC18CT960029)

an EU programme on environmental change

in North African Wetlands

Report Nos. 4 & 5

Editor: R.J. Flower

August 1999

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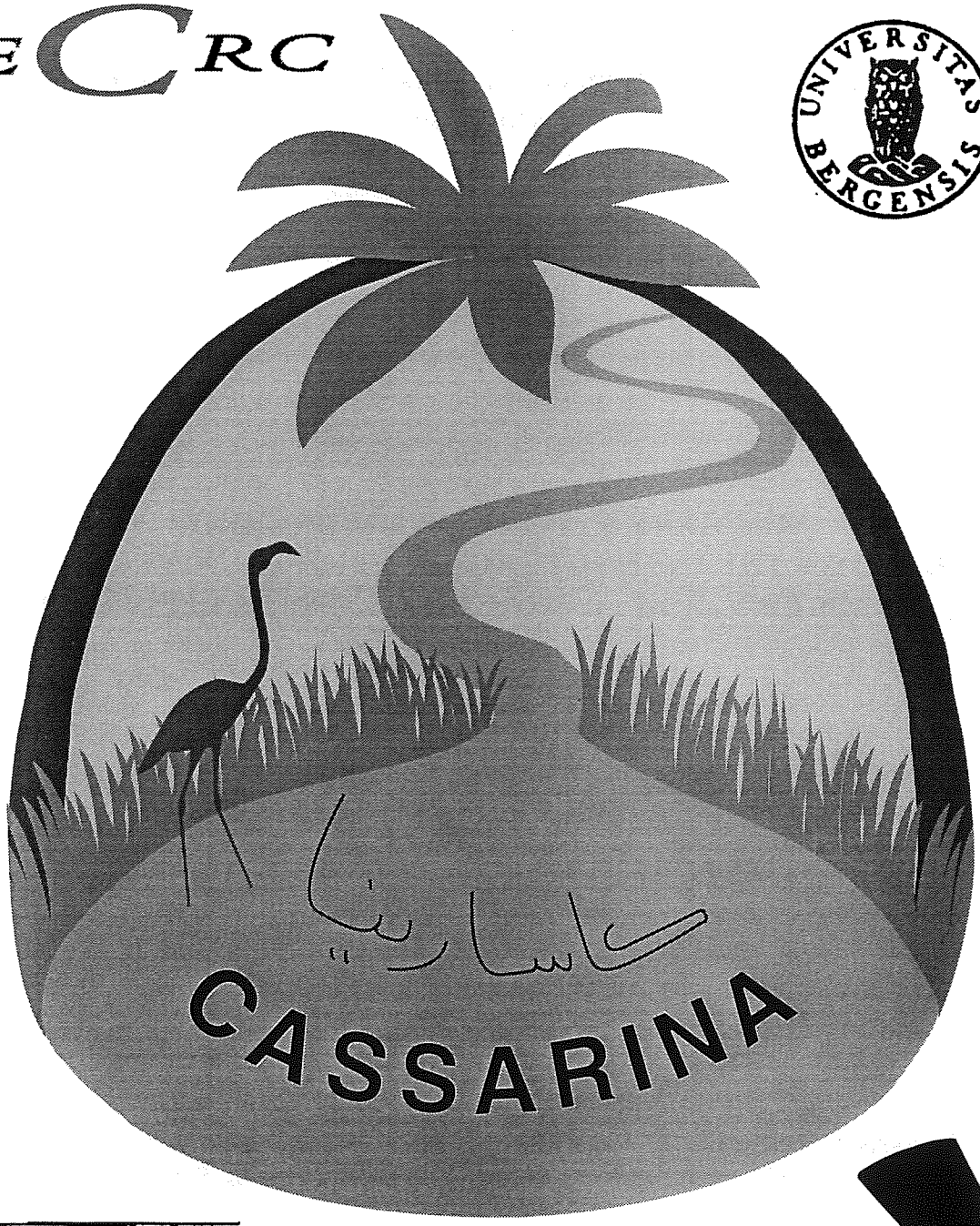
Change, Stress and Sustainability: Aquatic Ecosystem Resilience in North Africa



FACULTE DES SCIENCES DE TUNIS

IS-Rabat

المعهد العلمي

El-Minia

Reports (4 & 5) of the Third Cassarina Workshop Rabat (Morocco), December 1998 and the Fourth Cassarina Workshop, Alexandria (Egypt), May 1999

CASSARINA

Change, stress and sustainability: Aquatic Ecosystem Resilience in North Africa

THE THIRD CASSARINA WORKSHOP

SUMMARY REPORT OF A WORKSHOP HELD AT THE INSTITUTE SCIENTIFIQUE, UNIVERSITY MOHAMMED V, RABAT, MOROCCO, 2-5th DECEMBER 1998

CASSARINA REPORT No. 4

R. J. Flower (editor)

Workshop participants: M. Ramdani (Chairperson), R. J. Flower, S. Patrick, M. Kraeim, C. Ben Hamza, L. Baccar, A. Fathy, H. Abdelzaher, L. Somoue, F. Sarf.

January 1999

SUMMARY

1. One site, Merja Bokka, was lost the monitoring network in 1998 by land reclamation for agriculture. **Action: to continue with vegetation transects only.**

2. Water chemistry. Questionable measurements were found for some samples (caused by sample acidification, sample misidentification, or by consistencies in results e.g. very variable trace metals concentrations). Action: **to repeat some determinations on back-up samples; to use ion balances to check results.**

3. Water chemistry. To clarify data presentation by using four tables showing (i) routine laboratory and field measurements (from all groups: Alkalinity at two end points, conductivity in field, laboratory and calculated; pH ; temperature; Chl. *a*; transparency; depth), showing (ii) ion chemistry, (iii) showing trace metals and, (iv) ion balances. Moroccan and Tunisia data reports need contain only Table 1 unless 'extra' measurements were made. **All results to be entered into EXCEL spreadsheets**.

4. Phytoplankton. Some inconsistencies in cell concentrations (e.g. Sidi Bou Rhaba) and taxonomy. **Action: re-estimate old samples and carry out taxonomy checks.**

5. Zooplankton: larger samples needed from open water areas.

6. Fish: **lack of data for some sites**, full species inventories needed for some sites, taxonomy problems, larger sample sizes needed. Action: a priority to collect more biometric data in the next few months to allow comparisons between sites. To collect more fish during next field work in Egypt with preserved specimens for expert identification. No fish scales for the March 1998 sampling. **Action: to locate or estimate age on fish biometrics**

7. **More site information** (e.g. land-use change, vegetation change, climate, water level) must be included in final reports.

8. Palaeolimnological data: similar analyses made on different cores to be checked for any inconsistencies in profiles and identifications (e.g. forams and ostracods in cores analysed for plant macrofossils and invertebrates respectively). Pollen and aquatic macrofossil records need to be reconciled (e.g. Ichkeul). **All palaeolimnological data to be completed and presented at the next workshop**

9. For continuity, **basic monitoring should be carried out again in May 1999** for water, plankton, vegetation transects and diatoms (and fish where appropriate).

10. **Final monitoring reports to be prepared** with validated results (with re-analysed samples where appropriate) to be presented at the next workshop. (Data for 1999 can be added as an appendix. **Final palaeolimnological reports to be prepared for the next workshop**. Sites should be treated in an ordered sequence and names spelt consistently (see report).

11. Next workshop is in Egypt at the end of May 1999 (precise dates to be finalised in early 1999).

Introduction

The workshop began at 10.30 am Wednesday 2nd of December at the Institute Scientifique and was opened by the Institute's Director, Dr Driss Najid. A brief outline of the meeting was given by the chairperson, Dr Ramdani, who also noted that one CASSARINA primary site had ceased to contain surface water during summer 1998 due to land-use changes and agricultural expansion. After passing on apologies from participants who could not attend (Dr H. Birks and Dr. N. Elkhiati), Dr Ramdani explained that the first part of the workshop would deal with the results of modern monitoring then proceed by reporting the palaeoenvironmental studies before dealing with sample exchanges, finances and future planning. Dr Ramdani then introduced the first speaker. The meeting began with an account of the water chemistry measurements at the nine primary CASSARINA sites by Dr Fathy (Egypt).

Monitoring surveys:

Water chemistry

Dr Fathy presented a preliminary report on the water chemistry of the nine lakes. Although sampling was carried out at ca. 3 to 4 month intervals there was a clear seasonal signal in many determinands. Taking the Moroccan sites first conductivity was highest in May for Sidi Bou Rhaba (SBR) and in September for Zerga and Bokka. However the field measurements for these and the Tunisian sites were not included in presentation tables. For the Egyptian sites Edku had the lowest salinity and Manzala had highest Pb.

There were several inconsistencies in the data for all 9 sites:

i. In SBR measurements in the 1997 sample were consistently lower than in any period in 1998. Cation concentrations in SBR were lower in the highest conductivity sample (September 1998) than in the May 1998 sample. Phosphate was greater than an order of magnitude greater in the September sample.

ii. Field pH and alkalinities were not given for the Moroccan and Tunisian sites.

iii. Trace metal determinations were rather erratic at most sites, being zero in some samples and over 300 ug Pb/l in other samples from the same site (Zerga).

iv. High chlorides in Moroccan samples

v. Ion balances were clearly not satisfied for some measurements.

vi. A large variation in calcium ion concentration was observed for some sites, this may be an analytical problem.

Overall, the chemistry data showed some interesting features but there is clearly a needed to check some potential problems. The following checks were suggested:

1. To check analytical measurements, especially of calcium and all the measurements for M. Chitane in 1997.

2. To repeat measurements on Moroccan samples - some samples were possibly acidified in error.

3. To perform replicates on trace metal analyses, especially lead.

4. To measure alkalinity to two end points (4.5 and 4.2, see CASSARINA protocol).

5. To clarify conductivities: give field measurement, then laboratory measurement (at 25^0 C) and finally the calculated value from ionic concentrations.

6. To separate tables into Table I: full field data (supplied by each country) and respective laboratory measurements, pH, alkalinity, conductivity, temperature, Secchi disc depth and chlorophyll *a.* etc. Table II: cation and anion concentrations. Table III: trace metal results.

7. A fourth table should summarize the ion balances for each sample measured. Anions should balance cations with an error of less than 10%.

Dr Ben Hamza presented the Tunisian water chemistry results. He described the ground water influences on Lac de Korba and M. Chitane. A small aquifer supports the latter and Korba is on the margin of fresh ground water and marine seawater intrusion. pH was noted to vary in an unusual way with alkalinity.

M. Chitane is fed by several springs with acidic water supplied from a sandstone geology and it become isolated from aquifer supplies during the summer so the lake become less acid. Seasonal data shows Chitane to have a peak of ca. pH 8 peak in November 1998 when alkalinity is low, an error in pH measurement is likely here and data need checking. Korba and Ichkeul can become hypersaline during summer months. It was recommended to include rainfall data to help interpretation of these measurements.

Much more water chemistry data is available for Ichkeul because this site is monitored by a government supported laboratory, IPEU. It was suggested that some of these data could be used in the CASSARINA final report for the Tunisian lakes (with full acknowledgements).

Vegetation transects

Dr Abdelzaher gave a brief description of the vegetation transects for the Egyptian lakes. Only small changes in vegetation abundances were found and it was noted that Lake Burullus has now become a protected area. Some local decreases in water hyacinth had occurred due to weed control measures. It was noted that water depths need to be included and field observations to be noted in the 'remarks' column.

Dr Ramdani presented summary tables for the transect monitoring from April 1997 to September 1998 at the Moroccan sites. The main feature of the Bokka transect was the loss of surface water between May and September 1998 resulting in loss of aquatic plants. The shorter SBR transect showed seasonal changes in Charaphyte abundances with replacement by *Najas* during the autumn and no plant cover was found beyond 35 m from the shore (water depth ca. 1.5 m). The Merja Zerga transect passed over tidal wet muds and was dominated by *Salicornia(=Arthrocnemum).* However, it terminated at about 500 m, several 100 m short of the lake water margin. (Note *Chaetomorpha* not *Chaenopodium* is present on this transect).

It was recommended to extend the length of future Zerga transects to near the permanent water edge (to ca 1000m). It was noted that the Merja Khala transect should be continued.

Summary histograms of the Moroccan vegetation data were presented.

Zooplankton

Dr Ramdani presented tables giving the percentage abundances of zooplankton in samples from Bokka, SBR, Korba, Chitane, and Ichkeul for each monitoring occasion (April 1997-September 1998) and commenting on abundances of particular species. A pie chart example of data display for the Bokka counts was shown for discussion. He noted that zooplankton remains were not well enough preserved in sediments to allow counting. The increase in species numbers in the littoral zone compared with open water was emphasised. Zoobenthos needs to be studied in any future programme. The only acid site, M. Chitane, was unusual in supporting a large population of *Diaptomus cyaneus*.

It was suggested that in addition to other species diversity estimates to always quote species richness simply as the number of species per 200 individuals counted.

Fish data

Dr Kraiem began with the Tunisian check-list (see CASSARINA report number 2, appendix 4). He emphasized that more data were needed from the Moroccan and Egyptian lakes before species inventories could be produced (partners agreed to provide these). The particular problem of fish species identifications were noted for the Egyptian sites. Two genera, *Tilapia* and *Oreochromis* are common in the Delta lakes and some species can be difficult to separate to the non-expert. Identifications need to be clarified.

Some interesting differences in growth rates were noted and tables of fish weights, length and ages were given for the Tunisian and Moroccan sites. Particular problems with the Moroccan lakes is that Bokka no longer has water and fish were too small for growth rate analysis in SBR. **Comparison of growth rates (irrespective of species) in CASSARINA lakes is interesting and should be undertaken**.

Fish scales for March 1998 were missing for the Egyptian lakes and partners will attempt to recover these. Also the data for one fish seem to have been replicated for all 10 in the June 1998 sample from Burullus (Dr Fathy to investigate).

Dr Kraiem emphasised the need for a larger fish sample size, especially for the Egyptian sites, and this was recommended for the last sampling in 1999.

Lac Ichkeul

Dr Baccar gave a specific account of Ichkeul lake. He summarized recent changes in control of the lake, noting that the sluice gates on the Tinja river are under comprised control to minimise seawater intrusion in the summer. The gates were opened in October and seawater is flowing into the lake. Although this is beneficial for fisheries by allowing migratory fish (mullet and eels) to enter the lake, it causes the salinity to remain high.

Vegetation in the lake has changed completely during the 1990s with *Ruppia cirrosa* replacing *Potomogeton pectinatus* in the western sector of the lake. This dynamic submerged aquatic vegetation cover is almost certainly the result of increased salinity since *P. pectinatus* does not grow well above about 20 g/l salt. The value of *Ruppia* to birds is yet to be ascertained. The former *Scirpus* marshes remain reduced and *Salicornia* is now dominant in most exposed regions of the lake but improved regulation of the sluice gates and increased freshwater supply might encourage re-growth of *Scirpus* and *Phragmites* vegetation. However, the former needs regular inundation to flourish.

Phytoplankton

Dr Fathy presented phytoplankton data for the nine CASSARINA sites. The wide sampling periods means that the periodicity of phytoplankton was only shown in an approximate manner. Nevertheless, considerable seasonal variation in algal species and algal abundances were found. Green algae dominated the Egyptian lakes although diatoms and chrysophytes were also common. Cyanophyta were common in SBR but concentrations of *Microcystis* were much lower than expected in some samples. Bokka has a poor phytoplankton and none after summer 1998 due to total loss of surface water. Merja Zerga also has a poor plankton flora and most species present in the sample were benthic diatoms. In Tunisia, Ichkeul is very turbid and phytoplankton is in low abundance. Acidic M. Chitane has a diatom phytoplankton and Korba has high values for chlorophytes and blue-greens but for diatoms only in 1997.

The following comments or recommendations were made, especially concerning the low abundance values for SBR.

1. Concentration of samples should be carried out especially carefully when blue-green algae are present. Loss of material will reduce cell concentrations. Some samples from SBR need to be re-counted.

2. Avoid contamination.

3. Slides of phytoplankton samples were exchanged for checking diatom identifications.

4. Species richness to be calculated simply as the number of species in a fixed count of 200 individuals or colonies.

5. The reported occurrence of *Cyclotella ocellata* in Burullus lake is probably *C. capsia* (=*C. chotawotchiana*).

For diatom plankton AQC, slides were exchanged and the following noted:

Slides 1-3, Lake Edku. Sample 1 *Cyclotella meneghiniana*, *C. atomus, Thallasiosira weisfloggii, Nitzschia* spp. *Navicula* spp. and some broken *Bacillaria paradoxa* were present. Sample 2 (3.98) *Cyclotella meneghiniana, C. atomus, Thallasiosira weisfloggii, Stephanodiscus dubius (rare) , Nitzschia cf palaea* and some valves of *Gomphonema* were present. Sample 3 (9.98) only contained a few fragments.

Slides 4-6, Lake Manzala. Samples 4 and 6 (3.98, 6.98) only contained fragments. Sample 5 (6.98) was poorly preserved with partial dissolution of diatoms, present are *Synedra ulna, Cyclotella meneghiniana, C. atomus, Cocconeis placentula, Aulacoseira granulata.*

Slides 7-10, Lake Burullus. Sample 7 (3.98) contained only a few valves of *Cyclotella meneghiniana.* Sample 8 was devoid of diatoms and sample 9 (9.98) contained a few *C. meneghinina.*

Slides 10, Sidi Bou Rhaba (SBR) (3.98) did not contain diatoms.

Slide 11, M. Bokka (3.98) contained some benthic diatoms mainly *Navicula (Fallacia) pygmaea.*

Slide 12, M. Zerga (3.98) contained no diatoms.

Slide 13, SBR (9.98) contained no diatoms.

Slide 14, M. Bokka (9.98) contained only a few fragments.

Slide 15, M. Zerga (9.98) contained only a few fragments and remains of bluegreen filaments.

Slides 16-18. Ichkeul. Sample 16 (2.98) contained only the remains of filamentous algae. Sample 17 (5.98) contained a few valves of *Synedra ulna, Cocconeis placentula*, and *Nitzschia* sp. Sample 18 (8.98) contained a few valves of *Aulacoseira granulata* (contaminant?), *Nitzschia* and *Thalassiosira.*

Slides 19-21. M. Chitane (2.98) contained many diatoms mainly of *Eunotia pectinalis* and its variety *E. pectinalis* var. *minor.* A few valves of *Fragilaria* sp. were also present. Sample 20 (5.98) contained *Eunotia curvata* and some contaminants, *Anomoeoneis spherophora*, *Stephanodiscus tholiformis*, and *Nitzschia* spp.

Slides 22-24. Lac de Korba- only a few fragments present in each sample.

The rather disappointing examination of the concentrated phytoplankton samples revealed few diatoms, except for Edku and Chitane. Clearly, some samples are poor in diatoms because of sampling time but others indicate a problem in sample preparation, either caused by poor preservation (Manzala) or probably by sub-sampling difficulties (SBR, Burullus etc.). Contamination was observed in at least one sample (Chitane) where brackish water taxa were present.

The phytoplankton session ended with a request to provide more information on toxic blue-green algae, Dr Flower agreed to do this.

Palaeolimnology

Fungal spores

Dr H. Abdelzaher gave an account of fungal spore examinations of the sediments. The problem of counting resting spores in lake sediments was explained and so routine counting of spores was abandoned. Samples from one core, Edku Lake, were cultured for fungal growth. In the surface sediment a good response was found with *Trichoderma*, *Penicillium*, and *Aspergillus nigra* all growing. Below 6 cm sediment depth, the sediment was virtually sterile with nothing growing from below 10 cm depth.

Sediment chronologies

Dr Flower presented the preliminary sediment chronologies for each site (where available) based on radiometric measurements and age calculations made by Dr Appleby (University of Liverpool). Some further measurements are required for several cores but no chronologies are available for Lakes Edku and Burullus. This is because no fall-out radionuclides could be found at these sites and unsupported ^{210}Pb values were very low. These shallow lakes probably have ceased to accumulate modern sediments due to turbulence and subsequent sediment outwash. Furthermore the dated sections for Bokka and Manzala were rather short (upper 16 and 9 cm, respectively). It was noted that the entire upper section of M. Zerga could reflect sediment accumulation since the canal was opened in the mid-1950s. A possibility of sediment loss from the top of the Ichkeul core was suggested. A back-up core for Burullus is currently being measured for radionuclides but there will be no chronology for Edku.

Pollen and aquatic plant macrofossils

Dr Flower presented the pollen and macrofossil diagrams so far prepared by Dr S. Peglar and Dr H. Birks respectively. Information sheets were distributed to demonstrate the main features of those cores so far analysed.

SBR: Macrofossils in SBR core shows that Characeae, mites and *Plumatella* decreased from around 160 cm which by extrapolating the dating indicates some major

change in the 18th century. Pollen showed that shrub and arboreal vegetation had increased since the 18th century whilst Gramineae and herb pollen decreased these changes indicate that agriculture was formerly more widespread around the lake than it is today. *Argania* was pointed out as not being part of the local flora, *Phyllyrea* is however common.

M. Zerga: macrofossils in this core shows a shift from shelly marine mud to softer detrital sediments with some *Ruppia* remains. Pollen data are awaited.

Manzala: Macrofossils showed interesting declines in *Typha* and *Azolla nilotica* could indicate *inter alia* opening up of the reed swamp and expansion of open water areas. *Typha* is still common in the lake today but the latter species is probably extinct in the region. The nearest recorded modern occurrence of *A. nilotica* is Southern Sudan. *A. filliculoides* is currently expanding in the Nile delta (an alien from USA).

The forams etc. indicate suggest the lake has become more saline. Dr Ramdani also showed *Foraminifera* and *Cladocera* and it is recommended that there is some joint discussion on the differences between the independent analyses before the next workshop (note that the analyses are performed on different but adjacent cores).

The pollen shows clearly the start and increase in pollen as a result of planted *Casuarina*, a replacement of *Myriophyllum* by *Ceratophyllum*. Chenopod pollens are high in the middle section of the core, but this may be a percentage effect, caused by lower amounts of Gramineae pollen.

Ichkeul: The macrofossils show that both *Potomogeton* and *Ruppia* increased from around 40-50 cm depth (no record below 50 cm). About this time the Djoumine canal was constructed (increased freshwater supply?) Freshwater (?) snails increase at about this time. No clear record is apparent of the sharp increase in salinity after barrage construction the late 1980s.

The pollen diagram shows generally only small changes but *Potomogeton* and *Ruppia* clearly increase from around 40 cm depth (cf. macrophytes). *Isoetes* remains are relatively high throughout the core (in contrast to the macrofossil remains which disappear below 50 cm depth (so *Isoetes* was either not growing at the site at this time or fragments are not preserved in the lower core section). Much pollen was poorly preserved in this core.

Zooplankton sedimentary records

Dr Ramdani showed diagrams of *Cladocera* and *Foraminifera* for two sites, Burullus and Edku. *Loxoconcha* abundances indicated more marine conditions during the period represented by the middle section of the core. In Burullus, increased abundances of *Ammonia beccari* indicated a transition to more marine conditions in the upper core section. Analysis of the Ichkeul core indicated that marine influences were always significant here.

Diatom sedimentary records

Dr Flower gave accounts of the diatoms in each core analysed.

Tunisian material: results of the Chitane core were given at the last meeting and unfortunately the Ichkeul and Korba cores have very poor diatom preservation.

Moroccan material: diatom profiles were obtained from all three cores although preservation was poor below 60 cm depth in the Bokka core. Here the flora in the lower core was similar to that in SBR indicating shallow brackish water with turbulent resuspension. Between 40 and 15 cm. *Cocconeis placentula* showed peak abundances indicating increased aquatic macrophytes and less resuspension. At the core top *Navicula* taxa indicate an abundance of shallow silty sediment. The Zerga core shows a shift from epiphytic forms to those species preferring silty sediment surfaces. A good long record of diatoms occurs in the SBR core with epiphytic forms increasing below 100 cm sediment depth indicating more submerged plants in this period. Although epiphytic *Achnanthes marina* increases above this depth most cells are epiphytic on *Campylodiscus clypeus*, a diatom that thrives in shallow turbid brackish lakes prone to resuspension. There has probably been no major salinity change at this site.

Egyptian material: The Edku core shows a shift to freshwater taxa characteristic of epiphytic conditions to more brackish water surface sediment dwelling forms. However, the abundance of a marine diatom, *Biddulphia laevis* through the core does indicate regular marine incursions. The Manzala core clearly shows a fresher water phase in the middle of the core with direct marine incursions at the core base. In the Burullus core diatom preservation was poor below 17 cm and significant increase in planktonic diatoms is recorded. Marine incursions are indicated in the lower part of the core.

Finances

Dr Patrick gave an account of the financial constraints on the reminder of the project and indicated how to complete the partner cost statements.

Review of the monitoring results

During the meeting it was clear that some problems had arisen with the monitoring work. These were discussed systematically.

Water chemistry

The M. Chitane sample was clearly in error for 1997.

Some analysts are not reporting alkalinity measured to 4.5 and 4.2 end points.

The Moroccan samples 'B' had been acidified so invalidating ion concentration measurements.

Calcium concentrations were noticed to be very variable at some sites. It was recommended that measurements are to be repeated on back-up samples.

Some trace metal analyses seem to be inconsistent with values ranging from zero to >300 ug/l at some sites and measurements should be replicated.

Chemistry tables: For final reports it was recommended that all groups present TABLE 1 to give Alkalinity a&b, conductivity, pH, temperature, Chl. *a*, water depth, secchi disc depth as field data. The Egyptian group should give further laboratory analytical results: TABLE 2 of ion concentrations; TABLE 3 of Trace metal with replicates; TABLE 4 - Ion balance checks so that reliable samples must balance to <10%.

Phytoplankton and zooplankton

Cell concentrations to be verified for the phytoplankton data. Ecological indicator value of species should be given where possible, particularly for green algae. Dr Flower agreed to provide information on toxic blue-green algae before the next workshop.

Zooplankton samples are often too small to give a full representation of species.

Histograms were recommended to show changes in the main species with time. This is because the long and irregular sampling intervals make abundance curves questionable.

Species diversity can be calculated in various way but it is recommended that species richness is ALWAYS calculated. This is simply the number of taxa divided by a standard number counted (200 individuals for most cases). i.e. 10 taxa in a count of 200 is a richness factor of 0.5.

Vegetation transects

Standard tables need to be used in all cases for reporting these data, i.e. Quadrat number, distance, depth, species abundances, remarks (remarks should be used to describe condition of mud, growth form of plants, and nearby plants of interest). Remarks should also be used for indicating where floating plants and submerged plants make cover in excess of 100%.

Where transects are conducted over the foreshore regions they must be continued to the present water level.

Plant species identifications are particularly important for the common species.

It was thought important for future work that transects should be continued at Merja Bokka and Merja Khala.

Summary tables are welcome.

Dr Ramdani showed summary EXCEL histogram graphs of the main percentage abundance species changes along transects with different species colour coded. It was agreed to add a line to indicate water depth.

Fish

It was emphasized that missing data should be found (or compensated for i.e. by estimating fish age from biometric measurements) and full species inventories given in the final report. Fish from the Egyptian sites should be preserved for identification.

Reports

Recommendations on final report structure were proposed by Dr Flower.

Palaeolimnology

Given the patchy nature of the sediment core results (diatoms only present in some cores) it is preferable to produce one final report on this aspect of CASSARINA work. However, analyses will be only recently finished by May 1999 and we shall present reports in four sections - 1. lithostratigraphy, dating, pesticides, and trace metals, 2. diatoms and zooplankton, 3. pollen and 4. macrofossils - these sub-reports should be readily combined afterwards.

Modern monitoring

This work is primarily the responsibility of each partner country in North Africa and the suggested report structure is as follows:

1. *Introduction*:
Give the objectives of CASSARINA then outline the relevant responsibilities and activities for your country. (e.g. for Egypt, do the basic monitoring work, and analyse phytoplankton and ionic concentrations in water samples).

2. *Sites*:
Give an account of why the particular three sites (plus back-up site) were selected. Site diagrams to be supplied mainly by Dr Flower but more information is needed for M. Chitane). Give an account of the characteristics of each site, these are:

a. Climate, rainfall, temperature variation, seasonal averages for 1997-99.

b. Catchment characteristics of surrounding land-use and vegetation, details of groundwater, inflows, springs.

c. Birds and fish 'using' the lake.

d. Threats from pollution, reduced water supply etc.

e. Historical data, past bird numbers, fish data, old maps concerning changes in open water.

f. Publication references to any aspect of the study lake.

3. *Methods:*
Water chemistry and where appropriate refer to the 'protocol' report. Outline water sampling and vegetation surveys. Each country should describe their particular specialist technique(s).

4. *Results*
All reports should contain:

a. water chemistry. pH, temperature, conductivity, alkalinity, chl. *a*, etc. But the Egyptian report should note the results of replicate measurements made in their laboratory.

b. Vegetation transects, standard WORD Tables for all the data and with the dates when sampling was carried out (1997-late 1998). In addition construct summary histograms for each transect on each occasion.

In addition, the **specific** reports require:

For **Egypt**, this report should contain full chemistry data i.e. all four Tables as discussed above. Count data for all the phytoplankton samples given as tables and histograms. The CASSARINA water chemistry database - on EXCEL spread sheets - should be printed out and given as an appendix.

For **Morocco**, the data on zooplankton abundances need to be given in Tables for each site with species arranged vertically and sample dates horizontally. Histograms of the data are also required.

Tunisia, fish tables of lengths and weights. Fish species inventories, age determinations, calculation of condition factors and growth rates for key species at each site.

5. *Comparisons between sites:*
Give changes in mean variables between sites and changes in particular variable over time at each site.

6 *Discussion:*
Discuss the implications and significance of the results.

Conventions: Consistency in reports was emphasised:

Sites names should all be spelt similarly and data should be presented in the following order: SIDI BOU RHABA , ZERGA, (Khala), BOKKA, CHITANE, ICHKEUL, (Kelbia), KORBA, EDKU, BURULLUS and MANZALA, (Qarun). NB. Names in brackets are secondary sites. Text reports should be in MICROSOFT WORD and data in EXCEL spreadsheets. Data should be summarized in histograms where appropriate. Statistical analysis can be considered at the next workshop.

Dissemination and future work

Dr Flower asked partners to think about disseminating the results of the CASSARINA programme. Informing government and non-government organisations about our work is as important as writing papers. It was also necessary to think about a plan for CASSARINA II (see below).

Papers

Once the reports are all complete and the basic data validated we should plan a series of at least six papers with the group specified in ( ) to take lead roles. These ideas can be modified at the next workshop but BIODIVERSITY should be a main theme.

a. An introduction paper giving site details, sediment dating, field measurements and emphasizing the loss of M. Bokka and value of the work for monitoring environmental change in wetland lakes. (ECRC).

b. Phytoplankton and full chemistry - (Egypt).

c. Zooplankton in water and in sediment cores - (Morocco).

d. Diatoms, trace metal and pesticides. (ECRC).

e. Fish - a short paper on comparison of fish and growth rates at the nine sites - (Tunisia).

f. Pollen and macrofossils (note the need to collaborate with regard to paper 'd' concerning which papers report forams, ostracods etc. (Bergen).

IMPORTANTLY, monitoring data for 1999 can be added as an appendix so that tables for 1997/98 can be completed for the May 1999 report.

Additional work

The value of collecting some monitoring data for 1999 was emphasized and April/May 1999 was last suggested as the best date to collect additional data for water chemistry, phytoplankton and zooplankton, fish and vegetation transects (no livers for pesticide samples needed). The 1999 sampling in Egypt could be done during the sites visits during the last workshop.

Future funding

Dr Flower listed some possible sources but emphasised that CASSARINA II must include more sites, be biodiversity targeted, and use more diverse techniques and partner groups. The palaeoecological aspect of CASSARINA is largely finished and surveying aquatic vegetation with remote sensing is an obvious way forward.

Dr Flower asked each North African partner group to think about including more sites perhaps 12 in all of which approximately half can be running water (for Morocco several sites on the Mediterranean coast are needed).

a. Streams should be not more than 10 m wide and have some biological interest

b. They should support natural or semi natural vegetation.

c. Stream size is important, stretches for monitoring should be 100 m long and support a 200 m long vegetation transect ACROSS the stream so the surrounding landscape (woodland or shrubs, not agricultural crops) can be included.

d. They must be permanent but can be fresh or near seawater.

e. Sites that are significantly tidal, temporary, have no biological significance, or are grossly polluted or have been modified as part of civil engineering projects should be avoided.

Dr Baccar suggested that participants compile a list of sites with systematic characteristics shown in a table. Characteristics should be land type, site location and number, name, type, hydrology and chemistry, biological aspects, landuse, etc..

The personnel and roles of future personnel should be given in any preliminary submission to the new potential project.

Next meeting

The meeting began with a discussion about the date and content of the next meeting. Late May 1999 was agreed upon as the best date but this needs to be conformed by all participants. The value of collecting some monitoring data for 1999 was emphasized and April/May 1999 was suggested as the best date to collect additional data for water chemistry, phytoplankton and zooplankton, fish and vegetation transects (no livers for pesticide samples needed). The 1999 sampling in Egypt could be done during the sites visits during the last workshop if in May..

Content of the next meeting was briefly discussed and it was thought important to include the following topics:

1. Statistical analysis of data

2. Decisions about the form and content of papers to be published

3. Reconsideration of the quality of data and to check results of re-analysis for the problematic chemistry and phytoplankton samples.

4. Re-examination of the fish data: particularly growth rates estimates for each lake, species inventories and condition factors.

5. Report on the results of trace metal and pesticide analyses.

6. Consider the roles of people involved in CASSARINA II.

7. Report the results of 1999 monitoring

8. Future research and implementation of research results

Field visit

The workshop was closed by Dr Ramdani and during the afternoon and the 5th of December participants visited the Moroccan field sites.

CASSARINA

Change, Stress, and Sustainability: Aquatic Ecosystem Resilience in North Africa

THE FOURTH CASSARINA WORKSHOP

SUMMARY REPORT OF A WORKSHOP HELD AT THE INSTITUTE OF OCEANOGRAPHY, UNIVERSITY OF ALEXANDRIA, ALEXANDRIA, EGYPT, 18-20th MAY 1999

CASSARINA REPORT No. 5 (with provisional site maps)

Dr R J Flower (Editor)

Workshop participants: Dr. A. Fathy (chairperson), Dr R. J. Flower (UCL, UK), Dr. H. Abdelzaher (El Minia, Egypt). Dr A. Hussein (El Minia, Egypt), Dr. C. Ben Hamza and Dr M. Kraiem (Tunis, Tunisia), Dr. M. Ramdani (Rabat, Morocco), Dr H. H. Birks, Dr S. Peglar (Bergen, Norway).

July 1999

SUMMARY

During this workshop each partner group presented results of CASSARINA research topics relevant to their specific responsibilities. Each presentation was followed by a short discussion. Other sessions dealt with the formulation of scientific papers and on deciding how the project should evolve in 2000 and beyond.

1. Generally comprehensive reports were given on CASSARINA site descriptions, the water chemistry, phytoplankton, zooplankton, fish, vegetation, sedimentary diatoms, sedimentary pollen and sedimentary aquatic macrophyte remains.

2. It was agreed that more background referenced historical data are urgently needed for the CASSARINA lakes, especially for the Tunisian and Egyptian sites. Completion of a summary environmental change table for each lake is strongly recommended. Historical values for salinity are particularly important for the Egyptian lakes.

3. Maps for each of the nine lakes have been drafted (see appendix) and partners are asked to check and add information to the preliminary site maps (returning comments to Dr Flower by August 1999).

4. Vegetation transects: For consistency, it was agreed that all transects should be plotted as histograms of the common species against distance (m).

5. All botanical names must be checked with those in published floras and all environmental data used in CASSARINA documents should be referenced to sources(s).

6. There still remains a problem with quoting alkalinity and total hardness units, consistency is urged here. Additional sampling and chemistry are needed for the Tunisian sites. Trace metals in water samples results need further review.

7. Water level change data and epiphyton data are lacking for several Moroccan and Tunisian sites

8. It was agreed to accept the offer to publish a suite of CASSARINA papers in the Journal of Aquatic Ecology.

9. A final meeting was agreed for January 2000 in London. The aim is to review CASSARINA papers before publication and agree a strategy for funding further CASSARINA work that involves remote sensing and additional sites.

Introduction

This May 1999 workshop was convened six months before the end of the CASSARINA programme so that draft final reports could be presented and any outstanding data problems discussed.

The workshop was followed by a one day field visit to Lake Edku (17th May) and proceeded by a two day field visit to Lakes Burullus and Manzala (21st. and 22nd May). Vegetation data, water chemistry and zooplankton samples were collected as part of the CASSARINA monitoring programme.

Recommendations made in the fourth workshop represent the last major opportunity to correct errors and omissions in the final RESULTS reports to be submitted by each partner group at the end of 1999.

Tuesday 18th May start 10.15 am

Dr Fathy opened the meeting and continued with a presentation on the full nine lake water chemistry data set:

Water Chemistry

These data were presented in a new format according to agreements made at the third CASSARINA workshop, i.e. separate tables for field measurements, laboratory measurements and for derived data.

Routine measurements: Results were reported and points of difference are noted below:

In Sidi Bou Rhaba: Chla measurements made in the field were low compared with those obtained in the laboratory. Action: Drs Ramdani and Fathy to reconcile the differences. There are STILL some problems in consistency in Alkalinity measurements - these should all be in mg HCO_3 calculated from a 4.5 pH end point. Several very high total phosphate measurements were noted, these are probably in error and need to be checked - action Dr Fathy.

Merja Zerga: Some missing data here: action Drs Ramdani and Fathy to rectify.

Merja Bokka: It was noted that the SECCHI depth was 2.5 cm and that trace metal measurements were inconsistent.

Megene Chitane: Here there is a need to revise trace metal data and alkalinity measurements.

Ichkeul and Korba: it was requested that additional data be requested from other workers to improve the value of CASSARINA measurements.

Egyptian lakes: the data were adequate but note that SECCHI depths (missing in the 'RESULTS' report for November 1997) are given in the FIRST YEAR CASSARINA fieldwork reports.

Trace metals: There are some rather variable results here. In Bokka, trace metal concentrations are rather odd with very high Fe values but no Mn.

Ion Balances: Generally these were less than 10% in error and therefore satisfactory.

Salinity ranges: Where known for the Moroccan and Tunisian lakes, these should be communicated by Drs Ramdani and Kraiem to Dr Fathy. Note: always give the REFERENCE when ranges are given from the literature. NB. quote salinity in results EXCEL tables.

Overall comments: There is still a need for consistency concerning **alkalinity measurements** and **salinity** measurements. It is recommended to omit trace metal results where they are excessively variable and to check total phosphate measurements. Bicarbonate ion concentration should be given in the ion concentration results tables. **total** hardness and suspended matter (g/l) should also be given in the Tables. For paper writing, comparing **ratios** of ions in the samples with the ratios in SEAWATER is particularly important for showing which ions are conservative with regard to seawater (for example Na:Cl in seawater is 0.56). Action for Dr Fathy.

Zooplankton.

Dr Ramdani described the zooplankton populations of each lake. Common species and species turnover were described and unusual occurrences of species were noted. Species diversity was shown to change with salinity and habitat complexity. The absence of fish was noted at Chitane and Bokka and indicators of organic pollution (waste water) were found at Korba and Burullus.

Dr Ramdani requested more temperature data and it was suggested that species should be combined into ecological groupings. It was also suggested that more information on the biogeography and indicator value of zooplankton species should be included in any subsequent papers.

Fish

Dr Kraiem described the fish results: Species inventories were presented for each CASSARINA lake but these were incomplete for the three Egyptian sites. Urgent action for Dr Kraiem.

Interesting growth rate data were presented for Zerga and Ichkuel *Liza ramada* populations. Overall growth rate was higher in Ichkeul but Zerga fish were heavier in the autumn period. Ichkeul is relatively unproductive so the reasons for these differences are not simple. Urgent action: to assemble comparable data for the Egyptian sites.

There is an error in the June 1998 data for fish from Burullus Lake, all weight and length data are identical. These data must be checked with the original measurements: Dr Fathy to take action.

Epiphyton

Dr Flower reported on the diatom composition of epiphyton samples from the CASSARINA lakes. Species data were presented but seasonal trends are not clear at several sites because of lack of samples. Action: please check for samples from Merja Bokka or Korba. No samples were collected for 1999 from the Tunisian lakes (Dr Kraiem to collect 1999 samples)

Wednesday 19th May: 10.15

Site descriptions and landuse histories

Provisional maps of all nine CASSARINA sites are given in the appendix.

Morocco:

Dr Ramdani gave a detailed account of the sites and of the landuse changes (where known) occurring at the three Moroccan sites during the last ca. 100 years.

Sidi Bou Rhaba: The pool at the north end of the lake is seasonally dry and there is no communication with the Sebou River although this may have occurred in the past. The Sebou flows into the Atlantic immediately to the North of the lake. The *Eucalyptus* plantation at the lake was the first to be established in Morocco and dates to around 1920. A road was constructed isolating the north basin of the lake in 1917. The site was classified in 1964 as a Nature Reserve by BIRS (Bureau International de Recherche sur la Sauvagine). A small museum and training centre was established near the eastern shore of the lake in 1988.

Merja Zerga: A spatial map of the vegetation zones were recently constructed as part of the MedWet programme, this was shown. The Merja occupies a depression in Quaternary sediments and before 1955/56 only seawater was present in the southern part. Old maps show that the only source then of freshwater was springs and the Drader River (which inflows to the north eastern part of the lagoon). At this time *Salicornia* dominated the marginal vegetation. However, in 1956 the Nador Canal was build as part of a drainage scheme for the Gharb region and a supply of fresh runoff water was introduced to the southern part of the Merja. As such, the Merja was linked with the Sebou River system. This supply of freshwater promoted development of fringing macrophytes such as *Juncus* and *Phragmites*. This communities has however been severely depleted in recent years by over grazing and harvesting.

Merja Bokka: Old maps were used to trace the recent history of this lake. The earliest maps indicate that Bokka was an enlarged flood channel of the Sebou River. In the mid 1930s extensive planting of *Eucalyptus* began to the west of the lake as a result of French colonisation after 1928. French development plans also included local drainage schemes and before the 1930s Bokka was an extensive wetland region. Although

occasionally inundated by flood water, after the 1930s the wetland area was reduced and the area around the lake was used intensively for cereal crops. After 1960 more *Eucalyptus* was planted on the west side of the lake. Since the 1980s, flooding has been eliminated and the lake has been isolated from inflowing water.

Temperature and rainfall data: Data for the region from 1926-1956 were presented.

Vegetation transects: The vegetation transects showed no major changes at Merja Zerga and Sidi Bou Rhaba but at Bokka a major change has resulted from drainage of the lake: the lake area is now planted with commercial crop plants.

Overall comments: any known usage of pesticides at or around these lakes? *Action: Dr Ramdani.* NB Annual data on mean rainfall, temperature and prevailing winds is sufficient for the CASSARINA report. Data on lake level changes needed for each site infer these from vegetation transect water depths if stage boards were not used

Tunisia

Dr Ben Hamza gave a brief account of the Tunisian lakes.

Megene Chitane: This lake was ring fenced in 1992 to protect the surrounding vegetation. A new wooden fence has been constructed recently (1998). A diagram indicating hydrological aspects of the lake inflows was presented and features of the water chemistry of this acid lake were described.

Action: **More information is urgently needed for this site**: when was the land cleared for planting in the region to the east of the lake?, any references to previous work on the valley mire above the lake?, any dates for the start of cultivation within the catchment? Forestry Office records on stocking the lake and on introductions of plants are also needed. Any known use of pesticides?. Water chemistry data for the inflow springs should be included in the final CASSARINA report.

Ichkeul: Very little past information was given on this lake, more than 3000 m^3 of freshwater entered the lake annually before construction of the dams and more information about the changes in agriculture during the 20th century is needed for the final report.

Action: please provide these data and give a simple table to indicate the dates and types of hydrological changes (i.e. dates for the dam constructions).

Korba: The strong seasonal changes in this lake were described and a diagram of the ground water balance between freshwater and seawater was presented. Plans to increase seawater flushing are being considered but no detailed information was available. Again little information of agricultural changes was given. Also it is important to find out dates for waste water supply to the lake. Other projects on-going at this site should be referenced.

Action: For all the Tunisian sites dates and records of landuse changes at this site, particularly waste water input need to be researched and documented in the final

CASSARINA report. Data on lake level changes are needed for each site (for Ichkeul these are available elsewhere or infer these from vegetation transect water depths if stage boards were not used)

Vegetation transects: The results of vegetation survey transects were given and the problematic species of *Juncus* at Chitane was identified as *J. silvaticus*. However this is an old name for *Juncus acutiflorus*. *Juncus heterophyllus* is a genuine species; it is an aquatic plant that looks like *J. bulbosus*. Action: Dr Kraiem to find out more about the occurrence of this unusual plant. NB *Nymphaea* not *Nuphar* is present at Chitane.

Egypt

Drs Fathy and colleagues gave accounts of the three sites. The dominating effect of the Nile River was emphasized at these sites. Although a seasonal increase in irrigation water and the prevention of winter floods was referred to as major effect of the Aswan dam (completed in the mid 1960s), no specific or precise data were given on the associated hydrological changes. Furthermore, no precise accounts of other Nile regulation measures were given. The construction of barrages (1920s?) on the Nile branches should be documented as well as their effects. *Action: Dr Fathy to provide data for the final report.*

Edku Lake, Lake Burullus and Lake Manzala: No specific landuse data for the individual sites were given. One area of importance concerns the land reclamation progress at each site: since the 19th century large areas of each lake have been claimed for agriculture. It is important to know the dates of these major landuse changes. However a fairly detailed description of meteorological conditions over recent decades at each site was presented.

Action: Dr Fathy to provide referenced documentary accounts of changes at each lake since ca 1900. NB meteorological information can be simplified to graphs of annual means for temperature and rainfall; also prevailing wind directions.

Vegetation transects: The plant abundance data were given against time rather than distance (m). As agreed above primary data should be against distance. Botanical names should follow Loufty Boulos (1995) Flora of Egypt Checklist. Al Hadara Publishing. Zahran and Willis (1991) Vegetation of Egypt. is a good reference to ecological issues. Action: Dr Fathy.

Epiphyton**:** Dr Flower gave a brief account of the diatom epiphyton collected from each CASSARINA lake. Diatom species diversity was greatest in the Egyptian lakes but season changes were difficult to estimate because of sampling problems. These problems concerned differences in plant material sampled and more importantly samples were missing, especially from two lakes: Bokka and Korba. *Action: Drs Ramdani and Kraiem to check for additional samples for these sites.*

Overall comments on site descriptions, landuse change and vegetation transects:

Site Descriptions and Landuse change: Meteorological data should be summarized into graphs of annual mean rainfall and temperature for each site or each region as is

sufficient, with extreme values noted in the text or indicated by bars in the figures. Prevailing seasonal winds should also be noted please. Draft maps of each of the nine lakes were distributed for correction (see appendix).

Documentary evidence about landuse changes and historical background information are clearly inadequate for some sites and it is important to include this section in the Final Report. Dr Flower presented a table showing how these data could be summarized and presented (these should primarily concern catchment changes for the Moroccan and Tunisian sites but for the Nile fed lakes they should concern the surrounding landscape and the Nile regulation changes:

Period	Population change	Agricultural change	Pesticides	Water** pollution	Drainage/ Irrigation	Fish	Birds	Vegetation*	Lake area/depth
1980-2000									
1960-1980									
1940-1960									
1920-1940									
1900-1920									

**changes in fertilizers, sources of waste water, drain waters etc.
* marginal vegetation as well as agricultural crop changes in the catchment/surrounding landscape

NB For the Nile delta lakes there are also old salinity measurements available in reports dating from the 1950s at least. It is most important to reference and report these data.

Vegetation transect data: it was agreed to show the percentage abundances of the dominant species as shaded areas on single histogram bars and plotted against **distance**. Where there are changes in time along transects then separate histograms of specific distance points against **time** can be used. In addition, the water depth (where present) should be put on the same histogram.

Summarizing remaining tasks:

1. *Complete environmental change table*
2. *Check and add to the preliminary site maps (return comments to Dr Flower)*
3. *Plot vegetation transects against distance*
4. *Additional sampling and chemistry for Tunisian sites*
5. *Water level change data for Moroccan and Tunisian sites*
6. *Check all botanical names with published floras*
7. *Reference all data to original sources*

Thursday 20th May. Start 10.15 am

This day was mainly devoted to presentations of the palaeolimnological results.

Sediment Chronologies

Dr Flower gave a very brief summary of the sediment dating report prepared by Dr P. Appleby. The report was distributed to all partner groups. In summary only Burullus

core 1 was undatable but a chronology for the backup core BULR2 is available. Because of low rainfall, Pb was less satisfactory for dating than Cs but Cs dating alone gave higher estimates of sediment accumulation rates in EDKU3 and Burullus 2 cores.

Zooplankton

Dr Ramdani presented TILIAGRAPH generated diagrams showing the abundances of zooplankton remains in all nine cores. These were discussed and inferences were made about ecological changes and water quality variation in the past. Chitane was exceptional in several species that reflected the unusual acidic water at this site. The diagrams were very comprehensive but minor differences in labelling and groupings were noticed between diagrams. For the final report the need for consistency was emphasized. Also, placing ecological groupings on the horizontal axis is recommended. Separating taxa into plankton and benthic types or into salinity tolerant or intolerant would be useful.

Diatoms

Dr Flower presented TILIAGRAPH diagrams of diatom frequency abundances for 8 of the 9 sites. Diatoms were not preserved in Korba sediments and very poorly so in the Ichkeul core. Only Chitane and Sidi Bou Rhaba had good diatom preservation throughout the cores The diatoms were also grouped into salinity preference groups and plotted against depth. The groups were not expressed as salinity ranges. Action: Dr Flower to provide a salinity guide for the preference groups. The literature contains rather few attempts at equating salinity preference groups with salinity measurements. This is because of the difficulty in precisely defining distributional ranges from the literature. More recently, salinity optima are calculated for individual species using modern diatom water quality data sets. CASSARINA has no provision for generating a comprehensive modern data set and since many species do not yet have optima, salinity preference diagrams continue to be used here. One scheme (after Gasse et al. 1987) is:

Diatom preference groups	Salinity range (g/l)
halophobous	>0.0 - 0.5
oligohalobous	0.5 - 5.0
mesohalobous	5.0 - 20.0
Polyhalobous	20.0 - >30.0

Pollen

Dr Peglar presented pollen diagrams for six of the nine sites. In summary the Sidi Bou Rhaba core showed a decrease in Gramineae dating to the 20th century indicating a decline in local vegetation disturbance. Pollen in the Bokka core was very degraded but indicates an increase in cultivation and in water salinity intensity during the 20th century. Dinoflagellate cysts (marine?) occur at the base of the core and may indicate reworked sediment and/or a past marine transgression. *Eucalyptus* pollen is only recorded during the past 35 years. In Chitane there is a major organic input event recorded between 55 and 25 cm depth and this region of the core is characterized by large numbers of *Nymphaea* spines. The Ichkeul core shows little variation except

small increases in *Olea* and ruderal species in the last 50 years. In Lake Burullus the core shows increased tree and ruderal pollen above 40 cm depth but also strong decrease in pollen concentration indicating tree planting and a change in sediment sources, respectively. Dates are needed for the introduction of *Casuarina* and *Eucalyptus* to the region. A similar recent increase in tree pollen is recorded in the Manzala core but occurs rather earlier (**if the increases in *Casuarina* and *Eucalyptus* are synchronous in the two lakes and we have precise species introduction dates, we could evaluate more fully the dating profiles for these two cores).

Aquatic macrofossils

Dr H. Birks gave the results of macrofossil analysis of cores from 8 of the 9 lakes. The Sidi Bou Rhaba core shows a marked decline in *Chara*, oribatid mites and in *Plumatella* statoblasts abundances. Increasing salinity and/or siltation are possibly involved with these changes. The Merja Zerga core is unfinished but is mainly characterized by a large increase in bivalve shell debris at the core base. The Bokka core has high levels of *Chara* and mollusc shell in the 10-50 cm section of the core and the upper most section (*Zannichellia* with *Cruciferae* and urticoids) indicates more saline water and agriculture encroachment. In Ichkeul above about 20 cm the faunal remains indicate fresher conditions (also shown by the zooplankton record) which is *strongly at variance* with the known water quality changes: the salinity increased markedly since the late 1980s. The Burullus core indicates strongly marine conditions between 15 and 35 cm depth with fresher conditions in the core sections above and below. *Azolla nilotica* only recently disappeared at this site. In the upper section (above 15 cm) of the Manzala core there is also a marked change to fresher water conditions indicated.

Trace Metals

Results of analyses by A.. Bjune showed that zinc has increased slightly (no data below 85 cm?) in Sidi Bou Rhaba and also in the Zerga core. Higher levels of both lead and zinc occur in Bokka since ca 1960. Little change in contamination occurs in the Ichkeul core but in Korba lead concentration more than doubles in the top 5 cm. A similar increase occurs in the Edku and Burullus cores. However, metals decline in the upper part of the Manzala core and this could reflect the partial isolation of the core site area from waste water pollution by the extensive re-growth of emergent aquatic macrophytes in the past two decades.

Dr Flower presented some very preliminary data for metal contamination in fish and amphibians for the CASSARINA sites prepared by Dr J Boyle. Samples were too few to make any clear statements about contamination in particular lakes but levels of Pb and Zn were generally high. This may however be related to temperature and other factors rather than pollution *per se*. Dr Boyle could examine the results again when in receipt of growth rates for individual fish. Action Dr Kraiem to communicate with Dr Boyle on this matter (Email: jfb@liverpool.ac.uk)

Pesticides

Preliminary results for pesticide residues in six out of the nine lake sediment cores were given in a report by Dr A.. Peters. Two pesticides commonly occurred in the CASSARINA sediment core: hexachlorocyclohexane (HCH) and dichloro-diphenelethane (DDE, a product of DDT). Relatively high levels were found in Sidi Bou Rhaba and Bokka recent sediments. Chitane was unusual in that peak in pesticide residue values occurred in sediment dated to around 1980. There was some indication that residues has also recently decreased marginally in the Edku and Burullus cores. There was some discussion about the sources of pesticides in Chitane, since the catchment is mainly semi-natural vegetation with one small field for crops. Atmospheric sources could be significant at this site.

Action: Dr Kraiem was asked to enquiry about pesticide usage in the Chitane region by the Tunisian Forestry authorities.

Statistical analysis

In order to classify sites and to test hypotheses about estimating ecological 'resilience' at each site Dr H. Birks gave a brief account of some of the numerical methods that can possibly be applied to the CASSARINA data.

Data sets were exchanged between each group of CASSARINA workers and numerical analyses will be carried out at the Botanical Institute, Bergen. Excel version 2 was recommended are the preferable format for data exchanges.

Final Report issues

Final Report format: should have the CASSARINA logo on the front cover (white) and the title of the Project and the project code (see Report 5A), have the secondary title: 'FINAL REPORT' and date, the title of the Report: e.g. Site descriptions for the Egyptian lakes and results of water chemistry and phytoplankton for the CASSARINA Lakes. Report authors and address. The report should be black ring bound with a clear plastic over-cover.

Publications

An agreement has been made with the Editor of the journal Aquatic Ecology to publish a suite of papers resulting from the CASSARINA work. All participants received copies of the guide to authors for Aquatic Ecology. A deadline of February is set for these papers and the following format was agreed:

Modern ecology:

Change Stress and sustainability: Aquatic ecosystem resilience in North Africa: an overview of the CASSARINA Project. R. Flower (co-ordinator)

Aquatic vegetation and documentary records of recent (post ca 1900) environmental changes affecting CASSARINA lakes. Dr M. Ramdani (Institute Scientifique, Rabat) and others.

Water chemistry, phytoplankton and zooplankton in CASSARINA lakes. Dr A. Fathy (El Minia University, Egypt) and others.

Fish species in the CASSARINA lakes: growth rates and contamination levels. Dr M. Kraiem, Tunis University) and others.

Palaeoecology.

Constructing sediment chronologies and mineral sediment accumulation rates for the CASSARINA lakes. Drs P. Appleby & J Lees, UK.

Zooplankton remains in sediment cores from the CASSARINA lakes. Dr Ramdani, (Institut Scientifique) and others

Diatom evidence of recent environmental change and recent contamination records for the CASSARINA lakes. R Flower and others

Macrofossil evidence of recent environmental change in the CASSARINA lakes. Dr H.H.Birks (University of Bergen, Norway) and others.

Aquatic ecosystem change and resilience at the CASSARINA lakes: numerical analysis of the biological trends and gradients. H.J.B. Birks & H. H. Birks (Norway)

*At this stage, depending on contribution length, the pollen data may be placed elsewhere: with macrofossils or with the paper on site descriptions, aquatic vegetation and documentary evidence of recent environmental change, or may stand alone.

Close of the Workshop 5.00 pm 20th May, 1999

All participants were thanked for their contributions and partners were invited to attend a short final workshop in London during January 2000 to finalize paper writing and to review how to fund the next phase of CASSARINA research.

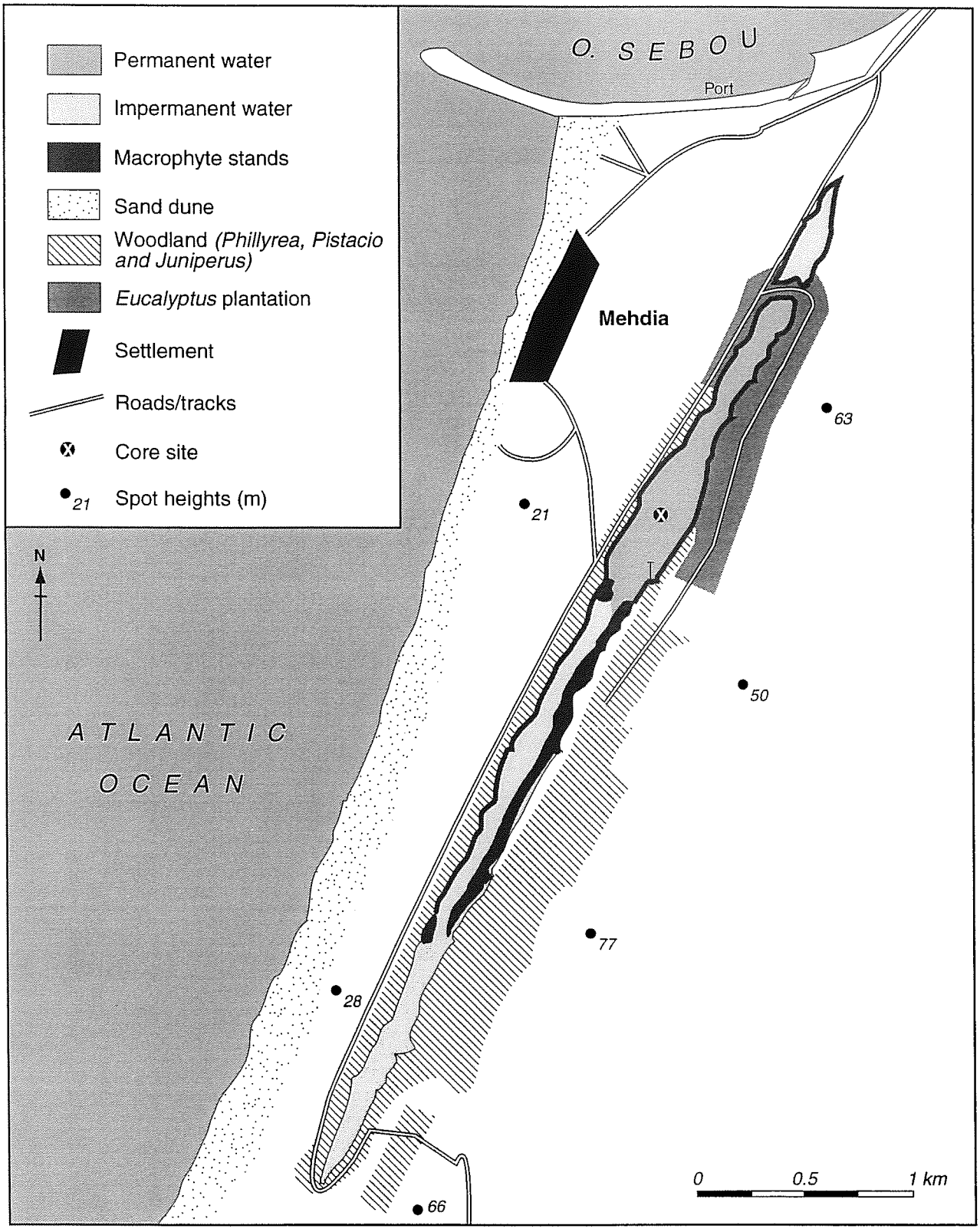
Acknowledgements

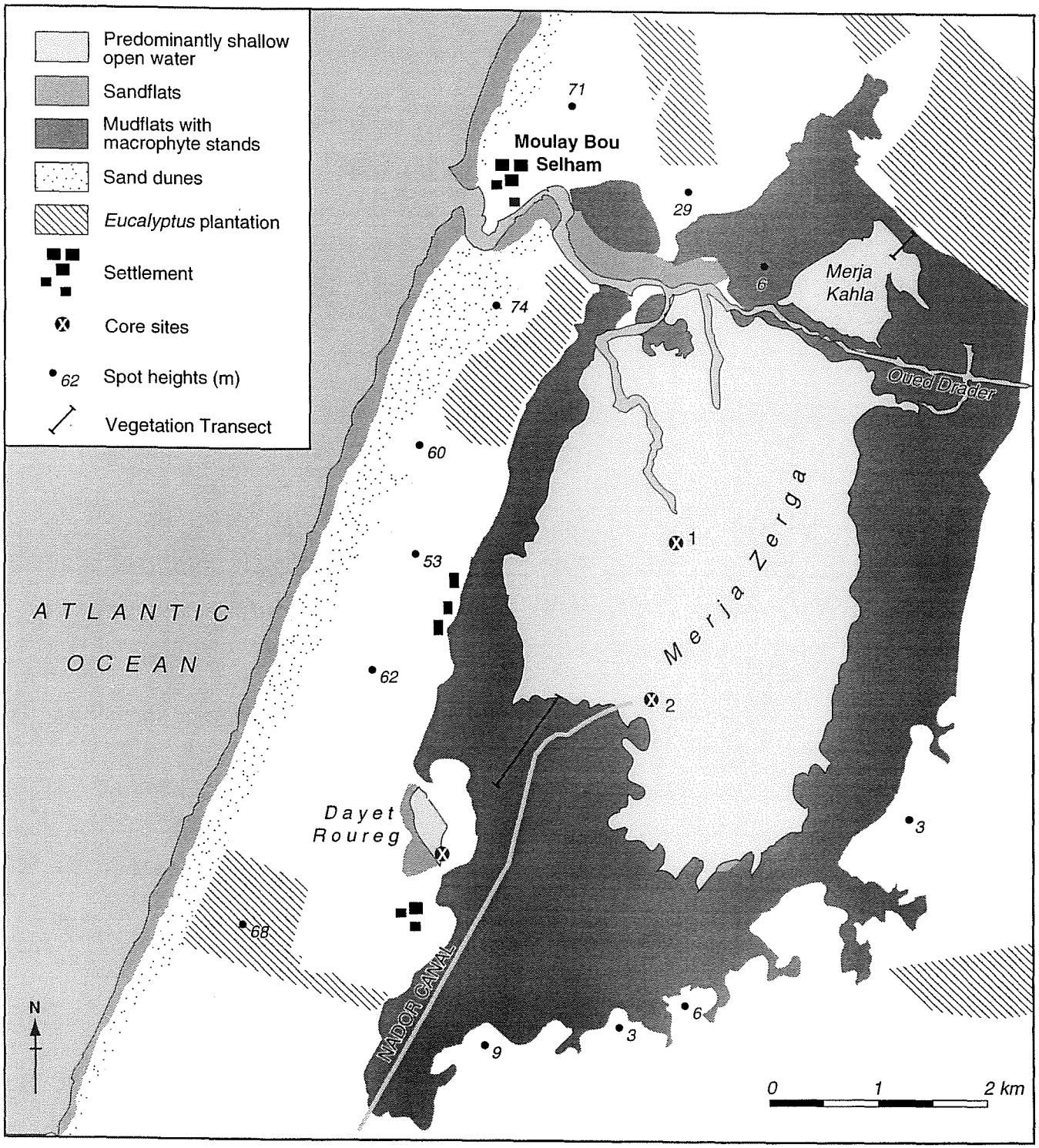
We thank the authorities at the Universities of El Minia and of Alexandria for providing the facilities that made this workshop possible.

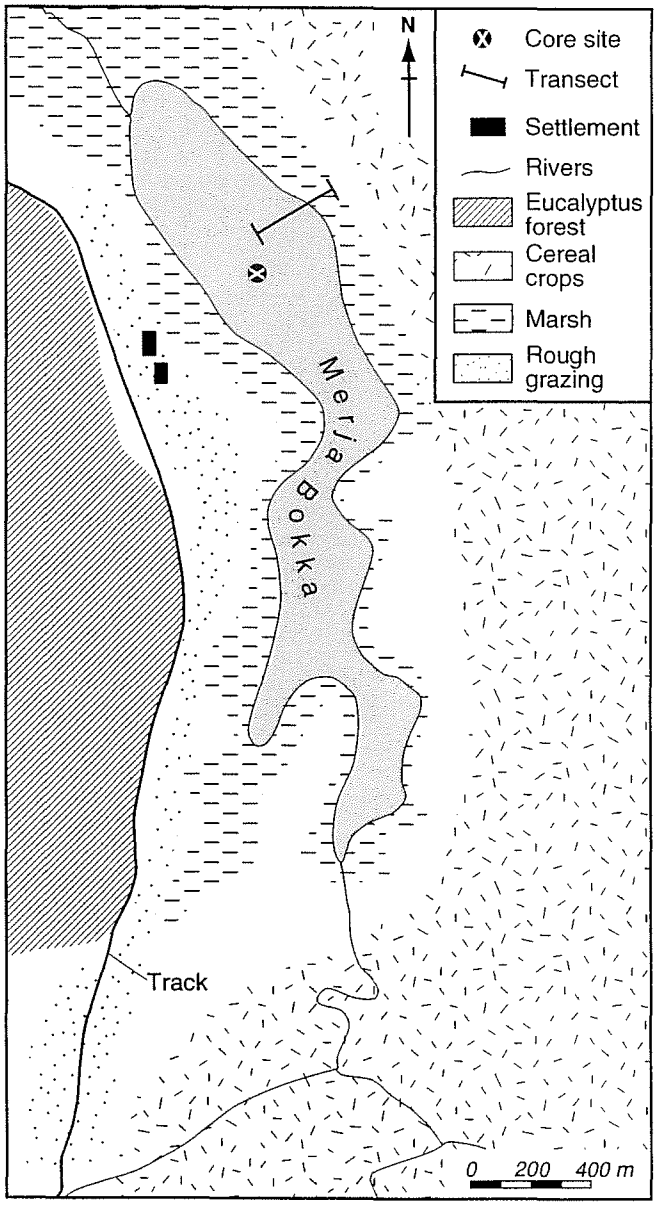
-Appendix -

Provisional maps of the nine primary CASSARINA sites

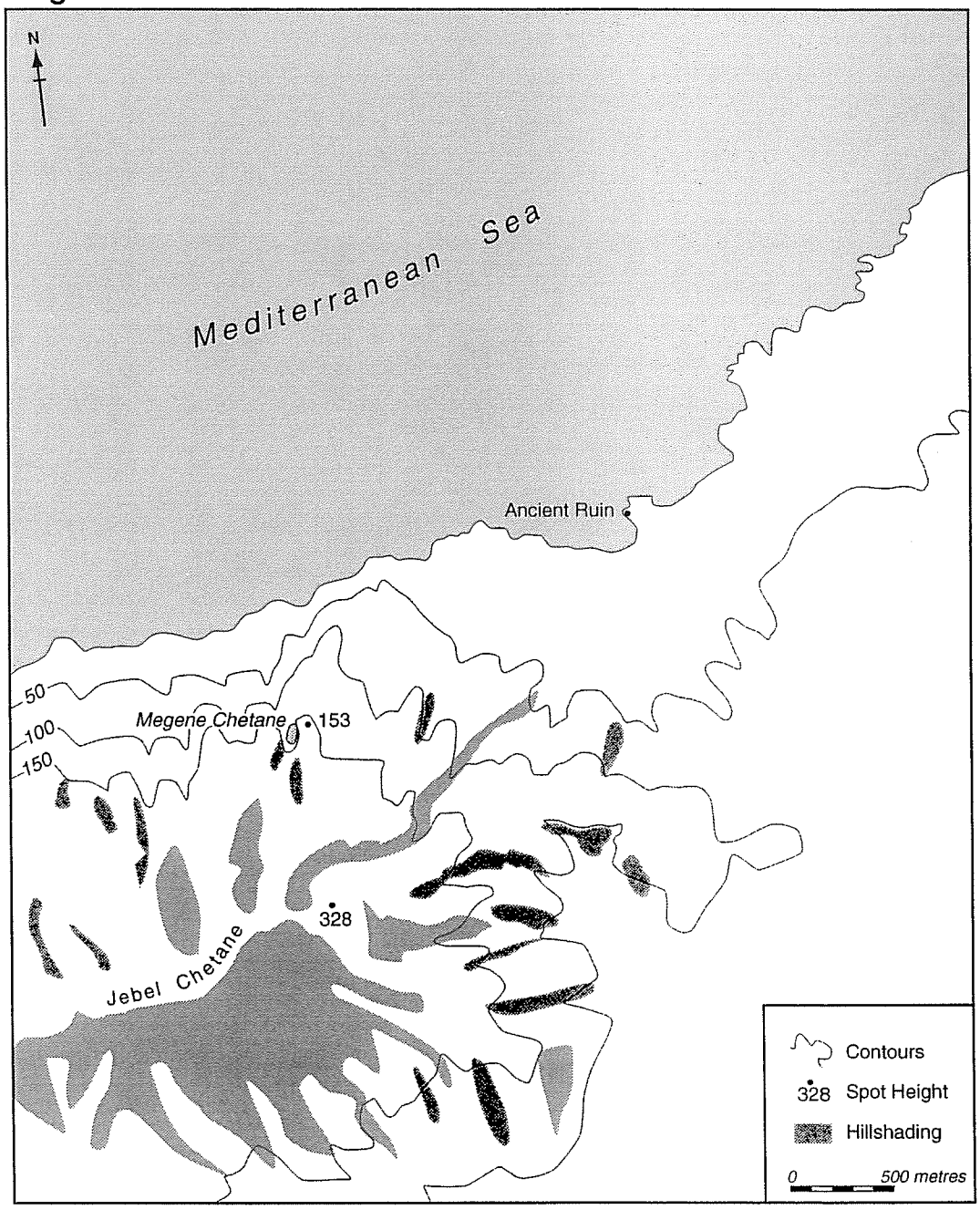
Merja Sidi Bou Rhaba

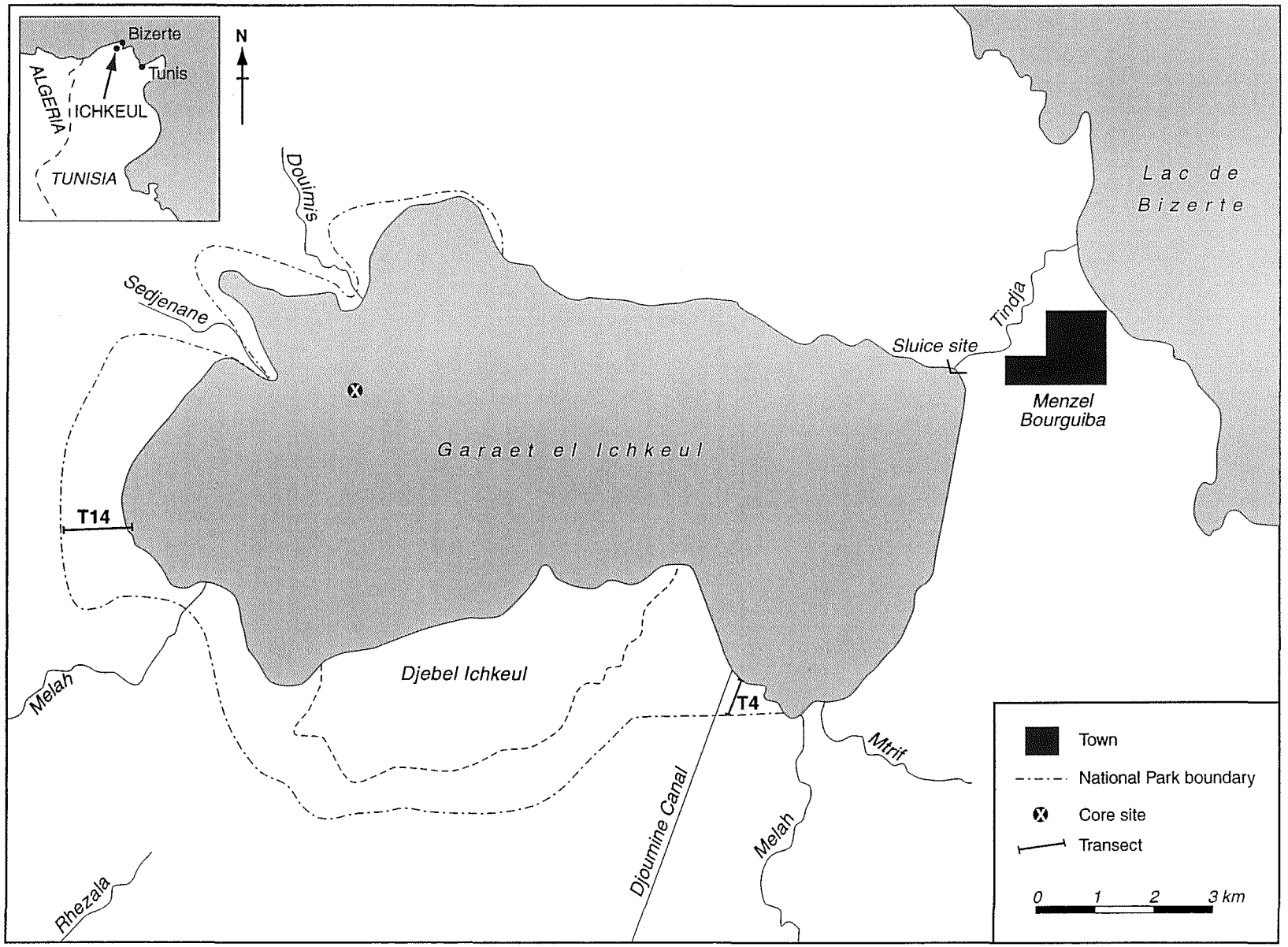



Predominantly shallow open water
Sandflats
Mudflats with macrophyte stands
Sand dunes
Eucalyptus plantation
Settlement
Core sites
62 Spot heights (m)
Vegetation Transect
71
Moulay Bou Selham
29
6
Merja Kahla
74
Oued Drader
60
1
53
Merja Zerga
ATLANTIC OCEAN
62
2
Dayet Roureg
3
68
NADOR CANAL
6
3
9
N
0 1 2 km

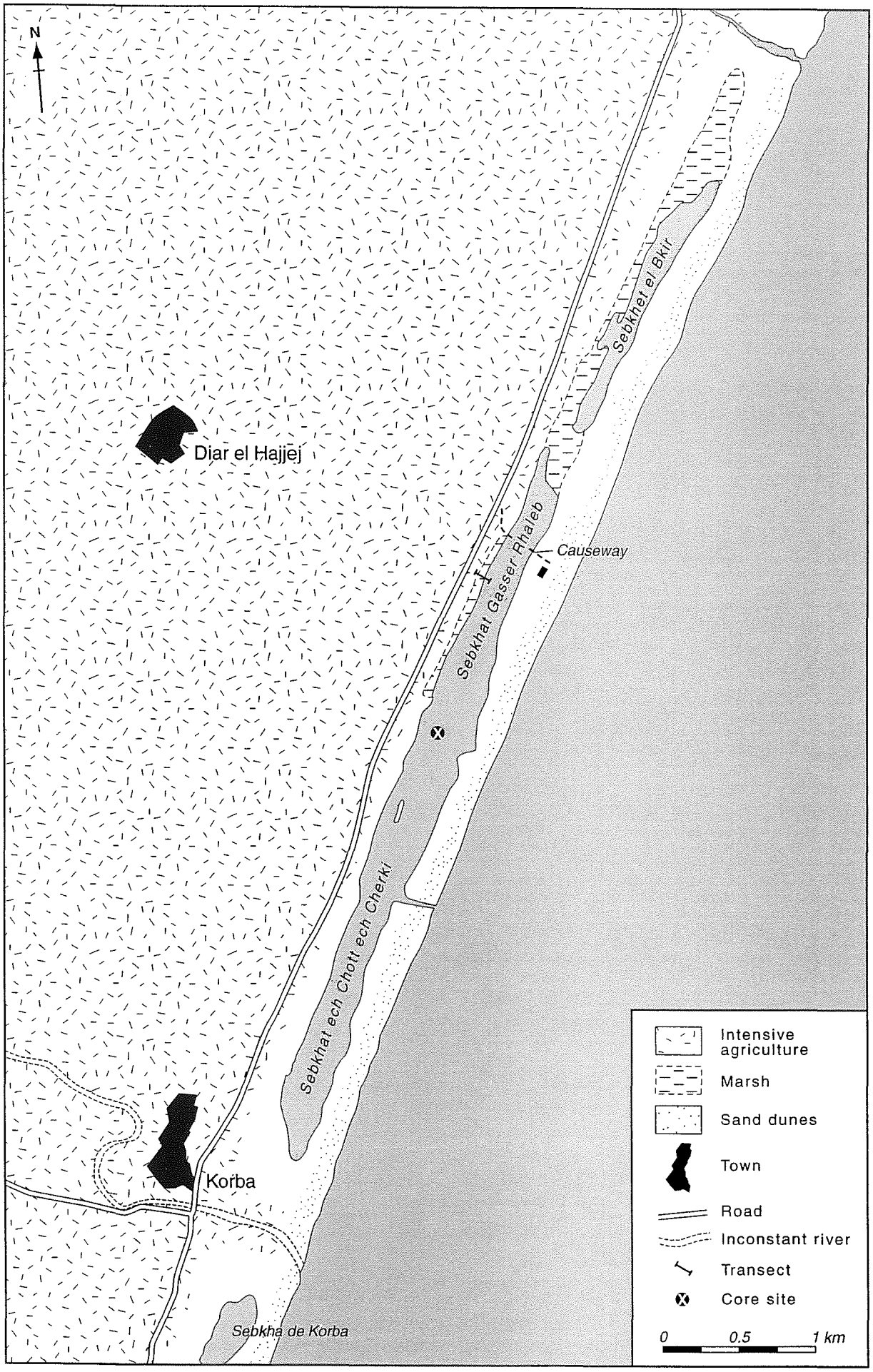

N
Core site
Transect
Settlement
Rivers
Eucalyptus forest
Cereal crops
Marsh
Rough grazing
Merja Bokka
Track
0 200 400 m

Megene Chetane

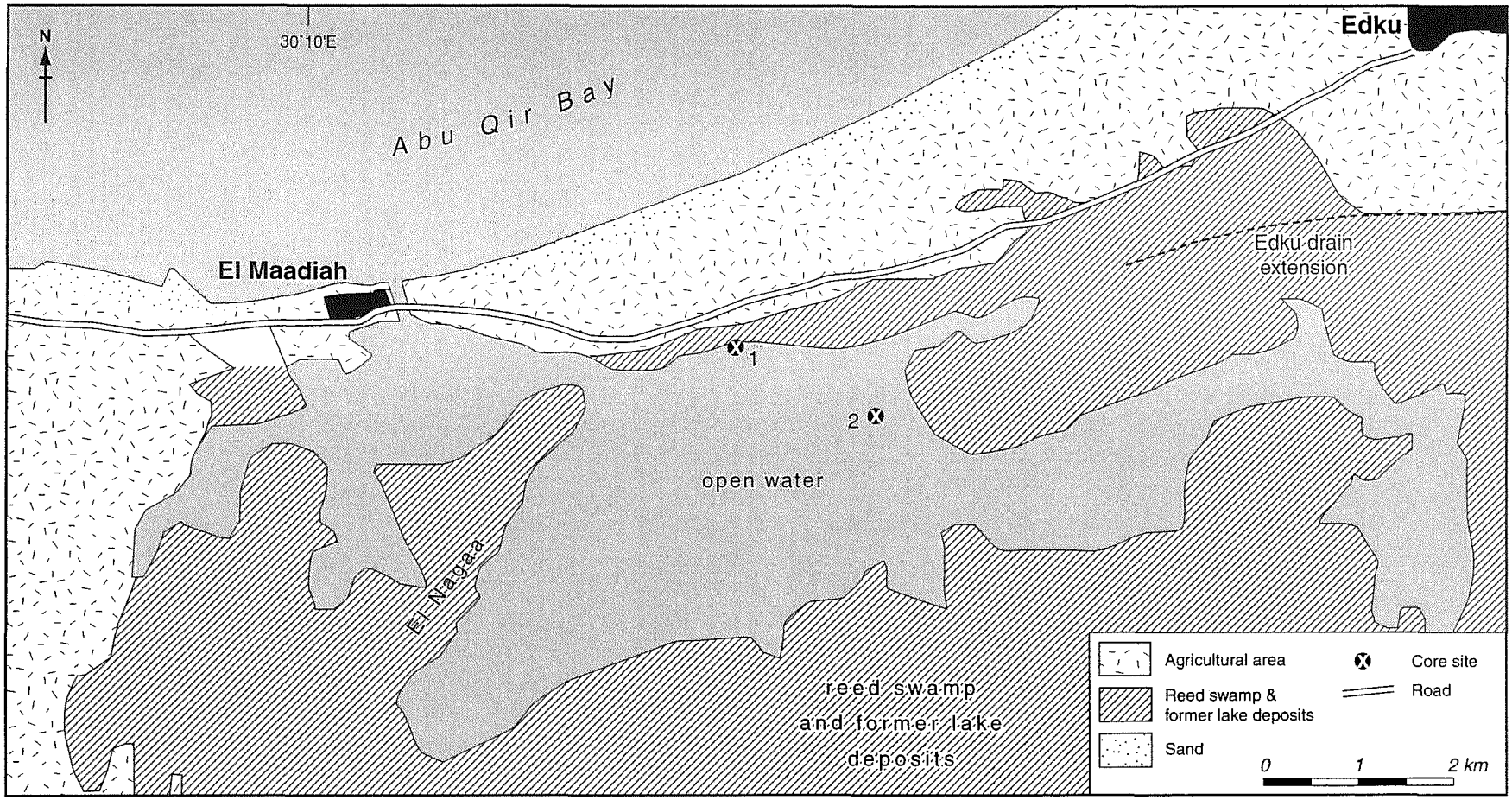



Bizerte
Tunis
ICHKEUL
ALGERIA
TUNISIA
N
Douimis
Sedjenane
Lac de Bizerte
Tindja
Sluice site
Menzel Bourguiba
Garaet el Ichkeul
T14
Djebel Ichkeul
T4
Melah
Mtrit
Djoumine Canal
Melah
Rhezala
Town
National Park boundary
Core site
Transect
0 1 2 3 km

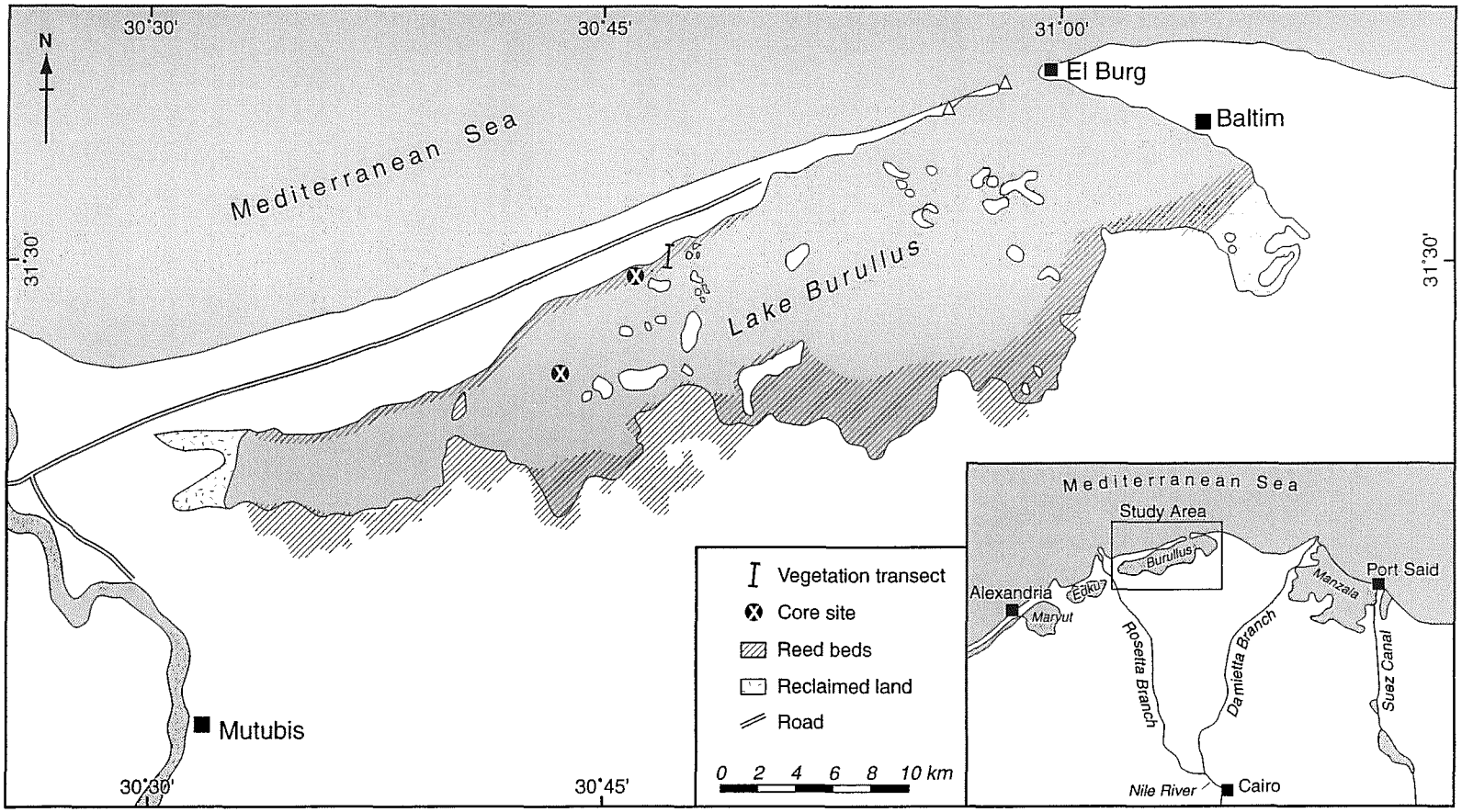
Lake Korba


N
Diar el Hajjej
Sebkhet el Bkir
Causeway
Sebkhat Gasser Rhaleb
Sebkhat ech Chott ech Cherki
Korba
Sebkha de Korba
Intensive agriculture
Marsh
Sand dunes
Town
Road
Inconstant river
Transect
Core site
0
0.5
1 km

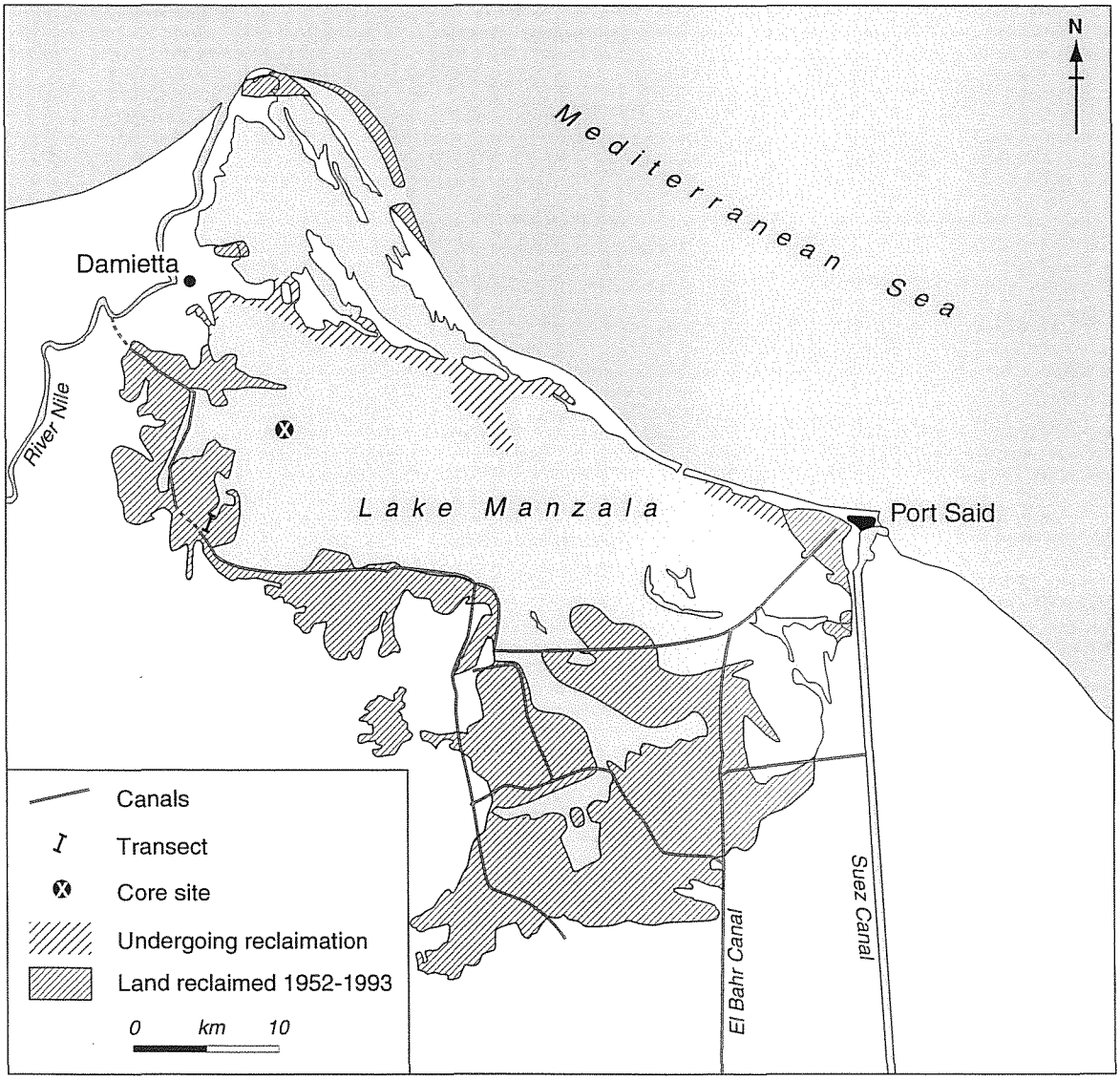
Lake Edku


N
30°10'E
Abu Qir Bay
Edku
El Maadiah
Edku drain
extension
1
2
open water
El-Nagaa
reed swamp
and former lake
deposits
Agricultural area
Reed swamp &
former lake deposits
Sand
Core site
Road
0
1
2 km

Lake Burullus



Lake Manzala



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1998. R. J. Flower (editor) The Second CASSARINA Workshop. A workshop held to discuss the results of the first year of the project. Tunis February 1998. CASSARINA Report Number 2. ECRC Report Number 48.

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1999. R. J. Flower (editor). The Third CASSARINA Workshop. A workshop held to discuss the results of the second year of the Project. 2nd to 5th December, Rabat. CASSARINA Report Number 2. University College London.