Euro-limpacs

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RE	Restricted to a group specified by the consortium (including the Commission Services)	
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Summary

This report, 'Deliverable 100: Further description of wetland sediment core analysis', follows on from 'Deliverable 59: Report summarising preliminary analyses of wetland sediment cores' which was submitted in month 18 and summarised progress on the three activities planned for the first twelve months in Work Package 3, Task 3.2, Wetland palaeoecology: 1- Selection of wetland site, 2 - Reconnaissance and collection of cores, and 3 - Sampling and processing of cores. This task aims to study a single key site to develop a new palaeoecological method for exploring long-term, nutrient-climate change interactions from sediment records and long-term data-sets in wetlands. The selected study site is Boxford Water Meadows (UK grid reference SU 428719), a Site of Special Scientific Interest (SSSI) which comprises a series of flood pastures and disused water meadows along the River Lambourn, Berkshire, UK.

Deliverable 59 included very preliminary data as the cores were only collected in April 2005. Therefore, here we provide a fuller description of the wetland sediment core analysis (Activity 5). The report focuses on presentation of the preliminary diatom, cladocera and spheroidal carbonaceous particle (SCP) data from a 90 cm Russian sediment core, BOXF1.

Diatom analysis was undertaken at UCL on 18 sub-samples at approximately 5 cm intervals throughout the core. Diatoms were present in all samples although at varying degrees of preservation. Three zones were identified in the diatom record: Zone 1 was dominated by non-planktonic forms, Zone 2 saw higher abundances of planktonic taxa that may signal an increase in water level and Zone 3 saw the expansion of taxa that may reflect an increase in productivity. Cladocera analysis was undertaken at NERI on 10 sub-samples at 10 cm intervals throughout the core. The whole core was dominated by macrophyte associated and benthic chydorids indicating low water level through the period represented by the sediment record. Three zones were identified: Zone 1 contained very few cladocera fragments, Zone 2 saw higher abundances of *Alona affinis* and *Acroperus* which could indicate an increase in water level, and Zone 3 saw the disappearance of *Alona affinis* and expansion of *Alona quarangularis* which may indicate a reduction in plant cover typically associated with an increase in nutrient concentrations. There is reasonable agreement between the timing and nature of the main shifts in the diatom and cladocera assemblages although both sets of data are difficult to interpret in the context of hydrological fluctuations or productivity changes. A further search of the ecological literature is required to interpret the findings more fully. UCL have screened the core for ostracods and molluscs but unfortunately only a few shells and fragments were found and ostracods were generally rare and poorly preserved.

Analysis of SCPs in 16 samples has been completed by UCL in order to establish an approximate chronology for the core. Preliminary results indicate that the last 150 years lie in the top 25 cm. The SCP data will be verified and a full interpretation of the results will be available by month 36. Sub-samples are currently being prepared for radiometric dating to provide a further independent chronology for the core. The availability of instrumental records will be explored and there may be potential to compare outputs with the INCA nutrient models of the Lambourn catchment developed at University of Reading (link to WP6) and hydrological monitoring data from the LOCAR project.

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Introduction

Work Package 3, Task 3.2, Wetland palaeoecology aims to study a single key site to develop a new palaeoecological method for exploring long-term, nutrient-climate change interactions from sediment records and long-term data-sets in wetlands.

This report builds on Deliverable 59: 'Interim report summarising analyses of wetland sediment cores' which summarised progress on the Activities 1 to 3 planned for the first twelve months and focused on presentation of the preliminary data from the first phase of analyses of the sediment cores. Here we report on the laboratory analysis of the selected master core, a 90 cm Russian core BOXF1 including diatom, cladocera and spheroidal carbonaceous particle (SCP) data (Activity 5).

Study site description

Boxford Water Meadows (UK grid reference SU428719) is a Site of Special Scientific Interest (SSSI) covering an area of approximately 14 hectares (Figure 1 & 2). The site comprises a series of flood pastures and disused water meadows along the River Lambourn. The site overlies alluvium and the soils consist of calcareous alluvial gleys. Traditionally the water meadows would have been managed as pasture for cattle or horses with controlled flooding along specially constructed carrier streams providing a supply of warm water in spring to encourage early growth of the sward. The meadows have not been grazed, with the exception of the southern-most field, for around 40 years and the vegetation types reflect both this and the gradient in soil moisture. The plant communities grade from *Carex acutiformis* swamp-fen to *Cynosurus cristatus-Caltha palustris* flood-pasture and water-meadow vegetation southwards across the site.

Figure 1 Aerial photograph of Boxford Water Meadows, Berkshire

a) **b)**

Figure 2 Photograph of a) coring site at Boxford Water Meadows, b) River Lambourn adjacent to coring site

Core description

A total of eight gouge cores were taken along a south to north transect on the west side of the river on 27th April 2005 (Figure 3). Coring site 8 at the northern-most end of the transect (grid reference SU 42880, 72213) was selected as the site for further study owing to it's location on the site of an old channel, the depth of sediment accumulation and the interesting stratigraphic changes observed. Hence, two overlapping drives with a standard Russian corer were taken and the core was coded BOXF1. Drive 1 covered the section from the sediment surface to a depth of 50 cm and drive 2 covered the section 40-90 cm (Figure 4). The upper 25 cm of drive 1 was comprised of dark brown sedge peat above a lighter brown peat with abundant vegetation remains. Drive 2 captured the lighter brown peat from 40 to ~80 cm below which a white coarse chalk aggregate was present. The core was extruded into plastic holders, wrapped in cling-film and transported to the laboratory for analysis.

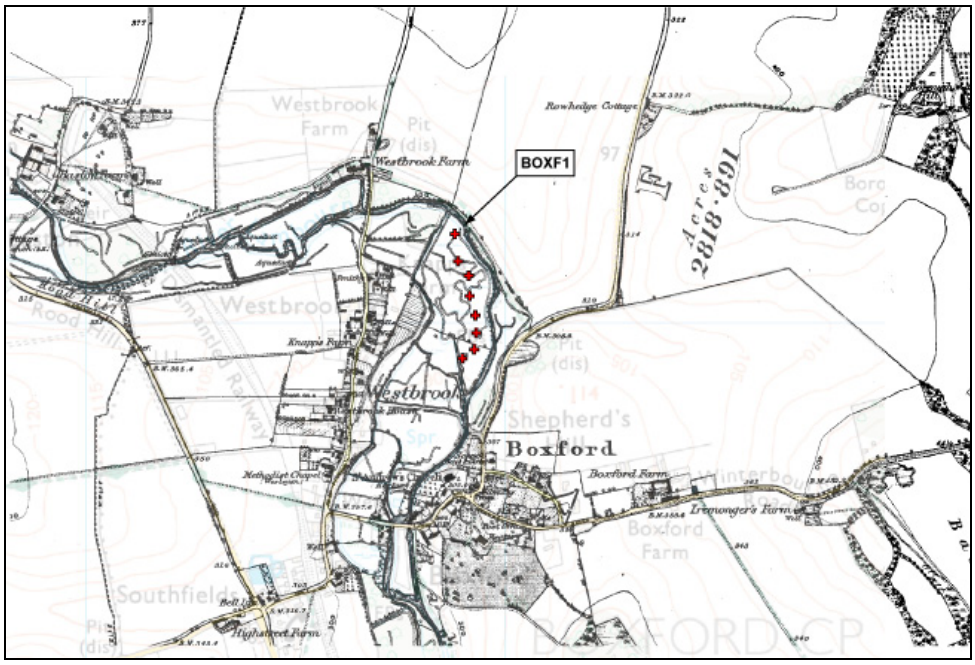

Figure 3 Map showing the location of the gouge coring transect and site of the Russian core BOXF1. The GPS coordinates of core BOXF1 and the core transect are overlaid on an Ordnance Survey map from 1882. Channels within the water meadows on the west side of the river are clearly visible.

a) **b)**

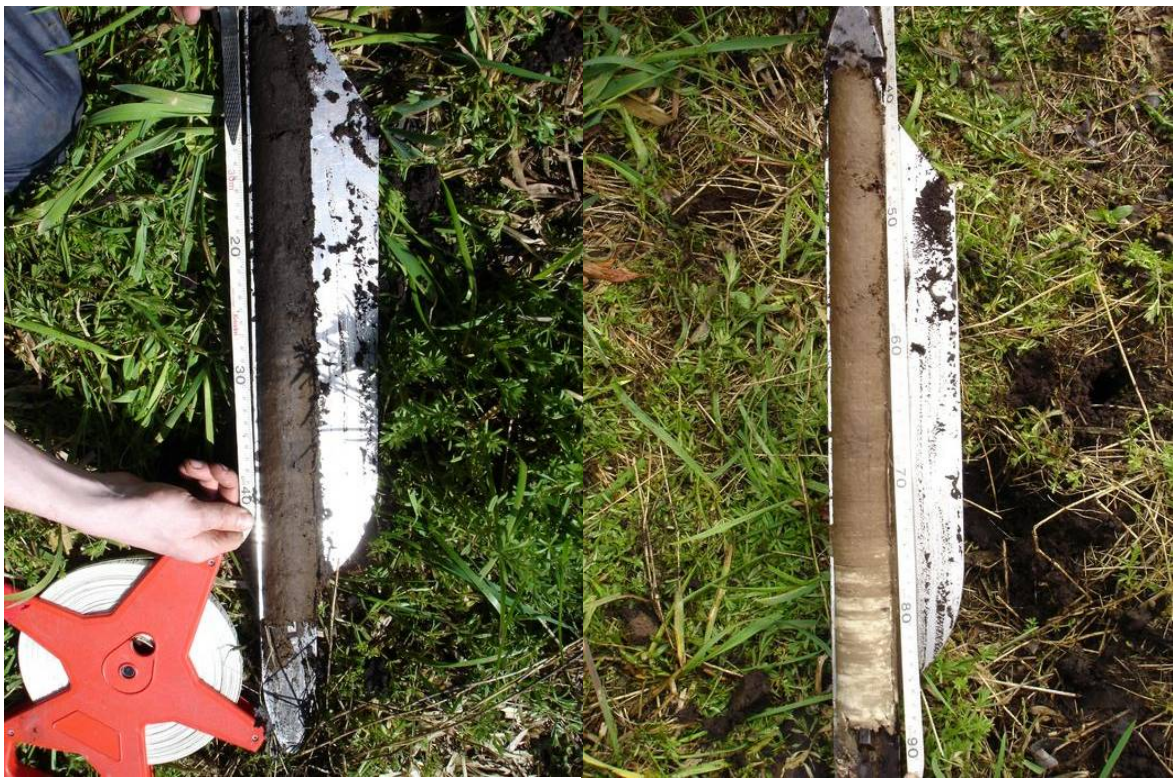

Figure 4 Photographs of Boxford Water Meadows core BOXF1, a) drive 1 (0-50 cm) and b) drive 2 (40-90 cm)

Activity 5: Laboratory analyses of sediment cores

Stratigraphy

In the laboratory, drive 1 of core BOXF1 was subsampled at 0.5 cm contiguous intervals from 0-50 cm and drive 2 was subsampled at 1 cm contiguous intervals from 50-90 cm. The main characteristics of the sediment and any stratigraphic changes were noted. The percentage dry weight (DW %) which gives a measure of the water content of the sediment, and percentage loss on ignition (LOI 550) which gives a measure of the organic matter content were determined for all subsamples, and carbonate content was determined for the section 40-90 cm only. All analyses followed standard techniques (Dean, 1974).

The results (Figure 5) show that the upper 25 cm is a dark brown, sedge peat with abundant root linings. The uppermost 16 cm has a very high organic content of ~80%, gradually decreasing to ~30% over the section 16-25 cm. The colour grades from dark brown to a lighter brown at ~25-30 cm and the light brown sedge peat then continues for a large section of the core sequence from ~25-70 cm. Organic matter content remains at ~30% from 25-57 cm but then declines to ~10-15% coincident with the presence of mineral fragments and chalk particles in the section 58-70 cm. From 70-80 cm, the sediment becomes lighter in colour and is comprised of a chalky mud matrix. The carbonate content fluctuates between ~10-20% over the section 40-80 cm. At 80 cm there is a marked change to a coarse chalk aggregate which is white in colour and consequently carbonate content rises to ~30-35%. The lowermost 10 cm are comprised of a fine grained calcareous mud with chalk clasts.

Diatoms

Eighteen sub-samples at 5 cm intervals throughout the core were prepared and analysed for diatoms at UCL using standard methods (Battarbee *et al*., 2001). Diatoms were present in all of the samples although at varying degrees of preservation, and in the 14.5-15 cm sample too few remains were present for counting to proceed. At least 300 valves were counted in each sample except where preservation was exceptionally poor and in some cases only ~100-200 valves could be found on the whole slide (Table 1). The diatom data are expressed as percentage relative abundance and Figure 6 summarises the stratigraphic changes in the common taxa. Zones based on cluster analysis are shown to facilitate description and allow comparison of the diatom and cladocera data.

A total of 85 diatom taxa were observed in the core although individual samples were not particularly diverse containing between 21 and 38 taxa (Table 1).

Table 1 Summary of the samples analysed for diatoms in BOXF1

Sample depth (cm)	Preservation	No valves counted	No taxa
0.5-1	Poor	331	24
4.5-5	Very poor	103	23
9.5-10	Very poor	212	36
14.5-15	Very poor (not possible to count)	0	0
19.5-20	Very poor	273	29
24.5-25	Good	307	33
29.5-30	Good	362	38
34.5-35	Very poor	110	21
39.5-40	Fair	337	38
44.5-45	Poor	316	28
49.5-50	Fair	315	35
54.5-55	Fair	326	31
59-60	Fair	326	33
64.5-65	Very poor	224	27
69-70	Poor	308	32
74.5-75	Very poor	208	24
79-80	Poor	318	32
88-90	Good	324	22

Cluster analysis identified three major zones:

Zone 1 (89-57 cm). The frustules in the lowermost sample (88-90 cm), the most calcareous section of the core, were very well preserved but in contrast the other samples in zone 1 contained high amounts of mineral matter and relatively few complete frustules. This zone was dominated by benthic *Fragilaria* taxa, namely *Fragilaria pinnata, Fragilaria brevistriata* and *Fragilaria construens* var *venter*, cosmopolitan taxa commonly observed in relatively productive, alkaline shallow waters. Other taxa present were *Cocconeis* (*disculus* and *pseudothumensis*), *Amphora pediculus*, a number of small *Navicula* species (*subatomoides*, *menisculus* and *subrotundata*), *Gyrosigma attenuatum* and *Achnanthes clevei*. These are all non-planktonic forms commonly found attached to plant, stone or mud surfaces.

Zone 2 (57-15 cm). Diatom preservation was highly variable in this zone with a number of well preserved samples containing abundant diatom remains but also some rather sparse samples, notably 34.5-35 cm and 19.5-20 cm (Table 1). As in Zone 1, the assemblages were dominated by *Fragilaria pinnata, Fragilaria brevistriata* and *Fragilaria construens* var *venter*. However a number of taxa that had been relatively abundant in Zone1 decreased, particularly *Cocconeis disculus, Cocconeis pseudothumensis, Amphora pediculus, Navicula menisculus, Navicula subrotundata, Gyrosigma attenuatum* and *Achnanthes clevei.* Conversely, *Synedra ulna*, *Cyclotella radiosa* and

Meridion circulare increased in Zone 2. *Cyclotella radiosa* is a planktonic species whilst *Synedra ulna* and *Meridion circulare* are common river diatoms and therefore the expansion of these taxa could signify an increase in water level from inputs of river water to the wetland.

Zone 3 (15-0 cm). The diatom frustules in the upper zone, which coincides with the dark brown sedge peat, were poorly preserved. The benthic *Fragilaria* taxa remained dominant in all except the surface sample. The most notable change in this zone was the marked increase in *Achnanthes lanceolata* and *Fragilaria nitzschioides* and to a lesser extent in *Fragilaria capucina*. A literature search of the ecology of these taxa is required to interpret the observed shifts but they may indicate an increase in nutrient levels. Conversely the relative abundances of *Synedra ulna* and *Cyclotella radiosa* declined which may reflect lower water levels than in Zone 2.

Cladocera

Ten sub-samples at 10 cm intervals throughout the core were prepared and analysed for cladocera at NERI (Table 2). The samples (approximately 1 g wet weight) were boiled in 30 ml 10% KOH for ~20 min and subsequently kept cold for no longer than two weeks before counting. After manual filtering, fragments larger than 80 µm were counted and identified using a stereomicroscope and an inverted light microscope. For the identification, keys of Frey (1959), Margaritora (1985), Hann (1990), Røen (1995) and Flössner (2000) were used. During the counting process, any ostracod and bryozoan statoblast (a seed-like resting stage of moss animals) remains were also noted and the numbers are recorded in Table 2. The cladocera data were expressed as numbers per gram dry weight and were subsequently converted into relative percentage abundance values. Figure 7 summarises the stratigraphic changes in the common taxa. Zones based on cluster analysis are shown to facilitate description and allow comparison of the diatom and cladocera data.

A total of 19 different types of remain were observed and individual samples contained between 5 and 11 types (Table 2). The whole core was dominated by macrophyte associated and benthic chydorids and no pelagic taxa were present indicating low water level through the period represented by the sediment record. Cluster analysis identified three major zones:

Zone 1 (90-70 cm). This zone contained very few cladocera fragments with only 5 types of in the lowermost sample and no remains in the 79-80 sample. The basal sample, the most calcareous section of the core, was comprised of *Pleuroxus* spp and *Chydoridae* spp.

Zone 2 (70-25 cm). Each sample contained between 8 and 10 different types of remain. *Chydoridae* spp continued to be abundant but there were higher abundances of *Alona affinis* and *Acroperus* relative to Zone 1 which could indicate an increase in the water level as these species are typically associated with macrophytes or with the sediment around macrophytes, and aquatic plants would need sufficient water depth to survive.

Zone 3 (25-0 cm). The samples in this upper zone, coincident with the dark brown sedge peat, contained between 8 and 11 different types of remain. The most notable changes were the disappearance of *Alona affinis* in the uppermost samples and expansion of *Alona quarangularis*. Whilst cladocera remains have not previously been analysed in wetland complexes such as Boxford Meadows, in lakes this shift would indicate a reduction in plant cover typically associated with an increase in nutrient concentrations. Therefore in recent times the wetland may have received water with higher nutrient concentrations than in the past.

Table 2 Summary of the samples analysed for cladocera in BOXF1

Sample depth	Total number cladocera remains	Total number ostracod remains	Total number bryozoan statoblast remains	Number remain types
cm	per g dw	per g dw	per g dw	per g dw
0.5-1	610	0	0	8
9.5-10	814	0	0	8
19.5-20	314	0	0	11
29.5-30	262	0	0	8
39.5-40	706	13	0	9
49.5-50	709	2	0	10
59-60	122	0	0	8
69-70	160	10	1	10
79-80	0	1	0	0
88-90	10	3	0	5

Comparison of diatom and cladocera results

There is reasonable agreement between the timing and nature of the main shifts in the diatom and cladocera assemblages although both sets of data are difficult to interpret in the context of hydrological fluctuations or productivity changes. The assemblages of both biological groups are dominated by non-planktonic taxa throughout the record indicating that water levels have not altered dramatically during the period represented by the core. However there is a slight increase in planktonic diatom forms in the middle of the sequence (55-25 cm), namely *Cyclotella radiosa* and *Synedra ulna,* and this overlaps with the increased amounts of *Alona affinis,* which could suggest that water levels were higher at this time. Both the diatom and the cladocera assemblages change in the upper 20 cm which could signify nutrient enrichment although it is not clear how exactly to interpret these shifts. A further search of the ecological literature is required to interpret the findings more fully.

Ostracods and molluscs

It was anticipated that ostracods may be particularly useful for identifying periods of wetting-drying of the wetland versus permanent wet episodes and therefore wet sub-samples from BOXF1 were sieved at 125µm by UCL to assess the amount of ostracod and mollusc remains. Unfortunately, only a few shells and fragments were found and ostracods were generally rare and poorly preserved. Calcareous remains were absent from the upper peat section, most likely as a result of post depositional dissolution. However, in the chalky, limnic sediments from 76 cm to the base ostracod and mollusc remains were found although preservation was poor (Table 3). Even the smaller mesh size of 80µm used by NERI during the cladoceran analysis failed to find more than a few fragments of ostracods in the 40-90 cm section and they were absent in the upper 40 cm. The lack of such remains throughout the complete core sequence suggests that the potential for carbonate isotope analysis is very limited and this is therefore unlikely to be pursued.

Table 3 Summary results of ostracod screening in BOXF1

Depth	Wet Weight (g)	Weight > 125μm (dry) (g)	Ostracods
41.5-43.5	3.0026	0.153	no
50-53	3.0842	0.1615	no
60-63	3.0063	0.4992	no
70-73	3.0786	0.8039	no
76-78	2.9635	1.2298	yes
81-84	2.9571	0.642	yes
85-88	2.6589	0.4009	yes

Spheroidal carbonaceous particles (SCPs)

Preliminary analysis of SCPs in 16 samples, taken at roughly equidistant levels from the sediment surface to the core base, has been completed by UCL using standard methods (Rose, 1994) in order to establish an approximate chronology for the core (Rose *et al*., 1995). The provisional profile is shown in Figure 8 and indicates that the last 150 years lie in the top 25 cm. Further refinement of the SCP results will be undertaken over the next 6 months to finalise a chronology and outputs will be compared with the results of radiometric dating.

Work plan (months 30-42)

Further processing of the core BOXF1 will be undertaken over the next six months. The SCP data will be verified and a full interpretation of the results will be available by month 36. Sub-samples are currently being prepared for radiometric dating (^{210}Pb and ^{137}Cs) at the BEIF lab at UCL to provide a further independent chronology for the core (Appleby *et al*., 1986).

The availability of instrumental records will be explored, particularly the Central England temperature data and hydrological records which will be valuable for comparison with the palaeoecological data. Following discussions with Paul Whitehead at the Euro-limpacs project meeting in Athens in September 2005 there may be potential to compare outputs with the INCA nutrient models of the Lambourn catchment developed at University of Reading (link to WP6) and hydrological monitoring data from the LOCAR project. An interim workshop to consider the state of information and attempt to draw general lessons is scheduled to be held jointly with WP3, task 3.1 in month 36.

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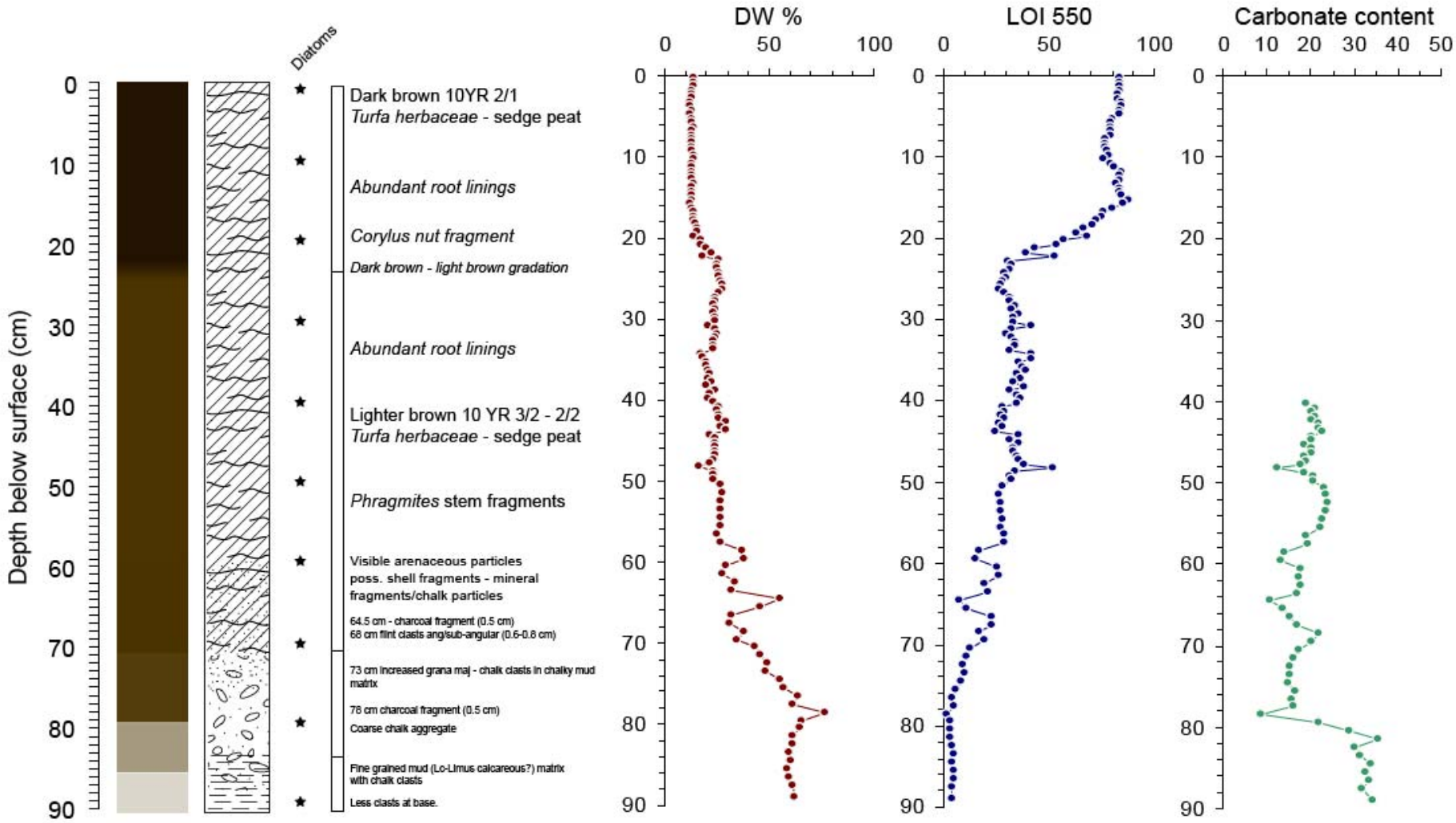

Figure 5 Summary stratigraphic diagram of Boxford Water Meadows core BOXF1
Carbonate content analysis carried out on the 40-90 cm section only; no carbonate data for 0-40 cm section
DW, LOI 550 and carbonate content data are all expressed as percentages.

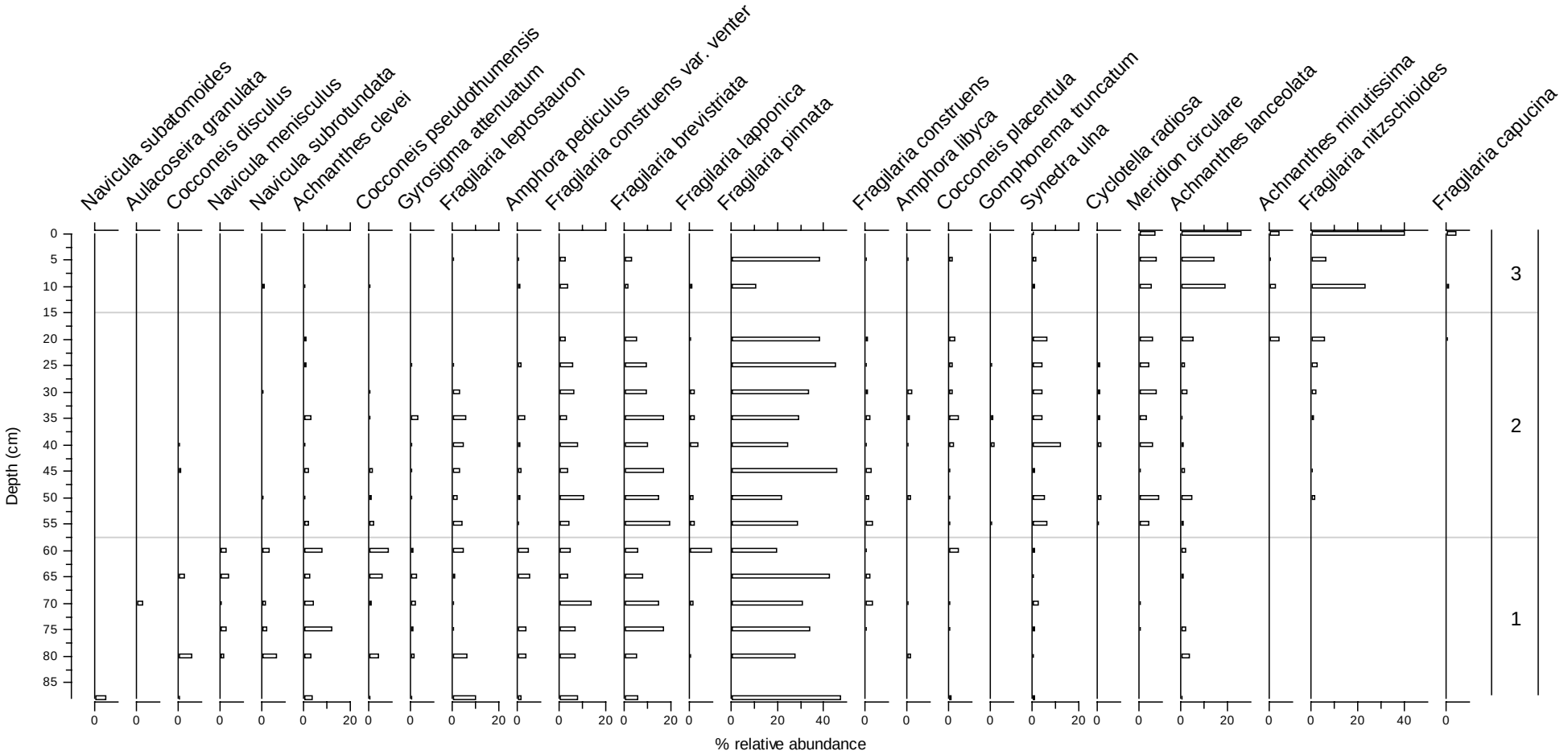

Figure 6 Summary diatom stratigraphy for core BOXF1

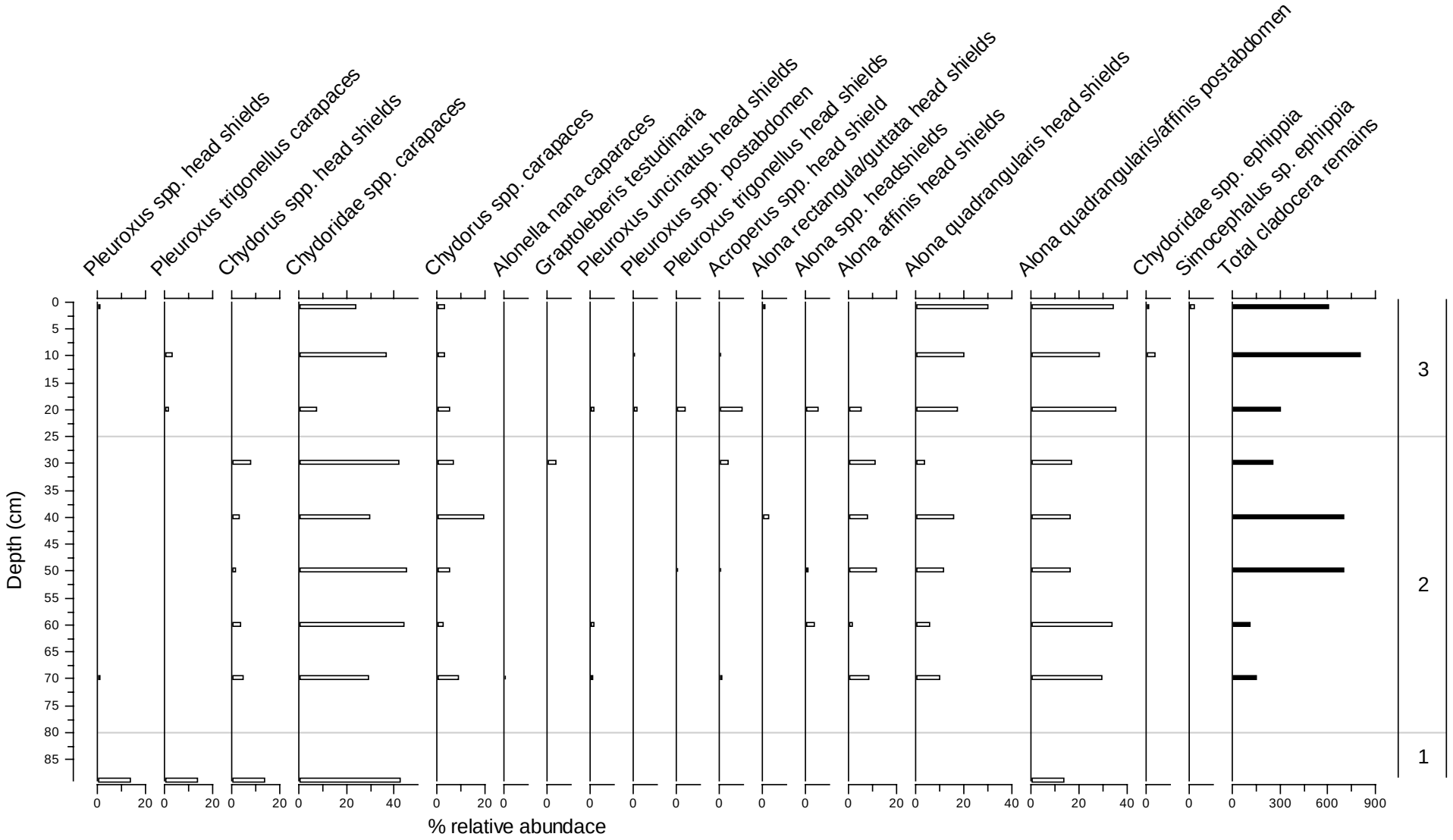

Figure 7 Summary cladocera stratigraphy for core BOXF1

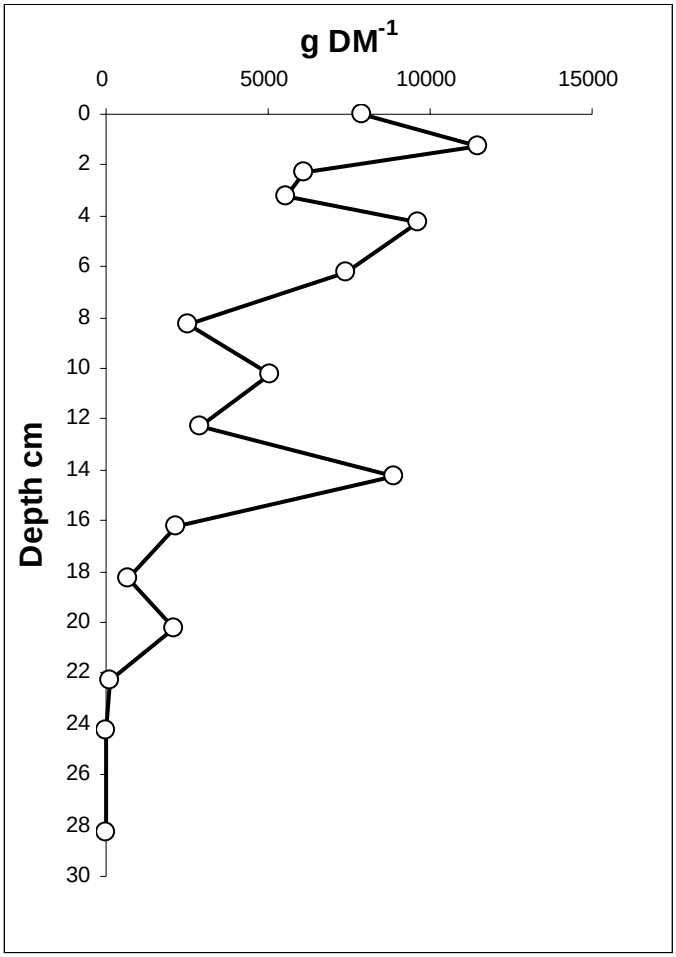

Figure 8 Provisional spheroidal carbonaceous particle concentration results for BOXF1