Quantification of the indicative meaning of a range of Holocene sea-level index points from the western North Sea.

Volume Two:

Figures and Appendices

by

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Contents of Computer disk

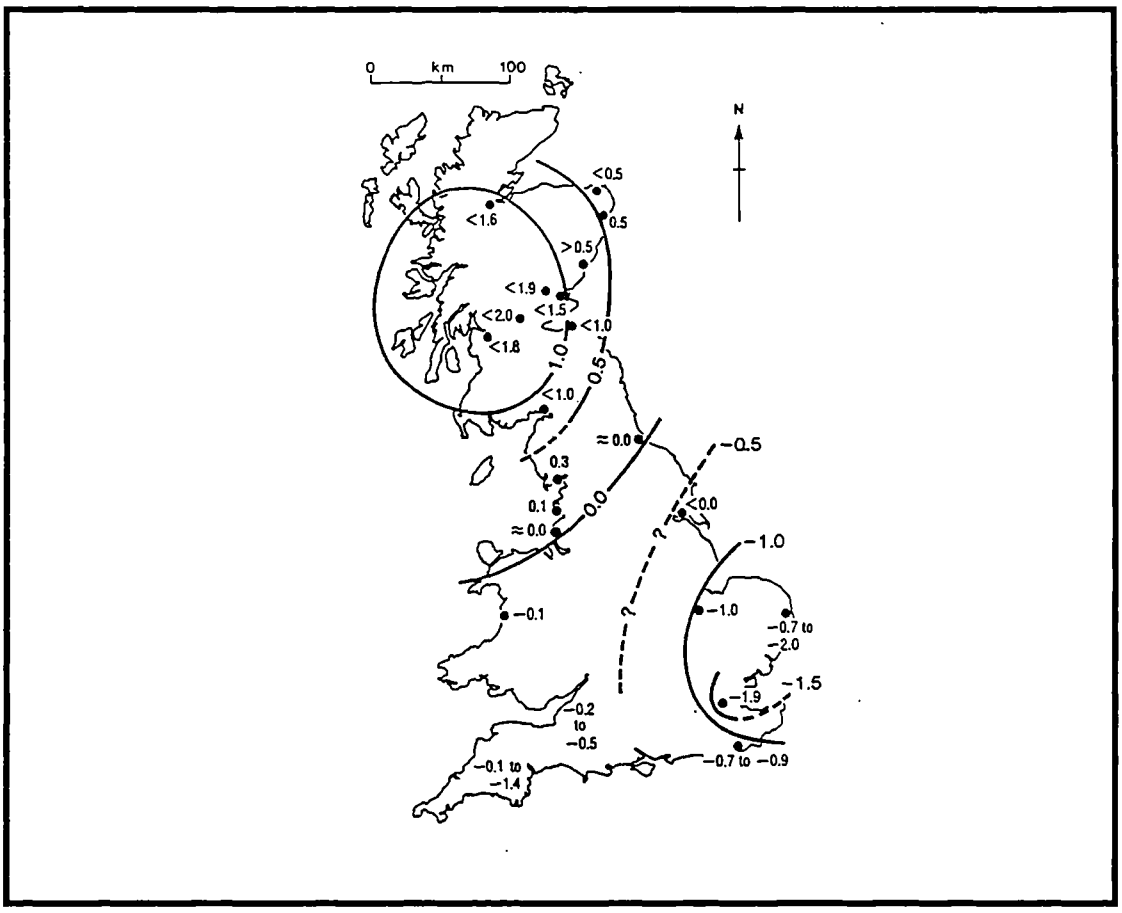
Data files from Cowpen, Welwick, Thornham and Brancaster Marsh are archived on Computer Disk One using Pkzip. The executable file "Pkunzip.exe" is also archived for the extraction of the following files and information:

Cowpen.zip: (1) cm951.txt to cm9610.txt (foraminiferal death assemblages from 25 two-weekly samples from each station of Cowpen Marsh);
(2) cmdiatom.txt (diatom assemblages for each station of Cowpen Marsh);
(3) cmenvir.txt (environmental variables from 4 three-monthly samples from stations of Cowpen Marsh).

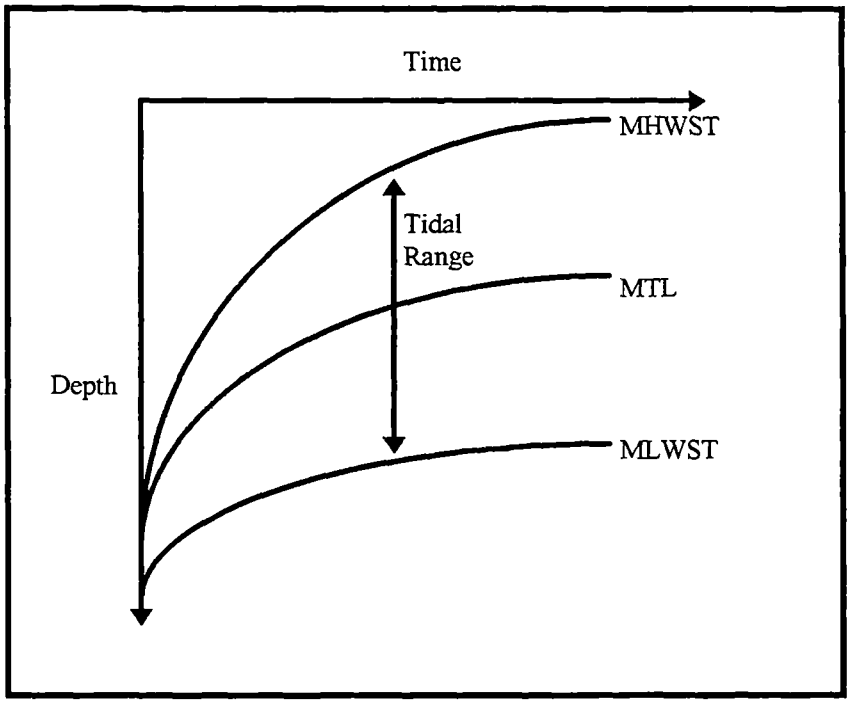
Welwick.zip: (1) we951.txt to we963.txt (foraminiferal death assemblages from 4 three-monthly samples from each station of Welwick Marsh);
(2) wediatom.txt (diatom assemblages for each station of Welwick Marsh).

Thornham.zip: (1) tm951.txt to tm963.txt (foraminiferal death assemblages from 4 three-monthly samples from each station of Thornham Marsh);
(2) tmdiatom.txt (diatom assemblages for each station of Thornham Marsh)

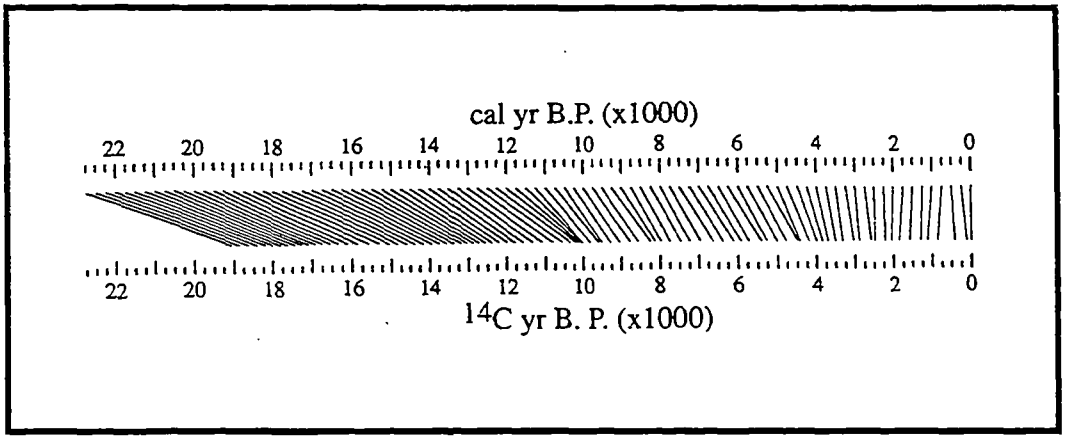
Brancast.zip: (1) bm951.txt to bm963.txt (foraminiferal death assemblages from 4 three-monthly samples from each station of Brancaster Marsh);
(2) bmdiatom.txt (diatom assemblages for each station of Brancaster Marsh).



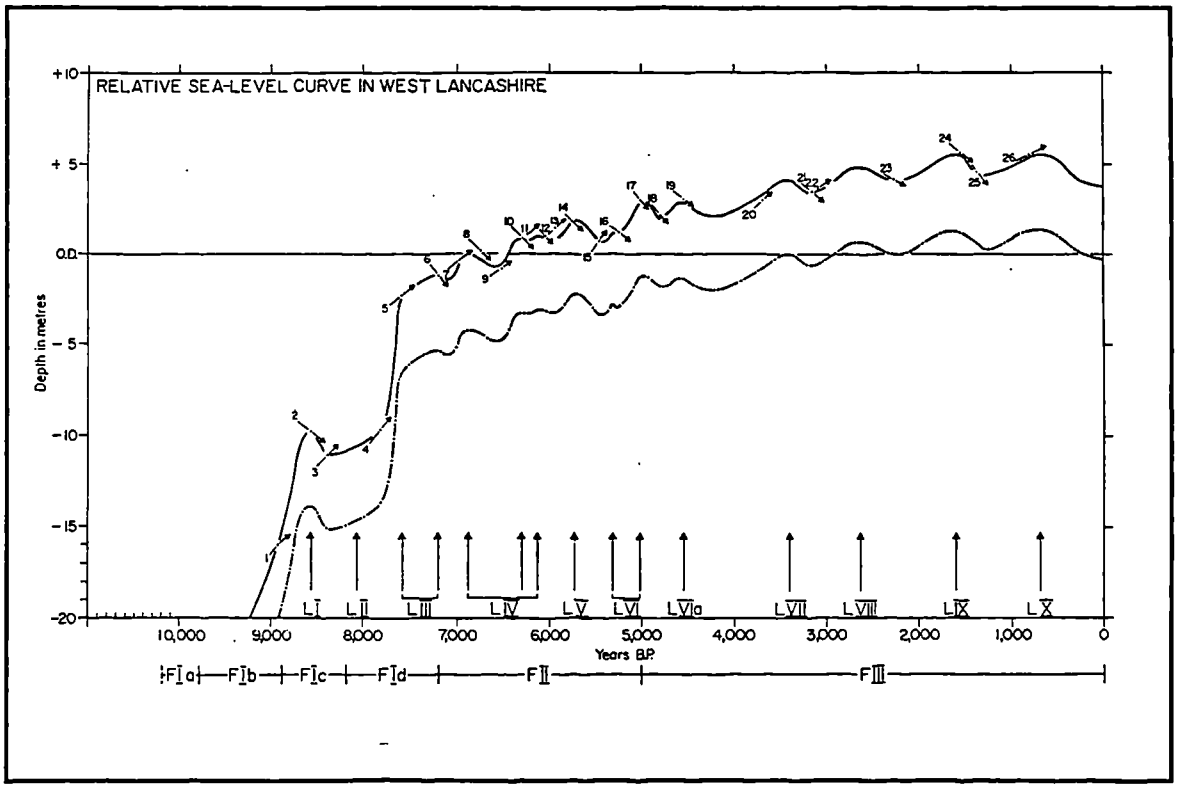
1.1 Map of estimated current rates of crustal movement (mm/yr.) in the UK (Source: Shennan, 1989). 1



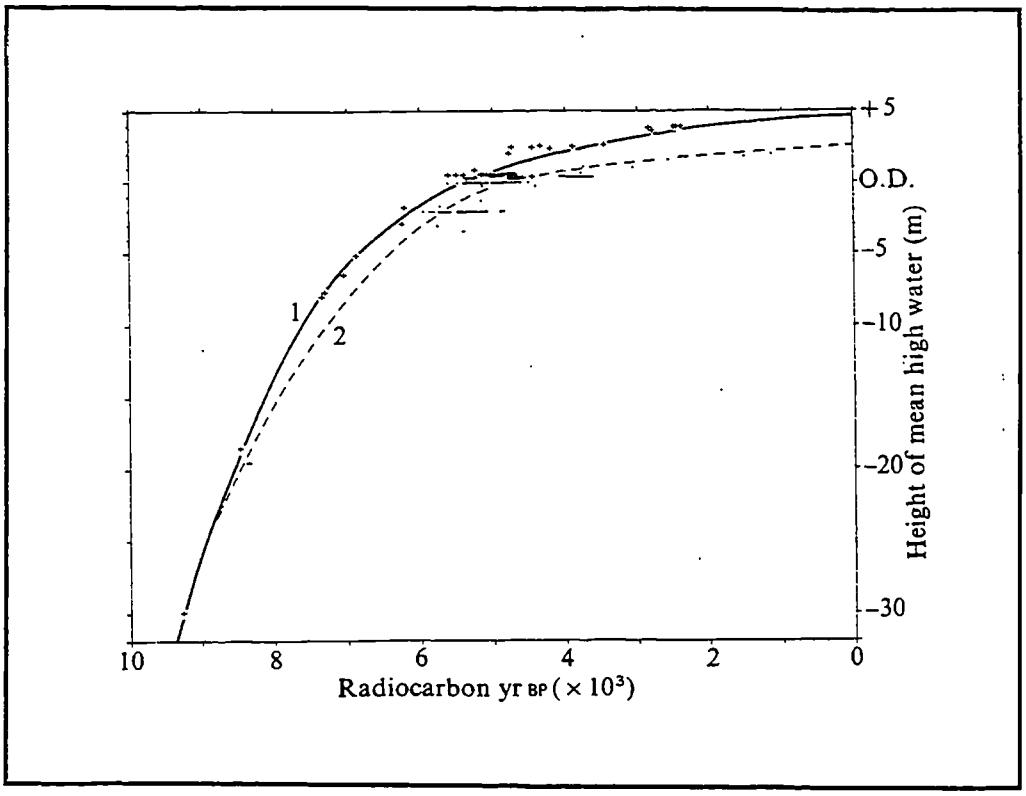
2.1 Diagram to illustrate how Mean High Water Spring Tide (MHWST) indicators plotted on an age/altitude graph give an overestimation of sea-level rise when the tidal range increases over time (Source: Gehrels *et al.*, 1995a). 2



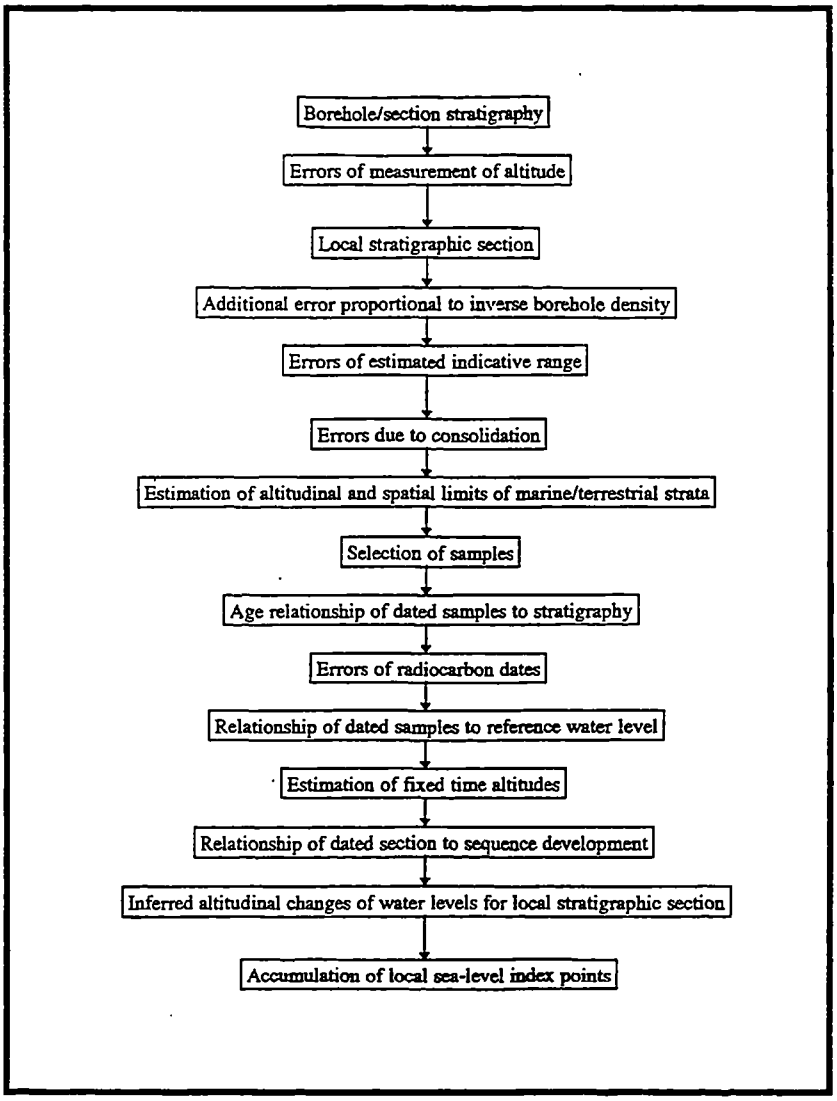
2.2 Relationship between calibrated and radiocarbon years BP (Source: Bartlein *et al.*, 1995).



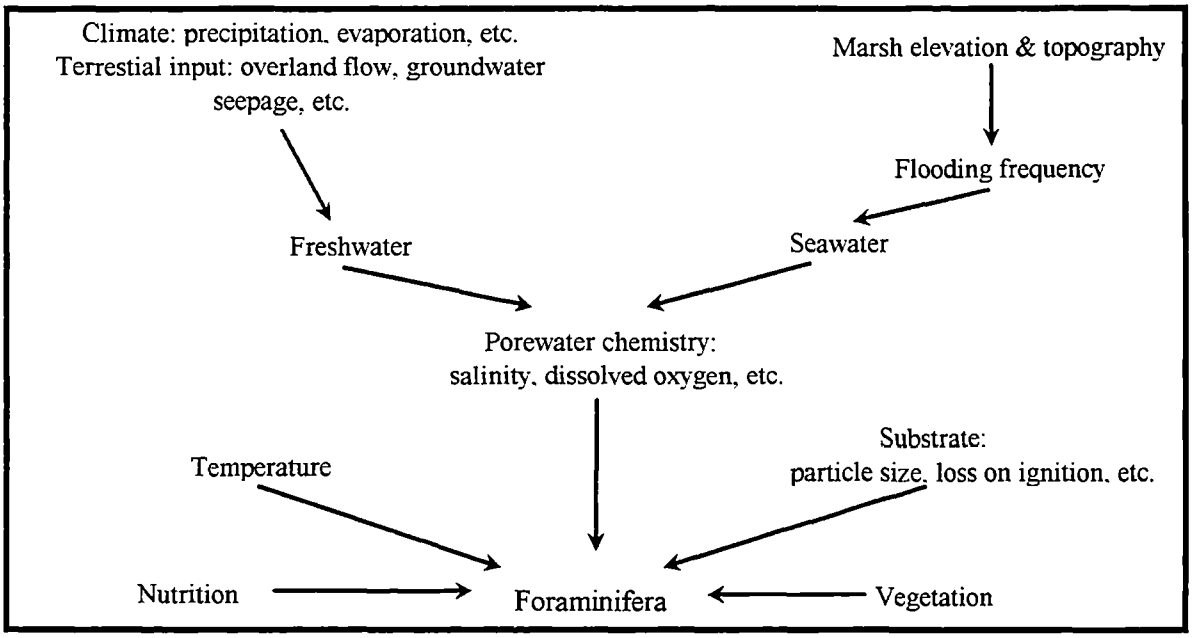
2.3 Relative sea-level changes in north-west England. A directional arrow is shown with each index point: an arrow pointing up represents a marine transgression, whereas an arrow pointing down represents a marine regression. The continuous line curve shows the movement of high tide level. The dot-dash line curve shows the movement of mean tide level. LI to LX are marine transgressions recognised in the type area of Lytham (Source: Tooley, 1978a). 4



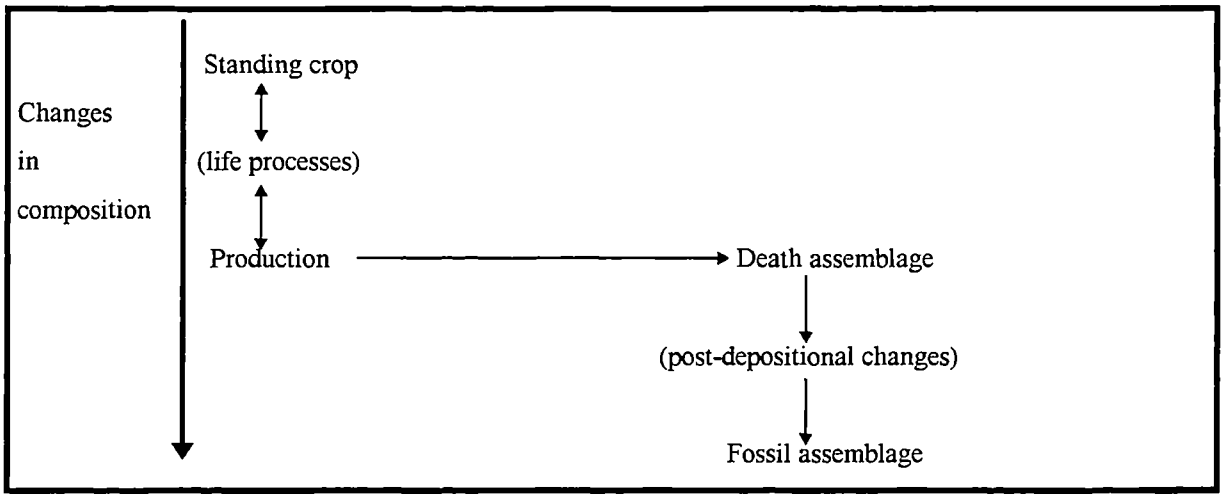
2.4 Relative sea-level curves from the Bristol channel (curve 1) and Cardigan Bay (curve 2) based upon 65 (crosses) and 142 (dots) index points respectively (Source: Kidson and Heyworth, 1978). 5



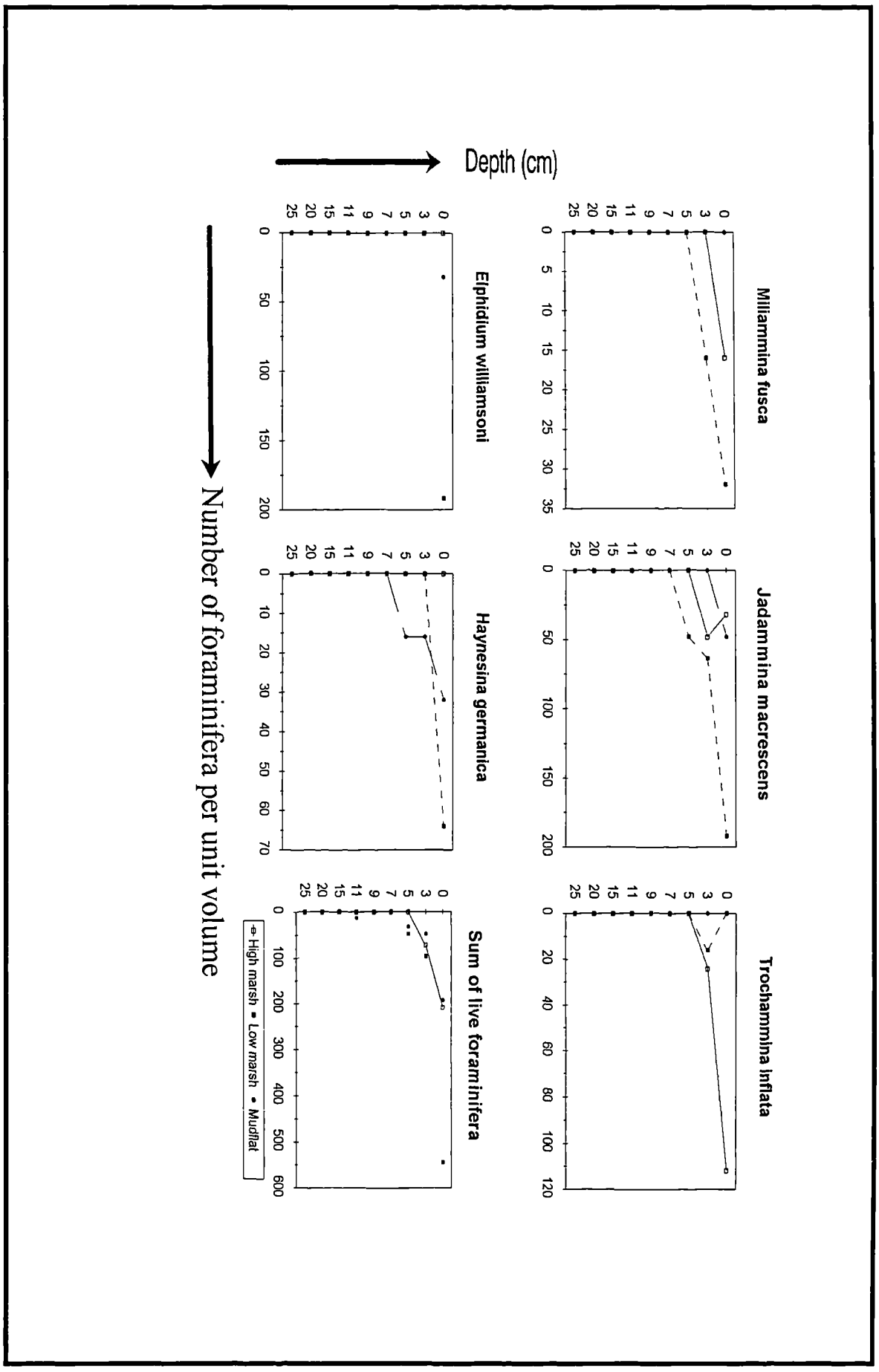
2.5 Model of sea-level research (Source: Shennan, 1983).



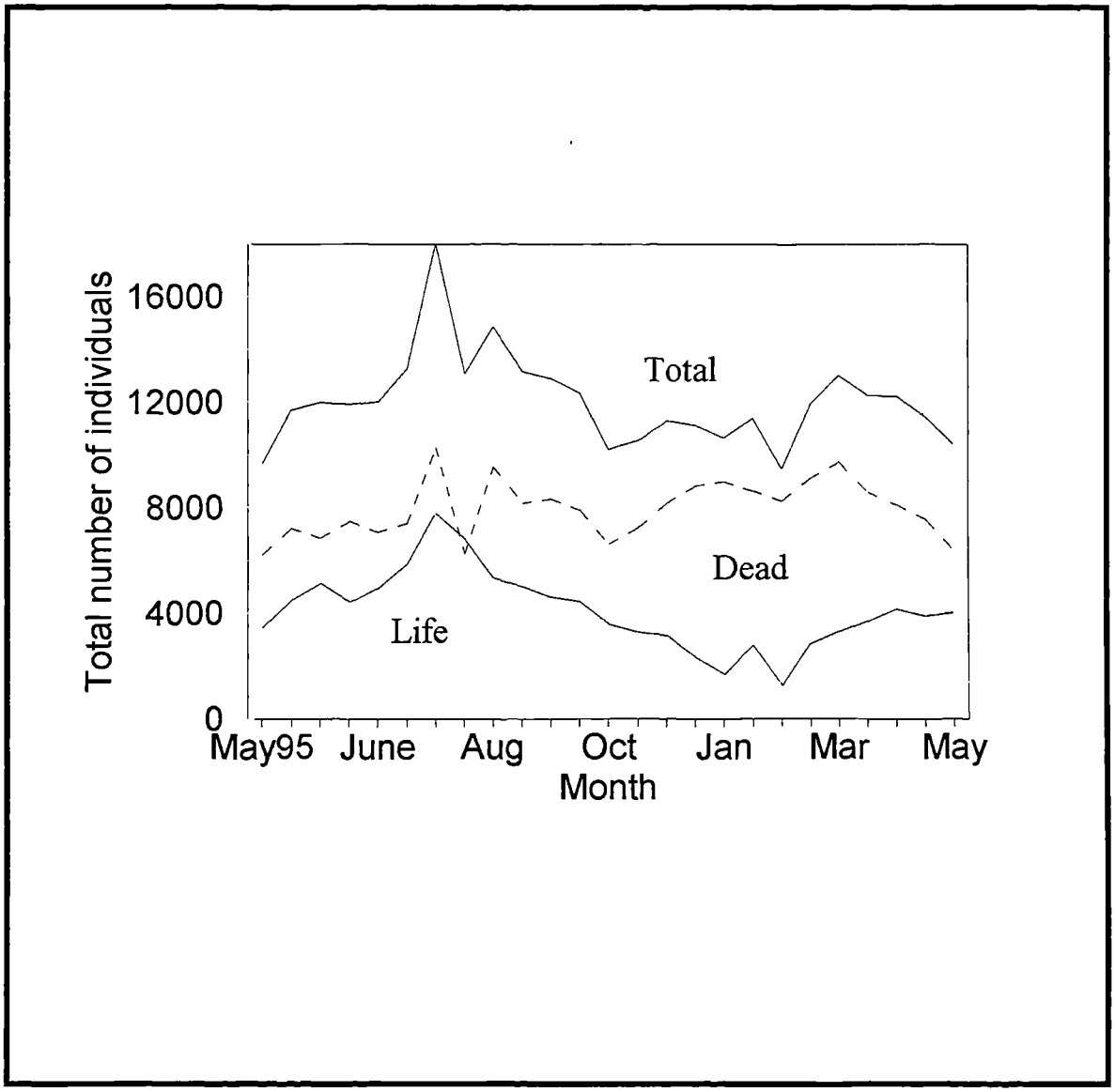
3.1 The relationship between foraminiferal distributions and the environment (after de Rijk, 1995a). 7



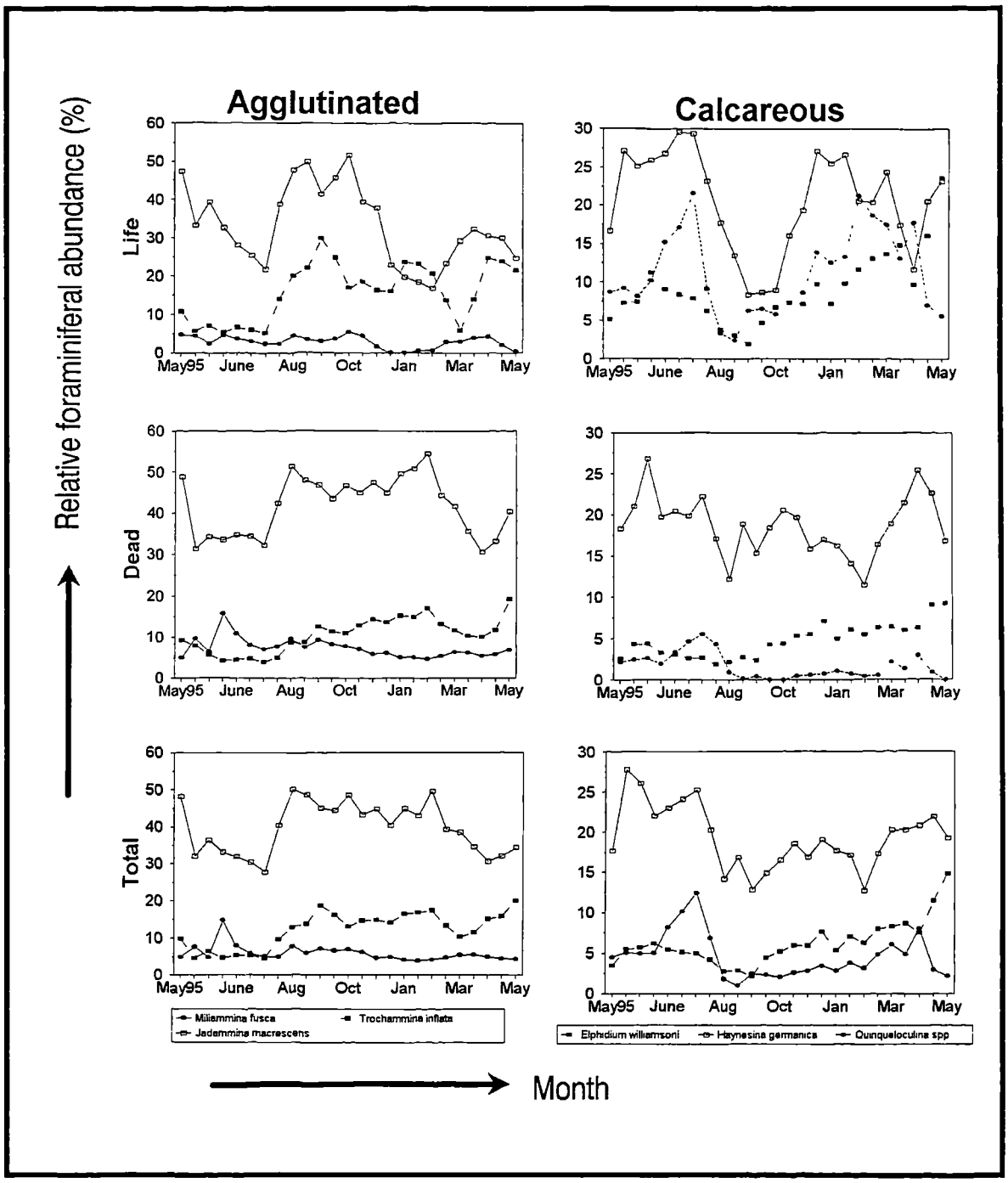
3.2 The relationship between life, death and fossil assemblages (Source: Murray, 1991).



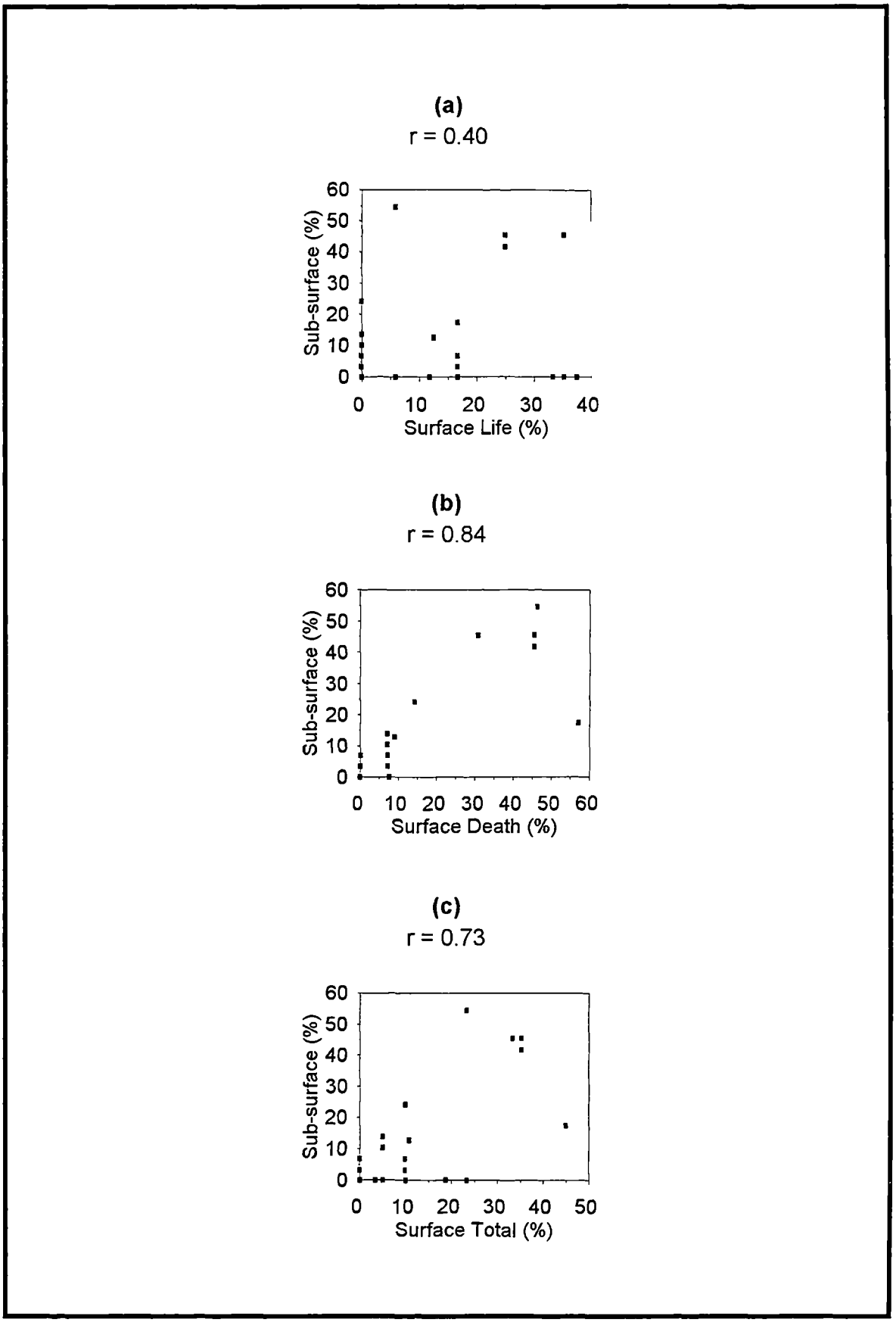
3.3 Infaunal abundance of five foraminiferal species per 10 cm^3 of Cowpen Marsh.



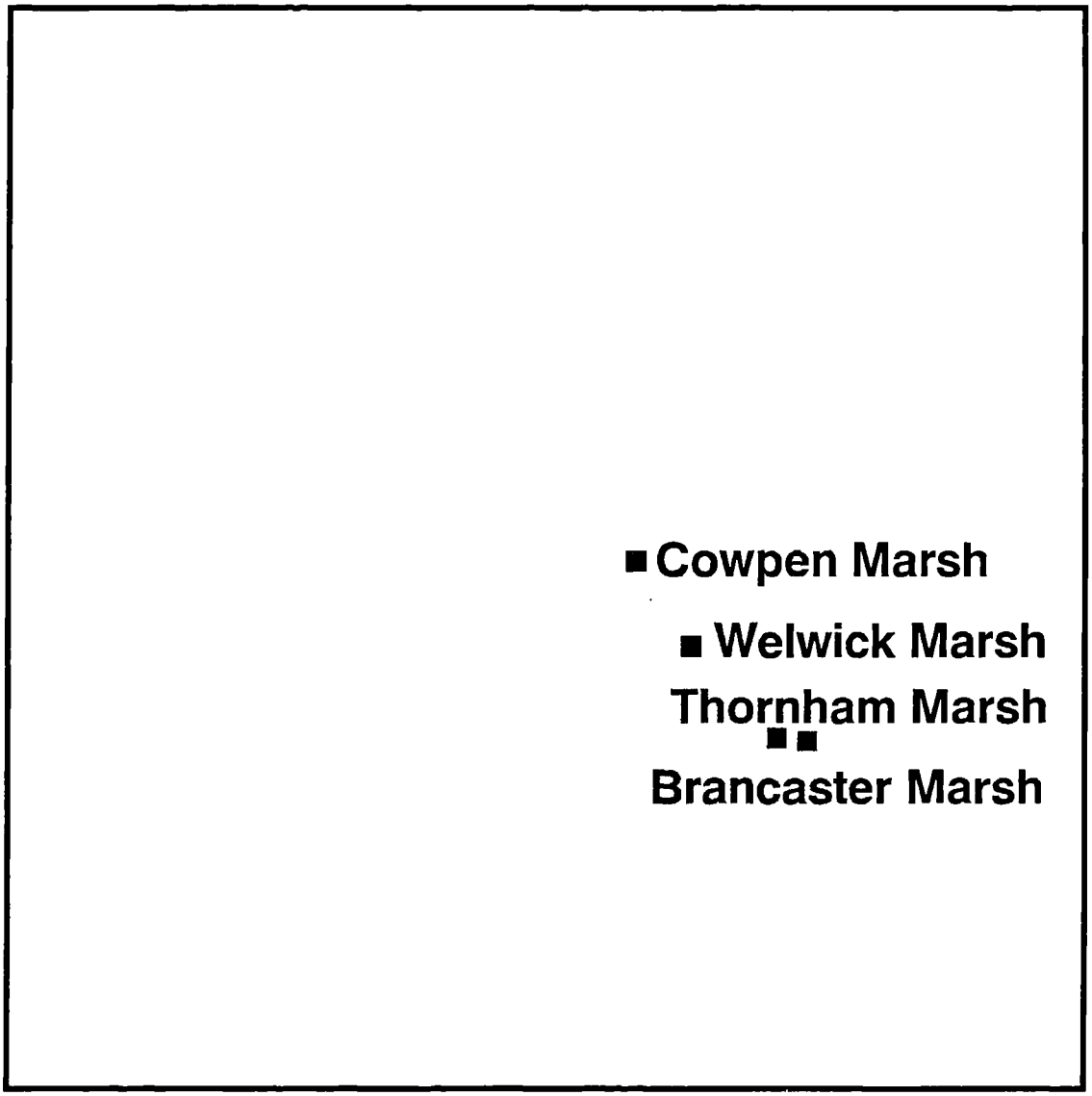
3.4 Life, death and total foraminiferal assemblage variations for all species of Cowpen Marsh.



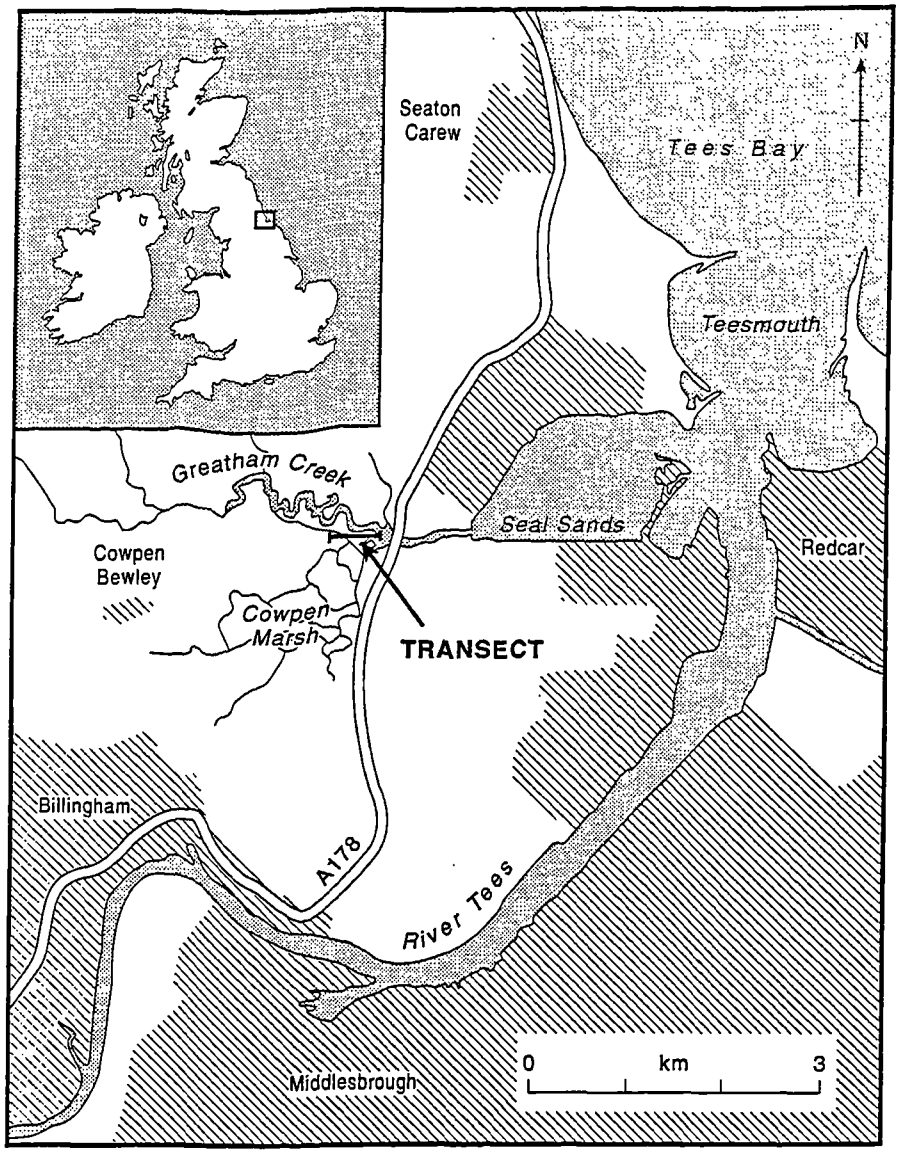
3.5 Life, death and total variations of six foraminiferal species of Cowpen Marsh. 11

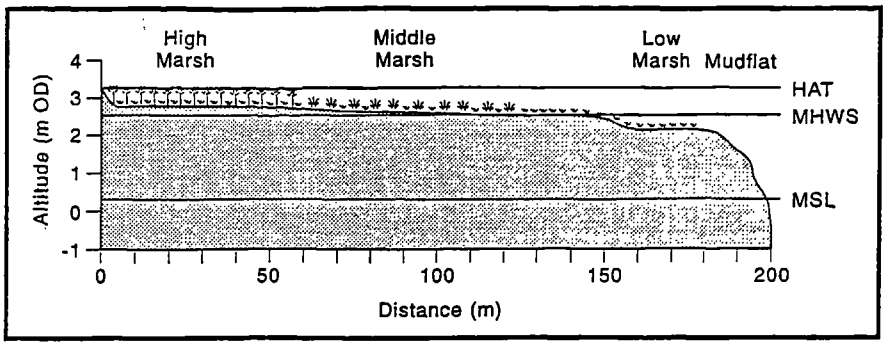


3.6 Scatter graphs and correlation coefficients (r) showing the relationship among (a) life, (b) death and (c) total surface and sub-surface foraminiferal assemblages of Cowpen Marsh.



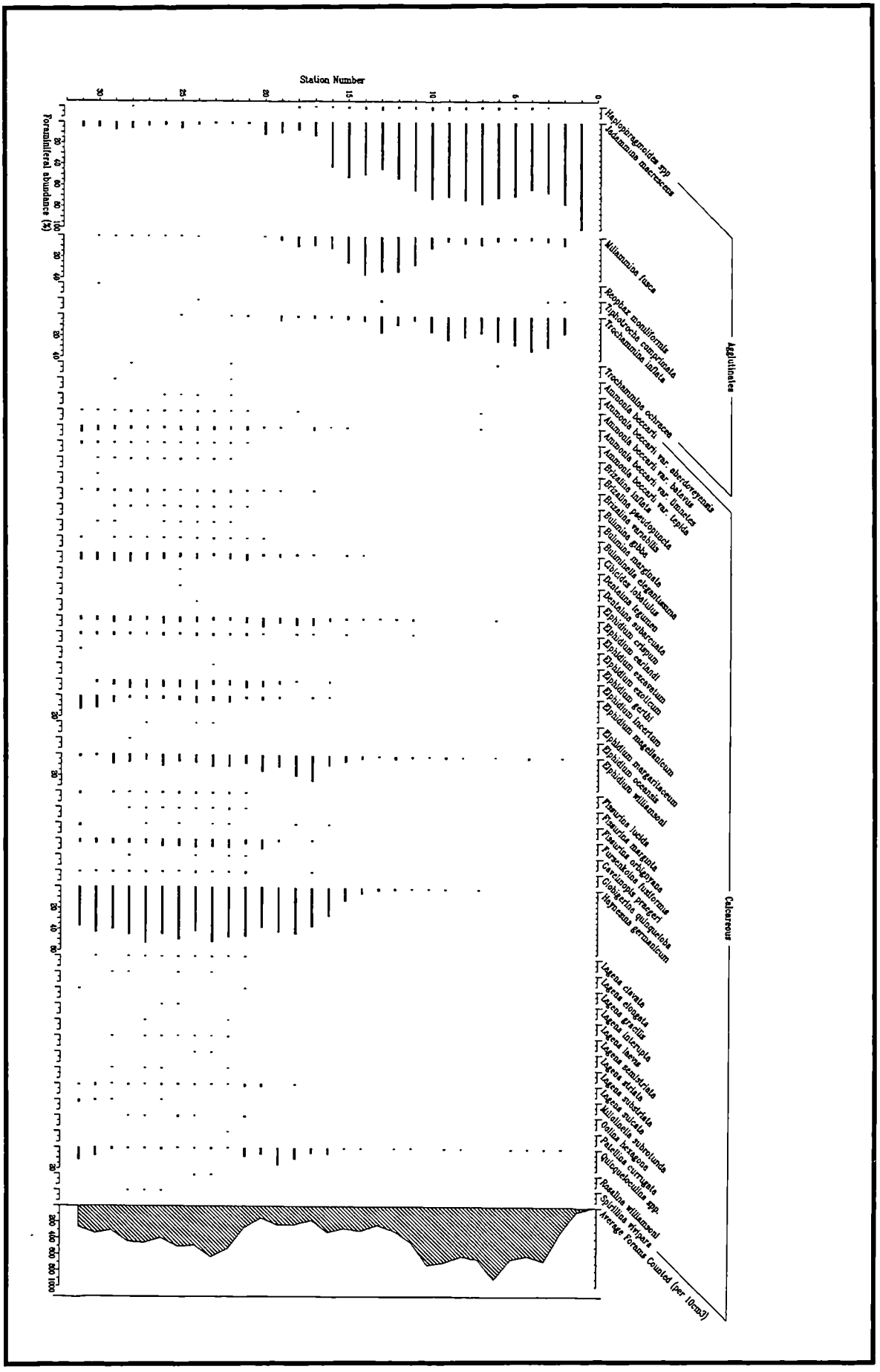
4.1 Location map of the UK showing the contemporary field sites.



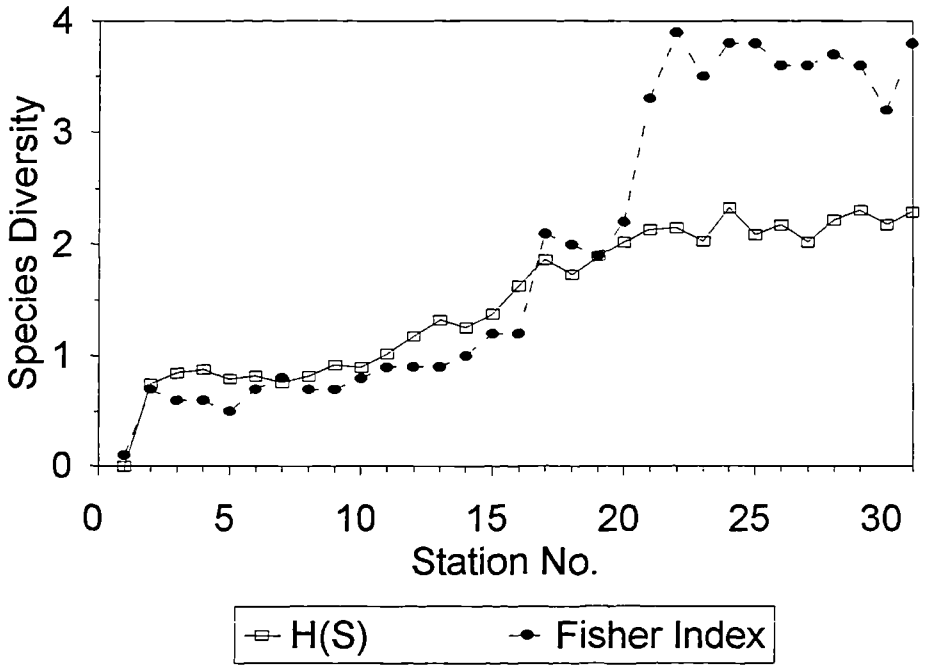


4.2.1 Locational map of Cowpen Marsh.

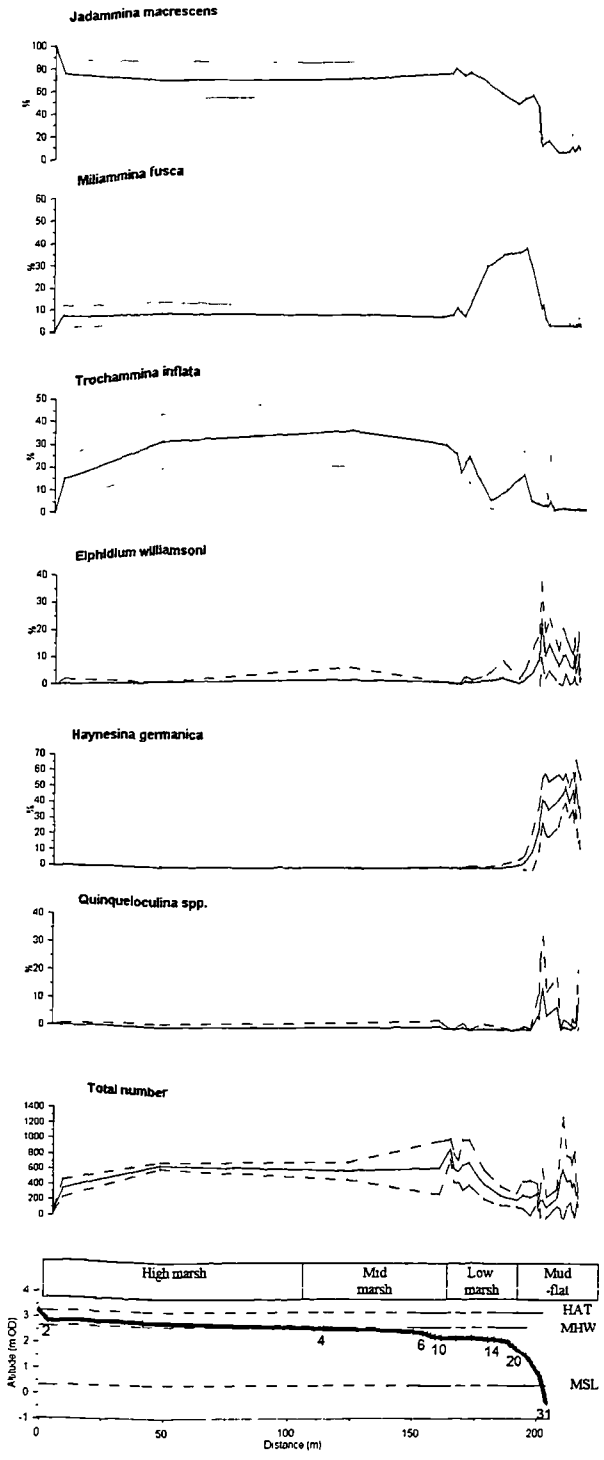
Altitude (m OD)	Vascular plants	Floral Zones
3.24	*Elytrigia atherica* *Festuca ovina* *Limonium vulgare* *Atriplex* spp. *Plantago maritima* *Suaeda maritima*	High Marsh
2.45	*Aster tripolium* *Festuca ovina* *Salicornia europaea* *Suaeda maritima*	Middle Marsh
2.12	*Festuca ovina* *Salicornia europaea*	Low Marsh
1.99		Mud-flat



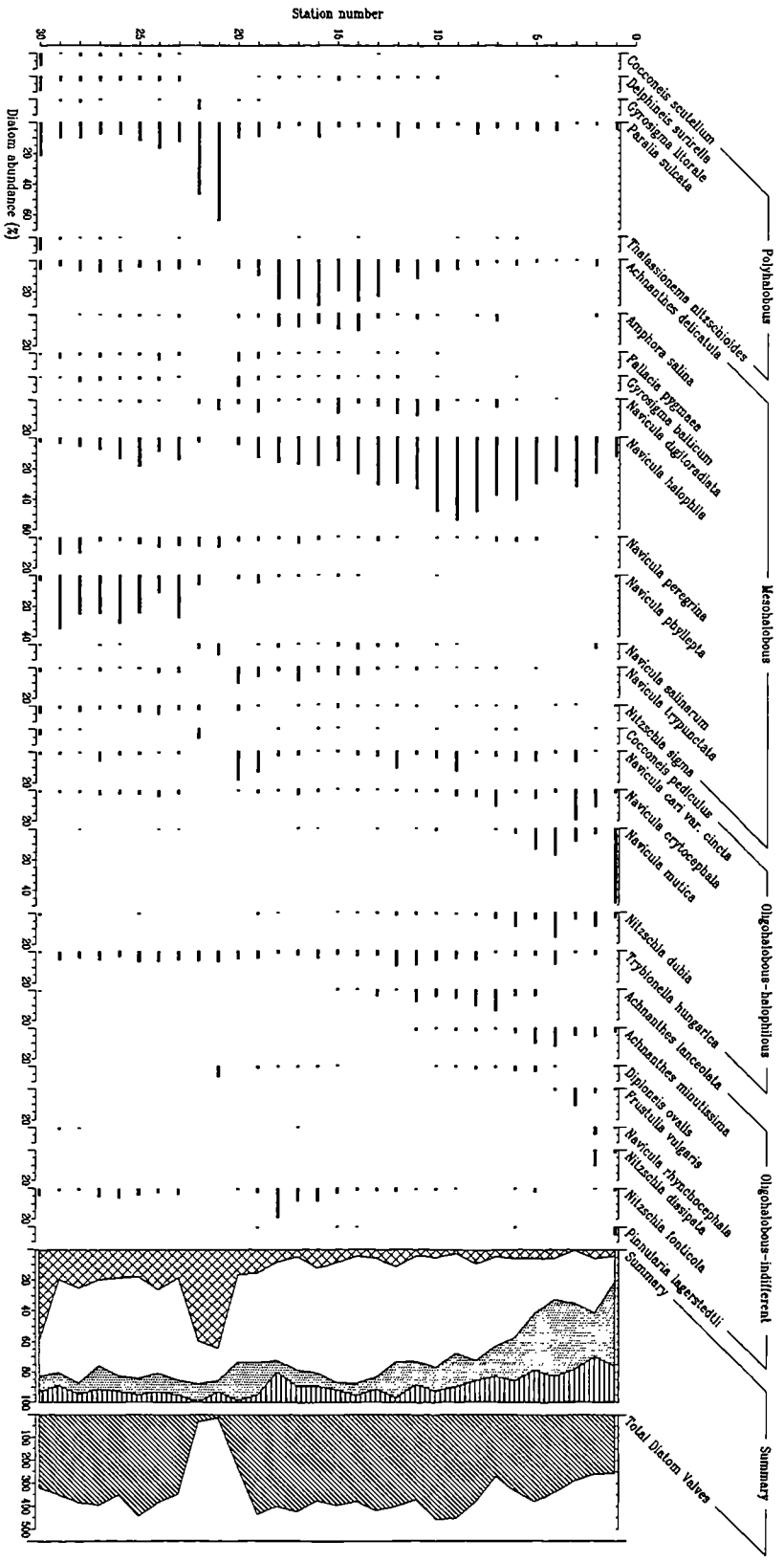
4.2.3 Average annual foraminiferal death assemblages from 25 two-weekly samples from each station of Cowpen Marsh. Foraminiferal abundance is expressed as a percentage of total count.



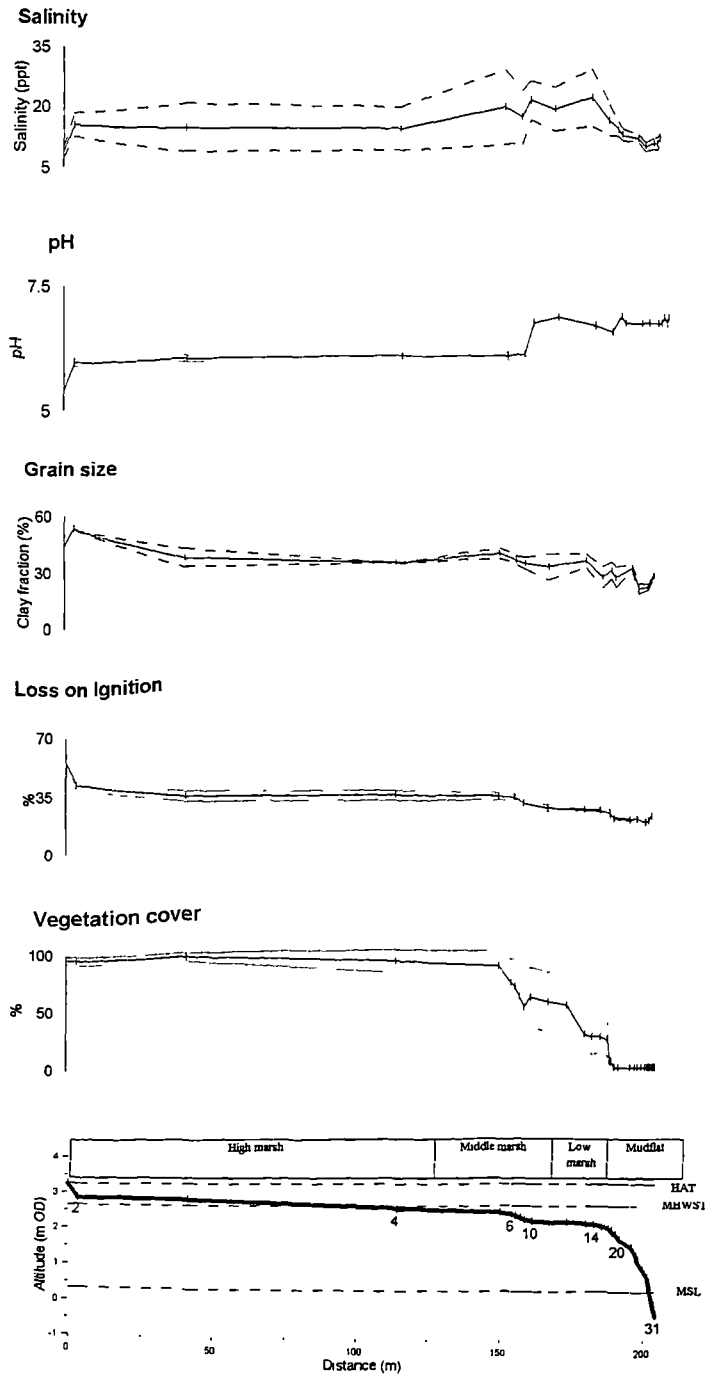
4.2.4 The Shannon-Weaver (H(S)) and Fisher indices of diversity of average annual foraminiferal death assemblages from 25 two-weekly samples from each station of Cowpen Marsh. 17



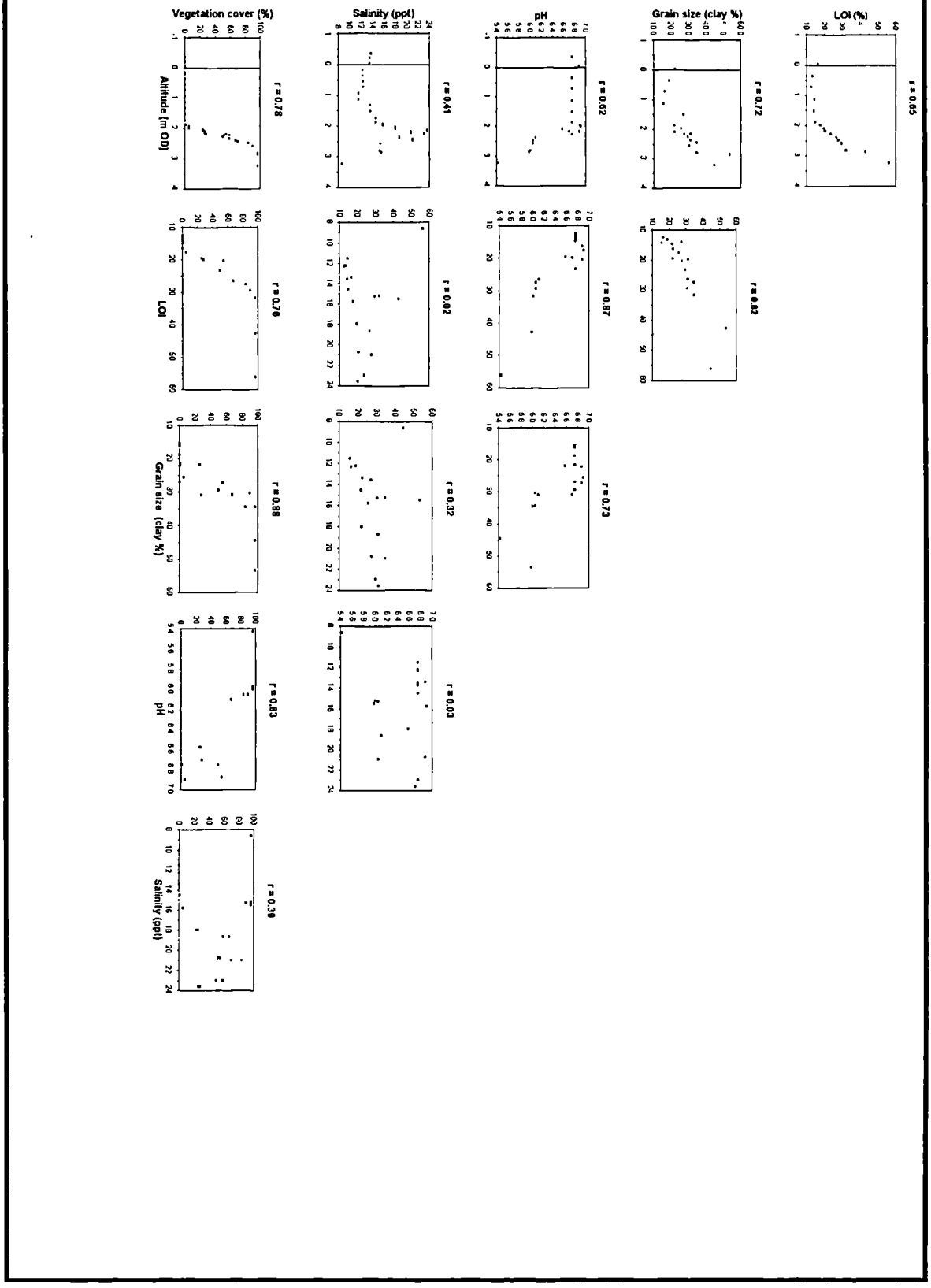
4.2.5 Relative dead abundance of six foraminiferal species from the twelve month study period of Cowpen Marsh. Solid and dashed lines indicate the mean and standard error for each station from 25 two-weekly samples. The altitude and floral zonations are indicated.



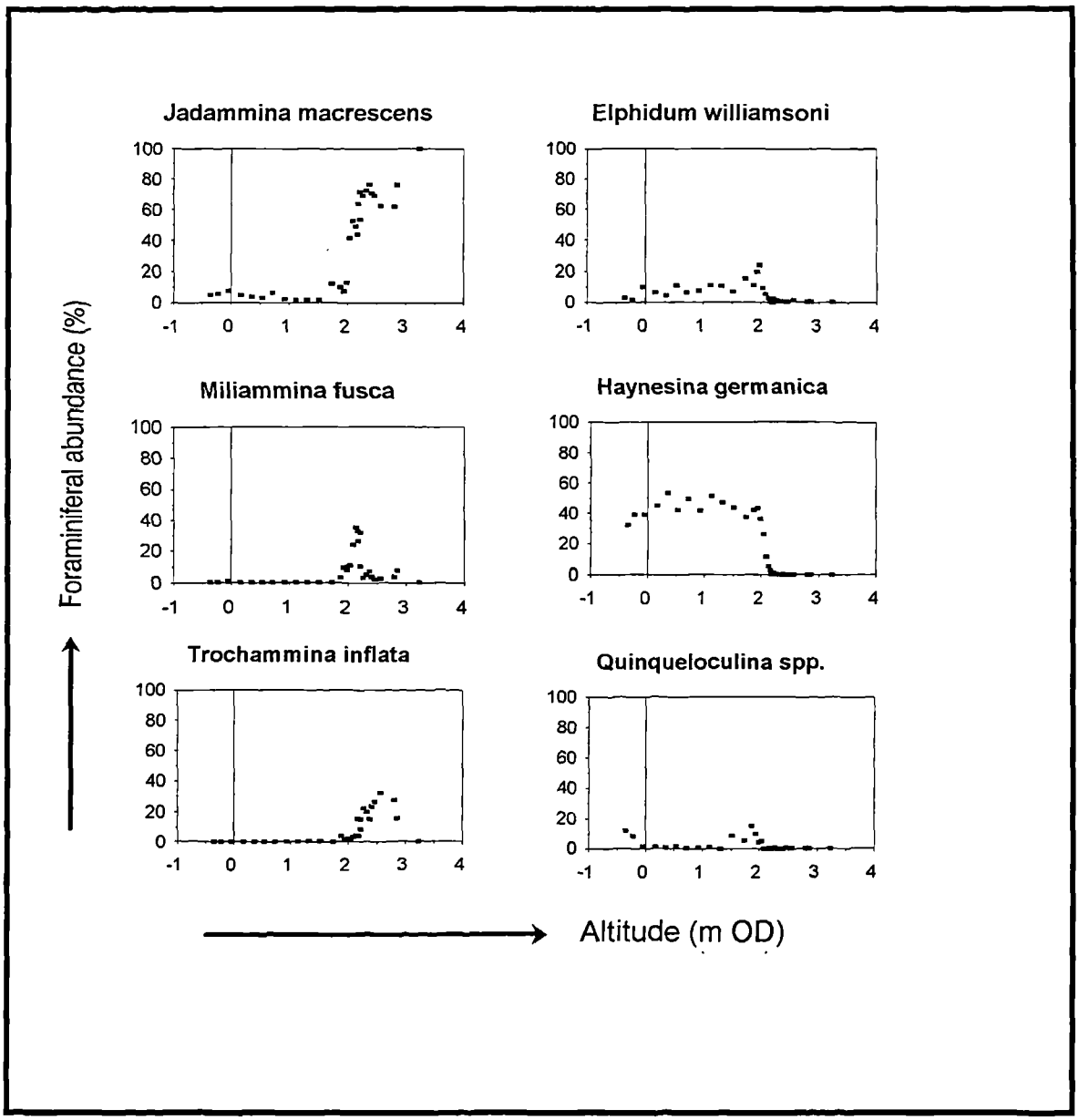
4.2.6 Diatom diagram for each station of Cowpen Marsh. Diatom frequencies are expressed as a percentage of total diatom valves. Only species which reach 5 % of the total sum are included. Summary classifications: polyhalobous = checked; mesohalobous = hollow; oligohalobous - halophilous = dashed; oligohalobous - indifferent = horizontal; and halophobes = solid.



4.2.7 Salinity, pH, grain size, LOI and vegetation cover from the twelve month study period of Cowpen Marsh. Solid and dashed lines indicate the mean and standard error for each station. The altitude and floral zonations are indicated.



4.2.8. Scatter plot matrix and correlation coefficients (r) among the annual average of environmental variables from Cowpen Marsh.



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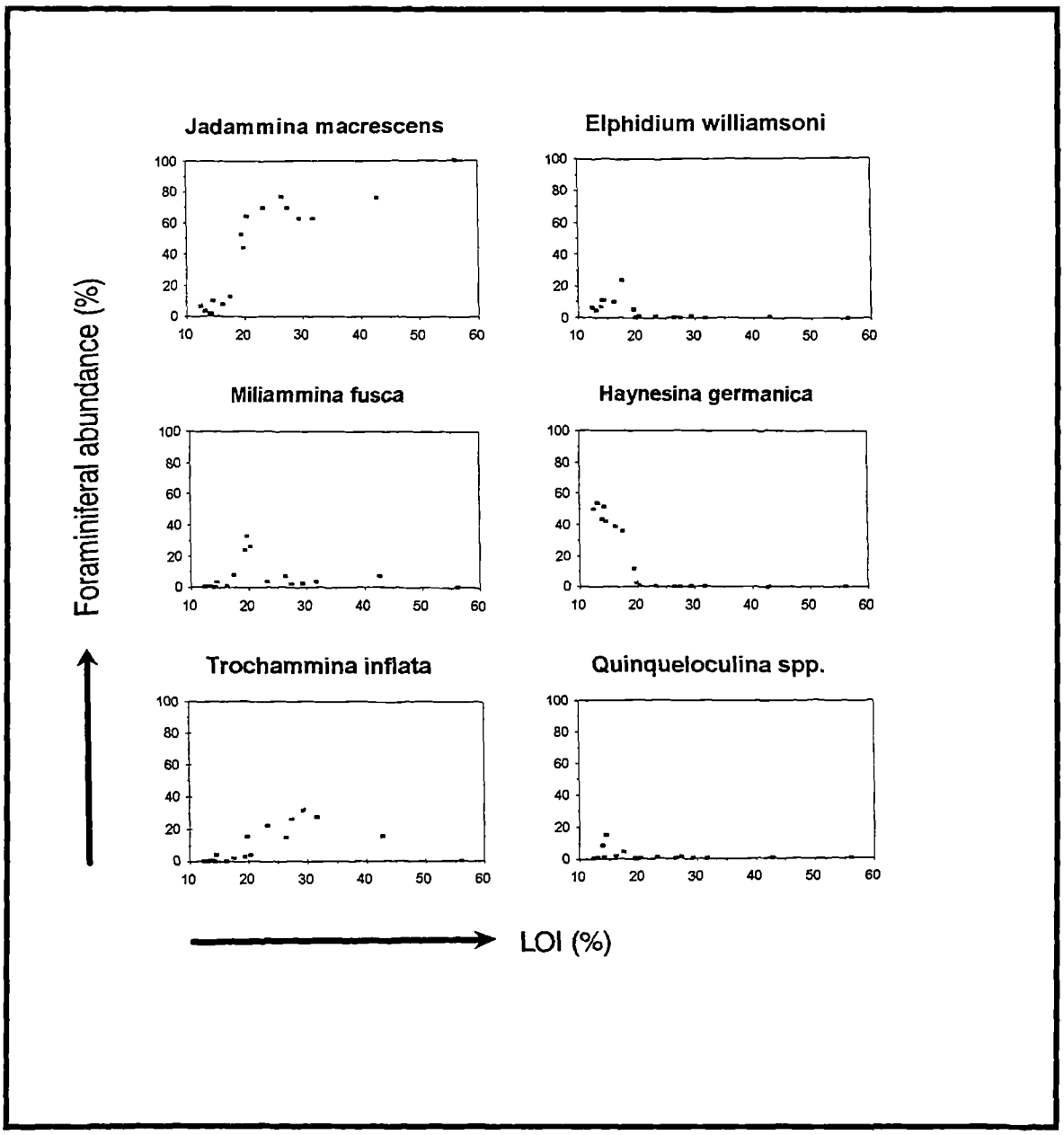

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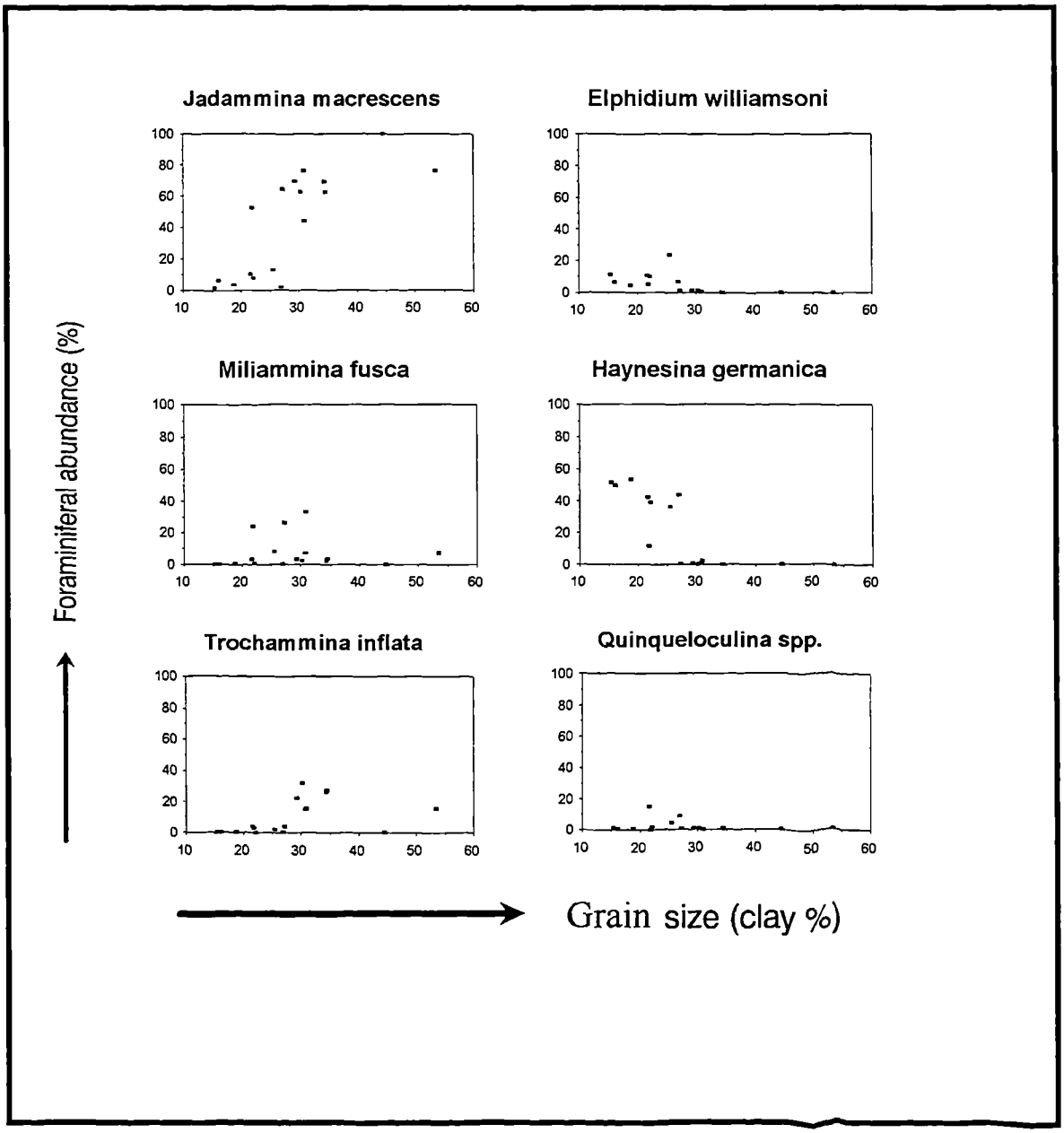
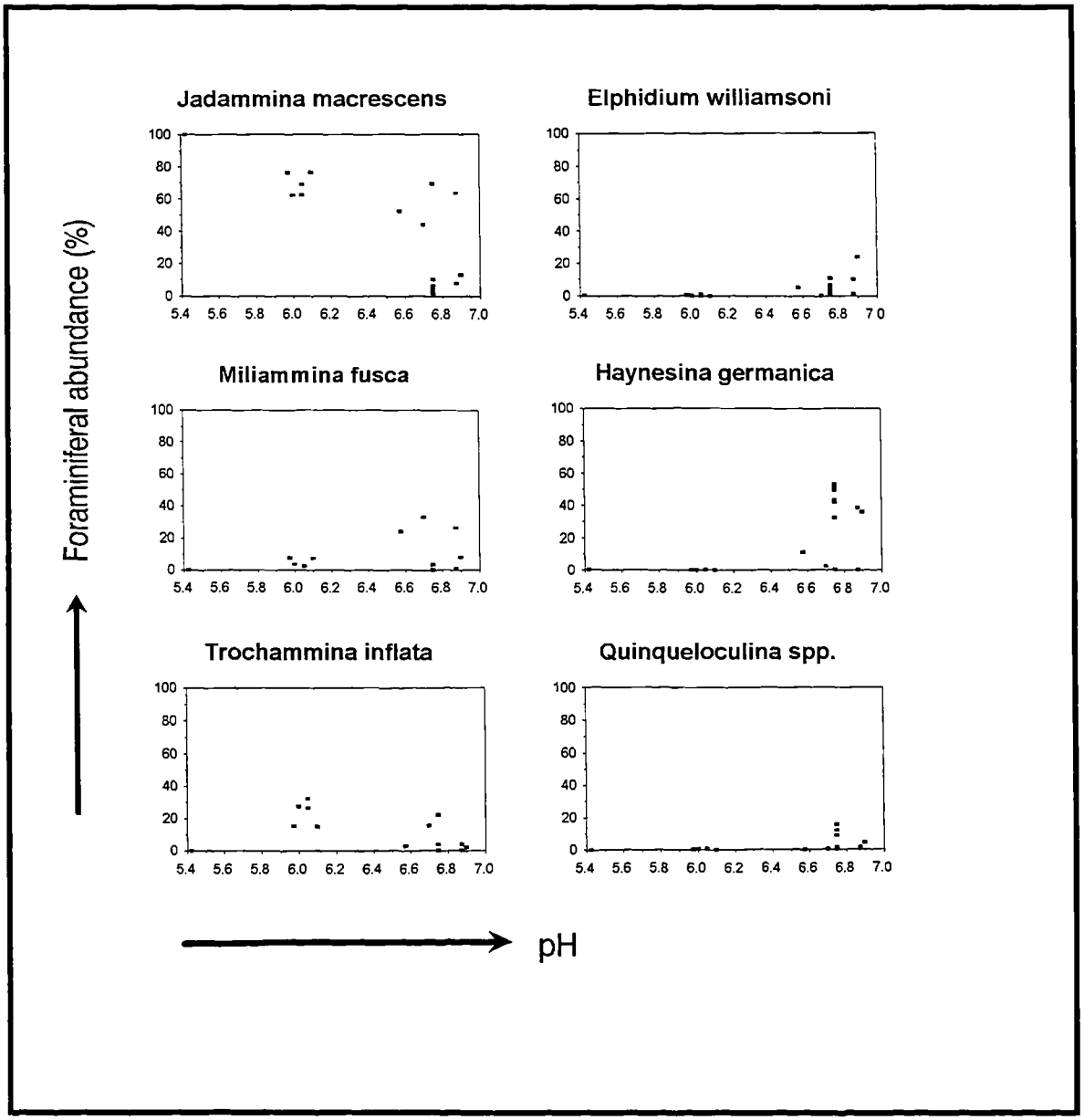


4.2.11. Scatter plots showing the relationship of grain size versus the annual average of six foraminiferal species of Cowpen Marsh.



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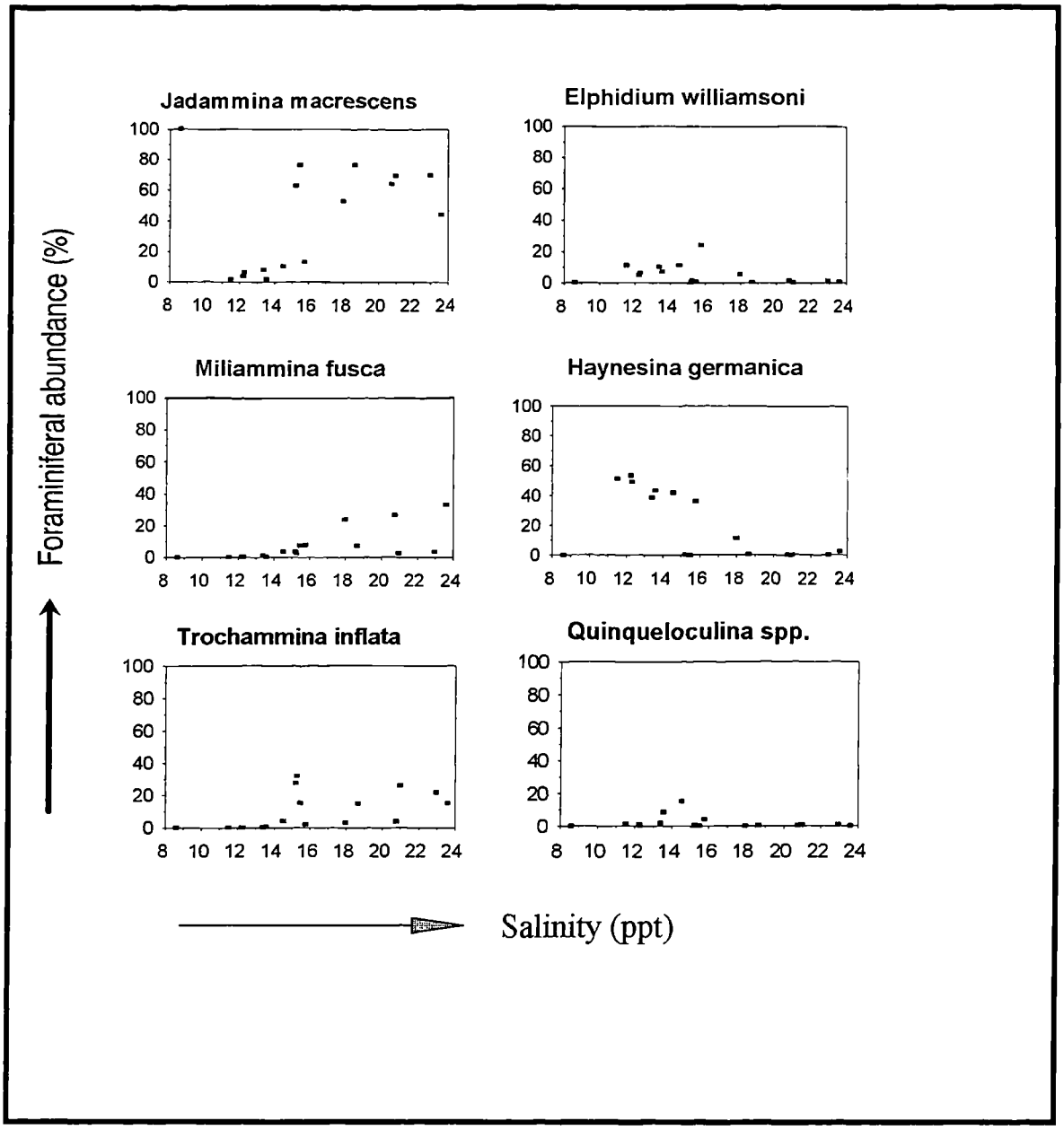

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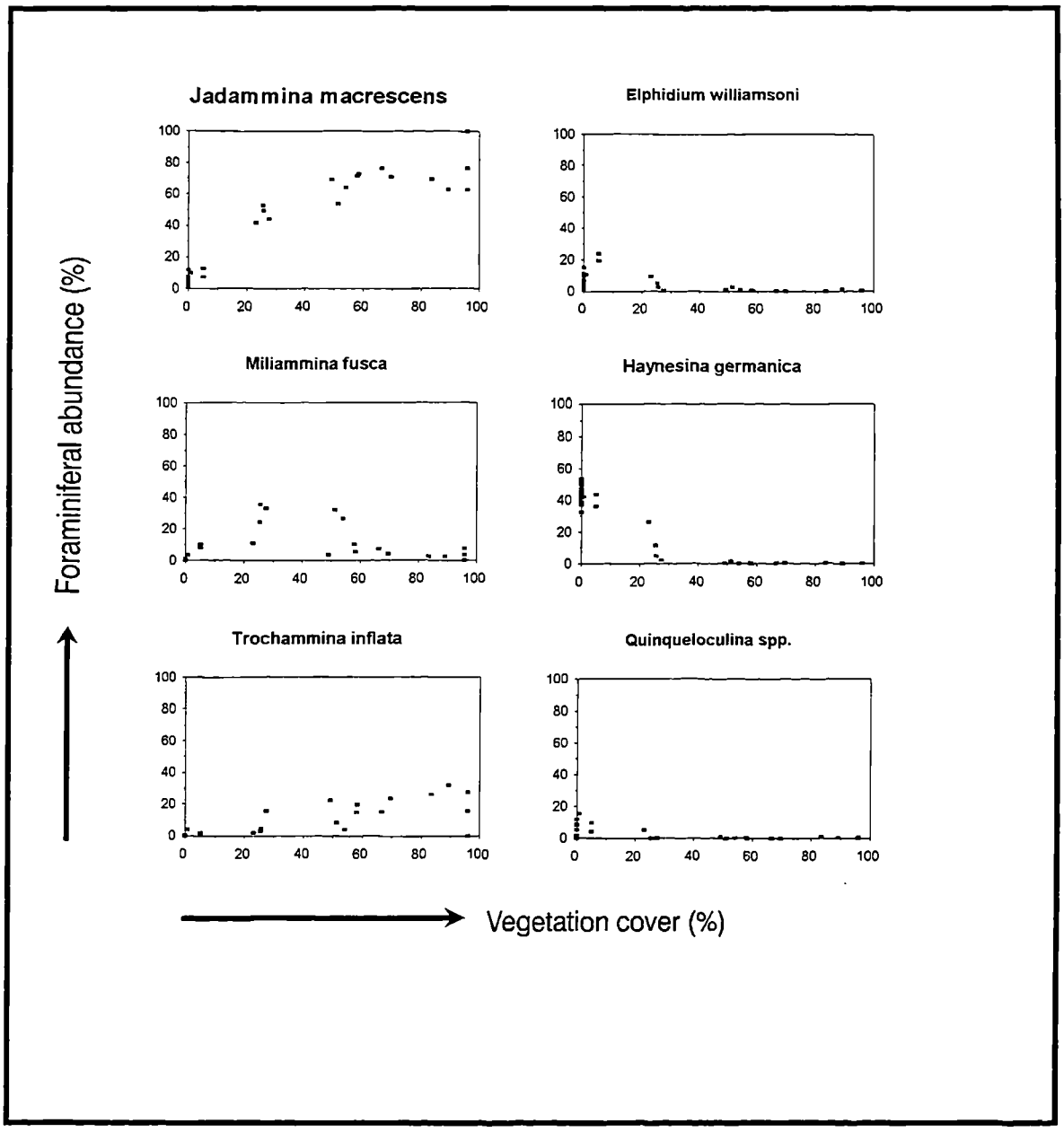

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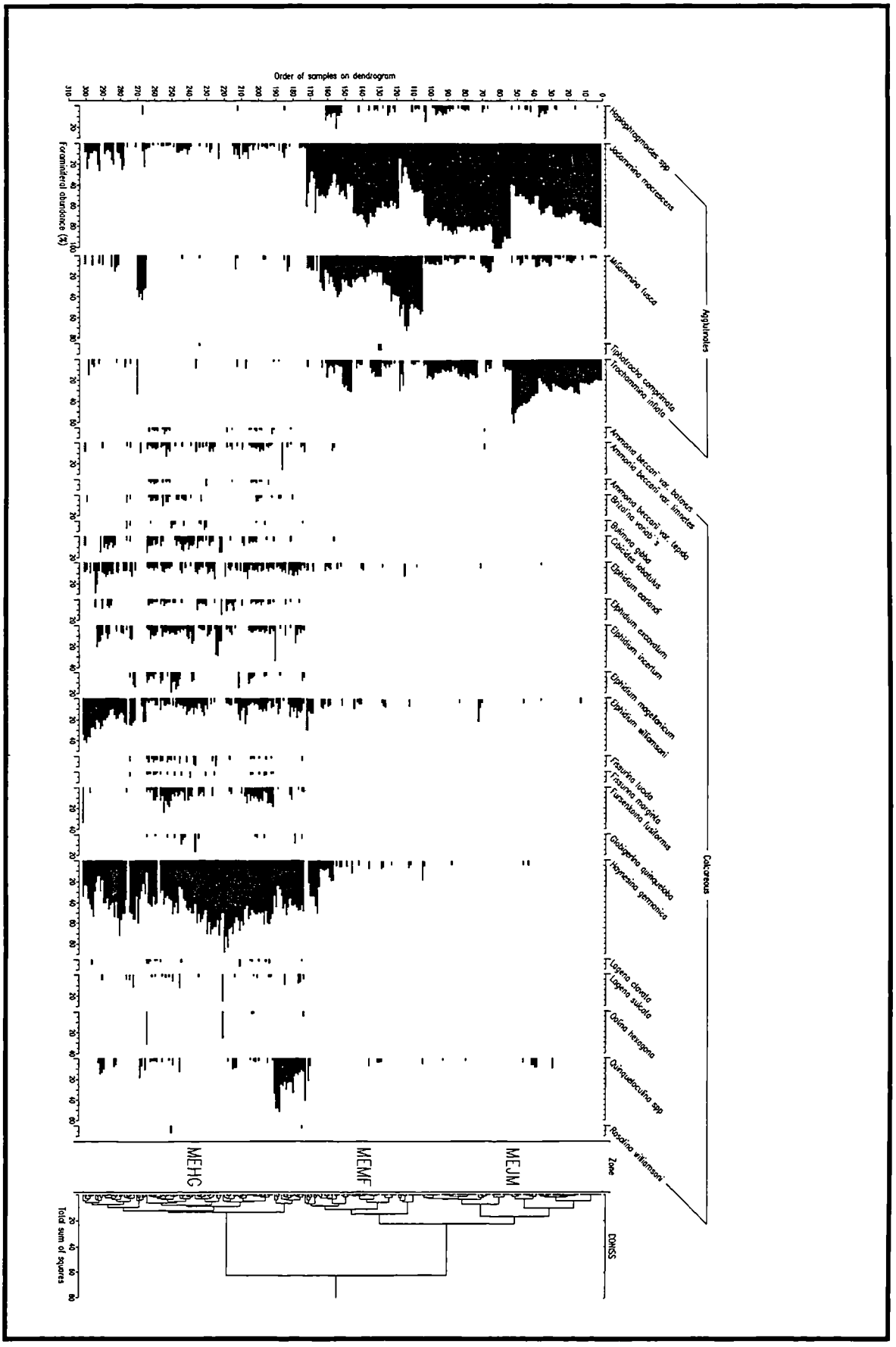
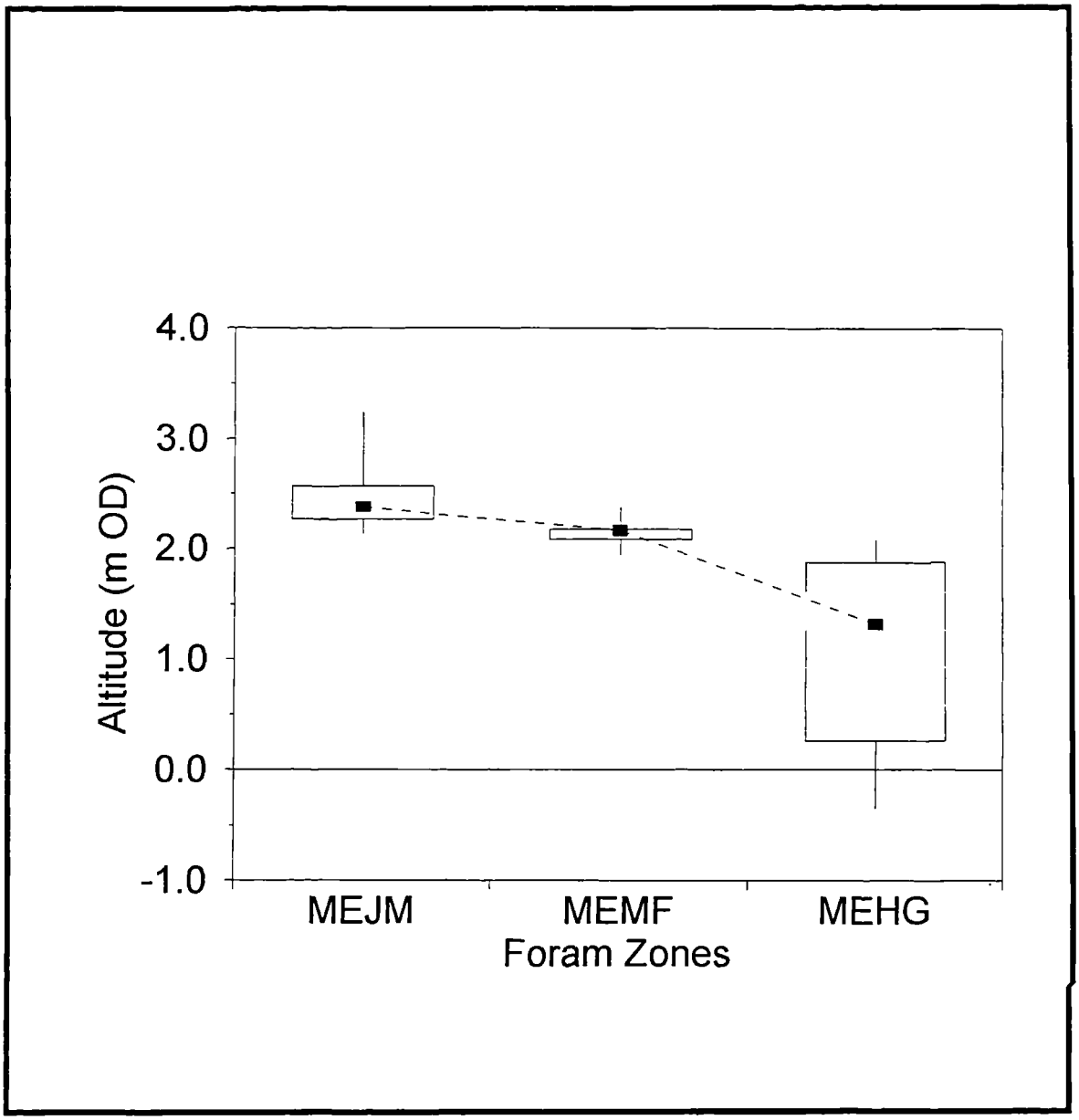
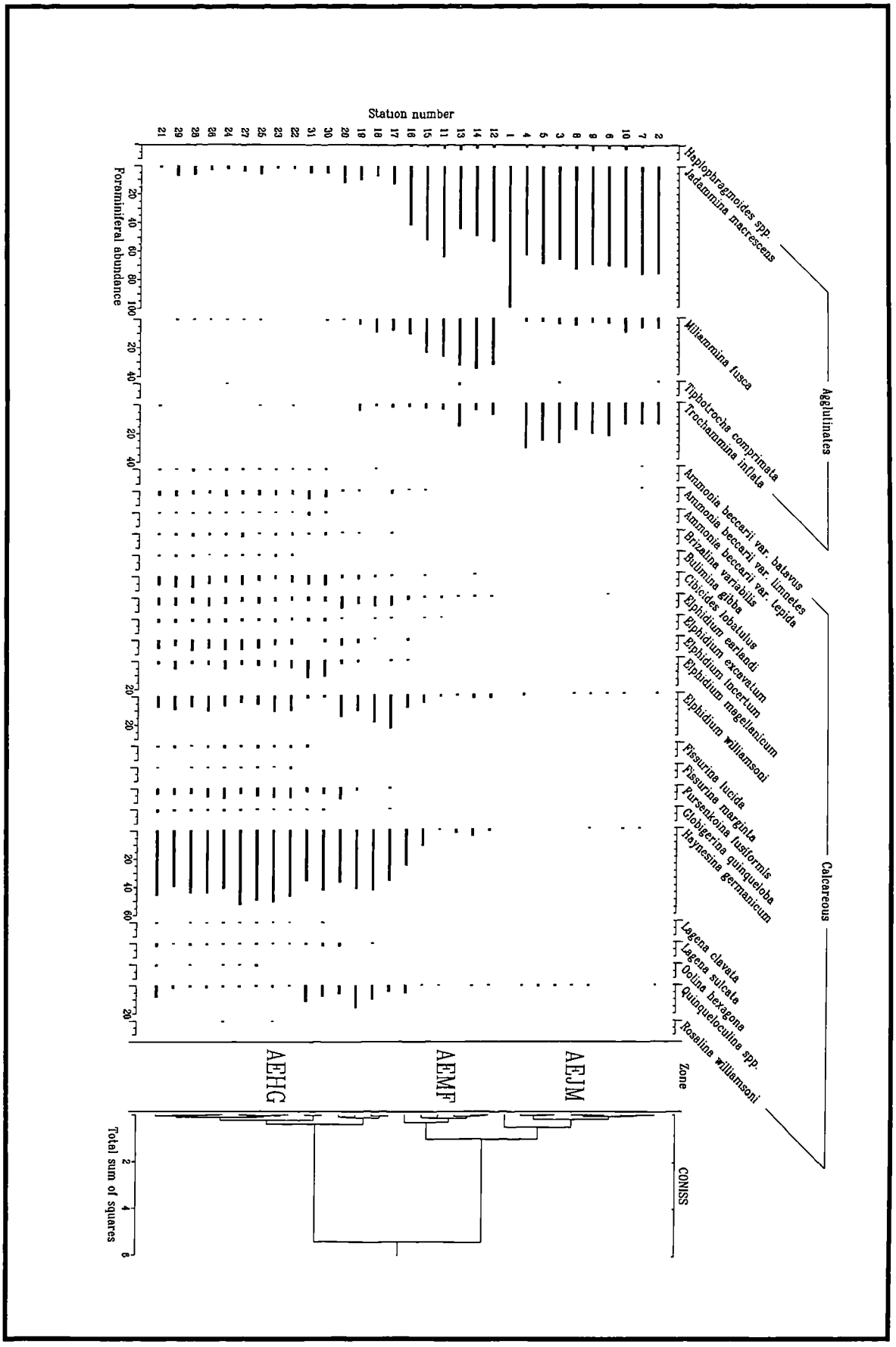


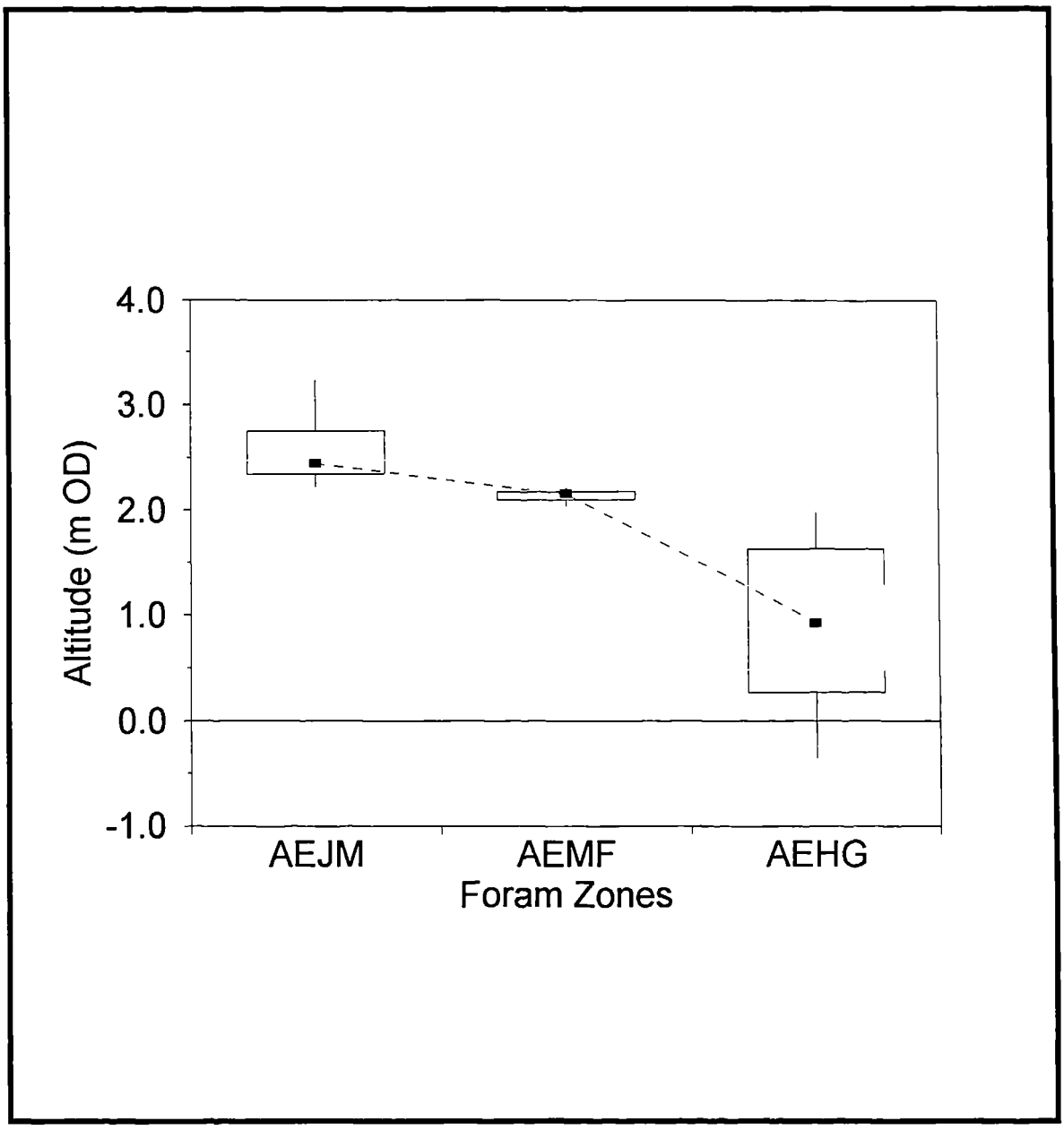
4.2.15 Unconstrained cluster analysis based on unweighted Euclidean distance of monthly foraminiferal death assemblages from samples collected over a twelve month period from Cowpen Marsh. Only samples with counts greater than 40 individuals and species which reach 5 % of the total sum are included.



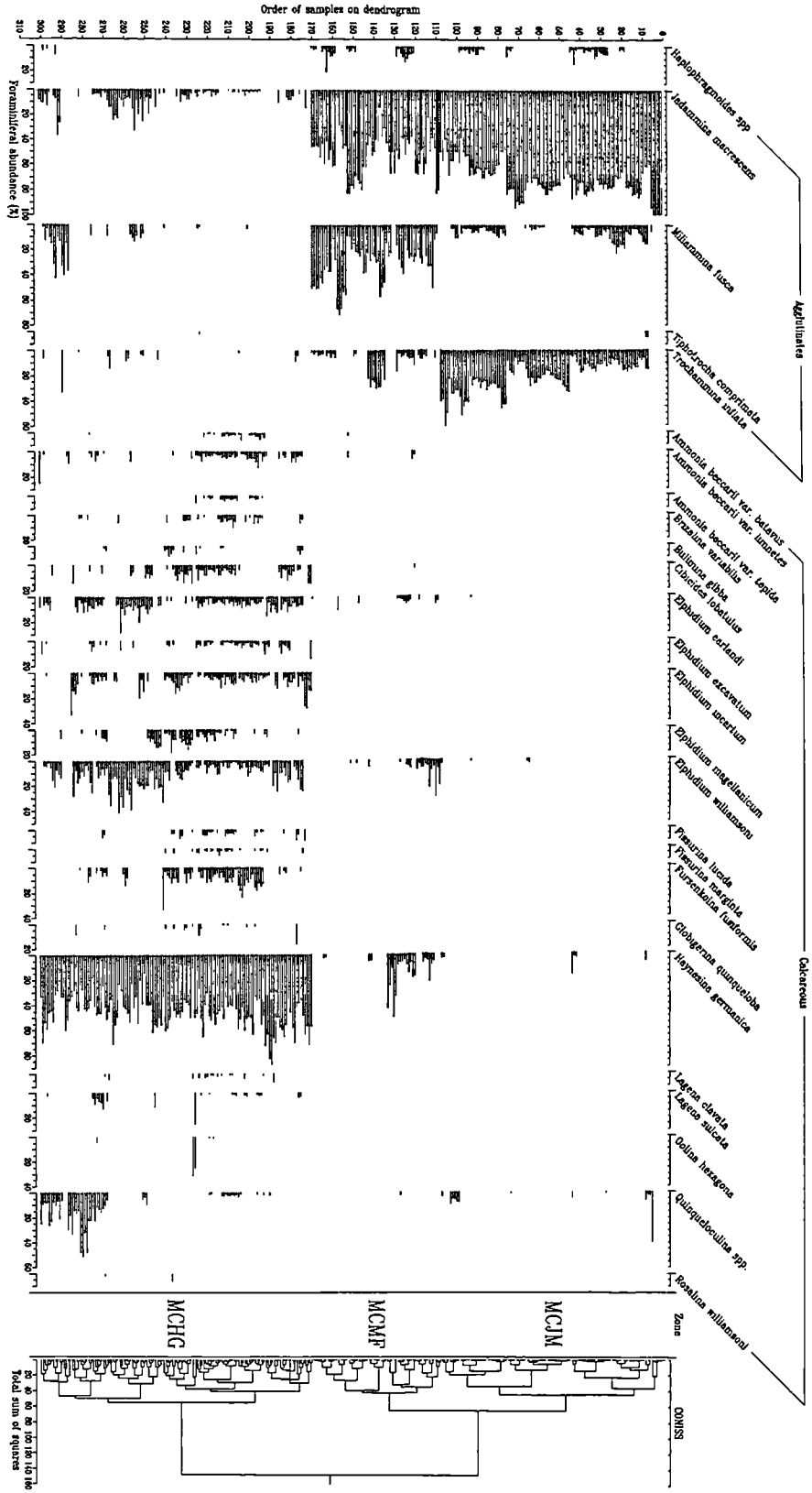
4.2.16 Boxplots showing maximum, minimum, interquartile ranges and median altitudes for monthly clusters based on Euclidean distance from Cowpen Marsh.



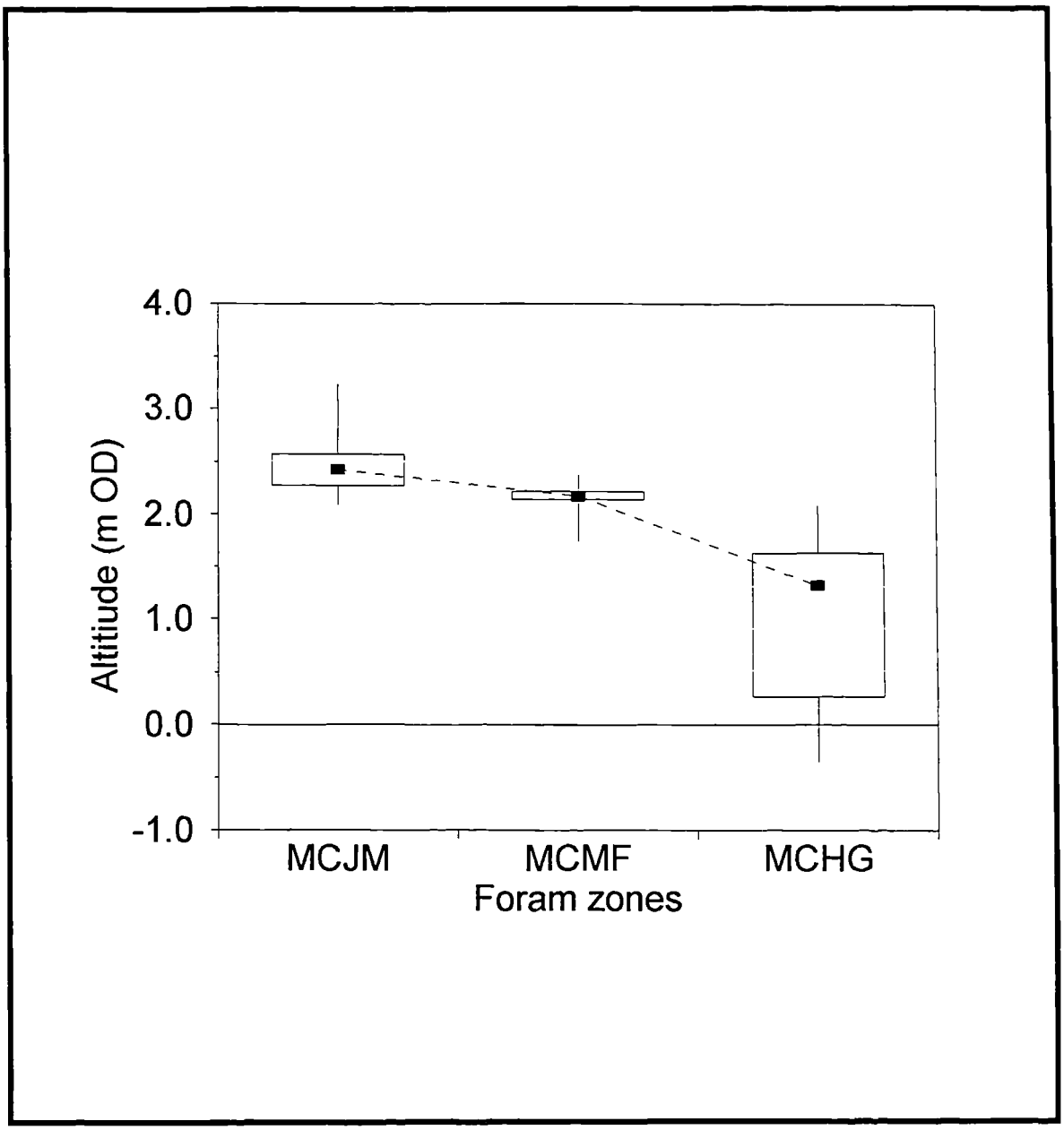
4.2.17 Unconstrained cluster analysis based on unweighted Euclidean distance of annual foraminiferal death assemblages from samples collected over a twelve month period from Cowpen Marsh. Only samples with counts greater than 40 individuals and species which reach 5 % of the total sum are included.



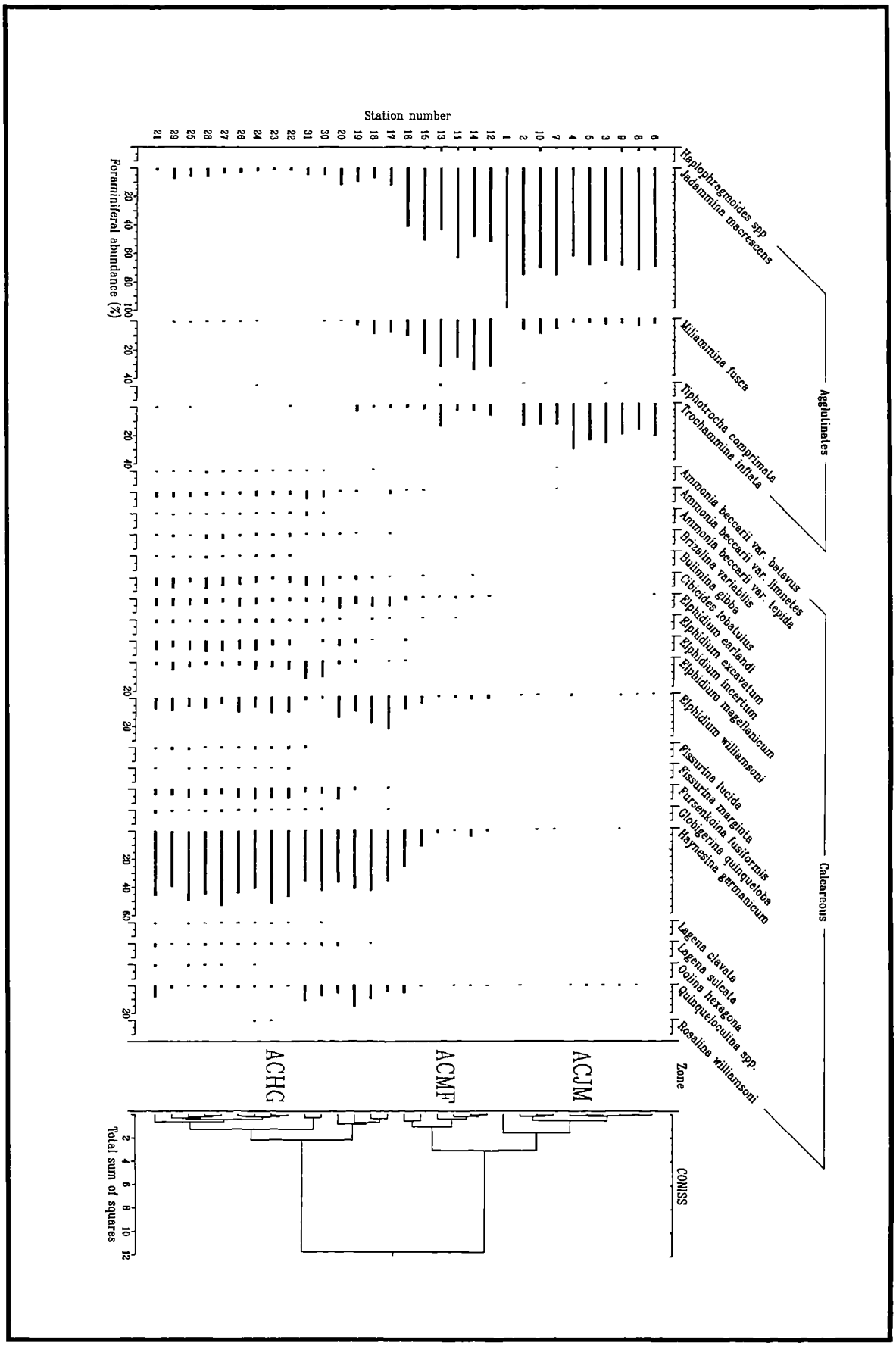
4.2.18 Boxplots showing maximum, minimum, interquartile ranges and median altitudes for annual clusters based on Euclidean distance from Cowpen Marsh.



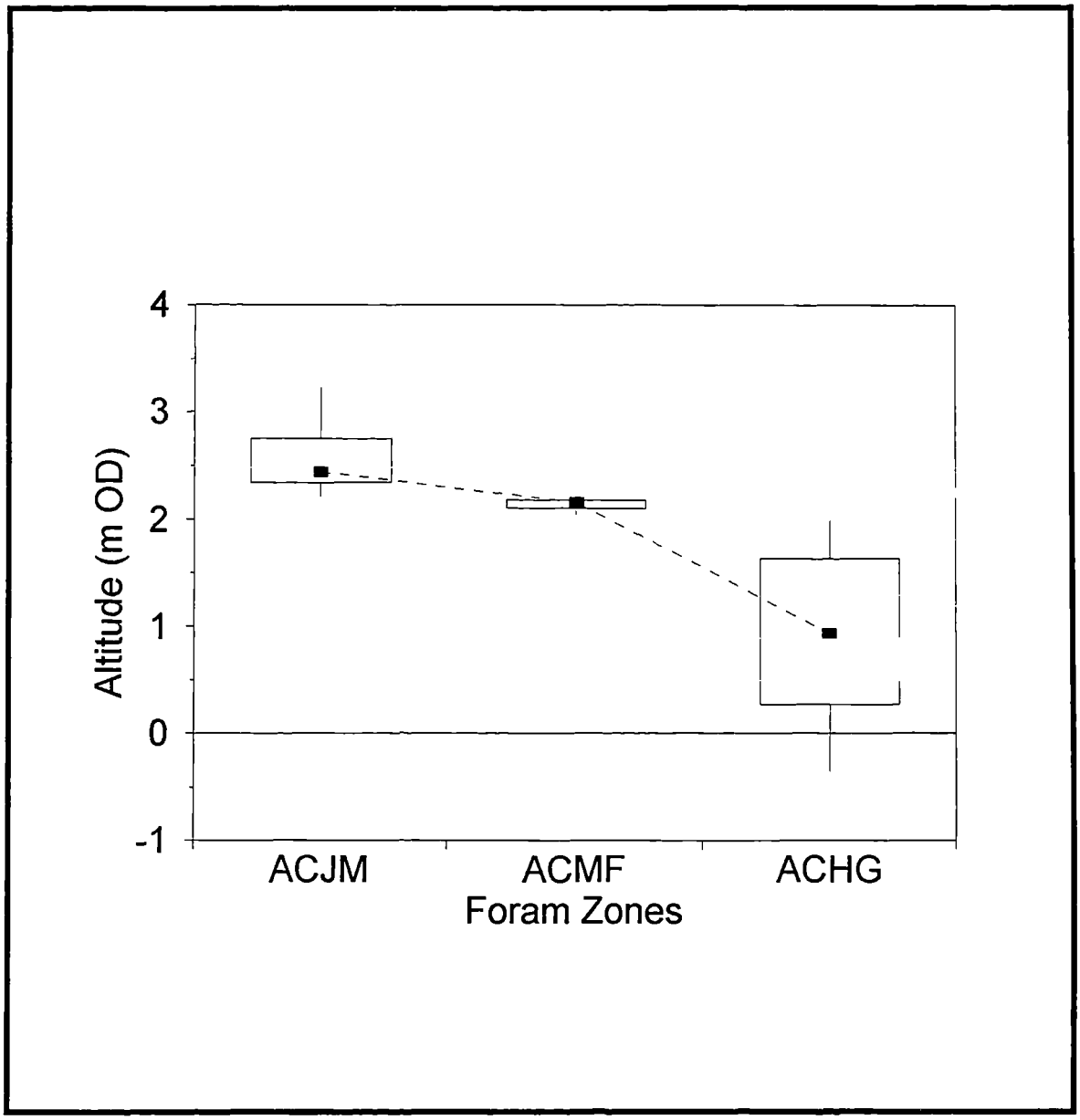
4.2.19 Unconstrained cluster analysis based on unweighted Chord distance of monthly foraminiferal death assemblages from samples collected over a twelve month period from Cowpen Marsh. Only samples with counts greater than 40 individuals and species which reach 5 % of the total sum are included. 32



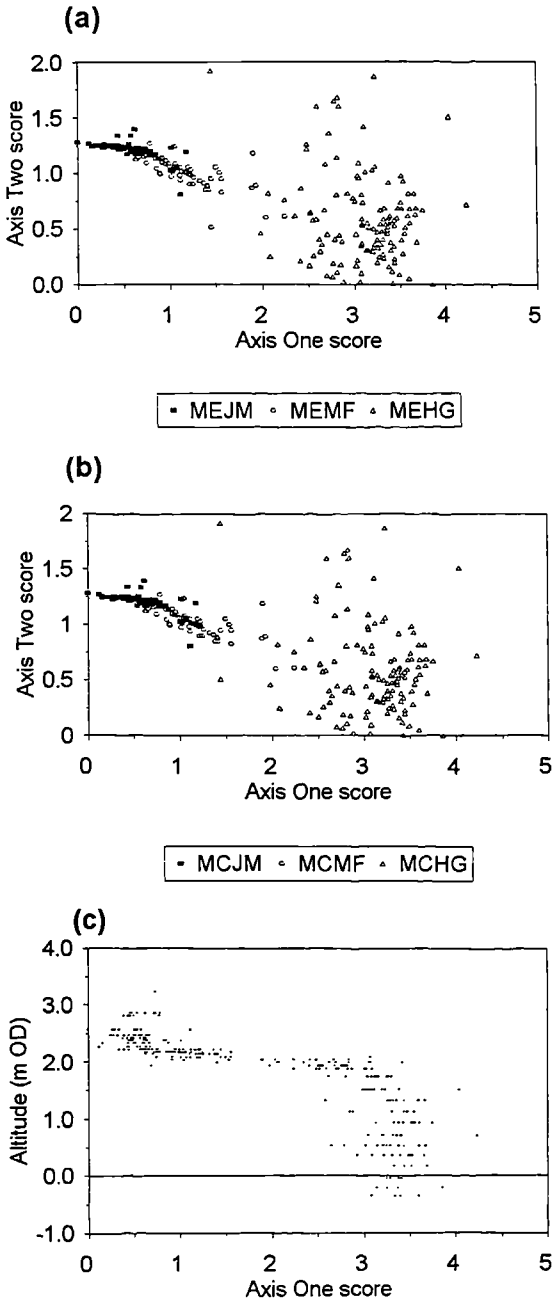
4.2.20 Boxplots showing maximum, minimum, interquartile ranges and median altitudes for monthly clusters based on Chord distance from Cowpen Marsh



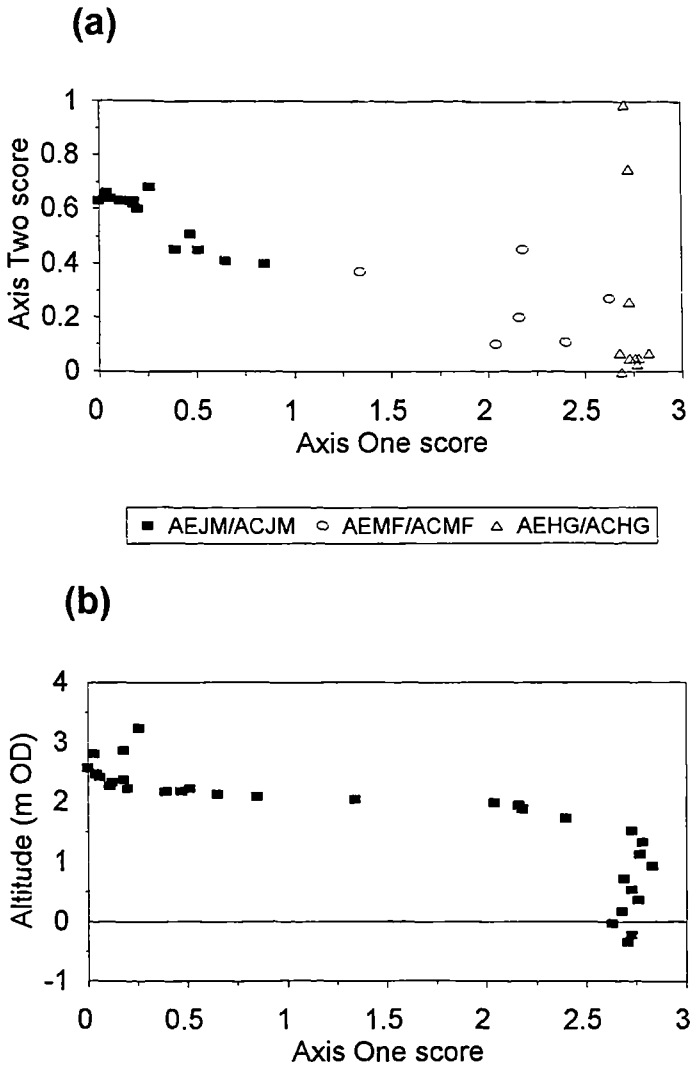
4.2.21 Unconstrained cluster analysis based on unweighted Chord distance of annual foraminiferal death assemblages from samples collected over a twelve month period from Cowpen Marsh. Only samples with counts greater than 40 individuals and species which reach 5 % of the total sum are included.



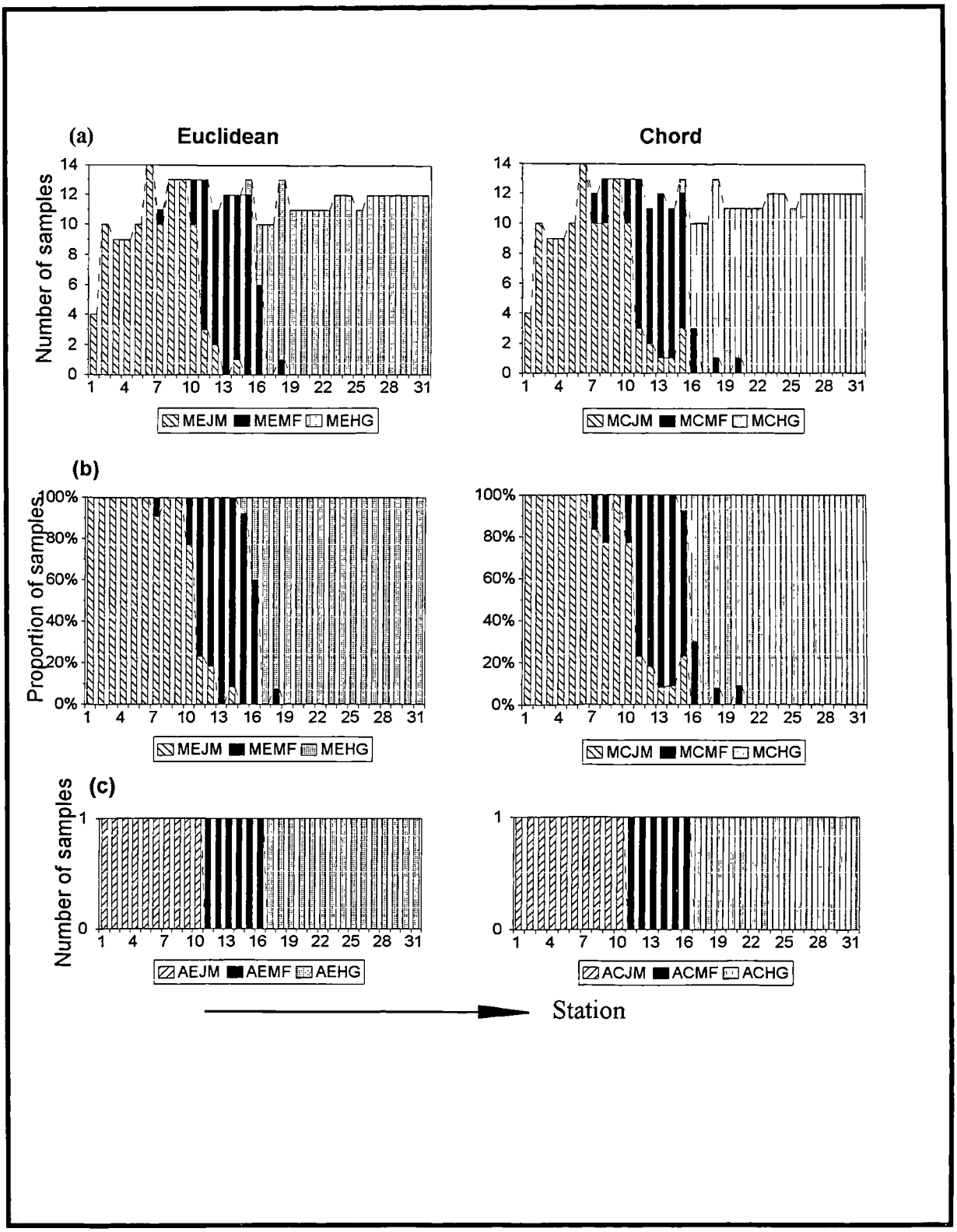
4.2.22 Boxplots showing maximum, minimum, interquartile ranges and median altitudes for annual clusters based on Chord distance from Cowpen Marsh.



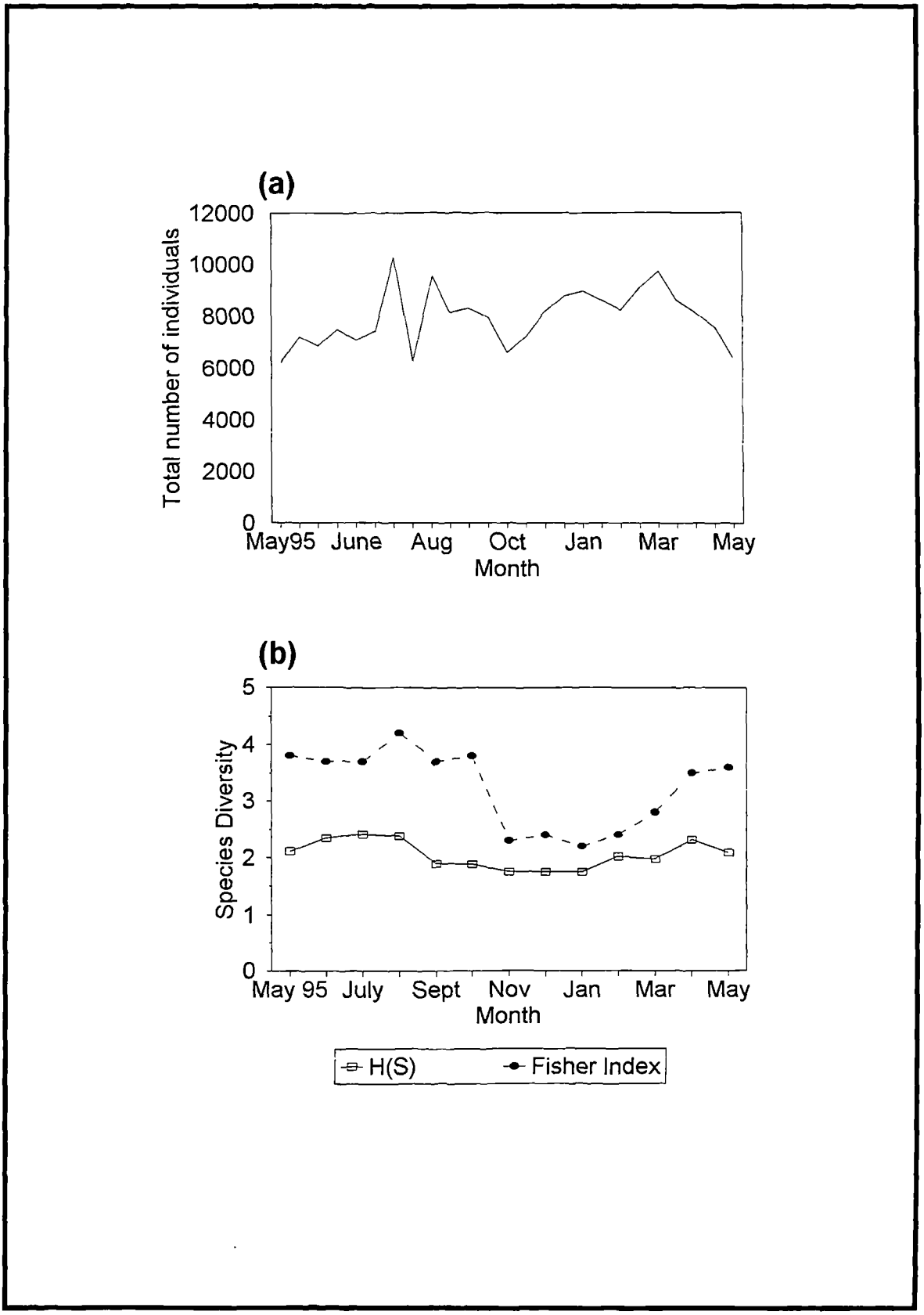
4.2.23 DCA of monthly foraminiferal death assemblages from Cowpen Marsh. The zonations produced by unconstrained cluster analysis based on unweighted (a) Euclidean distance and (b) Chord distance are shown. (c) DCA Axis One scores versus altitude.



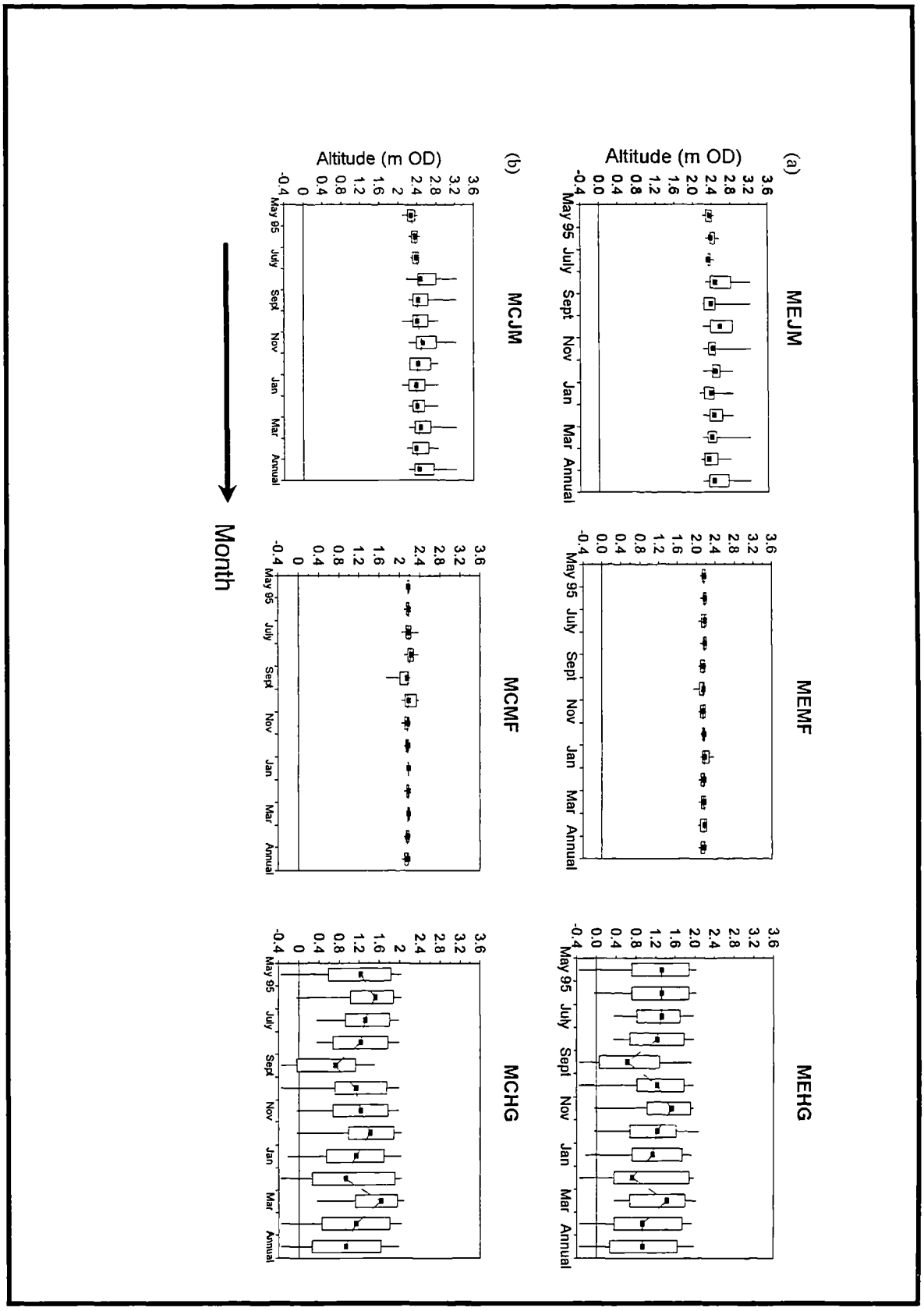
4.2.24 (a) DCA of annual foraminiferal death assemblages from Cowpen Marsh. The zonations produced by unconstrained cluster analysis based on unweighted Euclidean distance and Chord distance are shown. (b) DCA Axis One scores versus altitude.



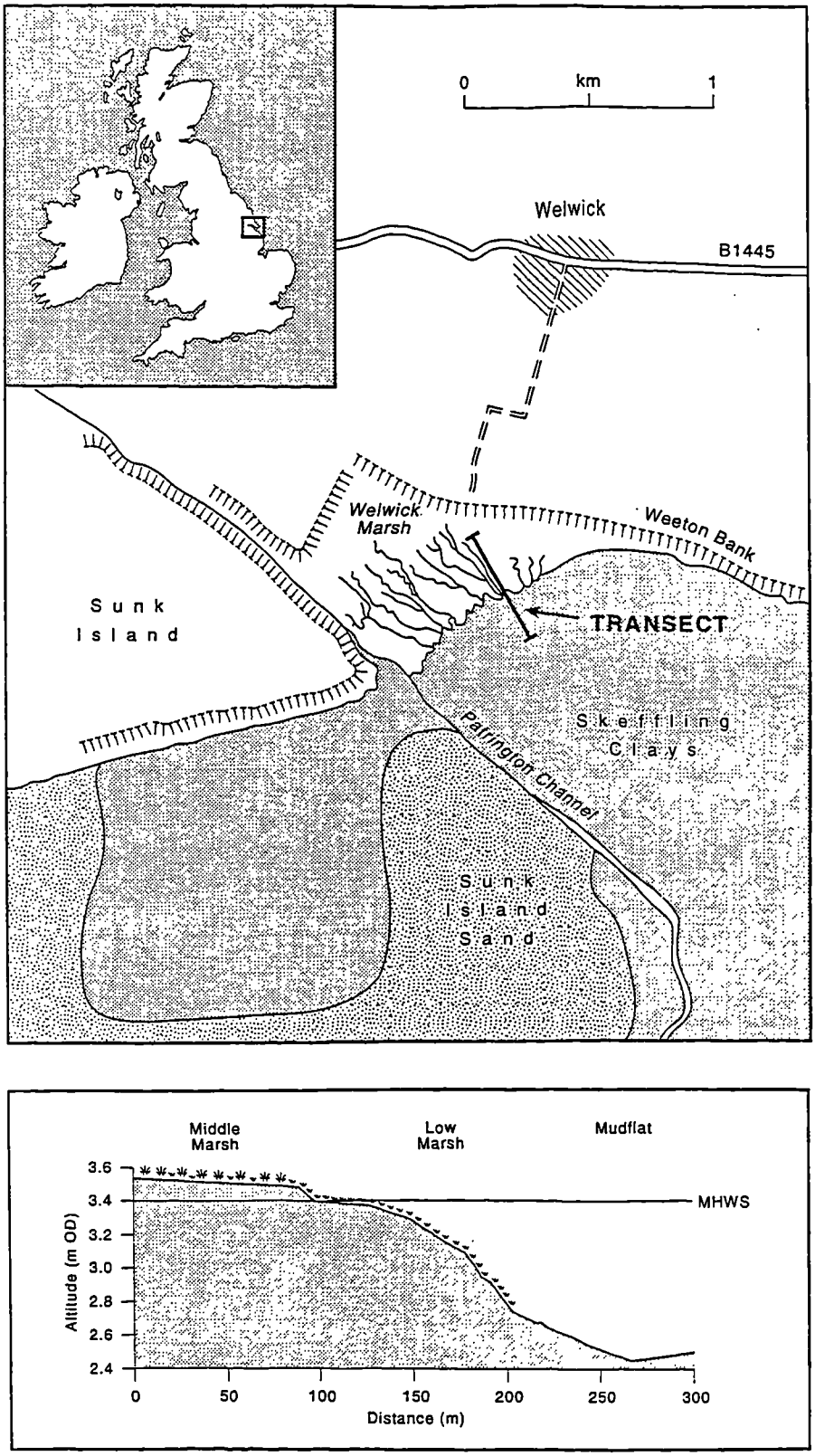
4.2.25 Stacked bar comparisons showing the distribution of Euclidean and Chord zones across the intertidal zone of Cowpen Marsh. (a) Station number versus the number of monthly samples, (b) station number versus the proportion of monthly samples (%) and (c) station number versus the number of annual samples. Only samples with counts greater than 40 individuals and species which reach 5 % of the total sum are included.



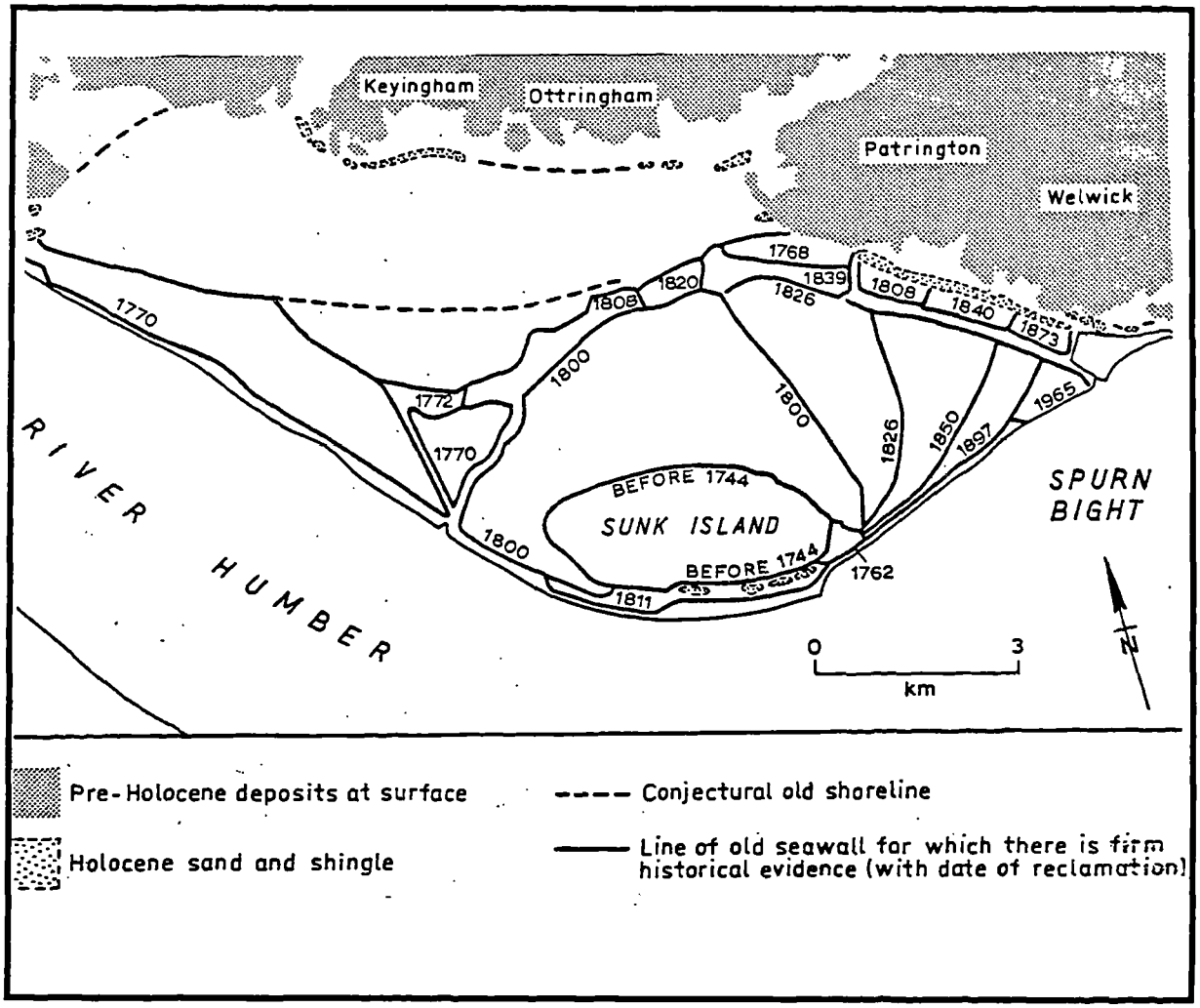
4.2.26 Seasonal variations of (a) total foraminifera death population and (b) species diversity indices from all stations over a twelve month study period from Cowpen Marsh.



4.2.27 Seasonal variations of boxplots showing maximum, minimum, interquartile ranges and median altitudes of unconstrained cluster analysis based on unweighted (a) Euclidean and (b) Chord distance of monthly foraminiferal death assemblages from samples collected over a twelve month period from Cowpen Marsh. Only samples with counts greater than 40 individuals and species which reach 5 % of the total sum are included.



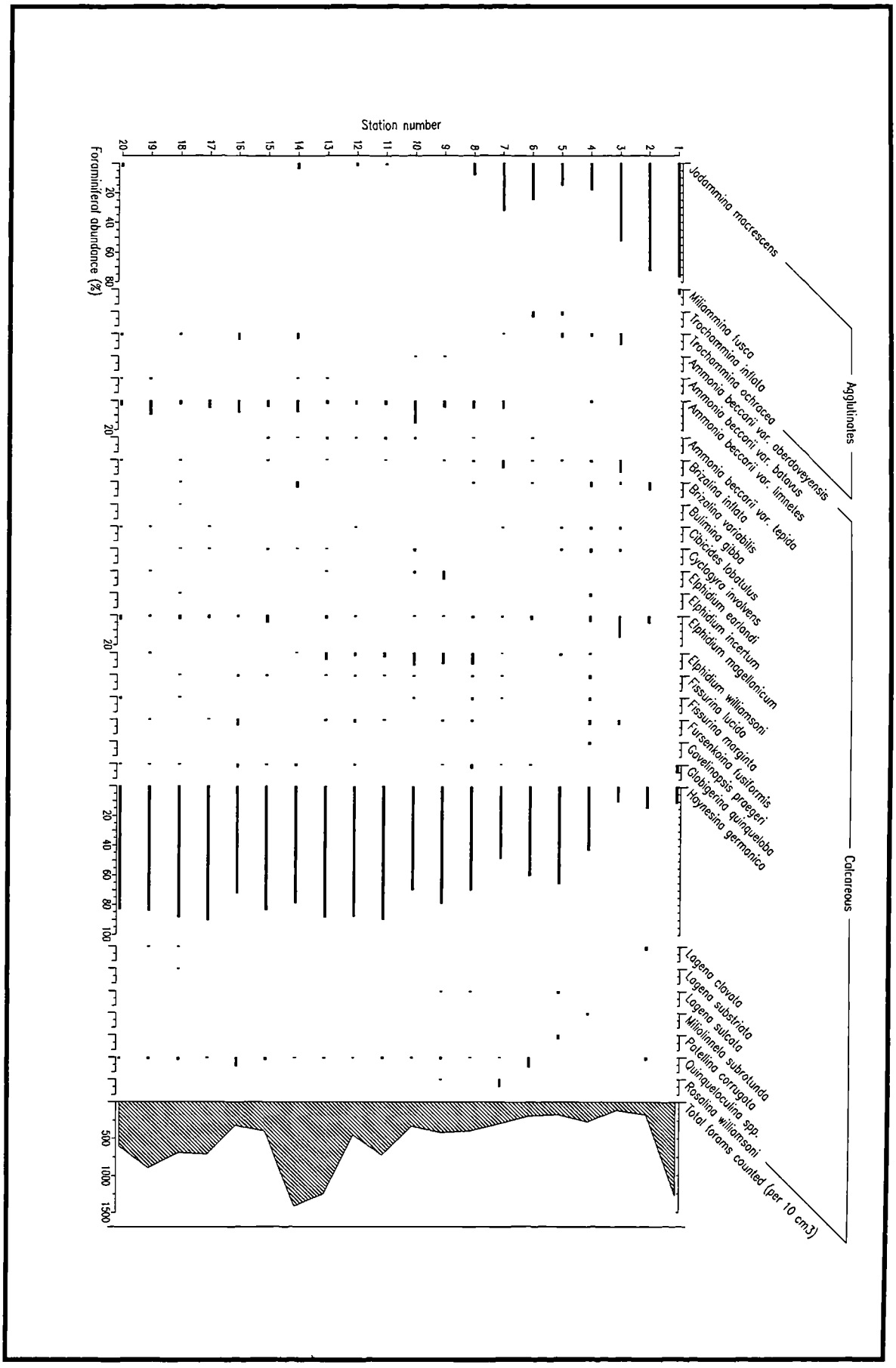
4.3.1 Locational map of Welwick Marsh.



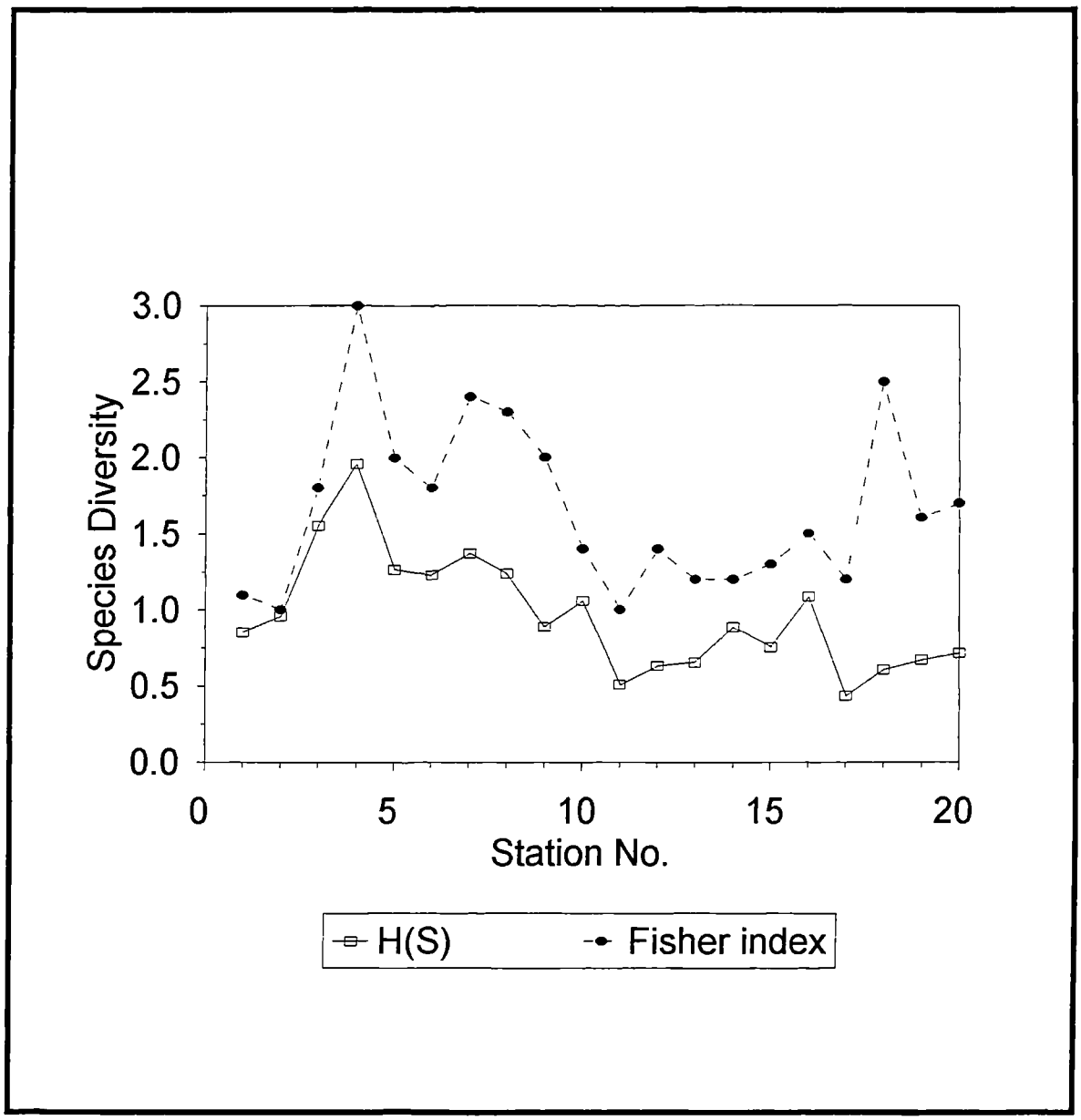
4.3.2 Land reclamation around Sunk Island (Source: Dinnin, 1997).

Altitude (m OD)	Vascular plants	Floral Zones
3.54	*Atriplex portulacoides* *Spergularia* spp. *Elytrigia atherica* *Suaeda maritima*	Middle Marsh
3.33	*Spartina anglica* *Salicornia europaea* *Inula crithmoides* *Elytrigia atherica*	Low Marsh
2.66		Mudflat
2.50		

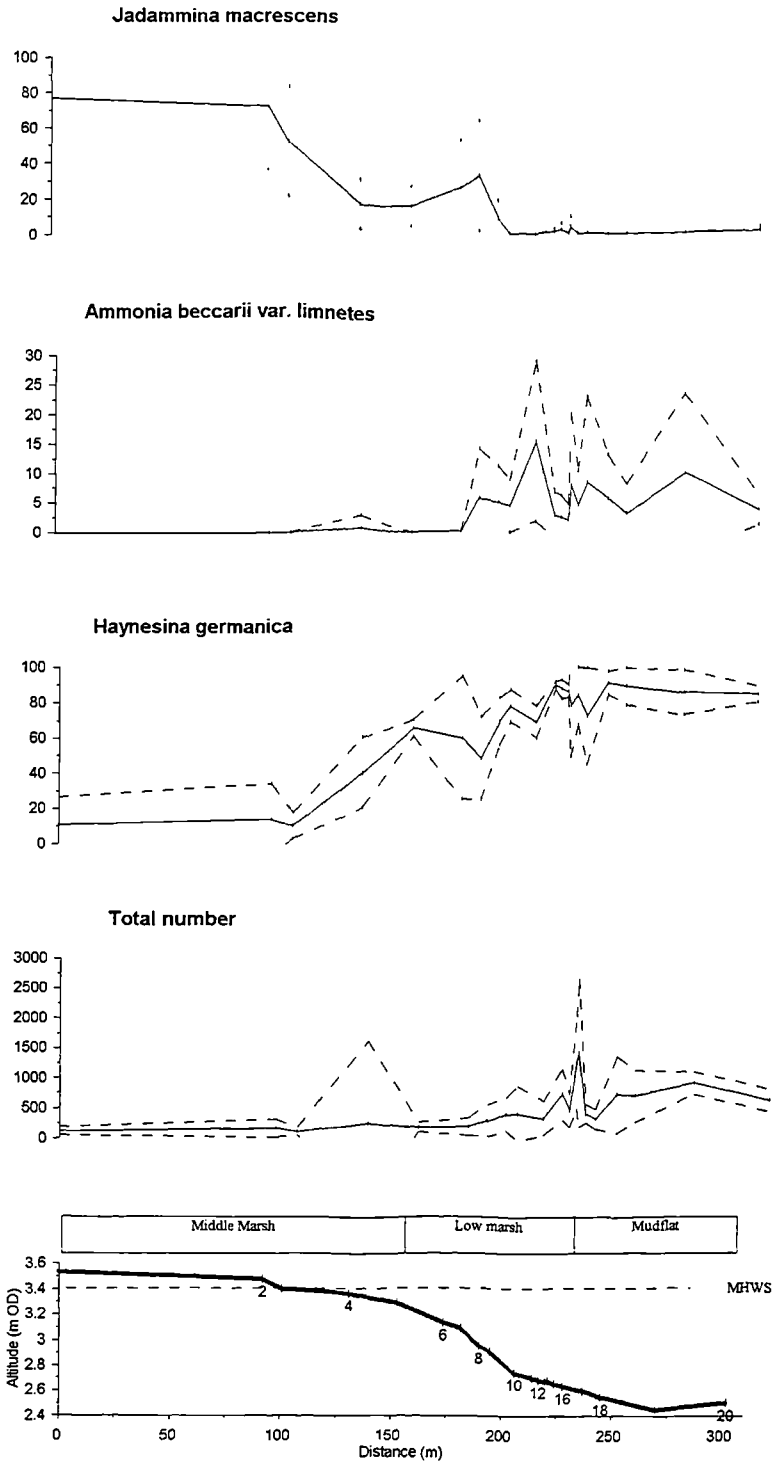
4.3.3 Flora of Welwick Marsh.



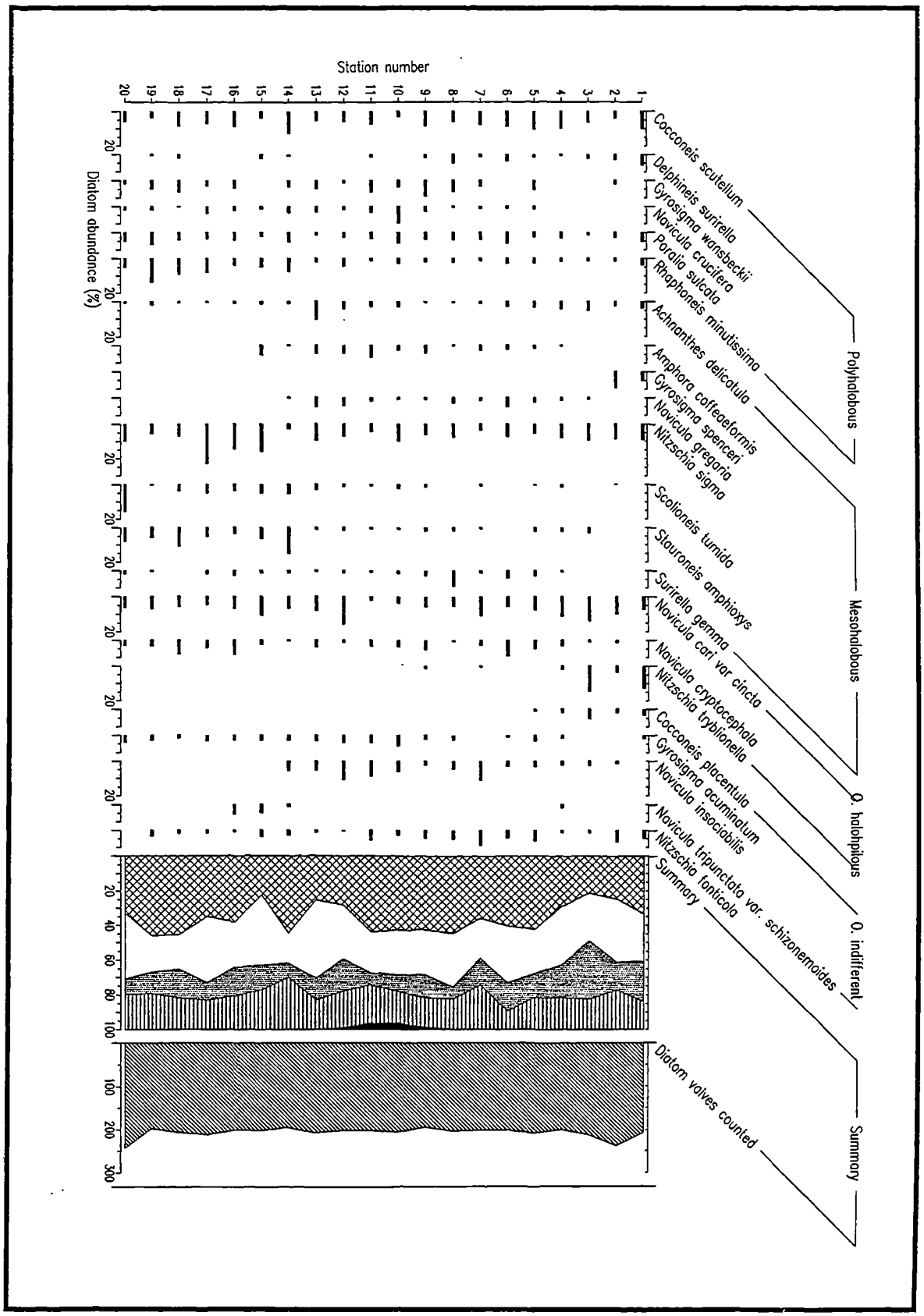
4.3.4 Average annual foraminiferal death assemblages from 4 three-monthly samples from each station of Welwick Marsh. Foraminiferal abundance is expressed as a percentage of total count.



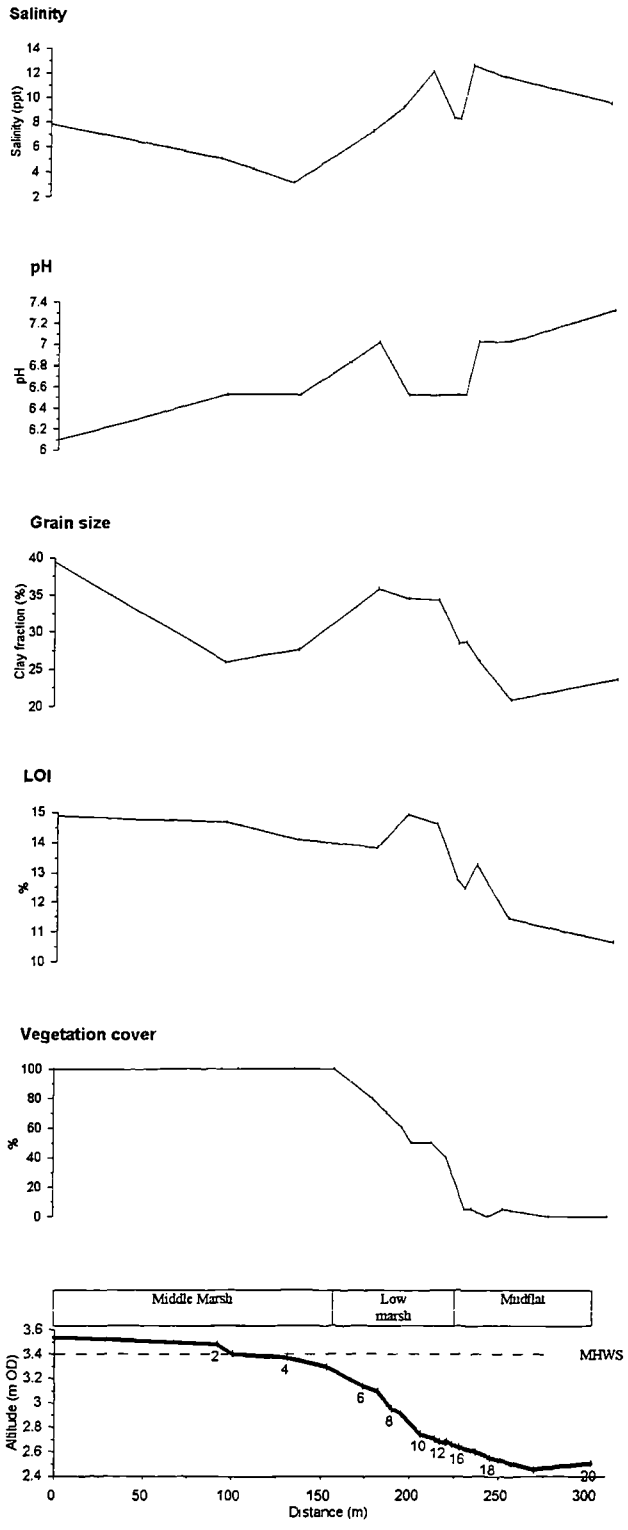
4.3.5 The Shannon-Weaver (H(S)) and Fisher indices of diversity of average annual foraminiferal death assemblages from 4 three-monthly samples from each station of Welwick Marsh.



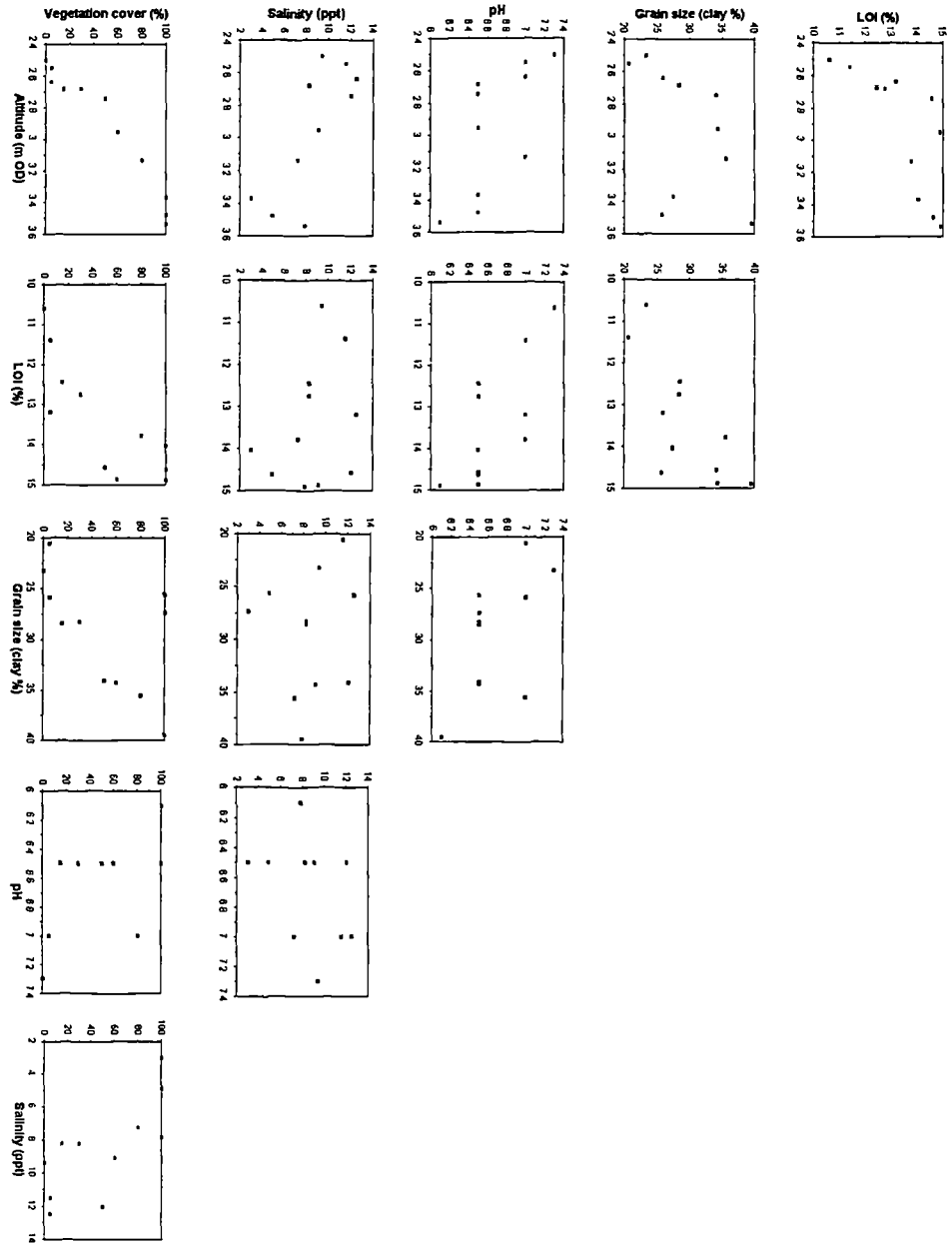
4.3.6 Relative dead abundance of three foraminiferal species from the twelve month study period of Welwick Marsh. Solid and dashed lines indicate the mean and standard error for each station from 4 three-monthly samples. The altitude and floral zonations are indicated.



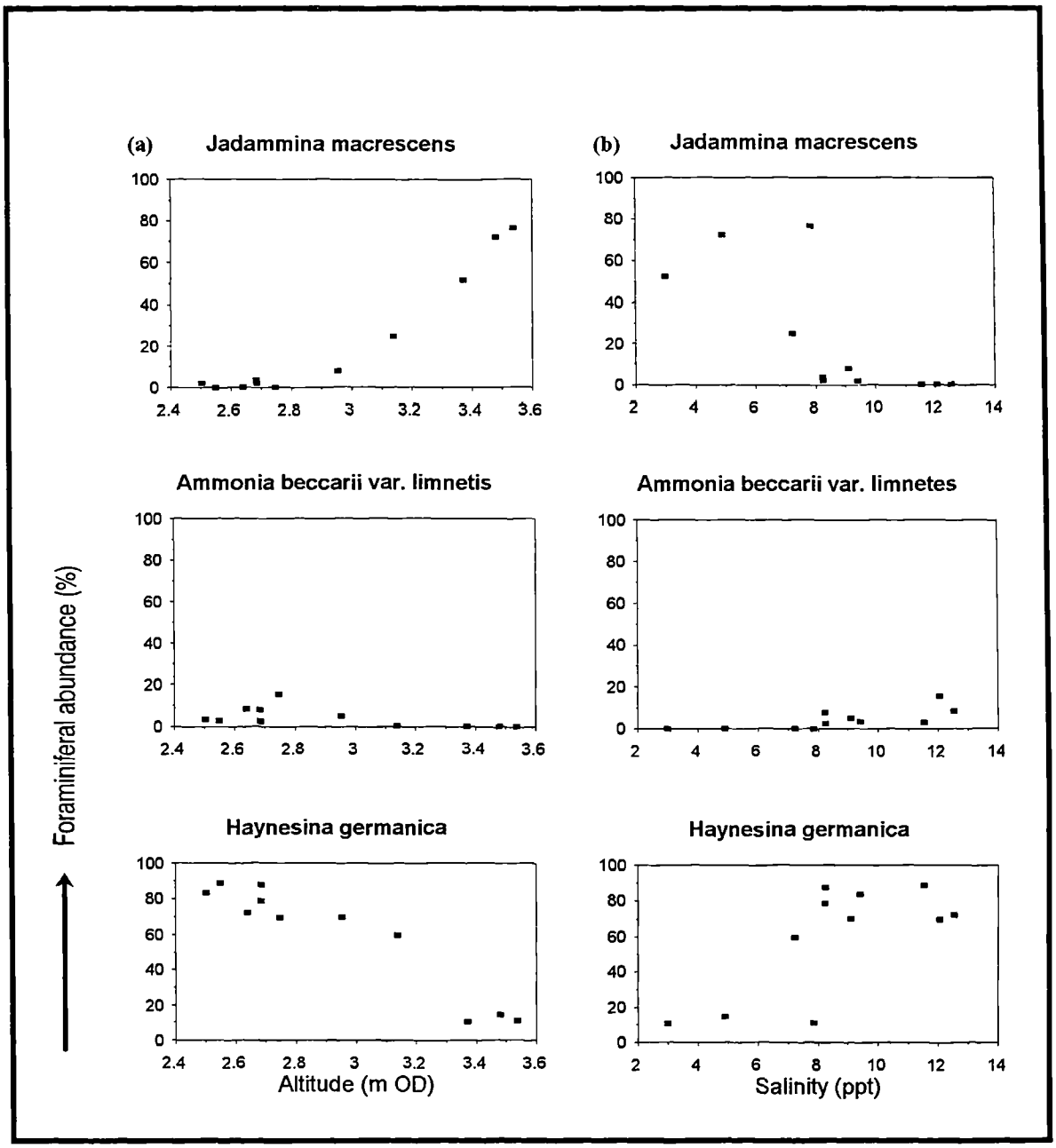
4.3.7 Diatom diagram for each station of Welwick Marsh. Diatom frequencies are expressed as a percentage of total diatom valves. Only species which reach 5 % of the total sum are included. Abbreviations: O = oligohalobous. Summary classifications: polyhalobous = checked; mesohalobous = hollow; oligohalobous - halophilous = dashed; oligohalobous - indifferent = horizontal; and halophobes = solid.



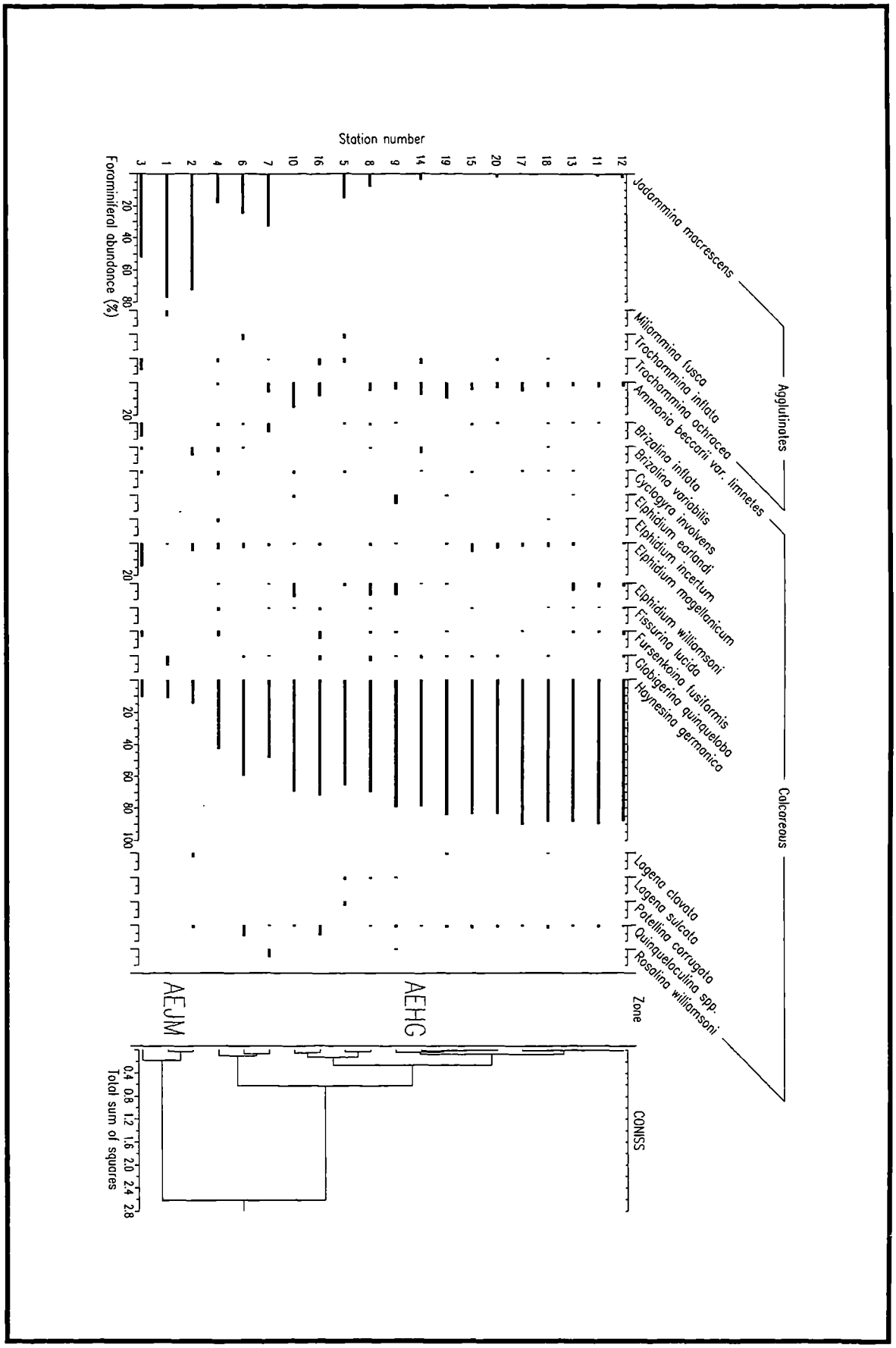
4.3.8 Salinity, pH, grain size, LOI and vegetation cover from Welwick Marsh. Samples were measured August 1996. The altitude and floral zonations are indicated.



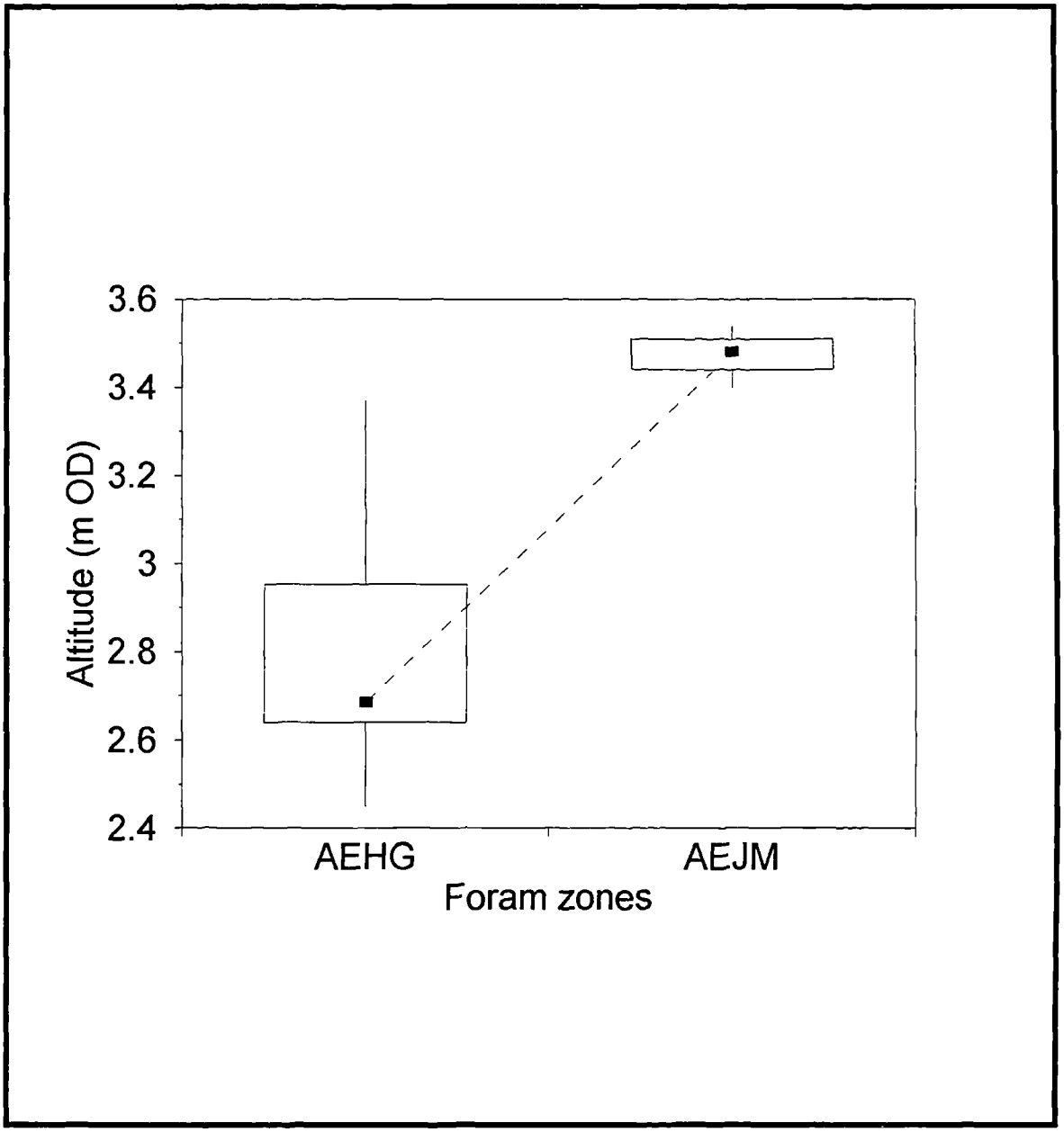
4.3.9 Scatter plot matrix among the environmental variables from Welwick Marsh.



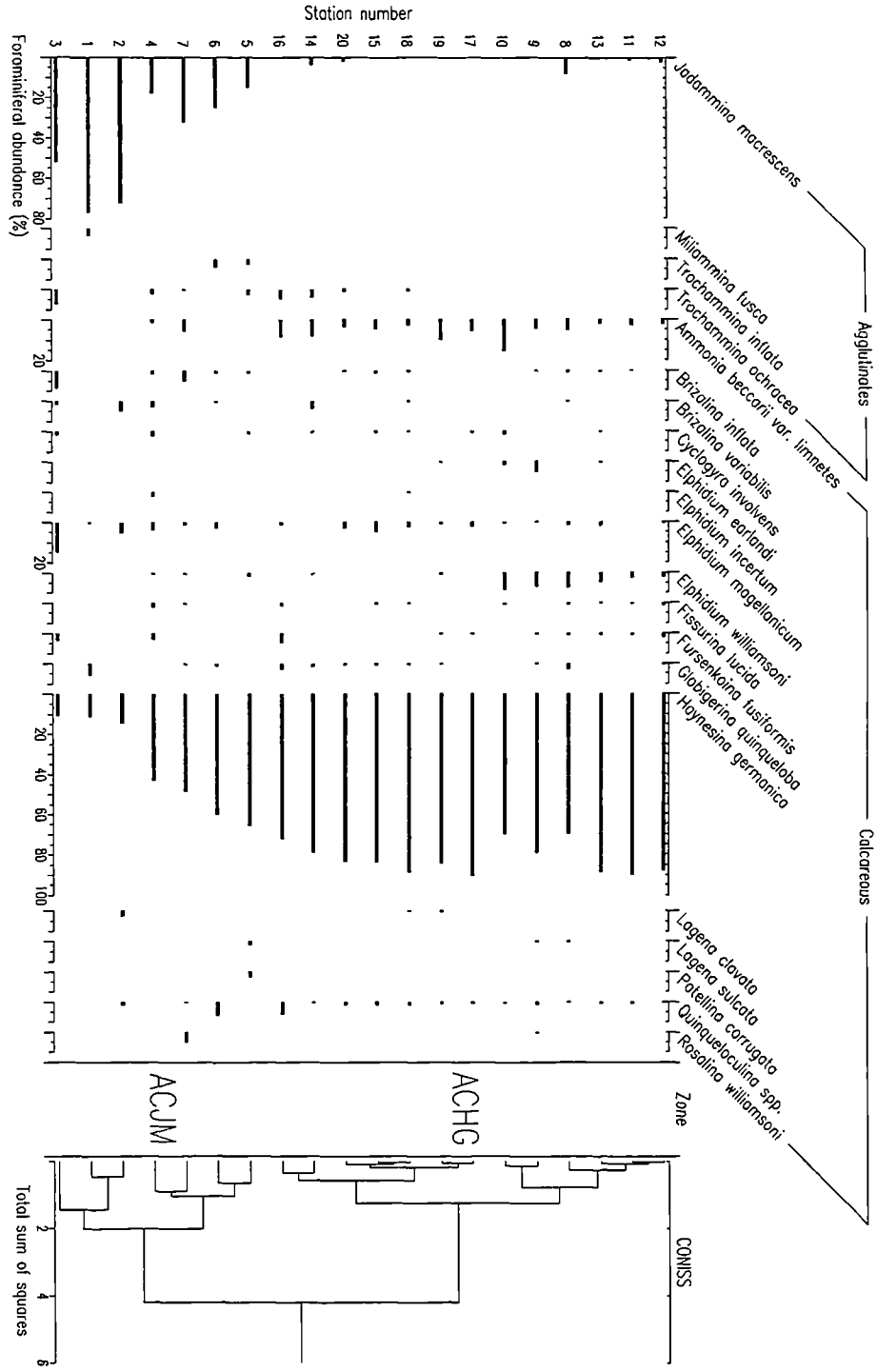
4.3.10 Scatter plots of (a) altitude and (b) salinity versus the annual averages of three foraminiferal species of Welwick Marsh.



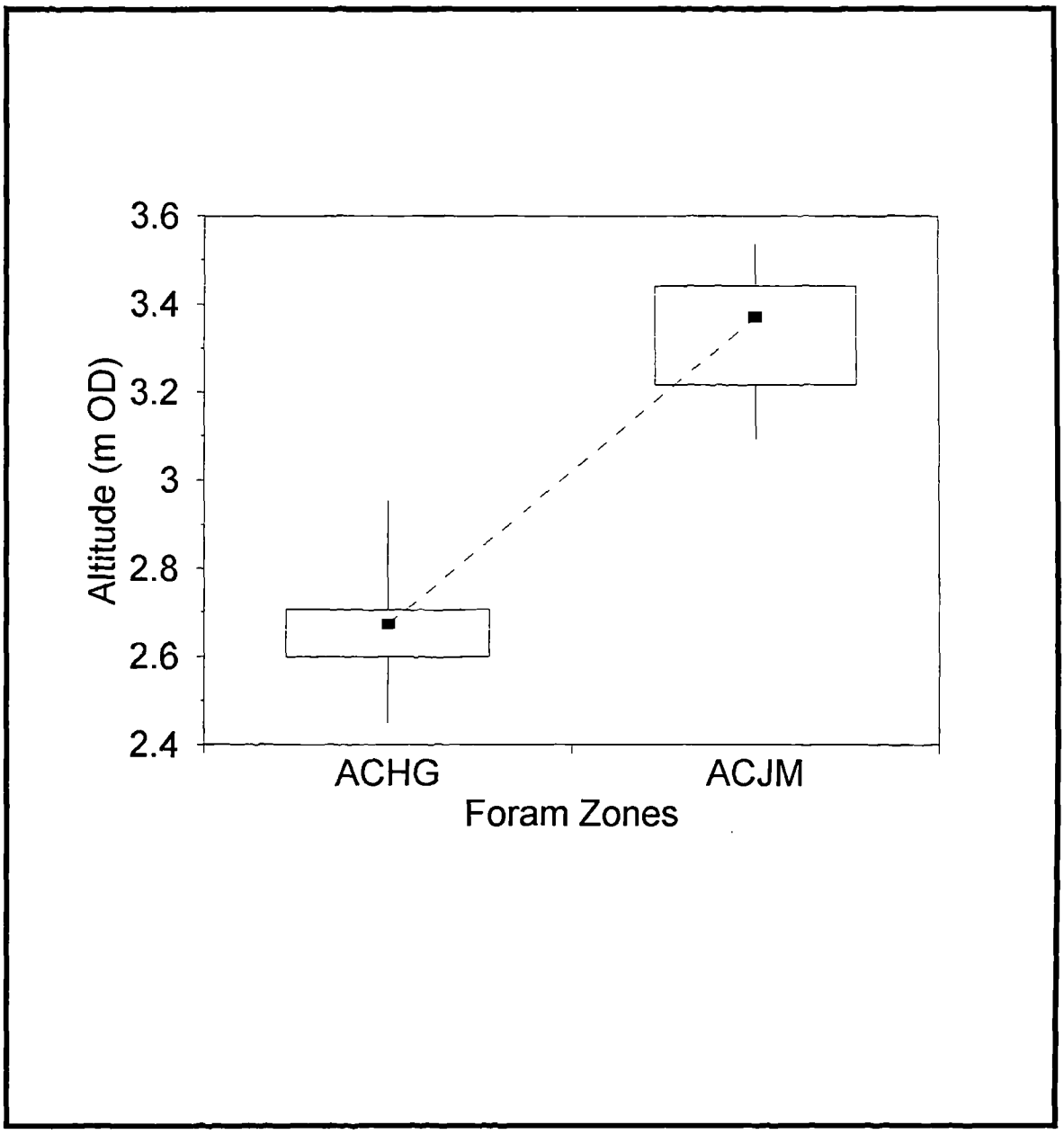
4.3.11 Unconstrained cluster analysis based on unweighted Euclidean distance of annual foraminiferal death assemblages from samples collected over a twelve month period from Welwick Marsh. Only samples with counts greater than 40 individuals and species which reach 5 % of the total sum are included.



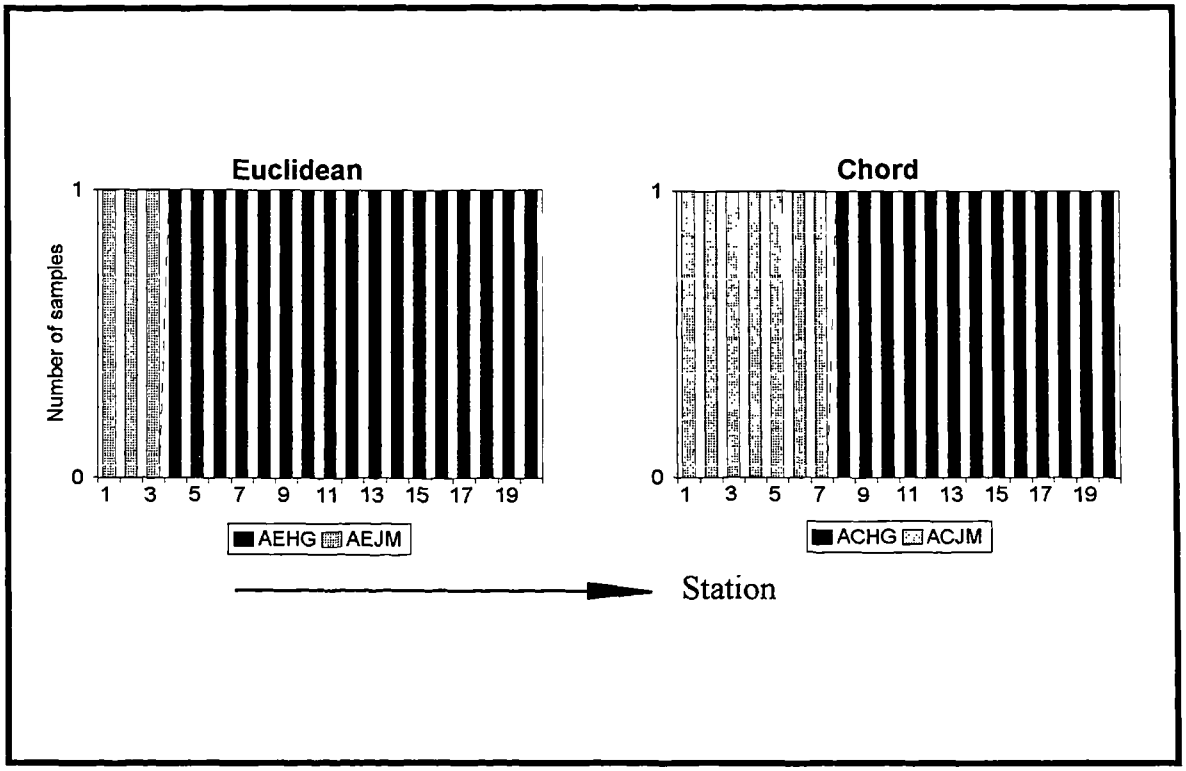
4.3.12 Boxplots showing maximum, minimum, interquartile ranges and median altitudes for annual clusters based on Euclidean distance from Welwick Marsh.



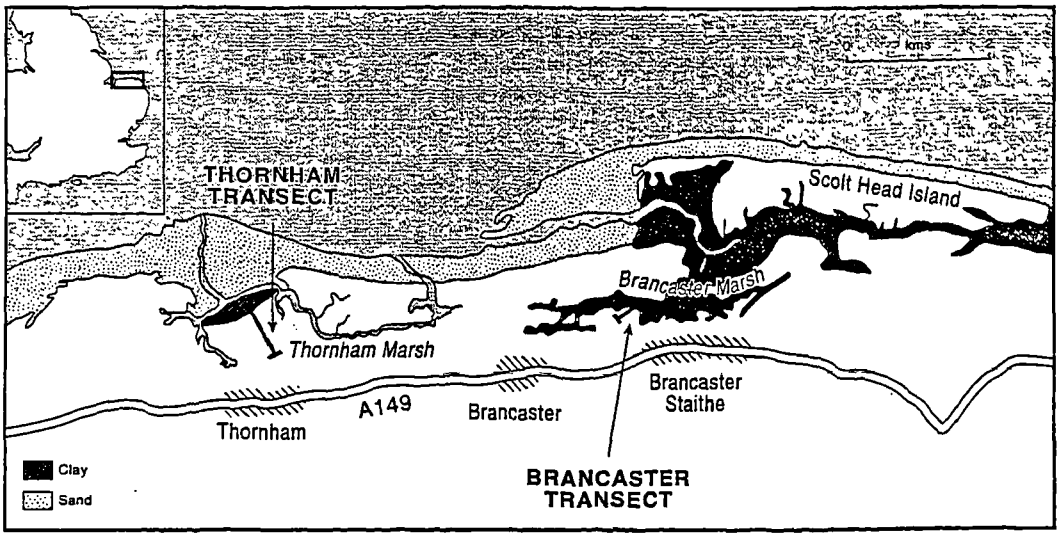
4.3.13 Unconstrained cluster analysis based on unweighted Chord distance of annual foraminiferal death assemblages from samples collected over a twelve month period from Welwick Marsh. Only samples with counts greater than 40 individuals and species which reach 5 % of the total sum are included.

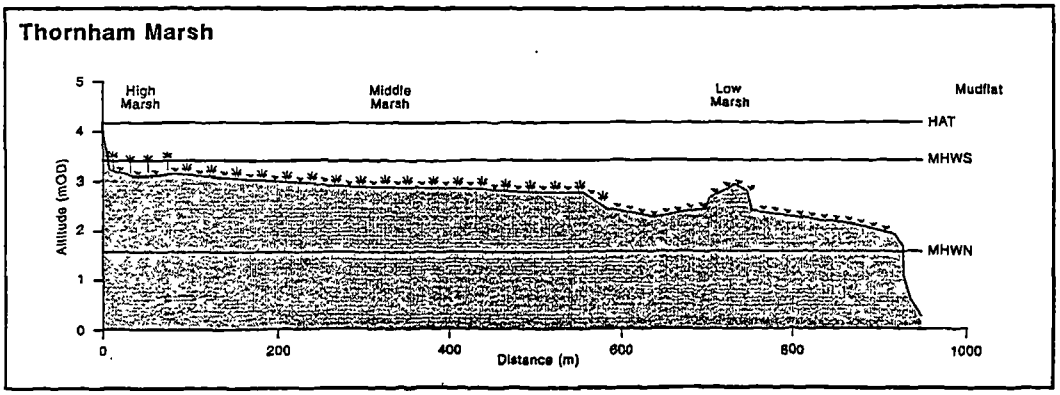


4.3.14 Boxplots showing maximum, minimum, interquartile ranges and median altitudes for annual clusters based on Chord distance from Welwick Marsh.



4.3.15 Stacked bar comparisons showing the distribution of annual Euclidean and Chord zones across the intertidal zone of Welwick Marsh.

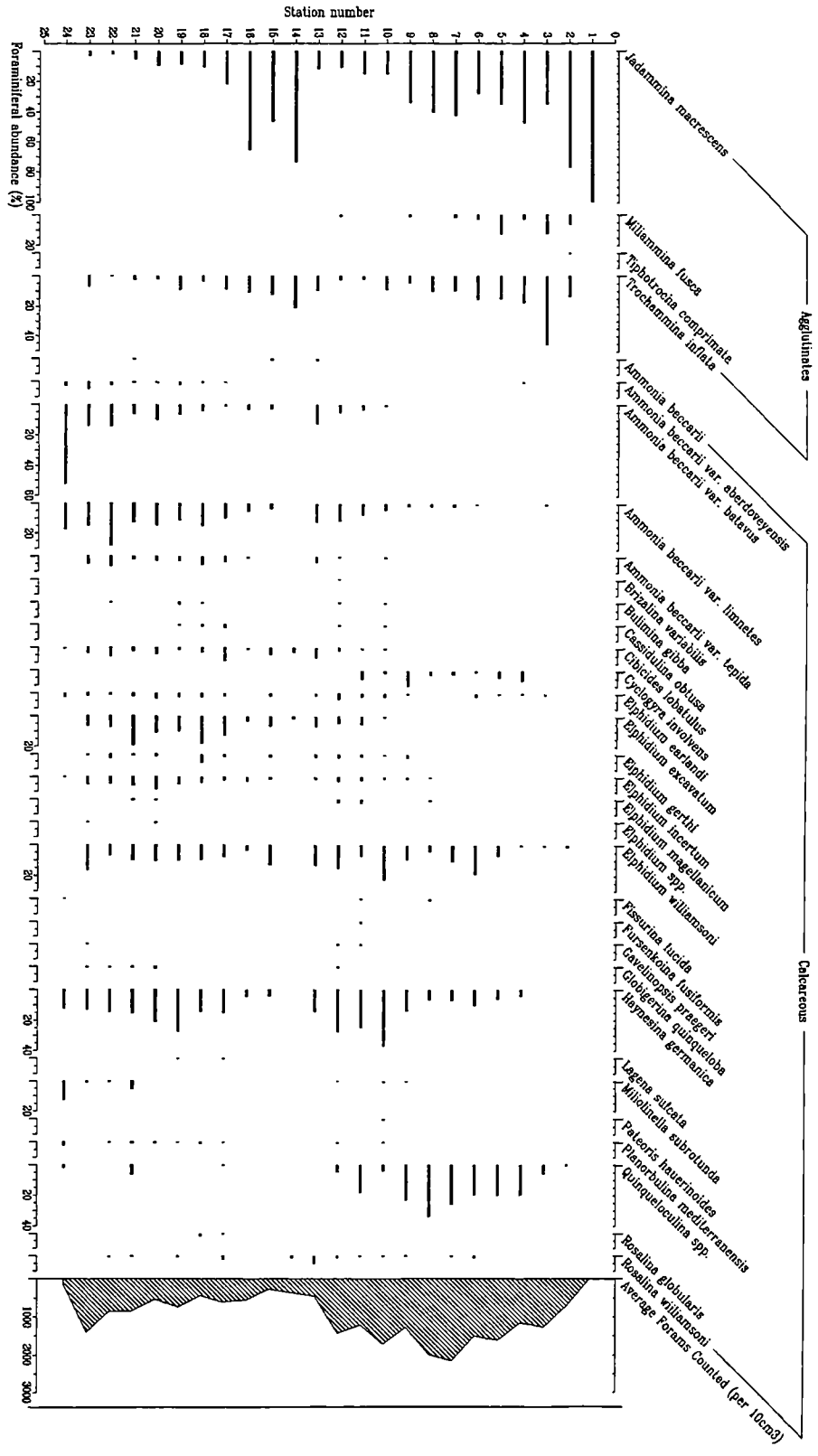




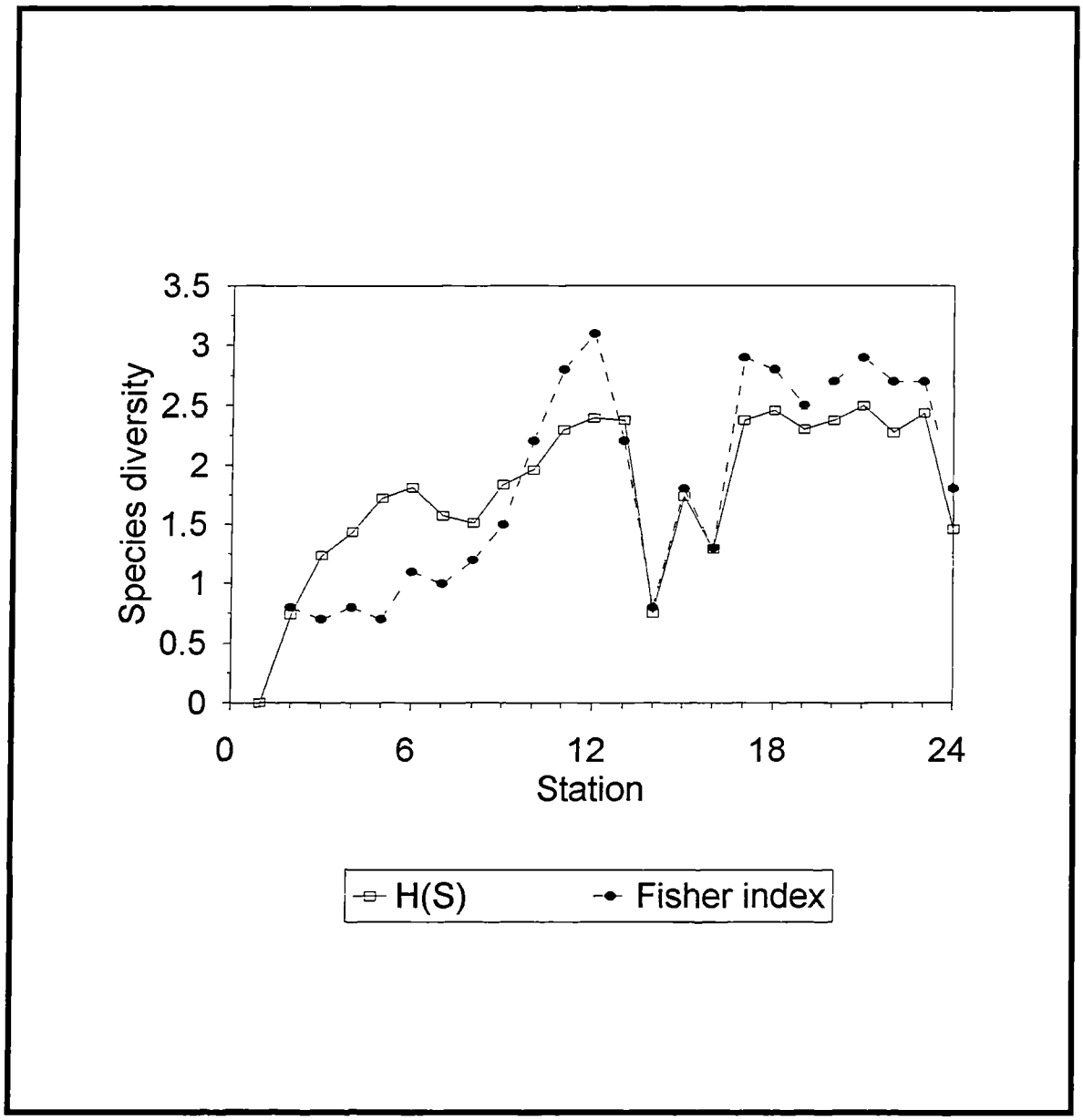
4.4.1 Locational map of Thornham Marsh.

Altitude (m OD)	Vascular plants	Floral Zones
4.32	*Spergularia marina* *Puccinellia maritima* *Elytrigia atherica*	High Marsh
3.16	*Elytrigia atherica* *Atriplex portulacoides* *Limonium vulgare*	Middle Marsh
2.56	*Atriplex portulacoides* *Salicornia europaea*	Low Marsh
1.30		Mud-flat
0.21		

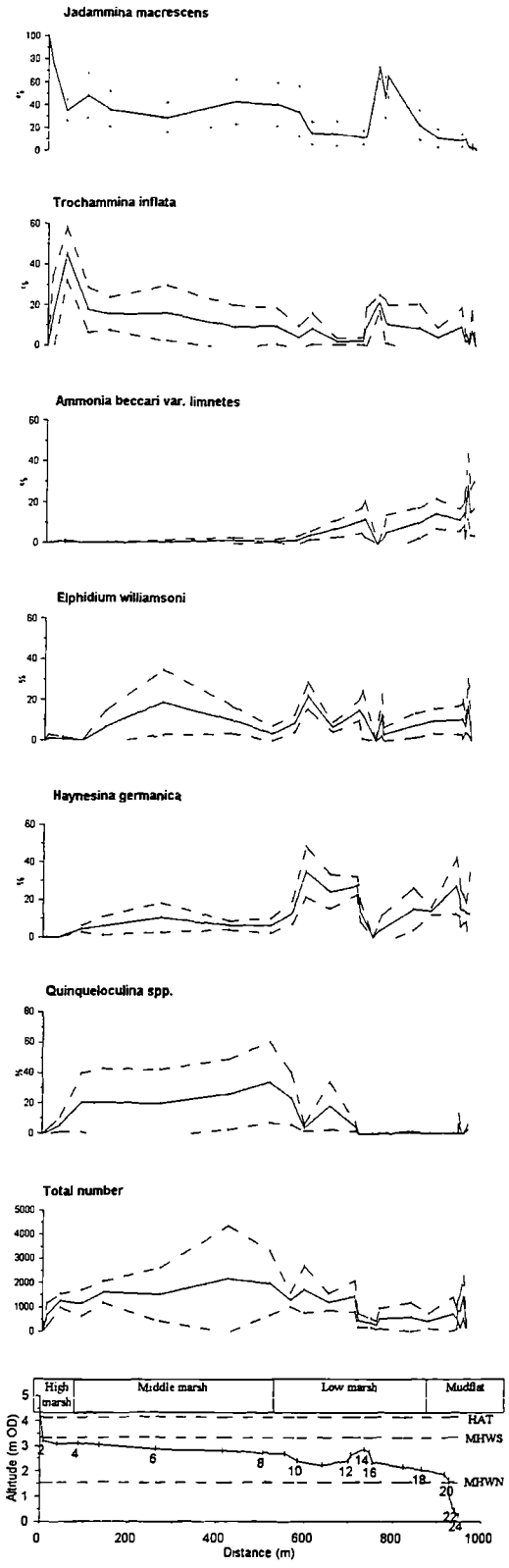
4.4.2 Flora of Thornham Marsh.



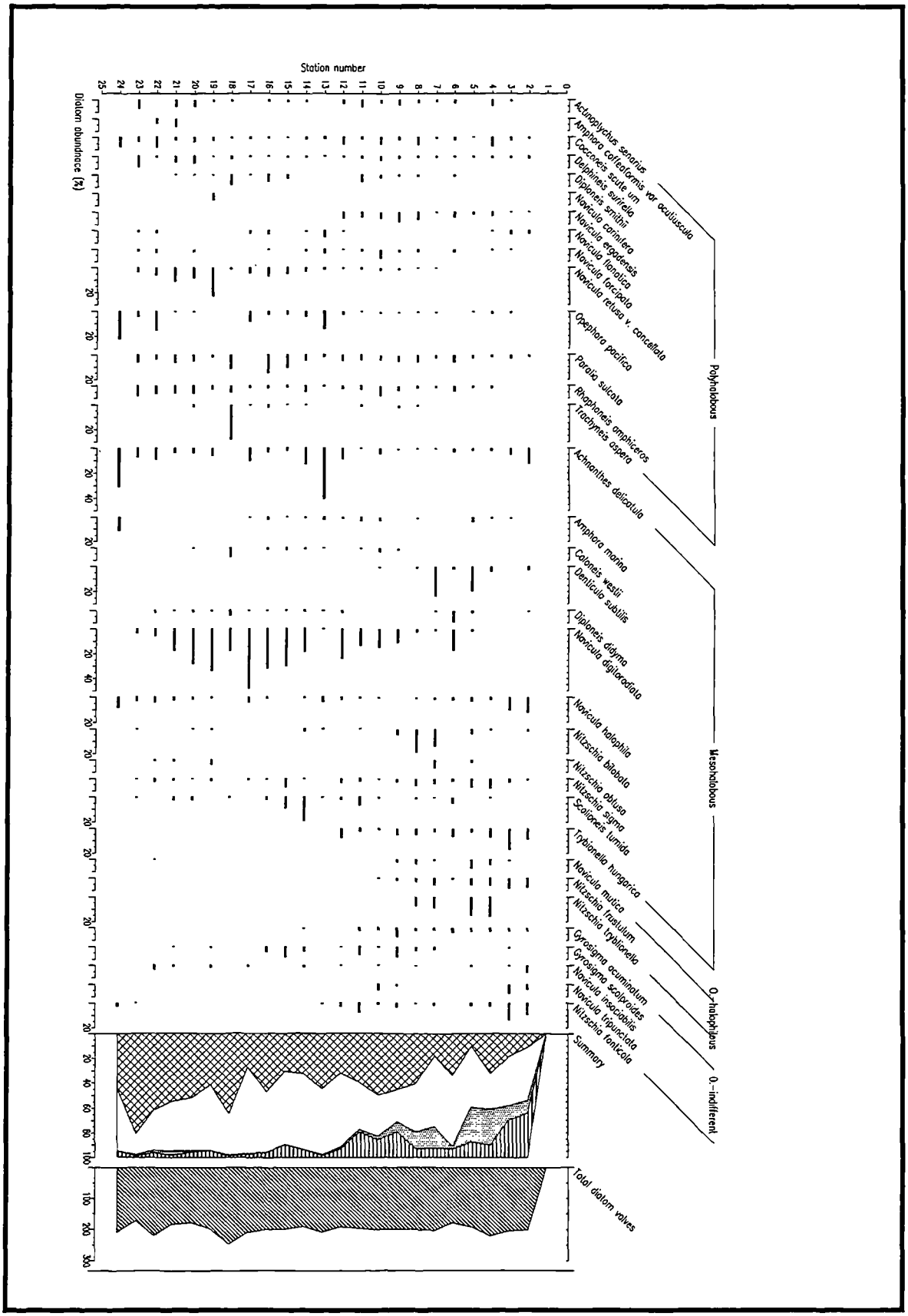
4.4.3 Average annual foraminiferal death assemblages from 4 three-monthly samples from each station of Thornham Marsh. Foraminiferal abundance is expressed as a percentage of total count.



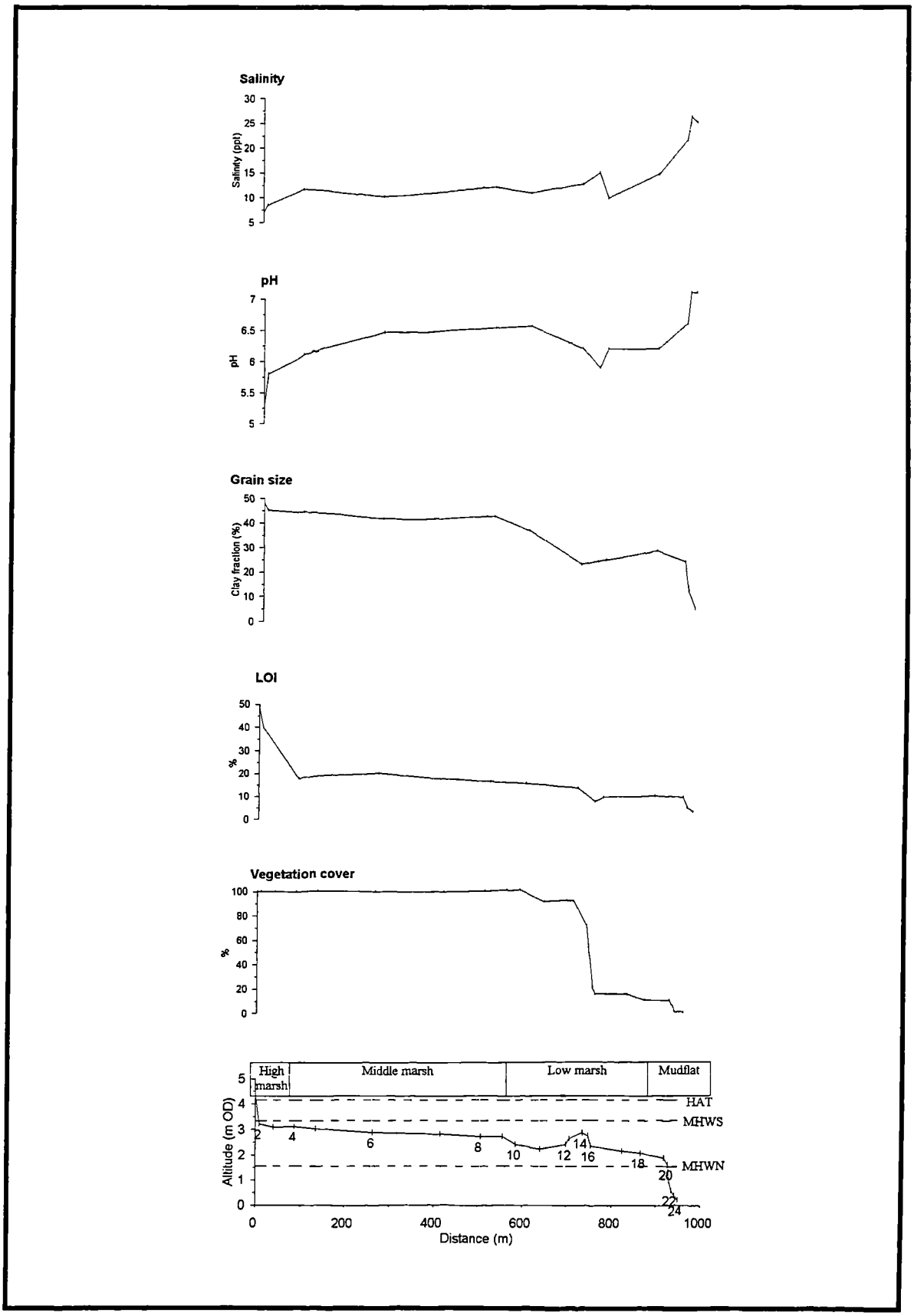
4.4.4 The Shannon-Weaver (H(S)) and Fisher indices of diversity of average annual foraminiferal death assemblages from 4 three-monthly samples from each station of Thornham Marsh.



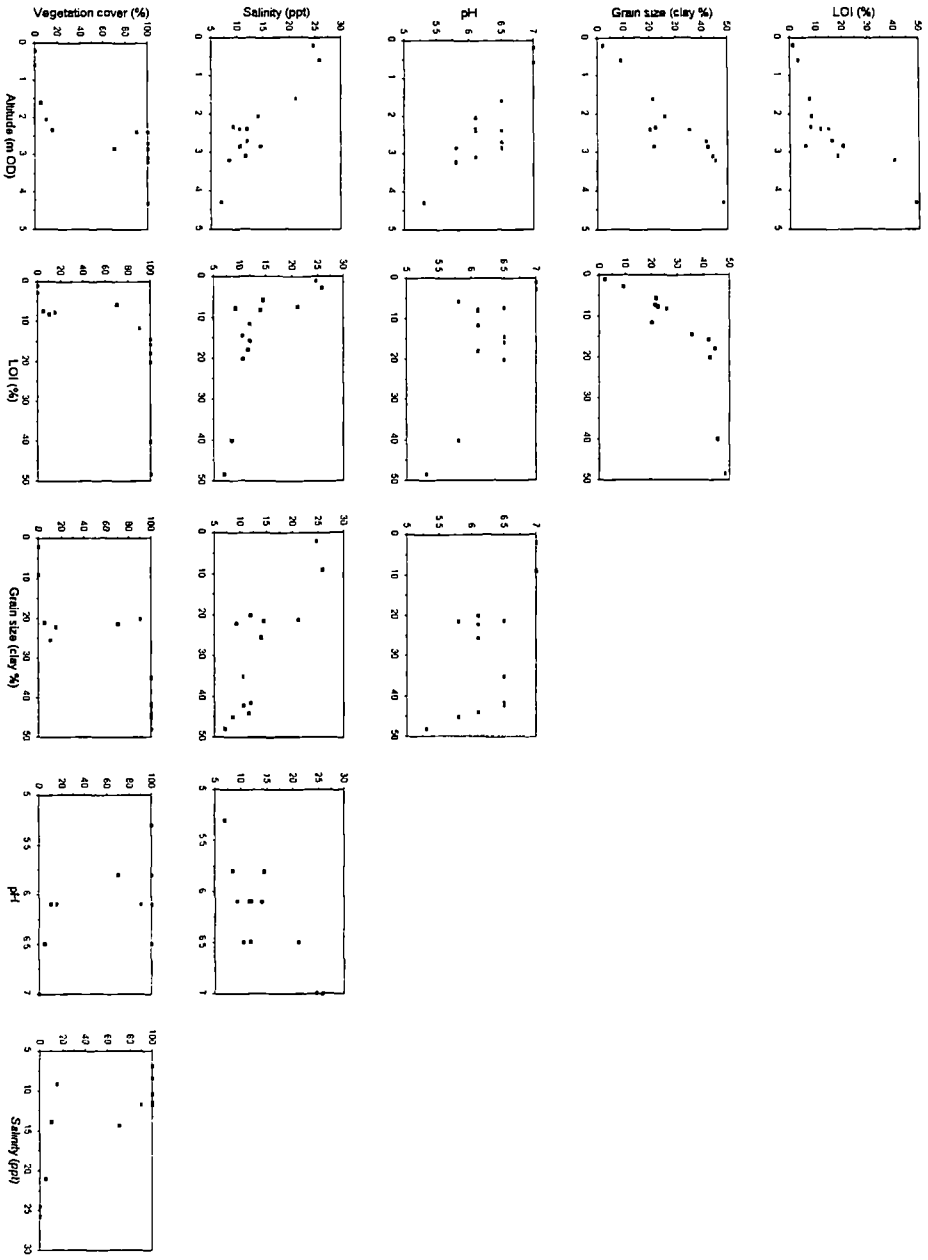
4.4.5 Relative dead abundance of six foraminiferal species from the twelve month study period of Thornham Marsh. Solid and dashed lines indicate the mean and standard error for each station from 4 three-monthly samples. The altitude and floral zonations are indicated. 60



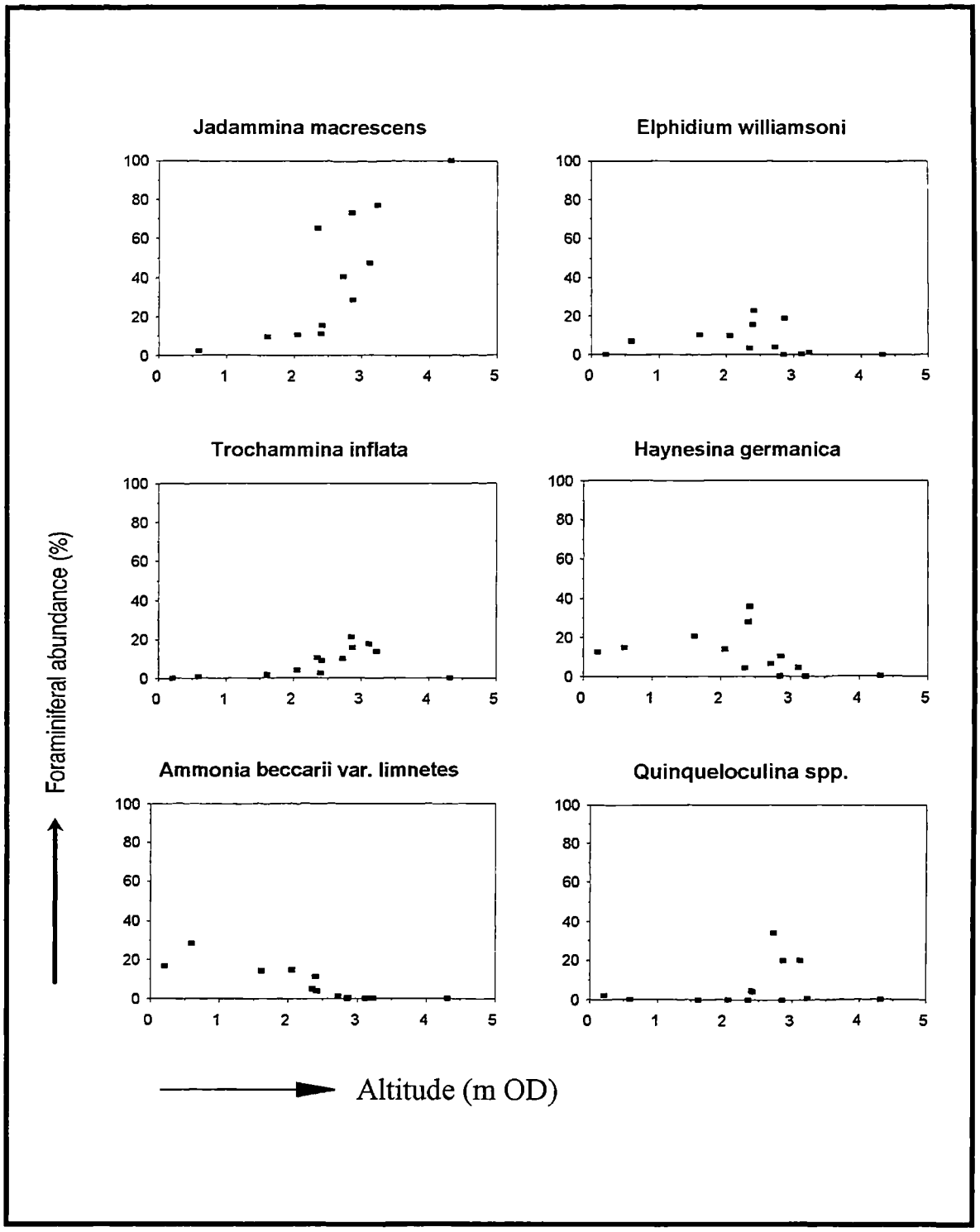
4.4.6 Diatom diagram for each station of Thornham Marsh. Diatom frequencies are expressed as a percentage of total diatom valves. Only species which reach 5 % of the total sum are included. Abbreviations: O = oligohalobous. Summary classifications: polyhalobous = checked; mesohalobous = hollow; oligohalobous - halophilous = dashed; oligohalobous - indifferent = horizontal; and halophobes = solid.



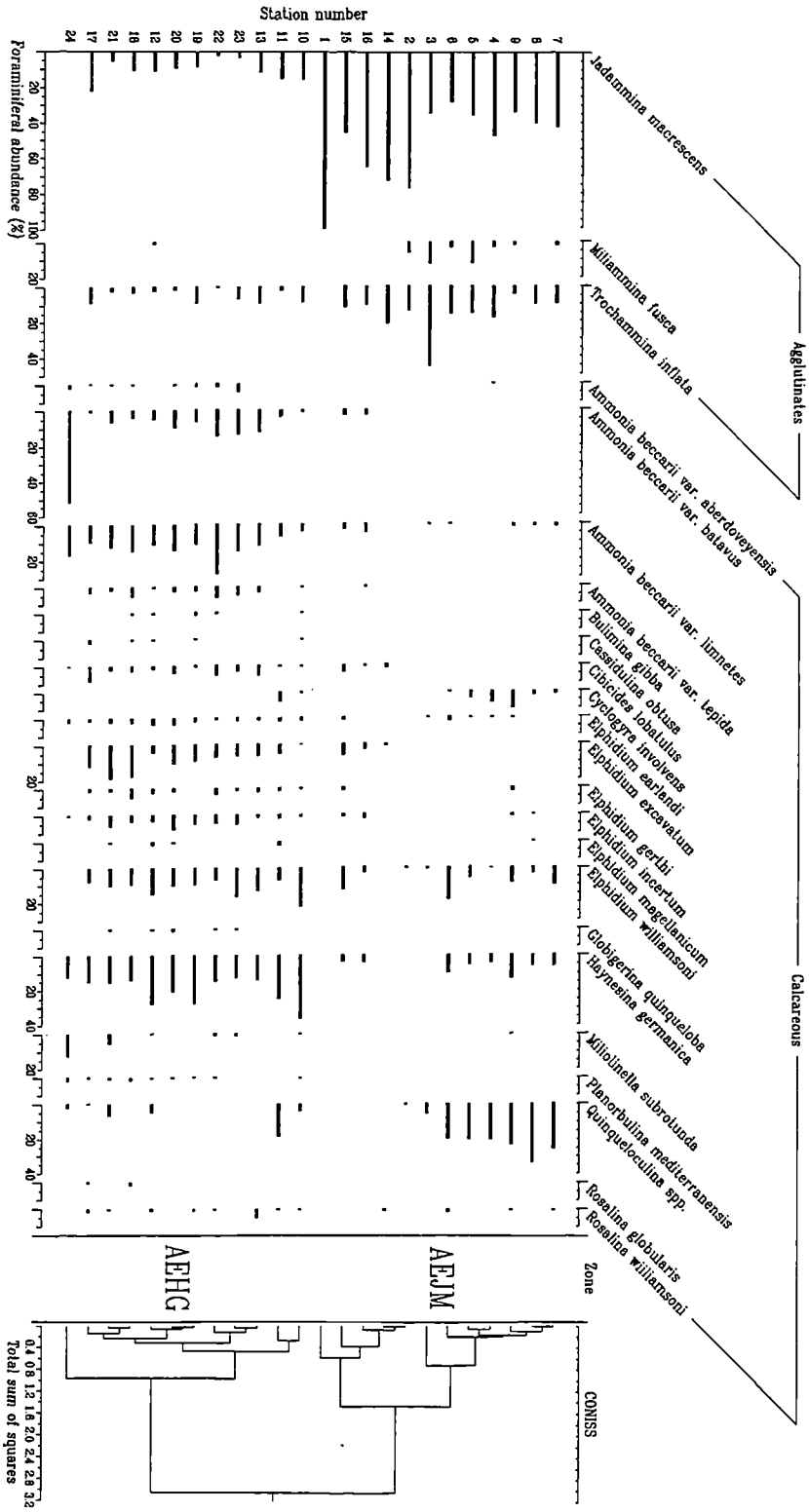
4.4.7 Salinity, pH, grain size, LOI and vegetation cover from Thornham Marsh. Samples were measured August 1996. The altitude and floral zonations are indicated.



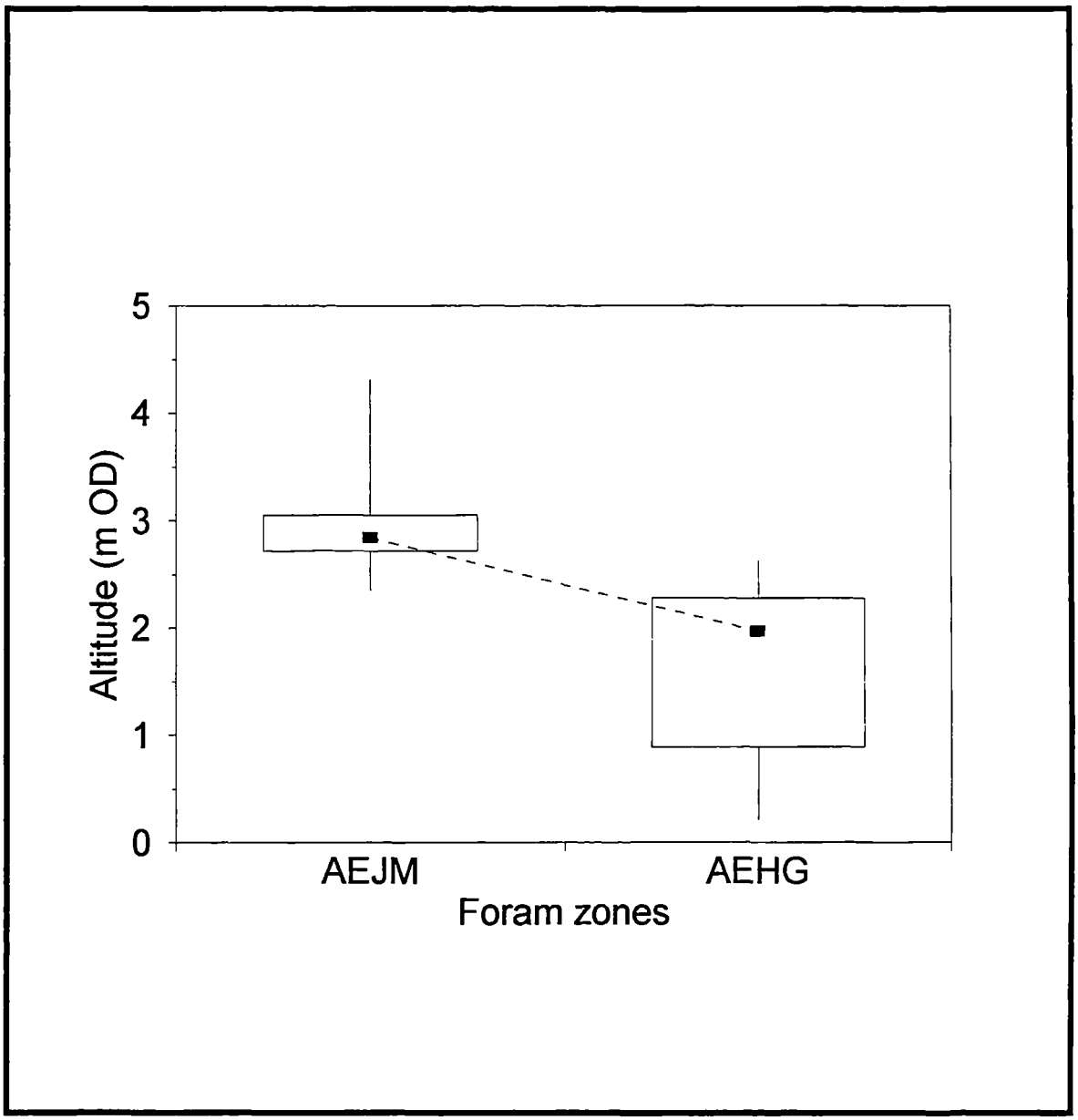
4.4.8 Scatter plot matrix among environmental variables of Thornham Marsh.



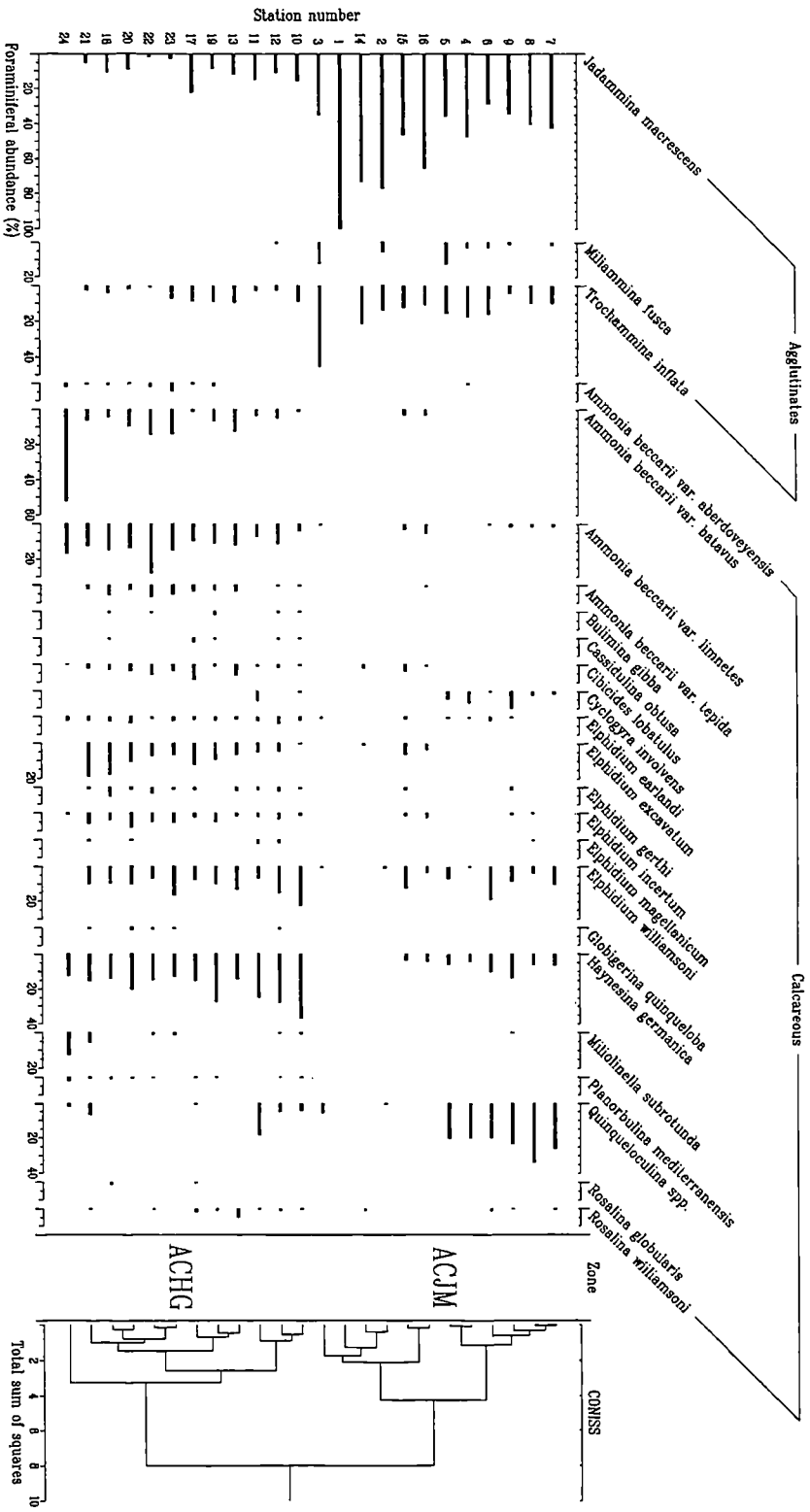
4.4.9 Scatter plots showing altitude versus the annual average of six foraminiferal species from Thornham Marsh.



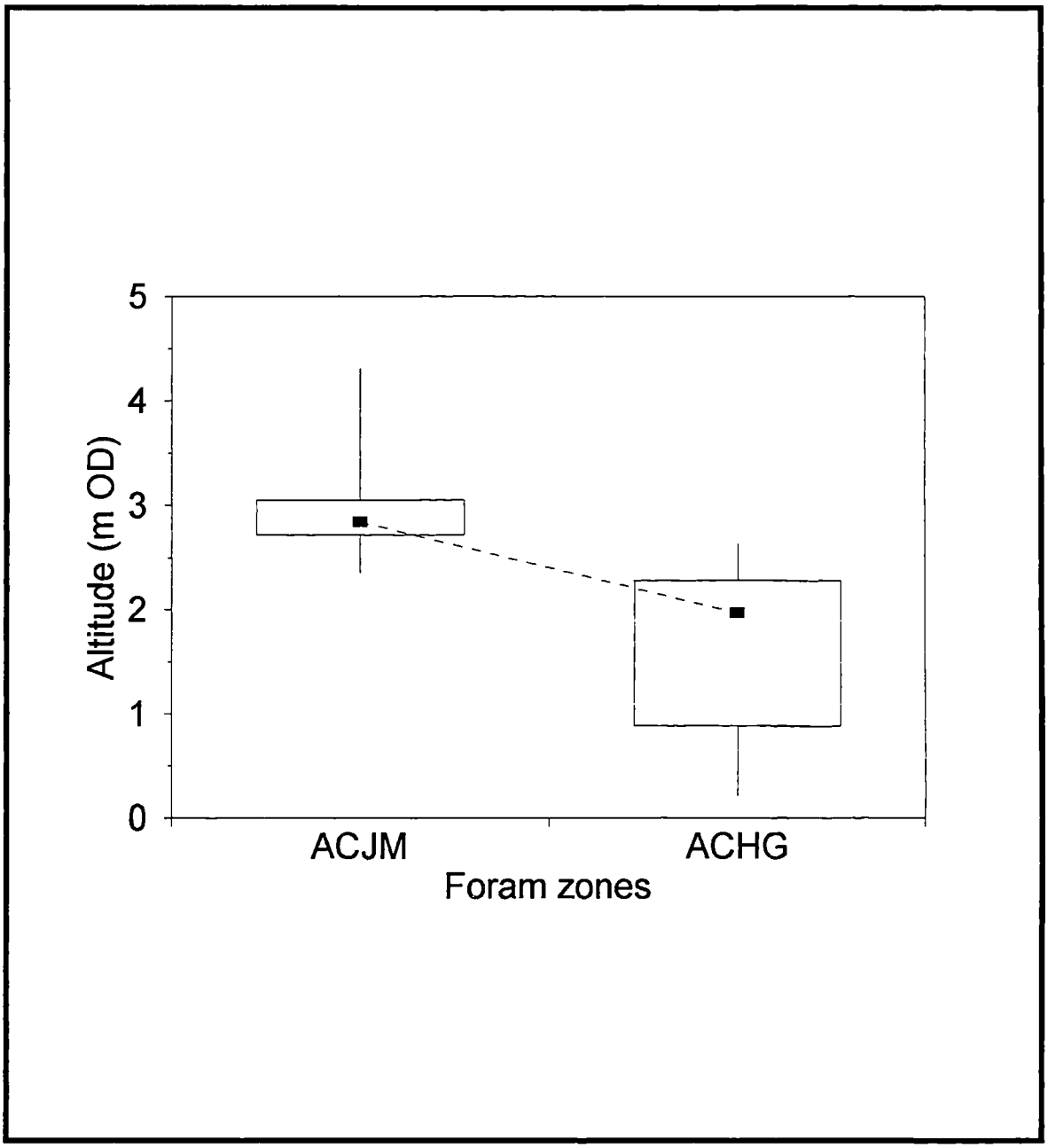
4.4.10 Unconstrained cluster analysis based on unweighted Euclidean distance of annual foraminiferal death assemblages from samples collected over a twelve month period from Thornham Marsh. Only samples with counts greater than 40 individuals and species which reach 5 % of the total sum are included.



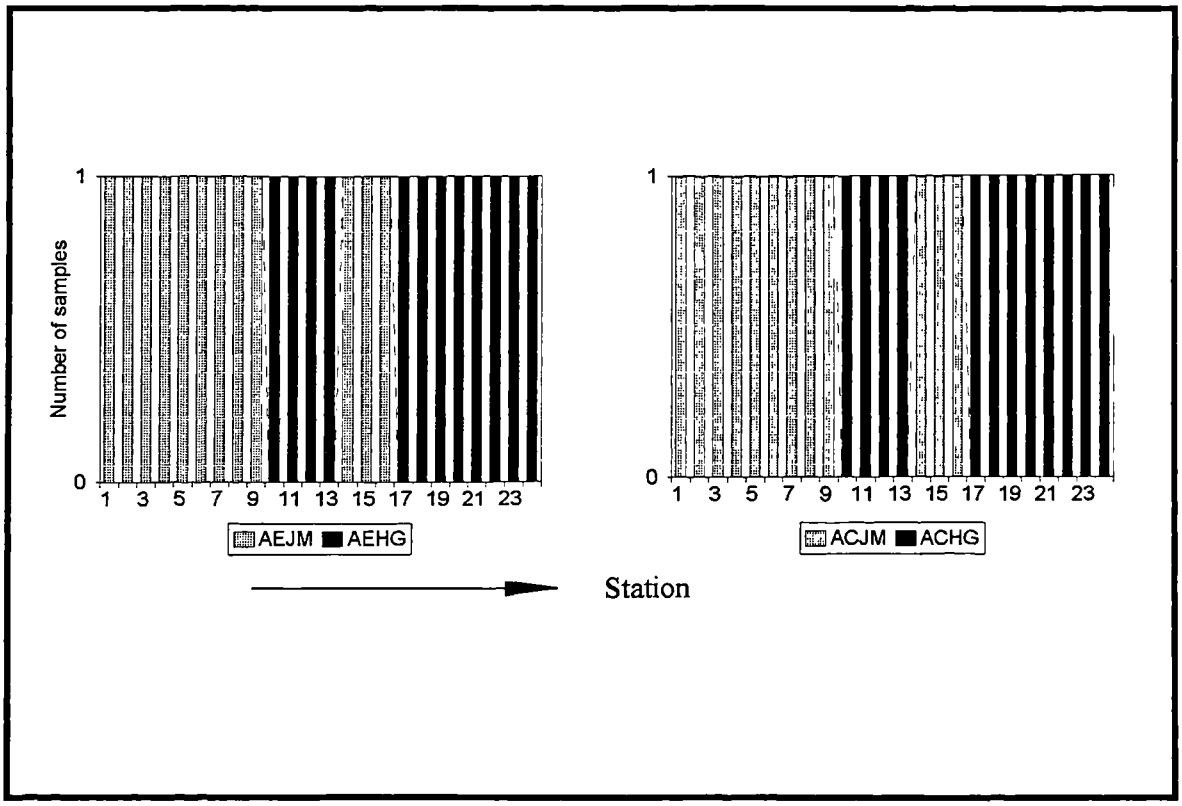
4.4.11 Boxplots showing maximum, minimum, interquartile ranges and median altitudes for annual clusters based on Euclidean distance from Thornham Marsh.



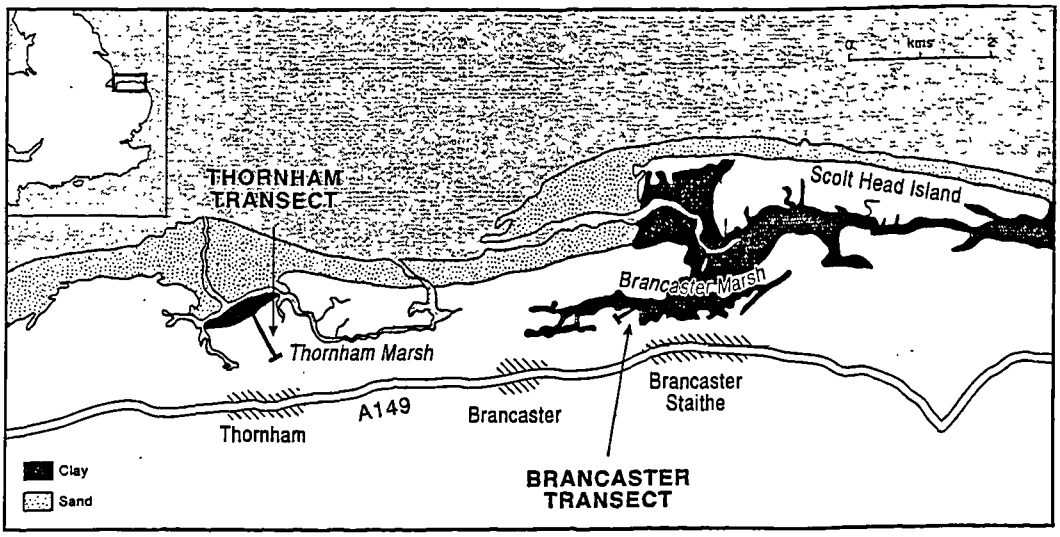
4.4.12 Unconstrained cluster analysis based on unweighted Chord distance of annual foraminiferal death assemblages from samples collected over a twelve month period from Thornham Marsh. Only samples with counts greater than 40 individuals and species which reach 5 % of the total sum are included.

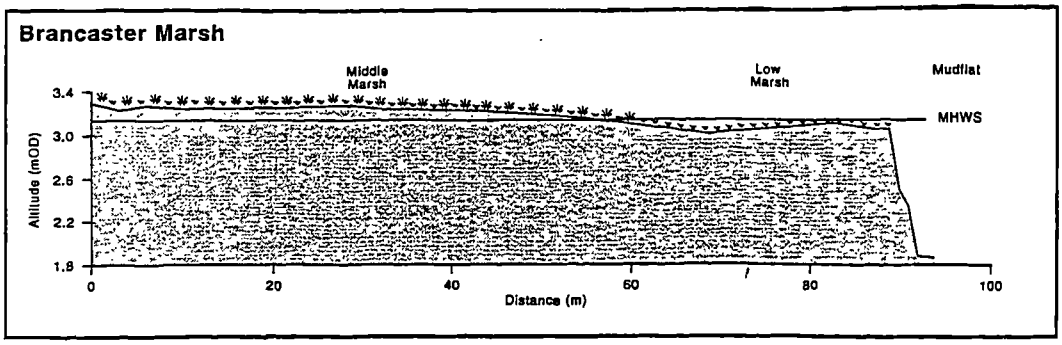


4.4.13 Boxplots showing maximum, minimum, interquartile ranges and median altitudes for annual clusters based on Chord distance from Thornham Marsh.



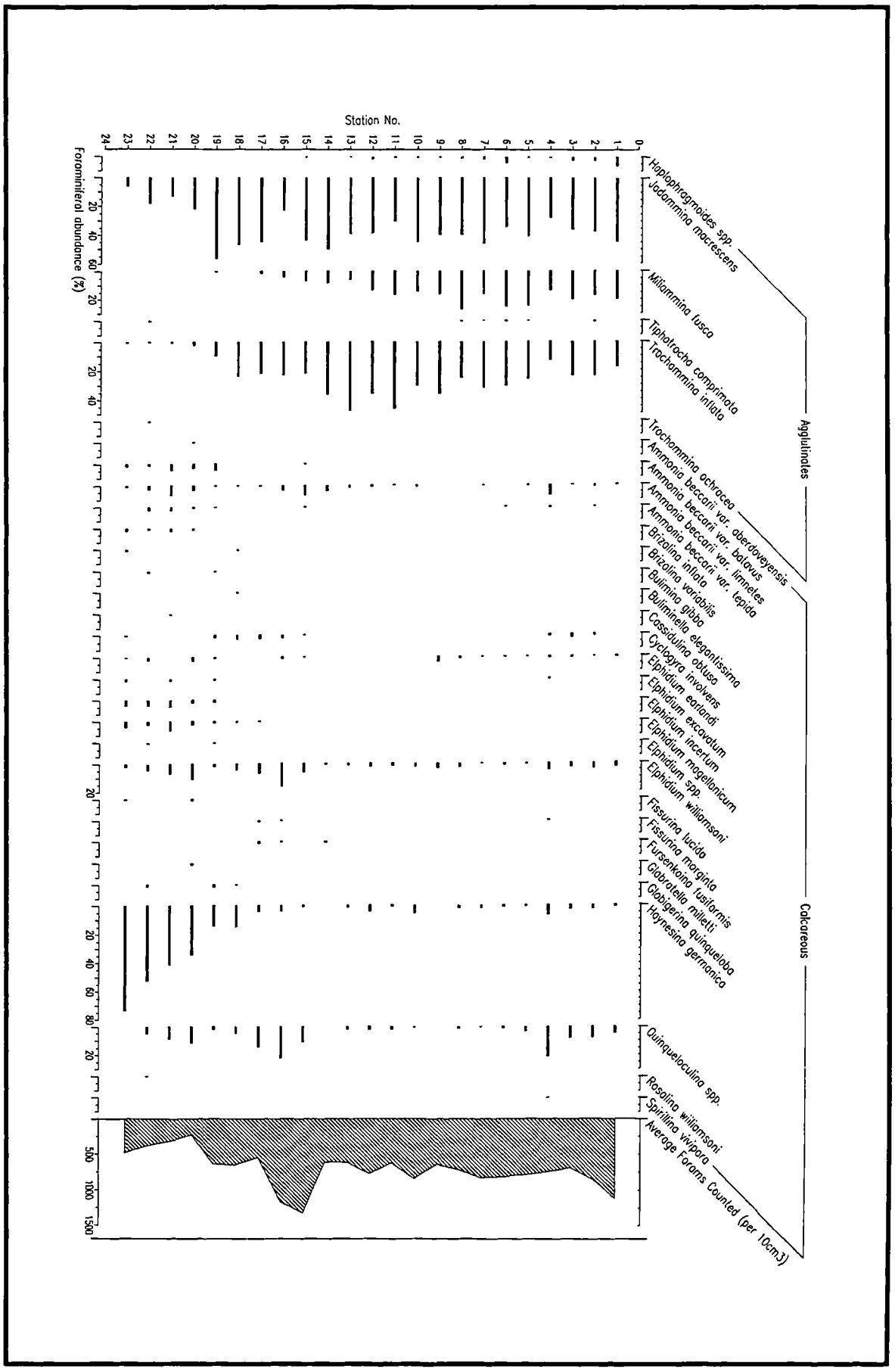
4.4.14 Stacked bar comparisons showing the distribution of annual Euclidean and Chord zones across the intertidal zone of Thornham Marsh.



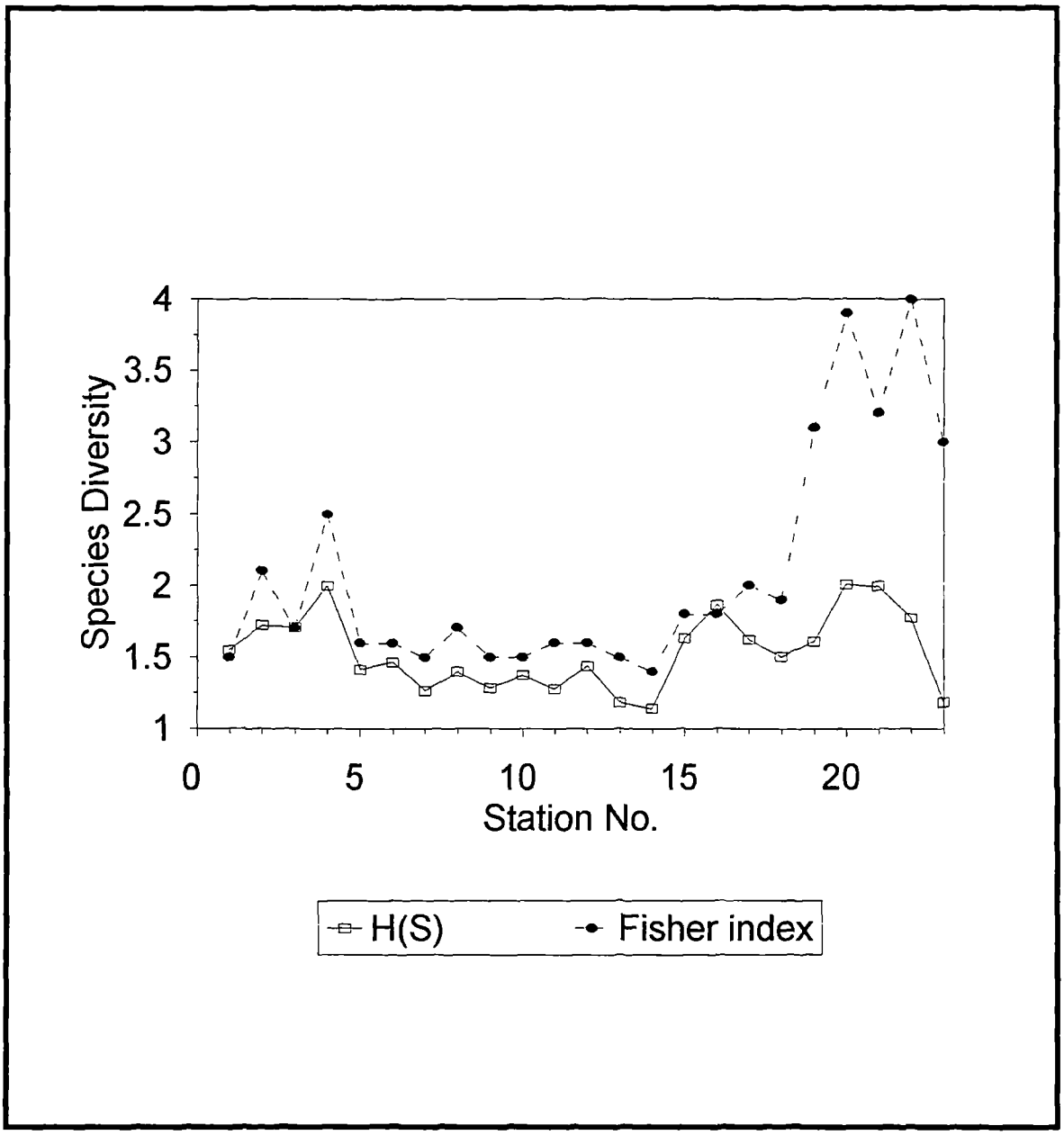


4.5.1 Locational map of Brancaster Marsh.

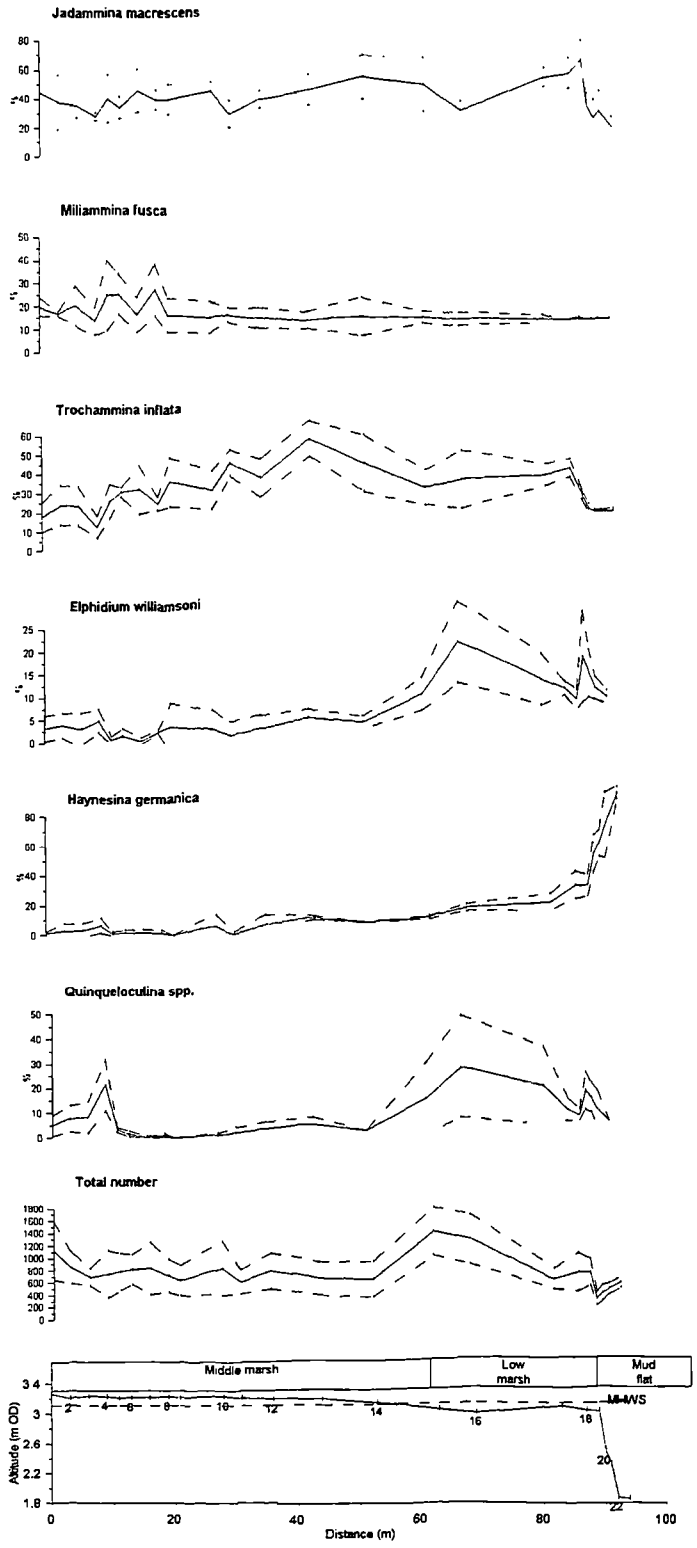
Altitude (m OD)	Vascular plants	Floral Zones
3.27	*Phragmites australis* *Plantago maritima* *Armeria maritima*	Middle Marsh
2.99	*Spartina spp.* *Artiplex portulacoides* *Inula crithmoides* *Salicornia europaea*	Low Marsh
1.88		
1.85		Mudflat



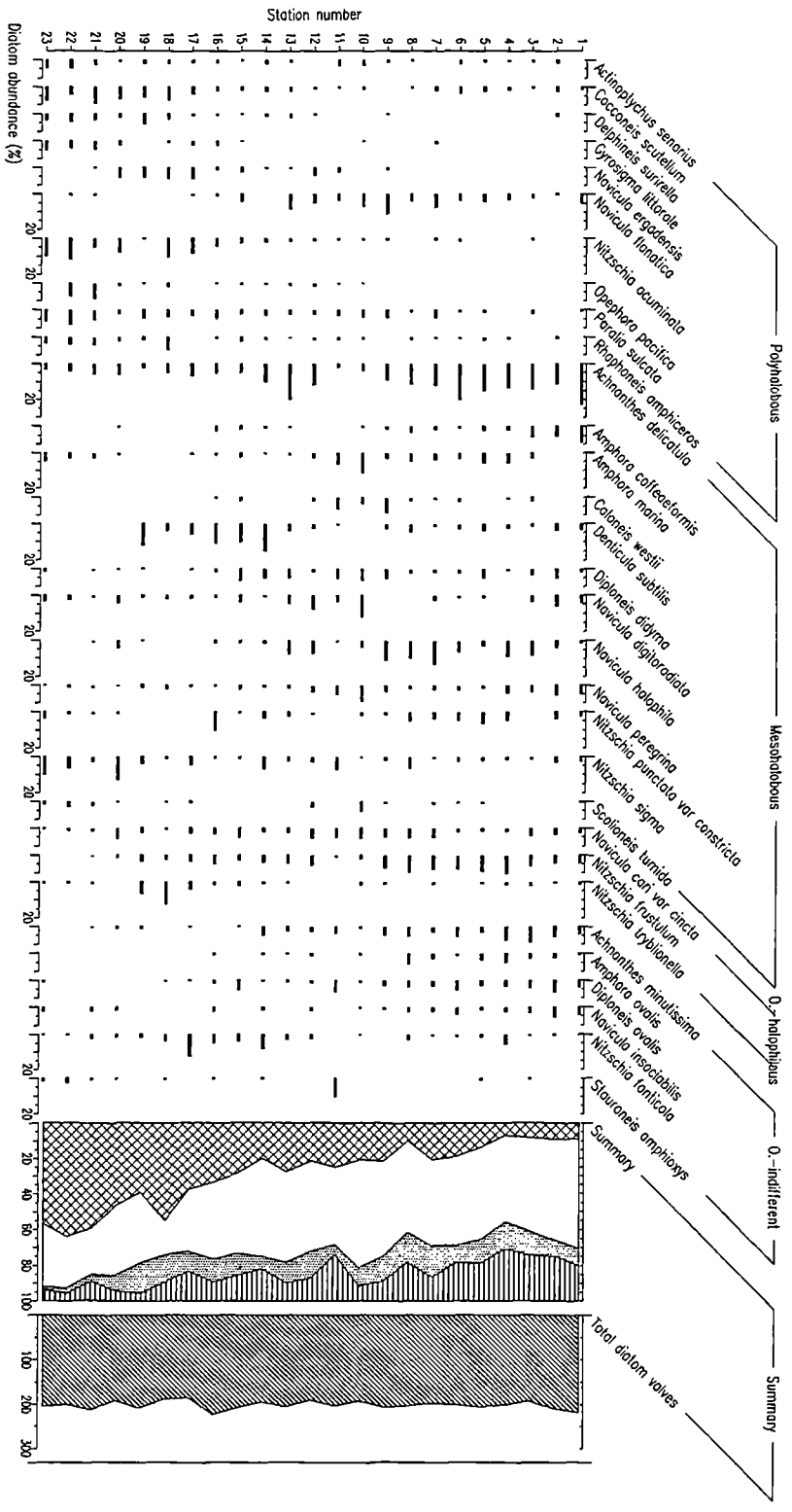
4.5.3 Average annual foraminiferal death assemblages from 4 three-monthly samples from each station of Brancaster Marsh. Foraminiferal abundance is expressed as a percentage of total count.



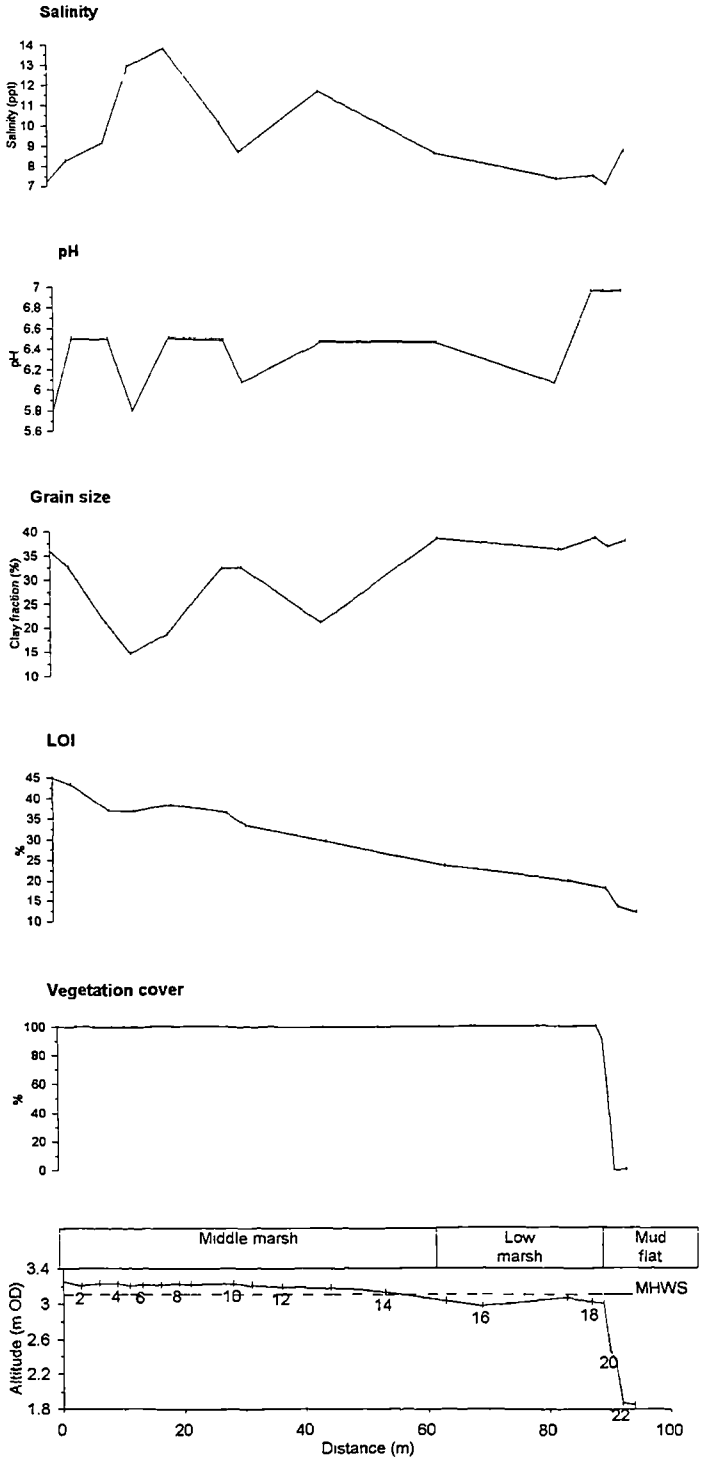
4.5.4 The Shannon-Weaver (H(S)) and Fisher indices of diversity of average annual foraminiferal death assemblages from 4 three-monthly samples from each station of Brancaster Marsh.



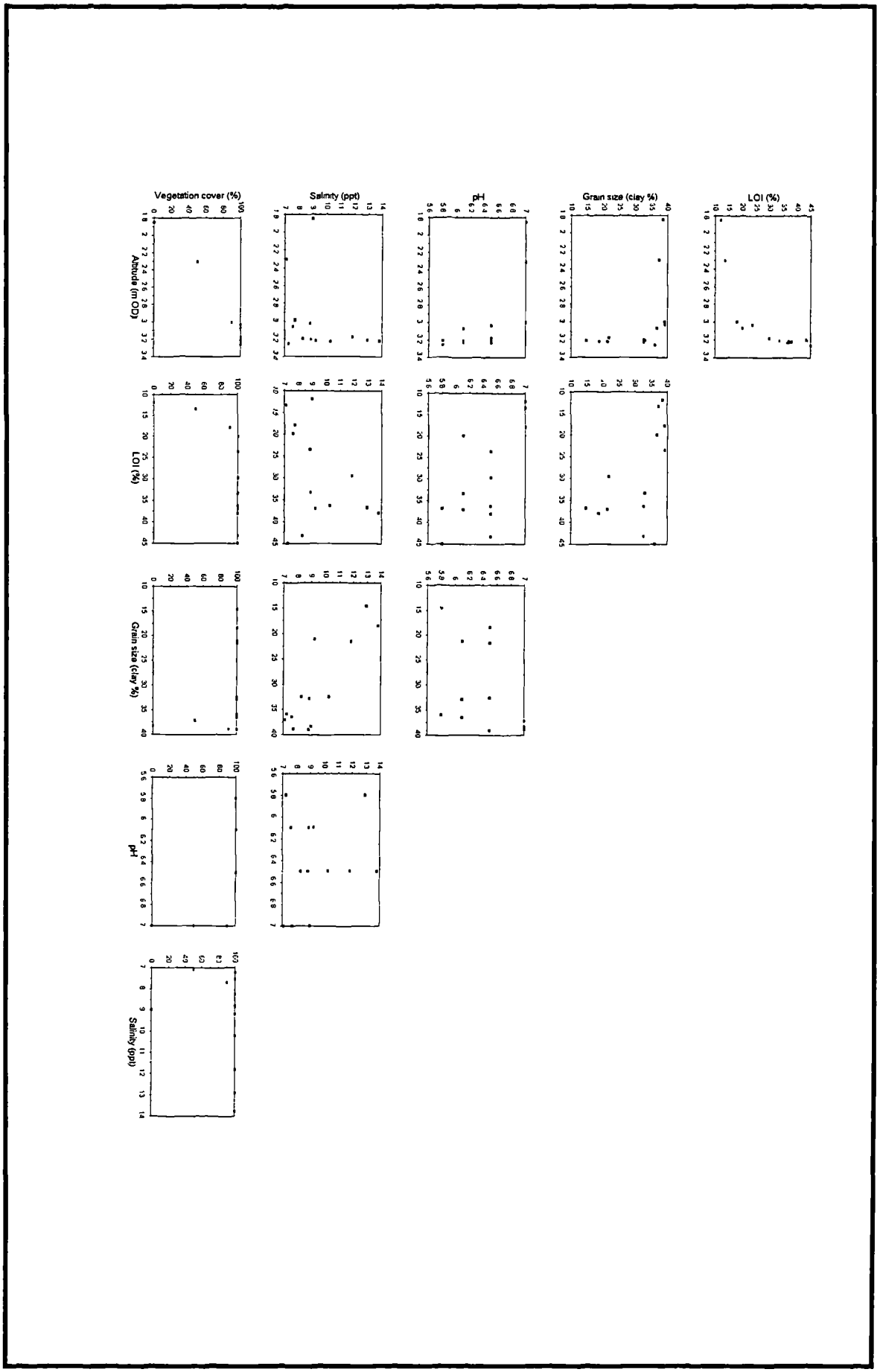
4.5.5 Relative dead abundance of six foraminiferal species from the twelve month study period of Brancaster Marsh. Solid and dashed lines indicate the mean and standard error for each station from 4 three-monthly samples. The altitude and floral zonations are indicated. 74



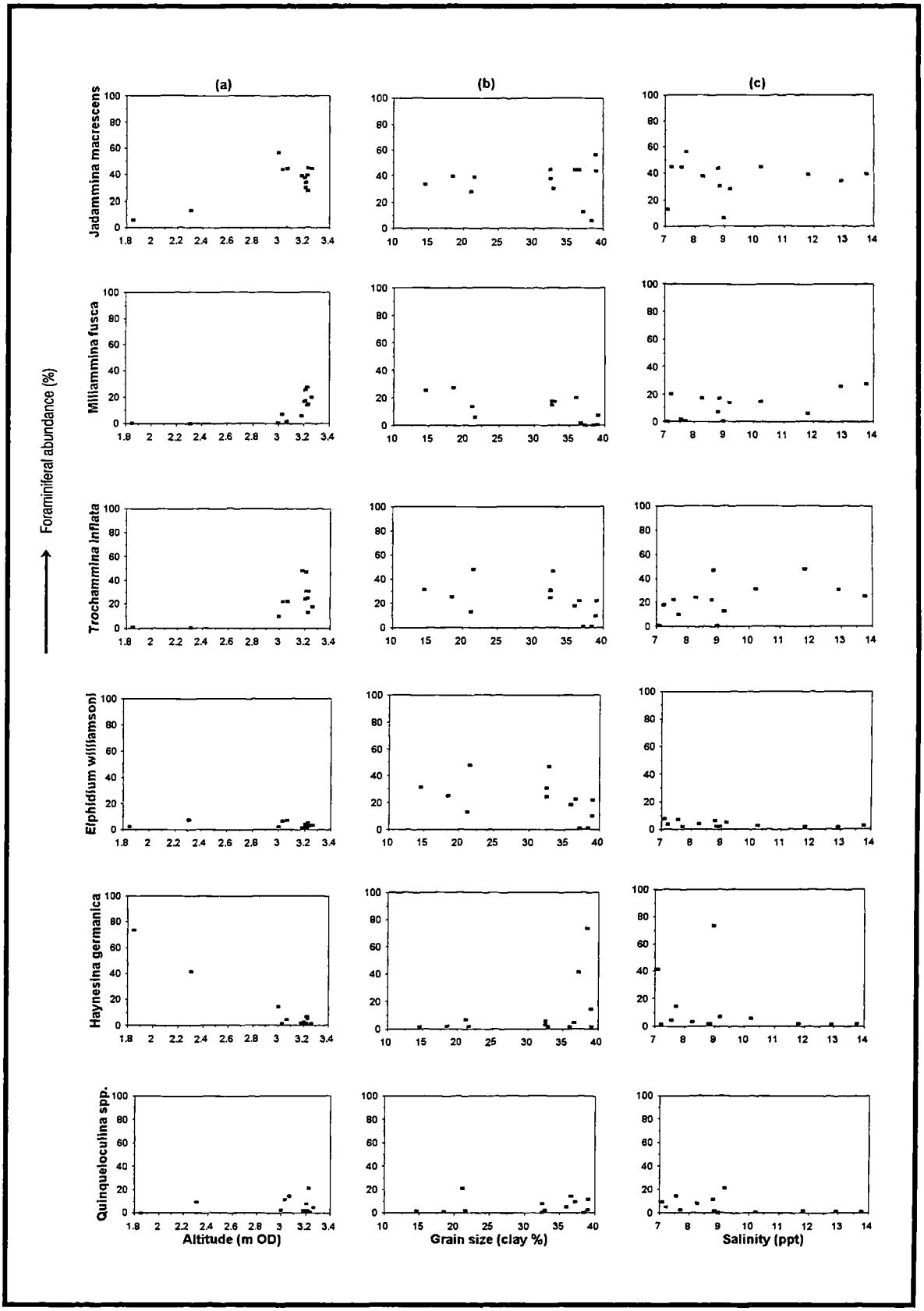
4.5.6 Diatom diagram for each station of Brancaster Marsh. Diatom frequencies are expressed as a percentage of total diatom valves. Only species which reach 5 % of the total sum are included. Abbreviations: O = oligohalobous. Summary classifications: polyhalobous = checked; mesohalobous = hollow; oligohalobous - halophilous = dashed; oligohalobous - indifferent = horizontal; and halophobes = solid.



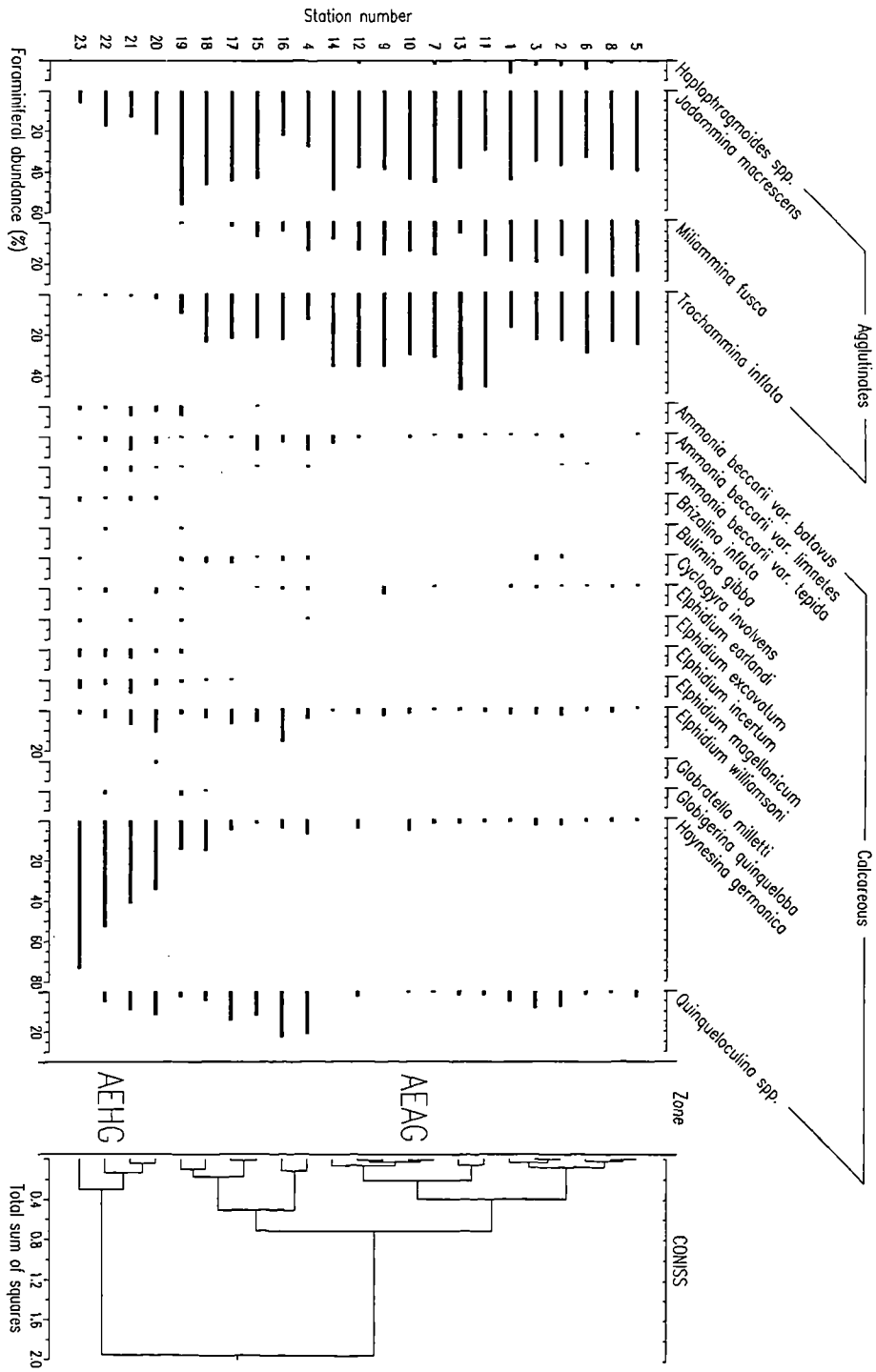
4.5.7 Salinity, pH, grain size, LOI and vegetation cover from Brancaster Marsh. The samples were measured August 1996. The altitude and floral zonations are indicated.



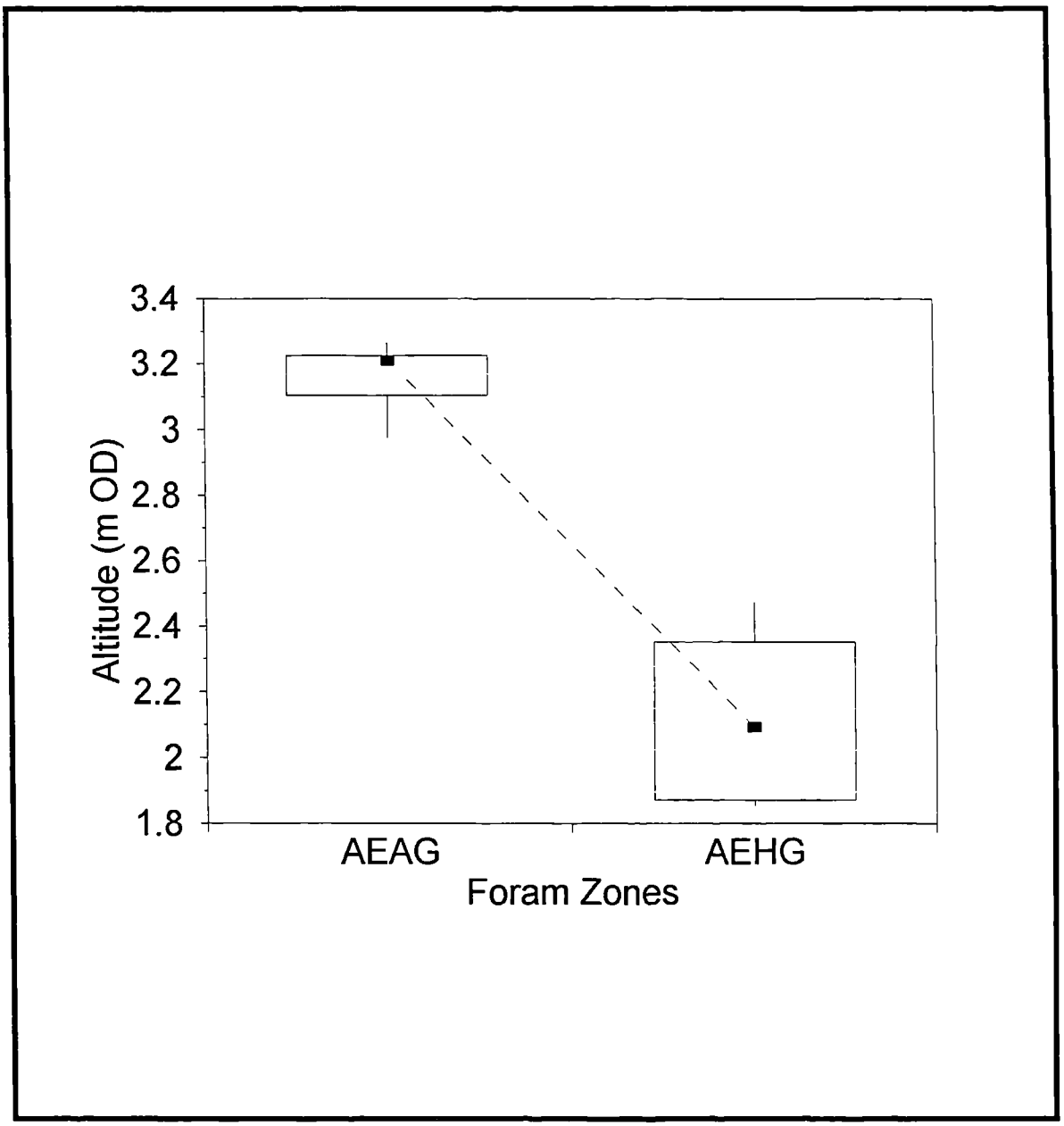
4.5.8 Scatter plot matrix among environmental variables of Brancaster Marsh.



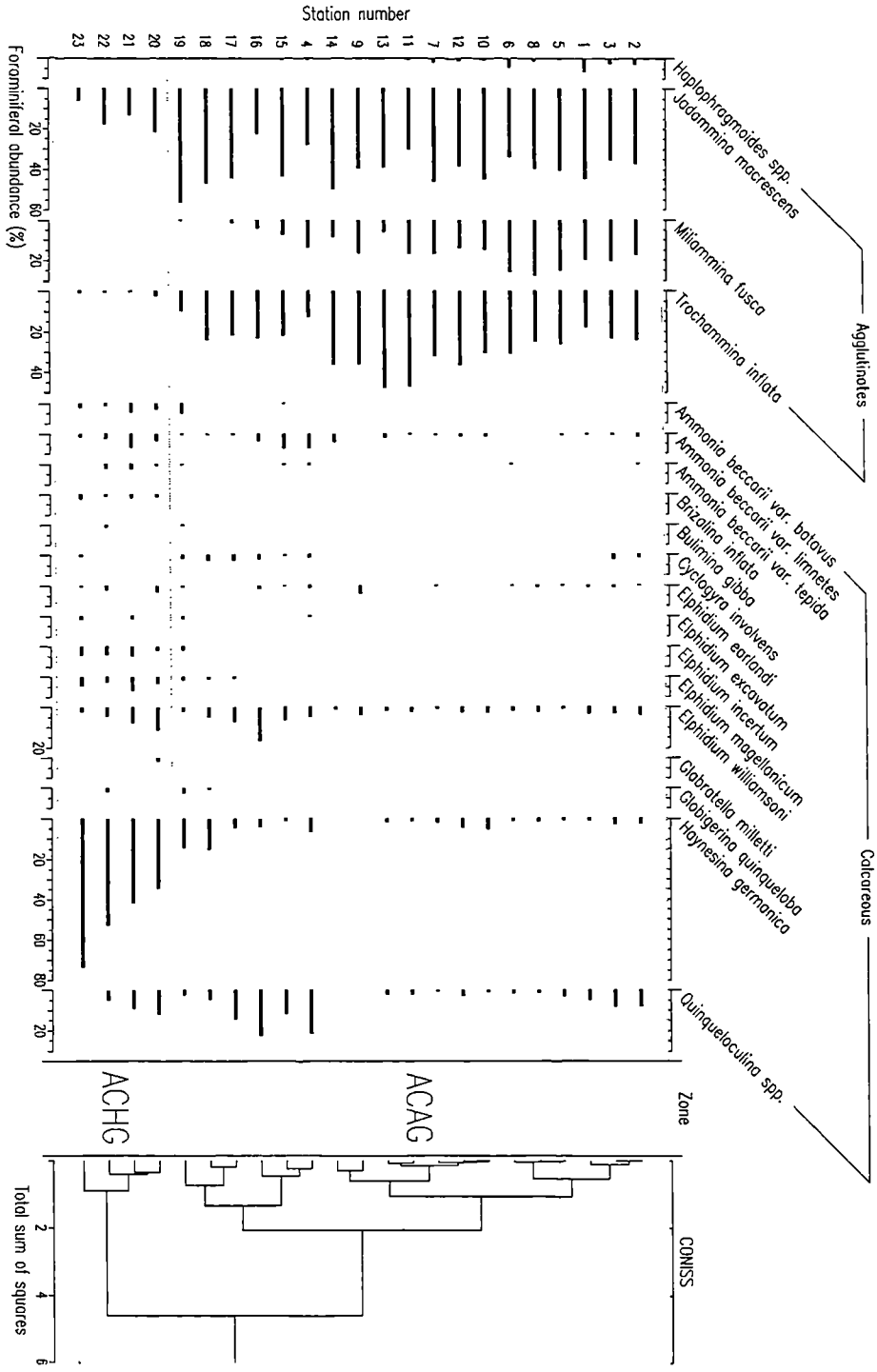
4.5.9 Scatter plots of (a) altitude, (b) grain size and (c) salinity versus the annual average of six foraminiferal species from Brancaster Marsh.



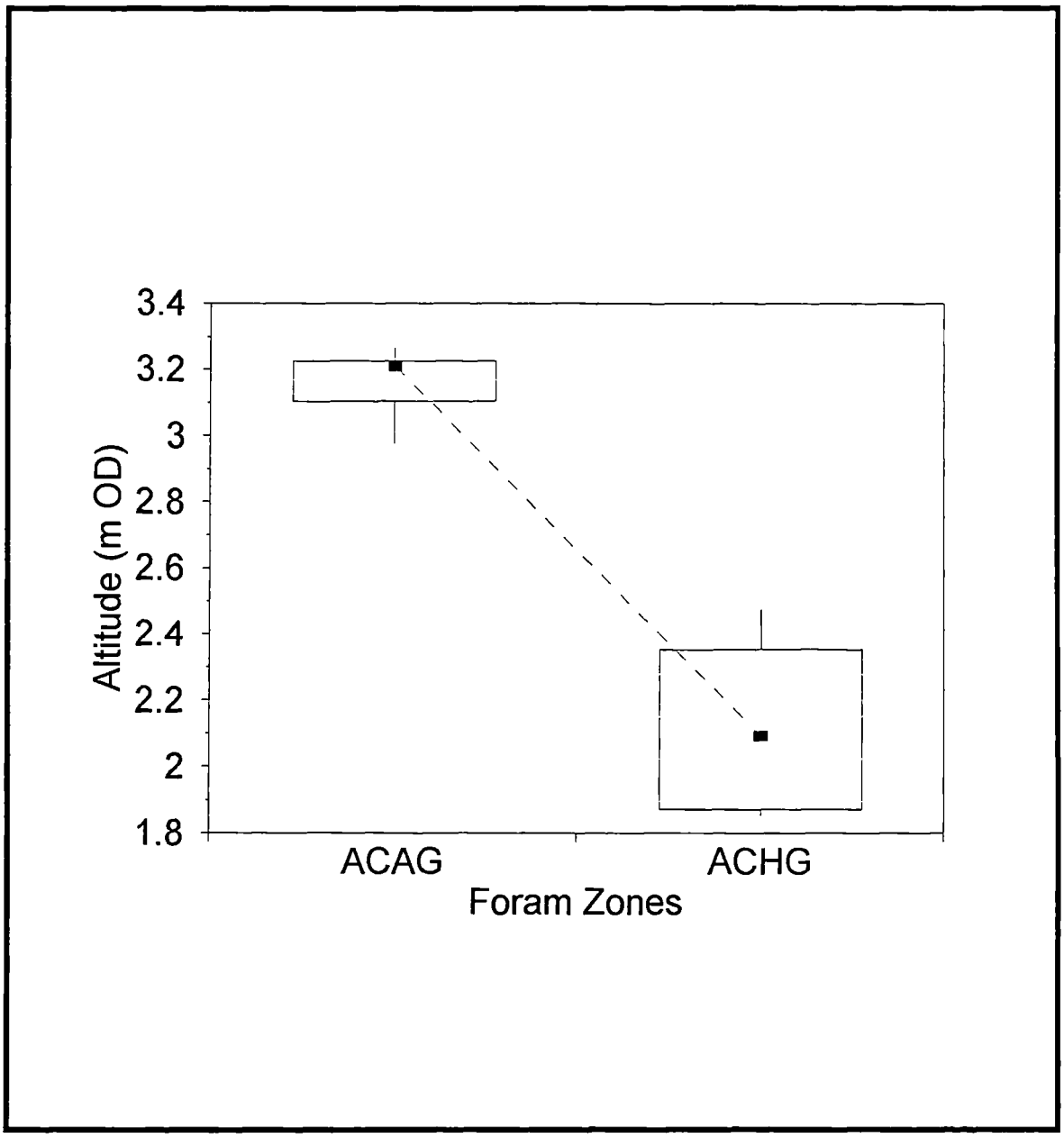
4.5.10 Unconstrained cluster analysis based on unweighted Euclidean distance of annual foraminiferal death assemblages from samples collected over a twelve month period from Brancaster Marsh. Only samples with counts greater than 40 individuals and species which reach 5 % of the total sum are included.



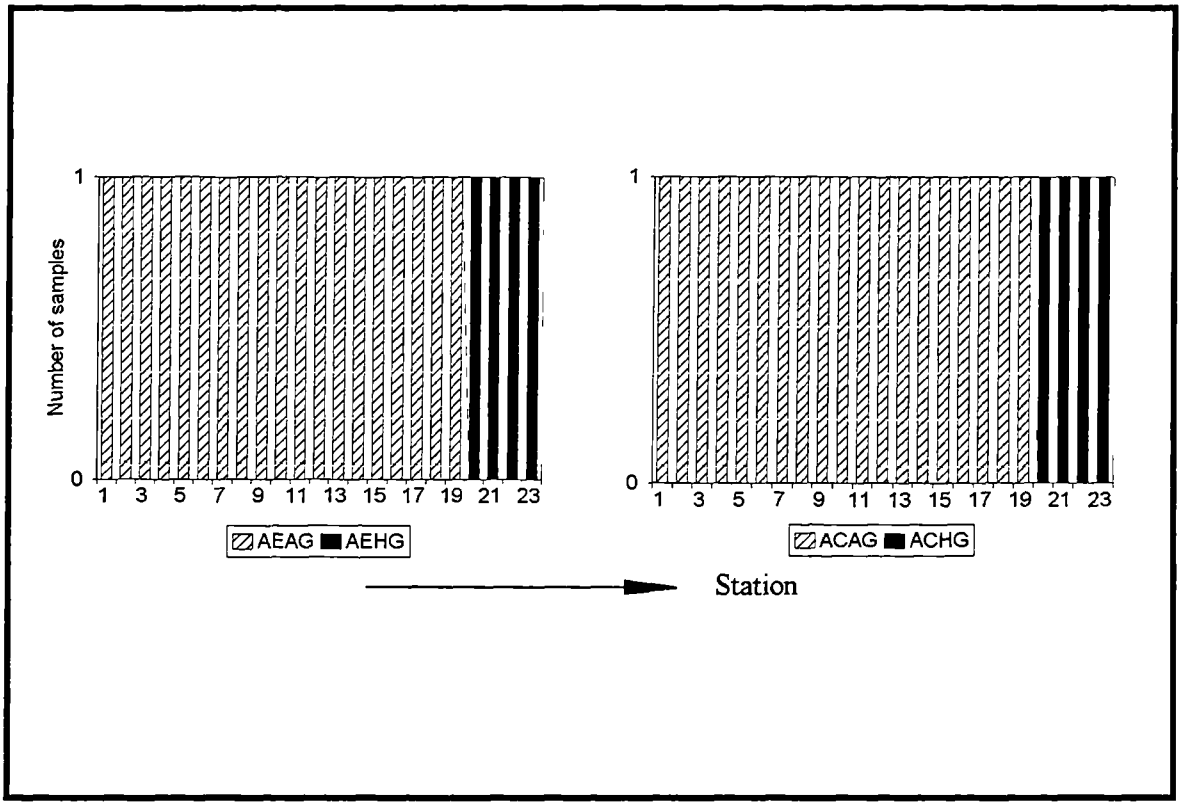
4.5.11 Boxplots showing maximum, minimum, interquartile ranges and median altitudes for annual clusters based on Euclidean distance from Brancaster Marsh.



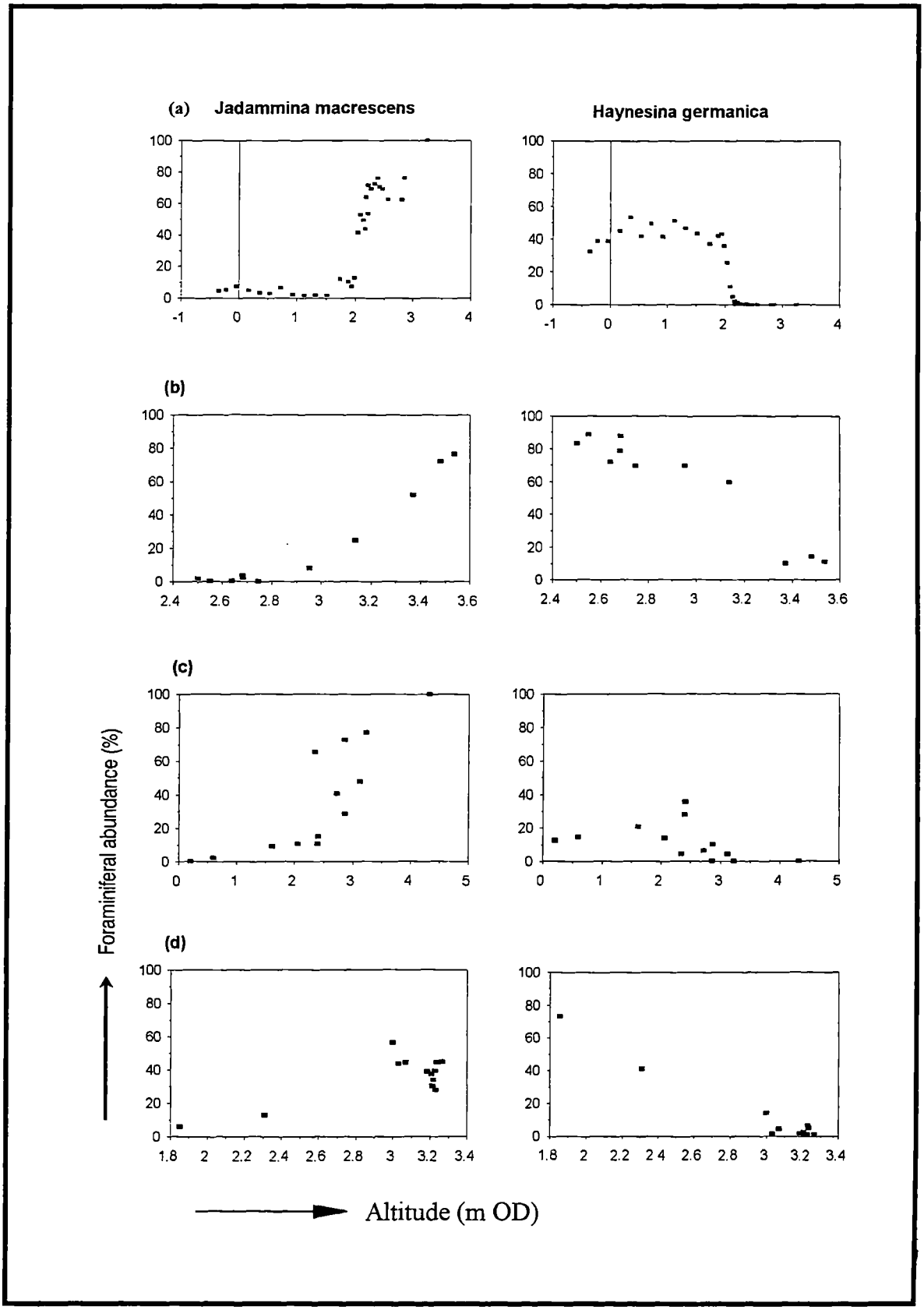
4.5.12 Unconstrained cluster analysis based on unweighted Chord distance of annual foraminiferal death assemblages from samples collected over a twelve month period from Brancaster Marsh. Only samples with counts greater than 40 individuals and species which reach 5 % of the total sum are included.



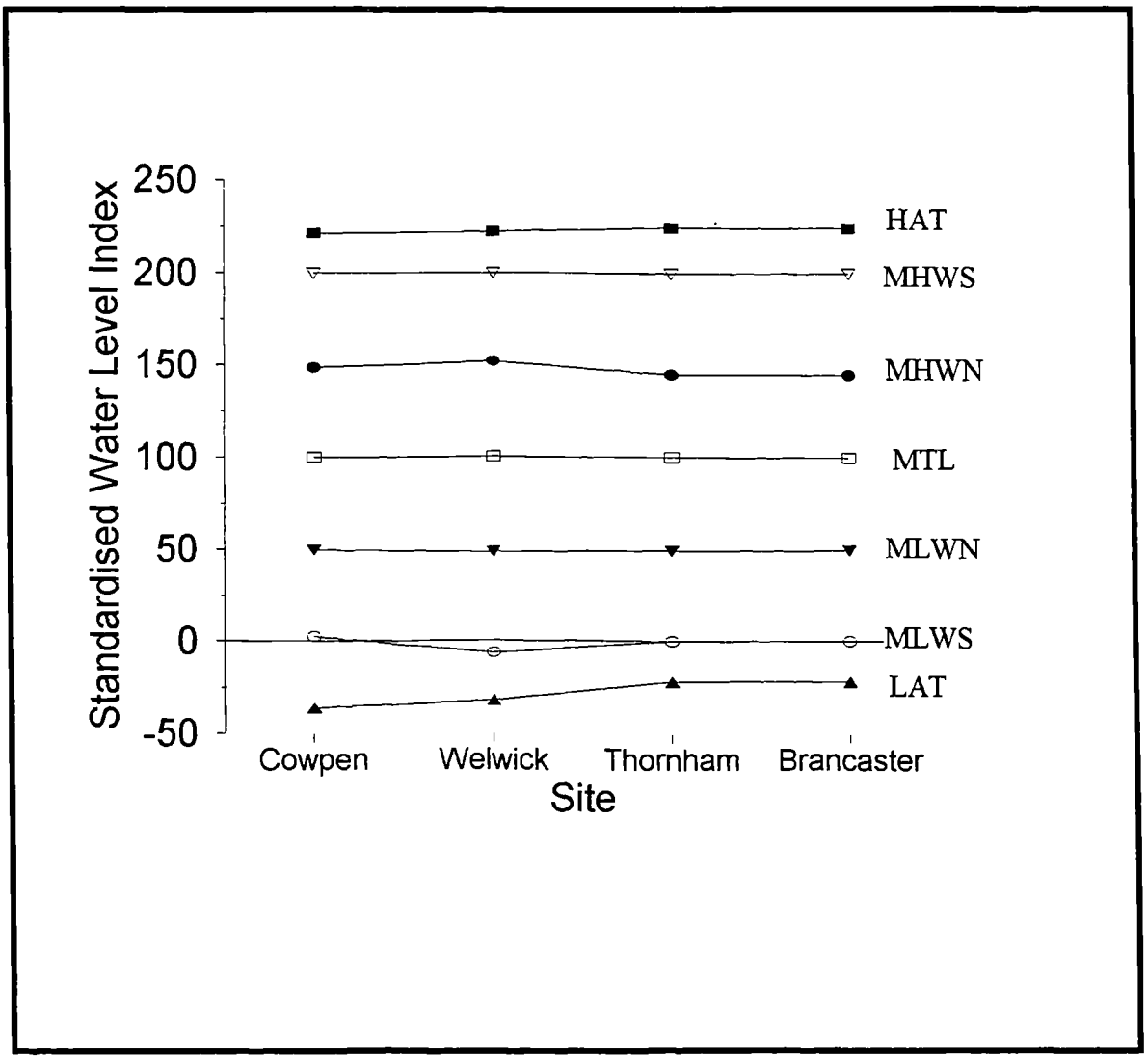
4.5.13 Boxplots showing maximum, minimum, interquartile ranges and median altitudes for annual clusters based on Chord distance from Brancaster Marsh.



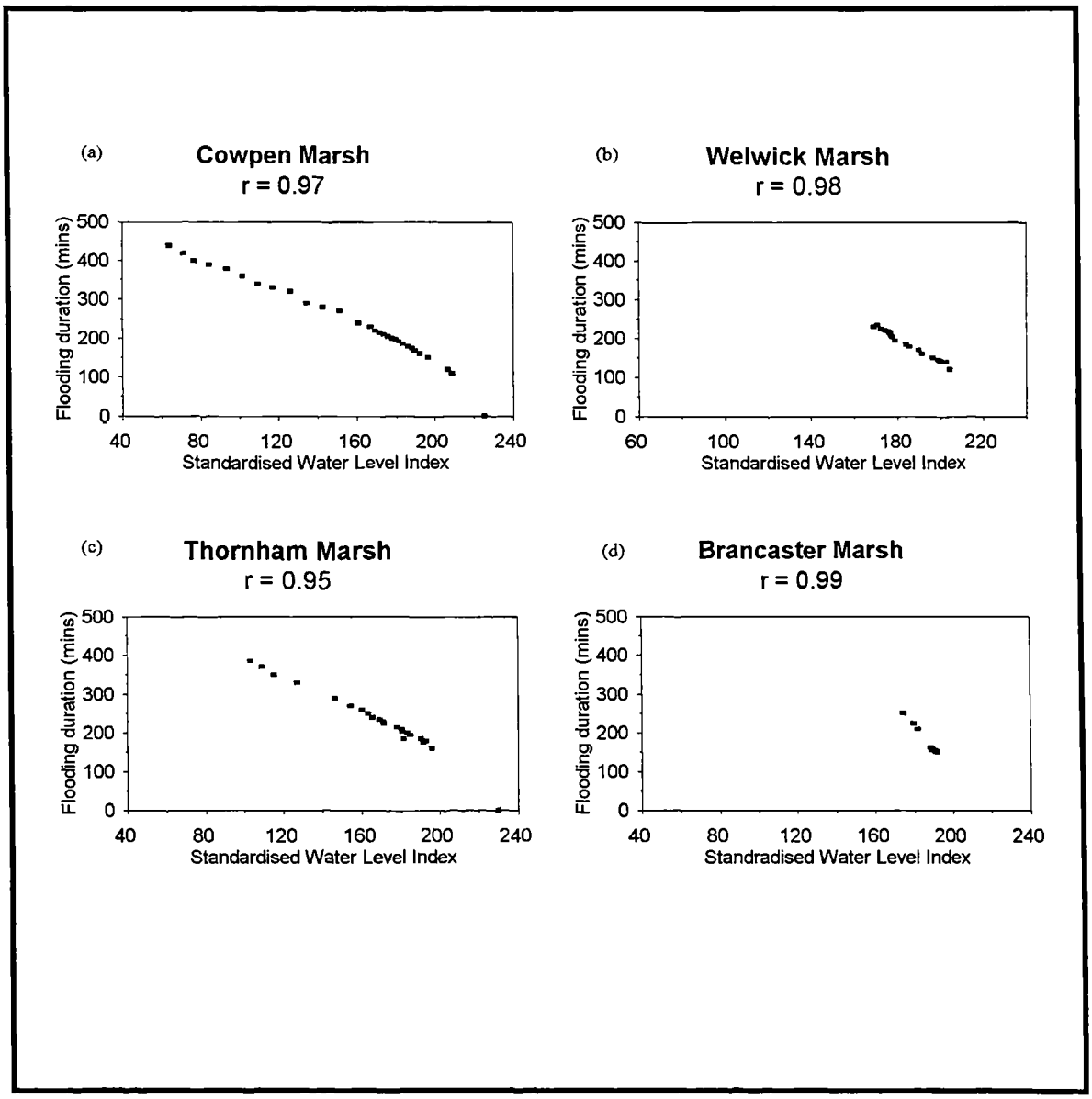
4.5.14 Stacked bar comparisons showing the distribution of annual Euclidean and Chord zones across the intertidal zone of Brancaster Marsh.



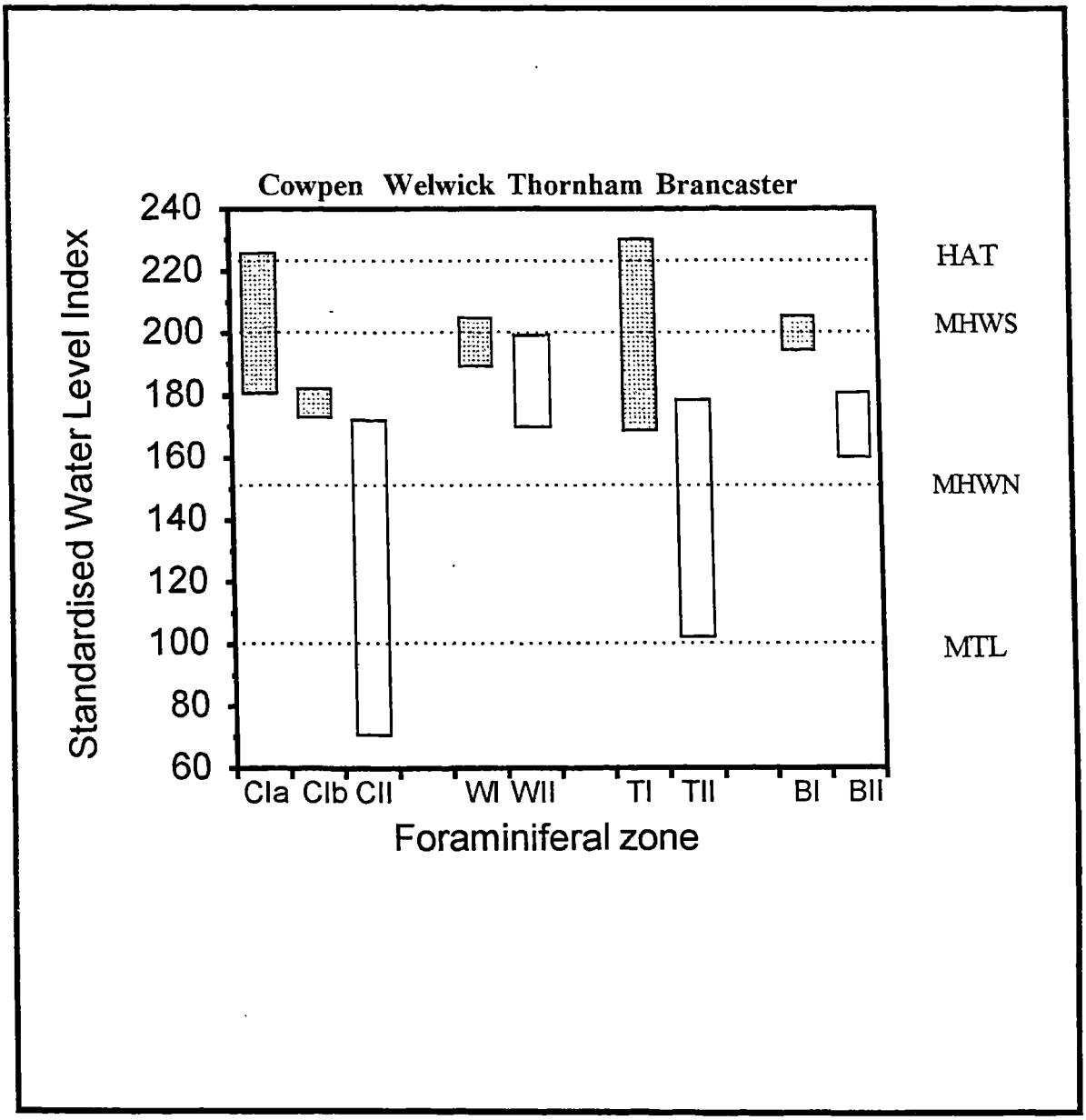
4.6.1 Scatter plots of altitude versus the annual average of *Jadammina macrescens* and *Haynesina germanica* from (a) Cowpen, (b) Welwick, (c) Thornham and (d) Brancaster Marsh.



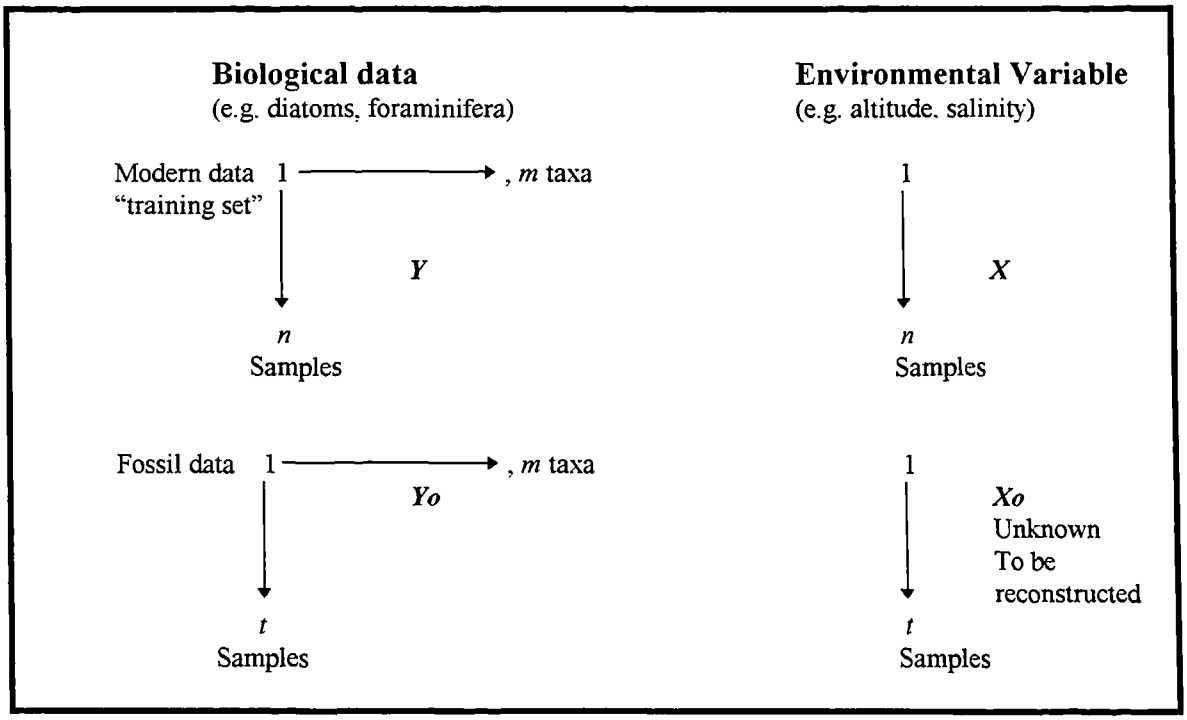
4.6.2 Comparisons among constructed tidal levels for Cowpen, Welwick, Thornham and Brancaster Marsh using Equation 1.



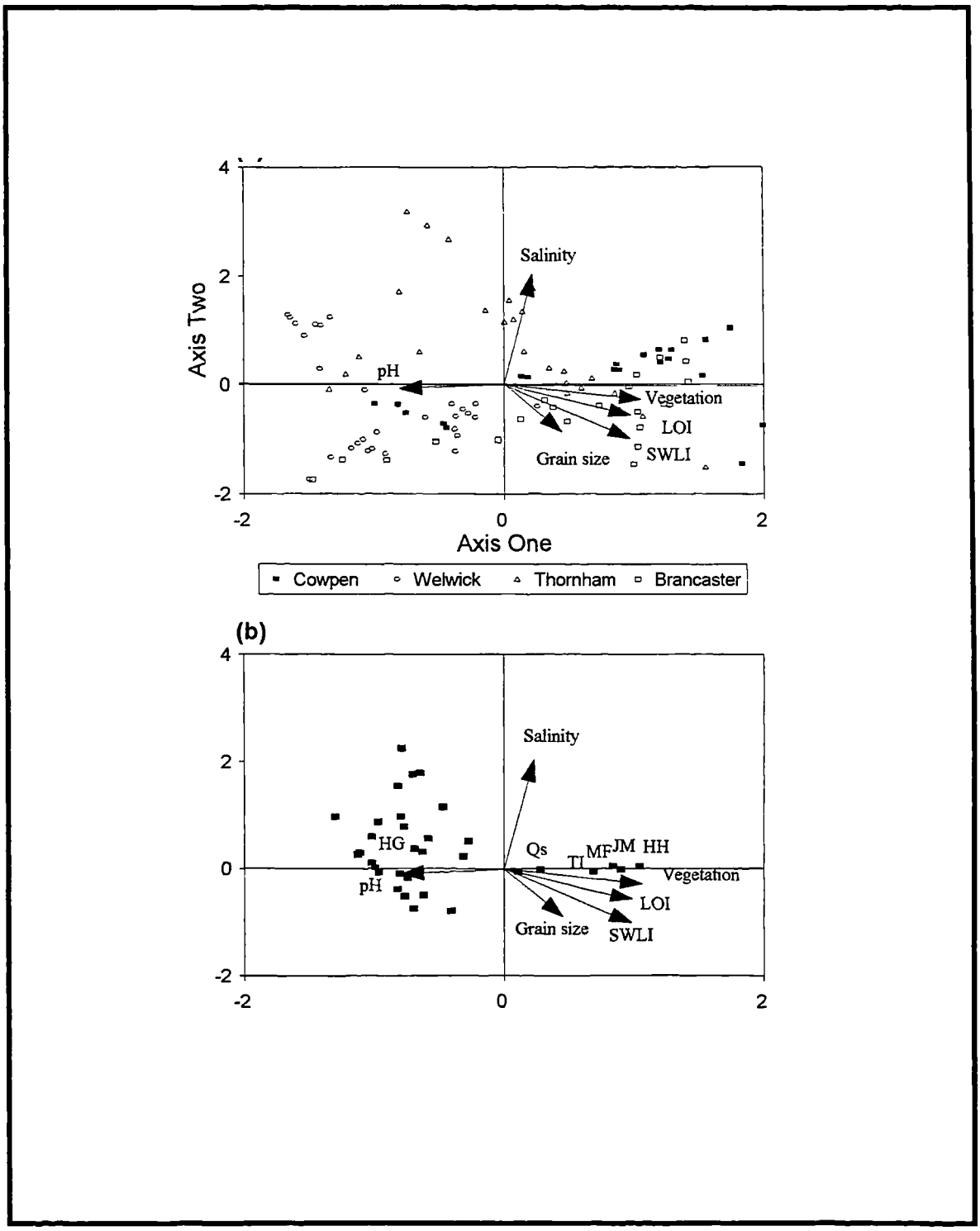
4.6.3 Scatter plots and correlation coefficients (r) of standardised water level index versus the flooding duration for (a) Cowpen, (b) Welwick, (c) Thornham and (d) Brancaster Marsh using Equation 1.



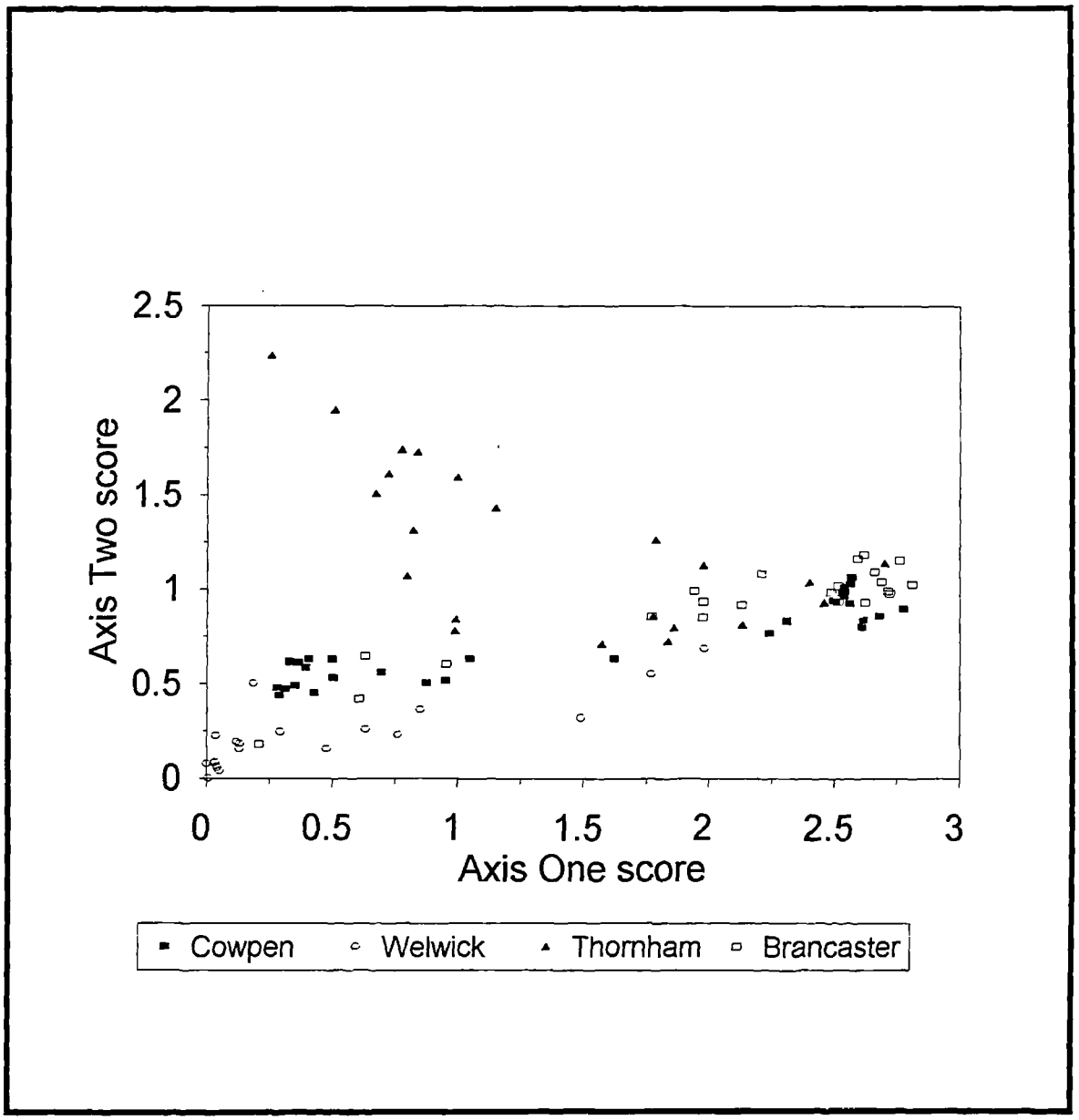
4.6.4 Vertical zonation of foraminiferal death assemblages of Cowpen, Welwick, Thornham and Brancaster Marsh. Standardised water level index is constructed using Equation 1. Shaded and clear sections denote Zones I and II respectively. Average tide levels of the four sites are shown.



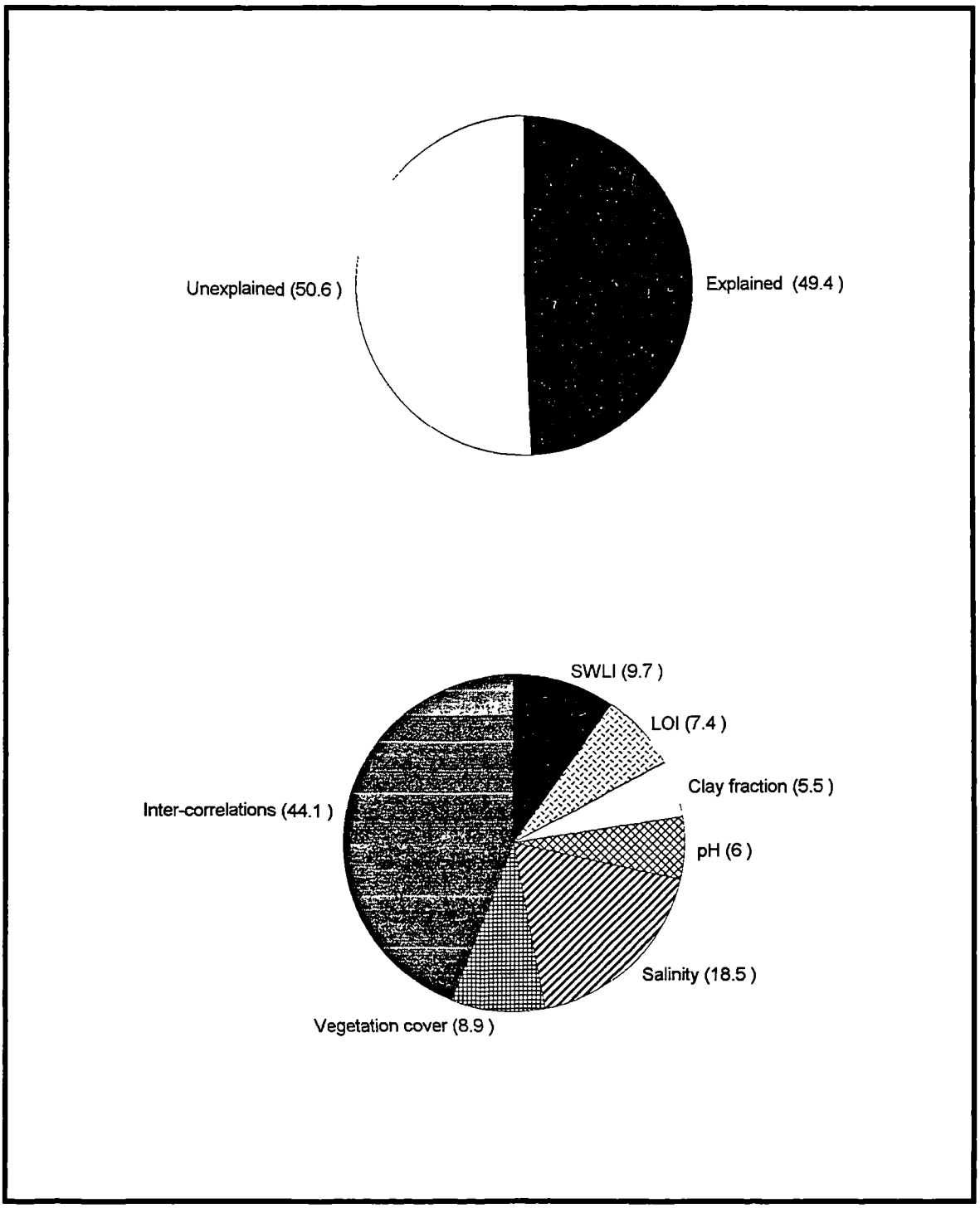
5.1 Principles of quantitative palaeoenvironmental reconstruction showing *Xo*, the unknown environmental variable to be reconstructed from fossil assemblage *Yo*, and the role of the modern training set consisting of modern biological *Y* and environmental data *X* (Source: Birks, 1995).



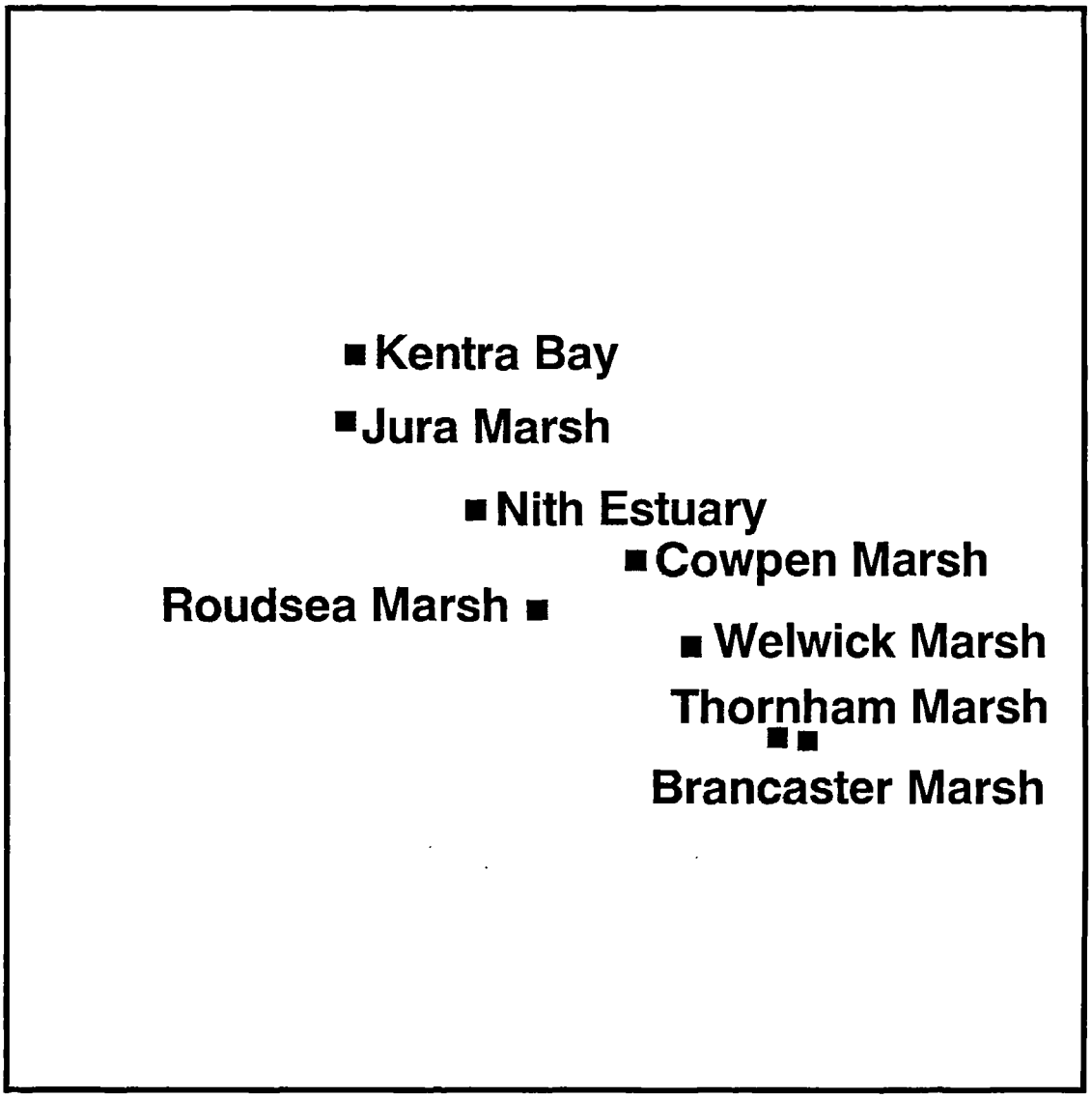
5.2 CCA biplots of (a) sample-environment and (b) foraminiferal species-environment. Species abbreviations: HG = *Haynesina germanica*; JM = *Jadammina macrescens*; MF = *Miliammina fusca*; Qs = *Quinqueloculina* spp.; and TI = *Trochammina inflata*. Environmental abbreviations: SWLI = Standardised Water Level Index. Only samples with counts greater than 40 individuals and species that reach 2 % of the total sum are included.



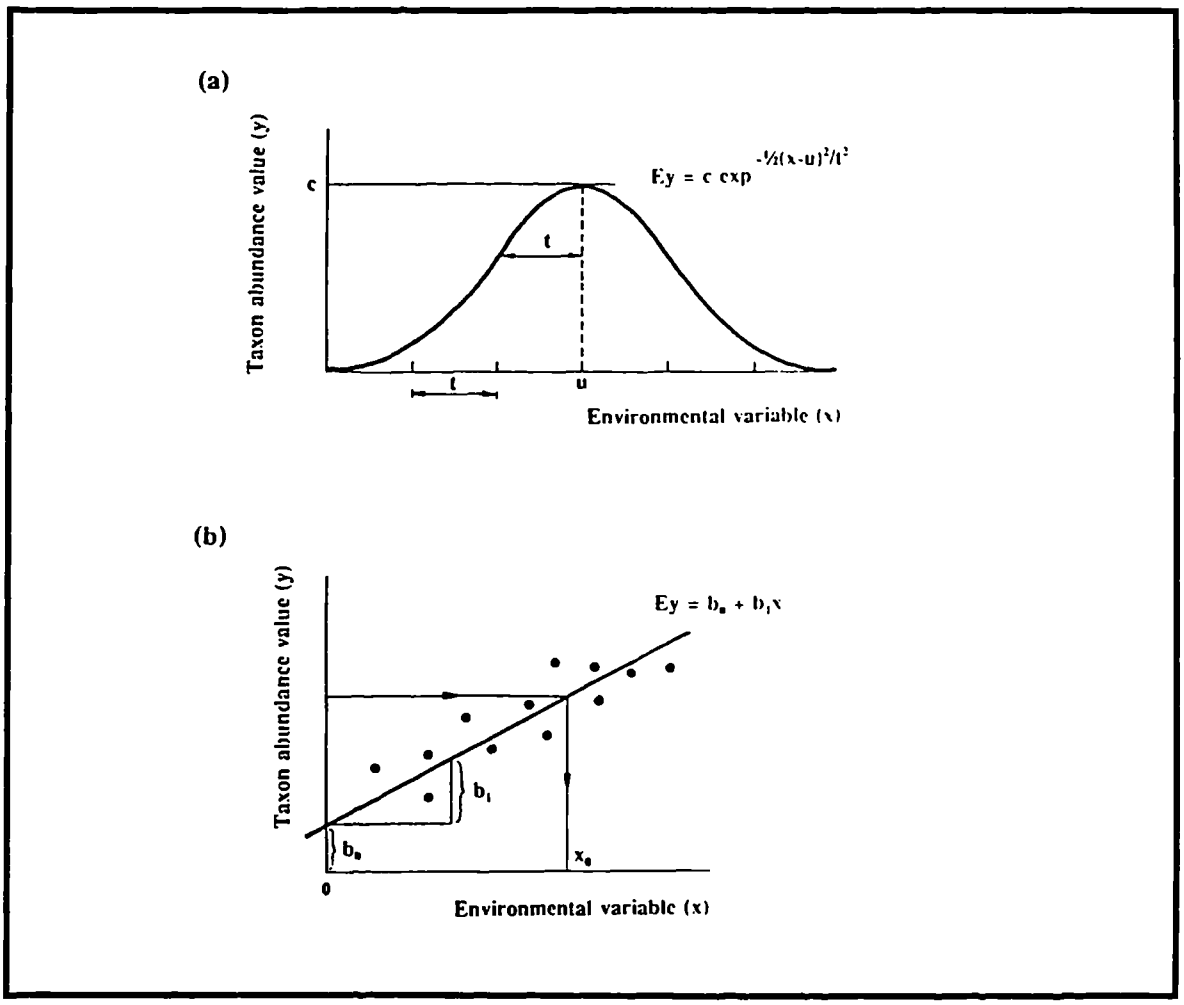
5.3 DCA of the foraminiferal training set. Only samples with counts greater than 40 individuals and species that reach 2 % of the total sum are included.



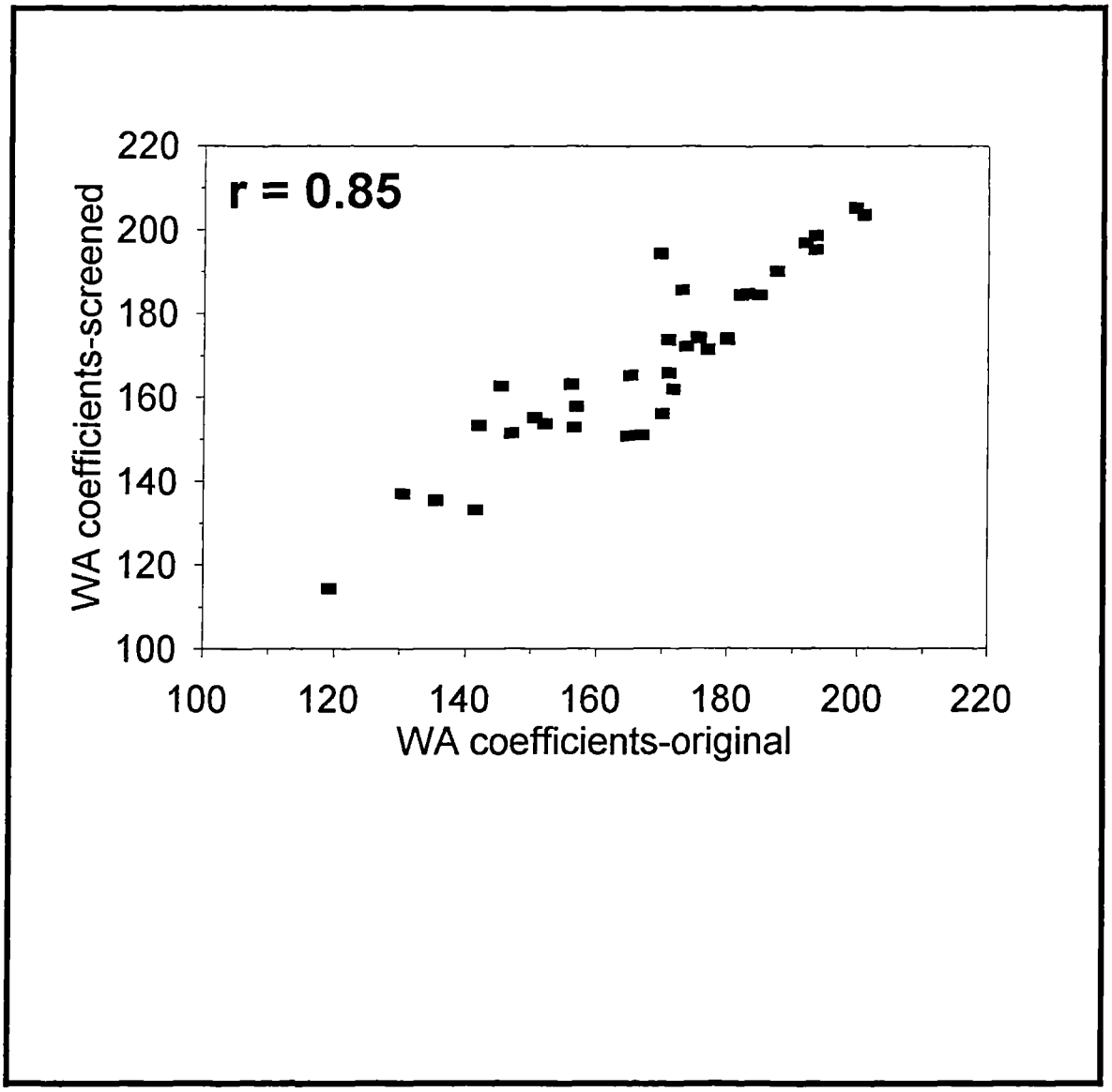
5.4 Pie charts showing the total variation of the foraminiferal training set in (a) explained and unexplained portions and (b) components representing the unique contributions of standardised water level index, salinity, LOI, vegetation cover, pH, grain size, location and inter-correlations among gradients.



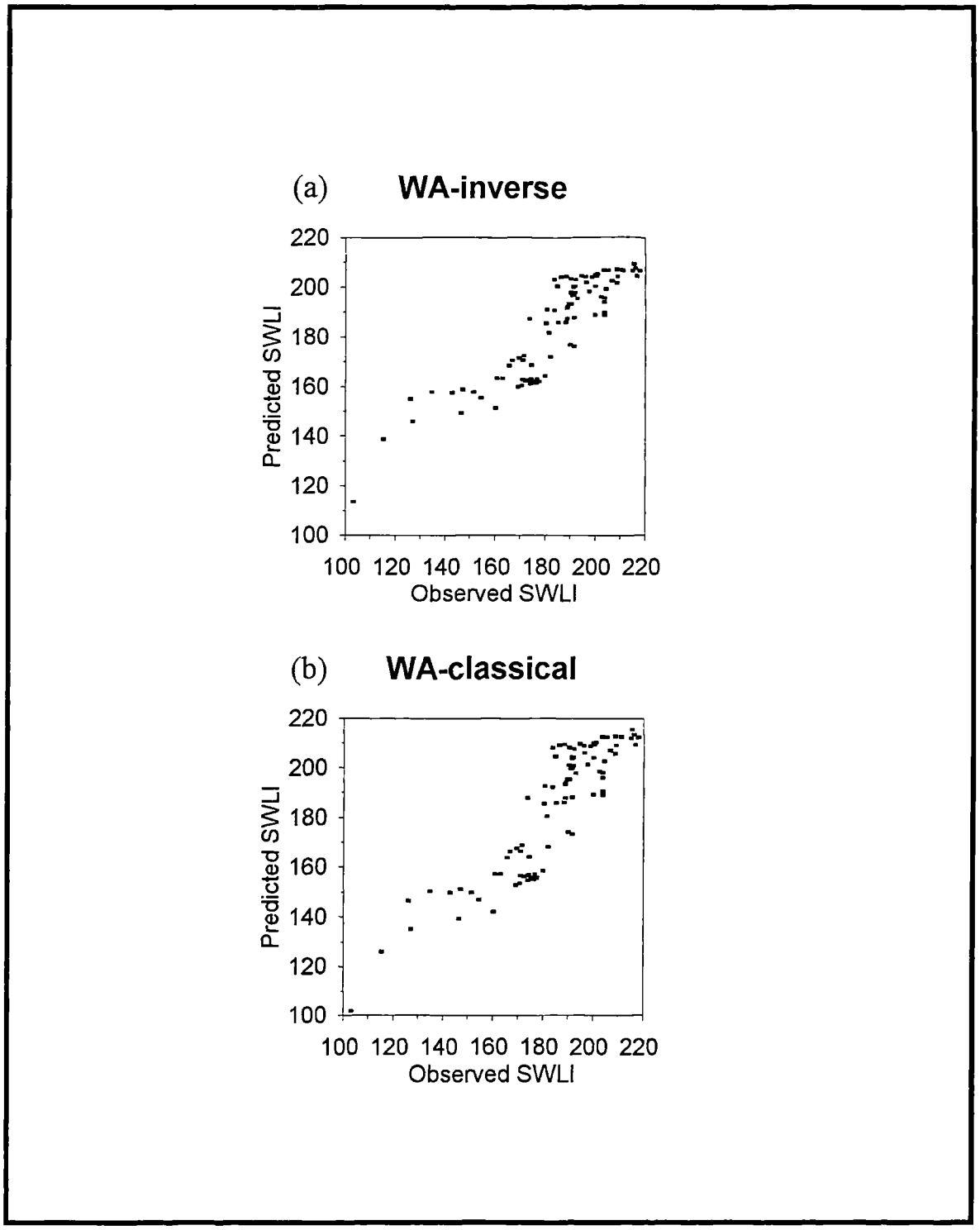
5.5 Location map of the UK showing contemporary field sites within the enlarged foraminiferal training set.



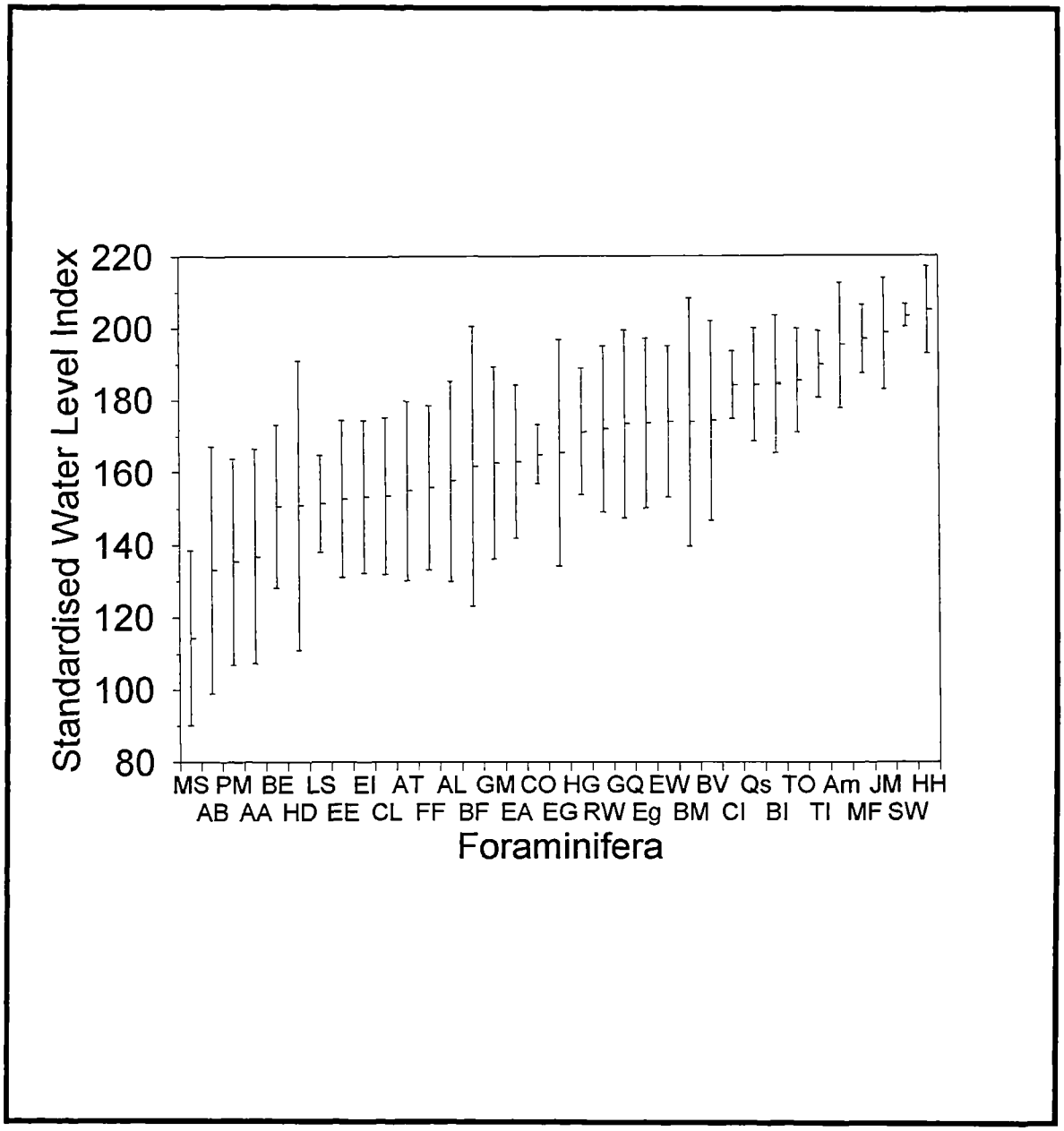
5.6 Species-environment response models. (a) Gaussian unimodal relationship between the abundance (y) of a species and an environmental variable (x). Abbreviations for ecological parameters are: u = optimum; t = tolerance; and c = maximum. The equation for the expected value of the species abundance y is given for the Gausian response model. (b) Linear relationship between the abundance (y) of a species and an environmental variable (x). The equation for the expected value of the species abundance y in relation to x is given for the linear response model where b_0 is the intercept and b_1 is the slope or regression coefficient (Source: Birks, 1995).



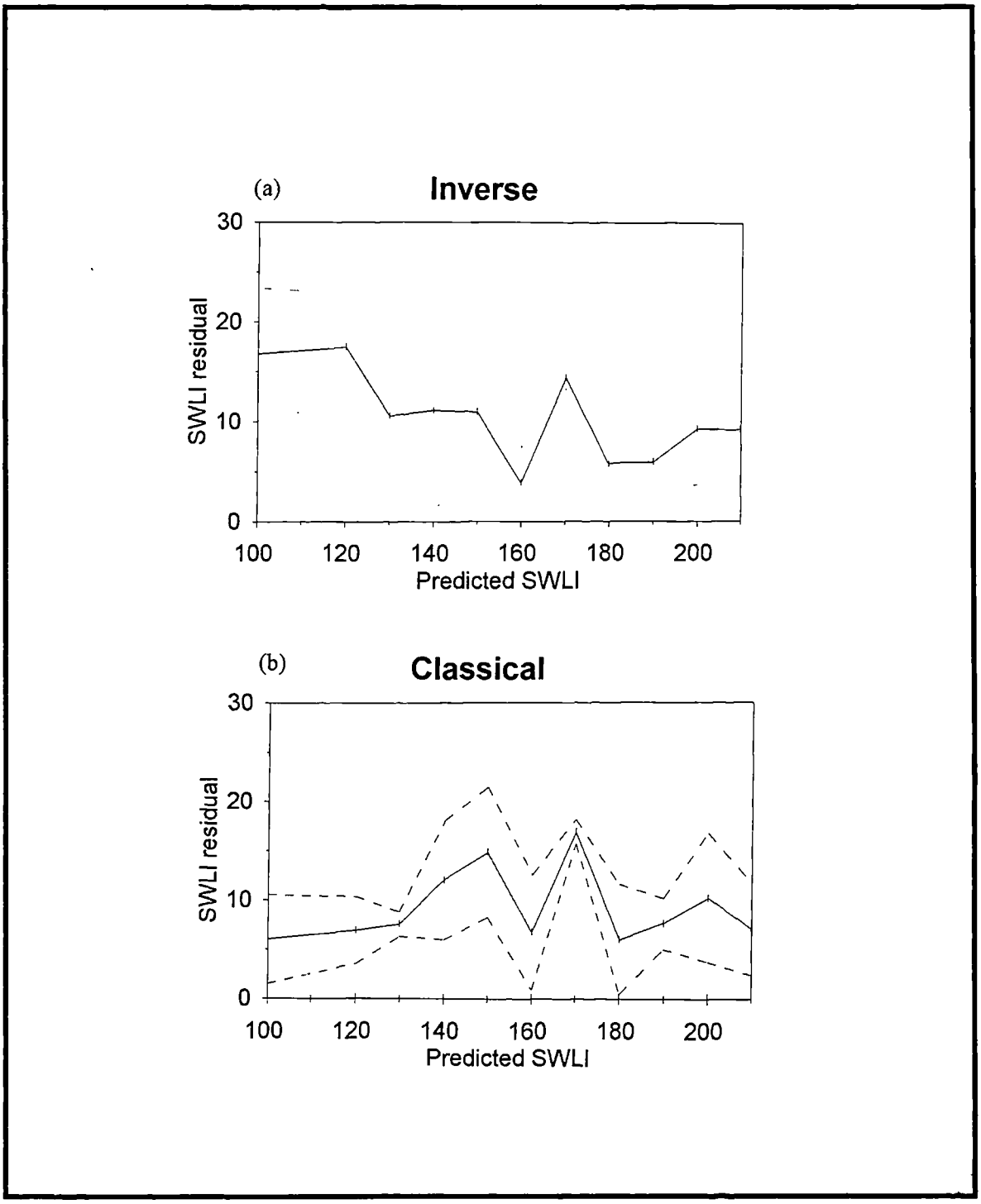
5.7 Scatter plot showing the relationship of weighted average (WA) coefficients derived from the original 135 sample foraminiferal training set versus the screened 101 sample training set. 94



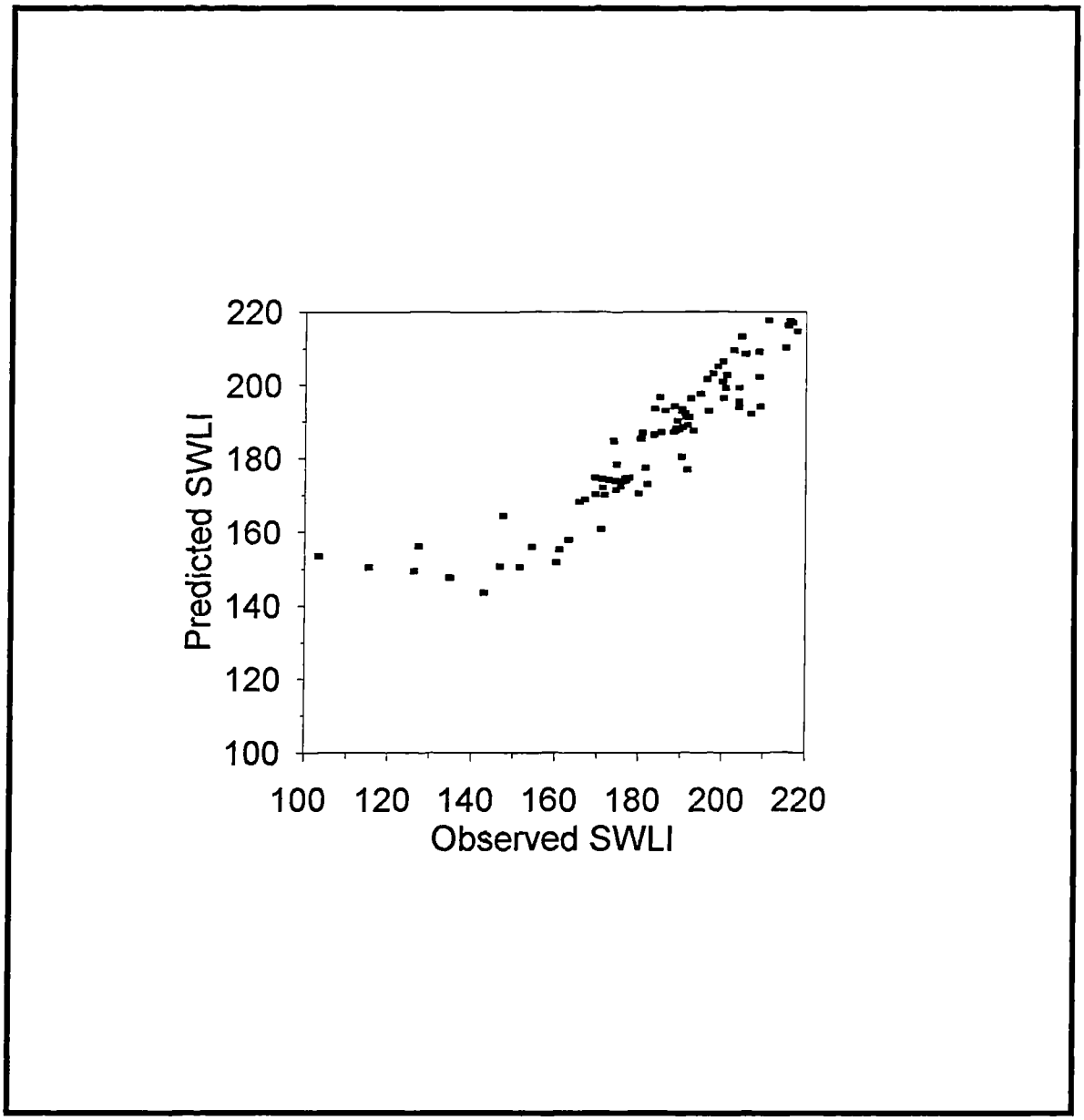
5.8 Scatter plots showing the relationship of the observed standardised water level index (SWLI) versus foraminiferal-predicted SWLI for (a) inverse- and (b) classical-deshrinking regression.



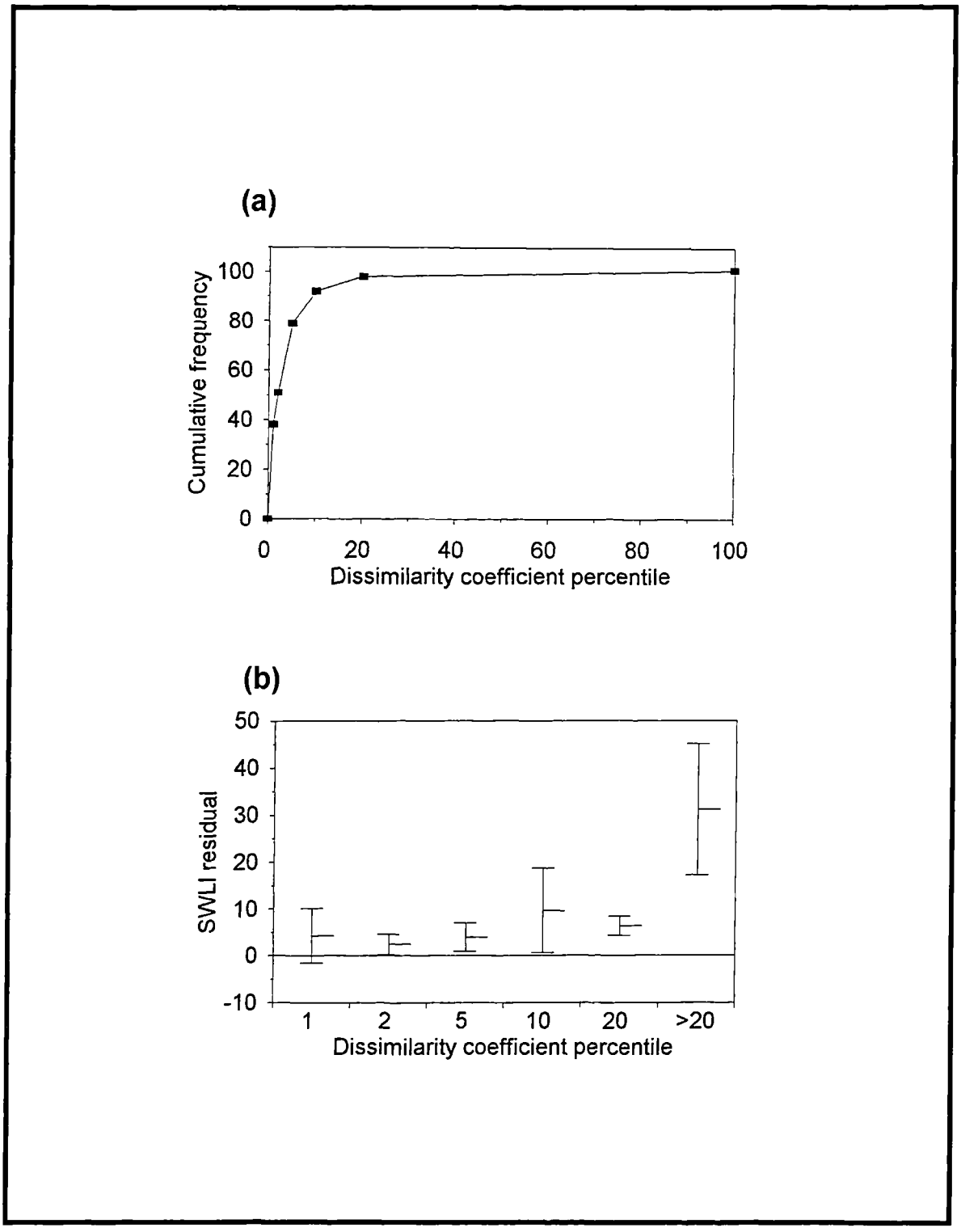
5.9 Foraminiferal species optima (weighted average) and tolerances (weighted standard deviation) for standardised water level index showing all taxa present in the foraminiferal training set. Species abbreviations are shown in Table 5.5.



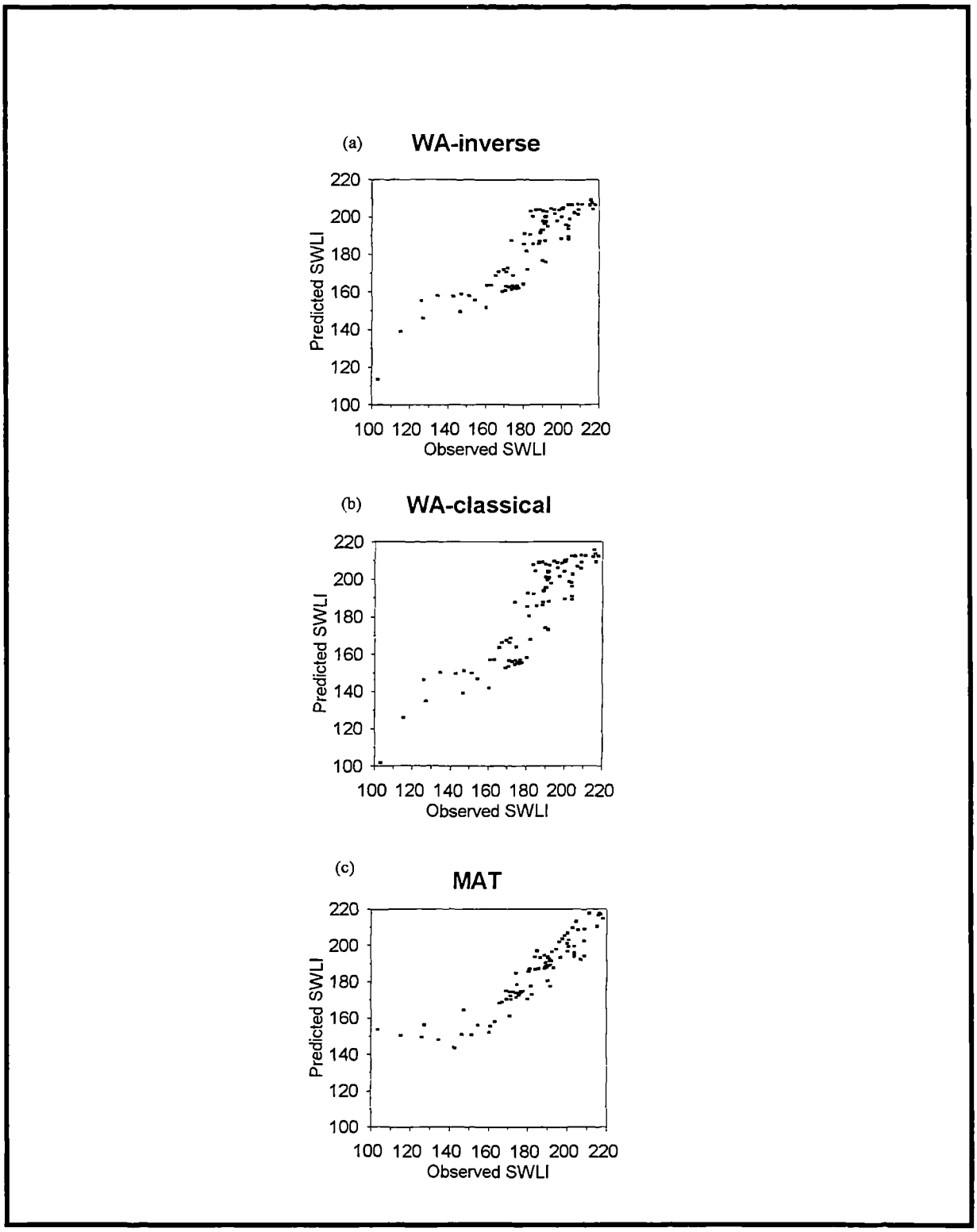
5.10 (a) Inverse and (b) classical residuals for foraminiferal-predicted standardised water level index (SWLI) based on weighted average transfer functions using inverse deshrinking regression. Solid and dashed lines indicate the mean and standard error.



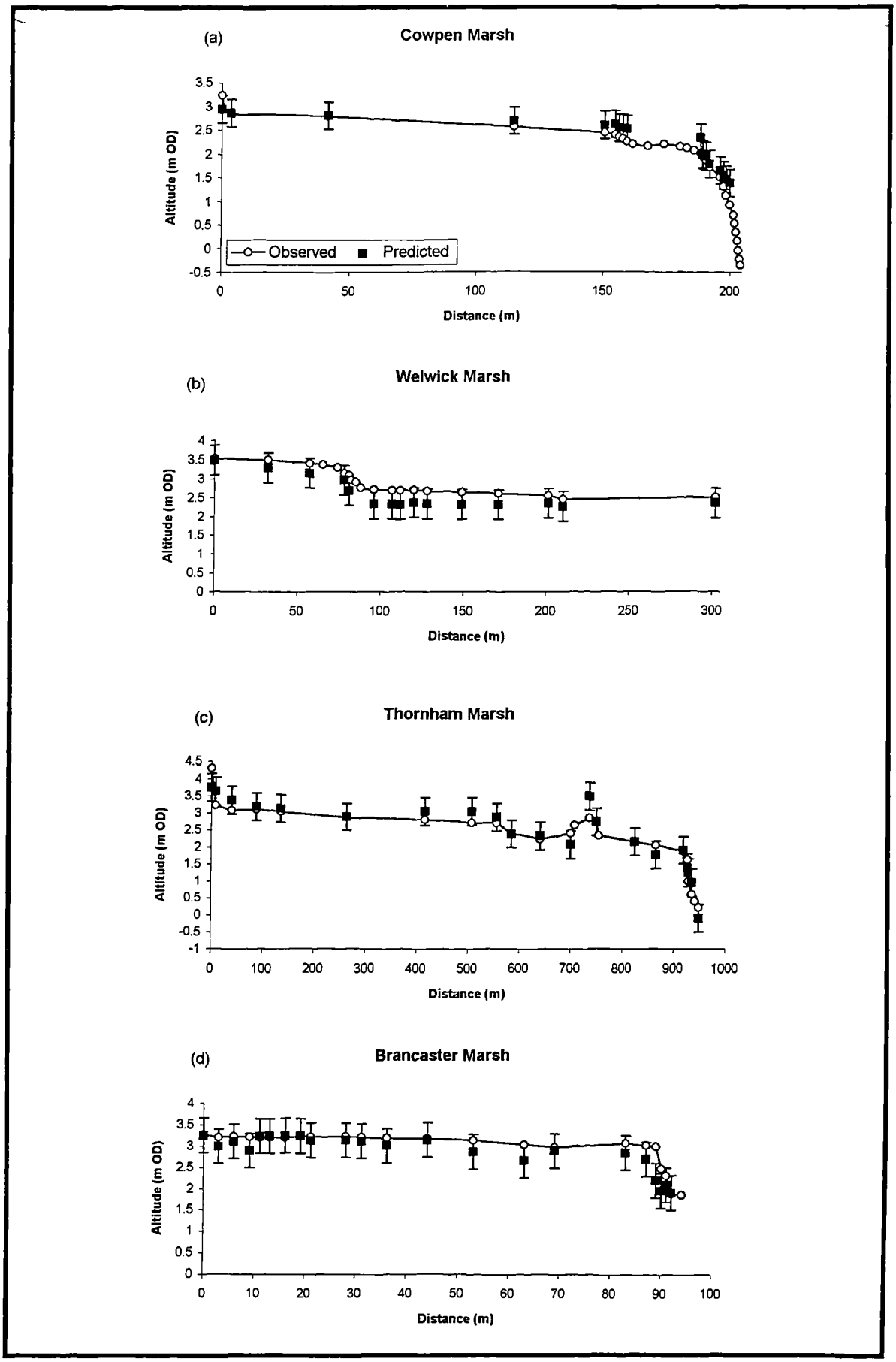
5.11 Scatter plot showing the relationship of observed standardised water level index (SWLI) versus foraminiferal-predicted SWLI for the matching analogue technique.



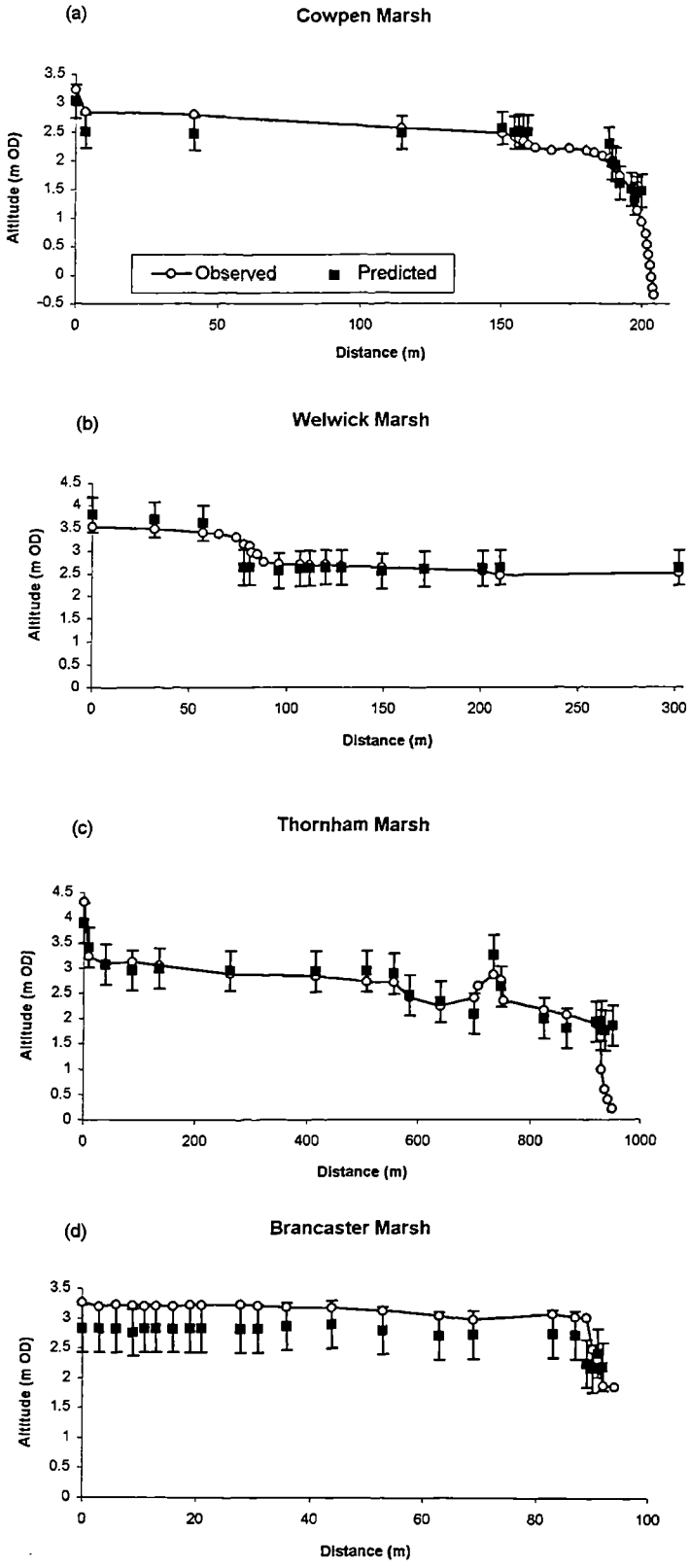
5.12 (a) Cumulative sample frequency of dissimilarity coefficient percentiles and (b) average and standard deviations of absolute residuals for standardised water level index (observed - predicted) versus dissimilarity coefficient percentiles for the matching analogue technique. Percentile values are shown in Table 5.7.



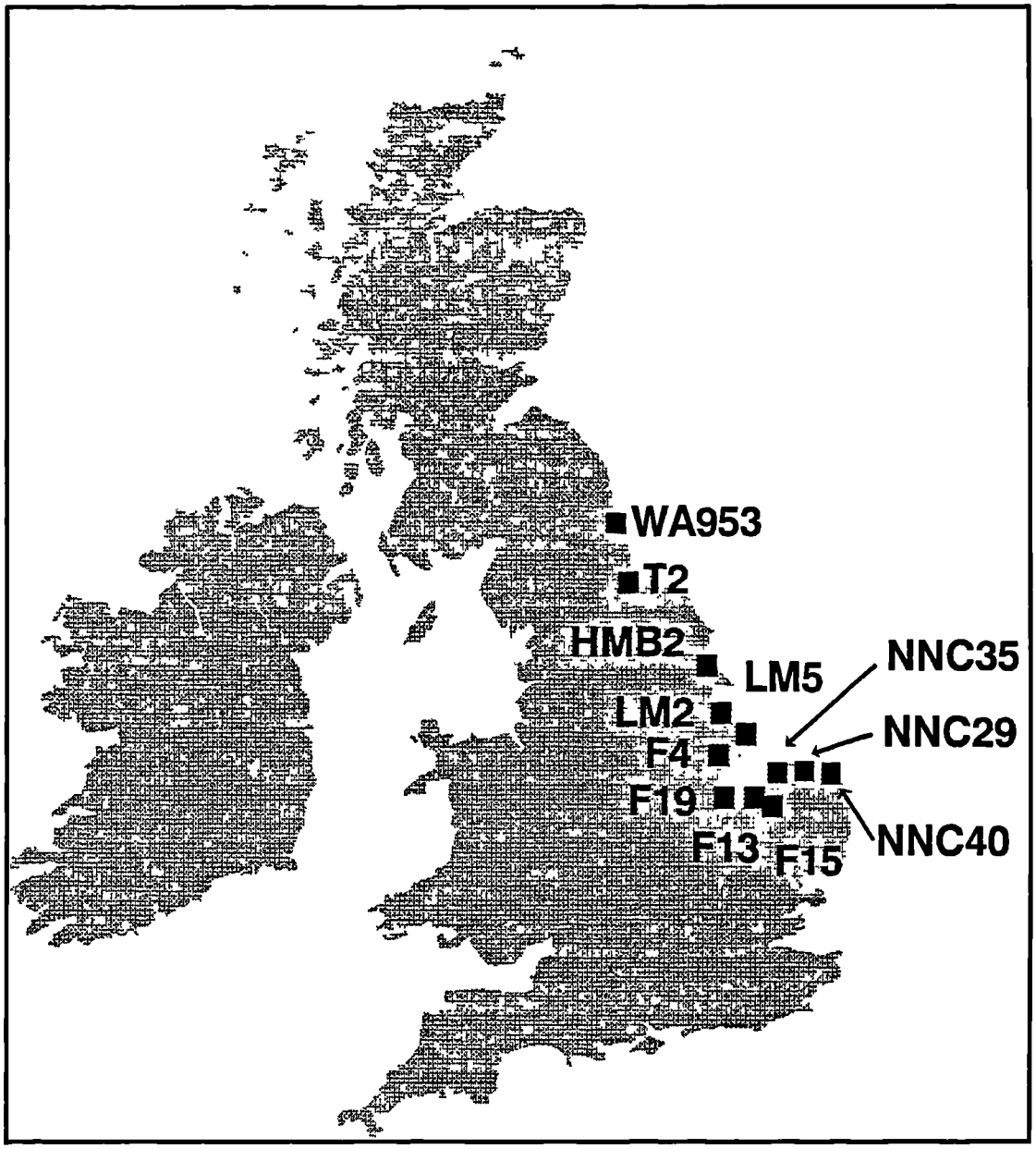
5.13 Scatter plot showing the relationship of observed standardised water level index (SWLI) versus foraminiferal-predicted SWLI based on (a) weighted average (WA) transfer functions using inverse deshrinking regression, (b) WA transfer functions using inverse deshrinking regression and (c) matching analogue technique (MAT). 100



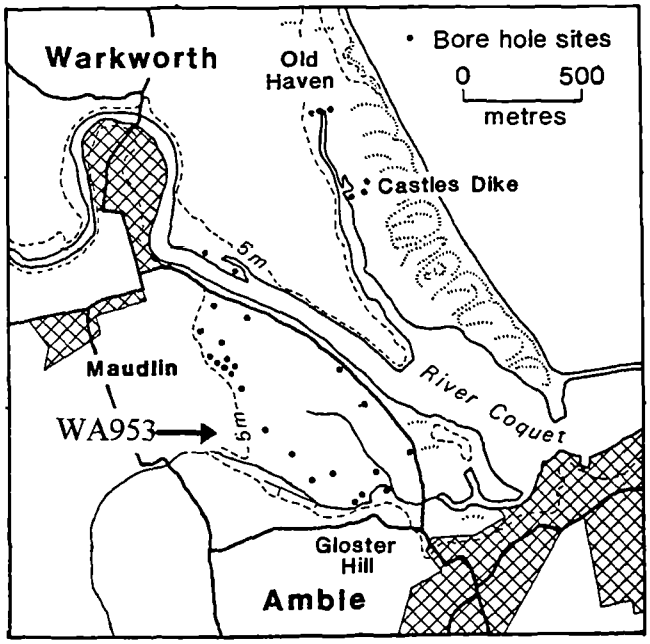
5.14 Transects of (a) Cowpen, (b) Welwick, (c) Thornham and (d) Brancaster Marsh showing the relationship of observed altitudes versus foraminiferal-predicted altitudes based on weighted average transfer functions using inverse and classical deshrinking regressions. The error ranges of the predicted altitudes are shown.



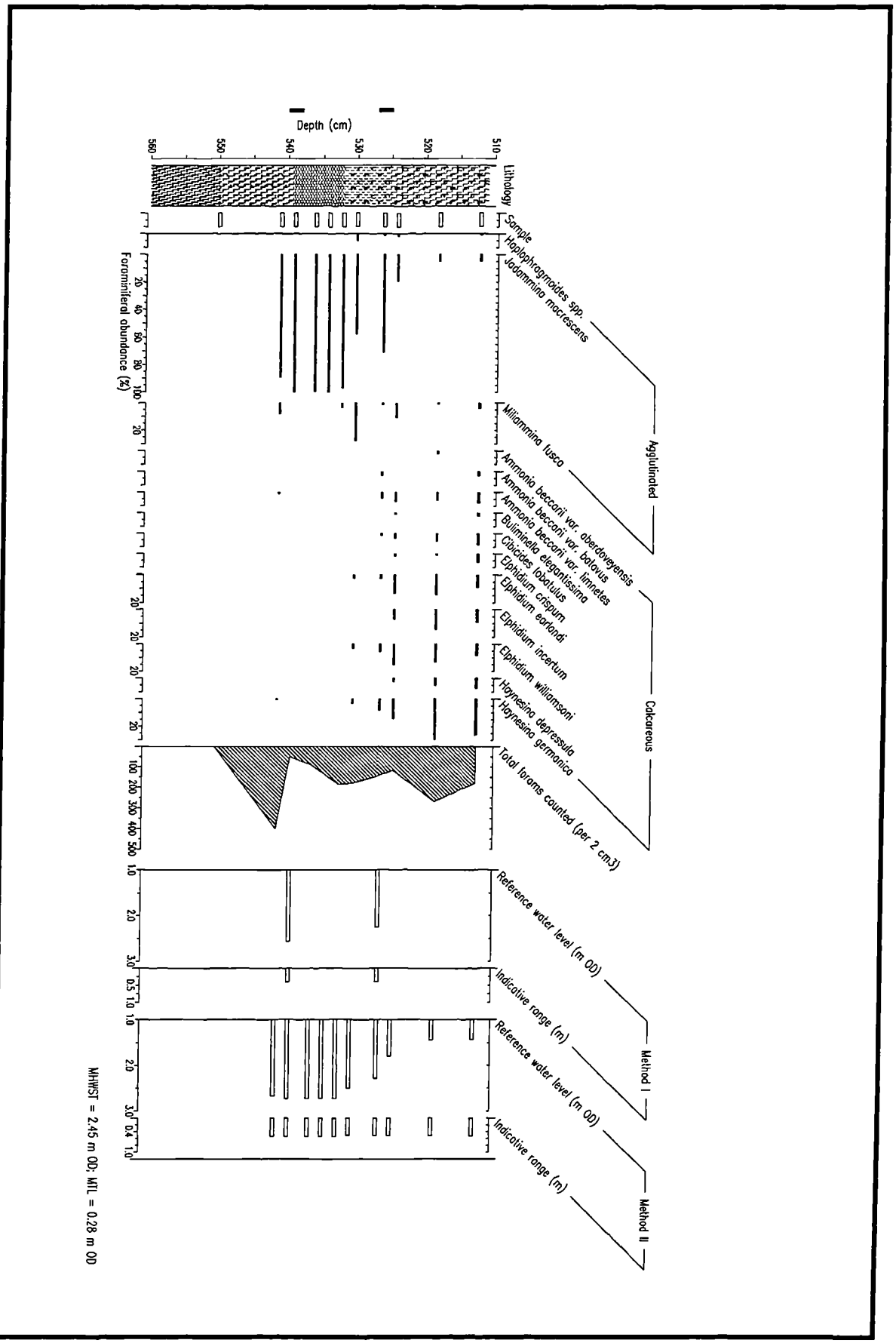
5.15 Transects of (a) Cowpen, (b) Welwick, (c) Thornham and (d) Brancaster Marsh showing the relationship of observed altitudes versus foraminiferal-predicted altitudes based on matching analogue technique. The error ranges of the predicted altitudes are shown.



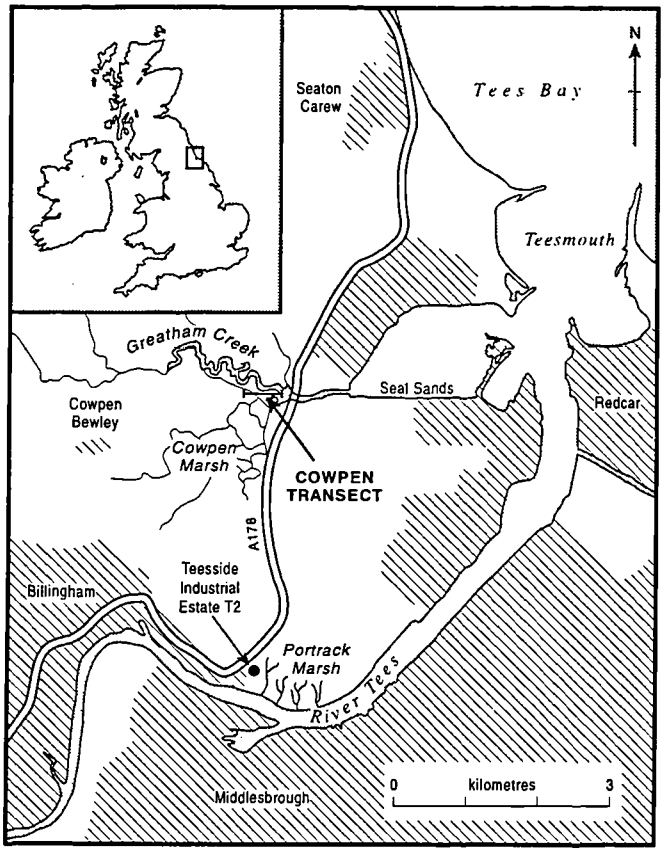
6.1 Location map of the UK showing fossil field sites.



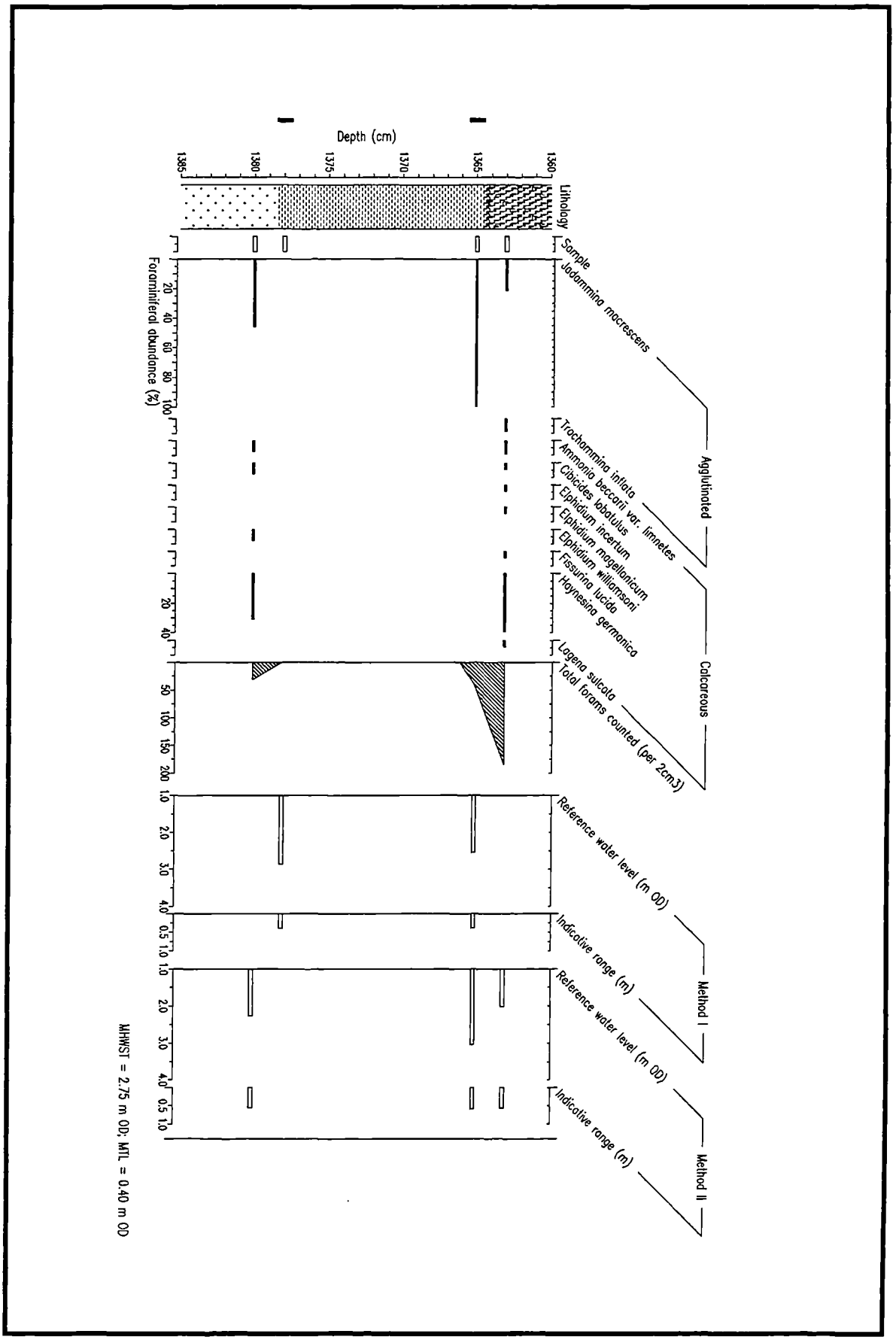
6.2 Location map of Warkworth (WA953) (Source: Plater and Shennan, 1992).



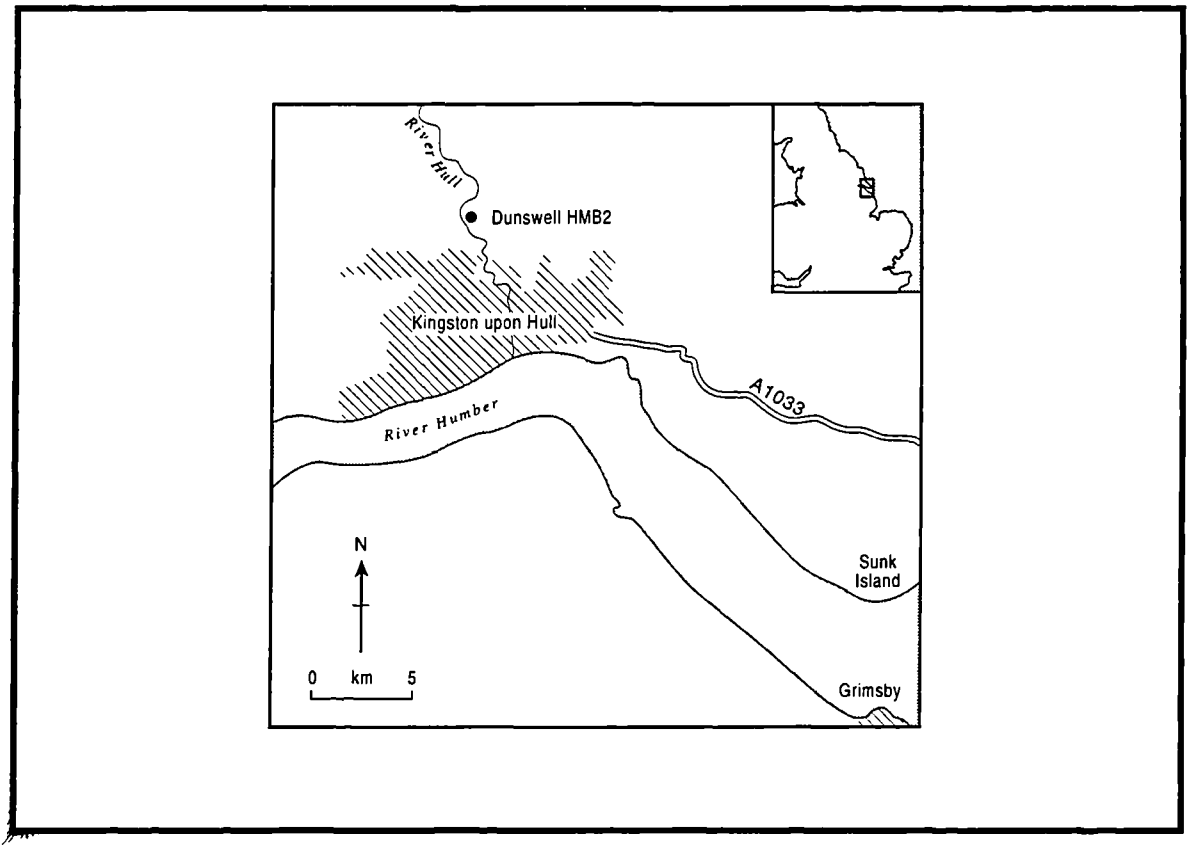
6.3 Warkworth WA95/3 foraminiferal diagram. Foraminiferal abundance is calculated as a percentage of total foraminiferal tests. Indicative meanings are estimated using both Methods I and II. The stratigraphy is drawn according to Troels-Smith (1955). The samples used as SLIs are shown. 105



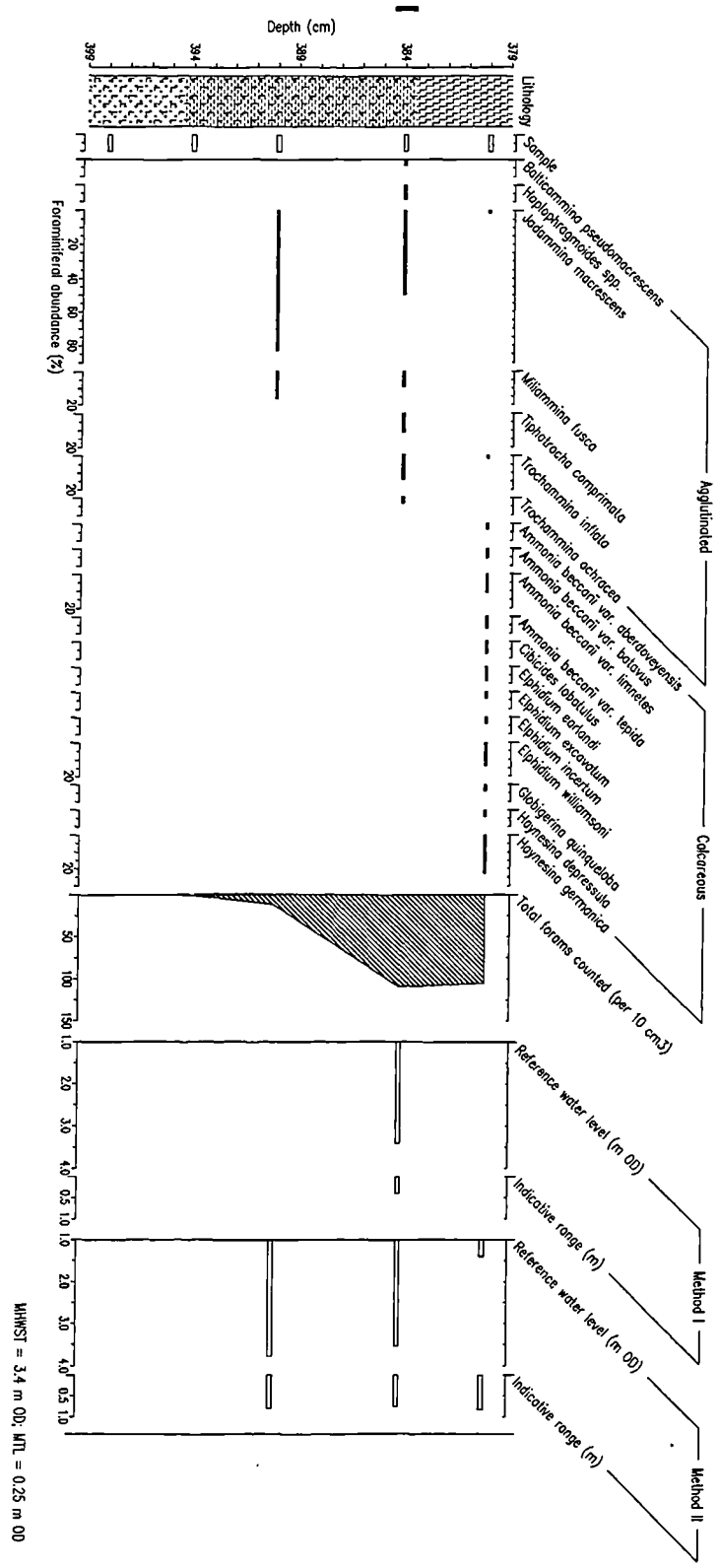
6.4 Location map of Teesside (T2).



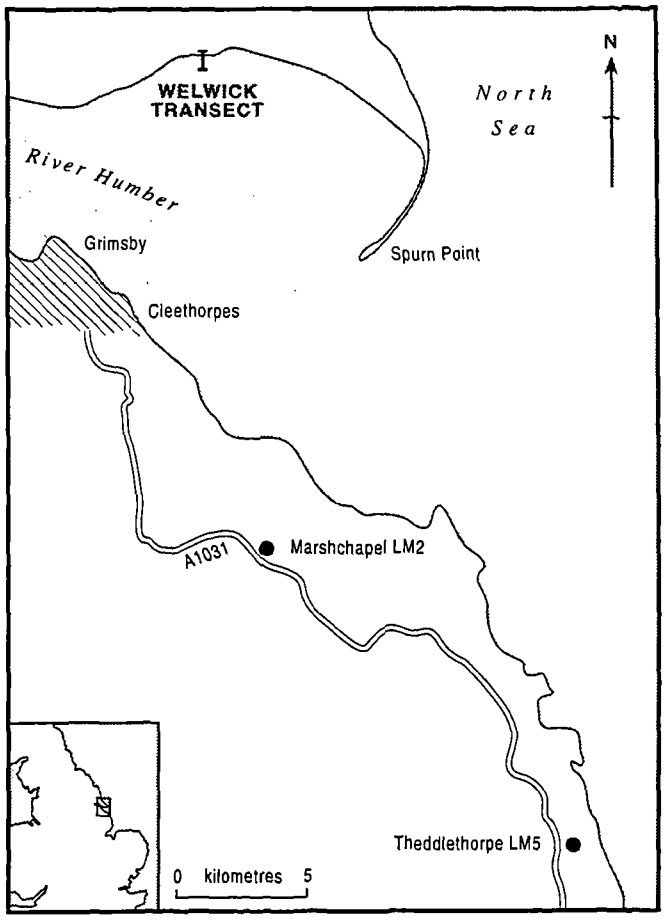
6.5 Teesside T2 foraminiferal diagram. Foraminiferal abundance is calculated as a percentage of total foraminiferal tests. Indicative meanings are estimated using both Methods I and II. The stratigraphy is drawn according to Troels-Smith (1955). The samples used as SLIs are shown.



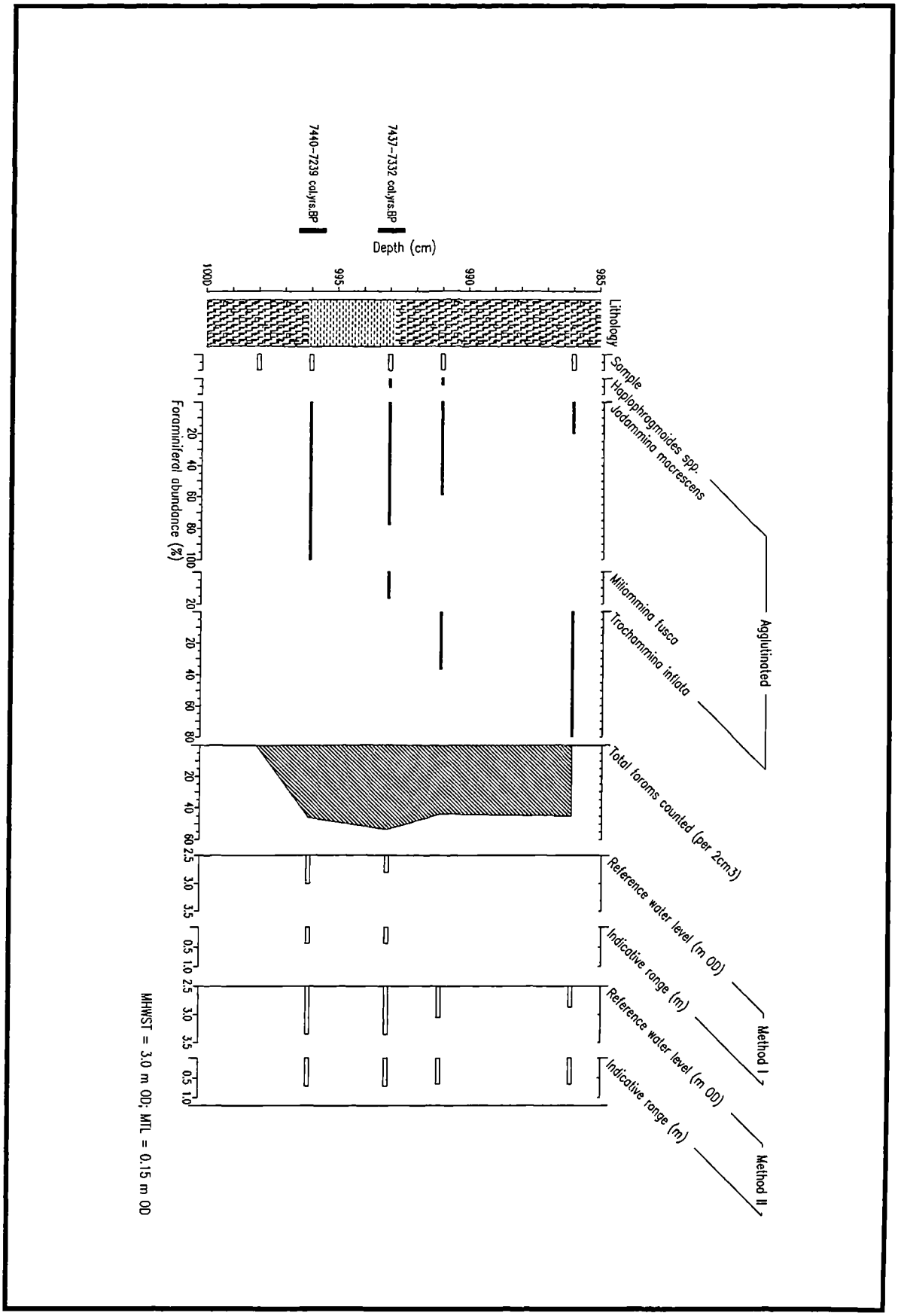
6.6 Location map of Dunswell (HMB2).



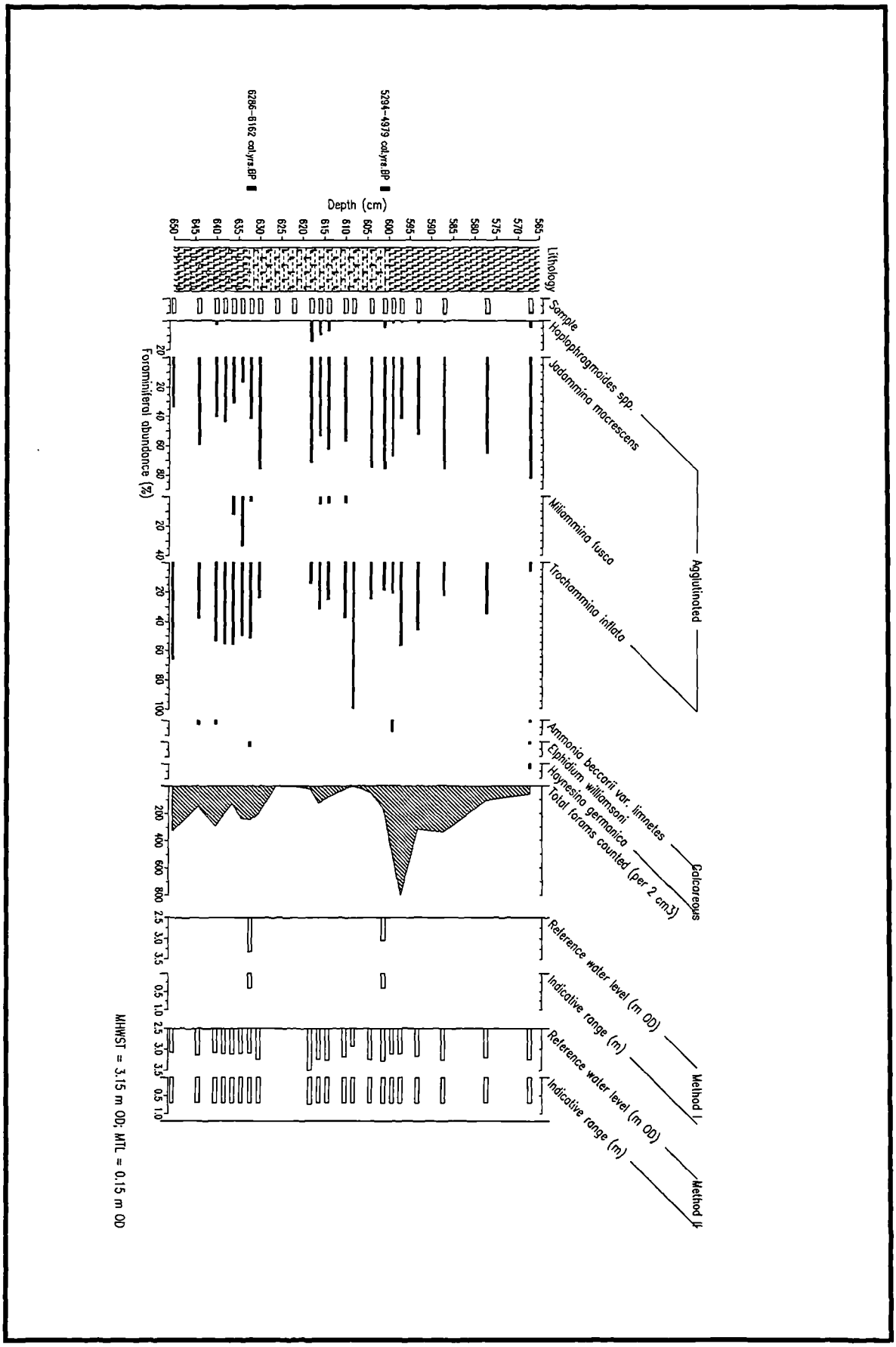
6.7 Dunswell HMB2 foraminiferal diagram. Foraminiferal abundance is calculated as a percentage of total foraminiferal tests. Indicative meanings are estimated using both Methods I and II. The stratigraphy is drawn according to Troels-Smith (1955). The samples used as SLIs are shown.



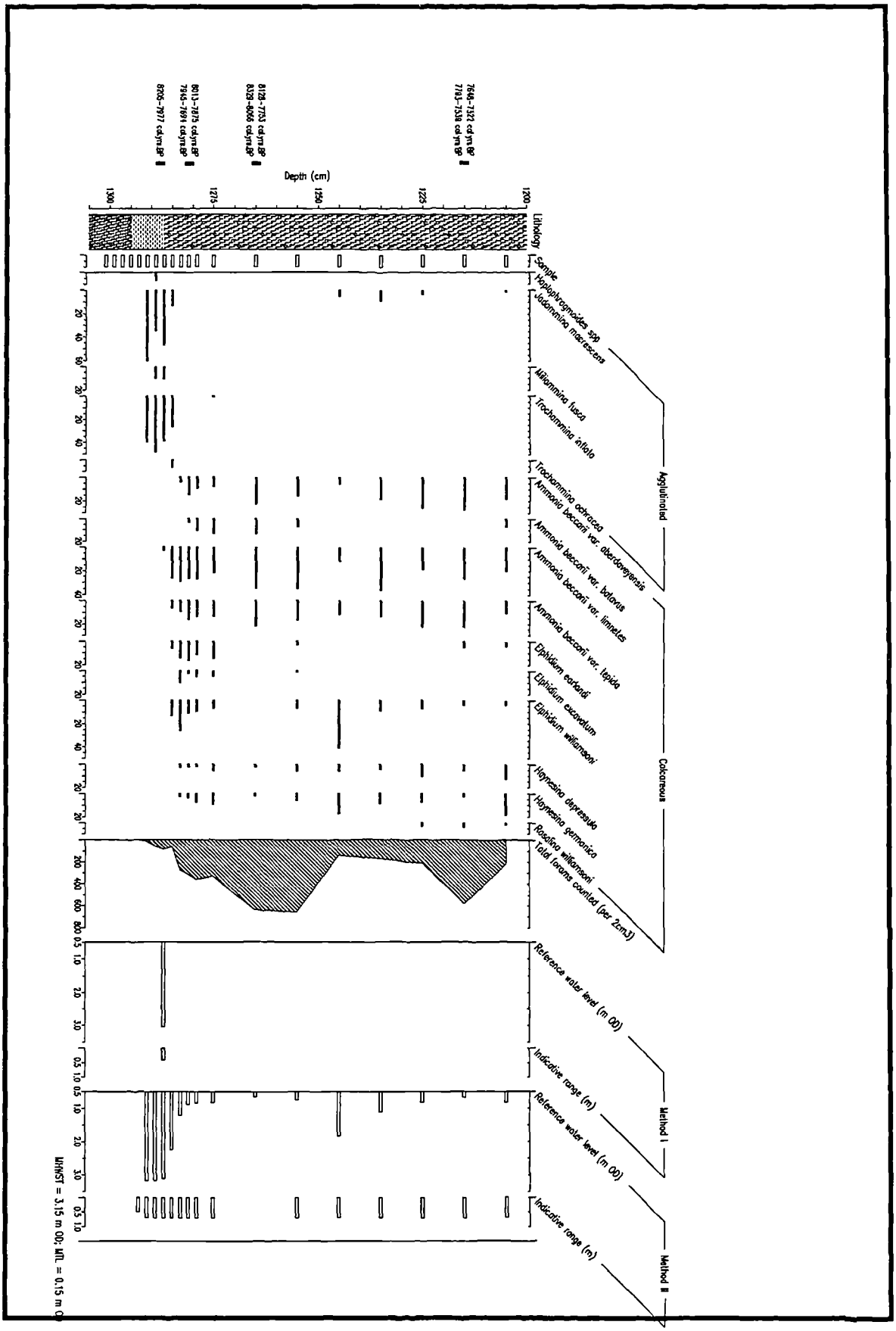
6.8 Location map of Marshchapel (LM2) and Theddlethorpe (LM5).



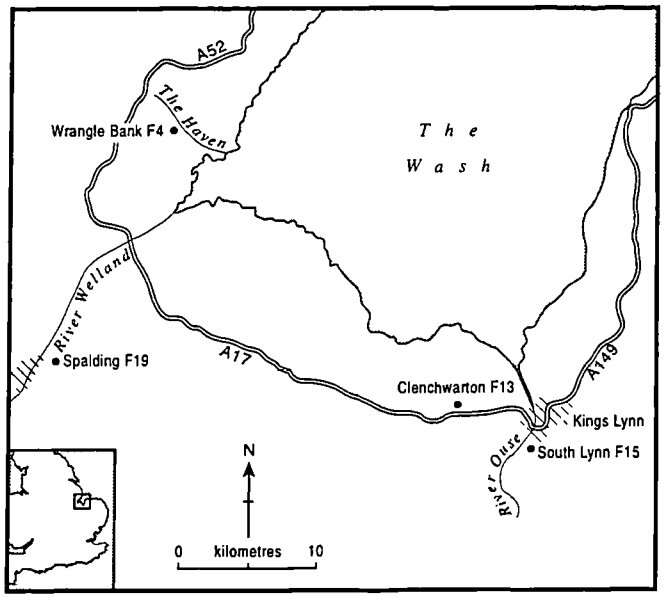
6.9 Marshchapel LM2 foraminiferal diagram. Foraminiferal abundance is calculated as a percentage of total foraminiferal tests. Indicative meanings are estimated using both Methods I and II. The stratigraphy is drawn according to Troels-Smith (1955). The radiocarbon dates of SLIs are shown.



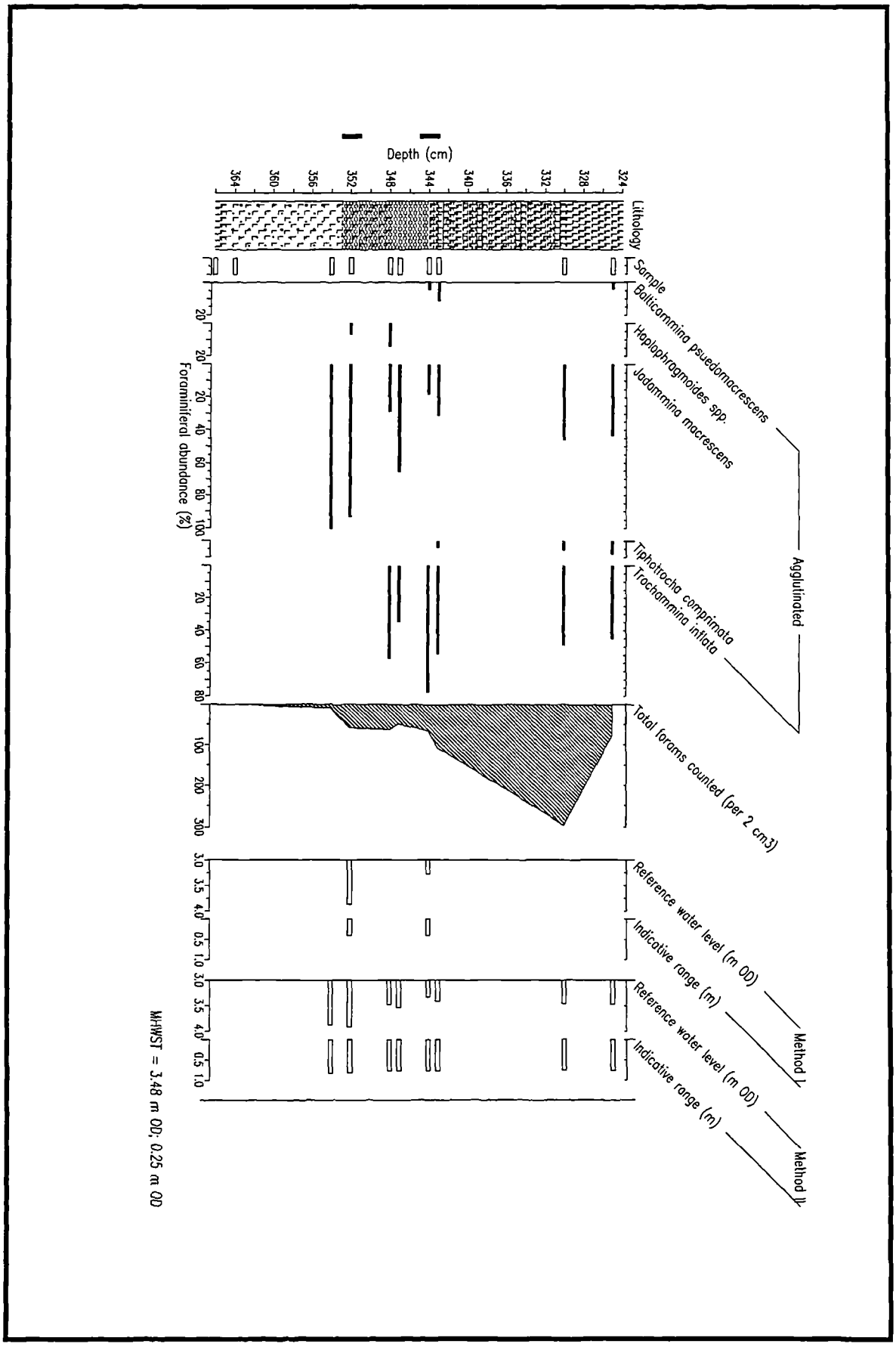
6.10 Theddlethorpe LM5a foraminiferal diagram. Foraminiferal abundance is calculated as a percentage of total foraminiferal tests. Indicative meanings are estimated using both Methods I and II. The stratigraphy is drawn according to Troels-Smith (1955). The radiocarbon dates of SLIs are shown. 112



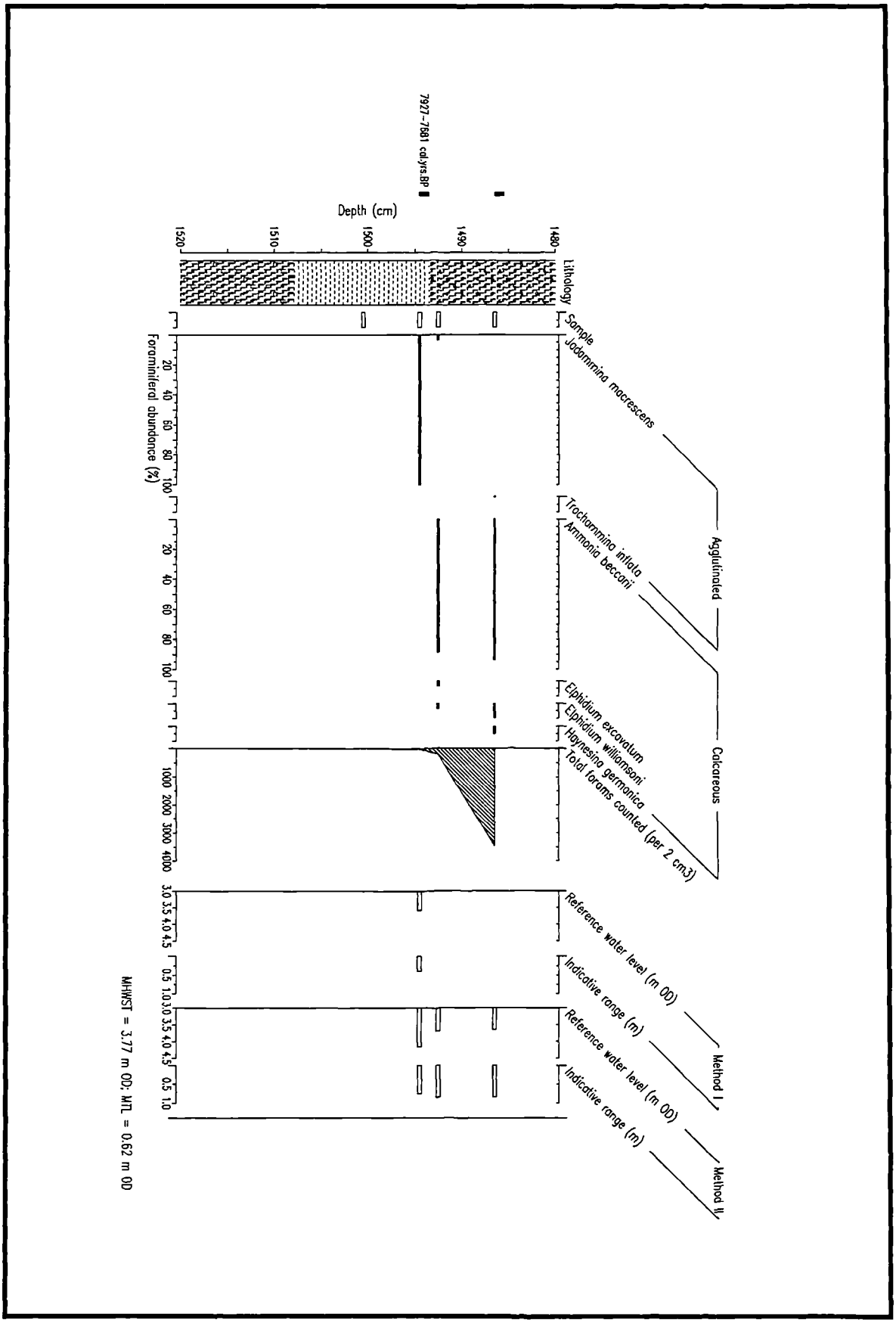
6.11 Theddlethorpe LM5b foraminiferal diagram. Foraminiferal abundance is calculated as a percentage of total foraminiferal tests. Indicative meanings are estimated using both Methods I and II. The stratigraphy is drawn according to Troels-Smith (1955). The radiocarbon dates of SLIs are shown. The upper paired dates are foraminifera and the lower are *Hydrobia ulvae*. 113



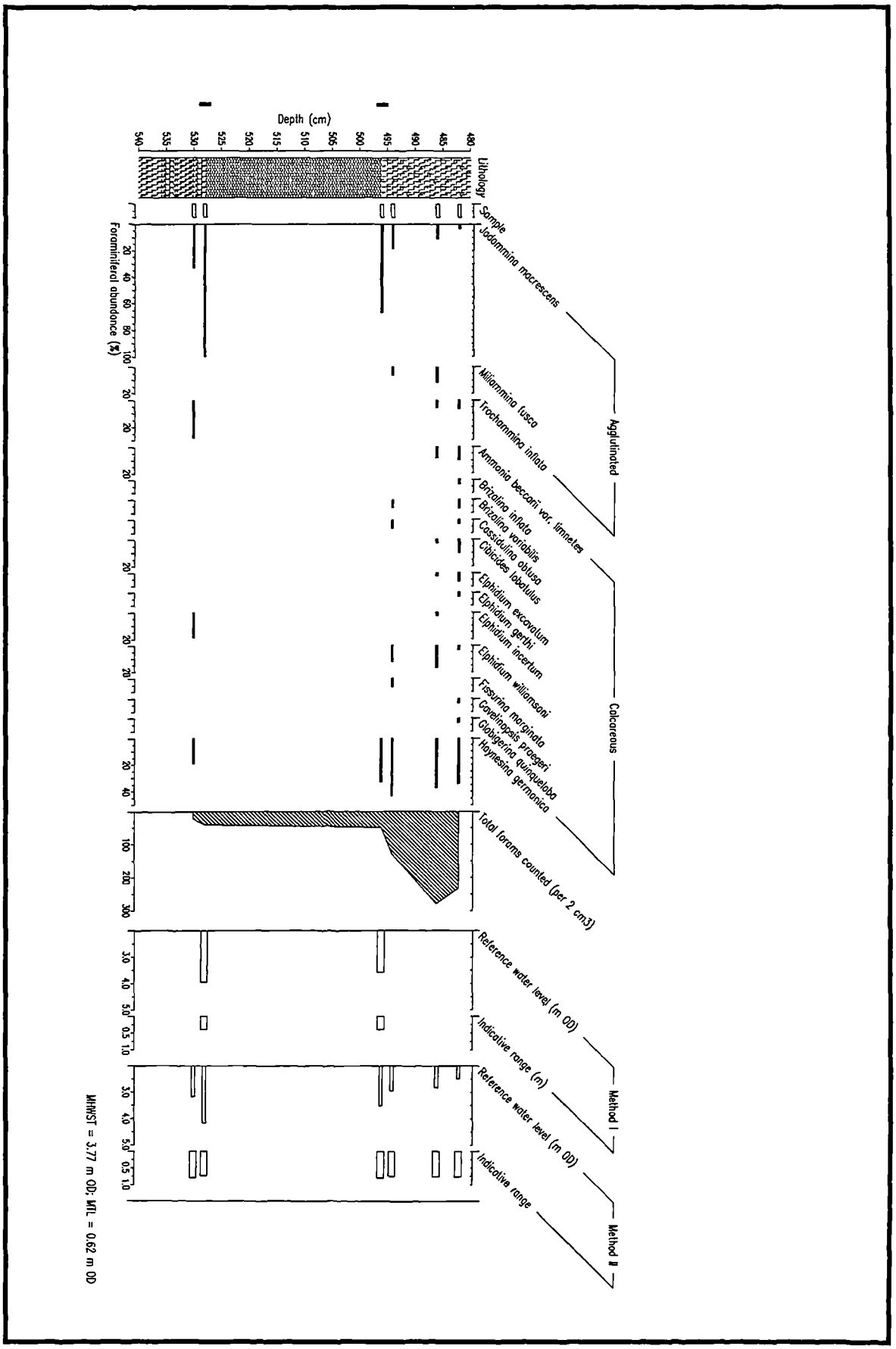
6.12 Location map of Wrangle Bank (F4), Clenchwarton (F13), South Lynn (F15) and Spalding (F19).



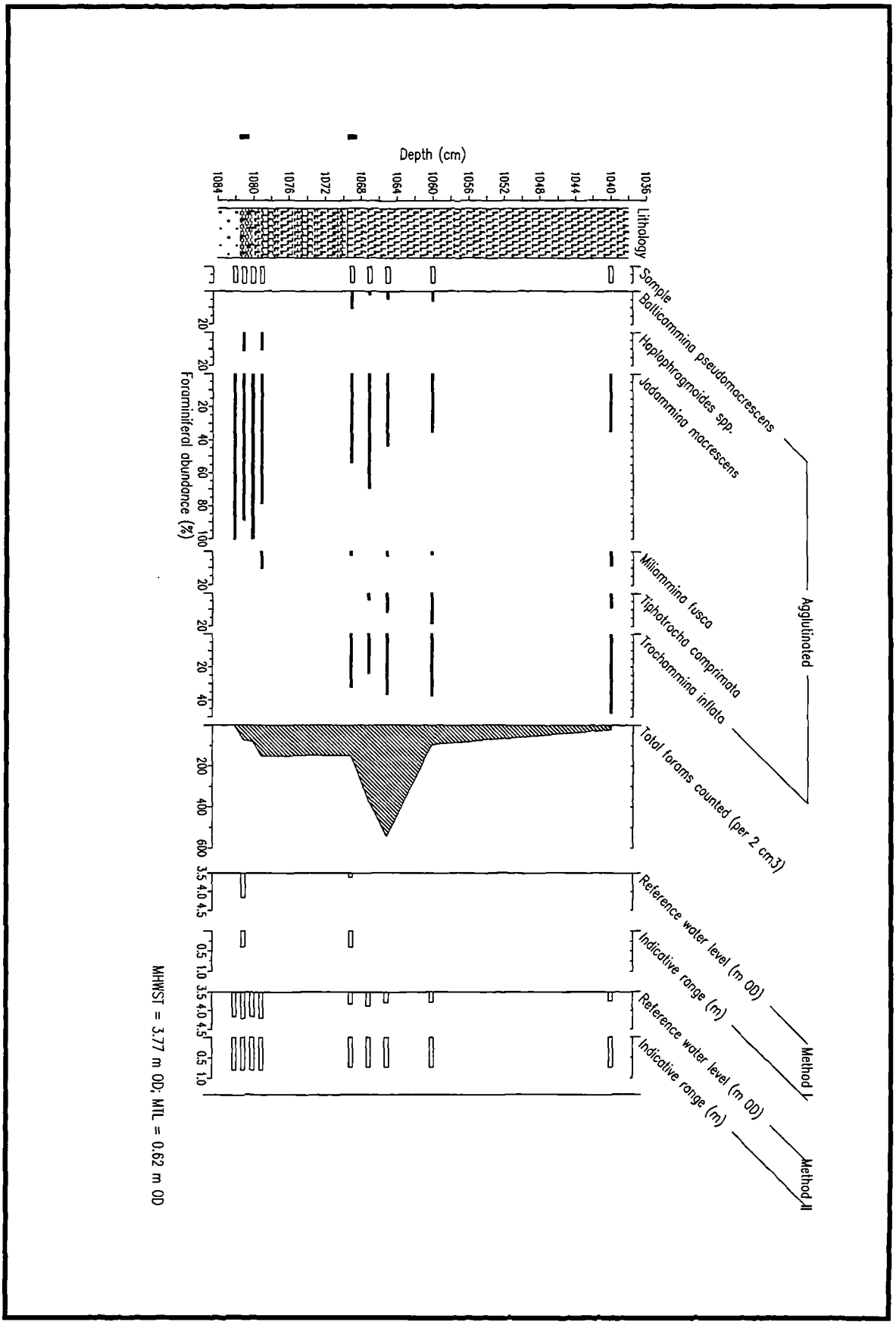
6.13 Wrangle Bank F4 foraminiferal diagram. Foraminiferal abundance is calculated as a percentage of total foraminiferal tests. Indicative meanings are estimated using both Methods I and II. The stratigraphy is drawn according to Troels-Smith (1955). The samples used as SLIs are shown.



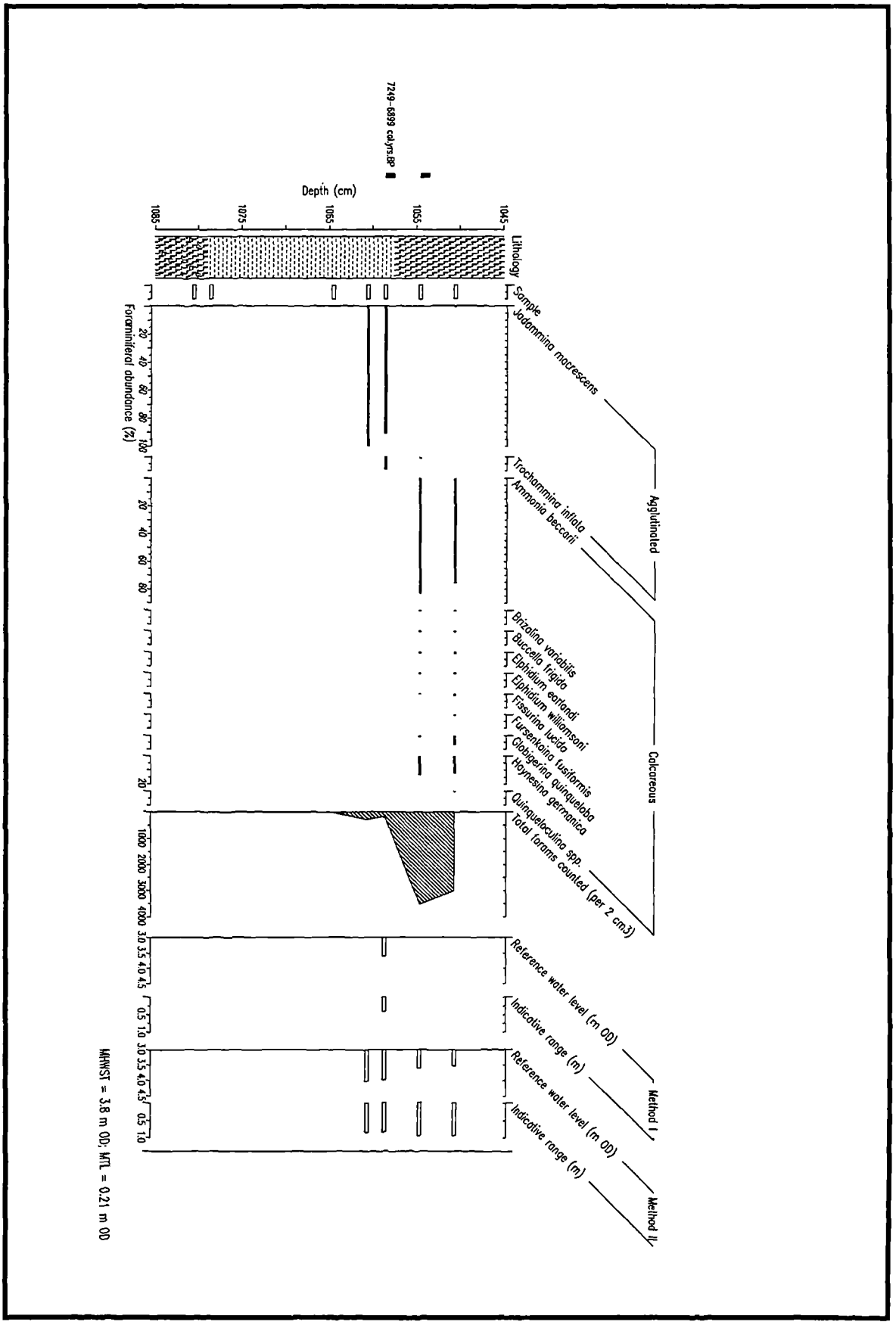
6.14 Clenchwarton F13 foraminiferal diagram. Foraminiferal abundance is calculated as a percentage of total foraminiferal tests. Indicative meanings are estimated using both Methods I and II. The stratigraphy is drawn according to Troels-Smith (1955). The radiocarbon date and the samples used as SLIs are shown.



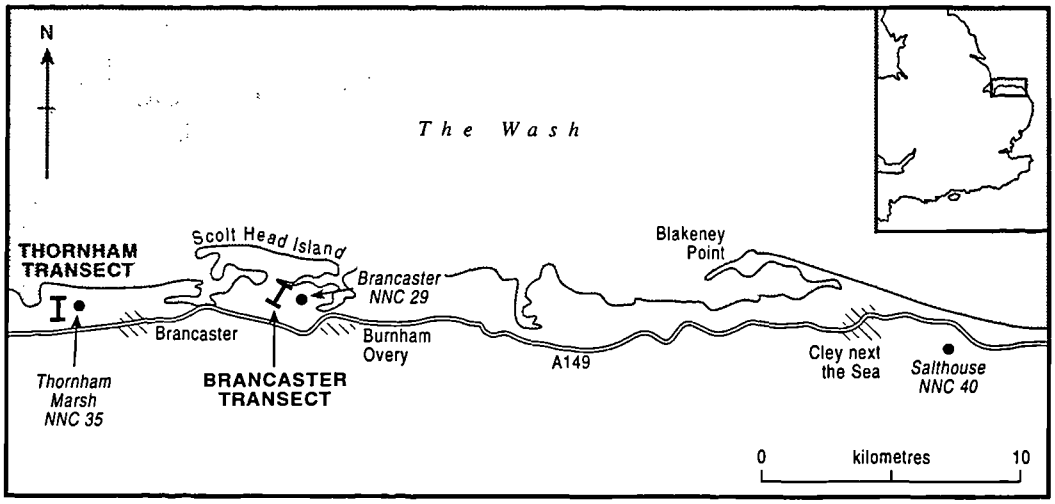
6.15 South Lynn F15a foraminiferal diagram. Foraminiferal abundance is calculated as a percentage of total foraminiferal tests. Indicative meanings are estimated using Methods I and II. The stratigraphy is drawn according to Troels-Smith (1955). The samples used as SLIs are shown.



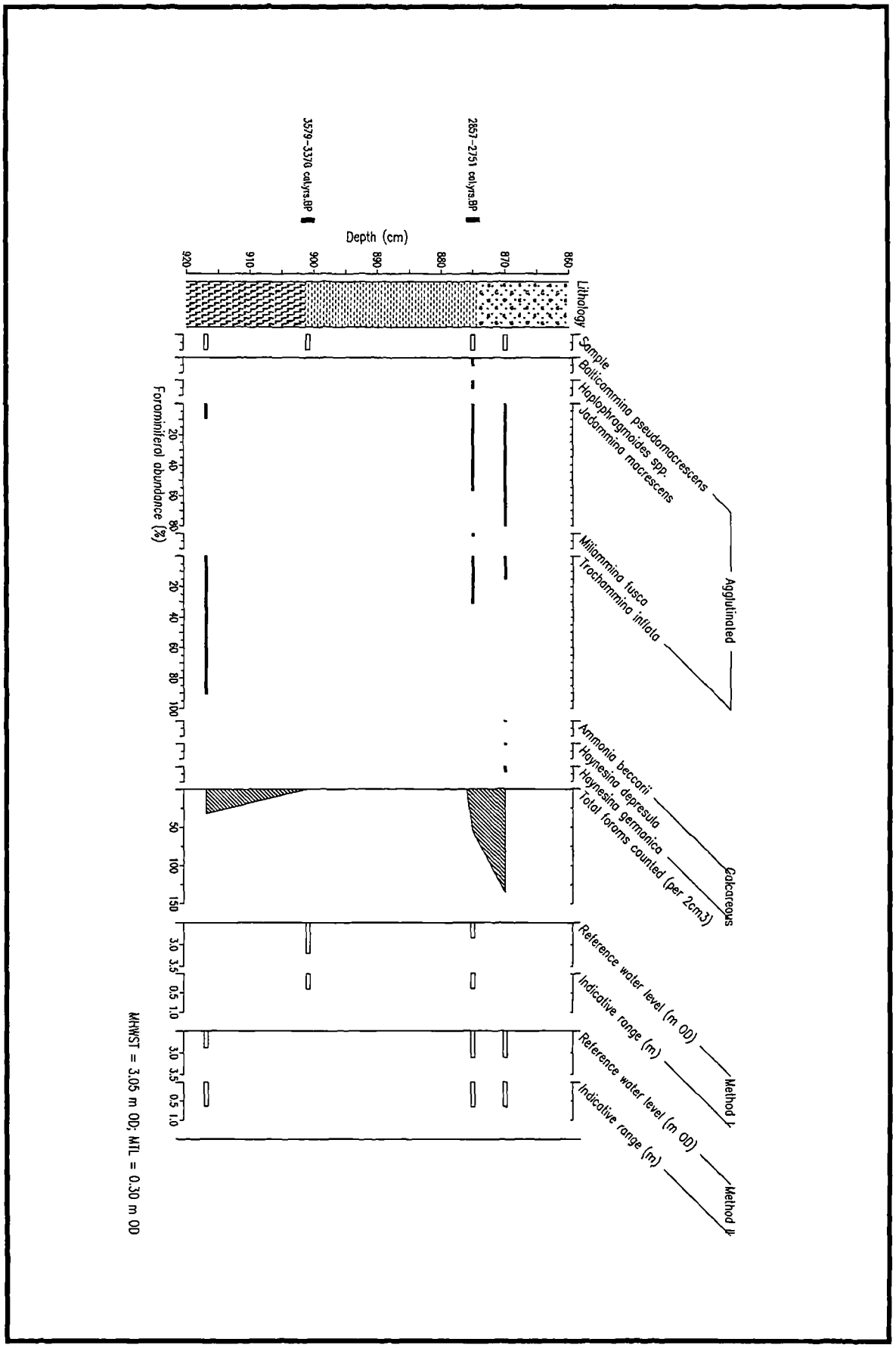
6.16 South Lynn F15b foraminiferal diagram. Foraminiferal abundance is calculated as a percentage of total foraminiferal tests. Indicative meanings are estimated using Methods I and II. The stratigraphy is drawn according to Troels-Smith (1955). The samples used as SLIs are shown.



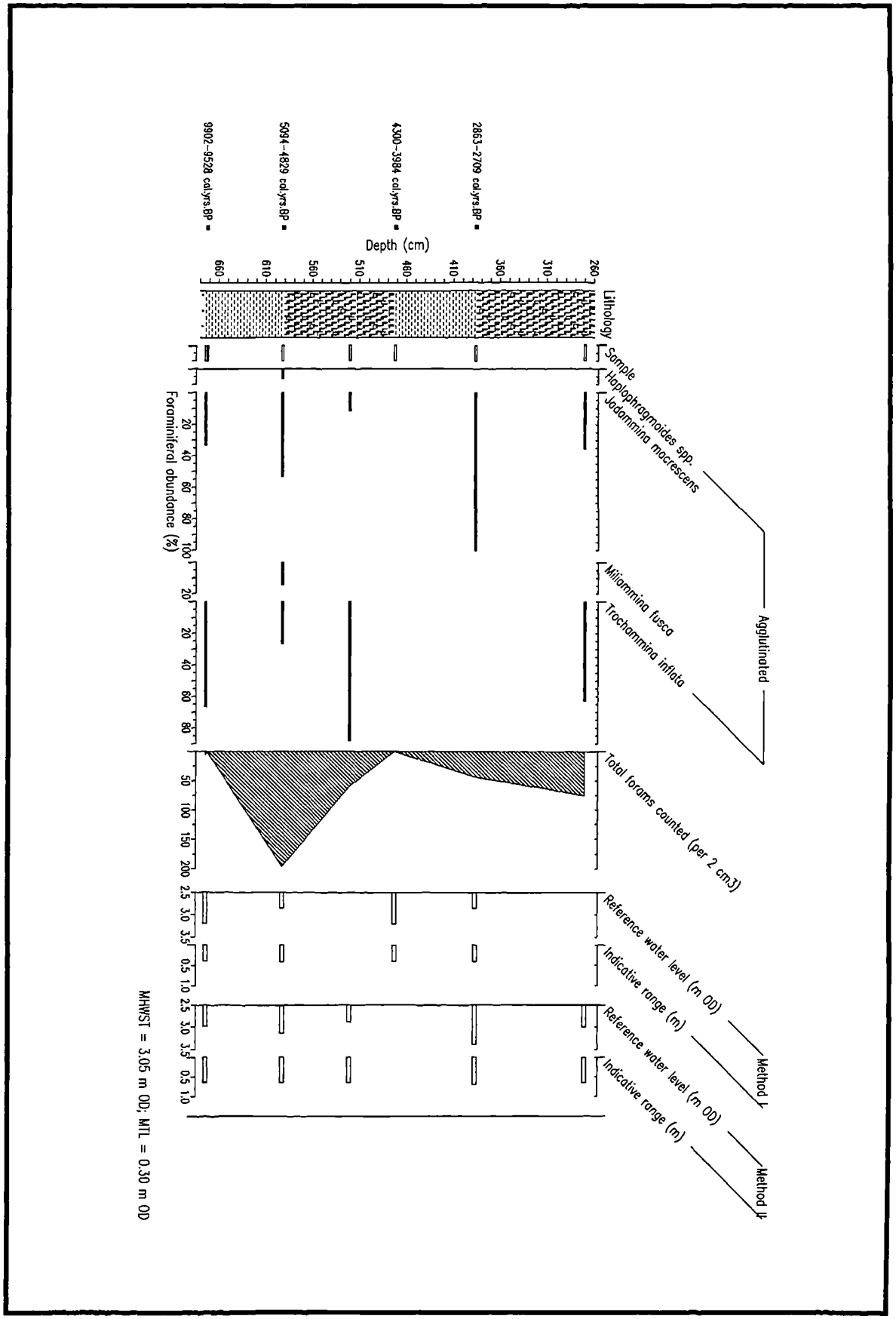
6.17 Spalding F19 foraminiferal diagram. Foraminiferal abundance is calculated as a percentage of total foraminiferal tests. Indicative meanings are estimated using Methods I and II. The stratigraphy is drawn according to Troels-Smith (1955). The radiocarbon date and samples used as SLIs are shown.



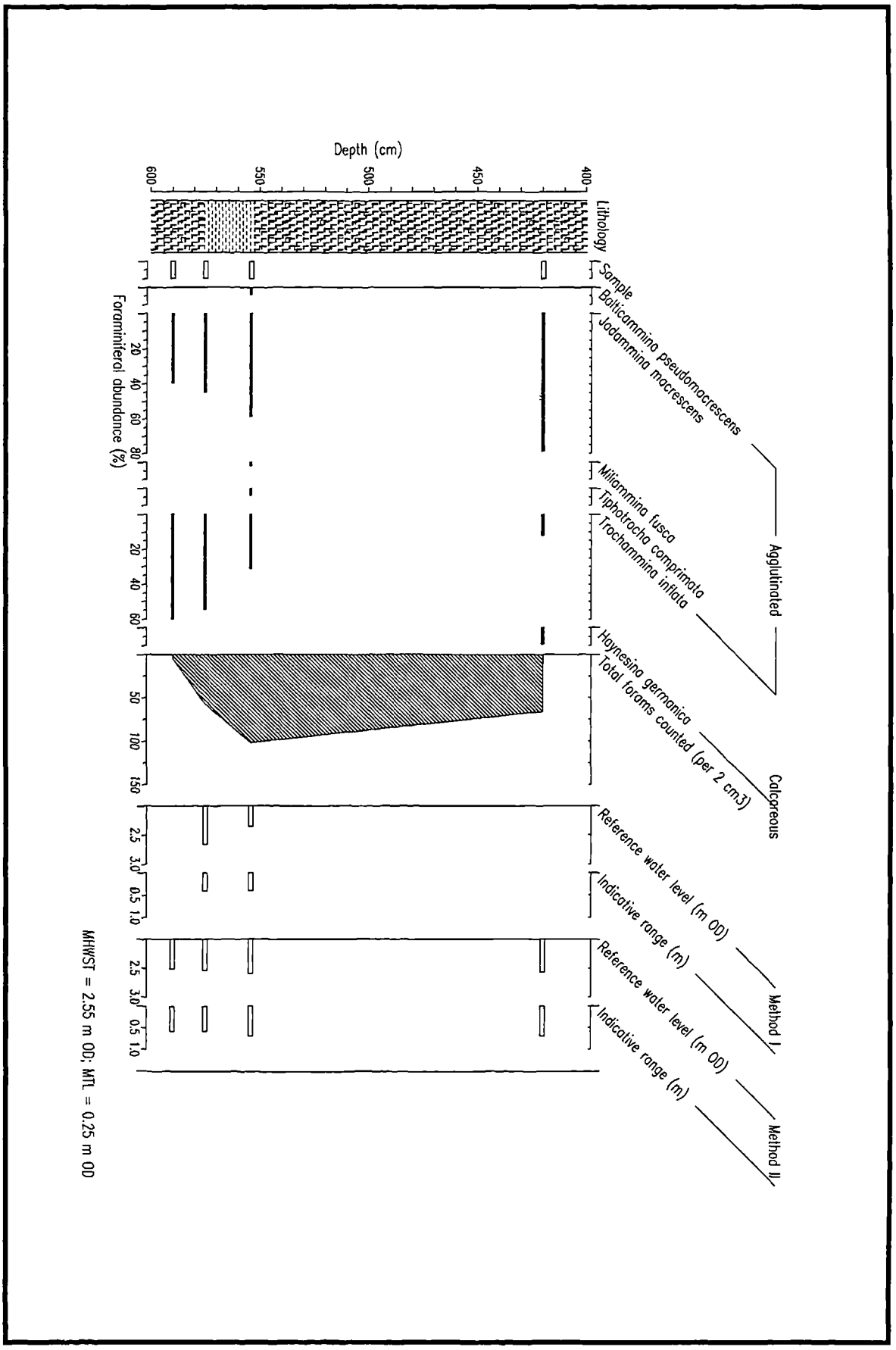
6.18 Location map of Brancaster (NNC29), Thornham Marsh (NNC35) and Salthouse (NNC40).



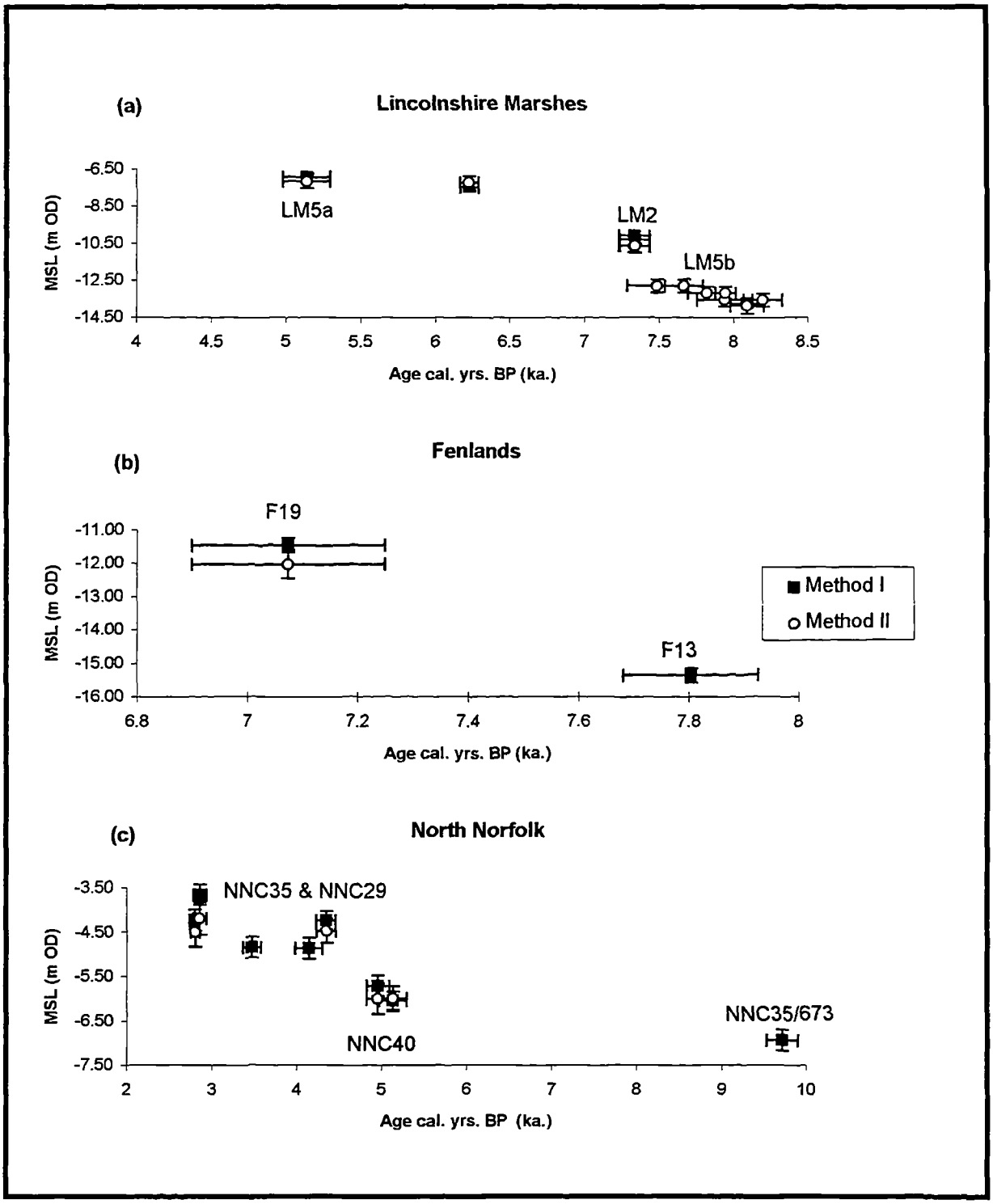
6.19 Brancaster NNC29 foraminiferal diagram. Foraminiferal abundance is calculated as a percentage of total foraminiferal tests. Indicative meanings are estimated using Methods I and II. The stratigraphy is drawn according to Troels-Smith (1955). The radiocarbon dates of SLIs are shown.



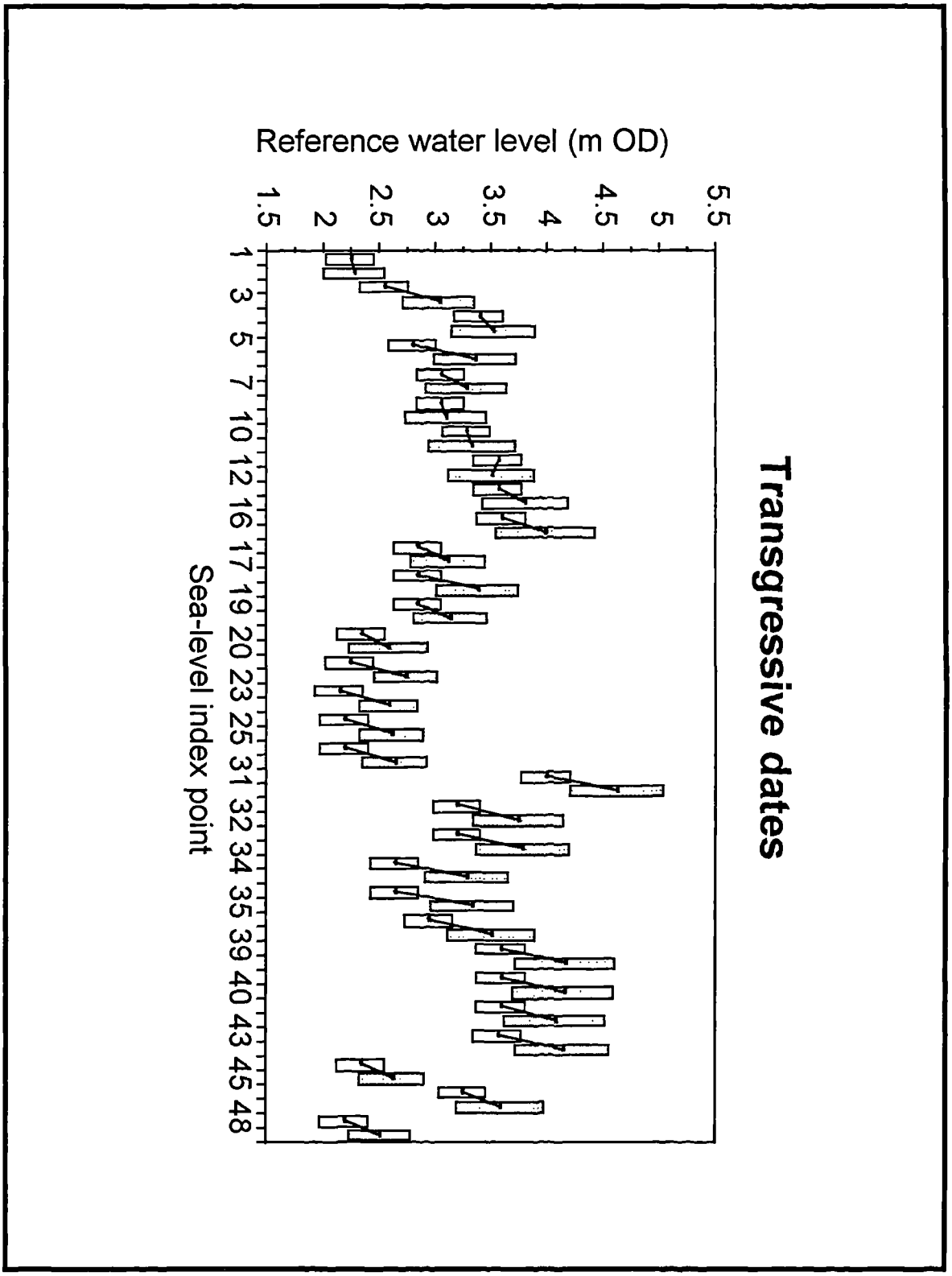
6.20 Thornham Marsh NNC35 foraminiferal diagram. Foraminiferal abundance is calculated as a percentage of total foraminiferal tests. Indicative meanings are estimated using Methods I and II. The stratigraphy is drawn according to Troels-Smith (1955). The radiocarbon dates of SLIs are shown.



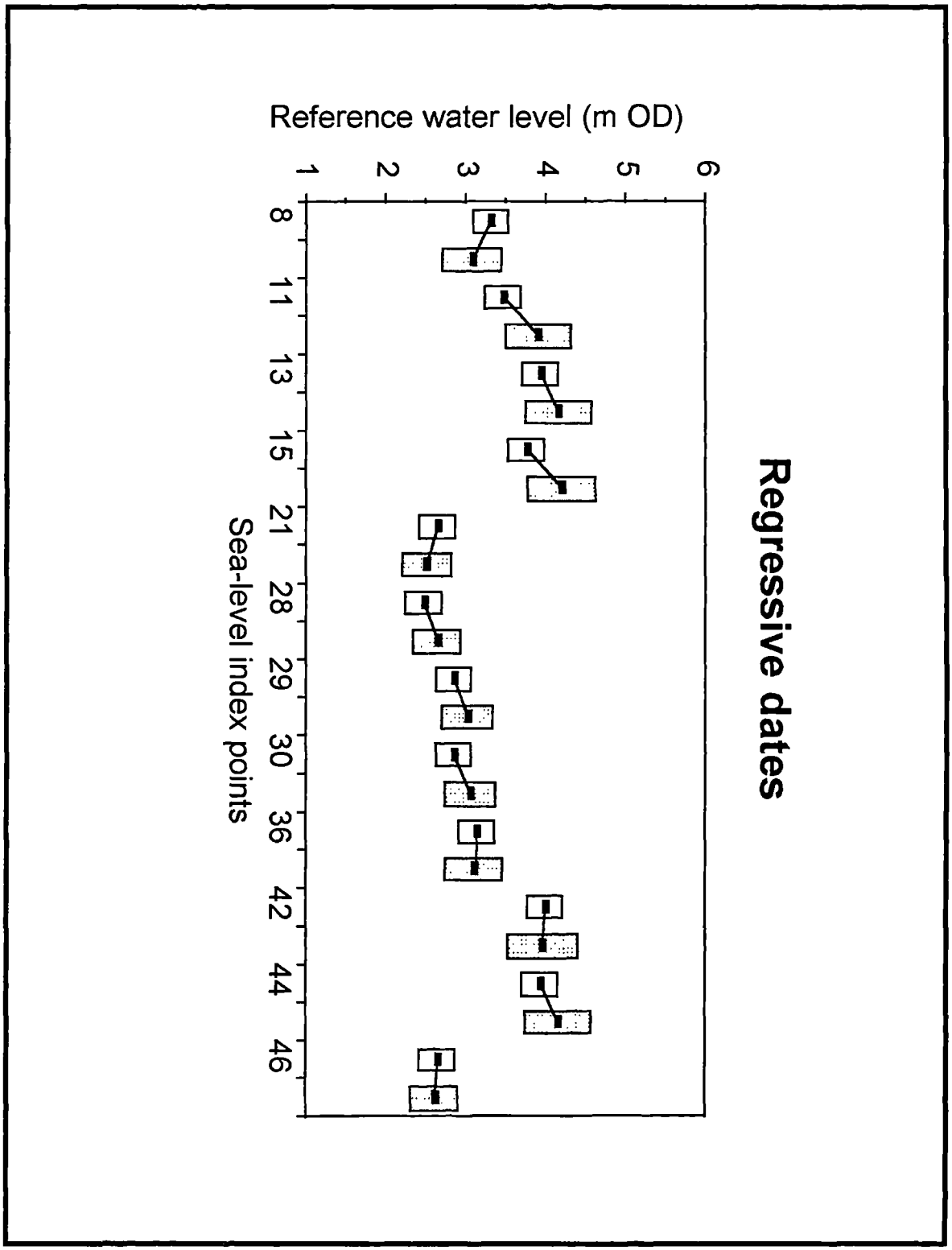
6.21 Salthouse NNC40 foraminiferal diagram. Foraminiferal abundance is calculated as a percentage of total foraminiferal tests. Indicative meanings are estimated using Methods I and II. The stratigraphy is drawn according to Troels-Smith (1955). The radiocarbon dates of SLIs are shown.



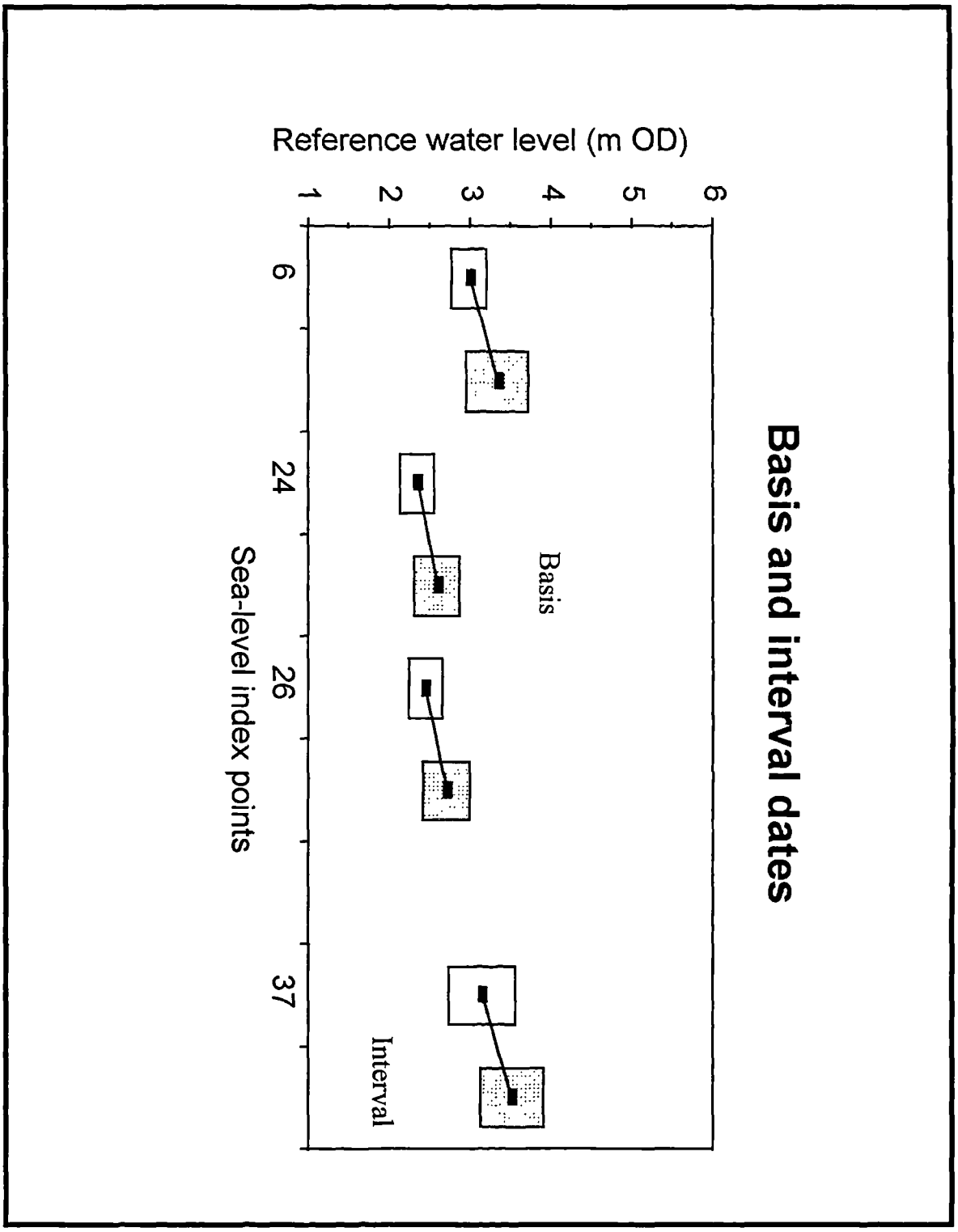
6.22 An age-altitude graph of sea-level index points (SLI) of (a) Lincolnshire Marshes, (b) Fenland and (c) North Norfolk. The altitude of each SLI has been corrected to OD. Error limits are calculated from the calibrated radiocarbon dates (2σ) and estimates for reference water levels and measurement of altitude.



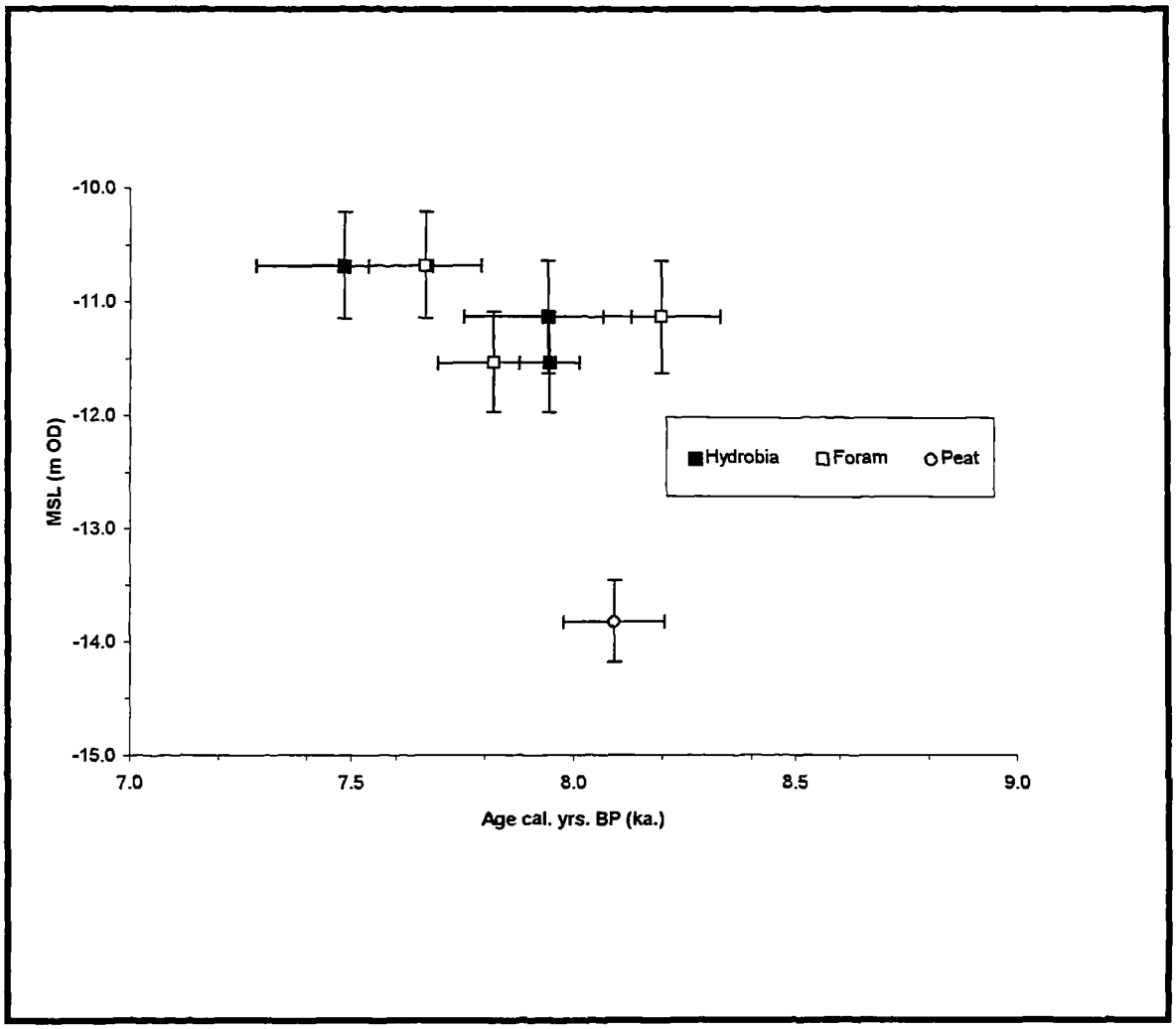
6.23 The indicative meanings of transgressive dates using Method I (clear) and Method II (shaded). Their reference water levels and indicative ranges are shown. See Table 6.9 and 6.10 for SLI numbers.



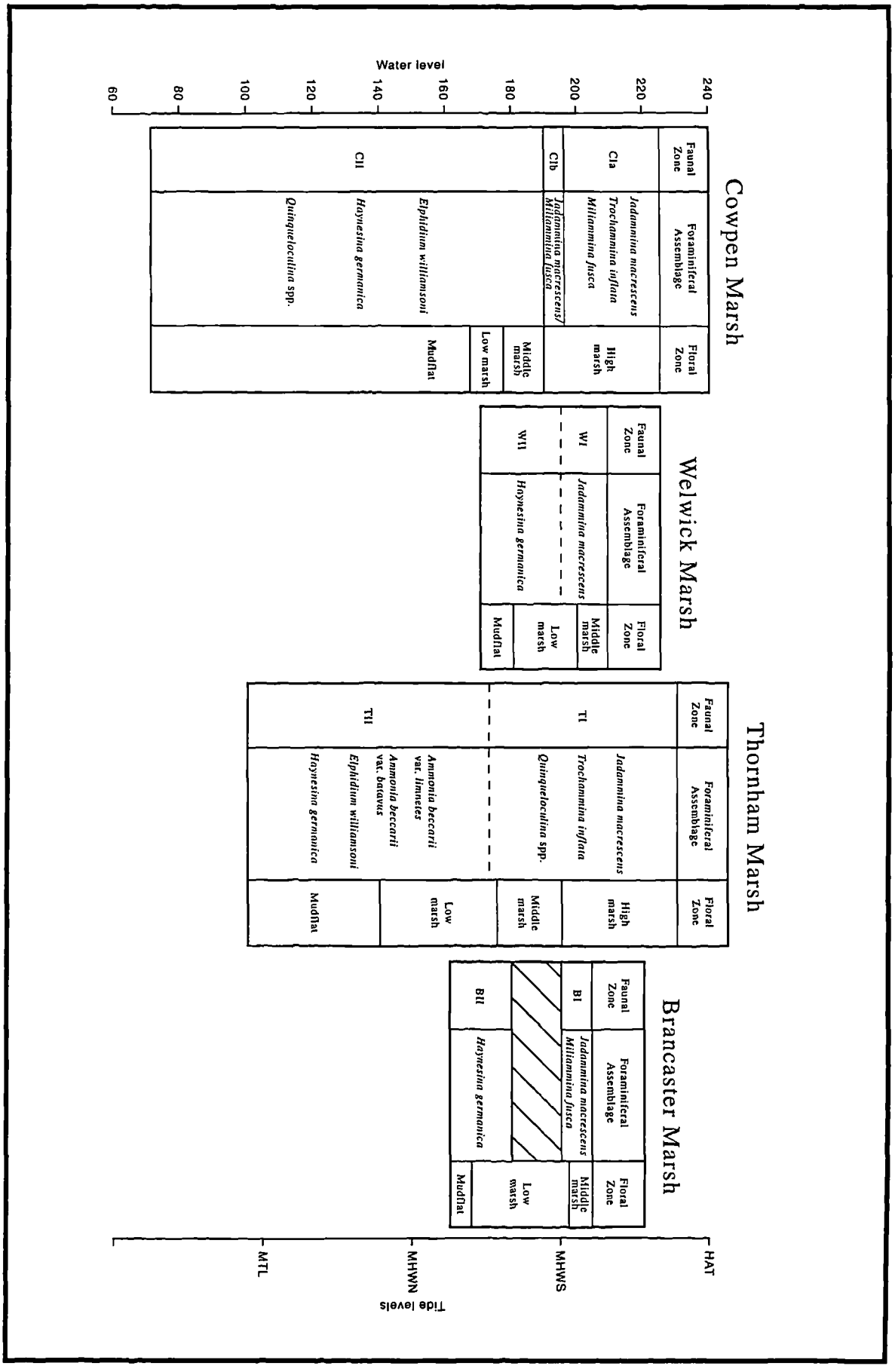
6.24 The indicative meanings of regressive dates using Method I (clear) and Method II (shaded). Their reference water levels and indicative ranges are shown. See Tables 6.9 and 6.10 for SLI numbers.



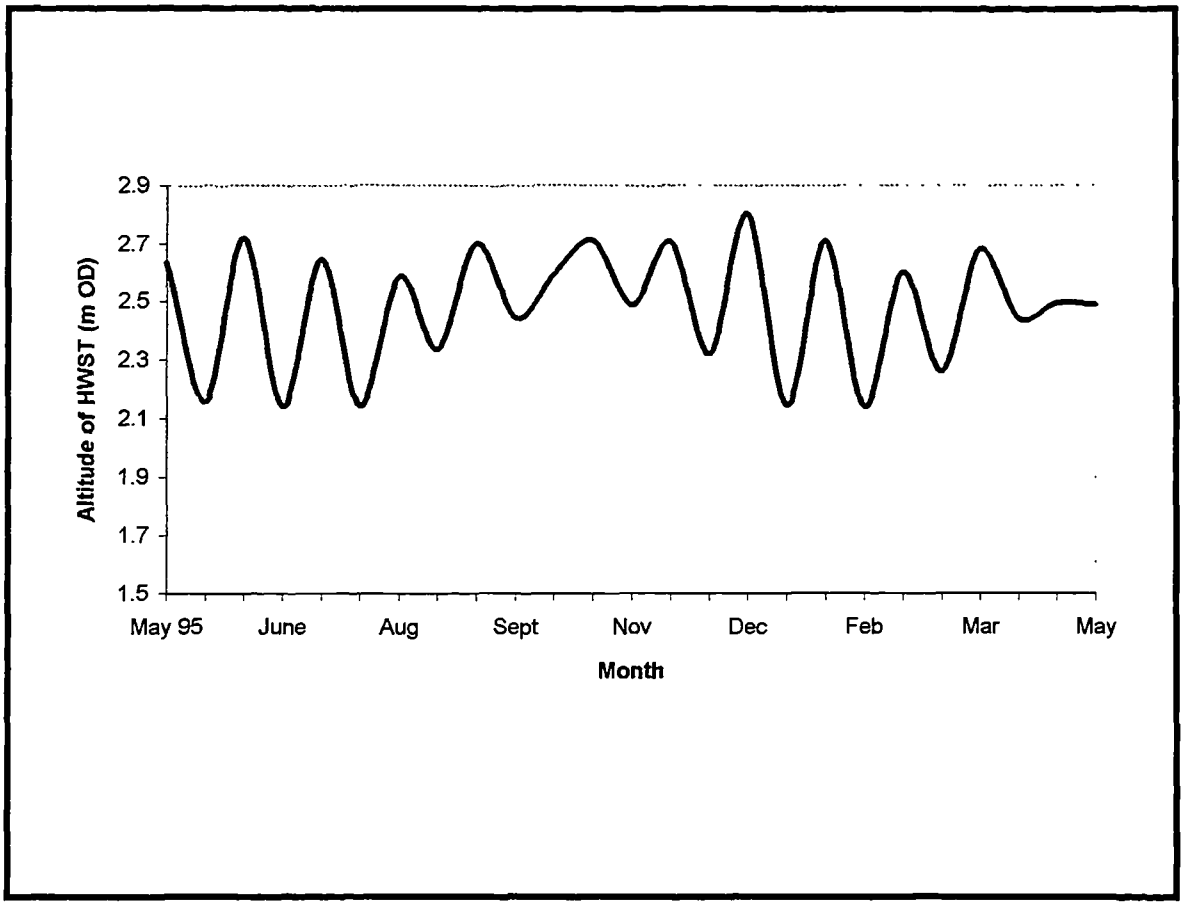
6.25 The indicative meanings of basis and interval dates using Method I (clear) and Method II (shaded). Their reference water levels and indicative ranges are shown. See Tables 6.9 and 6.10 for SLI numbers.



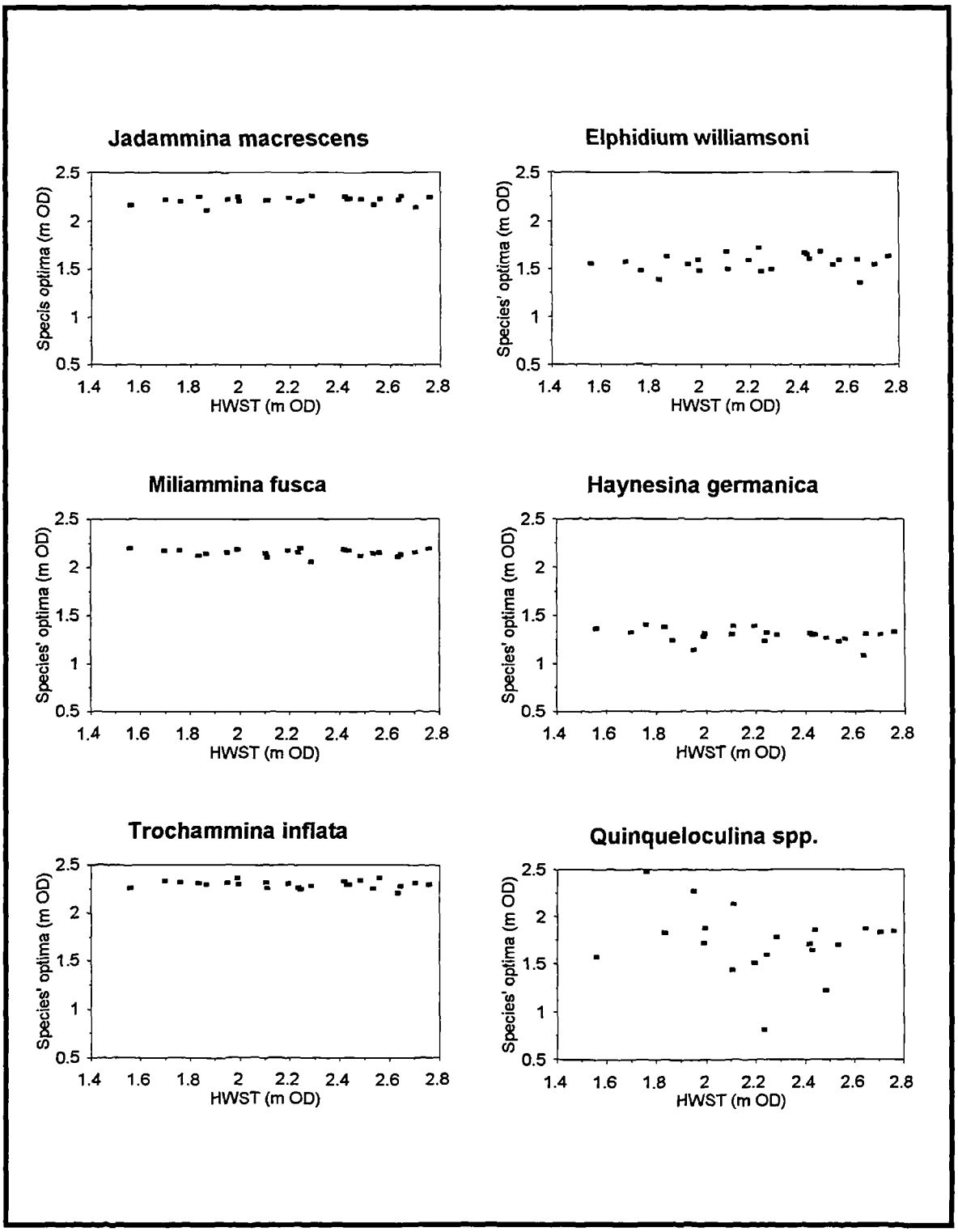
6.26 An age-altitude graph of AMS dated *Hydrobia ulvae*, calcareous foraminifera and peat from Theddlethorpe LM5b. The altitude of each sea-level index point has been corrected to mean sea-level. Error limits are calculated from the calibrated radiocarbon dates (2σ) and estimates for reference water levels and measurement of altitude. 128



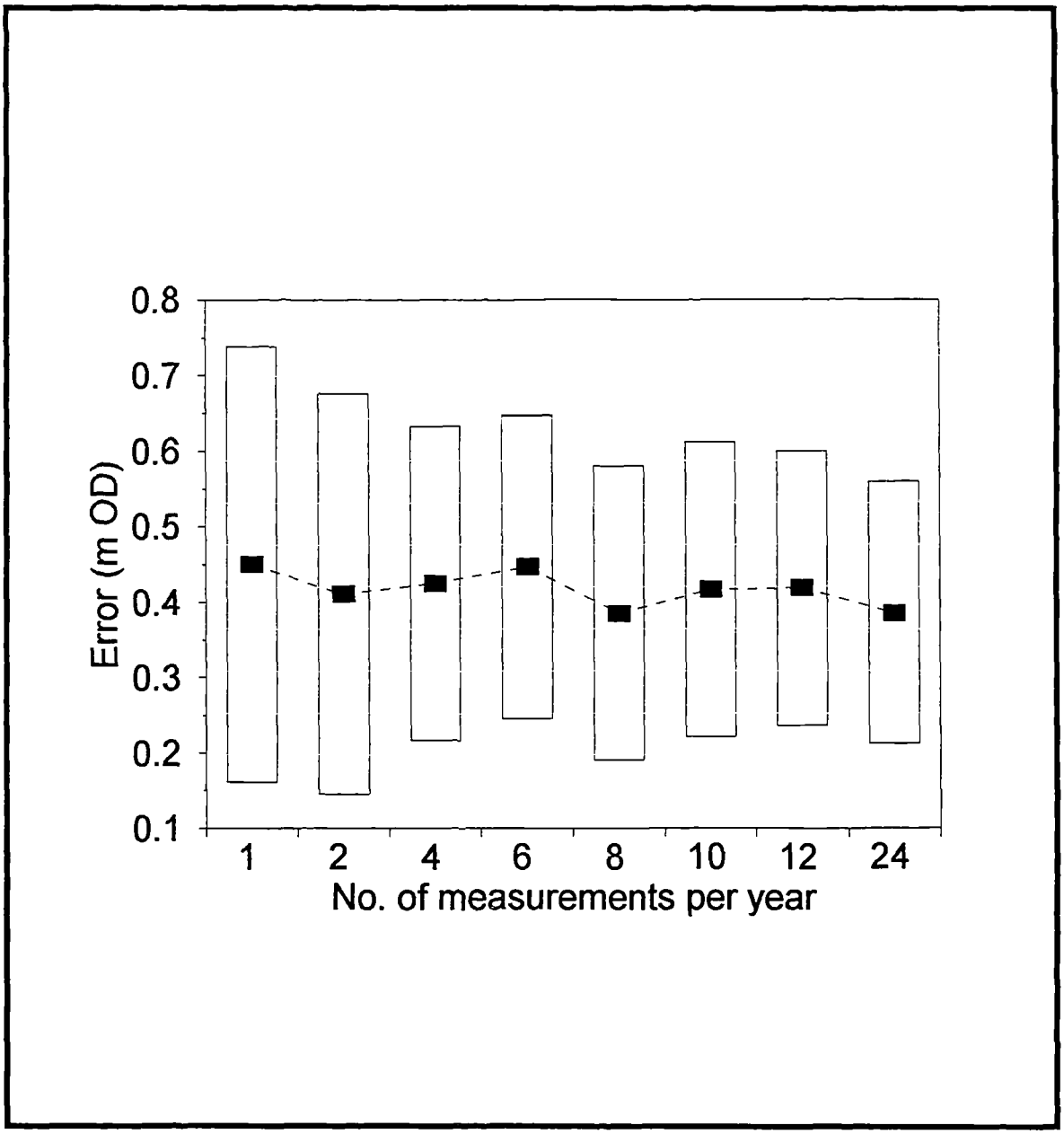
7.1 Summary of faunal zones, foraminiferal assemblages and floral zones for Cowpen, Welwick, Thornham and Brancaster Marsh. Dashed lines equal transitional boundaries. Shaded area equals an absence of data.



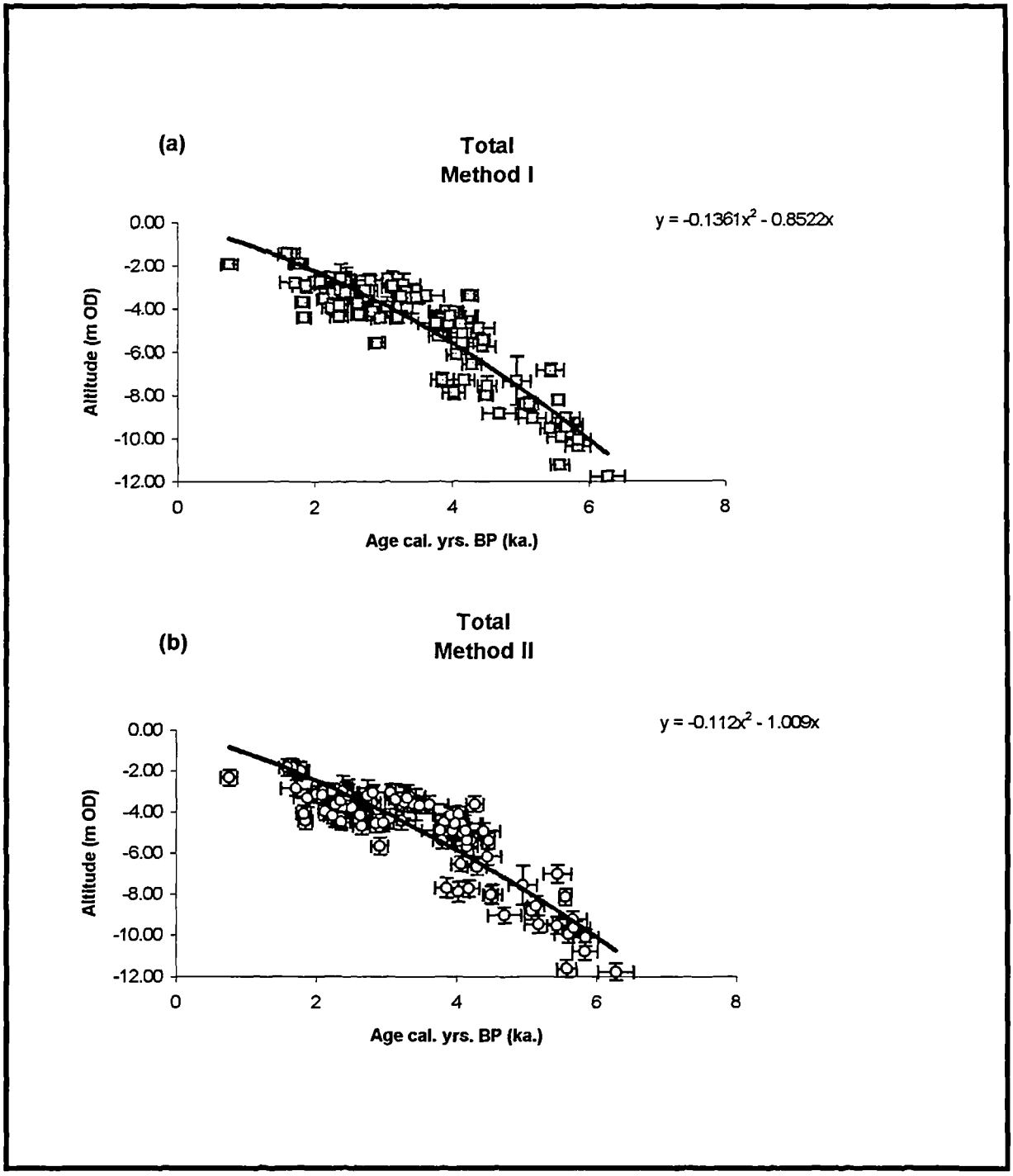
7.2 Variations in the altitude of High Water Spring Tide (HWST) of the River Tees between May 1995 to May 1996 (Source: Tees and Hartlepool Port Authority, 1995, 1996).



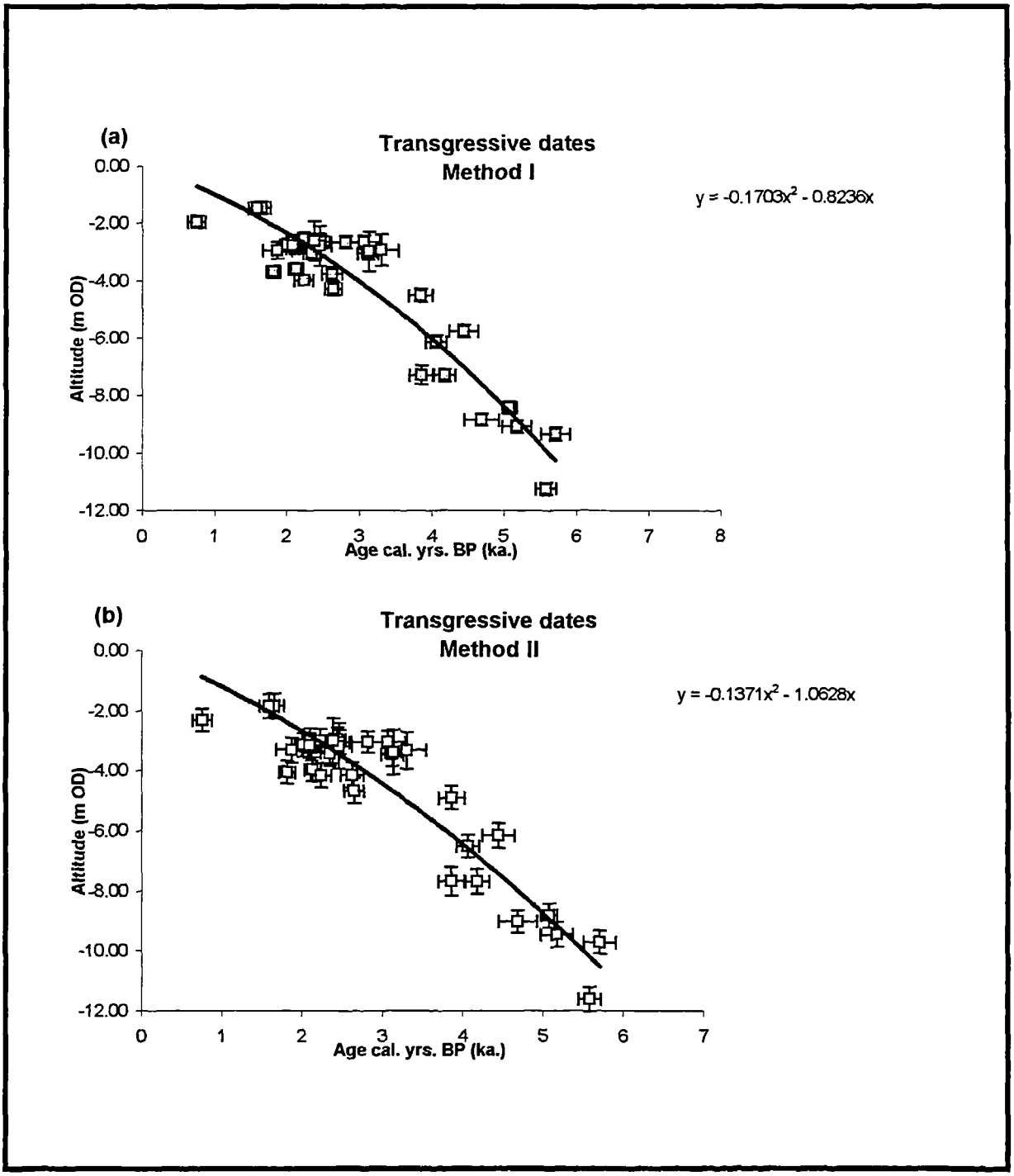
7.3 Scatter plots of the altitude of High Water Spring Tide (HWST) at the time of sampling versus the optima of six foraminiferal species from Cowpen Marsh.



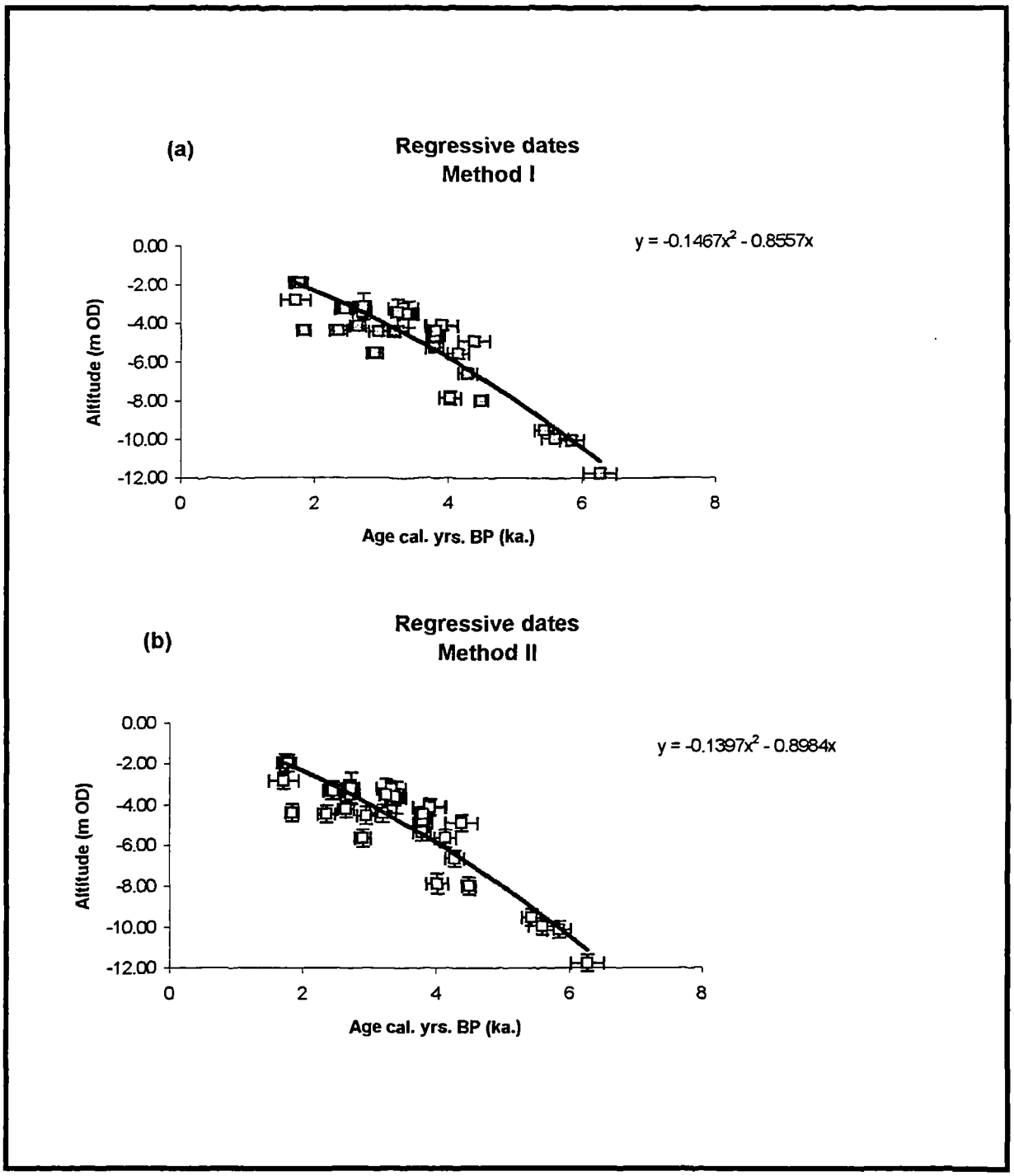
7.4 Bar chart showing the relationship between altitudinal errors (mean and standard deviation) for the Cowpen Marsh transect (observed versus foraminiferal-predicted) and the number of measurements per year. Altitudes are calculated using Method II.



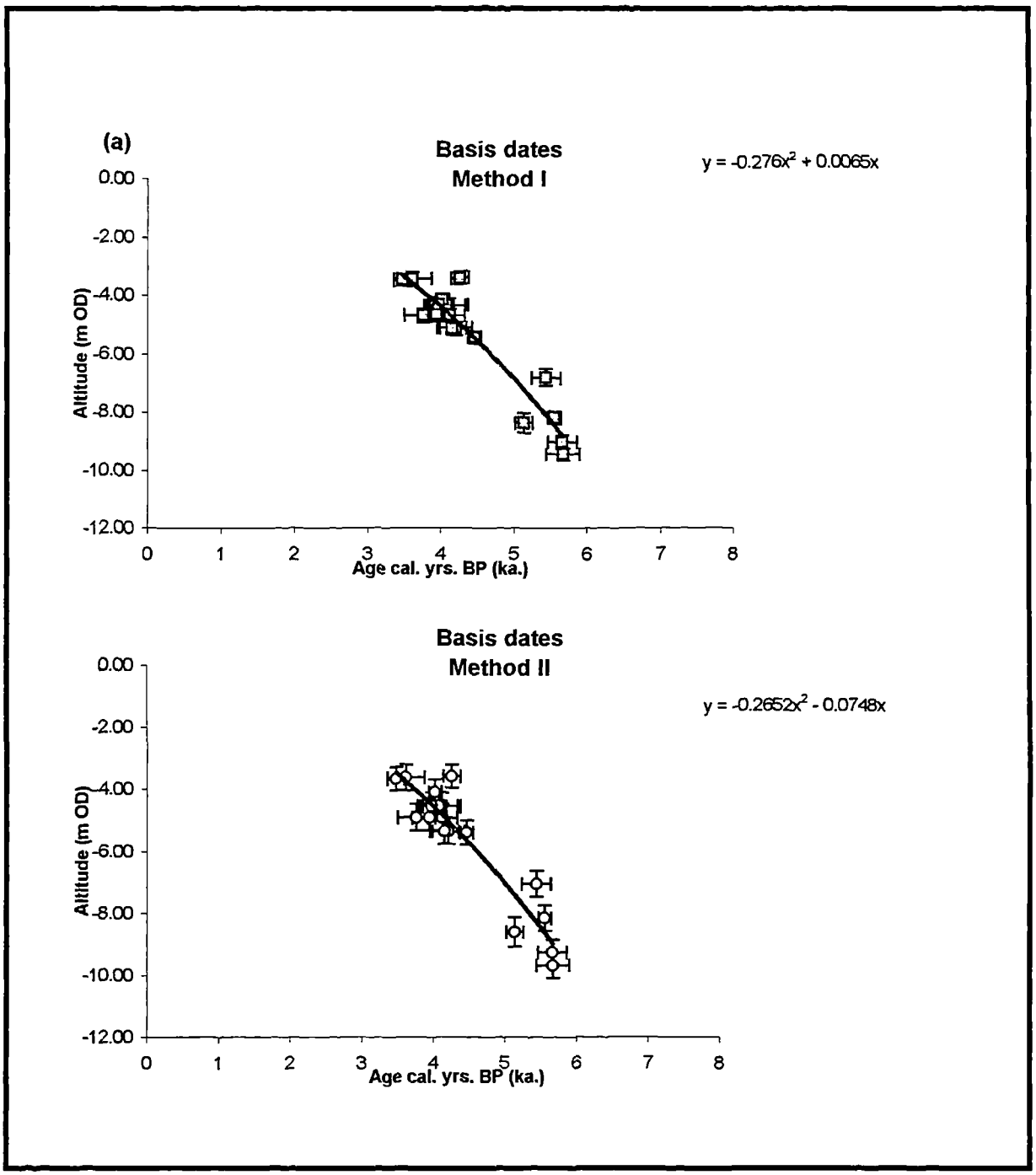
7.5 An age-altitude graph of sea-level index points (SLI) of the Fenland using (a) Methods I and (b) II. The altitude of each SLI has been corrected to OD. Error limits are calculated from the calibrated radiocarbon dates (2σ) and estimates for reference water levels and measurement of altitude. 133



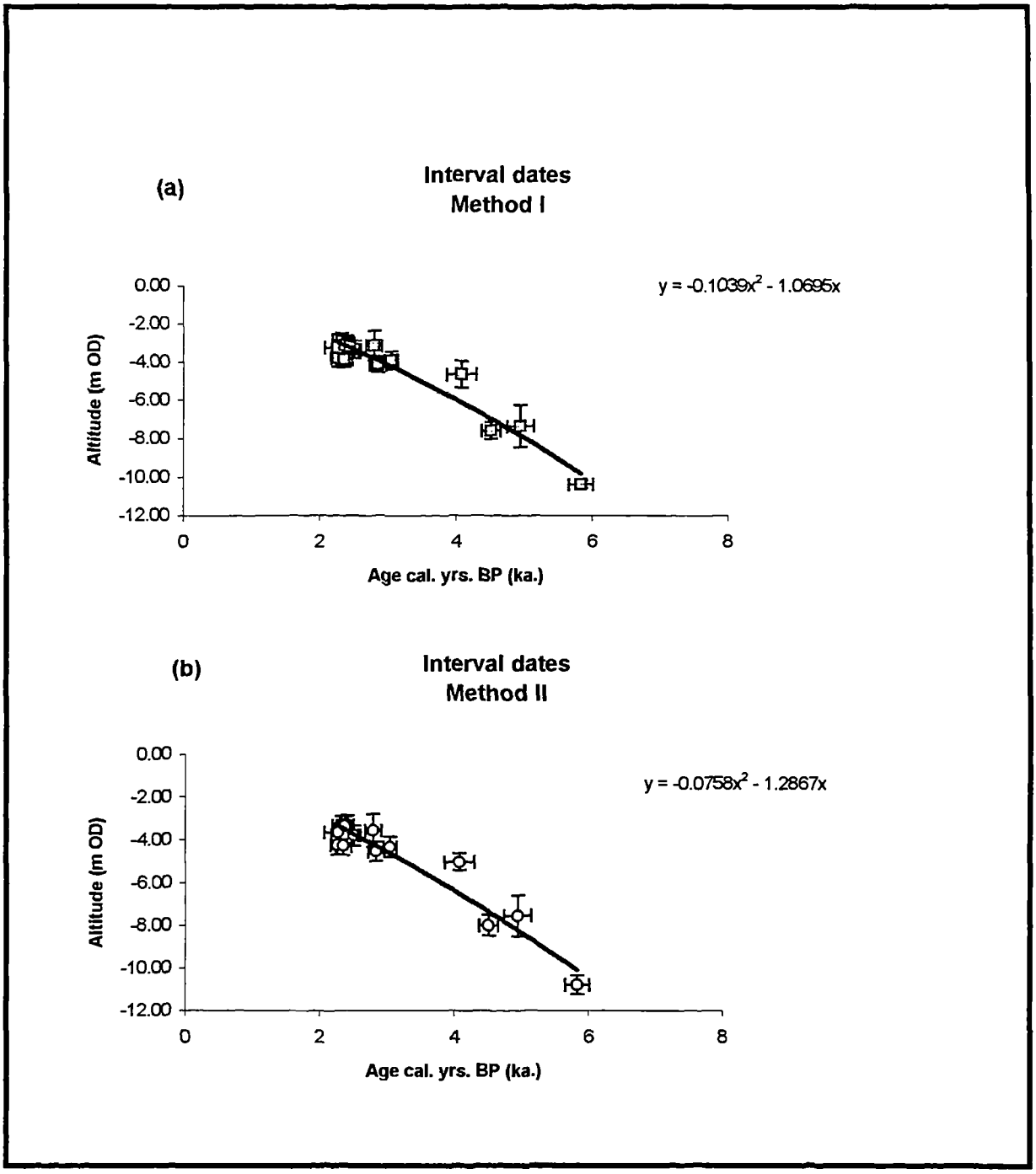
7.6 An age-altitude graph of transgressive sea-level index points (SLI) of the Fenland using (a) Methods I and (b) II. The altitude of each SLI has been corrected to OD. Error limits are calculated from the calibrated radiocarbon dates (2σ) and estimates for reference water levels and measurement of altitude. 134



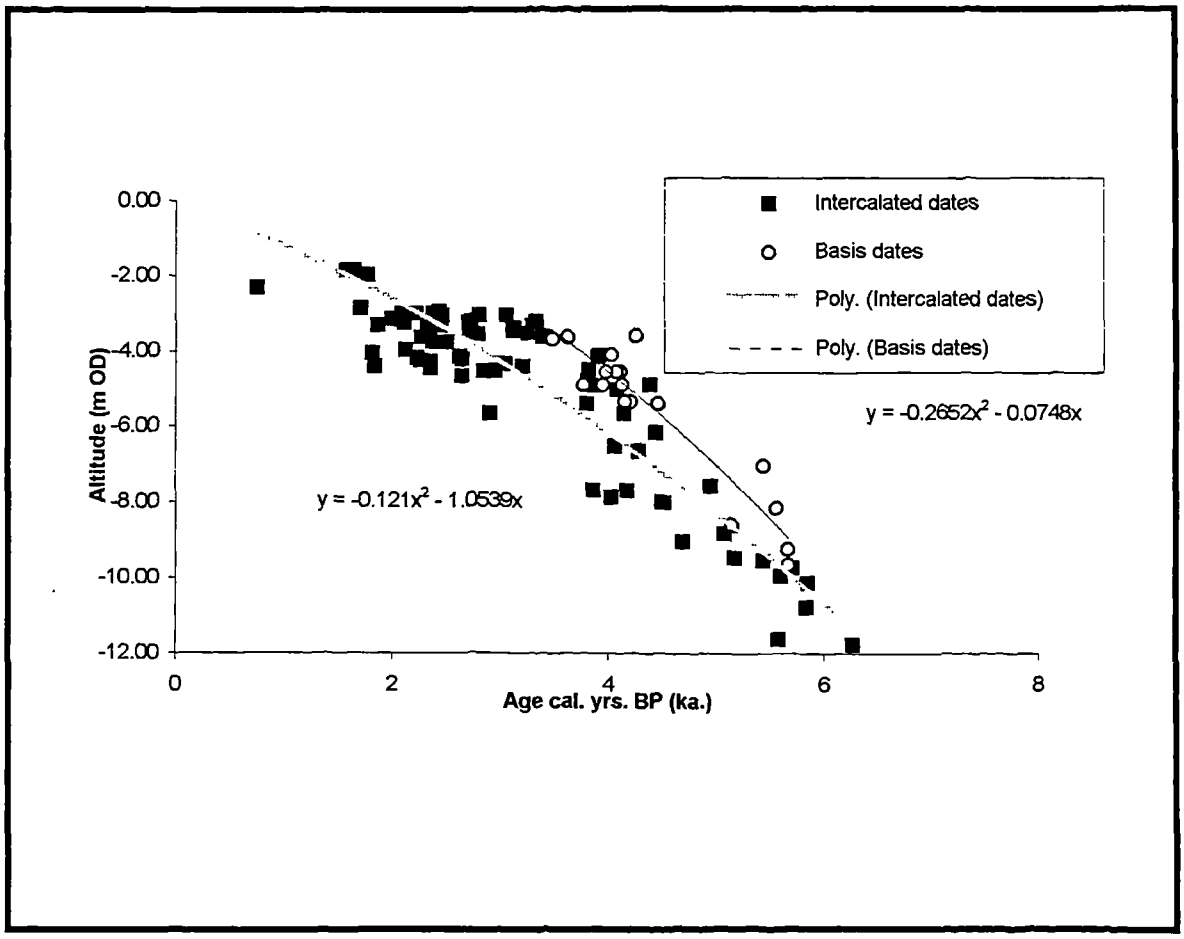
7.7 An age-altitude graph of regressive sea-level index points (SLI) of the Fenland using (a) Methods I and (b) II. The altitude of each SLI has been corrected to OD. Error limits are calculated from the calibrated radiocarbon dates (2σ) and estimates for reference water levels and measurement of altitude.



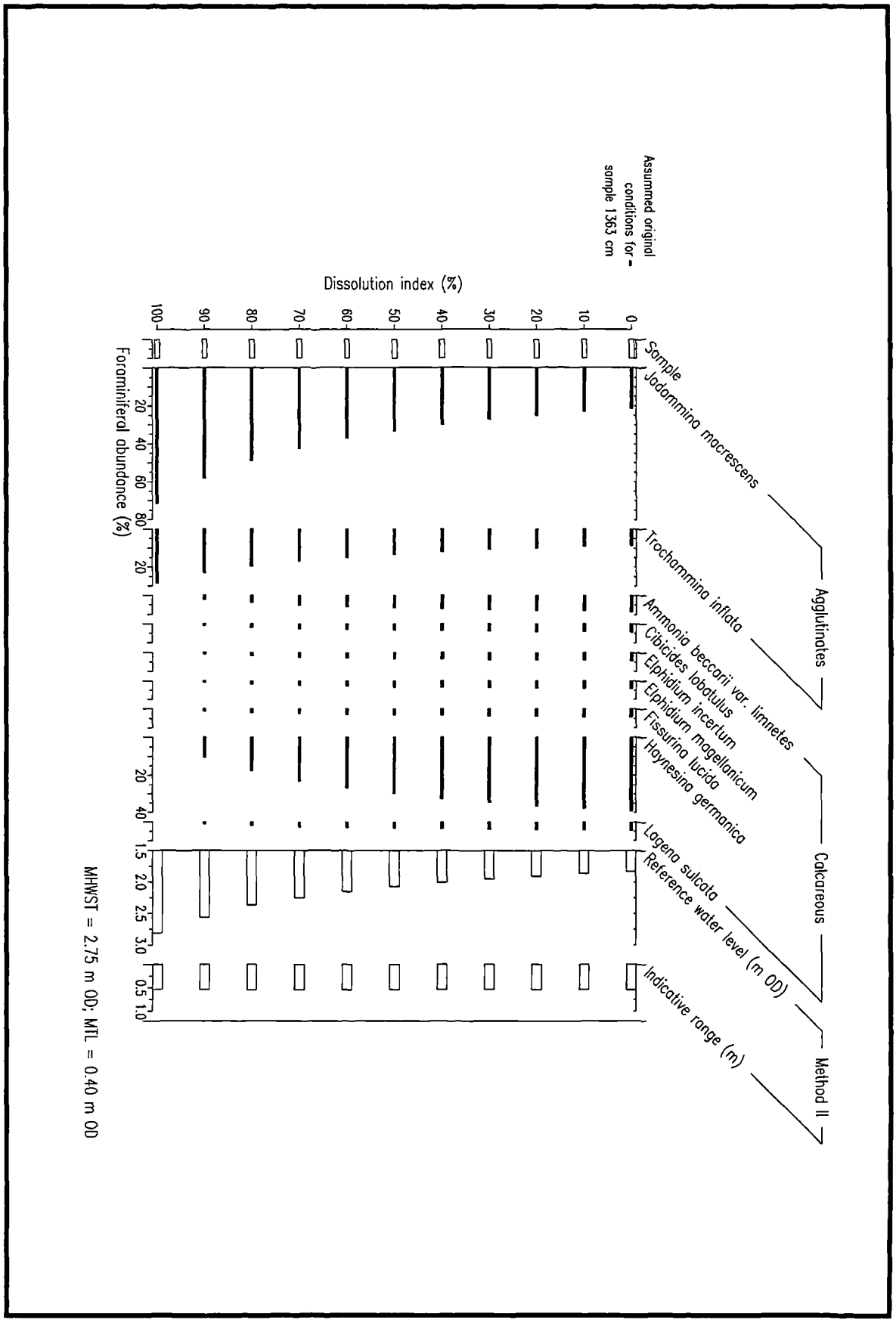
7.8 An age-altitude graph of basis sea-level index points (SLI) of the Fenland using (a) Methods I and (b) II. The altitude of each SLI has been corrected to OD. Error limits are calculated from the calibrated radiocarbon dates (2σ) and estimates for reference water levels and measurement of altitude.



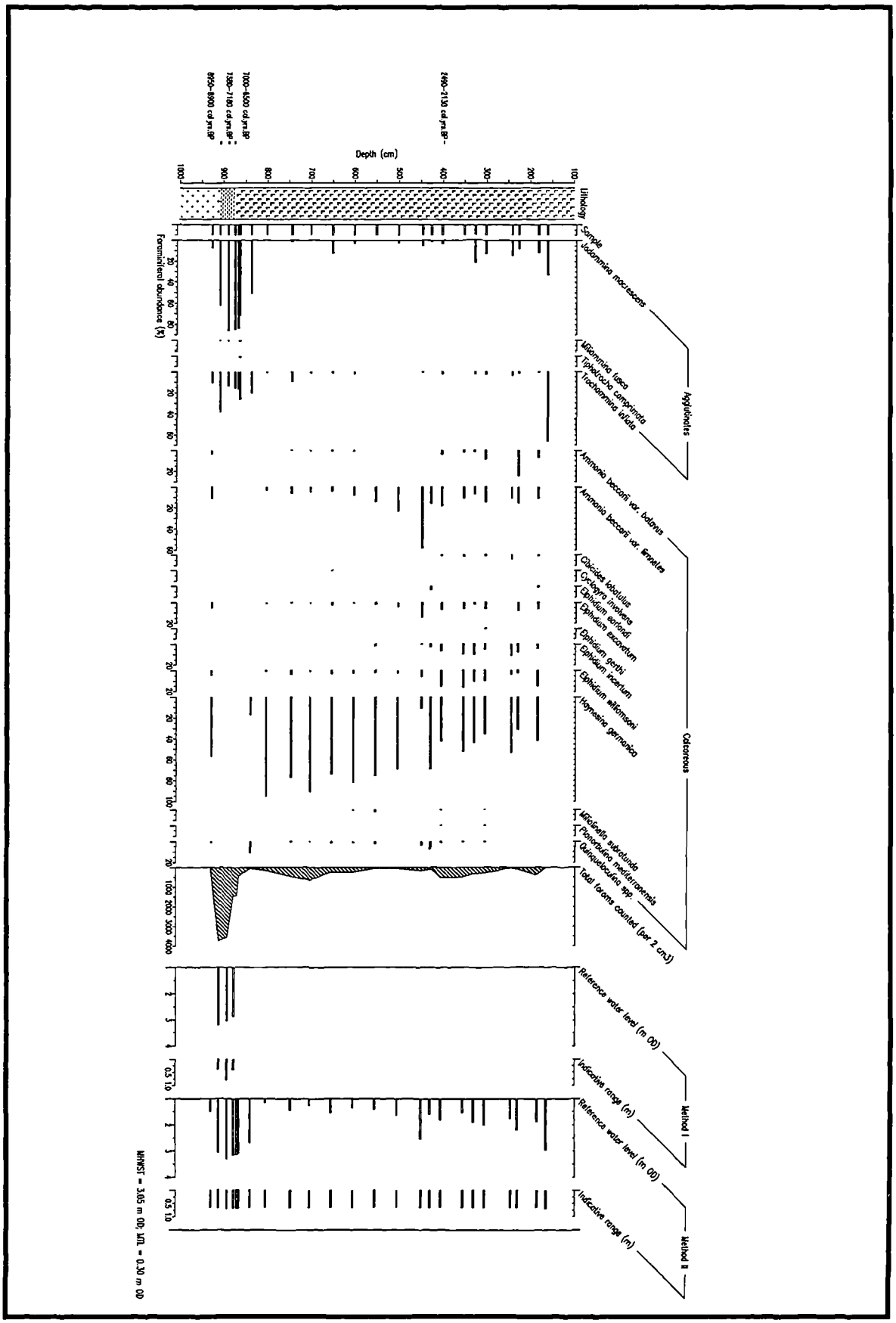
7.9 An age-altitude graph of interval sea-level index points (SLI) of the Fenland using (a) Methods I and (b) II. The altitude of each SLI has been corrected to OD. Error limits are calculated from the calibrated radiocarbon dates (2σ) and estimates for reference water levels and measurement of altitude. 137



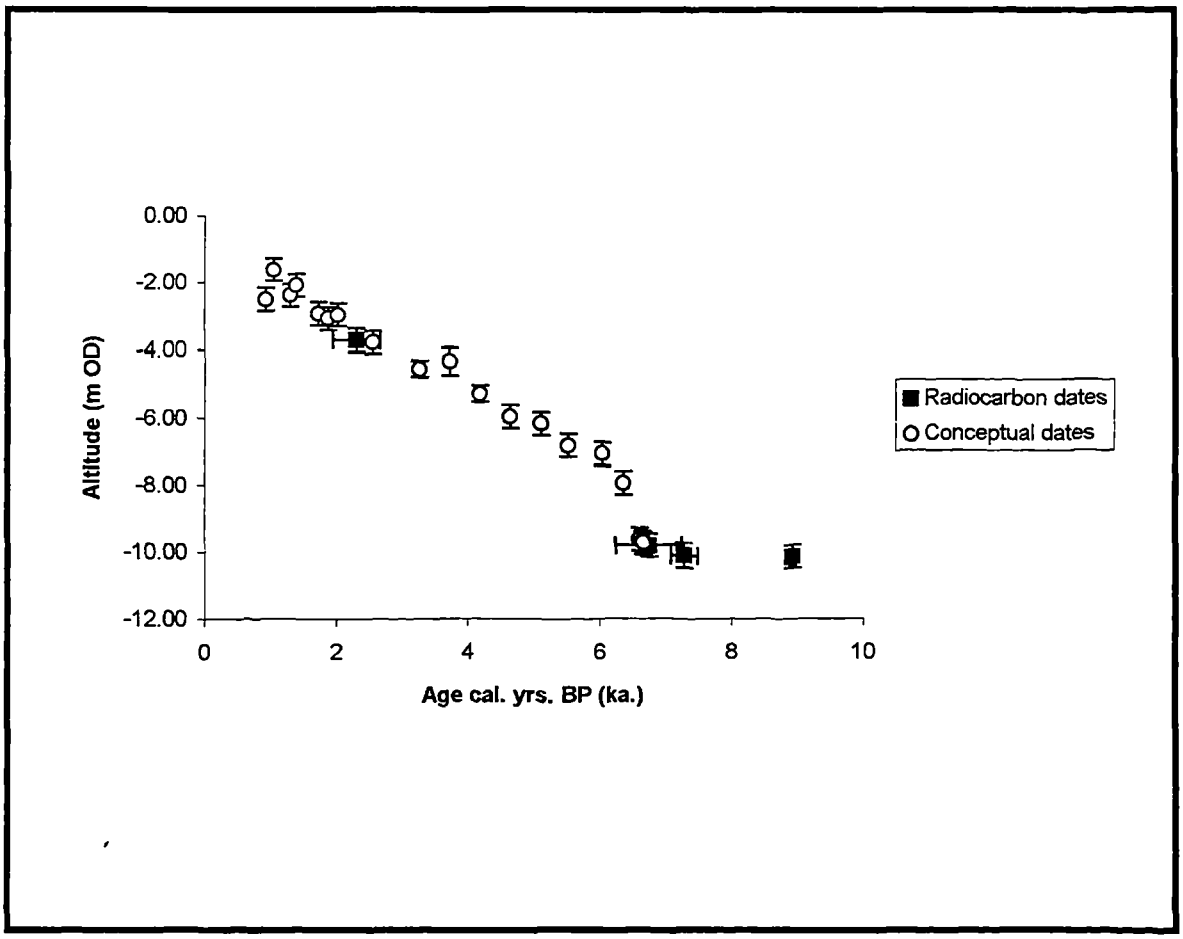
7.10 An age-altitude graph comparing transgressive, regressive and interval dates with basis dates to illustrate the effect of sediment compaction. Sea-level index points (SLI) of the Fenland are estimated using Method II. The altitude of each SLI has been corrected to OD. 138



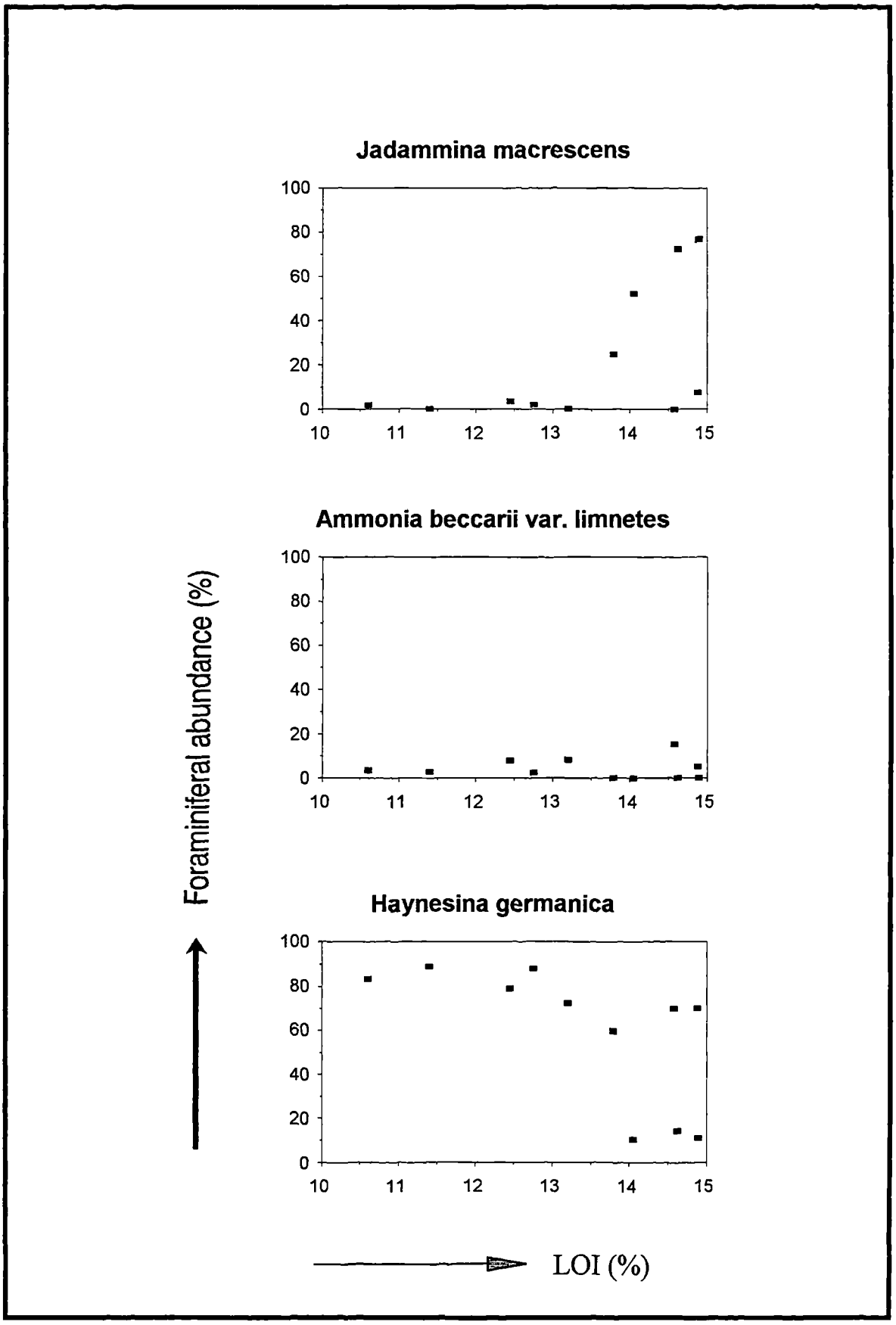
7.11 Foraminiferal diagram showing the influence of dissolution from D = 0 % (assumed original conditions) to D = 100 % for sample 1363 cm from Teesside industrial estate T2. Foraminiferal abundance is calculated as a percentage of total foraminiferal tests. Indicative meanings are estimated using Method II. 139



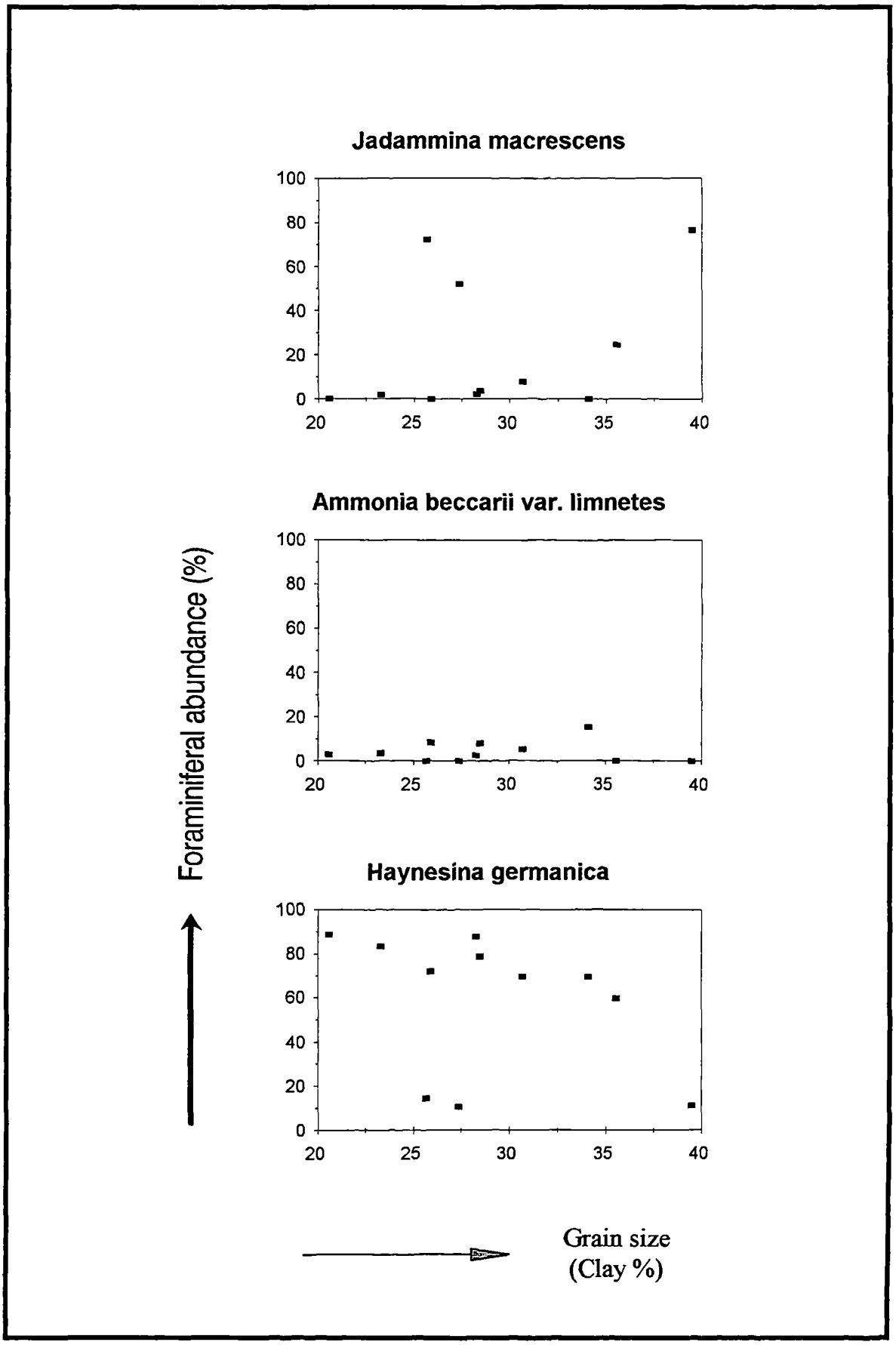
7.12 Holkam Core NNC17 foraminiferal diagram. Foraminiferal abundance is calculated as a percentage of total foraminiferal tests. Indicative meanings are estimated using Methods I and II. The stratigraphy is drawn according to Troels-Smith (1955). The radiocarbon date and the samples used as SLIs are shown.



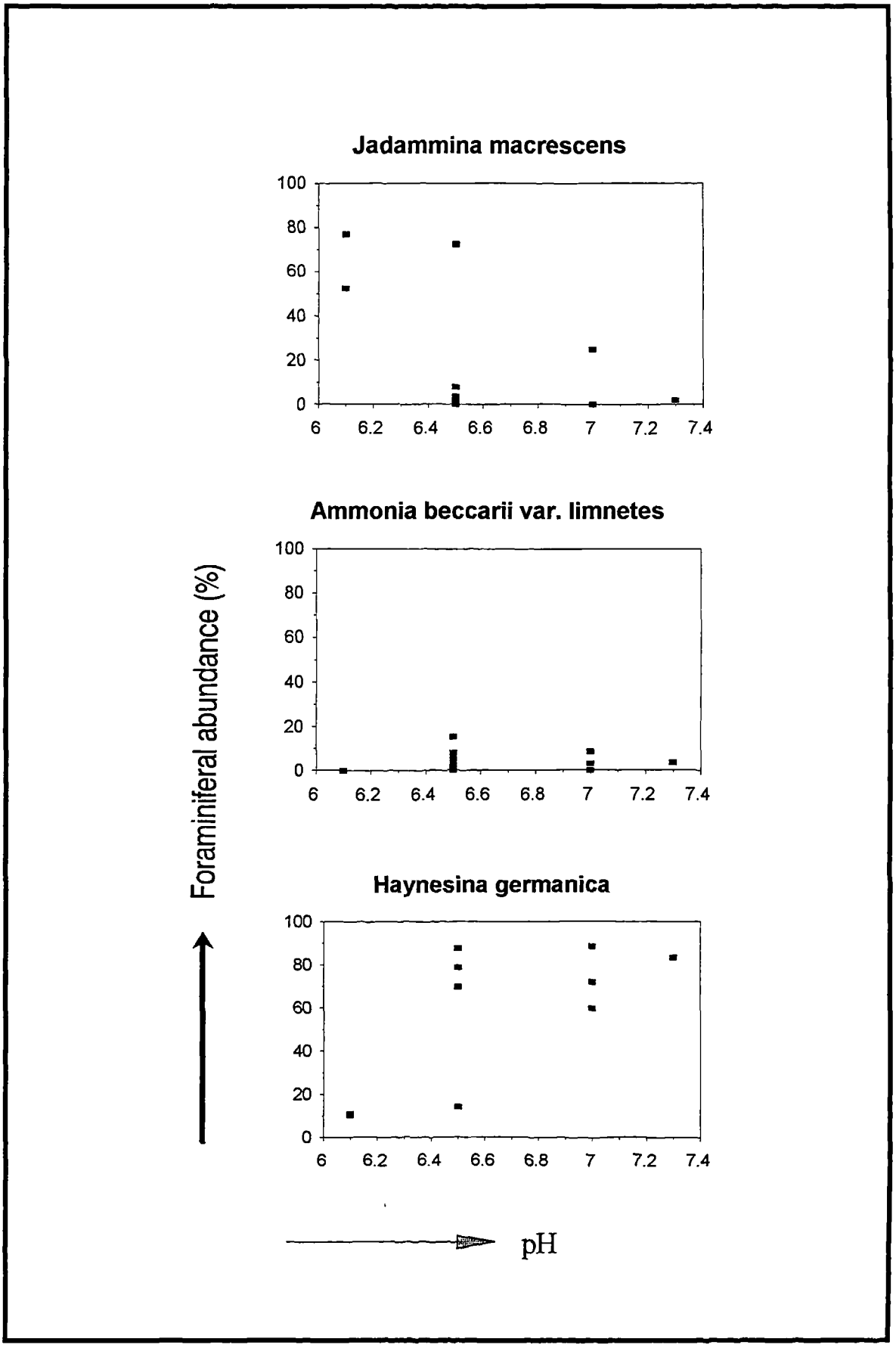
7.13 A conceptual age-altitude graph of sea-level index points (SLI) of the Holkam NNC17 using Method II. The altitude of each SLI has been corrected to OD. The ages of samples which have not been radiocarbon dated are estimated assuming a constant sedimentation rate Error limits are calculated from the calibrated radiocarbon dates (2σ) and estimates for reference water levels and measurement of altitude. Sample 445 cm is excluded



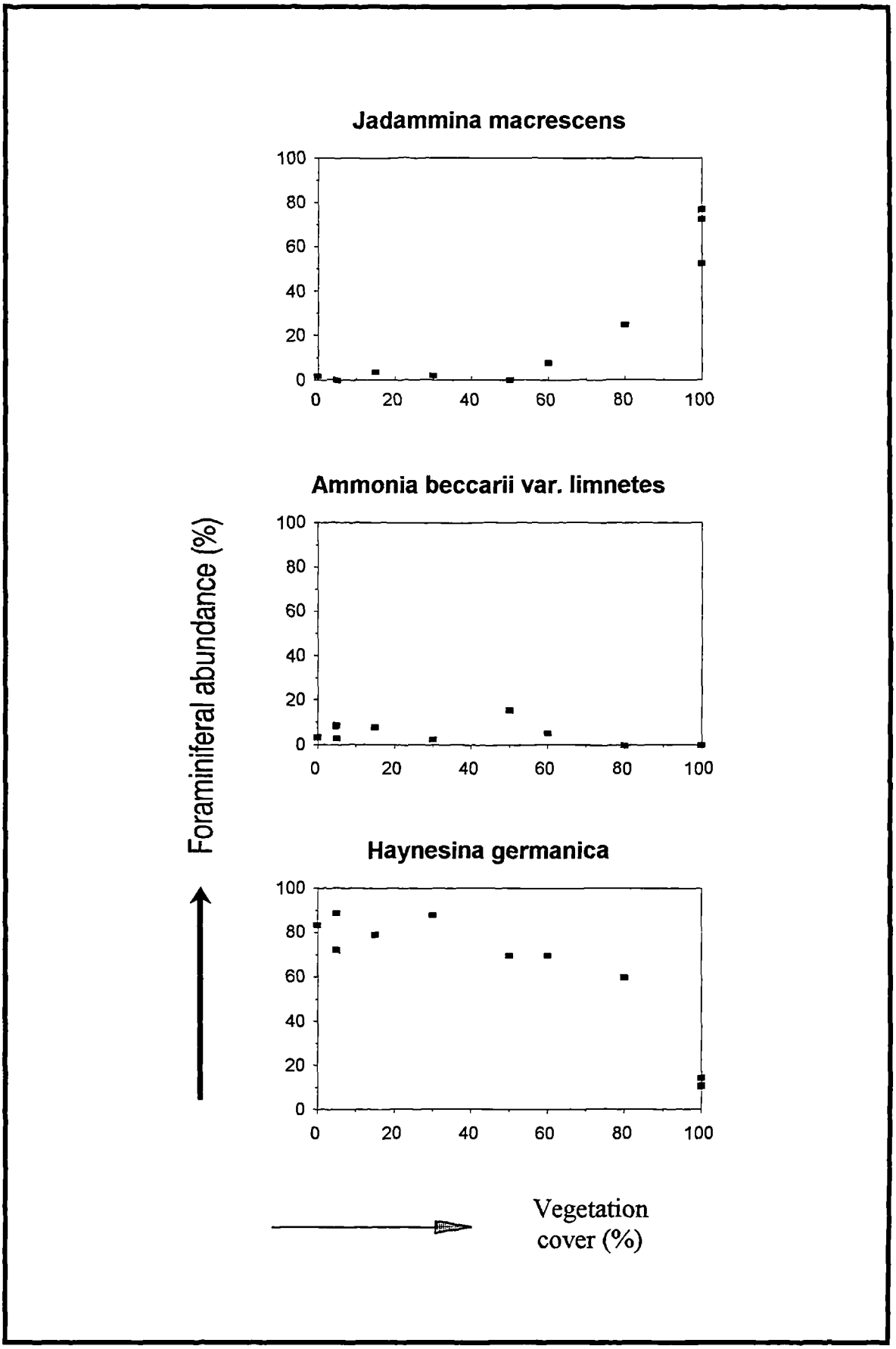
A4.1 Scatter plots of LOI versus the annual averages of three foraminiferal species of Welwick Marsh.



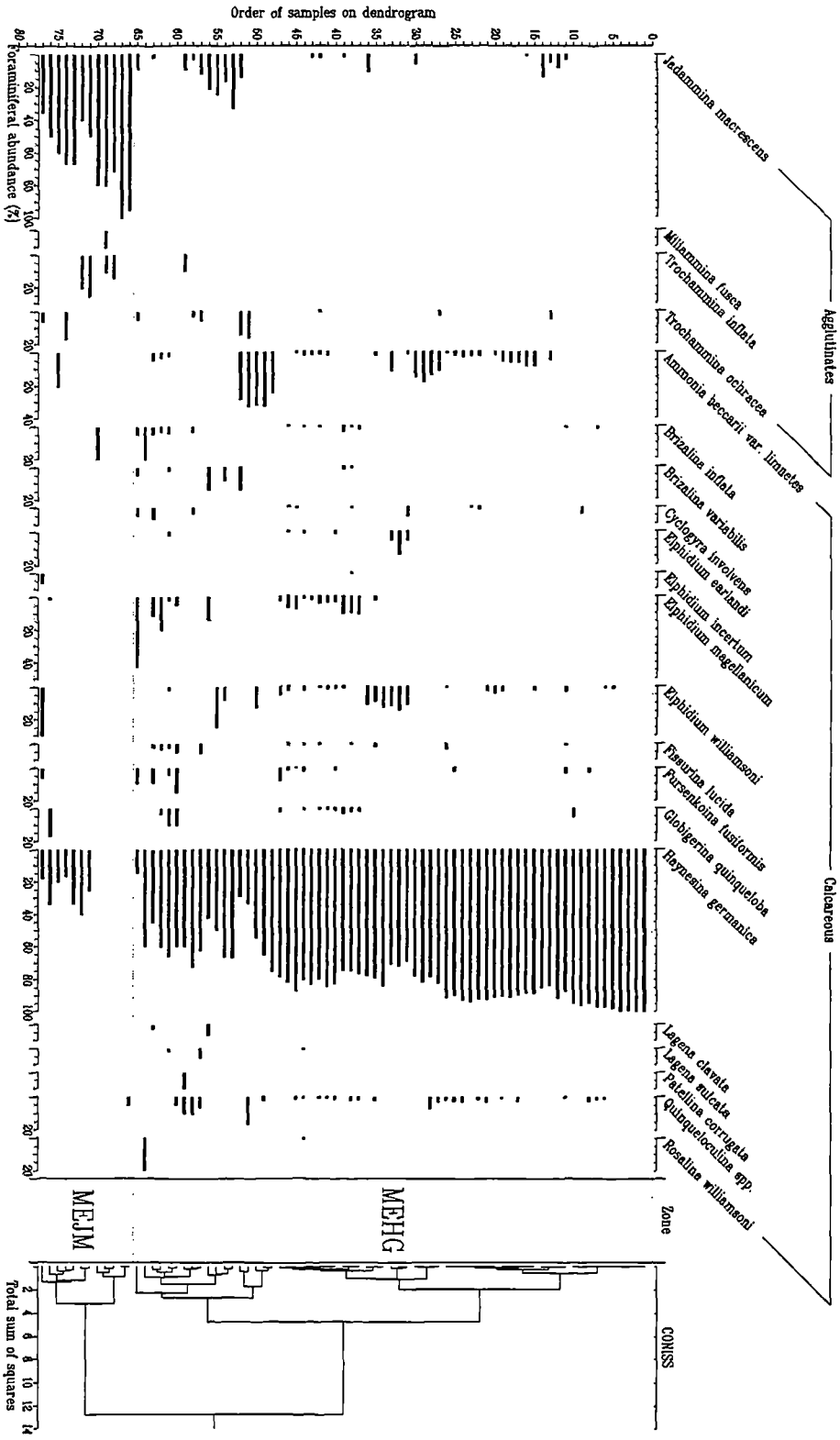
A4.2 Scatter plots of grain size versus the annual averages of three foraminiferal species of Welwick Marsh.



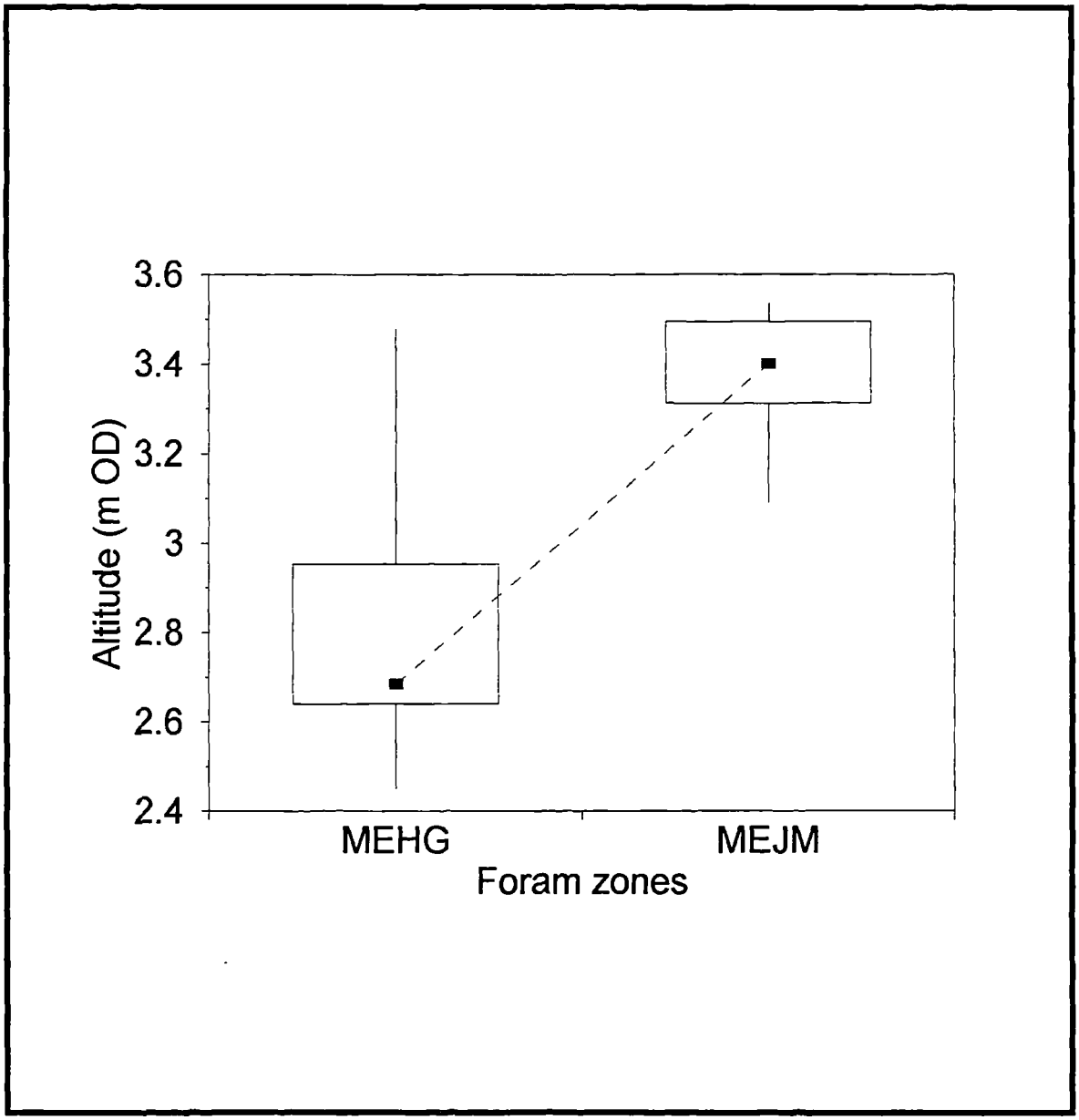
A4.3 Scatter plots of pH versus the annual averages of three foraminiferal species of Welwick Marsh.



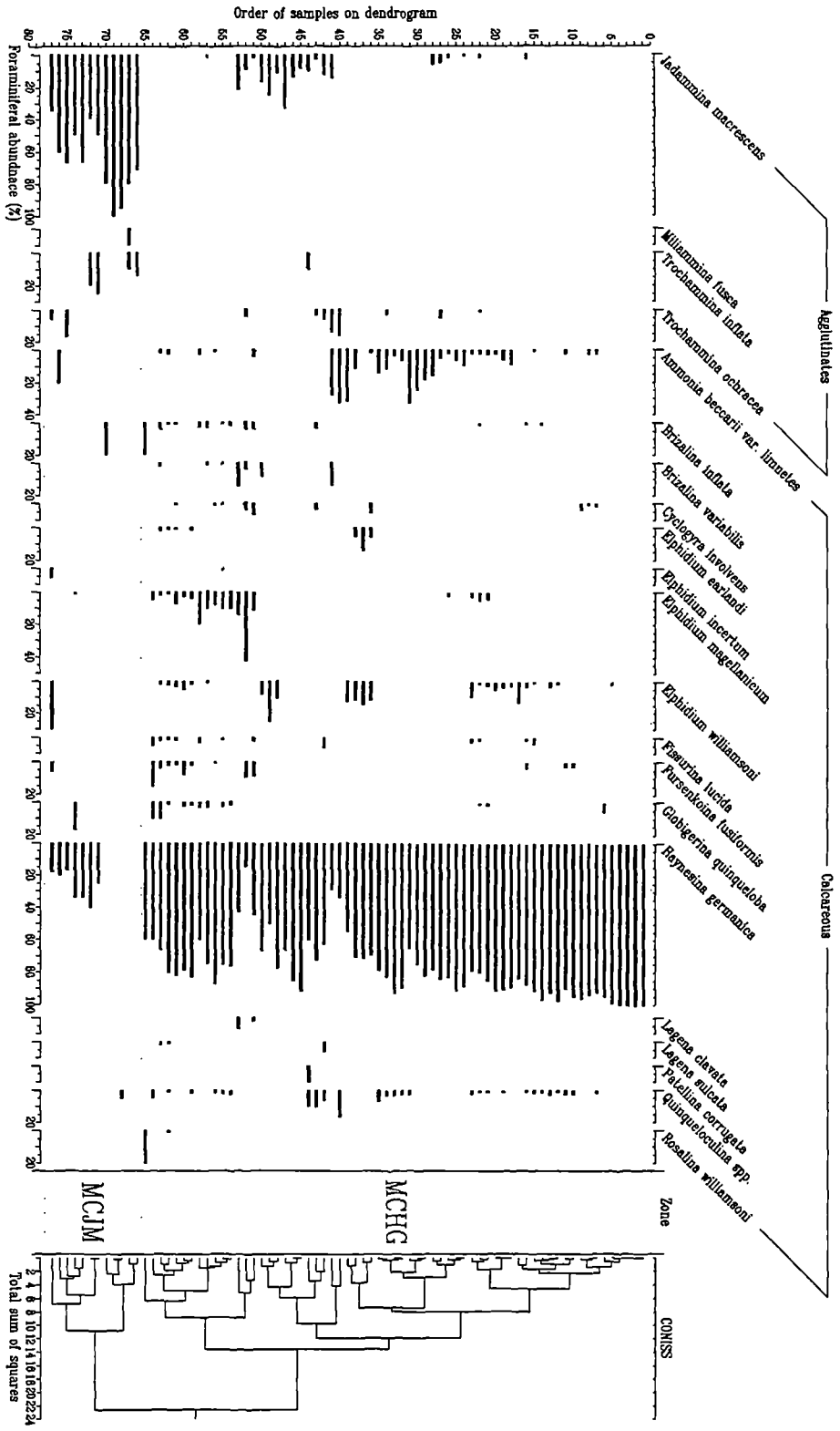
A4.4 Scatter plots of vegetation cover versus the annual averages of three foraminiferal species of Welwick Marsh.



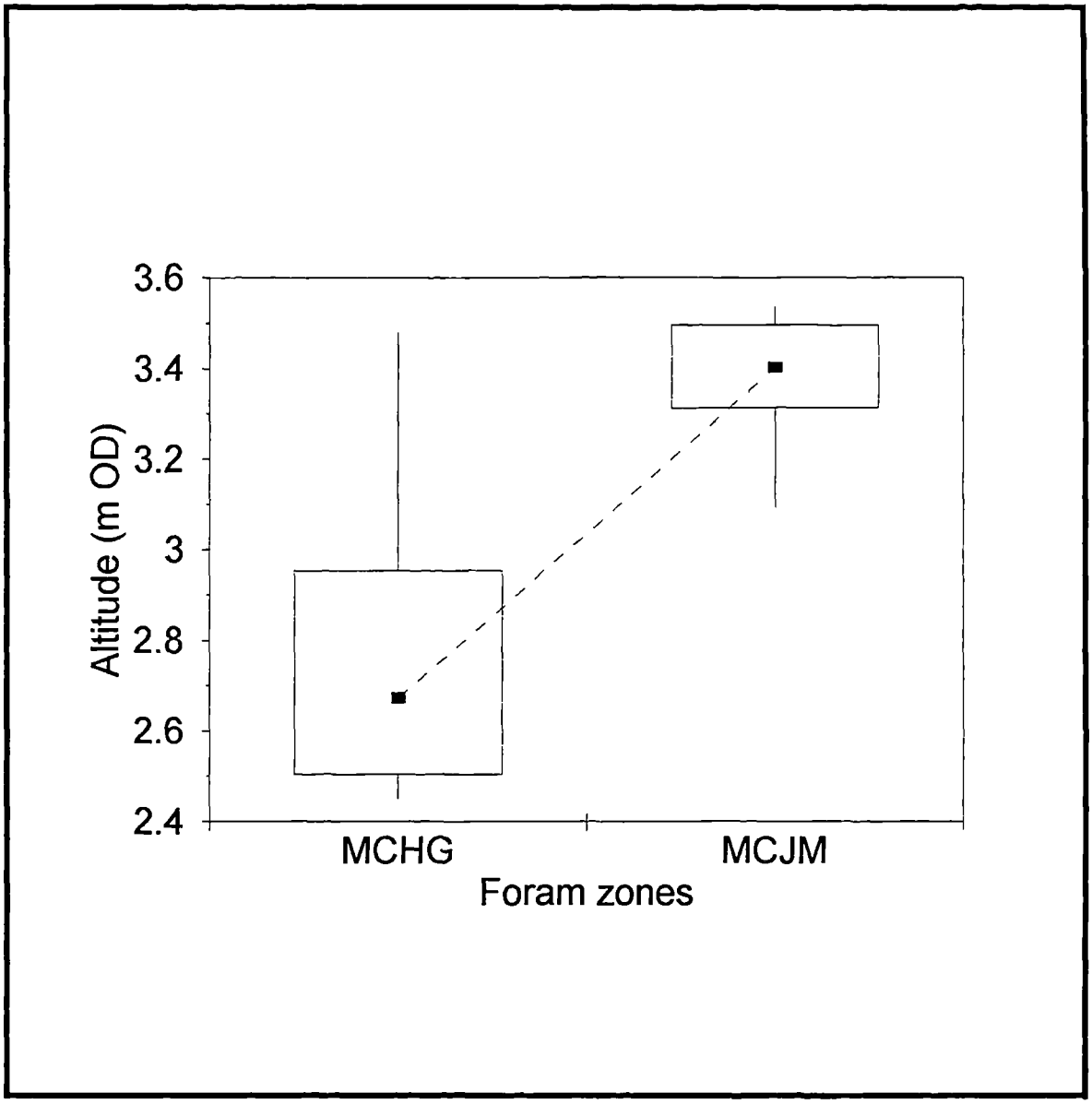
A4.5 Unconstrained cluster analysis based on unweighted Euclidean distance of monthly foraminiferal death assemblages from samples collected over a twelve month period from Welwick Marsh. Only samples with counts greater than 40 individuals and species which reach 5 % of the total sum are included.



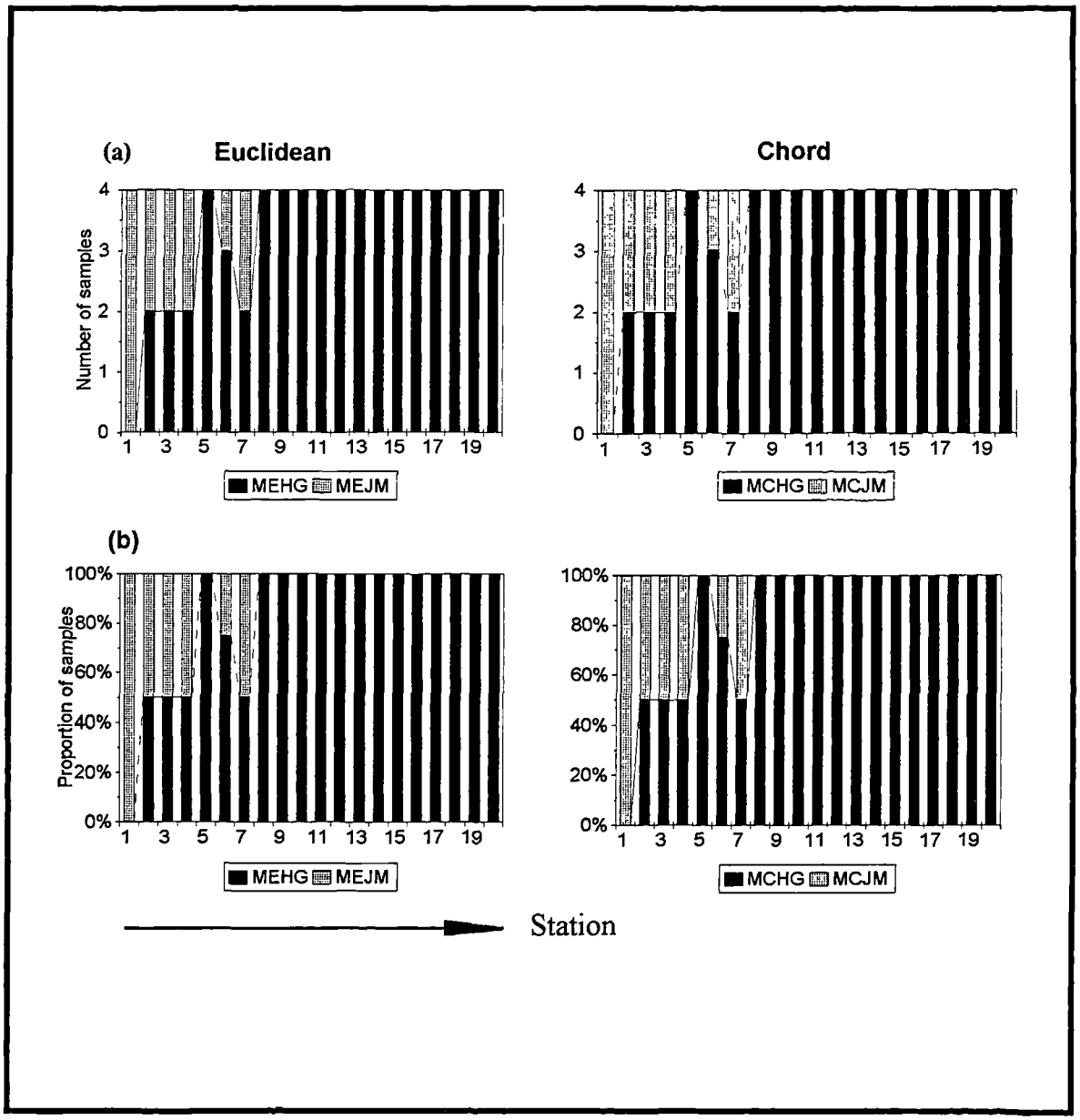
A4.6 Boxplots showing maximum, minimum, interquartile ranges and median altitudes for monthly clusters based on Euclidean distance from Welwick Marsh.



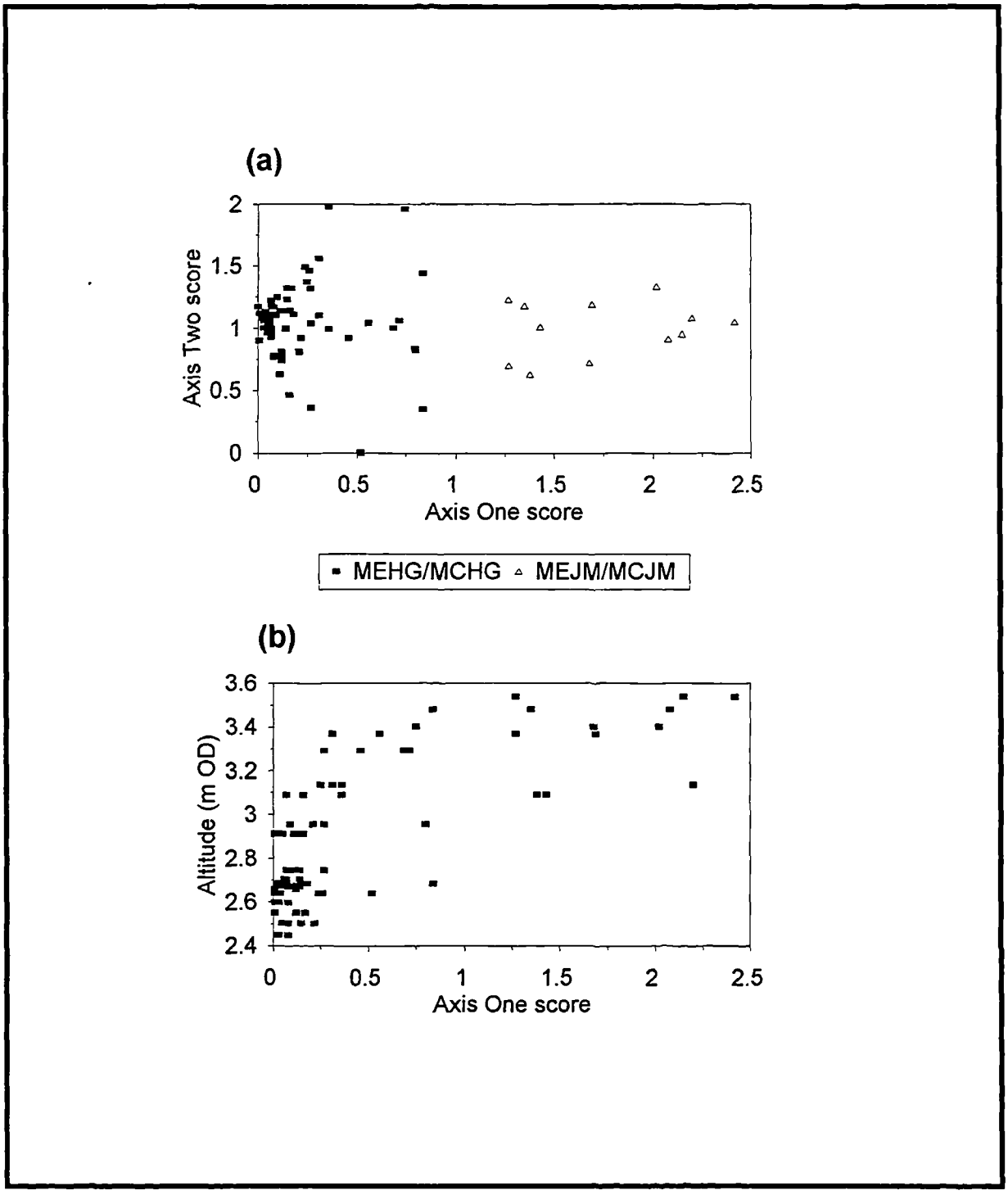
A4.7 Unconstrained cluster analysis based on unweighted Chord distance of monthly foraminiferal death assemblages from samples collected over a twelve month period from Welwick Marsh. Only samples with counts greater than 40 individuals and species which reach 5 % of the total sum are included.



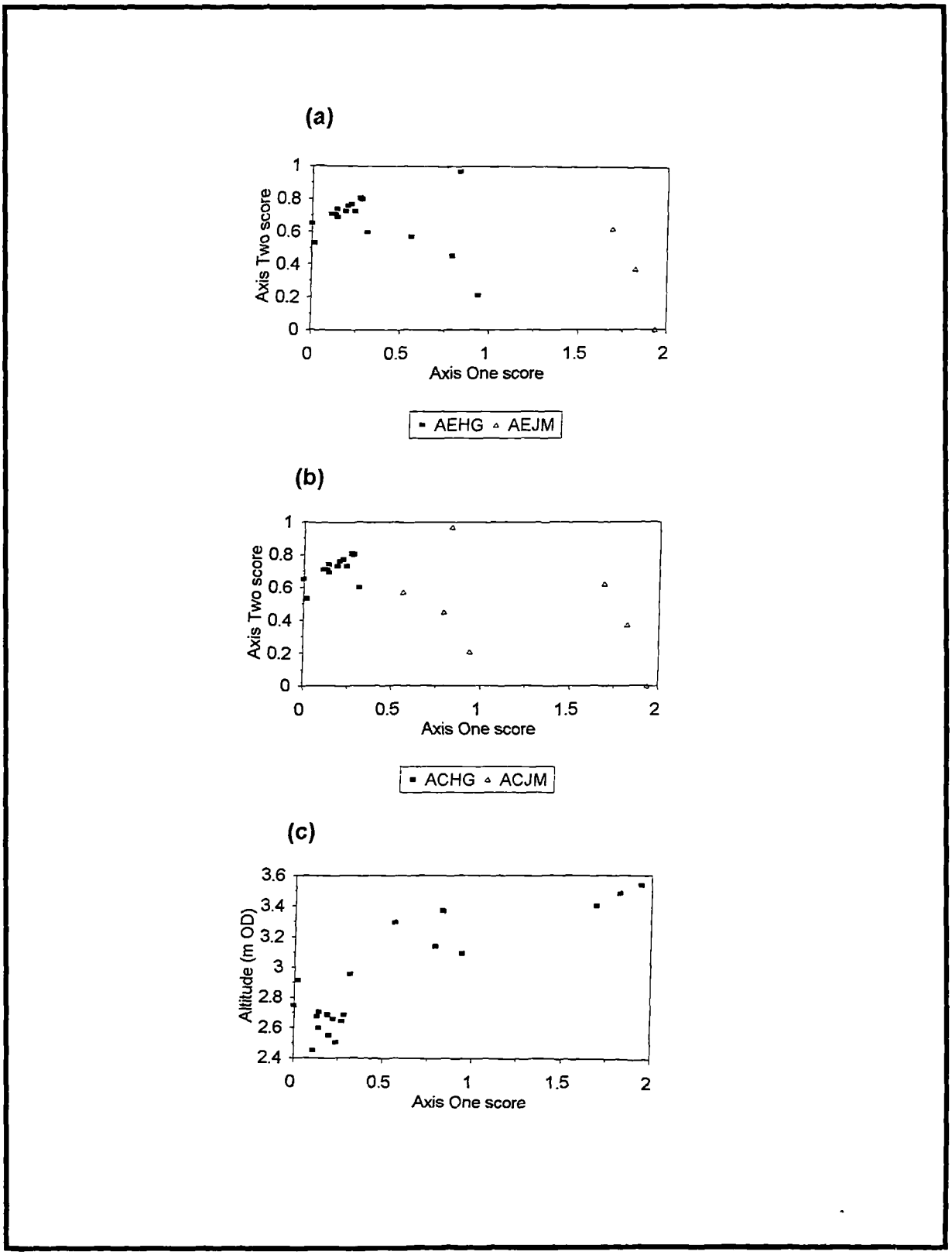
A4.8 Boxplots showing maximum, minimum, interquartile ranges and median altitudes for monthly clusters based on Chord distance from Welwick Marsh.



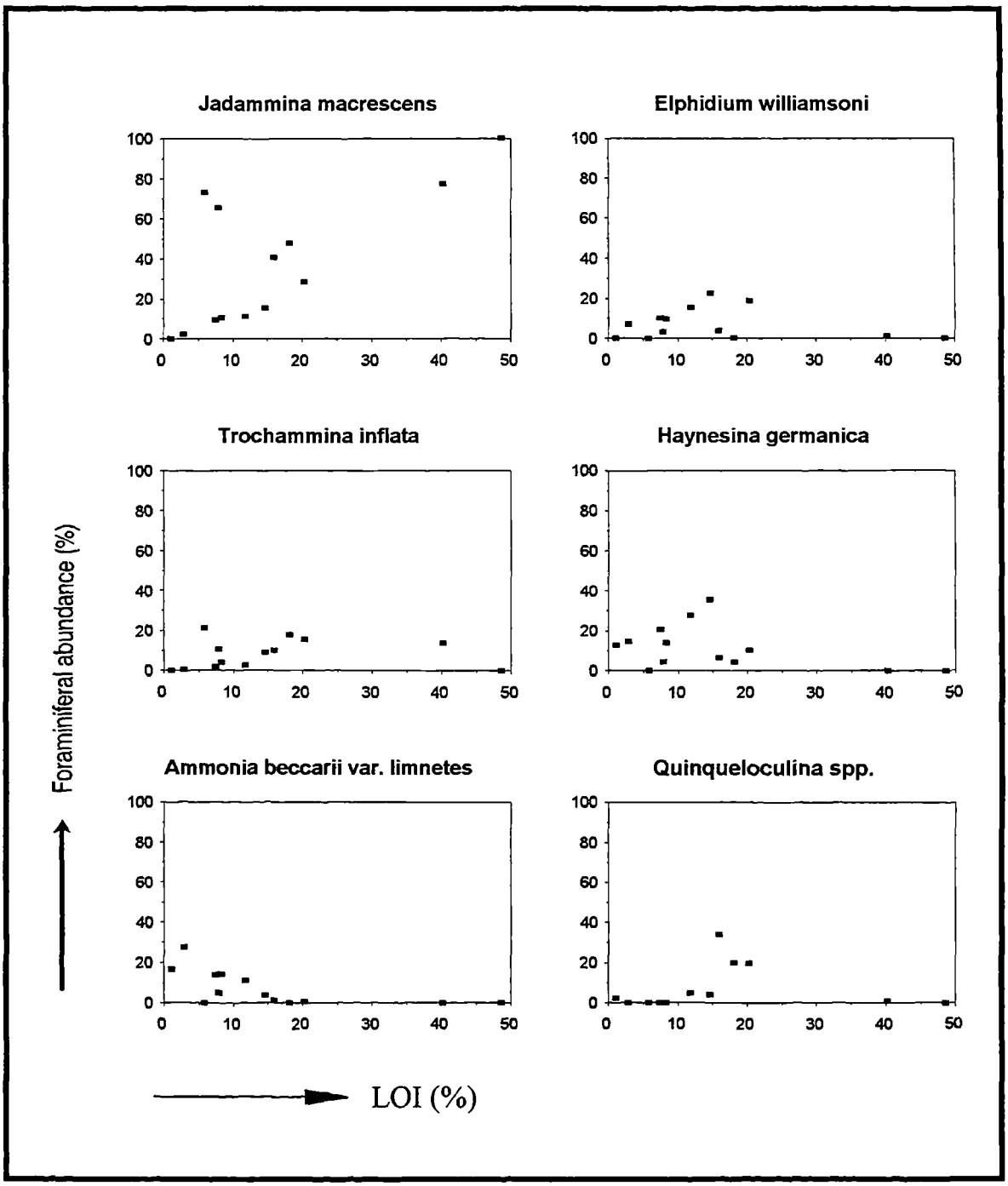
A4.9 Stacked bar comparisons showing the distribution of Euclidean and Chord zones across the intertidal zone of Welwick Marsh. (a) Station number versus the number of monthly samples and (b) station number versus the proportion of monthly samples (%) . Only samples with counts greater than 40 individuals and species which reach 5 % of the total sum are included.



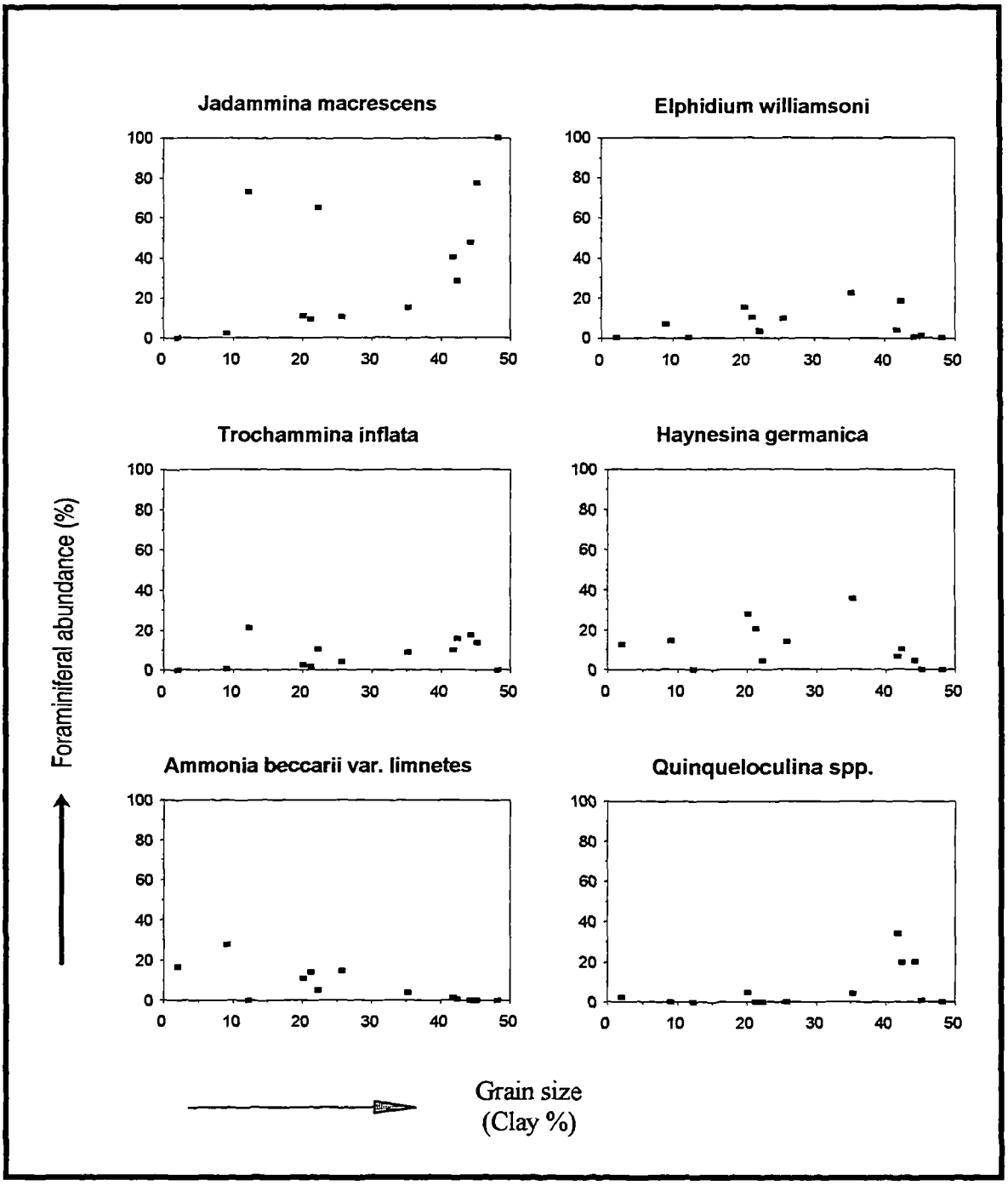
A4.10 (a) DCA of monthly foraminiferal death assemblages from Welwick Marsh. The zonations produced by unconstrained cluster analysis based on unweighted Euclidean distance and Chord distance are shown. (b) DCA Axis One scores versus altitude.



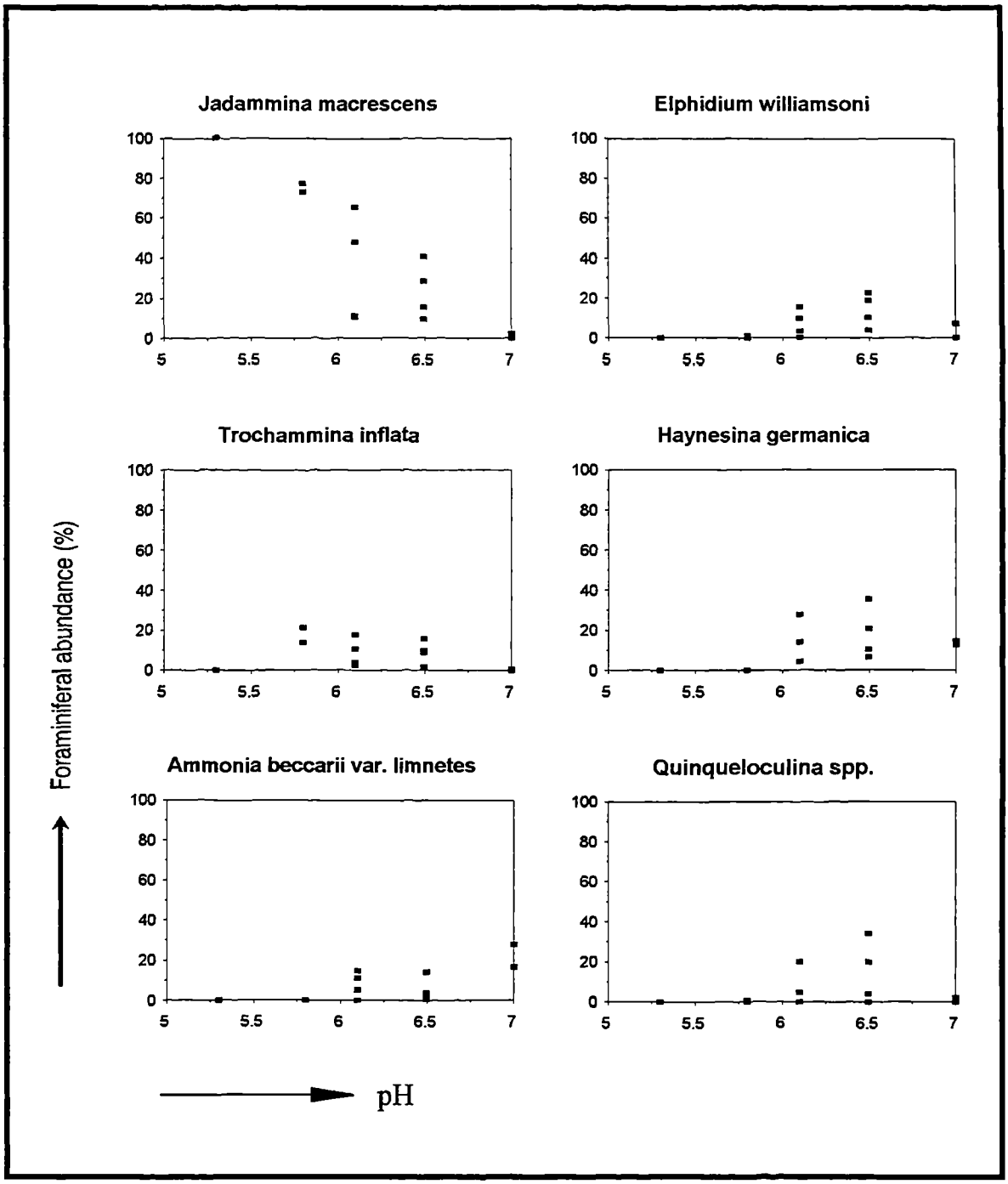
A4.11 DCA of annual foraminiferal death assemblages from Welwick Marsh. The zonations produced by unconstrained cluster analysis based on unweighted (a) Euclidean distance and (b) Chord distance are shown. (c) DCA Axis One scores versus altitude.



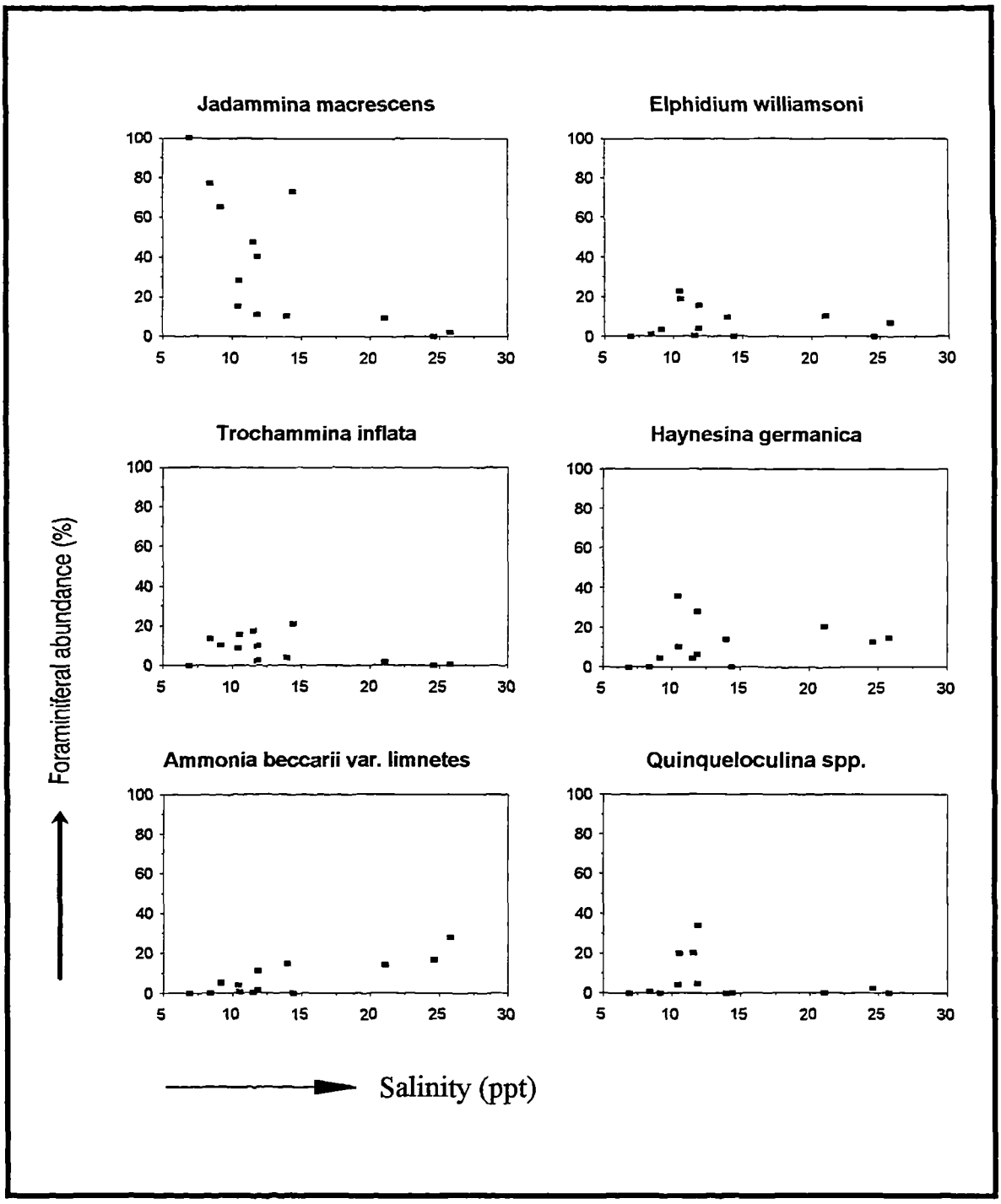
A5.1 Scatter plots showing LOI versus the annual average of six foraminiferal species from Thornham Marsh.



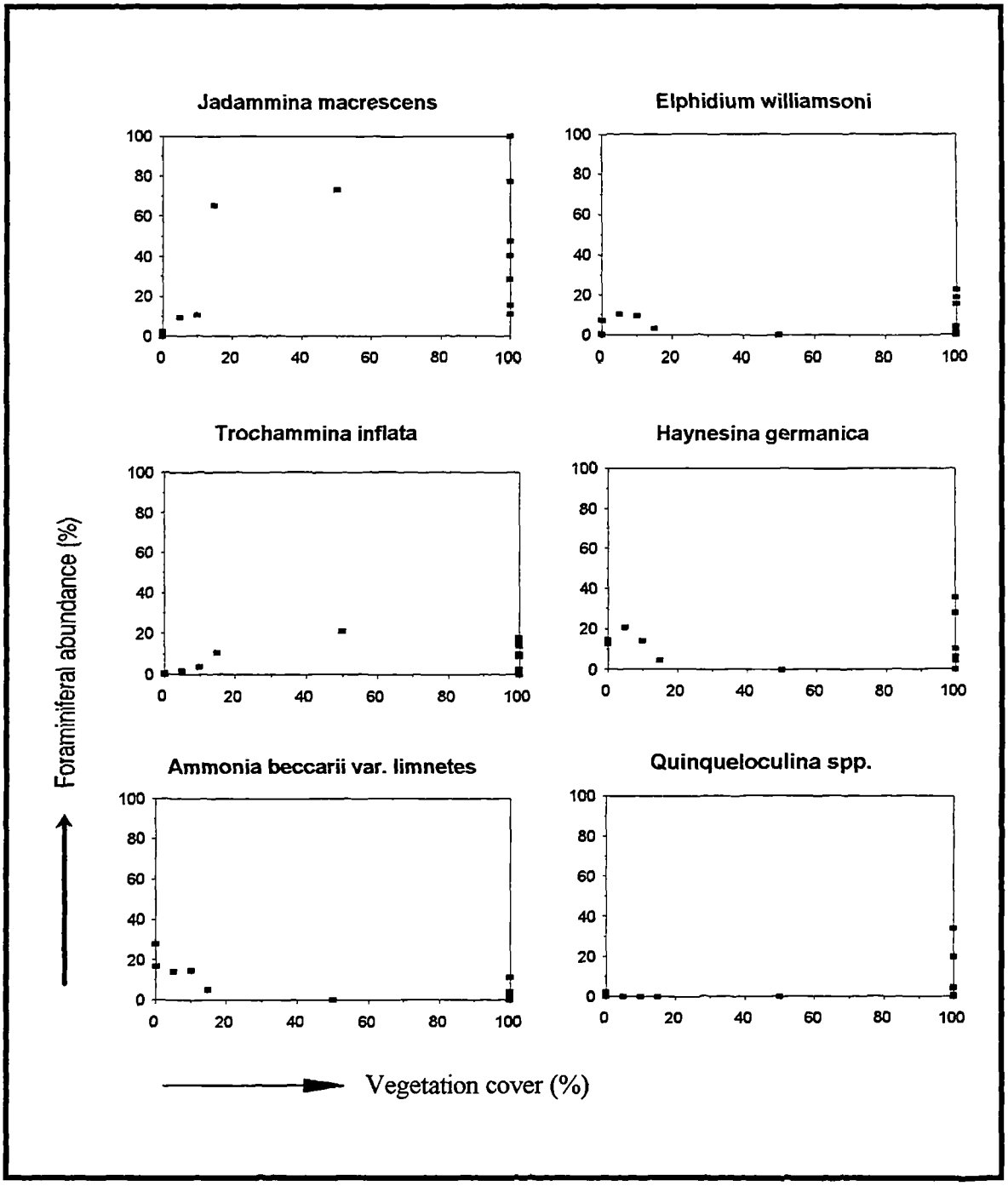
A5.2 Scatter plots showing grain size versus the annual average of six foraminiferal species from Thornham Marsh.



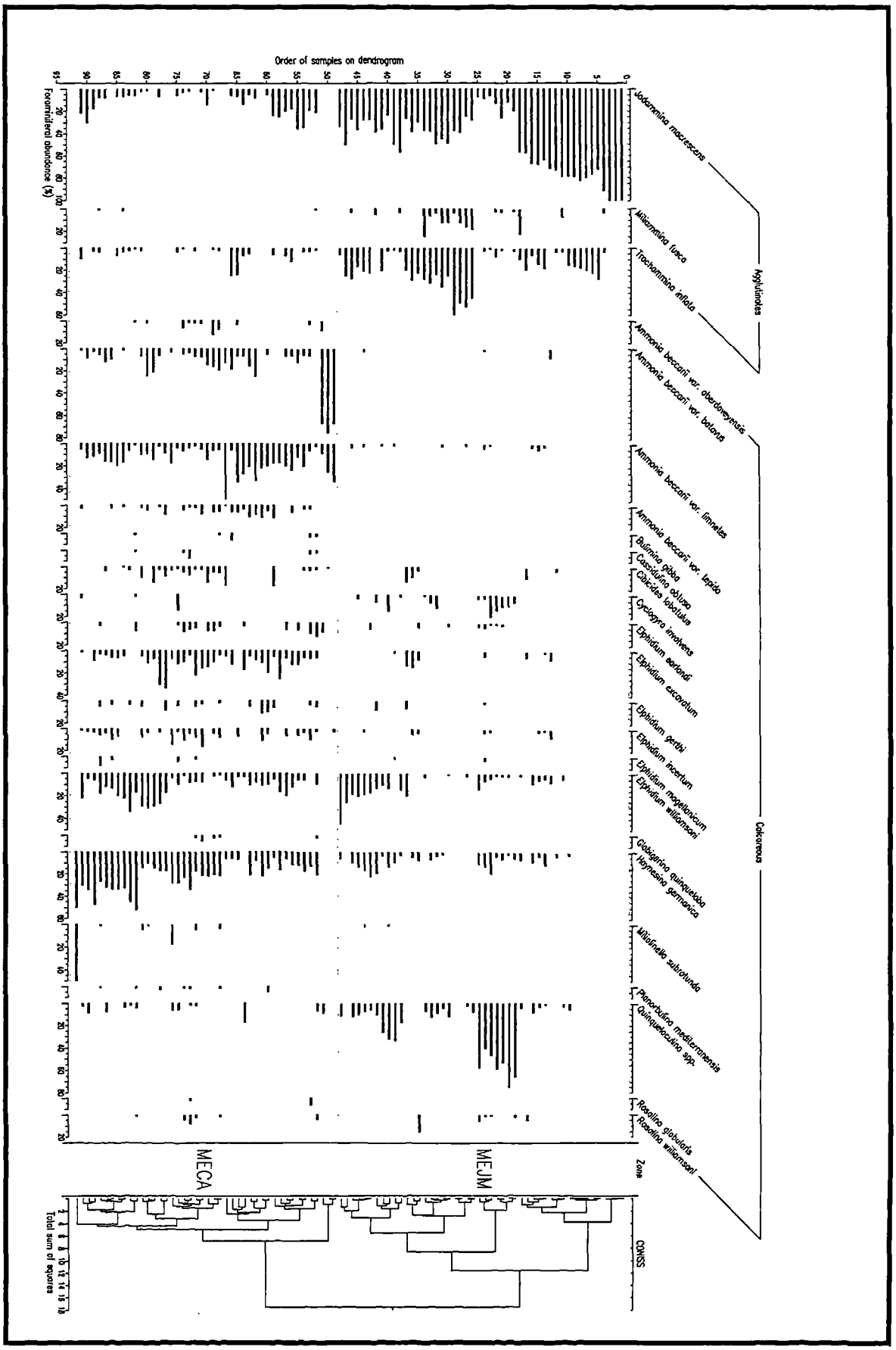
A5.3 Scatter plots showing pH versus the annual average of six foraminiferal species from Thornham Marsh.



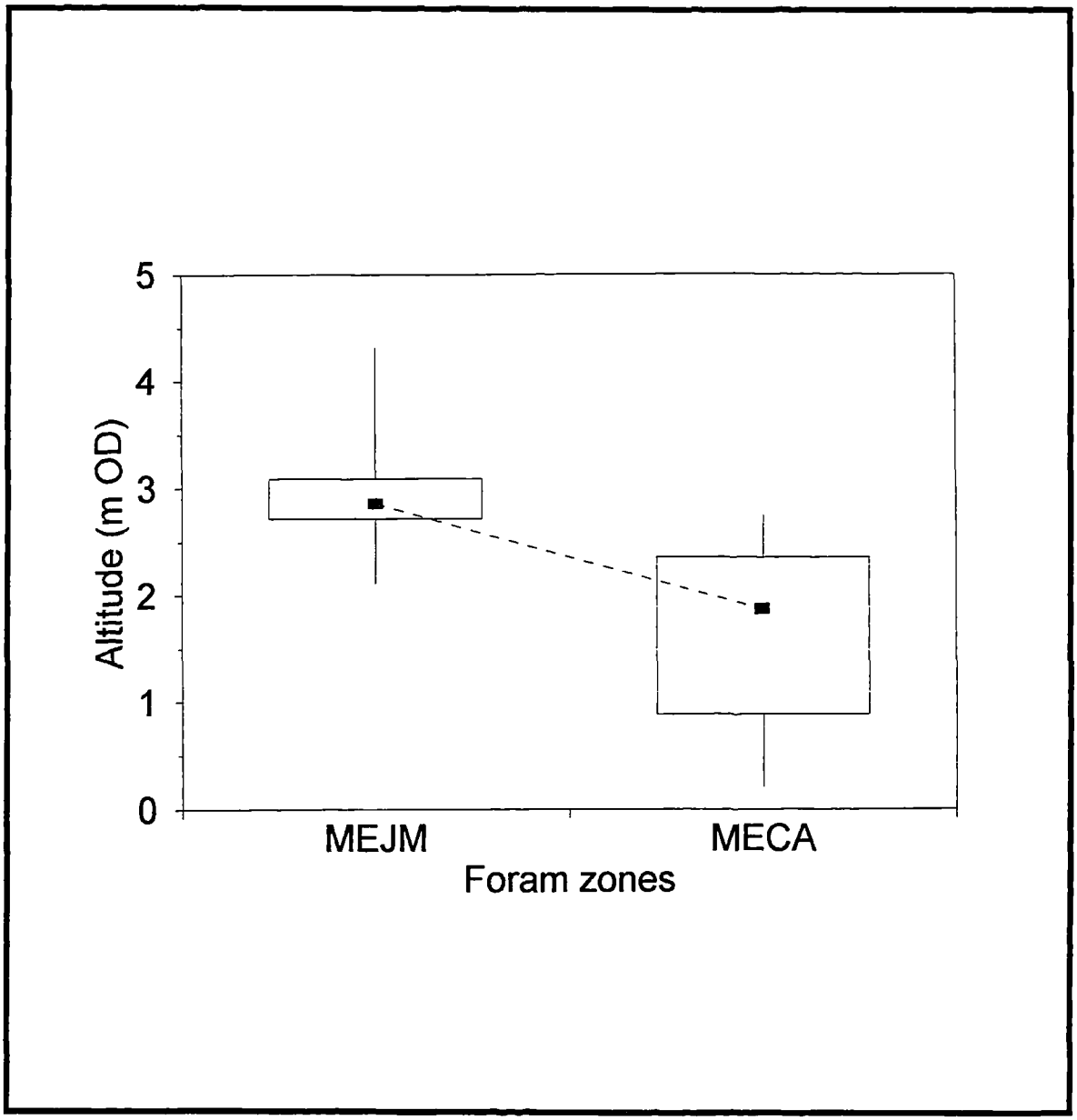
A5.4 Scatter plots showing salinity versus the annual average of six foraminiferal species from Thornham Marsh.



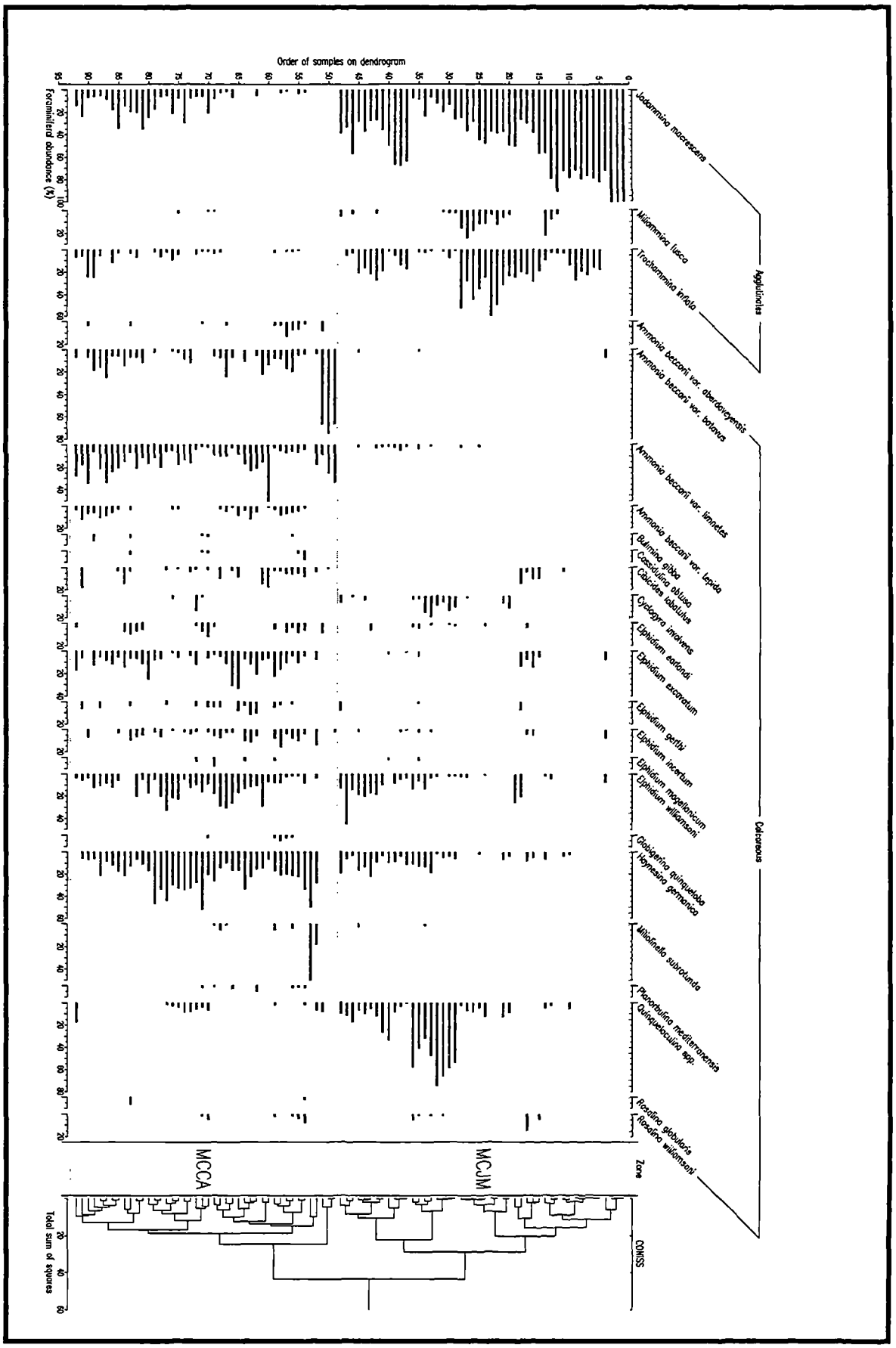
A5.5 Scatter plots showing vegetation cover versus the annual average of six foraminiferal species from Thornham Marsh.



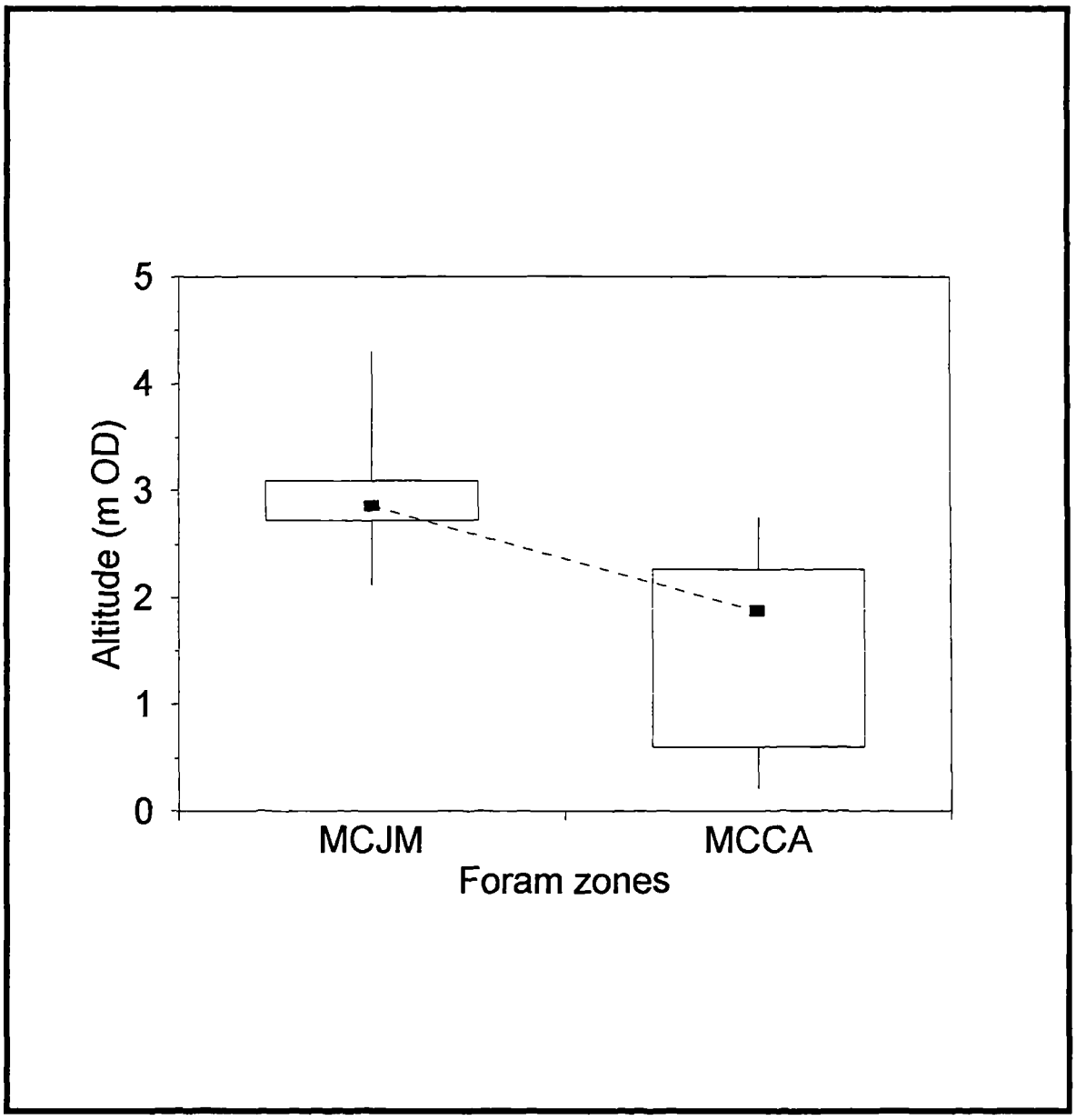
A5.6 Unconstrained cluster analysis based on unweighted Euclidean distance of monthly foraminiferal death assemblages from samples collected over a twelve month period from Thornham Marsh. Only samples with counts greater than 40 individuals and species which reach 5 % of the total sum are included.



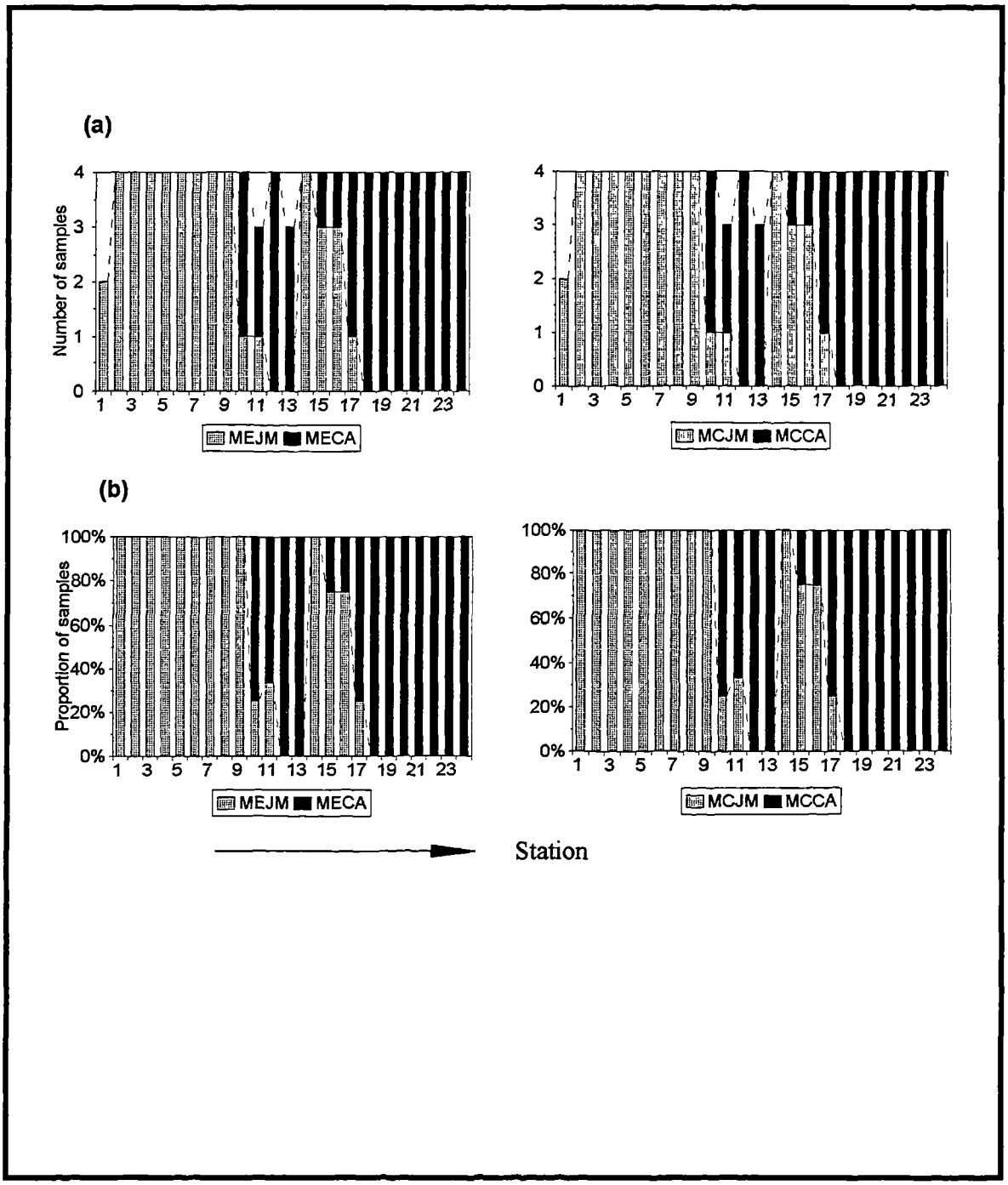
A5.7 Boxplots showing maximum, minimum, interquartile ranges and median altitudes for monthly clusters based on Euclidean distance from Thornham Marsh.



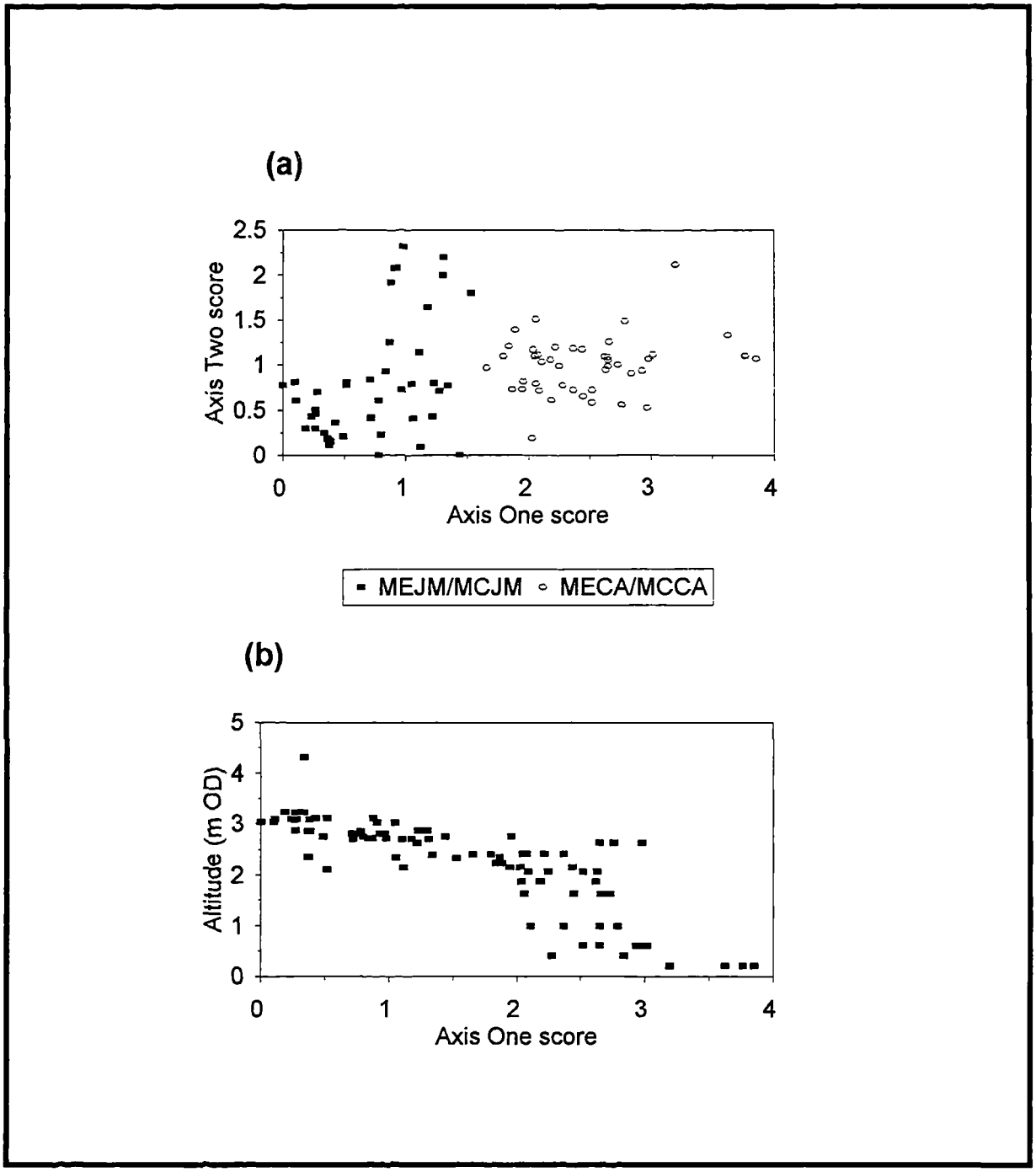
A5.8 Unconstrained cluster analysis based on unweighted Chord distance of monthly foraminiferal death assemblages from samples collected over a twelve month period from Thornham Marsh. Only samples with counts greater than 40 individuals and species which reach 5 % of the total sum are included.



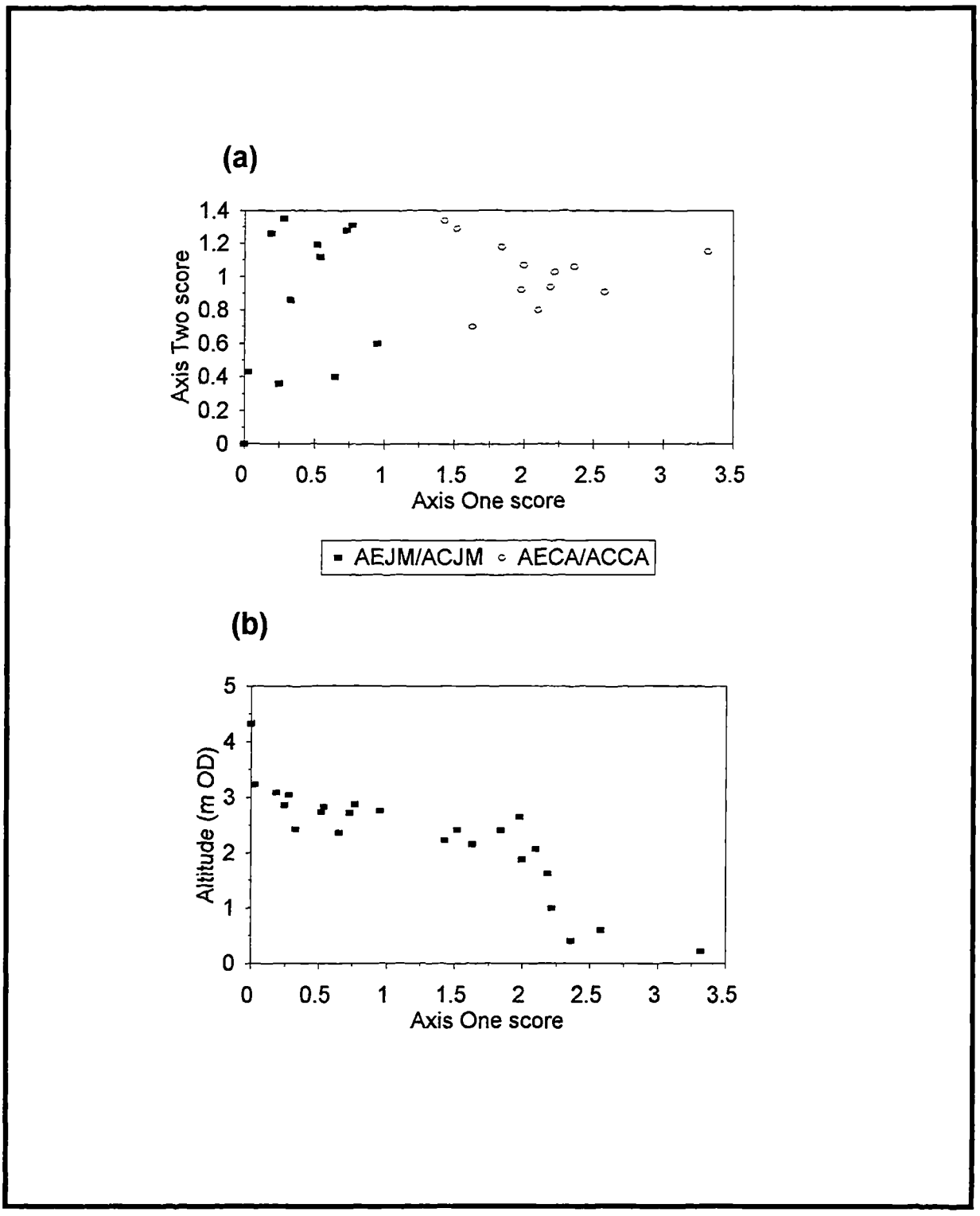
A5.9 Boxplots showing maximum, minimum, interquartile ranges and median altitudes for monthly clusters based on Chord distance from Thornham Marsh.



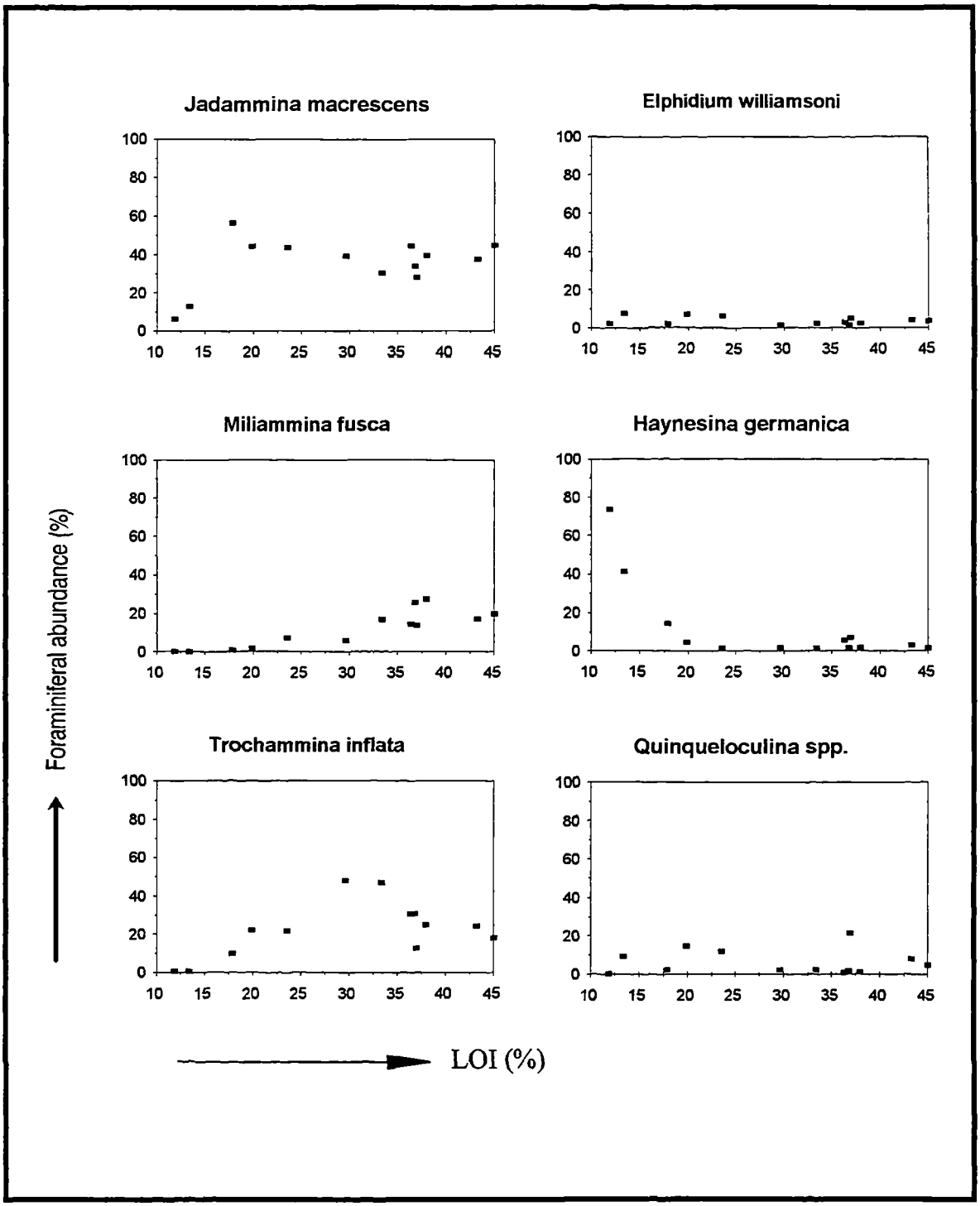
A5.10 Stacked bar comparisons showing the distribution of Euclidean and Chord zones across the intertidal zone of Thornham Marsh. (a) Station number versus the number of monthly samples and (b) station number versus the proportion of monthly samples (%). Only samples with counts greater than 40 individuals and species which reach 5 % of the total sum are included.



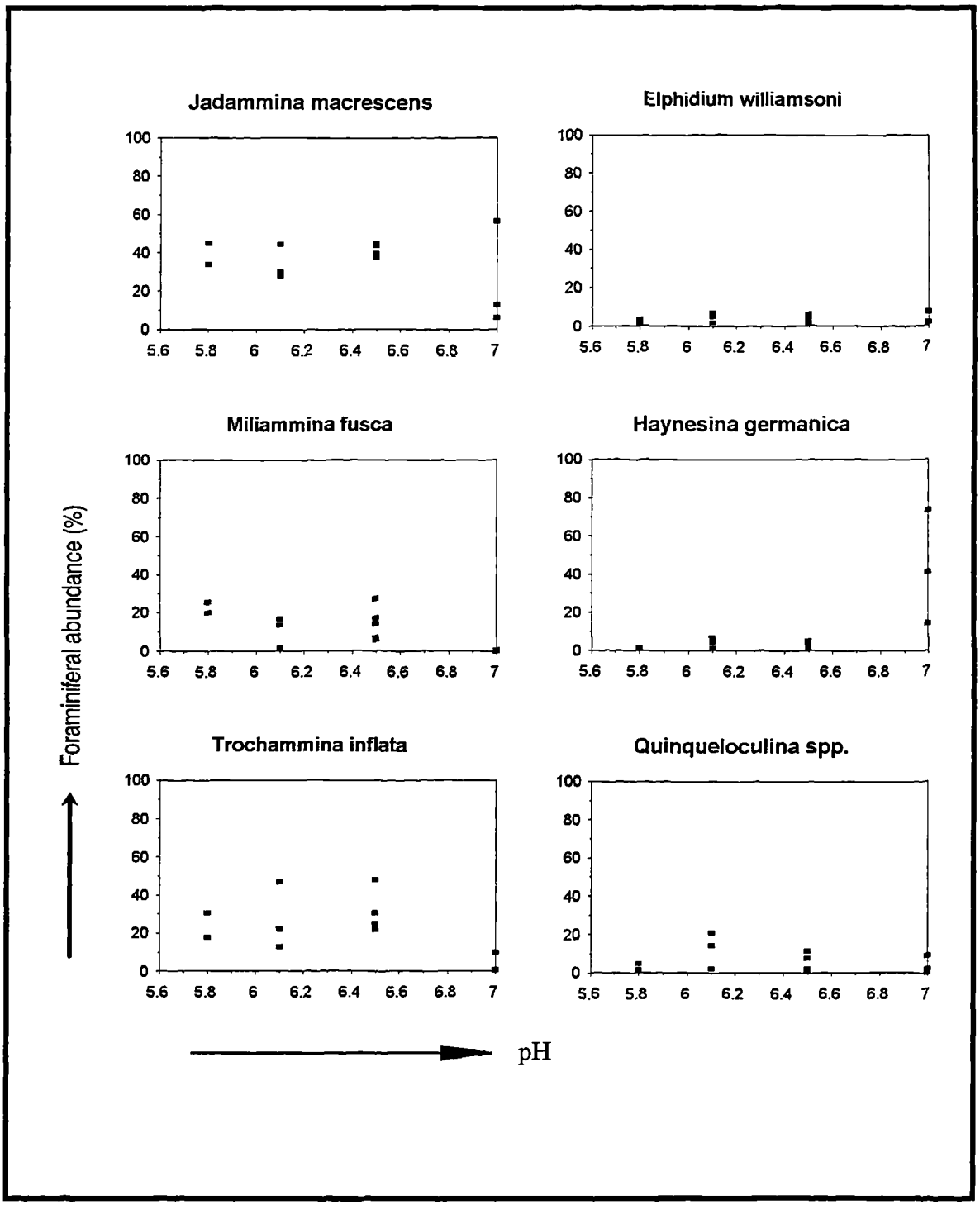
A5.11 (a) DCA of monthly foraminiferal death assemblages from Thornham Marsh. The zonations produced by unconstrained cluster analysis based on unweighted Euclidean distance and Chord distance are shown. (b) DCA Axis One scores versus altitude.



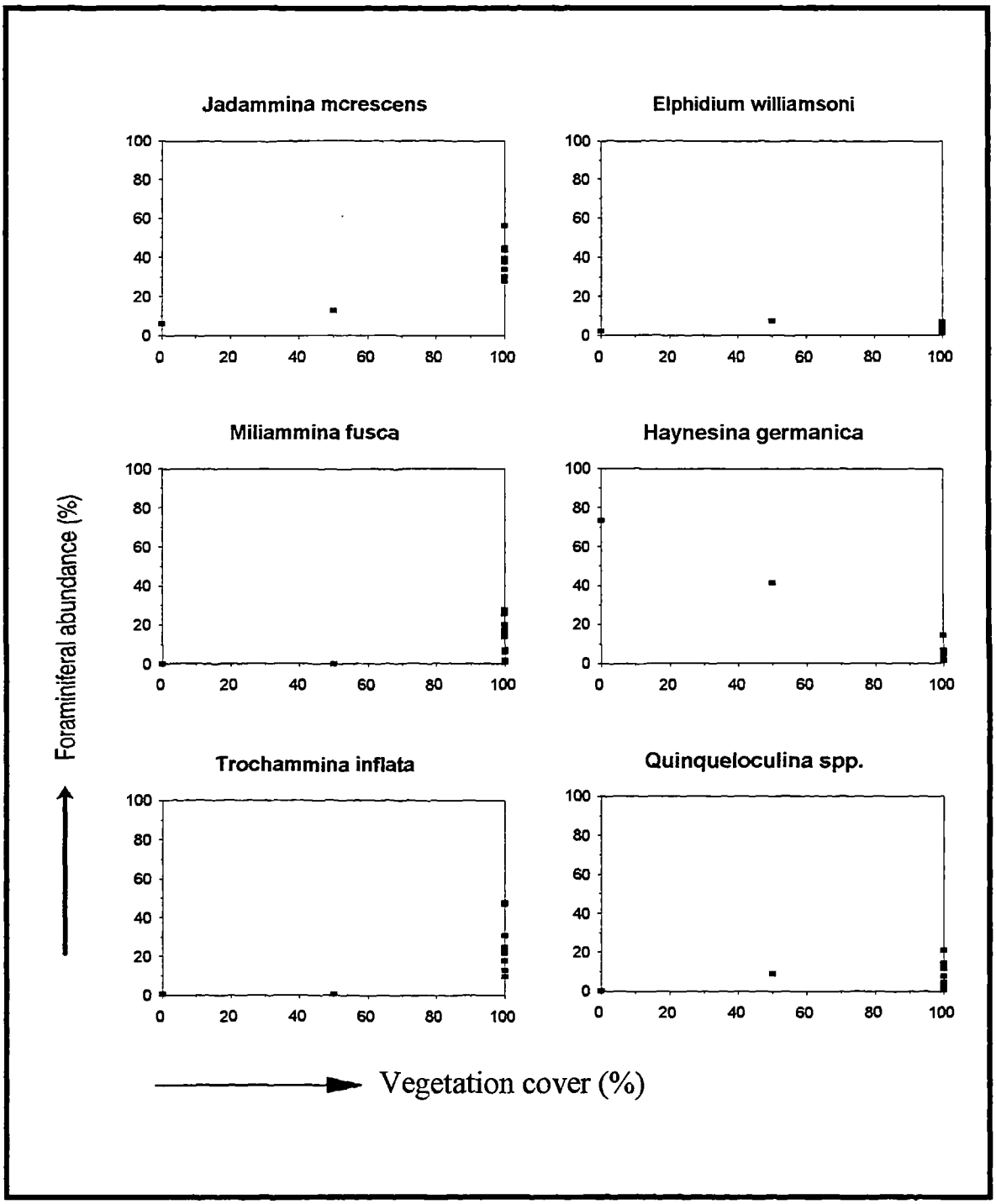
A5.12 (a) DCA of annual foraminiferal death assemblages from Thornham Marsh. The zonations produced by unconstrained cluster analysis based on unweighted Euclidean distance and Chord distance are shown. (b) DCA Axis One scores versus altitude.



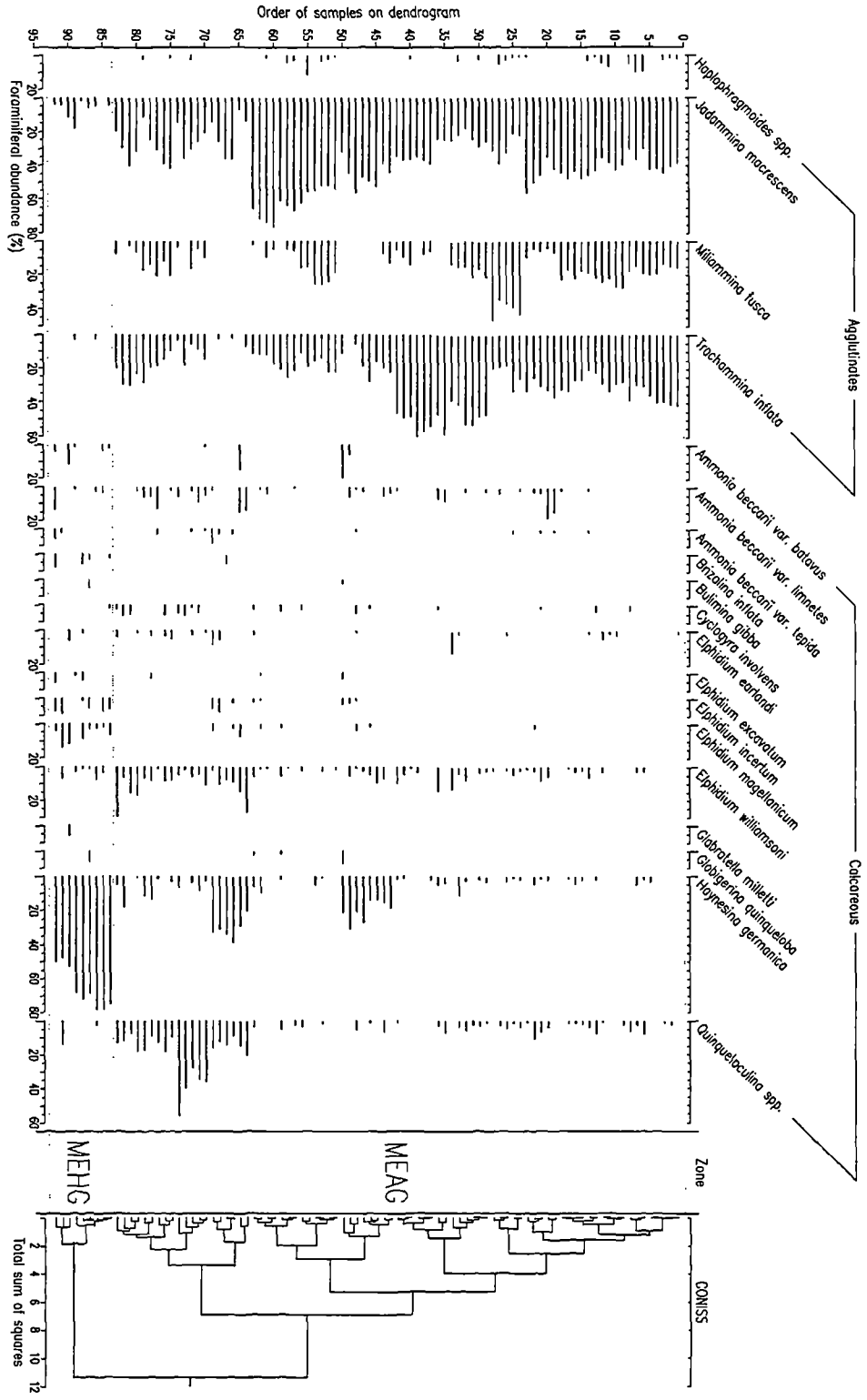
A6.1 Scatter plots of LOI versus the annual average of six foraminiferal species from Brancaster Marsh.



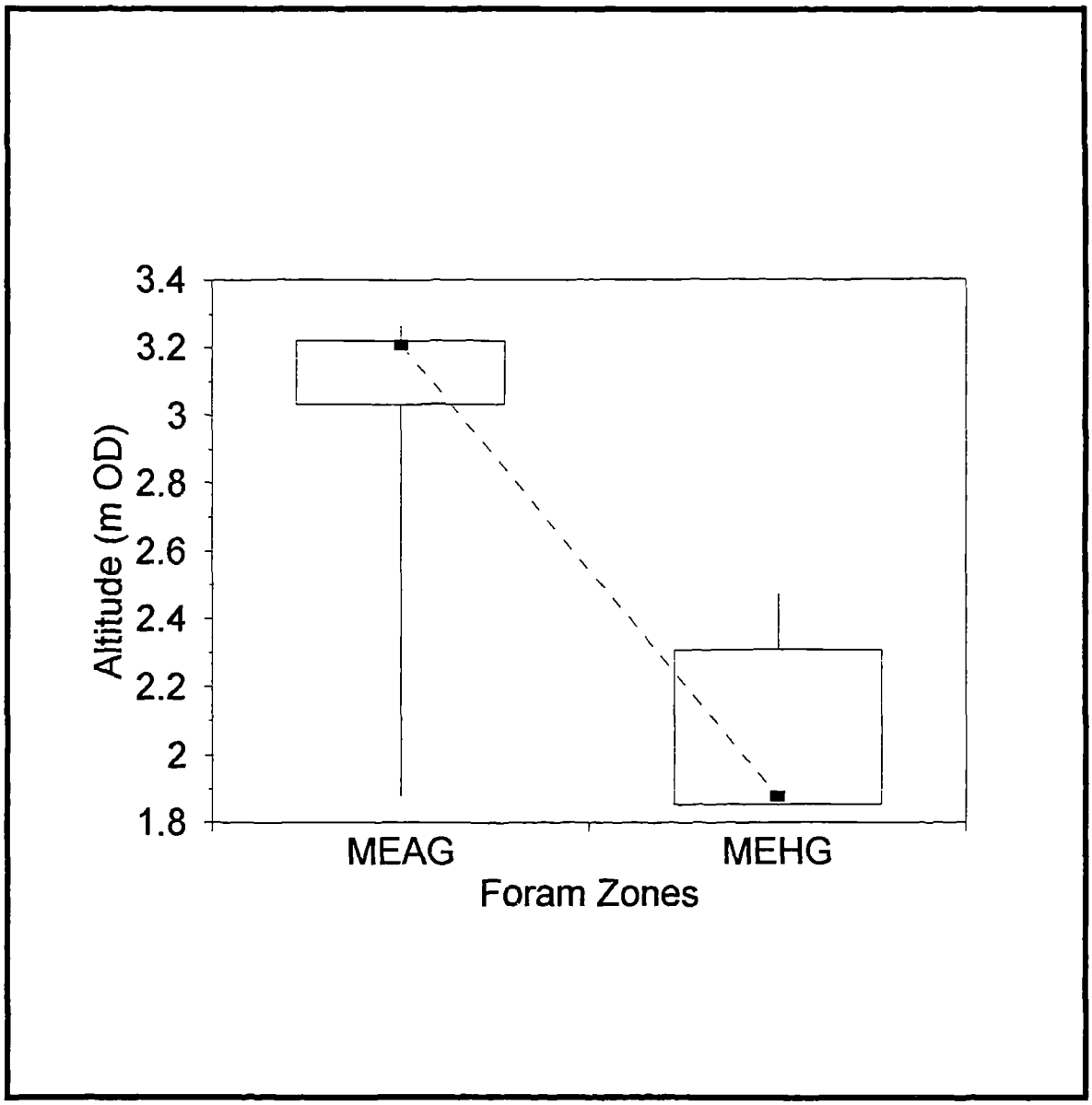
A6.2 Scatter plots of pH versus the annual average of six foraminiferal species from Brancaster Marsh.



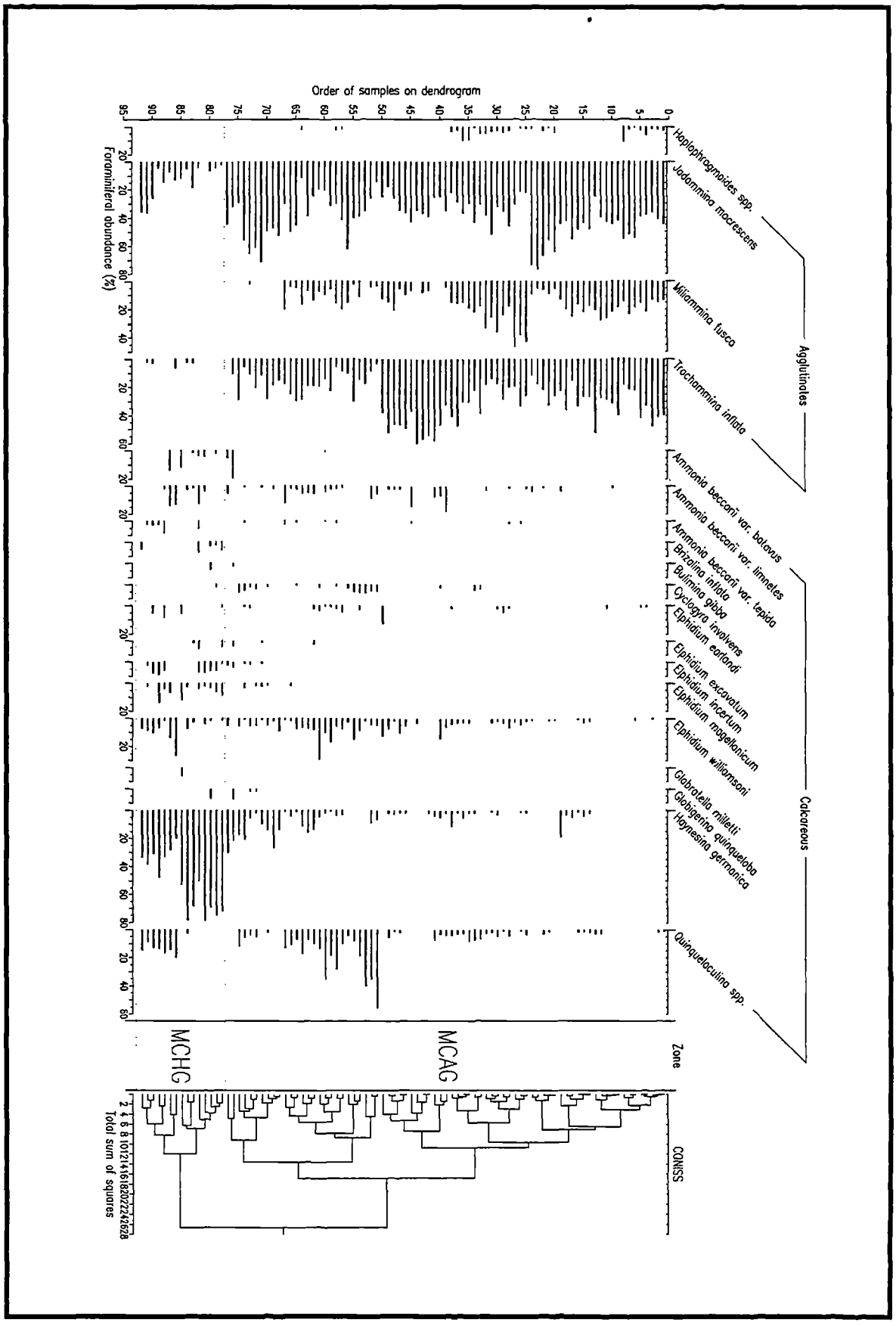
A6.3 Scatter plots of vegetation cover versus the annual average of six foraminiferal species from Brancaster Marsh.



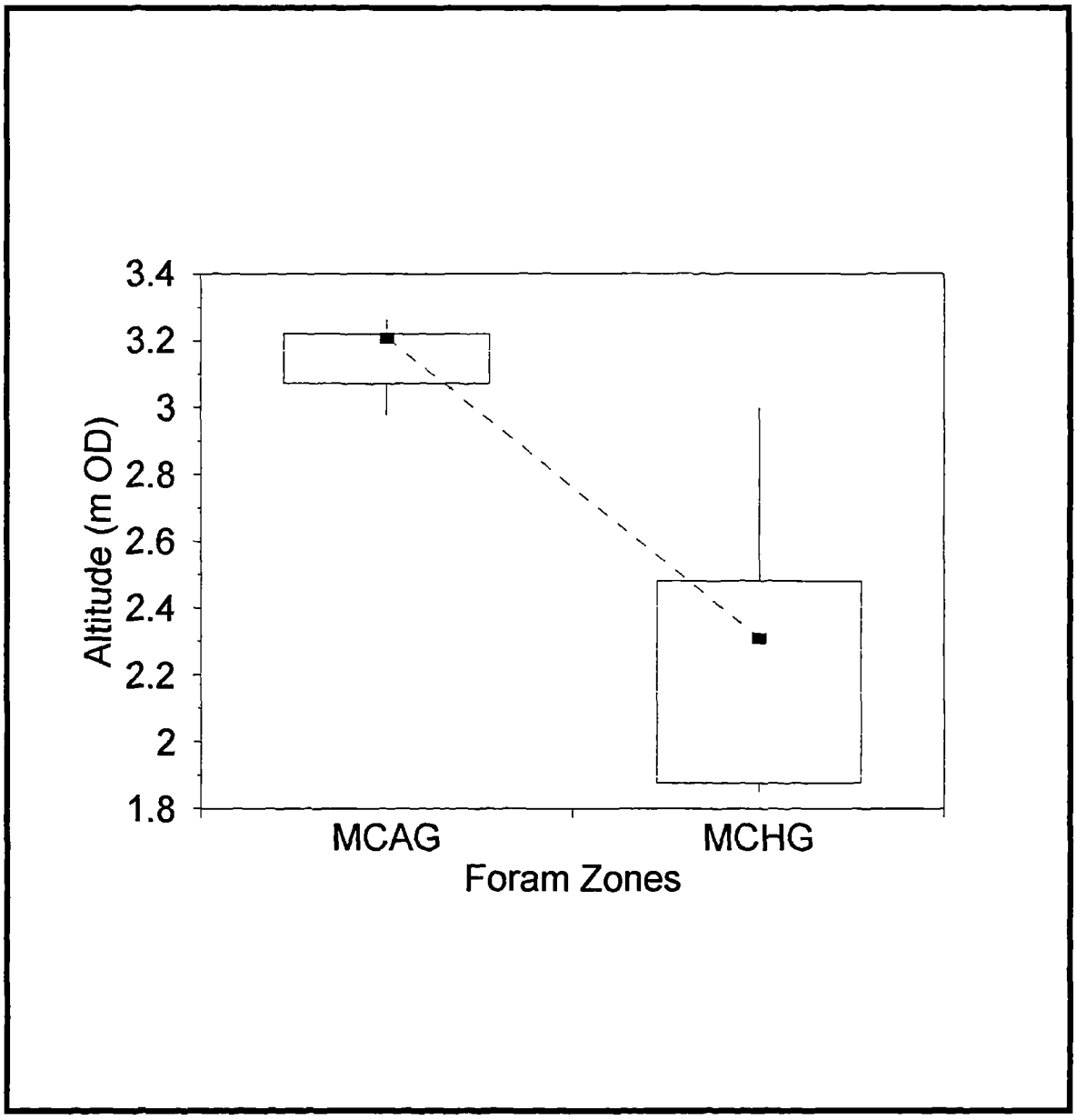
A6.4 Unconstrained cluster analysis based on unweighted Euclidean distance of monthly foraminiferal death assemblages from samples collected over a twelve month period from Brancaster Marsh. Only samples with counts greater than 40 individuals and species which reach 5 % of the total sum are included.



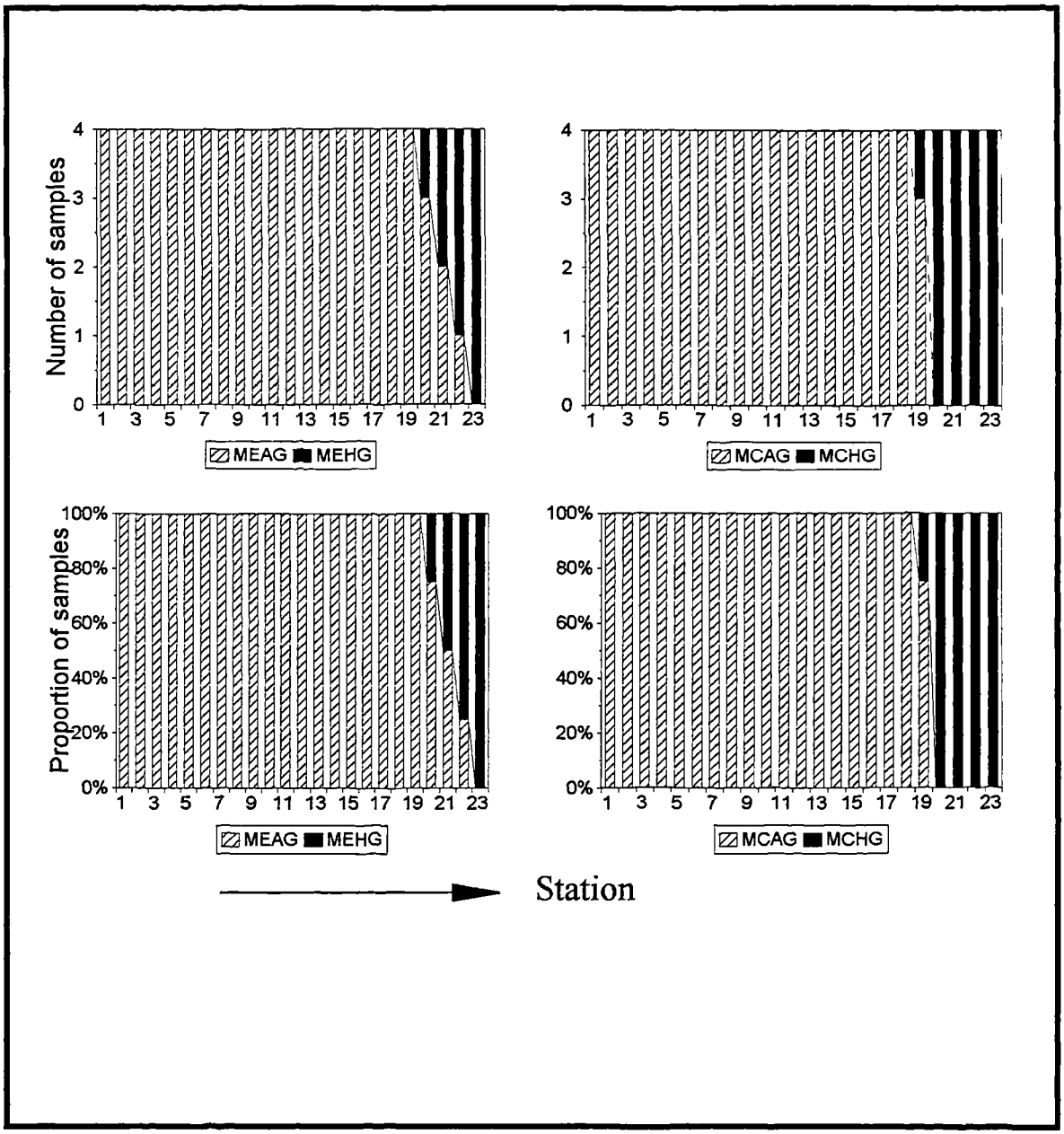
A6.5 Boxplots showing maximum, minimum, interquartile ranges and median altitudes for monthly clusters based on Euclidean distance from Brancaster Marsh.



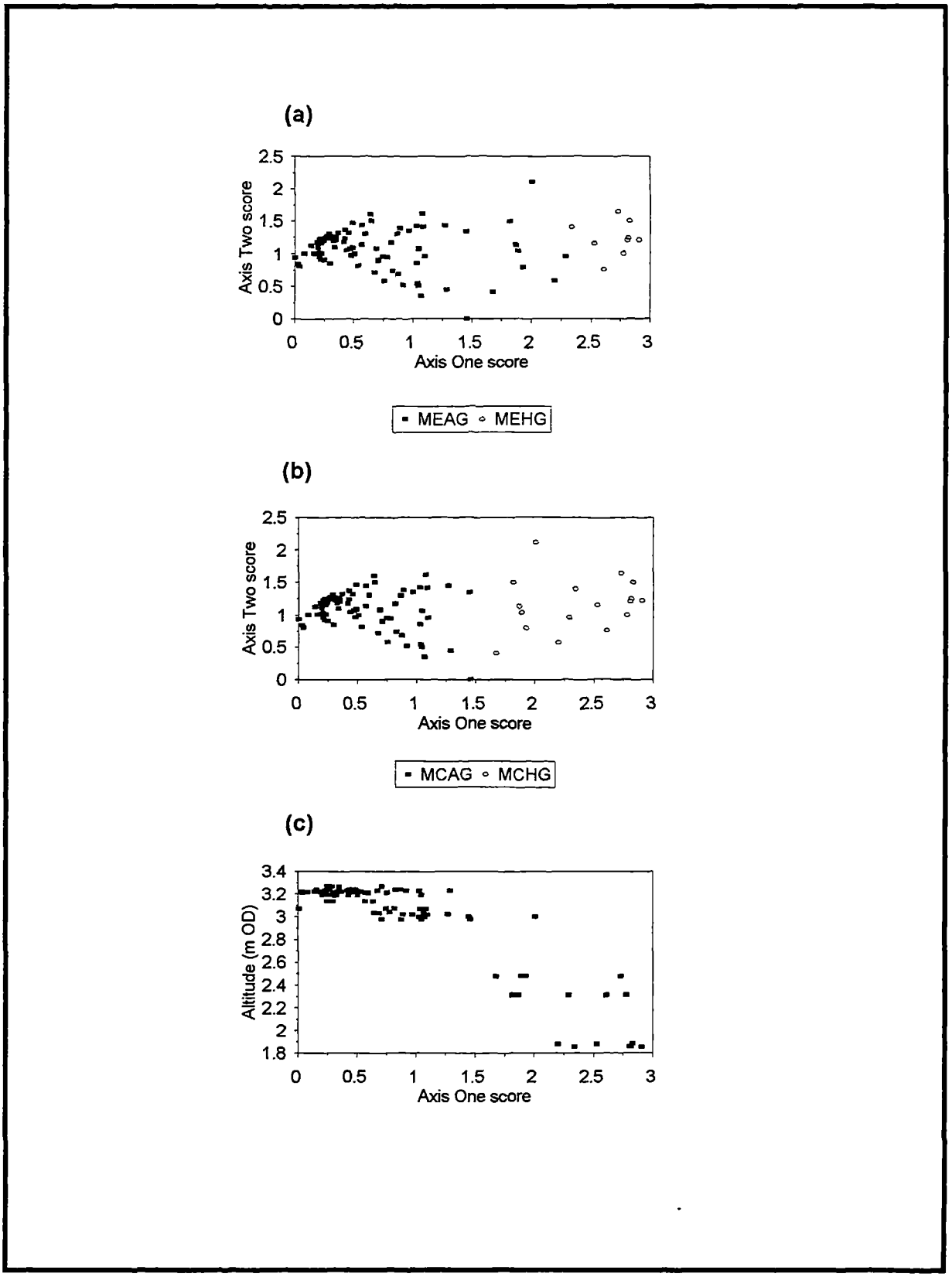
A6.6 Unconstrained cluster analysis based on unweighted Chord distance of monthly foraminiferal death assemblages from samples collected over a twelve month period from Brancaster Marsh. Only samples with counts greater than 40 individuals and species which reach 5 % of the total sum are included.



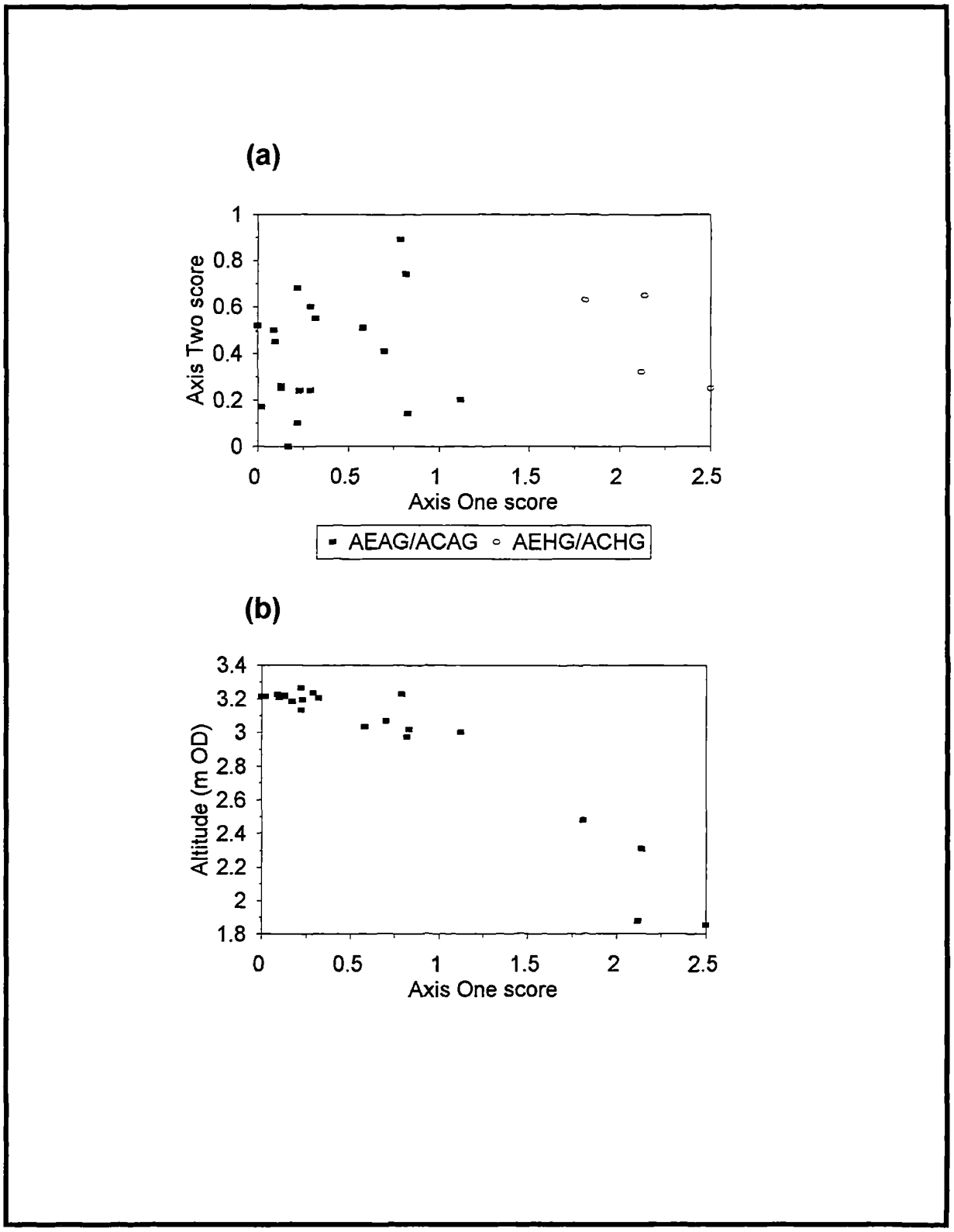
A6.7 Boxplots showing maximum, minimum, interquartile ranges and median altitudes for monthly clusters based on Chord distance from Brancaster Marsh.



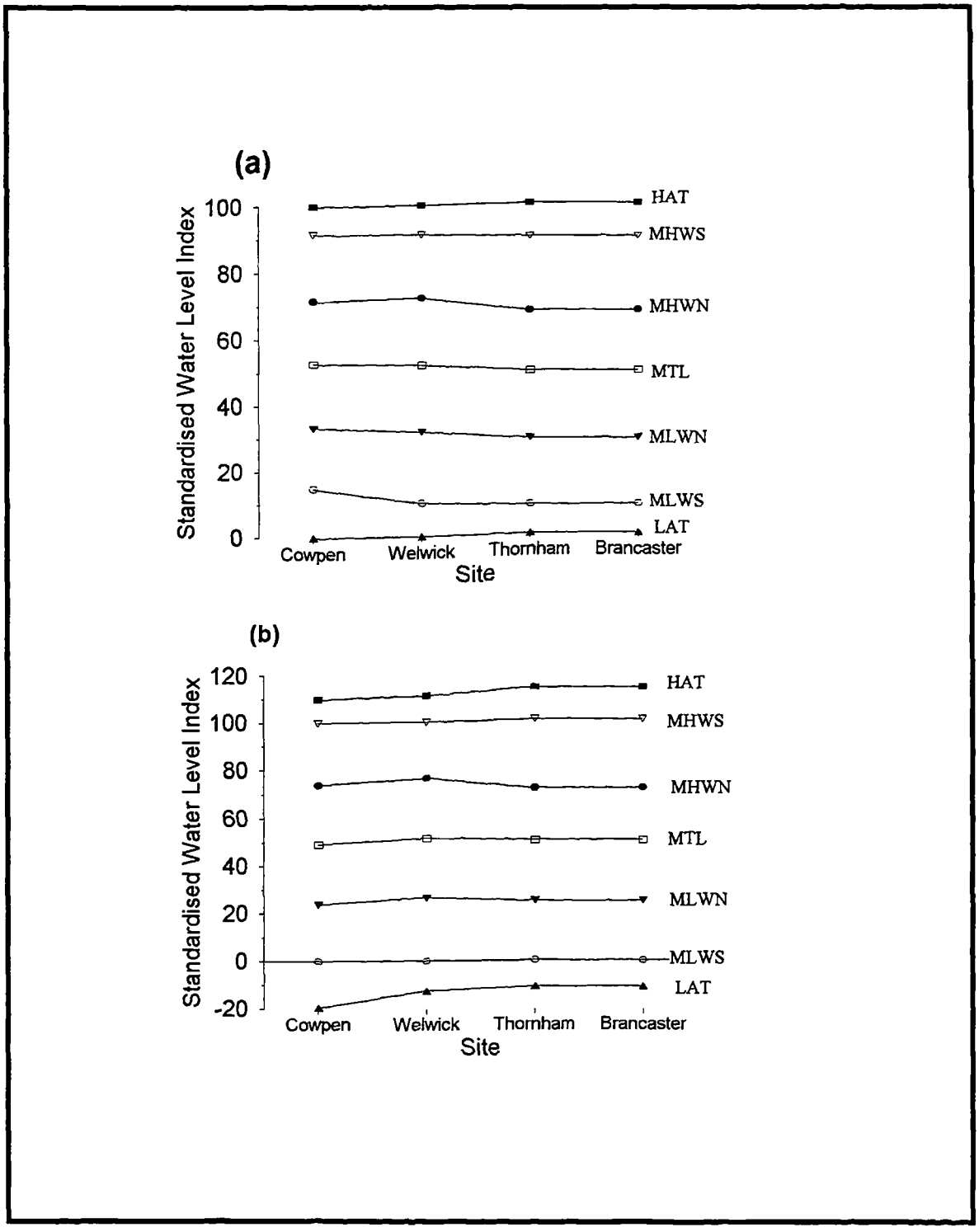
A6.8 Stacked bar comparisons showing the distribution of Euclidean and Chord zones across the intertidal zone of Brancaster Marsh. (a) Station number versus the number of monthly samples and (b) station number versus the proportion of monthly samples (%). Only samples with counts greater than 40 individuals and species which reach 5 % of the total sum are included.



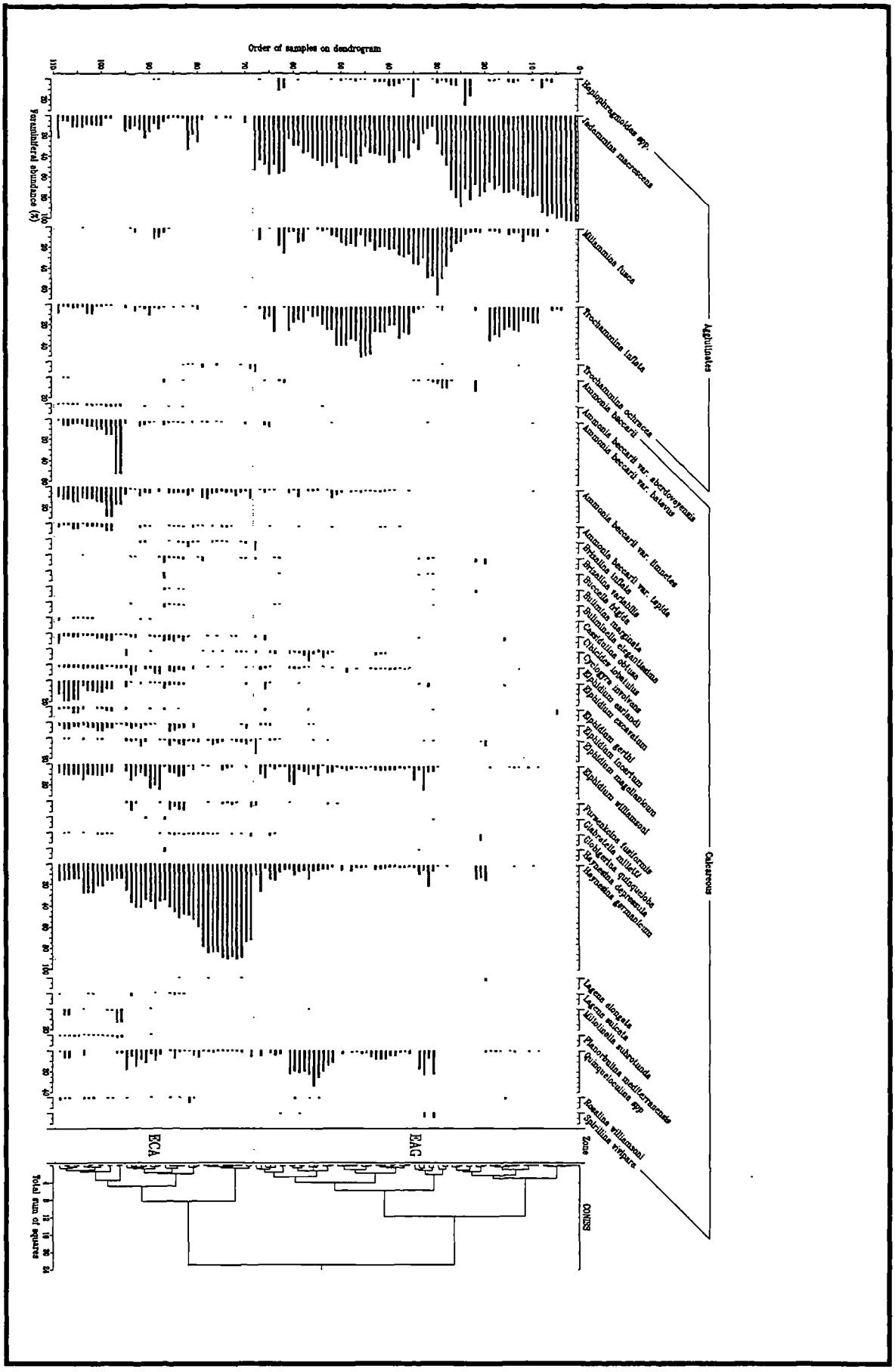
A6.9 DCA of monthly foraminiferal death assemblages from Brancaster Marsh. The zonations produced by unconstrained cluster analysis based on unweighted (a) Euclidean distance and (b) Chord distance are shown. (c) DCA Axis One scores versus altitude.



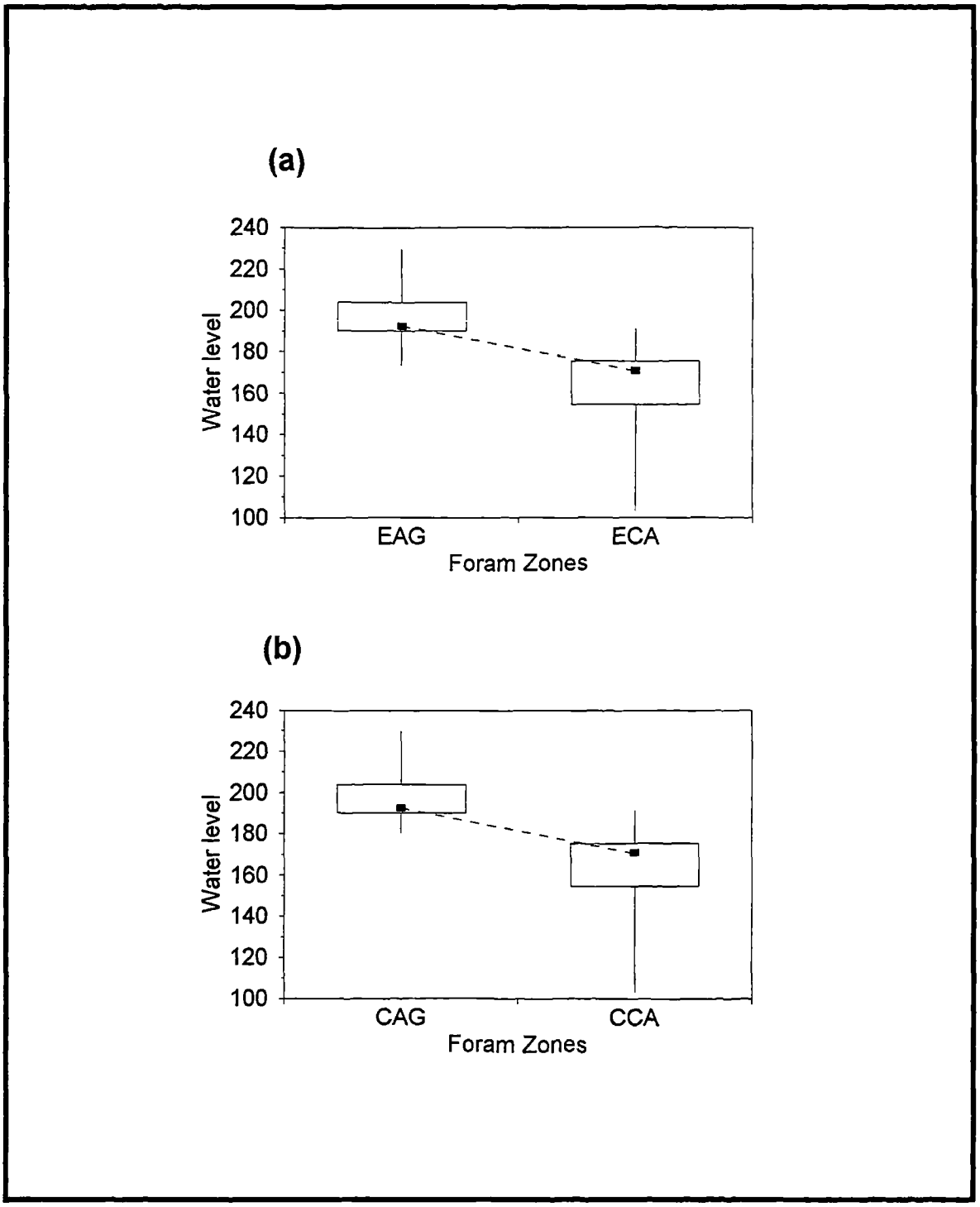
A6.10 (a) DCA of average annual foraminiferal death assemblages from Brancaster Marsh. The zonations produced by unconstrained cluster analysis based on unweighted Euclidean distance and Chord distance are shown. (b) DCA Axis One scores versus altitude.



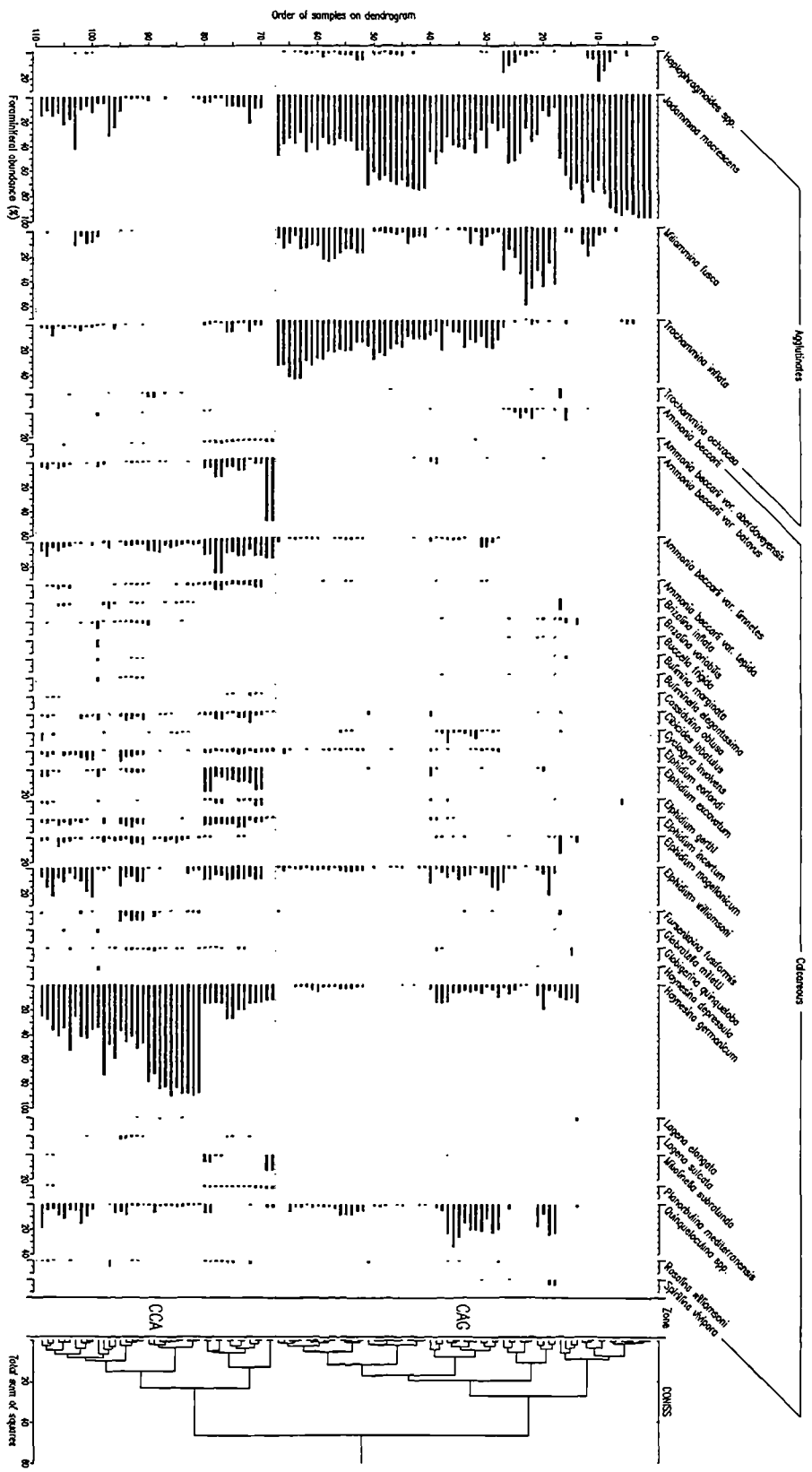
A7.1 Comparisons among constructed tidal levels for Cowpen, Welwick, Thornham and Brancaster Marsh using methods (a) Two and (b) Three.



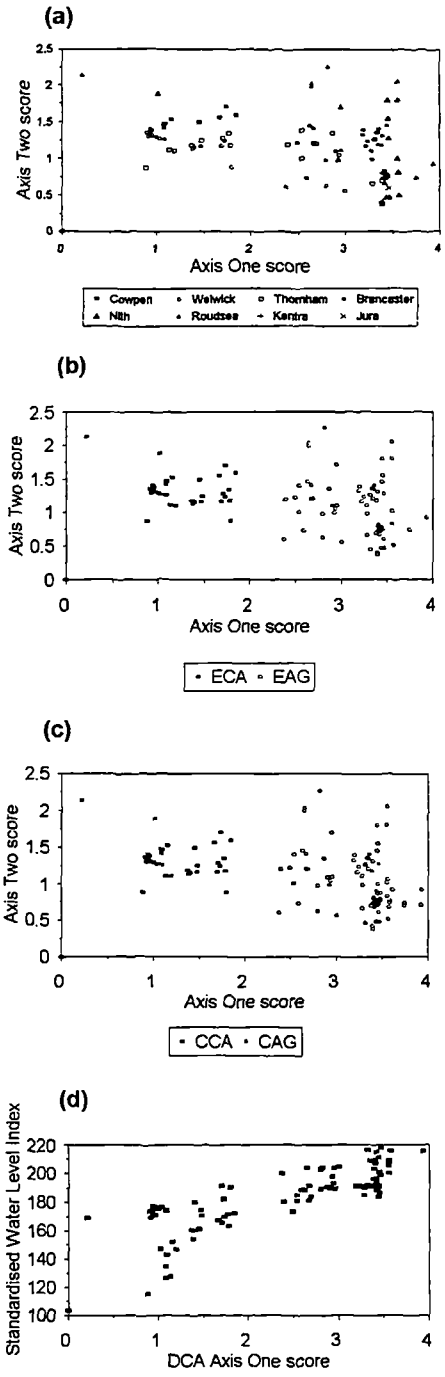
A8.1 Unconstrained cluster analysis based on unweighted Euclidean distance of the foraminiferal training set. Only samples with counts greater than 40 individuals and species which reach 2 % of the total sum are included.



A8.2 Boxplots showing maximum, minimum, interquartile ranges and median water levels for clusters based on (a) Euclidean and (b) Chord distance from the foraminiferal training set.



A8.3 Unconstrained cluster analysis based on unweighted Chord distance of the foraminiferal training set. Only samples with counts greater than 40 individuals and species which reach 2 % of the total sum are included.



A8.4 DCA of the foraminiferal training set. (a) The contemporary field sites and zonations produced by unconstrained cluster analysis based on unweighted (b) Euclidean distance and (c) Chord distance are shown.(d) DCA Axis One scores versus water level.

Appendix One: Laboratory Methods

The laboratory methods for lithostratigraphical (porewater salinity, grain size and loss on ignition analyses, and correction for sediment compaction) and biostratigraphical (foraminifera, diatom and pollen analyses, and extraction of calcareous foraminifera for AMS dating) analyses are described below. Furthermore, the Troels-Smith (1955) scheme of stratigraphic notation is illustrated.

1.1 Lithostratigraphy

1.1.1 Porewater salinity analysis (after Lambert *et al.*, 1949)

1. Weigh wet sample. Use greater than 60 g for inorganic sediments and greater than 90 g for organic sediments.
2. Place in an oven until dry (constant weight).
3. Weigh dry sample and calculate loss on drying as a percentage.
4. Add distilled water (at a ratio of: 5:1 for saline inorganic sediments and 10:1 for less saline organic samples) to approximately 10 g of dry sediment. The actual amount depends on site characteristics (i.e. more sediment needed for less saline areas or high moisture sediments).
5. Put a glass rod into a beaker and place in a sonic bath for 15 minutes.
6. Filter the sediment into a boiling tube.
7. Use the filtrate for chloride determination. Typically 2 ml aliquots are required for saline sites (water/sediment ratio is 5:1) and 5 ml aliquots for less saline sites(water/sediment ratio is 10:1).
8. Porewater salinity is calculated as follows:

$$A = \frac{1000}{\text{mls aliquot used}} * (\text{mls titration - blank})$$

$$B = 100 - \text{loss on drying \%}$$

$$C = \frac{\text{Weight of dry sediment used}}{B} * 100$$

$$D = \text{Weight of dry sediment used} * \text{ratio}$$

$$E = C - \text{weight of dry sediment used}$$

$F =$ $\underline{D} * A$ = chloride content in parts per million
E

$G =$ $\underline{F}$ = chloride content in parts per thousand
1000

$H =$ 1.80655 * G = **Salinity in parts per thousand**

1.1.2 Loss on ignition analysis (after Ball, 1964)

An oven dry sample is added to a crucible of known weight and placed in a furnace at 375 °C for 16 hours. Heating at this temperature removes all the organic matter.

Loss on ignition % = ((O - I)/O) * 100 (8)

where O is weight of oven dried sample; and I is the ignited weight.

1.1.3 Grain size analysis (after Folk, 1965)

1. Disaggregate air dry samples using a pestle and mortar.
2. Add 20 % solution of hydrogen peroxide (H_2O_2) to remove the organic matter.
3. Add 3.5 g of Clagon to saturate the clay exchange complex with the monovalent sodium ion, resulting in the deflocculation of the clay.
4. Wet sieve through a nest of sieves (4, 2, 0.5, 0.25, 0.125 and 0.064 mm). The fraction held on each sieve is transferred to a weighted container and the weight is obtained.
5. Analyse the fine fraction using the pipetted sedimentation technique to separate the silt sized particle from the clay.

1.1.4 Correction for sediment compaction

It is assumed that compaction is equally distributed within the sample. If this is not considered suitable, the sample is split into a number of sub-sections and the calculation is made independently on each.

The corrected depth is calculated by:

$$D_{corr} = (D_{base} - (D_{base} - D_{obs}))*(L_{exp}/L_{obs}) \quad (9)$$

where D_{base} is the known depth of base of a specific sample; D_{obs} is the observed depth; L_{exp} is the expected length of a core within the tube; L_{obs} is the observed length of a core within the tube; and D_{corr} is the corrected depth of a specific sample.

1.2 Biostratigraphy

1.2.1 Foraminiferal analysis (after Scott and Medioli, 1980a and de Rijk, 1995a)

1. Each standardised 10 cm^3 sample is placed in buffered ethanol. Protein stain rose Bengal is added to identify organisms living at the time of collection (Walton, 1952).
2. Wet sieve through 0.5 mm and 0.064 mm sieves (0.5 mm retains the coarse organics and allows the foraminifera to pass through to the 0.064 mm screen).
3. Fine organic material is separated from the foraminifera by decantation.
4. The greater than 500 μm and decanted fraction are examined before being discarded.

1.2.2 Diatom analysis (after Palmer and Abbott, 1986)

1. Extract 1 cm^3 of sediment and transfer to a beaker and add 30 % H_2O_2.
2. Heat gently for 6 hours, adding distilled water as necessary.
3. By pipetting, the diatom and water mixture is mounted onto a cover slip which is placed on a hotplate.
4. Evaporate slowly and add naphrax solution to the microscope slide.
5. Heat gently to liquefy the naphrax, cool and allow to set.

1.2.3 Pollen analysis (after Moore and Webb, 1978)

1. Measure 0.5 cm^3 of sediment by displacement in water using a 5 cm^3 measuring cylinder.
2. Add cold 10 % potassium hydroxide and heat in boiling water for 30 minutes.

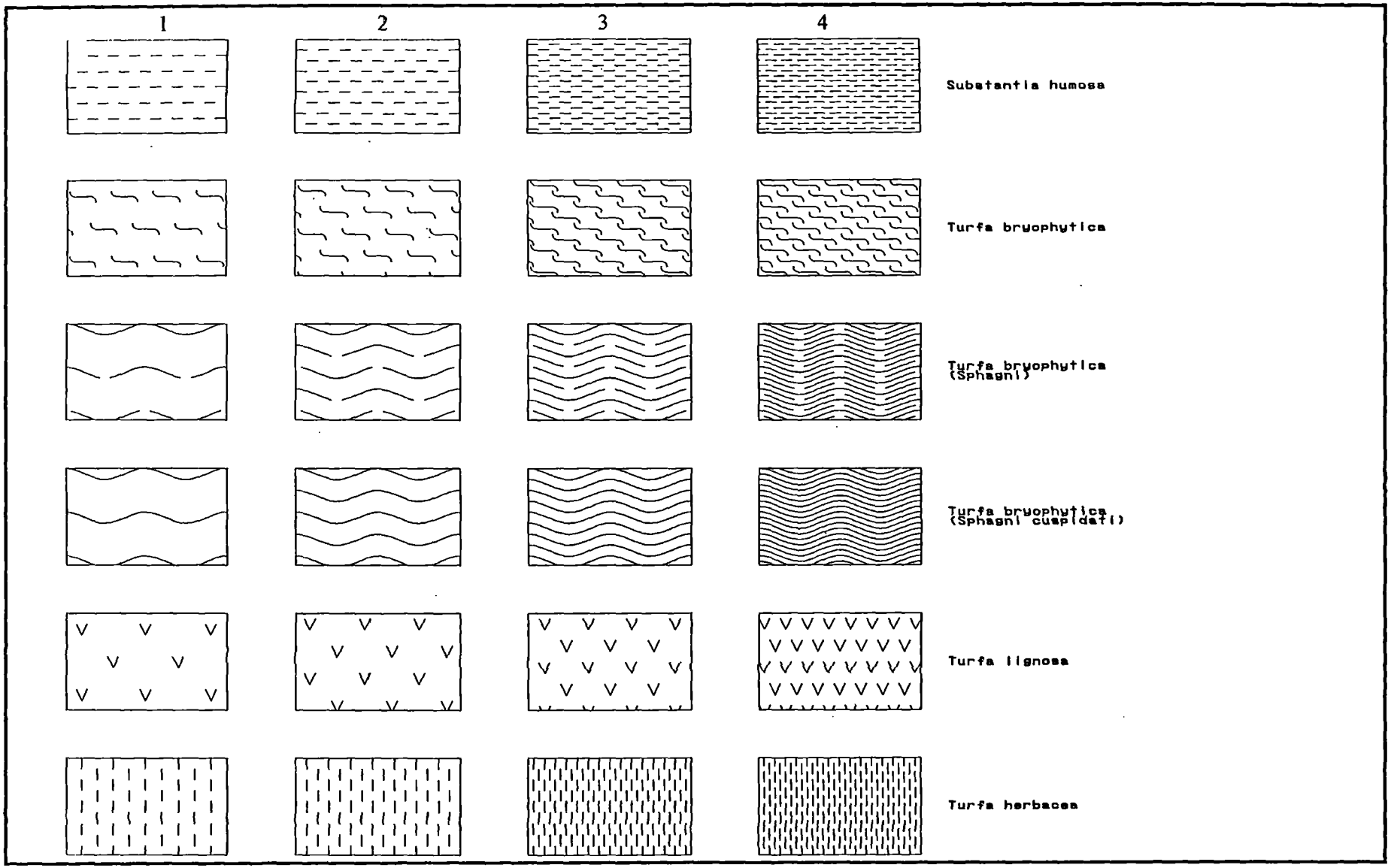
3. Decant through a 0.018 mm sieve, centrifuge and wash until liquid is unstained.
4. Add glacial acetic acid, stir and centrifuge.
5. Decant, add acetylation solution (sulphuric acid/acetic anhydride in at a ratio of 1:9), heat in boiling water for one minute, top up with glacial acetic acid, centrifuge and decant.
6. Add glacial acetic acid, centrifuge, decant. Then add distilled water, centrifuge and decant.
7. Stain by adding tertiary butyl alcohol and two drops of safranin solution, centrifuge and decant. Add 1 cm^3 of tertiary butyl alcohol, transfer to vial, centrifuge and decant.
8. Add silicone oil and leave for 12 hours.

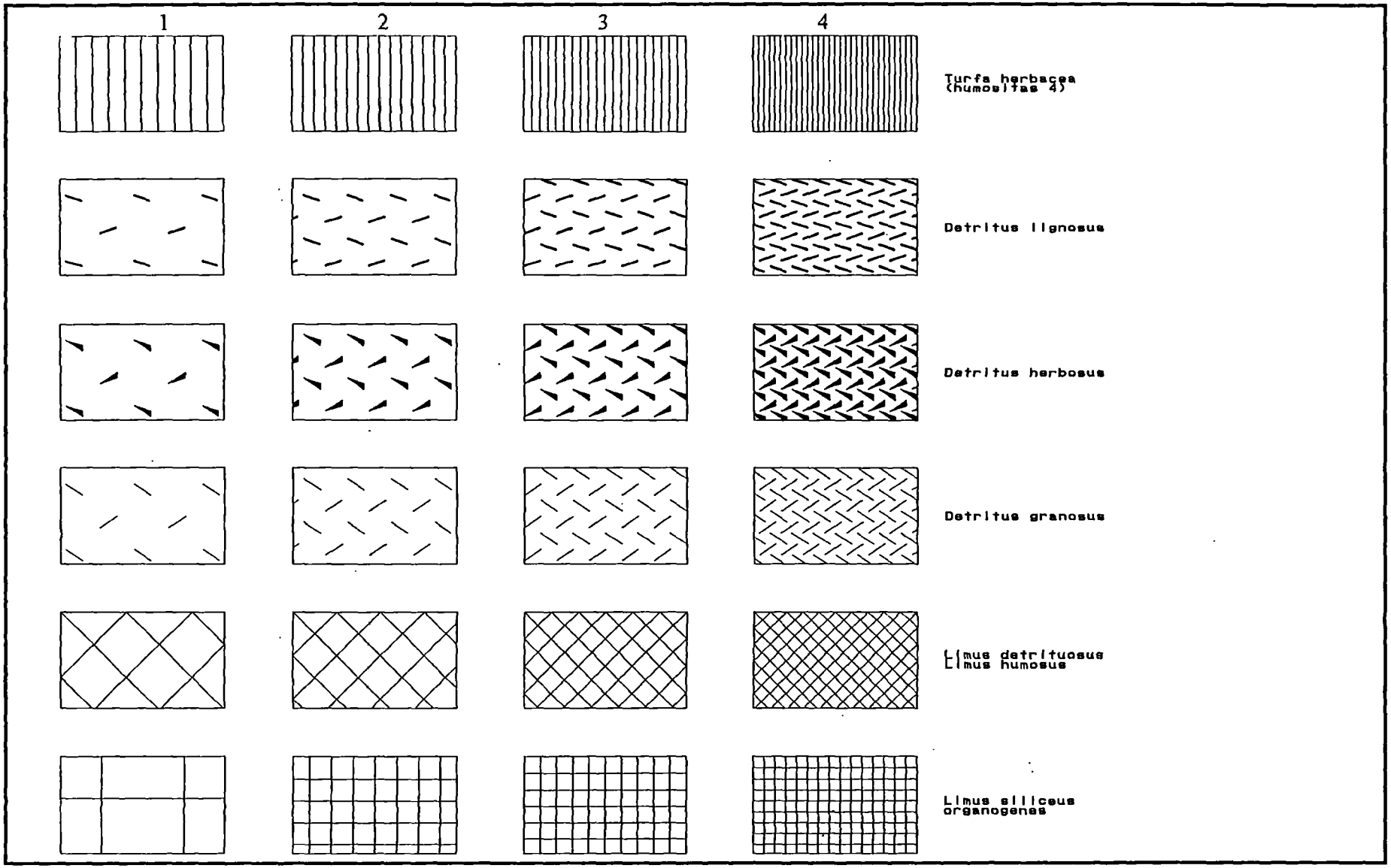
1.2.4 Extraction of foraminifera for AMS dating (after Feyling-Hanssen *et al.*, 1971, Meldgaard and Knudsen, 1979 and Heier-Nielsen, 1995)

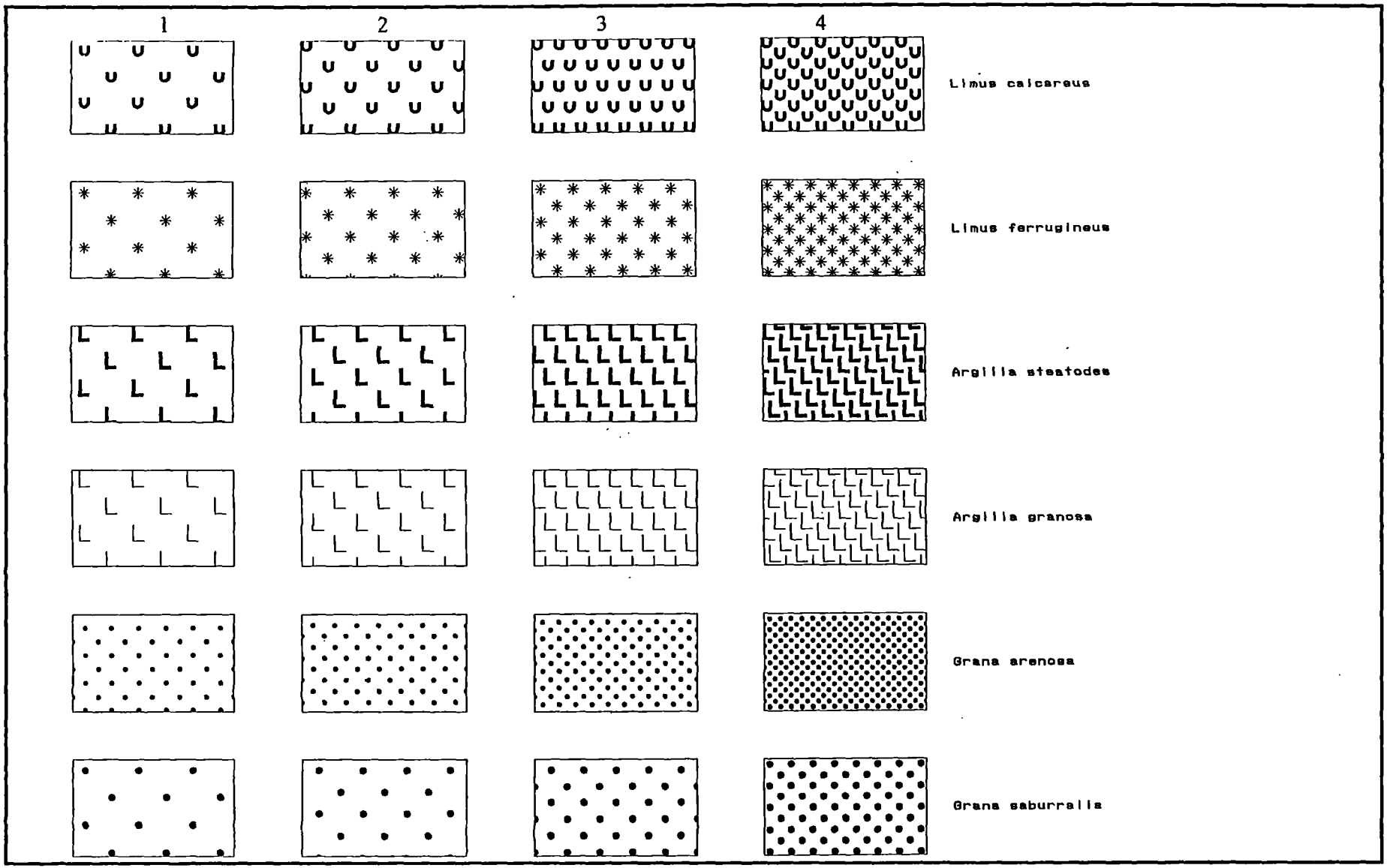
1. Oven dry the samples.
2. Wet sieve the dried sediment through sieves with mesh diameters of 0.5 mm and 0.064 mm.
3. The grain size fraction retained on the 0.064 mm screen is separated by floatation in carbon tetrafloride (CCl_4, ρ = 1.59 g/cm^3). Heier-Nielsen (1995) has shown that treatment with this organic liquid does affect the ^{14}C age of the foraminiferal samples.
4. The foraminifera are subsequently hand-picked from the lighter fraction. As the light, empty foraminiferal shells float in the heavy liquid they are decanted with the liquid and thus separate from the heavy mineral grains.
5. Foraminiferal samples are inspected during picking and partly dissolved or dubious specimens are avoided.

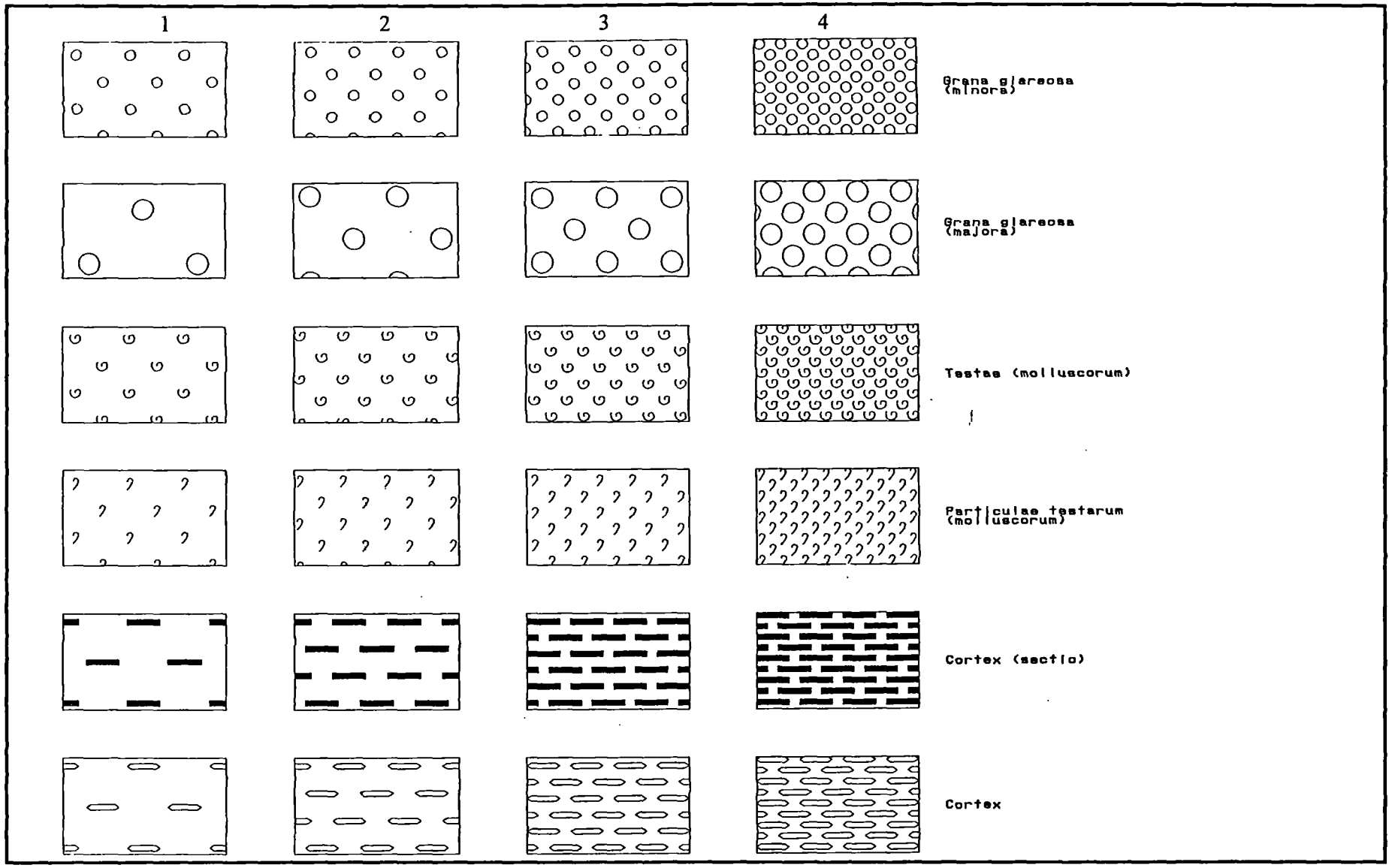
1.3 Troels-Smith (1955) scheme of stratigraphic notation

Troels-Smith (1955) described and defined an almost infinite list of unconsolidated deposits into a relatively small number of organic and inorganic elements, occurring as component parts. The proportion of component elements in a given deposit is estimated on a five-class scale where zero implies the absence of, and four the maximum presence of. The key for the Troels-Smith (1955) scheme of stratigraphic notation is shown below


1
2
3
4
Substantia humosa
Turfa bryophytica
Turfa bryophytica (Sphagni)
Turfa bryophytica (Sphagni cuspidati)
Turfa lignosa
Turfa herbacea


1
2
3
4
Turfa herbacea (humositas 4)
Detritus lignosus
Detritus herbosus
Detritus granosus
Limus detrituosus
Limus humosus
Limus silliceus organogenes


1
2
3
4
Limus calcareus
Limus ferrugineus
Argilla steatodes
Argilla granosa
Grana arenosa
Grana saburralia


1
2
3
4
Grana glareosa (minora)
Grana glareosa (majora)
Testae (molluscorum)
Particulae testarum (molluscorum)
Cortex (sectio)
Cortex

Appendix Two: Foraminiferal taxonomy

The phenotypical variation in species forms a taxonomical problem which has caused a sometimes confusing nomenclature (de Rijk, 1995a). This appendix briefly describes the dominant agglutinated and calcareous species identified from contemporary and fossil sites. They are species that occur in greater than 20 samples from the contemporary foraminiferal training set (Volume One, Table 5.5). Furthermore, the accuracy of foraminiferal taxonomy is assessed by recounting a sample from Cowpen Marsh.

Foraminiferal species found within the intertidal zone can be divided into two groups. First, agglutinated forms that dominate the vegetative marsh (belonging to the suborder Textulariina). Second, calcareous forms that dominate the mudflats and sandflats (belonging to the suborders Miliolina and Rotaliina). Generic names are in accordance with Murray (1971, 1979) and de Rijk (1995a) with three exceptions: *Haynesina germanica* in this thesis is equivalent to *Protelphidium germanicum* (Murray, 1979); the species *Haplophragmoides manilaensis* and *Haplophragmoides wilberti* are difficult to differentiate and are grouped as *Haplophragmoides* spp.; and similarly, the various *Quinqueloculina* species are grouped as *Quinqueloculina* spp. The species are listed in alphabetical order within three different suborders: Textulariina; Miliolina; and Rotaliina.

2.1 Suborder Textulariina

2.1.1 *Haplophragmoides* spp.

Haplophragmoides manilaensis: de Rijk (1995a) p. 25, Pl. I, Fig. 1-8.
Haplophragmoides wilberti: Murray (1979) p. 24, Fig. 5G-H.

Diagnostic features: The tests are agglutinated, composed of fine silt grains held together by an organic cement. They are pale brown in colour with a smooth finish and planispirally coiled. *H. manilaensis* and *H. wilberti* are difficult to differentiate and subsequently are grouped as *H.* spp. Likewise, de Rijk (1995a) stated that there are strong similarities between the two forms because of interspecific variability.

Death Distribution: *H.* spp. are present in all marsh habitats, but the abundance decreases in areas below MHWST.

2.1.2 *Jadammina macrescens* (Brady)

Trochammina inflata (Montagu) var. *macrescens*: Brady (1870) p. 290, Pl. 11, Fig. 5a-c.
Jadammina polystoma: Scott and Medioli (1980a) p. 39, Pl. 3, Fig. 9-11.
Trochammina macrescens: Phelger and Walton (1950) p. 280, Pl. 11, Fig. 5a-c; and Scott and Medioli (1980a) p. 39, Pl. 3, Fig. 4-8.
Trochammina macrescens forma *polystoma*: Scott *et al.*(1990) p. 737, Pl. 1, Fig. 2a-c.
Jadammina macrescens: Murray (1971) p. 41, Pl. 13, Fig. 1-5; Murray (1979) p.28, Fig. 6K-M; and de Rijk (1995a) p. 26, Pl. III, Fig. 4-6.

Diagnostic features: The tests are agglutinated, composed of extremely fine detrital grains with abundant organic cement and brown in colour. They are trochospirally coiled and compressed with a shallow umbilicus. The walls are thin and flexible when wet and the chambers commonly collapse when dried. *Jadammina* is distinguished from *Trochammina* by its primary aperture (Murray, 1971; Bronnimann and Whittaker, 1984; de Rijk, 1995a). The former has a multiple aperture consisting of a single interiomarginal slit at the base of the apertural face with scattered supplementary areal pores. The latter has an interiomarginal slit-like umbilical aperture between the coiling and the periphery.
Death Distribution: *J. macrescens* is the most abundant species in all contemporary sites and dominates most marsh habitats.

2.1.3 *Miliammina fusca* (Brady)

Miliammina fusca: Murray (1971) p. 21, Pl. 3, Fig. 1-6; Murray (1979) p.23, Fig. 5D-F; and de Rijk (1995a) p. 27, Pl. II, Fig. 10-12.

Diagnostic features: The tests are agglutinated, composed of detrital grains in an organic cement and pale brown in colour. The morphology varies slightly with grain size (sand or silt). They are elongate, rounded in section and made up of many chambers coiled on a milioline plan.
Death Distribution: *M. fusca* is abundant in all marsh habitats.

2.1.4 *Trochammina inflata* (Montagu)

Trochammina inflata: Murray (1971) p. 35, Pl. 10, Fig. 3-6; Murray (1979) p.26, Fig. 6E-G; and de Rijk (1995a) p. 34, Pl. II, Fig. 1-3.

Diagnostic features: The tests are agglutinated, composed of extremely fine detrital grains with abundant organic cement and brown in colour. They are trochospirally coiled with globular chambers. The size and globular character of the chambers varies among samples.
Death Distribution: *T. inflata* is abundant in all marsh habitats.

2.2 Suborder Miliolina

2.2.1 *Cyclogyra involvens* (Reuss)

Cyclogyra involvens: Murray (1971) p. 53, Pl. 18, Fig. 1-3; and Murray (1979) p.29, Fig. 7A-B.

Diagnostic features: The tests are calcitic with a porcellaneous white appearance. The proloculus is followed by a long planispirally coiled, tubular chamber with a simple terminal aperture.
Death Distribution: *C. involvens* is present in tidal flat and low marsh habitats.

2.2.2 *Quinqueloculina* spp.

Quinqueloculina spp.: Murray (1971) p. 57-65, Pl. 20-24; and Murray (1979) p.30-35, Fig. 7H-9I.

Diagnostic features: The tests are porcellaneous with a translucent to opaque appearance. The chambers are coiled on a quinqueloculine plan. The species has an aperture usually with a tooth. The various *Quinqueloculina* species are difficult to differentiate and are subsequently grouped as *Q.* spp. Similar, taxonomic problems were found by Whittaker (pers. comm., 1995).
Death Distribution: *Q.* spp. is present throughout the intertidal zone.

2.3 Suborder Rotaliina

2.3.1 *Ammonia beccarii* (Linne)

Ammonia beccarii: Murray (1971) p. 151, Pl. 62, Fig. 1-7; and de Rijk (1995a) p. 35.

Diagnostic features: The tests are calcitic with radially arranged crystallites and pores. They are glassy or translucent in appearance and sometimes brownish in colour. Furthermore, the tests are biconvex and subcircular in outline. The chambers are trochospirally coiled with six to nine chambers in the last whorl. The sutures on the spiral side of a test are flush to depressed whereas those on the umbilical side are depressed. *A. beccarii* includes four variants:

- *A. beccarii* var. *aberdoveyensis*: Murray (1979) p. 56, Fig. 18A-C;
- *A. beccarii* var. *batavus*: Murray (1979) p. 56, Fig. 18D-F;
- *A. beccarii* var. *limnetes*: Murray (1979) p. 56, Fig. 18G-I;
- *A. beccarii* var. *tepida*: Murray (1979) p. 56, Fig. 18J-L.

Death Distribution: *A. beccarii* is present in the low marsh and tidal flat.

2.3.2 *Brizalina variablis* (Williamson)

Brizalina variablis: Murray (1971) p. 113, Pl. 46, Fig 1-3; and Murray (1979) p.425, Fig. 12E.

Diagnostic features: The tests are compressed and biserial throughout with deeply depressed, straight and oblique sutures. The test walls are calcitic and composed of radially arranged crystallites. The aperture of a test is terminal with a toothplate.

Death Distribution: *B. variablis* is present in tidal flat environments.

2.3.3 *Cibicides lobatulus* (Walker and Jacob)

Cibicides lobatulus: Murray (1971) p. 175, Pl. 73 Fig. 1-7; and Murray (1979) p. 62, Fig. 21A-C.

Diagnostic features: The tests are calcitic, radial and granular nature. They have large pores which are often translucent in appearance. Furthermore, the tests are planoconvex, trochospirally coiled with plane spiral sides and convex umbilical sides. The aperture of a test is an arch and a slit, bordered by a lip which extends along the spiral suture on the spiral side. However, numerous morphological variations are observed.

Death Distribution: *C. lobatulus* is present, often in large numbers, in tidal flat environments.

2.3.4 *Elphidium earlandi* (Cushman)

Elphidium earlandi: Murray (1971) p. 157, Pl. 65, Fig. 1-7; and Murray (1979) p. 50, Fig. 15A-B.

Diagnostic features: The tests of all *Elphidium* species are planispirally coiled, involute and laterally compressed. Furthermore, all species have calcitic walls of radially arranged crystallites. The diagnostic features of *E. earlandi* are the long retral processes with only four or five present on each side.

Death Distribution: *E. earlandi* is common in low marsh and tidal flat habitats.

2.3.5 *Elphidium excavatum* (Terquem)

Elphidium excavatum: Murray (1971) p. 159, Pl. 66, Fig 1-7; and Murray (1979) p.50, Fig. 15C-D.

Diagnostic features: *E. excavatum* can be distinguished by the three to five very short retral processes on each chamber. There are eight to nine chambers in the outer whorl.

Death Distribution: *E. excavatum* is present in low marsh and tidal flats environments.

2.3.6 *Elphidium incertum* (Williamson)

Elphidium incertum: Murray (1979) p. 50, Fig. 15E-F.

Diagnostic features: The diagnostic features of *E. incertum* are the eight to eleven chambers in the outer whorl and the star shaped array of depressed sutures centred on the umbilicus.

Death Distribution: *E. incertum* is present in low marsh and tidal flats environments.

2.3.7 *Elphidium magellanicum* (Heron-Allen and Earland)

Elphidium magellanicum: Murray (1971) p. 163, Pl. 68, Fig. 1-7; and Murray (1979) p. 48, Fig. 14C-D.

Diagnostic features: *E. magellanicum* is easily identified due to the distinctive pattern of tubular ornament in the broadly depressed sutures.
Death Distribution: *E. magellanicum* is common in low marsh and tidal flat habitats.

2.3.8 *Elphidium williamsoni* (Williamson)

Elphidium williamsoni: Murray (1979) p. 52, Fig. 16C-D.

Diagnostic features: *E. williamsoni* is distinguished by the numerous long retral processes and the ten to twelve chambers in the outer whorl.
Death Distribution: *E. williamsoni* is the most abundant species of *Elphidium*. It is found in low marsh and tidal flat habitats.

2.3.9 *Haynesina germanica* (Ehrenberg)

Protelphidium germanicum: Murray (1979) p. 52, Fig. 16C-D.

Diagnostic features: The tests are calcitic with radially arranged crystallites. They are finely perforate and glassy in appearance. Furthermore, the tests are planispirally coiled with five to eleven chambers in the last whorl. The sutures are slightly depressed over the periphery but deeply depressed close to the umbilicus. The aperture of a test is a row of pores at the base of the last chamber.
Death Distribution: *Haynesina germanica* is the most abundant calcareous species. It is present in most low marsh and tidal flat habitats.

2.4 Evaluation of foraminiferal taxonomy

2.4.1 Materials and methods

A sample from station 18 of Cowpen Marsh, collected on 1 May 1995 was selected for recounting. The results were compared with the original count to assess the accuracy of the foraminiferal taxonomy. Sample collection and preparation (Appendix One) followed Scott and Medioli (1980a) and de Rijk (1995a).

2.4.2 Results

The differences between samples (relative abundance and absolute count) is generally relatively small. (Table A2.1). However, the relative differences become greater for minor species. For example, the relative abundance of *Lagena sulcata* is over three times greater in the original count. Nevertheless, the data shows that the foraminiferal taxonomy of this thesis can produce reliable results that are indicative of foraminiferal assemblages from a particular site. Furthermore, the variations maybe associated with errors of the wetsplitter (Volume One Section 3.3.1) rather than differences in the taxonomy.

Sample	Original		Recount	
	No.	%	No.	%
Ammonia beccarii var. *limnetes*	8	1.80	14	3.26
Buliminella elegantissima	0	0.00	2	0.47
Elphidium earlandi	16	3.60	20	4.65
Elphidium excavatum	16	3.60	12	2.79
Elphidium incertum	32	7.21	24	5.58
Elphidium williamsoni	8	1.80	10	2.33
Fursenkoina fusiformis	64	14.41	64	14.88
Lagena interrupta	16	3.60	16	3.72
Lagena sulcata	8	1.80	2	0.47
Haynesina germanica	268	60.36	256	59.53
Jadammina macrescens	8	1.80	8	1.86
Total	444	-	430	-

Table A2.1 Original and recount of sample 18, collected on 1 May 1995, Cowpen Marsh. Absolute and relative abundance of each foraminiferal species are shown.

Appendix Three: Biostratigraphical data of Cowpen Marsh

3.1 The pilot study of Cowpen Marsh

3.1.1 Sample preparation in the laboratory

Species	1	2	3	4	5	6	7	8
Haplophragmoides spp.	7	3	4	3	3	2	3	2
Miliammina fusca	22	23	18	21	22	23	27	23
Jadammina macrescens	129	138	128	162	125	140	150	136
Trochammina inflata	32	36	31	35	32	31	32	33
Cibicides lobatulus	1	0	2	1	0	0	0	2
Elphidium williamsoni	11	12	10	14	10	8	8	9
Haynesina germanica	7	11	7	7	8	4	7	6
Quinqueloculina spp.	3	9	7	7	5	3	4	5
Total counted	212	232	207	251	206	211	232	216

Table A3.1 Total foraminiferal counts of eight aliquots from a high marsh sample, Cowpen Marsh.

3.1.2 Determination of the life foraminiferal population

Species	0	3	5	7	9	11	15	20	25
Miliammina fusca	16	0	0	0	0	0	0	0	0
Jadammina macrescens	32	48	0	0	0	0	0	0	0
Trochammina inflata	112	24	0	0	0	0	0	0	0
Elphidium williamsoni	0	0	0	0	0	0	0	0	0
Haynesina germanica	0	0	0	0	0	0	0	0	0
Sum	208	72	0	0	0	0	0	0	0

Table A3.2 Infaunal abundance of five foraminiferal species and the sum of live foraminifera per 10 cm^3 from a high marsh environment of Cowpen Marsh.

Species	0	3	5	7	9	11	15	20	25
Miliammina fusca	32	16	0	0	0	0	0	0	0
Jadammina macrescens	192	64	48	0	0	0	0	0	0
Trochammina inflata	0	15	0	0	0	0	0	0	0
Elphidium williamsoni	192	0	0	0	0	0	0	0	0
Haynesina germanica	64	0	0	0	0	0	0	0	0
Sum	544	96	48	0	0	0	0	0	0

Table A3.3 Infaunal abundance of five foraminiferal species and the sum of live foraminifera per 10 cm^3 from a low marsh environment of Cowpen Marsh.

Species	0	3	5	7	9	11	15	20	25
Miliammina fusca	0	0	0	0	0	0	0	0	0
Jadammina macrescens	32	0	0	0	0	0	0	0	0
Trochammina inflata	0	0	0	0	0	0	0	0	0
Elphidium williamsoni	32	0	0	0	0	0	0	0	0
Haynesina germanica	32	16	16	0	0	0	0	0	0
Sum	192	48	32	0	2	13	0	0	0

Table A3.4 Infaunal abundance of five foraminiferal species and the sum of live foraminifera per 10 cm^3 from a mudflat environment of Cowpen Marsh.

3.1.3 Life versus death versus total assemblage constituents

Sampling code	Date
951	01/05/95
952	14/05/95
953	01/06/95
954	12/06/95
955	28/06/95
956	12/07/95
957	27/07/95
958	10/08/95
959	26/08/95
9510	09/09/95
9511	24/09/95
9512	08/10/95
9513	24/10/95
9514	07/11/95
9515	22/11/95
961	07/12/95
962	05/01/96
963	20/01/96
964	04/02/96
965	18/02/96
966	05/03/96
967	19/03/96
968	04/04/96
969	17/04/96
9610	03/05/96

Table A3.5 Sampling code and date of sampling during the twelve month study of Cowpen Marsh.

Species	95/1	95/2	95/3	95/4	95/5	95/6	95/7	95/8	95/9	95/10	95/11	95/12	95/13	95/14	95/15	96/1	96/2	96/3	96/4	96/5	96/6	96/7	96/8	96/9	96/10
Miliammina fusca	162	200	122	208	180	180	184	160	240	168	136	160	192	144	48	0	0	16	8	80	96	144	176	80	16
Jadammina macrescens	1634	1492	2020	1448	1382	1487	1696	2648	2544	2500	1904	2032	1856	1296	1184	528	328	512	208	656	960	1184	1264	1168	992
Trochammina inflata	370	254	364	236	324	350	408	956	1072	1100	1368	1104	608	608	512	368	392	640	256	384	192	512	1024	928	864
Elphidium williamsoni	175	324	380	494	444	488	616	432	200	152	88	208	240	240	224	224	120	272	144	368	448	544	400	624	944
Haynesina germanica	575	1220	1288	1146	1320	1728	2280	1584	944	676	384	384	320	528	608	624	424	736	256	576	800	640	480	800	928
Quinqueloculina spp.	300	412	416	450	748	1004	1680	628	176	121	288	288	208	240	272	320	208	368	264	528	576	480	736	272	224
Sum	3458	4494	5130	4428	4926	5845	7768	6832	5320	5003	4592	4448	3584	3280	3136	2304	1664	2768	1240	2816	3280	3664	4128	3888	4000

Table A3.6 Life variations of six foraminiferal species and total sum from the twelve month study period of Cowpen Marsh.

Species	95/1	95/2	95/3	95/4	95/5	95/6	95/7	95/8	95/9	95/10	95/11	95/12	95/13	95/14	95/15	96/1	96/2	96/3	96/4	96/5	96/6	96/7	96/8	96/9	96/10
Miliammina fusca	316	696	448	1552	777	600	712	479	912	612	776	656	512	512	480	544	448	432	384	480	608	528	432	432	432
Jadammina macrescens	3032	2264	2353	2512	2458	2556	3304	2652	4896	3901	3888	3440	3088	3248	3872	3952	4448	4384	4480	4032	4048	3056	2480	2512	2576
Trochammina inflata	580	284	396	320	317	357	392	306	832	702	1040	896	720	928	1168	1200	1360	1280	1392	1200	1136	880	816	880	1216
Elphidium williamsoni	156	316	300	245	209	192	272	114	200	220	192	336	288	384	448	624	448	528	448	576	624	512	512	688	592
Haynesina germanica	1135	2028	1808	1477	1444	1472	2280	1067	1160	1538	1272	1456	1360	1424	1296	1488	1456	1216	954	1488	1840	1840	2064	1712	1072
Quinqueloculina spp.	132	178	176	146	235	344	568	270	88	8	32	0	0	32	48	64	96	64	32	48	208	112	240	64	0
Sum	6215	7202	6849	7473	7081	7412	10264	6253	9536	8155	8296	7904	6608	7232	8160	8800	8976	8624	8224	9104	9744	8592	8112	7568	6384

Table A3.7 Death variations of six foraminiferal species and total sum from the twelve month study period of Cowpen Marsh.

Species	95/1	95/2	95/3	95/4	95/5	95/6	95/7	95/8	95/9	95/10	95/11	95/12	95/13	95/14	95/15	96/1	96/2	96/3	96/4	96/5	96/6	96/7	96/8	96/9	96/10
Miliammina fusca	478	896	570	1760	957	780	896	639	1152	780	912	816	704	656	528	544	448	448	392	560	704	672	608	512	448
Jadammina macrescens	4666	3756	4373	3960	3840	4043	5000	5300	7440	6401	5792	5472	4944	4544	5056	4480	4776	4896	4688	4688	5008	4240	3744	3680	3568
Trochammina inflata	950	538	760	556	641	707	800	1262	1904	1802	2408	2000	1328	1536	1680	1568	1752	1920	1648	1584	1328	1392	1840	1808	2080
Elphidium williamsoni	331	640	680	739	653	680	888	546	400	372	280	544	528	624	672	848	568	800	592	944	1072	1056	912	1312	1536
Haynesina germanica	1710	3248	3126	2623	2764	3200	4560	2651	2104	2214	1656	1840	1680	1952	1904	2112	1880	1952	1200	2064	2640	2480	2544	2512	2000
Quinqueloculina spp.	432	590	592	596	983	1348	2248	898	264	129	320	288	208	272	320	384	304	432	296	576	784	592	976	336	224
Sum	9673	11696	11979	11901	12007	13257	18032	13085	14856	13158	12888	12352	10192	10512	11296	11104	10640	11392	9464	11920	13024	12256	12240	11456	10384

Table A3.8 Total variations of six foraminiferal species and total sum from the twelve month study period of Cowpen Marsh.

Species	Mudflat	Low marsh	High marsh
Jadammina macrescens	0	96	52
Miliammina fusca	0	16	26
Trochammina inflata	16	0	52
Ammonia beccarii	0	0	0
Buliminella elegantissima	16	0	0
Cibicides lobatulus	0	0	0
Elphidium earlandi	0	16	0
Elphidium magellanicum	0	0	0
Elphidium williamsoni	16	96	0
Fursenkoina fusiformis	0	0	0
Fissurina lucida	0	0	0
Fissurina marginta	0	0	0
Haynesina germanica	16	32	0
Lagena clavata	0	0	0
Lagena sulcata	0	0	0
Quinqueloculina spp.	32	16	78
Sum	96	272	208

Table A3.9 Life surface assemblages from mudflat, low marsh and high marsh environments of Cowpen Marsh.

Species	Mudflat	Low marsh	High marsh
Jadammina macrescens	0	64	95
Miliammina fusca	0	96	19
Trochammina inflata	0	16	95
Ammonia beccarii	0	0	0
Buliminella elegantissima	16	0	0
Cibicides lobatulus	16	0	0
Elphidium earlandi	0	0	0
Elphidium magellanicum	16	0	0
Elphidium williamsoni	16	16	0
Fursenkoina fusiformis	32	0	0
Fissurina lucida	0	0	0
Fissurina marginta	0	0	0
Haynesina germanica	128	16	0
Lagena clavata	0	0	0
Lagena sulcata	0	0	0
Quinqueloculina spp.	0	0	0
Sum	224	208	208

Table A3.10 Death surface assemblages from mudflat, low marsh and high marsh environments of Cowpen Marsh.

Species	Mudflat	Low marsh	High marsh
Jadammina macrescens	0	160	147
Miliammina fusca	0	112	45
Trochammina inflata	16	16	147
Ammonia beccarii	0	0	0
Buliminella elegantissima	32	0	0
Cibicides lobatulus	16	0	0
Elphidium earlandi	0	16	0
Elphidium magellanicum	16	0	0
Elphidium williamsoni	32	112	0
Fursenkoina fusiformis	32	0	0
Fissurina lucida	0	0	0
Fissurina marginta	0	0	0
Haynesina germanica	144	48	0
Lagena clavata	0	0	0
Lagena sulcata	0	0	0
Quinqueloculina spp.	32	16	78
Sum	320	480	417

Table A3.11 Total surface assemblages from mudflat, low marsh and high marsh environments of Cowpen Marsh.

Species	Mudflat	Low marsh	High marsh
Jadammina macrescens	0	7	110
Miliammina fusca	0	9	34
Trochammina inflata	0	0	120
Ammonia beccarii	8	0	0
Buliminella elegantissima	8	0	0
Cibicides lobatulus	32	0	0
Elphidium earlandi	0	0	0
Elphidium magellanicum	24	0	0
Elphidium williamsoni	16	0	0
Fursenkoina fusiformis	41	0	0
Fissurina lucida	8	0	0
Fissurina marginta	16	0	0
Haynesina germanica	55	0	0
Lagena clavata	8	0	0
Lagena sulcata	16	0	0
Quinqueloculina spp.	0	0	0
Sum	232	16	264

Table A3.12 Sub-surface assemblages from mudflat, low marsh and high marsh environments of Cowpen Marsh.

3.2 The comprehensive dataset of Cowpen Marsh

The following three tables show the average annual foraminiferal death assemblages (%) from 25 two-weekly samples, the average annual environmental variables from 4 three-monthly samples and the annual diatom assemblages of stations at Cowpen Marsh. The raw counts are archived on Computer Disk One.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Ammonia beccarii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.61	0.00	0.00
Ammonia beccarii var. aberdoveyensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.09	0.04	0.15	0.00	0.00	0.00	0.00	0.00
Ammonia beccarii var. batavus	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.24	0.46	0.62	1.07	0.21	0.56	0.71	1.47	0.28	0.47	0.74
Ammonia beccarii var. limnetes	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.09	2.36	0.00	0.67	0.73	3.17	2.57	2.91	3.71	3.11	1.79	2.29	2.40	3.22	4.41	5.76
Ammonia beccarii var. tepida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.60	0.51	0.61	0.38	0.69	0.49	0.80	0.56	1.12	2.21
Brizalina inflata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	0.94	0.17	1.00	0.56	1.07	1.25	0.28	0.47	0.00
Brizalina psuedopuncta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00
Brizalina variabilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.92	0.00	0.40	0.54	0.85	1.93	1.44	1.47	0.31	1.36	2.74	2.26	1.53	1.64	0.74
Bulimina gibba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.97	1.43	1.17	0.81	0.14	0.82	1.16	1.07	0.00	0.00
Bulimina marginata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.13	0.12	0.08	0.14	0.00	0.00	0.46	0.33	0.00
Buliminella elegantissima	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.38	0.85	1.22	0.63	0.38	0.84	0.37	0.41	0.56	0.00	0.74
Cibicides lobatulus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.64	0.00	0.57	1.42	2.78	1.85	5.67	4.68	1.87	4.33	3.45	5.51	6.03	7.84	7.48	6.64	6.25
Dentalina legumen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Dentalina subarcuata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00
Elphidium crispum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Elphidium earlandi	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	1.47	0.98	0.46	0.85	1.22	2.64	6.81	6.63	4.99	8.28	5.08	2.61	2.75	4.61	4.19	6.13	2.92	3.88	5.19	3.42	2.94
Elphidium excavatum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.22	0.00	0.30	0.60	0.00	0.49	2.12	1.59	2.34	2.66	1.28	2.78	1.80	1.65	2.42	2.06	2.08
Elphidium exoticum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.74
Elphidium gerthi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Elphidium incertum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.30	0.00	0.30	2.66	4.63	6.04	3.83	3.74	7.44	6.21	6.24	7.32	7.50	4.22	1.96	0.00
Elphidium magellanicum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.56	0.00	1.41	2.53	1.53	5.45	4.12	5.65	3.41	2.72	2.54	1.52	5.57	11.32	12.50
Elphidium margaritaceum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.06	0.00	0.00	0.13	0.00	0.00	0.00	0.00
Elphidium oceansis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00
Elphidium williamsoni	0.00	0.46	0.00	1.11	0.00	0.06	0.00	0.14	1.00	0.30	1.20	2.58	0.51	2.58	5.31	8.86	23.53	19.13	10.70	15.01	7.60	10.56	10.91	7.18	6.25	10.59	4.62	7.32	9.08	1.31	2.08
Fissurina lucida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.76	1.69	1.26	1.77	1.90	1.25	1.00	0.20	1.29	0.00	1.47
Fissurina marginta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	1.47	0.42	0.74	0.79	0.46	0.81	0.44	0.00	0.00	0.00
Fissurina orbignyana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.11	0.00	0.00	0.00	0.29	0.05	0.00	0.48	0.00	0.22	0.00	0.00	0.00	2.08
Fursenkoina fusiformis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	0.00	1.66	8.34	3.81	7.13	6.70	7.46	6.14	6.33	3.87	3.92	4.40	4.17	2.94
Gavelinopis praegeri	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.23	0.00	0.30	0.00	0.00	0.00	0.64	0.00	0.00	0.00
Globigerina quinqueloba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.83	0.62	0.48	1.50	0.19	0.64	1.17	0.96	1.03	0.80	0.74
Haplophragmoides spp.	0.00	0.00	0.50	1.60	1.48	2.04	1.23	2.45	3.29	2.85	2.26	1.49	3.31	2.32	1.30	0.94	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00
Haynesina germanica	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.21	0.47	0.32	1.19	2.17	4.84	11.63	25.73	35.89	42.86	41.50	36.91	45.72	46.86	51.04	41.29	49.38	44.15	52.79	44.25	39.45	42.61	36.03
Jadammina macrescens	100.00	76.27	66.02	62.79	69.30	70.68	76.52	72.87	69.49	71.39	63.89	52.84	44.09	48.97	51.98	41.99	12.60	7.21	9.83	11.88	1.30	1.79	1.56	2.09	5.89	2.79	3.53	5.99	7.21	4.91	5.02
Lageba laevis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00
Lagena clavata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.73	0.00	0.00	0.44	0.14	0.63	0.49	0.66	0.35	0.51	0.15	0.00	0.47	0.00
Lagena elongata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.26	0.00	0.00	0.06	0.16	0.00	0.00
Lagena gracilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.74
Lagena interupta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.15	0.00	0.00	0.00	0.00	0.00
Lagena semistriata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.03	0.18	0.04	0.32	0.15	0.00	0.29	0.00	0.00
Lagena striata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lagena substriata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.00	0.00	0.00	0.19	0.16	0.00	0.46	0.00	0.00
Lagena sulcata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	2.25	2.10	0.44	0.49	0.79	0.60	0.99	0.33	1.32	0.16	2.16	0.74
Miliammina fusca	0.00	7.49	4.10	2.28	2.29	3.63	7.01	5.30	3.41	10.37	26.43	32.77	32.75	35.73	24.24	10.87	8.28	9.47	3.46	0.36	0.00	0.00	0.00	0.21	0.17	0.04	0.33	0.28	0.60	0.47	0.00
Miliolinella subrotunda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.00	0.00	0.60	1.31	2.08
Oolina hexagona	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	0.00	0.00	0.31	1.49	0.00	0.18	0.14	0.00	0.00	0.00
Patellina currugata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Quinqueloculina spp.	0.00	0.14	0.60	0.44	0.82	0.00	0.00	0.24	0.85	0.00	0.38	0.21	0.00	0.24	0.19	5.33	4.46	9.97	15.73	5.62	8.28	0.21	1.31	0.95	0.39	1.59	0.96	0.96	1.83	7.52	11.40
Reophax moniliformis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00
Rosalina williamsoni	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spirillina vivipara	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.07	0.07	0.00	0.00	0.00
Tiphotrocha comprimata	0.00	0.50	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trochammina inflata	0.00	15.14	28.15	31.77	26.11	22.98	14.79	19.00	21.75	14.62	3.85	7.94	15.32	4.29	2.90	1.90	2.08	1.21	4.22	0.00	0.54	0.49	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00
Trochammina ochracea	0.00	0.00	0.00	0.00	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.60	0.00	0.00	0.00	0.00	0.93	0.00	0.00	0.00
Average forams counted per 10ml	47	334	686	616	659	908	661	621	699	732	446	305	236	307	276	323	176	234	237	148	272	532	636	491	506	401	457	446	310	341	256

Table A3.13 Average annual foraminiferal death assemblages from 25 two-weekly samples from each station of Cowpen Marsh.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Achnanthes brevipes	0.00	0.00	0.00	0.00	0.26	0.60	0.00	0.53	0.00	0.00	0.80	0.00	0.72	2.90	2.28	0.53	0.00	0.50	0.00	2.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00
Achnanthes delicatula	0.00	3.86	0.34	0.29	1.58	2.99	1.48	3.16	5.95	7.22	12.03	7.98	23.63	27.18	20.56	29.71	25.00	25.31	9.91	5.22	0.00	3.13	5.75	6.20	4.50	7.12	7.54	6.79	3.45	5.63
Achnanthes lanceolata	0.00	0.00	0.00	0.00	3.95	4.19	14.07	10.53	5.73	5.03	8.02	0.50	4.53	0.53	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31
Achnanthes minutissima	3.13	5.79	5.52	12.35	10.26	3.59	1.11	2.11	1.98	0.88	1.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Actinoptychus senarius	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.92	0.87	0.00	0.00	0.00	1.03	0.68	0.00	0.50	0.00	0.29	2.50
Amphora coffeaeformis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.72	2.37	0.76	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Amphora ovalis	0.00	0.39	0.00	0.59	0.00	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.72	0.53	1.52	0.53	1.18	0.25	0.00	0.00	0.00	0.00	0.00	0.52	0.00	0.00	1.26	0.00	0.00	0.31
Amphora salina	0.00	2.32	0.00	0.00	0.00	0.00	4.07	1.32	0.00	1.09	3.48	1.00	2.86	11.09	10.41	6.63	8.73	8.19	2.07	2.61	0.00	0.00	2.30	0.52	0.90	1.71	0.50	0.26	0.00	0.00
Caloneis bacillum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	2.01	0.00
Caloneis westii	0.39	0.00	0.34	1.47	0.53	0.30	4.07	4.47	2.20	3.94	2.14	4.24	1.67	0.00	0.76	1.06	2.36	1.24	2.30	1.30	0.00	0.00	0.00	1.03	0.68	0.00	0.00	0.00	0.57	0.00
Cocconeis pediculus	0.00	0.39	0.00	0.00	0.00	1.20	0.74	0.00	0.00	0.66	0.00	0.00	0.24	0.00	0.25	1.06	0.00	0.74	0.00	0.00	0.00	6.25	0.00	0.00	0.00	0.00	0.00	0.52	0.29	3.44
Cocconeis placentula	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cocconeis scutellum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.57	1.81	0.45	1.99	2.01	1.83	0.29	8.13
Cymatosira belgica	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.50	0.00	0.00	0.00
Delphineis cf surirella	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	1.75	0.80	1.00	1.43	0.53	2.79	0.27	0.47	1.74	0.46	0.00	0.00	0.00	3.16	2.84	2.25	2.85	3.02	3.13	3.16	9.38
Diatoma vulgare	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.29	0.00	0.00	0.00	0.00	0.86	1.25
Diploneis didyma	0.39	0.39	0.00	1.18	0.00	0.30	0.00	0.26	0.00	0.44	1.60	1.25	0.00	0.00	1.02	0.00	0.47	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00
Diploneis interrupta	0.00	0.00	0.00	0.00	0.00	0.30	0.74	1.05	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.00
Diploneis litoralis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diploneis ovalis	0.39	0.00	0.00	0.59	3.68	2.99	1.11	1.84	0.88	0.44	0.00	0.00	0.00	0.00	0.25	1.06	1.18	0.50	1.61	0.00	7.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diploneis smithii	0.00	0.00	0.00	0.00	0.00	0.00	0.37	1.05	0.66	0.22	0.00	0.75	0.00	0.00	0.76	0.00	0.94	0.50	0.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fallacia pygmaea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.50	0.72	0.00	0.51	0.27	0.47	0.99	3.46	5.65	0.00	0.00	2.01	4.39	1.13	0.85	2.76	1.04	2.87	0.63
Fragilaria pinnata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.86	0.00
Frustulia vulgaris	0.78	2.70	11.03	1.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gomphoneis olivaceum	4.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gomphonema parvulum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.00	0.00	1.06	0.51	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.78	0.00	0.31
Gyrosigma balticum	0.00	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.66	0.00	1.25	1.67	0.26	2.28	0.80	0.94	0.99	2.76	6.52	0.00	0.00	0.86	2.33	1.80	1.71	2.51	3.39	0.57	0.31
Gyrosigma fasciola	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.57	0.00	1.04	0.00	0.00
Gyrosigma litorale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.87	0.00	5.25	0.00	0.26	0.00	0.00	0.50	2.09	1.15	0.00
Licmophora gracilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63
Meridion circulare	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00
Navicula cari var cincta	0.00	0.39	7.24	1.47	6.58	6.29	2.96	1.58	12.78	4.60	2.41	11.22	3.58	2.64	1.02	0.80	2.59	2.98	13.59	19.13	0.00	0.00	1.44	0.78	1.35	2.28	6.03	0.78	1.44	1.56
Navicula crucifera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.48	0.00	0.00	0.27	0.00	0.74	1.38	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00
Navicula cryptocephala	1.95	11.20	20.00	2.06	5.79	2.10	10.37	4.47	3.96	1.75	1.60	0.75	0.24	1.06	0.51	1.59	3.54	0.99	2.07	0.87	0.00	0.00	2.30	3.88	2.48	2.28	2.76	1.31	1.15	0.63
Navicula digitoradiata	0.39	0.00	0.00	0.29	0.00	0.60	5.56	1.58	0.88	7.44	11.23	9.98	5.25	2.64	9.90	2.65	1.18	1.24	8.76	3.04	7.14	3.13	0.00	0.52	1.80	1.42	0.50	0.52	0.29	0.00
Navicula halophila	12.89	23.94	32.76	22.65	30.79	41.02	38.15	48.68	54.19	48.36	33.42	30.17	31.50	24.01	15.99	18.83	17.69	16.38	13.36	4.78	0.00	3.13	14.37	9.04	18.47	13.68	7.79	5.74	3.45	2.50
Lyrella lyra	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.94
Navicula mutica	48.83	3.86	8.62	17.65	13.68	2.99	1.11	0.00	0.00	1.53	0.53	0.00	0.48	0.00	0.00	0.27	0.71	0.00	0.00	0.00	0.00	0.00	0.29	0.26	0.00	0.00	0.00	0.26	0.00	0.00
Navicula palpebralis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	1.02	0.80	1.18	0.50	1.15	0.00	0.00	0.00	0.86	2.33	1.13	0.28	0.50	1.57	0.29	1.56
Navicula peregrina	0.00	0.77	0.00	0.00	2.11	2.99	2.96	0.79	0.66	0.88	0.00	1.00	2.86	1.06	0.51	2.39	4.48	1.49	2.76	3.04	7.14	6.25	5.75	6.46	4.28	2.28	2.51	10.18	10.92	1.25
Navicula phyllepta	1.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.53	1.27	0.27	0.94	1.24	5.07	2.17	0.00	6.25	27.59	11.11	24.55	31.62	24.87	24.80	34.77	3.13
Navicula protracta	0.00	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.94	0.99	0.23	0.00	0.00	0.00	0.00	0.00	0.23	1.71	1.01	0.52	0.29	3.44
Navicula pusilla	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.86	0.00
Navicula rhyncocephala	0.78	5.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	1.15	0.00
Navicula salinarum	0.00	3.09	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.44	0.00	1.75	1.91	3.69	2.03	0.27	0.71	2.23	0.46	0.00	7.14	3.13	0.00	0.00	0.00	0.28	0.75	0.00	0.00	0.31
Navicula trypunctata	0.00	0.00	0.00	0.00	0.53	0.00	1.11	0.53	0.22	0.22	2.14	0.75	1.91	5.54	5.84	3.98	9.67	2.48	6.22	10.87	0.00	0.00	3.45	3.36	0.68	0.57	2.26	0.52	0.29	2.50
Nitzschia dubia	3.52	9.27	4.14	15.88	3.95	8.98	3.70	1.32	0.66	0.88	1.60	1.75	0.48	0.53	0.25	0.00	0.00	0.25	0.92	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.94
Nitzschia fonticola	1.56	0.39	0.00	0.00	2.63	0.60	0.00	0.00	0.66	0.88	1.07	2.49	1.67	1.58	3.55	8.75	8.02	19.11	2.53	0.87	0.00	0.00	3.74	2.58	4.05	5.98	5.53	1.04	1.44	4.69
Nitzschia fruticosa	4.30	3.86	4.14	2.35	0.53	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00
Tryblionella hungarica	0.00	2.70	1.38	8.82	2.89	3.29	1.11	5.53	4.85	6.35	9.09	10.22	3.10	3.43	2.79	5.04	3.07	1.74	4.84	5.22	7.14	6.25	5.75	6.46	6.53	3.70	5.78	3.92	5.17	0.31
Nitzschia navicularis	0.39	0.00	0.34	0.59	0.00	0.00	0.00	0.26	0.00	0.00	0.27	0.00	0.48	0.00	0.51	0.00	0.00	0.00	0.46	3.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.04	0.00	0.00
Nitzschia obtusa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.23	1.74	0.00	0.00	0.29	0.52	1.13	0.00	0.00	0.26	0.00	0.00
Nitzschia palea	0.39	0.77	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitzschia punctata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.28	0.00	0.00	0.00	0.00
Nitzschia sigma	0.78	0.00	0.34	0.29	0.00	1.80	0.37	0.53	0.66	0.00	1.07	0.75	0.48	1.32	2.54	0.53	0.71	0.00	0.69	3.48	0.00	3.13	2.59	5.43	4.05	1.99	2.01	3.66	1.72	4.69
Nitzschia tryblionella	1.17	1.16	1.72	4.12	4.47	3.59	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.00	0.00	0.00	0.00	0.00	0.00
Opephora marina	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.79	0.00	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.29	0.00	0.68	1.71	2.26	0.52	2.87	0.31
Paralia sulcata	4.30	1.54	0.69	5.59	5.53	4.49	3.70	7.63	1.54	3.06	3.48	9.48	2.86	2.64	3.30	9.81	1.89	3.72	9.22	10.00	64.29	46.88	12.64	16.80	11.49	7.98	7.54	9.92	10.06	21.88
Pinnularia gentilis	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pinnularia lagerstedtii	5.08	0.00	0.00	0.00	0.00	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.76	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plagiogramma vanheurckii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.00	1.99	0.25	1.04	0.29	0.00
Podosira stelligera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.25	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00
Rhabdonema minutum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31
Raphoneis amphiceros	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	3.13	0.00	0.00	0.68	0.85	0.25	0.00	0.00	0.31
Rhoicosphenia curvata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.50	1.04	0.29	0.00
Rhopalodia musculus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scoliotropis latestriata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	3.04	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.31
Stauroneis anceps	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	0.00	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.00	0.00	0.00	0.00	0.23	0.85	0.00	0.00	0.29	0.00
Surirella gemma	0.00	0.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00	0.43	0.00	0.00	1.72	2.84	2.03	0.60	0.25	2.09	0.29	0.00
Surirella ovata	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.22	0.27	0.00	0.48	0.26	0.76	0.27	0.00	0.25	0.23	0.00	0.00	0.00	0.57	2.58	0.45	0.57	1.01	2.09	3.45	0.31
Synedra pulchella	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.00	0.28	1.51	1.04	1.15	2.81
Tabellaria flocculosa	0.39	0.00	0.69	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Thalassionema nitzschioides	0.00	0.00	0.00	0.00	0.00	0.90	0.37	0.00	0.22	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.86	0.00	0.00	0.28	1.01	0.26	1.15	7.81
Thalassiosira eccentrica	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.27	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.00	0.50	0.26	0.29	4.06
Tryblionella acuminata	0.00	4.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.27	0.00	0.74	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.50	3.92	0.00	0.63
Sum	256	259	290	340	380	334	270	380	454	457	374	401	419	379	394	377	424	403	434	230	14	32	348	387	444	351	398	383	348	320

Table A3.14 Diatom assemblages from stations of Cowpen Marsh.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Altitude (m OD)	3.24	2.86	2.81	2.57	2.47	2.42	2.38	2.33	2.27	2.22	2.18	2.22	2.17	2.14	2.09	2.04	1.99	1.94	1.88	1.74	1.52	1.32	1.13	0.93	0.72	0.54	0.36	0.17	-0.04	-0.22	-0.35
LOI (%)	56.12	42.77	31.74	29.39	27.44		26.45		23.31		20.40		19.87		19.47		17.53		14.59		13.98		14.27		12.43		13.15		16.25		
Clay fraction (%)	44.50	53.50	34.53	30.30	34.40		30.87		29.37		27.27		30.95		21.90		25.53		21.67		26.95		15.43		16.13		18.80		22.15		
pH	5.43	5.98	6.00	6.05	6.05		6.10		6.75		6.88		6.70		6.58		6.90		6.75		6.75		6.75		6.75		6.75		6.88		6.75
Salinity (ppt)	8.62	15.49	15.23	15.29	20.99		18.66		22.98		20.76		23.61		17.99		15.78		14.53		13.57		11.52		12.30		12.25		13.41		13.70
Vegetation cover (%)	96.07	96.07	96.07	89.32	83.48	69.61	66.51	58.36	49.19	58.06	54.08	51.36	27.59	25.74	25.57	23.24	5.12	5.12	0.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A3.15 Average annual environmental variables from 4 three-monthly samples from stations of Cowpen Marsh.

Appendix Four Welwick Marsh

4.1 Relationships between foraminifera and environmental variables

The annual average of the three most important dead foraminifera found on the intertidal zone of Welwick Marsh are related to loss on ignition (LOI), grain size, pH and vegetation cover.

4.1.1 Foraminifera and LOI

The scatter plots for *Jadammina macrescens*, *Ammonia beccarii* var. *limnetes* and *Haynesina germanica* versus LOI show no relationships with LOI (Figure A4.1).

4.1.2 Foraminifera and grain size

The grain size distribution of Welwick Marsh is dominated by clay and silt size classes. The scatter plots for *J. macrescens*, *A. beccarii* var. *limnetes* and *H. germanica* versus LOI show no relationships with clay fraction (Figure A4.2).

4.1.3 Foraminifera and pH

The scatter plots of *J. macrescens* and *H. germanica* versus pH show a distinct threshold of pH values at 6.5 (Figure A4.3). Relatively high abundances of *J. macrescens* occur at pH values less than 6.6. Conversely, the scatter plot of *H. germanica* shows relatively high abundances at pH values greater than 6.4. *A. beccarii* var. *limnetes* is not related to pH.

4.1.4 Foraminifera and vegetation cover

The scatter plot of *J. macrescens* versus vegetation cover (Figure A4.4) shows a strong positive relationship which indicates a dominance in environments with dense vegetation cover such as the middle marsh. Conversely, the scatter plot of *H. germanica* shows a strong negative relationship

which suggests dominance in sparse or barren environments such as the low marsh and mudflat. *A. beccarii* var. *limnetes* does not shows a relationship with vegetation cover.

4.2 Multivariate analysis of contemporary foraminifera

Two methods are used to analyse the foraminiferal death assemblages (%) collected from stations 1 to 20 at three-monthly intervals for a twelve-month period: first, unconstrained cluster analysis based on unweighted Euclidean and Chord distance; and second, detrended correspondence analysis (DCA). Only samples with counts greater than 40 individuals and species that reach 5 % of the total sum are included.

4.2.1 Cluster analysis

Cluster analysis of monthly assemblages based on **unweighted Euclidean distance** detects cluster zones MEHG and MEJM (Figure A4.5):

I. Zone MEHG is dominated by calcareous species, notably *H. germanica* with low frequencies of *A. beccarii* var. *limnetes*, *Elphidium magellanicum* and *E. williamsoni*. The altitudes range from 3.48 m OD to 2.45 m OD (1.03 m) with an interquartile range of 0.31 m (2.95 m OD to 2.64 m OD) (Figure A4.6);
II. Zone MEJM is dominated by the agglutinated species *J. macrescens*. In addition there are low frequencies of *H. germanica* and *Trochammina inflata*. The altitudes of the zone range from 3.54 m OD to 3.09 m OD (0.45 m) with an interquartile range of 0.19 m (3.50 m OD to 3.31 m OD).

Cluster analysis based on **unweighted Chord distance** similarly classifies the monthly assemblages into two zones (MCHG and MCJM) (Figure A4.7). They correspond with the comparable Euclidean zones in terms of sample and species composition. Moreover, their altitudinal ranges are identical (Figure A4.8). The similarities between the two variants of cluster analyses are further shown in the stacked bar comparisons (Figure A4.9). The distributions of monthly Euclidean and Chord zones across the intertidal zone are identical.

4.2.2 Detrended correspondence analysis

DCA Axes One and Two account for 55 % and 21 % of the total variance of **monthly** species data (Figure A4.10a). Subsequently, Axis One controls the ordination diagram and has a relatively large eigenvalue (0.64). It has low positive or negative loadings for calcareous species (e.g. *E. earlandi*, *H. germanica* and *A. beccarii* var. *limnetes*) and large positive loadings for agglutinated species (e.g. *J. macrescens*, *T. inflata* and *Miliammina fusca*) (Table A4.1). Furthermore, DCA Axis One scores versus altitude shows a strong positive non-linear relationship (Figure A4.10b). Axis One scores greater than 1.0 show relatively small altitudinal variations. These scores identify with samples that are dominated by *J. macrescens*. Thus, the species loadings and Axis One scores imply that Axis One reflects an altitudinal gradient from middle marsh through low marsh to mudflat. Conversely, the loadings and scores of Axis Two (eigenvalue 0.24) do not reflect any major environmental gradient.

The zonations of monthly assemblages produced by cluster analysis based on Euclidean and Chord distance correspond to distinct regions in the ordination diagram. Zones MEHG/MCHG and MEJM/MCJM lie on Axis One and are mutually exclusive (Figure A4.10a).

DCA of **annual** assemblages produces an ordination diagram also controlled by Axis One. Axes One (eigenvalue = 0.53) and Two (eigenvalue = 0.05) account for 95 % of the total variation of species data (Figure A4.11a). Furthermore, the species loadings of Axis One (Table A4.2) and the scatter plot of Axis One scores versus altitude are comparable with the monthly assemblages (Figure A4.11c). The zonations produced by cluster analysis of annual assemblages based on unweighted Euclidean and Chord distance occupy a particular region in the diagram: Zones AEHG/ACHG and AEJM/ACJM are mutually exclusive. (Figure A4.11a, b).

Species	Axis One	Axis Two	Axis Three
Jadammina macrescens	2.15	0.95	0.99
Miliammina fusca	4.52	1.18	1.14
Trochammina inflata	2.47	1.73	2.83
Trochammina ochracea	1.49	-0.61	-0.24
Ammonia beccarii var. *limnetes*	-0.43	-0.82	1.00
Brizalina inflata	1.49	2.85	2.92
Brizalina variablis	1.36	1.48	0.58
Cyclogyra involvens	-0.13	2.31	-0.54
Elphidium earlandi	-0.99	0.55	2.14
Elphidium incertum	1.60	0.46	0.09
Elphidium magellanicum	0.60	2.58	-0.85
Elphidium williamsoni	1.03	0.12	2.04
Fissurina lucida	-0.13	1.84	-0.02
Fursenkoina fusiformis	0.52	2.34	-0.45
Globigerina quinqueloba	1.20	2.18	0.61
Haynesina germanica	0.01	1.12	1.28
Lagena clavata	1.38	2.46	2.67
Lagena sulcata	0.87	0.44	-0.20
Patellina corrugata	1.42	0.54	3.12
Quinqueloculina spp.	0.79	0.01	0.97
Rosalina williamsoni	0.27	3.68	3.86
Variance (eigenvalues)	0.64	0.24	0.17
Percent total variance	55	21	15
Cumulative percent of total variance	55	76	91

Table A4.1 Loading and percentages of variance explained by the first three detrended correspondence axes from monthly foraminiferal death assemblages of Welwick Marsh.

Species	Axis One	Axis Two	Axis Three
Jadammina macrescens	2.2	0.02	0.14
Miliammina fusca	2.93	-2.03	0.5
Trochammina inflata	1.13	-1.06	0.64
Trochammina ochracea	1.29	2.06	1.49
Ammonia beccarii var. *limnetes*	-0.36	0.68	1.34
Brizalina inflata	1.63	-0.14	-0.08
Brizalina variablis	1.68	2.81	-3.57
Cyclogyra involvens	1.1	2.82	0.61
Elphidium earlandi	-1.24	-1.17	0.23
Elphidium incertum	1.19	6.31	-0.45
Elphidium magellanicum	1.43	1.61	0.14
Elphidium williamsoni	-0.6	-0.2	0.71
Fissurina lucida	0.5	2.5	1.94
Fursenkoina fusiformis	1.01	2.37	2.91
Globigerina quinqueloba	1.36	-0.55	1.39
Haynesina germanica	0.13	0.72	0.13
Lagena clavata	2.17	1.88	0.3
Lagena sulcata	0.7	-0.25	-0.39
Patellina corrugata	0.94	0.72	0.5
Quinqueloculina spp.	0.73	0.12	2.4
Rosalina williamsoni	1.42	-4.04	0.23
Variance (eigenvalues)	0.53	0.05	0.02
Percent total variance	87	8	3
Cumulative percent of total variance	87	95	98

Table A4.2 Loading and percentages of variance explained by the first three detrended correspondence axes from annual foraminiferal death assemblages of Welwick Marsh.

4.3 Biostratigraphical data of Welwick Marsh

The following three tables show the average annual foraminiferal death assemblages (%) from 4 three-monthly samples, the diatom assemblages and the environmental variables from stations of Welwick Marsh. The foraminiferal three-monthly samples were collected on 12/12/95 (WE951), 03/03/96 (WE961), 27/05/96 (WE962) and 15/08/96 (WE963). These data are archived on Computer Disk One.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ammonia beccarii var. aberdoveyensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.48	0.00	0.00	0.00	0.00	0.83	0.00	0.00	0.00	0.00	0.00
Ammonia beccarii var. batavus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.35	0.00	0.00	0.00	0.00	0.76	0.33
Ammonia beccarii var. limmetes	0.00	0.00	0.00	1.48	0.00	0.00	5.56	5.04	4.48	15.38	2.88	2.44	2.13	7.84	4.40	8.33	5.54	2.94	9.62	3.46
Ammonia beccarii var. tepida	0.00	0.00	0.00	0.00	0.00	0.45	0.00	0.32	0.00	0.96	1.22	0.44	1.33	0.23	0.83	0.00	0.00	0.00	0.00	0.00
Balticammina pseudomacrescens	0.00	0.00	0.00	0.00	0.00	3.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Brizalina inflata	0.00	8.25	1.48	0.86	0.89	5.28	1.00	0.32	0.00	0.00	0.26	0.00	0.21	0.00	0.83	0.00	0.00	0.67	0.00	0.53
Brizalina variabilis	0.00	4.76	1.59	2.78	0.00	0.45	0.00	0.50	0.00	0.00	0.00	0.00	0.00	3.57	0.00	0.00	0.00	0.28	0.00	0.00
Bulimina gibba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00
Cibicides lobatulus	0.00	0.00	1.59	1.48	0.86	0.00	0.56	0.00	0.00	0.00	0.00	0.66	0.00	0.00	0.00	0.00	0.38	0.00	0.47	0.53
Cycloguyra involvens	0.00	0.00	1.59	2.22	0.86	0.00	0.00	0.00	0.00	1.44	0.00	0.00	0.21	0.23	0.98	0.00	0.61	0.28	0.00	0.00
Elphidium earlandi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	5.37	1.44	0.00	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.47	0.00
Elphidium incertum	0.00	0.00	0.00	1.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00
Elphidium magellanicum	0.33	4.76	14.29	3.70	0.00	2.68	1.11	1.45	0.32	0.58	0.00	0.66	1.91	0.00	5.00	1.25	2.01	2.56	0.94	3.19
Elphidium williamsoni	0.00	0.00	0.00	12.58	0.00	3.22	0.28	7.38	7.16	8.44	2.64	2.09	4.82	0.33	0.00	0.00	0.00	0.00	0.86	0.00
Fissurina lucida	0.00	0.00	0.00	0.74	1.56	0.00	0.28	0.50	0.32	0.58	0.26	0.88	0.42	0.00	0.83	1.25	0.00	0.28	0.00	0.00
Fissurina marginata	0.00	0.00	0.00	1.96	0.00	0.00	0.28	1.13	0.00	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	1.06
Fursenkoina fusiformis	0.00	0.00	3.17	2.96	0.00	0.00	0.00	1.00	0.65	0.00	0.78	1.97	1.06	0.00	0.00	4.41	0.22	0.00	0.47	0.00
Gavelinopis praegeri	0.00	0.00	0.00	1.48	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Globigerina quinqueloba	5.56	0.00	0.00	0.00	0.00	0.89	0.28	2.82	0.32	0.00	0.00	0.66	0.00	1.32	0.83	2.50	0.00	0.57	0.47	0.53
Haynesina germanica	11.11	14.29	10.32	42.92	65.40	59.62	48.33	69.73	78.85	69.53	89.88	87.68	86.56	78.66	83.66	72.02	90.41	88.57	84.31	83.31
Jadammina macrescens	76.67	72.21	52.06	18.06	14.82	24.65	32.22	7.81	0.00	0.00	1.07	2.08	0.00	3.57	0.00	0.00	0.00	0.00	0.00	1.85
Lagena elongata	0.00	2.38	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.47	0.00
Lagena substriata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00
Lagena sulcata	0.00	0.00	0.00	0.00	1.56	0.00	0.00	0.50	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Miliammina fusca	3.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Miliolinella subrotunda	0.00	0.00	0.00	1.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Patellina corrugata	0.00	0.00	0.00	0.00	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Quinqueloculina spp.	0.00	1.60	0.00	0.00	6.65	0.00	0.28	0.32	1.22	0.58	1.01	0.44	0.82	0.33	1.79	6.07	0.83	1.69	1.15	1.19
Rosalina williamsoni	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trochammina inflata	3.33	0.00	0.00	0.00	2.50	3.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trochammina ochracea	0.00	0.00	7.14	1.96	2.42	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00	3.57	0.00	4.17	0.00	0.74	0.00	1.32
Average forams counted per 10 ml	123	171	115	275	174	193	297	399	417	335	723	453	1253	1417	407	317	710	690	884	604

Table A4.3 Average annual foraminiferal death assemblages from 4 three-monthly samples from each station of Welwick Marsh.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Achnanthes brevipes	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	1.03	0.00	0.00	0.50	0.49	0.00	0.00	0.00	0.00	0.00	0.51	2.47
Achnanthes brevipes var parvula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00
Achnanthes delicatula	3.86	2.52	5.19	4.52	3.37	2.99	1.00	0.49	0.51	2.93	2.97	3.96	10.68	1.03	1.49	1.00	0.47	0.97	2.03	0.82
Achnanthes exigua	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00
Achnanthes hungarica	0.00	0.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Achnanthes kolbei	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.03	1.23
Achnanthes kuelbsii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Achnanthes lanceolata	0.00	0.00	0.00	0.00	0.48	0.00	0.50	0.00	0.00	0.00	0.99	0.00	0.00	0.00	0.99	0.50	0.00	0.97	1.02	0.00
Achnanthes minutissima	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.82
Achnanthes peragalli	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Actinoptychus senarius	0.97	0.00	0.47	0.00	1.92	0.50	0.00	0.98	2.05	0.49	0.99	0.50	0.00	0.00	0.99	0.50	1.42	3.40	0.00	0.41
Actinoptychus sp	0.97	0.00	0.00	0.00	0.00	0.00	0.50	1.47	0.00	0.00	0.50	0.00	0.00	0.51	0.00	0.50	0.00	0.97	0.51	1.65
Amphiprora paludosa	0.00	0.00	0.00	1.51	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Amphora coffeaeformis	0.00	0.00	0.00	0.50	1.44	2.49	2.99	0.49	4.62	2.44	6.93	4.46	4.85	0.51	5.45	0.00	0.00	0.00	0.00	0.00
Amphora exigua	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	1.95	0.00	0.50	1.46	0.00	1.98	0.50	0.00	0.00	0.00	0.00
Amphora ovalis	0.00	0.00	0.00	0.50	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Biddulphia alternans	0.48	0.84	0.00	1.01	0.48	1.49	1.49	0.49	0.00	0.49	0.50	0.00	0.00	0.00	0.50	0.50	0.00	0.97	1.52	0.82
Campylodiscus cymbelliformis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00
Caloneis clevei	0.00	1.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cocconeis pediculus	0.00	0.00	0.00	1.51	0.00	1.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00	0.50	0.47	0.00	0.00	0.00
Cocconeis peltoides	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cocconeis placentula	3.38	2.10	5.66	2.01	0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cocconeis scutellum	10.14	4.20	6.60	10.05	10.58	8.96	7.96	6.37	8.72	3.41	7.43	5.94	5.34	12.82	3.96	8.96	7.08	8.25	3.55	6.17
Cocconeis stauroneiformis	0.97	4.20	2.83	0.00	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coscinodiscus lineatus	0.00	0.00	0.94	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00
Coscinodiscus radiatus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyclotella striata	0.97	0.84	2.36	2.01	2.40	1.49	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cymbella affinis	0.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cymbella macrocephala	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cymbella prostrata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00
Cymbella sinuata	0.00	0.00	0.00	1.51	0.00	0.00	0.00	0.00	1.03	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cymbella ventricosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.94	0.00	0.00	0.00
Delphineis surirella	6.28	3.36	2.36	1.01	1.44	3.98	1.49	5.39	2.05	0.00	1.49	0.00	0.00	1.03	2.48	0.00	0.00	2.43	1.02	0.00
Denticula subtilis	0.00	0.00	2.83	1.01	0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diatoma vulgare	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.49	0.00	0.50	0.50	1.42	1.94	3.55	2.88
Diploneis didyma	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.97	0.00	0.00
Fragilaria construens v. venter	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.47	0.00	0.00	0.41
Fragilaria lapponica	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.97	0.00	0.00	0.00	0.00	0.00	0.00	0.41
Fragilaria pinnata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.41
Fragilaria virescens v. exigua	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.50	0.47	0.00	0.00	0.00
Fragilariopsis doliolus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
Gomphonema angustatum	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.49	1.03	0.00	0.00	3.47	0.97	1.03	0.99	2.99	1.89	0.00	1.02	0.41
Gomphonema clevei	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gomphonema gracile	0.00	0.84	3.30	2.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gomphonema parvulum	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gyrosigma acuminatum	1.93	0.00	0.00	2.01	3.37	1.00	0.00	2.45	2.56	6.34	4.46	4.46	3.40	3.09	3.47	2.99	3.30	1.94	3.05	4.12
Gyrosigma distortum	0.00	0.00	0.00	0.00	0.48	0.00	0.50	0.00	0.00	0.49	0.00	0.00	0.49	1.03	0.00	0.00	0.00	0.97	2.03	1.65
Gyrosigma fasciola	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.99	0.00	0.00	0.00	0.00	0.00	0.49	0.51	0.41
Gyrosigma littorale	0.00	0.00	0.00	0.00	0.96	1.49	0.50	0.00	0.51	0.00	1.49	0.50	1.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gyrosigma scalproides var eximia	0.97	2.94	0.00	0.00	0.96	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gyrosigma spencerii	4.83	9.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gyrosigma strigilis	0.00	0.84	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gyrosigma wansbeckii	0.00	2.52	0.00	0.00	5.77	0.00	3.48	6.86	9.23	3.90	6.93	1.49	4.85	3.59	0.00	4.48	3.30	6.80	5.08	2.06
Hantzschia amphioxys	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Haslea crucigera	0.00	0.00	0.00	0.00	0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navicula anglica	0.00	0.00	0.00	1.01	0.96	1.99	0.00	0.98	1.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navicula apiculata	0.00	0.00	0.00	0.00	1.92	1.49	1.49	0.98	3.08	9.76	3.47	1.98	3.40	3.59	1.49	2.49	3.77	0.49	2.03	2.06
Navicula arenaria	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navicula bacillum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00
Meridion circulare	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00
Navicula cari var cincta	7.25	10.08	13.68	11.56	7.69	5.47	10.95	5.39	5.64	3.41	1.98	15.84	8.25	6.67	10.89	6.97	4.72	5.83	7.11	6.17
Navicula cruciula	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.98	0.00	0.00	0.00	0.00	0.00	0.00	1.98	1.49	0.47	1.46	0.00	0.00
Navicula cryptocephala	0.00	1.26	0.94	3.52	4.81	8.96	2.99	0.49	5.13	3.41	3.47	1.49	3.88	0.51	2.97	8.46	4.25	8.25	3.55	2.88
Navicula digitoradiata	0.00	0.00	0.00	0.00	0.00	0.50	1.00	1.96	1.03	1.46	0.00	2.48	2.43	1.54	4.95	0.50	3.77	2.91	3.05	2.47
Navicula directa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navicula flanatica	0.00	0.00	0.00	0.00	2.88	1.00	0.00	0.49	0.00	0.00	1.49	0.00	0.00	1.54	0.00	0.50	0.00	0.00	1.02	0.00
Navicula forcipata	0.48	0.84	0.00	0.50	1.92	1.00	1.00	0.00	2.05	3.90	3.47	4.95	1.94	2.05	1.98	1.49	0.00	0.97	1.52	4.94
Navicula gregaria	0.00	0.00	0.94	1.51	2.40	5.47	1.49	3.43	1.03	0.98	1.98	4.46	5.34	0.51	0.00	0.00	0.00	0.00	0.00	0.00
Navicula humerosa	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navicula inseociabilis	0.00	1.68	2.83	2.51	3.37	2.99	10.95	4.41	2.56	6.34	8.91	10.89	5.34	5.64	0.00	0.00	0.00	0.00	0.00	0.00
Navicula lanceolata	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navicula lyroides	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.97	0.00	0.00
Navicula meniscus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41
Navicula mutica	3.38	1.26	0.94	0.00	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navicula peregrina	2.42	4.20	4.72	4.02	1.92	2.99	1.49	1.47	4.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.03	1.65
Navicula phyllepta	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navicula retusa v. cancellata	0.97	0.00	0.00	0.00	2.40	1.99	2.49	3.92	2.05	3.41	4.46	1.98	2.91	0.00	0.00	0.00	0.00	0.49	1.52	0.00
Navicula rhyncocephala	0.00	0.00	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navicula salinarum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00
Navicula tripunctata	2.42	3.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navicula tripunctata var. schizonemoides	0.00	0.00	0.00	2.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.54	4.95	5.47	0.00	0.00	0.00	0.00
Nitzschia acuminata	0.00	0.00	1.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitzschia bilobata	3.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitzschia epithemioides	0.00	0.00	0.00	3.02	0.96	1.49	1.99	2.45	0.00	0.49	2.48	0.99	3.88	1.03	1.49	0.00	0.00	0.00	0.00	0.00
Nitzschia filiformis	1.45	2.52	0.00	0.50	0.00	0.50	1.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.36	0.00	0.00	0.00
Nitzschia fonticola	4.83	6.72	1.42	1.51	6.25	4.48	8.96	4.90	4.62	2.93	5.94	0.50	1.46	3.08	3.96	1.00	1.89	1.94	3.55	0.00
Nitzschia frustulum	0.00	0.00	3.77	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00
Nitzschia hantzschiana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.03	2.93	3.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitzschia hungarica	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.98	1.54	2.93	1.49	1.49	0.49	0.00	0.50	0.50	0.00	2.91	1.52	0.00
Nitzschia lanceolata	0.00	0.00	0.00	0.00	0.48	0.00	0.00	0.00	1.54	0.49	0.00	0.99	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitzschia navicularis	0.48	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00	0.50	0.00	0.00	1.52	1.23
Nitzschia punctata	0.00	0.00	0.94	0.00	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.47	0.00	1.02	0.00
Nitzschia punctata var constricta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitzschia sigma	9.18	8.82	9.43	8.04	5.29	7.46	3.98	7.84	6.15	9.76	4.46	7.43	9.71	3.08	15.84	14.93	23.11	7.28	5.58	9.88
Nitzschia tryblionella	12.56	3.78	14.62	2.01	0.00	0.00	0.50	0.00	1.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitzschia tryblionella var levidensis	0.00	0.00	0.00	0.00	0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00
Nitzschia tryblionella var victoriae	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitzschia vitrea	0.00	3.36	0.00	2.51	0.48	0.50	2.49	2.45	0.51	0.00	0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Opephora martyi	0.00	1.68	0.00	0.50	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.47	0.00	0.00	0.41
Paralia sulcata	5.31	3.36	1.42	3.52	2.88	6.47	4.48	4.41	4.10	6.34	3.96	2.97	1.46	5.64	2.48	4.48	3.77	4.37	7.11	4.94
Plagiogramma staurophorum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41
Plagiogramma vanheurckii	0.00	2.10	0.94	2.01	1.44	1.00	0.50	1.47	1.54	1.95	1.49	0.00	0.97	0.00	0.00	0.50	0.00	0.97	0.00	0.00
Pleurosigma affine	0.00	0.00	0.94	1.51	0.96	1.49	0.50	0.98	0.51	0.98	0.99	1.98	0.00	2.56	0.00	1.00	1.42	0.97	1.52	1.65
Pleurosigma angulatum	0.00	0.00	0.00	1.51	0.00	1.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.54	0.00	1.99	1.42	1.94	1.52	0.00
Pleurosigma elongatum	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pleurosigma formosum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.82
Podosira stelliger	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.94	0.00	0.00	0.00
Rhabdonema minutum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rhaphoneis amphiceros	0.48	0.84	0.94	0.50	0.48	0.50	1.00	3.43	1.03	0.49	0.50	0.00	0.00	0.00	0.00	1.99	1.42	0.00	0.00	0.00
Rhaphoneis minutissima	3.86	1.68	1.89	2.01	2.88	2.99	1.49	2.45	2.05	2.93	1.49	4.46	2.43	7.69	4.95	3.98	8.02	9.22	13.71	4.94
Rhizosolenia imbricata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00
Rhizosolenia setigera	0.00	0.00	0.00	1.01	0.00	0.50	0.50	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.49	1.52	0.00
Scoliopleura tumida	0.00	0.42	0.00	1.51	0.48	0.00	1.00	0.00	1.54	2.44	0.99	1.49	3.40	5.64	4.95	3.98	5.19	3.88	0.51	15.64
Stauroneis acuta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stauroneis amphioxys	0.00	0.00	3.30	2.01	2.40	0.00	1.00	1.96	2.05	0.98	0.99	1.98	1.46	15.38	6.44	3.98	5.19	11.17	6.09	7.82
Stauroneis boundulata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.82
Stauroneis gregorii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00
Surirella gemma	0.00	0.00	0.00	1.01	2.88	4.48	1.49	8.82	2.56	1.46	0.99	1.49	0.97	1.54	1.49	2.99	1.89	0.00	0.51	1.65
Surirella ovata	0.48	0.84	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Synedra fasciculata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.49	0.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Synedra ulna	1.93	2.94	0.00	0.50	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tabellaria fenestrata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Thalassionema nitzschioides	0.00	0.00	0.00	2.01	0.96	1.99	1.99	1.47	1.54	1.46	2.48	0.00	0.49	0.51	1.49	1.49	1.89	2.43	1.02	0.41
Thalassiosira eccentrica	1.93	0.00	0.00	0.50	1.44	0.00	1.49	1.96	0.51	1.46	0.50	0.00	0.00	0.51	0.50	1.49	0.47	0.00	2.54	1.65
Tropidoneis elegans	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.47	0.00	0.98	0.00	0.00	0.00	0.51	0.99	1.49	0.00	0.00	0.00	0.00
Tropidoneis lepidoptera	0.00	0.84	0.00	2.01	0.96	1.99	2.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tropidoneis maxima	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum	207	238	212	199	208	201	201	204	195	205	202	202	206	195	202	201	212	206	197	243

Table A4.4 Diatom assemblage for each station of Welwick Marsh.

Station	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Altitude (m OD)	3.54	3.48	3.40	3.37	3.29	3.14	3.09	2.95	2.91	2.75	2.71	2.69	2.67	2.68	2.66	2.64	2.60	2.55	2.45	2.50
LOI (%)	14.90	14.63		14.05		13.79		14.88		14.58		12.76		12.45		13.20		11.40		10.61
pH	6.10	6.50		6.10		7.00		6.50		6.50		6.50		6.50		7.00		7.00		7.30
Clay fraction (%)	39.50	25.70		27.40		35.60		30.70		34.10		28.30		28.50		25.90		20.60		23.30
Salinity (ppt)	7.84	4.90		3.01		7.23		9.10		12.06		8.24		8.23		12.53		11.55		9.41
Vegetation cover (%)	100.00	100.00	100.00	100.00	100.00	80.00	70.00	60.00	50.00	50.00	40.00	30.00	20.00	15.00	5.00	5.00	0.00	5.00	0.00	0.00

Table A4.5 Environmental variables from stations of Welwick Marsh.

Appendix Five Thornham Marsh

5.1 Relationships between foraminifera and environmental variables

The annual average of the six most important dead foraminifera found on the intertidal zone of Thornham Marsh are related to loss on ignition (LOI), grain size, pH, salinity and vegetation cover.

5.1.1 Foraminifera and LOI

The scatter plot *Ammonia beccarii* var. *limnetes* shows a negative non-linear bimodal relationships with LOI (Figure A5.1). *Quinqueloculina* spp. shows a unimodal relationship whereas *Jadammina macrescens*, *Trochammina inflata, Elphidium williamsoni* and *Haynesina germanica* show no relationships with LOI.

5.1.2 Foraminifera and grain size

The grain size distribution for most of Thornham Marsh was dominated by clay and silt size classes. The scatter plots of all species show no relationships with clay fraction (Figure A5.2).

5.1.3 Foraminifera and pH

The scatter plots of *J. macrescens* and *T. inflata* show a wide range of abundances at pH values less than 6.6 with zero abundances above 6.5 (Figure A5.3). Conversely, the remaining calcareous species show a wide range of abundances at pH values greater than 6.0 with very low or zero abundances below 6.1.

5.1.4 Foraminifera and salinity

The scatter plot of *Q.* spp shows an unimodal relationship with salinity: relatively high abundances are found between 10 and 12 ‰. The remaining species show no relationships (Figure A5.4).

5.1.5 Foraminifera and vegetation cover

The scatter plots of the six foraminiferal species versus vegetation cover show non-linear relationships with two clusters of points (Figure A5.5).

5.2 Multivariate analysis of contemporary foraminifera

Two methods are used to analyse the foraminiferal death assemblages (%) collected from stations 1 to 24 at three-monthly intervals for a twelve-month period: first, unconstrained cluster analysis based on unweighted Euclidean and Chord distance; and second, detrended correspondence analysis (DCA). Only samples with counts greater than 40 individuals and species that reach 5 % of the total sum are included.

5.2.1 Cluster analysis

The first variant of cluster analysis of monthly assemblages **(unweighted Euclidean distance)** detects zones MEJM and MECA (Figure A5.6):

I. Zone MEJM is dominated by *J. macrescens* with low frequencies of *T. inflata* and *Q.* spp. The altitudes range from 4.32 m OD to 2.12 m OD (2.20 m) with an interquartile range of 0.37 m (3.09 m OD to 2.72 m OD) (Figure A5.7);
II. Zone MECA is dominated by calcareous species such as *A. beccarii* var. *batavus*, *A. beccarii* var. *limnetes*, *E. williamsoni* and *H. germanica*. The altitudes range from 2.75 m OD to 0.21 m OD (2.54 m) with an interquartile range of 1.48 m (2.36 m OD to 0.88 m OD).

Similarly, the second variant of cluster analysis of monthly assemblages (**unweighted Chord distance)** detects zones MCJM and MCCA (Figure A5.8). These zones correspond with Euclidean zones in terms of sample and species composition and altitudinal range (Figure A5.9). The similarities between the two variants are further shown in the stacked bar comparisons (Figure A5.10). Monthly Euclidean and Chord zones show identical bimodal distributions across the intertidal zone both in terms of the number and proportion of samples.

5.2.2 Detrended correspondence analysis

DCA Axes One and Two account for 52 % and 24 % of the total variance of **monthly** species data respectively: 76 % in all (Figure A5.11a). Axis One (eigenvalue = 0.61) has low positive or negative loadings for agglutinated species (e.g. *Miliammina fusca, J. macrescens* and *T. inflata*) and large positive loadings for calcareous species (e.g. *A. beccarii* var. *limnetes, A. beccarii* var. *batavus* and *Miliolinella subrotunda*) (Table A5.1). Furthermore, a strong negative non-linear relationship is shown Axis One scores and altitude. Axis One scores less than 2.0 show relatively small altitudinal variations. These scores identify with samples that are dominated by *J. macrescens* (Figure A5.11b). Therefore, the species loading and Axis One scores indicate that Axis One reflects an altitudinal gradient from high marsh to mudflat. Axis Two has an eigenvalue of 0.28 and does not reflect any major environmental gradient.

The zonations produced by monthly cluster analysis of unweighted Euclidean and Chord distance correspond to distinct regions in the ordination diagram: Zones MEJM/MCJM and MECA/MCCA are mutually exclusive (Figure A5.11a).

The DCA of **annual** assemblages produces a further ordination diagram controlled by Axis One (Figure A5.12a). Axes One (eigenvalue = 0.56) and Two (eigenvalue = 0.12) account for 89 % of the total variation of species data. The species loadings (Table A5.2), the scatter plot of Axis One scores versus altitude and the cluster zonations based on unweighted Euclidean and Chord distance (Figure A5.12a, b) are comparable with the results from monthly assemblages.

Species	Axis One	Axis Two	Axis Three
Jadammina macrescens	0.34	0.25	1.70
Miliammina fusca	- 1.65	1.97	.61
Trochammina inflata	0.52	- 0.08	0.76
Ammonia beccarii var. *aberdoveyensis*	3.99	1.48	- 1.06
Ammonia beccarii var. *batavus*	4.13	1.11	0.49
Ammonia beccarii var. *limnetes*	3.11	1.07	0.52
Ammonia beccarii var. *tepida*	3.24	0.67	- 0.08
Bulimina gibba	2.47	1.04	- 0.35
Cassidulina obtusa	2.91	1.92	- 0.38
Cibicides lobatulus	2.47	- 1.93	- 0.02
Cyclogyra involvens	1.05	2.74	- 0.70
Elphidium earlandi	2.38	1.84	- 0.21
Elphidium excavatum	2.58	0.36	0.71
Elphidium gerthi	2.63	0.87	1.25
Elphidium incertum	2.75	1.29	1.90
Elphidium magellanicum	2.23	2.22	1.90
Elphidium williamsoni	2.00	0.53	2.21
Globigerina quinqueloba	3.61	1.39	- 0.18
Haynesina germanica	2.23	1.85	2.24
Miliolinella subrotunda	4.16	2.39	3.73
Planorbulina mediterranensis	3.42	1.52	0.24
Quinqueloculina spp.	1.02	2.67	- 0.31
Rosalina globularis	2.77	1.67	- 0.29
Rosalina williamsoni	1.84	0.89	- 0.11
Variance (eigenvalues)	0.61	0.28	0.15
Percent total variance	52	24	13
Cumulative percent of total variance	52	76	89

Table A5.1 Loading and percentages of variance explained by the first three detrended correspondence axes from monthly foraminiferal death assemblages of Thornham Marsh.

Species	Axis One	Axis Two	Axis Three
Jadammina macrescens	0.00	0.00	1.14
Miliammina fusca	-1.46	2.77	-1.13
Trochammina inflata	0.66	1.67	-0.82
Ammonia beccarii var. *aberdoveyensis*	3.38	1.28	-0.37
Ammonia beccarii var. *batavus*	3.73	1.03	0.37
Ammonia beccarii var. *limnetes*	2.76	0.86	0.81
Ammonia beccarii var. *tepida*	2.84	0.28	-0.17
Bulimina gibba	2.57	1.38	-0.09
Cassidulina obtusa	2.14	-0.33	-0.36
Cibicides lobatulus	2.19	-0.17	0.16
Cyclogyra involvens	0.40	2.44	3.69
Elphidium earlandi	2.22	1.51	0.81
Elphidium excavatum	2.37	0.29	1.26
Elphidium gerthi	2.25	1.06	1.83
Elphidium incertum	2.45	0.78	1.11
Elphidium magellanicum	1.90	2.06	3.35
Elphidium williamsoni	1.72	1.56	-0.18
Globigerina quinqueloba	3.08	1.49	1.42
Haynesina germanica	1.99	1.56	0.99
Miliolinella subrotunda	4.38	1.48	1.25
Planorbulina mediterranensis	3.55	0.59	1.06
Quinqueloculina spp.	0.57	2.30	1.87
Rosalina globularis	2.53	-0.68	1.42
Rosalina williamsoni	1.82	0.45	-0.29
Variance (eigenvalues)	0.56	0.12	0.06
Percent total variance	73	16	8
Cumulative percent of total variance	73	89	97

Table A5.2 Loading and percentages of variance explained by the first three detrended correspondence axes from annual foraminiferal death assemblages of Thornham Marsh.

5.3 Biostratigraphical data of Thornham Marsh

The following three tables show the average annual foraminiferal death assemblages (%) from 4 three-monthly samples, the diatom assemblages and the environmental variables from stations of Thornham Marsh. The foraminiferal three-monthly samples were collected on 24/11/95 (TH951), 01/03/96 (TH961), 25/05/96 (TH962) and 16/08/96 (TH963). These data are archived on Computer Disk One.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Ammonia beccarii	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.3	0.0
Ammonia beccarii var. aberdoveyens	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.8	1.7	0.7	0.6	2.0	4.7	2.1
Ammonia beccarii var. batavus	0.0	0.0	0.6	0.0	0.0	0.4	1.5	1.3	1.5	3.9	6.8	11.1	11.8	0.0	2.9	3.2	1.0	4.3	6.7	9.7	6.2	14.4	13.9	52.1
Ammonia beccarii var. limnetes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.5	3.5	0.0	0.0	0.7	3.4	5.6	2.6	2.8	1.8	6.6	5.1	0.0
Ammonia beccarii var. tepida	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Brizalina variabilis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bulimina gibba	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.8	1.6	0.0	0.0	0.5	0.0	0.0
Cassidulina obtusa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.6	0.0	0.0	0.0	0.0	2.0	0.8	0.6	0.0	0.0	0.0	0.0	0.0
Cibicides lobatulus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	1.8	6.0	2.4	4.1	0.7	8.8	2.9	1.3	4.2	2.2	5.8	3.7	0.3
Cyclogyra involvens	0.0	0.0	0.0	6.6	4.3	0.7	1.7	2.3	9.9	1.0	5.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Elphidium earlandi	0.0	0.0	0.5	0.3	0.2	2.0	0.0	0.0	0.2	1.8	1.9	3.7	1.2	0.0	1.5	0.0	1.5	2.4	2.1	3.5	2.1	1.0	1.9	2.1
Elphidium excavatum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.3	5.2	4.5	6.6	1.2	6.3	3.2	12.3	17.9	9.5	10.9	19.2	7.2	6.6	0.0
Elphidium gerthi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.7	1.7	2.3	1.8	0.0	1.7	0.0	1.5	5.4	0.0	1.5	1.2	3.3	1.2	0.0
Elphidium incertum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.9	0.9	2.2	3.0	1.2	0.0	1.5	2.5	2.2	3.7	4.9	8.1	6.0	4.7	5.3	0.5
Elphidium magellanicum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	2.2	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.6	0.0	0.0	0.0
Elphidium spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.3	0.0
Elphidium williamsoni	0.0	1.0	0.7	0.3	6.4	18.6	10.2	3.9	8.7	22.4	6.8	15.2	13.0	0.0	12.7	3.2	7.6	9.6	10.0	10.3	10.2	7.0	16.6	0.0
Fissurina lucida	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Fursenkoina fusiformis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gavelinopsis praegeri	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
Globigerina quinqueloba	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.6	0.5	0.6	0.0
Haynesina germanica	0.0	0.0	0.0	4.4	5.8	10.0	6.4	6.2	13.6	35.5	24.8	27.8	14.2	0.0	3.7	4.3	15.2	14.1	27.3	20.6	15.3	14.7	13.1	12.5
Jadammina macrescens	100.0	77.3	34.8	47.7	35.7	28.4	42.6	40.5	34.1	15.2	14.9	11.0	11.6	72.9	46.2	65.4	22.1	10.5	8.5	9.2	5.2	2.1	3.1	0.0
Lagena sulcata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.4	0.0	0.0	0.0	0.0	0.0
Miliammina fusca	0.0	5.9	12.4	3.0	12.2	3.1	1.8	0.0	1.3	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miliolinella subrotunda	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.6	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5	1.0	1.4	12.5
Patellina hauerinoides	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Planorbulina mediterranensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.2	0.0	0.0	0.0	0.0	0.5	1.3	0.4	0.0	0.7	0.5	0.0	0.0
Quinqueloculina spp.	0.0	0.7	5.6	20.0	20.0	19.8	25.9	33.8	23.0	4.0	18.3	4.7	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	6.6	0.0	0.0	2.1
Rosalina globularis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.6	0.0	0.0	0.0	0.0	0.0	0.0
Rosalina williamsoni	0.0	0.0	0.0	0.0	0.0	1.3	0.4	0.0	0.2	0.4	0.4	1.1	4.9	1.2	0.0	0.0	2.0	0.0	1.1	0.0	0.6	0.5	0.0	0.0
Typhotrocha comprimata	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Trochammina inflata	0.0	13.7	45.4	17.6	15.3	15.6	9.4	9.8	4.3	8.7	2.2	2.4	9.2	21.1	12.0	10.4	8.6	3.7	8.9	1.7	2.3	0.5	7.0	0.0
Average forams counted per 10 ml	32	716	1276	1156	1626	1506	2156	1984	1280	1720	1211	1496	464	368	276	552	608	444	736	540	848	860	1408	148

Table A5.3 Average annual foraminiferal death assemblages from 4 three-monthly samples from each station of Thornham Marsh

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Achnanthes brevipes	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0
Achnanthes delicatula	0.0	12.4	4.9	1.8	1.6	2.2	0.5	0.5	0.5	4.0	0.5	8.9	40.9	13.1	2.5	3.5	10.5	0.0	6.1	3.9	3.8	9.1	7.6	30.6
Achnanthes minutissima	0.0	4.5	1.5	0.5	3.1	2.2	0.5	0.0	0.0	0.5	0.0	2.1	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9
Achnanthes valida	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Actinoptychus senarius	0.0	0.0	1.0	4.5	0.0	2.8	2.0	2.5	4.5	2.5	6.1	3.1	0.0	1.6	1.5	1.5	0.0	1.2	1.5	5.6	5.5	0.0	7.0	0.0
Actinoptychus splendens	0.0	0.0	0.0	0.0	0.0	1.1	0.5	0.5	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	1.1	0.0	0.0	0.0
Amphiprora alata	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0
Amphora coffeaeformis	0.0	1.0	0.0	1.4	1.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Amphora coffeaformis var acutiuscula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.6	4.5	0.0	0.0
Amphora exigua	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.1	0.5	0.0	0.0	0.0
Amphora marina	0.0	0.0	0.5	0.5	3.6	0.0	0.0	0.5	0.0	2.5	3.5	1.6	2.4	1.0	0.5	2.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	11.0
Amphora ostrearia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.6	1.5	0.6	0.0	0.9	0.0	0.0
Amphora ovalis	0.0	4.0	1.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Auricula dubia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0
Biddulphia alternans	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.5	0.5	0.5	0.0	0.0	0.0	0.5	0.0	0.0	1.0	0.0	0.0	0.6	0.0	0.9	0.6	0.0
Caloneis westii	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	3.0	1.0	0.0	0.5	1.0	2.0	1.5	0.0	7.7	0.0	0.6	0.0	0.0	0.0	0.0
Campylosira cymbelliformis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0
Cocconeis pediculus	0.0	0.5	1.5	1.8	1.0	1.1	0.0	0.0	2.0	0.5	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0
Cocconeis peltoides	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.8	1.0	1.5	1.0	1.0	0.0	0.5	0.6	0.5	1.4	1.2	8.1
Cocconeis scutellum	0.0	1.0	2.9	7.7	0.5	2.2	1.0	6.5	2.5	5.5	2.0	5.8	1.9	2.1	0.5	1.0	1.4	1.2	2.5	3.9	2.2	8.2	4.1	8.1
Cocconeis stauroneiformis	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyclotella striata	0.0	0.5	0.5	0.0	0.0	1.7	0.0	0.0	0.5	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cymatosira belgica	0.0	1.0	1.0	1.8	0.5	0.0	2.0	2.0	1.5	0.5	0.0	1.0	0.0	0.5	0.0	1.0	0.5	0.0	0.5	1.7	0.0	1.8	0.6	0.0
Cymbella parva	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Delphineis surirella	0.0	2.5	1.9	1.8	1.6	1.1	1.5	1.5	2.0	3.5	2.0	1.6	0.5	1.6	1.5	1.0	1.0	2.4	0.5	6.1	5.5	1.4	9.3	0.0
Denticula subtilis	0.0	2.5	0.0	3.6	19.2	1.7	22.9	0.5	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diatoma vulgare	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dimeregramma minor	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.5	0.0	1.0	2.4	2.1	0.0	0.0	1.4	0.8	0.0	0.0	0.0	0.0	0.6	2.9
Diploneis didyma	0.0	0.5	0.0	0.0	1.6	8.9	1.0	0.0	0.0	0.0	0.0	2.1	1.0	1.6	1.0	1.0	0.5	4.4	1.0	1.7	1.1	2.3	0.0	0.0
Diploneis litoralis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.9
Diploneis ovalis	0.0	3.5	1.9	1.4	0.5	0.6	0.0	0.0	0.0	1.5	2.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0
Diploneis papula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diploneis smithii	0.0	0.0	0.0	0.0	0.0	1.1	0.0	1.5	1.0	2.5	6.1	0.0	0.0	0.0	3.0	6.0	0.5	8.5	0.5	0.6	0.5	0.0	0.0	0.0
Fragilaria virescens v. exigua	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
Gomphonema angustatum	0.0	1.5	0.0	0.5	0.0	0.0	0.5	0.5	0.5	0.0	0.0	0.5	0.0	0.0	0.5	0.0	0.5	0.0	2.5	2.8	0.0	0.0	0.6	0.0
Gyrosigma acuminatum	0.0	2.5	2.4	2.7	2.6	3.3	2.0	2.0	7.0	2.0	2.5	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gyrosigma distortum	0.0	0.5	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gyrosigma littorale	0.0	0.0	0.0	0.9	0.0	1.1	0.5	3.0	4.0	2.0	1.0	0.5	1.0	0.0	1.0	1.0	0.5	0.0	0.5	2.2	1.1	2.3	0.6	0.0
Gyrosigma rectum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gyrosigma scalproides	0.0	0.0	1.0	0.0	0.0	0.0	2.4	3.0	8.0	1.0	7.1	0.5	0.0	3.7	8.5	4.5	0.0	0.0	1.0	0.0	0.5	0.0	0.0	0.0
Gyrosigma wansbeckii	0.0	2.0	0.5	0.9	0.0	0.0	0.0	0.0	4.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hantzschia amphioxys	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hantzschia virgata	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0
Mastogloia smithii	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula apiculata	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.5	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	1.2	0.0
Navicula cari var cincta	0.0	2.0	1.0	0.9	0.5	0.6	2.0	1.0	2.0	1.5	1.5	0.0	0.5	0.0	0.5	0.0	0.5	0.0	0.0	1.1	1.6	0.5	1.2	0.0
Navicula cariniferа	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	0.0	0.0	0.0	0.0	0.0	0.0
Navicula cruciculа	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula cryptocephala	0.0	0.0	0.5	0.0	0.0	0.0	0.5	0.0	0.5	0.5	0.0	1.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.9	0.0	0.0	0.0
Navicula digitoradiata	0.0	0.0	0.0	0.0	1.6	16.7	1.0	2.0	10.5	14.9	13.6	24.1	0.5	18.8	30.3	32.5	48.1	18.1	34.0	28.5	18.0	5.9	3.5	0.0
Navicula distans	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0
Navicula ergadensis	0.0	0.5	0.5	3.2	2.1	4.4	1.0	6.0	7.5	5.0	4.5	5.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula flanatica	0.0	2.5	2.9	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	5.3	0.5	0.0	3.0	2.4	0.0	0.0	0.0	0.0	1.8	1.2	0.0
Navicula forcipata	0.0	0.0	0.5	0.9	0.0	2.2	0.0	2.0	1.5	7.0	1.5	0.5	3.4	1.6	0.0	0.5	0.0	0.0	0.0	2.2	0.0	2.7	1.7	0.0
Navicula gregaria	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Navicula halophila	0.0	11.9	9.7	1.8	3.1	1.7	1.0	0.5	0.0	0.5	1.0	2.1	3.8	1.0	0.0	1.5	4.3	0.0	1.0	1.7	2.7	4.1	3.5	8.1
Navicula humerosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0
Navicula insociabilis	0.0	5.4	0.5	0.0	1.0	0.0	0.0	0.5	0.0	0.5	0.0	0.5	0.0	1.6	0.0	0.0	1.0	0.0	2.0	0.0	1.1	4.1	0.0	0.0
Navicula mutica	0.0	0.0	1.0	4.5	6.7	0.0	1.0	3.5	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
Navicula peregrina	0.0	1.5	1.0	2.7	0.0	3.9	0.0	0.0	1.0	0.5	2.0	1.0	0.0	0.0	0.0	0.0	0.5	1.6	0.0	0.0	4.4	0.0	0.0	0.0
Navicula retusa v. cancellata	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	1.0	1.5	1.5	0.5	1.9	3.1	5.0	7.0	4.3	1.2	22.8	8.4	10.9	5.9	3.5	0.0
Navicula salinarum	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.5	0.6	0.0
Navicula tripunctata	0.0	4.0	7.3	0.0	0.0	0.0	0.0	0.0	1.5	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitzschia acuminata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.1	1.8	2.3	0.0
Nitzschia bilobata	0.0	1.5	0.0	0.9	3.6	0.0	13.7	18.4	4.0	0.0	0.5	0.0	0.5	2.6	0.0	0.0	0.0	0.0	1.0	0.6	0.0	0.0	0.6	0.0
Nitzschia epithemioides	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0
Nitzschia fasciculata	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.5	0.0	0.0	0.5	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.6	1.1	0.0	0.0	0.0
Nitzschia fonticola	0.0	9.4	13.6	2.7	2.6	0.0	2.0	0.5	3.5	1.5	8.1	3.1	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	2.9
Nitzschia frustulum	0.0	7.4	7.8	5.9	5.2	0.6	5.4	2.5	1.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitzschia navicularis	0.0	1.0	3.9	0.5	1.0	2.2	2.9	3.0	0.5	4.0	0.5	4.7	0.0	0.5	0.5	1.0	0.0	0.8	0.5	0.0	1.1	0.9	0.0	0.0
Nitzschia obtusa	0.0	0.0	0.0	0.0	2.1	0.0	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1	0.0	1.6	0.9	0.0	0.0
Nitzschia punctata var constricta	0.0	0.5	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitzschia sigma	0.0	1.0	2.9	7.7	6.7	1.7	3.9	5.5	2.0	0.5	3.0	3.1	0.0	0.5	7.5	1.0	1.4	0.0	2.0	0.6	1.6	2.7	0.6	0.0
Nitzschia tryblionella	0.0	0.0	0.0	15.8	14.5	0.0	8.8	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Odontella aurita	0.0	0.0	0.0	1.4	0.5	0.6	0.5	0.5	2.5	1.5	0.5	0.0	0.5	0.5	0.5	0.5	1.0	0.0	0.0	0.0	1.6	0.0	9.3	0.0
Odontella rhombus	0.0	0.0	0.0	0.0	0.0	1.7	0.5	0.0	0.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opephora pacifica	0.0	0.0	1.5	1.8	0.5	0.0	1.0	1.0	0.5	1.0	0.5	2.6	14.4	4.7	3.0	3.0	8.6	0.0	0.0	1.1	0.5	15.9	4.7	22.0
Paralia sulcata	0.0	1.5	2.9	1.8	2.6	5.6	2.0	5.5	4.5	3.5	4.5	4.7	1.9	4.7	10.9	15.0	0.0	11.3	1.5	5.0	6.6	3.6	6.4	0.0
Plagiogramma staurophorum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4
Plagiogramma vanheurckii	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	1.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	1.8	4.1	0.0
Pleurosigma normanii	0.0	0.0	1.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rhaphoneis amphiceros	0.0	0.0	0.0	1.4	1.0	3.9	1.0	1.5	3.0	7.0	3.0	2.1	0.5	4.7	1.5	2.0	1.4	4.8	2.5	6.1	6.0	6.4	8.1	0.0
Rhaphoneis nitzschioides	0.0	0.0	0.0	0.9	1.0	1.1	0.0	0.5	0.5	3.0	2.5	2.1	0.0	1.6	0.0	0.0	0.0	0.8	0.0	1.7	1.6	0.0	4.7	0.0
Scolioneis tumida	0.0	0.0	0.0	0.9	0.0	4.4	0.5	1.0	0.0	1.0	7.1	2.1	0.5	19.4	9.0	2.5	0.0	0.8	0.0	2.8	2.7	0.0	0.6	0.0
Scoliotropis latestriata	0.0	0.0	1.0	0.0	0.0	4.4	0.0	1.0	1.5	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0
Stauroneis amphioxys	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	2.0	1.0	0.0	0.5	0.5	1.0	0.0	1.4	0.0	0.0	1.7	0.0	0.0	0.0	0.0
Stauroneis anceps	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stauroneis gregorii	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.6	3.0	1.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Surirella gemma	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Surirella ovata	0.0	0.5	0.5	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Synedra ulna	0.0	0.5	1.0	0.9	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thalassionema nitzschioides	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.5	0.0	0.0	0.0
Thalassiosira eccentrica	0.0	0.0	0.5	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.5	0.0	1.6	0.0	0.0	0.0	0.0	1.7	0.0
Thalassiosira lepotpus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.8	0.5	1.7	0.5	0.0	0.0	0.0
Trachyneis aspera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.5	0.0	1.5	0.0	0.0	0.5	0.5	2.5	0.5	28.2	0.0	2.2	0.0	0.0	0.0	0.0
Tricerratium favus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0
Tropidoneis elegans	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0
Trybionella hungarica	0.0	8.4	16.5	7.2	2.6	6.1	2.4	5.0	5.0	1.5	3.0	7.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	0	202	206	221	193	180	205	201	200	201	198	191	208	191	201	200	210	248	197	179	183	220	172	209

Table A5.4 Diatom assemblage for each station of Thornham Marsh.

Station	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*
Altitude (m OD)	4.32	3.23	3.09	3.12	3.04	2.87	2.82	2.72	2.71	2.42	2.23	2.40	2.64	2.86	2.75	2.35	2.15	2.06	1.87	1.62	0.99	0.60	0.40	0.21
LOI (%)	48.60	40.21		18.17		20.35		15.92		14.67		11.75		5.84		7.91		8.29		7.47		2.89		1.11
Clay fraction (%)	48.20	45.30		44.30		42.40		41.80		35.30		20.20		12.30		22.30		25.70		21.30		9.10		2.10
pH	5.30	5.80		6.10		6.50		6.50		6.50		6.10		5.80		6.10		6.10		6.50		7.00		7.00
Salinity (ppt)	6.93	8.42		11.53		10.55		11.88		10.47		11.88		14.42		21.08		9.19		13.95		25.79		24.60
Vegetation cover (%)	*100.00*	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	*90.00*	*90.00*	*90.00*	*70.00*	*20.00*	15.00	15.00	10.00	10.00	5.00	1.00	0.00	0.00	0.00

Table A5.5 Annual environmental variables from stations of Thornham Marsh.

Appendix Six Brancaster Marsh

6.1 Relationships between foraminifera and environmental variables

The annual average of the six most important dead foraminifera found on the intertidal zone of Brancaster Marsh are related to loss on ignition (LOI), pH and vegetation cover.

6.1.1 Foraminifera and LOI

The scatter plot of *Jadammina macrescens* versus LOI (Figure A6.1) shows a positive non-linear relationship with relatively high abundances at LOI values exceeding 17.5 %. Conversely, *Haynesina germanica* shows a strong negative non-linear relationship suggesting dominance in environments with a relatively low organic content such as the mudflat. The scatter plot of *Miliammina fusca, Trochammina inflata, Elphidium williamsoni* and *Quinqueloculina* spp. show non-linear relationships with LOI.

6.1.2 Foraminifera and pH

The scatter plots of *M. fusca, T. inflata* and *H. germanica* versus pH (Figure A6.2) show a distinct threshold of pH values at 6.5. Relatively high abundances of *M. fusca* and *T. inflata* occur at pH values less than 6.6. Conversely, the scatter plot of *H. germanica* shows relatively high abundances at pH values greater than 6.5. The scatter plots for *J. macrescens, E. williamsoni* and *Q.* spp. show no relationships with pH.

6.1.3 Foraminifera and vegetation cover

The scatter plots of *J. macrescens* and *T. inflata* versus vegetation cover (Figure A6.3) show strong positive non-linear relationships indicating a dominance in environments with dense vegetation cover such as the middle marsh. Conversely, the scatter plots of *H. germanica* show a strong negative relationship suggesting dominance in barren environments such as the mudflat. The scatter plots for *M. fusca, E. williamsoni* and *Q.* spp. show non-linear relationships with vegetation cover.

6.2 Multivariate analysis of contemporary foraminifera

Two multivariate techniques are used to analyse the foraminiferal death assemblages (%) collected from stations 1 to 23 at three-monthly intervals for a twelve-month period: first, unconstrained cluster analysis based on unweighted Euclidean and Chord distance; and second, detrended correspondence analysis (DCA). Only samples with counts greater than 40 individuals and species that reach 5 % of the total sum are included.

6.2.1 Cluster analysis

Cluster analysis of monthly assemblages based on **unweighted Euclidean distance** detects zones MEAG and MEHG (Figure A6.4):

I. Zone MEAG is dominated by three agglutinated species (*J. macrescens*, *M. fusca* and *T. inflata*) and one calcareous species (*Q.* spp.). The altitudes range from 3.27 m OD to 1.88 m OD (1.39 m). However, the lower quartile range is 1.15 m (3.03 m OD to 1.88 m OD) (Figure A6.5);
II. Zone MEHG is dominated by calcareous species, notably *H. germanica* with low frequencies of *J. macrescens*, *E. magellanicum* and *E. williamsoni*. This zone differs from MEAG because it has the highest percentages of *H. germanica*: exceeds 45 % total dead foraminifera in all samples. The altitudes range from 2.48 m OD to 1.85 m OD (0.63 m) with an interquartile range of 0.46 m (2.31 m OD to 1.85 m OD). However, the median is found at 1.88 m OD. The relatively low altitude of the median is due to the inclusion of numerous samples at the seaward limit of the transect.

The second variant of cluster analysis, **unweighted Chord distance** (Figure A6.6), classifies the data into two zones (MCAG and MCHG). The species composition of each zone corresponds with their Euclidean equivalents, though, the altitudinal ranges differ (Figure A6.7). The altitudinal range of Chord Zone MCAG is 1.10 m smaller than Euclidean Zone MEAG. Conversely, the altitudinal range of Chord Zone MCHG is 0.52 m larger than Euclidean Zone MEHG. Furthermore, the median altitude of the former is 0.43 m higher than its latter equivalent.

The similarities and differences between the two variants of cluster analysis are further shown in Figure A6.8. The distributions of monthly Euclidean and Chord zones across the intertidal zone are similar both in terms of the number and proportion of samples. However, Chord Zone MCHG completely dominates stations 20 to 22 whereas Euclidean Zones MEAG and MEHG combine to dominate these stations.

6.2.2 Detrended correspondence analysis

The first two DCA axes account for 63 % and 15 % of the total variance of **monthly** species data: 78 % in all. Therefore, it is Axis One that controls the ordination diagram (Figure A6.9a). Low positive or negative loadings of Axis One are found for agglutinated species that dominate the middle marsh such as *M. fusca*, *T. inflata* and *J. macrescens* (Table A6.1). Conversely, calcareous species that dominate the mudflat such as *H. germanica* and *E. magellanicum* have large positive loadings. Thus, the species loadings reflect an altitudinal gradient from middle marsh through low marsh to mudflat. This relationship is supported in Figure A6.9b. The scatter plot of DCA Axis One scores versus altitude shows a strong negative relationship. The loadings of Axis Two do not reflect any major environmental gradient.

The two zonations produced by cluster analysis of unweighted Euclidean and Chord distance correspond to distinct regions in the ordination diagram: the zones are mutually exclusive (Figure A6.9a).

DCA of **annual** assemblages produces an ordination diagram also controlled by Axis One (Figure A6.10a). Axes One (eigenvalue = 0.52) controls 86 % of the total variation of species data. Moreover, the species loadings of Axis One (Table A6.2), the scatter plot of Axis One scores versus altitude and the zonations produced by cluster analysis are comparable with the results from monthly assemblages (Figure A6.10a, b).

Species	Axis One	Axis Two	Axis Three
Haplophragmoides spp.	- 0.86	0.49	2.69
Jadammina macrescens	0.89	1.83	1.01
Miliammina fusca	- 0.62	0.38	1.92
Trochammina inflata	- 0.11	0.95	- 0.51
Ammonia beccarii var. *batavus*	3.17	3.47	- 0.83
Ammonia beccarii var. *limnetes*	1.81	-.0.02	- 0.70
Ammonia beccarii var. *tepida*	2.27	-0.76	2.08
Brizalina inflata	4.01	-0.02	1.87
Bulimina gibba	4.04	3.74	- 0.36
Cyclogyra involvens	1.41	- 0.09	1.07
Elphidium earlandi	1.79	- 0.25	1.32
Elphidium excavatum	3.25	2.54	1.38
Elphidium incertum	3.41	0.10	1.04
Elphidium magellanicum	3.43	1.00	0.67
Elphidium williamsoni	1.66	- 0.09	- 0.39
Glabratella millettii	4.22	3.54	- 1.25
Globigerina quinqueloba	2.79	4.16	0.03
Haynesina germanica	2.82	1.33	0.68
Quinqueloculina spp.	1.61	-0.68	1.23
Variance (eigenvalues)	0.57	0.14	0.08
Percent total variance	63	15	9
Cumulative percent of total variance	63	78	87

Table A6.1 Loading and percentages of variance explained by the first three detrended correspondence axes from monthly foraminiferal death assemblages of Brancaster Marsh.

Species	Axis One	Axis Two	Axis Three
Haplophragmoides spp.	-0.75	3.09	3.35
Jadammina macrescens	0.63	0.19	0.93
Miliammina fusca	-0.68	1.67	0.94
Trochammina inflata	-0.33	-0.55	-0.14
Ammonia beccarii var. *batavus*	2.56	1.07	-1.38
Ammonia beccarii var. *limnetes*	1.64	1.34	-2.18
Ammonia beccarii var. *tepida*	2.43	1.61	-0.23
Brizalina inflata	3.2	1.04	-1.22
Bulimina gibba	2.68	-2.85	4.79
Cyclogyra involvens	1.21	0.65	1.34
Elphidium earlandi	1.52	1.48	1.5
Elphidium excavatum	2.64	2.05	-2.62
Elphidium incertum	3.01	0.73	0.06
Elphidium magellanicum	2.89	0.79	-1.11
Elphidium williamsoni	1.53	1.26	-0.53
Glabratella millettii	2.51	0.61	0.59
Globigerina quinqueloba	2.12	-2.51	3.41
Haynesina germanica	2.66	0.07	1.2
Quinqueloculina spp.	1.41	2.05	-0.66
Variance (eigenvalues)	0.52	0.05	0.02
Percent total variance	86	9	3
Cumulative percent of total variance	86	95	98

Table A6.2 Loading and percentages of variance explained by the first three detrended correspondence axes from annual foraminiferal death assemblages of Brancaster Marsh.

6.3 Biostratigraphical data of Brancaster Marsh

The following three tables show the average annual foraminiferal death assemblages (%) from 4 three-monthly samples, the diatom assemblages and the environmental variables from stations of Brancaster Marsh. The foraminiferal three-monthly samples were collected on 24/11/95 (BR951), 01/03/96 (BR961), 25/05/96 (BR962) and 16/08/96 (BR963). These data are archived on Computer Disk One.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Ammonia beccarii var. aberdoveyensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.64	0.00	0.00	0.00
Ammonia beccarii var. batavus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	4.91	2.94	4.50	1.39	1.85
Ammonia beccarii var. limmeles	0.38	1.67	0.64	7.29	0.57	0.00	0.43	0.00	0.00	1.19	0.45	1.32	1.79	3.94	7.01	3.47	0.52	0.51	0.49	3.33	6.81	2.52	1.33
Ammonia beccarii var. tepida	0.00	0.25	0.00	0.92	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.00	0.00	0.23	0.64	2.49	2.06	0.00
Brizalina inflata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.19	1.85	0.78	1.99
Brizalina variabilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.89
Bulimina gibba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.00	0.00	1.20	0.00
Buliminella elegantissima	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cassidulina obtusa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.00	0.00	0.00
Cycloguya involvens	0.00	1.28	2.29	1.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	2.05	2.72	2.70	1.58	0.00	0.00	0.00	0.52
Elphidium earlandi	1.15	0.25	1.02	1.27	0.36	0.26	0.32	1.06	3.67	0.00	0.00	2.40	1.36	0.78	6.21	16.21	6.95	4.41	1.85	11.02	7.40	4.13	2.04
Elphidium excavatum	0.00	0.00	0.00	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	1.22	0.00	0.00	0.68	2.75	0.00	2.08	0.37
Elphidium incertum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.16	0.00	1.39	0.00	1.45
Elphidium magellanicum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.84	1.92	4.66	3.82	3.89
Elphidium spp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.81	1.43	2.94	6.66	2.43	4.26
Elphidium williamsoni	3.21	3.85	3.06	4.91	0.76	1.60	0.56	2.46	3.53	2.59	2.00	2.40	1.36	0.78	6.21	16.21	6.95	4.41	1.85	11.02	7.40	4.13	2.04
Fissurina lucida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.19	0.00	0.00	0.37
Fissurina marginta	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	1.15	0.00	0.00	0.00	0.00	0.00	0.00
Fursenkoina fusiformis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	1.15	0.00	0.00	0.00	0.00	0.00	0.00
Glabratella milletti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.47	0.00	0.00	0.00
Globigerina quinqueloba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42	2.24	0.00	0.00	1.56	0.00
Haplophragmoides spp.	6.37	2.58	2.41	0.58	0.29	4.31	1.75	1.06	0.20	0.52	0.42	1.30	0.23	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Haynesina germanica	1.37	2.84	3.17	6.79	1.12	1.38	1.89	1.63	0.00	5.35	1.25	4.27	1.77	0.00	1.41	4.11	4.50	14.93	14.27	34.26	41.15	52.67	73.39
Jadammina macrescens	44.71	37.52	35.55	27.86	40.37	33.84	45.83	39.41	39.65	44.56	30.16	38.34	38.96	49.46	43.59	22.48	44.40	46.63	56.27	21.61	12.87	17.52	5.94
Miliammina fusca	19.80	17.09	20.24	13.64	24.89	25.52	16.51	27.35	16.26	14.43	16.91	13.61	6.01	8.36	7.01	4.14	1.67	0.00	0.45	0.00	0.00	0.00	0.00
Quinqueloculina spp.	4.81	7.82	8.14	21.23	3.05	1.43	0.21	1.08	0.00	0.79	2.02	2.57	2.01	0.00	11.52	22.56	14.41	4.60	2.26	11.78	9.11	4.78	0.00
Rosalina williamsoni	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00
Spirillina vivipara	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Typhotrocha comprimata	0.00	0.65	0.00	0.00	0.36	0.66	0.21	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.00
Trochammina inflata	17.81	24.19	23.51	12.85	26.20	30.70	32.00	24.94	36.08	30.58	46.81	36.21	47.88	36.16	21.82	22.97	22.01	23.95	9.65	2.31	0.53	0.61	0.69
Trochammina ochracea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.00
Average forams counted per 10 ml	1116	846	692	740	780	814	832	708	636	834	620	766	612	606	1328	1166	538	642	634	226	318	378	478

Table A6.3 Average annual foraminiferal death assemblages from 4 three-monthly samples from each station of Brancaster Marsh.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Achnanthes brevipes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.37	0.00	0.00
Achnanthes delicatula	22.94	11.43	14.06	13.30	15.12	20.00	12.06	11.27	8.78	3.66	1.97	11.58	19.51	9.79	4.83	5.41	6.49	4.81	2.39	5.76	5.69	4.00	3.43
Achnanthes lanceolata	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Achnanthes minutissima	4.13	6.19	8.85	7.39	2.93	5.50	2.51	4.90	4.39	1.05	3.45	2.63	2.93	5.15	0.48	0.00	0.54	0.00	1.44	1.57	0.47	0.00	0.00
Achnathes austriaca	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00
Actinoptychus senarius	0.00	1.90	1.04	0.49	1.46	2.00	0.00	0.49	1.46	3.14	3.45	0.00	0.98	2.06	0.48	1.80	1.62	2.14	1.91	1.05	2.84	5.00	4.41
Amphora coffeaeformis	9.17	5.71	5.73	1.97	2.44	1.00	1.51	2.94	1.46	1.05	0.00	0.00	0.49	1.03	1.93	2.70	0.00	0.00	0.00	0.52	0.00	0.00	0.00
Amphora exigua	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.55	0.48	0.00	0.00	0.00	0.00	1.05	0.00	0.00	0.00
Amphora marina	0.00	0.00	3.13	5.42	5.85	3.00	3.52	4.41	2.93	11.52	6.40	2.63	0.98	0.52	2.42	1.35	1.08	0.00	0.00	1.05	2.37	3.00	4.90
Amphora ovalis	0.92	2.38	2.60	4.93	3.41	1.00	2.51	5.39	0.00	1.05	0.00	1.05	0.49	0.52	0.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Auricula complexa	0.00	0.00	0.00	0.49	0.98	1.00	0.50	0.98	1.95	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.54	0.53	1.91	0.00	0.00	0.00	0.00
Auricula dubia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.91	0.00	0.00	0.00	0.00
Biddulphia alternans	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.54	0.53	1.91	0.00	0.95	1.00	1.96
Caloneis westii	0.00	0.00	2.08	0.49	0.00	2.00	1.01	1.47	8.29	3.66	6.40	1.58	0.00	0.00	2.42	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Campylosira cymbelliformis	0.00	0.00	0.00	0.00	0.00	2.50	0.00	1.47	0.49	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cocconeis distans	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.00	0.00	0.00	0.00
Cocconeis pediculus	0.46	0.95	0.00	0.00	0.00	0.00	0.00	0.98	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00	0.00	0.49
Cocconeis peltoides	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cocconeis placentula	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cocconeis scutellum	1.38	2.86	1.04	1.97	2.93	3.50	2.51	0.98	0.00	1.57	0.99	1.05	2.44	2.58	2.42	2.70	4.32	7.49	6.22	6.81	9.48	4.50	7.84
Cocconeis stauroneiformis	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyclotella striata	0.00	0.48	0.52	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49
Cylindrotheca closterium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00	0.00	0.00	2.58	0.97	0.00	0.00	0.53	0.00	0.00	0.00	0.00	0.00
Cymatosira belgica	0.46	0.48	0.00	0.00	0.00	0.50	0.00	0.00	0.00	1.05	0.00	0.53	2.93	2.06	1.93	0.45	2.16	0.53	3.35	2.62	0.95	0.00	0.49
Cymbella affinis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Delphineis cf. surirella	0.00	0.00	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Delphineis surirella	0.00	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.53	1.95	1.03	0.48	0.90	1.08	3.21	5.74	2.09	3.32	4.50	3.43
Denticula subtilis	3.21	3.81	1.56	1.97	3.41	2.00	1.01	3.92	1.95	0.00	0.49	2.11	3.90	14.95	10.14	10.81	5.95	3.74	12.44	0.00	0.00	0.00	0.00
Dimeregramma minor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00
Diploneis didyma	1.83	5.24	3.13	0.49	4.88	2.00	1.51	1.96	4.88	6.28	5.42	1.05	4.88	5.15	6.76	1.80	0.54	0.00	0.48	0.52	0.47	0.00	1.96
Diploneis interrupta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.05	0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.00	1.42	0.50	0.00
Diploneis lineata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diploneis litoralis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00
Diploneis ovalis	4.13	6.67	4.17	2.96	2.93	5.50	3.02	3.43	2.93	1.05	6.40	1.05	0.98	0.52	5.80	1.80	0.54	0.53	0.00	0.00	0.00	0.00	0.98
Diploneis papula	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	2.44	0.52	4.93	1.05	0.98	0.00	1.45	0.00	0.00	0.00	0.00	0.00	0.47	0.50	0.49
Diploneis smithii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.00	0.00	0.00	1.45	1.80	1.62	0.53	0.48	0.00	0.95	0.50	0.49
Fragilaria pinnata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.07	0.00	0.00	0.00	0.00	0.00
Fragilaria virescens v. exigua	0.00	0.00	0.52	0.49	0.98	1.00	0.00	0.00	0.00	1.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.00	0.00	0.50	0.00
Gomphonema angustatum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.52	0.47	0.00	0.00
Gyrosigma acuminatum	0.00	0.00	2.08	0.99	0.49	0.00	0.50	0.49	0.00	0.00	1.48	0.00	0.00	0.52	0.97	0.45	2.16	4.28	0.00	0.00	3.32	0.50	0.00
Gyrosigma distortum	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gyrosigma littorale	0.00	0.00	0.00	0.00	0.00	0.00	1.51	0.00	0.00	0.52	0.00	0.00	0.00	0.00	0.48	2.70	2.16	1.07	0.00	2.62	4.74	4.00	5.39
Gyrosigma rectum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gyrosigma scalproides var eximia	0.00	0.48	0.00	0.00	1.46	0.00	0.00	0.00	0.00	0.00	3.45	3.68	0.00	2.06	2.90	0.45	3.78	1.07	0.00	0.00	0.47	0.00	0.00
Gyrosigma spenceri	1.38	1.90	1.04	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.00	0.54	0.00	2.39	0.52	0.00	0.00	0.00
Gyrosigma strigilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.50	0.00
Gyrosigma wansbeckii	0.00	0.00	0.52	0.00	1.95	0.50	0.00	0.00	0.00	0.00	0.49	0.00	0.00	1.03	0.97	3.60	2.16	1.07	0.48	0.00	0.00	1.00	1.47
Hantzschia virgata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00
Navicula apiculata	0.00	0.00	0.00	0.00	0.00	0.00	1.51	0.00	0.00	0.00	0.00	1.05	0.00	0.52	0.00	0.90	0.00	1.60	0.00	2.09	1.90	0.50	0.00
Navicula cari var cincta	2.75	3.33	4.17	1.48	1.46	1.50	5.03	4.90	4.39	5.76	4.93	5.26	2.93	2.06	5.31	3.60	3.24	0.53	2.87	5.76	1.42	1.50	0.49
Navicula crucicula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.42	1.50	0.49
Navicula cryptocephala	0.00	0.00	0.00	0.00	0.49	1.00	3.52	1.47	1.95	0.52	0.00	4.74	1.46	0.00	0.00	2.70	0.00	0.00	0.48	1.05	1.42	1.00	0.00
Navicula digitoradiata	4.13	6.19	3.13	0.00	0.98	0.50	2.51	0.00	0.00	12.04	3.45	7.37	4.39	0.52	3.86	1.35	1.62	2.14	1.44	4.19	0.47	2.50	3.43
Navicula ergadensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	0.00	2.46	4.21	0.49	0.52	2.90	1.35	6.49	6.42	5.74	5.76	0.47	0.00	0.00
Navicula flanatica	5.05	0.95	2.08	2.96	3.90	3.50	7.54	3.92	10.73	6.81	3.45	4.74	8.29	0.00	4.35	1.35	0.54	0.00	0.00	0.00	0.47	0.50	0.00
Navicula forcipata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.48	1.05	0.98	0.00	0.00	0.45	1.08	1.07	0.00	2.09	1.90	2.00	1.47
Navicula gregaria	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navicula halophila	1.38	3.81	7.81	8.37	2.93	5.50	12.56	9.31	10.73	3.66	0.49	6.84	7.32	1.55	1.45	1.80	0.00	0.00	0.48	4.19	0.47	0.00	0.00
Navicula insociabilis	4.59	5.71	3.13	1.97	1.46	3.50	2.01	1.96	0.98	0.52	0.00	1.58	0.00	1.55	0.00	2.25	0.00	0.00	0.00	1.57	1.90	0.00	2.45
Navicula marina	0.46	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navicula mutica	0.46	0.00	2.08	2.46	1.95	0.50	1.01	0.49	0.00	0.52	0.00	0.00	1.95	0.00	1.45	0.00	0.00	0.00	3.35	0.00	0.00	0.00	0.00
Navicula peregrina	5.05	5.71	3.65	4.43	0.98	2.00	2.01	1.47	3.41	8.90	4.93	3.16	1.95	1.03	2.42	0.90	1.08	2.14	1.91	0.52	0.95	1.00	0.49
Navicula placentula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49
Navicula retusa v. cancellata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.53	0.00	1.05	0.95	0.00	0.49
Navicula rhyncocephala	0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navicula salinarum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	2.63	0.98	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00
Navicula tripunctata	4.13	0.48	1.56	3.45	3.41	2.00	1.51	0.98	0.98	0.00	0.00	3.16	2.44	1.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Navicula viridula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.09	3.45	0.00	0.00	0.00	2.42	0.00	1.08	0.53	0.00	0.00	0.00	0.00	0.00
Nitzschia acuminata	0.00	0.00	1.04	0.00	0.00	1.50	1.01	0.00	0.98	1.05	0.99	1.05	1.46	2.06	2.90	4.50	8.65	10.70	0.48	7.85	4.74	12.00	10.29
Nitzschia bilobata	3.67	0.48	0.00	1.48	1.95	1.50	2.51	1.47	2.44	0.52	0.99	1.58	0.49	2.06	0.48	1.35	2.16	1.60	4.31	0.52	0.47	2.00	0.00
Nitzschia fasciculata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.96	0.00	0.00	0.00	0.00
Nitzschia fonticola	0.46	0.95	0.52	5.42	1.46	1.00	0.50	2.94	0.00	0.52	0.00	2.63	2.93	8.25	3.86	4.95	12.43	3.74	1.91	1.57	2.37	0.50	0.49
Nitzschia frustulum	4.59	4.29	5.73	9.85	8.78	7.00	7.54	9.31	6.83	2.09	0.99	5.26	4.88	4.12	3.38	4.95	3.78	2.67	3.83	1.57	0.47	0.00	0.00
Nitzschia navicularis	0.92	0.48	2.08	1.97	0.00	0.00	1.01	0.00	0.00	0.00	0.49	0.53	0.00	0.52	0.97	2.70	3.78	0.00	0.00	0.00	1.90	0.00	0.98
Nitzschia obtusa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.83	4.71	0.00	0.00	0.00
Nitzschia punctata var constricta	2.29	4.29	0.00	4.43	5.85	4.00	3.52	4.41	1.46	1.57	0.00	0.53	2.44	3.61	0.97	10.36	0.00	0.00	0.00	1.05	0.95	1.00	3.92
Nitzschia sigma	2.75	3.33	1.04	1.48	1.95	2.00	0.50	5.88	1.95	0.52	6.90	2.63	2.44	6.70	0.97	0.90	4.86	1.07	4.31	13.09	2.37	6.50	10.29
Nitzschia tryblionella	1.38	0.48	1.56	0.99	0.49	0.00	0.50	0.00	0.49	1.57	0.00	0.00	0.49	1.03	2.42	1.80	4.32	12.30	6.70	0.00	0.47	0.50	0.49
Nitzschia vitrea	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Odontella aurita	0.00	0.00	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Opephora martyi	0.46	2.38	1.04	0.00	0.49	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Opephora pacifica	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.49	1.58	0.98	0.52	0.97	0.45	0.00	2.14	0.48	1.57	8.06	7.00	0.00
Paralia sulcata	0.92	0.00	2.08	0.00	0.98	1.00	4.02	0.98	3.90	4.19	2.96	2.11	2.44	2.58	2.42	4.50	2.70	3.74	4.31	2.09	4.74	8.00	6.37
Plagiogramma vanheurckii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.00	0.00	1.05	0.00	0.00	1.96
Pleurosigma angulatum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.96	0.00	0.00	0.00	0.49
Pleurosigma normanii	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.53	0.49	0.52	0.00	0.00	0.00	0.00	0.48	1.05	1.42	2.00	1.47
Podosira stelligera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.00	0.00	0.47	0.00	0.00
Rhaphoneis amphiceros	0.00	0.95	0.00	0.99	1.46	0.50	0.50	0.98	0.00	1.05	1.48	1.05	0.49	1.03	2.42	0.90	0.00	6.95	1.91	2.09	3.79	4.00	3.43
Rhaphoneis minutissima	0.46	0.00	0.00	0.00	0.00	0.50	0.50	0.49	0.00	0.00	0.00	0.53	0.00	0.52	0.48	0.90	0.54	1.07	2.39	2.09	0.95	0.00	2.94
Rhizoselenia setigera	0.00	0.00	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scolioneis tumida	0.46	0.00	0.00	0.00	0.98	0.50	1.01	0.00	0.98	5.76	0.00	2.63	0.00	0.00	0.00	0.00	1.08	0.53	0.00	0.52	1.90	3.00	1.96
Scoliotropis latestriata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.09	2.84	2.00	0.00
Stauroneis amphioxys	0.00	0.00	0.52	0.00	0.98	0.00	0.00	0.00	0.00	0.00	10.34	0.00	0.00	0.52	0.00	0.45	0.00	0.53	0.00	0.52	0.95	2.50	1.96
Stauroneis amphioxys var. obtusa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stauroneis spicula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Surirella fastuosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	1.95	1.55	0.97	2.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Surirella gemma	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.54	1.07	0.00	0.52	0.95	1.50	0.98
Surirella ovalis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.50	1.96
Surirella ovata	0.00	0.00	0.52	0.99	2.44	2.00	0.00	0.49	0.49	1.05	0.99	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Synedra ulna	0.00	0.48	0.52	0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.50	0.00
Thalassionema nitzschioides	0.46	0.00	0.00	0.49	0.49	1.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Thalassiosira eccentrica	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.03	0.00	0.00	0.00	0.00	0.48	0.52	0.95	0.50	0.00
Thalassiosira leptopa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.48	0.00	0.54	3.21	1.44	0.00	0.00	1.50	0.00
Trachyneis aspera	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.97	0.00	1.08	0.00	0.00	0.00	0.00	0.00	0.00
Tropidoneis elegans	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	1.47
Tryblionella hungarica	2.29	2.38	2.08	1.97	1.46	3.00	1.01	0.49	0.00	0.00	0.00	0.00	0.49	0.52	0.00	0.00	0.54	0.00	0.00	0.00	0.00	0.00	0.49
Sum	218	210	192	203	205	200	199	204	205	191	203	190	205	194	207	223	185	187	209	191	211	200	204

Table A6.4 Diatom assemblage for each station of Brancaster Marsh.

Station	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00
Altitude (m OD)	3.27	3.21	3.24	3.23	3.21	3.22	3.22	3.23	3.22	3.24	3.21	3.19	3.19	3.14	3.03	2.98	3.07	3.02	3.00	2.48	2.31	1.88	1.85
LOI (%)	45.00	43.30		37.00		36.80		38.00		36.40		33.40		29.70		23.60		19.90		17.90		13.40	11.90
pH	5.80	6.50		6.10		5.80		6.50		6.50		6.10		6.50		6.50		6.10		7.00		7.00	7.00
Clay fraction (%)	36.00	32.50		21.20		14.60		18.50		32.50		32.90		21.60		39.10		36.60		39.00		37.20	38.40
Salinity (ppt)	7.23	8.27		9.20		12.92		13.77		10.23		8.85		11.82		8.80		7.56		7.71		7.10	8.97
Vegetation cover (%)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	90.00	50.00	0.00	0.00

Table A6.5 Environmental variables from stations of Brancaster Marsh.

Appendix Seven: Standardised Water Level Index

The altitudes of each station from Cowpen, Welwick, Thornham and Brancaster marshes differ with respect to tidal range and are not comparable. Therefore, the altitudes are converted to a standardised water level index (SWLI). Three methods are shown:

7.1 Method One

The altitudes of stations and tide levels are expressed as:

$$x_{ab} = [((A_{ab} - MTL_b)/(MHWST_b - MTL_b)*100) + 100] \quad (10)$$

where A_{ab} is the measured altitude (m OD) of station/tide level *a* at site *b*; MTL_b is the mean sea-level (m OD) at site *b*; $MHWST_b$ is the mean high water spring tide at site *b*; and x_{ab} is the SWLI of station/tide level *a* at site *b*. The addition of the constant (100) ensures that all reconstructed values within the training set are positive (various computer programmes do not accept negative values). Method One constructs SWLI for stations and tide levels from the four sites (Table A7.1 and A7.2 respectively).

7.2 Method Two

The altitudes of tide levels are expressed as:

$$x_{ab} = [(A_{ab} - LAT_b)/(HAT_b - LAT_b)]*100 \quad (11)$$

where A_{ab} is the measured altitude (m OD) of tide level *a* at site *b;* LAT_b is the lowest astronomical tide (m OD) at site *b*; HAT_b is the highest astronomical tide at site *b*; and x_{ab} is the SWLI of tide level *a* at site *b* expressed as a percentage. Table A7.2 shows the constructed tide levels and Figure A7.1a shows the relationship between sites. The largest variation occurs for MLWST ($V_c = 0.05$).

7.3 Method Three

The altitudes of tide levels are expressed as:

$$x_{ab} = [(A_{ab} - MLWST_b)/(MHWST_b - MLWST_b)]*100 \quad (12)$$

where A_{ab} is the measured altitude (m OD) of tide level *a* at site *b*;, $MLWST_b$ is the mean low water neap tide (m OD) at site *b*; $MHWST_b$ is the mean high water spring tide at site *b*; and x_{ab} is the SWLI of tide level *a* at site *b* expressed as a percentage. The constructed tide levels are shown in Table A7.2. MHWNT and LAT show the largest variations: their coefficients of variation are 0.04 and 0.07 respectively (Figure A7.1b).

Site	Station	Altitude (m OD)	SWLI	Site	Station	Altitude (m OD)	SWLI	Site	Station	Altitude (m OD)	SWLI	Site	Station	Altitude (m OD)	SWLI
Cowpen	1	3.24	225.32	Welwick	1	3.54	204.45	Thornham	1	4.32	229.82	Brancaster	1	3.27	191.95
	2	2.86	209.01		2	3.48	202.61		2	3.23	196.22		2	3.21	191.23
	3	2.81	206.87		3	3.40	200.06		3	3.09	191.94		3	3.24	191.58
	4	2.57	196.57		4	3.37	199.06		4	3.12	192.92		4	3.23	191.50
	5	2.47	192.27		5	3.29	196.55		5	3.04	190.46		5	3.21	191.25
	6	2.42	190.13		6	3.14	191.52		6	2.87	185.20		6	3.22	191.34
	7	2.38	188.41		7	3.09	190.03		7	2.82	183.63		7	3.22	191.34
	8	2.33	186.27		8	2.95	185.61		8	2.72	180.74		8	3.23	191.48
	9	2.27	183.69		9	2.91	184.29		9	2.71	180.34		9	3.22	191.38
	10	2.22	181.55		10	2.75	178.90		10	2.42	171.23		10	3.24	191.58
	11	2.18	179.83		11	2.71	177.58		11	2.23	165.63		11	3.21	191.30
	12	2.22	181.55		12	2.69	176.94		12	2.40	170.83		12	3.19	191.04
	13	2.17	179.40		13	2.67	176.55		13	2.64	178.09		13	3.19	190.94
	14	2.14	178.11		14	2.68	176.87		14	2.86	184.86		14	3.14	190.33
	15	2.09	175.97		15	2.66	176.06		15	2.75	181.54		15	3.03	189.04
	16	2.04	173.82		16	2.64	175.48		16	2.35	169.23		16	2.98	188.33
	17	1.99	171.67		17	2.60	174.16		17	2.15	163.17		17	3.07	189.50
	18	1.94	169.53		18	2.55	172.61		18	2.06	160.34		18	3.02	188.86
	19	1.88	166.95		19	2.45	169.32		19	1.87	154.52		19	3.00	188.64

Table 7.1 Station number, altitude (m OD) and constructed standardised water level index for all four contemporary sites using Equation 1.

Site	Station	Altitude (m OD)	SWLI	Site	Station	Altitude (m OD)	SWLI	Site	Station	Altitude (m OD)	SWLI	Site	Station	Altitude (m OD)	SWLI
Cowpen	20	1.74	160.94	Welwick	20	2.50	171.06	Thornham	20	1.62	146.62	Brancaster	20	2.48	182.08
	21	1.52	151.50						21	0.99	127.23		21	2.31	180.00
	22	1.32	142.92						22	0.60	115.38		22	1.88	174.58
	23	1.13	134.76						23	0.40	109.29		23	1.85	174.30
	24	0.93	126.18						24	0.21	103.42				
	25	0.72	117.17												
	26	0.54	109.44												
	27	0.36	101.72												
	28	0.17	93.56												
	29	-0.04	84.55												
	30	-0.22	76.82												
	31	-0.35	71.24												

Table 7.1 (continued) Station number, altitude (m OD) and constructed standardised water level index for all four contemporary sites using Equation 1.

Method	Tide level	Cowpen	Welwick	Thornham	Brancaster	Average	SD	V_c
One	HAT	221.46	222.58	224.62	224.62	223.32	1.36	0.01
	MHWST	200.00	200.00	200.00	200.00	200.00	-	-
	MHWNT	148.50	151.61	144.62	144.62	147.34	2.93	0.03
	MTL	100.00	100.00	100.00	100.00	100.00	-	-
	MLWNT	49.79	48.39	49.23	49.23	49.16	0.50	0.01
	MLWST	2.58	-6.45	0.00	0.00	-0.97	3.34	0.03
	LAT	-36.05	-32.26	-21.54	-21.54	-27.85	6.45	0.07
							Total =	0.15
Two	HAT	100.00	100.00	100.00	100.00	100.00	-	-
	MHWST	91.67	91.14	90.00	90.00	90.70	0.73	0.01
	MHWNT	71.67	72.15	67.50	67.50	69.70	2.21	0.04
	MTL	52.83	51.90	49.38	49.38	50.87	1.53	0.03
	MLWNT	33.33	31.65	28.75	28.75	30.62	1.96	0.04
	MLWST	15.00	10.13	8.75	8.75	10.66	2.57	0.05
	LAT	0.00	0.00	0.00	0.00	0.00	-	-
							Total =	0.18
Three	HAT	109.87	110.94	113.31	113.31	111.86	1.50	0.03
	MHWST	100.00	100.00	100.00	100.00	100.00	-	-
	MHWNT	73.91	76.56	71.31	71.31	73.27	2.18	0.04
	MTL	49.35	51.56	50.00	50.00	50.23	0.82	0.02
	MLWNT	23.91	26.56	24.62	24.62	24.93	0.99	0.02
	MLWST	0.00	0.00	0.00	0.00	0.00	-	-
	LAT	-19.57	-12.50	-10.77	-10.77	-13.40	3.63	0.07
							Average =	0.18

Table A7.2 Tide levels and constructed standardised water level index for all four contemporary sites using three different methods. The average, standard deviation (SD) and coefficient of variance (V_c) are shown.

Appendix Eight: Quantitative water level reconstructions

8.1 Environmental setting of additional field sites

The foraminiferal and standardised water level index (SWLI) data from Cowpen, Welwick, Thornham and Brancaster marshes are combined with data collected by the Environmental Research Centre (ERC), University of Durham. The environmental settings of the additional field sites are discussed below.

8.1.1 Nith estuary, Solway Firth, south-west Scotland

The River Nith is one of the main rivers draining into the north shore of the Solway Firth. The position in the inner Solway Firth accounts for the macro-tidal environment with a spring tidal range of 7.25 m. This has led to the development of expansive intertidal sandflats and mudflats at the mouth of the Nith estuary extending many kilometres into the Solway Firth itself. The high freshwater output of the Nith combined with the large tidal amplitude produces a wide range of salinity in the estuary. The site investigated is from the eastern shore of the estuary across a saltmarsh approximately 150 m wide. The seaward edge is bounded by a small cliff approximately 1 m in height. The landward edge passes into a narrow upland zone and is bounded by a coastal road. The small cliff accounts for the absence of a traditional pioneer marsh zone at this site. This saltmarsh is a Site of Special Scientific Interest (SSSI).

8.1.2 Roudsea Marsh, Morecambe Bay, north-west England

This site is located towards the head of the Leven estuary in the northern part of Morecambe Bay. The marsh lies within a small embayment along the south-west border of the Roudsea Wood National Nature Reserve. Although slightly grazed by sheep, there has been little disturbance by human activities. Hydrologically, the marsh is influenced mainly by discharges of freshwater from the Windermere catchment and sea water from Morecambe Bay and the Irish Sea. A small amount of freshwater also drains onto the marsh from slopes of the nature reserve. Water salinity during high spring tides varies between 5 ‰ to 25 ‰ (Zong, 1997a). This is a macro-tidal site with a spring tidal range of 8.4 m.

8.1.3 Kentra Bay, Argyll, north-west Scotland

Kentra Bay (*ca.* 4 km ^{2}) is well protected from waves by rocky outcrops and a narrow entrance. The floor of the bay is filled with fine grained sediments and is exposed entirely during low tides. On the north-east fringe of Kentra Bay, the marsh is only 120 m wide but covers a range of environments from tidal flat, through pioneer, low and high marshes, to raised bog (upland) from which acidic runoff is drained through the marsh into the Bay. The raised bog is designated as a SSSI. The landward end of the saltmarsh is bounded by a small road. The amount of freshwater running into the Bay is minimal and seems to have little effect upon the salinity of the incoming tides which is usually as high as 33 ‰. The predicted range of spring tides is meso-tidal (4.4 m).

8.1.4 Tramaig Bay, Jura, south-west Scotland

Tramaig Bay is a small, semi-circular tidal basin on the north-east coast of the Isle of Jura, protected by solid outcrops with a narrow inlet connecting to the Sound of Jura. At predicted low water of spring tides the basin is completely isolated from the Sound and a standing pool of saline water is left. The basin is affected by a micro-tidal regime (*ca.* 1.6 m range at spring tides). The southern part of the basin displays an undisturbed continuum from pioneer saltmarsh through to mature freshwater fen which is flat and poorly drained. This feature is mirrored on the northern side of the basin. However, the transition from upland to tidal flat over a distance of less than 20 m on the western side of the basin is interrupted by a narrow estate road. Due to the small output of freshwater from the upland, salinity within the basin is very close to that of sea water with little variation between tides.

8.2 Cluster analysis and detrended correspondence analysis

Unconstrained cluster analysis and detrended correspondence analysis (DCA) are extensively used in Chapter 4. Similarly, cluster analysis based on unweighted Euclidean and Chord distance is used to classify the contemporary samples according to their foraminiferal assemblage. The boxplots of maximum, minimum, median and interquartile flooding frequencies within the cluster are analysed to determine a vertical zonation of the intertidal zone. DCA is used to provide further information about the pattern of variation within and between groups. Furthermore, the relationship between Axis One scores and SWLI is explored to develop a transfer function (Fritz, 1990). To be comparable with

weighted average regression and calibration, cluster analysis and DCA use the screened foraminiferal training set (Volume One, Section 5.3.2).

8.2.1 Cluster analysis

Cluster analysis of unweighted Euclidean distance detects cluster zones EAG and ECA (Figure A8.1):

I. Zone EAG is dominated by agglutinated species *Jadammina macrescens*, *Miliammina fusca* and *Trochammina inflata*. The SWLI of Zone EAG is from 230 to 174 (Figure A8.2a);
II. Zone ECA is dominated by calcareous species, notably *Haynesina germanica* with low frequencies of *Ammonia beccarii* var. *limnetes* and *Elphidium williamsoni*. The SWLI is from 192 to 103.

The second variant of cluster analysis, **unweighted Chord distance**, similarly classifies the data into two cluster zones (CAG and CCA) (Figure A8.3). The sample, species composition and SWLI range of the zones are near-identical to the equivalent Euclidean clusters (Figure A8.2b).

8.2.2 Detrended correspondence analysis

DCA of the training set produces an ordination diagram to represent samples as points in a multi-dimensional space (Figure A8.4). The first two DCA axes account for 25 % and 9 % of the total variance of species data (34 % in all). Axis One (eigenvalue = 0.68) has large positive loadings for dominant agglutinated species (*H.* spp., *M. fusca, J. macrescens*, *T. inflata*) and low positive or negative loadings for calcareous species (*H. depressula, A. beccarii* var. *batavus, Fursenkoina fusiformis*) (Table A8.1). Therefore, the species loadings imply that Axis One reflects a water level gradient from mudflat to high marsh. The loadings and scores of Axis Two and Three (eigenvalues 0.23 and 0.13 respectively) do not reflect any major environmental gradient.

The DCA ordination diagram shows the contemporary field sites occupying similar ordination space, therefore, justifying the agglomeration of annual average and single measurements (Figure A8.4a). The zonations produced by cluster analysis of unweighted Euclidean and Chord distance correspond to distinct regions in the ordination diagram (Figure A8.4b, c). Euclidean Zones EAG and ECA lie on Axis One and are mutually exclusive. Chord Zones CAG and CCA also lie on Axis One but they zones overlap.

Species	Axis One	Axis Two	Axis Three
Haplophragmoides spp.	5.56	2.10	0.60
Jadammina macrescens	3.40	0.37	0.74
Miliammina fusca	3.58	2.72	0.95
Trochammina inflata	3.41	1.43	1.81
Trochammina ochracea	1.47	0.18	-0.71
Ammonia beccarii	2.74	2.99	0.11
Ammonia beccarii var. aberdoveyensis	0.18	-0.35	2.96
Ammonia beccarii var. batavus	-0.44	-0.23	2.40
Ammonia beccarii var. limnetes	1.12	0.46	2.43
Ammonia beccarii var. tepida	0.83	0.75	2.82
Brizalina inflata	1.56	-0.05	-1.08
Brizalina variablis	1.58	2.29	0.23
Buccella frigida	-0.47	3.33	2.19
Bulimina marginata	1.60	2.79	0.99
Buliminella elegantissima	0.03	2.84	2.03
Cassidulina obtusa	1.38	0.87	3.15
Cibicides lobatulus	0.78	2.17	2.58
Cyclogyra involvens	2.19	0.75	1.68
Elphidium earlandi	1.60	1.82	2.05
Elphidium excavatum	1.01	1.80	3.25
Elphidium gerthi	1.52	1.79	2.99
Elphidium incertum	0.87	1.08	2.34
Elphidium magellanicum	1.35	0.81	-0.36
Elphidium williamsoni	1.87	2.05	2.11
Fursenkoina fusiformis	0.69	1.70	0.03
Glabratella millettii	-0.68	3.16	2.05
Globigerina quinqueloba	1.56	0.02	0.29
Haynesina depressula	1.31	3.33	2.10
Haynesina germanica	0.87	1.41	-0.10
Lagena sulcata	2.03	-1.27	-0.24
Miliolinella subrotunda	1.23	-1.65	2.73
Planorbulina mediterranensis	-0.15	-0.56	3.19
Quinqueloculina spp.	2.13	2.07	1.42
Rosalina williamsoni	1.70	0.17	1.39
Spirillina vivipara	2.42	3.46	1.59

Table A8.1 Loading and percentages of variance explained by the first three detrended correspondence axes from foraminiferal training set.

Species	Axis One	Axis Two	Axis Three
Variance (eigenvalues)	0.67	0.23	0.16
Percent total variance	25	9	6
Cumulative percent of total variance	25	34	40

Table A8.1 (continued) Loading and percentages of variance explained by the first three detrended correspondence axes from foraminiferal training set.

8.2.3 Implications for sea-level studies

Statistical analyses are only able to classify the contemporary foraminiferal training set into two robust zones: Zone I dominated by agglutinated species *J. macrescens*, *M. fusca*, *T. inflata*; and Zone II dominated by calcareous species *H. germanica*, *A. beccarii* var. *limnetes* and *E. williamsoni* (Table A8.2). The exact sample and species composition and SWLI of each zone are derived from Euclidean Zones EAG and ECA respectively. It is preferred to use Euclidean rather than Chord zones because the DCA ordination diagrams show the former zones to be mutually exclusive whereas the latter zones overlap. Thus, the precise boundary between the Chord zones is arbitrary. Furthermore, Chapter 4 indicates that Euclidean zones are less susceptible to seasonal variations than Chords zones. This is because the former detects clusters based upon frequencies of dominant taxa (which remain relatively stable) whereas, the latter places more importance upon the minor taxa (which are prone to seasonal variations) when classifying the data. Therefore, the application of cluster analysis with unweighted Chord distance may distort the investigations (Hill, 1979; ter Braak, 1986; ter Braak and Verdonschot, 1995).

Zone	Dominant species	SWLI
I	*Jadammina macrescens*	230 to 174
	Miliammina fusca	
	Trochammina inflata	
II	*Ammonia beccarii* var. *limnetes*	192 to 103
	Elphidium williamsoni	
	Haynesina germanica	

Table A8.2 Foraminiferal zones of the training set derived from cluster analysis based on unweighted Euclidean distance.

Estimates of the indicative meanings can be developed from the premise that zones found vertically adjacent, without a hiatus, must have formed in environments that existed side by side in space (Table

A8.3). Therefore, the transition from Zone I to Zone II has an indicative range equal to the transition from one zone to the other, not that of the individual zone. For example, the indicative range of Zone I is 28 whereas the range of Zone I directly above Zone II is only 9. However, with only two zones being classified the indicative meaning can only be reconstructed for a limited range of index points. Furthermore, the very localised nature of some distributions (Scott and Medioli, 1978, 1980a; Patterson, 1990; Scott and Leckie, 1990; Jennings and Nelson, 1992; Gehrels, 1994; Horton, in press) implies that they are not regionally applicable.

	Indicative range	Reference water level
Zone I	28.0	202
Zone I directly above zone II	9.0	183
Zone II	44.5	147.5

Table A8.3 Indicative ranges and reference water levels (SWLI) for foraminiferal training set.

The relationship of DCA Axis One scores versus SWLI is inadequate in developing a transfer function (Figure A8.4d). Axis One scores between 0.9 and 1.0 relate to a relatively large range of SWLI (115 to 177). Furthermore, SWLI reconstructions are variable due to the absence of Axis One scores between 1.8 and 2.4.

8.3 Foraminiferal and standardised water level index data of additional field sites

The following pages show the foraminiferal and SWLI data for the Nith estuary, Roudsea Marsh, Kentra Bay and Tramaig Bay.

Table A8.4 Foraminiferal death assemblages and standardised water level index from each station of Nith estuary, Solway Firth, south-west Scotland.

Species	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Ammonia beccarii	0.00	0.00	0.00	0.00	0.00	0.00	0.44	7.62	3.42	8.29	0.72	2.86	10.20	3.48	2.74
Ammonia beccarii var. batavus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.66
Brizalina spathulata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.57
Brizalina variabilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.06	6.96	5.49
Buccella frigida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.74	5.49
Bulimina marginata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.04	0.00	1.52
Bulimina elegantissima	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.05
Cibicides lobatulus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.88
Elphidium excavatum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.61	5.79
Elphidium gerthi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.52
Elphidium magellanicum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.61
Elphidium margaritaceum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.52
Elphidium spp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.00	0.00	3.48	1.22
Elphidium williamsoni	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.00	13.02	1.71	0.00	1.74	1.22
Glabratella milletti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.44
Haplophragmoides spp.	0.00	3.45	8.16	0.00	1.83	6.37	5.75	2.86	3.80	1.38	17.00	8.57	0.00	2.61	0.00
Haynesina depressula	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.05
Haynesina germanicum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.38	0.00	2.17	4.57	12.24	32.17	34.45
Jadammina macrescens	97.00	93.10	91.84	87.50	95.42	78.92	71.24	47.62	27.00	37.72	26.04	53.71	65.31	23.48	5.49
Miliammina fusca	0.00	0.00	0.00	12.50	2.75	14.71	22.57	37.14	63.50	48.85	33.63	24.00	3.06	3.48	4.27
Trochammina inflata	3.00	3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.40	3.70	6.00	1.10	3.10	1.70	0.60
Trochammina ochracea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.00	0.00
Foraminifera tests counted (per 10 cm3)	69	49	64	436	816	452	105	526	868	2212	700	392	230	328	107
SWLI	220.7	217.9	216.2	215.1	211.1	208.7	205.4	200.9	200.0	200.7	200.2	198.8	197.6	200.9	147.3

Table A8.4 Foraminiferal death assemblages and standardised water level index from each station of Nith estuary, Solway Firth, south-west Scotland.

Species	18	19	20	21	22	23	24	25	27	28	29	30	31
Ammonia beccarii	0.00	0.00	1.01	1.82	0.00	0.63	0.23	2.44	2.74	3.04	2.99	2.33	1.20
Ammonia beccarii var. batavus	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.00	1.52	2.74	4.48	10.50	13.21
Brizalina pseudopunctata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.52	2.09	0.00	0.90
Brizalina spathulata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.20	3.60	3.60	2.40	0.90	2.10
Brizalina variabilis	0.00	0.00	0.76	0.91	0.00	0.21	1.38	3.18	7.90	3.65	2.09	2.04	3.30
Buccella frigida	0.00	0.00	0.51	0.68	0.00	0.42	0.23	4.65	9.73	10.03	8.96	10.50	11.41
Bulimina marginata	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.24	0.00	1.22	0.90	1.17	1.50
Bulimina elegantissima	0.00	0.00	0.25	0.23	0.00	0.00	0.00	1.22	1.52	1.82	2.39	2.33	3.30
Cibicides lobatulus	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.49	3.65	3.65	3.88	9.04	12.61
Elphidium excavatum	0.00	0.00	0.00	0.00	0.00	0.42	3.23	1.22	5.78	3.95	5.37	7.87	10.51
Elphidium gerthi	0.00	0.00	0.00	0.45	0.00	0.00	0.00	0.00	1.82	4.86	5.07	4.66	4.20
Elphidium magellanicum	0.00	0.00	0.25	0.91	0.49	0.00	0.00	0.00	4.56	4.26	5.37	2.33	1.50
Elphidium margaritaceum	0.00	0.00	0.25	0.68	0.00	0.00	0.00	0.49	2.43	2.74	1.19	2.04	2.10
Elphidium spp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.52	1.52	0.00	0.87	2.10
Elphidium williamsoni	0.00	0.00	1.77	5.00	22.09	3.16	5.76	11.00	5.47	6.08	1.79	2.33	0.60
Glabratella milletti	0.00	0.00	0.00	0.23	0.00	0.00	0.00	2.44	1.52	3.95	7.46	3.21	6.61
Haplophragmoides spp.	15.89	24.32	11.14	0.23	0.00	1.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Haynesina depressula	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.49	2.43	6.69	6.27	9.91	10.21
Haynesina germanicum	0.00	0.00	7.34	5.23	4.37	8.44	19.82	27.63	23.40	28.57	28.06	19.53	4.80
Jadammina macrescens	80.37	70.27	55.70	10.00	16.26	31.65	12.21	32.76	11.85	0.30	0.30	0.00	0.00
Miliammina fusca	3.74	5.41	16.71	45.68	28.16	34.39	47.47	7.82	0.00	0.00	0.00	0.00	0.00
Quinqueloculina lata	0.00	0.00	3.29	22.50	23.79	17.41	7.37	0.73	0.00	0.00	0.00	0.58	0.00
Quinqueloculina seminulum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.82	2.39	1.13	0.90
Rosalina spp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.65	1.22	0.00	0.00	0.00
Spirillina vivipara	0.00	0.00	0.25	4.55	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trochammina inflata	0.00	0.00	0.00	0.00	0.70	2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foraminifera tests counted (per 10 cm3)	74	395	440	412	474	434	409	302	329	329	335	343	333
SWLI	222.1	215.7	208.8	203.8	203.8	203.8	203.8	205.2	193.8	187.4	186.0	175.7	169.0

Table A8.5 Foraminiferal death assemblages and standardised water level index from each station of Roudsea Marsh, Morecambe Bay, north-west England.

(a) Kentra Bay

Species	35	36	37	38	39	40
Elphidium williamsoni	0.00	0.00	0.00	0.00	6.25	53.33
Haplophragmoides spp.	0.00	0.00	0.00	0.00	0.00	0.00
Jadammina macrescens	98.00	98.17	75.00	98.36	59.38	12.00
Miliammina fusca	0.00	0.00	12.07	0.33	15.63	24.00
Trochammina inflata	2.00	1.80	12.90	1.30	18.80	10.70
Foraminifera tests counted (per 10 cm3)	109	116	304	64	75	148
SWLI	227.0	216.8	194.6	172.4	157.8	150.8

(b) Tramaig Bay

Species	45	46	47
Haplophragmoides spp.	0.00	0.00	8.86
Jadammina macrescens	100.00	84.62	75.95
Miliammina fusca	0.00	11.54	5.06
Trochammina inflata	0.00	3.80	1.30
Trochammina ochracea	0.00	0.00	8.86
Foraminifera tests counted (per 10 cm3)	70	52	79
SWLI	203.5	172.3	142.2

Table A8.6 Foraminiferal death assemblages and standardised water level index from each station of (a) Kentra Bay, Argyll, north-west Scotland and (b) Tramaig Bay, Jura, south-west Scotland.

Appendix Nine: Fossil biostratigraphical data

The biostratigraphical data of the new sea-level index points (SLIs) of Chapter Six are described in this appendix (only species that reach 2 % of the total sum are shown).

Species	512	518	524	526	530	532	534	536	539	541	550
Ammonia beccarii var. aberdoveyensis	0.00	2.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia beccarii var. batavus	2.75	0.00	0.00	2.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia beccarii var. limnetes	7.69	5.56	6.78	4.17	0.00	0.00	0.00	0.00	0.00	1.00	0.00
Buliminella elegantissima	2.20	0.00	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cibicides lobatulus	8.24	5.56	3.39	1.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Elphidium crispum	6.04	1.11	1.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Elphidium earlandi	8.79	14.44	13.56	2.78	2.22	0.00	0.00	0.00	0.00	0.00	0.00
Elphidium incertum	9.34	14.44	6.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Elphidium williamsoni	8.79	13.33	15.25	5.56	3.33	0.00	0.00	0.00	0.00	0.00	0.00
Haplophragmoides spp.	1.10	0.00	1.69	1.39	5.56	0.00	0.00	0.00	0.00	0.00	0.00
Haynesina depressula	7.69	5.56	2.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Haynesina germanica	26.37	30.00	14.41	8.33	3.33	0.00	0.00	0.00	0.00	1.00	0.00
Jadammina macrescens	4.95	5.56	19.49	70.83	57.78	96.77	100.00	100.00	100.00	89.28	0.00
Miliammina fusca	3.85	1.11	10.17	1.39	27.78	3.23	0.00	0.00	0.00	7.73	0.00
Total forams counted (per 2 cm3)	182	270	118	144	180	186	135	89	51	401	0

(a)

Species	1363	1365	1378	1380
Ammonia beccarii var. limnetes	8.70	0.00	0.00	7.69
Cibicides lobatulus	4.35	0.00	0.00	7.69
Elphidium incertum	4.35	0.00	0.00	0.00
Elphidium magellanicum	4.35	0.00	0.00	0.00
Elphidium williamsoni	0.00	0.00	0.00	7.69
Fissurina lucida	4.35	0.00	0.00	0.00
Haynesina germanica	39.13	0.00	0.00	30.77
Jadammina macrescens	21.74	100.00	0.00	46.15
Lagena sulcata	4.35	0.00	0.00	0.00
Trochammina inflata	8.70	0.00	0.00	0.00
Total forams counted (per 2cm3)	184	42	0	32

(b)

Species	1378
Achnanthes delicatula	2.06
Actinoptychus senarius	6.70
Cocconeis peltoides	10.31
Cocconeis scutellum	0.52
Cymbella turgida	3.61
Delphineis surirella	4.12
Diploneis ovalis	1.03
Hantzschia amphioxys	1.03
Navicula forcipata	1.55
Navicula humerosa	1.03
Opephora pacifica	3.61
Paralia sulcata	55.67
Rhaphoneis amphiceros	4.64
Thalassiosira eccentrica	1.03
Tryblionella navicularis	3.09
Polyhalobous	88.14
Mesohalobous	6.19
Oligohalobous-indifferent	5.67
Diatom valves counted	194

Table A9.2 (a) Foraminiferal and (b) diatom assemblages of Teesside industrial estate T2.

Species	380	384	390	394	398
Ammonia beccarii var. aberdoveyensi	3.81	0.00	0.00	0.00	0.00
Ammonia beccarii var. batavus	5.71	0.00	0.00	0.00	0.00
Ammonia beccarii var. limnetes	11.43	0.00	0.00	0.00	0.00
Ammonia beccarii var. tepida	7.62	0.00	0.00	0.00	0.00
Balticammina pseudomacrescens	0.00	3.67	0.00	0.00	0.00
Cibicides lobatulus	7.62	0.00	0.00	0.00	0.00
Elphidium earlandi	8.57	0.00	0.00	0.00	0.00
Elphidium excavatum	3.81	0.00	0.00	0.00	0.00
Elphidium incertum	3.81	0.00	0.00	0.00	0.00
Elphidium williamsoni	13.33	0.00	0.00	0.00	0.00
Globigerina quinqueloba	3.81	0.00	0.00	0.00	0.00
Haplophragmoides spp.	0.00	8.26	0.00	0.00	0.00
Haynesina depressula	3.81	0.00	0.00	0.00	0.00
Haynesina germanica	22.86	0.00	0.00	0.00	0.00
Jadammina macrescens	1.90	49.54	83.33	0.00	0.00
Miliammina fusca	0.00	9.17	16.67	0.00	0.00
Tiphotrocha comprimata	0.00	11.01	0.00	0.00	0.00
Trochammina inflata	1.90	14.68	0.00	0.00	0.00
Trochammina ochracea	0.00	3.67	0.00	0.00	0.00
Total forams counted (per 2 cm3)	105	109	12	0	0

Table A9.3 Foraminiferal assemblages of Dunswell HMB2

Species	986	991	993	996	998
Haplophragmoides spp.	0.00	4.55	5.56	0.00	0.00
Jadammina macrescens	20.00	59.09	77.78	100.00	0.00
Miliammina fusca	0.00	0.00	16.67	0.00	0.00
Trochammina inflata	80.00	36.36	0.00	0.00	0.00
Total forams counted (per 2cm3)	45	44	54	46	0

Table A9.4 Foraminiferal assemblages of Marshchapel LM2.

Species	567	577	587	593	597	599	601	604	608	610	614	616	618	622	626	630	632	634	636	638	640	644	650
Ammonia beccarii var. Inmnetes	1.59	0.00	0.00	0.00	0.00	8.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.70	2.70	0.00
Elphidium williamsoni	1.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.23	0.00	0.00	0.00	0.00	0.00	0.00
Haplophragmoides spp.	4.76	0.00	1.19	1.25	1.00	1.64	4.76	0.00	0.00	0.00	6.98	9.76	14.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.70	0.00	0.00
Haynesina germanica	3.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jadammina macrescens	82.54	65.38	76.19	52.50	42.00	67.21	76.19	75.00	0.00	57.14	62.79	53.66	71.43	0.00	0.00	76.00	41.94	16.67	31.25	44.00	40.54	59.46	34.15
Miliammina fusca	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.76	4.65	4.88	0.00	0.00	0.00	0.00	3.23	33.33	12.50	0.00	0.00	0.00	0.00
Trochammina inflata	6.35	34.62	22.62	46.25	57.00	21.31	19.05	25.00	100.00	38.10	25.58	31.71	14.29	0.00	0.00	24.00	51.61	50.00	56.25	56.00	54.05	37.84	65.85
Total forams counted (per 2 cm3)	63	104	336	320	800	488	168	48	1	21	86	123	21	0	0	200	248	240	128	200	296	148	328

Table A9.5 Foraminiferal assemblages of Theddlethorpe LM5a

Species	1205	1215	1225	1235	1245	1255	1265	1275	1279	1281	1283	1285	1287	1289	1291	1293	1295	1297	1299	1301
Ammonia beccarii var. aberdoveyensis	18.43	27.40	25.93	18.18	5.88	15.85	22.50	8.43	9.89	15.38	4.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia beccarii var. batavus	7.37	0.00	0.00	0.00	0.00	7.32	13.75	13.25	10.99	3.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia beccarii var. limnetes	20.28	26.03	18.52	36.36	11.76	35.37	35.00	21.69	27.47	26.92	29.09	26.67	3.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia beccarii var. tepida	11.06	23.29	22.22	13.64	11.76	17.07	22.50	13.25	14.29	16.67	9.82	6.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Elphidium earlandi	3.69	5.48	0.00	0.00	0.00	3.66	0.00	14.46	12.09	16.67	14.55	6.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Elphidium excavatum	0.00	0.00	0.00	0.00	0.00	1.22	0.00	4.82	5.49	2.56	10.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Elphidium williamsoni	3.69	4.11	7.41	9.09	41.18	7.32	0.00	7.23	9.89	11.54	26.18	13.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Haplophragmoides spp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.90	0.00	0.00	0.00	0.00	0.00	0.00
Haynesina depressula	12.90	5.48	11.11	4.55	5.88	6.10	2.50	6.02	2.20	2.56	2.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Haynesina germanica	18.43	2.74	7.41	9.09	17.65	6.10	2.50	9.64	7.69	3.85	2.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jadammina macrescens	1.84	0.00	3.70	9.09	5.88	0.00	0.00	0.00	0.00	0.00	0.00	13.33	46.43	34.48	60.00	0.00	0.00	0.00	0.00	0.00
Miliammina fusca	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.71	10.34	0.00	0.00	0.00	0.00	0.00	0.00
Rosalina williamsoni	1.84	4.11	3.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trochammina inflata	0.00	0.00	0.00	0.00	0.00	0.00	1.20	0.00	0.00	0.00	0.00	26.67	39.29	48.28	40.00	0.00	0.00	0.00	0.00	0.00
Trochammina ochracea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total forams counted (per 2cm3)	217	584	216	176	136	656	640	332	364	312	275	60	86	58	10	0	0	0	0	0

Table A9.6 Foraminiferal assemblages of Theddlethorpe LM5b.

Species	325	330	343	344	347	348	352	354	364	366
Balticammina psuedomacrescens	3.95	0.00	11.32	4.55	0.00	0.00	0.00	0.00	0.00	0.00
Haplophragmoides spp.	0.00	0.00	0.00	0.00	0.00	14.29	6.67	0.00	0.00	0.00
Jadammina macrescens	43.42	45.95	31.13	18.18	65.31	28.57	93.33	100.00	0.00	0.00
Tiphotrocha comprimata	7.89	5.41	3.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trochammina inflata	44.74	48.65	53.77	77.27	34.69	57.14	0.00	0.00	0.00	0.00
Total forams counted (per 2 cm3)	76	296	106	66	49	63	60	10	0	0

Table A9.7 Foraminiferal assemblages of Wrangle Bank F4.

Species	1486	1492	1494	1500
Ammonia beccarii	93.90	88.90	0.00	0.00
Elphidium excavatum	0.00	3.70	0.00	0.00
Elphidium williamsoni	9.40	3.70	0.00	0.00
Haynesina germanica	5.50	0.00	0.00	0.00
Jadammina macrescens	0.20	3.70	100.00	0.00
Trochammina inflata	0.20	0.00	0.00	0.00
Total forams counted (per 2 cm3)	3472	216	10	0

Table A9.8 Foraminiferal assemblages of Clenchwarton F13.

Species	482	486	494	496	528	530
Ammonia beccarii var. limnetes	10.34	8.57	0.00	0.00	0.00	0.00
Brizalina inflata	3.45	0.00	0.00	0.00	0.00	0.00
Brizalina variabilis	6.90	0.00	6.25	0.00	0.00	0.00
Cassidulina obtusa	3.45	0.00	6.25	0.00	0.00	0.00
Cibicides lobatulus	10.34	2.86	0.00	0.00	0.00	0.00
Elphidium excavatum	6.90	2.86	0.00	0.00	0.00	0.00
Elphidium gerthi	3.45	0.00	0.00	0.00	0.00	0.00
Elphidium incertum	0.00	2.86	0.00	0.00	0.00	19.05
Elphidium williamsoni	3.45	17.14	12.50	0.00	0.00	0.00
Fissurina marginata	0.00	0.00	6.25	0.00	0.00	0.00
Gavelinopsis praegeri	3.45	0.00	0.00	0.00	0.00	0.00
Globigerina quinqueloba	3.45	0.00	0.00	0.00	0.00	0.00
Haynesina germanica	34.48	37.14	43.75	33.33	0.00	19.05
Jadammina macrescens	3.45	11.43	18.75	66.67	100.00	33.33
Miliammina fusca	0.00	11.43	6.25	0.00	0.00	0.00
Trochammina inflata	6.90	5.71	0.00	0.00	0.00	28.57
Total forams counted (per 2 cm3)	232	280	128	48	41	21

Table A9.9 Foraminiferal assemblages of South Lynn F15a.

Species	1040	1060	1065	1067	1069	1079	1080	1081	1082
Balticammina pseudomacrescens	0.00	6.25	4.41	2.17	10.81	0.00	0.00	0.00	0.00
Haplophragmoides spp.	0.00	0.00	0.00	0.00	0.00	10.53	0.00	11.11	0.00
Jadammina macrescens	34.78	35.42	44.12	69.57	54.05	78.95	100.00	88.89	100.00
Miliammina fusca	8.70	2.08	2.94	0.00	2.70	10.53	0.00	0.00	0.00
Tiphotrocha comprimata	8.70	18.75	11.76	4.35	0.00	0.00	0.00	0.00	0.00
Trochammina inflata	47.83	37.50	36.76	23.91	32.43	0.00	0.00	0.00	0.00
Total forams counted (per 2 cm3)	23	96	544	368	148	152	80	72	2

Table A9.10 Foraminiferal assemblages of South Lynn F15b.

Species	1050	1054	1058	1060	1064	1078	1080
Ammonia beccarii	75.70	83.00	0.00	0.00	0.00	0.00	0.00
Brizalina variabilis	0.50	0.50	0.00	0.00	0.00	0.00	0.00
Buccella frigida	0.80	0.50	0.00	0.00	0.00	0.00	0.00
Elphidium earlandi	1.10	0.70	0.00	0.00	0.00	0.00	0.00
Elphidium williamsoni	0.50	0.70	0.00	0.00	0.00	0.00	0.00
Fissurina lucida	1.10	0.20	0.00	0.00	0.00	0.00	0.00
Fursenkoina fusiformis	0.30	0.00	0.00	0.00	0.00	0.00	0.00
Globigerina quinqueloba	6.30	0.90	0.00	0.00	0.00	0.00	0.00
Haynesina germanica	12.20	13.30	0.00	0.00	0.00	0.00	0.00
Jadammina macrescens	1.10	0.00	90.90	100.00	0.00	0.00	0.00
Quinqueloculina spp.	0.30	0.00	0.00	0.00	0.00	0.00	0.00
Trochammina inflata	0.00	0.20	9.10	0.00	0.00	0.00	0.00
Total forams counted (per 2 cm3)	3024	3536	176	288	0	0	0

Table A9.11 Foraminiferal assemblages of Spalding F19

(a)

Species	870*	875	901	917*
Ammonia beccarii	0.70	0.00	0.00	0.00
Balticammina pseudomacrescens	0.00	5.17	0.00	0.00
Haplophragmoides spp.	0.00	5.17	0.00	0.00
Haynesina depresula	0.70	0.00	0.00	0.00
Haynesina germanica	3.70	0.00	0.00	0.00
Jadammina macrescens	80.00	56.90	0.00	9.38
Miliammina fusca	0.00	1.72	0.00	0.00
Trochammina inflata	14.81	31.03	0.00	90.63
Total forams counted (per 2cm3)	135	55	0	32

(b)

Species	901
Achnanthes brevipes	6.52
Caloneis westii	10.87
Cocconeis scutellum	4.35
Diploneis interrupta	19.57
Fragilaria virescens v. exigua	15.22
Navicula peregrina	6.52
Opephora pacifica	4.35
Petroneis humerosa	8.70
Pseudostaurosira brevistriata	6.52
Staurosirella pinnata	10.87
Synedra ulna	6.52
Polyhalobous	17.39
Mesohalobous	43.48
Oligohalobous-indifferent	39.13
Diatom valves counted	46

Table A9.12 (a) Foraminiferal and (b) diatom assemblages of Brancaster NNC29. * Counted by Dr I. Boomer, LOIS.

(a)

Species	270*	386	472	520*	592	673	674*
Haplophragmoides spp.	0.00	0.00	0.00	0.00	6.12	0.00	0.00
Jadammina macrescens	36.00	100.00	0.00	11.67	53.06	0.00	33.33
Miliammina fusca	0.00	0.00	0.00	0.00	14.29	0.00	0.00
Trochammina inflata	63.00	0.00	0.00	88.33	26.53	0.00	66.67
Total forams counted (per 2 cm3)	75	43	0	60	196	0	6

(b)

Species	472	673
Achnanthes brevipes	0.00	10.92
Achnanthes delicatula	21.93	6.90
Actinoptychus senarius	0.00	2.30
Actinoptychus sp.	0.00	1.15
Amphora marina	3.21	0.00
Amphora ovalis	1.60	0.00
Caloneis westii	8.56	3.45
Cocconeis scutellum	0.00	1.72
Diploneis didyma	5.88	0.57
Diploneis interrupta	4.81	11.49
Diploneis ovalis	2.14	0.00
Fragilaria virescens v. exigua	1.07	9.77
Navicula digitoradiata	0.00	1.15
Navicula peregrina	39.04	4.60
Nitzschia sigma	1.07	0.00
Opephora pacifica	0.00	12.07
Paralia sulcata	2.67	20.69
Petroneis humerosa	4.81	1.15
Plagiogramma staurophorum	0.00	1.72
Surirella ovata	0.00	1.15
Synedra ulna	2.67	5.75
Thalassiosira eccentrica	0.53	1.15
Trachyneis aspera	0.00	2.30
Polyhalobous	8.02	44.25
Mesohalobous	84.49	39.08
Oligohalobous-indifferent	7.49	16.67
Diatom valves counted	187	174

Table A9.13 (a) Foraminiferal and (b) diatom assemblages of Thornham NNC35. * Counted by Dr I. Boomer, LOIS.

Species	420*	554	575	590*
Balticammina pseudomacrescens	0.00	3.92	0.00	0.00
Haynesina germanica	9.09	0.00	0.00	0.00
Jadammina macrescens	78.79	58.82	45.16	40.00
Miliammina fusca	0.00	1.96	0.00	0.00
Tiphotrocha comprimata	0.00	3.92	0.00	0.00
Trochammina inflata	12.12	31.37	54.84	60.00
Total forams counted (per 2 cm3)	66	102	57	5

Table A9.14 Foraminiferal death assemblages of Salthouse NNC40. * Counted by Dr I. Boomer, LOIS.

Species	WA942~	AL951~	AL951~	BM957*	CP958*	BR968*	BR968~	HABB5*	PMC5*	DL961*	HMB5*	HMB10*	SM954*	SM954	SM955*	F5*	F5*	F8*	F16*	F17*	F17*	F21*	F21*	NNC2~	NNC2~	NNC28~	55/02/13VE~
Ammonia beccarii	78	180	244	132	43	72	86	527.5	454	332	864	974	250	268	17	1350	1385	297	738	565	571	446	477	815	823	1103	406
Jadammina macrescens	0 00	0 00	0 00	0 00	0 00	0 00	0.00	0 00	0.00	0.00	0.00	0.00	0 00	0 00	0.00	0.00	0.00	0.00	2.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Haplophragmoides spp	74 56	96 55	99 00	85 36	99 00	96 01	55 10	99.00	76 69	56.98	11 50	99.00	84 51	95.14	80.71	92.75	92.10	91.59	81.86	75.54	56.14	89.91	99.00	77.09	75.56	62.16	85.21
Miliammina fusca	11 11	0 00	0 00	0.00	0 00	0.00	4.88	0 00	11 57	15.97	0.00	0.00	0 48	0.00	0.00	0.00	0.00	0.00	0 00	0.00	0.00	0 00	0 00	0 00	0.00	0 00	0 00
Trochammina inflata	13.33	1 96	0 00	4 55	0.00	0 00	39 02	0 00	10 74	26 05	87 50	0 00	1.45	3 86	0 00	6 25	0 00	0 00	8 57	0 00	0 00	0 00	0 00	0 00	0 00	0 00	0 00
Total foram counted (per 2cm3)	0 00	0 49	0 00	9 09	0 00	2 99	0 00	0.00	0 00	0 00	0 00	0 00	12 56	0 00	18 29	0.00	6 90	7 41	5 71	23 46	42 86	0 00	0 00	21 91	23 44	36 84	13 79
	90	104	65	176	96	134	86	176	121	119	128	61	828	1294	1400	128	232	438	280	324	140	264	90	178	64	76	58

Table A9.15 Foraminiferal death assemblages for index points collected by ERC and other LOIS partner (~ = Dr W. R. Gehrels and * = Dr J. M. Lloyd)

Species	160	180	225	240	300	325	350	398	425	445	500	550	600	650	700	743	800	835	861	865	873	888	907	925
Ammonia beccarii var. batavus	0.00	6.95	24.32	0.00	8.90	1.90	2.06	3.73	0.00	0.00	0.00	0.00	0.85	0.85	0.63	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.37
Ammonia beccarii var. limnetes	0.00	11.17	16.22	10.71	14.73	6.96	10.91	18.24	16.18	58.56	22.92	14.58	8.05	4.27	4.84	6.18	2.94	0.00	0.00	0.00	0.00	0.00	0.00	11.24
Cibicides lobatulus	0.00	0.74	0.00	3.57	1.03	0.00	1.65	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cycloegyra involvens	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Elphidium earlandi	0.00	1.24	0.00	0.00	0.00	0.00	0.00	0.00	2.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Elphidium excavatum	0.00	6.45	8.11	0.00	6.51	2.22	6.17	6.67	0.00	14.36	4.17	2.08	0.85	2.56	0.94	0.85	0.74	0.00	0.00	0.00	0.00	0.00	0.00	5.62
Elphidium gerthi	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Elphidium incertum	0.00	4.22	8.11	10.71	5.14	10.44	9.88	6.67	2.94	0.55	0.00	2.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Elphidium williamsoni	0.00	14.89	2.70	3.57	10.27	10.76	16.46	14.71	0.00	6.08	2.08	2.08	2.54	2.99	0.63	4.05	0.74	0.00	0.00	0.00	0.00	0.00	0.00	4.49
Haplophragmoides spp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Haynesina germanica	0.00	41.69	31.08	53.57	35.96	43.67	52.47	42.75	69.12	11.60	68.75	75.00	81.78	73.93	90.63	76.97	94.85	17.02	0.00	0.00	0.00	0.00	0.00	56.74
Jadammina macrescens	33.33	11.66	8.11	14.29	13.36	21.84	0.00	3.14	1.47	4.97	2.08	0.00	2.54	11.97	0.78	1.28	0.00	51.06	71.84	83.66	84.53	85.94	61.67	7.30
Miliammina fusca	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.97	0.00	0.00	0.45	0.21	0.00
Miliolinella subrotunda	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.20	0.00	0.00	0.00	2.08	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Planorbulina mediterranensis	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Quinqueloculina spp.	0.00	0.00	0.00	0.00	0.34	0.00	0.41	0.78	7.35	3.31	0.00	2.08	0.85	1.71	0.31	0.64	0.00	10.64	0.00	0.00	0.00	0.00	0.00	1.12
Tiphotrocha comprimata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.97	0.00	0.00	0.00	0.00	0.00
Trochammina inflata	66.67	0.99	1.35	3.57	2.74	2.22	0.00	2.16	0.00	0.55	0.00	0.00	2.12	1.28	1.25	9.81	0.74	21.28	26.21	16.34	15.47	13.61	38.12	10.11
Total forams counted (per 2 cm3)	6	403	74	28	292	316	486	510	68	181	48	48	236	234	640	469	136	47	412	1420	1396	3528	3736	178

Table A9.16 Foraminiferal death assemblages of Holkam NNC17. Samples were counted by Dr I. Boomer, LOIS.