Palaeolimnological study of the history of Loe Pool, Helston, and its catchment.

by

Martin Andrew Coard

Volume 2

Figures, Plates and Appendices

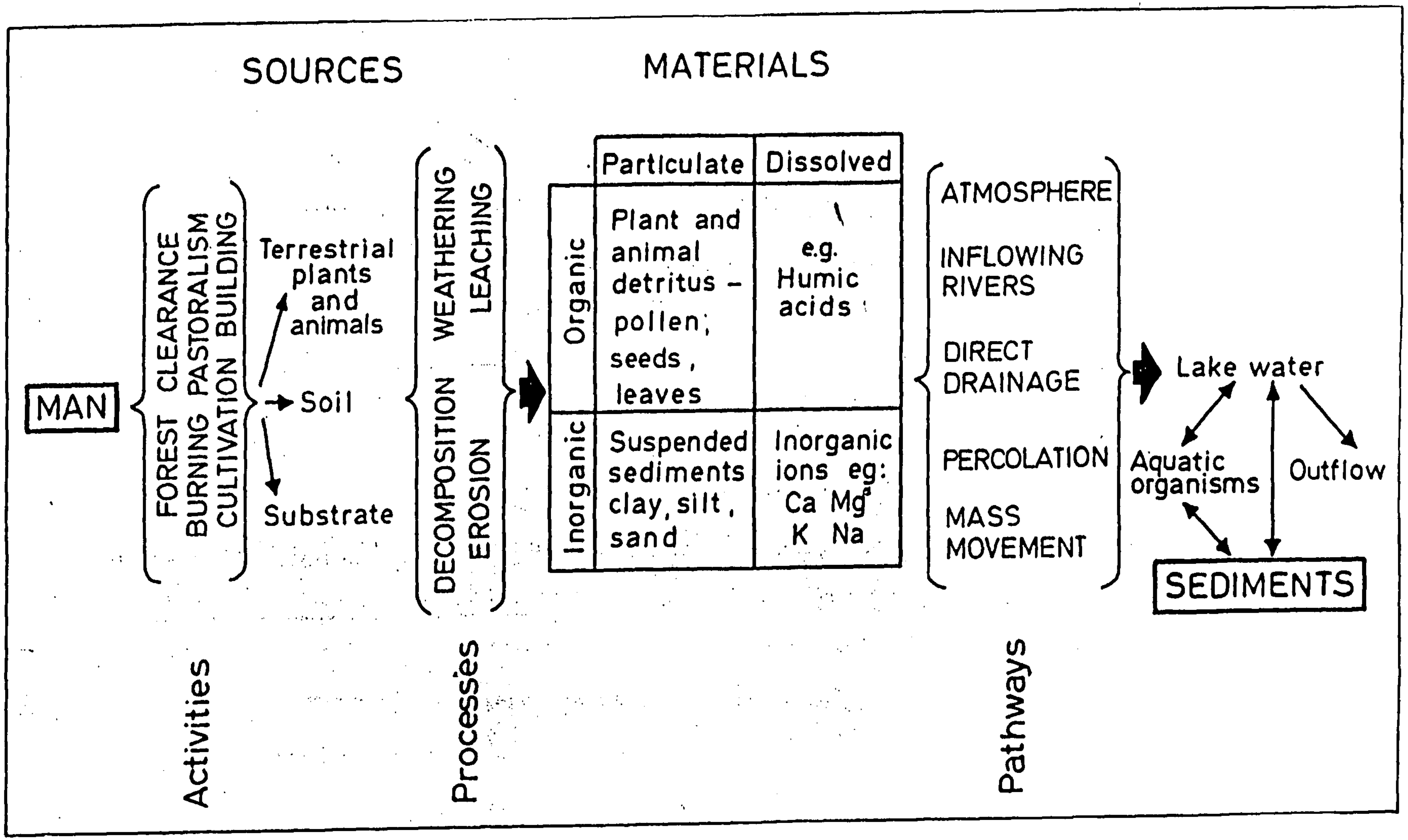


Fig. 1.1 A simplified partial model of lacustrine sedimentation in a lake-watershed ecosystem strongly influenced by ma.

(From: Oldfield 1977)

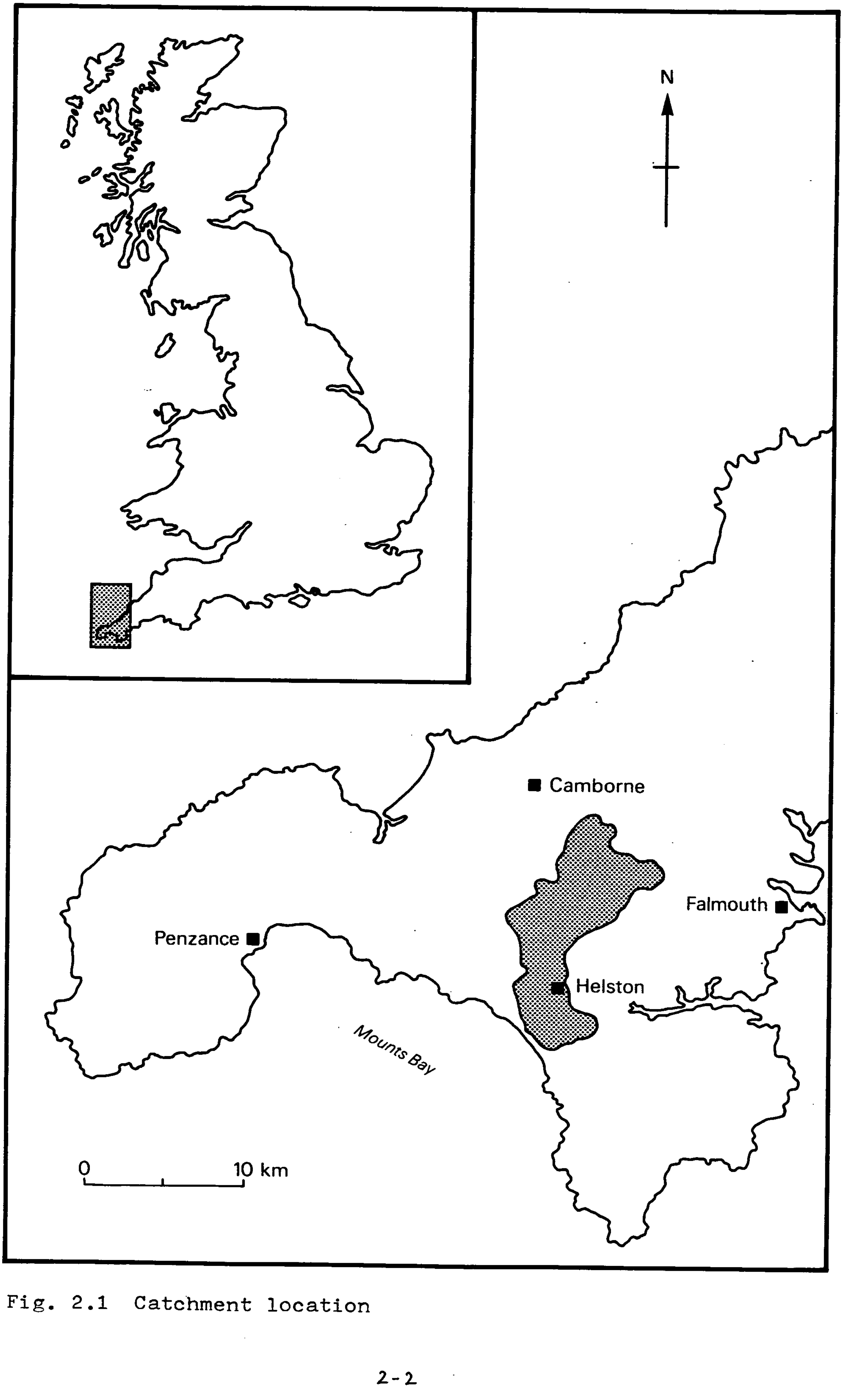


Fig. 2.1 Catchment location

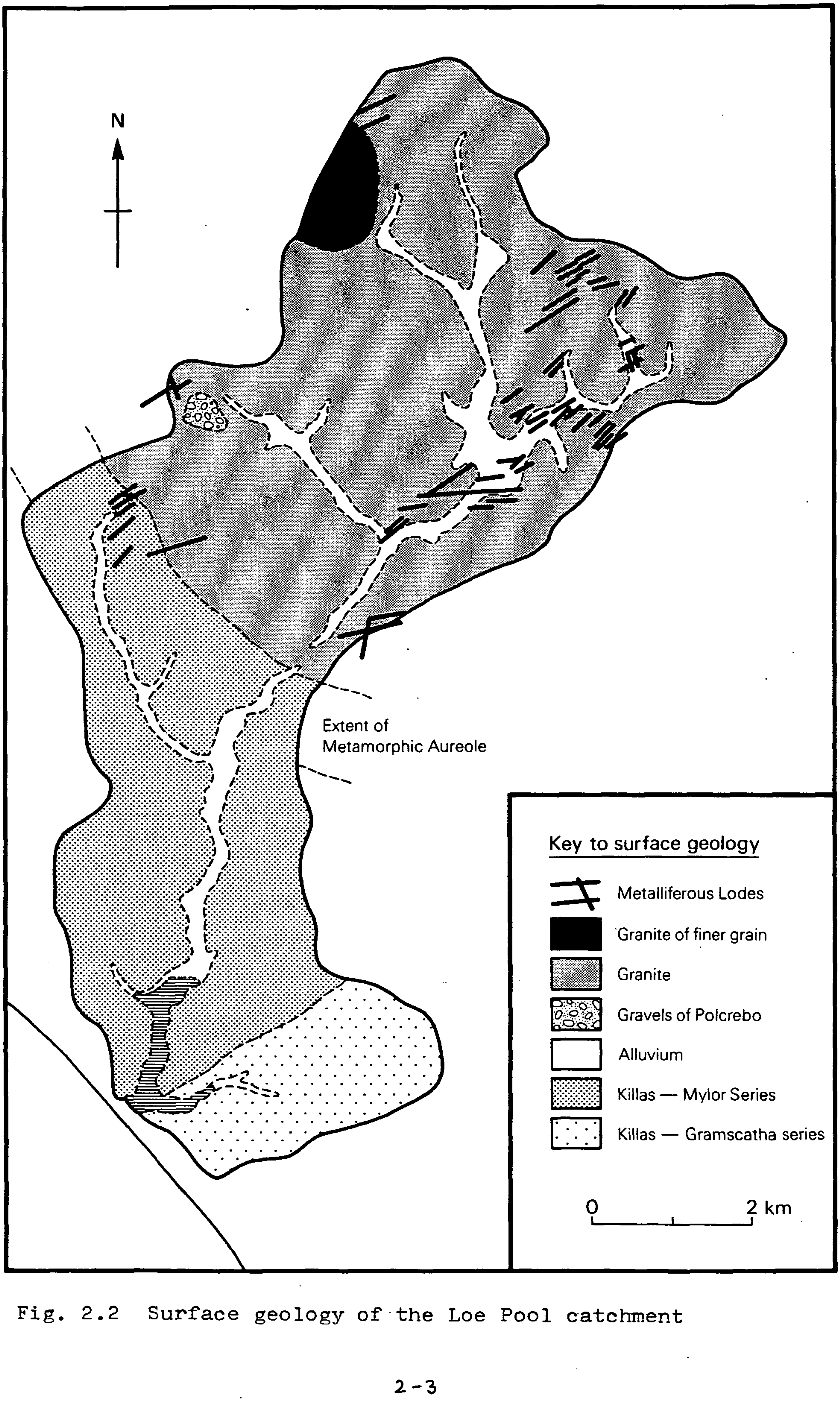


Fig. 2.2 Surface geology of the Loe Pool catchment

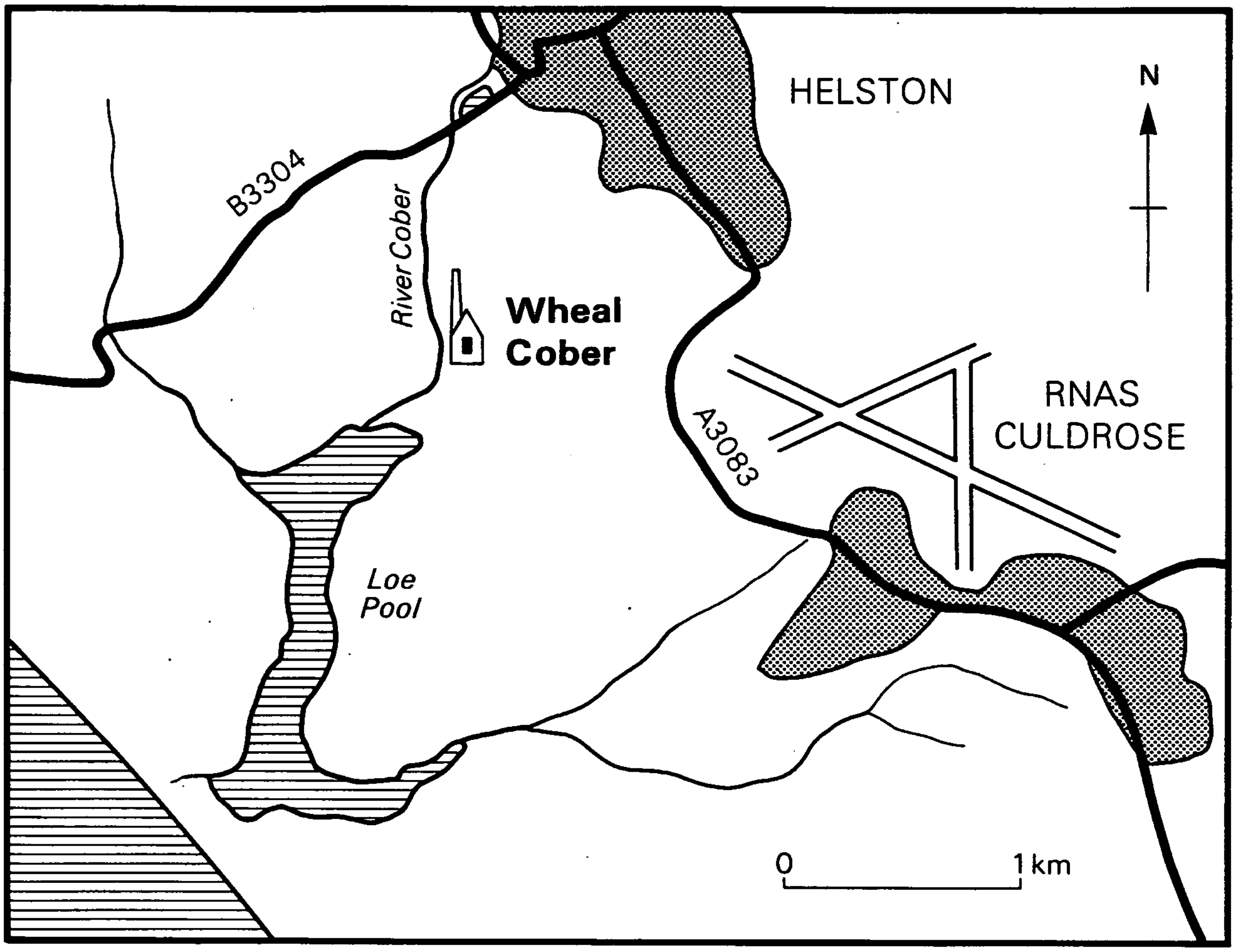


Fig. 2.3 Location of Wheal Cober

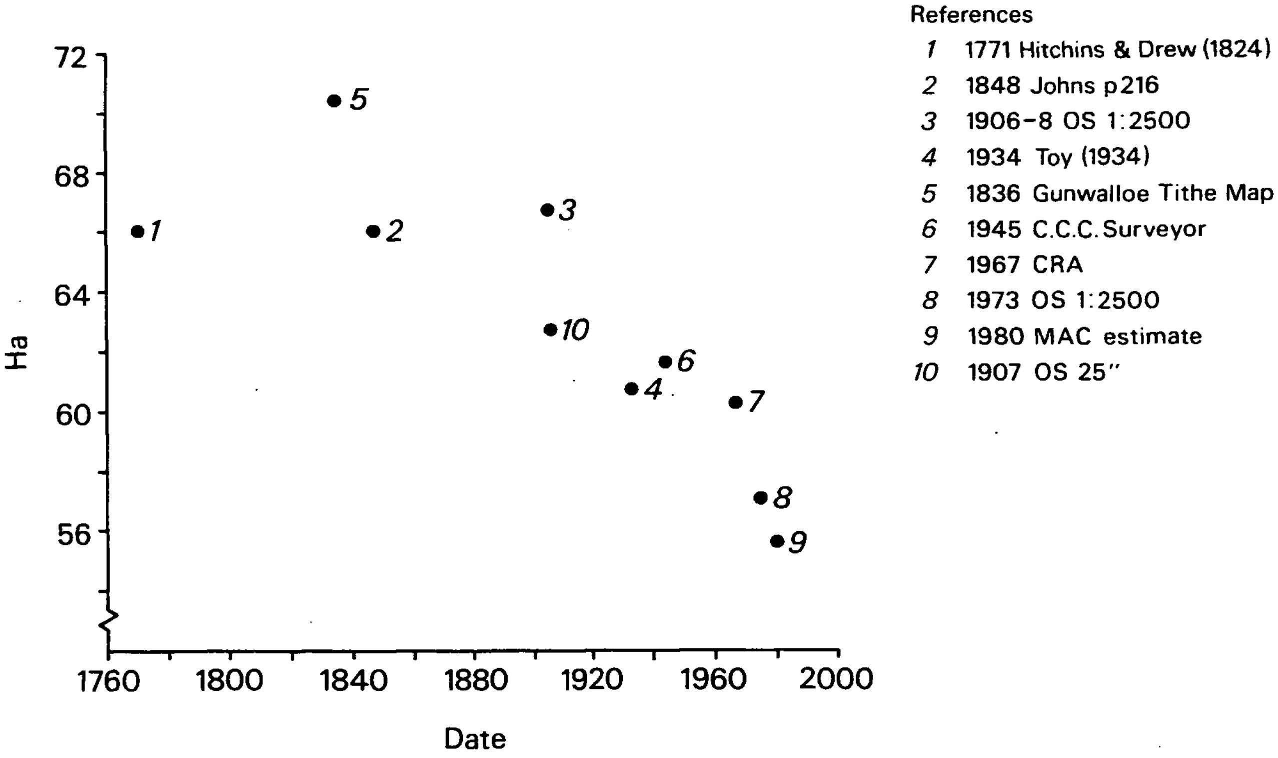
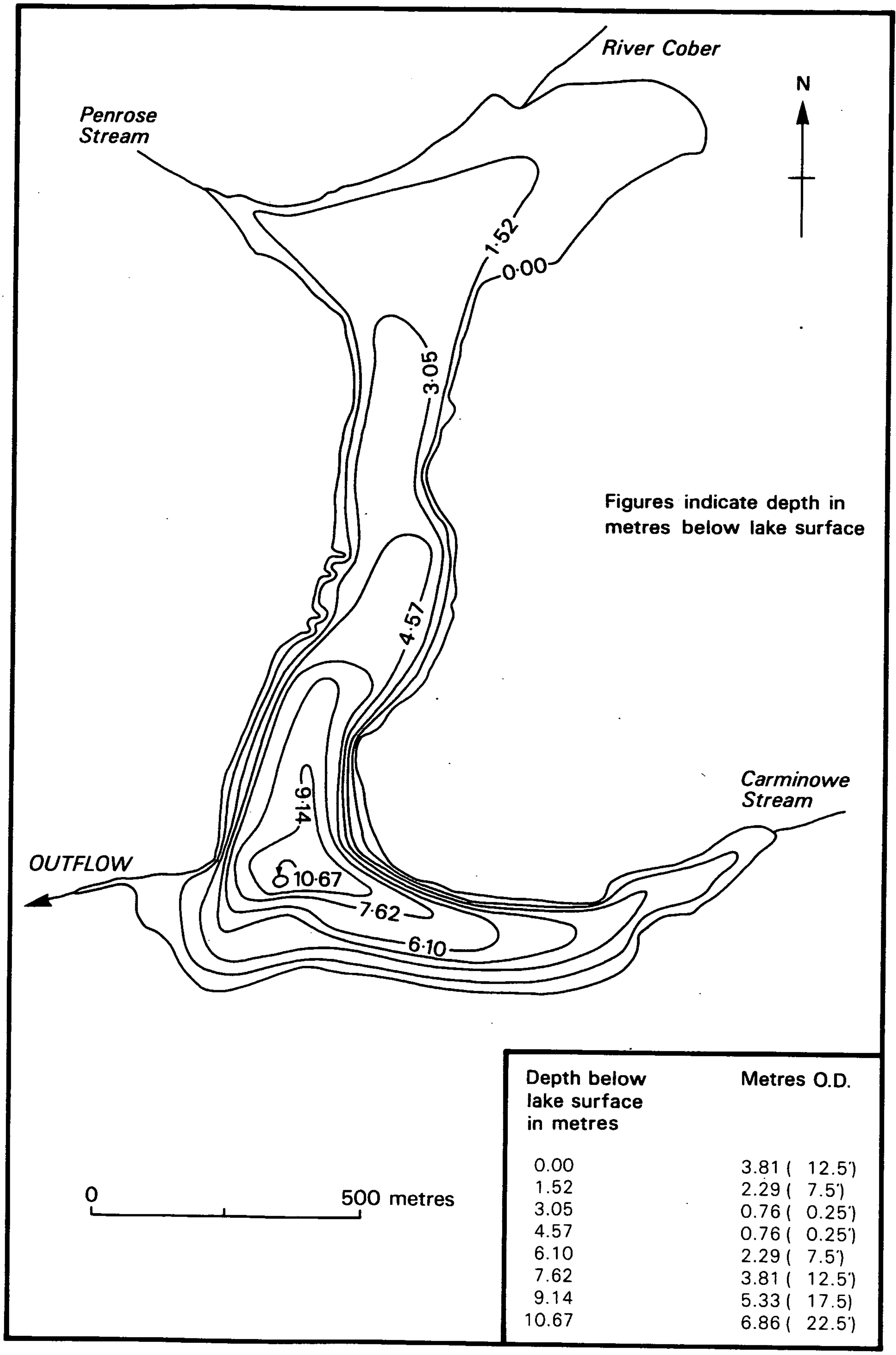


Fig. 2.4 Changes in the area of open water, Loe Pool, from 1701 to 1980.



Depth below lake surface in metres	Metres O.D.
0.00	3.81 (12.5')
1.52	2.29 (7.5')
3.05	0.76 (0.25')
4.57	0.76 (0.25')
6.10	2.29 (7.5')
7.62	3.81 (12.5')
9.14	5.33 (17.5)
10.67	6.86 (22.5')

Fig. 2.5 Isopleth map of Loe Pool

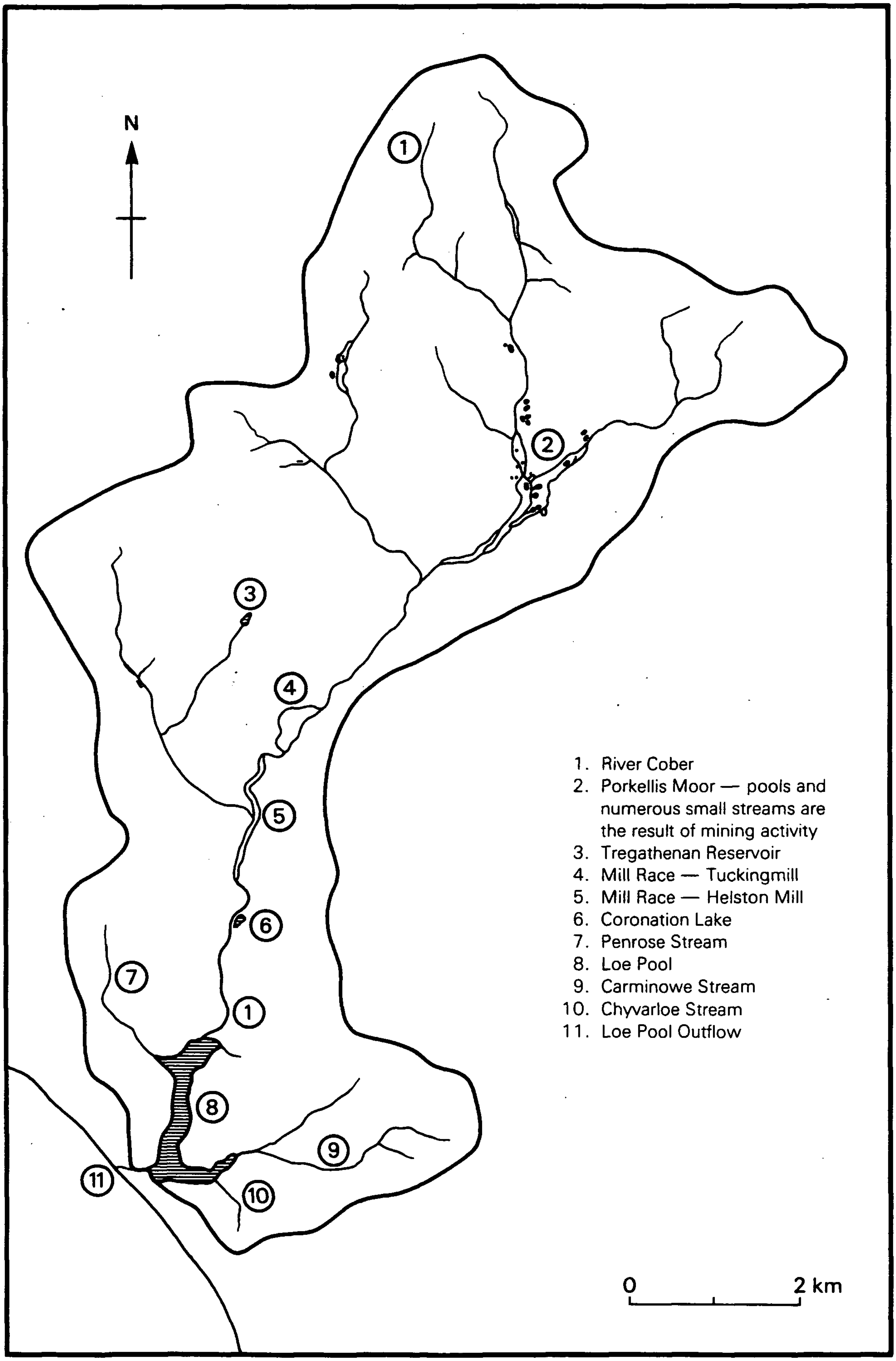


Fig. 2.6 Catchment drainage network

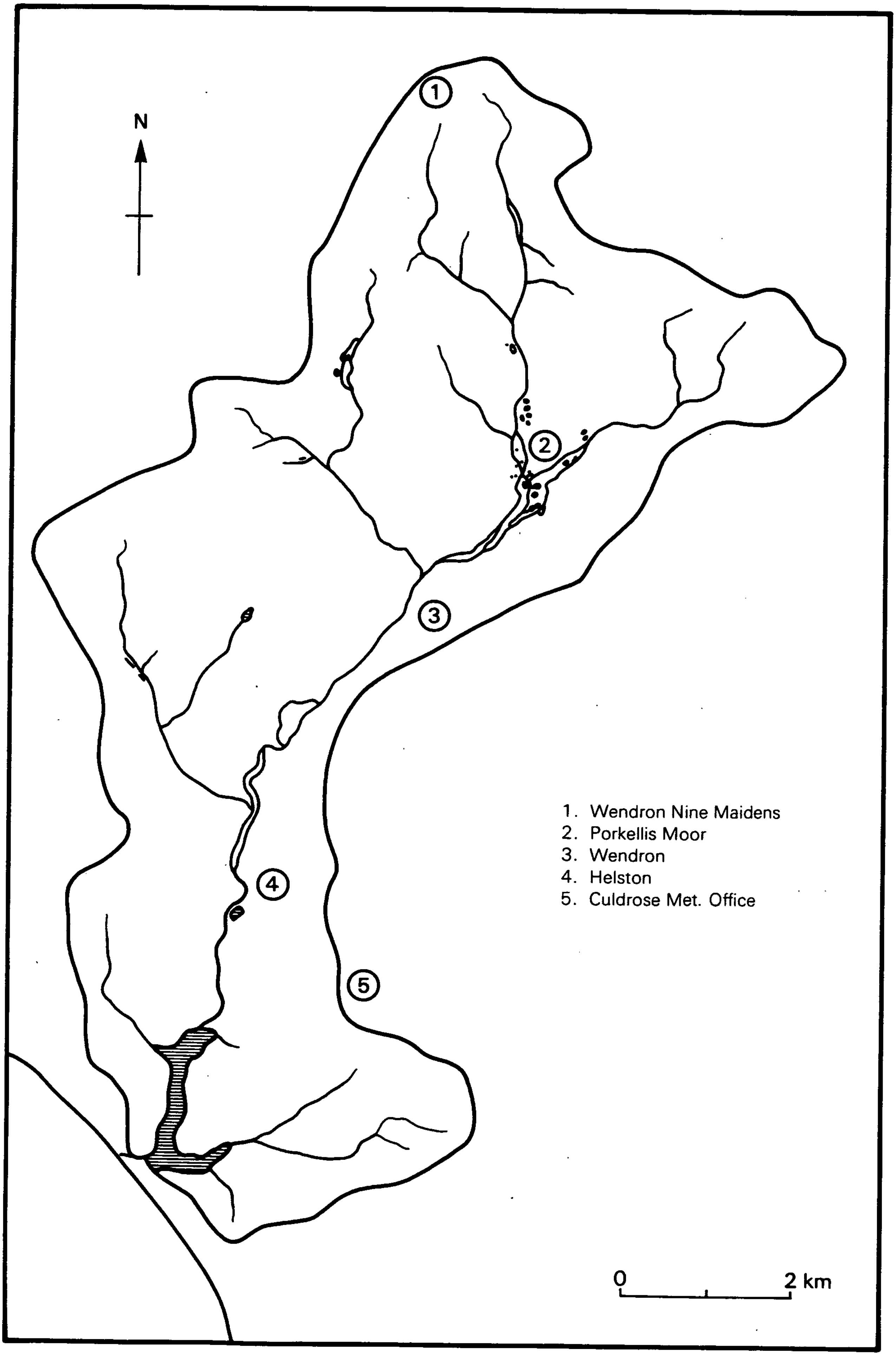


Fig. 2.7 Catchment raingauge locations

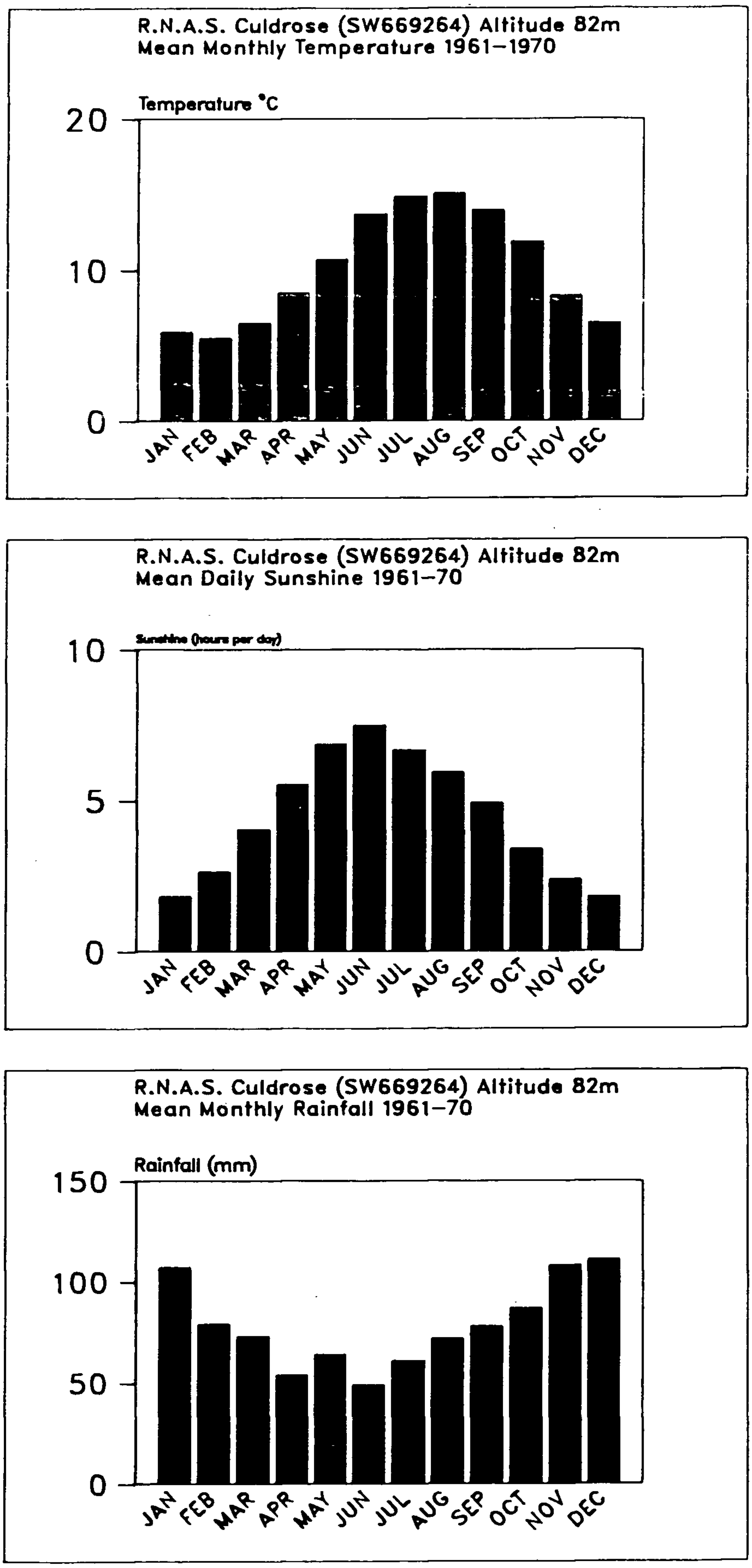

R.N.A.S. Culdrose (SW669264) Altitude 82m
Mean Monthly Temperature 1961–1970
Temperature °C
20
10
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
R.N.A.S. Culdrose (SW669264) Altitude 82m
Mean Daily Sunshine 1961–70
Sunshine (hours per day)
10
5
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
R.N.A.S. Culdrose (SW669264) Altitude 82m
Mean Monthly Rainfall 1961–70
Rainfall (mm)
150
100
50
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

Fig. 2.8

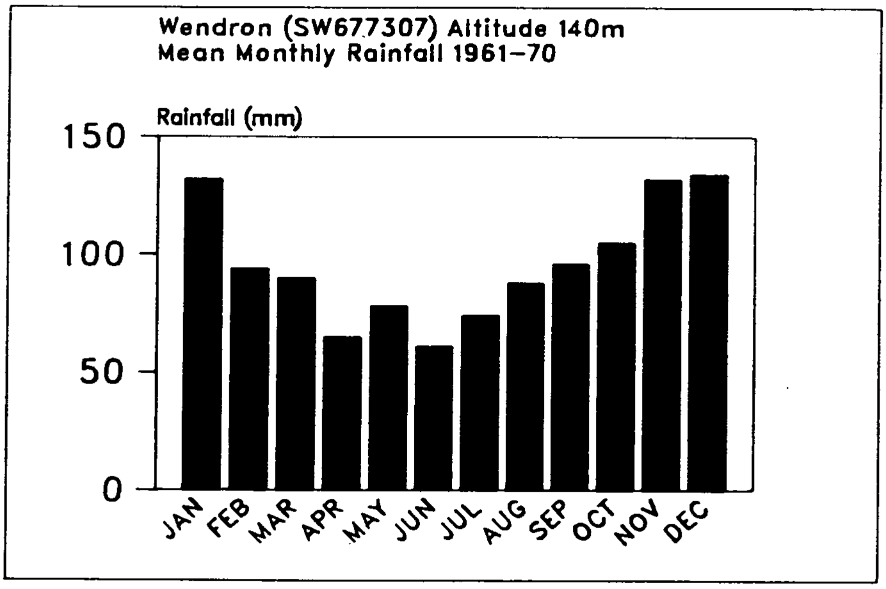
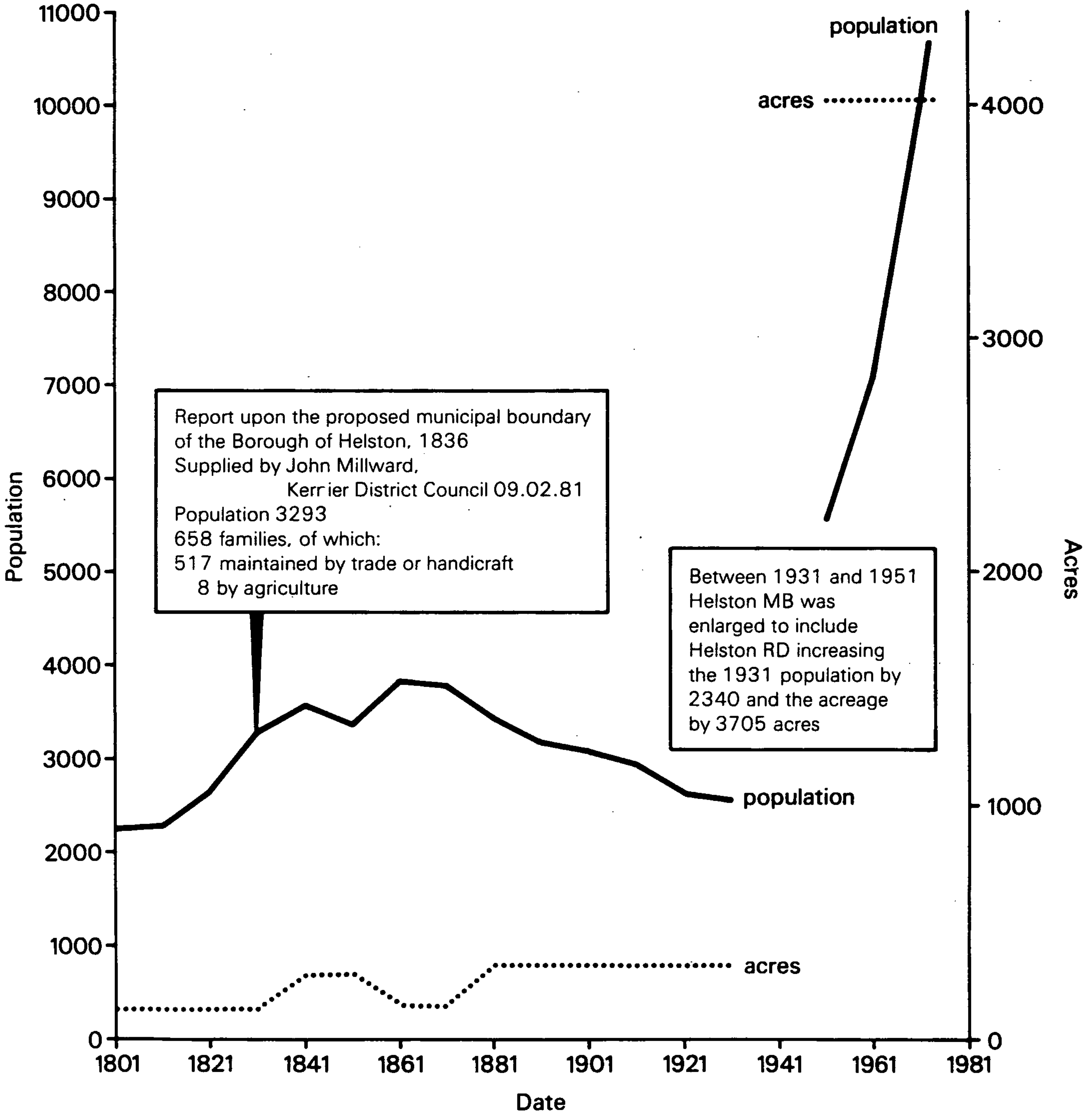

Wendron (SW677307) Altitude 140m
Mean Monthly Rainfall 1961–70
Rainfall (mm)
150
100
50
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

Fig. 2.9



Report upon the proposed municipal boundary of the Borough of Helston, 1836
Supplied by John Millward,
Kerrier District Council 09.02.81
Population 3293
658 families, of which:
517 maintained by trade or handicraft
8 by agriculture

Between 1931 and 1951 Helston MB was enlarged to include Helston RD increasing the 1931 population by 2340 and the acreage by 3705 acres

Fig. 2.10 Population changes in the Helston area from 1801 to 1981.

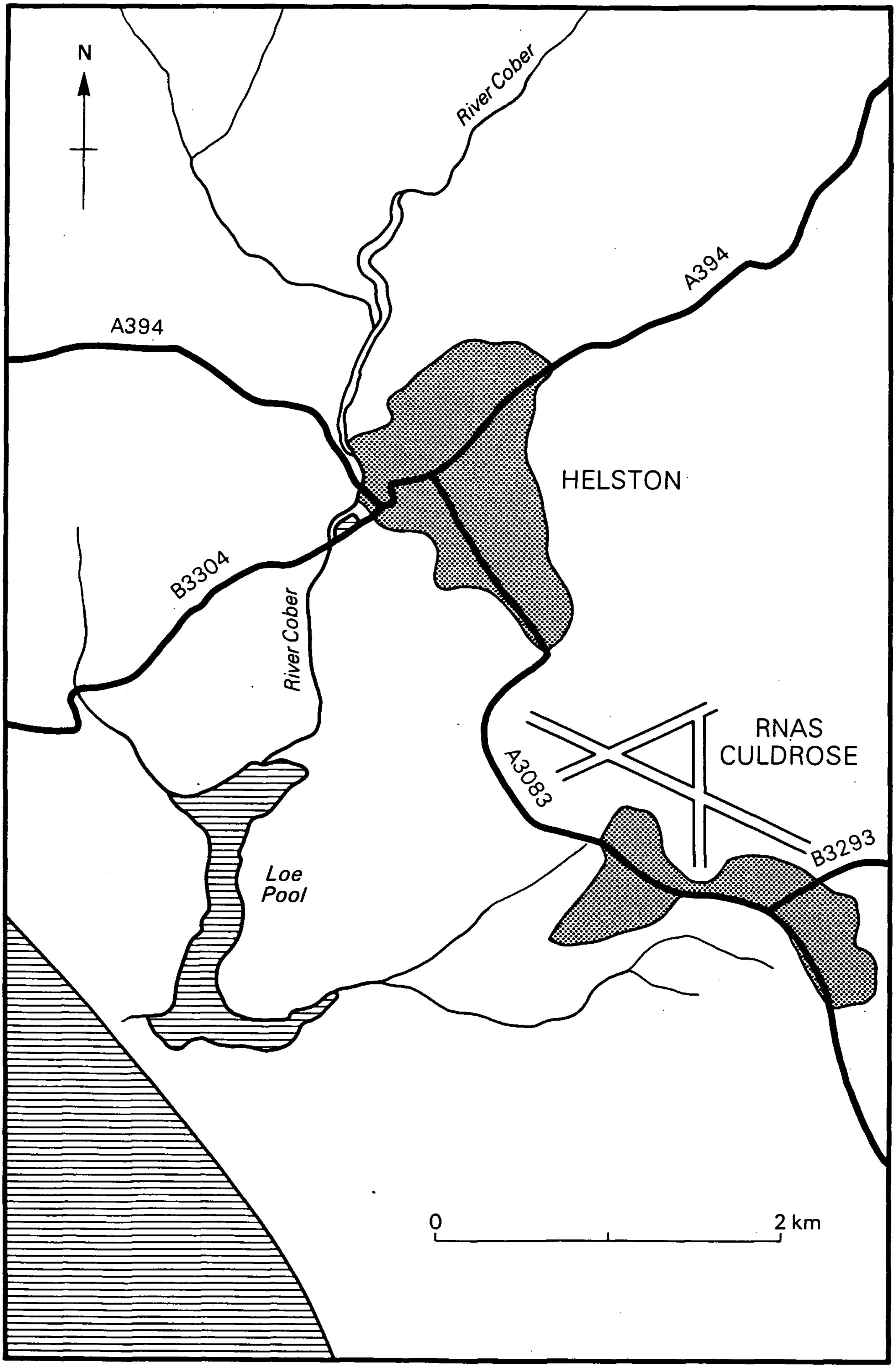


Fig. 2.11 Location of R.N.A.S. Culdrose

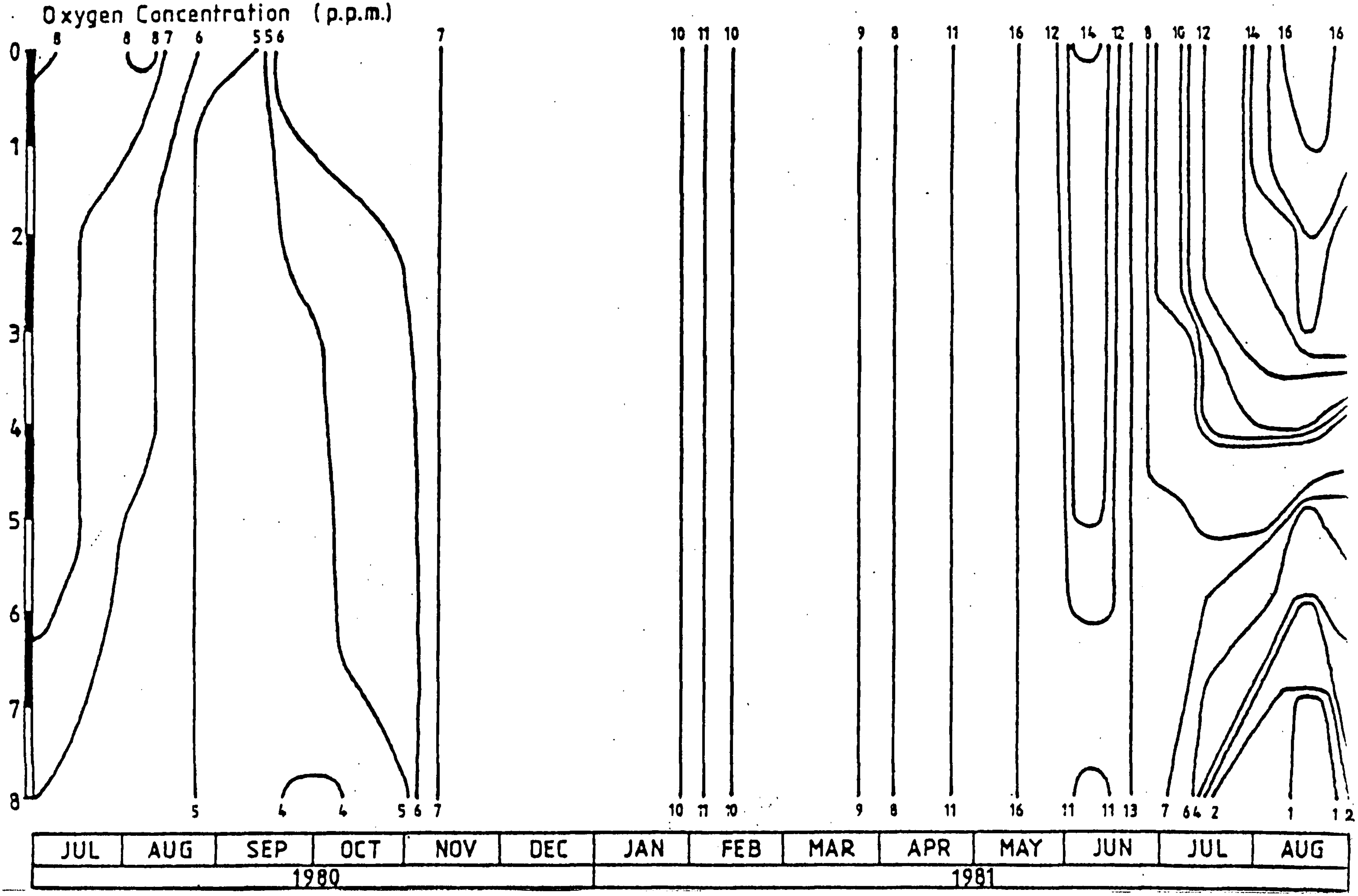


Fig. 2.12 Oxygen gradient at the deepest point of Loe Pool, 1980-81, (Lacey, unpublished data).

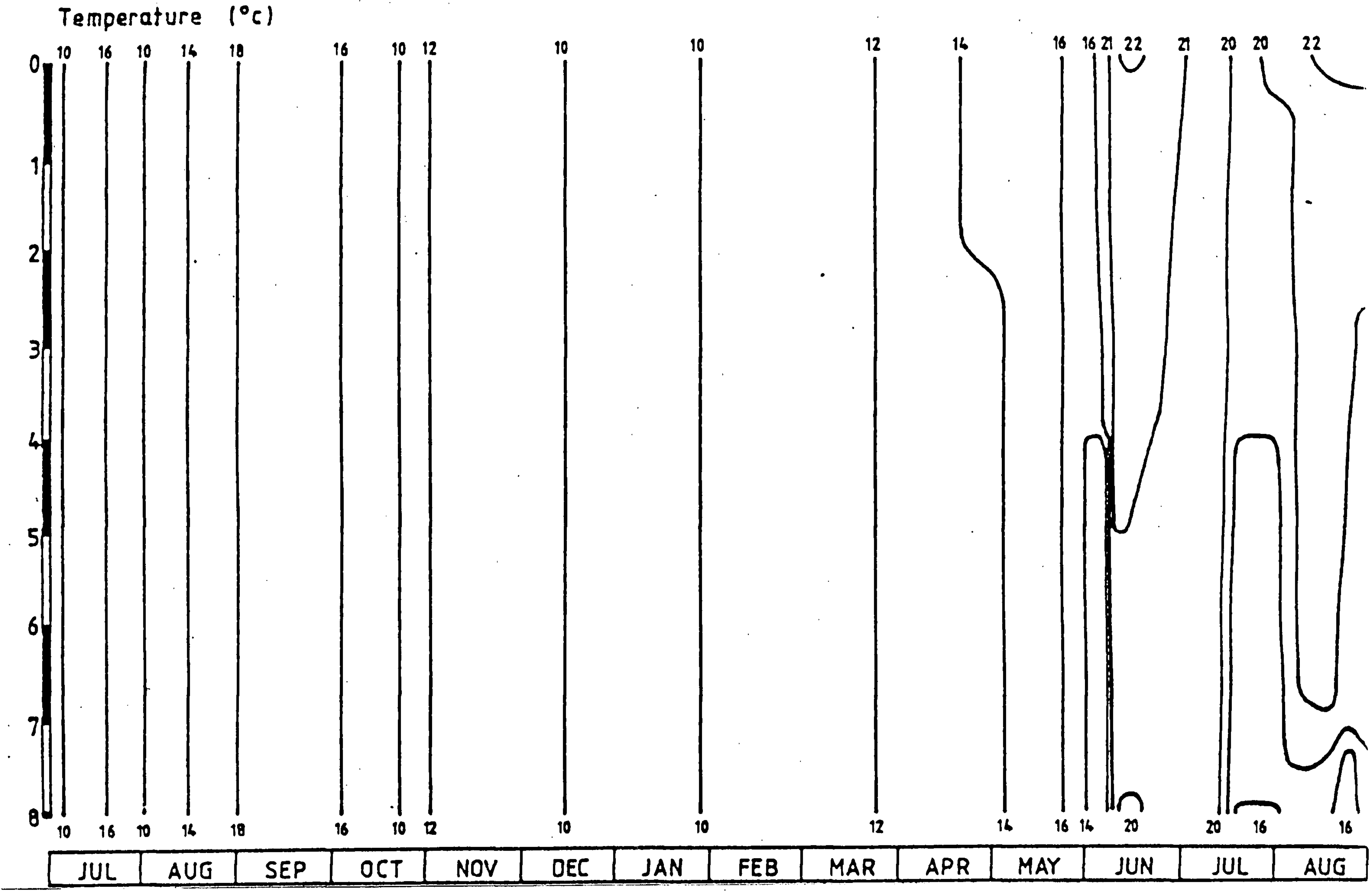


Fig. 2.13 Temperature gradient at the deepest point of Loe Pool, 1980-81, (Lacey, unpublished data).

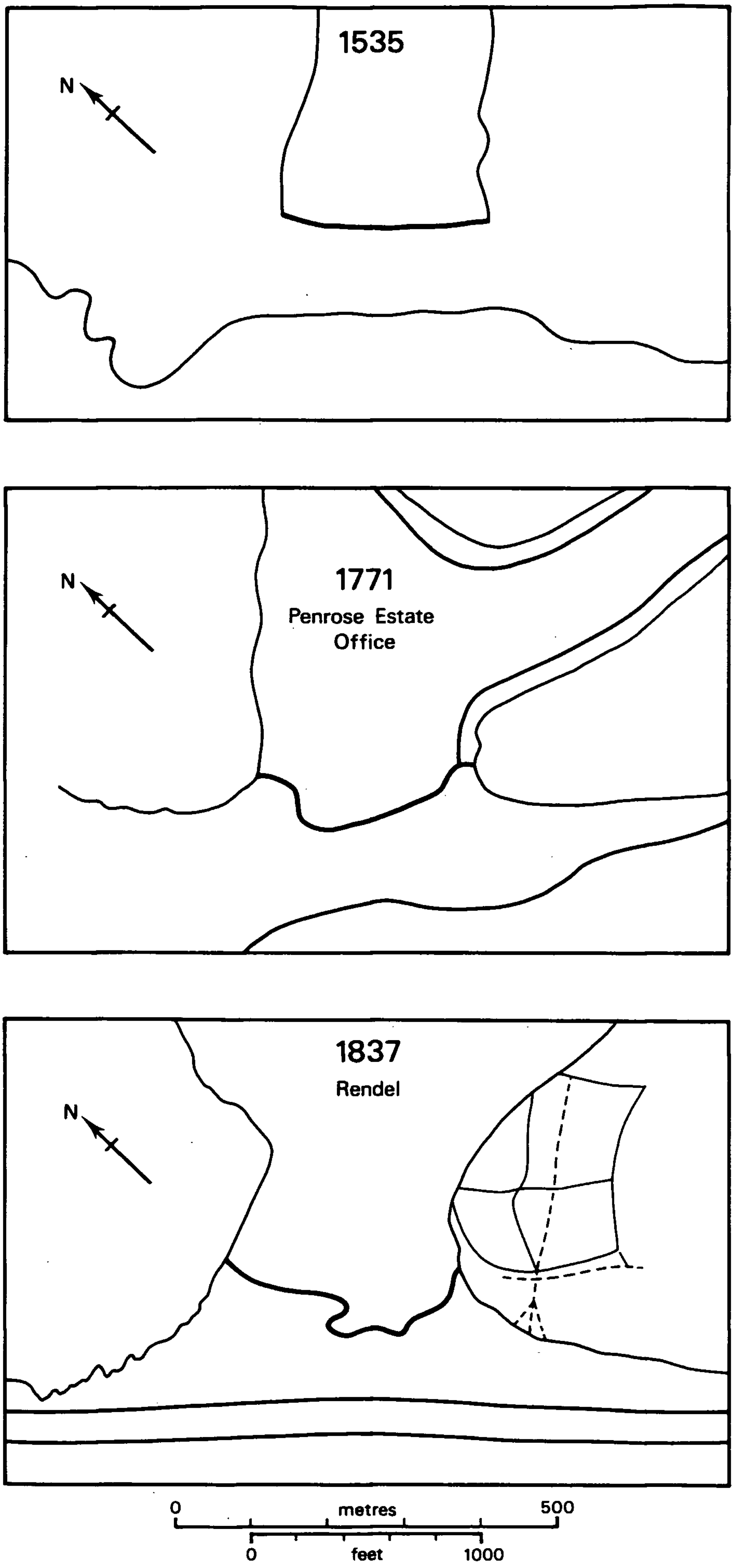


Fig. 3.1 Changes in the shape of Loe Bar

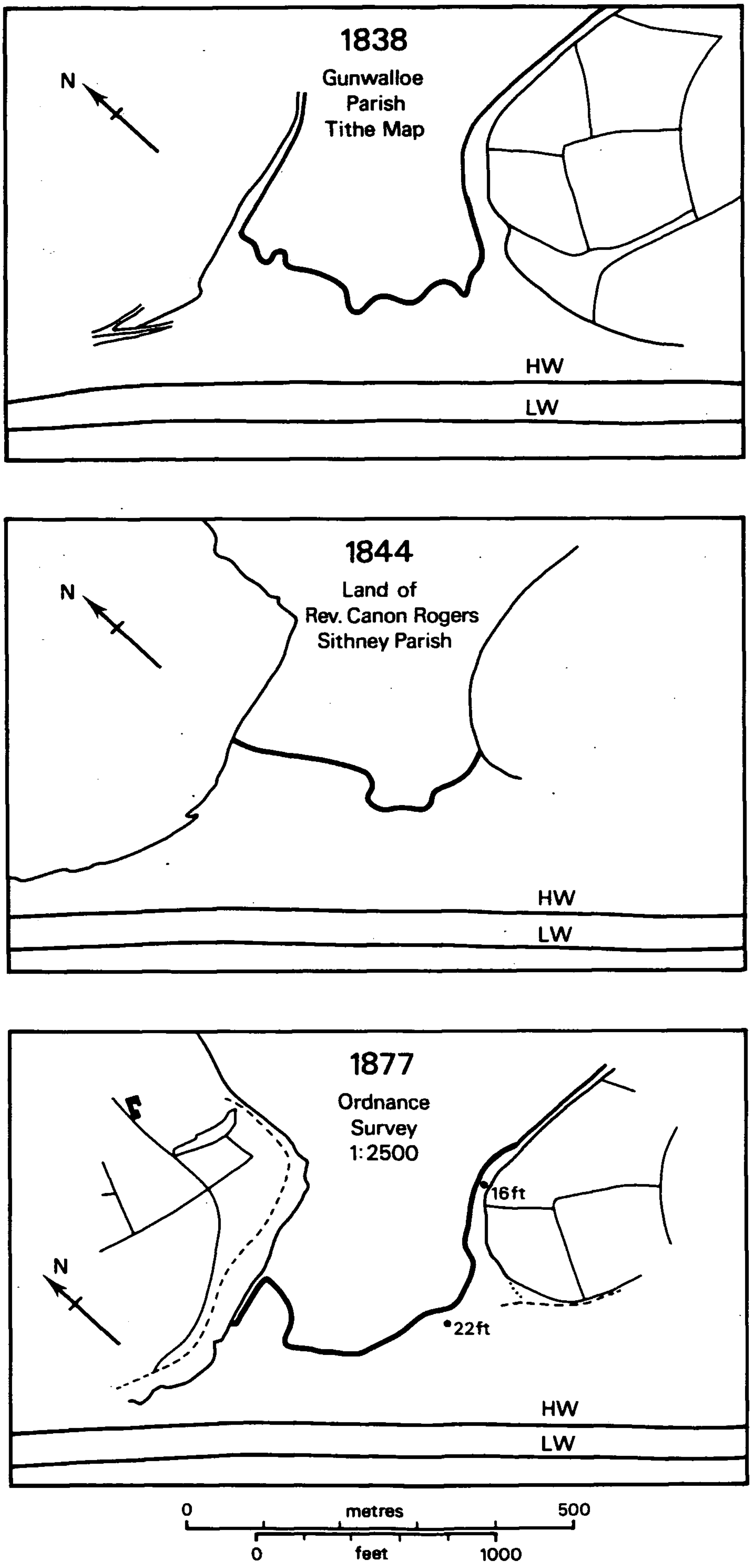


Fig. 3.2 Changes in the shape of Loe Bar

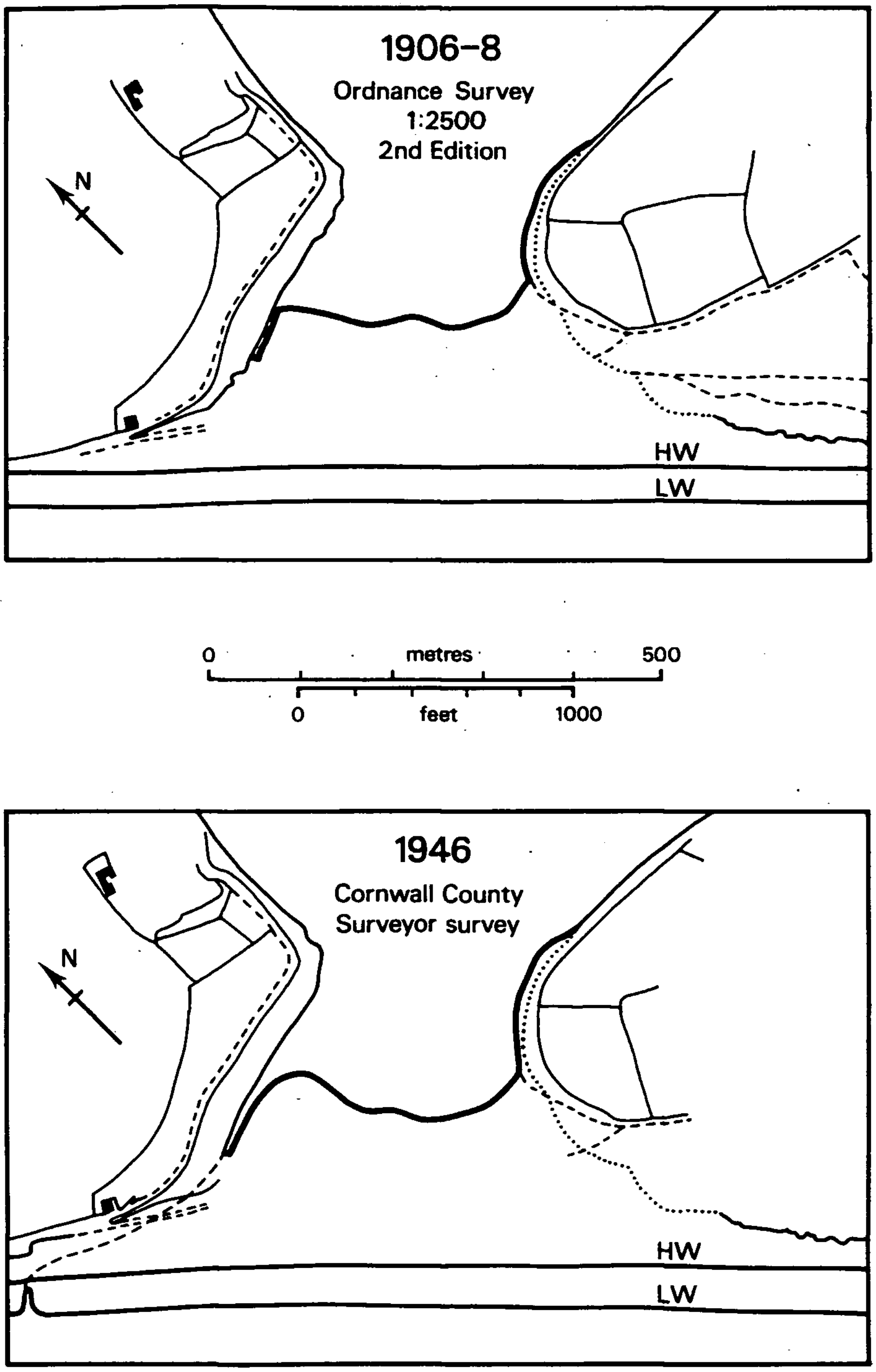


Fig. 3.3 Changes in the shape of Loe Bar

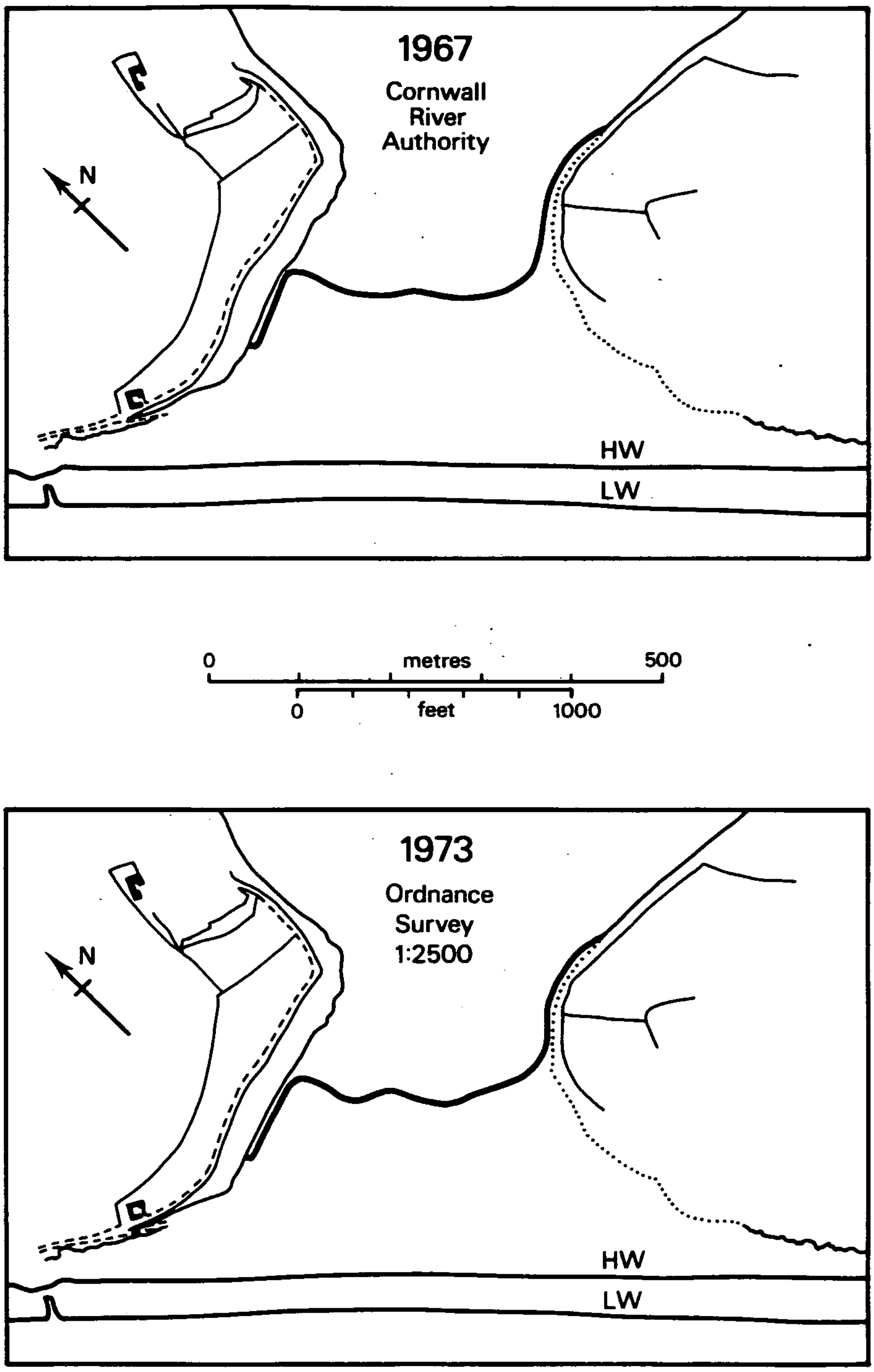


Fig. 3.4 Changes in the shape of Loe Bar

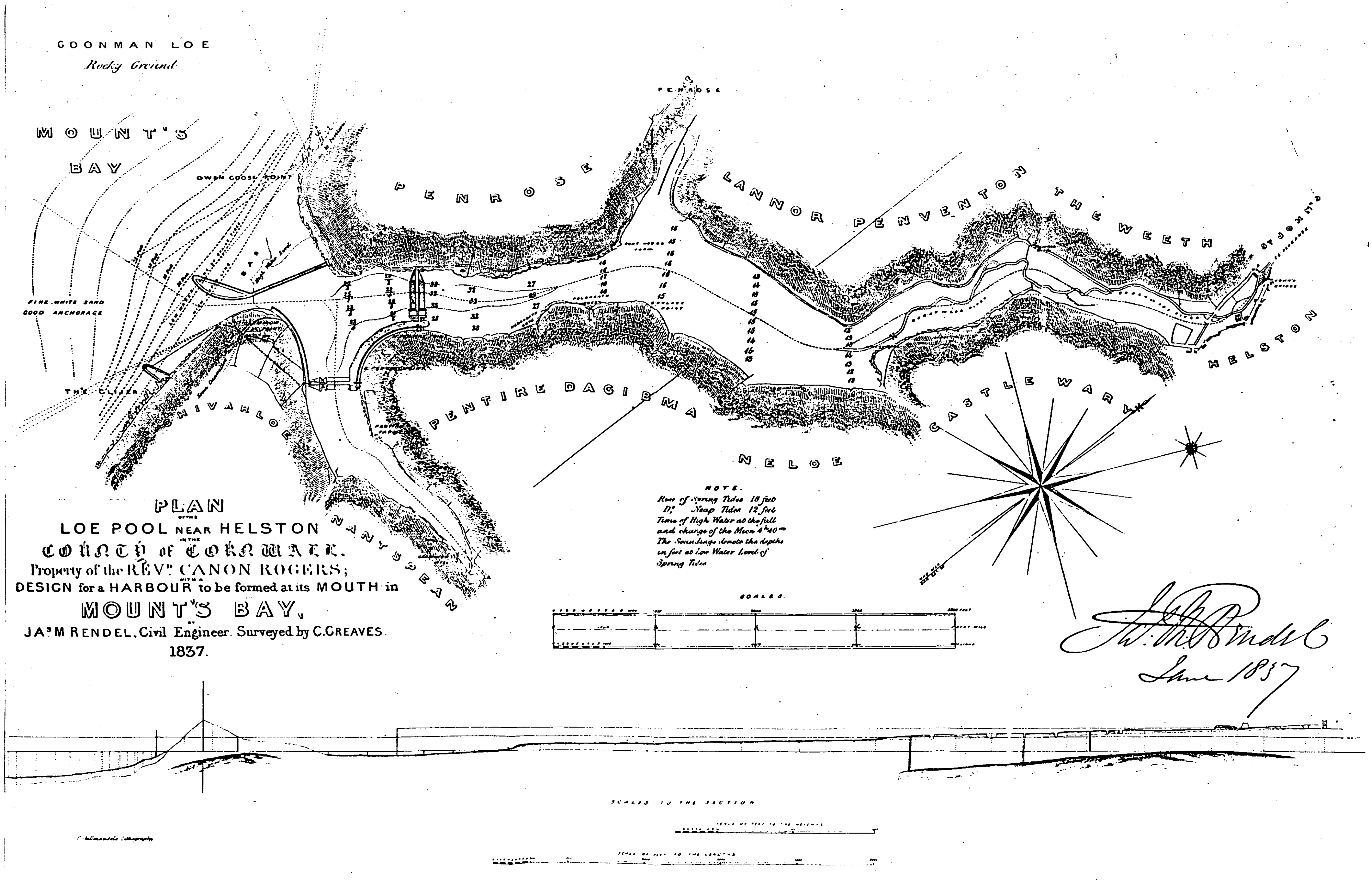


Fig. 3.5 Rendel's map of Loe Pool, 1873.

Fig. 3.5

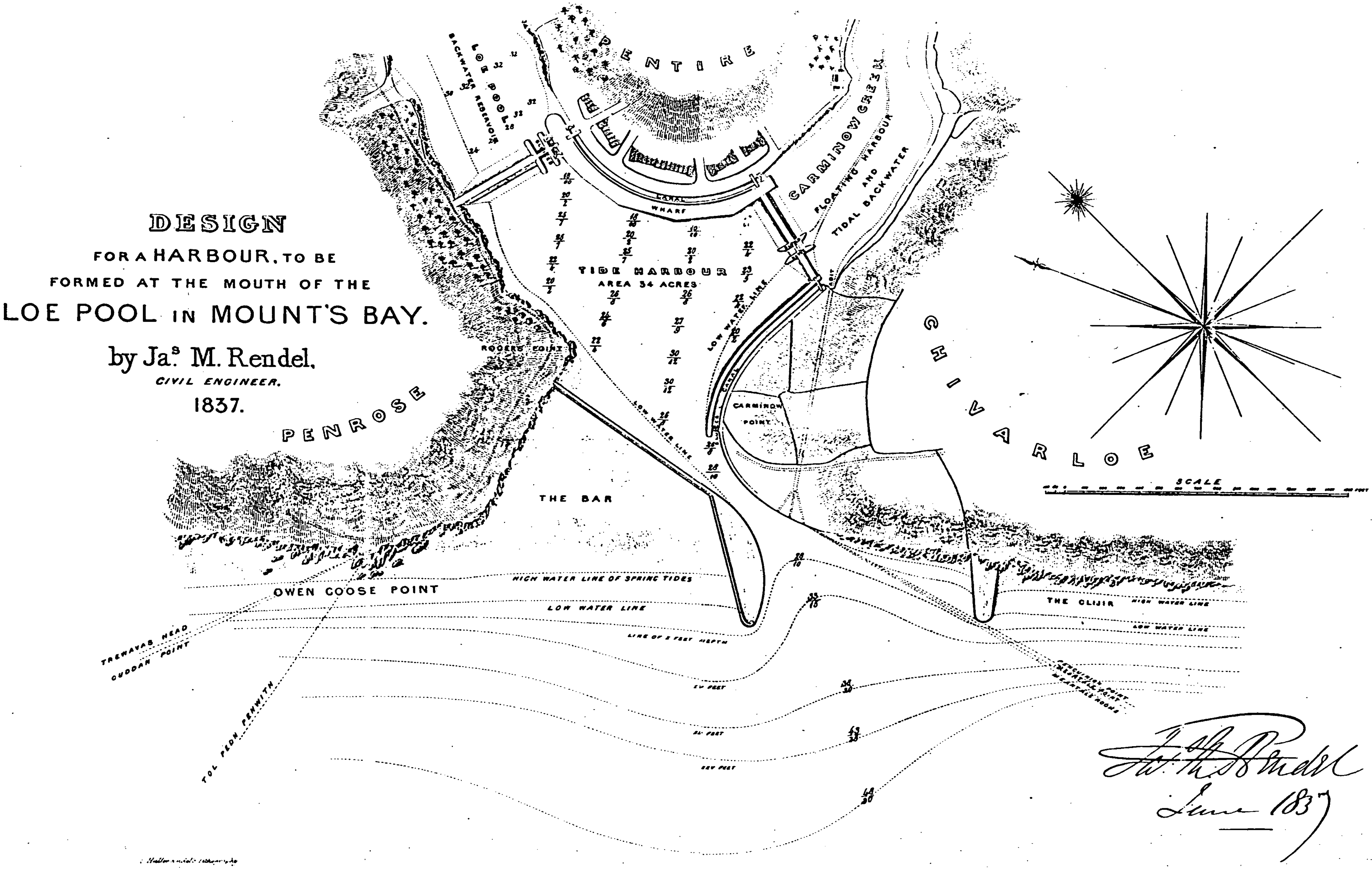


Fig. 3.6 Rendel's map of Loe Bar 1837

Fig. 3.6

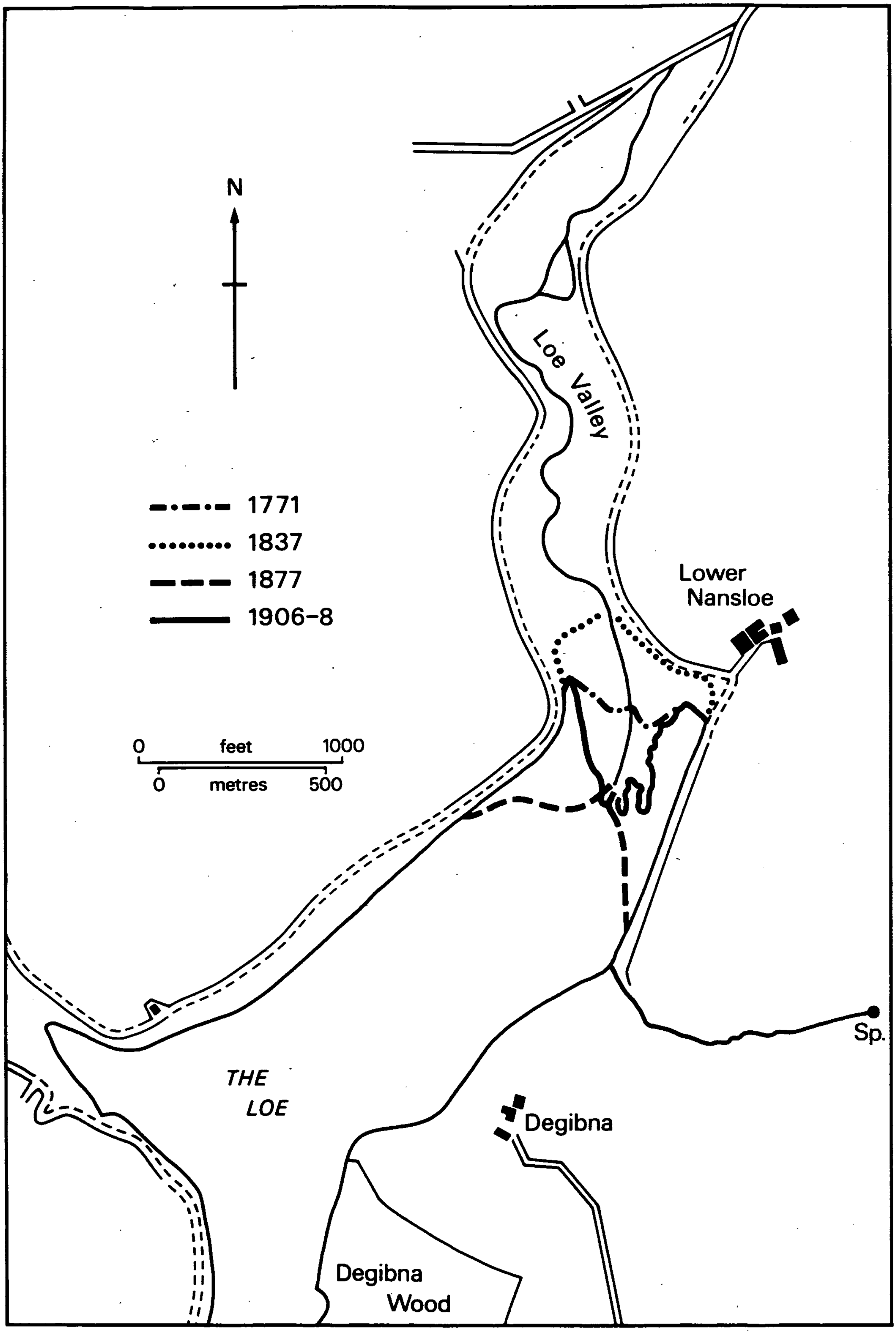


Fig. 3.7 Progressive infill of the Loe Valley, 1771-1908

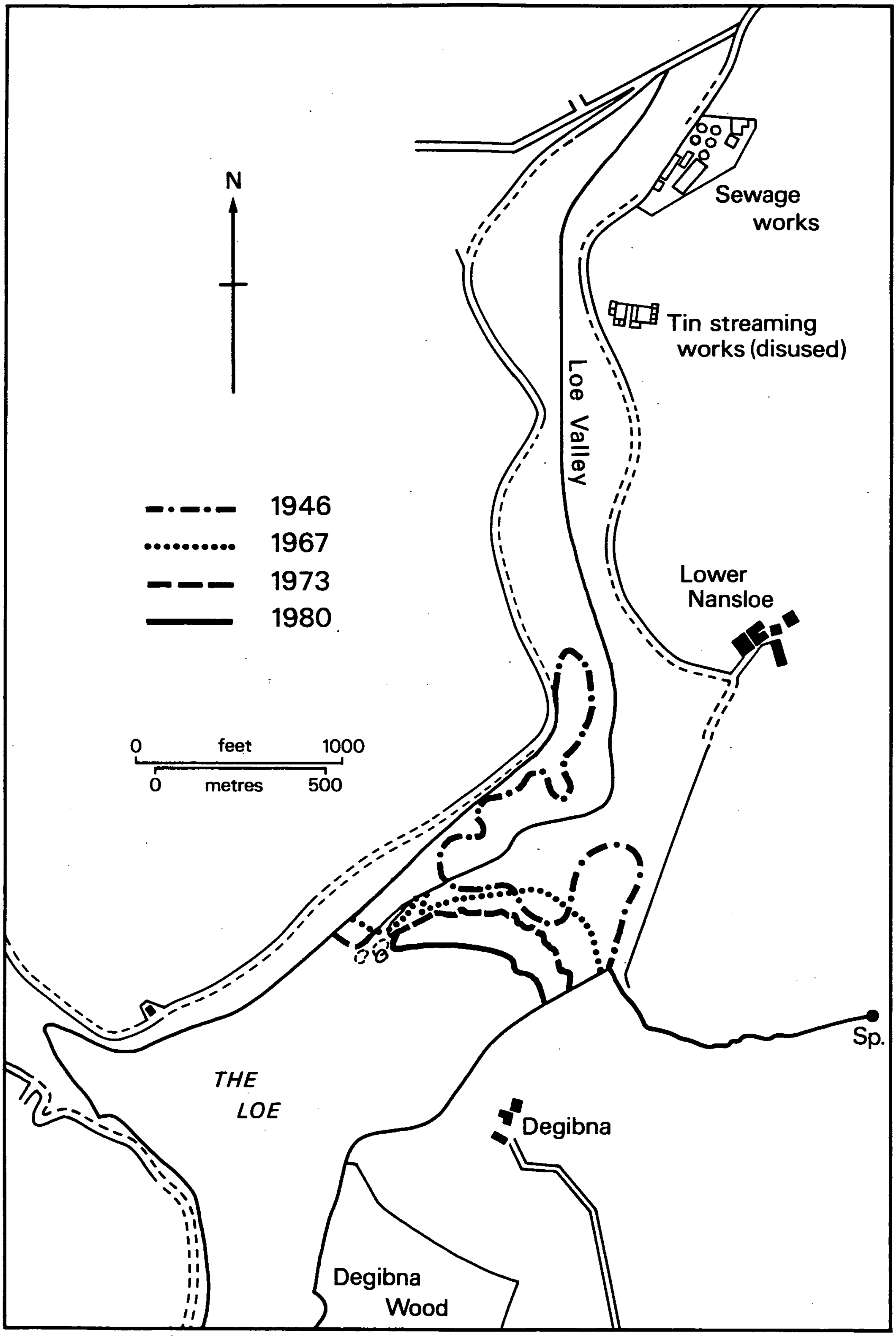


Fig. 3.8 Progressive infill of the Loe Valley, 1946-1980

Periods of Operation of Mines in the Loe Pool Catchment
Compiled from Jenkins (1962) and Brooke (Pers. Comm.)

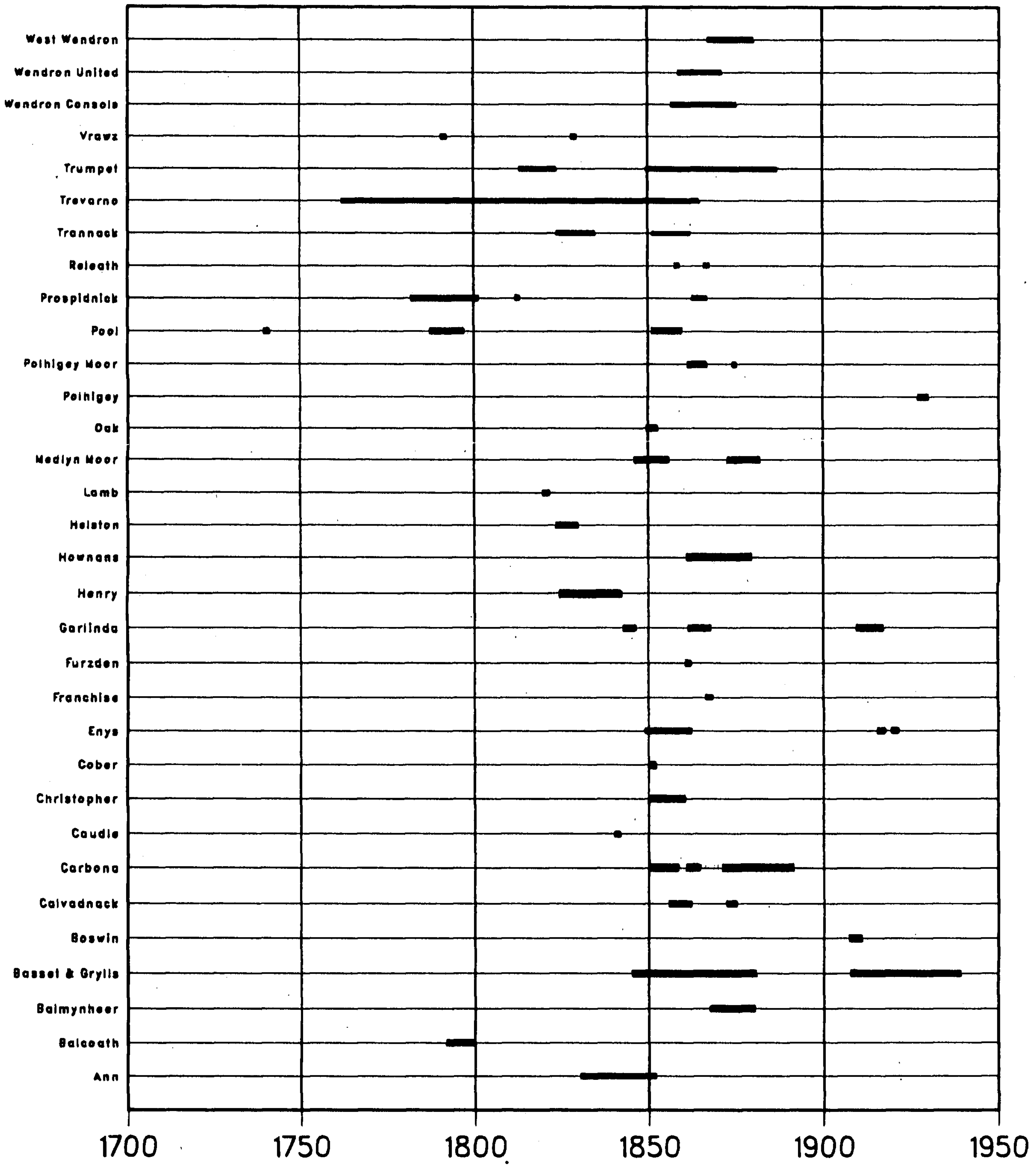


Fig. 3.9

Fig. 3.9

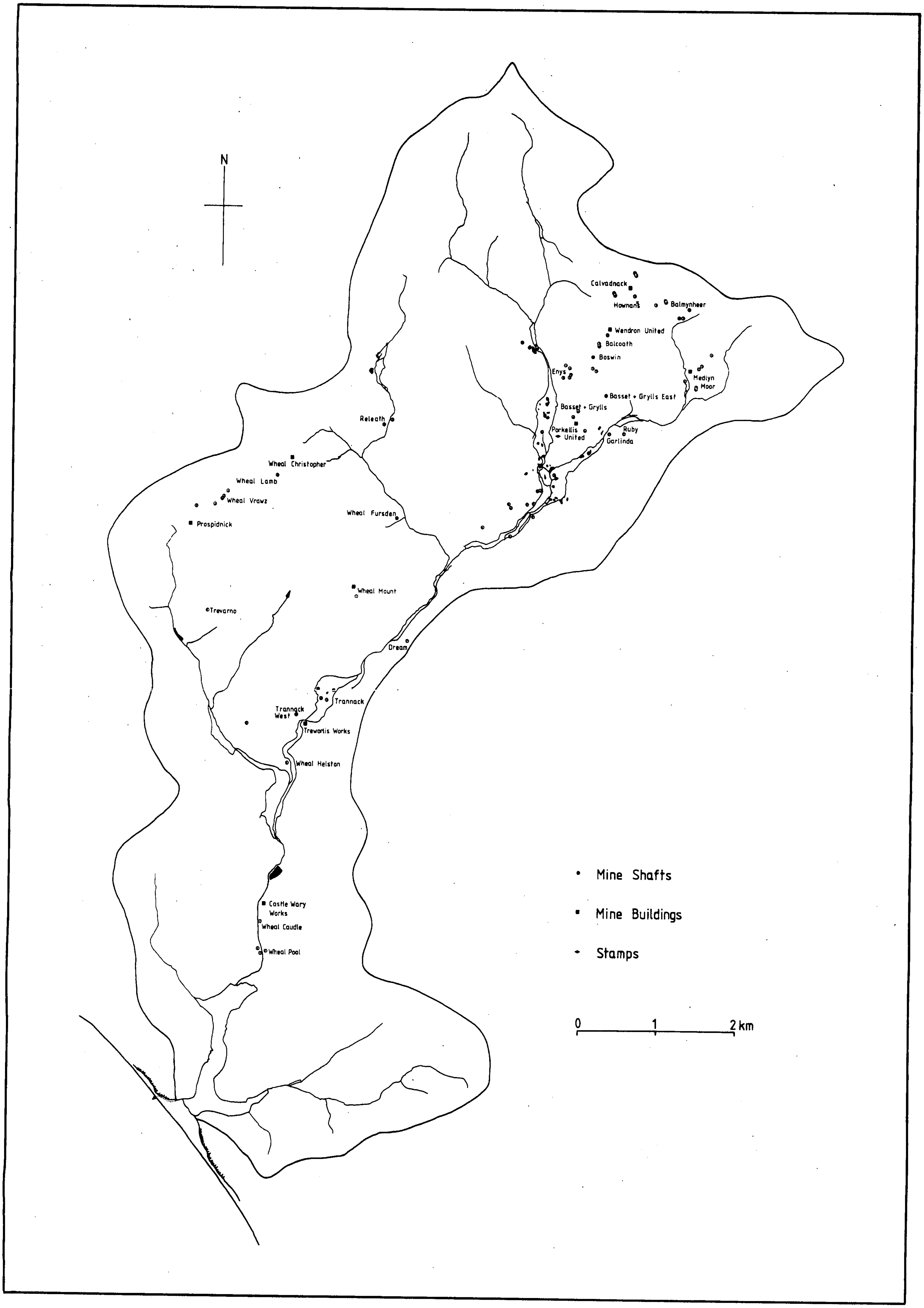


Fig. 3.10: The locations of all mine workings known to have been in operation at some time between 1700 and 1939.

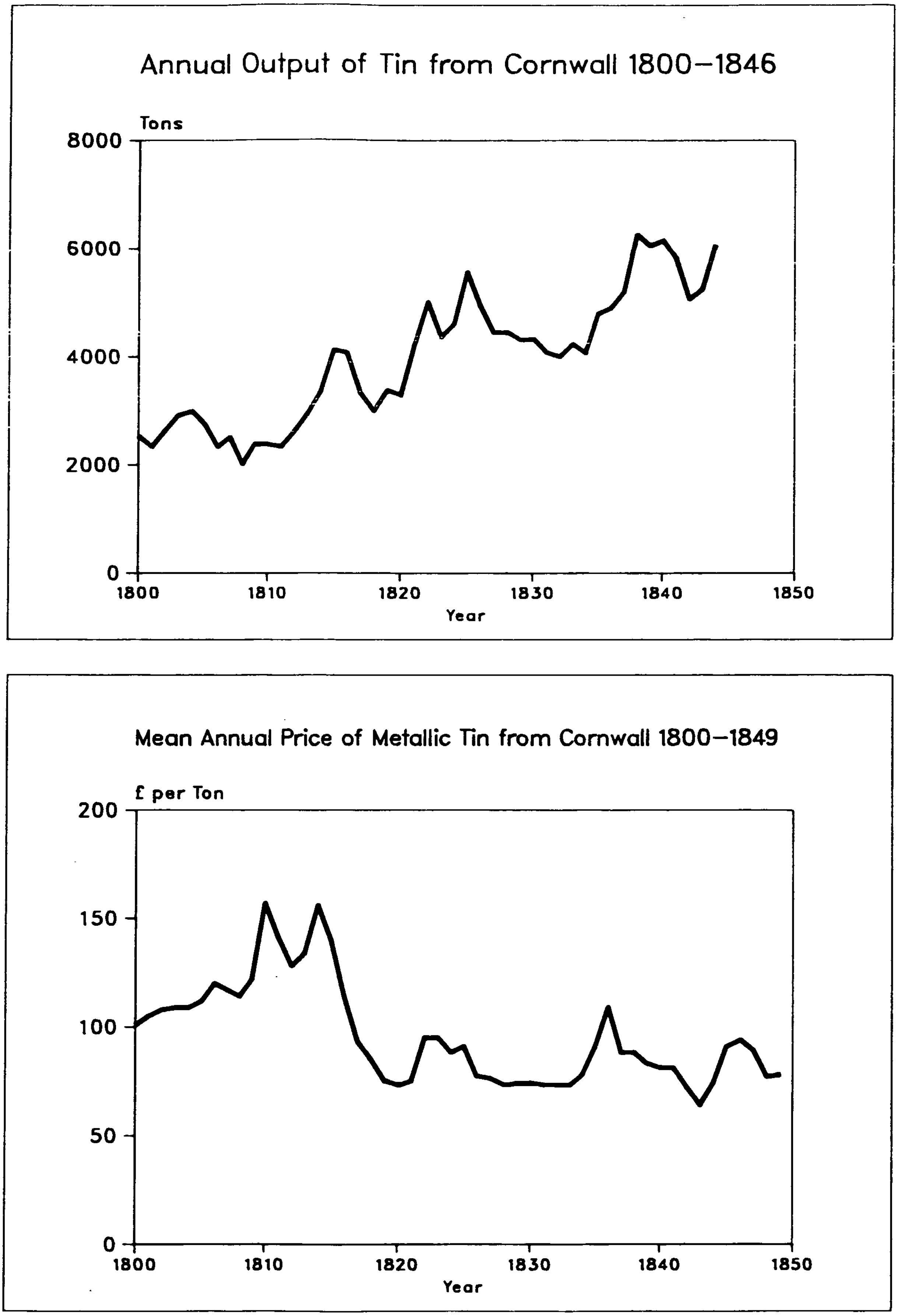
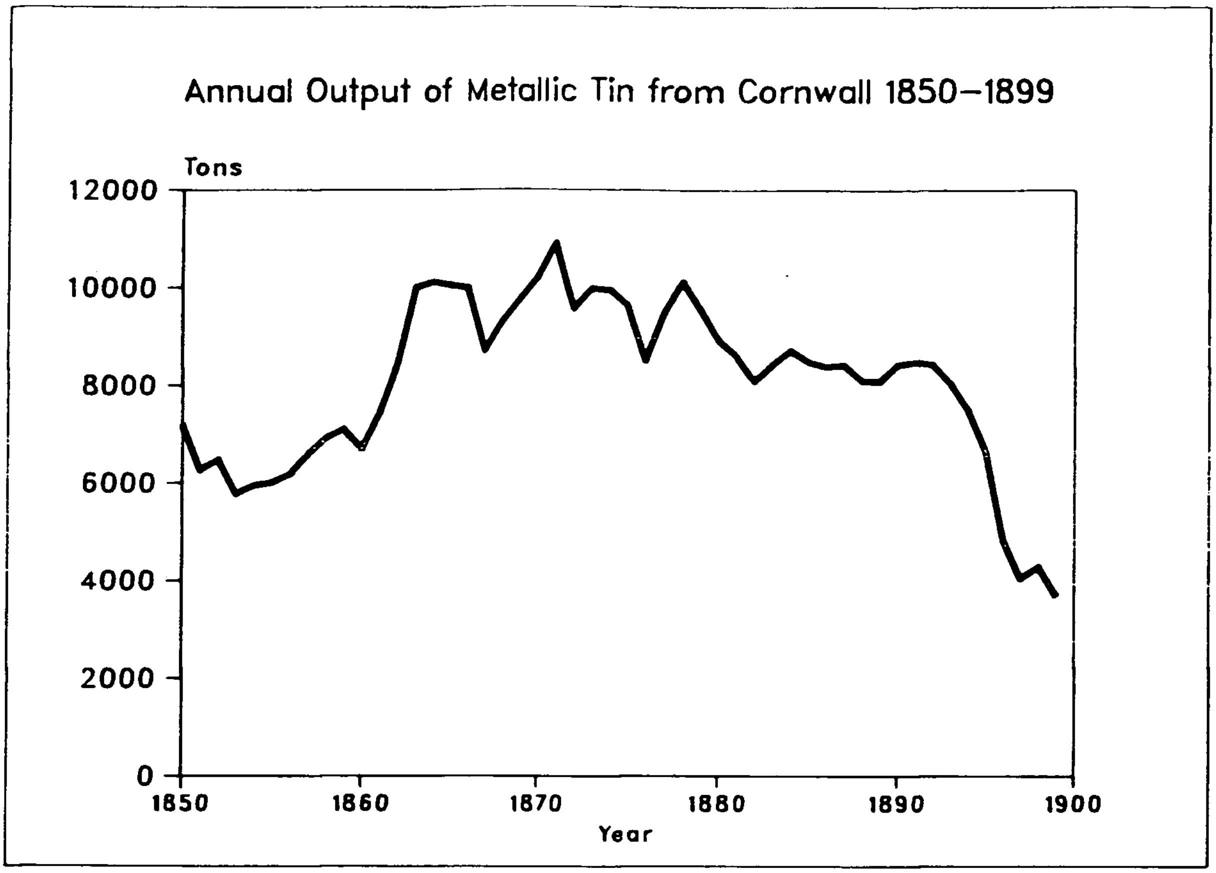
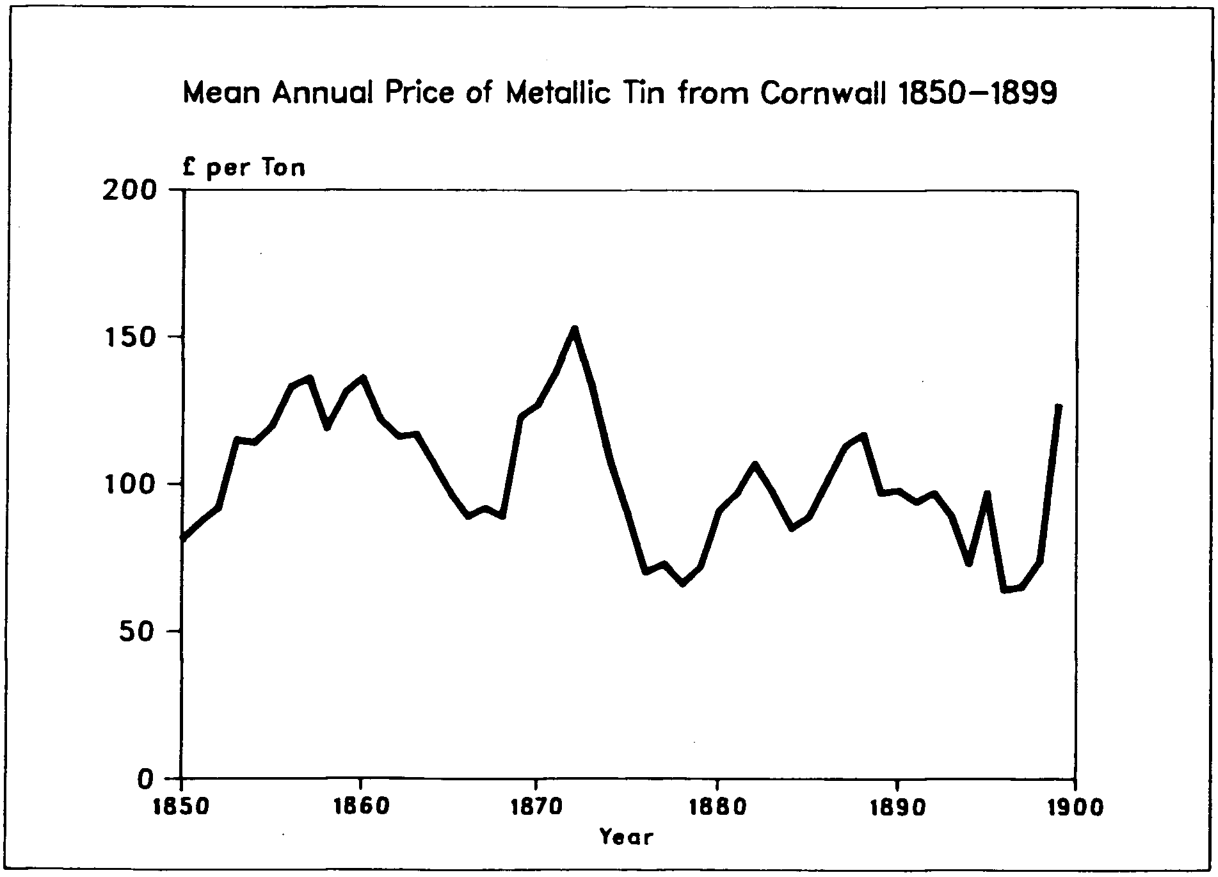

Annual Output of Tin from Cornwall 1800–1846
Tons
8000
6000
4000
2000
0
1800
1810
1820
1830
1840
1850
Year
Mean Annual Price of Metallic Tin from Cornwall 1800–1849
£ per Ton
200
150
100
50
0
1800
1810
1820
1830
1840
1850
Year

Fig. 3.11

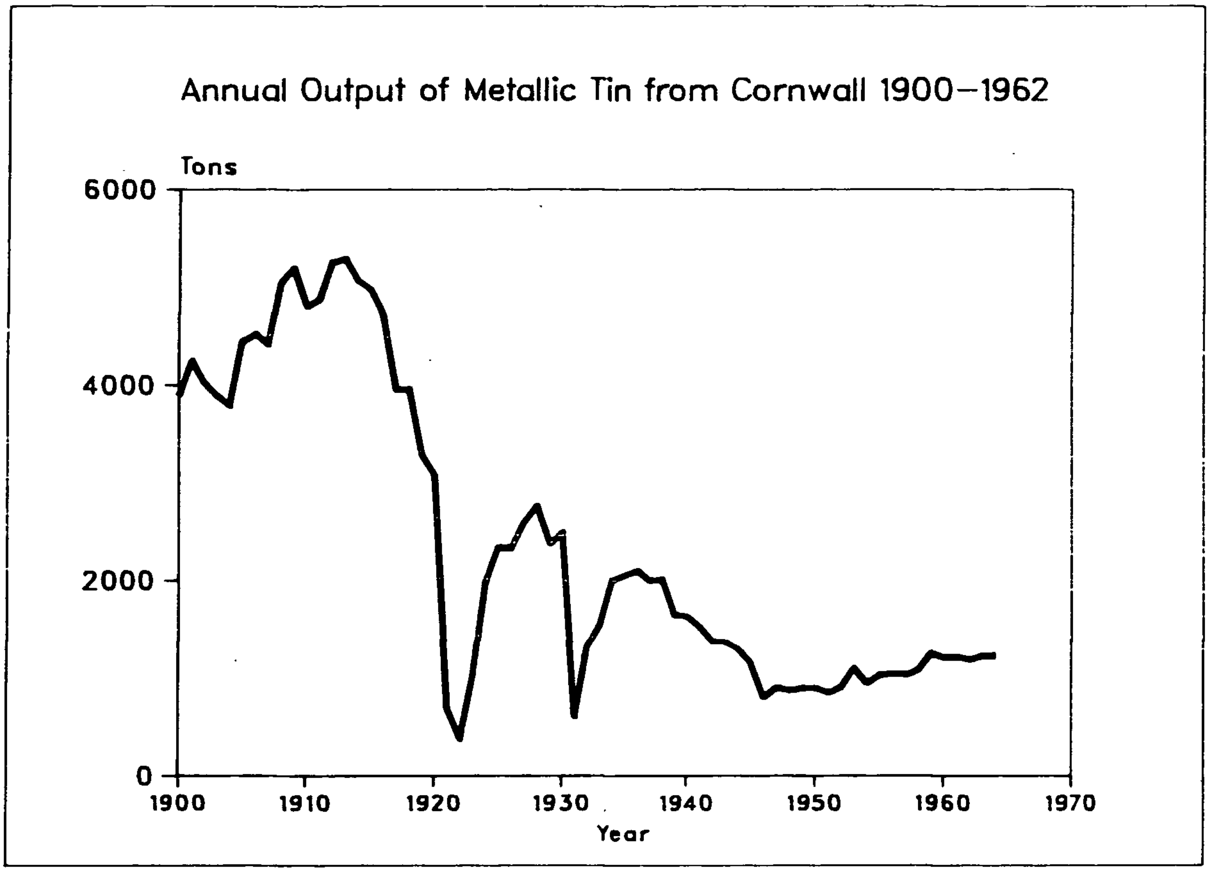


Annual Output of Metallic Tin from Cornwall 1850–1899



Mean Annual Price of Metallic Tin from Cornwall 1850–1899

Fig. 3.12


Annual Output of Metallic Tin from Cornwall 1900–1962
Tons
6000
4000
2000
0
1900
1910
1920
1930
1940
1950
1960
1970
Year

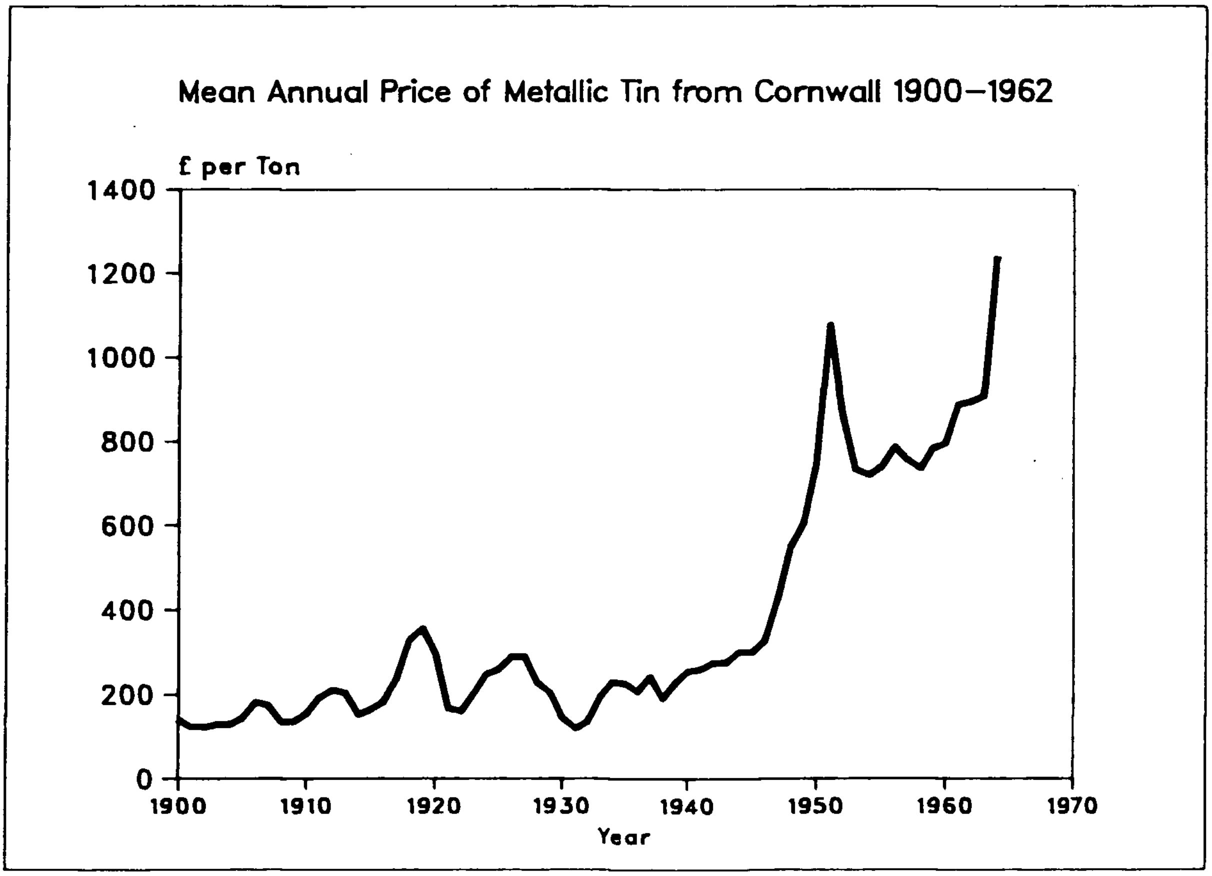

Mean Annual Price of Metallic Tin from Cornwall 1900–1962
£ per Ton
1400
1200
1000
800
600
400
200
0
1900
1910
1920
1930
1940
1950
1960
1970
Year

Fig. 3.13

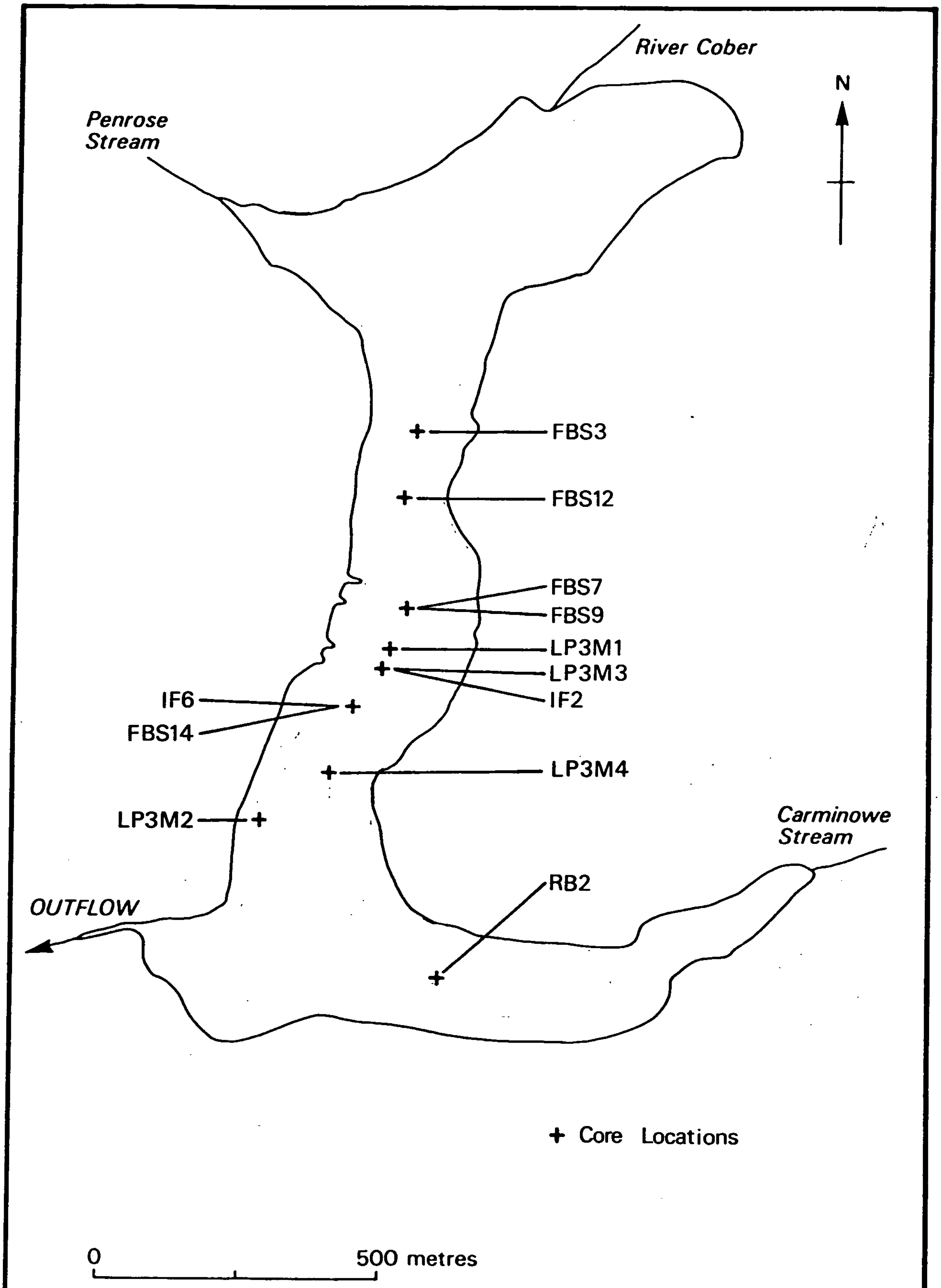
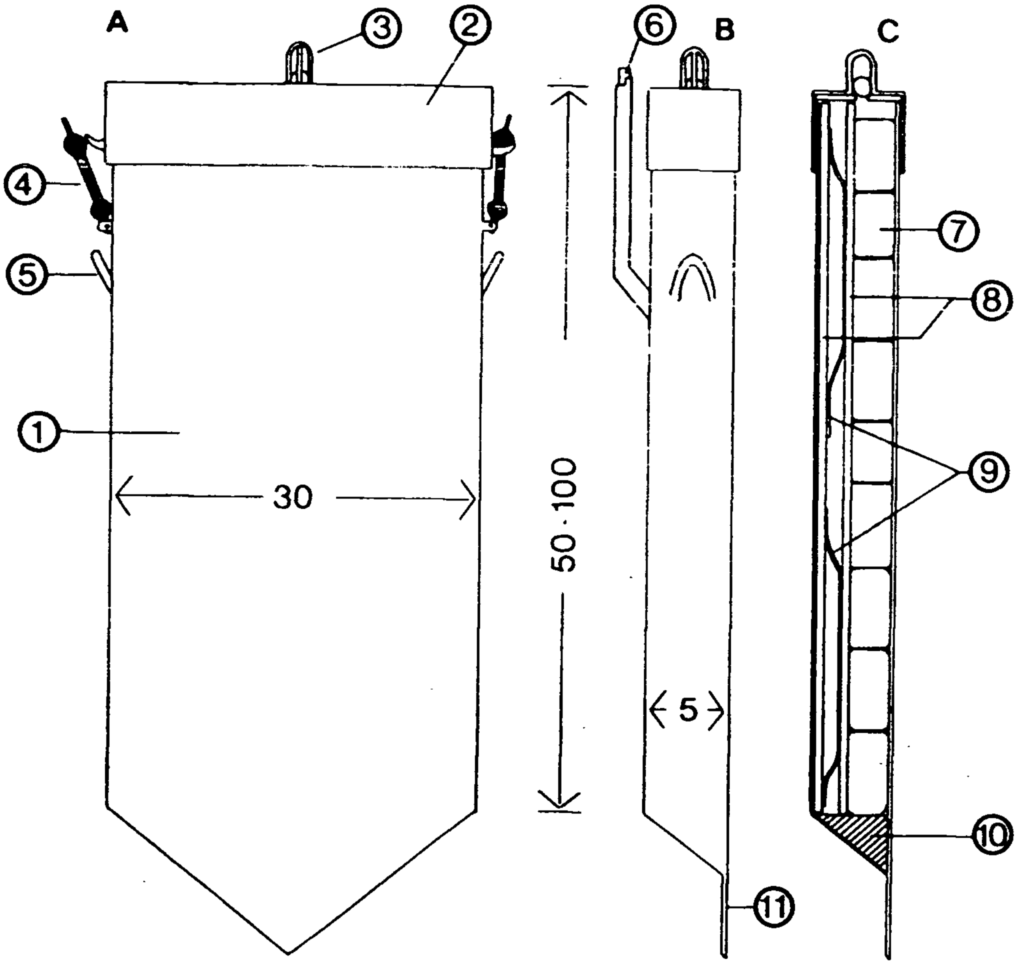

River Cober
N
Penrose Stream
FBS3
FBS12
FBS7
FBS9
LP3M1
LP3M3
IF2
IF6
FBS14
LP3M4
LP3M2
Carminowe Stream
RB2
OUTFLOW
+ Core Locations
0
500 metres

Fig. 4.1



Key:

A: Front view; 1. sampling face, 2. Lid, 3. Ball valve to allow venting of excess CO_2, 4. Clips attach lid, 5. Steel loops to attach ropes.

B: Side view; 6. Point of attachment for rods.

C: Lateral section; 7. 'Dry Ice', solid CO_2 (the pelleted form was used in this study), 8. Plywood pressure plate, 9. Flat springs made of spring steel, 10. Lead weight, 11. Keel.

Fig. 4.2: The type of Box Freezer used in this study to sample the sediments of Loe Pool. The diagram is taken from Huttunen & Merilänen (1978).

Fig. 4.2

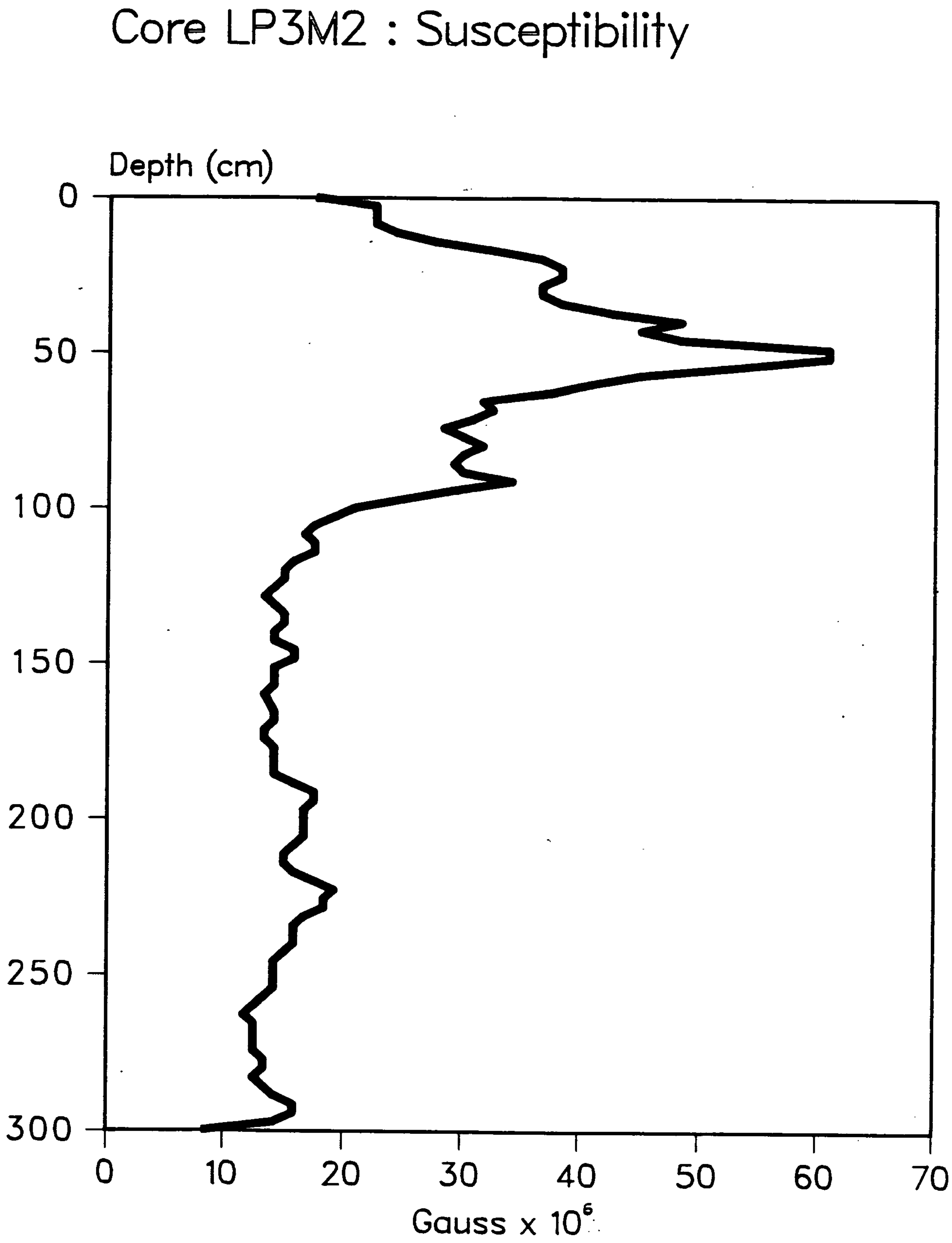

Core LP3M2 : Susceptibility
Depth (cm)
0
50
100
150
200
250
300
0
10
20
30
40
50
60
70
Gauss x 10^6

Fig. 5.1

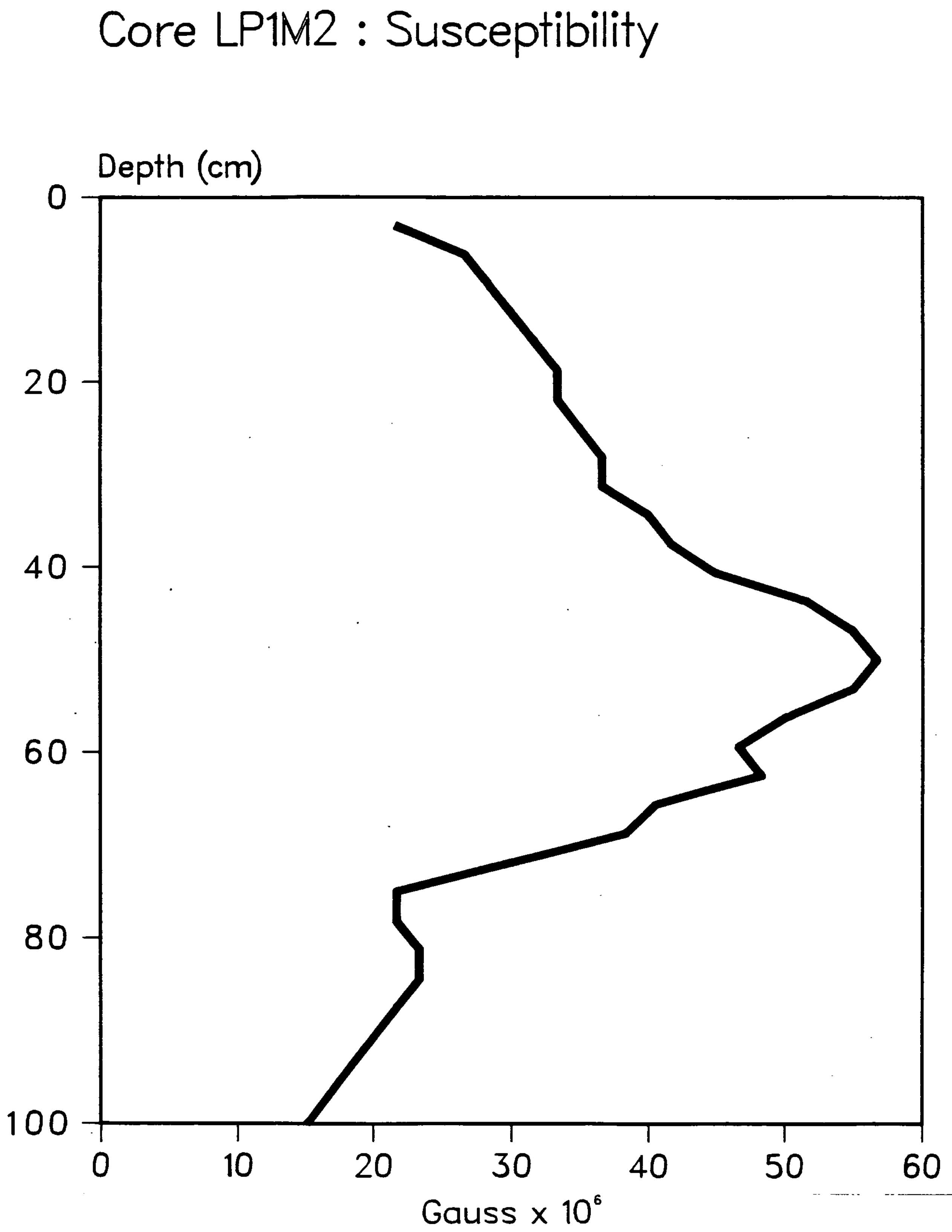

Core LP1M2 : Susceptibility
Depth (cm)
0
20
40
60
80
100
0
10
20
30
40
50
60
Gauss x 10⁶

Fig. 5.2

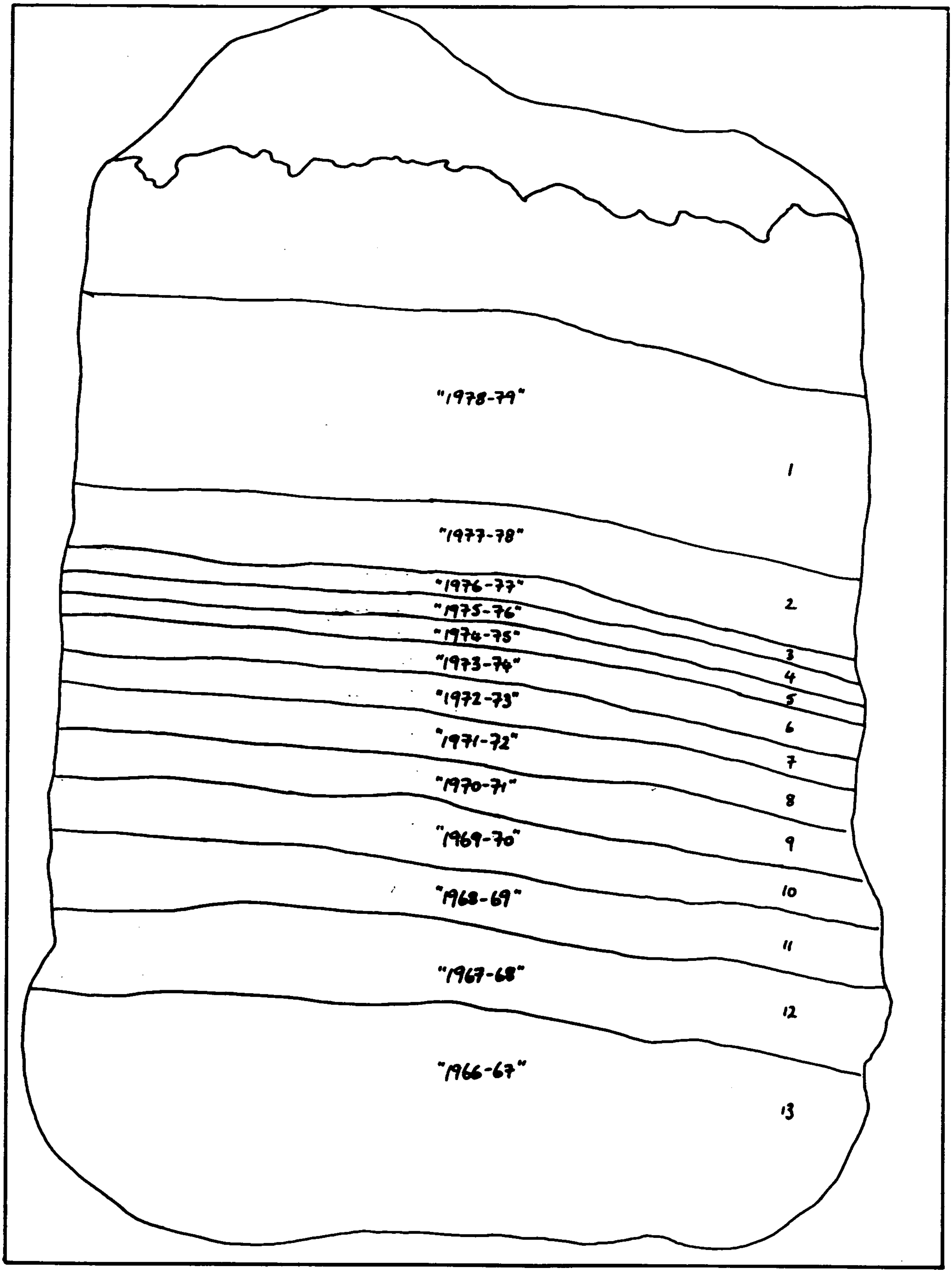


Fig. 5.3: Core FBS7 (See also overlay on Plate 5.2).The core was divided into a number of subsamples for Cs-137 analysis. The divisions were based on what were initially thought to be annual laminations and were derived from the alternating black and brown bands within the sediment.

Fig. 5.3

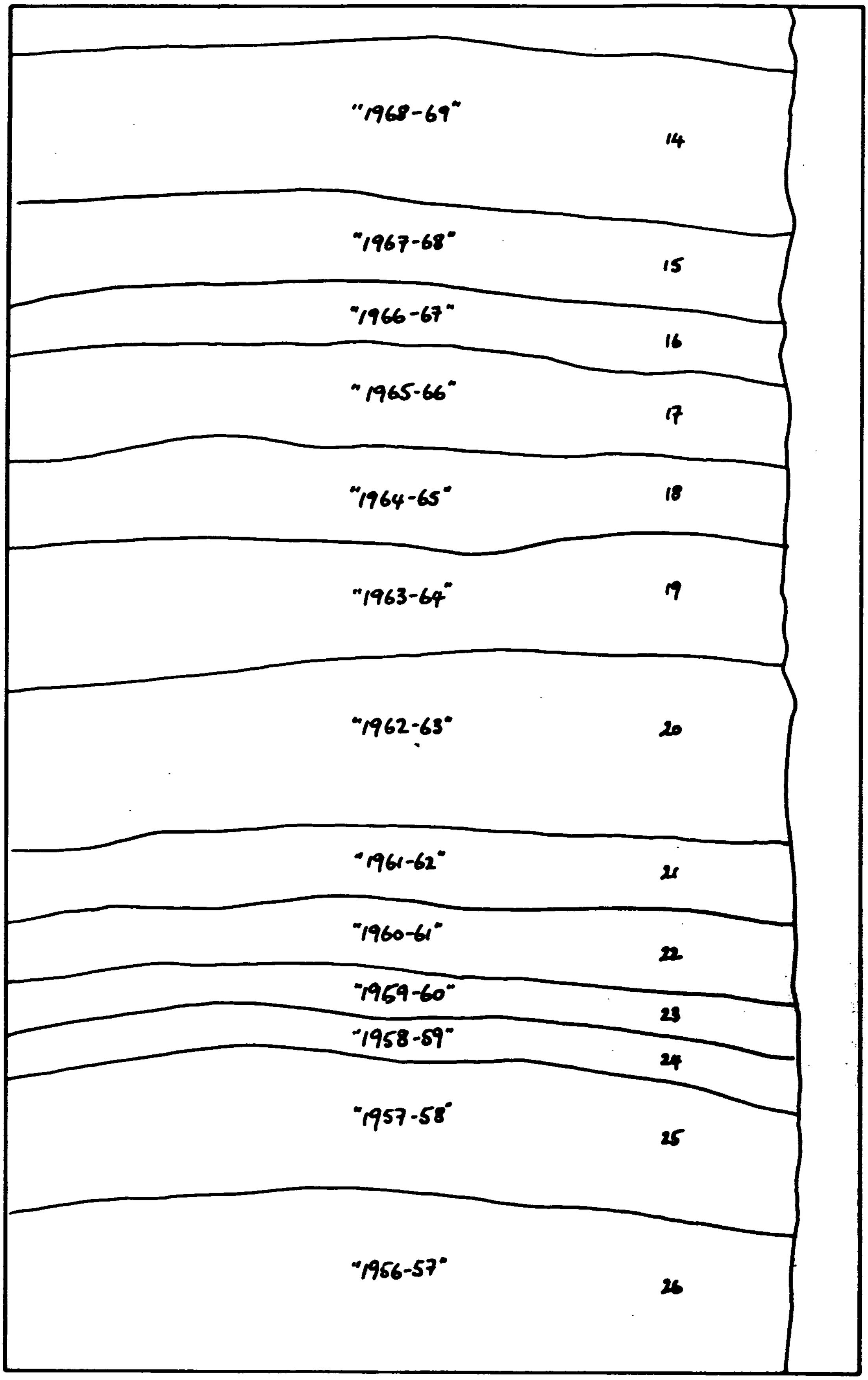


Fig. 5.4: Core FBS9 (See also overlay on Plate 5.3). The diagram shows the lines of division, the supposed dating of the subsamples for Cs-137 analysis, and the subsample numbers.

Fig. 5.4

Loe Pool Sample FBS7
Cs–137 analysis

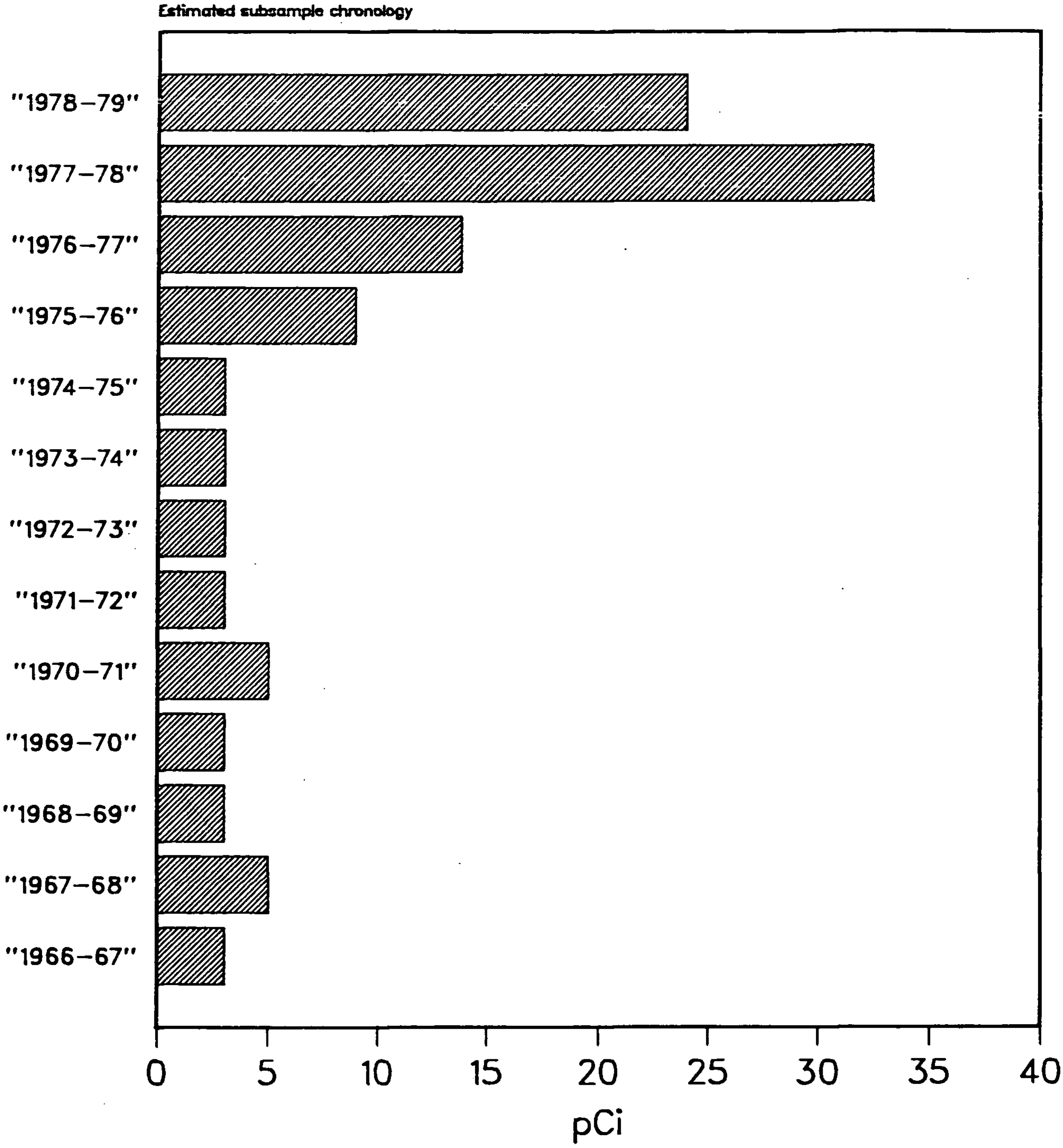


Fig. 5.5

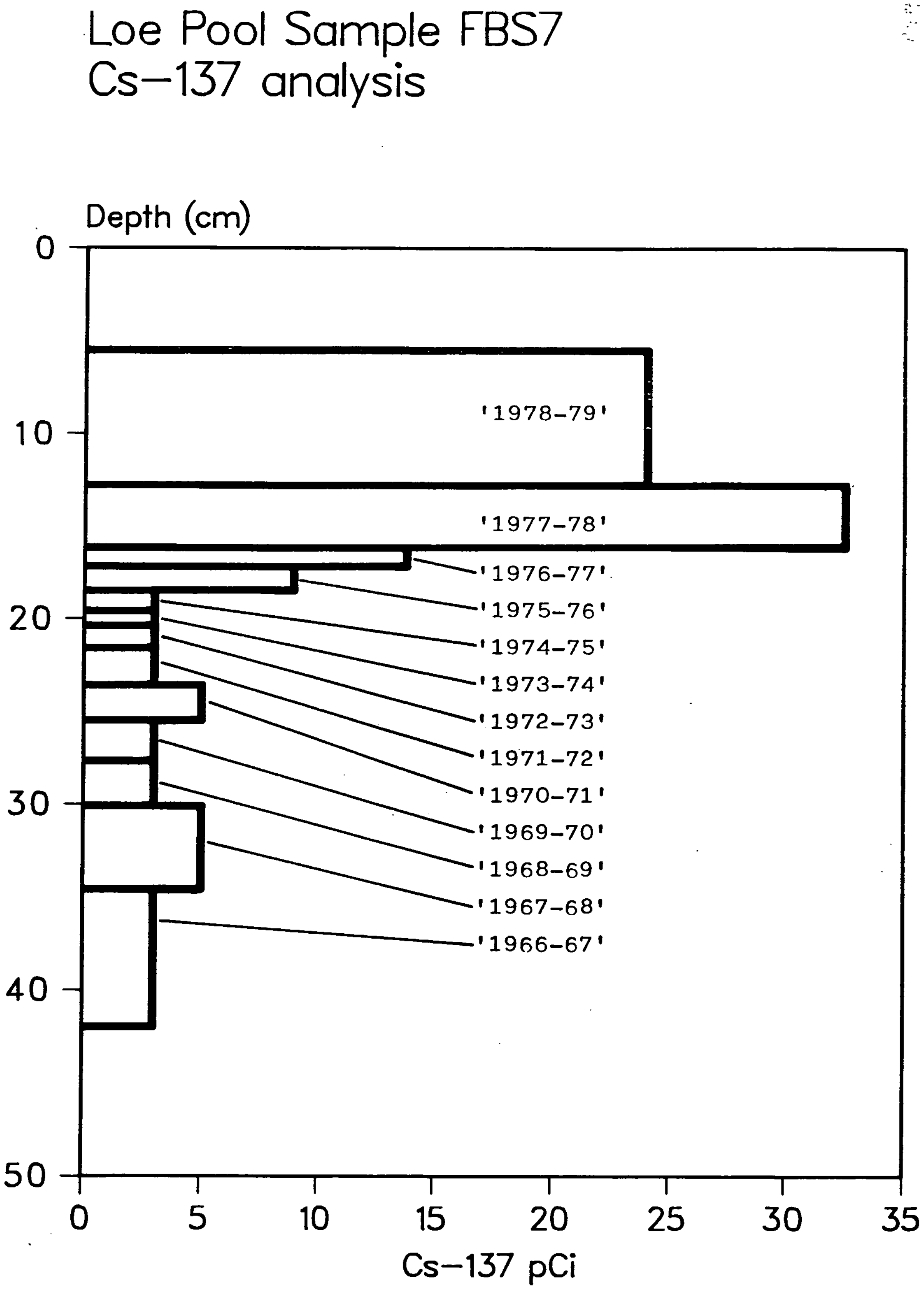
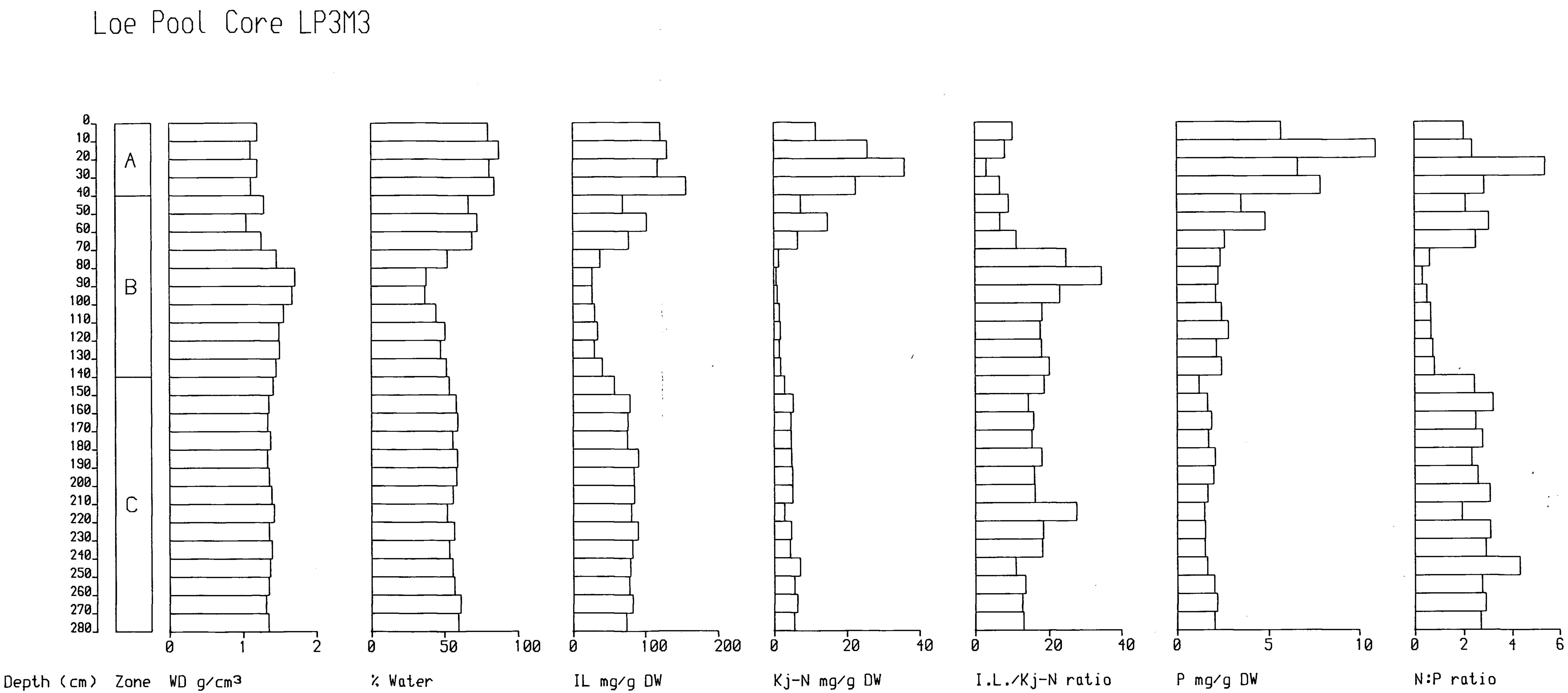

Loe Pool Sample FBS7
Cs–137 analysis
Depth (cm)
0
10
20
30
40
50
'1978-79'
'1977-78'
'1976-77'
'1975-76'
'1974-75'
'1973-74'
'1972-73'
'1971-72'
'1970-71'
'1969-70'
'1968-69'
'1967-68'
'1966-67'
0
5
10
15
20
25
30
35
Cs–137 pCi

Fig. 5.6



Loe Pool Core LP3M3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
A
B
C
0 1 2
0 50 100
0 100 200
0 20 40
0 20 40
0 5 10
0 2 4 6
Depth (cm)
Zone
WD g/cm³
% Water
IL mg/g DW
Kj-N mg/g DW
I.L./Kj-N ratio
P mg/g DW
N:P ratio

Fig. 6.1

Loe Pool Core LP3M3

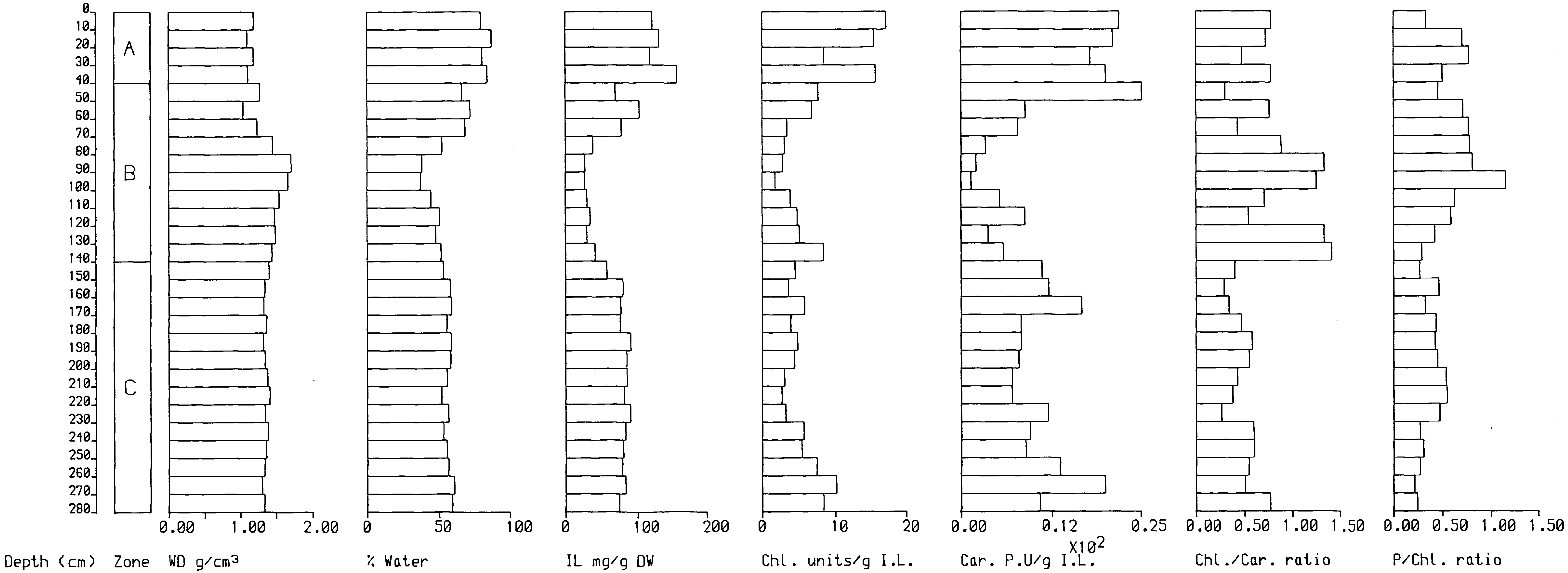


Fig. 6.2

Loe Pool Core LP3M3

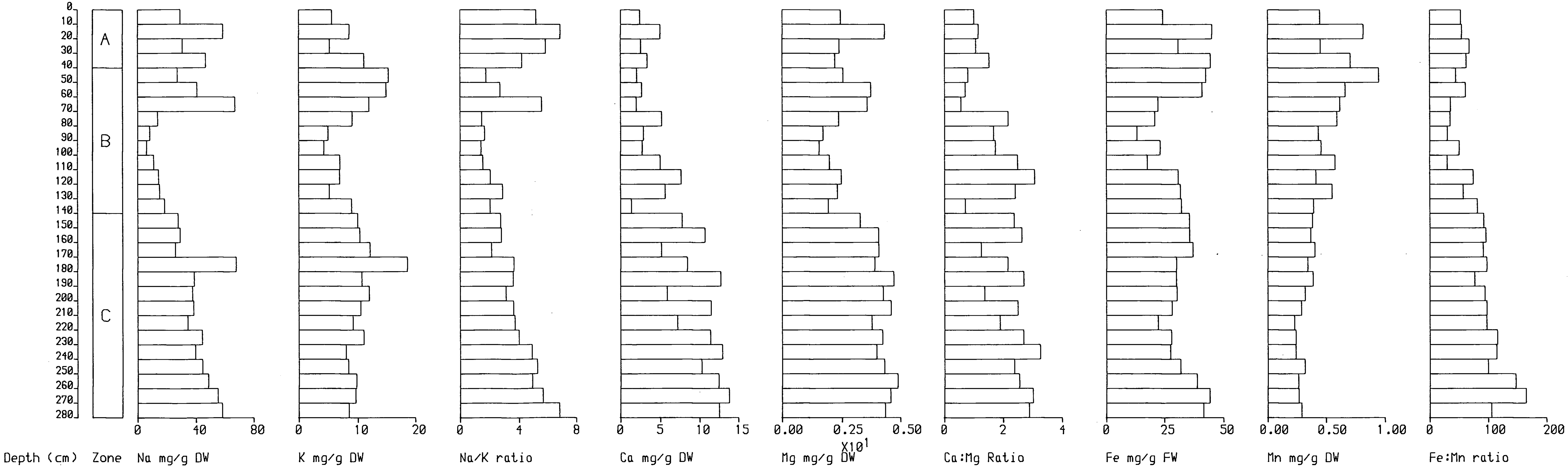
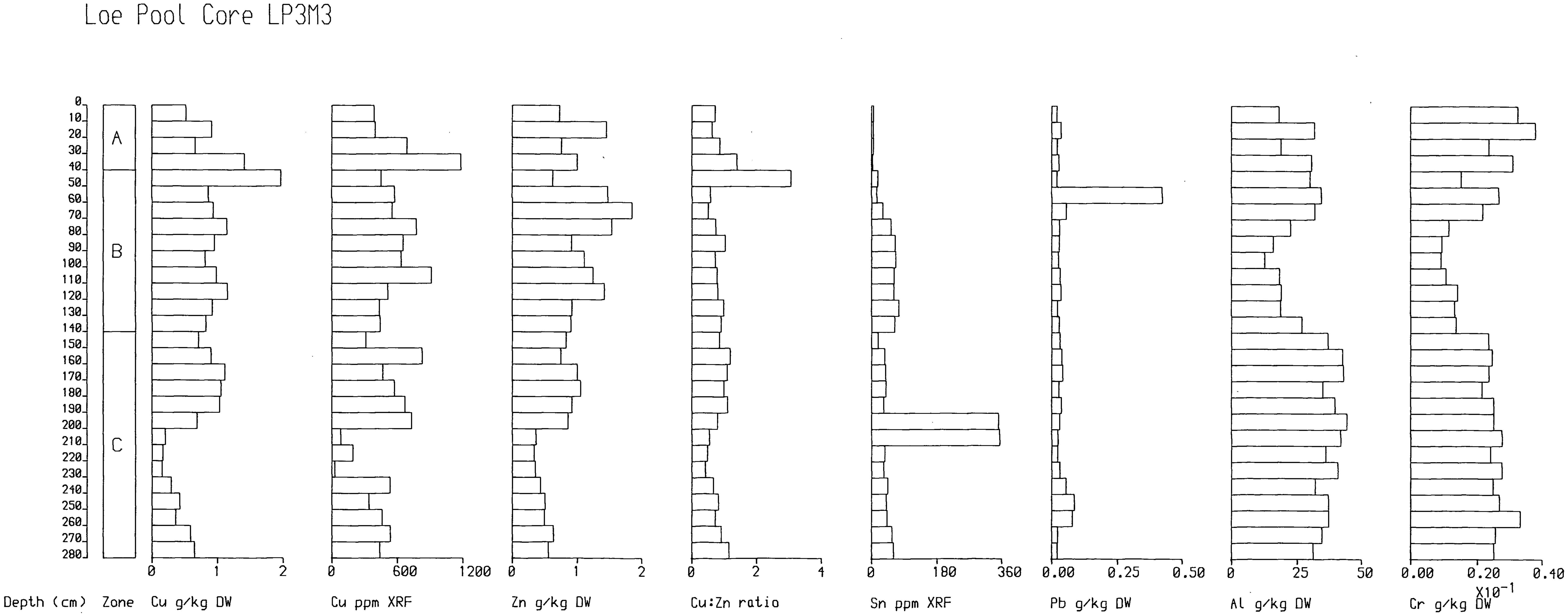


Fig. 6.3



Loe Pool Core LP3M3

Fig. 6.4

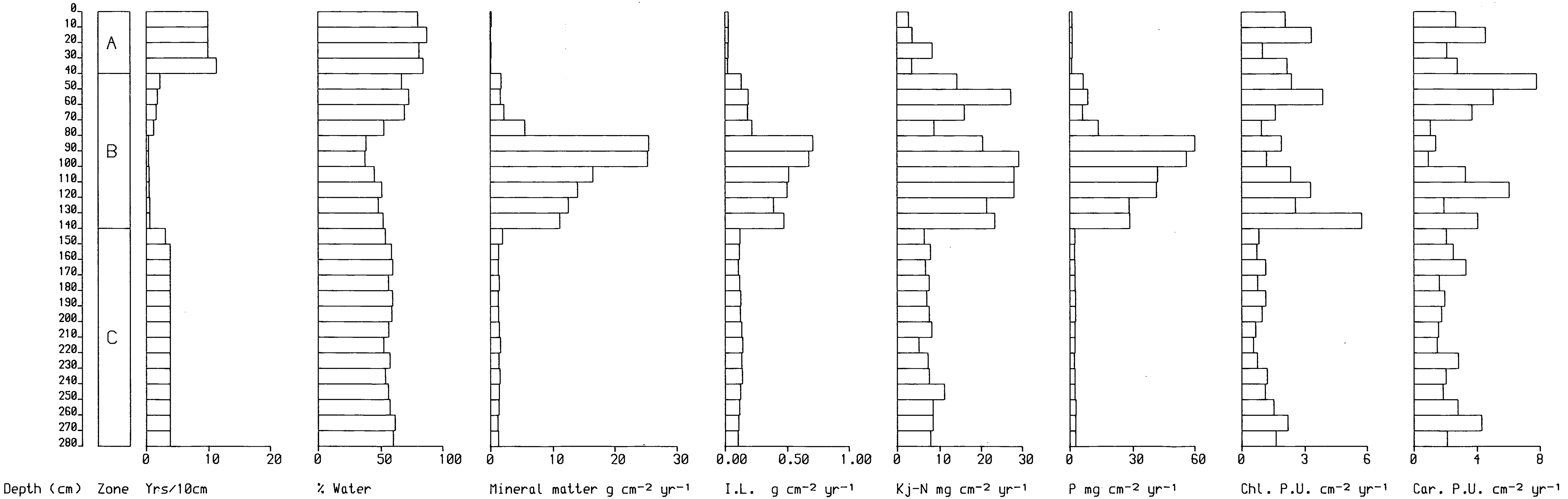

Loe Pool Core LP3M3

Fig. 6.5

Loe Pool Core LP3M3

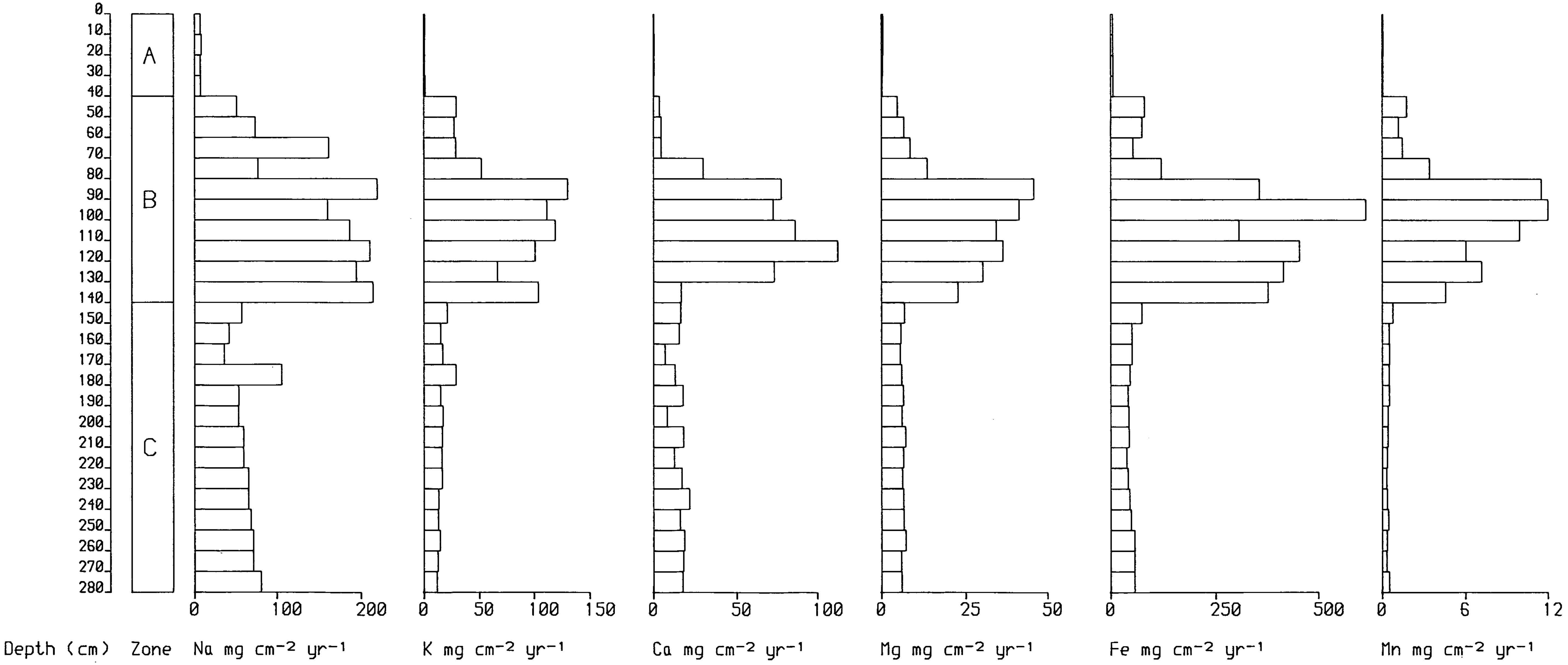


Fig. 6.6

Loe Pool Core LP3M3

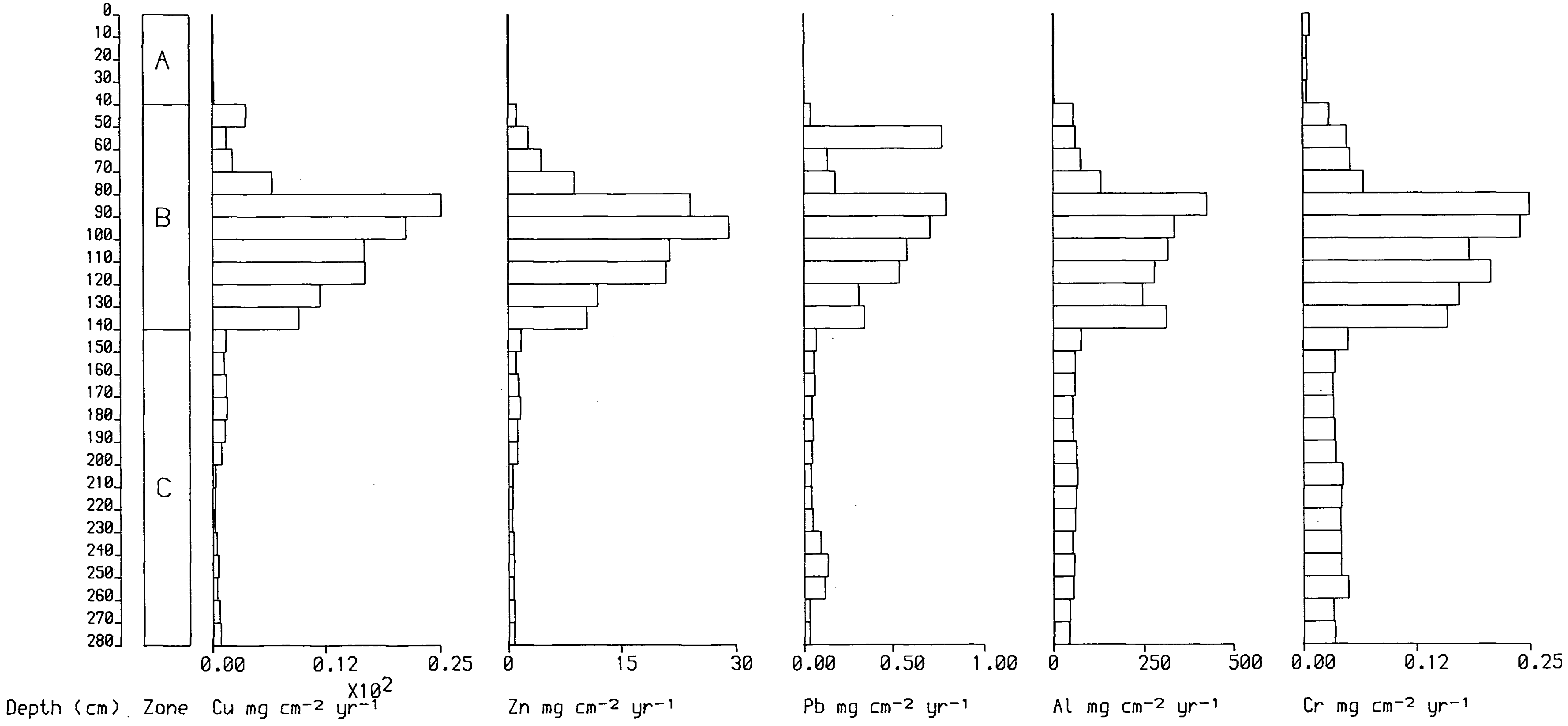


Fig. 6.7

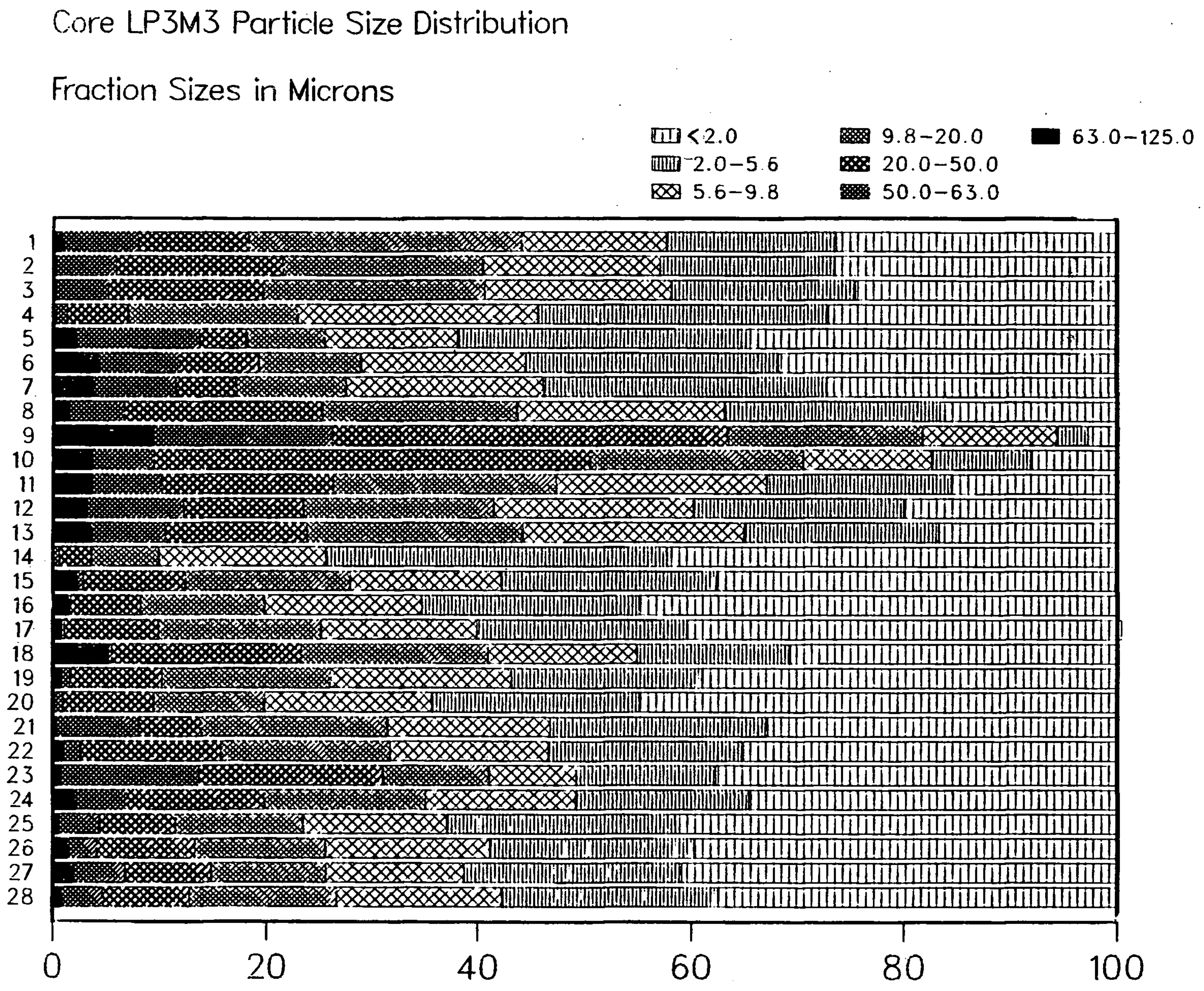

Core LP3M3 Particle Size Distribution
Fraction Sizes in Microns
<2.0
2.0-5.6
5.6-9.8
9.8-20.0
20.0-50.0
50.0-63.0
63.0-125.0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
0
20
40
60
80
100

Fig. 6.8

Fig. 6.8

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 **S.01**

Grid Ref. : Loe Pool

Date :

Name : Martin Coard

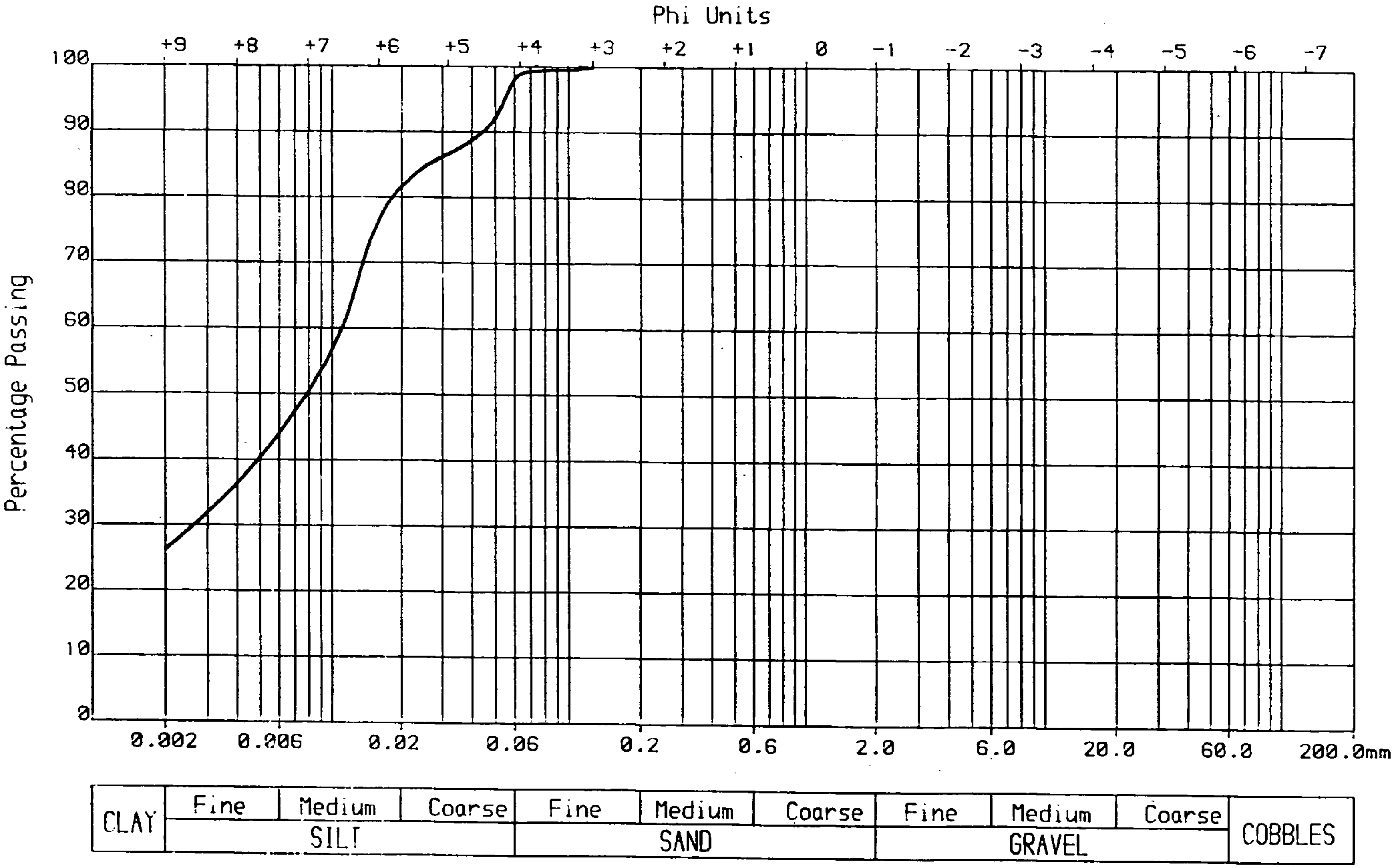


Fig. 6.9

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 **S.02**

Grid Ref. : Loe Pool

Date :

Name : Martin Coard

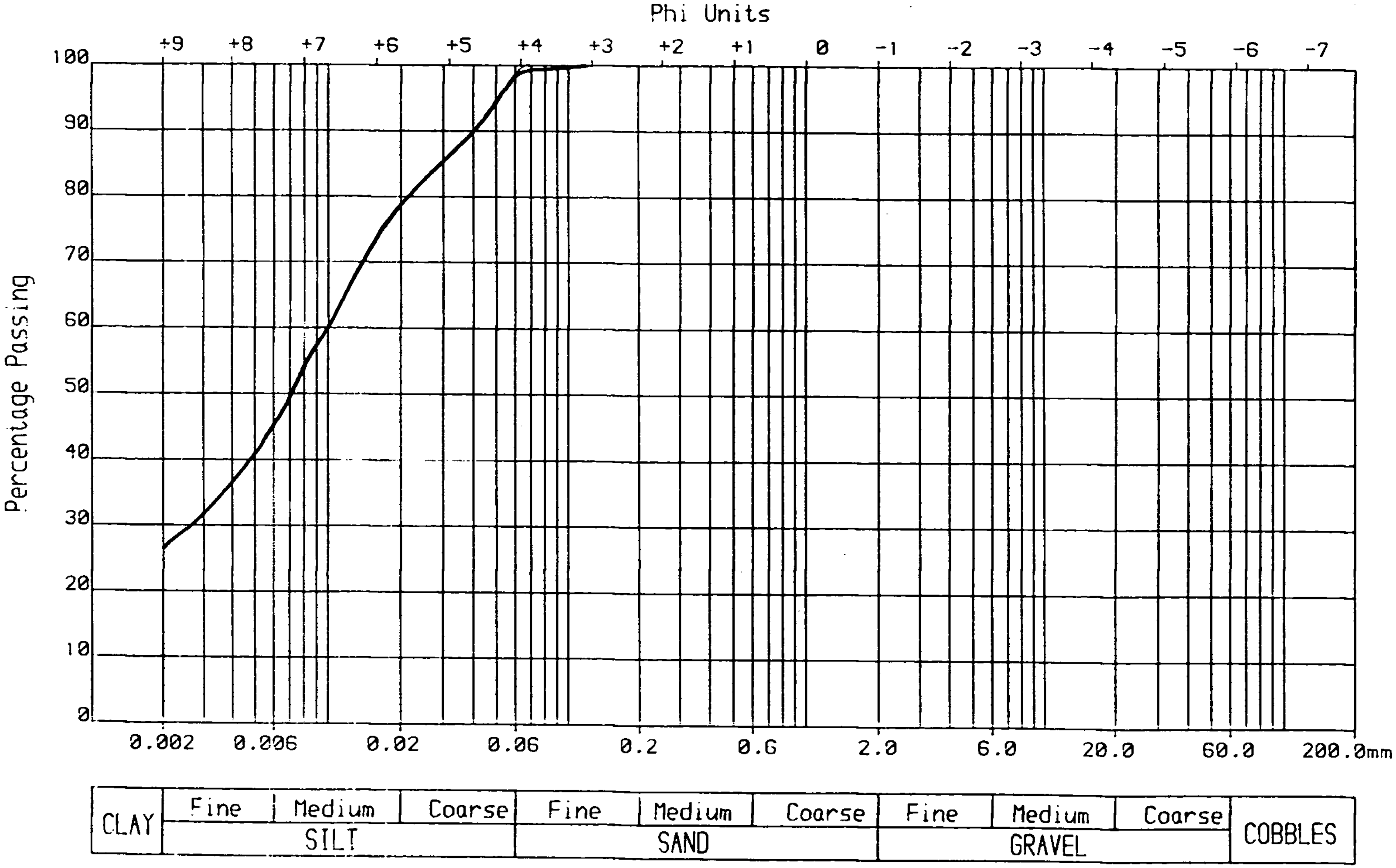


Fig. 6.10

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 **S.03**

Date :

Grid Ref. : Loe Pool

Name : Martin Coord

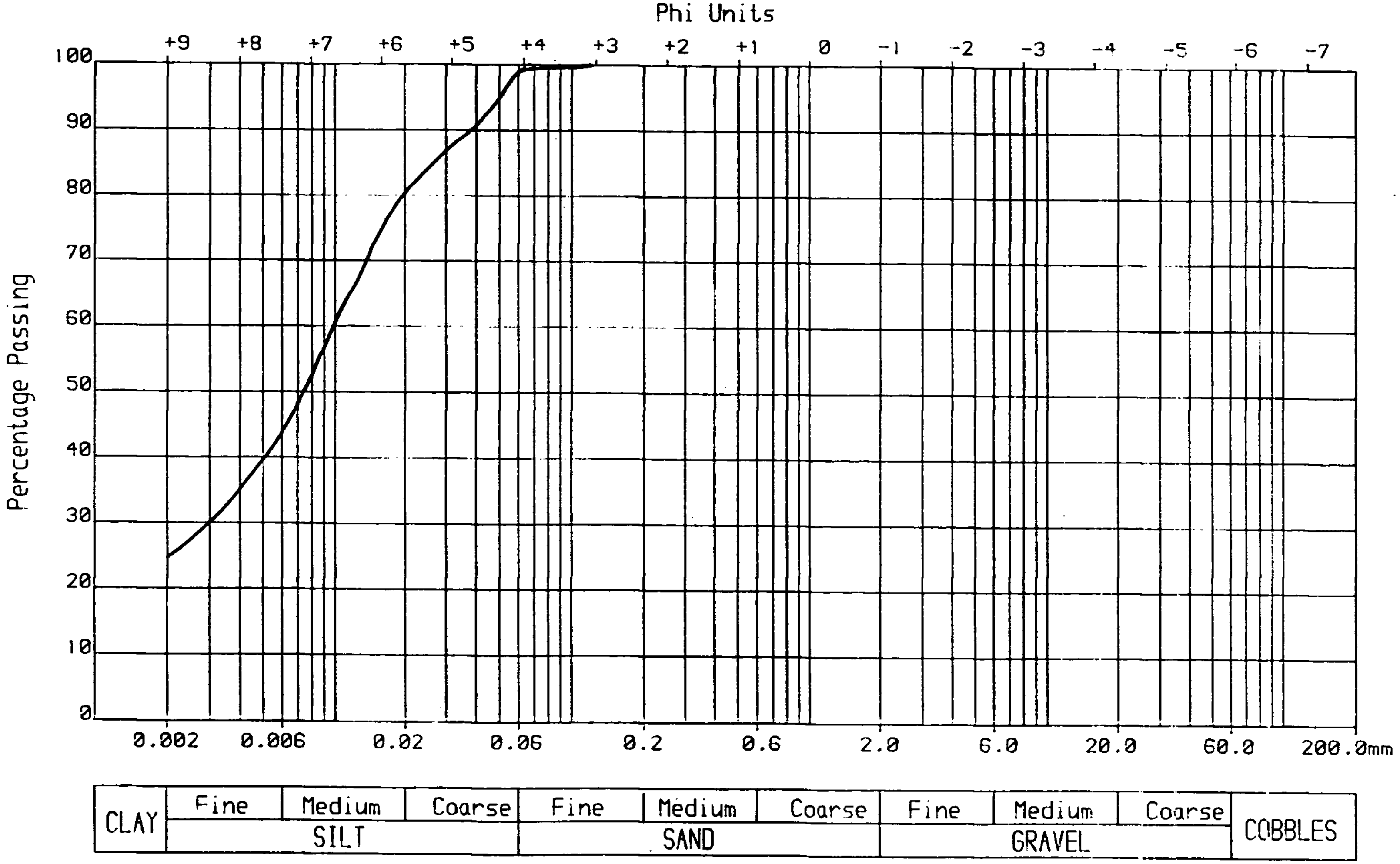


Fig. 6.11

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 **S.04**

Grid Ref. : Loe Pool

Date :

Name : Martin Coard

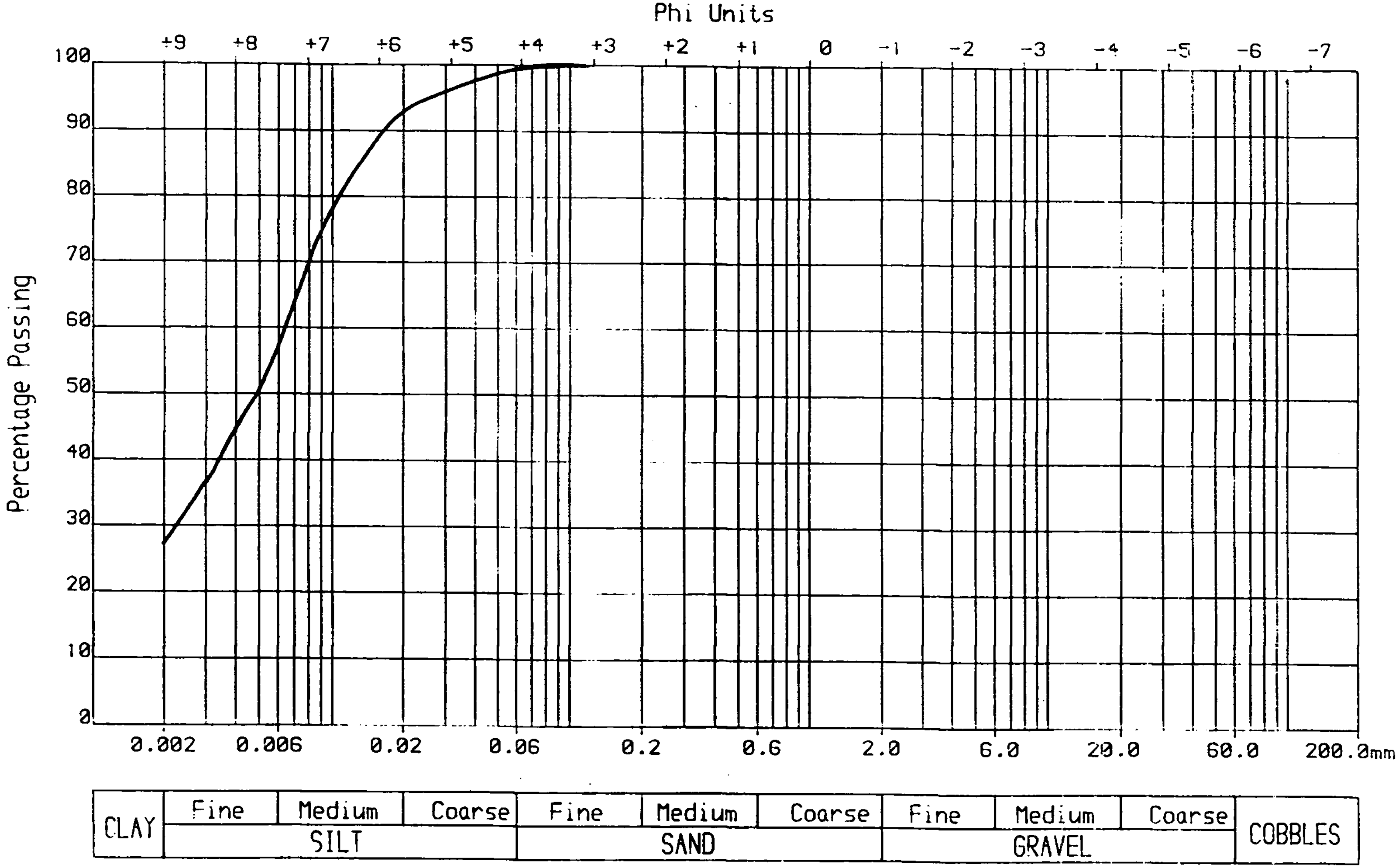


Fig. 6.12

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 **S.05**

Date :

Grid Ref. : Loe Pool

Name : Martin Coard

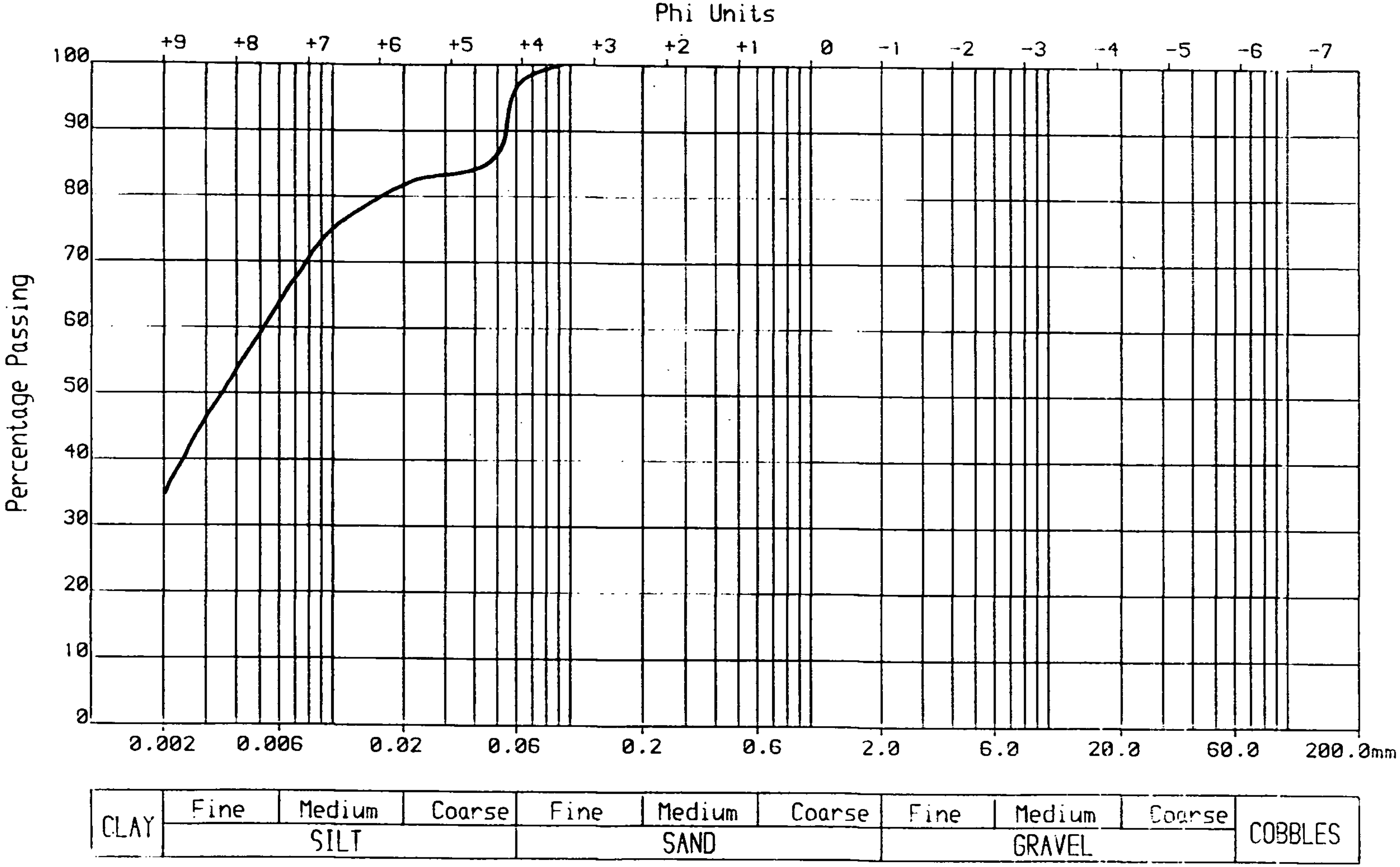


Fig. 6.13

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 **S.06**

Grid Ref. : Loe Pool

Date :

Name : Martin Coard

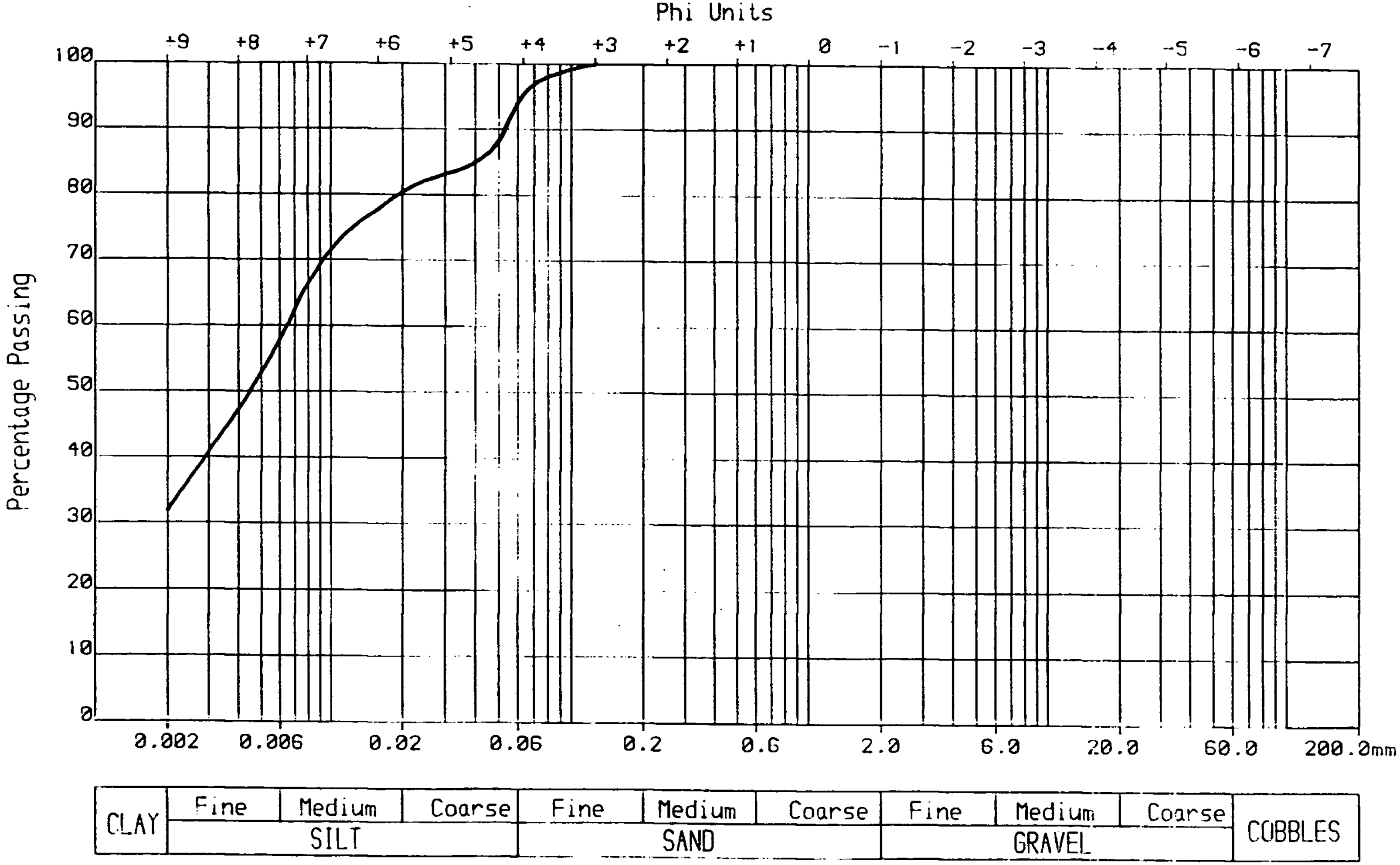


Fig. 6.14

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 **S.07**

Date :

Grid Ref. : Loe Pool

Name : Martin Coard

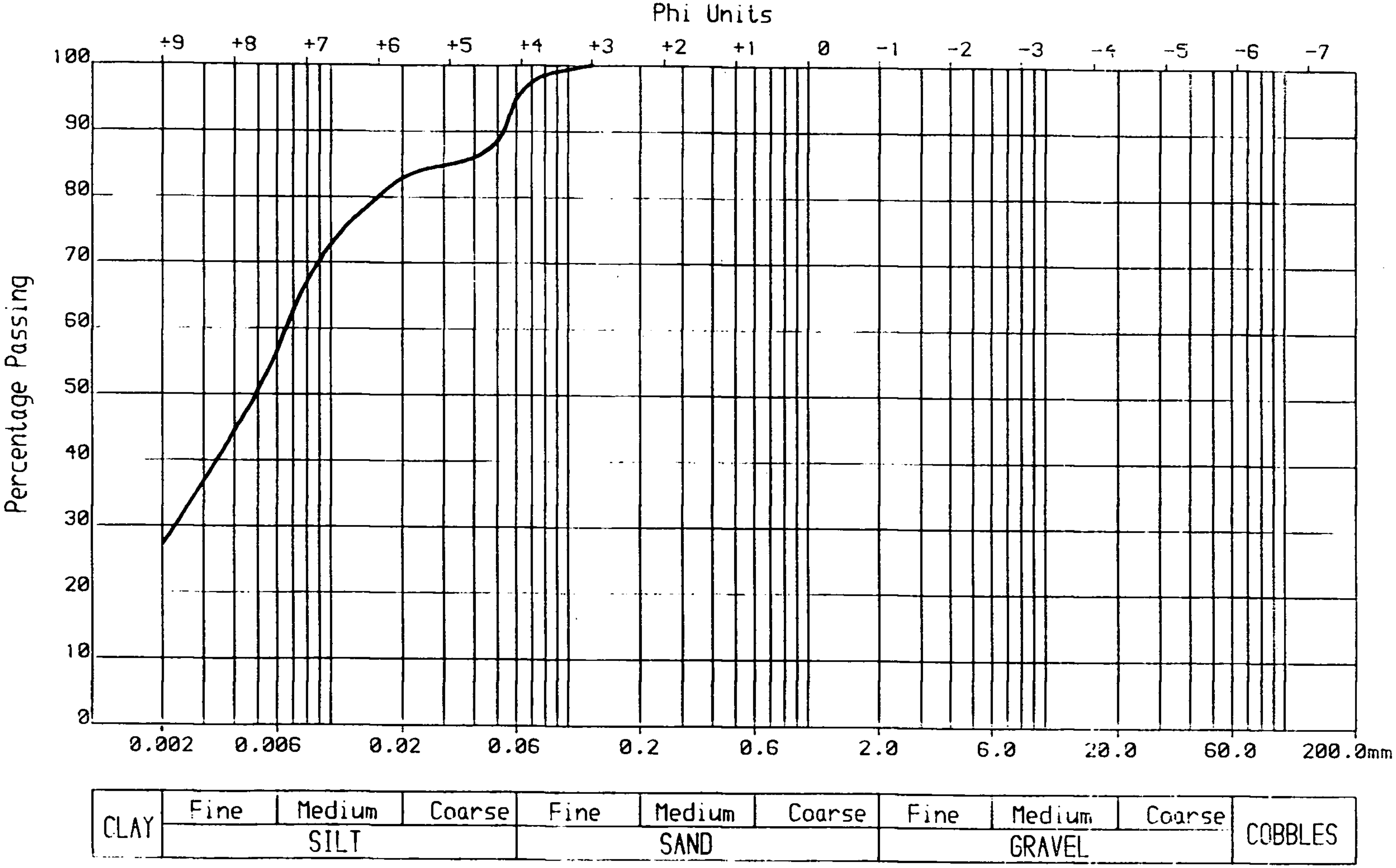


Fig. 6.15

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 **S.08**

Date :

Grid Ref. : Loe Pool

Name : Martin Coard

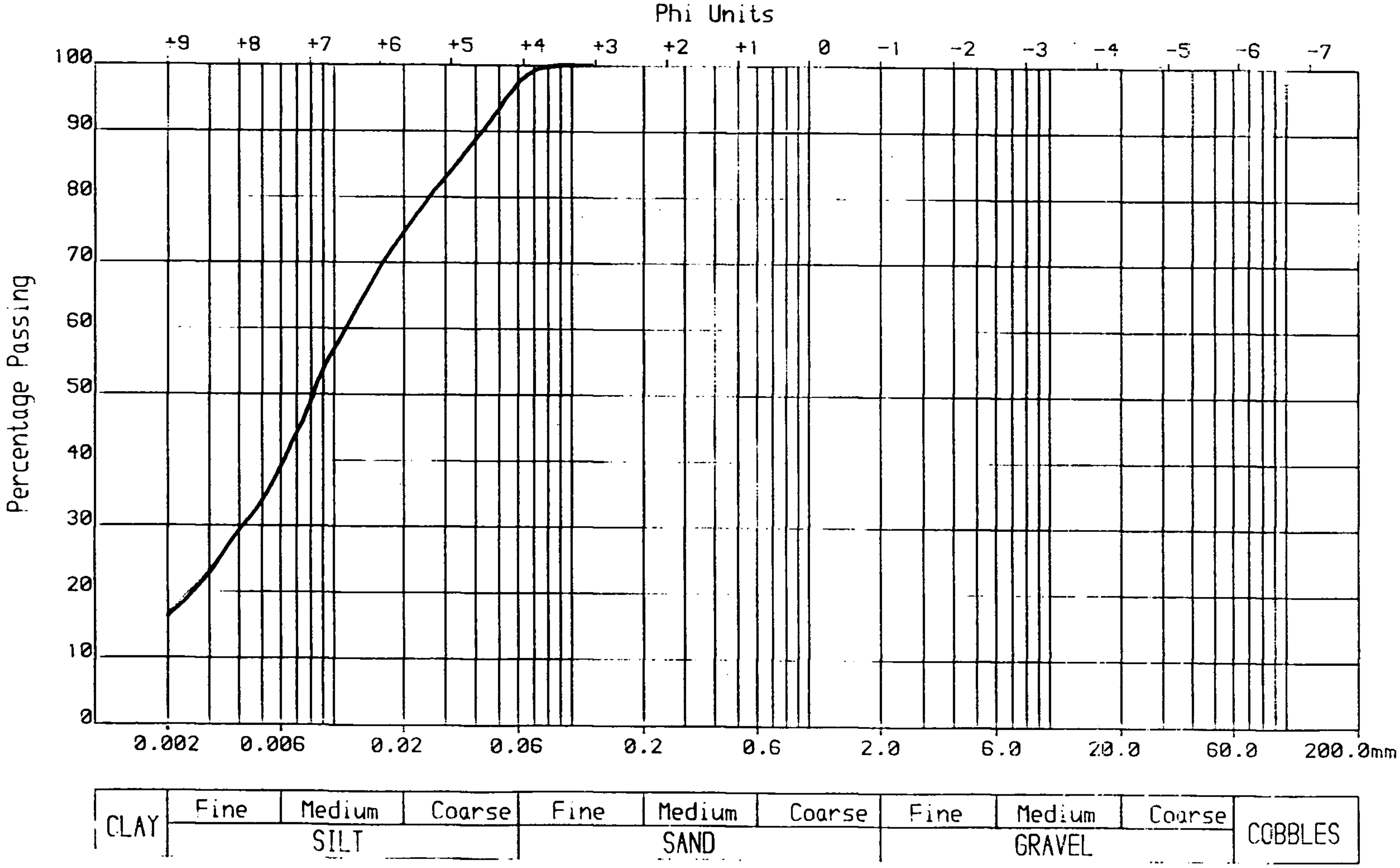


Fig. 6.16

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 **S.09**

Date :

Grid Ref. : Loe Pool

Name : Martin Coard

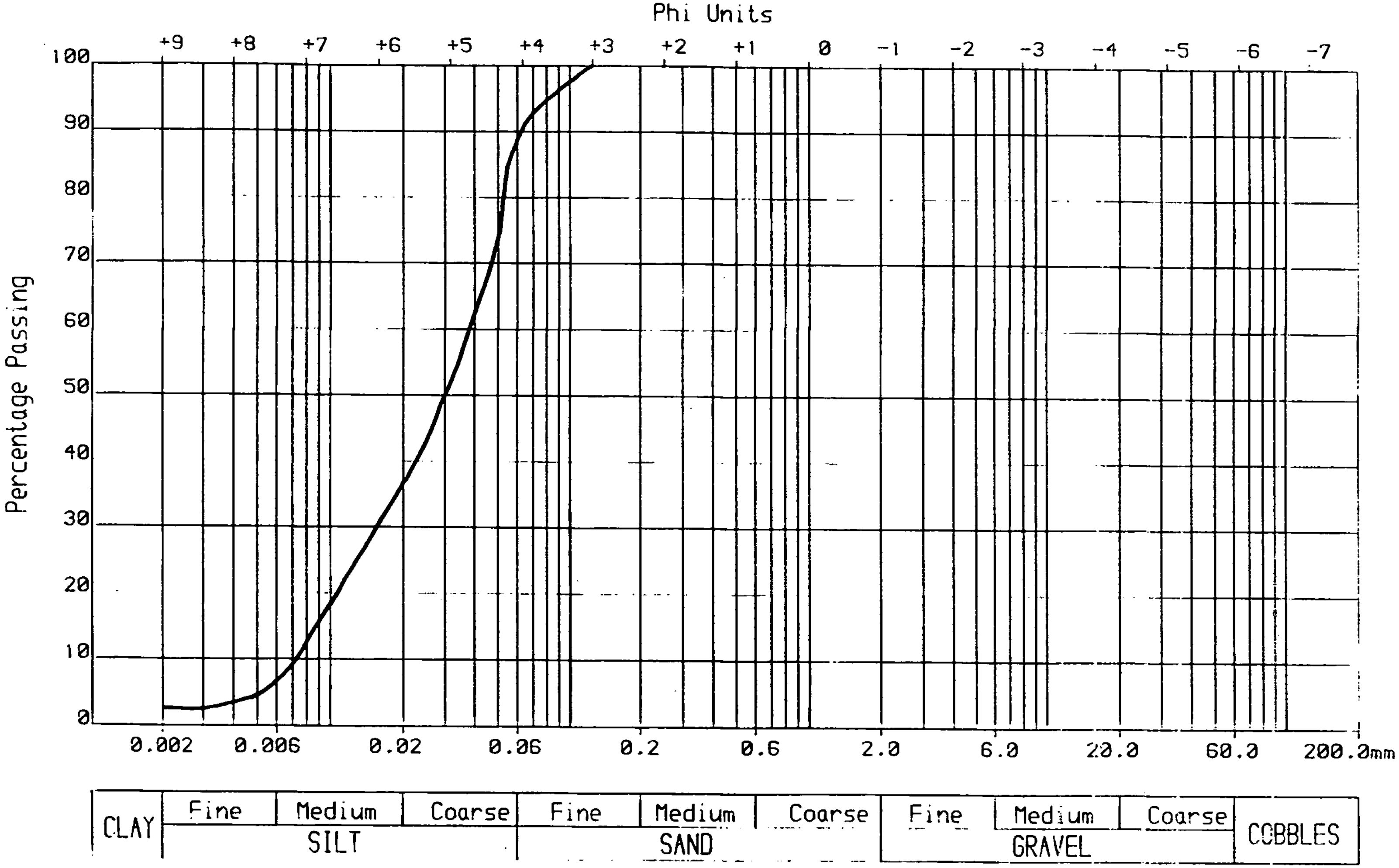


Fig. 6.17

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 **S.10**

Grid Ref. : Loe Pool

Date :

Name : Martin Coard

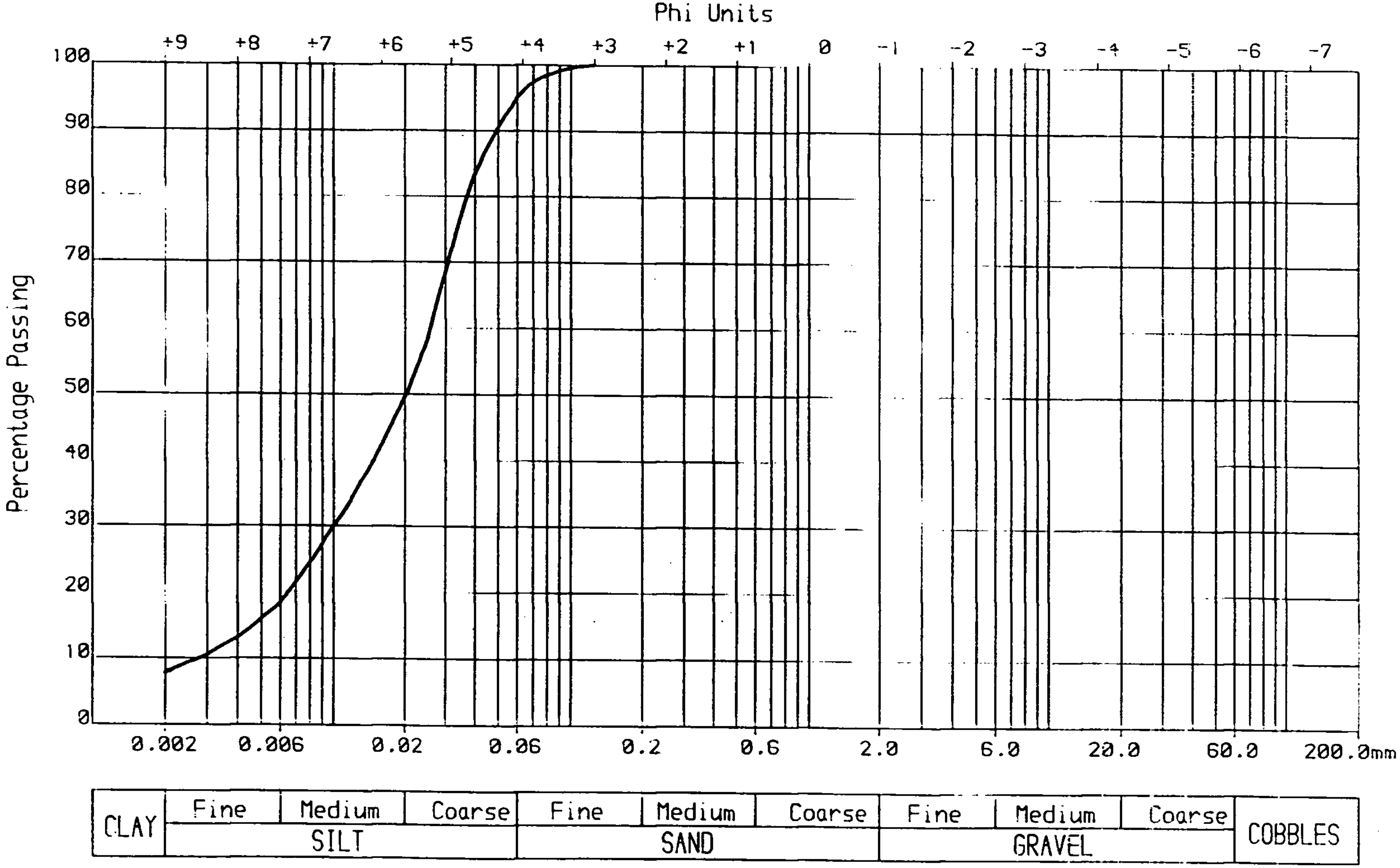


Fig. 6.18

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 **S.11**

Grid Ref. : Loe Pool

Date :

Name : Martin Coard

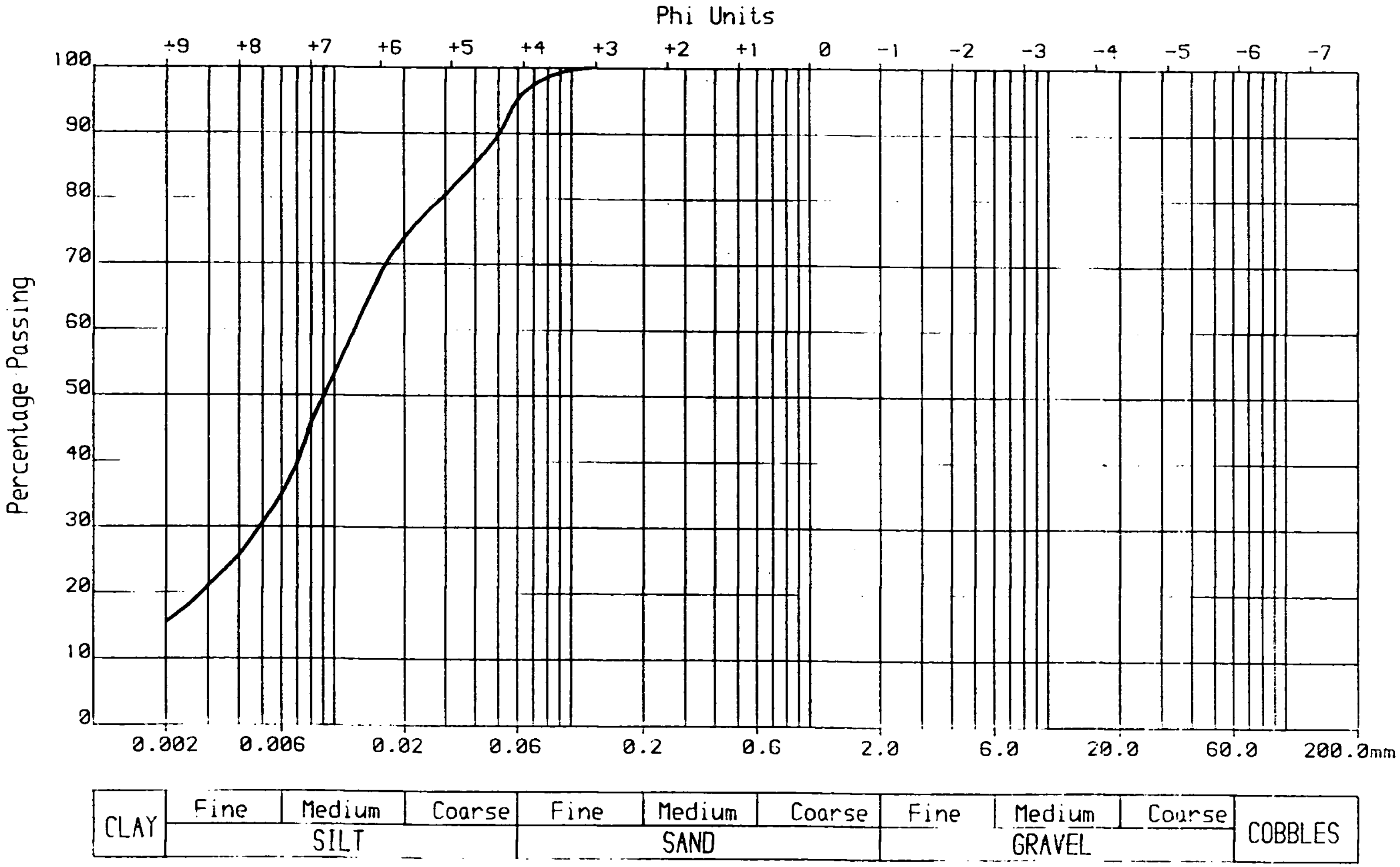


Fig. 6.19

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 **S.12**

Grid Ref. : Loe Pool

Date :

Name : Martin Coard

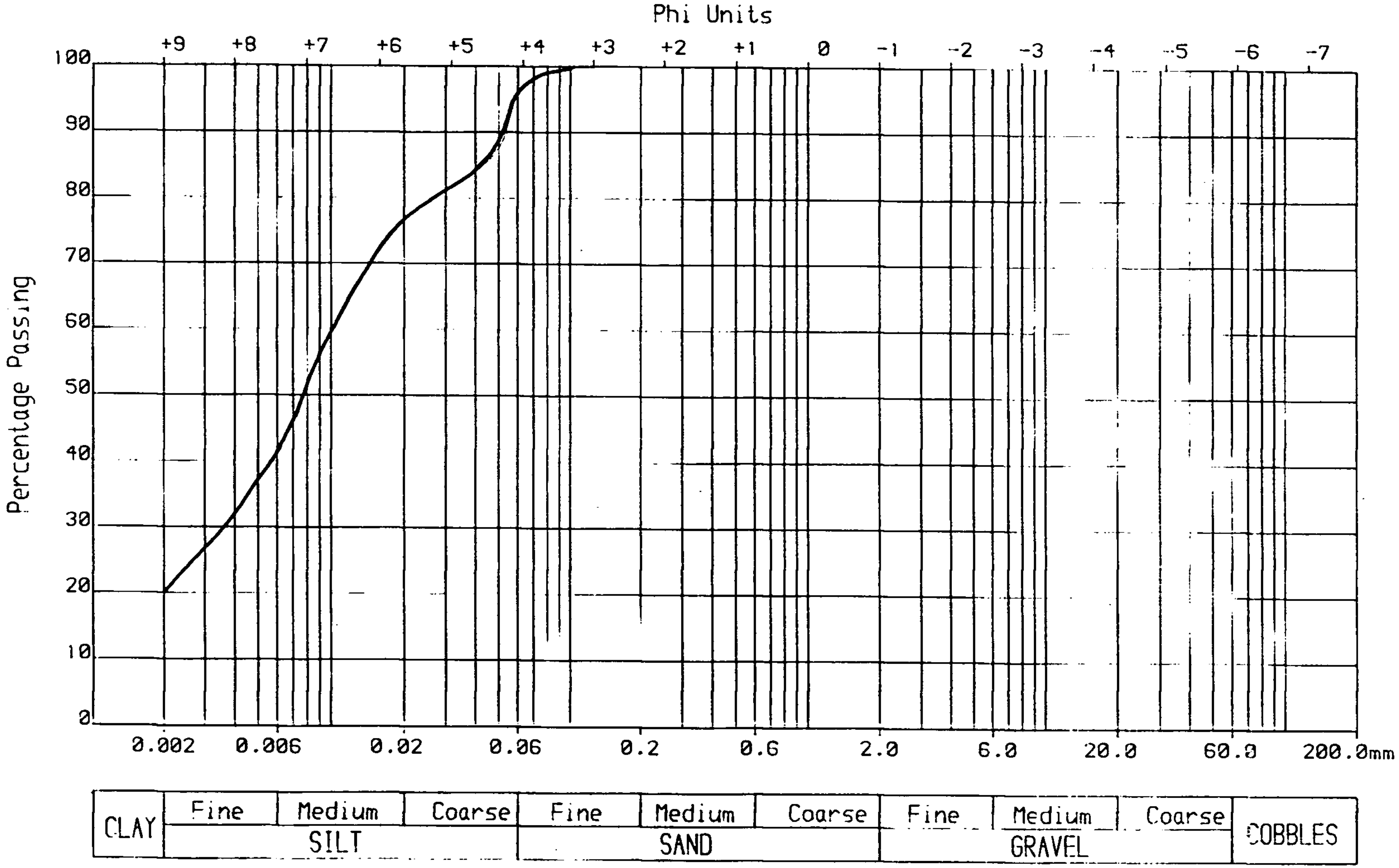


Fig. 6.20

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 **S.13**

Grid Ref. : Loe Pool

Date :

Name : Martin Coard

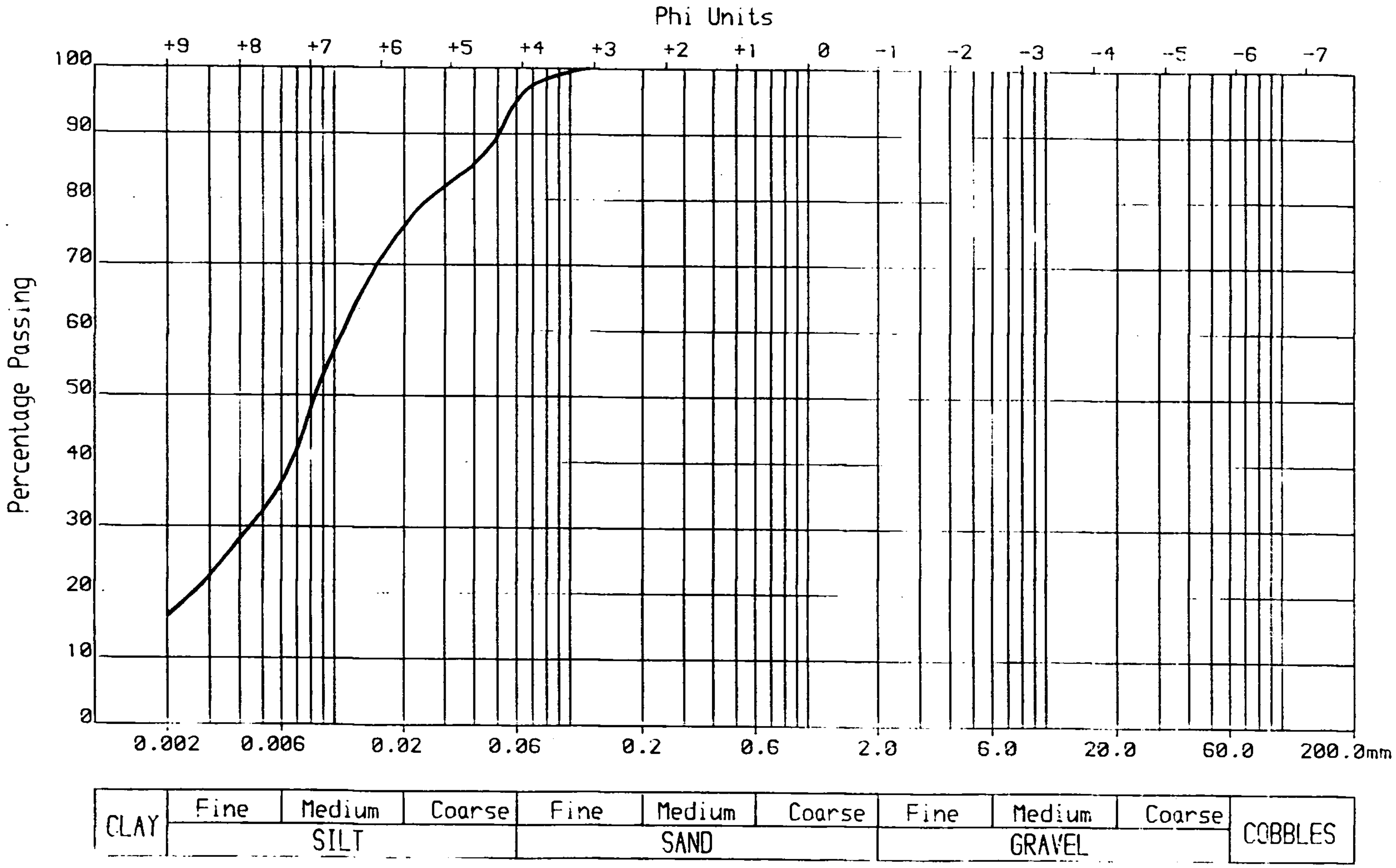


Fig. 6.21

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 **S.14**

Grid Ref. : Loe Pool

Date :

Name : Martin Coard

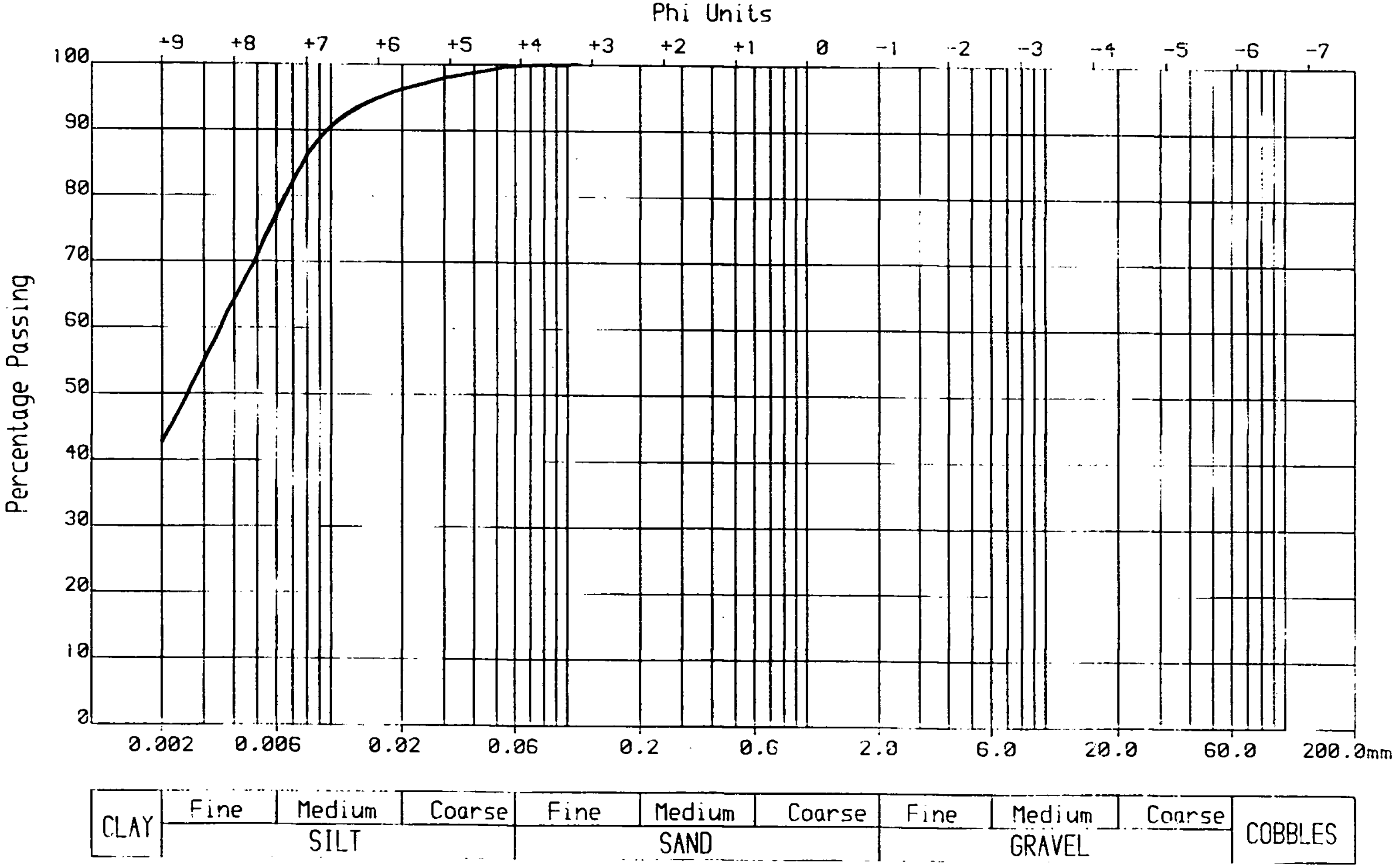


Fig. 6.22

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 S.15

Grid Ref. : Loe Pool

Date :

Name : Martin Coard

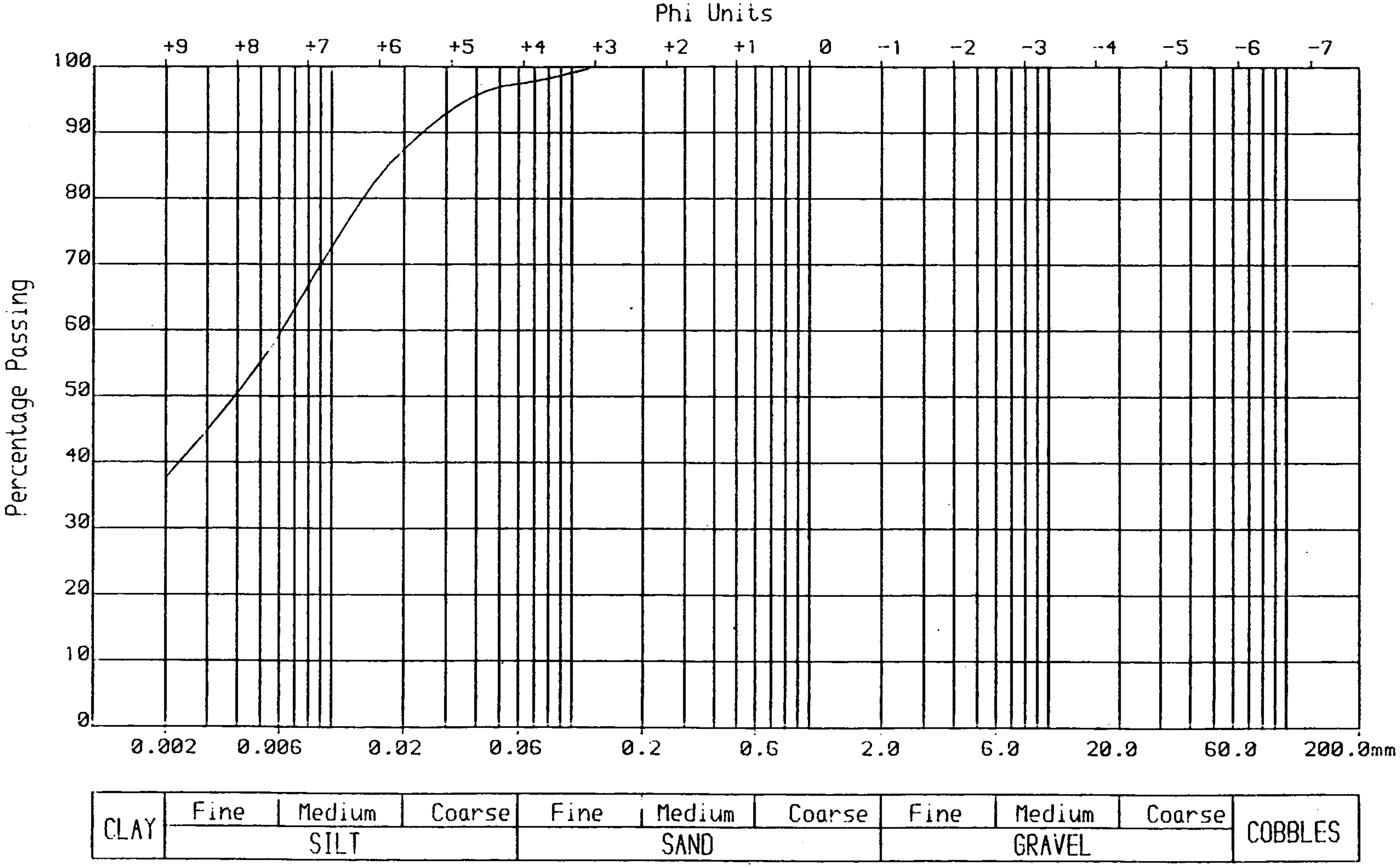


Fig. 6.23

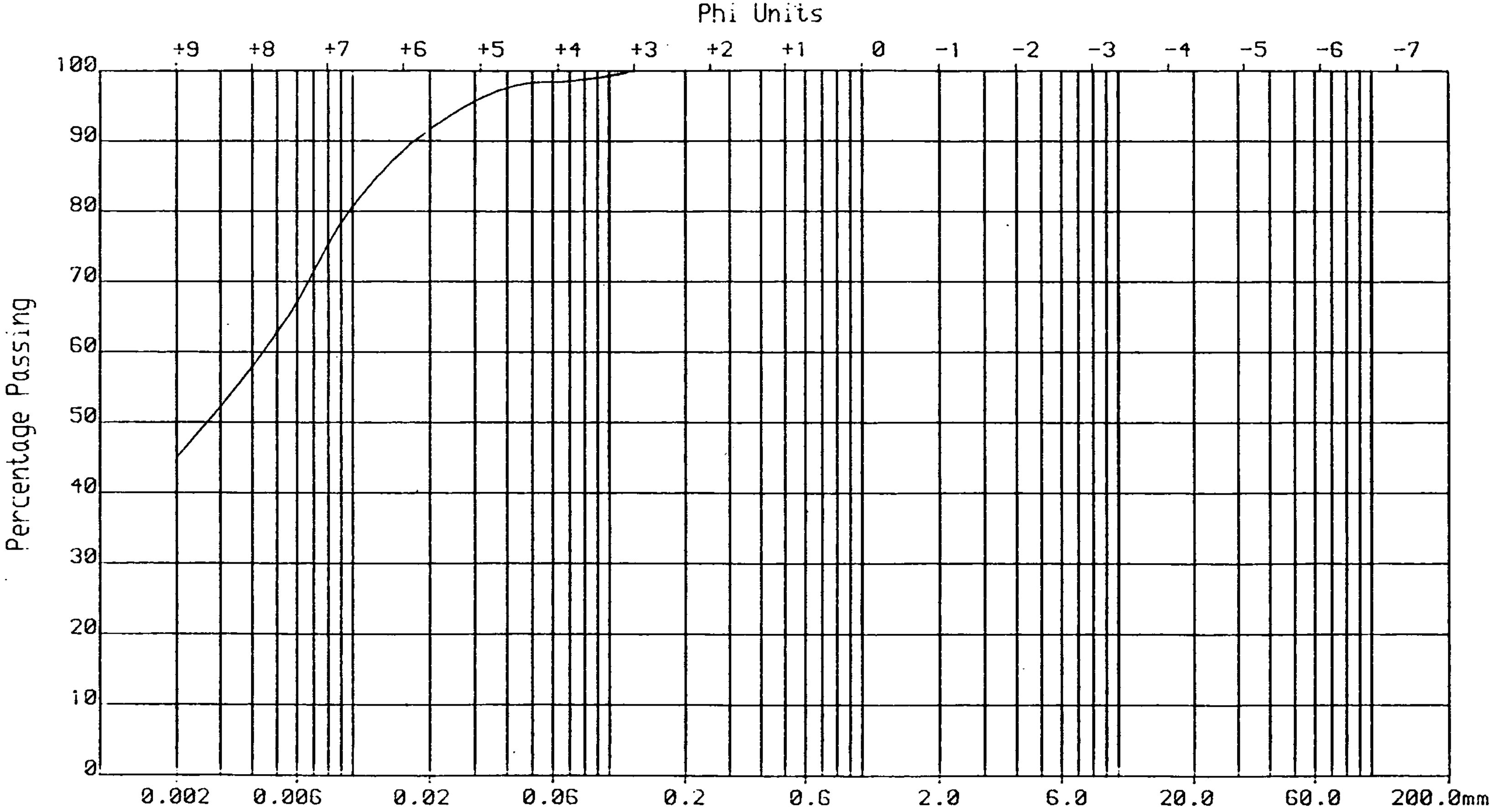
PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 S.16

Date :

Grid Ref. : Loe Pool

Name : Martin Coard



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Fig. 6.24

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 S.17

Grid Ref. : Loe Pool

Date :

Name : Martin Coard

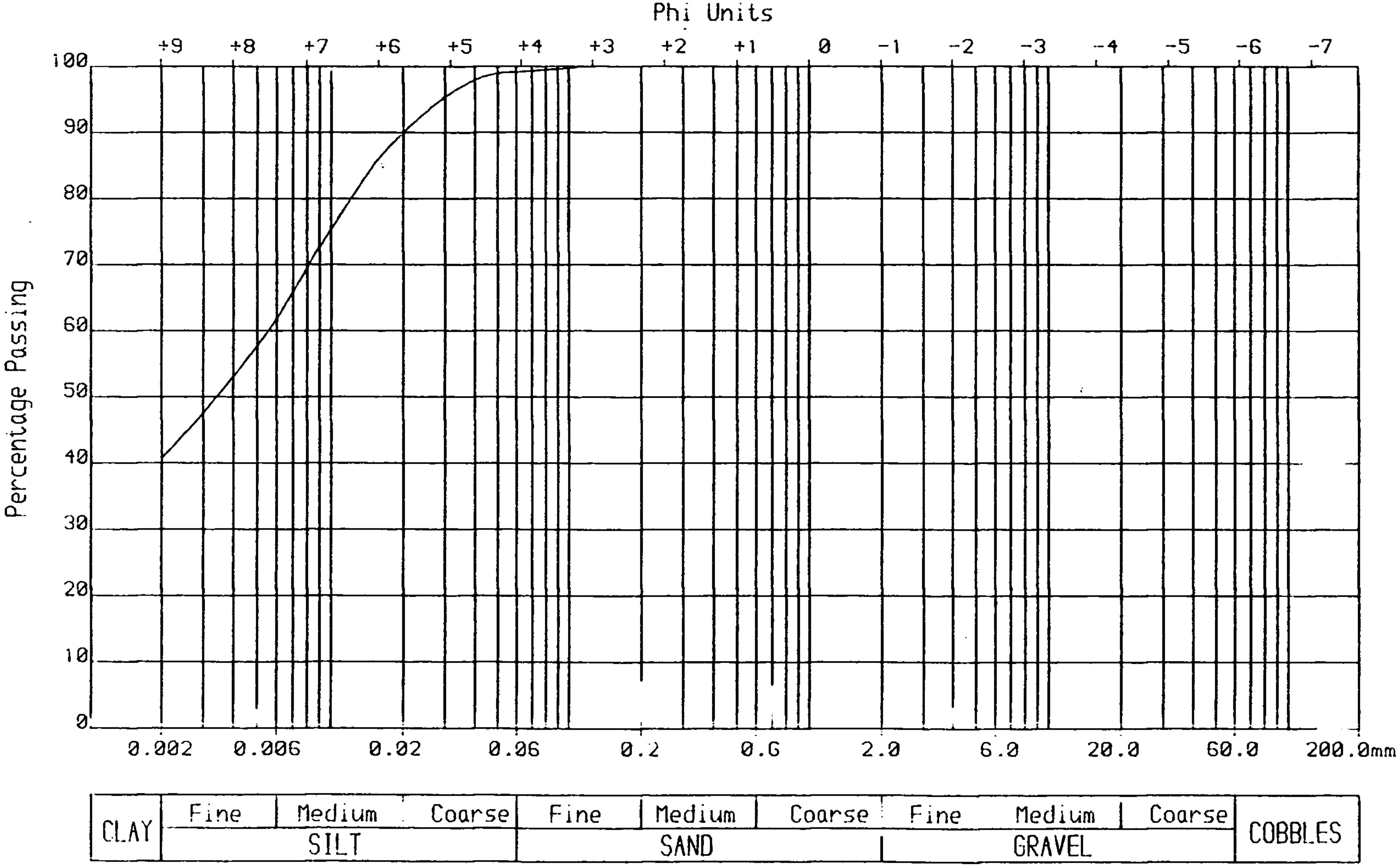


Fig. 6.25

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 S.18

Date :

Grid Ref. : Loe Pool

Name : Martin Coard

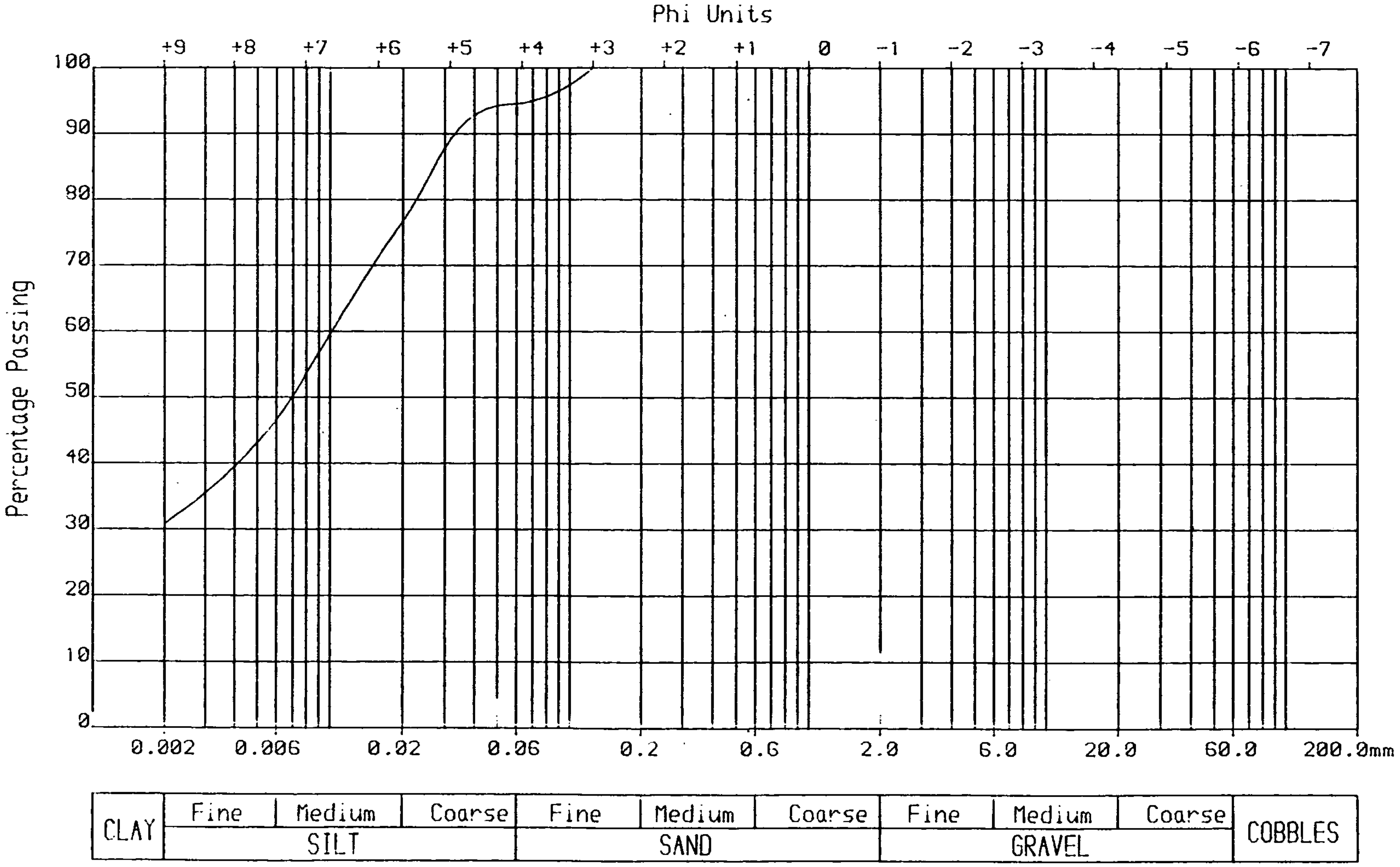


Fig. 6.26

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 S.19

Grid Ref. : Loe Pool

Date :

Name : Martin Coard

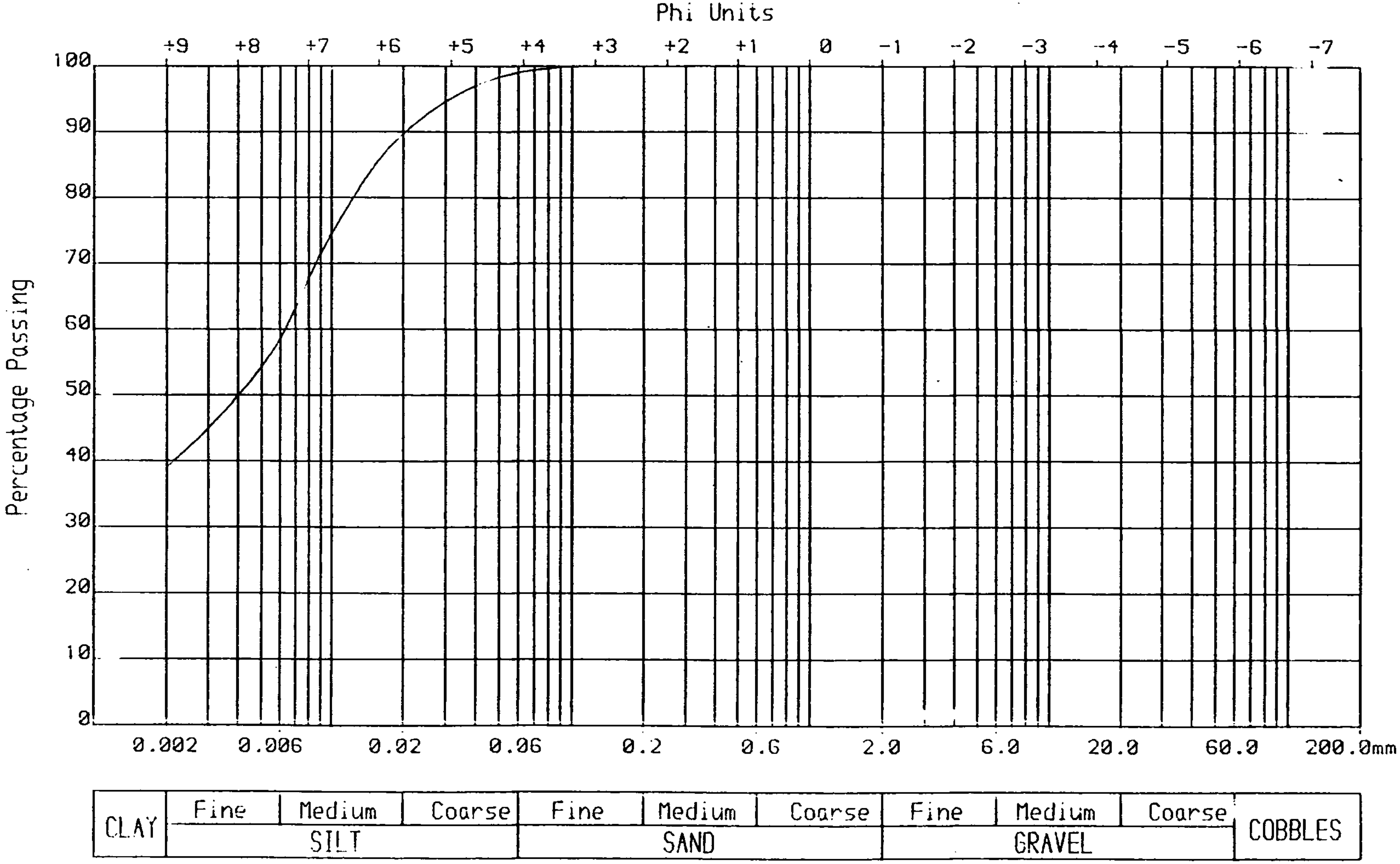


Fig. 6.27

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 S.20

Crid Ref. : Loe Pool

Date :

Name : Martin Coard

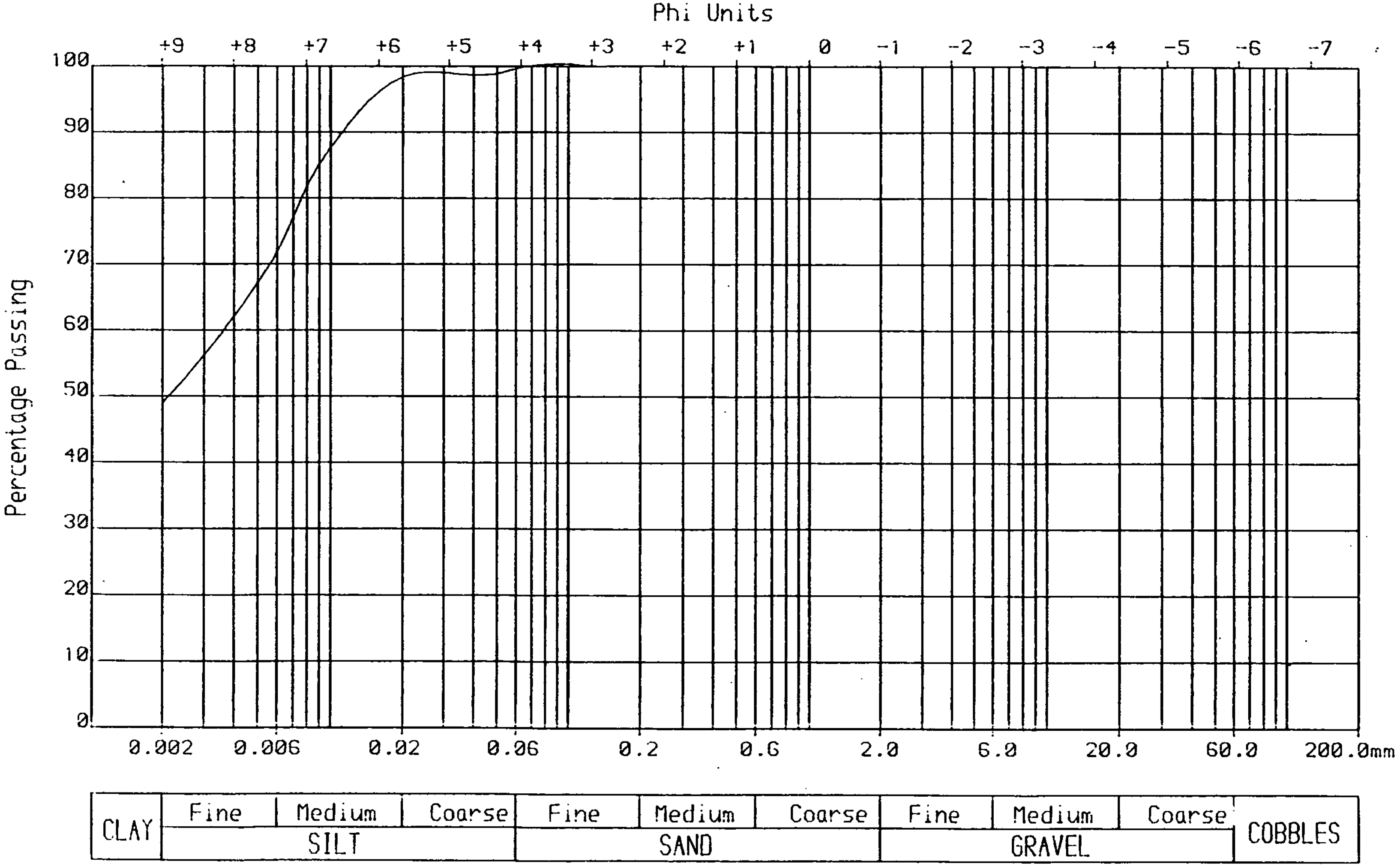


Fig. 6.28

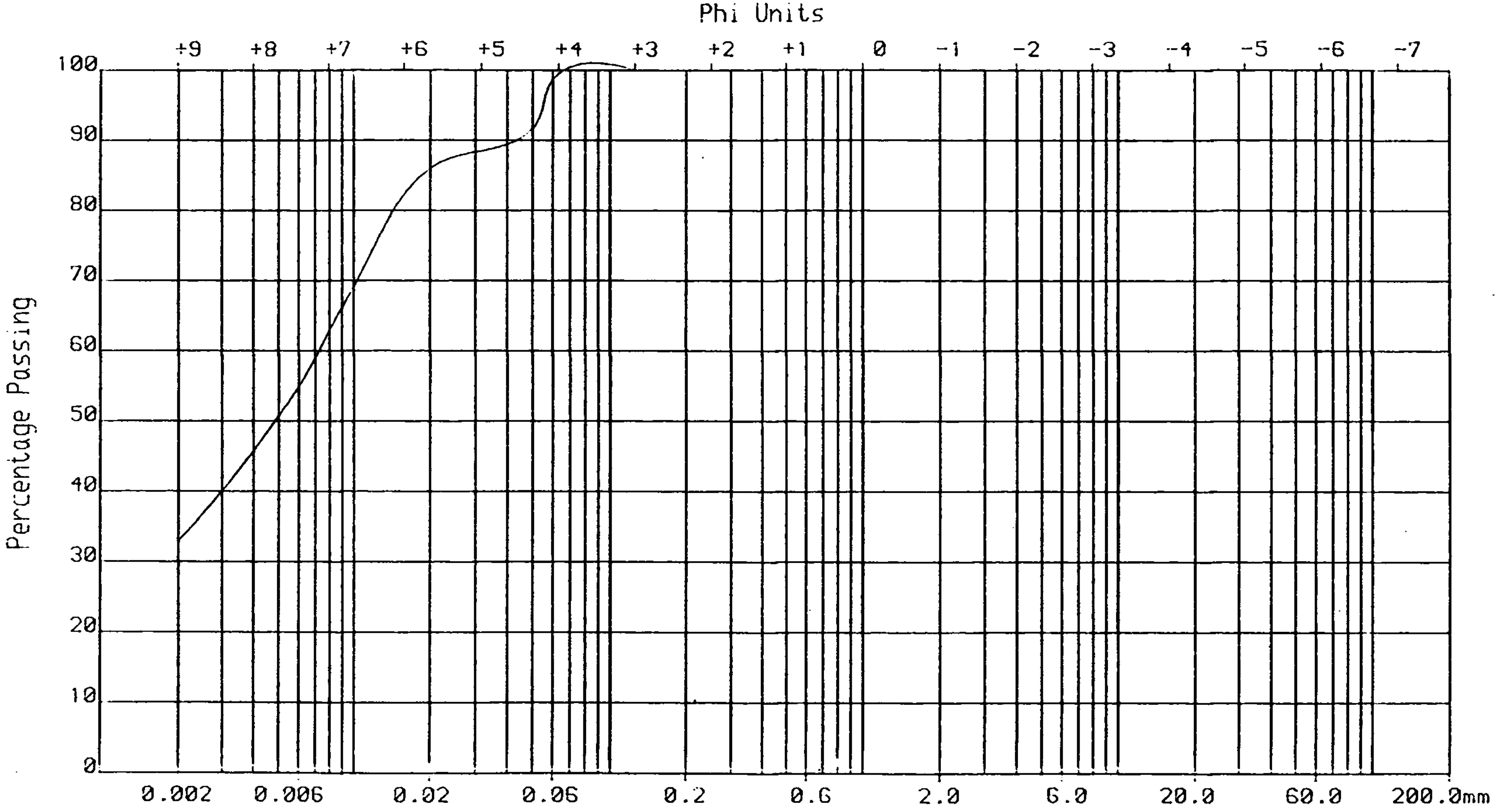
PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 S.21

Grid Ref. : Loe Pool

Date :

Name : Martin Coard



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Fig. 6.29

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 S.22

Grid Ref. : Loe Pool

Date :

Name : Martin Coard

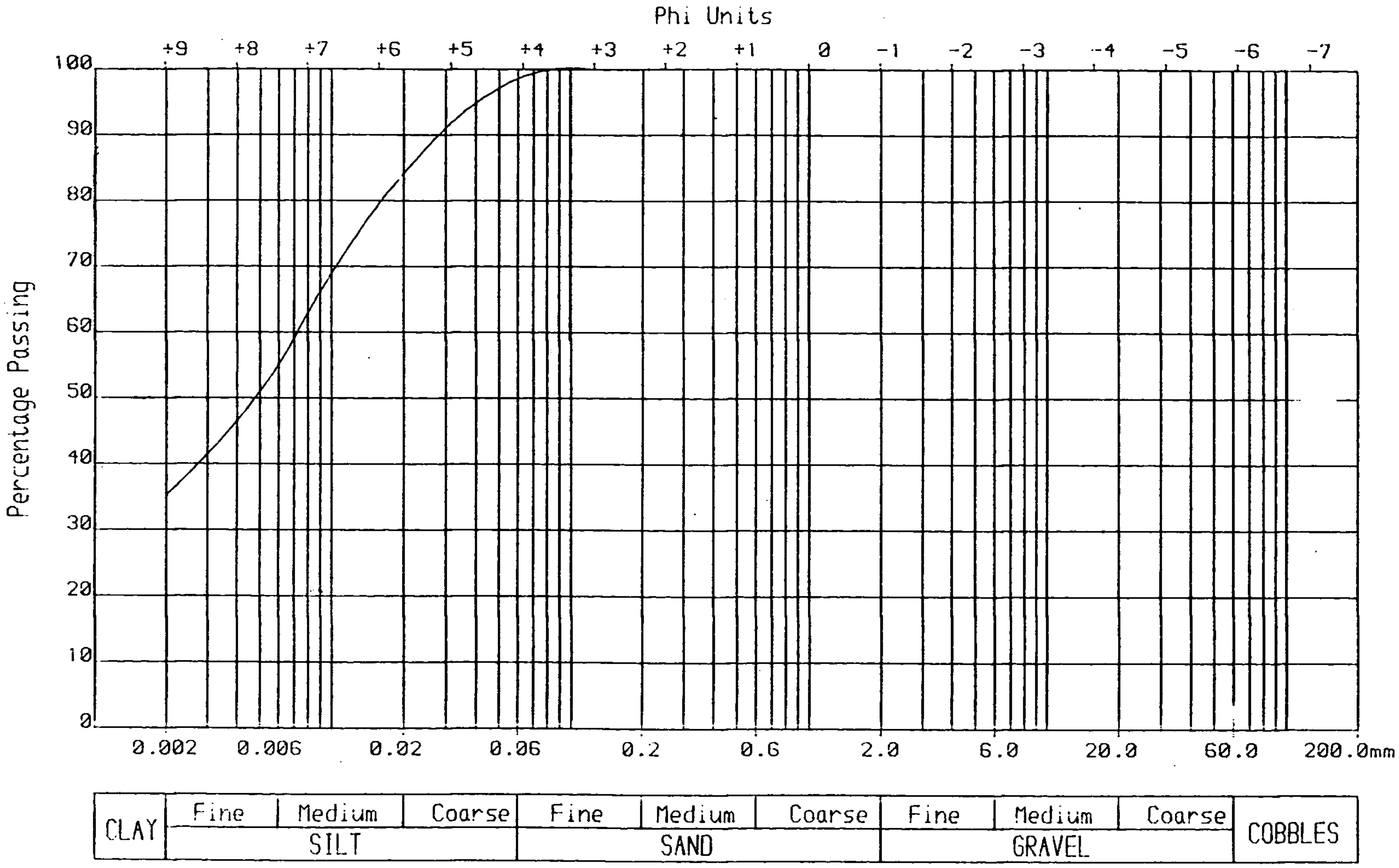


Fig. 6.30

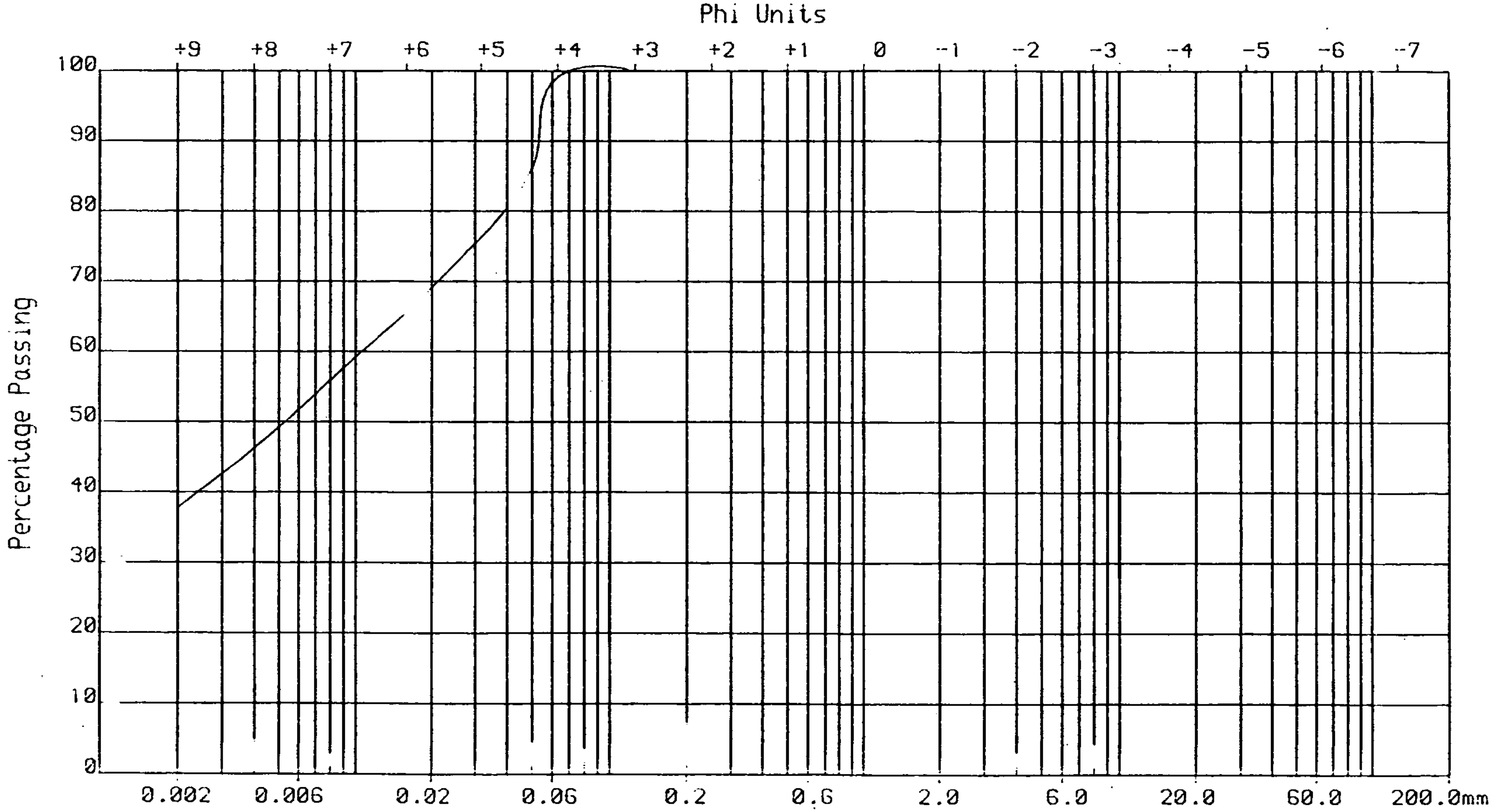
PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 S.23

Grid Ref. : Loe Pool

Date :

Name : Martin Coard



CLAY	SILT			SAND			GRAVEL			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	

Fig. 6.31

PARTICLE SIZE DISTRIBUTION

Sample No. LP3M3 S.24

Date :

Grid Ref. : Loe Pool

Name : Martin Coard

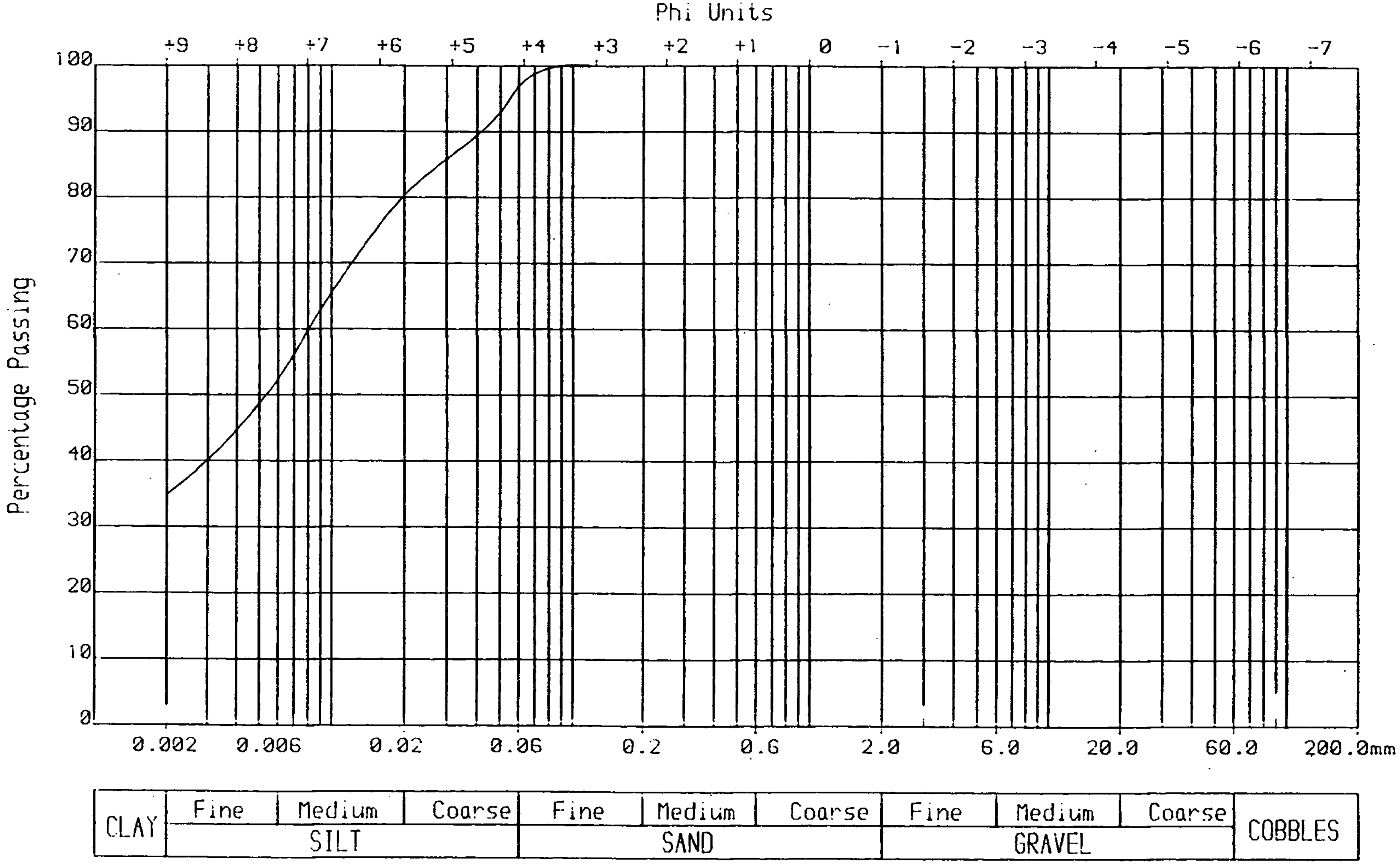


Fig. 6.32

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 S.25

Grid Ref. : Loe Pool

Date :

Name : Martin Coard

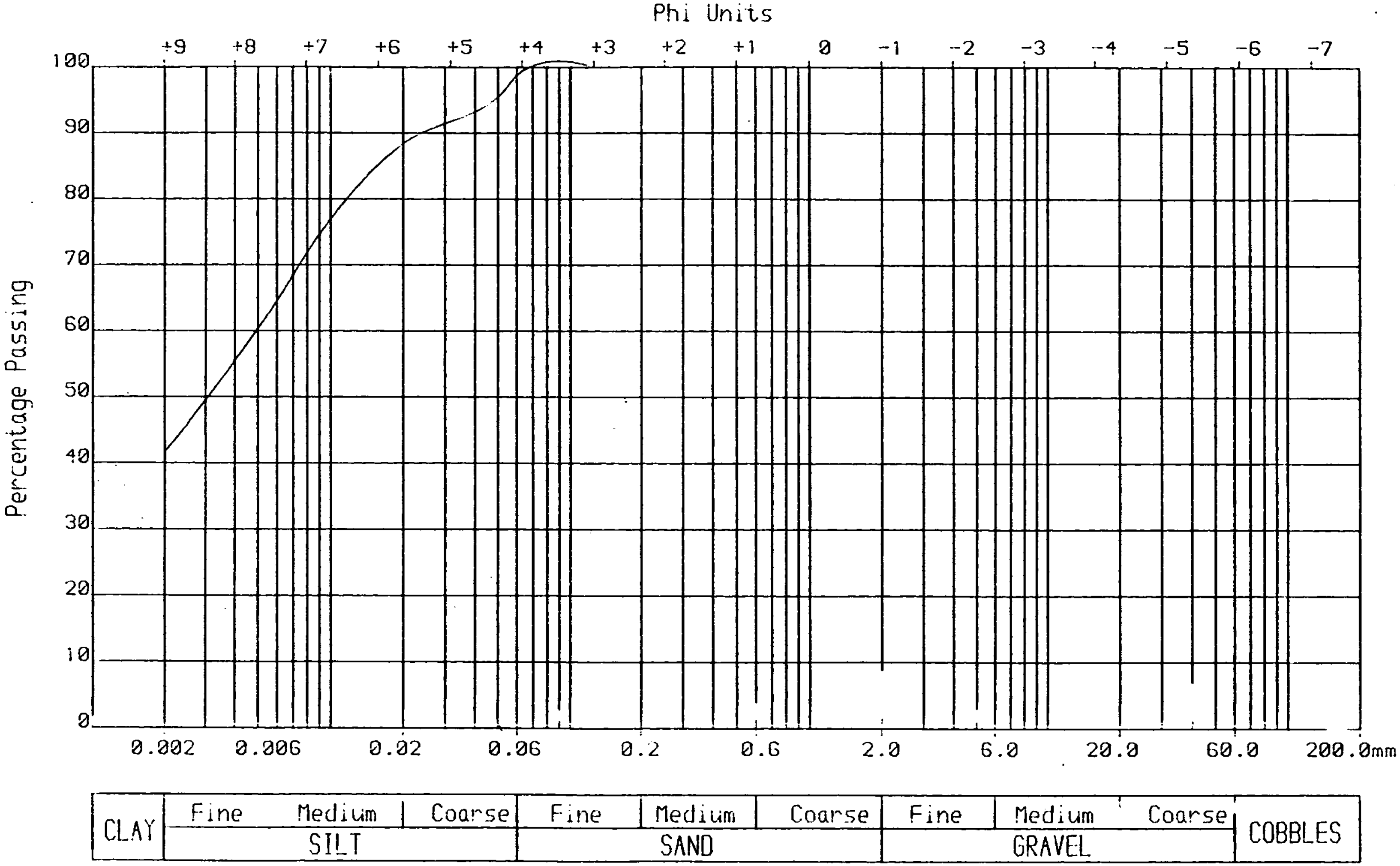


Fig. 6.33

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 S.26

Grid Ref. : Loe Pool

Date :

Name : Martin Coard

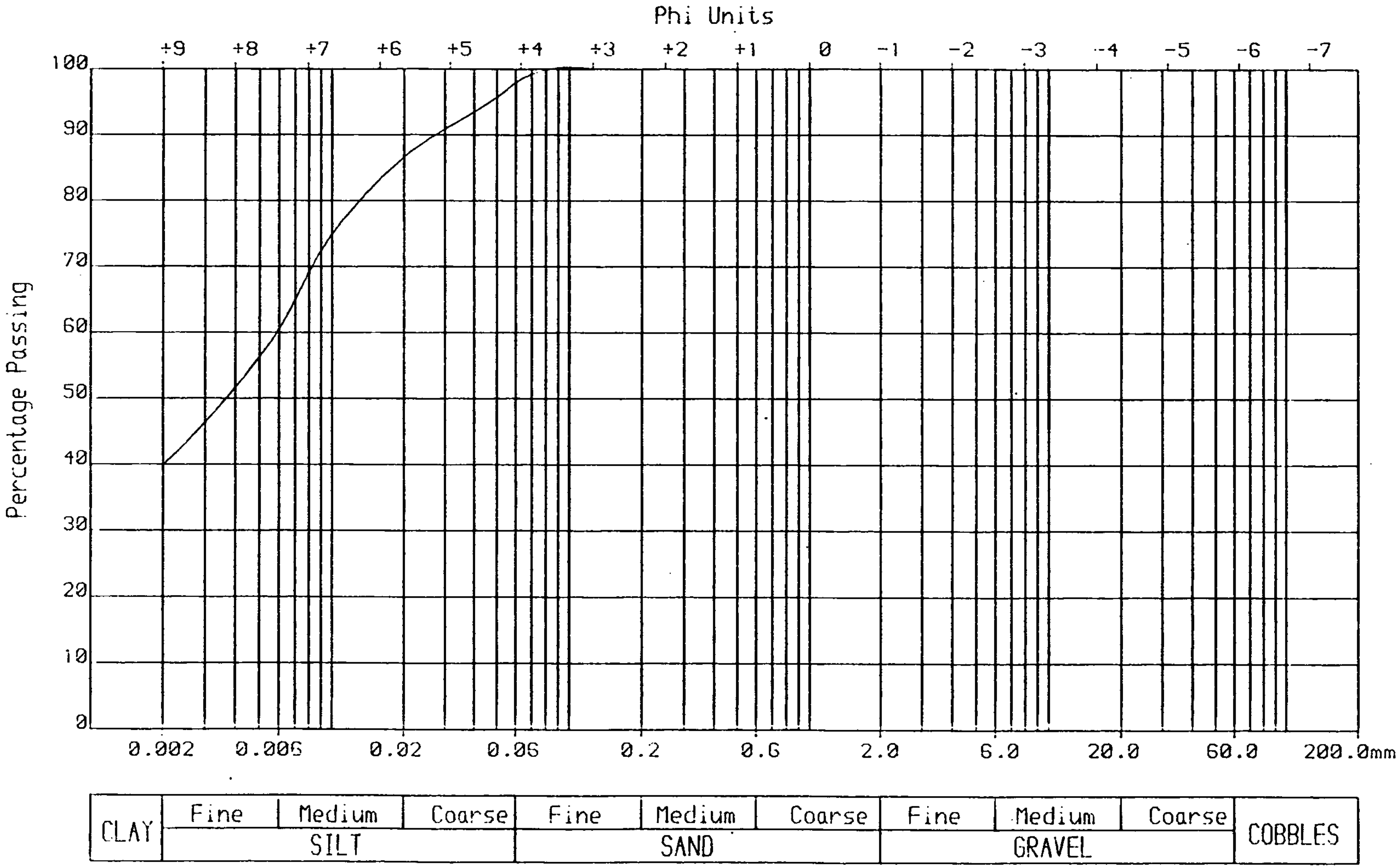


Fig. 6.34

PARTICLE SIZE DISTRIBUTION

Sample No. : LP3M3 S.27

Date :

Grid Ref. : Loe Pool

Name : Martin Coard

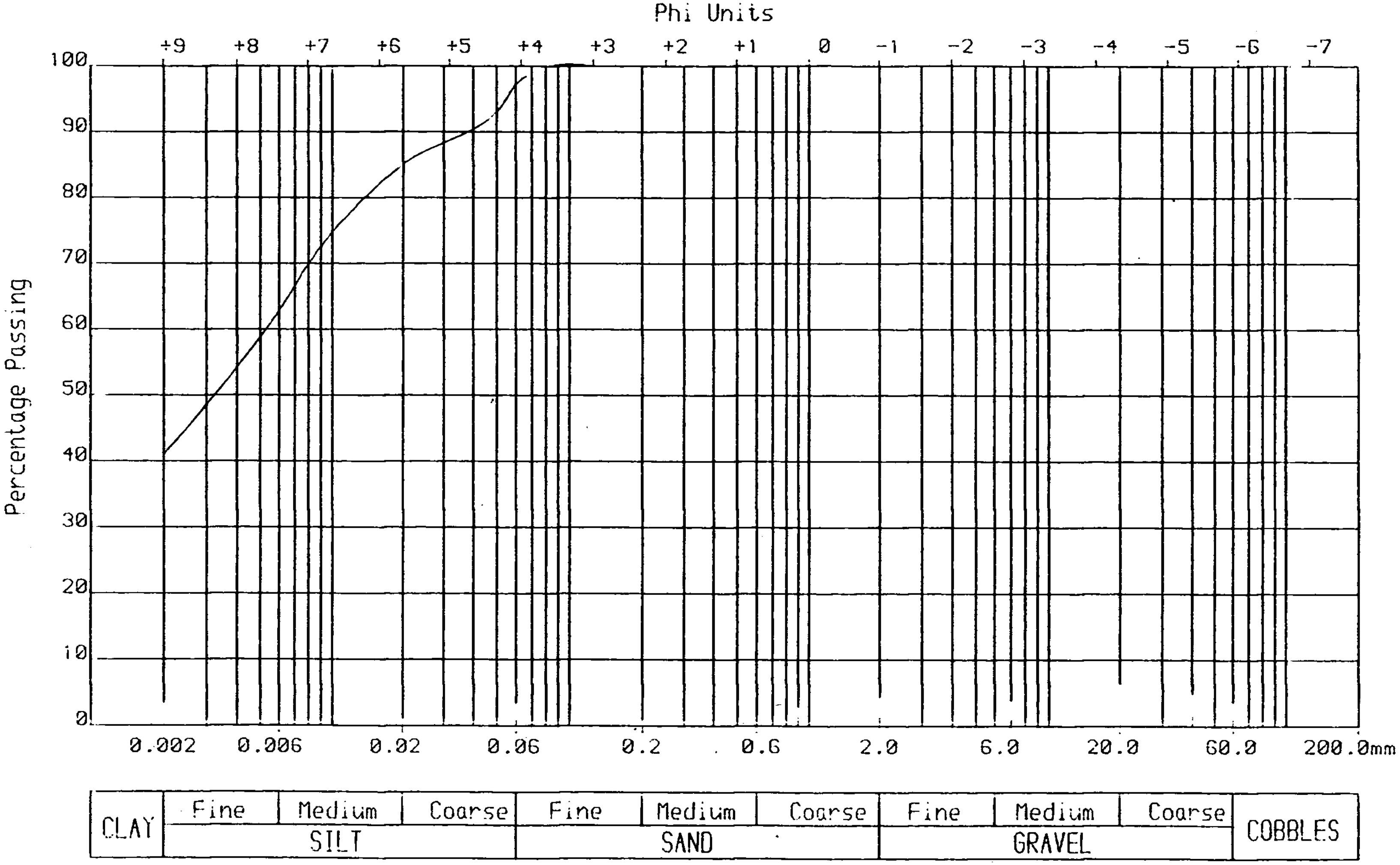


Fig. 6.35

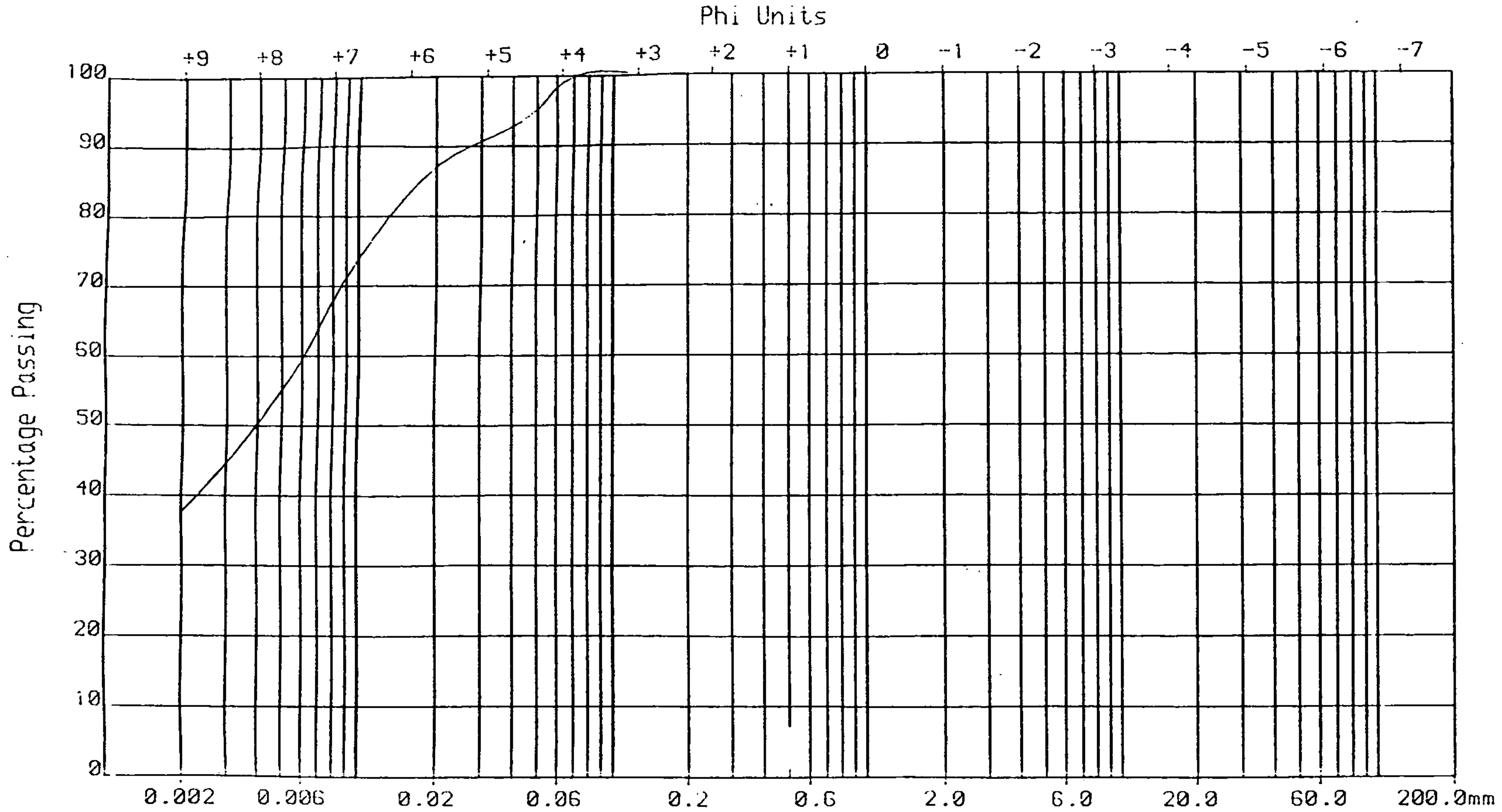
PARTICLE SIZE DISTRIBUTION

Sample No. LP3M3 S.28

Grid Ref. : Loe Pool

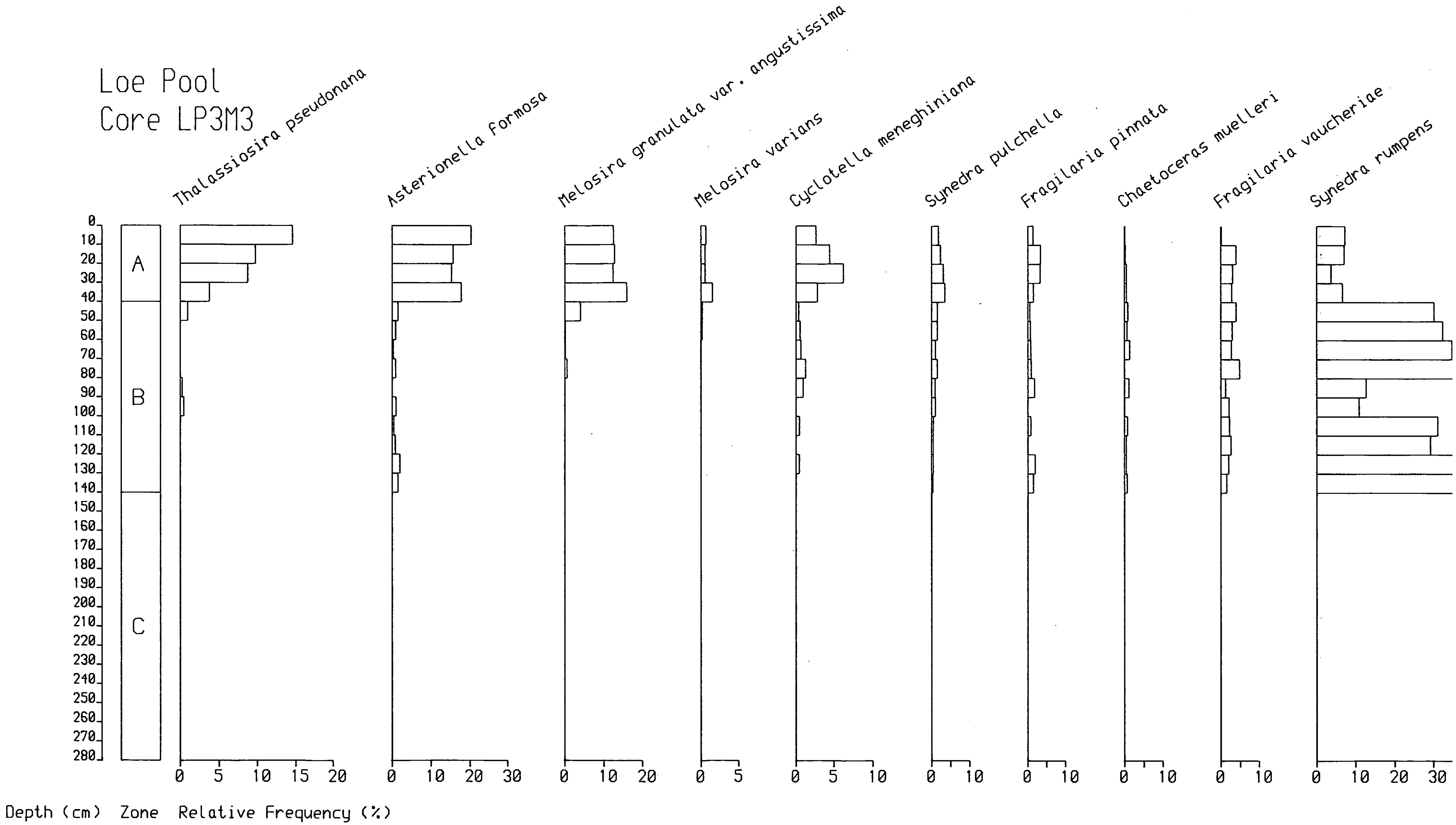
Date :

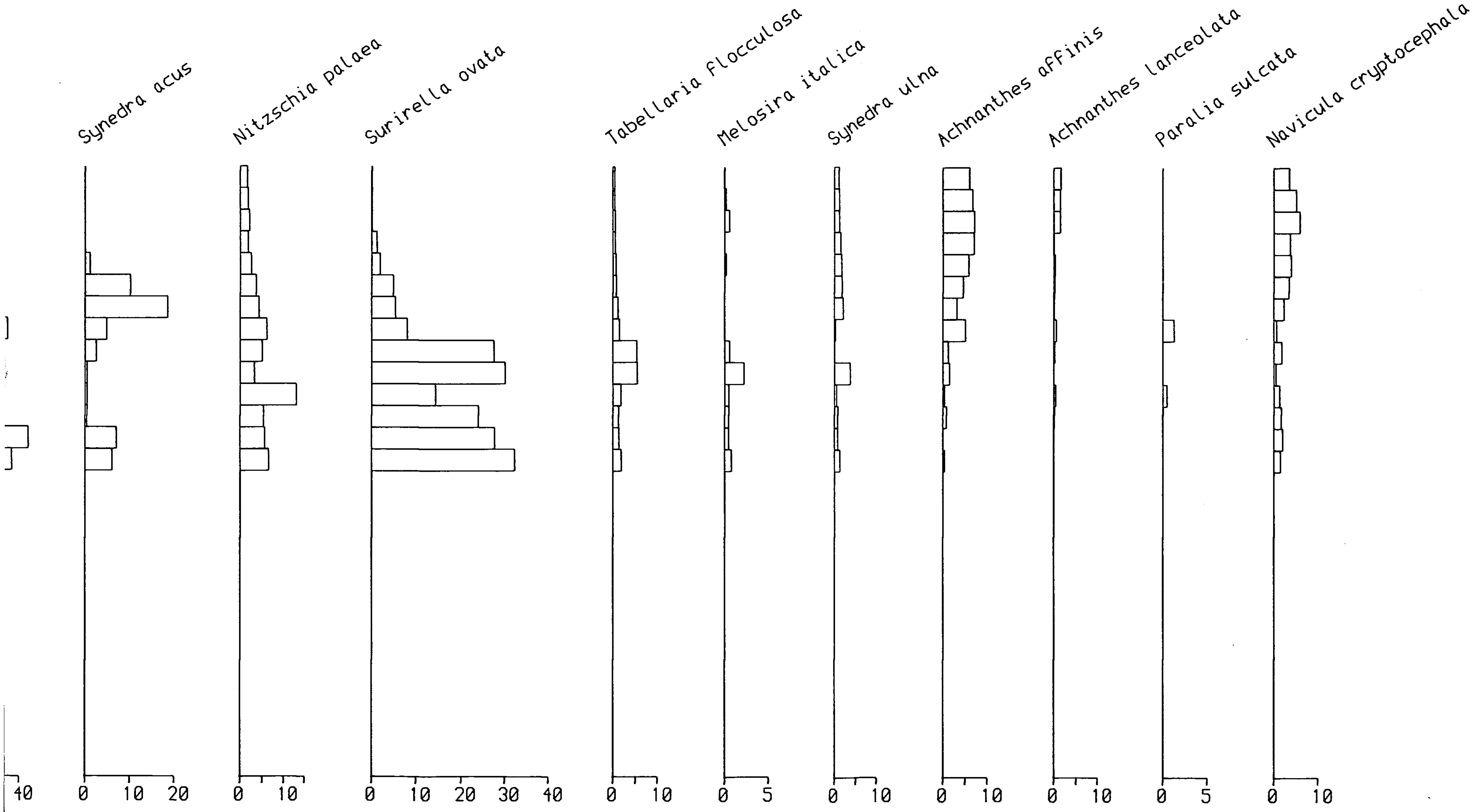
Name : Martin Coard



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

Fig. 6.36


Loe Pool
Core LP3M3
Thalassiosira pseudonana
Asterionella formosa
Melosira granulata var. angustissima
Melosira varians
Cyclotella meneghiniana
Synedra pulchella
Fragilaria pinnata
Chaetoceras muelleri
Fragilaria vaucheriae
Synedra rumpens
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
A
B
C
0 5 10 15 20
0 10 20 30
0 10 20
0 5
0 5 10
0 10
0 10
0 10
0 10
0 10 20 30
Depth (cm)
Zone
Relative Frequency (%)


Synedra acus
Nitzschia palaea
Surirella ovata
Tabellaria flocculosa
Melosira italica
Synedra ulna
Achnanthes affinis
Achnanthes lanceolata
Paralia sulcata
Navicula cryptocephala
40
0 10 20
0 10
0 10 20 30 40
0 10
0 5
0 10
0 10
0 10
0 5
0 10

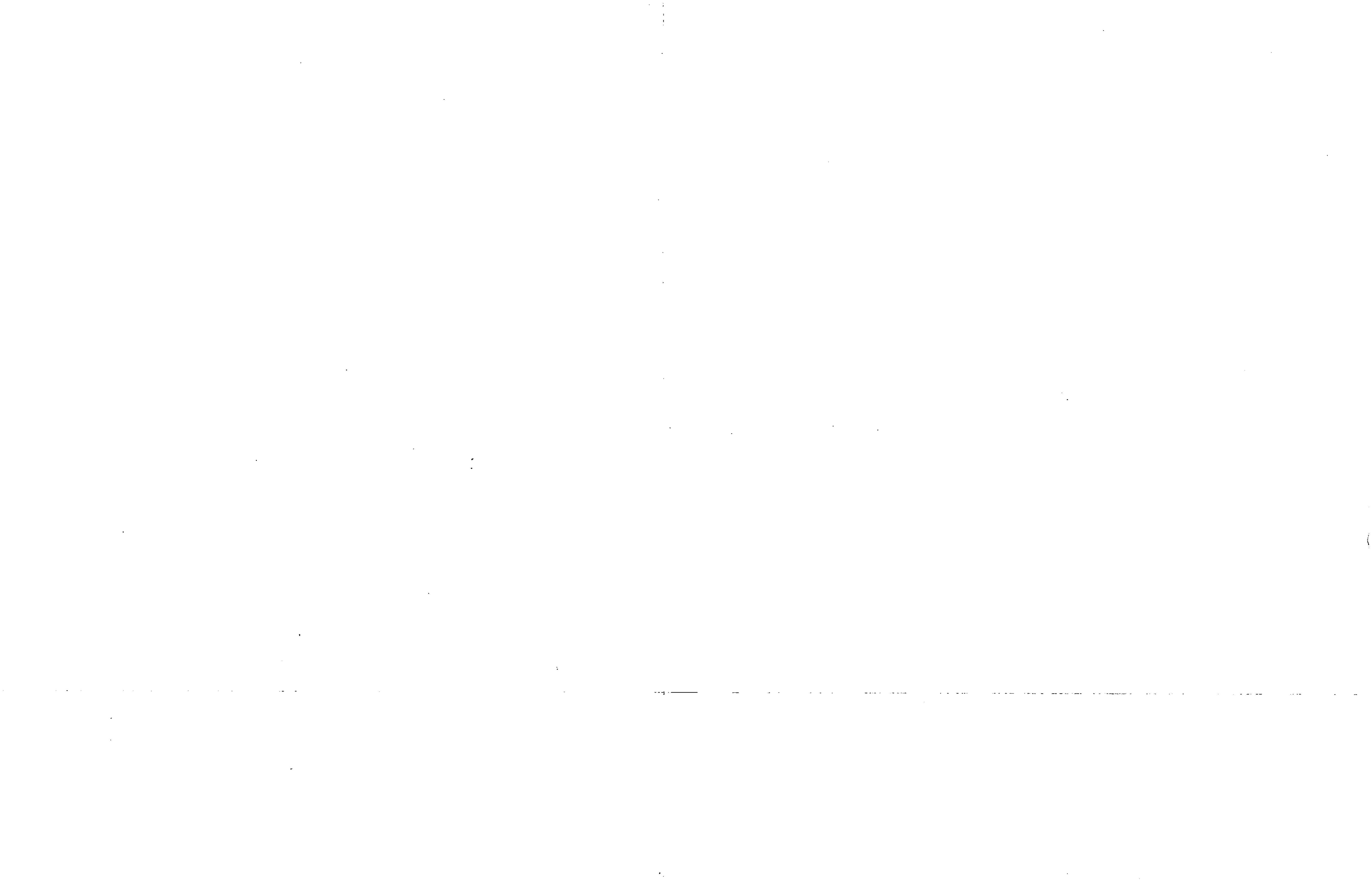


Fig. 7.1


Loe Pool
Core LP3M3
Total diatom valves
Thalassiosira pseudonana
Asterionella formosa
Melosira granulata var. angustissima
Melosira varians
Cyclotella meneghiniana
Synedra pulchella
Fragilaria pinnata
Chaetoceras muelleri
Fragilaria vaucheriae
Synedra rumpens
Synedra acus
Nitzschia palea
Surirella ovata
Tabellaria flocculosa
Melosira italica
Synedra ulna
Achnanthes affinis
Achnanthes lanceolata
Paralia sulcata
Navicula cryptocephal
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
A
B
C
0.00 0.20 0.40 0.60
X10^8
0.00 1.00 X10^6
0.00 0.40 X10^6
0.00 2.00 X10^6
0.00 1.00 2.00 X10^7
0.00 1.00 X10^7
0.00 0.20 0.40 X10^7
0.00 0.15 X10^7
0.00 0.20 X10^7
Depth (cm)
Zone
Influx: Diatom valves/cm2/year

Fig. 7.2

Core LP3M3
pH reconstruction 0.0–140.0cm depth

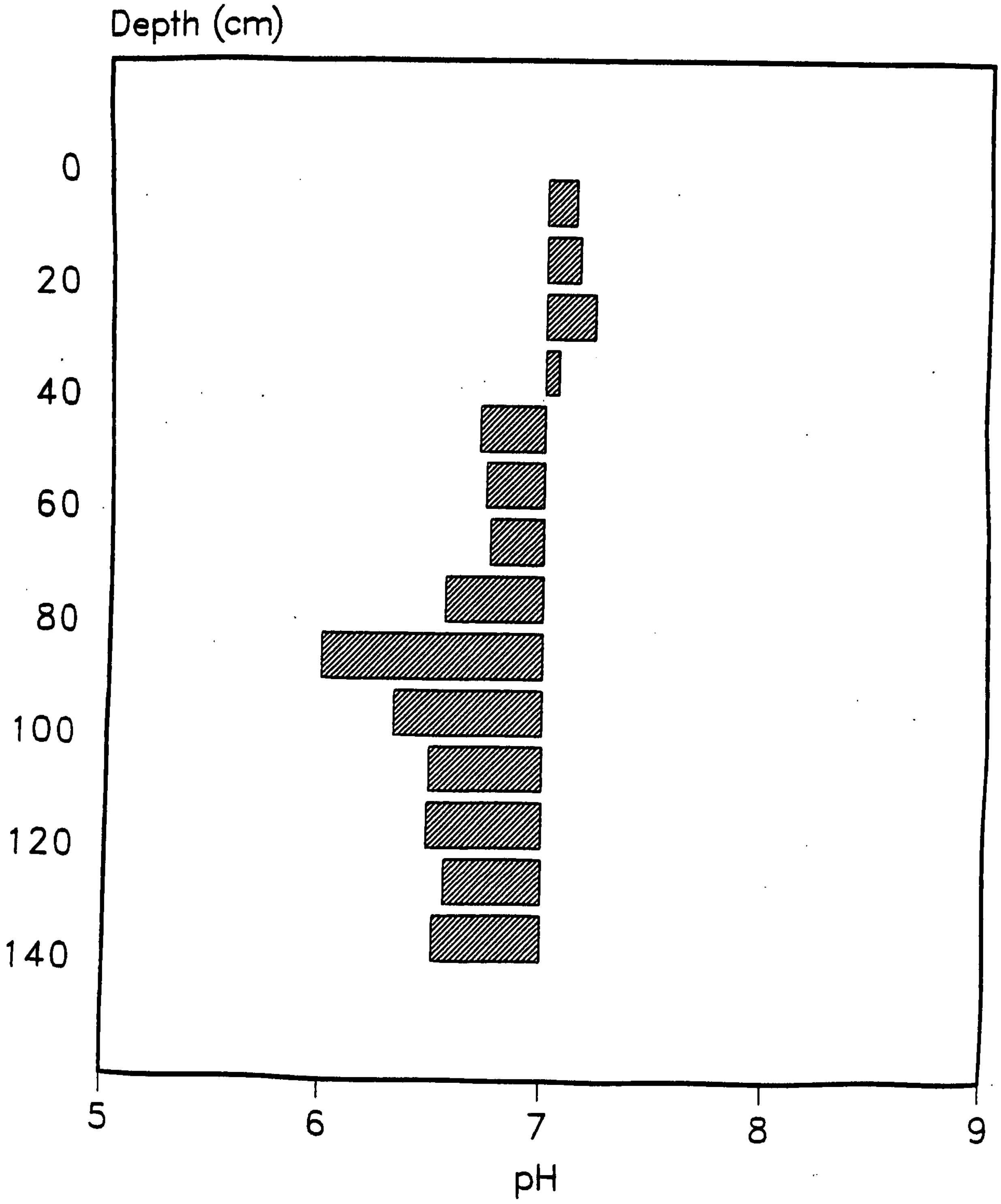


Fig. 7.3

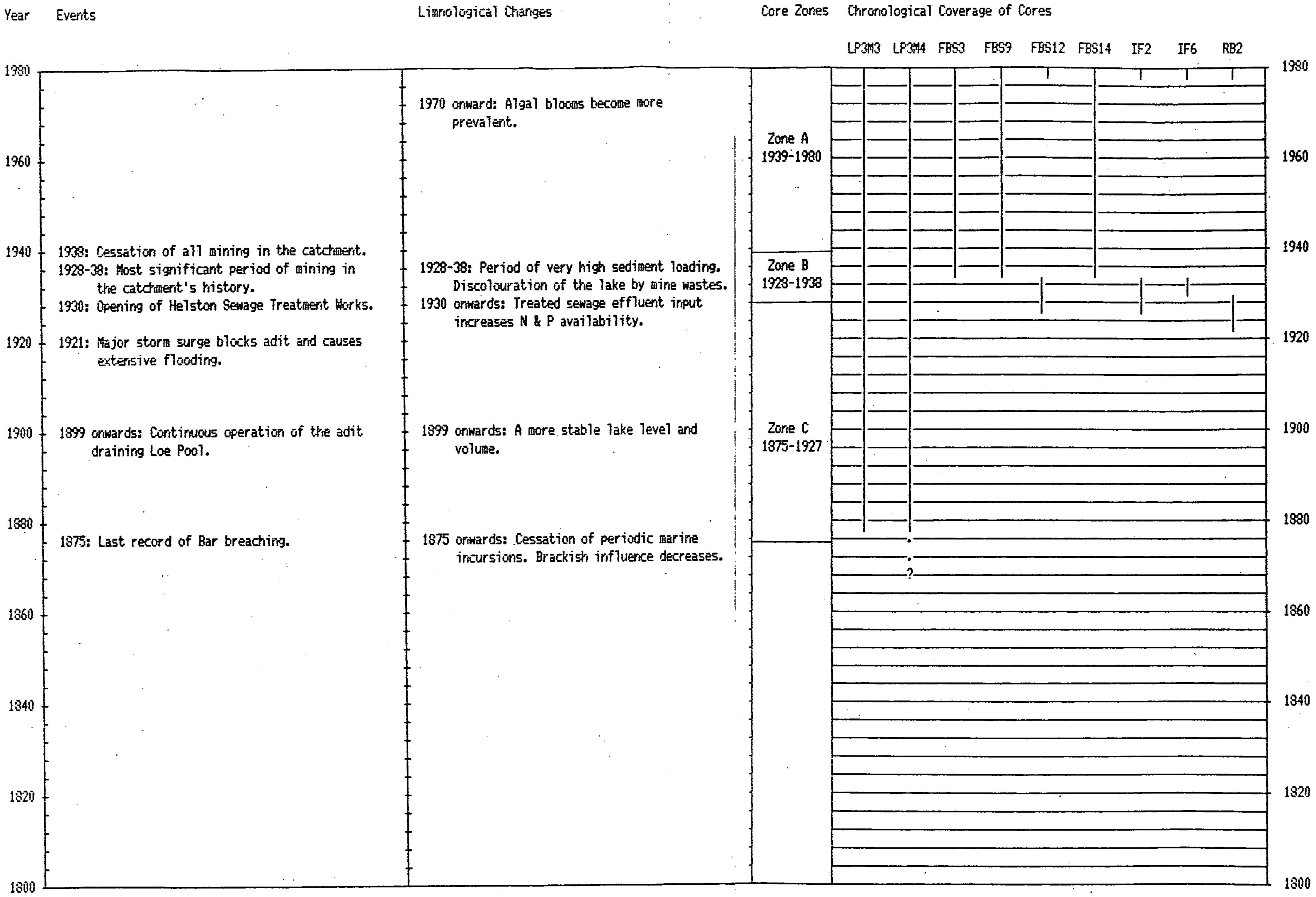

Core FBS10 - 0-26cm
Depth (cm)
Total Diatoms
Melosira varians
M. granulata var. angustissima
Pediastrum spp.
Scenedesmus spp.
Staurastrum spp. (single arms)
Thalassiosira pseudonana
Cyclotella meneghiniana
Asterionella formosa
Navicula cryptocephala
Synedra rumpens
Synedra pulchella
Synedra acus
Synedra ulna
Cocconeis placentula
Surirella capronii
Nitzschia spp.
Pinnularia spp.
Diploneis puella
Additional Diatoms
Chrysophyte Cysts
Sponge Spicules
Vivianite Crystals
No Diatoms Present
TWINSPAN Class 000
TWINSPAN Class 001
TWINSPAN Class 010
TWINSPAN Class 011
TWINSPAN Class 100
TWINSPAN Class 101
TWINSPAN Class 110
TWINSPAN Class 111
0
2
4
6
8
10
12
14
16
18
20
22
24
26
Zone A
Zone B
B010
B011
B012
B013
B015
0 20 40 60 80 100
0 10
0 20 40 60 80 100
0 10
0 10
0 10
0 10 20 30
0 10 20 30 40
0 10 20 30 40 50
0 10
0 20 40 60 80 100
0 10
0 10
0 10
0 20
0 10
0 10
0 10
0 10
0 10
0 10 20 30
0 10
0 10
0 1
0 1
0 1
0 1
0 1
0 1
0 1
0 1
0 1
Diatom valves per field of view

Fig. 7.5

2-76

Loe Pool Core RB2 - 460-470cm

Fig. 7.6



1938: Cessation of all mining in the catchment.

1928-38: Most significant period of mining in the catchment's history.

1930: Opening of Helston Sewage Treatment Works.

1921: Major storm surge blocks adit and causes extensive flooding.

1899 onwards: Continuous operation of the adit draining Loe Pool.

1875: Last record of Bar breaching.

1970 onward: Algal blooms become more prevalent.

1928-38: Period of very high sediment loading. Discolouration of the lake by mine wastes.

1930 onwards: Treated sewage effluent input increases N & P availability.

1899 onwards: A more stable lake level and volume.

1875 onwards: Cessation of periodic marine incursions. Brackish influence decreases.

Fig. 8.1 Summary diagram of the main catchment events, limnological changes, core zones and core chronologies referred to in this study.

Fig. 8.1

2-77(b)

Plate 2.1: An aerial view of Loe bar and Loe Pool, looking due north. (Photograph courtesy of the Photographic Department, R.N.A.S. Culdrose)

Plate 2.2: An aerial view, looking due west, of Carminowe Creek, the eastern arm of Loe Pool. Loe Bar can be seen in the middle distance. (Photograph courtesy of the Photographic Department, R.N.A.S. Culdrose)

Plate 2.3: An aerial view of the town of Helston, looking N.N.E. Helston sewage treatment works can be seen in the lower left-hand portion of the photograph. (Photograph courtesy of the Photographic Department, R.N.A.S. Culdrose)

Plate 2.4: A view of the lower part of Helston, looking south-west down the Loe Valley. In the foreground is the Coronation Lake, excavated in 1911, and on the left hand edge of the photograph, Helston sewage treatment works.

Plate 3.1: Four of the purses, containing three half-pences, that were traditionally presented to the 'lord of the manor' of Penrose whenever the inhabitants of Helston wished to cut Loe Bar. The dates on three of the purses is still legible.

Plate 3.1

Plate 3.2: Part of a chart, the original of which is held in the British Library (Cotton MS Augustus I i 35), dating from 1536. In the centre, it shows Mount's Bay, Loe Bar, Loe Pool and the town of Helston.

Plate 3.2

Plate 3.3: A detail from Plate 3.2. Loe Bar is very distinct and the lake is marked 'Looe'. Helston is marked as 'Helston - a Cunage [Coinage] Towne'.

Plate 3.4: An estate map of Penrose dating from 1771 and illustrating both the extent of Loe Pool and the size and shape of Loe Bar. The original map is held in Penrose House.

Plate 3.4

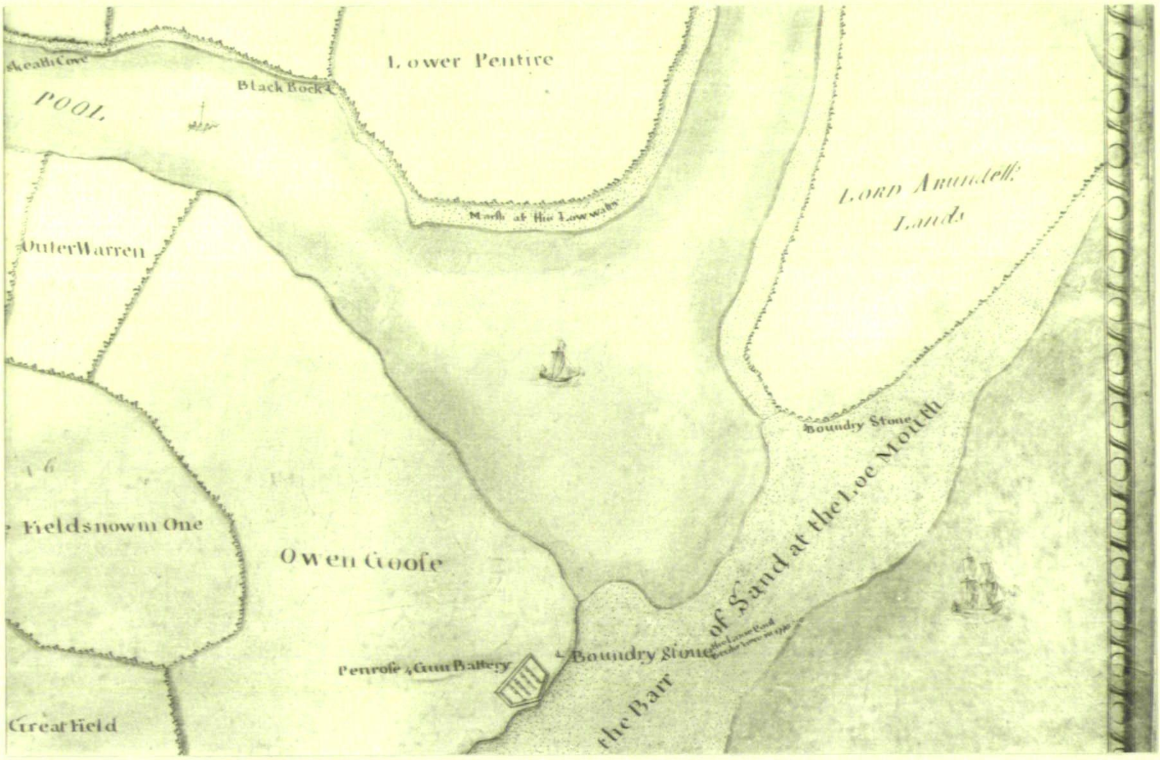


Plate 3.5: A detail from Plate 3.4, showing Loe Bar. On the bar are inscribed the words "the Looe Pool broke here in 1770", and the area of shingle removed on that occasion is also indicated.

Plate 3.5

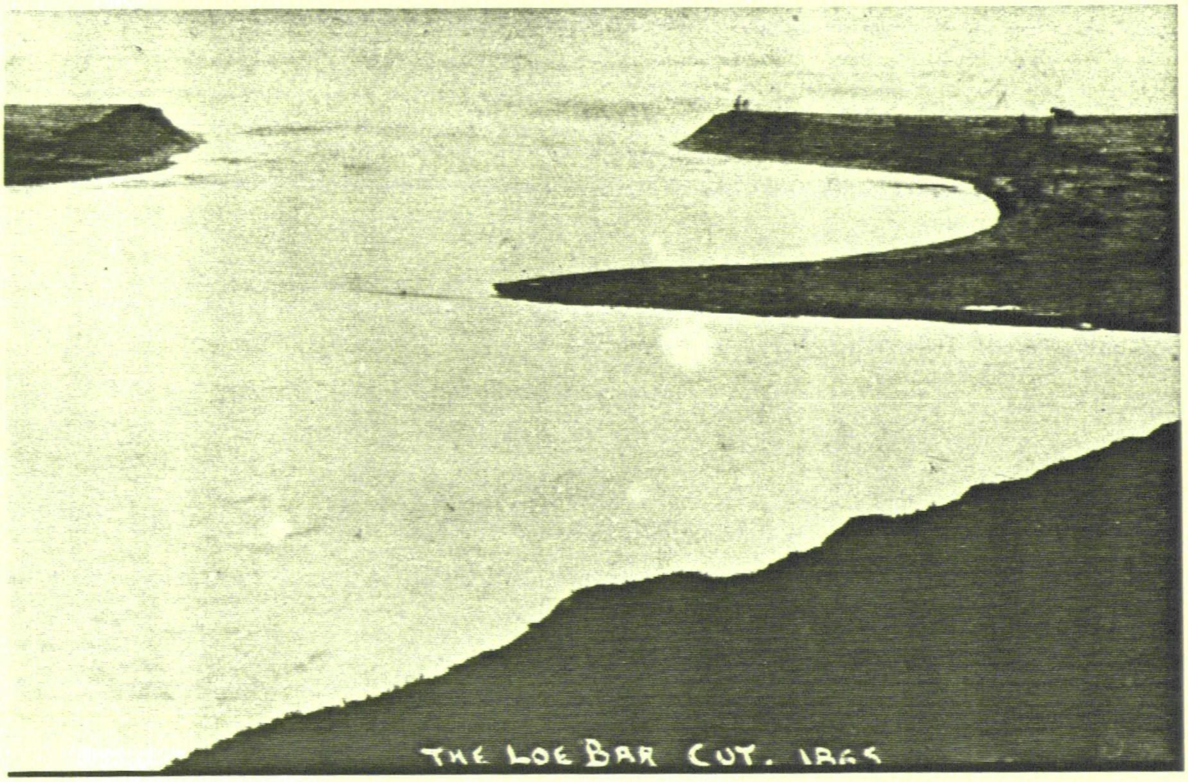


Plate 3.6: The extent of shingle removal during a bar breaching can be seen in this photograph of the cut which took place in 1865. (From an original photograph in Helston Folk Museum)

Plate 3.6

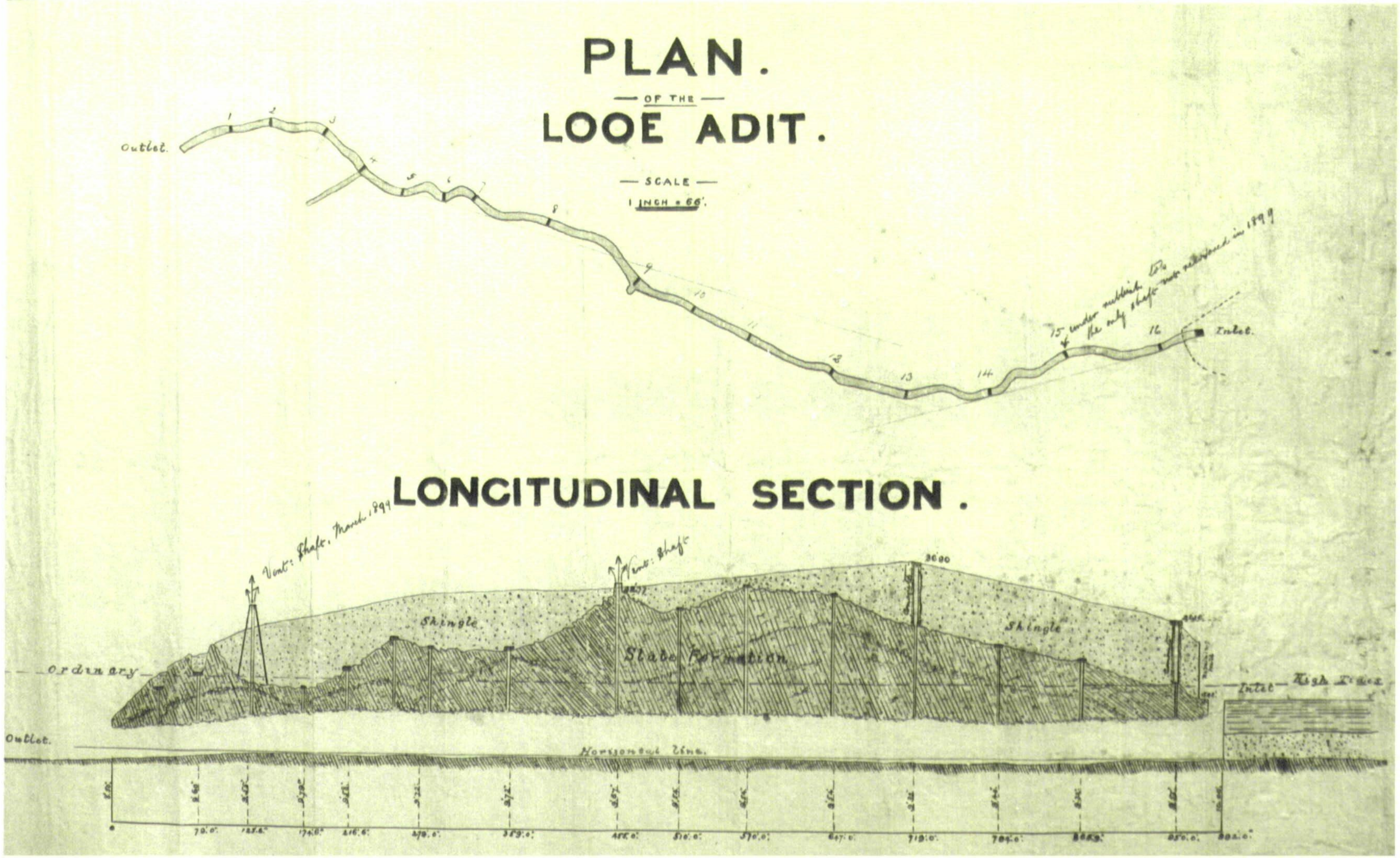


Plate 3.7: Longitudinal section through the Loe Pool drainage adit. The diagram probably dates from around 1900 as a number of the vent shafts cleared or constructed in 1899 are shown. (Original held in the Penrose Estate Office)

Plate 3.8: Lower Road in Helston, flooded in 1924 after the blockage of the Loe Pool drainage adit.

Plate 3.9: Another view of Lower Street, Helston, January 1924. (From original photographs in Helston Folk Museum)

Plates 3.8 & 3.9

Plate 3.10: Porthleven Road, Helston, during the flood of January 1924. The lake water rose to a similar height in Februry 1979 when the drainage adit was again blocked by shingle. (From an original photograph in Helston Folk Museum)

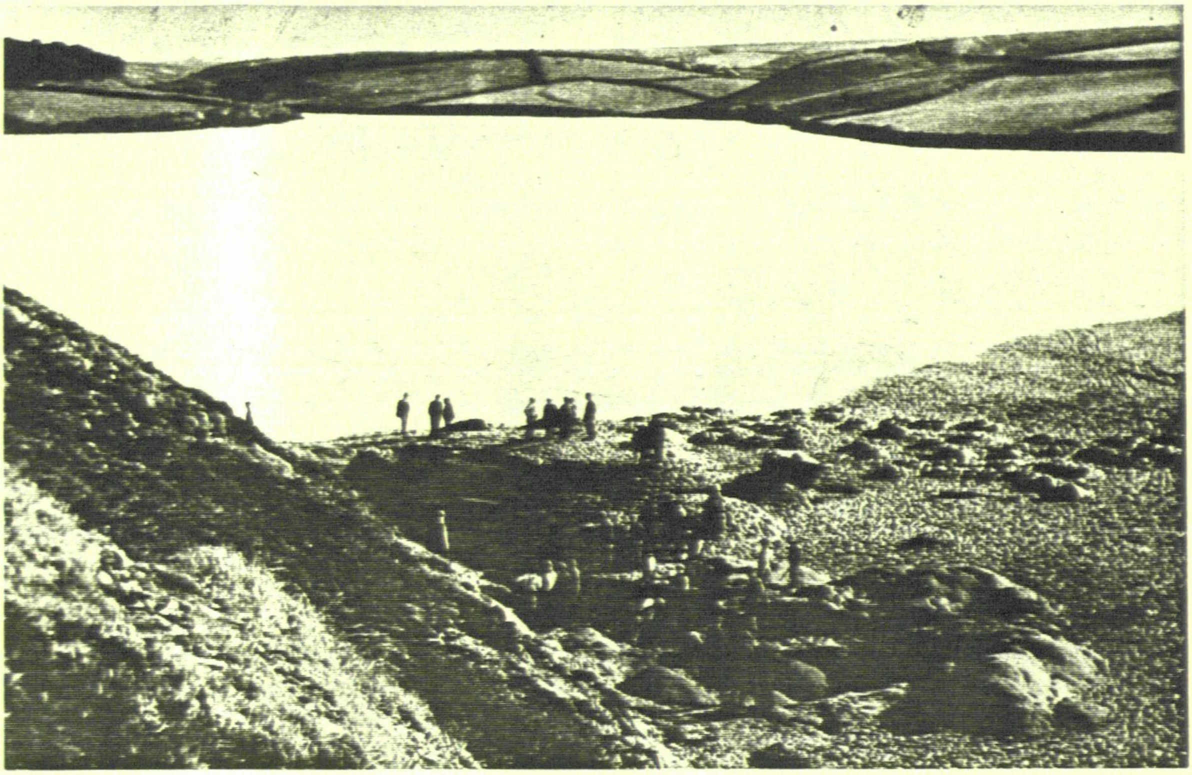


Plate 3.11: Clearing the mouth of the drainage adit in January 1924.

Plate 3.12: Clearing the outlet of the adit which had also been buried under large quantities of shingle. (From original photographs in Helston Folk Museum)

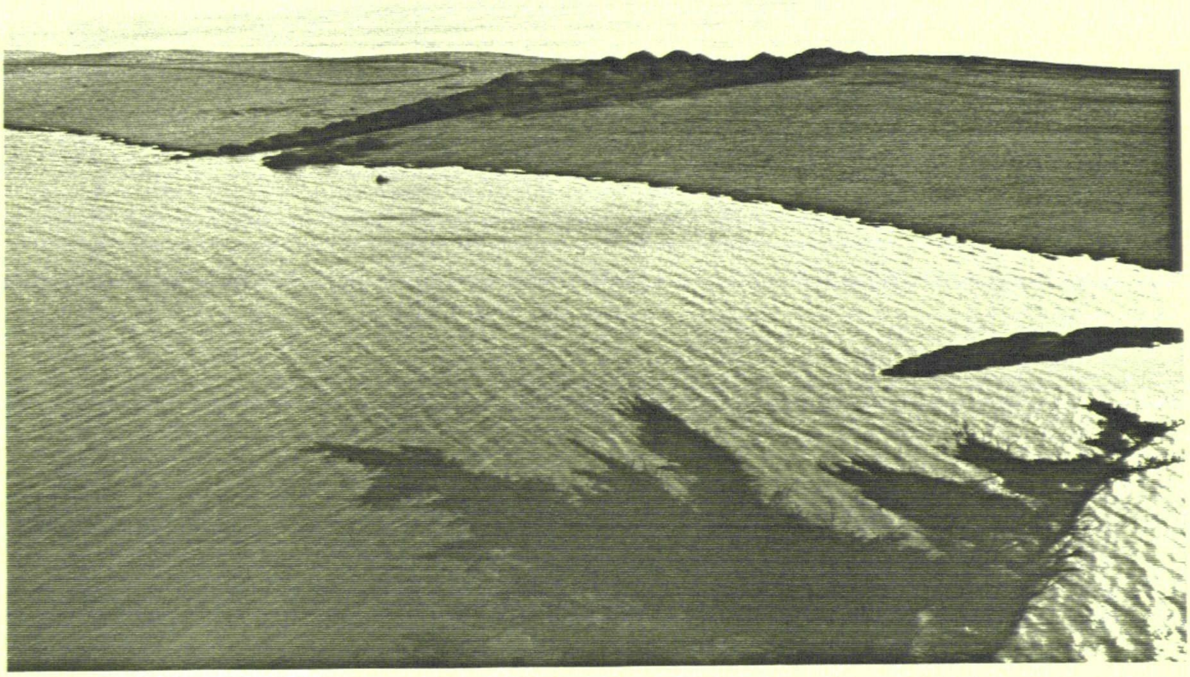


Plate 3.13: A severe storm again blocked the Loe Pool outlet in February 1979. The South West Water Authority cut a channel to lower the lake level in order that the adit mouth could be cleared.

Plate 3.14: Mechanical excavators being used to clear the adit entrance of shingle, February 1979.

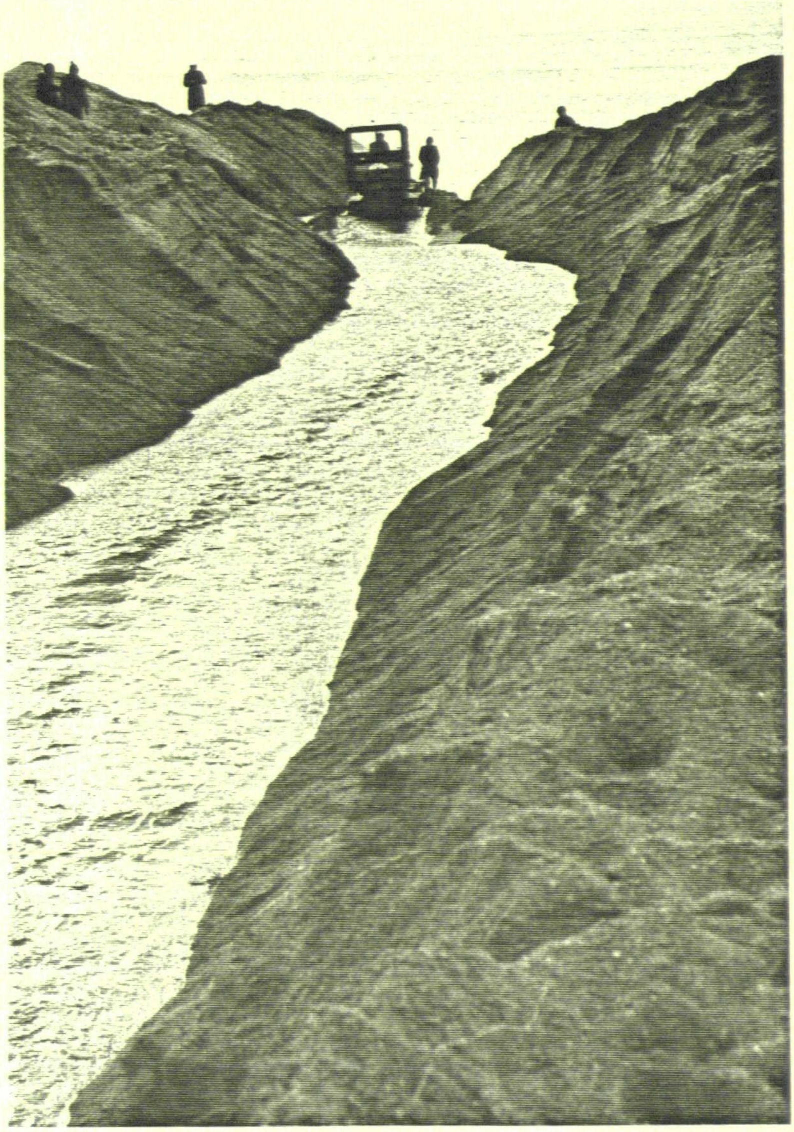


Plate 3.15: A bulldozer being used by the South West Water Authority to cut a channel through Loe Bar, February 1979.

Plate 3.15

Plate 3.16: A section through Loe Bar showing the laminated structure of alternating fine and coarse material, revealed in February 1979.

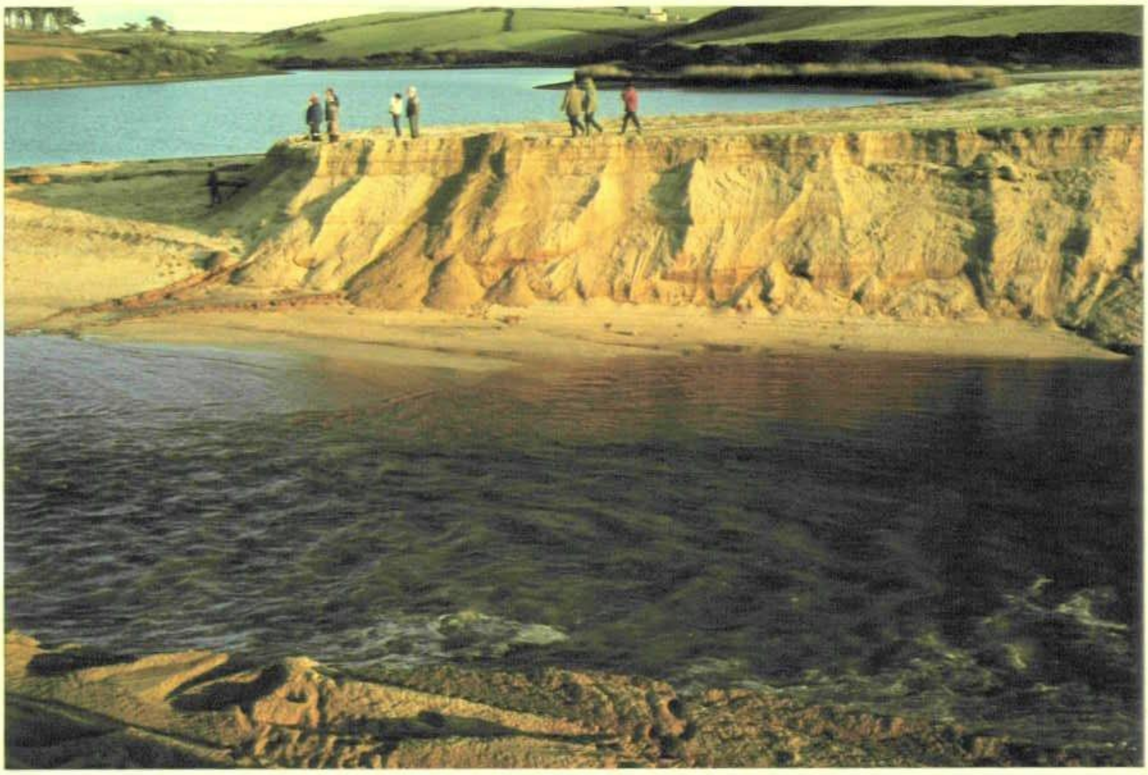


Plate 3.17: In December 1984, the drainage adit was again blocked and South West Water repeated the excavation of a channel through Loe Bar. On this occasion, the channel was deeper than that cut in 1979 and more of the bar structure was visible. Thick layers of the characteristically red coloured mine waste, deposited earlier in the century, were revealed. (Photograph: Dr. P.E. O'Sullivan)

Plate 3.17

Plate 3.18: December 1984. A more detailed view of the red silt and clay-rich layers which contributed greatly to the reduction in permeability of Loe Bar, and which were a consequence of mining activity within the catchment. (Photograph: Dr. P.E. O'Sullivan)

Plate 3.18

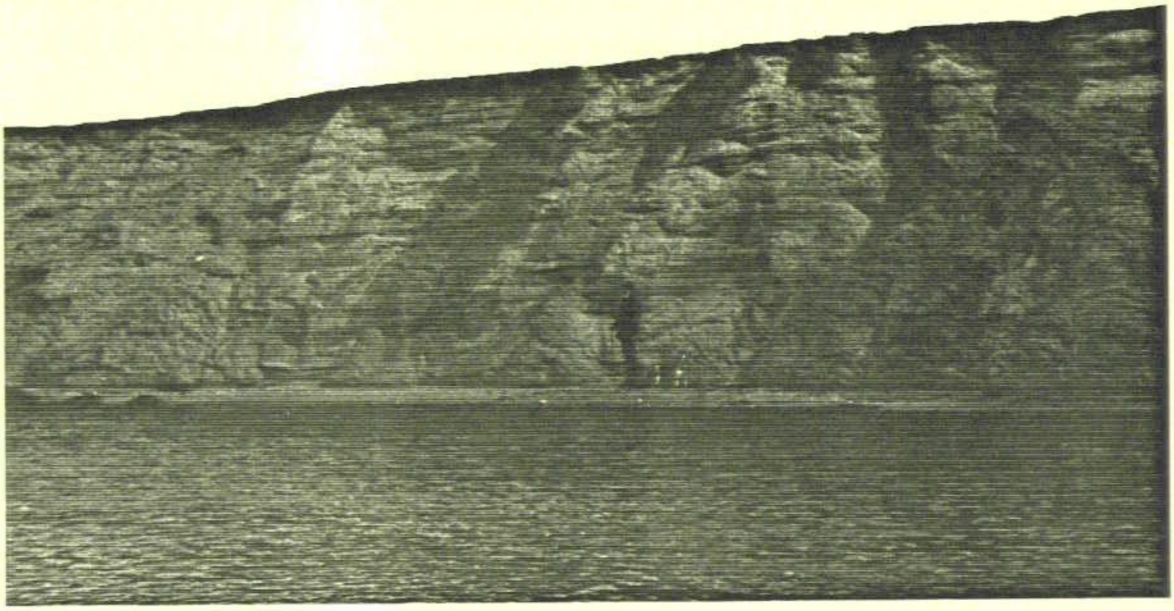


Plate 3.16: The structure of Loe Bar revealed in December 1984. The variation in grain size is clearly visible and reflects periods of storm overwash and aeolian deposition resulting in a gradual increase in the height of the bar. 19

Plate 3.19

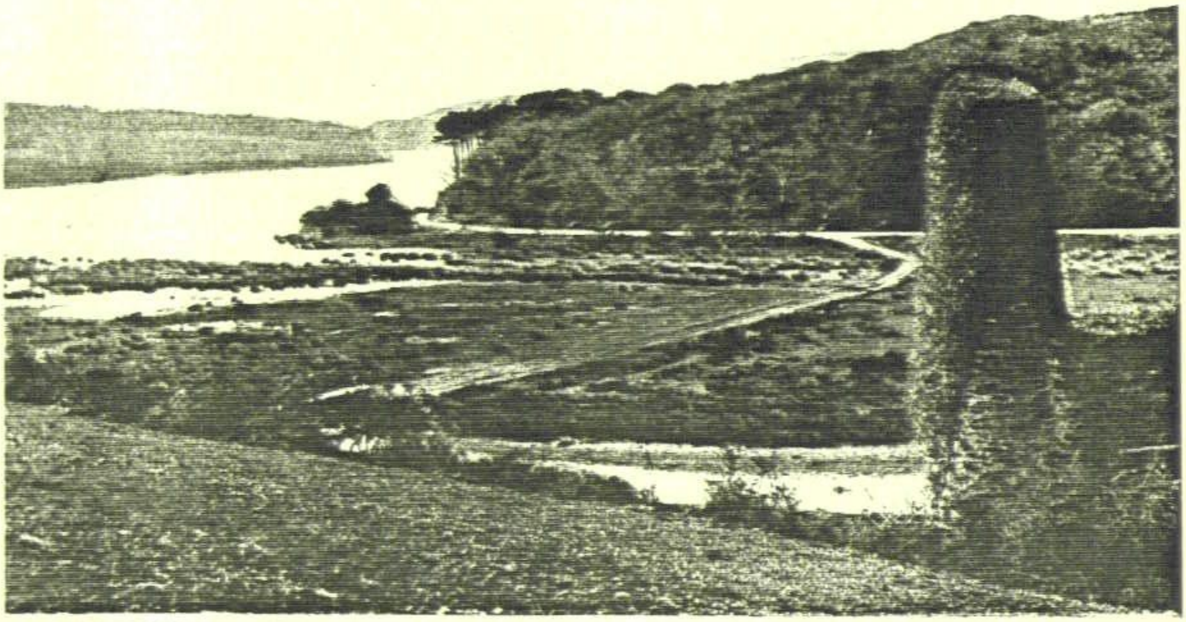


Plate 2.20: A postcard from the early part of the 20th century showing the head of Loe Pool and the poorly developed scrub vegetation on the floor of the Loe Valley. Part of the buildings associated with Wheal Pool can be seen in the foreground. The track which crosses the valley has since become disused and overgrown.

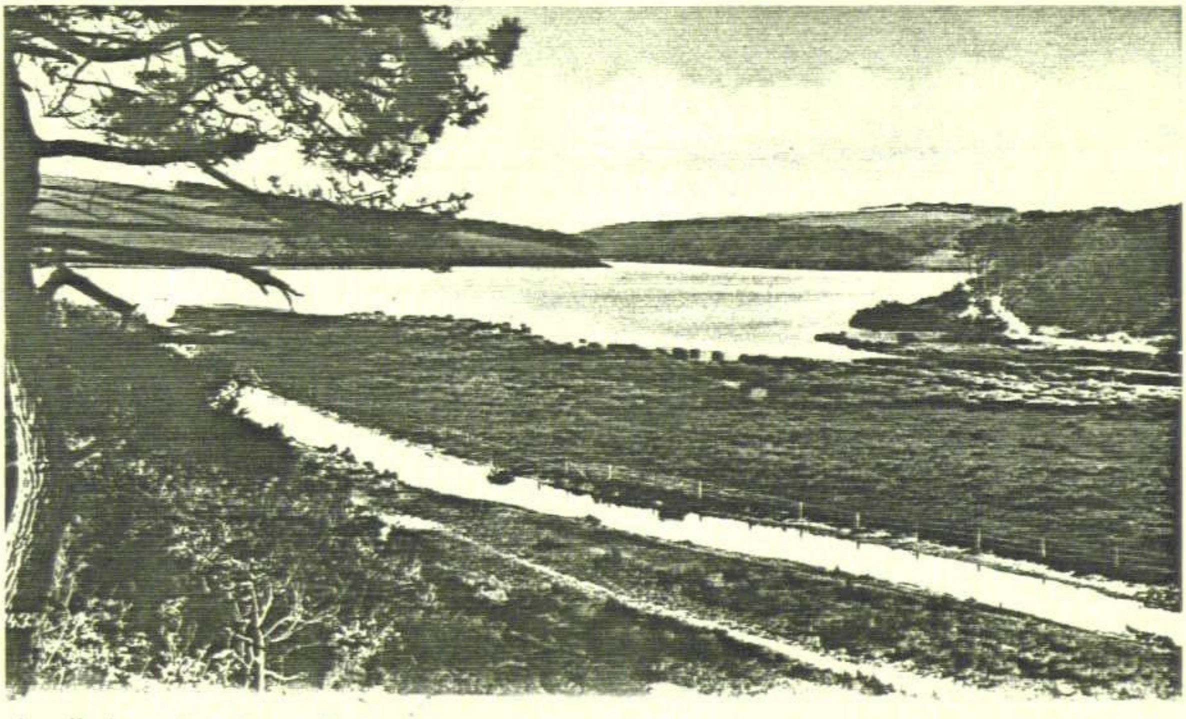


Plate 2.21: A slightly later (probably from the 1930's) view of the same area showing the mouth of the River Cober.

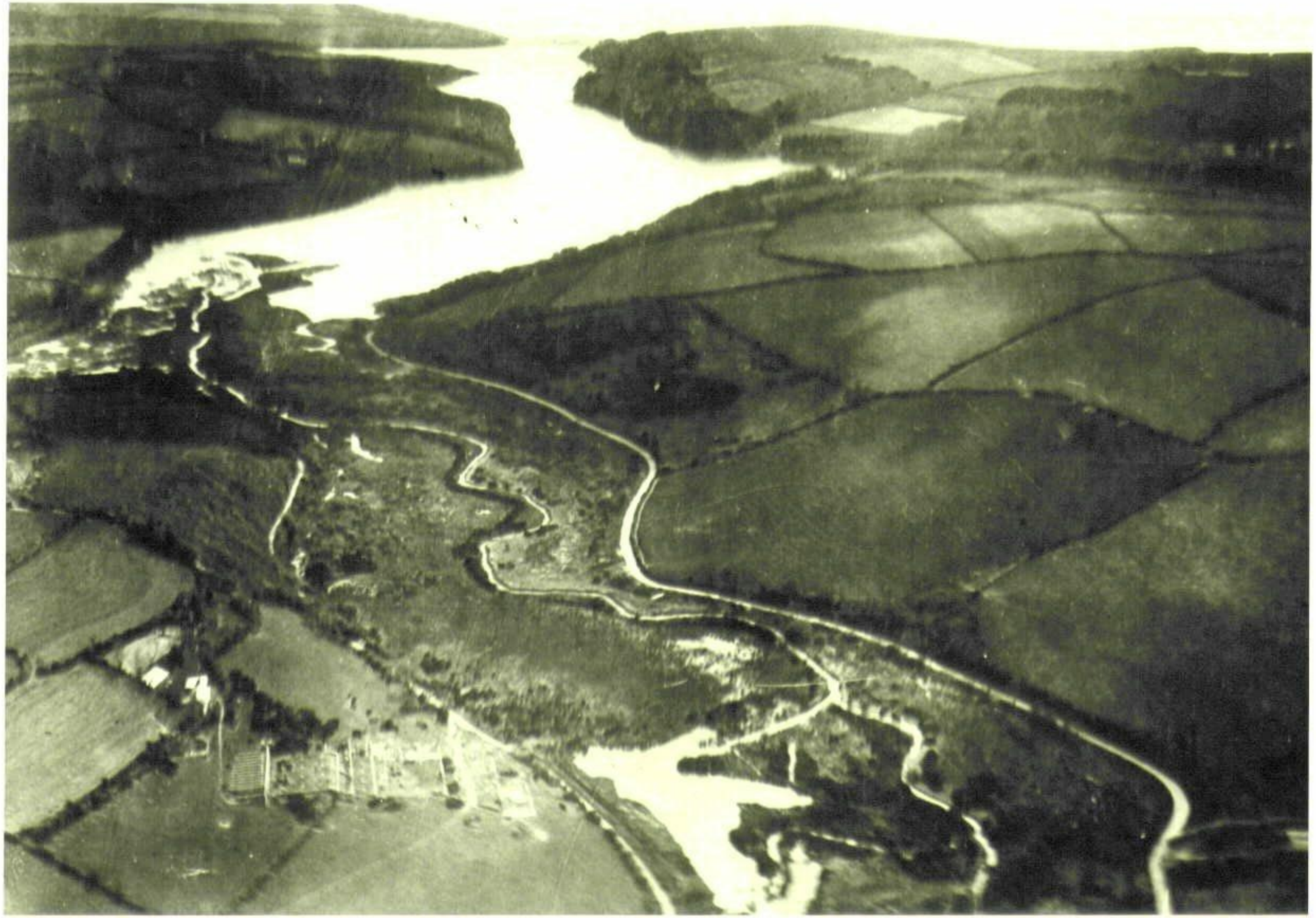


Plate 3.22: Aerial photograph of the Loe Valley, the mouth of the River Cober and Loe Pool thought to date from around the 1920's. In the left-hand foreground can be seen the works of the Helston Valley Tin Co., in operation from 1911-14.

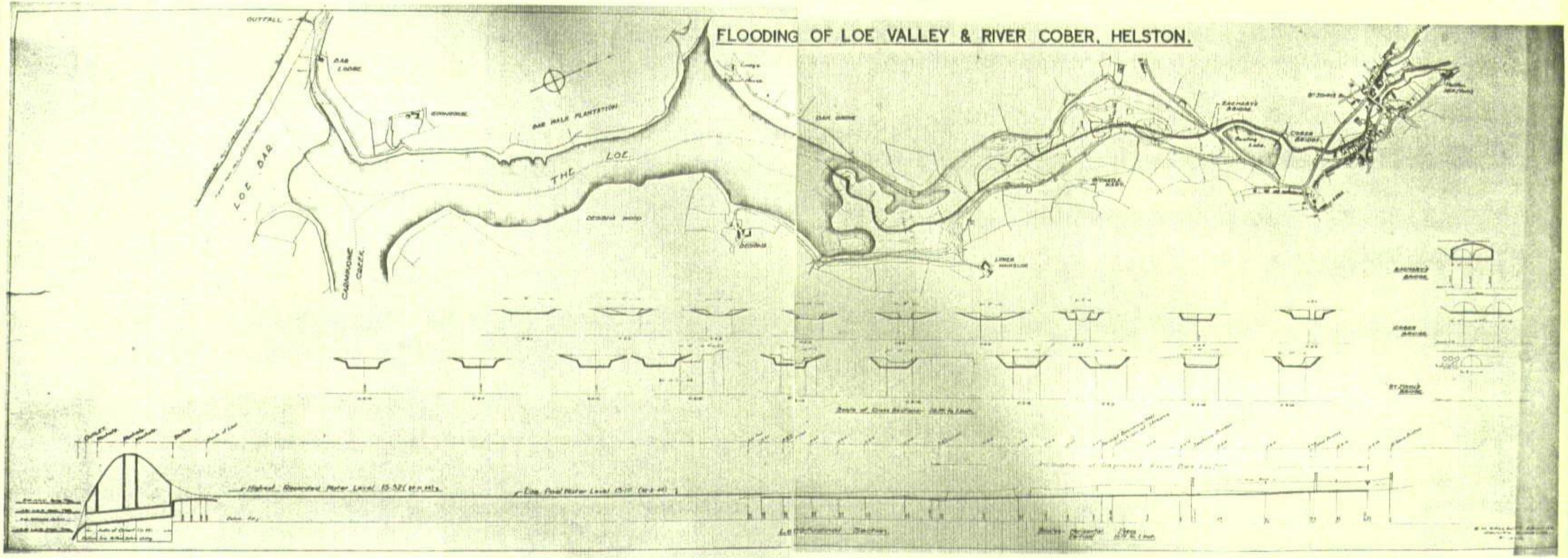


Plate 3.23: A map produced by the Cornwall County Surveyor in 1946 as part of a canalisation scheme which was implemented in 1946-47. The scheme was designed to ease the problem of the flooding of Helston following high winter discharge in the River Cober. This was to be effected by the straightening of portions of the river's course in the Loe Valley.

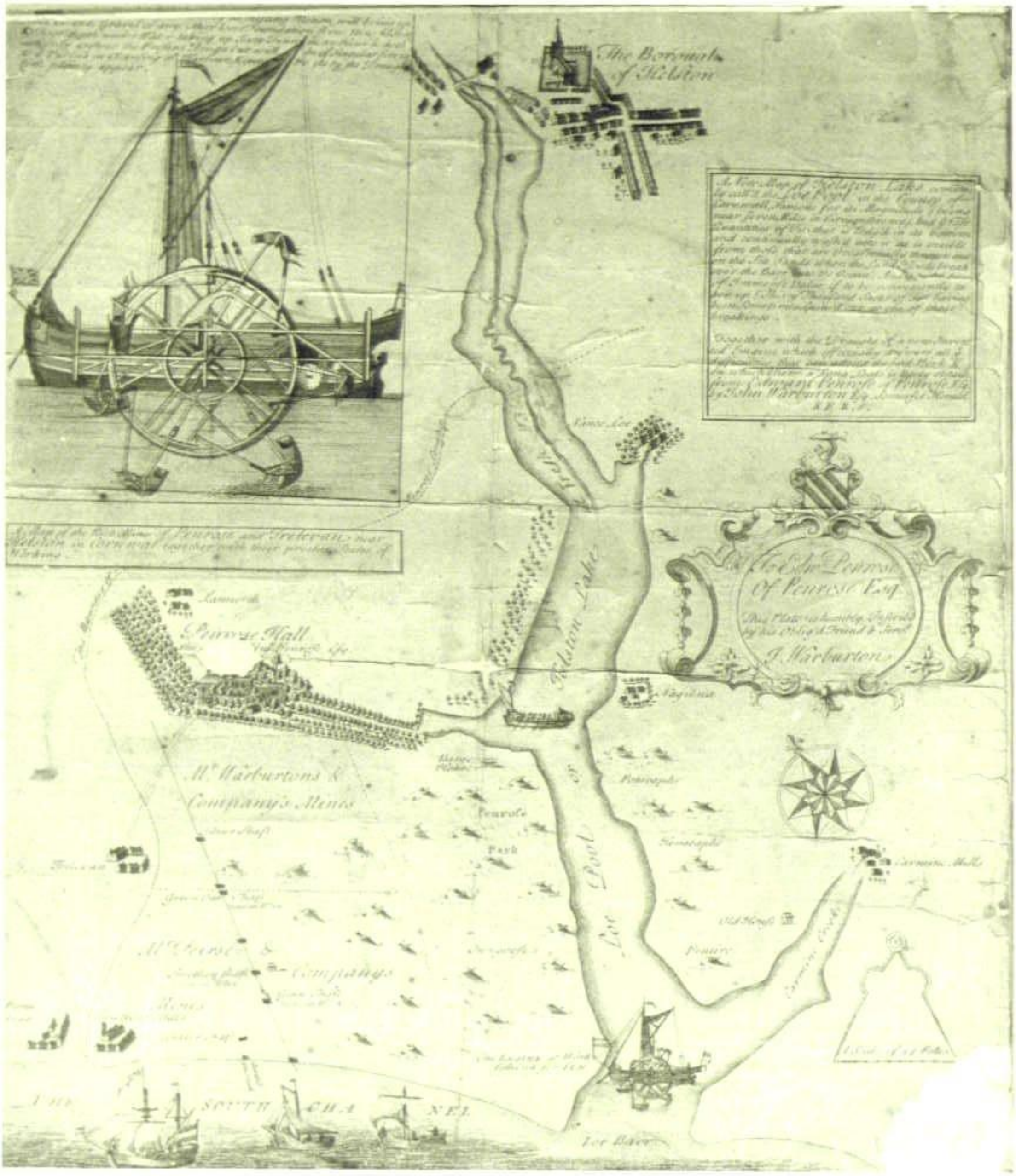


Plate 3.24: A map of Loe Pool and the mines of the area which formed part of a proposal (c. 1720) by John Warburton to dredge the lake for tin.

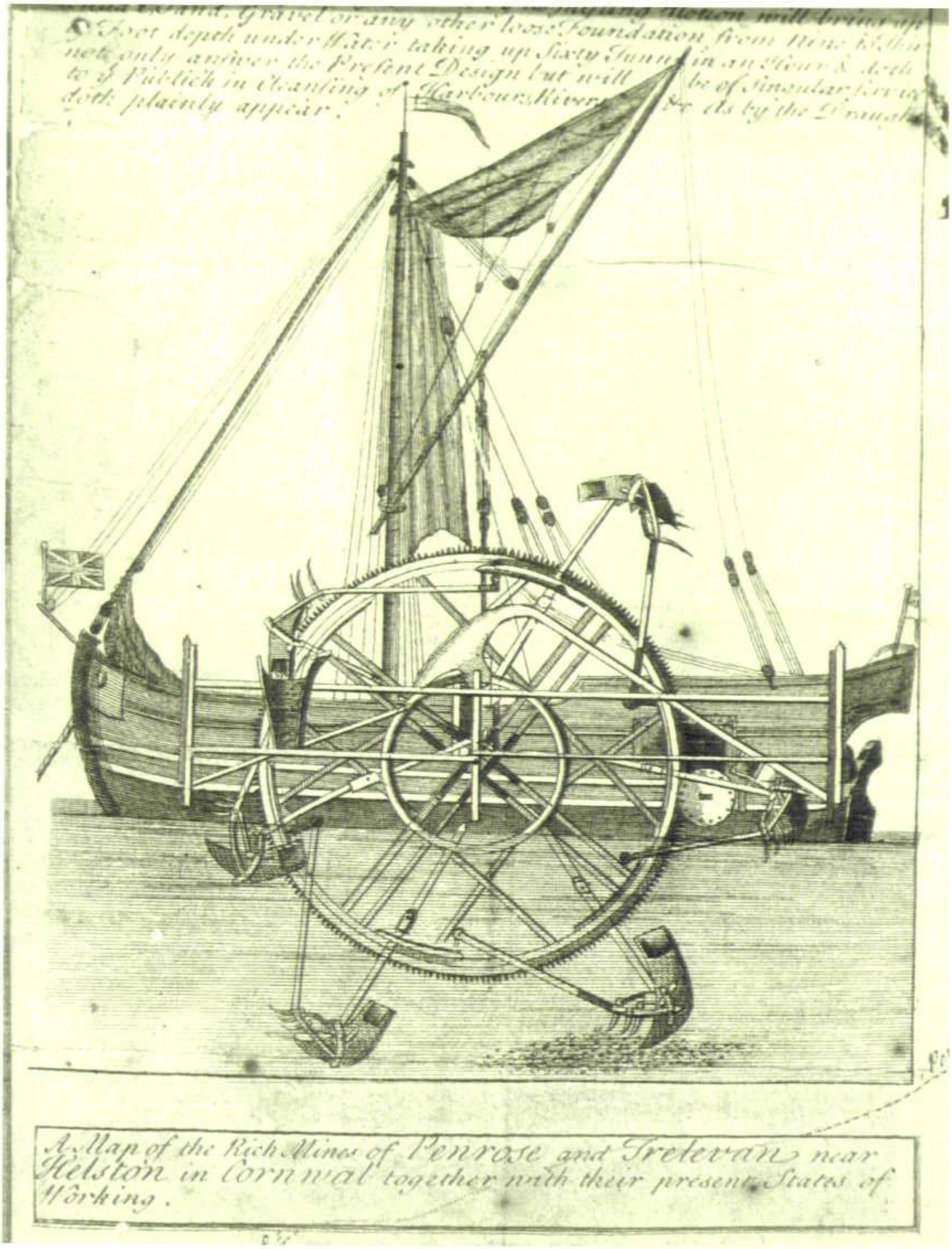


Plate 3.25: A detail from Plate 3.24 showing the dredge which John Warburton proposed to use in the retrieval of tin from the bed of Loe Pool.

Plate 3.25

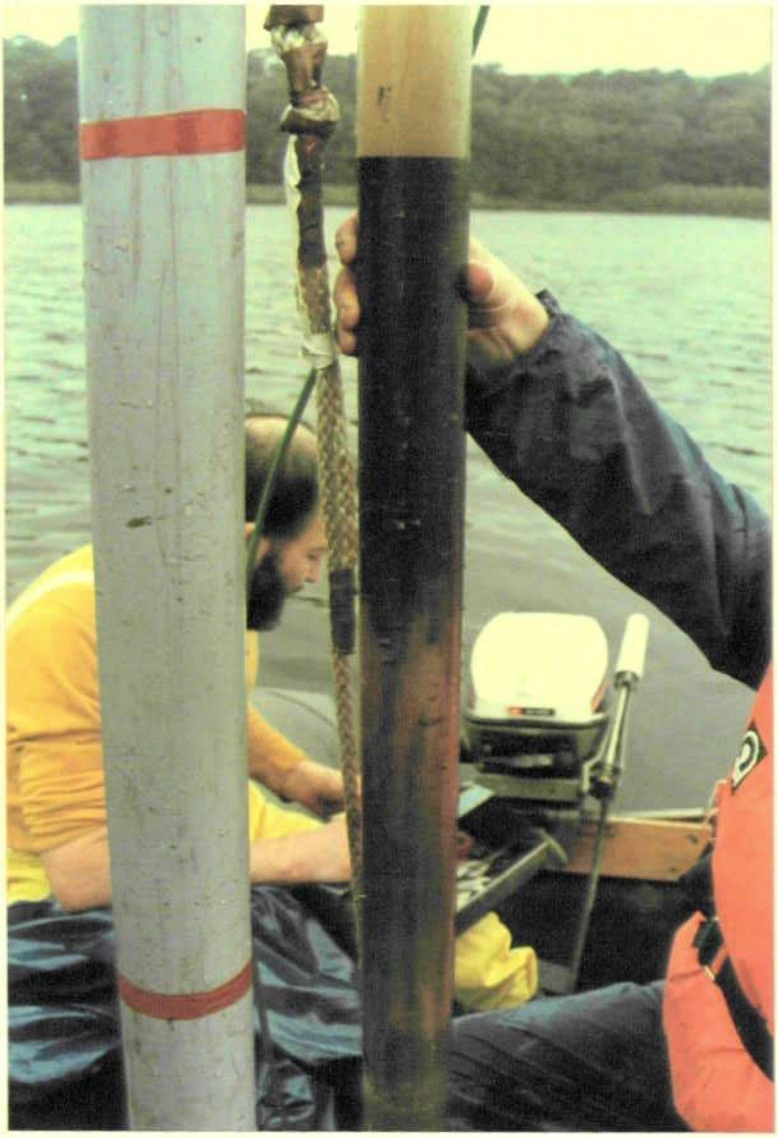


Plate 4.1: A 1m core taken using a Mackereth mini-corer. The marked difference in colour between the dark brown of Zone A and the red clays at the top of Zone B can clearly be seen. This type of corer causes considerable disturbance of the sediment structure.

Plate 4.1

Plate 4.2: A 'Russian' borer sample of the Loe Pool sediments showing material from the base of Zone B and, at the bottom of the sample, the start of the black/grey laminations which characterize Zone C.

Plate 4.3: An 'Icy-Finger' sampler, packed with solid carbon dioxide and acetone, prior to sediment sampling.

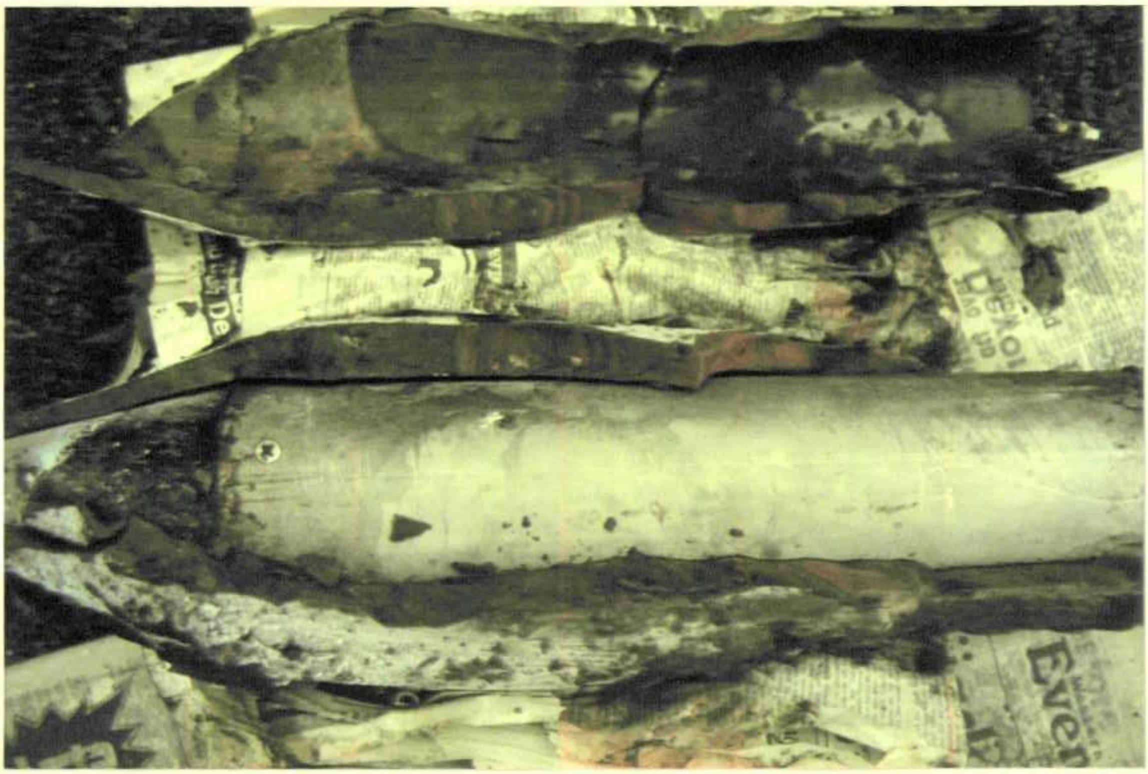


Plate 4.4: The type of sample retrieved using the 'Icy-Finger' sampler. The thickness of sample is determined by the length of time that the sampler remains buried in the sediment.

Plate 4.4

Plate 5.1 (a): Core LP3M3 (3m Mackereth core). Surface to 140cm depth. 10cm subsamples are shown with subsample numbers in parentheses. Some prominent laminations are numbered to enable comparison with other cores.

Plate 5.1(a)

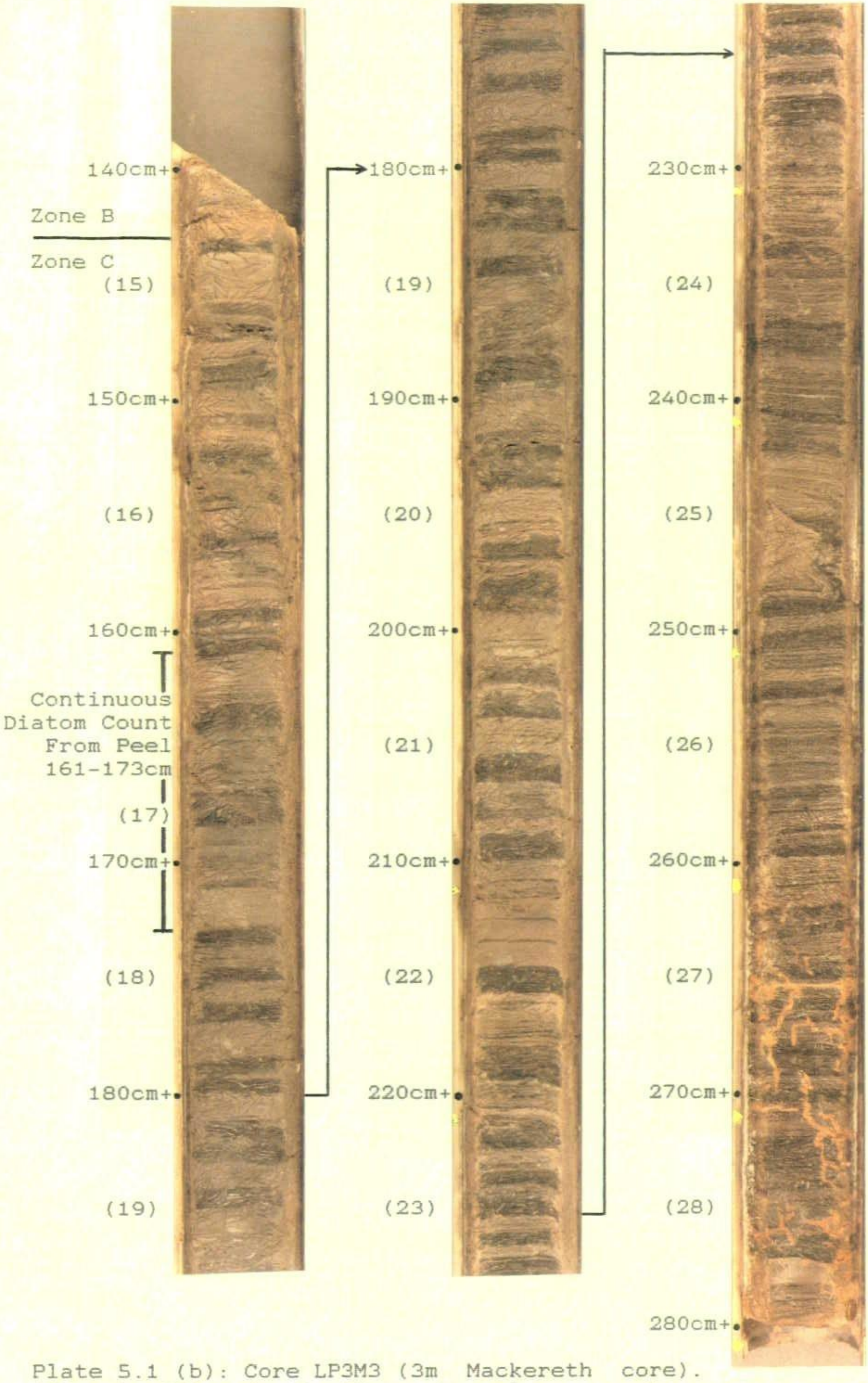


Plate 5.1 (b): Core LP3M3 (3m Mackereth core). 140cm to 280cm depth. 10cm subsamples are shown with subsample numbers in parentheses. The 12cm section (161-173cm) used for the diatom analysis detailed in Section 7.4, is also marked.

Plate 5.1(b)

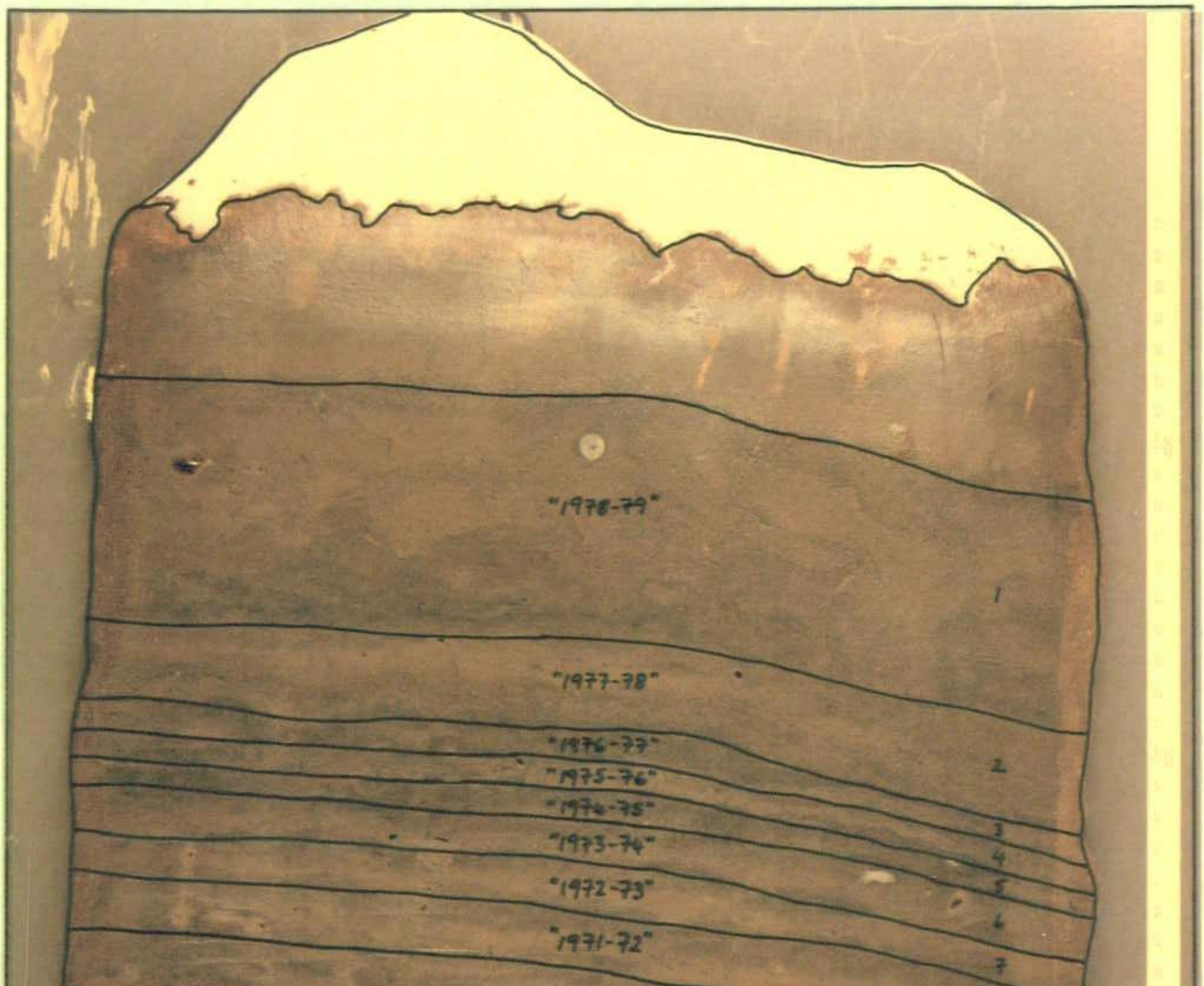


Plate 5.2: Core FBS7. The sample measures 42cm from the sediment-water interface to the base. A considerable amount of structure is preserved above the red clay, in Zone A.

Plate 5.2

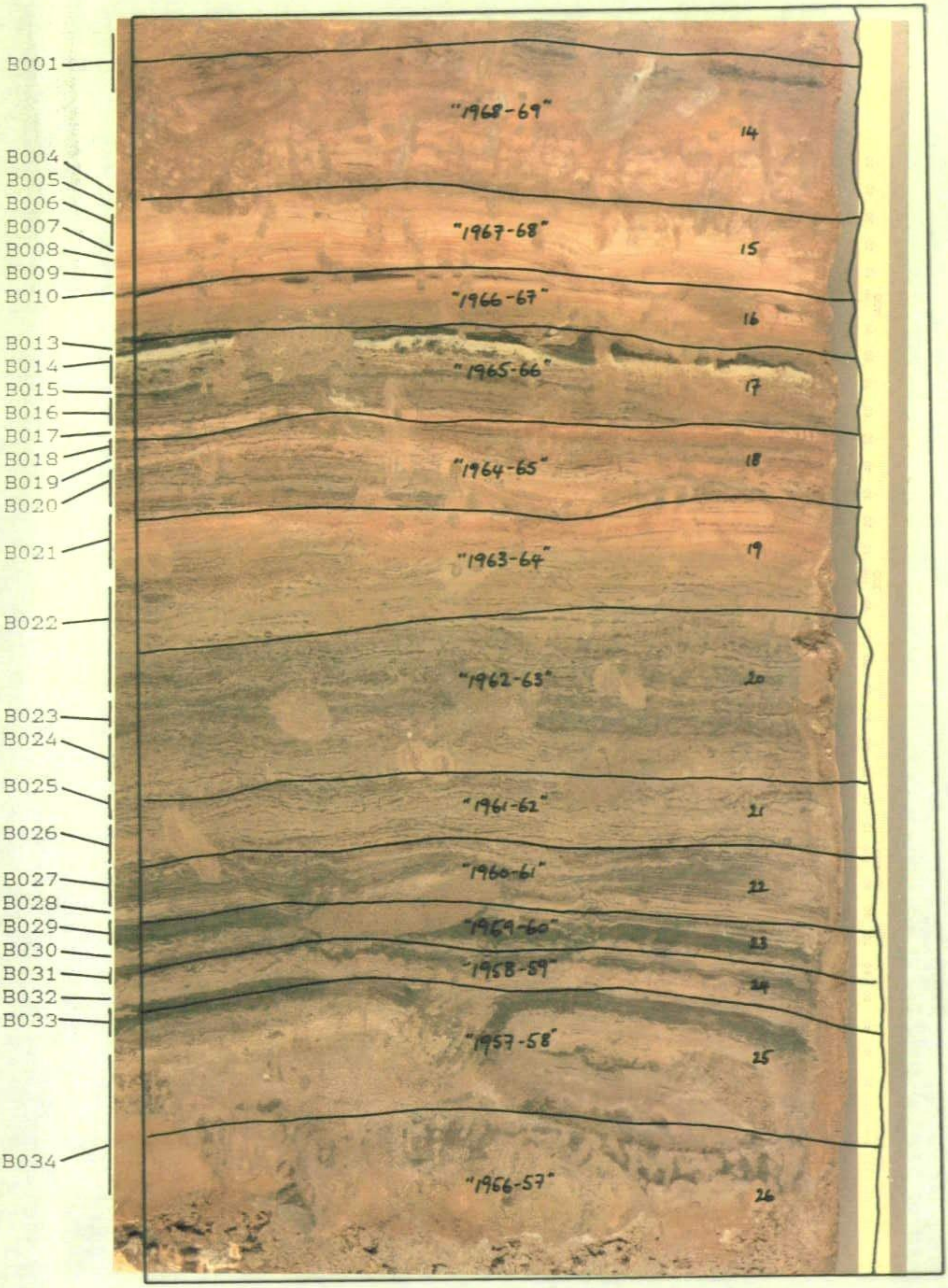


Plate 5.3: Core FBS9. The sample as shown is 45.4cm in length, and 25.5cm wide.

Plate 5.3

Plate 5.4: Core FBS3. The sample is 30cm wide and approximately 38.5cm from the sediment-water interface to the base. Zone A, above the red clay, shows considerable structure. However, the alternate brown and black layers are not annual in nature. Bioturbation can clearly be seen, with evidence of recent zoobenthic activity close to the surface.

Plate 5.4

Plate 5.5: Core FBS12. The sample measures 31cm in width and approximately 37cm from the sediment-water interface to the base. The majority of Zone A has been considerably bioturbed, but some structure is still visible towards the sediment surface. The burrows of benthic fauna can be seen penetrating into the red clays which mark the top of Zone B.

Plate 5.5

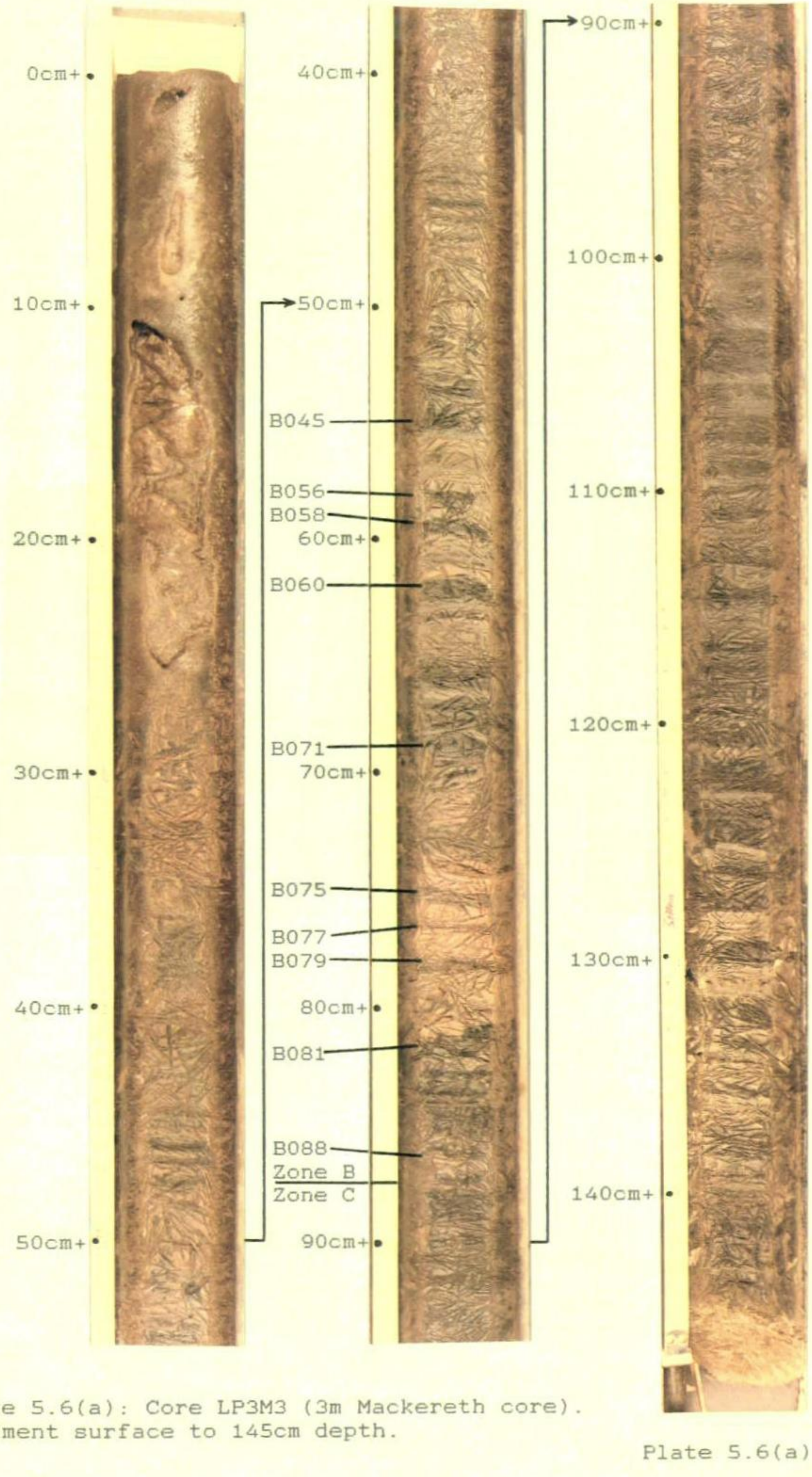


Plate 5.6(a): Core LP3M3 (3m Mackereth core). Sediment surface to 145cm depth.

Plate 5.6(a)

Plate 5.6 (b): Core LP3M4 (3m Mackereth core), 145cm to 294cm depth.

Plate 5.6(b)

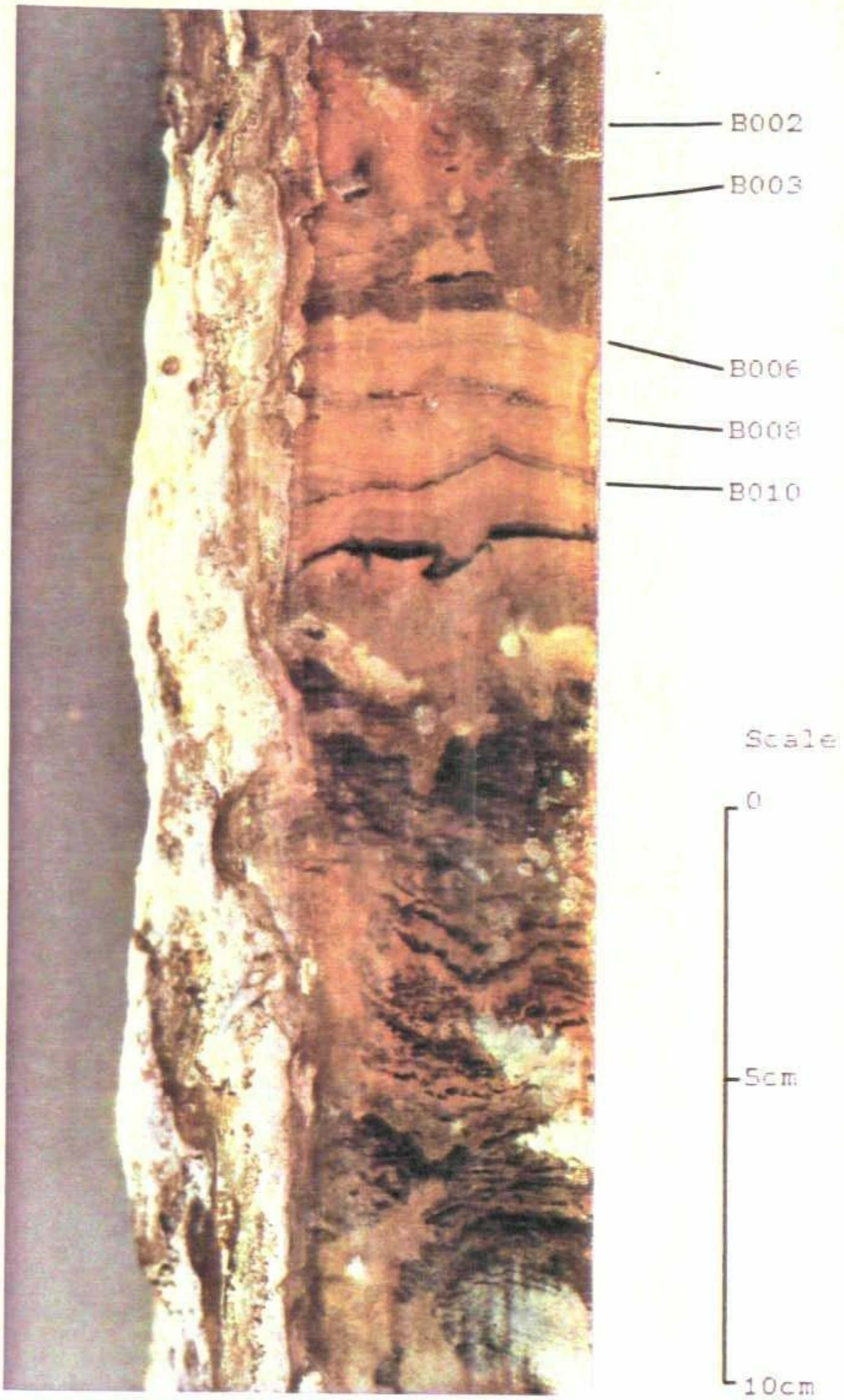


Plate 5.7: Core IF2. The photograph shows a tangential section through this cylindrical sample, taken using the 'icy-finger' sampler (see Plates 4.3 & 4.4). Despite considerable disturbance during sampling, some very fine stratigraphic detail is apparent. This section measures 24cm in length.

Plate 5.7

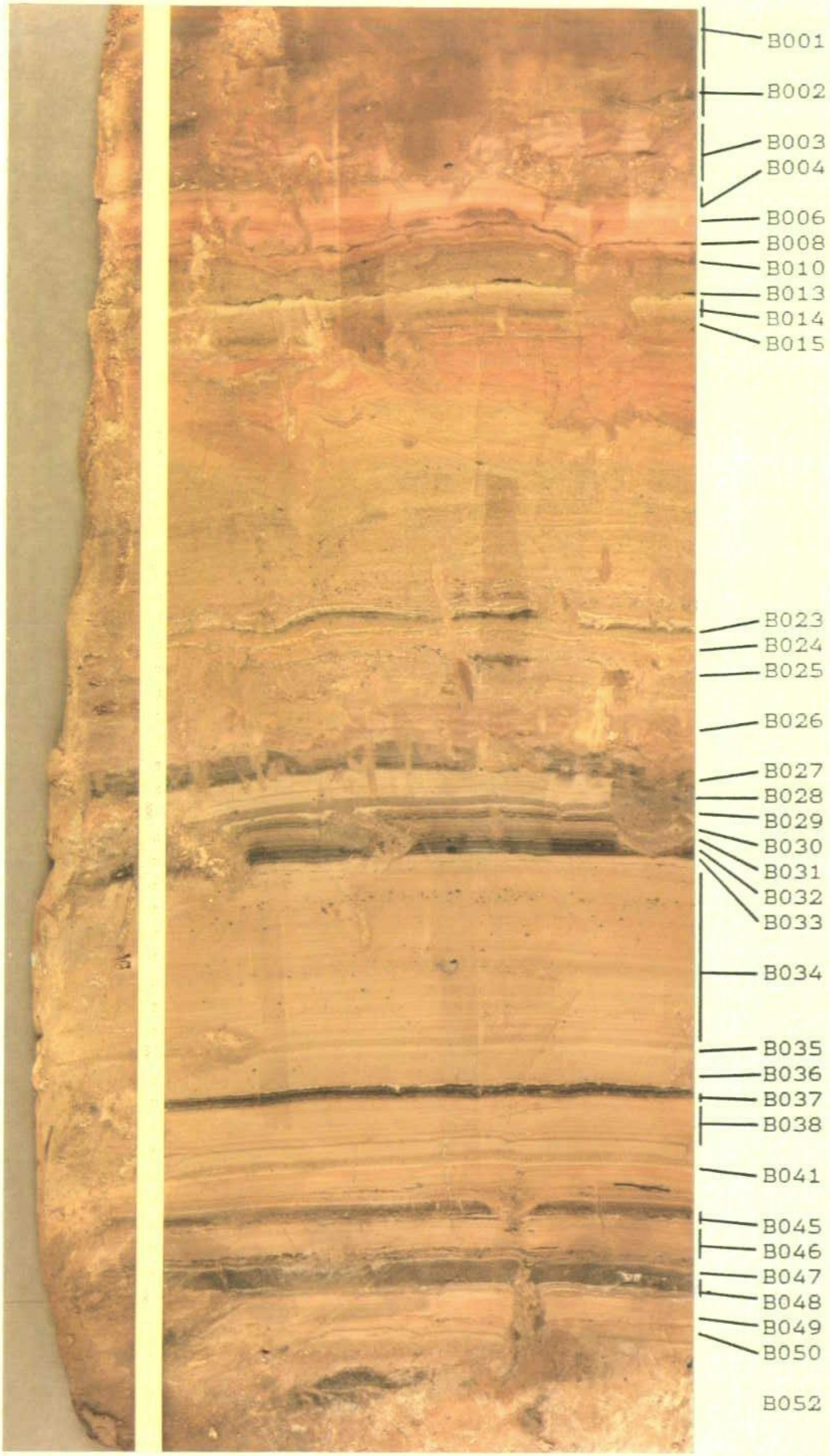


Plate 5.8: Core FBS14. The sample as shown is 27cm wide at the widest point and 60cm in length.

Plate 5.8

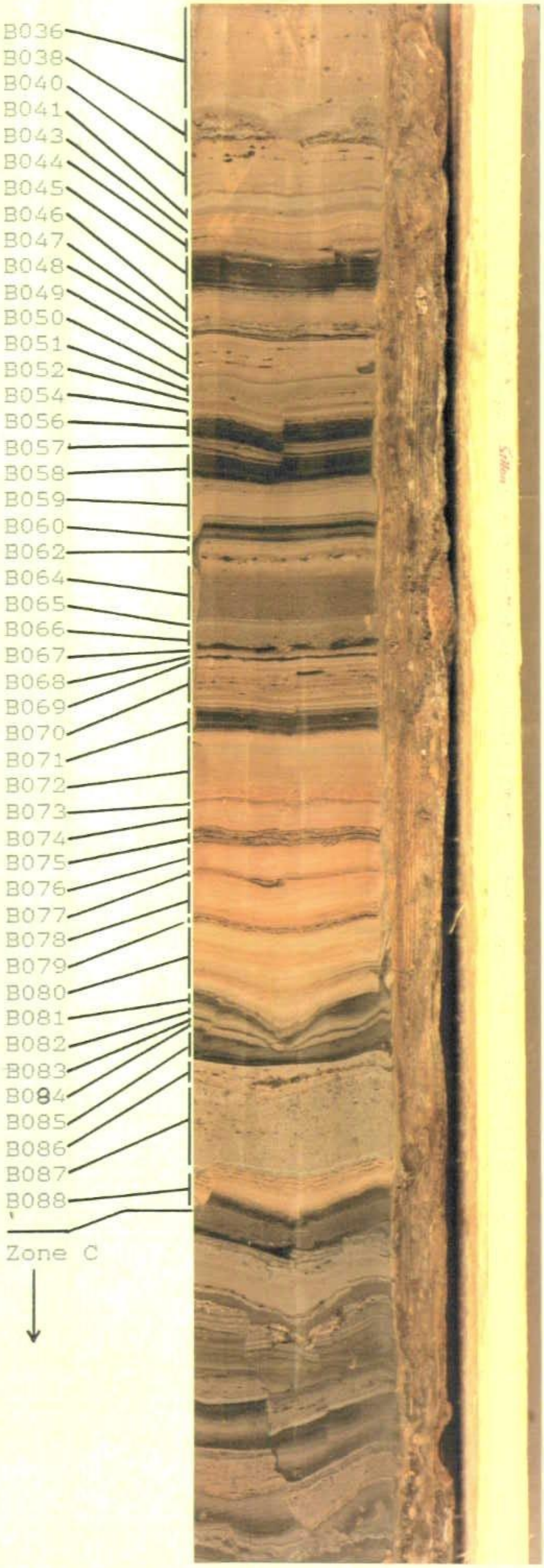


Plate. 5.9: Core IF6. A tangential section through this 'icy-finger' sample. The core as shown measures 56.5cm in length and the cleaned face is 8cm wide.

Plate. 5.9

Appendix 1

List of diatom taxa encountered during diatom counts

Melosira granulata (Ehr) Ralfs var. angustissima O. Müller

M. italica (Ehr) Kütz

M. juergensii Agardh

M. varians Agardh

Paralia (ex Melosira) sulcata (Ehr) Kütz

Podosira stelliger (Bailey) Mann

Drurigia compressa (West) Donkin

Thalassiosira pseudonana (Hust) Hasle and Heimdal

Cyclotella pseudostelligera Hust

C. stelligera Cleve et Grun

C. meneghiniana Kütz

Coscinodiscus sp.

Actinoptychus undulatus (Bailey) Ralfs

Chaetoceros müllerii Lemmermann

Rhabdonema minutum Kütz

Tabellaria fenestrata (Lyngb) Kütz
T. flocculosa (Roth) Kütz

Grammatophora serpentina (Ralfs) Ehr

Meridion circulare (Grev) Agardh

Diatoma elongatum (Lyngb) Agardh
D. haemale (Lyngb) Heiberg var. mesodon (Ehr) Grun
D. vulgare Bory

Opephora martyi Héribaud

Fragilaria brevistriata Grun
F. capucina Desmazières
F. pinnata Ehr

Synedra acus Kütz
S. parasitica (W. Smith) Hust var. subconstricta Grun
S. pulchella Ralfs ex Kütz
S. rumpens Kütz
S. tabulata (Agardh) Kütz
S. ulna (Nitz) Ehr
S. vaucheriae Kütz

Asterionella formosa Hass

Eunotia pectinalis (Dillwyn) Rabh

E. pectinalis (Dillwyn) Rabh var. minor (Kütz) Rabh

E. pectinalis var. ventralis (Ehr) Hust

E. exigua (Breb ex Kütz) Rabh

E. faba (Ehr) Grun

E. lunaris (Ehr) Grun

E. monodon Ehr

Cocconeis disculus Schum

C. placentula Ehr

Achnanthes affinis Grun

A. delicatula (Kütz) Grun

A. lanceolata (Breb.) Grun

A. linearis W. Smith

A. hungarica Grun

A. microcephala (Kütz) Grun

A. minutissima Kütz

Rhoicosphenia curvata (Kütz) Grun

Diploneis interrupta (Kütz) Cleve

D. ovalis (Hilse) Cleve

D. puella (Schum) Cleve

Amphipleura pelludica Kütz

Navicula anglica Ralfs

N. cryptocephala Kütz

N. gregaria Donkin

N. lanceolata (Agardh) Kütz

N. minima Grun

N. notha Wallace

N. peregrina (Ehr) Kütz

N. pupula Kütz

N. rhynchocephala Kütz

N. seminulum Grun

N. viridula Kütz

Pinnularia Brébissonii Hust

P. hilseana (Janisch) O. Müller

P. microstauron (Ehr) Cleve

P. stauroptera (Rabh) Cleve

P. subcapitata Gregory

P. viridis (Nitz) Ehr

Caloneis silicula (Ehr) Cleve

Gyrosigma acuminatum (Kütz) Rab

Amphora exigua Grun

A. ovalis Kütz

A. ovalis Kütz var. lybica (Ehr) Cleve

A. veneta (Kütz) Hust

Cymbella cuspidata Kütz

C. ventricosa Kütz

Gomphonema acuminatum Ehr

G. acuminatum Ehr var. coronata (Ehr) W. Smith

G. angustatum (Kütz) Rabh

G. constrictum Ehr

G. parvulum Kütz

G. tergestinum (Grun) Fricke

Epithemia turgida (Ehr) Kütz

Hantzschia amphyoxis (Ehr) Grun

Nitzschia amphibia Grun

N. hungarica Grun

N. kützingiana Hilse

N. palea (Kütz) W. Smith

Surirella capronii Breb

S. linearis W. Smith

S. ovata Kütz

Appendix 2

Diatom ecological preferences

The following diatom ecology profiles are based on the format designed by Lowe (1974). His reference list has been retained but with some additions. Lowe's information is included for those species for which he had already compiled ecological data. The majority of the diatom taxa that are listed in Appendix 1 are profiled here, including those of particular ecological interest. The references from which the information has been derived are given for each species and a key to the reference numbers is outlined below. Each of these references is included in full in the reference listings on pages 207-241.

.1 Blum (1957)
.2 Bock (1952)
.3 Budde (1931)
.4 Cholnoky (1968)
.5 Christiansen & Reimer (1968)
.6 Cupp (1943)
.7 Fjerdingstadt (1950)
.8 Foged (1948)
.9 Foged (1949)
.10 Foged (1953)
.11 Foged (1954)
.12 Foged (1958)
.13 Foged (1964)

.14 Foged (1968a)

.15 Foged (1968b)

.16 Gemeinhardt (1926)

.17 Hasle & Heimdal (1970)

.18 Hohn & Hellerman (1963)

.19 Hornung (1959)

.20 Hustedt (1937-38)

.21 Hustedt (1939)

.22 Hustedt (1942)

.23 Hustedt (1949)

.24 Hustedt (1955)

.26 Hustedt (1957)

.27 Jørgensen (1948)

.28 Jørgensen (1952)

.29 Kolbe (1927)

.30 Kolkwitz (1914)

.31 Kolkwitz & Marsson (1908)

.32 Lowe & Crang (1972)

.33 McIntire (1966)

.34 Manguin (1952)

.35 Meriläinen (1967)

.36 Niessen (1956)

.37 Patrick & Freese (1961)

.38 Patrick & Reimer (1966)

.39 Petersen (1943)

.40 Proschkina-Lavrenko (1959)

.41 Raabe (1951)

.42 Reimann _et al_. (1963)

.43 Scheele (1952)

.44 Schmidtz (1959)

.45 Schroeder (1939)

.46 Simonsen (1962)

.47 Stoemer & Yang (1970)

.48 Weber (1970)

.49 Van der Werff & Hulls (1958-66)

.50 Kjemperud (1977)

Taxon Melosira granulata (Ehr) Ralfs var. angustissima O. Müller

		7	8	9	11	14	24	26	27	34	41	49	Concensus & Notes
pH	Acidobiontic												Alkaliphilous range 6.2-9.0 (8,27)
	Acidophilous												
	Indifferent												
	Alkaliphilous		■	■	■	■		■	■				
	Alkalibiontic												
Nutrient	Eutrophic						■	■	■				Eutrophic
	Mesotrophic												
	Oligotrophic												
	Dystrophic												
Halobion	Polyhalobous												Indifferent
	Euhalobous												
	Mesohalobous												
	alpha range												
	beta range												
	Oligohalobous							■					
	halophilous												
	indifferent		■	■	■	■				■			
	halophobous												
	Euryhalobous												
Saprobien	Polysaprobic												Mesosaprobic
	Mesosaprobic												
	alpha range	■											
	beta range	■											
	Oligosaprobic												
	Saprophilic												
	Saproxenous												
	Saprophobic												
Current	Limnobiontic		■		■								Limnobiontic
	Limnophilous												
	Indifferent												
	Rheophilous												
	Rheobiontic												
General Habitat	Marine												Ponds + Lakes
	Estuary												
	Lake								■				
	Pond								■				
	River												
	Spring & Stream												
	Aerophilous												
	Other												
Specific Habitat	Euplanktonic						■		■	■	■		Euplanktonic
	Tychoplanktonic												
	Periphitic												
	epipelic												
	epilithic												
	epidendric												
	epizootic												
	epiphitic												
	attached												
	unattached												
Dist.	Winter												
	Spring												
	Summer												
	Autumn												
Temperature	Euthermal												
	Mesothermal												
	Oligothermal												
	Stenothermal												
	Metathermal												
	Eurythermal												
	Undesignated												
Salinity	M												Fresh-Brackish
	MB												
	BM												
	B												
	BZ												
	ZB											■	
	Z												

Geographical distribution and additional comments:

Cosmopolitan (24)

Taxon *Melosira italica (Ehr) Kütz*

		4	8	10	11	12	13	20	24	26	29	31	34	49	Concensus & Notes
pH	Acidobiontic														Alkaliphilous to Indifferent Range 6.7-8.0 (4, 8) opt >8 (4) 5.0-8.5 (49)
	Acidophilous														
	Indifferent		■		■		■			■					
	Alkaliphilous	■		■		■	■			■					
	Alkalibiontic														
Nutrient	Eutrophic														Mesotrophic
	Mesotrophic													■	
	Oligotrophic														
	Dystrophic														
Halobion	Polyhalobous														Indifferent to Halophobous
	Euhalobous														
	Mesohalobous													■	
	alpha range														
	beta range														
	Oligohalobous										■			■	
	halophilous														
	indifferent			■	■		■						■		
	halophobous						■			■					
	Euryhalobous														
Saprobien	Polysaprobic														Oligosaprobic to Saproxenous
	Mesosaprobic														
	alpha range														
	beta range														
	Oligosaprobic											■		■	
	Saprophilic														
	Saproxenous									■					
	Saprophobic														
Current	Limnobiontic														Indifferent
	Limnophilous														
	Indifferent		■		■										
	Rheophilous														
	Rheobiontic														
General Habitat	Marine														Lakes Ponds Rivers and Ditches
	Estuary														
	Lake							■							
	Pond							■							
	River							■							
	Spring & Stream														
	Aerophilous														
	Other							■							
Specific Habitat	Euplanktonic														Periphytic to Tychoplanktonic
	Tychoplanktonic						■						■		
	Periphitic						■	■	■				■		
	epipelic														
	epilithic														
	epidendric														
	epizootic														
	epiphitic														
	attached														
	unattached														
Seasonal Dist.	Winter														
	Spring														
	Summer														
	Autumn														
Temperature	Euthermal														
	Mesothermal														
	Oligothermal														
	Stenothermal														
	Metathermal														
	Eurythermal														
	Undesignated														
Salinity	M														Fresh-Brackish
	MB														
	BM														
	B														
	BZ														
	ZB													■	
	Z														

Geographical distribution and additional comments:

Cosmopolitan (24); indifferent to iron concentration (36); from fairly cold temperate climates (13.)

Ca 0-140 mg/l (49)
Fe 0-5.0
Si 0-2.0

Taxon **Melosira juergensii Agardh**

		References 49	46	Concensus & Notes
pH	Acidobiontic			
	Acidophilous			
	Indifferent			
	Alkaliphilous			
	Alkalibiontic			
Nutrient	Eutrophic	▨		
	Mesotrophic			Eutrophic
	Oligotrophic			
	Dystrophic			
Halobion	Polyhalobous			
	Euhalobous			
	Mesohalobous	■		β-mesohalobous
	alpha range			
	beta range		■	
	Oligohalobous			
	halophilous			
	indifferent			
	halophobous			
	Euryhalobous			
Saprobien	Polysaprobic			
	Mesosaprobic	■		
	alpha range			Mesosaprobic
	beta range			
	Oligosaprobic			
	Saprophilic			
	Saproxenous			
	Saprophobic			
Current	Limnobiontic			
	Limnophilous			
	Indifferent			
	Rheophilous			
	Rheobiontic			
General Habitat	Marine			
	Estuary			
	Lake			
	Pond			
	River			
	Spring & Stream			
	Aerophilous			
	Other			
Specific Habitat	Euplanktonic			
	Tychoplanktonic			
	Periphitic			
	epipelic			
	epilithic			
	epidendric			
	epizootic			
	epiphitic			
	attached			
	unattached			
Dist.	Winter			
	Spring			
	Summer			
	Autumn			
Temperature	Euthermal			
	Mesothermal			
	Oligothermal			
	Stenothermal			
	Metathermal			
	Eurythermal			
	Undesignated			
Salinity	M			
	MB			
	BM			Brackish
	B	■		
	BZ			
	ZB			
	Z			

Geographical distribution and additional comments:

Taxon Melosira varians Agardh

References

		1	2	4	8	9	11	14	19	20	21	26	27	29	31	34	39	41	43	45	46	49								Concensus & Notes
pH	Acidobiontic																													Alkaliphilous range 6.4-9.0 (8,27,43) optimum about 8.5 (4) range 5.0->9.0 (49) opt 6.7-8.5 (49)
	Acidophilous																													
	Indifferent																													
	Alkaliphilous			■	■	■	■	■	■			■	■						■	■		■								
	Alkalibiontic																													
Nutrient	Eutrophic			■					■	■	■		■									■								Eutrophic
	Mesotrophic																													
	Oligotrophic																													
	Dystrophic																													
Halobion	Polyhalobous																													Indifferent
	Euhalobous																													
	Mesohalobous			■																		■								
	alpha range																													
	beta range																													
	Oligohalobous											■		■		■					■	■								
	halophilous																													
	indifferent				■	■	■	■									■		■	■										
	halophobous																													
	Euryhalobous																													
Saprobien	Polysaprobic											■									■									B-Mesosaprobic but showing a great range
	Mesosaprobic																		■			■								
	alpha range																			■										
	beta range		■							■	■				■	■				■										
	Oligosaprobic	■							■																					
	Saprophilic																													
	Saproxenous																													
	Saprophobic								■																					
Current	Limnobiontic																													Indifferent
	Limnophilous																													
	Indifferent				■		■																							
	Rheophilous								■																					
	Rheobiontic																													
General Habitat	Marine																													Lakes, Ponds, Springs, Streams, Ditches
	Estuary																													
	Lake									■									■											
	Pond									■																				
	River									■																				
	Spring & Stream																		■											
	Aerophilous																													
	Other									■																				
Specific Habitat	Euplanktonic																													Periphytic
	Tychoplanktonic															■														
	Periphitic								■		■	■							■											
	epipelic																													
	epilithic																													
	epidendric																													
	epizootic																													
	epiphitic												■																	
	attached																													
	unattached																													
Dist.	Winter																													Summer form
	Spring																			■										
	Summer	■																■		■										
	Autumn																	■												
Temperature	Euthermal																													Eurythermal and Oligothermal to Mesothermal
	Mesothermal																		■											
	Oligothermal																		■											
	Stenothermal																													
	Metathermal																													
	Eurythermal																		■											
	Undesignated																													
Salinity	M																													Fresh-Brackish
	MB																													
	BM																													
	B																													
	BZ																													
	ZB																					■								
	Z																													

Geographical distribution and additional comments:

Cosmopolitan (21); euryoxybiontic (25); indifferent to iron concentration (36); Probably an obligate nitrogen heterotroph (4); has an extraordinarily large ecological range which on the one hand has massive growths in eutrophic waters in the summer and on the other hand, large growths in katharobic water in January + February (19)

Taxon Paralia sulcata (Ehr) Kütz (Ex Melosira sulcata)

		References			Concensus & Notes
		49	50	46	
pH	Acidobiontic				
	Acidophilous				
	Indifferent				
	Alkaliphilous				
	Alkalibiontic				
Nutrient	Eutrophic				
	Mesotrophic				
	Oligotrophic				
	Dystrophic				
Halobion	Polyhalobous		■	■	
	Euhalobous	■			Euhalobous
	Mesohalobous				
	alpha range				
	beta range				
	Oligohalobous				
	halophilous				
	indifferent				
	halophobous				
	Euryhalobous			■	
Saprobien	Polysaprobic				
	Mesosaprobic				
	alpha range				
	beta range				
	Oligosaprobic				
	Saprophilic				
	Saproxenous				
	Saprophobic				
Current	Limnobiontic				
	Limnophilous				
	Indifferent				
	Rheophilous				
	Rheobiontic				
General Habitat	Marine				
	Estuary				
	Lake				
	Pond				
	River				
	Spring & Stream				
	Aerophilous				
	Other				
Specific Habitat	Euplanktonic		■		
	Tychoplanktonic				
	Periphitic				
	epipelic				
	epilithic				
	epidendric				
	epizootic				
	epiphitic				
	attached				
	unattached				
Dist.	Winter				
	Spring				
	Summer				
	Autumn				
Temperature	Euthermal				
	Mesothermal				
	Oligothermal				
	Stenothermal				
	Metathermal				
	Eurythermal				
	Undesignated				
Salinity	M	■	■		
	MB				
	BM				Marine
	B				
	BZ				
	ZB				
	Z				

Geographical distribution and additional comments:

Taxon Podosira stelliger (Bailey) Mann

	References 49	Concensus & Notes
Acidobiontic		
Acidophilous		
Indifferent		
Alkaliphilous		
Alkalibiontic		
Eutrophic		
Mesotrophic		
Oligotrophic		
Dystrophic		
Polyhalobous		
Euhalobous	■	
Mesohalobous		
alpha range		Euhalobous
beta range		
Oligohalobous		
halophilous		
indifferent		
halophobous		
Euryhalobous		
Polysaprobic		
Mesosaprobic		
alpha range		
beta range		
Oligosaprobic		
Saprophilic		
Saproxenous		
Saprophobic		
Limnobiontic		
Limnophilous		
Indifferent		
Rheophilous		
Rheobiontic		
Marine	■	
Estuary		
Lake		
Pond		
River		
Spring & Stream		
Aerophilous		
Other		
Euplanktonic		
Tychoplanktonic		
Periphitic		
epipelic		
epilithic		
epidendric		
epizootic		
epiphitic		
attached		
unattached		
Winter		
Spring		
Summer		
Autumn		
Euthermal		
Mesothermal		
Oligothermal		
Stenothermal		
Metathermal		
Eurythermal		
Undesignated		
M	■	
MB		
BM		Marine
B		
BZ		
ZB		
Z		

Geographical distribution and additional comments:

Taxon Drurigia compressa (West) Donkin

		References 49	Concensus & Notes
pH	Acidobiontic		
	Acidophilous		
	Indifferent		
	Alkaliphilous		
	Alkalibiontic		
Nutrient	Eutrophic		
	Mesotrophic		
	Oligotrophic		
	Dystrophic		
Halobion	Polyhalobous		
	Euhalobous	■	Euhalobous
	Mesohalobous		
	alpha range		
	beta range		
	Oligohalobous		
	halophilous		
	indifferent		
	halophobous		
	Euryhalobous		
Saprobien	Polysaprobic		
	Mesosaprobic		
	alpha range		
	beta range		
	Oligosaprobic		
	Saprophilic		
	Saproxenous		
	Saprophobic		
Current	Limnobiontic		
	Limnophilous		
	Indifferent		
	Rheophilous		
	Rheobiontic		
General Habitat	Marine		
	Estuary		
	Lake		
	Pond		
	River		
	Spring & Stream		
	Aerophilous		
	Other		
Specific Habitat	Euplanktonic		
	Tychoplanktonic		
	Periphitic		
	epipelic		
	epilithic		
	epidendric		
	epizootic		
	epiphitic		
	attached		
	unattached		
Dist.	Winter		
	Spring		
	Summer		
	Autumn		
Temperature	Euthermal		
	Mesothermal		
	Oligothermal		
	Stenothermal		
	Metathermal		
	Eurythermal		
	Undesignated		
Salinity	M	■	Marine
	MB		
	BM		
	B		
	BZ		
	ZB		
	Z		

Geographical distribution and additional comments:

Taxon Thalassiosira pseudonana (Hust) Hasle and Heimdal

		References 17	26	44	Concensus & Notes
pH	Acidobiontic				Indifferent
	Acidophilous				
	Indifferent		■		
	Alkaliphilous				
	Alkalibiontic				
Nutrient	Eutrophic				
	Mesotrophic				
	Oligotrophic				
	Dystrophic				
Halobion	Polyhalobous				Mesohalobous
	Euhalobous				
	Mesohalobous				
	alpha range			■	
	beta range		■		
	Oligohalobous				
	halophilous				
	indifferent				
	halophobous				
Saprobien	Euryhalobous				
	Polysaprobic				
	Mesosaprobic				
	alpha range				
	beta range				
	Oligosaprobic				
	Saprophilic				
	Saproxenous				
	Saprophobic				
Current	Limnobiontic				
	Limnophilous				
	Indifferent				
	Rheophilous				
	Rheobiontic				
General Habitat	Marine	■			Marine or Estuary
	Estuary	■			
	Lake				
	Pond				
	River				
	Spring & Stream				
	Aerophilous				
	Other				
Specific Habitat	Euplanktonic				
	Tychoplanktonic				
	Periphitic				
	epipelic				
	epilithic				
	epidendric				
	epizootic				
	epiphitic				
	attached				
	unattached				
Dist.	Winter				
	Spring				
	Summer				
	Autumn				
Temperature	Euthermal				
	Mesothermal				
	Oligothermal				
	Stenothermal				
	Metathermal				
	Eurythermal				
	Undesignated				
Salinity	M				
	MB				
	BM				
	P				
	PZ				
	ZP				
	Z				

Geographical distribution and additional comments:

Taxon Cyclotella meneghiniana Kütz

		References																											
		3	4	6	8	9	11	20	24	26	27	29	30	31	34	36	39	41	43	45	46	49								Concensus & Notes
pH	Acidobiontic																													Alkaliphilous range 6.4–9.0 (8, 27, 43) optimum 8.0–8.5 (4)
	Acidophilous																													
	Indifferent																													
	Alkaliphilous		■		■	■	■			■	■								■			■								
	Alkalibiontic																													
Nutrient	Eutrophic																					■								Eutrophic
	Mesotrophic																													
	Oligotrophic																													
	Dystrophic																													
Halobion	Polyhalobous																													Halophilous
	Euhalobous																													
	Mesohalobous		■																											
	alpha range																													
	beta range																													
	Oligohalobous															■					■									
	halophilous	■			■	■	■	■	■	■		■					■		■			■								
	indifferent																													
	halophobous																													
Saprobien	Euryhalobous																				■									Alpha-Mesosaprobic
	Polysaprobic																				■									
	Mesosaprobic								■												■									
	alpha range			■									■							■										
	beta range			■																										
	Oligosaprobic													■	■															
	Saprophilic																													
	Saproxenous																													
	Saprophobic																													
Current	Limnobiontic																													Indifferent
	Limnophilous																													
	Indifferent				■		■	■											■											
	Rheophilous																													
	Rheobiontic																													
General Habitat	Marine																													
	Estuary																													
	Lake																													
	Pond																													
	River																													
	Spring & Stream																													
	Aerophilous																													
	Other																													
Specific Habitat	Euplanktonic		■								■																			Periphytic Tychoplanktonic and Euplanktonic
	Tychoplanktonic							■							■															
	Periphitic							■							■															
	epipelic																													
	epilithic																													
	epidendric																													
	epizootic																													
	epiphitic																													
	attached																													
	unattached																													
Dist.	Winter																													Autumn maximum
	Spring																													
	Summer																													
	Autumn																													
Temperature	Euthermal																													
	Mesothermal																													
	Oligothermal																													
	Stenothermal																													
	Metathermal																													
	Eurythermal																													
	Undesignated																													
Salinity	M																													Brackish-Fresh
	MB																													
	BM																													
	B																													
	BZ																					■								
	ZB																													
	Z																													

Geographical distribution and additional comments:

Cosmopolitan (21, 24); euryoxybiontic (26); a facultative nitrogen heterotroph (4); calcium indifferent (36).

Taxon Actinoptychus undulatus (Bailey) Ralfs

		References 49	Concensus & Notes
pH	Acidobiontic		
	Acidophilous		
	Indifferent		
	Alkaliphilous		
	Alkalibiontic		
Nutrient	Eutrophic		
	Mesotrophic		
	Oligotrophic		
	Dystrophic		
Halobion	Polyhalobous		
	Euhalobous		
	Mesohalobous		
	alpha range		
	beta range		
	Oligohalobous		
	halophilous		
	indifferent		
	halophobous		Euryhaline
	Euryhalobous	■	
Saprobien	Polysaprobic		
	Mesosaprobic		
	alpha range		
	beta range		
	Oligosaprobic		
	Saprophilic		
	Saproxenous		
	Saprophobic		
Current	Limnobiontic		
	Limnophilous		
	Indifferent		
	Rheophilous		
	Rheobiontic		
General Habitat	Marine		
	Estuary		
	Lake		
	Pond		
	River		
	Spring & Stream		
	Aerophilous		
	Other		
Specific Habitat	Euplanktonic		
	Tychoplanktonic		
	Periphitic		
	epipelic		
	epilithic		
	epidendric		
	epizootic		
	epiphitic		
	attached		
	unattached		
Dist.	Winter		
	Spring		
	Summer		
	Autumn		
Temperature	Euthermal		
	Mesothermal		
	Oligothermal		
	Stenothermal		
	Metathermal		
	Eurythermal		
	Undesignated		
Salinity	M		
	MB	■	Marine - Brackish
	BM		
	B		
	BZ		
	ZB		
	Z		

Geographical distribution and additional comments:

Cl concentration ± 3500 mg/L (49)

Taxon *Chaetoceros mülleri Lemmermann*

		References 49	Concensus & Notes
pH	Acidobiontic		
	Acidophilous		
	Indifferent		
	Alkaliphilous		
	Alkalibiontic		
Nutrient	Eutrophic		
	Mesotrophic		
	Oligotrophic		
	Dystrophic		
Halobion	Polyhalobous		
	Euhalobous		
	Mesohalobous	■	Mesohalobous
	alpha range		
	beta range		
	Oligohalobous		
	halophilous		
	indifferent		
	halophobous		
	Euryhalobous	■	Euryhalobous
Saprobien	Polysaprobic		
	Mesosaprobic		
	alpha range		
	beta range		
	Oligosaprobic		
	Saprophilic		
	Saproxenous		
	Saprophobic		
Current	Limnobiontic		
	Limnophilous		
	Indifferent		
	Rheophilous		
	Rheobiontic		
General Habitat	Marine		
	Estuary		
	Lake		
	Pond		
	River		
	Spring & Stream		
	Aerophilous		
	Other		
Specific Habitat	Euplanktonic		
	Tychoplanktonic		
	Periphitic		
	epipelic		
	epilithic		
	epidendric		
	epizootic		
	epiphitic		
	attached		
	unattached		
Dist.	Winter		
	Spring		
	Summer		
	Autumn		
Temperature	Euthermal		
	Mesothermal		
	Oligothermal		
	Stenothermal		
	Metathermal		
	Eurythermal		
	Undesignated		
Salinity	M		
	MB		
	BM		
	B	■	Brackish
	BZ		
	ZB		
	Z		

Geographical distribution and additional comments:

Neritic (49)

Taxon Rhabdonema minutum Kütz

	References 49	Concensus & Notes
Acidobiontic		
Acidophilous		
Indifferent		
Alkaliphilous		
Alkalibiontic		
Eutrophic		
Mesotrophic		
Oligotrophic		
Dystrophic		
Polyhalobous		
Euhalobous	■	Euhalobous
Mesohalobous		
alpha range		
beta range		
Oligohalobous		
halophilous		
indifferent		
halophobous		
Euryhalobous		
Polysaprobic		
Mesosaprobic		
alpha range		
beta range		
Oligosaprobic		
Saprophilic		
Saproxenous		
Saprophobic		
Limnobiontic		
Limnophilous		
Indifferent		
Rheophilous		
Rheobiontic		
Marine	■	Marine
Estuary		
Lake		
Pond		
River		
Spring & Stream		
Aerophilous		
Other		
Euplanktonic		
Tychoplanktonic		
Periphitic	■	
epipelic		
epilithic		
epidendric		
epizootic		
epiphitic		
attached		
unattached		
Winter		
Spring		
Summer		
Autumn		
Euthermal		
Mesothermal		
Oligothermal		
Stenothermal		
Metathermal		
Eurythermal		
Undesignated		
M	■	Marine
MB		
BM		
B		
BZ		
ZB		
Z		

Geographical distribution and additional comments:

Taxon *Tabellaria fenestrata* (Lyngb) Kütz

		References														Concensus & Notes
		4	8	10	11	12	14	26	27	30	35	38	45	46	49	
pH	Acidobiontic															Acidophilous range 4·5-9·0 (8,27) optimum 5·0 - 7·1 (4,27,45)
	Acidophilous	■	■	■	■	■	■	■	■		■					
	Indifferent											■				
	Alkaliphilous												■		■	
	Alkalibiontic															
Nutrient	Eutrophic											■				Found in all nutrient conditions
	Mesotrophic											■			■	
	Oligotrophic								■						■	
	Dystrophic								■							
Halobion	Polyhalobous															Halophobous
	Euhalobous															
	Mesohalobous															
	alpha range															
	beta range															
	Oligohalobous															
	halophilous															
	indifferent			■									■			
	halophobous		■		■		■	■						■		
	Euryhalobous															
Saprobien	Polysaprobic															Oligosaprobic to Saproxenous to β. Mesosaprobic
	Mesosaprobic															
	alpha range															
	beta range												■			
	Oligosaprobic									■			■			
	Saprophilic															
	Saproxenous							■								
	Saprophobic															
Current	Limnobiontic		■		■											Limnobiontic
	Limnophilous															
	Indifferent															
	Rheophilous															
	Rheobiontic															
General Habitat	Marine															Lakes + Ponds
	Estuary															
	Lake											■				
	Pond											■				
	River															
	Spring & Stream															
	Aerophilous															
	Other															
Specific Habitat	Euplanktonic															Periphytic and attached
	Tychoplanktonic															
	Periphitic											■				
	epipelic															
	epilithic															
	epidendric															
	epizootic															
	epiphitic															
	attached											■				
	unattached															
Dist.	Winter															Spring + Autumn maxima
	Spring												■			
	Summer															
	Autumn												■			
Temperature	Euthermal															
	Mesothermal															
	Oligothermal															
	Stenothermal															
	Metathermal															
	Eurythermal															
	Undesignated															
Salinity	M															Freshwater - Brackish
	MB															
	BM															
	B															
	BZ															
	ZB														■	
	Z															

Geographical distribution and additional comments:

Cosmopolitan, but seldom in the tropics (24); calcium indifferent (36)

Ca opt 140·0 - 280·0 mg/l (49)

Fe opt 0-2·5

Si 0-40

Taxon Tabellaria flocculosa (Roth) Kütz

	References																												Concensus & Notes
	4	7	8	9	10	11	12	13	26	27	30	35	36	38	45	49													
Acidobiontic	■			■																									Acidophilous range 4·2-9·0 (8, 27) optimum 5·0-5·3 (4)
Acidophilous			■		■	■	■	■	■	■		■	■		■	■													
Indifferent																													
Alkaliphilous																													
Alkalibiontic																													
Eutrophic																													Mesotrophic to Oligotrophic to Dystrophic
Mesotrophic														■															
Oligotrophic										■				■		■													
Dystrophic										■						■													
Polyhalobous																													Halophobous
Euhalobous																													
Mesohalobous																													
alpha range																													
beta range																													
Oligohalobous																													
halophilous																													
indifferent																													
halophobous			■	■	■	■		■	■						■														
Euryhalobous																													
Polysaprobic																													α-Mesosaprobic to Saproxenous
Mesosaprobic																													
alpha range		■																											
beta range		■																											
Oligosaprobic											■				■														
Saprophilic																													
Saproxenous									■																				
Saprophobic																													
Limnobiontic			■			■																							Limnobiontic
Limnophilous																													
Indifferent																													
Rheophilous																													
Rheobiontic																													
Marine																													Ponds
Estuary																													
Lake										■																			
Pond										■				■															
River																													
Spring & Stream																													
Aerophilous																													
Other														■															
Euplanktonic																													Periphytic and Tychoplanktonic
Tychoplanktonic															■														
Periphitic															■														
epipelic																													
epilithic																													
epidendric																													
epizootic																													
epiphitic																													
attached																													
unattached																													
Winter																													Spring & Autumn maxima
Spring															■														
Summer																													
Autumn															■														
Euthermal																													
Mesothermal																													
Oligothermal																													
Stenothermal																													
Metathermal																													
Eurythermal																													
Undesignated																													
M																													Freshwater
MB																													
BM																													
B																													
BZ																													
ZB																													
Z																■													

Geographical distribution and additional comments:

Cosmopolitan (21, 36); calcium indifferent (36)
Ca 0-420·0 mg/l (49)
Si 0-4·0
Fe 0-7·5

Taxon Grammatophora serpentina (Ralfs) Ehr

	References																												Concensus & Notes
	49																												
Acidobiontic																													
Acidophilous																													
Indifferent																													
Alkaliphilous																													
Alkalibiontic																													
Eutrophic																													
Mesotrophic																													
Oligotrophic																													
Dystrophic																													
Polyhalobous																													
Euhalobous	■																												Euhalobous
Mesohalobous																													
alpha range																													
beta range																													
Oligohalobous																													
halophilous																													
indifferent																													
halophobous																													
Euryhalobous																													
Polysaprobic																													
Mesosaprobic																													
alpha range																													
beta range																													
Oligosaprobic																													
Saprophilic																													
Saproxenous																													
Saprophobic																													
Limnobiontic																													
Limnophilous																													
Indifferent																													
Rheophilous																													
Rheobiontic																													
Marine	■																												Marine
Estuary																													
Lake																													
Pond																													
River																													
Spring & Stream																													
Aerophilous																													
Other																													
Euplanktonic																													
Tychoplanktonic																													
Periphitic																													
epipelic																													
epilithic																													
epidendric																													
epizootic																													
epiphitic																													
attached																													
unattached																													
Winter																													
Spring																													
Summer																													
Autumn																													
Euthermal																													
Mesothermal																													
Oligothermal																													
Stenothermal																													
Metathermal																													
Eurythermal																													
Undesignated																													
M	■																												Marine
MB																													
BM																													
P																													
BZ																													
ZB																													
Z																													

Geographical distribution and additional comments:

Taxon Meridion circulare (Grev) Agardh

		References																										Concensus & Notes
		4	7	8	9	10	11	13	14	19	21	23	27	29	31	34	38	39	43	45	46	49								
pH	Acidobiontic																												Alkaliphilous range 6·4-9·0 (8, 27, 43) optimum around 8·0 (4)
	Acidophilous																												
	Indifferent																												
	Alkaliphilous	■		■	■	■	■	■	■	■		■	■						■			■							
	Alkalibiontic																												
Nutrient	Eutrophic												■																Eutrophic
	Mesotrophic																												
	Oligotrophic																												
	Dystrophic																												
Halobion	Polyhalobous																												Indifferent
	Euhalobous																												
	Mesohalobous																												
	alpha range																												
	beta range																												
	Oligohalobous	■										■					■				■	■							
	halophilous																												
	indifferent			■	■	■	■		■										■	■									
	halophobous													■				■											
	Euryhalobous																				■								
Saprobien	Polysaprobic																												Oligosaprobic
	Mesosaprobic																												
	alpha range																												
	beta range																												
	Oligosaprobic		■												■	■													
	Saprophilic																												
	Saproxenous											■																	
	Saprophobic		■																										
Current	Limnobiontic																												Rheobiontic to Rheophilous
	Limnophilous																												
	Indifferent							■																					
	Rheophilous										■	■					■					■							
	Rheobiontic			■			■			■									■										
General Habitat	Marine																												Lakes, Ponds, Rivers Springs + Streams
	Estuary																												
	Lake							■					■																
	Pond							■					■																
	River							■																					
	Spring & Stream							■		■																			
	Aerophilous																												
	Other																												
Specific Habitat	Euplanktonic																												Periphytic or Tychoplanktonic
	Tychoplanktonic																			■									
	Periphitic																			■									
	epipelic																												
	epilithic																												
	epidendric																												
	epizootic																												
	epiphitic																												
	attached							■																					
	unattached																												
Seasonal Dist.	Winter																												Spring form
	Spring																			■									
	Summer																												
	Autumn																												
Temperature	Euthermal																												Eurythermal and Oligothermal to Mesothermal
	Mesothermal																		■										
	Oligothermal																		■										
	Stenothermal																												
	Metathermal																												
	Eurythermal																		■										
	Undesignated																												
Salinity	M																												Freshwater - Brackish
	MB																												
	BM																												
	B																												
	BZ																												
	ZB																					■							
	Z																												

Geographical distribution and additional comments:

Cosmopolitan (21, 24); seldom in the tropics (24); calciphilous (36); an indicator of high oxygen concentration (4)

Taxon Diatoma elongatum (Lyngbye) Agardh

		References						Concensus & Notes
		26	27	39	46	50	49	
pH	Acidobiontic							Alkaliphilous opt >7.0 (49) opt 7.4-7.8 (4)
	Acidophilous							
	Indifferent	■						
	Alkaliphilous					■	■	
	Alkalibiontic							
Nutrient	Eutrophic							
	Mesotrophic							
	Oligotrophic							
	Dystrophic							
Halobion	Polyhalobous							
	Euhalobous							Halophilous
	Mesohalobous							
	alpha range							
	beta range							
	Oligohalobous					■		
	halophilous	■		■	■	■	■	
	indifferent							
	halophobous							
	Euryhalobous							
Saprobien	Polysaprobic							
	Mesosaprobic							
	alpha range							
	beta range							
	Oligosaprobic							
	Saprophilic							
	Saproxenous							
	Saprophobic							
Current	Limnobiontic							
	Limnophilous							
	Indifferent							
	Rheophilous							
	Rheobiontic							
General Habitat	Marine							
	Estuary							
	Lake							
	Pond							
	River							
	Spring & Stream							
	Aerophilous							
	Other							
Specific Habitat	Euplanktonic		■			■		Euplanktonic
	Tychoplanktonic							
	Periphitic							
	epipelic							
	epilithic							
	epidendric							
	epizootic							
	epiphitic							
	attached							
	unattached							
Seasonal Dist.	Winter							
	Spring							
	Summer							
	Autumn							
Temperature	Euthermal							
	Mesothermal							
	Oligothermal							
	Stenothermal							
	Metathermal							
	Eurythermal							
	Undesignated							
Salinity	M							
	MB							
	BM							
	B							Brackish-Fresh
	BZ					■	■	
	ZB							
	Z							

Geographical distribution and additional comments:

Mesooxybiontic (26)
Pleioeuryhaline (46)
Ca opt 0-140.0 mg/l (49)
fe opt 0-2.5
Si 0-4.0

Taxon Diatoma vulgare Bory

		References																												Concensus & Notes
		1	4	7	8	9	11	12	13	19	20	26	27	29	31	38	39	43	49	49										
pH	Acidobiontic																													Alkalibiontic to Alkaliphilous range 6.4-8.3 (8,27,43) optimum 8.2(4) 3.5-6.0(49)
	Acidophilous																			■										
	Indifferent																													
	Alkaliphilous			■				■		■								■												
	Alkalibiontic				■	■	■		■			■	■																	
Nutrient	Eutrophic		■													■														Eutrophic
	Mesotrophic																													
	Oligotrophic																													
	Dystrophic																													
Halobion	Polyhalobous																													Indifferent
	Euhalobous																													
	Mesohalobous																													
	alpha range																													
	beta range																													
	Oligohalobous																			■										
	halophilous																													
	indifferent				■	■	■					■					■	■	■											
	halophobous													■																
	Euryhalobous																													
Saprobien	Polysaprobic																													β-mesosaprobic to Oligosaprobic
	Mesosaprobic																													
	alpha range																													
	beta range			■						■					■															
	Oligosaprobic	■		■																										
	Saprophilic																													
	Saproxenous											■																		
	Saprophobic																													
Current	Limnobiontic																													Rheophilous
	Limnophilous																													
	Indifferent																													
	Rheophilous				■		■			■	■	■				■		■												
	Rheobiontic																													
General Habitat	Marine																													
	Estuary																													
	Lake																													
	Pond																													
	River																													
	Spring & Stream																													
	Aerophilous																													
	Other																													
Specific Habitat	Euplanktonic																													Periphytic and Epiphytic
	Tychoplanktonic																													
	Periphitic												■																	
	epipelic																													
	epilithic																													
	epidendric																													
	epizootic																													
	epiphitic												■																	
	attached																													
	unattached																													
Dist.	Winter	■																												Winter dominant
	Spring																													
	Summer																													
	Autumn																													
Temperature	Euthermal																													Eurythermal and Oligothermal to Mesothermal
	Mesothermal																	■												
	Oligothermal															■		■												
	Stenothermal																													
	Metathermal																													
	Eurythermal																	■												
	Undesignated																													
Salinity	M																													
	MB																													
	BM																													
	B																													
	BZ																													
	ZB																			■										
	Z																													

Geographical distribution and additional comments:

Ca opt 0-140.0 mg/L (49)
Fe opt 2.5-5.0
Si opt 0-1.0

Taxon Fragilaria brevistriata Grun.

		References																Concensus & Notes
		4	8	9	10	11	12	14	20	21	26	27	29	35	38	39	49	
pH	Acidobiontic																	Alkaliphilous range 6.5-9.0 (8, 27) opt 7.5-7.8 (4) range 6.7-9.0(49)
	Acidophilous																	
	Indifferent																	
	Alkaliphilous	■	■	■	■	■	■	■			■	■		■			■	
	Alkalibiontic																	
Nutrient	Eutrophic											■						Eutrophic
	Mesotrophic																	
	Oligotrophic																	
	Dystrophic																	
Halobion	Polyhalobous																	Indifferent
	Euhalobous																	
	Mesohalobous																■	
	alpha range																	
	beta range																	
	Oligohalobous														■		■	
	halophilous												■					
	indifferent		■	■	■	■		■		■	■					■		
	halophobous																	
	Euryhalobous		■															
Saprobien	Polysaprobic																	Oligosaprobic
	Mesosaprobic																	
	alpha range																	
	beta range																	
	Oligosaprobic										■							
	Saprophilic																	
	Saproxenous																	
	Saprophobic																	
Current	Limnobiontic																	Indifferent
	Limnophilous																	
	Indifferent																	
	Rheophilous																	
	Rheobiontic																	
General Habitat	Marine																	Lakes + Ponds
	Estuary																	
	Lake											■						
	Pond											■						
	River																	
	Spring & Stream																	
	Aerophilous																	
	Other																	
Specific Habitat	Euplanktonic																	Periphytic
	Tychoplanktonic																	
	Periphitic								■	■								
	epipelic																	
	epilithic																	
	epidendric																	
	epizootic																	
	epiphitic																	
	attached																	
	unattached																	
Seasonal Dist.	Winter																	
	Spring																	
	Summer																	
	Autumn																	
Temperature	Euthermal																	
	Mesothermal																	
	Oligothermal																	
	Stenothermal																	
	Metathermal																	
	Eurythermal																	
	Undesignated																	
Salinity	M																	Fresh-Brackish
	MR																	
	BM																	
	R																	
	RZ																	
	ZR																■	
	Z																	

Geographical distribution and additional comments:

Cosmopolitan (21, 24); in a wide range of conductivity

Taxon Fragilaria pinnata Ehr.

		References																											Concensus & Notes
		4	7	8	9	10	11	12	13	14	19	20	21	26	27	34	35	38	39	46	49								
pH	Acidobiontic																												Alkaliphilous range 5.7-9.0 (8, 27) optimum 7.6-7.8 (4)
	Acidophilous																												
	Indifferent																												
	Alkaliphilous	■		■	■	■	■	■	■	■				■	■		■				■								
	Alkalibiontic																												
Nutrient	Eutrophic												■		■						■								Eutrophic
	Mesotrophic																												
	Oligotrophic																												
	Dystrophic																												
Halobion	Polyhalobous																												Indifferent
	Euhalobous																												
	Mesohalobous																												
	alpha range																												
	beta range																												
	Oligohalobous																	■											
	halophilous																												
	indifferent			■	■	■	■			■			■	■		■			■	■									
	halophobous																												
Saprobien	Euryhalobous																			■									Beta-Mesosaprobic to Oligosaprobic
	Polysaprobic																												
	Mesosaprobic																												
	alpha range																												
	beta range		■																										
	Oligosaprobic													■															
	Saprophilic																												
	Saproxenous																												
	Saprophobic																												
Current	Limnobiontic										■																		Indifferent to Limnobiontic
	Limnophilous																												
	Indifferent																												
	Rheophilous			■			■																						
	Rheobiontic																												
General Habitat	Marine																												Lakes and Ponds
	Estuary																												
	Lake														■														
	Pond														■														
	River																												
	Spring & Stream																												
	Aerophilous																												
	Other																												
Specific Habitat	Euplanktonic																												Periphytic
	Tychoplanktonic															■													
	Periphitic											■	■			■													
	epipelic																												
	epilithic																												
	epidendric																												
	epizootic																												
	epiphitic																												
	attached																												
	unattached																												
Seasonal Dist.	Winter																												
	Spring																												
	Summer																												
	Autumn																												
Temperature	Euthermal																												
	Mesothermal																												
	Oligothermal																												
	Stenothermal																												
	Metathermal																												
	Eurythermal																												
	Undesignated																												
Salinity	M																												Fresh-Brackish
	MB																												
	BM																												
	B																												
	BZ																												
	ZB																				■								
	Z																												

Geographical distribution and additional comments:

Cosmopolitan (21, 24); thrives optimally only in oxygen rich water (4)

Taxon Synedra acus Kütz

		References																			Concensus & Notes
		1	4	8	9	10	11	12	14	21	26	27	29	30	31	34	35	38	45	49	
pH	Acidobiontic																				Alkaliphilous range 6.2–9.0 (8, 27) optimum 7.4–7.6 (4)
	Acidophilous																				
	Indifferent				■													■			
	Alkaliphilous		■	■		■	■	■	■		■	■					■			■	
	Alkalibiontic																				
Nutrient	Eutrophic											■									Eutrophic
	Mesotrophic																				
	Oligotrophic																				
	Dystrophic																				
Halobion	Polyhalobous																				Indifferent
	Euhalobous																				
	Mesohalobous																				
	alpha range																				
	beta range																				
	Oligohalobous									■	■		■							■	
	halophilous																		■		
	indifferent			■	■	■	■		■							■					
	halophobous																				
	Euryhalobous																				
Saprobien	Polysaprobic																				Oligosaprobic
	Mesosaprobic																				
	alpha range																				
	beta range													■							
	Oligosaprobic	■									■			■	■					■	
	Saprophilic																				
	Saproxenous																				
	Saprophobic																				
Current	Limnobiontic																				Limnophilous
	Limnophilous			■			■														
	Indifferent																				
	Rheophilous																				
	Rheobiontic																				
General Habitat	Marine																				Lakes + Ponds
	Estuary																				
	Lake											■									
	Pond											■									
	River																				
	Spring & Stream																				
	Aerophilous																				
	Other																				
Specific Habitat	Euplanktonic																				Periphytic or Tychoplanktonic
	Tychoplanktonic															■			■		
	Periphitic									■						■			■		
	epipelic																				
	epilithic																				
	epidendric																				
	epizootic																				
	epiphitic																				
	attached																		■		
	unattached																				
Seasonal Dist.	Winter																				Spring + Summer form
	Spring																		■		
	Summer	■																			
	Autumn																				
Temperature	Euthermal																				
	Mesothermal																				
	Oligothermal																				
	Stenothermal																				
	Metathermal																				
	Eurythermal																				
	Undesignated																				
Salinity	M																				Fresh-Brackish
	MB																				
	BM																				
	B																				
	BZ																				
	ZB																			■	
	Z																				

Geographical distribution and additional comments:

Cosmopolitan (21); seems to prefer water which does not have a very low conductivity, more often found in waters of medium hardness (38)

63

Taxon Synedra pulchella Ralfs ex Kütz

References

		3	4	8	9	10	11	12	20	24	26	27	39	48	46	69	41													Concensus & Notes
pH	Acidobiontic																													Indifferent to Alkaliphilous pH 6.9-7.7 (27)
	Acidophilous																													
	Indifferent			■			■				■	■																		
	Alkaliphilous			■		■	■	■																						
	Alkalibiontic																													
Nutrient	Eutrophic										■					■														Eutrophic
	Mesotrophic																													
	Oligotrophic																													
	Dystrophic																													
Halobion	Polyhalobous																													Mesohalobous Euryhalobous
	Euhalobous																													
	Mesohalobous		■	■	■	■	■		■	■			■	■	■	■	■													
	alpha range																													
	beta range	■																												
	Oligohalobous																													
	halophilous																													
	indifferent																													
	halophobous																													
Saprobien	Euryhalobous			■							■		■		■	■														
	Polysaprobic																													
	Mesosaprobic																													
	alpha range																													
	beta range																													
	Oligosaprobic																													
	Saprophilic																													
	Saproxenous																													
	Saprophobic																													
Current	Limnobiontic			■																										Limnobiontic
	Limnophilous																													
	Indifferent																													
	Rheophilous																													
	Rheobiontic																													
General Habitat	Marine																													
	Estuary																													
	Lake																													
	Pond																													
	River																													
	Spring & Stream																													
	Aerophilous																													
	Other																													
Specific Habitat	Euplanktonic																													Periphytic
	Tychoplanktonic																													
	Periphitic								■																					
	epipelic																													
	epilithic																													
	epidendric																													
	epizootic																													
	epiphitic																													
	attached																													
	unattached																													
Seasonal Dist.	Winter																													
	Spring																													
	Summer																													
	Autumn																													
Temperature	Euthermal																													
	Mesothermal																													
	Oligothermal																													
	Stenothermal																													
	Metathermal																													
	Eurythermal																													
	Undesignated																													
Salinity	M																													Brackish-Fresh
	MB																													
	BM																													
	B																													
	BZ															■														
	ZB																													
	Z																													

Geographical distribution and additional comments:

Usually in freshwater of high mineral content or slightly brackish water (37)

Taxon Synedra rumpens Kütz

		References										Concensus & Notes
		2	4	8	10	11	21	27	34	35	49	
pH	Acidobiontic											Indifferent range 6.0-9.0 (2,8,27) opt 6.4-6.8 (4)
	Acidophilous		■									
	Indifferent	■		■	■	■		■				
	Alkaliphilous									■		
	Alkalibiontic											
Nutrient	Eutrophic										■	
	Mesotrophic											
	Oligotrophic											
	Dystrophic											
Halobion	Polyhalobous											Indifferent
	Euhalobous											
	Mesohalobous											
	alpha range											
	beta range											
	Oligohalobous						■		■		■	
	halophilous											
	indifferent			■	■	■						
	halophobous											
	Euryhalobous											
Saprobien	Polysaprobic											
	Mesosaprobic											
	alpha range											
	beta range											
	Oligosaprobic											
	Saprophilic											
	Saproxenous											
	Saprophobic											
Current	Limnobiontic											Indifferent
	Limnophilous											
	Indifferent			■		■						
	Rheophilous											
	Rheobiontic											
General Habitat	Marine											
	Estuary											
	Lake											
	Pond											
	River											
	Spring & Stream											
	Aerophilous											
	Other											
Specific Habitat	Euplanktonic											Periphytic
	Tychoplanktonic											
	Periphitic								■			
	epipelic											
	epilithic											
	epidendric											
	epizootic											
	epiphitic											
	attached											
	unattached											
Seasonal Dist.	Winter											
	Spring											
	Summer											
	Autumn											
Temperature	Euthermal											
	Mesothermal											
	Oligothermal											
	Stenothermal											
	Metathermal											
	Eurythermal											
	Undesignated											
Salinity	M											Fresh-Brackish
	MB											
	BM											
	B											
	BZ											
	ZB										■	
	Z											

Geographical distribution and additional comments:

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Taxon Synedra tabulata (Agardh) Kütz

		References													Concensus & Notes
		4	8	9	10	11	12	14	21	26	27	41	46	49	
pH	Acidobiontic														Alkaliphilous range 6·4–9·0 (8,27) 3·5–8·5 (49
	Acidophilous														
	Indifferent							■		■					
	Alkaliphilous		■	■	■	■	■				■				
	Alkalibiontic														
Nutrient	Eutrophic										■			■	Eutrophic
	Mesotrophic														
	Oligotrophic														
	Dystrophic														
Halobion	Polyhalobous														Mesohalobous to Halophilous Euryhaline
	Euhalobous														
	Mesohalobous	■			■			■		■		■	■	■	
	alpha range														
	beta range														
	Oligohalobous														
	halophilous		■	■		■									
	indifferent														
	halophobous														
Saprobien	Euryhalobous								■	■			■	■	Oligosaprobic
	Polysaprobic														
	Mesosaprobic														
	alpha range														
	beta range														
	Oligosaprobic									■					
	Saprophilic														
	Saproxenous														
	Saprophobic														
Current	Limnobiontic														Indifferent
	Limnophilous														
	Indifferent		■			■									
	Rheophilous														
	Rheobiontic														
General Habitat	Marine														Lakes + Ponds
	Estuary														
	Lake										■				
	Pond										■				
	River														
	Spring & Stream														
	Aerophilous														
	Other														
Specific Habitat	Euplanktonic														Periphytic
	Tychoplanktonic														
	Periphitic								■						
	epipelic														
	epilithic														
	epidendric														
	epizootic														
	epiphitic														
	attached														
	unattached														
Seasonal Dist.	Winter														
	Spring														
	Summer														
	Autumn														
Temperature	Euthermal														
	Mesothermal														
	Oligothermal														
	Stenothermal														
	Metathermal														
	Eurythermal														
	Undesignated														
Salinity	M														Brackish-Marine
	MB														
	BM													■	
	B														
	BZ														
	ZB														
	Z														

Geographical distribution and additional comments:

Cosmopolitan (21)

Fe 2·5-5·0 mg/l (49

Ca 0-140·0

33

Taxon Synedra ulna (Nitz) Ehr.

		References																												Concensus & Notes
		1	7	8	11	13	14	16	19	21	26	27	29	30	31	34	35	38	41	43	45	49								
pH	Acidobiontic																													Alkaliphilous range 5·7-9·0 (8,11,27) 3·5-9·0 (49)
	Acidophilous																													
	Indifferent					■					■																			
	Alkaliphilous			■	■	■	■		■		■	■					■			■		■								
	Alkalibiontic																													
Nutrient	Eutrophic									■	■											■								Eutrophic
	Mesotrophic																													
	Oligotrophic																													
	Dystrophic																													
Halobion	Polyhalobous																													Indifferent
	Euhalobous																													
	Mesohalobous																													
	alpha range																													
	beta range																													
	Oligohalobous							■										■				■								
	halophilous																													
	indifferent			■	■		■				■		■			■				■	■									
	halophobous																													
	Euryhalobous									■			■								■									
Saprobien	Polysaprobic																													Oligosaprobic to β-Mesosaprobic
	Mesosaprobic			■																										
	alpha range																													
	beta range		■							■	■			■																
	Oligosaprobic	■	■											■	■	■														
	Saprophilic																													
	Saproxenous																													
	Saprophobic		■																											
Current	Limnobiontic																													Indifferent
	Limnophilous															■						■								
	Indifferent			■	■															■		■								
	Rheophilous																													
	Rheobiontic																													
General Habitat	Marine																													
	Estuary																													
	Lake																													
	Pond																													
	River																													
	Spring & Stream																													
	Aerophilous																													
	Other																													
Specific Habitat	Euplanktonic															■														Euplanktonic
	Tychoplanktonic																													
	Periphitic																													
	epipelic																													
	epilithic																													
	epidendric																													
	epizootic																													
	epiphitic																													
	attached																													
	unattached																													
Seasonal Dist.	Winter																													Spring, Summer & Autumn
	Spring																		■											
	Summer	■																												
	Autumn																		■		■									
Temperature	Euthermal																													Eurythermal and Oligothermal to mesothermal
	Mesothermal																			■										
	Oligothermal																			■										
	Stenothermal																													
	Metathermal																													
	Eurythermal																			■										
	Undesignated																													
Salinity	M																													Fresh-Brackish
	MB																													
	BM																													
	B																													
	BZ																													
	ZB																					■								
	Z																													

Geographical distribution and additional comments:

Cosmopolitan (21,24); great ecological span (45); prefers dirty water (16); calcium indifferent (36); it is unsuitable as an ecological indicator (21)

Ca opt 140·0-420·0 mg/l (49)

Fe opt 7·5

Si opt 16·0

Taxon Asterionella formosa Hass

		4	7	8	9	14	20	26	27	30	31	38	39	41	45	46	49	Concensus & Notes
pH	Acidobiontic																	Alkaliphilous range 4·0-9·0 (8, 27) optimum 7·2-7·8 (4, 45)
	Acidophilous																	
	Indifferent																	
	Alkaliphilous	■		■	■	■		■	■						■		■	
	Alkalibiontic																	
Nutrient	Eutrophic						■					■					■	Eutrophic to Mesotrophic
	Mesotrophic											■						
	Oligotrophic																	
	Dystrophic																	
Halobion	Polyhalobous																	Indifferent
	Euhalobous																	
	Mesohalobous																	
	alpha range																	
	beta range																	
	Oligohalobous							■								■	■	
	halophilous																	
	indifferent			■	■	■							■					
	halophobous																	
Saprobien	Euryhalobous															■		Oligosaprobic to β - Mesosaprobic
	Polysaprobic																	
	Mesosaprobic																	
	alpha range																	
	beta range		■							■								
	Oligosaprobic		■					■		■	■							
	Saprophilic																	
	Saproxenous																	
	Saprophobic																	
Current	Limnobiontic			■														Limnophilous to Limnobiontic
	Limnophilous							■										
	Indifferent																	
	Rheophilous																	
	Rheobiontic																	
General Habitat	Marine																	
	Estuary																	
	Lake																	
	Pond																	
	River																	
	Spring & Stream																	
	Aerophilous																	
	Other																	
Specific Habitat	Euplanktonic						■			■		■		■	■			Euplanktonic
	Tychoplanktonic																	
	Periphitic																	
	epipelic																	
	epilithic																	
	epidendric																	
	epizootic																	
	epiphitic																	
	attached																	
	unattached																	
Seasonal Dist.	Winter																	Summer maximum
	Spring																	
	Summer														■			
	Autumn																	
Temperature	Euthermal																	
	Mesothermal																	
	Oligothermal																	
	Stenothermal																	
	Metathermal																	
	Eurythermal																	
	Undesignated																	
Salinity	M																	Fresh - Brackish
	MB																	
	BM																	
	B																	
	BZ																	
	ZB																■	
	Z																	

Geographical distribution and additional comments:

Cosmopolitan but seldom observed in the tropics (24)

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Taxon Eunotia pectinalis (Dillwyn) Rabh.

		4	7	8	9	10	11	12	13	21	26	27	35	38	39	49	Concensus & Notes
pH	Acidobiontic																Acidophilous range 5.0-8.0 (8,27) optimum around 8.5 (4)
	Acidophilous	■		■	■		■				■	■	■			■	
	Indifferent					■		■	■								
	Alkaliphilous																
	Alkalibiontic																
Nutrient	Eutrophic													■			Oligotrophic to eutrophic (38)
	Mesotrophic																
	Oligotrophic											■		■		■	
	Dystrophic																
Halobion	Polyhalobous																Halophobous
	Euhalobous																
	Mesohalobous																
	alpha range																
	beta range																
	Oligohalobous									■	■					■	
	halophilous																
	indifferent					■											
	halophobous			■	■		■				■				■		
Saprobien	Euryhalobous																Oligosaprobic to Alpha-Mesosaprobic
	Polysaprobic																
	Mesosaprobic																
	alpha range		■														
	beta range																
	Oligosaprobic										■						
	Saprophilic																
	Saproxenous																
	Saprophobic																
Current	Limnobiontic																Indifferent
	Limnophilous																
	Indifferent			■			■										
	Rheophilous																
	Rheobiontic																
General Habitat	Marine																
	Estuary																
	Lake																
	Pond																
	River																
	Spring & Stream																
	Aerophilous																
	Other																
Specific Habitat	Euplanktonic																
	Tychoplanktonic																
	Periphitic																
	epipelic																
	epilithic																
	epidendric																
	epizootic																
	epiphitic																
	attached																
	unattached																
Seasonal Dist.	Winter																
	Spring																
	Summer																
	Autumn																
Temperature	Euthermal																
	Mesothermal																
	Oligothermal																
	Stenothermal																
	Metathermal																
	Eurythermal																
	Undesignated																
Salinity	M																Freshwater
	MB																
	BM																
	B																
	BZ																
	ZB																
	Z															■	

Geographical distribution and additional comments:

Cosmopolitan (21,24); prefers waters of low mineral content (38); most commonly found in the cooler regions of the northern or central parts of the USA (38)

Taxon Eunotia exigua (Breb ex Kütz) Rabh.

		References																											Concensus & Notes
		4	8	9	10	11	12	13	21	26	27	37	39	46	49															
pH	Acidobiontic										■																			Acidophilous-acidobiontic range 4.3-8.0 (21) opt 5.2-5.3 (4) 3.5-6.0 (49)
	Acidophilous									■																				
	Indifferent																													
	Alkaliphilous																													
	Alkalibiontic																													
Nutrient	Eutrophic																													Oligotrophic
	Mesotrophic																													
	Oligotrophic															■														
	Dystrophic																													
Halobion	Polyhalobous																													Halophobous
	Euhalobous																													
	Mesohalobous																													
	alpha range																													
	beta range																													
	Oligohalobous								■							■														
	halophilous																													
	indifferent																													
	halophobous									■			■																	
Saprobien	Euryhalobous																													Saproxenous
	Polysaprobic																													
	Mesosaprobic																													
	alpha range																													
	beta range																													
	Oligosaprobic																													
	Saprophilic																													
	Saproxenous									■																				
	Saprophobic																													
Current	Limnobiontic																													
	Limnophilous																													
	Indifferent																													
	Rheophilous																													
	Rheobiontic																													
General Habitat	Marine																													
	Estuary																													
	Lake																													
	Pond																													
	River																													
	Spring & Stream																													
	Aerophilous																													
	Other																													
Specific Habitat	Euplanktonic																													
	Tychoplanktonic																													
	Periphitic																													
	epipelic																													
	epilithic																													
	epidendric																													
	epizootic																													
	epiphitic																													
	attached																													
	unattached																													
Seasonal Dist.	Winter																													
	Spring																													
	Summer																													
	Autumn																													
Temperature	Euthermal																													
	Mesothermal																													
	Oligothermal																													
	Stenothermal																													
	Metathermal																													
	Eurythermal																													
	Undesignated																													
Salinity	M																													Freshwater
	MB																													
	BM																													
	B																													
	BZ																													
	ZB																													
	Z														■															

Geographical distribution and additional comments:

Often found associated with mosses in acid water of low mineral content
Also found in bogs, springs + small streams (37)

Ca 0-1400 mg/l (49)
Fe 0-7.5
Si 0-4.0

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Taxon Cocconeis placentula Ehr.

		References																				Concensus & Notes
		4	7	8	9	10	11	14	19	20	21	26	27	34	35	38	39	43	45	46	49	
pH	Acidobiontic																					Alkaliphilous range 4.7-9.0 (8,27) optimum around 8.0 (4)
	Acidophilous																					
	Indifferent																					
	Alkaliphilous	■		■	■	■	■	■	■			■	■		■	■		■			■	
	Alkalibiontic																		■			
Nutrient	Eutrophic																					
	Mesotrophic																					
	Oligotrophic																					
	Dystrophic																					
Halobion	Polyhalobous																					Indifferent
	Euhalobous																					
	Mesohalobous																					
	alpha range																					
	beta range																					
	Oligohalobous																			■	■	
	halophilous																					
	indifferent			■	■	■	■	■			■	■	■			■	■	■				
	halophobous																					
	Euryhalobous			■																■		
Saprobien	Polysaprobic																					Saprophobic to Alpha-Mesosaprobic
	Mesosaprobic																					
	alpha range		■																			
	beta range																					
	Oligosaprobic								■			■									■	
	Saprophilic																					
	Saproxenous																					
	Saprophobic		■																			
Current	Limnobiontic																					Indifferent
	Limnophilous																					
	Indifferent			■			■				■							■				
	Rheophilous								■													
	Rheobiontic																					
General Habitat	Marine																					
	Estuary																					
	Lake																					
	Pond																					
	River																					
	Spring & Stream																					
	Aerophilous																					
	Other																					
Specific Habitat	Euplanktonic																					Periphytic and Epiphytic
	Tychoplanktonic																					
	Periphitic								■	■	■			■								
	epipelic																					
	epilithic																					
	epidendric																					
	epizootic																					
	epiphitic															■			■			
	attached																					
	unattached																					
Seasonal Dist.	Winter																					Autumn maxima
	Spring																		■			
	Summer																					
	Autumn								■										■			
Temperature	Euthermal																					
	Mesothermal																					
	Oligothermal																					
	Stenothermal																					
	Metathermal																					
	Eurythermal																					
	Undesignated																					
Salinity	M																					Fresh-Brackish
	MB																					
	BM																					
	B																					
	BZ																					
	ZB																				■	
	Z																					

Geographical distribution and additional comments:

Cosmopolitan (21,24); calcium indifferent (36)

Taxon Achnanthes affinis Grun.

		References																												Concensus & Notes
		4	19	38	45	46	49	50																						
pH	Acidobiontic																													Alkaliphilous optimum over 7.0 (4)
	Acidophilous																													
	Indifferent																													
	Alkaliphilous	■	■	■				■																						
	Alkalibiontic	■																												
Nutrient	Eutrophic																													
	Mesotrophic																													
	Oligotrophic																													
	Dystrophic																													
Halobion	Polyhalobous																													Indifferent and Euryhalobous
	Euhalobous																													
	Mesohalobous																													
	alpha range																													
	beta range						■																							
	Oligohalobous					■	■																							
	halophilous																													
	indifferent				■																									
	halophobous																													
	Euryhalobous				■	■																								
Saprobien	Polysaprobic																													
	Mesosaprobic																													
	alpha range																													
	beta range																													
	Oligosaprobic																													
	Saprophilic																													
	Saproxenous																													
	Saprophobic																													
Current	Limnobiontic																													
	Limnophilous																													
	Indifferent																													
	Rheophilous																													
	Rheobiontic																													
General Habitat	Marine																													
	Estuary																													
	Lake																													
	Pond																													
	River																													
	Spring & Stream																													
	Aerophilous																													
	Other																													
Specific Habitat	Euplanktonic																													
	Tychoplanktonic																													
	Periphitic							■																						
	epipelic																													
	epilithic																													
	epidendric																													
	epizootic																													
	epiphitic																													
	attached																													
	unattached																													
Seasonal Dist.	Winter		■		■																									Winter maximum
	Spring																													
	Summer																													
	Autumn																													
Temperature	Euthermal																													
	Mesothermal																													
	Oligothermal																													
	Stenothermal																													
	Metathermal																													
	Eurythermal																													
	Undesignated																													
Salinity	M																													Fresh-Brackish
	MR																													
	RM																													
	R																													
	RZ																													
	ZR						■																							
	Z																													

Geographical distribution and additional comments:

Requires high oxygen concentrations (4)

Taxon Achnanthes lanceolata (Bréb) Grun

		References																			Concensus & Notes
		4	8	9	11	12	13	14	19	21	26	27	34	35	38	39	43	45	46	49	
pH	Acidobiontic																				Alkaliphilous range 4.0-9.0 (21, 27. 43) optimum 7.2-7.5 (4)
	Acidophilous																				
	Indifferent					■									■						
	Alkaliphilous	■	■	■	■			■	■	■	■	■		■	■		■			■	
	Alkalibiontic																				
Nutrient	Eutrophic																			■	Eutrophic
	Mesotrophic																				
	Oligotrophic																				
	Dystrophic																				
Halobion	Polyhalobous																				Indifferent
	Euhalobous																				
	Mesohalobous																				
	alpha range																				
	beta range																				
	Oligohalobous																			■	
	halophilous																				
	indifferent		■	■			■	■		■	■		■			■	■	■	■		
	halophobous																				
	Euryhalobous																	■	■		
Saprobien	Polysaprobic																				Oligosaprobic
	Mesosaprobic																				
	alpha range																				
	beta range																				
	Oligosaprobic										■										
	Saprophilic																				
	Saproxenous																				
	Saprophobic																				
Current	Limnobiontic																				Rheophilous to Rheobiontic
	Limnophilous																				
	Indifferent																				
	Rheophilous								■		■				■					■	
	Rheobiontic		■		■																
General Habitat	Marine																				Springs and Streams
	Estuary																				
	Lake																				
	Pond																				
	River																				
	Spring & Stream								■	■					■		■				
	Aerophilous																				
	Other																				
Specific Habitat	Euplanktonic																				Periphytic
	Tychoplanktonic																				
	Periphitic								■				■					■			
	epipelic																				
	epilithic																				
	epidendric																				
	epizootic																				
	epiphitic																				
	attached																	■			
	unattached																	■			
Seasonal Dist.	Winter																				Spring and Autumn maxima
	Spring								■									■			
	Summer																				
	Autumn																	■			
Temperature	Euthermal																				
	Mesothermal																				
	Oligothermal																				
	Stenothermal																				
	Metathermal																				
	Eurythermal																				
	Undesignated																				
Salinity	M																				Fresh-Brackish
	MB																				
	BM																				
	B																				
	BZ																				
	ZB																			■	
	Z																				

Geographical distribution and additional comments:

Cosmopolitan (24, 34); requires high oxygen concentrations (4); calciphilous (36)
one of the first taxa to colonise new streams (33)

Taxon: Achnanthes hungarica (Grun) Grun

		References									Concensus & Notes
		4	20	21	26	27	38	45	46	49	
pH	Acidobiontic										Alkaliphilous range 6.4-8.3 (21,27) 6.4-8.5 (49) optimum about 8.5 (4)
	Acidophilous										
	Indifferent										
	Alkaliphilous	■		■	■	■	■			■	
	Alkalibiontic										
Nutrient	Eutrophic										Oligo-mesotrophic
	Mesotrophic									■	
	Oligotrophic									■	
	Dystrophic										
Halobion	Polyhalobous										Indifferent
	Euhalobous										
	Mesohalobous										
	alpha range										
	beta range										
	Oligohalobous			■						■	
	halophilous										
	indifferent				■			■	■		
	halophobous										
	Euryhalobous								■		
Saprobien	Polysaprobic										β-mesosaprobic
	Mesosaprobic										
	alpha range										
	beta range				■						
	Oligosaprobic										
	Saprophilic										
	Saproxenous										
	Saprophobic										
Current	Limnobiontic										Limnophilous to Indifferent
	Limnophilous		■								
	Indifferent			■							
	Rheophilous										
	Rheobiontic										
General Habitat	Marine										Lakes + Ponds
	Estuary										
	Lake						■				
	Pond						■				
	River										
	Spring & Stream										
	Aerophilous										
	Other										
Specific Habitat	Euplanktonic										Periphytic
	Tychoplanktonic										
	Periphitic			■							
	epipelic										
	epilithic										
	epidendric										
	epizootic										
	epiphitic										
	attached										
	unattached										
Seasonal Dist.	Winter										Autumn maximum
	Spring										
	Summer										
	Autumn						■				
Temperature	Euthermal										
	Mesothermal										
	Oligothermal										
	Stenothermal										
	Metathermal										
	Eurythermal										
	Undesignated										
Salinity	M										Freshwater-Brackish
	MB										
	BM										
	B										
	BZ										
	ZB									■	
	Z										

Geographical distribution and additional comments:

Cosmopolitan (21,24); often associated with aquatic plants especially Lemna (26)
can thrive only at oxygen saturation (4)
Ca 140.0-420.0 mg/l (49)
Fe 0.-25
Si 0-4.0

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Taxon Achnanthes microcephala (Kütz) Grun

		4	8	9	10	11	12	13	19	21	38	49	Concensus & Notes
pH	Acidobiontic												Indifferent to Alkaliphilous range 6.5-8.5 (21,38) optimum 6.4-6.6 (4)
	Acidophilous	■											
	Indifferent				■	■	■	■					
	Alkaliphilous			■							■		
	Alkalibiontic									■			
Nutrient	Eutrophic												± Oligohalobous
	Mesotrophic											■	
	Oligotrophic												
	Dystrophic												
Halobion	Polyhalobous												
	Euhalobous												Indifferent
	Mesohalobous												
	alpha range												
	beta range												
	Oligohalobous									■		■	
	halophilous												
	indifferent		■	■	■	■							
	halophobous												
	Euryhalobous												
Saprobien	Polysaprobic												
	Mesosaprobic												
	alpha range												
	beta range												
	Oligosaprobic												
	Saprophilic												
	Saproxenous												
	Saprophobic												
Current	Limnobiontic												
	Limnophilous								■				Indifferent to Limnophilous
	Indifferent		■			■							
	Rheophilous												
	Rheobiontic												
General Habitat	Marine												
	Estuary												
	Lake												
	Pond												
	River												
	Spring & Stream												
	Aerophilous												
	Other												
Specific Habitat	Euplanktonic												
	Tychoplanktonic												
	Periphitic												
	epipelic												
	epilithic												
	epidendric												
	epizootic												
	epiphitic												
	attached												
	unattached												
Seasonal Dist.	Winter												
	Spring												
	Summer												
	Autumn												
Temperature	Euthermal												
	Mesothermal												
	Oligothermal												
	Stenothermal												
	Metathermal												
	Eurythermal												
	Undesignated												
Salinity	M												
	MR												
	RM												
	R												Freshwater
	RZ												
	ZR												
	Z											■	

Geographical distribution and additional comments:

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Taxon Achnanthes minutissima Kütz

		References																				Concensus & Notes
		2	3	4	7	8	9	10	11	12	13	19	21	26	27	34	35	38	39	43	49	
pH	Acidobiontic																					Indifferent range 4.3–9.2 (2,8,21,27,43) 5.5–>9.0 (49) opt 7.5–7.8 (4) 6.0–8.5 (49)
	Acidophilous																					
	Indifferent					■	■	■	■	■	■		■	■	■		■			■		
	Alkaliphilous	■		■														■			■	
	Alkalibiontic																					
Nutrient	Eutrophic																					
	Mesotrophic																					
	Oligotrophic																					
	Dystrophic																					
Halobion	Polyhalobous																					Indifferent
	Euhalobous																					
	Mesohalobous																					
	alpha range																					
	beta range																					
	Oligohalobous												■			■					■	
	halophilous																					
	indifferent					■	■	■	■					■					■			
	halophobous																					
	Euryhalobous																					
Saprobien	Polysaprobic																					Mesosaprobic to Oligosaprobic
	Mesosaprobic		■																			
	alpha range				■																	
	beta range				■																	
	Oligosaprobic											■		■								
	Saprophilic																					
	Saproxenous																					
	Saprophobic																					
Current	Limnobiontic																					Indifferent
	Limnophilous																					
	Indifferent					■			■											■		
	Rheophilous											■										
	Rheobiontic																					
General Habitat	Marine																					
	Estuary																					
	Lake																					
	Pond																					
	River																					
	Spring & Stream																					
	Aerophilous																					
	Other																					
Specific Habitat	Euplanktonic																					Periphytic
	Tychoplanktonic																					
	Periphitic															■						
	epipelic																					
	epilithic																					
	epidendric																					
	epizootic																					
	epiphitic																					
	attached																					
	unattached																					
Seasonal Dist.	Winter																					
	Spring																					
	Summer																					
	Autumn																					
Temperature	Euthermal																					
	Mesothermal																					Eurythermal
	Oligothermal																					
	Stenothermal																					
	Metathermal																					
	Eurythermal												■									
	Undesignated																					
Salinity	M																					
	MB																					
	BM																					Freshwater
	B																					
	BZ																					
	ZB																					
	Z																				■	

Geographical distribution and additional comments:

Cosmopolitan (24.34.39); one of the most ubiquitous diatoms known (39); is the best indicator of high oxygen concentrations in alkaline waters (4); calcium + iron indifferent (36).

Ca 140.0–560.0 mg/l (49)

Fe 0.0–7.5

Si 0–4.0

Taxon Rhoicosphenia curvata (Kütz) Grun ex Rabh

References

		4	7	8	9	11	14	15	20	26	27	29	30	31	34	38	39	43	45	46	49	Concensus & Notes
pH	Acidobiontic																					Alkaliphilous range 5.4-9.0 (8,27,43) opt. > 8.0 (4) range 3.5-6.0 (49)
	Acidophilous																					
	Indifferent				■																	
	Alkaliphilous	■		■		■	■			■	■					■		■				
	Alkalibiontic																					
Nutrient	Eutrophic										■										■	Eutrophic
	Mesotrophic																					
	Oligotrophic																					
	Dystrophic																					
Halobion	Polyhalobous																					Indifferent
	Euhalobous																					
	Mesohalobous								■													
	alpha range																					
	beta range																					
	Oligohalobous								■	■		■				■					■	
	halophilous														■				■		■	
	indifferent			■	■	■	■				■						■	■				
	halophobous																					
Saprobien	Euryhalobous										■	■										Mesosaprobic
	Polysaprobic																					
	Mesosaprobic														■							
	alpha range		■					■					■									
	beta range		■					■					■	■								
	Oligosaprobic		■							■												
	Saprophilic																					
	Saproxenous																					
	Saprophobic																					
Current	Limnobiontic																					Indifferent to rheophilous
	Limnophilous																					
	Indifferent			■		■												■				
	Rheophilous	■						■		■						■						
	Rheobiontic																					
General Habitat	Marine																					
	Estuary																					
	Lake																					
	Pond																					
	River																					
	Spring & Stream																					
	Aerophilous																					
	Other																					
Specific Habitat	Euplanktonic																					Epiphytic: particularly on Cladophora (27)
	Tychoplanktonic																					
	Periphitic																	■				
	epipelic																					
	epilithic																					
	epidendric																					
	epizootic																					
	epiphitic	■									■											
	attached																					
	unattached																					
Seasonal Dist.	Winter																					Spring maximum
	Spring																		■			
	Summer																					
	Autumn																					
Temperature	Euthermal																					Eurythermal
	Mesothermal																					
	Oligothermal																					
	Stenothermal																					
	Metathermal																					
	Eurythermal																	■				
	Undesignated																					
Salinity	M																					Fresh-Brackish
	MB																					
	BM																					
	B																					
	BZ																					
	ZB																				■	
	Z																					

Geographical distribution and additional comments:

Cosmopolitan (20); lives optimally in oxygen rich water (4)

Ca 0-140.0 mg/l (49)
Fe 0-5-0

10'

Taxon Diploneis interrupta (Kütz) Cleve

		References														Concensus & Notes
		3	4	8	9	10	11	12	13	26	38	39	41	46	49	
pH	Acidobiontic															Alkaliphilous
	Acidophilous															Range 68-79 (8)
	Indifferent															
	Alkaliphilous			■		■		■								
	Alkalibiontic															
Nutrient	Eutrophic														■	Eutrophic
	Mesotrophic															
	Oligotrophic															
	Dystrophic															
Halobion	Polyhalobous															
	Euhalobous															
	Mesohalobous		■	■	■	■	■	■	■	■	■	■	■		■	Mesohalobous
	alpha range															
	beta range	■												■		
	Oligohalobous															
	halophilous															
	indifferent															
	halophobous															
	Euryhalobous									■					■	
Saprobien	Polysaprobic															
	Mesosaprobic															
	alpha range															
	beta range															
	Oligosaprobic															
	Saprophilic															
	Saproxenous															
	Saprophobic															
Current	Limnobiontic															
	Limnophilous															
	Indifferent															
	Rheophilous															
	Rheobiontic															
General Habitat	Marine															
	Estuary									■						Coastal form
	Lake															
	Pond															
	River															
	Spring & Stream															
	Aerophilous															
	Other															
Specific Habitat	Euplanktonic															
	Tychoplanktonic															
	Periphitic															
	epipelic															
	epilithic															
	epidendric															
	epizootic															
	epiphitic															
	attached															
	unattached															
Seasonal Dist.	Winter															
	Spring															
	Summer															
	Autumn															
Temperature	Euthermal															
	Mesothermal															
	Oligothermal															
	Stenothermal															
	Metathermal															
	Eurythermal															
	Undesignated															
Salinity	M															
	MB															
	BM															
	B														■	Brackish
	BZ															
	ZB															
	Z															

Geographical distribution and additional comments:

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Taxon Diploneis ovalis (Hilse) Cleve ≡ Diploneis oblongella (Naeg ex Kütz) Ross

		References							Concensus & Notes
		46	27	39	26	37	50	49	
pH	Acidobiontic								Alkaliphilous range 6.4->9.0 (27) 5.0-9.0 (49)
	Acidophilous								
	Indifferent								
	Alkaliphilous		■		■		■	■	
	Alkalibiontic								
Nutrient	Eutrophic								
	Mesotrophic								
	Oligotrophic								
	Dystrophic								
Halobion	Polyhalobous								Oligohalobous indifferent
	Euhalobous								
	Mesohalobous								
	alpha range								
	beta range								
	Oligohalobous	■		■	■		■	■	
	halophilous								
	indifferent			■	■		■		
	halophobous								
	Euryhalobous	■							
Saprobien	Polysaprobic								Saproxenous
	Mesosaprobic								
	alpha range								
	beta range								
	Oligosaprobic								
	Saprophilic								
	Saproxenous				■				
	Saprophobic								
Current	Limnobiontic								
	Limnophilous								
	Indifferent								
	Rheophilous								
	Rheobiontic								
General Habitat	Marine								
	Estuary								
	Lake								
	Pond								
	River								
	Spring & Stream								
	Aerophilous								
	Other								
Specific Habitat	Euplanktonic								Periphytic
	Tychoplanktonic								
	Periphitic						■		
	epipelic								
	epilithic								
	epidendric								
	epizootic								
	epiphitic								
	attached								
	unattached								
Seasonal Dist.	Winter								
	Spring								
	Summer								
	Autumn								
Temperature	Euthermal								
	Mesothermal								
	Oligothermal								
	Stenothermal								
	Metathermal								
	Eurythermal								
	Undesignated								
Salinity	M								Fresh-Brackish
	MB								
	BM								
	B								
	BZ								
	ZB					■	■	■	
	Z								

Geographical distribution and additional comments:

Sometimes in damp places (aerophil) (37)

Ca 0-5600 mg/l (49)
Fe 0-50
Si 0-4.0

Taxon Diploneis puella (Schum) Cleve

		References																												Concensus & Notes
		37																												
pH	Acidobiontic																													
	Acidophilous																													
	Indifferent																													
	Alkaliphilous																													
	Alkalibiontic																													
Nutrient	Eutrophic																													
	Mesotrophic																													
	Oligotrophic																													
	Dystrophic																													
Halobion	Polyhalobous																													
	Euhalobous																													
	Mesohalobous																													
	alpha range																													
	beta range																													
	Oligohalobous																													
	halophilous																													
	indifferent																													
	halophobous																													
	Euryhalobous																													
Saprobien	Polysaprobic																													
	Mesosaprobic																													
	alpha range																													
	beta range																													
	Oligosaprobic																													
	Saprophilic																													
	Saproxenous																													
	Saprophobic																													
Current	Limnobiontic																													
	Limnophilous																													
	Indifferent																													
	Rheophilous																													
	Rheobiontic																													
General Habitat	Marine																													
	Estuary																													
	Lake																													
	Pond																													
	River																													
	Spring & Stream																													
	Aerophilous																													
	Other																													
Specific Habitat	Euplanktonic																													
	Tychoplanktonic																													
	Periphitic																													
	epipelic																													
	epilithic																													
	epidendric																													
	epizootic																													
	epiphitic																													
	attached																													
	unattached																													
Seasonal Dist.	Winter																													
	Spring																													
	Summer																													
	Autumn																													
Temperature	Euthermal																													
	Mesothermal																													
	Oligothermal																													
	Stenothermal																													
	Metathermal																													
	Eurythermal																													
	Undesignated																													
Salinity	M																													
	MB																													
	BM																													Fresh-Brackish
	B																													
	BZ																													
	ZB	■																												
	Z																													

Geographical distribution and additional comments:

Taxon Amphipleura pellucida Kütz

References

		4	8	9	11	21	26	27	30	34	38	45	46	49	Concensus & Notes
pH	Acidobiontic														Alkaliphilous
	Acidophilous														range 6·2-8·0(8,27)
	Indifferent														7·0-8·5(49)
	Alkaliphilous	■	■	■	■		■	■						■	opt 7·3 (4)
	Alkalibiontic														
Nutrient	Eutrophic					■								■	
	Mesotrophic														Eutrophic
	Oligotrophic														
	Dystrophic														
Halobion	Polyhalobous														
	Euhalobous														Indifferent
	Mesohalobous														
	alpha range														
	beta range														
	Oligohalobous													■	
	halophilous														
	indifferent		■	■	■					■			■		
	halophobous						■						■		
	Euryhalobous												■	■	
Saprobien	Polysaprobic														
	Mesosaprobic														Oligosaprobic to
	alpha range														β-MesoSaprobic
	beta range								■						
	Oligosaprobic						■		■						
	Saprophilic														
	Saproxenous														
	Saprophobic														
Current	Limnobiontic		■		■										
	Limnophilous														Limnobiontic
	Indifferent														
	Rheophilous														
	Rheobiontic														
General Habitat	Marine														
	Estuary														
	Lake														
	Pond														
	River														
	Spring & Stream														
	Aerophilous														
	Other														
Specific Habitat	Euplanktonic														
	Tychoplanktonic											■			
	Periphitic					■				■		■			Periphytic
	epipelic														
	epilithic														
	epidendric														
	epizootic														
	epiphitic														
	attached											■			
	unattached											■			
Seasonal Dist.	Winter											■			
	Spring														Winter Maximum
	Summer														
	Autumn														
Temperature	Euthermal														
	Mesothermal														
	Oligothermal														
	Stenothermal														
	Metathermal														
	Eurythermal														
	Undesignated														
Salinity	M														
	MR														
	BM														
	R														Fresh-Brackish
	RZ														
	ZR														
	Z														

Geographical distribution and additional comments:

Cosmopolitan (34): usually found in fairly hard water (38)

Ca 140-420 mg/l (49)
Fe 0-50
Si 0-2·0

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Taxon Navicula cryptocephala Kütz

		References																											Concensus & Notes
		1	3	4	7	8	9	10	11	14	19	26	27	30	31	34	35	38	43	45	46	49							
pH	Acidobiontic																												Alkaliphilous range 5.4-9.0 (8,27,43) optimum around 8.0 (4)
	Acidophilous																												
	Indifferent																												
	Alkaliphilous			■		■	■	■	■	■	■		■				■		■			■							
	Alkalibiontic																												
Nutrient	Eutrophic			■																									Eutrophic to mesotrophic
	Mesotrophic																					■							
	Oligotrophic																												
	Dystrophic																												
Halobion	Polyhalobous																												Indifrent
	Euhalobous																												
	Mesohalobous			■																									
	alpha range																												
	beta range																	■											
	Oligohalobous										■							■				■							
	halophilous																												
	indifferent						■	■	■	■		■				■				■	■								
	halophobous																		■										
Saprobien	Euryhalobous		■			■															■								Beta-Mesosaprobic but tolerant of a broad saprobien spectrum
	Polysaprobic																												
	Mesosaprobic																												
	alpha range				■															■									
	beta range				■									■	■					■									
	Oligosaprobic	■			■																								
	Saprophilic				■																								
	Saproxenous				■																								
	Saprophobic				■																								
Current	Limnobiontic																												Indiffrent
	Limnophilous																												
	Indifferent					■			■										■										
	Rheophilous																												
	Rheobiontic																												
General Habitat	Marine																												Lakes Rivers + Bogs
	Estuary																												
	Lake																	■											
	Pond																												
	River																	■											
	Spring & Stream																												
	Aerophilous																												
	Other																	■											
Specific Habitat	Euplanktonic																												
	Tychoplanktonic																												
	Periphitic																												
	epipelic																												
	epilithic																												
	epidendric																												
	epizootic																												
	epiphitic																												
	attached																												
	unattached																												
Seasonal Dist.	Winter																												Spring Summer + Autumn
	Spring																			■									
	Summer	■																											
	Autumn																			■									
Temperature	Euthermal																												Eurythermal and Oligothermal to Mesothermal
	Mesothermal																		■										
	Oligothermal																		■										
	Stenothermal																												
	Metathermal																												
	Eurythermal																		■										
	Undesignated																												
Salinity	M																												Fresh-Brackish
	MB																												
	BM																												
	B																												
	BZ																												
	ZB																					■							
	Z																												

Geographical distribution and additional comments:

Cosmopolitan (21,24); euryoxybiontic (26); calcium Indiffrent (36)

Taxon Navicula lanceolata (Agardh) Kütz

		References												Concensus & Notes
		4	8	9	11	12	14	20	21	26	27	38	49	
pH	Acidobiontic													Alkaliphilous range 6·3 - 9·0 (8, 27, 49) opt about 8·0 (4)
	Acidophilous													
	Indifferent													
	Alkaliphilous	■	■	■	■	■	■		■	■	■		■	
	Alkalibiontic													
Nutrient	Eutrophic										■		■	Eutrophic
	Mesotrophic												■	
	Oligotrophic													
	Dystrophic													
Halobion	Polyhalobous													Indifferent
	Euhalobous													
	Mesohalobous												■	
	alpha range													
	beta range							■				■		
	Oligohalobous							■				■		
	halophilous													
	indifferent		■	■	■		■		■	■				
	halophobous													
	Euryhalobous													
Saprobien	Polysaprobic													
	Mesosaprobic													
	alpha range													
	beta range													
	Oligosaprobic													
	Saprophilic													
	Saproxenous													
	Saprophobic													
Current	Limnobiontic													Limnophilous
	Limnophilous													
	Indifferent													
	Rheophilous													
	Rheobiontic													
General Habitat	Marine													Lakes + Ponds
	Estuary													
	Lake										■			
	Pond										■			
	River													
	Spring & Stream													
	Aerophilous													
	Other													
Specific Habitat	Euplanktonic													Periphytic
	Tychoplanktonic													
	Periphitic								■					
	epipelic													
	epilithic													
	epidendric													
	epizootic													
	epiphitic													
	attached													
	unattached													
Seasonal Dist.	Winter													
	Spring													
	Summer													
	Autumn													
Temperature	Euthermal													
	Mesothermal													
	Oligothermal													
	Stenothermal													
	Metathermal													
	Eurythermal													
	Undesignated													
Salinity	M													Fresh-Brackish
	MB													
	BM													
	B													
	BZ													
	ZB												■	
	Z													

Geographical distribution and additional comments:

Cosmopolitan (21); seems to prefer water of high mineral content (38)

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Taxon Navicula notha Wallace

		References																												Concensus & Notes
pH	Acidobiontic																													
	Acidophilous																													
	Indifferent																													
	Alkaliphilous																													
	Alkalibiontic																													
Nutrient	Eutrophic																													
	Mesotrophic																													
	Oligotrophic																													
	Dystrophic																													
Halobion	Polyhalobous																													
	Euhalobous																													
	Mesohalobous																													
	alpha range																													
	beta range																													
	Oligohalobous																													
	halophilous																													
	indifferent																													
	halophobous																													
Saprobien	Euryhalobous																													
	Polysaprobic																													
	Mesosaprobic																													
	alpha range																													
	beta range																													
	Oligosaprobic																													
	Saprophilic																													
	Saproxenous																													
	Saprophobic																													
Current	Limnobiontic																													
	Limnophilous																													
	Indifferent																													
	Rheophilous																													
	Rheobiontic																													
General Habitat	Marine																													
	Estuary																													
	Lake																													
	Pond																													
	River																													
	Spring & Stream																													
	Aerophilous																													
	Other																													
Specific Habitat	Euplanktonic																													
	Tychoplanktonic																													
	Periphitic																													
	epipelic																													
	epilithic																													
	epidendric																													
	epizootic																													
	epiphitic																													
	attached																													
	unattached																													
Seasonal Dist.	Winter																													
	Spring																													
	Summer																													
	Autumn																													
Temperature	Euthermal																													
	Mesothermal																													
	Oligothermal																													
	Stenothermal																													
	Metathermal																													
	Eurythermal																													
	Undesignated																													
Salinity	M																													
	MB																													
	BM																													
	B																													
	BZ																													
	ZB																													
	Z																													

Geographical distribution and additional comments:

Seems to prefer water of low mineral content (38)

Taxon Navicula peregrina (Ehr) Kütz

		3	4	8	9	10	12	13	26	35	38	41	46	49	Concensus & Notes
pH	Acidobiontic														Alkaliphilous range 6·8–7·9 (8)
	Acidophilous														
	Indifferent			■											
	Alkaliphilous			■		■	■	■		■					
	Alkalibiontic														
Nutrient	Eutrophic														
	Mesotrophic														
	Oligotrophic														
	Dystrophic														
Halobion	Polyhalobous														
	Euhalobous														Mesohalobous
	Mesohalobous		■	■	■	■	■	■			■	■	■	■	
	alpha range								■						
	beta range	■													
	Oligohalobous														
	halophilous														
	indifferent														
	halophobous														
	Euryhalobous												■	■	
Saprobien	Polysaprobic														
	Mesosaprobic														
	alpha range														
	beta range														
	Oligosaprobic														
	Saprophilic														
	Saproxenous														
	Saprophobic														
Current	Limnobiontic														
	Limnophilous														
	Indifferent														
	Rheophilous														
	Rheobiontic														
General Habitat	Marine														
	Estuary														
	Lake														
	Pond														
	River														
	Spring & Stream														
	Aerophilous														
	Other														
Specific Habitat	Euplanktonic														
	Tychoplanktonic														
	Periphitic														
	epipelic														
	epilithic														
	epidendric														
	epizootic														
	epiphitic														
	attached														
	unattached														
Seasonal Dist.	Winter														
	Spring														
	Summer														
	Autumn														
Temperature	Euthermal														
	Mesothermal														
	Oligothermal														
	Stenothermal														
	Metathermal														
	Eurythermal														
	Undesignated														
Salinity	M														
	MB														
	BM														
	B													■	Brackish
	BZ														
	ZB														
	Z														

Geographical distribution and additional comments:

Seems to prefer water of high mineral content (38)

Taxon Navicula rhynchocephala Kütz

		References																												Concensus & Notes
		4	8	9	10	11	12	13	20	21	26	27	29	31	38	36	45	46	49											
pH	Acidobiontic																													Alkaliphilous range 6.4-9.0 (8,27) optimum 7.3-7.6 (4)
	Acidophilous																													
	Indifferent																													
	Alkaliphilous	■	■	■	■	■	■	■			■	■							■											
	Alkalibiontic																													
Nutrient	Eutrophic											■																		
	Mesotrophic																		■											Eutrophic-Mesotrophic
	Oligotrophic																													
	Dystrophic																													
Halobion	Polyhalobous																													
	Euhalobous																													Indifferent to Halophilous
	Mesohalobous																													
	alpha range																													
	beta range								■										■											
	Oligohalobous								■										■											
	halophilous			■	■		■						■		■															
	indifferent		■			■				■	■				■	■		■												
	halophobous																													
Saprobien	Euryhalobous																	■												
	Polysaprobic																													
	Mesosaprobic																													β-Mesosaprobic
	alpha range																													
	beta range													■			■													
	Oligosaprobic																													
	Saprophilic																													
	Saproxenous																													
	Saprophobic																													
Current	Limnobiontic																													
	Limnophilous																													Indifferent
	Indifferent		■			■																								
	Rheophilous																													
	Rheobiontic																													
General Habitat	Marine																													
	Estuary																													
	Lake																													
	Pond											■																		Ponds
	River																													
	Spring & Stream																													
	Aerophilous																													
	Other																													
Specific Habitat	Euplanktonic																													
	Tychoplanktonic																													
	Periphitic									■																				Periphytic
	epipelic																													
	epilithic																													
	epidendric																													
	epizootic																													
	epiphitic																													
	attached																													
	unattached																													
Seasonal Dist.	Winter																													
	Spring																■													Spring and Autumn maxima
	Summer																													
	Autumn																■													
Temperature	Euthermal																													
	Mesothermal																													
	Oligothermal																													
	Stenothermal																													
	Metathermal																													
	Eurythermal																													
	Undesignated																													
Salinity	M																													
	MB																													
	BM																													
	B																													Fresh-Brackish
	BZ																													
	ZB																		■											
	Z																													

Geographical distribution and additional comments:

Cosmopolitan (21,24); mesooxybiontic (26); seems to prefer wate of high mineral content (38)

Ca 140.0-280.0 mg/l (49)
Fe 0.2.5
Si 0-1.0

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Taxon Naviella seminulum Grun.

		References									Concensus & Notes
		4	8	9	10	13	26	27	35	38	
pH	Acidobiontic										Indifrent range 5.4–8.4 (2,27) optimum about 8.4 (4)
	Acidophilous										
	Indifferent		■	■	■	■	■	■	■		
	Alkaliphilous	■									
	Alkalibiontic										
Nutrient	Eutrophic							■			Oligotrophic to Eutrophic
	Mesotrophic										
	Oligotrophic							■			
	Dystrophic										
Halobion	Polyhalobous										Indifferent to B-mesohalobous
	Euhalobous										
	Mesohalobous										
	alpha range										
	beta range									■	
	Oligohalobous									■	
	halophilous		■								
	indifferent			■			■				
	halophobous										
Saprobien	Euryhalobous										
	Polysaprobic										
	Mesosaprobic										
	alpha range										
	beta range										
	Oligosaprobic										
	Saprophilic										
	Saproxenous										
	Saprophobic										
Current	Limnobiontic										Indifferent
	Limnophilous										
	Indifferent		■								
	Rheophilous										
	Rheobiontic										
General Habitat	Marine										Ponds
	Estuary										
	Lake										
	Pond							■			
	River										
	Spring & Stream										
	Aerophilous										
	Other										
Specific Habitat	Euplanktonic										
	Tychoplanktonic										
	Periphitic										
	epipelic										
	epilithic										
	epidendric										
	epizootic										
	epiphitic										
	attached										
	unattached										
Seasonal Dist.	Winter										
	Spring										
	Summer										
	Autumn										
Temperature	Euthermal										
	Mesothermal										
	Oligothermal										
	Stenothermal										
	Metathermal										
	Eurythermal										
	Undesignated										
Salinity	M										
	MB										
	BM										
	B										
	BZ										
	ZB										
	Z										

Geographical distribution and additional comments:

Probably cosmopolitan but seldom seen in the tropics (24); a facultative nitrogen heterotroph that tolerates low oxygen concentrations (4) mesooxybiontic (26)

Taxon Navicula viridula Kütz

		References																		Concensus & Notes
		1	3	4	9	10	11	12	14	20	21	26	27	29	34	38	39	45	49	
pH	Acidobiontic																			Alkaliphilous range 5.5-9.0(8,21,27) 7.3-79 (49) opt 7.5(4,21)
	Acidophilous																			
	Indifferent															■				
	Alkaliphilous		■	■	■	■	■	■	■		■	■	■			■				
	Alkalibiontic																			
Nutrient	Eutrophic												■						■	Eutrophic
	Mesotrophic																			
	Oligotrophic																			
	Dystrophic																			
Halobion	Polyhalobous																			Indifferent
	Euhalobous																			
	Mesohalobous									■										
	alpha range																			
	beta range																			
	Oligohalobous									■				■	■	■			■	
	halophilous																			
	indifferent		■		■	■	■		■		■	■					■	■		
	halophobous																			
	Euryhalobous										■							■		
Saprobien	Polysaprobic																			Oligosaprobic to Mesosaprobic
	Mesosaprobic																			
	alpha range																	■		
	beta range																	■		
	Oligosaprobic	■																		
	Saprophilic																			
	Saproxenous																			
	Saprophobic																			
Current	Limnobiontic																			Rheophilous to Indifferent
	Limnophilous																			
	Indifferent											■								
	Rheophilous		■				■													
	Rheobiontic																			
General Habitat	Marine																			Lakes + Ponds
	Estuary																			
	Lake												■							
	Pond												■							
	River																			
	Spring & Stream																			
	Aerophilous																			
	Other																			
Specific Habitat	Euplanktonic																			Periphytic
	Tychoplanktonic																	■		
	Periphitic										■				■			■		
	epipelic																			
	epilithic																			
	epidendric																			
	epizootic																			
	epiphitic																			
	attached																			
	unattached																			
Seasonal Dist.	Winter																			Summer form
	Spring																			
	Summer	■																		
	Autumn																			
Temperature	Euthermal																			
	Mesothermal																			
	Oligothermal																			
	Stenothermal																			
	Metathermal																			
	Eurythermal																			
	Undesignated																			
Salinity	M																			Fresh-Brackish
	MB																			
	BM																			
	B																			
	BZ																			
	ZB																		■	
	Z																			

Geographical distribution and additional comments:

Cosmopolitan (21,24); Mesooxybiontic (26)

Taxon Pinnularia Brébissonii Hustedt

		References																												Concensus & Notes
		21																												
pH	Acidobiontic																													
	Acidophilous																													
	Indifferent																													
	Alkaliphilous	■																												
	Alkalibiontic																													
Nutrient	Eutrophic																													
	Mesotrophic																													
	Oligotrophic																													
	Dystrophic																													
Halobion	Polyhalobous																													
	Euhalobous																													
	Mesohalobous																													
	alpha range																													
	beta range																													
	Oligohalobous	■																												
	halophilous																													
	indifferent																													
	halophobous																													
Saprobien	Euryhalobous																													
	Polysaprobic																													
	Mesosaprobic																													
	alpha range																													
	beta range																													
	Oligosaprobic																													
	Saprophilic																													
	Saproxenous																													
	Saprophobic																													
Current	Limnobiontic																													
	Limnophilous																													
	Indifferent																													
	Rheophilous																													
	Rheobiontic																													
General Habitat	Marine																													
	Estuary																													
	Lake																													
	Pond																													
	River																													
	Spring & Stream																													
	Aerophilous																													
	Other																													
Specific Habitat	Euplanktonic																													
	Tychoplanktonic																													
	Periphitic																													
	epipelic																													
	epilithic																													
	epidendric																													
	epizootic																													
	epiphitic																													
	attached																													
	unattached																													
Seasonal Dist.	Winter																													
	Spring																													
	Summer																													
	Autumn																													
Temperature	Euthermal																													
	Mesothermal																													
	Oligothermal																													
	Stenothermal																													
	Metathermal																													
	Eurythermal																													
	Undesignated																													
Salinity	M																													
	MB																													
	BM																													
	B																													
	BZ																													
	ZB																													
	Z																													

Geographical distribution and additional comments:

Seems to prefer cool water of low mineral content (37)

Taxon *Pinnularia microstauron (Ehr) Cleve*

		References					Concensus & Notes
		26	27	39	46	49	
pH	Acidobiontic						Acidophilous range 4·3 – >9·0 (27) most frequently 4·3-6·5 (27) pH opt >7·0 (4) / 4·3-6·5 (49)
	Acidophilous		■			■	
	Indifferent	■					
	Alkaliphilous						
	Alkalibiontic						
Nutrient	Eutrophic						Oligotrophic
	Mesotrophic						
	Oligotrophic					■	
	Dystrophic						
Halobion	Polyhalobous						Oligo halobous indiffrent
	Euhalobous						
	Mesohalobous						
	alpha range						
	beta range						
	Oligohalobous	■			■		
	halophilous						
	indifferent	■		■	■		
	halophobous						
	Euryhalobous						
Saprobien	Polysaprobic						Oligosaprobic
	Mesosaprobic						
	alpha range						
	beta range						
	Oligosaprobic	■				■	
	Saprophilic						
	Saproxenous						
	Saprophobic						
Current	Limnobiontic						
	Limnophilous						
	Indifferent						
	Rheophilous						
	Rheobiontic						
General Habitat	Marine						
	Estuary						
	Lake						
	Pond						
	River						
	Spring & Stream						
	Aerophilous						
	Other						
Specific Habitat	Euplanktonic						
	Tychoplanktonic						
	Periphitic						
	epipelic						
	epilithic						
	epidendric						
	epizootic						
	epiphitic						
	attached						
	unattached						
Seasonal Dist.	Winter						
	Spring						
	Summer						
	Autumn						
Temperature	Euthermal						
	Mesothermal						
	Oligothermal						
	Stenothermal						
	Metathermal						
	Eurythermal						
	Undesignated						
Salinity	M						Freshwater
	MB						
	BM						
	B						
	BZ						
	ZB						
	Z					■	

Geographical distribution and additional comments:

Meioeuryhaline (46)

Ca 0-420·0 mg/L (49)
Fe 0-7·5
Si 0-4·0

Taxon Pinnularia viridis (Nitz) Ehr

References

		2	4	7	8	9	10	11	13	14	21	26	27	29	34	35	38	39	41	46	49									Concensus & Notes
pH	Acidobiontic																													Indifrent
	Acidophilous		■																											
	Indifferent	■			■	■	■	■	■	■		■	■			■	■													range 4·2-9·0 (2,8,21,27)
	Alkaliphilous	■									■																			optimum 5·6-6·0 (4)
	Alkalibiontic																													
Nutrient	Eutrophic																													
	Mesotrophic																				■									± Mesotrophic
	Oligotrophic																													
	Dystrophic																													
Halobion	Polyhalobous																													
	Euhalobous																													Indifferent
	Mesohalobous																													
	alpha range																													
	beta range																													
	Oligohalobous										■			■							■									
	halophilous																													
	indifferent				■	■	■	■		■		■						■		■										
	halophobous																													
	Euryhalobous																			■										
Saprobien	Polysaprobic																													Oligosaprotic to
	Mesosaprobic																													
	alpha range			■																										α - mesosaprotic
	beta range																													
	Oligosaprobic											■									■									
	Saprophilic																													
	Saproxenous																													
	Saprophobic																													
Current	Limnobiontic																													
	Limnophilous																													Indifferent
	Indifferent				■			■			■																			
	Rheophilous																													
	Rheobiontic																													
General Habitat	Marine																													
	Estuary																													
	Lake																													
	Pond																													
	River																													
	Spring & Stream																													
	Aerophilous																													
	Other																													
Specific Habitat	Euplanktonic																													
	Tychoplanktonic																													Peiphytic
	Periphitic														■															
	epipelic																													
	epilithic																													
	epidendric																													
	epizootic																													
	epiphitic																													
	attached																													
	unattached																													
Seasonal Dist.	Winter																													
	Spring																		■											Spring + Autumn
	Summer																													maxima
	Autumn																		■											
Temperature	Euthermal																													
	Mesothermal																													Eurythermal
	Oligothermal																													
	Stenothermal																													
	Metathermal																													
	Eurythermal																													
	Undesignated																													
Salinity	M																													
	MB																													
	BM																													
	B																													Fresh-Brackish
	BZ																													
	ZB																				■									
	Z																													

Geographical distribution and additional comments:

Cosmopolitan (21); probably withstands oxygen poor waters (4); mesooxybiontic (21) calcium indifferent (36); found in water of higher mineral content than many of the species belonging to Pinnularia (38)

Taxon Amphora ovalis Kütz

		2	7	8	9	10	11	14	19	20	21	26	27	29	30	31	34	36	39	43	46	49	Concensus & Notes
pH	Acidobiontic																						Alkaliphilous range 6.2-9.0 (2, 8, 21, 27) optimum 7.0-8.5 (36)
	Acidophilous																						
	Indifferent																						
	Alkaliphilous	■		■	■	■	■	■			■	■	■				■	■				■	
	Alkalibiontic																						
Nutrient	Eutrophic																					■	
	Mesotrophic																						
	Oligotrophic																						
	Dystrophic																						
Halobion	Polyhalobous																						Indifferent
	Euhalobous																						
	Mesohalobous																						
	alpha range																						
	beta range																						
	Oligohalobous										■			■								■	
	halophilous																						
	indifferent			■	■	■	■	■				■					■		■		■	■	
	halophobous																			■			
	Euryhalobous			■																			
Saprobien	Polysaprobic																						Oligosaprobic
	Mesosaprobic																						
	alpha range		■																				
	beta range																						
	Oligosaprobic		■									■			■	■							
	Saprophilic																						
	Saproxenous																						
	Saprophobic																						
Current	Limnobiontic																						Indifferent to Limnophilous
	Limnophilous								■														
	Indifferent			■			■																
	Rheophilous																						
	Rheobiontic																						
General Habitat	Marine																						Standing water
	Estuary																						
	Lake																						
	Pond																						
	River																						
	Spring & Stream																						
	Aerophilous																						
	Other								■		■												
Specific Habitat	Euplanktonic																						Periphytic
	Tychoplanktonic																						
	Periphitic								■	■	■						■						
	epipelic																						
	epilithic																						
	epidendric																						
	epizootic																						
	epiphitic																						
	attached																						
	unattached																						
Seasonal Dist.	Winter																						
	Spring																						
	Summer																						
	Autumn																						
Temperature	Euthermal																						
	Mesothermal																						
	Oligothermal																						
	Stenothermal																						
	Metathermal																						
	Eurythermal																						
	Undesignated																						
Salinity	M																						
	MR																						
	BM																						
	B																						
	BZ																						
	ZB																						■	
	Z																						

Geographical distribution and additional comments:

Cosmopolitan (21, 24); calciphilous (36)

Ca 140.0-420.0 mg/L (49)

Fe 0-5.0

Si 0-6.0

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Taxon Amphora ovalis Kütz var. lybica (Ehr) Cleve

References

		10	11	12	13	14	29	34	35	45	69	Concensus & Notes
pH	Acidobiontic											
	Acidophilous											Alkaliphilous
	Indifferent	■										
	Alkaliphilous		■	■	■	■		■	■			
	Alkalibiontic									■		
Nutrient	Eutrophic											
	Mesotrophic											
	Oligotrophic											
	Dystrophic											
Halobion	Polyhalobous											
	Euhalobous											Indifferent
	Mesohalobous											
	alpha range											
	beta range											
	Oligohalobous											
	halophilous						■					
	indifferent	■				■	■	■				
	halophobous											
	Euryhalobous						■					
Saprobien	Polysaprobic											
	Mesosaprobic											
	alpha range											
	beta range											
	Oligosaprobic											
	Saprophilic											
	Saproxenous											
	Saprophobic											
Current	Limnobiontic											
	Limnophilous											
	Indifferent											
	Rheophilous											
	Rheobiontic											
General Habitat	Marine											
	Estuary											
	Lake											
	Pond											
	River											
	Spring & Stream											
	Aerophilous											
	Other											
Specific Habitat	Euplanktonic											
	Tychoplanktonic											Periphytic
	Periphitic							■				
	epipelic											
	epilithic											
	epidendric											
	epizootic											
	epiphitic											
	attached											
	unattached											
Seasonal Dist.	Winter											
	Spring											Autumn
	Summer											Weak autumn maximum
	Autumn									■		
Temperature	Euthermal											
	Mesothermal											
	Oligothermal											
	Stenothermal											
	Metathermal											
	Eurythermal											
	Undesignated											
Salinity	M											
	MB											
	BM											Fresh-Brackish
	B											
	BZ											
	ZB										■	
	Z											

Geographical distribution and additional comments:

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Taxon Amphora veneta (Kütz) Hust

		3	4	8	9	10	12	13	20	26	29	39	46	49	Concensus & Notes
pH	Acidobiontic														Alkaliphilous range 7.2-7.8 (8) optimum over 8.5 (4)
	Acidophilous														
	Indifferent							■		■					
	Alkaliphilous		■			■	■								
	Alkalibiontic		■	■											
Nutrient	Eutrophic													■	Eutrophic
	Mesotrophic														
	Oligotrophic														
	Dystrophic														
Halobion	Polyhalobous														Indifferent and euhalobous
	Euhalobous														
	Mesohalobous								■						
	alpha range														
	beta range													■	
	Oligohalobous								■					■	
	halophilous				■	■									
	indifferent			■						■	■	■	■		
	halophobous														
Saprobien	Euryhalobous	■									■		■		
	Polysaprobic														
	Mesosaprobic														
	alpha range														
	beta range														
	Oligosaprobic														
	Saprophilic														
	Saproxenous														
	Saprophobic														
Current	Limnobiontic														Limnobiontic to Indifferent
	Limnophilous			■											
	Indifferent									■					
	Rheophilous														
	Rheobiontic														
General Habitat	Marine														
	Estuary														
	Lake														
	Pond														
	River														
	Spring & Stream														
	Aerophilous														
	Other														
Specific Habitat	Euplanktonic														Periphytic
	Tychoplanktonic														
	Periphitic								■						
	epipelic														
	epilithic														
	epidendric														
	epizootic														
	epiphitic														
	attached														
	unattached														
Seasonal Dist.	Winter														
	Spring														
	Summer														
	Autumn														
Temperature	Euthermal														
	Mesothermal														
	Oligothermal														
	Stenothermal														
	Metathermal														
	Eurythermal														
	Undesignated														
Salinity	M														Brackish-Freshwater
	MB														
	BM														
	B														
	BZ													■	
	ZB														
	Z														

Geographical distribution and additional comments:

Cosmopolitan (24); mesooxybiontic (26); often found with Epithemia sorex (20)

Taxon Cymbella ventricosa Kütz

		References																					Concensus & Notes
		1	3	4	7	8	10	11	14	19	26	27	29	31	34	35	36	39	43	45	46	49	
pH	Acidobiontic																						Indifferent range 5·3-8·5 (19,27,43) optimum 7·7-7·8 (4)
	Acidophilous																						
	Indifferent				■	■	■	■	■	■	■	■				■			■				
	Alkaliphilous			■													■						
	Alkalibiontic																						
Nutrient	Eutrophic																					■	Eutrophic
	Mesotrophic																						
	Oligotrophic																						
	Dystrophic																						
Halobion	Polyhalobous																						Indifferent
	Euhalobous																						
	Mesohalobous																						
	alpha range																						
	beta range																						
	Oligohalobous									■					■							■	
	halophilous																						
	indifferent					■	■	■	■		■		■					■		■	■		
	halophobous																		■				
	Euryhalobous					■							■							■	■		
Saprobien	Polysaprobic																						Oligosaprobic to Mesosaprobic
	Mesosaprobic																						
	alpha range				■																		
	beta range				■																		
	Oligosaprobic	■	■											■									
	Saprophilic																						
	Saproxenous																						
	Saprophobic																						
Current	Limnobiontic																						Rheophilous to Indifferent
	Limnophilous																						
	Indifferent									■									■				
	Rheophilous					■		■															
	Rheobiontic																						
General Habitat	Marine																						
	Estuary																						
	Lake																						
	Pond																						
	River																						
	Spring & Stream																						
	Aerophilous																						
	Other																						
Specific Habitat	Euplanktonic																						Periphytic
	Tychoplanktonic																						
	Periphitic									■					■				■				
	epipelic																						
	epilithic																						
	epidendric																						
	epizootic																						
	epiphitic																						
	attached																						
	unattached																						
Seasonal Dist.	Winter																						Summer and autumn form
	Spring																						
	Summer	■																					
	Autumn																			■			
Temperature	Euthermal																						Eurythermal and oligothermal to mesothermal
	Mesothermal																		■				
	Oligothermal																		■				
	Stenothermal																						
	Metathermal																						
	Eurythermal																		■				
	Undesignated																						
Salinity	M																						Fresh-Brackish
	MB																						
	BM																						
	B																						
	BZ																						
	ZB																					■	
	Z																						

Geographical distribution and additional comments:

Ca 0-420·0 mg/l (49)
Fe 0-5·0
Si 0-4·0

130

Taxon Gomphonema acuminatum Ehr

References

		2	4	8	9	10	11	12	13	14	21	26	27	29	30	31	35	39	49	Concensus & Notes
pH	Acidobiontic																			Alkaliphilous range 5·4-9·0 (2,8,27) optimum around 8·0 (4) opt 6·0-7·0 (49)
	Acidophilous																			
	Indifferent																			
	Alkaliphilous	■	■	■	■	■	■	■	■	■	■	■	■				■			
	Alkalibiontic																			
Nutrient	Eutrophic																		■	Eutrophic
	Mesotrophic																			
	Oligotrophic																			
	Dystrophic																			
Halobion	Polyhalobous																			Indifferent
	Euhalobous																			
	Mesohalobous																			
	alpha range																			
	beta range																			
	Oligohalobous										■			■					■	
	halophilous																			
	indifferent			■	■	■	■			■		■						■		
	halophobous																			
	Euryhalobous																			
Saprobien	Polysaprobic																			Oligosaprobic
	Mesosaprobic																			
	alpha range																			
	beta range																			
	Oligosaprobic											■			■	■				
	Saprophilic																			
	Saproxenous																			
	Saprophobic																			
Current	Limnobiontic																			Limnophilous
	Limnophilous			■		■				■										
	Indifferent																			
	Rheophilous																			
	Rheobiontic																			
General Habitat	Marine																			
	Estuary																			
	Lake																			
	Pond																			
	River																			
	Spring & Stream																			
	Aerophilous																			
	Other																			
Specific Habitat	Euplanktonic																			Periphytic
	Tychoplanktonic																			
	Periphitic										■									
	epipelic																			
	epilithic																			
	epidendric																			
	epizootic																			
	epiphitic																			
	attached																			
	unattached																			
Seasonal Dist.	Winter																			
	Spring																			
	Summer																			
	Autumn																			
Temperature	Euthermal																			Mesothermal and metathermal
	Mesothermal	■																		
	Oligothermal																			
	Stenothermal																			
	Metathermal	■																		
	Eurythermal																			
	Undesignated																			
Salinity	M																			Fresh-Brackish
	MB																			
	BM																			
	B																			
	BZ																			
	ZB																		■	
	Z																			

Geographical distribution and additional comments:

Cosmopolitan (21,24); more abundant in temperate than tropical regions (24)
Ca opt 140·0-280·0 mg/l (49)
Fe 0-10·0 mg/l

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Taxon Gomphonema angustatum (Kütz) Rab.

		References				Concensus & Notes
		49	46	27	26	
pH	Acidobiontic					Alkaliphilous range 6·7-9·0 (27) opt 7·5-7·9 (4)
	Acidophilous					
	Indifferent					
	Alkaliphilous			■	■	
	Alkalibiontic					
Nutrient	Eutrophic					± Mesotrophic
	Mesotrophic	■				
	Oligotrophic					
	Dystrophic					
Halobion	Polyhalobous					Oligohalobous indifferent
	Euhalobous					
	Mesohalobous					
	alpha range					
	beta range					
	Oligohalobous	■	■		■	
	halophilous					
	indifferent		■		■	
	halophobous					
	Euryhalobous					
Saprobien	Polysaprobic					Oligosaprobic
	Mesosaprobic					
	alpha range					
	beta range					
	Oligosaprobic				■	
	Saprophilic					
	Saproxenous					
	Saprophobic					
Current	Limnobiontic					
	Limnophilous					
	Indifferent					
	Rheophilous					
	Rheobiontic					
General Habitat	Marine					
	Estuary					
	Lake					
	Pond					
	River					
	Spring & Stream					
	Aerophilous					
	Other					
Specific Habitat	Euplanktonic					
	Tychoplanktonic					
	Periphitic					
	epipelic					
	epilithic					
	epidendric					
	epizootic					
	epiphitic					
	attached					
	unattached					
Seasonal Dist.	Winter					
	Spring					
	Summer					
	Autumn					
Temperature	Euthermal					
	Mesothermal					
	Oligothermal					
	Stenothermal					
	Metathermal					
	Eurythermal					
	Undesignated					
Salinity	M					Fresh-Brackish
	MB					
	BM					
	B					
	BZ					
	ZB	■				
	Z					

Geographical distribution and additional comments:

Not rare in some eutrophic ponds (27)

Taxon Gomphonema parvulum Kütz

		3	4	7	8	9	10	11	12	13	14	20	21	26	29	31	34	35	39	43	46	49								Concensus & Notes
pH	Acidobiontic																													Indifferent range 4.3-9.0 (8.21.43) optimum 7.8- 8.2 (4)
	Acidophilous																													
	Indifferent				■	■	■	■	■				■	■				■		■										
	Alkaliphilous		■				■		■		■																			
	Alkalibiontic																													
Nutrient	Eutrophic																					■								Mesotrophic
	Mesotrophic																					■								
	Oligotrophic																													
	Dystrophic																													
Halobion	Polyhalobous																													Indifferent
	Euhalobous																													
	Mesohalobous																													
	alpha range																													
	beta range																													
	Oligohalobous																					■								
	halophilous	■													■															
	indifferent				■	■	■	■			■		■	■			■		■	■	■									
	halophobous																													
Saprobien	Euryhalobous				■								■				■			■	■									Mesosaprobic
	Polysaprobic																													
	Mesosaprobic																■													
	alpha range			■																										
	beta range															■														
	Oligosaprobic																													
	Saprophilic																													
	Saproxenous																													
	Saprophobic																													
Current	Limnobiontic																													Rheophilous
	Limnophilous											■																		
	Indifferent													■																
	Rheophilous				■			■												■										
	Rheobiontic																													
General Habitat	Marine																													
	Estuary																													
	Lake																													
	Pond																													
	River																													
	Spring & Stream																													
	Aerophilous																													
	Other																													
Specific Habitat	Euplanktonic																													Periphytic
	Tychoplanktonic																													
	Periphitic																■			■										
	epipelic																													
	epilithic																													
	epidendric																													
	epizootic																													
	epiphitic																													
	attached																													
	unattached																													
Seasonal Dist.	Winter																													
	Spring																													
	Summer																													
	Autumn																													
Temperature	Euthermal																													Mesothermal and Stenothermal
	Mesothermal												■							■										
	Oligothermal																													
	Stenothermal												■							■										
	Metathermal																													
	Eurythermal																													
	Undesignated																													
Salinity	M																													Fresh-Brackish
	MB																													
	BM																													
	B																													
	BZ																													
	ZB																				■									
	Z																													

Geographical distribution and additional comments:

Cosmopolitan (21); a facultative nitrogen heterotroph and may be a pollution indicator (4); the great adaptability of this species accounts for its variability (21); calcium and iron indifferent (26)

Taxon Gomphonema tergestinum (Grun) Fricke

		References 26	Concensus & Notes
pH	Acidobiontic		Alkaliphilous
	Acidophilous		
	Indifferent		
	Alkaliphilous	■	
	Alkalibiontic		
Nutrient	Eutrophic		
	Mesotrophic		
	Oligotrophic		
	Dystrophic		
Halobion	Polyhalobous		
	Euhalobous		
	Mesohalobous		
	alpha range		Oligohalobous
	beta range		indifferent
	Oligohalobous	■	
	halophilous		
	indifferent	■	
	halophobous		
	Euryhalobous		
Saprobien	Polysaprobic		
	Mesosaprobic		
	alpha range		Saproxenous
	beta range		
	Oligosaprobic		
	Saprophilic		
	Saproxenous	■	
	Saprophobic		
Current	Limnobiontic		
	Limnophilous		
	Indifferent		
	Rheophilous		
	Rheobiontic		
General Habitat	Marine		
	Estuary		
	Lake		
	Pond		
	River		
	Spring & Stream		
	Aerophilous		
	Other		
Specific Habitat	Euplanktonic		
	Tychoplanktonic		
	Periphitic		
	epipelic		
	epilithic		
	epidendric		
	epizootic		
	epiphitic		
	attached		
	unattached		
Seasonal Dist.	Winter		
	Spring		
	Summer		
	Autumn		
Temperature	Euthermal		
	Mesothermal		
	Oligothermal		
	Stenothermal		
	Metathermal		
	Eurythermal		
	Undesignated		
Salinity	M		
	MB		
	BM		
	B		
	BZ		
	ZB		
	Z		

Geographical distribution and additional comments:

Taxon Epithemia turgida (Ehr) Kütz

		References																												Concensus & Notes
		4	7	8	9	10	11	12	13	14	20	21	26	27	29	30	31	34	35	36	39	49								
pH	Acidobiontic																													Alkaliphilous to Alkalibiontic range 4·6-9·0 (8,27) 7·0 >9·0(49) optimum around 8·2 (4)
	Acidophilous																													
	Indifferent																													
	Alkaliphilous	■		■	■	■	■	■				■		■				■	■											
	Alkalibiontic								■	■		■	■							■		■								
Nutrient	Eutrophic																													
	Mesotrophic																													
	Oligotrophic																													
	Dystrophic																													
Halobion	Polyhalobous																													Indifferent
	Euhalobous																													
	Mesohalobous																													
	alpha range																													
	beta range										■																			
	Oligohalobous										■											■								
	halophilous																					■								
	indifferent			■	■	■	■			■			■		■			■			■									
	halophobous																													
	Euryhalobous														■															
Saprobien	Polysaprobic																													Saproxenous to β-mesosaprobic
	Mesosaprobic																													
	alpha range																													
	beta range		■																											
	Oligosaprobic															■	■													
	Saprophilic																													
	Saproxenous												■																	
	Saprophobic																													
Current	Limnobiontic																													Limnophilous
	Limnophilous			■			■																							
	Indifferent																													
	Rheophilous																													
	Rheobiontic																													
General Habitat	Marine																													
	Estuary																													
	Lake																													
	Pond																													
	River																													
	Spring & Stream																													
	Aerophilous																													
	Other																													
Specific Habitat	Euplanktonic																													Periphytic
	Tychoplanktonic																													
	Periphitic											■						■												
	epipelic																													
	epilithic																													
	epidendric																													
	epizootic																													
	epiphitic																													
	attached																													
	unattached																													
Seasonal Dist.	Winter																													
	Spring																													
	Summer																													
	Autumn																													
Temperature	Euthermal																													
	Mesothermal																													
	Oligothermal																													
	Stenothermal																													
	Metathermal																													
	Eurythermal																													
	Undesignated																													
Salinity	M																													Fresh-Brackish
	MB																													
	BM																													
	B																													
	BZ																													
	ZB																					■								
	Z																													

Geographical distribution and additional comments:

Cosmopolitan (21,24); Calciphilous (36)
Ca 140·0-560·0 mg/L (49)
Fe 0-7·5
Si 0-4·0

Taxon Nitzschia amphibia Grun.

		References																										Concensus & Notes
		2	3	4	8	9	10	11	12	13	14	21	26	27	28	34	39	43	46	49									
pH	Acidobiontic																												Alkaliphilous to alkalibiontic range 4.0-9.3 (8,21,27,43) opt. slightly >8.5 (4)
	Acidophilous																												
	Indifferent																												
	Alkaliphilous			■			■		■	■	■		■					■											
	Alkalibiontic			■	■	■		■						■															
Nutrient	Eutrophic													■						■									Eutrophic
	Mesotrophic																												
	Oligotrophic																												
	Dystrophic																												
Halobion	Polyhalobous																												Indifferent
	Euhalobous																												
	Mesohalobous			■																									
	alpha range																												
	beta range		■																										
	Oligohalobous											■			■														
	halophilous																												
	indifferent	■			■	■	■	■			■					■	■		■	■									
	halophobous																	■											
	Euryhalobous																	■											
Saprobien	Polysaprobic																												
	Mesosaprobic																												
	alpha range																												
	beta range																												
	Oligosaprobic																												
	Saprophilic																												
	Saproxenous																												
	Saprophobic																												
Current	Limnobiontic																												Indifferent
	Limnophilous																												
	Indifferent				■			■										■											
	Rheophilous																												
	Rheobiontic																												
General Habitat	Marine																												Lakes Ponds and Streams
	Estuary																												
	Lake											■		■															
	Pond													■															
	River																												
	Spring & Stream											■																	
	Aerophilous																												
	Other																												
Specific Habitat	Euplanktonic																												Periphytic
	Tychoplanktonic																												
	Periphitic											■				■		■											
	epipelic																												
	epilithic																												
	epidendric																												
	epizootic																												
	epiphitic																												
	attached																												
	unattached																												
Seasonal Dist.	Winter																												
	Spring																												
	Summer																												
	Autumn																												
Temperature	Euthermal																												Eurythermal, Oligothermal to Mesothermal
	Mesothermal																	■											
	Oligothermal																	■											
	Stenothermal																												
	Metathermal																												
	Eurythermal																	■											
	Undesignated																												
Salinity	M																												Fresh-Brackish
	MB																												
	BM																												
	B																												
	BZ																												
	ZB																			■									
	Z																												

Geographical distribution and additional comments:

Cosmopolitan (21,24), it is at least a facultative nitrogen heterotroph (4) mesooxybiontic (26)

Taxon *Nitzschia hungarica Grun*

		References																												Concensus & Notes
		4	8	9	20	21	24	26	29	34	35	41	43	66	69															
pH	Acidobiontic																													Alkaliphilous range 6.5-8.2 (8)
	Acidophilous																													
	Indifferent																													
	Alkaliphilous		■	■				■																						
	Alkalibiontic												■																	
Nutrient	Eutrophic																													
	Mesotrophic																													
	Oligotrophic																													
	Dystrophic																													
Halobion	Polyhalobous																													Mesohalobous to Halophilous
	Euhalobous																													
	Mesohalobous	■	■			■			■		■			■	■															
	alpha range									■																				
	beta range				■			■																						
	Oligohalobous				■																									
	halophilous			■		■		■		■		■	■																	
	indifferent																													
	halophobous																													
Saprobien	Euryhalobous													■	■															
	Polysaprobic																													
	Mesosaprobic																													
	alpha range																													
	beta range																													
	Oligosaprobic																													
	Saprophilic																													
	Saproxenous																													
	Saprophobic																													
Current	Limnobiontic																													Indifferent to Rheophilous
	Limnophilous																													
	Indifferent							■																						
	Rheophilous		■																											
	Rheobiontic																													
General Habitat	Marine																													
	Estuary																													
	Lake																													
	Pond																													
	River																													
	Spring & Stream																													
	Aerophilous																													
	Other																													
Specific Habitat	Euplanktonic																													Periphytic
	Tychoplanktonic																													
	Periphitic									■																				
	epipelic																													
	epilithic																													
	epidendric																													
	epizootic																													
	epiphitic																													
	attached																													
	unattached																													
Seasonal Dist.	Winter																													
	Spring																													
	Summer																													
	Autumn																													
Temperature	Euthermal																													
	Mesothermal																													
	Oligothermal																													
	Stenothermal																													
	Metathermal																													
	Eurythermal																													
	Undesignated																													
Salinity	M																													
	MB																													
	BM																													
	B																													
	BZ														■															
	ZB																													
	Z																													

Geographical distribution and additional comments:

Cosmopolitan (21, 24); withstands oxygen depleted waters (4); mesooxybiontic (26)

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Taxon Nitzschia palea (Kütz) W. Smith

		References																											Concensus & Notes
		1	2	4	7	8	9	11	12	13	19	20	21	26	27	29	34	35	41	43	45	49								
pH	Acidobiontic																													Indifferent range 4·2–9·0 (2,8,21,27,43) optimum about 8·4 (4)
	Acidophilous																													
	Indifferent					■	■	■	■	■				■	■			■		■										
	Alkaliphilous		■	■									■																	
	Alkalibiontic																													
Nutrient	Eutrophic			■									■		■							■								Eutrophic
	Mesotrophic																													
	Oligotrophic														■															
	Dystrophic																													
Halobion	Polyhalobous																													Indifferent
	Euhalobous																													
	Mesohalobous																													
	alpha range																													
	beta range																													
	Oligohalobous																					■								
	halophilous																													
	indifferent		■			■	■	■					■			■	■			■	■									
	halophobous																													
Saprobien	Euryhalobous										■										■									Mesosaprobic to Polysaprobic
	Polysaprobic	■										■		■																
	Mesosaprobic	■										■	■				■		■	■	■	■								
	alpha range				■																									
	beta range				■																									
	Oligosaprobic																													
	Saprophilic																													
	Saproxenous																													
	Saprophobic																													
Current	Limnobiontic																													Indifferent
	Limnophilous																													
	Indifferent					■		■												■										
	Rheophilous																													
	Rheobiontic																													
General Habitat	Marine																													Lakes and Ponds
	Estuary																													
	Lake														■															
	Pond														■															
	River																													
	Spring & Stream																													
	Aerophilous																													
	Other																													
Specific Habitat	Euplanktonic																													Tychoplanktonic or periphytic
	Tychoplanktonic																■													
	Periphitic																■													
	epipelic																													
	epilithic																													
	epidendric																													
	epizootic																													
	epiphitic																													
	attached																													
	unattached																													
Seasonal Dist.	Winter																													Spring Summer + Autumn
	Spring										■										■									
	Summer										■																			
	Autumn																				■									
Temperature	Euthermal																													Eurythermal range 0°–30° (2,43)
	Mesothermal																													
	Oligothermal																													
	Stenothermal																													
	Metathermal																													
	Eurythermal		■								■									■										
	Undesignated																													
Salinity	M																													Fresh-Brackish
	MB																													
	BM																													
	B																													
	BZ																													
	ZB																				■									
	Z																													

Geographical distribution and additional comments:

Cosmopolitan (21); a very good indicator of pollution, an obligate nitrogen heterotroph (4); euryoxybiont (26); calcium indifferent (36); tolerates a wide span of ecological conditions (45)

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Taxon Surirella capronii De Brébisson

		References				Concensus & Notes
		26	27	39	49	
pH	Acidobiontic					Alkaliphilous pH opt 8.0 (4) ±70 (49)
	Acidophilous					
	Indifferent					
	Alkaliphilous	■				
	Alkalibiontic					
Nutrient	Eutrophic				■	Eutrophic
	Mesotrophic					
	Oligotrophic					
	Dystrophic					
Halobion	Polyhalobous					probably indifferent
	Euhalobous					
	Mesohalobous					
	alpha range					
	beta range				■	
	Oligohalobous				■	
	halophilous					
	indifferent	■	■	■		
	halophobous					
	Euryhalobous					
Saprobien	Polysaprobic					Saproxenous
	Mesosaprobic					
	alpha range					
	beta range					
	Oligosaprobic					
	Saprophilic					
	Saproxenous	■				
	Saprophobic					
Current	Limnobiontic					
	Limnophilous					
	Indifferent					
	Rheophilous					
	Rheobiontic					
General Habitat	Marine					
	Estuary					
	Lake					
	Pond					
	River					
	Spring & Stream					
	Aerophilous					
	Other					
Specific Habitat	Euplanktonic					
	Tychoplanktonic					
	Periphitic					
	epipelic					
	epilithic					
	epidendric					
	epizootic					
	epiphitic					
	attached					
	unattached					
Seasonal Dist.	Winter					
	Spring					
	Summer					
	Autumn					
Temperature	Euthermal					
	Mesothermal					
	Oligothermal					
	Stenothermal					
	Metathermal					
	Eurythermal					
	Undesignated					
Salinity	M					Fresh-Brackish
	MB					
	BM					
	B					
	BZ					
	ZB				■	
	Z					

Geographical distribution and additional comments:

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Taxon Surirella linearis W.Smith

		References					
		49	21	26	27	39	Concensus & Notes
pH	Acidobiontic						pH 4.7-8.5 (49) 4.0-8.2 (21) opt 55-5.6 (21) Acidophilous → indifferent
	Acidophilous	■			■		
	Indifferent			■		■	
	Alkaliphilous						
	Alkalibiontic						
Nutrient	Eutrophic						Meso-oligotrophic
	Mesotrophic	■					
	Oligotrophic	■					
	Dystrophic						
Halobion	Polyhalobous						Oligohalobous indifferent
	Euhalobous						
	Mesohalobous						
	alpha range						
	beta range						
	Oligohalobous	■	■	■		■	
	halophilous						
	indifferent			■			
	halophobous						
Saprobien	Euryhalobous						Oligosaprobic to saproxenous
	Polysaprobic						
	Mesosaprobic						
	alpha range						
	beta range						
	Oligosaprobic			■			
	Saprophilic						
	Saproxenous			■			
	Saprophobic						
Current	Limnobiontic						
	Limnophilous						
	Indifferent						
	Rheophilous						
	Rheobiontic						
General Habitat	Marine						
	Estuary						
	Lake						
	Pond						
	River						
	Spring & Stream						
	Aerophilous						
	Other						
Specific Habitat	Euplanktonic						
	Tychoplanktonic						
	Periphitic						
	epipelic						
	epilithic						
	epidendric						
	epizootic						
	epiphitic						
	attached						
	unattached						
Seasonal Dist.	Winter						
	Spring						
	Summer						
	Autumn						
Temperature	Euthermal						
	Mesothermal						
	Oligothermal						
	Stenothermal						
	Metathermal						
	Eurythermal						
	Undesignated						
Salinity	M						Fresh-Brackish
	MB						
	BM						
	B						
	BZ						
	ZB	■					
	Z						

Geographical distribution and additional comments:

Ca: <190 — >420 mg/L (49)
Fe 0-2.5
Si 0-4.0

Taxon Surirella ovata Kütz

		References 3	4	8	9	11	12	13	19	26	27	39	43	45	46	49	Concensus & Notes
pH	Acidobiontic																Alkaliphilous range 6.4-8.2 (8) opt 7.5-8 (4,45) 7.0-8.5 (49
	Acidophilous																
	Indifferent																
	Alkaliphilous		■	■	■	■	■	■	■	■			■	■			
	Alkalibiontic																
Nutrient	Eutrophic															■	Eutrophic
	Mesotrophic																
	Oligotrophic																
	Dystrophic																
Halobion	Polyhalobous																Indifferent
	Euhalobous																
	Mesohalobous															■	
	alpha range																
	beta range	■	■														
	Oligohalobous															■	
	halophilous																
	indifferent				■	■				■		■	■	■	■		
	halophobous																
	Euryhalobous	■												■	■		
Saprobien	Polysaprobic			■													Mesosaprobic
	Mesosaprobic			■													
	alpha range													■			
	beta range										■			■			
	Oligosaprobic																
	Saprophilic																
	Saproxenous																
	Saprophobic																
Current	Limnobiontic																Rheophilous
	Limnophilous																
	Indifferent																
	Rheophilous			■		■			■				■				
	Rheobiontic																
General Habitat	Marine																
	Estuary																
	Lake																
	Pond																
	River																
	Spring & Stream																
	Aerophilous																
	Other																
Specific Habitat	Euplanktonic																
	Tychoplanktonic																
	Periphitic																
	epipelic																
	epilithic																
	epidendric																
	epizootic																
	epiphitic																
	attached																
	unattached																
Seasonal Dist.	Winter								■					■			Winter maximum
	Spring																
	Summer																
	Autumn																
Temperature	Euthermal																Oligothermal Eurythermal range 0°-24°C
	Mesothermal																
	Oligothermal	■															
	Stenothermal																
	Metathermal																
	Eurythermal	■															
	Undesignated																
Salinity	M																
	MR																
	RM																
	R																
	RZ																
	ZR															■	
	Z																

Geographical distribution and additional comments:

List of papers derived from this study, copies of which are contained within the folder on the inside back cover:

Coard, M.A. et al. (1983): Palaeolimnological studies of annually laminated sediments in Loe Pool, Cornwall, U.K. Hydrobiologia, 103, 185-191.

O'Sullivan, P.E., Coard, M.A., Cousen, S.M. & Pickering, D.A. (1984): Studies of the formation and deposition of annually-laminated sediments in Loe Pool, Cornwall, U.K. Verh. Internat. Verein. Limnol., 22, 1383-1387.

Simola, H., Coard, M.A. & O'Sullivan, P.E. (1981): Annual laminations in the sediments of Loe Pool, Cornwall. Nature (London), 290, (5803), 238-241.

Verh. Internat. Verein. Limnol. | 22 | 1383—1387 | Stuttgart, Dezember 1984

Studies of the formation and deposition of annually-laminated sediments in Loe Pool, Cornwall, U. K.

P. E. O'Sullivan, M. A. Coard, S. M. Cousen and D. A. Pickering

With 2 figures in the text

Introduction

Recently, paleolimnologists have become increasingly interested in studies of annually-laminated (varved) lake sediments (Renberg 1982; Renberg & Segerström 1981; Saarnisto 1979). Four main types, here termed *calcareous*, *ferrogenic*, *biogenic*, and *clastic* (O'Sullivan 1983), have been described.

The first three are formed in lakes deep for their surface area, and consists of a mixture of mainly autochthonous, and some allochthonous matter. Their composition largely reflects seasonal patterns of production and deposition within the lake. Clastic laminations, however, may be composed almost entirely of allochthonous material, and their structure thus reflects seasonality of sediment supply from catchment to lake. The area of the catchment compared to the area/volume of the lake also seems to be an important factor in their formation, as does the rate of sediment supply versus the rate of in-lake mixing processes (O'Sullivan 1983).

So far, most paleolimnological studies have concentrated on the first three types. Here we present, however, a study of annual laminations formed in a small, shallow lake, whose sediments are almost entirely clastic in origin.

Site description

Loe Pool (Fig. 1) is a coastal lake ($A = 55.6\,\text{ha}$, $V = 3.09 \times 10^6\,\text{m}^3$, $Z_{max} = 11\,\text{m}$, $Z_r = 4\,\text{m}$, $D = \text{ca. } 55\,\text{km}^2$) 1 km south of Helston, Cornwall, U.K. (latitude 50°4′ N, longitude 5°17′ W, altitude 4 m).

It was formed by the damming of the River Cober by a shingle bar. This was in existence by the mid-C^{16}, but it was not until 1800 A.D., when a tunnel (or *adit*) was constructed to drain the Pool to the sea, that it became a stable permanent feature. Before then both spontaneous outbreaks of lake water, and deliberate "bar-breaking", in order to alleviate floods, were a common occurrence (Coard unpubl.).

Earlier (Coard et al. 1983; O'Sullivan et al. 1982; Simola et al. 1981) we have described the topmost 3 m of Loe Pool sediments, which consist of annually-laminated clays. In this paper we present further stratigraphic studies, including results of investigations of deeper sediments (3—5 m).

Methods

Our previous longest core of Loe Pool sediment, whose stratigraphy was described by Simola et al. (1981), was taken with a 3 m Mackereth sampler at the location shown in Fig. 1. In the last five years, we have also taken over fifty shorter (1—1.5 m) cores, using both mini-Mackereth, and two types of freezer samplers (Huttunen & Merilainen 1978; Saarnisto 1979).

We obtained cores of the deeper sediments using the "Russian" peat sampler (Jowsey 1966), which we operated from a raft anchored some 200 m north of the Mackereth coring station (Fig. 1). The cores were wrapped in aluminium foil and polyethylene, and sealed in the field. In the laboratory they have been stored at 8 °C.

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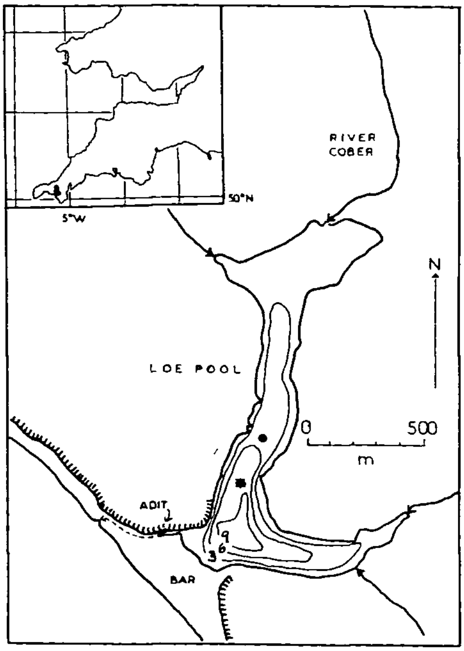

Fig. 1. Loe Pool, Cornwall, showing position of 3 m MACKERETH core (*), and "Russian" cores (●). Depth contours in m.

Lamination counts were prepared by direct measurement, and using infra-red (black & white), and colour photographs. Sediment description was carried out using MUNSELL colour charts, and the classification system of TROELS-SMITH (1955). Samples for diatom and XRF analysis were prepared by the methods described in COARD et al. (1983).

Results

(1) Sediment description

By the TROELS-SMITH system, the Loe Pool sediments may be described as:

As 4 strf 4 clas 0 sicc 2 nig (var)

i. e., a highly laminated, compact, plastic, unhumified clay of variable colour. The uppermost 20—60 cm, however, consist of a watery dark-brown clay-*gyttja*, below which is a pink clay, composed mainly of haematite (Fe_2O_3) deposited during tin-mining operations in the 1930s (COARD et al. 1983).

The source of this material was the Porkellis United mine, 10 km north of Helston, which ceased operations in 1938. Multiple coring has shown that it is widely distributed throughout the lake, so that we are able to use it as a rapid means of intercore correlation (O'SULLIVAN et al. 1982). These studies have also shown that the thickness of the brown clay-*gyttja* at the deep-coring site is 20 cm. The stratigraphy of the deep core is therefore:

(0—20 cm)	Dark brown watery clay-*gyttja*
20—32 cm	Pink haematite clay (MUNSELL Soil Colour nos 5YR 3/4-4/4), containing two black laminations.

32—97 cm	Massive grey (10YR 3/2) and dark grey (2-5 Y 2/0) clay.
97—282 cm	Regularly laminated black (10YR 2/1) and grey (7-5YR 2/0) clay, each pair ca. 1—3 cm thickness. Pink laminae replace greys at 144—145 cm, 151—152 cm, 153—154 cm, 163—169 cm, 195—197 cm, 200—201 cm, 205 cm, 209—210 cm, 226—230 cm, 232—233 cm, 235 cm and 237—238 cm.
282—286 cm	Yellow-brown (2.5Y 3/2, 5Y 2.5/2) clay
286—326 cm	Further grey-black laminations
326—533 cm	Stiff (sicc 3) brown (2.5Y 3/2) clay with many fine (ca. 1 mm), and several prominent (ca. 5 mm) pale grey (5Y 5/1) laminations.

Below 533 cm this clay was impenetreable to the Russian peat sampler.

Many parts of the core also contain much finer (ca. 1 mm) laminae, whose colour varies against that of the main laminations. Thus in pink and grey layers fine black laminae are often present, whereas black layers may contain fine pink or grey ones. Below 326 cm, besides the abundant grey-green fine laminae already mentioned, dark brown, pale brown and black layers are also seen.

The pink haematite-clay (20—32 cm) is the prominent marker horizon deposited in the years 1937—38. The massive grey clay (32—97 cm) was also deposited in the 1930's (Simola unpubl.), and consists largely of mining waste. The regularly-laminated section (97—282 cm) is that shown by Simola et al. (1981) to contain annual laminations. The brown clay below 326 cm predates the onset of black-grey lamination formation.

(2) Chronology

As pointed out, the pink and grey clays (20—97 cm) date from the 1930's. This finding has been confirmed by ^{137}Cs-dating of the overlying clay-*gyttja* (Simola et al. 1981). Counting of the black-grey laminations indicates that the yellow-brown clay at 282—286 cm dates from ca. 1840 (A. D.). Below this are a further 25 laminations, so that the junction between the brown clay and the overlying black/grey laminae probably dates from ca. 1815 A. D. (see below).

(3) Diatom analysis

Results of a preliminary diatom analysis of the brown clay below 326 cm show the presence of a very diverse flora, the planktonic elements of which are dominated by *Diatoma elongatum* (Lyngbye) Agardh, and *Thalassiosira pseudonana* (Hasler & Heimdal). Brackish influence, in the form of marine taxa such as *Melosira sulcata* (Ehrenberg) Kützing and *Coscinodiscus* spp. is also recorded. We conclude that this section shows the presence of a freshwater lake which was under some brackish influence. In the lowest 0.5 m, the scales of a *Mallamonas* sp. are also found, more abundantly in the brown matrix of the clay than in the grey-green laminae.

(4) Sn analysis

Results of XRF analysis of this core for Sn are shown in Fig. 2. A strong contrast is seen between the lowest brown clay, where values are mainly below 200 ppm, and the overlying black/grey laminations, where they reach 600—3600 ppm. The increase in Sn

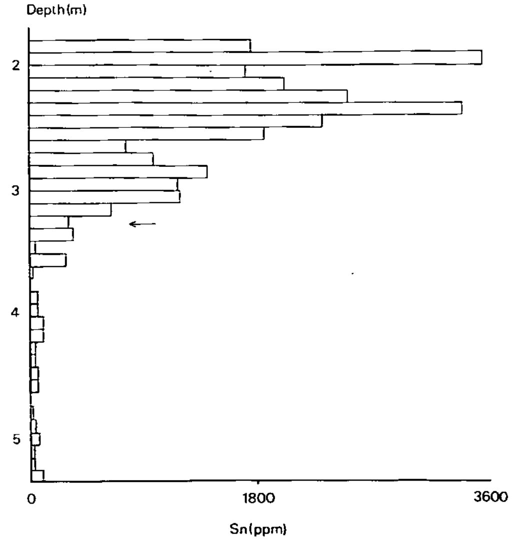

Fig. 2. Sn content of Loe Pool sediment (2—5 m), based on XRF analysis. Arrow indicates position of junction between brown clay and overlying black/grey laminated clay.

values lies below the transition between these two sediment types. According to the lamination count the peaks in Sn at 195—205 cm, 235—245 cm, and 285—295 cm, date from ca. 1885, 1870 and 1835 (A. D.). These correspond closely with historical records of periods of mining activity in the catchment of the Pool (Coard unpubl.).

Discussion and conclusions

Below ca. 3.25 m of annually-laminated lacustine sediments, Loe Pool contains a brown, finely-laminated clay, also formed under freshwater conditions.

XRF analysis shows that Sn levels in the sediments increase strongly in the black/grey laminated clay rising to a number of peaks which can be shown, on the basis of varve counting, to correlate with documented phases of increased mining activity. Shaft-mining in the Cober catchment began in ca. 1780 (A. D.), but did not expand until ca. 1840 (Coard unpubl.).

The major part of the core examined here is composed of a laminated black/grey, occasionally black/pink clay. On the basis of diatom microstratigraphy, Simola, Coard & O'Sullivan (1981) showed that the black laminae correspond to the summers and the grey/pink to winters. The colour changes appear to be associated with both seasonal variation in sediment supply to the lake, and changing redox conditions in the water column.

When air-dried, the black laminae change colour to a bright orange (10YR 6/8) whereas the greys remain almost the same. This suggests that the summer layers contain reduced Fe species, and were laid down under reducing conditions. The winter layers, however, contain clays deposited in an oxidizing environment, as does the brown clay, which underlies the black/grey laminations.

Conditions in which reduced sediments may be deposited do exist from time to time in Loe Pool. For example, in the summer of 1983, thermal stratification developed and hypolimnetic waters below 8 m contained very little oxygen (< 1.5 %, 0.1 mg^{-1}; A. M.

Greaves, K. P. Lacey pers. comm.). In former times, when the lake was somewhat deeper ($\bar{Z} > 7$ m), this may have happened even more frequently.

However, on the deepest sediment so far recorded, although there are laminations, these do not contain layers of black, reduced sediment. During the C19 therefore, a change in the (bio)geochemistry of the Pool took place, leading to the establishment, on a seasonal basis, of reducing conditions. This process along with the nature of the laminations within the brown clay will be subject of future investigations.

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Annual laminations in the sediments of Loe Pool, Cornwall

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Annually laminated freshwater lacustrine sediments have been recorded at several sites in central Europe[1-5], North America[6-13] and Fennoscandia[14-24]. The presence of laminations may reflect either (1) regular changes within the lake ecosystem itself or (2) variation in the intensity of erosion and transport of material from the catchment, particularly where instability in the lake-watershed system has occurred as a result of human activities[22]. The principal cause of lamination is, therefore, seasonal variation of environmental conditions, particularly climate. Lakes with laminated sediments tend to be physically deep, exhibit a strong seasonal stratification, and be situated in areas of continental climate. We describe here what we believe to be the first reported instance of a long sequence of laminated lake sediments from Great Britain. Unlike most of the previous examples, these have been formed in a shallow, polymictic lake, in an oceanic climate.

Loe Pool (Fig. 1) is a eutrophic freshwater lagoon at $\sim$4 m OD, 1 km south of Helston in south-west England (GR SW 648250, lat 50°4′ N, long 5°17′ W) with an area of $\sim$44 hectares and a mean depth of 4 m. Its catchment covers $\sim$50 km^2, and is mainly farmland, with one major settlement (Helston, population $\sim$10,000). The main stream entering the pool is the River Cober, which drains $\sim$90% of the total catchment. In the nineteenth and early twentieth century this area was the site of extensive mining operations, principally for tin[25].

Three sediment cores were taken from beneath $\sim$7 m of water at the location shown in Fig. 1, where studies (M.A.C. unpublished data) indicate that an undisturbed conformable sequence of sediments is available. One was obtained using a 3-m version of the Mackereth corer[26] and two with 1-m *in situ* freezing device[27]. The Mackereth core was frozen at ~ -20 °C to preserve lamination. The surfaces of all cores were then cleaned while still frozen to facilitate description and photography of sediment structures. The stratigraphy of the three cores was easily matched by using prominent marker horizons and characteristic sequences of laminations.

The cores were then allowed to dry in the freezer for a few days to allow adhesive tape preparations to be made[18]. These enable the fine structure of the sediment to be examined, especially for changes in abundance of sub-fossil diatoms. The stratigraphy of the sediment at the sampling site was:

0–40 cm: Highly organic *gyttja*, with four or five pairs of light and dark brown laminations just below the sediment surface (0–5 cm), the rest more homogeneous.
40–120 cm: Irregularly laminated sequence containing red and grey clays alternating with darker layers.
120–300 cm: More regularly laminated sediment consisting of paired grey and black layers, average thickness 3 cm per pair.

The sections 0–7.2 cm, 40–110 cm, 194–206 cm and 230–242 cm were examined. Remains of diatoms, other algae and vivianite crystals were recorded in consecutive 200-µm fields. We shall concentrate here on information obtained from the first and third sections, results being presented in Figs 2 and 3.

In all sections studied, diatom and other algal taxa appear in repeating sequences, the cyclic nature of which we attribute to seasonal algal production and sedimentation. It is therefore possible to define annual increments of deposition, which correspond closely with clearly visible stratigraphic changes. We can therefore identify laminations in these sediments which are truly annual in their nature. Interruptions to the sequence are mainly associated with the deposition of layers of clay, sometimes massive, in which diatoms are relatively scarce, and which we consider to represent dilution of diatom influx by allochthonous, clastic material.

For example, in Fig. 2 (0–7.2 cm), six phases (*a–f*) are defined. In each of these, *Thalassiosira pseudonana* and *Cyclotella meneghiniana* are succeeded by *Asterionella formosa*, *Melosira granulata* var. *angustissima* and then *Melosira varians*. In monthly plankton sampling of the pool by one of us (M.A.C.) in 1979, the first two taxa were prominent during spring and early summer, and the *Melosira* species in the autumn and winter. It is therefore considered that this sedimentary sequence records seasonal diatom succession in the pool, the *Thalassiosira/Cyclotella* stages representing the spring and summer, the *Asterionella/Melosira* stages the autumn and winter. The appearance of *Fragilaria* spp, and 'other' (mainly sessile) diatoms in layers thought to represent the winter, would then be consistent with the idea of increased influx of sediment from the littoral and the catchment during these months. Similarly, the summer abundance of *Pediastrum boryanum* in lake plankton samples is recorded in summer laminations. Crystals of vivianite ($Fe_3(PO_4)_2\cdot 8H_2O$) seem to be concentrated in some winter layers. This has also been observed in Lovojärvi (Finland)[17,18].

In this section, summer layers coincide with the lighter bands of sediment, and winter layers with the darker. Below 5 cm, however, the sediment structure and the diatom peaks are less well defined. Inspection of these and other cores indicates considerable bioturbation of the sediments between 5 and 40 cm.

Figure 3 (194–206 cm) shows a section in which five peaks of diatom deposition (*p–t*) are separated by relatively barren layers. The most abundant taxa present are *Chaetoceros muelleri*, *Surrirella ovata* and *Synedra rumpens*, which tend to appear

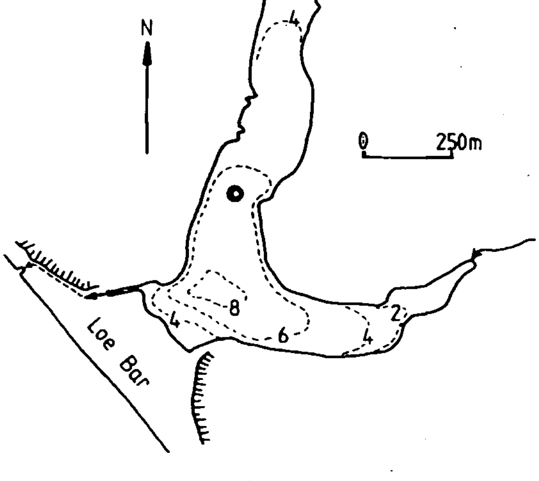

Fig. 1 Loe Pool, Helston, Cornwall, showing depth contours (dashed line) and position of coring site (●).

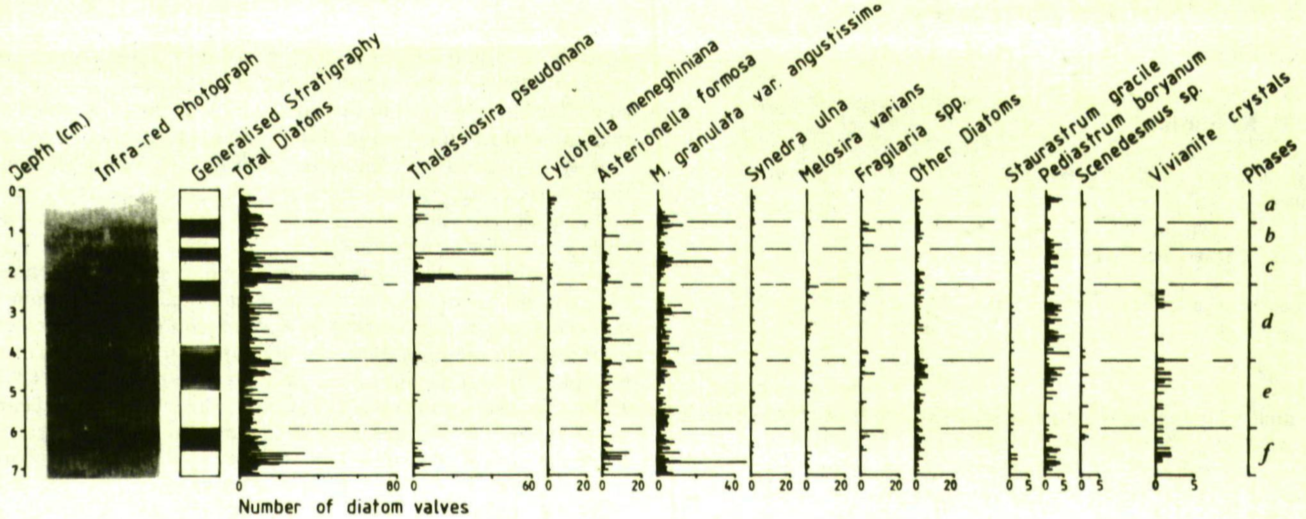

Fig. 2 IR photograph of and results of diatom, other algal and vivianite crystal counts from the section 0–7.2 cm of frozen sediment from Loe Pool.

in a sequence which denotes seasonal succession. On three occasions, maxima of these planktonic diatoms are immediately followed by peaks of *Cysta microcarpa* (*sensu* Nygaard)[28]. We interpret the planktonic diatom peaks, which coincide with darker bands of sediment, as representing the summer months, and the relatively barren layers, which correspond to the grey-brown clays, and in which 'other' diatoms largely occur, as the winter.

Figure 4 clearly shows that despite the oceanicity of the climate of this part of Europe, a pronounced winter maximum of rainfall and stream flow occurs, and that summer temperatures substantially exceed those of the winter. This contrast between the seasons seems sufficient to account for the formation of the Loe Pool laminations.

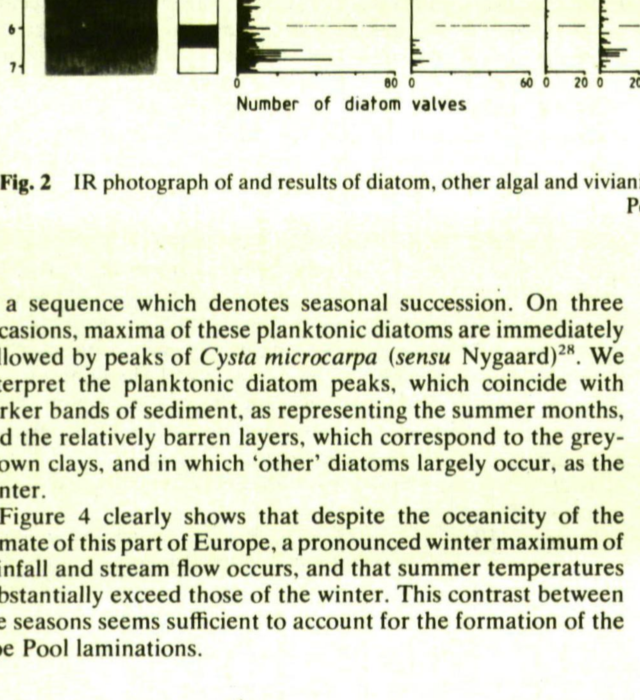

Fig. 3 IR photography, and results of diatom and *Cysta microcarpa* counts from the section 194–206 cm of a frozen sediment core from Loe Pool. Irregular, diagonal striations are caused by ice-crystal formation during freezing of the Mackereth core.

From 300 to ~120 cm these consist of pairs of black (summer) and grey-brown (winter) layers, recording increased inflow of clastic material in the winter months, covering a period of ~60 yr. Then, between 120 and 40 cm, massive clay layers occur, which, according to diatom analysis not described in detail here (H.L.K.S. and M.A.C., in preparation), cover a period of only 7 yr. Here a high proportion of the sediment consists of material originating as mining wastes, and peaks in planktonic diatoms are separated by as much as 20 cm of clay in which diatom influx has been considerably diluted, thus indicating very rapid accumulation. We correlate this sequence with the most recent period of active mining in the catchment which ended in AD 1938. Within this section, two layers of red, haematite-rich clay occur, the upper at 40–46 cm, the lower at 65–70 cm. Documentation[29] shows that during the 1920s and 1930s the pool was heavily polluted by mining wastes, often to the extent that discoloration of the waters occurred. We therefore conclude that the red clay layers were deposited during this time. Between 1860 and 1920 active, but less intensive mining took place[25]. Above 40 cm, laminations are not observed until ~5 cm from the sediment surface. Here there are four or five laminations which are not visually prominent, but which are well defined in the algal stratigraphy. Between 5 and 40 cm the

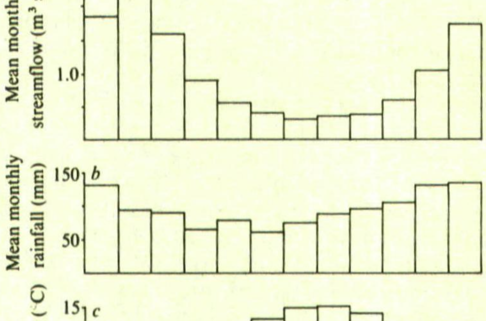

Fig. 4 *a*, Mean monthly streamflow (River Cober, 1970–79); *b*, mean monthly rainfall (1941–70); and *c*, mean monthly temperature (1960–74) for the Loe Pool catchment. Streamflow data from the South West Water Authority gauging station at Helston, rainfall data from Wendron, and temperature data from RNAS Culdrose.

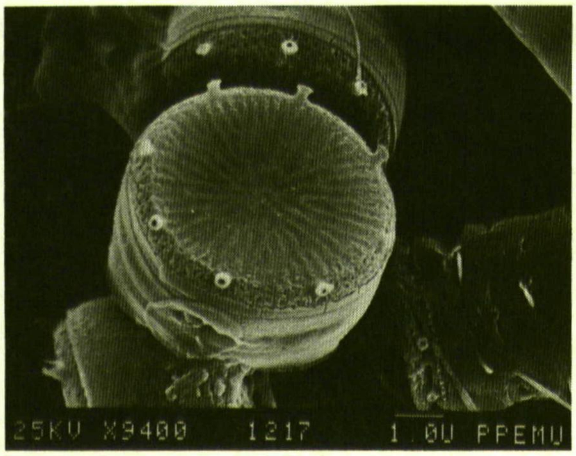

Fig. 5 Scanning electron micrograph of *Thalassiosira pseudonana* Hasle et Heimdal from Loe Pool plankton samples. (Photograph Martin Coard.)

sediment is considerably bioturbed, but ^{137}Cs analysis shows that the 1963 peak lies between 14 and 16 cm depth. This suggests a mean accumulation rate for the section between 16 cm and the sediment surface of 1 cm yr^{-1}, which is in agreement with the rate calculated from lamination counts just below the sediment surface.

The section 0–40 cm, between the top of the upper haematite clay and the sediment surface, thus represents the period since 1938, and has a mean accumulation rate very close to 1 cm yr^{-1}. Together with a sedimentation rate of 80 cm in 7 yr for the section 40–120 cm (based on diatom stratigraphy), and of 3 cm yr^{-1} for the section 120–300 cm (based on lamination counts), this estimate allows us to conclude that the Loe Pool cores cover a period of ~110 yr.

Between ~1870 and ~1920 the main cause of lamination seems to have been a steady inflow of mining wastes in winter. During the period of most intensive mining (1920–38) this increased to massive proportions (80 cm in 7 yr). Between 1940 and 1975 laminations were not formed. The presence of the remains of numerous burrows indicates that this was a phase of considerable benthic activity. The formation of laminations in very recent years is attributed to increased eutrophy of the pool, which has led to occasional instances of anoxia at the sediment surface during the summer months. These most recent laminations are therefore being produced in different conditions from those formed at an earlier date, which may in part account for colour difference between the respective summer and winter layers.

We thank Lieutenant Commander J. P. Rodgers and the National Trust for permission to carry out work at Loe Pool. We also thank R. S. Cambray for ^{137}Cs analysis and Dr A. C. Hamilton for the loan of a Mackereth corer. The work was carried out while H.L.K.S. and M.A.C. were supported by Devon Local Authority Research Assistantships, and H.L.K.S. by a grant from the Alfred Kordelin Foundation (Finland).

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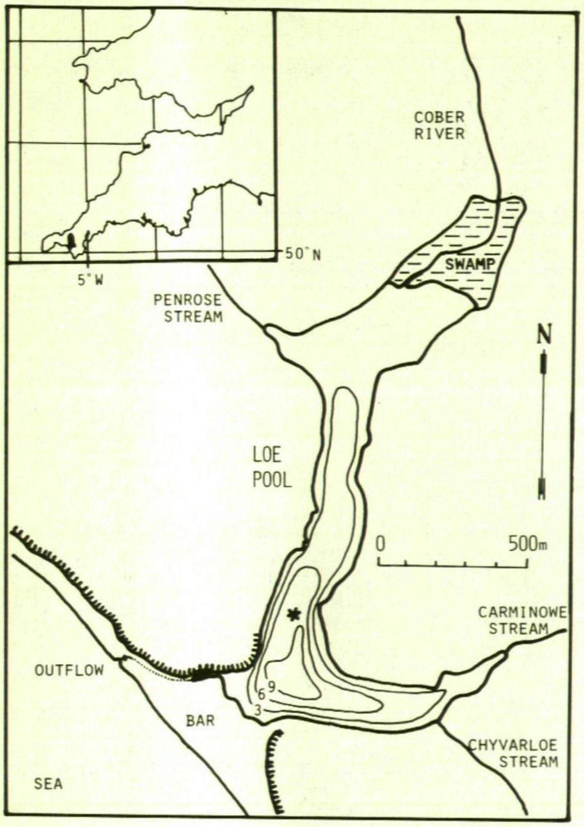

Fig. 1. Loe Pool, showing depth contours (m) and main coring site (asterisk). Inset map indicates the location of the lake's catchment area near the SW tip of Great Britain.

Table 1. Principal physical and hydrological characteristics of Loe Pool.

Latitude	50 ° 04′ N
Longitude	5° 17′ W
Altitude	4 m OD
Area (A)	55.6 ha
Length (L)	1.25 km
Breadth (B)	250 m
Maximum depth (Z_{max})	10.67 m
Mean depth ($\bar{Z}$)	3.47 m
Relative depth (Z_r)*	1.27
Volume (V)	1.93×10^6 m^3
Mean hydraulic residence time	20 days
Area of drainage basin (D)	50 km^2
D/A	98.9

* $Z_r = 50\ Z_{max} \sqrt{\pi}\,(\frac{1}{\sqrt{A}})$

Sediment stratigraphy and chronology

The location of the main coring site is shown in Fig. 1. Here occur sediments that are undisturbed either by the influence of the river Cober, or by marine incursions through Loe Bar. These appear to have taken place until the late nineteenth century.

The stratigraphy of the upper 3 m of Loe Pool sediment has been reported by Simola *et al.* (1981), and by O'Sullivan *et al.* (1982). At the top of the sediment are found 20–40 cm of dark brown clay-gyttja, underlain by a thick layer of red and grey

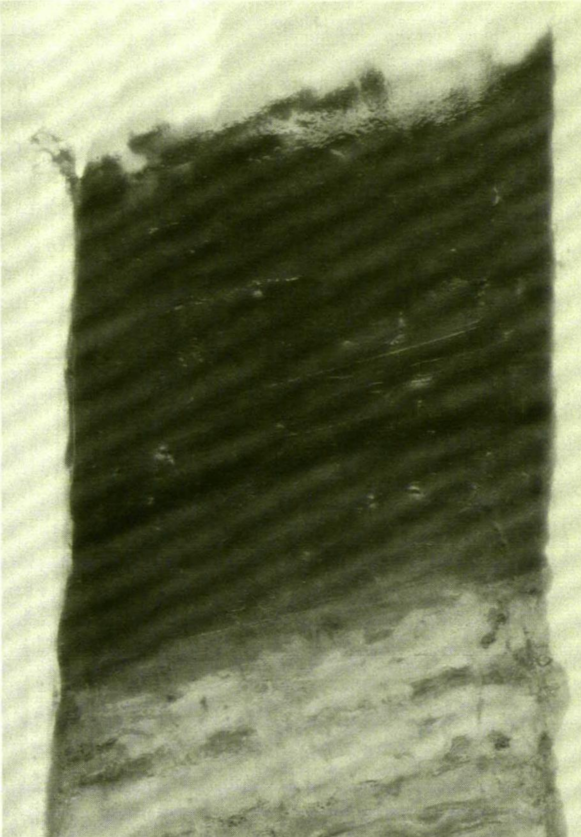

Fig. 2. Infra-red photograph of a frozen sample of the uppermost sediments of Loe Pool. Junction between brown clay-gyttja and red haematite-clay occurs in this section at 36 cm (Photograph: S. Johnson).

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Paleolimnological studies of annually-laminated sediments in Loe Pool, Cornwall, U.K.

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Keywords: paleolimnology, annual laminations, magnetism, sediment influx, sediment chemistry, eutrophication

Abstract

The sediments of Loe Pool, a eutrophic coastal lake in south west England, consist largely of laminated clays and clay-gyttjas. Studies of the diatom microstratigraphy of frozen sediment cores from the Pool indicate that the laminations are annual, and that they contain pairs of light and dark bands formed by seasonal variations in the supply of sediment to the Pool from its catchment. Analysis of the magnetic properties of individual laminations demonstrates the presence of physical and mineralogical microstratigraphic variations, which may also be related to seasonality.

A varve chronology, which is confirmed by ^{137}Cs analysis and historical records, has been used to provide a timescale for the interpretation of data from other paleolimnological studies. A close agreement between variations in the abundance of sedimentary Sn, and the history of mining in the catchment, has been found. Similarly, analysis of total organic matter, total phosphorus, sedimentary chlorophyll *a*, sterols, diatoms and Cladocera in the uppermost sediments all indicate eutrophication of the Pool in the period AD 1940 to the present.

Introduction

The sediments of Loe Pool (Fig. 1), a small eutrophic coastal lake, 1 km south of the town of Helston, Cornwall (south-west England) are annually-laminated (Simola *et al.* 1981). Here we present a summary of studies undertaken so far on the paleolimnology of the Pool, which was originally formed by the damming of the mouth of the river Cober by a shingle bar. The morphometry of the present basin is shown in Fig. 1 and the major physical and hydrological characteristics of Loe Pool and its catchment are listed in Table 1.

Most of the northern half of the catchment is underlain by the Carnmenellis granite, with which several areas of former mining, especially for cassiterite (SnO_2), are associated. The major contemporary economic activity is farming and the main town in the catchment is Helston (population ~ 10 000). A further important centre of population is the military base of RNAS Culdrose, commissioned in 1947.

In a number of recent years, visible blooms of green (*Chlorella, Volvox* spp.) and blue-green (*Microcystis aeruginosa*) algae have appeared in Loe Pool. The lake receives from its catchment some 300 t N and 14 t P a^{-1}. About 75% of the N comes from agricultural run-off, and ~80% of the P from two sewage treatment works, serving Helston and Culdrose. The main taxa present in the phytoplankton are characteristic of eutrophic lakes. In August, total chlorphyll *a* levels in the water column may exceed 500 $\mu g\ l^{-1}$ in sheltered parts of the lake.

Hydrobiologia 103, 185–191 (1983).

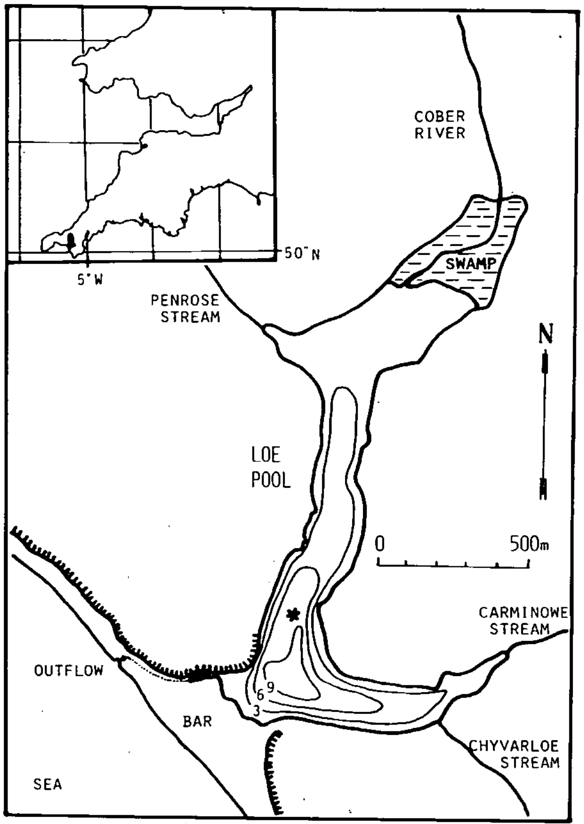

Fig. 1. Loe Pool, showing depth contours (m) and main coring site (asterisk). Inset map indicates the location of the lake's catchment area near the SW tip of Great Britain.

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The stratigraphy of the upper 3 m of Loe Pool sediment has been reported by Simola *et al.* (1981), and by O'Sullivan *et al.* (1982). At the top of the sediment are found 20–40 cm of dark brown clay-gyttja, underlain by a thick layer of red and grey

Fig. 2. Infra-red photograph of a frozen sample of the uppermost sediments of Loe Pool. Junction between brown clay-gyttja and red haematite-clay occurs in this section at 36 cm (Photograph: S. Johnson).

clay. In some cores, the uppermost, highly organic, section is laminated throughout (Fig. 2). In others, a bioturbated layer, corresponding approximately to the 1960's, occurs. The dark-brown layers represent the winter months and the light brown, which are more diatomaceous, the summer (Simola *et al.* 1981).

The red colour found in the irregularly laminated claycy section below is due to the presence of haematite (Fe_2O_3). At one of the former mines in the Cober catchment, that known as Bassett and Grylls/Porkellis United, the cassiterite ore was embedded in a ground rock (or *mundic*) rich in this mineral. Several newspaper and other accounts dating from the 1920's and 1930's (Hamilton-Jenkins 1978) describe the Pool as being completely discoloured by mine waste material, rich in haematite, which was discharged into the River Cober. We therefore correlate haematite layers in the cores with periods of activity at this mine.

Basset and Grylls was closed in 1938, and since 1940, no mines have operated in the Cober catchment. The transition between the uppermost layer of haematite clay, which is a very prominent marker in Loe Pool sediments, and the overlying brown clay-gyttja can thus be dated to AD 1938.

The mean sediment accumulation rate of the clay-gyttja is therefore *ca.* 1 cm a^{-1}. The peak of ^{137}Cs activity (cf. Pennington *et al.* 1973) of AD 1963, lies at ~16 cm in this core, halfway between the top of the uppermost haematite clay, and the present sediment surface.

Deposition of the red and grey clays was very much more rapid. In all, only eight years are represented by *ca.* 80 cm of sediment. Below these are regularly laminated black/grey clays that accumulated at ~3 cm a^{-1}. In total therefore, a 3 m core from Loe Pool sediment may represent only the last 100–120 a.

Using the red clay as a marker, O'Sullivan *et al.* (1982) investigated the distribution of these three sediment types throughout Loe Pool. They found the average thickness of the clay-gyttja to be 35 cm, and that of the uppermost red haematite clay to be 20 cm. The depth of the black/grey clay is, as yet, unknown.

By calculating dry matter and ash content of each type of sediment, it is possible to show that the brown clay-gyttja represents the accumulation of some 18 t dry matter ha^{-1} a^{-1} over the basin of the Pool. This is the equivalent to the erosion of some 20 t km^{-2} a^{-1} of mineral matter from the Cober catchment as a whole.

During the 1930's, however, when mining was intensive, accumulation equalled 440 t dry matter ha^{-1} a^{-1}, and erosion rates some 450–550 t km^{-2} a^{-1}. The latter figure is however, probably a considerable overestimate of the general soil erosion level, as the main sources of matter during this period were very small mining areas. In the late nineteenth century the dry matter accumulation rate in the Pool was 163 t ha^{-1} a^{-1}, and the average erosion rate 236 t km^{-2} a^{-1} from the catchment.

Magnetic studies

Figure 3 illustrates the results of single-sample analysis of two cores of Loe Pool sediment for magnetic susceptibility (χ). On the right of the diagram is shown analysis of a 1 m Mackereth core, on the left analysis of a frozen sediment section taken using the 'box-freezer' sampler (Huttunen & Meriläinen 1978). In each case the position of the top

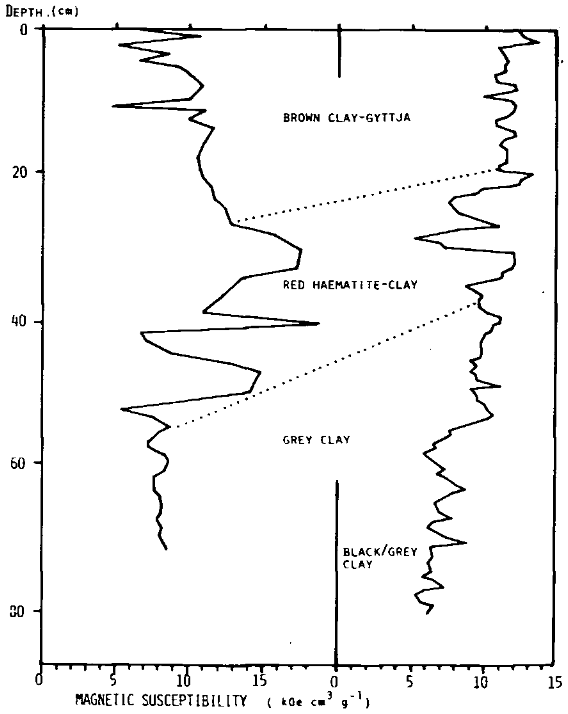

Fig. 3. Magnetic susceptibility (χ) of single samples from two cores of Loe Pool sediment.

and bottom of the uppermost red haematite clay is shown.

In both cores, χ rises to a maximum at the top of the red clay, but then falls sharply to a minimum, particularly in the Mackereth core. A pronounced peak in χ, associated with a black (summer) layer then occurs. At the base of the red clay, χ again reaches a maximum. These results suggest that χ may be used to identify precisely the location of the red clay layer in whole cores, and thus allow refinement of investigations such as that of sedimentation in the Pool described above.

At the top of the frozen section, a series of fluctuations in χ are associated with colour changes in the sediment. Peaks in χ are correlated with the paler (summer) layers, and minima with the darker (winter) laminations. Similarly, in the lower parts of both this section, and the Mackereth core, peaks in χ are associated with summer layers, and minima with winters. It may therefore be that magnetic parameters may be used to identify seasonal changes in sediment composition associated with lamination formation.

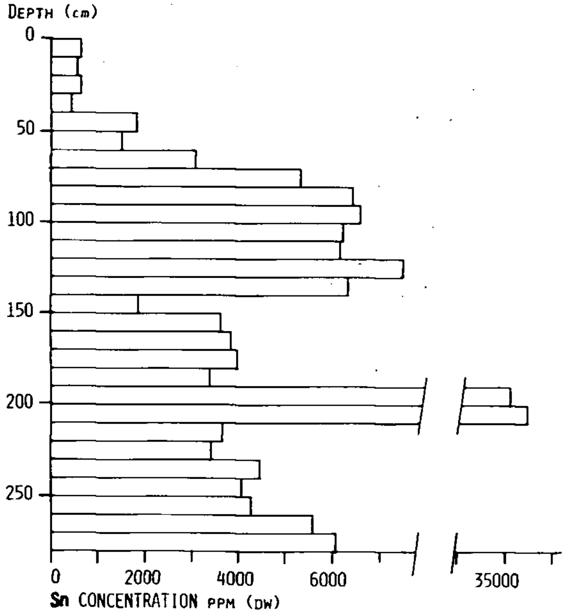

Fig. 4. XRF analysis of 10 cm segments of a 3 m Mackereth core from Loe Pool for Sn.

Tin (Sn) concentration

The Sn content of 10 cm sections of the same 3 m core as analysed by Simola *et al.* (1981) was measured using the technique of X-ray fluorescence (XRF). A ^{241}Am source, at 60 keV was employed. Results are shown in Fig. 4.

In the organic clay-gyttja (0–40 cm), Sn values are relatively low (<1 000 ppm), but in the red haematite-clay (80–140 cm) they rise to a peak of ~6 400 ppm. According to the varve chronology outlined above, this peak corresponds to AD 1925–1936, which coincides with the last documented phase of mining. Sn values then fall to ~3 600 ppm (below 140 cm), except for a peak of >35 000 ppm (3.5%!) at 200 ± 10 cm. This peak dates from the period AD 1900–1910, when mines were very active in the Cober catchment. Finally, at the base of the core, in the period AD 1870–1876, a peak of ~6 000 ppm occurs. This is the earliest period represented here, and one in which the greatest number of mines ever (28) were active in the Cober catchment.

There is thus a very close agreement between the results of XRF analysis for Sn, the varve chronology of the Loe Pool sediments, and the mining history of the catchment. The results confirm ideas about the origin of haematite-clays as mine wastes, and demonstrate the potential of XRF as a paleolimnological technique.

Organic geochemistry

Analysis of a 1 m Mackereth core for total organic matter (TOM), sedimentary chlorophyll *a*, and also total phosphorus (P_{tot}) are shown in Fig. 5. The results indicate that since AD 1938, TOM, sedimentary chlorophyll *a*, and P_{tot} have all significantly increased. We interpret these results as indicating higher internal P loading, and increased productivity of the Pool, in the period since AD 1940, as a result of greater nutrient inputs from its catchment.

At present, the precise cause of eutrophication of Loe Pool is uncertain. Inorganic fertilisers have been used in the area since the 1940's, and Helston sewage treatment works was first opened in 1930, extended in 1959, and again in 1974. Before that time, untreated sewage from the town was dis-

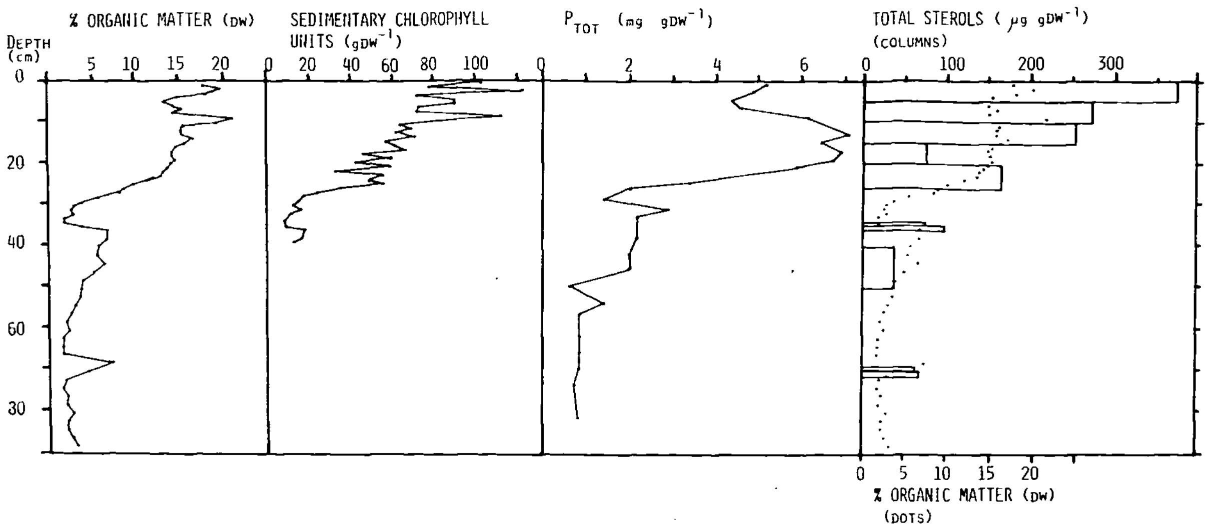

Fig. 5. Organic matter percentage, sedimentary chlorophyll *a*, total phosphorus (P_{tot}) and total sterol concentration in a 1 m Mackereth core from Loe Pool.

charged directly into the Cober, and even in AD 1900, was the cause of unpleasant odours (Vallentin 1903). RNAS Culdrose, which has a separate sewage works, was commissioned in 1947.

Eutrophication of Loe Pool over the last few decades is also suggested by analysis of sediment cores for sterols using both gas-liquid chromatography (GLC) and computerised gas chromatography mass-spectrometry (GCMS).

Different sterols or groups of sterols may be characteristic of various groups of organisms (Huang & Meinschein 1979). In particular, it has been shown that C_{27} sterols, which are produced by phytoplankton, are more abundant in the sediments of eutrophic lakes (Gaskell & Eglinton 1976) and that C_{29} sterols are more characteristic of higher plants.

In cores of both frozen and unfrozen sediments from Loe Pool, a total of 14 sterols were identified. The majority of these were C_{29} sterols, which suggests considerable allochthonous input of organic matter into the sediment. Total sterol abundance increases from <100 μg gdw^{-1} in the red and grey clays, to over 350 μg gdw^{-1} near the sediment surface, (Fig. 6). However, this distribution may be due as much to degradation of sterols below the sediment surface, as to any real increase in the original concentrations. More significant is the finding that the ratio of C_{27}:C_{29} sterols increases in the upper parts of the clay-gyttja (Fig. 7). This strongly suggests an increase in the internal productivity of the Pool in the period since AD 1940.

Figure 6 also shows the results of analysis of the sterol content of some individual laminations.

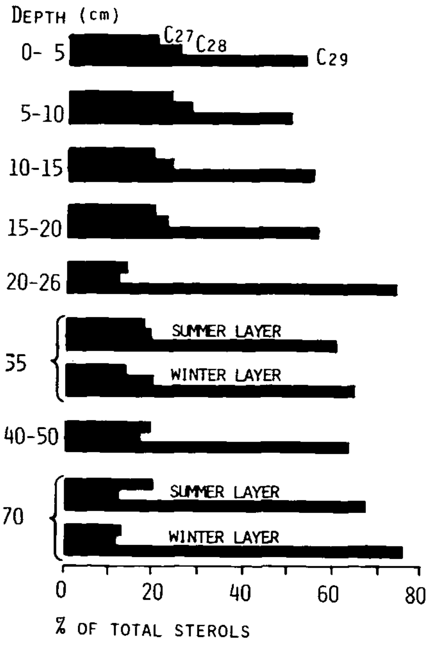

Fig. 6. Relative proportions of C_{27}, C_{28} and C_{29} sterols in various strata of the sediment of Loe Pool.

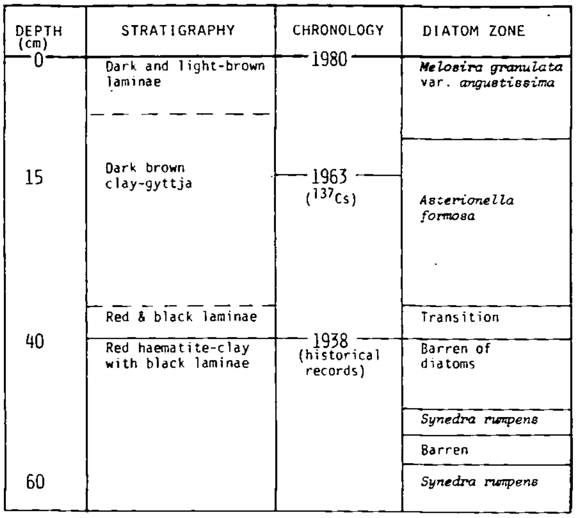

Fig. 7. Summary diagram of diatom stratigraphy of the uppermost sediment of Loe Pool.

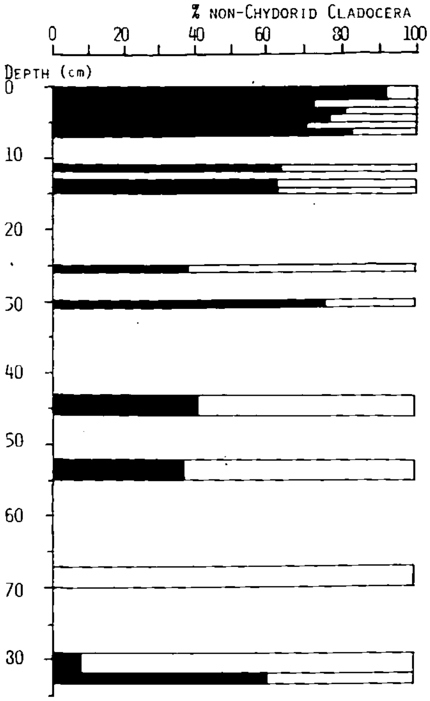

Fig. 8. Percentage of non-Chydorids (black column) of total Cladoceran remains at various levels in a 1 m Mackereth core from Loe Pool.

Again, an increase in the proportion of C_{27} sterols is shown in the 'summer' laminations. This is consistent with the idea that this part of each lamination is deposited in the growth season for phytolankton (Simola *et al.* 1981).

Diatom analysis

A summary of results of an adhesive tape analysis of the uppermost sediments of Loe Pool are shown in Fig. 7. The analytical methods employed are identical to those of Simola (1977).

The results show that in about 1940 a change in the diatom flora of the Pool occurred, with the replacement of *Synedra rumpens* as the most abundant diatom by *Asterionella formosa*. During the 1950's & 60's taxa such as *Synedra pulchella, S. acus, S. ulna, Cocconeis placentula, Surirella capronii, Nitzschia* spp. and *Pinnularia* spp. gradually became less abundant, and were replaced by *Thalassiosira pseudonana, Cyclotella meneghiniana,* and also the green algae *Pediastrum* spp. and *Scenedesmus* spp. Finally, in 1968, *Melosira granulata* var. *angustissima* increased rapidly in abundance, *Scenedesmus* became rare, and *Cyclotella meneghiniana* and *Asterionella formosa* declined. We interpret these changes as indicating eutrophication of the Pool, in association with increased nutrient loadings.

Cladoceran analysis

Results of analysis of Cladoceran remains are summarised in Fig. 8. The methods of extraction and counting employed were those described by Frey (1979). As in the case of the diatom analysis, a major change in the Cladoceran fauna of the Pool took place in the 1950's, when the proportion of non-Chydorid Cladocera present increased from <50% to over 60% of the total present. In the topmost sediments (1970–1980), non-Chydorids constitute 70–90% of the total. In the lower part of the core (below 40 cm), the main taxa encountered were *Chydorus sphaericus, Alona* sp. and *Daphnia* cf. *longispina.* In the upper sediments, however, *Bosmina* species, both *longirostris* and *coregoni*, are abundant. Again this result confirms the idea that the Pool has become more eutrophic in recent decades.

Acknowledgements

We would like to thank Lt. Cdr. J. P. Rogers, and the National Trust for England and Wales, for permission to work at Loe Pool, and for their continued interest in our research. We would also like to acknowledge the help of Professor Geoffrey Eglinton, who kindly allowed the use of GLC and GCMS facilities at the University of Bristol. Dr. Mary Boucherle, of the University of Indiana, USA gave helpful advice on Cladoceran analysis. Much of the work was carried out whilst M.A.C., K.P.L. and H.S. were supported by Devon Local Authority Research Assistantships, A.M.G. by a SERC studentship, and D.A.P. by a NERC studentship. Heikki Simola also received financial support from the Alfred Kordelin Foundation (Finland).

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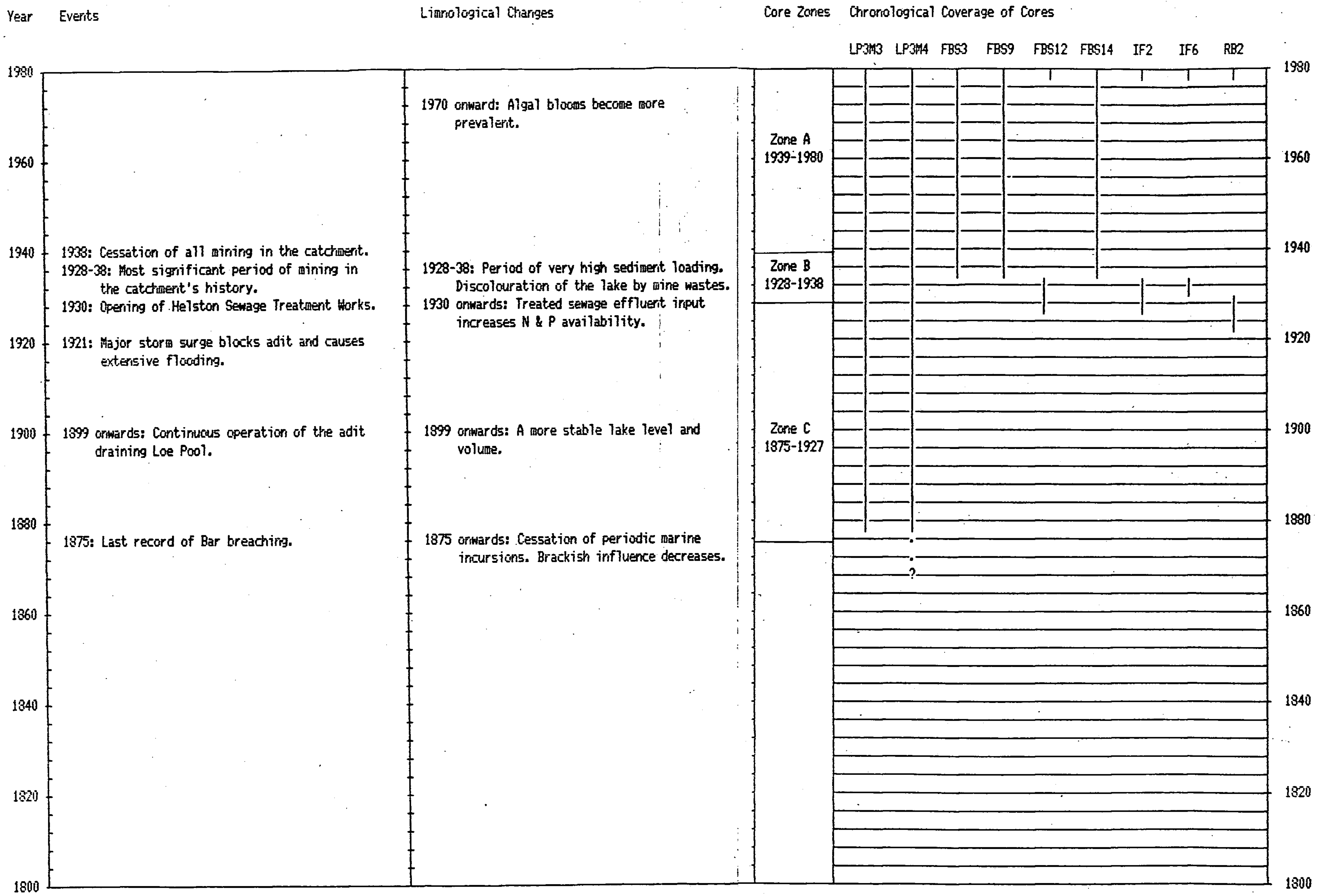

1938: Cessation of all mining in the catchment.

1928-38: Most significant period of mining in the catchment's history.

1930: Opening of Helston Sewage Treatment Works.

1921: Major storm surge blocks adit and causes extensive flooding.

1899 onwards: Continuous operation of the adit draining Loe Pool.

1875: Last record of Bar breaching.

1970 onward: Algal blooms become more prevalent.

1928-38: Period of very high sediment loading. Discolouration of the lake by mine wastes.

1930 onwards: Treated sewage effluent input increases N & P availability.

1899 onwards: A more stable lake level and volume.

1875 onwards: Cessation of periodic marine incursions. Brackish influence decreases.

Fig. 8.1 Summary diagram of the main catchment events, limnological changes, core zones and core chronologies referred to in this study.