

UHI Research Database pdf download summary

Garroch Head Sludge Dumping Ground Survey

Blackstock, John; Pearson, Tom

Publication date:
1984

The re-use license for this item is:
Unspecified

The Document Version you have downloaded here is:
Publisher's PDF, also known as Version of record

[Link to author version on UHI Research Database](#)

Citation for published version (APA):
Blackstock, J., & Pearson, T. (1984). *Garroch Head Sludge Dumping Ground Survey: Preliminary report on the monitoring survey carried out on 7th-12th May 1984.* (SAMS Internal Reports; No. 117). Scottish Association for Marine Science.

General rights

Copyright and moral rights for the publications made accessible in the UHI Research Database are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights:

- 1) Users may download and print one copy of any publication from the UHI Research Database for the purpose of private study or research.
- 2) You may not further distribute the material or use it for any profit-making activity or commercial gain
- 3) You may freely distribute the URL identifying the publication in the UHI Research Database

Take down policy

If you believe that this document breaches copyright please contact us at RO@uhi.ac.uk providing details; we will remove access to the work immediately and investigate your claim.

SCOTTISH MARINE BIOLOGICAL ASSOCIATION

GARROCH HEAD SLUDGE DUMPING GROUND SURVEY

Preliminary report on the monitoring survey carried out
on 7th - 12th May 1984.

J. BLACKSTOCK,
T.H. PEARSON,

Dunstaffnage Marine Research Laboratory,
P.O. Box No. 3, Oban, Argyll.

June, 1984

S.M.B.A. Internal Report

no. 117

1984

INTRODUCTION

Sampling was carried out between the 7th and 12th May 1984 from R.V. 'Calanus'. A total of sixty-one sampling stations were occupied where various samples were taken as detailed below. A list of all sampling stations and samples taken is given in Table 1. The station positions were based on the Decca Navigator grid as shown in Figure 1 and are listed in Table 1(a). In addition otter trawl samples were taken over the dumping ground and over a control area some six kilometres to the north west of the dumping ground. Agassiz trawl samples were taken over several locations. Trawl sample areas are marked on Figure 1.

Sediment Redox Potential Survey

Core samples were taken at sixty sampling stations occupied throughout the area and the redox potential (Eh) profile down the core was recorded using standard redox electrodes. The redox levels at 40 mm depth in the sediment have been used for interstation comparisons. Low redox values are indicative of highly reducing conditions in the sediment brought about by the degradation of large amounts of carbonaceous material. Figure 2 shows those areas found to have low redox values.

Reducing conditions (negative redox values) were found around the dumping grounds in an area some 10 Km² in extent. Very low redox values were found 1 Km to the north and about 0.5 Km to the south of the centre of the dumping area. A further area of low potentials was found to the north of the designated grounds and some two kilometres south of Garroch Head. This northerly area of low potentials was similar in extent to that observed in May 1983. The area of low redox values in the

centre of the grounds was similar in extent to that seen in 1983. In general redox values in the most affected areas were somewhat higher than in May, 1983.

Oxygen content of overlying water

The oxygen content of the water immediately above the sediment surface was measured at station P1 situated seven kilometres from the centre of the dumping ground and at four stations situated from the edge to the centre of the grounds. The values obtained are given in Table 2 and vary about 8 mg O₂/L i.e. the bottom water over the dumping ground was fully oxygenated.

Transect Survey

The two lines of transect stations sampled during the previous surveys were again occupied. A grab sample was obtained from selected stations and sieved on a 1 mm mesh and the residue examined for large benthic invertebrates. At several of these stations the residue was retained for detailed examination of the macrobenthic fauna. Samples for the analysis of the heavy metal and organochlorine contents of the sediments were obtained from replicate core samples taken at the transect stations. Populations of macrofauna were present in all the samples taken. Numbers found in the centre of the grounds were similar to the low numbers found in 1983. Preliminary visual examination of the samples for the presence or absence of particular large dominant macrofaunal species showed that sedimentary conditions and faunal communities varied in essentially the same manner along both transects. In the centre of the dumping grounds the sediments contained large

quantities of organic material, were black in colour and showed negative redox potential. The fauna in these areas consisted of a few small nematodes, Capitellid and Spionid worms. Total abundance appeared to be similar to those seen in the centre of the grounds in 1983. As distances from the centre of the dumping area increased these small worms were replaced by a more varied fauna of larger polychaetes and molluscs until at the edges of the affected area, some 3.5 Km² from the centre, where the sediments were brown/grey in colour, contained little visible organic material and showed positive redox potentials, a diverse community of polychaetes, molluscs, echinoderms and crustacea, similar to that found on soft silt sediments elsewhere in the Firth of Clyde, was found.

Diagrammatic summaries of these various changes along the transects are given in Figures 3 and 4.

Conditions along the northern arm of the N/S transect are slightly more varied than in other areas. In that area redox potentials are more variable and faunal distributions suggest a fluctuating but generally higher input of organic material to the sediments.

Depth of Sludge Deposit

Long core samples were taken by gravity cores from the centre of the dumping ground (station P7), from station P5 at 2 Km west of the centre and from station P1 situated 7 Km west of the centre of the ground. At P7 the upper 13 cm of the sample consisted of a black deposit of sludge. Below 60 cm normal light-brown clay sediment was present. No sludge was obvious in the samples from P1 and P5 (Figure 5).

Trawl Survey

Two ten minute otter trawl hauls were taken, the first across the centre of the dumping ground, the second from station G1 to G3 some 6 Km north-west of the centre of the dumping grounds. Large numbers of Saithe were taken in the trawl from the dumping ground with Cod and Long Rough Dab less numerous than in 1983. Seven other species were present. Ten species were found in the G1/G3 trawl with Norway Pout, Cod and Poor Cod the most numerous species present. There were, however, fewer fish in this area compared with those caught at D11/E12 in 1983. A summary of the species taken in the various hauls is given in Table 3. Specimens of live fish from the centre of the dumping ground and the area to the NE were taken for bacteriological examination.

Agassiz trawl hauls were taken in the areas shown in Table 4. Distributions of large epibenthic species e.g. Nephrops norvegicus (Norway lobster), Crangon allmani (Shrimp), Pandalus montagui (Prawn) and Buccinum undatum (Whelk) were similar to those observed in previous years in most of the areas examined. Near the centre of the dumping area, however, few of these species were obtained in the hauls (see Table 4). Specimens of invertebrates were deep frozen and retained for metal and organochlorine analyses.

Conclusions

Areas of reduced sediment were present in the vicinity of the designated dumping grounds and in an area to the north of the grounds but redox values in these areas were somewhat higher than in 1983. Macrofaunal populations in the centre of the dumping grounds appeared to be similar to those noted in the previous survey in May, 1983. High

populations of Saithe were again taken over the dumping grounds, but the numbers of Cod and Long Rough Dab were considerably less than in 1983.

Table 1. List of stations occupied, sediment type and samples taken.

| <u>Station</u> | <u>Depth (m)</u> | <u>Sample Taken*</u> | <u>Sediment Type</u> | <u>Gear</u> |
|----------------|------------------|----------------------|---|------------------------|
| A8 | 92 | Eh,pH | 0-10 cm light brown silt, darker below | Corer |
| C7 | 76 | Eh,pH | 0-10 cm light brown silt, black below | Corer |
| C8 | 88 | Eh,pH | 0-10 cm light brown silt, black below | Corer |
| D7 | 96 | Eh,pH F, HM, OC. | 0-4 cm light brown silt with black streaks, black below | Corer Van-Veen Grab |
| D9 | 96 | Eh,pH | 0-10 cm light brown silt brown-black below | Corer |
| E6 | 80 | Eh,pH | 0-10 cm light brown silt, brown-black below | Corer |
| E7 | 89 | Eh,pH F, HM, OC | 0-10 cm light brown silt with black streaks, black below | Corer Van-Veen Grab |
| E8 | 100 | Eh,pH | 0-10 cm light brown silt brown-black below | Corer |
| F7 | 84 | Eh,pH F, HM, OC | 0-10 cm light brown silt with black streaks, black below | Corer |
| G1 | 93 | Eh,pH F, HM, OC | Light brown silt throughout | Corer Van-Veen Grab |
| G5 | 62 | Eh,pH | 0-7.5 cm dark brown silt | Corer |
| G6 | 78 | Eh,pH | 0-4 cm brown, brown-black below | Corer |
| G7 | 80 | Eh,pH F, HM, OC | 0-10 cm light brown silt, black areas below | Corer Van-Veen Grab |
| G8 | 84 | Eh,pH | 0-4 cm light brown silt, black below | Corer |
| G9 | 83 | Eh,pH | 0-8 cm light brown silt, brown-black below | Corer |
| I7 | 80 | Eh,pH F, HM, OC | 0-10 cm brown silt, brown-black below | Corer Van-Veen Grab |
| I8 | 90 | Eh,pH | 0-3.5 cm light brown silt, occasional black streaks | Corer |

Table 1 (continued)

| <u>Station</u> | <u>Depth (m)</u> | <u>Sample Taken*</u> | <u>Sediment Type</u> | <u>Gear</u> |
|----------------|------------------|----------------------------------|--|------------------------|
| J5 | 88 | Eh,pH | Brown silt throughout | Corer |
| J7 | 77 | Eh,pH | Dark brown silt throughout | Corer |
| J9 | 75 | Eh,pH | Brown silt throughout | Corer |
| K7 | 80 | Eh,pH F,HM,OC | 0-10 cm brown silt, dark-brown below | Corer Van-Veen Grab |
| L7 | 76 | Eh,pH F,HM,OC. | 0-3 cm brown silt, brown-black below | Corer Van-Veen Grab |
| M5 | 92 | Eh,pH | Dark brown silt throughout | Corer |
| M7 | 74 | Eh,pH F,HM,OC. | Dark brown-grey silt throughout with some black streaks | Corer Van-Veen Grab |
| M9 | 76 | Eh,pH | 0-4 cm brown silt, dark-brown below | Corer |
| M11 | 76 | Eh,pH | 0-4 cm brown silt, dark-brown below | Corer |
| N7 | 76 | Eh,pH F,HM,OC. | Dark-brown-black silt flocculent on surface | Corer Van-Veen Grab |
| O7 | 80 | Eh,pH | Dark brown-black silt flocculent at surface | Corer |
| P1 | 144 | Eh,pH,O ₂ F,HM,OC. | 0-19 cm light brown silt throughout | Corer Van-Veen Grab |
| P2 | 154 | Eh,pH | 0-1 cm light brown silt, brown below | Corer |
| P3 | 167 | Eh,pH | Light brown silt throughout | Corer |
| P4 | 156 | Eh,pH F,HM,OC. | Light brown silt, darkening below | Corer Van-Veen Grab |
| P5 | 126 | Eh,pH,O ₂ F,HM,OC. | Light brown silt throughout | Corer Van-Veen Grab |
| P5.5 | 110 | Eh,pH F,HM,OC. | Dark brown silt throughout | Corer Van-Veen Grab |
| P6 | 96 | Eh,pH,O ₂ F,HM,OC. | 0-10 cm dark-brown silt, with black streaks | Corer Van-Veen Grab |

Table 1 (continued)

| <u>Station</u> | <u>Depth (m)</u> | <u>Sample Taken</u> | <u>Sediment Type</u> | <u>Gear</u> |
|----------------|------------------|----------------------------------|---|------------------------|
| P6.5 | 92 | Eh,pH | Sludge at surface black below | Corer |
| P7 | 86 | Eh,pH,O ₂ F,HM,OC. | Sludge at surface Black sludge silt below | Corer Van-Veen Grab |
| P7.5 | 77 | Eh,pH | Sludge at surface black silt below | Corer |
| P8 | 74 | Eh,pH,O ₂ F,HM,OC | Sludge at surface, silt below | Corer Van-Veen Grab |
| P8.5 | 68 | F | | Van-Veen Grab |
| P9 | 65 | Eh,pH F,HM,OC. | 0-4 cm light-brown, dark brown below | Corer Van-Veen Grab |
| P9.5 | 80 | Eh,pH | Dark brown silt throughout with black streaks | Corer |
| P10 | 79 | Eh,pH F,HM,OC. | Brown silt at top slightly darker brown below | Corer Van-Veen Grab |
| P10.5 | 81 | Eh,pH | Brown silt at top slightly darker brown below | Corer |
| P11 | 86 | Eh,pH F,HM,OC. | Brown silt throughout very slightly darker brown below | Corer Van-Veen Grab |
| P12 | 78 | Eh,pH F,HM,OC. | Brown silt throughout | Corer Van-Veen Grab |
| Q7 | 84 | Eh,pH | Dark brown-black throughout | Corer |
| R7 | 100 | Eh,pH F,HM,OC. | Sludge at surface, black throughout | Corer Van-Veen Grab |
| S3 | 116 | Eh,pH | 0-10 cm dark brown silt throughout | Corer |
| S5 | 165 | Eh,pH | 0-10 cm dark brown silt, some black streaks below | Corer |
| S7 | 108 | Eh,pH F,HM,OC. | Sludge at surface black throughout | Corer Van-Veen Grab |

Table 1 (continued)

| <u>Station</u> | <u>Depth (m)</u> | <u>Sample Taken</u> | <u>Sediment Type</u> | <u>Gear</u> |
|----------------|------------------|---------------------|---|------------------------|
| S9 | 76 | Eh,pH | Dark brown silt, black below | Corer |
| S11 | 80 | Eh,pH | Brown silt throughout, darker brown below | Corer |
| T7 | 122 | Eh,pH F, HM, OC. | 0-5 cm dark brown-grey at surface, flocculent at top (0.5 cm), darker below | Corer Van-Veen Grab |
| U7 | 158 | Eh,pH | Dark brown silt throughout | Corer |
| V5 | 142 | Eh,pH | Dark brown silt throughout | Corer |
| V7 | 180 | Eh,pH F, HM, OC. | Brown silt throughout | Corer Van-Veen Grab |
| V9 | 119 | Eh,pH | Dark brown silt throughout | Corer |
| W7 | 166 | Eh,pH | Dark brown silt throughout | Corer |
| X7 | 144 m | Eh,pH F, HM, OC. | Dark brown silt throughout | Corer Van-Veen Grab |
| AZ7 | 106 | Eh,pH F, HM, OC | Brown silt throughout | Corer Van-Veen Grab |

- * Eh, Redox potential measurements taken at 1 cm intervals down core samples.
- pH, Acidity measurements taken at 1 cm intervals down core samples.
- O₂, Oxygen content of water immediately above the sediment surface measured.
- F, Grab sample for faunal analysis taken.
- HM, Sediment sample for Heavy Metal Analysis taken.
- OC, Sediment sample for Organochlorine Analysis taken.

Table 1(a). Station positions.

| <u>Station</u> | <u>Decca co-ordinates</u> | | <u>Chart co-ordinates</u> | |
|----------------|---------------------------|---------------|---------------------------|-------------|
| | <u>Red</u> | <u>Purple</u> | <u>North</u> | <u>West</u> |
| A 8 | D23.0 | J68.0 | 55°43.25' | 4°59.5' |
| C 7 | E 0.0 | J66.0 | 55°42.92' | 5°0.55' |
| C 8 | D23.0 | J66.0 | 55°42.72' | 4°59.65' |
| D 7 | E 0.0 | J65.0 | 55°42.68' | 5°0.30' |
| D 9 | D22.0 | J65.0 | 55°42.32' | 4°58.72' |
| E 6 | E 1.0 | J64.0 | 55°42.60' | 5°1.57' |
| E 7 | E 0.0 | J64.0 | 55°42.44' | 5°0.70' |
| E 8 | D23.0 | J64.0 | 55°42.25' | 4°59.72' |
| F 7 | E 0.0 | J63.0 | 55°42.18' | 5°0.72' |
| G 1 | E 6.0 | J62.0 | 55°42.95' | 5°6.23' |
| G 5 | E 2.0 | J62.0 | 55°42.28' | 5°2.62' |
| G 6 | E 1.0 | J62.0 | 55°42.14' | 5°1.72' |
| G 7 | E 0.0 | J62.0 | 55°41.95' | 5°0.75' |
| G 8 | D23.0 | J62.0 | 55°41.77' | 4°59.81' |
| G 9 | D22.0 | J62.0 | 55°41.62' | 4°58.80' |
| I 7 | E 0.0 | J60.0 | 55°41.47' | 5°0.85' |
| I 8 | D23.0 | J60.0 | 55°41.32' | 4°59.95' |
| J 5 | E 2.0 | J59.0 | 55°41.57' | 5°2.75' |
| J 7 | E 0.0 | J59.0 | 55°41.25' | 5°0.84' |
| J 9 | D22.0 | J59.0 | 55°40.94' | 4°59.06' |
| K 7 | E 0.0 | J58.0 | 55°41.00' | 5°1.30' |
| L 7 | E 0.0 | J57.0 | 55°40.77' | 5°1.36' |
| M 5 | E 2.0 | J56.0 | 55°40.85' | 5°2.90' |
| M 7 | E 0.0 | J56.0 | 55°40.52' | 5°1.05' |
| M 9 | D22.0 | J56.0 | 55°40.21' | 5°0.78' |
| M11 | D20.0 | J56.0 | 55°39.90' | 5°2.62' |
| N 7 | E 0.0 | J55.0 | 55°40.29' | 5°1.10' |
| O 7 | E 0.0 | J54.0 | 55°40.06' | 5°1.15' |
| P 1 | E 6.0 | J53.0 | 55°40.73' | 5°6.72' |
| P 2 | E 5.0 | J53.0 | 55°40.58' | 5°5.78' |

Table 1(a) (continued)

| <u>Station</u> | <u>Decca co-ordinates</u> | | <u>Chart co-ordinates</u> | |
|----------------|---------------------------|---------------|---------------------------|-------------|
| | <u>Red</u> | <u>Purple</u> | <u>North</u> | <u>West</u> |
| P 3 | E 4.0 | J53.0 | 55°40.43' | 5°5.12' |
| P 4 | E 3.0 | J53.0 | 55°40.25' | 5°3.98' |
| P 5 | E 2.0 | J53.0 | 55°40.11' | 5°3.05' |
| P5.5 | E 1.5 | J53.0 | 55°40.02' | 5°2.53' |
| P 6 | E 1.0 | J53.0 | 55°39.97' | 5°2.14' |
| P6.5 | E 0.5 | J53.0 | 55°39.88' | 5°1.68' |
| P 7 | E 0.0 | J53.0 | 55°39.80' | 5°1.20' |
| P7.5 | D23.5 | J53.0 | 55°39.74' | 5°0.74' |
| P 8 | D23.0 | J53.0 | 55°39.65' | 5°0.30' |
| P8.5 | D22.5 | J53.0 | 55°39.58' | 4°59.86' |
| P 9 | D22.0 | J53.0 | 55°39.52' | 4°59.38' |
| P9.5 | D21.5 | J53.0 | 55°39.43' | 4°58.88' |
| P10 | D21.0 | J53.0 | 55°39.35' | 4°48.45' |
| P10.5 | D20.5 | J53.0 | 55°39.30' | 4°58.00' |
| P11 | D20.0 | J53.0 | 55°39.20' | 4°57.70' |
| P12 | D19.0 | J53.0 | 55°39.05' | 4°56.60' |
| Q 7 | E 0.0 | J52.0 | 55°39.58' | 5°1.25' |
| R 7 | E 0.0 | J51.0 | 55°39.35' | 5°1.35' |
| S 3 | E 4.0 | J50.0 | 55°39.70' | 5°5.00' |
| S 5 | E 2.0 | J50.0 | 55°39.40' | 5°3.18' |
| S 7 | E 0.0 | J50.0 | 55°39.12' | 5°1.32' |
| S 9 | D22.0 | J50.0 | 55°38.80' | 4°59.56' |
| S11 | D20.0 | J50.0 | 55°38.53' | 4°57.70' |
| T 7 | E 0.0 | I79.0 | 55°38.87' | 5°1.40' |
| U 7 | E 0.0 | I78.0 | 55°38.65' | 5°1.45' |
| V 5 | E 2.0 | I77.0 | 55°38.67' | 5°3.30' |
| V 7 | E 0.0 | I77.0 | 55°38.38' | 5°1.50' |
| V 9 | D22.0 | I77.0 | 55°38.12' | 4°59.70' |
| W 7 | E 0.0 | I76.0 | 55°38.15' | 5°1.53' |
| X 7 | E 0.0 | I75.0 | 55°37.93' | 5°1.57' |
| AZ 7 | E 0.0 | I71.0 | 55°36.97' | 5°1.77' |

Table 2. Oxygen content of the water immediately above the sediment surface (mean values from two samples).

| Station | Oxygen Content mg O ₂ /L |
|---------|-------------------------------------|
| P1 | 7.8 |
| P5 | 7.9 |
| P6 | 8.2 |
| P7 | 8.0 |
| P8 | 8.4 |

(Taken at 10.00 hrs 7.5.84; prior to daily sludge disposal).

Table 3. Species taken in otter trawl hauls.

1. Trawl across dumping ground (07-Q7) 10 minutes on bottom.

| | | |
|-----------------|-------------------------------------|-----|
| Cod, | <u>Gadus morhua</u> | 29 |
| Saithe, | <u>Pollachius virens</u> | 202 |
| Norway Pout, | <u>Trisopterus esmarki</u> | 2 |
| Common Dab | <u>Limanda limanda</u> | 1 |
| Long Rough Dab, | <u>Hippoglossoides platessoides</u> | 16 |
| Whiting, | <u>Merlangius merlangus</u> | 5 |
| Poor Cod, | <u>Trisopterus minutus</u> | 13 |
| Haddock | <u>Melanogrammus aeglefinus</u> | 2 |
| Plaice, | <u>Pleuronectes platessa</u> | 4 |
| Flounder | <u>Platichthys flesus</u> | 2 |

2. Trawl 6 km north-west of dumping ground (G1-G3)

10 minutes on bottom.

| | | |
|----------------|-------------------------------------|----|
| Cod | <u>Gadus morhua</u> | 6 |
| Norway Pout, | <u>Trisopterus esmarki</u> | 27 |
| Long Rough Dab | <u>Hippoglossoides platessoides</u> | 3 |
| Whiting | <u>Merlangius merlangus</u> | 4 |
| Poor Cod, | <u>Trisopterus minutus</u> | 6 |
| Haddock | <u>Melanogrammus aeglefinus</u> | 1 |
| Plaice | <u>Pleuronectes platessa</u> | 4 |
| Flounder | <u>Platichthys flesus</u> | 2 |
| Hake | <u>Merluccius merluccius</u> | 5 |
| Gurnard | <u>Eutriglia gurnardus</u> | 1 |

Table 4. Species taken in Agassiz Trawl hauls.

1. E11-D12. 2 trawls of 10 min on bottom.
Nephrops and Pandalus numerous.
Buccinum and Crangon also obtained.
2. D7-E7, 10 minutes on bottom.
Specimens of Apphoraus pes-pelecani and Buccinum numerous.
Pandalus and Crangon, common.
Nephrops occasional.
3. I7-J7. 10 minutes on bottom.
Specimens of Apphoraus pes-pelecani, Buccinum, Pandalus and
Crangon, common and collected.
4. Q7-R7
2 trawls at 10 min on bottom, no macrofauna obtained.
5. Q7-R6 2 trawls at 10 min on bottom.
A few Buccinum only, mainly cirratulid polychaetes in hauls.

Captions to Figures.

Figure 1. Map showing sampling grid and station positions with trawl positions marked.

Figure 2. Redox potential (Eh) values at 4 cm depth in the sediment.

Figure 3. Variation in redox potential at 4 cm depth in the sediment along the East-West transect compared with the distribution of large macrofaunal species observed in the grab samples.

Key Bl, Brissopsis lyrifera; Ns, Nucula sp.;
 Ac, Amphiura chiajei; Sk, Spiophanes kroyeri;
 Aa, Abra alba; Lj, Lipobranchius jeffreysi;
 Ga, Glycera alba; Tf, Thyasira flexuosa;
 Nl, Notomastus latericeus;
 Ct, Cirriformia tentaculata; Capitella capitata;
 Sf, Scolelepis fuliginosa.

Figure 4. Variation in redox potential at 4 cm depth in the sediment along the North-South transect compared with the distribution of large macrofaunal species observed in the grab samples.

Key as for Fig. 3

Figure 5. Comparison of sediment colour profiles at various points along the East-West transect with estimates of sludge depth.

FIG. 1

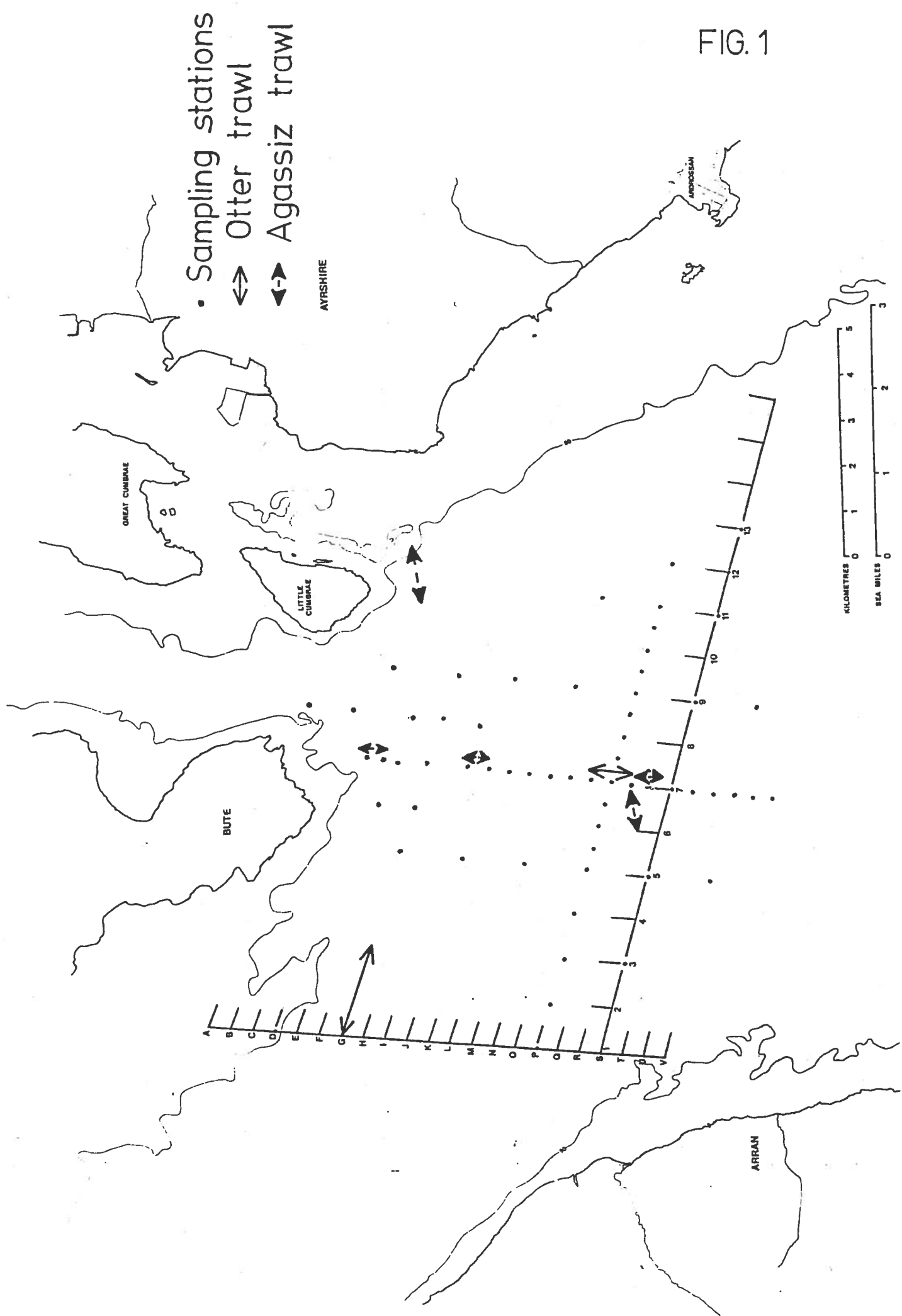


FIG 2

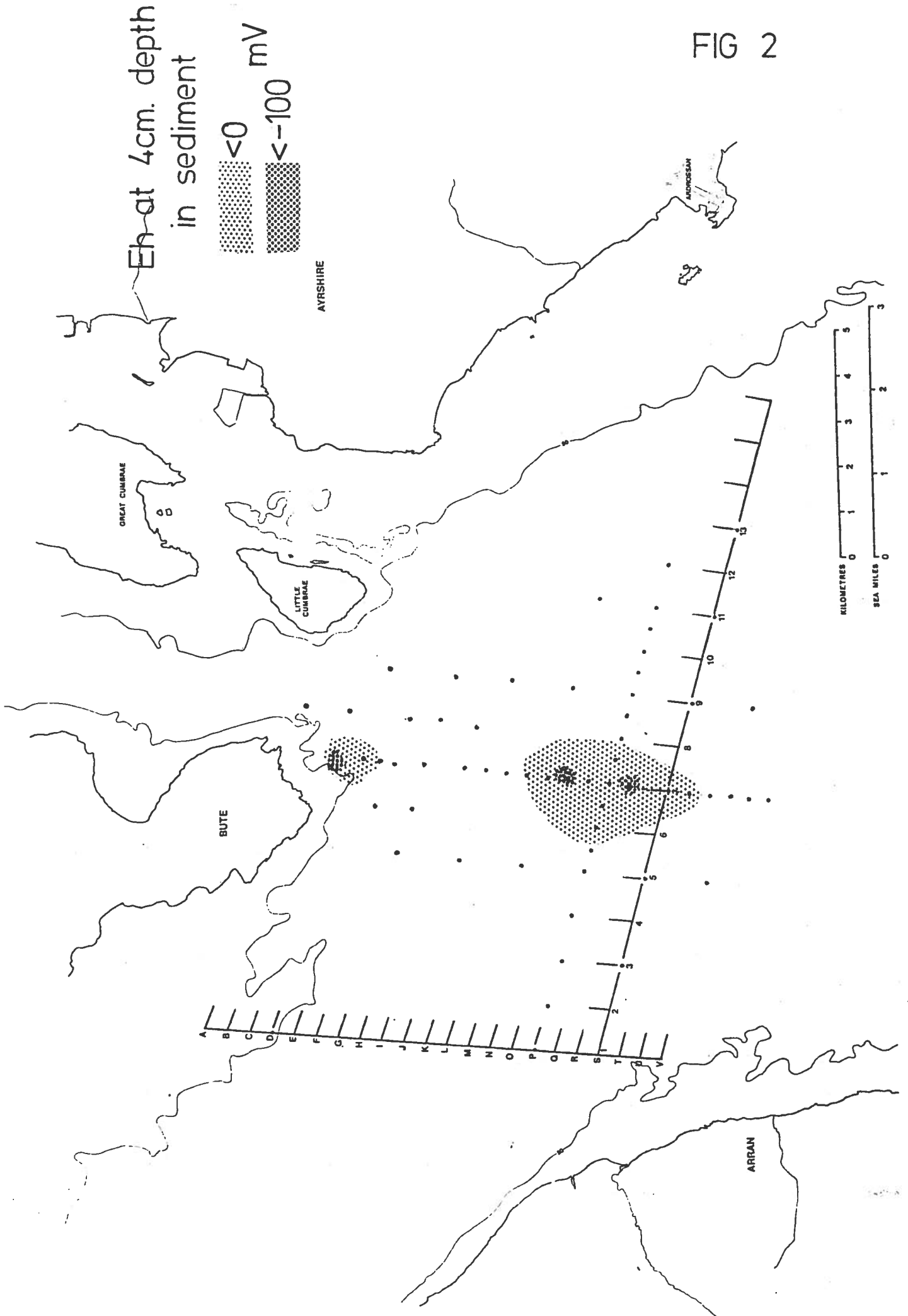
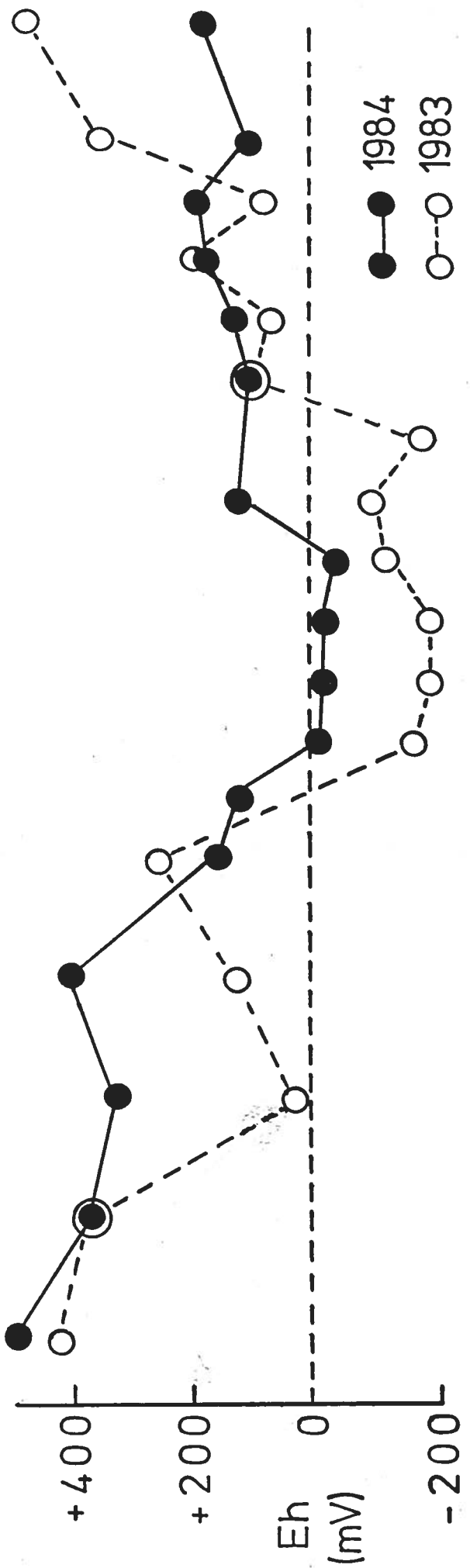


FIG 3



P1 P2 P3 P4 P5 P6 P7 P8 P9 P10 P11 P12

Bi
Ns
Ac
Sk
Aa
Lj
Ga
Tt
Ni
Ct
Cc
Sf

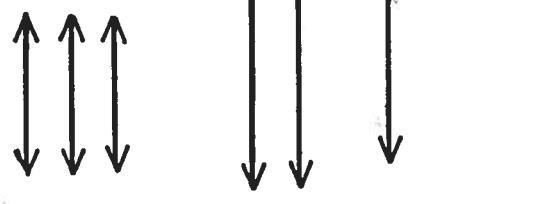


FIG 4

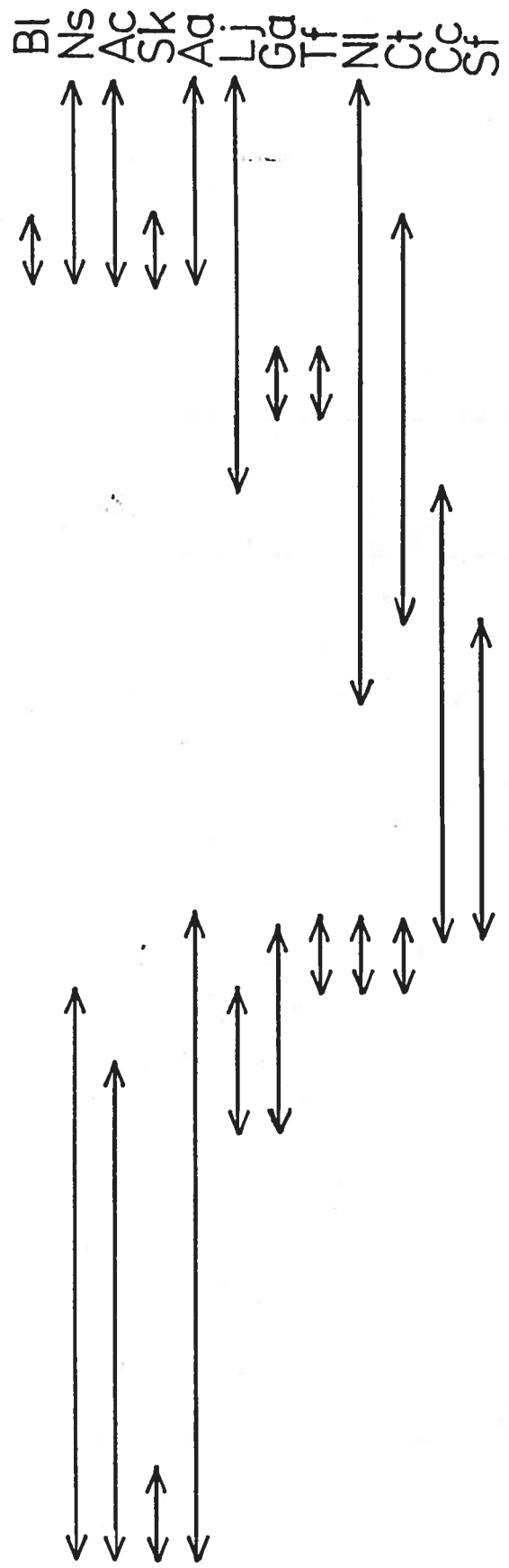
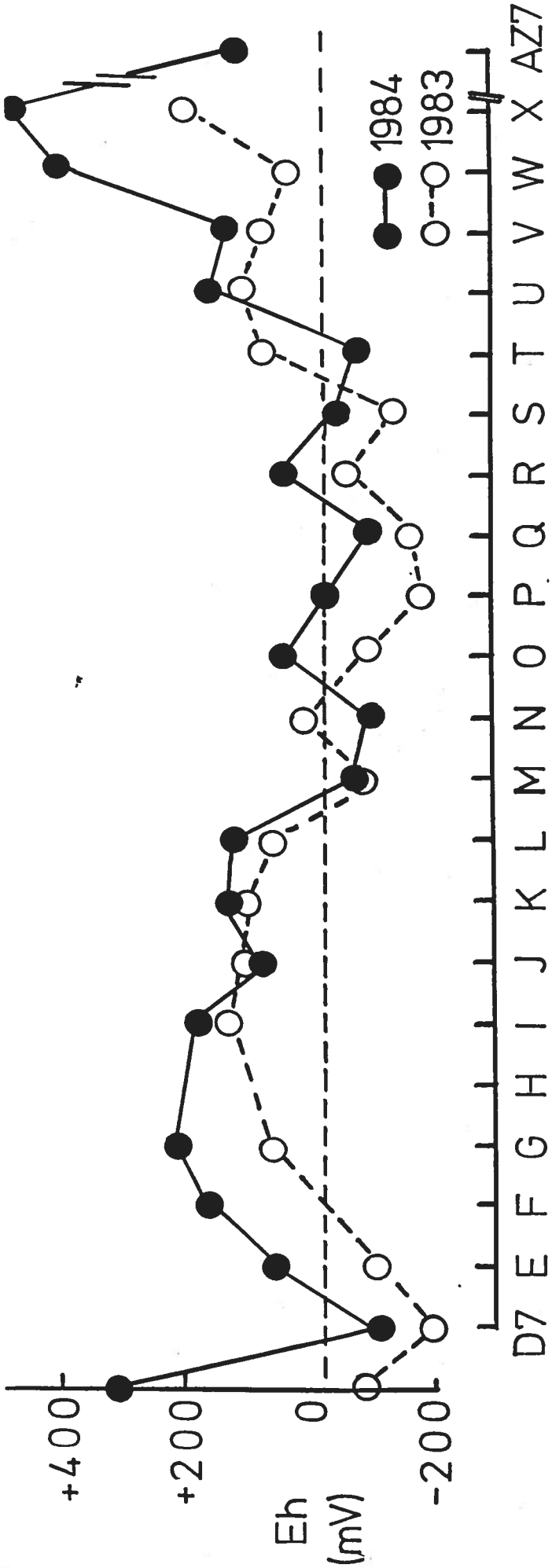


FIG 5

