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SOLUTE PATHWAYS IN THE NARRATOR CATCHMENT. DARTMOOR

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SOLUTE PATHWAYS IN THE NARRATOR CATCHMENT, DARIMOOR

FIGURES AND PLATES

VOLUME 2

ANDREW GRAHAM WILLIAMS

Department of Geographical Sciences,
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September, 1983.

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VOLUME 2

FIGURES AND PLATES

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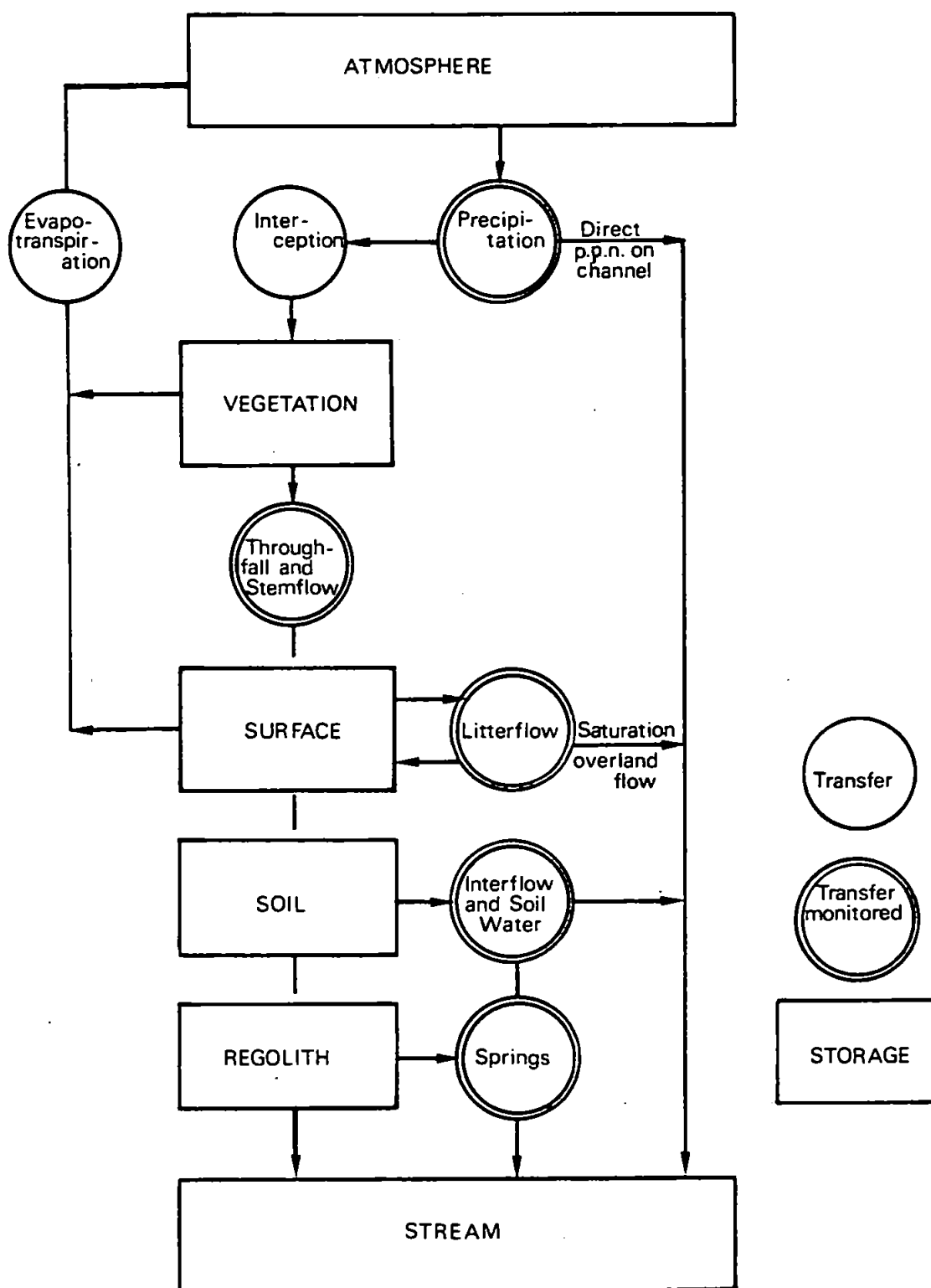


Figure 1.1 Hydrological pathway from the atmosphere to the stream showing transfers monitored by this investigation

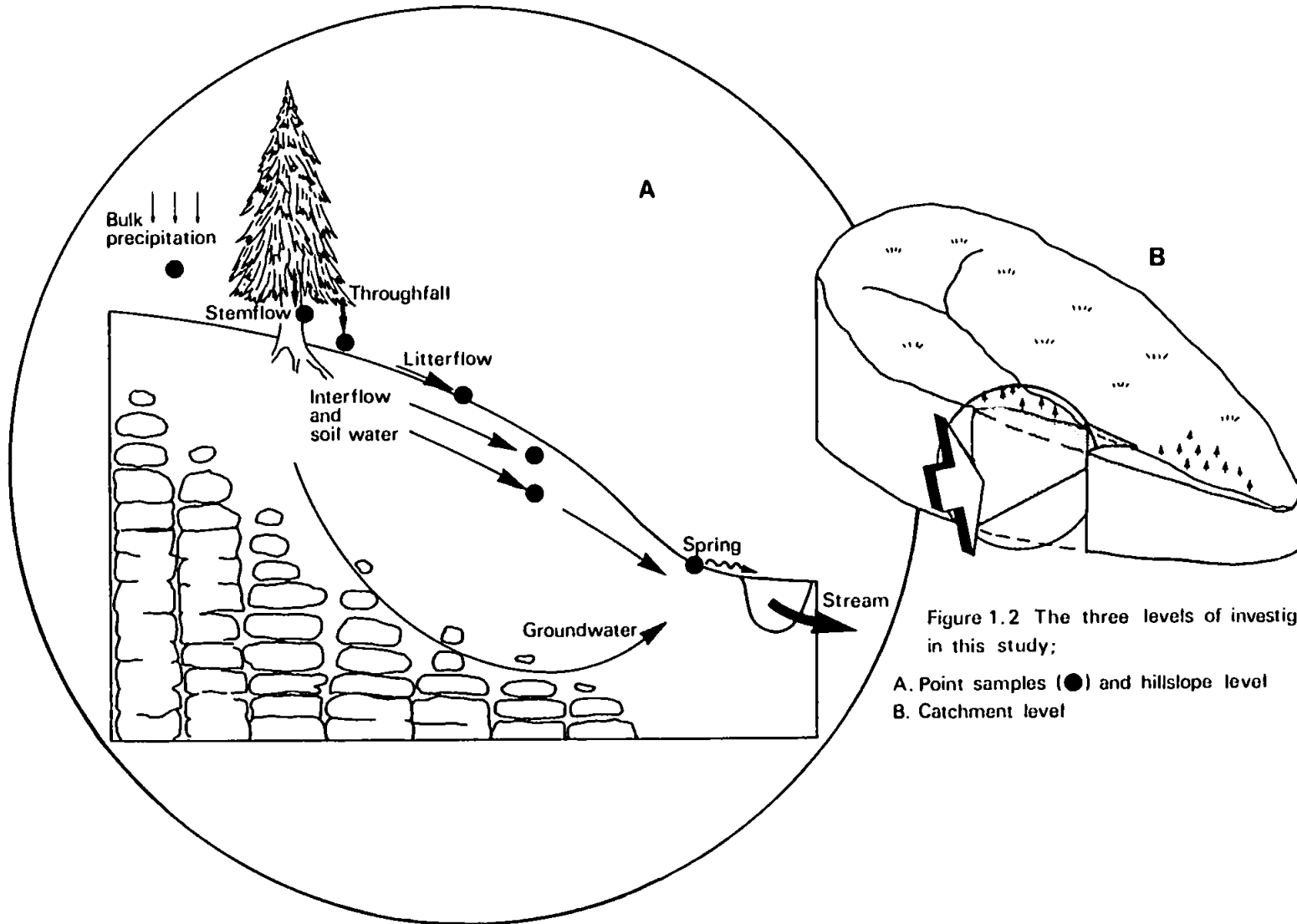


Figure 1.2 The three levels of investigation in this study;

- A. Point samples (●) and hillslope level
- B. Catchment level

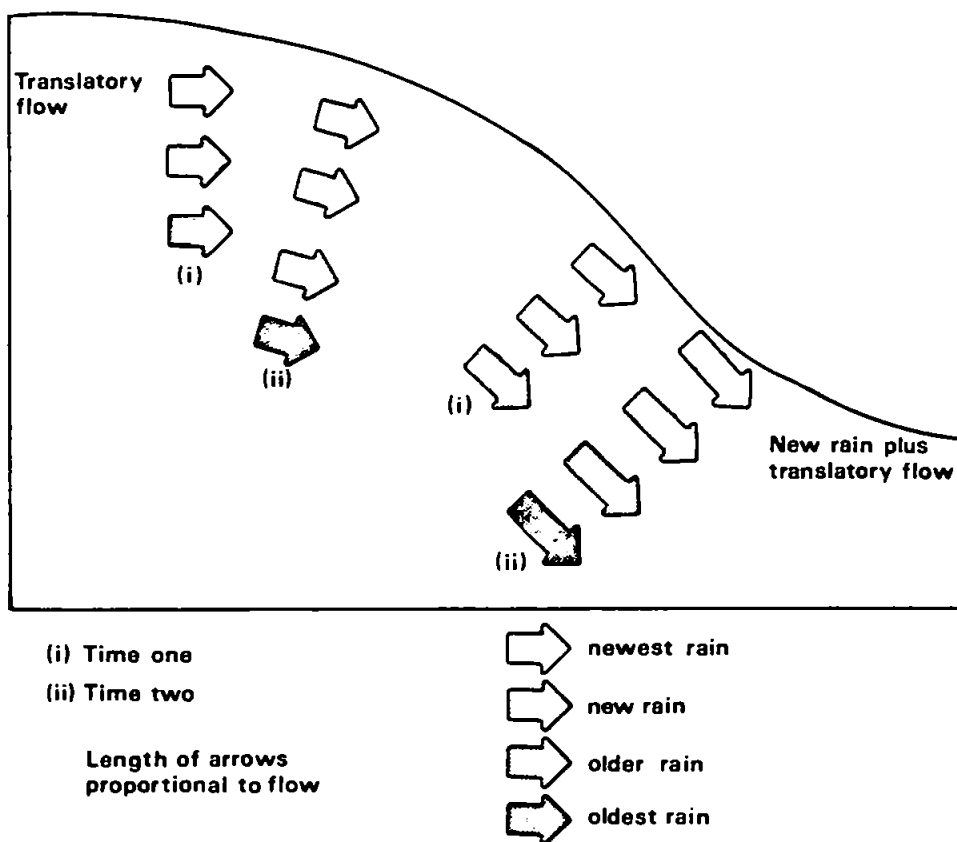


Figure 1.3 Translatory flow on a hillslope

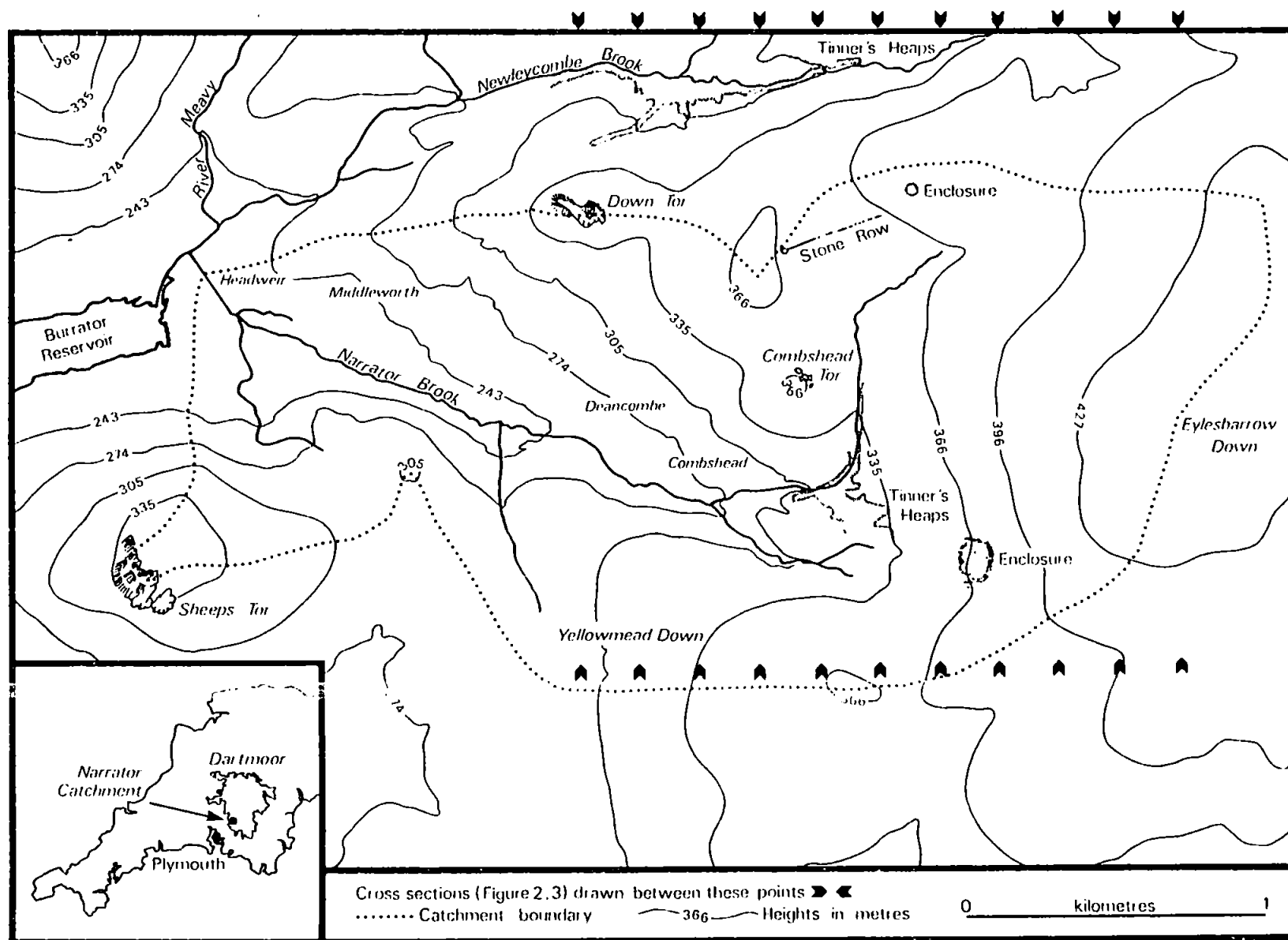


Fig. 2.1. Location and topography of the Narrator catchment (arrows indicate cross profiles)

AVERAGE AIR TEMPERATURE AT HEADWEIR

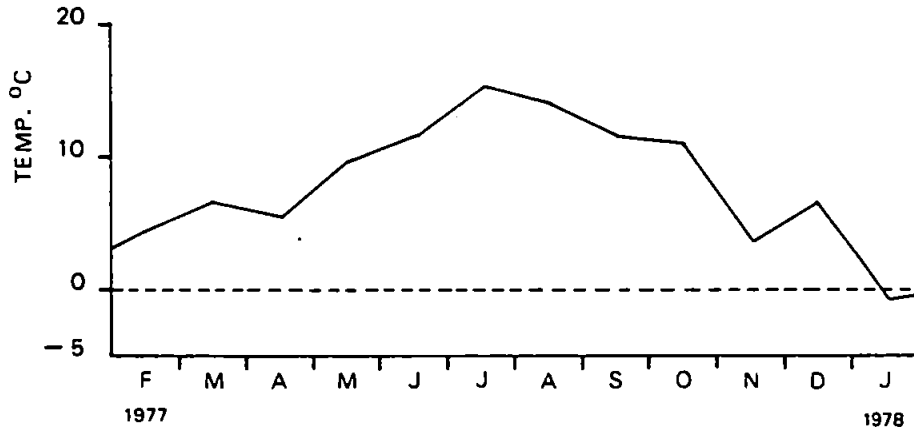


Fig. 2.2a. Temporal variation in air temperature

TOTAL MONTHLY PRECIPITATION AT HEADWEIR

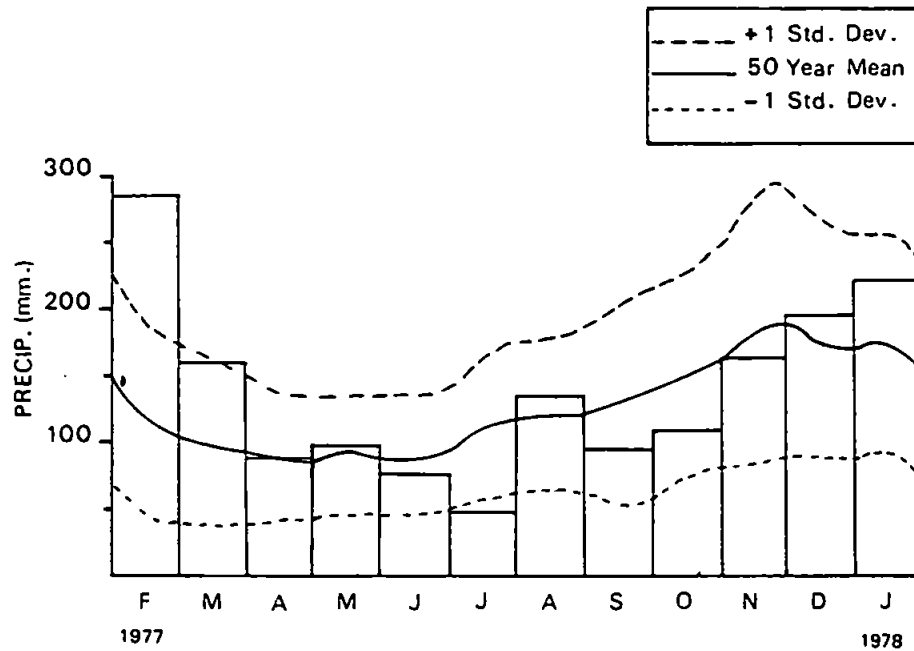


Fig. 2.2b. Temporal variation in precipitation

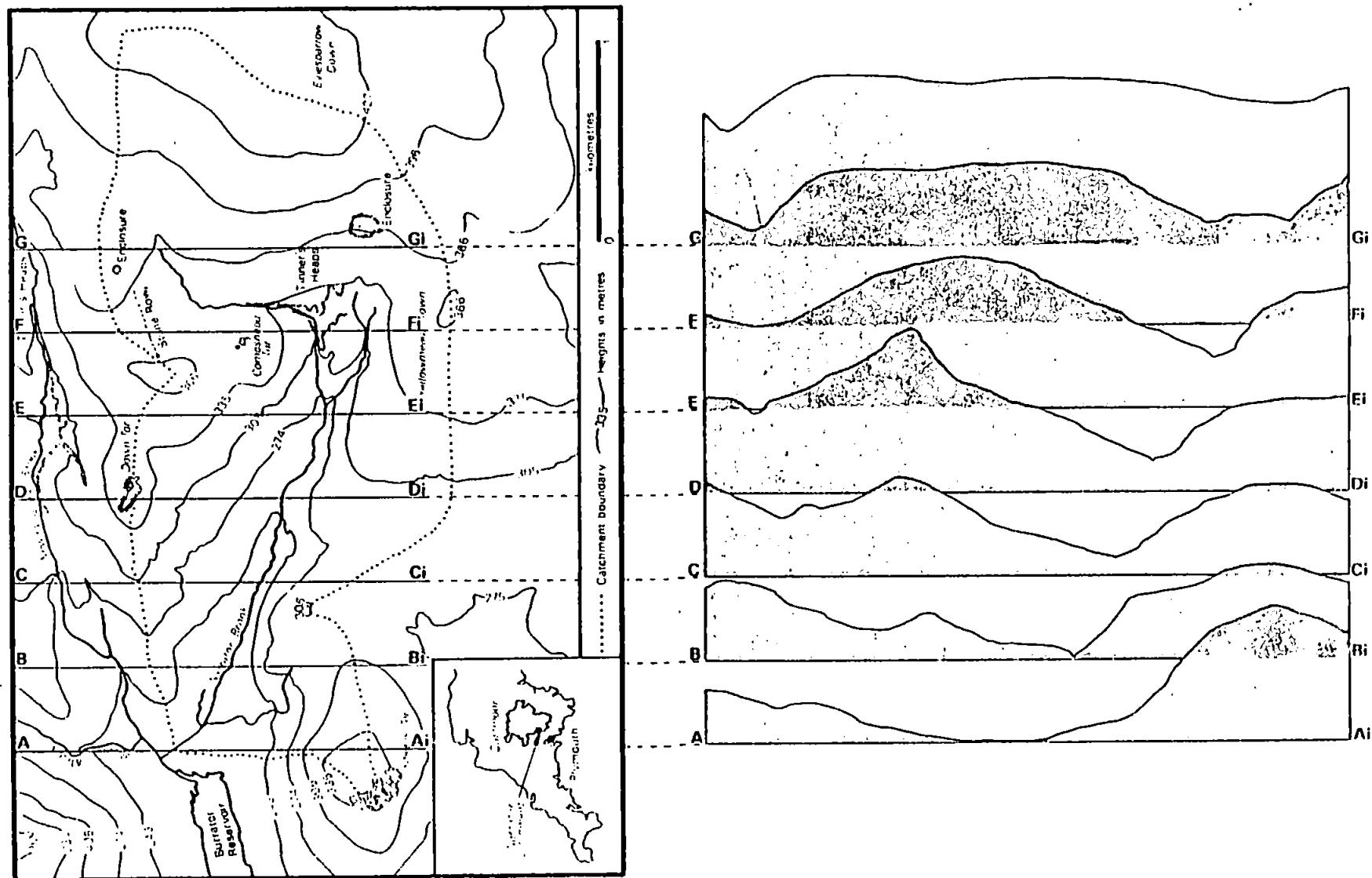


Fig. 2.3. Valley cross profiles in the Narrator catchment

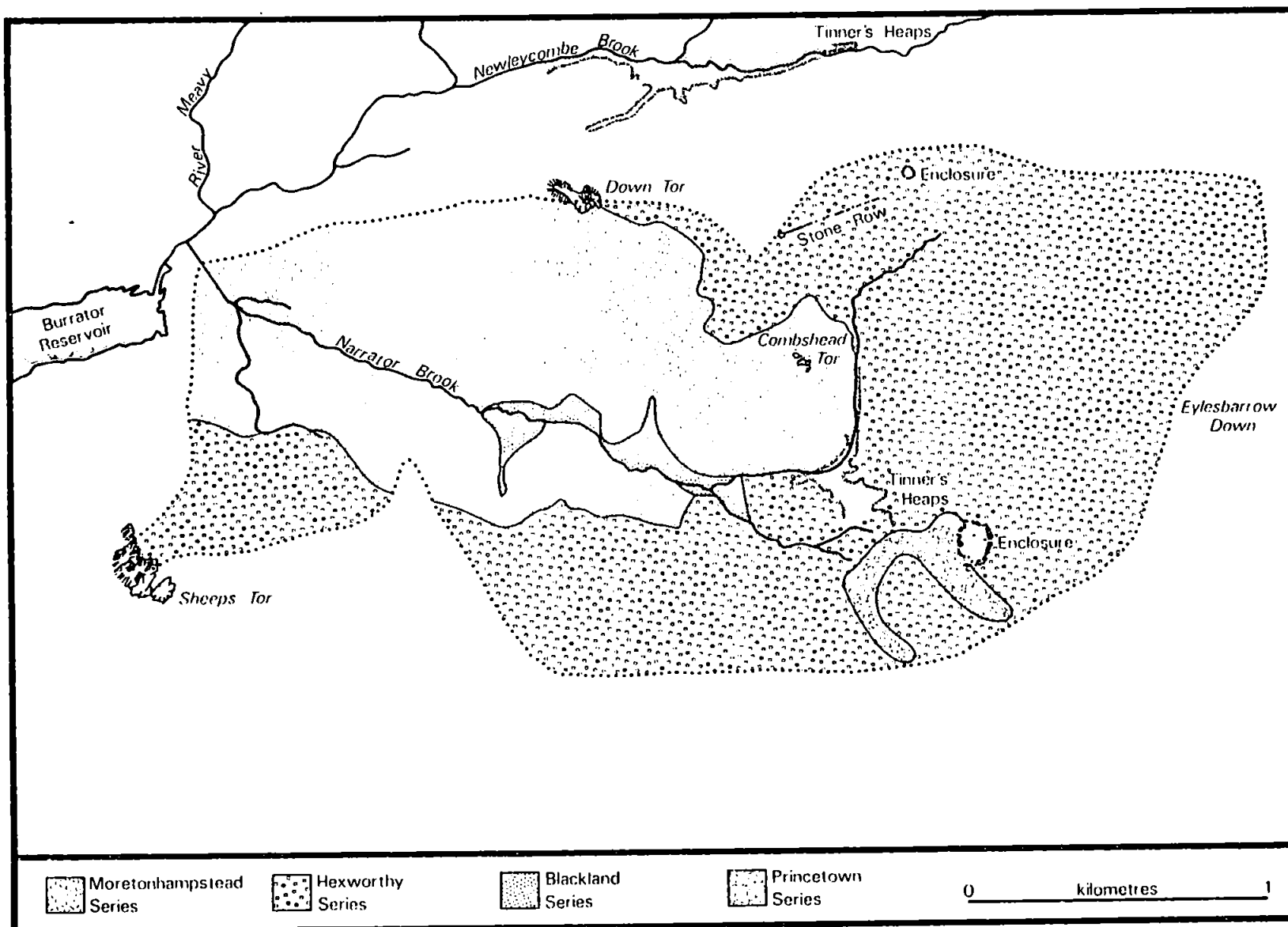


Fig. 2.4. Distribution of soil types in the Narrator catchment

Moretonhampstead series

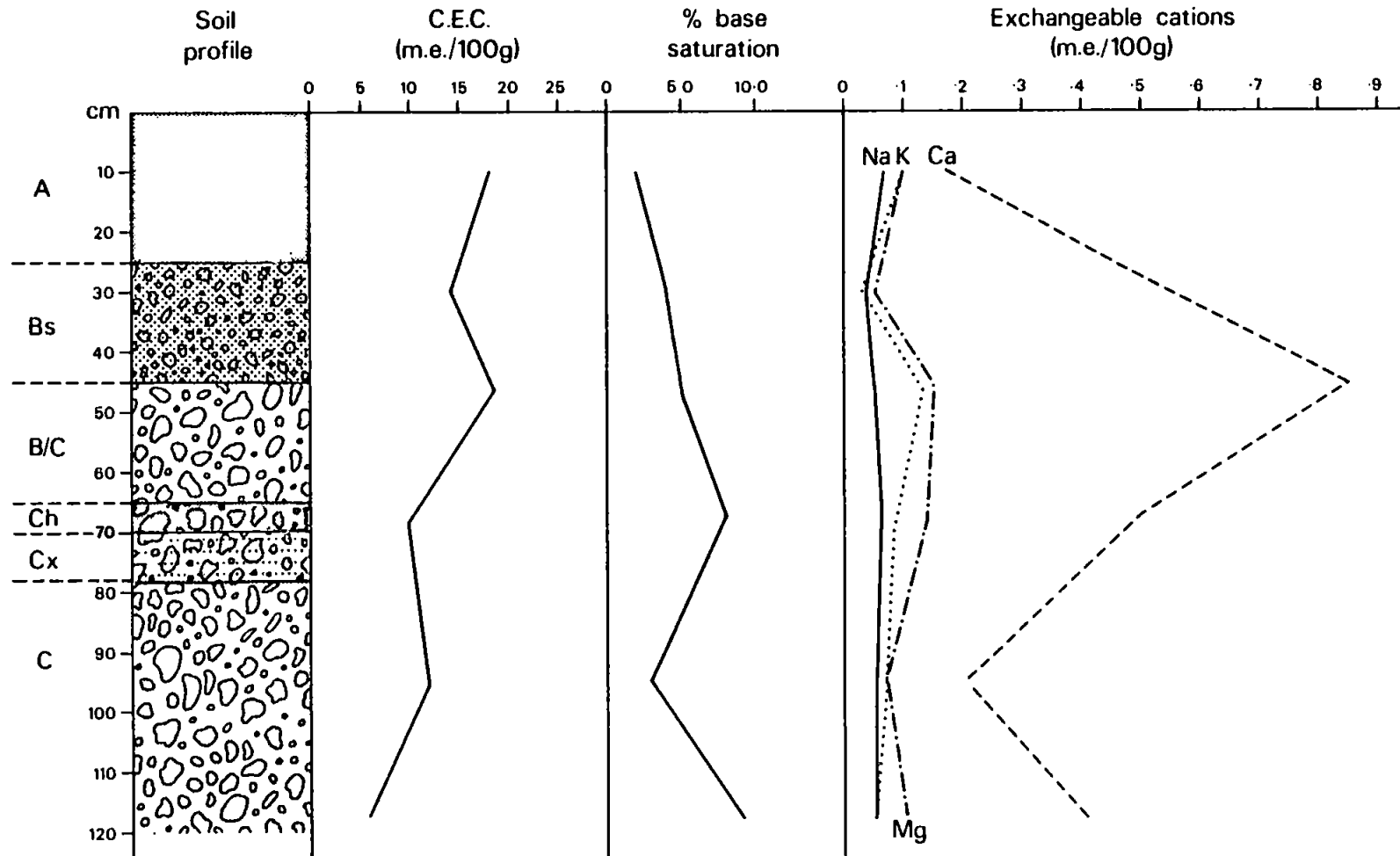


Fig. 2.5a. Cation exchange capacity, per cent base saturation and exchangeable cations of the Moretonhampstead series

Hexworthy series

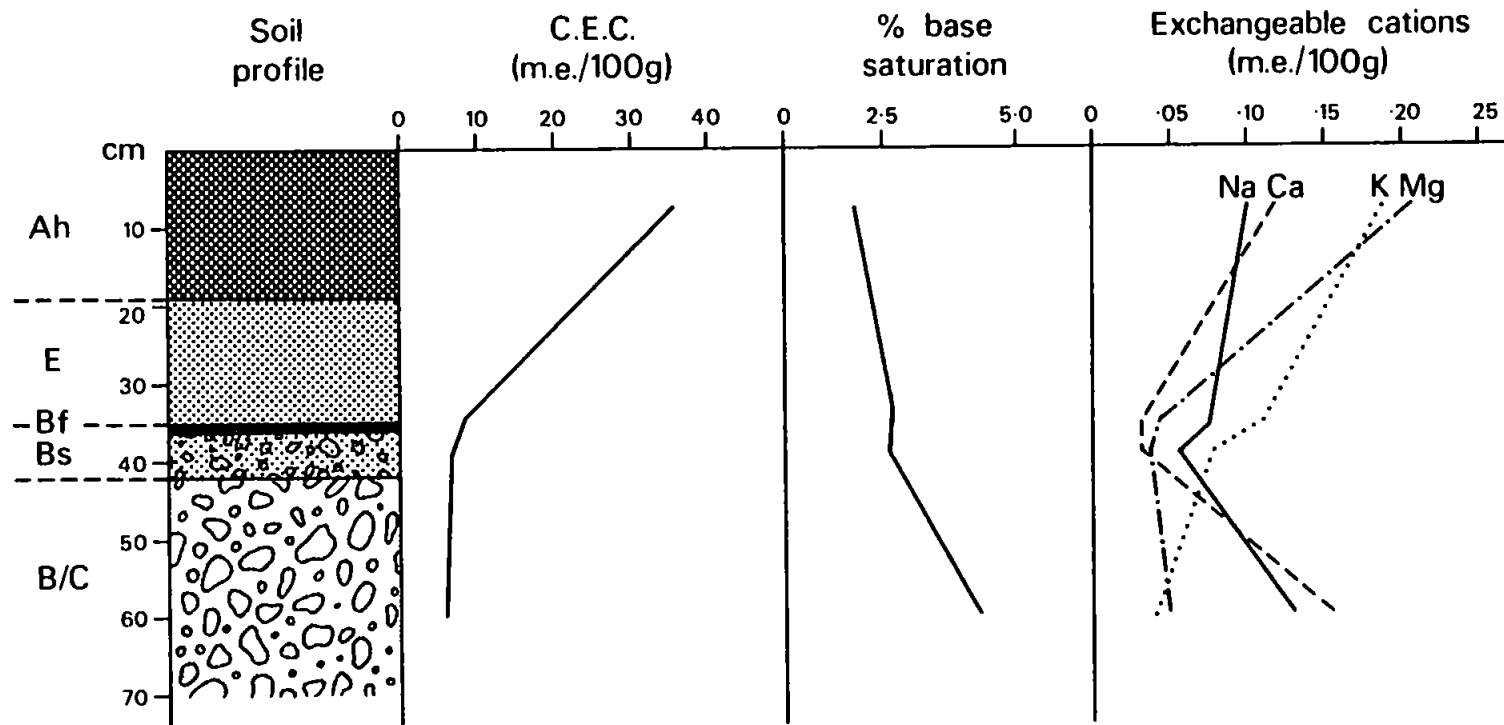


Fig. 2.5b. Cation exchange capacity, per cent base saturation and exchangeable cations of the Hexworthy series

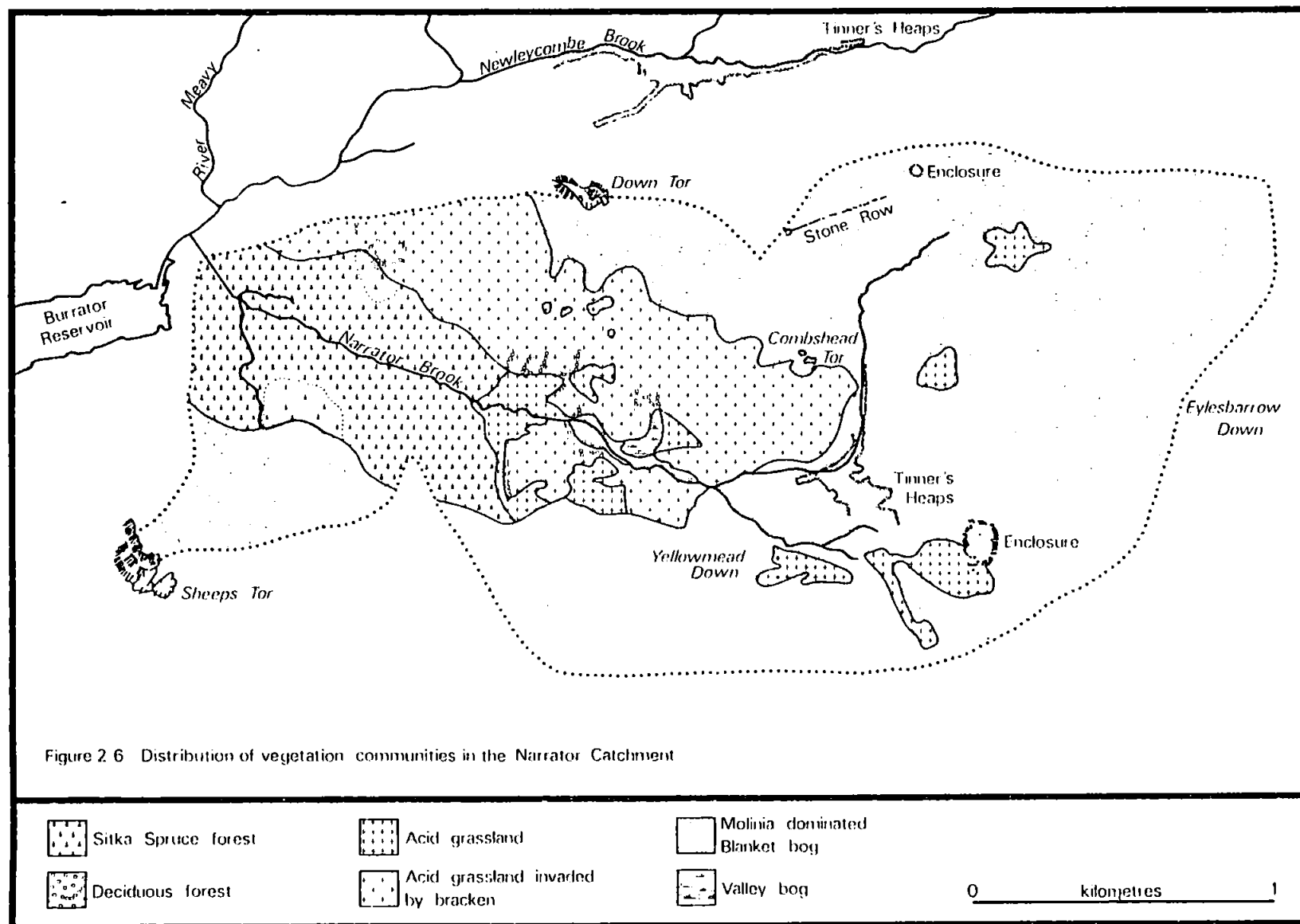
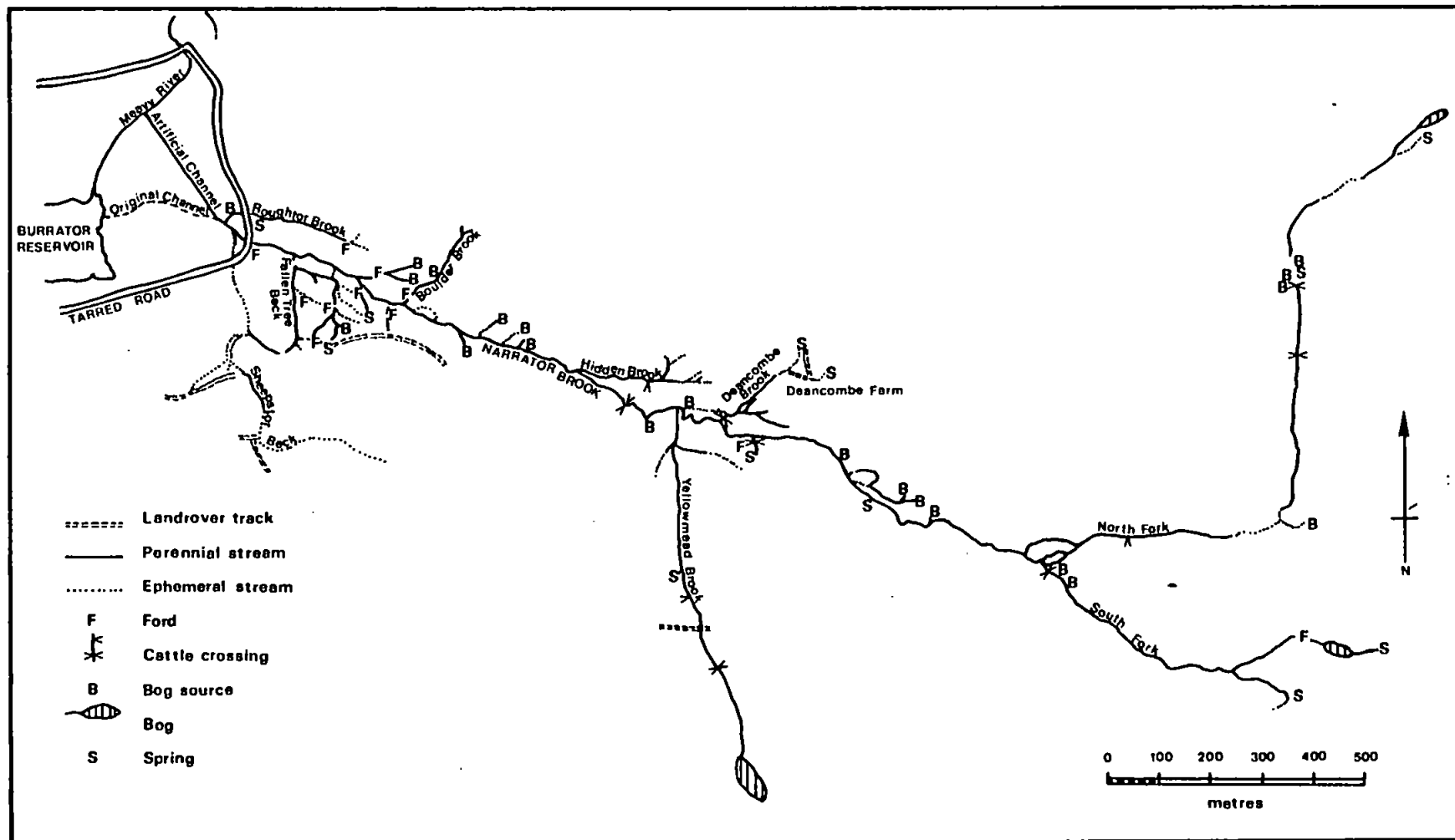


Fig. 2.6. Distribution of the vegetation communities in the Narrator catchment



Drainage net in the Narrator catchment

Fig. 2.7. Drainage net in the Narrator catchment (after Murgatroyd, 1980)

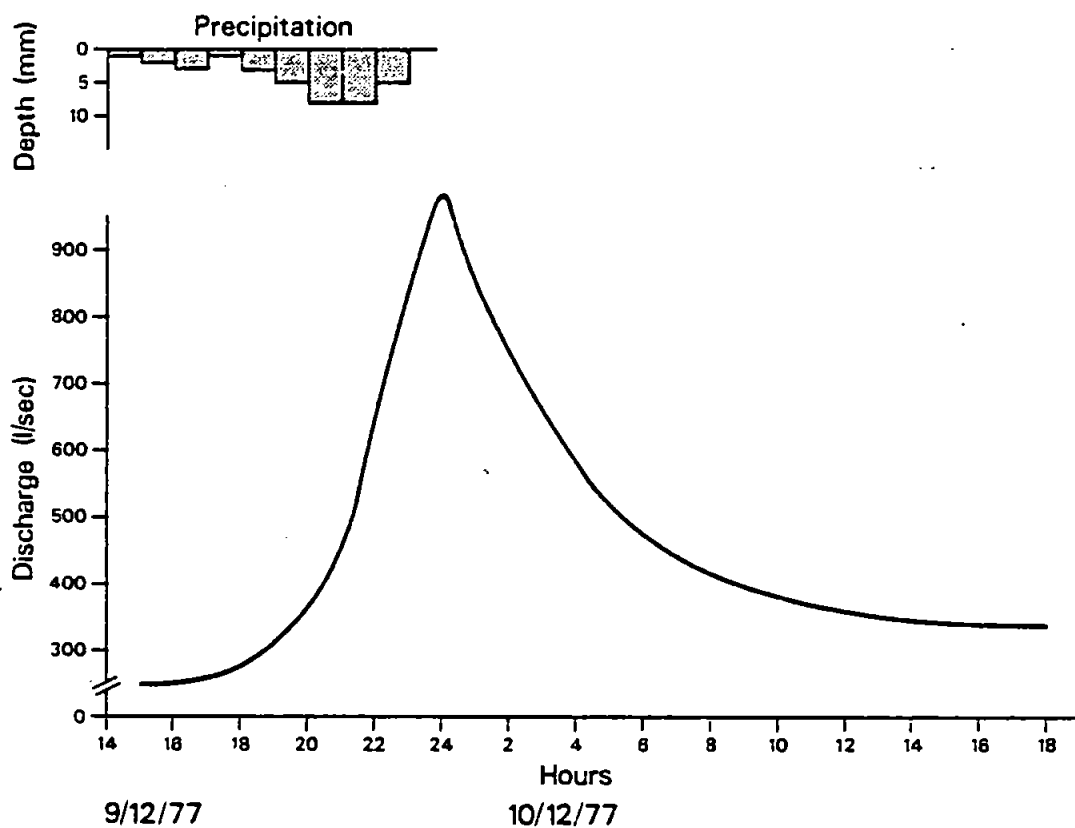


Fig. 2.8. Typical storm hydrograph in the Narrator Brook
(See Figure 8.2, storm 2/5/77)

TOTAL MONTHLY STREAM FLOW AT HEADWEIR

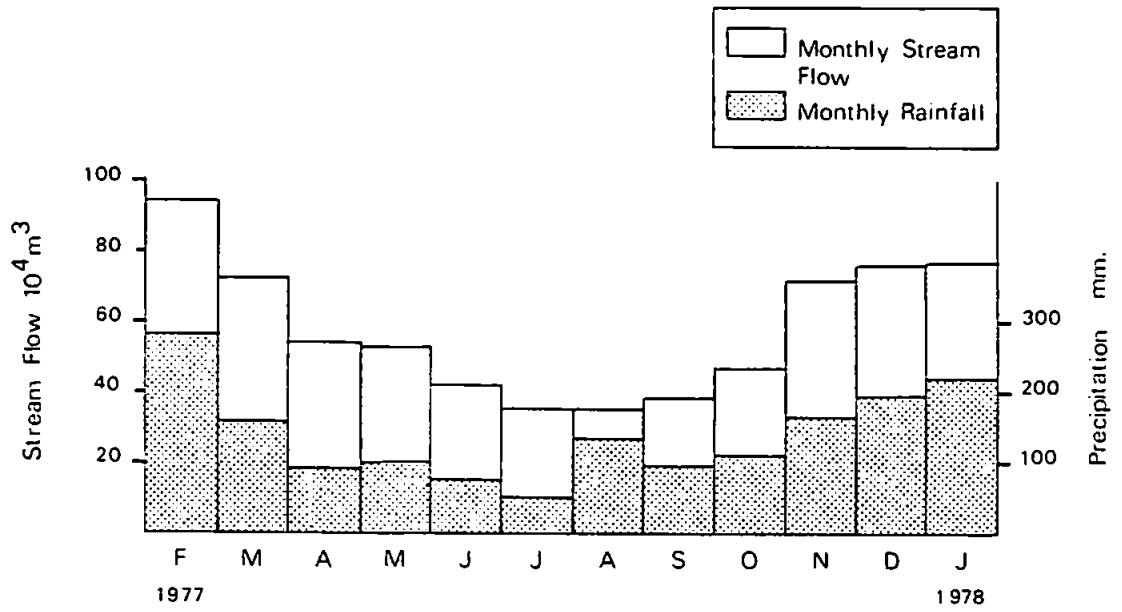
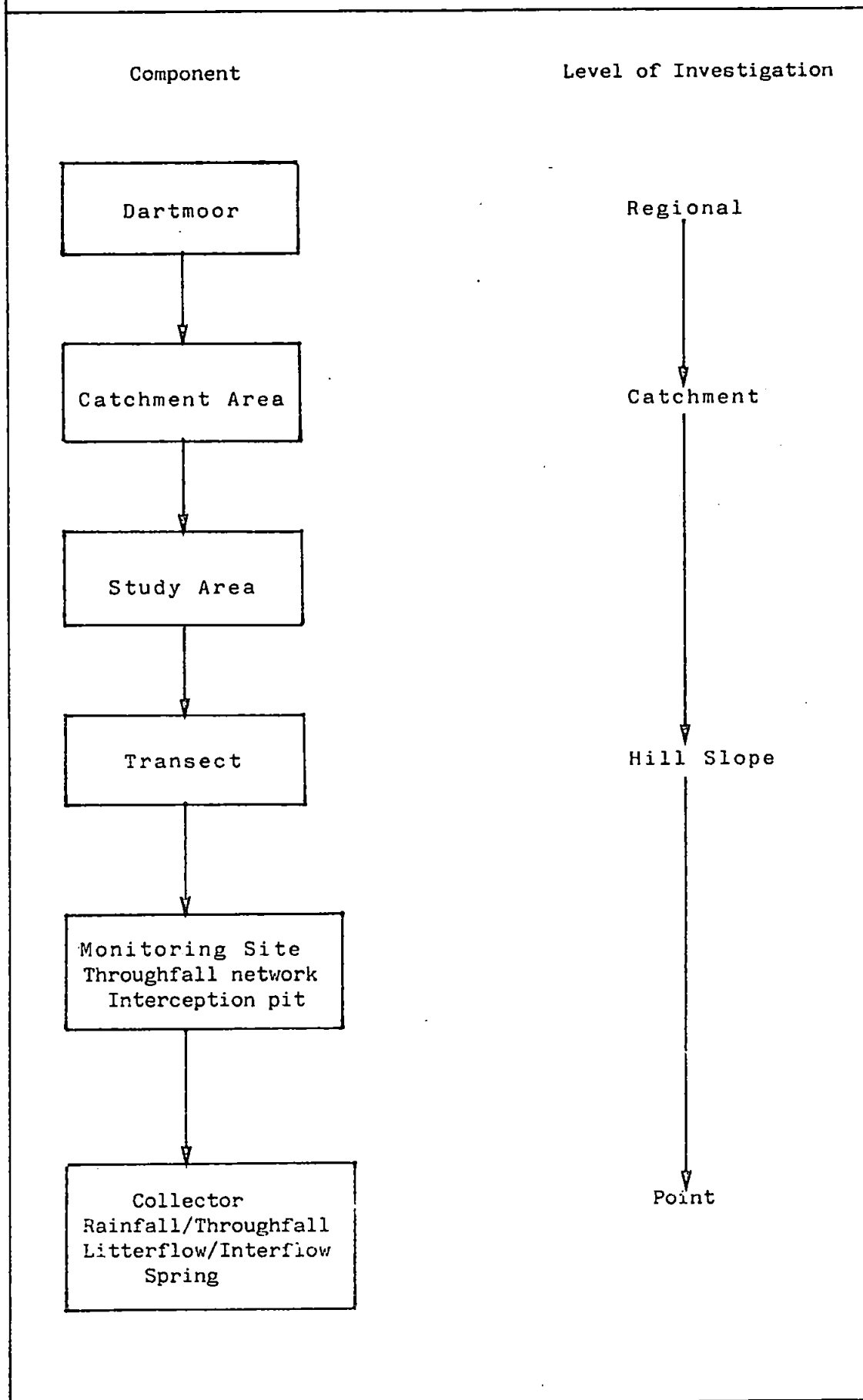


Fig. 2.9. Temporal variation in discharge in the Narrator catchment

Figure 3.1. Research design and the various levels of investigation involved.



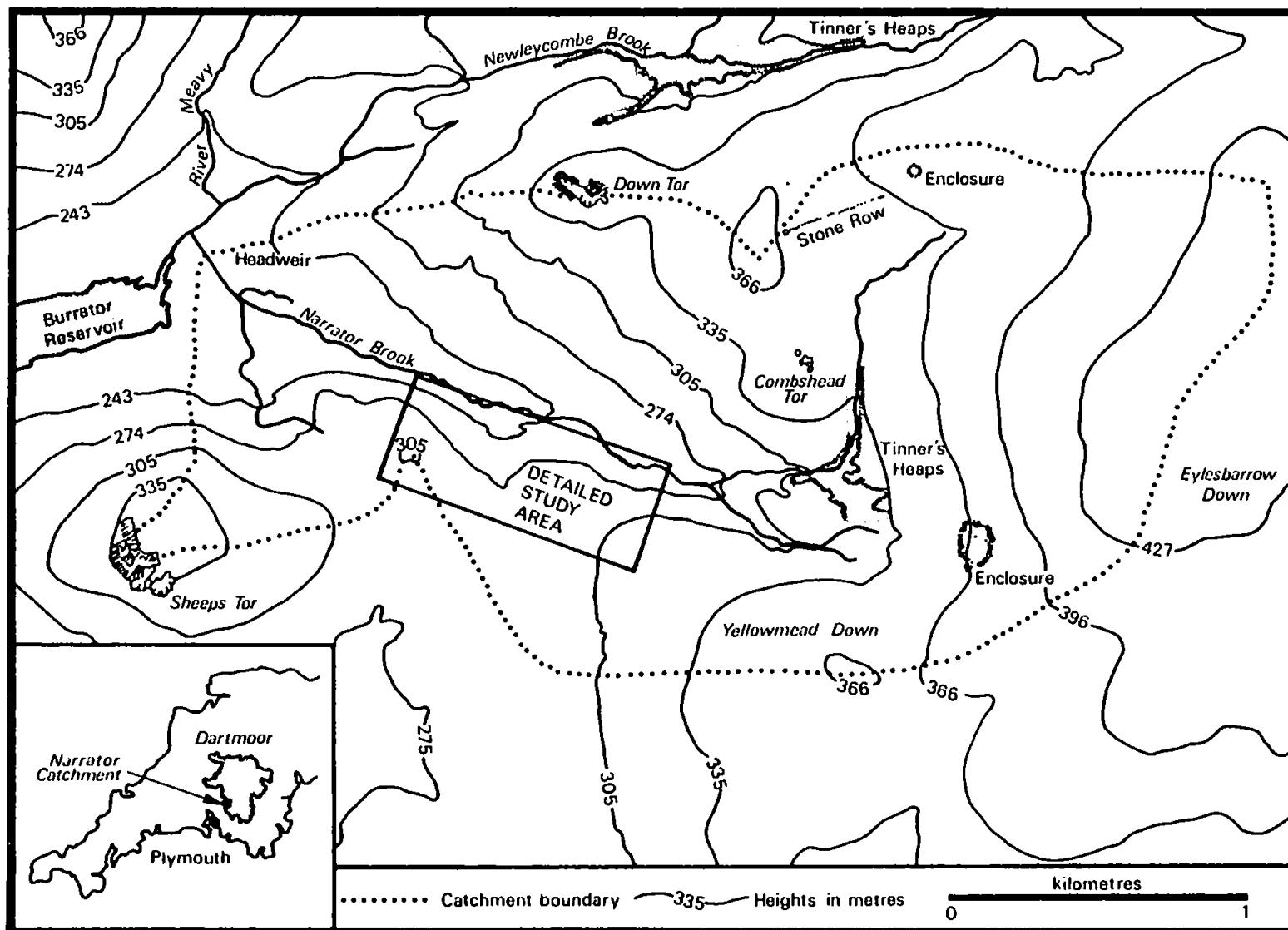


Fig. 3.2. Location of detailed study area in Narrator catchment

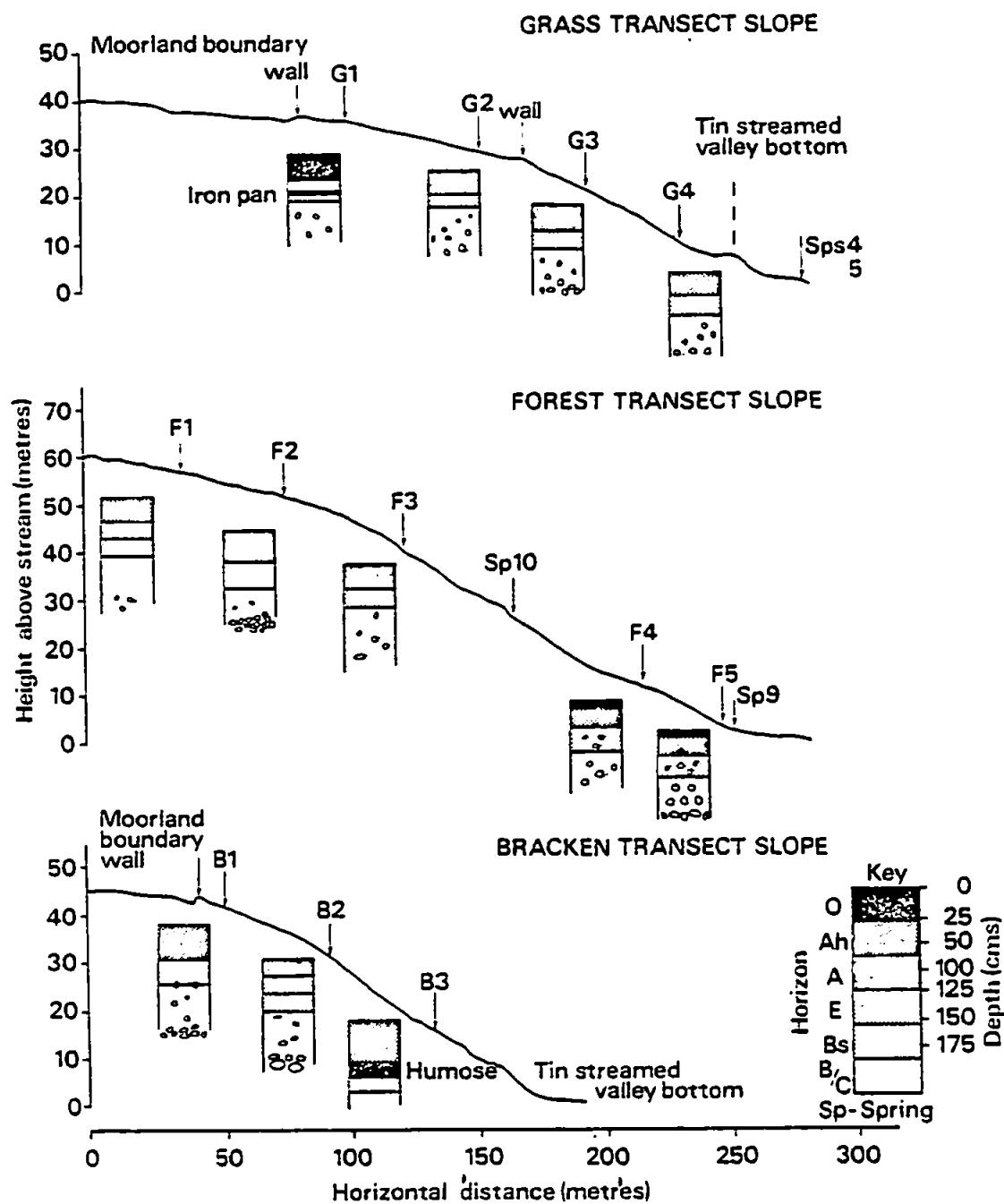


Fig. 3. 3. Three slope profiles showing the position of the interception pits, their soil profiles and the location of nearby springs

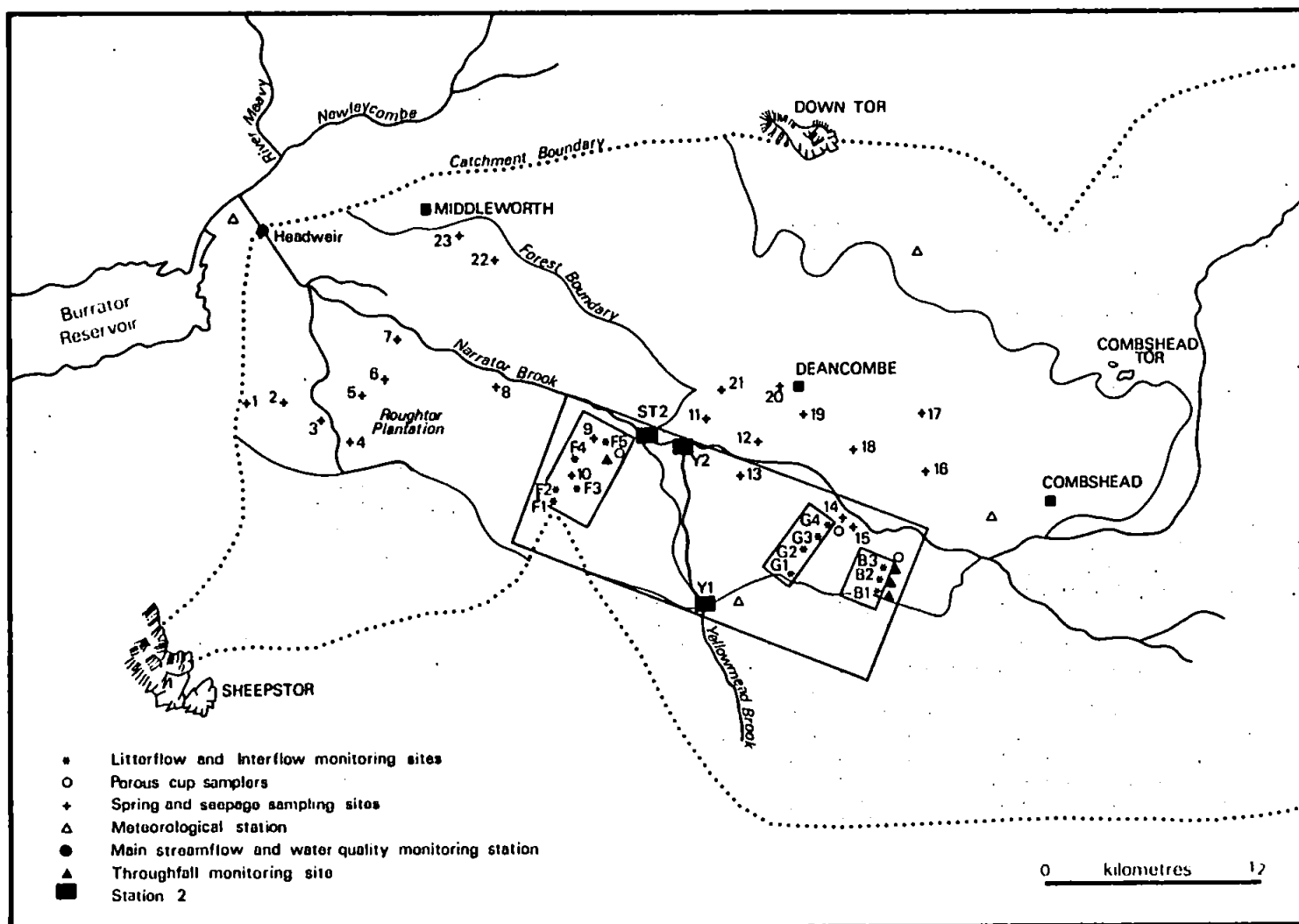
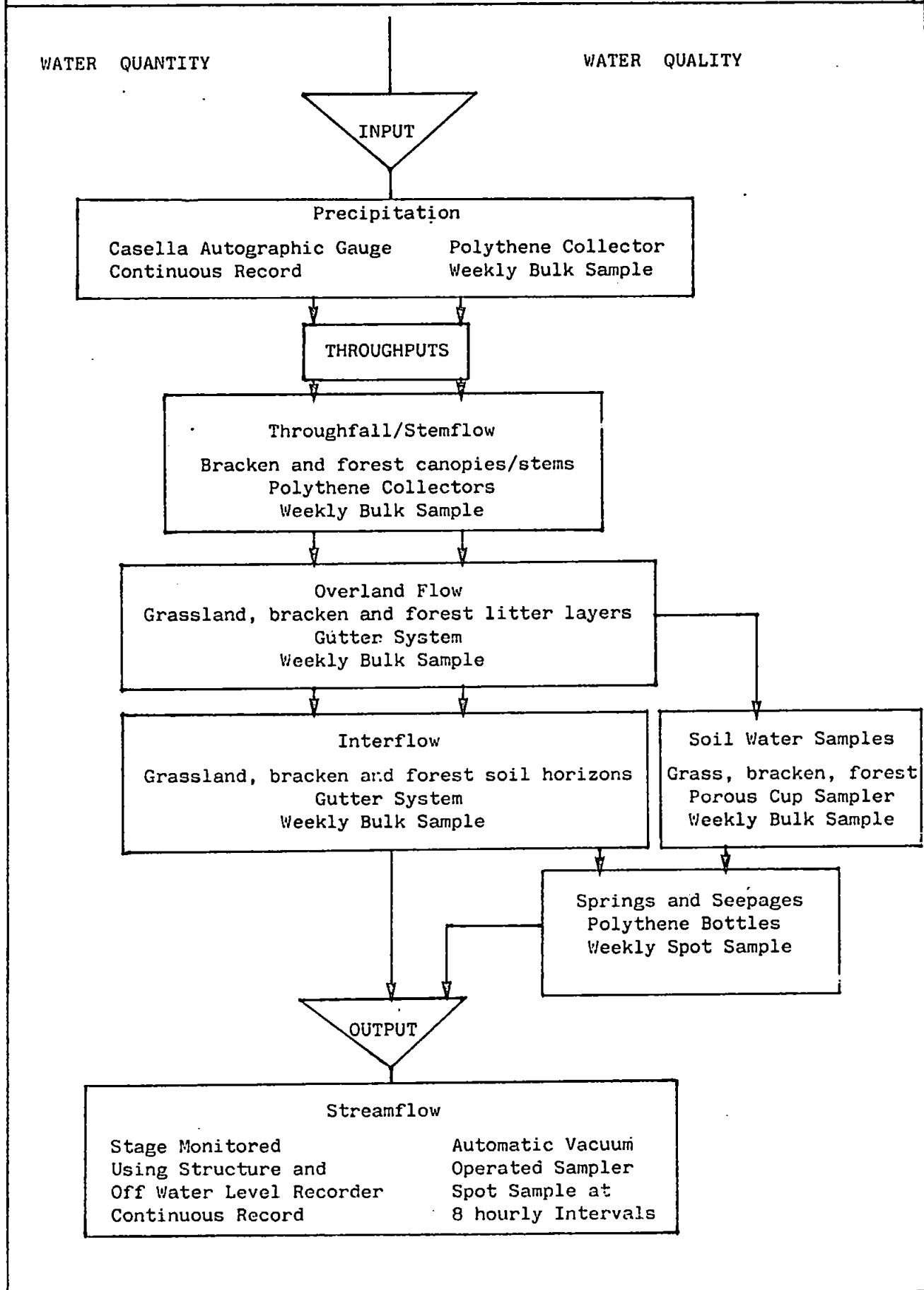


Fig. 3.4. Instrumentation in the Narrator catchment

Figure 3.5⁴. Process monitoring diagram (after Foster, 1977)



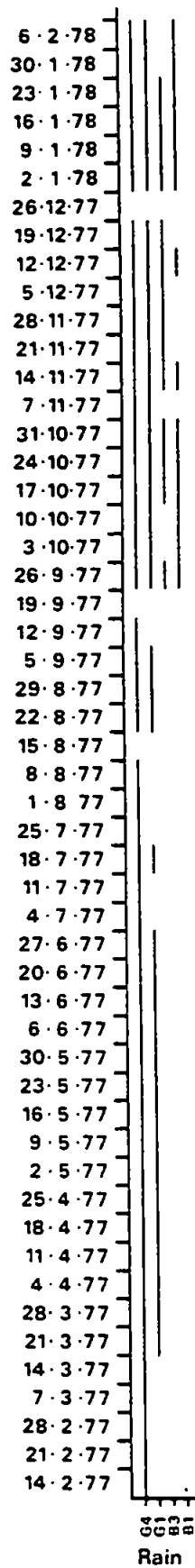


Figure 3.6 Period of operation of bulk precipitation collectors

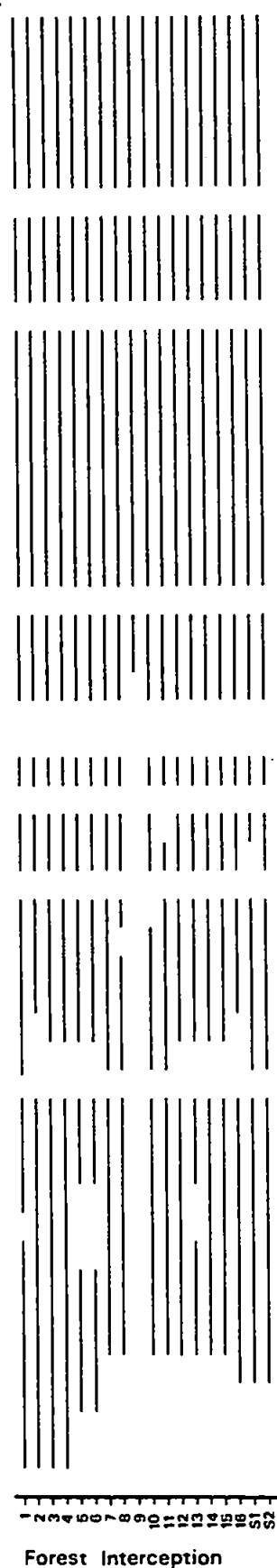


Figure 3.8 Period of operation of throughfall and stemflow collectors beneath silka spruce

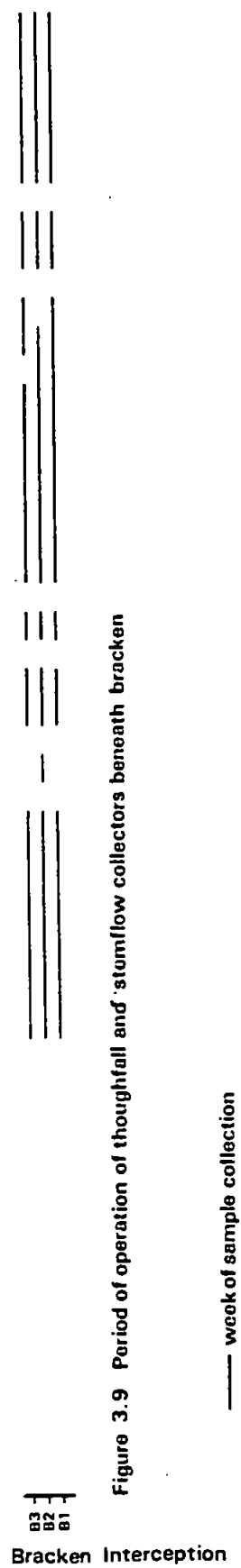


Figure 3.9 Period of operation of throughfall and stemflow collectors beneath bracken

— week of sample collection

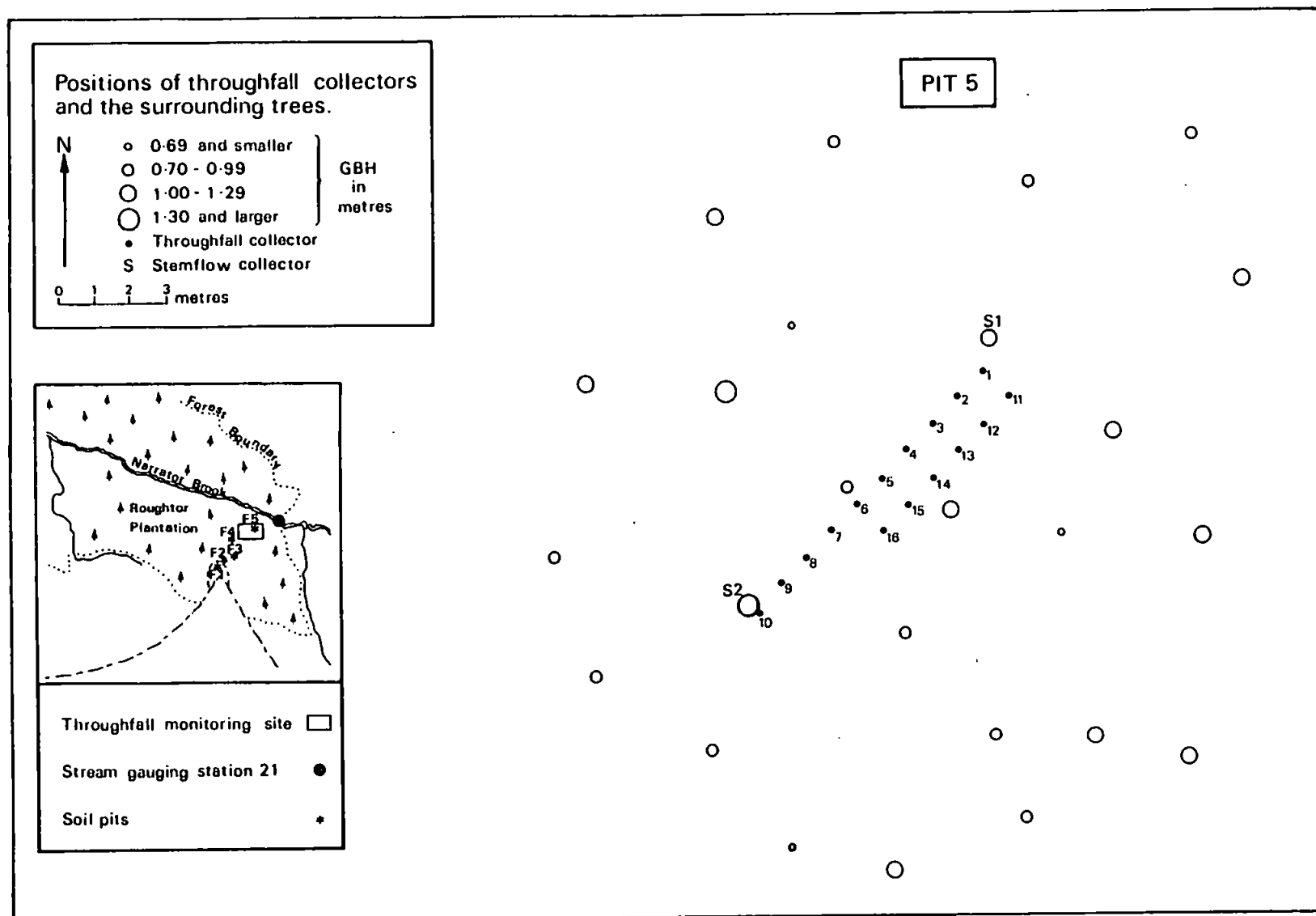
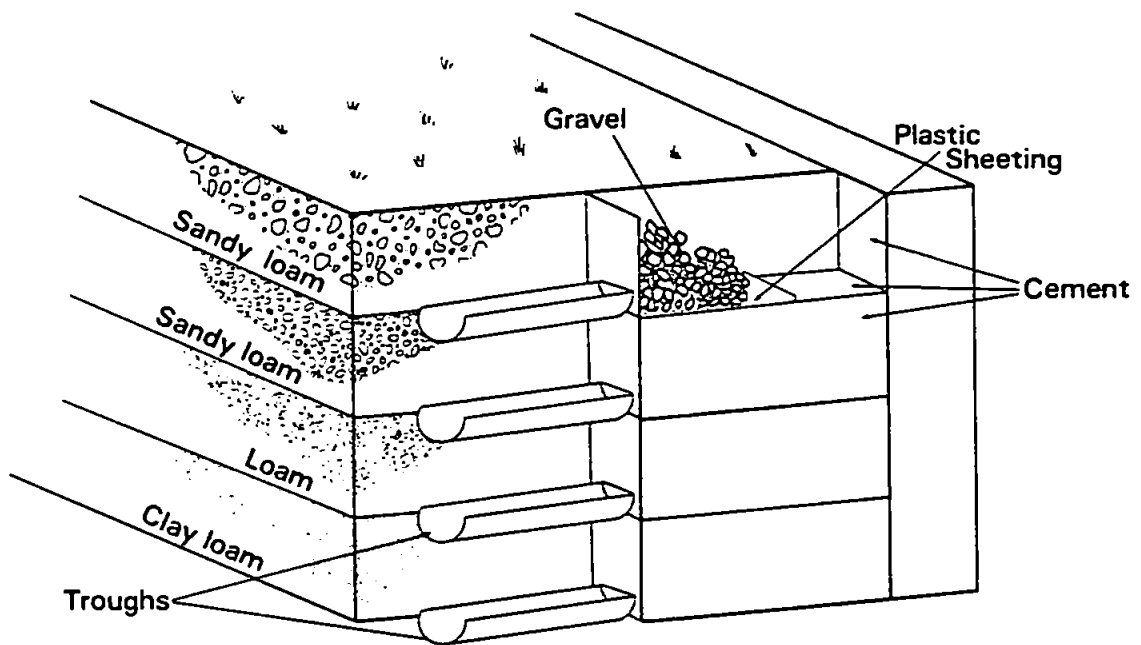


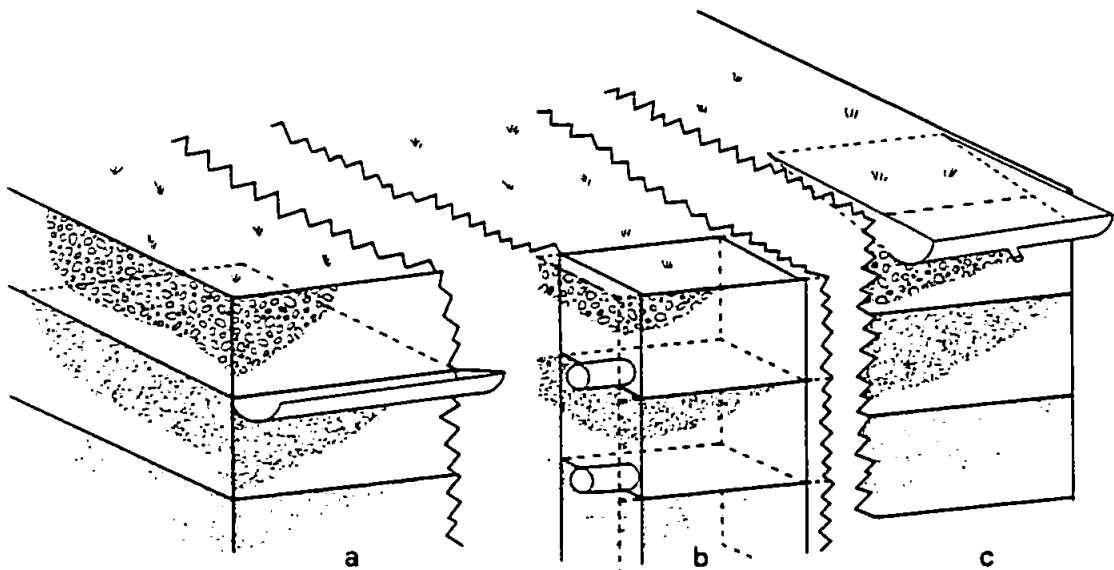
Fig. 3.7. Arrangement of throughfall and stemflow collectors in sitka spruce forest



INTERFLOW GUTTER SYSTEM
(after Whipkey, 1965)

Fig. 3.10. Interflow gutter system (after Whipkey, 1965)

PAN LYSIMETER INSTALLATIONS



- a Pan Lysimeter (Parizek and Lane, 1970)
- b Interflow Trough (Arnett, 1974)
- c Gerlach Trough (Gerlach, 1967; Schick, 1967)

Fig. 3.11a. Pan lysimeter (after Parizek and Lane, 1970)
b. Interflow trough (after Arnett, 1974)
c. Gerlach trough (after Gerlach, 1967; Schick, 1967)

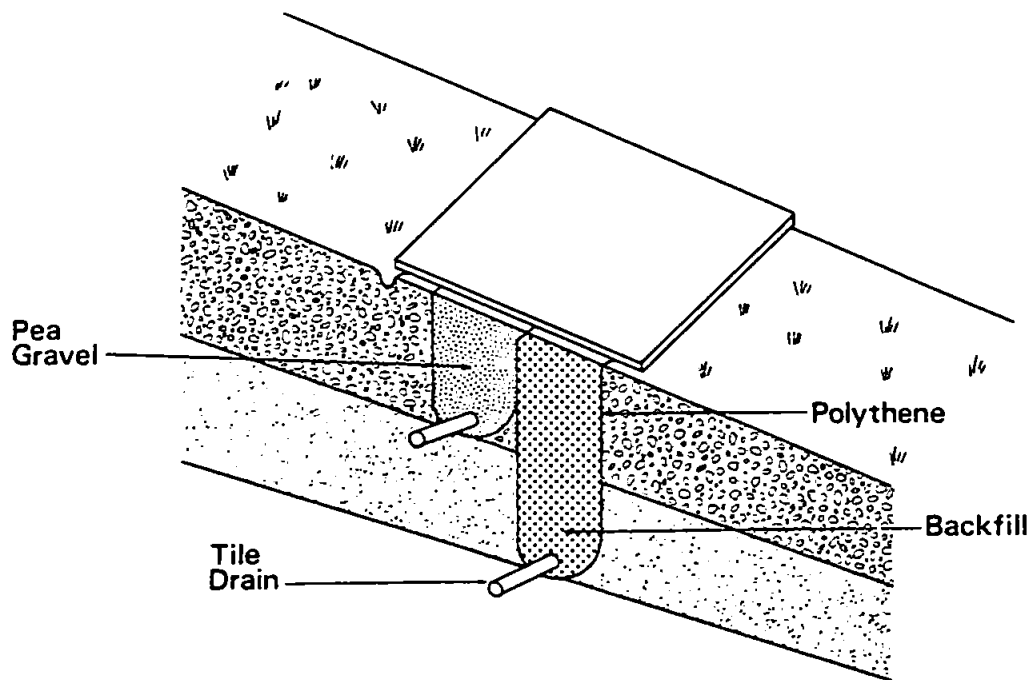


Fig. 3.12. TRENCH SYSTEM (after DUNNE & BLACK, 1970)

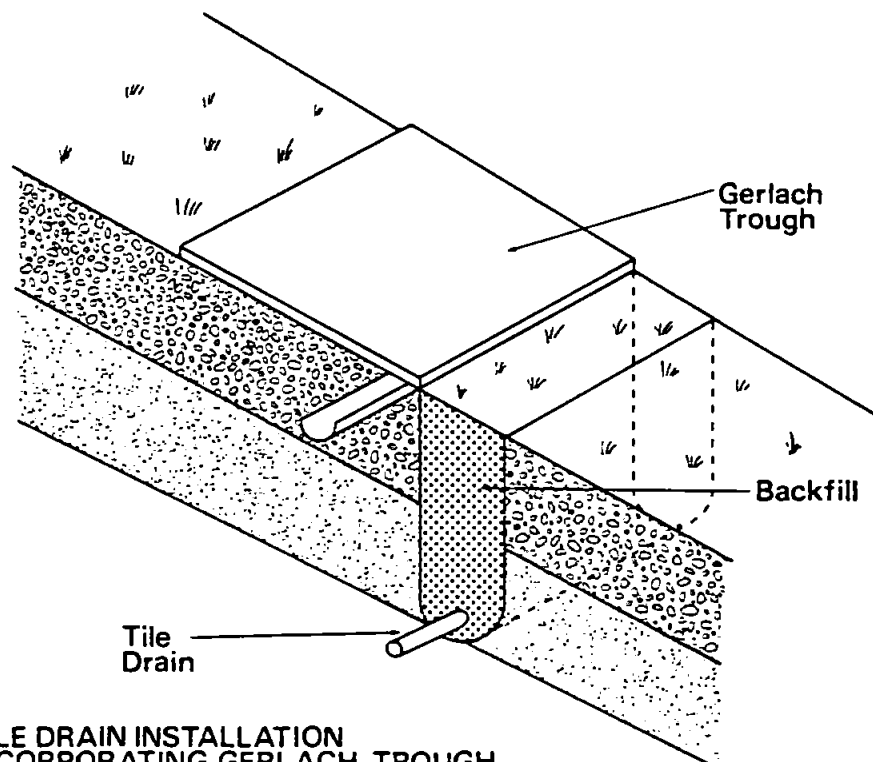
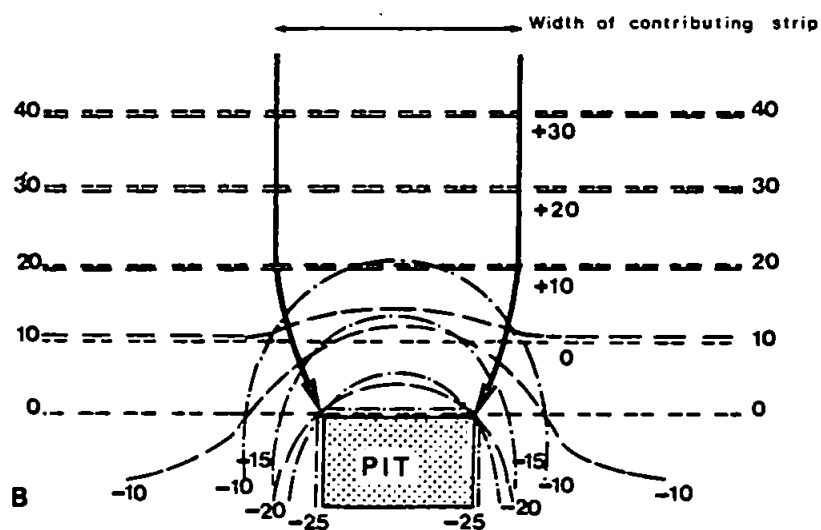
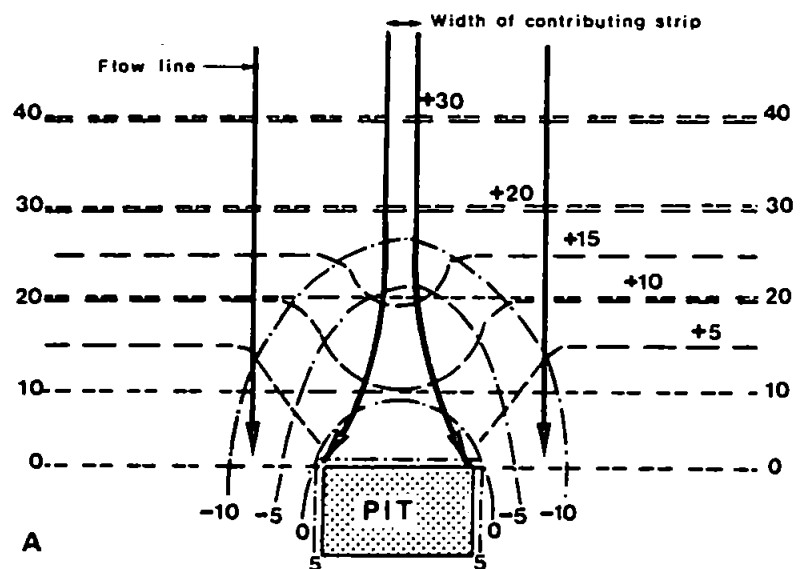


Fig. 3.13. TILE DRAIN INSTALLATION
INCORPORATING GERLACH TROUGH
(F.D.E.U., 1976)



- - - - - Contours of gravitational potential
 — — — — — Contours of total hydraulic potential
 - . - . - Contours of pressure potential

Fig. 3.14. Variations in the pattern of subsurface flow due to the presence of a pit (after Atkinson, 1978)
 a. unsaturated conditions
 b. saturated conditions

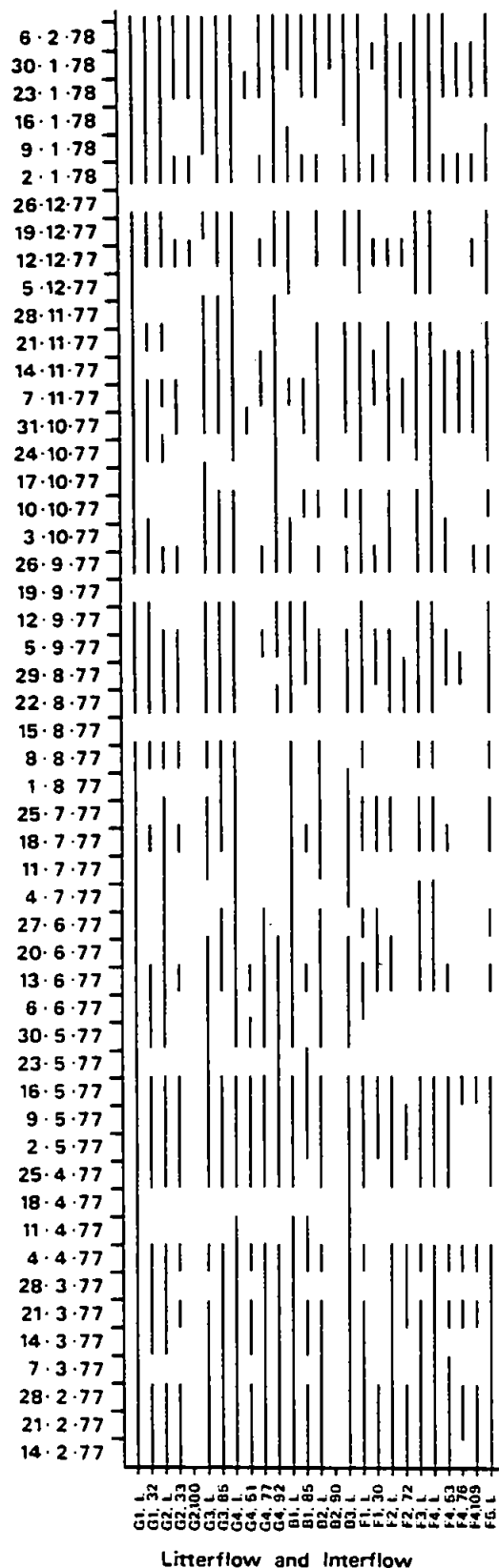


Figure 3.15 Period of operation of litterflow and interflow collectors



Figure 3.16 Period of operation of porous cup water samplers

— week of sample collection

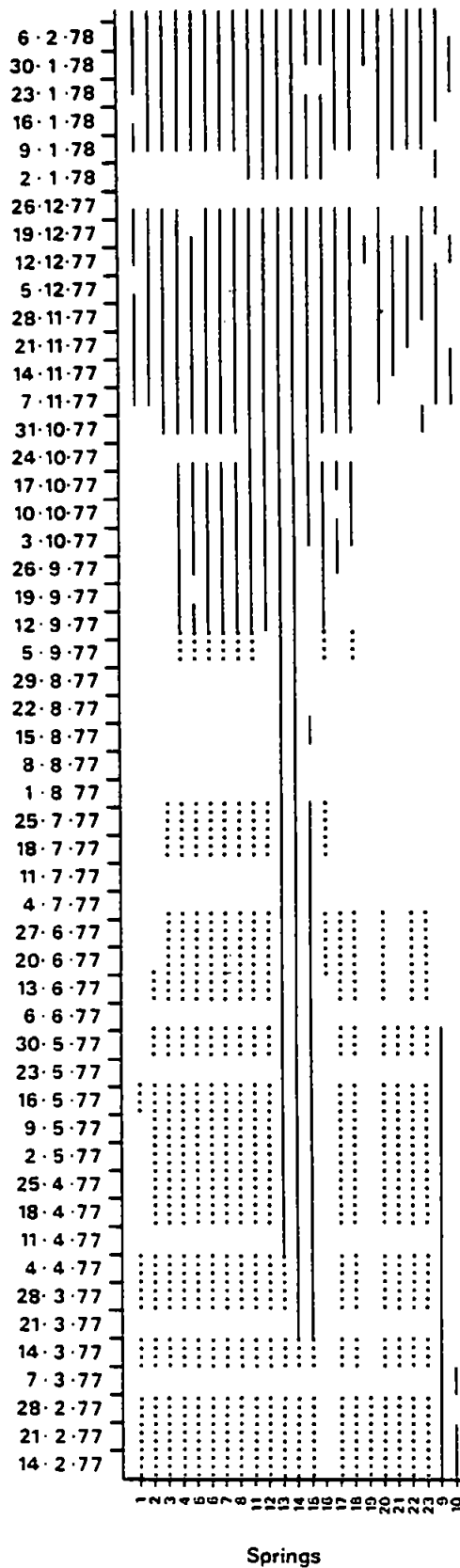


Figure 3.17 Period of monitoring the springs (..... Temperature, conductivity, pH and silica
 ——— Temperature, conductivity, pH and all the ions)

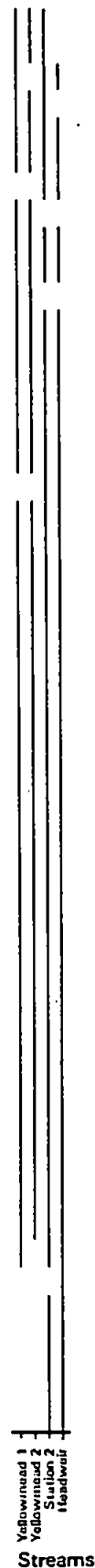
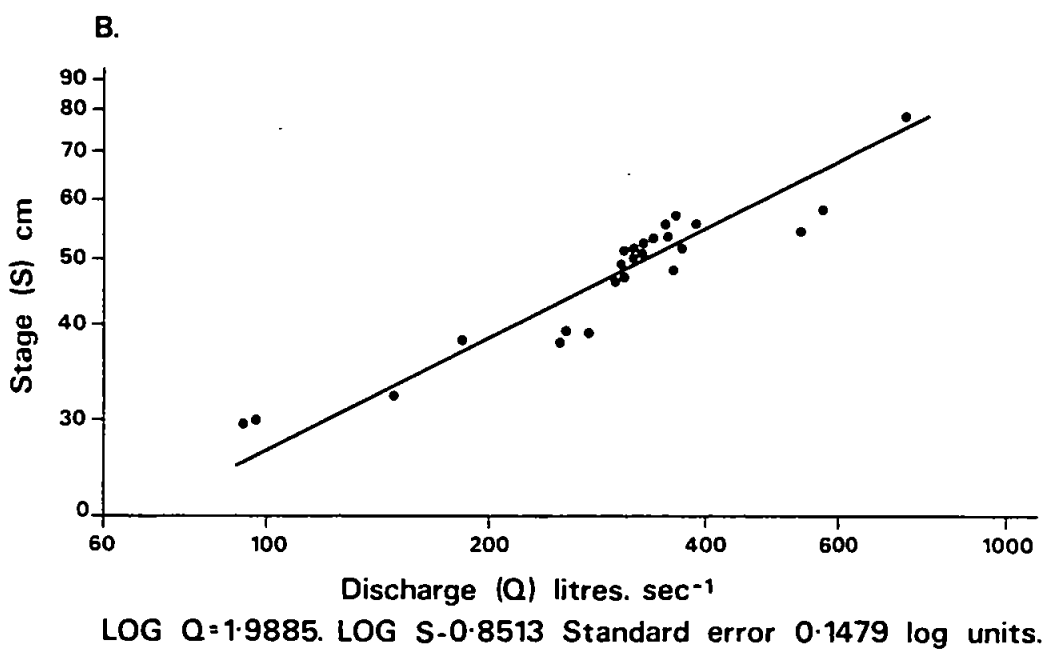
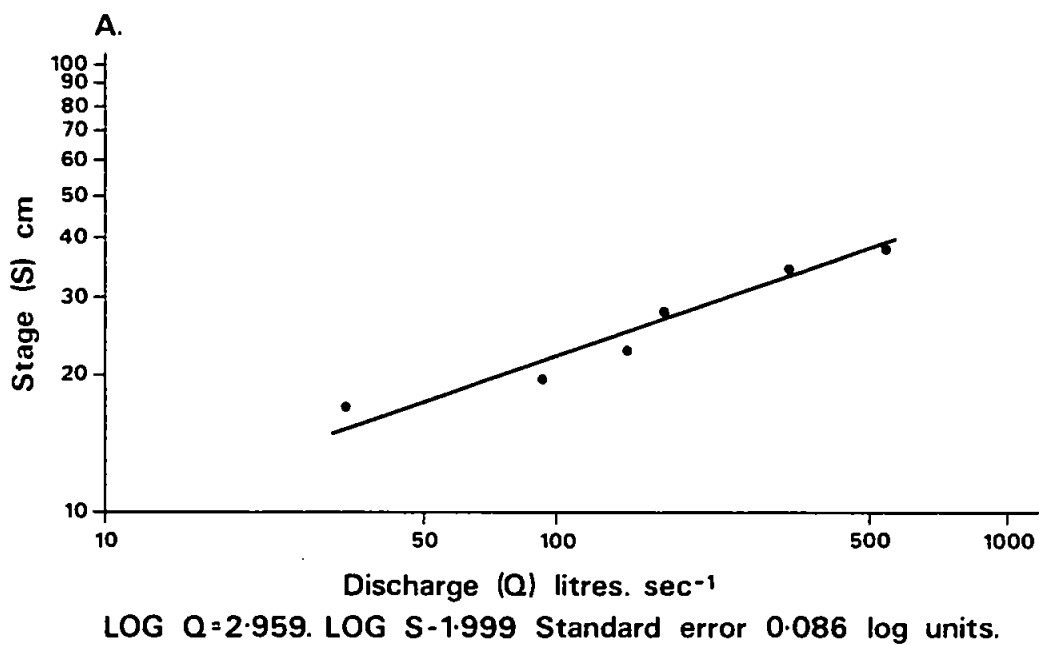


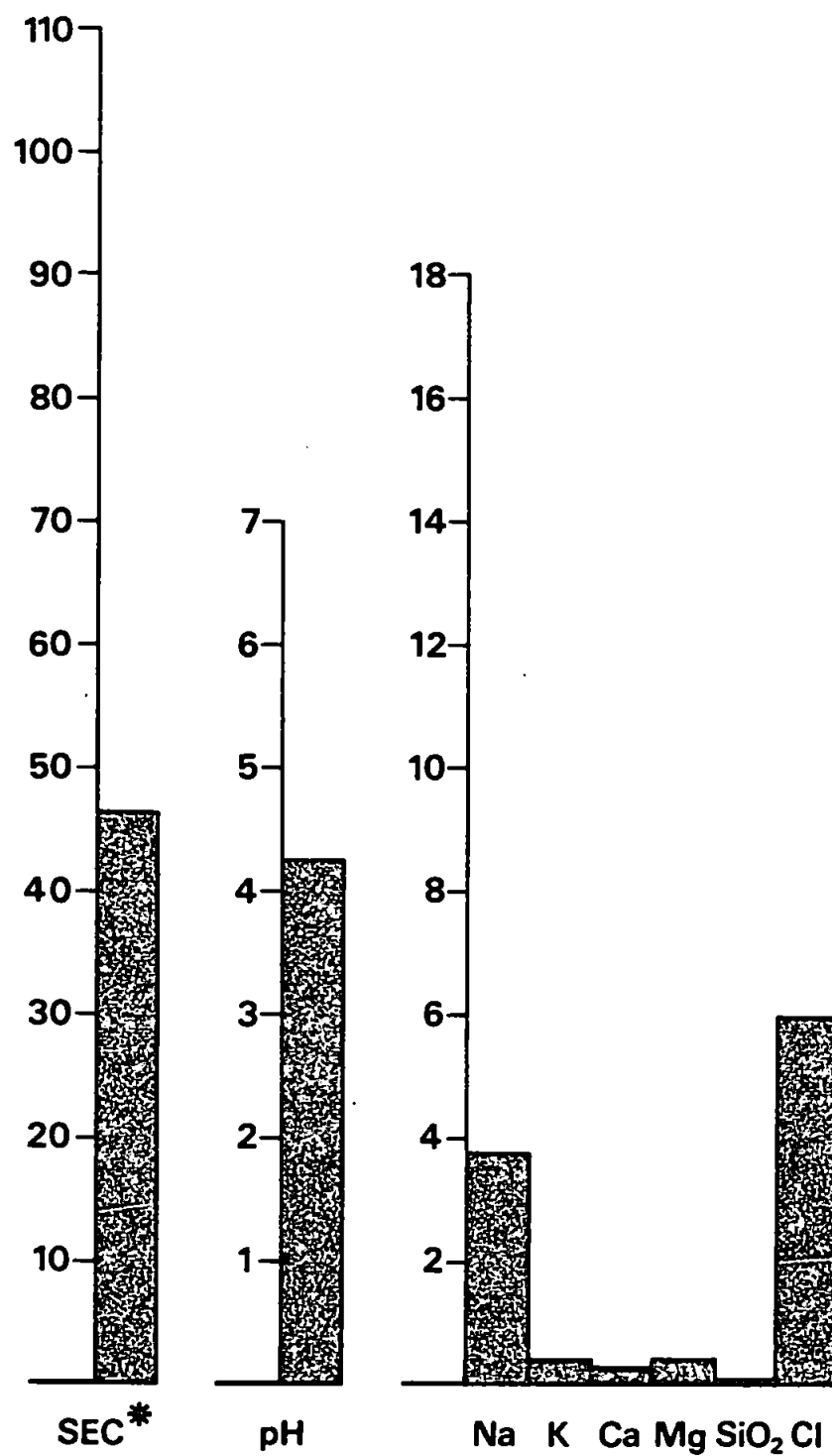
Figure 3.19 Period of monitoring of Yellowmead Brook (weekly samples) and Narrator Brook (daily samples)

—— week of sample collection



A: Station 2
B: Headweir

Fig. 3.18. Stage discharge relationships for the two gauging stations in the Narrator Brook
a. Station 2
b. Headweir



*Unweighted mean

Fig. 4.1. Mean weighted solute concentration in bulk precipitation

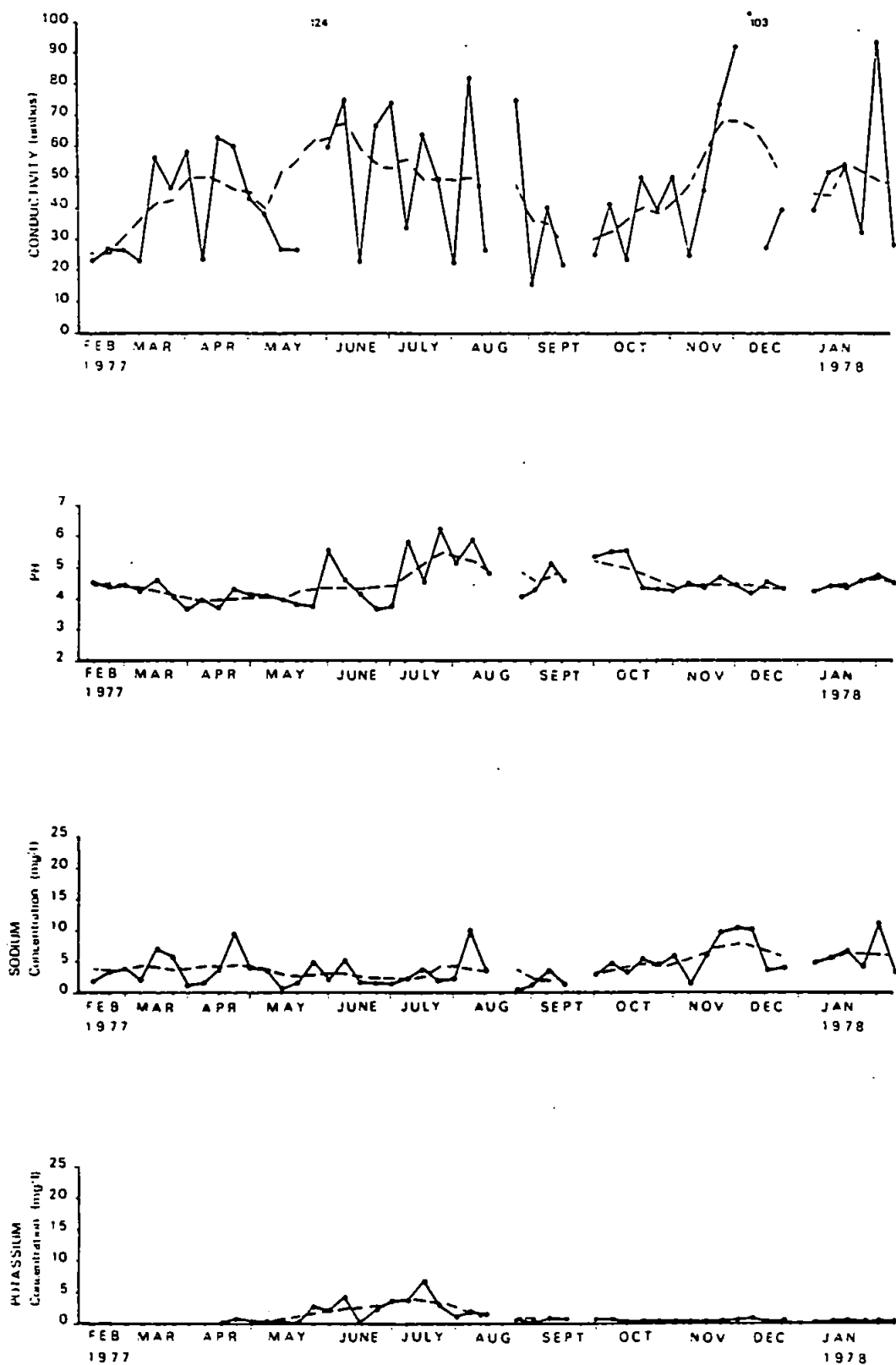


Fig.4.2. Temporal variation in bulk precipitation chemistry

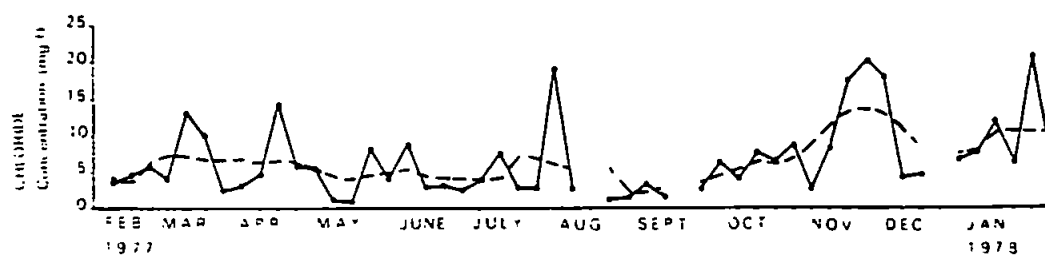
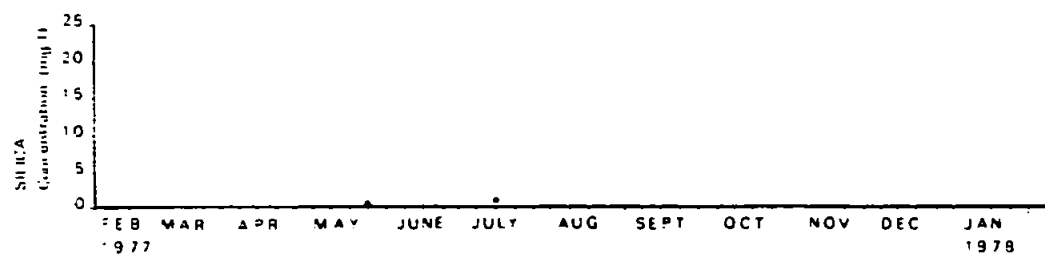
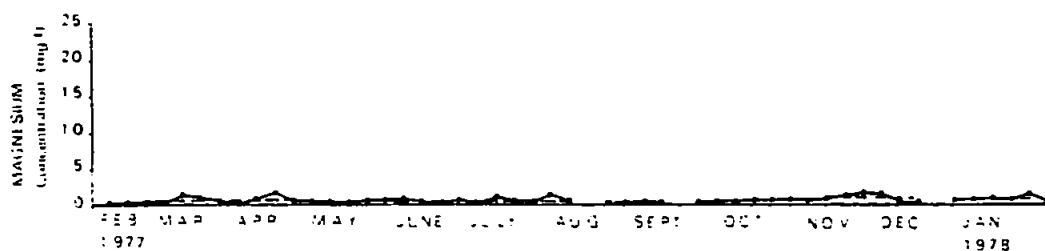
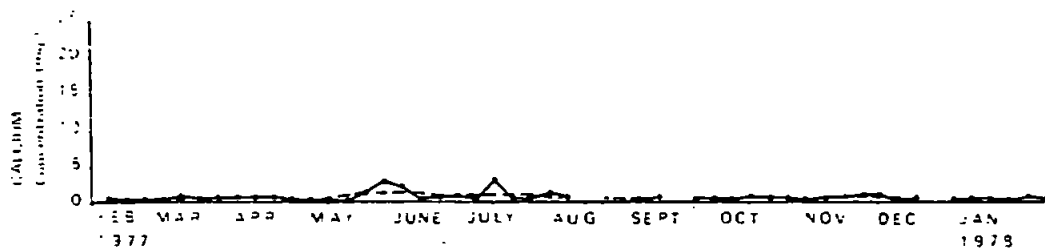
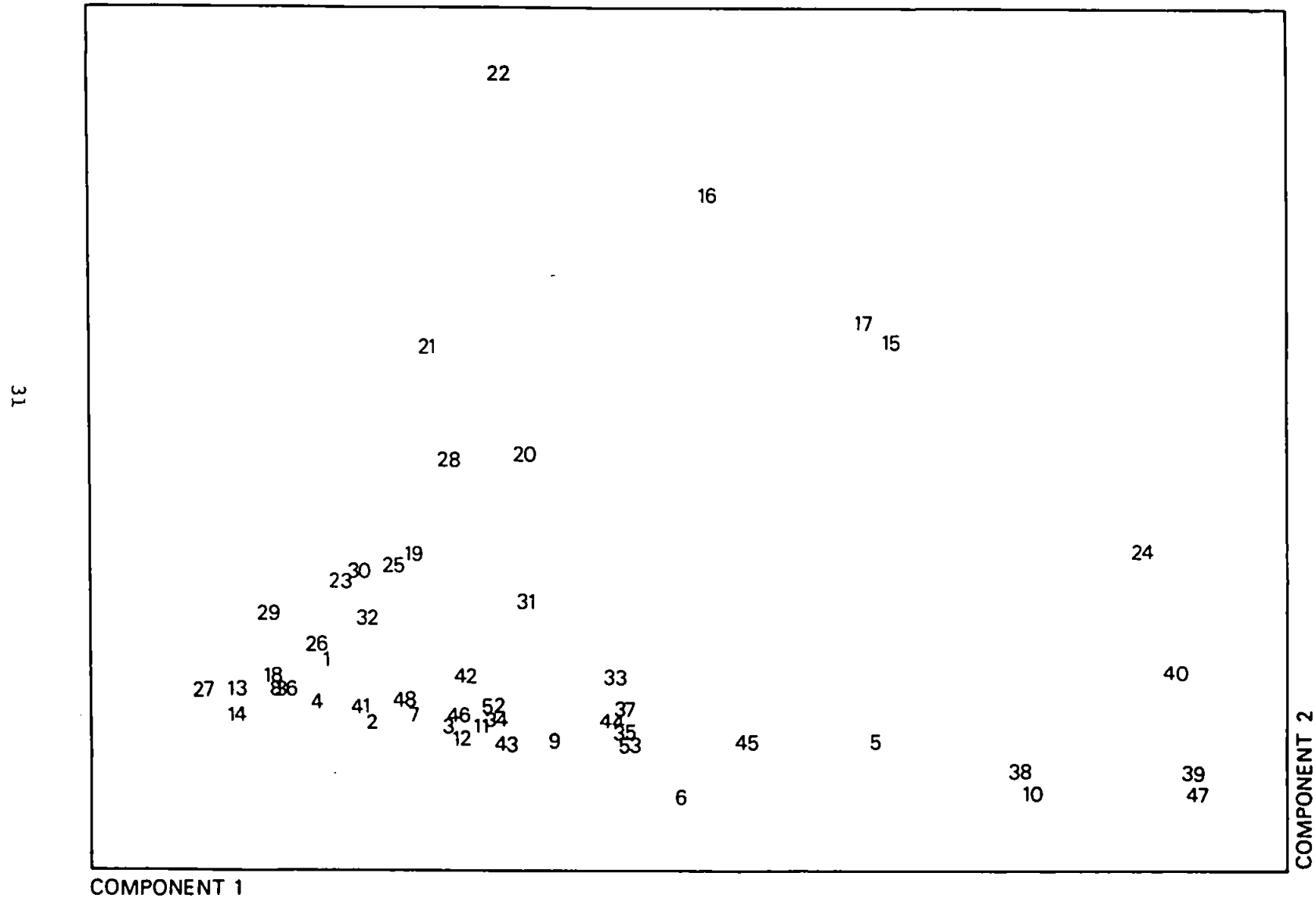


Fig.4.2. (continued)

PRINCIPAL COMPONENTS ANALYSIS OF RAINFALL CHEMICAL DATA



COMPONENT 1

Fig. 4.3

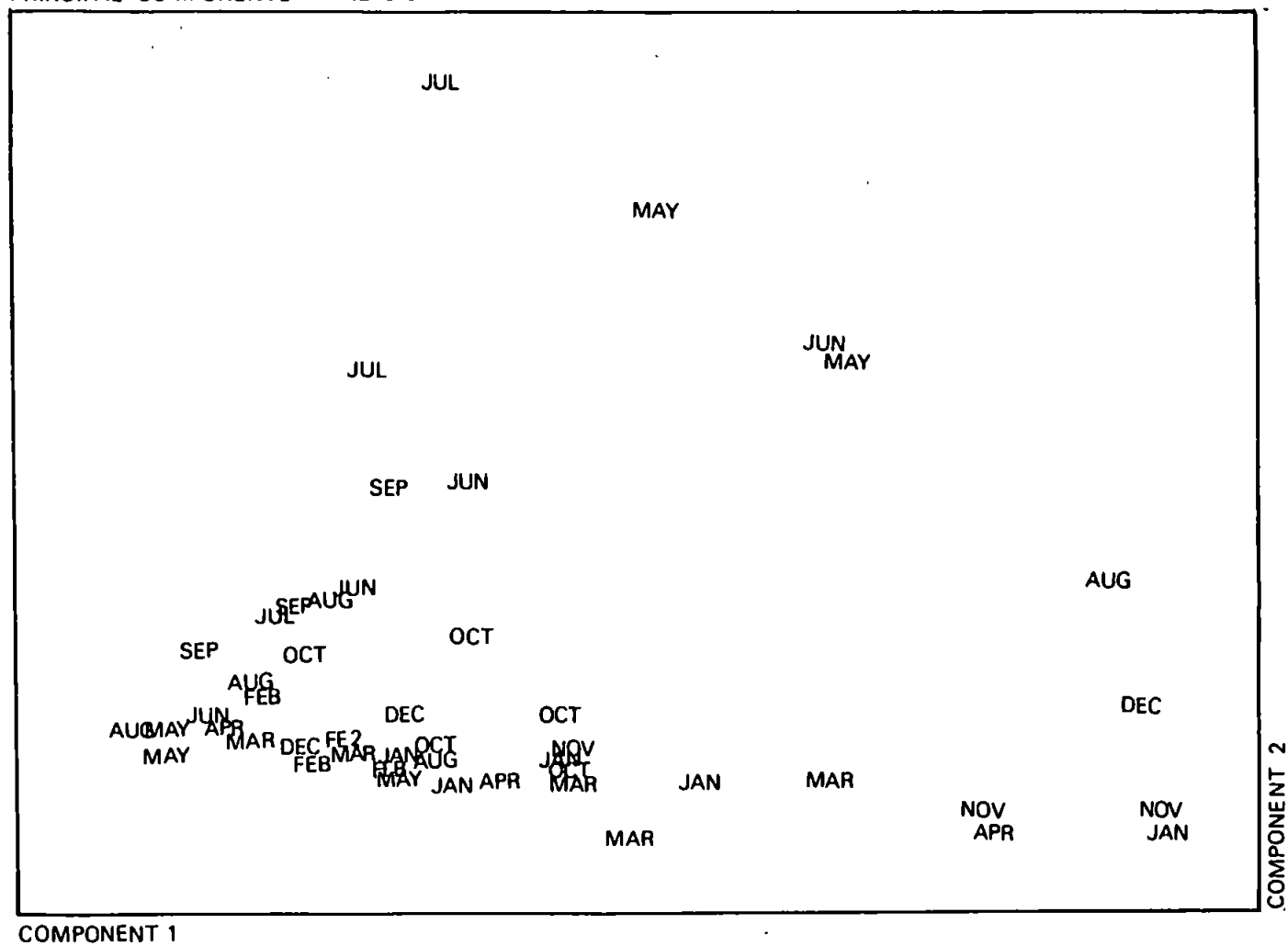


Fig.4.3. Principal components analysis of rainfall chemical data

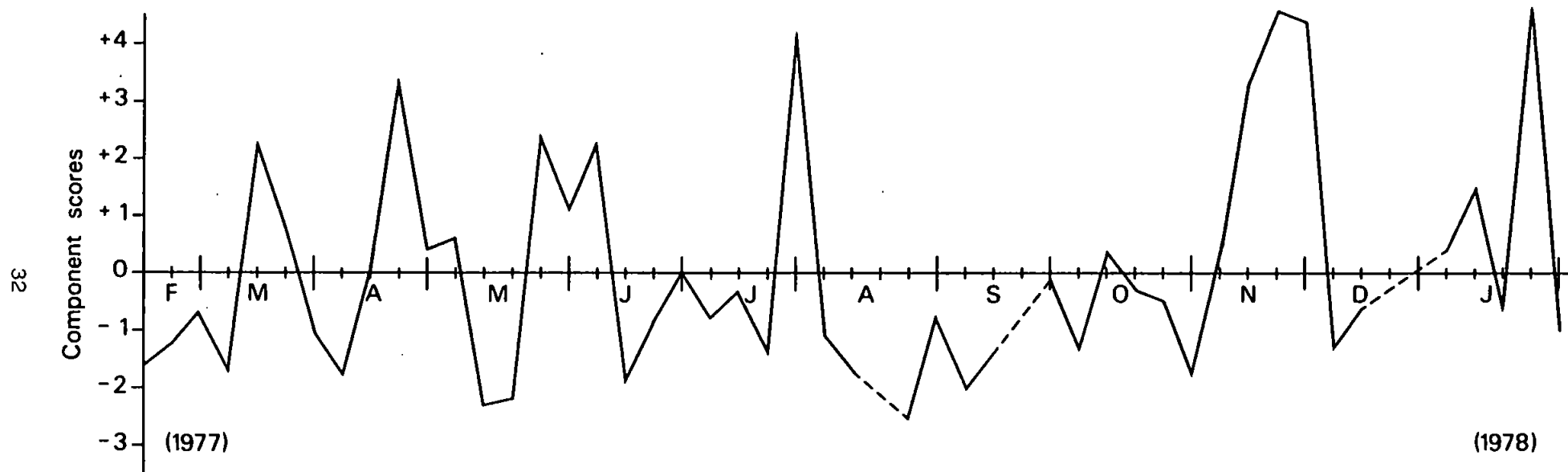
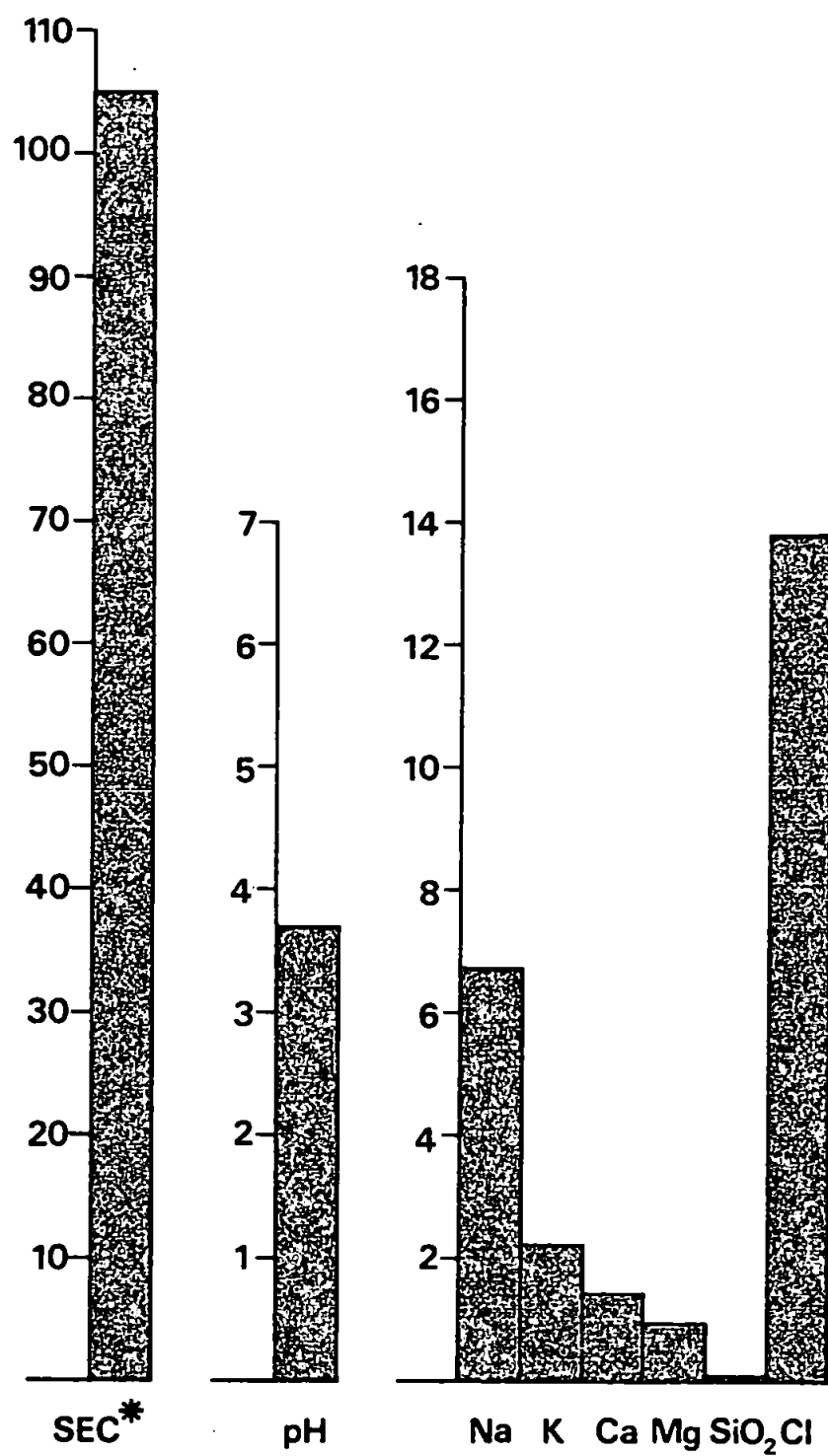


Fig. 4.4. Temporal change in component I scores of bulk precipitation



*Unweighted mean

Fig. 4.5. Mean weighted solute concentrations in sitka spruce throughfall

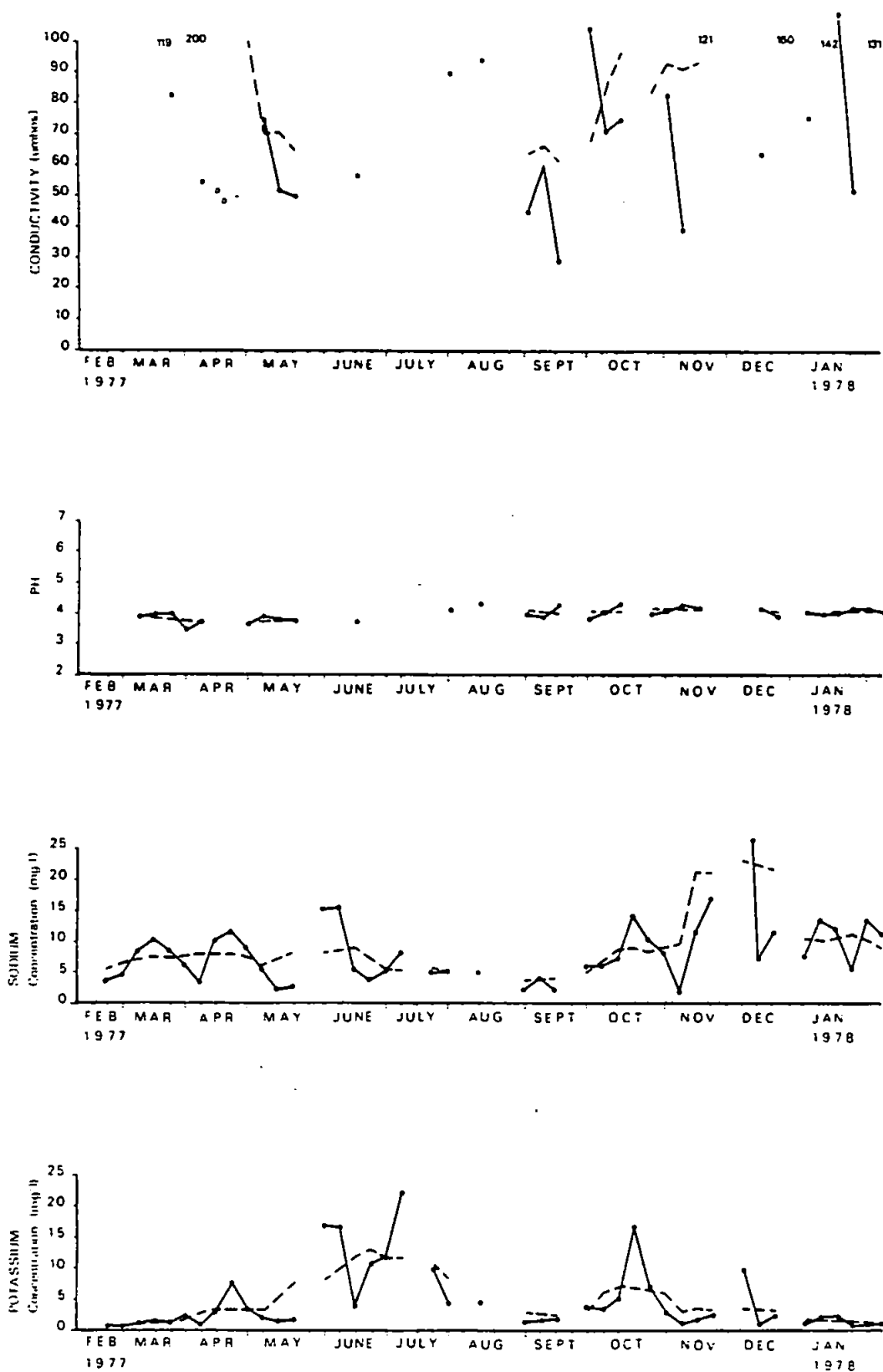


Fig. 4.6. Temporal variation in throughfall chemistry beneath sitka spruce

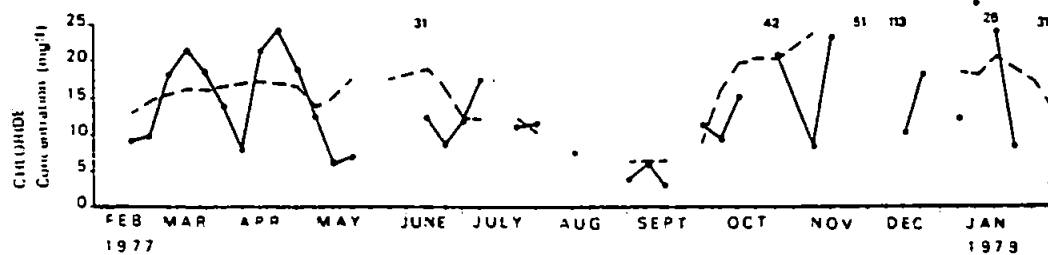
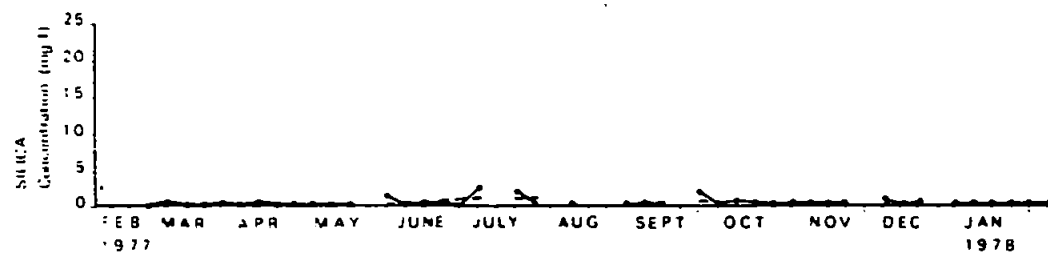
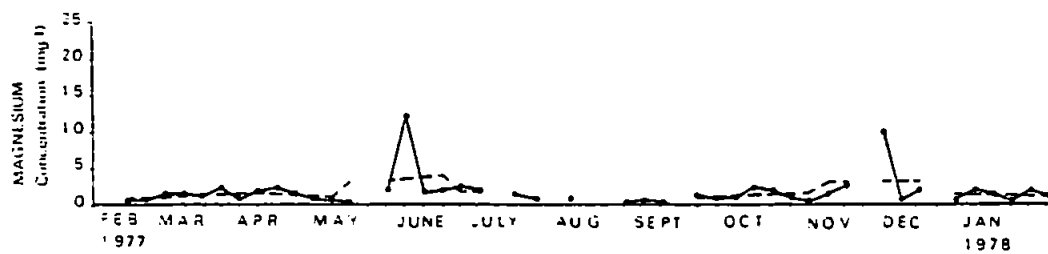
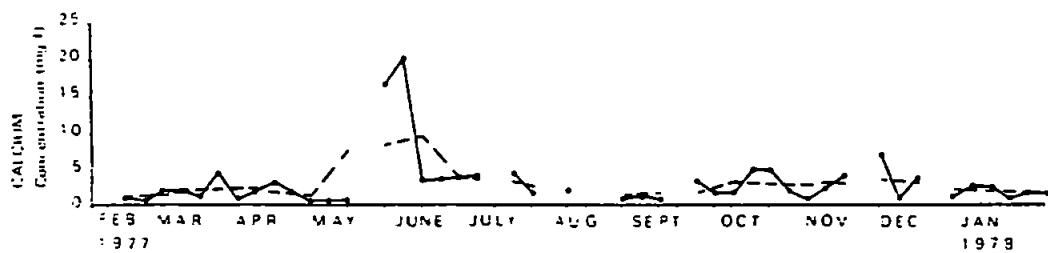
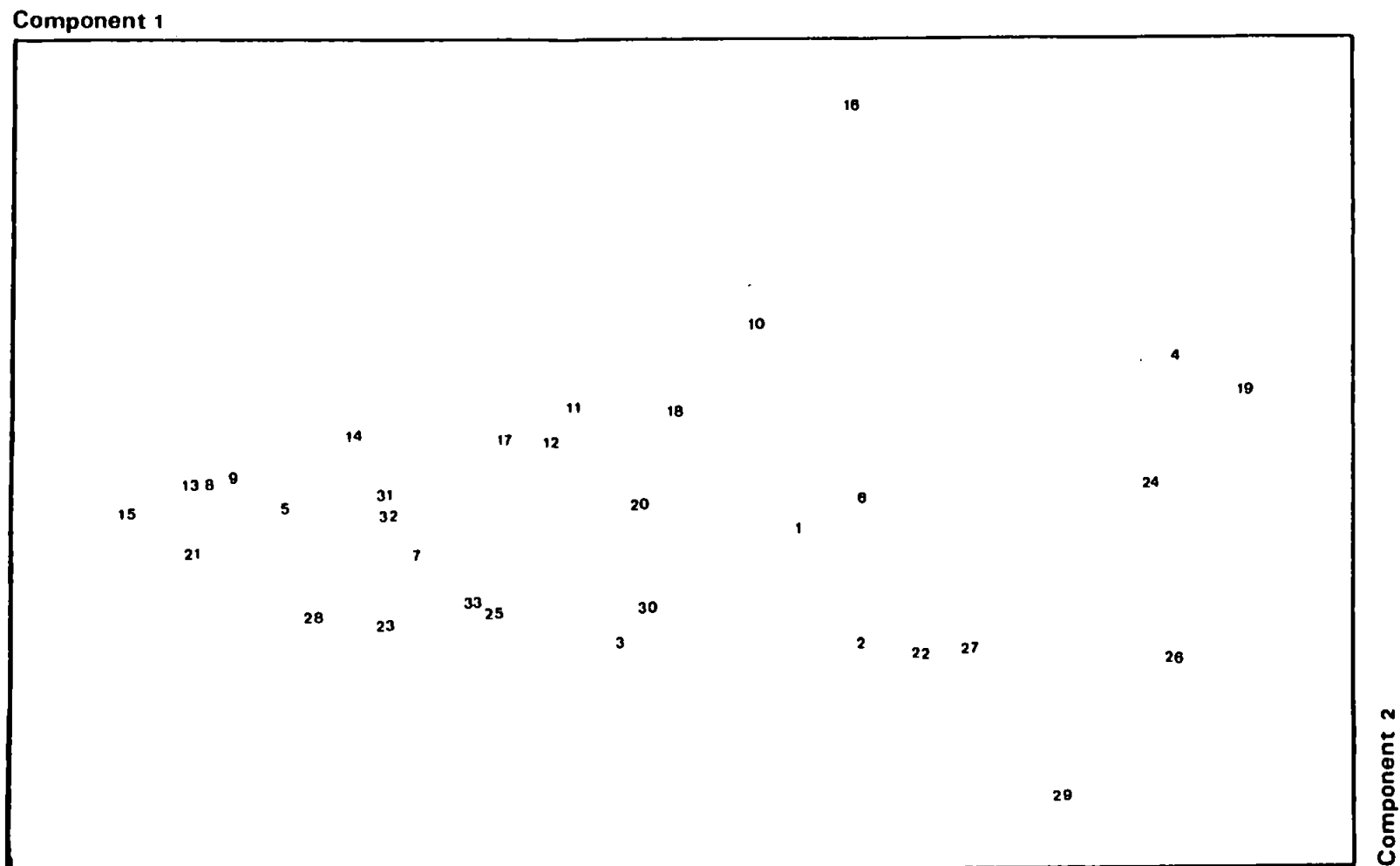


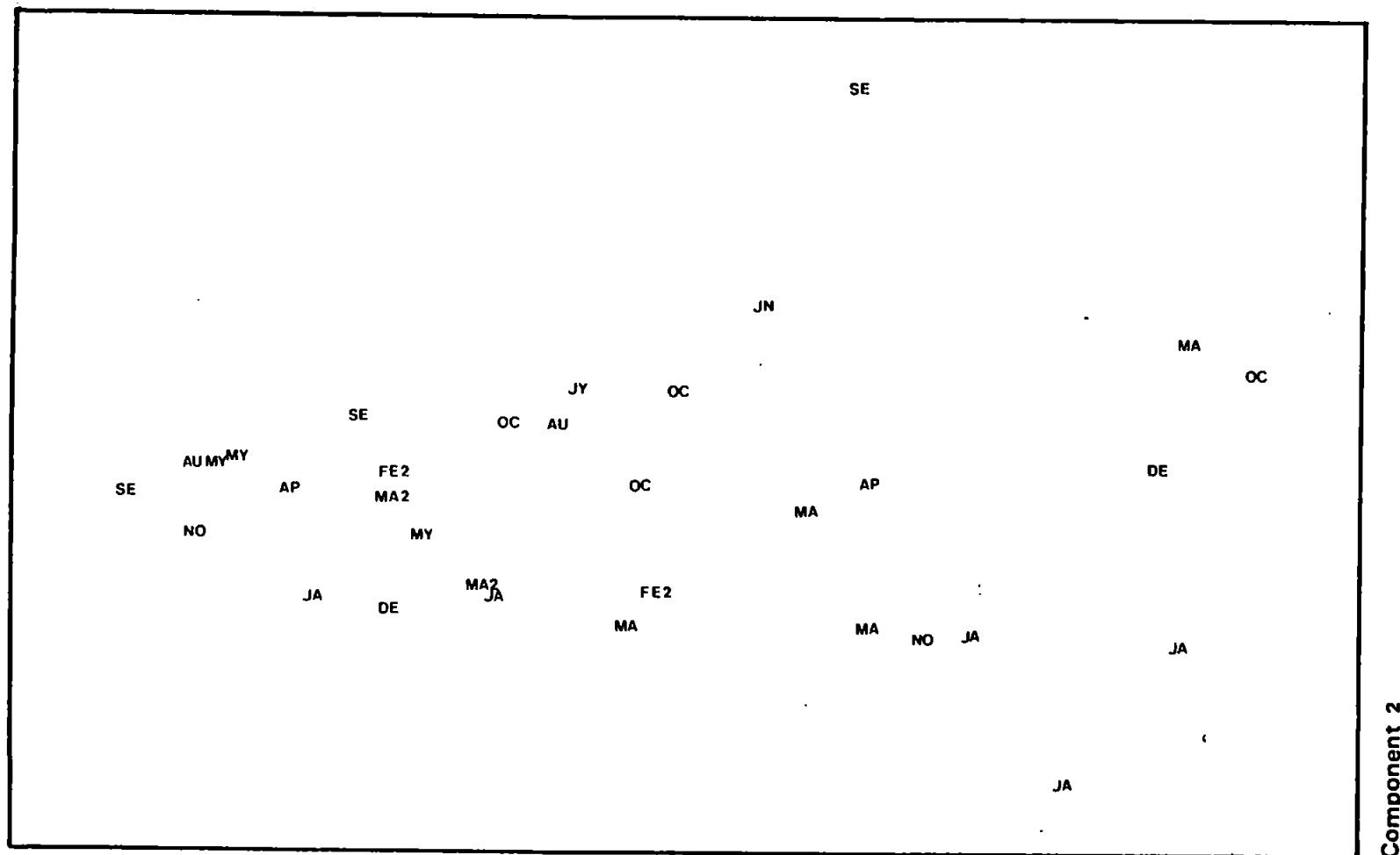
Fig. 4.6 (continued)



Principal Components Analysis of Sitka Throughfall Chemical Data 1977 - 78

Fig. 4.7. Principal components analysis of sitka throughfall chemical data

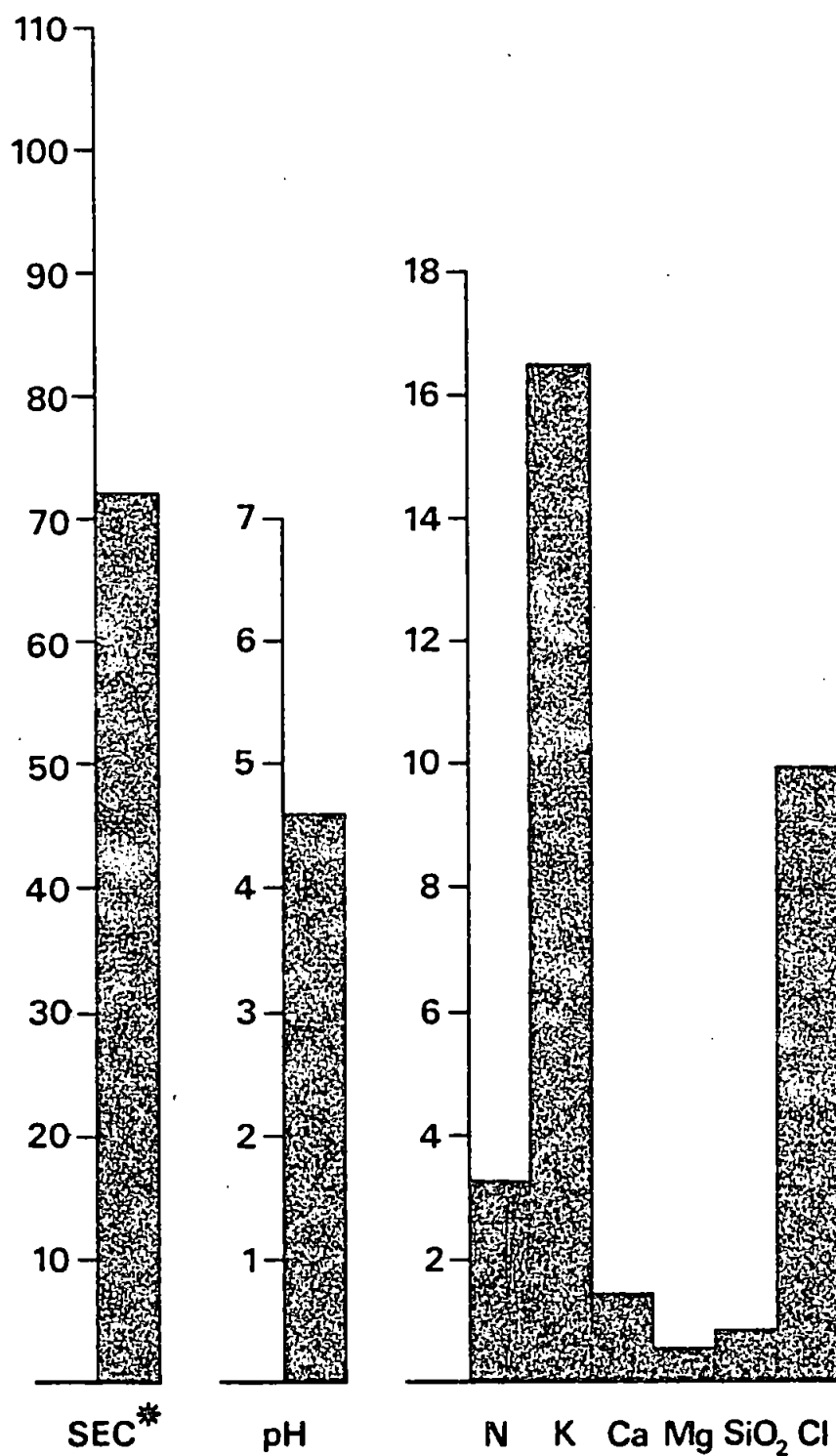
Component 1



Component 2

Principal Components Analysis of Sitka Throughfall Chemical Data 1977-78

Fig. 4.7 continued



*Unweighted mean

Fig 4·8 Mean weighted solute concentration in throughfall and stemflow beneath bracken 6·6·77-31·11·77 (SEC in $\mu\text{mhos cm}^{-1}$ at 25°C, all other ions except pH in Mgl^{-1})

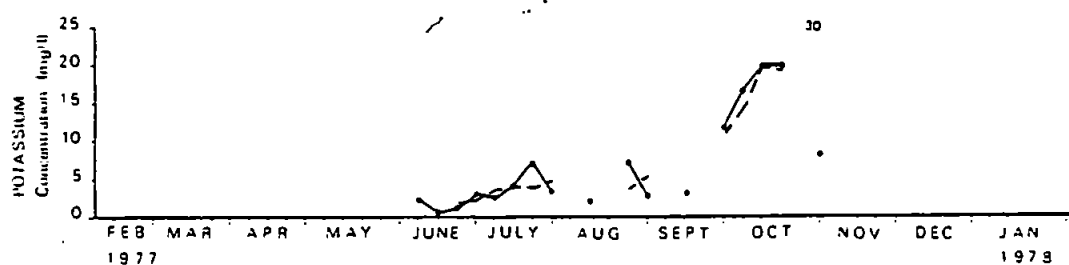
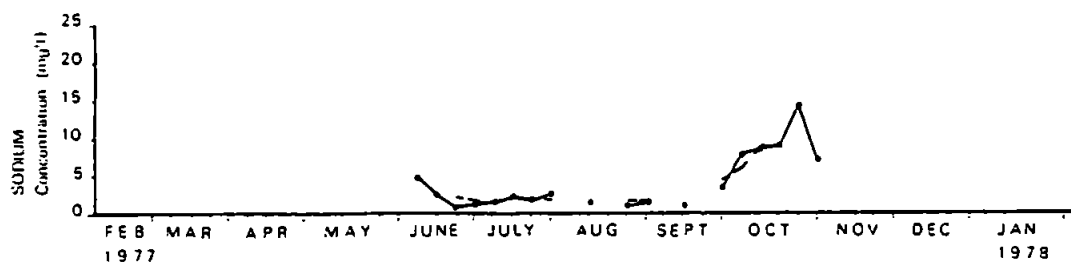
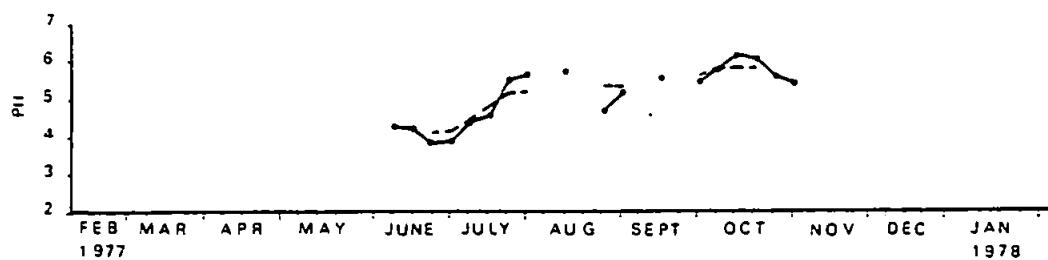
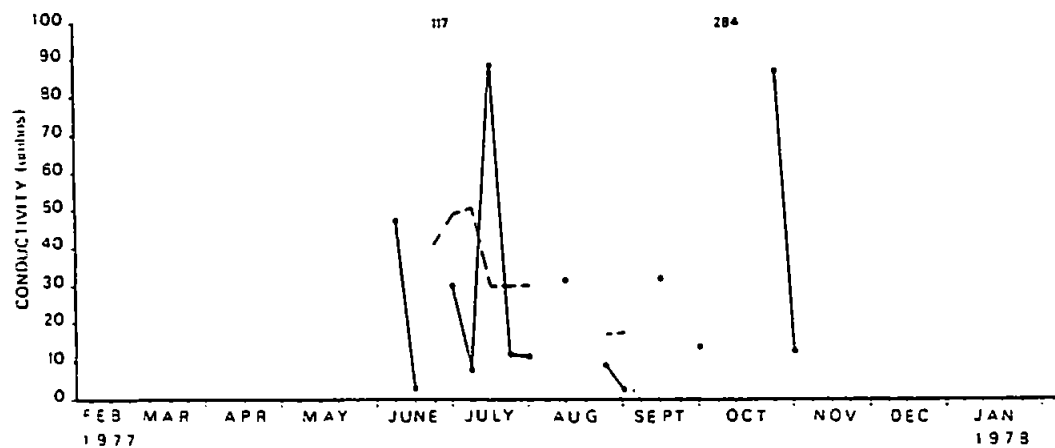


Fig. 4.9. Temporal variation in throughfall and stemflow chemistry beneath bräcken

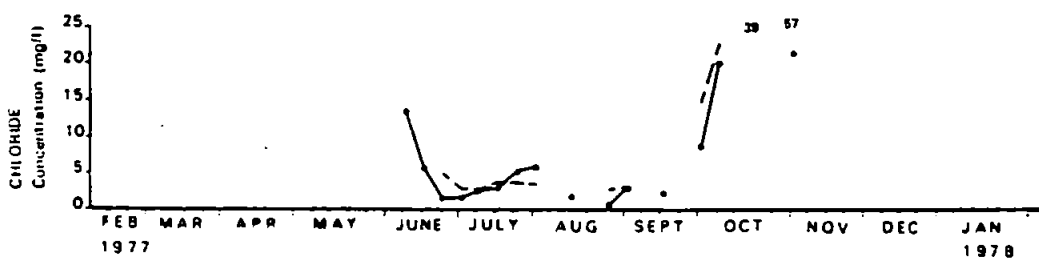
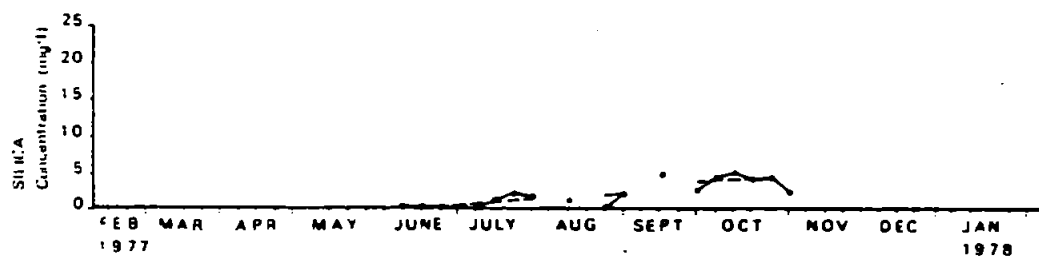
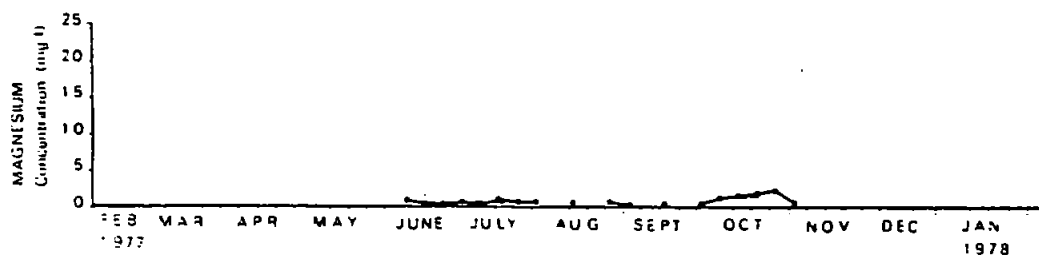
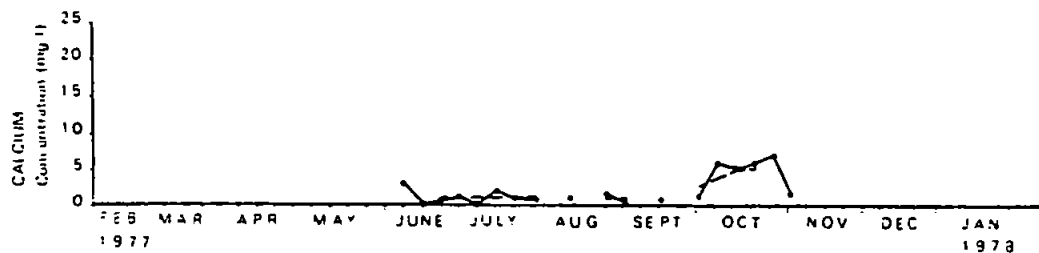
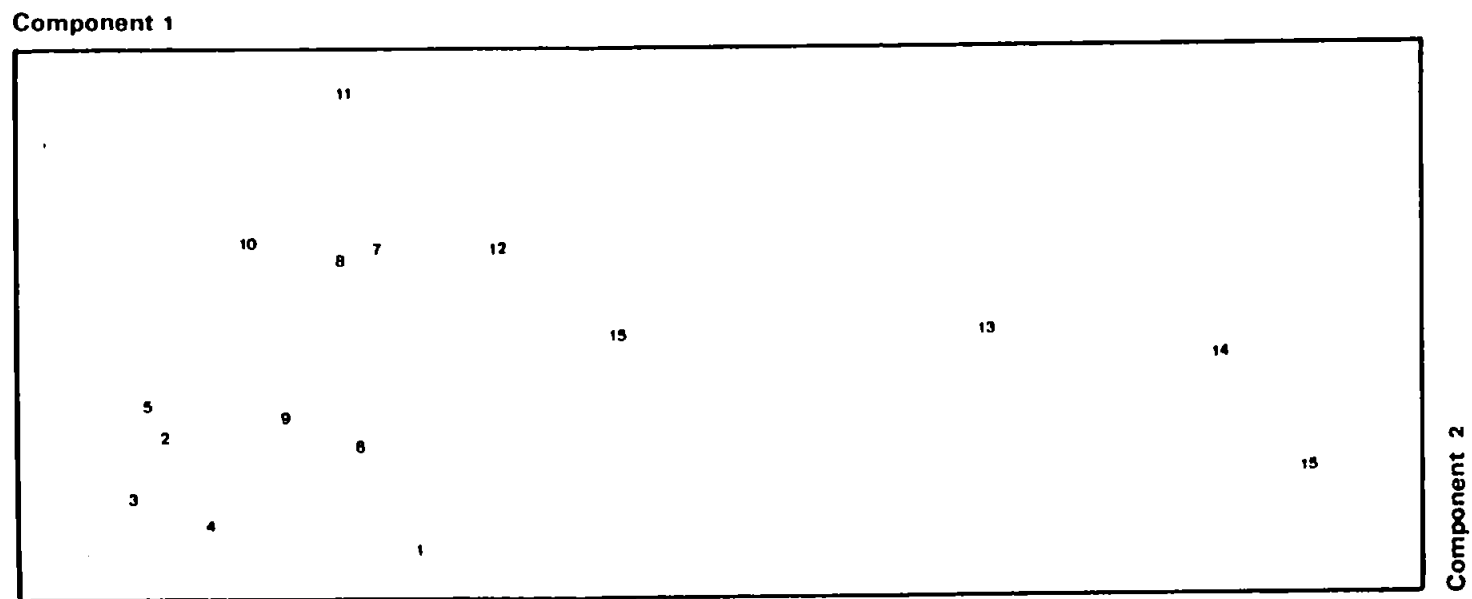


Fig. 4.9 (continued)



Principal Components Analysis of Bracken Throughfall Chemical Data 1977-78

Fig. 4.10. Principal components analysis of bracken throughfall and chemical data

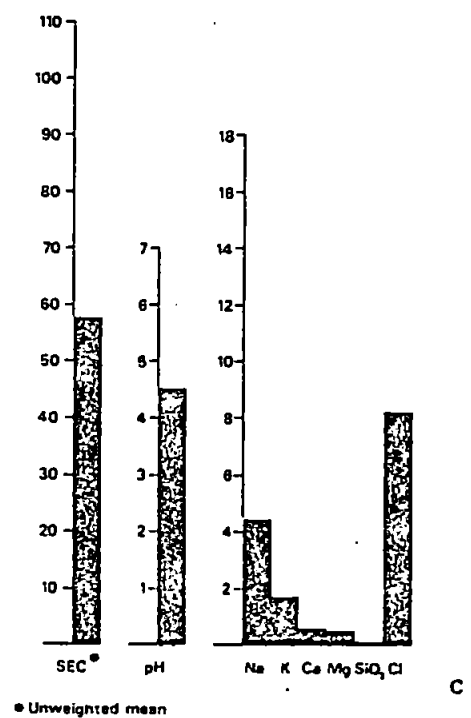
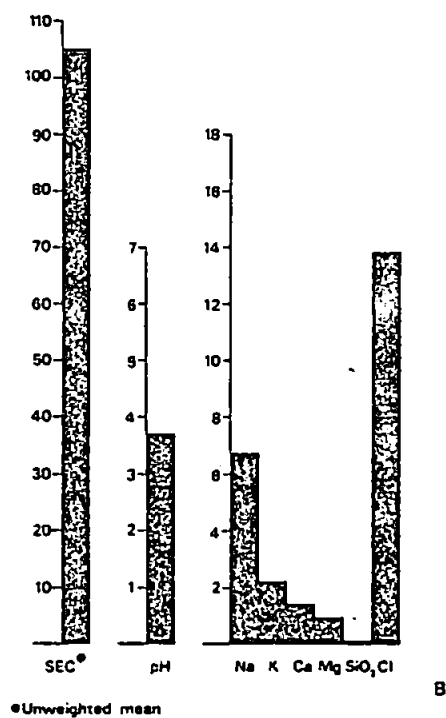
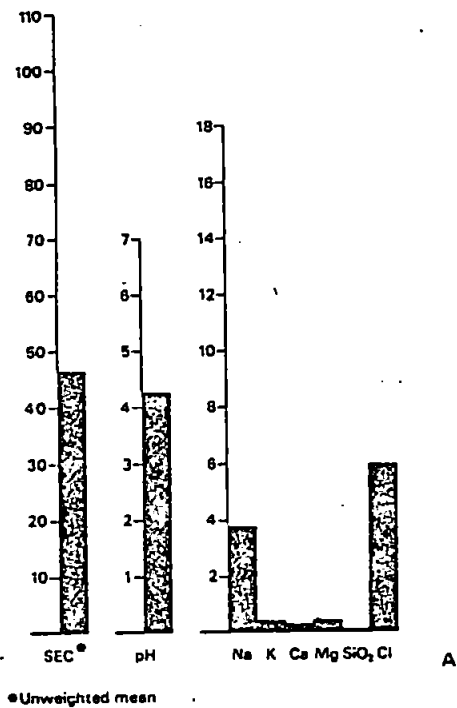


Fig. 4.11. Annual mean weighted solute concentrations in
 a. bulk precipitation
 b. sitka spruce throughfall and
 c. bracken throughfall and stemflow



Fig. 4.10. continued

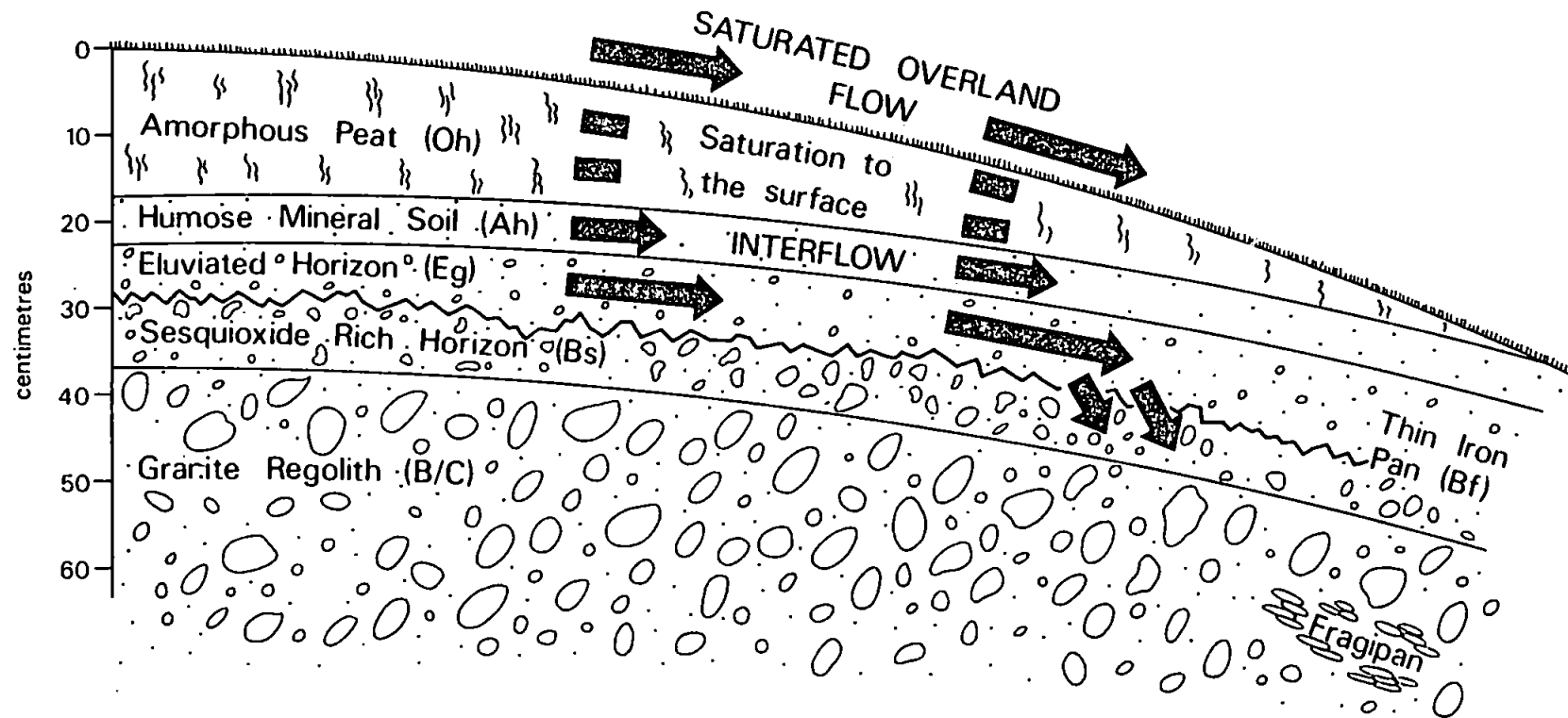


Fig. 5.1. Saturated overland flow developed where soil is saturated to the surface due to an impermeable iron pan

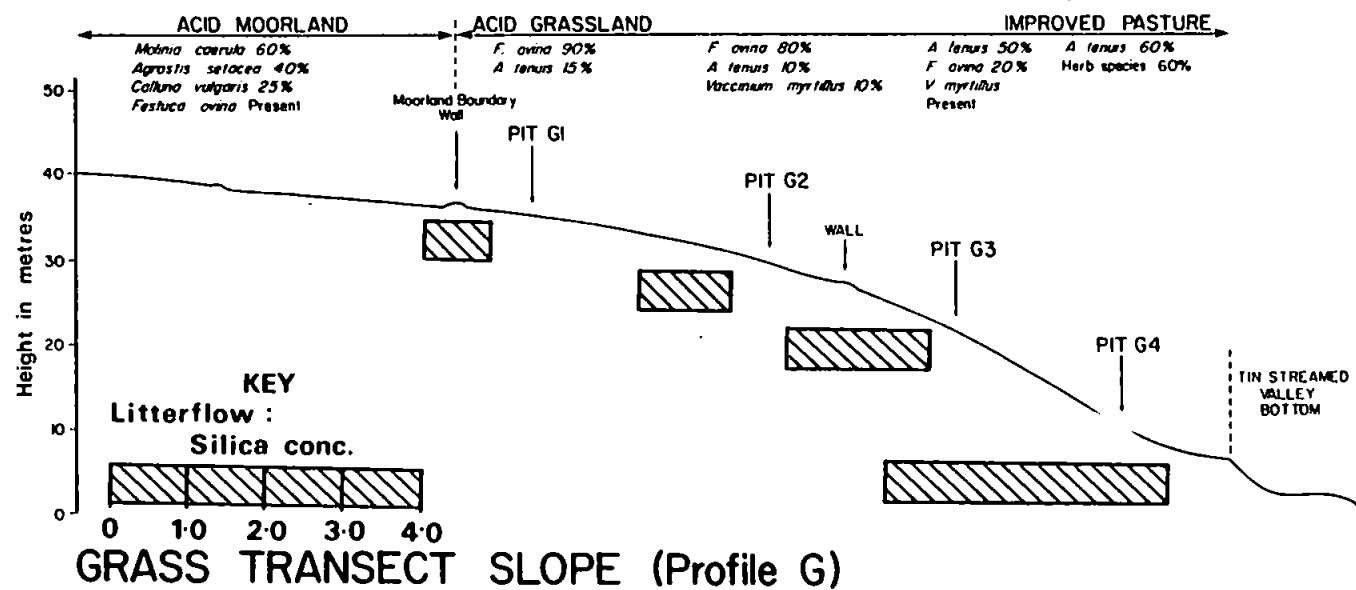


Fig. 5.10. Species of vegetation and silica concentrations in litterflow in the grassland

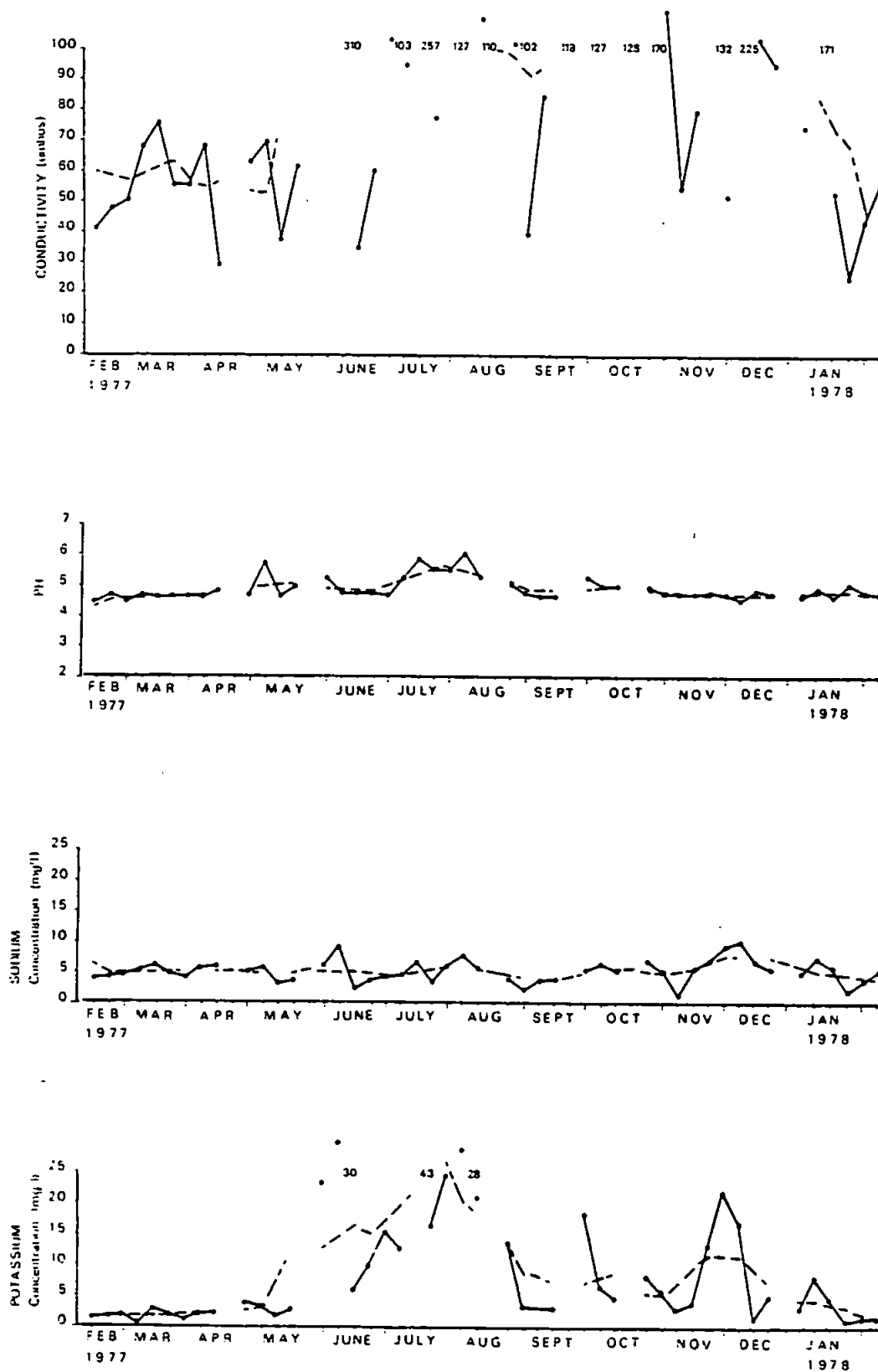


Fig. 5.11. Temporal variation in litterflow solute concentrations in the grassland (G4)

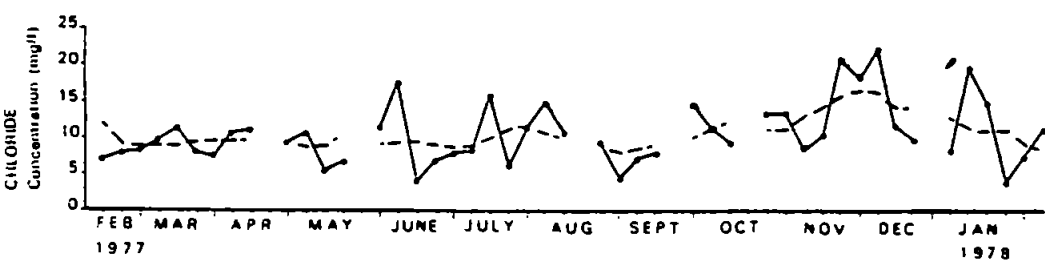
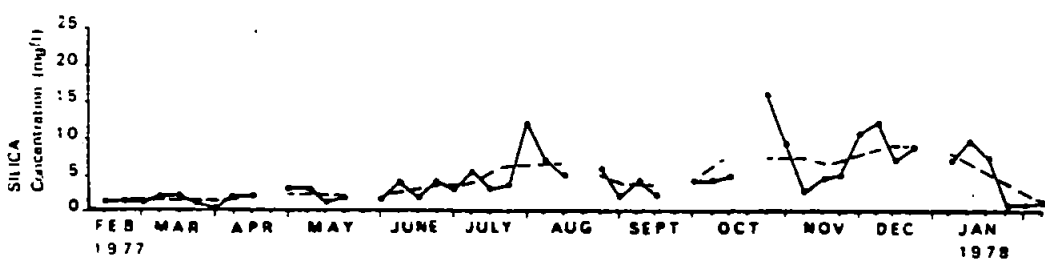
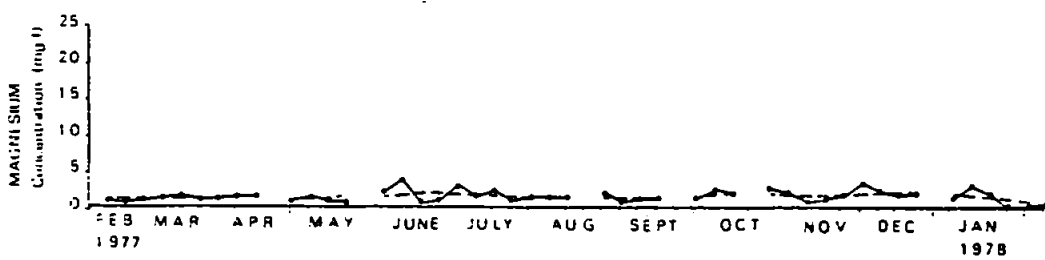
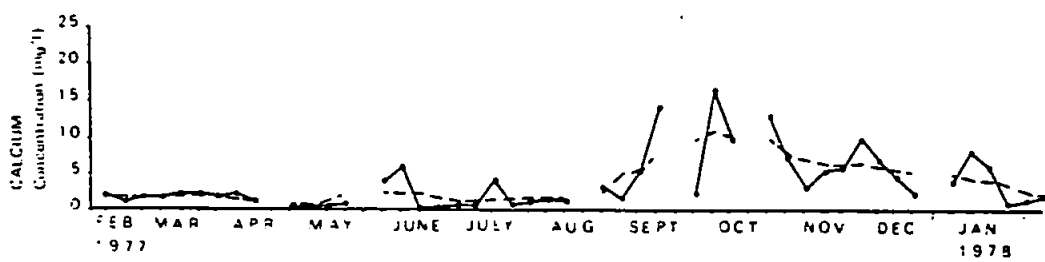


Fig. 5.11 (continued)

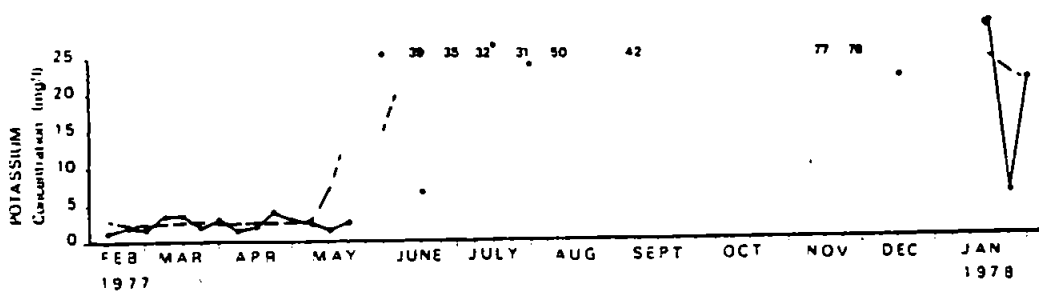
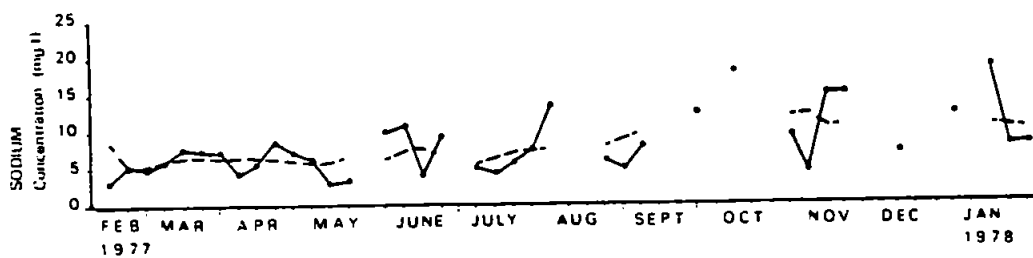
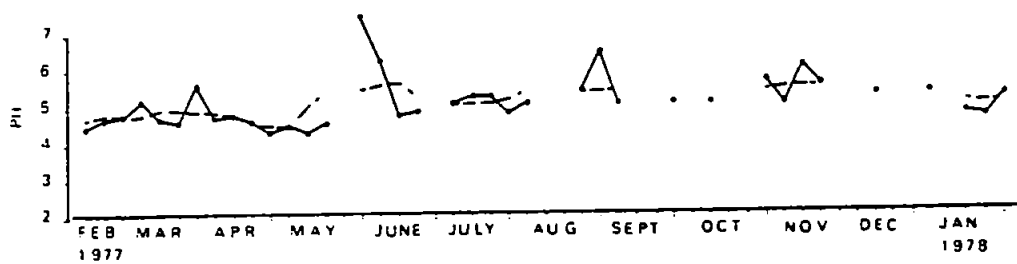
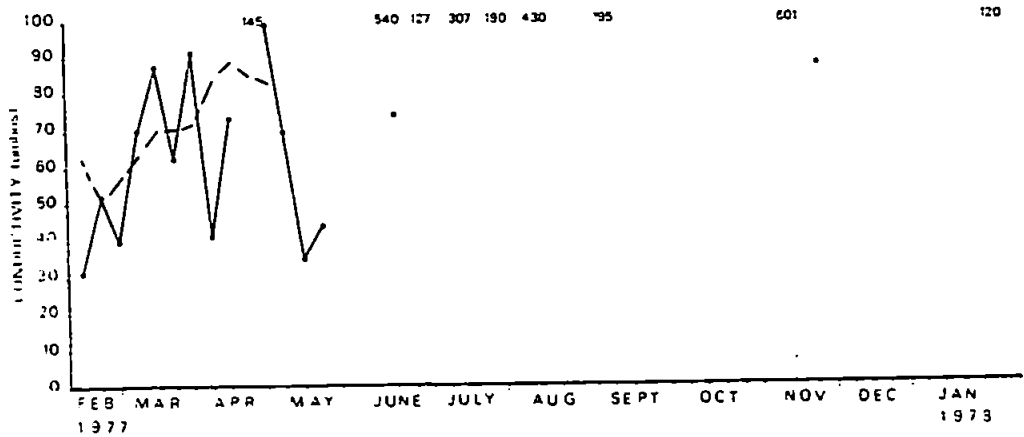


Fig. 5.12. Temporal variation in litterflow solute concentrations in the bracken (B3)

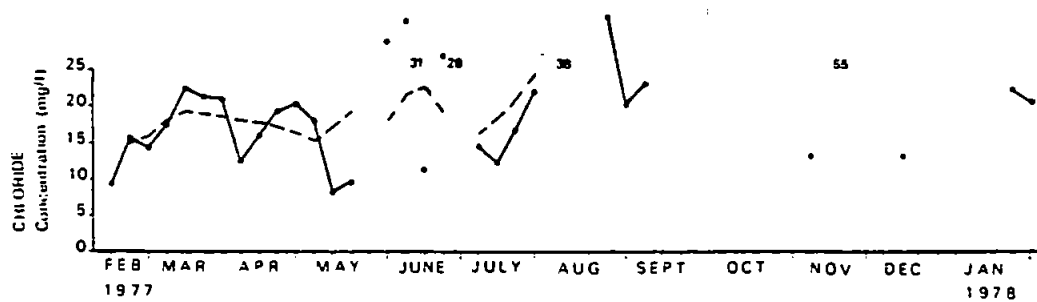
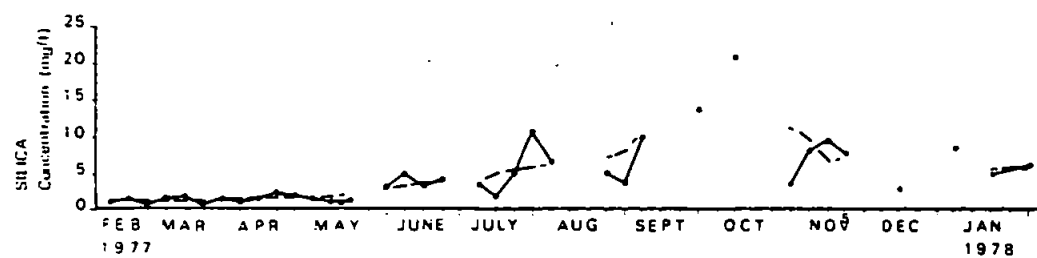
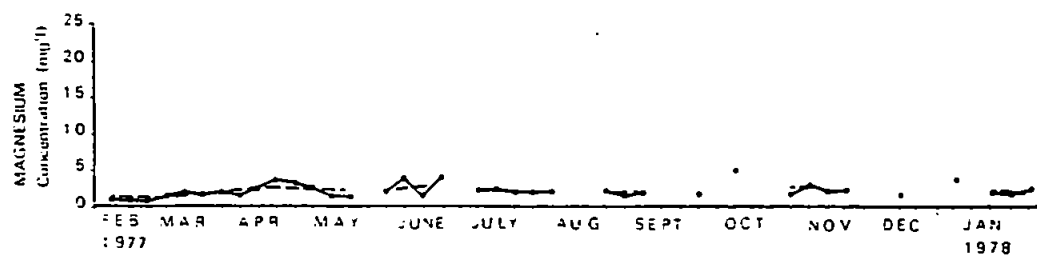
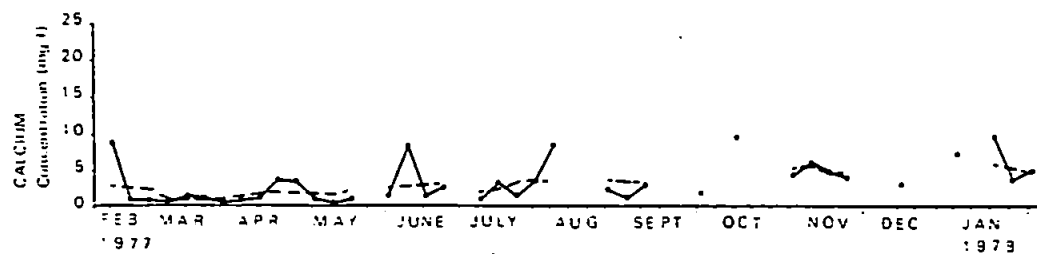


Fig. 5.12 (continued)

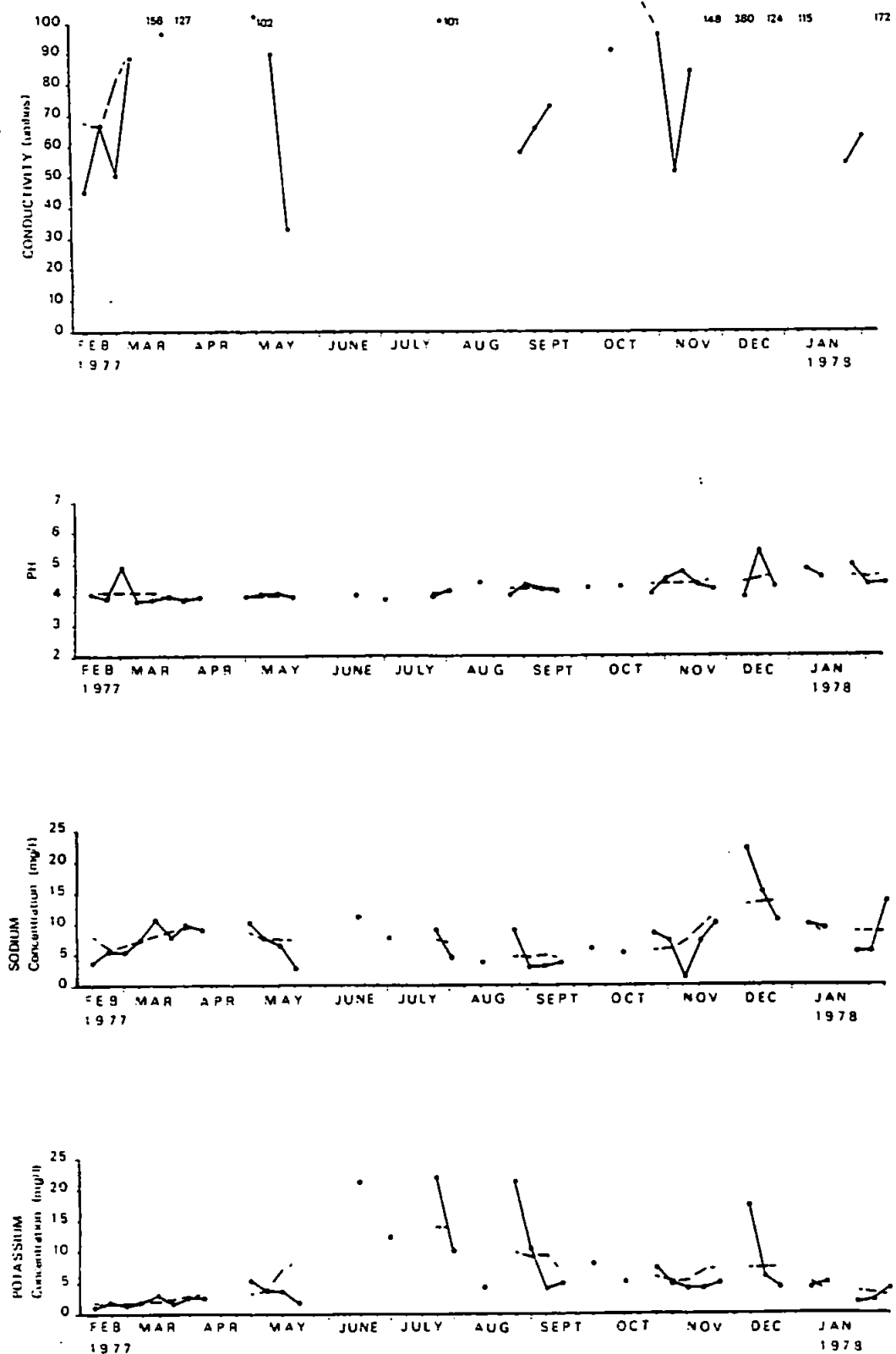


Fig. 5.13. Temporal variation in litterflow solute concentrations in the forest (F5)

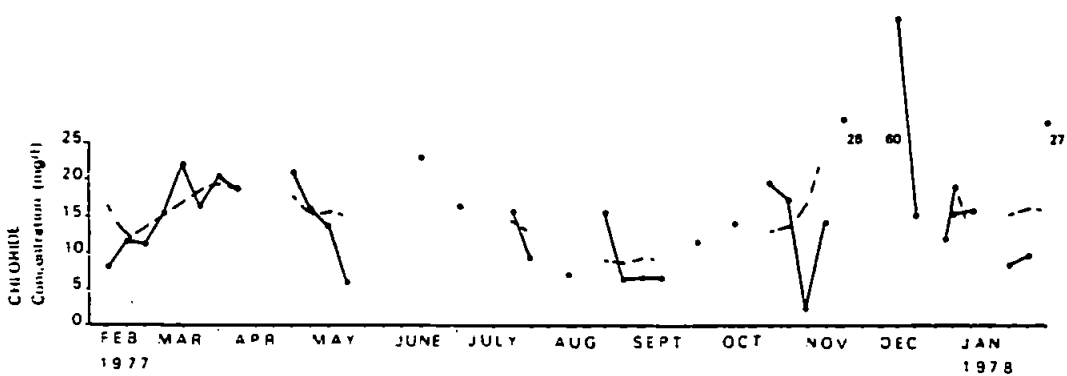
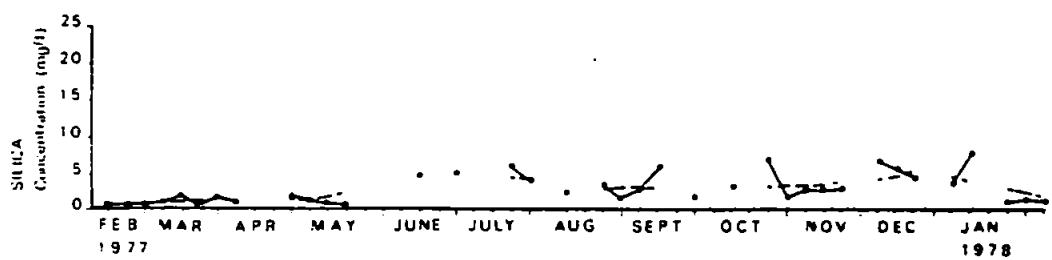
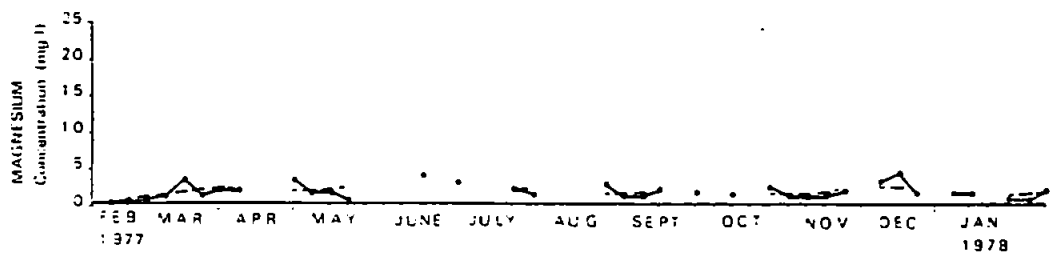
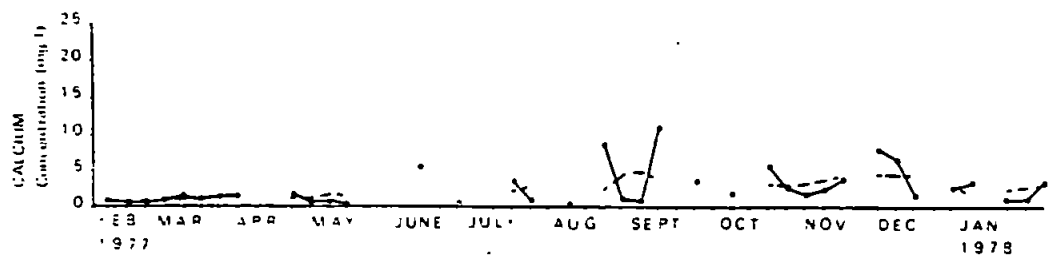


Fig. 5.13 (continued)

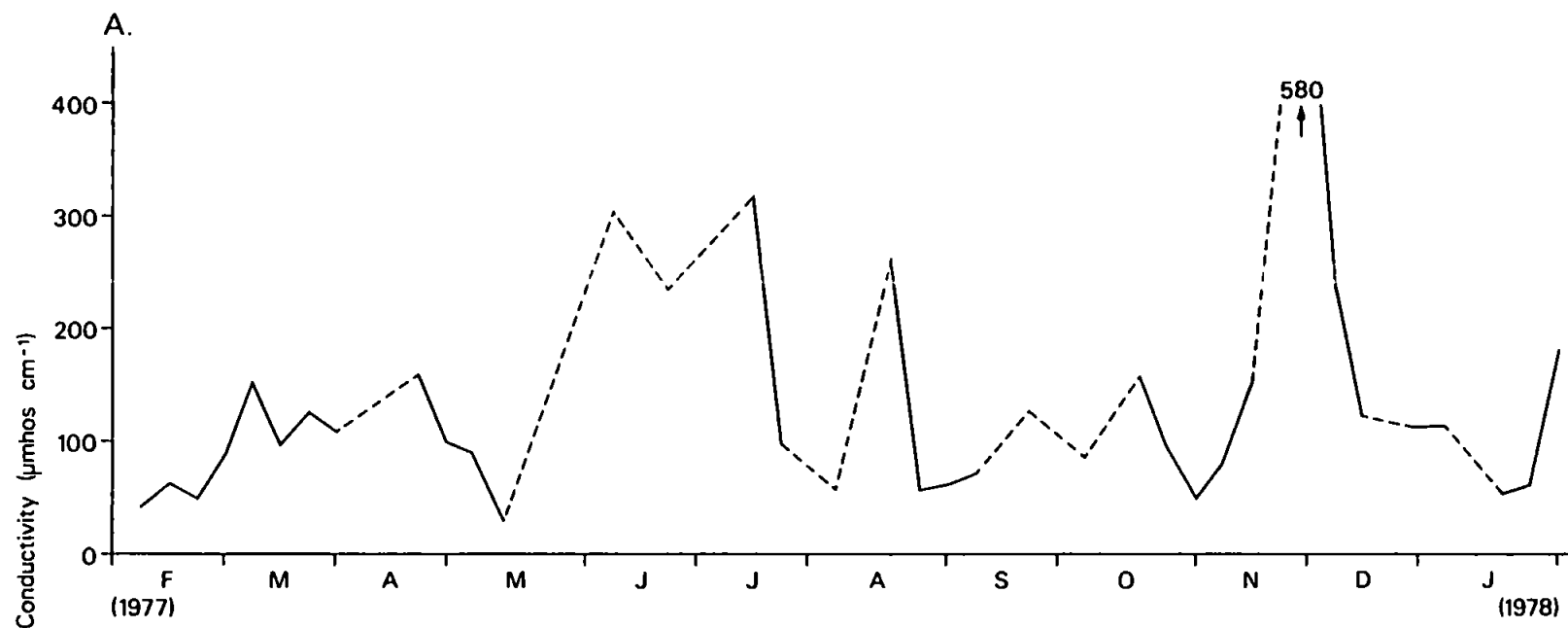


Fig. 5.14. Temporal variation in conductivity in forest litterflow (F5) in the Narrator catchment

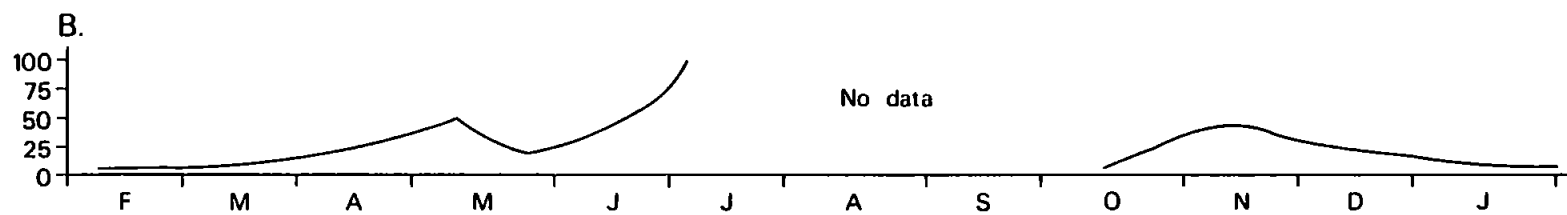


Fig. 5.15. Temporal variation in conductivity in forest litterflow after McColl (1973)

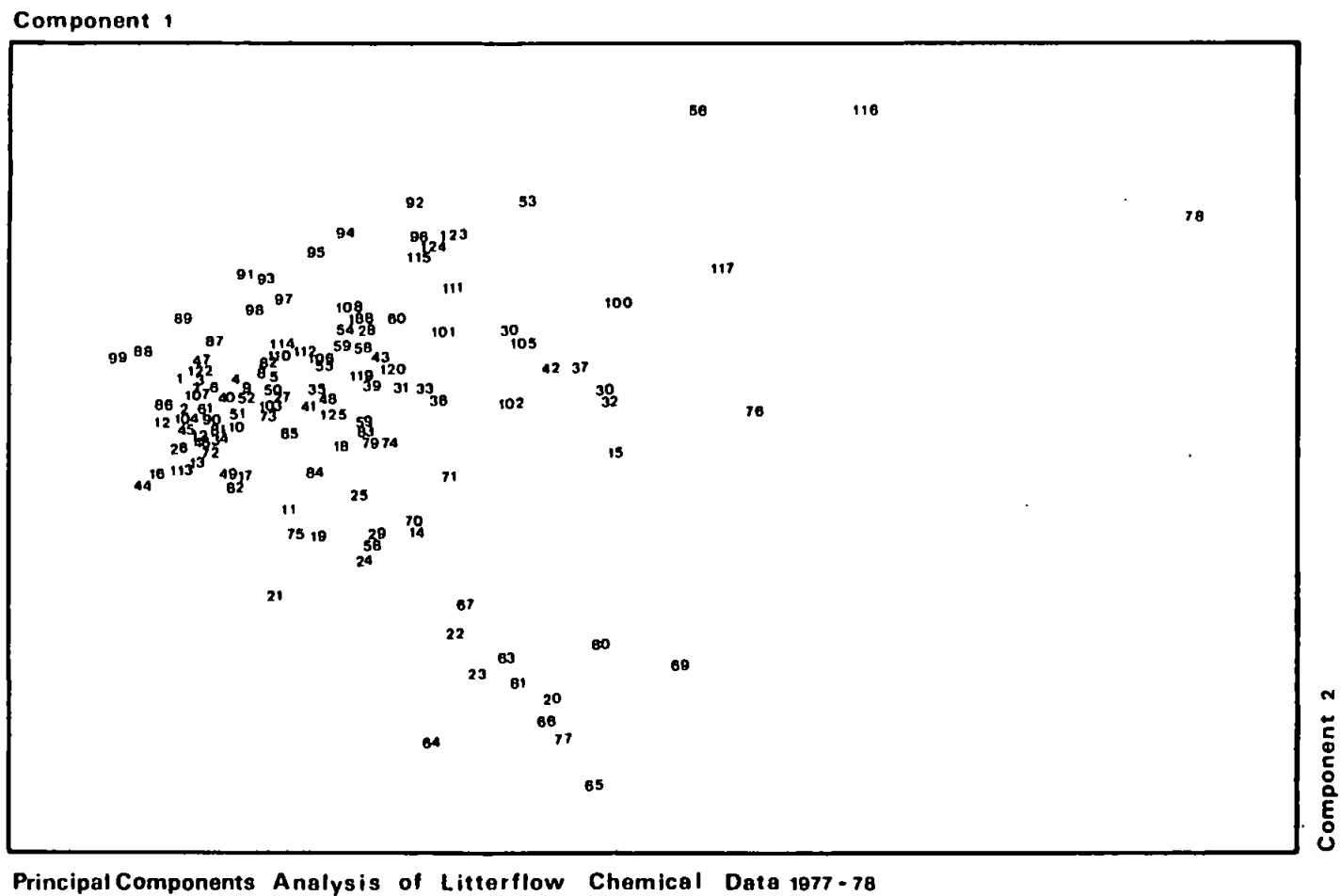
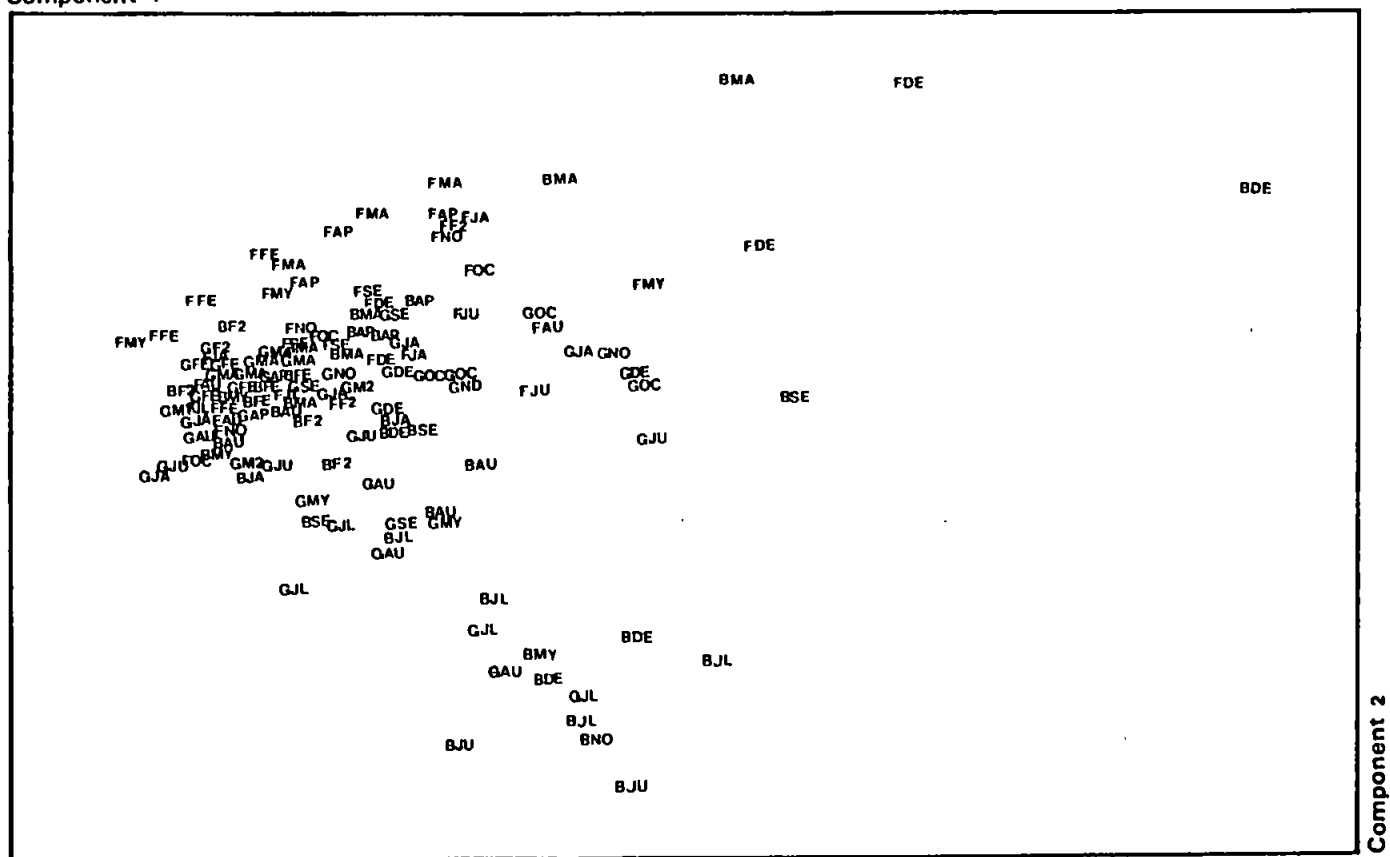


Fig. 5.16. Principal components analysis of litterflow chemical data



Principal Components Analysis of Litterflow Chemical Data 1977 - 78

Fig. 5.16. continued

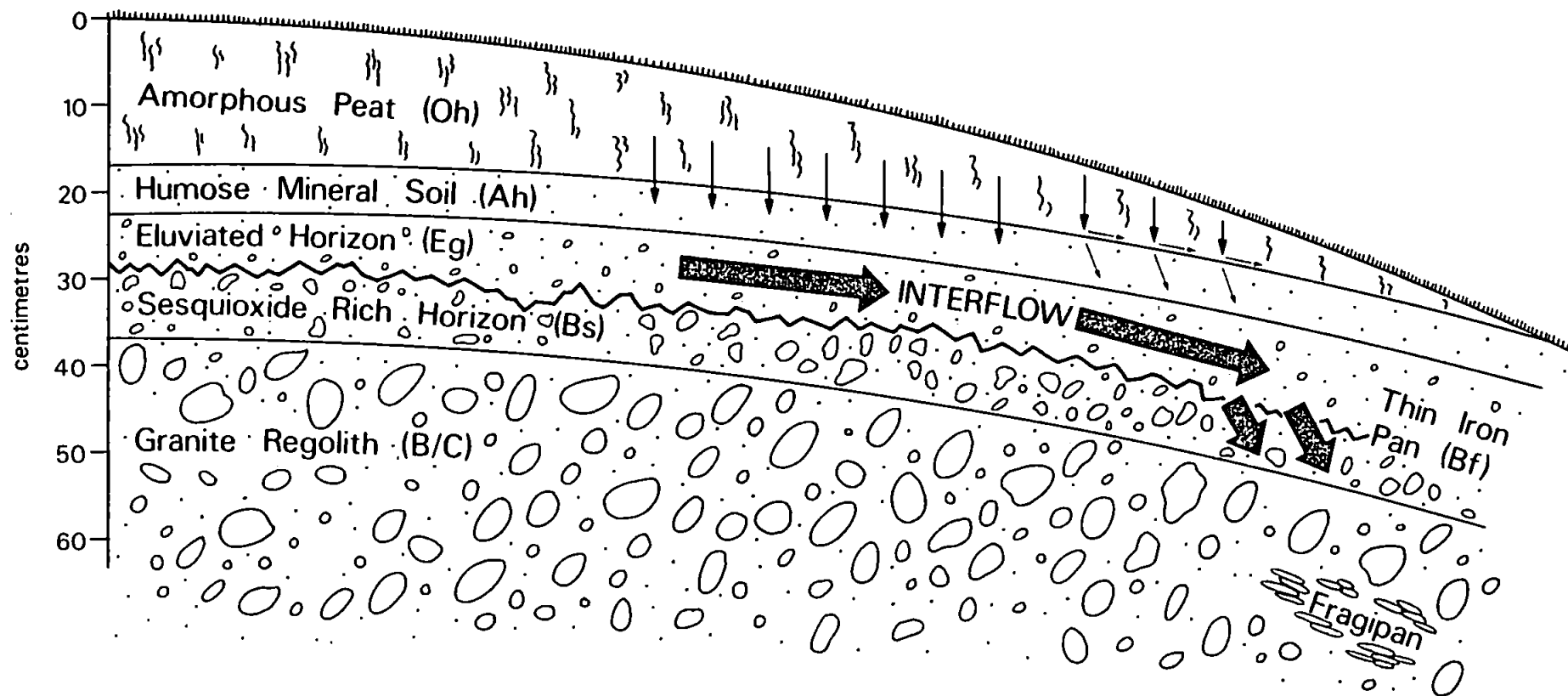


Fig. 6.1. Interflow above an iron pan (pathway 1)

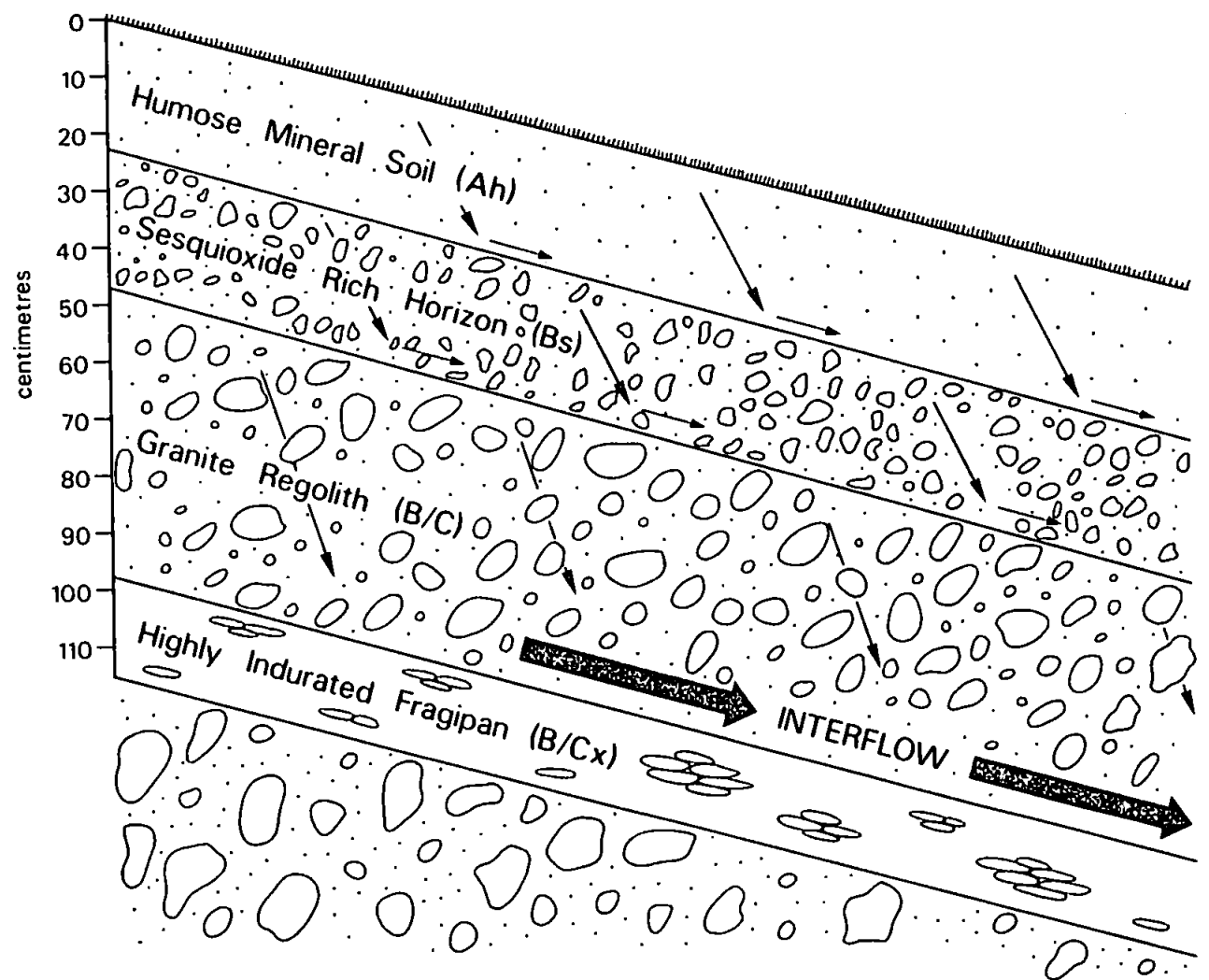


Fig. 6.2. Interflow above a fragipan (pathway 2)

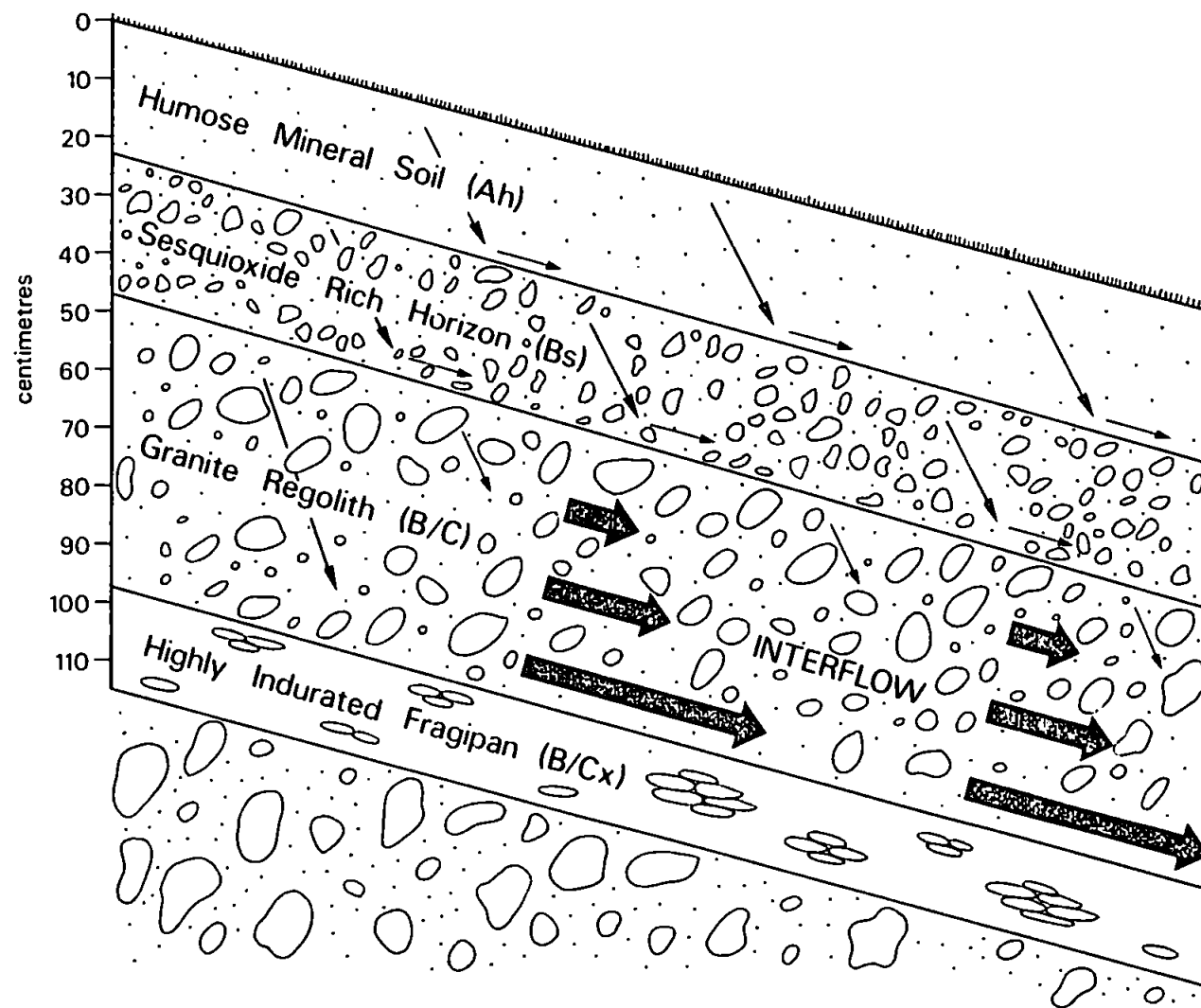


Fig. 6.3. Saturation upwards above a fragipan (pathway 3)

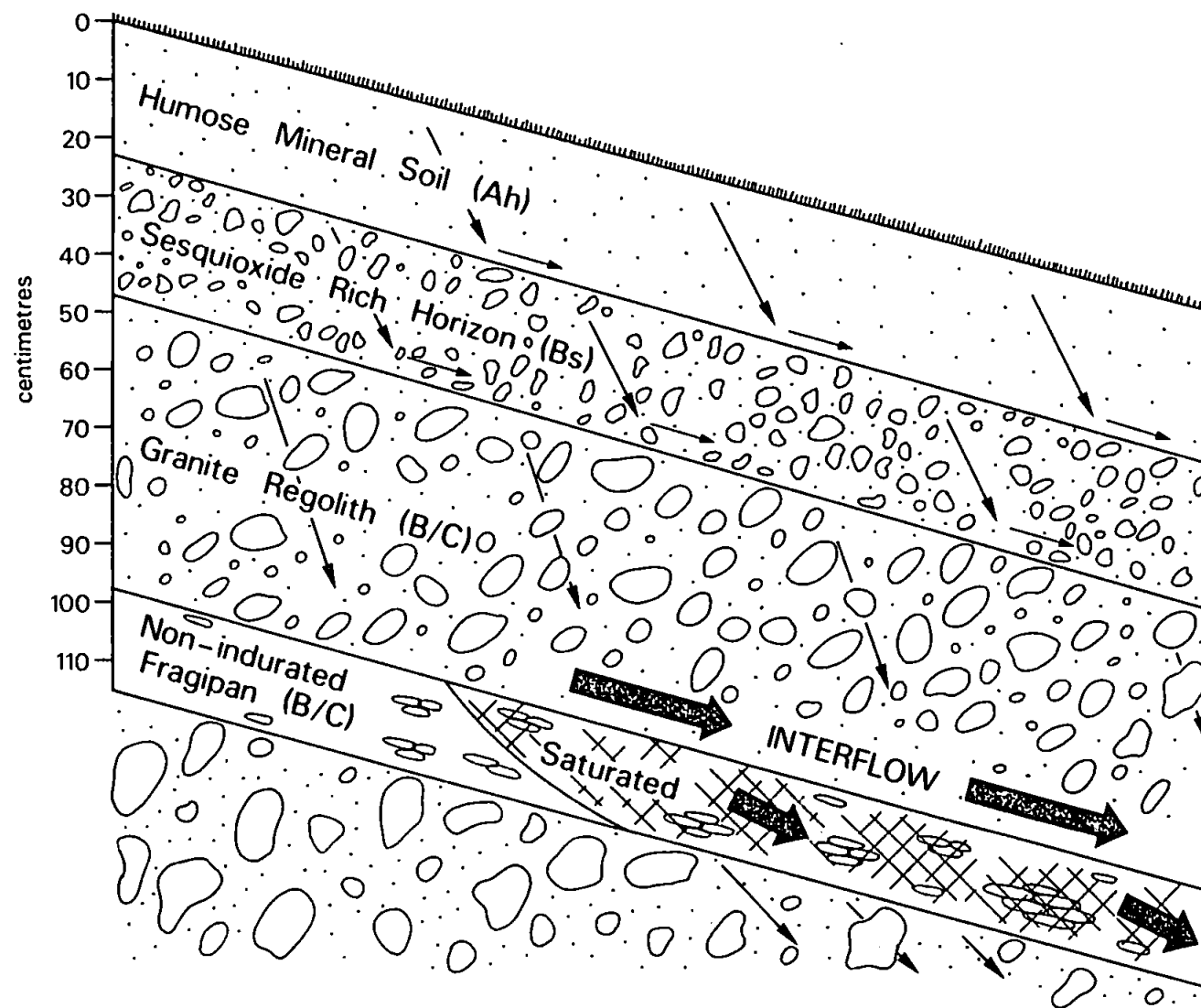


Fig. 6.4. Saturation within an impeding layer (pathway 4)

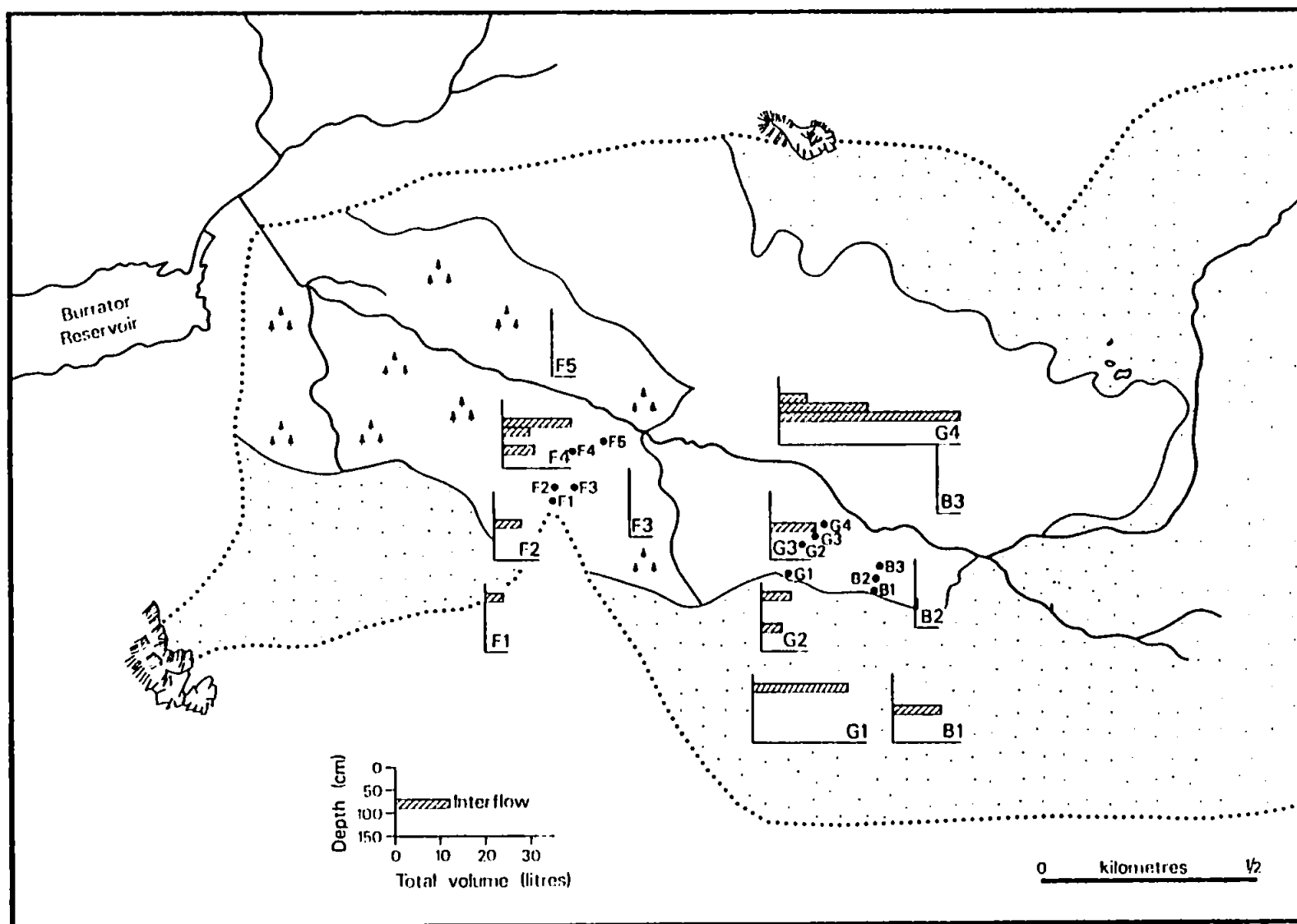


Fig. 6.5. Volumes of interflow recorded for one year at twelve monitoring sites in the Narrator catchment

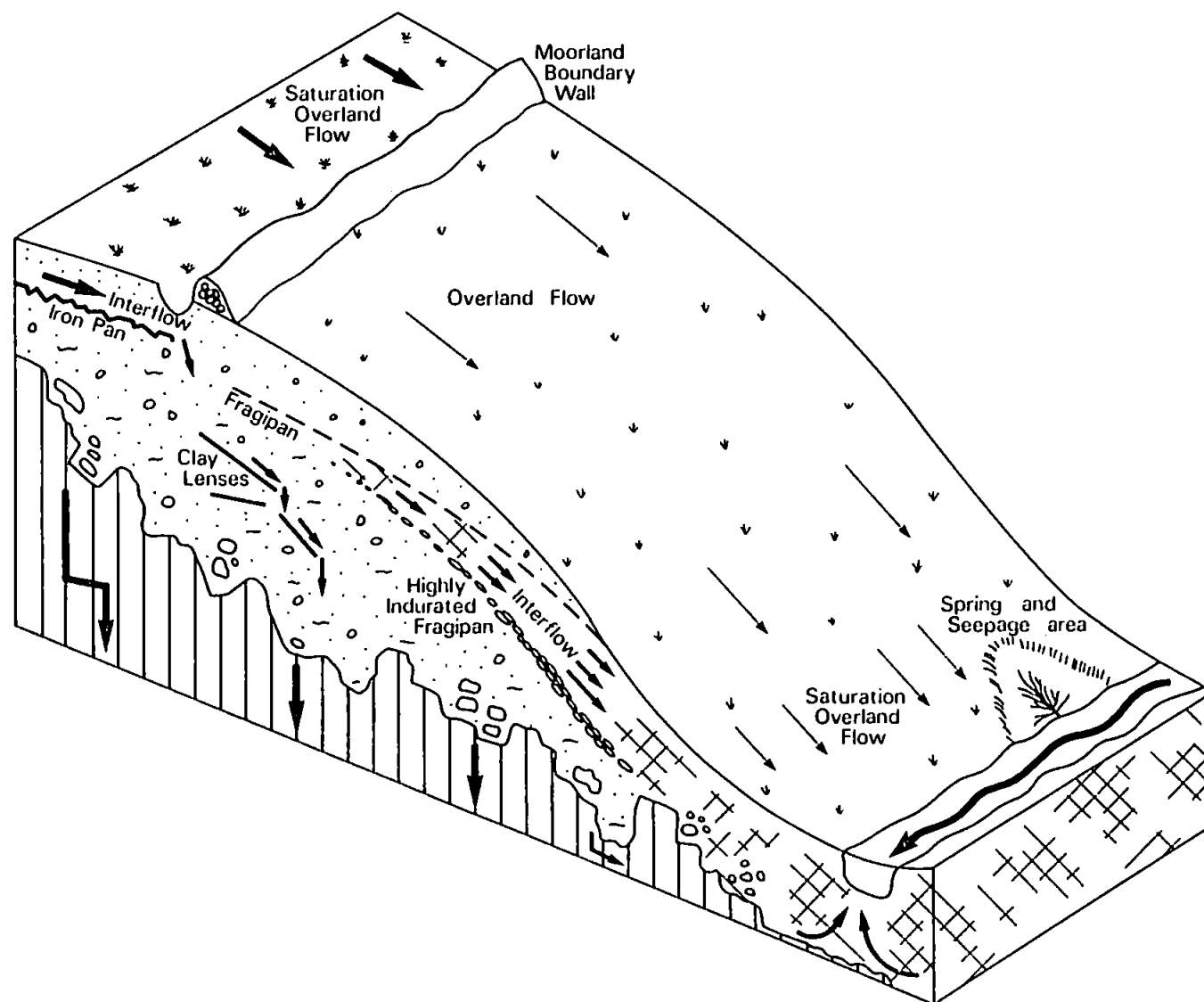


Fig. 6.6. Hydrological model for a Dartmoor hillslope

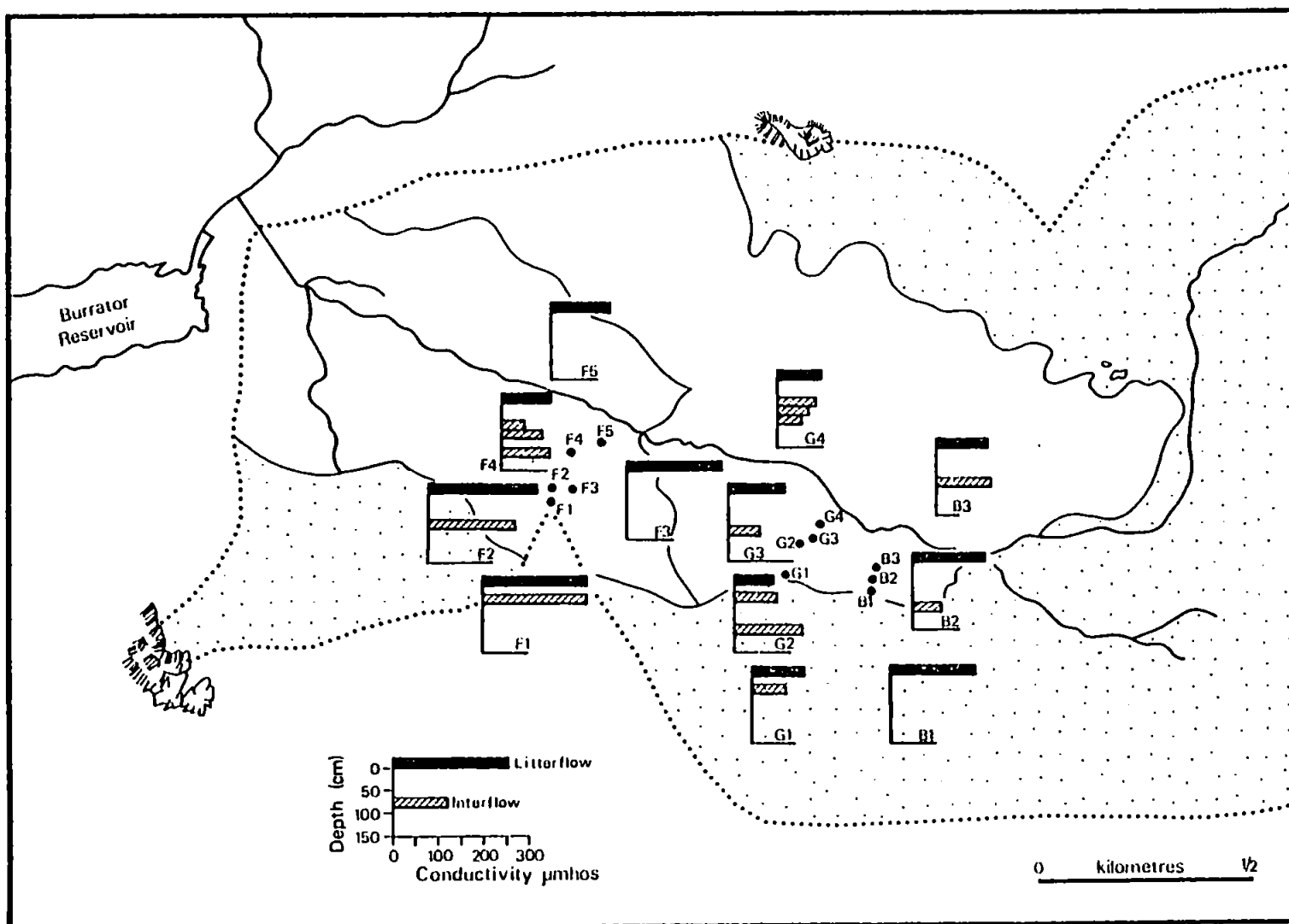


Fig. 6.7. Conductivity levels in litterflow and interflow

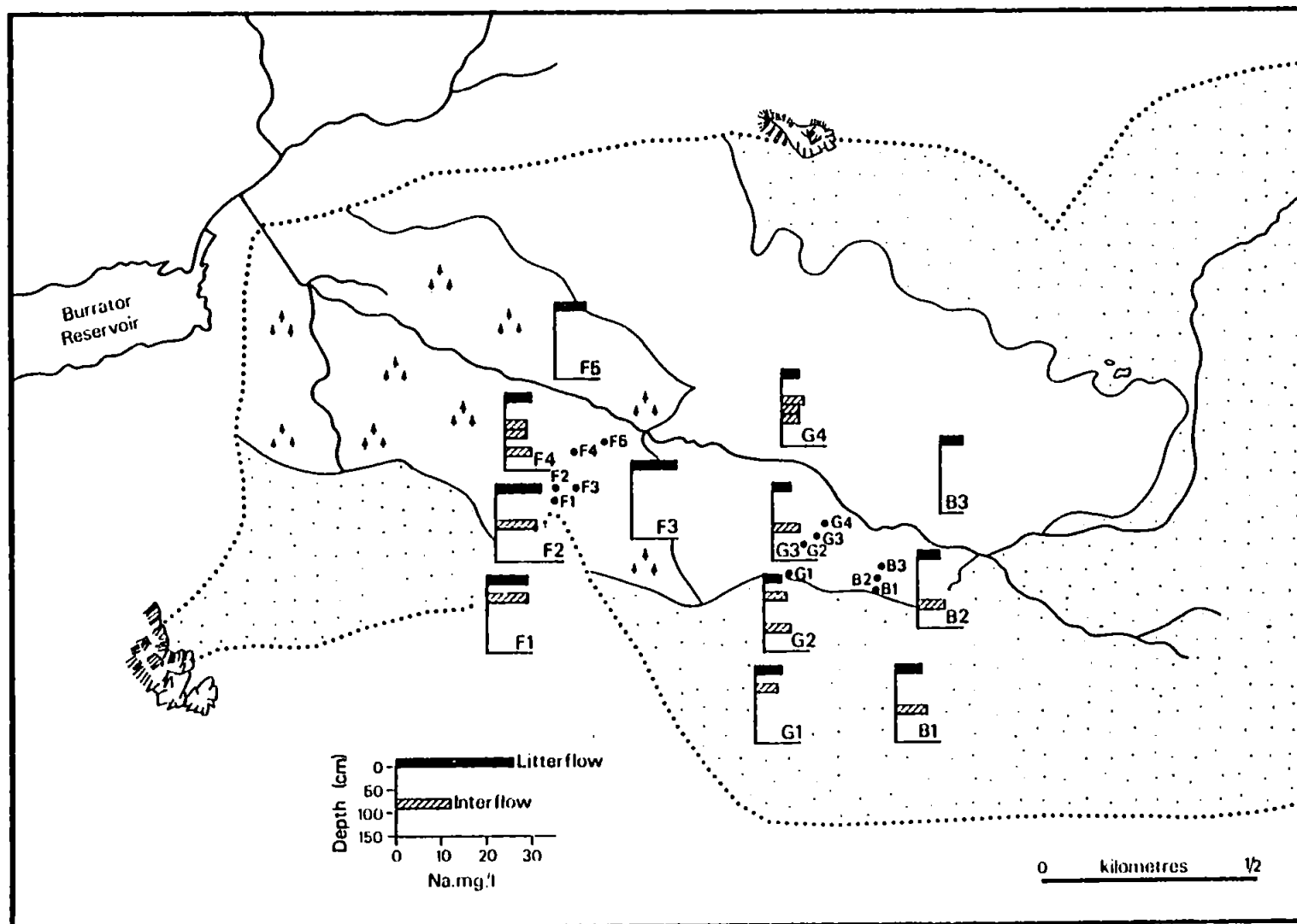


Fig. 6.8. Sodium concentrations in litterflow runoff and interflow

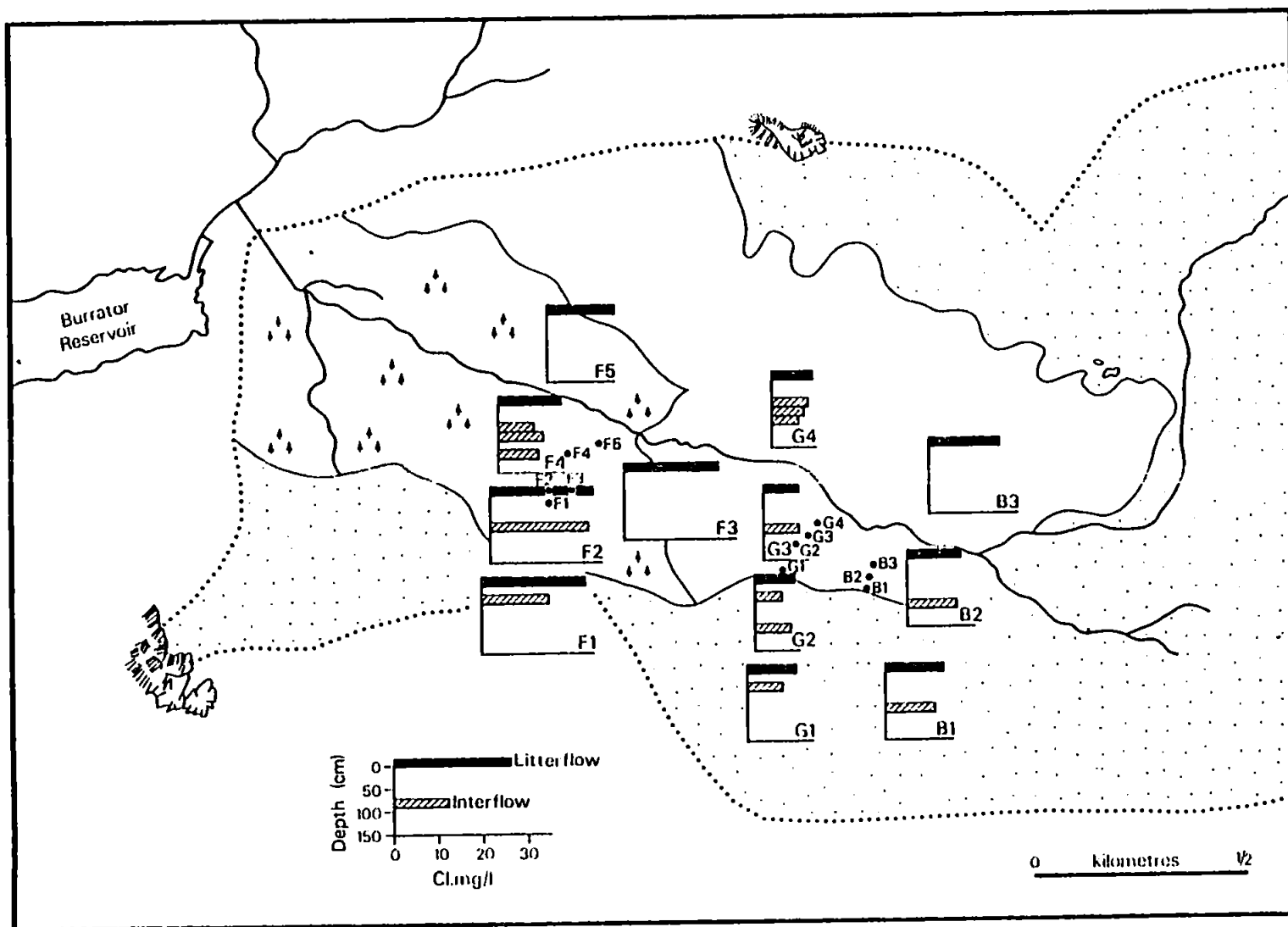


Fig. 6.9. Chloride concentrations in litterflow runoff and interflow

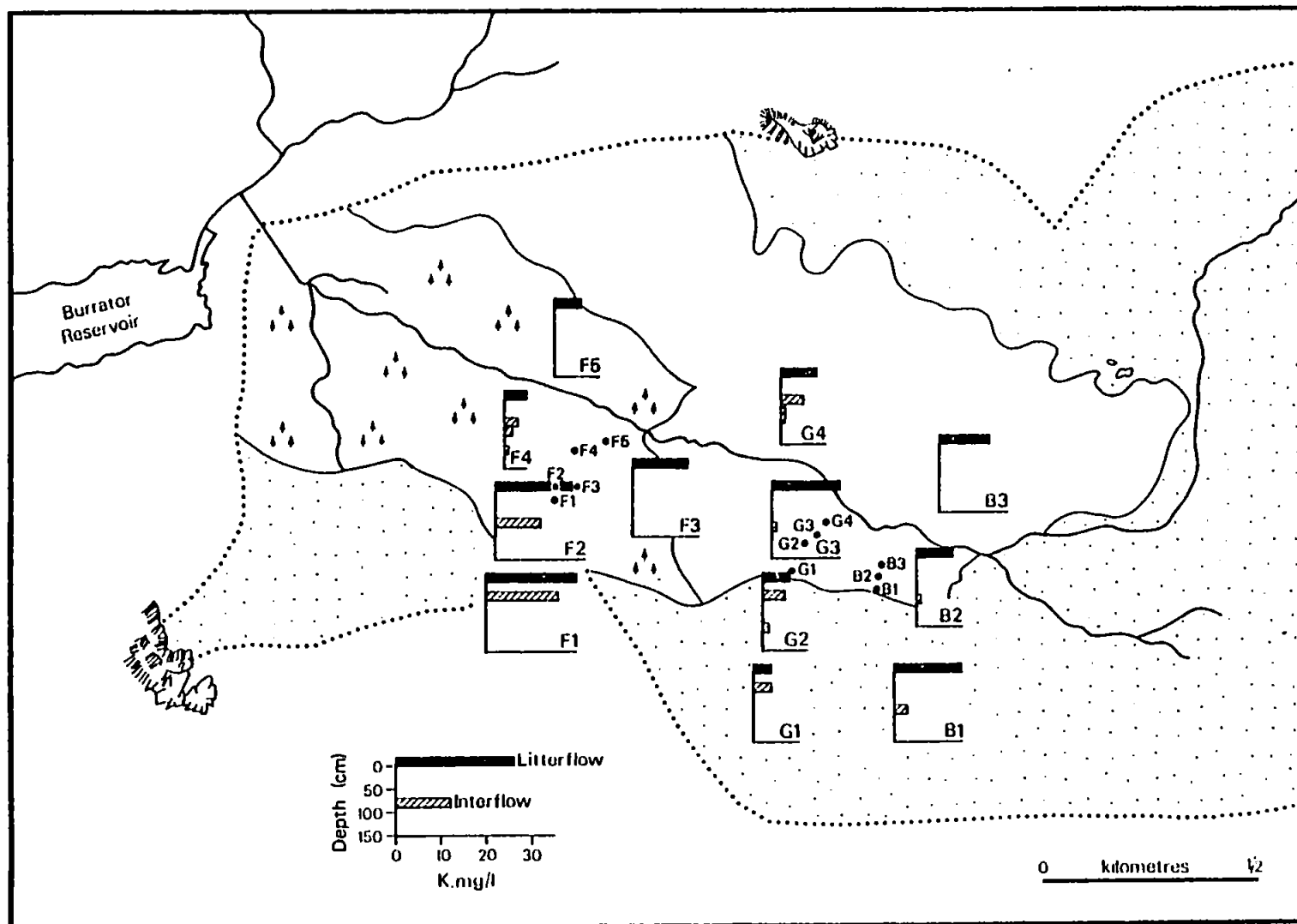


Fig. 6.10. Potassium concentrations in litterflow runoff and interflow

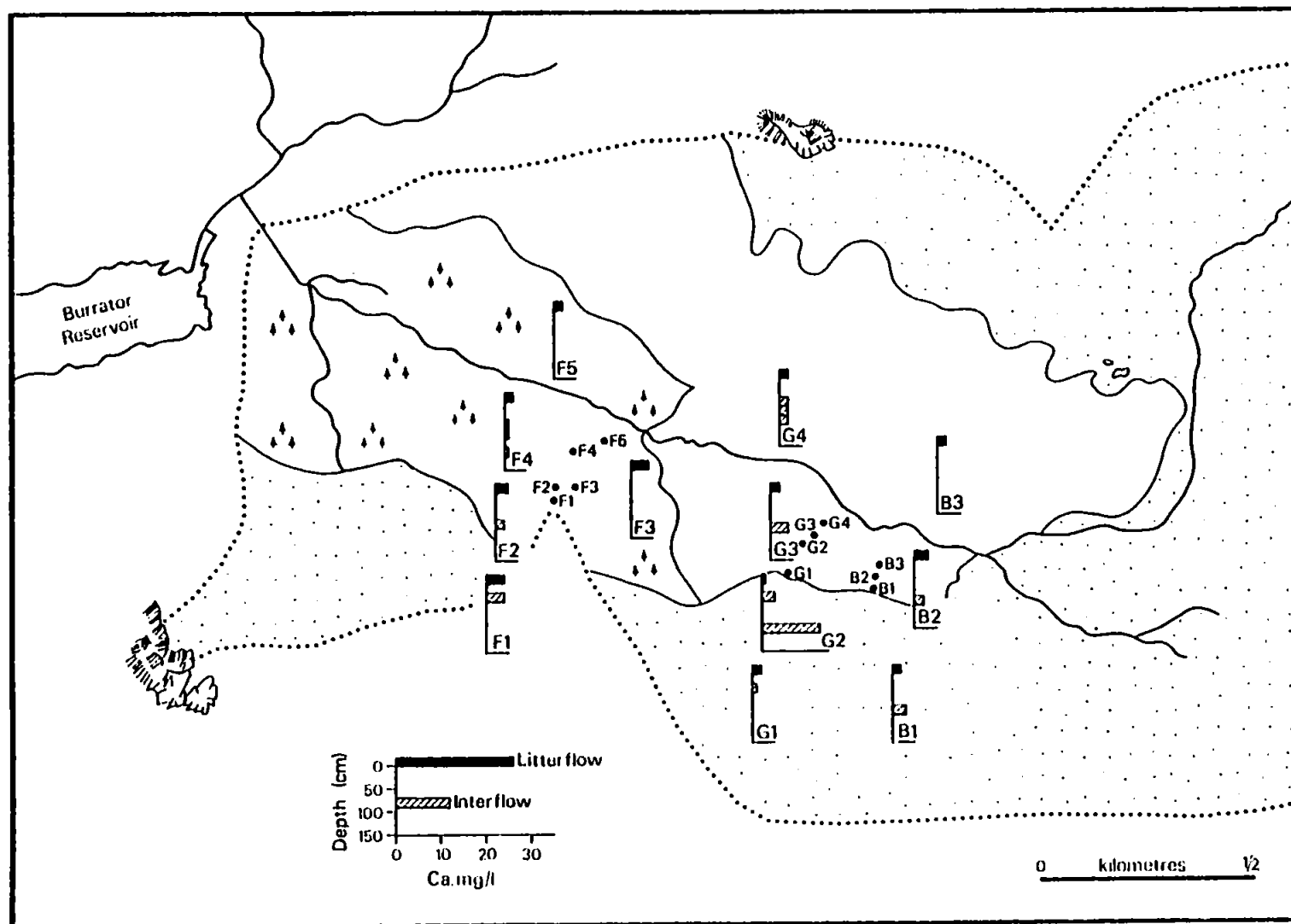


Fig. 6.11. Calcium concentrations in litterflow runoff and interflow

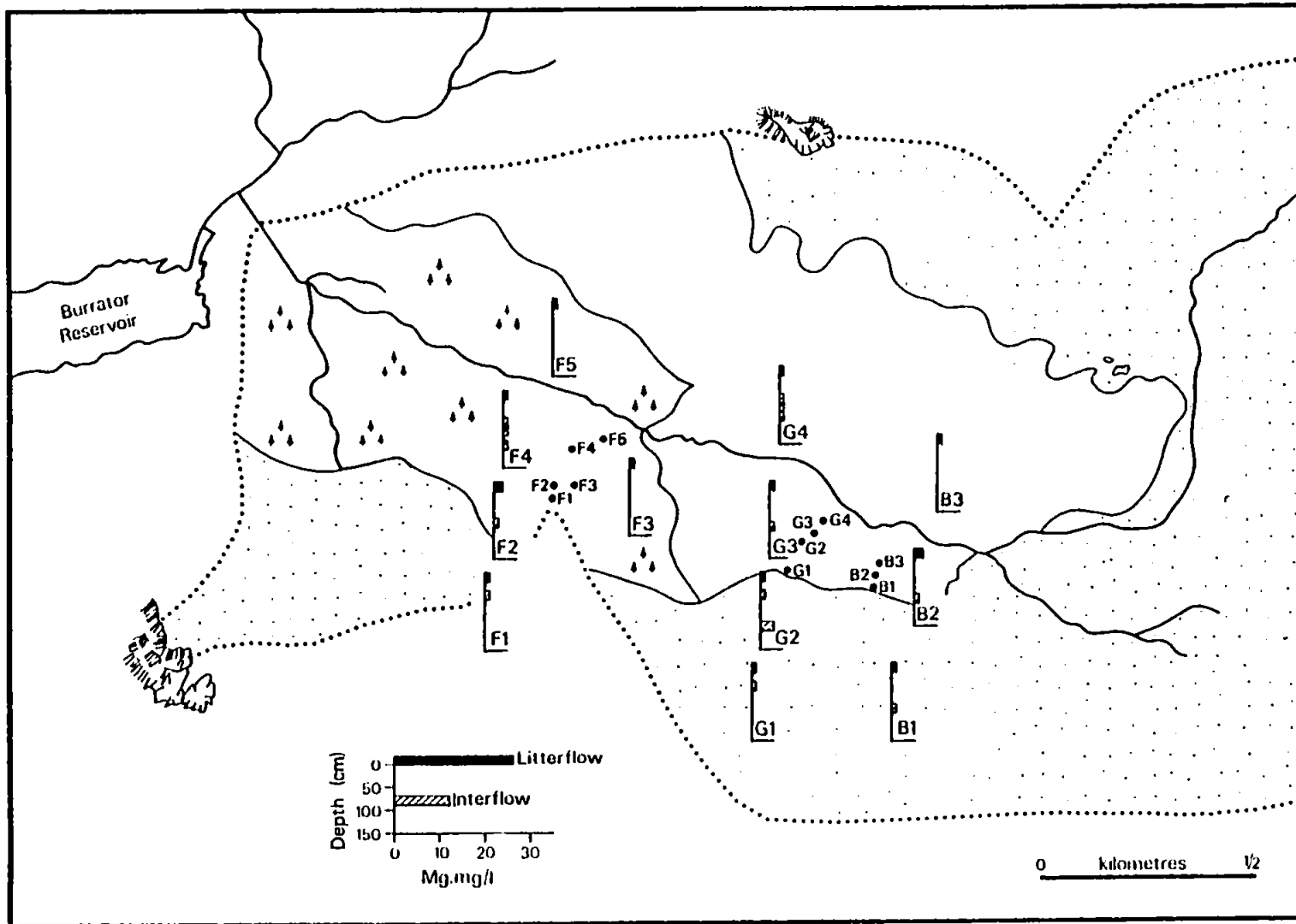


Fig. 6.12. Magnesium concentrations in litterflow runoff and interflow

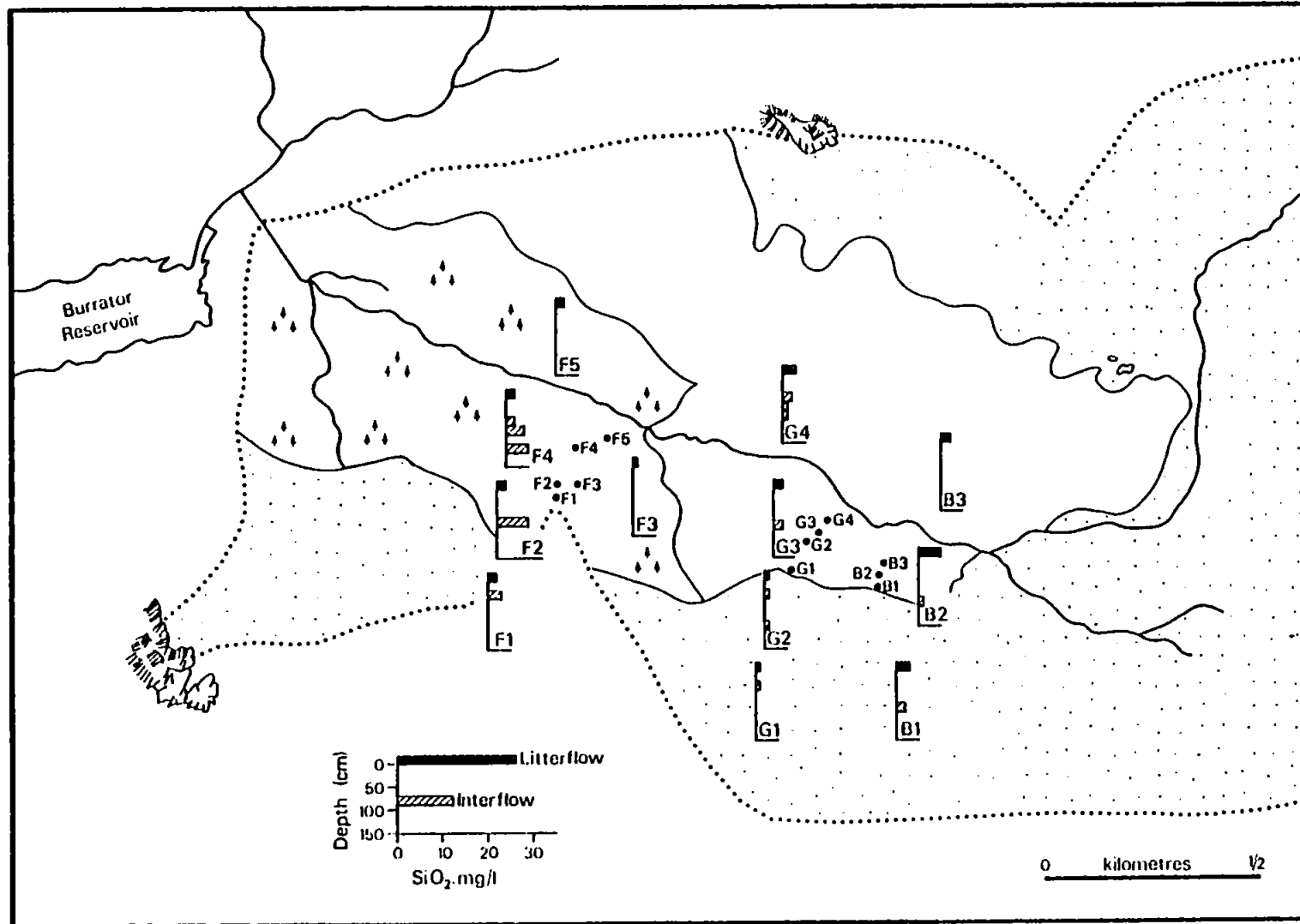


Fig. 6.13. Silica concentrations in litterflow runoff and interflow

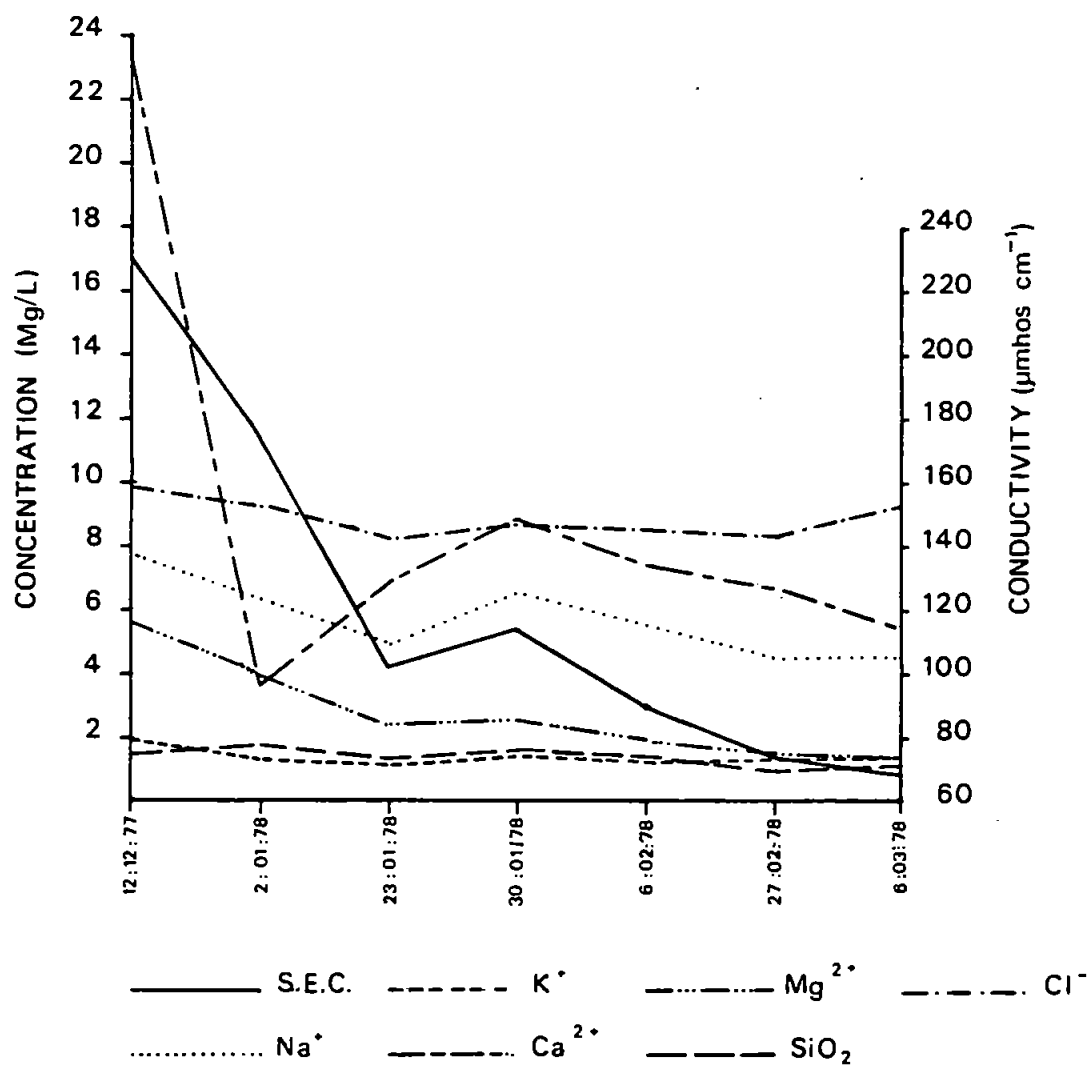


Fig. 6.14. Temporal variation in grassland interflow chemistry (G2, 100 cm depth) during weeks of flow

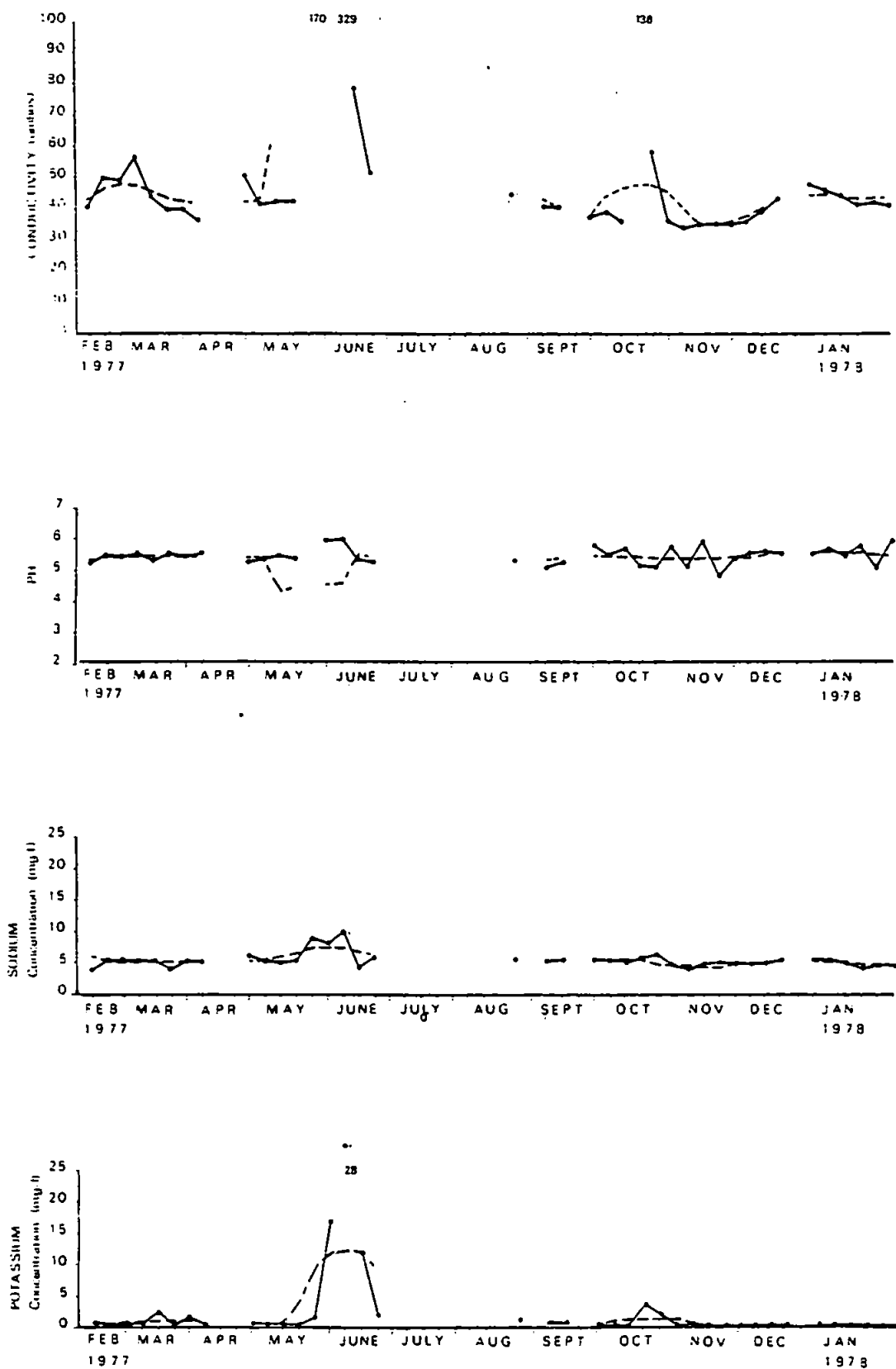


Fig. 6.15. Temporal variation in grassland interflow chemistry (G4, 92 cm depth)

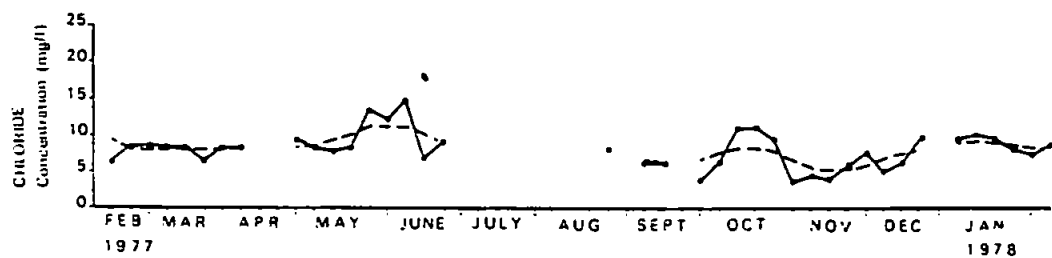
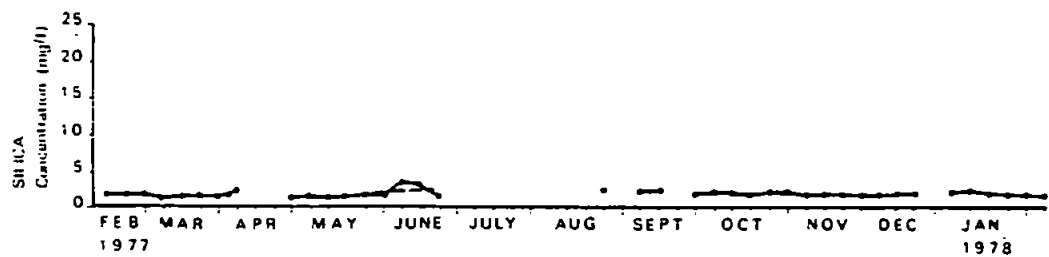
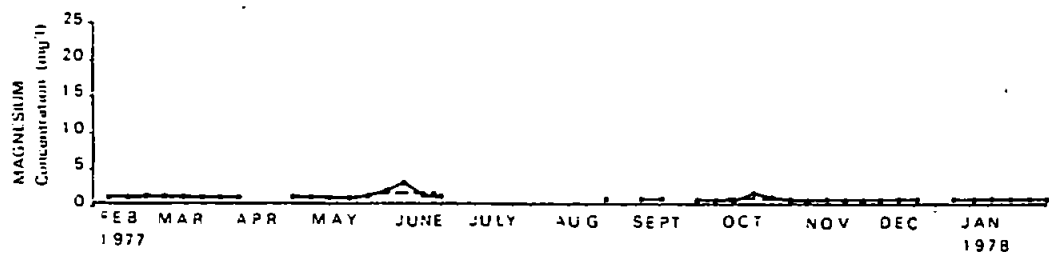
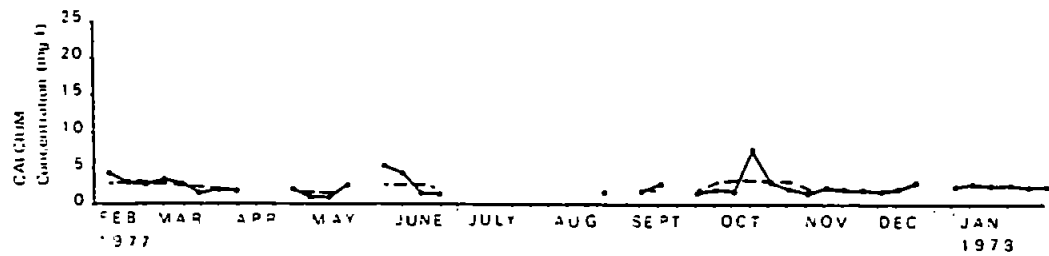


Fig. 6.15 (continued)

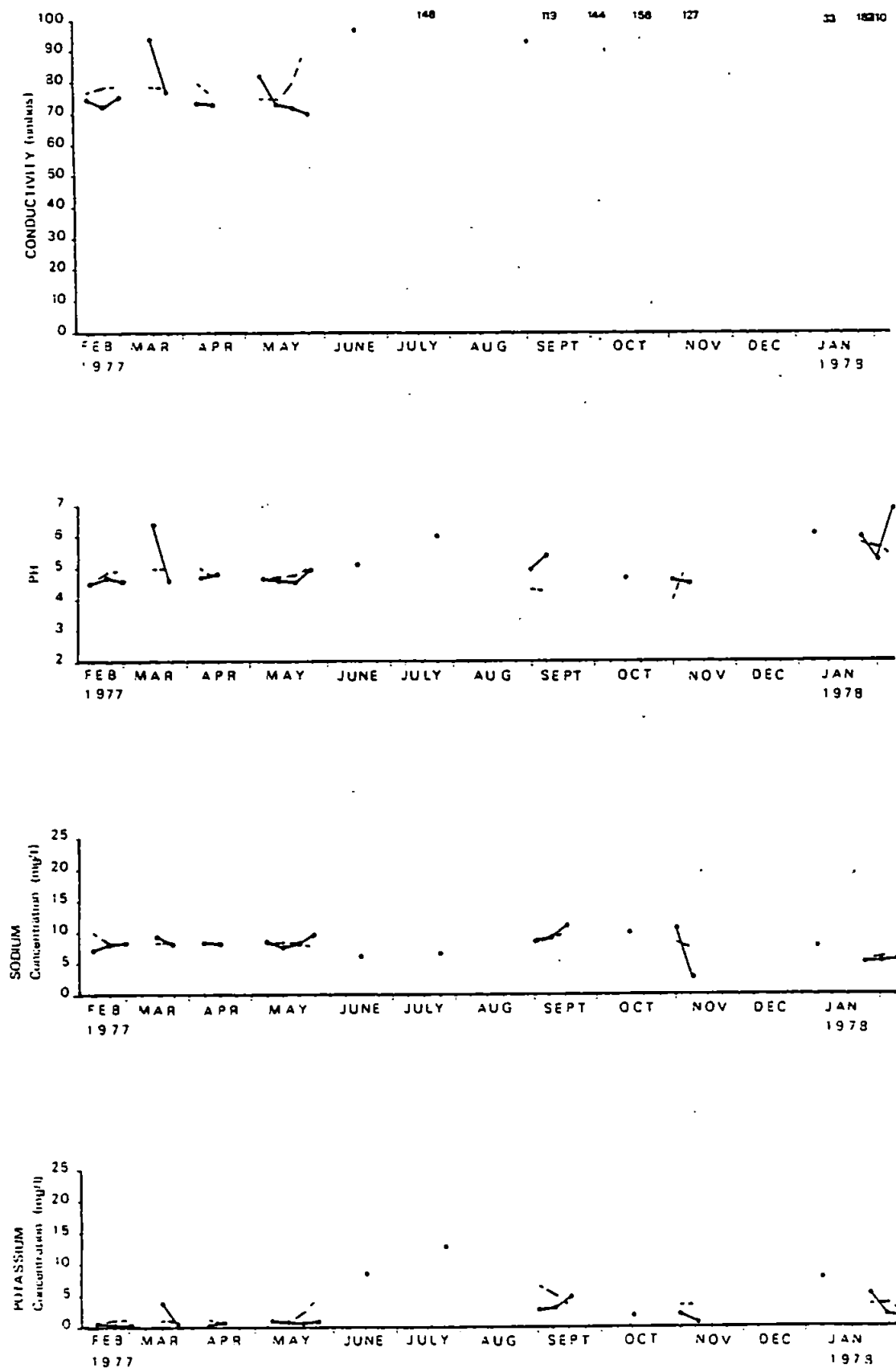


Fig. 6.16. Temporal variation in bracken interflow chemistry (B1, 85 cm depth)

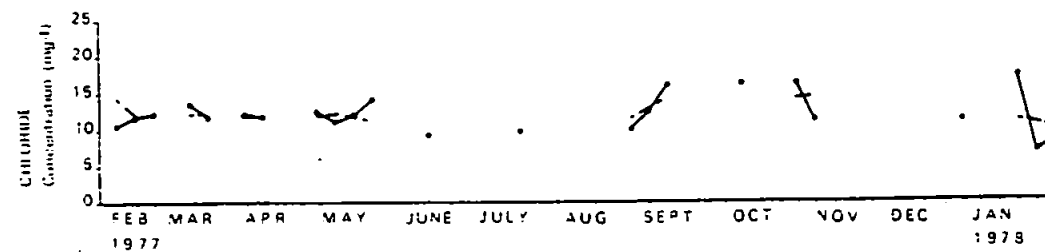
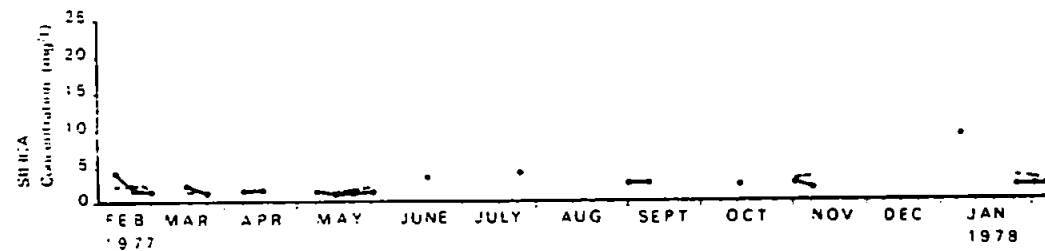
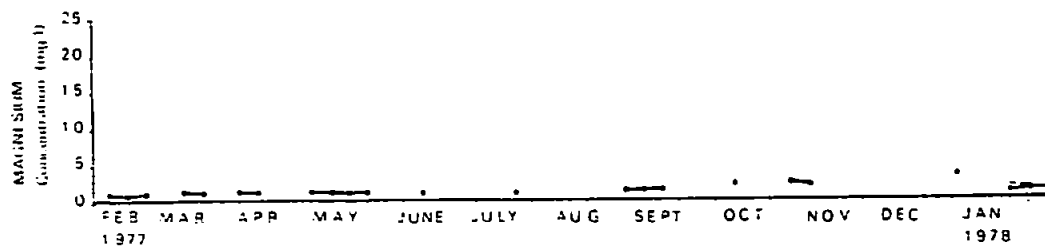
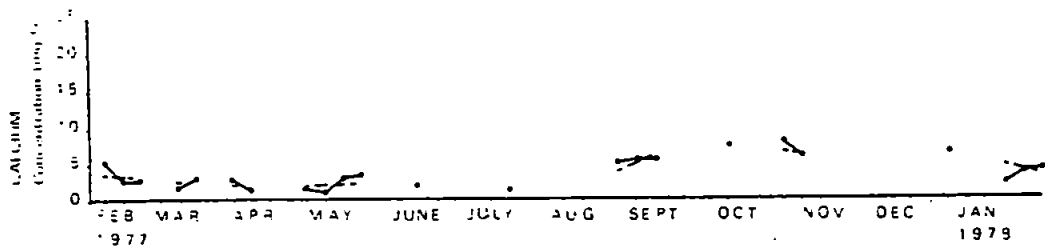


Fig. 6.16 (continued)

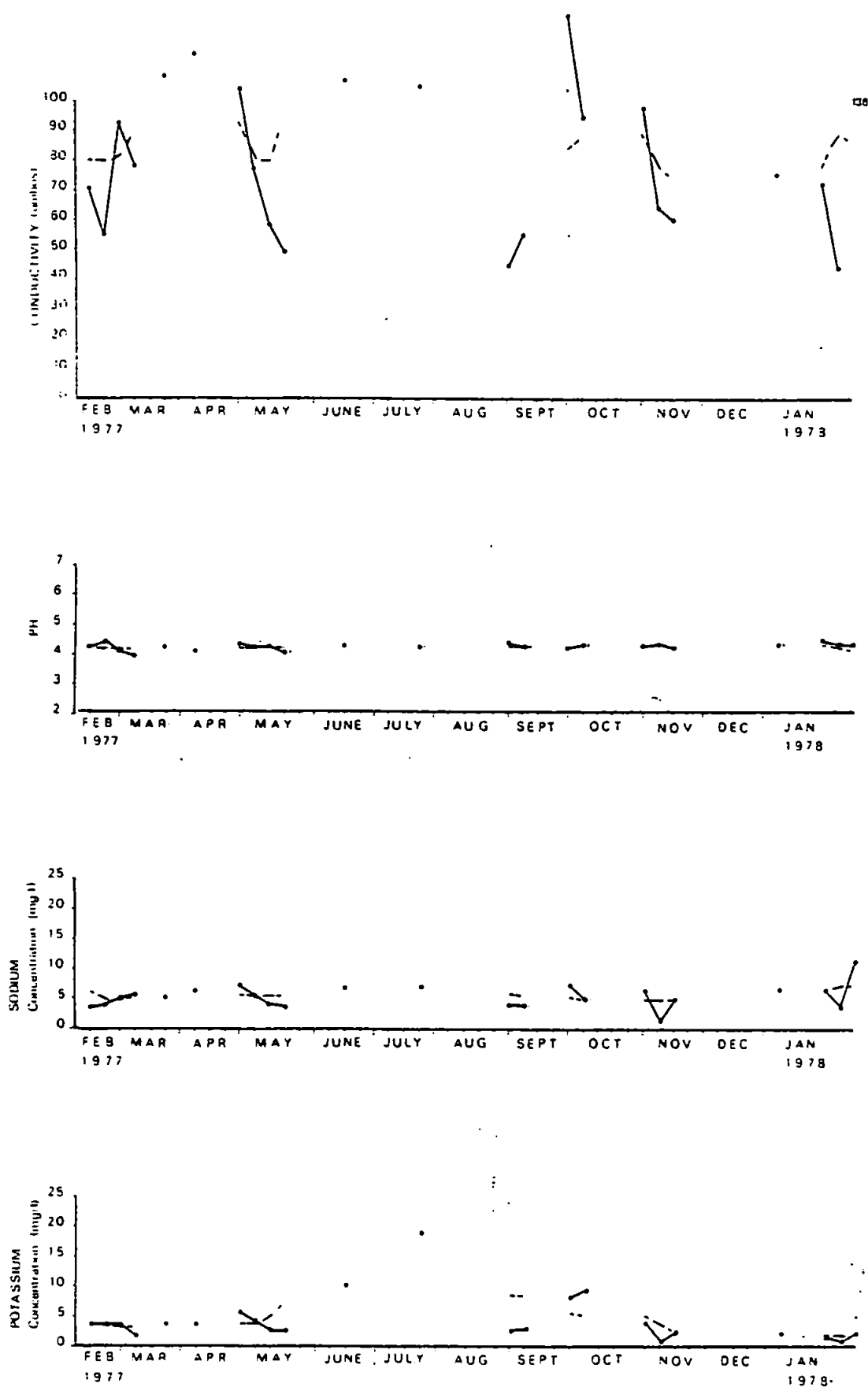


Fig. 6.17. Temporal variation in forest interflow chemistry (F4, 53 cm depth)

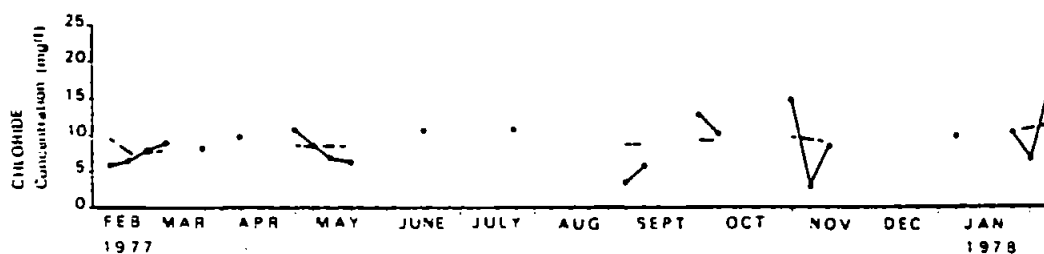
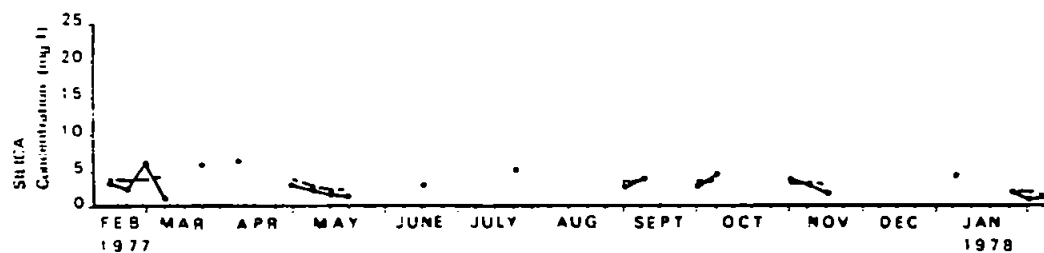
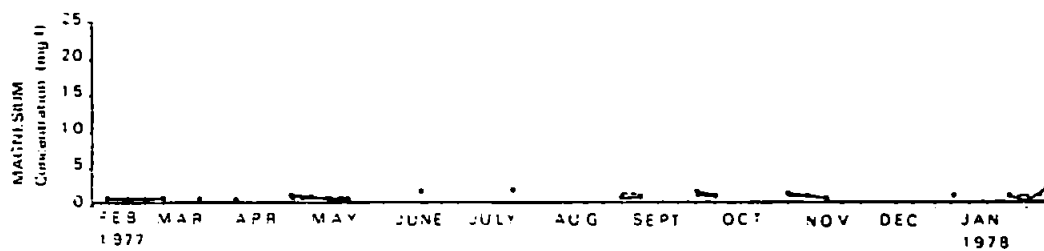
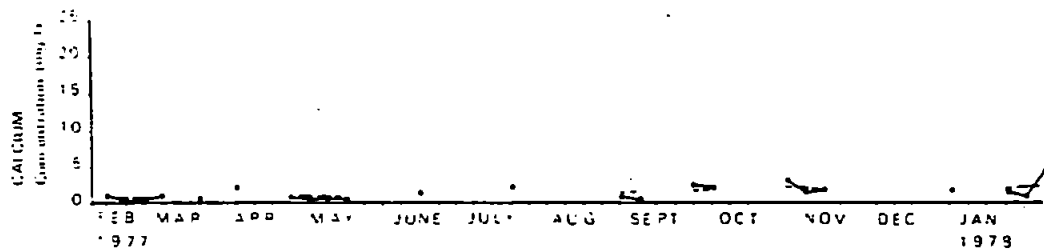
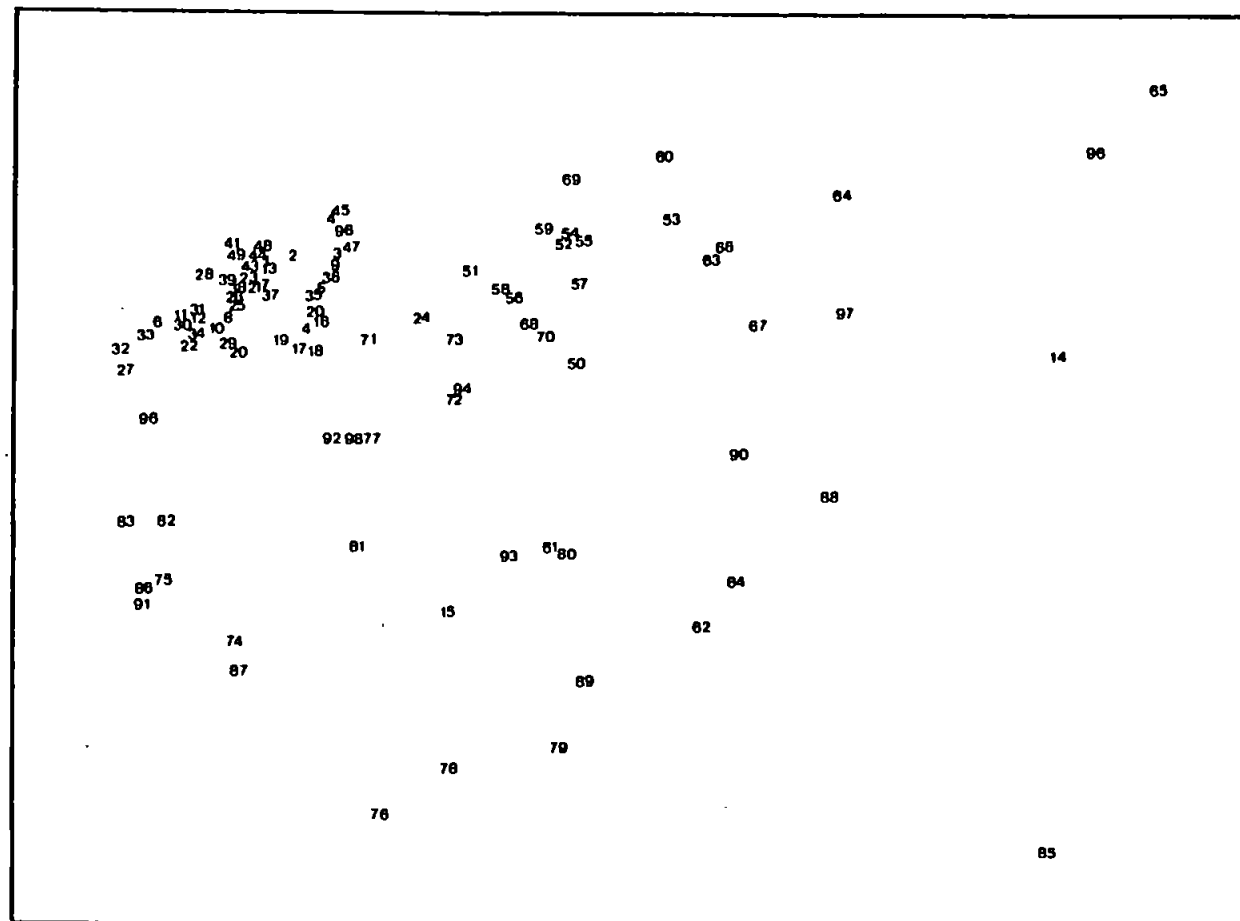


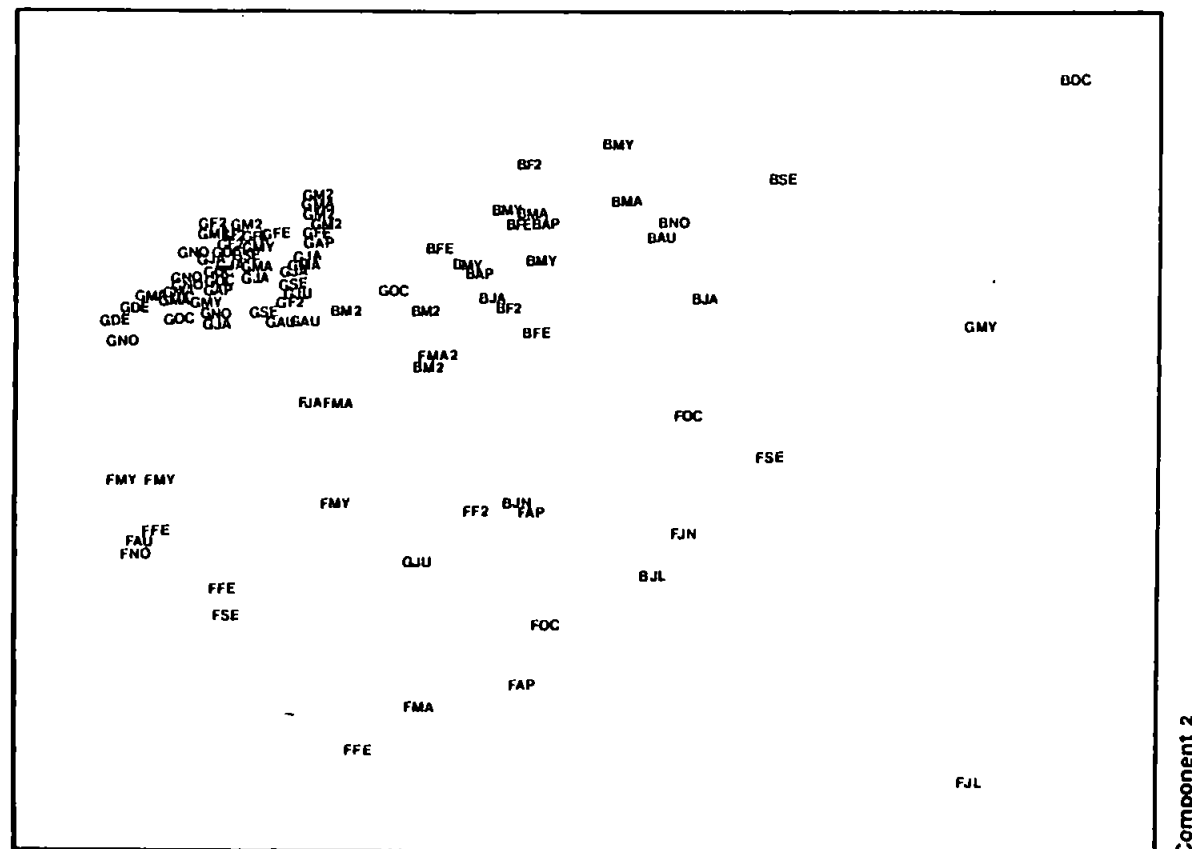
Fig. 6.17 (continued)

Component 1



Principal Components Analysis of Interflow Chemical Data 1977 - 78

Fig. 6.18. Principal components analysis of interflow chemical data



Principal Components Analysis of Interflow Chemical Data 1977 - 78

Fig. 6.18. continued

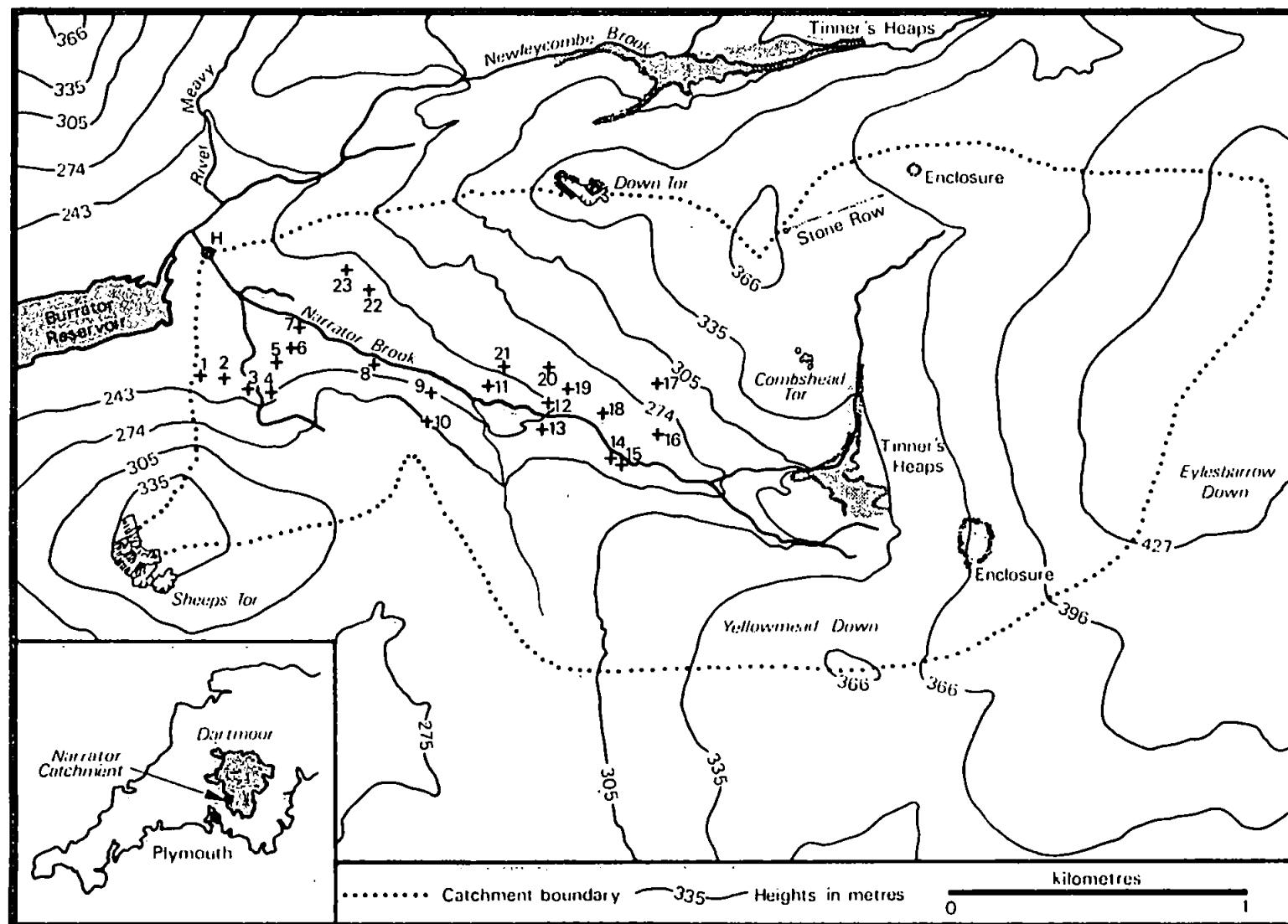


Fig. 7.1. Location of springs monitored in the Narrator catchment

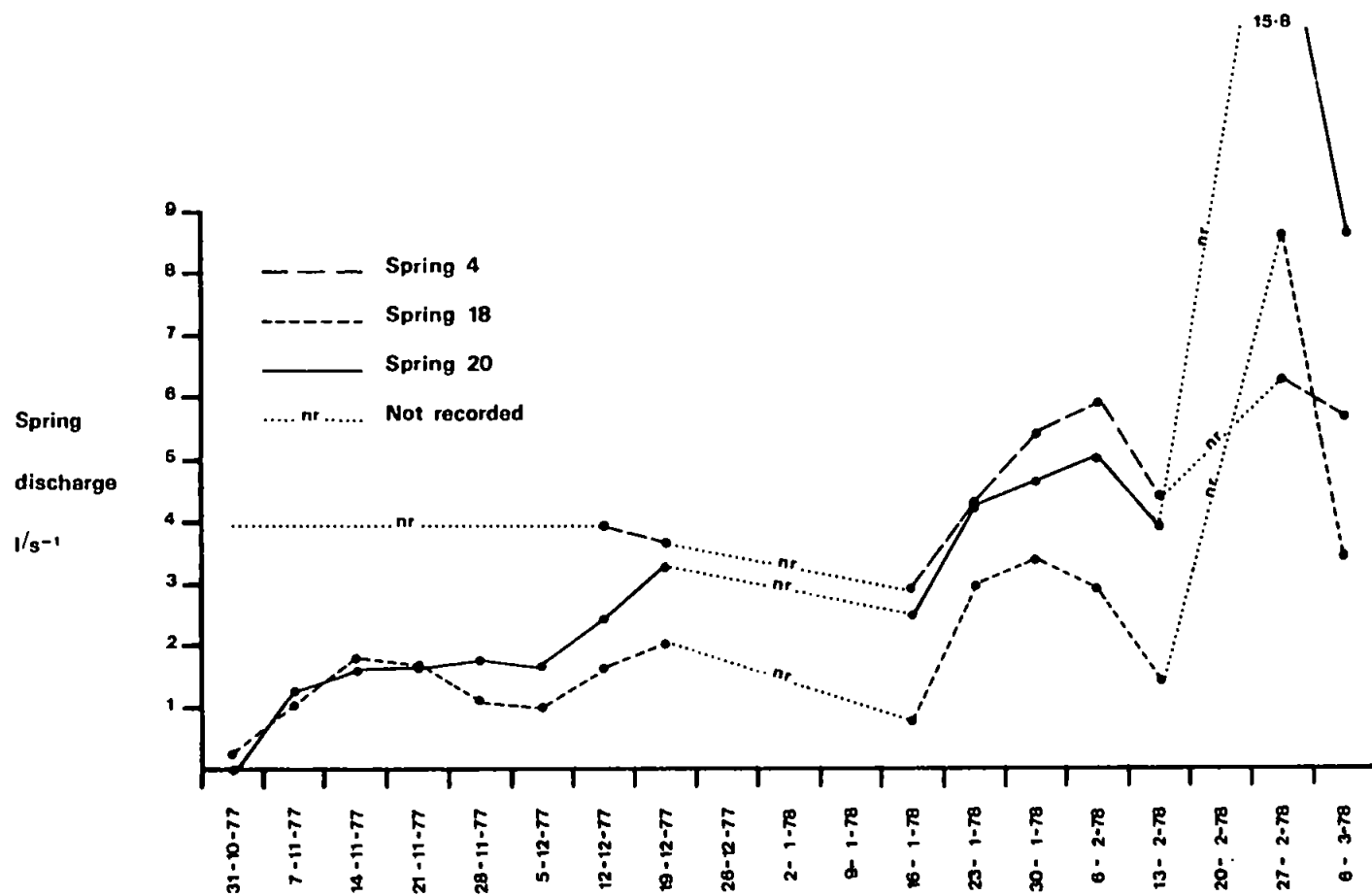


Fig. 7.2. Discharge of springs 4, 18 and 20

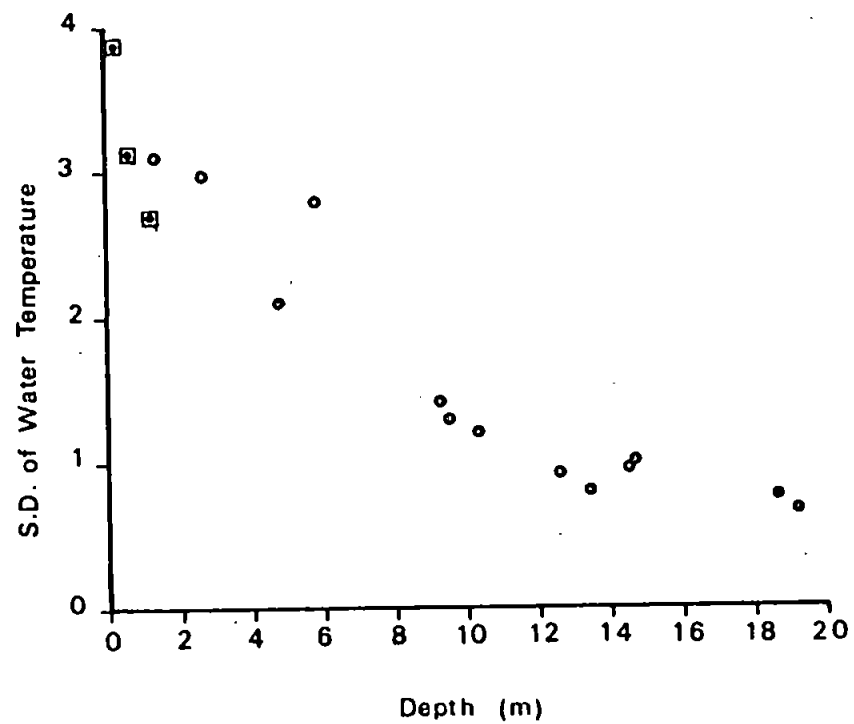


Figure 7.3 Soil (■) and ground water (●, after Alexander, 1983) temperature variability data in the Narrator catchment

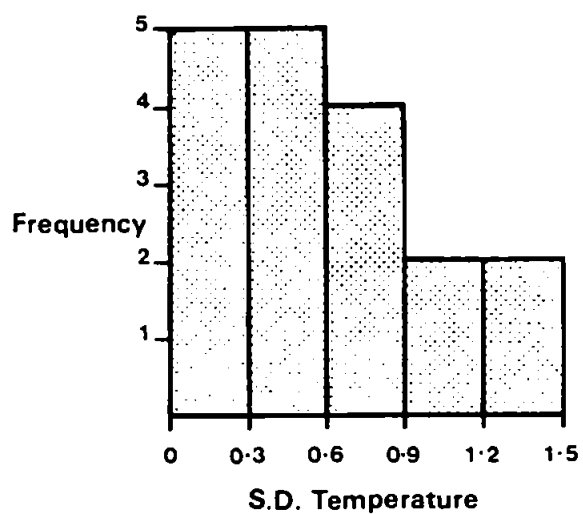


Fig. 7.4. Distribution of the standard deviation of spring temperatures for the springs in the Narrator catchment (N = 18)

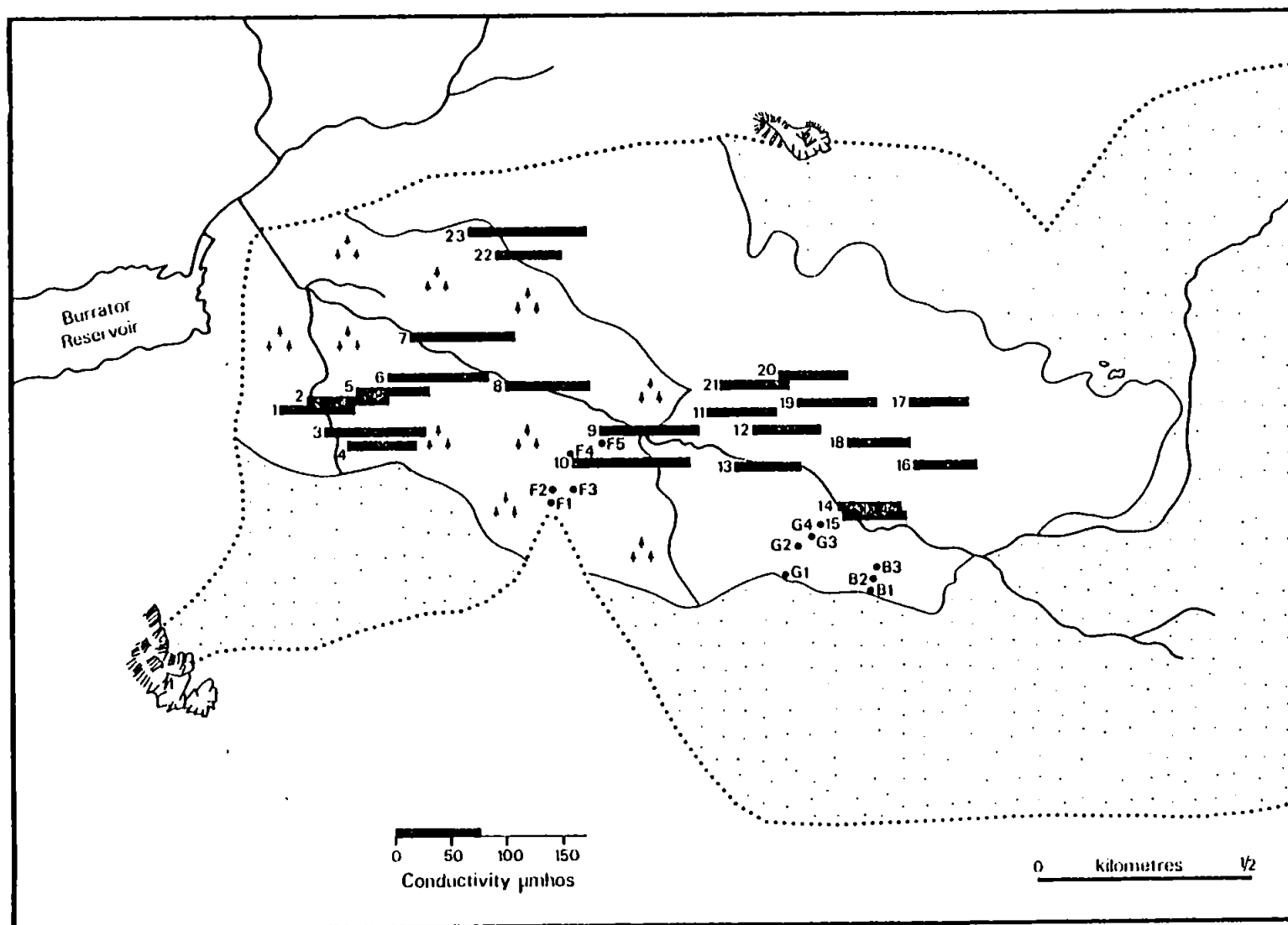


Fig. 7.5. Conductivity levels in springs

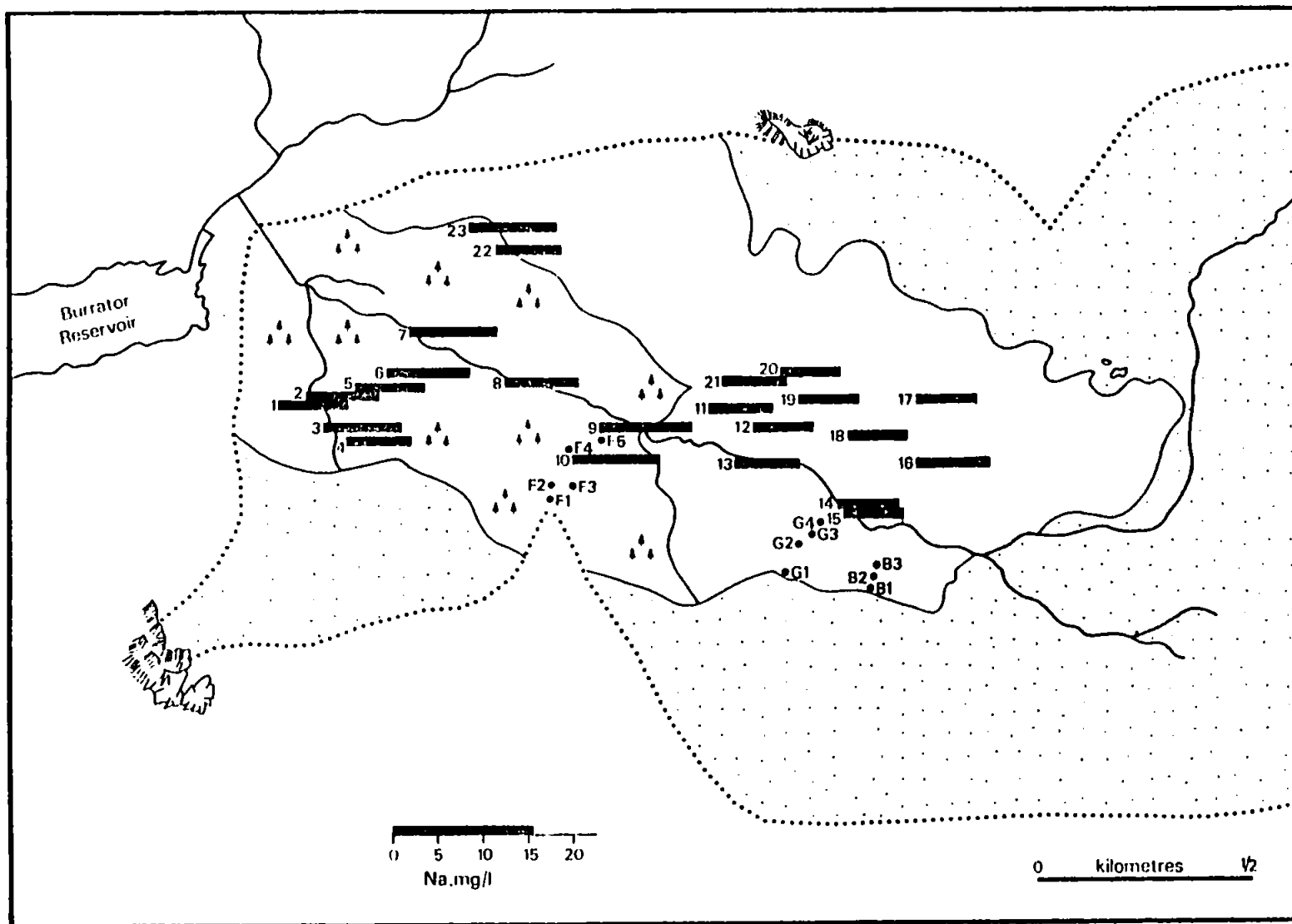


Fig. 7.6. Sodium concentrations in springs

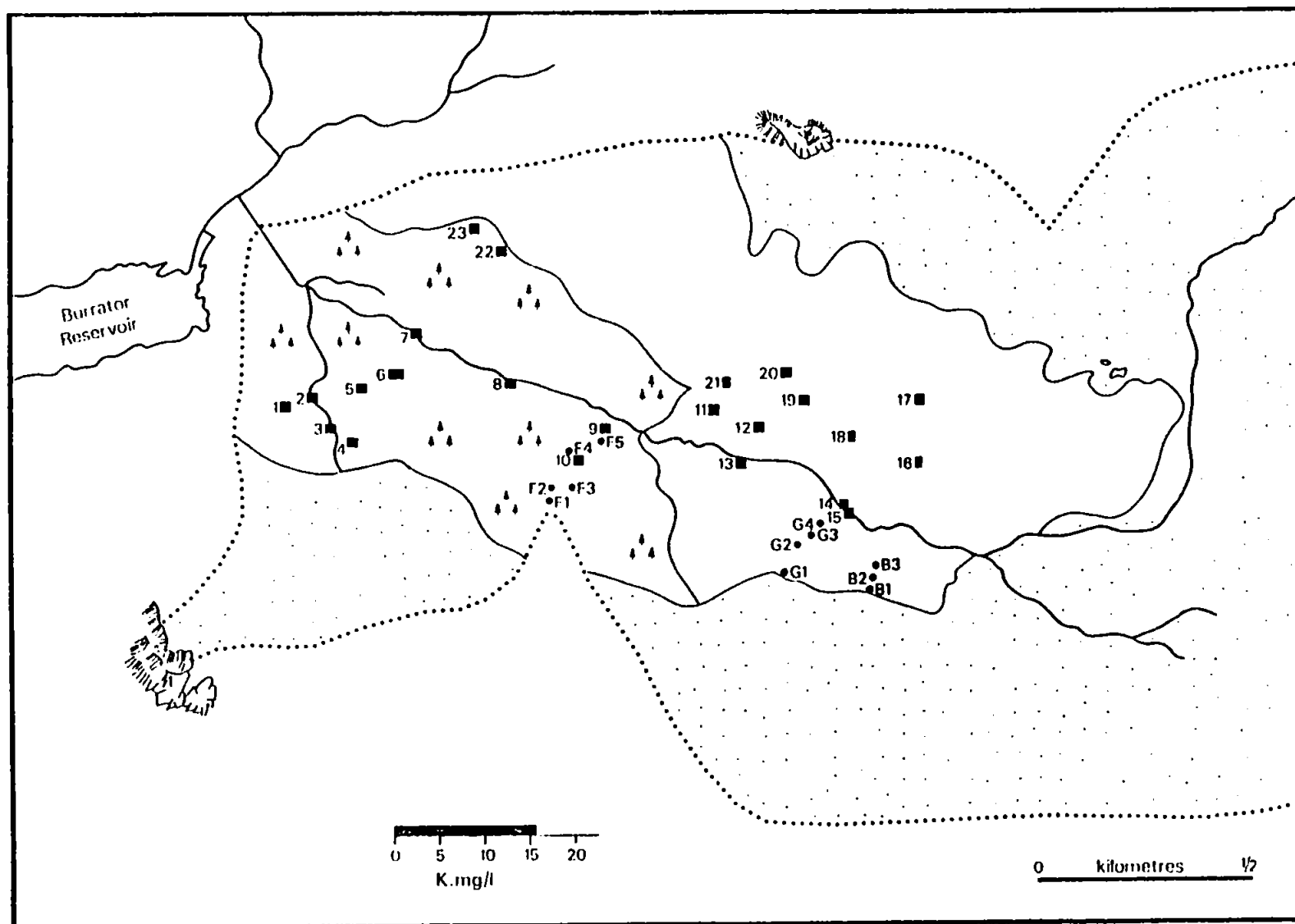


Fig. 7.7. Potassium concentrations in springs

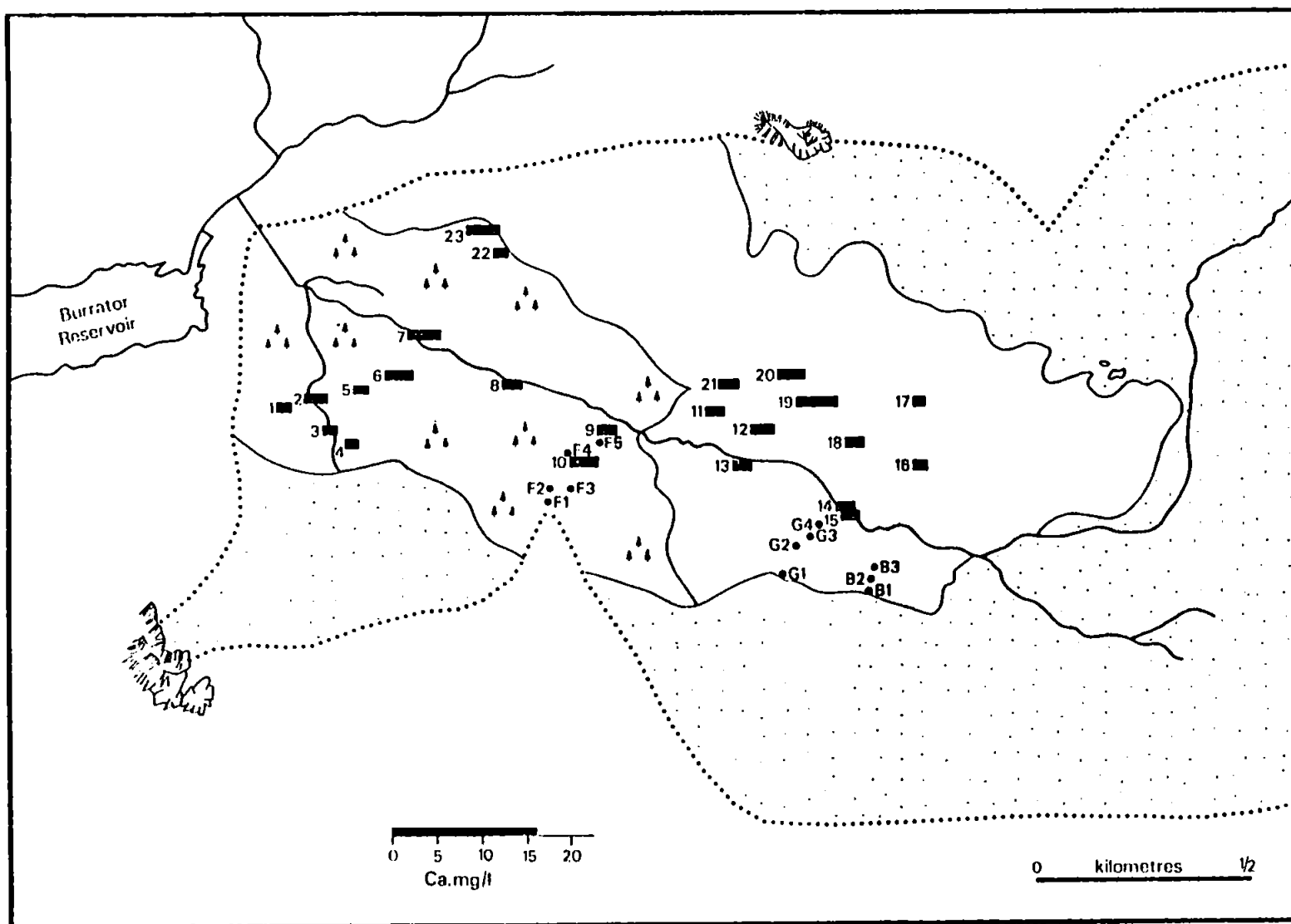


Fig. 7.8. Calcium concentrations in springs

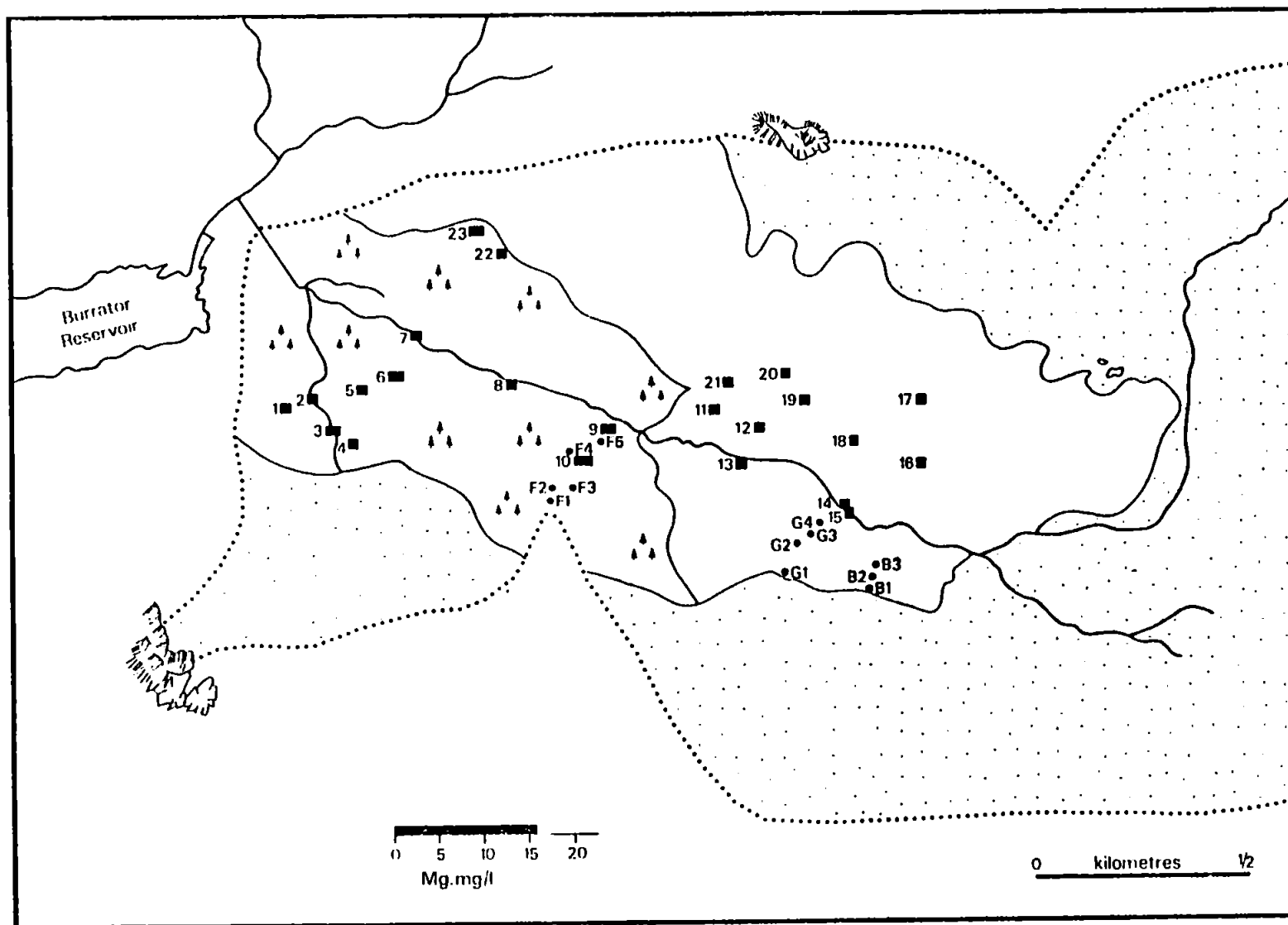


Fig. 7.9. Magnesium concentrations in springs

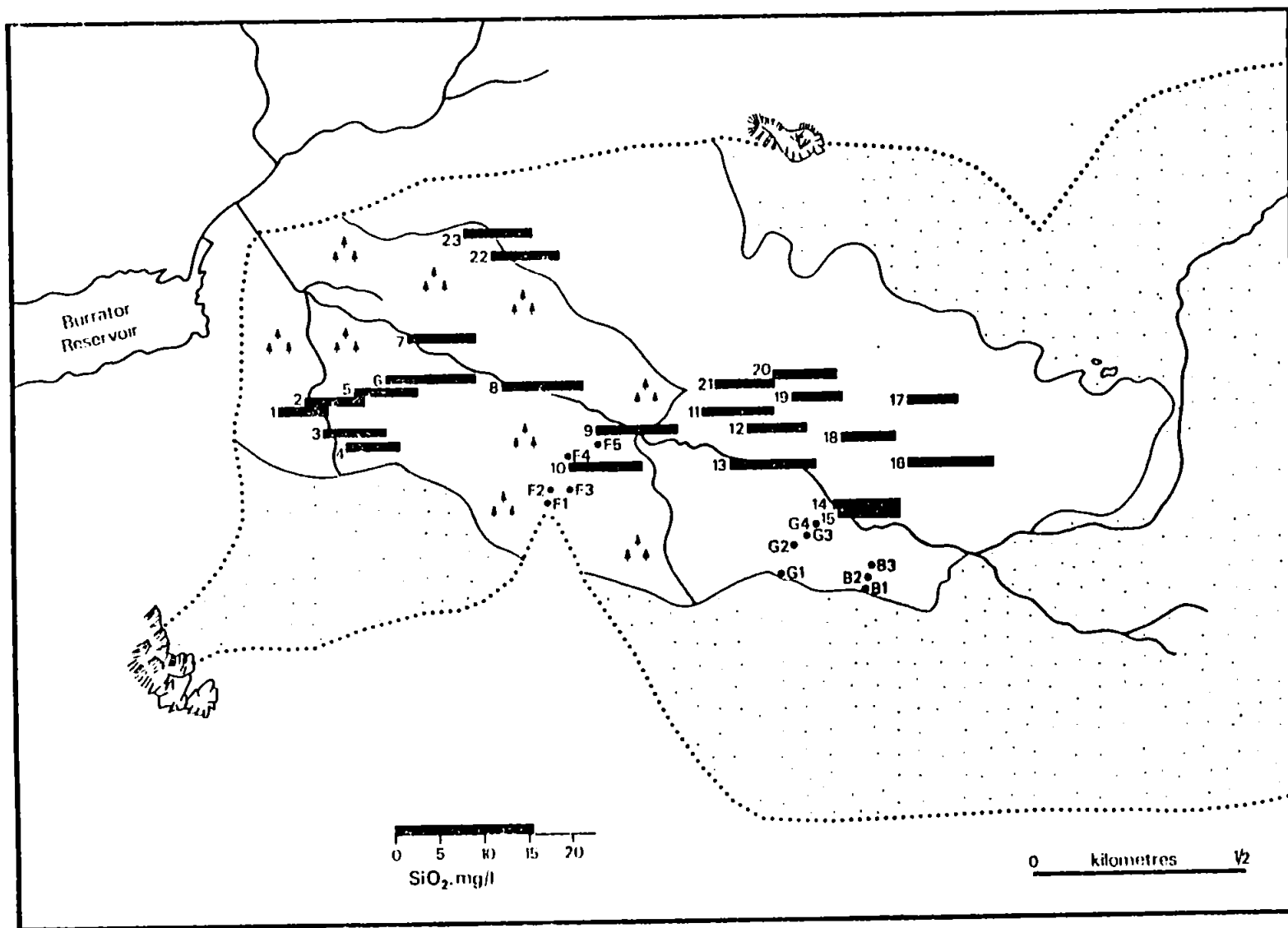


Fig. 7.10. Silica concentrations in springs

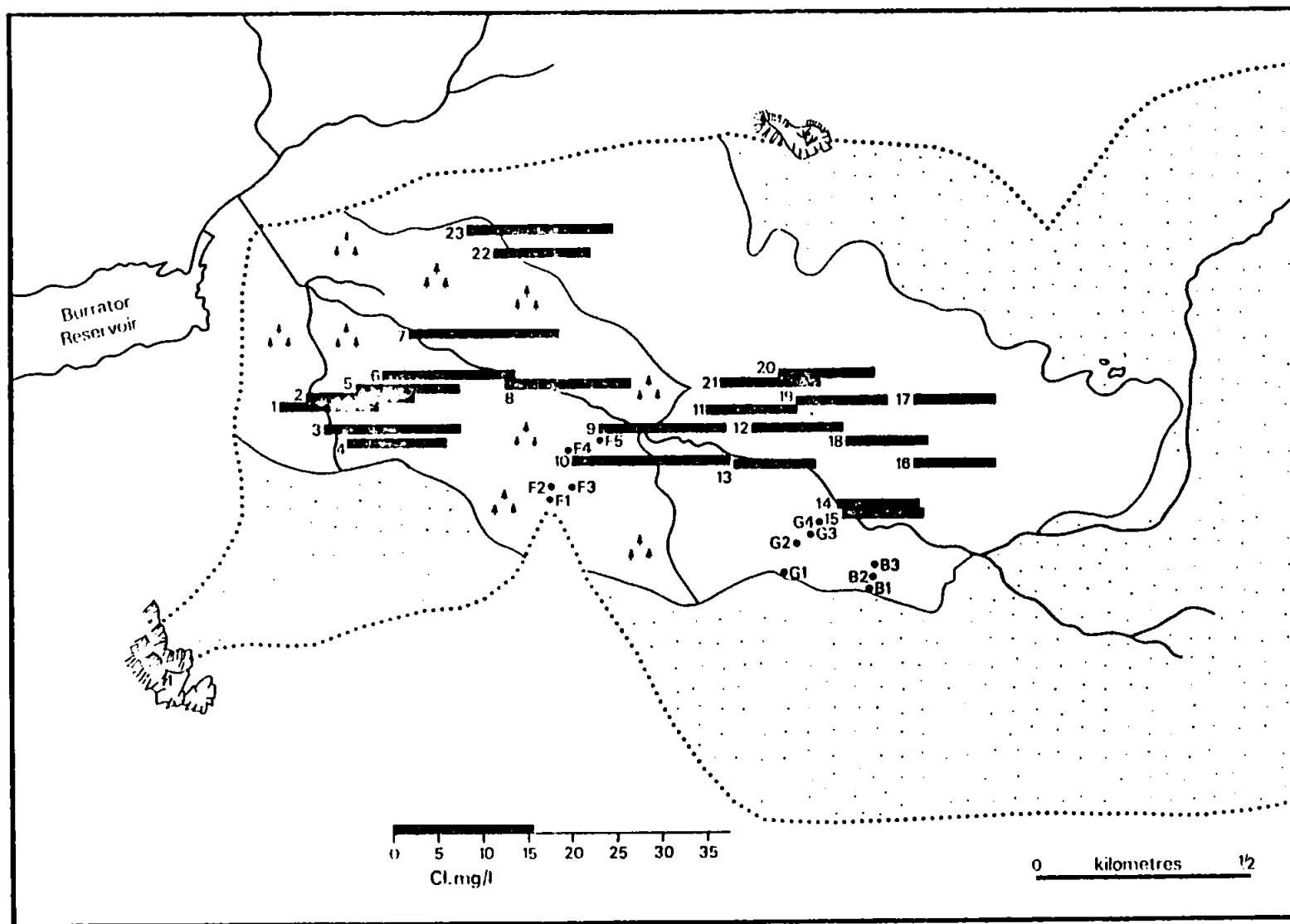


Fig. 7.11. Chloride concentrations in springs

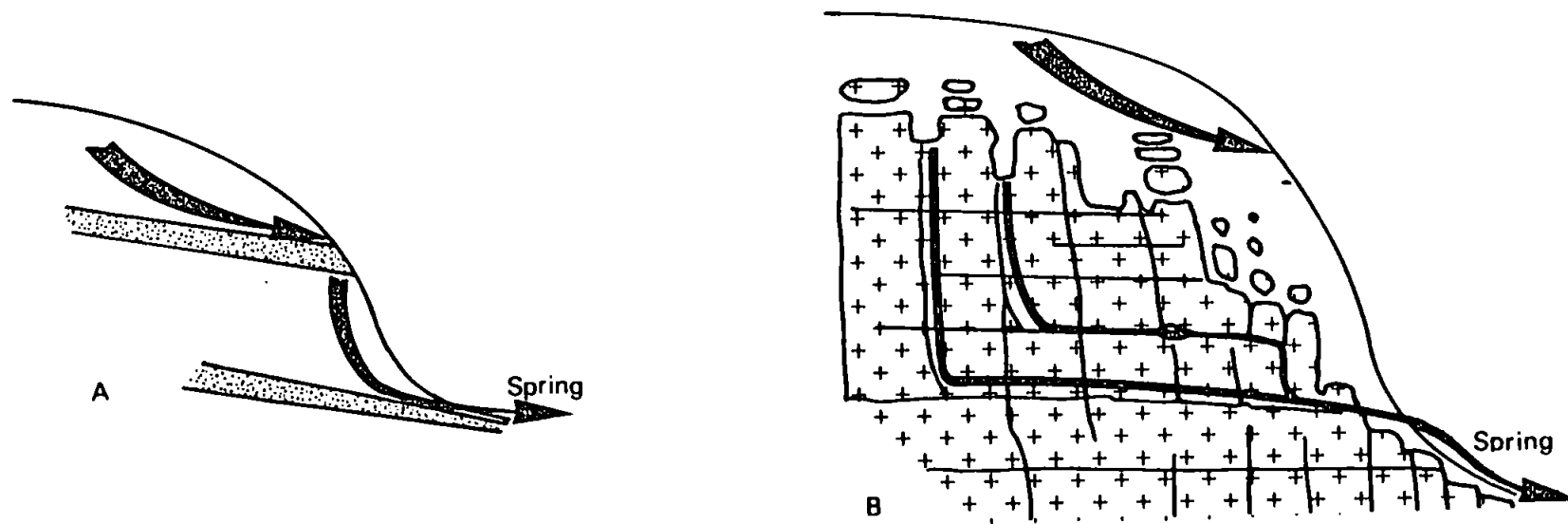


Fig. 7.12. Permeability differences in the regolith and spring emergence

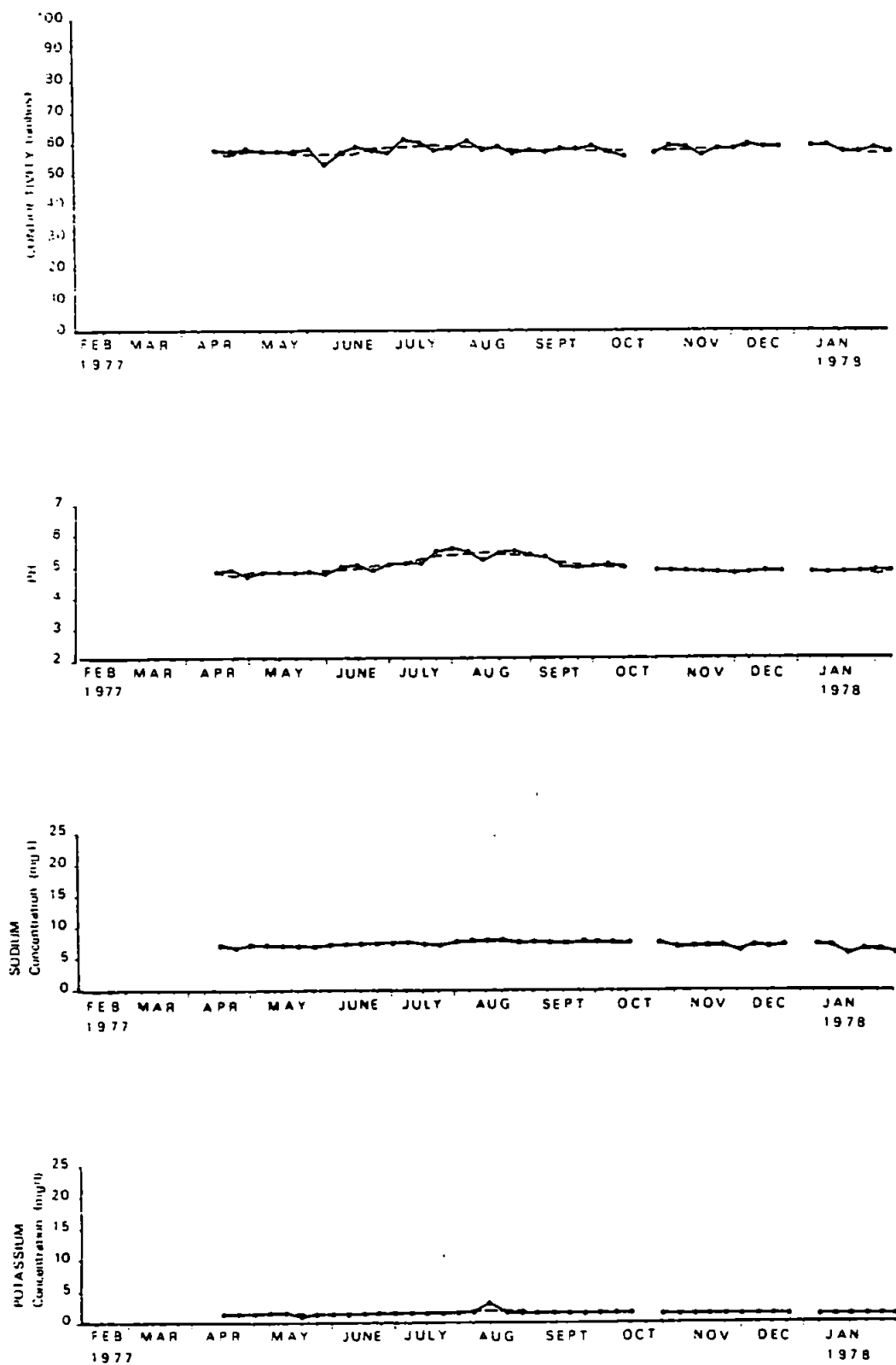


Fig. 7.13. Temporal variation in solute chemistry of spring 13

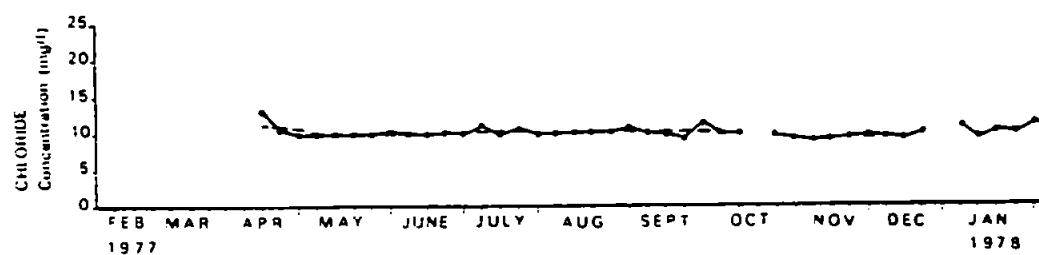
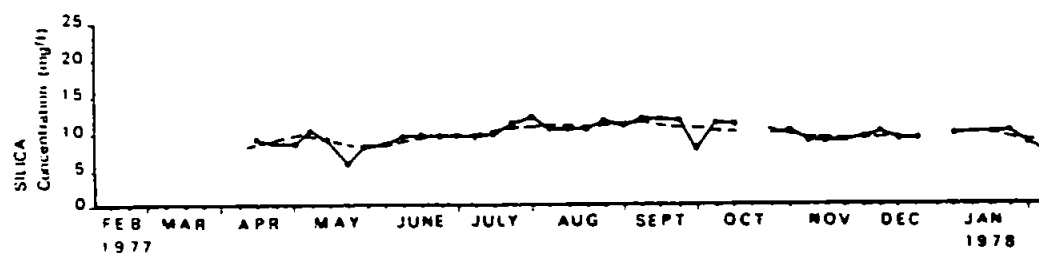
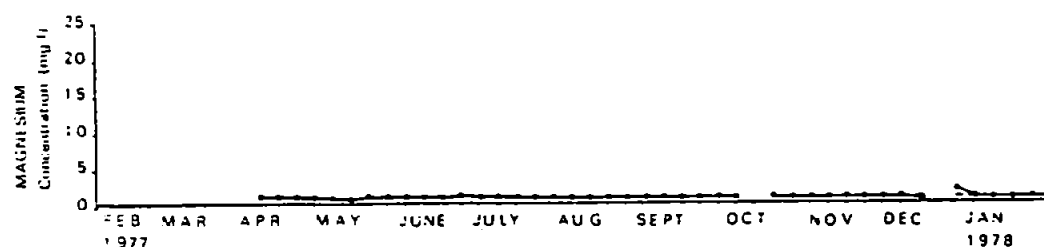
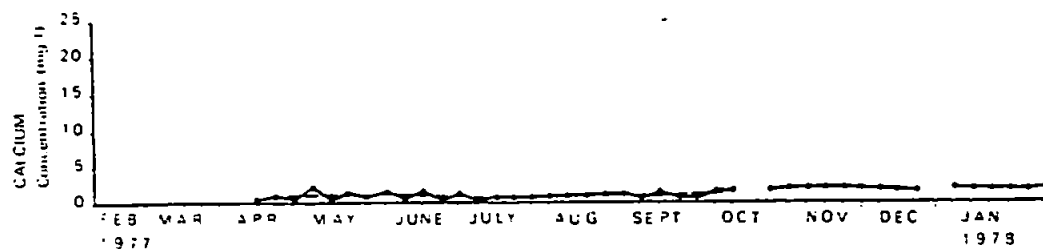


Fig. 7.13 (continued)

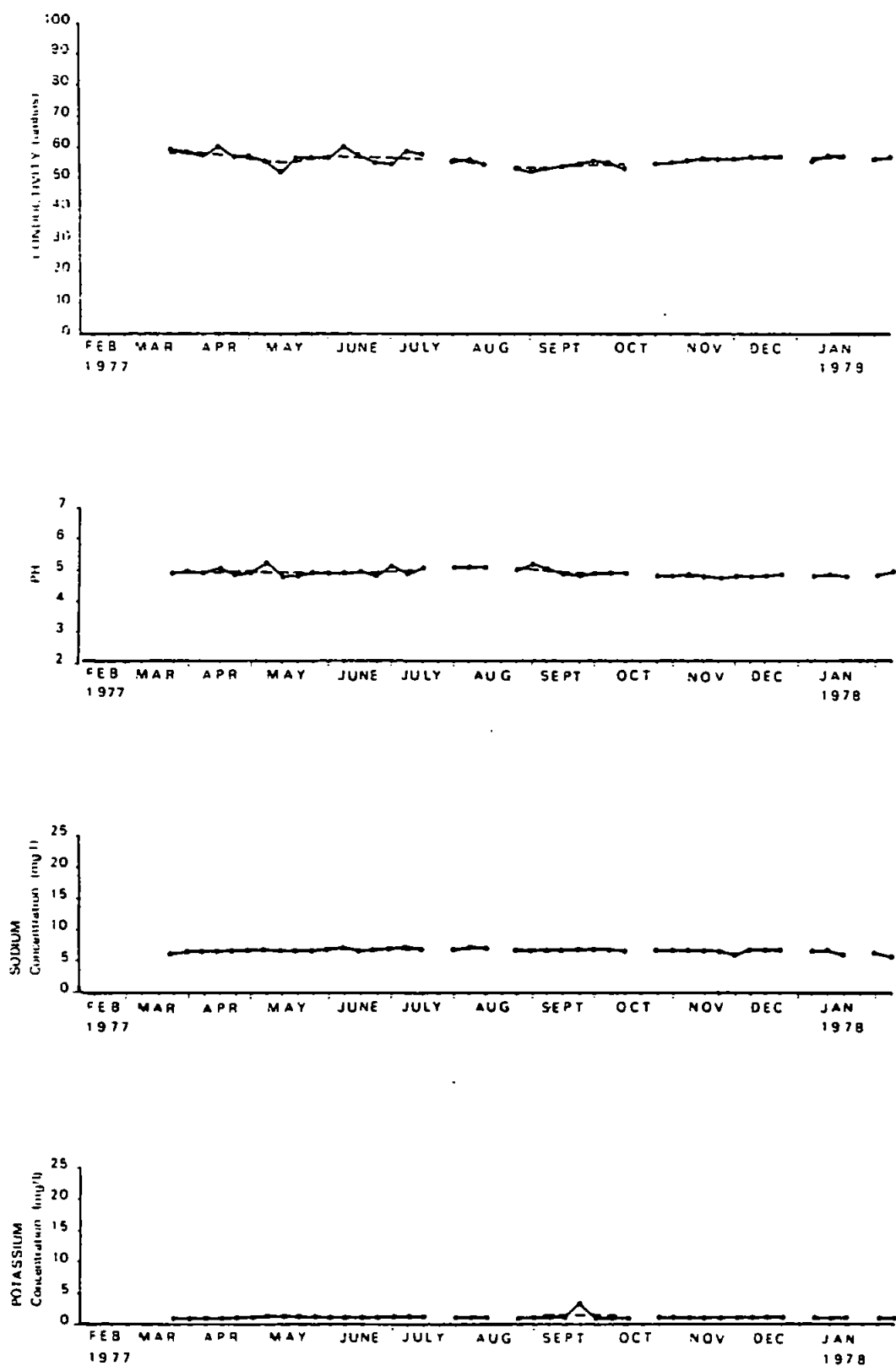


Fig. 7.14. Temporal variation in solute chemistry of spring 14

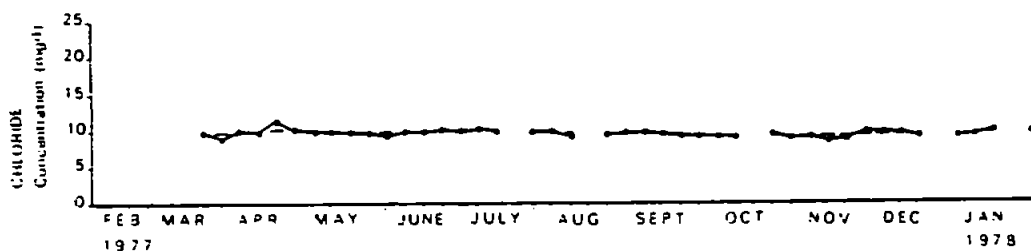
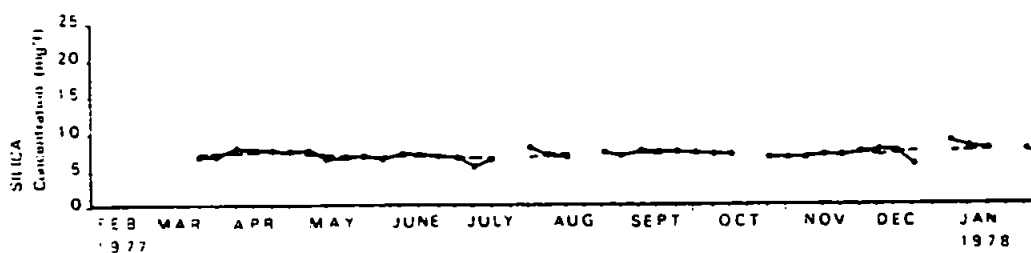
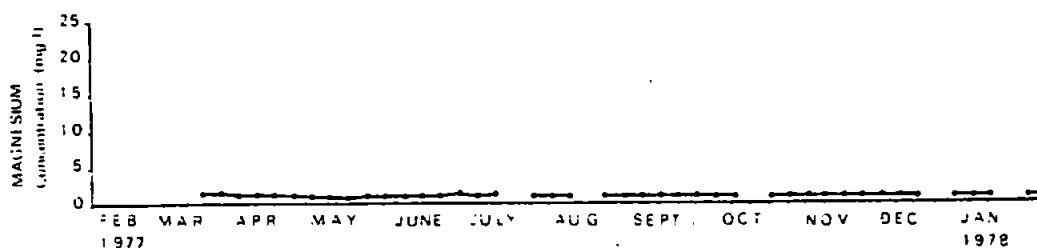
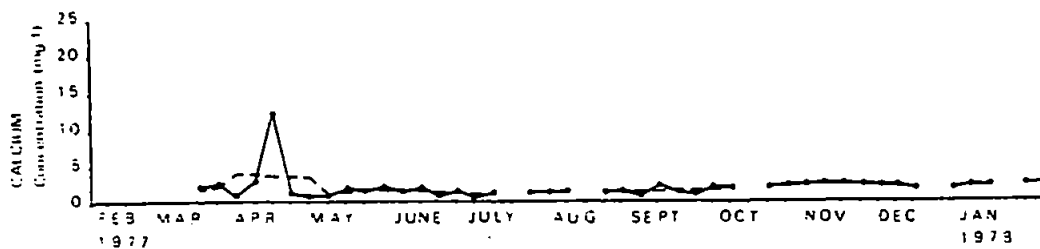


Fig. 7.14 (continued)

PRINCIPAL COMPONENTS ANALYSIS OF SPRING DATA

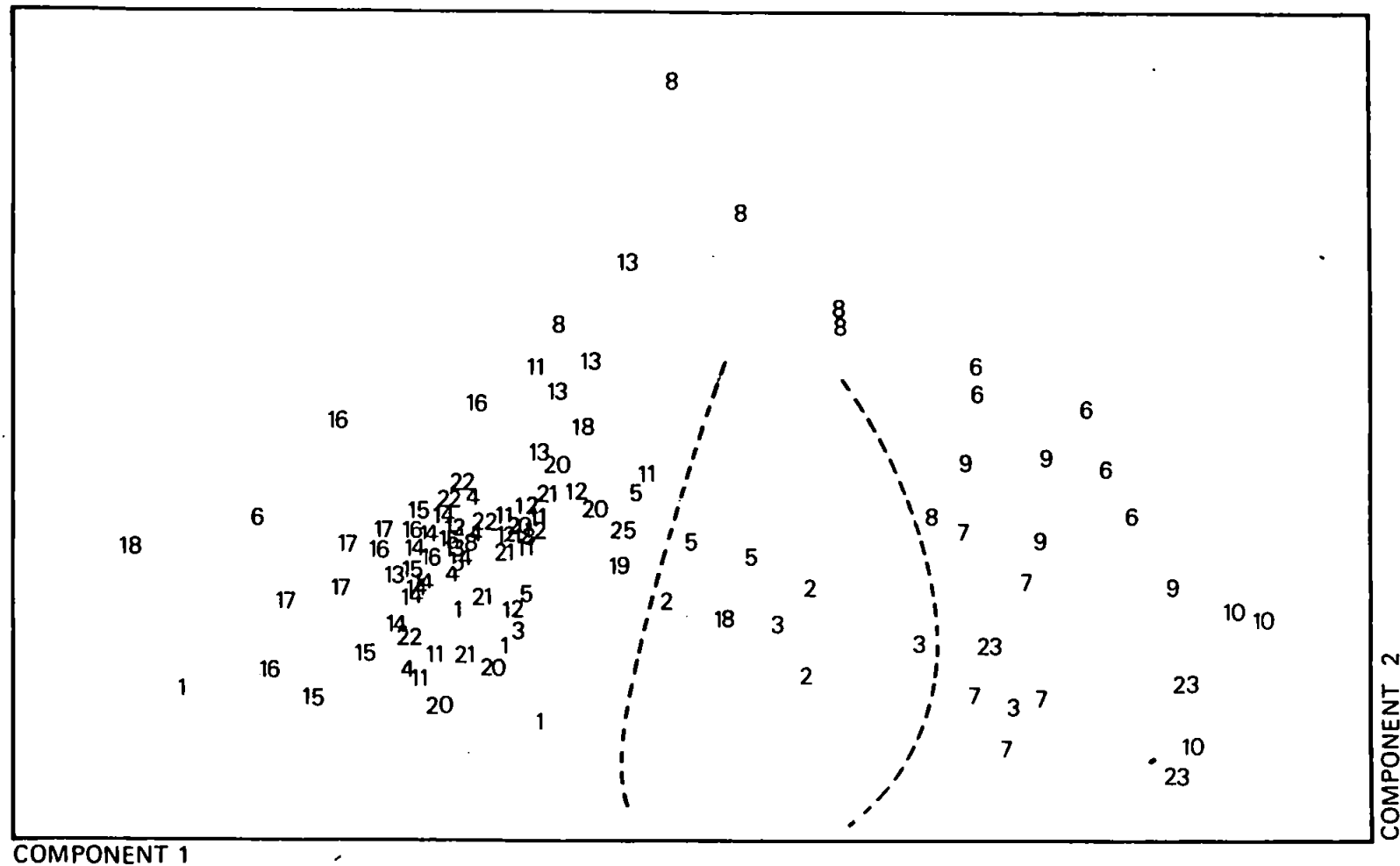
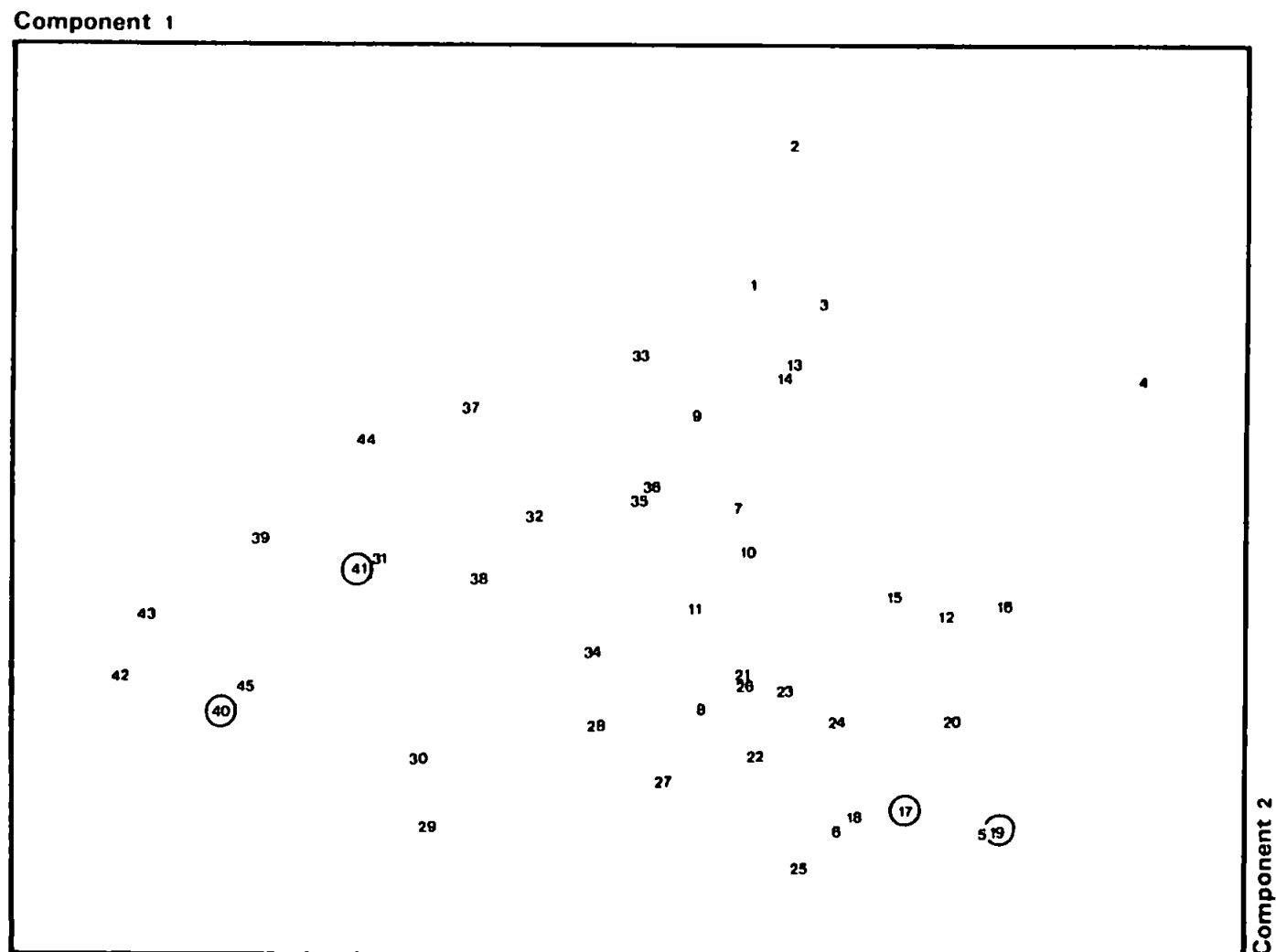


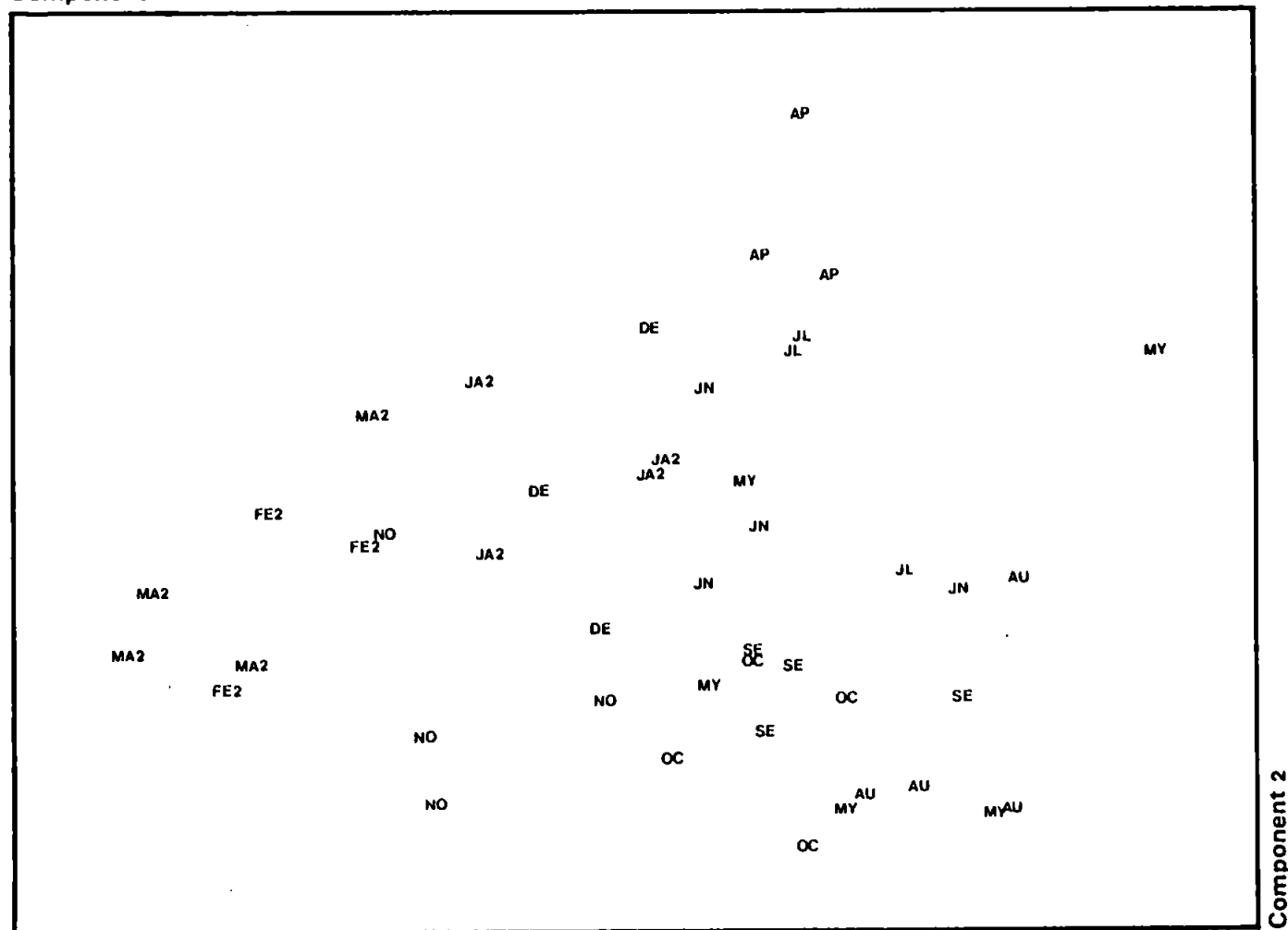
Fig. 7.15. Principal components analysis of spring chemical data



Principal Component Analysis of Spring 14 Chemical Data 1977-78

Fig. 7.16. Principal components analysis of spring 14 chemical data

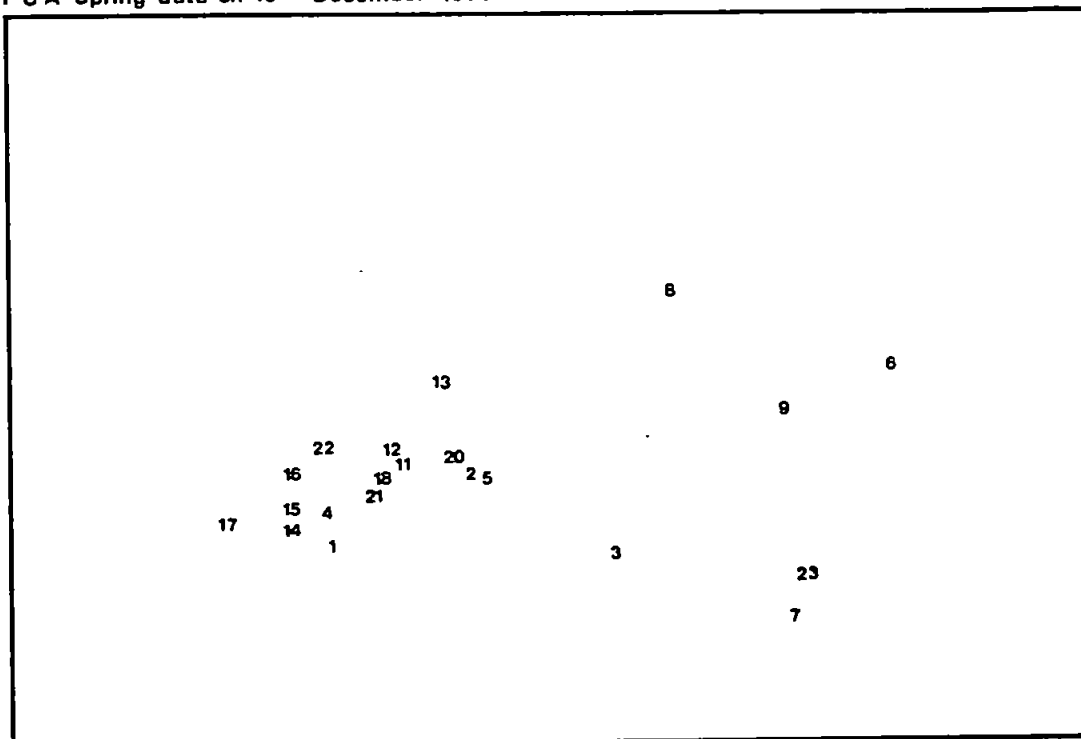
Component 1



Principal Components Analysis of Spring 14 Chemical Data 1977-78

Fig. 7.16 continued

a. PCA Spring data on 19th December 1977



b. Location evidence for spring sources

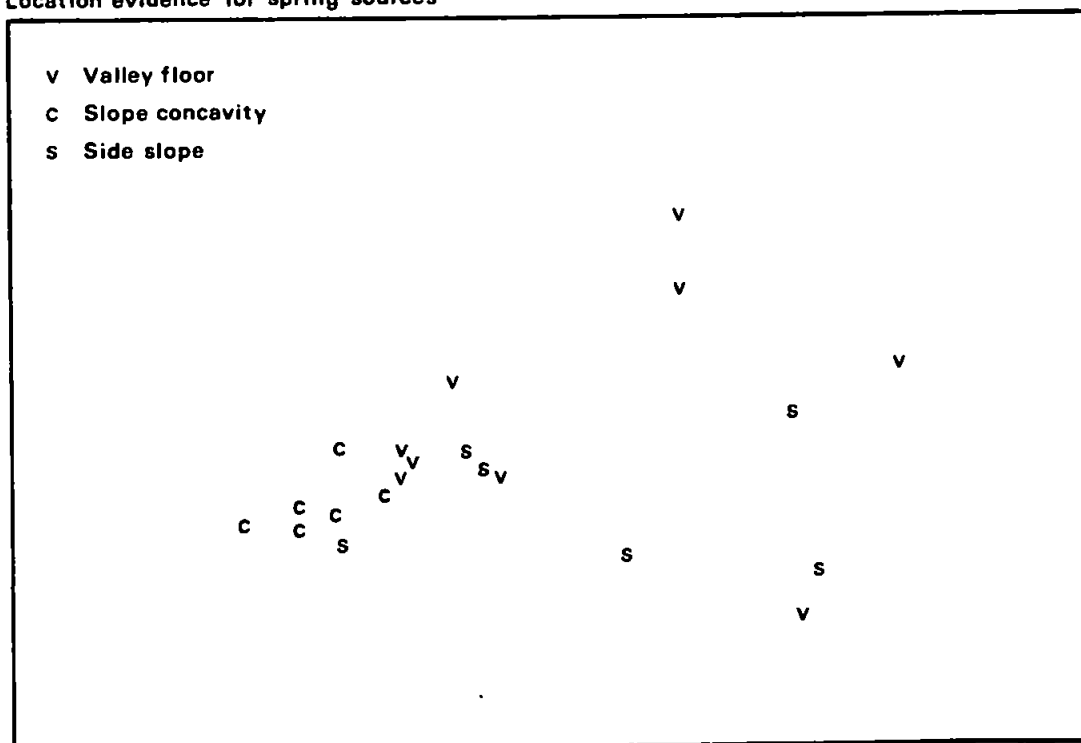
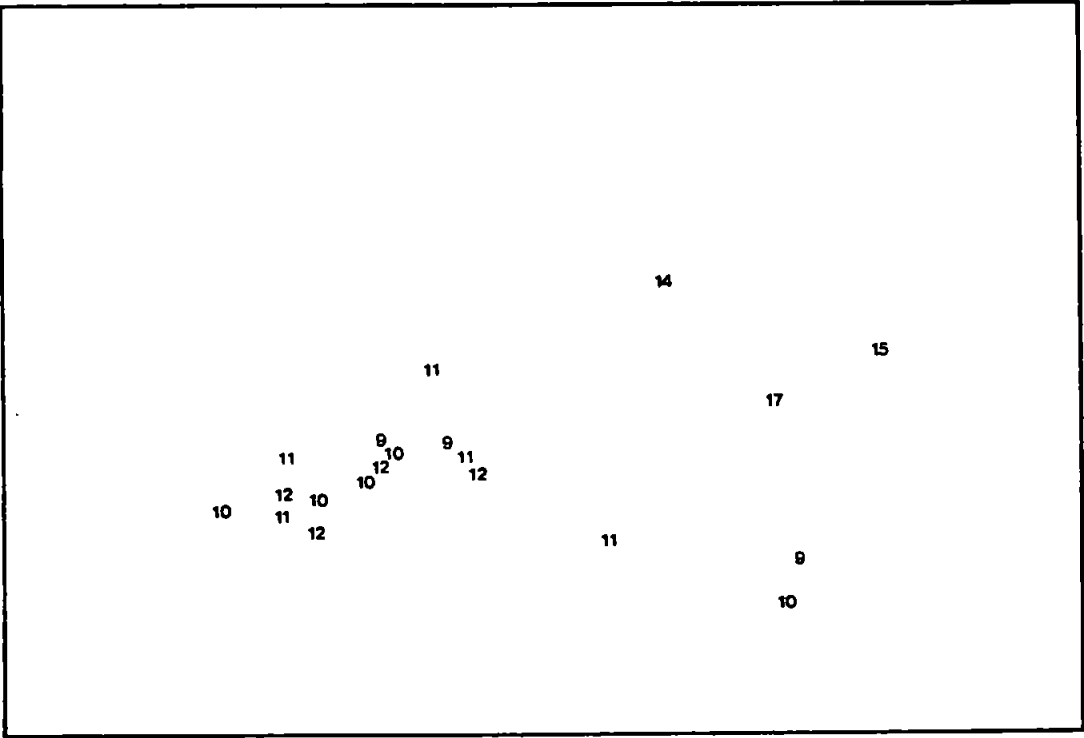


Fig. 7.17. Principal components analysis of spring chemical data on 19th December, 1977

c. Slope angle (using relief ratio)



d. Site evidence, forest/non-forest

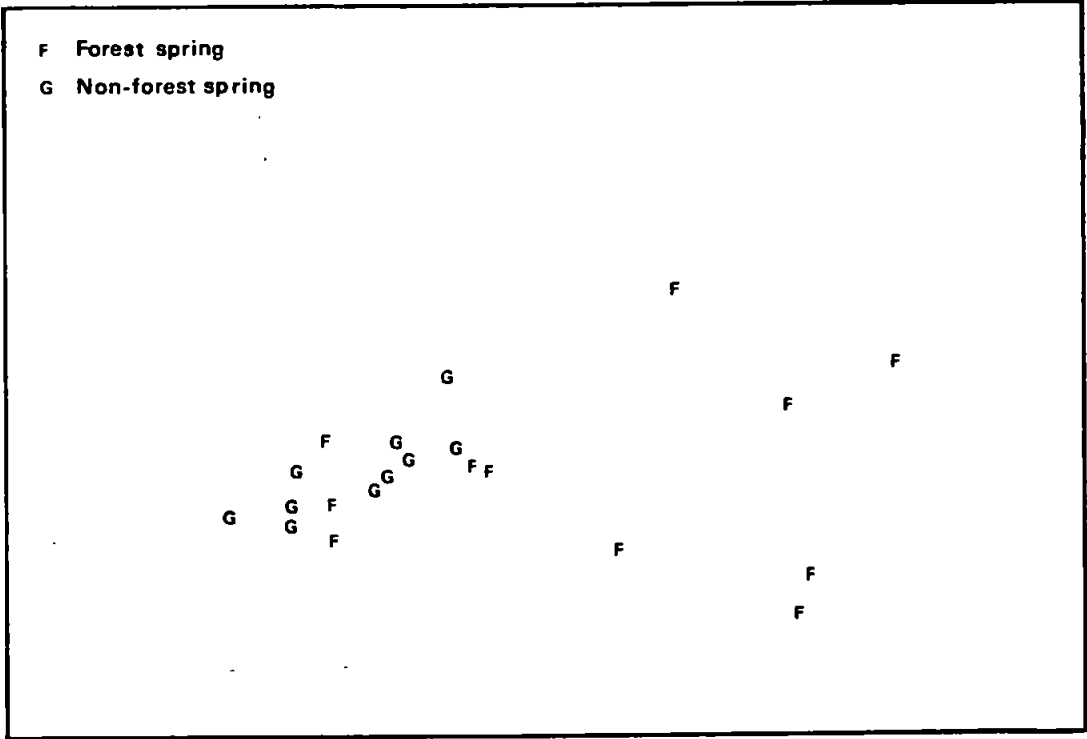
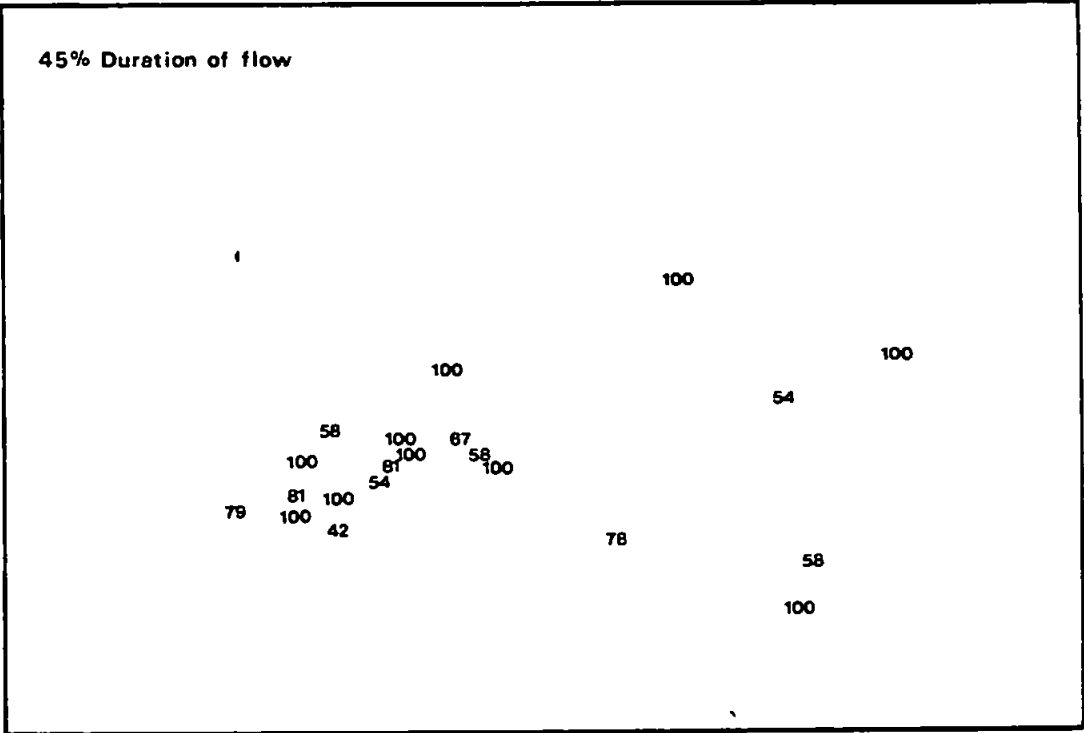


Fig. 7.17. continued

e. Hydrological evidence for spring sources, flow frequency



f. Hydrological evidence for spring sources, temperature variability

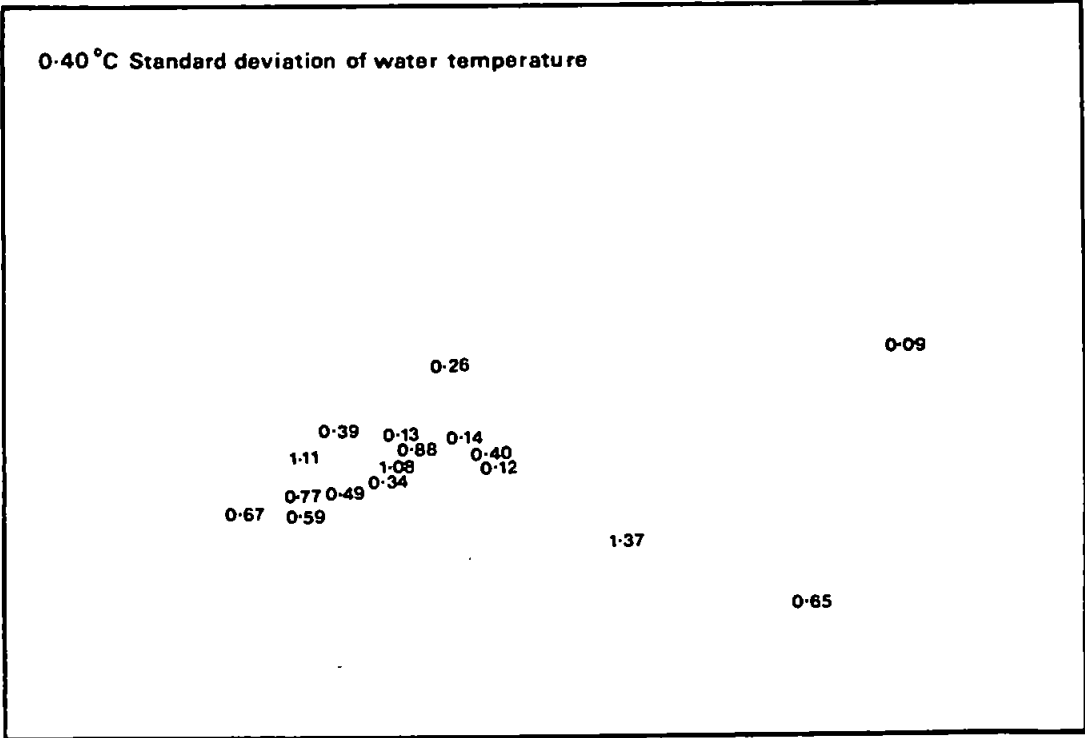


Fig. 7.17. continued

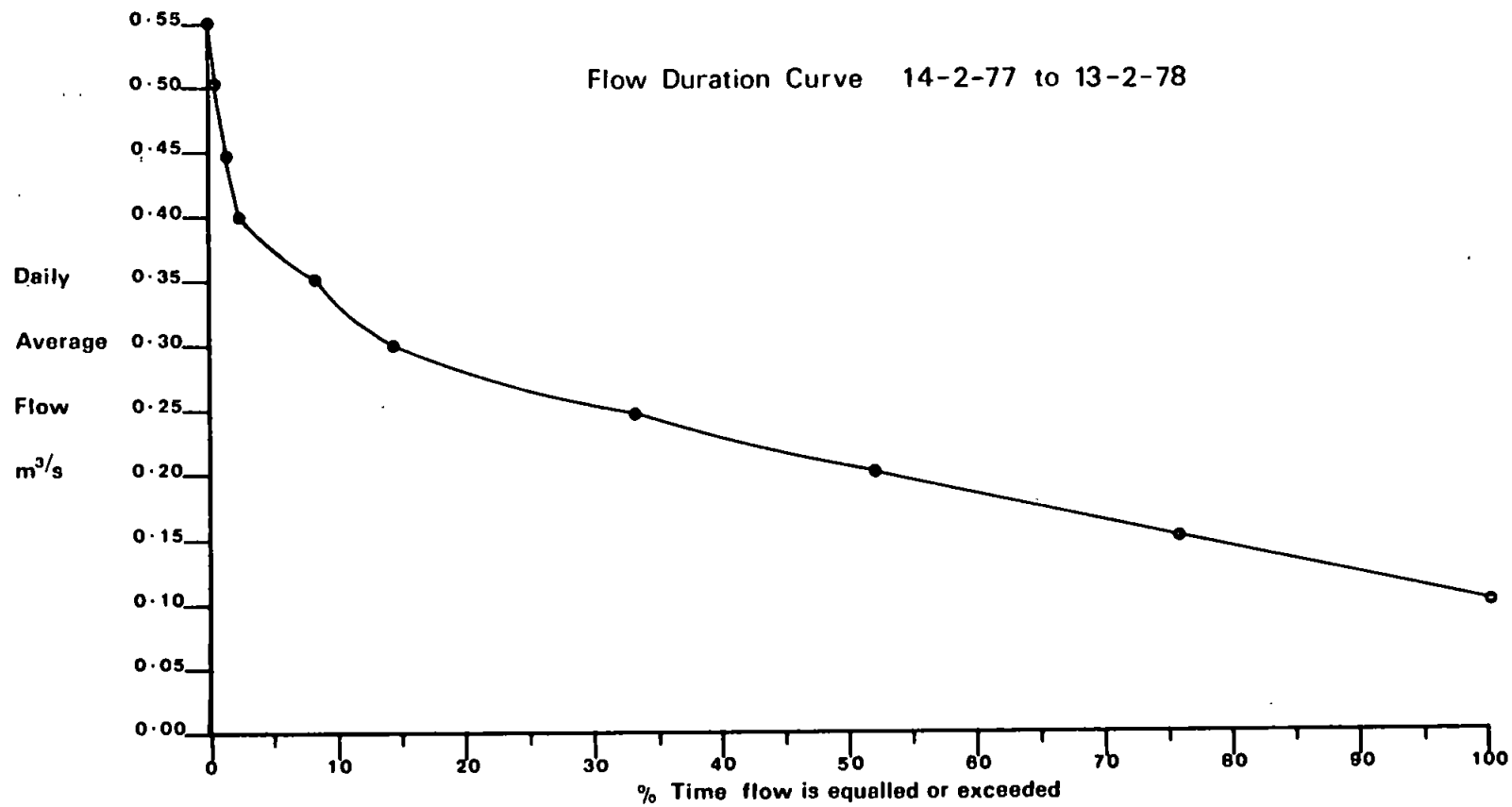


Fig. 8.1. Flow duration curve for the Narrator Brook

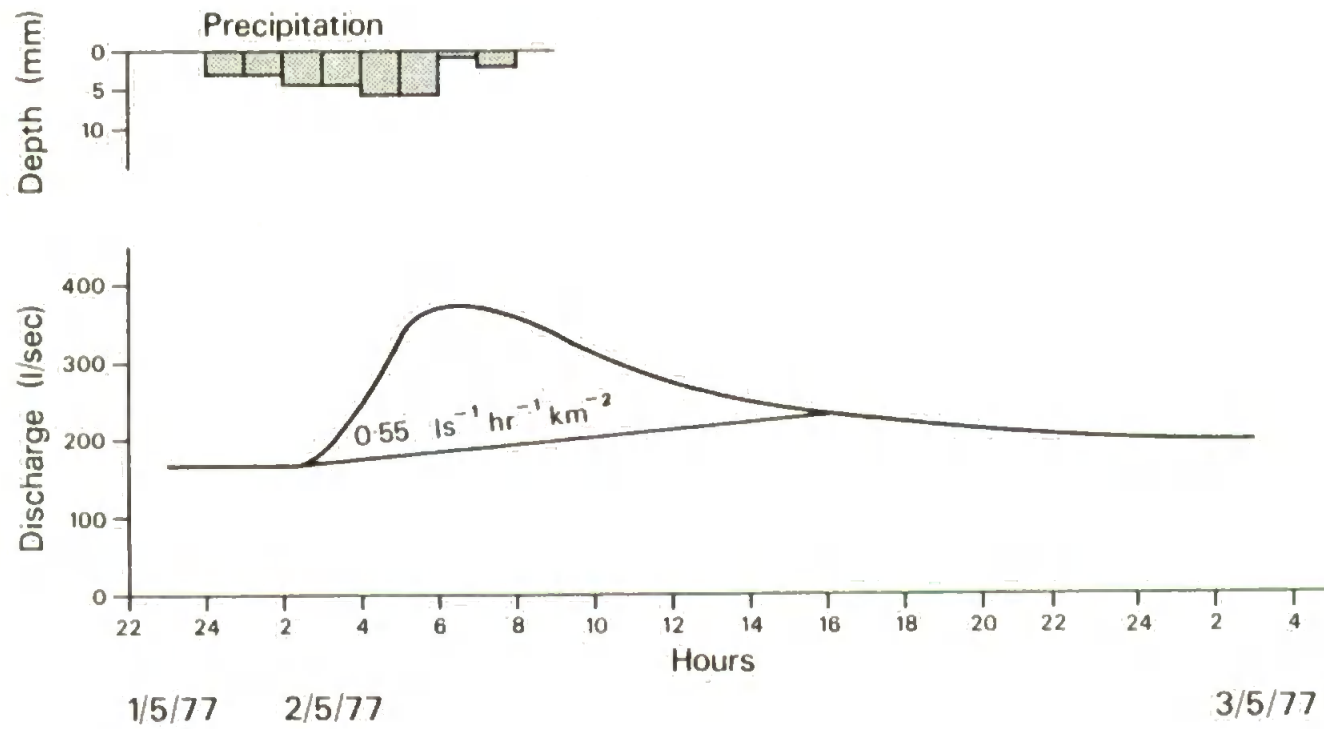


Fig. 8.2. Selected stream hydrographs for the Narrator Brook

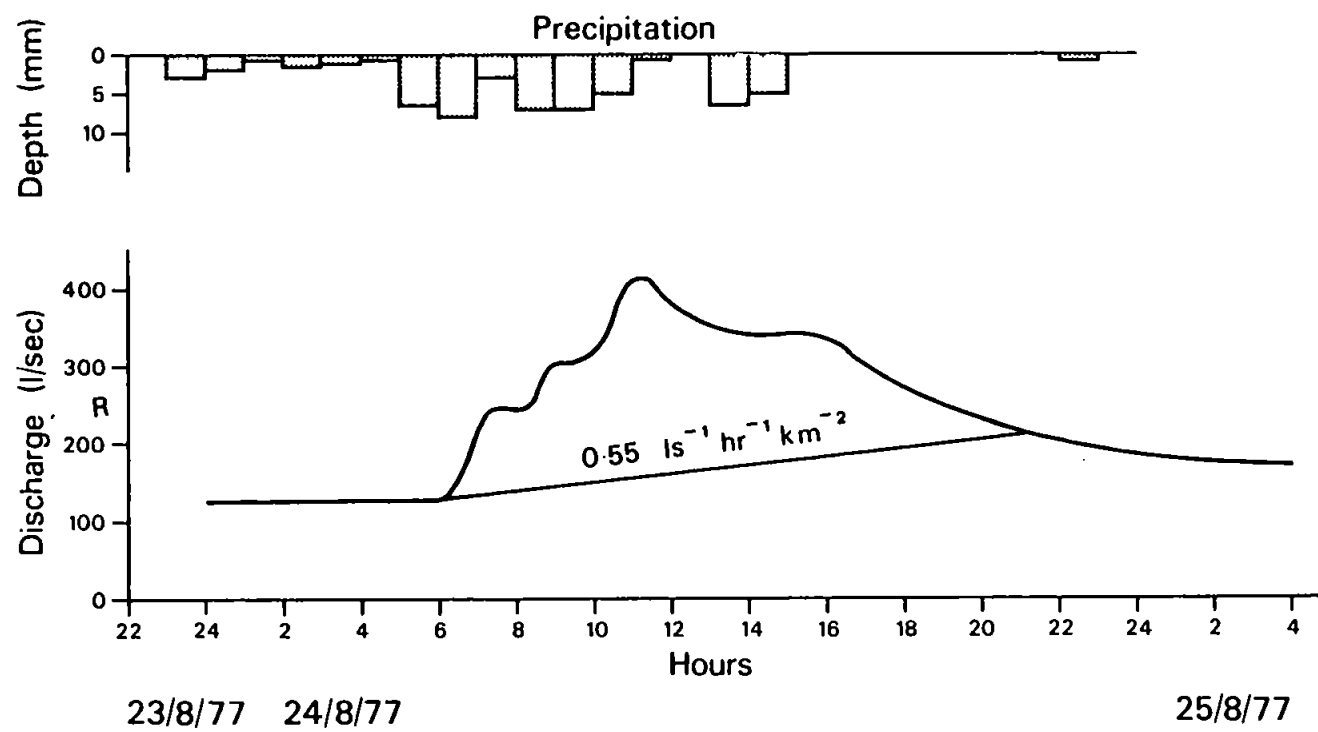


Fig. 8.2. continued

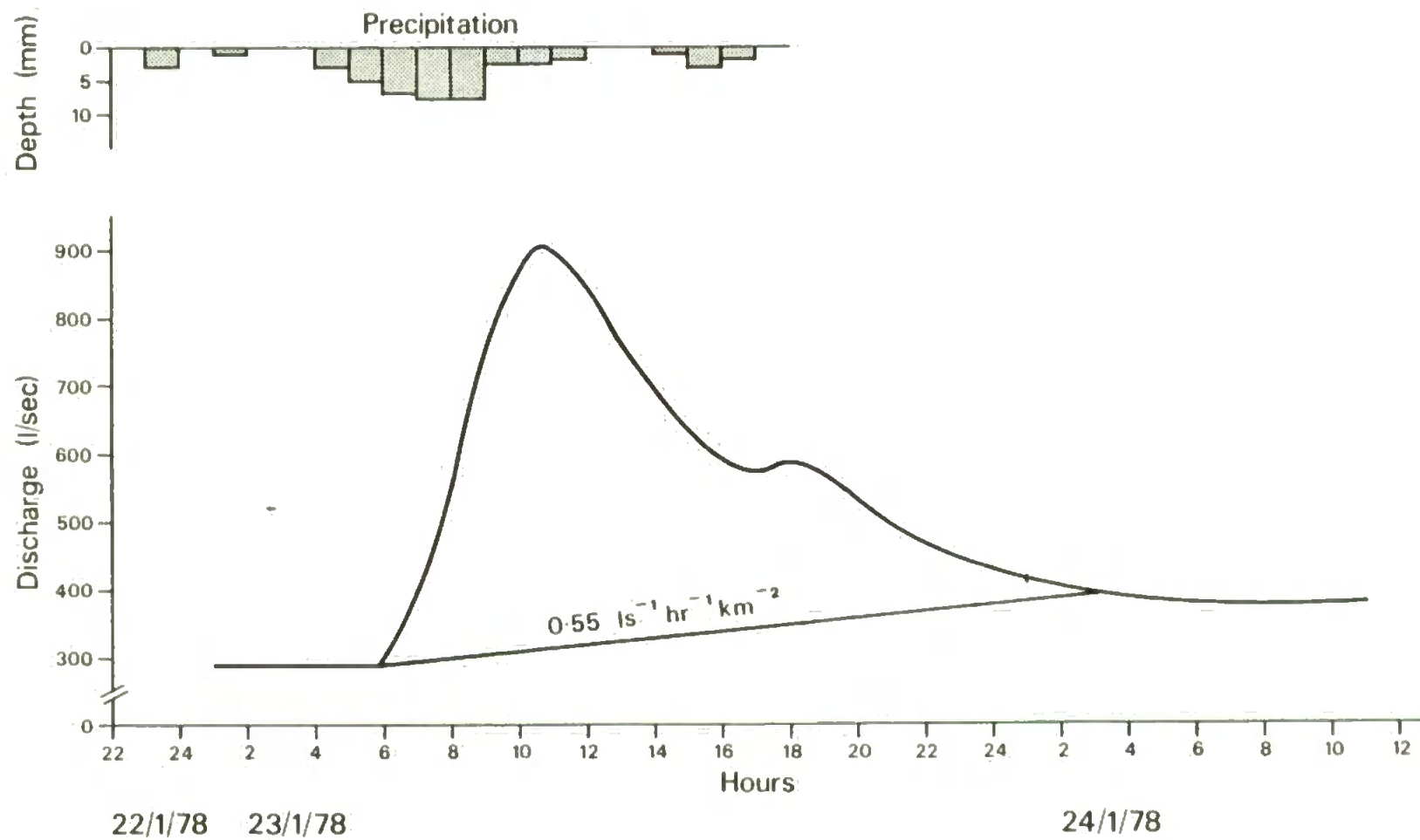


Fig. 8.2. continued

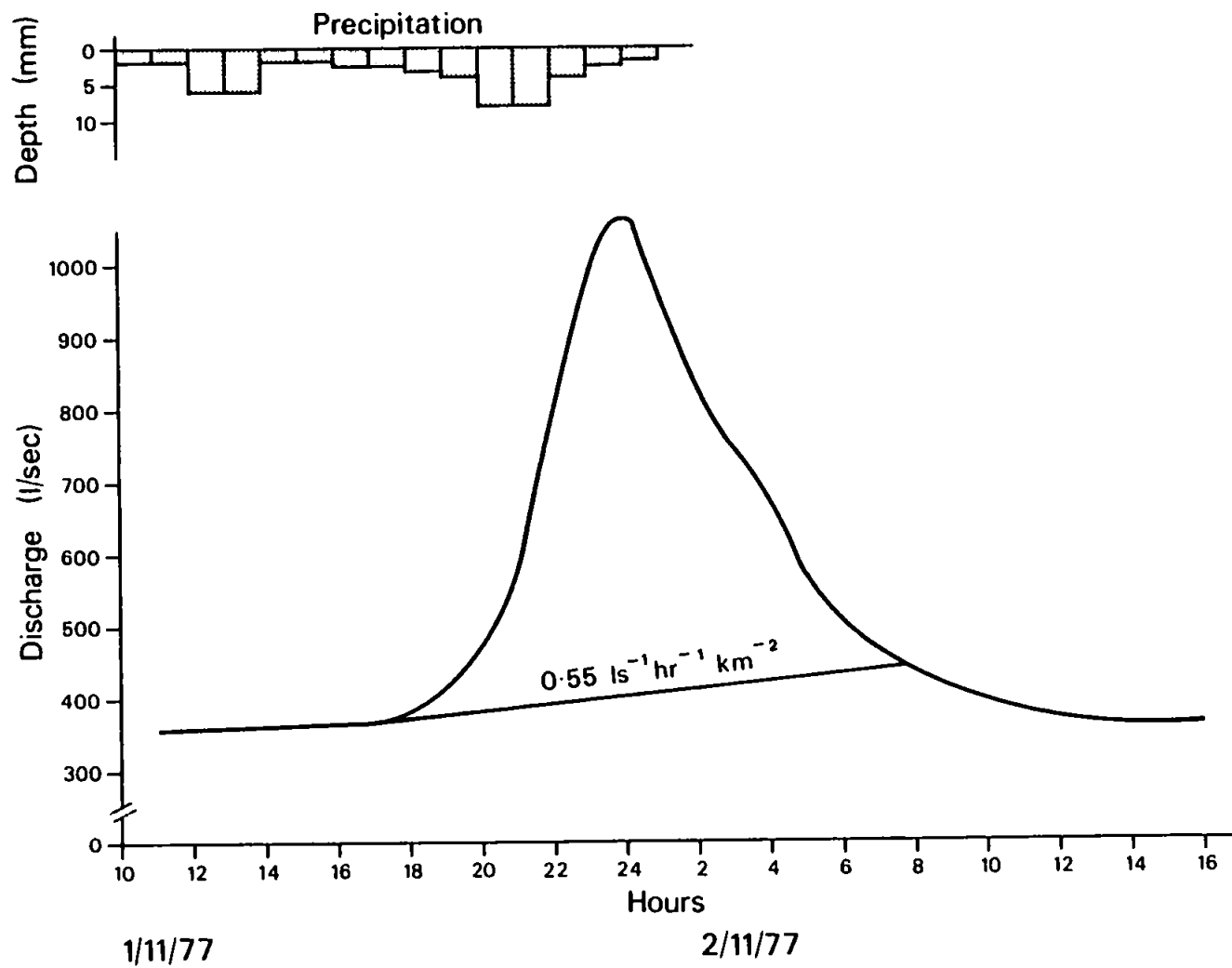


Fig. 8.2. continued

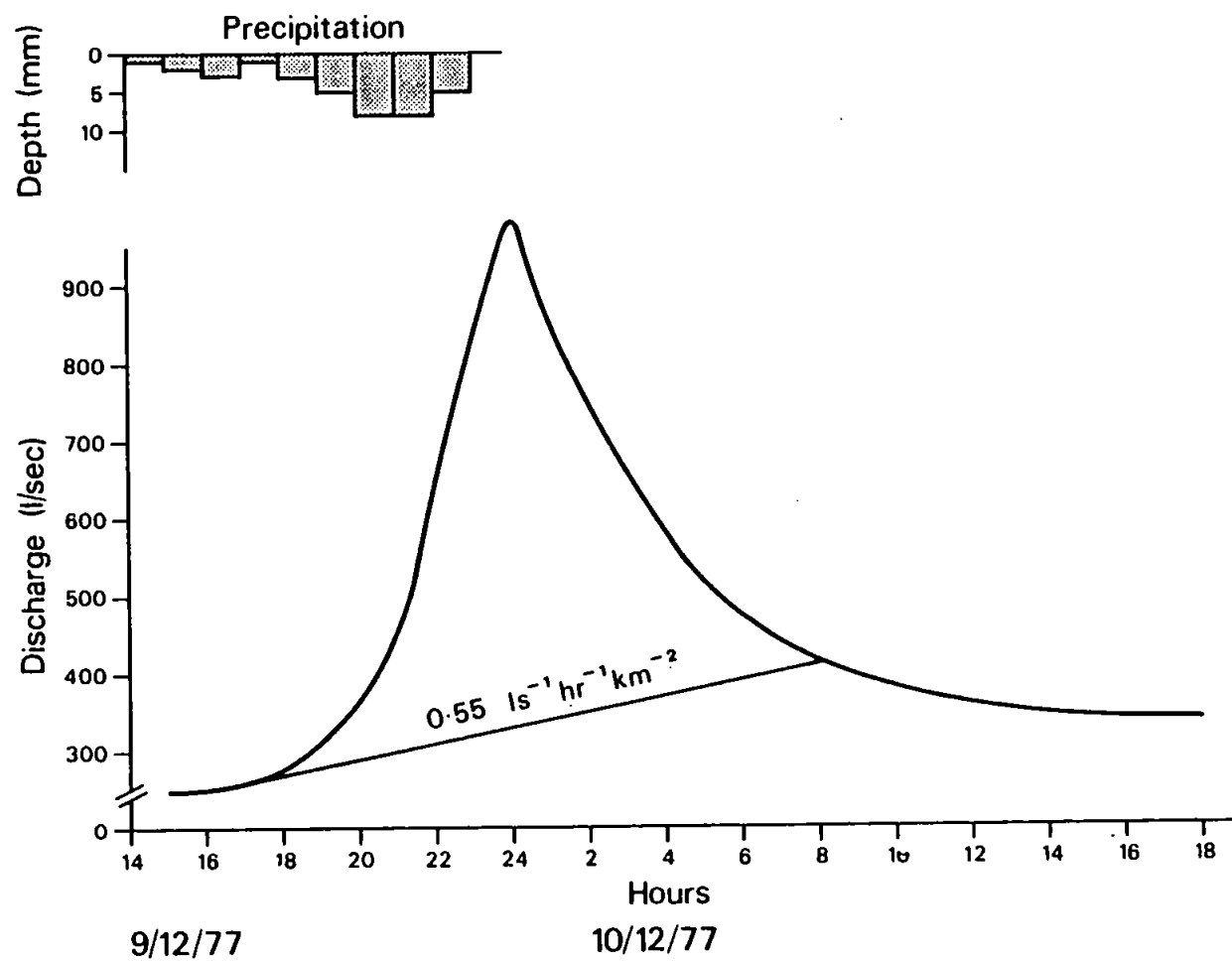


Fig. 8.2. continued

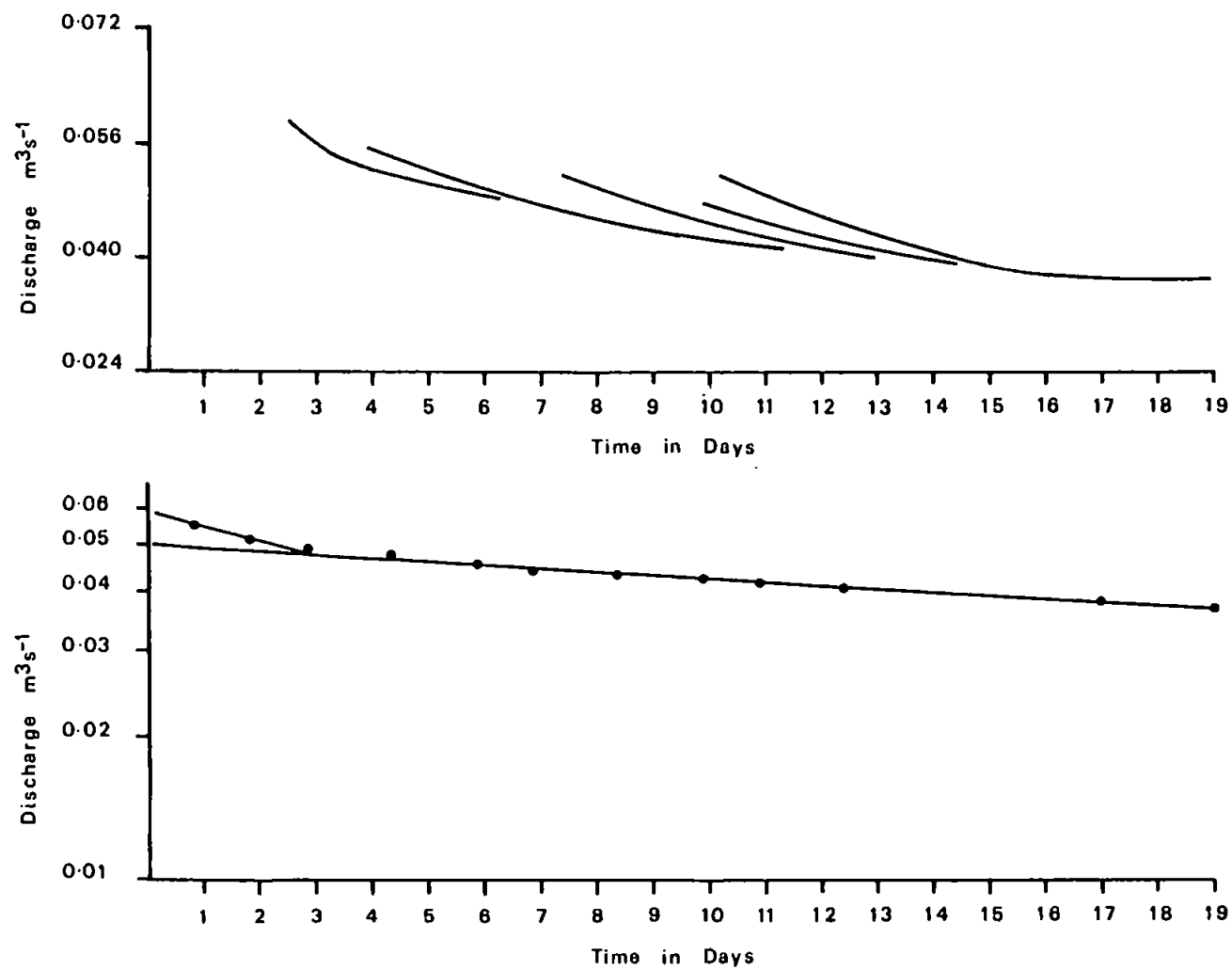


Fig. 8.3. Master recession curve for the Narrator Brook (after Sims, 1976)

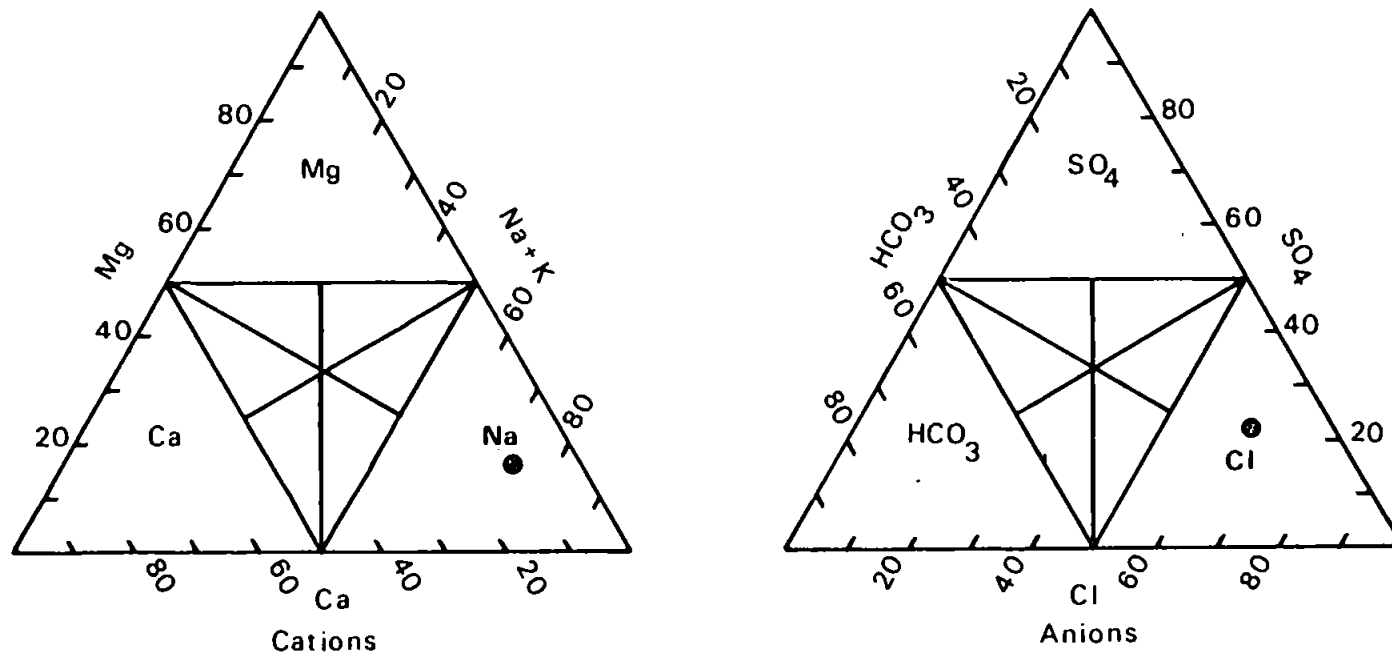


Fig. 8.4. Classification of streamwater in the Narrator catchment

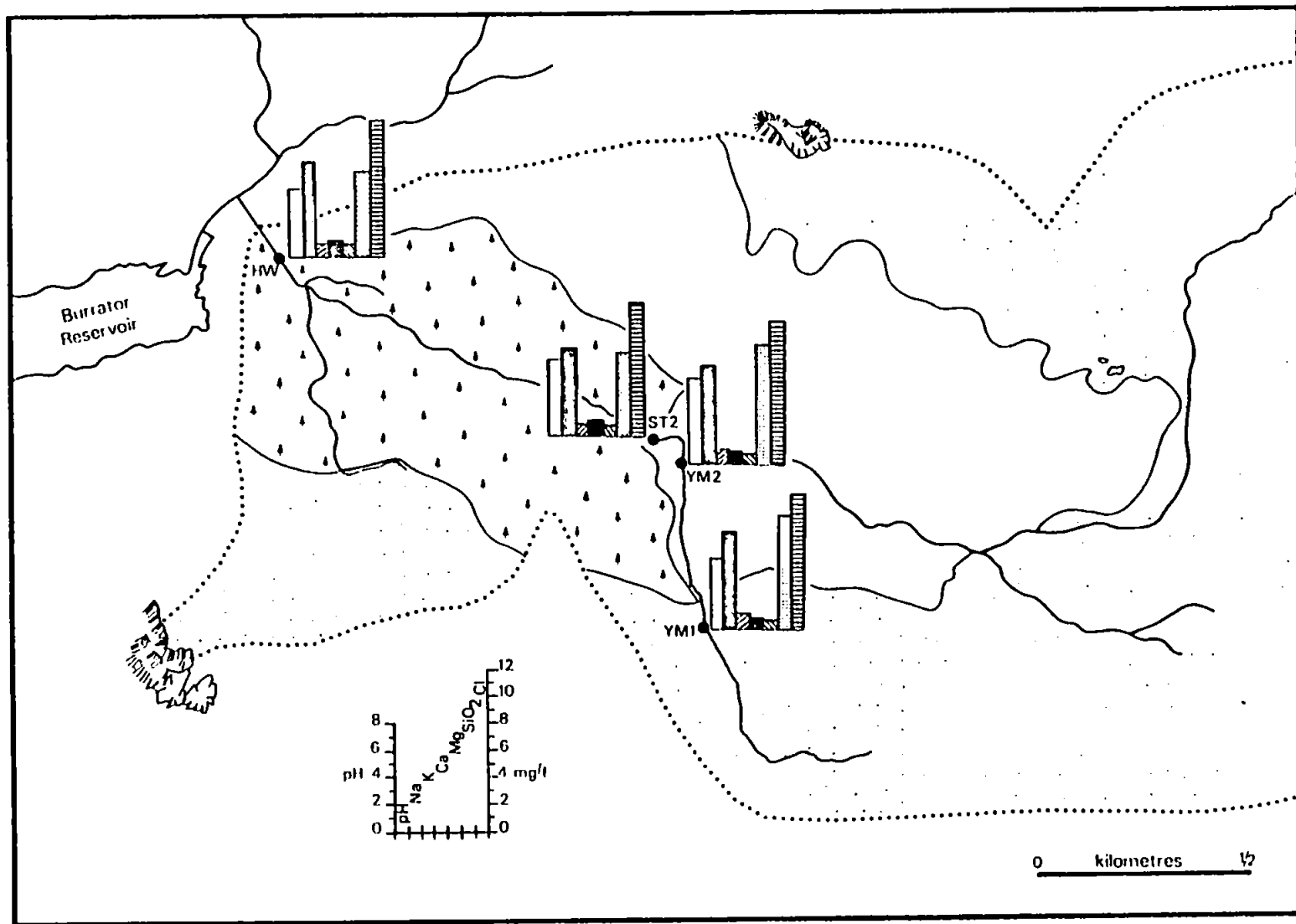


Fig. 8.5. Downstream variations in solute concentrations in the Narrator catchment

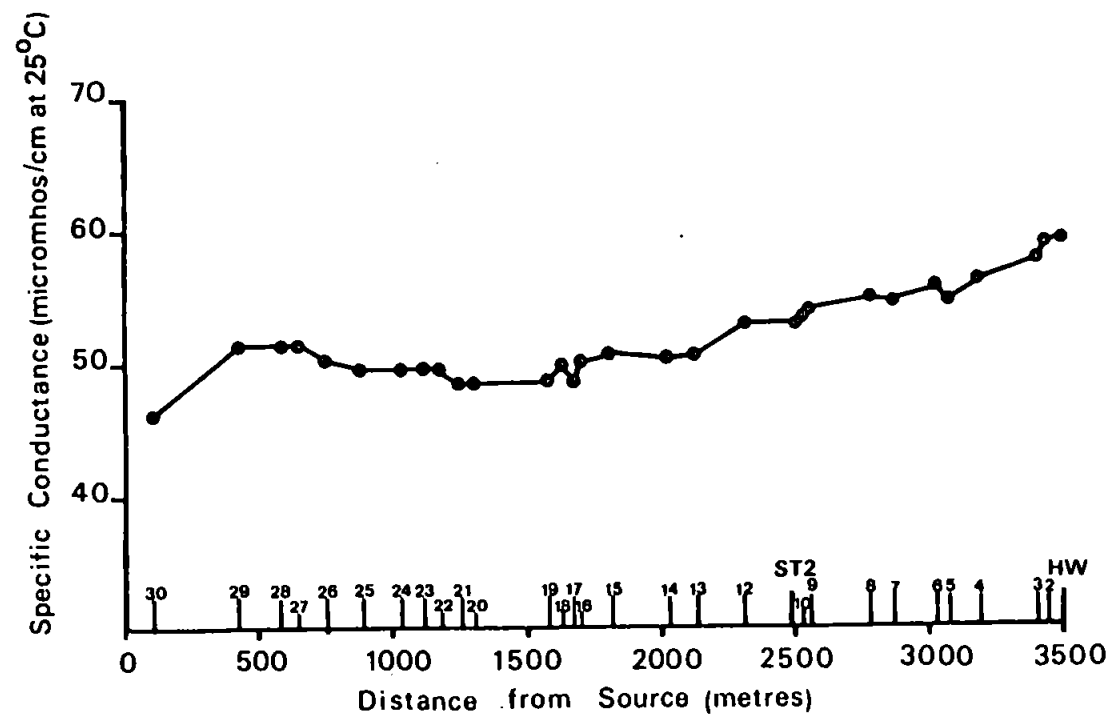


Fig. 8.6. Downstream variation in conductivity (after Murgatroyd, 1980)

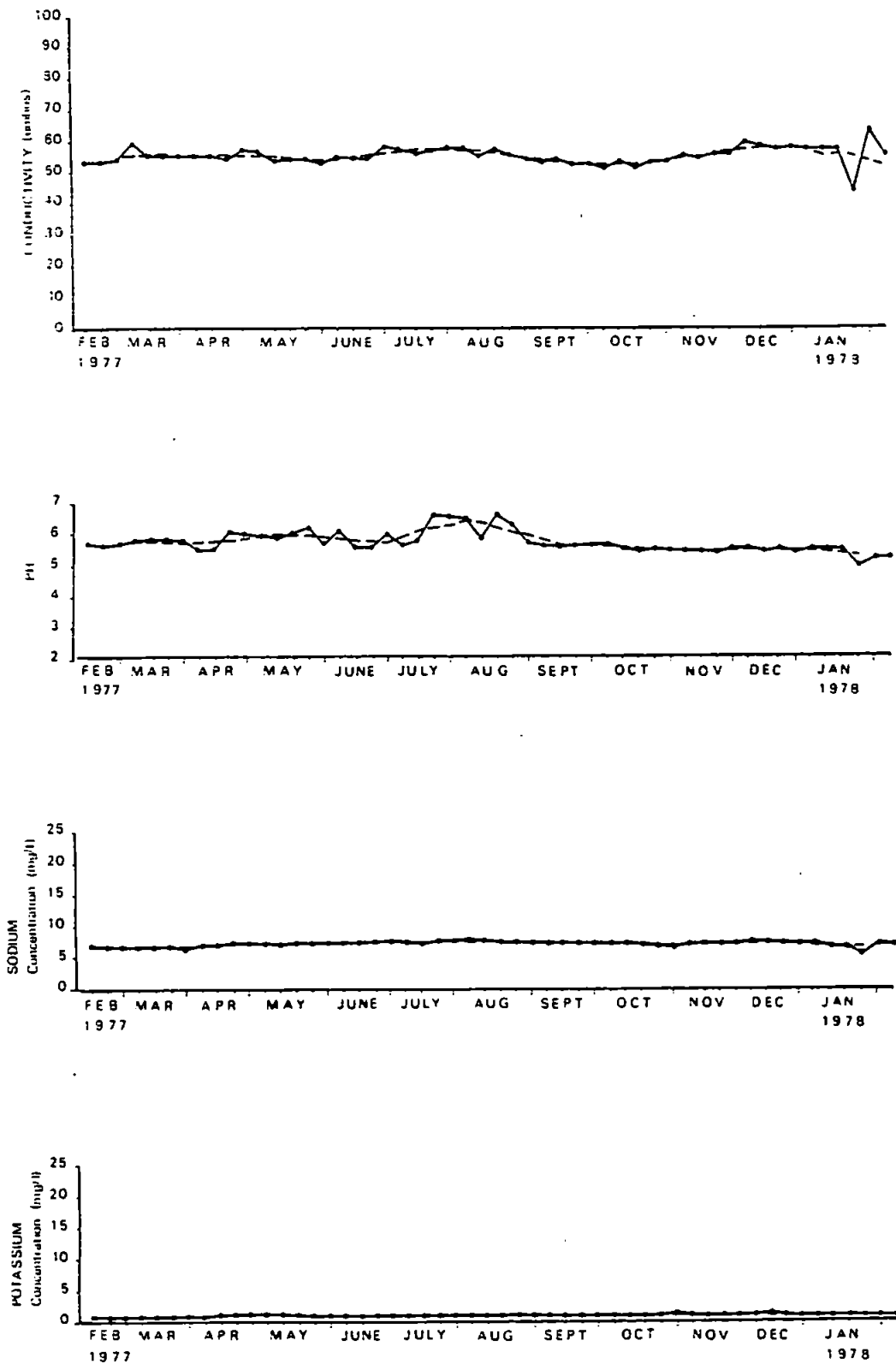


Fig. 8.7. Temporal variation in stream chemistry

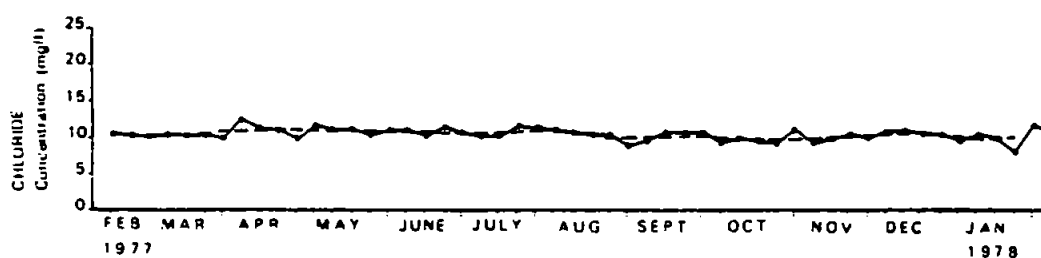
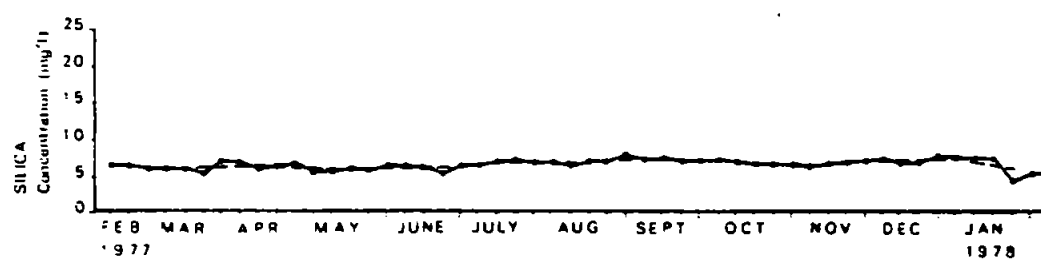
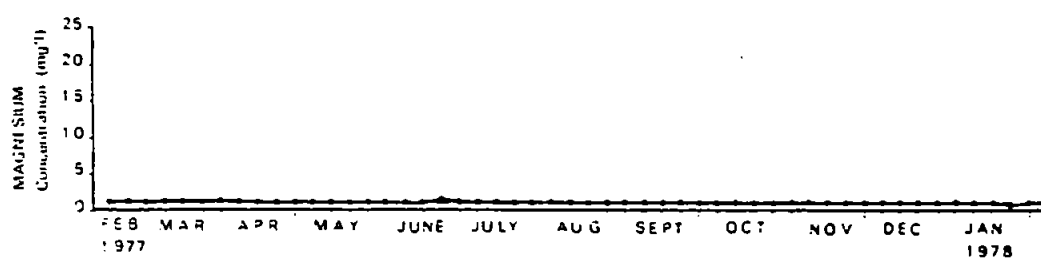
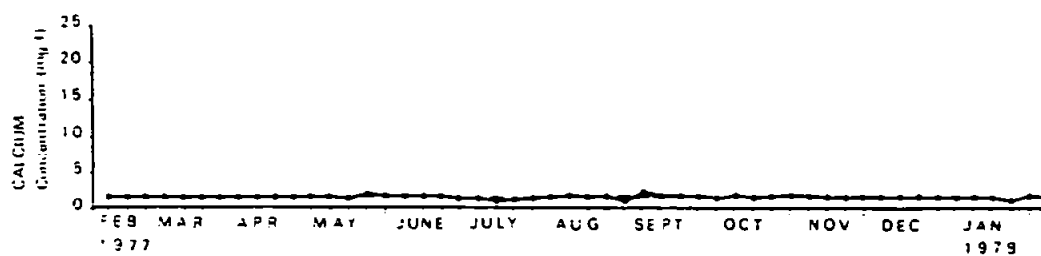


Fig. 8.7. (continued)

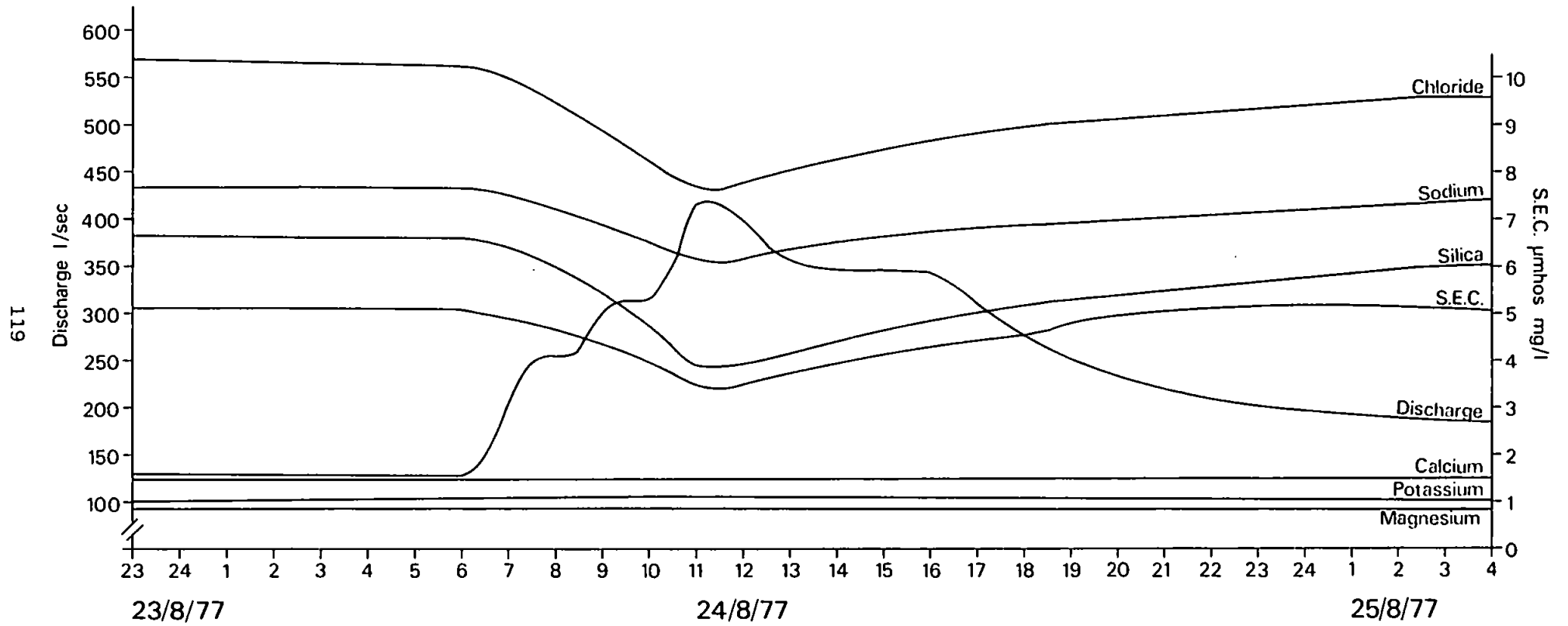


Fig. 8.8. Chemographs and their associated storm hydrographs

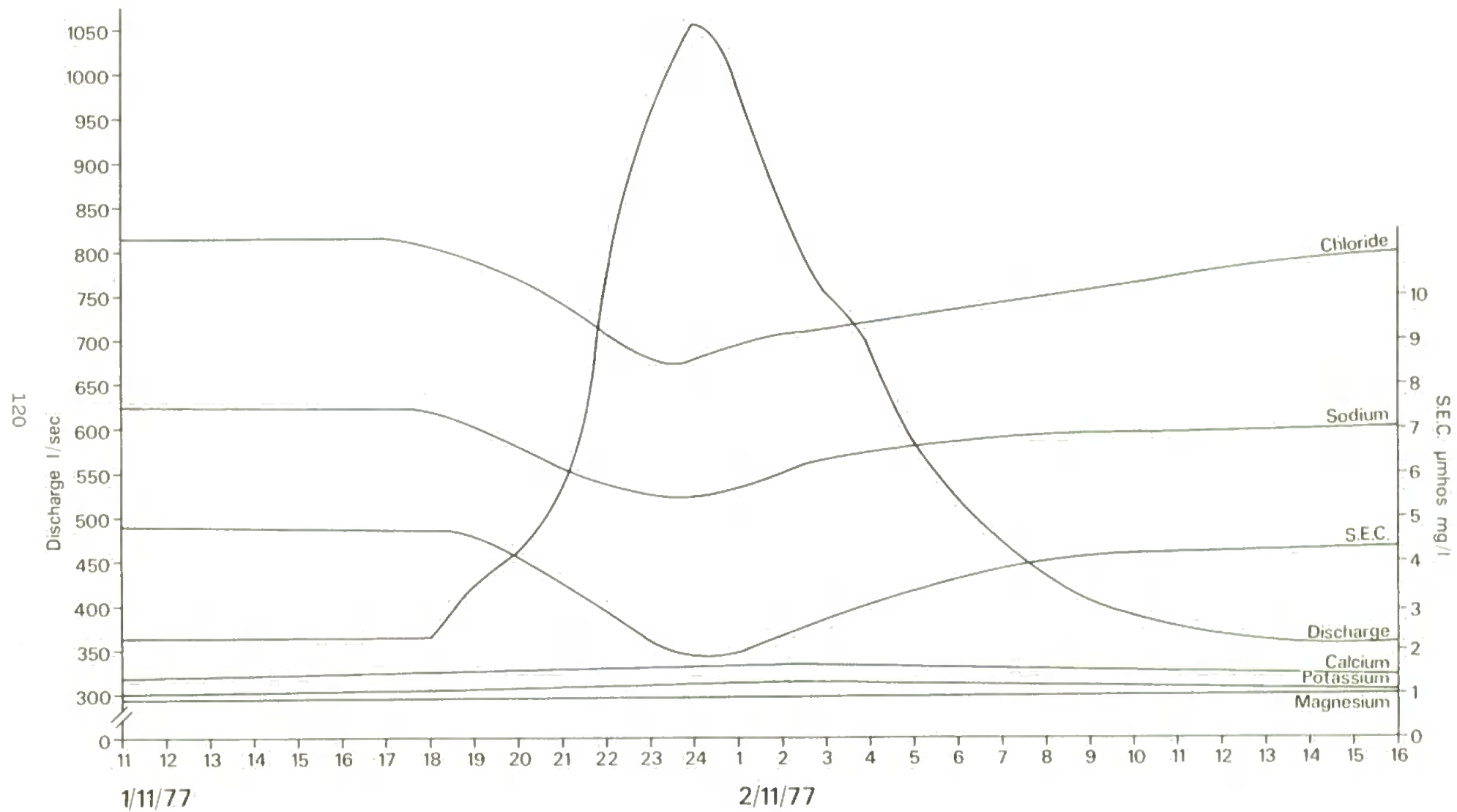


Fig. 8.8. continued

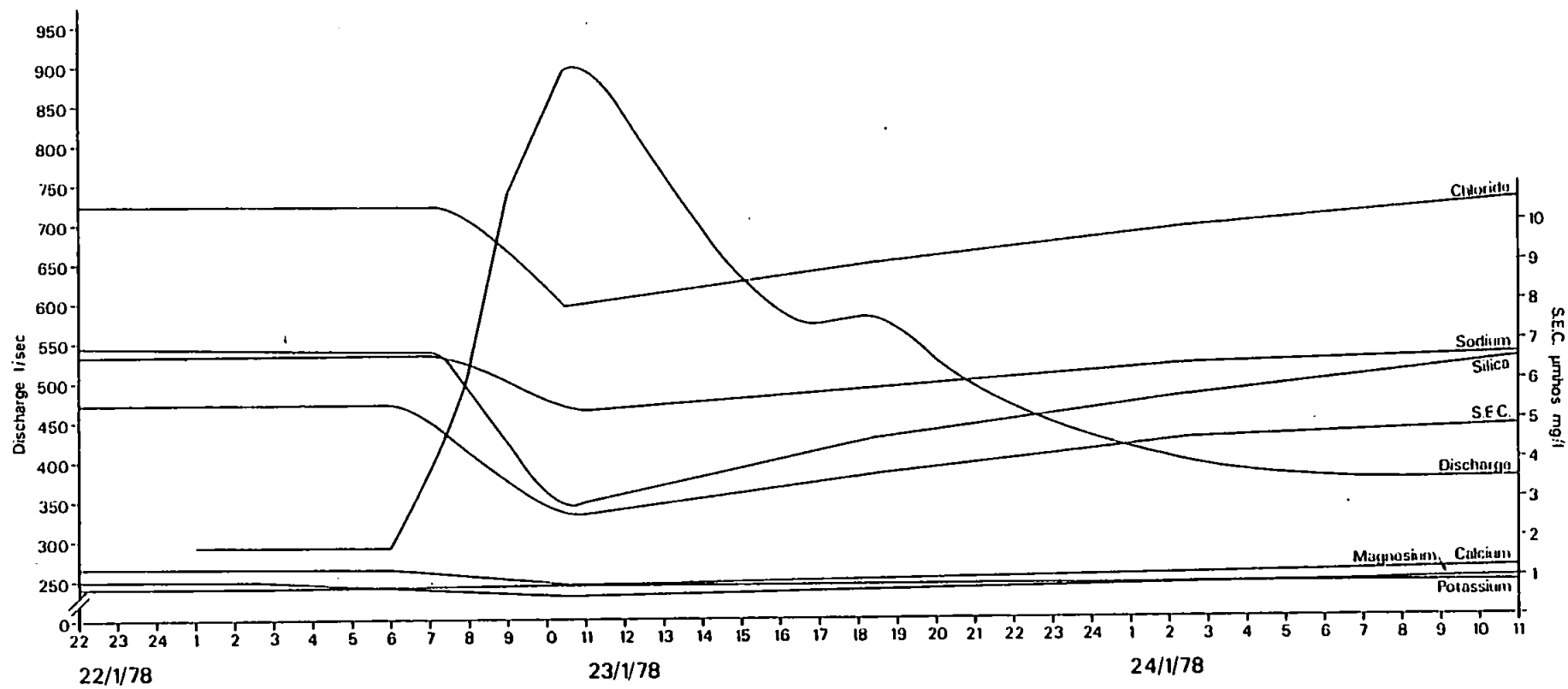


Fig. 8.8. continued

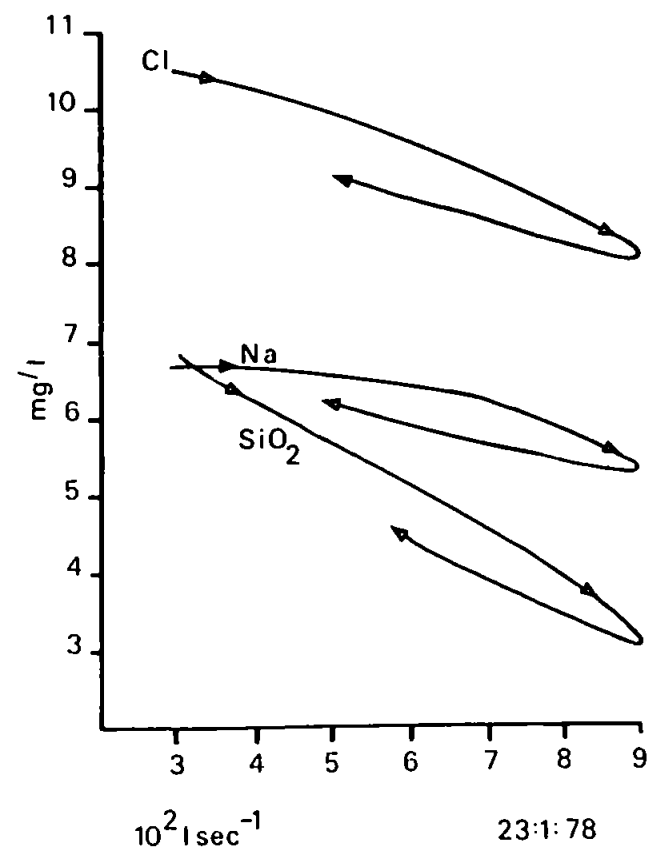
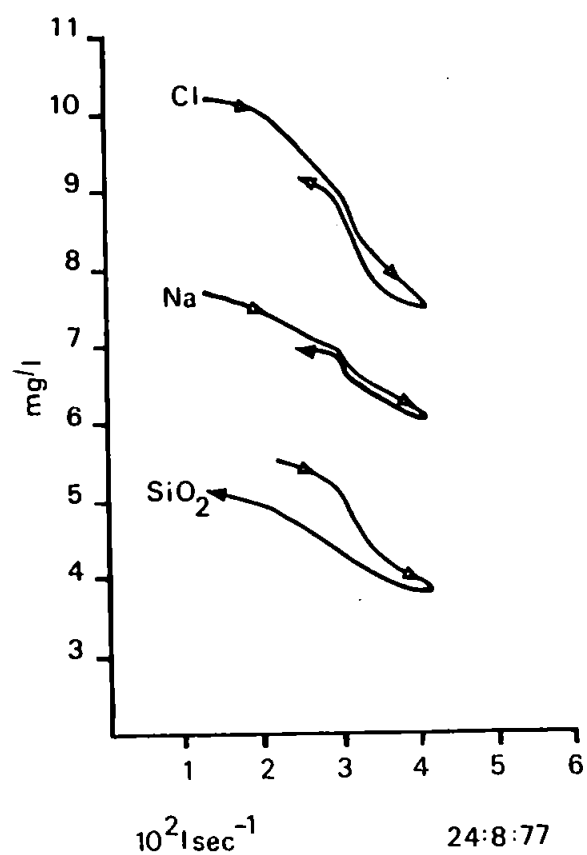


Fig. 8.9. Hysteresis loops for sodium, silica and chloride

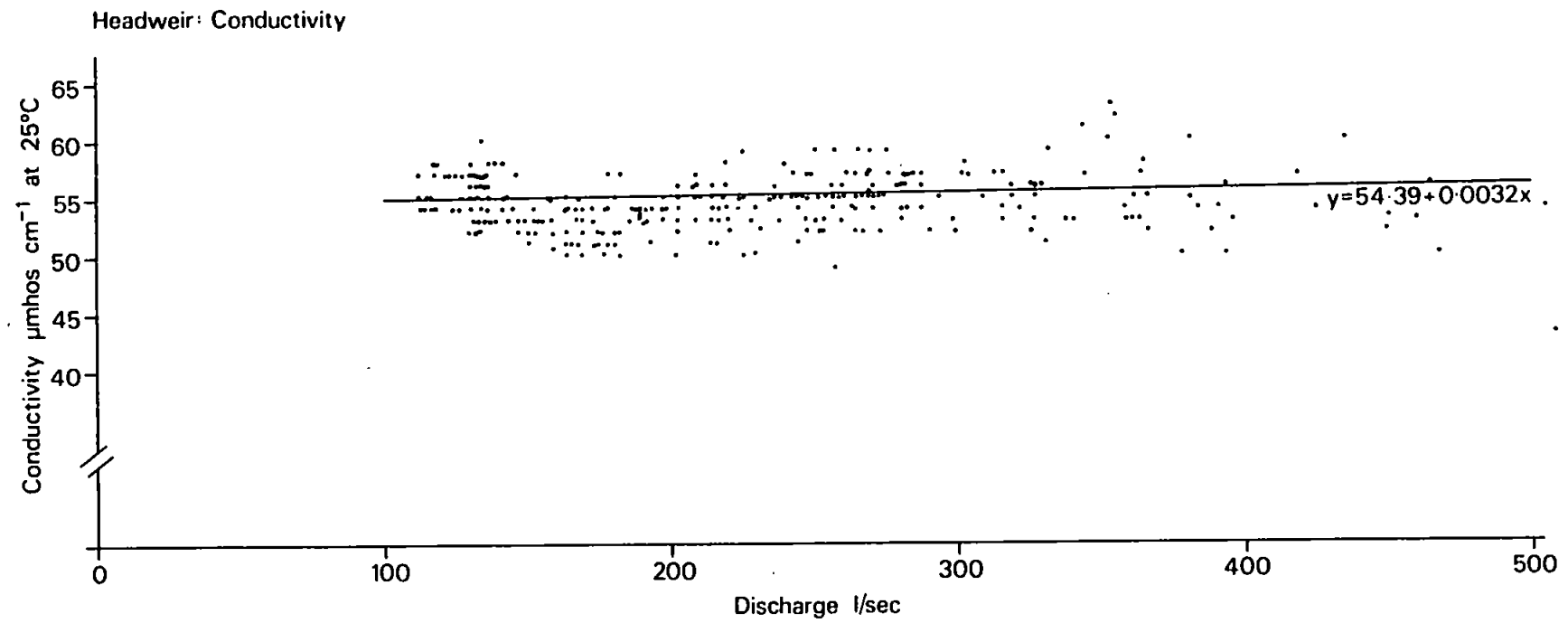


Fig. 8.10. Solute rating curves for the Narrator catchment

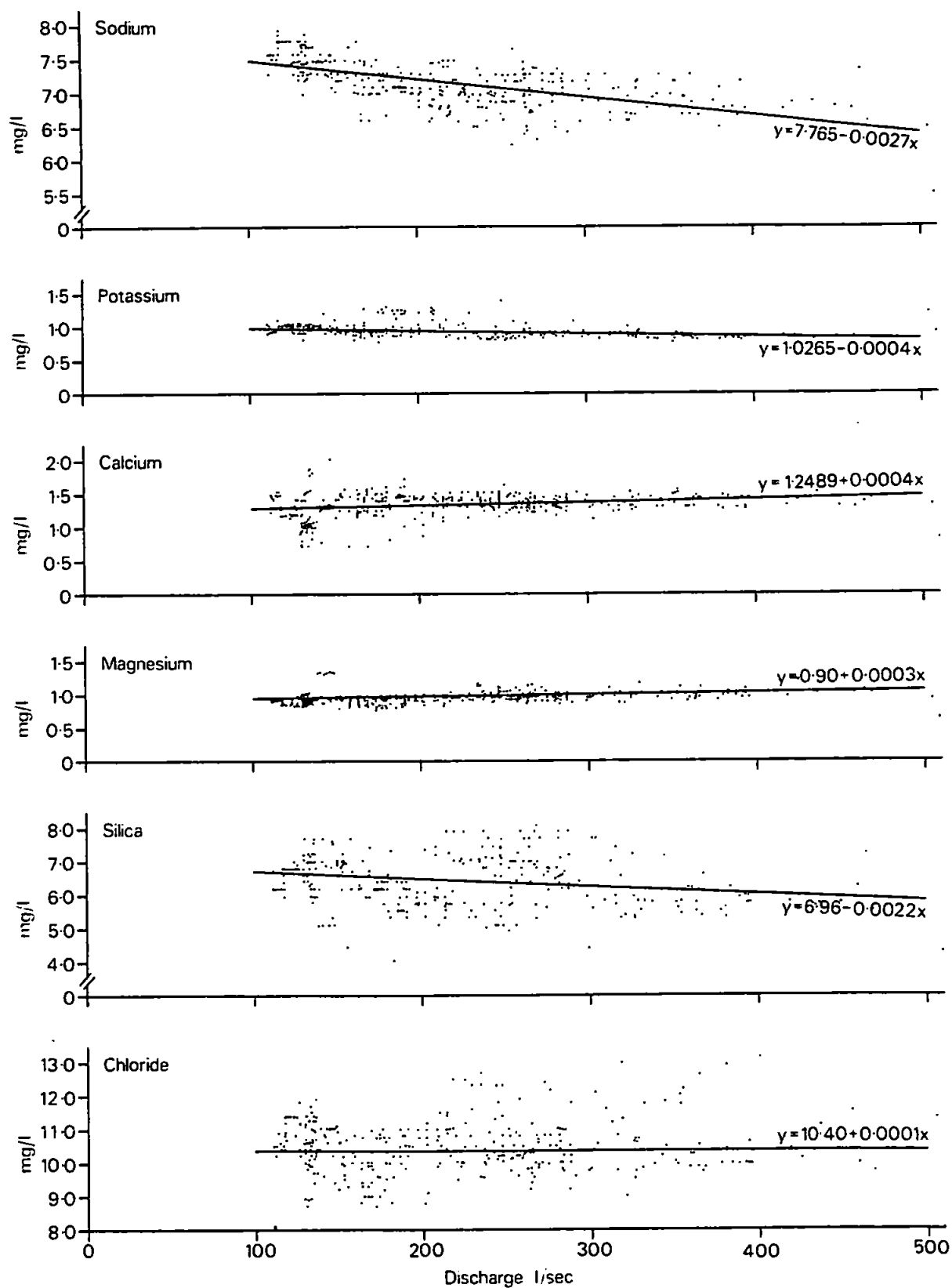


Fig. 8.10. continued

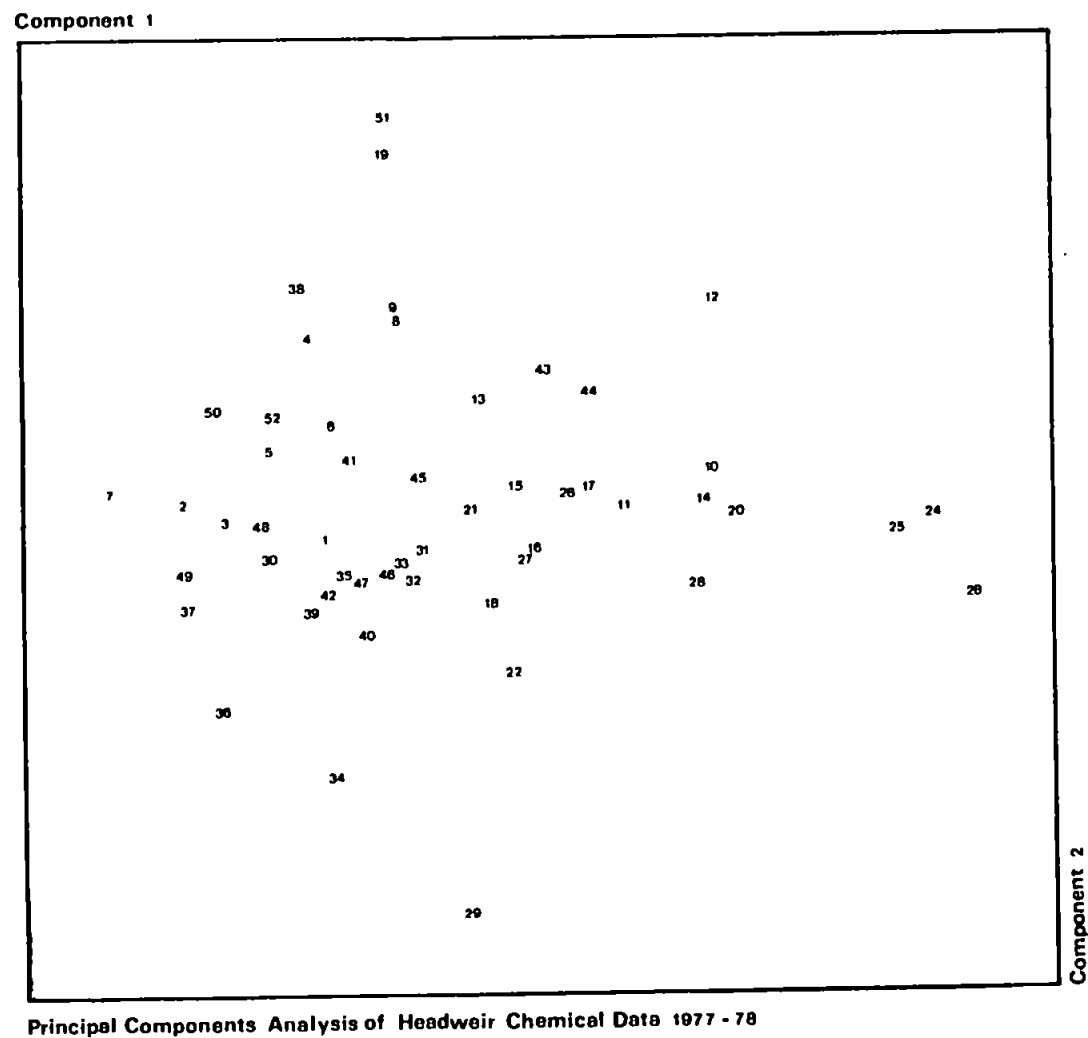


Fig. 8.11a. Principal components analysis of stream chemical data for Headweir

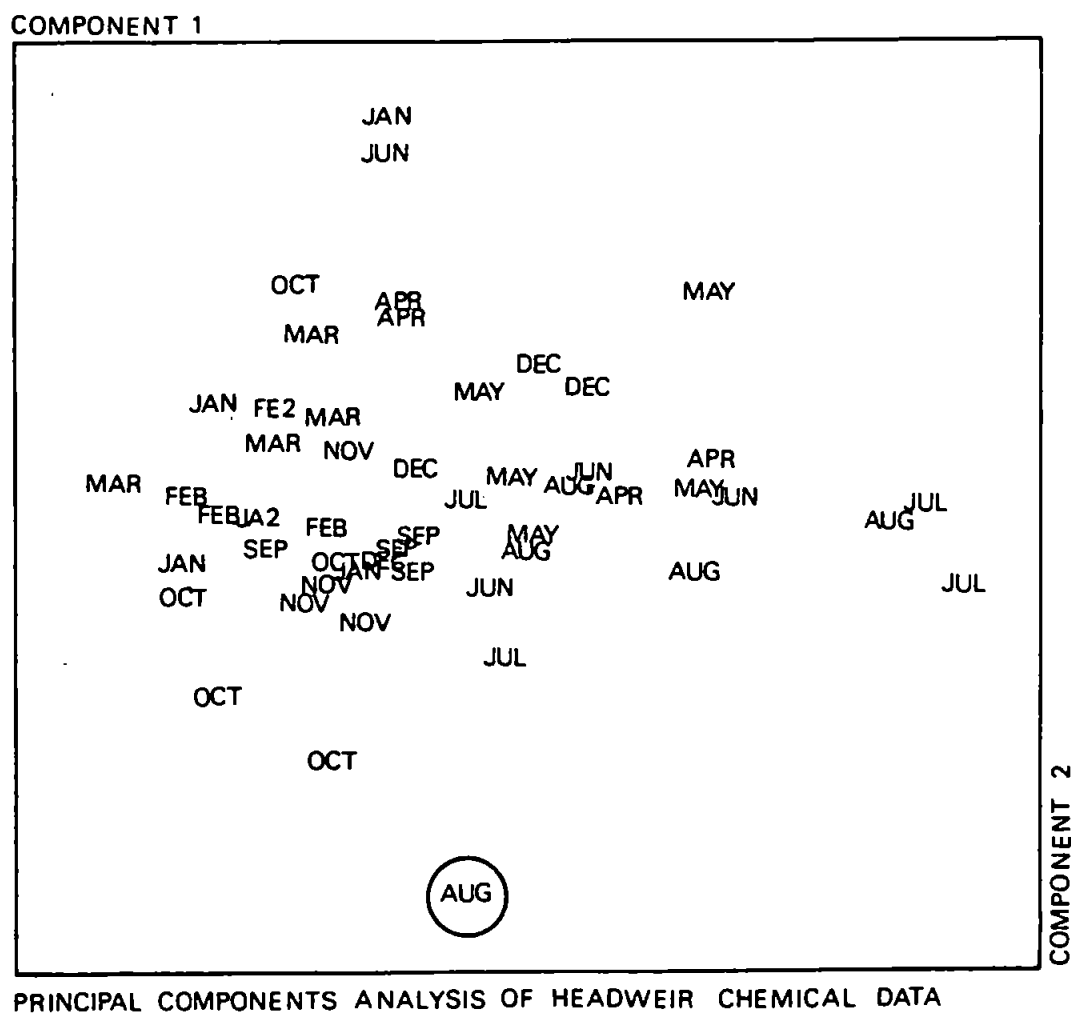


Fig. 8.11b. Principal components analysis of stream chemical data for Headweir

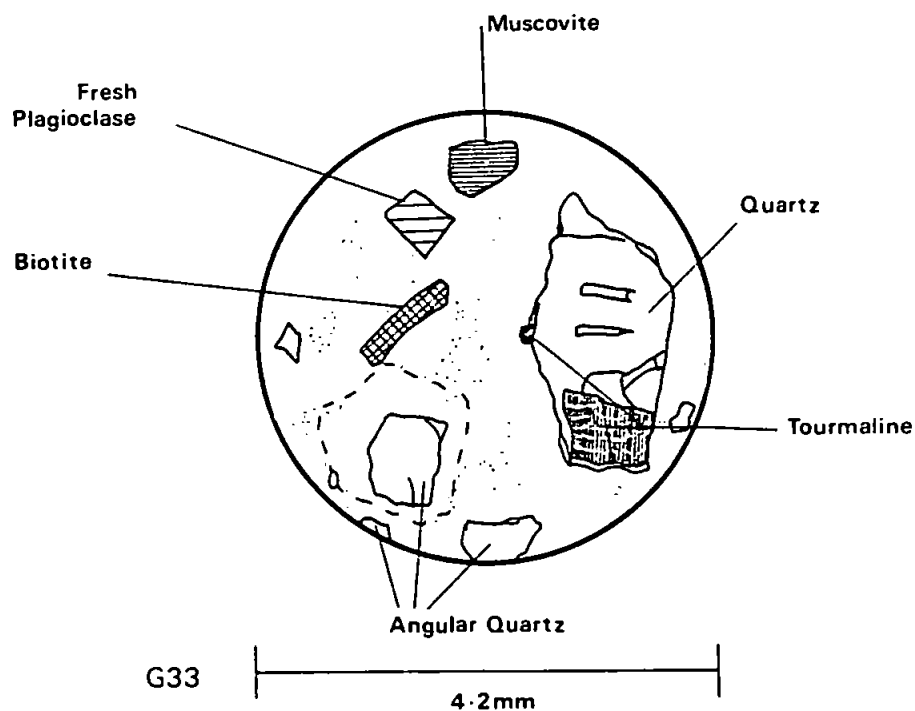


Fig. 9.1. Thin section of Moretonhampstead soil (G4, 33 cm depth)

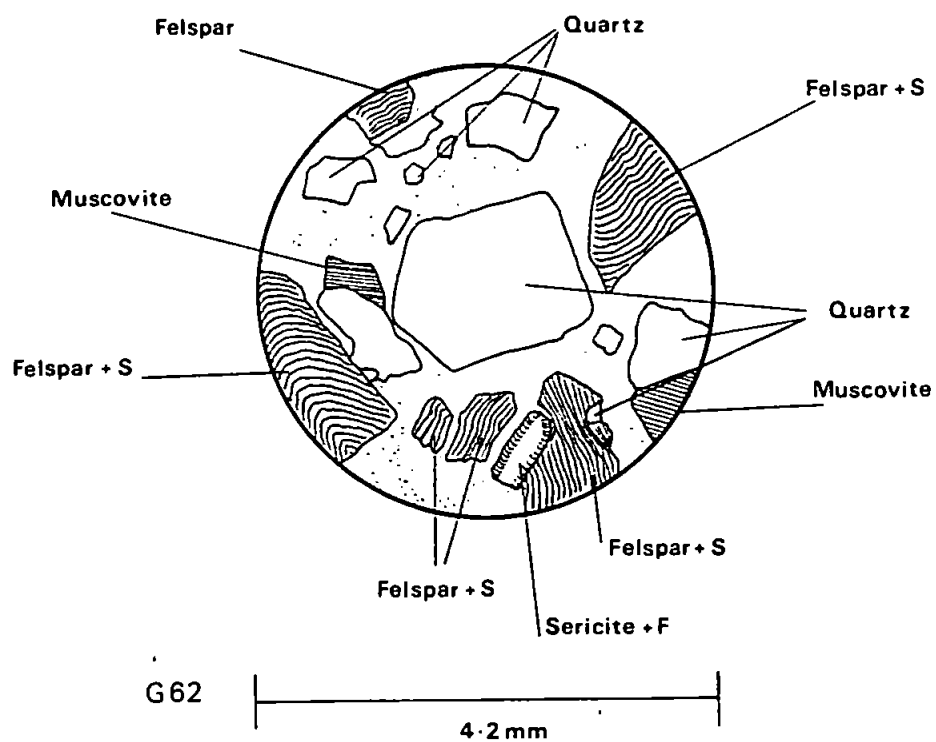


Fig. 9.2. Thin section of Moretonhampstead soil (G4, 62 cm depth)

Stability diagrams for water samples from Grassland, non-forest springs, streams and reservoir

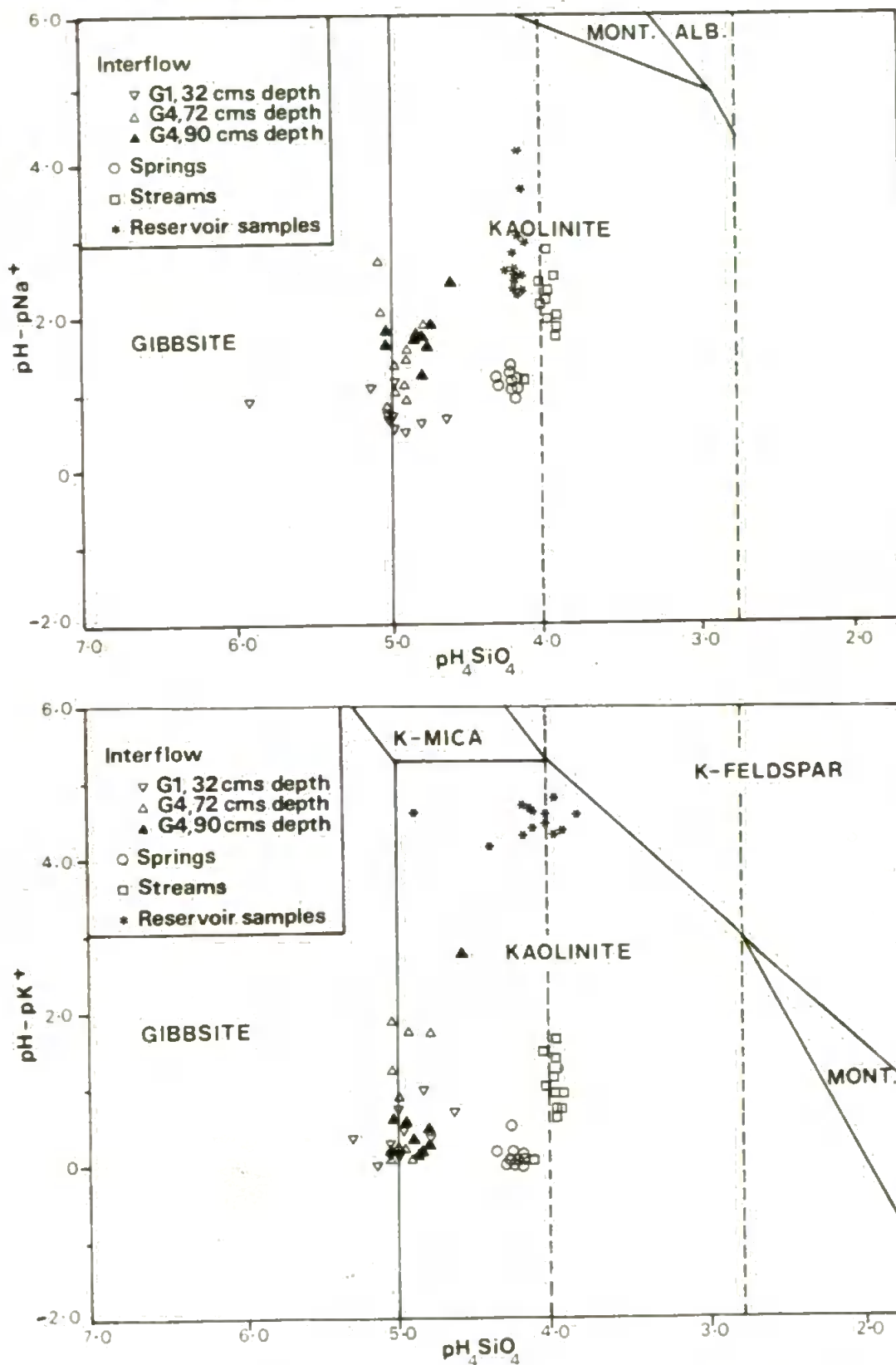


Fig. 9.3. Stability diagrams for grassland interflow (G4, 92 cm depth), spring 14, stream and reservoir

Stability diagrams for water samples from Bracken, non-forest springs, streams and reservoir

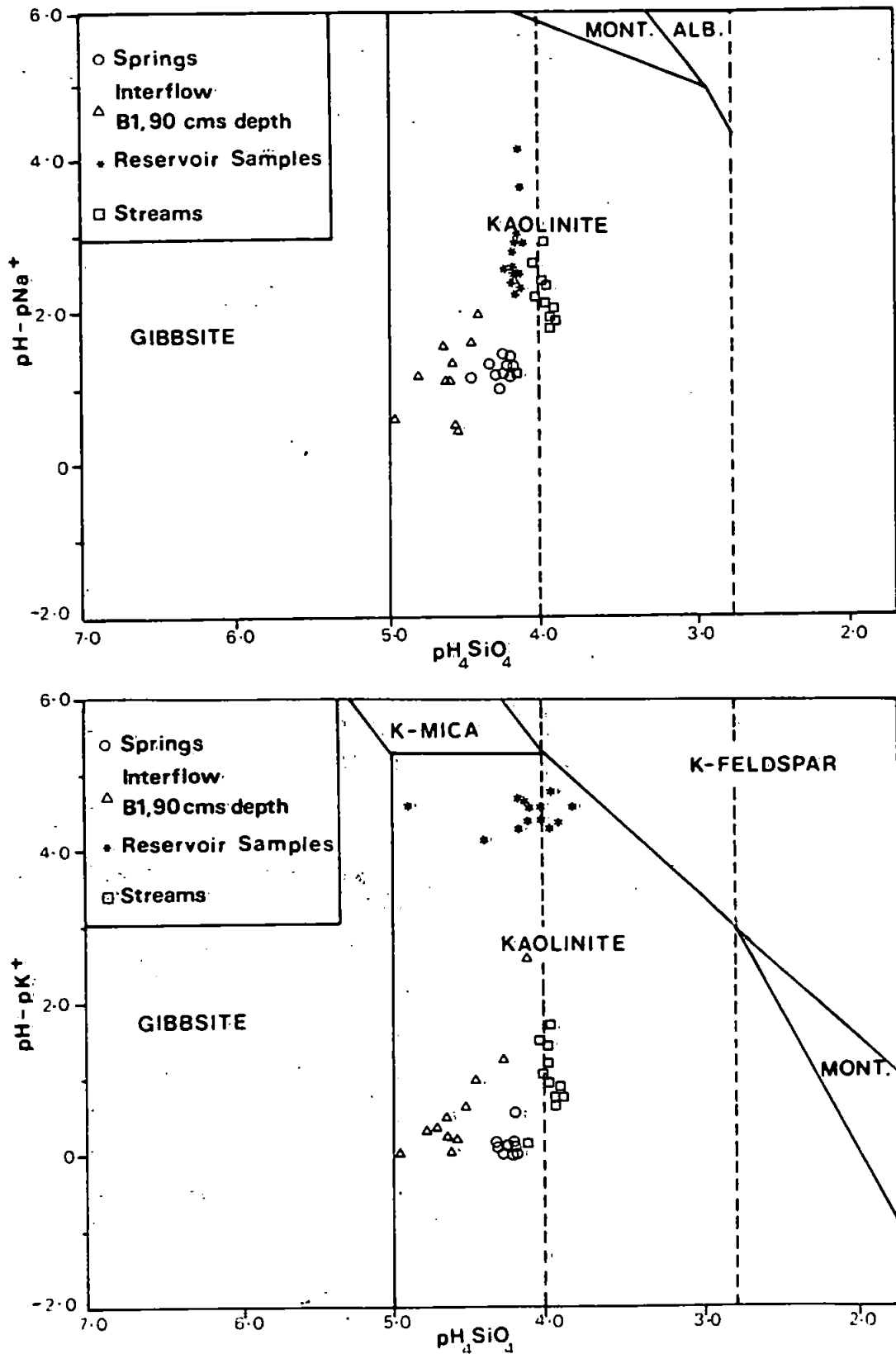


Fig. 9.4. Stability diagrams for bracken interflow (B1, 85 cm depth), spring 14, stream and reservoir

Stability diagrams for water samples from Forest, forest springs, streams and reservoir

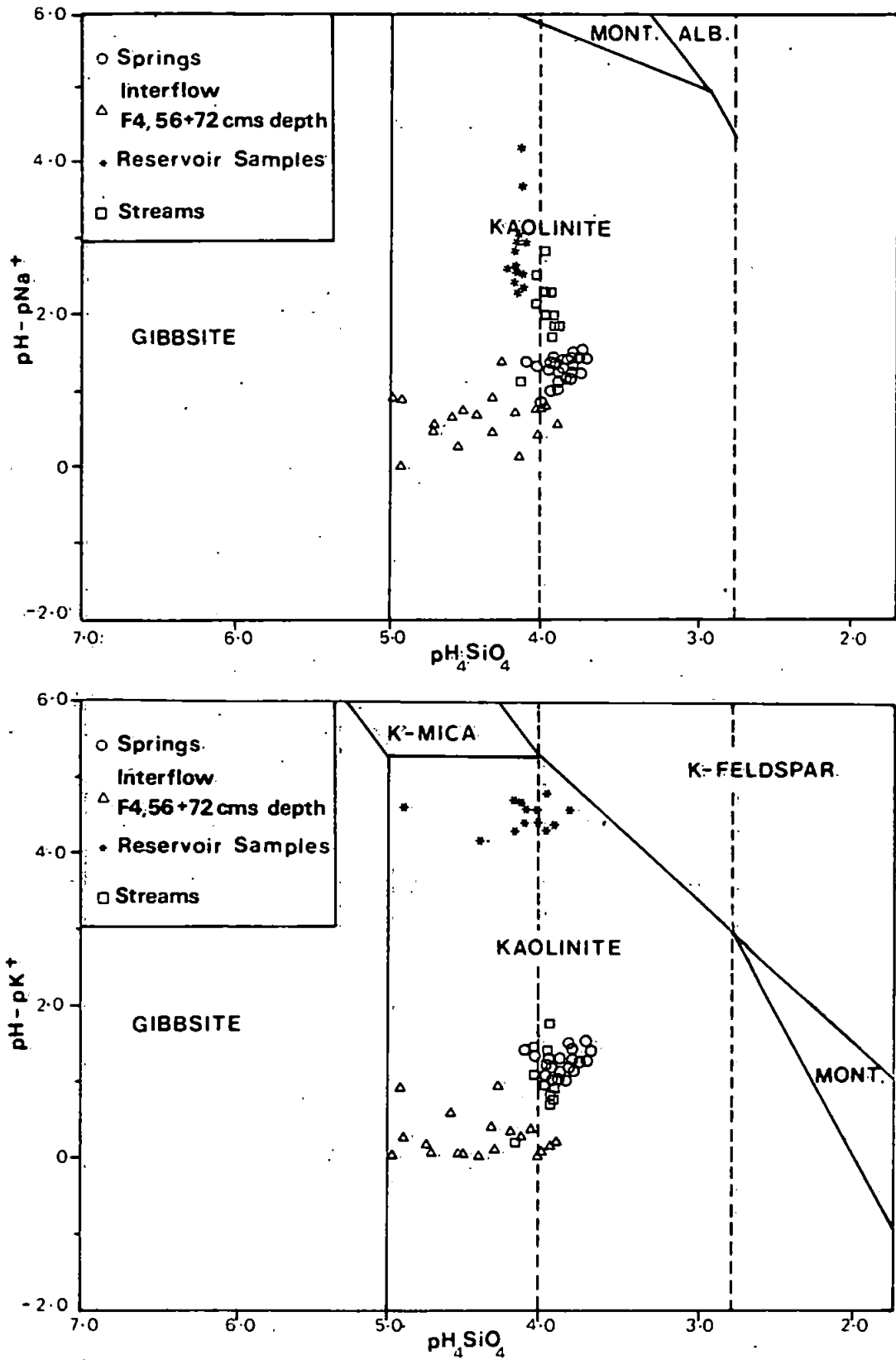


Fig. 9.5. Stability diagrams for forest interflow (F4, 53 cm and 76 cm depth), springs 17, 18 and 19, stream and reservoir



Plate 2.1. Narrator catchment and study area looking S.W.
from Combshead Tor.



Plate 2.2. Profile of the Moretonhampstead series



Plate 2.3. Profile of the Hexworthy series



Plate 3.1. Throughfall and stemflow collector
beneath bracken



Plate 3.2a. Whipkey type gutter system: insertion of polythene in face of soil profile

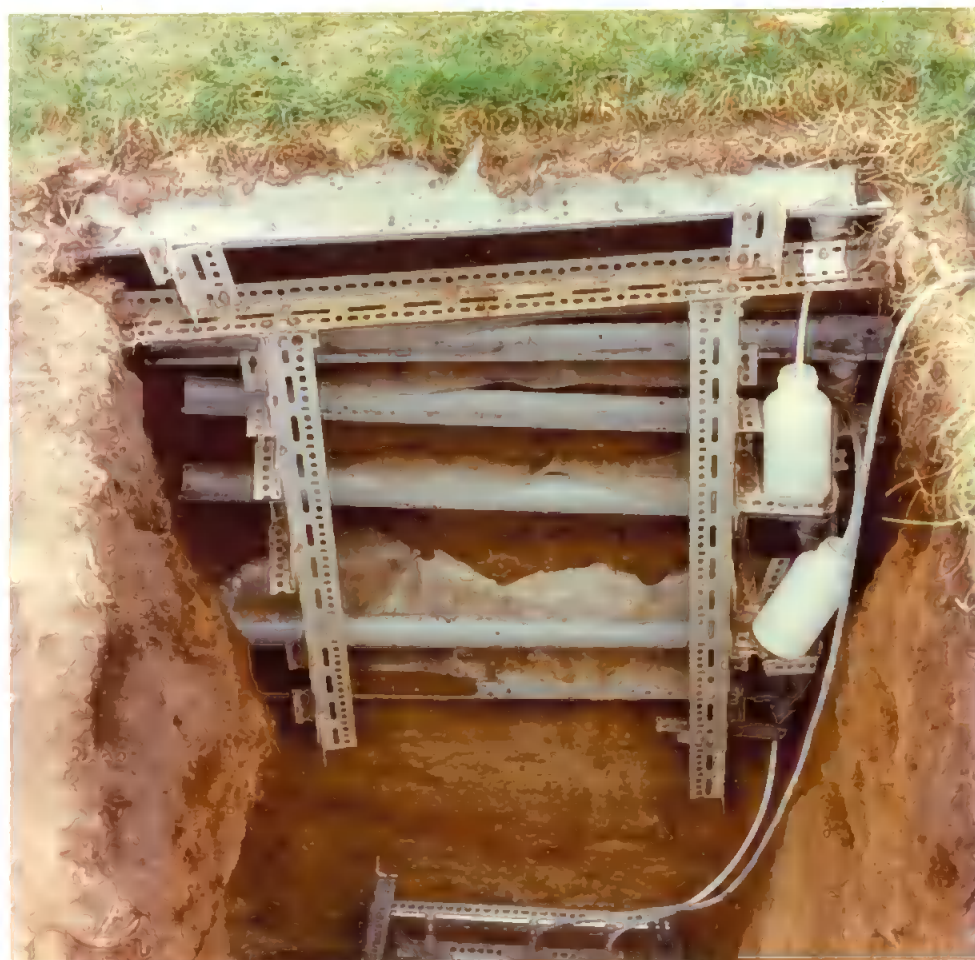


Plate 3.2b. Whipkey type gutter system: complete installation

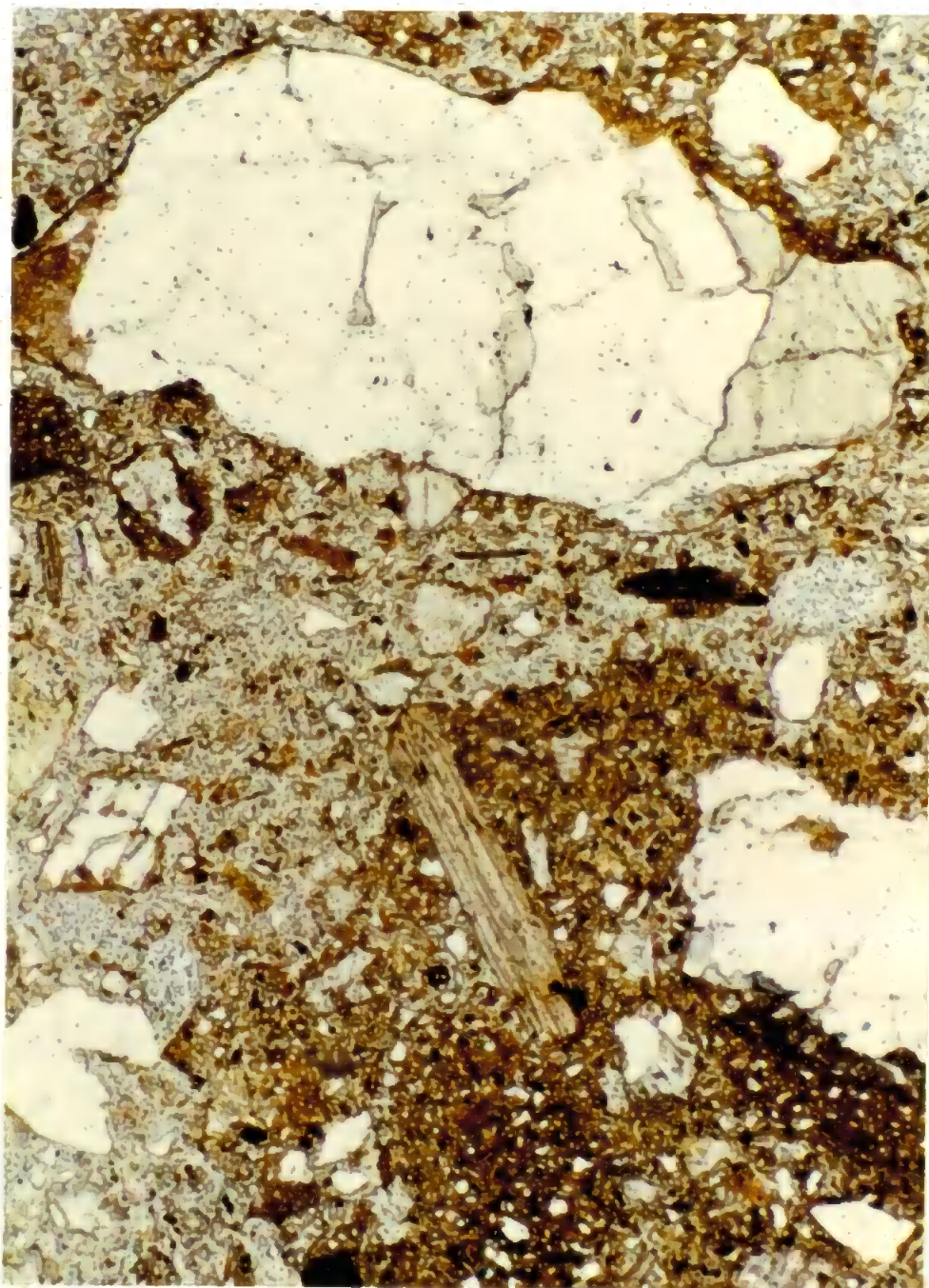


Plate 9.1. Thin section of Moretonhampstead soil
(G4, 33 cm depth)

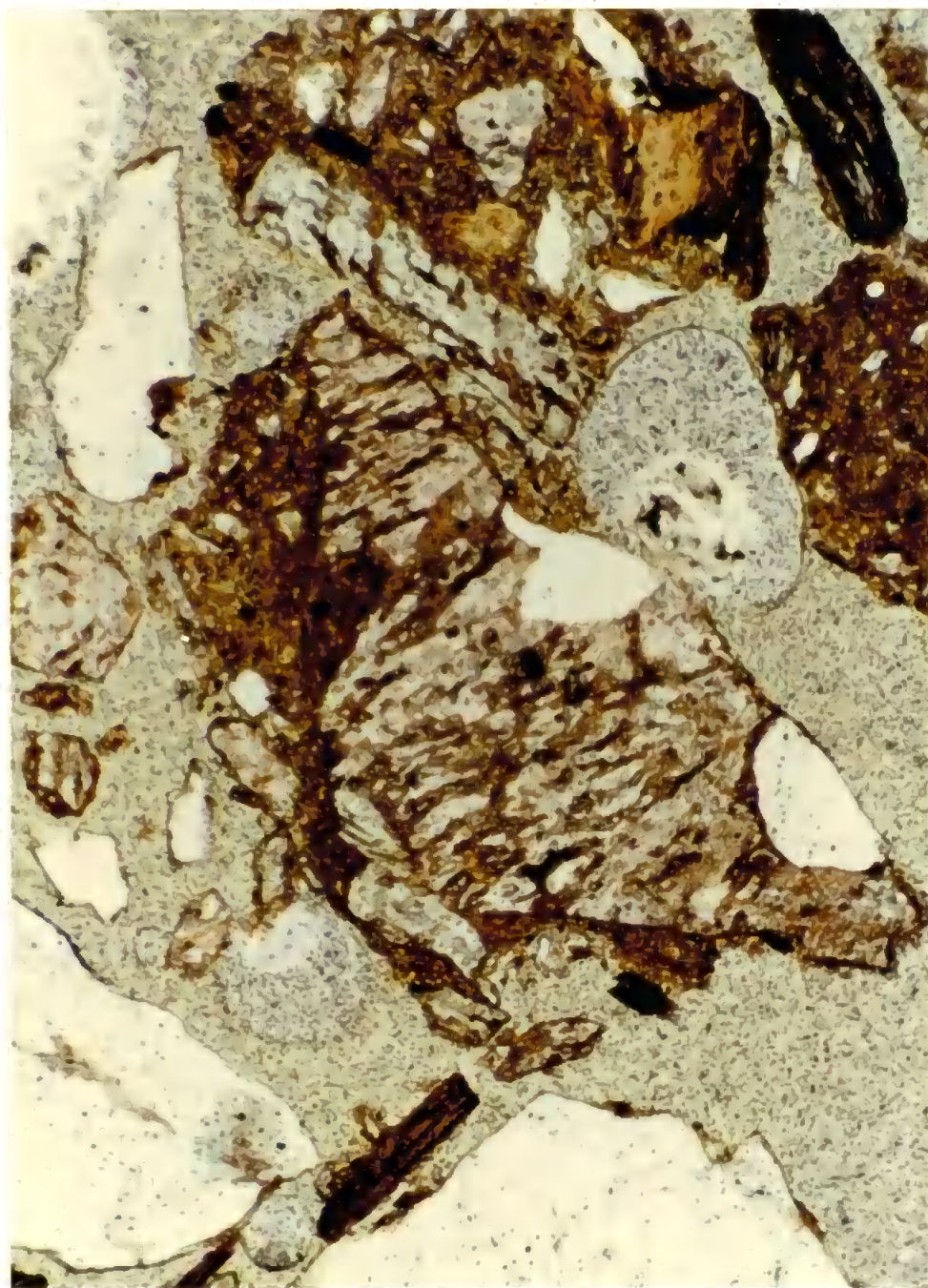


Plate 9.2. Thin section of Moretonhampstead soil
(G4, 62 cm depth)