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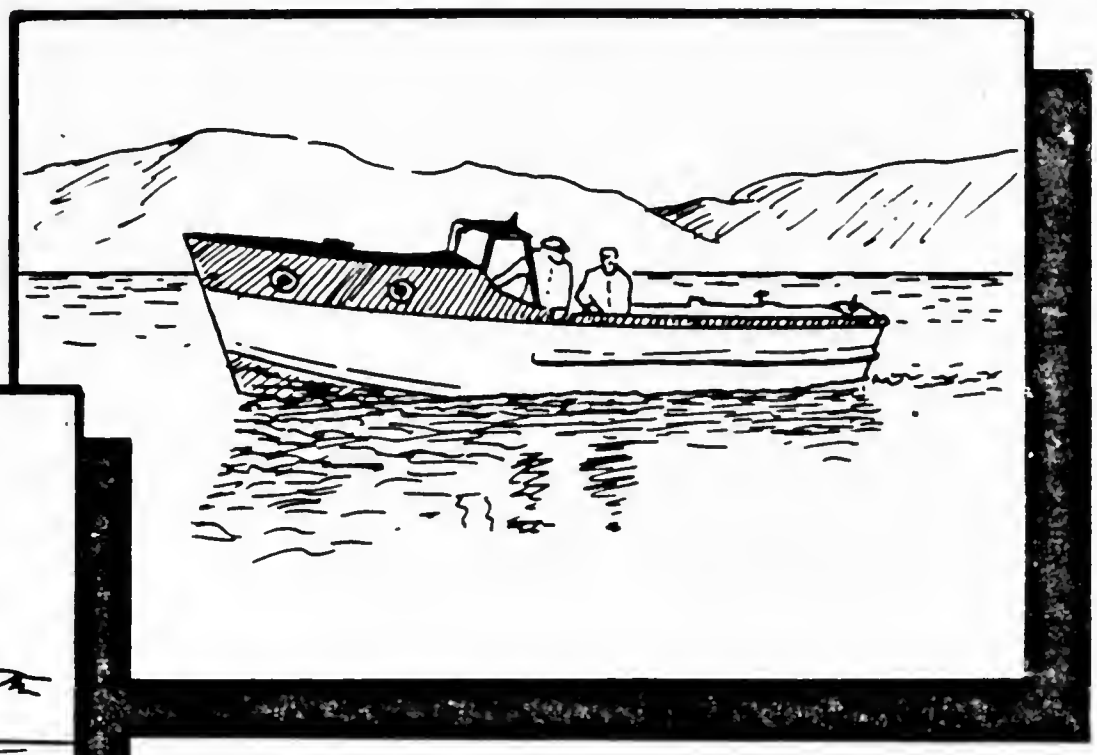
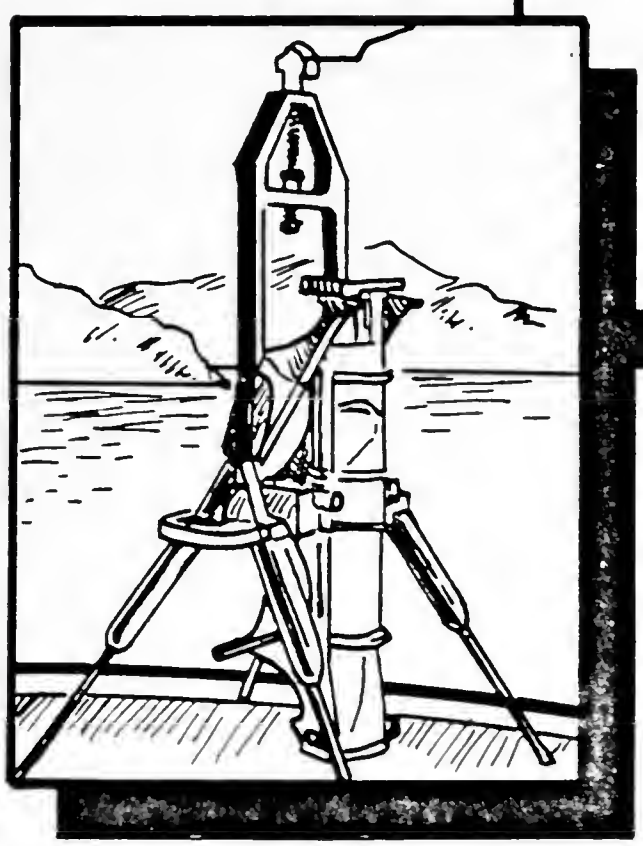
TENTH INTERNATIONAL SYMPOSIUM ON OSTRACODA ABERYSTWYTH 1988

RECENT FRESHWATER OSTRACODA OF THE LAKE DISTRICT

D.J. HORNE





SCHOOL OF EARTH SCIENCES

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RECENT FRESHWATER OSTRACODA OF THE LAKE DISTRICT

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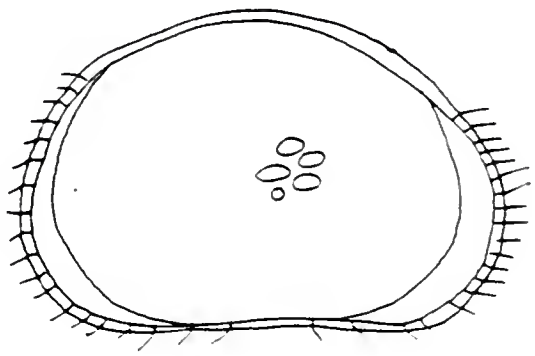
ITINERARY

Day 1: Lakes
- Locality 1.1: Brothers Water
- Locality 1.2: Loughrigg Tarn
- Locality 1.3: Esthwaite Water

Day 2: Small tarns and pools
- Locality 2.1: Barrow Plantation Tarns
- Locality 2.2: Podnet Tarn
- Locality 2.3: Gummer's Howe

Day 3: Windermere - North and South Basins



This book has been produced solely for those participating in the post-Symposium field excursion in August 1988. Any subsequent users of this guide are reminded that the Lake District is a National Park and that much of the land belongs to the National Trust and other bodies; they are advised to contact the Freshwater Biological Association* in the first instance with regard to obtaining permission to collect ostracods.

*FBA Windermere Laboratory, The Ferry House, Far Sawrey, Ambleside, Cumbria, LA22 0LP.

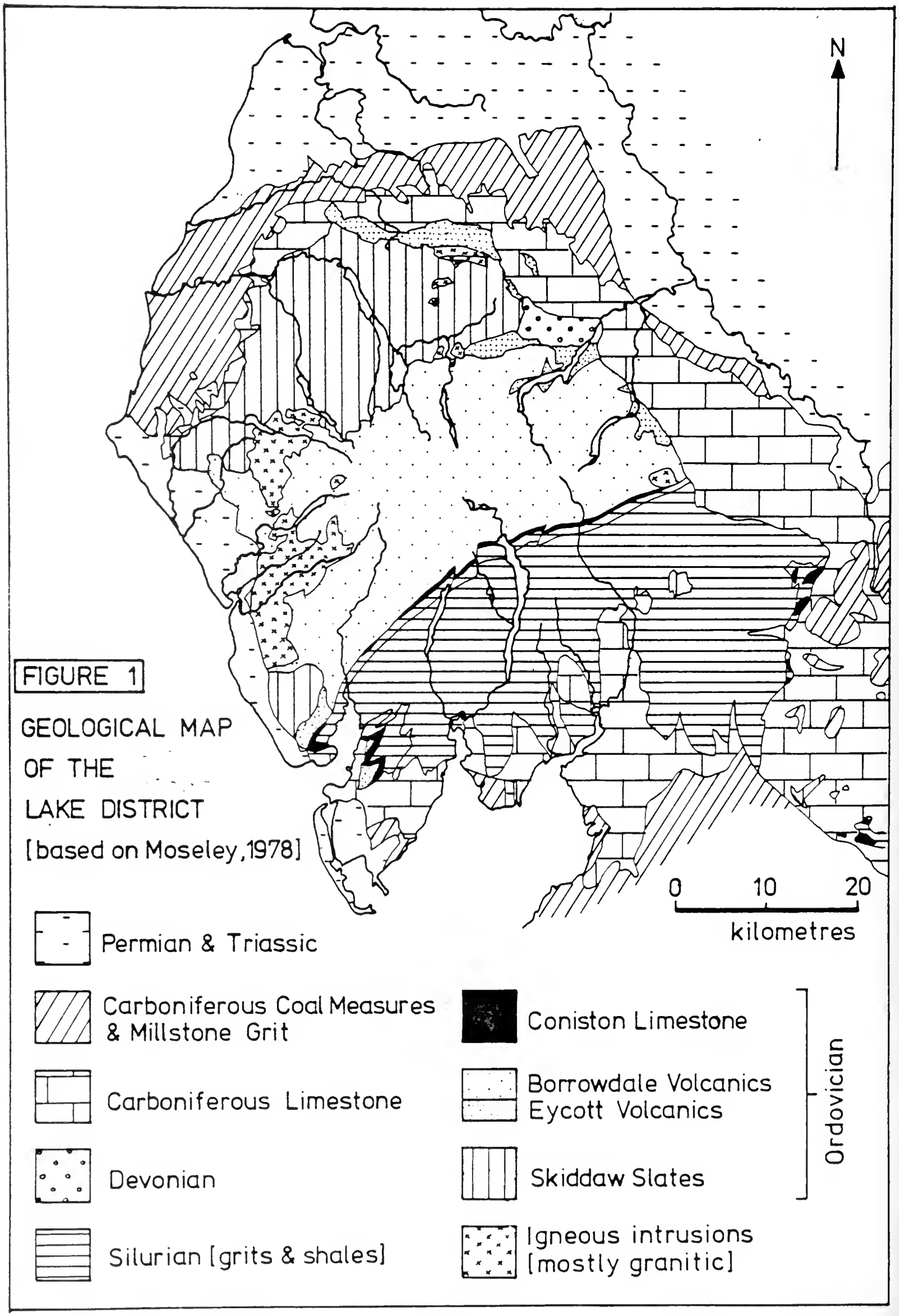


FIGURE 1

GEOLOGICAL MAP OF THE LAKE DISTRICT [based on Moseley, 1978]

INTRODUCTION

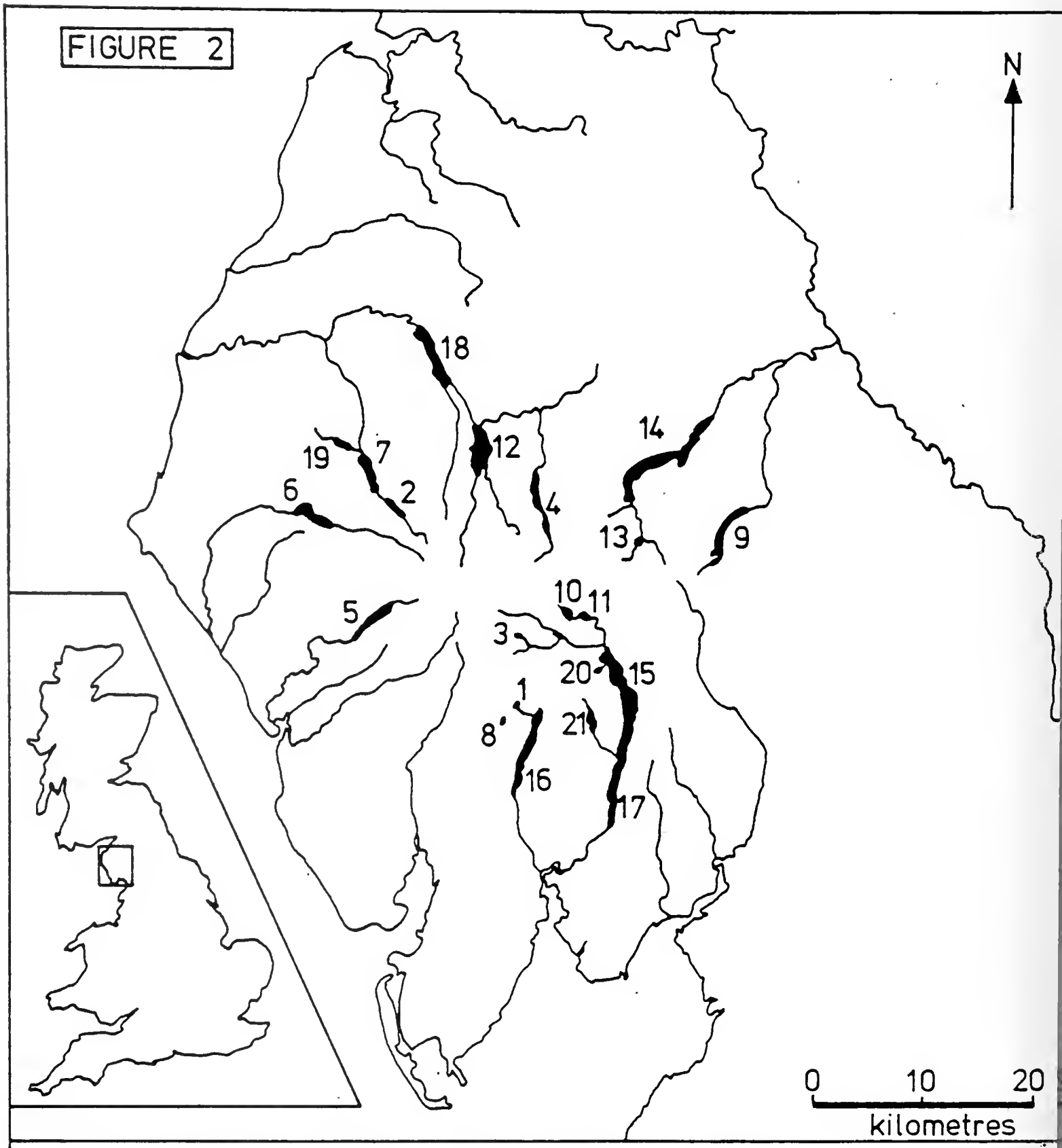
The English Lake District lies in north-west England between the Solway Firth and Morecambe Bay. The landscape was shaped mainly by the effects of Quaternary glaciation on uplands of domed Palaeozoic rocks. Borrowdale Volcanics Group lavas and tuffs form the rugged central fells which reach almost 1000m above sea-level, contrasting with the smooth outlines of the Skiddaw Slates topography to the north and the more subdued hills of Silurian grits and shales to the south (see Fig.1); the lakes occupy glacially deepened and widened valleys.

The water bodies range from unproductive (oligotrophic) lakes like Wastwater, low in dissolved nutrients and organic matter and with mainly rocky shores, to productive (eutrophic) lakes such as Esthwaite, which have little or no rocky shore and are rich in nutrients, particularly nitrates and phosphates (see Fig.2); additionally there are hundreds of the smaller water bodies known as "tarns", together with springs, streams ("becks") and rivers. During summer stratification the hypolimnion of smaller, shallower lakes such as Esthwaite may become deoxygenated.

Reeds (Phragmites australis) are the commonest emergent plants in the lakes, while tarns are characterised by the bottle sedge, Carex rostrata. Lakes are short-lived in geological terms; many of the lakes,tarns and kettle-holes that existed in late-glacial times have been filled in. In smaller water-bodies and in sheltered bays of the larger lakes the infill has been by the succession from reed-swamp through wet fen carr woodland to peat bog (e.g. Blelham Bog, near the north-west side of Windermere); larger water-bodies have been filled or reduced in size by advancing deltas (e.g., Derwentwater and Bassenthwaite formed by the partial infill of a once single basin). These processes may be seen in action today, for example at the north end of Esthwaite where vegetation grows on the top of an advancing underwater delta, and in the flat valley floor south of Brotherswater, indicating the alluvial infill of a once much larger lake.

Some "hard" waters occur on the Carboniferous Limestone of the surrounding area, but most of the lakes and tarns of the Lake District lie on Skiddaw Slates, Borrowdale Volcanics or Silurian rocks and are relatively "soft"; many are slightly acid, with pH 6-7, and some of the high tarns situated on igneous rocks have water with a pH of 5 or even less. Even in the more productive lakes such as Esthwaite and Windermere the mean pH is around 7, although algal blooms in summer sometimes raise it as high as 10. Upland tarns and streams, particularly those on Borrowdale Volcanics and Skiddaw Slates, have typically low concentrations of dissolved ions, predominantly sodium and chloride. Total ionic concentrations and proportions of calcium and bicarbonate alkalinity both increase with decreasing altitude, particularly in water-bodies on Silurian rocks; here bicarbonate may exceed the combined chloride and

FIGURE 2



LAKES OF THE ENGLISH LAKE DISTRICT numbered approximately in order of increasing productivity and total ion concentrations.

1, Levers Water; 2, Buttermere; 3, Blea Tarn; 4, Thirlmere;
5, Wastwater; 6, Ennerdale Water; 7, Crummock Water;
8, Goats Water; 9, Haweswater; 10, Grasmere; 11, Rydal Water;
12, Derwentwater; 13, Brotherswater; 14, Ullswater;
15, Windermere North Basin; 16, Coniston Water;
17, Windermere South Basin; 18, Bassenthwaite Lake;
19, Loweswater; 20, Blelham Tarn; 21, Esthwaite Water.

Based on Sutcliffe et al., 1982, fig. 1.

sulphate concentrations, which are greatest in lowland productive lakes such as Coniston, Esthwaite and Windermere. There is no evidence that the acidity of Lake District waters has increased over the last 50 years.

The Lake District has a not entirely unjustified reputation for wet weather. The climate is not so different from that of the rest of northern England, but the mountains tend to accentuate the extremes; thus rainfall is a little heavier and cloud more persistent in wet seasons, while in dry summers there is a greater likelihood of drought. In the central fells, around the head of Borrowdale, the annual total rainfall averages as much as 470 cm, and only the peripheral regions receive less than 152 cm. In winter, heavy snowfalls are not uncommon, and the tops of the higher fells are often at least lightly snow-covered from late October to early May. Small tarns (and on rare occasions, such as in 1963, even the larger lakes) become frozen over.

In spite of the extensive biological and ecological studies of Lake District waters carried out by the Freshwater Biological Association, which has had its Headquarters on Windermere for more than 50 years, there is remarkably little published information on the ostracods of the region. This is certainly not because of a lack of ostracods - even my own occasional and admittedly haphazard sampling over the past few years has already yielded a respectable species list (see Table 1). The dearth of information may be due, in part, to the fact that interest seems to have been focussed more on the planktonic than on the benthonic crustacea of the lakes, and perhaps also to the apparent aversion of the majority of biologists to getting to grips with ostracod taxonomy. The expertise certainly exists - witness Fryer's (1985) list of 36 ostracod species from lowland water bodies in Yorkshire - but given the present climate of financial constraint in research it may be many more years before such knowledge and experience can be brought to bear on Lake District ostracods, unless their application to a problem of immediate interest, such as Acid Rain, can attract funding.

At present so little is known that a comprehensive account of "Lake District Ostracoda" is an impossibility; it is certain that anyone using this guidebook will be able to add to the sparse information detailed herein, in terms of both species and localities.

LAKE DISTRICT OSTRACODS: PUBLISHED RECORDS

The earliest records of Lake District ostracods were published, not surprisingly, by G.S.Brady (1868a), who found Cypris obliqua (= Cypricercus) in Loughrigg Tarn in the summer of 1861 and also recorded Cypris laevis and Cypris ovum (both now referred to Cyclocypris) from "pools in Ennerdale", while in his "Monograph of the Recent British Ostracoda" (Brady, 1868b) he noted the occurrence of Cypridopsis villosa (now Potamocypris) in moorland pools near Easedale Tarn; he subsequently added Ilyodromus robertsoni (now Psychrodromus) to the list, recording it from a pool on Loughrigg (Brady, 1910). Brady & Norman (1889) listed Cypris obliqua from High Cross Tarn near Coniston and Derwentwater, and Cyclocypris globosa from "pools at the head of Easedale, Westmoreland". Holmes (1937) described a new species, Pseudocandona elongata, that he found in Low Wray Bay in Windermere (North Basin) in August, 1936, together with Cryptocandona vavrai; his Windermere sampling of that year also yielded Candona neglecta and a single specimen of Cytherissa lacustris, the latter from the deepest part (about 60m) of the North Basin. Scourfield (1943) recorded a single dead carapace of Cypria ophthalmica in bottom deposits from Windermere; this species was later found in 13 out of 17 lakes sampled by Smyly (1968), who subsequently reported its declining abundance in Esthwaite Water from 1956 to 1970 (Smyly, 1973).

LAKE DISTRICT OSTRACODS: RECENT COLLECTIONS

In late 1976 I was temporarily employed at the FBA under a "job creation" scheme and was occasionally able to collect ostracods while assisting various researchers with field work. This opportunistic sampling yielded Cypria ophthalmica from Esthwaite, Cyclocypris globosa from a pond in Dovedale (NY 392116), and several species from various localities on Windermere: Herpetocypris reptans, Cypridopsis vidua, juvenile Candona spp, a single adult female tentatively identified as Pseudocandona elongata, and Darwinula stevensoni (a single female with juvenile instars in the brood space).

Since 1982 I have gradually added to the faunal list by sampling a variety of water bodies during holiday visits to the area. My own collections have been considerably augmented by those of my parents, residents of Windermere, who now plan their weekend walks to include shoreline sampling of at least one tarn and spend many evenings at the microscope. The sampling techniques we have employed are many, from towing a plankton net through near-shore vegetation in tarns to catching individuals, literally by hand, in ditches; they are unquantitative, uncomparable and undoubtedly hit-and-miss, but they do demonstrate the existence of a hitherto neglected ostracod fauna.

The following collections were made by myself, John E.M.Horne and Doreen M.Horne; the actual collector's initials are given in brackets after the date of sampling.

Barrow Plantation Tarns

This is an unofficial name given by us to a group of small tarns just east of Barrow Plantation, and should not be confused with the larger tarn south of the plantation, referred to by Horne & Horne (1985) as Barrow Plantation Tarn (Stonehills Tarn) (SD 418944). We have designated them A,B,C,D and Q (for quarry tarn) (see fig.); A,B,D and Q are close together (SD 422949); we have not yet sampled tarn C, which is somewhat removed from the others (SD 425951) and on private ground.

2:9:86 (DMH, JEMH)
- A Cyclocypris ovum
- B Notodromas monacha

17:4:87 (DJH, JEMH)
- A Candona candida
  Cyclocypris ovum
  Cypria exsculpta
  Cypridopsis vidua
  Paracandona euplectella
- B Cypridopsis vidua ? (juvenile)
- D Candona sp. (juvenile)
  Cyclocypris globosa
  Cyclocypris ovum
  Cypridopsis vidua ? (juvenile)

16:9:87 (DJH, JEMH)
- A (13°C, pH 6.7)
  Candona candida
  Cyclocypris ovum
  Cypria exsculpta
  Cypridopsis vidua
- B (13°C, pH 6.7)
  Cyclocypris ovum
  Notodromas monacha
- D (13°C, pH 6.8)
  no ostracods
- Q (13°C, pH 6.8)
  Cyclocypris ovum
  Cypridopsis vidua

Beacon Tarn SD 273901

17:3:88 (DMH, JEMH)
Cyclocypris ovum

Birket Houses Allotment SD 402919

Pools in wet carr fen / Sphagnum bog.

26:3:88 (DJH)
Cyclocypris globosa
Cyclocypris ovum
Cypridopsis vidua

Bolton's Tarn SD 446935

15:10:86 (DMH, JEMH)
Cypridopsis vidua

Brotherswater NY 401125

19:9:87 (DJH)

a) SW margin of lake, near stream inflow (pH 6.9)

Candona lactea
Candona siliquosa
Cyclocypris laevis

b) sluggish, marshy stream on W margin of lake (pH 7.2)

Candona sp. (juvenile)
Psychrodromus robertsoni

27:3:88 (DJH)

a) SW margin of lake, near stream inflow

Candona candida
Candona siliquosa
Candona vavrai
Cyclocypris laevis
Cyclocypris serena

b) sluggish, marshy stream on W margin of lake

Candona candida
Candona reducta
Candona vavrai
Psychrodromus robertsoni.

Cleabarrow Tarn SD 424963

6:9:86 (DMH)

Notodromas monacha

25:4:87 (DMH)

Cypria exsculpta
Cypria ophthalmica
Cypridopsis vidua
Herpetocypris reptans? (juvenile)

Esthwaite Water SD 362954

16:9:87 (DJH)

a) marshy pools by SW margin of lake (15°C, pH 6.3)

Candona sp. (juvenile)

b) SW margin of lake (15°C, pH 7.3)

Candona sp. (juvenile)
Cyclocypris laevis
Cypridopsis vidua

28:3:88 SW margin of lake

Candona candida
Cyclocypris laevis
Cypricercus? sp (juvenile)
Cypridopsis vidua

Gummer's Howe SD 390880

Marshy pools and ditches with sluggish flowing water beside path on south side, just south of where a stream crosses the path.

31:12:82 (DJH)
- Candona reducta
- Candona vavrai
- Cyclocypris ovum

20:4:87 (DJH, JEMH)
- Candona candida
- Candona reducta
- Candona vavrai
- Cyclocypris ovum
- Eucypris pigra
- Psychrodromus robertsoni

16:9:87 (DJH) (14°C, pH 6.8)
- Candona candida
- Candona reducta
- Cyclocypris ovum
- Eucypris pigra
- Psychrodromus robertsoni

High Arnside Tarn NY 331011

21:1:88 (JEMH)
- Candona candida
- Herpetocypris reptans

Loughrigg Tarn NY 343044

21:8:86 (DJH) W margin of tarn
- Candona albicans? (juvenile)
- Candona rostrata
- Cypridopsis vidua
- Metacypris cordata

16:9:87 (DJH)

a) marshy pools by W margin of tarn (15°C, ph 6.4)
- Cyclocypris ovum

b) W margin of tarn (15!C, pH 7.4)
- Candona sp. (juvenile)
- Cypridopsis vidua

25:3:88 (DJH)

a) marshy pools by W margin of tarn
- Cyclocypris globosa

b) W margin of tarn
- Candona albicans? (juveniles)
- Candona candida
- Cyclocypris globosa
- Cypria exsculpta
- Cypridopsis vidua
- Herpetocypris reptans? (juveniles)

Middle Fairbank Tarn SD 448974

2:10:86 (DMH, JEMH)
- Cypricercus affinis
- Potamocypris villosa

Podnet Tarn SD 404925

24:8:86 (DJH)

Cypridopsis vidua
Herpetocypris reptans

25:9:86 (DMH, JEMH)

Cypridopsis vidua? (juvenile)
Herpetocypris reptans? (juvenile)

2:11:86 (DMH, JEMH)

Cypridopsis vidua? (juvenile)

12:12:86 (DMH, JEMH)

Cypridopsis vidua? (juvenile)

18:4:87 (DJH)

Candona candida

16:9:87 (DJH) (18°C, pH 7.2)

Herpetocypris reptans? (juvenile)

26:3:88 (DJH)

Candona candida
Cypria exsculpta
Herpetocypris reptans

Rydal Water

a) 31:10:82 (DJH) marshy pool near river inflow on W side of lake NY 350064

Candona candida
Cyclocypris globosa
Cypria ophthalmica

b) 22:8:86 (DJH) pool near footbridge over river W of the lake NY 347064

Candona candida
Cypridopsis vidua? (juvenile)

School Knott Tarn SD 428973

14:5:87 (DMH)

Cypria exsculpta
Cypridopsis vidua

25:8:86 (JEMH)

Candona sp. (juvenile)
Cypria exsculpta
Cypridopsis vidua

Skeggles Water NY 480033

7:9:86 (JEMH & DMH)

Cyclocypris laevis

Unnamed tarn near Rosthwaite Farm SD 405933

18:4:87 (DJH, DMH, JEMH)

Candona siliquosa
Cyclocypris ovum
Cypria ophthalmica
Herpetocypris reptans

Unnamed tarn south of Grandsire SD 431971

23:8:86 (DMH)

Cyclocypris ovum

Unnamed pool beside the Walna Scar track, near Coniston, SD 288970

31:12:82 (DJH)

Candona candida
Cyclocypris ovum

Windermere (localities sampled from boat on 17:9:87 by DJH)

a) South Basin, bay N of Rawlinson Nab SD 384933, depth 1m
Candona sp. (juvenile)
Cypridopsis vidua
Herpetocypris reptans

b) North Basin, High Wray Bay NY 376004, depth 2m
Cyclocypris sp.
Cypridopsis vidua

c) North Basin, at the mouth of the Brathay NY 373032, depth 1-2m
Candona candida? (juvenile)
Candona sp.
Cyclocypris cf serena
Cypria ophthalmica
Herpetocypris reptans? (juvenile)

Several Ekman Grab samples were taken in deeper water (to 57m) in both North and South Basins on the same day, but no ostracods were obtained.

ACKNOWLEDGEMENTS

My identifications of Lake District ostracods have been greatly facilitated by Peter Henderson, who kindy allowed me to use a draft version of his forthcoming Freshwater Ostracods volume in the Linnean Society's "Synopses of the British Fauna" series.

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TABLE 1

Ostracods recorded in the English Lake District
(see text for details)

* previously unpublished records

* Candona albicans (Brady, 1864) (?; juveniles only)
* Candona candida O.F.Müller, 1785
* Candona lactea Baird, 1850
Candona neglecta Sars, 1887
* Candona reducta (Alm, 1914)
* Candona rostrata Brady & Norman, 1889
* Candona siliquosa Brady, 1910
Candona (Cryptocandona) vavrai (Kaufman, 1900)
Cyclocypris globosa Sars, 1863
Cyclocypris laevis (O.F.Müller, 1776)
Cyclocypris ovum (Jurine, 1820)
* Cyclocypris serena (Koch, 1837)
* Cypria exsculpta (Fischer, 1855)
Cypria ophthalmica (Jurine, 1820)
* Cypricercus affinis (Fischer, 1851)
Cypricercus obliquus (Brady, 1868)
* Cypridopsis vidua (O.F.Müller, 1776)
Cytherissa lacustris Sars, 1863
* Darwinula stevensoni (Brady & Robertson, 1870)
* Eucypris pigra (Fischer, 1851)
* Herpetocypris reptans (Baird, 1835)
* Metacypris cordata Brady & Norman, 1870
* Notodromas monacha (O.F.Müller, 1776)
* Paracandona euplectella (Brady & Norman, 1889)
Potamocypris villosa (Jurine, 1820)
Pseudocandona elongata Holmes, 1937
Psychrodromus robertsoni (Brady & Norman, 1889)

ITINERARIES
(see Fig.3)

Day 1: Lakes (Fig.4)

Locality 1.1: Brothers Water NY 403127

Brotherswater is a small, moderately productive lake (surface area 0.2 square km, maximum depth 15m), situated on Borrowdale Volcanics at an altitude of 173m. Sutcliffe et al. (1982) gave the following mean values for the period July 1974 - July 1976:

pH:	6.7
Alkalinity:	188 µequiv. per litre
Total anions:	550 µequiv. per litre
Total cations:	548 µequiv. per litre

The following species have been collected by shoreline sampling near the river inflow at the SW corner of the lake (NY 401125):

Candona candida
Candona lactea
Candona siliquosa
Candona vavrai
Cyclocypris laevis
Cyclocypris serena

Nearby, the sluggish marshy stream that enters the W margin of the lake (NY 400126) has yielded:

Candona candida
Candona reducta
Candona vavrai
Psychrodromus robertsoni

Smyly (1968) recorded a single specimen of Cypria ophthalmica from Brotherswater.

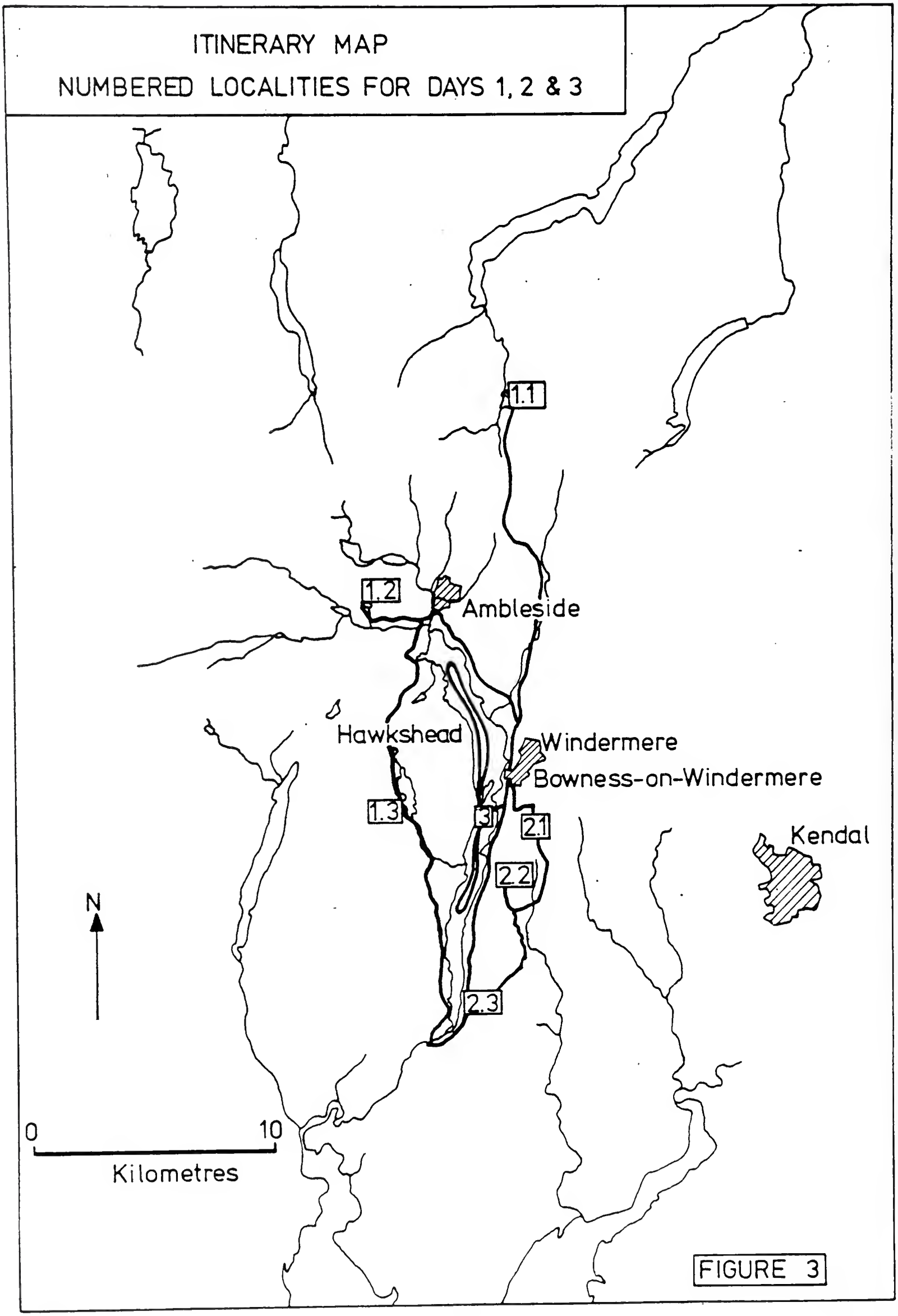

ITINERARY MAP
NUMBERED LOCALITIES FOR DAYS 1, 2 & 3
1.1
1.2
Ambleside
Hawkshead
Windermere
Bowness-on-Windermere
1.3
3
2.1
2.2
2.3
Kendal
N
0
10
Kilometres

FIGURE 3

Locality 1.2: Loughrigg Tarn NY 343044

Loughrigg Tarn is a small productive lake (the common emergent plant is Phragmites) with a surface area of 0.086 square km and a maximum depth of 10m; it is situated on Borrowdale Volcanics at an altitude of 94m. The following water chemistry ranges for 1974 are taken from Carrick & Sutcliffe (1982):

pH:	6.7-7.3
Alkalinity:	338-405 µequiv. per litre
Total anions:	698-755 µequiv. per litre
Total cations:	681-722 µequiv. per litre

Sampling from the wooded NW shore of the lake has yielded:

Candona albicans?
Candona candida
Candona rostrata
Cyclocypris globosa
Cypria exsculpta
Cypridopsis vidua
Herpetocypris reptans?
Metacypris cordata

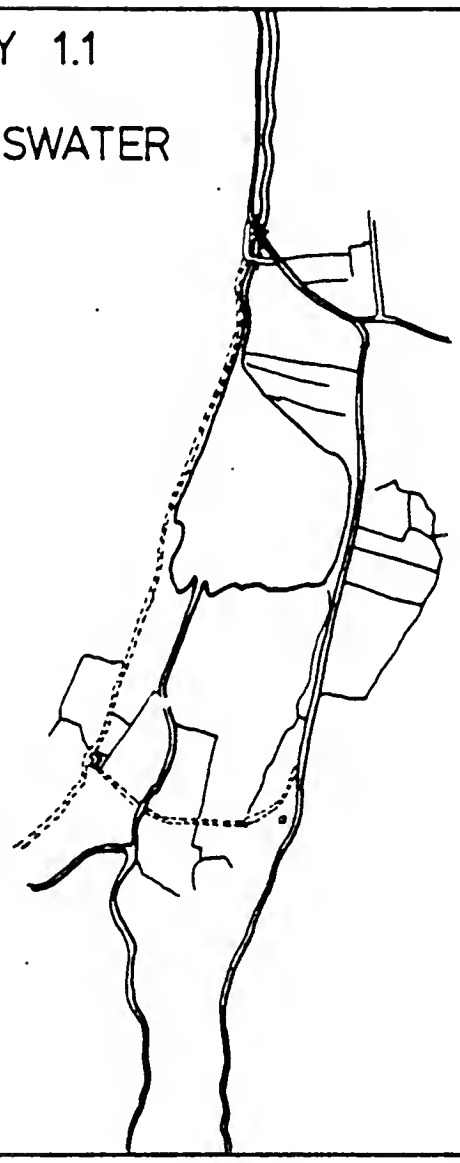
Cypricercus obliquus was recorded here by Brady (1868a). In addition, Cyclocypris globosa and Cyclocypris ovum have been obtained from marshy pools in the woods on the NW margin of the lake.

LOCALITY 1.2

LOUGHRIGG TARN

LOCALITY 1.1

BROTHERSWATER



LOCALITY MAPS FOR DAY 1

N

0 1 km

FIGURE 4

LOCALITY 1.3

ESTHWAITE WATER

Locality 1.3: Esthwaite Water SD 360965

Esthwaite, at an altitude of 65m, is one of the most productive lakes; it has a surface area of 1.0 square kilometre and a maximum depth of 15.5m. It rests on Silurian rocks covered by glacial drift and has little rocky shore. Sutcliffe et al. (1982) gave the following mean values for the period May 1974 - February 1978:

pH: 7.1
Alkalinity: 386 µequiv. per litre
Total anions: 933 µequiv. per litre
Total cations: 923 µequiv. per litre

Sampling amongst the reeds on the around the SW edge of the lake near the car park has yielded:

Cyclocypris laevis
Cypricercus? sp.
Cypridopsis vidua
Candona candida

Juvenile Candona were also collected from marshy pools in the woods on the lake shore. Cypria ophthalmica has been recorded from the northern part of the lake (e.g., by Smyly, 1973).

Day 2: Small tarns and pools (Fig.5)

All of the localities for Day 2 are situated on Silurian rocks.

Locality 2.1: Barrow Plantation Tarns SD 422949

This is a group of small, shallow tarns, interconnected by boggy ground and sluggish streams (see Fig.), at an altitude of 160m. Tarns A,B,D and Q, had similar pH values of 6.7-6.8 on 16:9:87; no other water chemistry data are available. Each tarn seems to have a distinctive ostracod fauna although they have several species in common; the apparent differences in their ostracod faunas are as yet unexplained, but may be related to differences in substrate and vegetation.

The following ostracods have been recorded (tarn C is some distance from the others and has not yet been sampled):

Tarn A
Candona candida
Cyclocypris ovum
Cypria exsculpta
Cypridopsis vidua
Paracandona euplectella

Tarn B
Cypridopsis vidua ? (juvenile)
Cyclocypris ovum
Notodromas monacha

Tarn D
Candona sp. (juvenile)
Cyclocypris globosa
Cyclocypris ovum
Cypridopsis vidua ? (juvenile)

Tarn Q (in a small abandoned quarry)
Cyclocypris ovum
Cypridopsis vidua

Locality 2.2: Podnet Tarn SD 404925

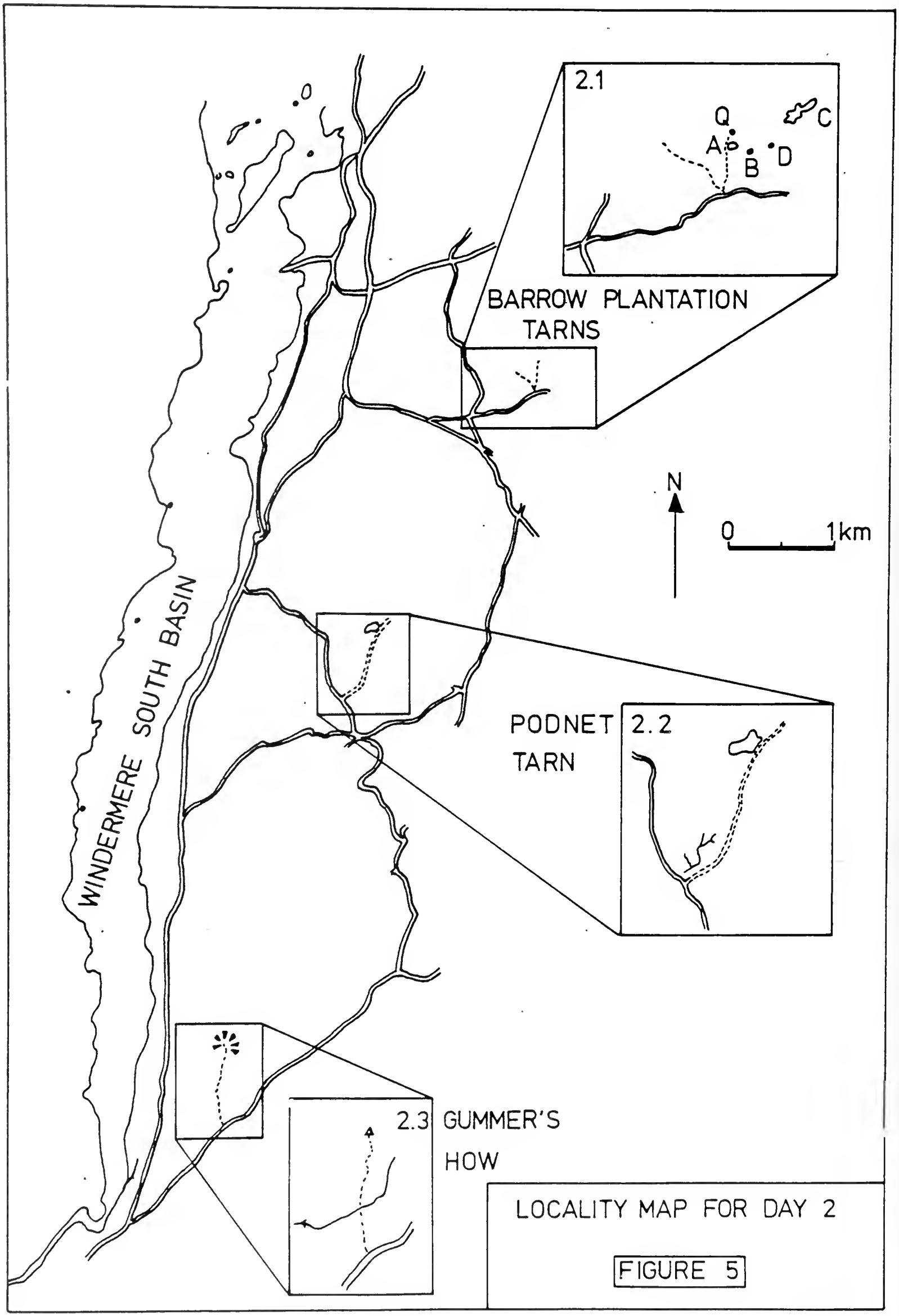
On the way to the tarn, pools in wet carr fen woodland and Sphagnum bog on the left (northern) side of the road may be sampled; these have yielded:

Cyclocypris globosa
Cyclocypris ovum
Cypridopsis vidua

Podnet is a shallow tarn measuring about 100 x 150m; it is 91m above sea-level. The only published water chemistry data are for 31:1:55, when the recorded alkalinity was 134 µequiv. per litre (Carrick & Sutcliffe, 1982). On 16:9:87 a pH of 7.2 was recorded.

The following ostracods have been found in Podnet Tarn:

Candona candida
Cypria exsculpta
Cypridopsis vidua
Herpetocypris reptans



LOCALITY MAP FOR DAY 2

FIGURE 5

Locality 2.3: Gummer's Howe SD 390880

Gummer's Howe (altitude 321m) overlooks the southern end of Windermere Lake and affords superb views northwards along the length of the lake to the central fells. From the road, a footpath leads northwards to Gummer's Howe, initially across fairly level ground until it is crossed by a small stream, after which it climbs steeply to the summit.

Ostracods may be collected from the marshy pools and ditches with sluggish flowing water to the south of the stream (altitude 200m); a pH of 6.8 was recorded on 16:9:87. The following species have been recorded:

Candona candida
Candona reducta
Candona vavrai
Cyclocypris ovum
Eucypris pigra
Psychrodromus robertsoni

Day 3: Windermere

North and South Basins (Figs 6, 7, 8)

Sampling will be carried out from the launch Velia, based at the Ferry House, the Headquarters of the Freshwater Biological Association.

Windermere is the largest lake in terms of both length (17km) and volume (347 million cubic metres); the lake surface has a mean altitude of 39m. Its main tributaries are the Rivers Rothay and Brathay, flowing into the north end (NY 372032), Trout Beck, entering the North Basin about half-way down its eastern side (SD 395996), and Cunsey Beck, bringing water from Esthwaite into the South Basin (SD 384936); the outflow, at the extreme southern end of the South Basin (SD 380870), is the River Leven. The water takes about 9 months to flow through the entire length of the lake. Windermere becomes stratified during the summer months, with the establishment of a thermocline at 10-15m depth.

The lake is divided into two basins (see Fig. 6) by a region of shallow water (less than 5m) and islands, the largest of which is Belle Isle; freshwater biologists regard the North and South Basins as separate lakes. Windermere is one of the more productive lakes, and the South Basin is more productive and has a higher total ion concentration than the North Basin. The following data are taken from Sutcliffe et al. (1982).

South Basin

(max. depth 42m, surface area 6.7 square km)

Mean values for the period April 1974 - February 1978:

pH: 7.1
Alkalinity: 236 µequiv. per litre
Total anions: 677 µequiv. per litre
Total cations: 683 µequiv. per litre

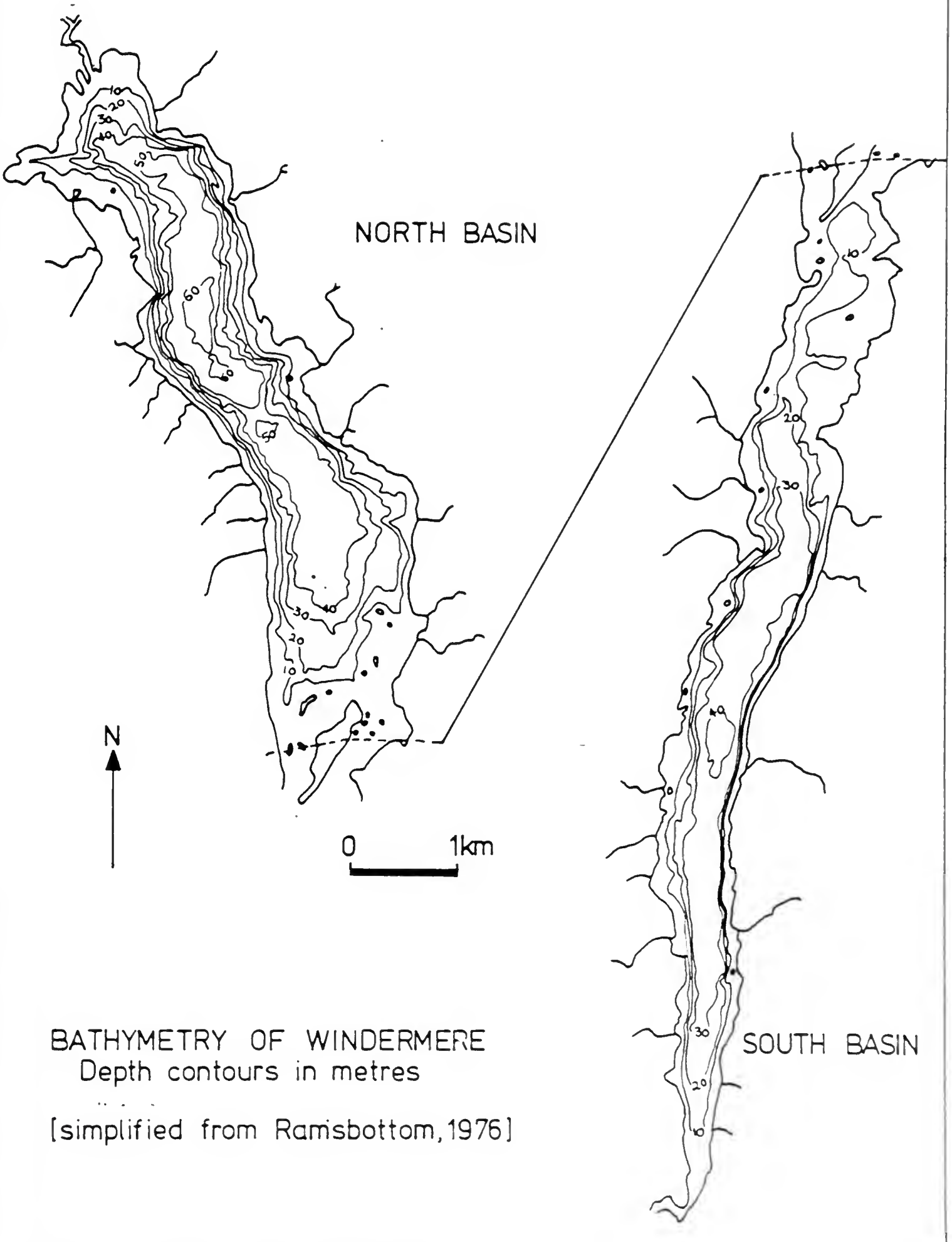
North Basin

(max. depth 64m, surface area 8.1 square km)

Mean values for the period April 1974 - March 1978:

pH: 7.0
Alkalinity: 204 µequiv. per litre
Total anions: 608 µequiv. per litre
Total cations: 611 µequiv. per litre

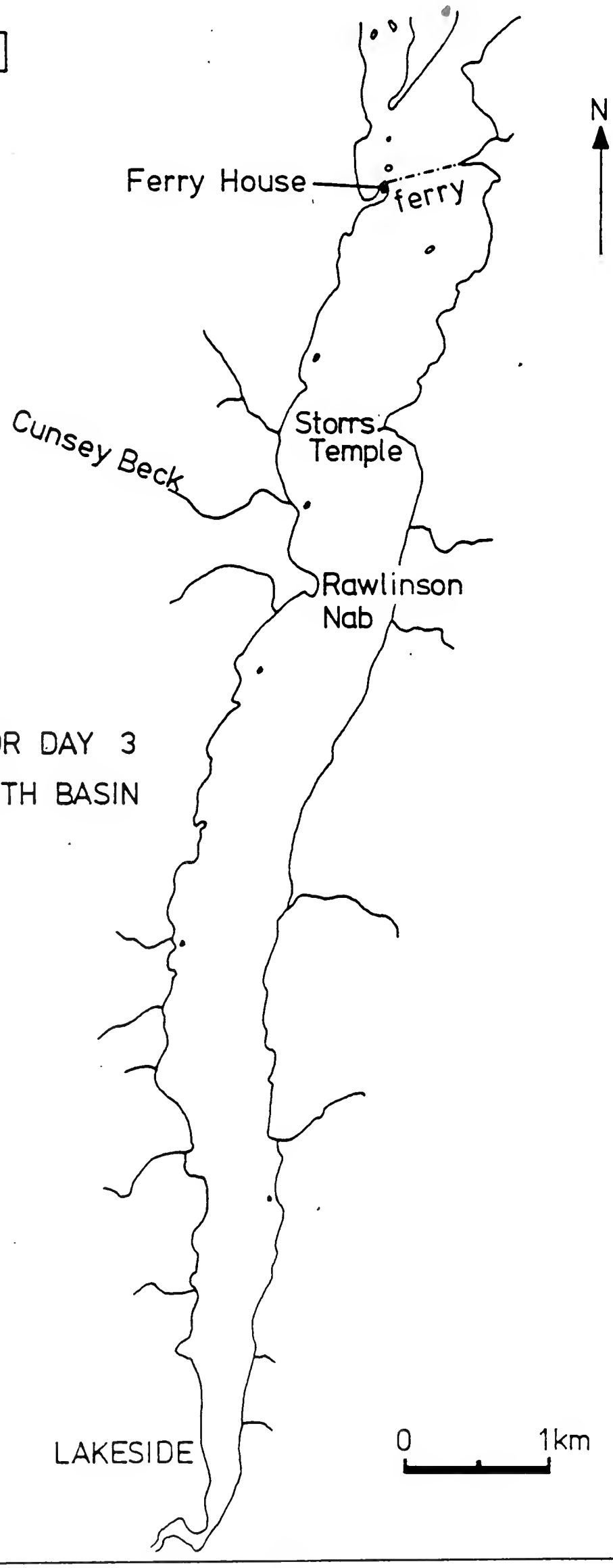
FIGURE 6



BATHYMETRY OF WINDERMERE
Depth contours in metres

[simplified from Ramsbottom, 1976]

FIGURE 7



LOCATION MAP FOR DAY 3
WINDERMERE SOUTH BASIN

The following ostracods have been recorded from Windermere, mostly in the shallower parts:

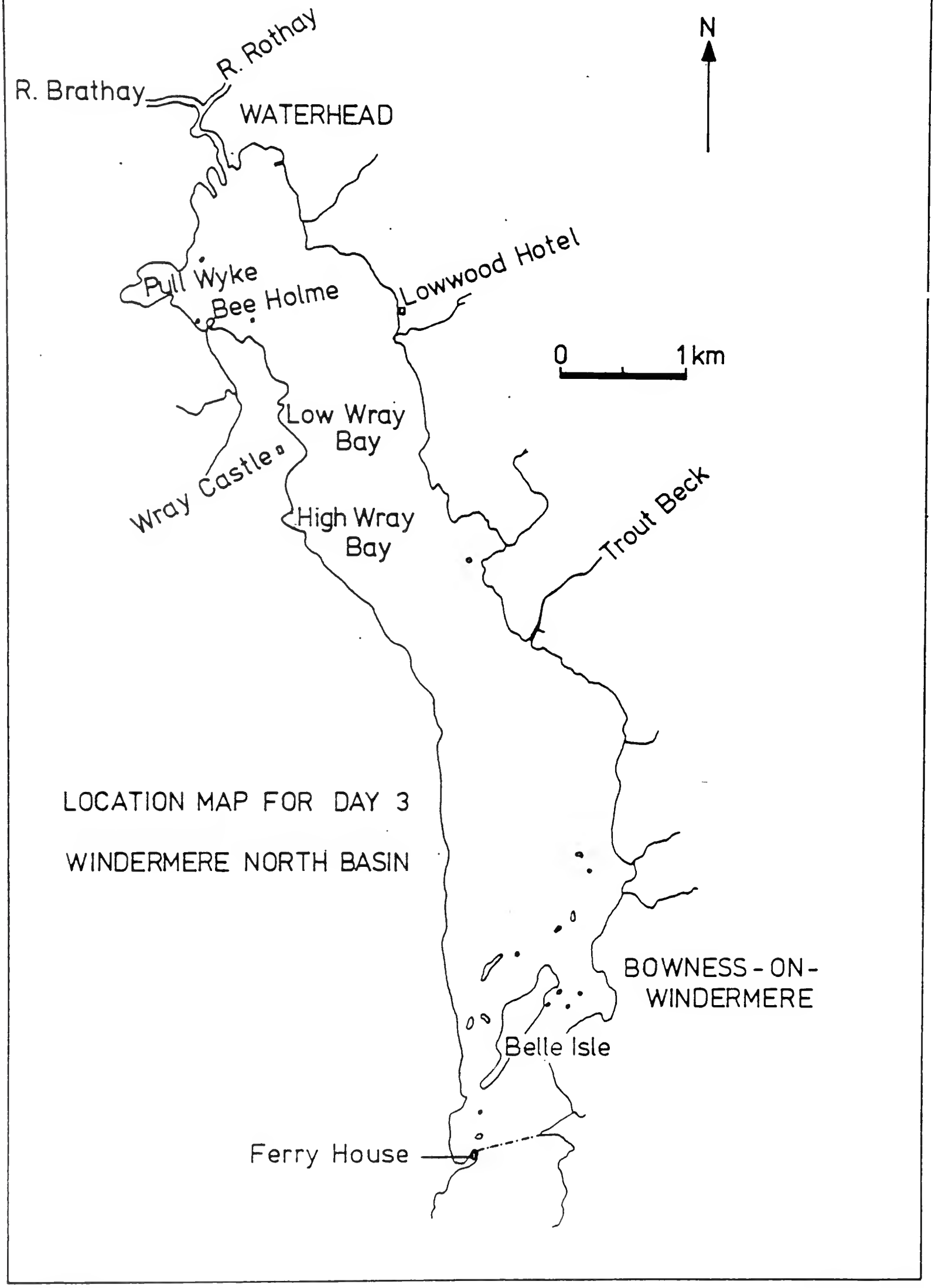
South Basin (Fig.7)

Candona sp. (juveniles)
Cypridopsis vidua
Herpetocypris reptans

North Basin (Fig. 8)

Candona candida? (juveniles)
Candona neglecta
Candona vavrai
Cyclocypris cf. serena
Cypria ophthalmica
Cypridopsis vidua
Cytherissa lacustris
Darwinula stevensoni
Herpetocypris reptans? (juveniles)
Pseudocandona elongata

FIGURE 8



LOCATION MAP FOR DAY 3

WINDERMERE NORTH BASIN

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