PROVISIONAL ATLAS OF THE MARINE DINOFLAGELLATES OF THE BRITISH ISLES

Edited by JOHN D. DODGE

1981

BIOLOGICAL RECORDS CENTRE

Institute of Terrestrial Ecology,
Monks Wood Experimental Station,
Huntingdon

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FOREWORD

This atlas is the first to present data from one of the Biological Records Centre's marine recording schemes. It is hoped that it will give encouragement to recorders, both of dinoflagellates and also of other marine organisms.

These maps are only a summary of the data accumulated by Professor Dodge. Copies of the record cards have been deposited in the archives of biological records held by the Biological Records Centre. The Biological Records Centre is grateful to Professor Dodge for providing the original data and editing this provisional atlas.

Under the terms of a contract with the Natural Environment Research Council the work of the Biological Records Centre receives financial support from the Nature Conservancy Council. This support is given as part of the Nature Conservancy Council's programme of research into the conservation of nature.

Monks Wood
February 1981

Henry R Arnold
General Editor, Marine Recording Schemes

INTRODUCTION

Dinoflagellates form a very important component of the marine plankton, many are primary producers and probably all are utilised as food by filter-feeding animals. Some dinoflagellates produce exotoxins which can affect fish and others contain extremely potent neurotoxins which are concentrated by filter-feeding molluscs and can then affect humans. It is therefore important to discover more about the distribution of dinoflagellates and the factors which govern their ecology. At the same time it is vital that the species can be identified correctly. The present volume stems from a project supported by NERC (1969-1978) aimed at producing an up-todate monograph of the marine dinoflagellates around the British Isles. In order to work on the morphology and taxonomy of the organisms it was necessary to collect samples and, in addition, much material was obtained from various laboratories and marine biologists (see p. iv for acknowledgements). Careful records were kept of the species present in each sample and attempts were made to make the coverage of samples as comprehensive as possible. The results are shown in Map 1 which shows the areas from which samples were obtained. In addition to our own records some lists of species were provided by Mr D D Seaton (DAFS Aberdeen) and a few were abstracted from the literature, going back to about 1900.

TAXONOMY

Nomenclature in the group is in a state of flux, numerous changes having been proposed over the past few years. The names used here are those employed in the forthcoming 'Marine Dinoflagellates of the British Isles' by J D Dodge (MAFF, London, 1981) and the majority are the same as those to be found in 'Check-List of British Marine Algae - third revision' by Parke & Dixon (1976, *J. mar. biol. Ass. UK 56,* 527-594). With the aid of the checklist for the present name it is possible to identify many dinoflagellates using the classical monographs of Lebour (Dinoflagellates of Northern Seas, 1925) and Schiller (Kryptogamenflora Vol. 10 pt I 1933, pt II 1937).

Ecology

Marine dinoflagellates occupy a number of ecological habitats. Some species are found only on the shores, living on sandy beaches where they may form a brownish surface colouration when the tide is out, or in the water film on wet sand or on mud surfaces in salt marshes. Others are to be found in high-tide pools on rocky shores or in the permanent pools in the higher parts of salt marshes. In these sorts of situations the salinity and temperature may vary greatly and the organisms are consequently very adaptable. Examples of these are:

Sand inhabiting:	*Amphidinium herdmanae*	Map 8
	Prorocentrum lima	Map 78
Pool and salt marsh inhabiting:	*Amphidinium carterae*	Map 5
	Glenodinium foliaceum	Map 43
	Herdmania litoralis	Map 62
	Oxyrrhis marina	Map 72

Many dinoflagellates are found in neritic waters such as those of estuaries and shallow water near the shore. Here, nutrients are usually in good supply, the salinity may be fairly low and the temperature can be rather variable. Examples of species found mainly in these situations are:

Gonyaulax polyedra	Map 47
Heterocapsa triquetra	Map 63
Katodinium rotundatum	Map 67
Noctiluca scintillans	Map 70
Polykrikos schwartzii	Map 76
Sclerodinium calyptroglyphe	Map 118
Scrippsiella faeroense	Map 119

The habitat in which most species are found is that which encompasses much of the neritic zone, except perhaps the estuaries, and extends out into the ocean. Here, the salinity tends to be more stable, the temperature less variable and the nutrients in poorer supply. This is the habitat of most of the species shown in the maps and is the situation of those which are most common around the British Isles in the important genera *Ceratium, Dinophysis* and *Protoperidinium.* Examples here are very numerous and include:

Ceratium furca	Map 15
C. tripos	Map 24
Dinophysis acuta	Map 28
D. rotundata	Map 37
Peridiniopsis (Dissodium) asymmetrica	Map 73
Protoperidinium depressum	Map 91
P. ovatum	Map 105
Prorocentrum micans	Map 79.

A number of species which can be found in the relatively shallow waters around Britain are strictly oceanic organisms which appear to be brought in from the Atlantic by the Gulf Stream. The distribution of these species can clearly be tied in with the presence of high-salinity oceanic water.

Examples are:

Ceratium arietinum	Map 12
C. azoricum	Map 13
C. compressum	Map 14
C. hexacanthum	Map 17
C. platycorne	Map 23
Dinophysis caudata	Map 29
Protoperidinium oceanicum	Map 104
Triadinium polyedricum	Map 124

In recent years the dinoflagellate *Gyrodinium aureolum,* which may be toxic, has appeared in large numbers around several parts of the coasts of Europe. In many cases it has been shown that these blooms are linked to oceanographic frontal systems where there is a boundary between mixed water and that which is stratified. The frontal blooms may appear in the open sea but they can also run into the shore (Map 57). (c.f. Holligan & Harbour, 1977, *J. mar. biol. Ass. UK 57,* 1075 for further details.)

Finally, some dinoflagellates are parasitic or symbiotic for part, at least, of their life cycle. No symbionts are included in this atlas and only one of the many parasites which are found in or on copepods, foraminiferans and appendicularians. This organism, *Dissodinium pseudolunula* has a parasitic stage living on the eggs of copepods but there are free-living stages found in the plankton. The map (41) shows the distribution of the easily-recognised lunate cyst stage.

Interpretation of the patterns of distribution shown in this atlas might be helped by reference to the 'Atlas of the Seas Around Great Britain' (edited by A. J. Lee & J.W. Ramster, MAFF, London, 1981) where charts give information on temperature , salinity, water movement etc.

Methods of collecting data

The samples examined (approx. 5000) were obtained by a wide variety of methods. Sometimes, especially where shore-collecting was carried out, these consisted of tubes or bottles filled from pools or depressions in the sand then examined alive as soon as possible. Many of the sea samples were obtained by dipping a bucket, or using a pump or special water sample bottle, and then fixing the sample in Lugol's iodine. Most of the area has been covered by this type of sample. About half the samples examined were collected by some form of plankton net. In some cases this was a fine net towed near the surface or utilised on deck with a pumping system. In other cases the net was of coarse mesh-size and was towed on an oblique path from the surface to the bottom and back again. Net samples have usually been preserved in neutralised formaldehyde.

The different types of sample give different results. Live samples are excellent for the delicate naked dinoflagellates, such as those of the genera *Amphidinium, Gymnodinium* and *Gyrodinium* but these organisms are difficult to identify and as soon as they stop moving they usually become distorted. Lugol's fixed samples may preserve many of the naked dinoflagellates (e.g. *Gyrodinium aureolum*) but they are heavily stained and not always easy to identify. These samples do retain the smaller dinoflagellates. Net samples are excellent for the large, armoured species and, because a big volume of water can be filtered, it is an especially useful method for species which are not very abundant.

All samples were returned to a laboratory and scanned by use of an ordinary microscope until 200 cells had been counted or several drops of suspension had been examined. In the case of the Lugol's samples, the whole sediment was normally counted using an inverted microscope.

SPECIES MAPPED

In the maps 2-125 which follow, the presence of a particular species within a 50 km square of the UTM grid is shown by a circle. This can mean that it was found there once or any number of times. The more common species may have been present every time the particular square was sampled. The number of samples examined from any square varied from over 100 (e.g the square which includes Plymouth Sound) to just one, in some of the more remote Atlantic areas. Clearly absence of a record of a species from a particular square cannot be taken to mean that the species is not present there.

The 124 maps which are included show the species which were recorded 10 or more times plus a few important species which were present on less occasions. The most common species was *Ceratium fusus* with over 1500 records; the most common *Protoperidinium* species were *P. ovatum* and *P. depressum* both with over 1250 records. Of the other important genera *Prorocentrum micans* was recorded over 800 times, *Dinophysis acuta* 550, and *Gonyaulax digitale* 430.

A further 85 species were found during the survey but their records are so sparse that the maps have been omitted. These include rather a large number of species belonging to the genera of naked dinoflagellates, *Amphidinium, Gymnodinium* and *Gyrodinium.* These organisms are not easy to fix and so do not generally show up in the preserved material which formed the larger portion of our samples.

ACKNOWLEDGEMENTS

Grateful thanks are due to my two Research Assistants (financed by a grant from NERC), Mrs. J. Carslake 1969-1972 and Barbara Hart-Jones 1972-1978. They were responsible for examining the majority of the samples and identifying the species. In addition we together, or individually, made collecting trips to various parts of the shoreline, often in conjunction with the British Phycological Society field meeting. The main shore areas collected were: Kent and Sussex Coast, Isle of Wight, Dorset Coast, Plymouth area, Scillies, Pembrokeshire, Anglesey, Isle of Man, Galloway, Hebrides, Orkney, Aberdeen area, Yorkshire Coast, the Wash, Norfolk Coast.

Thanks are due to the following persons and laboratories who specially obtained samples or who kindly made available collected material. They are placed here in geographical order:

Mr. D. D. Seaton (DAFS Laboratory, Aberdeen)

Mr. P. Wakefield (Tay Estuary Research Centre, Newport-on-Tay)

Professor M. F. Laverack (The Gatty Laboratory, St. Andrews)

Dr. F Evans (Cullercoats Marine Laboratory, North Shields)

Dr P. C. Head (Department of Civil Engineering, University of Newcastle-on-Tyne)

Dr. J. Lewis (Robin Hoods Bay Marine Laboratory)

Dr. S. Coles (Coastal Ecology Research Station, Norwich)

Dr. N. Reynolds (MAFF Fisheries Laboratory, Lowestoft)

Mr. D. Harding (MAFF Fisheries Laboratory, Lowestoft)

Mrs. A. Lincoln (MAFF Fisheries Laboratory, Lowestoft)

Mr. J. Nichols (MAFF Fisheries Laboratory, Lowestoft)

Mr. D. Ayres (MAFF Shellfish Laboratory, Burnham-on-Couch)

Mrs. M. Cullen (MAFF Shellfish Laboratory, Burnham-on-Crouch)

Mr. P. Davidson (MAFF Shellfish Laboratory, Burnham-on-Crouch)

Dr. W. Farnham (Marine Laboratory, Hayling Island)

Dr. P. J. L. Williams (Department of Oceanography, Southampton University)

Dr. G. Boalch (Marine Biological Association, Plymouth)

Mr. J. Green (Marine Biological Association, Plymouth)

Dr. P. Holligan (Marine Biological Association, Plymouth)

Dr. P. C. Reid (IMER, Plymouth)

Mr. G. A. Robinson (IMER, Plymouth)

Mr. N. R. Collins (IMER, Plymouth)

Dr. J. Hayward (Botany Department, University College, Swansea)

Dr. W. E. Jones (Marine Sciences Laboratory, Menai Bridge)

Dr. I Lucas (Marine Sciences Laboratory, Menai Bridge)

Mrs. D. Hepper (MAFF Shellfish Laboratory, Conway)

Miss F. M. Smith (MAFF Shellfish Laboratory, Conway)

Mr. F. Evans (Lancs. & W. Sea Fish Laboratory, Lancaster)

Dr. N. Jones (Marine Laboratory, Port Erin, Isle of Man)

The Director (University Marine Biological Station, Millport)

Dr. P. Tett (SMBA, Dunstaffnage Laboratory, Oban)

Dr. C. Pybus (Department of Oceanography, Galway, Eire)

Dr. I. Jenkinson (Department of Oceanography, Galway, Eire)

I apologise if anyone has been inadvertantly omitted from this list. Finally my grateful thanks are due to the BRC for preparing the record cards and in particular Mr. Henry Arnold, for collating the data and preparing the final maps.

Future Recording

It is hoped to continue to add information to the data-bank on marine dinoflagellates. Anyone with lists of dinoflagellates or who could obtain samples is requested to communicate with the editor at the address below.

John D. Dodge February 1981
Department of Botany
Royal Holloway College
Egham Hill
Egham
Surrey U.K.

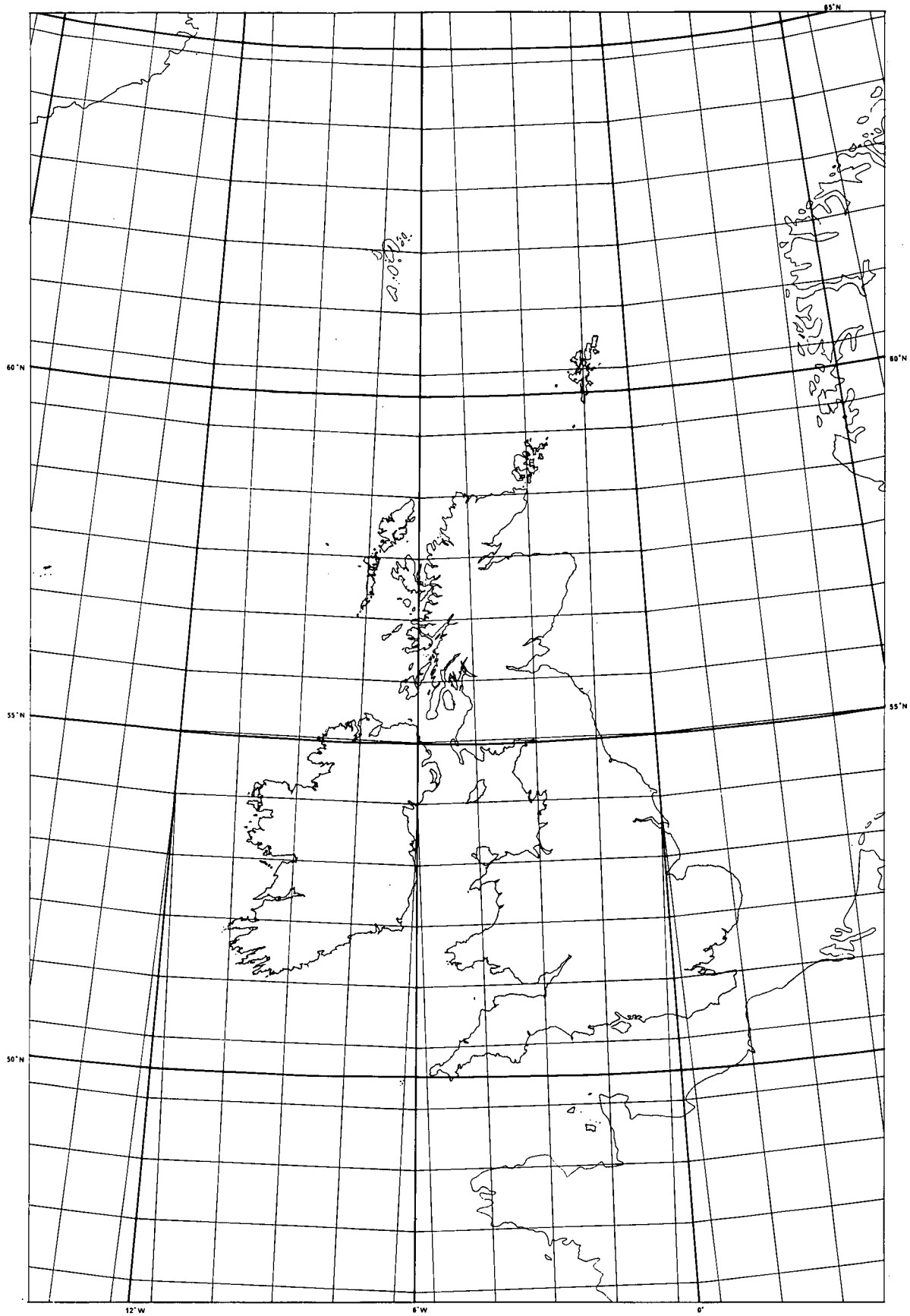


Figure I Base map showing 100 km. squares of the UTM grid.

THE UNIVERSAL TRANSVERSE MERCATOR GRID IN RELATION TO THE BRITISH ISLES

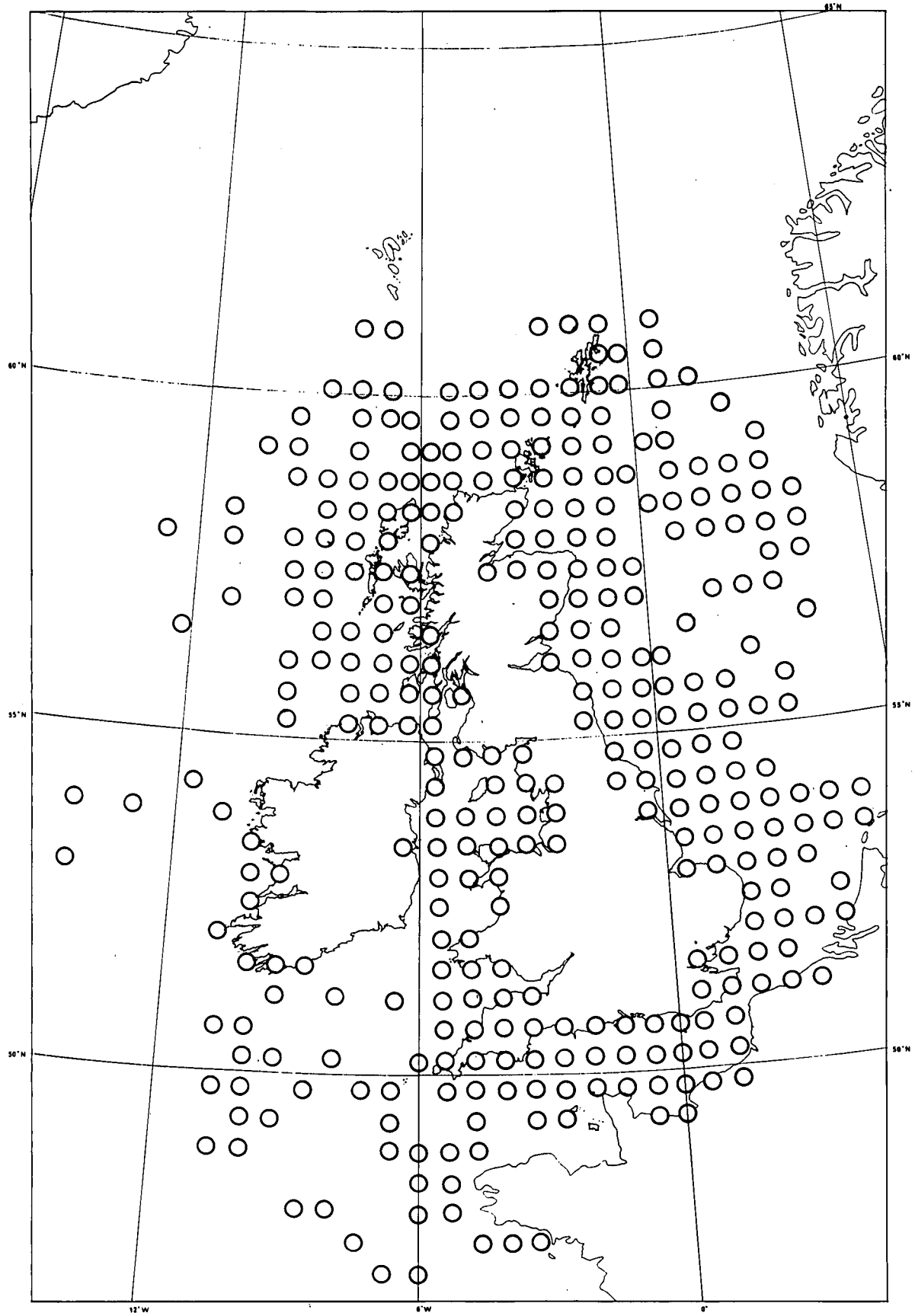
Because the earth is a sphere, any representation of its surface on a flat sheet involves distortion. Map projections are geometrical schemes to reduce this distortion to a minimum. Many different projections have been devised for particular purposes, and are determined by the size and shape of the area being mapped. For topographic maps for large areas it is necessary to divide the area into strips, termed *zones,* which are projected onto a plane in an orderly fashion. One such system of strip projection is the Transverse Mercator with the strips (*zones*) running north-south rather than east-west as in the standard Mercator projection. A special type of Transverse Mercator is the Universal Transverse Mercator (UTM) projection. In this projection, which is now widely used throughout the world, the earth is divided into zones 6° of longitude wide.

The British Isles and the surrounding sea areas fall into four zones which are shown on the maps in this atlas.

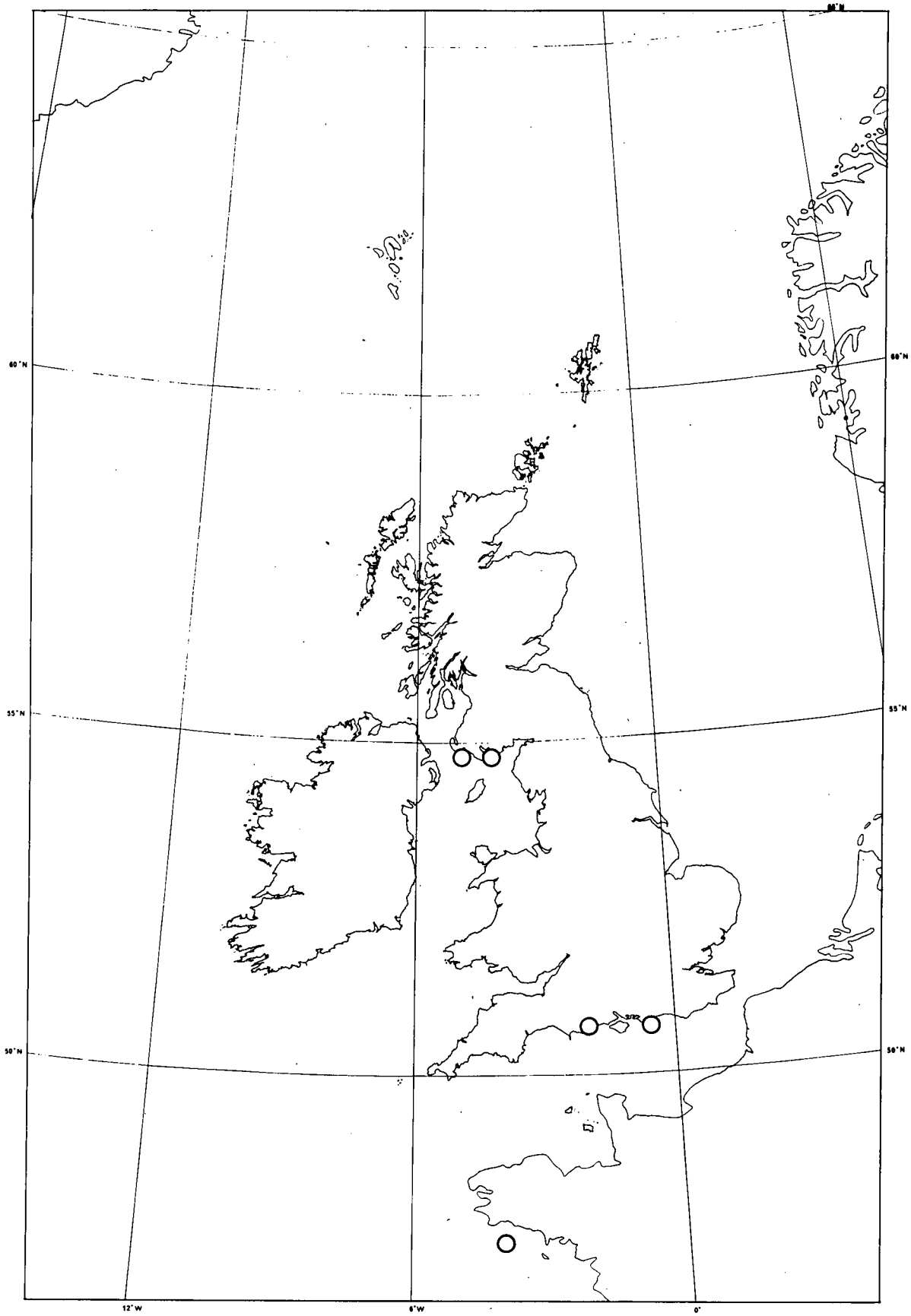
Use of the UTM grid for mapping this area is necessary avoid the considerable distortion which would arise by extending the British National grid beyond the boundaries for which it was devised.

The grid is derived by using the equator as the northings origin and the central meridian (longitude) of the zone concerned as the eastings origin. By dividing the meridian metrically, starting at the equator and ruling both parallel to and at right angles to the central meridian, a grid of squares is produced. These squares are those of the UTM grid. Figure 1 shows the map marked with the 100 km squares.

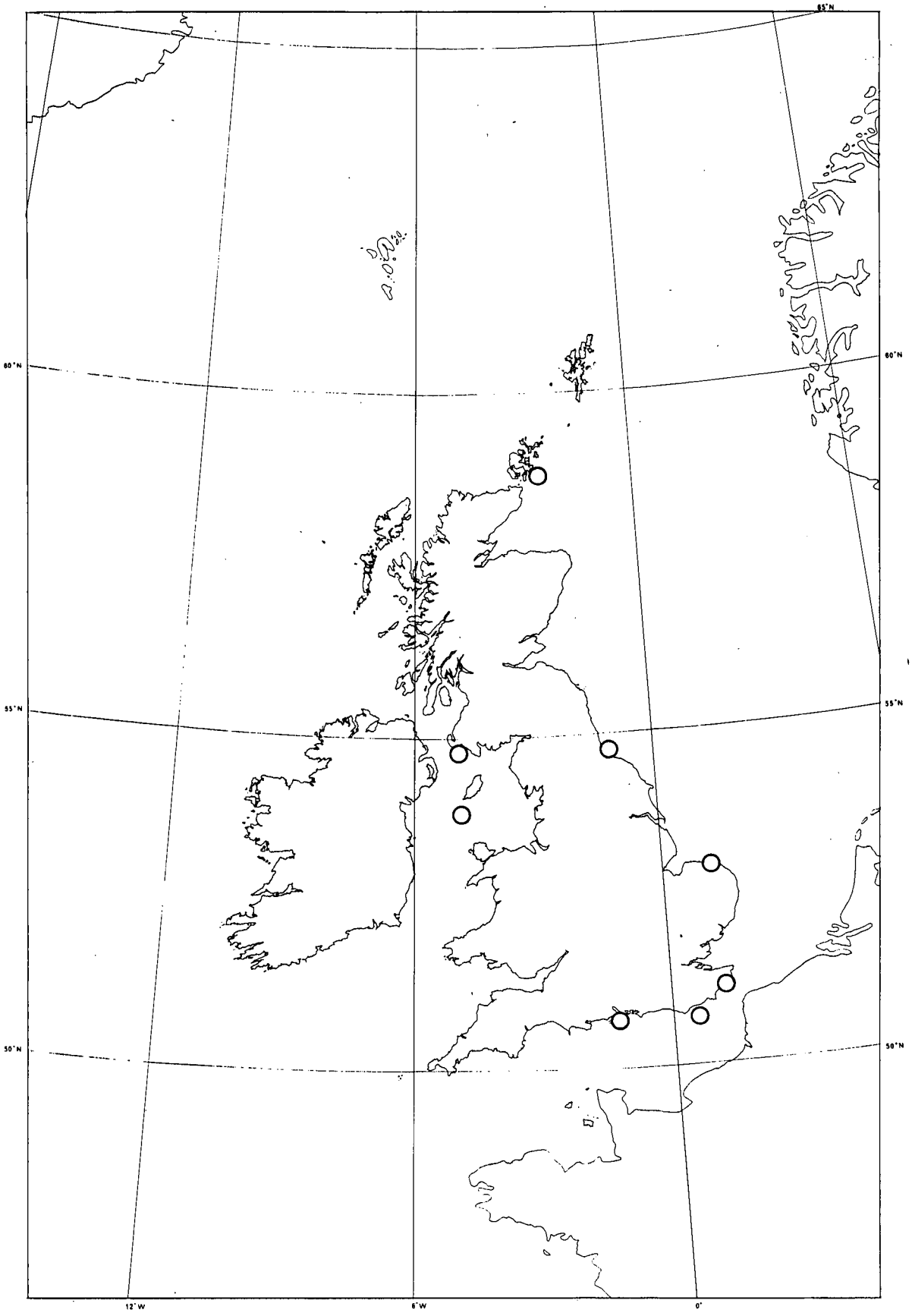
At the junction of each zone the grid lines meet the meridian at an angle producing a series of rectangles. The area in which these rectangles occur is known as the "zone of compensation". When referring to large scale maps in the field no problems should arise in giving grid references within the zone of compensation.



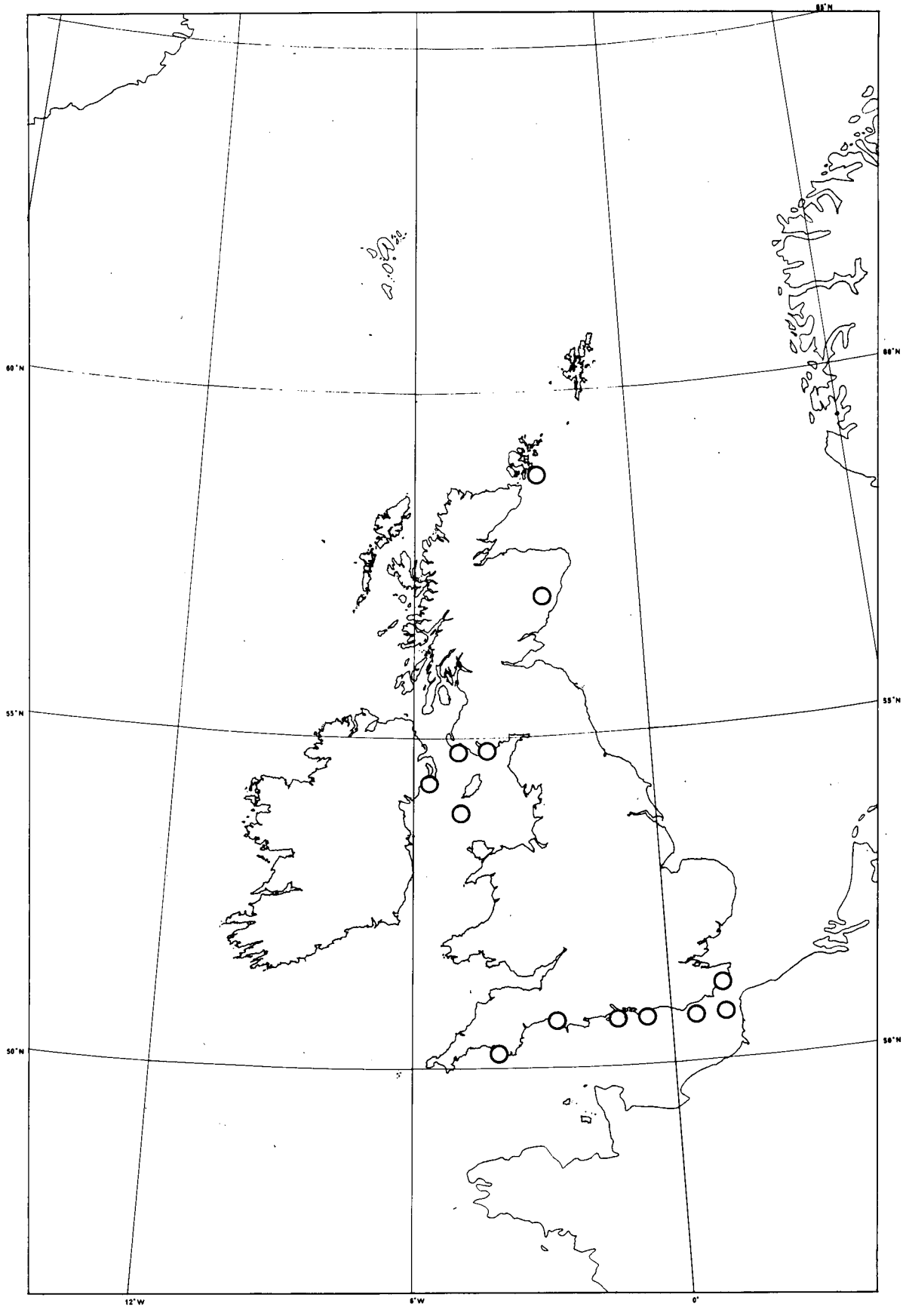
1. Squares recorded



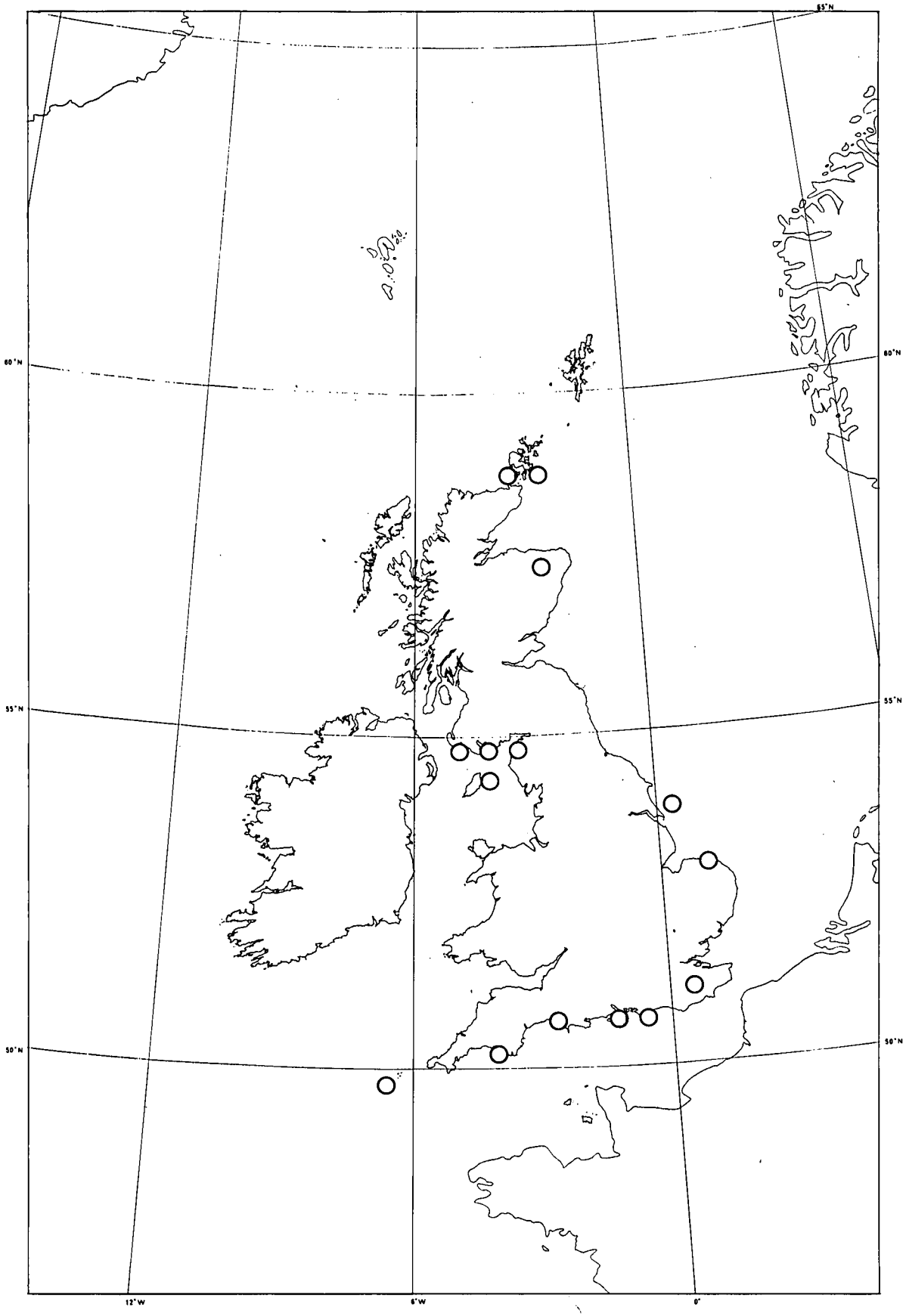
2. *Amphidiniopsis swedmarkii* (Balech) Dodge



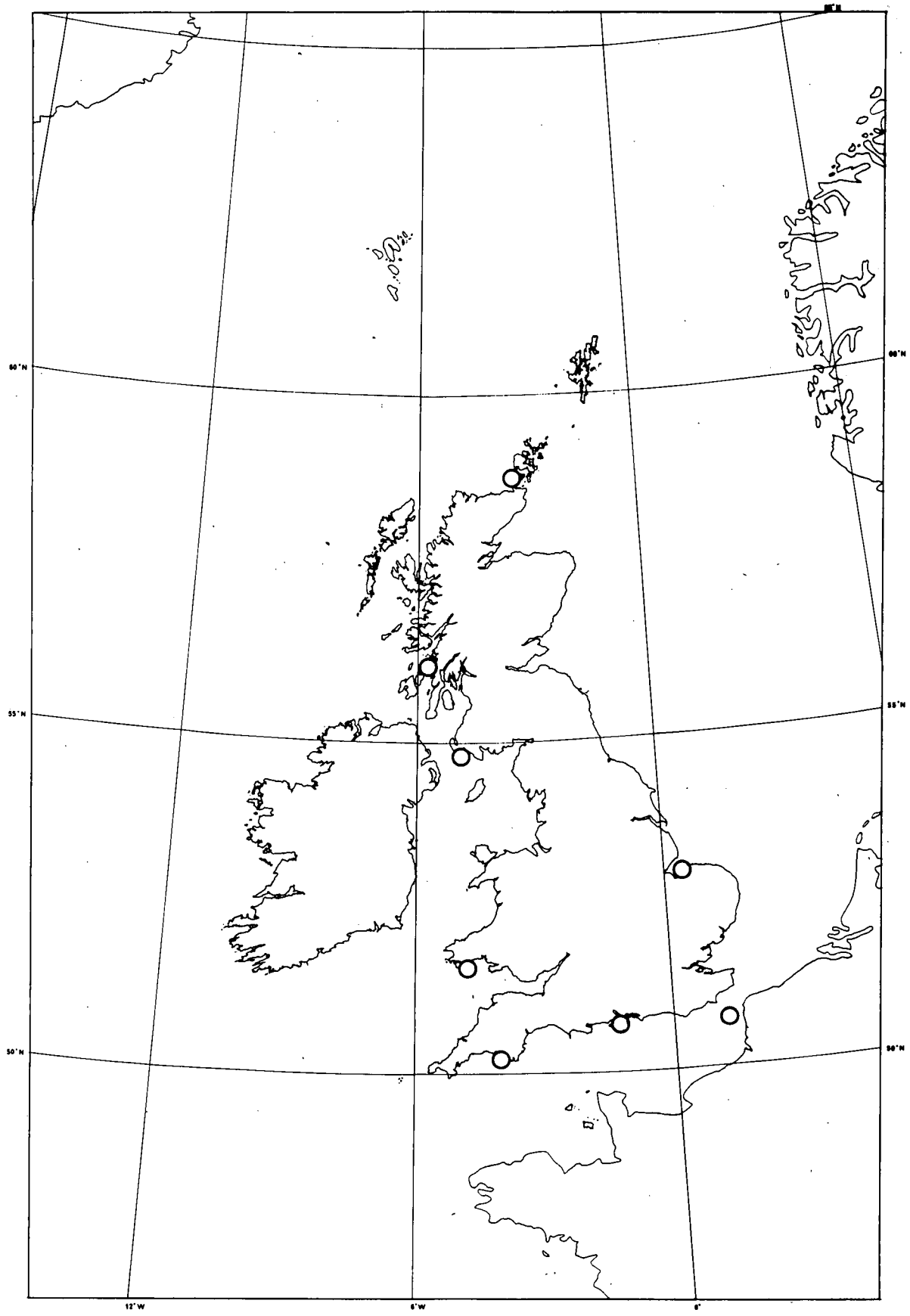
3. *Amphidinium bipes* C. Herdm.



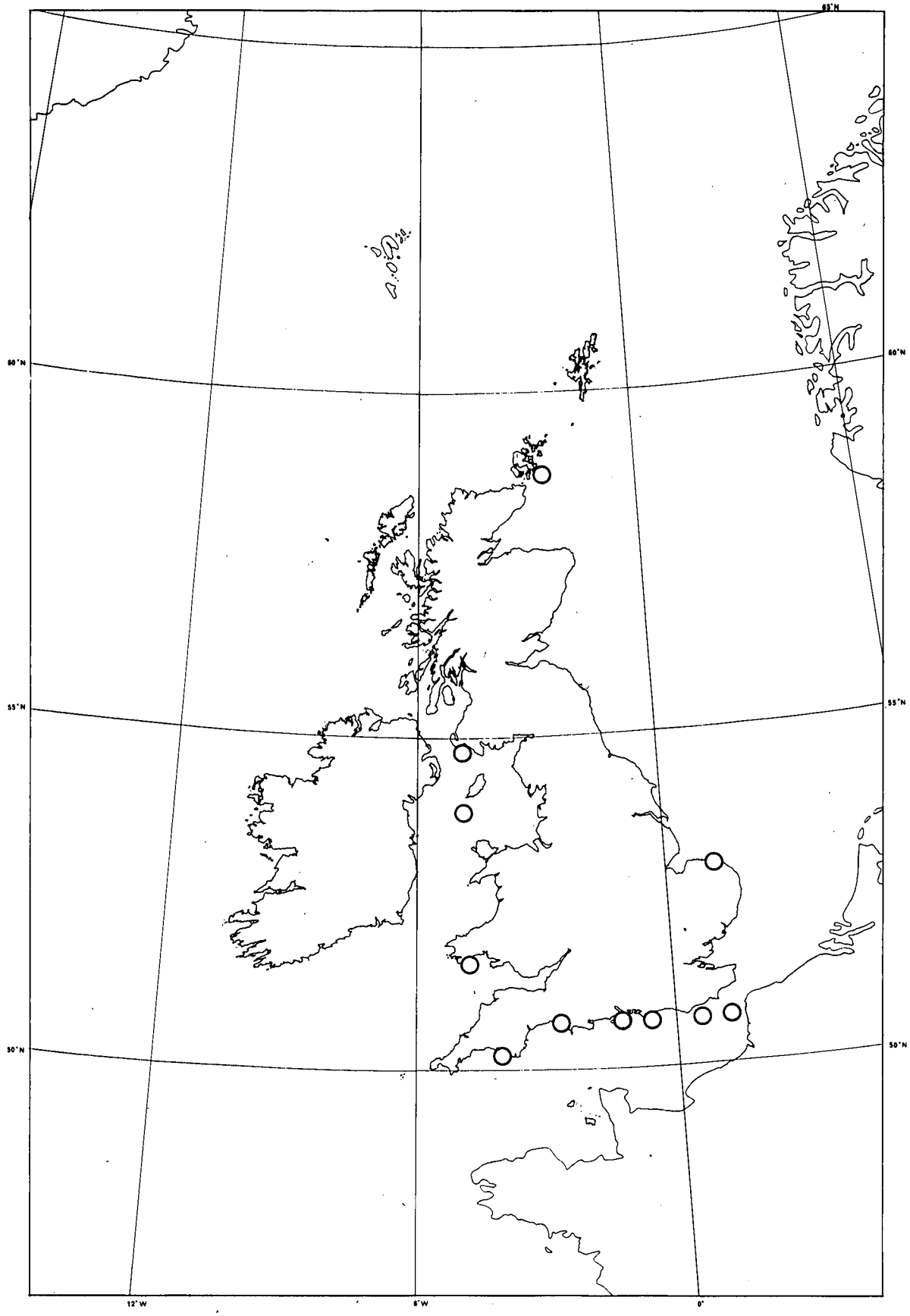
4. *Amphidinium britannicum* (C. Herdm.) Lebour



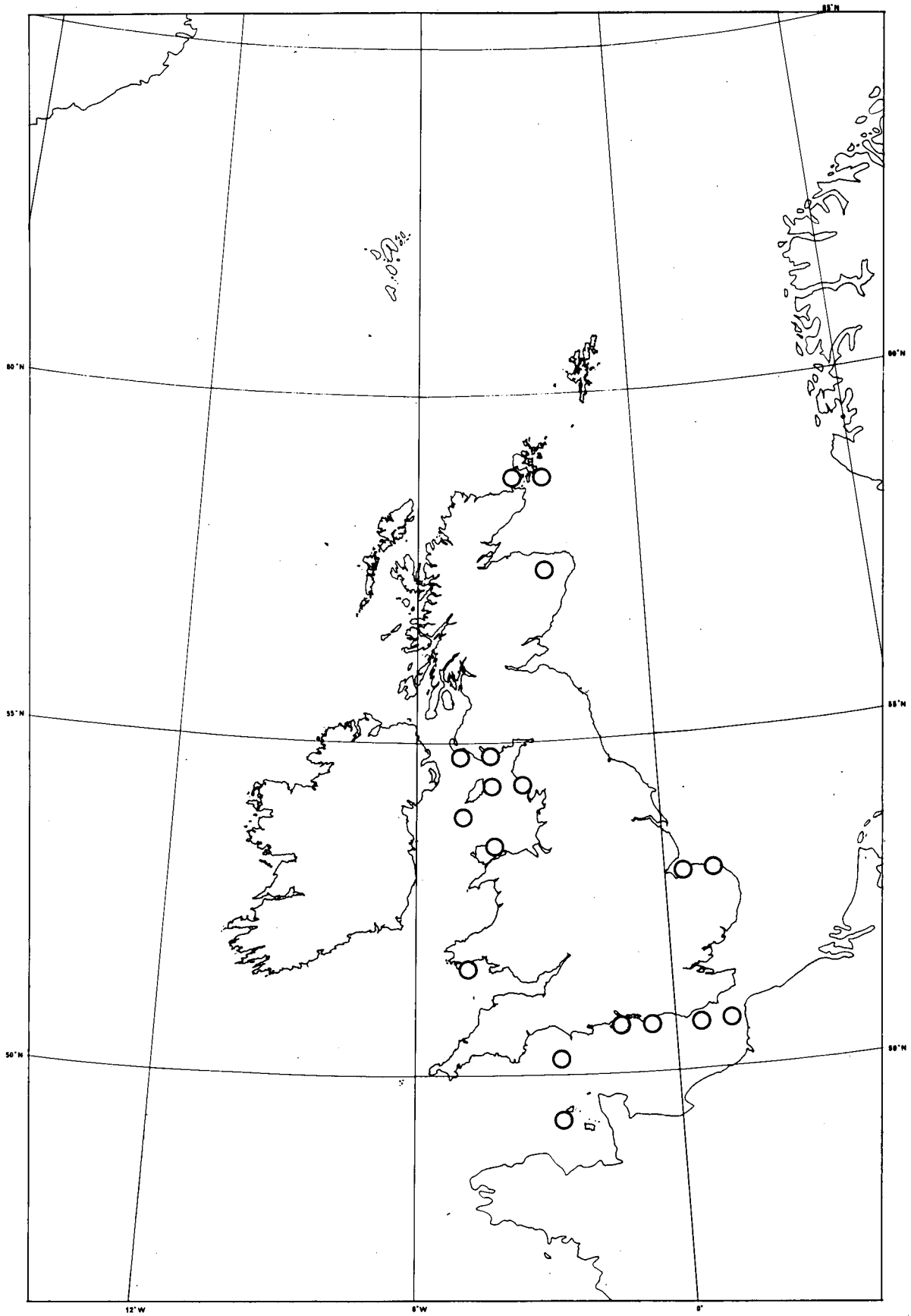
5. *Amphidinium carterae* Hulburt



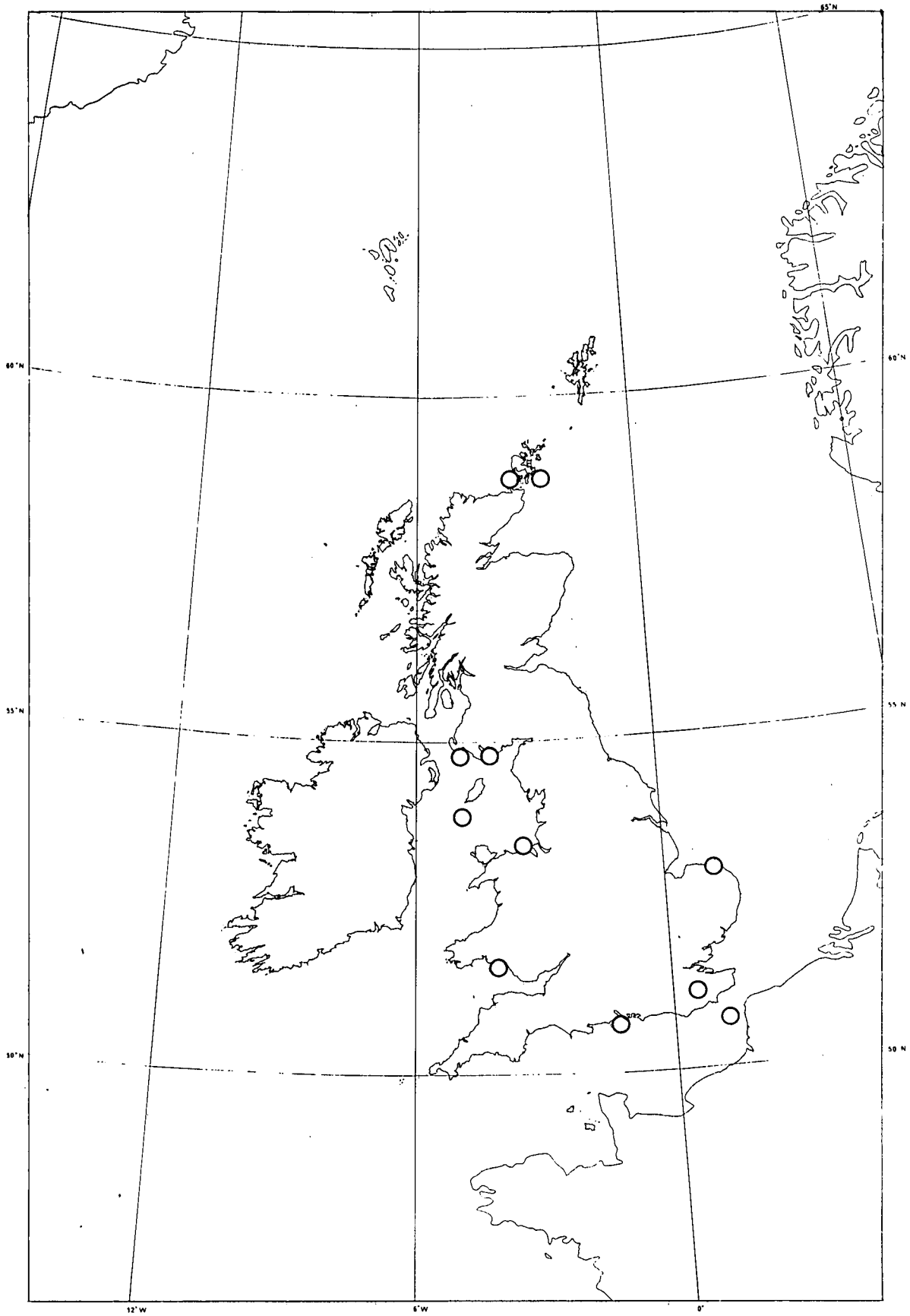
6. *Amphidinium crassum* Lohm.



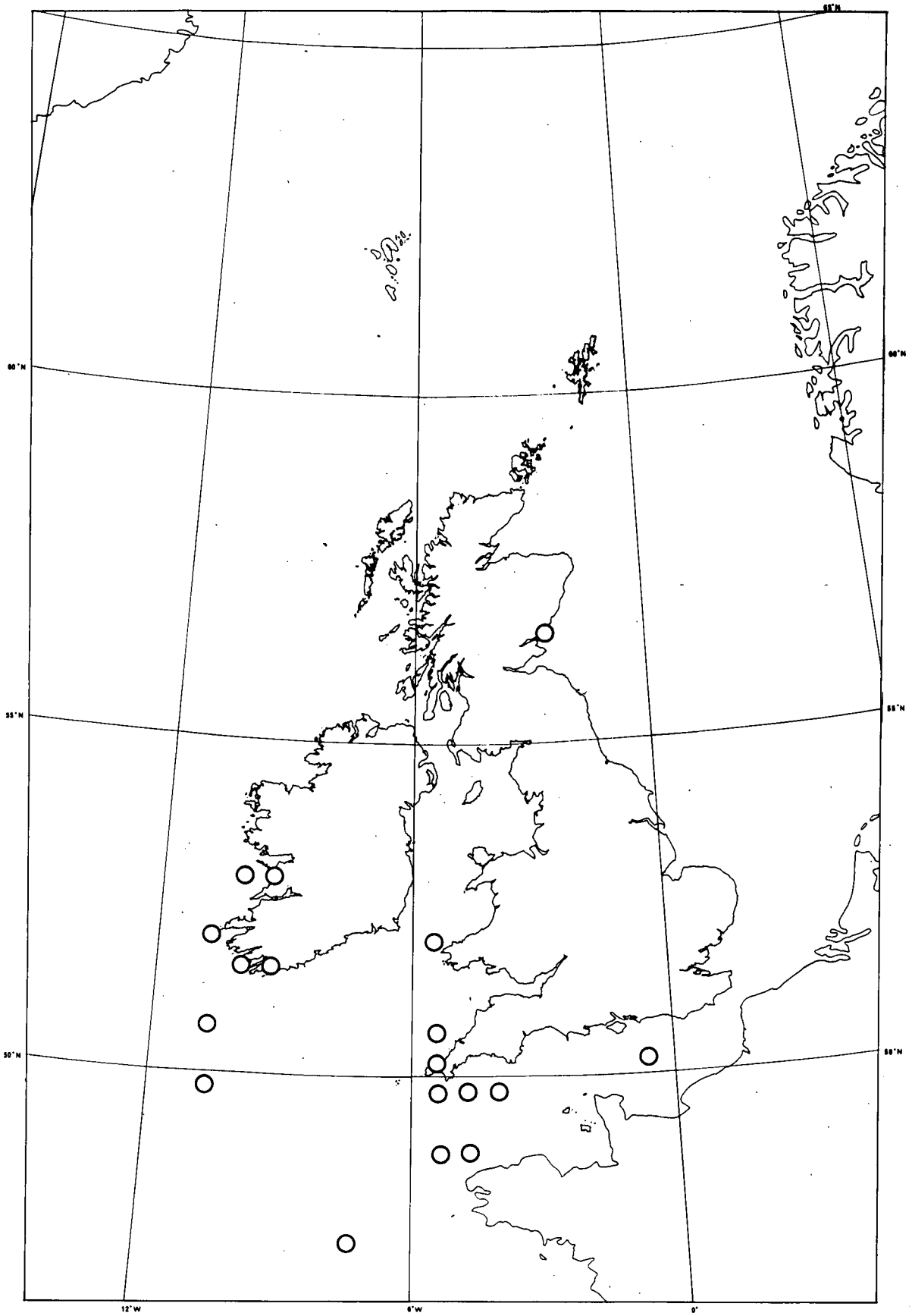
7. *Amphidinium flexum* C. Herdm.



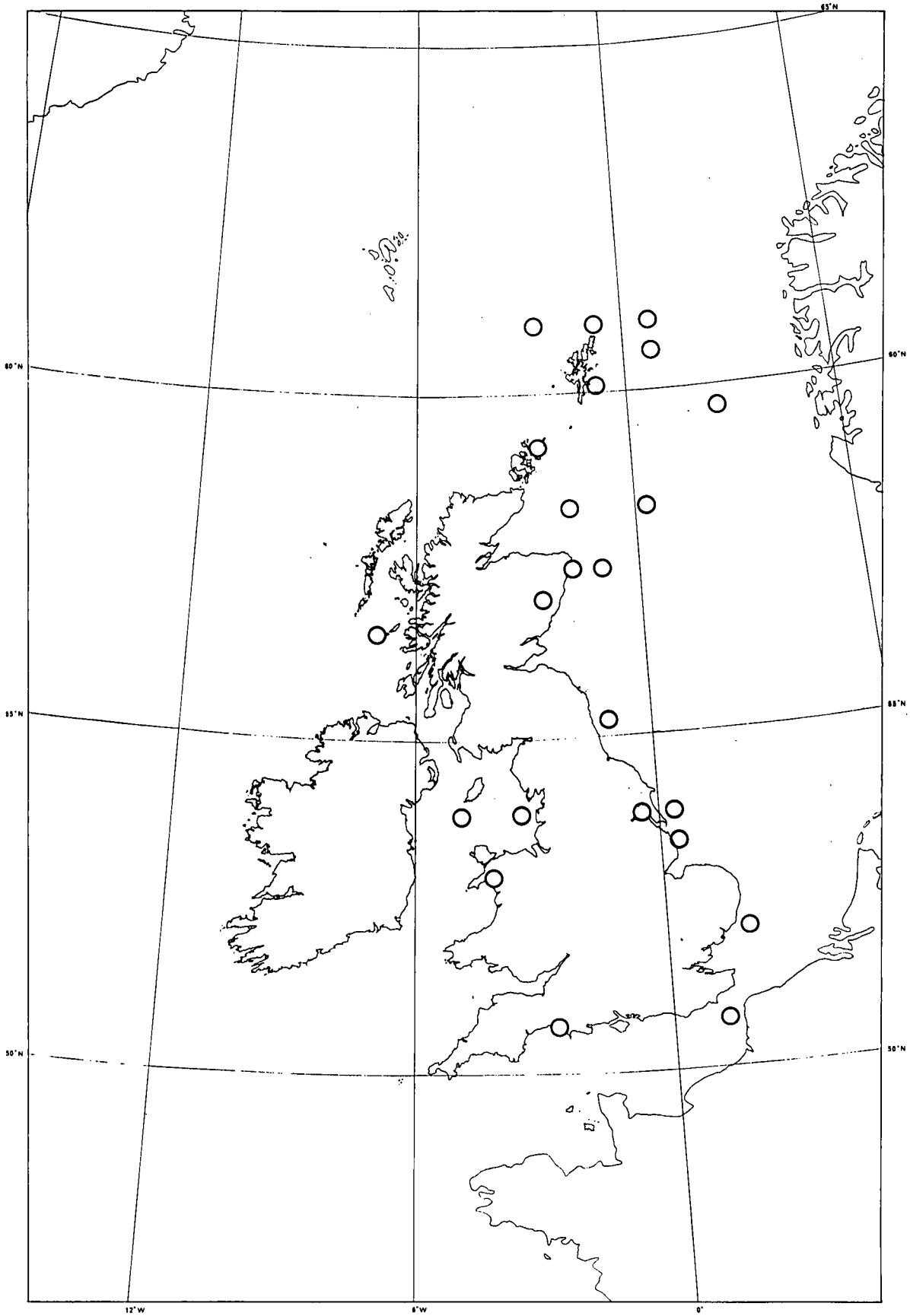
8. *Amphidinium herdmanae* Kof. & Swezy



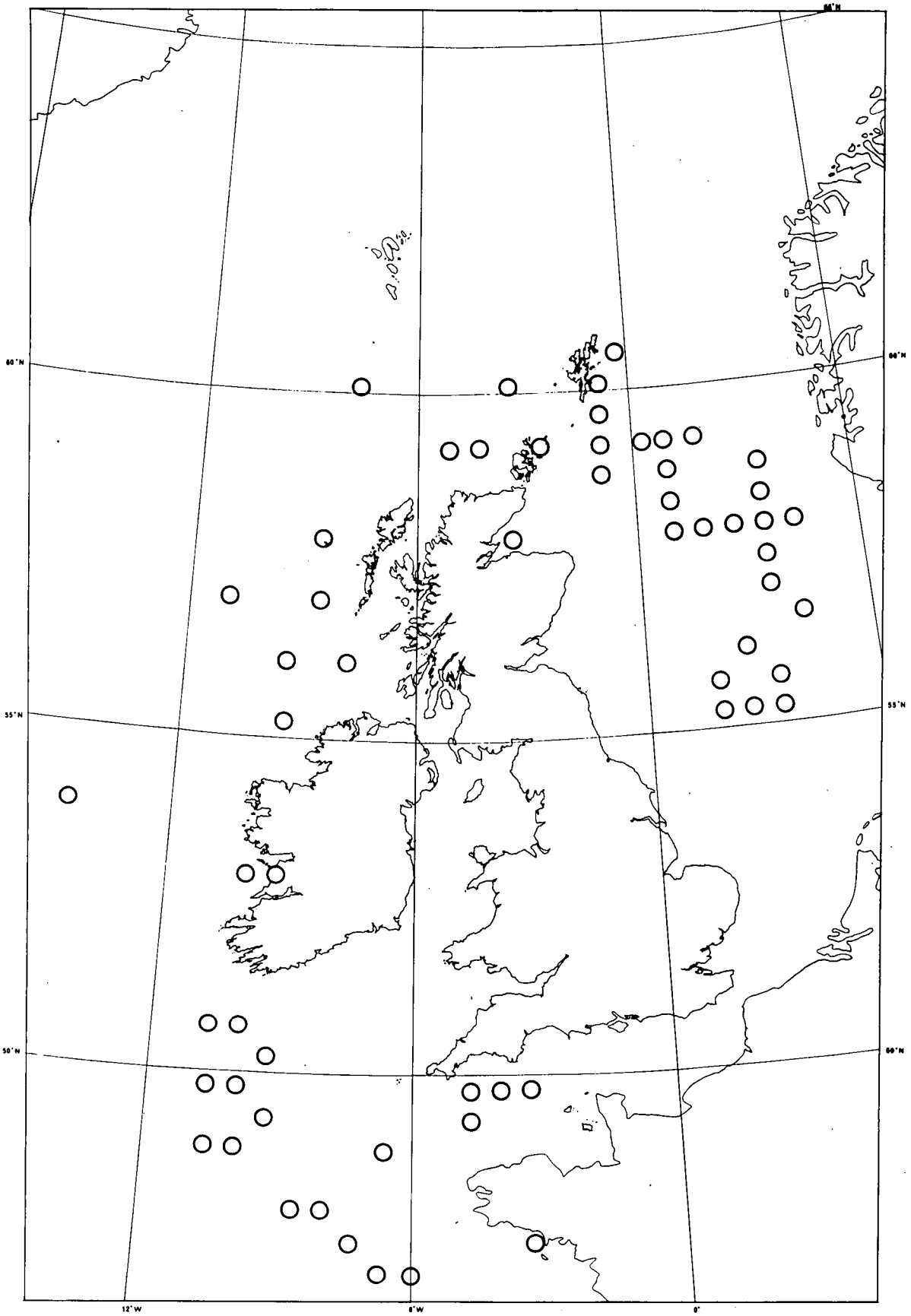
9. *Amphidinium operculatum* Clap. & Lachm.



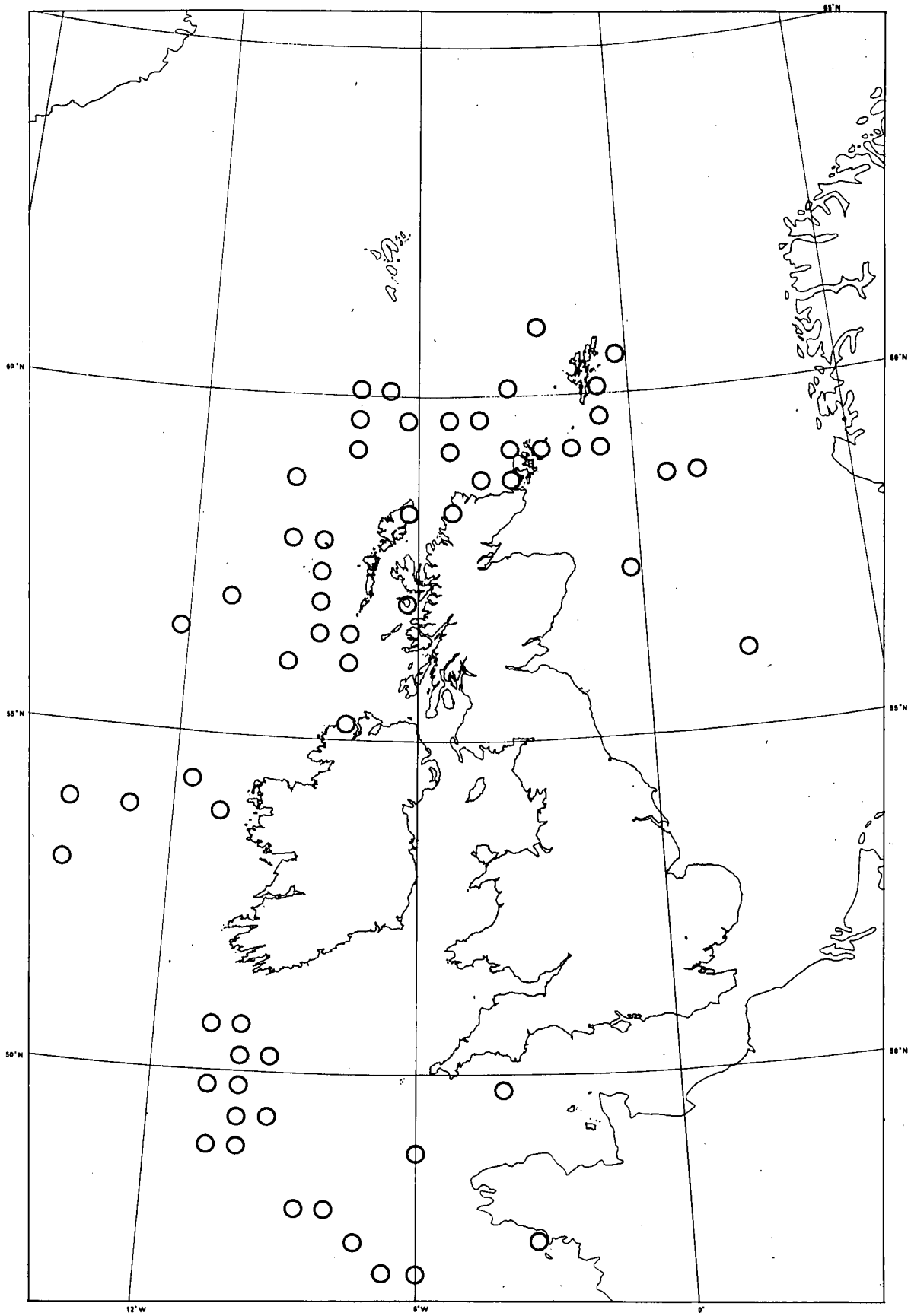
10. *Amphidoma caudata* Halldal



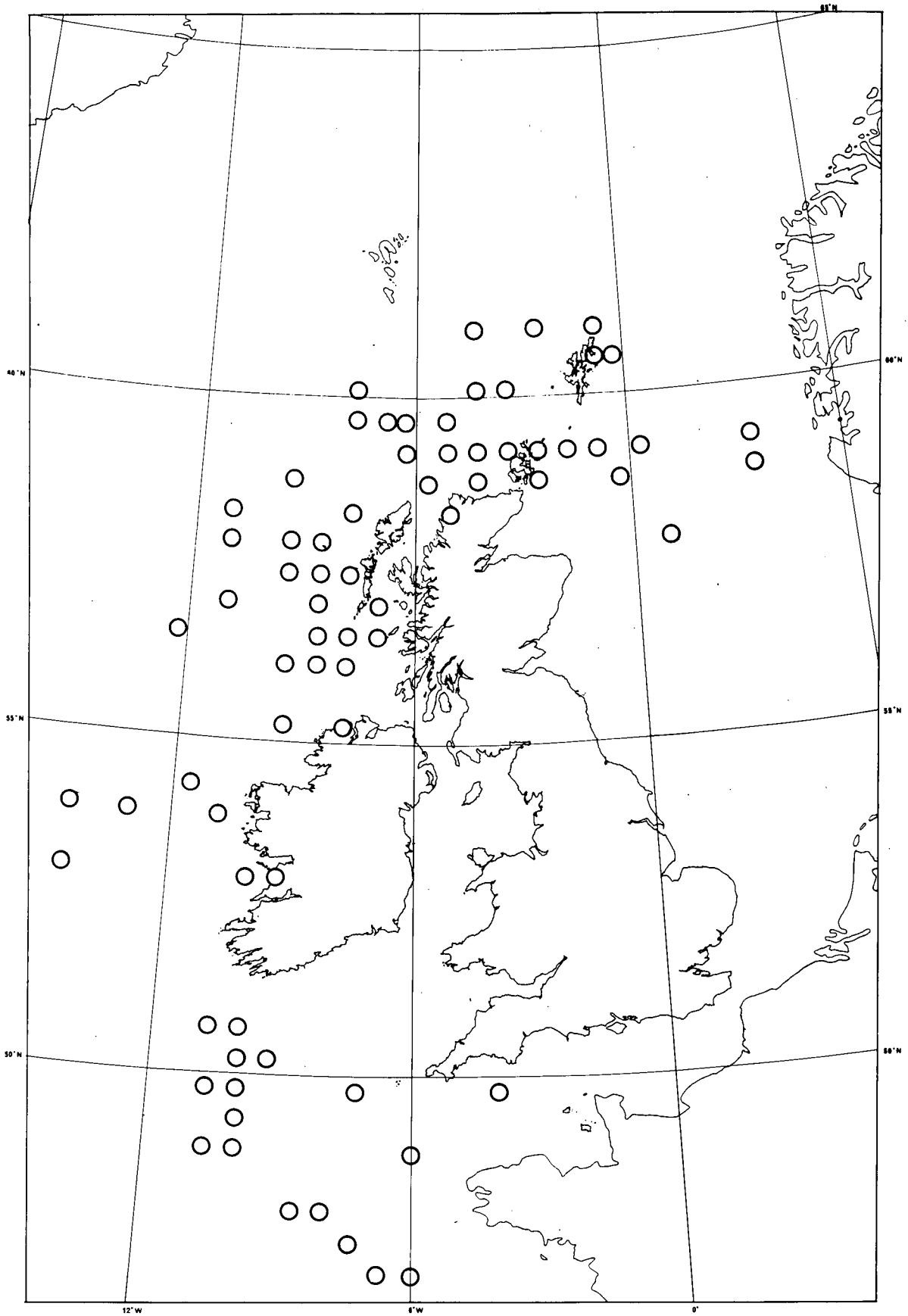
11. *Ceratium arcticum* (Ehrenb.) Cleve



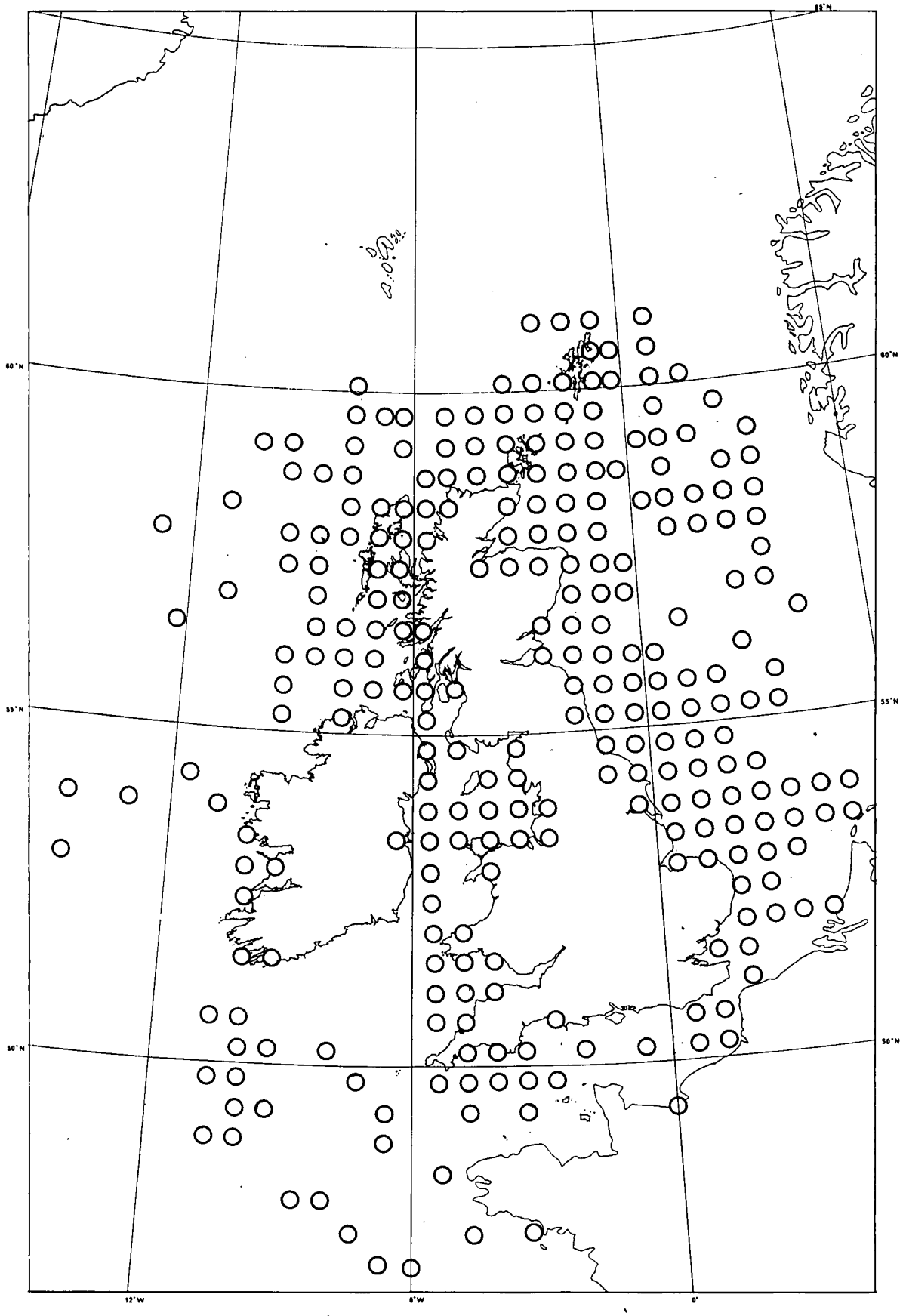
12. *Ceratium arietinum* Cleve



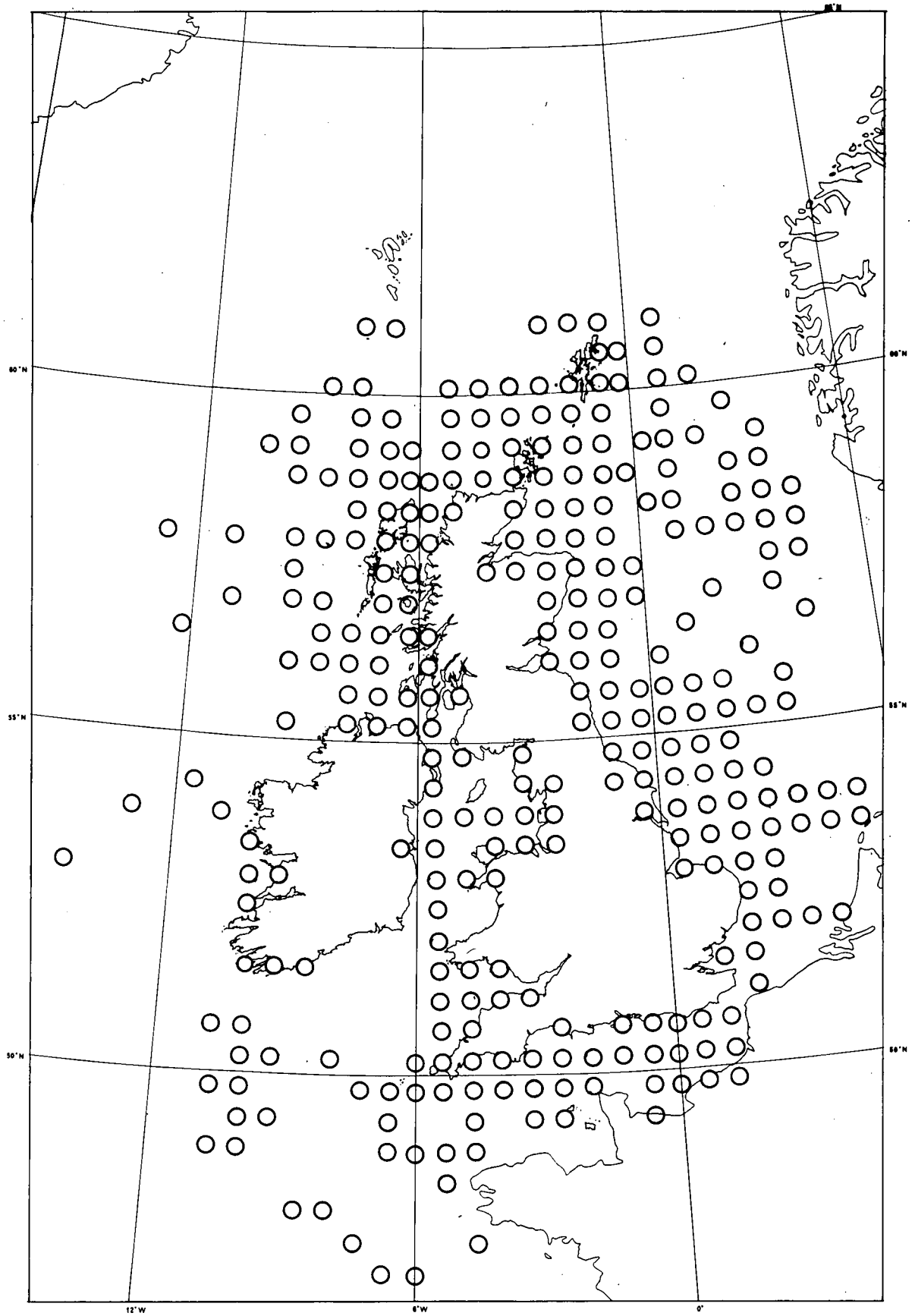
13. *Ceratium azoricum* Cleve



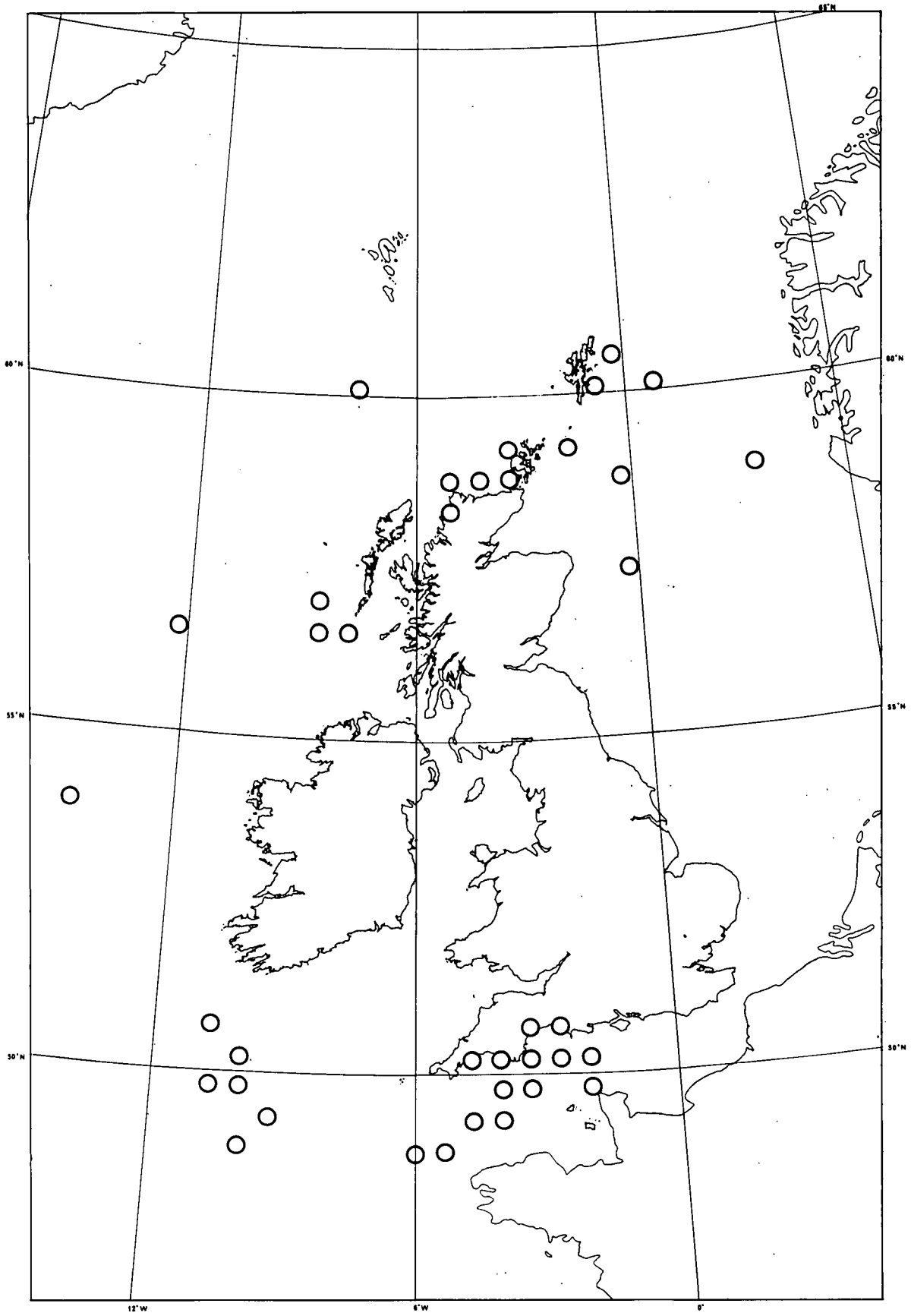
14. *Ceratium compressum* Gran



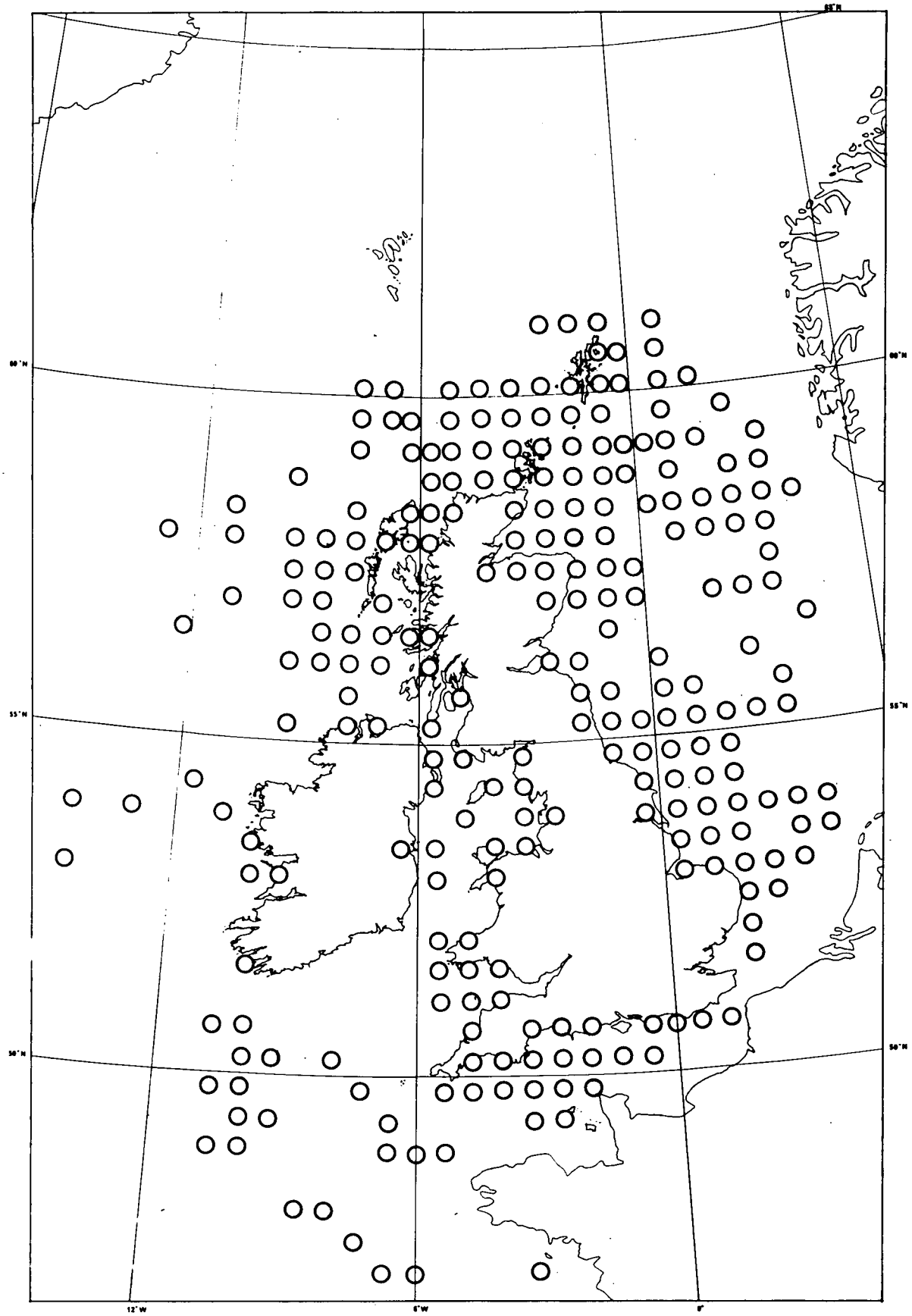
15. *Ceratium furca* (Ehrenb.) Clap. & Lachm.



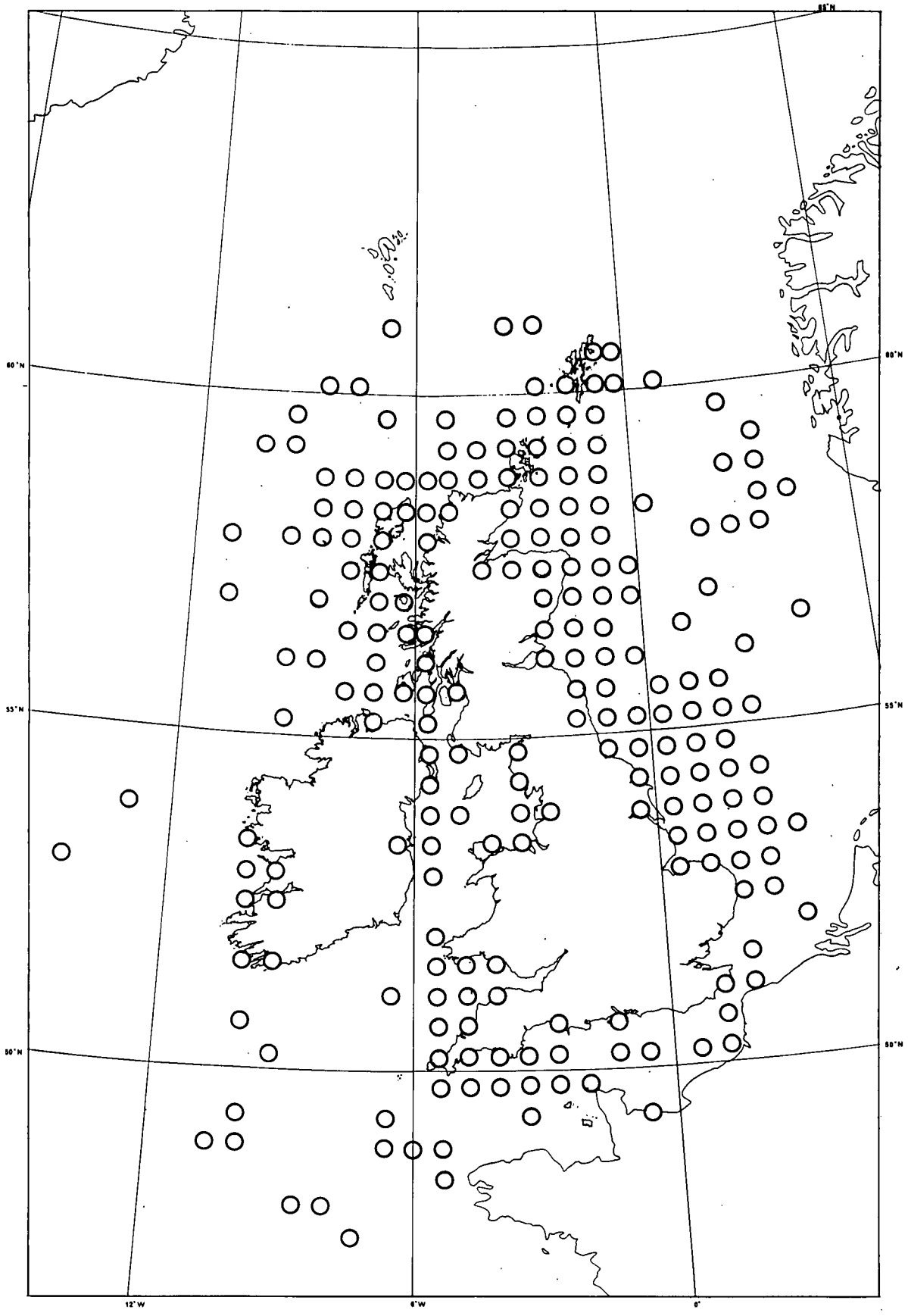
16. *Ceratium fusus* (Ehrenb.) Dujard.



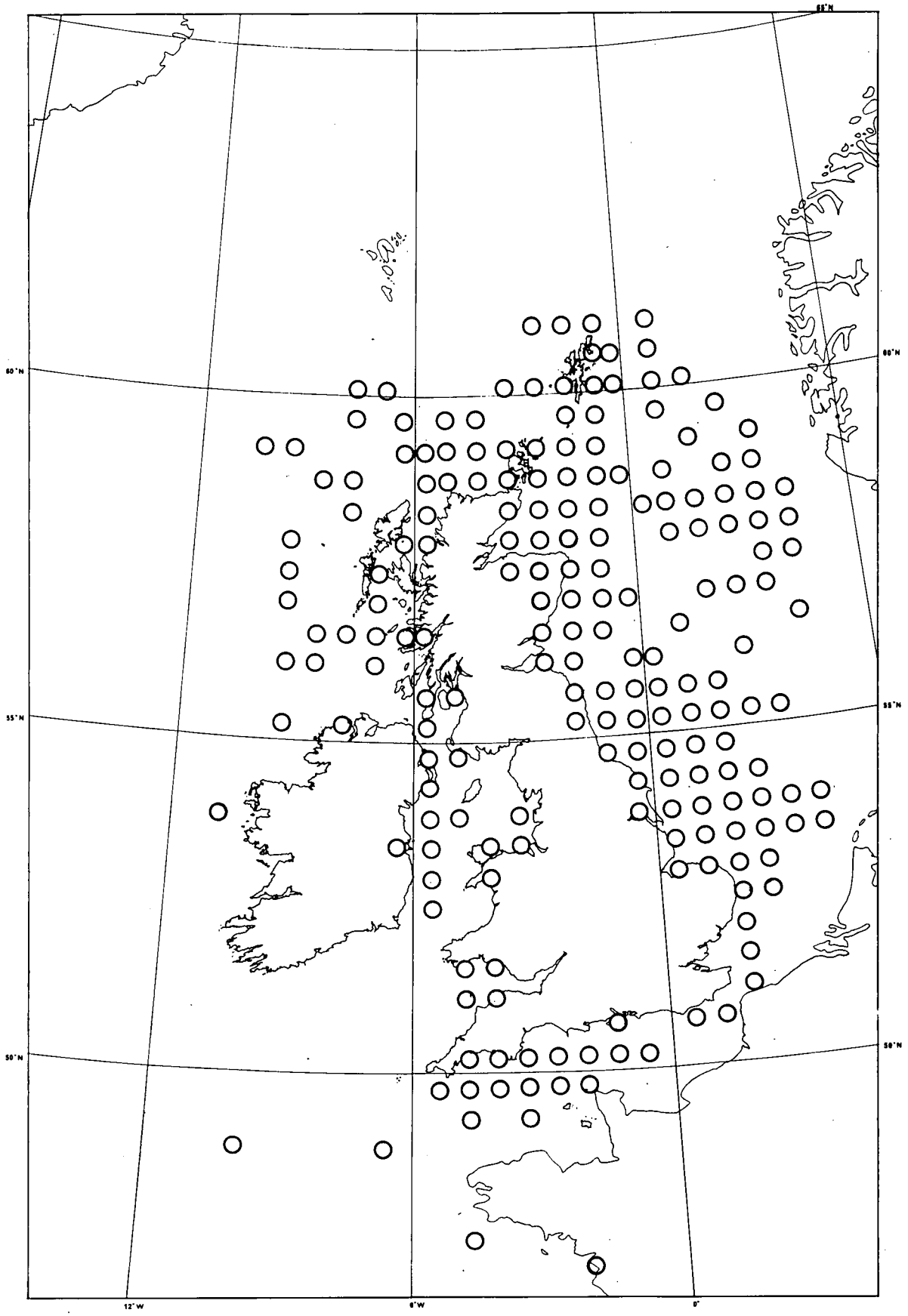
17. *Ceratium hexacanthum* Gourr.



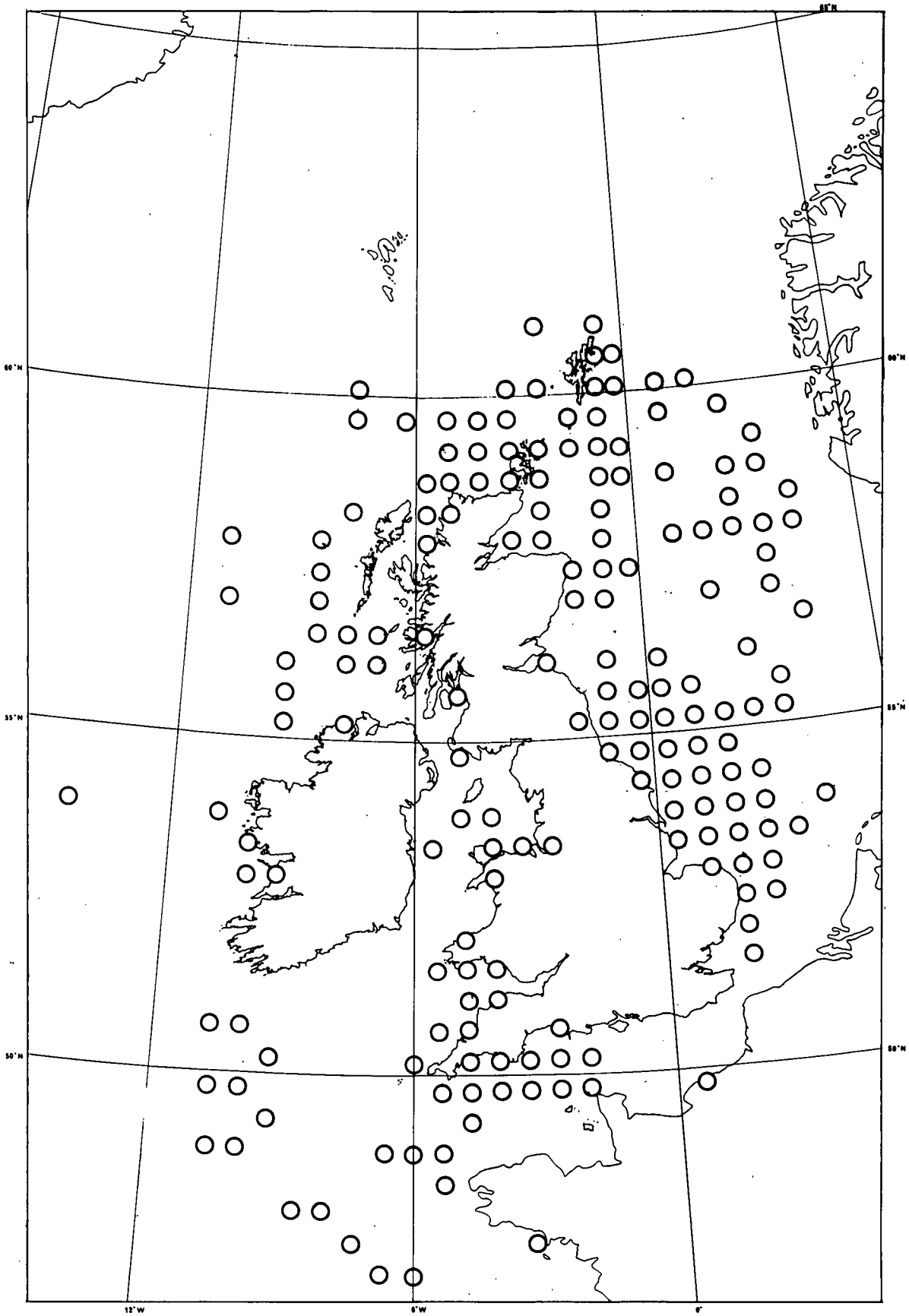
18. *Ceratium horridum* (Cleve) Gran



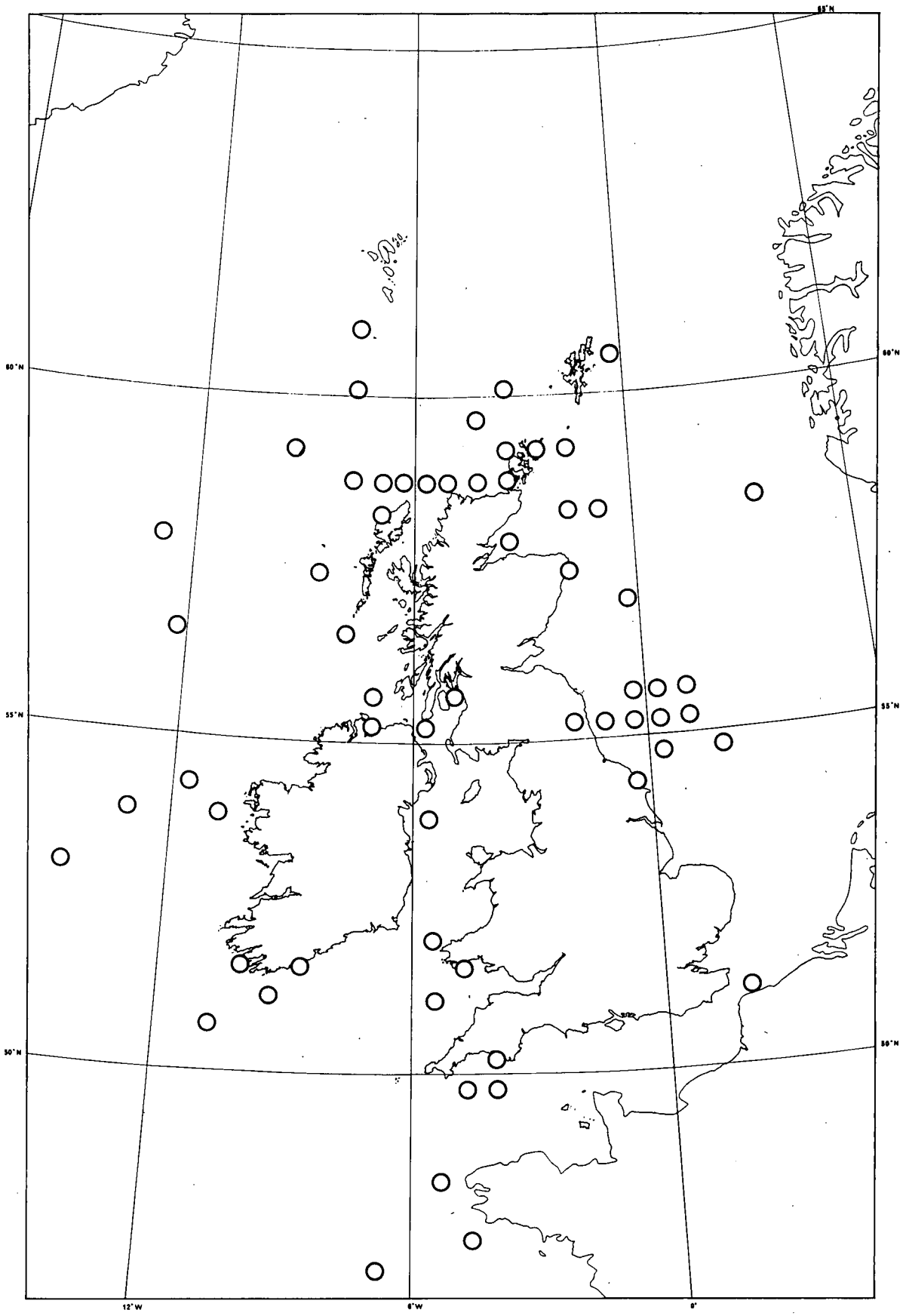
19. *Ceratium lineatum* (Ehrenb.) Cleve



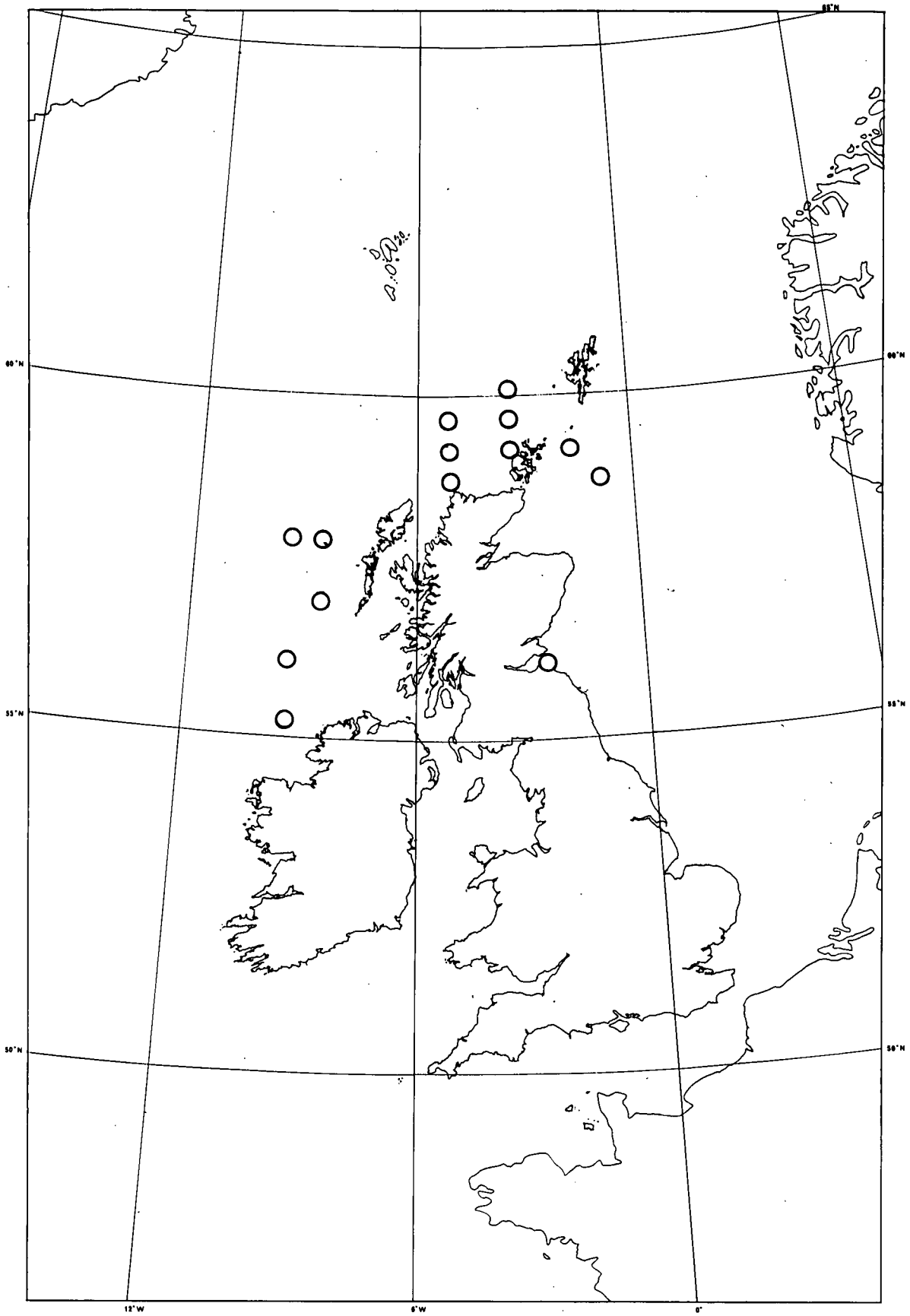
20. *Ceratium longipes* (Bail.) Gran



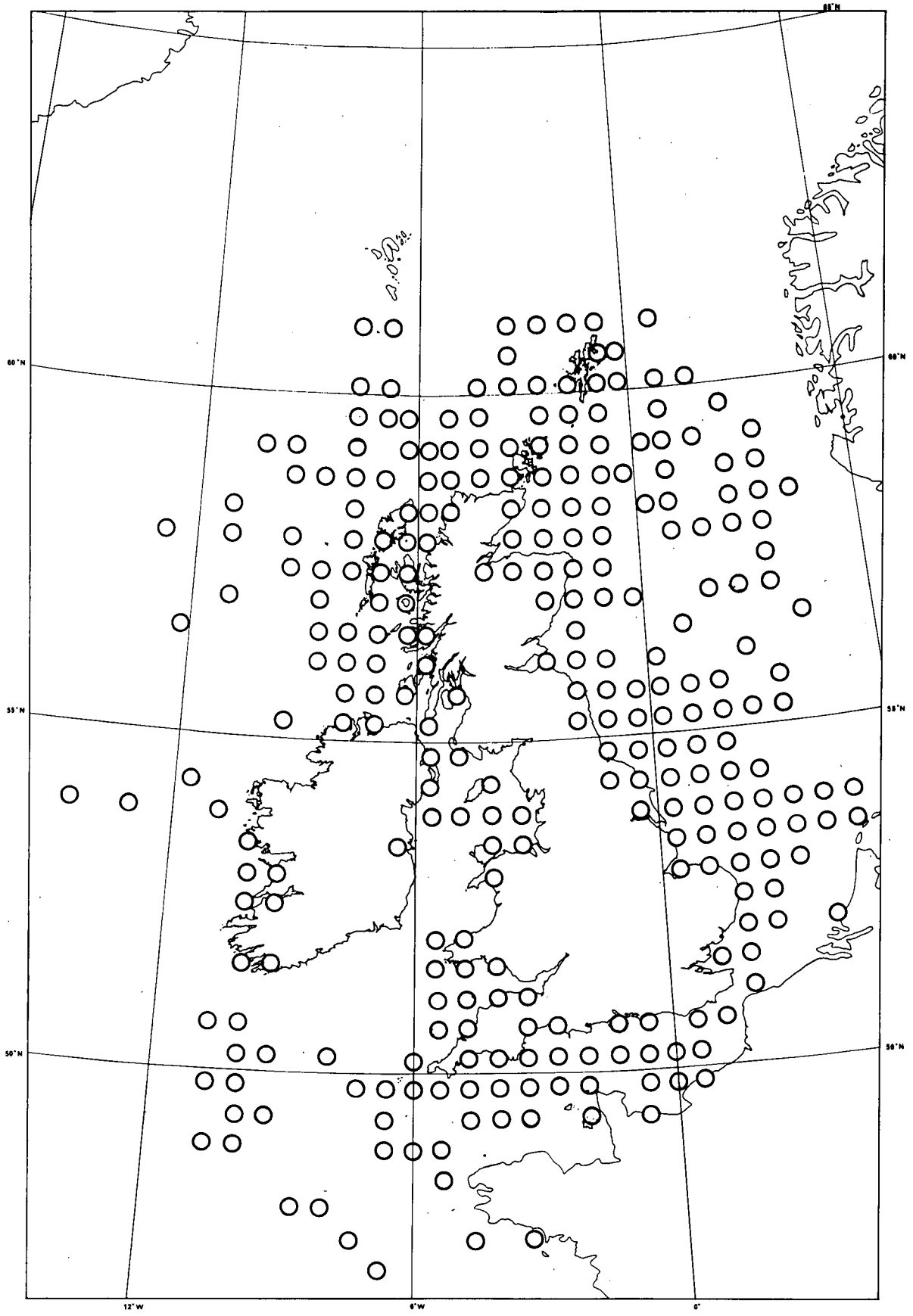
21. *Ceratium macroceros* (Ehrenb.) Vanhoffen



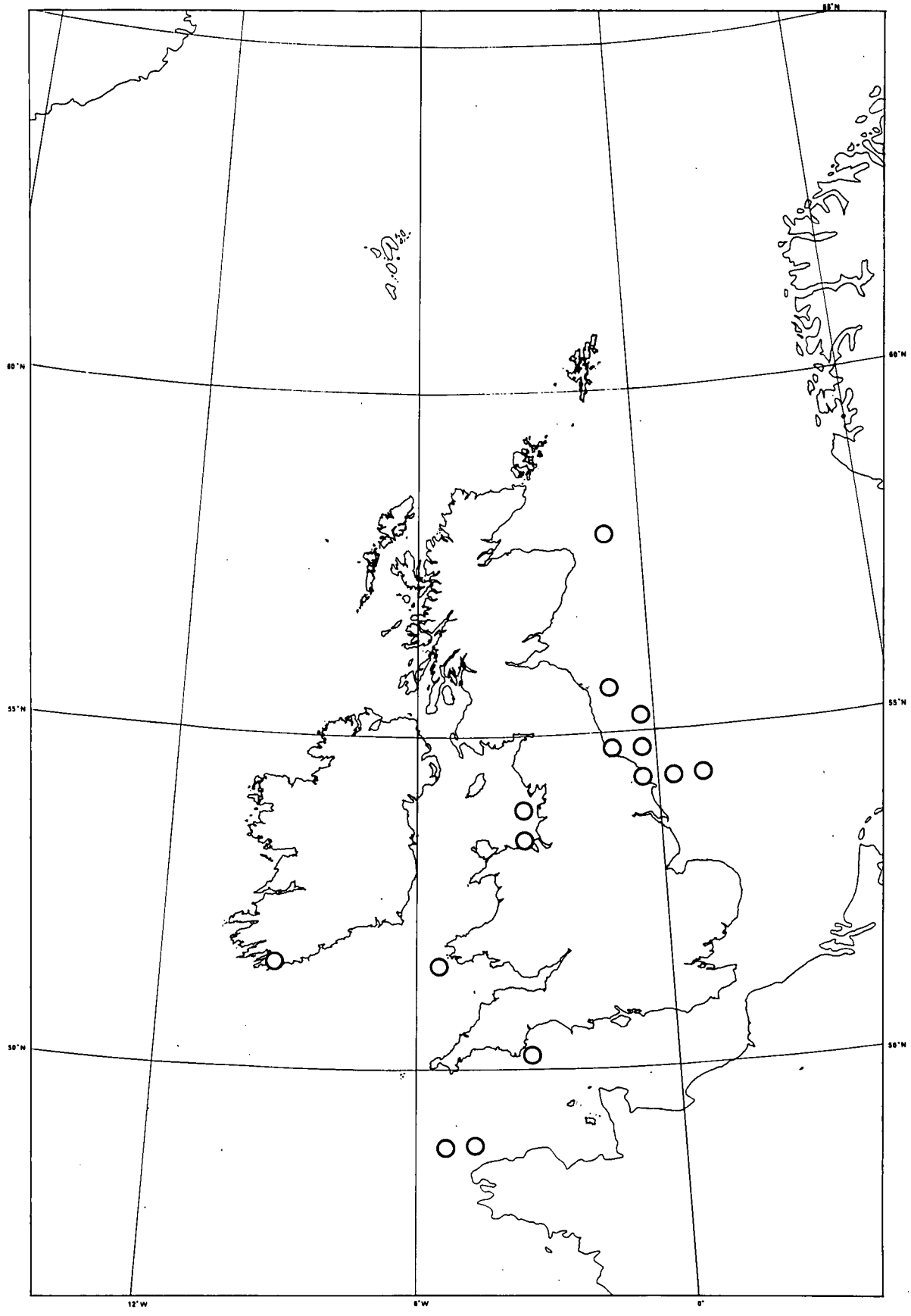
22. *Ceratium minutum* Jorg.



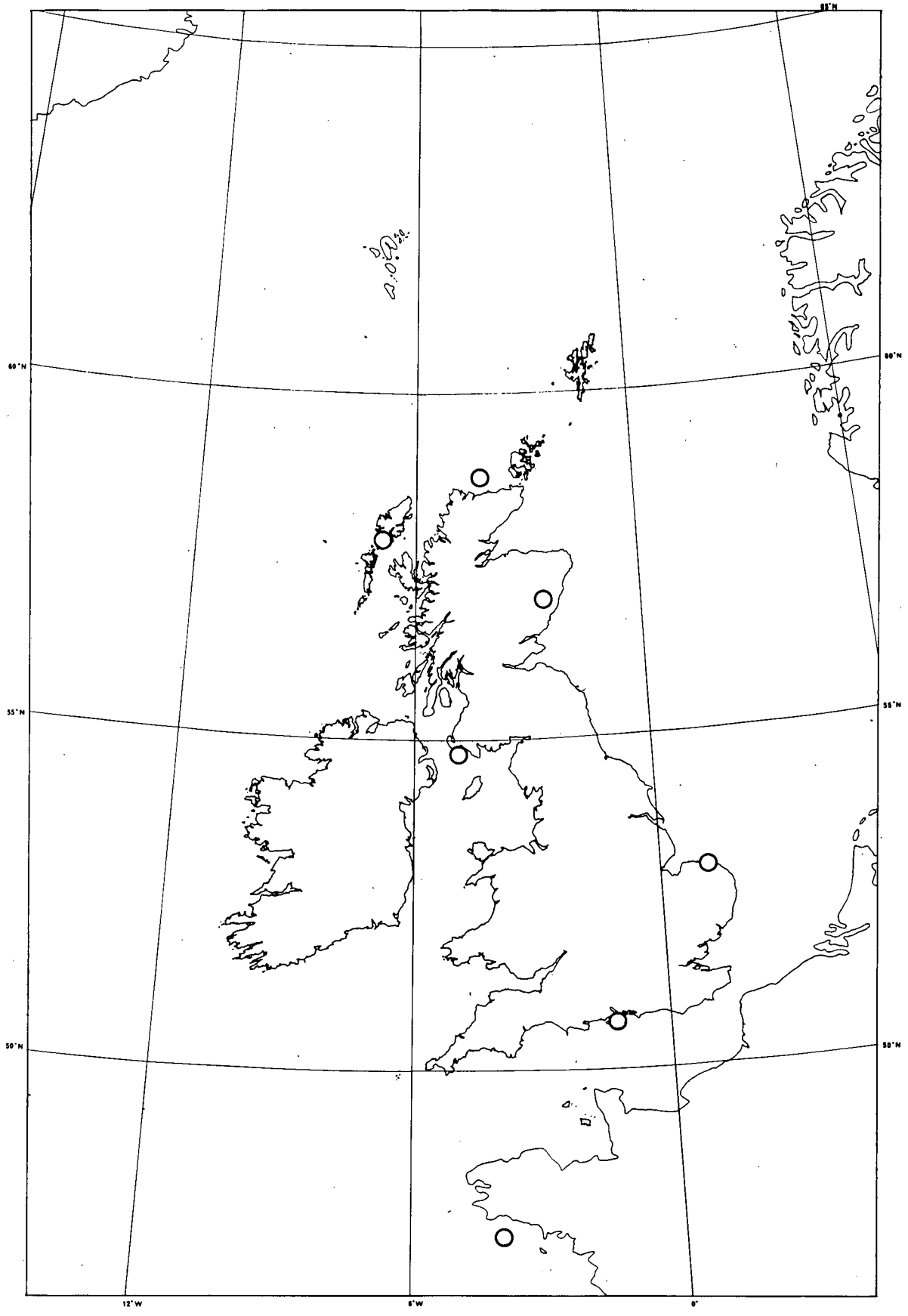
23. *Ceratium platycorne* Daday



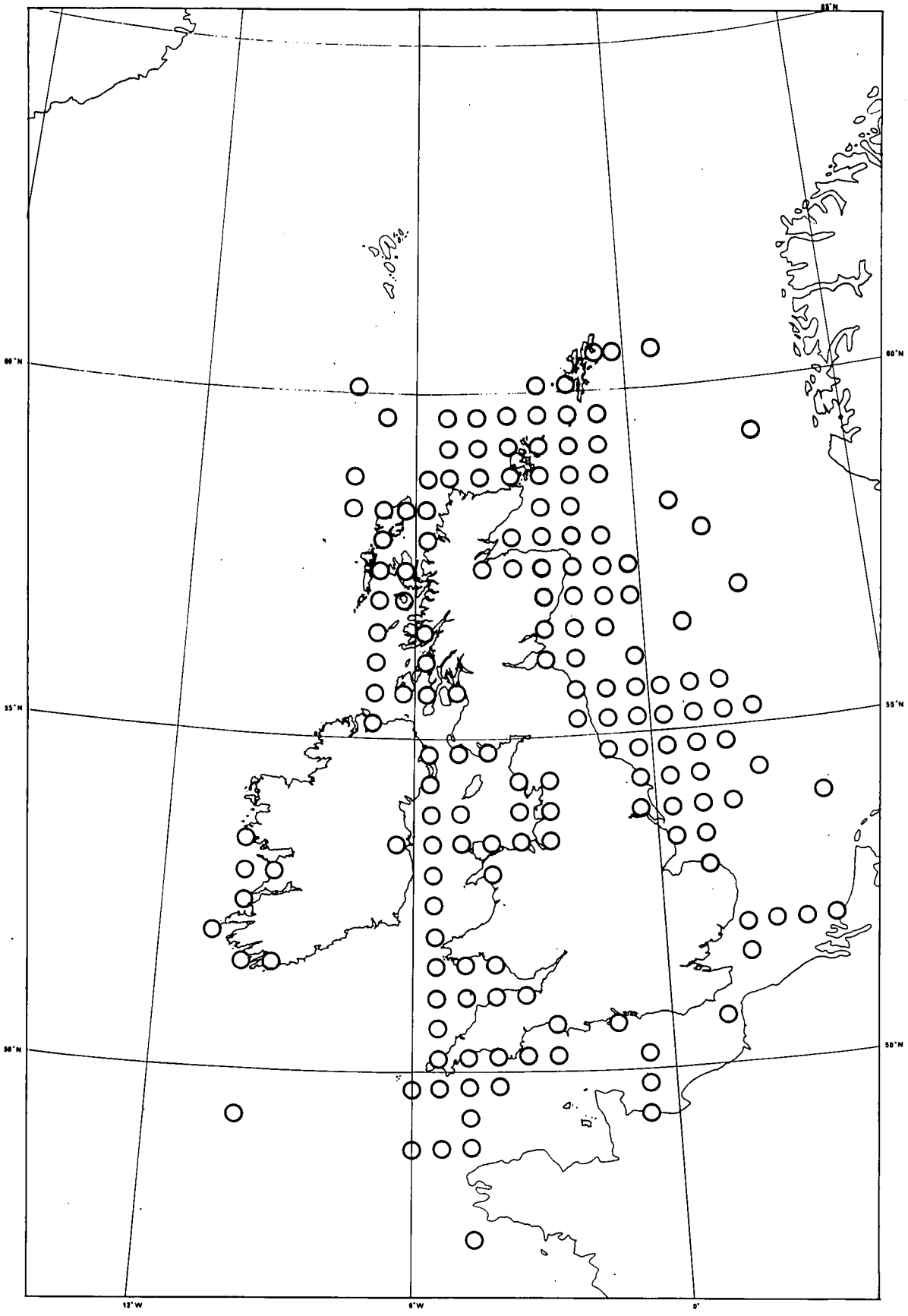
24. *Ceratium tripos* (O. F. Mull.)Nitzsch



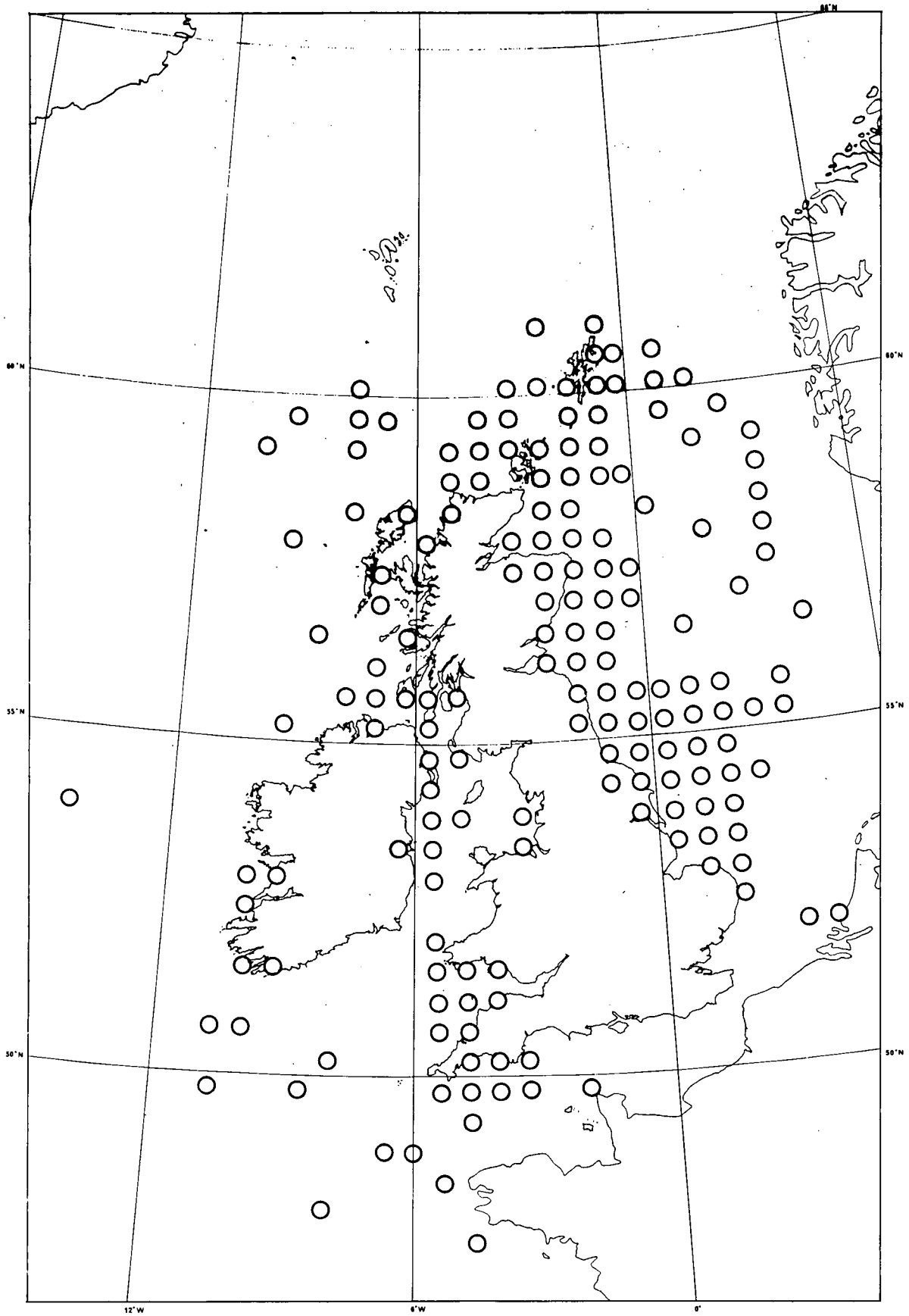
25. *Cochlodinium vinctum* Kof. & Swezy



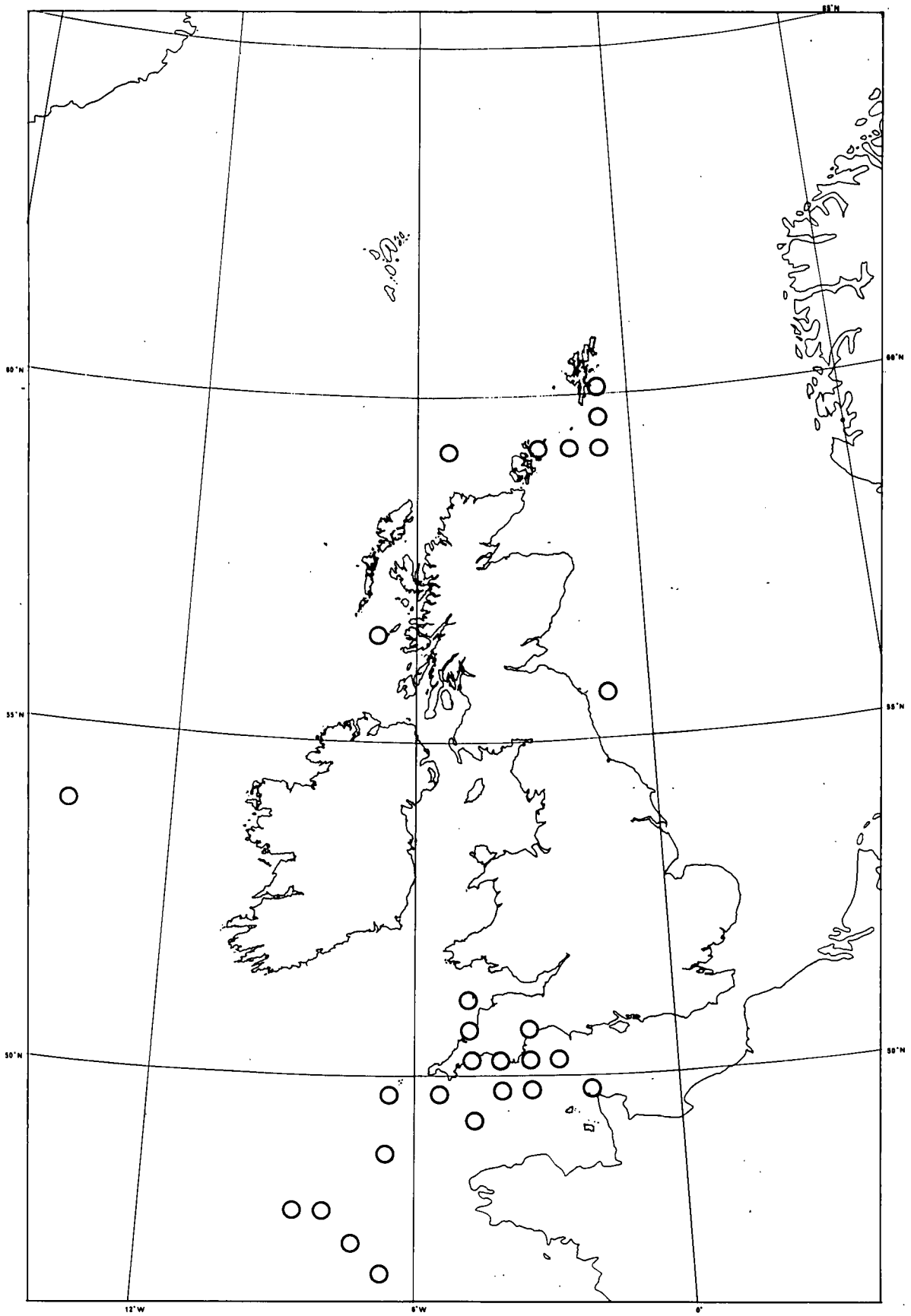
26. *Coolia monotis* Meun.



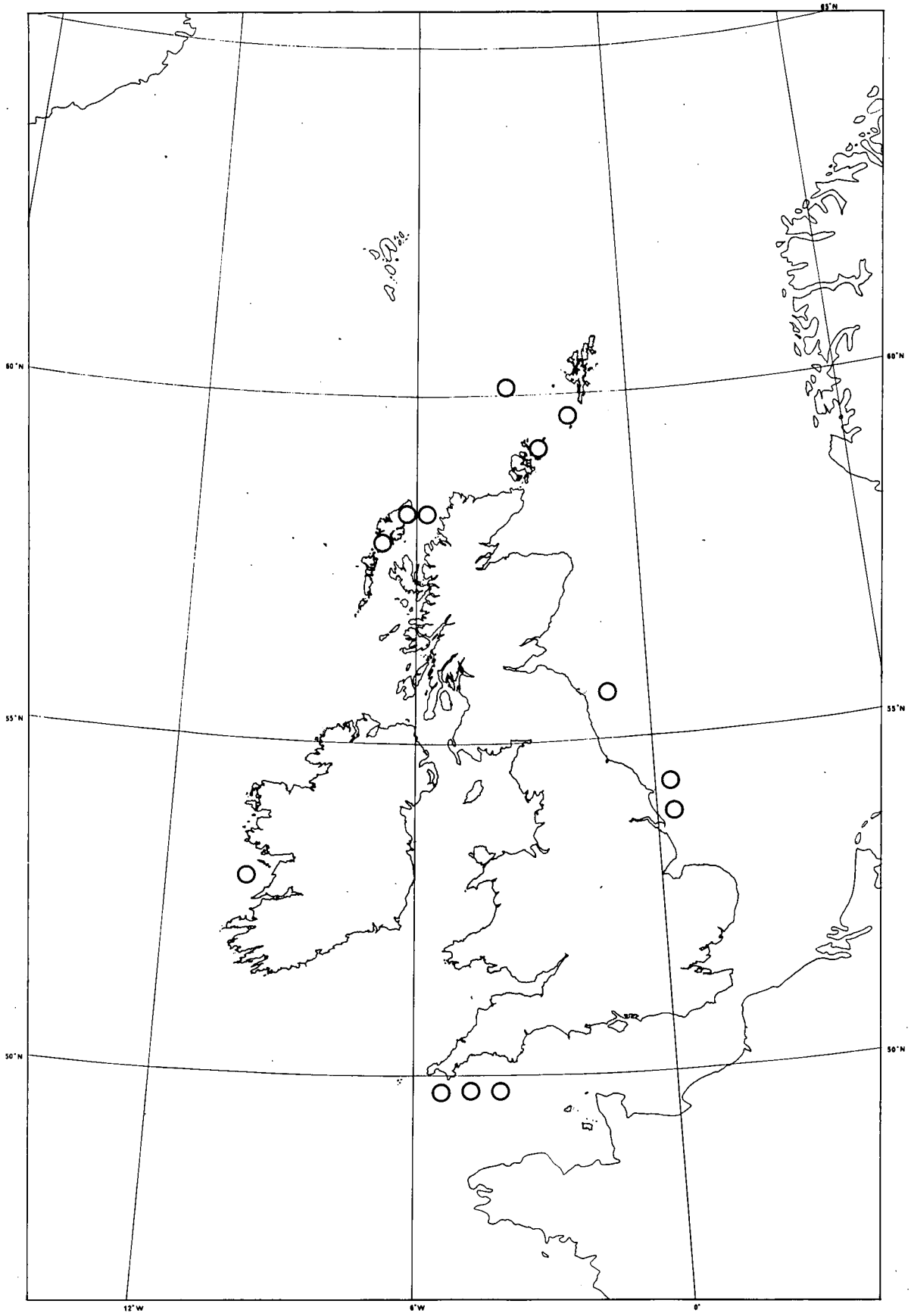
27. *Dinophysis acuminata* Clap. & Lachm.



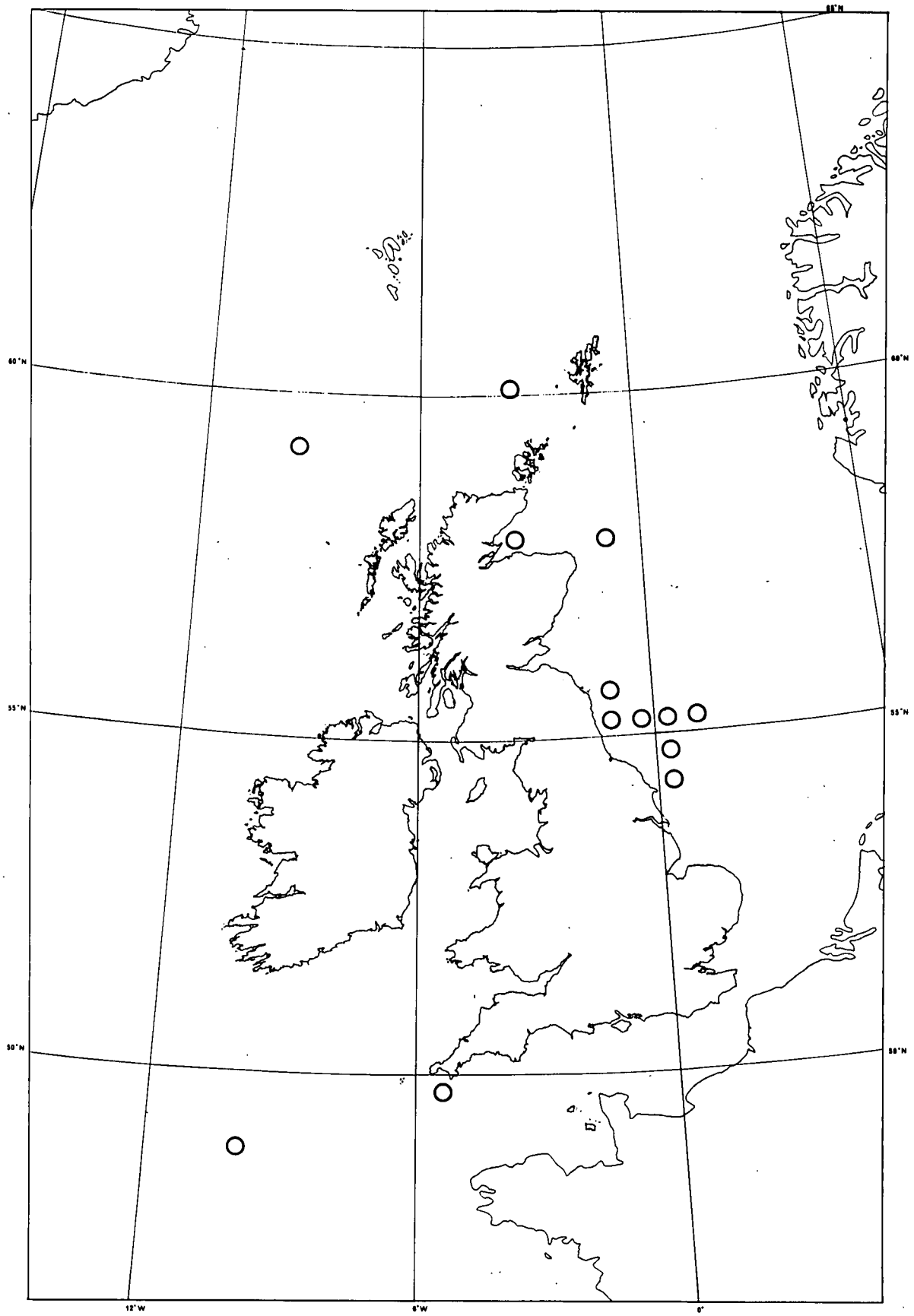
28. *Dinophysis acuta* Ehrenb.



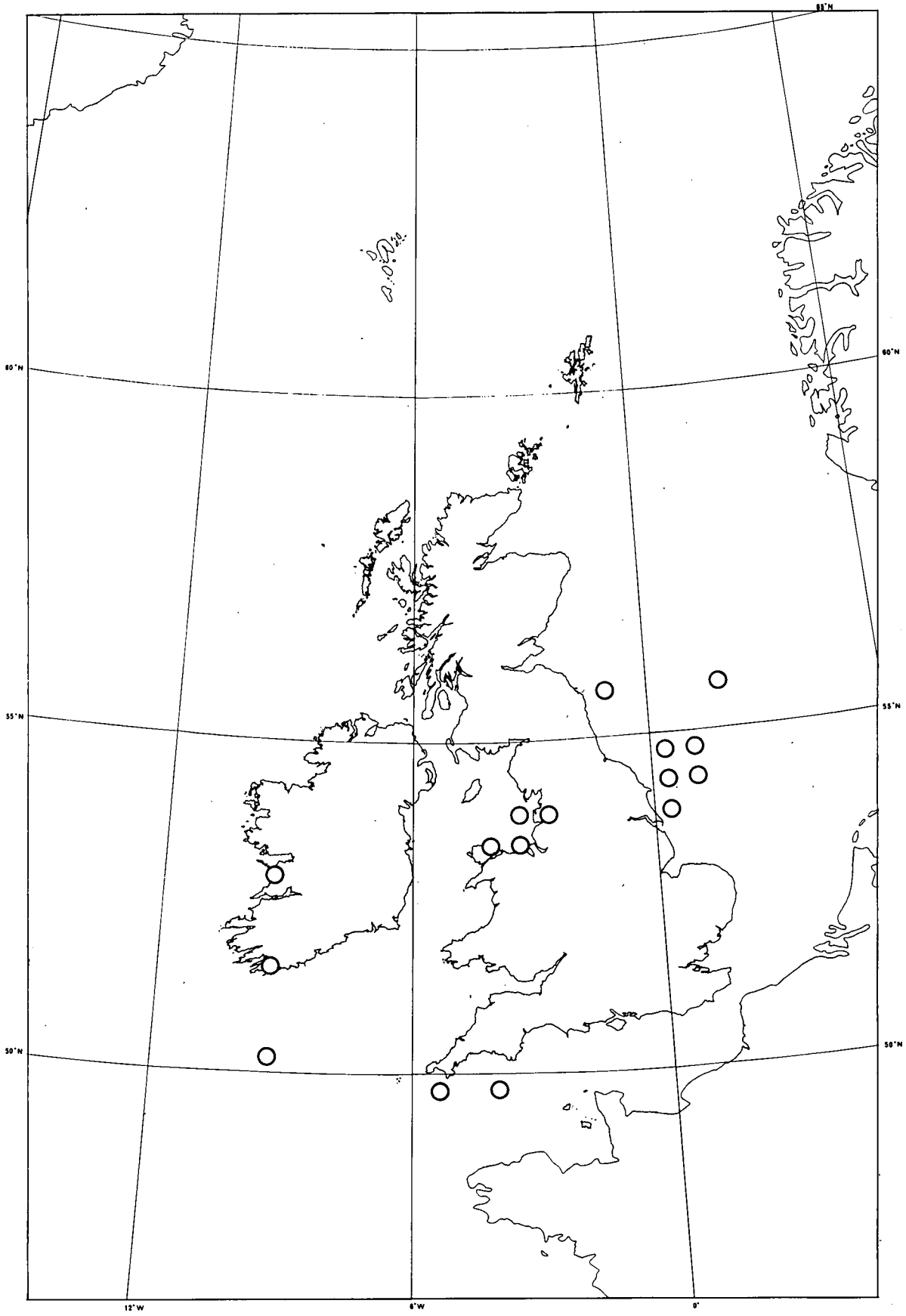
29. *Dinophysis caudata* Kent



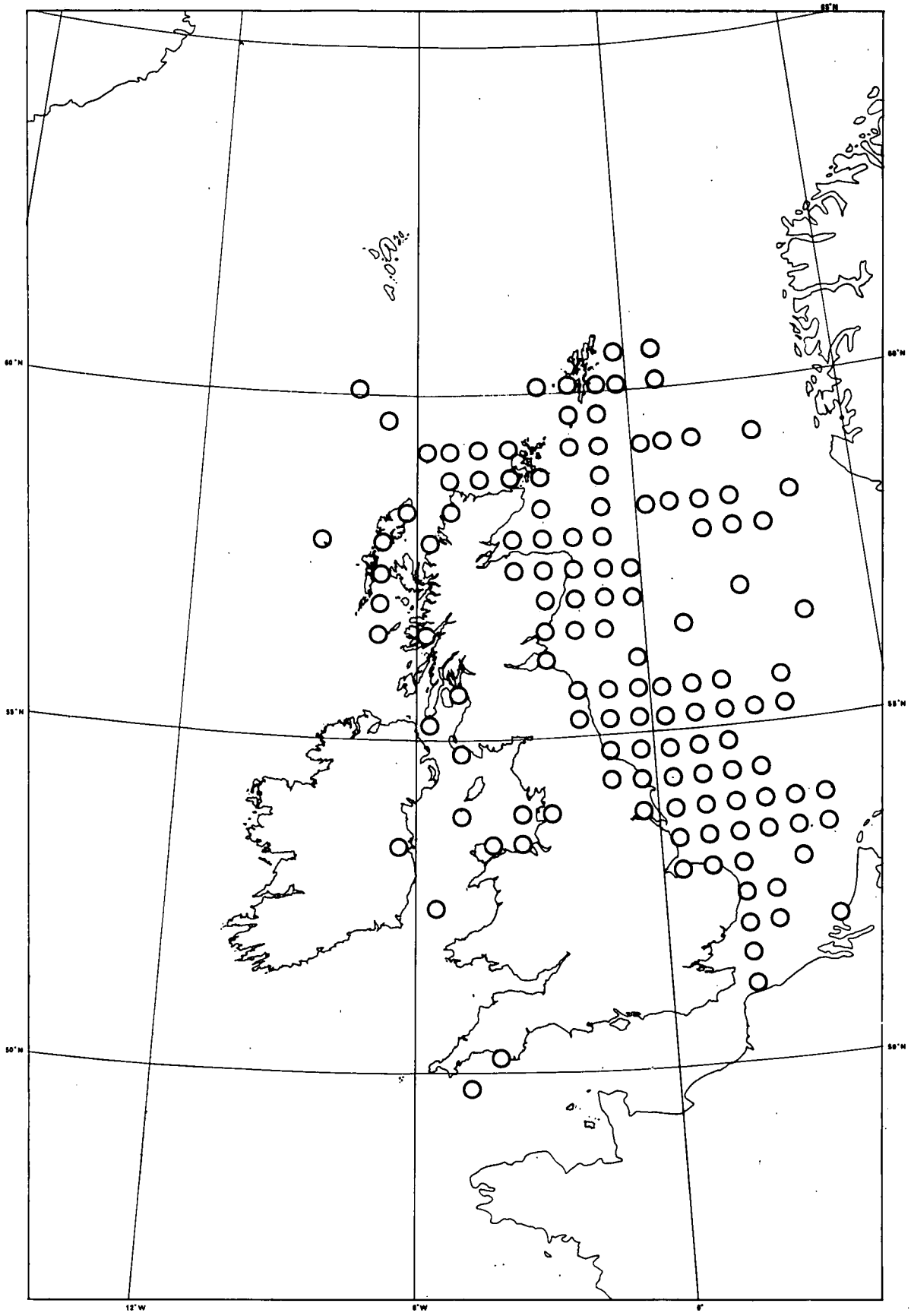
30. *Dinophysis dens* Pav.



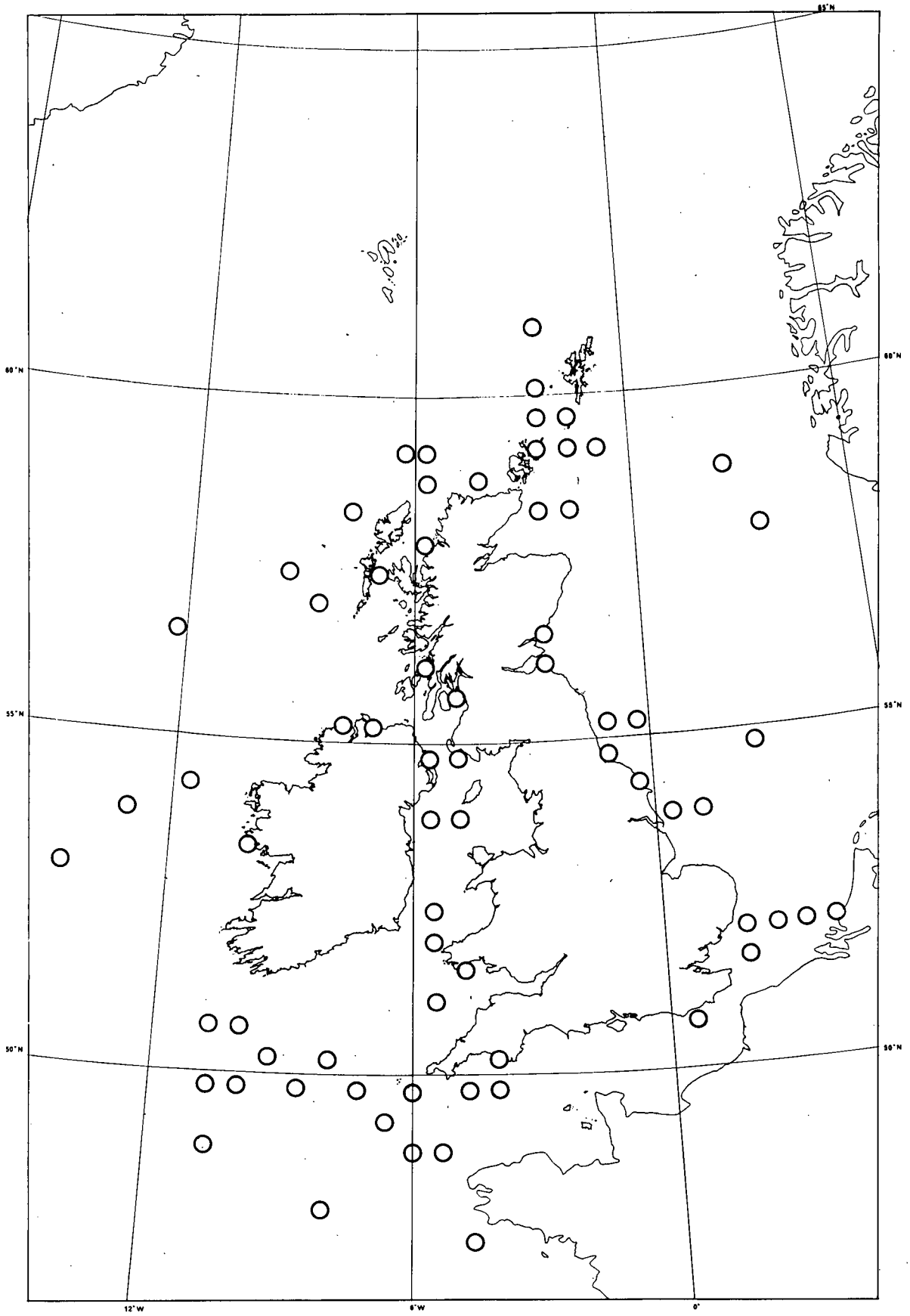
31. *Dinophysis hastata* Stein



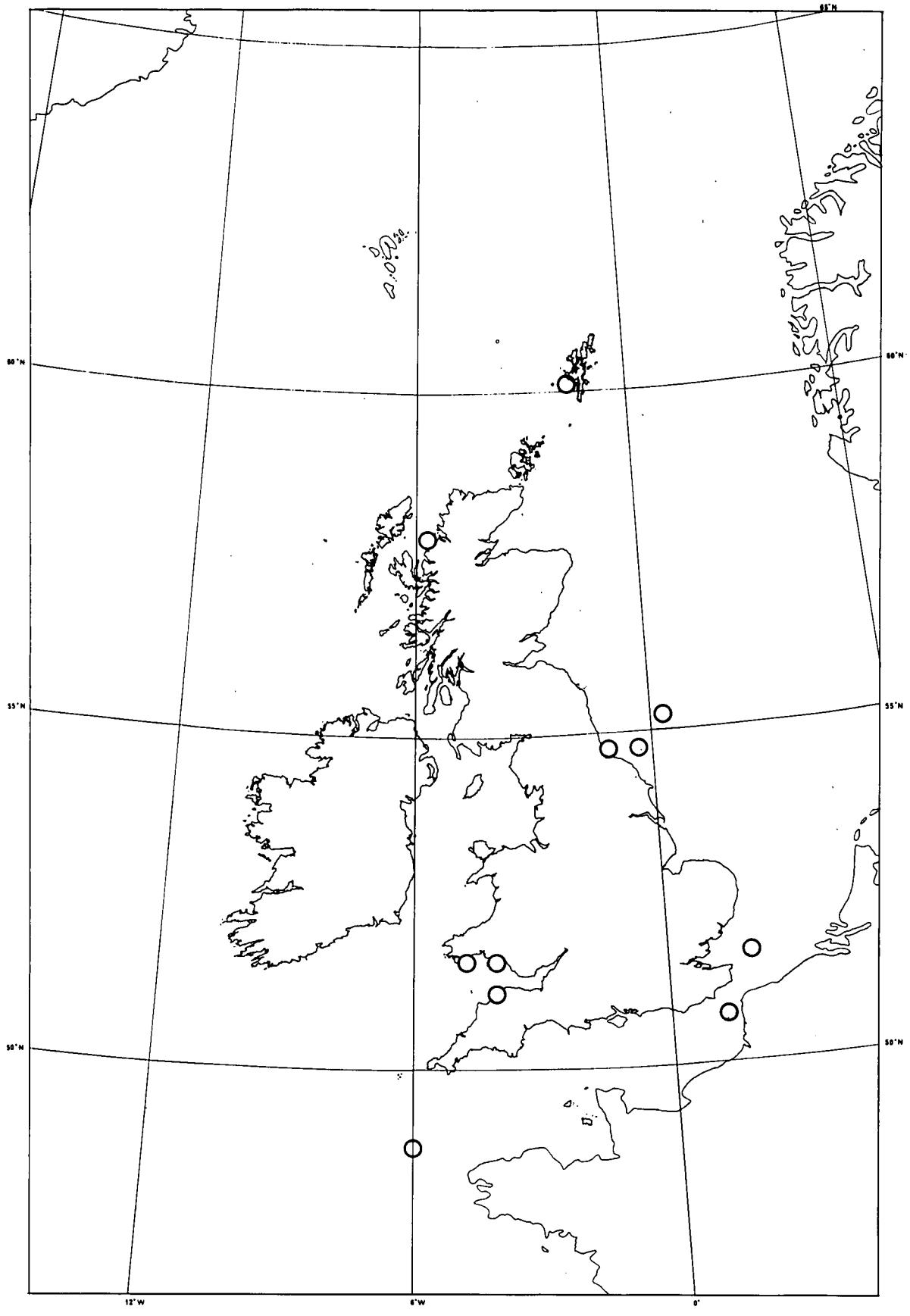
32. *Dinophysis nasuta* (Stein) Parke & Dixon



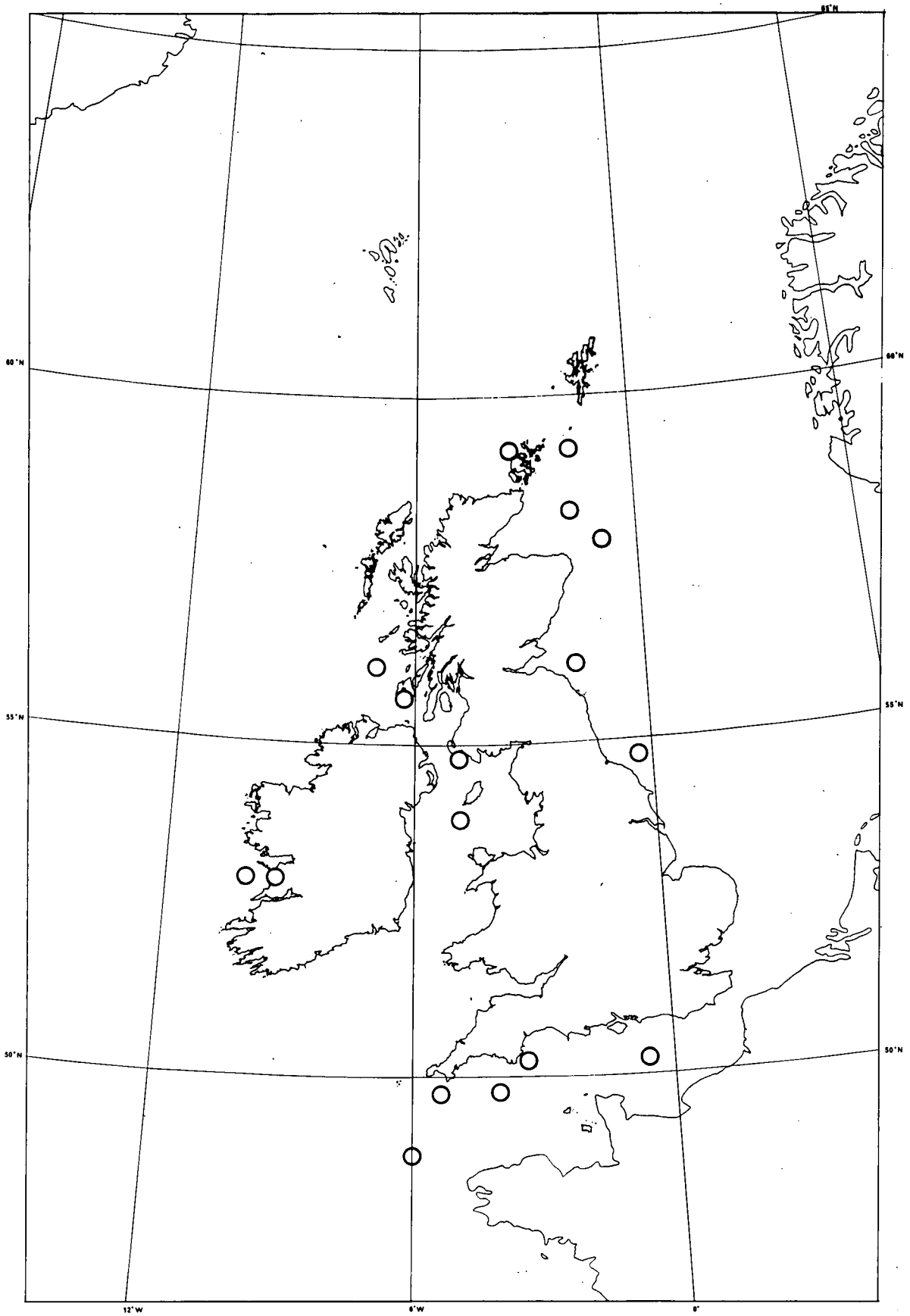
33. *Dinophysis norvegica* Clap. & Lachm.



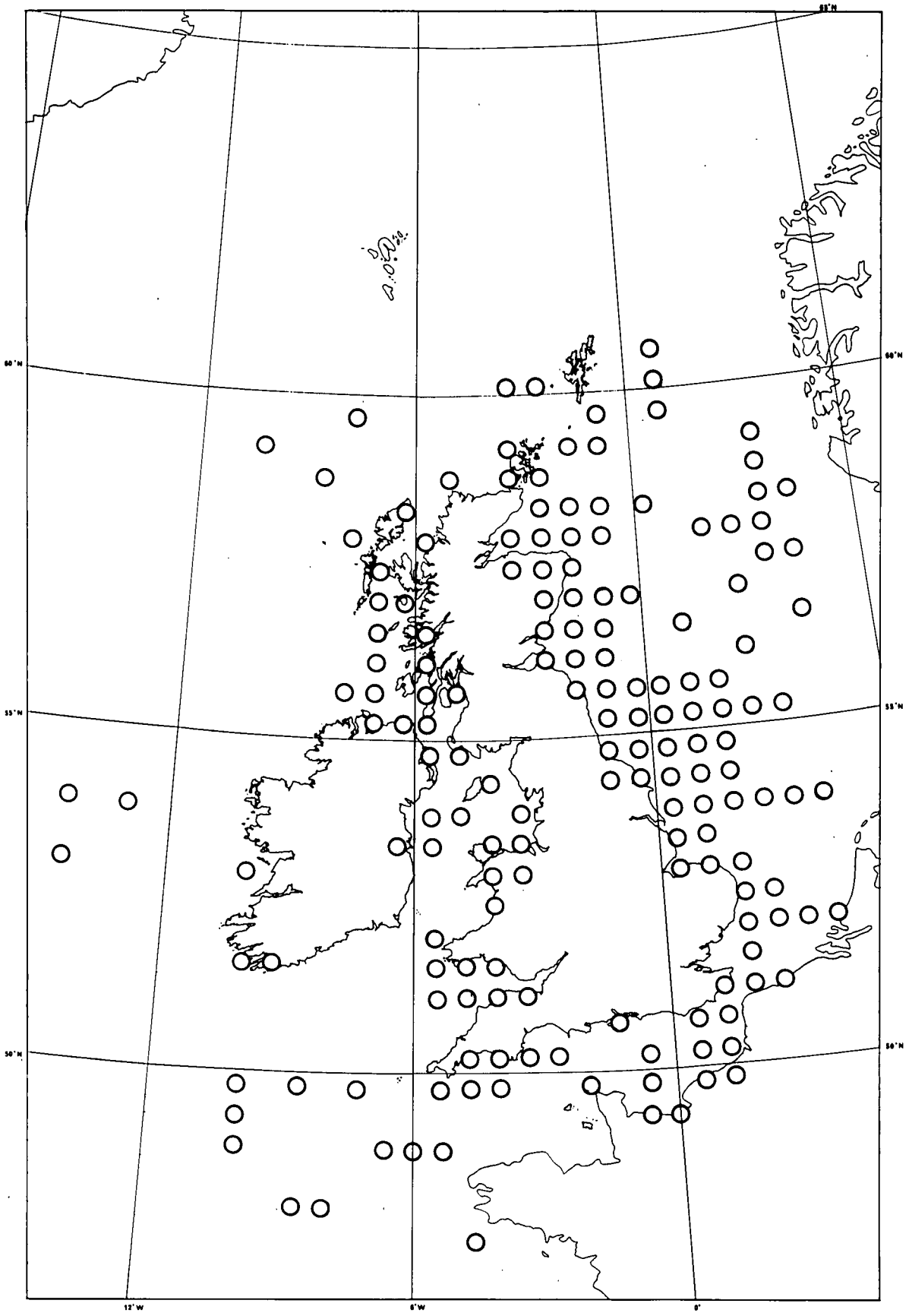
34. ***Dinophysis ovum*** **Schutt**



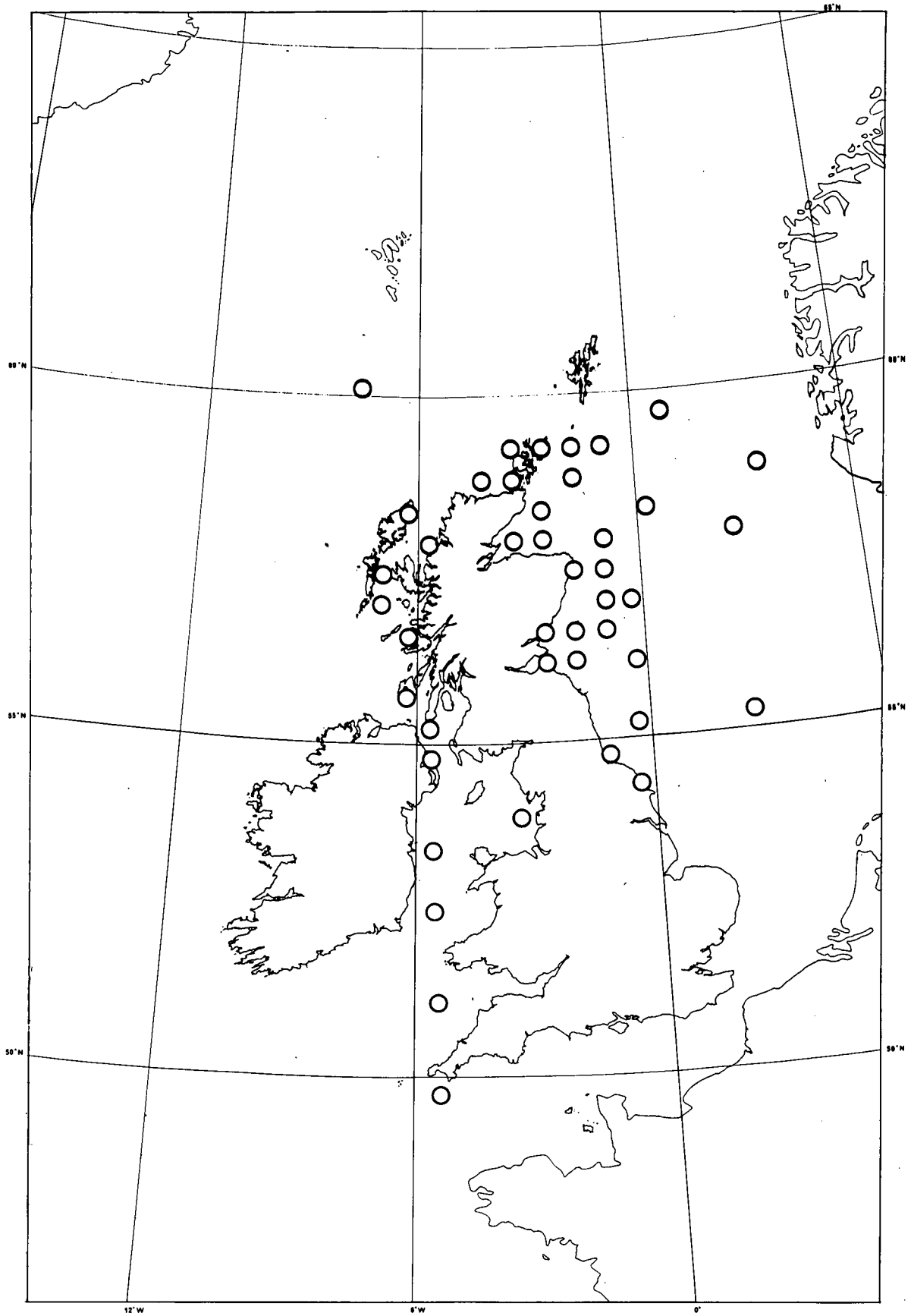
35. *Dinophysis pulchella* (Lebour) Balech



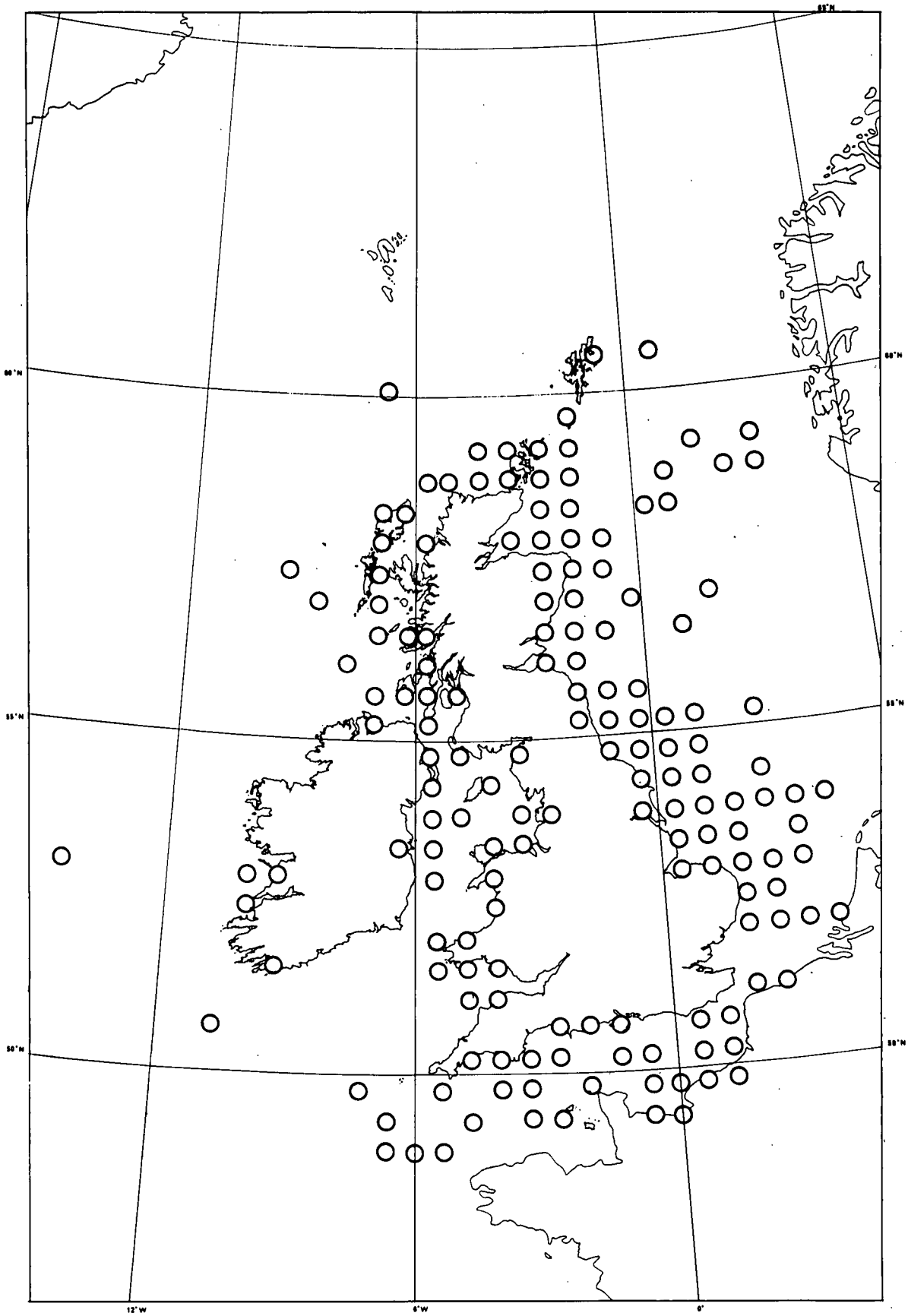
36. *Dinophysis recurva* Kof. & Skogsb.



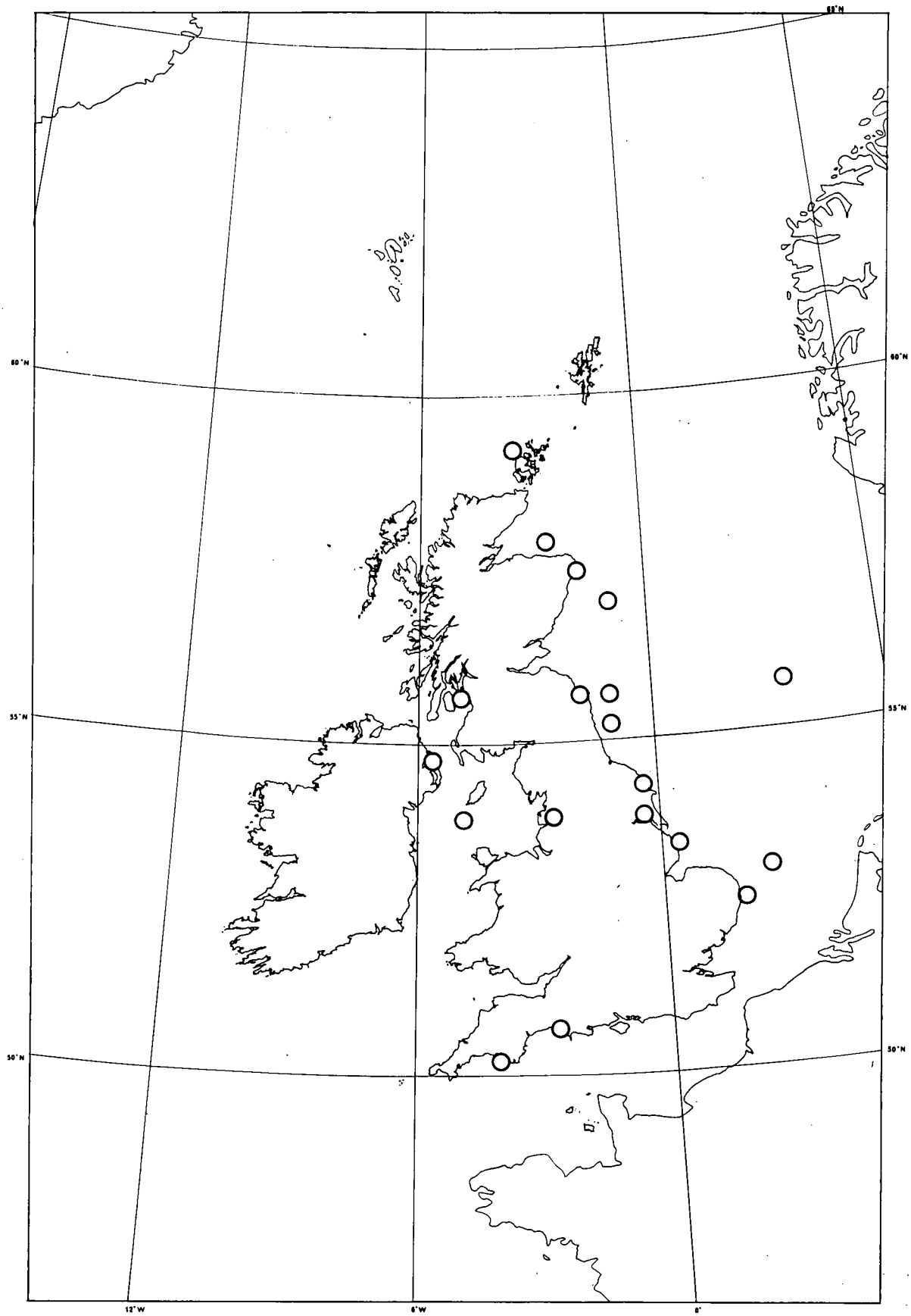
37. *Dinophysis rotundata* Clap. & Lachm.



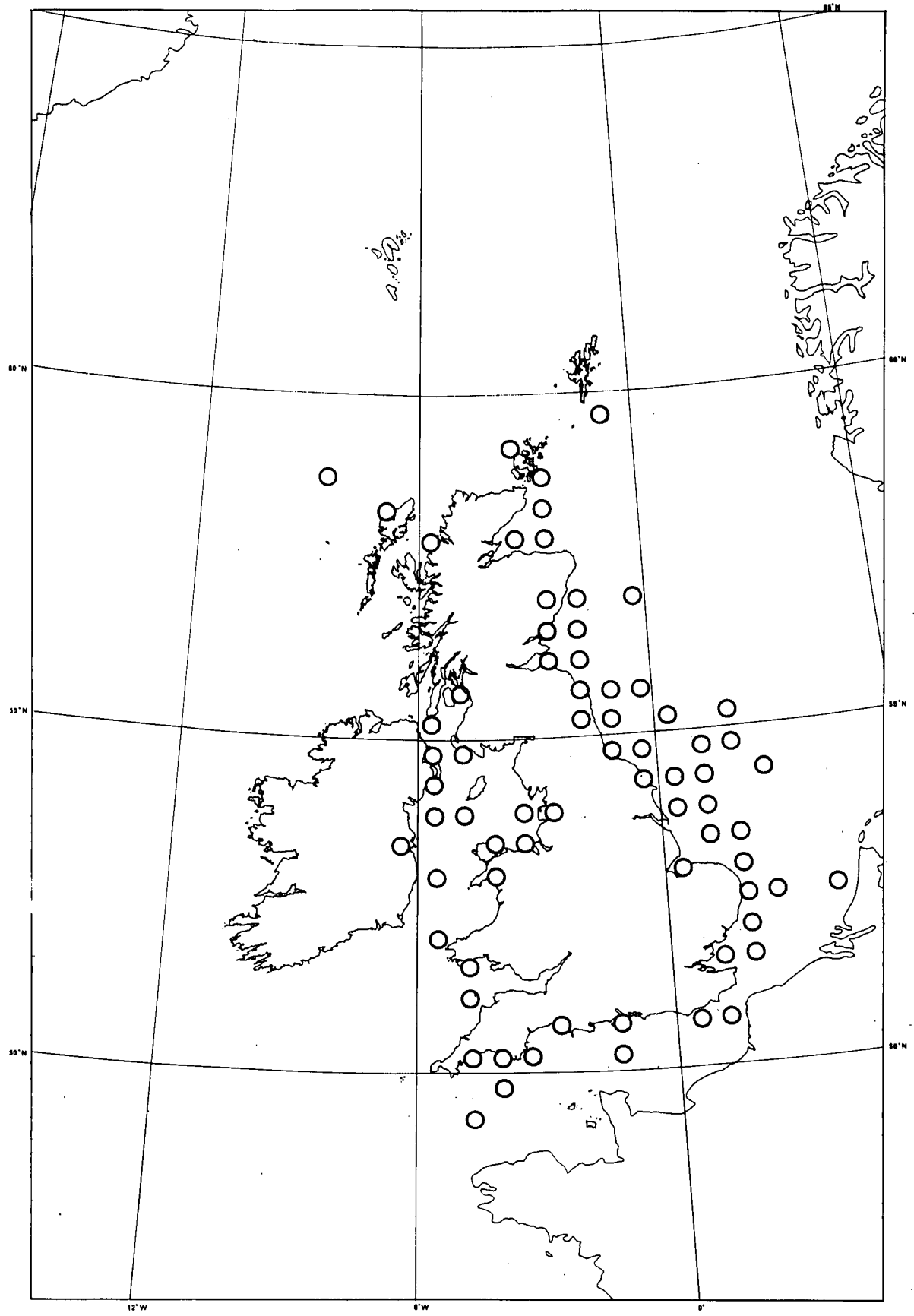
38. *Dinophysis skagii* Pauls.



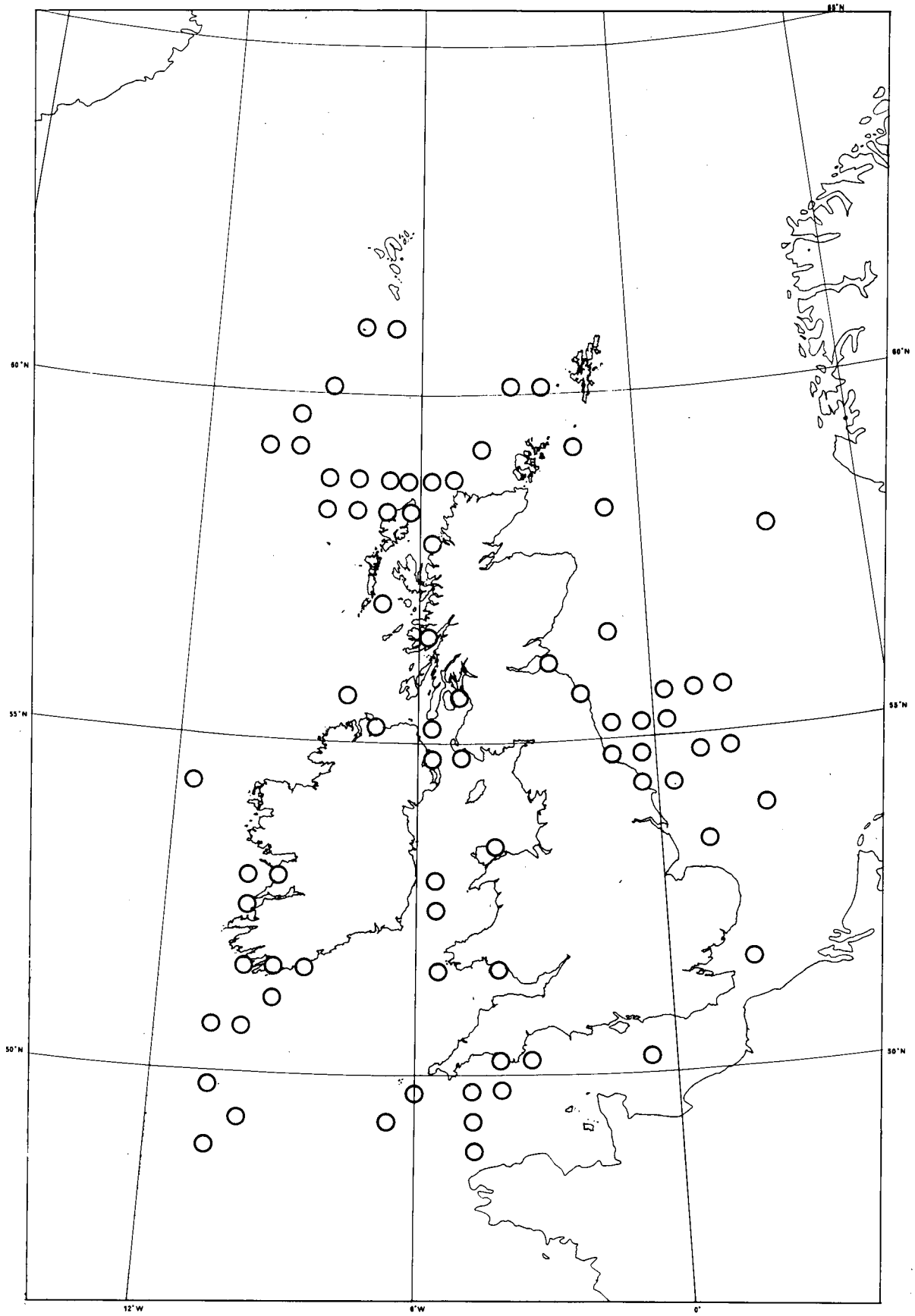
39. *Diplopsalis lenticula* Bergh



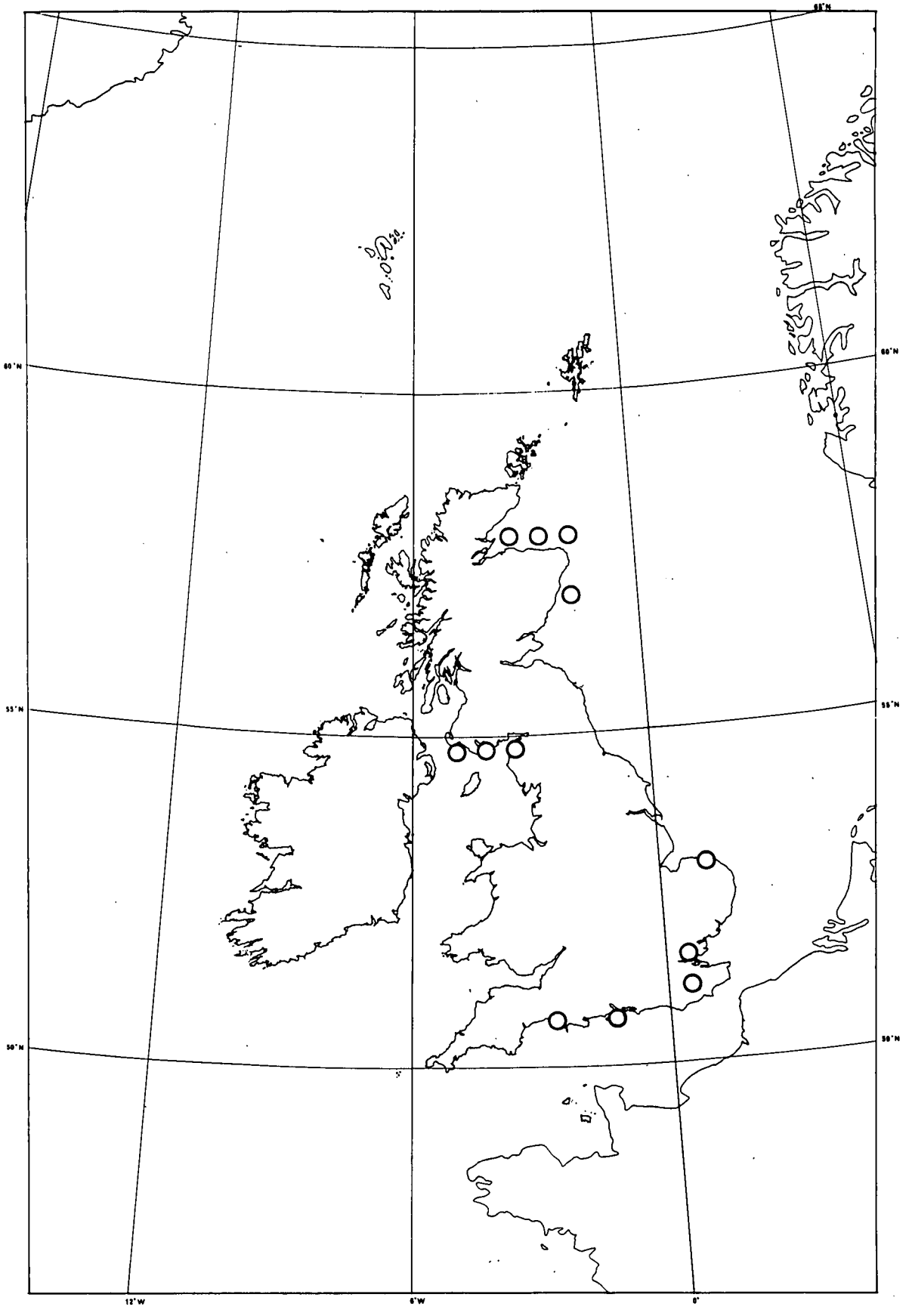
40. *Diplosalopsis orbicularis* (Pauls.) Meun.



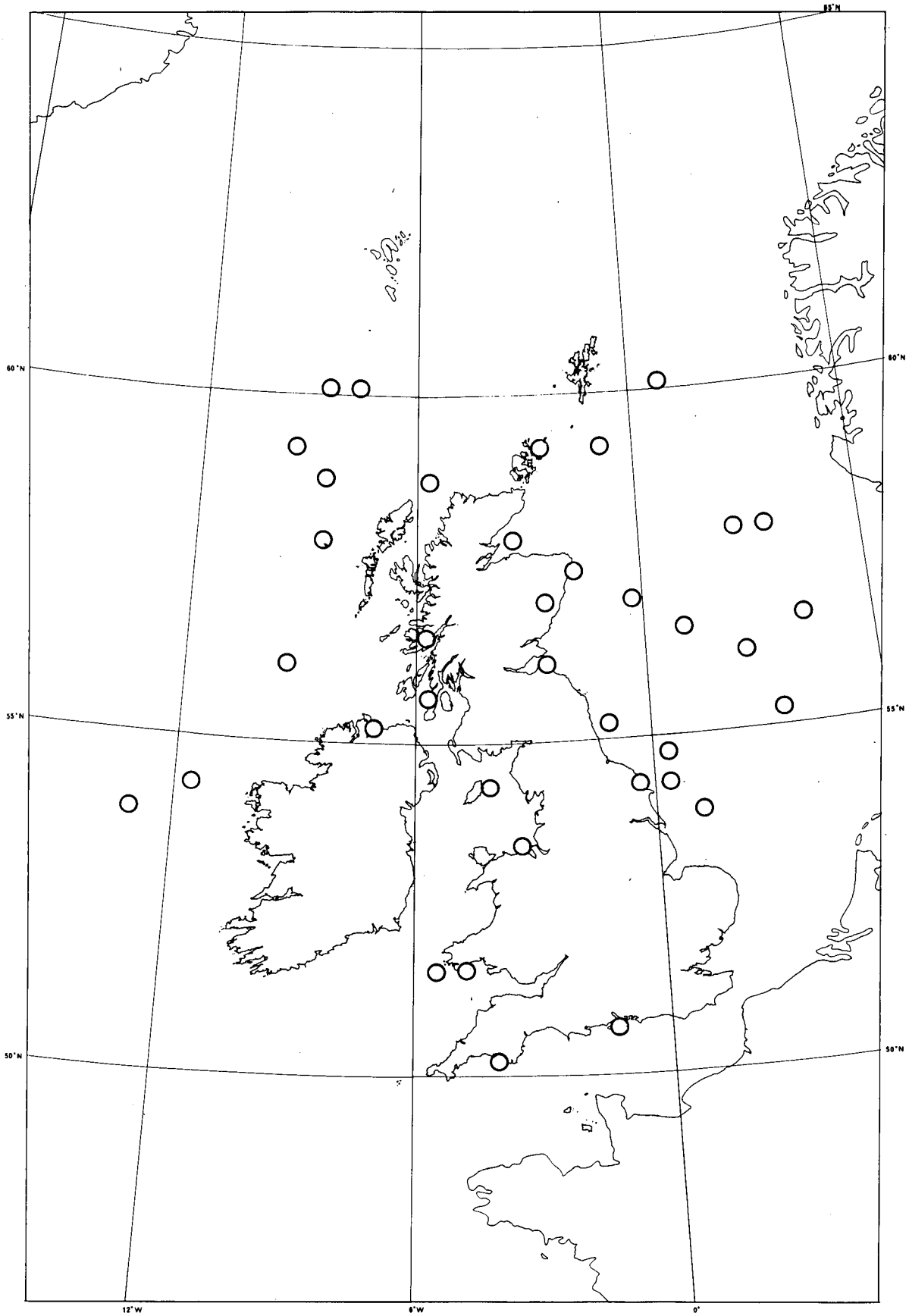
41. *Dissodinium pseudolunula* Swift



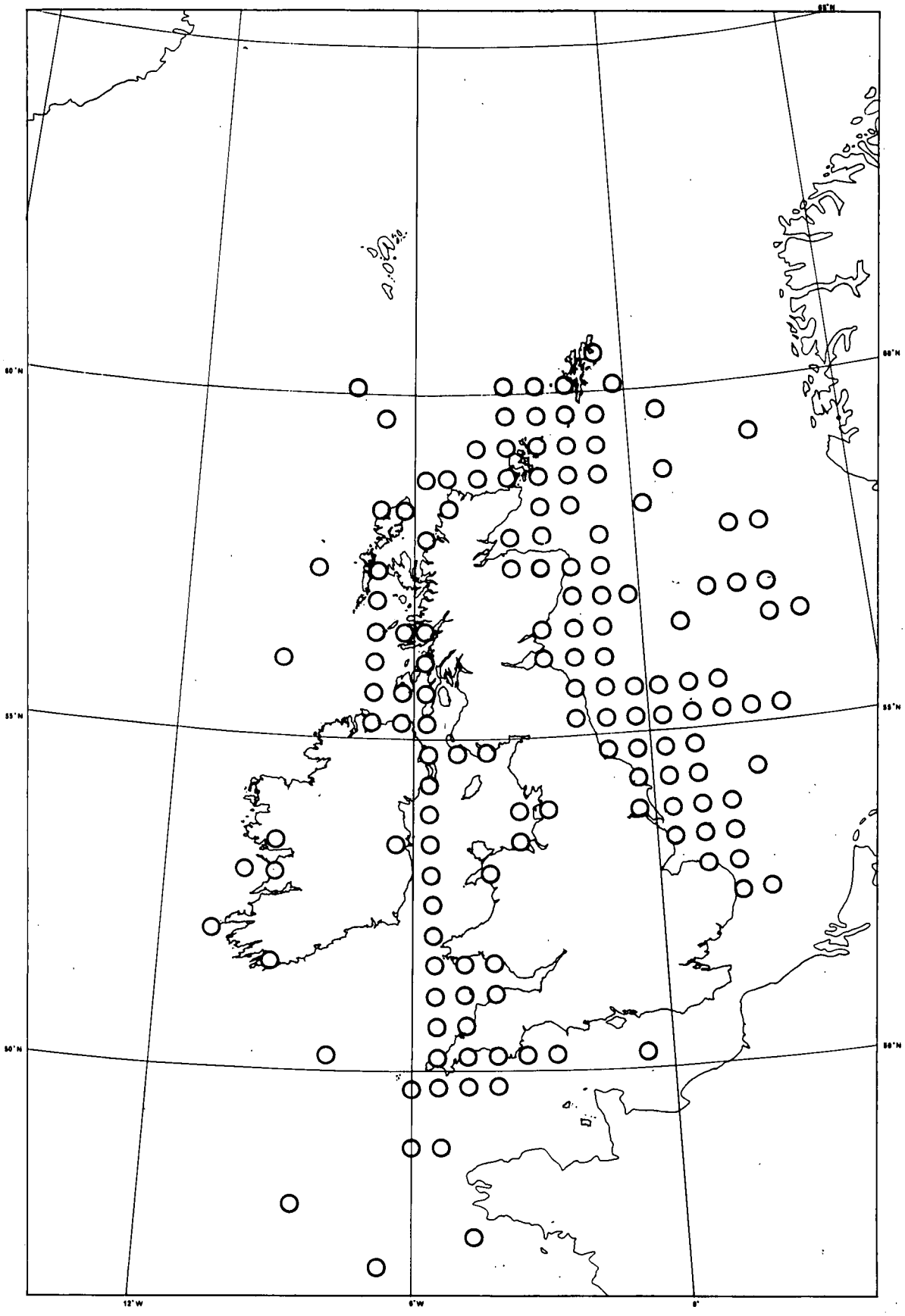
42. *Glenodinium danicum* Pauls.



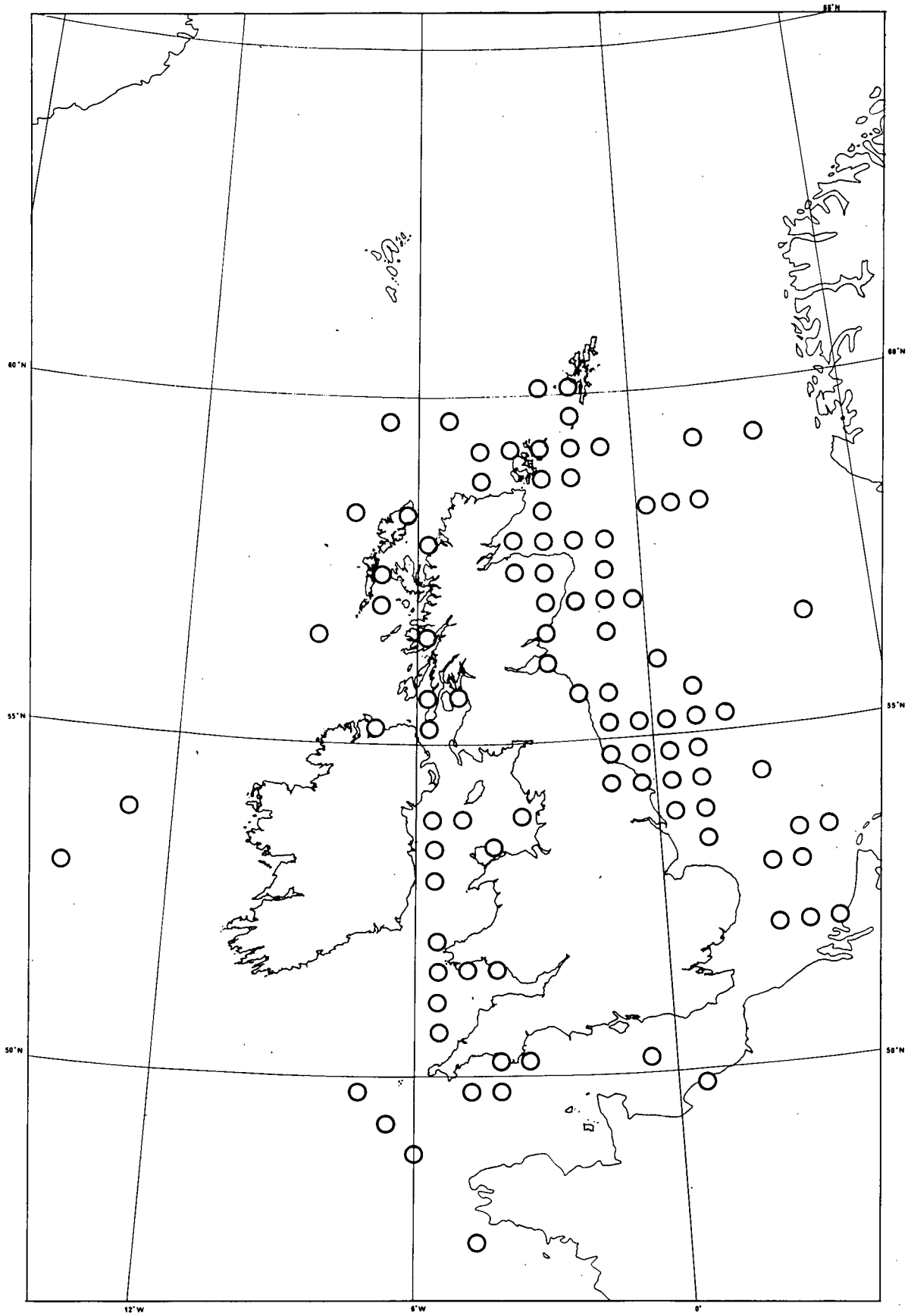
43. *Glenodinium foliaceum* Stein



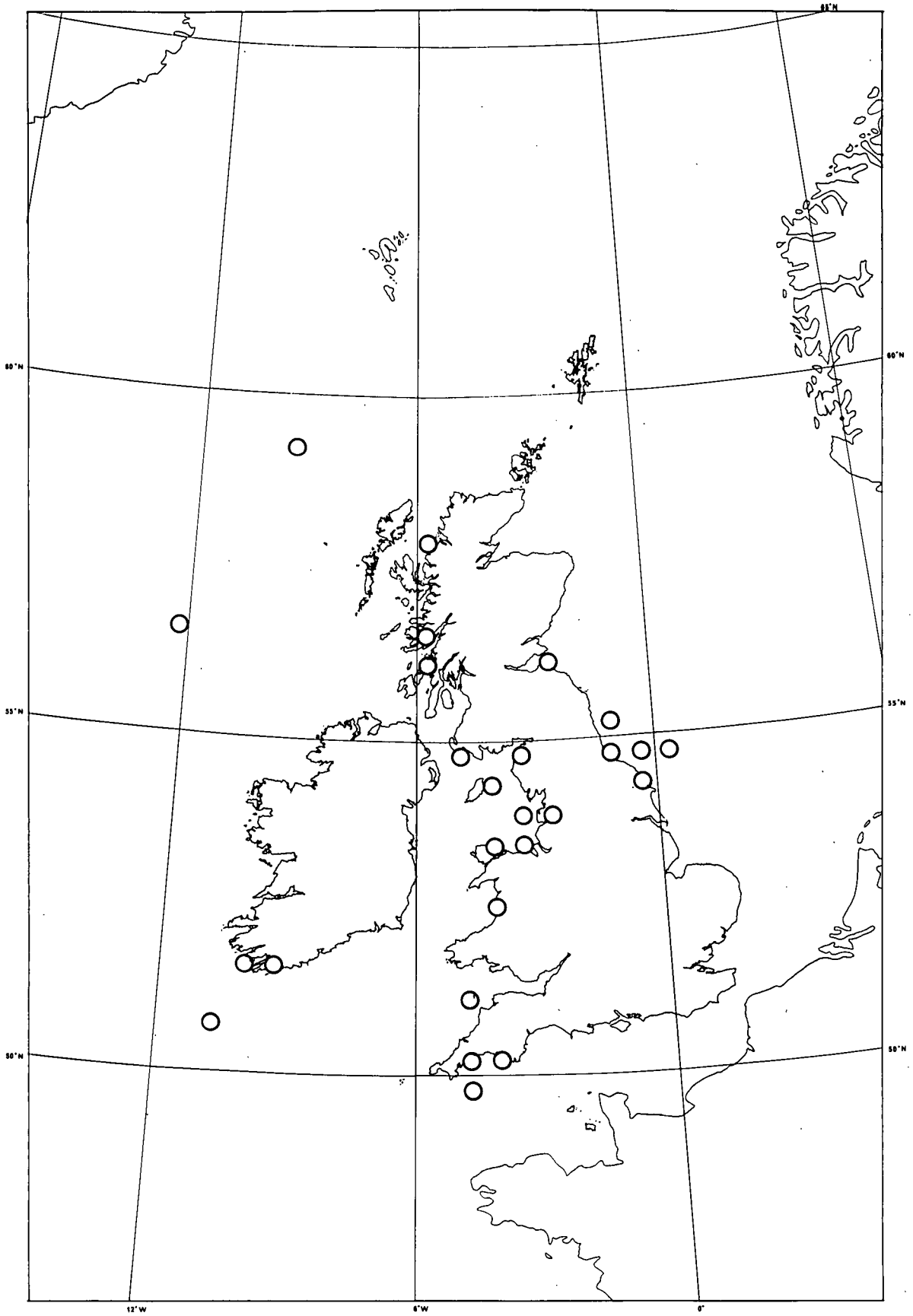
44. *Gonyaulax diegensis* Kof.



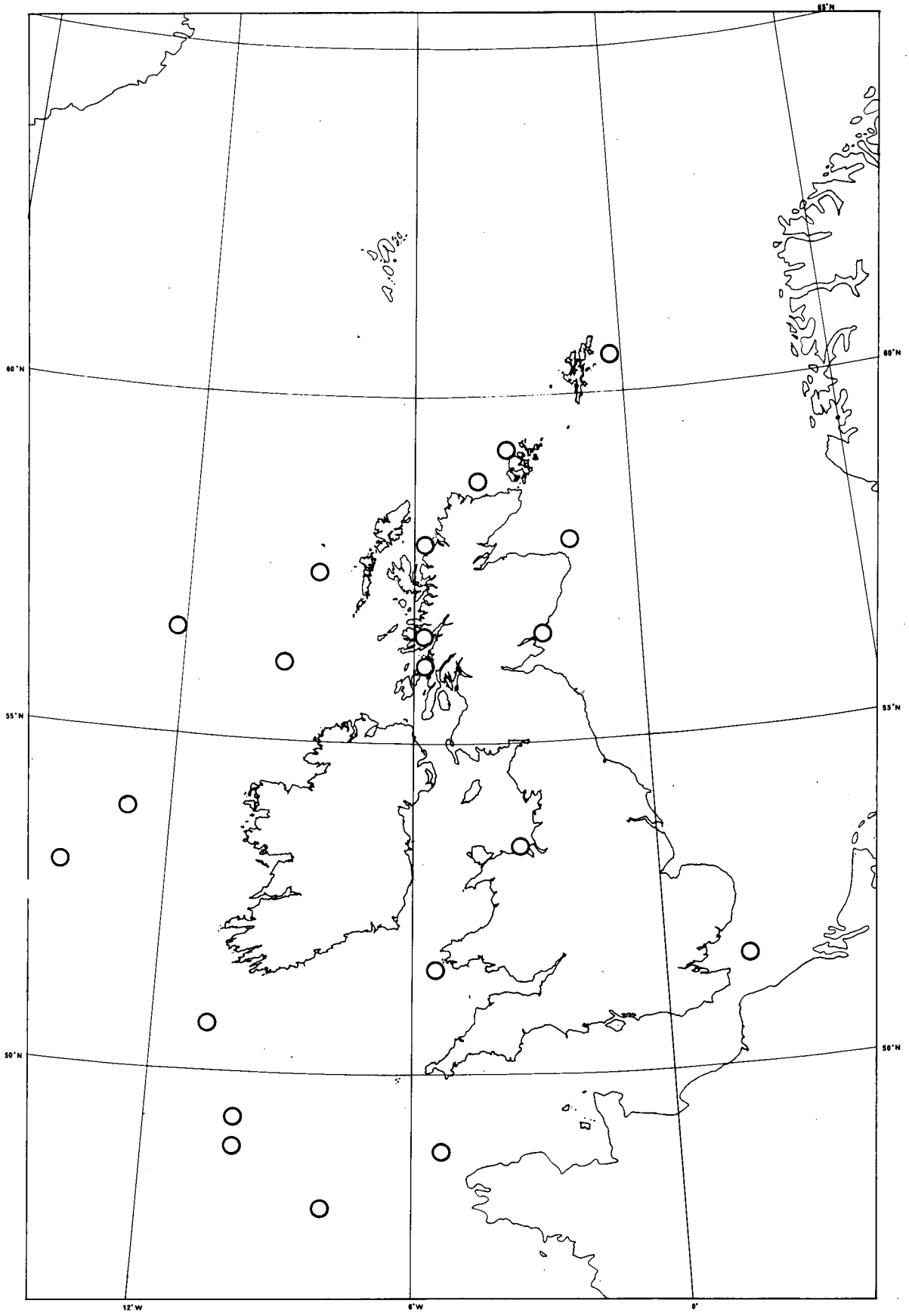
45. *Gonyaulax digitale* (Pouchet) Kof.



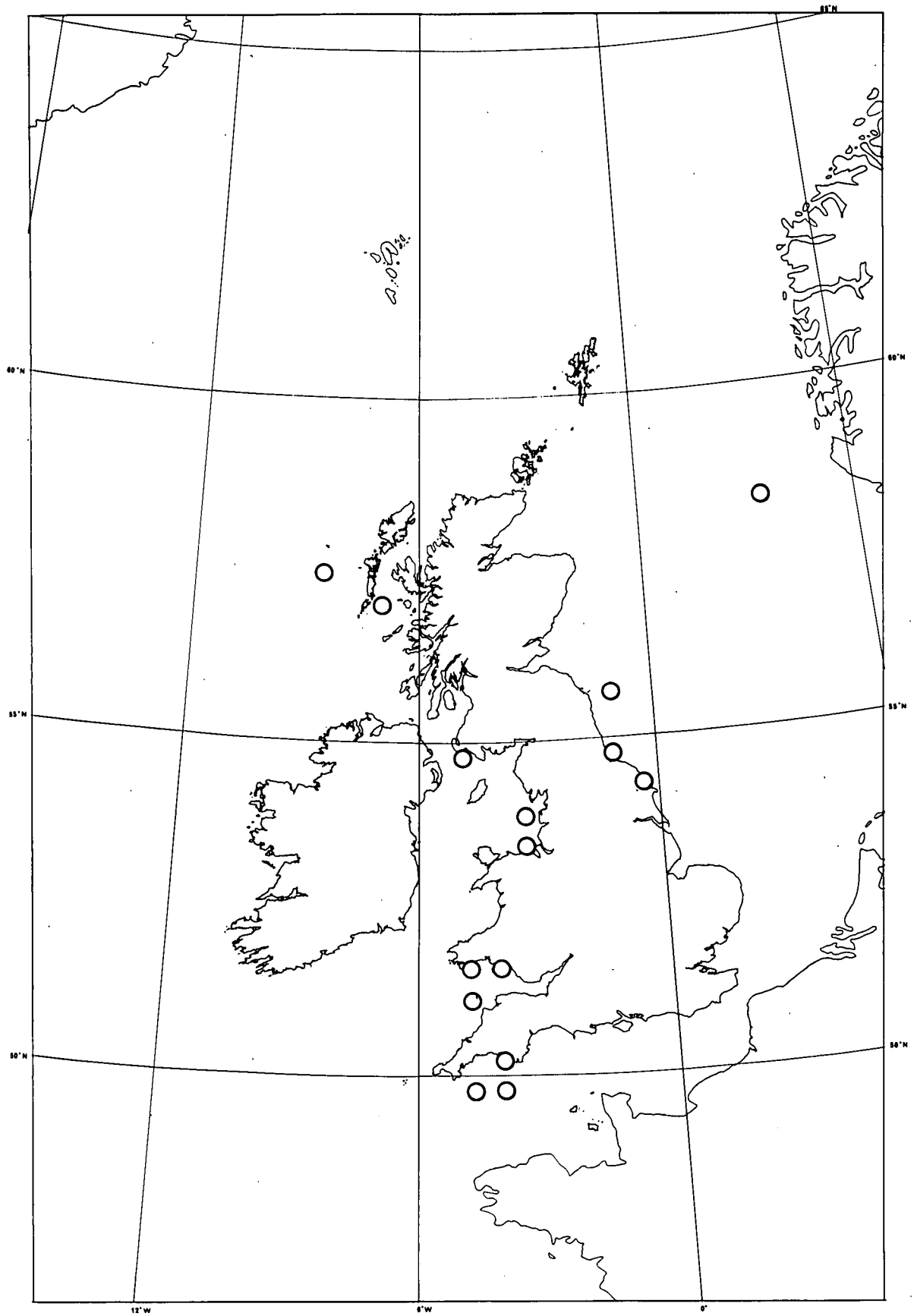
46. *Gonyaulax grindleyi* Reinecke



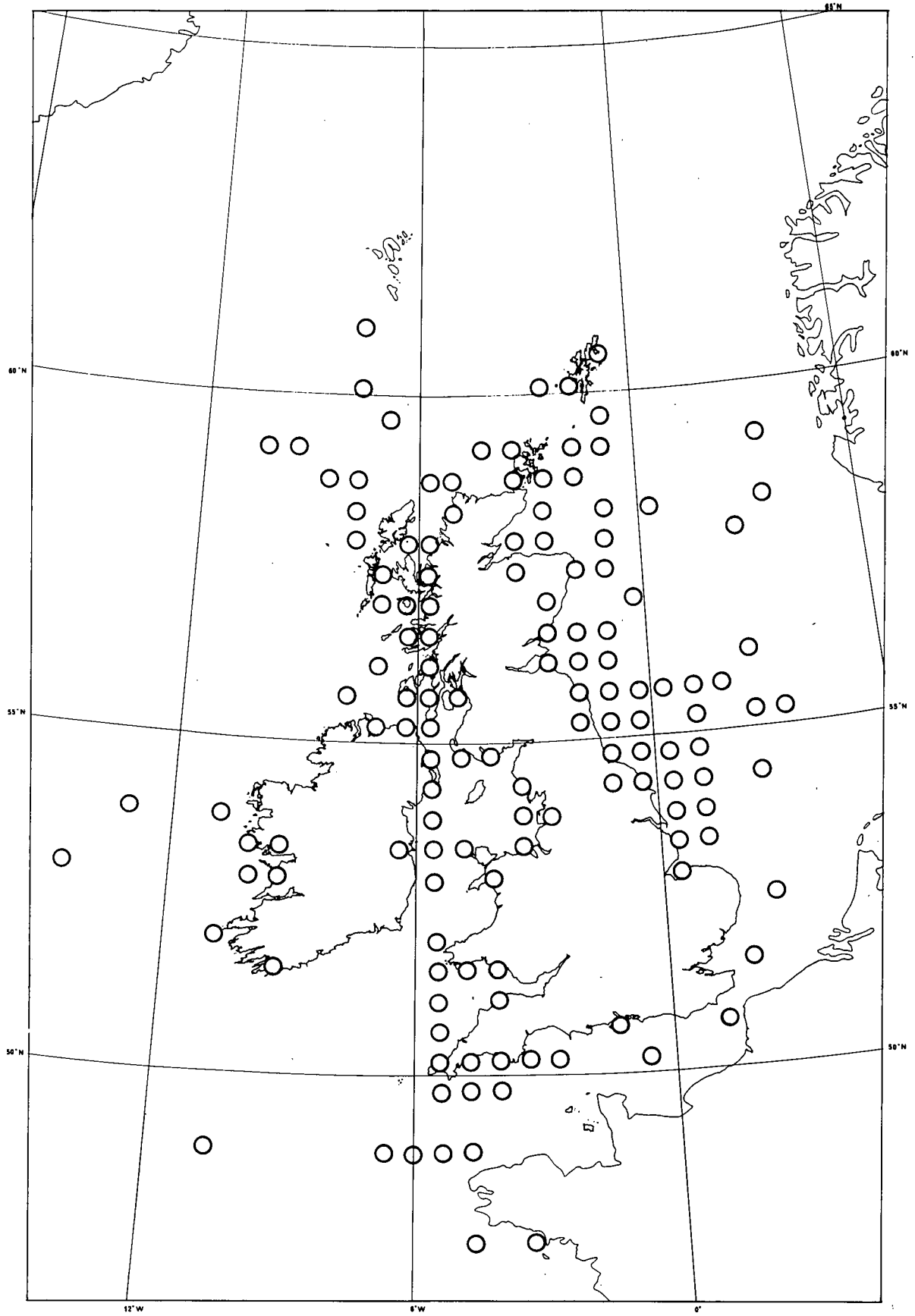
47. *Gonyaulax polyedra* Stein



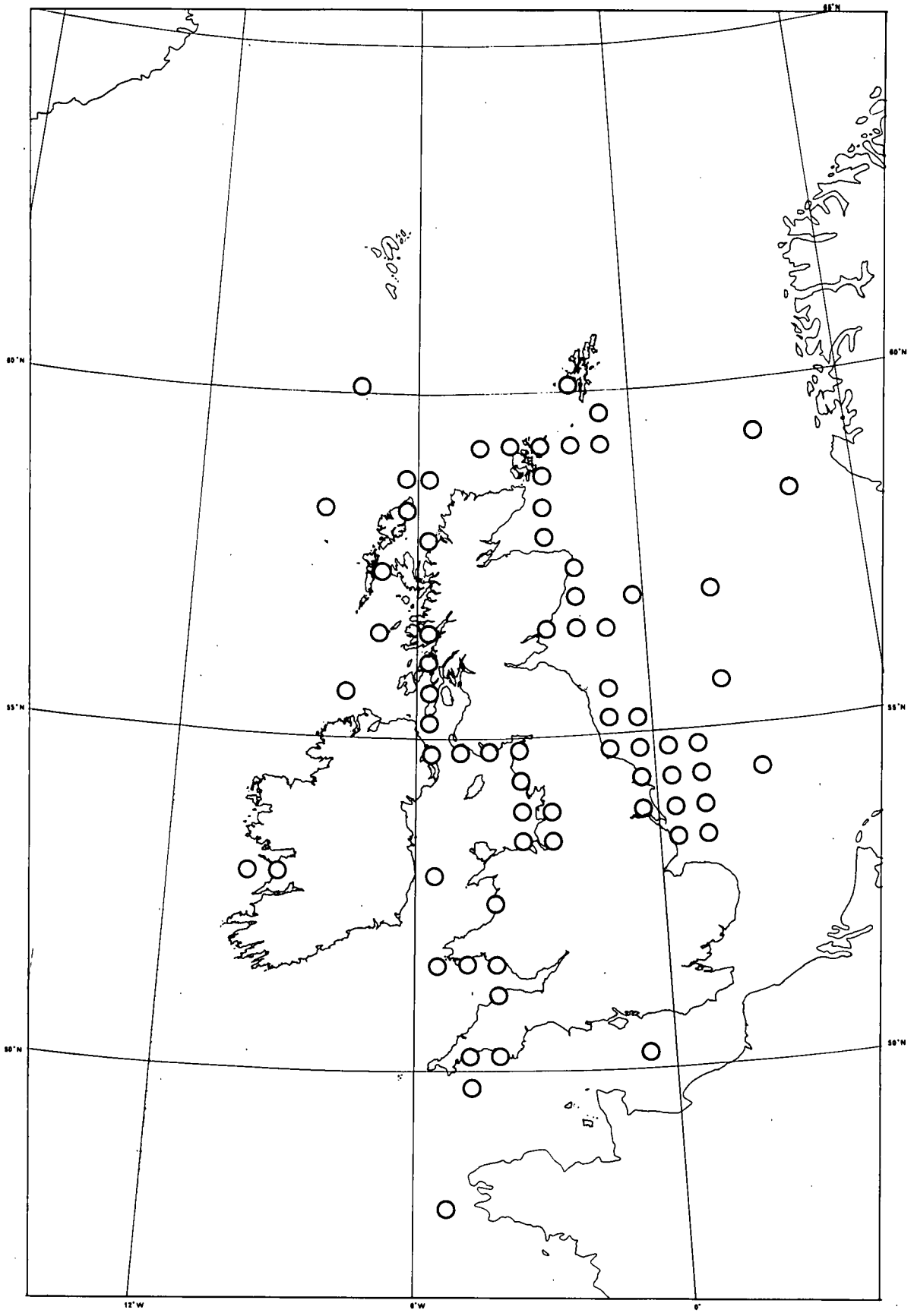
48. *Gonyaulax polygramma* Stein



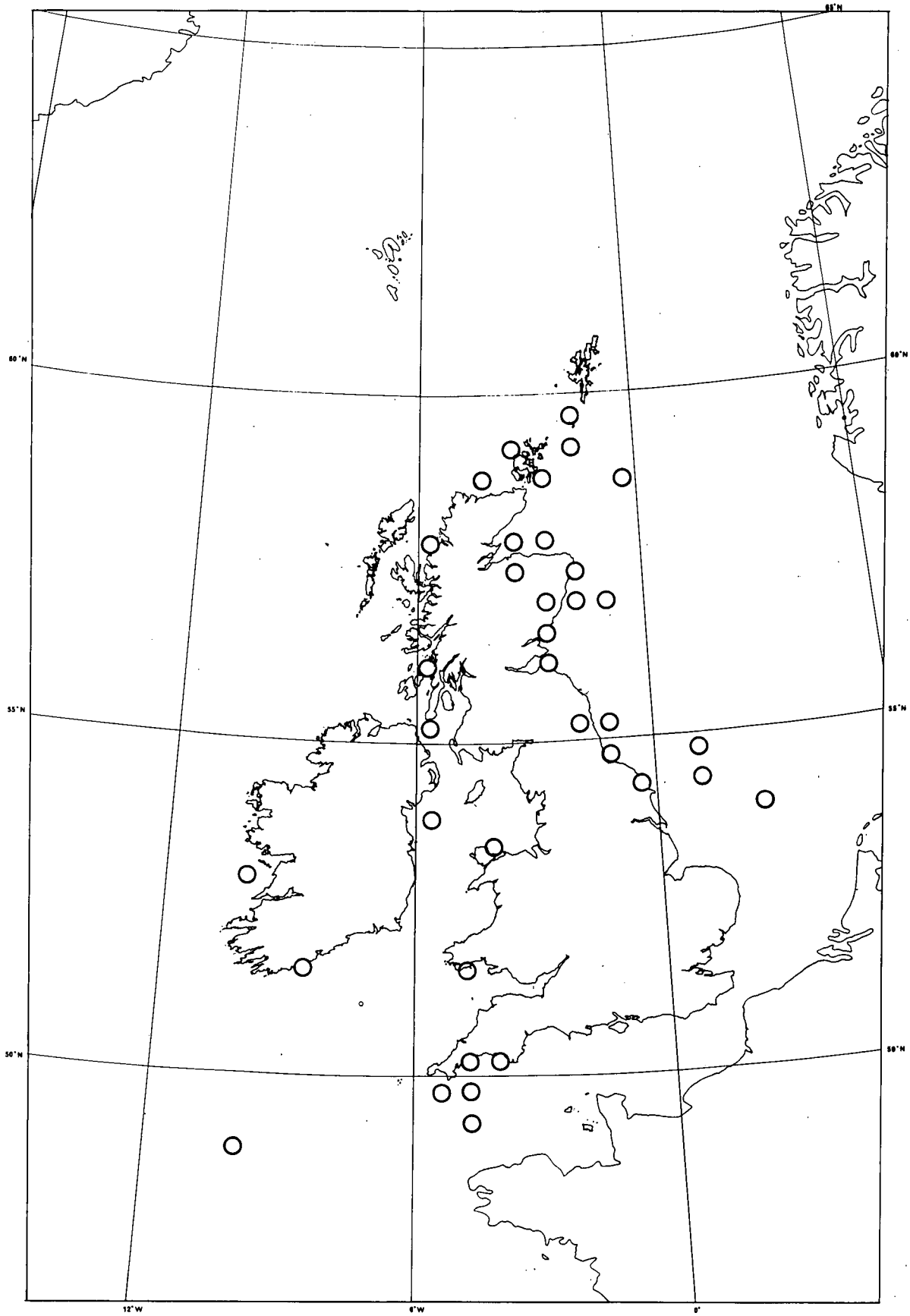
49. *Gonyaulax scrippsae* Kof.



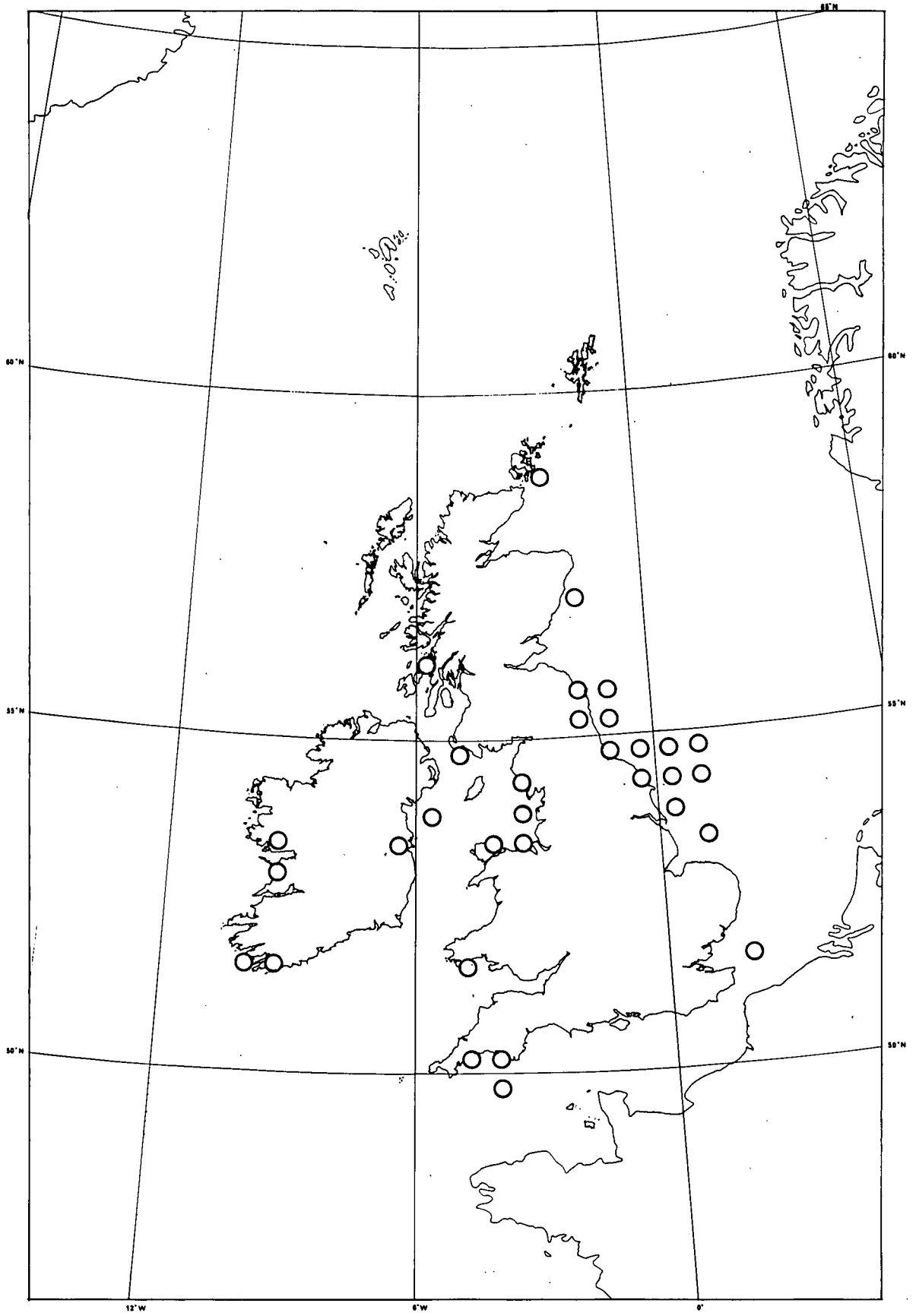
50. *Gonyaulax spinifera* (Clap. & Lachm.) Dies.



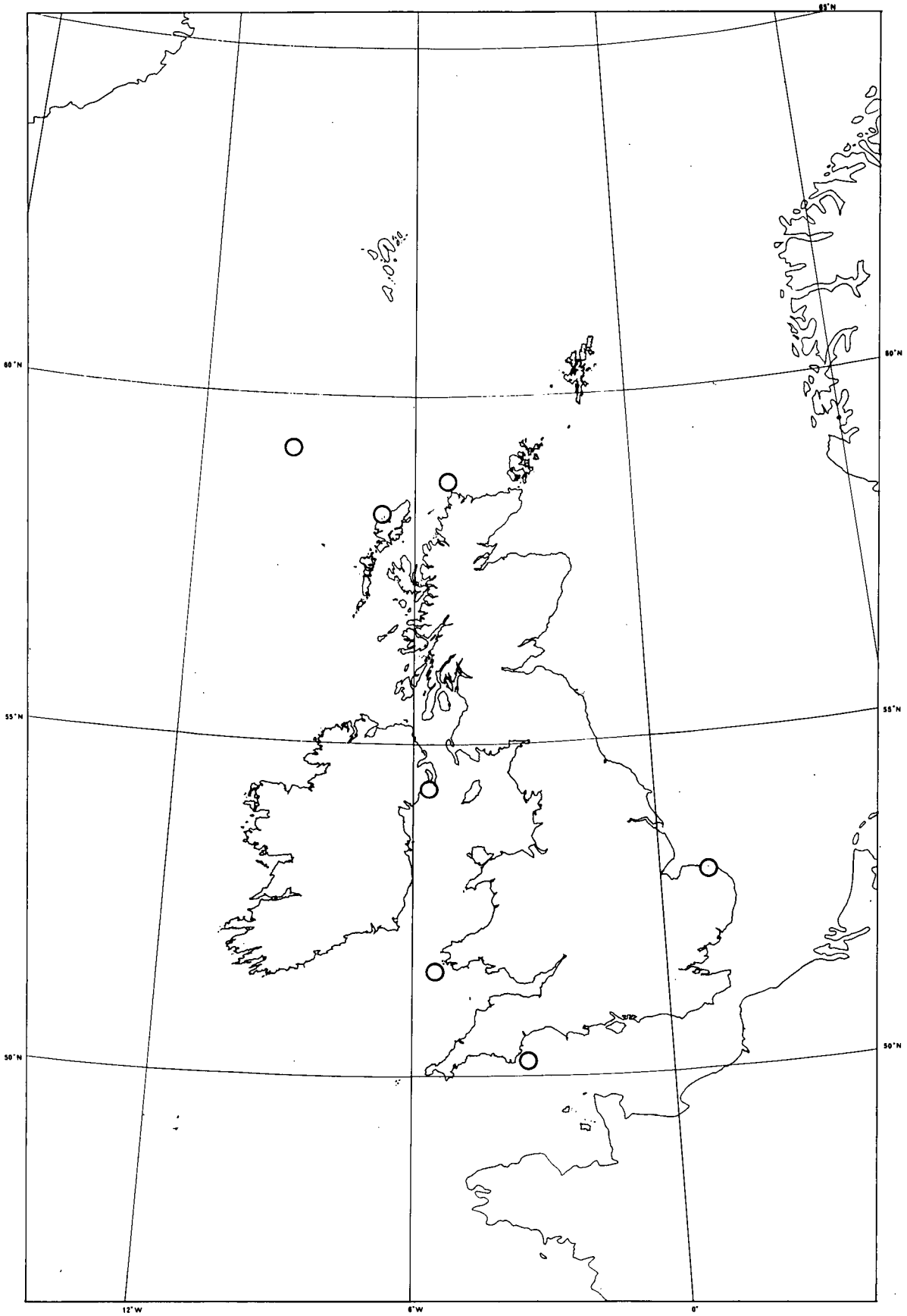
51. *Gonyaulax tamarensis* Lebour



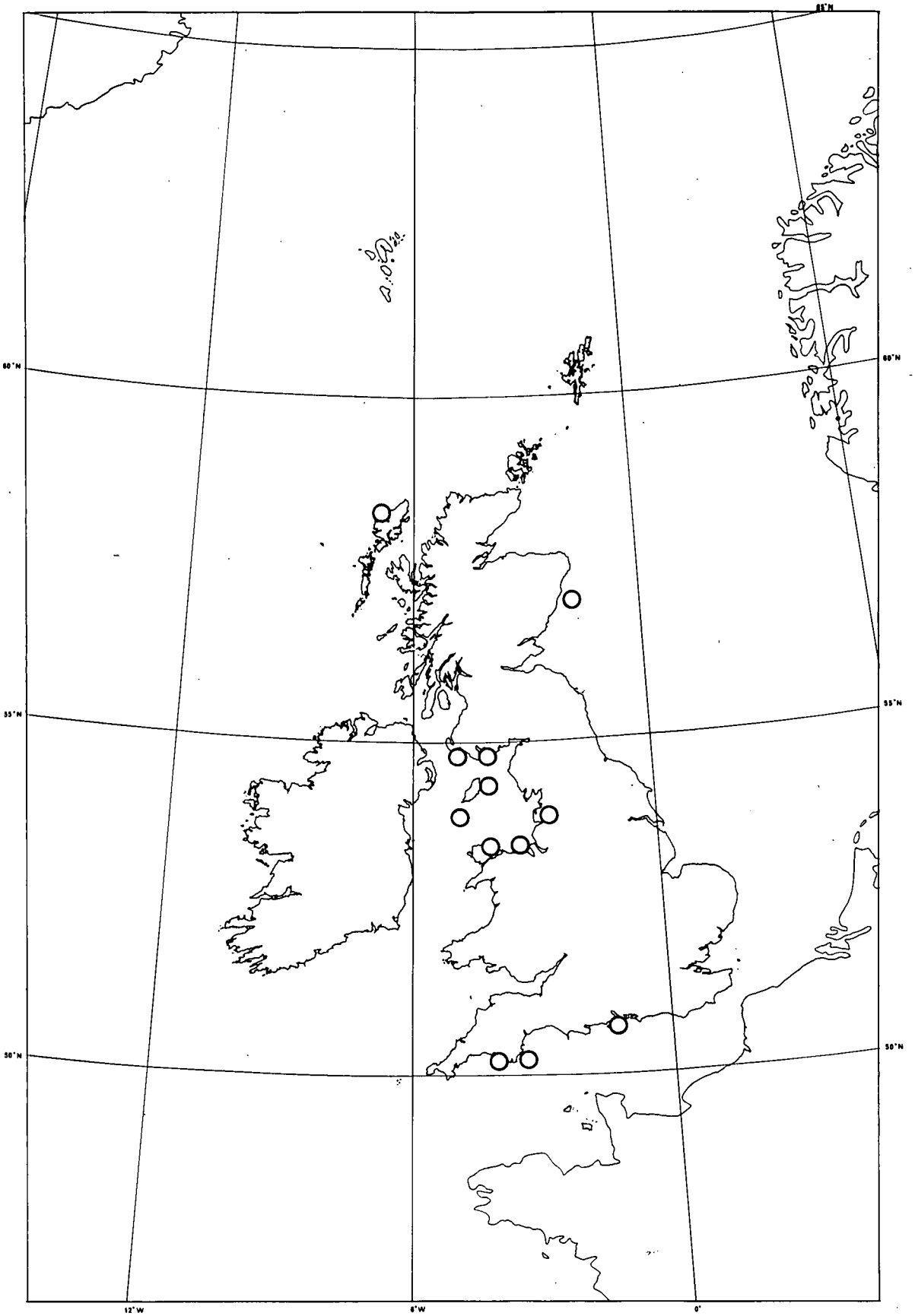
52. *Gonyaulax triacantha* Jorg.



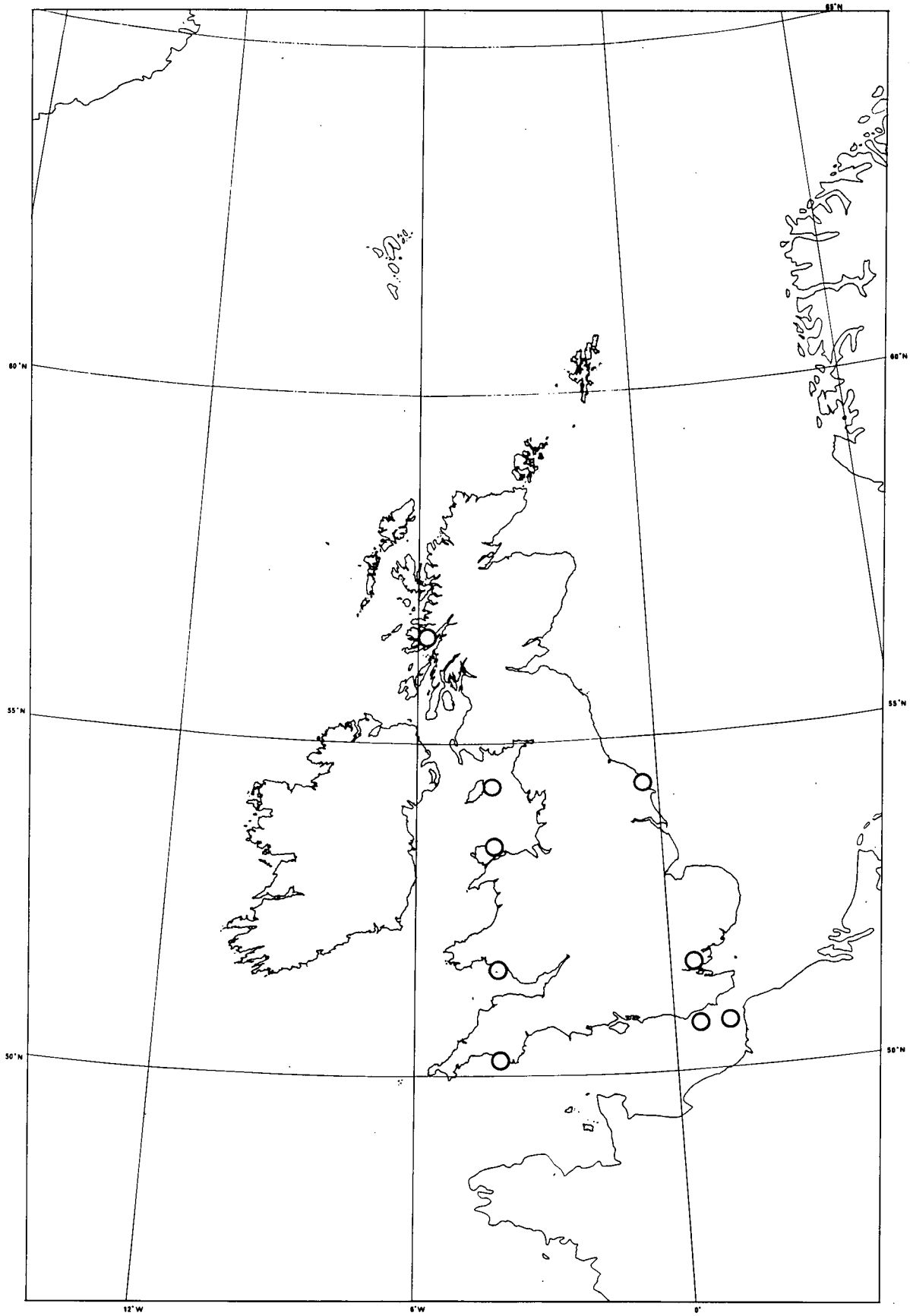
53. *Gonyaulax verior* Sournia



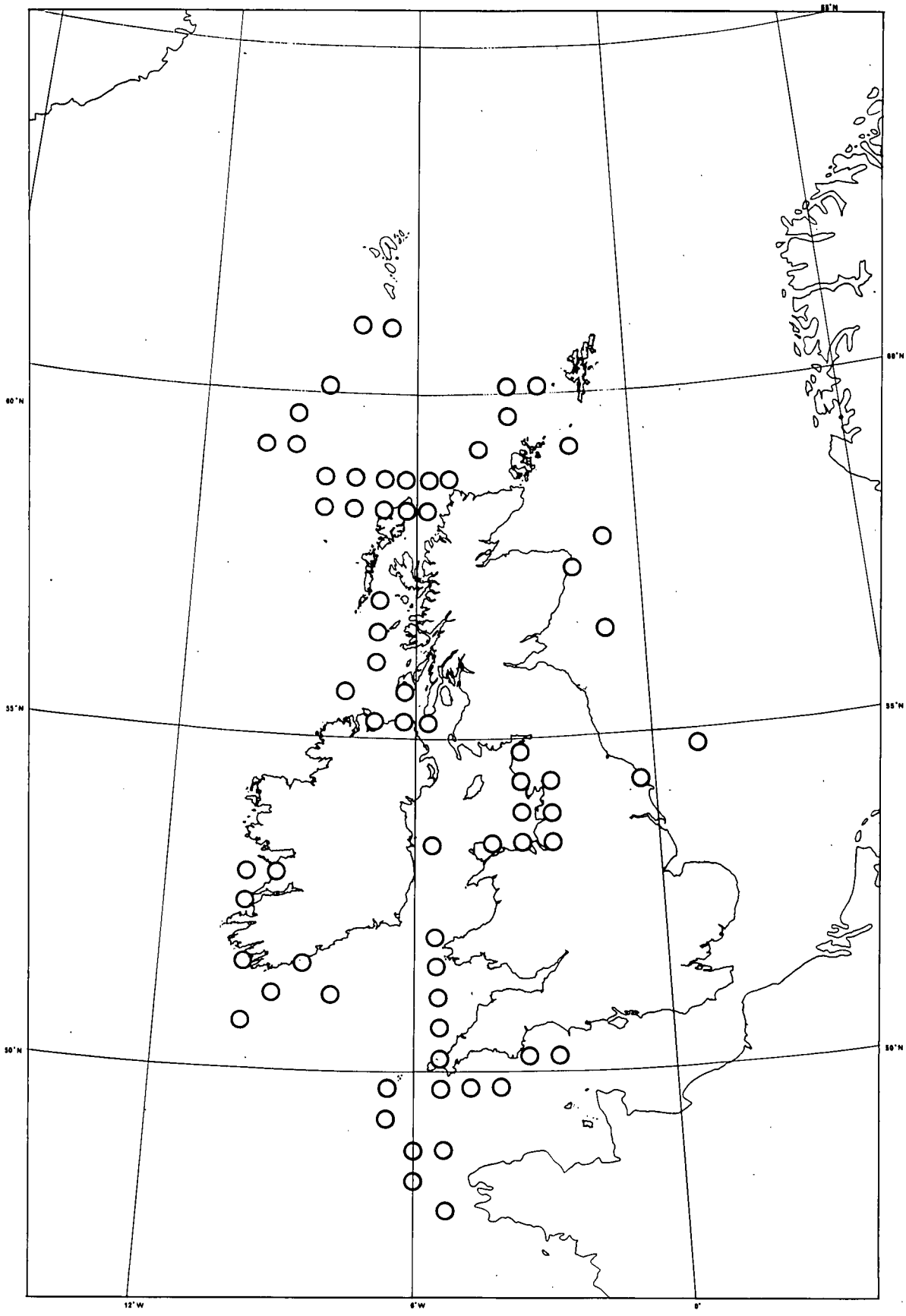
54. *Gymnodinium filum* Lebour



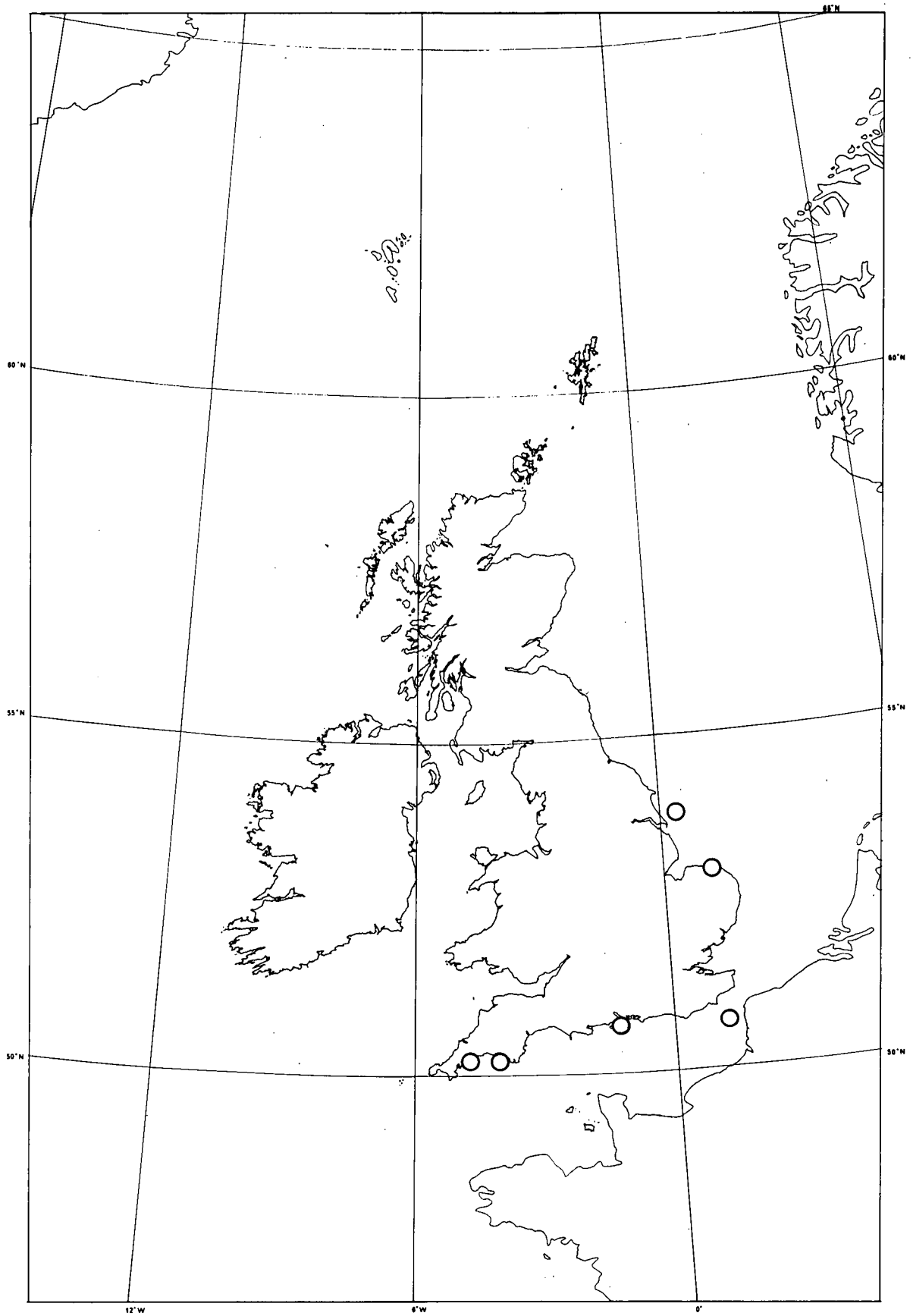
55. *Gymnodinium splendens* Lebour



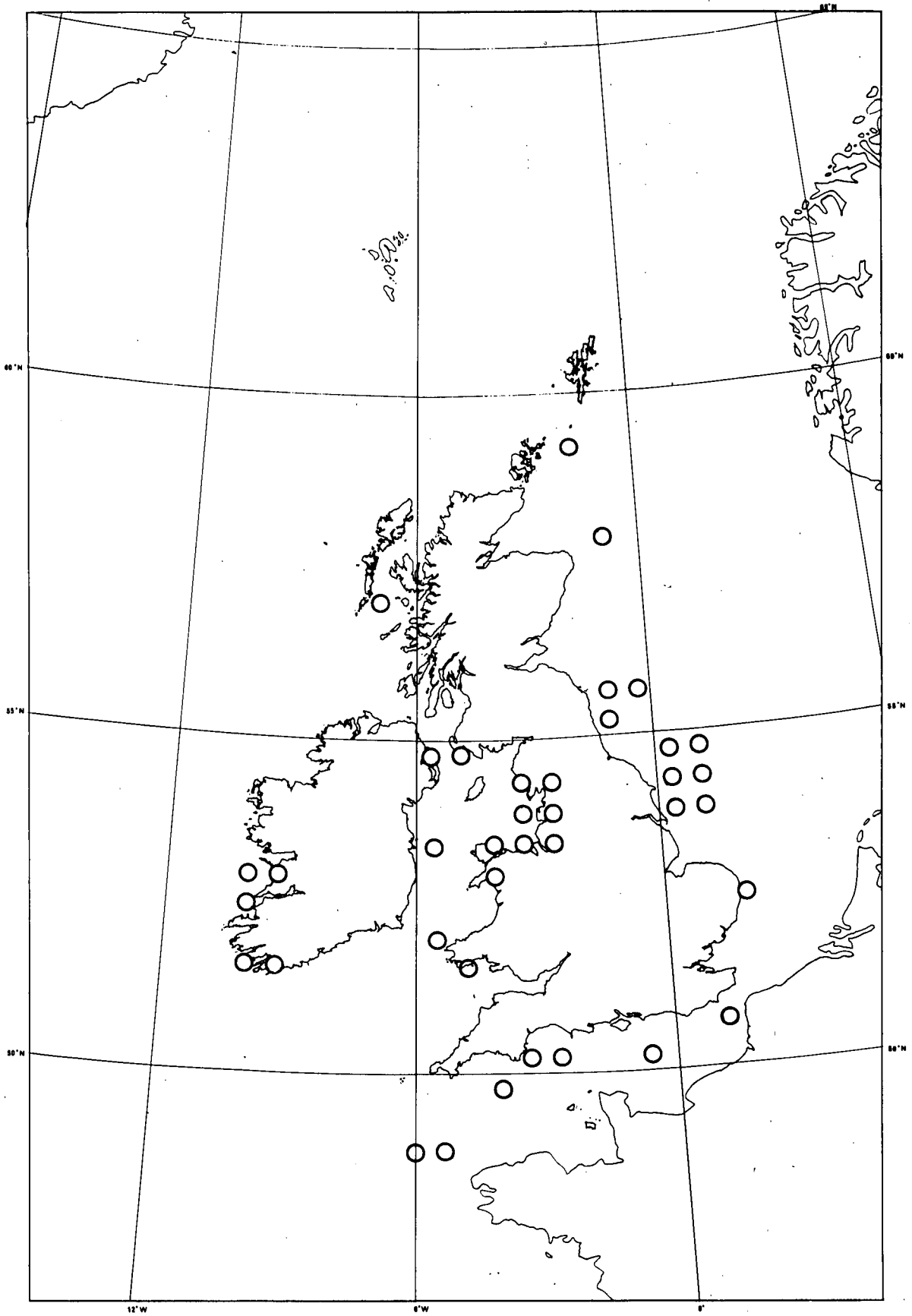
56. *Gymnodinium variabile* C. Herdm.



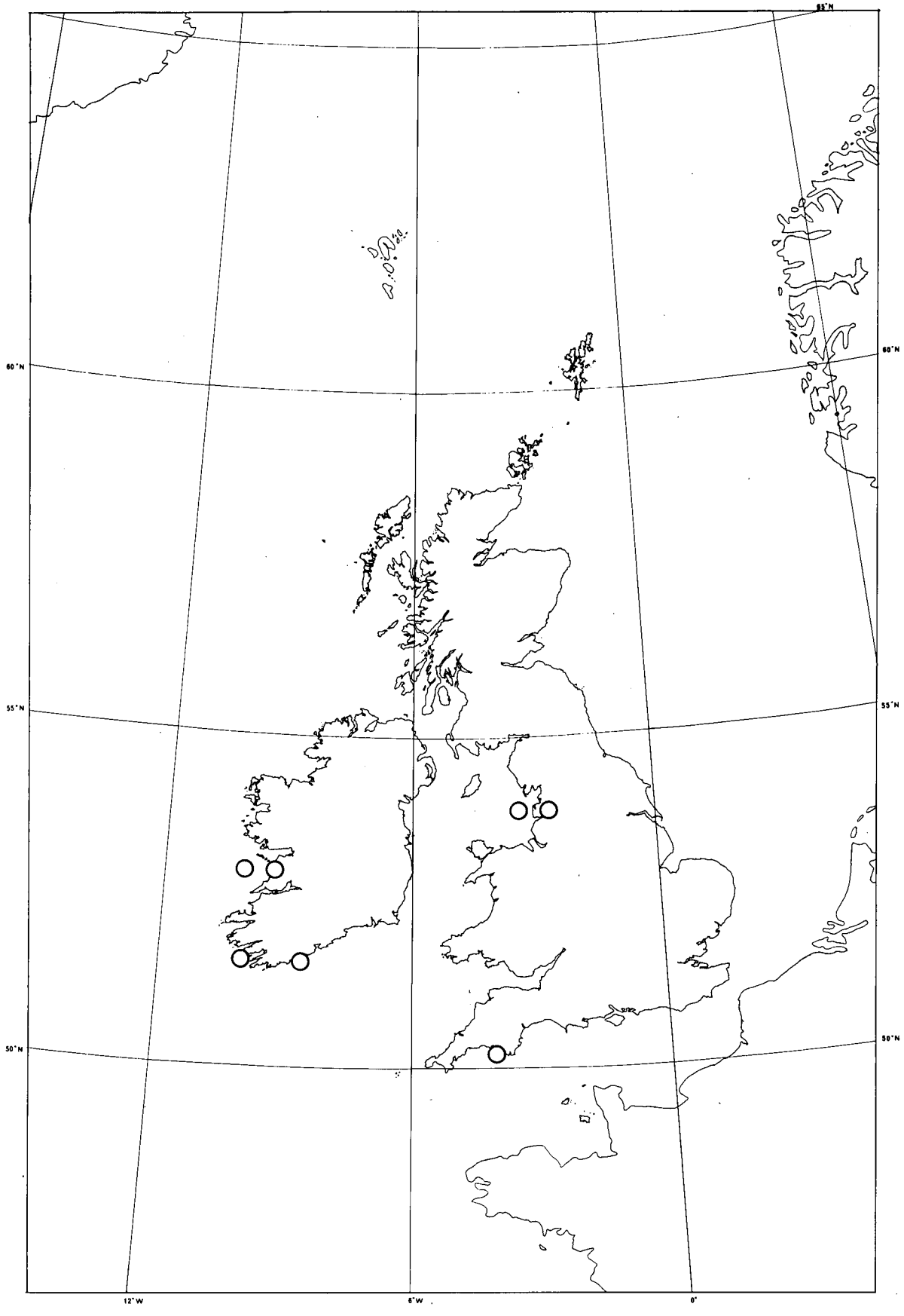
57. *Gyrodinium aureolum* Hulburt



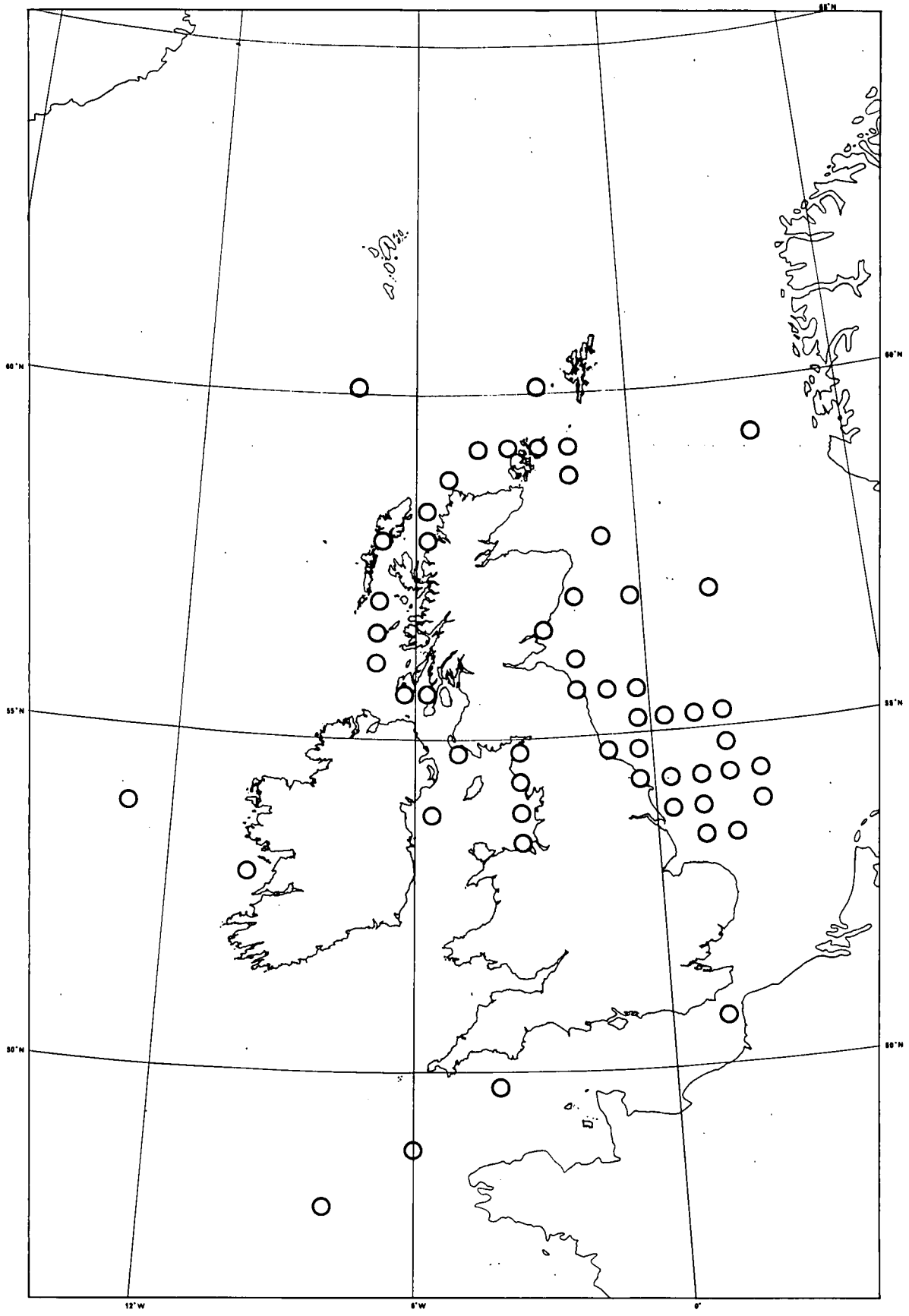
58. *Gyrodinium fissum* (Lev.) Kof. & Swezy



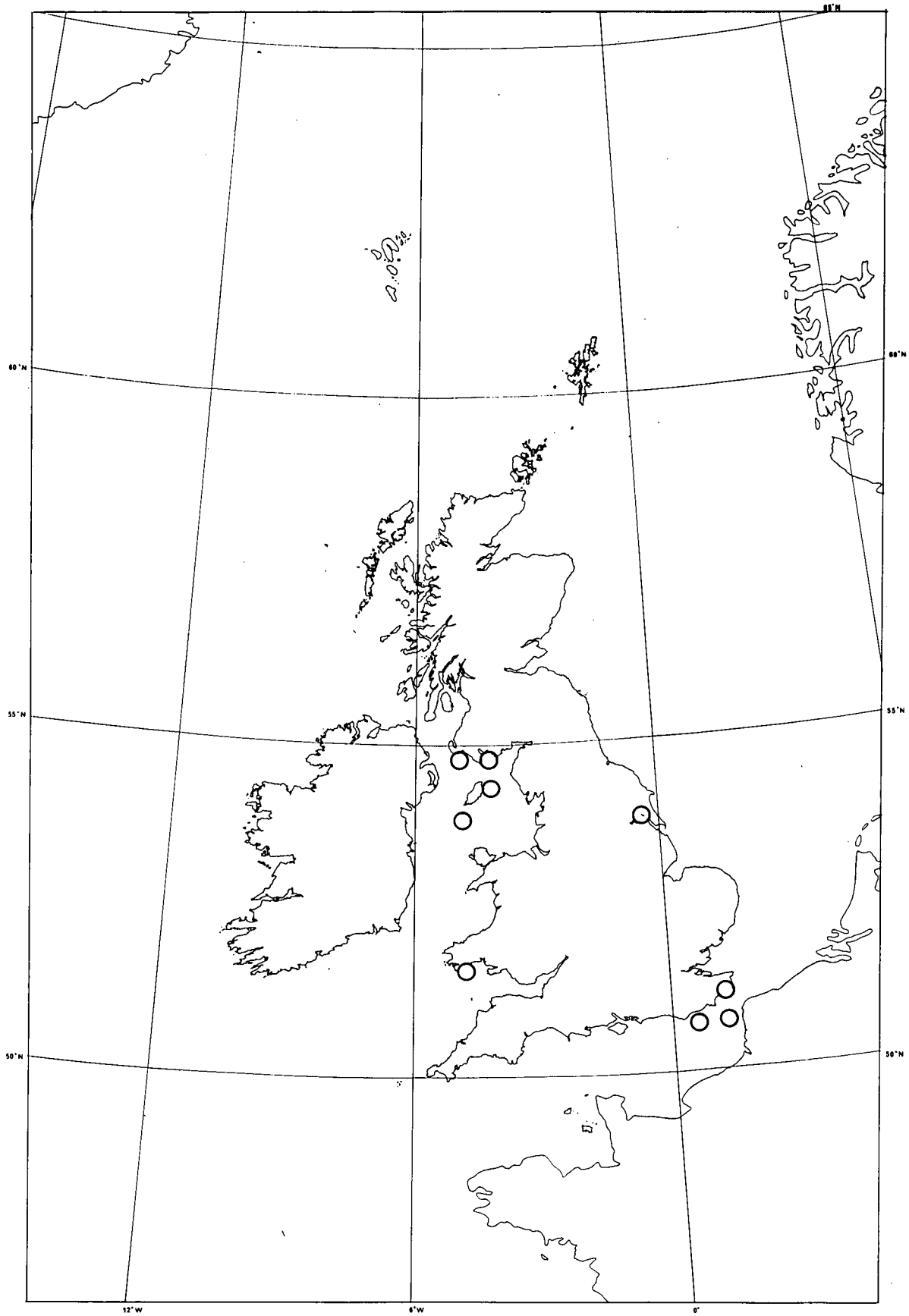
59. *Gyrodinium fusiforme* Kof. & Swezy



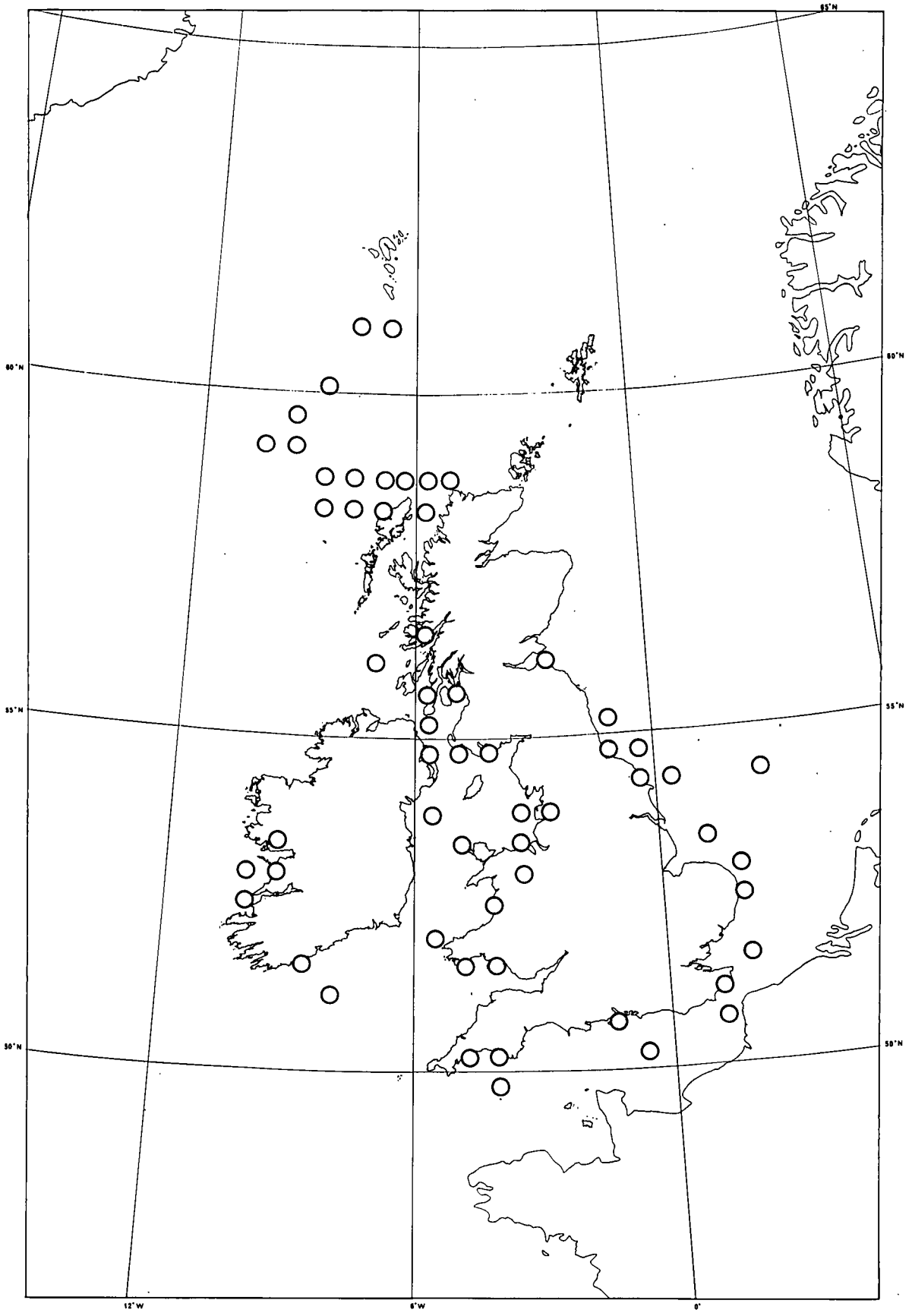
60. *Gyrodinium spirale* (Bergh) Kof. & Swezy



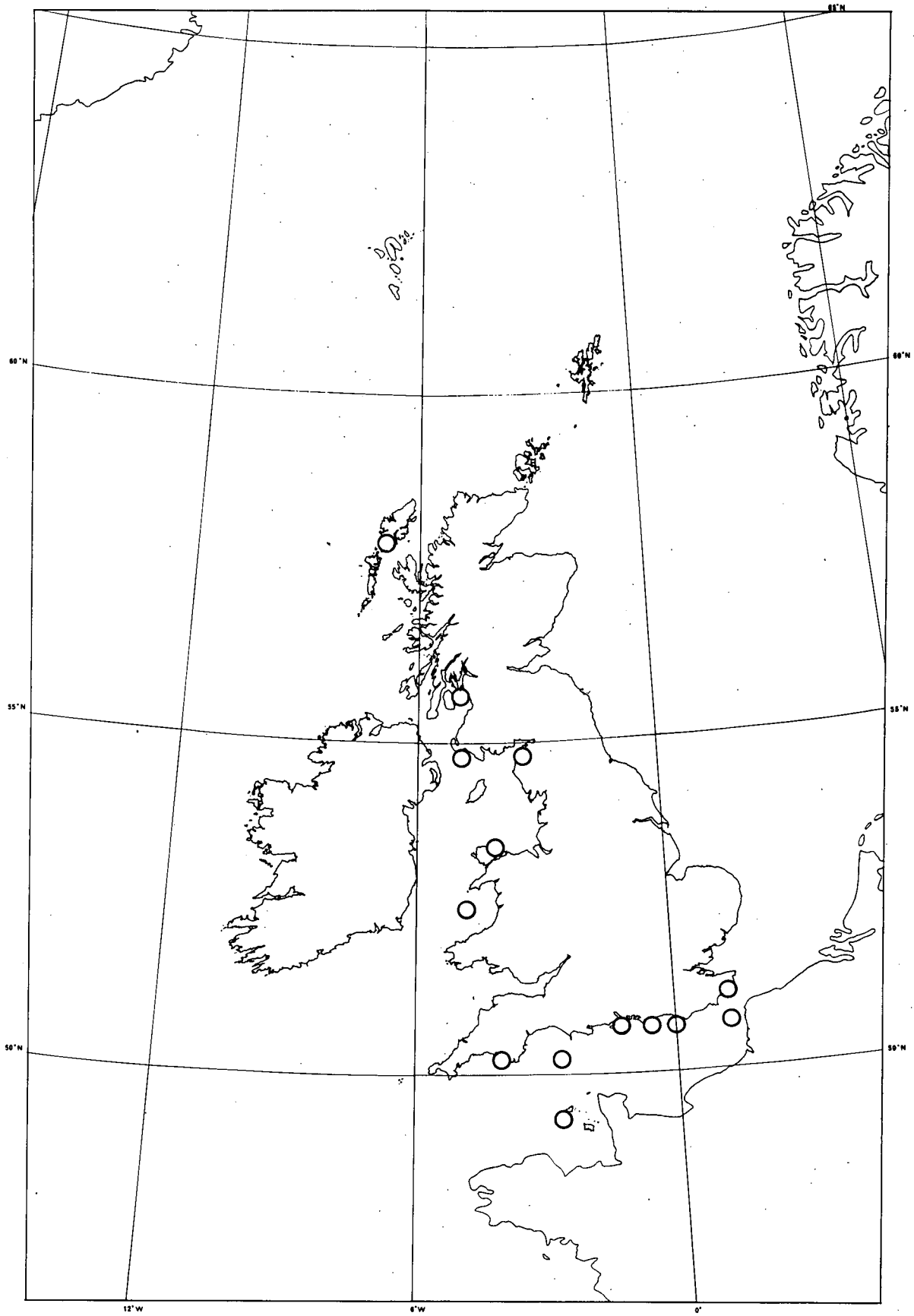
61. *Helgolandinium subglobosum* Stosch



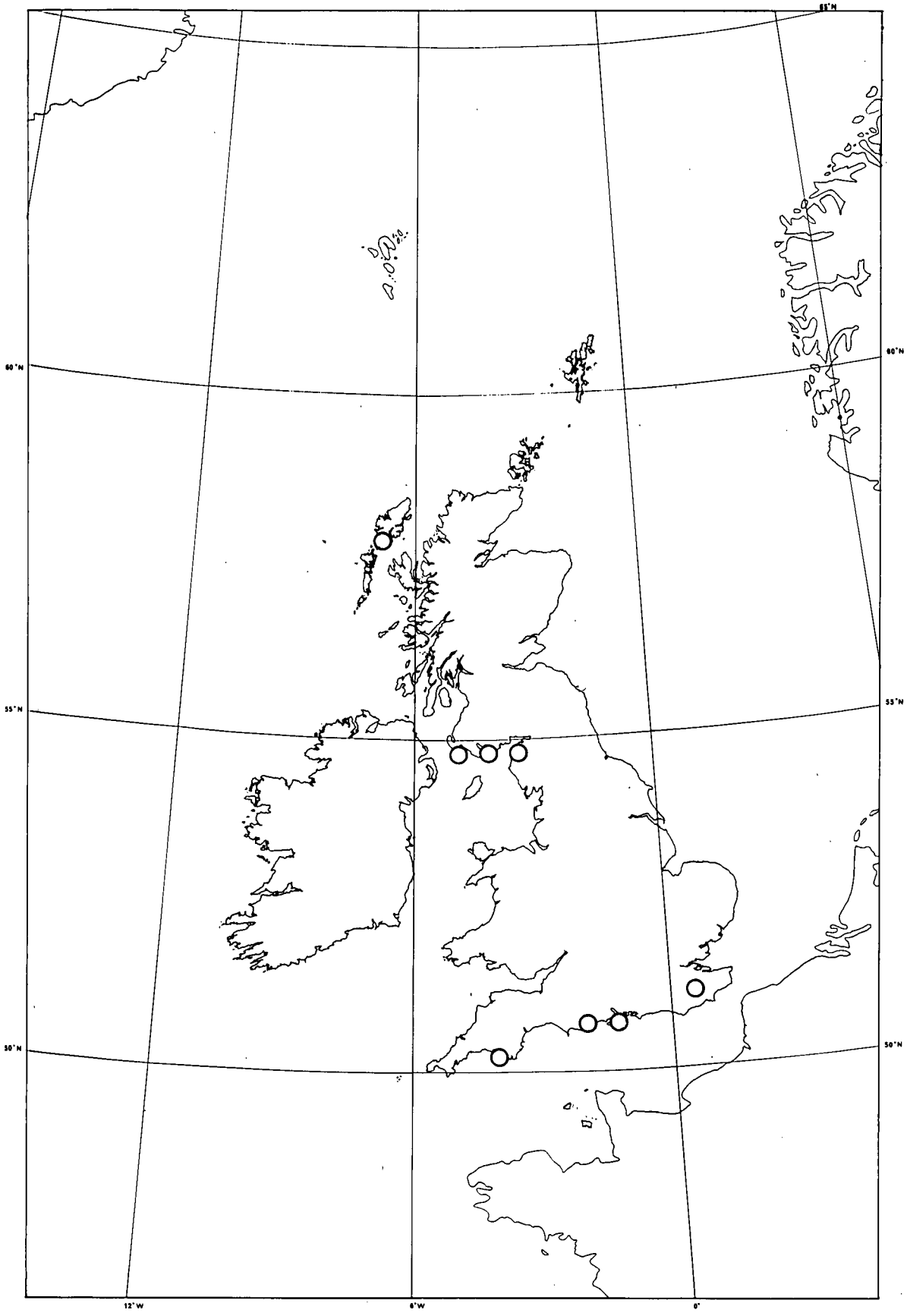
62. *Herdmania litoralis* Dodge



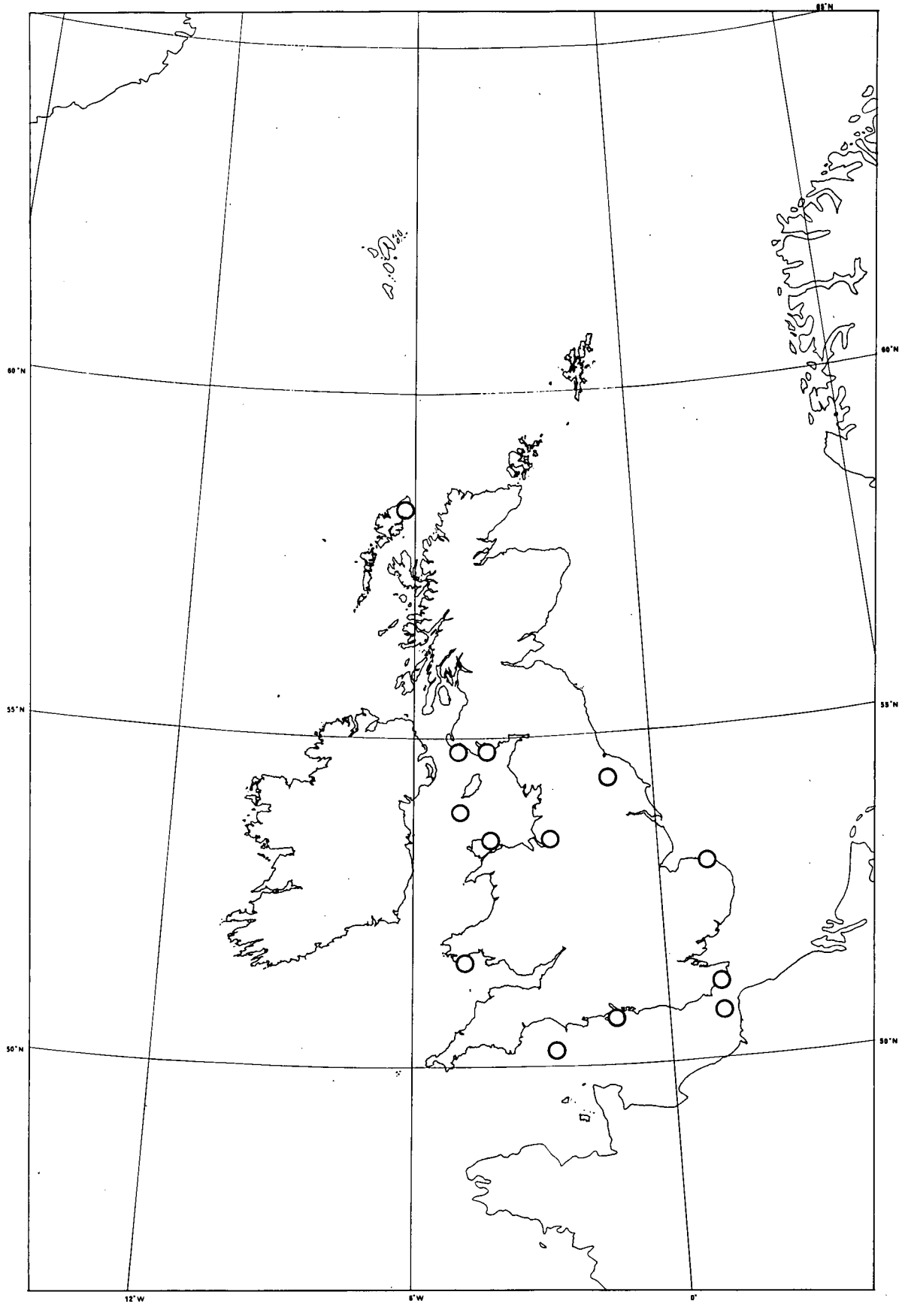
63. *Heterocapsa triquetra* (Ehrenb.) Stein



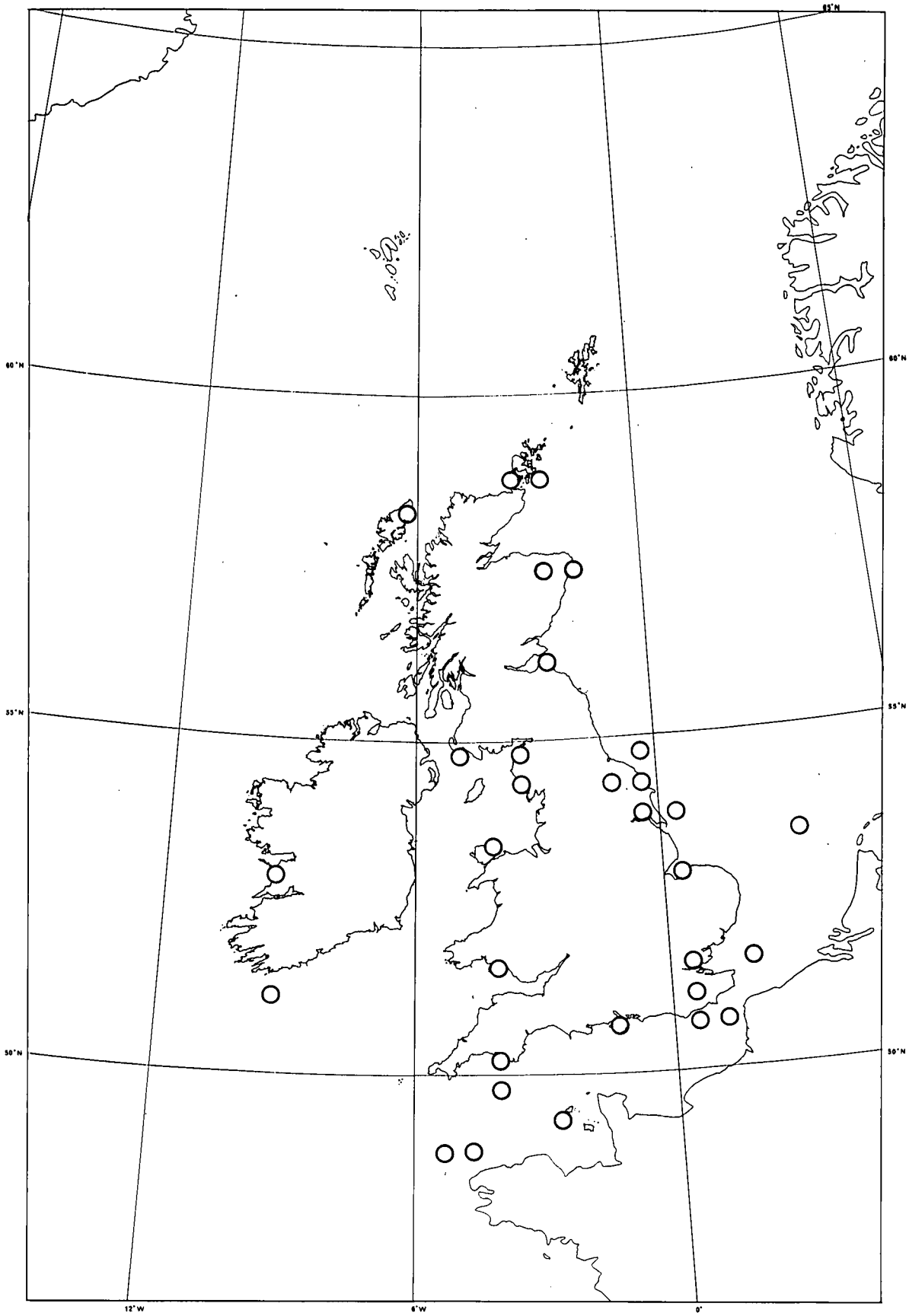
64. *Katodinium assymetricum* (J. Massart) Loeblich



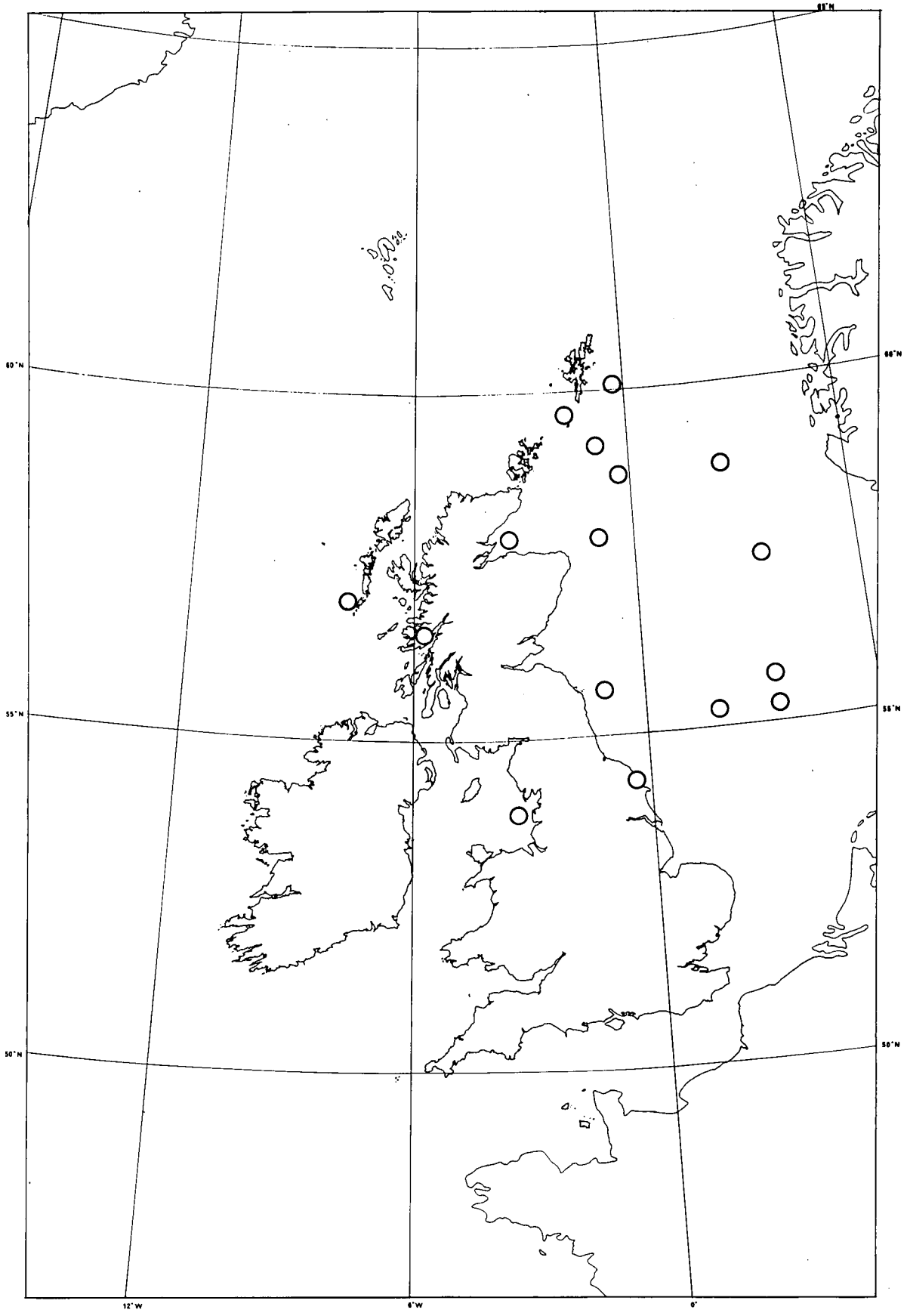
65. *Katodinium fungiforme* (Anisomova) Loeblich



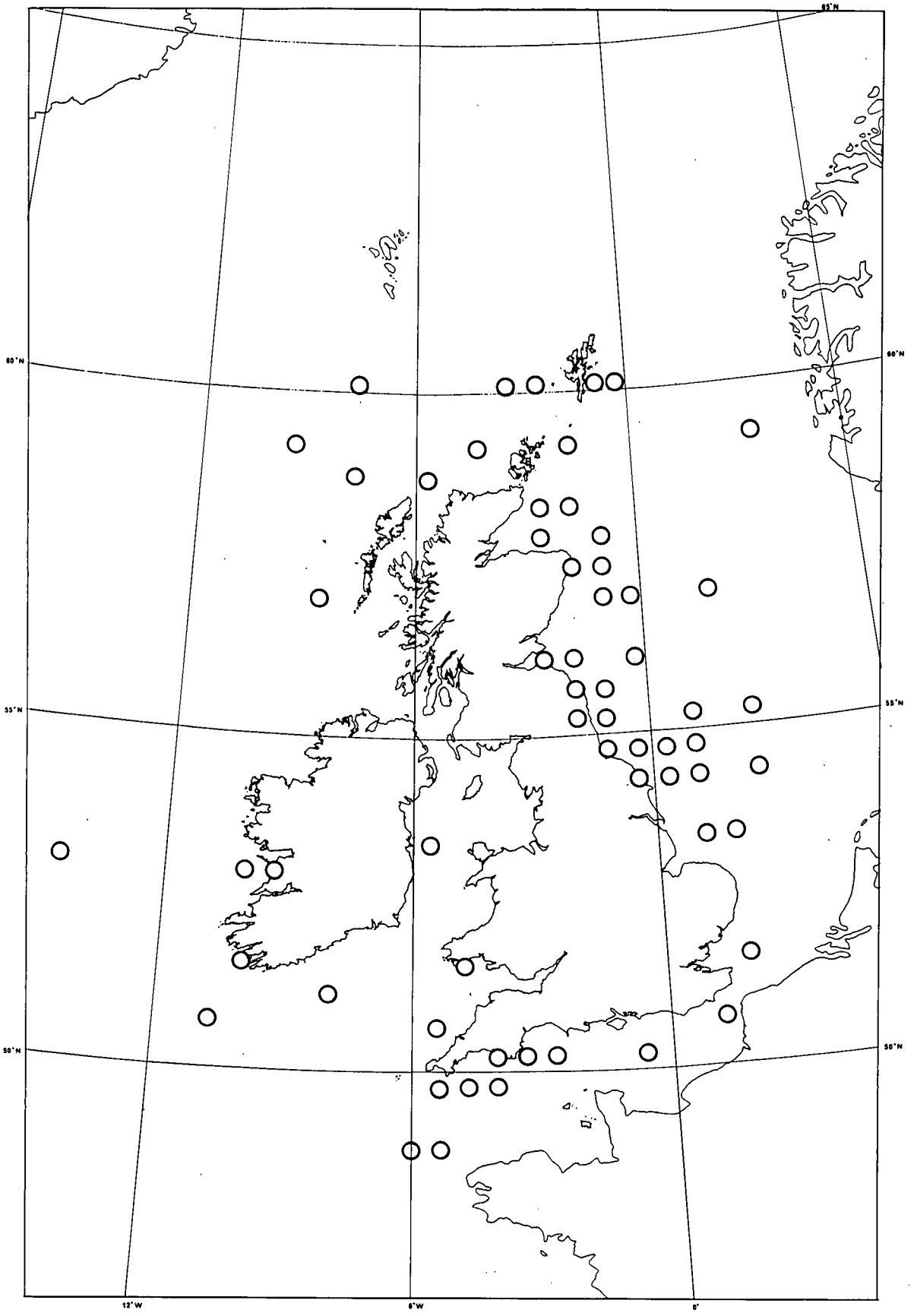
66. *Katodinium glandulum* (C. Herdm.) Loeblich



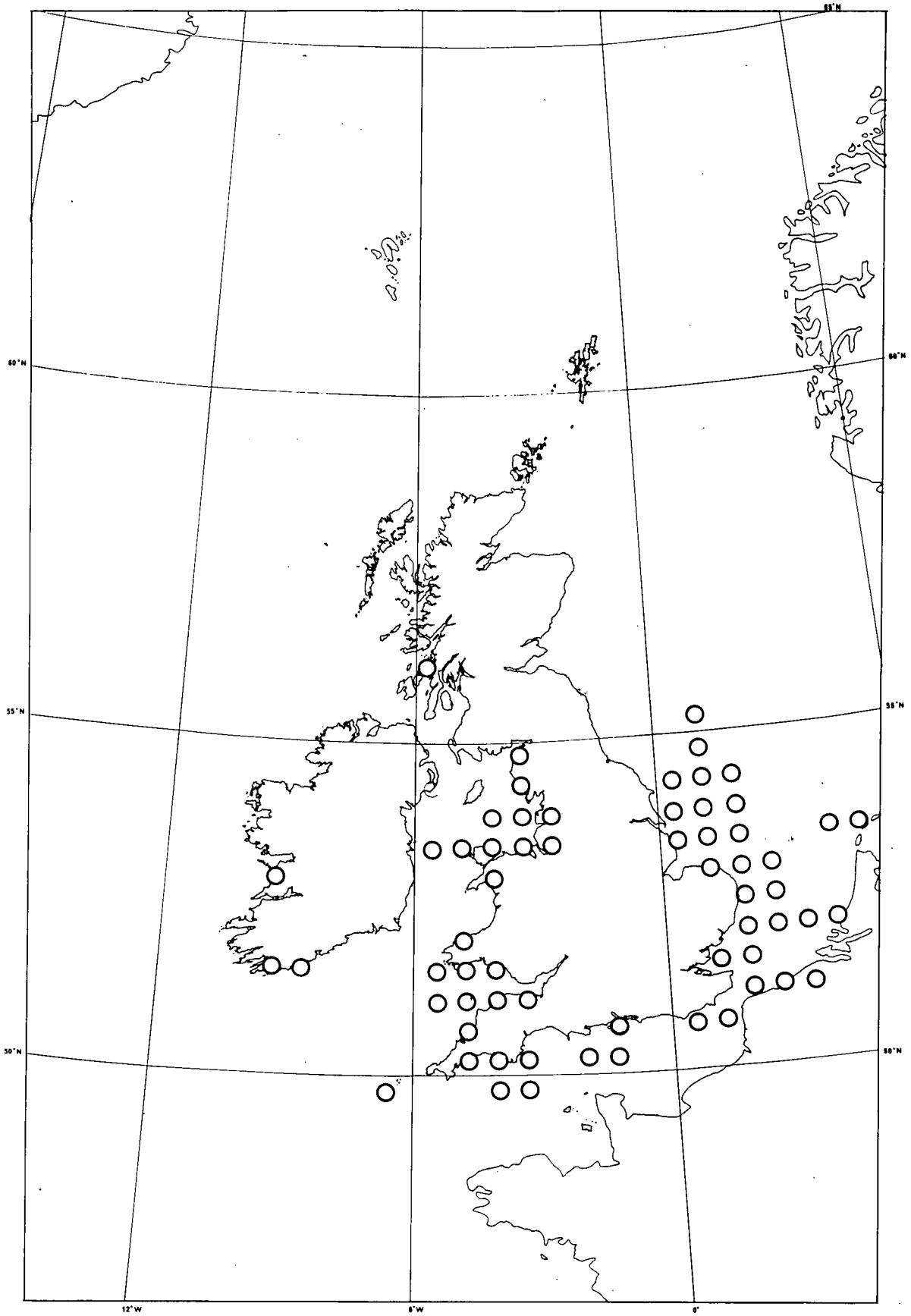
67. *Katodinium rotundatum* (Lohm.) Loeblich



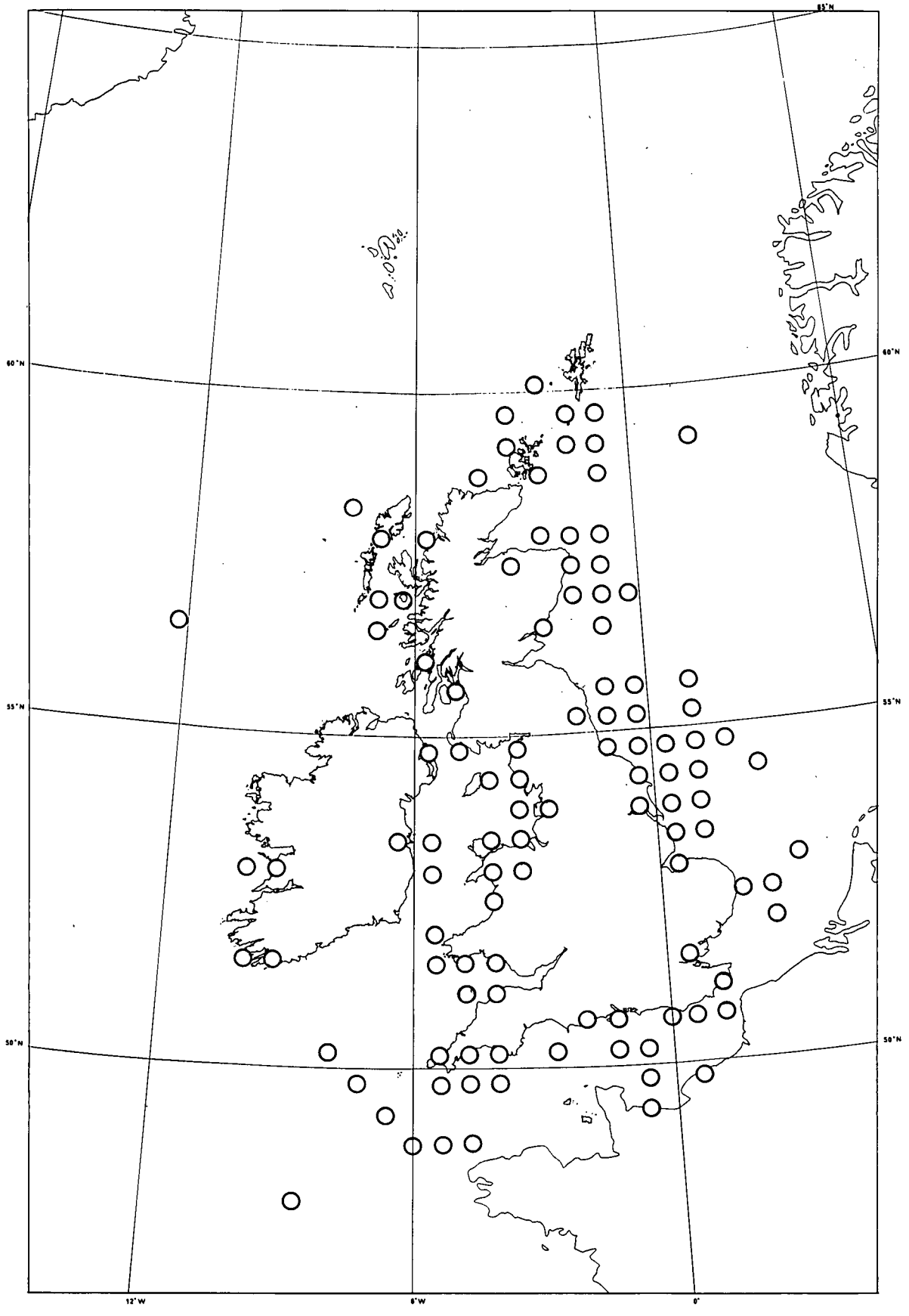
68. *Kofoidinium velleloides* Pav.



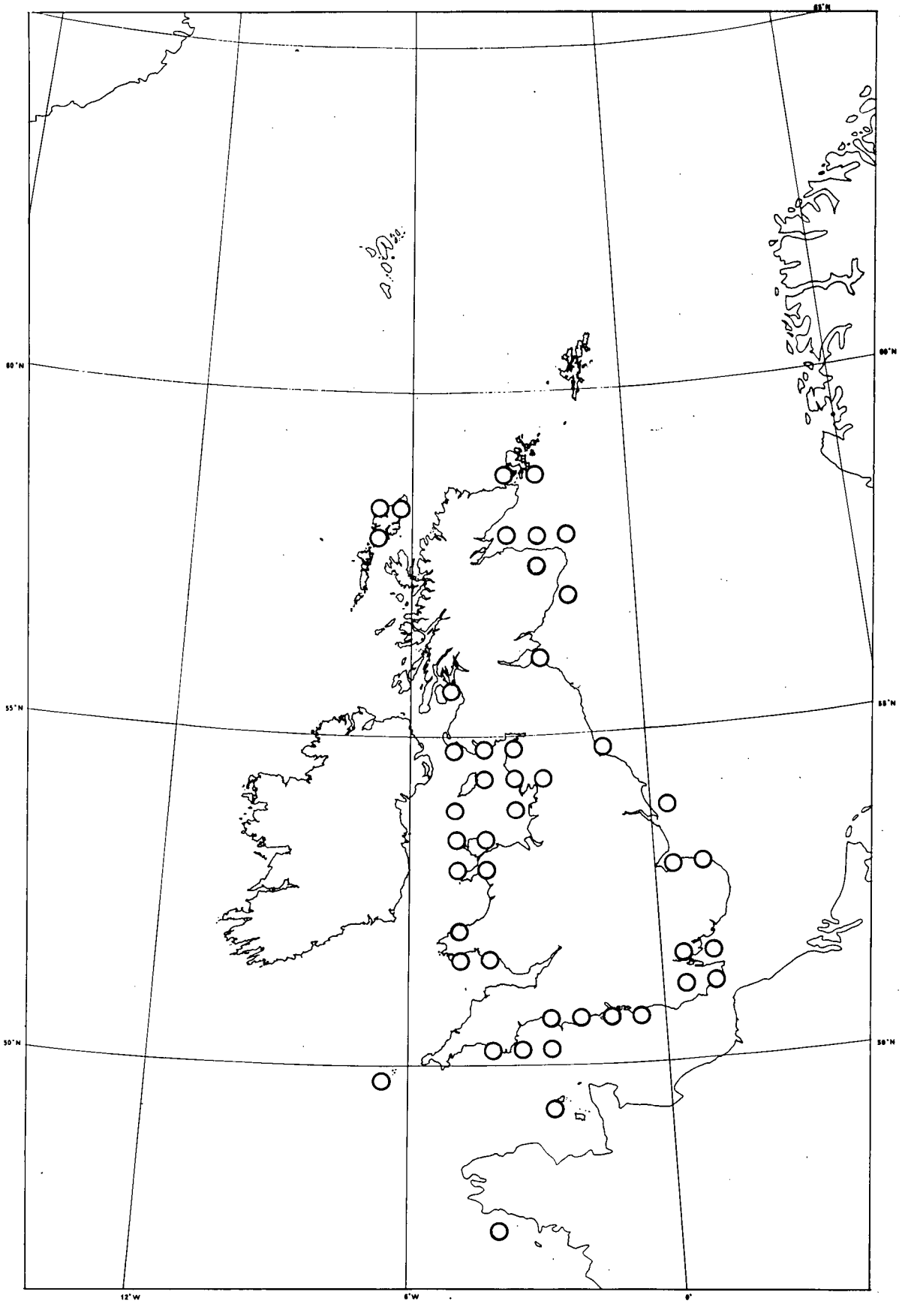
69. *Mesoporus perforatus* (Gran) Lillick



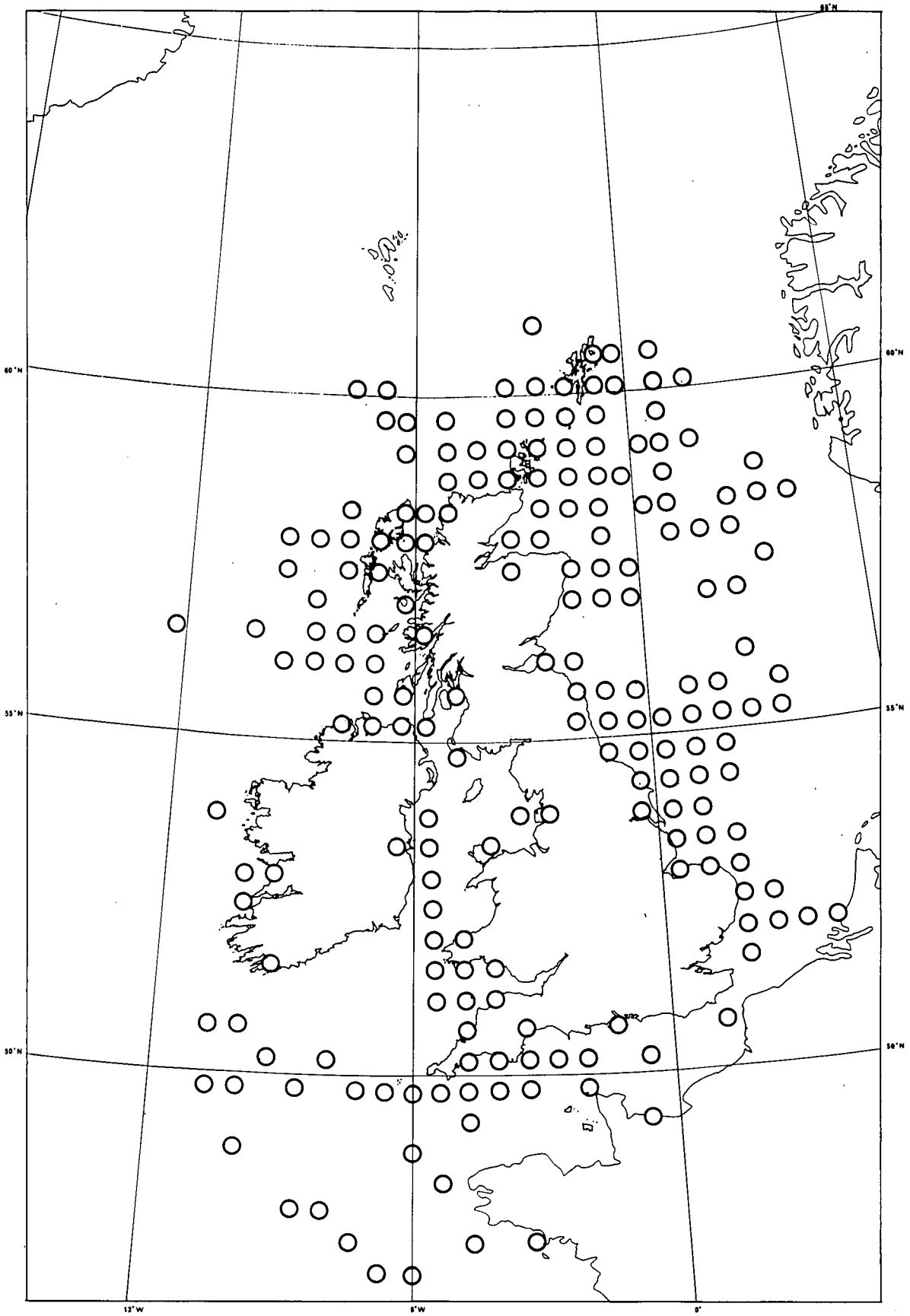
70. *Noctiluca scintillans* (Macartney) Ehrenb.



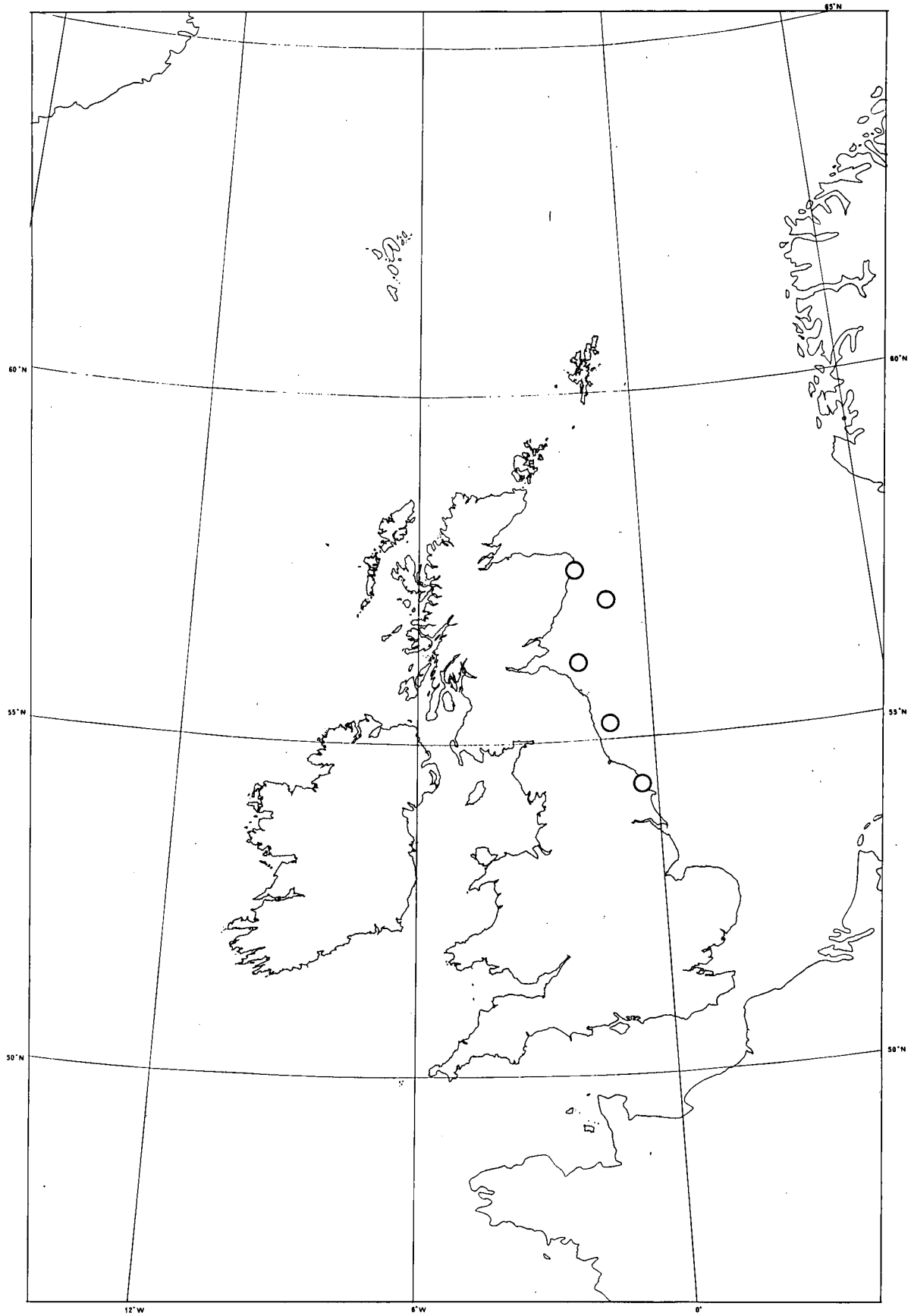
71. *Oblea rotunda* (Lebour) Balech ex Sournia



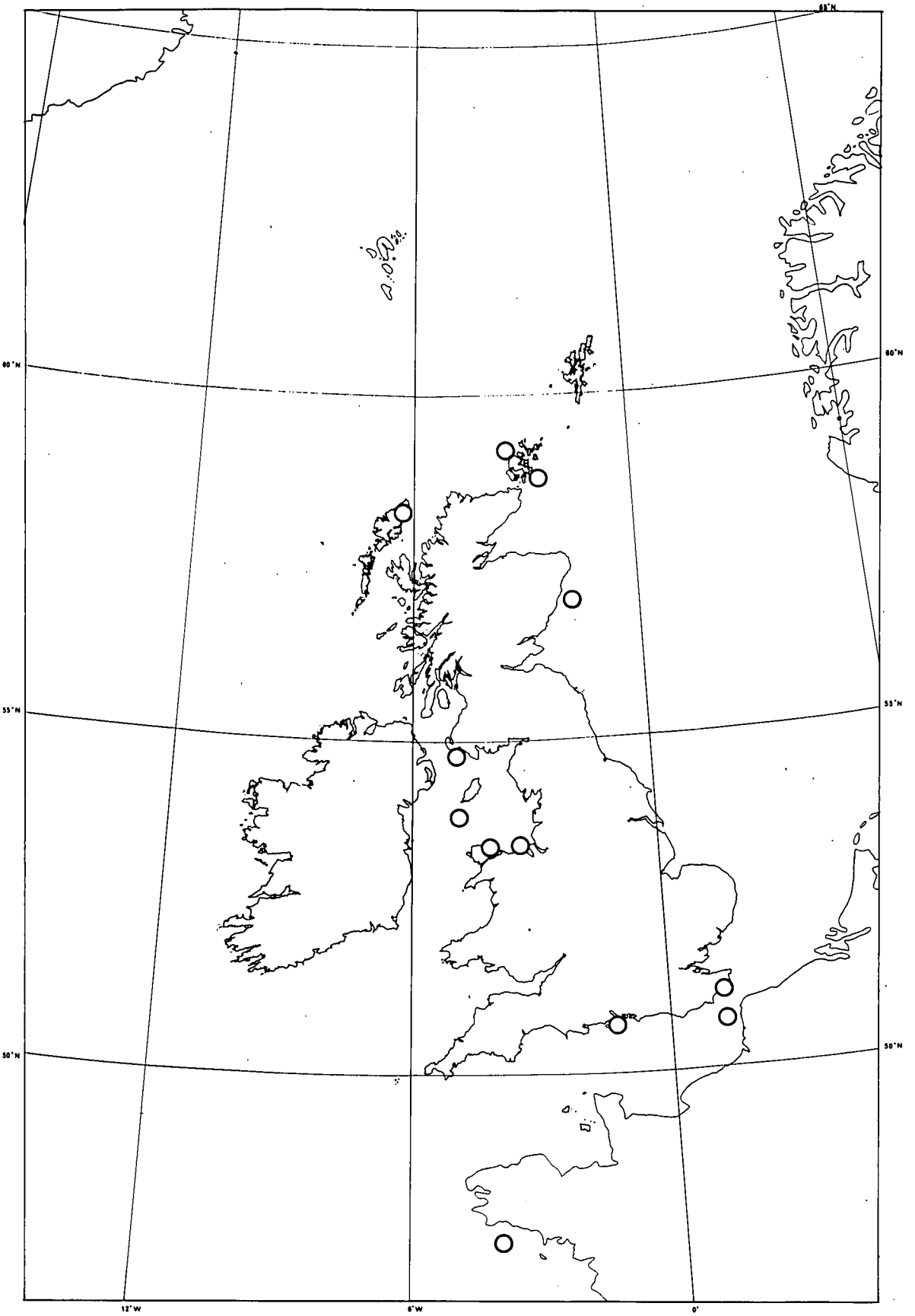
72. *Oxyrrhis marina* Dujard



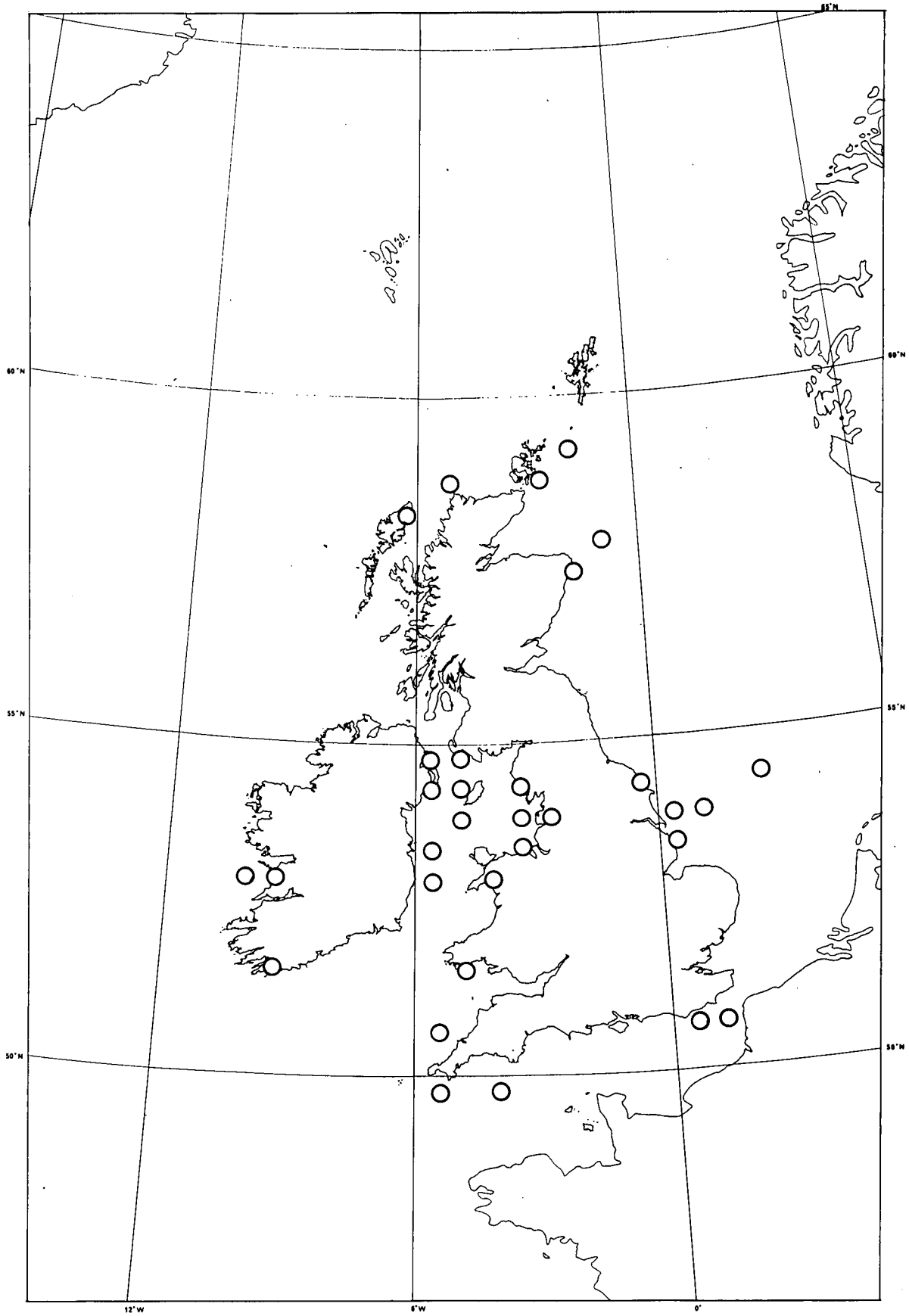
73. *Peridiniopsis (Dissodium) assymetrica* Mangin



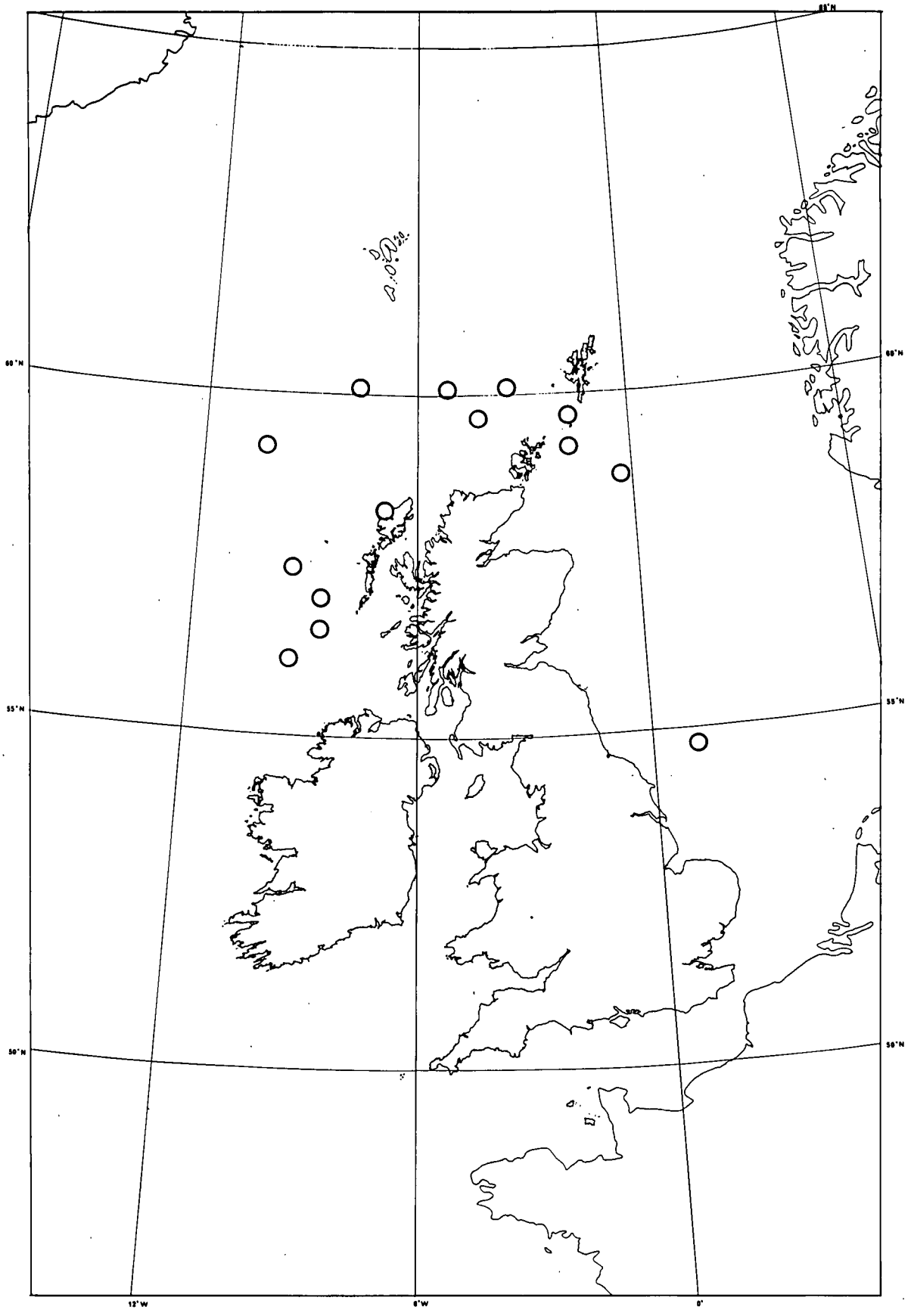
74. *Peridiniopsis (Dissodium) excentrica* (Nie) Taylor



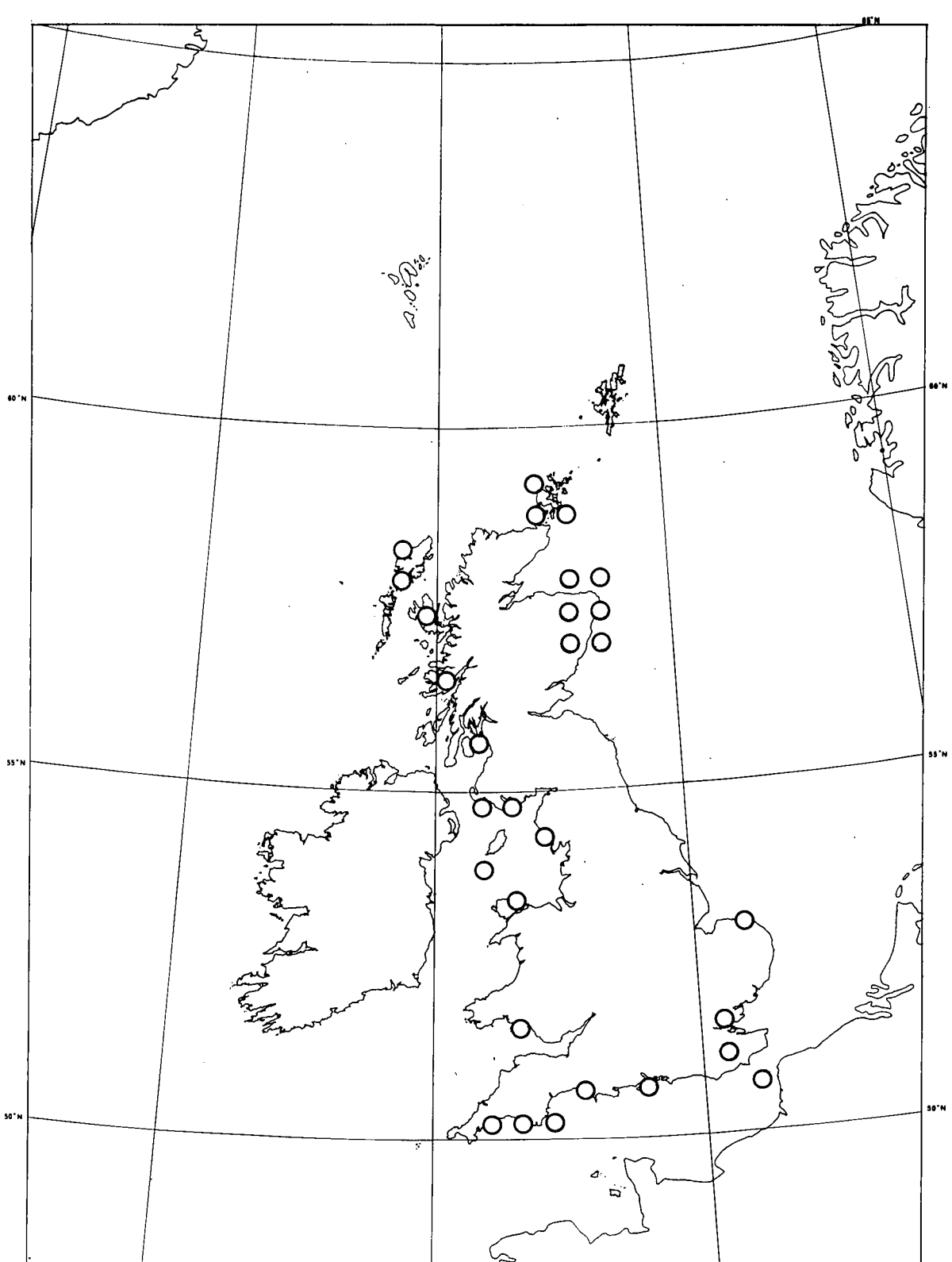
75. *Polykrikos lebourae* C. Herdm.



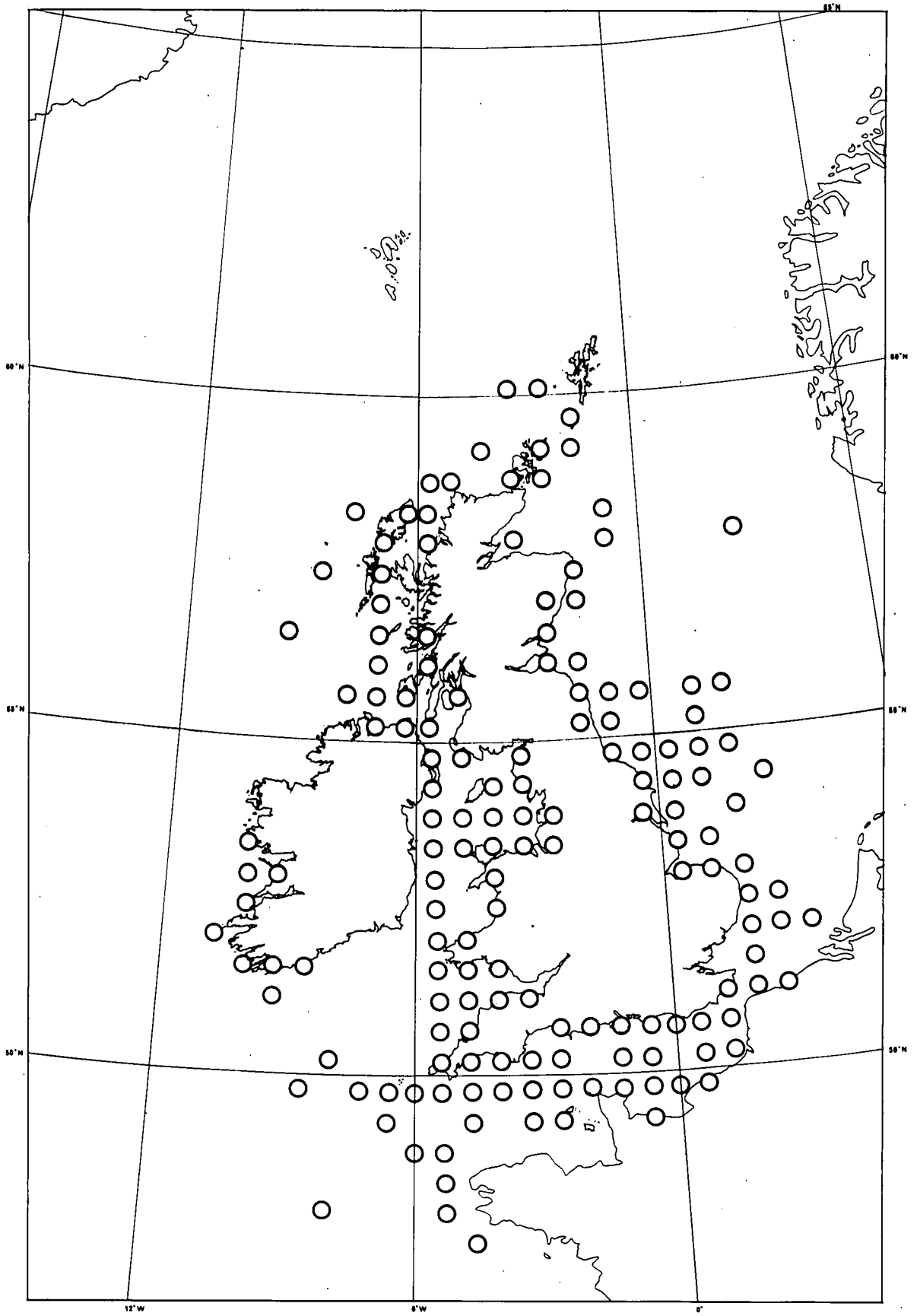
76. *Polykrikos schwartzii* Butschli



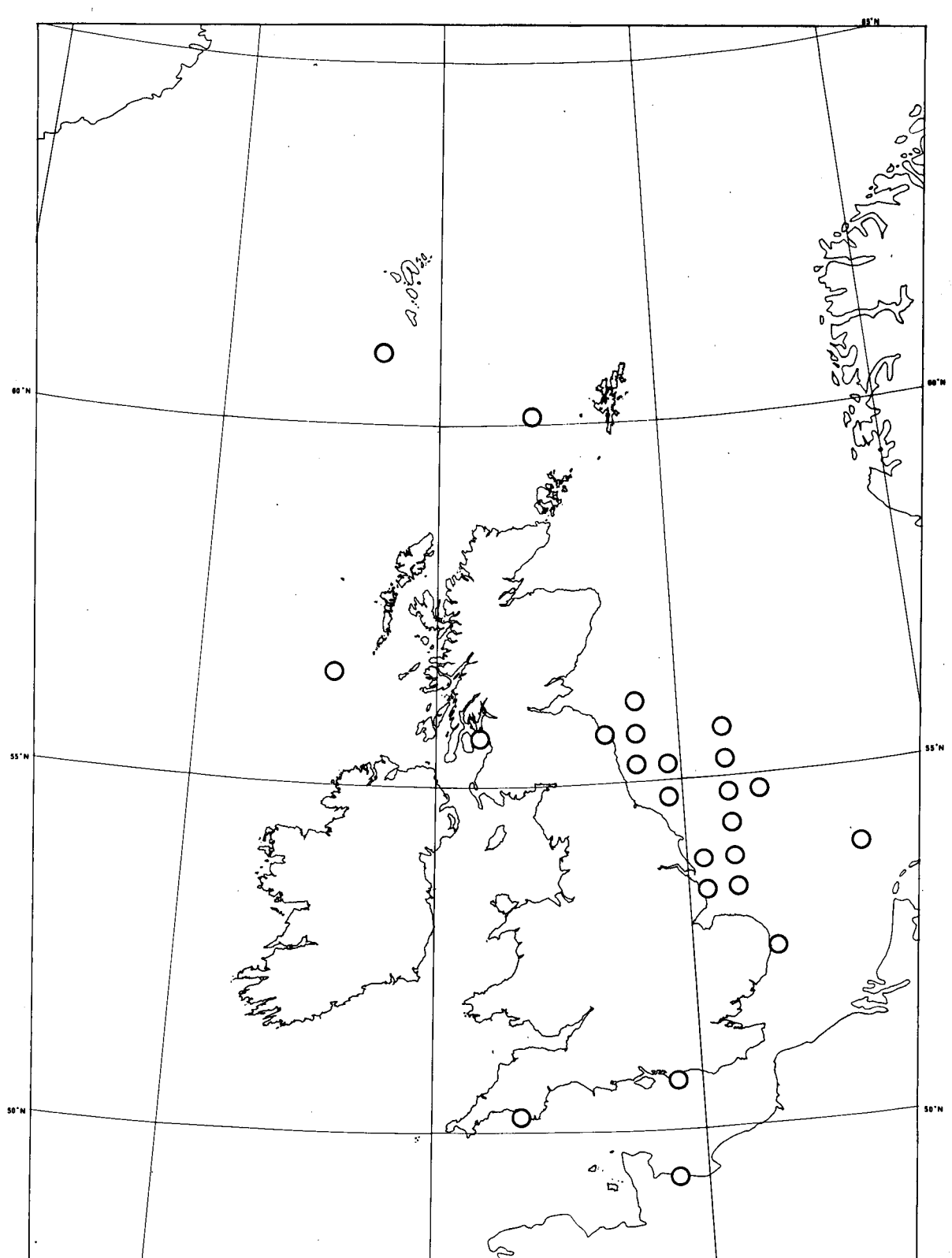
77. *Prorocentrum compressum* (Bail.) Abe ex Dodge



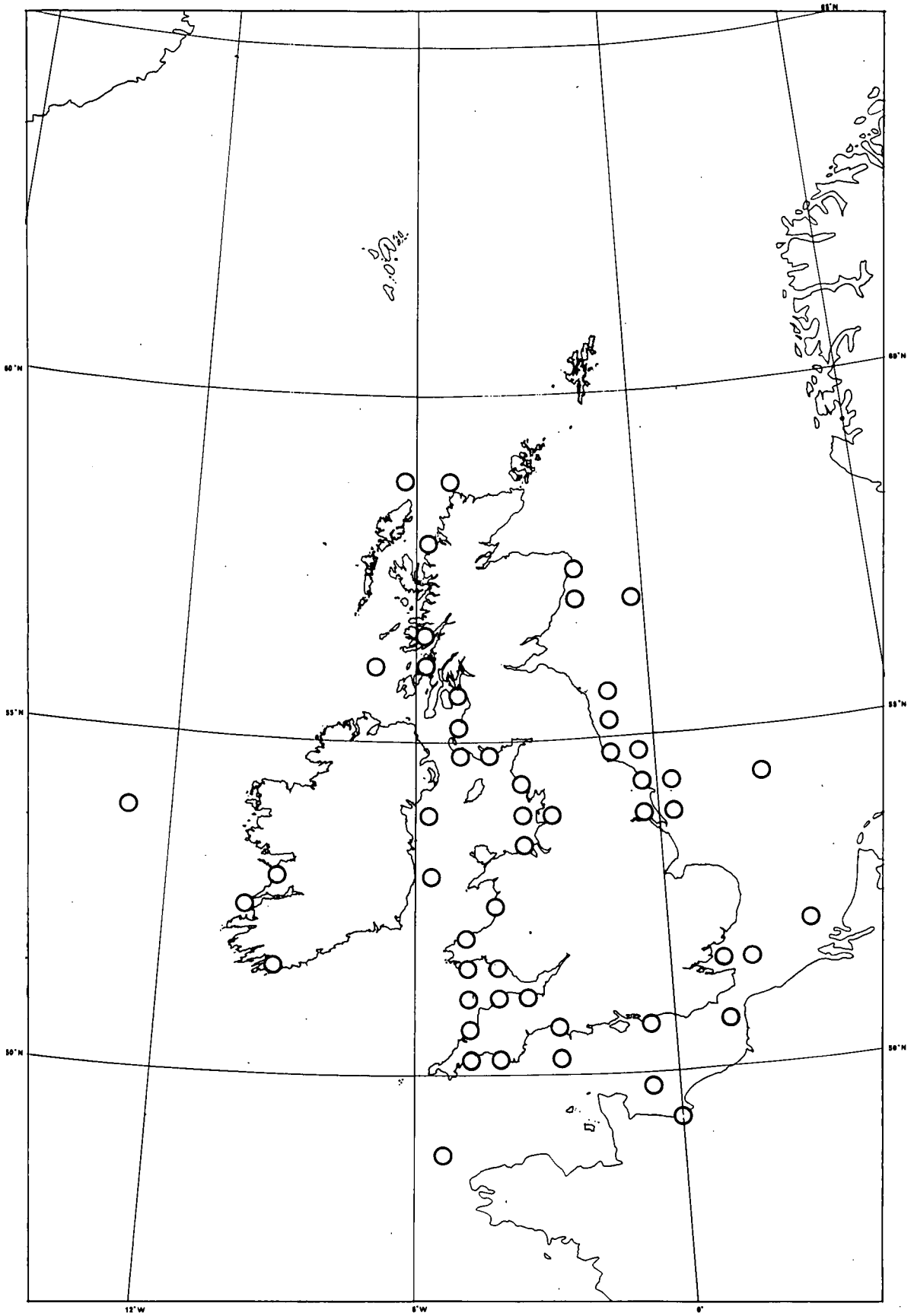
78. *Prorocentrum lima* (Ehrenb.) Dodge



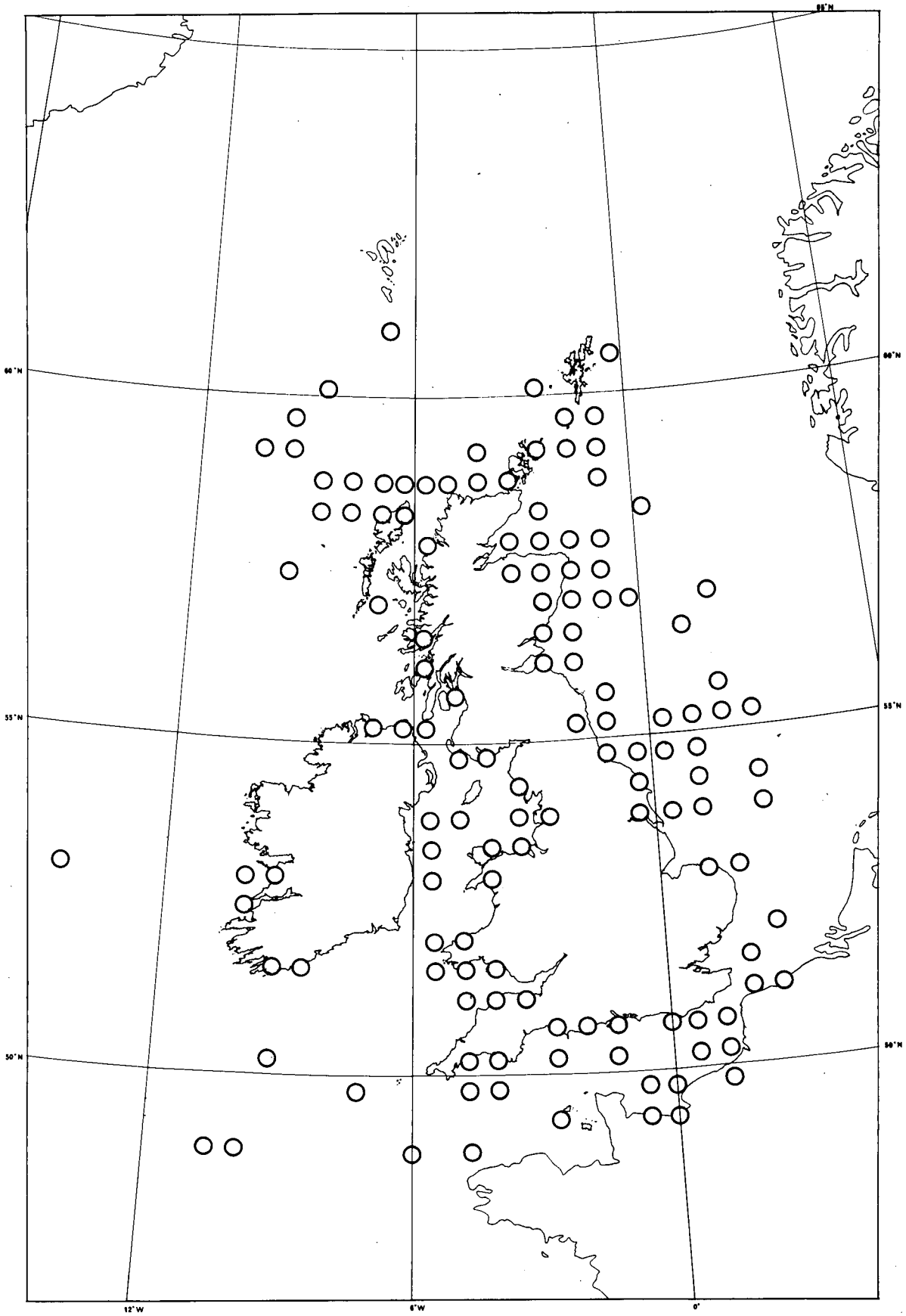
79. *Prorocentrum micans* Ehrenb.



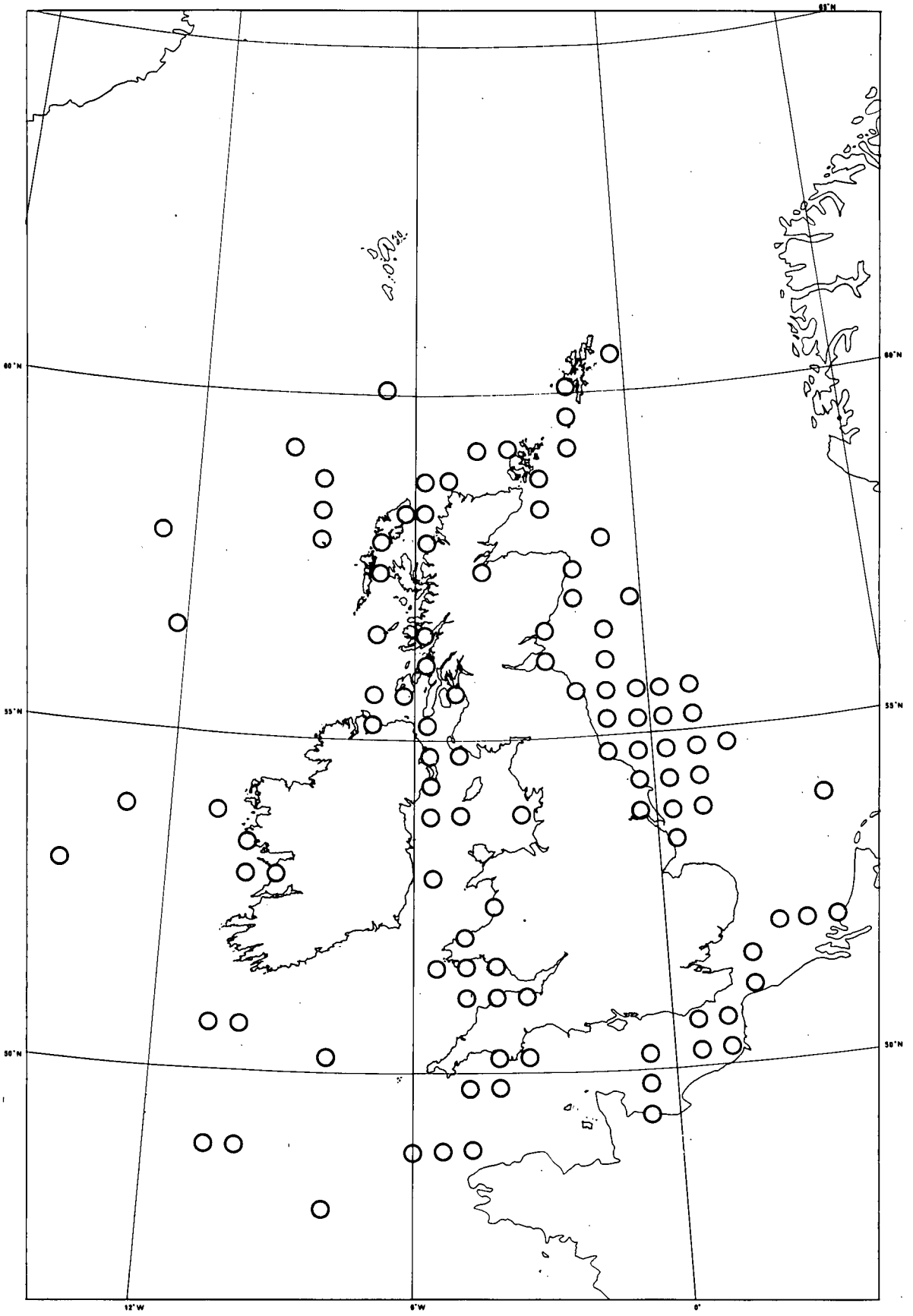
80. *Protoperidinium achromaticum* (Lev.) Balech



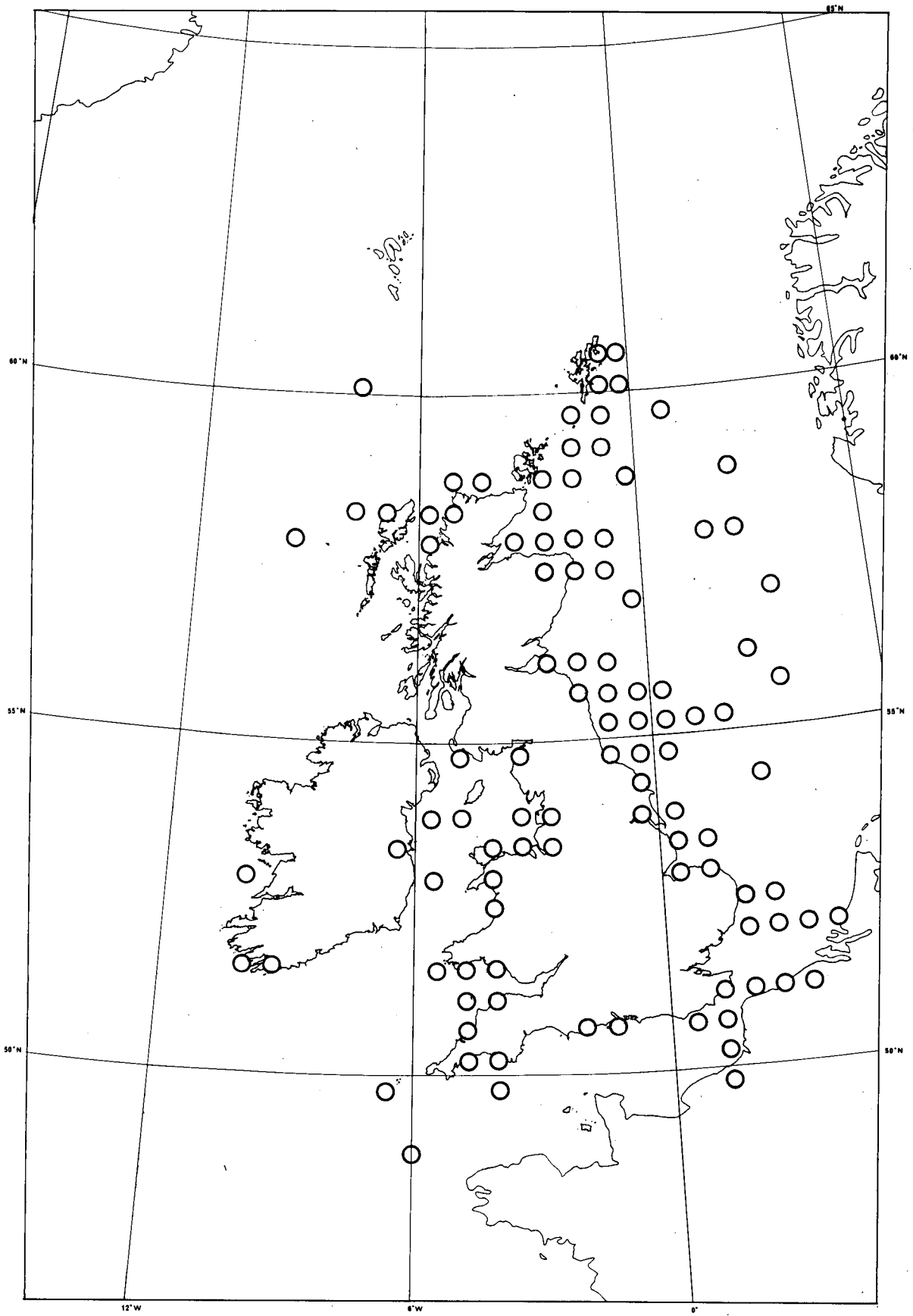
81. *Protoperidinium bipes* (Pauls.) Balech



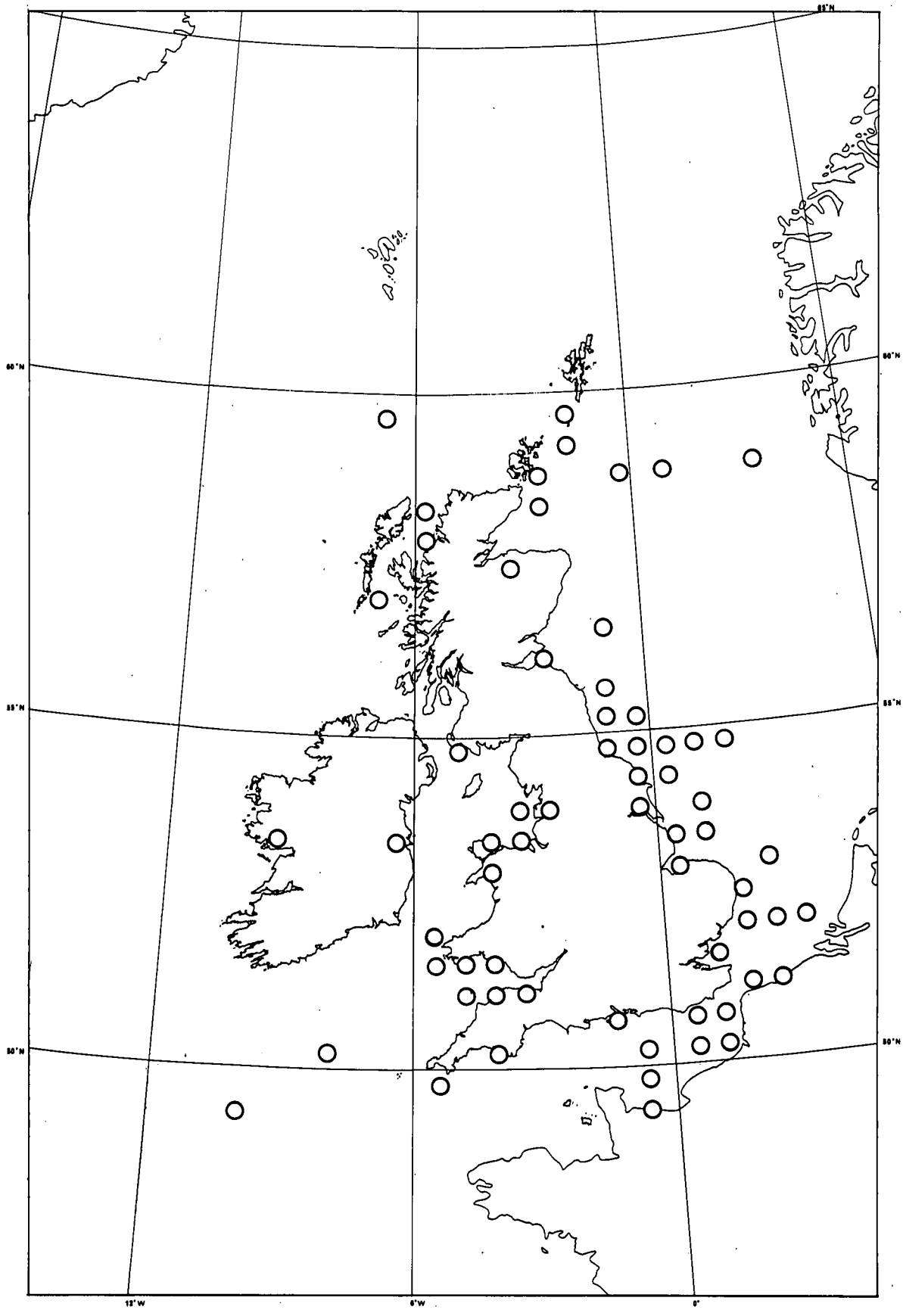
82. *Protoperidinium brevipes* (Pauls.) Balech



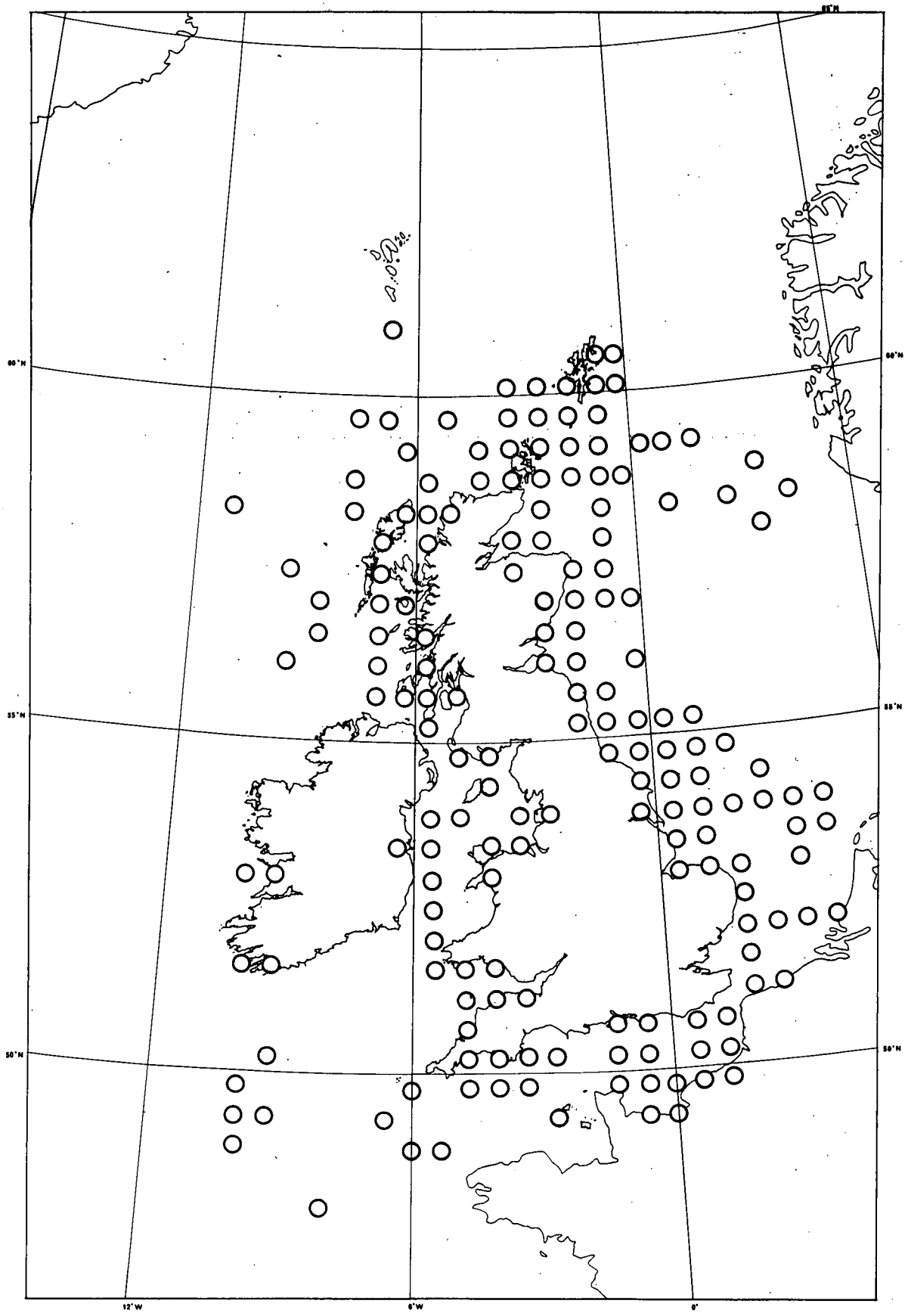
83. *Protoperidinium cerasus* (Pauls.) Balech



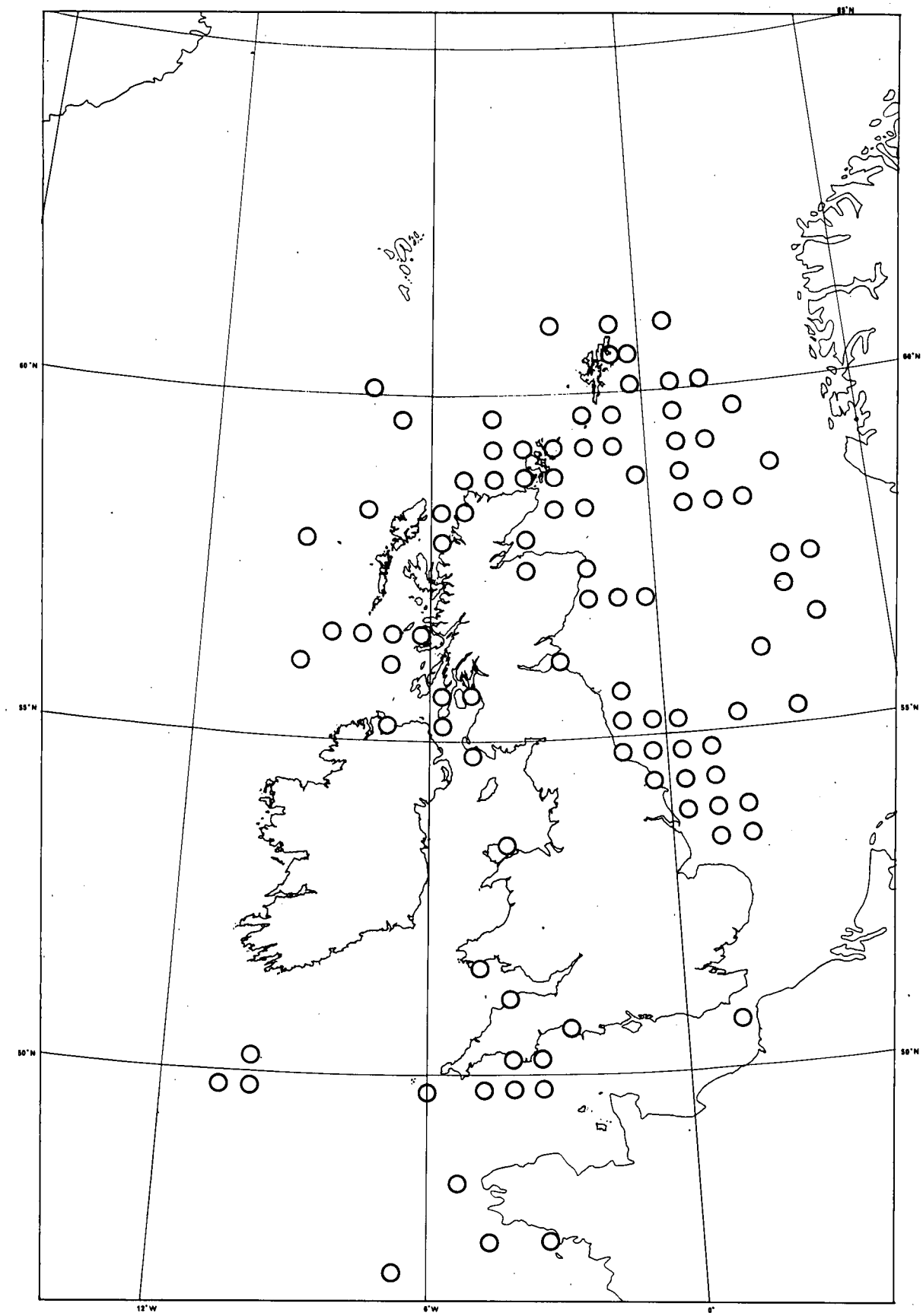
84. *Protoperidinium claudicans* (Pauls.) Balech



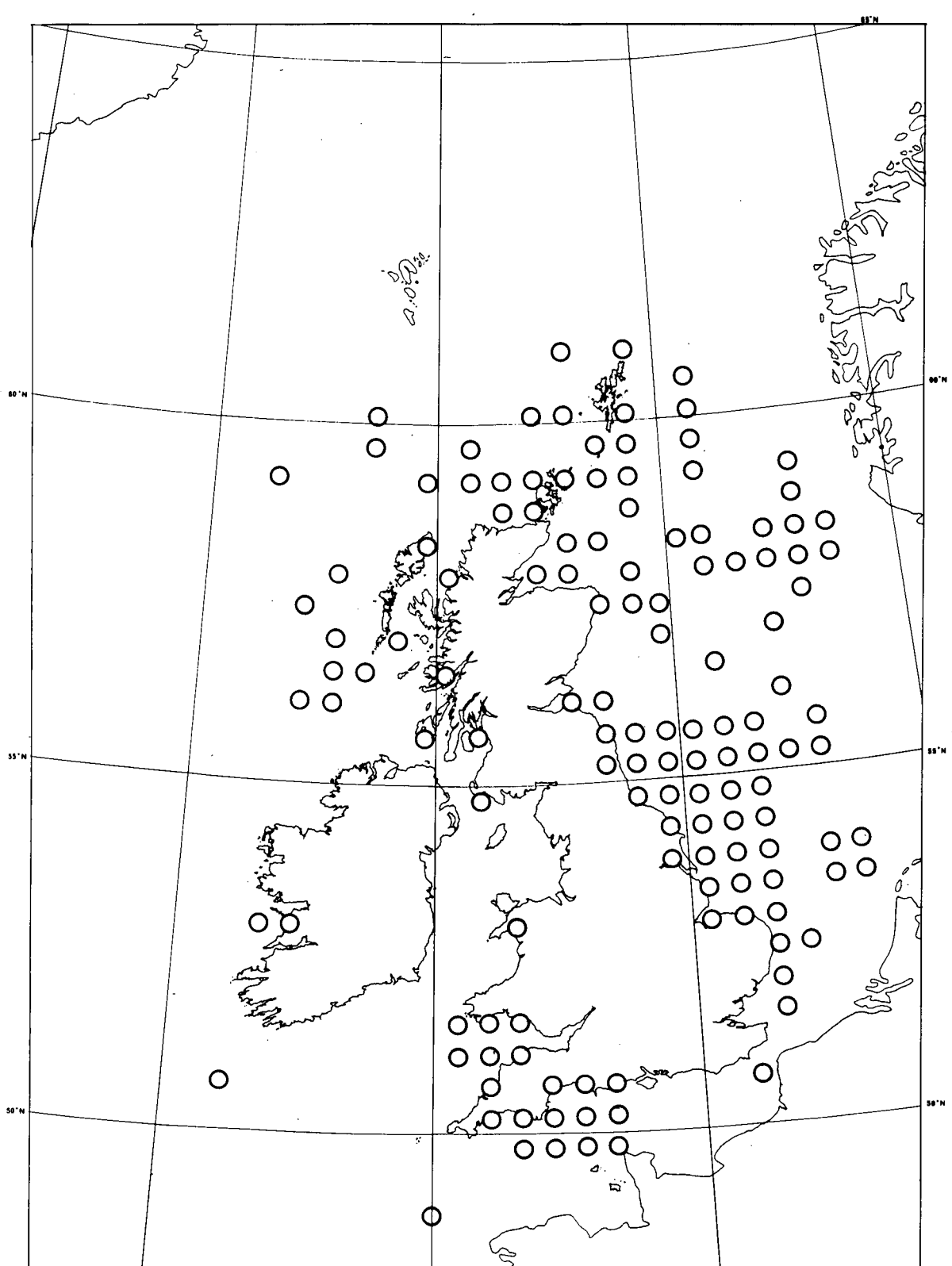
85. *Protoperidinium conicoides* (Pauls.) Balech



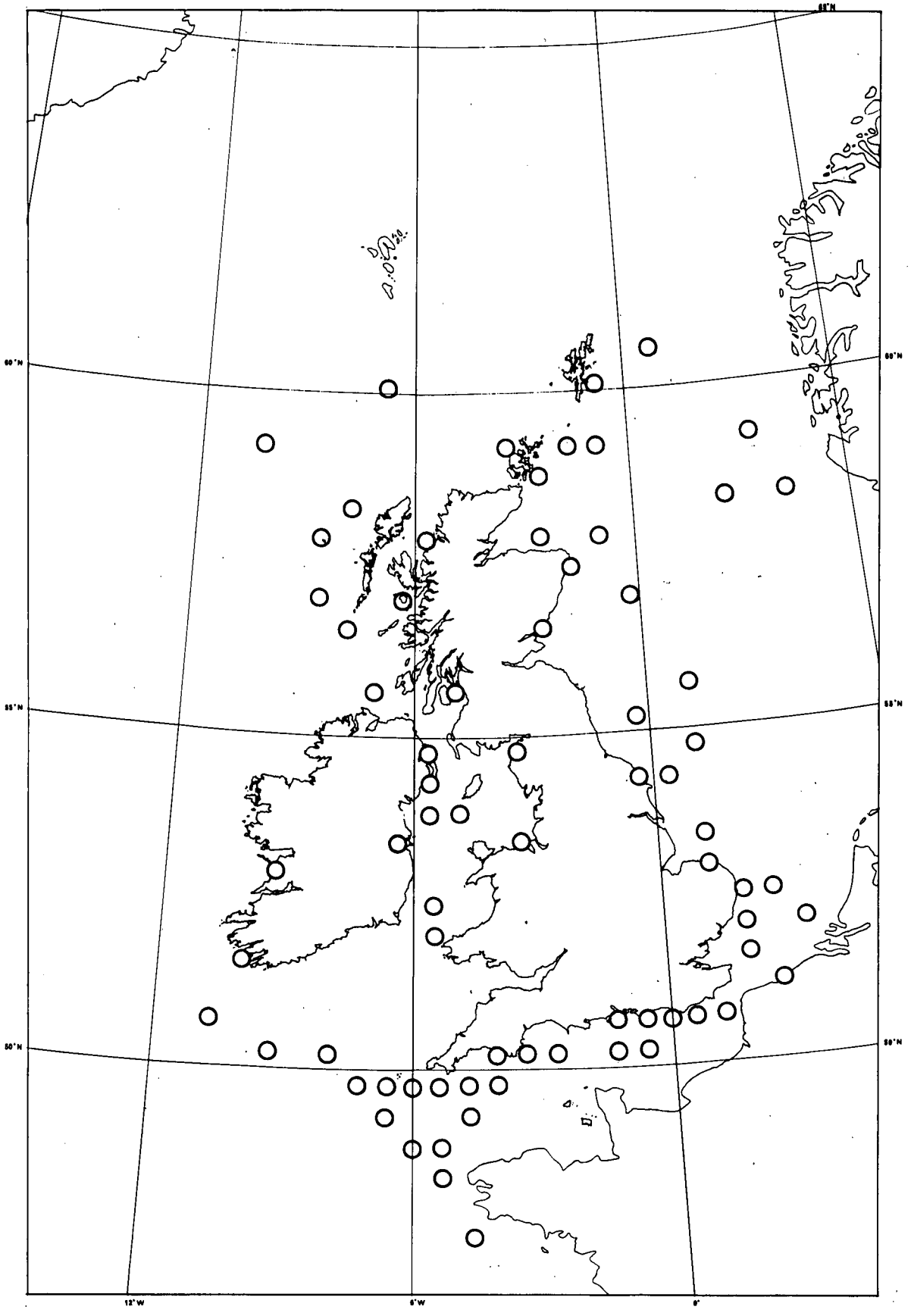
86. *Protoperidinium conicum* (Gran) Balech



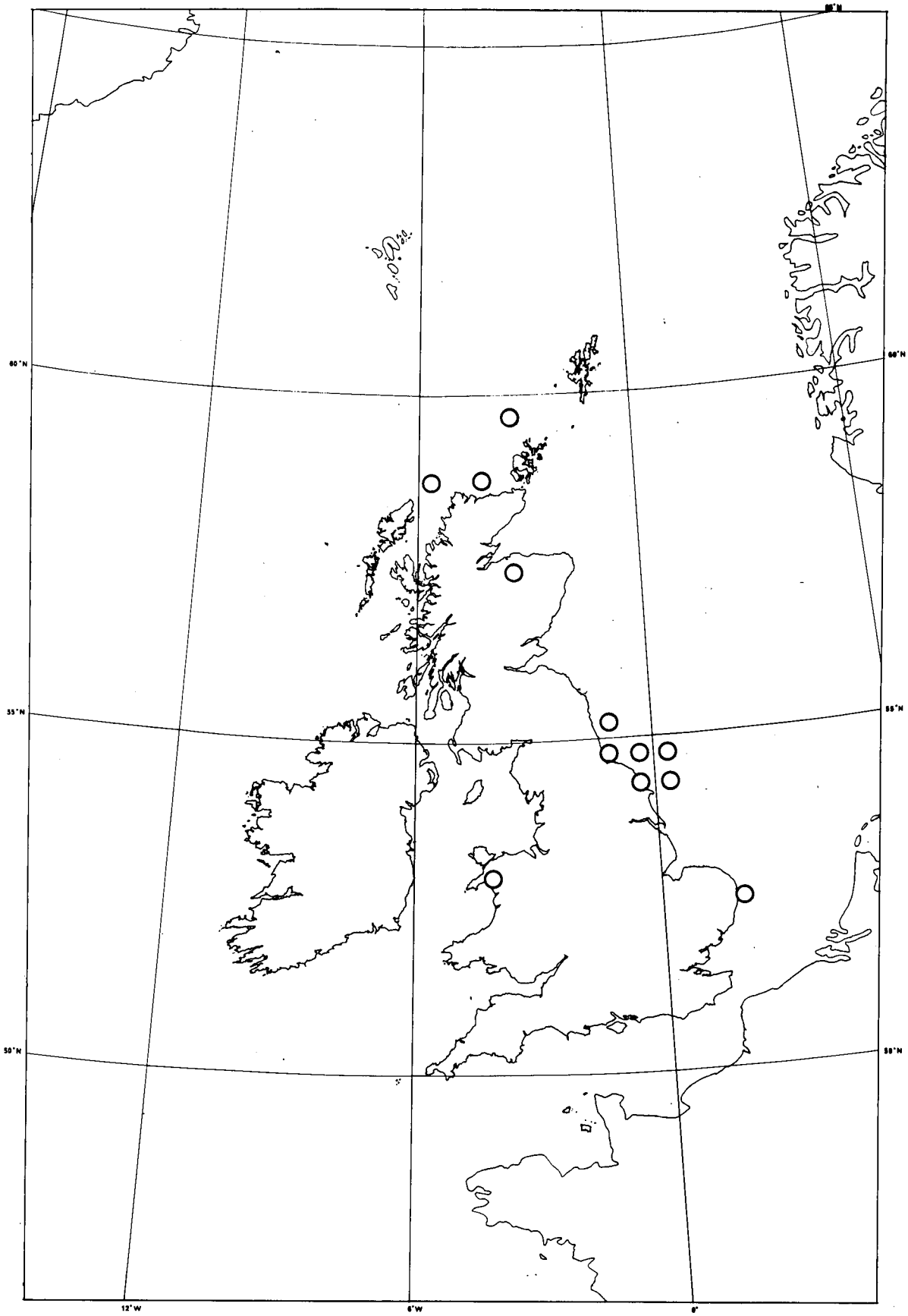
87. *Protoperidinium crassipes* (Kof.) Balech



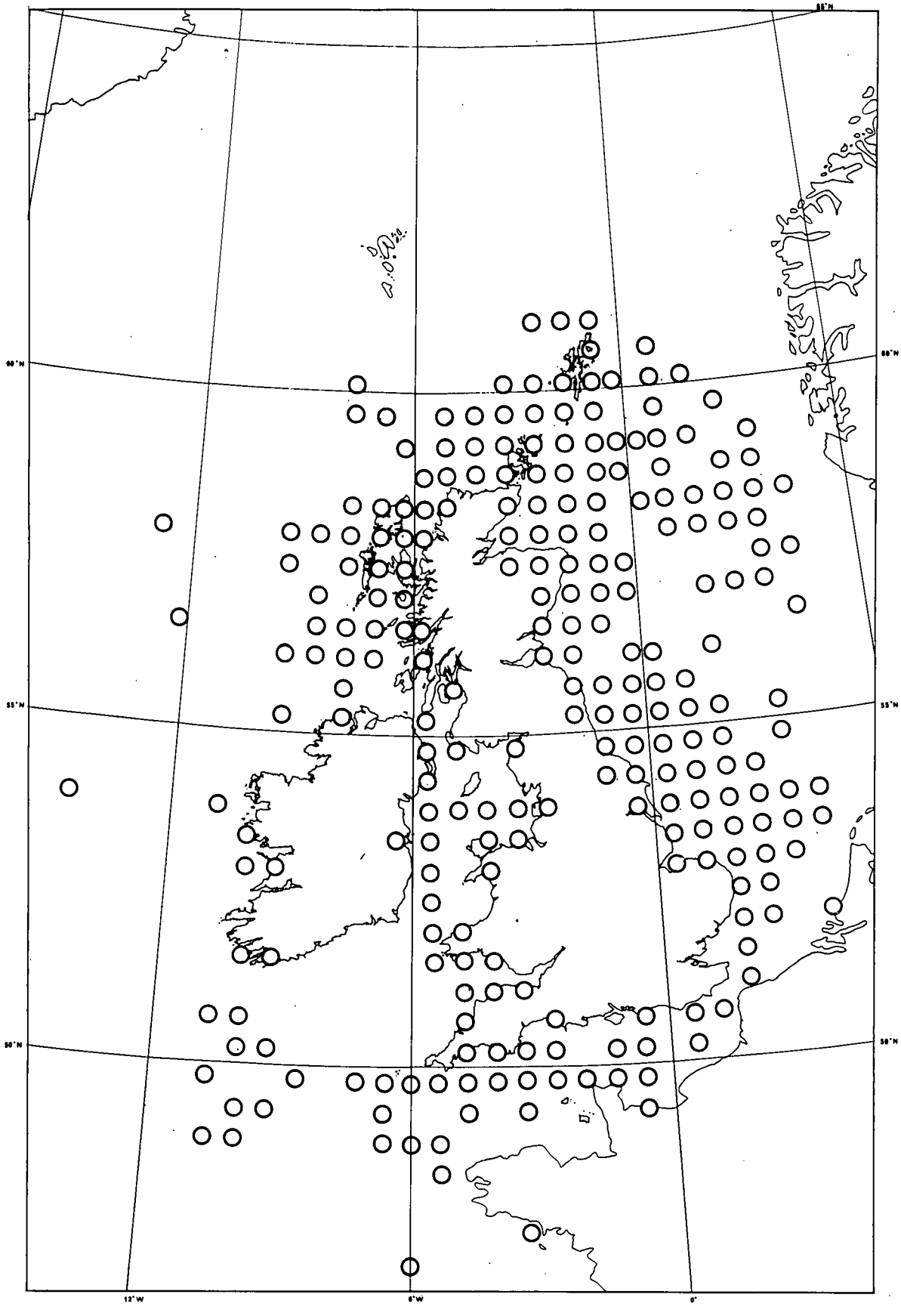
88. *Protoperidinium curtipes* (Jorg.) Balech



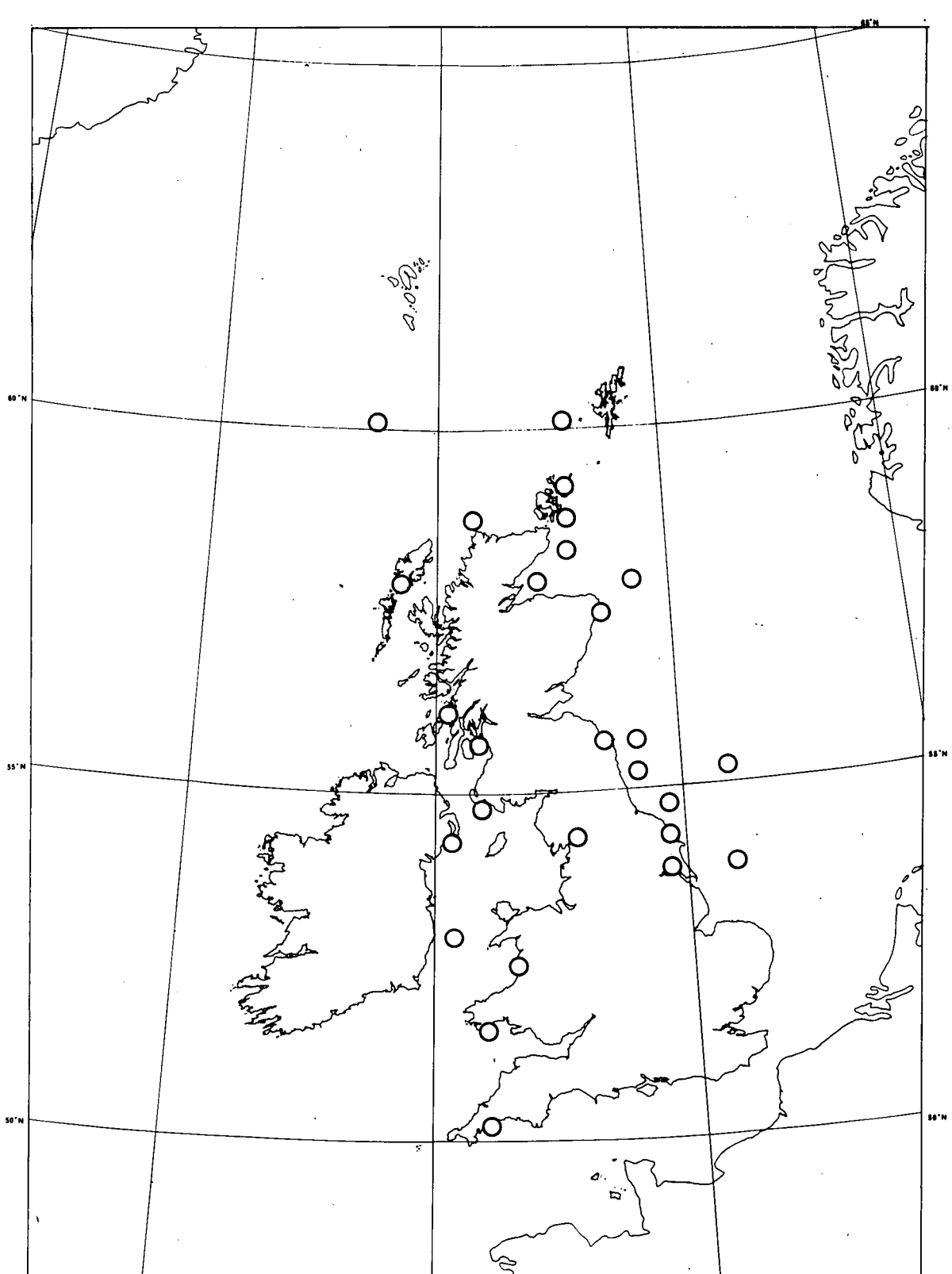
89. *Protoperidinium curvipes* (Ostenf.) Balech



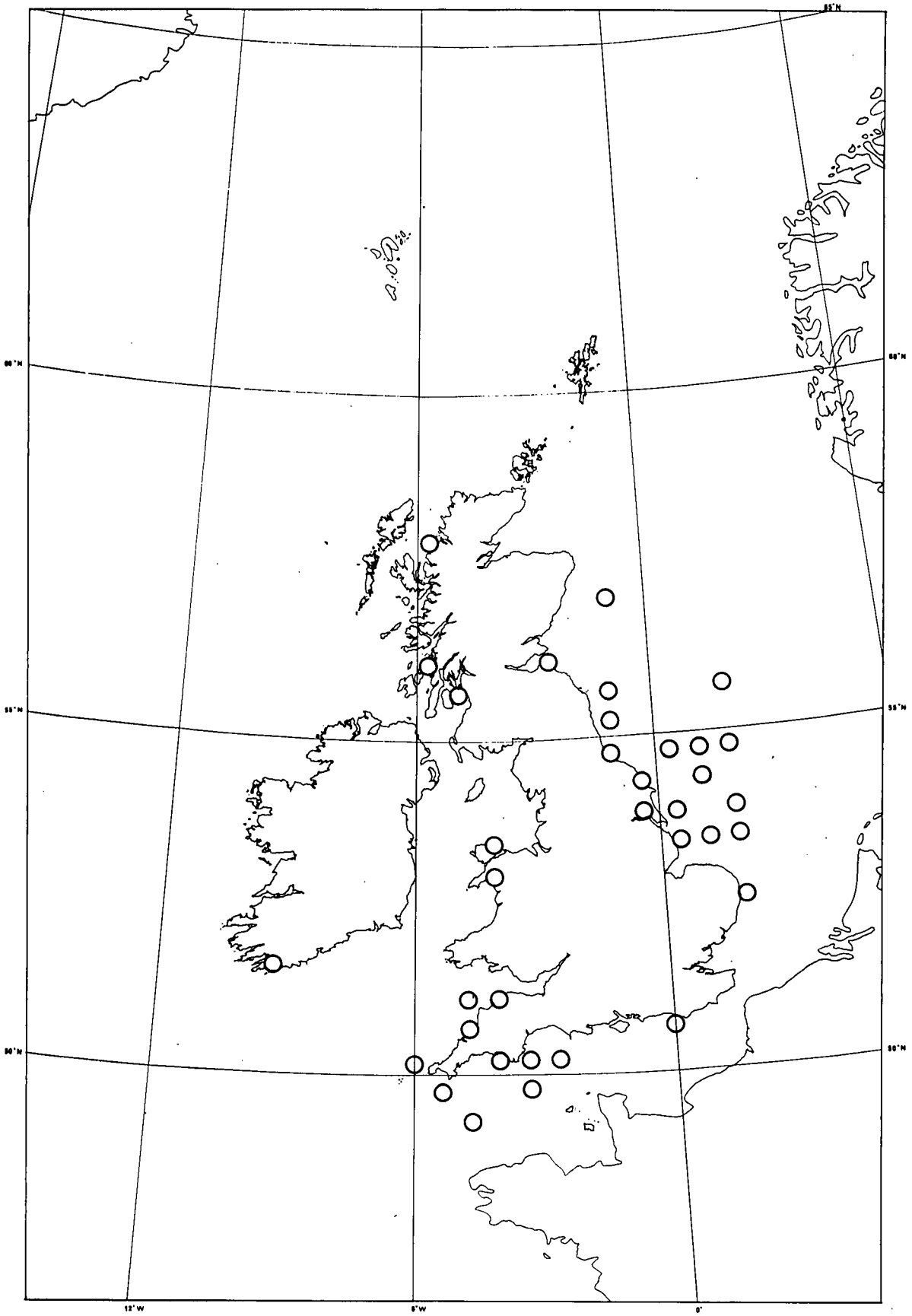
90. *Protoperidinium denticulatum* (Gran & Braarud) Balech



91. *Protoperidinium depressum* (Bail.) Balech



92. *Protoperidinium diabolum* (Cleve) Balech



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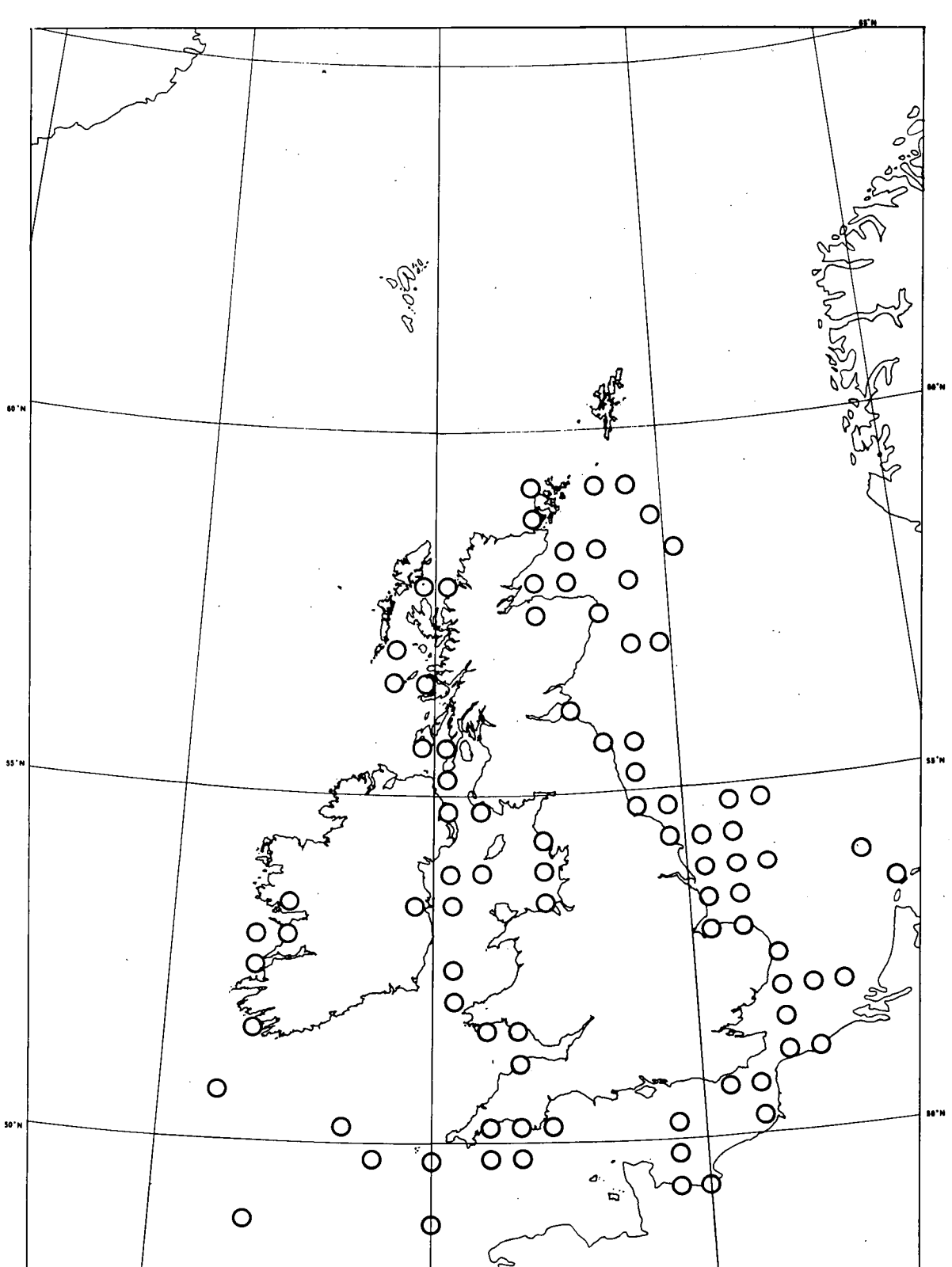

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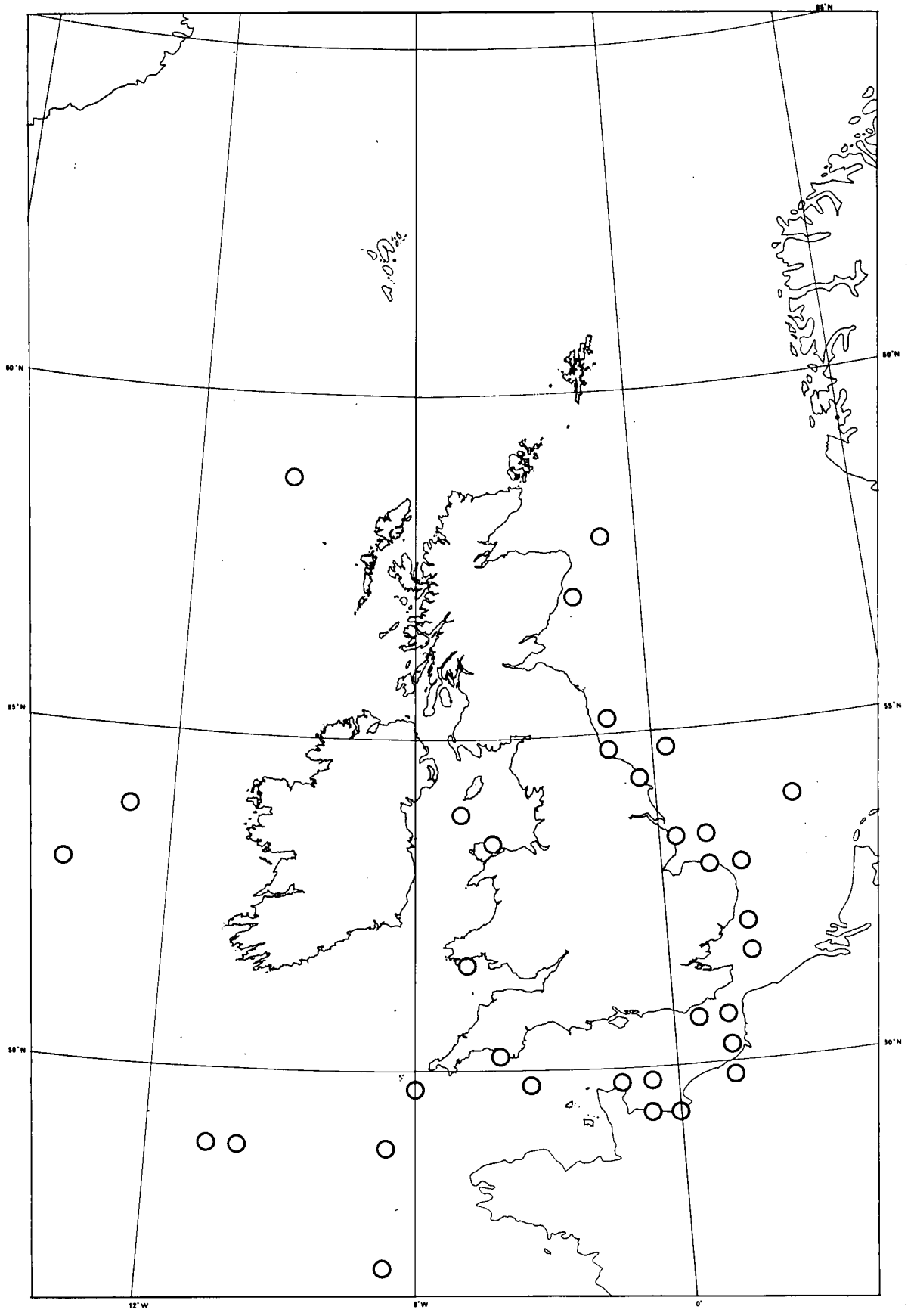

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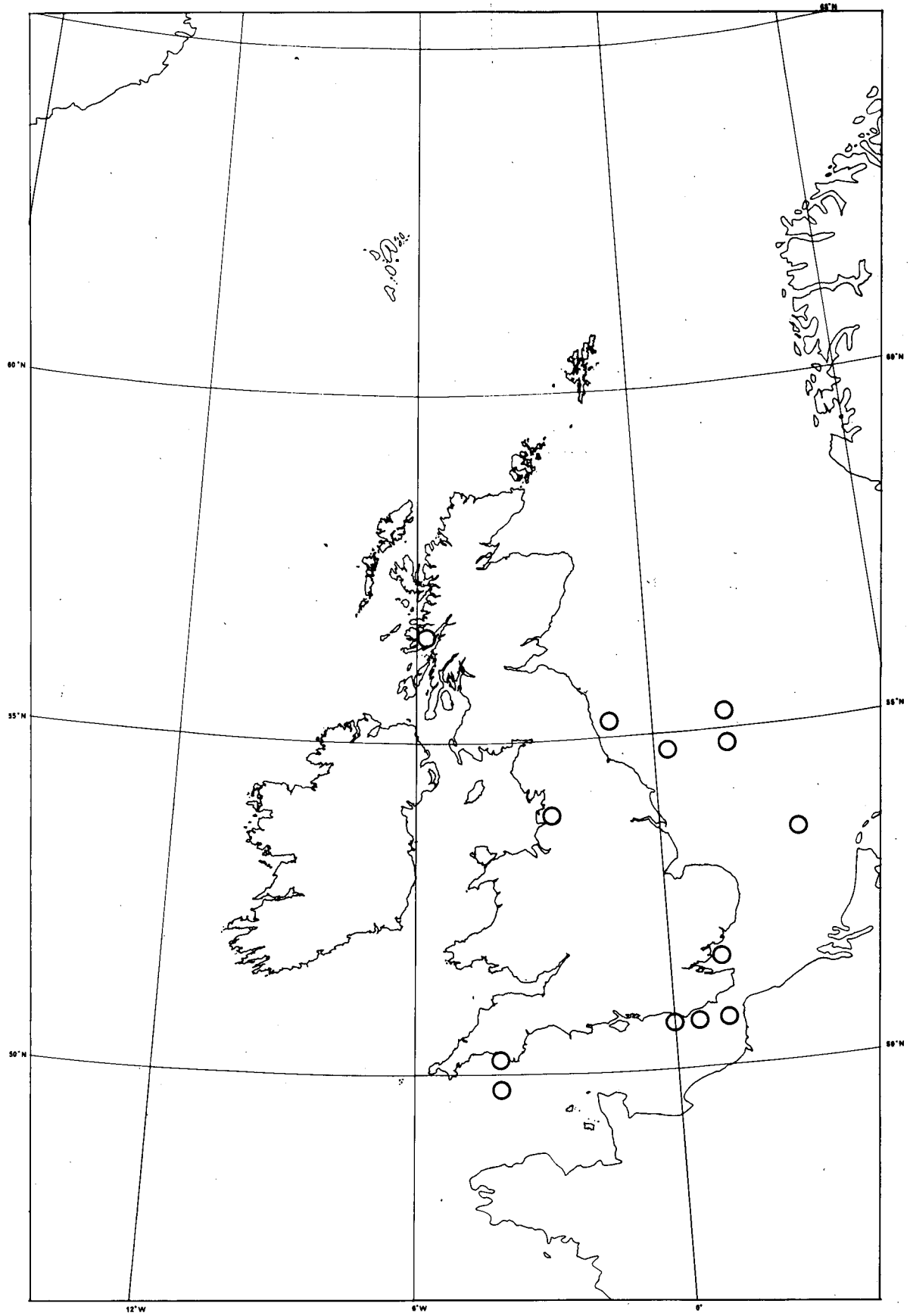

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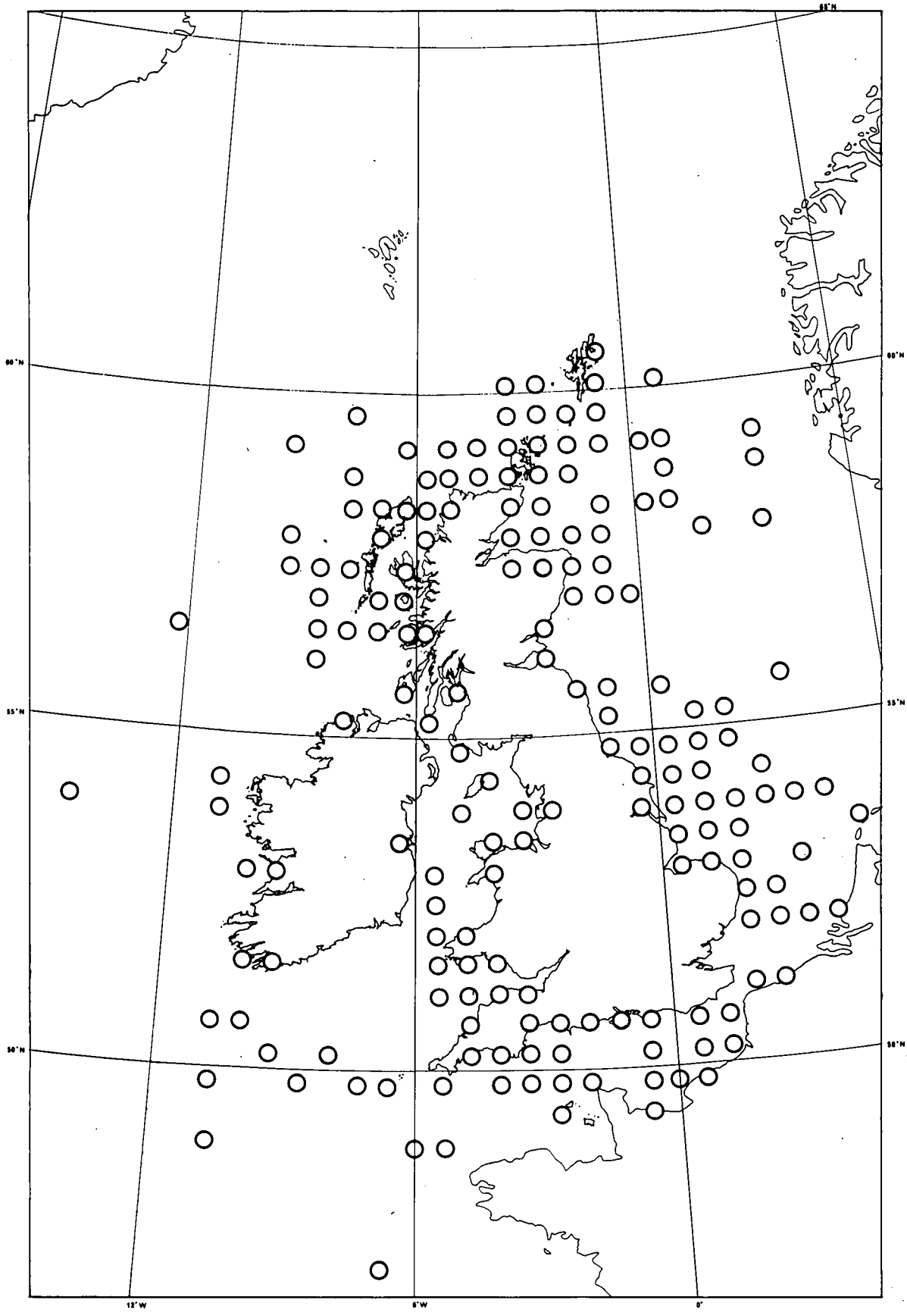

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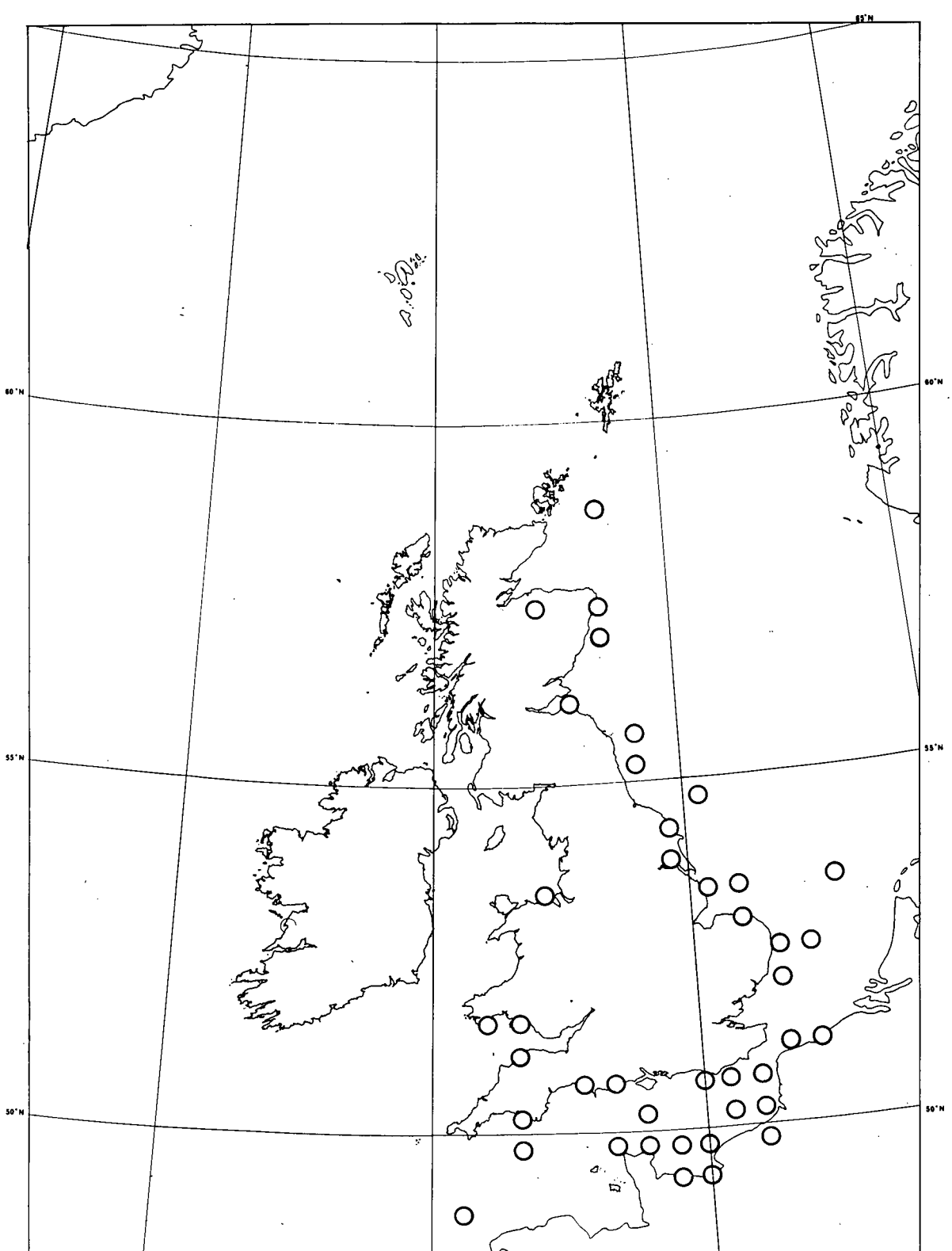

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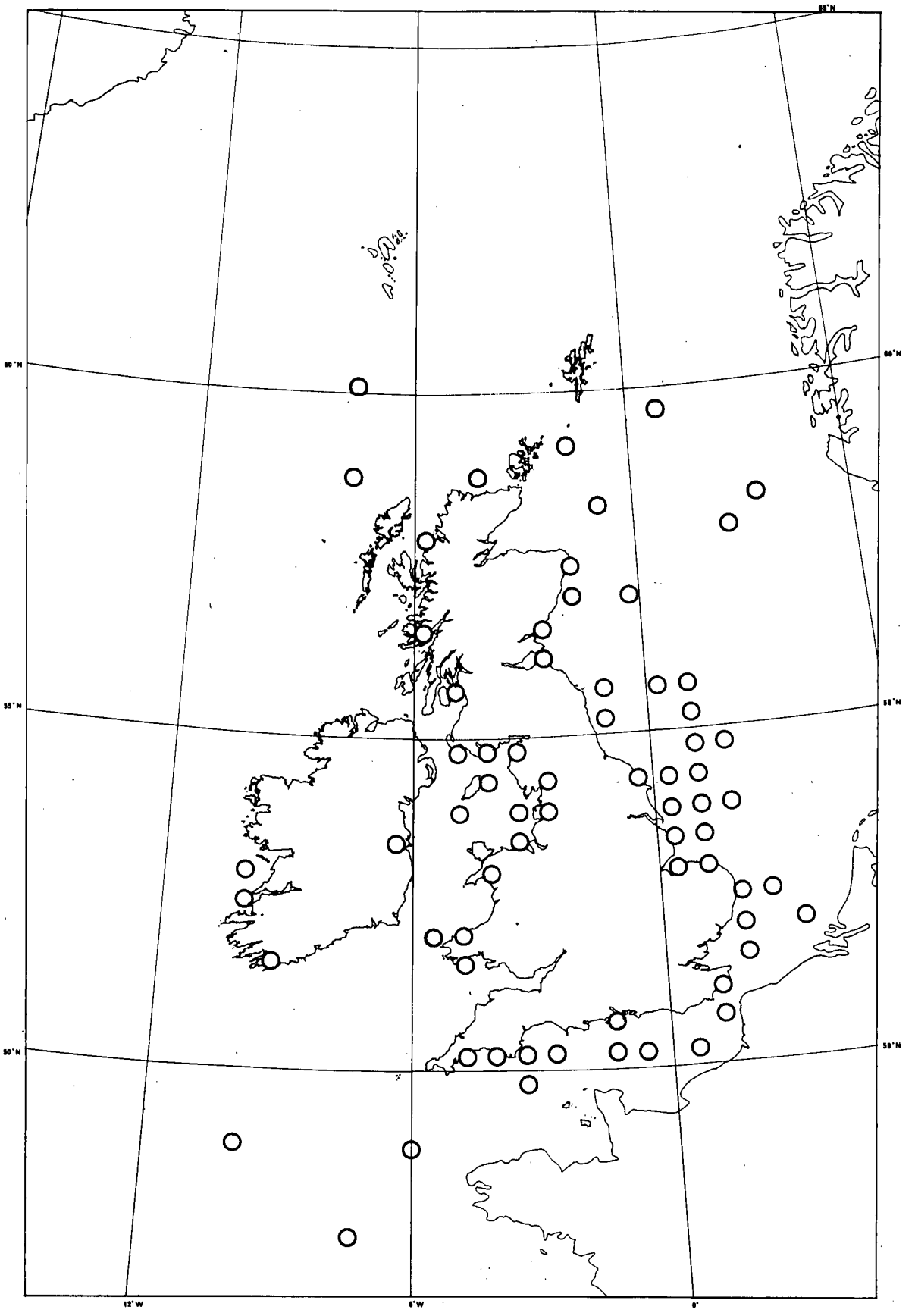

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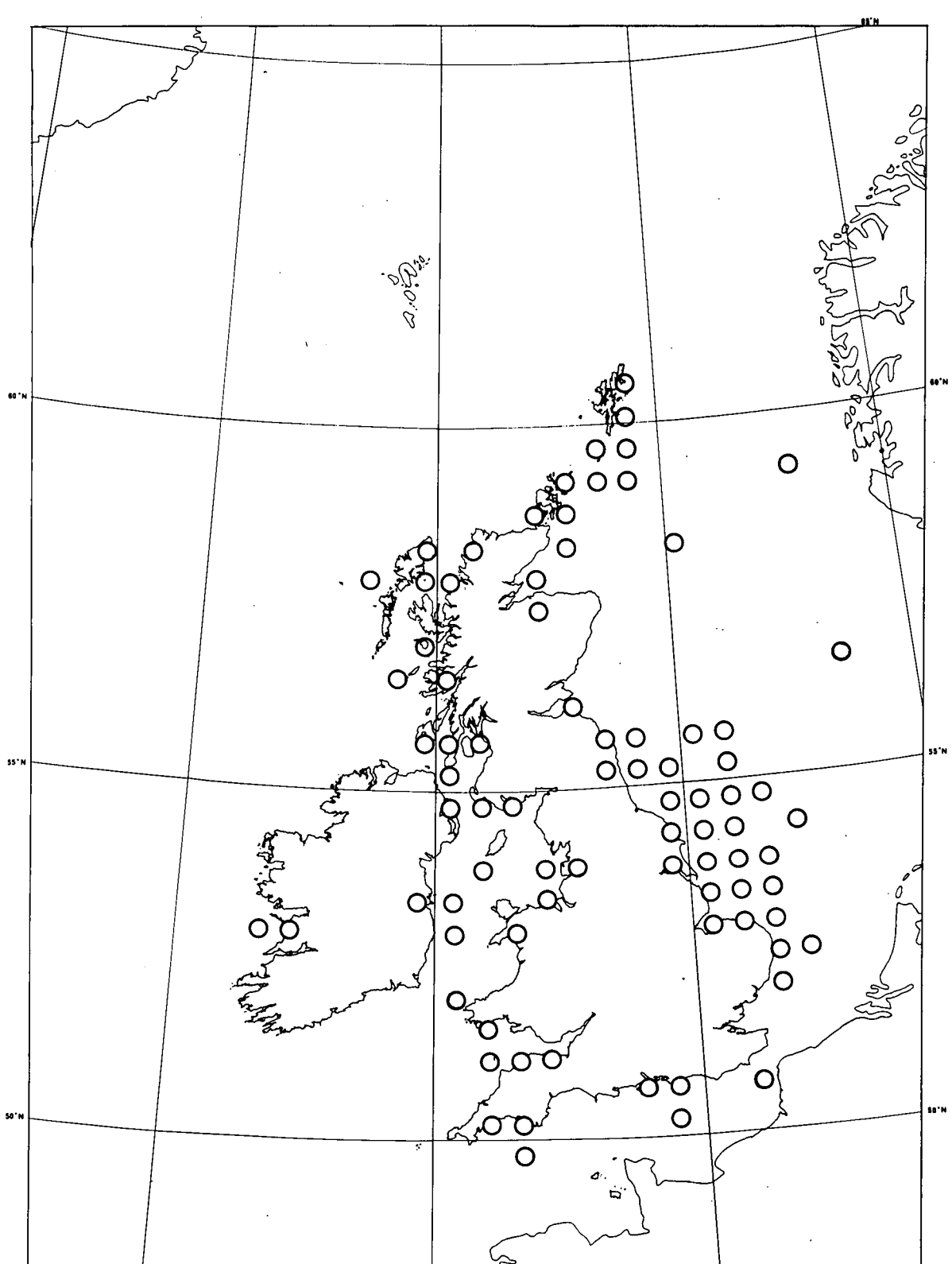
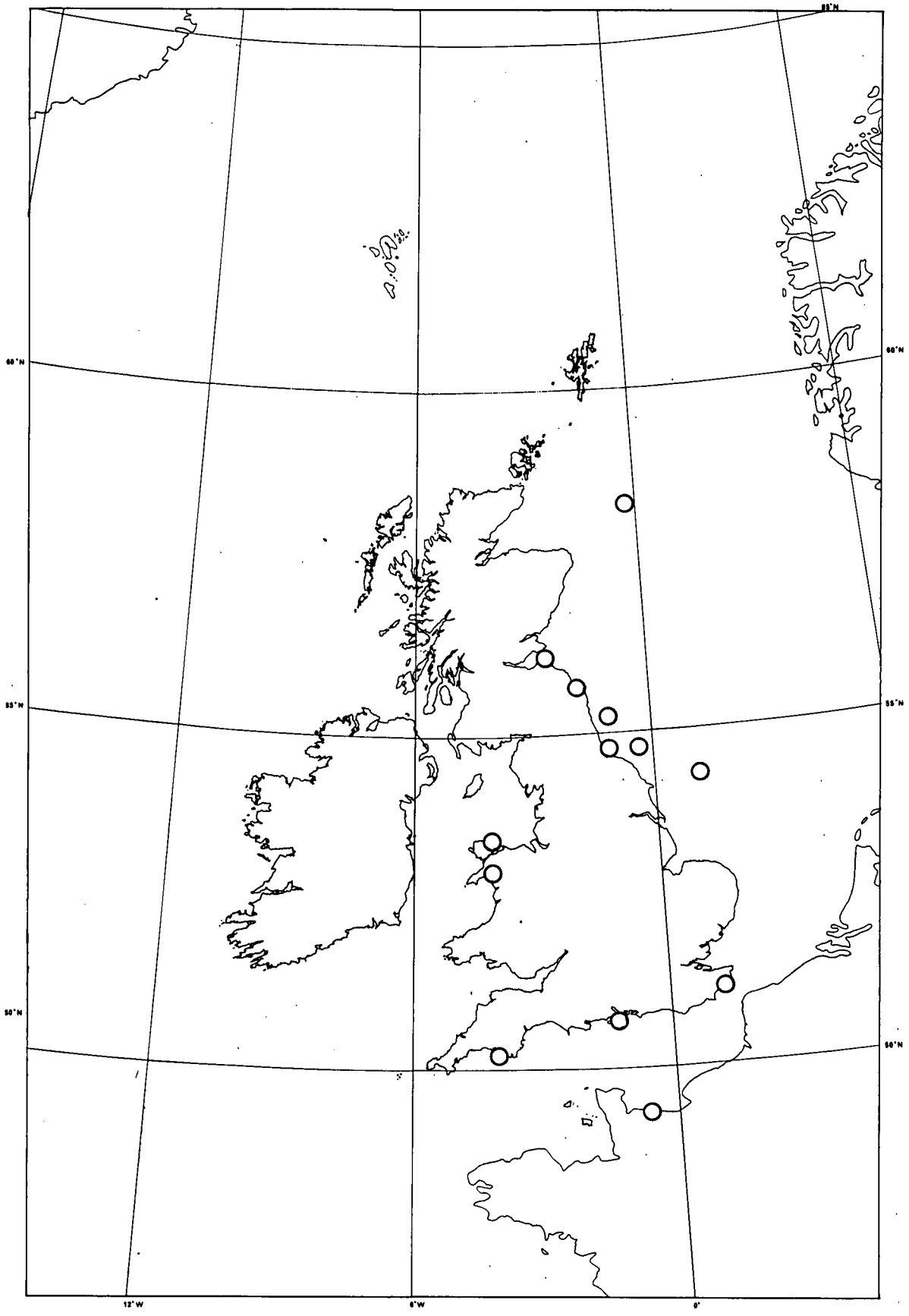
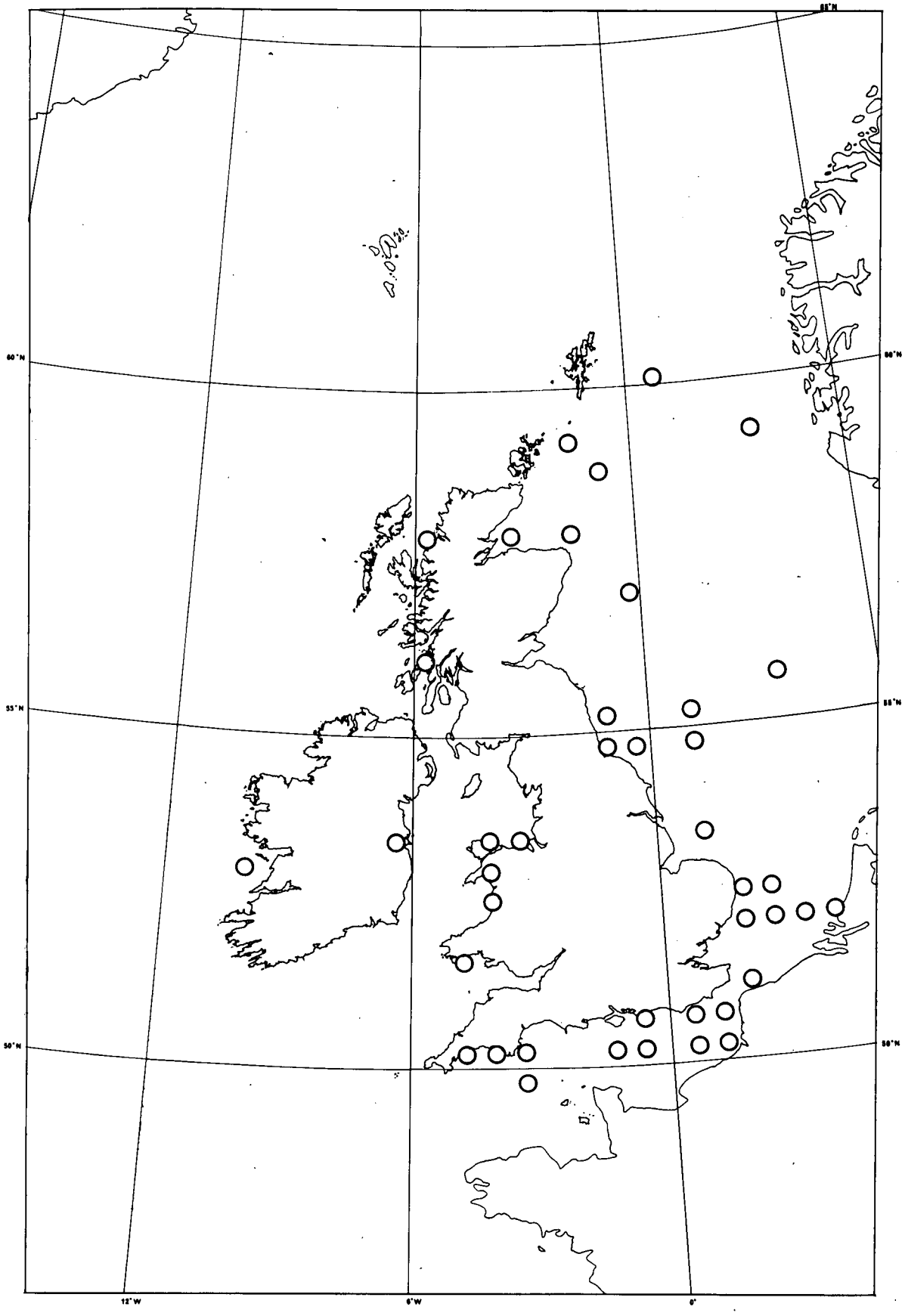


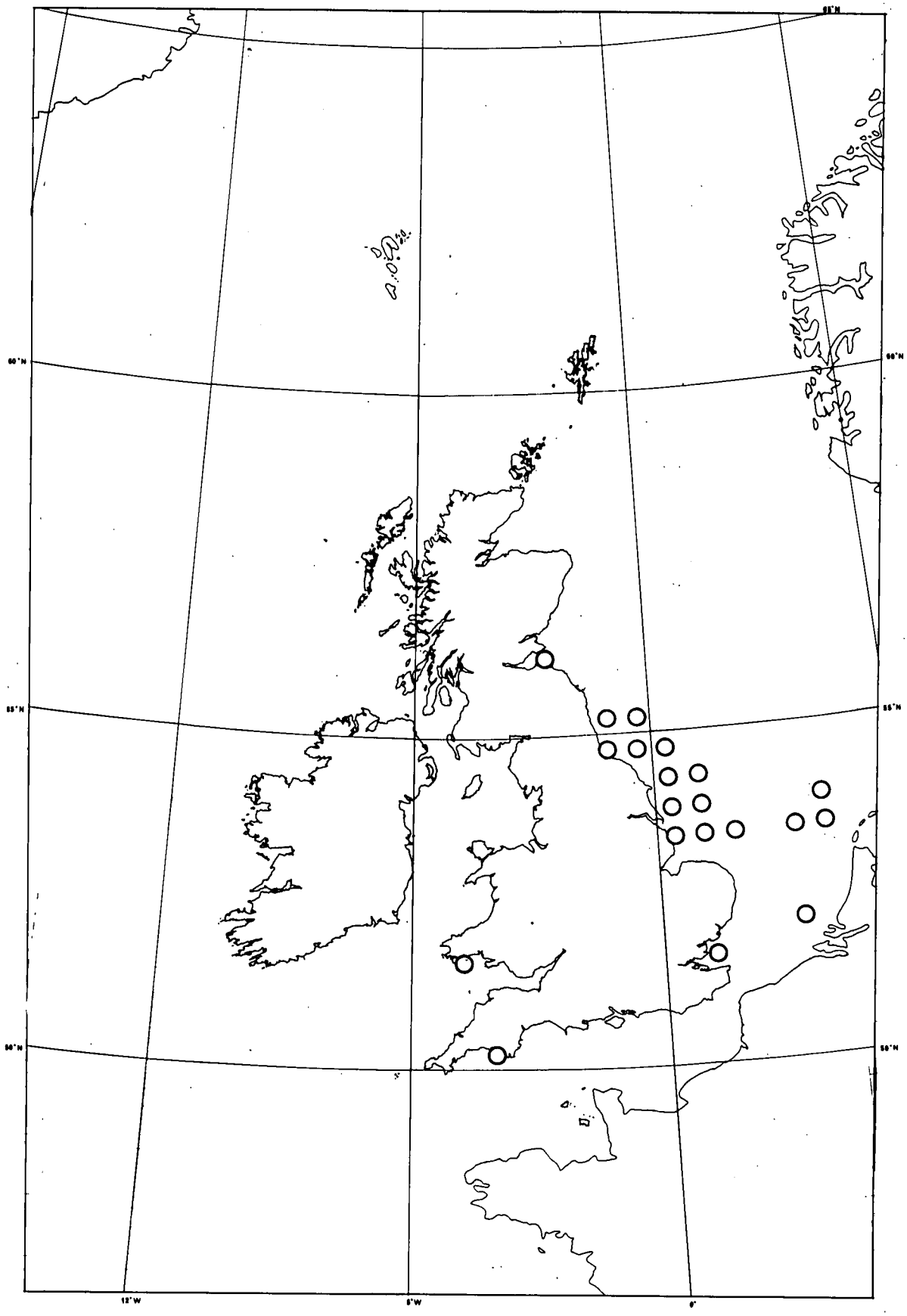
100. *Protoperidinium mite* (Pav.) Balech



101. *Protoperidinium nudum* (Meun.) Balech



102. ***Protoperidinium oblongum*** **(Aurivillius) Parke & Dodge**



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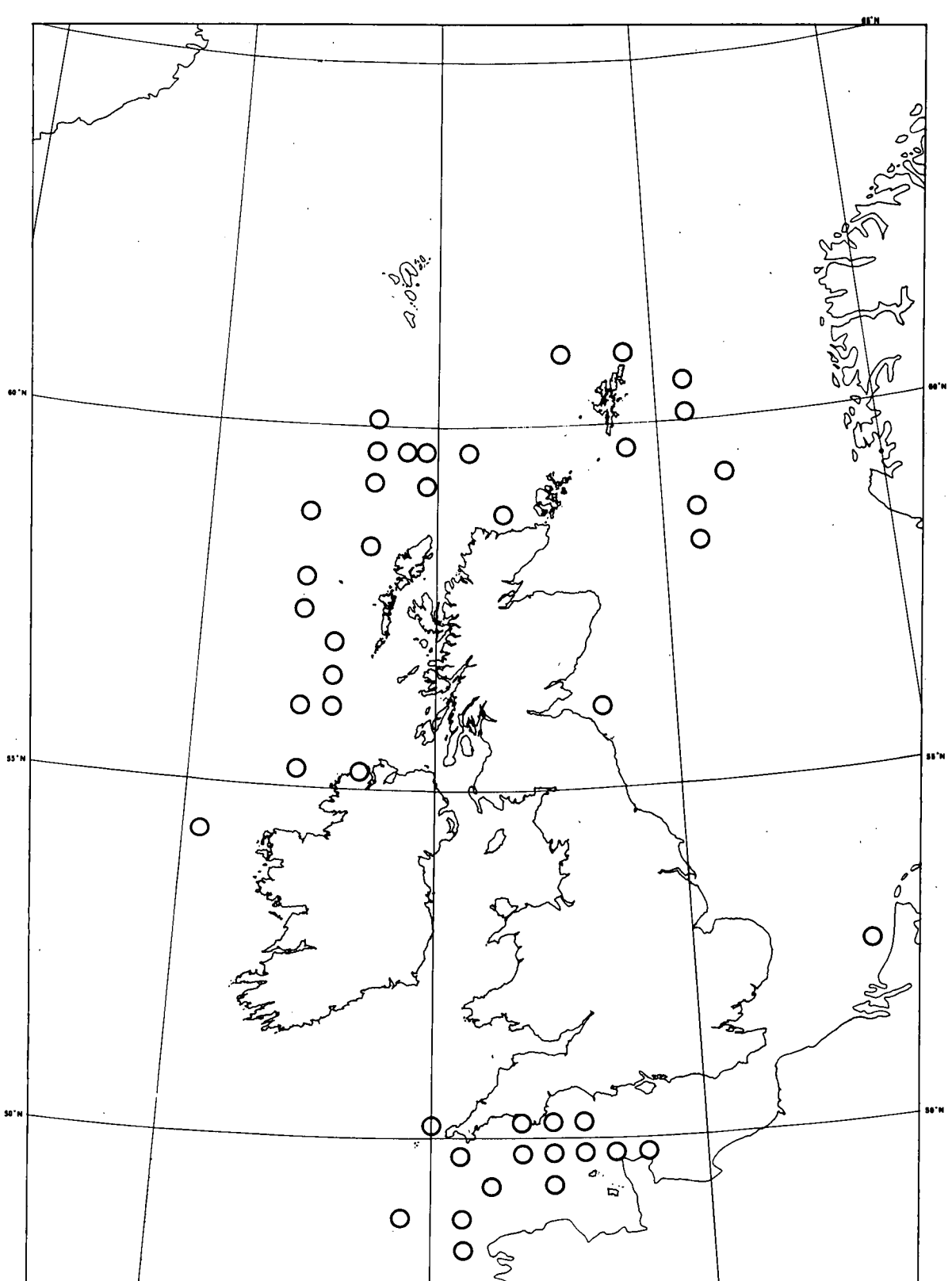

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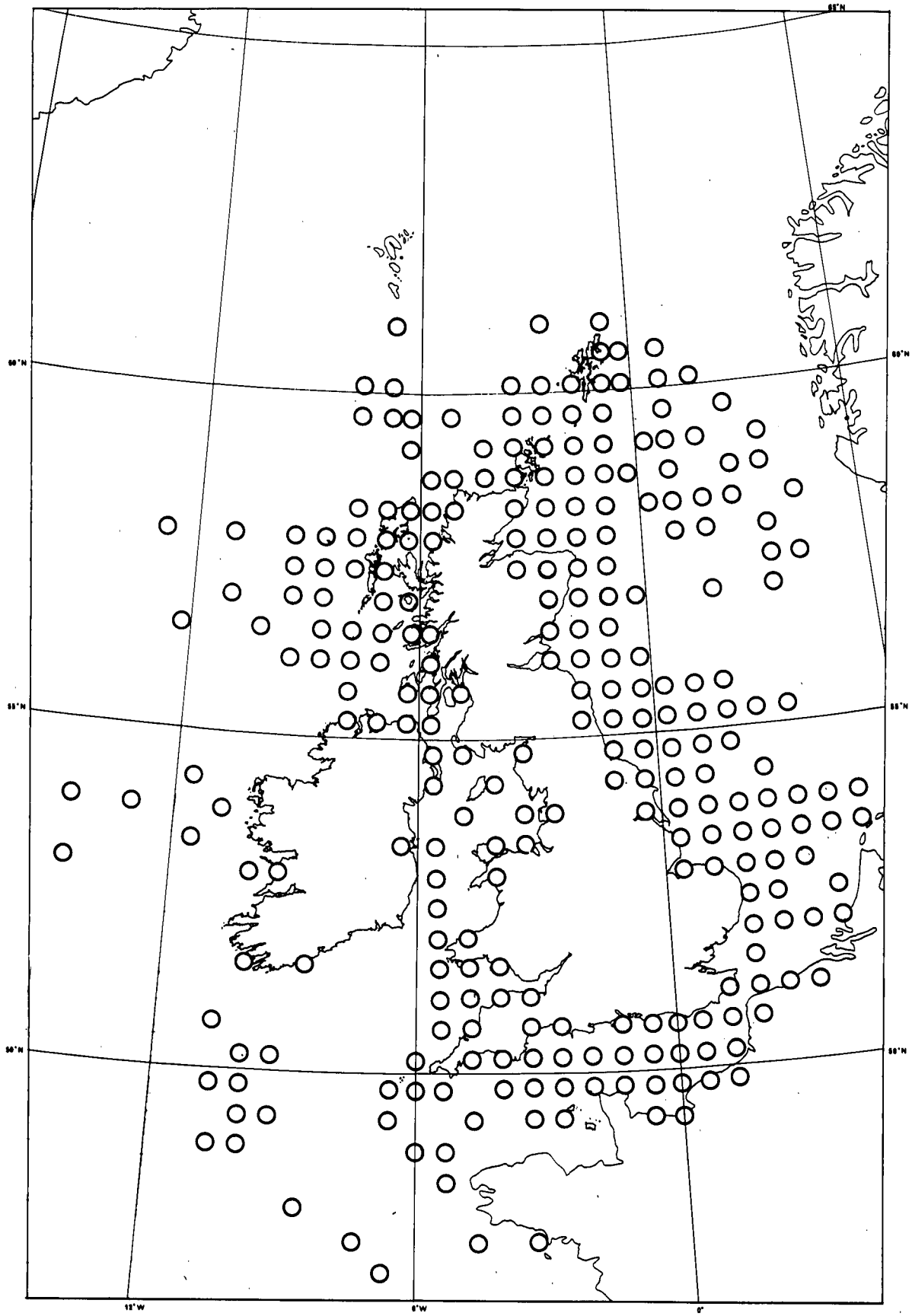

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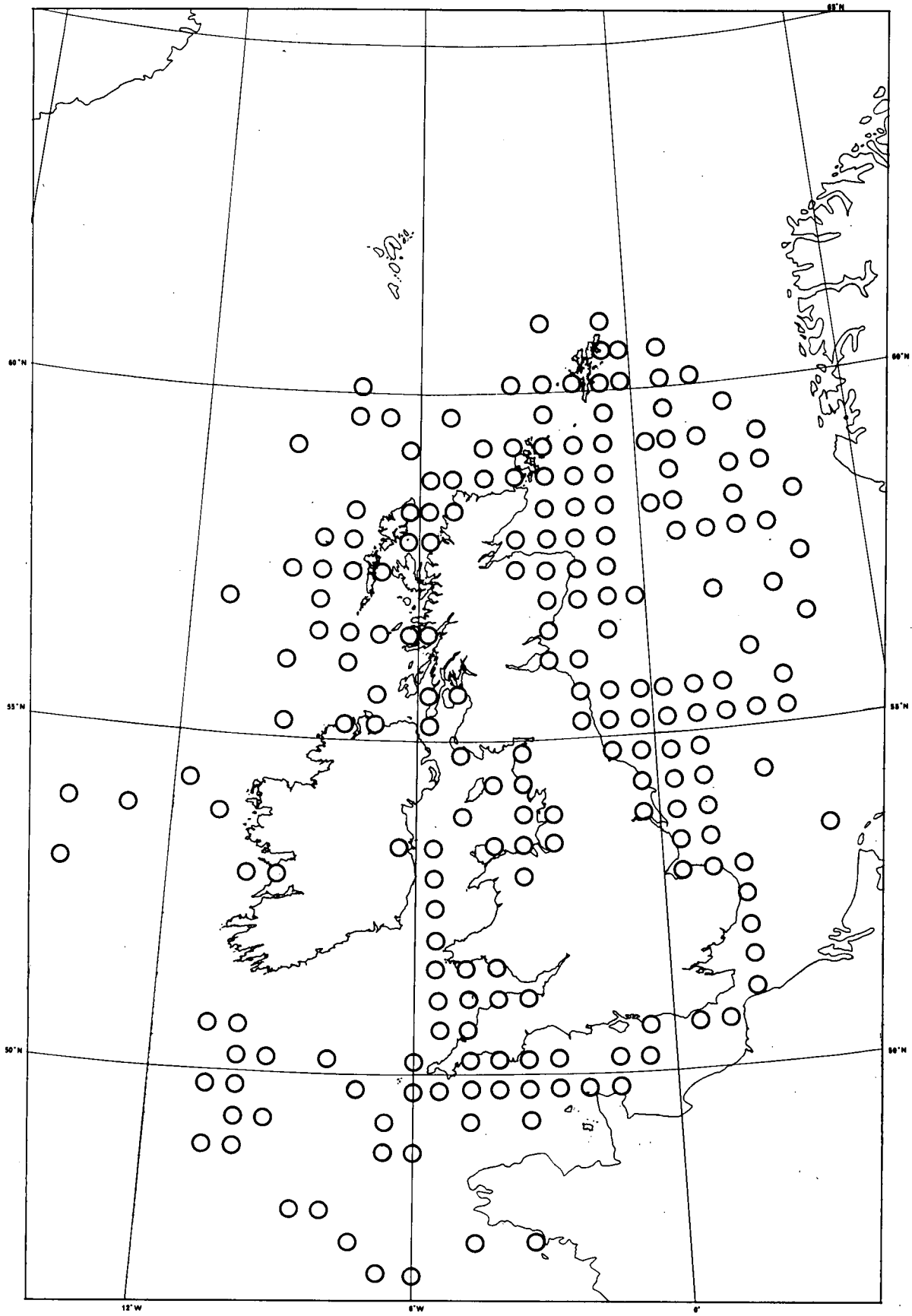

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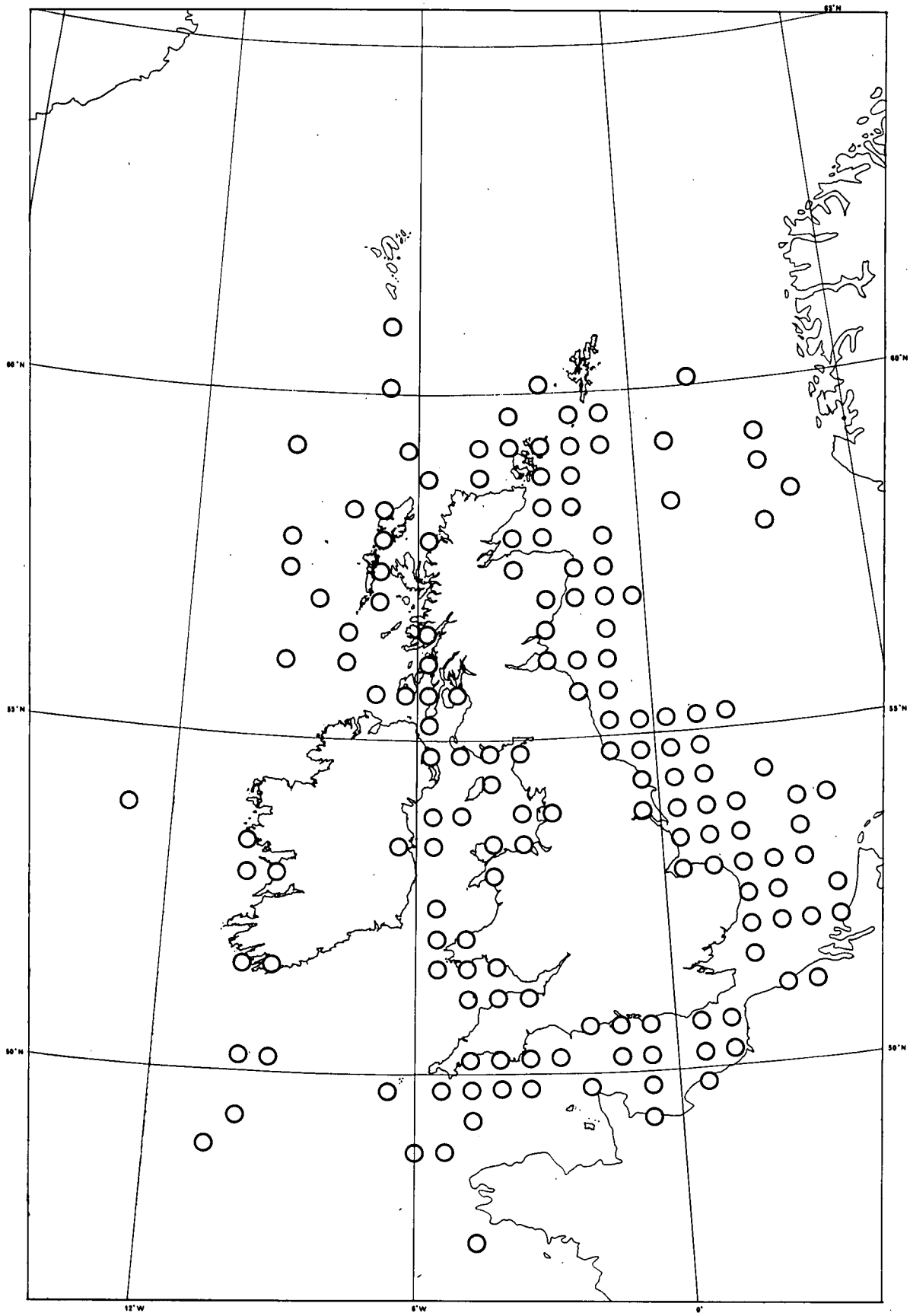
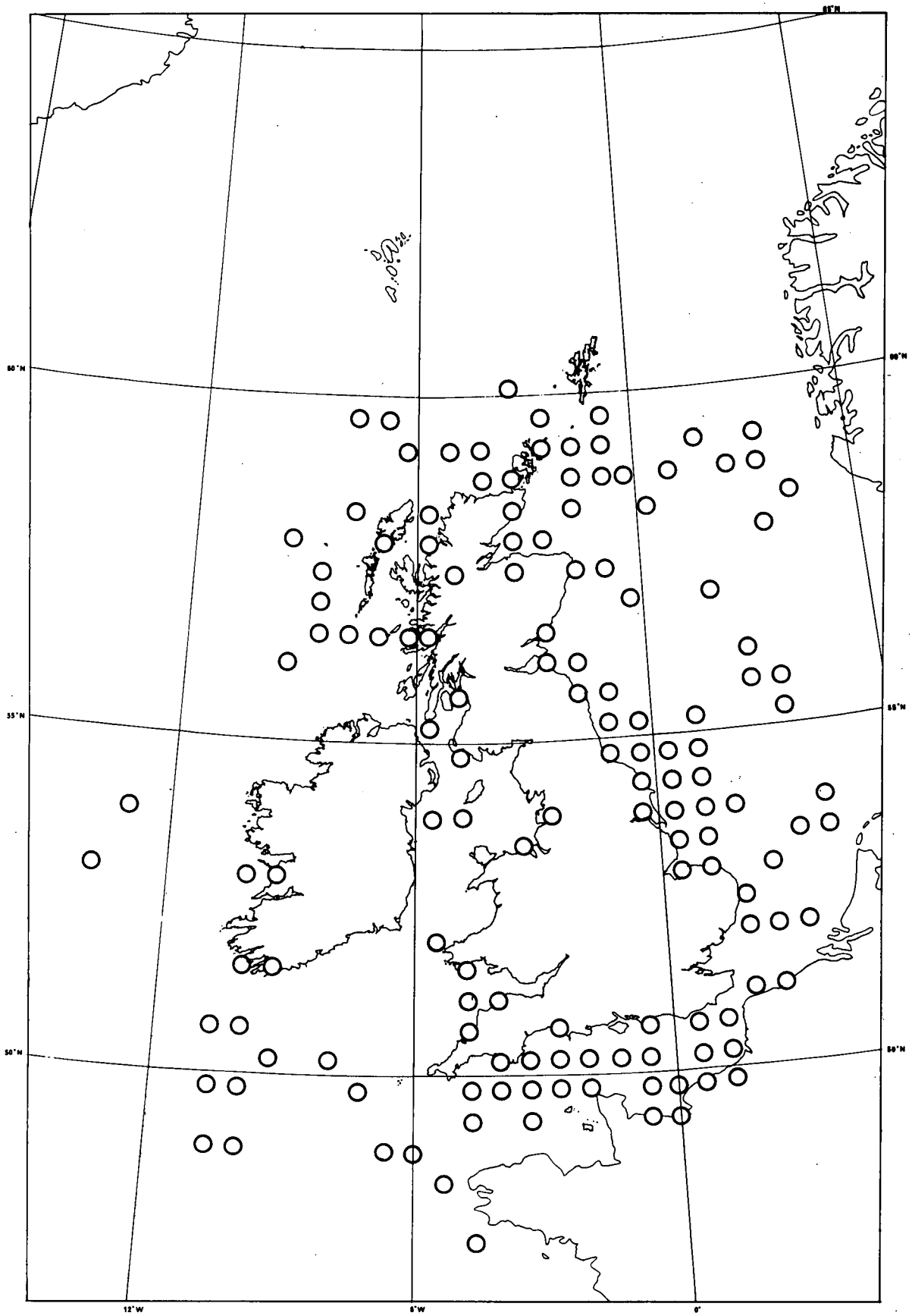


107. *Protoperidinium pellucidum* Bergh



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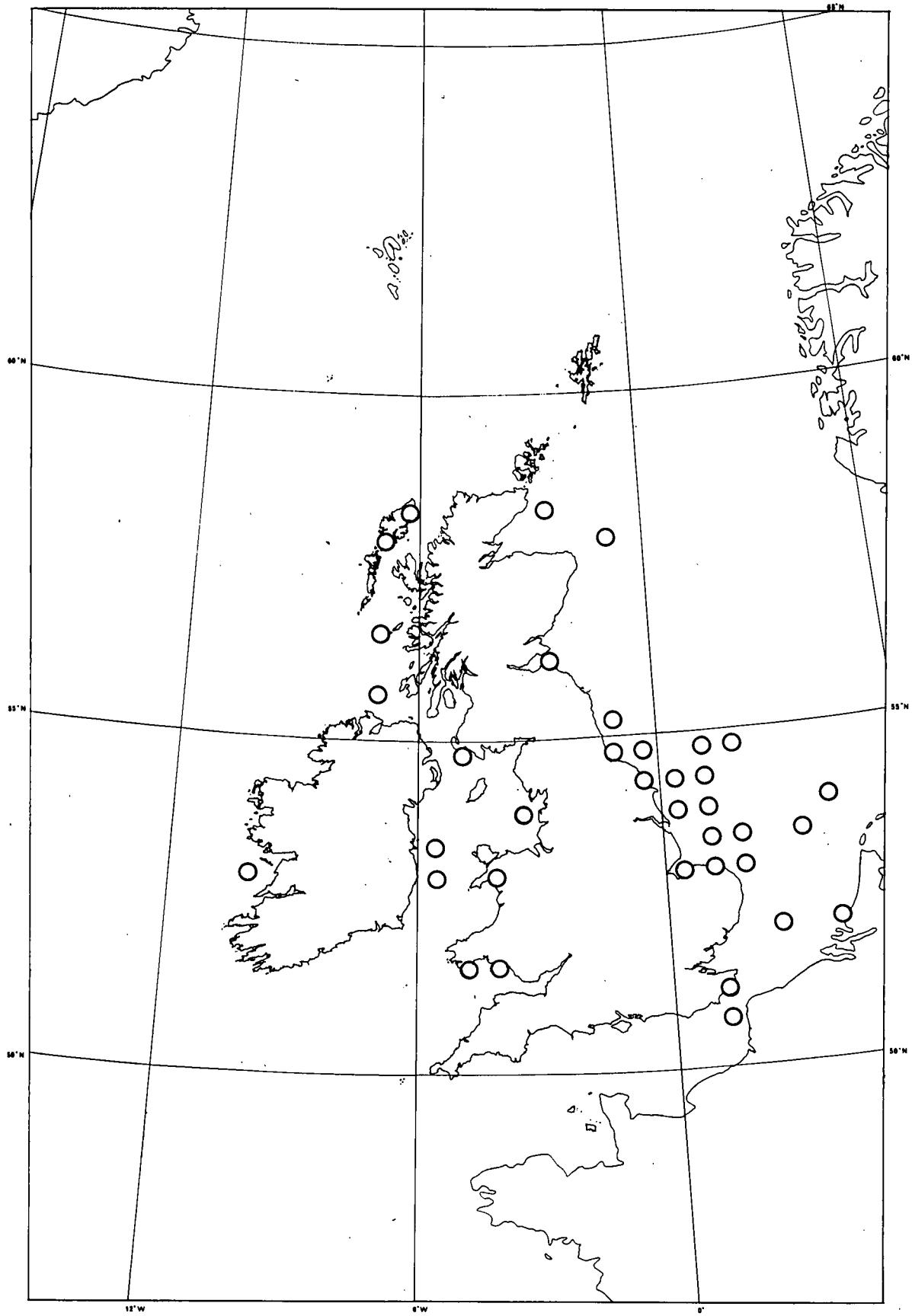
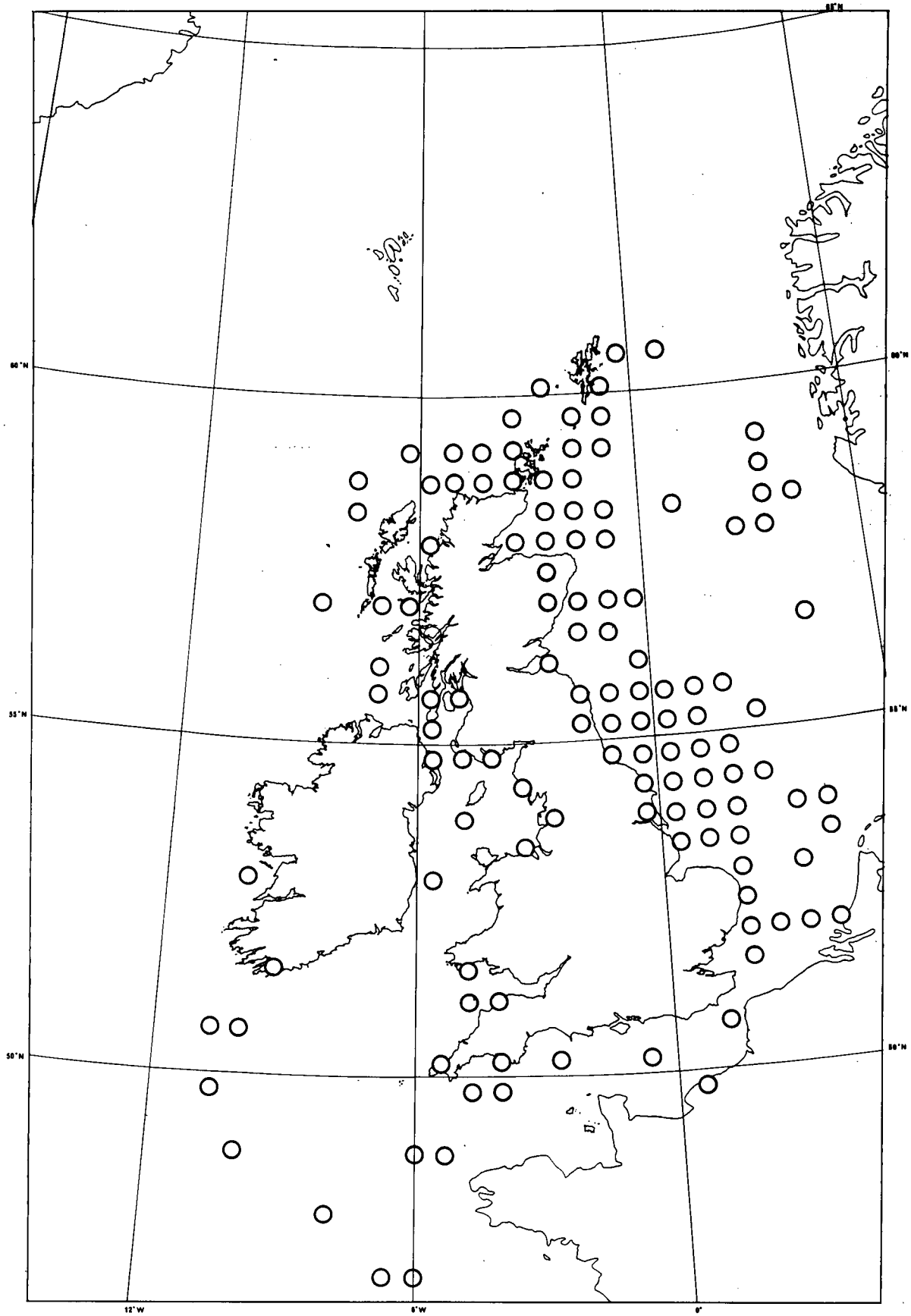
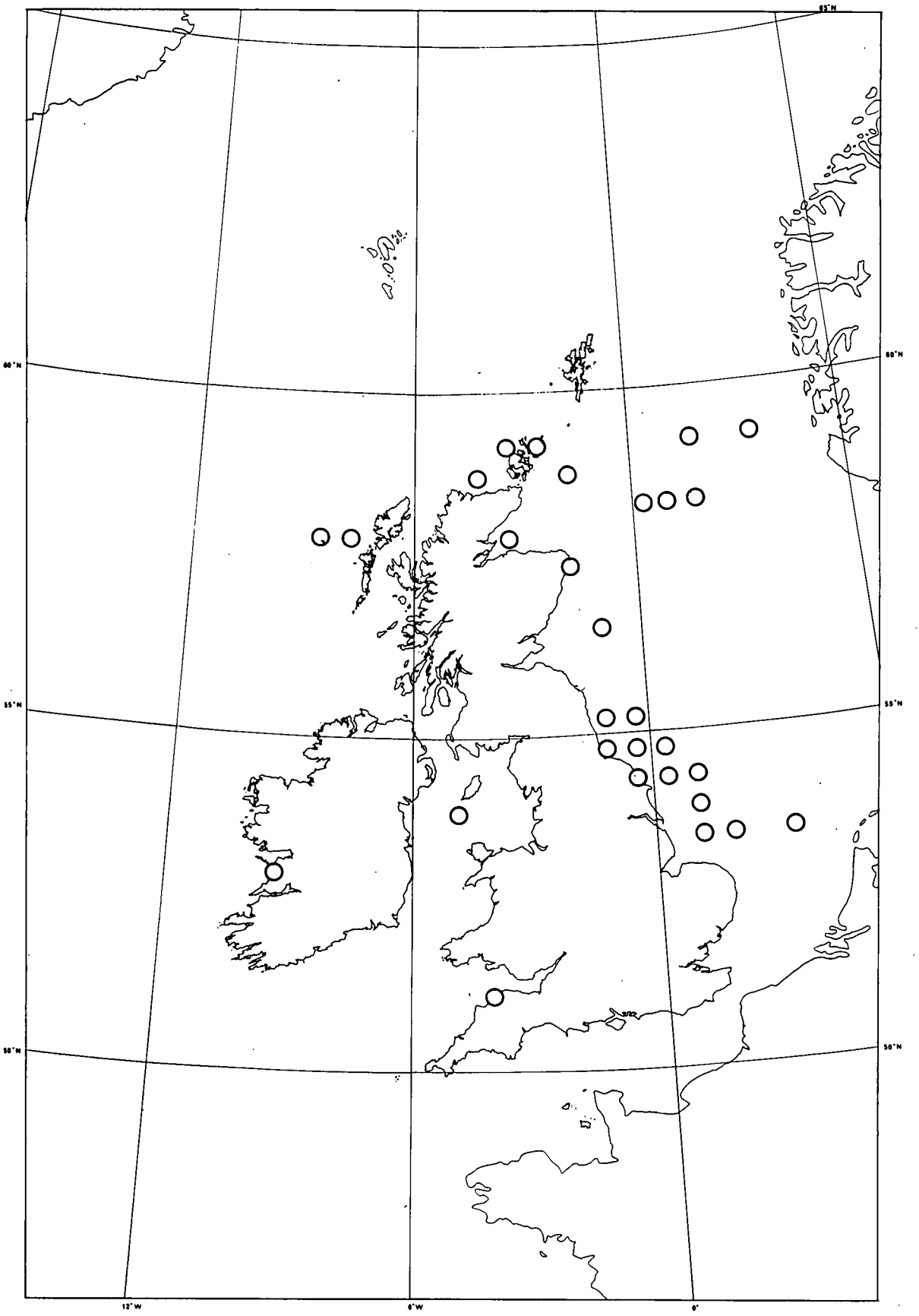


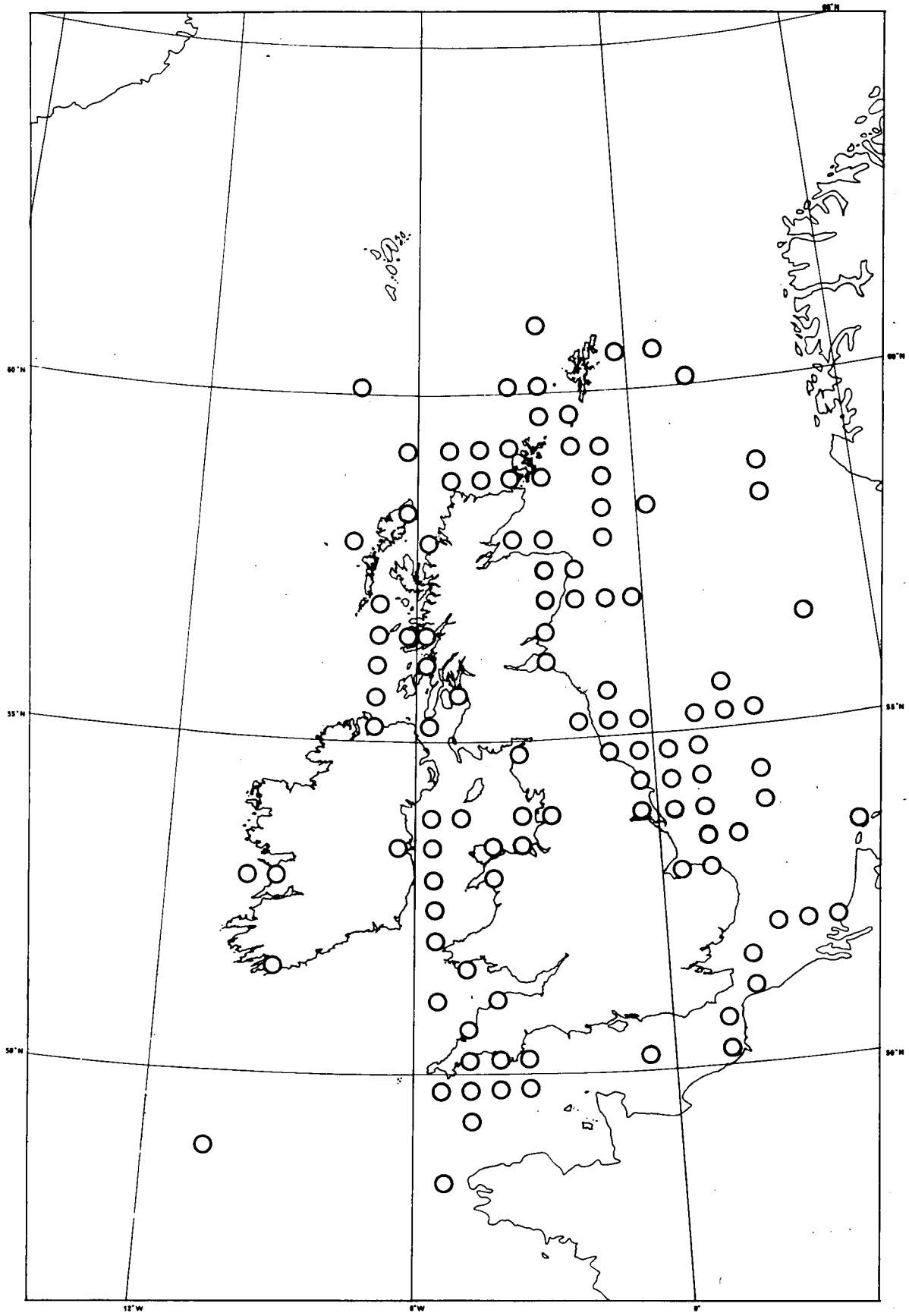
109 *Protoperidinium punctulatum* (Pauls.) Balech



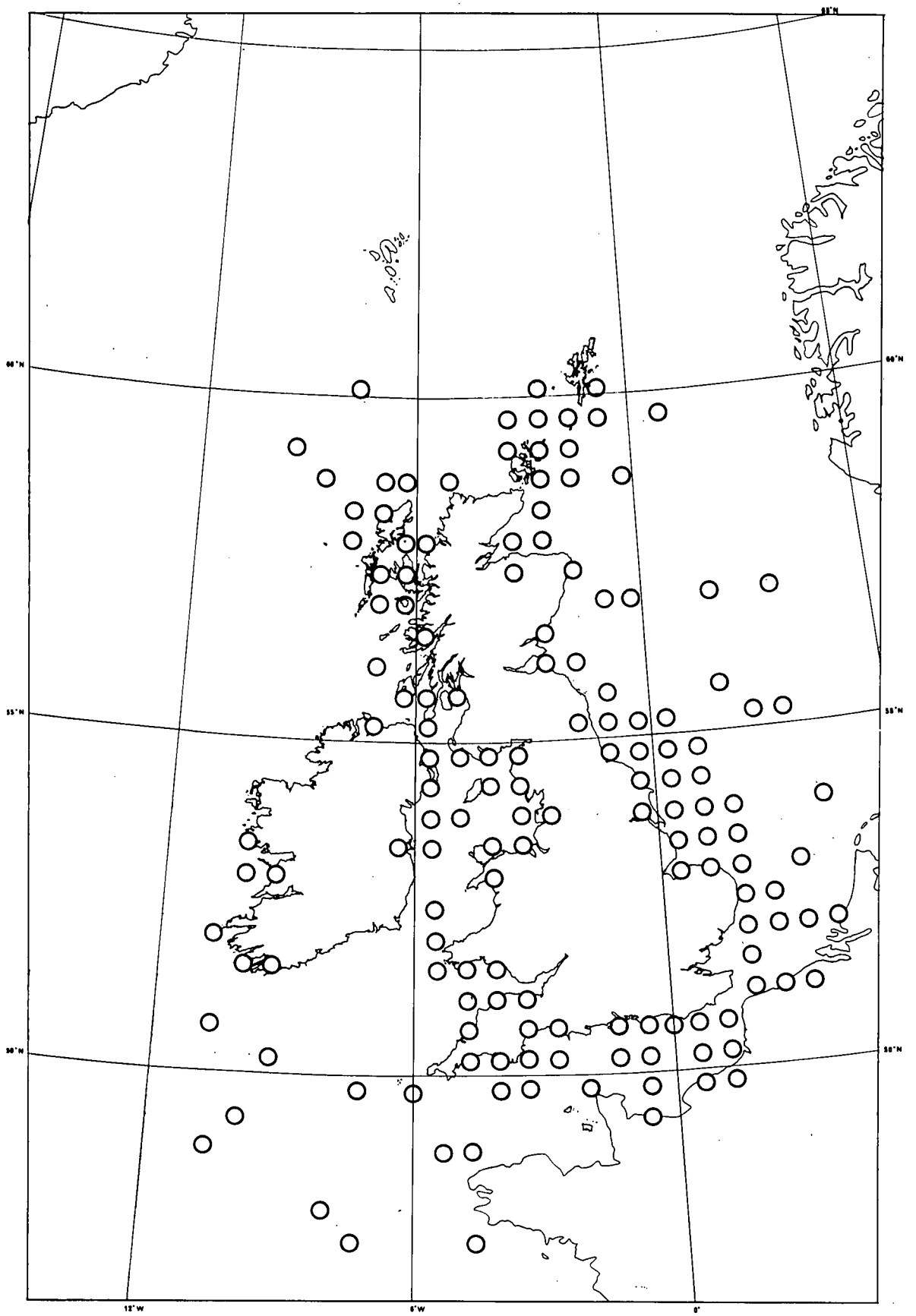
110. *Protoperidinium pyriforme* (Pauls.) Balech including *Peridinium breve* Pauls.



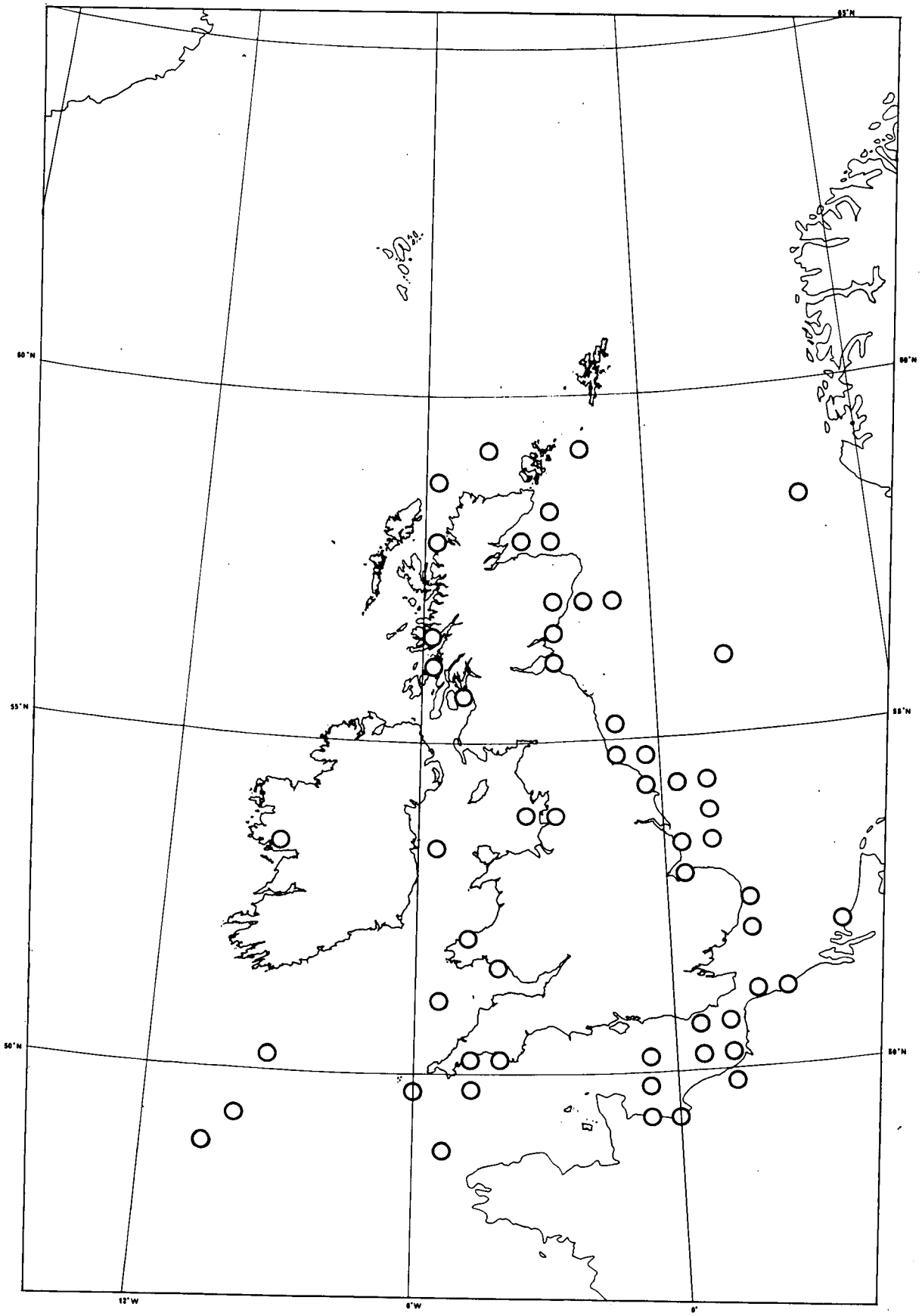
111. *Protoperidinium saltans* (Meun.) Balech



112. *Protoperidinium steinii* (Jorg.) Balech



113. *Protoperidinium subinerme* (Pauls.) Loeblich



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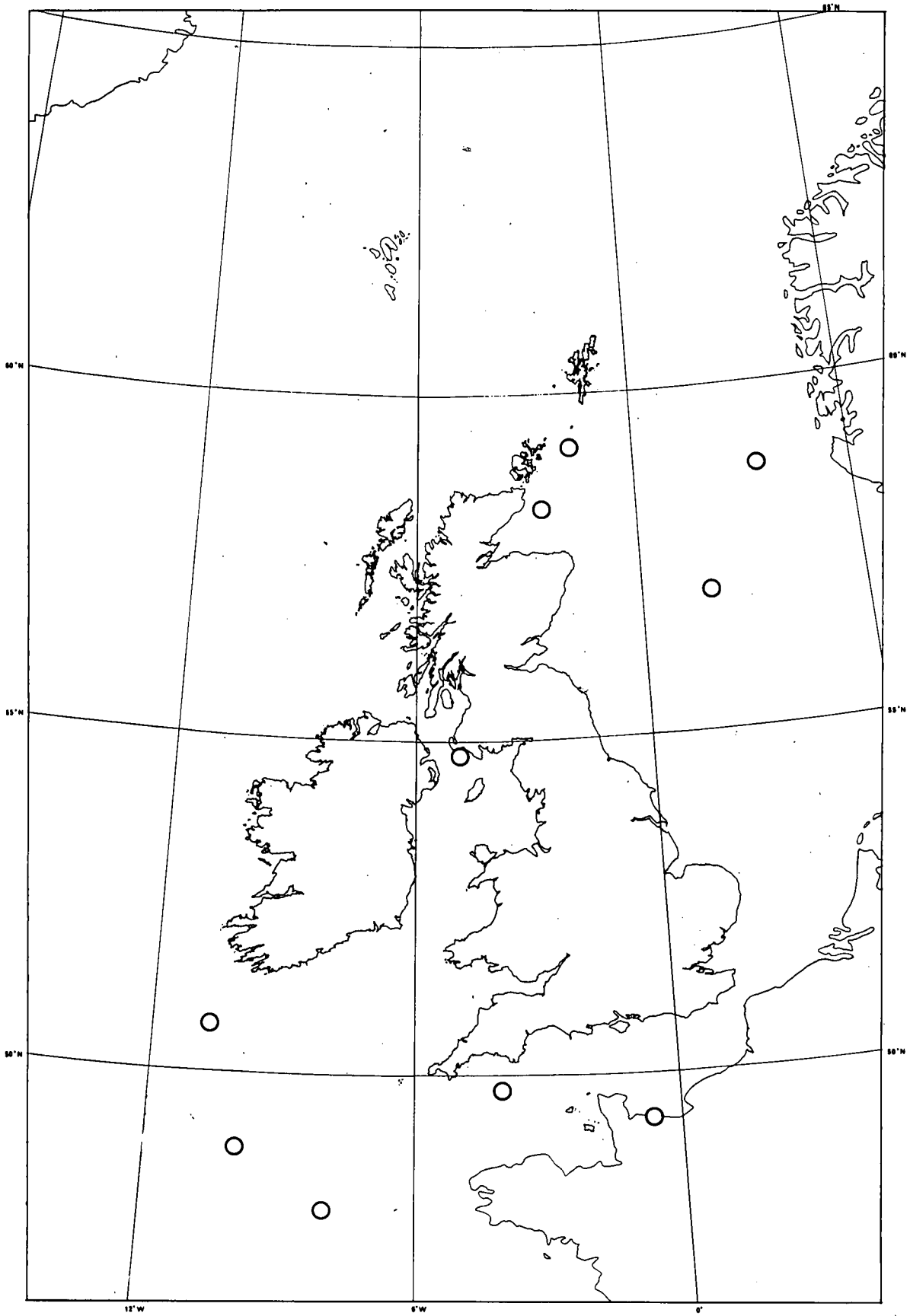
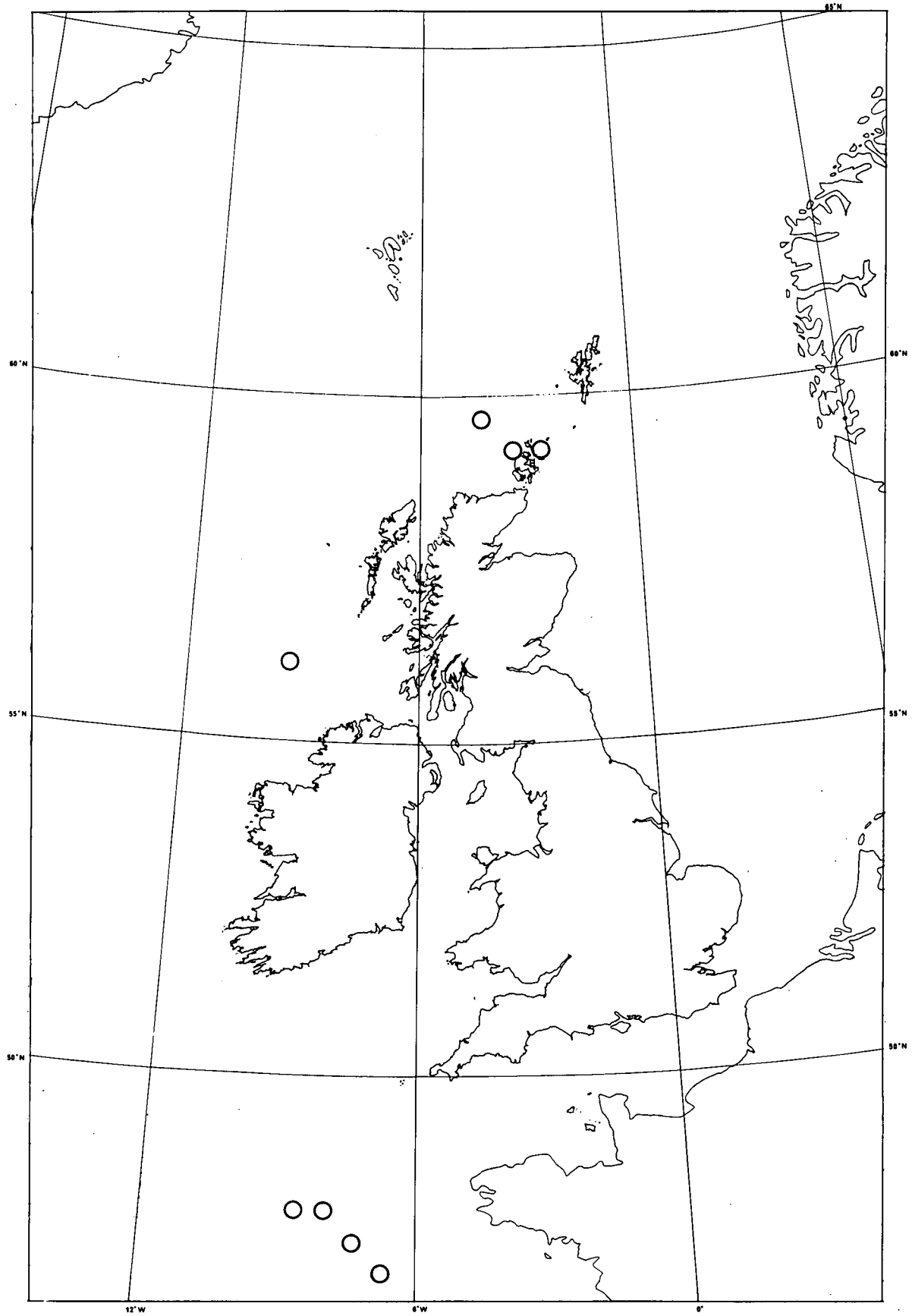
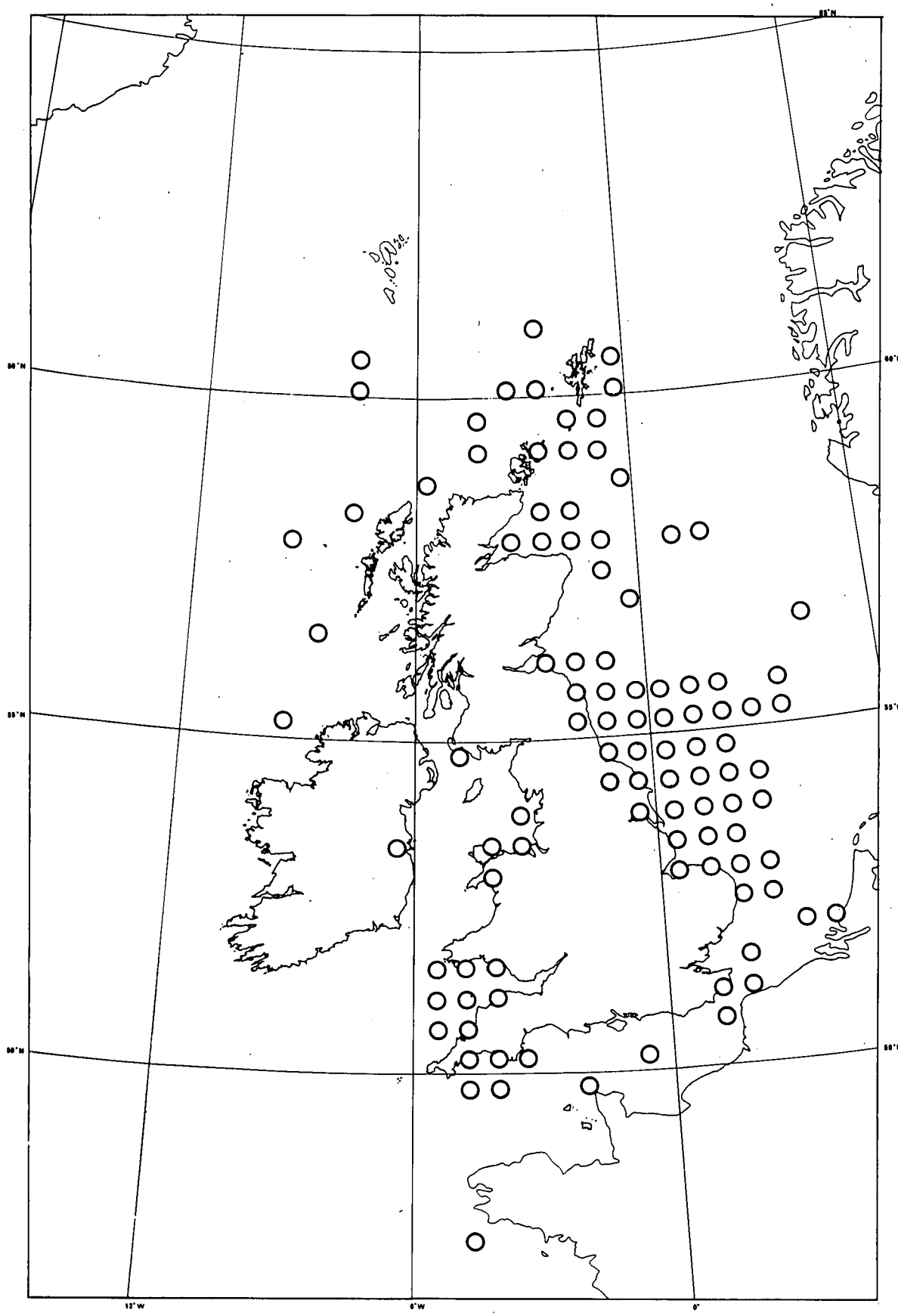


115. *Protoperidinium thulesense* (Balech) Balech



116. ***Ptychodiscus noctiluca*** **Stein**



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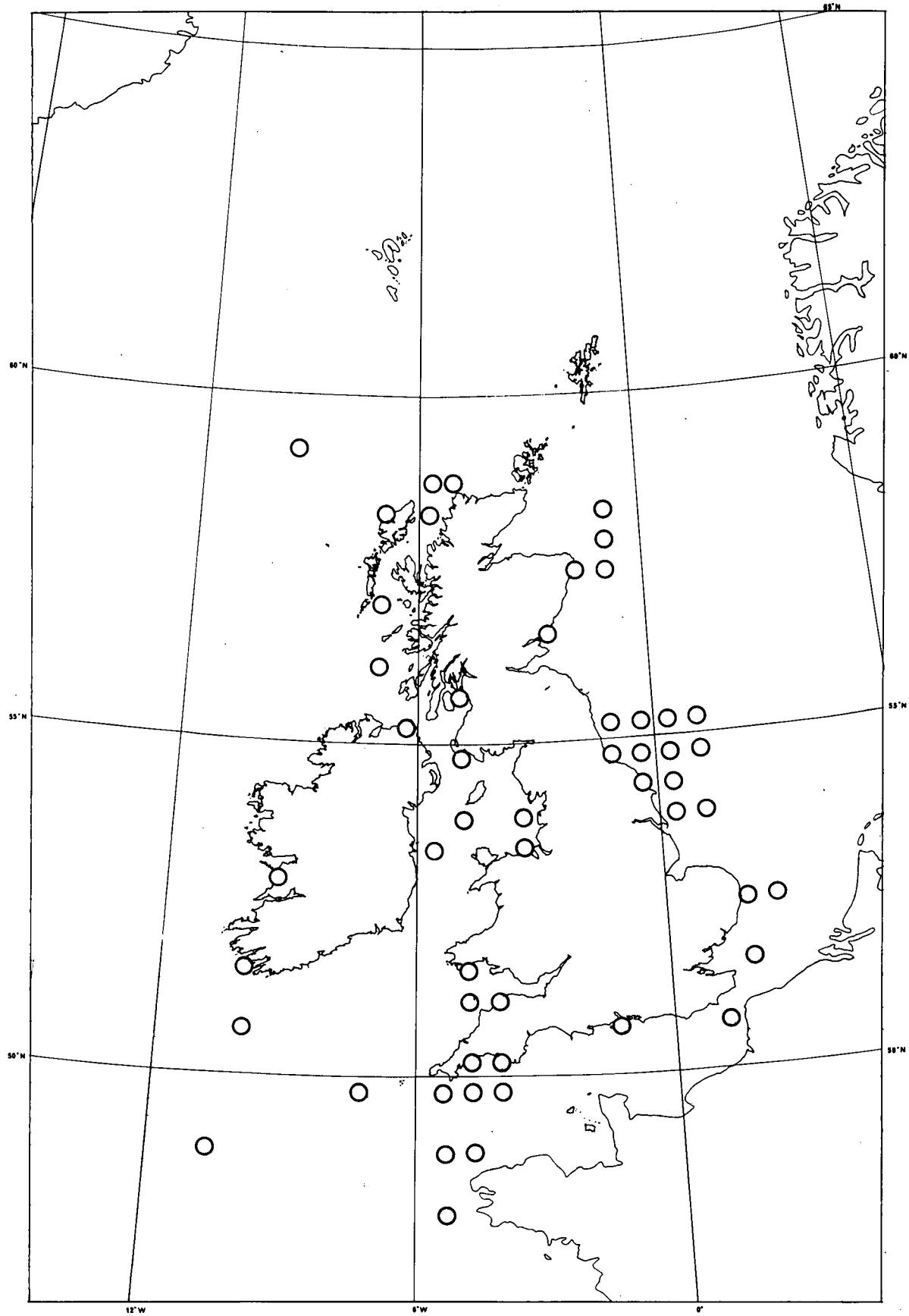

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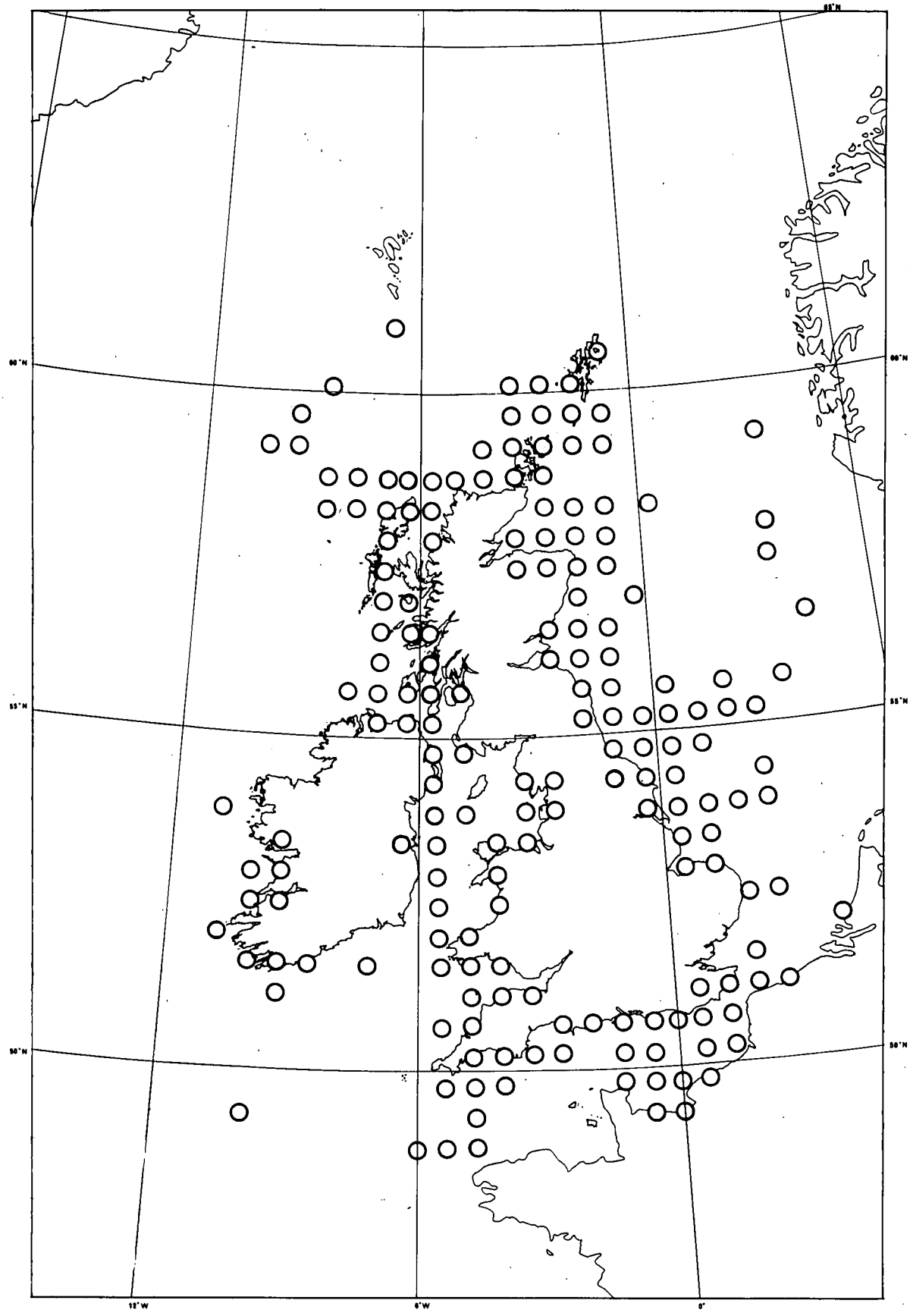

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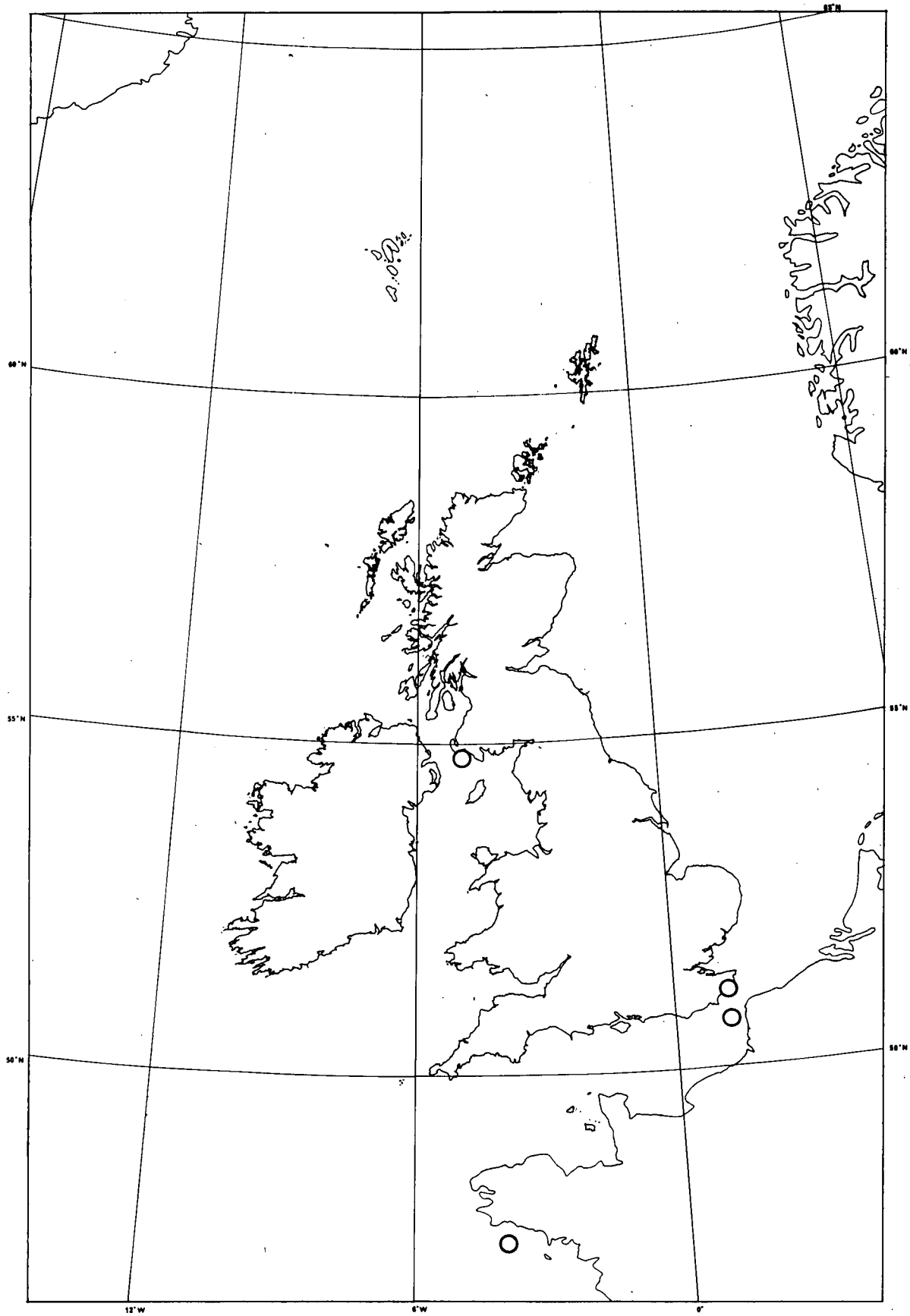

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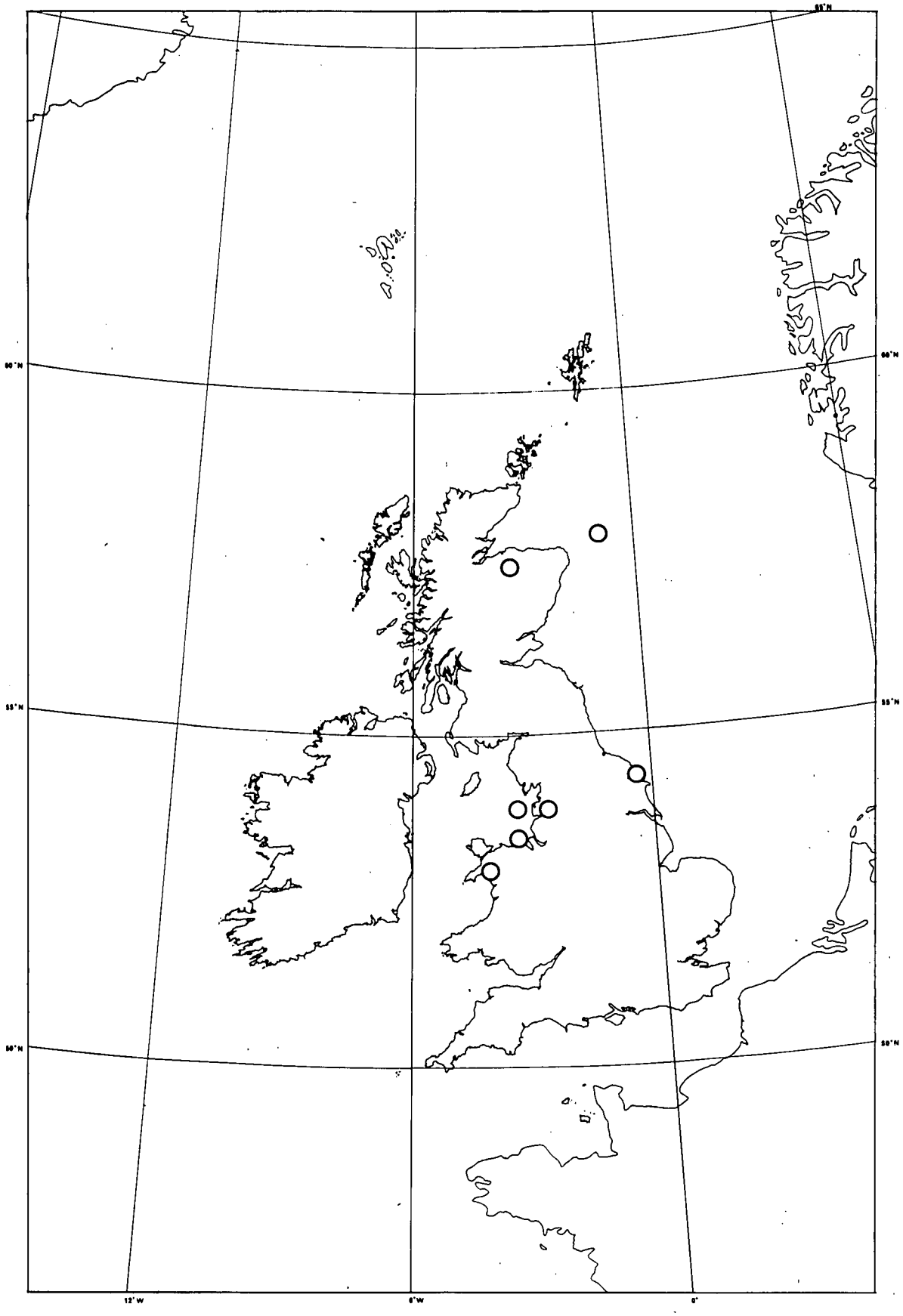

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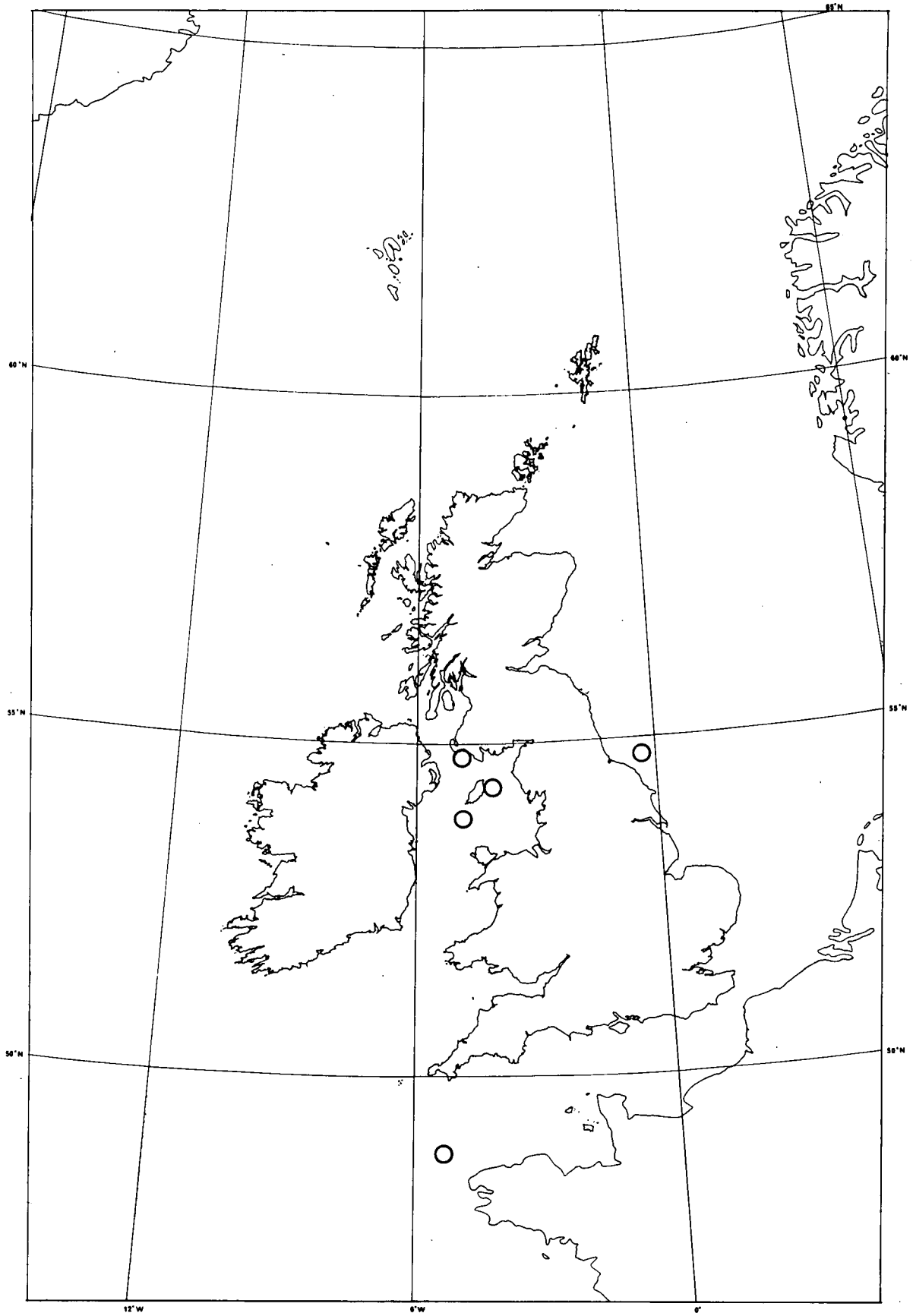

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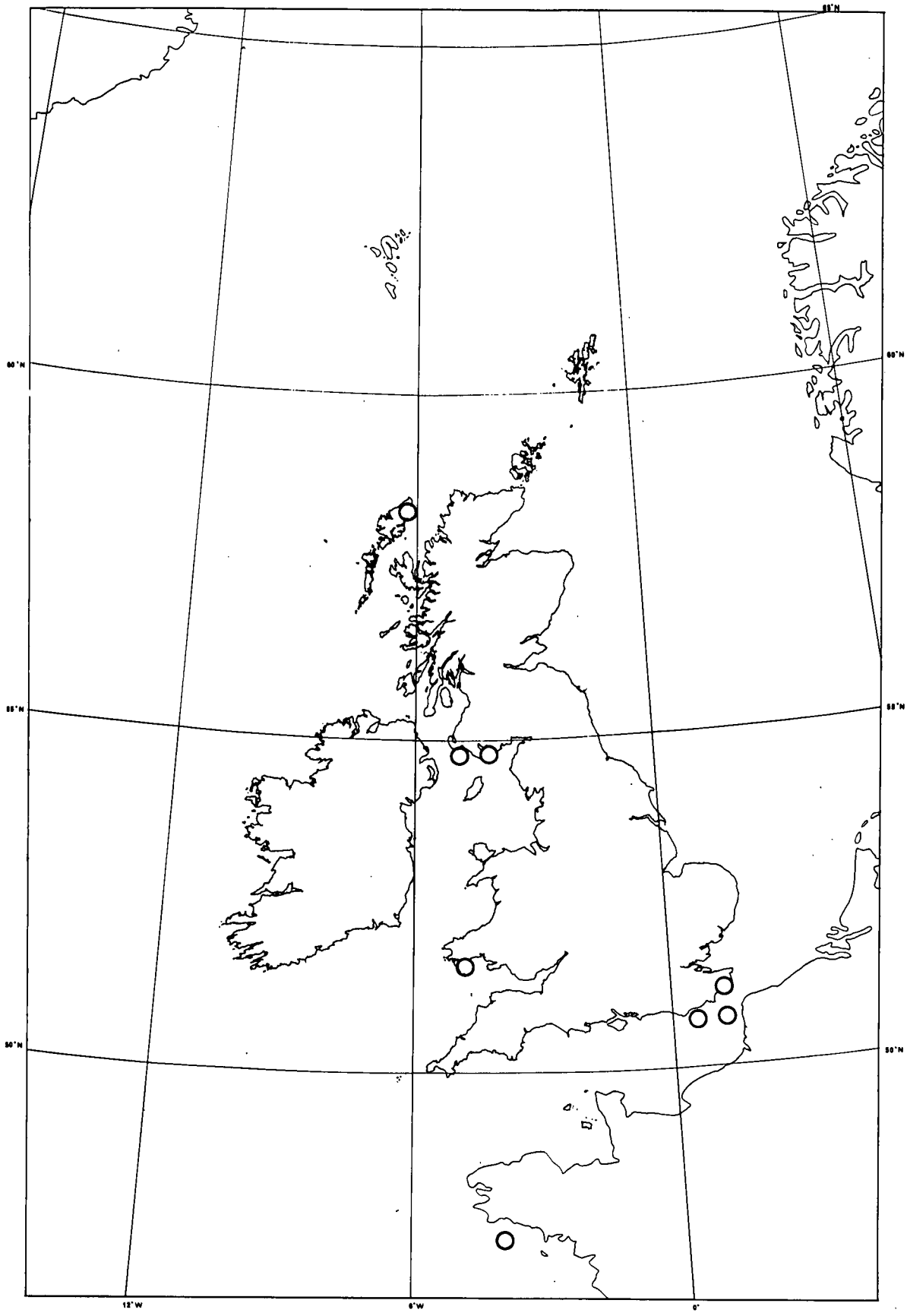

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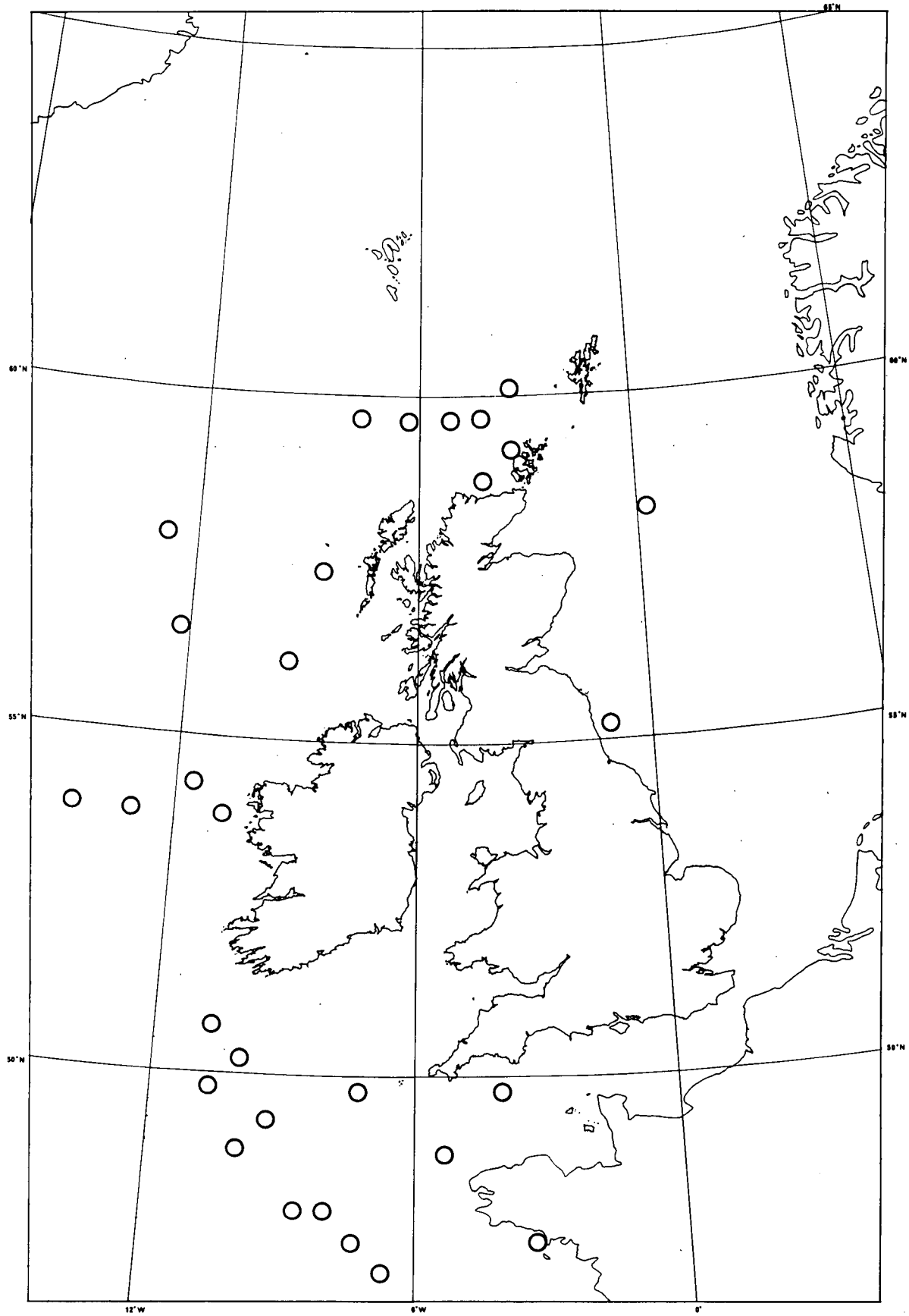

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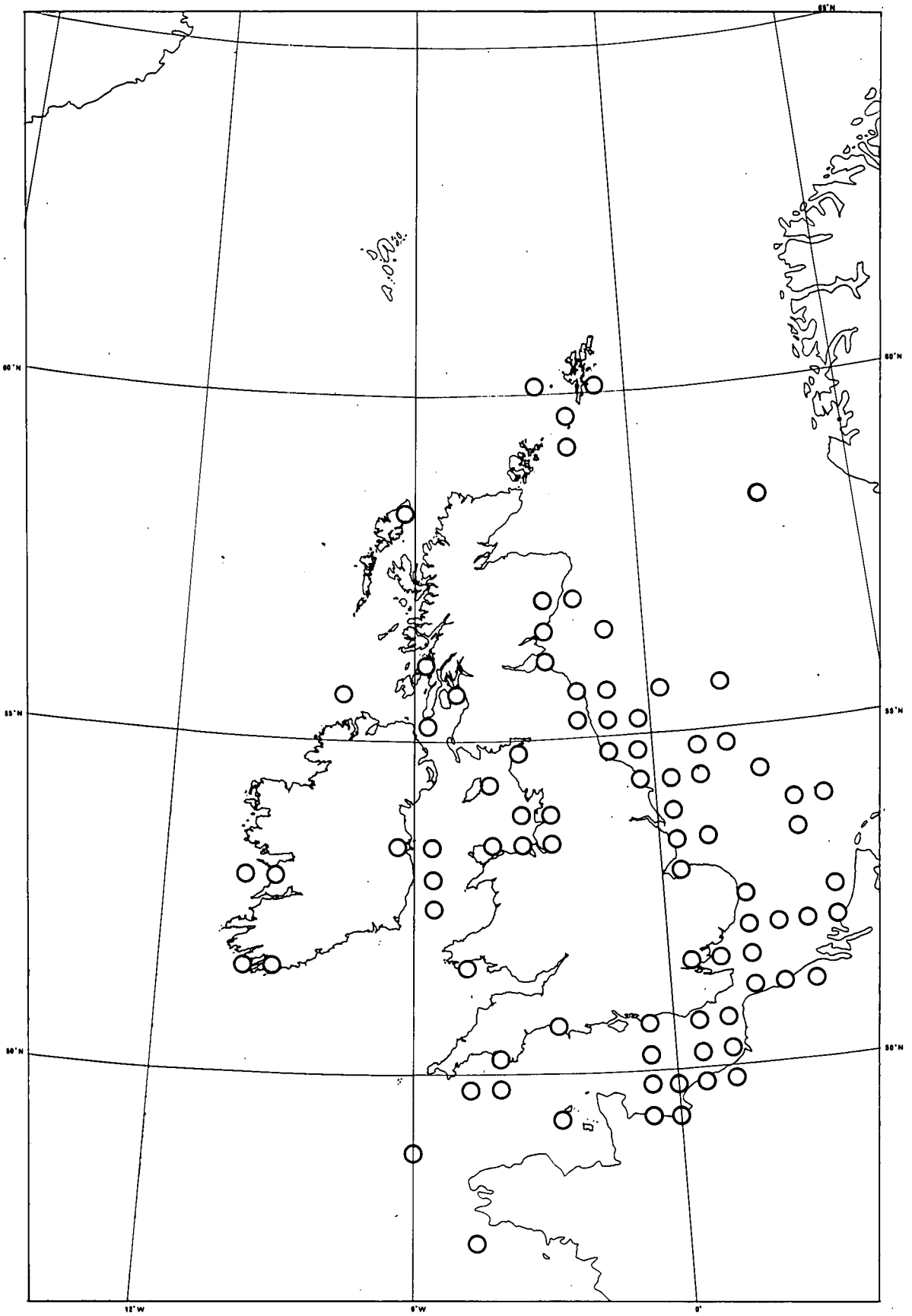

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