

THE CONTINENTAL DISTRIBUTION OF BRITISH AND IRISH MILLIPEDES

R. D. Kime

Institut Royal des Sciences Naturelles, Dept. Entomologie, 29, rue Vautier, B-1000 Bruxelles, Belgium.

INTRODUCTION

The distribution on the Continent of the millipede species that occur in Britain and Ireland is becoming better known than it was even a few years ago. Well-worked countries include those in Scandinavia, Germany, the Benelux countries, Switzerland, Austria, Slovenia and Italy (especially northern Italy). The fauna of France is rather well-known, but, as it is such a large country there are extensive areas, particularly in the centre, north and west where there is a shortage of distributional data. In Spain and Portugal, with the exception of Catalunya and the Pyrenees, there are not enough data to work out the limits of the geographical ranges of most species. It is certain that more, as yet unknown, species will be found in Spain and Portugal. Most European countries have a reasonably comprehensive list of species and all countries have been studied, sometimes in an intensive manner locally: other than in the countries previously mentioned their records are generally patchy.

Distributional patterns are an intriguing field of study because the Continental distributions are of markedly different types. In many instances it would be virtually impossible to predict these distributions from those mapped in these islands, even for common species. On the other hand, viewed from the Continent, most of the species in Britain and Ireland are distributed in a fairly predictable way. As suggested by Barber & Jones (1996), there remain some species whose presence in these islands is best explained by chance introduction. I intend to review the evidence for each species, at the same time presenting a map of its presently known geographical range. This first paper will deal with the order Julida, about half the fauna; a subsequent paper will treat all the other orders.

ORIGIN OF THE BRITISH AND IRISH FAUNA

First, I would like to outline some general considerations which relate to the arguments made by Barber & Jones (1996). Most, if not all of the species in Britain and Ireland are pioneer species that have spread north since the last glaciation: many of these have quite extensive geographical ranges in Europe. This is quite different from the situation in and south of the Alpine mountains, where most species have small ranges. Whereas species found in Britain often occur in Scandinavia, species found in Spain almost never occur in Greece, and very few of them occur in Italy. Southern Europe houses between one and two thousand mainly regional or point endemics. The distributional data are not yet sufficiently worked out to permit a precise estimation.

Suffice it to say that, in Europe, there are about one hundred species commonly found north of the Alpine mountains (Pyrenees, Alps, Carpathians), plus some others that are marginal to these mountains (peri-Alpine species), and about 1500 known species in and south of these mountains. This latter figure is subject to some taxonomical revision, which will tend to reduce the number of species, and some new discoveries which will surely be made to augment it. I am aware of a number of recently found species waiting to be described at the moment.

The effect of the formation of the English and Irish Channels after the last glaciation is interesting, leaving a number of possibilities with respect to the origin of our present fauna.

1. It is possible that species survived the last period of glaciation on the fringe of what is now these islands, if only in the South/West. According to Huntley & Birks (1983) tree species survived the Devensian in Ireland (the Atlantic was not frozen over) and the possibility of survival of millipedes cannot be ruled out - they survived on nunataks in the icefields of the continental mountains, and in caves. From our present knowledge we can say that, if this happened, it should have only involved a few of the hardiest species that occur in northern regions today.
2. Species will certainly have moved north and north-west from the still attached "Continent" during the climatic improvement that took place after the last glaciation and before Ireland and then Britain were cut off by sea-water.
3. Since the climate further improved for a while after the formation of the English Channel, species which would have arrived later may have drifted across or been transported by human agency (introduced) onto these islands and now appear to be naturally distributed; this applies especially to those which appear to be confined to southern areas. Theoretically they should be present in northern France and/or the Benelux countries.
4. Other species which may not occur in northern France or the Benelux countries, but which nevertheless find the Atlantic environment favourable, may have been introduced, and either exist in previously vacant ecological niches or compete successfully with an impoverished local fauna. Looking at their maps of distribution these species are on the face of it quite apparent introductions. But it is not all that simple because there are species on mainland Europe which occur in the mountains further south and occur in disjunct patches much further north. For instance the chordeumatid *Ceratosphys amoena* occurs in the Pyrenees and in Belgium and has not yet been found in between. The centipede *Lithobius microps exarmatus* occurs in the Pyrenees, Wales and the Belgian Ardennes and has not to my knowledge been recorded elsewhere either. Are these native relics which had a wider distribution when it was colder? There are several other examples of this phenomenon in the myriapod fauna of Western Europe.

It is likely that some species so far unrecorded do actually occur and will be found in Britain or Ireland. There are several species with continental distributions that resemble those of species which occur here, and which are possible candidates.

An important step that is required in order to further elucidate these possibilities is the accumulation of data on the fauna of the northern and western regions of the Continent. As already indicated, the best worked parts of France are the South and East; the North and West have received little attention, together with much of the Centre. This matter is being rectified, but in a large country of almost 550,000km² the task with respect to 10km mapping is immense. The list of species is more complete than the distribution maps; nearly 300 species have been recorded (Geoffroy, 1996). Given the gaps that occur in Northern Spain and Portugal as well, distribution limits of Atlantic species are often unclear. Most of the north-west corner of Germany is very poorly known too. Thus, my comments on European distributions of British and Irish species have to be tempered with some uncertainty about a number of them, particularly those confined to the Atlantic zone.

The maps will speak for themselves, some are much more complete than others.

CLIMATIC ZONES OF EUROPE

From a biogeographical standpoint we know that climatic factors are of paramount importance in determining millipede distribution. At our latitudes, minimum winter temperatures, humidity and rainfall may be especially significant parameters. Minimum summer temperatures may be significant too, as well as maximum summer temperatures, especially in the southern half of Europe, where they may exceed 40 C. These are factors that limit distribution on a continental scale. In discussing geographical range of whole species we do not need to discuss locally important ecological factors, such as humus type, unless they are limited on a regional scale by these major climatic considerations.

Britain and Ireland are in the Atlantic Zone (see Figure 1). Subject to local variation, with respect to the Continent the summers are relatively cool and the winters are relatively mild. However, in the West of France and the North-west of Spain it is similarly oceanic and generally warmer than in Britain; in Norway it is cooler. These are very evident facts, they are also very significant. Whereas the temperature declines from south to north in summertime, it tends to decline from west to east in winter when eastern France is much colder than the West. Whilst in Britain and Ireland we may see a SW-NE gradient of sorts (e.g. see Hill, 1991), in France there is a big difference in the fauna of the Atlantic zone and that of the East. Most Atlantic species do not occur in Alsace, not even in the eastern half of France south of the Atlantic zone, according to present evidence. Central Spain is colder than the coastal regions in winter, hotter in summer and dryer during both. All these factors restrict Atlantic species. However, we do also have Central, Alpine and Mediterranean species in Britain and Ireland.

TYPES OF MILLIPEDE DISTRIBUTION

There are strict Atlantic species, which do not occur outside the zone shown on Figure 1, many of which do not get as far north as Britain. There is a second group which is basically Atlantic, but which extends to different degrees into the Central and Baltic

zones and/or into the Mediterranean zone. These species may reach as far as Southern Finland/Russia near the North and Baltic seas, or as far as North-east Spain/North-west Italy in the Mediterranean Basin. Those that reach the Eastern zone are generally synanthropic there.

Unsurprisingly, many British and Irish species are Atlantic in distribution. Yet there is another large group which extends north-west from Central Europe; these species reach the North Sea coast but not the west or south coasts of France. They appear to withstand colder temperatures in winter than the Atlantic species: they may not be suited to high summer temperatures - some of them are mainly confined to montane areas in the more continental part of their range. They may extend to Ireland and they may be commoner in the north and east of Britain e.g. *Craspedosoma rawlinsi*, *Melogona voigti*: our species extend into southern Scandinavia (the Baltic zone) as well. From the European perspective, many central species do not reach either Britain or Scandinavia, nor even the North German Plain. They are strictly central species. Those that do reach our shores should probably be referred to as Central/NW species, but I will refer to them as central species with regard to Britain and Ireland.

Apart from these three noticeable groups of millipedes there are other types of distribution, including the pan-European species found more or less throughout the Continent. There are very few of these, in marked contrast to the case of more mobile groups of animals, e.g. insects.

There are those already referred to which occur in the Alps and/or Pyrenees and then much further north. These are not the zoological equivalent of Arctic/Alpine plants, since there are no Arctic, or Boreal millipedes. Millipedes are almost non-existent in the northern half of Scandinavia.

There are, of course, some maritime myriapods. While some have maritime tendencies, e.g. *Cylindroiulus latestriatus*, *Brachyiulus pusillus*, entirely littoral species are very few.

British species which have not yet been found in France or Belgium are particularly hard to explain, with the exception of species which clearly have their origin in the Mediterranean zone and may be introductions: these may eventually be found in France as well.

Summarising, I shall refer to the following categories:

1. **Atlantic.** Used strictly for species confined to the zone.
2. **Extended Atlantic.** Used for species stretching further east into other zones.
3. **Central.** Species extending NW towards Britain and Ireland and N towards Scandinavia from the Alps.
4. **Pan-European.** Species found almost everywhere in Europe.
5. **Alpine.** In our case species occurring in the Alps and/or Pyrenees, not yet found in lowland France or the Benelux Countries and found in Britain/Ireland. Distributions are disjunct.
6. **Littoral.** Maritime species.
7. **Introduced.** Used where this seems to be reasonably certain.

Most of our species fall fairly easily into one of these categories. The origins of some, however, remain highly debatable.

EUROPEAN DISTRIBUTION OF BRITISH AND IRISH SPECIES

The species listed in this section are numbered to correspond with the numbers on their maps of distribution.

Order JULIDA

Family NEMASOMATIDAE

1. *Thalasssobates littoralis* (Silvestri, 1903.)

While we may certainly regard this species as littoral, there is not enough known about its distribution to fully explain its presence in Britain. The British records, together with another from the west coast of Sweden, constitute the Atlantic/North Sea data. All other existing records emanate from the western part of the Mediterranean Basin, as far east as the Adriatic Sea. The dearth of records from the western coasts of continental Europe may be entirely due to a lack of collecting. On the other hand it may not, it is too early to say. The Atlantic coast has been largely neglected by myriapodologists. There is also the question of substrate to consider; the records indicate that shingle or rocky coasts are important habitats whereas there are long stretches of coast without these features. Some sandy or muddy coasts have been examined, but these were mainly along the North Sea. At present we are left with a huge gap between the Mediterranean records and the others. It would be useful to know how this specialised species is dispersed in the normal course of events. As it has been introduced into the USA (Enghoff, 1987), is this the way that it spread to the several sites in Britain?

2. *Nemasoma varicorne* C. L. Koch, 1847.

Enghoff (1976, 1994) provides a map of distribution which shows that a bisexual form occupies Central Europe and that a parthenogenetic form exists in the peripheral areas which include Britain, Ireland and southern parts of Scandinavia. It is in fact a species of Mediterranean origin (Enghoff, 1976), although, as far as we know, it occurs only sporadically in that zone today, and occupies a rather central position. Aided doubtless by its parthenogenesis, it has managed to colonise a large part of Europe, into the Atlantic, Baltic and Eastern zones.

My map shows some blank areas in regions where *N. varicorne* is common. This is because, for instance, the important reference work for Germany by Schubart (1934) does not give localities for this species, containing just a list of regions. In the past authors often had this approach to common species. I have only placed dots on my maps when I had a precise locality to refer to. But I shall indicate such anomalies in the text of future atlases. *Nemasoma varicorne* probably occurs in all regions of Central Europe. My experience is that it is patchy, I have looked under the dead bark of countless trees without finding it, I found it much more frequently in England than I do on the Continent.

Family BLANIULIDAE

3. *Proteroiulus fuscus* Am Stein, 1857.

Maps showing the distribution of *P. fuscus* have been published by Enghoff (1978) and Kime (1990). It is another parthenogenetic species, with a more extensive northern distribution than *N. varicorne*, occurring in Iceland, northern Finland and further east in Russia. *P. fuscus* is one of the most abundant millipedes in Europe between 48°N and the Arctic Circle. It might also be regarded technically as a central species, however, it is less common in Central Europe, where it is largely confined to forests in the mountains. For instance, Pedroli-Christen (1993) gives only nine stations for the whole of Switzerland, a rather well-recorded country. Like *N. varicorne* it is unrecorded from Iberia and most of France; it is also unrecorded from the Balkans. Yet it is a pioneering species and has reached Madeira, the Azores, North America and South Africa. There is an isolated record from a mountain in Sicily. Under-bark temperatures may be significant, it appears to be absent from hot areas. It may have moved both north and upwards since the ice age. My impression is once again that this animal is far more abundant in Britain than in Northern France, Belgium, Luxemburg or West Germany. On a visit to Finland it was the species that I found the most.

4. *Choneiulus palmatus* (Nemec, 1895)

Blaniulids associate so much with human activity that it is sometimes difficult to fully discern their range in natural habitats. The genus *Choneiulus* is centred on the western half of the Mediterranean zone, *C. palmatus* being its only representative north of the Alpine mountains. It appears to have an extended Atlantic distribution; most references from the north and east of its range are synanthropic. It has reached Madeira, the Azores and North America. Data from SW France suggest that it is not a central species, even though there are many records from some central regions. In Switzerland it is found in the warmer valleys, consistent with an Atlantic species. In Western Europe, too, it occurs in deciduous forests, where it may be found in the soil, leaf litter or under bark. This might be a natural habitat.

5. *Nopoiulus kochii* (Gervais, 1847)

I have some reservations about its type of distribution. It occurs in all central countries, but is also reported from western parts of France. It has been found often in SE Europe, as far afield as Greece and Turkey, and down the Italian peninsula to Sicily. It occurs in the Caucasus and extends towards the Ural Mountains in Russia. Unfortunately there has been some taxonomic confusion concerning this species. Other species of the genus occur in the Mediterranean Basin. *N. kochii* is the pioneering species, having been recorded from New Zealand, North and South America in addition to much of Europe. It might eventually be found anywhere in Europe.

6. *Blaniulus guttulatus* (Fabricius, 1798)

There are about ten species of *Blaniulus* occurring mainly in the western Mediterranean area, reminiscent of *Choneiulus*. The pioneering and strongly synanthropic *B. guttulatus* has a large extended Atlantic distribution at least. Some authors have said that it occurs throughout Europe, though this does not appear to be the case. Records from southern Europe are extremely scarce. It is clearly yet another pioneer and might turn up almost anywhere. It has an extensive distribution outside Europe, especially in Canada, the United States of America and Atlantic Islands. If synanthropic records are ignored it is found in woodland on calcareous soils in

Western Europe, and, like *C. palmatus*, might be native to woodland in the Atlantic zone. It is also regularly found in caves. Several species of *Blaniulus* are troglobionts.

7. *Archiboreoiulus pallidus* (Brade-Birks, 1920)

Much less frequently recorded on the Continent than the preceding blaniulids, *A. pallidus* is found in similar base-rich situations to *B. guttulatus* and *C. palmatus*, mostly in NW Europe, where, again, it is found in forests as well as in association with man. Once more, an extended Atlantic distribution is implicated. It extends to Finland and Russia as a synanthrope. The species has been found in Canada. A significant proportion of continental records are from soil samples and caves; in Hungary it is known only as a cavernicole.

8. *Boreoiulus tenuis* (Bigler, 1913)

This is yet another species found in base-rich soils and occurring in forest in the north of the Atlantic zone as well as synanthropically. The map suggests that it is a central species.

Family JULIDAE

9. *Ommatoiulus sabulosus* (Linnaeus, 1758)

The well-known and much-studied *O. sabulosus* is one of the most widely distributed European millipedes. It occurs in all the climatic zones and is as entitled to be called pan-European as any other millipede. It has not been found in Greece, a number of major Mediterranean islands and much of Iberia, where many more species of the genus are present. In fact, in Spain, there are at least thirty recorded species of *Ommatoiulus* and much uncertainty about distributional limits. My map is not complete, particularly to the south and east of the Baltic Sea. It reaches the Eastern zone in Russia and the Ukraine. It is eurytopic and has an altitudinal range of nearly 3000m, even though it is particularly associated with warm habitats and sandy areas. Its distribution nevertheless appears spatially patchy and populations fluctuate considerably with the passage of time.

10. *Tachypodoiulus niger* (Leach, 1815)

This animal has an extended Atlantic distribution, shown clearly on the map. It is eurytopic and generally very common throughout its range, reaching maximum population densities in woodland, especially on limestone. It is very scarce on peaty soils, being rare or absent from the polders in Belgium and Holland. Although we may regard it as thermophile it is absent from the Bavarian plain and from low ground in the south of France (Mauriès, pers. comm.). Yet it is common further south but higher up in the Pyrenees and extends into the northern mountains of Spain where its limits of distribution remain to be worked out. Gaps in the map in the northern half of France are attributable to a lack of collecting.

11. *Cylindroiulus londinensis* (Leach, 1815)

C. londinensis has an Atlantic distribution. On the Continent there are correct records only from west and central parts of France and from some northern parts of Spain. All the references to this species from other Continental countries actually relate to *C. caeruleocinctus*, with which it was either confused or thought to be conspecific. Most of the true data are from woodland, frequently oakwoods on calcareous soils, but there are others from litter in woods on well-drained acidic soils. Some of these woods were

fairly open or scrubby. Demange (1981) states that it reaches 2000m in France, above the tree line. On the map in Kime (1990) the dots for southern France and Spain were accidentally printed one square too far to the south: with the possible exception of the southernmost dot this was of little consequence but has been rectified here. It may well occur in NW Spain, the area is practically unstudied.

12. *Cylindroiulus caeruleocinctus* (Wood, 1864)

I have identified several thousand individuals of this species, mainly as a result of pitfall trapping in Belgium and Luxemburg, where it is abundant in open habitats, principally grassland. But it may be equally common in cultivated ground, parks, orchards and gardens, showing pioneering and synanthropic tendencies. On the Continent SE of Britain it is one of the most abundant species as far as the Jura mountains and the western calcareous Alps in Switzerland. In Britain it has been linked with calcareous soils, e.g. by Blower (1985). The same is true on the Continent, e.g. by Pedrolí-Christen (1993) and Haacker (1968), who described it as a synanthropic species of fields and gardens on hard alkaline soil. However, I have also found it in acidic woodland on greensand in Surrey, Hampshire and Sussex and suggested that this might reflect its tolerance of dry environments. SE England is relatively dry, differing in some respects from the rest of Britain. In Belgium and Luxemburg the woods are full of chordeumatids; I have not found *C. caeruleocinctus* in continental woodland. In SE England chordeumatids are rare, one of its particular features, probably connected with well-drained sandy or calcareous substrates and the low rainfall. Rainfall figures are higher in Belgium.

The distribution type of *C. caeruleocinctus* is presumably extended Atlantic. Doubts may arise because it has an unusually large distribution for one of this kind, extending through Poland into Russia in synanthropic situations. But then it has also colonised the eastern regions of North America. Doubts might also arise because of the paucity of records from the Atlantic part of France. But the amount of collecting in open sites has been minimal here; I have found it in the Atlantic zone in soil samples taken from fields in agricultural areas on chalk.

13. *Cylindroiulus vulnerarius* (Berlese, 1888)

This is one of the 42 species of *Cylindroiulus* found on the Italian list (Foddai *et al.*, 1995) over half of which are endemics. There are numerous records north of the Alps now, substantially in biotopes associated with human activity in or near cities; I have precise data on more localities from Belgium and the Netherlands (Berg, 1995) than from Italy. In view of the large gap on the map between occurrences in Italy and those in France, the Low Countries, Sweden and Britain it is most likely to have been introduced everywhere outside Italy.

14. *Cylindroiulus salicivorus*

C. salicivorus is listed as an Italian endemic species with a cis-Alpine distribution. Its recent discovery in Scotland is the only known occurrence elsewhere. It must have been introduced.

15. *Cylindroiulus punctatus* (Leach, 1815)

We know that *C. punctatus* is extremely common in NW Europe. It has an extended Atlantic distribution. It does not penetrate into areas that are regularly cold in the

winter and, presumably for this reason, is absent from high ground within its range. Like *T. niger* it is widely reported from the Pyrenees and possibly occurs throughout the northern Spanish mountains. The gaps on the map in northern France and Spain are as usual due to lack of collection. On the occasions when I have looked for it in the north of France I have usually found it. But further south in Aquitaine I think that it is considerably more scarce; I have examined large numbers of logs and not very often uncovered it despite noting the usual occurrence of centipedes. It might be useful to do some work on log temperatures: Haacker (1968), in his experiments, found that the species survived between -6 C and 43 C, with a range of preference between 2 C and 36 C, and an optimum of 18-26 C. In Aquitaine the temperature regularly exceeds 30 C in spring and summer, sometimes reaching 40 C. For instance, last summer (1998) the shade temperature reached 41 C in August. Whatever the reason, it is much less rewarding looking under bark in the southern half of France than in Britain.

16. *C. latestriatus* (Curtis, 1845)

This has an extended Atlantic distribution as well, in one way more confined and in another way exaggerated. *C. latestriatus* is well-known as a coastal species, common in dunes and sandy areas. At the same time, it is one of the World's most spectacular pioneering species. It has colonised a wide range of habitats associated with human activity, especially horticultural establishments, gardens and greenhouses. In such places it has reached Finland, Russia, the Ukraine and Hungary. Another feature of this species is its occurrence on the coasts of Portugal, the Azores, the Canary Islands; it has spread to North, Central and South America. It occurs in the remotest part of the Pacific, on Easter Island, and even in the Antarctic (see Blower, 1985). Few British and Irish species have been recorded from Portugal, which is still poorly worked like most of Spain. The Atlantic zone in Iberia should be rich in species; most unfortunately we still do not adequately know this fauna.

This much travelled species, and also the next species, illustrates well the connection between European millipedes and the old colonies of the western European empires.

17. *C. britannicus* (Verhoeff, 1891)

The distribution of this British and Irish millipede is difficult to explain. It has not been found at all in Spain, France or Belgium, but it does occur on Portuguese territory, including the Azores and Madeira. The records from Holland and Germany eastwards are supposedly or quite certainly synanthropic. It might have spread from Britain to Canada, the USA and New Zealand. Where was it during the Devensian glaciation? The genus *Cylindroiulus* is firmly based around the Western Mediterranean basin. Is this an Iberian species? A Lusitanian species? There are two records from Portugal and none from Spain. The only places where it certainly occurs "wild" are Britain and Ireland! Did it survive here? In "wild" stations it is strictly Atlantic. It might of course still be found in France. It is remarkable that there is so far absolutely no trace of it there. We cannot assume that it reached Britain through France.

18. *Cylindroiulus parisiorum* (Broelemann & Verhoeff, 1896)

This species is about as enigmatic as the last. Common features are that there are more records from Britain than from any other country and that it is synanthropic in the east on the Continent. There are no reports of it from Ireland, Iberia or the west of France. Paris is as far west as it has been found on the Continent. From the distributional

evidence it entirely conforms to a central species. Pedrolí-Christen (1993) has found it wild in Switzerland, as I have in Belgian woodland. The odd thing is that there are few records from Central Europe. It is, of course, fairly easily overlooked, and has occasionally been confused with or regarded as *C. truncorum*. More data of both species from France would help to clarify the distributional situation. *C. parisiorum* should have spread to Britain from the Continent.

19. *Cylindroiulus truncorum* (Silvestri, 1896)

Yet another difficult *Cylindroiulus*! According to present data, it occurs neither in Italy nor in Iberia, but in North Africa, from where Schubart (1934) suggested that it was introduced into northern Europe. This seems to be the best explanation. It is becoming locally common in N European countries. In Belgium it is discovered regularly and some infestations of property have been reported. It too, has been introduced into N & S America.

20. *Allaiulus nitidus* (Verhoeff, 1891)

This is a central species; it is quite clear from its distributional range which in this instance fortunately lies mainly in well-explored areas. It should therefore occur more in N and E Britain than in the south-west and Ireland, as appears to be the case. An interesting feature of British distributions is that central species missing from western parts of France nevertheless arrive in Cornwall. If *A. nitidus* is not common in Britain it is probably because it is at the limits of its range. It is found in mull humus in deciduous woodland and burrows during adverse periods.

21. *Enantiulus armatus* (Ribaut, 1909)

E. armatus is a strictly Atlantic species, known outside England only from the western half of France, and there not yet from the north. The allopatric *E. nanus* is a central species on the Continent, occurring in Denmark, Sweden, Germany, Holland, Belgium, NE France and further east. It might turn up one day, most likely in E England or Scotland. It looks like a small *A. nitidus* or a pale juline, the male has very distinctive gonopods, easily distinguishable from those of *E. armatus*.

22. *Haplopodoiulus spathifer* (Brolemann, 1897)

In view of its links with the Royal Botanic Gardens *Haplopodoiulus spathifer* is almost certainly an introduction. It is a strict Atlantic species, occurring in the western half of the Pyrenees and neighbouring Spanish mountains. The limits of its distribution in Spain are not yet known. This year I have found it in the Landes, a hundred kilometres north of the Pyrenees. The absence of records between Sussex and the Landes might be due to either its absence or a lack of collecting. If, in France, it is more or less limited to the Pyrenees, it might be regarded as an Alpine as well as an Atlantic species.

N.B. The map shown in Figure 1, based on one published by the European Environment Agency (1995), does not include a Pyrenean zone. These are Alpine mountains and I would include a Pyrenean Alpine zone, which in fact houses a large number of endemic species. It is the case that the Alps proper and the Pyrenees house almost entirely different millipede faunas.

23. *Julus scandinavicus* Latzel, 1884.

This is quite definitely a central species, as the map shows. In Britain, its relative scarcity in South-east England might be connected with the few records in France other than those in the extreme NE and East, where it is very common. I have both received and collected a lot of data on this animal since its distribution was published in the 1990 atlas. It is a very common central European species. The 1990 map showed one dot in France west of Calais. I have re-examined the material from this site in Normandy, which was published in the BMG Bulletin No. 4 (R. D. Kime, J. G. E. Lewis, S. J. Lewis, 1987). There should and might have been a male, but I have discovered that the reference tube contains entirely black female julines as well as the other species that were recorded. On dissection I found vulvae resembling those of *Leptoiulus belgicus*. The record, which is entirely my own responsibility, must be considered highly doubtful, preferably null and void! I was prompted to re-examine this material, not because of its geographical location, but chiefly as a result of finding several specimens of all-black *L. belgicus* both in Belgium and in France. Recently I found a male *L. belgicus* in the Dordogne which had a marbled brown and cream coloration and no dorsal stripe. Although the gonopods were strikingly reminiscent of *L. belgicus* I sent it to Dr. Mauriès in Paris for him to reassure me that it was not a new species. I add all this as a cautionary note to all collectors. According to Jeekel (1973) *J. scandinavicus* has been introduced into the USA.

24. *Ophiulus pilosus* (Newport, 1842)

We come to one of the most remarkable European distributions known. It is difficult to understand the biogeographical history of this species. The genus (+/- 20 spp) is based in Italy and so we may begin from there. *O. pilosus* is common in N Italy and neighbouring alpine regions; it has also been found high up in mountains along the Italian peninsula to the south. The simplest view to take is that all the other patches of distribution are consistent with introductions. Outside Europe it has been introduced into N. America and New Zealand, where I collected it myself on a visit, suggesting that it is not rare there. If it has been able to colonise quite extensive areas in the New World it will have been able to do the same in Europe.

The present data do not support the view that *O. pilosus* moved north into Britain, Ireland and Scandinavia in the normal course of expansion. There are gaps in the distribution between Bavaria and Czechoslovakia on the one hand and NE Germany and Denmark on the other. There are almost no records at all from W Germany, none from Belgium and only a small patch in France in the Pas-de-Calais and the Somme departments near the coast where the population densities were locally high. Did these go over from England on the ferries?! There is no immediately obvious reason for these small patches of *O. pilosus* other than recent introduction. To the east and south-east of this French patch I have collected for years without finding any *O. pilosus*. Compared with other areas it is phenomenally common in Ireland and Britain. Did it survive the ice age or has there been a massive spread following introductions? It is a tough pioneering species. Some detailed genetic studies of its different populations might shed some light on the situation, and it would be helpful to include closely related species occurring chiefly in Italy, as well as the alpine variety *major* quoted in Blower (1985) which was described as a species by Bigler in 1913 - *Ophiulus major*.

25. *Leptoiulus belgicus* (Latzel, 1884)

This has a classical extended Atlantic distribution with a marked SW orientation in Britain. East of the Atlantic zone it is confined to warmer areas, extending almost across Germany and just reaching Austria. It is mainly found at low altitude, is locally common and very patchy in distribution. It has a pronounced activity period in the autumn in Belgium.

26. *Leptoiulus kervillei* (Brolemann, 1896)

L. kervillei has a strict Atlantic distribution, extending as far as the southern tip of the Netherlands. It favours silty basic soils: it is very common on these in Belgium. In France it has proved to be common on similar soils in Eastern Normandy and the Perigord and it probably occurs from the Pyrenees to Belgium in all such areas. It is usually found in woodland on mulls. *L. kervillei* has not yet been found in either Germany or Spain, although it reaches the western side of the Moselle valley in Luxemburg.

27. *Metaiulus pratensis* Blower & Rolfe, 1956.

On the basis of the few existing records this has a strict Atlantic distribution as well. Originally found in heavy clay soils in SE England, it was subsequently found in SW France, where three sub-species were described from caves in Aquitaine. The typical form was then found further north by Dick Jones in farmland in the Vienne and by myself in the Dordogne. This still leaves something of a gap between the Vienne and Sussex. However, it may very likely be found in NW France and SW England. It is quite difficult to locate of course.

28. *Brachyiulus pusillus* (Leach, 1815)

The several species of this genus are mainly located in the Mediterranean zone, especially in the Balkans. The two species that spread north of the Alpine mountains are *B. bagnalli* in the east and *B. pusillus* mainly, but not by any means only, in the west. Unfortunately these two species have sometimes been confused. *B. pusillus* is a pioneering species; Hoffman (1979) infers that it has been widely spread by commerce. It occurs in territory around the Atlantic Ocean (USA, Argentina, South Africa) as well as many of the oceanic islands. I found it in forest on Tenerife. Although it has been described as a littoral species by some authors, it clearly frequently occurs as a synanthrope a long way from the sea, although regularly associated with water in wet pastures, as well as arable land and gardens. Its distribution in Europe is obviously quite widespread and not easy to interpret without knowledge of the Mediterranean origin of the genus.

29. *Unciger foetidus* (C. L. Koch, 1838)

This is a central - even east-central - animal which has extended northwards as far as Norway and NW to Britain. Looking at its distribution it is quite logical that it should be found in East Anglia. At the same time it is synanthropic in the northern parts of its range and almost certainly introduced into Norway and Britain. Enghoff (1974) thinks that it may have been introduced even into Denmark. It was recorded from the Netherlands but the record is not substantiated according to Berg (1995). To the SE on the Continent it is more and more found in forest: the other species of the genus occur in E Europe. Its E-central orientation is similar to that of *Melogona voigti*, rather than the W-central orientation of *A. nitidus* or *J. scandinavicus*.

CONCLUDING REMARKS

Generalising, it is possible to say that among the orders of millipedes found in Britain and Ireland the Julida are the most able to live in adverse habitats. A lot of them have thus extended their geographical ranges beyond where they originally existed, often aided by human activity. Several European species have moved into the colder northern and eastern areas following the retreat of the ice. Some are almost or entirely synanthropic in these regions. They are good pioneering species. There has also been a major movement of species into and across the Atlantic and even further afield following the development of colonies by European maritime powers. It is noteworthy that there has not been a corresponding movement from the New World into Europe. The British and Irish fauna is mainly of European Atlantic origin (pushing north and east or not), of Central European origin pushing north-west or southern (Mediterranean) origin and introduced.

Considering distributions within Britain and Ireland, I am struck by the fact that while some of the central species are commoner in the East and North others, e.g. *J. scandinavius*, appear to be common all the way to Cornwall, whereas they are missing from NW France. However, this brings me back to the point that much of the Atlantic zone in France and Spain is seriously under-explored. To better understand and clarify our own biogeography we need more expeditions to these areas.

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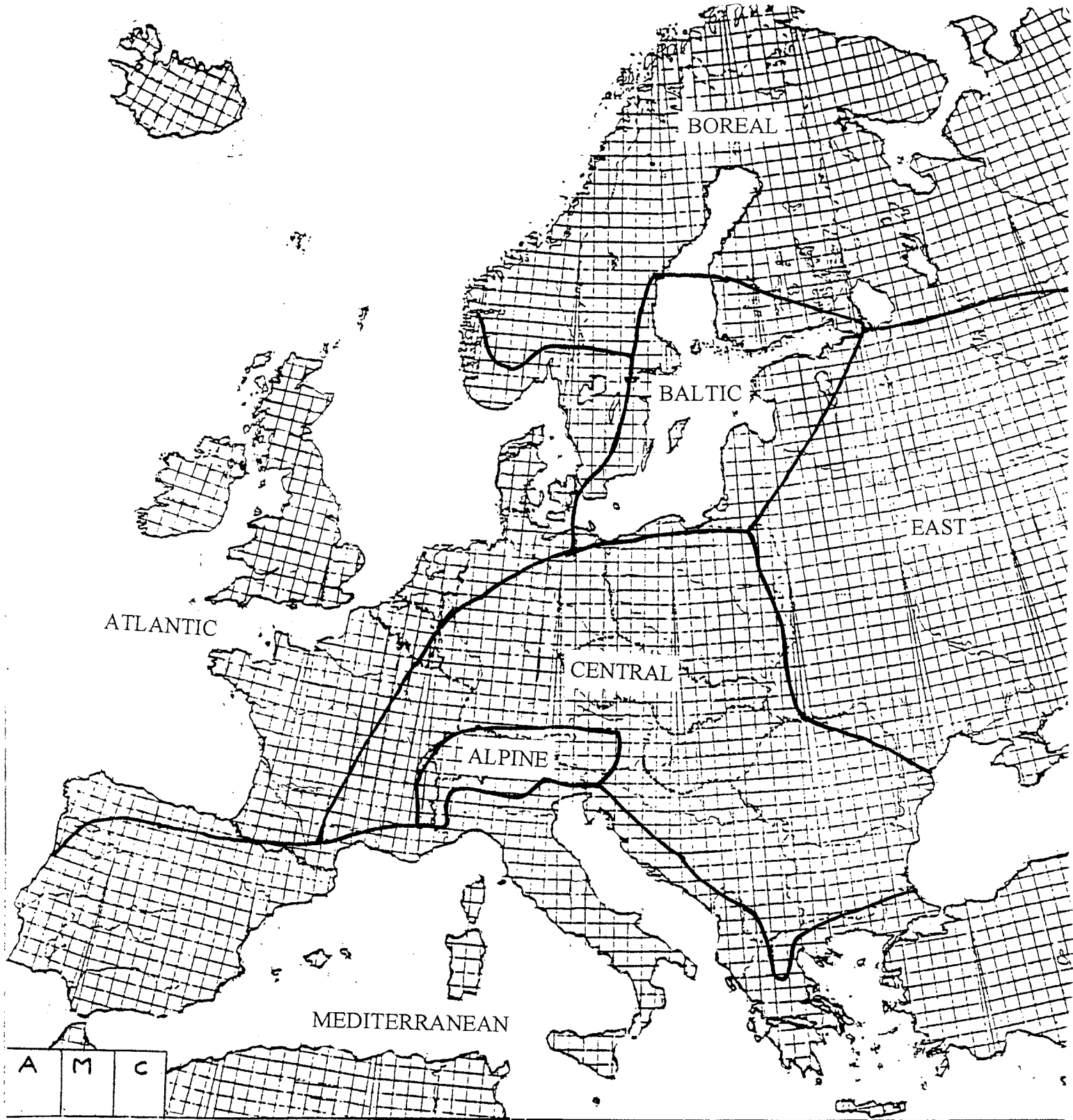


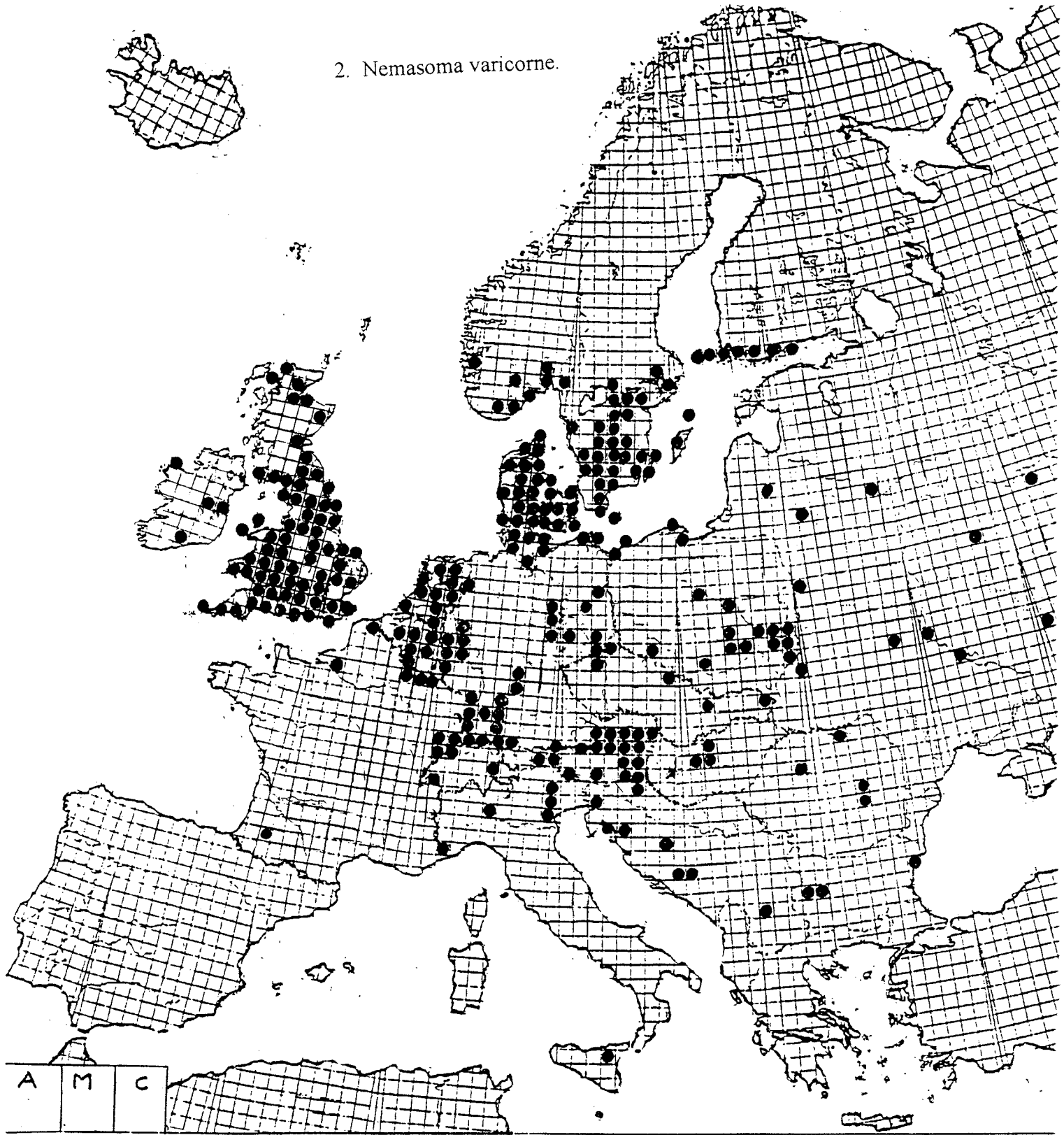
Figure 1. European map showing geographic zones.

In the following maps the boxes A, M and C indicate the presence of species in the Azores, Madeira and the Canary Islands if a dot is situated in them.

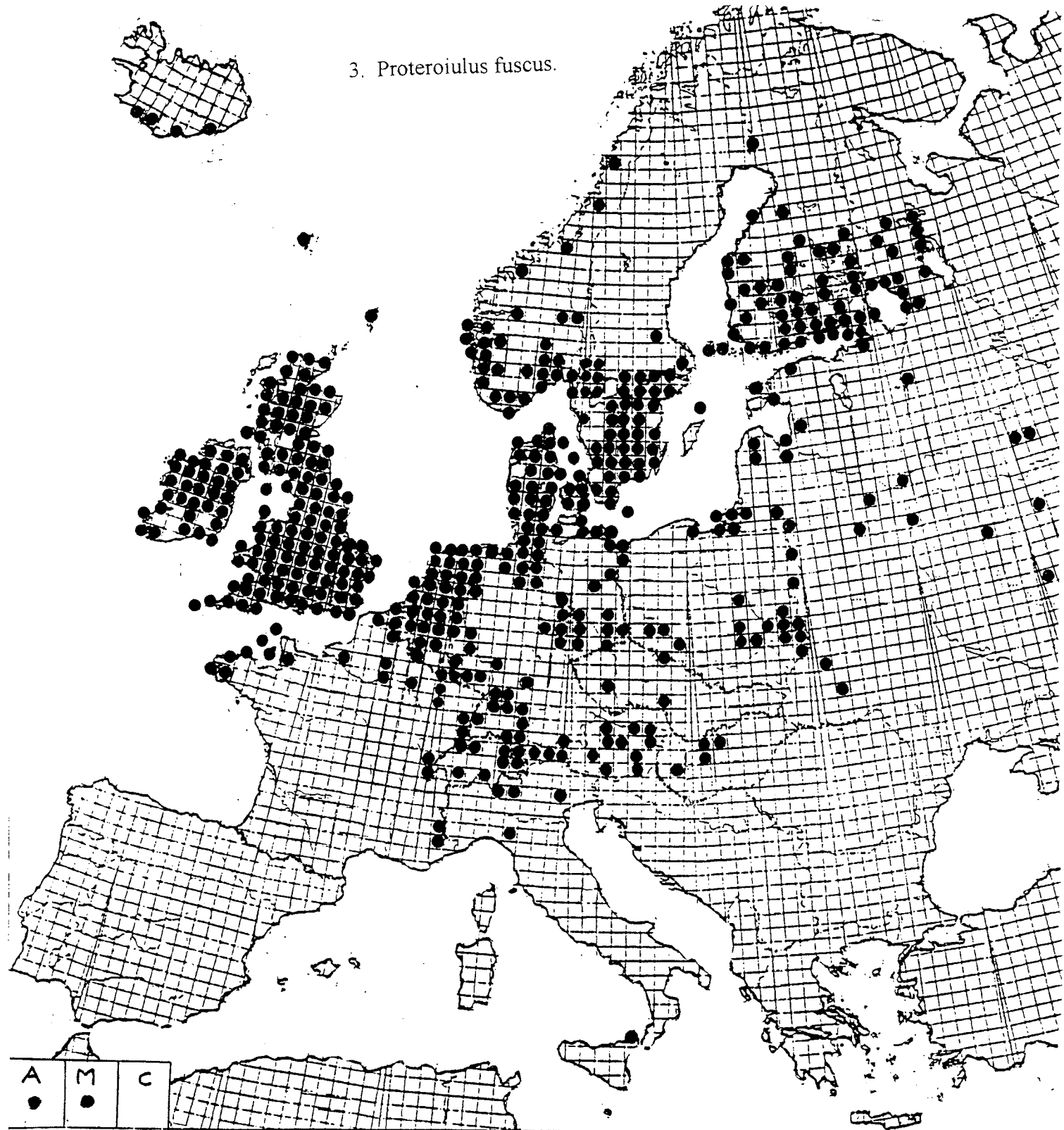
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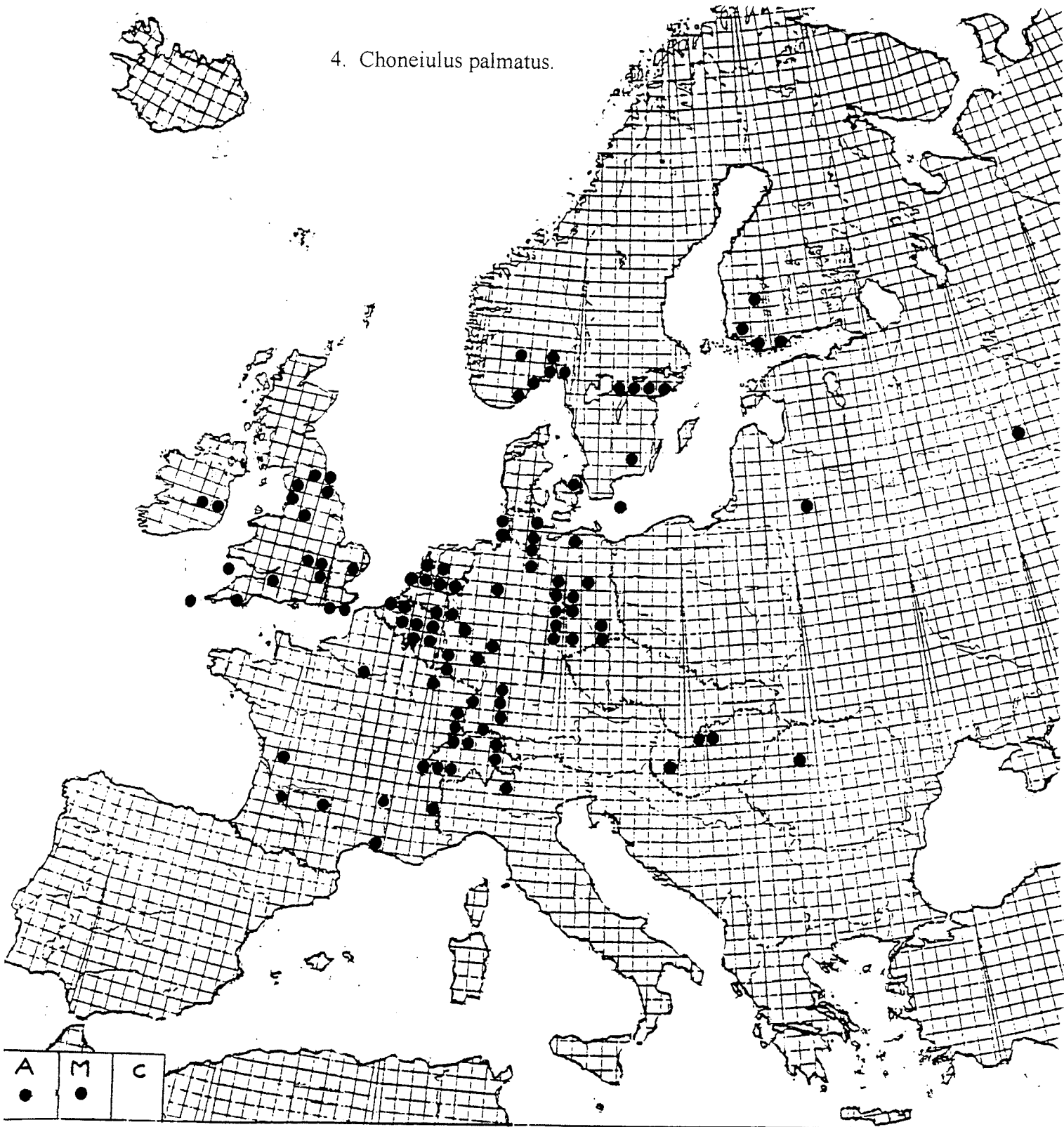
2. *Nemasoma varicorne*.



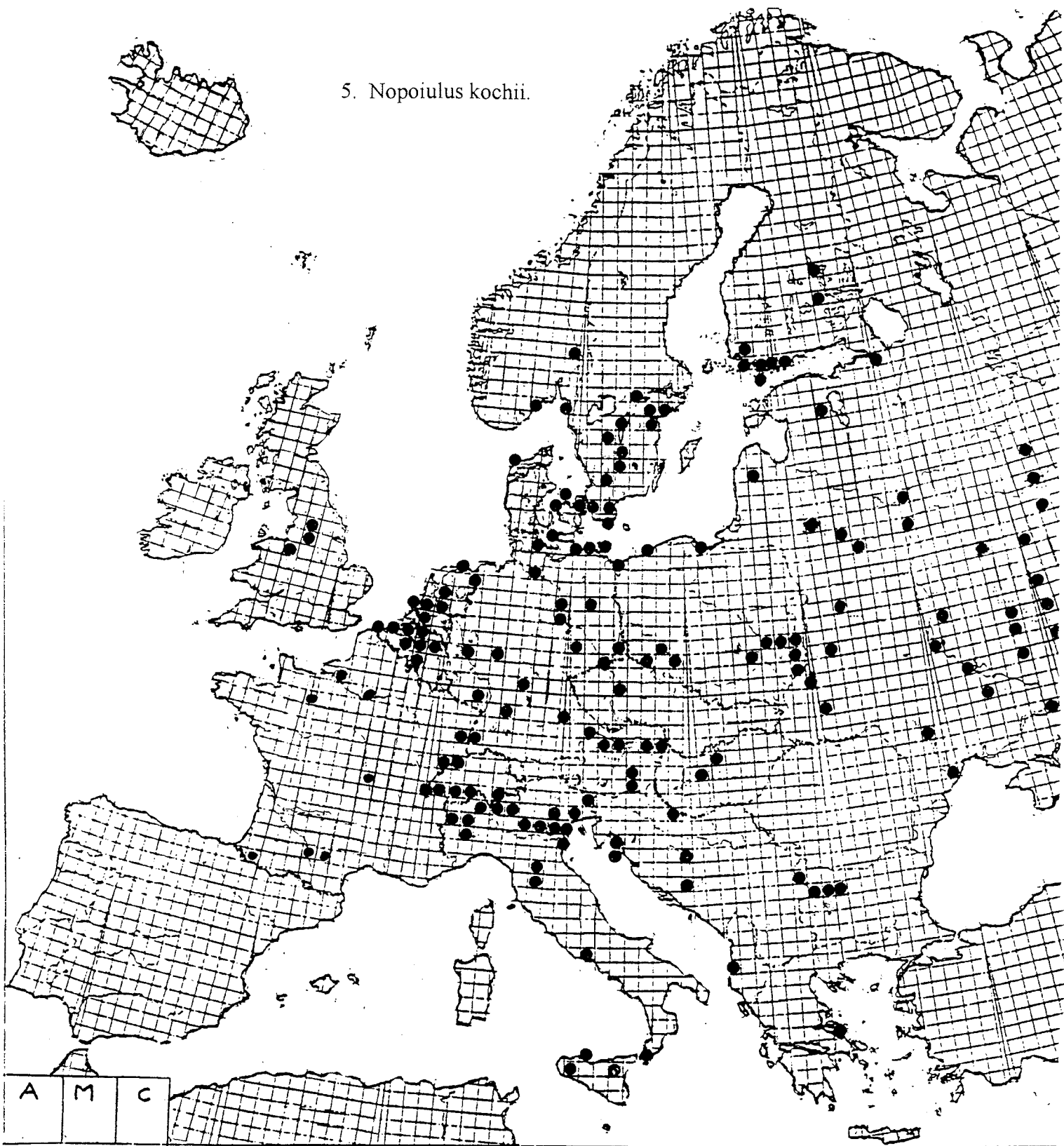
3. *Proteroiulus fuscus*.



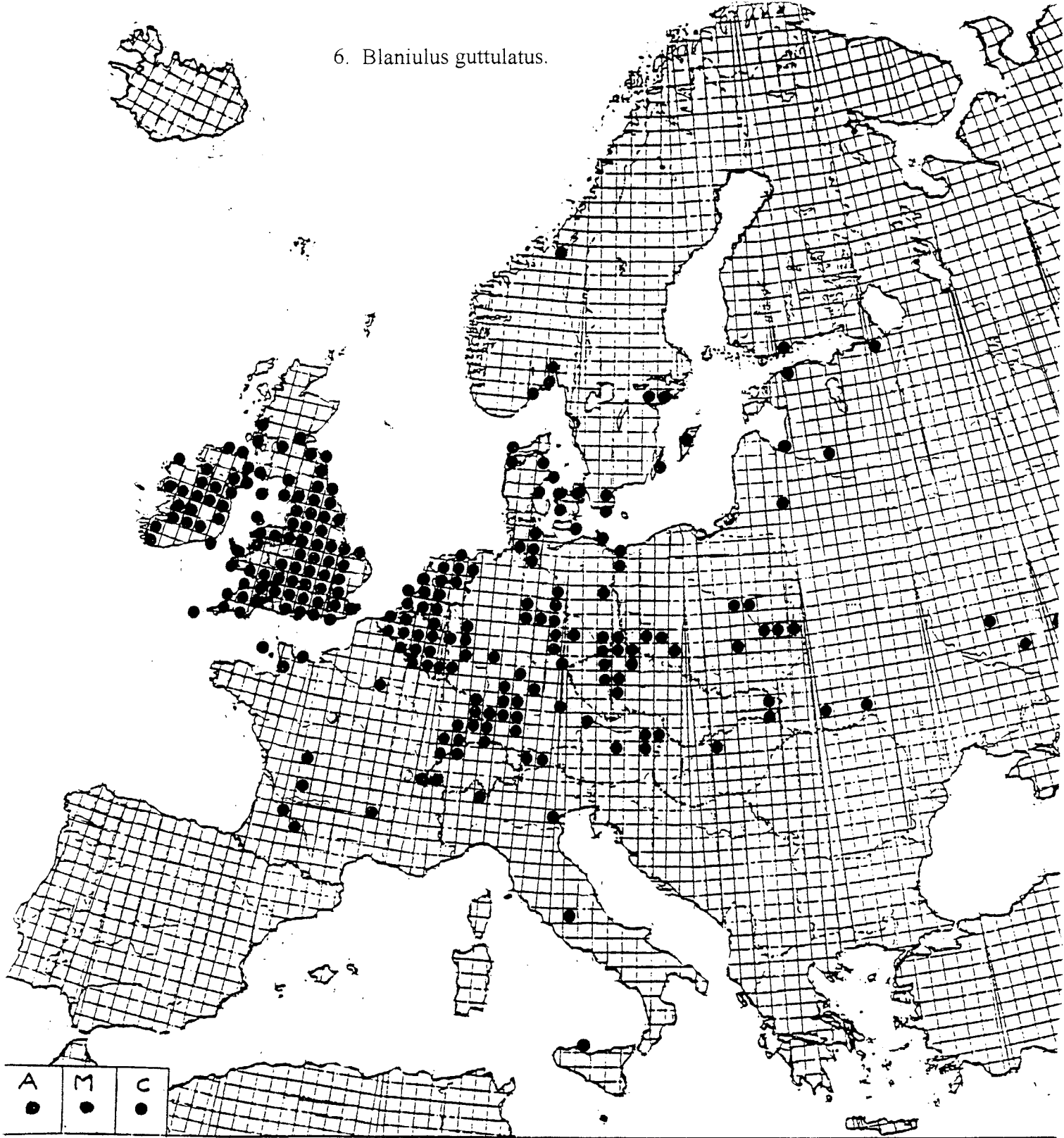
4. *Choneiulus palmatus*.



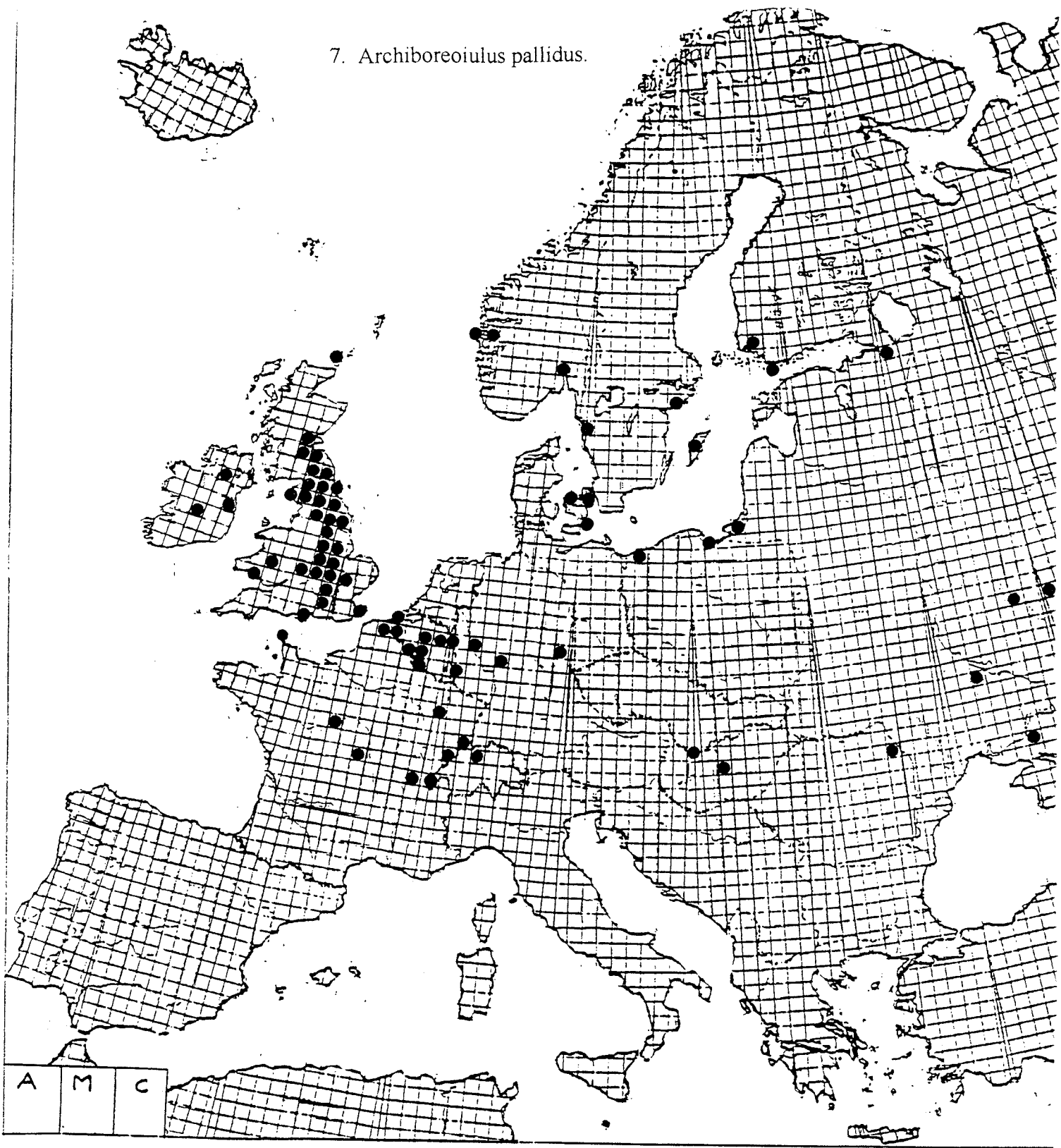
5. *Nopoiulus kochii*.



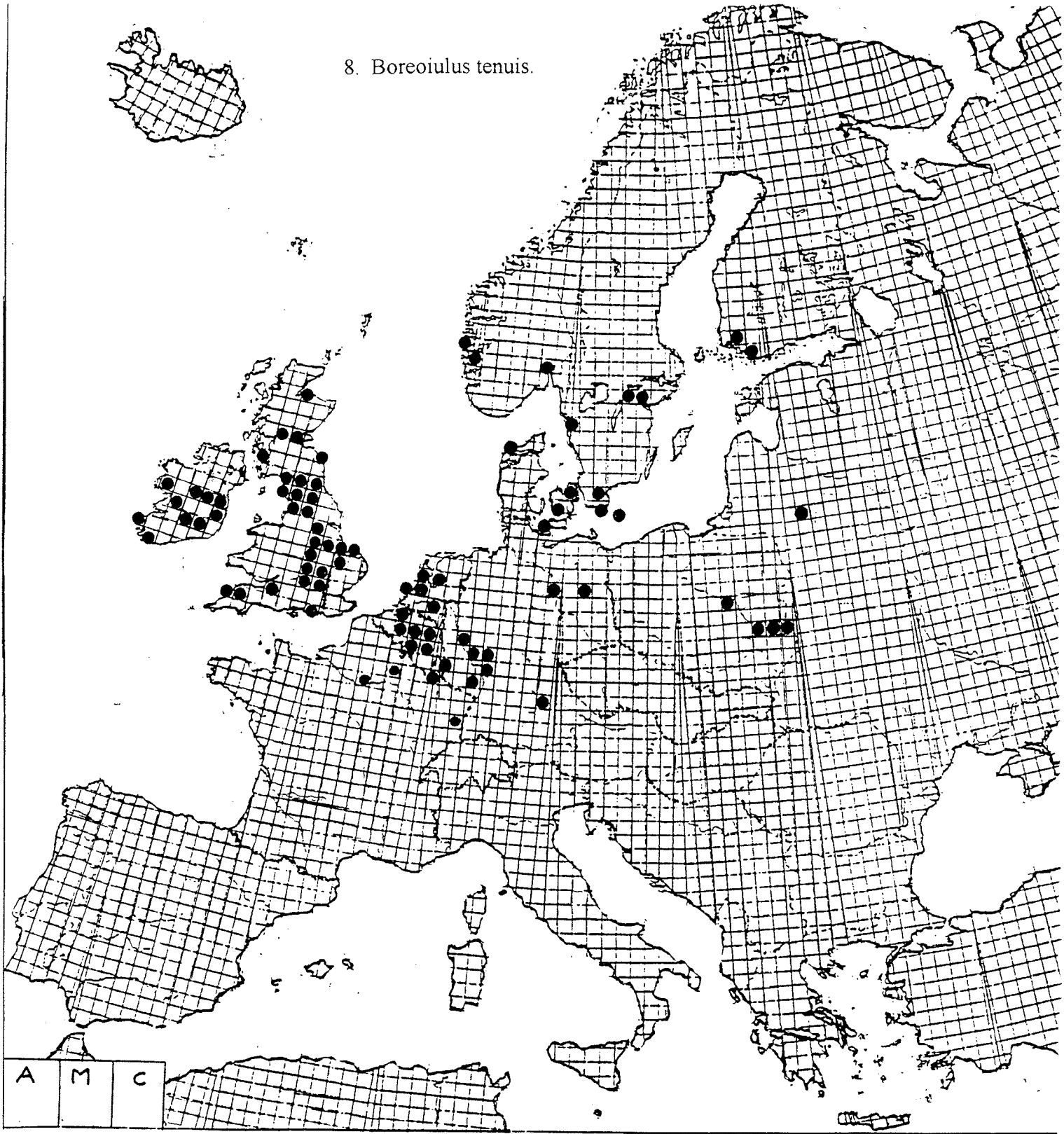
6. *Blaniulus guttulatus*.



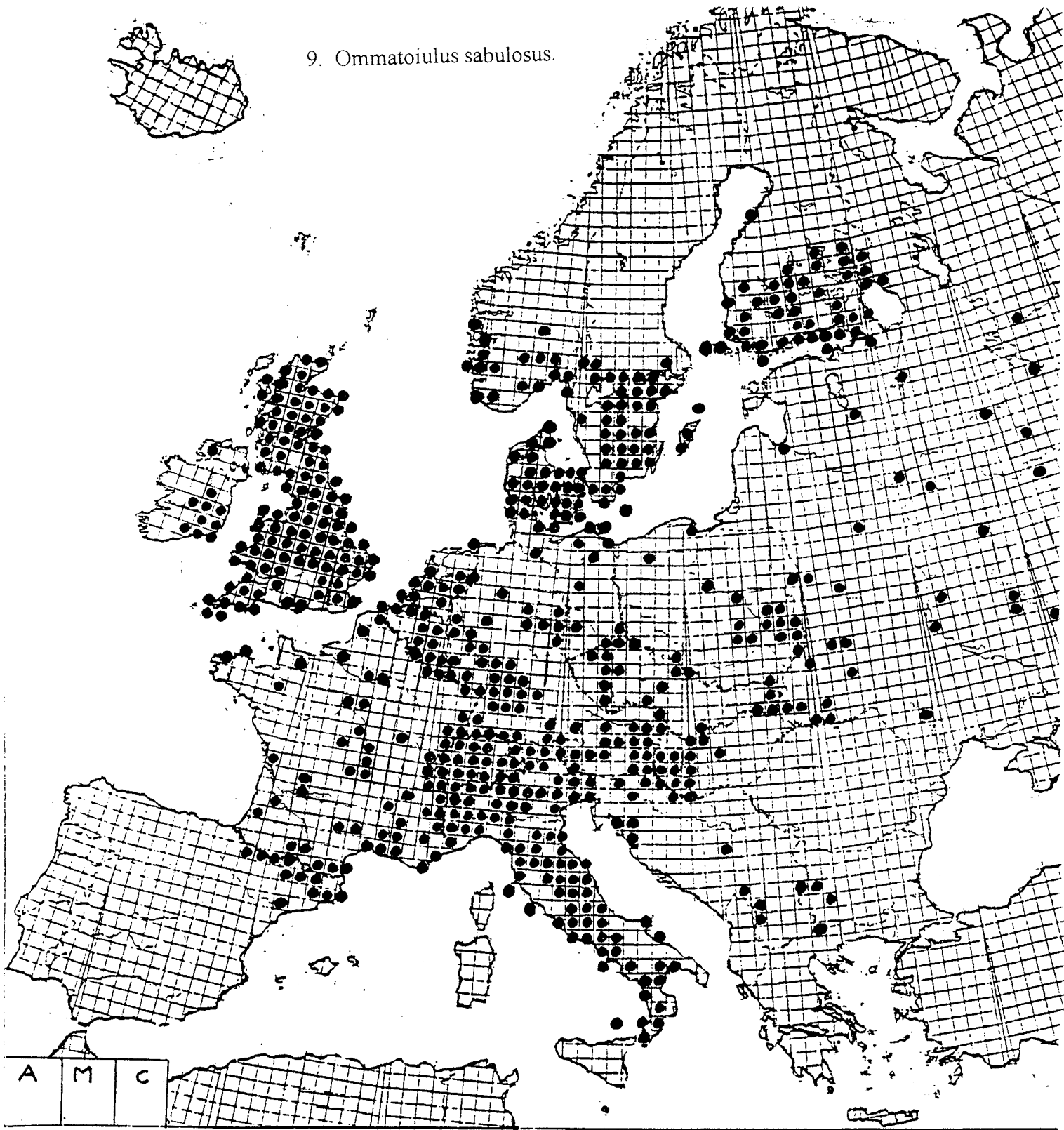
7. *Archiboreoiulus pallidus*.



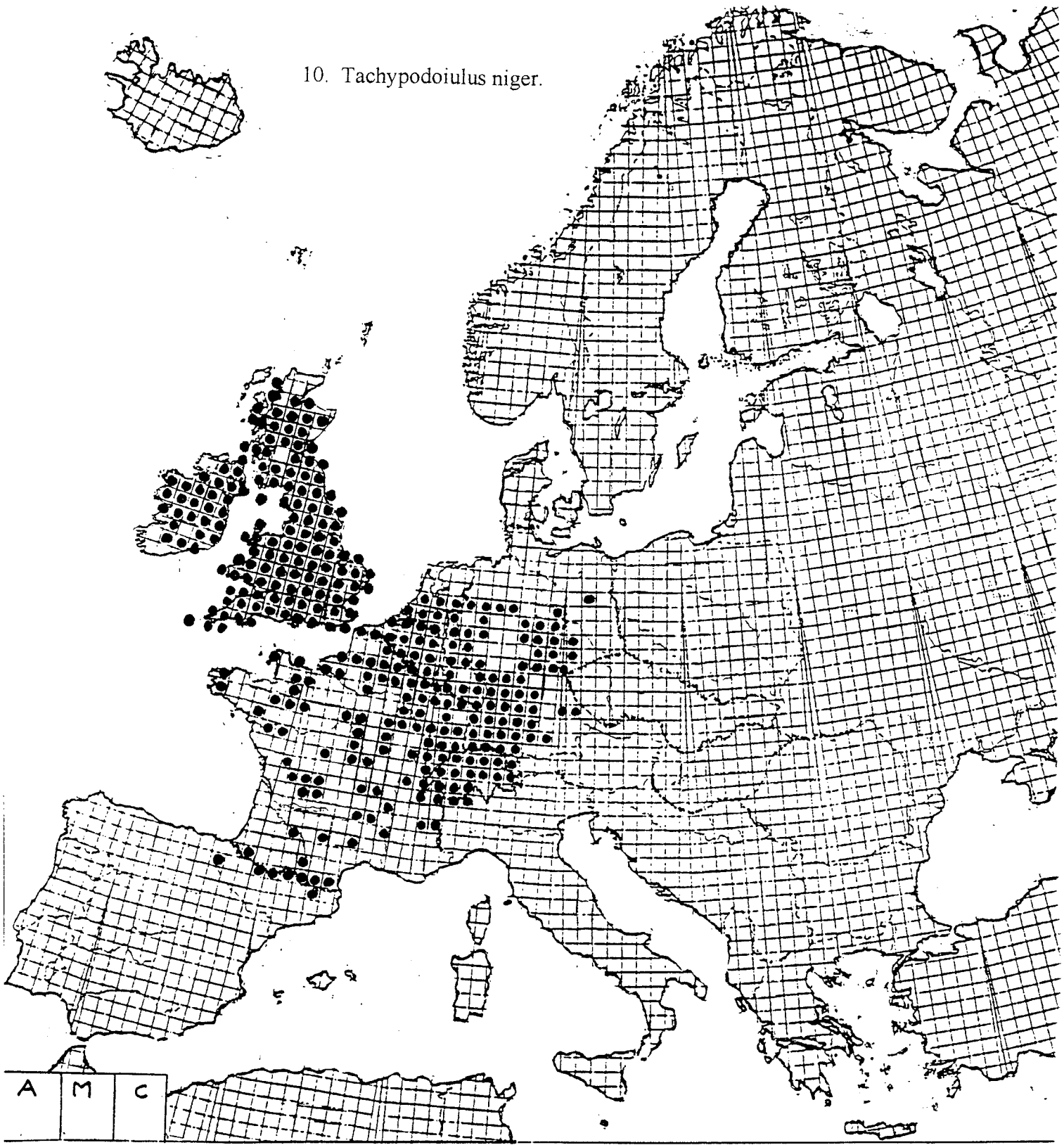
8. *Boreoiulus tenuis*.



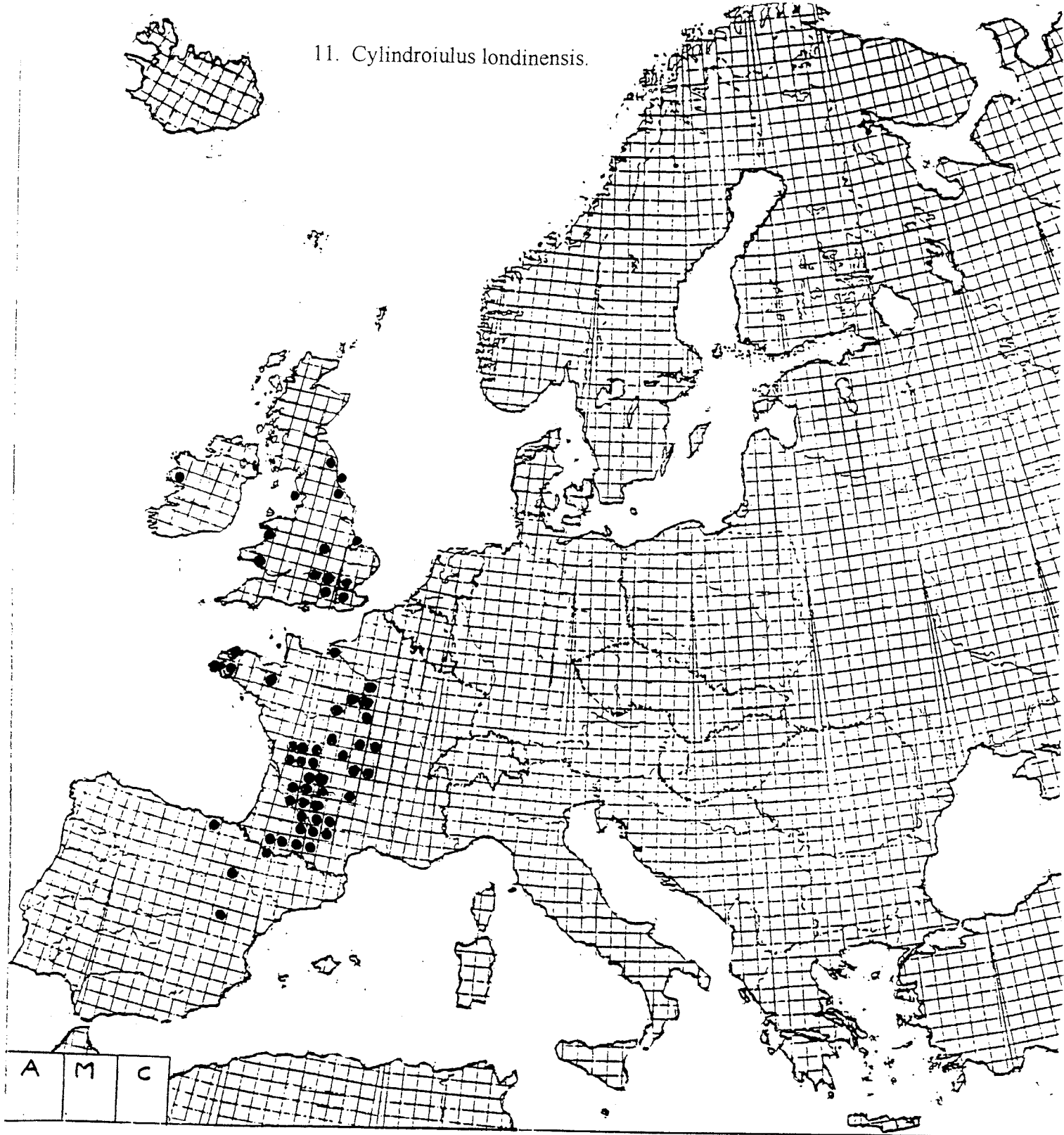
9. *Ommatoiulus sabulosus*.



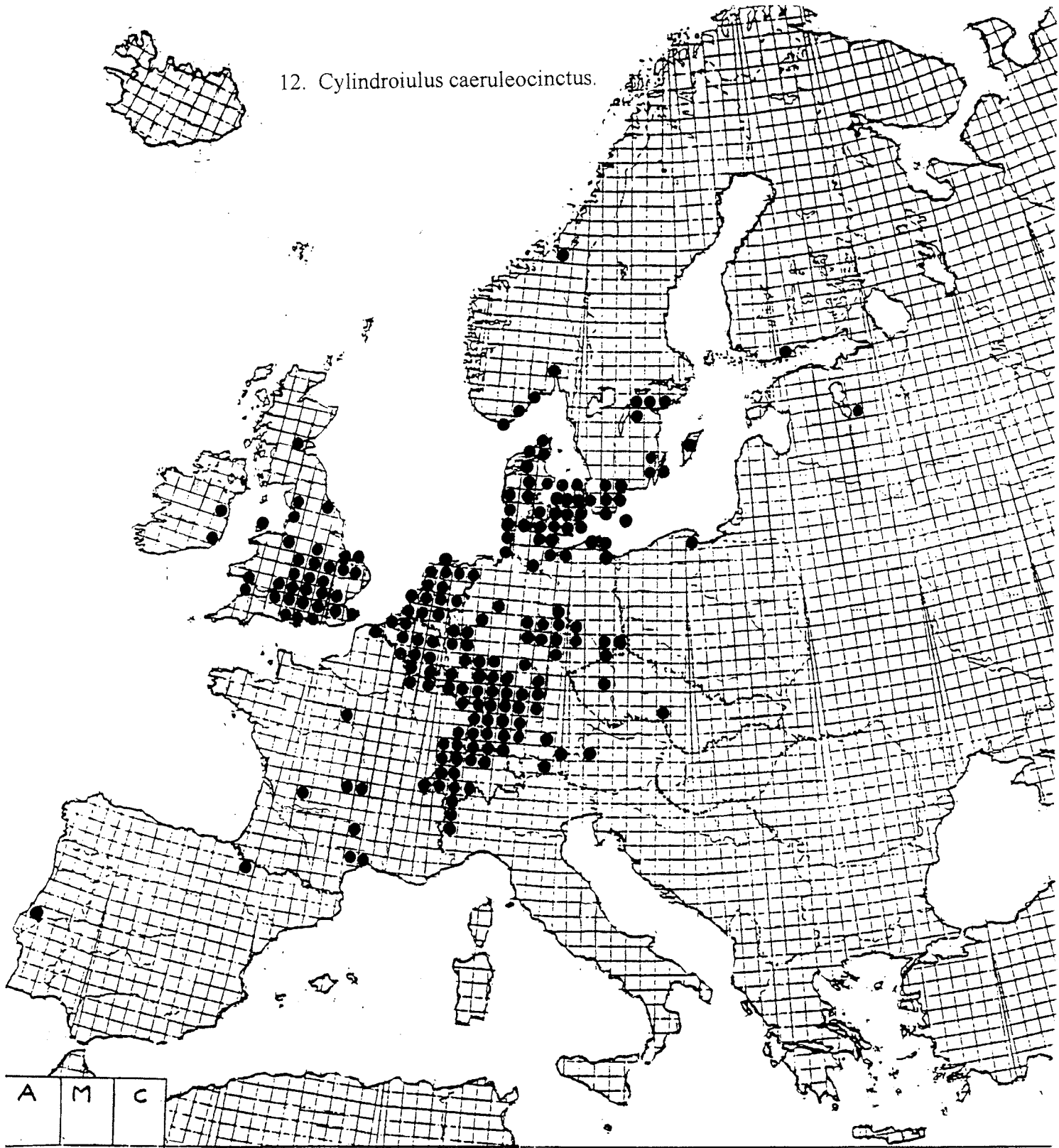
10. *Tachypodoiulus niger*.



11. *Cylindroiulus londinensis*.

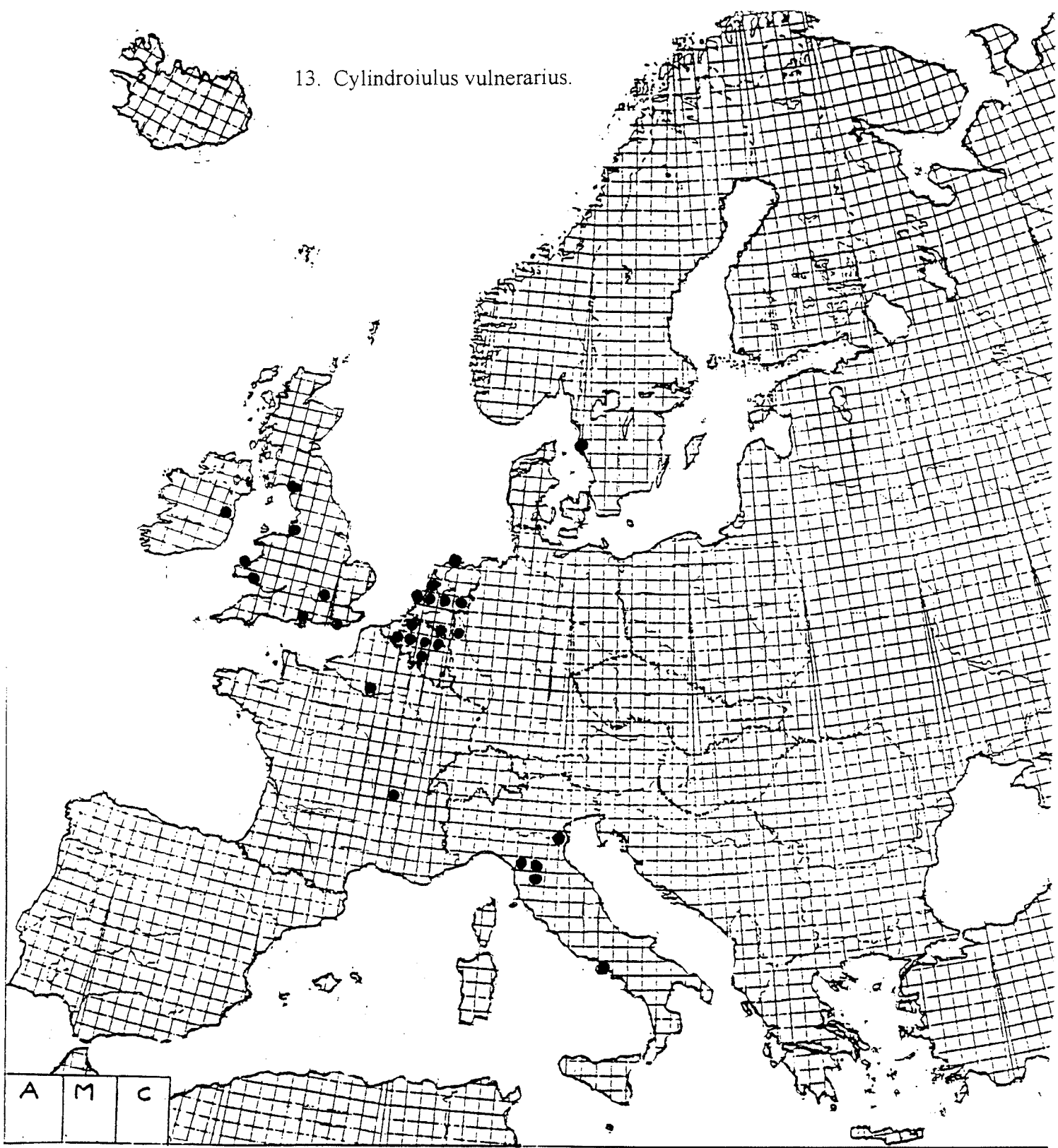


12. *Cylindroiulus caeruleocinctus*.

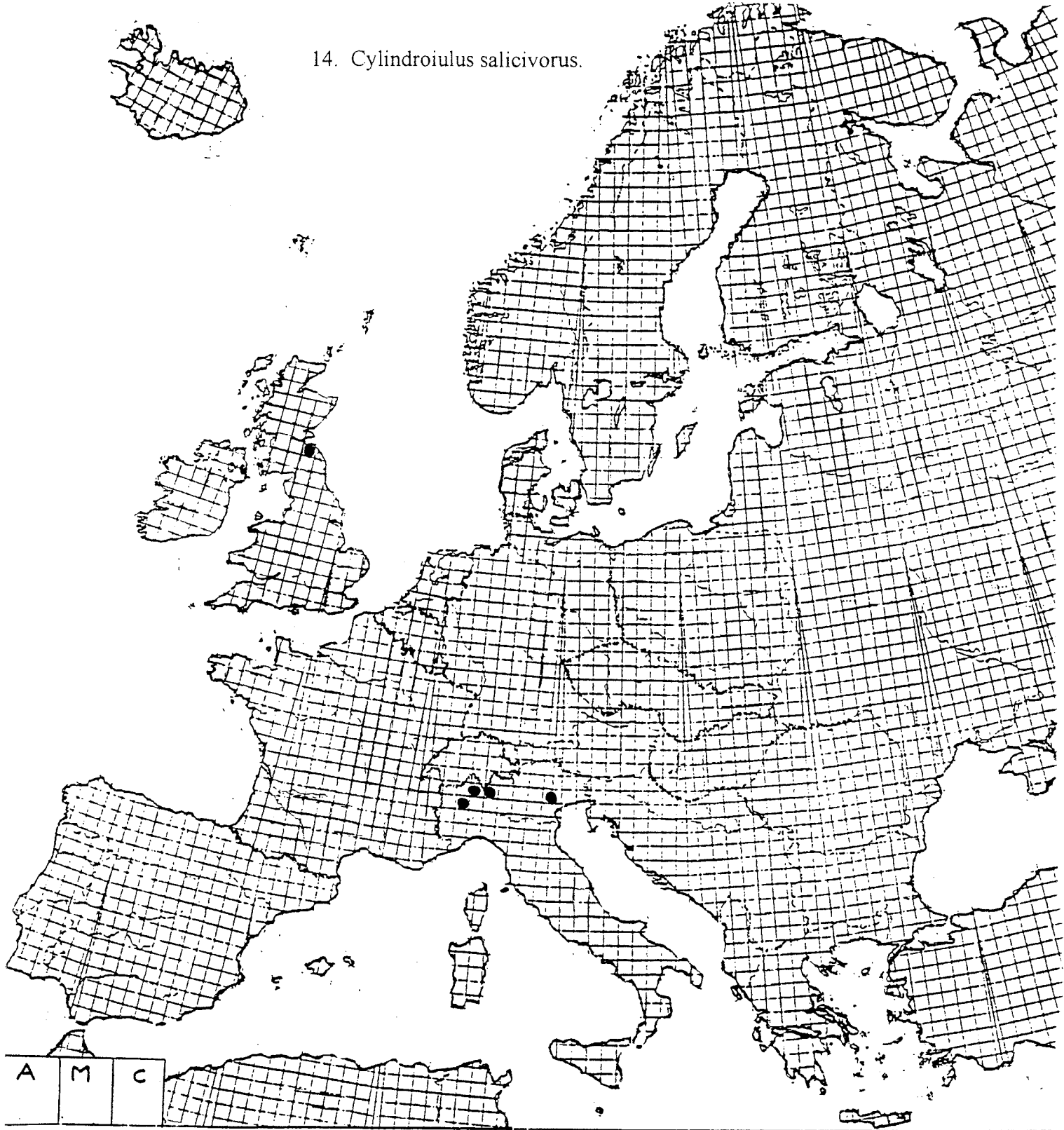


I have not yet located several regional records from Poland and some from other parts of East Europe.

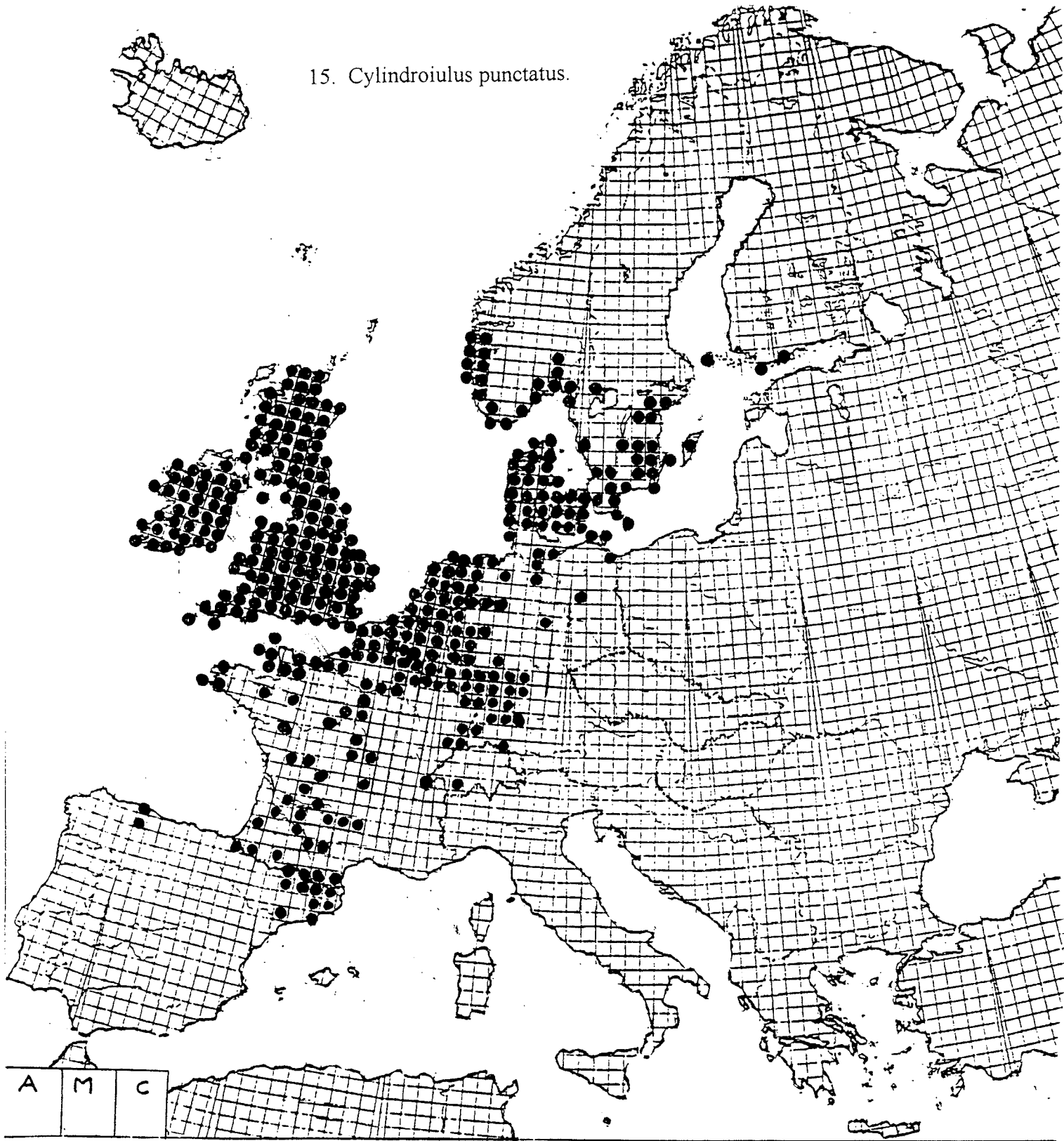
13. *Cylindroiulus vulnerarius*.



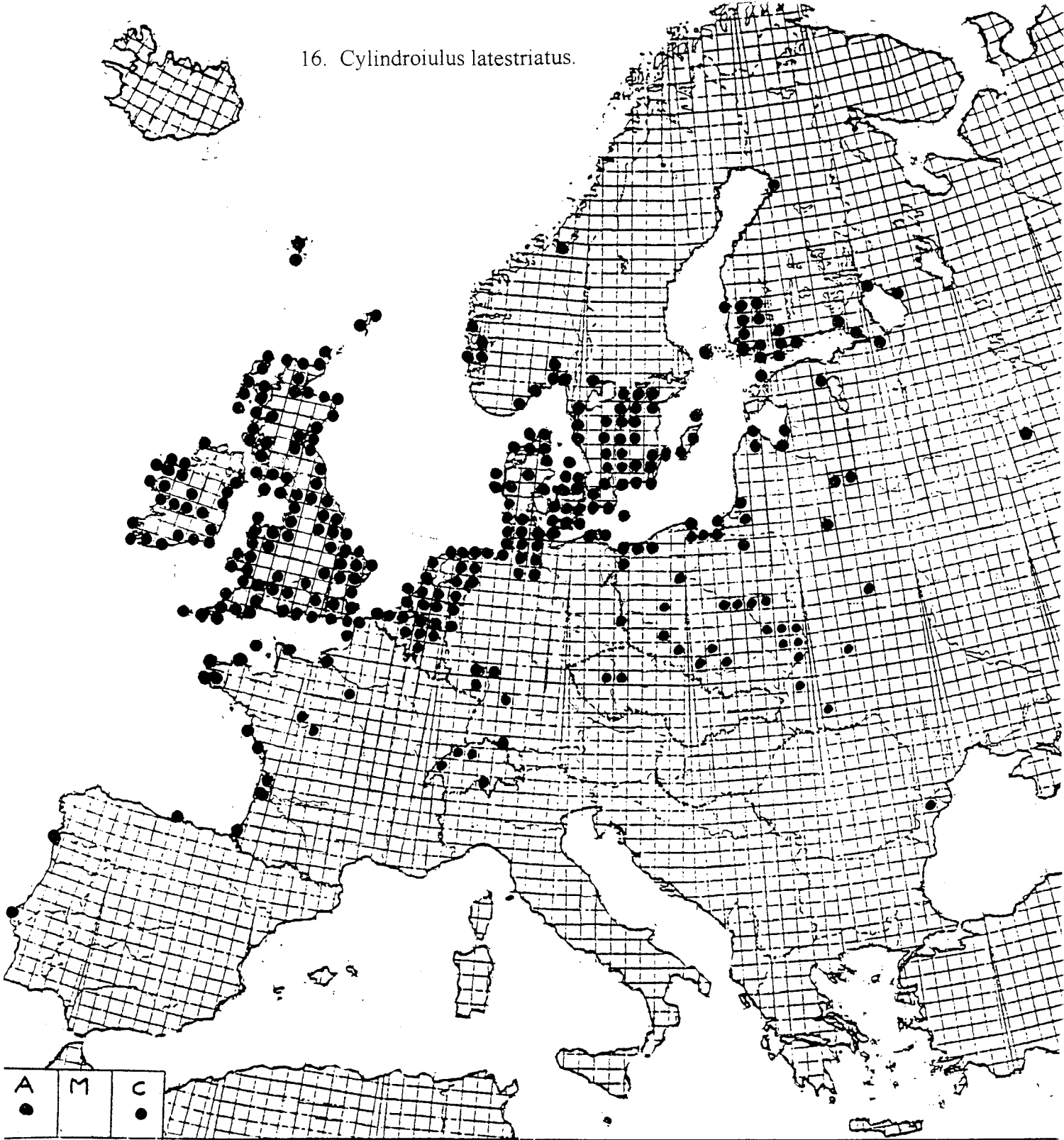
14. *Cylindroiulus salicivorus*.



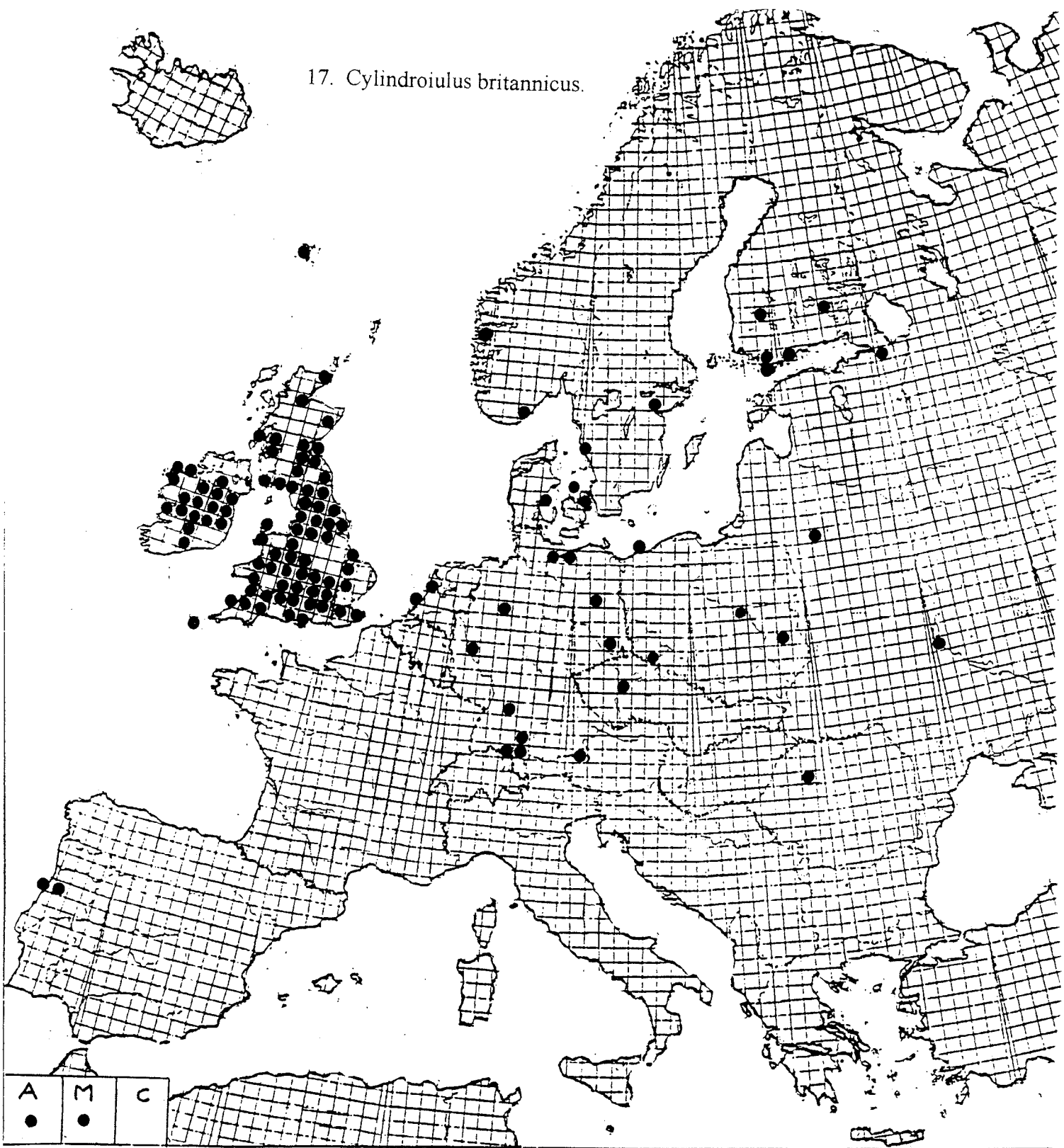
15. *Cylindroiulus punctatus*.



16. *Cylindroiulus latestriatus*.



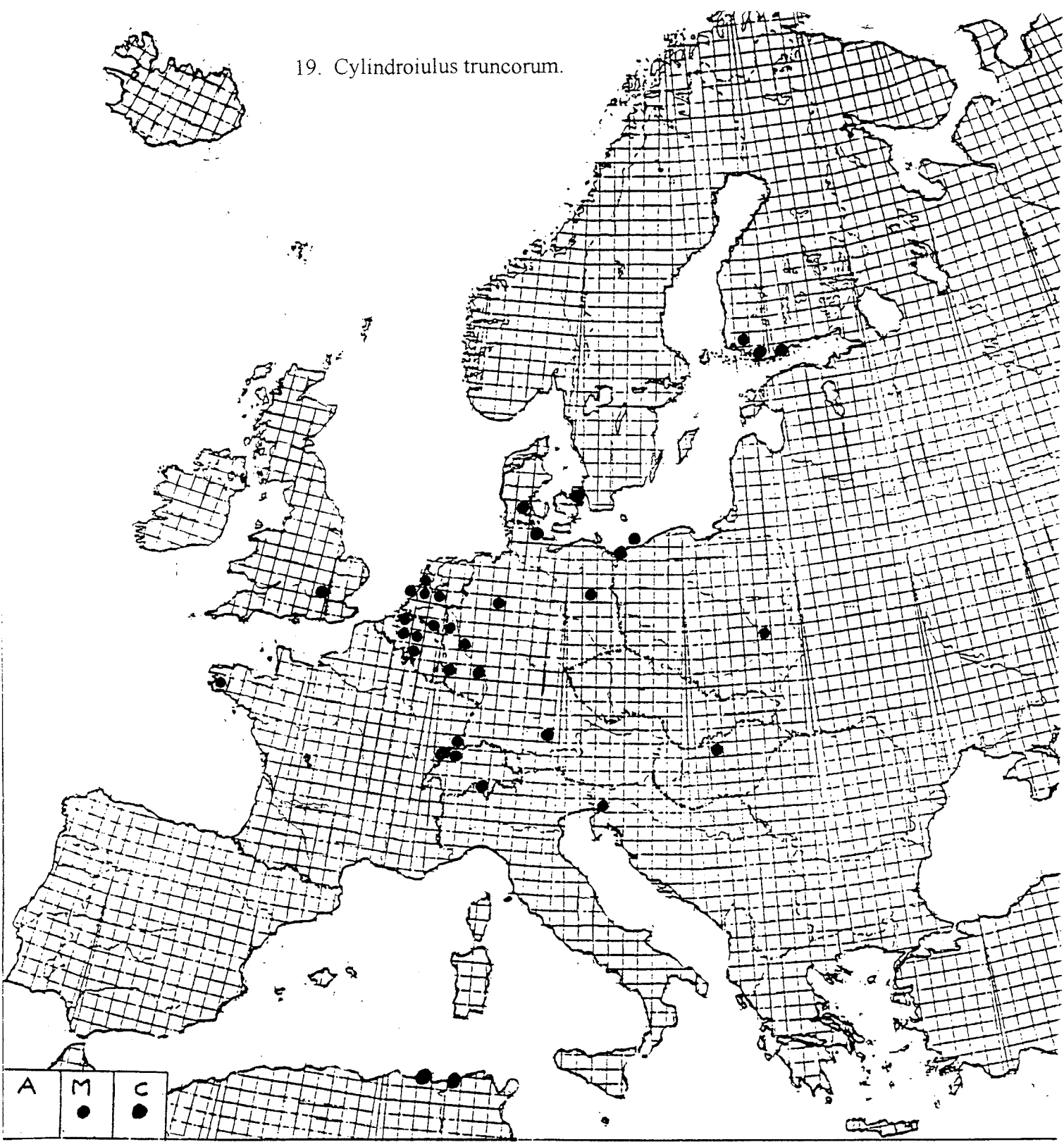
17. *Cylindroiulus britannicus*.



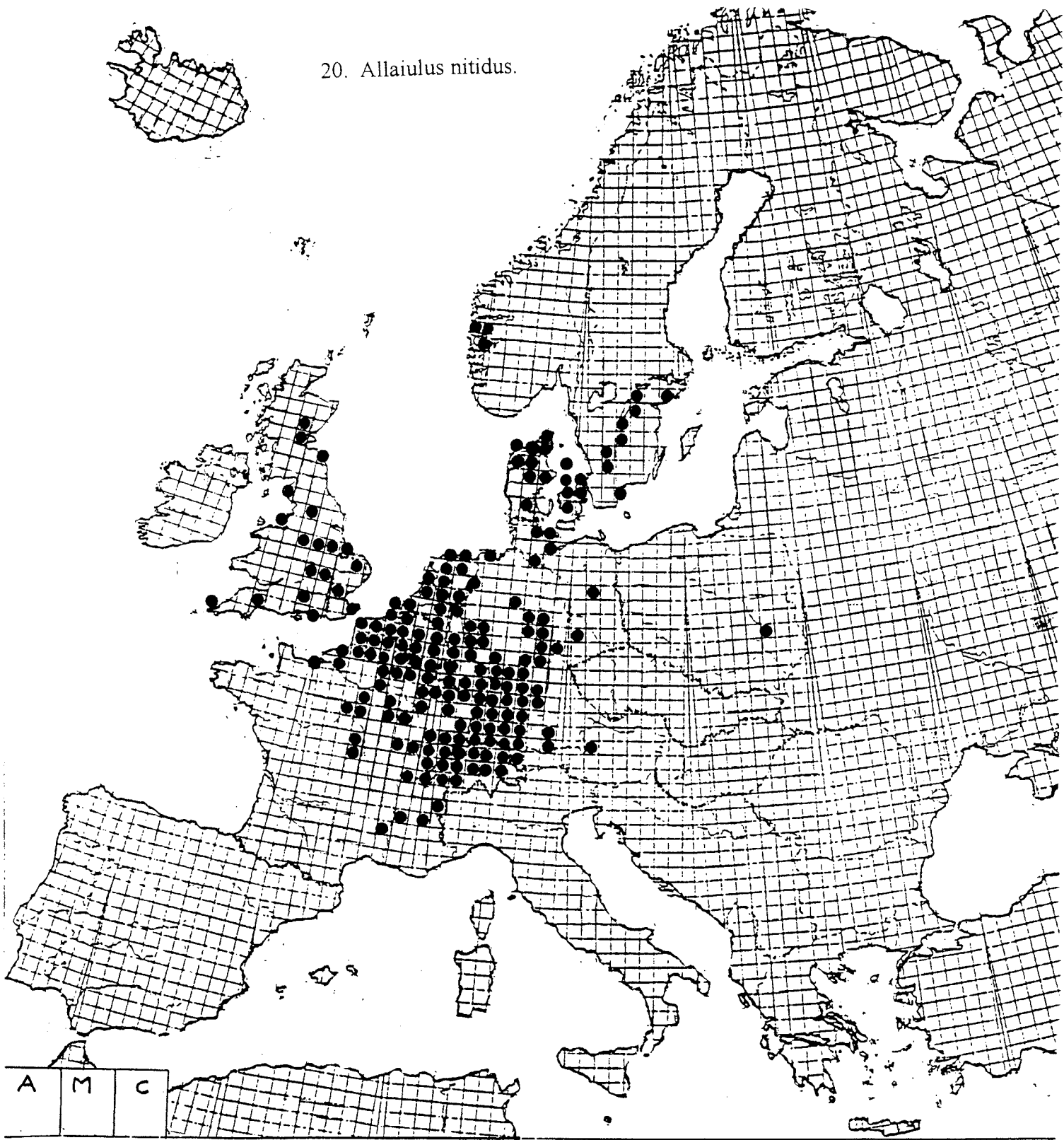
18. *Cylindroiulus parisiorum*.



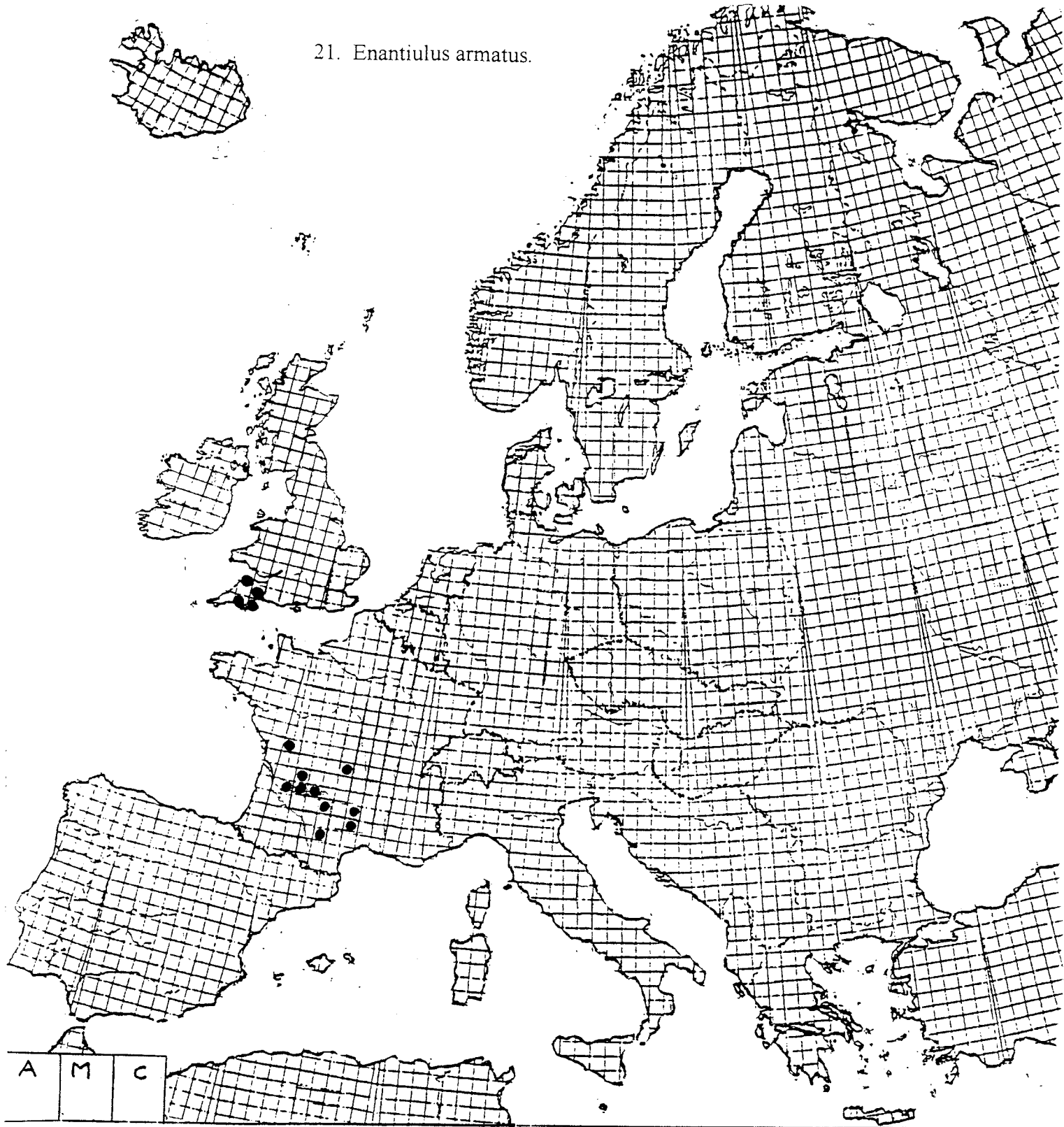
19. *Cylindroiulus truncorum*.



20. *Allaiulus nitidus*.



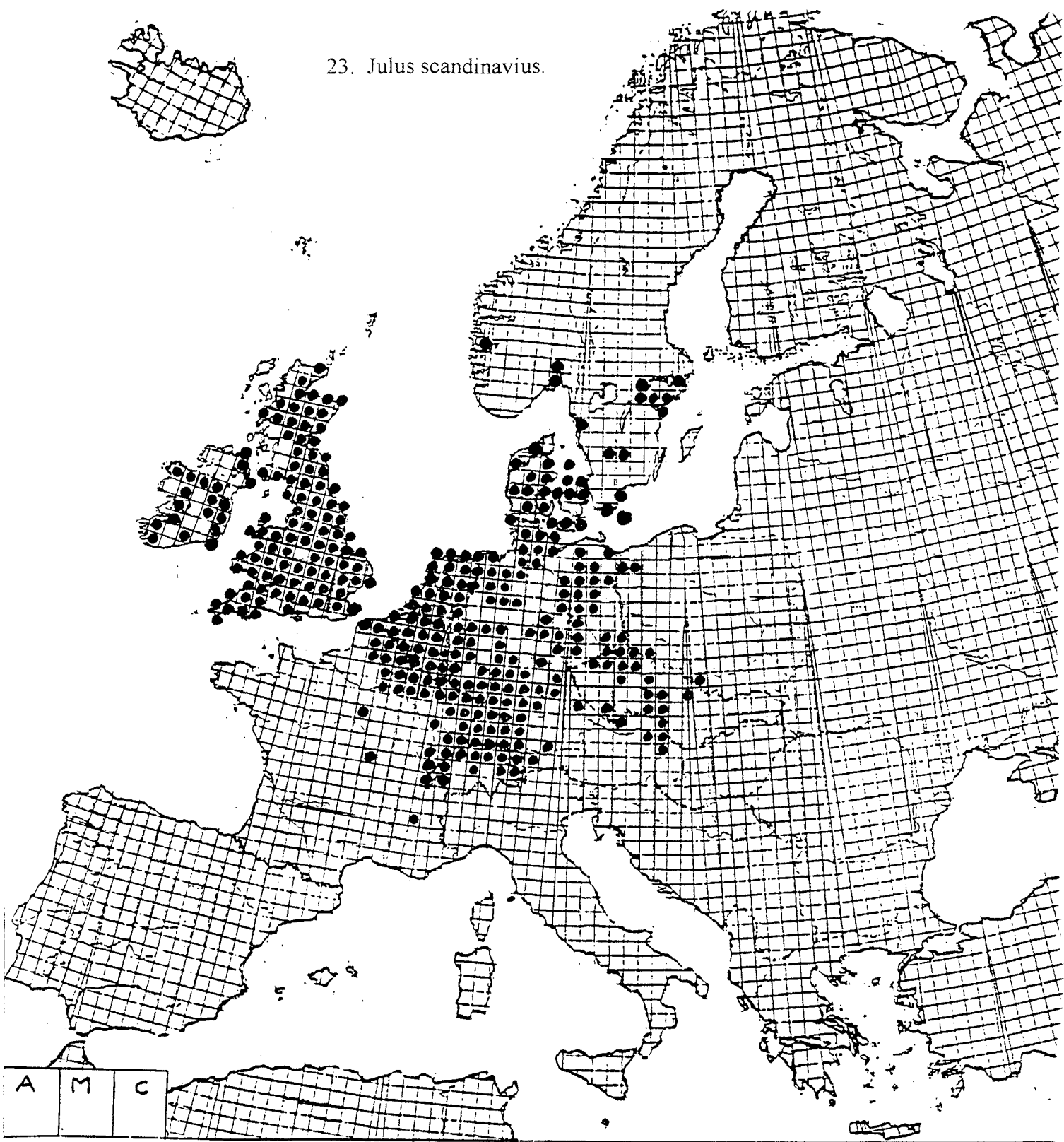
21. *Enantiulus armatus*.



22. *Haplopodoiulus spathifer*.



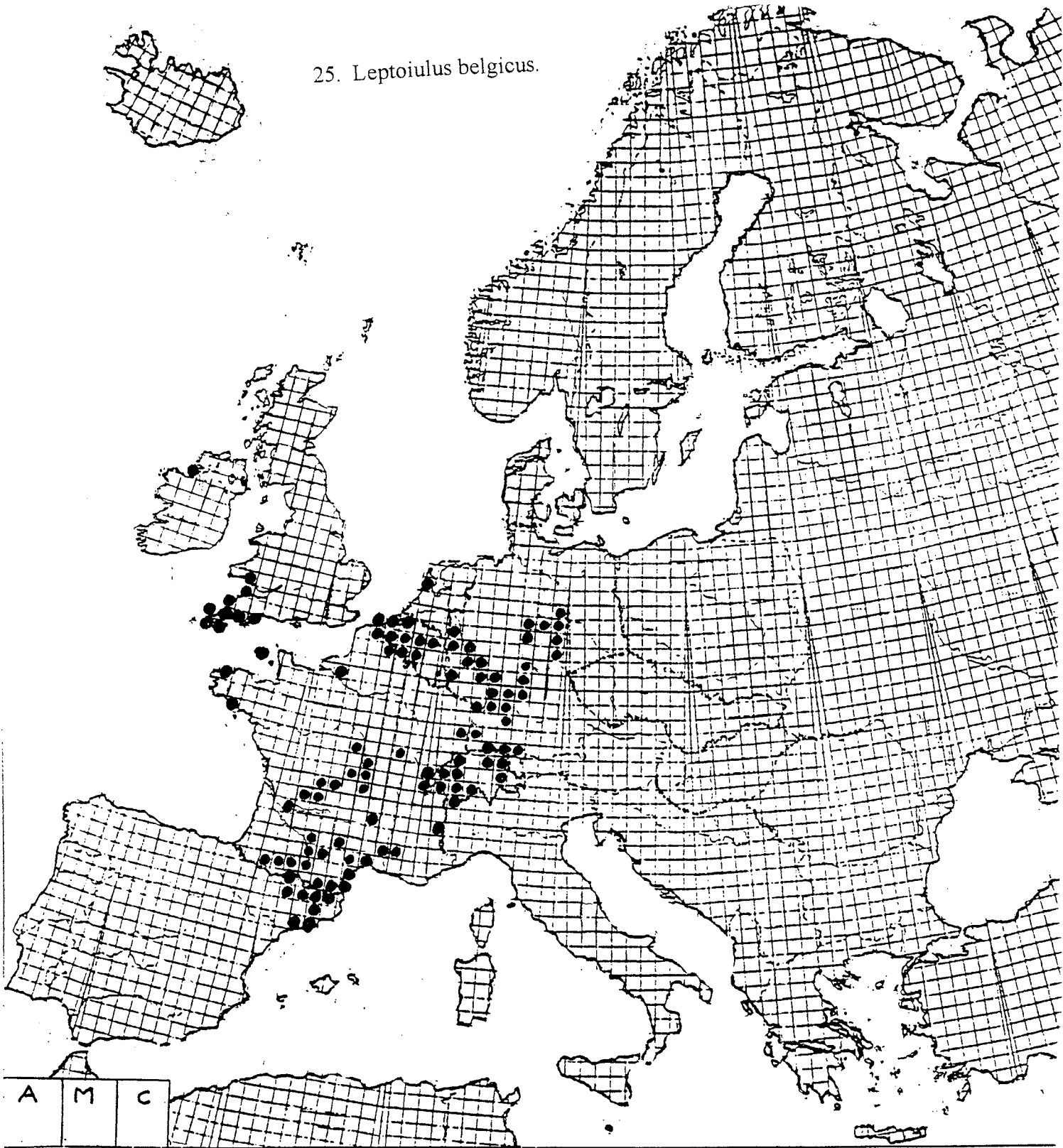
23. *Julus scandinavicus*.



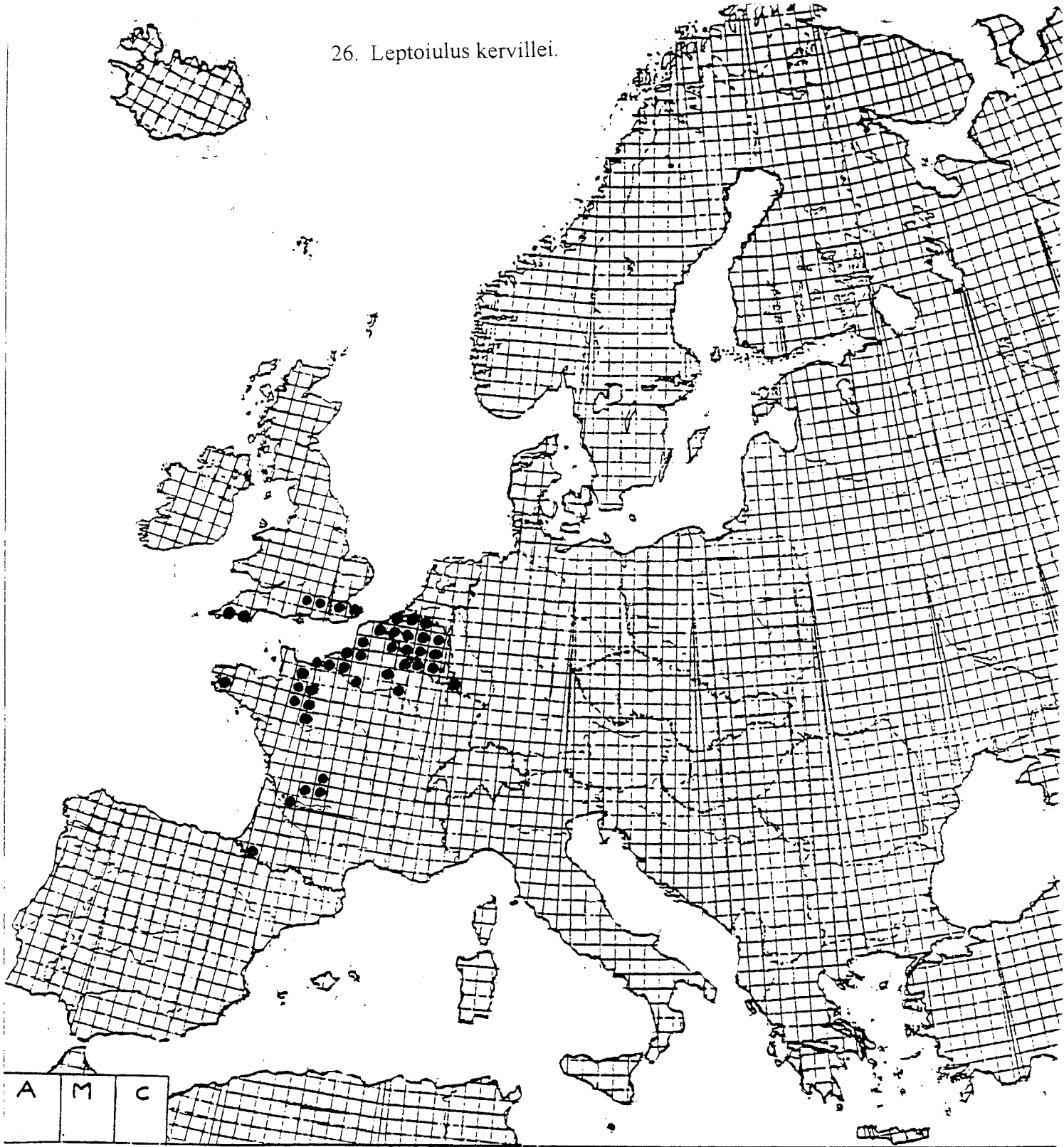
24. *Ophiulus pilosus*.



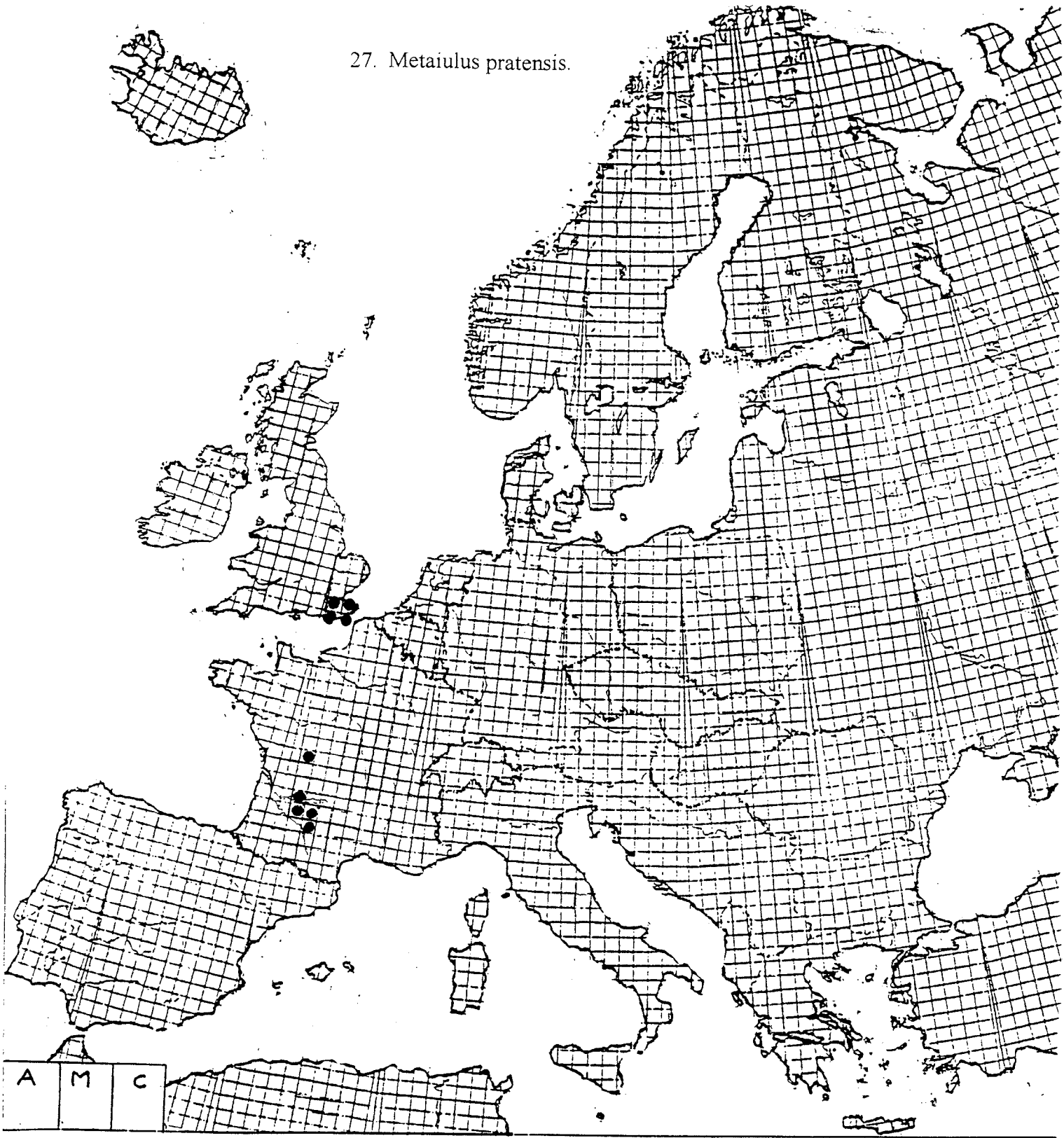
25. *Leptoiulus belgicus*.



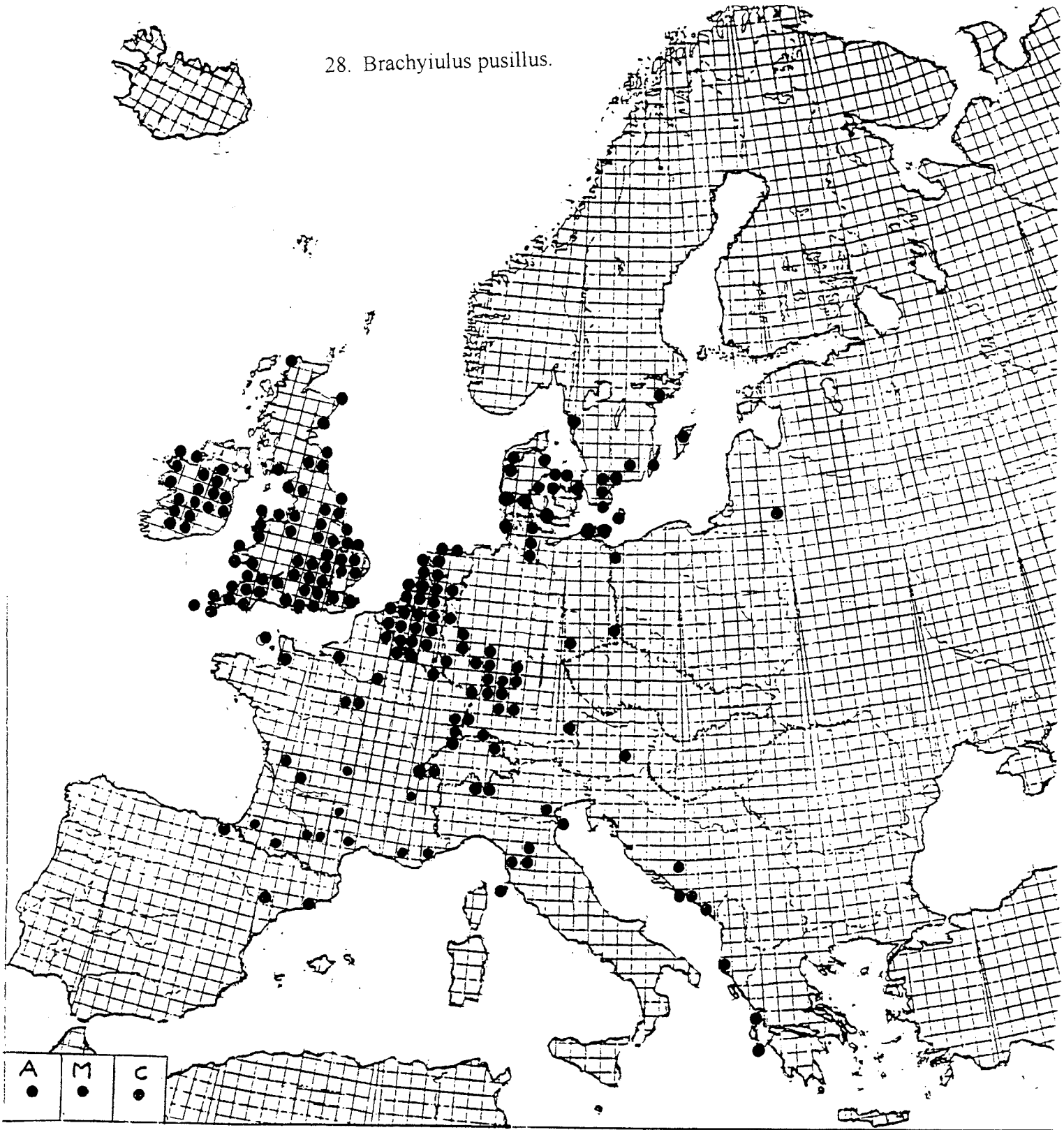
26. *Leptoiulus kervillei*.



27. *Metaiulus pratensis*.



28. *Brachyiulus pusillus*.



29. *Unciger foetidus*.

