Visualisation of a possible simple "Synanthropy Spectrum" for Centipedes, Millipedes and Woodlice

Anthony D. Barber

7 Greenfield Drive, Ivybridge, Devon PL21 0UG

E-mail: abarber159@btinternet.com

Abstract

In addition to distribution maps for Britain and Ireland, considerable amounts of habitat data for centipedes, millipedes and woodlice was generated by the BMIG recording schemes for these three groups. Crude percentage data on its own can give a false impression because of the different total numbers of records in each recording category and the different total numbers for individual species. Weighting of the data can be used to produce figures that may be used to compare options in each recording category. One particular category was for "Urban", "Suburban/Village" and "Rural" and by using these an attempt is made to explore the "Synanthropy Spectrum" of each of the three groups.

Introduction: Synanthropy and a "Synanthropy Spectrum"

Synanthropy, with some animal species being described as synanthropic and inhabiting habitats associated with human activity is a familiar one. In the recent centipede atlas (Barber, 2022) there was some discussion of this. There are probably both potential benefits and disadvantages of living in synanthropic habitats for centipedes as generalist carnivores and millipedes and woodlice as scavengers/detritus feeders and examples of all three groups are widely found in significantly human influenced sites. One of the likely factors involved could well be local climate when urban/built environments act as "heat islands" in otherwise rural areas. This could act directly on the species or via other members of the food chain and one consequence could be the establishment of some species in warmer locations further north than they might otherwise occur (Barber, 1985). Blackburn *et al*. (2002) comment that northward moving propagules perhaps can only survive in or near urban heat islands. Another aspect of urban sites could possibly be the impact of calcium from construction materials, likely to be more important to millipedes and woodlice rather than centipedes.

The presence of synanthropic species in a site could well be excluding what we might term the "locally native" ones by out-competing them or it could be that the latter are unable to survive in synanthropic sites because of the conditions and synanthropes have taken their place. The account of centipede species in various parks and open spaces in London (actually Watsonian Vice-county 21, Middlesex) by Barber & Milner (2023) illustrates the range of species in a large urban area with some apparent survivals from pre-urban times.

The presence of synanthropic species in any particular location could be due either to accidental human importation (with plants, construction materials, etc.) or to natural geographical spread. *Cryptops anomalans*, a large and distinctive example of a strongly synanthropic species, was first described (as *Cryptops savignii*) by Leach (1817) from the garden of the British Museum at Bloomsbury. Pocock (1902, 1906) recording it from Kew, commented that "this species belongs typically to the fauna of the Mediterranean area". The centipede atlas (Barber, 2022) recorded it from 79 hectads (10km grid squares) in Great Britain and one each from Ireland and from the Channel Islands. Wesener *et al.* (2016) described it as "most likely introduced from the Mediterranean to Northern Europe" – and, interestingly, a single bar-coding haplotype suggesting either human introduction from a homogenous source population or rapid spread of the species.

Whatever the factors involved in distribution, spread and survival, it is notable that certain species, which may be termed "avoiders" are rarely if ever found in synanthropic sites whilst others ("dwellers") are regularly found there. In the context of bird species, Guetté *et al.* (2017) referred to a continuum between these two extremes and it is interesting to see if we can visualise some such sort of spectrum of species occurrence in our myriapods and woodlice.

In discussion of this with Dr Helen Read, she drew my attention to the work of Hauser & Voigtländer (2019) who, in their volume on German millipedes, reviewed by her in 2020 (Read, 2020), included an intersection ecogram (Abt. 34) showing species preferences in woodland (Waldarten), synanthropic sites (Synanthrope Arten) and open areas (Offenlandarten) and also, interestingly, a diagram (Abt. 33) showing relative synanthropy in common millipedes ranging from various *Glomeris* species to *Melogona voigtii* and *Ophiodesmus albonanus*.

For this latter they had used data derived from that in Schubart (1957) for Mark Brandenburg using catch numbers for each species and the various biotopes they were found in. In some cases, the numbers for particular species were small but the graphs show, in a diagrammatic way, a picture of a synanthropy spectrum and the relative positions along it of individual species. Clearly some species are apparently confined to "synanthropische biotopes"; those more centrally on the spectrum show different proportions from natural and synanthropic sites; and, at the other end, those seemingly confined to "naturliche biotopes".

Possible Synanthropy Diagrams for British Species

Abt.33 (in Hauser & Voigtländer, 2019) seemed to be the sort of idea that might possibly be applied to British centipedes, millipedes and woodlice but this would require some form of quantification of relative synanthropy for the various species so that they may be arranged in an appropriate way in a chart.

Data such as that of Schubert is not conveniently available for Britain and Ireland. However what we do have is the fact that, when launched, the national recording schemes for woodlice (British Isopod Study Group, commenced 1968) and centipedes and millipedes (British Myriapod Group, launched 1970) in association with the Biological Records Centre, included provision for the collection of habitat data as well as date and location on the record cards to be used. These cards for the three schemes had a common format apart from the species list and used a "tick-box" system. Examples are illustrated by Barber and Fairhurst (1974) and Harding and Sutton (1985).

One category of data asked for with each record was whether the site from which it derived could be classified as "Urban", "Suburban / Village" or "Rural". The woodlouse scheme ceased to collect habitat data in this way in 1982 but when the two myriapod schemes' cards were revised, recording of these categories alongside other habitat data continued. Accepting that these categories are vague and somewhat subjective, a large amount of such data was accumulated, up to several thousand or more records in the case of some species. "Urban" and "Synanthropic" are not exactly identical categories and similarly "Rural" and "Non-synanthropic" but they approximate to these and are used for the purposes of this exercise since it would seem reasonable to assume that, essentially, records described as "Urban" would fit into the synanthropic category.

Data was presented in the centipede atlas (Barber, 2022) both as numbers of records and, for species with 31 or more records, percentage values, weighted ("standardised") to take account of the variation in both the number of records with data for an individual species and the number of records for that particular habitat. It seemed interesting to see if this data as presented in the atlas (and similar data for millipedes and woodlice) could be used to produce some sort of visualisation of the relative synanthropy of British and Irish species in a similar way to the German one.

Species recorded only from heated greenhouses (and similar locations) and those considered to be marine littoral are excluded so as to concentrate on outdoor terrestrial ones. Species with less than 31 records were included in the calculation of total numbers of records in each category and used in the weighting exercise but are not shown in the final tables and charts.

Calculation of a Species Synanthropy Spectrum Index

(Centipede data from Barber, 2022, see pages 18-20 for explanation)

1. Crude percentages:

The total numbers of records for each of the three categories, Urban, Suburban/Village and Rural can be expressed as simple (crude) percentages.

e.g. for *Stigmatogaster subterranea*

	Urban	Suburban/Village	Rural
Records:	332	683	1,177
Crude %	15.1	31.2	53.7

This would suggest that we have a species with more than 50% rural records but through 'personal experience' we are aware that the species, outside the South and West, is typically found in synanthropic sites.

2. Weighting of records data:

Data can be distorted by: (a) the different numbers of overall species records – 74% of these are from "Rural" sites. (b) The different numbers of records of the species as a percentage of total records in each habitat category. The need to weight ("standardise") the data to take account of these was recognised in the provisional centipede atlas (Barber & Keay, 1988) and is described in Barber (2022, pp 19-20) where such weighted values are given for individual species.

Using *Stigmatogaster subterranea* as an example the process is outlined below.

	Urban	**Suburban / Village**	**Rural**
All centipede spp: total number of records	2596	6856	26957
All centipede spp: as percentage of those records	7	19	74
Stigmatogaster subterranea: number of records	332	683	1,177
As percentage of all centipede records	12.8	10	4.4
S. subterranea Crude %	15.1	31.2	53.7
***S. subterranea* Weighted %**	**47.1**	**36.8**	**16.1**

The **Crude %** is simply the percentage of records of a given species (in this case *S. subterranea*) in a given sub-category (in this case Urban, Suburban/Village and Rural).

To derive the **Weighted %** the total number of centipede records (all species) within each sub-category needs to be taken into account. Thus the **Weighted %** for Urban sub-category is calculated as follows:

$$\frac{\text{\% of records of } \textit{S. subterraneus} \text{ in urban sub-category}}{\text{\% of all } \textit{S. subterraneus} \text{ in urban+suburban/village+rural sub-categories}} \times 100$$

i.e. 12.8 / (12.8+10+4.4) x 100 = 47.1 (Weighted %)

3. Converting three categories into two:

If the three categories can be converted into two, this would allow calculation of a single percentage figure. The boundaries between "Urban" and "Suburban/Village" and between the latter and "Rural" are not sharp and also suburban areas and villages frequently contain locations, often collected from, which are best described as synanthropic.

There are various possible ways to do this. One chosen here is to divide the "Suburban/Village" category evenly and combine each of these fractions with each of the other categories (i.e. Urban + 50% Suburban/Village and Rural + 50% of Suburban/Village). Different ways of doing this would produce different values for the "Spectrum Index" but if consistently applied to all the data a coherent set of values could be produced which might be used to give an alternative form of the index to the one used herein (see *Discussion* below).

Using the 50/50 division of "Suburban/Village" i.e. choosing to divide the Suburban/Village data evenly we obtain:

e.g. for *Stigmatogaster subterranea* (values as in section **2.** above):

Urban + 50% of Suburban/Village	47.1% + (36.8% / 2) = 65.5%
Rural + 50% of Suburban/Village	16.1% % + (36.8% / 2) = 34.5%

4. Calculating a Synanthropy "Spectrum Index":

For each species, a synanthropy "Spectrum Index" (Urban + 50% of Suburban/Village) may be derived so that comparisons between species can be made (Table 1):

$$\text{Number of Urban records} + \frac{\text{Number of Suburban / Village records}}{2} = \text{Spectrum Index}$$

e.g. for *Stigmatogaster subterranea* (as shown in section **3.** above):

Weighted percentages are: Urban 47.1%; Suburban/Village 36.8%; Rural 16.1%

Spectrum Index: 47.1% + (36.8% / 2) = **65.5%**

This "Index" is, of course, simply a percentage for the "wider urban" records of the total records and if all records were in this category the index would be 100% whilst if none were it would be 0%. If the three original categories were one third / one third / one third, the index becomes 50%. A species with values close to this is the common brown centipede *Lithobius forficatus*:

	Urban	Suburban/Village	Rural
Records	37.4	683	1,177
Crude %	8.72	20.67	70.60
Weighted %	37.4	33.5	29.1

Thus, Synanthropy "Spectrum Index" = 37.4% + (33.5% / 2) = **54.2%**

Clearly the values obtained are only meaningful in terms of giving a very broad and generalised idea of relative synanthropy in the species listed rather than accurate figures with clear confidence limits but may be helpful in visualisation of an overall pattern.

Centipedes

Total records available, including those subsequently excluded from the analysis (marine littoral, heated greenhouse, species with 30 or less records) were 36,409. Using the values in the 2022 atlas (Barber, 2022) and applying the index calculation with "Suburban / Village" being evenly divided, the species of centipede are tabulated with index value for the three orders Geophilomorpha, Scolopendromorpha and

Lithobiomorpha respectively as shown in Table 1. They are then set out as a chart in Figure 1. Species with less than 100 records (but >30) with appropriate data are shown in red.

Table 1: Centipede Records

Weighted percentages for locations described as Urban, Suburban/Village or Rural and a calculated "Spectrum Index" for each species. (Pre-2019, excluding marine littoral, hothouse and species with 30 or less records; derived from Barber (2022)). Species with <100 records (but >30) are shown in red.

Species	Total Records	Urban %	Suburban / Village %	Rural %	"Spectrum Index" %
Geophilomorpha					
Stigmatogaster subterranea	2,849	47.1	36.8	16.1	**65.5**
Schendyla dentata	37	52.8	44.4	2.8	**75.0**
Schendyla nemorensis	1,789	31.1	36.1	32.8	**49.2**
Henia brevis	73	58	38.9	3.0	**77.5**
Henia vesuviana	238	59.2	31.7	9.1	**75.1**
Strigamia acuminata	672	5.1	30.8	64.1	**20.5**
Strigamia crassipes	481	24.7	33.1	42.2	**41.3**
Geophilus carpophagus s.s.	175	33.7	56.6	9.7	**62.0**
Geophilus easoni	727	19.0	19.0	61.9	**28.5**
Geophilus electricus	344	38.1	43.8	18.1	**60.0**
Geophilus flavus	2,440	34.9	36.9	28.2	**53.4**
Geophilus impressus	1,359	37.0	39.8	23.2	**56.9**
Geophilus osquidatum	147	46.4	42.2	11.4	**67.5**
Geophilus truncorum	2,713	10.9	27.5	61.7	**24.7**
Stenotaenia linearis	61	66.0	31.2	2.8	**81.6**
Scolopendromorpha					
Cryptops anomalans	176	72.7	24.3	3.1	**84.9**
Cryptops hortensis	2,211	43.3	37.8	18.9	**62.2**
Cryptops parisi	310	62.5	31.7	5.8	**78.4**
Lithobiomorpha					
Lithobius borealis	552	6.2	9.4	84.3	**10.9**
Lithobius calcaratus	553	4.3	18	77.6	**13.3**
Lithobius forficatus	9,456	37.4	33.5	29.1	**54.2**
Lithobius macilentus	203	5.2	23.8	71.0	**17.1**
Lithobius melanops	2,331	38.3	35.3	26.4	**56.0**
Lithobius muticus	287	4.4	21.9	73.6	**15.4**
Lithobius piceus	103	6.9	46.8	46.3	**30.3**
Lithobius pilicornis	226	64.5	25.7	9.8	**77.4**
Lithobius tricuspis	50	0	37.1	62.9	**18.6**
Lithobius variegatus	6,855	11.3	29.2	59.5	**25.9**
Lithobius crassipes	2,594	5.9	19.7	74.4	**15.8**
Lithobius curtipes	171	0	5.8	94.2	**2.9**
Lithobius microps	4,472	36.9	35.8	27.3	**54.8**
Lamyctes emarginatus	595	31.6	17.9	50.3	**40.6**

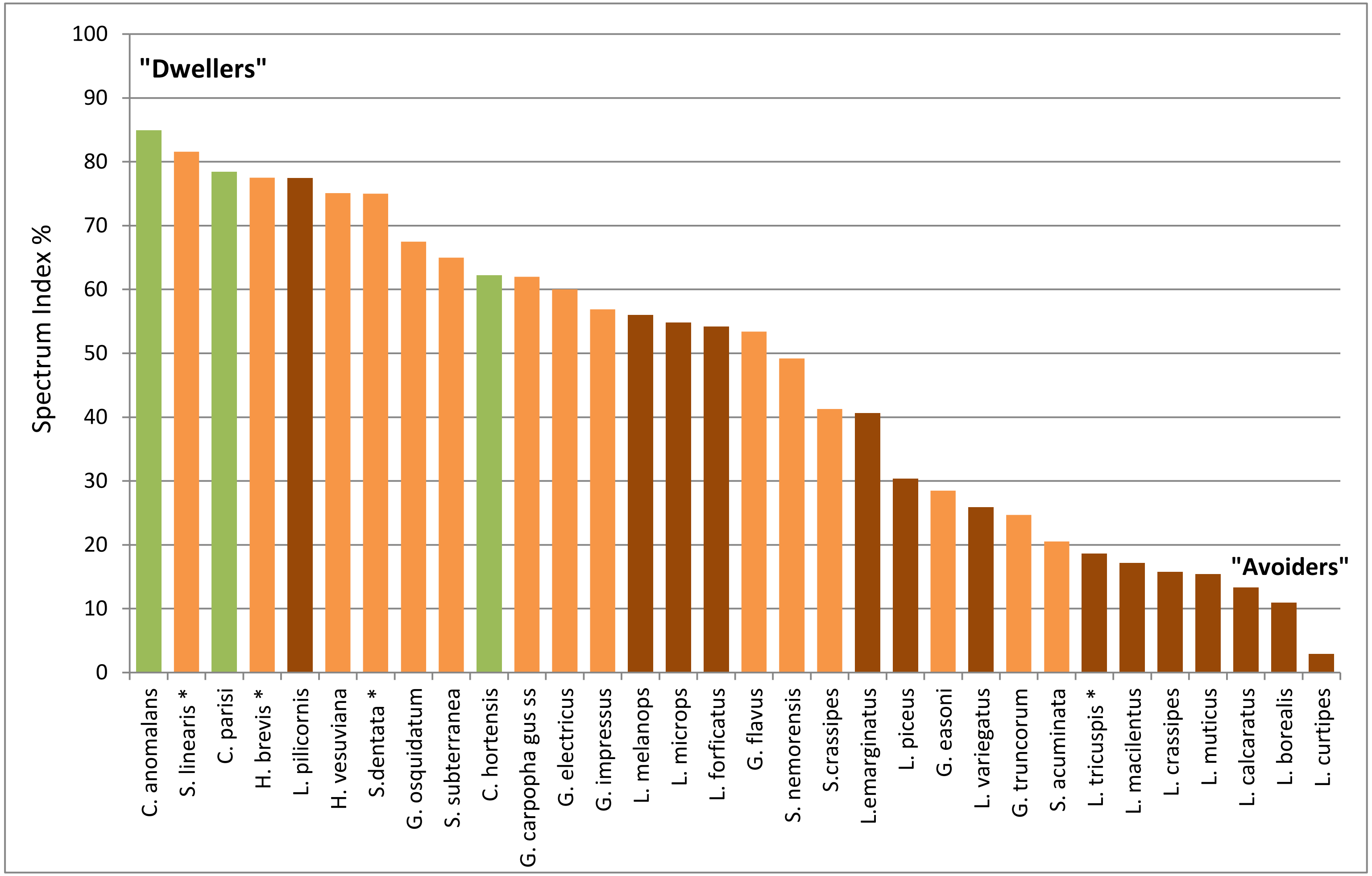

Figure 1: Visualisation of a centipede "synanthropy spectrum" using data in Table 1.

Geophilomorpha Scolopendromorpha Lithobiomorpha

* species with <100 records (but >30)

Comments

In a review of distribution and habitat patterns by the present author based on a somewhat smaller set of centipede records (Barber, 1992), ordination of species was carried out in terms of relative habitat preferences using "First Order Habitat" data as in the original version of the BMG Centipede Recording Scheme (Barber and Keay, 1988). The results were presented as scatter diagrams and those with ordinations of species in terms of habitat preferences and some similarities to the pattern seen in our synanthropy spectrum from dwellers to avoiders can be discerned.

Blackburn *et al*., (2002) collected centipedes along with physical variables from 45 sampling sites across an area of about 4,000 km^2 in north-east England. They found a total of 14 species, seven geophilomorphs and the same number of lithobiomorphs. Three they described as "rare", (≤ 3 individuals; *Strigamia acuminata*, *Lithobius macilentus* & *L. borealis*), six "intermediate" (10-50: *Stigmatogaster subterranea*, *Schendyla nemorensis*, *Geophilus* e*lectricus*, *G. flavus*, *Lithobius melanops, L. muticus*) and five "common" (100+: *Geophilus impressus* (*G. insculptus*), *G. truncorum, Lithobius variegatus, L. forficatus, L. melanops*). Only the last group provided sufficient data for statistical analysis but the "intermediate" group showed that the geophilomorphs were markedly synanthropic whereas the lithobiomorphs were not. Overall, synanthropic sites had the highest centipede density but this was caused by the synanthropic tendencies of "intermediate" species. The overall picture of the five "common" species proved to be complex. Some of the findings matched the expectations of experienced fieldworkers, notably the negative association between *G. truncorum* and pH. Others were unexpected or counterintuitive.

Our "Synanthropy Spectrum" for a somewhat larger group of species than that used by Blackburn *et al*. seems to support the general idea of geophilomorphs being more likely to be synanthropic than lithobiomorphs but with several significant exceptions. *G. truncorum* is very clearly low down on the spectrum index score as are *Geophilus easoni* (not recorded by Blackburn *et al*.) and *Strigamia acuminata* (only three specimens found in their survey). The latter has been found in a diversity of habitats in Britain (although rare or absent in Ireland), occurs in sites up to 1,000m in Wales and seems markedly less synanthropic than the congeneric *Strigamia crassipes* which, itself, is only about halfway up the "spectrum". The comment about the association of *G. truncorum* with low pH is borne out by atlas data and, although having only a relatively small number of records, data for *G. easoni* seems to indicate a likely similar preference for acid soils (Table 2). Other interesting points that arise are (a) the already recognised marked difference in habits between *Geophilus carpophagus* s.s. and *Geophilus easoni*; (b) the way *Geophilus electricus*, *Geophilus flavus* and *Geophilus impressus* seem to cluster together especially the latter two species even though their geographical distribution is not identical; (c) the marked similarity in synanthropy index in our two species of *Henia* even though their morphology and ecology may appear to be rather different. Our three (outdoor) species of *Cryptops*, well known for their tendency to occur in synanthropic sites, are all well up on the spectrum, especially *C. parisi* and even more so *C. anomalans.*

The one lithobiomorph on our chart which clearly does not fit the suggested generalised geophilomorph / lithobiomorph pattern is *Lithobius pilicornis* for which records are reported as less than 10% "rural" and has an "index" of nearly 80%, comparable with distinctly synanthropic geophilomorphs and the two larger *Cryptops* species. However, *L. pilicornis* has been found in some clearly rural woodlands in western Cornwall. Both *Lithobius melanops* (56) and *Lithobius microps* (55) are frequently found in gardens, both domestic and ornamental whilst *Lithobius forficatus* (54) has been noted already.

Table 2: Extract from atlas records for Geophilomorpha.
Weighted percentage of locations described as calcareous or non-calcareous.
(From Barber, 2022)

Species	Total Records with data	Calcareous %	Non-calcareous %
Stigmatogaster subterranea	876	57.9	42.1
Schendyla nemorensis	457	58.1	41.9
Strigamia acuminata	142	54.8	45.2
Strigamia crassipes	98	58.7	41.3
Geophilus carpophagus s.s.	23	82.9	17.1
Geophilus easoni	45	29.4	70.6
Geophilus electricus	106	51.5	48.5
Geophilus flavus	648	63.1	36.9
Geophilus impressus	522	62.4	37.6
Geophilus truncorum	790	38.0	62.0

Millipedes

It seemed interesting to see if the procedure described above might be applied to other groups where such data was available. For instance millipedes where total records available, including those subsequently excluded (marine littoral, heated greenhouse, 30 or less records) were 31,764.

The preliminary atlas for millipedes (British Myriapod Group, 1988) did not include habitat data unlike Paul Lee's more recent one (Lee, 2006) which has a parallel set of figures to those for centipedes (his Appendix 3, Table 5). However, in his account the data is presented in terms of raw figures and in only two categories, "Rural" and "Suburban/Urban". Although these could be standardised and used for index calculations, it was considered important to use the same methodology as for centipedes. The Biological Records Centre (UKCEH), with Paul Lee's agreement, kindly provided raw millipede data with all three categories (Table 3).

The numbers recorded for British/Irish millipedes can therefore be as in the data preparation for the centipede atlas (Table 4).

Our one marine littoral species (*Thalassisobates littoralis*) and millipedes recorded only from heated greenhouses and similar are excluded from the calculations and only species with more than 30 records are shown in the synanthropy table and diagram (Table 4 and Figure 2). Nomenclature is as in the millipede atlas (Lee, 2006). Species with less than 100 (>30) records with relevant data are shown in red.

Comments

The millipede analysis exercise was carried out without direct reference to the text of the individual species accounts in the atlas (Lee, 2006) but subsequent attention to comments in the latter shows the author specifically remarking on synanthropic habits in species which emerge towards the higher end of our spectrum such as *Macrosternodesmus palicola*, *Ophiodesmus albonanus*, *Boreoiulus tenuis* and *Cylindroiulus caeruleocinctus*. At the other extreme, species tending to avoid synanthropic sites include *Glomeris marginata*, *Proteroiulus fuscus* and *Cylindroiulus punctatus*. However, the pattern is, in fact, more complex with some of our species (e.g. *Choneiulus palmatus*) tending to be more synanthropic in the more northern parts of their range.

Millipedes do present a more diverse variety than the centipedes and a less clear pattern in relation to synanthropy. In addition, undoubtedly a wide variety of environmental factors, including pH, types of soil, degree of habitat wetness and presence of woodland do seem to affect the occurrence of these animals. In Table 4 the species included are grouped by family and in the chart (Figure 2) they are grouped according to the four orders represented.

The data (250 records) for *Polyxenus lagurus* is somewhat puzzling with the species having something of an apparent preference for suburban/village sites. Whether this is due to some particular feature of such sites is unclear. One intriguing possibility is "recorder bias", collectors deliberately going to such sites – including the walls of village churches and burial grounds so as to be able to find it - and skewing the record pattern accordingly.

Both of our included glomerids are strikingly non-synanthropic. In the Order Chordeumatida, *Craspedosoma raulinsii* and its fellow craspidosomatid, *Nanogona polydesmoides* are well apart on the spectrum and the three chordeumatids (*Chordeuma* and *Melogona*) are not close together. Our three species of *Brachychaeteuma* tend to be fairly well up the table towards "dwelling" although all have low numbers of records so their values need to be taken with caution. Amongst the Order Polydesmida, *Ophiodesmus albonanus* and *Macrosternodesmus palicola*, as already noted, are known for their synanthropic habits and this shows up in the chart, both having indices of >70%. Three of our species of *Polydesmus* are around the middle of the chart as is *Brachydesmus superus* and seem to have a wide habitat tolerance. However, *Polydesmus denticulatus* is very much lower down on the spectrum, with more than 60% of (weighted) records from rural locations. Although it has been found in a wide variety of habitats, notably woodland, the millipede atlas (Lee, 2006) suggests a strong association with wetland.

The so-called "snake millipedes" (Order Julida), which represent about half of our species, show a wide range of tolerances of synanthropic sites. The blaniulids are mostly in the range 60-80% although the relatively rare *Choneiulus palmatus* is more strongly synanthropic at 86%. In the north it is usually recorded from gardens and greenhouses, further south it has been collected from deciduous woodland (Lee, 2006). Towards the other end of the spectrum is the common litter and sub-cortical species, *Proteroiulus fuscus* (40%) while the nemasomatid *Nemasoma varicorne* is even more of an "avoider" at 31%

Top of the synanthropy list for the family Julidae is *Cylindroiulus vulnerarius* with 85% (weighted) of its records being recorded as "urban" although there are only 40 in total. Supposedly endemic to Italy, it was only recorded in Britain in 1975 for the first time and in the millipede atlas (Lee, 2006) is described as from about 20, mainly urban sites, and strongly synanthropic (glasshouses, gardens, parks, urban open spaces). Lowest on the list are *Cylindroiulus londinensis* and *Ommatoiulus sabulosus* although there are only a fairly small number of records (57) of the former and the latter is referred to below. Most of our most familiar julids are in the index range 40-70% with the typically woodland *Cylindroiulus punctatus* just below this.

Cylindroiulus latestriatus is a somewhat special case in relation to coastal sites. Although not an apparent obligate halophile in the way that *Thalassisobates littoralis* is, it is a common animal above the shoreline. However, it also occurs in inland locations (>15km from coast). Table 5, which uses millipede atlas data for coastal and inland habitats for some of our julids, shows how *C. latestriatus* reflects its maritime tendency strongly in both the raw and the weighted percentages. Since a good proportion of collected coastal locations are outside urban areas, this impacts on the synanthropy data for the species (Table 4 and Figure 2). *Ommatoiulus sabulosus* (27%) is often found in sand-dunes as well as elsewhere and this also seems to be reflected to a certain extent in its data in the same way in these tables.

Table 3: Millipedes: Numbers of Records and Calculated (Crude) Percentages for Urban, Suburban/Village and Rural habitats (derived from BRC data)

Note: The first number is the number of records for that species from that habitat sub-category. Second number, if given, is the unweighted percentage of records for that species from that habitat. **Source:** Numbers of records courtesy of Biological Records Centre, UKCEH, October 2023.

Species	Total Records	Urban	Suburban / Village	Rural	Notes
Adenomeris gibbosa	2	0	1	1	<30 records
Allajulus nitidus	96	9 : 9.38%	33 : 34.38%	54 : 56.25%	<100 records
Amphitomeus attemsi	1	0	1	0	Hothouse sp.
Anamastigona pulchella	1	0	0	1	<30 records
Anthogona britannica	12	0	0	12	<30 records
Archiboreoiulus pallidus	214	22 : 10.28%	52 : 24.30%	140 : 65.42%	
Blaniulus guttulatus	1053	161 : 15.29%	305 : 28.96%	587 : 55.74%	
Boreoiulus tenuis	303	29 : 9.57%	131 : 43.23%	143 : 47.19%	
Brachychaeteuma bagnalli	39	3 : 7.69%	21 : 53.84%	15 : 38.46%	<100 records
Brachychaeteuma bradeae	32	6 : 18.75%	12 : 34.5%	14 : 43.75%	<100 records
Brachychaeteuma melanops	85	14 : 16.47%	36 : 42.35%	35 : 41.76%	<100 records
Brachydesmus superus	1593	62 : 3.89%	218 : 13.68%	1375 : 86.32%	
Brachyiulus lusitanus	2	0	2	0	<30 records
Brachyiulus pusillus	409	26 : 6.36%	81 : 19.80%	302 : 73.84%	
Choneiulus palmatus	81	27 : 33.3%	19 : 23.46%	35 : 43.21%	<100 records
Chordeuma proximum	224	7 : 3.13%	30 : 13.39%	187 : 83.48%	
Chordeuma sylvestre	5	0	0	5	<30 records
**Craspedosoma raulinsii*	75	1 : 1.33%	4 : 5.33%	70 : 93.33%	
Cylindrodesmus hirsutus	2	0	2	0	Hothouse sp.
Cylindroiulus britannicus	657	65 : 9.89%	140 : 21.30%	452 : 68.80%	
Cylindroiulus caeruleocinctus	448	70 : 15.63%	164 : 36.61%	214 : 47.77%	
Cylindroiulus latestriatus	805	11 : 1.37%	90 : 11.18%	704 : 87.45%	
Cylindroiulus londinensis	57	0	11 : 19.30%	46 : 80.70%	<100 records
Cylindroiulus parisiorum	54	7 : 12.96%	13 : 24.07%	34 : 62.96%	<100 records
Cylindroiulus punctatus	4883	122 : 2.50%	567 : 11.61%	4194 : 85.90%	
Cylindroiulus salicivorus	8	8	0	0	Hothouse sp.
Cylindroiulus truncorum	12	4	5	3	<30 records
Cylindroiulus vulnerarius	40	24 : 60%	13 : 32.5%	3 : 7.5%	<100 records
Enantiulus armatus	27	0	8	19	<30 records
Eutrichodesmus sp. Eden A	2	0	2	0	Hothouse sp.
Geoglomeris subterranea	54	0	2 : 3.70%	52 : 96.30%	<100 records
Glomeris marginata	2387	17 : 0.71%	188 : 7.88%	2182 : 91.41%	
Haplopodoiulus spathifer	1	0	1	0	<30 records
Julus scandinavius	1141	42 : 3.68%	153 : 14.41%	946 : 82.91%	
Leptoiulus belgicus	104	7 : 6.73%	22 : 21.15%	75 : 72.11%	
Leptoiulus kervillei	53	1 : 1.89%	5 : 9.43%	47 : 88.68%	<100 records
Macrosternodesmus palicola	370	59 : 15.95%	141 : 38.11%	170 : 44.95%	

Melogona gallica	97	12 : 12.37%	18 : 18.56%	67 : 69.07%	<100 records
Melogona scutellaris	305	24 : 7.87%	79 : 25.90%	202 : 66.23	
Melogona voigtii	1	0	1	0	<30 records
Metaiulus pratensis	4	0	2	2	<30 records
Nanogona polydesmoides	1701	120	308	1273	
Nemasoma varicorne	492	9	36	447	
Nopoiulus kochii	25	14	7	4	<30 records
Ommatoiulus sabulosus	1050	13 : 1.24%	75 : 7.14%	962 : 91.62%	
Ophiodesmus albonanus	242	39 : 16.12%	106 : 43.80%	97 : 40.08%	
Ophyiulus pilosus	2069	112 : 5.41%	347 : 16.77%	1610 : 77.82%	
Oxidus gracilis	29	21	6	2	Hothouse sp.
Paraspirobolus lucifugus	2	0	2	0	Hothouse sp.
Polydesmus angustus	2795	107 : 3.83%	364 : 3.02%	2234 : 77.92%	
Polydesmus barberii	8	3	1	4	<30 records
Polydesmus coriaceus	802	47 : 5.86%	172 : 1.45%	583 : 72.69%	
Polydesmus denticulatus	312	5 : 1.60%	18 : 5.77%	289 : 92.63%	
Polydesmus inconstans	289	13 : 4.50%	39 : 13.49%	237 : 82.01%	
Polyxenus lagurus	250	11 : 4.40%	56 : 22.40%	183 : 73.20%	
Polyzonium germanicum	29	0	1	28	<30 records
Poratia digitata	4	3	1	0	Hothouse sp.
Propolydesmus testaceus	8	1	0	7	<30 records
Prosopodesmus panporus	1	0	1	0	Hothouse sp.
Proteroiulus fuscus	2070	60 : 2.90%	225 : 10.87%	1785 : 86.23%	
Pseudospirobolellus avernus	1	0	1	0	Hothouse sp.
Rhinotus purpureus	1	0	1	0	Hothouse sp.
Stosatea italica	25	5	5	15	<30 records
Tachypodoiulus niger	4373	152 : 3.48%	596 : 13.63%	3625 : 82.90%	
Thalassisobates littoralis	21	0	3	18	Littoral
Trachysphaera lobata	6	0	1	5	<30 records
Unciger foetidus	3	0	3	0	<30 records

***** *Craspedosoma raulinsii* Leach, 1817 with a "u" is the correct spelling (Read & Enghoff, 2023)

Table 4: "Synanthropy Spectrum" values for Millipedes

Weighted ("Standardised") numbers derived from BRC (UKCEH) data.
Species with <100 records (but >30) shown in red.

Species	**Total Records**	**Urban %**	**Suburban / Village %**	**Rural %**	**Spectrum Index %**
Polyxenidae					
Polyxenus lagurus	250	27.9	44.4	27.5	50.1
Glomeridae					
Geoglomeris subterranea	54	0	16.8	83.2	8.4
Glomeris marginata	2387	8.2	28.5	63.3	22.5

Craspedosomatidae					
Craspedosoma raulinsii	75	15.9	19.3	64.8	25.6
Nanogona polydesmoides	1701	41.6	32.6	25.8	57.9
Chordeumatidae					
Chordeuma proximum	224	25.9	33.8	0.3	42.8
Melogona gallica	97	56.1	25.7	18.3	68.9
Melogona scutellaris	305	40.1	40.2	19.7	60.2
Brachychaeteumatidae					
Brachychaeteuma bagnalli	39	29.3	62.2	8.5	60.4
Brachychaeteuma bradeae	32	57.2	35.0	7.7	74.7
Brachychaeteuma melanops	85	51.7	40.6	7.5	72.0
Polydesmidae					
Brachydesmus superus	1593	29.7	31.9	38.4	45.7
Polydesmus angustus	2705	30.7	31.9	37.4	46.7
Polydesmus coriaceus	802	35.2	39.3	25.6	54.8
Polydesmus denticulatus	312	18.3	20.1	61.6	28.3
Polydesmus inconstans	237	33.6	30.7	35.7	48.9
Macrosternodesmidae					
Macrosternodesmus palicola	370	52.0	38.9	9.0	71.4
Ophiodesmus albonanus	242	50.7	42.0	7.3	71.7
Blaniulidae					
Archiboreoiulus pallidus	214	47.8	34.5	17.7	65.1
Blaniulus guttulatus	1053	55.8	32.3	11.9	72.0
Boreoiulus tenuis	303	37.5	51.7	10.8	63.4
Choneiulus palmatus	81	77.5	16.7	5.9	85.8
Proteroiulus fuscus	1785	25.3	29.7	45.0	40.2
Nemasomatidae					
Nemasoma varicorne	492	19.6	23.9	56.6	31.5
Julidae					
Allajulus nitidus	96	40.5	45.3	14.1	63
Brachyiulus pusillus	409	38.1	36.2	25.8	56.1
Cylindroiulus britannicus	657	48.5	31.9	19,7	64.4
Cylindroiulus caeruleocinctus	448	52.8	37.8	9.4	71.7
Cylindroiulus latestriatus	805	13.8	34.5	51.6	31.1
Cylindroiulus londinensis	57	0	55.6	44.4	27.8
Cylindroiulus parisiorum	54	54.1	30.6	15.3	69.4
Cylindroiulus punctatus	4883	22.6	32.1	45.3	38.7
Cylindroiulus vulnerarius	40	85.0	14.4	0.7	92.2
Julus scandinavius	1141	29.2	32.4	38.4	45.4
Leptoiulus belgicus	104	38.7	34.5	24.2	56.0
Leptoiulus kervillei	53	19.0	28.9	24.2	33.5
Ommatoiulus sabulosus	1050	14.1	24.9	61	26.6
Ophyiulus pilosus	2969	35.9	34.0	30.1	52.9
Tachypodoiulus niger	4373	27.4	33.6	39.0	44.2

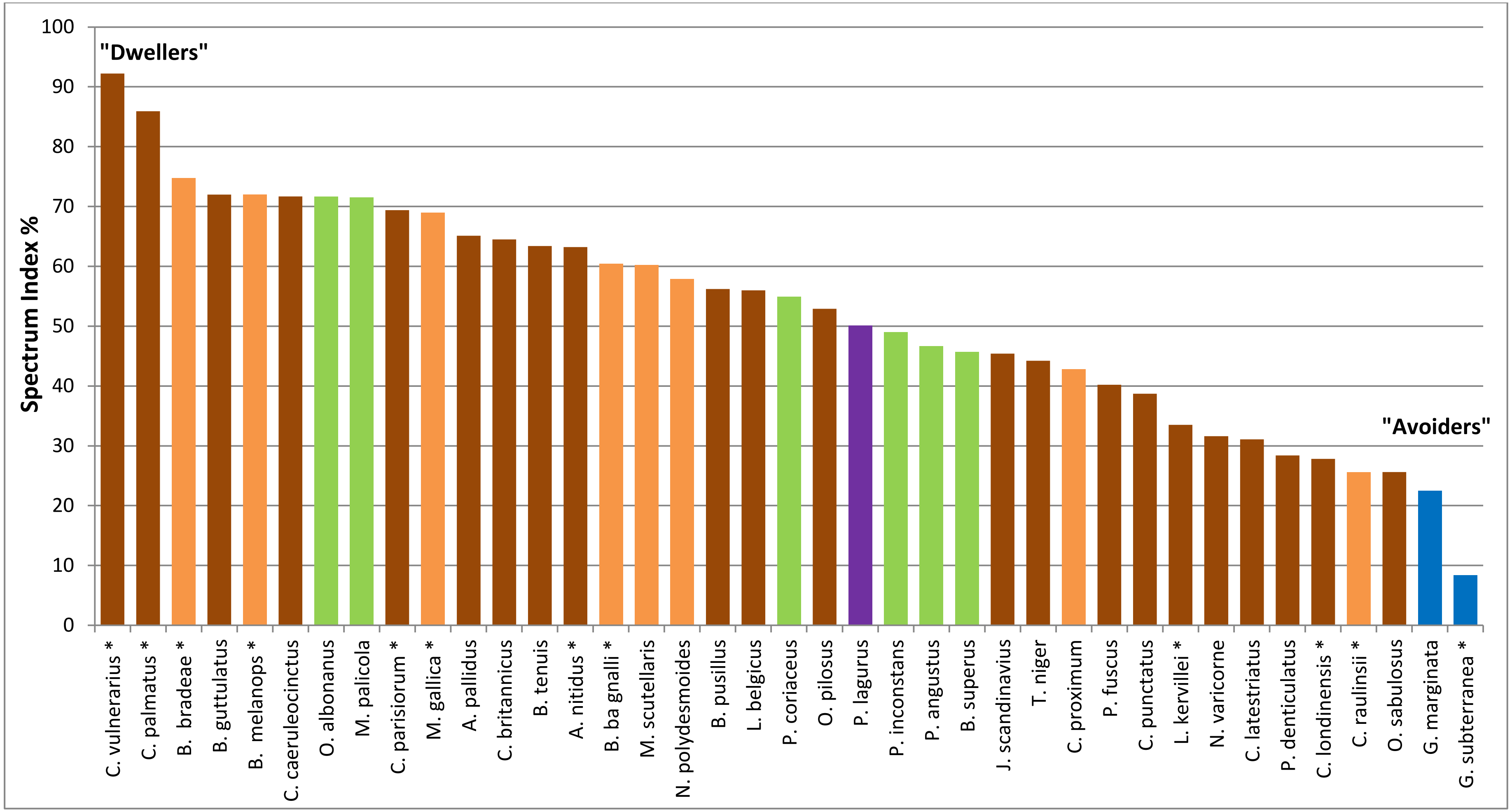

Figure 2: Visualisation of a millipede "synanthropy spectrum"

Polyxenida Glomerida Chordeumatida Polydesmida Julida

* species with <100 records (but >30)

Table 5: Millipede numbers and percentages (coastal and inland), in part. Less or more than 15km from the sea.
Data derived from Millipede Atlas Appendix 3.3 (Lee, 2006, pg. 199).
Species with <100 records shown in red.

Species	Total number records	Coastal <15km (Total)	Inland >15km (Total)	Coastal <15km (Raw %)	Inland >15km (Raw %)	Coastal <15km (Weighted)	Inland >15km (Weighted)
Cylindroiulus britannicus	676	230	446	34.0%	66.0%	53.0%	47.0%
C. caeruleocinctus	465	78	387	16.8%	83.2%	30.7%	69.3%
C. *latestriatus*	817	700	117	85.7%	14.3%	92.9%	7.1%
C. londinensis	58	15	43	25.95%	74.1%	43.2%	56.8%
C. parisiorum	51	3	48	5.9%	94.1%	12.1%	87.9%
C. punctatus	5054	1415	3639	28.0%	72.0%	46.0%	54.0%
C. salicivorus	8	8	0				
C. truncorum	8	2	6				
C. vulnerarius	39	13	26	33.3	66.7%	9.9%	90.1%
Julus scandinavius	1202	124	778	35.3%	64.7%	43.2%	56.8%
Ophyiulus pilosus	2102	708	1394	33.7%	66.3%	52.6%	47.4%
Ommatoiulus sabulosus	1098	489	609	44.5%	55.5%	63.7%	36.3%
Tachypodoiulus niger	4605	1130	3475	24.5%	75.5%	41.6%	58.4%

Comparison with the Mark Brandenburg data

It is of some interest to compare the picture presented in Figure 2 with that of Hauser & Voigtländer (2019) bearing in mind the differences between the millipede faunas of Britain and Ireland and that of Mark Brandenburg and also the different methodology used. A listing, in reverse order to those authors but derived from their Abt. 33, is shown in Table 6. This includes only species common to both the German list and that of Britain and Ireland. It also excludes such species with 30 records or less and gives a total of 26 names; the full German list contains 46.

Given the differing origins of the data, the varying numbers of records and the differences between the two faunas, it is not surprising that there are differences in the sequence of species names as between the two "spectra" but a number of names in common occur at both the "dweller" and "avoider" ends. Indeed, the same ten species are listed at the synanthropic end in both cases, although the order differs, *Glomeris marginata* is the most extreme "avoider" in both sequences. Only seven species have moved five or more positions up or down in one list in comparison with the other. *Brachychaeteuma bradeae*, at second highest in the Britain and Ireland list is seventh in the German one but the number of records for the species in the former case is low (32) so that confidence of its position in the British/Irish spectrum should be accordingly relatively low. On the other hand, *Polydesmus angustus*, five positions higher towards the dwellers in the German list could, one assumes, perhaps, be due to some difference in its relative abundance/occurrence or ecology. Similarly for the common *Cylindroiulus punctatus* which Kime & Enghoff (2017) describe as "more rural than synanthropic", listing it from a variety of habitats as well as woodland, is found at five positions lower on the scale for Britain/Ireland compared with the German data. Both the schizophyllines *Tachypodoiulus niger* and *Ommatoiulus sabulosus*, though not close to each other on either list, are six places closer to the synanthropic end of the spectrum in the German list whilst *Cylindroiulus caeruleocinctus* is six places lower.

The most marked difference is seen in *Cylindroiulus latestriatus*, eleventh (i.e. "mid-range") on the German list but twenty-first (distinctly "avoider") on the British/Irish one. The reason for this, at least in part and as already noted, could be well be the inflation of the British/Irish "rural" data by its widespread occurrence (and recording) in rural, maritime influenced areas. The European millipede atlas (Kime & Enghoff, 2017) comments that it is found "among the roots of halophytes on fixed coastal dunes and in grassland on a sandy substrate; inland strongly associated with sandy soils, common on some heaths, has been found in the deciduous litter of woodland on light soils but more usually synanthropic. Abundant in some horticultural areas and found often in urban gardens".

Table 6: Millipedes from Mark Brandenburg

Ranked in order from extreme synanthropes ("Dwellers") to extreme non-synanthropes ("Avoiders").
(Derived from Hauser & Voigtländer, 2019)

Shown as from "Synanthrope Biotope" ("Dwellers")	**Shown as from "Synanthrope Biotope" and also from "Naturliche Biotope"**	**Shown as from "Naturliche Biotope" ("Avoiders")**
Ophiodesmus albonanus	*Blaniulus guttulatus*	*Polyxenus lagurus*
Macrosternodesmus palicola	*Cylindroiulus caeruleocinctus*	*Nemasoma varicorne*
Cylindroiulus parisiorum	*Cylindroiulus latestriatus*	*Glomeris marginata*
Choneiulus palmatus	*Tachypodoiulus niger*	
Cylindroiulus britannicus	*Brachyiulus pusillus*	
Boreoiulus tenuis	*Ophyiulus pilosus*	
Brachychaeteuma bradeae	*Cylindroiulus punctatus*	
Allajulus nitidus	*Polydesmus inconstans*	
	Brachydesmus superus	
	Julus scandinavius	
	Ommatoiulus sabulosus	
	Polydesmus angustus	
	Polydesmus denticulatus	
	Craspedosoma raulinsii	
	Proteroiulus fuscus	

Notes:

a. These species names are in reverse order to those in Hauser & Voigtländer's diagram (Abt.33) with *O. albonanus* as the most synanthropic and *G. marginata* the least.

b. Only the 26 species that have been recorded from Britain/Ireland with more than 29 records are listed here, Hauser & Voigtländer list a total of 46 altogether for Mark Brandenburg.

c. Species recorded from Britain/Ireland with <31 records which are also in the German list are *Polyzonium germanicum*, *Unciger foetidus*, *Nopoiulus kochii*, *Cylindroiulus truncorum* and *Melogona voigti*. These are not included above.

Woodlice

As far as woodlouse data is concerned, record cards carrying habitat data were only used in the first phase (up to 1982) of the (then) BISG woodlouse recording scheme. The results were published, as percentage figures, in Harding and Sutton (1985). Millipede and centipede habitat data continued to be recorded up until the publication of the respective atlases.

Since the total number of records for each woodlouse species was included in the data set in Harding & Sutton (1985), it is possible to "back calculate" to get numbers of records (with a small margin of error due to "rounding up" effects) for the period of time between the launch of the recording scheme and the cessation of habitat recording in 1982 (Table 7). Such values can then be used to give us weighted values (Table 8) from which a synanthropy index may be calculated and displayed in a chart (Figure 3). Total records available, including those subsequently excluded (marine littoral, freshwater aquatic, heated greenhouses, etc., 30 or less records) were 23,444.

For species that might be considered as marine littoral and therefore best excluded from the exercise, the distinction is less clear than in, say, centipedes. Both *Buddelundiella cataractae* and *Metatrichoniscoides celticus* are also known from inland sites and are described as terrestrial inland species that may stray on to the coast whilst *Miktoniscus patiencei* and *Stenophiloscia glarearum* (*S. zosterae*) favour habitats above highest tides but do not occur inland beyond saltwater influence. *Halophiloscia couchii* seems to occur lower down beaches, often co-existing with the intertidal and seawater tolerant *Ligia oceanica* (S.J.Gregory *pers. comm*.). *B. cataractae* and *M. celticus* could therefore be included in the present study but numbers of records for these are low and relevant data is not available; the others are excluded. *Armadillidium album* occurs typically above the highest tides, always on sandy substrates of the appropriate grain size (although not confined to dunes) and never inland (S.J.Gregory *pers. comm.*) so is also left out as is *Trichoniscoides saeroeensis*, described on the BMIG website (bmig.org.uk) as "mostly coastal" but with some upland limestone records (Gregory, 2009 and *pers. comm*.).

As with the other groups, only species with at least 31 records are shown in the synanthropy table (Table 8) although others with <31 records were used in the calculation of habitat totals where data was available. The synanthropy spectrum is visualised in Figure 3. Nomenclature follows the woodlice atlas (Gregory, 2009) and species are grouped by families in Table 8 and Figure 3. Those species with less than 100 records (>30) with relevant data are in red.

A feature of *Platyarthrus hoffmannseggii* is its well-known association with ants so that habitat information, including that relating to synanthropy, will reflect not only the ecology of the woodlice but also that of the ants. However, at the northern limit of its range in Cumbria and Lancashire it has a restricted occurrence (coastal limestone) despite the widespread presence of the relevant ant species (Gregory, 2009). *Trichoniscus pusillus* was regarded by Harding & Sutton (1985) as having two forms, *Trichoniscus pusillus* form *pusillus* and *Trichoniscus pusillus* form *provisorius*. Gregory (2009) refers to them as two distinct races, *provisorius* (sexual) and *pusillus* (parthenogenetic) and notes that they have been raised to the status of two full species by Schmalfuss (1984). They are mapped as an aggregate in the atlas and also separately (Gregory, 2009). We do not have data to treat them separately for the present purposes.

Armadillidium depressum comes out highest in our spectrum and along with *Cylisticus convexus* and the well-known, typically orange or pink coloured small synanthrope *Androniscus dentiger* which all lie within the 70-80% spectrum scores. Two other species of A*rmadillidium*, *A. nasatum* and the common *A. vulgare* are much closer to the middle of the range whilst *A. pulchellum* with only 71 records, exclusively from rural sites actually comes out with a score of zero. Others around mid-range are *Haplophthalmus danicus*, *P. hoffmannseggii*, *Trichoniscus pygmaeus* and three of the very common, larger woodlice, *Oniscus asellus*, *Philoscia muscorum* and *Porcellio scaber*. Other species of *Porcellio* range between 35% and 68%. Other than *A. pulchellum*, the lowest species on the scale is *Ligidium hypnorum*.

Table 7: Woodlice Calculated Numbers and Percentages for Urban, Suburban/Village and Rural habitats (excluding littoral and hothouse species)

Totals and crude percentages for each species are from Harding & Sutton, 1985.
Record numbers for each category are established by calculation from these.

Species	**Total Records**	**Urban**	**Suburban: Village**	**Rural**
Androniscus dentiger	608	103.36 : 17%	206.72 : 34%	297.92 : 49%
Armadillidium depressum	100	24 : 24%	43 : 43%	33 : 33%
Armadillidium nasatum	113	9.04 : 8%	24.86 : 22%	79.1: 70%
Armadillidium pictum	8	No detailed data		
Armadillidium pulchellum	71	0	0	71 : 0%
Armadillidium vulgare	1804	90.2 : 5%	378.84 : 21%	1334.96 : 74%
Buddelundiella cataractae	5	No detailed data		
Cylisticus convexus	119	26.18 : 22%	40.46 : 34%	52.36 : 44%
Eluma caelata (*E. purpurascens*)	35	0	10.15 : 29%	24.85 71%
Haplophthalmus danicus	145	11.6 : 8%	43.5 : 30%	89.9 : 62%
Haplophthalmus mengii agg.	260	5.2 : 2%	23.4 : 9%	231.4 : 89%
Ligidium hypnorum	102	0	8.16 : 8%	93.84 : 92%
Metatrichoniscoides celticus	8	No detailed data		
Oniscus asellus	5611	280.55 : 5%	1009.98 : 18%	4320.47 : 77%
Oritoniscus flavus	44	0.88 : 2%	5.28 : 12%	37.84 : 86%
Platyarthrus hoffmannseggii	452	22.6 : 5%	103.96 : 23%	325.44 : 72%
Philoscia muscorum	3337	100.11 : 3%	600.66 : 18%	2636.23 79%
Porcellionides cingendus	320	6.4 : 2%	57.6 : 18%	256 : 80%
Porcellionides pruinosus	165	21.45 : 13%	61.05 : 37%	82.5 : 50%
Porcellio dilatatus	39	5.07 : 13%	10.92 : 28%	23.01 : 59%
Porcellio laevis	24	4.08 : 17%	13.92 : 58%	6.0 : 25%
Porcellio scaber	4662	326.64 : 7%	885.78 : 19%	3449.88 : 74%
Porcellio spinicornis	361	36.1 10%	104.69 : 29%	220.21 : 61%
Trachelipus rathkii	70	7 : 10%	13.3 : 19%	49.7 : 71%
Trichoniscoides albidus	22	No detailed data		
Trichoniscoides sarsi agg.	15	No detailed data		
Trichoniscus pusillus agg.	3569	107.07 : 3%	571.04 : 16%	2890.89 : 81%
Trichoniscus pygmaeus	485	24.25 : 5%	106.7 : 22%	354.24 : 73%

Table 8: "Synanthropy Spectrum" Values for Woodlice
Weighted ("Standardised") numbers derived from Harding & Sutton (1985)

Species with <100 records (but >30) shown in red.

Species	Total records	Urban %	Suburban / village %	Rural %	"Synan-thropy Index" %
Diplocheta **Ligiidae**					
Ligidium hypnorum	**102**	0	25.4	74.6	**12.7**
Synocheta **Trichoniscidae**					
Androniscus dentiger	**608**	56.6	31.7	11.7	**72.5**
Haplophthalmus danicus	**145**	38.4	40.3	21.3	**58.4**
Haplophthalmus mengii agg.	**260**	17.7	22.4	59.9	**28.9**
Oritoniscus flavus	**44**	17.4	29.2	53.4	**32.0**
Trichoniscus pusillus agg.	**3569**	22.6	33.8	43.6	**39.5**
Trichoniscus pygmaeus	**485**	30.6	37.5	31.9	**49.3**
Crinocheta **Oniscidae**					
Oniscus asellus	**5611**	32.1	32.5	35.4	**48.4**
Philosciidae					
Philoscia muscorum	**3337**	21.9	36.9	41.2	**40.3**
Platyarthridae					
Platyarthrus hoffmannseggii	**452**	30.2	38.9	31.0	**49.6**
Armadillidiidae					
Armadillidium depressum	**100**	62.5	31.4	6.1	**78.3**
Armadillidium nasatum	**113**	41.9	32.2	26.1	**57.8**
Armadillidium pulchellum	**71**	0	0	71	**0.0**
Armadillidium vulgare	**1804**	31.0	36.3	32.7	**49.1**
Eluma caelata	**35**	0	61.6	38.4	**30.8**
Cylisticidae					
Cylisticus convexus	**119**	63.5	27.5	9.1	**77.2**
Porcellionidae					
Porcellio dilatatus	**39**	51.9	31.3	16.8	**67.5**
Porcellio scaber	**4662**	39.8	30.3	30.0	**54.9**
Porcellio spinicornis	**361**	44.5	36.1	19.4	**62.6**
Porcellionides cingendus	**320**	15.7	39.5	44.8	**35.4**
Porcellionides pruinosus	**165**	48.3	38.5	13.3	**67.5**
Trachelipodidae					
Trachelipus rathkii	**70**	51.8	27.6	20.6	**65.6**

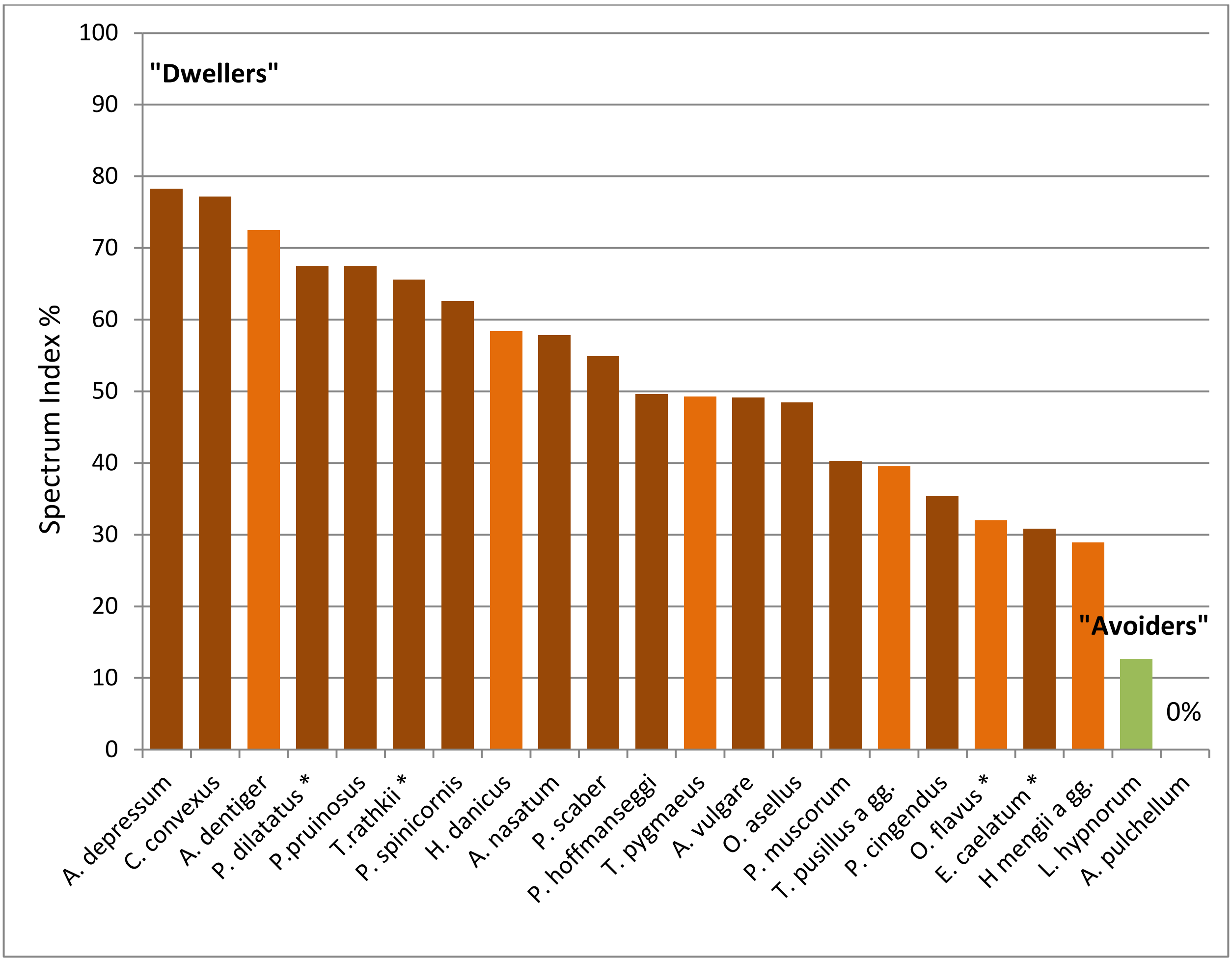

Figure 3: Visualisation of a woodlouse "synanthropy spectrum"

Diplocheta Synocheta Crinocheta * species with <100 records (but >30)

Discussion

In relation to the manipulation and use of the data, it needs to be recognised that collection of records overall was on an **unsystematic** "as and when" basis with many recorders submitting records over a long period of time. In addition, recording species absences was not part of the process. Although, in principle, a system such as that of Hauser & Voigtländer (2019) on the basis of records per habitat type might have been used this would have been cumbersome. There seemed to be no simple way to link habitat detail with synanthropy and detail (e.g. of woodland type) was often not recorded in BISG/BMIG data. The BMIG centipede, millipede and woodlouse data, on the other hand, was readily available.

1) The terms "urban" and "rural" are in this account are treated as synonymous with "synanthropic" and "non-synanthropic" (with an intermediate "suburban/village") although this is not strictly correct. Our urban areas tend to have mostly synanthropic habitats but also some open spaces of various sizes whilst rural ones (at least in lowland Britain) tend to contain at least some synanthropic sites. However, on the basis that urban areas are likely to be mostly synanthropic and rural ones mostly non-synanthropic and with suburban/village somewhere in between we can use these categories to sort out species when we have sufficient data.

2) During the processing of the data it was recognised that the number of records in the three different categories was very heavily biased towards rural sites and that the number of records from these represented about 75% (centipedes and woodlice) or 80% (millipedes) of the total and would cause significant bias in the percentage data. For this reason, weighting (“standardisation”) was carried out as described in the centipede atlas (Barber, 2022). Table 12 shows the crude percentage figures, unweighted and the indices they would generate for a number of millipede species (all with >100 records) compared with those from the weighted data as already calculated (column B). These indices do seem tend to show a pattern but using them would be inappropriate because of the rural/urban biased figures.

3) A decision on how much, if any of the suburban/village data should be included had to be made. Should we use only “urban” data to calculate our index or “Urban” + ”Suburban/Rural” (as in the table in Lee, 2006) or “Urban” + part of “Suburban/Village” (as in this present account). Table 12, columns D – E show the indices we would obtain if, instead of using SI = U + (SV / 2), we choose to include only the urban data (SI = U) or, alternatively, include the whole of the Suburban/Village records (SI = U + S/V). This is to indicate the range of values we could obtain depending on what proportion of the suburban/village data that is included.

Table 12: “Synanthropy Spectrum” Values for some Millipedes calculated using different methods

A = Total records for the species in the three categories
B = Index (U + SV/2) calculated using unweighted data
C = Index (U + SV/2) calculated using weighted data
D = Index (U) calculated using urban only (weighted) data
E = Index (U + SV) calculated using urban and all suburban/village (weighted) data

	A	B		C		D	E
Species	Total Records	SI Crude data only		SI (as used) Weighted		SI Urban only	SI Urban + All S/V
Polyxenus lagurus	250	15.6		50.65		27.9	72.3
Glomeris marginata	2387	4.61		22.5		8.2	36.7
Nanogona polydesmoides	1701	16.11		57.9		41.6	74.2
Chordeuma proximum	224	9.83		42.8		25.9	59.7
Melogona scutellaris	305	20.82		60.2		40.1	80.3
Brachydesmus superus	1593	10.73		45.7		29.7	61.6
Polydesmus angustus	2705	5.34		46.7		30.7	62.6
Polydesmus coriaceus	802	6.59		54.8		35.2	74.5
Polydesmus denticulatus	312	4.49		28.3		18.3	38.4
Polydesmus inconstans	237	11.25		48.9		33.6	64.3
Macrosternodesmus palicola	370	35.01		71.4		52	90.9
Ophiodesmus albonanus	242	38.02		71.7		50.7	92.0
Archiboreoiulus pallidus	214	22.43		65.1		47.8	82.3
Blaniulus guttulatus	1053	29.77		2.0		55.8	89.1
Boreoiulus tenuis	303	31.19		63.4		37.5	51.7
Proteroiulus fuscus	1785	8.34		40.2		25.3	55.0

4) As well as the vagueness and subjectivity of the three categories as seen by different recorders there was no overall systematic collection (temporally, spatially or by habitat) of data which was gathered by a large number of different, often non-specialist, recorders. In addition, the number of records varied widely between different individual species: those with large numbers of records would give a more reliable picture of that species habits than those with few. For this reason, species with less than 100 (>30) records are distinguished in red in the tables and those with 30 or less not included.

5) Different species occupy different geographical areas and some species are widespread in rural sites in one part of their range but seemingly solely or largely synanthropic in others whilst apparently entirely absent from other regions. Thus the proportion of synanthropic records for a species is likely to vary depending on the region looked at. The figures calculated here are for Britain and Ireland as a whole. If we were to calculate such figures for the various different regions, no doubt we should see clear differences between them especially as between north and south and possibly east and west. As an example, the centipede *Stigmatogaster subterranea* is a very common and typical geophilomorph of a variety of habitats in SW England but, as Blackburn *et al.* note, it is markedly synanthropic in NE England. Possibly a way might be found to include regional distribution data but this may not be necessarily easy especially in terms of having adequate numbers of regional records.

Conclusions

The pictures that emerge for the three groups from our data as used in this account do seem to fit fairly well with our knowledge of the different species. However, there are several important methodological issues / assumptions including the need to weight data to take into account the different numbers of records both for individual species and individual habitat categories. In addition, there is the need to convert the data from three habitat categories into two to allow derivation of index figures.

The concept of a “Synanthropy Index” used here is not intended to be a precise measurement (with clear confidence limits) of synanthropy, or some aspect of it, but as a tool to be used in the production of a chart (or similar) to visualise degree of synanthropy towards “dwellers” or “avoiders” ends of the spectrum. Such charts allow us to visualise a spectrum of the various species and their relationships to each other and to the concepts of “dwellers” and “avoiders” using the type of data produced by the relevant recording schemes.

Different approaches may be needed for other groups. It might also, perhaps, be able to inform the possibility of the three groups being able to be used as biological indicators.

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