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EDITORIAL

Although still a young organisation, the I.B.S. is fulfilling its major objective of leading us to better understand the ecology of the Irish flora and fauna. A great deal of the Society's success is not easily measured in terms of visible results. For example, it has performed the important function of bringing together amateur and professional naturalists, in the lecture room, and out in the field where the forum for an exchange of ideas and views has been extremely valuable to all of those involved. The frequent Newsletters and the annual Bulletin, of which this is the second issue, are the main tangible outcome of our activities, but members' publications in other journals often owe something to the stimulus of the I.B.S.

Undoubtedly, the Bulletin is the main organ of our work and will provide the lasting mark of our efforts. This issue holds a great deal of interesting material that will be quoted in international journals and it is for this reason that the Editorial Committee has been strict in maintaining a high standard of accuracy in all records. However, in no way do we wish to discourage the publication of observations that appear to be scant or incomplete in some ways, but that are quite unique in their content. It is in this context that the Bulletin aims to fill a vacant niche in Ireland, and we therefore appeal to anyone who has original records or observations to submit them at any time to a member of the Editorial Committee (our addresses can be found at the end of this Bulletin). Papers received before the 15th November of any year will, if accepted, appear in the Bulletin of the following spring.

A page giving suggestions for authors appeared in Bull. Ir. biogeog. Soc., 1, 2. Some of the articles submitted for this issue of the Bulletin conformed to the standard and required very little editing, but in closing, may I appeal to those submitting items for future Bulletins to provide better manuscripts. It should not be the Editors job to correct bad English, to supply scientific names of species, or to write-up other peoples records from disjointed notes!

Donald C.F. Cotton.

MICRO-GEOGRAPHICAL POLYMORPHISM IN ANNUAL PLANT SPECIES

T.G.F. Curtis & M.B. Quigley

A preliminary investigation of *Erophila spathulata* Lang. and *Veronica agrestis* L.

Most annual plants of marginal and ephemeral habitats are inbreeding, being for the most part self-pollinated and self-fertilised, (Stebbins, 1950). Consequently populations in any one locality tend to be uniform genetically, especially if selection pressures are not irregular nor disruptive. Populations of the same species within the same geographical area may therefore differ genetically and this may be apparent, morphologically. Marked polymorphism is thus likely to be a feature of such species due to the existence of numerous biotypes, and many of these have been described, figured and even ranked as separate species as by Druce (1930) for the *Erophila verna* agg. and Drabble & Little (1931) for *Veronica agrestis* L.

Inbreeding may thus produce a number of pure genetic lines, each of which persists unchanged in an area over a number of generations, under uniform ecological conditions. However, inter-biotype crossing may occur and alter the genotypic composition of subsequent generations, or the nature and direction of selection pressures may change and initiate further alterations of the genotype. According to current views on the mechanisms of speciation these changes may increase the chances of a species elaborating new adaptive devices by the maintenance of sufficient genetic heterozygosity.

The recombinant offspring (seeds) may then produce new individuals differing in genetic constitution from one another, some of which may be better able to adapt to the environment of the parental population, whilst others may be capable of occupying new habitats and persisting there. In this way new habitats may be colonised and new genetic lines, (by continuous selfing over a number of generations) may be built up, until such a time as inter-biotype crossing is again possible. In this manner sufficient genetic heterozygosity is maintained to provide for gradual adaptation to possible environmental changes (Proctor & Yeo, 1973).

The advantage of self-fertilisation in evolutionary terms, is that in those habitats subject to great fluctuations in climatic conditions from season to season, it enables those populations occupying such habitats, to produce a bountiful supply of seeds in a very short time, without the attendant hazards which an obligate outbreeder may face in securing cross-pollination. As the sizes of the populations may be greatly reduced due to unfavourable climatic conditions, there is positive selection on the ability of the parents to produce large numbers of progeny which will possess a genetic system which favours opportunism and enables a favourable genotype to be fixed over a number of generations.

It is now known that gene exchange between populations is very restricted. Pollen flow is extremely skewed, most of it, transported (by wind or insects) to within a few metres of its source (Bradshaw 1972; Levin & Kerster 1974). Even in dioeious species, pollinator flight distances are short and a vector is likely to travel only from one individual plant to its nearest neighbour, thereby restricting gene flow and the frequency of recombination, within the population, to very low levels (Levin & Kerster loc.cit.). Indeed there may even be selection pressures operating on a population to reduce gene flow (Antonovics & Bradshaw, 1970), as widespread gene exchange hinders local adaptation by enlarging the gene pool.

As a result of restricted gene exchange and constant local selection pressures, differentiation of plant populations, may occur in response to micro-habitat features over distances of a few metres (Bradshaw, loc.cit). One might expect this process to be accentuated in obligate outbreeders, as only on rare occasions, when climatic conditions are optimal, are such species capable of outbreeding (Hurka et al., 1976). Even then skewed distribution of pollen and short pollinator flight distances would ensure that out-breeding occurred only under exceptional circumstances. The fact that so many biotypes of Capsella and Erophila have been described in the taxonomic literature shows that differentiation is the rule, even within a small geographical area. It should then be possible to detect differences between populations of self-fertilised annual species across distances of only a few metres.

Cases of adaptation to micro-habitat features have been shown to occur at the physiological level, if selection pressures are sufficiently intense (Snaydon 1970; Davies 1975) but few instances of morphological differences have been recorded between populations occupying a very small area. It was against this background that a trial investigation on populations of two annual species, was conducted by the authors. Populations were scored for morphological characteristics to see if there were differences between them.

Description of the Site

The site was limestone pavement 2 km. NW of Cong, west of the Cong Canal, Co. Mayo (M13.54). The area was bounded by dense *Salix* and *Corylus* scrub to the east and north, and by a wall which ran around the southern and western perimeter, beyond which lay *Ulex europaeus* and *Calluna vulgaris* heath. The area was undisturbed by cattle since the walls denied access. The area examined was approximately 24 m. long and 16 m. wide and sloped 2 - 5^{o} in an easterly direction. It's surface was broken by grykes in which *Rubus fruticosus* agg. was the commonest species but the level surface bore little perennial vegetation with the exception of *Festuca rubra* L. However, four other perennial species occurred (listed below) which were associated with the populations of annual species investigated.

The level surface contained shallow solution depressions characteristic of exposed limestone pavements. These ranged in size from 0.25 m^2 to 1 m^2. Within these humus-rich soil occurred not greater than 3 - 4 cms. in depth. These solution depressions were mostly occupied by the plants listed in Table 1.

TABLE 1

List of species occurring in solution hollows of limestone pavement.

Annual species

Erophila spathulata Lang. (det by criteria in Clapham et al, 1962)

Veronica agrestis L.

Montia fontana ssp. chondrosperma (Fenzl). S.M. Walters

Cardamine hirsuta L.

Saxifraga tridactylites L.

Geranium molle L.

G. robertianum L.

Cerastium glomeratum Thuill.

Sonchus asper (L.) Hill

Perennial species

Trifolium repens L.

Festuca rubra L.

Sedum acre L.

Taraxacum officinale Weber. agg.

The species selected for study were Erophila spathulata and Veronica agrestis. Specimens of both species have been deposited in the Herbarium National Botanic Gardens (DBN).

Methods

A map of the area was constructed on a scale of 1 : 100, and the positions and sizes of the solution depressions mapped (Figure 1). Of the 16 sites mapped, 5 were sampled for Erophila and 4 for Veronica, using the morphological characters outlined in Table II.

TABLE II

Sites sampled, number of individuals scored, and characters measured in E. spathulata and V. agrestis.

E. spathulata

Site Numbers	2	6	12	14	16
Number Sampled	3	3	3	3	3
Characters	Silicula length, and breadth; Leaf length and breadth; Plant height; Number teeth per leaf.				

V. agrestis

Site Numbers	2	4	10	14
Number Sampled	5	3	3	3
Characters	Leaf length, and breadth; Calyx length and breadth; Capsule length, and breadth; Pedicel length.			

All characters were measured in mms., and where possible three readings were taken for each individual. As the number of individuals in each population was usually not greater than 10 - 12, a sample size of 3 individuals per site was considered to be adequate for the purposes of analysis. A summary of the data collected on each species is given in Table III.

TABLE III

Summary of the data collected on E.spathulata and V.agrestis.

A) E. spathulata (all measurements are in mms.)

Character	2 X	2 S	6 X	6 S	12 X	12 S	14 X	14 S	16 X	16 S	Overall X	Overall S
Silicula length	4.66	1.06	3.94	0.16	4.38	0.41	3.94	0.30	3.83	0.48	4.15	.24
Silicula breadth	2.33	0.79	1.33	0.25	2.38	0.33	2.66	0.50	1.50	0.23	2.04	.49
Silicula B/L	0.50	1.50	0.34	2.92	0.54	1.82	0.66	1.50	0.39	2.56	0.49	2.02
Leaf length	9.60	1.74	7.88	1.53	10.16	0.43	12.5	4.18	8.0	1.41	9.62	0.10
Leaf breadth	4.60	0.66	3.11	0.99	3.0	0.52	4.48	1.33	3.38	0.74	3.71	0.26
Leaf B/L	0.42	2.34	0.39	2.55	0.29	3.43	0.36	2.74	0.43	2.30	0.38	2.62
Plant height	46.6	2.88	67.66	8.71	35.0	4.35	51.66	14.43	67.33	8.73	54.06	.018
No. teeth	1		2.5		1		1		2.5			

B) V. agrestis

	2 X	2 S	14 X	14 S	4 X	4 S	10 X	10 S	Overall X	Overall S
Leaf length	7.14	0.13	10.38	0.09	9.38	0.10	10.22	0.09	9.23	0.108
Leaf breadth	4.70	0.21	6.72	0.14	6.61	0.15	7.22	0.13	6.08	0.164
Leaf B/L	0.63	1.57	0.64	1.54	0.70	1.42	0.67	1.48	0.66	1.515
Calyx length	3.72	0.26	4.53	0.22	4.26	0.23	4.41	0.02	4.25	0.236
Calyx breadth	2.13	0.46	2.53	0.42	2.20	0.45	2.58	0.38	2.32	0.430
Calyx B/L	0.59	1.68	0.47	2.09	0.83	1.20	0.58	1.69	0.62	1.61
Capsule length	2.50	0.40	2.41	0.41	3.50	0.40	2.16	0.46	2.40	0.42
Capsule breadth	3.25	0.30	2.83	0.35	3.00	0.00	3.16	0.31	2.66	0.37
Capsule B/L	0.75	1.32	1.01	0.98	0.52	1.90	0.90	1.1	1.19	0.84
Pedicel Length	7.29	0.13	7.44	0.13	9.00	0.11	8.16	0.12	7.90	0.13

X - Mean. S - Standard deviation.

Results

The Kruskal-Wallis technique was applied to the data for both species using the data collected on the characters outlined in Table IV. This distribution-free ranking method was thought to be suitable in this study as it tests for distinctiveness of populations from each other. If on the application of the test a non-significant result should be obtained, then the Null hypothesis that the true 'location' of the populations is the same, is retained. If, on the other hand, a significant result is obtained the Null hypothesis is rejected and the populations must be assumed to differ from each other.

TABLE IV

Results of the Kruskal-Wallis Test applied to data collected from E. spathulata and V. agrestis.

A) E. spathulata

Character	K value	Significance of K value using X^2 distribution
Silicula length	6.0	N.S.
Silicula breadth	3.32	N.S.
Silicula ratio B/L	9.30	*
Leaf length	4.00	N.S.
Leaf breadth	14.27	**
Leaf ratio B/L	5.74	N.S.

B) V. agrestis

Character	K value	Significance of K value using X^2 distribution
Leaf length	8.68	*
Leaf breadth	9.00	*
Leaf ratio B/L	6.01	N.S.
Calyx lobe length	3.60	N.S.
Calyx lobe breadth	3.09	N.S.
Calyx lobe ratio B/L	0.23	N.S.
Capsule length	0.38	N.S.
Capsule breadth	0.62	N.S.
Capsule ratio B/L	3.80	N.S.
Pedicel length	4.29	N.S.

* significant at 5% level. ** significant at 1% level.

N.S. not significant at 5% level.

It will be apparent from Table IV(B) that in V. agrestis few inter-site differences were recorded, especially for the more critical characteristics such as reproductive structures. Although differences may exist with regard to the length and breadth characteristics of some organs, the breadth to length ratios, which can be taken as a measure of their shapes, show no significant differences. The differences recorded between the populations for length and breadth dimensions of the various organs are thus due to plasticity in response to the environment and indicate how finely the populations respond to the micro-habitat features operating at each individual site. Consequently the populations of V.agrestis cannot be said to differ genotypically from one another.

In the case of E. spathulata, although leaf breadth differs significantly between the sites, no differences exist between the populations with respect to leaf shape. Thus, leaves in this species are also phenotypically variable characters. The computation of Pearsons Product Moment Correlation Co-efficient for leaf length and leaf breadth further confirms this interpretation, see Table V.

As can be seen from the highly significant result of the correlation co-efficient (r), breadth increases in direct proportion to length, despite differences in dimensions, i.e. there is a constancy of leaf shape. This must be directly attributable to the plasticity of the phenotype in response to the environment, within the individual sites. However, though the lengths and breadths of the siliculae do not differ between sites, their shapes, as measured by their breadth/length ratios, do differ between populations. Consequently the shapes and dimensions of this feature seem likely to reflect genotypic differences.

TABLE V

Correlations carried out on selected variable pairs in E. spathulata.

Characters compared	Correlation Co-efficient(r)	Significance Level
Leaf length : Leaf breadth	+ 0.71	P = 0.1%
Capsule length : Plant height	- 0.07	N.S.C.
Capsule length : Leaf length	+ 0.16	N.S.C.
Leaf length : Plant height	- 0.10	N.S.C.

N.S.C. - Not significantly correlated.

In view of the widely recognised phenotypic plasticity of annual species, and obligate inbreeders (Baker 1953, Stebbins 1950, Heslop-Harrison 1964), it seemed necessary that an analysis of characters which possibly affects the shape and development of the siliculae should be carried out to indicate if these were related to the dimensions of this structure. The correlation co-efficients were computed for the variable pairs outlined in Table V, the results indicating that the variables are independent of each other and moreover are unrelated to plant stature and/or age.

It must therefore be concluded that all variation with respect to siliculae dimensions is genotypic in origin.

But how far has differentiation taken place within the site as a whole? Plots of silicula length by silicula breadth, and plant height by capsule ratio indicate (Figs. 2A and 2B respectively) that the five populations sampled can be placed in two groups. The first, which includes Sites 6 and 16, has individuals bearing siliculae which are elliptical in shape whilst in Sites 12 and 14, the shape tends to be more oblong. Site 2 occupies a somewhat intermediate position between the two types with one of the individuals apparently bearing siliculae of neither type. This site displays such a range of variation with respect to this characteristic, that it would appear that little differentiation has taken place within it.

Discussion and Conclusions

The two species sampled are seen to exhibit two different patterns of variation. E. spathulata shows statistical differences, with regard to silicula shape, between populations, with little variation between the individuals at any one site, while V. agrestis reveals no significant differences and intra-population variation is quite marked. However, in both species much of the observed variation is attributable to phenotypic plasticity. The situation could resemble that described by Baker (1953) and Rogers (1971), where the type of variation pattern displayed by a species can be correlated with its breeding mechanism; inbreeders displaying distinct morphological discontinuities between populations whilst outbreeders show overlap in variation between populations. E. spathulata would appear to be predominantly inbreeding and hence show a greater tendency than V. agrestis to form distinct populations over a small area.

Even though V. agrestis shows a tendency towards the formation of biotypes throughout its range, it shows no tendency towards differentiation within such a small area as the one described in this study, and consequently gene flow, whether by pollen or seed must be the rule. How then could this be accomplished? Though no insect pollinators were noted visiting the flowers of this species during the study it has been stated by Clapham et al. (1962) that though sometimes selfed, it is predominantly pollinated by species of the Diptera and Hymenoptera. E. spathulata on the other hand is a self-pollinated species (Clapham et al. 1962; Proctor & Yeo 1973).

As significant differences occur, with respect to silicula shape in E. spathulata, gene flow would appear to be the exception, or if it does occur selection pressures are so intense so as to prevent its effects. If differentiation were complete, within the site, five separate groups could be expected to occur. As only two lines of differentiation are apparent it seems possible that immigration into the site has only occurred quite recently and the trend towards total differentiation is only in its early stages.

E. spathulata would appear then to be an opportunist coloniser of the solution hollows, where a little soil accumulates and which are very prone to drying out during the summer months. For success in such habitats it is necessary that a species possess a high degree of adaptive ability and that it conserves those genetic combinations necessary for this by rigorous inbreeding (Baker, 1959).

This would appear to restrict its distribution to a few habitats, typically dry, open and stony or gravelly situations and it never occurs in arable land. V. agrestis would appear to be able to exploit a much wider range of habitats and is of frequent occurrence as a weed among annual crops (Clapham et al. loc cit.). Though in the short term, self-pollination and consequent differentiation would appear to be a successful method of ensuring rapid colonisation and survival in marginal and ephemeral habitats in E. spathulata, in the long term it is restricted to such habitats with concomitant effects on its distribution.

As this study was carried out only as a preliminary to further investigations of this type, it may be useful to pinpoint what additional information should be collected if further work of this type were to be attempted. Ideally details on soil depth, solution hollow depth and a list of species occurring at each site should have been obtained. In addition the density of individuals at each site should have been estimated, especially as Harper (1961) has indicated that the extent to which plasticity occurs in individuals, is greatly affected by population density. Also, due to the great range of plasticity recorded for annual species it would have been best to concentrate on data collection from reproductive structures as these show less tendency to become modified by environmental factors.

Acknowledgements

This project was carried out during the Easter field meeting (1977) of the I.B.S. to Cong, Co. Mayo and the assistance of the following members in helping to collect data in the field is gratefully acknowledged: B. Arnold, M. Chadwick, K. Heslin, C. Murphy, N. McGough and J. Russell.

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Authors' address:

School of Botany,
Trinity College,
Dublin 2 (T. Curtis)

Dept. of Geography,
Carysfort College of Education,
Blackrock, Co.Dublin.(M. Quigley)

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Fig. 1

Distribution of Surveyed Solution Depressions Occupied by the Annual Species Listed in Table 1.

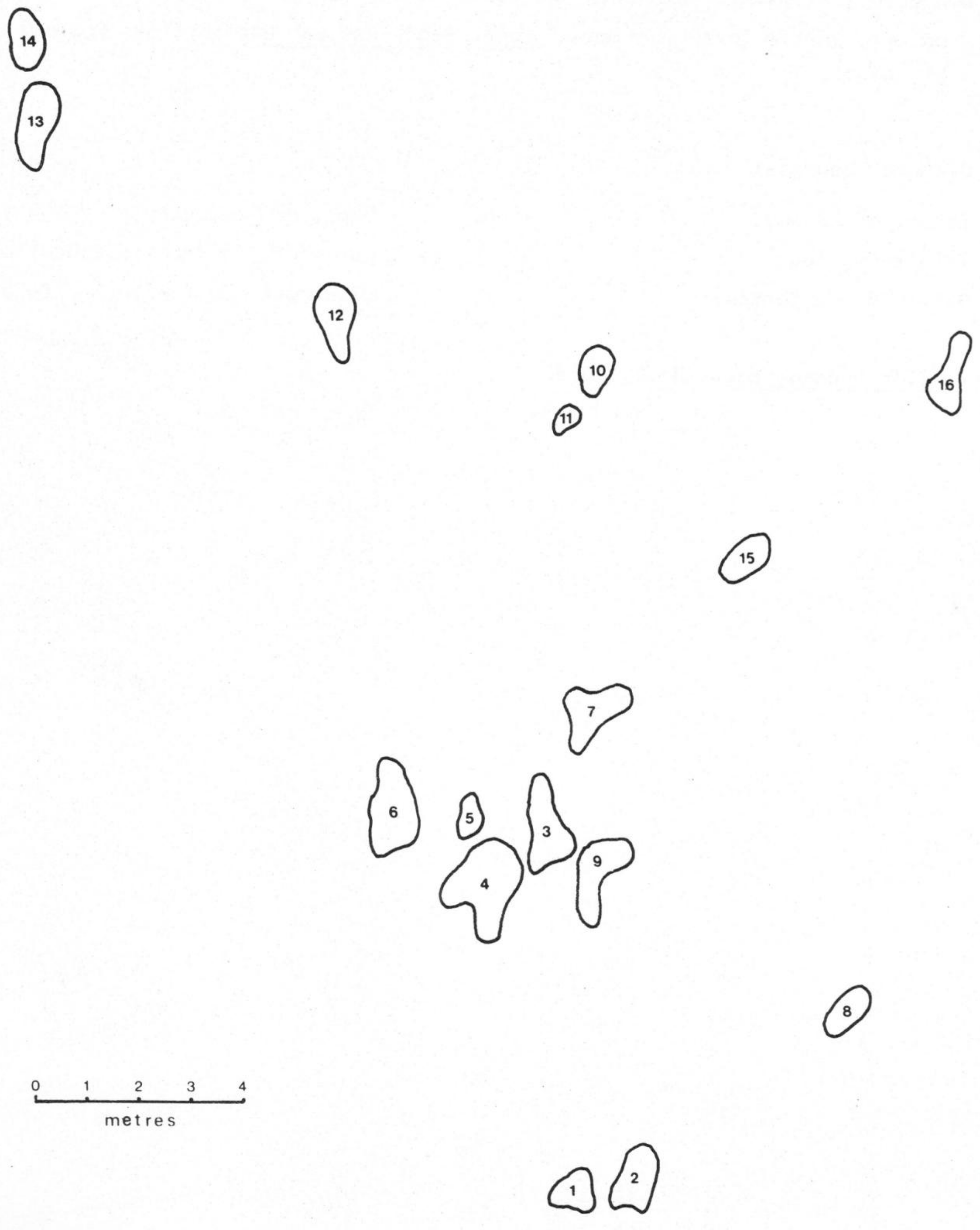


Fig. 2a

Erophila spathulata : Capsule Breadth x Length

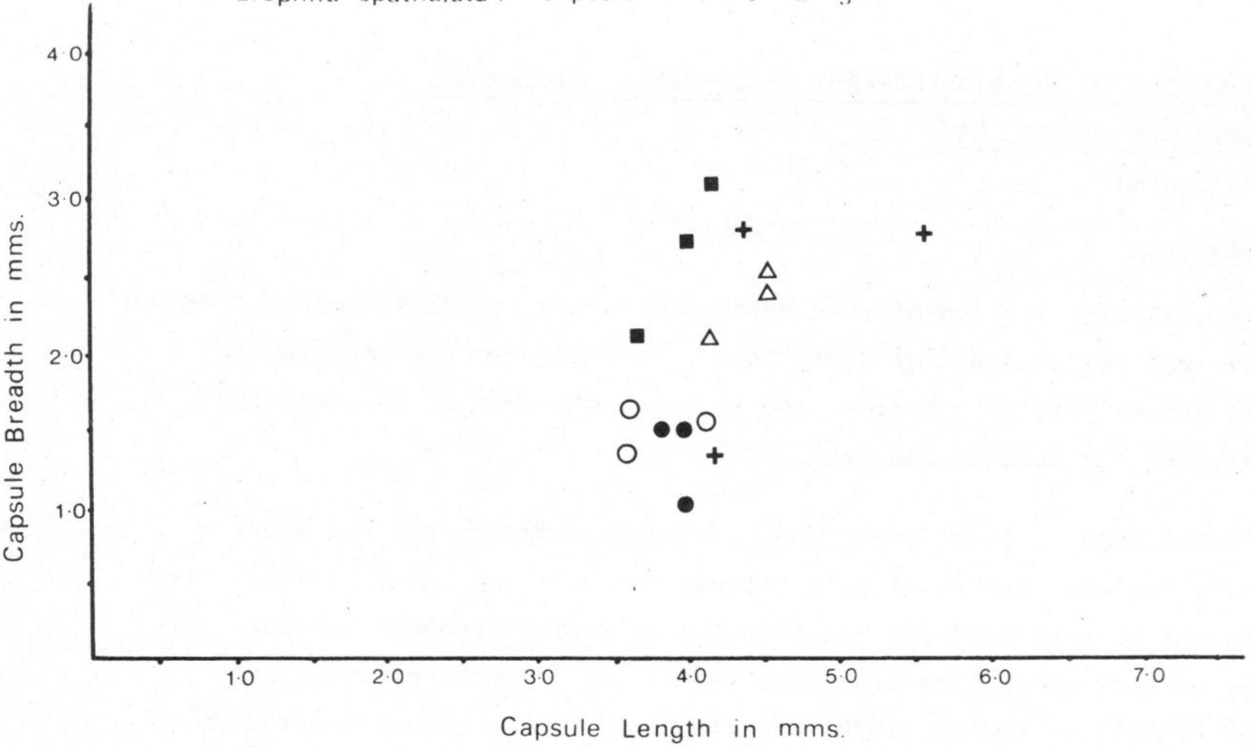
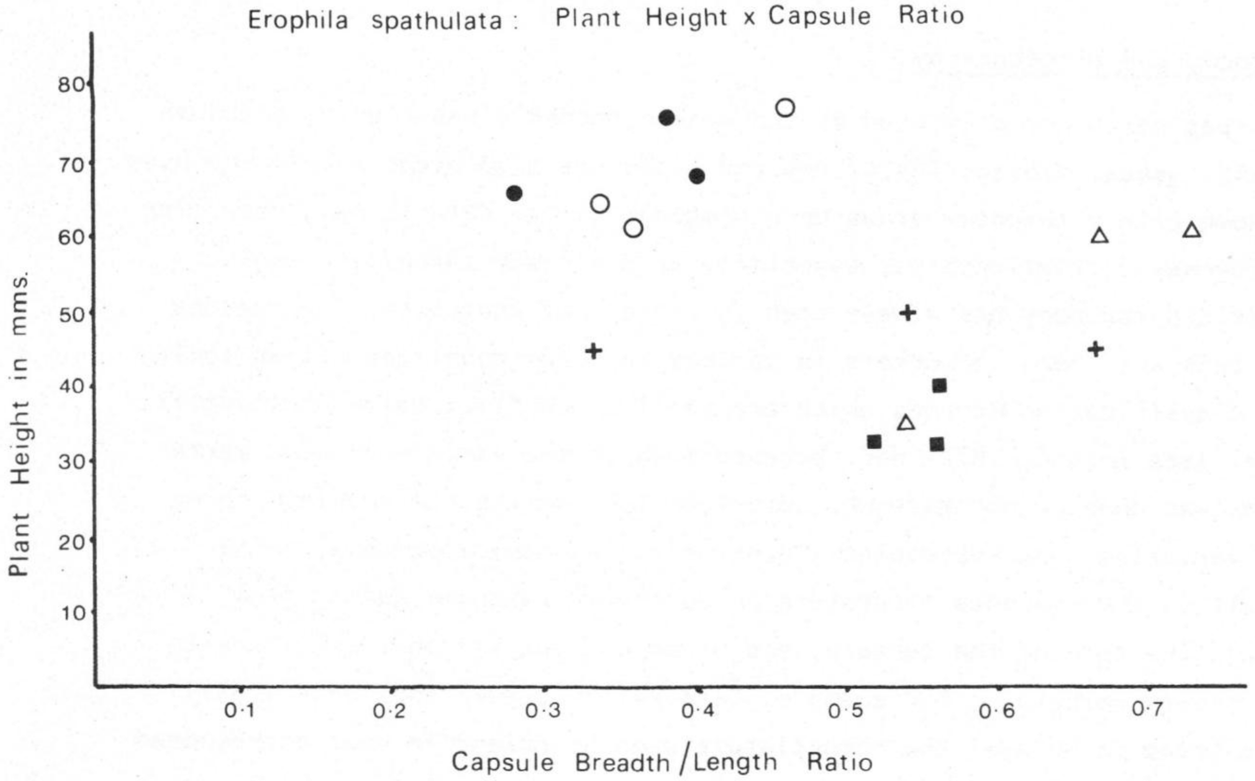


Fig. 2b

Erophila spathulata : Plant Height x Capsule Ratio



+ Population in Depression No. 2

● " " " No. 6

△ " " " No. 12

■ " " " No 14

○ " " " No. 16

MQ

OBSERVATIONS ON THE BIOGEOGRAPHY OF LUMBRICID EARTHWORMS (OLIGOCHAETA:LUMBRICIDAE)

D.C.F. Cotton.

Introduction

The natural distribution of this earthworm family is the Palaearctic region and the eastern seaboard of N.America. To the north the permanently frozen ground acts as a barrier and to the south most of the area is bordered by hot deserts and seas.

The Lumbricidae is considered to be the most advanced, and therefore a recently evolved, family of oligochaetes (Edwards and Lofty, 1972). It is thought to have been derived from the only other endemic European family of earthworms, the Glossoscolecidae (of Stephenson (1930) nec Bouché (1972)). Bouché (1970) described two new species of earthworms for which he has erected a new family, the Diporodrilidae, and suggests that this family is the most recent, having evolved from either the Hormogastridae or the Lumbricidae.

Taxonomy and biogeography

The species is normally used as the biogeographer's basic unit, although family, genus, sub-species, forms and types are also occasionally employed. To some extent taxonomy draws upon biogeographical data to help determine phylogenetic relationships, especially at the lower taxonomic levels. Lumbricid taxonomy has always been in a state of confusion. The reasons for this are, because workers in various European countries set up their own classification schemes which are still in conflict below the specific level (see Bouché, 1972) and, because much of the early work upon earthworms was done by amateurs who were keen to describe new species, forms and varieties, and subsequently mis-identified many specimens. The result is a voluminous literature on earthworm taxonomy dating from around the turn of the century, and often without suitable specimens to aid modern workers. For example, Černosvitov (1942) and Roots (1957) have tried to unravel the nomenclature used by Friend in over one-hundred minor papers.

The mode of reproduction has also led to confusion in earthworm taxonomy because it can cause a high level of variability within a species. Some species reproduce sexually, only very rarely producing viable parthenogenetic cocoons. These species show a normal range of genetic variation, but isolated populations may exhibit extreme forms due to the founder effect. There are also species that are facultatively parthenogenetic, commonly using both sexual and asexual means of reproduction. Specimens reproducing parthenogenetically can be morphologically different from the sexual form; e.g. Roots (1953) thinks that Allolobophora rosea (Savigny, 1826) f.macedonia is the parthenogenetic form of A.rosea f.typica. Finally, there are obligate parthenogenetic species which have no sexual means of propagating. The method of reproduction used by many of the British and Irish earthworms is still not described.

Both the founder effect and parthenogenesis can cause a morphological abnormality to become widespread in members of a local population. For example, I have observed that genetically isolated populations of Eisenia foetida (Savigny, 1826), inhabiting garden compost heaps, can show an abnormality common to a large proportion of the inhabitants of one heap that is not present in populations living in other compost heaps.

Factors affecting the distribution of earthworms

Earthworms are adapted to live in stable environments and therefore have no need for special dispersal mechanisms. Their lack of an ability to spread is exemplified in works by van Rhee (1969a and b) in reclaimed polder soils and Dunger (1969a and b) in reclaimed dumps from open-cast mining. Van Rhee showed that an earthworm fauna introduced into previously uncolonised soils advanced by only 4-6 m yr^{-1}. Dunger observed that it took an earthworm fauna 5 years to colonise a reclaimed site, from adjacent fields, and that another 5-10 years passed before the earthworms reached their usual dominant state in the soil community. Personal observations (Curry and Cotton, unpublished) made at a fen peat bog, Lullymore, Co. Kildare, revealed no earthworms in the virgin bog, and only low densities of Allolobophora caliginosa (Savigny, 1826) and A.chlorotica (Savigny, 1826) in a reclaimed cut-away bog that had been heavily limed and sown with perennial rye grass (Lolium perenne L.) for 10 years. An adjacent site (within 100 m) that had been reclaimed for 50 years had 4 times the number of earthworms with 6 species being present.

It is likely that chance is the only factor enabling distribution over greater distances. Cocoons could be accidentally transported by either birds or mammals, although this is unlikely because they are smooth objects and usually buried in the soil. Moving bodies of fresh-water are the only probable natural agent. I know of no published records to substantiate this idea, but in Bouché (1972) there are mapped examples of lumbricid species found only in certain drainage basins in France.

There can be no doubt that the activity of man has been the most important factor in distributing earthworms. The accidental transportation of specimens in soil adhering to plant roots or vehicle tyres is well documented. Gates (1972) has broadened our knowledge of the world distribution of lumbricids simply by recording specimens of worm intercepted with potted plants arriving at international airports in the United States. Man has also intentionally carried earthworms to new parts of the world to gain from their beneficial effects upon soil structure and nutrient cycling (e.g. Stockdill, 1959 in New Zealand). Where Lumbricidae have been introduced they have been very successful competitors, often ousting the native earthworm family.

Physical and biotic factors are important in limiting species distributions. These are too numerous to list in detail, although either high salinity or low pH, temperature and soil moisture, prevent earthworm colonisation of soils. Such factors are not only of biogeographical significance at the macro-level, but result in micro-distribution patterns that need to be considered when collecting records. Personal observation shows that earthworm species can have an unexpected micro-distribution. Whilst studying the earthworms in a 10 ha. permanent pasture in Ireland, samples were taken from three 1.2 ha. sites with slightly different drainage characteristics. It can be seen from Table 1 that Octolasion cyaneum (Savigny, 1826) and Lumbricus terrestris L., 1758 were confined to the areas that were either freely drained or with slightly impeded drainage whilst Allolobophora caliginosa, Dendrobaena mammalis (Savigny, 1826) and Lumbricus friendi Cognetti, 1904 were much more abundant in the wettest area. A casual sampling programme for presence/absence data could have recorded any of the last three species in Table 1 as 'absent', had only one part of the field been sampled. A further three species were present

TABLE 1 The average density of five earthworm species, from three sites with different drainage characteristic, in an Irish pasture.
(Data are presented as the average number of worms m^{-2}, calculated from 30 samples each of $0.25m^2$)

Earthworm species	Date Sampled	Drainage characteristics of the three sites		
		Free	Slightly impeded	Moderately impeded
A. caligninosa	Feb. '77	8.80	-	21.87
	Apr. '77	11.60	12.00	27.73
D. mammalis	Feb. '77	3.87	-	23.33
	Apr. '77	10.00	16.00	23.47
O. cyaneum	Feb. '77	1.73	-	0.00
	Apr. '77	2.40	0.13	0.00
L. friendi	Feb. '77	0.53	-	6.00
	Apr. '77	0.67	0.40	3.87
L. terrestris	Feb. '77	12.93	-	0.00
	Apr. '77	16.27	14.13	0.13

in the same site at an average density of less than 1 per m^2, and could have gone unrecorded in a biogeographical survey.

Discussion

Defining the geographical distribution of species is not a purely academic pursuit but has practical implications in systematics, ecology and palaeogeography. For the earthworms, the state of our knowledge is too limited to draw many conclusions because of the taxonomic problems already described. The information available about the distribution of this group is also scant and biased. It is scant because only a limited number of people in the world have been both interested and capable of identifying specimens, and it is biased because these workers have put most of their effort into studies of the earthworms in agricultural soils near to populated areas where there are obvious economic implications. The bias due to uneven distribution of recorders is inherent in data collected for most biological groups and allowance must always be made for this source of error when analysing distribution patterns (Sharrock, 1976).

As mentioned earlier, earthworms live in stable habitats and consequently are poor colonisers. In ecological terms they are at the K end of the r-K spectrum defined by MacArthur and Wilson (1967) and recently summarised by Southwood (1977). This classification divides organisms into species which have a high reproductive rate (r) and are adapted to colonising habitats rapidly, and those with a low reproductive rate that are adapted to adjust their population density to suit the carrying capacity (K) of the more stable habitat. Some general points about K-strategists may be drawn from my observations of lumbricid biogeography. Their geographical distribution will tend to be well-defined, being limited by physical barriers such as seas, deserts, mountain ranges or water sheds (unless they have been artificially transported by man). Within their gross range they will have a micro-distribution that reflects habitat preferences.

Any biogeographical study of a K-strategist should have clearly defined objectives. If one is interested in delimiting the geographical distribution of the species then widely-spaced samples, taken from the correct micro-habitat, will suffice. A vice-county, or even country, approach will be adequate for most species. If one is attempting to define the micro-habitat preferences of a species, then intensive sampling from small areas and at several localities within the known geographical range is required. I believe that 10 km. or 2 km. square systems of recording are a waste of effort for K-selected species.

Data collected for K species are particularly useful in two areas. In palaeo-geography these data can be used to map past events; for example, the present-day lumbricid distribution in N.Europe has been used to help map the extent of the most recent glaciation (Støp-Bowitz, 1969). Geographical studies of such species are also likely to reveal valuable data that may help to show the phylogenetic relationships for the group.

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A CHECK LIST OF IRISH SYRPHIDAE (DIPTERA).

Martin C.D. Speight.

The Irish Syrphidae were recently revised by Speight et al (1975), but since then 13 species have been added to the Irish list and various name changes have been introduced, so it would seem desirable to provide an up-to-date list at this juncture, for the benefit of recorders. I have set out to provide such a list here.

Names given in the following list are as in Kloet and Kincks (1976), with certain exceptions as follows:

Microdon eggeri Mik is here regarded as a synonym of M. latifrons Lw.,
Baccha obscuripennis Mg. is here regarded as a synonym of B.elongata (Fab.),
Pipiza lugubris (Fab.) is here regarded as a form of P. noctiluca (L.)
Meligramma Frey is here accorded full generic status.
In addition, the names of all Pipiza species given here should be regarded as provisional. In order to comply with the International Rules of Zoological Nomenclature, I am unable to include the name of the hover-fly listed below as 'Cheilosia sp.n.'. Description of this species is ready for publication and will, I hope, appear in the Irish Naturalists Journal in the none-too-distant future.

In the following list, the name of each species representing an addition to the Irish fauna published since Speight et al (1975) went to press is followed by a reference to the publication in which that species is first recorded for Ireland. For each of reference, genera and species are listed here in alphabetical order. Names of critical species are followed by the symbol (C), rare species by the symbol (R). Species for which there are less than five published records from Ireland are regarded as rare.

SPECIES LIST

ANISIMYIA

A.lineatus
A.lunulatus(Mg.)
A.transfugus(L.)

ARCTOPHILA

A.fulva(Harr.)

BACCHA

B.elongata Fab.

BRACHYOPA

B.scutellaris Desv.(R)

BRACHYPALPUS

B.bimaculatus Macqt.(R)

CHEILOSIA

C.albipila Mg.
C.albitarsis Mg.
C.antiqua Mg.
C.bergenstammi Beck.(C)
C.chrysocoma Mg.(R)
C.fraterna Mg.(C,R)
C.grossa(Fal.)
C.illustrata(Harr.)
C.impressa Lw.
C.intonsa Lw.
Cheilosia sp.n.
C.longula Zett.(R)
C.nebulosa Verr.(C,R)
C.paganus Mg.
C.praecox Zett.(C,R) (Speight, in press)
C.proxima Zett.(C,R)
C.pubera Zett.(C,R)
C.scutellata(Fal.)(C)
C.semifasciata Beck.
C.variabilis(Pz.)
C.velutina Lw.(C,R)
C.vernalis (Fal.)
C.vulpina(Mg.) (R)

CHRYSOGASTER

C.chalybeata Mg.(C)
C.hirtella Lw.
C.macquarti Lw.(C)
C.solstitialis (Fal.)
C.virescens Lw.

CHRYSOTOXUM

C.arcuatum(L.)
C.bicinctum(L.)
C.festivum(L.)

CRIORHINA

C.berberina Fab.
C.floccosa(Mg.)
C.ranunculi(Panz.)(R) (Nash & Speight, 1976)

DASYSYRPHUS

D.albostriatus(Fal.)
D.lunulatus(Mg.)
D.tricinctus(Fal.)
D.venustus(Mg.)

DIDEA

D.alneti(Fal.)(R)
D.fasciata Macqt.

DOROS

D.conopseus Fab.(R)

EPISTROPHE

E.eligans(Harr.)
E.grossulariae(Mg.)
E.nitidicollis(Mg.)(C,R) (Speight, 1975)

EPISYRPHUS

E.balteatus(DeG.)

ERISTALINUS

E.aeneus(Scop.) E.sepulchralis(L.)

ERISTALIS

E.abusivus(Coll.) E.horticola(DeG.) E.pertinax(Scop.)
E.arbustorum(L.) E.intricarius(L.) E.rupium Fab.(C,R)
E.cryptarum(Fab.) E.nemorum(L.) E.tenax(L.)

EUMERUS

E.strigatus(Fal.)

FERDINANDEA

F.cuprea(Scop.)

HELOPHILUS

H.hybridus Lw. H.pendulus(L.)

LEJOGASTER

L.metallina(Fab.) L.splendida(Mg.) (Speight, in press)

LEUCOZONA

L.glaucius(L.) L.laternarius(Muell.) L.lucorum(L.)

MEGASYRPHUS

M.annulipes(Zett.)(R) (Speight, 1976b)

MELANGYNA

M.arcticus(Zett.)(C) M.lasiophthalmus(Zett.) M.umbellatarum(Fab.)
M.compositarum(Verr.)(C,R) M.quadrimaculatus Verr.(R)

MELANOSTOMA

M.mellinum(L.) M.scalare(Fab.)

MELIGRAMMA

M.cinctus(Fal.) M.guttatus(Fal.)(R)

MELISCAEVA

M.auricollis(Mg.) M.cinctellus(Zett.)

MERODON

M.equestris(Fab.)

METASYRPHUS

M.corollae(Fab.)
M.latifasciatus(Macqt)
M.latilunulatus(Coll.)(C,R)
M.luniger(Mg.)(C)

MICRODON

M.latifrons Lw.(R)
(Breen, 1977)
M.mutabilis(L.)

MYATHROPA

M.florea(L.)

NEOASCIA

N.aenea Mg.(R)
N.dispar(Mg.)
N.geniculata(Mg.)
N.podagrica(Fab.)

NEOCNEMODON

N.latitarsis Egg.(C,R)

ORTHONEVRA

O.brevicornis Lw.(R)
(Speight, in press)
O.geniculata(Mg.)(R)
O.nobilis(Fal.)
O.splendens(Mg.)

PARAGUS

P.haemorrhous Mg.(C)
(Speight & Irwin,in press)
P.tibialis Fal.(C,R)

PARAPENIUM

P.flavitarsis(Mg.)

PARASYRPHUS

P.annulatus(Zett.)(C,R)
P.lineola(Zett.)(C,R)
P.malinellus(Coll.)(C)
P.punctulatus(Verr.)
P.vittiger(Zett.)(C,R)
(Nash, 1975)

PARHELOPHILUS

P.consimilis Malm(R)
P.versicolor(Fab.)

PIPIZA

P.austriaca Mg.(C)
P.bimaculata Mg.(C,R)
P.luteitarsis Zett.(R)
P.noctiluca (L.)(C)

PIPIZELLA

P.heringyii(Zett.)(R)
P.varipes(Mg.)

PLATYCHEIRUS

P.albimanus(Fab.)
P.ambiguum(Fal.)
P.angustatus(Zett.)
P.clypeatus(Mg.)
P.discimanus Lw.(R)
P.fulviventris(Macqt)(C)
P.immarginatus(Zett.)
P.manicatus(Mg.)
P.peltatus(Mg.)
P.perpallidus Verr.(C,R)
P.podagratus Zett.
P.scambus(Staeg.)
P.scutatus(Mg.)
P.sticticus(Mg.)(R)

PORTEVINIA

P.maculata(Fal.)

PYROPHAENA

P.granditarsa(Foerst.)
P.rosarum(Fab.)

RHINGIA

R.campestris Mg.

SCAEVA

S.pyrastri(L.)
S.selenitica(Mg.)(R)

SERICOMYIA

S.lappona(L.)
S.silentis(Harr.)

SPHAEROPHORIA

S.abbreviata Zett.(C)
S.menthastri(L.)(C)
S.philanthus(Mg.)(C)
S.rueppellii Wied.(R) (Speight, 1976c)
S.scripta(L.)
S.taeniata(Mg.)(C,R)

SPHEGINA

S.clunipes(Fal.)
S.kimakowiczi Strobl

SYRITTA

S.pipiens(L.)

SYRPHUS

S.ribesii(L.)
S.torvus O.-S.
S.vitripennis Mg.

TROPIDIA

T.scita(Harr.)

VOLUCELLA

V.bombylans(L.)
V.pellucens(L.)

XANTHANDRUS

X.comptus(Harr.)(R)

XANTHOGRAMMA

X.citrofasciatum(DeG)

XYLOTA

X.abiens Mg.(R)
X.coeruleiventris Zett.(C) (Speight, 1976a)
X.florum(Fab.)(C,R)
X.sylvarum(L.)

XYLOTOMIMA

X.lenta Mg.
X.nemorum(Fab.)(R)

A list of keys from which the above mentioned species may be identified, is available from Martin Speight.

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Author's address: 158 Barton Road East, Dundrum, Dublin 14.

STEPHANOSPHAERA PLUVIALIS COHN. IN IRISH SOLUTION HOLLOWS

Cilian Roden

Lund (1961) describes a characteristic algal flora in limestone solution hollows which are frequent in the Malharm Tarn district of England. One of the most distinctive members of the flora is the planktonic, colonial green alga Stephanosphaera pluvialis, which can be easily identified using Fritsch & West (1927). This species is known to occur in the Burren (Lund, 1961), though it has been rarely reported there. Its ecology is little understood so it appeared an interesting organism to study during the I.B.S. meeting at Cong.

Four sites were investigated; the shore of Loch Corrib at Headford (M.24 44), the shore of Loch Mask near Ballinrobe (M.13 61) and two areas of limestone pavement, one at Cong (M.15 56) and one near Headford (M.23 44). In all four areas, solution hollows occurred in the outcropping Carboniferous Limestone, but those on the karst differed from those by the lake shore. The karst hollows were shallow and oval in shape (3 x 20 x 5 cm deep). The hollows were much commoner on the lake shore than on karst. The majority of pools contained a black deposit which had a slimy texture when wet but which was powdery in dried out pools. The quantity of this deposit varied: in some pools it occupied half the pool volume, though in most hollows it was less abundant. The blue-green alga Gloeocapsa,which has a black or purple sheath, was a common constituent of the deposit and may account for its colour, though Lund mentions that soot is part of a similar deposit at Malharm Tarn (soot seems an unlikely ingredient in the west of Ireland). Several pools had a reddish deposit formed by Haematococcus pluvialis: however this deposit was less common than the black one. A range of organic material was also seen in some pools, including dead leaves, dead worms and insects, hazel nuts and bird droppings. Such objects would seem to be the only possible external source of nutrients and as such are important. The probability of any hollow being enriched is small but if it is, nutrient levels will be raised considerably due to the very small volume of water in the hollow. The resulting nutrient regime will consist of long periods of nutrient shortage randomly interspersed by periods of abundant nutrients.

The algae of the solution hollows were examined using a portable microscope. This allowed one to study the organisms in the field. Furthermore the contents of forty pools were preserved in Lugols iodine and examined in the laboratory. (Lugols was in fact not a good preservative as the black deposit seemed to neutralise its effect). Most of the algae were identified to genus and some to species level, but there were several microflagellates which were not identified.

The flora of the hollows was very constant; blue-green algae formed the most abundant non-planktonic element while flagellates were the major component of the plankton. The non-planktonic element was found in nearly every pool examined; the dominant genera were Gloeocapsa, Scytonema, Nostoc, Aphanocapsa, Gloeothece and Synechococcus. In addition filamentous green algae such as Oedogonium, Spirogyra and Zygogonium were sometimes very common but were sporadic in occurrence. In contrast the plankton flora was sometimes so common that it coloured the water, but in most hollows the flagellate flora was sparse or absent. The commonest species was Haematococcus pluvialis which occurred in most pools. In a few pools it gave the water a brick red colour. Other plankton species included Chlamydomonas, Cryptomonas, Gonium and, of course, Stephanosphaera pluvialis the subject of this note. Its distribution reflects that of the plankton species generally; it was found in ten pools out of a total of about 100 examined. However, it was normally common where it occurred.

No obvious pattern can be seen in Stephanosphaera's distribution; it was usually accompanied by Haematococcus and the non-planktonic genera already mentioned. Stephanosphaera was found in karst and lake shore pools though it was not seen on the Headford karst or the Loch Mask lake shore. The pools in which Stephanosphaera occurred varied but as a group did not differ noticeably from the other pools which were examined. Droop (1952) suggests that humus has an adverse effect on Stephanosphaera. However, the species was plentiful in a pool full of decaying leaves on the Cong pavement, though it could not be found in nearby hollows which contained no detritus. Pools which contained Stephanosphaera had an abundant plankton either of the species itself or of one of the other flagellate forms. Such pools could be recognised by the red or green colour of their water but, as has already been mentioned, they were infrequent. Not every one of these pools contained Stephanosphaera. Other species sometimes caused the coloration of the water e.g. Haematococcus, Chlamydomonas, Gonium, Cryptomonas and the saccorderm desmid Mesotaenium. The random and infrequent distribution of the plankton flora (including Stephanosphaera) might be explained by the hypothesis that the flagellate plankton only develops in nutrient rich conditions. Such an idea would explain several observations:

1) the plankton's random occurrence (which would reflect the nutrient regime described above);

2) the dense blooms of plankton (which are more reminiscent of a laboratory culture than a eutrophic lake and indicate very high nutrient levels);

3) the variety of bloom forming species present (which may indicate a variety of nutrient sources, e.g. animal or plant detritus);

4) most of the bloom species are flagellate Chlorophyceae (in experimental cultures, such organisms are favoured by nutrient enrichment - see Shapiro, 1973);

5) most pools contained only a blue-green algal flora whose universal occurrence suggests a tolerance of adverse conditions. As this flora was also found in plankton-rich hollows it cannot be regarded as an alternative flora; rather it is the typical flora of the unenriched solution pools and indeed of the limestone generally.

My hypothesis suggests that the flagellate flora flourishes temporarily under favourable nutrient conditions but declines after nutrient exhaustion. This would explain Lund's observation that Stephanosphaera appeared and disappeared from a pool at Malharm over a period of years without obvious cause (Lund, 1961).

This hypothesis is easily testable as enrichment of hollows should cause a flagellate bloom. The exact factors causing a Stephanosphaera bloom are not obvious. It was found in several pools containing dead leaves or hazel nuts and also as an associate of Haematococcus in pools with no recognisable organic remains. However it is possible that Stephanosphaera distribution could be explained in terms of nutrient requirements rather than in terms of water chemistry as has been done to-date (e.g. Droop, 1952; Lund, 1961).

List of algal genera encountered in pools

CYANOPHYTA	CHLOROPHYTA	OTHERS
Gloeocapsa	Haematococcus	Cryptomonas
Aphanocapsa	Gonium	Euglena
Synechococcus	Chlamydomonas	
Gloeothece	Stephanosphaera	
Scytonema	Scenedesmus	
Nostoc	Oedogonium	
Phormidium	Spirogyra	
Chrococcus	Zygonium	
	Mesotaenium	
	Closterium	
	Cosmarium	

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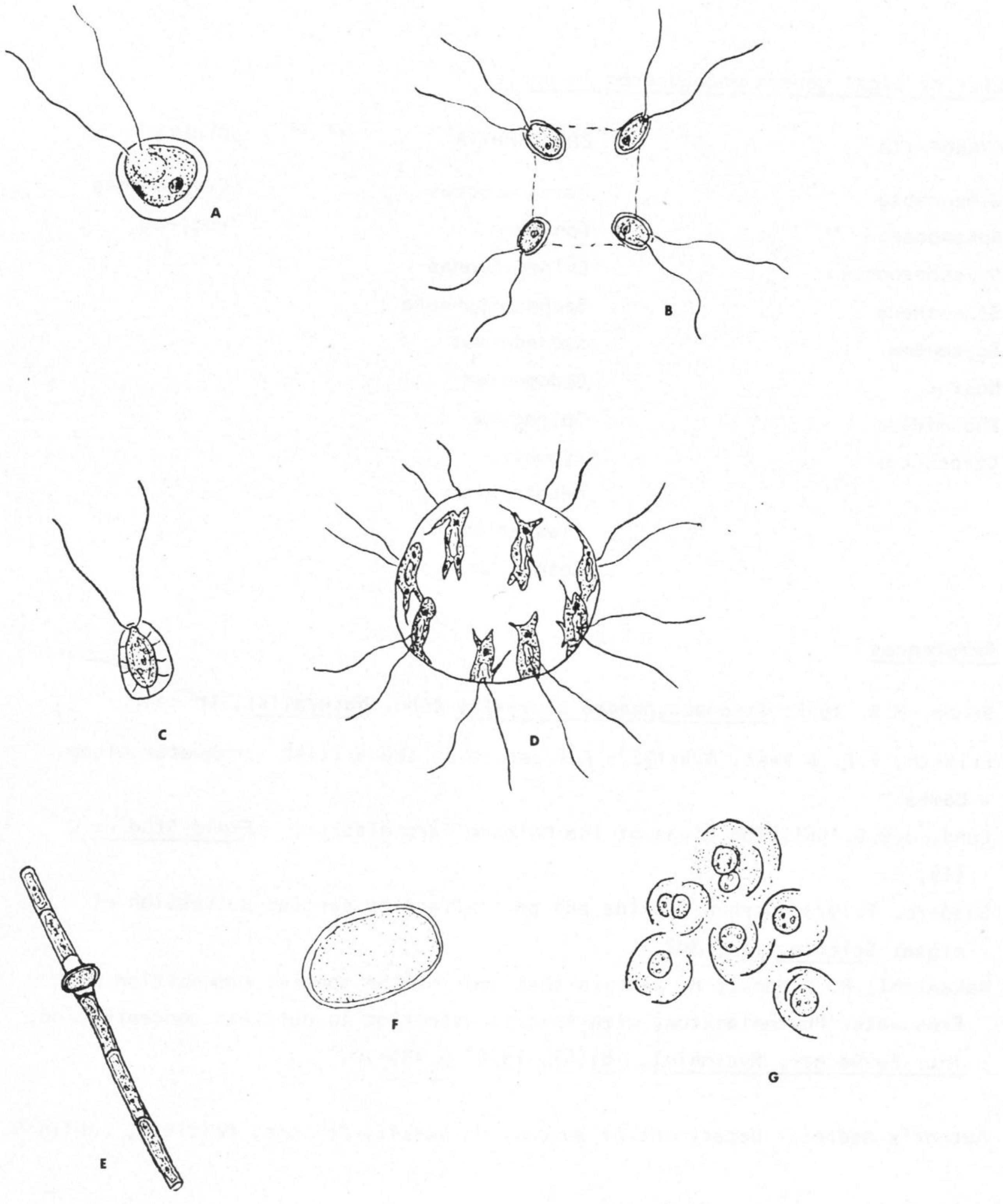

FIGURE 1. Some of the algae found in limestone solution hollows.

a) Chlamydomonas sp. a unicellular green flagellate. b) Gonium sp. a four celled green colony. c) Haematococcus pluvialis, a green flagellate which is often red in colour due to the presence of haematochrome pigment.
d) Stephanosphaera pluvialis. e) Oedogonium sp. a green filamentous alga.
f) Synechococcus sp. a blue-green unicell without a conspicuous sheath.
g) Gloeocapsa sp. a blue-green alga with a striking purple-black sheath.
(All drawings were made freehand from living material magnified X200)

FURTHER NOTES ON THE AQUATIC INVERTEBRATES OF HARE ISLAND AND ITS ENVIRONS, LOUGH REE, CO. WESTMEATH.

J.P. O'Connor and M.A. Norton

A preliminary account of the aquatic invertebrates of Lough Ree, Co. Westmeath, has already been given (O'Connor and Norton, 1977). As previous work was mainly carried out on Hare Island, littoral collections were made in the vicinity of Coosan Point in 1977. This area is situated on the southern shore of the lake, opposite the island (N 048461). An examination of the samples has shown that the faunal composition is similar to that described in O'Connor and Norton (op.cit.). However, some new data were discovered and these are now reviewed.

Hemiptera : Heteroptera

Two species of water-bug were added to the previous list. The water-scorpion Nepa cinerea L. was recorded in large numbers under stones and in boggy areas near the water's edge around Coosan Point. Often three to four individuals occurred under the same stone. The corixid Cymatia bonsdorffi (C.Sahlb.) was also found in this locality. Both species are common and widely distributed in Ireland (Halbert, 1935).

Megaloptera

Further analysis of the 1976 samples revealed a probable larva of the alder-fly Sialis nigripes Pictet which had been taken in one of the reed-beds on Hare Island. As a result of the Athlone field meeting, this species was recognised as new to the British Isles (Barnard, 1977). On the 2.5.1977 and the 6.6.1977 the lake was revisited in an attempt to collect additional larvae. The littoral region on both sides of Coosan Point was extensively searched for specimens. Large numbers of Sialis lutaria (L.) larvae and adults were taken but surprisingly no S. nigripes. The former species was particularly common in the Phragmites beds where adults were observed laying eggs in June. It now seems certain that in this area of Lough Ree, S. nigripes is restricted to Hare Island. In the near future, it is hoped to describe the larva of S. nigripes in co-operation with Dr. J.M. Elliott. The island will therefore be revisited in the spring of 1978.

Trichoptera

The tentative identification of the larval caddisfly Apatania wallengreni McLachlan in O'Connor and Norton (op.cit.) was confirmed on the 2.5.1977. Several adults were collected near Coosan Point (O'Connor, in press a). Although in June 1976 only one larva of Anabolia nervosa (Curtis) was taken, the species was found to be very common around the point particularly in the Phragmites. A larva of Ecnomus tenellus (Rambur) was also found in the same locality on the 6.6.1977. King and Halbert (1910) reported E. tenellus from the area, but no individuals were taken in 1976.

Imagines of Tinodes maculicornis (Pictet) were recorded by King and Halbert (op.cit.) from Lough Ree but no larvae were collected during the Athlone meeting. However, on the 6.6.1977, numerous specimens were discovered occurring on calcium carbonate encrusted stones, rocks etc., both in and beside the Phragmites beds near Coosan Point. It is interesting to note that T. maculicornis has not been found in Great Britain and that it may be a relict species in this country (O'Connor, in press b).

Discussion

A comparison of the fauna of Lough Ree with those of some other Irish lakes reveals several notable differences. Recently a detailed study of the littoral faunas of Lough Dan, Co. Wicklow and Lough Sillan, Co. Cavan was completed (O'Connor and Bracken, in press). The former lake is humic and oligotrophic, the latter moderately eutrophic. Calcium concentrations are low in both water-bodies (1.2 to 9.0 p.p.m.). By contrast, a calcium ion content of 29.9 p.p.m. has been reported from Lough Ree (Macan and Lund, 1954).

The following distinctive species were only obtained in Lough Ree:- Diura bicaudata (L.), ?Leuctra nigra (Olivier), Ephemerella ignita (Poda), Sigara fallenoidea (Hungerford), Sialis nigripes, Apatania wallengreni, Metalype fragilis (Pictet) and Tinodes maculicornis. As calcium plays an important role in the distribution of many fresh-water animals (see Macan, 1974), it will be interesting to discover whether the listed insects form a lentic community characteristic of calcareous waters in Ireland. When further information becomes available, this possibility will be fully reviewed.

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For a list of texts employed in determinations, please consult O'Connor and Norton (1977).

Author's address: National Museum of Ireland (J.P.O'C.)
Grove Road, Finglas, Dublin 11. (M.A.N.)

A RETURN VISIT TO HARE ISLAND

Martin C.D. Speight

I was able to visit Hare Island (N.0446, Co. Westmeath) again on the 26th June, 1977. A lot of my time on the island was spent in a fruitless search for the fly Rhagio annulatus (Deg.), one specimen of which was collected during the course of the IBS meeting there in 1976. Evidently R. annulatus is a spring species. R. scolopacea (L.) was in abundance on the island on this second visit, and since I had to catch every specimen seen, just in case it was R. annulatus, I had rather a wearisome time! Most of the rest of my time was spent equally fruitlessly, in searching for larvae of the alder-fly Sialis nigripes Pict. Again, I was, presumably, too late in the year, because at this time the adults of S. nigripes Pict. were common (4 males, 15 females collected), resting on the small alder bushes along the shore, in the vicinity of the landing stage. I did not find any S. lutaria on the island. As upon the previous occasion, the weather was overcast with squalls of rain, the sun only appearing fitfully and rather late in the day. My general collecting consequently yielded few insects, but as a result of this visit I can add three saw-flies to the island's list. Some acalypterate Diptera (asterisked below) collected during the 1976 visit, but only recently determined, can also be recorded for the island at this juncture:

Tenthredinidae

Dolerus aericeps C.G. Thoms.
Nematinus luteus (Panz.)
Tenthredo atra L.

*Heleomyzidae

Suillia dumicola (Coll.)

*Lauxaniidae

Lyciella rorida Fal.(Det.B.Cogan,B.Mus.)
Minettia longipennis (Fab.) " " " "

The series of S. nigripes proved to be of some interest, in that they demonstrate the relative utility of the taxonomic characters used by

Barnard (1977) to separate females of this species from other Sialis. While sternite 7 does have a pronouncedly concave posterior margin as he suggests, the form of the 8th sternite is rather more variable than he indicates, frequently differing from his illustration of S. nigripes by as much as the females of other Sialis species. I should perhaps add that the series of specimens collected on Hare Island in 1977 represents twice as many specimens as were known previously from the British Isles all together.

A male and female from the Hare Island series has been sent to each of the following:

Dr. J.M. Elliott (FBA, Ambleside, Cumbria, England).
Dr. Mike Kirby (Dept.of Zoology, University of Manchester, England).
Robert Nash (Ulster Museum, Belfast).

Dr. Kirby is currently organising a recording scheme for Neuroptera in the British Isles.

The remainder of the Hare Island series of S. nigripes (1 male, 12 females) has been deposited with Dr. Jim O'Connor, for the collections of the National Museum in Dublin.

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Author's address: 158 Barton Road East, Dundrum, Dublin 14.

NEW ADDITIONS TO THE FLORA OF COUNTY LEITRIM, H 29

Tom Curtis & Carmel Mothersill

South Leitrim is a low undulating area of shaly limestone with a thick covering of glacial drift, amongst which lie many drumlins and lakes. The area is described by Praeger in the Botanist in Ireland as uninteresting, except possibly for aquatics.

During a three day visit, centred in Ballinamore in August 1975, the authors recorded twelve species of flowering plants not previously recorded for the vice-county. A subsequent visit by one of us (T.C.) in 1976 to the shores of Lough Boderg produced a further new county record, which brings the total number of new species to twelve. This serves to indicate how underworked this area of Leitrim is.

The grid reference given after the locality for each species is that of the 5 Km.sq. in which it occurs. The following list of species new to the county are arranged according to the Census Catalogue of the Flora of Ireland by Scannell, M.J.P., & Synnott, D.M. 1972.

* indicates that the species is probably introduced.

* Salix triandra L. Hedgerow near Drumcoura lake. H 15.05. New county record (NCR).

* Humulus lupulus L. Roadside near Drumeanan. H 05.10 NCR.

* Erysimum cheiranthoides L. Dry gravel by the roadside near Drumcoura lake. H 15.05 NCR.

* Sedum telephium L. On a roadside wall in Drumeanan. H 05.10 NCR.

* Malva moschata L. Roadside near Drumcoura lake. H 15.05 NCR.

Oenanthe aquatica (L.) Poiret . In Garadice Lough. H 15.10 NCR.

Verbascum thapsus L. Roadside verge near Ballinamore. H 10.10 NCR.

* Lolium multiflorum Lam. Roadside near Ballinamore. H 10.10 NCR.

Agrostis gigantea Roth . In a wet roadside ditch at Ballinamore. H 10.10 NCR.

Sparganium angustifolium Michx . In Lough Nabellog H 00.15 and also in St. John's Lake H 05.15 NCR.

Juncus kochii F.W. Schultz (sensu Clapham et al. 1962) Lough Nabellog on Slieve Anierin H 00.05 Note: Though not included by Scannell &

Synnott, critical examination of this form of the *J. bulbosus* agg. showed it to belong to this species. Most of the Irish material of this group would appear to belong to this taxon and not to *J. bulbosus* L. sensu stricto.

x *Festulolium loliaceum* (Huds.) P. Fourn. (*Festuca pratensis* x *Lolium perenne*). Roadside verge near Fenagh. H 10.05 NCR.

Other species included the cliff community on Slieve Anierin. Praeger (1934) described the area as wet and gloomy with little of interest, but among the species found were *Rhodiola rosea* L., *Hymenophyllum wilsonii* Hooker, and *Thelypteris phegopteris* (L.) Slosson. The cliffs facing north-east over Lough Nabellog are very wet with some *Calluna* and *Narthecium*, but where the vegetation is less luxuriant *Epilobium brunnescens* (Cockayne) Raven & Engelhorn and *Cystopteris fragilis* (L.) Bernh. occur. *Littorella uniflora* (L.) Ascherson occurs commonly on the lake shore.

The old record for *Cicuta virosa* L. in south Leitrim was confirmed when numerous plants were found around St. John's Lake. This lake lies in a shallow depression and is partly surrounded by a thick belt of *Phragmites australis* (Cav.) Trin.ex. Steud. and *Scirpus lacustris* L. The adjoining area is a wet meadow with *Cicuta virosa*, *Veronica scutellata* L., *Polygonum minus* Hudson, *Eleocharis acicularis* (L.) Roem. & Schult. with *Sparganium angustifolium* in shallow water near the shore, alongside which *Potamogeton alpinus* Balb. occurred.

Hebe salicifolia (G. Forster) Pennell was found naturalised on the banks of the river in Ballinamore.

The new record made in 1976 was:-

Lemna polyrhiza L. In *Phragmites* beds at Lough Boderg N 00.90 NCR. In addition a new locality for *Carex strigosa* L. was found in mixed scrub/woodland on an island in the eastern bay of Lough Boderg. N 00.90

It is hoped to do more work in Leitrim in 1978 and in subsequent years, and any records which people may have for the county will be gratefully received by Carmel Mothersill, who is the county recorder for H 29.

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Authors' address: St. Michael's, Meath Road, Bray, Co. Wicklow. (T. Curtis)

23 Springfield Road, Templeogue, Dublin, 6. (C. Mothersill)

GAMMARUS DUEBENI (CRUSTACEA:AMPHIPODA) IN IRELAND

J.M.C. Holmes.

Gammarus duebeni Liljeborg is the common brackish and freshwater amphipod in Ireland. Because of its abundance there is considerable interest in its distribution and economic importance. It is an important source of food for fish and plays a large part in the energy budget of lakes and rivers throughout the country.

The earliest notable paper on the species is by Reid (1939). He summed up the general situation to that date and listed a large number of localities where the animals had been found. He also included all previously published records and he recognised two forms, a brackish form round the coast and an inland freshwater form.

These two forms have led to much discussion. Stock and Pinkster (1970) regard them as subspecies, the brackish G. duebeni duebeni Liljeborg and the freshwater G. duebeni celticus Stock and Pinkster, the latter being peculiar to Ireland and Brittany. These subspecies differ in their sodium ion tolerance, and this is reflected in their distribution, though with some anomalies. The main works with distribution maps are by Hynes (1951, 1954, 1955) and Sutcliffe (1967, 1970). The current situation is best stated by Pinkster et al. (1970), and the recent Freshwater Biological Association key by Gledhill, Sutcliffe and Williams (1976). The two subspecies are difficult to separate anatomically and crosses between them have been proved to be fertile.

There is a need for more work to be done on the two forms in Ireland, to discover more precisely the factors influencing their distribution. This is partly because recent discoveries by workers in the north of the island have indicated that the distribution of amphipods is changing due to invasion by alien species, notably Gammarus pulex (L.). G. pulex is spreading rapidly and replacing G. duebeni where they coincide. These changes must be monitored, firstly because they may influence other sorts of organisms besides amphipods, and secondly because G. duebeni celticus is one of the very few animals peculiar to Ireland and Brittany.

Due to the author's interest in Gammarus over the past few years, specimens of G. duebeni have been collected in various places and these localities are listed below as they have not been published elsewhere.

Recently the author had an opportunity to examine the Gammarid collection in the National Museum of Ireland (Dublin), which proved to contain specimens of G. duebeni from a number of localities. These specimens are also recorded below because many of them were previously unnamed or misidentified and labelled under some other specific name. The records based on these specimens are asterisked.

Antrim: * Cavehill Quarry; freshwater spring; coll. R. MacDonald, 1938; N.M.I. 175. 1977.

Belfast: * Strandtown; coll. R. Patterson.

Clare: R7187, Mountahannon, L. Derg. August 1975.

Cork: V.8430, Ballyrisode, Toomore Bay; coll.M. Holmes, August 1977.

* Bantry Bay, coll. A.R.C. Newburgh; N.M.I.122. 1892, labelled G. locusta.

* L. Doon, coll. R.F. Scharff, N.M.I.100.1894, labelled G. pulex DeG.

* Sherkin I. coll.A.R. Nichols. N.M.I. 190.1895.

Down: J.55, muddy shore nr. Portaferry, coll.M.Holmes, March 1972.

* Killough Harbour, with G. zaddachi, coll. R. MacDonald, 1939, N.M.I.175. 1977.

Dublin: 0.35, Lambay Is., coll. B. West, June 1970.

0.22, Killiney, a specimen discovered by a colleague in her bath, January 1971.

* Scalp, on display, Nat.Mus.Dublin, labelled G. pulex.

Fermanagh: * L. Erne, coll. R. Welsh. N.M.I. 115.1900.

Galway: * L. Corrib, coll. R.F. Scharff, August 1905, N.M.I.131.1905.

Kerry: * L. Eagher, coll. R.I.A., N.M.I.100.1898.

* Mt. Brandon, lake at 2,255 ft., coll.Miss J. Stephens, N.M.I.305.1913.

* Small tarn beside L. Doon, Connor Pass, Dingle, 1,000 ft., coll. Miss J. Stephens, July 1913, N.M.I.305.1913.

Leitrim: * Mohill, coll. P.H. Grierson, N.M.I.41.1899.

Mayo: Inishkea South, F.52, coll.B. West, March/April 1970.L.99, L. Furnace, coll.M. Holmes, September 1970. G.20 L. Conn nr. Pontoon, coll.M. Holmes, July 1972. F.9940, Belderg R.

coll. M. Holmes, 9th July 1972.

*Westport, coll. W.T. Calman, N.M.I.63.1896.

*Achill Is., coll. E. Williams, N.M.I.134.1898.

G.4115, L. Talt, coll. M. Holmes, August 1975.

Sligo: *L. Gill, coll. R. Welch.

Westmeath: N.4256, L. Owel, calcareous lake, in abundance, coll. M. Holmes, 24th September and 7th November 1970, typical G. duebeni celticus.

Wicklow: 0.2911, streams S. of Greystones, coll. M. Holmes, July/August 1970, typical G. duebeni duebeni.

0.3011, stream S. of Greystones, at point where it flowed onto beach, coll. M. Holmes, 1st April 1972.

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Author's address: National Museum of Ireland,
Dublin, 2.

PROGRESS REPORT ON THE RECORDING SCHEMES FOR HARVESTMEN, FALSE-SCORPIONS AND CENTIPEDES.

Carmel Mothersill.

The recording of harvestmen, false-scorpions and centipedes has been sporadic in Ireland and the published material largely pre-dates significant changes of nomenclature within these groups. A new recording effort was initiated in late 1976 which aims at a more systematic study of their distribution with the ordnance survey 10 km grid square utilised as the recording unit.

Harvestmen (Phalangida)

Pack-Beresford (1926) and Bristowe (1949) attemtped to map the distribution of this group by using the vice-county as their recording units. Sankey and Savory (1974) reviewed the literature for the British Isles and included some additional records from Mackie (1970).

The present effort has been concentrated in areas that were considered to have been under-recorded, such as Kildare (1 species previously recorded), Wexford (2 species previously recorded) and the midland counties. Figure 1 shows the 10 km squares visited in 1977. I have identified most of the material collected but await verification from Dr. J.P. Sankey before publishing any revised distribution maps. The preliminary determinations indicate that Nelima gothica (Simon), a western species on the island of Great Britain and first recorded there in 1935, is widespread in Ireland. Lacinius ephippiatus (C.L. Koch), Opilio saxatilis (C.L. Koch)and Leiobunum blackwallii Meade, also appear to be under-recorded in Ireland as pre-1976 records show them to occur in 16, 4, and 13 vice counties respectively. These species were all commonly encountered during the present survey.

The most successful way of collecting harvestmen was by searching under stones. Beating the foliage of trees was rarely productive.

Sifting beech-leaf litter usually revealed Lacinius ephippiatus.

False-Scorpions (Pseudoscorpionida)

Irish work on false-scorpions was mainly carried out at the beginning of this century by H. Wallis Kew (1911a, b, 1916) who published a "Synopsis of the False Scorpions of Britain and Ireland" (1911) followed by a supplement devoted mostly to Irish material (1916). A recording scheme is now in operation in Britain organised by P.E. Jones, Monk's Wood and records from the present survey have been sent to this scheme. Fig.2 shows the Irish situation at the end of 1977. All the species were identified for the author by P.E. Jones. The most interesting records include Allocernes dubius (O.P.-Camb.) collected by D. Doogue from Ireland's Eye, only recorded previously from Co.Wicklow (1895) and Co. Antrim (1913), and Cthtonius orthodactylus (Leach) also collected by D. Doogue from Castletown, Co. Laois and which appears to be new to Ireland.

False scorpions were not commonly found during field work and generally occurred only singly or in pairs under logs and stones. Occasionally specimens were sifted from leaf litter but this method was time consuming and relatively unproductive. Specimens were never found attached to the legs of harvestmen as has been reported!

Centipedes (Chilopoda)

This group of the Myriapoda is one of the most underworked animal groups in the Irish fauna. Only 153 records had been received by the myriapod survey according to a report they produced in 1975. Very little published work exists for the Myriapoda in Ireland. According to Johnson (1912) a list was published by Templeton in 1836 and subsequently five papers were published by Pocock, Carpenter, Brölemann and Selbie (1893-1912). Johnson increased their total of 34 Irish species of Myriapod to 36. Since then on systematic study has been undertaken. The present total number of Irish centipedes is 20. Millipedes, the other group of the Myriapoda are not being studies by this author.

This study began in 1977 but at present material is only being accumulated and old records will be traced at a later date. Fig.3 shows the squares visited during 1977 from which specimens were collected. All material is being determined by A. Barber, the British scheme organiser. A number of new county records have been added; these are Lithobius dubosqui (Brölemann) new to Carlow, Tipperary and Meath, Necropholephagus longicornis (Leach), new to Carlow and Meath, Geophilus electricus (Linn.) new to Offaly. A considerable number of specimens remain to be identified, so a full report on this and the other groups under investigation will be published at a later date.

Help is gratefully acknowledged from the British scheme organisers for determinations of specimens, from D. Doogue who contributed a large number of records and from I.B.S. members who helped, particularly during the trips to Nephin Beg and to Cong.

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Author's address: 23 Springfield Road, Templeogue, Dublin 6.

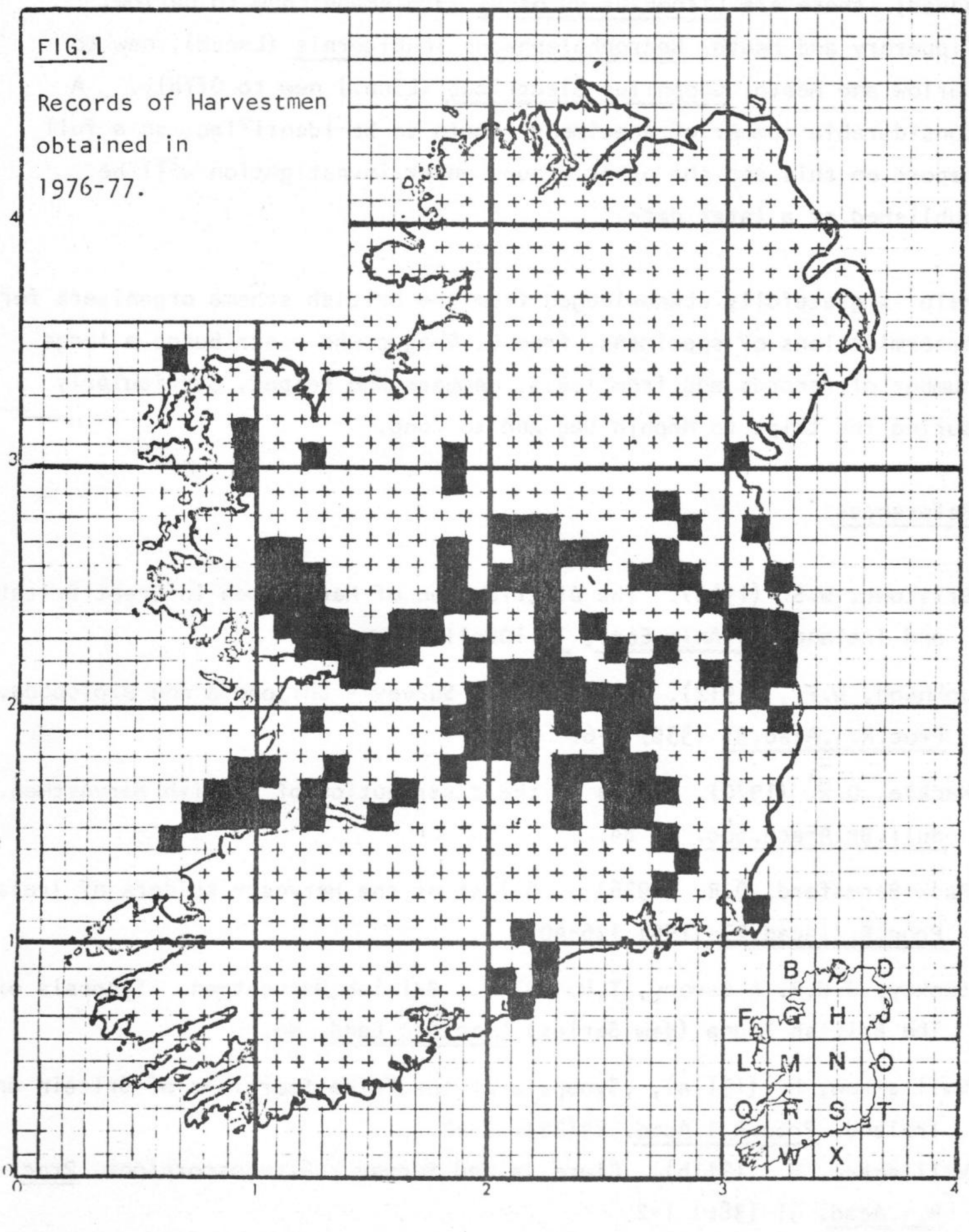

FIG.1

Records of Harvestmen obtained in 1976-77.

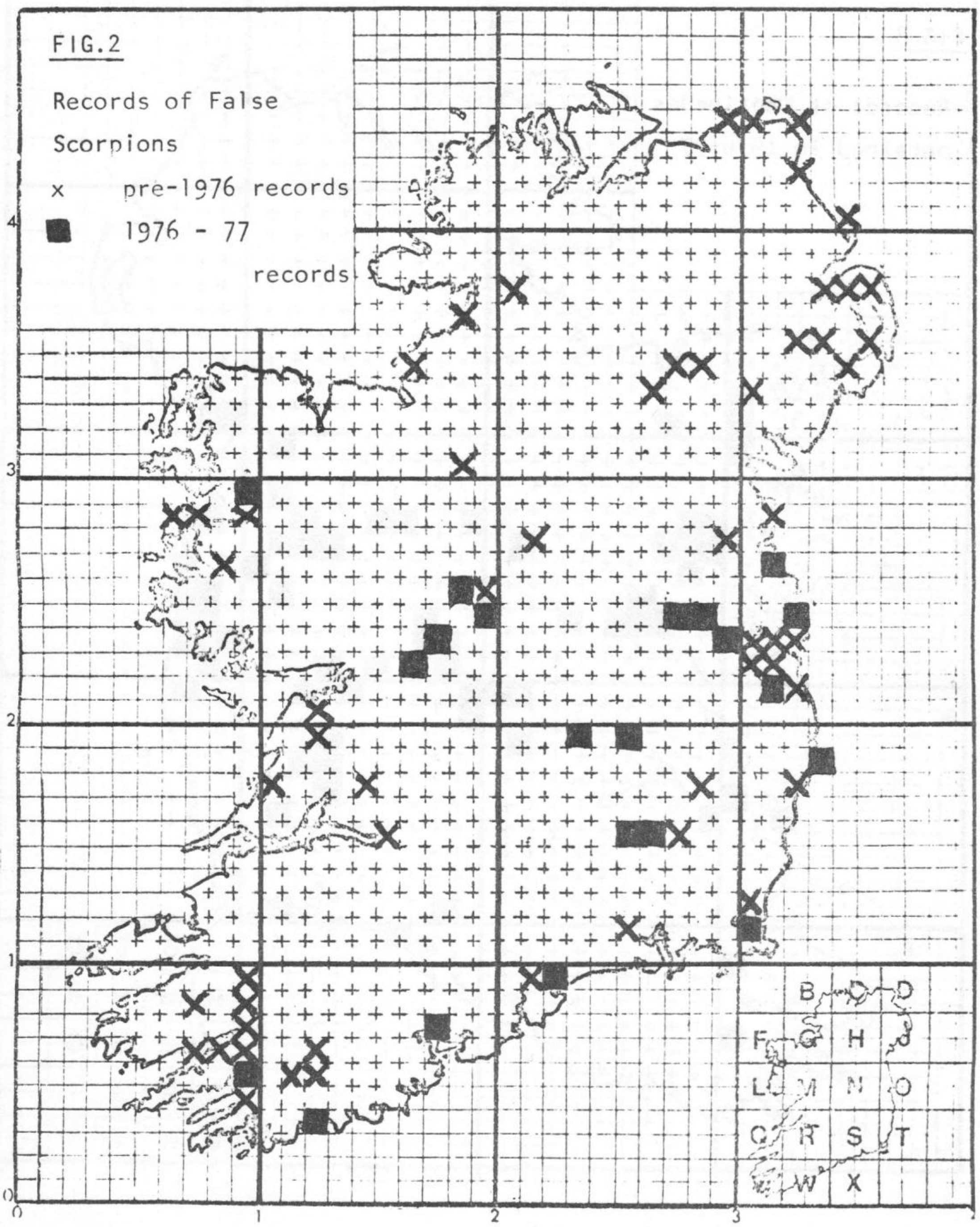
FIG.2
Records of False Scorpions
x pre-1976 records
1976 - 77 records
B C D
F G H J
L M N O
Q R S T
W X
0
1
2
3
4

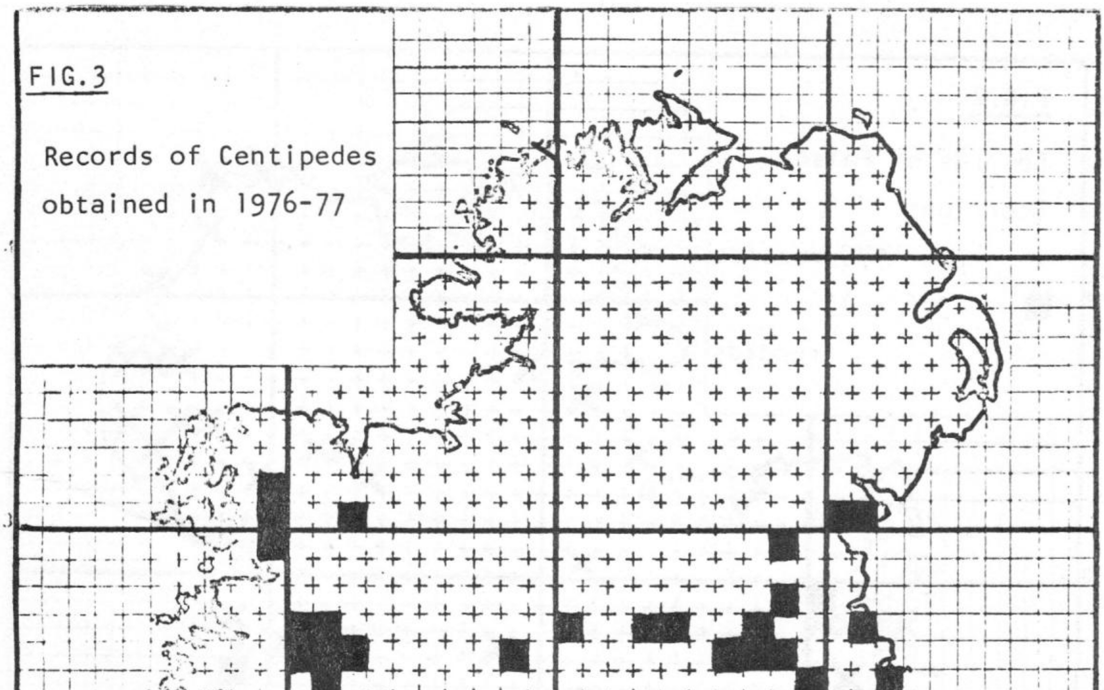
FIG.3
Records of Centipedes obtained in 1976-77
B C D
F G H J
L M N O
Q R S T
W X
0
1
2
3
4

OBSERVATIONS OF THE VERTEBRATES RECORDED IN THE CONG DISTRICT OF CO. MAYO BETWEEN THE 8TH AND 11TH APRIL, 1977.

Donald C.F. Cotton

Notes on the vertebrate fauna were made as a part of the Irish Biogeographical Society's field study in the Cong district. Nine species of mammal were recorded either through a sighting of the animal or their unmistakable tracks and signs. Rhinolophus hipposideros (Bechstein), the Lesser Horseshoe bat, was found in two limestone caves about 1 km apart (10 km square M.15, new record). A single bat was present in each cave and the forearm measurements of 32 mm and 39 mm confirmed their identification as being of this species. Droppings of the fox (Vulpes vulpes L.) were found at several locations (M.15 and M.16) and a paw print of the badger (Meles meles (L.)) was seen in fresh mud near to Lough Mask (M.16). A cave surrounded by dense scrub and trees contained fresh moss that had been used as bedding material by a fairly large mammal and the additional signs of well-used tracks and many small holes dug into the soil were also taken as evidence of the badgers' presence in this part of the country (M.15). A small herd of feral goats (Capra hircus L.), led by a large male, were briefly seen before they ran into the dense thicket leaving an unpleasant smell and many scattered droppings (M.16, new record). At the same location a pile of hazel nuts (Corylus avellana L.) were found that had had their kernals removed by wood mice (Apodemus sylvaticus (L)). A. sylvaticus has not previously been recorded from this area, making this an interesting observation. Rattus norvegicus (Berkenhout), the brown rat, was commonly seen around the edge of Cong village (M.15). The rabbit (Oryctolagus cuniculus (L)) was seen at one place (M.05) and skulls of this species were found in caves at another site (M.15). The Irish hare (Lepus timidus hibernicus Bell) and the red squirrel (Sciurus vulgaris leucourus Kerr) were both reported to have been seen near Cong (M.15) by other members of the party.

Records of 65 bird species were made, amongst which were a few late winter visitors and the earlier members of our migratory breeding species. In the first category was the redwing (Turdus iliacus), a maximum of four birds being seen at one time. A skein of 14 white-fronted geese (Anser albifrons), observed flying over Lough Corrib, were thought to be on migration as they progressed on a flight path taking them away at N 20°E. Three goldeneye (Bucephala clangula) were seen at one place on Lough Mask and a single bird was seen at another location. Both sexes were in breeding plumage and must have been due to fly north at any time. A flock of about 40 golden plover (Pluvialis apricaria) which were still in winter plumage were also seen beside Lough Mask. Some of these birds may breed locally.

The most interesting record was that of an immature great northern diver (Gavia immer) which was seen fishing in Lough Corrib on 10th April. The fact that it had not yet moved north is not unusual; inland records of this species are not common in Ireland.

Evidence of the spring migration into this country was provided by the presence both of chiffchaffs (Phylloscopus collybita) and willow warblers (Phylloscopus trochilus). Singing birds of these species were encountered in many of the suitable habitats available for nesting. A pair of wheatears (Oenanthe oenanthe) and several small groups of hirundines, from which only the sand martin (Riparia riparia) was identified, provided further examples of recently arrived migrants.

Comments on the relative abundance of certain species are also worthy of inclusion in this article. The mistle thrush (Turdus viscivorus) was observed to be a very common bird, about one pair being seen every 2-300 metres along country roads where the land was used for sheep pasture and where there were also occasional mature trees along the field borders. This species was thought to be numerically dominant to the song thrush (Turdus philomelos) in this area. The common gull (Larus canus) was also very common in fields where sheep were grazing and was sometimes accompanied by the black-headed gull (Larus ridibundus). A roost of 40 common gulls were seen upon an island in Lough Mask. Two pairs of collared doves (Streptopelia decaocto) in Cong village and another singing bird around farm buildings, show that the invasion of this species across Europe has reached the most western parts of the continent. A bird which was not seen, but which would normally be associated with this sort of country, is the skylark (Alauda arvensis). The small size of the fields probably make the habitat unsuitable for the species thus offering an explanation for its apparent absence.

The only amphibian recorded was the common frog (Rana temporaria L.) and this was identified from masses of spawn found at two localities (M.15 and M.16).

Author's address: Department of Agricultural Biology,
University College, Dublin 9.

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THE INFLUENCE OF TOPOGRAPHY ON THE DEVELOPMENT OF VEGETATION IN THE CAMARGUE, FRANCE.

M. Sheehy-Skeffington.

The Camargue is a fascinating and unique area for natural history. It is perhaps best known for its diversity of nesting and passage migrant birds which find an abundance of food and comparative peace in the reserve. This diversity of bird life is a reflection of the varied habitats provided by the vegetation and topography for waders, flamingoes, freshwater and marine duck, birds of prey and passerines, especially warblers.

This area of deltaic deposits has a topography that rarely exceeds 0.5 m N.G.F. (Nivellement General de la France) and therefore a difference in water level of a few centimetres can have a significant effect on the vegetation. The water table is always above or near the ground surface and mixes with an underlying wedge of sea water. Its salinity and level fluctuates with rainfall. The lake Vaccares (see Map) has tended to become less saline in recent years as it now receives much of the freshwater run-off from nearby rice fields. Since the end of the 19th century when dykes were built to prevent flooding, there has been no direct communication with either the Rhone or the sea.

The highest piece of land (3 m) is on the radeaux des Rieges which is a part of a fossil dune system (Flahault 1937) and is occupied by the much proclaimed Bois des Rieges. Here as in other dune systems, a lens of freshwater collects under the dunes during the rainy season (October to April) and has allowed a non-halophytic woodland community to develop. These woods are interesting because they are dominated by _Juniperus phoenicea_ L., a cypress-leaved juniper. Individual plants may be several centuries old and can reach 6 - 8 m in height with a trunk diameter of approximately 30 cm (Corre 1975a).

Being isolated by standing water and salt marsh for a radius often exceeding 5 km, the vegetation has come to consist almost entirely of ornithochorous species i.e. species that have seeds (generally borne in berried fruits) normally dispersed by birds. The second storey of the community is composed of shrubs such as Phillyrea angustifolia L., Pistacia terebinthus L., P. lentiscus L. and Rhamnus alaternus L. The under-storey includes Daphne gnidium L., Asparagus acutifolius L. and Osyris alba L., and is virtually impenetrable (except by wild boar) due to the binding powers of the lianes Smilax aspera L. and Rubia peregrina L., which both produce berried fruits. None of the fruit-eating birds nest in the woods, but both Blackbird and Song Thrush are present in winter (Coulet 1975). The common finches, especially Chaffinches, are generally seed-eaters but do eat some berries. Flahault (op.cit.) noted the high number of adventive plant species on mediterranean dunes, notably those with smooth seeds that are more likely to be transported by birds than the wind, e.g. Rumex pulcher L., Raphanus raphanistrum L., Bellardia trixago (L.) All. and Teucrium polium L. One species common dune systems around the Camargue is the Parasol Pine Pinus pinea L. It is however absent from the Bois de Rieges, possibly because its seeds through being heavy are a hindrance to long distance dispersal. Two other species of Pine, P. halepensis Miller and P. pinaster Aiton, which are rarer on nearby dunes, are also absent from the Rieges. The Rieges are thus an interesting example of a well structured and relatively stable community that has arisen almost entirely from one type of dispersal strategy.

More than half of the Camargue is uncultivated and consists of a complex lake system and saline marsh. Some of the saline areas with sparse halophytic vegetation, are flooded in winter and become bare patches of cracked mud whitened by salt deposits if they dry up in summer (Molinier & Tallon 1965). Some of these smaller lakes were the subject of a more detailed study by the author. The edges of these appear to have a denser and more diversified vegetation than the surrounding areas which coincides with the presence of a ridge of sediment, not higher than 0.50 m and accumulated as a result of wave action generated by the north-westerly or south-easterly winds.

A series of transects, perpendicular to the edges of some of these lakes were put down to determine how the vegetation was affected by this ridge. The presence or absence of each plant species was noted. It seems that certain species tend to occur only on a limited area of a transect, coinciding with the crest of the ridge. Thus the slightly less tolerant species, mostly Gramineae such as Lepturus filiformis (Roth) Trin., Aeluropus littoralis, Agropyron elongatum (Host) Beauv., and Inula crithmoides L. tend to be confined in their distribution to the ridge, whereas Arthrocnemum fruticosum (L.) Moq., and to a lesser extent Halimione portulacoides (L.) Aellen, which prefers well-drained soil (Chapman 1960), were more evenly distributed along the transect. Arthrocnemum glaucum (Delile) Ung.Sternb., though sparse, dominated the most saline areas which are furthest from the lake edge.

A series of cores taken from along the transect, showed the ridge to be of a coarse sandy texture, especially on the side facing the water. Previous studies (Heurteaux 1969, Corre 1975b) have shown that coarse textured soils and a slight elevation tend to produce less saline conditions than in the more widespread and finer limon soils.

Finer sediments, filtered by the vegetation, settles on the surfaces of plants and on the ground just behind the top of the ridge. It is interesting that vegetation heights (for the one species, A. fruticosum) reach a maximum at this point, possibly due to the accumulation of organic nutrients as the sediment is rich in plant and animal debris (ranging from the pollen of the aquatic plant Ruppia brachypus L. to tiny Cardium shells). In an area where the availability of nitrogen is especially low it is probable that this is a growth response to added nutrient supply and increased microbial activity.

The vegetation can thus be divided into groups along gradients of soil salinity and humidity (degree of water-logging) and it appears that the ridge increases the range for these two factors, at least along a transect. This is recognisable a zonation of vegetation types parallel to the lake edge.

This study exemplifies the effect of mesorelief on the vegetation. As a consequence of the shifting of the course of the Rhone during the Holocene, before it was endyked, a complex system of fluvial deposits now covers the delta. Vegetation mapping of the Basse Camargue brings out this mosaic pattern with a recurrence of the same groups of species on the hummocks as were found on the ridges mentioned above. Water conditions are consequently very variable over the whole area, providing a myriad of habitats for both micro- and macro-flora and fauna.

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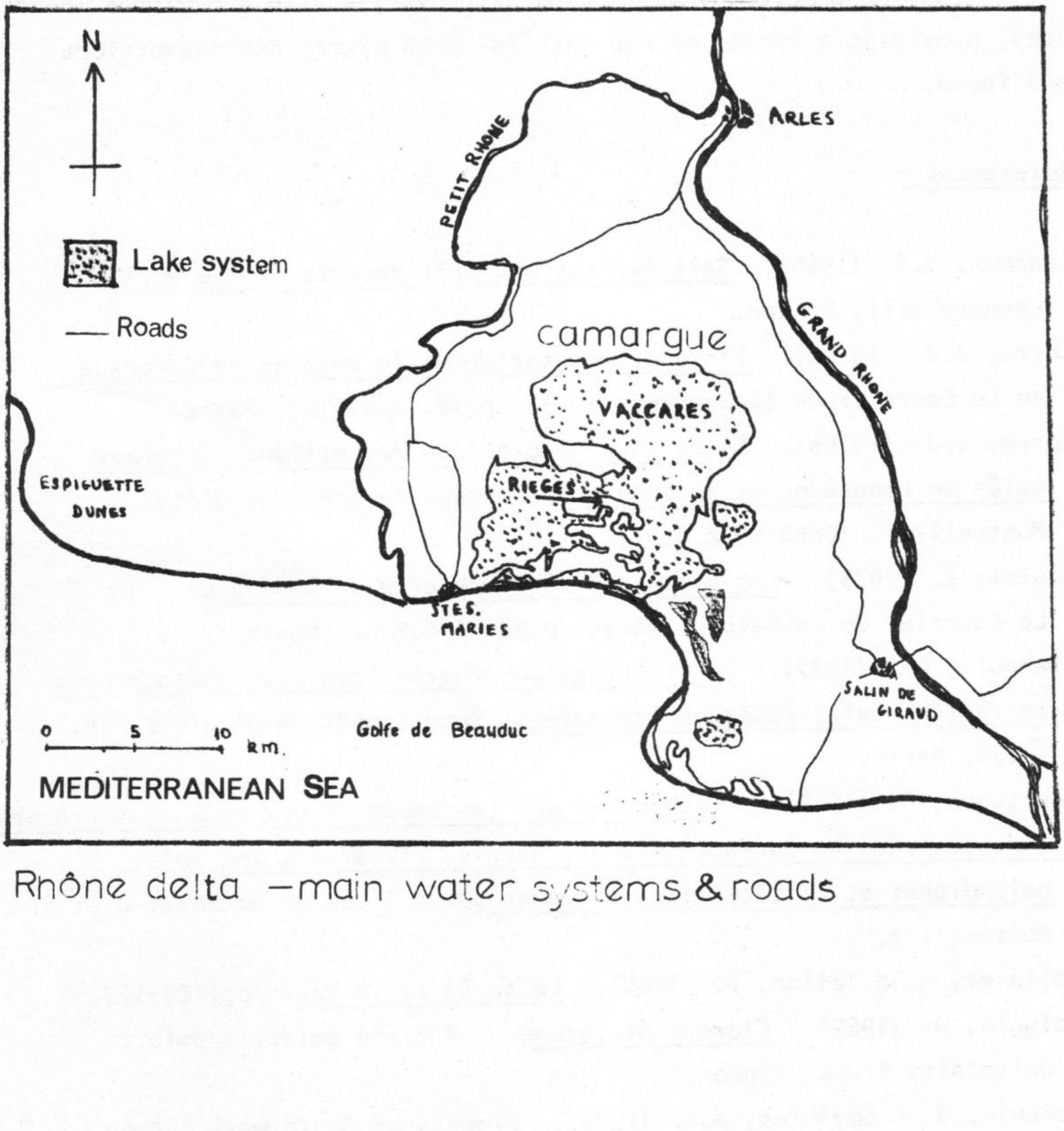

Rhône delta —main water systems & roads

WHAT IS A REFERENCE COLLECTION?

Martin C.D. Speight

National reference collections ideally function as a repository of named material belonging to all species known in the nation thus providing a basis for taxonomic research, a set of voucher specimens against which anyone can check specimens they wish to determine and base-line material for any biogeographical study. Indeed, such objectives would frequently be regarded as rather minimal for institutions housing national collections, and the more well-endowed national centres are able to work actively towards accumulating series of specimens belonging to each of the species known within the nation, such that all forms of intra-specific morphological variation are represented. An integral part of such series-collection processes is the gathering of specimens from as many different parts of the known range of a species as is possible, since morphological variants are so frequently restricted to particular areas or biotopes. It is self-evident that any well-curated collection with these characteristics is potentially an extremely valuable source of biogeographical information.

To any biogeographer engaged in the interpretation of field data, access to a reasonably comprehensive and reliably determined reference collection is frequently an essential aid to determination of unnamed specimens, due to the shortcomings of identification keys and the scarcity of specialists prepared to undertake determinations. Museum collections like those described above not only provide the necessary comparative material, they also represent sources of biogeographical data. But how often are such museum collections available?

No nation in the world has national collections so comprehensive that they include named examples of all plant and animal species occurring nationally. Few have national collections in which a majority of the taxonomic groups is represented by a reasonably comprehensive set of correctly determined specimens. Indeed, it is most unusual to find a national institution in which more than a handful of taxonomic groups is represented by comprehensive collections reliably named. And even if the biogeographer is lucky enough to discover that the national collection is both comprehensive and reliably determined, for some group of organisms in which he or she is interested, how accessible is that collection? In order to make use of a museum collection to any significant extent, one would in my opinion either have to work within walking distance of the museum and have many opportunities to take time between 9.00 a.m. and 5.00 p.m. in the museum while it is open, or be employed to work professionally on the collections oneself! In reality, it is unusual for most people wishing to consult museum collections to be able to do so for more than the odd morning or afternoon a few times a year.

Given that one needs repeatedly to identify representatives of some organism group, that specialist help is available to only a minor extent, that keys are by themselves insufficiently reliable, that reference collections provided by institutions are inadequate and/or unreliably determined and that such collections are in any case generally inaccessible, there is little alternative to amassing a usable reference collection oneself!

The "do-it-yourself" reference collection

In considering what a personal reference collection might most usefully comprise, I am going to assume that it is being accumulated by someone interested in distributional phenomena relating to one or two selected groups of organism, within some national context. It is by no means impossible to gather together a personal reference collection that is extremely valuable in furthering such an interest. As defined above, I suppose the ideal reference collection of a particular taxonomic group would contain an adequate number of reliably determined specimens of all the species recorded for the nation and belonging to that group, together with reliably determined specimens of any additional species that might be expected to occur, though as yet unrecorded there (admittedly this presupposes that the collector can establish which species are recorded, from some published national list for the group concerned, and this may not be available). To amass such a collection takes time, but long before a collection approaches any such degree of completeness it becomes very useful. In fact it can be made useful very rapidly, since as reference material certain species are more useful than others and collecting effort can be concentrated, right from the start, on obtaining these more useful species. Various categories of species that are "useful" in this limited sense, may be recognised:-

1. Species representative of different genera.
2. Species representative of each of the major subdivisions of large genera, as segregated in dichotomous keys to the species used by the collector.
3. Species keyed out in the terminal couplets of dichotomous keys used by the collector.
4. Any additional "especially difficult to determine" (i.e. "critical") species, as mentioned in literature.

Initially, it is well worthwhile setting out to obtain species in as wide a range of different genera as possible, since keys to species cannot be used until the correct genus to which a specimen belongs can be recognised. The major subdivisions in a key to species are of similar importance, in large genera. "Critical species" are almost inevitably those keyed out in terminal couplets of keys, since by definition they are distinguished by the most insignificant, obscure and imprecise of differences. However, in a key to all the species of a large genus, divided within the key to say four big subgroups, there would be four sets of terminal couplets, all of which could involve critical species.

It may seem quite unrealistic to suggest that an individual unfamiliar with the group of organisms he or she is starting to collect can, with any hope of success, set out to obtain particular species - after all, how can someone selectively collect something which they cannot recognise when they find it? However, unless the organisms concerned are so small that they cannot be distinguished one from another in the field by even an experienced observer, in most groups it is possible to familiarise oneself sufficiently with the generic characteristics from descriptions and illustrations provided in literature, backed up by an afternoon spent examining named material in a museum collection, for one to recognise a large proportion of the genera in the field, when seen for the first time. Also usually available from the literature is a certain amount of ecological information indicating in what sort of countryside one's search for genus X might be most successful. This approach is thus likely to result in the acquisition of specimens belonging to a range of genera, and to get most specimens allotted to their correct genus. Once a given genus can be recognised, an attempt may be made in the same way to collect representatives of its major subdivisions. Through the increased experience of identifying material the recorder will very quickly find that he is able to recognise more obvious and well-defined species in that genus. At the same time, other specimens belonging to that genus and that defy determination will have been collected. It is at this stage that contact with other people interested in the same group of organisms becomes vital - such contacts open up possibilities of exchanging material and getting doubtful determinations checked, and correctly named specimens of critical species can be obtained by both methods. Contacts in other countries are often more useful as a source of exchange material than are people close at hand, because species common in one country are frequently rare in another, and vice versa, so that using foreign contacts species easily obtained in one's own country can often be exchanged for species difficult to obtain there. The etiquette attached to requesting someone else to check one's determinations, or identify enigmatic specimens, has been discussed by Harding (1977), so I will not go into the matter here, beyond saying that anyone is more likely to respond positively to a request received in advance of a box of unnamed material, than to a note enclosed with a mass of specimens! From one's own viewpoint, it is also more instructive to attempt to determine specimens oneself, and attach determination labels to them, prior to sending them off for the opinion of someone else, since in this way when they are returned one can see if mistakes have been made in interpretation of keys, or where the keys are incorrect or inadequate, etc.

Given that for each species one should attempt to obtain specimens representative of its full range of morphological variation and geographical distribution, there is generally a greater need for long series of polymorphic or widely distributed organisms than for sexually dimorphic or local ones. The whole question of how many specimens to retain from each species becomes complicated when factors like the relative taxonomic stability of different groups, or the availability of storage space, are also brought into consideration. Obviously there is a need to retain more specimens of taxonomically instable species-groups than of stable ones, due to the possibility of subsequent name changes, species redefinitions, descriptions of new species, etc., which would otherwise play havoc with any distribution survey, but, for the average mortal, storage space is liable to run out long before adequate series have been obtained, even if each specimen takes up only a modest amount of space. For instance, a collection of adequate series of 100 species of small insect, reasonably housed, would require perhaps three cubic feet of storage space, while the same specimens, were they dragon-flies, would require 90 cubic feet! In my view, the phenomenon of intra-specific variation can usually be coped with in insect species which are not demonstrably polymorphic by obtaining a series of 10-15 specimens from one locality and on the same date. Geographic variation may then be catered for by adding pairs of specimens from other localities, choosing localities as widely separated as possible. I would point out that I am not suggesting these figures are appropriate for all other groups of organism - to apply them to other groups could be a recipe for disaster, resulting not only in inappropriately constituted collections but also, quite possibly, in local extinction of some species. For entomologists, an attempt has been made in Britain to produce a "Code for insect collecting", published recently (Joint Committee for the conservation of British Insects, 1972) and available in reprint form from the Royal Entomological Society of London.

Finally, the critical importance of effective curation of reference material cannot be too-strongly stressed. All too frequently tremendous effort is put into collecting and determining specimens, only to have them then dumped, inadequately labelled, into some ramshackle container in a damp room! While curation does take time, effective maintenance of a collection of 1,000 specimens takes no more time each year than would be needed for an excursion into the field to replace only 10 of them! A reasonably maintained reference collection can be invaluable, so it is worth treating with respect. It is particularly necessary to bear this in mind if through ill-health or loss of interest one considers disposing of a collection - deposited in a National Museum it could be of tremendous value to others. Many a valuable collection has been lost because its owner failed to consider what should become of it. Specimens that are of especial scientific interest are best not retained in personal collections at all, but, as I have suggested before (Speight, 1977), should be deposited in the collections of some reputable institution as soon as possible, seeing the ultimate fate of a personal collection is so uncertain.

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Author's address: 158 Barton Rd. East, Dundrum, Dublin 14.