Variation in the white-toothed shrews (*Crocidura* spp.) in the British Isles

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Ten skull characters were measured on each of 300 specimens of *Crocidura suaveolens* (Pallas) and 99 specimens of *C. russula* Hermann from five of the Scilly Isles, four of the Channel Isles and one locality on the mainland of France. No place contained both species. The characters were skull length, skull width, lengths of upper and lower tooth rows, distance between the third upper molars, distance between the upper premolars, length from the palate to the foramen magnum, the combined length in ventral aspect of the third upper incisor and canine and the mandibular height.

The means of each measurement at each locality were calculated. Analyses of variance were also calculated and from these variance components within locality groups were obtained. An analysis into canonical variates was made with a view to accounting for the largest possible part of the variation between groups using a limited number of linear combinations of the original measurements. Most of the variance (82 %) was contained in the first canonical variate and from the dispersion of the means of the samples the populations of *Crocidura* separated into two main groups. One contained animals from Alderney, Guernsey and Cap Gris Nez (*C. russula*) and the other the remainder (*C. suaveolens*). The latter group subdivided, particularly with reference to the second canonical variate, into animals from Sark and Jersey and those from the Isles of Scilly. Differences between populations from the Scilly Isles are very small, suggesting origin from a common stock. The shrews from Sark and Jersey differ more from each other than do any pair of Scilly Island populations. The three populations of *C. russula* do not form as close a cluster as the Scilly Island ones. The analyses of variance agree with these findings although for certain characters highly significant differences often occur between localities in a particular group.

Introduction

White-toothed shrews of the genus *Crocidura* Wagler occur in the Channel and Scilly Isles but not on mainland Britain. From the Channel Islands Miller (1912) recorded *C. russula russula* Hermann as present on Guernsey and Alderney whilst Montagu & Pickford (1923) diagnosed the Guernsey form as a distinct subspecies (*C. r. peta*). From shrew remains in owl pellets Morrison-Scott (1937) suggested that *C. russula* occurred on Jersey. It was not until Cranbrook & Crowcroft (1958) examined further material from these three islands as well as Sark that it was appreciated that two species of *Crocidura* were present—*C. russula* on Alderney and Guernsey and *C. suaveolens* (Pallas) on Jersey and Sark. These authors did not recognize *C. r. peta* as a valid subspecies. Cranbrook & Crowcroft (1961) recorded

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C. russula from Herm Island. Both species occur on the Continent although *C. suaveolens* has not been recorded from the mainland of northern France.

Hinton (1924) provided the first record of *Crocidura* from the Scilly Isles when he described *C. cassiteridum* from 'an uninhabited island'. Later, Ellerman & Morrison-Scott (1951) and Cranbrook & Crowcroft (1958) suggested this species was, in fact, a subspecies of *C. suaveolens* distinguished from the Channel Island form by the low paracone of the upper premolar. Rood (1963) subsequently questioned the validity of this character. In the Scillies *Crocidura* has been recorded from Bryher (Spencer-Booth 1956), St Mary's, Tresco, St Agnes, St Martin's (Rood 1963), Tean, Annet and Samson (Southern 1964).

The skulls of ten isolated populations of *Crocidura* belonging to two species have been examined in the present study and attempts made to analyse the pattern of variation between these populations. The populations examined originated from five of the Scilly Isles, four of the Channel Isles and the mainland of France. The study has been restricted to an examination of the skull. Differences amongst collectors in the methods of measuring external characters (which cannot be made accurately or checked on preserved material) has been responsible for their exclusion. Both univariate and multivariate analyses have been undertaken as they have previously been found to give good results in studying variation in *Apodemus* inhabiting an archipelago in north-west Scotland (Delany 1964; Delany & Healy 1964).

Materials and measurements

Three hundred and ninety-nine skulls were examined (these being the total available) consisting of 144 from Tresco, 16 from Bryher, 12 from St Agnes, 7 from St Martin's, 90 from St Mary's, 25 from Sark, 6 from Jersey, 26 from Alderney, 53 from Guernsey and 20 from Cap Gris Nez, France. The location of these and other islands referred to in the text are shown in figure 1. The following measurements were made on each skull:

1. The skull length from the anterior margin of the first upper incisors to the hindermost margin of the supraoccipital.
2. Maximum width of the skull.
3. The length of the upper tooth row from the hindermost margin of the third molar to the anterior edge of the first incisor measured in a line parallel to the long axis of the skull.
4. The minimum distance between the third upper molars.
5. The minimum distance between the upper premolars.
6. The distance from the hinder margin of the palate to the foramen magnum in the midventral line.
7. The distance between the exoccipital condyles.
8. The maximum combined length of the third upper incisor and canine when viewed ventrally.

(The above are illustrated in figure 2.)

9. The length of the mandibular tooth row, excluding the first incisor and measured with the lower jaw viewed laterally from the most anterior portion of the second incisor to the hindermost margin of the third molar.

10. Height of the mandible measured from the notch where the angular process originates on the lower margin of the jaw to the tip of the coronoid process.

Calipers measuring to 0·05 mm were used in determinations of lengths and widths of skulls. The other measurements were obtained under a low-power monocular microscope; the length of the upper tooth row with a graduated microscope stage measuring to 0·1 mm and the remainder with a micrometer eye-piece graduated in units of 0·07 mm. No measure of the height of the skull was obtained as Pucek (1963) has shown this to vary seasonally in *Sorex* L.

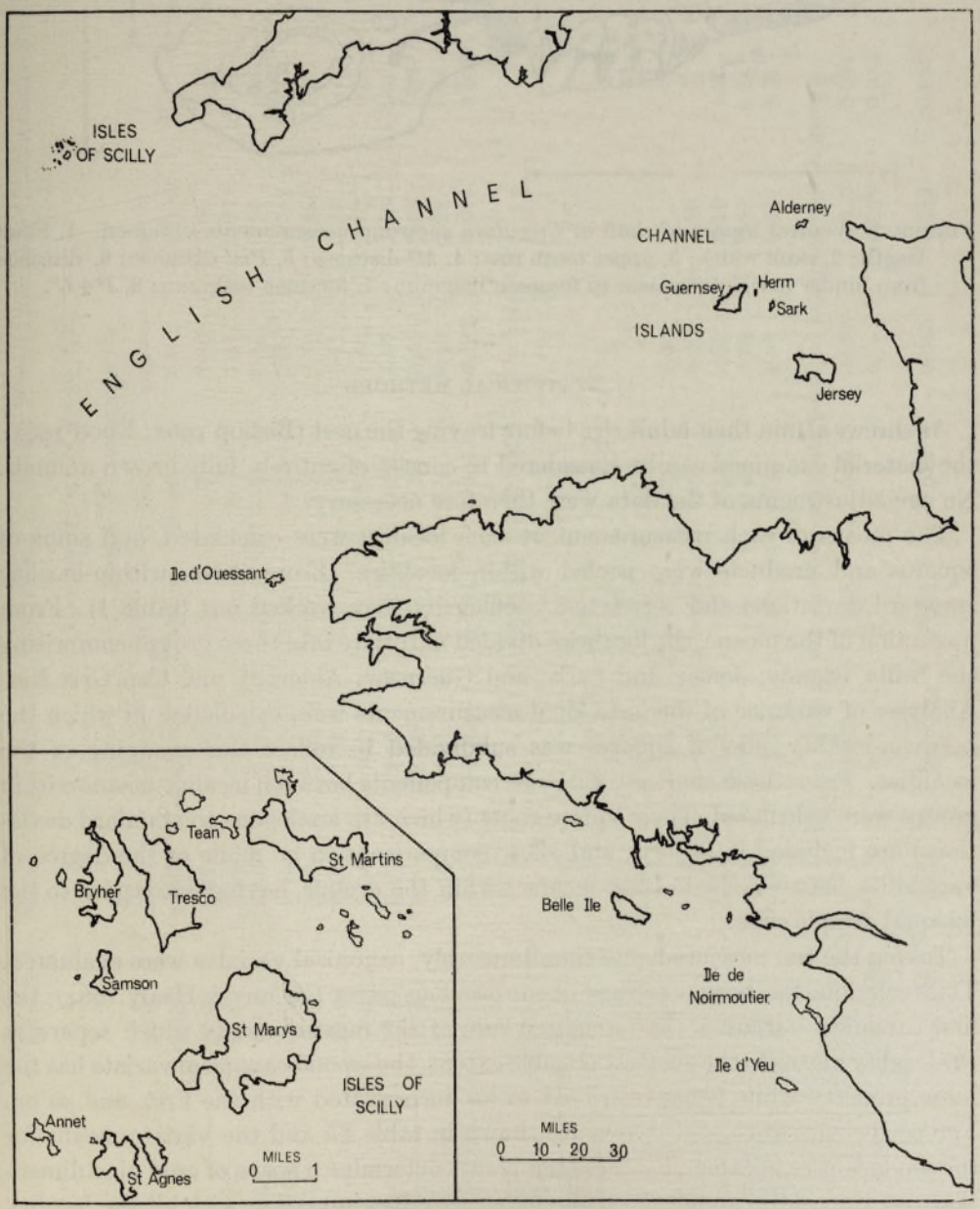

FIGURE 1. Map showing location of islands referred to in the text.

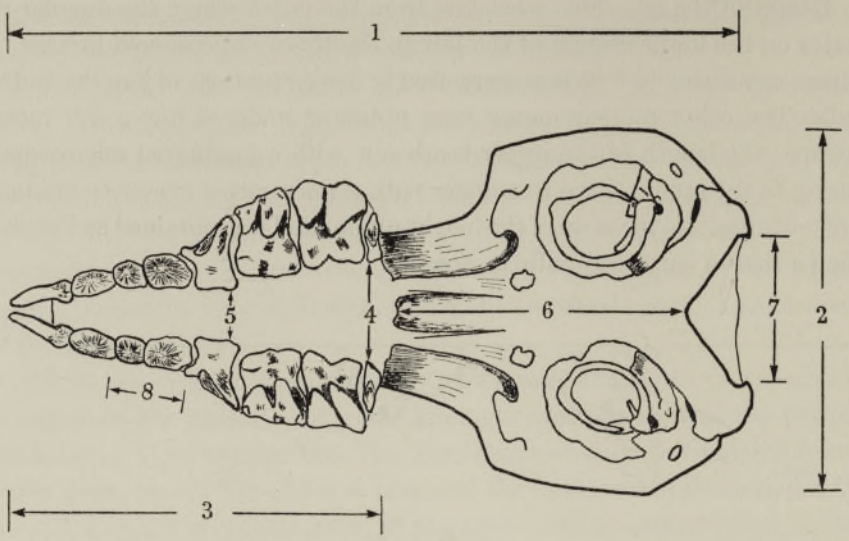

FIGURE 2. Ventral aspect of skull of *Crocidura* showing measurements obtained. 1, Skull length; 2, skull width; 3, upper tooth row; 4, M^3 distance; 5, Pm' distance; 6, distance from hinder margin of palate to foramen magnum; 7, foramen magnum; 8, I^3+C'.

STATISTICAL METHODS

As shrews attain their adult size before leaving the nest (Bishop 1962; Rood 1963). the material examined can be considered to consist of entirely fully grown animals. No age adjustments of the data were therefore necessary.

The means of each measurement at each locality were calculated, and sums of squares and products were pooled within localities. From these, within-locality standard deviations and correlation coefficients were worked out (table 1). From inspection of the means, the localities divided naturally into three groups comprising the Scilly Islands; Jersey and Sark; and Guernsey, Alderney and Cap Gris Nez. Analyses of variance of the individual measurements were calculated, in which the between-locality sum of squares was subdivided to reflect this grouping of the localities. From these analyses, variance components between locality means within groups were calculated. Their square roots (which are analogous to standard deviations) are included in table 1, and allow comparisons to be made of the degree of variability between the locality means within the groups, having due regard to the unequal sample sizes.

Taking the ten measurements simultaneously, canonical variates were evaluated. This technique has been described in our previous paper (Delany & Healy 1964); the first canonical variate is that weighted sum of the measurements which separates the locality means to the greatest possible extent, the second canonical variate has the same property while being restricted to be uncorrelated with the first, and so on. The coefficients of these variates are shown in table 2*a* and the variate means for the ten localities in table 2*b*—these ten points determine a space of only nine dimensions, so the tenth canonical variate gives zero discrimination with all the locality means equal.

TABLE 1. MEASUREMENTS ON *CROCIDURA RUSSULA* HERMANN AND *C. SUAVEOLENS* (PALLAS)

(All measurements are in mm)

a. Means of measurements

	skull length	skull width	upper tooth row	M^3 distance	Pm' distance	palate–F.M.	foramen magnum	I^3+C'	lower tooth row	mandibular height	sample size
Tresco	17·99	8·19	7·70	2·10	1·23	7·80	2·61	1·12	5·38	4·25	144
Bryher	17·89	8·10	7·74	2·02	1·19	7·67	2·63	1·16	5·40	4·21	16
St Agnes	17·95	8·10	7·77	2·03	1·13	7·81	2·56	1·12	5·32	4·24	12
St Martin's	18·06	8·16	7·70	2·09	1·25	7·98	2·74	1·12	5·37	4·31	7
St Mary's	17·93	8·16	7·65	2·07	1·17	7·78	2·61	1·14	5·28	4·22	90
Sark	18·10	8·10	7·84	2·21	1·23	7·71	2·55	1·10	5·43	4·33	25
Jersey	17·65	8·06	7·52	2·18	1·20	7·67	2·67	1·04	5·22	4·25	6
Alderney	19·63	8·97	8·45	2·46	1·26	8·57	3·17	1·42	5·70	4·79	26
Guernsey	19·48	8·70	8·50	2·41	1·29	8·54	3·08	1·37	5·81	4·69	53
Cap Gris Nez	19·98	9·12	8·61	2·42	1·30	8·66	2·98	1·41	5·85	4·87	20
within localities S.D.	0·383	0·231	0·188	0·064	0·062	0·192	0·074	0·049	0·113	0·122	

b. Correlation coefficients within localities

skull length	1·00									
skull width	0·63	1·00								
upper tooth row	0·76	0·36	1·00							
M^3 distance	0·45	0·46	0·21	1·00						
Pm' distance	0·29	0·32	0·09	0·44	1·00					
palate–F.M.	0·78	0·50	0·51	0·43	0·33	1·00				
foramen magnum	0·26	0·11	0·21	0·15	0·20	0·25	1·00			
I^3+C'	0·43	0·24	0·35	0·17	0·11	0·33	0·19	1·00		
lower tooth row	0·70	0·36	0·75	0·22	0·08	0·52	0·22	0·34	1·00	
mandibular height	0·80	0·63	0·60	0·49	0·32	0·65	0·22	0·32	0·59	1·00

c. Square roots of variance components between localities within groups

Scillies	0	0	0·029	0·033	0·040	0·053	0·029	0·014	0·059	0·018
Jersey, Sark	0·289	0	0·214	0	0	0	0·079	0·043	0·145	0·039
Guernsey, Alderney, Cap Griz Nez	0·236	0·220	0·062	0·025	0·018	0·046	0·083	0·033	0·068	0·102

Table 2. Results of canonical analysis

a. Coefficients of canonical variates, standardized to unit s.d. within groups

	I	II	III	IV	V	VI	VII	VIII	IX	X
skull length	1·50	−0·03	−0·86	−0·95	0·68	1·53	1·43	3·25	−5·70	0·58
skull width	−0·64	−1·78	0·49	−1·22	−0·21	1·71	1·00	−4·90	0·40	1·92
upper tooth row	−1·93	0·15	−0·97	−1·27	0·35	−5·31	−2·57	−1·26	3·91	6·27
M^3 distance	−8·14	14·89	−3·60	−3·22	2·96	−3·66	6·54	−1·64	1·22	−2·40
Pm' distance	3·83	−0·62	−3·93	11·22	−2·61	6·64	2·61	5·12	5·74	8·70
palate–F.M.	−0·87	−2·00	2·88	1·30	−4·48	−4·80	2·43	−1·29	2·71	−1·64
foramen magnum	−7·71	0·49	9·37	3·76	3·32	1·83	−3·51	−0·61	−3·44	1·87
I^3+C'	−9·82	−11·09	−5·04	−4·43	7·62	3·30	5·03	6·11	10·18	−5·21
lower tooth row	0·26	0·14	−5·36	8·99	1·61	1·94	−0·19	−5·75	−1·83	−7·18
mandibular height	−0·63	1·66	0·78	−3·14	−5·35	4·03	−9·98	2·82	5·42	−4·60

b. Means of groups, adjusted to zero overall mean

Tresco	2·83	−0·21	−0·31	0·49	−0·12	0·27	0·45	−0·25	0·06	0·00
Bryher	2·88	−1·47	−0·42	0·49	0·98	0·50	−0·35	−0·05	−0·02	0·00
St Agnes	3·39	−1·11	0·03	−0·97	−0·26	−0·98	−0·22	−0·09	0·02	0·00
St Martin's	2·01	−0·52	1·36	1·21	−0·81	0·13	−0·13	0·20	0·02	0·00
St Mary's	2·78	−0·89	0·39	−0·82	0·21	0·04	0·45	0·19	−0·06	0·00
Sark	2·66	2·02	−1·93	−0·05	0·17	−0·09	−0·04	0·20	0·03	0·00
Jersey	2·48	2·41	1·35	−0·38	−0·09	0·21	−0·15	−0·17	−0·05	0·00
Alderney	−7·67	0·12	1·17	−0·85	0·50	0·19	−0·01	0·06	0·06	0·00
Guernsey	−5·86	0·33	−0·15	1·31	0·34	−0·76	0·11	−0·05	−0·04	0·00
Cap Gris Nez	−5·54	−0·66	−1·45	−0·47	−0·91	0·45	−0·11	−0·06	−0·04	0·00
M.S. between groups	176·51	15·00	11·32	6·34	2·97	2·17	0·64	0·23	0·02	0·00
% of total	82	7	5	3	1	1	—	—	—	—

In the coordinates provided by the canonical variates, the distribution of readings at a particular locality has zero correlations and unit standard deviations in all directions. The distances (in nine dimensions) between the points whose coordinates are in table 2*b* are thus straightforward (inverse) measures of the amount of overlap between the corresponding groups, making proper allowance for the correlations and unequal standard deviations of the original measurements. These distances are set out in table 3.

TABLE 3. GENERALIZED DISTANCES IN NINE DIMENSIONS BETWEEN GROUPS

	Tresco	Bryher	St Agnes	St Martin's	St Mary's	Sark	Jersey	Alderney	Guernsey
Bryher	1·88	—							
St Agnes	2·33	2·54	—						
St Martin's	2·26	2·97	3·22	—					
St Mary's	1·74	2·05	1·54	2·68	—				
Sark	2·93	4·00	4·01	4·51	3·84	—			
Jersey	3·30	4·52	4·10	3·46	3·56	3·37	—		
Alderney	10·73	10·89	11·28	10·01	10·54	10·99	10·44	—	
Guernsey	8·83	9·09	9·66	8·20	9·04	9·00	8·96	3·27	
Cap Gris Nez	8·57	8·78	9·21	8·24	8·64	8·74	9·07	2·77	3·00

RESULTS

From the means of the measurements (table 1) the animals from Alderney, Guernsey and Cap Gris Nez (*C. russula*) are larger for every character than those from elsewhere (*C. suaveolens*). Examination of the *C. suaveolens* populations indicates that the Sark and Jersey shrews have on average greater distances between the third upper molars and relatively small third incisors and canines. The raw data for these two characters are illustrated in figure 3 as well as the lengths of the lower tooth rows. Of all the *C. suaveolens* examined, the means length of the upper and lower tooth rows and the skull are largest in the Sark animals and smallest in the Jersey ones. From figure 3 considerable overlap can be seen in the measurements from different populations.

Analyses of variance showed that, apart from the fairly obvious differences between the three groups of localities, highly significant differences often occurred between localities in a particular group. The extent of these differences is illustrated by the variance components in table 1*c*. In general the Scilly Island localities are the most homogeneous.

In the discriminant function analysis (table 2) approximately 82 % of the variance is contained in the first canonical variate, which is mainly influenced by size differences. The first variate clearly separates *C. russula* from *C. suaveolens*. The second variate separates the Sark and Jersey animals from those from the Scillies which form a very close cluster (figure 4). The most interesting feature of the third variate (figure 5) is the separation of Sark and Jersey populations, which are less close together than appears in figure 4. It is of interest that these two populations show very little difference with respect to any other variate. The subsequent canonical

variates did not provide any very marked separation between the island means.

The distance functions based on all nine dimensions (table 3) largely confirm the foregoing. It is, however, interesting to note that the Tresco animals apparently

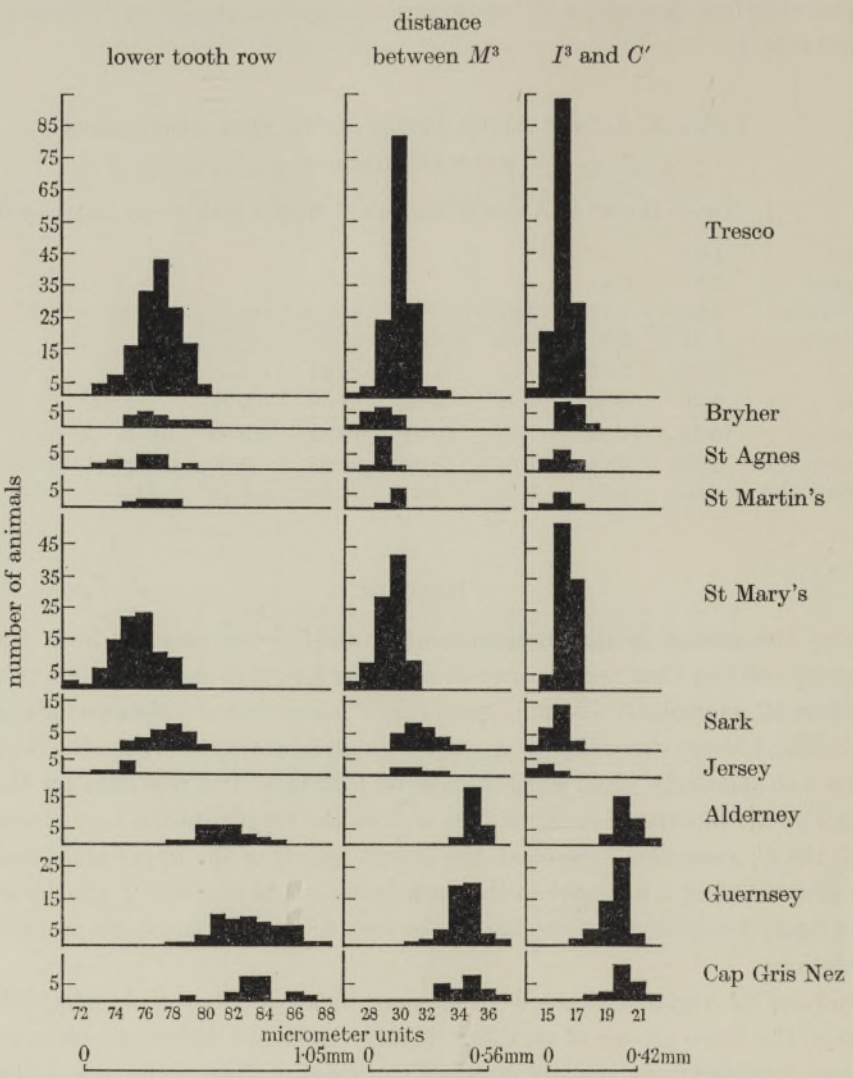

FIGURE 3. Histograms showing measurements on lower tooth row, distance between M^3 and $I^3 + C'$.

show closer similarity to those from Sark and Jersey than the latter do to each other. In addition, the shrews from the five Scilly Isles are more alike than those from Sark and Jersey. The values of the generalized distances between the three populations of *C. russula* are generally higher than those between pairs of Scilly Islands though lower than between any of the Scilly Islands and either Sark or Jersey. This suggests that the three populations of *C. russula* show more differentiation than the five populations of *C. suaveolens* in the Scilly Isles.

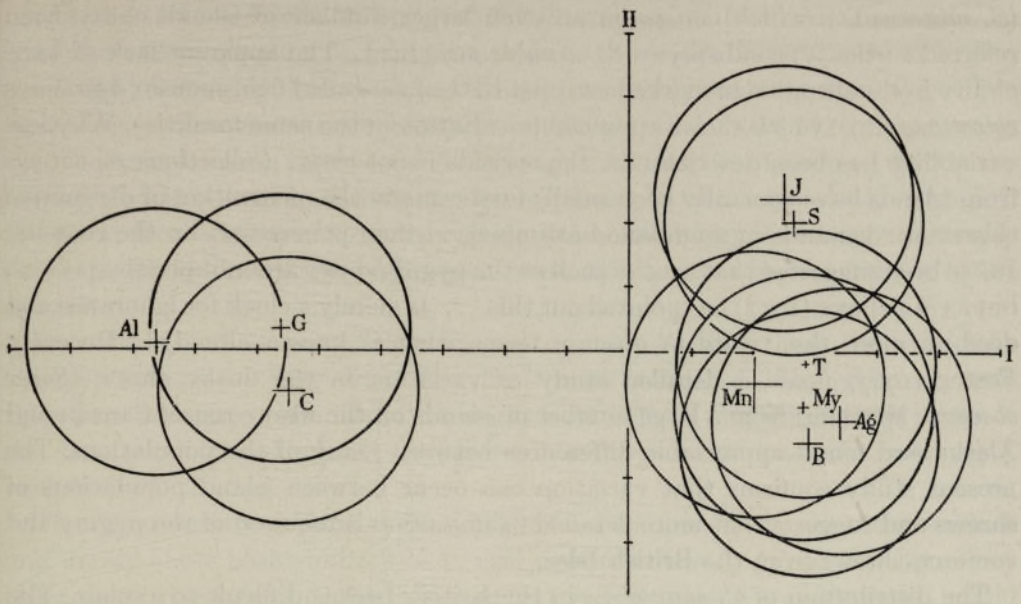

FIGURE 4. Disposition of ten groups of *Crocidura* with respect to the first two canonical variates. The circles are drawn to enclose 90 % of the animals in each group; the bars extend for one standard error on either side of the group means. Ag, St Agnes; Al, Alderney; B, Brhyer; C, Cap Gris Nez; G, Guernsey; J, Jersey; Mn, St Martin's; My, St Mary's; S, Sark; T, Tresco.

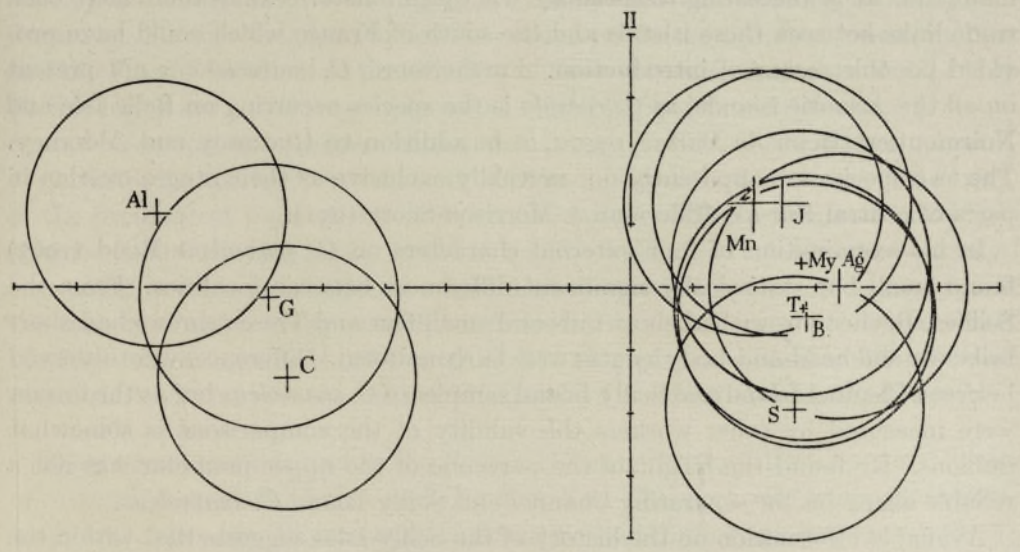

FIGURE 5. Disposition of ten groups of *Crocidura* with respect to the first and third canonical variates. Legends as in figure 4.

DISCUSSION

Few studies have been made on variation in island populations of soricids. In the British Isles, island subspecies of the common shrew (*Sorex araneus* L.) have only been described from Jersey and Islay (Southern 1964) although this species is present on many other islands. All the British specimens of the pygmy shrew

(*S. minutus* L.), which occurs on an even larger number of islands, have been referred to the type subspecies *S. minutus minutus* L. The apparent lack of variability in the shrews is in marked contrast to the long-tailed field-mouse (*Apodemus sylvaticus* (L.)), which shows appreciable variation in the same localities. Why less variability has been described for the soricids is not clear. Collections of shrews from islands have generally been small; furthermore, the recognition of distinctive characters demands more detailed examination than is necessary in the rodents. It has been suggested that species such as the pygmy shrew are 'not plastic species', but as Matthews (1952) has pointed out this '. . .is merely a cloak for ignorance and does no more than state in obscure terms what is known already'. Recently Foster (1963) made a detailed study of variation in the dusky shrew (*Sorex obscurus* Merriam) from a large number of islands off the west coast of Canada and Alaska and found appreciable differences between many of the populations. The present study confirms that variation can occur between island populations of shrews and suggests that more detailed examination is required of the pygmy and common shrews from the British Isles.

The distribution of *C. suaveolens* in the British Isles is difficult to explain. The situation is further complicated by the distribution of this species in France, where it is apparently absent from the mainland in the north but present on the islands of Ouessant and Yeu (Heim de Balzac 1940*b*, 1951; Cranbrook & Crowcroft 1958). Thus, although present on several islands it is invariably absent from the adjacent mainland. It is interesting to speculate whether in historic times there have been trade links between these islands and the south of France which could have provided possible means of introduction. Furthermore, *C. suaveolens* is not present on all the Atlantic islands, as *C. russula* is the species occurring on Belle Isle and Noirmoutier (Heim de Balzac 1940*a*, *b*) in addition to Guernsey and Alderney. The two species are apparently not mutually exclusive as their ranges overlap in parts of central Europe (Ellerman & Morrison-Scott 1951).

In his examination of four external characters on *C. suaveolens* Rood (1963) found small but statistically significant differences between localities. From the Scillies, Bryher shrews had short tails and small feet and Tresco shrews had short tails; ear and head-and-body lengths were fairly uniform. Differences were observed between Channel Island and Scilly Island samples of *C. suaveolens* but as the former were measured by other workers the validity of the comparisons is somewhat dubious. He found the height of the paracone of the upper premolar was not a reliable character for separating Channel and Scilly Island *C. suaveolens*.

Available information on the history of the Scilly Isles suggests that within the last few thousand years they have been appreciably larger and more unified than at present (O'Neil 1961). Numerous archaeological remains which are now partially or completely covered by the sea are mentioned by Dunbar (1958). It is possible at present to see at low tide the stone walls running between Tresco and Samson. Woodley (1822) stated that the flats between Samson, Bryher and Tresco were dry at low tide and a man could easily wade between St Mary's and St Martin's (a feat no longer practicable). This suggests that considerable erosion and subsidence has taken place within as short a time as 150 years. The widespread

distribution of *Crocidura* on both inhabited and uninhabited islands would be consistent with introduction at a time prior to the separation of the islands. The similarity of the populations examined supports the possibility that they have been derived comparatively recently from a single stock. Corbet (1961) suggests that the spread among the islands was through the transport of seaweed used in the kelping industry which thrived in the seventeenth and eighteenth centuries. However, Rood (1963) has recently shown that, although *Crocidura* occasionally occurs in seaweed at about high-water mark, this is not a typical habitat of the animal.

In contrast to the shrews, field-mice only occur on St Mary's and Tresco and the two populations are very dissimilar. Their more restricted distribution suggests they were brought to the islands later than the shrews, while the distinctness of the two populations indicates separate introductions or comparatively rapid evolution.

The situation in the Channel Islands is more complex, as the shrews from Sark and Jersey show both similarities to and dissimilarities from one another. They differ more widely from each other than do the Scilly Island animals and it would appear that, if they were derived from a common stock, they have diverged further. This could have resulted from longer isolation, less-frequent interchange between the populations or different selective pressures. Population densities on the Channel Islands are apparently, inexplicably lower than on the Scilly Isles (Bishop & Delany 1963; Rood 1963); *C. russula* was numerous on Alderney and Guernsey. Further detailed studies are needed on the animals from Ouessant, Yeu and the French mainland as the affinities of these shrews to one another and to the British forms are not clearly understood. Until such work is undertaken it would be unwise to consider further the taxonomic status of the island forms.

The introduction of *C. russula* to the Channel Islands is easier to explain in view of the presence of populations on the mainland of northern France although its absence from Sark and Jersey is not so readily understood. A tentative explanation could be that small islands afford a more restricted range of habitats than the mainland and thereby not offer sufficient diversity of terrain to support two, possibly competing, species of *Crocidura*. The first species to reach an island would establish itself and prevent the establishment of a second species subsequently.

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References

Bishop, I. R. 1962 Studies on the life histories, ecology and systematics of small mammals inhabiting the Channel Islands. Southampton University M.Sc. thesis.

Bishop, I. R. & Delany, M. J. 1963 The ecological distribution of small mammals in the Channel Islands. *Mammalia*, **27**, 99–110.

Corbet, G. B. 1961 Origin of the British insular races of small mammals and of the 'Lusitanian' fauna. *Nature, Lond.* **191**, 1037–1040.

Cranbrook, the Earl of & Crowcroft, P. 1958 The white-toothed shrews of the Channel Islands. *Ann. Mag. Nat. Hist.* (13) **1**, 359–364.

Cranbrook, the Earl of & Crowcroft, P. 1961 Small mammals from Herm Island. *J. Linn. Soc.* (*Zool.*), **44**, 365–368.

Delany, M. J. 1964 Variation in the long-tailed field-mouse (*Apodemus sylvaticus* (L.)) in north-west Scotland. I. Comparisons of individual characters. *Proc. Roy. Soc.* B, **161**, 191–199.

Delany, M. J. & Healy, M. J. R. 1964 Variation in the long-tailed field-mouse (*Apodemus sylvaticus* (L.)) in north-west Scotland. II. Simultaneous examination of all characters. *Proc. Roy. Soc.* B, **161**, 200–207.

Dunbar, J. 1959 *The lost land.* London: Collins.

Ellerman, J. R. & Morrison-Scott, T. C. S. 1951 *Checklist of Palaearctic and Indian mammals.* London: British Museum.

Foster, J. B. 1963 The evolution of the native land mammals of the Queen Charlotte Islands and the problem of insularity. University of British Columbia Ph.D. thesis.

Heim de Balzac, H. 1940*a* Faune mammalienne des îles littorales atlantiques. *C.R. Acad. Sci., Paris*, **211**, 212–214.

Heim de Balzac, H. 1940*b* Peuplement mammalian des îles atlantiques françaises. *C.R Acad. Sci., Paris*, **211**, 296–298.

Heim de Balzac, H. 1951 Peuplement mammalian des îles atlantiques françaises: Ouessant. *C.R. Acad. Sci., Paris*, **233**, 1678–1680.

Hinton, M. A. C. 1924 On a new species of *Crocidura* from Scilly. *Ann. Mag. Nat. Hist.* (9) **14**, 509–510.

Matthews, L. H. 1952 *British mammals.* London: Collins.

Miller, G. S. 1912 *Catalogue of the mammals of western Europe.* London: British Museum.

Montagu, I. G. S. & Pickford, G. 1923 On the Guernsey *Crocidura*. *Proc. Zool. Soc. Lond.* 1043–1044.

Morrison-Scott, T. C. S. 1937 A note on the distribution of the two shrews found in Jersey. *J. Anim. Ecol.* 6, 284–285.

O'Neil, B. H. St J. 1961 *Ancient monuments of the Isles of Scilly*, 2nd ed. London: H.M.S.O

Pucek, Z. 1964 Seasonal changes in the braincase of some representatives of the genus *Sorex* from the Palaearctic. *J. Mammal.* **44**, 523–536.

Rood, J. P. 1963 Ecological studies on the small mammals of the Isles of Scilly. Southampton University Ph.D. thesis.

Southern, H. N. (ed.) 1964 *The handbook of British mammals.* Oxford: Blackwell.

Spencer-Booth, Y. S. 1956 Shrews (*Crocidura cassiteridum*) on the Scilly Isles. *Proc. Zool. Soc. Lond.* **126**, 167–170.

Woodley, G. 1822 *A view of the present state of the Scilly Islands.* London: Rivington.