Preliminary analysis of a contact zone between karyotypic races of the common shrew (Sorex araneus) in Scotland

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Preliminary analysis of a contact zone between karyotypic races of the common shrew (*Sorex araneus*) in Scotland[1]

BY

S.J. MERCER and J.B. SEARLE[2]

Summary.–MERCER S.J. and SEARLE J.B., 1991. Preliminary analysis of a contact zone between karyotypic races of the common shrew (*Sorex araneus*) in Scotland. *In*: J. HAUSSER, ed. The cytogenetics of the *Sorex araneus* group and related topics. Proceedings of the ISACC's Second International Meeting. *Mém. Soc. vaud. Sc. nat. 19.1*: 73-78.

The Oxford and Aberdeen karyotypic races of the common shrew are characterised by the metacentric arm combinations *kq*, *no*, *pr* and *ko*, *np*, *qr* respectively. These races are parapatric in central Scotland, and to analyse the presumptive contact zone, we karyotyped 59 animals from 11 sites within 40 km of the city of Stirling. To the east of the region sampled, we collected monomorphic Aberdeen and Oxford race samples within 8.5 km of each other. To the west, two sites revealed Robertsonian polymorphism such that the Oxford race arm combinations were found in both metacentric and twin-acrocentric form. This suggests that a hybrid zone similar to that found between the Oxford and Hermitage races in southern England may occur in this region, whilst to the east, there may be a different type of contact zone, or a geographic barrier between the two races.

Résumé.–MERCER S.J. et SEARLE J.B., 1991. Analyse préliminaire d'une zone de contact entre races chromosomiques de la musaraigne carrelet (*Sorex araneus*) en Ecosse. *In*: J. HAUSSER, dir. The cytogenetics of the *Sorex araneus* group and related topics. Proceedings of the ISACC's Second International Meeting. *Mém. Soc. vaud. Sc. nat. 19.1*: 73-78.

Les races chromosomiques Oxford et Aberdeen de la musaraigne carrelet sont respectivement caractérisées par les combinaisons métacentriques *kq*, *no*, *pr* et *ko*, *np*, *qr*. Ces races sont parapatriques dans le centre de l'Ecosse. 59 animaux provenant de 11

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localités situées dans un rayon de 40 km autours de Stirling ont été caryotypés dans le but d'analyser la zone de contact. A l'est de la région prospectée, des échantillons monomorphes des races Aberdeen et Oxford ont été récoltés à moins de 8.5 km l'un de l'autre. A l'ouest, dans deux localités, les combinaisons de type Oxford montrent un polymorphisme, chacune d'entre elles pouvant être présent sous forme de métacentriques ou d'acrocentriques. Ceci suggère l'existence, à l'ouest de la région, d'une zone hybride similaire à celle trouvée dans le sud de l'Angleterre entre les races Oxford et Hermitage, alors qu'à l'est on aurait soit un type de contact différent, soit une séparation géographique entre les deux races.

INTRODUCTION

The complex karyotypic variation in the common shrew (*Sorex araneus*) has been the subject of much study. This variation has arisen as the result of a series of Robertsonian fusion mutations, each characterised by the fusion of a certain pair of single-armed (acrocentric) chromosomes to form a double-armed (metacentric) chromosome. Different acrocentric chromosomes have fused in different parts of the range of the common shrew, with the result that different metacentrics characterise different populations, and the species is divided into a number of "karyotypic races" on this basis. Three of these are recognised in Britain, each named after the type locality (SEARLE 1984b). The Aberdeen race is found in northern Scotland, Anglesey, southwest Wales, southwest England and the Isle of Wight (SEARLE 1988). It is distinguished by the presence of the metacentrics *ko* and *np* (nomenclature of FREDGA and NAWRIN 1977). The Oxford race occupies the south and east of Britain, and is characterised by the metacentrics *kq* and *no*. The Hermitage race occurs in a region intermediate between the other two races in the south of Britain, and possesses the metacentric *ko*. Each of these basic racial types is found with regional variations, the metacentrics *pr* and *qr* also present in some areas, as well as the acrocentrics *k*, *n*, *o*, *p*, *q*, and *r*. In addition, the metacentric *jl* is found to exhibit a low level of polymorphism, with a slightly higher frequency of the twin-acrocentric state in the south.

At the interfaces between races, a complex of chromosomal clines marks the change from one karyotype to the other. In some cases, there may be the presence of acrocentric chromosomes within the zone not found in either pure racial type, as with the hybrid zone between the Oxford and Hermitage races (SEARLE 1986). The presence of such acrocentrics reduces the frequency of "complex" heterozygotes which are expected to form long chains or rings at prophase I of meiosis and to suffer from a degree of infertility (MERCER *et al.* 1991).

Although the Oxford–Hermitage hybrid zone has been thoroughly studied and there is some information on the Hermitage–Aberdeen hybrid zone (SEARLE 1988, J.B. SEARLE and A.J. REILLY, unpublished data), nothing is known of the zone between the Oxford and Aberdeen races, which is expected in central Scotland (SEARLE 1988). Each race possesses three fusions not found in the other, the Oxford race with *kq*, *no*, and *pr* in this area, whilst the Aberdeen race has *ko*, *np*, and *qr*. Hybrids between these races have been generated in captivity (SEARLE, 1984a), and are expected to form a ring VI configuration at prophase I of meiosis. The study of the Oxford–Aberdeen contact zone provides an interesting contrast to the Oxford–Hermitage hybrid zone.

MATERIAL AND METHODS

Animals were collected in unbaited Longworth traps (CHITTY and KEMPSON 1949), checked at frequent intervals. All captures were fed and housed in the manner of SEARLE (1983) overnight, and sacrificed the following day. Mitotic preparations were made from bone marrow by the air-drying method of FORD (1966). Slides were aged and G-banded using the technique of SEARLE (1986), and microscopically examined at 1000 x magnification under oil immersion. A minimum of five complete banded spreads were scored for each individual before the karyotype was recorded.

RESULTS

A total of 59 animals were collected from eleven sites in central Scotland (Fig. 1), and the frequency of each metacentric chromosome at all sites is presented in table 1. The majority of sites were found to be of one or other pure racial type, with two main areas of interest outlined below.

Polymorphism was only found in two sites, both to southeast of Loch Lomond (Fig. 1): Dalmary and Drymen. All the Oxford race arm comb-

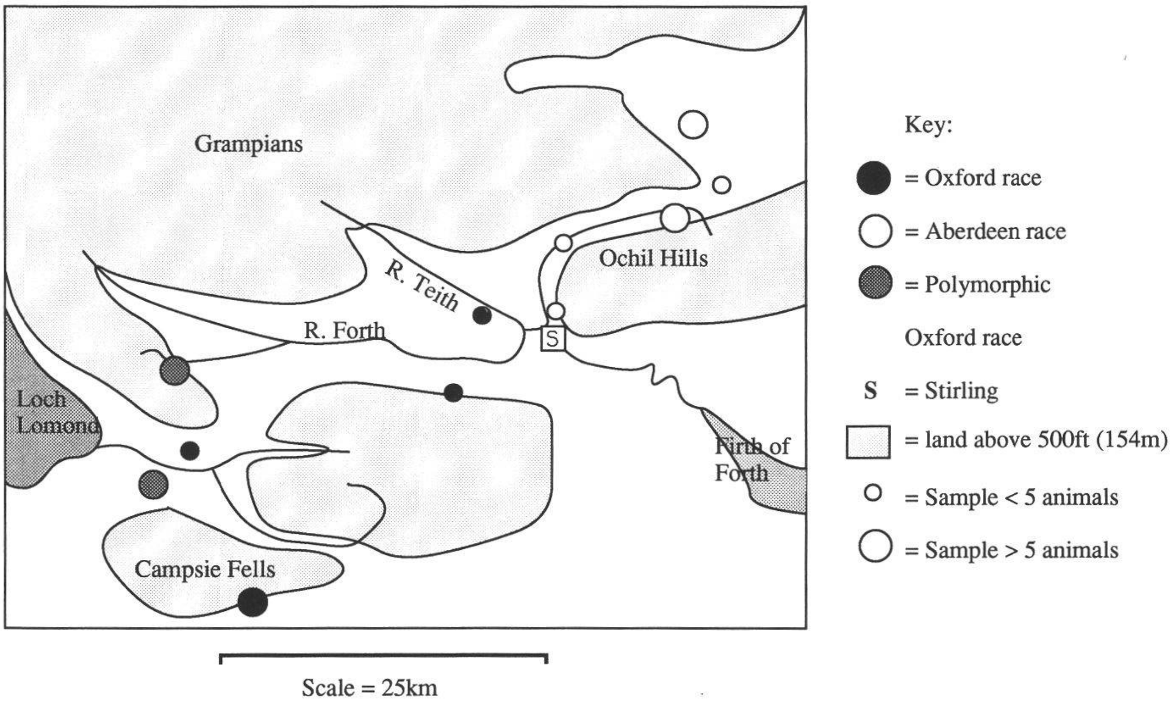

Figure 1.–The contact zone between the Oxford and Aberdeen races in central Scotland.

inations (*kq*, *no*, *pr*) were present in both a metacentric and twin–acrocentric state in Dalmary, and one individual was a triple heterozygote. It is probable that Dalmary and Drymen are located at the southern edge of an area of polymorphism surrounding the putative Oxford–Aberdeen hybrid zone, akin to that found in association with the Oxford–Hermitage hybrid zone in southern Britain.

Further east, in the immediate vicinity of Stirling (Fig. 1), we have found both the Oxford and Aberdeen races. The distance between the nearest Aberdeen and Oxford race sites, of Stirling and Doune respectively, is approximately 8.5 km. No polymorphism is found in this region, indicating that if there is a hybrid zone here, it is extremely narrow. It is possible that the inter-racial boundary coincides with a river such as the Teith or the Forth, to the northwest and southwest of Stirling respectively, but neither is sufficiently large to serve as a complete barrier to dispersal. Nonetheless, it seems that the degree of introgression of either set of race-specific metacentrics is negligible in this region.

Table 1.–Trapsites in central Scotland.

Site	Grid reference[1]	No Animals	Frequency of metacentrics *jl*	*ko*	*np*	*qr*	*kq*	*no*	*pr*	Race
Drymen	NS 468,853	5	1	0	0	0	0.9	1	0.9	Oxford
Dalmary	NS 510,946	7	1	0	0	0	0.86	0.79	0.86	Oxford
Killearn	NS 518,885	1	1	0	0	0	1	1	1	Oxford
Blairskaith	NS 586,757	5	1	0	0	0	1	1	1	Oxford
Kippen	NS 650,920	3	1	0	0	0	1	1	1	Oxford
Doune	NS 730,978	4	1	0	0	0	1	1	1	Oxford
Stirling	NS 812,961	4	1	1	1	1	0	0	0	Aberdeen
Greenloaning	NN 818,058	4	1	1	1	1	0	0	0	Aberdeen
Blackford	NN 885,085	7	1	1	1	1	0	0	0	Aberdeen
Gleneagles	NN 904,113	4	1	1	1	1	0	0	0	Aberdeen
Muthill[2]	NN 910,180	15	1	1	1	1	0	0	0	Aberdeen

1: References from the Ordnance survey Landranger series maps, 1:50,000 scale
2: J.B. Searle and J.M. Wójcik, unpublished data

DISCUSSION

From our findings here, taken together with previous data for Scotland, (SEARLE 1984b, FORD and GRAHAM 1964, FORD and HAMERTON 1970, J.B. SEARLE and JM WÓJCIK, unpublished data) we can now tentatively sketch the course of the Oxford–Aberdeen contact zone. The zone appears to follow low ground in the east from the region of Stirling northwestwards, probably along the valley of the river Teith. The zone then crosses the southern part of the Grampian mountains until it reaches the coast at some point between the sites of Dunstaffnage near Oban (on the mainland, opposite the island of Mull), and Balmacara, near Kyle of Lochalsh (opposite Skye). A number of the more southerly of the Scottish islands have been sampled (FORD and GRAHAM 1964, J.B. SEARLE and J.M. WÓJCIK, unpublished data), and are assigned to the Oxford race. It is interesting to note that polymorphism for the metacentric *pr* is found on the island of Islay.

The polymorphism observed at the sites of Drymen and Dalmary suggests a hybrid zone structure similar to that of the Oxford–Hermitage hybrid zone, at least for part of the region of contact between the Oxford and Aberdeen races. All the variable chromosome arms *k*, *n*, *o*, *p*, *q*, and *r* are found in an acrocentric state at Dalmary, despite the apparent lack of polymorphism within the main distribution of either bordering race (SEARLE, 1984b). This suggests an "acrocentric peak" similar to that involving the acrocentrics *k* and *o* in the zone between the Oxford and Hermitage races (SEARLE 1986). Presumably in the putative Oxford–Aberdeen hybrid zone, individuals with a substantially acrocentric karyotype are favoured over those with a hybrid karyotype involving several metacentrics with monobrachial homology, with the latter expected to suffer reduced fitness due to meiotic irregularities (MERCER *et al.* 1991).

We have documented in more detail the contact between the Oxford and the Aberdeen races to the east, in the region of Stirling. Here, there is no apparent polymorphism, and although sample sizes are small, our data indicate that there may be less than 8.5 km between sites of the two monomorphic races. This contrasts with an area of polymorphism approximately 100 km in width for the Oxford - Hermitage hybrid zone. The region between the sites of Doune (Oxford race) and Stirling (Aberdeen race) is level fertile agricultural land, with no obvious barriers to dispersal, except for small rivers. It may be, however, that the contact between races in this region is relatively recent, occurring only in historic times with the drainage of the lowland mires, an unfavourable habitat for the common shrew (YALDEN 1982). In this case, it may be that introgression of metacentrics and the formation of a hybrid zone in this region is just beginning, and more work on this zone is required to determine this.

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