Institution: Anglia Ruskin University

Unit of Assessment: 5 Biological Sciences

Title of case study:

The black squirrel: enhancing public understanding and engagement in science

1. Summary of the impact (indicative maximum 100 words)

Two areas of impact are described:

(i) Impact associated with increased national and international public understanding of science via extensive national and international media coverage and the development of an interactive website (www.blacksquirrelproject.org), designed to engage members of the public and to explain genetic concepts. Media exposure has reached an estimated 45 million people in the UK alone.

(ii) Impact associated with increased public participation in science ('citizen science') by seeking the involvement of the public to use the interactive website to report on squirrel populations, thus providing a research tool to generate data and to inform the public.

2. Underpinning research (indicative maximum 500 words)

The underpinning research for this case study concerns the biochemical and genetic basis of melanism in the grey squirrel (*Sciurus carolinensis*), which was introduced into Great Britain from North America in the late nineteenth century. Melanic (black) variants of the grey squirrel are common in their native habitat, but the first sighting reported in Britain was in the early twentieth century. These black squirrels, now a common sight in Bedfordshire, Cambridgeshire, and Hertfordshire, live in mixed populations with the grey squirrels.

This programme of work was initiated at Anglia Ruskin University (ARU) in 2005 by Dr Alison Thomas (Senior Lecturer 1996-present) and Dr Sheila Pankhurst (Principal Lecturer 1996-present), and was continued by Helen McRobie (Senior Lecturer 2010-present, and previously a PhD student at ARU, supervised by Thomas). These authors hypothesised that the melanocortin 1 receptor (MC1R) was a likely candidate for differences in pigmentation. They went on to sequence the *extension* locus (*E*), which encodes MC1R, in black, grey and brown-black squirrel sub-populations, identifying a 24 base pair deletion that correlated with a melanic phenotype, and proving their theory. They also showed that this genetic difference is incompletely dominant. Homozygous wildtype ($E^{+/+}$) squirrels are grey, whilst homozygous mutant ($E^{B/B}$) squirrels are black and heterozygotes ($E^{+/B}$) are brown-black. Research on the MC1R was extended to characterise, structurally and pharmacologically, the wildtype and mutant versions of the receptor.

Further work aimed to establish whether the origin of this variant of the black squirrel was in Britain. Samples of melanic grey squirrel DNA were obtained from Britain and North America and the gene sequences compared, to establish if E^{B} was a novel mutation indigenous to the British Isles or whether the melanic variant had been introduced from North America as well. This study proved the latter. Research on melanism in squirrels was subsequently extended to two other species, the North American fox squirrel and Eurasian red squirrel (in collaboration, respectively, with Dr Nancy Moncrief from Virginia Natural History Museum in the USA, and Dr Cristina Fanutti from the University of East Anglia). Unlike the grey squirrel, no association between sequence variation in the MC1R and melanism was found in these two species. This work has recently been submitted for publication in the *Journal of Heredity*.

To complement the molecular data analysis, a 'citizen science' project was established to monitor the spread of the black squirrel across the British Isles. A public-access website was established by McRobie in 2011 ("The Black Squirrel Project") to enable members of the public to record sightings of black, grey and red squirrels on an electronic map of the British Isles. The website was

launched by McRobie in 2012 on BBC1's "The One Show", in collaboration with the NERC/Defra Biological Records Centre. Subsequent extensive national media coverage has publicised the website and encouraged public participation. By this means, the researchers have generated data that documents the spread of the black squirrel in the British Isles. Once finalised, these data will be submitted for publication in an academic journal.

3. References to the research (indicative maximum of six references)

1. McRobie, H., Thomas, A., Kelly, J., 2009. The genetic basis of melanism in the gray squirrel (*Sciurus carolinensis*). *Journal of Heredity*, 100 (6), pp.709-714.
doi: 10.1093/jhered/esp059

This reference is to a paper published in an internationally recognised journal that has a rigorous peer-review process.

4. Details of the impact (indicative maximum 750 words)

The impact from this work is divided into two areas:
i) enhancement of the public understanding of genetics and stimulation of public debate
ii) increased public participation in science.

The main beneficiaries of this research are members of the public, with school-age children in particular being targeted.

i) Enhancing the public understanding of genetics
The grey squirrel is a controversial and a charismatic species which is familiar to the general public. The underlying genetics revealed by the research is a new "text book" case of incomplete dominance, and has proved to be an interesting and accessible example for the public to understand. Indeed this example has been used in a recently published undergraduate genetics text book written by Thomas [6].

This research has been followed enthusiastically by the media, locally and nationally. This began with the publication of an article by Thomas in a local wildlife magazine in 2005 [7], while subsequent press releases issued by ARU in April 2008 and January 2012 led to renewed and significant media interest in the findings.

McRobie was first invited to appear in BBC1's 'The One Show' in 2008 to explain the genetic basis of melanism in squirrels, and has since featured in numerous television and radio broadcasts explaining genetics to a wide audience [1, 2]. Television appearances include BBC1's 'Countryfile' (22/03/09 and 13/01/12, approximately 7 million viewers each), 'The One Show' (14/05/08, 30/01/12 and 05/03/13, approximately 5 million viewers each), 'Inside Out' (21/01/09) and 'Breakfast' programme (15/10/10). McRobie was also interviewed for BBC Radio 4's 'Shared Earth' and 'Material World' programmes (03/03/11). Local television and radio interviews have included BBC1's 'Look East' and ITV's 'Anglia News' (four appearances each, 2008-2013) and 'Gulf Radio Services', broadcasting to armed forces in the Persian Gulf (27 and 29/02/12).

Coverage of the research has also appeared in the national press including *The Times* (26/4/08 and 31/01/12), The *Sunday Times* (27/4/08), The *Daily Express* (26/4/08), The *Daily Telegraph* (26/4/08 and 31/1/12), The *Daily Mail* (26/4/08 and 01/02/12), and *The Week* (11/02/12). Finally, many national and international websites (including American, Russian, Romanian and Indian websites) have included articles on the genetics of the black squirrels [8].

Combined media exposure across these sources has reached several million people [1, 2], with an estimated 45 million individual viewings (some of these will be repeat viewings by the same people), contributing to a wider understanding of genetic concepts. This exposure has also publicised the project website at www.blacksquirrelproject.org [3] which contains accessible explanations of the genetics and underlying molecular biology of squirrel hair pigmentation.

Additionally, the media exposure has engaged and stimulated debate with the public, which can be seen from the numerous independent websites with discussion forums and blogs that follow black squirrel work [9]. Many of these reference ARU and www.blacksquirrelproject.org.

The public understanding of genetics has been further enhanced by outreach work, such as exhibitions and talks. McRobie has curated exhibitions for the Cambridge Natural History Society's (CNHS) Conversazione (12-14/06/09) [4] and the University of Cambridge's Science Festival (14-27/03/11) [5]. McRobie has also given invited talks on the genetics of black squirrels to local wildlife groups: for example, CNHS (11/09) [4] and Ely's Natural History Society (2009).

An important strand of the impact has been specifically on schoolchildren, whose engagement with and understanding of genetics has been enhanced. This was initiated in 2008 with Thomas's article for *Biological Sciences Review* [10], a magazine aimed at sixth formers. McRobie has also become active in presenting the fundamentals of genetics to schoolchildren. She appeared on BBC1's children's programme 'Newsround' where she was interviewed by children on the genetics of black and grey squirrels (08/10/10). She also spoke at primary schools during Science Week in Cambridge (18/03/09 and 17/03/10) and delivered a lecture to secondary school pupils at an event hosted by Cambridge University as part of the 'Aimhigher' initiative (04/03/09). Her appearance on 'The One Show' (2012), as discussed above, was also the starting point for a genetics lesson at Comberton Village College, Cambridgeshire for 12 year olds (2012).

(ii) Public participation in science

The Black Squirrel Project, launched on BBC1's 'The One Show' [1], has been widely advertised through television, radio, newspaper, magazine and internet coverage. The website for the project, www.blacksquirrelproject.org [3], was created firstly to inform members of the public about the genetics of melanism in squirrels, and secondly, to enable members of the public to record and comment on sightings of black, grey and red squirrels in the British Isles.

The website is an interactive, public-access tool for data generation on squirrel sub-population dynamics and also provides the public with accessible information. The website has received approximately 140,000 visits and more than 5,600 squirrel sightings have been recorded. In addition, more than 300 emails have been received via the website, including some from members of the public in the USA, Germany and France [3]. This demonstrates the public participation and impact achieved by this research, across a wide range of age groups and communities both nationally and internationally.

5. Sources to corroborate the impact (indicative maximum of 10 references)

[1] Series Producer, 'The One Show' (BBC One)

[2] Researcher, 'Countryfile' (BBC One)

[3] Managing Director, Cambridge IT Consultants Ltd (website developer for the public-access website, www.blacksquirrelproject.org)

[4] Vice-President, Cambridge Natural History Society

[5] Science Festival Co-ordinator, University of Cambridge

[6] Thomas, A., 2013. *Thrive in Genetics*. Oxford: Oxford University Press, p.39. Available from HEI on request.

[7] Thomas, A. and Pankhurst, S. 2005. The Black Squirrels of Cambridgeshire. *Nature in Cambridgeshire*, 46: 61. Available from HEI on request.

[8] List of national and international websites corroborating the impact:
http://www.bbc.co.uk/nature/16789326
http://www.bbc.co.uk/news/uk-16829257
http://www.bbc.co.uk/news/magazine-11444893
http://www.countryfile.com/news/britains-unknown-fourth-squirrel-brunette
http://wildmaryland101.blogspot.co.uk/2013/03/maryland-weird-and-wonderful-melanistic.html
http://lenta.ru/news/2008/04/28/squirrels/
http://www.szabadsag.ro/szabadsag/servlet/szabadsag/template/article,PArticleScreen.vm/id/69722
http://www.thehindu.com/todays-paper/tp-national/cracking-the-mystery-of-colour-change-in-animals/article3301655.ece

[9] List of independent websites with discussion forums and blogs that follow black squirrel work
http://www.wildaboutbritain.co.uk/forums/mammal-forums/2851-black-squirrels.html
http://www.woodlands.co.uk/blog/flora-and-fauna/the-black-squirrel-project/
http://www.pestcontrolsupplies.co.uk/blog/the-search-for-black-squirrels-a434
http://www.wildaboutbritain.co.uk/forums/mammal-forums/31657-black-squirrel-3.html
http://blog.jojomamanbebe.co.uk/index.php/join-the-search-for-the-black-squirrel/
http://ecocentrus.co.uk/blog/black-squirrels
http://worldsoffascination.blogspot.co.uk/2012/02/uk-invasive-species-war-of-grey-and.html
http://www.sffchronicles.co.uk/forum/48752-black-squirrels-peril-2-the-grey.html
http://stanleykemp.blogspot.co.uk/2009/01/black-squirrels-are-in-uk-with.html

[10] Thomas, A. 2008. Black Squirrels. *Biological Sciences Review* 21 (2): 39-41. Available from HEI on request.