Alderney's Blonde Hedgehogs

A Report By

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We would firstly like to send a big thank you to all the citizen science volunteers who took part in our 2021 surveys. Without your efforts our independently run study would not have been possible.

The following report will not only explain the 2021 surveys more fully, but also review the work carried out on Alderney's hedgehogs by other researchers, highlight some of the questions arising from these collective studies, and outline some of our exciting future research.

Why study Alderney's hedgehogs?

The quick answer is that the population is isolated, and so lends itself to study, as compared to one on a larger land mass. Indeed, island populations of fauna and flora are researched around the world due to the infrequent, or lack of, incomers, and so, offer themselves to more manageable ecological, behavioural, and genetic investigation.

Why is there so much interest in Alderney hedgehogs?

People who live on Alderney will come across them regularly in the hours after dark, either walking around the wilder areas, or on the golf course, campsite, running along the roads, or in their gardens.

Further, coming across brown or blonde hedgehogs, when out and about, seems quite normal to Alderney residents, however, it is not to the outside world.

Blonde hedgehogs are extremely uncommon throughout the geographic range of the species. Indeed, in the UK there has only been seven reports, from various hedgehog hospitals, of blonde individuals between 2008 and 2021. So, the high number of blondes on Alderney is extraordinarily rare*.

> **There are only two known populations of blonde hedgehogs in the world, both in the UK, one on Alderney, and the other is on North Ronaldsay in Scotland.*
>
> *No other high numbers of blonde hedgehogs in one population is known to exist.*

Picture of a single blonde hedgehog recently found in Wiltshire UK in 2021

The brown and blonde hedgehogs of Alderney

L **Photo Alderney Suzy Weir and Karen Hill (2019)**

The European hedgehog's scientific name is Erinaceus europaeus. Palaeontologists explain that they evolved around 15 million years ago, and are one of the oldest species of mammals on the planet (in comparison, humans evolved around 300,000 years ago), and its geographic range stretches from the UK and Eire into Europe, and Scandinavia. The animal's normal colour is described as brown, and is referred to as the **wildtype** of the species, meaning that it is the typical colour. Any other phenotype (observable characteristic) is a genetic mutation from that wildtype, and so blonde animals have a genetic mutation that suppresses the production of pigmentation. This mutation is called **leucism**, from the Greek leukos meaning white.

The only other animal that has been reported to have high numbers of blonde individuals in the population is the black bear (Ursus americanus) of British Columbia, and are known as the Kermode bear (Ursus americanus kermodei), although native Canadians prefer to call them Spirit bears. These cute bears have a prominent place in the oral traditions of the indigenous people of the area.

Black bear with cubs (one Spirit bear cub) in British Columbia

So, as the hedgehogs of Alderney are an island population with such high numbers of blonde animals, they are an ideal subject for research, due to their accessibility, and the extreme rarity of the blonde population.

How did hedgehogs arrive on Alderney?

The anecdotal evidence has been described by others. To summarise:

In his book of 1974 Coysh noted that G A Martin remarked that there were no hedgehogs on the island in the 1800s.

In the early 1900's Iris Godfery (b. 1910), mentioned that she remembered seeing hedgehogs as a child in the 1920s. Also, another record suggests that Mr Osleton (senior) supplied hedgehogs for food to a regiment before 1917 (some reports suggest that the regiment was Welsh, however when referring this story to Trevor Davenport (Alderney's local military historian) he said that there were a number of regiments stationed on the island between those dates: from 1910 to 1913 The Royal Irish Regiment, from 1913 to 1914 the Yorkshire Regiment (The Green Howards), from 1914 to 1916 The North Staffordshire Regiment. Between 1916 to 1917 The Royal Alderney Militia, The North Lancaster Regiment in 1919 and The Royal Irish Regiment in 1920). The records mention that Mr Osleton (senior) left the island during WW1 and when he came back he remarked that there weren't any hedgehogs left. Further, his son, who was on Alderney during WW11, pointed out that there were no hedgehogs on the island during that period (1939-1945).

So, according to accounts, hedgehogs were reintroduced in the 1960s. Two pairs being brought to the island from the UK, with one pair having been purchased from Harrods. We can confirm that account as we have managed to track down the person who, as a young boy, caught and sold the hedgehogs to Harrods, who, on discussion, confirmed that he never saw any blonde individuals. Unfortunately, we don't know where on the mainland of the UK the other pair came from. Another pair is understood to have been sourced from Guernsey. So, it seems, from this information, that hedgehogs were brought to the island in the early 1900s, disappeared by the end of WW1, and were reintroduced in the 1960s.

As mentioned above, these are anecdotal reports, and although the importing of 3 pairs of hedgehogs likely happened, the existence of a hidden, relic population on the island cannot be ruled out.

That being said, our working hypothesis is that six brown animals were imported and that the blondes immerged from this founder population.

The difference between leucistic and albino hedgehogs.

Photo: Suzy Weir and Karen Hill Alderney July 2019

This very rare picture is of a leucistic (right) and albino (left) hedgehog.

These two phenotypic (observable characteristics) outcomes are produced by different genetic mutations. As can be seen from the photo, the leucistic animal has dark eyes, and the albino has red eyes (the difference in eye colour is the way to tell the specific mutation, and is the general rule throughout the animal kingdom).

Young Alderney albino hedgehog Matt Scragg Aug 2021

We can also confirm that albinism, a fully recessive gene condition, is still on the island, albeit in low frequency, as the two pictures, the adult from 2019, and the hoglet from 2021, prove.

What effect has leucism have on the individual animal?

This mutation clearly causes the absence of colour in the spines and hair. This lack of pigment extends to the skin too. One of the genes that mutate to cause this trait is a developmental control gene of the embryo. In fact, it not only controls that development of cells called melanocytes (these are the cells within which pigment is produced), but can, but not always, inhibit the development of other cells such as sensory and gut nerves. Two of the possible outcomes can be hearing and/or intestinal problems.

Although there are many human, and some other mammalian studies that have been carried out investigating the pathologies caused by this mutation, there are none for hedgehogs, and so how, and if, this mutation effects the growing leucistic hedgehog embryo in other ways except colour is presently unknown*.

**There is some more information about the genes that can cause leucism at the end of this report.*

A leucistic whale

A leucistic human

A leucistic squirrel

Previous hedgehog studies on Alderney

The only scientific publication on the Alderney hedgehogs is a survey in 1993 when student Allison Tutt and her supervisor Dr Pat Morris looked at the proportions of brown to blonde hedgehogs.

The paper is entitled: Leucistic hedgehogs on the island of Alderney, published in the Journal of Zoology (volume 239, pp 387-389 1996), where they reported that the proportions of 75% brown/25% blonde.

This paper is based on Allison Tutt's full report that was kindly lent to us by Barbara Head, who assisted them with their field work.

Another study, that followed the same method used by the above work, was carried out by Rebecca Brown for her University of Southampton MSc thesis (2008). She concluded that proportions were 30% brown/70% blonde hedgehogs.

Our commentary

After checking these studies, we found that there was a significant problem with the data. Both mentioned that some of the individuals were characterised as intermediates. However, there was no description, and no pictures, (Tutt and Morris characterised **all intermediates as brown**, i.e. 20 out of the total of 67 individuals counted were reported as intermediates, and so that 17 out of 67 counted were considered blonde).

In the other study, **all intermediates were considered blonde**, and they concluded that 74% were blonde (i.e. 40 out of 54 total counted were blonde).

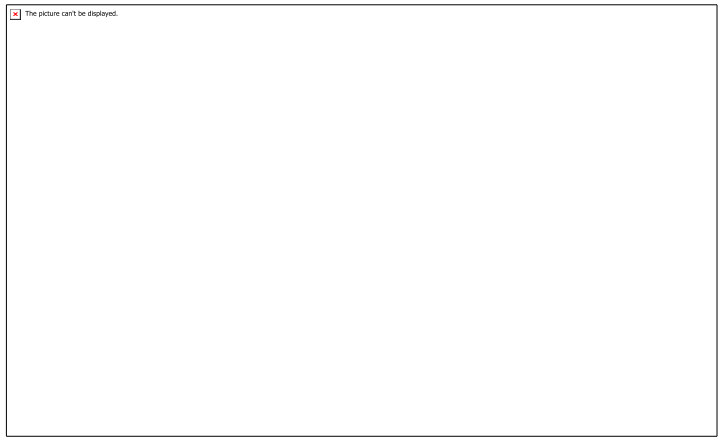
Both results are therefore problematic.

We have been in communication with Dr Morris and the supervisor for the M.Sc. student Rebecca Brown, but unfortunately, both couldn't help us with the intermediate description problem. We have therefore concluded that the brown/blonde proportions suggested in both these studies cannot be critically investigated.

Indeed, as a follow up, we asked our 2021 volunteers to let us know if they could not identify a hedgehog as brown or blonde, but we didn't receive any such reports. Furthermore, during July to early September 2021, we went out regularly to work with the hedgehogs, and we concluded that all the blondes we found were clearly blonde. Which suggests that present day identifiable intermediates are rare.

Also, in our view, it is unlikely that between the 1996 and 2008 counts the proportion of blondes went from 25% to 74%.

Population density and size.



1 Hectare is bigger than a football pitch.

It is generally recognised that counting animals to estimate population size is fraught with difficulty. However, there are accepted methods that can be employed.

Tutt and Morris's used the transect method. This is done by counting hedgehogs along a number of defined transects (routes) a number of times, and at the same time identifying the vegetation types where the animals were found. Then the island's total hectarage of each vegetation type is calculated. Combining these data, the density of animals on the island, i.e. hedgehogs per hectare (ha), is evaluated.

In Tutt and Morris's case they found that the minimum animal per hectare to be 0.42/ha and the maximum to be 1.83/ha, and from these figures they calculated the overall population size by multiplying 546 ha (their figure of the total area of grassland, woodland, and residential on the island) by both 0.42 and 1.83, and reported the estimated population between 299 and 999 hedgehogs.

The same method, and transects, was used by Rebecca Brown. She concluded the hedgehog density to be a minimum of 0.88/ha to a maximum of 9.47/ha, and then based the population size on four vegetation types (described as maritime grassland, rough grassland, short grassland, and residential/runway), with a density average of 3.67/hectare. That is much higher than Tutt and Morris maximum, and the geographic areas chosen were different. Based on that she concluded that the population size to be 1315.

Comparing these results with some UK mainland hedgehog studies, Pat Morris and Nigel Reeve (In Mammals of the British Isles 2008) note that densities vary considerably according to habitat. They contend that in mixed farmland and pasture densities range from 0.21 to 1.23 per hectare, and that numbers are higher in suburban sites, from 0.83 to 1.79 per hectare. Also, in another study, by Richard Young (Durrell Wildlife Conservation Trust), the population density on amenity grassland was calculated to be 1.5 per hectare.

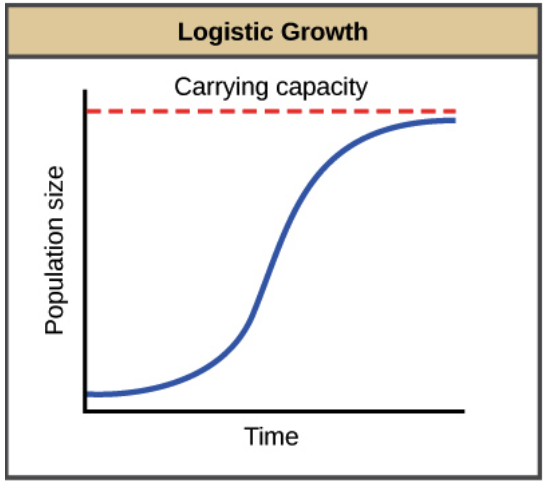
Our commentary

When comparing these population studies, there is a correlation between the UK and Tutt and Morris's Alderney study with respect to population density (hedgehogs/hectare), with the Alderney 2008 report being an outlier. Further, because the two Alderney studies calculated the population size using varying vegetation types, it is not clear whether the results are analogous.

General Understanding of Population Growth:

The graph below is a representation of how a population grows from founder individuals, as would have been the case with Alderney's first six founder hedgehogs.

As can be seen, growth is initially slow, as there are few individuals, then the numbers will increase quickly, followed by a slowing of growth to a maximum due to some limiting factor or factors. This point is called the carrying capacity for any particular population when the population size stabilises.



Comparing the population size, and timing of hedgehog introductions with two comparable island cases, both in Scotland, North Ronaldsay and South Uist, (as with Alderney), there were no predators of hedgehogs on these two islands, and the populations grew to a high carrying capacity, and became a pest species*. To resolve this problem, it was decided to remove large numbers by flying them back to the mainland.

This is a predictable outcome when introducing breeding animals into an environment where it can successfully breed and have no significant predators.

The point is that, in both cases, the population expansion, without predators**, grew fast and to ecologically damaging proportions.

**As described by James Lowen (Page 93-94) a postman imported 2 hogs onto North Ronaldsay in 1972. A population count was carried out 14 years later estimated to be between 400-600 animals. For this to occur the population growth would have been 50%, i.e. half the hoglets surviving to breed. After the survey, and due to the concern that the hedgehogs were having a damaging effect on the ground breeding bird populations, 180 hogs were airlifted to the mainland.*

On South Uist, hogs were introduced in 1974. Numbers and range expanded quickly and within 20 years population estimate was between 3000-5000 (an average survival rate of 45%). Finally, 650 hogs were culled, as they were reporting to be decimating the ground nesting bird eggs. Culling was stopped after an outcry and translocation to mainland UK of around 1600 hogs was carried out instead. It is not clear, whether hogs were the only reason for bird decline.

*** James Vizard (Alderney Airport's Firefighter) has reported (in 2021) two incidences of rare predatory behaviour. A buzzard carrying away a hedgehog in broad daylight, and a short eared owl hunting a hedgehog in darkness, both observed on the airfield.*

Why hasn't that happened on Alderney?

If we assume that there were 6 founders that were brought onto the island in the 1960s, and there were 3 males and 3 females, all capable of reproduction, and that each pair had an average litter of 4 hoglets (the average size of a hedgehog litter), with a mortality rate of 70% in the first year of life (a figure suggested by Pat Morris in correspondence with us), then Tutt and Morris's highest population figure of 999 animals would have been reached by year 19 to 20, whereas their study was carried out around 30 years after the founders arrived, and around 60 years from the present day.

Clearly, if their higher estimated population number was correct, then the carrying capacity was reached before their study, and that some significant limiting factor(s) are at play to keep the island's hedgehog population much lower than these figures would suggest.

The question is: What are the limiting factors?

The answer to this question is presently unknown, and the identification of the significant limiting factor(s) is (are) difficult to elucidate.

Some have suggested that it may be dehydration and/or starvation. However, it may be difficult to confirm.

During our ongoing research we will be keeping this question in mind and hope to offer some suggestions.

Survey Results

The 2021 surveys.

The question asked in these surveys was, what are the present proportions of brown and blonde hedgehogs on the island? The method we used was to run a citizen science project. We asked the volunteers to count the brown and blonde hedgehogs either on set routes we had identified around the island, or in their gardens, and that everybody would count the hedgehogs on the same date, and at the same time, for a duration of 40 minutes. Four dates throughout the active hedgehog season were selected. These data were reported back to us.

The results are summarised in Table 1 below:

Table 1.

Date	**May 26th 2021**	**24th July 2021**	**21st Sept 2021**	**21st Oct 2021**
Blonde	**30**	**35**	**45**	**18**
Brown	**24**	**30**	**24**	**18**
Total	**54**	**65**	**69**	**36**

These results show that in May 2021 survey the count identified 30 blonde, and 24 brown animals, with a total count of 54 hedgehogs, in the July count, 35 blonde, and 30 brown were reported with the total animal count of 65, in September, 45 blonde, and 24 brown, and the total being 69, and in October 18 were blonde and 18 were brown, and the total being 36.

Further, a comparison of the blonde/brown proportions in the four surveys were:

May count: 55% blonde and 45% brown

July count: 54% blonde and 46% brown.

Sept count: 65% blonde and 35% brown.

Oct count: 50% blonde and 50% brown.

The first two results give a strong indication of a roughly 50/50 split between the two colour morphs, and in September, the results suggest that the blondes are a higher proportion, with the October results showing a 50/50 split, as suggested in May and June.

Comparing these data to previous surveys

It is fortunate that there has been a number of other surveys carried out in the 2010 decade, including Suzy Weir's surveys. A summary of these data are presented in Table 2 below (for completeness Tutt and Morris (1998), and Ms Brown's results (2008) are included).

Table 2.

	Tutt and Morris Sept 1993 *	Becky Brown Sept 2008 #	Suzy Weir 24th Sept-7th Oct 2011 +	Suzy Weir 12th Sept to 13th Nov 2012 +	Suzy Weir 23rd May to 10th Oct 2013"	Suzy Weir 21st April to 26th Oct 2014"	Suzy Weir 25th Aug to 22nd Oct 2015"	Melzack and Weir 26th May 2021^	Melzack and Weir 24th July 2021^	Melzack and Weir 21st Sept 2021^	Melzack and Weir Oct 2021^
Blonde	17	40	31	57	23	58	40	30	35	45	18
Brown	50	14	24	32	11	40	30	24	30	24	18
Total	67	54	55	89	34	98	70	54	65	69	36
% Blonde	**25% Intermediate Problem**	**74% Intermediate Problem**	**56% Tags used**	**64% No Tags Problem**	**68% Tags used**	**59% Tags used**	**57% Tags used**	**55% Citizen Science survey**	**54% Citizen Science survey**	**65% Citizen Science survey**	**50% Citizen Science survey**

Surveyors and Site Selection Methods:

Key:	*	#	+	"	^
	Tutt and Morris	**Becky Brown**	**AWT volunteer**	**Suzy Weir**	**Melzack and Weir**
	J.Zool Lond	**M.Sc Thesis**	**Lead surveyor**	**Lead surveyor**	**Lead surveyors**
	1996, 239, 387-389	**Univ of Southampton**			
	Island Transects	**Island Transects**	**Selected Island Sites**	**Selected Island Sites**	**Island Citizen Science Survey**

The table describes the three different survey methods that were employed. Tutt and Morris and Ms Brown used a transect technique, the AWT volunteer and Suzy Weir used a selected site method, and in 2021 we opted for a citizen science surveyor technique.

As mentioned before, we have excluded the 1993 and 2008 data from our analysis as we couldn't interpret the intermediate animals they reported. So, the data employed for onward analysis were from the years 2011, 2103, 2014, 2015, and 2021 (2012 data was not included because, unlike the other three years using this technique, the hedgehogs were not tagged, so double counting was possible).

When carrying out tests for statistical significance, comparing the numbers of brown and blonde hedgehogs in each year, no significance was found, which means that we can conclude that the chances of observing a brown or a blonde hedgehog in the field is 50/50 throughout this period*.

As leucism is described as a recessive ** mutation, this, very surprisingly consistent, generation after generation, 50/50 result, runs contrary to an expected classical dominant/recessive gene relationship.

**Statistical information can be found at the end of the report.*

***Recessive denotes heritable characteristics, controlled by genes, that will be expressed in the offspring only when inherited from both parents.*

Our Commentary

With regard to the blondes appearing and proliferating, there are two important questions that need positing.

As it is assumed that the founders were all brown, within the genetic makeup of at least two of these animals was a gene, or a number of genes, that produced the first blonde hedgehogs to appear on the island.

1. **This is the: How did the blondes appear question?**

Then, over time, their numbers have increased to a consistent 50% today.

2. **This is the: How did that happen question, when the mutation is described as a recessive trait?***

One prevailing theory is, due to the small size of the population, genetic drift caused the survival of many more blondes than straight forward dominant versus recessive ratios would predict.

The concept of genetic drift is essentially a description of genetic or environmental chance. So, by chance, the recessive gene became over represented increasing the blonde population to a higher ratio than would be typically expected, or, by chance, something within the environment conspired to give blondes an advantage over the browns.

From the genetic stand point it should be pointed out that leucism is genetically complex. The prevailing understanding is that there are at least 6 separate genes that could be in play to produce a leucistic animal. So, although genetic drift cannot be ruled out completely, and may be part of the answer, it is probably not the full explanation.

This conundrum clearly needs more study.

Similarly, an environmental explanation may have some merit, and it is hoped that, again, more study will give some indication to the validity, or not, of this as, at least, part of the explanation*.

**We have been in communication with Dr Pat Morris regarding the leucistic hedgehogs of Alderney being based on a recessive gene he kindly replied (March 2020):*

"Regarding the leucistic animals, I had always assumed that it was due to a recessive gene. This need not have been evident in the founder population, which was probably only a couple of pairs anyway. If so, then inevitable inbreeding between, say the founder generation and offspring, would lead to one quarter of the young carrying the double recessive and showing the characteristic pale spines. There is also the proportion which I found. I always wondered whether this would persist or the population slowly revert to normal colour. It's interesting that it has not done so yet and may never do so especially if I was wrong to assume it was simply due to a recessive gene".

The mating habits of Alderney's hedgehogs

The picture below shows that browns and blondes will mate, it is also understood that hedgehogs are promiscuous, and so, to make it even more complicated, it is possible that the hoglets produced by a female may have different fathers.

Courtesy of AWT

Although the reasons for the blonde mutation reaching 50% of the population may have a number of interplaying factors, including multiple gene effects, it is useful to consider how this could have initially arisen based on a single gene dominant/recessive mutation.

The two tables (3 and 4) below show the offspring outcomes in generation 1 and generation 2. (capital B is the dominant gene, and small b is the recessive gene).

Table 3. **The Founder Parents Brown (B) but carriers of the leucistic gene (b).**

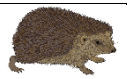
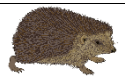
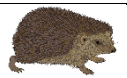
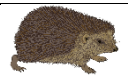
	Parent Male Bb	**Parent** Female Bb
Offspring	 BB	 Bb
Offspring	 Bb	 bb

Table 4. **The next generation would produce 50% blonde offspring (see picture above)**

	Parent Bb	**Parent** bb
Offspring	 Bb	 bb
Offspring	 Bb	 bb

If the brown founders arrived on the island as carriers of the leucistic gene, so Bbs, then Bb would produce a brown hoglet, and bb would produce a blonde hoglet.

Table 3 represents a founder pair, that would mean that the only way a blonde would appear is if they were both carrying one recessive gene.

Table 4 represents the next generation when a blonde, carrying two recessive genes mated with a brown that had a recessive gene. In that circumstance 50% of the offspring would be blonde.

The question must be asked, what are the chances that any of the founders carried the recessive gene onto the island?

Of course, the founders can't be checked, but it is possible to check the present day brown hedgehogs to see if they are carriers, by running a captured breeding programme, and breeding browns with browns, browns with blondes, and blondes with blondes, and see what offspring emerge.

However, although this would be the working hypothesis for such a breeding experiment, it would be expected that the results would be unlikely to be clear cut, and it is hoped that other genetic and environment studies would assist to resolve this question.

Hedgehog Weights

By checking the weights of the hedgehog population gives an indication of their success in finding food.

Although we didn't carry out this work in 2021 there is some very useful data available from studies carried out by others. Indeed, one of the hypotheses for high mortality rates is starvation, so looking at this preliminary data will give some information for research going forward.

Table 5 shows the general weights of the hedgehogs. The data used for this were the weights reported by Tutt and Morris (1993), and Ms Brown's data (2008), along with Suzy Weir's data from 2011, 2013, and 2014.

Table 5.

	Tutt and Morris 1998	Becky Brown 2008	Suzy Weir 2011	Suzy Weir 2013	Suzy Weir 2014
Weights gms	140 to 1000	220 to 1040	160 to 1080	185 to 980	180 to 1200

This shows the spread of weights found for each of those years, from young hoglets to very big individuals.

We also decided to check the weights of the animals in October for years 2012, 2013, and 2014. We found that average October weights for 2012 and 2014 were 600gm and 780gm respectively. However, in 2013 the average was considerably lower at 400gm.

As, presently, we don't have information about the hedgehog hibernation habits on Alderney, it is difficult to interpret this result. It is hoped that the 2013 animals continued to feed in November and reach a safe hibernation weight.

We also analysed the data that Suzy Weir supplied to see if there was any difference in weights between brown and blondes. The statistics show that, in all three years, there is no significant difference, so, we can conclude that the blondes find food as successfully as the browns and that there is no wildtype selective advantage.

Conclusion

It is clear from this report that there is much to learn, and study, about this extraordinary population of hedgehogs. Apart from their colouration, behaviour and ecology, they have a great deal to offer that is hidden in their genetic makeup.

The 2021 surveys were important to understand that the present proportions of brown and blonde animals are still a consistent 50/50, and confirms that there is a genetic/environmental conundrum**: how does a supposedly recessive trait persists in such large numbers?**

Undoubtedly, there is much fascinating study to be done. To that end we have identified some initial research projects, some for next year, and others for the future.

Studies going forward

It is clear, from the report, that there are multiple and continuing, fascinating questions to be asked and investigated. Indeed, although there are many research topics that need our attention, we wanted to list some of the ecological and genetic studies we are planning.

1. We are hoping to run the citizen science surveys on a yearly basis, and will be updating our volunteers with these plans before the hedgehog season begins. These data will continue to give us a present day understanding of the brown/blonde trends.

2. To study whether food is a limiting factor, we will initiate a study to get a fuller understanding of the feeding success of Alderney hedgehogs by weighing the animals, tagging them, and hopefully finding, and reweighing, them throughout the season.

3. The genetics of the founders. As described in the report, the working hypothesis, regarding the founder population, is that there were initially 3 males and 3 females, and that these 6 individuals "seeded" Alderney's hedgehogs. There is a way to attempt to confirm this by comparing specific genetic sequences in a significantly large number of hedgehogs. The first task therefore is to collect the samples. We expect that task to take at least two seasons.

4. Another genetic sequencing research project will be the study of gene(s) that contribute to the mutation that causes leucism. The aim is to try to understand the genetic basis of the trait in Alderney's hedgehogs and to inform the scientific community of our findings so that they can compare with studies of other mammalian species. We expect to have preliminary results by 2023.

5. A Phenotypic Study of Colour: Apart from the reported intermediates, it has also been suggested that the brown hedgehogs of Alderney are generally lighter (described as fawn rather than brown), than the ones in the UK. We will be investigating the viability of a camera based method to achieve realistic and true colour images to be able to investigate this question, and also be searching and, if found, describing any blonde/brown intermediates.

Other research aspirations:

Radio tracking the hedgehogs: To study the movements of the hogs on Alderney.

Breeding Programme: To study the colour ratios of the offspring.

An Extra Pair Paternity study (A study of litters of hoglets to ascertain each hoglets' paternity)

Studying the pathology of leucistic hedgehogs

Ecto and endoparasites of Alderney hedgehogs

The Genetics of Leucism

Although there are a number of genes that have an effect on this condition, two genes are generally considered the most significant candidate genes to initially study when considering leucism.

KIT gene which codes for:

Protein important for signalling of cellular processes such as cell growth and proliferation (division) and migration (movement), also for development of germ cells, hematopoietic stem cells (early blood cells) mast cells (part of immune and neuroimmune system) interstitial cells (gastrointertinal cells of Cajal (ICC)), **and development and function of melanocytes.**

The protein, called, and one of the family of, receptor tyrosine kinases, sits in the cell membrane, and stem cell factor protein binds to it to activate KIT protein by phosphorylation. This transmits a signal to other proteins within the cell, which activates multiple signalling pathways effecting the list of functions above.

MITF gene (Melanocyte inducing transcription factor) gene which codes for:

Protein helps control the **development, survival, and function of melanocytes,** by attaching itself to a specific area of DNA and is part of the activity control of particular genes. That is why it is called a transcription factor.

N.B The protein is also the cellular membrane protein controlling the production of eumelanin (Agouti is its counterpart effecting the production of pheomelanin).

Percentages of brown and blonde Alderney hedgehogs, Year 2011, 2013, 2014, 2015, May 2021, July 2021, September 2021, October 2021

Figures from Table 5

	Brown	Blonde
2011	24	31
2013	11	23
2014	40	58
2015	30	40
May-21	24	30
Jul-21	30	35
Sep-21	24	45
Oct-21	18	18

t-Test: Two-Sample Assuming Unequal Variances

	Brown	*Blonde*
Mean	25.125	35
Variance	74.69642857	161.1428571
Observations	8	8
Hypothesized Mean Difference	0	
df	12	
t Stat	-1.818754255	
P(T<=t) one-tail	0.04698878	
t Critical one-tail	1.782287556	
P(T<=t) two-tail	0.09397756	
t Critical two-tail	2.17881283	

The Null Hypothesis says that throughout the sampling period there is no significant difference between the numbers of brown and blonde hedgehogs on Alderney.

Pstat = 0.09 Pcrit = 2.18, so the null hypothesis is accepted confirming that the numbers of blonde hedgehogs remains consistently high.

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