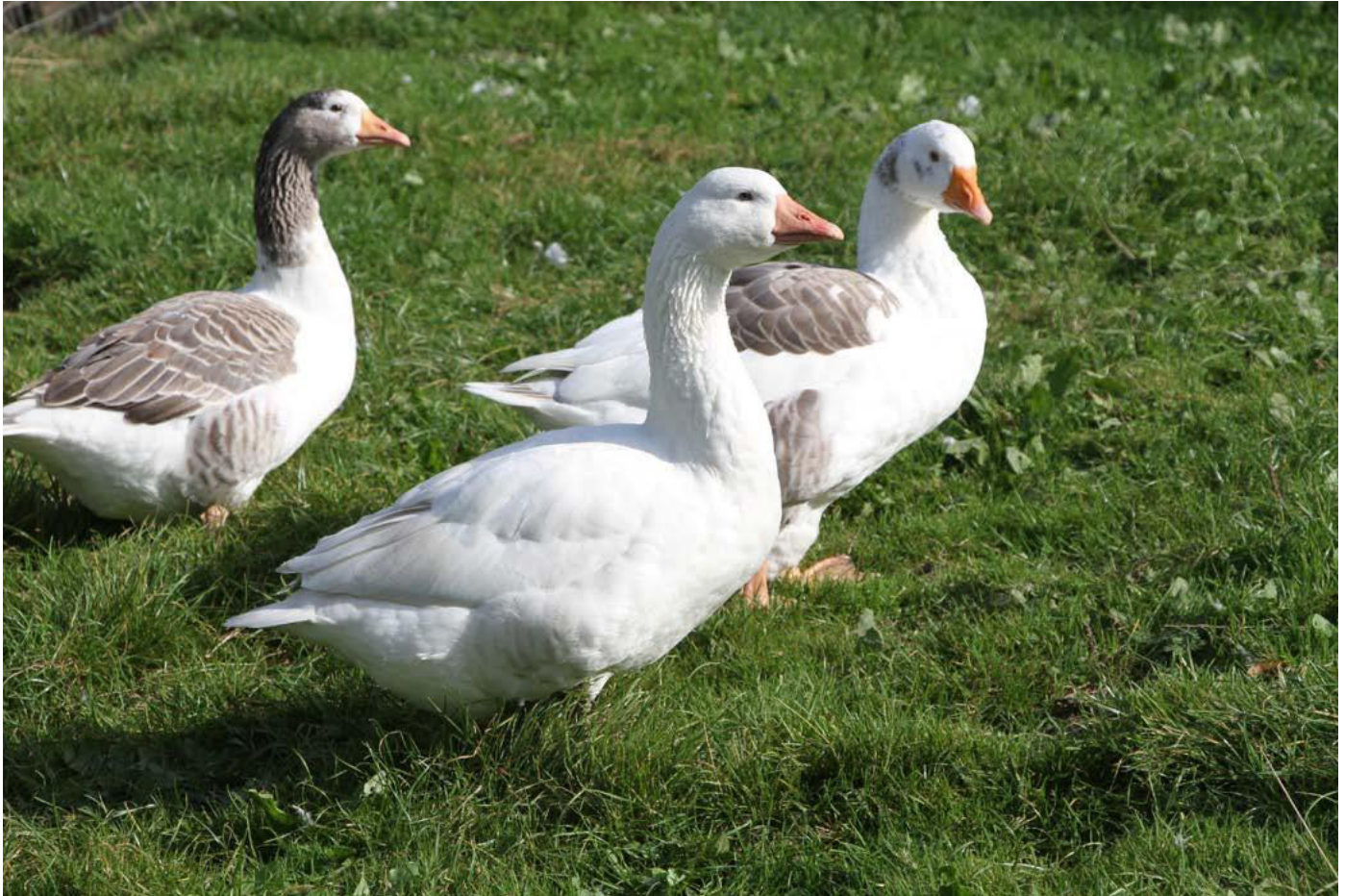


Auto-sexing pied geese: mystery of how it works almost solved

Chris and Mike Ashton explore the practicalities of breeding



A trio of auto-sexing Shetland geese: West of England and Normandy geese follow the same pattern for colour as Shetlands. Females have a grey saddleback pattern, and males are almost white. You can tell the sex by the colour. Any white gander put to a pied goose need not produce auto-sexing goslings. So what would happen if we crossed pure Shetland and pure white Czech geese in reciprocal matings?

Goose colours are rather limited compared to the varied pattern and colour mutations in ducks and chickens. Prior to the buff mutation in the Brecon and blue in the Steinbacher, there were only shades of grey plus white in geese. This lack of distinctive variation in goose plumage is one of the reasons why auto-sexing colour in pied geese has never been satisfactorily explained in published conventional genetics. The other reason is that there are very few 'pure breed' lines of geese. Perceived plumage colour and pattern may not determine what a goose will breed; without a pedigree of sorts from a goose breeder of some years of experience, breed names can be worthless.

THE PROBLEM

European geese are derived from the greylag goose, and goose colours have been investigated by authors such as F N Jerome and R D Hawes in the USA. They established that 'white' in European geese is controlled by the interaction of two genes (spot [sp] and sex-linked dilution [Sd], also explained in *The Smallholder* in 2021). When combined, these two genes interact to produce 'white' geese. If you take away 'dilution', then the area of white spotting is seen to leave a dark grey-back pattern on the body of both sexes. This saddle of grey feathers on the back, a grey head and neck, and grey thigh coverts, is also referred to as pied.

Experimentally, this explanation works well for white geese and pied

(non-diluted) grey-backs such as the Pomeranian. The pied pattern (produced by white spotting on the ground colour) is even seen faintly in the fluff of infant white (diluted) Embdens, but the goslings lose this pattern as they grow, and feather in white.

However, this conventional analysis does not explain why we have auto-sexing pied geese where the male is almost white, but the female keeps her grey back, albeit in a slightly 'diluted' grey. The plumage of the two sexes looks different - hence the term auto-sexing by colour in the Shetlands. It has generally been assumed that these auto-sexing breeds also carry recessive white spotting (sp) plus dilution (Sd). But that



Czech goslings are excellent grazers and fast growers. The three females in the background of this group have light grey fluff on the back and a small patch of grey on the head. The three foreground males are yellow on the head and slightly paler grey on the back.

combination is the one which works for Embdens. Something must be different in auto-sexing breeds.

THE STARTING POINT FOR A SOLUTION

Testing the colour genetics of breeds of geese requires the experiment's starting point involves pure ingredients i.e. gene pools which can be relied upon to breed true. One cannot guess the genotype of a grey & white, or an apparently white, bird. One can only be sure of genotype by assessing what birds actually produce. Are the offspring uniform in colour and pattern? Or do they produce a mixture of patterns in the offspring?

Having kept and bred geese for many years, we have evolved genetically reliable material which has enabled us to run an experiment on the genotype of Shetland geese. That has come about because of the interest in the UK of rare breeds. So, although there may not be the sheer numbers of goslings demanded by an academic study, the material for this experiment is as good as you can get. The stock birds are known to be reliably homozygous for spot and their own type of dilution.

ON ONE SIDE ARE THE CZECH GEES

Bohemian geese from southern Germany are generally called 'Czech' in the UK. They are small, white, talkative geese which display a faint pied pattern in the fluff. These Czechs mostly auto-sex in the fluff to the experienced eye – but the characteristic pigment and pattern is less reliable than in infant Embdens, for example, where the females can be distinctly dark. Czechs and Embdens have long been selected for their pure white adult feathers and down – and we found this selection for 'whiteness' in our Czechs to be a complicating factor in this year's experiment.

ON THE OTHER SIDE ARE THE SHETLAND GEES

These small attractive birds from the Shetland Isles appear to have the same auto-sexing characteristics as the West of England and Normandy geese. Our Shetland X Normandy retained the same auto-sexing plumage characteristics

from the parent male was a key factor in determining sex-linked colour:

* **Mating (a)** The male Shetland was mated to a white Czech female and the female goslings did follow the colour of the father. The goslings auto-sexed by colour. In total, there were three such females and just one male. The females all carried dark grey fluff on the back region, thighs and head. The surprise, as they feathered, was that the charcoal grey areas were more limited than in pure Shetland females i.e. the dark grey was reduced by an extension of white spotting which limited the amount of grey on the scapulars and thigh coverts. The smaller back feathers were charcoal grey.

The one yellow/faint olive-grey male gosling was (as expected) paler than a pure Shetland male gosling, because this F1 male carried dilution from both his Shetland father and from his white Czech mother. The Czech dilution must therefore be dominant over the Shetland dilution because (a) and (b) males could not be distinguished from each other. In adult plumage, none of the white males had the characteristic Shetland male thigh coverts which have a grey edging.

* **Mating (b)** The white male Czech was mated to a Shetland female, and the goslings follow the colour of the father's Czech dilution. He produced 4 white males and 6 white females. The females carried an occasional grey feather on the back or rump, which is characteristic of Embdens and Czechs.

In the fluff, male and female Shetlands both show a distinct charcoal grey back and head; the remainder is yellow fluff. The female is distinguished by a darker beak (seen on the left of the pair). By 3-4 weeks, new fluff on the male body begins to show as white; and by eight weeks, all his first feathers are almost white. Adult males still retain just a few grey feathers on the rump, and male thigh coverts are faintly marked with grey. This faint, adult grey does not occur with pure male Embdens and Czechs.



The six F1 yellow/pale grey goslings in the photo look just like pure Czech, and also made their way to Australia, New Zealand, North America and even South Africa with European colonists.

The five females [top] carry the father's Czech dilution and grew to be white. They should breed true for white with a Czech mate because they have just one copy of Czech dilution.

On the other hand, the one male gosling [bottom left] should carry one copy of Czech dilution and one of Shetland dilution. He will not be a true breeder.



Hatch 1 at day two. There are 6 goslings from the white Czech father, plus one dark female (right) from the Shetland father.

Hatch 2 at 12 weeks – 3/3 females

i) F1 - Czech male's white daughter: slight grey rump

ii) F1 - Shetland male's pied daughter: grey back/head/thigh coverts.

Typical pure pied Shetland female. She is not included in hatch 2 totals.

iii) sibling of (ii). The grey feathers are reduced in area in these pied F1 daughters i.e. there is an extension of white spotting beyond the neat grey back pattern preferred in pied geese.

These birds are all known to be homozygous for spot (sp).



Hatch 3: 4/4 males.

Three have a Czech father.

One has a Shetland father and was snipped. The fluff on his tail is carefully marked. The fluff on his tail is

These males all have one copy of dilution from the father and one copy from their mother. They are very similar in appearance.

All fourteen goslings were closed rung at 4-5 weeks of age.



By chance, there was just one interesting cross breed in 2021: a Shetland male (Sd/ Sd, sp/sp) fertilised a Brecon Buff female (sd+/— Sp+/Sp+), resulting in a grey female* with several white flights, white breast patch and white chin spot. She was as expected. She could not inherit buff from her mother because buff is sex-linked: the mother cannot pass buff on to female offspring. This female gosling inherited one copy of spot from her father, one 'not spot' from her mother, plus a copy of Shetland father's dilution; she is (Sd/— Sp+/sp)



Shetland Father Mother *	Sd	sp	Sd	sp	2023 progeny from Shetland male x Female *
Sd sp	Sd/Sd	sp/sp	Sd/Sd	sp/sp	Pure dilution Pure spot
Sd Sp+	Sd/Sd	Sp+/sp	Sd/Sd	Sp+/sp	Pure dilution Heterozygous spot
- sp	Sd/-	sp/sp	Sd/-	sp/sp	Hemi dilution Pure spot
- Sp+	Sd/-	Sp+/sp	Sd/-	Sp+/sp	Hemi dilution Heterozygous spot

The inheritance of Shetland dilution means that all birds in this gene pool will reliably auto-sex

most female white geese. They inherited Czech dilution and should breed as typical Czechs. The males looked 'white' but, like male (a), they are also split for characteristic Shetland and Czech dilution.

WHAT DO THE RESULTS SHOW?

- The Shetland parent male has passed on his obvious auto-sexing, reduced intensity, dilution to his hemizygous daughters. However, the area of charcoal grey in these daughters is more limited in extent than with pure Shetland females.
- The Czech parent male's daughters look just like pure female Czech goslings in the fluff.
- The F1 male goslings (from both pairings) are all heterozygous for Shetland inherited dilution and Czech inherited dilution. They look similar to pure Czech males in the fluff, suggesting that the Czech dilution is dominant over Shetland dilution and makes birds appear 'whiter'.
- Thus the quality of Shetland dilution is different from Czech dilution. That could be because there are differing alleles of dilution, but it could be that there are modifying factors associated with dilution which cause it to vary in its expressivity.
- White spotting in European geese commonly produces the pied pattern. The surprise here was that white sporting extended further over the saddleback area normally associated with female grey feathers. These F1 daughters from the Shetland male had reduced extent of pigmented feathers (now in smaller patches). We attribute this to selection for 'whiteness' in these Czech geese. Thus spot (sp) is extended in its expression here (and spoiled the expected pied pattern); but (sp) itself is not the mechanism of auto-sexing.

WHAT IF WE HAD USED A SOLID PATTERN FEMALE X SHETLAND MALE - INSTEAD OF A WHITE CZECH FEMALE?

The expectation for 2023 (if she is successfully mated back to a Shetland gander) is that all the offspring will be pure for Shetland dilution but half will be heterozygous for spot. Female offspring will automatically follow Shetland father's dilution. Male offspring will also receive Shetland dilution from this goose+, and thus be pure (homozygous) for the Shetland type of dilution.

A lot simpler! It should also show that birds which receive only auto-sexing dilution will remain auto-sexing, whatever the distribution of white spotting. This is the case in reliable American Cordon Patch Geese which show a range of markings, but always produce auto-sexing offspring.