

A STUDY OF THE INHERITANCE OF SUPERNUMERARY
MAMMARY IN GUINEA PIGS

by

BETTY LANNING GOERTZEN

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INTRODUCTION

The number of pairs of mammae varies greatly between the different species of mammals; however, a rather uniform number occurs within each species. Those animals which normally possess a great number of mammae usually have larger litters than those with a single pair. Guinea pigs, with only one inguinal pair of mammae, are an exception to this general rule since they usually give birth to more than one and often to as many as four or five young. More rarely litters of six or seven occur.

In some species the frequency of occurrence of extra mammae is much higher than in others. In the guinea pig variation from the normal pair is quite rare and has been recorded in the literature only once (Sollas, 31). In her report an attempt was made to determine the mode of inheritance, but a lack of sufficient cases made a definite assumption impossible. The purpose of this paper is to add to the meager information available concerning supernumerary mammae in guinea pigs with special attention given to the distribution of the mammae on the body, possible sex differences, the effect on litter size, and the mode of inheritance. A review of the literature has been made, since the occurrence of the character in other mammals may lead to a better understanding of the condition in guinea pigs.

REVIEW OF THE LITERATURE

Guinea Pigs

The occurrence of one or two supernumerary mammae located on the milk line was reported in guinea pigs (Sollas, 31). These mammae existed in both males and females and in every grade of development from a mere bare circular skin patch to a pair of functional mammary glands. When unpaired, the supernumerary mamma was on the left side more often than on the right. The mode of inheritance of the character did not show clear dominance or recessiveness. It arose in the offspring of normal parents, and when two parents possessing extra mammae were mated they bore normal young as well as those having the character.

Humans

The hereditary factor in polymastia in humans, the distribution of the mammae on the body, the frequency of their incidence in populations, possible sex differences, and their relation to fecundity and twinning have been studied by a series of investigators.

The hereditary factor in polymastia was pointed out by Peterquin (26); Leichtenstern (17); Neugebauer (22); Marie (20); Otani (24); Iwai (11); and Klinkowes (15); but there have

been no definite conclusions made as to the exact mode of inheritance.

When supernumerary mammae occur in humans they are located on the milk line in most cases. As many as eight functional supernumerary breasts have been reported to occur in humans (Neugebauer, 22) with six located above the normal breasts and two below. There is a racial difference in the location of these accessory mammae. Among Japanese, Iwai (11) reports 86.30 percent of the accessory mammae occur above and external to the normal breasts with the usual location being the anterior wall of the axilla. In a large Finnish population 98.7 percent of the supernumerary mammae were below the normal breasts (Kajava, 14).

Most authorities agree on the mammae occurring more often on the left side. In 8,568 cases of hyperthelia in young men, Bardeleben (2) reported the extra nipple was on the right side in 30 percent, left in 39 percent, and bilateral in 31 percent of the cases. Landauer (16) accumulated the data of some of the previous investigators along with his own data showing the relative frequency of hyperthelia on the right and left side. He found the excess of hyperthelia on the left side, above the 50 percent expected by chance, to be 4.2 ± 0.65 percent. Out of 936 accessory glands in Japanese, Iwai (11) reported 481 on the left, 454 on the right, and one on the median line. At least two authors came to the opposite conclusions, Stier (34) and Stannus (33), but in both of these instances the total

number of cases was very small.

Varying results have been reported with regard to the frequency of occurrence of supernumerary mammae in humans. Polymastia is found at the rate of about one person in 500 according to Leichtenstern (17). Ammon (1) found 5.3 percent of 2189 conscripts examined at Baden, Germany had polymastia. Among Japanese, Iwai (11) found 3.75 percent out of 11,789 persons examined had polymastia. Landauer (16) accumulated data mainly from college and university students of the United States and applicants of the Civilian Conservation Corps. Out of 20,832 who were checked during physical examinations, 357 had supernumerary nipples or a frequency of 1.71 percent. Most authorities agree on the frequency being between 1 and 5 percent.

There is also variation in reports of the frequency of occurrence of supernumerary mammae in males and females. Landauer (16) gave the frequency of extra nipples in men as 1.94 percent and, in women, 1.2 percent. Kajava (14), in a large Finnish population, found 4 percent incidence in men and 1.4 percent in women. Among Japanese, Iwai (11) reported a higher frequency in females than in males with 2.04 percent in males and 6.09 percent in females.

A number of geneticists believe the incidence of twinning is probably higher in humans with polymastia. Iwai (12) studied 24 cases of multiple births in Japan and found that 17 of the mothers (67 percent) had extra breasts. Leichtenstern

(17) cited three cases of twins among 70 patients with extra breasts or an incidence of 4.28 percent in contrast to 1.37 percent, which is given as the normal proportion of twin births in Europe. Marie (20) describes 20 cases of supernumerary nipples and five pairs of twins in four generations. Petrignani (27) found six pairs of twins and a set of triplets in three generations of a family possessing polymastia. Iwai (12) states there is a probable relation between polymastia and multiparous birth, and that those women who have supernumerary glands have a tendency to become more frequently pregnant than those who do not. Many more data are required before a higher incidence of fecundity and twinning can be shown to occur in cases of polymastia in humans.

Sheep

In sheep the relation of supernumerary mammae to twinning and fecundity has been the chief interest of investigators. Dr. Alexander Graham Bell carried on sheep breeding experiments in an attempt to produce a breed of sheep which were multi-nippled and twin bearing. When the experiment began the lambs averaged 2.27 nipples each, and this average was increased to 5.40. By systematic selection and inbreeding a strain was successfully established having four functional nipples and producing largely twins. An analysis of Graham Bell's experiment was made by Castle (4). He found that supernumerary nipples were strongly

inherited, evidently dominant, but he concluded that the hereditary element in twinning is probably very small while that of the environment is large. He found no evidence of a relation between nipple number and twinning.

Ritzman (29) states that when the multinippled trait was introduced by the sire there was a much greater scatter of variates in the nipple character of the offspring with a tendency toward recurrence of both parent forms, and that the average nipple number of the offspring was higher, due to greater uniformity, where the multinippled trait was introduced by the dam. He concludes that the factors for multinipples are cumulative, and the number of nipples present is proportional to the number of "doses" in the gametes.

Swine

In swine there is apparently a breed difference in regard to the number of mammae, and a great deal of variation occurs within the breeds. In Tamworths and Berkshires 77 percent have 13, 14, or 15 mammae. In Duroc Jerseys, 90 percent have 10, 11, or 12 mammae with five pair the usual number (Wentworth, 35). Wentworth (35); Parker and Bullard (25); Nachtsheim (21); Schmidt, Lauprecht and Staubesand (30); and Plua (28) have demonstrated a tendency for the mammae to be inherited in pairs with the simplest type of variation one more or one less pair than the usual number. The distribution is

not always regular, but even numbers of mammae appear in excess of odd ones. The number of pigs with even numbers of mammae varied from 57.40 percent in Wachtsheim's data from 1000 pigs of various breeds and crosses in Germany to 66.51 percent in Plum's data from 1523 Danish Landrace pigs collected from four different breeding centers in Denmark. Wentworth (35) reported the rudimentary pair of mammae located back of the normal pair in Duroc Jerseys behaved as a sex limited dominant. A heterozygous or homozygous dominant male would, in this case, have rudimentary mammae in the inguinal region while only the homozygous dominant females would show the condition. Plum (28) concludes from his data that the number of mammae in swine is a typical quantitative character, showing no dominance, and is continuous in variation.

Cattle

In Russia and some other European countries there is a belief among many dairy cattle breeders that the presence of supernumerary teats is evidence of abundant milk supply. In the United States there is a tendency to look upon polythelia with disfavor.

Ivanova (10) made observations on 25 dairy herds on farms at breeding stations in Russia. She found that the cows with supernumerary teats gave about 13 percent more milk than the normals. Juler (13) made a similar investigation on the records

of Angler cattle in Germany and found no significant difference between the normals and animals with accessory teats in the annual production of milk and butterfat. Leroy (18) examined 90 cows, representing the different breeds in France, for polythelia and found no significant difference when he compared the milk production of the two groups. Gifford (7) substantiated the findings of Juler and Leroy when he examined seven groups of dairy cows in Missouri. The evidence of most investigators is contrary to the belief that the genes causing polythelia are linked with genes for larger amounts of milk.

The frequency of occurrence of polythelia in American breeds studied is less than that reported in European breeds. In Europe, Buehard (3) found approximately 38 percent of the cattle examined had extra teats. Henneberg (9) substantiated Buehard's findings in a very extensive study of the frequency of occurrence of accessory mammae in 2373 females of various breeds of European cattle. Approximately 39 percent possessed supernumerary teats. Mackenzie and Marshall (19) found polythelia occurred in more than 50 percent of the 276 dairy cows and heifers examined at the Cambridge University farm and seven other dairy farms. Juler (13) made 1472 observations on breeds of dairy cattle in Germany and found about 23 percent had extra teats. Emerson (5) found an incidence of 44 percent when the udder of 370 beef and dairy cattle were examined in Iowa. Leroy (18) reported 69 percent of the 90 cows examined from breeds in France had polythelia. Gifford (8) found an

incidence of 25.8 percent in females and 14.07 percent in male dairy cattle from 4,831 female and 135 male dairy cattle examined in Missouri. Since many European breeders believed that factors for polythelia and high milk production were linked there probably has been no discrimination against animals possessing accessory mammae. This could account for a higher frequency of occurrence of polythelia in European breeds than in American breeds.

Ivanova (10) found the supernumerary teats that were posterior to and separated from the normal teats were present on both sides in about 50 percent of the animals possessing the character and only on one side in the others. When only a single accessory teat occurred there was equal distribution between right and left sides. She concluded from her data that the tendency to produce extra teats is dominant.

MATERIALS AND METHODS

The data for this experiment were obtained from the records kept on guinea pigs in the Kansas Agricultural Experiment Station Genetics Laboratory. These records covered the period December, 1927 to June, 1940. The occurrence of supernumerary mammae was observed and recorded during an experiment in which the belly was checked closely for roan hair. Since this character was not handled as a regular experiment the animals were not always examined for the presence or absence of

accessory nipples, and the matings were not made with any consideration of this character.

Sheets containing information concerning the litters and their parents were examined. The litter sheets contained a diagram of each animal in the litter and notations on sex, color, size of the litter, and other pertinent data. The diagrams showed the number and location of extra mammae. In order to study the mode of inheritance the offspring were observed from those matings in which one parent or both parents had supernumerary mammae. By observation and accumulation of the data the location of the mammae and possible sex differences could be determined. Statistical tests were made to determine the effect of accessory mammae on litter size.

RESULTS

Distribution of Supernumerary Mammae on the Body

The number of supernumerary mammae in this stock varied from one to five. In every case the extra mammae were located in the position of the embryonic milk ridge, anteriorly to the normal inguinal pair. When one accessory mamma was present it was located either on the right or left side with a preponderance on the right side (Plate I, A and B). When two extra mammae occurred they were usually located in pairs, one on each side. The pairs were located either at the same level of the

milk line on each side (Plate I, C), or were asymmetrical (Plate I, D and E). In two cases both mammae appeared on the same side at different levels on the milk line (Plate I, G). When three extra mammae occurred two of the nipples appeared in symmetrical pairs with the odd mamma on the right side (Plate I, H). Two nipples were located on each side in both cases where four accessory nipples were present (Plate I, F). In the one female with five extra mammae two were on the right and three on the left side (Plate I, I).

In most cases the accessory mammae were very rudimentary and in one case occurred only as a darkly pigmented spot. The supernumerary mammae were never found to be functional. There was no absence of hair in the immediate area of the extra nipple as is found in the normal pair (Plate II), and it was impossible to observe the character unless an actual check was made. A number of the animals were not checked and for this reason the frequency of incidence in the population could not be determined.

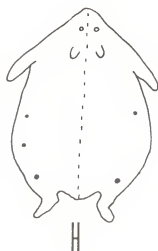
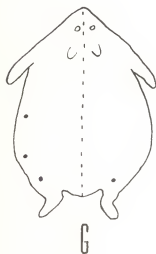
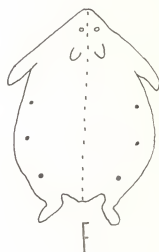
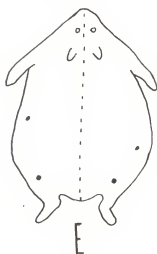
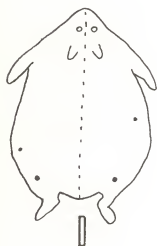
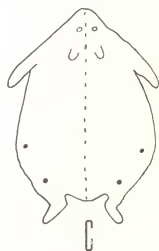
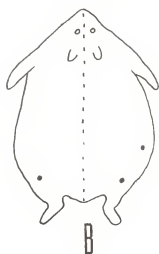
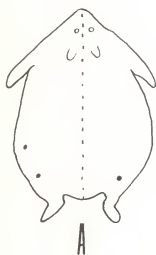
In the stock at the genetics laboratory a single accessory mamma occurred in 58.7 percent of the total cases of supernumerary mammae, with 32.61 percent with two extra mammae, 2.17 percent with three, 4.35 percent with four, and 2.17 percent with five (Table 1). Sollas's data showed an extra pair occurring as frequently as a single accessory mamma. Ten of the 15 animals listed as having two extra mammae had mammae occurring on both sides of the body and two animals had both accessory mammae

EXPLANATION OF PLATE I

Diagrammatic drawings showing the normal pair of mammae in the inguinal region and the variation in location and number of accessory mammae on the milk line anterior to the normal pair.

- A - A single accessory mamma occurred on the right side in 20 animals
- B - A single accessory mamma occurred on the left side in 3 animals
- C - A single symmetrical pair of accessory mammae occurred in 6 animals
- D - Two animals had a single asymmetrical pair of extra mammae with the left mamma located anterior to the right mamma
- E - Two animals had a single asymmetrical pair of extra mammae with the right mamma located anterior to the left mamma
- F - One animal had four extra mammae occurring in symmetrical pairs, two on each side
- G - Two animals, with two accessory nipples, had them both occurring on the right side
- H - One animal had three accessory nipples with two occurring as a symmetrical pair anterior to the odd mamma which occurred on the right side
- I - One animal had five supernumerary mammae with three on the left and two on the right side with none of them occurring symmetrically along the milk line

PLATE I



EXPLANATION OF PLATE II

A normal guinea pig showing the location of the single pair of mammae in the inguinal region. This picture was taken originally to show the occurrence of whitish hairs ventrally.

PLATE II



occurring on the right side. The location of the two accessory mammae was not indicated on the diagram in three other animals. The occurrence of a single accessory mamma is significantly higher in the guinea pigs at this laboratory than an extra pair. The exact location of the supernumerary mamma was given on the diagram in 23 out of the 27 animals with a single accessory mamma. Of these 23, 20 were present on the right side (Plate I, A) and three on the left side (Plate I, B) which shows a significant difference (Table 2). When the total number of supernumerary nipples recorded on the diagrams are considered there are 42 on the right and only 21 on the left side. These numbers again show a significant difference with a preponderance of mammae occurring on the right side (Table 3).

Table 1. Frequency distribution of the number of supernumerary mammae in guinea pigs.

Sex		Number of supernumerary mammae					Total
		1	2	3	4	5	
Female	Number	15	7	1	1	1	25
	Percent	60.00	28.00	4.00	4.00	4.00	
Male	Number	12	8	0	1	0	21
	Percent	57.14	38.10		4.76		
Total	Number	27	15	1	2	1	46
	Percent	58.70	32.61	2.17	4.35	2.17	

Sollas (31) also found a significant difference in the location of supernumerary mammae; however, in her animals the mammae occurred more often on the left side. By totaling both groups of data (Table 4) the difference between the occurrence of a single mamma on the right and left side is not significant. Since each group of data separately shows a high deviation from the 50 percent expected by chance, but in the opposite directions, the justification for pooling the data is doubtful. It may be possible that there is a difference in usage of the terms right and left side. In this laboratory the mammae were recorded on the diagram as they appeared while looking at the animal ventrally; thus the mammae shown on the left side of the diagram were on the right side of the animal and vice versa. The diagrams show a preponderance of mammae on the left and thus actually a proponderance on the right side of the animal.

Table 2. Number of guinea pigs with a supernumerary mamma on the right and left side.

Sex :	Right side :	Left side :	Total
Female	11	2	13
Male	9	1	10
Total	20	3	23
Chi square = 12.6			
Probability = <.01			

Table 3. The total number of supernumerary mammae occurring on the right and left side.

Sex	Right side	Left side	Total
Female	23	12	35
Male	19	9	28
Total	42	21	63

Chi square = 7
Probability = <.01

Table 4. Frequency distribution of single supernumerary mammae on the right and left side in guinea pigs as given in the data by Sollas and in Table 2.

Investigator	Right side	Left side	Total
Present investigation	20	3	23
Sollas	2	12	14
Total	22	15	37

Chi square = 1.4
Probability = approx. .20

Supernumerary Mammas and Litter Size

There has been a great deal of interest in other mammals as to whether or not females with supernumerary mammas produce larger litters than are normally produced. A study was made in the stock at the genetics laboratory to determine if there was an increase in litter size in cases where the female parent had more than the normal pair of mammas. In guinea pigs there is a difference in the number occurring in the litter depending on when that litter is produced by the female. First litters are smaller in number than the succeeding litters. The litters gradually increase in size with a drop in the number in the litter as the female approaches the end of fertility. The first two litters that were born to females with supernumerary mammas were considered first since all of the female parents with accessory mammas gave birth to at least two litters. The normal female parents were chosen at random from those contemporary females of the same age as the parent with supernumerary mammas. In this way the effect of any seasonal difference or change in feed on litter size should affect the size of the litter from the normal and abnormal parents to the same degree since they would be producing litters at approximately the same time. Two normal female parents were chosen at random for every abnormal female parent. When only the first two litters were considered, a total of 48 litters, the chi square value was 5.19. The probability of this

high a chi square value happening by chance alone would be about one time out of fifteen (Table 5). In order to get a larger number of litters for a more accurate test the first four litters were used, and two of the abnormal female parents that produced less than four litters were omitted along with the four corresponding normal parents of the same age. By using the first four litters of both the abnormal and normals there was a total of 84 litters tested, 28 abnormal and 56 normal. A very low chi square value of 2.18 with four degrees of freedom indicates no difference in litter size between those females with supernumerary mammae and those with the normal inguinal pair (Table 6).

Table 5. Effect of supernumerary mammae on size of the first two litters.

Female parents :	Size of the litters				Total number of litters
	: 1	: 2	: 3	: ≥ 4	
Abnormal*	0	9	4	3	16
Normal	5	13	12	2	32
Total	5	22	16	5	48

Chi square = 3.19
Probability = .10-.20

* Female with one or more supernumerary mammae.

Table 6. Effect of supernumerary mammae on the size of the first four litters.

Female parents :	Size of the litters					:Total number :of litters
	1	2	3	4	≥5	
Abnormal ^a	3	12	9	3	1	28
Normal	12	17	20	5	2	56
Total	15	29	29	8	3	84
Chi square = 2.18						
Probability = .70						

^a Female with one or more supernumerary mammae.

A possible explanation for any lack of correlation between the occurrence of supernumerary mammae and increased litter size may be due to the normal occurrence of plural births in guinea pigs even though they possess only a single inguinal pair of mammae. Since the litter size is already greater than would be expected with the normal number of mammae the addition of mamma or mammae would have no effect on litter size.

Sex Differences

Supernumerary mammae occurred in both sexes. Out of 49 males examined within the experiment 21 had accessory mammae and 25 of the 46 females examined had the character. This does not show a significant difference in the occurrence of the character in males and females (Table 7). In both males and females a single accessory mamma appeared most frequently;

57.14 percent of the abnormal males had a single extra mamma and 60.0 percent of the females (Table 1). There was no significant difference between the sexes in the occurrence of mammae on the right and left side (Tables 3 and 4). The average nipple number for the 25 females possessing supernumerary mammae was 1.64, and 1.52 was the average nipple number for the 21 males showing the character. The accessory nipple number for the two sexes is not significantly different.

Mode of Inheritance of Supernumerary Mammae

It is quite evident that supernumerary mammae is hereditary in guinea pigs. Of the 46 cases occurring in the genetics laboratory all but one female, N950.1, could be traced back to a single mating. The dam from this mating, A863.1, was of unknown parentage, and she was bred by an unknown male. Since the mutation for supernumerary mammae occurs so rarely in guinea pigs it is very likely that N950.1 had at least one of the unknown parents of A863.1 or the unknown male parent included in her ancestry.

In every case in which an actual check could be made of the parents producing offspring with supernumerary mammae, at least one of the parents had one or more accessory nipples, which indicates that the occurrence of extra mammae is due to a dominant gene or genes.

Table 7. The frequency of occurrence of supernumerary mammae in males and females in which an examination was made.

Description	Male	Female	Total
Normal	28	21	49
With extra mammae	21	25	46
Total	49	46	95
Chi square = 1.24			
Probability = .20-.30			

When both parents had extra mammae 26 offspring showed the character while 20 did not. When a male with accessory nipples was mated to a normal female 6 of the 7 offspring examined had supernumerary mammae. When one parent had extra mammae and the other parent was questionable, since it was not examined, 15 normal offspring were produced and 3 with the character (Table 8).

The inheritance of the number of nipples or the location of the nipples, whether on the right or left side, could not be traced with such a limited number of cases.

Table 8. Number of offspring from matings in which one or both parents had supernumerary mammae showing those that were normal and those that possessed one, two, three, or four extra mammae.

Parents showing :		:	Offspring					:
accessory mammae:		:	Number of accessory mammae					:
possessed by		: Sex :						Total
each animal		:						:
Female :	Male :	:	0	1	2	3	4	:
1*	4*	Female	2	2	2	1		7
		Male	3	3	3			9
4*	1*	Female	4	1				5
		Male	3	2	1			6
0	4*	Female		3				3
		Male	1	1	2			4
2*	2*	Female	1	1	3			5
		Male	2	4				6
1*	2*	Female	1	1				2
		Male	4				1	5
?	2*	Female	4		1			5
		Male	7	1				8
4*	?	Female			1			1
		Male	4					4
2*	1*	Female		1				1
		Male						
Total			36	20	13	1	1	71

* Number of accessory nipples present in each parent.

DISCUSSION

The number of supernumerary nipples in guinea pigs may be due to dosage effect; however, in the stock at the genetics laboratory modifying factors are more plausible in explaining this variation. The dominant autosomal gene would, in this case, produce the abnormal character, but the number of extra nipples would depend on the modifying factors that were present. In Sollas's stock not more than two accessory mammae were present in guinea pigs possessing supernumerary mammae. This can be explained by the absence of some of the plus modifying factors in her animals that were present in the stock at the genetics laboratory at Kansas State College, where as many as five accessory mammae appeared on a single animal.

Since none of the accessory mammae was functional it is quite possible that another gene, not present in our stock, is necessary for the development of the glandular tissue and the production of a functional accessory mamma.

SUMMARY

Supernumerary mammae occurred in 46 guinea pigs at the genetics laboratory at Kansas State College. The number of supernumerary mammae varied from one to five, and in every case they were nonfunctional. All were located on the milk line anterior to the normal inguinal pair. Accessory mammae

occurred in both males and females, and in both sexes a single supernumerary mamma was the most common type of variation. The single mamma occurred on both the left and right sides, but a significantly higher number appeared on the right side in both males and females. When two extra mammae were present, the position of the mammae on the body was variable with both occurring on the right side or one on each side in asymmetrical or symmetrical pairs. When three extra mammae were present, two of the mammae were paired symmetrically with the odd mamma on the right. When four extra mammae occurred they always appeared in pairs, two on the left and two on the right side. Five supernumerary mammae occurred in only one animal and three of these mammae were on the left with two on the right side.

The presence of supernumerary mammae in the female parent had no effect on the size of litter produced.

The hereditary factor in supernumerary mammae in guinea pigs is an autosomal dominant. In every case where the offspring showed supernumerary mammae at least one of the parents also expressed the character. It is quite possible that another gene, not present in the stock at the genetics laboratory at Kansas State College, is necessary for the glandular tissue to develop in order for the mammae to be functional. The genetic basis for the wide variation in nipple number, one to five, could not be explained with the limited data in this experiment.

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