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The effect of selection for body weight on the skeletal variation of the mouse

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SUMMARY

The incidence of many minor skeletal variants in the inbred mouse strain C57BL can be influenced by the diet on which the parents live: in many cases, the effect is mediated by a correlation with body size. This also seems to be true in Falconer's (1973) Q-strain in which body size has been increased or decreased by selection. However, there was so much heterogeneity between replicates within selection lines that variants influenced by body size could be detected as a group, but not identified individually.

1. INTRODUCTION

Minor variants of the skeleton have been studied in considerable detail in the mouse (for a general review see Grüneberg, 1963). Their incidence differs greatly between inbred strains (Howe & Parsons, 1967; Wickramaratne, 1974) which is clear evidence that part, at least, of this interstrain variation is under genetical control. Within a given inbred strain, a small part of the variance is due to tangible causes such as sex, maternal age and parity, but intangible non-genetic factors accounted for over 80 % of the variance in three-quarters of the characters studied by Searle (1954*a*). In an attempt to identify other causes of this large amount of 'chance' variation, Searle (1954*c*) kept mice of the C57BL inbred strain on an unbalanced (oats) diet; the young borne of parents on that diet showed striking changes in the frequency of many minor variants, some frequencies going up and others down. These findings were confirmed by Deol & Truslove (1957) with a variety of unbalanced cereal diets (oats, wheat, barley and buckwheat). These authors made the additional discovery that the incidence of about half of those variants which responded to diet were correlated with body size. The frequency of variants which tended to occur in large mice went down whereas those which occurred in small mice went up, in both cases because on these unbalanced diets the average size of the young was reduced. This raised the question whether a similar effect on minor skeletal variants could be demonstrated when the size of the mouse was increased or decreased genetically as in selection experiments. An opportunity to test this question arose in the replicated selection experiments for

body weight of Falconer (1973). Professor Falconer generously placed animals from these experiments at my disposal and the findings are reported here.

2. MATERIAL AND METHODS

The details of the Q-strain experiment are given by Falconer (1973) and will only be summarized here. A random-bred strain of mice was divided into six replicates (labelled A–F inclusive) and each of them was selected for large and small body-size at six weeks with an unselected control (designated Large, Small

Table 1. *Number of skeletons collected, mean ages and 6-week weights in the replicates with the selection and control means*

Line	No. of skeletons	Mean age (days)	Mean 6-week No. weighed	Mean 6-week weight (g)
QLA	110	130	69	34·2
QLB	107	113	58	32·7
QLC	101	97	37	30·8
QLD	105	111	67	31·9
QLE	105	112	99	31·6
QLF	108	128	83	31·6
Large	636	115	413	32·1
QCA	104	112	44	22·8
QCB	100	118	54	25·5
QCC	104	106	39	21·4
QCD	104	119	63	22·6
QCE	109	127	75	22·6
QCF	111	110	62	20·0
Control	632	115	337	22·5
QSA	102	114	70	15·1
QSB	103	115	51	17·5
QSC	136	114	115	16·5
QSD	103	118	85	14·7
QSE	105	113	86	15·2
QSF	100	118	70	14·8
Small	649	115	477	15·6

and Control). Each line was maintained by minimal inbreeding from eight single-pair matings. For the first ten generations the overall mean responses were linear and very regular both up and down. But, 'over the first ten generations the six replicates gave widely divergent estimates of the realised heritability and of the asymmetry of the response'. After generation 10 the upward regression decreased but the downward regression increased, and the regressions were no longer clearly linear (Falconer, 1973).

About 50 ♂♂ and 50 ♀♀ were collected from each of the 18 replicates at generations 13 + 14 (Table 1) and after preparing the skeletons by the papain maceration method they were classified for an array of 52 minor variants (Tables 2, 5). For a description of the skeletal characters see Deol (1955) and Berry & Searle

(1963) and for turned-up nose, size of p.s. of ThI and pink caudal vertebrae see Appendix. Falconer also supplied data such as age at killing and 6-week weight (where this was known; litters other than the first were not always weighed as they did not usually contribute to the next generation). The collection of some 1900 animals occupied a considerable time and inevitably included mice from several generations, although the bulk of them came from generations 13 and 14. Care was taken to avoid bias in classification and the results were recorded on printed cards, coded and punched on data cards. The sexes were at first treated separately, but

Table 2. *Mean percentage incidence of 37 minor skeletal variants in the Q-strain, based on the data given in Appendix, Table 5*

Variant	Large ± S.E.	Control ± S.E.	Small ± S.E.
1. Bent nose	0·5 ± 0·3	1·7 ± 1·2	3·8 ± 1·9
2. Turned-up nose	0·3 ± 0·3	0·6 ± 0·3	3·9 ± 1·7
3. Maxillary-turbinal fusion	16·5 ± 2·5	18·7 ± 3·6	13·1 ± 1·8
4. Nasals fused	0·3 ± 0·2	0·3 ± 0·3	2·9 ± 1·8
5. Fused frontals	22·3 ± 4·9	19·6 ± 6·3	10·2 ± 3·3
6. Interfrontal absent	9·3 ± 4·1	10·3 ± 4·5	10·2 ± 2·4
7. Interfrontal–frontal fusion	5·6 ± 2·9	3·0 ± 1·0	2·5 ± 1·0
8. Parted frontals	77·4 ± 10·8	91·9 ± 3·2	89·1 ± 8·7
9. Frontal fontanelle	0·8 ± 0·3	4·3 ± 2·3	12·6 ± 7·7
10. Frontal foramen double	5·4 ± 0·8	2·8 ± 0·5	3·1 ± 0·6
11. Preoptic sutures	35·0 ± 10·6	26·9 ± 5·4	43·8 ± 7·8
12. Metoptic roots abnormal	18·9 ± 4·7	25·7 ± 6·9	34·5 ± 10·1
13. Basisphenoid–presphenoid fusion	10·4 ± 2·6	5·2 ± 1·2	8·2 ± 3·1
14. Basisphenoid–basioccipital fusion	13·5 ± 3·8	2·7 ± 1·6	2·3 ± 1·0
15. Preorbital foramen double	14·1 ± 1·8	17·5 ± 1·9	20·6 ± 2·0
16. Accessory maxillary foramen	5·7 ± 1·2	6·7 ± 1·3	3·6 ± 0·8
17. Foramen palatinum majus double	11·3 ± 1·7	6·7 ± 0·6	7·9 ± 2·4
18. Foramen ovale single	17·1 ± 2·6	25·6 ± 6·5	32·7 ± 6·4
19. Foramen sphenoidale medium	79·1 ± 3·1	77·9 ± 3·2	75·8 ± 5·6
20. Absent processus pterygoideus	3·8 ± 1·2	12·7 ± 5·3	16·4 ± 3·2
21. Interparietal–occipital fusion	2·0 ± 1·3	1·0 ± 0·5	1·4 ± 0·6
22. Occipital–periotic fusion	3·6 ± 1·5	1·9 ± 1·0	1·8 ± 1·8
23. Foramen hypoglossi double	76·3 ± 1·5	64·9 ± 5·9	62·6 ± 4·0
24. Absent fenestra flocculi	5·2 ± 1·5	3·7 ± 1·6	5·0 ± 2·8
25. Accessory mental foramen	9·7 ± 1·3	17·3 ± 3·0	17·3 ± 3·9
26. Lower third molar missing	0·4 ± 0·2	0·0	0·9 ± 0·4
27. Dyssymphysis posterior CII	3·0 ± 1·0	1·1 ± 0·8	0·5 ± 0·5
28. Absent arch foramina CIII	2·0 ± 0·4	3·0 ± 0·9	2·2 ± 0·3
29. Foramen transversarium on CVII	4·4 ± 2·2	2·3 ± 0·8	2·2 ± 1·1
30. Size processus spinosus ThI	17·4 ± 5·6	9·5 ± 4·1	2·0 ± 1·1
31. Absent processus ThII	4·8 ± 2·4	4·8 ± 1·8	10·0 ± 4·5
32. Arch foramina ThV	26·1 ± 4·8	23·7 ± 3·5	25·7 ± 4·0
33. LVI sacralized	6·9 ± 3·9	2·5 ± 0·9	2·6 ± 0·8
34. Sacral fusions	30·4 ± 5·1	32·3 ± 3·5	19·0 ± 4·2
35. Pink caudal vertebrae	6·0 ± 1·4	2·4 ± 0·8	0·6 ± 0·4
36. Fossa olecrani perforata	9·7 ± 1·3	4·6 ± 1·6	0·9 ± 0·2
37. Foramen acetabuli perforans	0·6 ± 0·3	0·3 ± 0·2	0·2 ± 0·1

as they generally did not differ from each other in the frequencies of the variants examined, the data were subsequently pooled. The sorting of the data was done by computer which was programmed to produce tables with the number of skeletons affected in each replicate and the percentages of affected animals. Only the first 37 of the original 52 variants were used in this analysis (Tables 2, 5). The remaining variants occurred in so few animals in this material that they contributed virtually no information and were therefore disregarded.

3. RESULTS

The statistical treatment of the data has proved difficult and controversial; the full data have therefore been given in the Appendix (Table 5) so that the reader may carry out his own tests. The mean percentage incidence of 37 minor skeletal variants and their standard errors are given in Table 2, and this shows that in many cases the replicates differ widely from each other. Considering the variants jointly as a group, if the Large, Control and Small mice are designated 1, 2, 3 respectively, then if there is a correlation between variant and body size, one would expect the respective means to be either in the order 1, 2, 3 or 3, 2, 1

Table 3. *Analysis of variance of percentage incidence of five variants with significant F values*

Character	Mean sq. between L, C and S	$F_{2, 10}$	Mean sq. between replicates	$F_{5, 10}$	Mean sq. residual
2. Turned-up nose	25·8	5·0	7·2	1·4	5·2
10. Frontal foramen double	12·7	4·4	1·5	0·5	2·9
14. Basisphenoid–basioccipital fusion	233·9	12·8*	70·8	3·9	18·2
35. Pink caudal vertebrae	44·4	11·1*	8·6	2·2	4·0
36. Fossa olecrani perforata	115·7	18·8*	13·2	2·1	6·2

* $P < 0{\cdot}005$.

(i.e. in ascending or descending order as in variants 5 and 1 in Table 2). The other four possible orders would not constitute a *prima facie* case for correlation. In the absence of correlation with body size, the six possible orders are equally likely, with 1, 2, 3 and 3, 2, 1 combined expected to form one third of the total. A significant excess of these two classes over that expectation would constitute evidence that the group as a whole includes variants whose manifestation is correlated with body size.

Variants 4, 25 and 31 (Table 2) cannot be used for this test as two of the three means are identical. Among the remaining 34 variants, there are 19 which occur in the order 1, 2, 3 or 3, 2, 1 (chance expectation in the absence of correlation = 11·33). The difference is significant at the 0·01 level ($\chi^2_1 = 7{\cdot}79$) and hence the

conclusion seems justified that the array of 34 variants includes a group whose manifestation is correlated with body size.

An analysis of variance of percentages of each of the 37 variants revealed five with significant F values (Table 3). Even though the usual assumptions of analysis of variance are not altogether met, these seem reasonably trustworthy. For pink caudal vertebrae (no. 35 of Table 2) and fossa olecrani perforata (36) there was a significant difference between the means of the selections and the controls. In turned-up nose (2) the mean for Small mice was significantly different from both the other two means, which were not significantly different from each other. For frontal foramen double (10) and basisphenoid-basioccipital fusion (14) Large

Table 4. *Q-strain (generation 10): birth weights, 3-week weights and 6-week weights of Large (L) and of Small (S) mice; L/S values*

	Birth weights	3-week weights	6-week weights
A	1·153	1·787	1·766
B	1·087	1·334	1·746
C	1·172	1·004	1·411
D	1·159	1·353	1·768
E	1·093	1·358	1·691
F	1·371	1·378	1·896
Mean	1·173	1·369	1·713

mice were significantly different from the other two groups which, again, were not significantly different from each other. In each of these cases (except for frontal foramen double) the means are in ascending or descending order (see above) and therefore constitute evidence for correlation with size. Frontal foramen double, which is a bilateral character, affected very few animals symmetrically and is not a particularly common variant in this material. However, the variant was present in Large mice almost twice as frequently as in the Control and Small mice, although this does not constitute evidence for correlation with size.

Selection in Falconer's Q-strain was based on 6-week weights. The majority of the minor skeletal variants arise in pre-natal life. Hence, if the genes selected mostly affect post-natal growth, they would not be expected to influence the manifestation of variants which arise before birth. For generation 10 (and this will differ little from generations 13–14), Professor Falconer has kindly supplied birth- and 3-week weights of Large, Control and Small mice; the 6-week weights were read off Falconer's (1973) graphs in Fig. 7. Values of L/S for the six replicates are given in Table 4. At birth, L already exceeds S by about 17 % in weight, and it may be presumed that this difference arose early enough in pre-natal life to have influenced the manifestation of some of the 34 variants; later the difference increases to 37 % at 3 weeks and to 71 % at 6 weeks. The high degree of heterogeneity between replicates is noteworthy. The correlation between birth weights and 60-day weights could be demonstrated from other sources but, coming from different

(and inbred) strains, it would have been less direct, and in any case the data of Table 4 are sufficient for our purpose.

4. DISCUSSION

As shown above, there is good evidence that a group of skeletal variants in the Q-strain include some characters which are correlated with body size. It would be of interest to compare them with the similar group of variants identified in the diet experiment of Deol & Truslove (1957). Unfortunately, this is fraught with difficulty. The C57BL strain is noted for the richness of its skeletal variation. The Q-strain mice, by contrast, are rather disappointingly uniform in this respect, and many of the features studied in C57BL are either completely absent or so rare as to give virtually no information either way. Moreover, the four variants for which there is evidence for correlation with size have not been classified in C57BL. It therefore seems unprofitable to discuss these variants in detail. The most that can be said is that the present data do not seem to be at variance with those found in the C57BL experiment.

All the replicates in the Q-strain have unique skeletal profiles so far as the minor skeletal variants are concerned, and this is presumably mainly, if not entirely, the result of genetic drift (Falconer, personal communication). On the other hand, the skeletons of Large and Small mice have characteristic bones (i.e. size, shape, density, etc.) which presumably are the direct or indirect result of selection. The study of these differences is outside the scope of the present investigation, but they may well turn out to be of considerable interest.

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APPENDIX

The full data are given in Table 5, below. The variants not previously described are as follows:

(i) *Variant 2: turned-up nose*

Turned-up nose, unlike bent-nose (Searle, 1954*b*), only involves the anterior border of the nasals. These bones instead of being almost flat dorsally have the anterior quarter tilted dorsally. There may also be shortening of the underlying jaw bones. This variant tends to be a particular feature of Small mice.

(ii) *Variant 30: size of processus spinosus on ThI*

In 17 % of the Large mice there was an abnormally large processus spinosus on the neural arch of the first thoracic vertebra. This was not associated with a dystopia of a large spine from the second thoracic vertebra. In fact this latter condition was extremely rare (4 mice in QLE, 2 in QLF and 1 in QCB), while the size of the spine on ThI was increased irrespective of the size of that on ThII. This is in marked contrast to the position in C57BL, where dystopia is the most usual cause of an increase in the size of the processus spinosus on ThI (Grüneberg, 1950).

(iii) *Variant 35: pink caudal vertebrae*

This is a new entity which was noticed as the skeletons were processed and after they had passed through hydrogen peroxide and through acetone. Some of the proximal caudal vertebrae in certain skeletons seemed to be stained pale pink and further investigation revealed that this was usually confined to the larger animals (Table 2, no. 35). On the other hand there were some skeletons where the proximal caudal vertebrae were yellowish or brown. These may have started off as pink vertebrae, but faded in the light. If the skeletons were classified for coloured caudal vertebrae (pink, yellow or brown) then there are 57 % in L, 36 % in C and 36 % in S. Males are more often affected than females (L, 59 % ♂♂, 55 % ♀♀; C, 37 % ♂♂, 34 % ♀♀; S, 48 % ♂♂, 23 % ♀♀).

The substance causing the coloration has not been identified, but it is not soluble in acetone and it does not fluoresce in u.v. light. Levin & Flyger (1971) report an increase in the amount of uroporphyrin I in fox squirrels (*Sciurus niger*) owing to the lower activity of uroporphyrinogen III cosynthetase in tissue extracts compared with similar extracts from grey squirrels (*Sciurus carolinensis*). In the

former animals the bones are pink, but the authors do not say in what state the bones are, as all of them always look pink in freshly killed animals. The authors claim that this provides a small animal model for studies of erythropoietic porphyria, an hereditary disease of man and cattle which is associated with a similar partial deficiency of uroporphyrinogen III cosynthetase. It looks as though there may perhaps be a similar condition in the mouse, even though the only bones that are coloured are the first few caudal vertebrae.

Table 5. *Incidence of minor skeletal variants in the six replicates (A–F) of Large (L), Control (C) and Small (S) mice of the Q-strain*

(For central characters the numbers refer to individuals and for bilateral characters to sides of individuals)

Variant		A	B	C	D	E	F
1. Bent nose	L	0/110	2/107	0/101	0/105	0/105	1/108
	C	0/104	0/100	8/104	0/104	1/109	2/111
	S	0/102	10/103	0/136	4/103	0/105	9/100
2. Turned-up nose	L	0/110	0/107	0/101	0/105	0/105	2/108
	C	0/104	0/100	1/104	0/104	2/109	1/111
	S	0/102	8/103	1/136	4/103	2/105	10/100
3. Maxillary–turbinal fusion	L	42/220	21/214	28/202	33/210	57/210	29/216
	C	38/208	11/200	63/208	30/208	56/218	38/222
	S	21/204	20/206	23/272	31/206	38/210	37/200
4. Nasals fused	L	1/110	0/107	0/100	0/105	0/105	1/108
	C	0/103	0/100	0/104	0/103	2/109	0/111
	S	0/102	6/103	1/133	1/102	0/105	11/100
5. Fused frontals	L	13/110	9/107	34/101	24/105	41/105	21/108
	C	52/104	13/100	23/104	10/104	15/109	11/111
	S	6/102	27/103	8/136	11/103	9/105	5/100
6. Interfrontal absent	L	13/110	5/107	29/101	4/105	6/105	2/108
	C	7/104	27/100	23/104	3/104	3/109	2/111
	S	9/102	2/103	27/136	9/103	9/105	10/100
7. Interfrontal–frontal fusion	L	4/194	2/202	12/132	7/200	37/198	2/212
	C	15/192	4/144	2/158	5/198	4/210	3/214
	S	1/180	12/202	1/206	3/174	10/190	1/172
8. Parted frontals	L	95/110	88/107	96/101	102/105	27/105	84/108
	C	83/104	98/100	94/104	103/104	94/109	109/111
	S	102/102	47/103	130/136	101/103	98/105	100/100
9. Frontal fontanelle	L	1/110	0/107	1/101	2/105	1/105	0/108
	C	0/104	15/100	0/104	5/104	5/109	2/111
	S	24/102	1/103	0/136	49/103	2/105	6/100
10. Frontal foramen double	L	12/220	10/214	5/202	14/210	17/210	11/216
	C	6/208	5/200	8/208	2/208	10/218	4/222
	S	8/204	5/206	8/272	11/206	3/210	5/200
11. Preoptic sutures	L	51/220	131/214	34/202	15/210	58/210	156/216
	C	38/208	96/198	46/208	79/208	49/218	32/222
	S	84/204	120/206	79/270	156/206	76/210	52/200
12. Metoptic roots abnormal	L	14/220	62/214	29/202	30/210	78/210	27/216
	C	86/208	15/198	23/208	80/208	26/218	94/222
	S	20/204	26/206	47/270	135/206	117/210	102/200

Table 5 (*cont.*)

Variant		A	B	C	D	E	F
13. Basisphenoid–presphenoid fusion	L	15/110	10/107	2/101	7/105	22/105	10/108
	C	2/104	6/100	6/104	3/104	11/109	5/111
	S	2/102	6/103	3/136	6/103	15/105	21/100
14. Basisphenoid–basioccipital fusion	L	29/110	20/107	2/101	4/105	13/105	18/108
	C	10/104	5/100	0/104	0/104	1/109	1/111
	S	5/102	6/103	3/136	0/103	1/105	0/100
15. Preorbital foramen double	L	48/220	31/214	25/202	32/210	19/210	24/214
	C	37/208	46/200	44/208	40/208	29/218	25/222
	S	33/204	39/206	42/272	51/206	58/208	44/200
16. Accessory maxillary foramen	L	13/220	10/214	22/202	13/210	8/210	6/216
	C	9/208	22/200	10/208	16/208	20/218	7/222
	S	5/204	5/206	16/272	2/206	10/210	9/200
17. Foramen palatinum majus double	L	19/220	28/214	29/202	33/210	10/210	25/216
	C	12/208	12/200	19/208	14/208	16/218	11/222
	S	8/204	11/206	52/272	11/206	13/210	7/200
18. Foramen ovale single	L	43/220	18/214	35/202	35/210	57/210	29/216
	C	76/208	94/200	36/208	31/208	11/218	75/222
	S	63/204	81/206	87/272	121/206	27/210	46/200
19. Foramen sphenoidale medium	L	22/110	24/107	23/101	35/105	17/105	12/108
	C	85/104	71/100	93/104	80/104	74/109	89/111
	S	88/102	76/103	122/136	74/103	81/105	51/100
20. Absent processus pterygoideus	L	19/220	9/214	3/202	2/210	11/210	4/216
	C	10/208	12/200	1/208	76/208	37/218	24/222
	S	11/204	25/206	76/272	36/206	41/210	24/200
21. Interparietal-occipital fusion	L	0/110	1/107	0/101	9/105	2/105	1/108
	C	0/104	1/100	2/102	0/104	0/109	3/111
	S	0/102	2/103	5/136	2/103	0/105	0/100
22. Occipital-periotic fusion	L	4/220	8/214	3/202	3/210	5/210	23/216
	C	12/208	1/200	2/208	9/208	0/218	0/222
	S	0/204	22/206	0/272	1/206	0/210	0/200
23. Foramen hypoglossi double	L	159/220	171/214	149/202	153/210	165/210	174/216
	C	143/208	161/198	97/208	98/206	157/218	162/222
	S	155/204	139/206	155/272	129/206	140/210	95/200
24. Absent fenestra flocculi	L	6/220	8/214	3/202	16/210	8/208	25/216
	C	5/208	3/200	21/208	14/206	0/218	3/222
	S	2/204	37/206	5/272	2/204	2/210	17/200
25. Accessory mental foramen	L	23/220	31/214	23/202	12/210	15/210	19/216
	C	32/208	41/200	36/208	61/208	34/218	15/222
	S	52/204	68/206	41/272	23/206	19/210	22/220
26. Lower third molar missing	L	1/220	0/214	1/202	0/210	3/210	0/216
	C	0/208	0/200	0/208	0/208	0/218	0/222
	S	3/204	0/206	3/272	1/206	0/210	5/200
27. Dyssymphysis posterior CII	L	0/110	1/107	5/101	7/105	3/105	3/108
	C	1/102	1/100	0/104	5/104	0/109	0/111
	S	3/101	0/103	0/136	0/103	0/105	0/100
28. Absent arch foramina CIII	L	1/220	4/214	5/202	3/208	6/210	6/214
	C	1/208	13/198	3/208	8/208	6/216	6/218
	S	5/204	6/206	8/272	3/204	4/210	2/200

Table 5 (*cont.*)

Variant		A	B	C	D	E	F
29. Foramen transversarium on CVII	L	0/218	3/214	28/198	6/208	16/210	2/214
	C	1/208	2/198	5/206	11/208	1/218	9/222
	S	14/202	9/204	0/272	3/206	1/210	2/200
30. Size of processus spinosus ThI	L	17/110	13/106	18/100	5/104	10/105	47/107
	C	0/103	6/100	24/104	4/104	23/109	3/110
	S	0/102	3/103	1/136	1/103	1/105	7/99
31. Absent processus ThII	L	13/110	1/106	1/100	0/104	13/104	2/107
	C	8/103	3/99	2/104	13/103	1/108	3/107
	S	28/100	8/101	2/133	5/100	20/104	0/91
32. Arch foramina ThV	L	33/220	32/214	44/202	94/208	56/210	73/216
	C	51/208	31/200	41/208	81/208	37/218	59/222
	S	55/204	38/206	34/272	79/206	74/210	53/200
33. LVI sacralized	L	2/220	1/212	0/202	6/210	30/210	49/214
	C	13/208	1/200	6/208	0/208	8/218	4/222
	S	5/204	13/206	5/272	2/204	6/210	2/200
34. Sacral fusions	L	42/110	16/107	18/101	34/105	31/105	52/108
	C	39/104	46/100	28/104	28/104	38/109	25/111
	S	17/102	27/103	23/136	5/103	16/105	35/100
35. Pink caudal vertebrae	L	1/110	9/107	6/101	3/105	10/105	9/108
	C	0/104	2/100	2/104	1/104	4/109	6/111
	S	2/102	0/103	0/136	0/103	0/105	2/100
36. Fossa olecrani perforata	L	18/220	34/214	18/202	19/210	13/210	21/216
	C	19/208	19/200	1/208	4/208	6/218	9/222
	S	0/204	3/206	4/272	2/206	2/210	1/200
37. Foramen acetabuli perforans	L	4/220	0/214	0/202	2/210	0/210	1/216
	C	0/208	1/198	2/208	0/208	0/218	1/222
	S	0/204	0/206	1/272	0/206	0/210	1/200