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BIOMETRIC COMPARISONS BETWEEN
NORTH AMERICAN
AND EUROPEAN MAMMALS

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EJNAR MUNKSGAARD

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BIOMETRIC COMPARISONS BETWEEN
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AND EUROPEAN MAMMALS

BY

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K Ø B E N H A V N

EJNAR MUNKSGAARD

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I. A COMPARISON BETWEEN ALASKAN AND FENNOSCANDIAN WOLVERINE (*GULO GULO* LINNAEUS)

INTRODUCTION

The taxonomy of many circumpolar mammals is not at present in a satisfactory state. Whereas many European students favour the circumpolar species concept, the approach of American students has often had a provincial tinge. This attitude has been criticized by one of us (RAUSCH, 1953). This holds also for the wolverine or glutton, subject of the present study: DEGERBOL 1935, ELLERMAN & MORRISON-SCOTT as well as BOBRINSKII *et al.* unite Nearctic and Palaearctic wolverine in a single species, but many American writers hold them to be specifically distinct. Moreover, following the very doubtful example set by MERRIAM in his bear studies, numerous "species" have been erected on what we believe to be individual variants (and this is certainly not an exclusive North American practice; in Europe, MATSCHIE has contributed to this kind of superfluous species-making). These "species" may be perfunctorily dismissed; there is no reason for further belabouring the species concept of Merriam and Matschie, which belongs to bygone times. The main issue here discussed is whether the Nearctic *Gulo* can be held as a species distinct from the Palaearctic *Gulo gulo*.

Apart from its intrinsic interest, the question has practical importance, for instance in the fields of parasitology and game preservation. Furthermore, it is of evolutionary importance.

With particular regard to the fossil species question, one of us (KURTÉN, in press) has tried to develop a method for the study of the degree of taxonomic affinity between populations, based on statistical study of skeletal parts, particularly skull and dentition. This method consists of bivariate analysis of a relatively large number of variate pairs in the two populations to be compared, and determination of the relative frequency of the instances in which significant differences in regression turn up. This gives a "differentiation index", which appears to be inverse to the degree of affinity of the populations: its value is relatively high in the comparison of distinct species, lower for subspecies of one species, and still lower for local demes in close contact. This is only natural: for the growth patterns, which are the subject of bivariate analysis, have a genetic basis, and changes in them arise from changes in the genome. Hence it seems likely that

the index of differentiation runs more or less parallel to the actual genetic differentiation, and may be useful in studies of this kind.

In order to test this method, and at the same time contribute to the taxonomy of circumpolar species and genera, we plan to study some of the closely related mammals of Alaska and Fennoscandia. The beginning is here made with the wolverine. In addition to our two main samples, some statistical data on other populations, including fossil glutton, have been culled from the literature.

Besides bivariate analysis, univariate analysis has also been used in the comparisons, and, finally, some data permit analysis of the differentiation on the population level within one of our type areas (Alaska); this throws further light on the supposed species *Gulo hylaesus*.

MATERIAL

The Fennoscandian material includes data on Swedish glutton published in DEGERBØL (1935) and a series of skulls from Finland in the Zoological Museum and the Anatomical Institute of Helsingfors University. Most of the Fennoscandian material was unsexed, but it could be sexed on the basis of skull dimensions, as described below in the section on univariate analysis. The Swedish material consists of 7 skulls, of which 3 are probably male, 4 female; the Finnish, of 19 skulls, probably 6 males and 13 females.

The Alaskan sample is made up of 47 male and 21 female skulls, collected by the Zoonotic Disease Section of the Arctic Health Research Center, and in addition 3 males and 1 female from the collections of the Chicago Natural History Museum; part of this sample was published in RAUSCH (1953).

DEGERBØL also published a small sample (three skulls and four jaws) collected by the "Fifth Thule" Expedition in arctic Canada. This sample is used here under the designation "Thule-Exp."

A fourth sample consists of fossil glutton from the Pleistocene of Europe. The data have been culled from KOBV (1951) and HILZHEIMER (1936), both of whom assembled numerous data from the works of earlier authors. The sample is mainly late and latest Pleistocene (Last Glaciation), the Grubenloch glutton (in HILZHEIMER) probably earliest Postglacial. A very small sample (only two lower carnassials) is from the middle Pleistocene.

BIVARIATE ANALYSIS

Method.—In the introduction were outlined the principles of the computation of a "differentiation index", based on bivariate analysis of a great number of variate pairs. It remains to touch on the details of the analysis. It was carried out in the form of an allometry study,

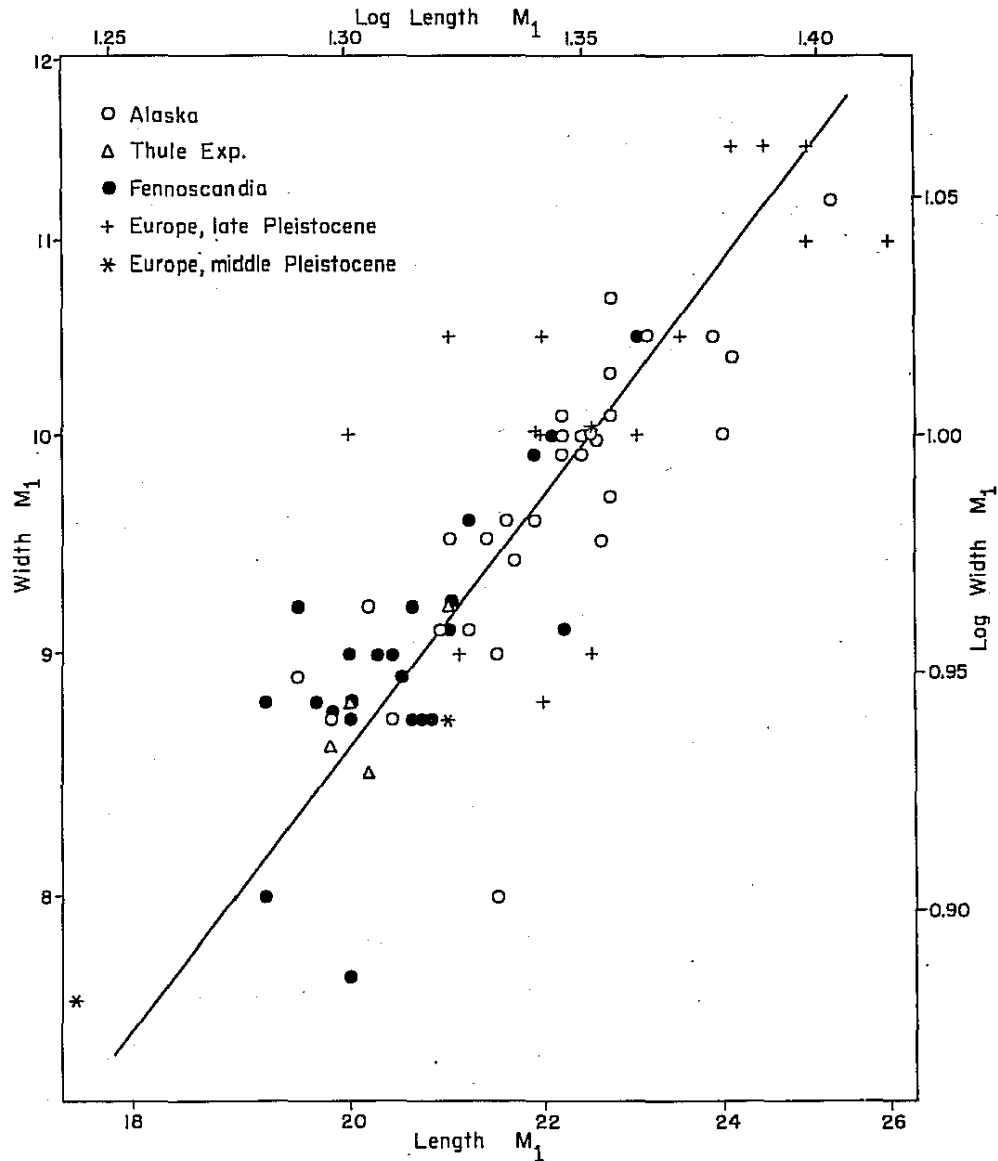


Fig. 1. Scatter diagram, showing the allometry of width on length in the lower carnassial of *Gulo*.

whereby also the presence or absence of growth gradients could be determined. Logarithms were used with two decimals in the mantissa for calculation, and three for the plotting of scattergrams. Populations were compared by means of analysis of variance, as outlined in SNEDECOR, 1945. The method can be used for the comparison of several samples at a time, but here comparison was only made between pairs of populations; in this case the variance ratio (F) = t^2 .

Evaluation of significance was based on the value of t and the number of degrees of freedom (D. F.), i.e. the combined sample minus 4.

In the illustrating scattergrams, all of which are logarithmic (with absolute data along left and lower borders, and logs along upper and right borders), trend lines are drawn in for the main populations. These lines conform to the allometry equation,

$$y = bx^k$$

The value of k , the coefficient of allometry, was obtained as

$$k = \frac{\sigma_{\log y}}{\sigma_{\log x}}$$

If several different populations do not differ significantly from each other, only one axis, for the combined sample, was computed. Exception is made if two populations are shown to differ significantly from each other, but a third one cannot be significantly dissociated from either; the position of the trend line for the third population, then, indicates its probable affinities with the two others.

Table 1 gives the covariation data. To calculate the coefficient b in the allometry equation seems to be of little practical use, and we give, instead, the means for $\log y$ and $\log x$, from which, together with k , b may be calculated if desired.

The following measurements were subjected to bivariate analysis:

Dentition: Length and width of P^4 and M_1 ; width (transverse) of M^1 , length (anteroposterior) of the inner lobe of M^1 , and length (anteroposterior) across constriction in the middle, of M^1 .

Skull: Condylbasal length, palatal length, interorbital width, and zygomatic width.

In the bivariate analysis, only dimensions with an obvious growth relationship were paired, for instance two dimensions of one and the same tooth. Moreover, duplication was avoided (e. g. comparison of two length dimensions of the skull with the same width dimension), since otherwise one and the same change in a growth gradient (e.g. increasing the relative width of the skull) would be recorded twice.

M_1 , width and length.—The scattergram fig. 1 shows the covariation between width and length of M_1 . No significant differences were found between the samples studied. The highest t -value was found in the comparison between the 16 late Pleistocene specimens and the total Recent sample, and this value was only 2.57. This should probably not be considered significant, considering in particular that the data on the fossil specimens were generally given with less accuracy (to 0.5 mm.) than the others, and are sampled from the work of many different students.

It is interesting to note that the earliest forms, the middle Pleistocene specimens from Hungary, do not show any significant deviations from the trend axis, though in absolute size they average much smaller than the late Pleistocene and living wolverine. All this suggests that the growth

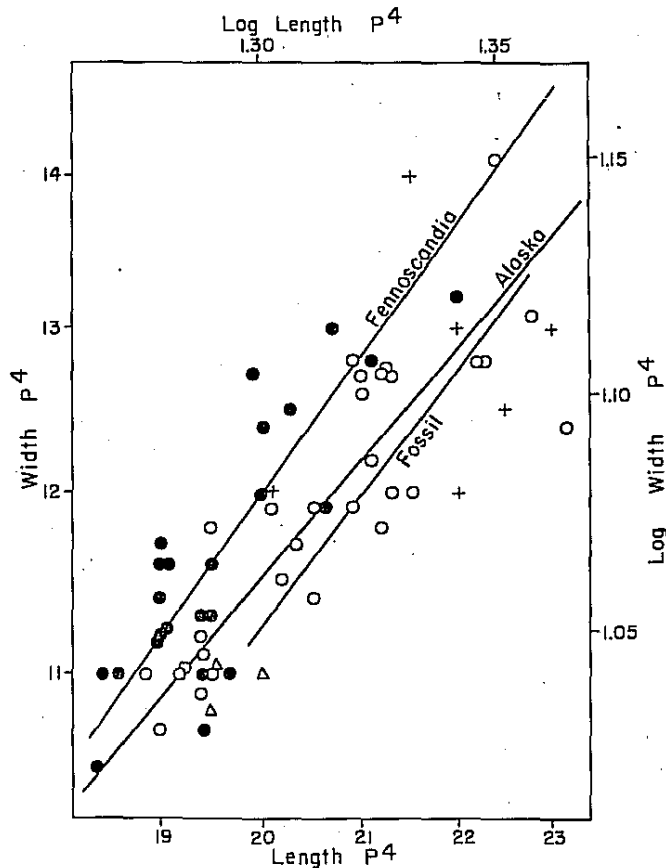


Fig. 2. Allometry width/length in upper carnassials of *Gulo*; symbols as in fig. 1.

gradient between width and length of the lower carnassial in *Gulo* is of great evolutionary stability, and has persisted unchanged in an enormous number of generations.

The allometry of width on length is positive, and absolutely larger lower carnassials, thus, will tend to be relatively broader.

P^4 , width on length.—This variate pair shows more complex relations. Our two main samples, the Fennoscandian and Alaskan, differ slightly but significantly from each other; $t = 3.02$ for 50 D.F., which is highly significant. The nature of the difference appears from the scattergram, fig. 2: the Fennoscandian upper carnassials average somewhat broader than Alaskan ones of equal length.

The two other samples (the "Thule-Exp." and fossil) cannot be significantly dissociated from either of the two main samples. The position in the scattergram, as well as geographic considerations, indicate that the "Thule-Exp." sample is most likely to agree with that from Alaska. As to the fossil sample, its axis coincides almost exactly with that for the Alaskan wolverine, and

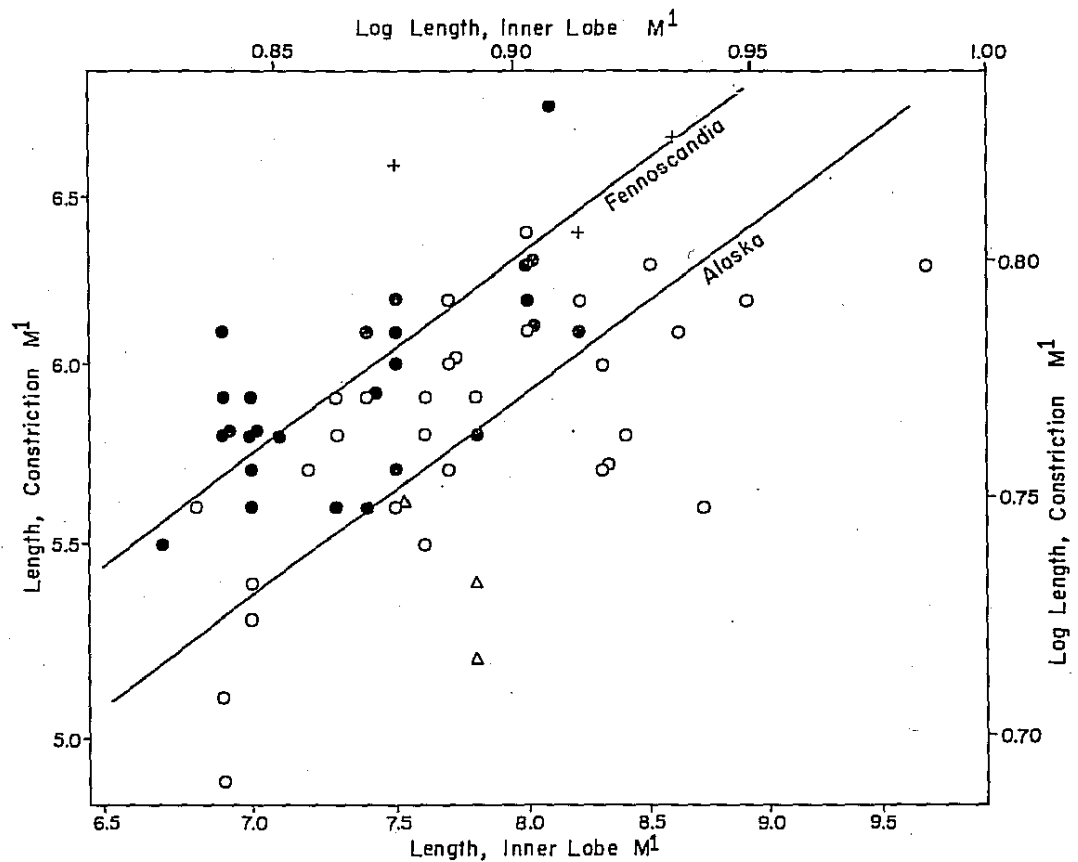


Fig. 3. Allometric relationships between the length of the upper molar (measured anteroposteriorly across constriction in middle) and its width (transverse diameter). Symbols as in fig. 1.

differs markedly from the Fennoscandian. In a comparison between the fossil and Fennoscandian samples, t is 1.85 for 26 D.F. The significance is low, but nevertheless favours identification with the Alaskan rather than with the Fennoscandian regression. Geographically, this may seem odd. However, we hope to show below that there is additional evidence for such an affinity between the Recent population of Alaska and the fossil glutton of Europe.

M^1 , length of inner lobe and width.—This variate pair shows no differentiation at all in the populations studied, and t -values fluctuate around 1. At least from the late Pleistocene on, this relationship seems to have been stable. There is a slight positive allometry of inner-lobe length on crown width.

M^1 , length at constriction and length of inner lobe.—There is strong and easily detected differentiation in this relationship. In his comparison of "Thule-Exp." and Swedish

Table 1. Mean logs and allometry coefficients (k) for variate pairs, as given under y and x , in wolverine samples.

y	x	Sample	N	$M_{\log y}$	$M_{\log x}$	k
Width P^1	Length P^1	Alaska	30	1.0768	1.3148	1.168
		Fennoscandia	24	1.0653	1.2907	1.385
		Fossil	6	1.1028	1.3412	1.311
		Thule-Exp.	3	1.041	1.298	—
Length, constriction M^1	Length, inner lobe M^1	Alaska	30	0.7638	0.8908	0.726
		Fennoscandia	26	0.7745	0.8664	0.718
		Fossil	3	0.818	0.908	—
		Thule-Exp.	3	0.731	0.888	—
Length, inner lobe M^1	Width M^1	Total	63	0.8809	1.1291	1.206
Width M_1	Length M_1	Total	74	0.9790	1.3359	1.299
Palatal length	Condylbasal length	Total	89	1.8669	2.1533	1.187
Interorbital width	Zygomatic width	Total	101	1.5985	1.9943	1.018
Interorbital width	Condylbasal length	Alaska	69	1.6059	2.1536	1.370
		Fennoscandia	25	1.5813	2.1501	1.365
		Fossil	5	1.6385	2.1685	1.133

wolverine, Degerbol pointed out that the American forms seem to be characterised by a more strongly constricted M^1 . This is fully borne out by our material. The axes for the Fennoscandian and Alaskan samples are parallel but quite distinct (fig. 3), and the difference is highly significant, t being 4.08 for 52 D.F. In both cases, the allometry is negative, so that larger teeth are relatively more strongly constricted.

The small "Thule-Exp." sample differs with the highest significance from the Fennoscandian ($t=4.86$ for 25 D.F.), but it also seems to differ from the Alaskan. Here, t is 2.77 for 29 D.F., which is perhaps not absolutely significant, but highly suggestive; the "Thule-Exp." specimens seem on an average more strongly constricted than the Alaskan.

Finally, the fossil sample differs quite certainly from the Alaskan ($t=3.83$ for 29 D.F.). It may possibly differ from the Fennoscandian, too ($t=2.85$ for 25 D.F.), but this difference seems doubtful. It is due only to a single specimen, which was measured from a photograph in reduced scale (a Grubenloch skull), and part of the deviation may be due to inaccuracy in mensuration. We therefore think it safer not to base any such conclusions on a single specimen, but to equate the fossil and Fennoscandian samples, seeing that the other fossil specimens conform well to the Fennoscandian type.

Palatal length and Condylbasal length of skull.—No differentiation was found. The palatal length is slightly positively allometric to the skull length.

Interorbital width and Zygomatic width of skull.—This relationship also appears to be identical in all the samples studied. It is practically isometric.

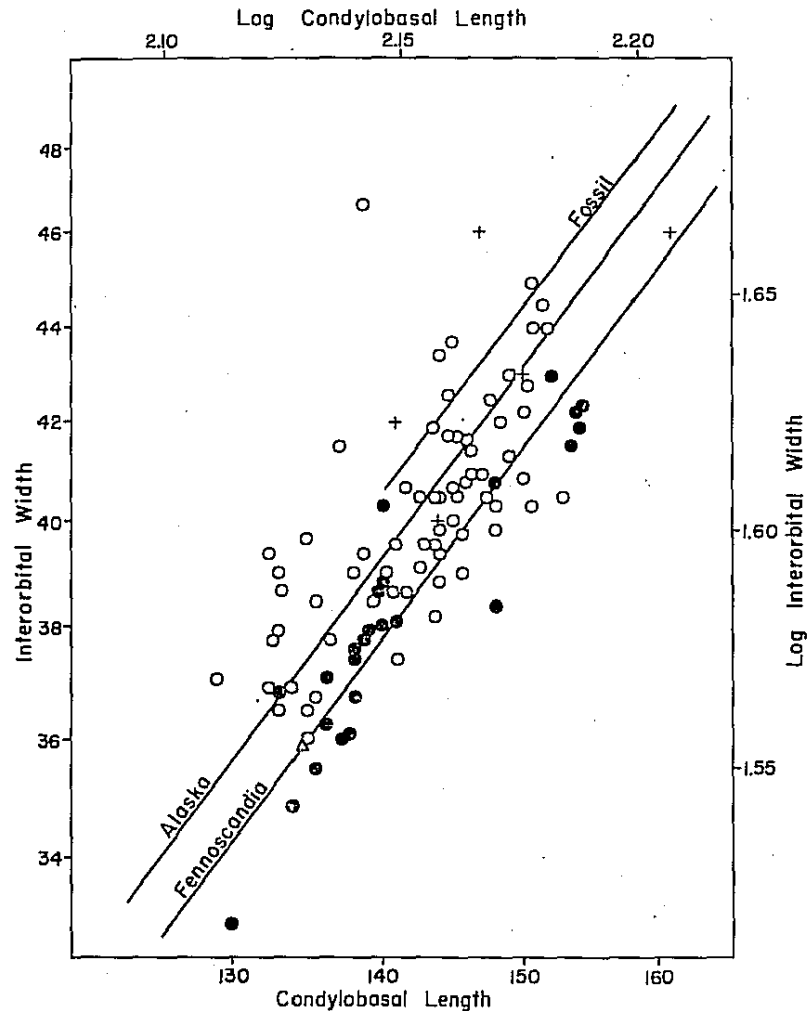


Fig. 4. Allometric relationships between the interorbital width and the condylobasal length of *Gulo* skulls. Symbols as in fig. 1.

Interorbital width and Condylobasal length of skull.—In this character the Alaskan and Fennoscandian samples differ with the highest significance ($t=6.26$ for 90 D.F.). The distinction is very evident in the scattergram (fig. 4), which shows that a rather large percentage of the total sample may immediately be classified, on this criterion alone, as of North American or European origin; the American skulls are relatively broader.

The fossil sample appears to agree rather well with the Alaskan growth pattern; the fossil skulls are also rather broad, and the difference is not highly significant ($t=2.51$ for 74 D.F.). On the other hand, the fossil skulls differ with the highest significance from the Fennoscandian ($t=5.30$ for 26 D.F.). In this character, again, the fossil glutton of Europe resembles the American form more closely than the living European form.

Table 2. Distribution of growth types in the wolverine populations.
 Italicized, differences from ancestral (Pleistocene) growth patterns.

	Fossil	Fennoscandia	Alaska	"Thule-Exp."
Width/Length P^1	P	<i>F</i>	P	P
Length inner lobe/Width M^1	P	P	P	P
Constriction/Length inner lobe M^1	P	P	<i>A</i>	<i>T</i>
Width/Length M_1	P	P	P	P
Palate length/Condylbasal length.....	P	P	P	P
Interorbital width/Zygomatic width.....	P	P	P	P
Interorbital width/Condylbasal length.....	P	<i>F</i>	P	P

The single "Thule-Exp." specimen may agree with either type; actually, it is closer to the Fennoscandian trend line, but this is not significant.

The trends of the width-length relationships here found were corroborated by similar comparisons of other width and length data, which gave identical results; but these are not recorded separately here. Seemingly, the difference between the two groups—Alaskan and fossil wolverine on one hand, Recent Fennoscandian on the other—simply consists in a change of the width-length growth gradient, which appears in the comparison of any width dimension with any length dimension. The growth type seen in the Alaskan population appears to be the older of the two, as it is also found in the European Pleistocene sample.

Differentiation.—The growth patterns found in the different populations may be summarized as in table 2. The Pleistocene population is taken to be more or less directly ancestral to the Recent ones, and growth patterns occurring in this population are denoted P. Alaskan, Fennoscandian and "Thule-Exp." modifications of these growth types are denoted *A*, *F* and *T* respectively. This gives some information on the evolution and differentiation of the populations.

For instance, out of seven characters recorded, six pass unchanged from the Pleistocene to the living Alaskan population, whereas only five are inherited without change to the Fennoscandian.

Table 3. Differentiation indices, giving the percentage of differentiated growth patterns in two populations compared.

	Alaska	Fennoscandia	"Thule-Exp."	Fossil
Fossil.....	14	29	17	0
"Thule-Exp.".....	17	33	0	
Fennoscandia	43	0		
Alaska.....	0			

The change concerns different characters in the two instances, the result being that the Recent Fennoscandian and Alaskan populations agree in only four characters out of seven.

Table 4. Statistical parameters for dimensions of wolverine skull and teeth.

		<i>N</i>	<i>M</i>	σ	<i>F</i>
Condylobasal length	Alaska, female	21	135.10 $\pm$ 0.65	2.98	2.2
	Fennoscandia, female	16	137.94 $\pm$ 0.56	2.25	1.7
	Alaska, male	48	145.75 $\pm$ 0.50	3.44	2.4
	Fennoscandia, male	8	150.37 $\pm$ 1.87	5.29	3.6
Length <i>P</i> ¹	Alaska, female	13	19.23 $\pm$ 0.11	0.39	2.0
	Fennoscandia, female	17	19.18 $\pm$ 0.11	0.44	2.3
	Alaska, male	24	21.25 $\pm$ 0.17	0.85	4.0
	Fennoscandia, male	7	20.62 $\pm$ 0.29	0.78	3.8
	Fossil, unsexed	7	22.02 $\pm$ 0.39	1.04	4.8
Length <i>M</i> ₁	Alaska, female	10	20.79 $\pm$ 0.23	0.72	3.5
	Fennoscandia, female	17	20.21 $\pm$ 0.15	0.63	3.2
	Alaska, male	20	22.77 $\pm$ 0.20	0.88	3.9
	Fennoscandia, male	8	21.70 $\pm$ 0.34	0.96	4.4
	Fossil, unsexed	24	22.90 $\pm$ 0.35	1.69	7.4
Length <i>M</i> ₂	Alaska, female	10	5.83 $\pm$ 0.10	0.30	5.2
	Fennoscandia, female	12	5.68 $\pm$ 0.07	0.26	4.5
	Alaska, male	20	6.40 $\pm$ 0.10	0.46	7.2
	Fennoscandia, male	6	6.10 $\pm$ 0.19	0.46	7.6

These relationships may be more formally expressed in the form of "indices of differentiation" giving the percentage of differentiated growth patterns in the comparison of two samples; these indices are set forth in table 3. They vary between 14 and 43, the greatest differentiation being found between Fennoscandian and Alaskan wolverine, and the least between Alaskan and fossil European ones.

Despite the relatively marked differentiation between the living and late Pleistocene gluttons of Europe (index 29) certainly no one will doubt that they belong to one and the same species, *Gulo gulo*. It would therefore seem incorrect to place the American form, which is still closer to the Pleistocene glutton of Europe, in a different species.

The indices found are rather below the average for subspecies of a single species, and very much lower than indices found for distinct species (KURTÉN, in press). This also favours the view that Nearctic and Palearctic populations are conspecific.

UNIVARIATE ANALYSIS

Sexual dimorphism and sexing of specimens.—The Alaskan sample is sexed throughout, and hence gives good information on sex dimorphism in a wolverine population. Statistics

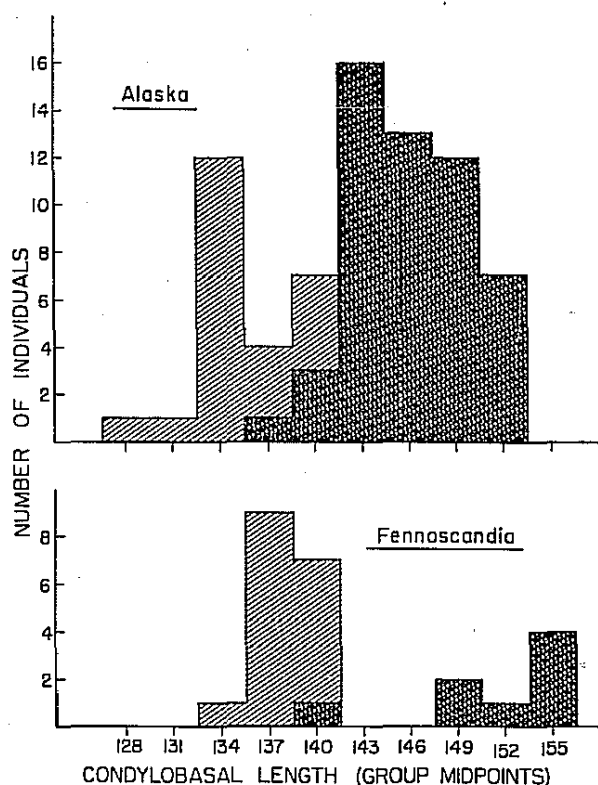


Fig. 5. Distribution of condylobasal skull lengths in *Gulo* samples from Fennoscandia and Alaska, showing sexual dimorphism in size.

for some measurements are given in table 4. The males average significantly larger than the females in all instances. The overlap between the sexes is particularly low as regards skull length; the variability in either sex is very low, as shown by the value of V , the coefficient of variation. It is also low for the other dimensions; only the vestigial M_2 is more variable.

The Fennoscandian sample may be sexed on the basis of skull length. It shows a very clear division into two distinct distributions (fig. 5). The few specimens which were sexed beforehand generally agree with this division. One of the smaller Finnish animals, however, was labelled a male. It is in the upper part of the "female" distribution and may actually be a male. One of the largest Swedish skulls, however (a Copenhagen museum specimen), was published as a female in Degerbøl. As it is larger than even the largest Alaskan males, we suspect that the museum label may have been erroneous, and treat it as a male.

In this connexion it is interesting to note the difference in the sex distributions of our two samples. The Alaskan sample consists of 50 males and 22 females, or 69 per cent males and 31 per cent females. In the Fennoscandian sample there are 9 males and 17 females, or 35 per cent males and 65 per cent females. The difference is certainly significant, and difficult to account for. The high frequency of males in the Alaskan sample might perhaps be due to the

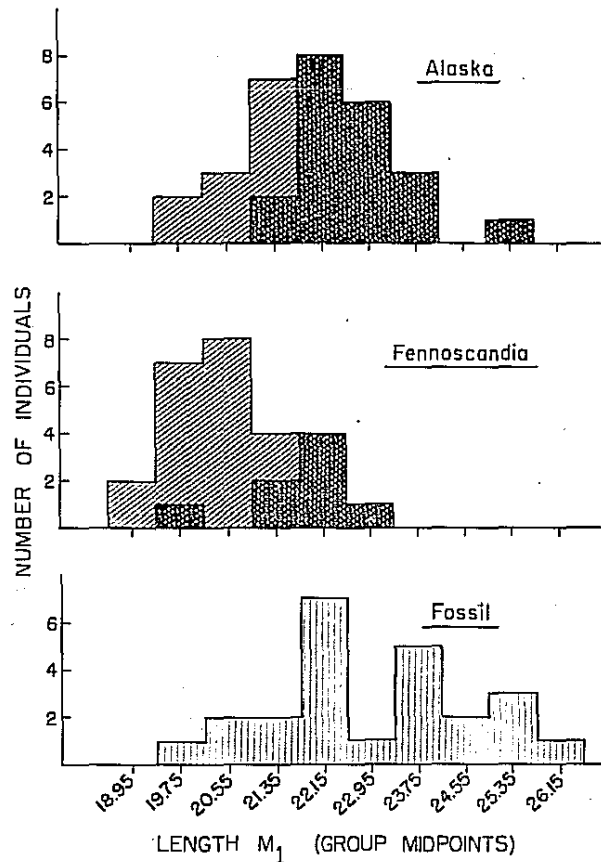


Fig. 6. Distribution of lower carnassial length in samples of *Gulo* from Fennoscandia and Alaska, and in a late Pleistocene to early postglacial sample from Europe. The fossil sample is unsexed; in the recent sample, the male specimens are deeply hatched.

fact that males travel farther and are more active in the months when the animals are legally trapped (December to April inclusive).

However this may be, a direct comparison by means of univariate analysis, between the total Alaskan and Fennoscandian samples, would give incorrect results. Alaskan averages would tend to be too high, and Fennoscandian to be too low. The only possibility is to compare males with males, and females with females.

There is sex dimorphism in the dentition also (table 4), but the overlap is higher than for the skull dimensions (no separate distributions or even clear bimodality in fig. 6). For this reason, the fossil specimens, which are often more or less fragmentary, cannot all be sexed, though the distribution for length of the lower carnassial indicates a probable grouping into females with average dimensions around 22 mm. and males with an average length of perhaps 24 mm.

Comparison of samples.—The teeth of the Alaskan wolverine seem to average somewhat larger than those of the Fennoscandian glutton. The difference is of doubtful significance in

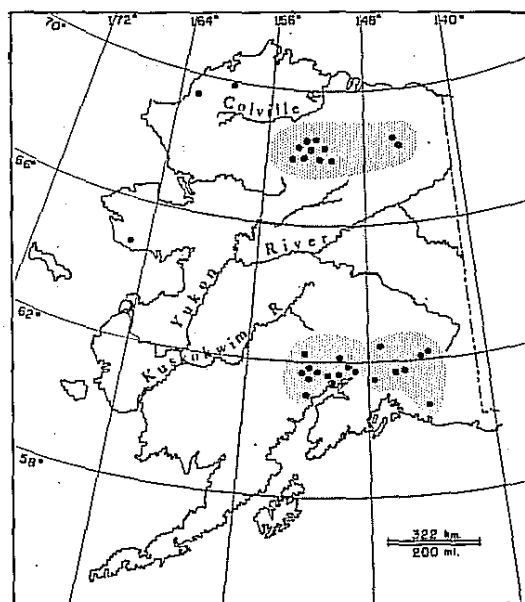


Fig. 7.

most cases, but it appears universally in every comparison, as shown in table 4. Moreover, it is probably significant in at least one instance: length of M_1 in males, where $t=2.76$ for 26 D.F.

On the other hand, the skull dimensions of the Alaskan sample seem to be somewhat inferior to those of the Fennoscandian. The condylobasal length of Alaskan females averages significantly shorter than in Fennoscandian females ($t=3.30$ for 35 D.F.).

It follows that the teeth are markedly larger in the Alaskan wolverine, also in relation to skull size, and this explains the greater crowding of the teeth in the American form, which was noted by Degerbøl.

The Pleistocene gluttons of Europe have rather large tooth dimensions, a fact repeatedly noted by investigators (e.g. Koby, 1951), and are classified as a distinct subspecies *Gulo gulo spelaeus* (Goldfuss). For instance, the length of M_1 averages 22.90 mm. in the unsexed fossil sample, and 22.77 mm. in the Recent Alaskan males. Since the fossil sample surely comprises both sexes, the dimension must have averaged still larger in the Pleistocene males. Gluttons of this large size persist as late as in the Allerød (DEGERBØL, 1946). It is clear that there has been a relatively rapid reduction in size during post-Allerød time. Such a postglacial dwarfing is found in many mammal species.

LOCAL DIFFERENTIATION IN ALASKA

With few exceptions, the Alaskan wolverine material comes from two well separated areas, each of them of limited extent (shaded in fig. 7). The southern area extends from Skwentna and

Table 5. Dimensions of male wolverine in two regional samples from Alaska.

		<i>N</i>	<i>M</i>	<i>σ</i>
Condylobasal length	(1) Brooks Range	29	144.78 ± 0.58	3.10
	(2) Skwentna Region	15	147.93 ± 0.69	2.69
Length, maxillary tooth row	(1) Brooks Range	29	53.24 ± 0.25	1.36
	(2) Skwentna Region	17	55.29 ± 0.22	0.90
Length, upper carnassial	(1) Brooks Range	12	20.95 ± 0.14	0.49
	(2) Skwentna Region	10	21.50 ± 0.33	1.04

Beluga Lake in the west to Chistochina and Chitina in the east, and the main part of the material was collected in the neighbourhood of Skwentna. This will be called the Skwentna Region. The northern area is in the Brooks Range, with material from the Anaktuvuk Pass area and Arctic Village. Within each region, no significant differences between local samples were found. Between the regions, however, such differences do exist.

The sample of females is somewhat too small for useful comparison, but the trend appears to be similar as for the males, on which the statistics are given in table 5. Three dimensions were compared, condylobasal length, length of maxillary tooth row, and length of upper carnassial. In each case the length in the Brooks Range sample averaged inferior to that in the Skwentna sample. The difference is highly significant for the condylobasal length ($t=3.49$ for 42 D.F. and maxillary tooth row length ($t=6.13$ for 44 D.F.), not significant for carnassial length ($t=1.54$ for 20 D.F.), on which we have less numerous data.

Within the Brooks Range, the males from Arctic Village averaged very slightly larger than those from Anaktuvuk Pass (though still much smaller than the Skwentna males), but the difference is not significant.

The results establish the presence of south-north cline with slight reduction of size to the north, a situation which appears to be in conflict with Bergmann's rule. Whether the difference results from stunting in the Brooks Range population, or from genetic differentiation, can hardly be evaluated at present.

The difference found is on the deme level, and should not be reflected in formal nomenclature. ELLIOT (1905) based a new "species", *Gulo hylaeus*, on material from Susitna River, within our Skwentna Region. We do not consider the name valid, not even on the subspecies level (see also RAUSCH, 1953, p. 114). If any necessity for a special denomination arises in a case like this, it can be well met by using a vernacular name (e.g. the Skwentna "strain" or deme of *Gulo gulo luscus*). To recognize subspecies on this scale would entirely obscure the broader and more significant infraspecific grouping.

TAXONOMIC CONCLUSIONS

The American and European wolverine are significantly different in a number of quantitative characters. The American form has somewhat larger teeth, but a shorter skull; the skull is broader in relation to its length, M^1 is more constricted in the middle, and P^4 is somewhat narrower. The salient points are shown in the accompanying plate. But all of these characters, except the greater constriction of M^1 , seem to be inherited from the Pleistocene European *Gulo gulo*, which apparently represents the common ancestor of American and European wolverine. It may therefore be thought that the American form is a relatively late immigrant, and that most of the differentiation results from late Pleistocene and postglacial evolution, particularly in the European branch. Pleistocene American wolverine, for instance the excellent skull from Cumberland Cave described by GIDLEY and GAZIN (1938), seem to be perfectly identical with their living descendants (though it has been placed in a distinct "species", *Gulo gidleyi* HALL). The age of this specimen appears to be Illinoian or Sangamon (Penultimate Glaciation or Last Interglacial); see HIBBARD (1958), and the wolverine might perhaps be an Illinoian immigrant in North America.

The difference between the fossil wolverine of Europe and the Recent of America is actually less marked than that between the fossil and living forms in Europe. No one doubts that the Pleistocene glutton of Europe belongs to the species *Gulo gulo*. There can then be no valid reason for dissociating the American population from that species. It may be concluded that the European and American wolverine form two distinct subspecies, but that they are not specifically distinct. The valid subspecies names are *Gulo gulo gulo* (L.) for the European, and *Gulo gulo luscus* (L.) for the American form.

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