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The function of the dewclaw in the Scandinavian red fox (*Vulpes vulpes*)

Jan K. Å. Englund

ABSTRACT. In foxes, *Vulpes vulpes*, the dewclaw sits on the forelimb a bit up from the ground. It is usually thought to be functionless. The length of metacarpal 1 and metacarpal 3, as well as the relation between them (Mc1 / Mc3), increases northwards from Denmark to northern Sweden. If it were the same physiological system regulating the growth of all the metacarpal bones, they would increase at the same ratio and the long metacarpal 3 (43–64 mm) would therefore increase northwards in absolute length more than the shorter metacarpal 1 (13–20 mm). In this case the dewclaw in northern foxes would be set higher above the ground than in southern ones. If measured as a percentage, however, the mean length of metacarpal 1 shows a larger increase northwards than that of the other metacarpal bones. The tip of the nail of the dewclaw in foxes is shown to be 12–15 mm above the ground in all areas in Scandinavia, and the dewclaw is therefore considered to have an important function. It is believed to increase the effectiveness of hunting voles, when the dewclaws will hit the back of the prey.

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KEY WORDS: anatomical adaptation, dewclaw, metacarpal, red fox, *Vulpes vulpes*.

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О функции первого пальца передней конечности у скандинавской обыкновенной лисицы (*Vulpes vulpes*)

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РЕЗЮМЕ. У лисиц укороченный (рудиментарный) первый палец расположен на передней конечности выше остальных пальцев и не достает до земли. Принято считать, что он не несет функциональной нагрузки. Длина первой и третьей метакарпальных костей, как и величина отношения между ними (Mc1 / Mc3) возрастают в направлении от Дании к северной Швеции. Если бы рост всех метакарпальных костей регулировался одним и тем же физиологическим механизмом, то их абсолютная длина увеличивалась бы равно пропорционально, и длинная Mc3 (43–64 мм) удлинялась бы в северном направлении значительнее, чем более короткая Mc1 (13–20 мм). В этом случае первый палец у северных лисиц оказался бы расположенным выше над поверхностью земли, чем у южных. Если же выразить увеличение длины в процентах, то окажется, что средняя длина Mc1 возрастает к северу больше, чем длина других метакарпальных костей. Согласно полученным данным, конец когтя первого пальца находится на расстоянии 12–15 мм от поверхности земли у лисиц во всех областях Скандинавии. Вероятно, первый палец несет важную функциональную нагрузку и служит увеличению эффективности охоты на полевок, помогая удерживать добычу.

КЛЮЧЕВЫЕ СЛОВА: анатомическая адаптация, рудиментарный первый палец, метакарпалии, обыкновенная лисица, *Vulpes vulpes*.

Introduction

The dewclaw in the red fox *Vulpes vulpes* (Linnaeus, 1758) sits on the fore legs and high up from the ground, and its distal end does not make contact with the ground, when the animals are standing. It is often thought to be totally functionless. But in such a case, why is the dewclaw still left on the fore leg whereas the corresponding toe has disappeared at the hind leg? Dr. Chris Zink (pers. comm., 2019) at the John Hopkins University (USA) believes that the dewclaws are very important for dogs. As she says there are 5 tendons attached to the dewclaw and at the other end of the tendons there are muscles. When the dog is galloping the dewclaw, which then is in contact with the ground, will dig into the ground, which make it easier for the

dog to change the direction. In this situation the muscles attached to the dewclaw will reduce the risk of twisting the fore legs.

Material and methods

The present paper is based mainly on data obtained from the author´s private collection of foxes collected in Scandinavia in 2010–2018 and some few specimens from the author´s collection at the Swedish Museum of Natural History in Stockholm.

Some foxes are from the coniferous belt in northern and southern Norrland (here called S1, 62–68° N latitude and S2, 59.5–62° N; the southern part of Dalarna is included in southern Norrland). The agricultural habitats are represented by three areas, which are the central part of Sweden (S3, 58.5–60° N), the most southern province in Sweden called Scania (S4, 55.3–56.3° N; the southern part of Halland and Blekinge are included) and Denmark (Dk, 55–58° N, Fig. 1).

Metacarpal 1 (Mc1) and metacarpal 3 (Mc3) were measured to the nearest 0.01 mm. In juvenile specimens only those bones that were full grown according to the suture conditions in metacarpal 3 have been taken into account. The distance between the tips of the nails of the dewclaw and the second toe has been measured to the nearest mm, the foot being straightened. Metacarpal 1 was measured according to as it is shown in Fig. 2.

To examine whether the foxes in the different groups differed in size, ANOVA tests followed by Hochberg's GT2 post hoc tests were carried out. Figures were drawn using the software package PIA (Bignert, 2013). The error bars in the figures specify the 95% confidence interval of the mean.

The significance of the differences in the means are shown by asterisks where (**) = $p < 0.02$, ** = $p < 0.01$ and *** = $p < 0.001$. Differences in measurements were considered significant when $p < 0.02$. The number of specimens is given below the shortenings of the areas studied.

Results

Except for the very large foxes in Scania (S4), metacarpal 1 and metacarpal 3 show continual increase in length northwards from Denmark to northern Sweden (Fig. 3) and Appendices 1, 2).

The quotient between the lengths of metacarpal 1 and metacarpal 3 increases northwards as well (Fig. 4). This means that the percentage increase of the length of metacarpal 1 is larger than that of metacarpal 3.

Except for the large foxes in Scania, the distance between the tips of the nails of the dewclaw and the second toe increases continually from Denmark to northern Norrland (Fig. 5, Appendix 3). In spite of that the tip of the nail of the dewclaw will be set at practically the same distance above the ground in all the areas studied (Appendix 4).

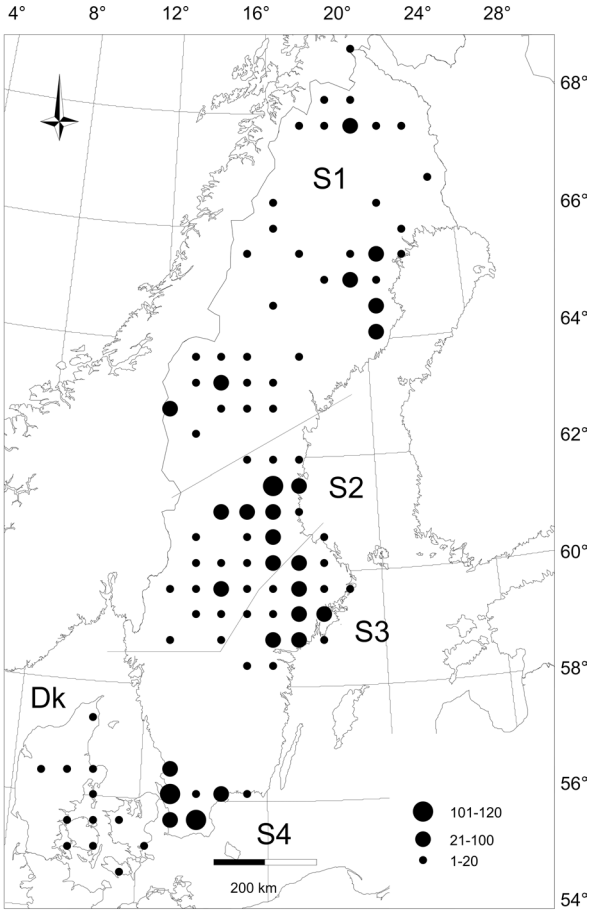

Fig. 1. The distribution of the material per 50 × 50 km squares within five areas in Scandinavia (S1 — northern Norrland, S2 — southern Norrland, S3 — central Sweden, S4 — Scania, Dk — Denmark). Size of black circles shows the number of fox specimens studied.

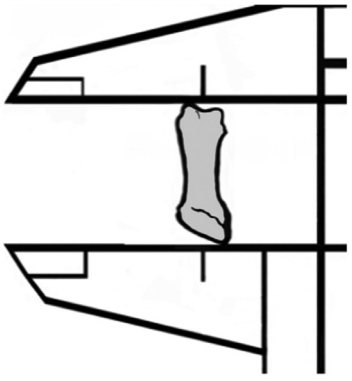

Fig. 2. When measuring the length of metacarpal 1 the two markings on the device are placed above the middle of the score and the sloping part at the opposite end of the bone.

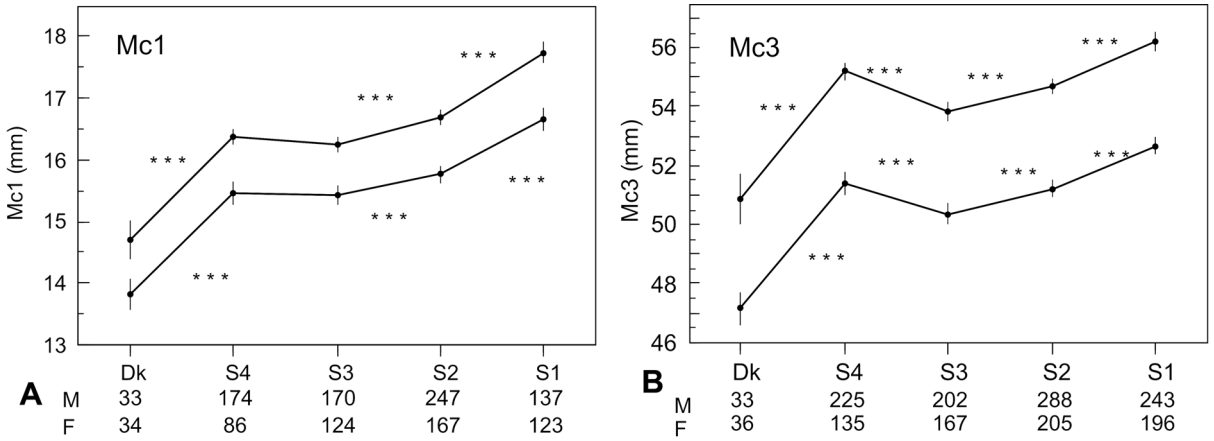

Fig. 3. Mean length of metacarpal 1 (A) and metacarpal 3 (B) in Scandinavian red foxes.

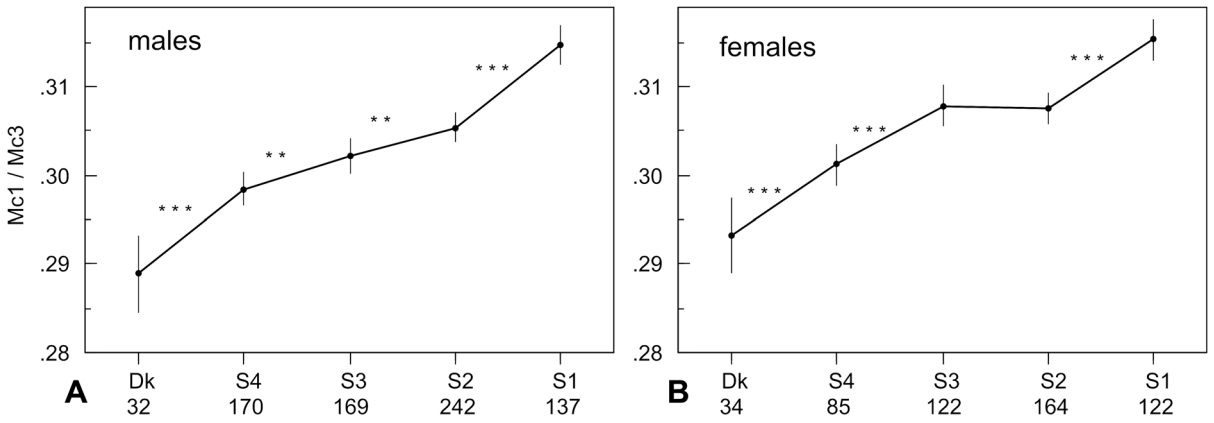

Fig. 4. The mean of the ratio between the lengths of metacarpal 1 and metacarpal 3 (Mc1 / Mc3) in Scandinavian red foxes.

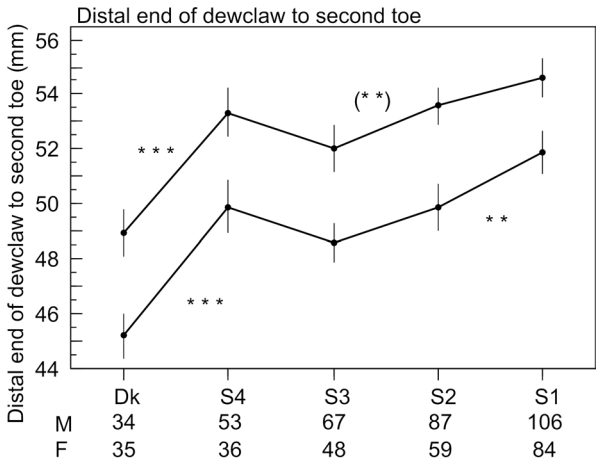

Fig. 5. The mean distance (mm) between the tips of the nails of the dewclaw and the second toe in Scandinavian red fox.

Discussion

The dewclaw is set high up from the ground in the fore legs and therefore its claw will not reach down to the ground. This digit is considered by many to be an ancient relic, which completely lacks any value. Dr. Zink (pers. comm., 2019), however, argues that the dewclaw is vital, since the muscles attached to metacarpal 1 will decrease the risk for twisting the leg. This is a strong argument showing that the dewclaw and metacarpal 1 are vital but there is no argument as to why the dewclaw will sit above the ground level.

Apart from the foxes in Scania, which have very long legs because the foxes there are very large (unpublished data) the legs show a continuous increase in length northwards as an adaptation to the larger amount of snow (unpublished data). Since metacarpals 2–5 are an extension of the fore legs these bones also increase in length northwards (Fig. 3). If it were the same physiological system that had caused the lengthening of all the five metacarpals, the length of all the bones would increase with the same percentage. The mean length of metacarpal 3 varies between 47 and 56 mm whereas the mean length of metacarpal 1 varies between 14 and 18 mm (Fig. 3 and Appendices 1, 2), both increasing northwards. In such a case the absolute length of metacarpal 3 should show a larger increase than that of metacarpal 1 and the distal end of the dewclaw would therefore be higher above the ground in the northern foxes.

However, metacarpal 1 increases more in per cent than metacarpal 3 (Fig. 4), which means that the distal end of the dewclaw in the northern foxes is in fact closer to the ground than it otherwise should have been. Thus the dewclaw must have some function to perform that has to do with the distance to the ground.

The mean distance between the tips of the nails of the dewclaw and the second toe increases about six mm from Denmark to northern Norrland (Fig. 5, Appendix 3). Since foxes walk on their digits and not on the distal tips of them, the distance between the tip of the nail of the dewclaw and the ground is equal to the distance between the tips of the nails of the dewclaw and the second toe (stretched) minus the total length of all digits of the second toe (which approximately is about twice the length of the proximal phalange of the second toe). Since the toes are longer in the northern foxes (unpublished data) the distal end of the nail of the dewclaw is at about the same level above the ground in foxes from all areas in Scandinavia, a mean value varying from 14 to 15 mm in males and 12 to 13 mm in females (Appendix 4).

When foxes are hunting voles (a technique known as mousing) they leap into the air and strike their prey from above. The chance to catch the vole will obviously increase if the tips of the nails of the dewclaw hit the back of the vole, especially if the prey had moved a little while the fox is up in the air.

Thus, the possible function of the dewclaw is to make the mousing more effective. However, to have a correct length of metacarpal 1 so the hunting of voles will be more successful seems not to be as important as to have the appropriate length of the legs, since metacarpal 3 has a lower variation (SD) than metacarpal 1 in ten times out of ten and with $p < 0.01$ in seven of the comparisons (Appendix 5).

The suggestion that the dewclaw will make the vole hunting more effective can be verified or questioned by examining the skins from voles captured by foxes.

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References

Bignert A. 2013. The PIA Application for Statistical Analysis of Time-series Data. Available from http://www.amap.no/documents/.

Appendix 1. Mean length of metacarpal 1 (mm). Diff = difference.

	Males					Females				
Region	Dk	S4	S3	S2	S1	Dk	S4	S3	S2	S1
Mean	14.7	16.4	16.2	16.7	17.7	13.8	15.4	15.4	15.8	16.7
SD	0.892	0.896	0.860	0.938	1.080	0.689	0.890	0.851	0.912	0.991
n	33	174	170	247	137	34	86	124	167	123
Median	14.7	16.2	16.3	16.6	17.8	13.6	15.4	15.4	15.8	16.7
Max	16.5	19.2	18.3	19.6	20.0	15.7	19.1	17.9	18.9	19.5
Min	13.2	14.6	13.6	14.6	14.9	12.6	13.7	13.7	13.6	14.0
	Dk-S4		S4-S3	S3-S2	S2-S1	Dk-S4		S4-S3	S3-S2	S2-S1
Diff, mm	1.7		-0.1	0.4	1.1	1.6		0.0	0.3	0.9
Diff, %	11.3		-0.8	2.7	6.3	11.8		-0.2	2.2	5.7
p <	0.001			0.001	0.001	0.001			0.001	0.001

Appendix 2. Mean length of metacarpal 3 (mm). Diff = difference.

	Males					Females				
Region	Dk	S4	S3	S2	S1	Dk	S4	S3	S2	S1
Mean	50.8	55.2	53.8	54.7	56.2	47.1	51.4	50.4	51.2	52.7
SD	2.419	2.362	2.287	2.426	2.665	1.694	2.290	2.251	2.256	2.147
n	33	225	202	288	243	36	135	167	205	196
Median	50.9	55.3	53.8	54.8	56.1	47.2	51.5	50.3	51.2	52.7
Max	58.7	61.4	59.9	61.4	64.0	50.8	60.4	56.5	57.2	58.1
Min	45.6	48.1	48.6	47.4	49.3	43.3	44.7	45.0	42.7	47.6
	Dk-S4		S4-S3	S3-S2	S2-S1	Dk-S4		S4-S3	S3-S2	S2-S1
Diff, mm	4.3		-1.4	0.9	1.5	4.2		-1.0	0.9	1.4
Diff, %	8.6		-2.5	1.6	2.8	9.0		-2.0	1.7	2.8
p <	0.001		0.001	0.001	0.001	0.001		0.001	0.001	0.001

Appendix 3. The distance between the tips of the nails of the dewclaw and the second toe (mm). Diff = difference.

	Males					Females				
Regions	Dk	S4	S3	S2	S1	Dk	S4	S3	S2	S1
Mean	49.0	53.3	52.0	53.6	54.6	45.2	49.9	48.6	49.8	51.9
SD	2.407	3.174	3.505	3.172	3.776	2.400	2.816	2.507	3.251	3.690
n	34	53	67	87	106	35	36	48	59	84
Median	49	53	52	54	54	46	50	49	49	52
Max	54	62	60	63	65	50	59	55	59	61
Min	45	46	44	43	45	40	44	42	44	44
	Dk-S4		S4-S3	S3-S2	S2-S1	Dk-S4		S4-S3	S3-S2	S2-S1
Diff, mm	4.3		-1.3	1.6	1.0	4.7		-1.3	1.2	2.1
Diff, %	8.8		-2.4	3.1	1.9	10.4		-2.6	2.5	4.2

Appendix 4. The distance between the tip of the nail of the dewclaw and the ground (mm).

	Males					Females				
Regions	Dk	S4	S3	S2	S1	Dk	S4	S3	S2	S1
Mean	14	15	14	15	14	13	13	12	13	13
SD	2.142	2.582	3.091	2.880	3.186	2.104	2.221	2.213	2.417	2.980
n	34	53	67	87	103	34	35	47	59	83
Median	14	14	14	15	13	13	13	12	13	14
Max	19	22	20	24	23	17	18	18	20	19
Min	10	11	4	5	5	8	8	6	8	5

Appendix 5. The standard deviation (SD) of normalised data of the length of metacarpal 1 (Mc1) and metacarpal 3 (Mc3) and the proportion of the $(SD)^2$ for Mc1 (SD1) and Mc3 (SD3).

	Males					Females				
Regions	Dk	S4	S3	S2	S1	Dk	S4	S3	S2	S1
SD, Mc1	0.059	0.055	0.053	0.056	0.061	0.050	0.058	0.054	0.058	0.059
SD, Mc3	0.047	0.044	0.041	0.043	0.047	0.036	0.046	0.041	0.042	0.042
n	32	169	169	242	137	34	85	121	164	121
$(SD1)^2/(SD3)^2$	1.546	1.567	1.651	1.678	1.674	1.894	1.550	1.762	1.898	2.021
$p <$	–	0.01	0.01	0.0001	0.01	–	0.05	0.01	0.0001	0.001