Morphometrics: elephant back and tail lengths

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Introduction

East African savannah elephant (*Loxodonta Africana*) back lengths are shown to be the same as their shoulder heights. As the latter are reasonable criteria for estimating ages, back lengths from aerial photographs taken vertically over individuals and herds can also be used to establish elephant population structures. The mean tail lengths are a constant proportion of shoulder heights regardless of gender or age; however, the variance of 22.8% around the mean renders them unusable as ageing criteria for individual elephants.

To record information on the morphometrics of a population of savannah elephant, Laws et al. (1975, Appendix B, 1. Body measurements) took 11 body measurements from culled carcasses. This field note compares three measurements: shoulder heights, back lengths, and tail lengths. These data have been referenced previously (Laws et al. 1975; Laws 1969), but due to being hidden amidst a wealth of other material, they warrant representation for potential use in analysing elephant populations.

Materials and Methods

Elephant culling in Uganda between 1965 and 1967 has been described in detail by Laws et al. (1975) and Parker and McCullagh (2021). The measurements (taken with a steel tape to the nearest cm) presented here were made immediately post-mortem. The height of the shoulders was a straight line from the side of the forefoot to the leg column locked straight to where it was intersected at right angles by a straight line across the two scapulae crests (n = 2,877 adopted as standard measure of elephant size). The back lengths (n = 393) and tail lengths (n = 185) were taken as subsamples of the 1,200 animals culled in Murchison Falls National Park (NP) north of the Victoria Nile. The length of the back was a straight line from where the posterior border of the ear met the head, touched the convexity of the dorsal ridge, and the point where a straight line, a right angle from the tape, touched the posterior outline of the body. (Fig. 1). Tail lengths were the straight-line distance between the end of the extended tail (excluding hairs, which can be more than 50 cm long) and the point where the underside of the tail meets the body.

Results

Shoulder heights and back lengths are presented as means in five-year-of-age cohorts (for reasons see Parker 2023) for both genders separately and combined in Table 1 and Fig. 2. Differences between the means of shoulder heights and back lengths are all <5% of shoulder height, with a single exception (males in the 20–25-year cohort 5.9%). There were no significant differences between shoulder heights and back lengths for either sex, independently or in combination (t test 0.867).

Table 2 and Fig. 3 present tail lengths as proportions (%) of shoulder heights as the means of five-year age-cohorts, showing genders separately. Across the nine (female) and eight (male) cohorts for which data were available, tail lengths, respectively, averaged 43.4% and 43.8% of the average shoulder heights. However, the raw data of the individuals from whom the cohort data are derived indicate that <5% fell within the cohort means (variance ranging between 33.8% and 56.6% of shoulder height). Consequently, as a metric to establish individual age or body size, tail length is inappropriate.

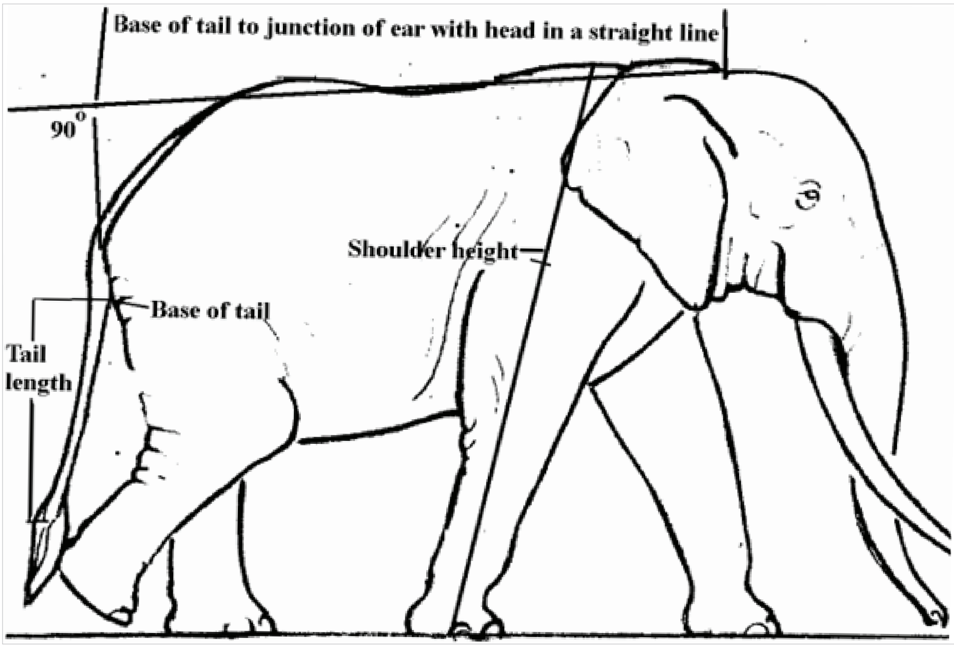

Figure 1. The measurements of shoulder, back and tail lengths are illustrated diagrammatically.

Discussion

Morphological measurements of culled elephants were made because no such data set had previously been available at the population level. At the time, there were few keys to estimating wild elephant ages: among them were dentition (Laws 1966; Sykes 1966; Buss and Smith 1966), shoulder heights (Laws and Parker 1968), and eye lens weights (Laws 1967). Dentition and shoulder heights are both obtainable from anaesthetized animals or, with the addition of eye lenses from dead specimens, but measurements are difficult to acquire quickly in the field at population levels. To do so, a method to achieve this without killing or anaesthetising subjects has always been desirable. Photographs of elephants taken vertically above and calibrated for height permit back length to be transformed into the age of the elephant. Aerial photography allows population structures to be assessed quickly and on a large, albeit coarse scale, without physical contact. This was applied by Laws (1969) in Kenya's Tsavo East and West NPs. However, as illustrated here, while back length can be taken as an ageing key as shoulder height, the 1:1 ratio between shoulder and back may not apply elsewhere. As reported by Hall-Martin in Bosman and Hall-Martin (1986), the proportions of elephants seem to differ across Africa. For example, the back lengths of elephants in Botswana and western Zimbabwe subjectively appeared to the author, to be greater than their shoulder heights. Back length as an ageing key needs recalibration regionally, raising a point: the relationship between shoulder height and age established from dentition illustrated in Laws et al. (1975), seems widely used outside East Africa (Whyte and Hall-Martin 2017). Has it been validated as a population parameter anywhere else?

Tail lengths averaging 43.3% of mean shoulder heights were constant for both genders of all ages. However, while that is a population overview created by deliberately smoothing the data into five-year cohorts, at the individual level, a variance of 22.8% about the mean renders the metric unreliable as an index of age or any other morphological parameter.

Acknowledgements

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Table 1. Compares shoulder heights to back lengths as averages of 5-year cohorts, the difference between them in cm, and as a proportion (%) of shoulder heights. Cohorts in years **I** = 0–5.5; **II** = 6.5–10.5; **III** = 11.5–15.5; **IV** = 16.5–20.5; **V** = 21.5–25.5; **VI** = 26.5–30.5; **VII** = 31.5–35.5; **VIII** = 36.5–40.5; **IX** = 41.5–45.5; **X** = 46.5–50.5, **XI** = 51.5–55.5; **XII** = 56.5–60.5.

Sex	Age in 5-year cohorts	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Females	Sample size 221→	59	31	16	23	22	23	14	7	10	5	8	3
	Shoulder cm	140.0	191.4	220.6	225.2	236.0	239.0	248.0	252.3	252.0	263.0	248.0	251.0
	Back cm	139.0	190.6	219.5	224.9	232.0	239.0	246.0	254.7	255.0	263.0	248.0	249.0
	Difference shoulder/back cm	5.5.0	5.9	6.9	9.4	9.7	9.4	8.2	3.4	9.8	11.6	9.0	3.0
	Difference as % of shoulder	3.9	3.1	3.1	4.2	4.1	3.9	3.3	1.4	3.9	4.4	3.6	1.2
	SD	2.1	2.2	2.4	2.7	2.8	2.9	3.4	4.5	2.9	3.3	2.8	1.3
Males	Sample size 172 →	69	34	16	15	20	13	3	2	0	0	0	0
	Av. Shoulder height cm	141.0	230.9	246	262.8	252.0	305.0	290.0	285.0				
	Av. Back Length cm	138.0	226.4	234.0	252.2	273.0	287.0	285.0	304.0				
	Av. Difference cm	4.7	8.6	12.1	11.5	10.5	18.0	5.5	19.0				
	Av. difference as % of shoulder height	3.2	3.7	4.9	4.4	3.7	5.9	1.9	6.7				
	SD	2.3	2.1	3.3	3.2	3.1	4.2	2.2	4.4				
All	Sample size 393	129	65	32	38	42	36	17	9	10	4	8	3
	Av. Shoulder height cm	141.0	196.2	226.0	233.5	249.0	254.0	258.0	254.3	252.0	263.0	248.0	251.0
	Av. back length cm	140.0	193.4	229.0	228.5	242.0	251.0	253.0	255.8	255.0	263.0	248.0	249.0
	Av. difference cm	5.0	6.0	7.8	10.4	10.5	9.8	9.9	3.9	9.8	11.1	9.0	3.0
	Difference as % of Shoulder height	3.7	3.1	3.4	4.5	4.3	3.9	3.9	1.5	3.9	4.4	3.6	1.2
	SD	2.0	2.3	2.5	2.9	3.0	3.0	3.0	1.7	3.0	3.3	2.8	1.3

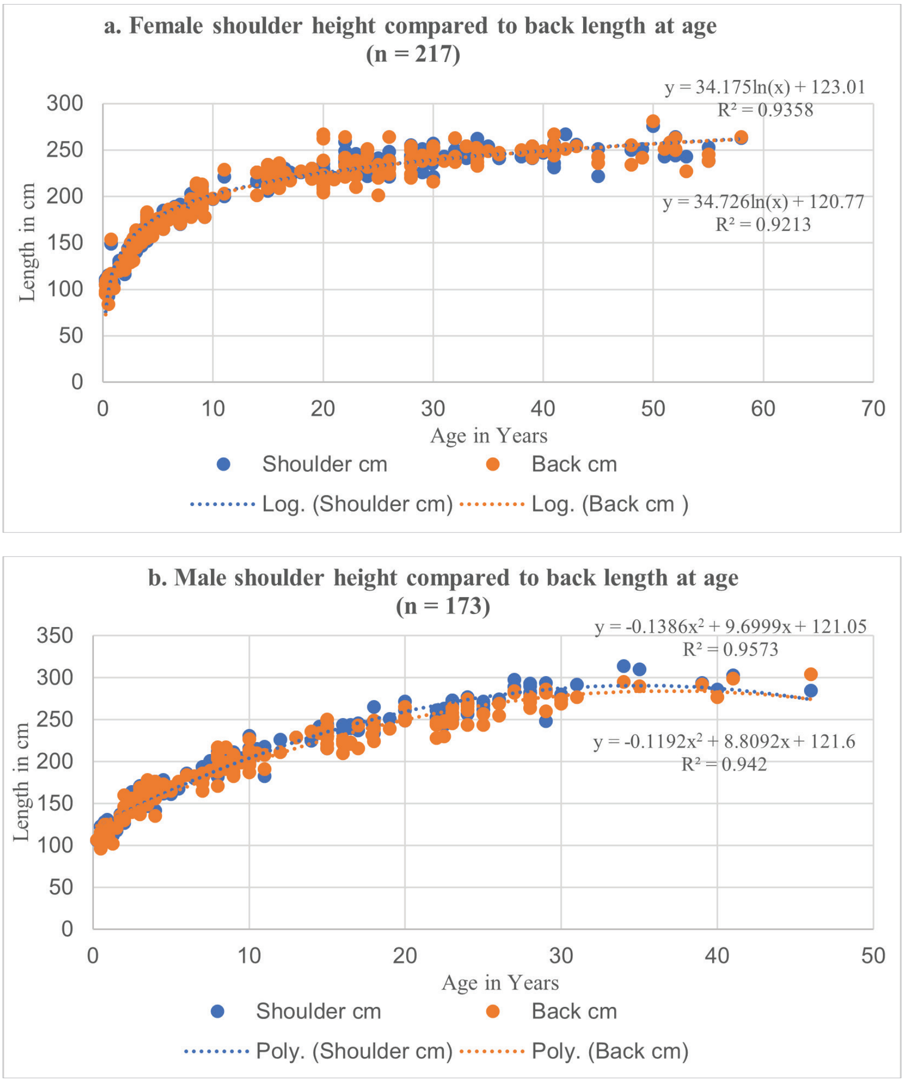

Figure 2. Panel a = females and Panel b = males comparing shoulder heights with back lengths, showing that they were almost mirror images of each other.

Table 2. Elephant tail lengths as proportions (%) of shoulder heights presented as means in 5-year cohorts. Data were not available for females >50.5 years and males > 45.5 years.

Sex	Age cohort	Sample	Mean cm of the shoulder	Tail mean cm	Tail as % of shoulder	SD
Females	0–5.5	n = 10	143.9	61	42.5	6.73
	6.5–10.5	n = 21	183.9	77.7	42.1	6.51
	11.5–15.5	n = 13	218.6	91.3	41.8	6.46
	16.5–20.5	n = 8	224.8	98.5	43.8	6.62
	21.5–25.5	n = 17	233.7	99.3	42.5	6.52
	26.5–30.5	n = 7	240.3	102.4	42.7	6.53
	31.5–35.5	n = 11	249.1	109.5	44.0	6.62
	36.5–40.5	n = 3	259.3	117.0	45.2	6.72
	41.5–45.5	n = 2	268	122.5	45.7	6.76
Males	0–5.5	n = 9	133	62	46.6	6.81
	6.5–10.5	n = 19	187.2	83	44.3	6.64
	11.5–15.5	n = 13	231.6	102.8	44.4	6.66
	16.5–20.5	n = 12	257.7	109.2	42.4	6.51
	21.5–25.5	n =11	272.7	118.7	43.5	6.59
	26.5–30.5	n = 24	287.3	125.4	43.6	6.60
	31.5–5.5	n = 4	290.8	121.3	41.9	6.47
	36.5–40.5	n = 1	319	140	43.9	

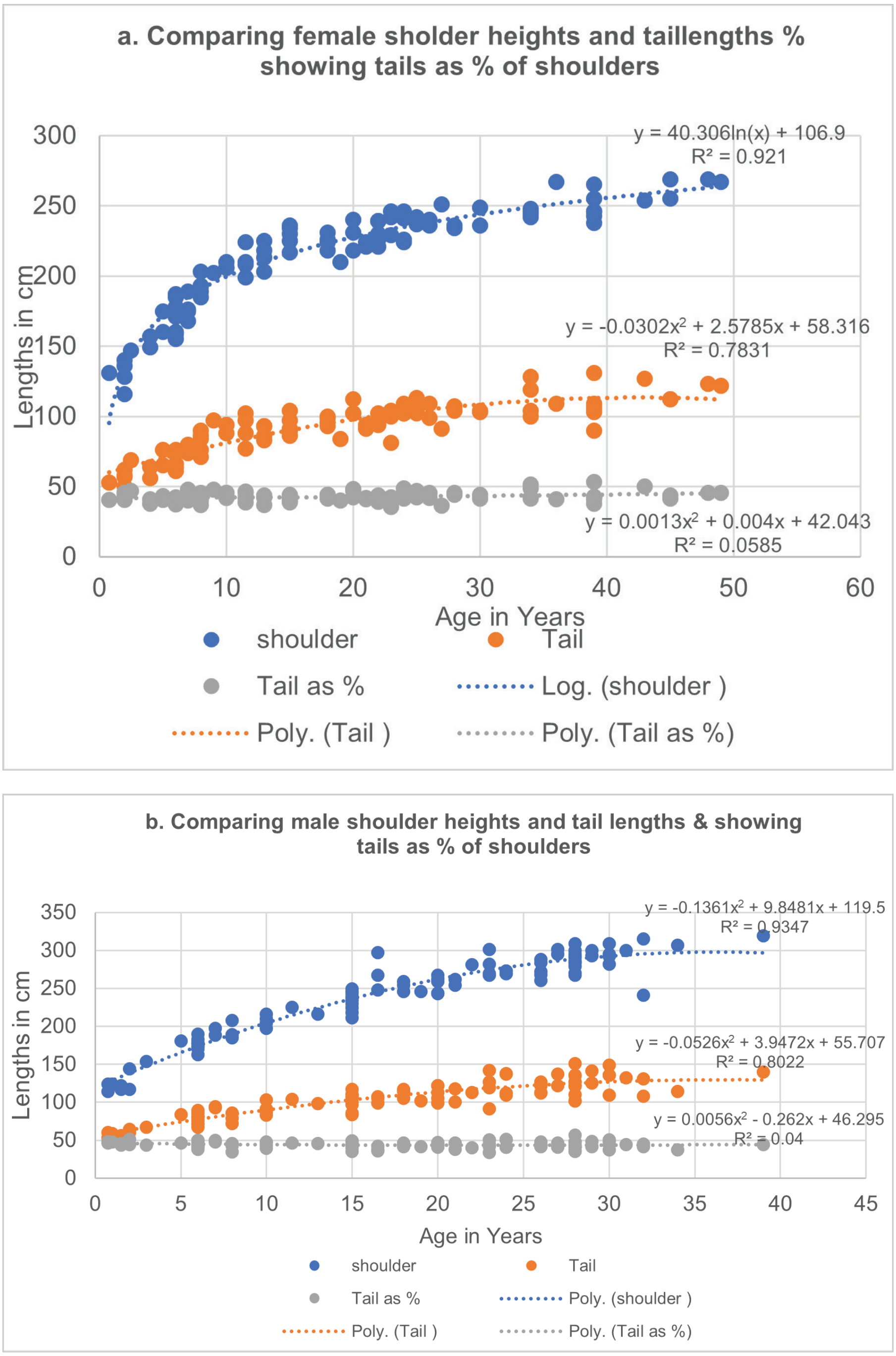

Figure 3. Panel a = female data, and Panel b = male data, which present tail lengths as constant proportions of shoulder height regardless of age or gender.

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