Ribs in Mammalia / by R.J. Anderson.

RIBS IN MAMMALIA

BY

R. J. ANDERSON.

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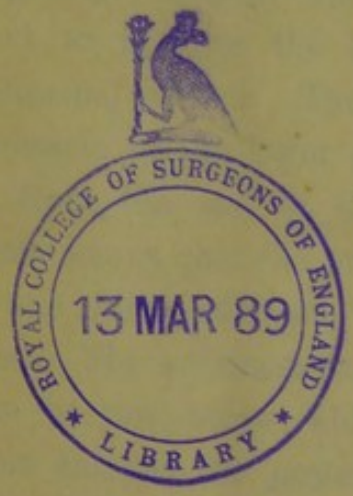

LEIPZIG.

G. THIEME.

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Measurements of ribs

in

Mammals

by

R. J. Anderson
in Galway.

(With Pl. II. u. III.)

I give here the breadths of the ribs in several mammals. The measurements are in millimetres. The term radial breadth is used where the principal surfaces of the ribs look forwards and backwards. The anterior surfaces were measured. The term tangential breadth is used to indicate the breadth of the outer surface, where this is the principal surface. The length of the vertebral rib was taken from the tubercle to the lower end. The length of the sternal rib or cartilage from the end of the vertebral rib to the sternum is given. Everyone knows that the prominent features of some ribs are the broad outer and inner surfaces, of others the broad anterior and posterior surfaces. The surfaces that are anterior and posterior above may become narrow below whilst the borders may widen into surfaces. In some animals the posterior surface turns out as we trace the rib from the vertebral to the sternal end. In some forms the ribs have a marked increase in the tangential breadth near the tubercle in others the increase is most decided near the lower end.

[1]) The author desires to express his thanks to Professor Trinchese of Naples who gave him permission to examine his skeletons and to his assistants for their kindness and courtesy.

Ornithorhyncus Paradoxus.

The greatest diameters of the ribs are radial. The 16th, 15th and 14th increase in breadth below the angle and show narrow edges above this point. All the ribs behind the eighth are thicker below the angle. The depth of the thorax, that is, the distance from the first to the last transverse process is 130 mm. The posterior surfaces of all the ribs from the second to the eighth inclusive turn outwards at a distance of about 3—4 mm above the cartilages. The cartilages are very wide in the lower ribs. That of the thirteenth rib measures eight mm at a distance of 15 cm from the rib end.

The following table gives the measurements.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
A	30	35	45	50	60	65	65	70	70	68	66	62	60	53	45	35	20
B	10	20	25	28	28	25	20	—	—	—	—	—	—	—	—	—	—
C	10	10	8	8	13	28	50	40	35	30	30	25	20	—	—	—	—
D	3	4	3	3,5	4	4	4	4	4	4	4	3	3	2,5	2,5	2,5	2
E	3	3	3	3	3,5	3,5	3,5	3,5	3	3	3	3	3	3	3	3	2
F	2	2	2	2,5	2,5	2,5	2,5	3	3	3	3	2,5	2,5	3	3	2,5	2,5

A = Length of the vertebral rib from the tubercle to the lower end.
B = Length of the sternal rib.
C = Length of the cartilage.
D = Breadth of the rib at the lower end.
E = Radial breadth at the angle.
F = Tangential breadth at the angle.

Echidna has the anterior ribs flattened from before back, middle anteroposterior flattening above and interoexternal flattening below.

Macropus giganteus.

Giebel says of the Kangaroos generally that, the surfaces of the ribs look forwards and backwards above. Then the upper border turns back and the surfaces are inner and outer below.

The following table gives the breadths,

Ribs.	1	2	3	4	5	6	7	8	9	10	11	12	13
Radial breadth at Angles.	15	14	13	12	10	10	9	9	9	9	9	9	9
Tangential breadth at or near lower ends.	10	8	8	10	12	10	11	10	10	10	13	15	7

The entire depth of the chest is 365 mm. The ribs are round in the middle and measure about 5—8 mm. in diameter.

The diminution in the tangential breadths of the ribs in very gradual, in the middle and upper ribs especially and one is reminded of the condition in man.

The anterior surface becomes internal in is the ribs behind the first in the trombat.

The Flying Lemur (Galeopithecus Volans).

In Galeopithecus Volans (Pl. II. Fig. 1) the second rib becomes wider posteriorly. The flattening and widening becomes well marked from the fifth to the last. The distance from the first dorsal vertebra to the last is 12,5 cm.

The following table gives the measurements.

Nuhn [1]) notes the great breadths of the ribs.

	1	2	3	4	5	6	7	8	9	10	11	12	13
A	15	28	38	46	56	60	61	63	58	50	46	40	35
B	5	17	25	30	38	54	50	60	50				
C	3	2	2	3	3,5	4	4,5	4	4	3	4	4	3
D	4	3	4,5	5	5,5	5	6	6	6	6	6	5	4
E	4	3	4,5	4	5,5	5	6	6	6	6	6	5	
F	20	22	30	35	40	30	25	30	20	30	13	8	

A = Length of rib from tubercle to lower end.
B = Length of cartilage.
C = Breadth of rib at lower end.
D = Breadth at widest part.
E = Breadth at angle.
F = Distance of widest part from lower end.

Lemur Macaco.

The increase of breadths at the angles is very marked. The breadths decrease towards the anterior ends, where they become wide again a short distance above the lower end.

[1]) Anat. p. 324.

	1	2	3	4	5	6	7	8	9	10	11	12	13
A	24	35	50	60	70	73	70	72	70	68	60	50	25
B	15	15	20	20	27	30	35	50	—	—	—	—	—
C	3	2,5	2,5	2	2	3	3	3	2,5	2,5	3	3	2,5
D	5	4,5	4	4	5	4	4	3,5	3	3	2	2	2

The greatest breadths are tangential except the first and reach inwards and outwards from the angles.

The letters have the same meaning as in the last.

In Galago the ribs are also wide behind but less so in proportion to the breadths of the lower ends than in the last mentioned.

The sloth (Bradypus tridactylus).

The three toed sloth, Bradypus tridactylus, has the anterior two or three cartilages or sternal ribs united to the vertebral ribs (ribs proper). The breadths which are greatest in the tangential direction are given in the subjoined table and the radial breadths which are small are not given. These breadths will be represented by 2—3 mm.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14
A	40	50	60	65	80	95	100	100	100	100	96	90	86	77	60
B	—	—	6	10	13	20	30	45	60	35	—	—	—	—	—
C	7	4	4	6	6	6	6	7	5	4	3	2,5	3	3	2,5
D	5	4	5	7	7	8	7	8	8	8	7	7	8	6,5	7
E	5	5	5	7	7	7	7	8	9	8	8	8	8	5	5
F	30	40	50	50	50	60	60	80	80	80	70	70	70	60	50

A = Length of rib from tubercle to anterior end (in first rib the length of rib and the length of de cartilage which is ossified).

The other letters are the same as in Lemur.

Myrmacophaga didactyla.

Length of the dorsal region 90 mm. At side 75 cm.

No. Rib.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Length of rib.	17	20	23	29	30	30	35	33	33	35	35	35	30	28	26	26	15
Length of Cartilage.	—	—	8	7	9	10	15	18	25	15	—	—	—	—	—	—	—
Breadth at lower end.	3	2	2	2	2	1.5	1.5	1.75	2	1	1	1	1	1	1	1	2
Greatest Breadth.	3	5	4	5	6	6	6	6	6	6	7	7	6	5	5	4	3
Distance of the angle frome the lower end	Measurement radial.	Rib thick radial.	Breadth Tangential.	do.	15 mm. to angle.	15 mm. to angle.	Angle 20 mm. from end.	Angle 20 mm. from end.	20 do	13 do.	14 do.	10 do.	15 do.	12 do.			

The overlap is best marked in the space lying between the spine internally and a line 25 mm. external to the spine in the middle of the dorsal region.

The imbrication is favoured by the thinning of the anterior edge at the expense of the outer surface and of the posterior border of the ribs at the expense of the internal surface.

The external thinning reaches quite 2 mm. in the middle dorsal region, to that only 2—3 mm. of rib is single at this place.

The opposite surfaces are thinned also so that the ribs except the first two show a distinct thickening along the middle of their breadth and anterior and posterior thin borders.

The tangential breadths are the most prominent features.

I note also that two sets of tubercles are present as the angles and to a line 3 mm outside the angles.

The 7th, 8th, 9th, 10th and 11th ribs have each a groove on the inner and posterior parts of the lower ends. There is a slight trace of this groove in the sixth and 13th.

The length of ribs means the length from the tubercles to the lower ends.

Prof. Giebel mentions the two rows of tubercles and has also noted the character of the inferior border below (op. cit. 378). The notching of the posterior borders is also mentioned by the same writer.

Myrmacophaga tetradactyla.

Length of the upper part of the thorax, 190 mm.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Length of ribs	35	43	47	52	55	56	60	67	68	70	70	70	65	65	60	45	30
Length of Cartilages.	13	18	20	25	31	35	40	45	53	70	—	—	—	—	—	—	—
Lower end.	4	8	9	7(r)	4(r)	3,5(t)	4,5	5	5,5	6	7	7	6	5	4	3	2,5
Broadest part.	9	12	9	8(t)	8(t)	8 (t)	8	8	7	7	7	7	6	6	4	5	6
Distance of the Broadest part from end.	10	10	—	35	45	47	45	45	50	45	45	45	45	45	40	33	Uniform

The broad surfaces of the first and second look forwards. The 3rd also, but superiorly surface of this rib begins to look outwards and inwards. The fourth has a wide tangential diameter above I indicate by (t). The radial breadth is indicated by (r).

The great breadths as the lower extremities of the second, third and fourth ribs correspond to the same surface breadths at the upper parts of the ribs.

Behind the sixth the lower ends commence to widen again and then the surfaces look backwards as well as outwards whilst the upper widening which is tangential looks forwards as well as outwards.

The surfaces of the ribs below are at right angles to the surfaces above. The surfaces look more and more outwards as the ribs are traced backwards. So that the posterior ribs look outwards and upwards.

The lower borders of all the ribs from the third to the fifteenth have thin lower borders in the middle thirds of their lengths. The thinness is produced at the expense of the inner surfaces.

The ribs are compressed just outside the tubercles, and again above the lower ends, the ribs except the anterior 2 or 3 and the posterior 2 or three.

I note that in another skeleton the narrowness of the ribs just below the tubercles is most marked.

„Sie sind weniger gekrümmt als bei der zweizehigen Art, ihr Hinterrand gleichfalls erweitert aber am unteren Ende nicht nach aussen gerandet, sondern allmählich sich verwischend.“ (Giebel).

Manis Macrura.

Length of dorsal region 120 mm.

Ribs.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Length of vertebral.	47	50	50	50	57	58	60	60	60	60	51	55	55	40
Length of sternal.	—	15	25	27	33	40	50	—	—	—	—	—	—	—
Breadth lower end.	4 (r)	4 (r)	3 (r)	3 (r)	5 (t)	5	5,5	6	6	4	4	3	3	2
Greatest Breadth.	4 (r)	4 (r)	5 (r)	5	5	5	6	6	6	5	5	3	3	5
Distance of Greatest breadths above end.	—	46	40	37	35	35	35	30	40	40	40	40	35	30

r = radial, t = tangential diameter.

The ribs from the 4th—10th (incl.) diminish in breadths above their lower ends to increase again near the junction of the middle and upper thirds.

Above and internal to the angles the radial breadths so far as the 10th predominate. Behind the tenth the necks are rounded.

The posterior edges are not sharp.

Dasypus Septemcinctus.

First to last dorsal = 75 cm.

Ribs.	1	2	3	4	5	6	7	8	9
Length of ribs.	30	45	50	55	55	55	50	50	40
Length of cartilage.	—	18	25	30	36	—	—	—	—
Breadth at lower end.	11 (r)	4	3	4	5	7	6	5	4
Greatest Breadth.	11	5	6	6	6	7	8	9	8
Distance of Broadest part from lower end.	At lower end.	At angle.	40 mm. from lower end.	44	35	Nearly Uniform.	35	35	25

The cartilages of the 2nd, 3rd, 4th and 5th ribs articulate.

The first rib is thinned along the middle of its length.

The second at the outer and posterior.

The third is thin in front and is thinned at the expense of its outer as well as its inner surface.

All the other ribs are thinned at their anterior and posterior margins, at the expense of their internal surfaces both in front and behind.

The thickest parts of the ribs are nearer the posterior borders than the anterior except in the case of the second where the thickest part is at the front. The ribs as John Hunter said are here groined.

As is well known the hollowing of the outer surface near the anterior margine is very conspicuous except in the first and second.

The thick ridge occupies the posterior part altogether except at the angles. In the lower thirds, the thickening reaches farther forwards and the thicknesses of all the ribs are more nearly uniform at the lower end.

The entire depth of the thorax in this creature is 70 mm. in the lines of the angles. The sum of the breadths is equal to 59 mm. These measurements are skeletal.

Myrmecophaga didactyla (Figured by Nuhn in his Anatomy p. 324). The expansion resembles the condition in chelonia, „but overlap or join by squamous instead of dentale sutures.“ (Owen's Anatomy vol. II. 398). See also — Meckel & Cuvier.

The Armadillo.

The Armadillo gives broad tangential diameters in the anterior ten ribs but in the posterior three the tangential diameters are nearly equal to the radial. A slight nodular prominence marks the angles of the sixth seventh and eighth and the posterior borders of the ribs from the fifth to the tenth especially the seventh exhibit a number (7 in the seventh rib) of notches on the lower borders. The radial diameters of the upper ribs are about 2,3 mm. The 5th, 6th and 7th ribs show a marked tubercle near the lower extremity the distance of the eleventh dorsal transverse process from the first is about 100 mm. The sternal ribs corresponding to the 2nd, 3rd, 4th and 5th vertebral ribs have their radial diameters greatest. The 6th however shows a greater tangential diameter viz. 12 mm. near the anterior end.

	1	2	3	4	5	6	7	8	9	10	11
A	30	40	55	63	65	70	70	65	70	60	60
B	—	20	28	35	42	50	30	25	25	20	—
C	10	5	5	4	4	5	5	5	5	5	—
D	16	5	5	5,5	5	6,5	6	6	5	5	4
E	9	6	5	5	5	4,5	4,5	4	4,5	4	4
F	10	25	30	30	30	25	25	30	30	30	—

The Donkey. (Equus asinus).

The length of the first rib is from tubercle to lower end 140 mm. (Pl. III. fig. 6) The breadth of the lower end 30 mm. The breadth 3 cm. length 20 mm. and in below of the tubercle 15 mm. The rib is thick (Pl. III).

The length of the 2nd rib is 190 mm. from the lower anterior extremity to the tubercle and the greatest breadth is 18 mm. one cm. above the lower end.

The 3rd rib measures 220 mm, and has a breadth of 79 mm. at a distance of two cm. behind lower extremity.

The 4th rib measures 260 mm. in length and has a breadth of 20 mm.

The 5th rib measures 295 mm. from the lower extremity of the tubercle and has a nearly uniform breadths of 28 mm so far up as the angle, above which in becomes narrower.

The 6th rib measures 325 and has a breadth of 22 mm. The anterior border is sharp, the posterior thick.

The 7th rib measures from tubercle to angle 340 mm. and is 20 mm. broad at the lower extremity which is increased to 22 mm. at a distance of 10 cm. from that point.

The 8th rib is of nearly uniform breadth and measures 18 mm. below.

The 9th 15 mm. The 18th and last 10 mm. The ribs between the 10th and 18th have abreadth of 10 mm. and diminish in length. The ribs from the the 8th to the 13th are thicker in proportion to their breadth than those ribs above the 8th. The lower ribs are flat.

In the *horse*. The ribs from the 2nd to the 8th are thinned at the expense of their outer surfaces anteriorly to that they are sharp anteriorly and blunt posteriorly.

The breadth of the 5th ribs at a point 12 cm. above the lower end is 40 mm. This is the widest part of the rib. The fourth measures at its widest part 35 mm. and the 6th the same, above and below the ribs are narrower.

Phacochaerus Ethiopicus.

The first rib in Phacochaerus (Pl. III fig. 7) is nearly straight 130 mm. long, 25 mm. wide at the lower end and 15 mm. at a distance of 8 cm. from the lower end.

The second rib measures 180 mm. in length and gives 8 mm. at the lower end and 18 mm. at a distance of 7 cm. from the lower end. The breadth diminishes as the rib is traced upwards from this point so that at a distance of 12 cm. from the lower end. The rib measures 15 mm. the second rib has a concave posterior border and a convex anterior. The anterior margins is thin and the posterior thick.

The third rib measures 205 mm. in length 8 mm. at the lower end and becomes gradually wider as we trace it upwards, so that at 6 cm., the breadth is 18 mm. and at 10 cm. The breadth is 23 mm. The rib then diminishes gradually as we trace it upwards beyond the latter point and measures 15 mm. at a distance of 2 cm. below the tubercle.

The anterior margin of the third rib is convex and the posterior concave and thick. The anterior convexity is more marked than the posterior concavity.

The fourth rib measures 10 mm. as the lower end and at a distance of 11 cm. measures 31 mm. in breadth at 4 cm. the breadth is 18 mm. at 8 cm. 26 mm. at 14 cm. 25 mm. The fourth rib gains in radial breadth beyond this point, the anterior margin is convex and the posterior nearly straight and thicker than the anterior margine. The posterior border of the 4th is thinner than that of the third and the latter than that of the 2nd. The length is 240 mm.

The fifth rib is 10 mm. broad at the lower extremity at 4 cm. 15 mm., at 7 cm. 23 mm.. at 12 cm. 20 mm., at 16 cm. 17 mm. The posterior border runs nearly straight from the angle to a point 4 cm. from the anterior extremity. It then becomes convex. The anterior

border is thinner and convex where the rib is widest. The length is 270 mm.

The sixth rib is 305 mm. long, measures 10 mm. at its lower end; 13 mm. at a distance of 5 cm. from this point, 15 mm. at 10 cm., 10 mm. at 14 cm. This rib has a more uniform breadth than the four preceding. The anterior border is thin and sharp for 10 cm.

The remaining seven ribs are rod like and after the seventh diminish in length from the second to the sixth.

The distance from the first dorsal transverse process to the 13th is 40 cm.

A line drawn from the anterior part of the lower end of the first rib to the posterior part of the lower extremity of the last rib measures 52 cm.

The lower seven ribs have an average breadth of 10 mm.

Bos Taurus.

Ribs.	1	2	3	4	5	6	7	8	9	10	11	12	13
Greatest Widths.	50[1])	25	35	45	50	60	60	60	55	60	60	60	45

The 2nd has a nearly uniform breadth.

The depth of the thorax is 800 mm. in the lateral line.

The 1st Rib is 250 mm. long.
The 8th „ „ 620 „ „
The 12th „ „ 640 „ „
The 13th „ „ 530 „ „

The sum of all the breadths is 670 mm.

The first is thick, the second thinner flat below, convex and thick in the middle.

The lower part of the outer surface is concave from before back in the 3rd, 4th, 5th and 6th.

As is well known the groove near the anterior (inner border) of the anterior ribs is formed at the expense of the outer surface. From

[1]) Measurement made at lower end.

the 9th to the 12th, the groove is in the border, and on the thirteenth it is internal being overlapped by the prominent outer lip of the anterior margin.

The groove gets shorter from the eighth rib back. It is 30 cm. long in the 8th and only 5 cm. long in the 13th.

The anterior and posterior edges of the ribs below the termination of the grooves externally are quite sharp in the lower three ribs the posterior edges being convex and the anterior concave.

The 9th and 10th have thick upper edges as far down as the lower third.

Bos Americanus.

The narrower character of the ribs, the absence of the grooves in the lower part of the outer surface have been pointed out by Meckel, Cuvier and other anatomists. The absence of the grooves is most remarkable. The anterior margin projects forwards in the 12th rib (180 mm. above the lower end).

The 10th and 11th have a backward prolongation, the former, at a distance of 110 mm. above the lower end causing the breadth to increase from 22 mm. to 30 mm. The increase in breadth of the second takes place at a point 120 mm. below the lower end.

Cephalolophus Mergens.

The distance of the last dorsal transverse process from the first is 185 mm.

The tangential breadths are given except at the angles, where the radial breadths of the first eight and the tangential of the last five are given.

The seventh rib is the broadest and bends below the lower angle.

The radial breadths are but slightly in excess of the tangential breadths beyond the angles, but above *i. e.* between the angles and the vertebral column the anterior surfaces are broader than the lateral, as we find in many other ungulates.

The letters have the same signification as the last.

	1	2	3	4	5	6	7	8	9	10	11	12	13
A	60	70	90	100	110	120	130	140	150	145	135	115	105
B	—	7	7	10	15	20	30	45	—	—	—	—	—
C	10	4	5	6	4	4	4	4	3,5	3	2	3	2,5
D	10	6	6	6	8	7	8	6	5	5	5	5	5
E	5	5	5	5	5	6	6	5	4	4	3	3	3
F	—	22	20	5	10	15	25	30	40	25	40	40	40

Auchenia Llama.

The 3rd, 4th, 5th and 6th ribs are convex from before back. The 7, 8, 9, 10 and 11th concave from before back in the lower thirds.

The inner surfaces of the anterior ribs are concave from above down and flat from before back.

The posterior six ribs are convex from before back.

First rib broad near lower and rounded greatest breadth 25 mm.

Second has the tangential diameter greatest viz 30 mm.

Third very broad = 35 mm.

Fourth = 32 mm., 5th 30, 6th 25 mm. although the 5th is narrower than the fourth, the breadth is carried higher up. The foregoing show a thick central part.

Camelus Dromedarius.

The seventh, eighth, and ninth ribs — are more uniformly thick expecially at their lower ends than the ribs behind or in front of this point.

Ribs.	1	2	3	4	5	6	7	8	9	10	11	12	
Breadths lower ends.	30	40	50	60	60	55	50	40	40	53	38	30	
Broadest parts.	25	25	35	35	55	55	50	48	50	50	40	35	At the middle.
Breadth at angles.	20	25	30	30	32	32	27	22	23	27	20	20	

The 5th rib is the thickest along the middle of its breadth. The anterior and posterior borders are sharp.

Cervus tarandus.

Ribs.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Breadths at lower end.	30	18	23	22	25	25	18	12	12	18	14	11	9	10
Breadth at angle.	15	15	—	—	—	—	19(r)	10	—	—	—	—	—	—
Greatest breadths.	30	20	20	27	27	26	23	15	14	17	14	14	15	16
Distance of broad part from lower end.	—	50	continued up.	70	70	50	40	110	110	—	80	70	50	50

The 4th rib is flat in the lower half and thicker along a line running along the anterior border.

The groove on the anterior past of the 10th rib reaches farther down that the grooves on the ribs before and behind this point.

The Dolphin. (Delphinus).

	1	2	3	4	5	6	7	8	9	10	11	12	13
A	160	210	270	390	310	330	330	335	340	320	300	270	250
B	70	75	83	90	110	—	—	—	—	—	—	—	—
C	11	17	12	14	15	9	7	8	4	4	4	3	3
D	23 r	17	12	14	15	9	7	10	9	9	9	8	8
E	23×3	17×5	11×5	11×6	10×4	10×4	10×5	10×5	8×5	8×4	5×5	5×5	4×4

E gives two measurements the first is the radial breadth and the second the tangential, we see that, in the dolphin, the ribs give larger radial diameters in the upper thirds and larger tangential diameters in the lower thirds. The middle thirds are rounded. The sixth rib gives 170 mm. for the lower flattening and 90 mm. for the upper leaving 90 mm. rounded. The lower flattening reaches farther upwards in the anterior part of the thorax than in the posterior. And the upper antero-posterior compression extends lower down in the posterior ribs.

In *Delphinus Acutus*. The first rib is uniformly broad 17 mm. at the anterior end 160 mm. long and the extremity is hollowed. The second is 20 mm. at the broadest place. The *third* 15 mm., 4th 15, 6th 15. Behind the *sixth* the lower end of the ribs have large tangential diameters, and these are nearly equal to the radial diameters above.

Balaenoptera Rostrata.

First rib. Lower extremity widest then the rib gradually diminishes.

Second rib. The lower end is narrower than the part immediately above.

Third rib is narrow at the end. It becomes broad as it is traced upwards and becomes narrow again at the upper part.

Fourth rib broad in the lower third except at the end. 5th Broad lower third, narrower in the middle, broader above. 6th Wide at the junction of the middle and inferior third. 7th Broad at the junction of the middle and lower fourth. The others are broad at the junction of the lower fourth with the next.

The upper show also a great increase in breadth, in all except the first five and the last.

The fifth is more uniform.

Manatus Australis.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
A	170	220	270	355	350	380	400	410	400	400	400	400	380	350	370	330	260
C	15	10	10	9	9	7	10	12	12	11	10	10	10	10	10	10	9
D	35×15	20×20	33×20	25×25	20×30	24×28	15×40	40	40	38	42	42	44	40	47	30	20
E	—	—	—	—	36	30	30	35	35	33	35	35	32	27	30	20	17
F	150	180	230	260	260	290	280	240	240	250	240	230	230	200	210	180	230

D = Radial by tangential breadths.
E = approximate breadths at the angles.
F = distance of the broadest part from the lower end.

The depth of the thorax is 99 mm., the ribs have large tangential diameters in proportion to the radial diameters except in the anterior three. The fourth rib widens above and the increased tangential diameter extends farther downwards in each succeeding rib until the last is reached. The angles given in the tables are the posterior angles.

Hyrax Capensis.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A	23	30	40	48	53	56	60	60	60	60	58	55	54	52	48	—	40	36	35
B	—	10	14	17	20	22	34	45	—	—	—	—	—	—	—	—	—	—	—
C	4 r	2,5	2,5	3	3	3	3,5	2,5	2,5	2,5	2	1,5	1,5	1,5	1,5	—	1,5	1,5	1,5
D	5 r	3 r	3 r	3 r	3 r	3,5r	3 r	3 r	3 r	2,5t	2,5	2,5	3	3	2,5	—	1,5	1,5	1,5

The measurement of D for the first rib was taken at the tubercle the others at the angles. The radial breadth is taken in the first 9 in the others the tangential. The antero posterior flattening is marked in the anterior ribs and the upper thirds of the first nine are very strong. Below the 9th rounded.

The Rhinocerus.

Thorax 120 cm.

First rib 75 mm. in front, and diminishes to the angle which is 40 mm. 2nd 35 mm. at the lower end and 35 mm. at the middle. 3rd 40 mm. above. 4th 35 mm. below, 35 mm. at the middle and 50 mm. at the angle. 5th 50 mm., 40 and 35 respectively (radial). 6th 40, 35, 30. The sixth is nearly square on section. The seventh = 40, 27, 30 and square section. 8th 35, 30, 30 tangential measurements. 9th 30, 35, 28. 10th 25, 35, 25. 11th 25 t, 37 t, 25 t all tangential. 12th 23, 37, 25. The second measurement is made at the middle in the last three ribs. 13th 19, 35, 25. 14th 15, 36, 30. 15th 15, 34, 25. 16th 20, 37, 25. 17th 20, 30, 25.

The posterior edges of the lower ten are sharp.

The depth of the thorax (antero posterior) in the lateral line is 140 cm.

The Elephant.

First broader below than above second uniformly broad and with a sharp anterior border, surface convex from before back.

3rd rib very thick strong and broad, lower end compressed from within out middle piece thick especially along the middle.

The 3rd, 4th and 5th ribs are of nearly uniform breadth so far as the angles, the thickness is greatest along the middle a little above the lower ends.

The third and fourth ribs viewed from the interior show a curve with the convexity directed backwards. The fifth and sixth show a double curve each half the size of the curve of the precedings and with the convexity directed back.

Behind the seventh the anterior border of the ribs gets thicker and the greatest breadths which are tangential are near the middle of the rib.

Phoea Vittullina.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	50	65	100	120	130	140	155	170	180	185	190	190	180	170	145
B	60	70	90	100	120	130	140	140	150	170	—	—	—	—	—
C	12×8	8×10	8×12	9×14	13	13	14	16	16	17	15	12	12	10	8
D	20	20	15	15	15	14	15	16	16	16	20	15	15	18	15
E	20	13	13	13	12	12	13	13	12	10	10	10	7	7	7
F	50	65	80	100	120	150	145	150	60	170	170	170	160	160	135

The letters have the usual significations. First rib wider above than below and the greatest diameter is the radial. A line drawn from the lower end of the 1st rib to the lower end of the last marks the rounded middle parts of the ribs

Radial breadths above and the tangential breadths below are the greatest. The 10th ribs are broader below.

Pelagius Monachus.

The 6th, 7th, 8th and 9th ribs are very strong and *thick* below.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	23	20	20	20	22	25	22	23	23	23	23	23	22	22	23
B	20	t—r 10×15	t—r 15×15	17	18	18	19	19	19	19	15	15	15	14	12
C	12	10	10	12	9	9	9	9	9	10	10	10	13	—	—

A = Radial breaths at the tubercles. B = breadths at the ends. C = least breadths.

The measurements are radial except in 2nd and 3rd where tangential and radial are both given. The least measurements of breadths are 30 mm. above the lower ends. The outer surfaces are wide at the middle especially in the middle ribs. The outer surface of the second measures 15 mm. near the middle.

The Fox.

The first rib is rounded and enlarged at the lower extremity. The second has a large tangential diameter below. The outer surface becomes the anterior above and gets narrower. The flattening of the third reaches half the length of the rib so that the tangential diameter is large in the lower half.

The tangential breadth of the fourth is less than that of the preceding.

The anterior and posterior borders of the 2nd, 3rd, 4th and fifth ribs are very sharp below.

The posterior ribs are rounded and rod like.

Where two measurements are given in the following table, the radial comes first.

	1	2	3	4	5	6	7	8	9	10	11	12	13
A	30	50	65	85	100	105	110	110	110	105	95	80	75
B	15	20	25	30	35	40	45	50	—	—	—	—	—
C	8	6	4	4	4	3	3	4	3,5	3	3	2,5	3
D	8	8	9	5	5	4	3	4	3	3,5	4	3	3
E	3	4	5×2	4×3	4×3	4×2,5	3×3	3	3	3×3	3×3	3×3	3
F	30	10	17	20	23	30	—	—	—	—	40	30	—

A and D are tangential. C near lower end. D widest. E at angles radial and tangential.

For general see *Giebel* in Bronn.

Felis Leo.

In the Lion the breadths of the first four ribs diminish gradually as they are traced up from the lower ends. The remaining ribs have tangential breadths at the lower ends greatly in excess of the radial but they breadths diminish immediately as the ribs are traced up. The following are the breadths in the specimen examined 1st 20 mm., 2nd 19, 3rd 15, 4th 17, 5th 18, 6th 16, 7th 15, 8th 18, 9th 17, 10th 14, 11th 16, 12th 17, 13th 10.

In the *Hyaena* the 3rd, 4th, 5th and 6th ribs are broad tangentially. Narrow at the extreme end, then wider higher up.

The first gives 9 mm. at the lower end and the breadth above this point is uniform the second 9 mm. uniform. 3rd 9 mm. at the end and 11 mm. a little higher up. 4th 6 mm. as compared with 13 mm. higher up. 5th 7 mm. to 16, 6th 8 mm. and 17 above the lower end.

The *Hyaena*. Behind the 6th the middle thirds are broader tangentially than the inferior thirds which are rounded and compressed except at the lower ends which are broader.

Ursus Arctos.

480 mm. Dorsal.

	Length of rib.	Breadth at and extremth.	Breadth at angles.		
First rib.	120 mm.	23	30 r		
2nd	150 „	15	23 r		
3rd	200 „	14	20 r		
4th		17	20 r		
5th		17	20 r		
6th	340 „	17	17		
7th	370 „	18	17		
8th	395 „	20	20	broadest.	Distance of broadest part from end.
9th	415 „	19	20	20	
10th	415 „	17	16	18 (r)	150 mm.
11th	395 „	14	16	15 (t)	200 „
12th	350 „	14	16	16	180 „
13th	305 „	16	14		
14th	260 „	18	14		

The radial diameters behind and the tangential diameters in front are the most considerable as is very well known.

The second rib is of nearly uniform tangential breadth as far as the eight.

The 3th and 4th ribs increase in breadth at first and then diminish, when traced upwards.

The 5th maintains its diameter for 4 cm. and then diminishes. The sixth has a uniform breadth for some distance from the lower end.

The seventh experiences a very gradual decrease in diameter for the lower fourth then the breadth is the same up to the middle and then the breadth increases gradually in the upper half.

In the 8th the decrease in the breadth of the rib is more rapid

as the rib is traced up. Rapid decrease in the 9th and in the 11th and 12th an increase takes place.

In the middle ribs the tangential breadth commences to exceed the radial at a point about the middle of their length although the actual breadth is less here than farther forwards.

The inner border of the first and the lower parts of the anterior borders (1/2—2/3) of the following ribs are sharp.

The breadth of the 8th ribs is greater at a point 130 mm., above the lower end than above or below that point.

Lutra Vulgaris. The first rib is very strong and has a single curve. The other ribs are flattened from before back above and their inner surfaces turn back inferiorly so that a large triangular surface turns backwards and outwards below see *Beaver.*

The Beaver.

The ribs have considerable radial breadths (Pl. II. fig. 3). The posterior surfaces of the 4th, 5th, 6th, 7th and 8th become the outer below and here the rib diameter becomes considerably greater.

The distance of the first dorsal transverse process from the last is 17,5 cm.

The following table gives the measurements.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A	53	68	80	100	110	120	120	115	112	110	110	105	100	95
B	15	23	40	60	60	104	120							
C	10	7	8	9	10	10	11	10	6	5	5	5	6	5
D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E	8	7	7	9	7	7	7	5	5	5	5	5	4	4

Lepidus timidus.

The radial and tangential breadths of the lower 5 ribs are nearly equal.

From the second to the sixth, the tangential breadths exceed the radial, except near the tubercle.

These ribs show a thickening all along the middle and have very harp anterior margins expecially in their lower thirds. 5 mm., 8 mm.,

and 9 mm. are the greatest breadths for the 2nd, 3rd and 4th ribs. 7 mm., 7 mm. and 4 mm. for the 5th, 6th and 7th. These breadths are about 15 mm. above the margins.

The breadths fall off quickly below this.

Behind the seventh the ribs are much narrower tangentially.

Where the ribs are very broad they are also very thin and the intercostal spaces are narrower; of course all these notes are taken in the dry skeleton.

The 2nd rib is thinned below at the expense of the anterior surface. In the *rabbit* the breadths of the ribs do not vary much as far as the ninth. The lower three are smaller. (Krause [1]).

Arctomys Marmota. The radial breadths are the most considerable. In the lower thirds the posterior surfaces turn outwards. The greatest diameters are near the angles and the lower ends. In the middle of their lengths the ribs are narrow.

The Flying Squirrell (Pteromys).

The posterior four have a uniform breadths from the tubercles to the angles (Pl. II. fig. 5).

	1	2	3	4	5	6	7	8	
A	10	20	30	40	50	55	60	55	The ninth rib shows a slight increase in the breadth a little below the tubercle, where it measures 3 mm. The others are about 2 mm. each.
B	10	17	17	23	25	34	47	55	
C	3	2	2	2,5	2,5	2,5	2,5	2,5	
D	3	3	4	5	5	4	3,5	3,3	
E	—	15	25	32	45	45	45	45	

Centetes Ecaudatus. Tanree.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
A	15	25	29	40	45	50	50	52	50	48	45	45	42	38	35	30	30	22
B	8	9	12	17	25	27	30	30	35	—	—	—	—	—	—	—	—	—
C	5	3	3	3	4	4	4	4	4	3,5	3	3	2,5	2,5	2,5	2,5	2	2
D	5	3	3	3	3	3	2,5	2,5	2	2	2	2	2	2	2	1,5	1,5	1

[1]) Anatomie des Kaninchens.

The breadths at the lower end (Pl. II. fig. 2) diminish as they are traced upwards to the junction of the lower fourth with the second fourth. A less distance than this in front and a greater distance behind. The radial breadths at the angles of the anterior nine are greatest. The ribs are rounded at the middle thirds and the posterior surfaces turn out as they are traced downwards and increase in size as before mentioned.

Myogale Muscovitica Desm. The ribs like the last mentioned are expanded at their sternal ends from the third to the 10th.

The outer surfaces are *grooved* in the lower thirds or are concave from before back.

The fifth rib measures 3 mm. at its sternal end 2 mm. at the junction of its inferior with its middle third 1,5 mm. at the middle and 1 mm. between the angle and the tubercle. The outer surface looks backwards.

The lower ends of the middle ribs in the mole are wide.

The lower ends of the ribs of *Myogale Pyrenaeaea* also are expanded and grooved.

Pteropus (Flying fox).

	1	2	3	4	5	6	7	8	9	10	11	12
A	20	35	50	60	63	63	62	50	52	80	43	30
B	10	10	10	10	11	13	20	12	—	—	—	—
C	5	2	3	3	2,5	2,5	2	2	2	1	1	1
D	—	2,5	2,5	3	3	3	2,5	2	1,5	1	1	1
E	4	2,5	3	3	4	3	3	2	1	1	1	1
F	20	30	40	50	51	48	47	44	—	—	—	—
G	—	2	2	2	2	2	2	1,5	1	1,5	1,5	1

The breadths given opposite D are all *tangential* except the first and second (Pl. II. fig. 4).

E = Breadths of the ribs near the angles.

F = Distance of the widest parts from the lower end.

G = The tangential breadths at the side.

The ribs from the 3rd to the 9th are expanded behind and in front and are narrow in the middle. After the sixth the wider inferior portion is limited to the extremities, the 11th and twelfth, however, taper off.

Dinops Astonii has a thorax 16 mm. from behind forwards close to the spinal column. Ribs wide tangentially at the angles and intercostal spaces nearly obliterated. The ribs are very thin near the posterior borders and inferiorly.

Rhinolophus tridens. Ribs broad above and behind, breadth diminishes as the ribs are traced down.

The *middle* ribs are slightly concave from before back.

The intercostal spaces are absent above and behind in the middle of the thorax.

Rhinopoma macrophyllus has the posterior eight ribs broad above and behind and the intercostal spaces are absent, in the back part of the thorax.

Simia Satyrus.

1	2	3	4	5	6	7	8	9	10	11	12	
15	10	9	9	10	11	11[1])	10	8	5	6	4	Breadths at lower ends.
8	6	6	6	—	—	8	8	7	7	7	8	Breadths at the angles.

Cynocephalus Sphynx thorax 160 mm. in depth from 1st to the last dorsal.

The lower ends of the ribs are expanded quite at their extremities. The widening (8 mm.) is carried up in the last rib. From the third to the 11th (incl.). The ribs are 6 mm. at the lower end and 8—10 mm. at the middle.

Macacus rhesus has ribs with wide middle thirds narrow and round lower thirds except at the ends. The tangential diameters are the most considerable. There is a peculiarity of this nature. The tenth (10th) for example first diminishes then continues. The same then increases at the angles.

Lower end — 3 mm. at 2 cm. 2,3 mm. at lower angle, three mm. middle 2,5, upper angle 3 mm. M. fuliginosus *different.* In some skeletons the above character is best seen in the middle ribs.

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[1]) The diameters become less a little above the lower ends and then increase. The breadths of the anterior ribs, as the ribs are traced up diminish at first and then increase thorax 113 mm.

In *Cebus* the lower expansion is continued up for *20 mm.* more or less in the anterior 9 ribs and the ribs are constricted above this.

In one skeleton the expanded lower end is carried up but in the posterior (lower) the vertebral halves are are very wide for 20 mm. (From 8—11) and then become distinctly wider and keep their width for a shirt distance and then diminish to the angles. Beyond which point the radial breadths again increase.

The lower end of the 11th is notched. The posterior borders in the middle thirds are sharp.

In *Cercopithecus.* Tangential diameter increased outside angles. The rod like character is not present below.

In *Hapale Jacchus* the upper halves of middle ribs are wide.

Mydas rufimanus 65 mm. in depth. The ribs are wide from the angle to the junction of the middle and lower thirds 6, 7, 8 and 9 widest. Breadth diminishes below. Anterior margins of all except the first three or four sharp, inner edge grooved.

Ribs thickest near the middle or a little nearer the upper border.

The ribs in man are well known. A an account of the diameters and of the change in the different ribs as the are traced backwards will be found in the English Journal of Anatomy for 1884.

We then see that mammalian ribs may be expanded.

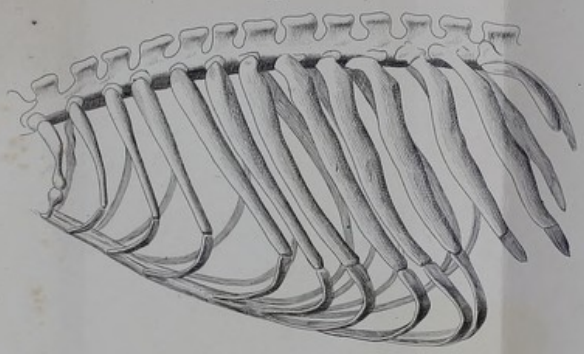
1. Radially in their whole length.
2. Tangentially in their whole length.
3. Radially above and tangentially in below.

The varieties under these three heads are given.

The normal number of ribs was not present in some cases.

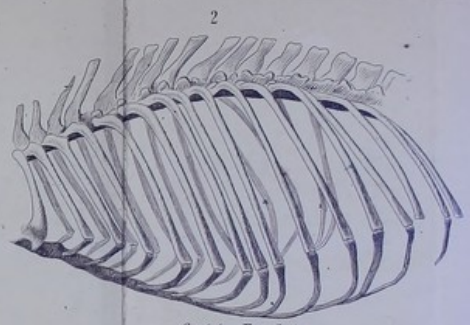
In some the ribs are so wide that the intercostal spaces are entirely occluded. In others the great breadth of the ribs causes the intercostal spaces to be greatly diminished. And the intercostal muscles are so fixed that overlapping is not interfered with by the attachment of these muscles.

1.



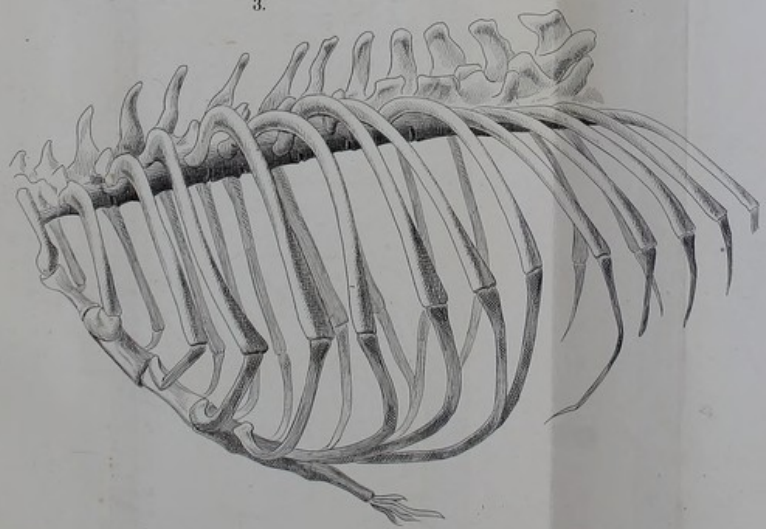
Galeopithecus Volans.

2



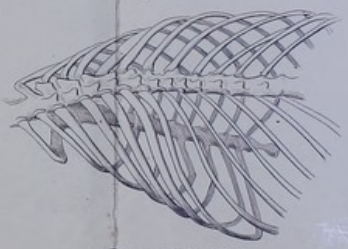
Centetes Ecaudatus.

3.



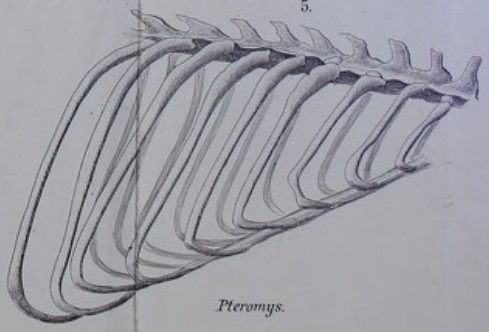
Castor Fiber.

4.



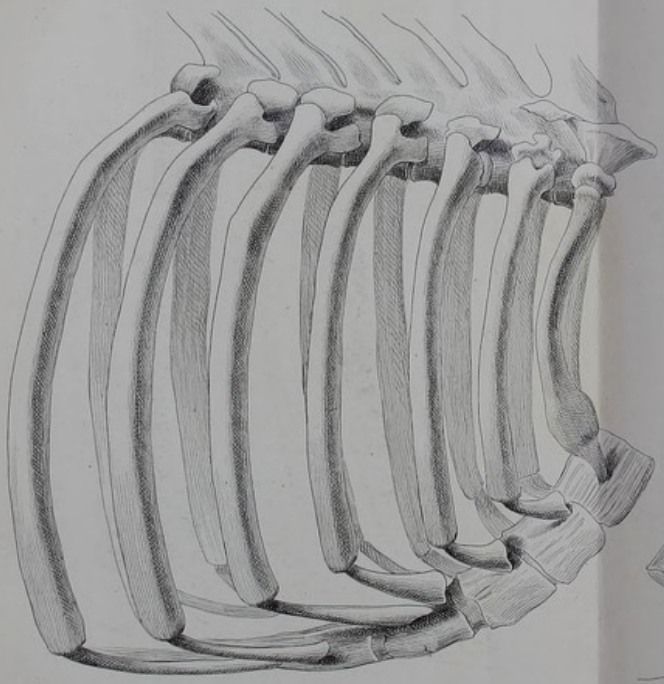
Pteropus Edwardsii.

5.



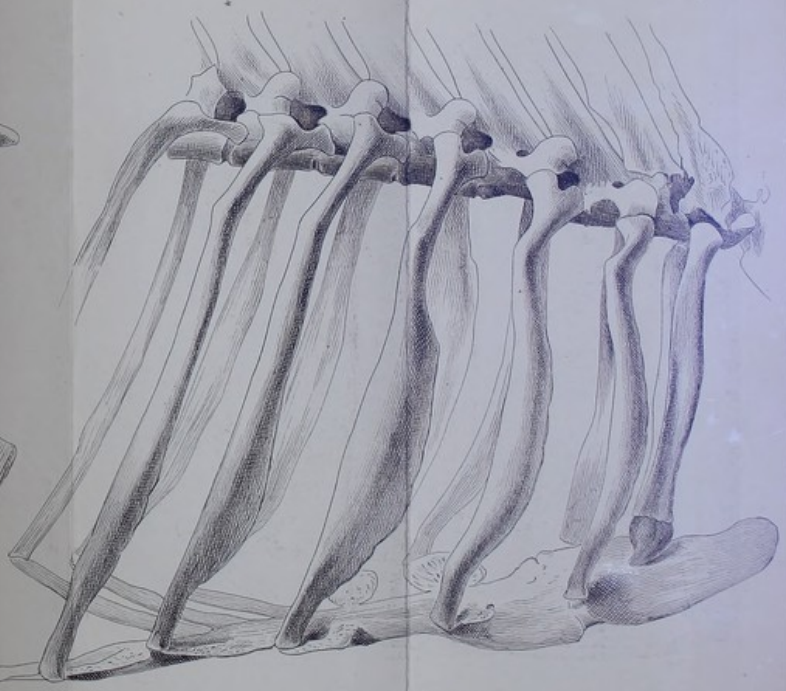
Pteromys.

6.



Equus Asinus.

7.



Phacochaerus Æthiopicus.