

S1: The squircle metric of squareness

In 1992, Manuel Guasti proposed a definition for the squircle²⁵. The polar coordinate definition of a squircle is

$$\left[\frac{s^2}{4} \sin^2(2(\theta - \psi)) \right] r^4 - (k_y^2 \cos^2(\theta - \psi) + k_x^2 \sin^2(\theta - \psi)) r^2 + k_x^2 k_y^2 = 0, \quad (18)$$

where k_x and k_y represent dimensions of the shape in the horizontal and vertical directions, allowing for changes in aspect ratio, and ψ represent a rotation. The squareness parameter s is 0 when the shape is a circle and 1 when the shape is square. Like our squareness metric presented in the main text, this squircle metric yields values between 0 and 1. For $s \in (0, 1]$, we may solve for r^2 using the quadratic formula, such that

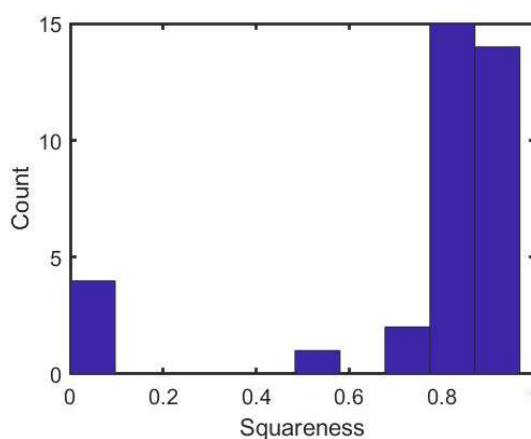
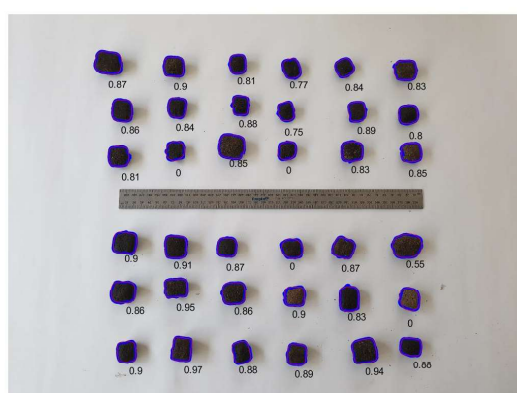
$$a = \frac{s^2}{4} \sin^2(2(\theta - \psi)), \quad (19)$$

$$b = -(k_y^2 \cos^2(\theta - \psi) + k_x^2 \sin^2(\theta - \psi)), \quad (20)$$

$$c = k_x^2 k_y^2, \quad (21)$$

$$r^2 = \frac{-b - \sqrt{b^2 - 4ac}}{2a}. \quad (22)$$

Note that there is only $-$, rather than $\pm$ in Equation 22. With the definition in the form $r(\theta)$, we may do a regression to find a best fit for the parameters r, k_x, k_y, ψ for any given set of points expressed in polar coordinates. We minimize the squared error between our squircle definition and the data points using MATLAB's `fminsearch`. The fitted value for s is the resulting squareness. When applied to the wombat feces, we get the following results.



We see that this metric evaluates most wombat feces as very square, but for a couple samples, it evaluates them to be very circular. We saw similar variations in sensitivity to small changes in the shape when applying the metric to the model, evaluating one frame at 0.4, but then the very next frame at close to 0. This sensitivity makes the squircle definition less useful to measure squareness in practice. Thus, we will evaluate our wombat feces using the metric proposed in the main text.

Figure S1. Linear regression of weight versus stretch for each adjacent pair of tick marks on the first wombat intestine sample.

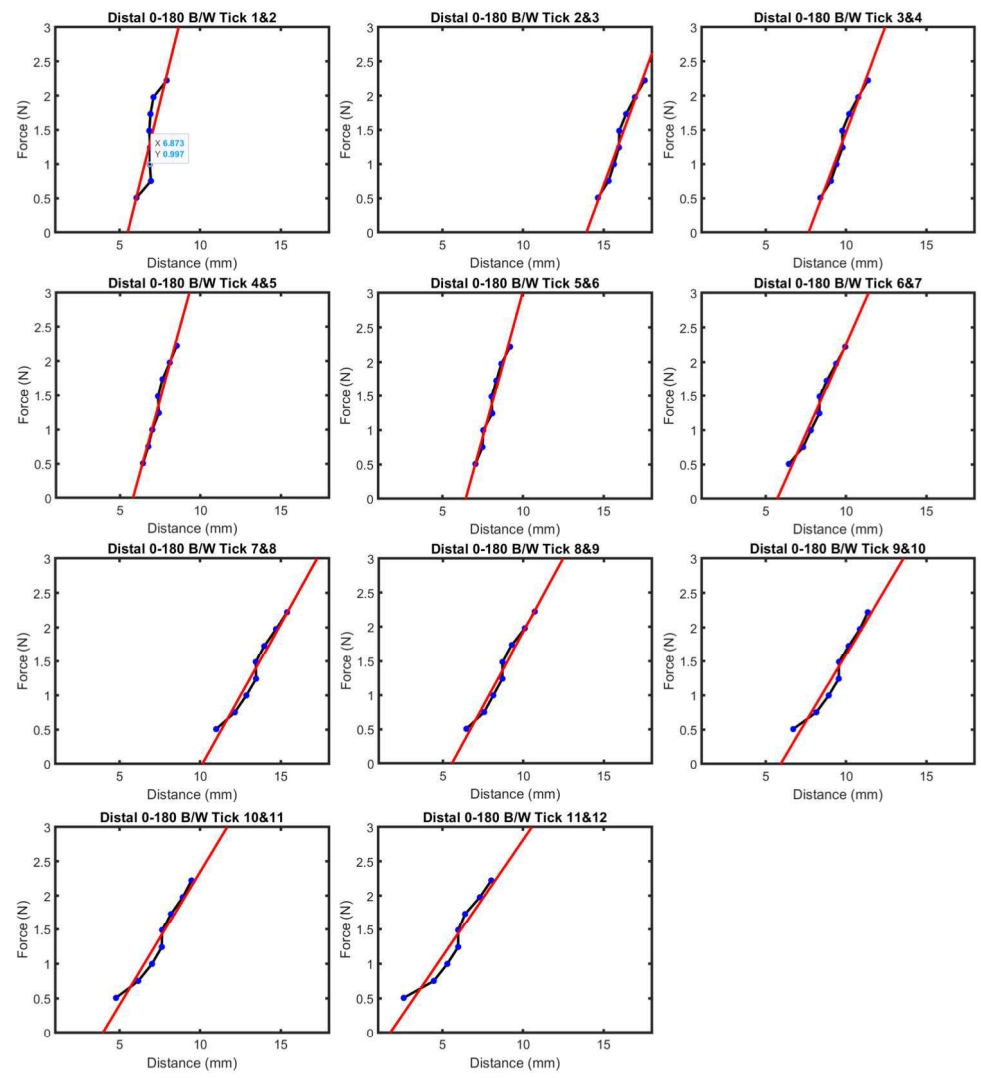


Figure S2. Linear regression of weight versus stretch for each adjacent pair of tick marks on the second wombat intestine, cut 180° offset from the first sample.

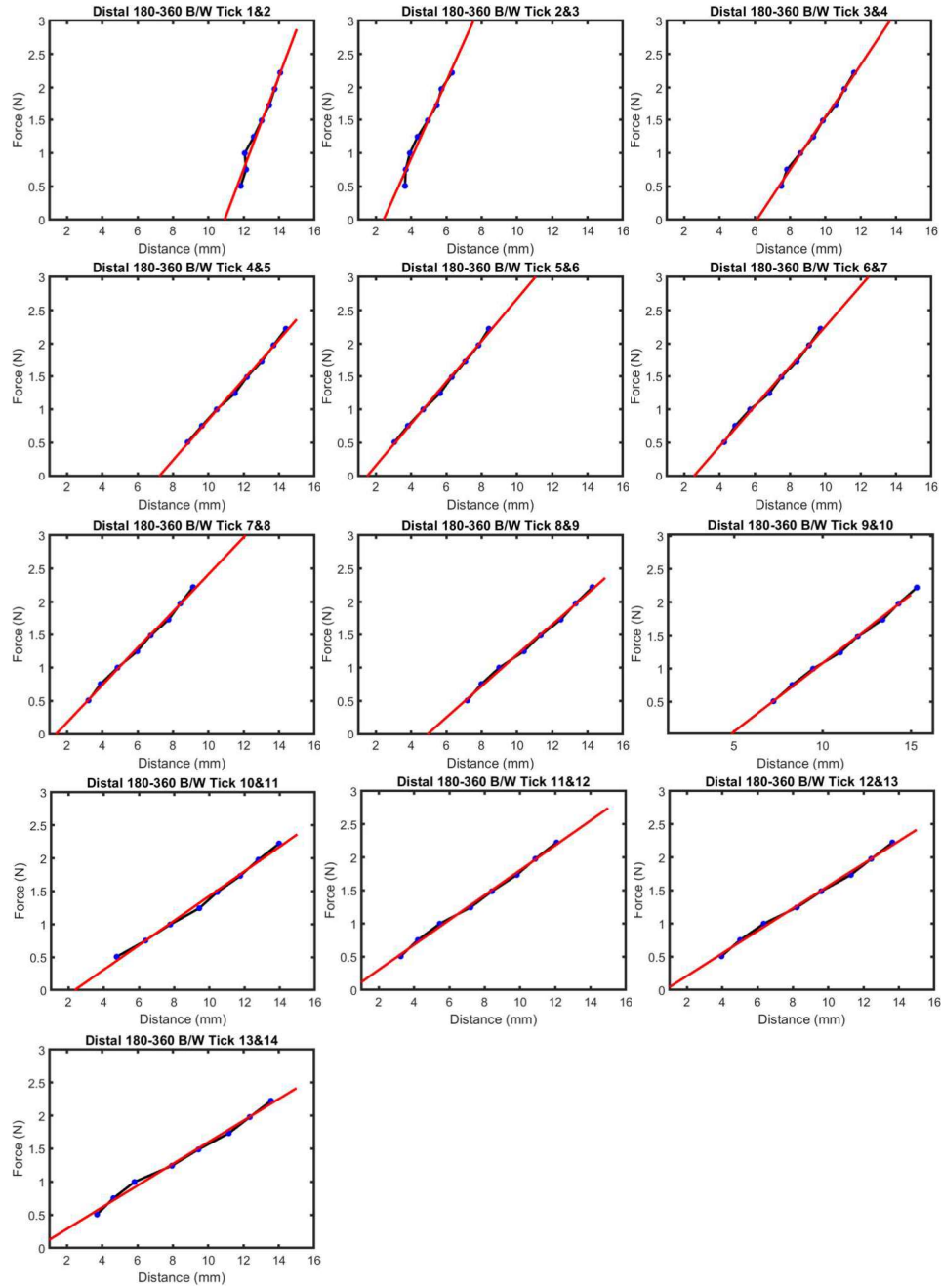


Table S1. Tissue thickness measured by histology at different azimuthal positions of the intestine.

Angle (degree)	Colon	Letter	Circumference (cm)	Depth (cm)	Londitudinal (μm)	Circular (μm)	Glandular (μm)	Mucosal (μm)	Total (μm)
0	Proximal	C	1	2	17.2974972	23.3067247	35.41891969	15.66938138	91.69252297
0	Proximal	C	1	3	12.61543079	23.54354154	26.17319528	11.11065707	73.44282469
0	Proximal	C	1	4	17.35670142	21.36285308	26.37547634	12.44768552	77.54271636
25	Proximal	C	2	2	4.307106406	15.87659612	22.40386047	14.09553608	56.68309908
25	Proximal	C	2	3	5.999360125	15.36842664	22.02890046	13.07426343	56.47095065
25	Proximal	C	2	4	6.625938033	17.89447301	17.56391616	10.62222233	52.70654952
50	Proximal	C	3	2	6.625938033	15.56577401	14.24354661	13.03479396	49.47005261
50	Proximal	C	3	3	6.566733821	15.59537612	15.284554	10.44460969	47.89127363
50	Proximal	C	3	4	6.976229619	16.26635718	14.59877188	14.11527082	51.95662951
75	Proximal	C	4	2	7.494266472	18.62465828	10.86890654	10.56301812	47.55084941
75	Proximal	C	4	3	7.731083319	18.27930038	15.24015084	12.64996658	53.90050113
75	Proximal	C	4	4	9.201321245	20.17383516	9.783495994	11.40667813	50.56533053
100	Proximal	C	5	2	6.10790118	22.09797204	20.7905457	17.9290088	66.92542771
100	Proximal	C	5	3	4.968220104	20.22810569	19.4387162	17.60831932	62.2433613
100	Proximal	C	5	4	4.889281155	16.44396982	15.11187505	12.29474131	48.73986733
125	Proximal	C	6	2	7.084770674	21.93516046	15.4128298	11.87537814	56.30813907
125	Proximal	C	6	3	8.490870704	19.44364988	26.40507845	18.14609091	72.48568994
125	Proximal	C	6	4	5.644134855	25.51208159	12.26020552	16.56731193	59.98373389
150	Proximal	C	7	2				10.80476865	
150	Proximal	C	7	3	6.57660119	27.02178899	27.34741215	10.27193074	71.21773307
150	Proximal	C	7	4	4.001217978	21.53553203	19.84327831	14.81092031	60.19094863
175	Proximal	C	8	2	6.685142245	31.49170697	23.72115418	13.12853396	75.02653736
175	Proximal	C	8	3	8.209650698	25.65515843	21.63420572	8.831294921	64.33030977
175	Proximal	C	8	4	10.29659916	28.0233269	20.29717727	9.872302312	68.48940564
200	Proximal	C	9	2	7.198245414	29.24194693	19.61139515	9.867368627	65.91895611
200	Proximal	C	9	3	8.076441221	30.67271538	18.41744354	10.28673179	67.45333194
200	Proximal	C	9	4	10.16338969	29.8783922	19.25123619	9.536811778	68.82982986
225	Proximal	C	10	2	5.111296949	28.20587322	25.16179	10.69622759	69.17518776
225	Proximal	C	10	3	5.510925378	24.02704261	24.22932366		
225	Proximal	C	10	4	4.553790621	24.10598156	17.66752353	9.388801249	55.71609695
250	Proximal	C	11	2	6.764081194	22.05356888	12.71903816	10.44460969	51.98129793
250	Proximal	C	11	3	7.716282267	21.41218992	13.94752555	8.500738072	51.57673581
250	Proximal	C	11	4	8.717820182	21.02736254	14.17940872	8.831294921	52.75588637
275	Proximal	C	12	2	10.60248759	20.75600991	24.77696262	11.91484762	68.05030774
275	Proximal	C	12	3	7.222913835	21.27404676	27.4263511	10.60248759	66.52579929
275	Proximal	C	12	4	8.165247539	22.65547837	25.92651107	10.99224865	67.73948563
300	Proximal	C	13	2	4.504453778	11.52508656	11.71750024	6.300314869	34.04735545
300	Proximal	C	13	3	7.884027533	19.75447199	14.83065505	8.693151761	51.16230633
300	Proximal	C	13	4	6.778882247	10.59755391	12.29474131	7.252515941	36.9236934
325	Proximal	C	14	2	7.217980151	16.55251087	17.62805405	8.569809653	49.96835473
325	Proximal	C	14	3	7.203179098	17.37643615	18.69372986	9.758827572	53.03217269
325	Proximal	C	14	4	6.453259082	14.08566872	20.38598358	7.962966482	48.88787786

Angle (degree)	Colon	Letter	Circumference (cm)	Depth (cm)	Londitudinal (μm)	Circular (μm)	Glandular (μm)	Mucosal (μm)	Total (μm)
0	Distal	A	1	3	9.956174945	35.45345548	24.84110052	30.47536801	100.7260989
0	Distal	A	1	4	8.33792649	37.13090814	18.59505618	26.5136195	90.57751031
0	Distal	A	1	5	6.699943298	35.20677126	19.29563935	23.38566365	84.58801756
40	Distal	A	2	3	8.377395965	26.26693529	20.24784042	18.41250986	73.30468153
40	Distal	A	2	4	10.64689075	31.30916065	23.27218891	19.30057303	84.52881335
40	Distal	A	2	5	7.405460155	31.43743645	26.54322161	23.50407207	88.89019028
80	Distal	A	3	3	7.953099114	26.17319528	27.8358469	24.52041104	86.48255233
80	Distal	A	3	4	10.60248759	26.18306265	13.25680975	27.16979952	77.21215951
80	Distal	A	3	5	9.097713874	28.90152271	15.47203401	23.20311733	76.67438792
120	Distal	A	4	3	13.7748466	21.45659308	16.76959298	27.16979952	79.17083218
120	Distal	A	4	4	14.63330767	21.61940466	14.63330767	28.58083323	79.46685324
120	Distal	A	4	5	12.30954236	22.70481521	21.59473624	24.85096789	81.4600617
160	Distal	A	5	3	27.02178899	28.7781806	20.98295939	26.43961424	103.2225432
160	Distal	A	5	4	22.25584994	28.5265627	19.16736356	25.72423001	95.67400621
160	Distal	A	5	5	23.22285206	26.8589774	16.2614235	29.15314061	95.49639357
200	Distal	A	6	3	12.61543079	28.0233269	19.76927304	21.92529309	82.33332383
200	Distal	A	6	4	10.28179811	28.27987849	18.79733723	22.57160573	79.93061957
200	Distal	A	6	5	14.54943504	31.40783434	19.4387162	25.94624581	91.34223138
240	Distal	A	7	3	12.71410448	28.80778271	16.09861192	18.64439302	76.26489212
240	Distal	A	7	4	11.08598865	26.96258477	19.36471093	16.36996455	73.78324891
240	Distal	A	7	5	10.99224865	27.29314162	18.97001619	14.97866558	72.23407204
280	Distal	A	8	3	7.810022268	19.29563935	16.21702034	11.95925078	55.28193273
280	Distal	A	8	4	6.843020143	20.3810499	18.49638249	11.2586676	56.97912014
280	Distal	A	8	5	8.061640168	26.26693529	14.82572136	14.40142451	63.55572133
320	Distal	A	9	3	12.91145185	37.26411762	21.71807835	21.60953729	93.50318511
320	Distal	A	9	4	12.06285815	33.7167986	17.82046774	22.82322363	86.42334812
320	Distal	A	9	5	9.334530721	28.84725218	16.30582666	24.39706893	78.88467849