Supplemental Information

Morphological differences between *Proteles* taxa

1. **Differences in fur colouration and markings**

Cabrera (1910) described how the fur of *pallidior* is unicolored and lacks the brown base of *cristatus*. This latter character appears to be consistent in an Ethiopian specimen in National Museums Scotland (NMS.Z.1877.15.5) compared with three skins of *cristatus* of Namibian and South African origin (NMS.Z.2020.44, NMS.Z.2020.46.1 and NMS.Z.2020.46.6) also in the collections of National Museums Scotland (Figure 1), although it would appear to be a difference in the coloration of the underfur. However, a Zimbabwean specimen (NMS.Z.1950.68) also had only pale underfur, which appears to contradict Cabrera (1910), so the usefulness of this character is in doubt.

Figure 1: Unicolored fur of an Eastern aardwolf from Ethiopia (NMS.Z.1877.15.5) (left) and bicoloured fur of a Southern aardwolf of South African origin (NMS.Z.2020.44) (right).

In reviewing georeferenced photographs of aardwolves from throughout the range, the striping pattern appeared to be variable, but overall East African specimens tended to be paler, with more contrasting stripes with a pale forehead compared with the longer, greyer or ochre-grey fur in Southern African specimens, which have broader less distinctive stripes (A.C.K. pers. obs.). However, fur length and hence stripe distinctiveness may just be a phenotypic response to lower temperatures at higher latitudes compared with equatorial East African specimens.

Additional preliminary observations were made on pelage coloration and markings based on the skins above and live specimens of both taxa kept at Hamerton Zoo Park, Cambridgeshire, UK. The live specimens offer a unique opportunity to examine these characters at the same latitude and environmental conditions, so that phenotypes should reflect genetic differences between taxa. Two pelage characters appear to be different between the two taxa. Firstly the stripes in *cristatus* tend to broader and less well defined, whereas in *septentrionalis* they are thinner, more contrasting and break up into spots on the neck. Secondly the forehead coloration is dark grizzled grey in *cristatus*, but lighter yellowish-grey or creamy-grey in *septentrionalis*. Further investigation is required to examine pelage variation from throughout

the ranges of both taxa to see if these characters are diagnostic and to determine additional diagnostic characters.

2. Skull morphometric analyses

In addition to skull measurements taken from specimens in the Naturla History Museum, London (NHMUK), Museum of Vertebrate Zoology (MVZ) and National Museums Scotland (NMS), measurements of skulls were taken from the literature (Allen 1909, Heller 1913 Hollister 1918, Roberts 1932, 1951) (Table 1). Comparison of means confirmed that mean post-orbital breadth is significantly greater in *septentrionalis* than in *cristatus* ($t_{8,16}=4.10$, $P<0.001$) (Figure 2). However, there are no differences between the means of other skull measurements, including condylobasal length of skull (Figure 3), zygomatic width, inter-orbital breadth, brain-case width and mandible length (all $P>0.05$). As noted above with skins, sample sizes are small and thus the significant difference in mean post-orbital breadth between the two taxa remains tentative subject to examination of a larger sample.

Table 1: Skull measurements of Proteles taxa from museum specimens and the literature (Allen 1909, Heller 1913 Hollister 1918, Roberts 1932, 1951)

| Specimen	Taxon	Sex	Condylobasal length	Zygomatic width	Greatest brain case width	Inter-orbital breadth	Post-orbital breadth	Mandible length	Reference
NHMUK ZD 1904.3.1.58	*P. c. cristatus*	NA	134	77.4	44.7	24.8	29.3	93	Cabrera 1910
NHMUK ZD 1902.9.1.28	*P. c. cristatus*	NA	139.1	81.3	46.3	29.4	33	97	Cabrera 1910
NHMUK ZD 1934.11.1.5	*P. c. cristatus*	NA	134.3	77.2	44.9	24.6	26.7	NA	NHUMUK
NHMUK ZD 1883.11.91	*P. c. cristatus*	NA	134.5	78.3	46.4	28.4	32.2	NA	NHUMUK
MVZ 118478	*P. c. cristatus*	NA	126.3	NA	46.1	23.7	31.4	NA	MVZ
MVZ 117841	*P. c. cristatus*	NA	132.9	81.2	46.5	25.3	27.7	NA	MVZ
Albany District	*P. c. cristatus*	M	143	81.7	50	28	29.5	96.5	Roberts 1951
Albany District	*P. c. cristatus*	M	135	78.5	46	30.6	34.5	93	Roberts 1951
Vryburg	*P. c. cristatus*	M	136	81.5	46.5	25.4	28	93	Roberts 1951
Okanhandja District	*P. c. cristatus*	M	140	84	51	28.6	31.3	95	Roberts 1951
TM 1915	*P. c. cristatus*	F	137.5	82.2	50.5	28.2	32	94.5	Roberts 1932, 1951; type *transvaalensis*
NMS.Z.2020.44	*P. c. cristatus*	NA	143.5	NA	51.1	30.1	33.6	NA	NMS/Twycross Zoo
NMS.Z.2020.46.3	*P. c. cristatus*	NA	139.1	NA	46.2	29.5	30.7	NA	NMS/Hamerton Zoo
NMS.Z.2020.46.1	*P. c. cristatus*	NA	137.4	NA	46.6	25.6	27.2	NA	NMS/Hamerton Zoo
NMS.Z.2020.46.5	*P. c. cristatus*	NA	129.2	NA	46.4	28.2	33.9	NA	NMS/Hamerton Zoo
NMS.Z.2020.46.4	*P. c. cristatus*	NA	138	NA	47.2	33.4	34.5	NA	NMS/Hamerton Zoo
NHMUK ZD 1904.8.2.25	*P. c. septentrionalis*	M	130	80	45.8	36	37	93	Cabrera 1910; type *pallidior*
NHMUK ZD 1905.12.2.2	*P. c. septentrionalis*	NA	134	82	45	31	36	94	Cabrera 1910
NHMUK ZD 1895.5.2.2	*P. c. septentrionalis*	NA	144	85	47	33.5	37	102	Cabrera 1910
USNM 181523	*P. c. septentrionalis*	F	136	75	46	26	33	96	Heller 1913; type *termes*
AMNH 27768	*P. c. septentrionalis*	M	141	82	NA	NA	34	NA	Allen 1909
USNM 164503	*P. c. septentrionalis*	M	140	82	NA	NA	35.8	98	Hollister 1918
USNM 181495	*P. c. septentrionalis*	M	127	72	NA	NA	33.5	89	Hollister 1918
USNM 164837	*P. c. septentrionalis*	F	135	88	NA	NA	34.8	97	Hollister 1918
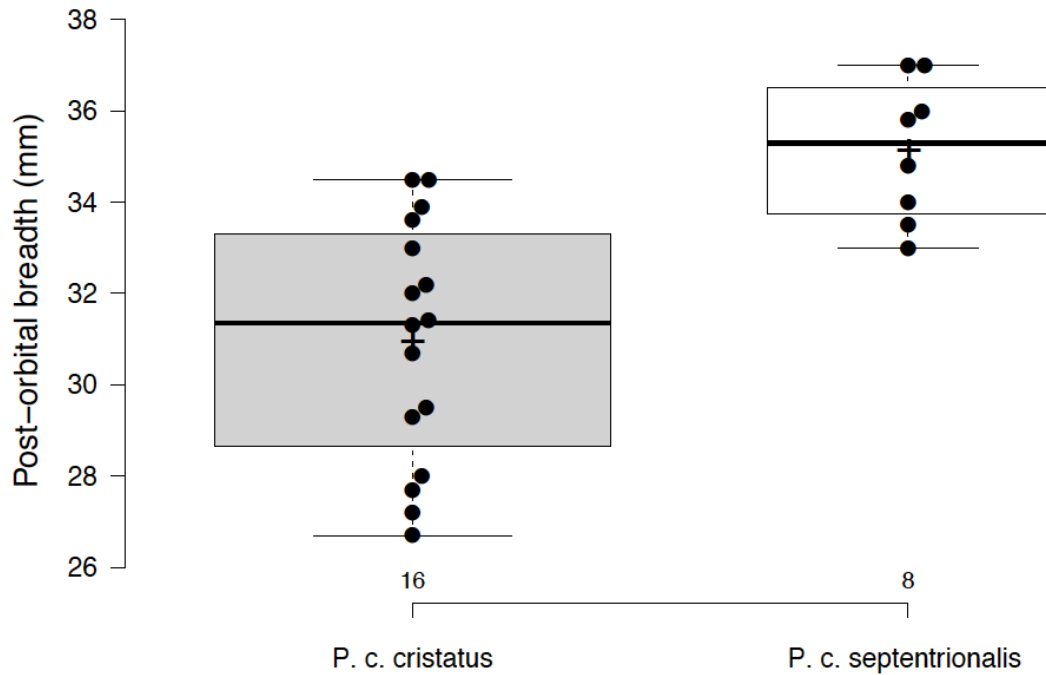
Figure 2: Box and jitter plot of post-orbital breadths of *Proteles* taxa: *cristatus* (left) and *septentrionalis* (right). Graph generated with BoxPlotR (http://shiny.chemgrid.org/boxplotr/).
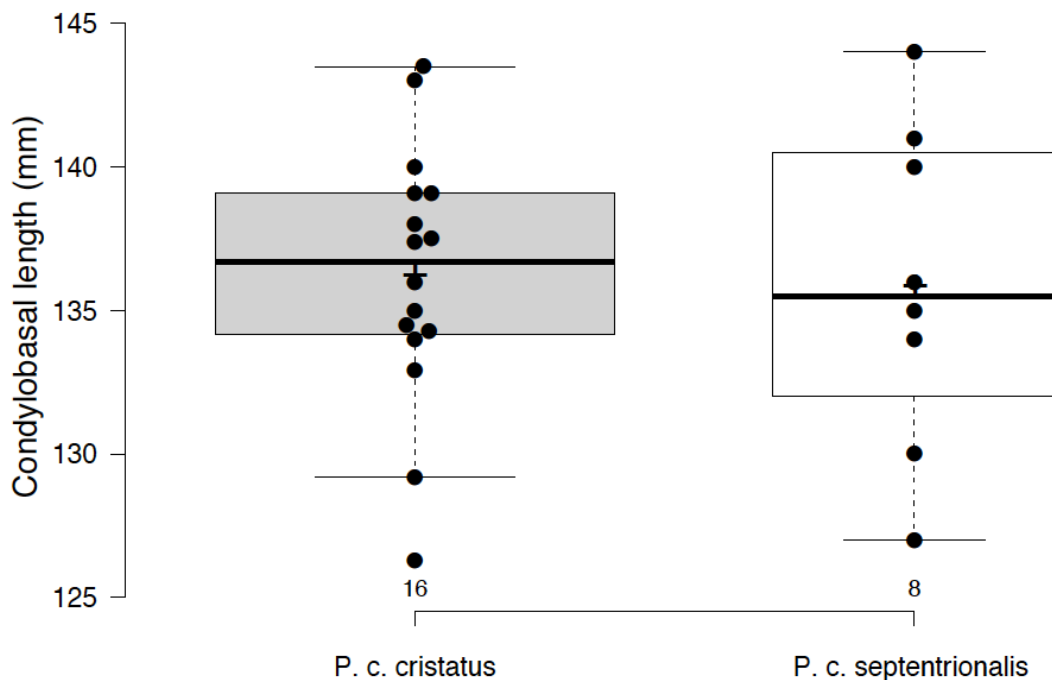

Figure 3: Box and jitter plot of condylobasal lengths of skull of *Proteles* taxa: *cristatus* (left) and *septentrionalis* (right). Graph generated with BoxPlotR (http://shiny.chemgrid.org/boxplotr/).

Summary

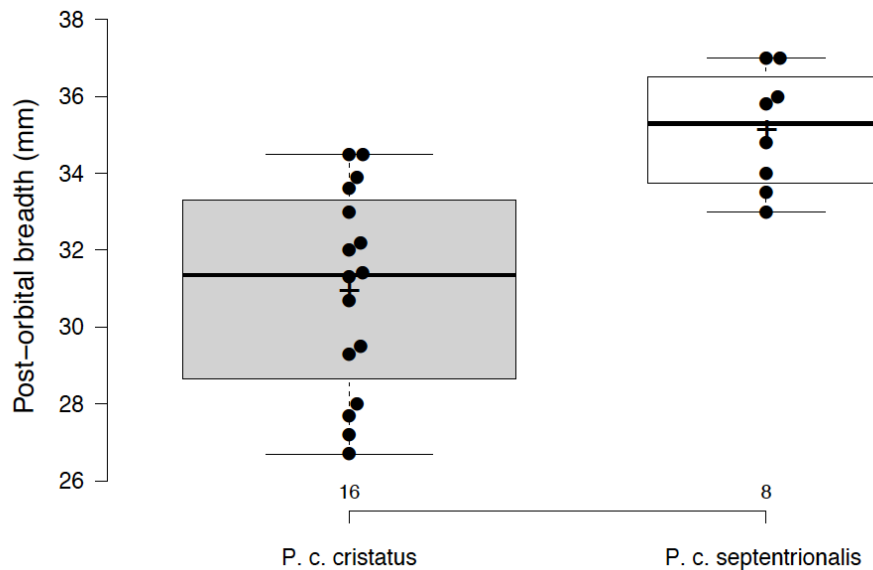|	*P. cristatus*	*P. septentrionalis*
Stripe pattern	Broad and poorly defined black stripes	Thin contrasting black stripes breaking up into spots on the neck
Forehead colouration	Dark grizzled grey	Yellowish-grey/creamy-grey
Hair colouration	Bicoloured; dark at base	Unicoloured; pale
Postorbital breadth	≤34.6 mm	≥33.0 mm

References

Allen, J.A. (1909). Mammals from British East Africa, collected by the Tjäder Expedition of 1906. Bulletin of the American Museum of Natural History 26: 147-175.

Hammer, Ø., Harper, D.A.T., and Ryan, P.D. (2001). PAST: Paleontological Statistics Software Package for Education and Data Analysis. *Palaeontologia Electronica* 4(1): 9pp.

Heller, E. (1913). New antelopes and carnivores from British East Africa. *Smithosnian Miscellaneous Collections* 61(13): 1-15.

Hollister, N. (1918). East African mammals in the United States National Museum. Part I. Insectivora, Chiroptera, and Carnivora. *Bulletin of the United States National Museum* 99: 1-194.

Roberts, A. (1932). Preliminary descriptions of fifty-seven new forms of South Afrucan mammals. Annals of the Transvaal Museum 15(1): 1-19.

Roberts, A. (1951). *The mammals of South Africa.* The Mammals of South Africa Book Fund, Johannesburg.

Statistical analyses

All statistical analyses were carried out using Past 4.02 (Hammer et al. 2001).

Post-orbital breadth
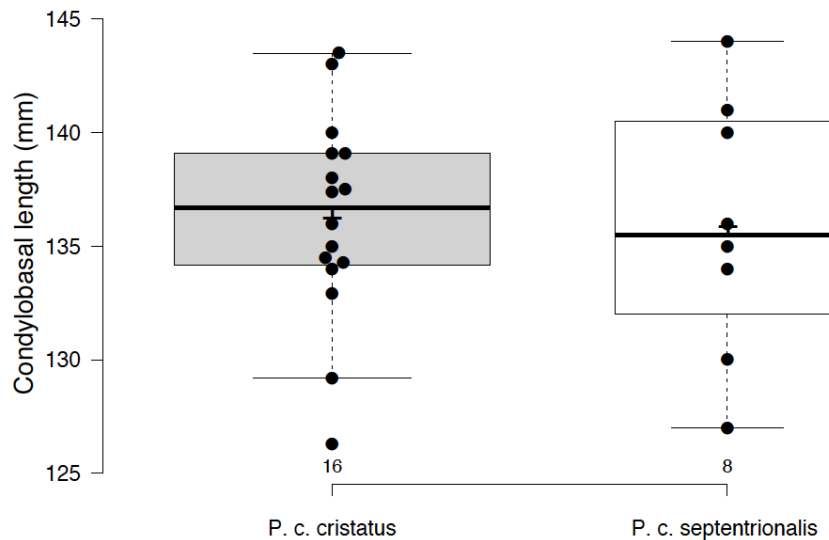

Graph generated with BoxPlotR (http://shiny.chemgrid.org/boxplotr/).

t tests for equal means

POB - C	POB - S
N: 16	N: 8
Mean: 30.969	Mean: 35.138
95% conf.: (29.563 32.374)	95% conf.: (33.843 36.432)
Variance: 6.9596	Variance: 2.397

Difference between means: 4.1688
95% conf. interval (parametric): (2.0612 6.2763)
95% conf. interval (bootstrap): (2.55 5.7625)
t : 4.1022   p (same mean): 0.0004701   Critical t value (p=0.05): 2.0739
Uneq. var. t : 4.8639   p (same mean): 8.0558E-05
Monte Carlo permutation: p (same mean): 0.0009
Exact permutation: p (same mean): 0.00061457

F test for equal variances

POB - C	POB - S
N: 16	N: 8
Variance: 6.9596	Variance: 2.397

F : 2.9035   p (same var.): 0.15928
Critical F value (p=0.05): 4.5678
Monte Carlo permutation: p (same var.): 0.0638
Exact permutation: p (same var.): 0.061063

Condylobasal length
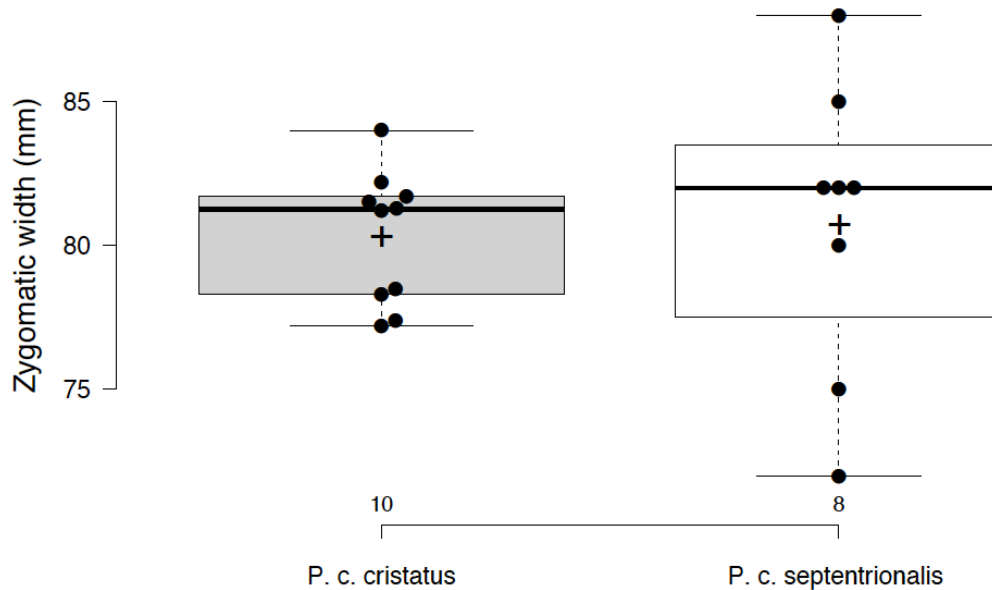

Graph generated with BoxPlotR (http://shiny.chemgrid.org/boxplotr/).

t tests for equal means

CBL - C	CBL - S
N: 14	N: 7
Mean: 136.19	Mean: 136.71
95% conf.: (133.44 138.94)	95% conf.: (131.55 141.88)
Variance: 22.664	Variance: 31.238

Difference between means: 0.52143
95% conf. interval (parametric): (-4.3588 5.4017)
95% conf. interval (bootstrap): (-3.85 5.0929)
t : 0.22363   p (same mean): 0.82543   Critical t value (p=0.05): 2.093
Uneq. var. t : 0.21144 p (same mean): 0.83659
Monte Carlo permutation: p (same mean): 0.8265
Exact permutation: p (same mean): 0.82662

F test for equal variances

CBL - C	CBL - S
N: 14	N: 7
Variance: 22.664	Variance: 31.238

F : 1.3783   p (same var.): 0.58781
Critical F value (p=0.05): 3.6043
Monte Carlo permutation: p (same var.): 0.6635
Exact permutation: p (same var.): 0.66178

Zygomatic width

Graph generated with BoxPlotR (http://shiny.chemgrid.org/boxplotr/).

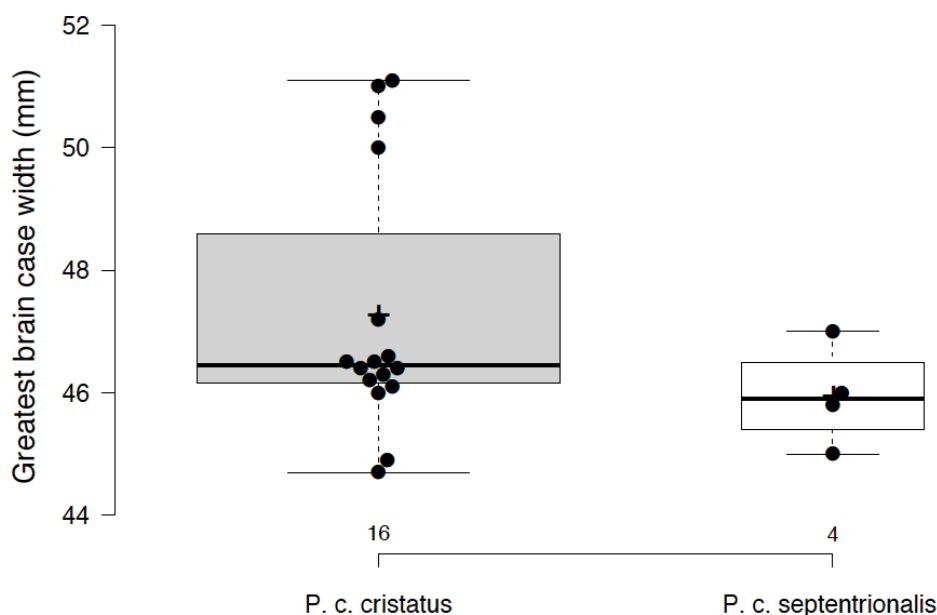*t tests for equal means*

ZW - C   ZW - S

N: 10   N: 8

Mean: 80.33   Mean: 80.75

95% conf.: (78.682 81.978)   95% conf.: (76.446 85.054)

Variance: 5.3068   Variance: 26.5

Difference between means: 0.42

95% conf. interval (parametric): (-3.4194 4.2594)

95% conf. interval (bootstrap): (-3.04 4.145)

t : 0.2319   p (same mean): 0.81956   Critical t value (p=0.05): 2.1199

Uneq. var. t : 0.21424 p (same mean): 0.83501

Monte Carlo permutation: p (same mean): 0.8188

Exact permutation: p (same mean): 0.823

F test for equal variances

ZW - C   ZW - S

N: 10   N: 8

Variance: 5.3068   Variance: 26.5

F : 4.9936   p (same var.): 0.029217

Critical F value (p=0.05): 4.197

Monte Carlo permutation: p (same var.): 0.0832

Exact permutation: p (same var.): 0.079643

Brain case width
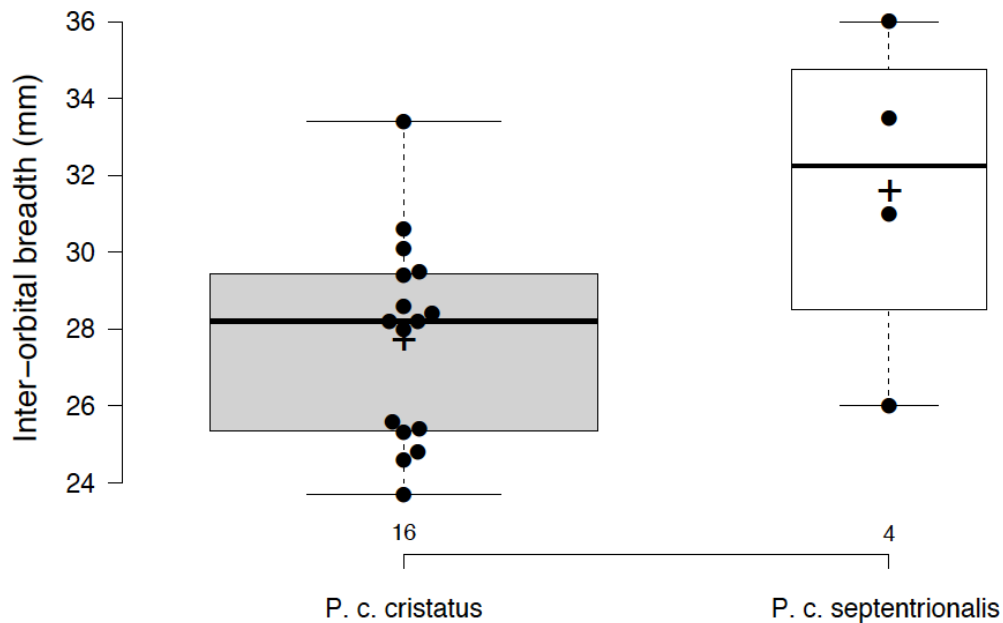

Graph generated with BoxPlotR (http://shiny.chemgrid.org/boxplotr/).

t tests for equal means

BCW - C	BCW - S
N: 16	N: 4
Mean: 47.275	Mean: 45.95
95% conf.: (46.15 48.4)	95% conf.: (44.641 47.259)
Variance: 4.4607	Variance: 0.67667

Difference between means: 1.325
95% conf. interval (parametric):   (-0.97345 3.6234)
95% conf. interval (bootstrap):   (0.05625 2.5188)
t : 1.2111   p (same mean): 0.24151   Critical t value (p=0.05): 2.1009
Uneq. var. t : 1.9797   p (same mean): 0.068296
Monte Carlo permutation: p (same mean): 0.254
Exact permutation: p (same mean): 0.26749

F test for equal variances

BCW - C	BCW - S
N: 16	N: 4
Variance: 4.4607	Variance: 0.67667

F : 6.5921   p (same var.): 0.14604
Critical F value (p=0.05): 14.253
Monte Carlo permutation: p (same var.): 0.2578
Exact permutation: p (same var.): 0.24974
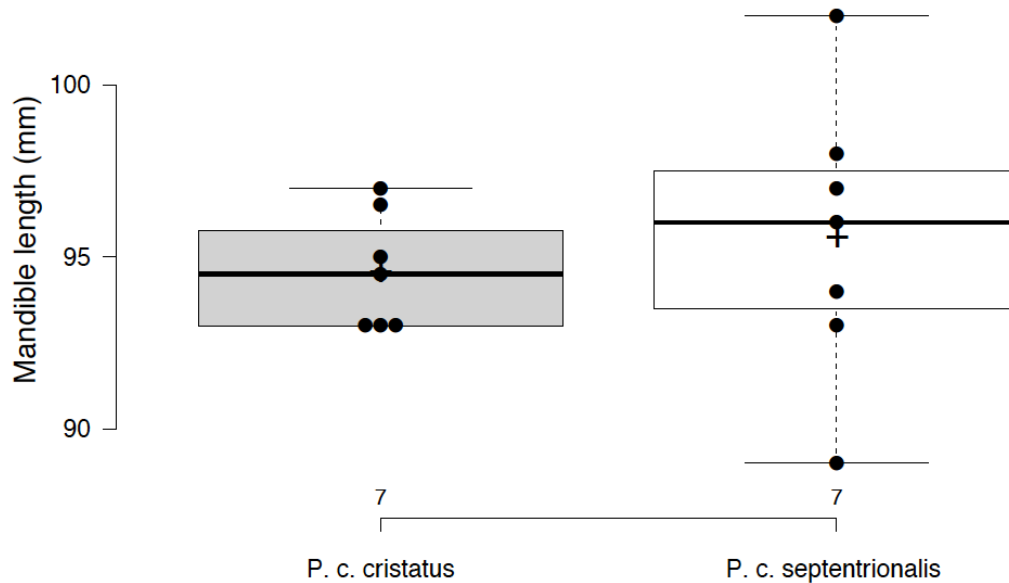
Inter-orbital breadth

Graph generated with BoxPlotR (http://shiny.chemgrid.org/boxplotr/).

t tests for equal means

IOB - C	IOB - S
N: 16	N: 4
Mean: 27.738	Mean: 31.625
95% conf.: (26.333 29.142)	95% conf.: (24.831 38.419)
Variance: 6.9425	Variance: 18.229

Difference between means: 3.8875
95% conf. interval (parametric): (0.39884 7.3762)
95% conf. interval (bootstrap): (0.29375 7.8)
t : 2.3411   p (same mean): 0.030936   Critical t value (p=0.05): 2.1009
Uneq. var. t : 1.7401   p (same mean): 0.16491
Monte Carlo permutation: p (same mean): 0.0274
Exact permutation: p (same mean): 0.028896

F test for equal variances

IOB - C	IOB - S
N: 16	N: 4
Variance: 6.9425	Variance: 18.229

F : 2.6257   p (same var.): 0.17702
Critical F value (p=0.05): 4.1528
Monte Carlo permutation: p (same var.): 0.3181
Exact permutation: p (same var.): 0.31827

Mandible length

Graph generated with BoxPlotR (http://shiny.chemgrid.org/boxplotr/).

t tests for equal means

ML - C	ML -S
N: 7	N: 7
Mean: 94.571	Mean: 95.571
95% conf.: (93.005 96.138)	95% conf.: (91.764 99.379)
Variance: 2.869	Variance: 16.952

Difference between means: 1

95% conf. interval (parametric): (-2.6664 4.6664)

95% conf. interval (bootstrap): (-2 4.0714)

t : 0.59427   p (same mean): 0.56337   Critical t value (p=0.05): 2.1788

Uneq. var. t : 0.59427   p (same mean): 0.56881

Monte Carlo permutation: p (same mean): 0.5889

Exact permutation: p (same mean): 0.59732

F test for equal variances

ML - C	ML -S
N: 7	N: 7
Variance: 2.869	Variance: 16.952

F : 5.9087   p (same var.): 0.048245

Critical F value (p=0.05): 5.8198

Monte Carlo permutation: p (same var.): 0.103

Exact permutation: p (same var.): 0.11305