

COMMENTS ON TRIASSIC PTEROSAURS WITH A COMMENTARY ON THE “ONTOGENETIC STAGES” OF KELLNER (2015) AND THE VALIDITY OF *BERGAMODACTYLUS WILDI*

FABIO M. DALLA VECCHIA

Supplementary information

Specimen	mcIV	h	r	wph1	f	mcIV/h	mcIV/r	f/r	f/wph1
TM6924	10	16.5	26.7	37	12.5	0.61	0.37	0.47	0.34
Unknown	10	15.3	26	33	12.4	0.65	0.38	0.48	0.38
MNHU nn	10	17	28	37.5	13.8	0.59	0.36	0.49	0.37
BSP 1877 X 1	9.6	14.6	23.8	31.1	11.5	0.66	0.40	0.48	0.37
BSP 1889 XI 1	9.5	15.5	24	32.3	11.7	0.61	0.40	0.49	0.36
RM St. 18182	8	14.5	24	-	-	0.55	0.33	-	-
BSP 1959 I 400	12	19	32	44	15.7	0.63	0.375	0.49	0.36
BSP 1938 I 1	11.6	17	29.5	40.5	12.5	0.68	0.39	0.42	0.31
PTH 1966.6	9	16.8	27	35.5	-	0.54	0.33	-	-
MM nn	9	14.5	25	31	14	0.62	0.36	0.56	0.45
MM nn	11	14	23	29	12	0.79	0.48	0.52	0.41
SL 010	9.5	15.3	25.5	36	12.3	0.62	0.37	0.48	0.34
MB nn	11.2	18	28	39.5	13.5	0.62	0.40	0.48	0.34
JS nn	9	15.5	25	32.5	10.5	0.58	0.36	0.41	0.32
MNHU nn	10	16	26	36	-	0.63	0.38	-	-
MB nn	7.8	14.5	22.5	29.3	11	0.54	0.35	0.49	0.37
CM 11433	10	16.5	26	37.3	-	0.61	0.38	-	-
MMK V.45/1	8.5	13.5	21	30	11	0.63	0.40	0.52	0.37
MMK 1891.740	9.5	15.5	24.7	33.2	-	0.61	0.38	-	-
BSP 1934 I 36	11.8	19.5	30	50	-	0.60	0.39	-	-
PTH nn	14	24	36	48	18	0.58	0.39	0.50	0.37
UB E 544	13.7	21.8	37.5	53.8	17	0.63	0.36	0.45	0.32
NHMUK 42738	15	24.5	40	60	16.5	0.61	0.375	0.41	0.27
KS nn	14	-	34	50.5	17	-	0.41	0.50	0.34
JS nn	10	19	33.5	49.5	16	0.53	0.30	0.48	0.32
PTH 1951.14	6	17.5	27.5	-	-	0.34	0.22	-	-
GIE nn	12.5	20	32.6	45.7	-	0.62	0.38	-	-

Tab. 1 - Wing metacarpal, humerus, radius, wing phalanx 1 and femur lengths and relative ratios in a sample of *Rhamphorhynchus muensteri* (sensu Bennett 1995) specimens belonging to the small size-class (skull ranging 31-65 mm in length; R. *'longicaudus'*, cf. R. *'longicaudus'*, R. *'intermedius'*, and cf. R. *'intermedius'* of Wellnhofer (1975). Measurements are in millimetres. Data are taken from Wellnhofer (1975) and partly updated. Symbols: -, no measurement/ratio. Anatomical abbreviations: **f**, femur; **h**, humerus; **mcIV**, metacarpal IV; **r**, radius; **wph1**, wing phalanx 1. Institutional abbreviation: **AMNH**, American Museum of Natural History, New York (USA); **BSP**, Bayerische Staatssammlung für Paläontologie und Geologie, Munich (Germany); **CM**, Carnegie Museum of Natural History, Pittsburgh (USA); **ES**, E. Schöpfung collection, Obereichstätt (Germany); **GIE**, Geologische Institut der Universität Erlangen, Erlangen (Germany); **GPIH**, Geologisch-Paläontologisch Institut der Universität Heidelberg, Heidelberg (Germany); **GPK**, Geologisch-Paläontologisch Institut der Universität und Museum, Heidelberg (Germany); **HDL**, Hessisches Landmuseum, Darmstadt (Germany); **JS**, J. Schmitt collection, Frankfurt am Main (Germany); **KS**, K. Strobl collection, Eichstätt (Germany); **MB**, Museum Berger, Hartof near Eichstätt (Germany); **MCZ**, Museum of Comparative Zoology, Harvard University, Cambridge (USA); **MLU**, Martin-Luther Universität, Halle-Wittenberg (Germany); **MM**, Bürgermeister-Müller Museum, Solenhofen (Germany); **MMK**, Mineralogisk Museum, Copenhagen (Denmark); **MNHU**, Museum für Naturkunde Berlin (Germany); **MSA**, Museum am Solenhofer Aktienverein, Maxberg bei Solenhofen (Germany); **MT**, Institut und Museum für Geologie und Paläontologie der Universität Tübingen (Germany); **NHMUK**, The Natural History Museum, London (UK); **nn**, without museum number; **PMZ**, Paläontologisches Institut und Museum der Universität, Zürich (Switzerland); **PTH**, Philosophisch-Theologische Hochschule, Natural History collections, Eichstätt (Germany); **RM**, Rijksmuseum van Geologie en Mineralogie, Leiden (The Netherlands); **SL**, H. Leich collection, Bochum (Germany); **SMD**, Staatliches Museum für Mineralogie und Geologie, Dresden (Germany); **SMF**, Senckenberg Forschungsinstitut und Naturmuseum, Frankfurt am Main (Germany); **SMNS**, Staatliches Museum für Naturkunde Stuttgart (Germany); **TM**, Teyler Museum, Haarlem (The Netherlands); **UB**, Katedra geologie a palaeontologie, Brno University (Czech Republic); **USNM**, United States National Museum of Natural History (Smithsonian Institution), Washington (USA); **WE**, Jura-Museum, Eichstätt (Germany); **XS**, X. Schöpfung collection, Gungolding (Germany); **YPM**, Yale Peabody Museum, New Haven (USA); **YPM-PU**, Yale Peabody Museum, Princeton Collection, New Haven (USA).

Specimen	mcIV	h	r	wph1	f	mcIV/h	mcIV/r	f/r	f/wph1
YPM 1778	17	31.5	56	95	-	0.54	0.30	-	-
MLU nn	19	33	56	91	28	0.58	0.34	0.50	0.31
SMD nn	18	34	58	95	28	0.53	0.31	0.48	0.29
AMNH 1943	21	38.5	67.3	114.1	35	0.54	0.31	0.52	0.31
TM 6920/21	21.7	42	66.1	109	36	0.52	0.33	0.54	0.33
NHMUK 37003	23	-	-	113	32	-	-	-	0.28
BSP AS VI 34	21	39.5	68.5	117.5	-	0.53	0.31	-	-
NHMUK 37787	24	45	73.5	123.5	-	0.53	0.33	-	-
SMF R 4128	21	38	66	114.5	33	0.55	0.32	0.50	0.29
MM nn	19	32	59.5	92.5	31	0.59	0.32	0.52	0.33
PTH 1954.39b	-	32	-	101	31	-	-	-	0.31
XS nn	22	36.5	-	99	30	0.60	-	-	0.30
PMZ A/III 107	17.3	31	56.7	83	26.7	0.56	0.30	0.47	0.32
HDL V 432	19.5	34	56	92	28.5	0.57	0.35	0.51	0.31
BSP 1955 I 28	25	42	72.5	120	37	0.59	0.34	0.51	0.31
ES nn	22.3	35.5	64	100	30.8	0.63	0.35	0.48	0.31
MNHU nn	21	37	60	102.5	30	0.57	0.35	0.50	0.29
CM 11429	20	36	61.5	88.5	-	0.56	0.35	-	-
CM 11432	19.7	34.5	59	96	28.5	0.57	0.33	0.48	0.30
NHMUK R 2786	19	38	62	102	30	0.50	0.31	0.48	0.29
CM 11431	19	39	60	100	31	0.49	0.32	0.52	0.31
BSP AS I 771	21	40	62.5	105.4	-	0.52	0.34	-	-
BSP 1927 I 36	21.5	-	-	101	35	-	-	-	0.35
CM 11427	-	40	61	105	29.5	-	-	0.48	0.28
BSP 1907 I 37	25	-	-	100	35.5	-	-	-	0.36
BSP AS I 772	21	-	-	120	36	-	-	-	0.30
WE nn	21	40.5	67	111	-	0.52	0.31	-	-
WE nn	22.5	41	71	110	35.7	0.55	0.32	0.50	0.32
ES nn	19.5	34.5	57.5	96	-	0.56	0.34	-	-
ES nn	19	31	55	88	-	0.61	0.34	-	-
XS nn	-	44	68	117	36.5	-	-	0.54	0.31
MSA nn	16.7	35.5	58	93	-	0.47	0.29	-	-
GPK nn	19	29.5	53.7	-	25.5	0.64	0.35	0.47	-
MSA nn	20	40	58	99	-	0.50	0.34	-	-
YPM-PU 11984	20	35	60	96.5	30.5	0.57	0.33	0.51	0.32
MMK 1891.738	17.3	30	50.5	80.5	25.3	0.58	0.34	0.50	0.31
MNHU3965-3967	21	-	64	-	27	-	0.33	0.42	-
GPIH MYE.13	18	38.5	61	102.5	27.5	0.47	0.29	0.45	0.27
USNM 2420	-	41	71	112	30	-	-	0.42	0.27
PTH nn	20	43	6	113	30	0.46	0.29	0.44	0.26
ES nn	21	36	61.5	99.5	26	0.58	0.34	0.42	0.26
CM11428	20	44	64	100	30	0.45	0.31	0.47	0.30
MB nn	16.5	34	54.5	83	-	0.48	0.30	-	-
NHMUK 43004	20	37	62	103	-	0.54	0.32	-	-
PTH 1955.135 a	19	37	59.5	99	31	0.51	0.32	0.52	0.31
ES nn	20	-	64	102	-	-	0.31	-	-
RM St. 18185	20	36.5	60.5	101.5	27.3	0.55	0.33	0.45	0.27
SL nn	18	-	56	89.5	-	-	0.32	-	-
MCZ 1504	19	38	63	105	-	0.50	0.30	-	-
SMD nn	23	40	63.5	102	-	0.57	0.36	-	-
SMNS 9620	21.5	35.5	58.5	95	-	0.60	0.37	-	-

Tab. 2 - Wing metacarpal, humerus, radius, wing phalanx 1 and femur lengths and relative ratios in a sample of *Rhamphorhynchus muensteri* (sensu Bennett 1995) specimens belonging to the medium size-class (skull ranging 78.7-125 mm in length; *R. 'muensteri'*, *R. cf. 'muensteri'*, *R. 'gemmingi'*, *R. 'longiceps'* CM11428 and *Rhamphorhynchus* sp. of Wellnhofer 1975). Measurements are in millimetres. Data are taken from Wellnhofer (1975) and partly updated. Symbols, institutional abbreviations and anatomical abbreviations are like in Tab. 1.

Specimen	mcIV	h	r	wph1	f	mcIV/h	mcIV/r	f/r	f/wph1
BSP 1929 I 69	34	59	99	178	52	0.58	0.34	0.52	0.29
MT nn	35	64.5	96	149	45.5	0.54	0.36	0.47	0.30

Tab. 3 - Wing metacarpal, humerus, radius, wing phalanx 1 and femur lengths and relative ratios in a sample of *Rhamphorhynchus muensteri* (sensu Bennett 1995) specimens belonging to the large size-class (skull ranging 150-160 mm in length; *R. 'longiceps'* and *R. 'muensteri'* BSP 1929 I 69 of Wellnhofer 1975). Measurements are in millimetres. Data are taken from Wellnhofer (1975). Symbols, institutional abbreviations and anatomical abbreviations are like in Tab. 1.

Ratio	Sample	Small	Medium	Large	Ms	Msmall	Mmedium	Mlarge
mcIV/h	0.34-0.79	0.34-0.79	0.45-0.64	0.54-0.58	0.57 (68)	0.60 (26)	0.54 (40)	0.56 (2)
mcIV/r	0.22-0.48	0.22-0.48	0.29-0.37	0.34-0.36	0.34 (71)	0.37 (29)	0.33 (42)	0.35 (2)
f/r	0.41-0.56	0.41-0.56	0.42-0.54	0.47-0.52	0.48 (49)	0.48 (19)	0.49 (28)	0.50 (2)
f/wph1	0.26-0.45	0.27-0.45	0.26-0.36	0.29-0.30	0.32 (53)	0.35 (19)	0.30 (32)	0.30 (2)

Tab. 4 - Wing metacarpal/humerus, wing metacarpal/radius, femur/radius and femur/wing phalanx ratio ranges within the sample of *Rhamphorhynchus muensteri* (sensu Bennett 1995) of Tabs. 1-3. The numbers in parentheses are the number of specimens. Abbreviations are like in Tab. 1 plus: **Mlarge**, mean of the large size-class ratios; **Mmedium**, mean of the medium size-class ratios; **Msmall**, mean of the small size-class ratios; **Ms**, mean of the whole *Rhamphorhynchus muensteri* sample.

REFERENCES

- Bennett S.C. (1995) - A statistical study of *Rhamphorhynchus* from the Solnhofen Limestone of Germany: year-classes of a single large species. *J. Paleontol.*, 69: 569-580.
- Wellnhofer P. (1975) - Die Rhamphorhynchoidea (Pterosauria) der Oberjura-Plattenkalke Süddeutschlands. Teil II: Systematische Beschreibung. *Palaeontographica*, 148:132-186.

