DENTAL DEVELOPMENTAL TIMING in PAN PANISCUS with COMPARISONS to PAN TROGLODYTES.

Debra R. Bolter* and Adrienne L Zihlman+   AAPA 2010 Albuquerque, New Mexico
*Department of Anthropology, Modesto College, Modesto, CA 95350 bolterd@mjc.edu +Department of Anthropology, University of California, Santa Cruz, CA 95064 azihlman@ucsc.edu

INTRODUCTION

Timing of dental eruption is one component of a chimpanzee's physical development; it marks the stages of growth, and helps characterize transitions from juvenile to adult. Hypotheses about the evolution of growth, development and life history typically rely on captive *Pan troglodytes* to represent the *Pan* pattern (e.g., Schultz, 1973; Bogin and Smith, 1996; Godfrey et al., 2003). Little is known of dental development in *Pan paniscus* as they are the rarest ape and number only 140 in captivity world-wide (Reinartz et al., 2003).

This study presents new data on the timing and sequence of dental development in female captive *Pan paniscus* (n=6) in comparison with *Pan troglodytes*. Growth patterns in *P. paniscus* are of interest for their contribution to life history evolution, as some researchers support *P. pansicus* as a better model for human evolution than *P. troglodytes* (e.g., Zihlman et al., 1978; Zihlman, 1984).

MATERIALS AND METHODS

The sample consists of six captive female pygmy chimpanzees of known ages.TABLE 1.

Data comprise a mixed longitudinal sample of maxillary teeth emergence times, and sequence of emergence for both maxillary and mandibular teeth. Observations were made during life, at death (gingival) and after dissections (alveolar). If left and right stages of emergence differed, the lesser-developed stage was used. Teeth were considered emerged if they pierced through the gingiva (live observation) or surpassed the alveolar bone (skeletal observation).

TABLE 1: SAMPLE

	Age (years)
Infant 1	Newborn
Infant 2	.8
Juvenile 1	6.8
Juvenile 2	7.3
Adult 1	8.5
Adult 2	11.7

RESULTS

Newborns have no teeth emerged. By 3.5 months, the upper incisors have emerged. By 10 months, the first deciduous molars are partially emerged through the gingiva, but not the second molars and canines. By 6.8 years, permanent maxillary teeth I1, P4 and M1

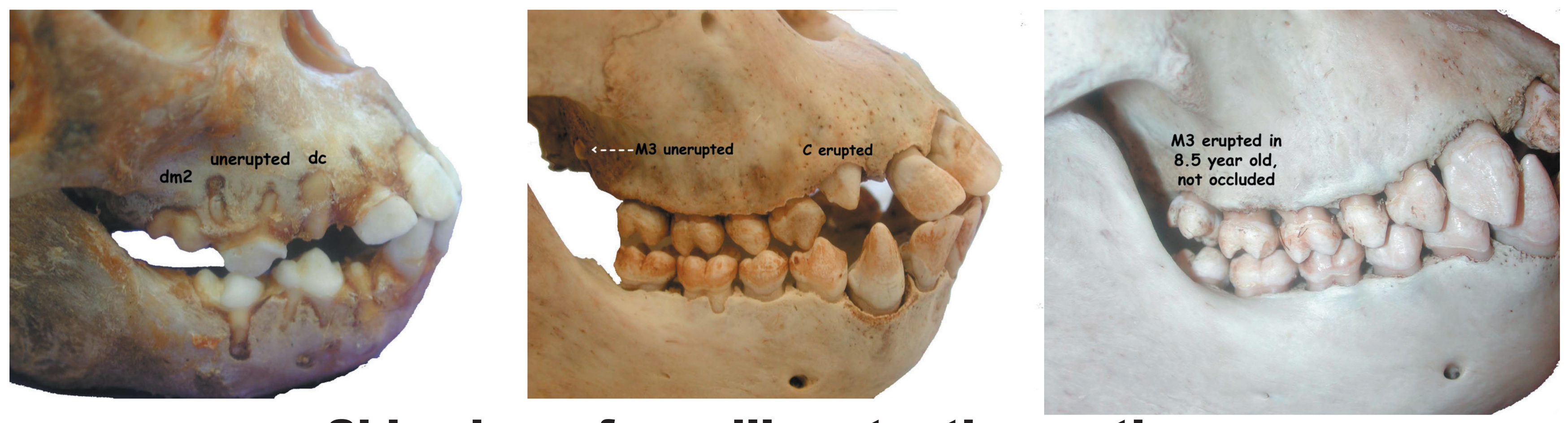
TABLE 2: Timing in years of decidious maxillary tooth eruptions in captive female *Pan paniscus* and *troglodytes*

	Pan paniscus	*Pan troglodytes*	
	This study	Neugebauer 1980	Conroy & Mahoney 1991
i1,2	0 < x < .29 yrs	.083 - .125 yrs	.34 (.21-.53) yrs
m1	<.8	<.67	.43 (.30-.64)
m2	>.8	<.67	.90 (.68-1.20)
c	>.8	<.67	1.16 (.81-1.39)

.8 yr old 6.8 yr old

TABLE 3: Timing in years of permanent maxillary tooth eruption in captive female *Pan paniscus* and *troglodytes*

	Pan paniscus	*Pan troglodytes*	
	This study	Conroy & Mahoney 1991	Nissen & Riesen 1964
M1	<6.8 yrs	3.28 (2.73-3.85) yrs	3.37 (2.75-3.75) yrs
I1	<6.8	5.45 (4.74-6.46)	5.63 (4.50-6.75)
P4	<6.8	6.55 (5.38-7.53)	7.47 (6.25-8.33)
M2	<6.8	6.40 (5.33-7.31)	6.75 (5.92-7.58)
P3	~6.8	6.52 (5.36-7.99)	6.96 (6.08-8.08)
I2	6.8 < x < 7.3	6.51 (5.33-6.92)	6.79 (5.83-8.25)
C	~7.3	7.89 (6.78-8.74)	9.03 (7.58-10.08)
M3	7.9 < x < 8.5	nd	11.33 (9.75-13.08)



Side view of maxillary tooth eruptions: .8 yr old, 7.3 yr old and 8.5 yr old

are fully erupted, with P3s partially erupted and M2s almost in occlusion. By 7.3 years, P3s, I2s and M2s are fully erupted, with Cs partially emerged. M3s had not emerged through the gingiva by 7.9 years, but were partially erupted 7 months later, at 8.5 years. By 11.7 years, M3s were in occlusion and reproductive life had commenced.

Results show that the sequence of deciduous tooth eruption is

[i1 i2] dm1 [dm2 c]
[i1 i2] dm1 [dm2 c]

and permanent tooth eruption sequence is

[M1I1 P4] M2 P3 I2 C M3
[M1I1 P4] M2 I2 P3 C M3

DISCUSSION

P^4 erupts early in this sample and is a sequence polymorphism not yet reported for *P. paniscus,* while the late eruption of I^2 is common in *P. paniscus* housed at the Tervurin Museum (Kinzey, 1984). A number of sequence polymorphisms are reported for *P. troglodytes* (Conroy and Mahoney, 1991).

This study does not support one *Pan* level pattern of dental emergence timing. Captive *Pan pansicus* generally conform to the timing data of captive *Pan troglodytes*, but a few teeth suggest a distinct signature for *paniscus*. TABLE 2 and 3. In particular, maxillary I2 emerges a little later compared to other teeth. The M3 emergence by 8.5 years in *pansicus* is over 1 year earlier than the youngest emergence times available for captive *P. troglodytes* (9.75-13.08 years).

No data exist on timing of dental emergence in wild *Pan pansicus*, but we surmise that the wild animals erupt teeth later than their captive counterparts, a pattern found in *P. troglodytes,* gorillas and orangutans (Zihlman et al., 2004, 2007; Kelley and Schwartz, 2010). This faster pace in growth is consistent with other *P. paniscus* life history accelerations in captivity; for example, the age of first birth averages 10.5 years, whereas in the wild averages 14-15 yrs (Neugebauer, 1980; Kuroda, 1989; Furuichi et al., 1989; Idani, 1991; Kano, 1992; Hashimoto, 1997; De Lathouwers and Van Elsacker, 2005; Stevens et al., 2008; Mulavwa et al., 2008).

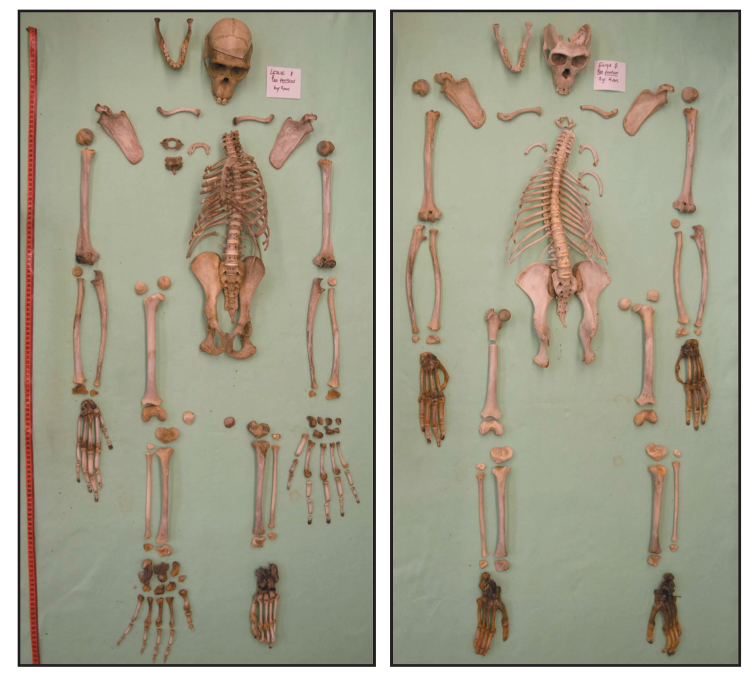
The completion of dental development before first reproduction as marked by M3 emergence in female *Pan paniscus* may be a shared life history pattern for hominoids, which supports the findings of Dirks and Bowman (2007) and contrasts with the pattern for cercopithecoids where females reproduce before M3 emergence.

CONCLUSIONS

These data demonstrate that *Pan paniscus* dental timing and developmental sequence are generally consistent with *Pan troglodytes* with two notable differences in I2 and M3. We hypothesize that an accelerated growth pattern in dentition characterizes captive populations of *Pan paniscus* compared to their wild counterparts.

SUMMARY

- Pygmy chimpanzee timing of dental development is generally consistent with common chimpanzees, with the exception of the upper second incisors and third molars.
- Pygmy chimpanzee females have their third molars emerged (all their permanent teeth) before their first reproductions.
- Captive pygmy chimpanzees have accelerated physical development compared to their wild counterparts, and we hypothesize that dental development is also accelerated, consistent with data on captive and wild *P. troglodytes*, *Gorilla* and *Pongo*.



6.8 yr old 7.3 yr old

ACKNOWLEDGMENTS

We thank Jan Rafert, Gay Reinart, and Milwaukee Zoo personnel, and the San Diego Zoo for their cooperation in providing the specimens and information, and to Heather Hankins, Robin McFarland, Brian Sinclair and Carol Underwood for assistance.

REFERENCES

Bogin B and Smith BH (1996) Evolution of the Human Life Cycle American Journal of Biology *8*: 703-716.

Conroy GC, and Mahoney CJ (1991) Mixed longitudinal study of dental emergence in the chimpanzee, *Pan troglodytes* (Primates, pongidae). American Journal of Physical Anthropology *86:* 243-254.

Dirks W and Bowman J (2007) Life history theory and dental development in four species of catarrhine primates. Journal of Human Evolution *53*: 309-320.

Furuichi T, Idani G, Ihobe H, Kuroda S, Kitamura K, Mori A, Enomoto T, Okayasu N, Hashimoto C, and Kano T (1989) Population Dynamics of Wild Bonobos (*Pan paniscus*) at Wamba. International Journal of Primatology *19*(6): 1029-1043.

Godfrey, L. R., Samonds, K. E., Jungers, W. L. & Sutherland, M. R., 2003. Dental development and primate life histories. In: Kappeler, P. M. & Pereira, M., (Eds). Primate Life Histories and Socioecology. Chicago University Press, Chicago, pp. 177-203.

Hashimoto C (1997) Context and development of sexual behavior of wild bonobos (*Pan paniscus*) at Wamba, Zaire. International Journal of Primatology. *18*(1): 1-21.

Idani G (1991) Social relationships between immigrant and resident bonobo (*Pan paniscus*) females at Wamba. Folia primatologica. *57*(2): 83-95.

Kano T (1992) The last ape: pygmy chimpanzee behavior and ecology. Stanford: Stanford U Press

Kelley J, and Schwartz, G (2010) Dental development in and life history in living African and Asian apes. Proceedings National Academy Sciences.

Kinzey WG (1984) The dentition of the pygmy chimpanzee, *Pan paniscus*. In: RL Susman (ed), The Pygmy Chimpanzee. New York: Plenum Press, pp. 65-88.

Kuroda S (1989) Developmental Retardation and Behavioral Characteristics of Pygmy Chimpanzees. In: P.G. Heltne and L.A. Marquardt (eds) *Understanding Chimpanzees*. Cambridge: Harvard University Press, 184-193.

De Lathouwers M, and Van Elsacker L (2005) Reproductive Parameters of Female *Pan paniscus* and *P. troglodytes*: Quality versus Quantity. International Journal of Primatology (*26*)1:55-71.

Neugebauer W (1980) The status and management of the Pygmy chimpanzee. Interational Zoo Yearbook *20*:64-70.

Nissen H, and Riesen A (1946) The eruption of the permanent dentition of chimpanzee. American Journal of Physical Anthropology *22*:285-294.

Reinartz G, Friedrichs S, Ellis L, Leus K, Van Puijenbroeck B (2003). Bonobo (*Pan paniscus*) *Master Plan 2002: Recommendations for the Global Captive Population*. Zoological Society of Zilwaukee.

Schultz, A (1973) Age changes, variability and generic differences in body proportions of recent hominoids. Folia Primatologica. *19*: 338-359.

Zihlman AL, Cronin JE, Cramer DL and Sarich VM (1978) Pygmy chimpanzee as a possible prototype for the common ancestor of humans, chimpanzees and gorillas. Nature *275*: 744-746.

Zihlman, A (1984) Body Build and Tissue Composition in *Pan paniscus* and *Pan troglodytes*, with Comparisons to Other Hominoids. In: RL Susman (ed), The Pygmy Chimpanzee. New York: Plenum Press, pp. 179-200.

Zihlman, A. L., Bolter, D. & Boesch, C (2004) Wild chimpanzee dentition and its implications for assessing life history in immature hominin fossils. Proceedings National Academy of Sciences 101(29): 10541-10543.

Zihlman , A. L., Bolter, D. R. & Boesch, C (2007) Skeletal and dental growth and development in chimpanzees of the Taï National Park, Côte D'Ivoire. Journal of Zoology, London, 273, 63-73.