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New Approaches to Juvenile Age Estimation in Forensics: Application of Transition Analysis via the Shackelford et al. Method to a Diverse Modern Subadult Sample

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Short Title: Transition Analysis in Dental Age Estimation

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Abstract

Dental development is one of the most widely utilized and accurate methods available for estimating age in subadult skeletal remains. The timing of tooth growth and development is regulated by genetics and less affected by external factors, allowing reliable estimates of chronological age. Traditional methodology focused on comparing tooth developmental scores to corresponding age charts. Using the Moorrees, Fanning, and Hunt developmental scores, Shackelford and colleagues embed the dental development method in a statistical framework based on transition analysis. They generated numerical parameters underlining each 'stage' and age-at-death distribution and applied them to fossil hominins and Neanderthals with limited application to modern humans. We use this same method on a subadult test sample (*n*=201), representing modern individuals that may become part of the forensic record. We assess the probability coverage of the Shackelford et al. method derived from MFH standards as it applies to all available dentition. Results indicate promise as the age range at 90% and 95% confidence levels include the chronological age of almost every individual tested. The maximum likelihood age estimates (MLE) underestimate age by 0.5 to 2.5 years for individuals aged 0-15, and greater than 2.5 years from 16 to 18 years, as previously shown. In an attempt to refine the method, we adjusted the numerical parameters underlying the stages for developing teeth based on a combined modern reference sample (*n*=1694) and tested these revised parameters using the same test sample. The estimated ages from the modified method differ from the original Shackelford et al. methodology by underestimating age to a lesser degree. The modified method does include mean age-at-attainment values for earlier stages of several teeth allowing for the calculation of more narrow confidence intervals. While this study highlights areas of future research in refining

dental developmental aging by transition analysis, it also demonstrates that the Shackelford et al. method is applicable and accurate when aging modern subadults in forensic work.

Age estimation is an essential component in establishing a biological profile of a set of unidentified human skeletal remains. This information is used to narrow down the number of potential antemortem comparisons when making an identification. In its most basic form, age estimation is based on predictable patterns of growth and development or degeneration of bony features and/or dentition. In subadults, dentition-based methods are preferred for estimating age because of their high degree of accuracy and reliability. The timing and sequence of tooth growth and development is heavily regulated by genetics and minimally impacted by environmental or cultural factors, as is the case with other skeletal age indicators (Ubelaker 1989; Moorrees et al. 1963a, b; Scheuer and Black 2004). Because of their strict sequence in growth and development, dental age estimation methods are highly reliable, with estimates as narrow as 6 months to greater than three years in either direction depending on the method used (Reppien et al. 2006; Liversidge 2009; Phillips and van Wyk Kotze 2009). Further, dental development is largely applicable and can be used across populations.

Traditional dentition-based age estimation methods for subadults have focused on comparisons of crown and root development (Moorrees et al. 1963a; Demirjian et al. 1973) and comparisons of erupted teeth to dental charts and atlases (Schour and Massler 1941; Gustafson and Koch 1974; Ubelaker 1978; Kahl and Schwarze 1988; AlQahtani et al. 2010). Methods that assess the degree of enamel and root formation have proven to be superior to dental eruption patterns as eruption patterns are affected by various factors including tooth loss and available space in the dental arcade (Shackelford et al. 2012). A popular method examining dental development was created by Moorrees et al. (1963a, b). They developed graphical representations of dental development phases throughout the subadult life stage based on a longitudinal study of subadult dental radiographs. Unfortunately, the numerical parameters associated with the study sample are not available, limiting their assessment capabilities (Shackelford et al. 2012). Nonetheless, researchers believed the method to be valuable, and have adapted the method to provide numerical and statistical data associated with the phases developed by Moorrees et al. (referred to herein as the “MFH method”) (1963a, b) (Phillips and van Wyk Kotze 2009; Liversidge 2015). A review of the literature demonstrating the process in refining and modifying the MFH method is discussed in Shackelford et al. (2012) and will not be reiterated here.

Shackelford et al. (2012) expanded the MFH method through the application of transition analysis to developmental phases. This method, referred to here as the “SSK method”, was developed to estimate age in modern, archaeological, and early hominin fossil groups. Shackelford et al. (2012) calculated age at death parameters through digitization of the graphics in the original Moorrees et al. (1963a) publication. Because the SSK method was developed for early hominin samples, and minimally tested on modern individuals, its performance reliability is unknown for a large sample of forensic casework.

The SSK method provides maximum likelihood point age estimates (MLE) and age ranges expressed as confidence intervals (CIs) at the 90% and 95% levels, satisfying the Daubert requirements for forensic evidence (Christensen and Crowder 2008). Importantly, transition analysis allows for age to be estimated without the need of informative priors, reducing the impact of age mimicry, a common issue in age estimation methods in forensic casework (Milner and Boldsen 2012). Harris (2007) argues that the MFH method allows for lower observer error and higher accuracy. This, in combination with transition analysis, makes the method ideal for forensic casework.

The current study is twofold. First, it aims to validate the SSK method on forensically significant subadult skeletal remains. Second, it tests the accuracy of the estimates using the original transition parameters derived from Moorrees et al. (1963a) by Shackelford et al. 2012) against a recalculated age of transition structure based on a more recent subadult sample. Here, we use a modified version of the SSK method to assess dental age through MLE and CIs in a U.S. forensic sample with known ages. We then generate new age parameters using forensically significant specimens of known age individuals from London and South Africa, which are then substituted into the original SSK code to reflect variation in modern dental development. Lastly, we use a modern U.S. sample to evaluate the modified method using the newly calculated mean age-at-attainment parameters. The purpose of this research is to validate the use of transition analysis in modern subadult dental aging methods and explore refinement of age estimation parameters in subadult aging methods using dental development from forensically significant samples.

Materials and Methods

Three different samples of known age individuals and their associated tooth scores were used to address the research questions. Two samples were combined and used as reference material for recalculating age parameters, while the third sample was used for testing.

The Reference Sample. The reference dataset, (n=1694) is derived from two, large, known-age samples of modern subadults from South Africa (Phillips and van Wyk Kotze 2009) and London, England (Liversidge 2011) (see Table 1). The South African sample is derived from two different sources of radiographic material taken in the late 1970's to early 2000's. The first source is composed of pantomographic radiographs from the archival records of the Dental Faculty of the University of Western Cape from mixed ancestry children and Xhosa children, a Bantu population. Individuals of mixed ancestry represent individuals with various ancestral groups from slaves, indigenous Khoisan, and European descent (Phillips and van Wyk Kotze 2009). The second source includes an Indian sample and a Zulu subsample from two orthodontic offices in Durban Kwa-Zulu Natal. Ages in the South African sample range from 3 to 17 years. Each tooth in the dental arcade was previously scored following the Moorrees, Fanning, and Hunt (1963a) methodologies. The London sample is composed of panoramic dental radiographs taken at the Institute of Dentistry, Bart's and the London School of Medicine and Dentistry in London, England. The patients range in age from 2.07 to 22.99 years old and are composed of males and females from White and Bangladeshi ethnic groups. No scan dates were provided in the original publication (Liversidge 2009). Mandibular teeth on the left side were previously scored in the London sample following MFH method with the addition of a crypt stage described in Liversidge (2008). The England dataset was reconciled to match the original Moorrees et al. (1963a) scores prior to analysis. The raw tooth scores were used from both datasets to create our reference sample.

The Test Sample. A test sample was created from a subset of radiographic data (*n*=201; *N*=9,709) collected from the Pediatric Radiology Interactive Atlas (Patricia) databank (Ousley et al. 2013). The Patricia databank is a forensic sample composed of non-standard radiographic images taken during autopsy or physical examination of subadults that died in the U.S. after January 1, 2000. We aimed to collect forty individuals from each age group but were limited by two criteria (see Table 1 and Figure 1). Radiographic images were chosen based on two query variables: image quality and age. Only images that corresponded to an image quality of 'very good' or 'good' were collected for individuals aged 0 to 18. This sample may not be ideal, but because of its nature, it represents the type of data commonly encountered by forensic practitioners in casework as many medical examiner's and coroner's offices do not have access to advanced imaging technology.

Dental development was assessed from visible dentition in each radiograph following Moorrees et al.'s (1963a) original publication. The SSK method estimates age by assessing dental development scores via the statistical software, R (R Core Team 2016). Dental development phase data is via a data.frame in R that requires a numerical score or 'NA' for the following dentition: dc, dm1, dm2, UI1, UI2, LI1, LI2, C, PM3, PM4, M1, M2, and M3. Available and clearly visible teeth were scored for every individual. If a tooth was absent or not easily visible, it was assigned a value of 'NA'. Anterior dentition was frequently unobservable due to the lateral radiographs depicting the incisors and canines as stacked and difficult to distinguish. All individuals who had only one tooth scored, or the full suite of dentition scored as Ac (apex closed, 14) for all teeth were removed from subsequent analysis, as TA analysis requires at least one tooth to still be developing in order to provide the upper range estimate. Elamin and Liversidge (2013) note that malnutrition doesn't significantly impact the timing and development of dentition. Therefore, the use of Patricia, a forensic sample where cause of death was unknown, was deemed appropriate for use in this study.

We first calculated the coverage of the reference sample within its age limits. This test measures the performance of the sample within the age bounds (Liversidge 2015), by assessing the relationship between the chronological age and estimated age of the reference sample. Acceptable coverage means that 50% of the sample should be captured within the calculated age range (have actual ages within the range), while the remaining 50% of the sample should be split equally above and below the range (Konigsberg et al. 2008). Coverage was assessed comparing the calculated MLE values to the age cohort based on chronological age.

The scores for each individual in the Patricia sample were first run through the original SSK method code in R Studio (see Konigsberg's website[1]), then a modified version. Our modified version, called 'tooth.test' (see Supplement A) is a function that loops a large dataset through the 'get.age' function and compiles each output in a single .csv file. This function has two important aspects. One aspect displays a line at the MLE, and another set of lines reflecting the within plus between-tooth variance values and the within-tooth variance value in the associated age estimation graphic (Figure 2). The other aspect sets the "high" value of the age estimate based on tooth scores of the teeth present in the data entry sheet. Values returned were the high age estimate value (hi), the mean natural log conception-corrected age (*mu*), the within-tooth variance, the between-tooth variance, and the lower and upper limit of integration on a straight scale. We calculated the MLE, the upper range and the lower range at the 50%, 90%, and 95% CI using *mu*.

Testing the SSK Method. In the second part of this study, the original age parameters from the SSK method were replaced with the newly generated age parameters, and the Patricia test sample was run through the 'tooth.test' loop function again. The MLE ages and CIs from the new age parameters were calculated and compared to the unmodified method.

Recalculation of the Age-at-Death Parameters

[1] http://faculty.las.illinois.edu/lylek/SHK2012/index.htm

Based on the MLE scores from the reference sample, the age parameters of the SSK method were recalculated to reflect dental development in a more forensically significant population. First, the scoring system for each tooth was optimized following the Lagrange multiplier test described in Konigsberg et al. (2016). With this test, outliers for each tooth at each stage were identified and removed. Next, the three separate data tables (MFH, MFH2, and MUS) that inform the 'get.age' function were recalculated using the reference sample. A discussion on the methods used to compile these tables are beyond the scope of this paper and can be found in Shackelford et al. (2012).

Results

The general project outline was to assess the SSK method, recalculate the underlying parameters, and compare the modified method to the original. The results are structured to reflect that order.

In general, the original SSK method performed well for estimating age in subadults between 0 and 11 years old in the Patricia dataset. The original method underestimated age by less than one year for individuals aged 0 to 5 years. Once individuals reached age 6, underestimation increased to 1 to 2 years. After age 15, underestimation increased to 2+ years (Table 2). At age 18, ages were underestimated were by 5.35 years. Coverage values for the original methods at the 50%, 90% and 95% CI are displayed graphically in Figure 3a. Between the ages of 0 and 3, thirteen individuals in the test sample did not produce enough information to calculate a between-tooth variance value, which is necessary to calculate CI bands.

The underlying parameters in the MFH, MFH2, and MUS tables were recalculated for each stage and tooth (see Supplement B). Values for dc, dm1, dm2, UI1, UI2, and early stages of development in C and M1 were supplemented with Shackelford et al.'s (2012) original data due to underrepresentation in the reference sample. Results from the Lagrange test are listed in Table 3. The optimization test did indicate that scores for P4 and M3 in females, might benefit from reevaluation or collapse of scoring stages. All other stages were optimized once the outliers were removed.

The test sample under the modified parameters produced an MLE that was closer to 1:1 ratio with chronological age than the SSK parameters. Table 4 shows the percentage of individuals whose chronological age fell within the calculated age range (CI band). The modified parameters narrowed the CI bands, which sometimes excluded chronological age from the estimated range. These excluded individuals were typically less than +/-1 year outside of the cohort's age range.

Comparison of the Original and Modified SSK Methods

Because the reference sample did not include individuals under 2 years old, we excluded individuals younger than 2 years from the Pearson test. Correlation between the MLEs and chronological age on individuals older than 2 years of age returned a value of 0.97 for the original and the modified SSK methods. Despite a high correlation with age, comparisons of average differences between MLEs and chronological age by cohort were different across the two methods (Table 2). The modified method underestimated age to a lesser degree than the original SSK method (Figure 4). Further, the revised method generated a narrower age range from CI calculation (Figure 3b). Interestingly, under the parameters of the modified method, CI bands were generated for more of the test sample for ages 0 and 3, indicating better performance in estimating the variance than the original method (Table 4).

Discussion

The goals of this research were to 1) validate the original SSK method for use in forensic casework and 2) test the original parameters against recalculated age-of-attainment parameters in a modern subadult sample to determine if the method could be further refined.

Overall, the SSK method performs well when estimating age, especially in individuals younger than 14 years old. After 5 years of age, the method begins to slightly underestimate age, a trend that increases to 2+ years after 16 years of age. Constrained by the Patricia test sample, estimates of individuals in their teenage years may not be accurately capturing variation, as more than one third of the sample is outside the bounds of our reference sample. The Patricia sample may not be the most suitable for evaluating a method's performance; however, it is realistic and represents real-world scenarios. In our test of the SSK method, several cohorts had differences between the chronological age and MLE of -2 years or less. The largest average difference between estimated MLE and chronological age was for the 18.0-18.9 cohort, with an average difference of -5.32 years. Because of our small test sample size for 18-year-olds, this could represent delayed development in the second and third molars, which is not unusual as third molar formation is more variable between the sexes (Mincer et al. 1999) and populations (Prieto et al. 2005). Underestimation of age using the MFH score system is consistent with previous studies (Liversidge 2015; Phillips and van Wyk Kotze 2009). The SSK method is based on Moorrees et al.'s original study and graphs, which, when reevaluated (Šešelj et al. 2018), indicate discrepancies in crown and root development ages in the original publication (Moorrees et al. 1963a), which may explain some of the underestimation.

The Recalculated Method

Results from our modified version of the SSK method indicate that there is a difference in age estimation. The MLE values reported were closer to the 1:1 MLE to chronological age ratio under the new parameters. Additionally, three changes were apparent when comparing CI band values. First, the modified method narrowed the CI band estimates, which sometimes excluded the actual age if the age was underestimated. This occurred more often in the 12, 13, 16 and 18-year-old cohorts, and likely reflects sample size. It is necessary to address this in future research, as too narrow age range estimates can be detrimental to forensic investigations, excluding the target individual from analysis. Second, the modified method also calculated CIs for individuals that were not calculated in the original method. This improvement is reflected in Table 4 where an increased number of individuals had CI bands for the modified method in early cohorts. Lastly, another difference between the two methods was in the method estimation parameters. The recalculation of the age-at-attainment parameters refined some of the values in the SSK method, including the age-at-attainment values for earlier developmental stages (Cr.5, Cr.75, and Cr.c) in the lower permanent incisors (LI1 and LI2). This refinement allowed for the calculation of a between-tooth variance value, which was not calculable under the original SSK parameters for certain individuals with tooth scores ranging from 4 to 6 for LI1 and LI2 (see Figure 5a and 5b). Further, the Cr.c and Ri values were reexamined and refined for LI1 and LI2, allowing for further refinement of MLE estimates. In the original SSK method, the age-of-attainment values for Cr.c and Ri were the same for all four permanent incisors. Although distinguishing these two stages is difficult because of their similarity in expression, the optimization test indicated that stages did not need to be collapsed for these teeth. The optimization test in this study suggested that P4 and M3 for females would benefit from reevaluation of the scoring stages. We did not investigate the possible collapsing of stages here and note that this may contribute to inaccurate estimates in age when these teeth are present.

Although this study provided valuable results, there are three potential limitations that relate to sampling. First, the Patricia sample is representative of radiographs frequently encountered in forensic casework in the United States; the images are not standardized and may not be of the best quality, which can hinder observation and scoring of teeth. The lateral radiographic images in Patricia were taken at autopsy, where dentition was likely not a primary focus of the image. Anterior teeth appeared crowded and overlapping in the radiographs, making them difficult to score. Additionally, it was difficult to distinguish between dm1, dm2, and M1 in very young individuals with early developmental scores. Misidentification of teeth could contribute to errors in age estimation. One potential remedy to this issue is to use the 'plot.teeth' function within the SSK method package to assess the normed likelihood development sequence of each tooth. If a particular tooth is not in alignment with the suite of teeth in the graphic, it could suggest misidentification of a tooth, and call for reexamination of the radiograph. However, it is not unusual to find individuals that have accelerated or decelerated growth rates of a particular part of a dental sequence. Shackelford et al. (2012) noticed differential growth on scores for the Roc de Marsal fossil (Bayle et al. 2009), and three individuals from Anderson et al.'s (1976) sample. In instances such as this, we advise a reexamination of the tooth or teeth in question, but we caution the observer against changing the score purely to fit it within the bounds of the other scores. Finally, this study evaluated the aging through mean age-at-attainment parameters. Lastly, this study evaluated the age at which individuals transition from one stage into the next on an aggregate level. In order to understand individual variation within transitions, longitudinal data from a series of radiographs on the same individual over some interval of time is required.

One issue observed in this study was the frequent underestimation of age for M1 when compared to other teeth within an individual. When reviewing the plots, we noted that M1 frequently produced age ranges slightly younger than other teeth observed within an individual, particularly those over the age of 10. This issue will be addressed in future research as M1 will likely be an important assessment in forensic casework because of radiographic limitations and retention in skeletal remains. In casework, the practitioner may be limited to lateral cranial radiographs rather than dental radiographs, making M1 an easily defined and clearly visible landmark for scoring enamel and root development. The authors relied heavily on M1 in this study, which was limited to lateral cranial radiographs, with M1 being the most frequently scored tooth (80.9% scored) for the U.S. modern sample, followed by M2 at 45.8%. Second, there is a tendency to lose single-rooted dentition postmortem, while the two and three-rooted molars are more commonly preserved in occlusion. Thus, it will be important to accurately estimate age when limited to posterior dentition.

A final observation worth noting is that this research suggests possible secular change in dental development, which Šešelj et al. (2018) report for root development. This contrasts with Liversidge and Smith's (2014) conclusions that dental development exhibits insignificant levels of secular change in samples with birth years from the 1930's to the early 2000's. Application of this method to archaeological and undocumented historical samples may provide slightly inaccurate estimates. Secular change will be an important component to explore in future studies in order to make this method applicable across anthropological research.

Perspectives

Our study confirmed that the modified version of the SSK method performs better when estimating age on modern juveniles, specifically individuals aged between birth and 15 years. Future research will attempt to improve upon age estimation through a larger sample collection that includes more individuals in their teenage years and individuals younger than 2 years. Additional considerations will examine the method's performance by sex and ancestry. Further refinement of the early developmental mean age-at-attainment values for the incisors and a reassessment of all developmental stages that the reference sample failed to cover in this study would be beneficial to test and improve accuracy in classification. Additional research will focus on exploration into the type, number, and combination of teeth used in age estimation models. Given that forensic anthropologists are often given radiographs or skeletal cases with missing dentition, assessing the usefulness of specific, anchor teeth in calculating accurate estimates is important. Lastly, we hope to improve the accuracy of this method on modern subadults and increase its user-ability in hopes of attracting practitioners to use this reliable age estimation method in practice.

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Table 1. Age Structure of the Reference and Test Sample

Age Cohort (Year)	*Reference Sample*			*Test Sample*
	London	*South African*	***Total:***	*Patricia*
0.0-0.9	0	0	**0**	36
1.0-1.9	0	0	**0**	35
2.0-2.9	50	0	**50**	30
3.0-3.9	50	8	**56**	11
4.0-4.9	51	35	**86**	8
5.0-5.9	51	60	**111**	14
6.0-6.9	50	94	**144**	7
7.0-7.9	48	114	**162**	8
8.0-8.9	48	147	**195**	2
9.0-9.9	50	140	**190**	3
10.0-10.9	49	126	**175**	8
11.0-11.9	50	168	**218**	5
12.0-12.9	50	96	**146**	3
13.0-13.9	49	46	**95**	1
14.0-14.9	51	41	**92**	3
15.0-15.9	48	18	**66**	8
16.0-16.9	40	12	**52**	10
17.0-17.9	42	1	**43**	6
18.0-18.9	32	0	**32**	3
19.0-19.9	32	0	**32**	0
20.0-20.9	15	0	**15**	0
21.0-21.9	14	0	**14**	0
22.0-22.9	10	0	**10**	0
		Totals:	**1964**	**201**

Table 2. Average Differences (by age cohort) between Chronological Age and Age Estimates

Age Cohort (years)	*Original SSK (years)*	*Modified SSK (years)*
0.0-0.9	-0.23	-0.23
1.0-1.9	-0.35	-0.03
2.0-2.9	-0.29	0.33
3.0-3.9	-0.96	-0.44
4.0-4.9	-0.23	0.16
5.0-5.9	-0.31	0.13
6.0-6.9	-1.09	-0.49
7.0-7.9	-1.58	-0.77
8.0-8.9	-1.43	-0.58
9.0-9.9	-1.94	-0.92
10.0-10.9	-1.38	-0.38
11.0-11.9	-0.70	0.18
12.0-12.9	-0.72	0.47
13.0-13.9	1.11*	2.98*
14.0-14.9	-0.80	-0.30
15.0-15.9	-1.32	-0.08
16.0-16.9	-2.91	-1.79
17.0-17.9	-2.59	-1.01
18.0-18.9	-5.32	-4.20

Negative values: underestimation of age.
Positive values: overestimation of age.
*The 13-year-old cohort only had one individual and reflects the difference between chronological age and the age estimate.

Table 3. Probability Values from the Optimization Test

Tooth	*Females*					*Males*				
	(n)	*(all data)*		*(outliers removed)*		*(n)*	*(all data)*		*(outliers removed)*	
		normal	*log*	*normal*	*log*		*normal*	*log*	*normal*	*log*
LI1	862	0.78	0.93	0.84	0.78	805	0.29	**4.70E-03**	0.43	0.63
LI2	863	0.67	0.97	0.73	0.60	806	0.91	0.62	0.93	0.67
C	411	0.78	0.92	0.78	0.92	420	0.16	0.92	0.71	0.35
P3	408	**0.03**	0.12	0.58	0.26	411	3.00E-04	0.15	0.09	0.51
P4	765	0.38	0.06	0.31	**0.02**	835	0.99	0.42	0.57	0.51
M1	867	0.56	0.10	0.99	0.88	808	**1.49E-14**	**9.84E-05**	0.45	0.06
M2	867	0.84	0.15	0.68	0.68	770	**0.01**	0.24	0.82	0.49
M3	630	**0.03**	0.16	**0.02**	0.19	554	**0.01**	0.44	0.96	0.82

Bolded values are significant at the $p=0.05$ level; n=number of teeth used.

Table 4. Percent of Individuals That Fall within the Generated Age Range at the 50%, 90%, and 95% CI and Percent of Individuals That Do Not Produce a CI Range

Age Cohort (years)	*Total (n)*	*Original SSK (CI bands)*				*Modified SSK (CI bands)*			
		50%	*90%*	*95%*	*no band*	*50%*	*90%*	*95%*	*no band*
0.0-0.9	36	22.2%	63.8%	72.2%	13.9%	22.2%	52.7%	72.2%	13.8%
1.0-1.9	35	34.2%	62.8%	74.2%	0.0%	48.5%	91.4%	97.1%	0.0%
2.0-2.9	30	43.3%	83.3%	90.0%	20.0%	46.7%	80.0%	86.7%	0.0%
3.0-3.9	11	27.3%	63.6%	63.6%	18.2%	18.2%	63.6%	72.7%	9.1%
4.0-4.9	8	75.0%	75.0%	87.5%	0.0%	50.0%	87.5%	87.5%	0.0%
5.0-5.9	14	71.4%	100.0%	100.0%	0.0%	71.4%	92.8%	100.0%	0.0%
6.0-6.9	7	28.5%	85.7%	100.0%	0.0%	42.8%	85.7%	85.7%	0.0%
7.0-7.9	8	0.0%	62.5%	87.5%	0.0%	62.5%	100.0%	100.0%	0.0%
8.0-8.9	2	50.0%	100.0%	100.0%	0.0%	0.0%	100.0%	100.0%	0.0%
9.0-9.9	3	33.3%	33.3%	66.7%	0.0%	0.0%	0.0%	33.3%	0.0%
10.0-10.9	8	37.5%	87.5%	100.0%	0.0%	50.0%	100.0%	100.0%	0.0%
11.0-11.9	5	60.0%	100.0%	100.0%	0.0%	0.0%	100.0%	100.0%	0.0%
12.0-12.9	3	33.3%	100.0%	100.0%	0.0%	66.7%	66.6%	66.6%	0.0%
13.0-13.9	1	100.0%	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
14.0-14.9	3	33.3%	100.0%	100.0%	0.0%	66.7%	100.0%	100.0%	0.0%
15.0-15.9	8	37.5%	75.0%	87.5%	0.0%	62.5%	100.0%	100.0%	0.0%
16.0-16.9	10	0.0%	60.0%	80.0%	0.0%	20.0%	70.0%	80.0%	0.0%
17.0-17.9	6	16.7%	100.0%	100.0%	0.0%	66.7%	100.0%	100.0%	0.0%
18.0-18.9	3	0.0%	66.7%	66.7%	0.0%	0.0%	33.3%	33.3%	0.0%

Supplement A

```
tooth.test=function ()
{
   tooth_ages <- c()
   for (i in 1:nrow(tooth.scores))
   {
      # vector output
      m<-tooth.scores[i,]
      m[is.na(m)]<-0
      if (m[,2] > 0) {h=3}
      else if (m[,3] > 0) {h=3}
      else if (m[,4] > 0) {h=3}
      else h=25.75
      if (m[,2] > 3) {h=5}                 # set to (m[,2] > 1) {h=5} for the recalculated MFH2 and
MUS matrices
      else if (m[,3] > 3) {h=5} # set to (m[,3] > 1) {h=5} for the recalculated MFH2 and MUS
matrices
      else if (m[,4] > 3) {h=5} # set to (m[,4] > 1) {h=5} for the recalculated MFH2 and MUS
matrices
      else h=h
      if (m[,2] > 8) {h=15}
      else if (m[,3] > 8) {h=15}
      else if (m[,4] > 8) {h=15}
      else h=h
      if ((m[,12] < 12) & (m[,2] < 1) & (m[,3] < 1) & (m[,4] < 1)) {h=15}
      else h=h
      model <- get.age(i,hi=h,def.int=0.01)
      scores_i <- cbind(model$lab,h,model$mu,model$within,model$between,model$p.seq)
      # add vector to a dataframe
      age_i <- data.frame(scores_i)
      tooth_ages <- rbind(tooth_ages,age_i)
   }
   write.table(tooth_ages,
file="pat_original_new_tooth_results2.csv",sep=",",col.names=c("lab","hi","mu","within","betw
een","p.seq"),row.names=FALSE)

   return(data.frame(tooth_ages))

}
```

Supplement B

Table B1. The Recalculated MFH Table

x	*Sex*	*Tooth*	*Stage*	*L2SD*	*L1SD*	*Mean*	*U1SD*	*U2SD*	*WithoutMean*	*WithMean*
1	M	c	Cco	NA	NA	NA	0.003	0.071	-0.2900	-0.2900
2	M	c	Coc	0.008	0.076	0.163	0.254	0.363	-0.0892	-0.0894
3	M	c	Cr1/2	0.100	0.182	0.272	0.380	0.494	0.0270	0.0260
4	M	c	Cr3/4	0.264	0.368	0.467	0.603	0.748	0.2079	0.2055
5	M	c	Crc	0.422	0.547	0.680	0.816	0.978	0.3536	0.3544
6	M	c	Ri	0.543	0.685	0.826	0.983	1.166	0.4545	0.4546
7	M	c	R1/4	0.676	0.819	0.976	1.155	1.339	0.5467	0.5466
8	M	c	R1/2	0.947	1.114	1.292	1.503	1.730	0.7180	0.7171
9	M	c	R3/4	1.380	1.602	1.840	2.103	2.395	0.9513	0.9514
10	M	c	Rc	1.482	1.716	1.956	2.239	2.536	0.9975	0.9971
11	M	c	A1/2	1.936	2.207	2.491	2.827	3.201	1.1801	1.1793
12	M	c	Ac	2.386	2.696	3.051	3.438	3.855	1.3348	1.3349
13	M	c	Res1/4	4.866	5.461	6.101	6.799	7.549	1.9223	1.9228
14	M	c	Res1/2	6.797	7.569	8.433	9.388	10.406	2.2170	2.2170
15	M	c	Res3/4	7.967	8.842	9.803	10.890	12.074	2.3580	2.3577
16	M	c	Exf	8.639	9.606	10.670	11.837	13.113	2.4348	2.4349
17	M	m1	Coc	NA	NA	NA	-0.021	0.056	-0.2900	-0.2900
18	M	m1	Cr1/2	0.010	0.080	0.178	0.262	0.370	-0.0837	-0.0819
19	M	m1	Cr3/4	0.048	0.127	0.211	0.314	0.427	-0.0334	-0.0348
20	M	m1	Crc	0.207	0.308	0.415	0.535	0.680	0.1553	0.1547
21	M	m1	Ri	0.330	0.445	0.564	0.711	0.862	0.2781	0.2770
22	M	m1	Rcleft	0.389	0.502	0.629	0.769	0.939	0.3242	0.3236
23	M	m1	R1/4	0.471	0.589	0.730	0.882	1.052	0.3927	0.3925
24	M	m1	R1/2	0.613	0.750	0.915	1.052	1.267	0.5015	0.5031
25	M	m1	R3/4	0.819	0.990	1.169	1.363	1.582	0.6498	0.6502
26	M	m1	Rc	0.942	1.114	1.306	1.510	1.738	0.7189	0.7192
27	M	m1	A1/2	1.218	1.424	1.645	1.886	2.157	0.8724	0.8727
28	M	m1	Ac	1.469	1.707	1.947	2.227	2.529	0.9935	0.9932
29	M	m1m	Res1/4	4.318	4.850	5.428	6.063	6.732	1.8193	1.8196
30	M	m1m	Res1/2	6.106	6.810	7.588	8.469	9.401	2.1217	2.1215

31	M	m1m	Res3/4	7.614	8.466	9.405	10.445	11.584	2.3182	2.3181
32	M	m1d	Res1/4	5.074	5.714	6.361	7.087	7.882	1.9606	1.9608
33	M	m1d	Res1/2	6.742	7.497	8.337	9.287	10.299	2.2080	2.2078
34	M	m1d	Res3/4	8.123	9.021	10.000	11.126	12.333	2.3771	2.3766
35	M	m1d	Exf	8.744	9.728	10.792	11.959	13.246	2.4453	2.4454
36	M	m2	Cco	NA	NA	NA	-0.012	0.058	-0.2900	-0.2900
37	M	m2	Coc	0.009	0.089	0.182	0.266	0.376	-0.0793	-0.0776
38	M	m2	Cr1/2	0.091	0.175	0.266	0.378	0.486	0.0201	0.0192
39	M	m2	Cr3/4	0.269	0.378	0.489	0.620	0.757	0.2159	0.2156
40	M	m2	Crc	0.457	0.563	0.710	0.856	1.019	0.3761	0.3766

x	*Sex*	*Tooth*	*Stage*	*L2SD*	*L1SD*	*Mean*	*U1SD*	*U2SD*	*WithoutMean*	*WithMean*
41	M	m2	Ri	0.635	0.765	0.925	1.097	1.285	0.5163	0.5162
42	M	m2	Rcleft	0.683	0.813	0.975	1.157	1.345	0.5479	0.5473
43	M	m2	R1/4	0.934	1.139	1.327	1.534	1.776	0.7274	0.7281
44	M	m2	R1/2	1.162	1.364	1.577	1.816	2.080	0.8448	0.8447
45	M	m2	R3/4	1.433	1.654	1.898	2.167	2.459	0.9736	0.9737
46	M	m2	Rc	1.553	1.795	2.046	2.337	2.646	1.0295	1.0292
47	M	m2	A1/2	1.872	2.148	2.440	2.771	3.121	1.1601	1.1601
48	M	m2	Ac	2.392	2.710	3.061	3.453	3.882	1.3387	1.3385
49	M	m2m	Res1/4	5.298	5.933	6.609	7.386	8.210	1.9971	1.9969
50	M	m2m	Res1/2	6.932	7.699	8.591	9.512	10.547	2.2315	2.2321
51	M	m2m	Res3/4	8.440	9.378	10.408	11.540	12.804	2.4122	2.4122
52	M	m2d	Res1/4	5.968	6.671	7.455	8.285	9.160	2.1009	2.1017
53	M	m2d	Res1/2	7.693	8.539	9.478	10.530	11.703	2.3268	2.3265
54	M	m2d	Res3/4	8.966	9.984	11.060	12.295	13.594	2.4697	2.4696
55	M	m2d	Exf	9.416	10.474	11.618	12.916	14.283	2.5156	2.5155
56	F	c	Coc	NA	0.059	0.137	0.232	0.328	-0.1165	-0.1173
57	F	c	Cr1/2	0.074	0.151	0.247	0.352	0.475	0.0007	0.0000
58	F	c	Cr3/4	0.247	0.355	0.469	0.587	0.726	0.1943	0.1950
59	F	c	Crc	0.429	0.555	0.680	0.824	0.983	0.3585	0.3583
60	F	c	Ri	0.570	0.711	0.850	1.011	1.196	0.4721	0.4716

61	F	c	R1/4	0.742	0.894	1.052	1.241	1.442	0.5926	0.5919
62	F	c	R1/2	0.949	1.126	1.299	1.524	1.738	0.7232	0.7220
63	F	c	R3/4	1.332	1.551	1.775	2.042	2.325	0.9292	0.9286
64	F	c	Rc	1.560	1.790	2.047	2.332	2.651	1.0298	1.0296
65	F	c	A1/2	1.941	2.212	2.507	2.843	3.205	1.1825	1.1822
66	F	c	Ac	2.324	2.631	2.981	3.353	3.775	1.3156	1.3158
67	F	c	Res1/4	3.908	4.386	4.916	5.468	6.072	1.7306	1.7314
68	F	c	Res1/2	5.838	6.526	7.238	8.069	8.980	2.0805	2.0800
69	F	c	Res3/4	7.038	7.824	8.701	9.680	10.739	2.2469	2.2467
70	F	c	Exf	7.710	8.569	9.514	10.602	11.746	2.3305	2.3302
71	F	m1	Cr1/2	NA	0.078	0.157	0.244	0.351	-0.0972	-0.0973
72	F	m1	Cr3/4	0.078	0.158	0.247	0.346	0.459	-0.0008	-0.0013
73	F	m1	Crc	0.153	0.242	0.344	0.457	0.578	0.0904	0.0903
74	F	m1	Ri	0.337	0.448	0.566	0.696	0.837	0.2737	0.2739
75	F	m1	Rcleft	0.353	0.455	0.576	0.702	0.851	0.2819	0.2820
76	F	m1	R1/4	0.409	0.525	0.656	0.794	0.960	0.3403	0.3404
77	F	m1	R1/2	0.632	0.748	0.895	1.069	1.260	0.5061	0.5044
78	F	m1	R3/4	0.804	0.963	1.137	1.323	1.533	0.6335	0.6338
79	F	m1	Rc	0.925	1.091	1.258	1.475	1.705	0.7061	0.7043
80	F	m1	A1/2	1.093	1.284	1.488	1.719	1.963	0.8057	0.8057
81	F	m1	Ac	1.335	1.562	1.787	2.050	2.331	0.9318	0.9317
82	F	m1m	Res1/4	3.927	4.394	4.901	5.504	6.113	1.7349	1.7343
x	*Sex*	*Tooth*	*Stage*	*L2SD*	*L1SD*	*Mean*	*U1SD*	*U2SD*	*WithoutMean*	*WithMean*
83	F	m1m	Res1/2	5.811	6.483	7.234	8.043	8.925	2.0758	2.0761
84	F	m1m	Res3/4	7.114	7.922	8.816	9.773	10.849	2.2567	2.2570
85	F	m1d	Res1/4	4.078	4.590	5.165	5.763	6.412	1.7731	1.7740
86	F	m1d	Res1/2	6.155	6.896	7.658	8.518	9.463	2.1292	2.1292
87	F	m1d	Res3/4	7.590	8.409	9.360	10.408	11.518	2.3137	2.3137
88	F	m1d	Exf	8.175	9.086	10.100	11.216	12.428	2.3839	2.3839
89	F	m2	Cr1/2	0.067	0.152	0.249	0.355	0.463	-0.0033	-0.0028
90	F	m2	Cr3/4	0.246	0.348	0.456	0.579	0.719	0.1895	0.1891
91	F	m2	Crc	0.449	0.572	0.702	0.838	1.009	0.3720	0.3721
92	F	m2	Ri	0.632	0.775	0.929	1.094	1.285	0.5170	0.5172

93	F	m2	Rcleft	0.674	0.818	0.973	1.149	1.335		0.5449	0.5447
94	F	m2	R1/4	0.954	1.135	1.321	1.528	1.755		0.7272	0.7274
95	F	m2	R1/2	1.147	1.328	1.548	1.776	2.037		0.8308	0.8311
96	F	m2	R3/4	1.414	1.630	1.881	2.136	2.433		0.9641	0.9648
97	F	m2	Rc	1.504	1.736	1.986	2.266	2.563		1.0062	1.0063
98	F	m2	A1/2	1.805	2.067	2.354	2.679	3.013		1.1328	1.1328
99	F	m2	Ac	2.206	2.494	2.825	3.194	3.592		1.2753	1.2751
100	F	m2m	Res1/4	4.848	5.423	6.084	6.750	7.536		1.9180	1.9188
101	F	m2m	Res1/2	6.692	7.433	8.275	9.192	10.228		2.2005	2.2004
102	F	m2m	Res3/4	8.132	8.992	10.011	11.138	12.368		2.3775	2.3772
103	F	m2d	Res1/4	5.574	6.223	6.941	7.692	8.563		2.0378	2.0382
104	F	m2d	Res1/2	6.957	7.726	8.597	9.553	10.612		2.2355	2.2354
105	F	m2d	Res3/4	8.044	8.926	9.929	10.999	12.257		2.3683	2.3683
106	F	m2d	Exf	8.994	9.968	11.090	12.314	13.646		2.4713	2.4714
107	M	UI1	Crc	4.271	4.797	5.336	5.954	6.643		1.8075	1.8072
108	M	UI1	R1/4	5.065	5.648	6.301	7.032	7.792		1.9533	1.9533
109	M	UI1	R1/2	5.568	6.215	6.911	7.713	8.551		2.0375	2.0372
110	M	UI1	R2/3	6.064	6.781	7.527	8.387	9.274		2.1138	2.1138
111	M	UI1	R3/4	6.489	7.235	8.052	8.939	9.912		2.1737	2.1739
112	M	UI1	Rc	7.007	7.781	8.619	9.570	10.643		2.2398	2.2393
113	M	UI2	Crc	4.738	5.306	5.895	6.591	7.301		1.8957	1.8953
114	M	UI2	R1/4	5.560	6.242	6.910	7.726	8.571		2.0391	2.0385
115	M	UI2	R1/2	6.099	6.781	7.569	8.407	9.309		2.1165	2.1169
116	M	UI2	R2/3	6.488	7.234	8.036	8.945	9.925		2.1741	2.1739
117	M	UI2	R3/4	7.062	7.865	8.717	9.662	10.713		2.2478	2.2478
118	M	UI2	Rc	7.785	8.673	9.625	10.662	11.848		2.3389	2.3390

119	M	**LI1**	**Cr1/2**	**0.822**	**1.345**	**1.867**	**2.389**	**2.911**	**0.9084**	**0.1912**
120	M	**LI1**	**Cr3/4**	**1.286**	**1.706**	**2.126**	**2.547**	**2.967**	**1.0288**	**1.0344**
121	M	**LI1**	**Crc**	**1.888**	**2.574**	**3.260**	**3.945**	**4.631**	**1.3502**	**1.3579**
122	M	**LI1**	**Ri**	**2.967**	**3.449**	**3.930**	**4.411**	**4.893**	**1.5298**	**1.5325**
123	M	**LI1**	**R1/4**	**4.053**	**4.387**	**4.721**	**5.055**	**5.389**	**1.6948**	**1.6958**
124	M	**LI1**	**R1/2**	**4.929**	**5.211**	**5.492**	**5.774**	**6.056**	**1.8288**	**1.8293**

x	*Sex*	*Tooth*	*Stage*	*L2SD*	*L1SD*	*Mean*	*U1SD*	*U2SD*	*WithoutMean*	*WithMean*
125	M	**LI1**	**R2/3**	**4.718**	**5.279**	**5.876**	**6.550**	**7.289**	**1.8919**	**1.8917**
126	M	**LI1**	**R3/4**	**5.242**	**5.709**	**6.177**	**6.645**	**7.112**	**1.9297**	**1.9308**
127	M	**LI1**	**Rc**	**5.102**	**6.232**	**7.362**	**8.492**	**9.622**	**2.0683**	**2.0733**
128	M	**LI1**	**A1/2**	**6.418**	**6.929**	**7.440**	**7.951**	**8.462**	**2.0980**	**2.0990**
129	M	**LI1**	**Ac**	**5.760**	**8.770**	**11.780**	**14.790**	**17.800**	**2.4477**	**2.4637**
130	M	**LI2**	**Cr1/2**	**1.077**	**1.536**	**1.994**	**2.453**	**2.912**	**0.9728**	**0.9802**
131	M	**LI2**	**Cr3/4**	**1.402**	**2.071**	**2.739**	**3.408**	**4.076**	**1.2006**	**1.2104**
132	M	**LI2**	**Crc**	**2.693**	**3.249**	**3.805**	**4.362**	**4.918**	**1.4972**	**1.5010**
133	M	**LI2**	**Ri**	**3.893**	**4.217**	**4.541**	**4.864**	**5.188**	**1.6612**	**1.6622**
134	M	**LI2**	**R1/4**	**4.709**	**5.042**	**5.375**	**5.709**	**6.042**	**1.8087**	**1.8095**
135	M	**LI2**	**R1/3**	**4.510**	**5.042**	**5.618**	**6.278**	**7.003**	**1.8536**	**1.8532**
136	M	**LI2**	**R1/2**	**5.354**	**5.713**	**6.073**	**6.432**	**6.792**	**1.9168**	**1.9175**
137	M	**LI2**	**R2/3**	**5.488**	**6.141**	**6.823**	**7.618**	**8.456**	**2.0263**	**2.0259**
138	M	**LI2**	**R3/4**	**5.907**	**6.406**	**6.906**	**7.405**	**7.904**	**2.0301**	**2.0312**
139	M	**LI2**	**Rc**	**6.287**	**6.919**	**7.552**	**8.184**	**8.817**	**2.1091**	**2.1106**
140	M	**LI2**	**A1/2**	**6.934**	**7.650**	**8.366**	**9.081**	**9.797**	**2.0218**	**2.2037**

141	M	LI2	Ac	6.760	9.591	12.423	15.254	18.086	2.5152	2.5278
142	M	C	Ci	0.256	0.370	0.492	0.613	0.741	0.2071	0.2089
143	M	C	Cco	0.472	0.627	0.762	0.924	1.059	0.4069	0.4082
144	M	C	Coc	1.019	1.389	1.760	2.131	2.501	0.8919	0.8976
145	M	C	Cr1/2	1.289	2.001	2.713	3.424	4.136	1.1849	1.1963
146	M	C	Cr3/4	3.332	3.739	4.147	4.555	4.963	1.5799	1.5816
147	M	C	Crc	4.006	4.396	4.787	5.178	5.569	1.7052	1.7065
148	M	C	Ri	4.790	5.204	5.618	6.032	6.446	1.8460	1.8470
149	M	C	R1/4	5.668	6.311	6.953	7.595	8.238	2.0328	2.0346
150	M	C	R1/2	6.943	7.576	8.209	8.842	9.475	2.1864	2.1876
151	M	C	R3/4	8.624	9.229	9.834	10.439	11.044	2.3553	2.3561
152	M	C	Rc	9.833	10.395	10.957	11.519	12.081	2.4573	2.4579
153	M	C	A1/2	10.438	11.164	11.890	12.615	13.341	2.5327	2.5334
154	M	C	Ac	11.522	13.485	15.448	17.411	19.374	2.7660	2.7698
155	M	PM3	Ci	1.456	1.649	1.842	2.035	2.228	0.9454	0.9468
156	M	PM3	Cco	1.720	2.061	2.403	2.745	3.087	1.1334	1.1364
157	M	PM3	Coc	2.359	2.753	3.146	3.540	3.933	1.3470	1.3496
158	M	PM3	Cr1/2	3.165	3.592	4.019	4.445	4.872	1.5519	1.5539
159	M	PM3	Cr3/4	3.977	4.334	4.692	5.049	5.407	1.6887	1.6898
160	M	PM3	Crc	4.551	5.115	5.678	6.241	6.804	1.8509	1.8529
161	M	PM3	Ri	5.437	6.019	6.601	7.184	7.766	1.9870	1.9885
162	M	PM3	R1/4	6.535	7.131	7.728	8.325	8.921	2.1312	2.1325
163	M	PM3	R1/2	8.017	8.547	9.077	9.607	10.137	2.2815	2.2822

164	M	PM3	R3/4	9.227	9.609	9.990	10.372	10.753	2.3724	2.3727
165	M	PM3	Rc	9.883	10.356	10.829	11.302	11.775	2.4471	2.4475
166	M	PM3	A1/2	10.550	11.083	11.616	12.149	12.682	2.5126	2.5131
x	*Sex*	*Tooth*	*Stage*	*L2SD*	*L1SD*	*Mean*	*U1SD*	*U2SD*	*WithoutMean*	*WithMean*
167	M	PM3	Ac	11.060	13.106	15.151	17.196	19.242	2.7451	2.7493
168	M	PM4	Ci	1.776	2.445	3.115	3.785	4.455	1.3124	1.3203
169	M	PM4	Cco	3.059	3.467	3.876	4.285	4.694	1.5219	1.5238
170	M	PM4	Coc	3.377	3.716	4.054	4.393	4.731	1.5632	1.5645
171	M	PM4	Cr1/2	3.975	4.346	4.716	5.087	5.458	1.6928	1.6940
172	M	PM4	Cr3/4	4.691	5.141	5.592	6.043	6.493	1.8408	1.8421
173	M	PM4	Crc	5.332	5.910	6.489	7.067	7.645	1.9714	1.9730
174	M	PM4	Ri	6.558	7.048	7.537	8.027	8.517	2.1103	2.1112
175	M	PM4	R1/4	7.633	8.090	8.546	9.003	9.459	2.2266	2.2272
176	M	PM4	R1/2	8.892	9.278	9.665	10.052	10.438	2.3415	2.3419
177	M	PM4	R3/4	9.509	10.027	10.546	11.065	11.583	2.4218	2.4223
178	M	PM4	Rc	9.652	10.526	11.400	12.274	13.148	2.4908	2.4921
179	M	PM4	A1/2	10.958	11.735	12.512	13.289	14.066	2.5806	2.5815
180	M	PM4	Ac	12.578	14.246	15.914	17.582	19.250	2.8005	2.8031
181	M	M1	Cco	NA	-0.007	0.089	0.221	0.329	-0.1479	-0.1548
182	M	M1	Coc	0.149	0.263	0.359	0.509	0.641	0.1168	1.1419
183	M	M1	Cr1/2	1.179	1.451	1.723	1.996	2.268	0.8900	0.8931
184	M	M1	Cr3/4	1.759	1.948	2.136	2.324	2.513	1.0545	1.0556
185	M	M1	Crc	2.020	2.500	2.980	3.460	3.940	1.2951	1.2993

186	M	**M1**	**Ri**	**2.791**	**3.069**	**3.346**	**3.624**	**3.902**	**1.4043**	**1.4055**
187	M	**M1**	**Rcl**	**3.112**	**3.561**	**4.010**	**4.459**	**4.907**	**1.5489**	**1.5512**
188	M	**M1m**	**R1/4**	**3.939**	**4.302**	**4.665**	**5.027**	**5.390**	**1.6834**	**1.6846**
189	M	**M1m**	**R1/2**	**4.565**	**5.023**	**5.480**	**5.937**	**6.394**	**1.8225**	**1.8239**
190	M	**M1m**	**R3/4**	**5.240**	**5.804**	**6.368**	**6.932**	**7.496**	**1.9547**	**1.9563**
191	M	**M1m**	**Rc**	**6.468**	**6.937**	**7.405**	**7.873**	**8.341**	**2.0945**	**2.0953**
192	M	**M1m**	**A1/2**	**7.272**	**7.882**	**8.491**	**9.101**	**9.710**	**2.2182**	**2.2193**
193	M	**M1m**	**Ac**	**6.981**	**9.766**	**12.551**	**15.336**	**18.121**	**2.5284**	**2.5403**
194	M	**M1d**	**R1/4**	**3.939**	**4.302**	**4.665**	**5.027**	**5.390**	**1.6834**	**1.6846**
195	M	**M1d**	**R1/2**	**4.565**	**5.023**	**5.480**	**5.937**	**6.394**	**1.8225**	**1.8239**
196	M	**M1d**	**R3/4**	**5.240**	**5.804**	**6.368**	**6.932**	**7.496**	**1.9547**	**1.9563**
197	M	**M1d**	**Rc**	**6.468**	**6.937**	**7.405**	**7.873**	**8.341**	**2.0945**	**2.0953**
198	M	**M1d**	**A1/2**	**7.272**	**7.882**	**8.491**	**9.101**	**9.710**	**2.2182**	**2.2193**
199	M	**M1d**	**Ac**	**6.981**	**9.766**	**12.551**	**15.336**	**18.121**	**2.5284**	**2.5403**
200	M	**M2**	**Ci**	**2.351**	**2.801**	**3.252**	**3.703**	**4.153**	**1.3706**	**1.3738**
201	M	**M2**	**Cco**	**3.084**	**3.497**	**3.911**	**4.325**	**4.738**	**1.5293**	**1.5313**
202	M	**M2**	**Coc**	**3.823**	**4.214**	**4.605**	**4.997**	**5.388**	**1.6713**	**1.6727**
203	M	**M2**	**Cr1/2**	**3.884**	**4.418**	**4.951**	**5.485**	**6.019**	**1.7296**	**1.7318**
204	M	**M2**	**Cr3/4**	**4.478**	**5.181**	**5.883**	**6.585**	**7.287**	**1.8777**	**1.8806**
205	M	**M2**	**Crc**	**5.860**	**6.395**	**6.931**	**7.466**	**8.001**	**2.0326**	**2.0338**
206	M	**M2**	**Ri**	**6.568**	**7.061**	**7.554**	**8.047**	**8.540**	**2.1123**	**2.1132**
207	M	**M2**	**Rcl**	**7.152**	**7.709**	**8.266**	**8.823**	**9.380**	**2.1942**	**2.1952**
208	M	**M2m**	**R1/4**	**8.027**	**8.716**	**9.404**	**10.093**	**10.782**	**2.3121**	**2.3133**

x	*Sex*	*Tooth*	*Stage*	*L2SD*	*L1SD*	*Mean*	*U1SD*	*U2SD*	*WithoutMean*	*WithMean*
209	M	**M2m**	**R1/2**	**9.067**	**9.696**	**10.324**	**10.953**	**11.582**	**2.4006**	**2.4014**
210	M	**M2m**	**R3/4**	**10.170**	**10.719**	**11.269**	**11.819**	**12.368**	**2.4839**	**2.4844**
211	M	**M2m**	**Rc**	**10.874**	**11.575**	**12.275**	**12.976**	**13.677**	**2.5633**	**2.5640**
212	M	**M2m**	**A1/2**	**11.845**	**12.795**	**13.745**	**14.695**	**15.645**	**2.6684**	**2.6694**
213	M	**M2m**	**Ac**	**13.922**	**15.225**	**16.528**	**17.831**	**19.134**	**2.8423**	**2.8437**
214	M	**M2d**	**R1/4**	**8.027**	**8.716**	**9.404**	**10.093**	**10.782**	**2.3121**	**2.3133**
215	M	**M2d**	**R1/2**	**9.067**	**9.696**	**10.324**	**10.953**	**11.582**	**2.4006**	**2.4014**
216	M	**M2d**	**R3/4**	**10.170**	**10.719**	**11.269**	**11.819**	**12.368**	**2.4839**	**2.4844**
217	M	**M2d**	**Rc**	**10.874**	**11.575**	**12.275**	**12.976**	**13.677**	**2.5633**	**2.5640**
218	M	**M2d**	**A1/2**	**11.845**	**12.795**	**13.745**	**14.695**	**15.645**	**2.6684**	**2.6694**
219	M	**M2d**	**Ac**	**13.922**	**15.225**	**16.528**	**17.831**	**19.134**	**2.8423**	**2.8437**
220	M	**M3**	**Ci**	**6.719**	**7.500**	**8.281**	**9.062**	**9.843**	**2.1912**	**2.1931**
221	M	**M3**	**Cco**	**7.558**	**8.505**	**9.452**	**10.399**	**11.346**	**2.3117**	**2.3138**
222	M	**M3**	**Coc**	**8.588**	**9.388**	**10.188**	**10.988**	**11.788**	**2.3855**	**2.3868**
223	M	**M3**	**Cr1/2**	**8.851**	**10.051**	**11.251**	**12.451**	**13.651**	**2.4723**	**2.4748**
224	M	**M3**	**Cr3/4**	**9.462**	**10.440**	**11.417**	**12.394**	**13.372**	**2.4906**	**2.4922**
225	M	**M3**	**Crc**	**10.412**	**11.326**	**12.240**	**13.154**	**14.068**	**2.5579**	**2.5592**
226	M	**M3**	**Ri**	**11.141**	**12.356**	**13.570**	**14.784**	**15.999**	**2.6526**	**2.6544**
227	M	**M3**	**cleft**	**11.913**	**13.085**	**14.257**	**15.429**	**16.601**	**2.7008**	**2.7024**
228	M	**M3m**	**R1/4**	**13.868**	**14.646**	**15.424**	**16.202**	**16.980**	**2.7805**	**2.7811**
229	M	**M3m**	**R1/2**	**14.727**	**15.394**	**16.061**	**16.728**	**17.395**	**2.8201**	**2.8205**
230	M	**M3m**	**R3/4**	**16.730**	**16.730**	**16.730**	**16.730**	**16.730**	**2.8611**	**2.8611**

231	M	**M3m**	**Rc**	**12.350**	**14.320**	**16.290**	**18.260**	**20.230**	**2.8185**	**2.8219**
232	M	**M3m**	**A1/2**	**18.710**	**18.710**	**18.710**	**18.710**	**18.710**	**2.9684**	**2.9684**
233	M	**M3m**	**Ac**	**15.670**	**17.374**	**19.215**	**21.219**	**23.468**	**2.9931**	**2.9933**
234	M	**M3d**	**R1/4**	**13.868**	**14.646**	**15.424**	**16.202**	**16.980**	**2.7805**	**2.7811**
235	M	**M3d**	**R1/2**	**14.727**	**15.394**	**16.061**	**16.728**	**17.395**	**2.8201**	**2.8205**
236	M	**M3d**	**R3/4**	**16.730**	**16.730**	**16.730**	**16.730**	**16.730**	**2.8611**	**2.8611**
237	M	**M3d**	**Rc**	**12.350**	**14.320**	**16.290**	**18.260**	**20.230**	**2.1815**	**2.8219**
238	M	**M3d**	**A1/2**	**18.710**	**18.710**	**18.710**	**18.710**	**18.710**	**2.9684**	**2.9684**
239	M	**M3d**	**Ac**	**16.368**	**18.119**	**20.051**	**22.198**	**24.424**	**3.0342**	**3.0343**
240	F	UI1	Crc	3.859	4.346	4.849	5.389	6.057	1.7223	1.7224
241	F	UI1	R1/4	4.789	5.367	5.967	6.687	7.468	1.9089	1.9080
242	F	UI1	R1/2	5.254	5.877	6.537	7.302	8.128	1.9883	1.9878
243	F	UI1	R2/3	5.719	6.387	7.092	7.910	8.780	2.0614	2.0610
244	F	UI1	R3/4	6.094	6.799	7.557	8.427	9.335	2.1182	2.1179
245	F	UI1	Rc	6.581	7.317	8.165	9.073	10.040	2.1858	2.1862
246	F	UI1	A1/2	7.204	8.014	8.922	9.898	10.978	2.2679	2.2682
247	F	UI2	Cr2/3	3.617	4.060	4.540	5.103	5.695	1.6687	1.6682
248	F	UI2	Crc	4.517	5.072	5.665	6.325	7.046	1.8584	1.8584
249	F	UI2	R1/4	5.252	5.890	6.565	7.293	8.134	1.9886	1.9889
250	F	UI2	R1/2	5.732	6.408	7.135	7.916	8.794	2.0631	2.0635
x	*Sex*	*Tooth*	*Stage*	*L2SD*	*L1SD*	*Mean*	*U1SD*	*U2SD*	*WithoutMean*	*WithMean*
251	F	UI2	R2/3	6.220	6.940	7.698	8.591	9.521	2.1363	2.1358
252	F	UI2	R3/4	6.692	7.450	8.291	9.206	10.211	2.2010	2.2011

253	F	UI2	Rc	7.323	8.163	9.033	10.046	11.172	2.2834	2.2828
254	F	UI2	A1/2	7.735	8.605	9.551	10.609	11.749	2.3325	2.3324
255	F	**LI1**	**Cr1/2**	**0.715**	**1.192**	**1.670**	**2.147**	**2.624**	**0.8314**	**0.8418**
256	F	**LI1**	**Cr3/4**	**1.304**	**1.940**	**2.575**	**3.211**	**3.847**	**1.1527**	**1.1625**
257	F	**LI1**	**Crc**	**2.658**	**3.027**	**3.395**	**3.764**	**4.133**	**1.4120**	**1.4140**
258	F	**LI1**	**Ri**	**3.241**	**3.653**	**4.065**	**4.478**	**4.890**	**1.5625**	**1.5644**
259	F	**LI1**	**R1/4**	**4.043**	**4.402**	**4.761**	**5.121**	**5.480**	**1.7015**	**1.7025**
260	F	**LI1**	**R1/2**	**4.868**	**5.155**	**5.443**	**5.730**	**6.017**	**1.8206**	**1.8212**
261	F	**LI1**	**R3/4**	**5.275**	**5.840**	**6.405**	**6.969**	**7.534**	**1.9599**	**1.9614**
262	F	**LI1**	**Rc**	**5.257**	**6.267**	**7.278**	**8.288**	**9.298**	**2.0625**	**2.0666**
263	F	**LI1**	**A1/2**	**6.139**	**6.920**	**7.700**	**8.480**	**9.261**	**2.1233**	**2.1255**
264	F	**LI1**	**Ac**	**5.983**	**8.997**	**12.012**	**15.027**	**18.041**	**2.4690**	**2.4845**
265	F	**LI2**	**Cr1/2**	**1.326**	**1.699**	**2.073**	**2.446**	**2.819**	**1.0151**	**1.0196**
266	F	**LI2**	**Cr3/4**	**1.782**	**2.380**	**2.979**	**3.577**	**4.176**	**1.2823**	**1.2891**
267	F	**LI2**	**Crc**	**3.255**	**3.698**	**4.140**	**4.583**	**5.026**	**1.5769**	**1.5790**
268	F	**LI2**	**Ri**	**3.818**	**4.196**	**4.574**	**4.952**	**5.330**	**1.6658**	**1.6671**
269	F	**LI2**	**R1/4**	**4.534**	**4.911**	**5.289**	**5.667**	**6.045**	**1.7934**	**1.7943**
270	F	**LI2**	**R1/3**	**4.138**	**4.626**	**5.166**	**5.796**	**6.487**	**1.7817**	**1.7809**
271	F	**LI2**	**R1/2**	**5.467**	**5.837**	**6.207**	**6.577**	**6.947**	**1.9362**	**1.9369**
272	F	**LI2**	**R2/3**	**5.076**	**5.699**	**6.344**	**7.079**	**7.837**	**1.9586**	**1.9587**
273	F	**LI2**	**R3/4**	**6.029**	**6.444**	**6.859**	**7.274**	**7.689**	**2.0256**	**2.0264**
274	F	**LI2**	**Rc**	**6.229**	**7.014**	**7.800**	**8.585**	**9.370**	**2.1352**	**2.1373**
275	F	**LI2**	**A1/2**	**7.011**	**7.839**	**8.667**	**9.495**	**10.323**	**2.2327**	**2.2347**

276	F	LI2	Ac	6.897	9.767	12.636	15.506	18.375	2.5317	2.5442
277	F	C	Ci	0.221	0.349	0.460	0.582	0.705	0.1816	1.8340
278	F	C	Cco	0.437	0.559	0.711	0.857	1.032	0.3732	0.3744
279	F	C	Coc	1.198	1.493	1.789	2.085	2.380	0.9144	9.1790
280	F	C	Cr1/2	1.575	2.187	2.799	3.411	4.023	1.2275	1.2353
281	F	C	Cr3/4	3.291	3.681	4.070	4.459	4.848	1.5645	1.5661
282	F	C	Crc	3.844	4.247	4.651	5.054	5.457	1.6795	1.6809
283	F	C	Ri	4.615	4.991	5.366	5.741	6.116	1.8061	1.8071
284	F	C	R1/4	5.387	6.015	6.644	7.273	7.902	1.9915	1.9934
285	F	C	R1/2	6.589	7.226	7.864	8.502	9.139	2.1465	2.1479
286	F	C	R3/4	8.079	8.646	9.213	9.781	10.348	2.2948	2.2956
287	F	C	Rc	8.998	9.718	10.438	11.158	11.878	2.4096	2.4106
288	F	C	A1/2	9.741	10.605	11.468	12.332	13.196	2.4966	2.4979
289	F	C	Ac	10.837	12.960	15.083	17.206	19.329	2.7389	2.7435
290	F	PM3	Ci	1.262	1.582	1.902	2.221	2.541	0.9565	0.9602
291	F	PM3	Cco	1.652	1.990	2.327	2.664	3.001	1.1086	1.1116
292	F	PM3	Coc	2.360	2.745	3.129	3.514	3.899	1.3432	1.3457

x	*Sex*	*Tooth*	*Stage*	*L2SD*	*L1SD*	*Mean*	*U1SD*	*U2SD*	*WithoutMean*	*WithMean*
293	F	PM3	Cr1/2	3.153	3.619	4.085	4.551	5.017	1.5641	1.5665
294	F	PM3	Cr3/4	3.829	4.307	4.785	5.263	5.741	1.7017	1.7035
295	F	PM3	Crc	4.876	5.195	5.513	5.832	6.150	1.8314	1.8321
296	F	PM3	Ri	5.505	5.978	6.451	6.924	7.397	1.9688	1.9699
297	F	PM3	R1/4	6.624	7.182	7.741	8.299	8.857	2.1335	2.1346

298	F	**PM3**	**R1/2**	**8.091**	**8.573**	**9.055**	**9.538**	**10.020**	**2.2799**	**2.2805**
299	F	**PM3**	**R3/4**	**8.919**	**9.433**	**9.947**	**10.461**	**10.975**	**2.3671**	**2.3676**
300	F	**PM3**	**Rc**	**9.798**	**10.242**	**10.686**	**11.130**	**11.575**	**2.4349**	**2.4353**
301	F	**PM3**	**A1/2**	**10.590**	**11.092**	**11.594**	**12.096**	**12.598**	**2.5111**	**2.5115**
302	F	**PM3**	**Ac**	**11.093**	**13.106**	**15.119**	**17.132**	**19.145**	**2.7437**	**2.7478**
303	F	**PM4**	**Ci**	**2.377**	**2.825**	**3.273**	**3.720**	**4.168**	**1.3761**	**1.3793**
304	F	**PM4**	**Cco**	**2.692**	**3.290**	**3.888**	**4.486**	**5.085**	**1.5129**	**1.5172**
305	F	**PM4**	**Coc**	**3.594**	**3.971**	**4.348**	**4.725**	**5.101**	**1.6219**	**1.6233**
306	F	**PM4**	**Cr1/2**	**4.104**	**4.453**	**4.801**	**5.150**	**5.499**	**1.7091**	**1.7101**
307	F	**PM4**	**Cr3/4**	**4.820**	**5.204**	**5.588**	**5.971**	**6.355**	**1.8419**	**1.8428**
308	F	**PM4**	**Crc**	**5.474**	**6.045**	**6.616**	**7.187**	**7.758**	**1.9893**	**1.9908**
309	F	**PM4**	**Ri**	**6.423**	**7.017**	**7.610**	**8.204**	**8.798**	**2.1171**	**2.1184**
310	F	**PM4**	**R1/4**	**7.405**	**8.032**	**8.660**	**9.287**	**9.915**	**2.2361**	**2.2373**
311	F	**PM4**	**R1/2**	**8.484**	**9.073**	**9.662**	**10.250**	**10.839**	**2.3389**	**2.3397**
312	F	**PM4**	**R3/4**	**9.436**	**10.012**	**10.588**	**11.164**	**11.740**	**2.4249**	**2.4256**
313	F	**PM4**	**Rc**	**10.247**	**10.844**	**11.441**	**12.038**	**12.635**	**2.4977**	**2.4983**
314	F	**PM4**	**A1/2**	**11.324**	**11.957**	**12.591**	**13.224**	**13.858**	**2.5880**	**2.5886**
315	F	**PM4**	**Ac**	**12.380**	**14.080**	**15.780**	**17.480**	**19.180**	**2.7917**	**2.7944**
316	F	M1	Cco	0.059	0.158	0.263	0.351	0.438	-0.0098	-0.0052
317	F	M1	Coc	0.490	0.612	0.764	0.892	1.078	0.4059	0.4076
318	F	**M1**	**Cr1/2**	**1.135**	**1.400**	**1.665**	**1.930**	**2.195**	**0.8664**	**0.8695**
319	F	**M1**	**Cr3/4**	**1.754**	**2.003**	**2.251**	**2.500**	**2.748**	**1.0903**	**1.0921**
320	F	**M1**	**Crc**	**1.622**	**2.268**	**2.914**	**3.560**	**4.206**	**1.2575**	**1.2657**

321	F	**M1**	**Ri**	**2.872**	**3.197**	**3.522**	**3.847**	**4.171**	**1.4447**	**1.4462**
322	F	**M1**	**cleft**	**3.258**	**3.669**	**4.079**	**4.489**	**4.900**	**1.5655**	**1.5673**
323	F	**M1m**	**R1/4**	**3.980**	**4.341**	**4.701**	**5.062**	**5.422**	**1.6903**	**1.6914**
324	F	**M1m**	**R1/2**	**4.592**	**5.006**	**5.421**	**5.835**	**6.249**	**1.8141**	**1.8152**
325	F	**M1m**	**R3/4**	**5.632**	**6.100**	**6.569**	**7.038**	**7.506**	**1.9853**	**1.9863**
326	F	**M1m**	**Rc**	**6.452**	**6.957**	**7.462**	**7.966**	**8.471**	**2.1008**	**2.1017**
327	F	**M1m**	**A1/2**	**7.224**	**7.874**	**8.524**	**9.174**	**9.824**	**2.2210**	**2.2222**
328	F	**M1m**	**Ac**	**7.116**	**9.916**	**12.716**	**15.516**	**18.316**	**2.5416**	**2.5534**
329	F	**M1d**	**R1/4**	**3.980**	**4.341**	**4.701**	**5.062**	**5.422**	**1.6903**	**1.6914**
330	F	**M1d**	**R1/2**	**4.592**	**5.006**	**5.421**	**5.835**	**6.249**	**1.8141**	**1.8152**
331	F	**M1d**	**R3/4**	**5.632**	**6.100**	**6.569**	**7.038**	**7.506**	**1.9853**	**1.9863**
332	F	**M1d**	**Rc**	**6.452**	**6.957**	**7.462**	**7.966**	**8.471**	**2.1008**	**2.1017**
333	F	**M1d**	**A1/2**	**7.224**	**7.874**	**8.524**	**9.174**	**9.824**	**2.2210**	**2.2222**
334	F	**M1d**	**Ac**	**7.116**	**9.916**	**12.716**	**15.516**	**18.316**	**2.5416**	**2.5534**

x	*Sex*	*Tooth*	*Stage*	*L2SD*	*L1SD*	*Mean*	*U1SD*	*U2SD*	*WithoutMean*	*WithMean*
335	F	**M2**	**Ci**	**2.351**	**2.801**	**3.252**	**3.703**	**4.153**	**1.3706**	**1.3738**
336	F	**M2**	**Cco**	**3.084**	**3.497**	**3.911**	**4.325**	**4.738**	**1.5293**	**1.5313**
337	F	**M2**	**Coc**	**3.823**	**4.214**	**4.605**	**4.997**	**5.388**	**1.6713**	**1.6727**
338	F	**M2**	**Cr1/2**	**3.884**	**4.418**	**4.951**	**5.485**	**6.019**	**1.7296**	**1.7318**
339	F	**M2**	**Cr3/4**	**4.478**	**5.181**	**5.883**	**6.585**	**7.287**	**1.8777**	**1.8806**
340	F	**M2**	**Crc**	**5.860**	**6.395**	**6.931**	**7.466**	**8.001**	**2.0326**	**2.0338**
341	F	**M2**	**Ri**	**6.568**	**7.061**	**7.554**	**8.047**	**8.540**	**2.1123**	**2.1132**
342	F	**M2**	**cleft**	**7.152**	**7.709**	**8.266**	**8.823**	**9.380**	**2.1942**	**2.1952**

343	F	**M2m**	**R1/4**	**8.027**	**8.716**	**9.404**	**10.093**	**10.782**	**2.3121**	**2.3133**
344	F	**M2m**	**R1/2**	**9.067**	**9.696**	**10.324**	**10.953**	**11.582**	**2.4006**	**2.4014**
345	F	**M2m**	**R3/4**	**10.170**	**10.719**	**11.269**	**11.819**	**12.368**	**2.4839**	**2.4844**
346	F	**M2m**	**Rc**	**10.874**	**11.575**	**12.275**	**12.976**	**13.677**	**2.5633**	**2.5640**
347	F	**M2m**	**A1/2**	**11.845**	**12.795**	**13.745**	**14.695**	**15.645**	**2.6684**	**2.6694**
348	F	**M2m**	**Ac**	**13.922**	**15.225**	**16.528**	**17.831**	**19.134**	**2.8423**	**2.8437**
349	F	**M2d**	**R1/4**	**8.027**	**8.716**	**9.404**	**10.093**	**10.782**	**2.3121**	**2.3133**
350	F	**M2d**	**R1/2**	**9.067**	**9.696**	**10.324**	**10.953**	**11.582**	**2.4006**	**2.4014**
351	F	**M2d**	**R3/4**	**10.170**	**10.719**	**11.269**	**11.819**	**12.368**	**2.4839**	**2.4844**
352	F	**M2d**	**Rc**	**10.874**	**11.575**	**12.275**	**12.976**	**13.677**	**2.5633**	**2.5640**
353	F	**M2d**	**A1/2**	**11.845**	**12.795**	**13.745**	**14.695**	**15.645**	**2.6684**	**2.6694**
354	F	**M2d**	**Ac**	**13.922**	**15.225**	**16.528**	**17.831**	**19.134**	**2.8423**	**2.8437**
355	F	**M3**	**Ci**	**6.710**	**7.735**	**8.760**	**9.785**	**10.810**	**2.2375**	**2.2405**
356	F	**M3**	**Cco**	**7.784**	**8.724**	**9.663**	**10.602**	**11.542**	**2.3327**	**2.3348**
357	F	**M3**	**Coc**	**8.638**	**9.534**	**10.430**	**11.325**	**12.221**	**2.4060**	**2.4076**
358	F	**M3**	**Cr1/2**	**9.314**	**10.354**	**11.394**	**12.434**	**13.474**	**2.4876**	**2.4894**
359	F	**M3**	**Cr3/4**	**9.695**	**10.771**	**11.847**	**12.923**	**13.999**	**2.5242**	**2.5261**
360	F	**M3**	**Crc**	**11.060**	**12.001**	**12.942**	**13.882**	**14.823**	**2.6108**	**2.6120**
361	F	**M3**	**Ri**	**12.458**	**13.328**	**14.198**	**15.068**	**15.938**	**2.7003**	**2.7012**
362	F	**M3**	**Rcl**	**11.870**	**13.033**	**14.195**	**15.358**	**16.520**	**2.6967**	**2.6983**
363	F	**M3m**	**R1/4**	**13.748**	**14.561**	**15.374**	**16.187**	**17.000**	**2.7771**	**2.7778**
364	F	**M3m**	**R1/2**	**15.440**	**15.835**	**16.230**	**16.625**	**17.020**	**2.8314**	**2.8315**
365	F	**M3m**	**R3/4**	**16.726**	**16.726**	**16.726**	**16.726**	**16.726**	**2.8608**	**2.8608**

366	F	**M3m**	**Rc**	**17.370**	**17.370**	**17.370**	**17.370**	**17.370**	**2.8970**	**2.8970**
367	F	**M3m**	**A1/2**	**18.710**	**18.710**	**18.710**	**18.710**	**18.710**	**2.9684**	**2.9684**
368	F	M3m	Ac	16.370	18.131	20.066	22.194	24.392	3.0340	3.0343
369	F	**M3d**	**R1/4**	**13.748**	**14.561**	**15.374**	**16.187**	**17.000**	**2.7771**	**2.7778**
370	F	**M3d**	**R1/2**	**15.440**	**15.835**	**16.230**	**16.625**	**17.020**	**2.8314**	**2.8315**
371	F	**M3d**	**R3/4**	**16.726**	**16.726**	**16.726**	**16.726**	**16.726**	**2.8608**	**2.8608**
372	F	**M3d**	**Rc**	**17.370**	**17.370**	**17.370**	**17.370**	**17.370**	**2.8970**	**2.8970**
373	F	**M3d**	**A1/2**	**18.710**	**18.710**	**18.710**	**18.710**	**18.710**	**2.9684**	**2.9684**
374	F	M3d	Ac	16.943	18.745	20.721	22.930	25.139	3.0654	3.0657

Bolded values: recalculated by the authors.
Plain text values: from the Shackelford et al. (2012) publication.
When importing into R, omit the first column to calculate the 'withmean' and 'withoutmean' values.

Table B2. Recalculated Log-Corrected Mean Age-at-Attainment Values (MFH2 table) for Each Tooth and Developmental Stage

	dc	*dm1*	*dm2*	*UI1*	*UI2*	*LI1*	*LI2*	*C*	*P3*	*P4*	*M1*	*M2*	*M3*
C.i	-	-	-	-	-	-	-	0.196	**0.963**	**1.371**	-	**1.404**	**2.227**
C.co	-0.385	-	-	-	-	-	-	0.391	**1.138**	**1.533**	-0.080	**1.556**	**2.333**
C.oc	-0.103	-0.411	-0.078	-	-	-	-	**0.924**	**1.358**	**1.599**	**0.261**	**1.658**	**2.403**
Cr.5	0.013	-0.090	0.008	-	-	**0.924**	**1.023**	**1.256**	**1.569**	**1.707**	**0.892**	**1.741**	**2.491**
Cr.75	0.200	-0.018	0.202	-	-	**1.131**	**1.284**	**1.581**	**1.703**	**1.847**	**1.078**	**1.883**	**2.516**
Cr.c	0.356	0.123	0.374	1.765	1.877	**1.406**	**1.552**	**1.699**	**1.849**	**1.988**	**1.308**	**2.040**	**2.591**
R.i	0.463	0.276	0.517	1.765	1.877	**1.558**	**1.670**	**1.831**	**1.985**	**2.119**	**1.430**	**2.131**	**2.683**
Cl.i	0.463	0.303	0.546	1.765	1.877	**1.558**	**1.670**	**1.831**	**1.985**	**2.119**	**1.567**	**2.215**	**2.707**
R.25	0.569	0.367	0.728	1.931	2.014	**1.703**	**1.805**	**2.022**	**2.138**	**2.235**	**1.692**	**2.322**	**2.782**
R.5	0.720	0.504	0.838	2.013	2.090	**1.828**	**1.930**	**2.174**	**2.284**	**2.343**	**1.823**	**2.415**	**2.827**
R.75	0.940	0.642	0.969	2.146	2.225	**1.952**	**2.032**	**2.329**	**2.372**	**2.427**	**1.977**	**2.496**	**2.861**
R.c	1.013	0.712	1.018	2.213	2.311	**2.088**	**2.132**	**2.438**	**2.443**	**2.499**	**2.102**	**2.572**	**2.867**
A.5	1.181	0.839	1.146	2.268	2.332	**2.119**	**2.227**	**2.520**	**2.515**	**2.588**	**2.226**	**2.667**	**2.968**
A.c	1.325	0.963	1.307	2.268	2.332	**2.538**	**2.586**	**2.774**	**2.766**	**2.809**	**2.594**	**2.849**	**3.014**
Res.25	1.827	1.777	1.958	-	-	-	-	-	-	-	-	-	-
Res.5	2.149	2.099	2.216	-	-	-	-	-	-	-	-	-	-
Res.75	2.302	2.288	2.395	-	-	-	-	-	-	-	-	-	-

Bolded values: recalculated by the authors.
Plain text values: from the Shackelford et al. (2012) publication.

Table B3. Recalculated Mean Log Conception-Corrected Ages in Years for Teeth within Specific Developmental Stages

	dc	*dm1*	*dm2*	*UI1*	*UI2*	*LI1*	*LI2*	*C*	*P3*	*P4*	*M1*	*M2*	*M3*
C.i	-	-	-	-	-	-	-	**-0.294**	**1.051**	**1.452**	-	**1.480**	**2.280**
C.co	-0.244	-	-0.240	-	-	-	-	**0.658**	**1.248**	**1.566**	0.091	**1.607**	**2.368**
C.oc	-0.045	-0.250	-0.035	-	-	-	-	**1.090**	**1.464**	**1.653**	**0.576**	**1.699**	**2.447**
Cr.5	0.107	-0.054	0.105	-	-	**1.079**	**1.153**	**1.418**	**1.636**	**1.777**	**0.985**	**1.812**	**2.503**
Cr.75	0.278	0.052	0.288	-	-	**1.269**	**1.418**	**1.640**	**1.776**	**1.917**	**1.193**	**1.961**	**2.553**
Cr.c	0.410	0.199	0.446	1.848	1.945	**1.482**	**1.611**	**1.765**	**1.917**	**2.053**	**1.369**	**2.085**	**2.637**
R.i	0.516	0.289	0.531	1.848	1.945	**1.631**	**1.737**	**1.926**	**2.061**	**2.177**	**1.498**	**2.173**	**2.695**
Cl.i	NA	0.335	0.637	-	-	-	-	-	-	-	**1.629**	**2.269**	**2.744**
R.25	0.644	0.435	0.783	1.972	2.052	**1.765**	**1.868**	**2.098**	**2.211**	**2.289**	**1.758**	**2.369**	**2.805**
R.5	0.830	0.573	0.904	2.079	2.157	**1.890**	**1.981**	**2.251**	**2.328**	**2.385**	**1.901**	**2.455**	**2.844**
R.75	0.977	0.677	0.994	2.179	2.268	**2.020**	**2.082**	**2.384**	**2.408**	**2.463**	**2.040**	**2.534**	**2.864**
R.c	1.097	0.775	1.082	2.240	2.322	**2.103**	**2.179**	**2.479**	**2.479**	**2.543**	**2.164**	**2.619**	**2.918**
A.5	1.253	0.901	1.227	-	-	**2.328**	**2.407**	**2.647**	**2.640**	**2.697**	**2.410**	**2.758**	**2.991**
A.c	1.576	1.370	1.632	-	-	-	-	-	-	-	-	-	-
Res.25	1.988	1.938	2.087	-	-	-	-	-	-	-	-	-	-
Res.5	2.225	2.193	2.305	-	-	-	-	-	-	-	-	-	-
Res.75	-	-	-	-	-	-	-	-	-	-	-	-	-

Bolded values: recalculated by the authors.
Plain text values: from the Shackelford et al. (2012) publication.

This table replaced the MUS table.

Figure. 1

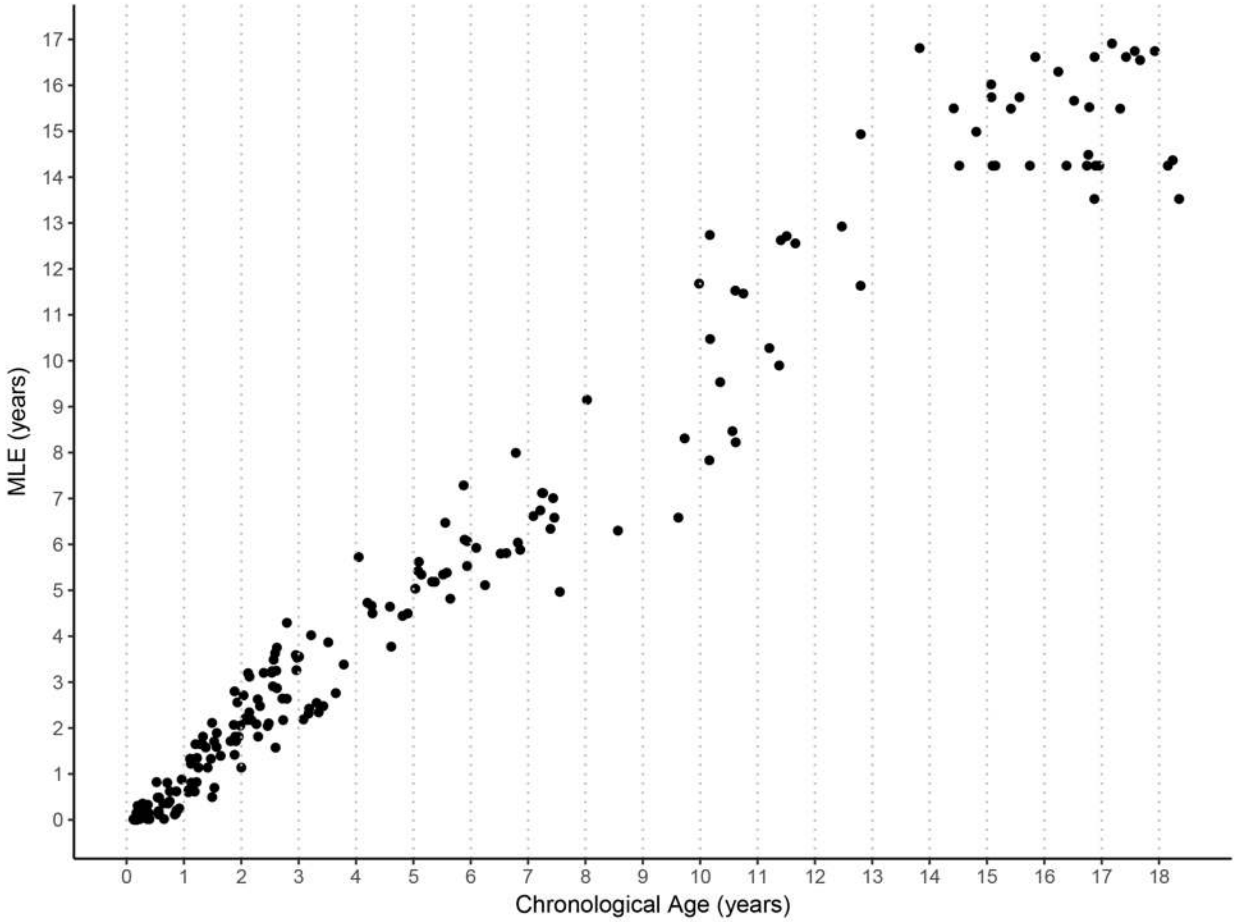

MLE (years)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
Chronological Age (years)

Figure 2.

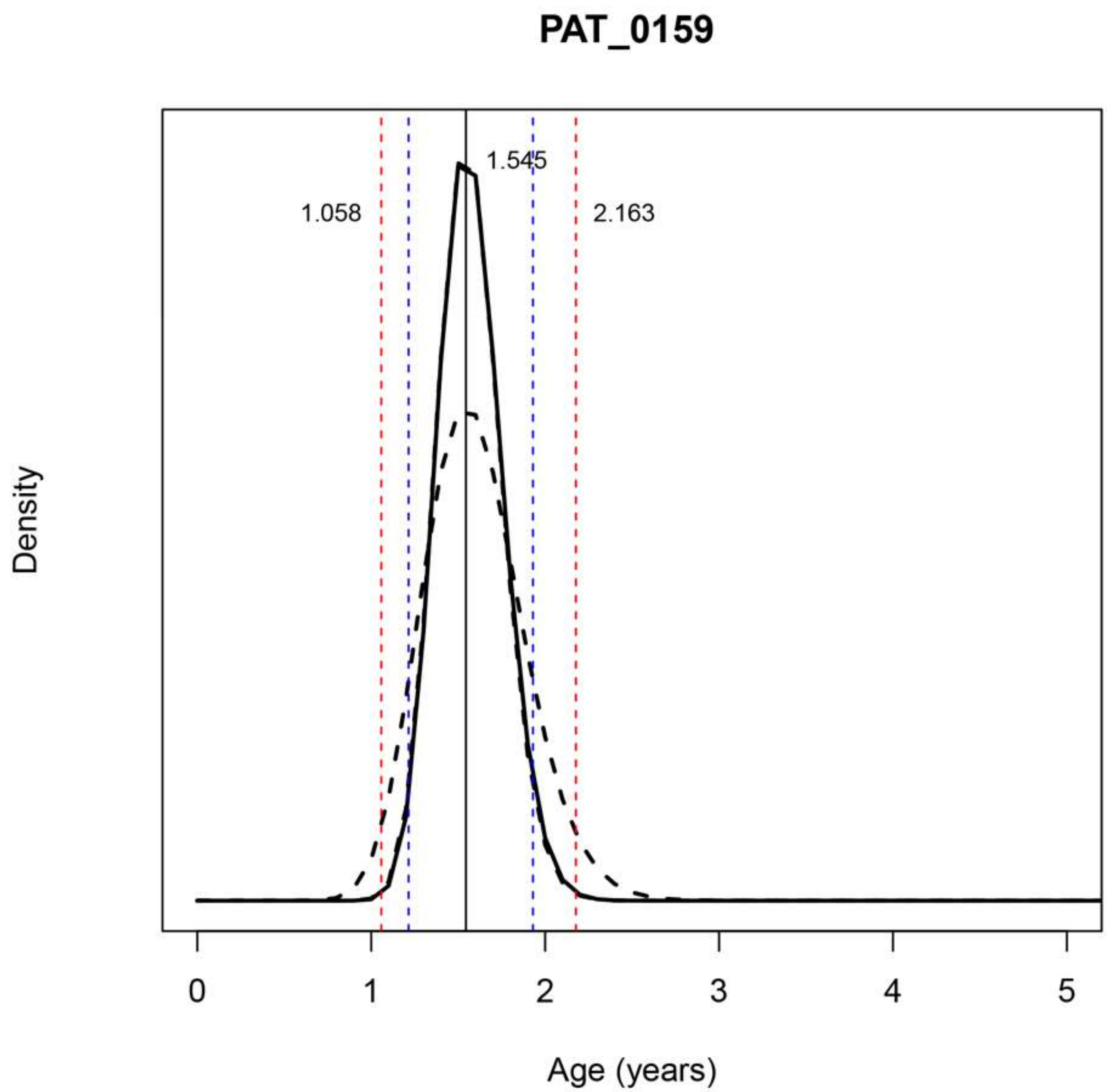
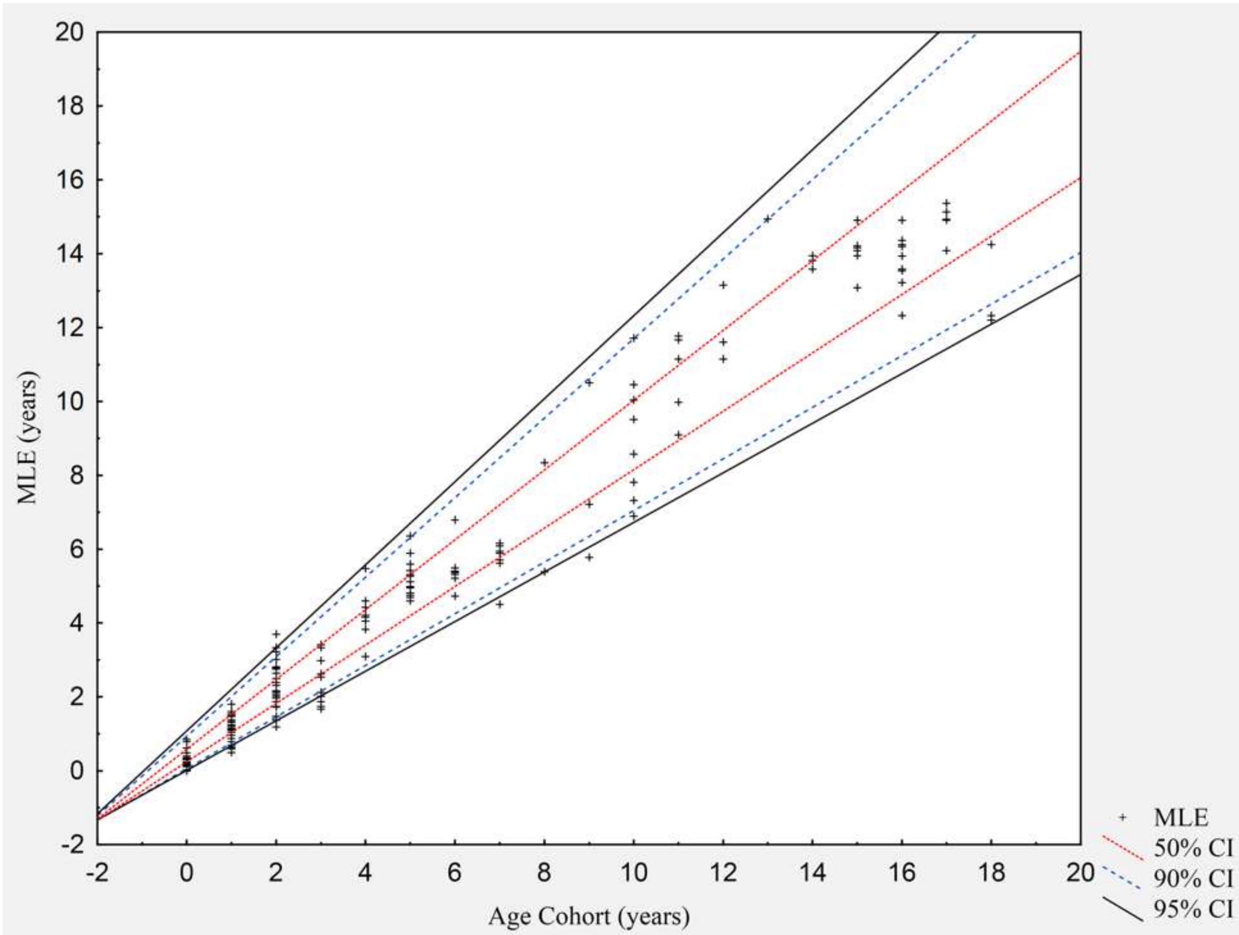
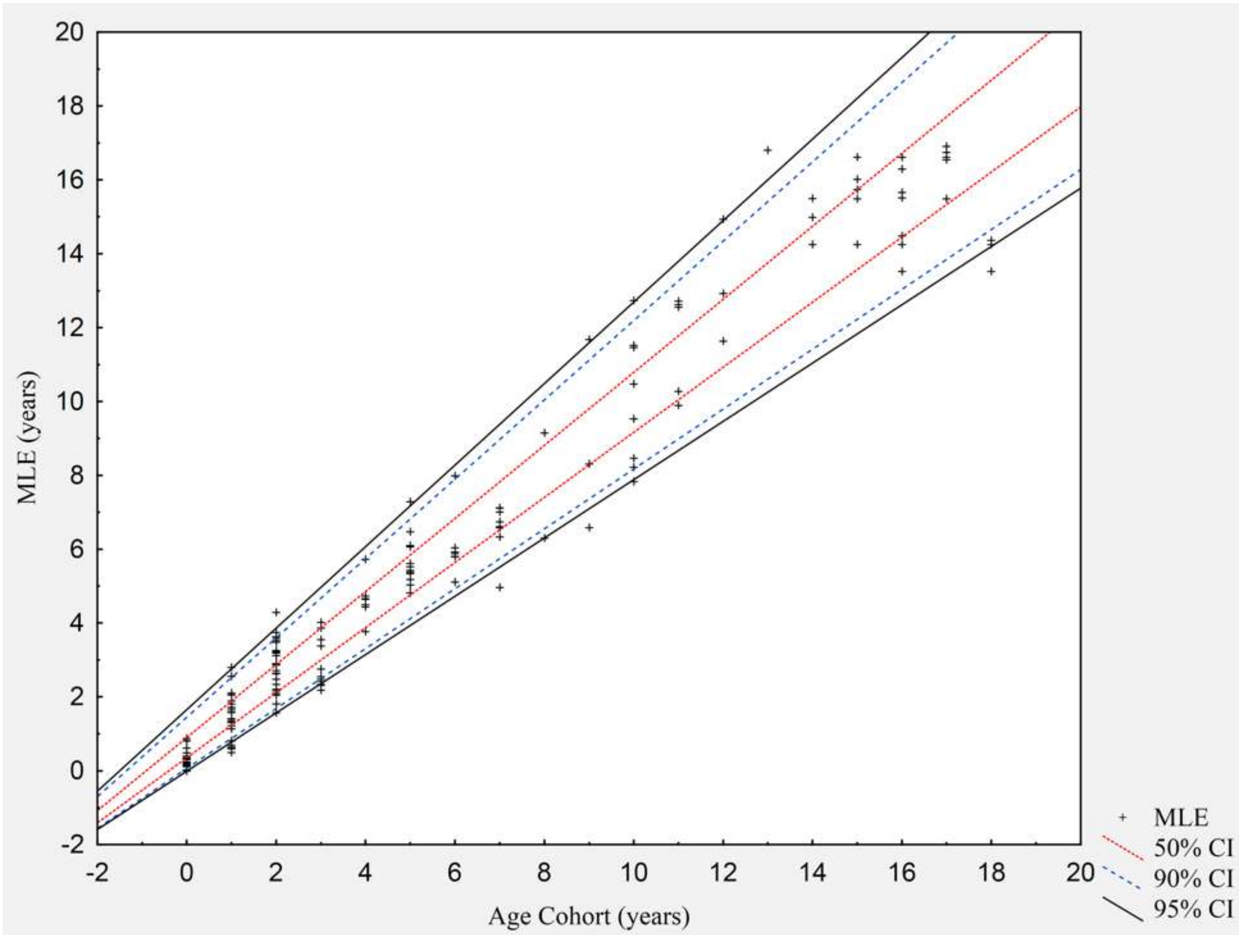


Figure 3A.



MLE (years)
Age Cohort (years)
-2
0
2
4
6
8
10
12
14
16
18
20
MLE
50% CI
90% CI
95% CI

Figure 3B.



MLE (years)
Age Cohort (years)
-2
0
2
4
6
8
10
12
14
16
18
20
MLE
50% CI
90% CI
95% CI

Figure 4.

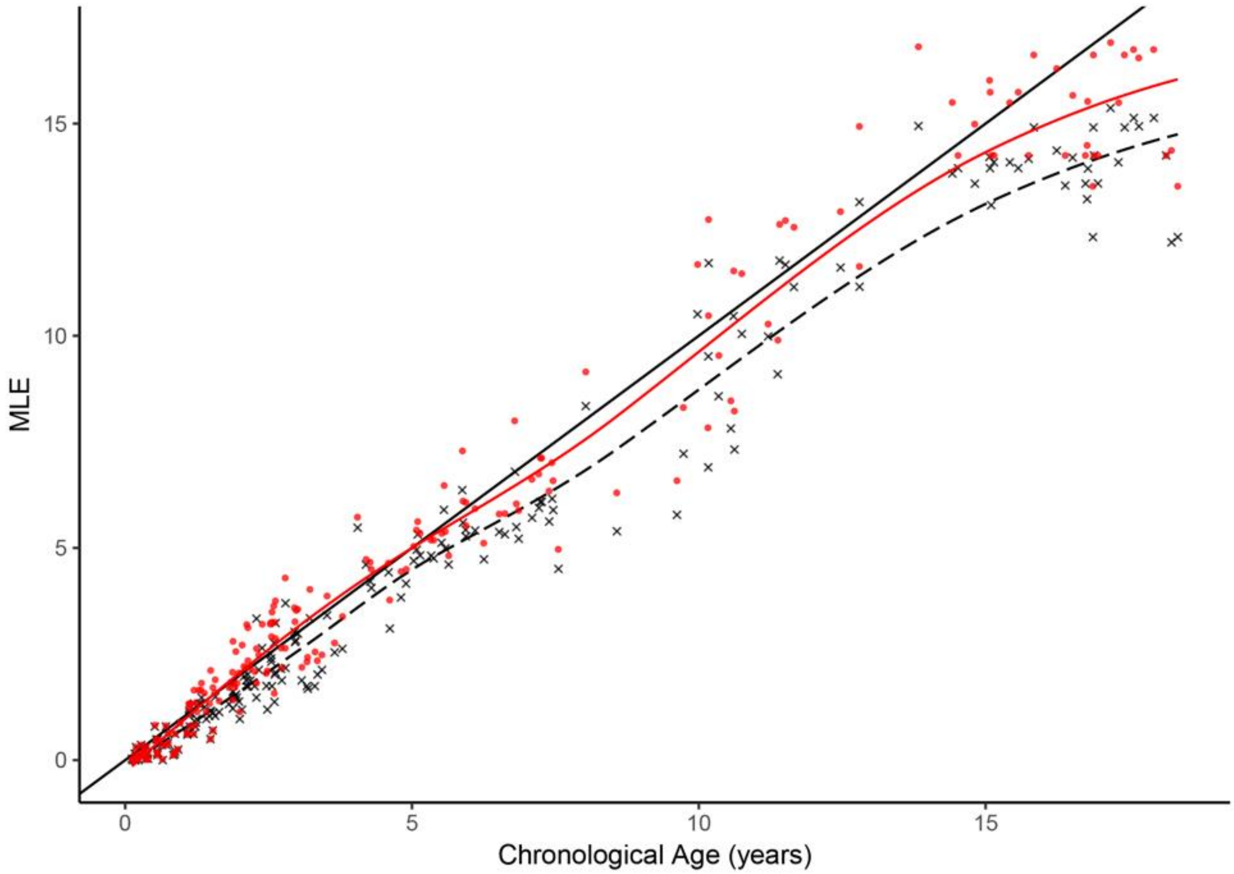
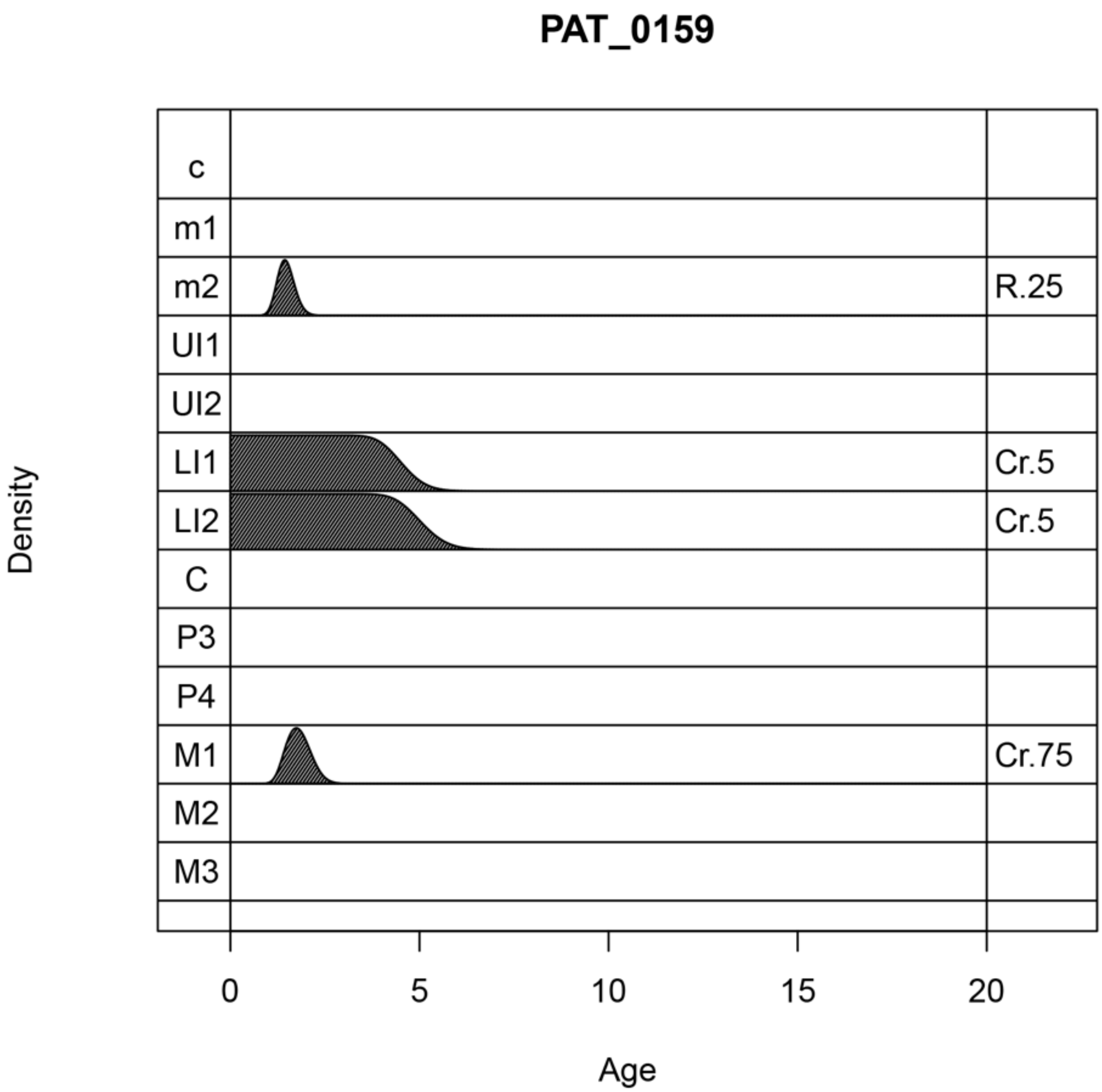


Figure 5A.



PAT_0159
c
m1
m2
UI1
UI2
LI1
LI2
C
P3
P4
M1
M2
M3
R.25
Cr.5
Cr.5
Cr.75
Density
0
5
10
15
20
Age

Figure 5B.

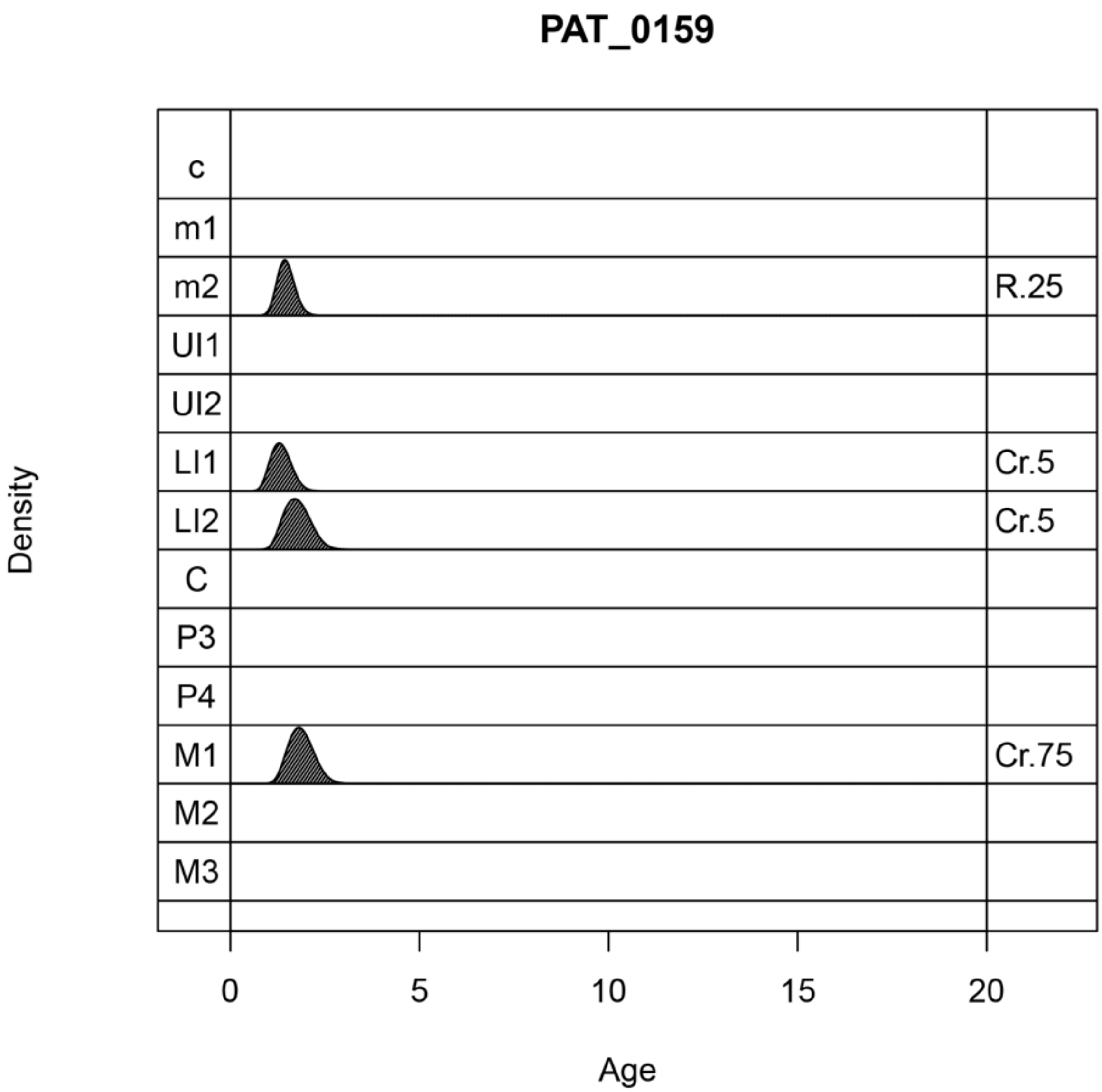

PAT_0159
c
m1
m2
UI1
UI2
LI1
LI2
C
P3
P4
M1
M2
M3
R.25
Cr.5
Cr.5
Cr.75
Density
0
5
10
15
20
Age

Figure Captions

Figure 1. Distribution of the reference sample.

Figure 2. Graphical output from the get.age function with modifications by the second author. The solid line in the center of the density is the MLE; the dotted lines represent the within and within+between tooth variance.

Figures 3A and 3B. Graphical representations of age estimates and confidence intervals using the unmodified (a) and modified (b) versions of the SSK method parameters. MLE ages are represented by black hatch marks, which are shown within low and high bounds of the 50%, 90%, and 95% CI bands.

Figure 4. Plot of MLEs against known chronological ages for the test sample for both methods. *Dotted line*: loess fit of the data under the original SSK method. *Solid line:* loess fit of the data using the modified method. *Diagonal line:* a 1:1 line between MLE and chronological age.

Figures 5A and 5B. Figure 5a and 5b: The 'plot.teeth' plots for PAT_0159 using the original (a) and the modified (b) SSK methods. The 'plot.teeth' graphic exhibits a more complete developmental score due to the addition of ages-of-attainment for earlier stages.