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**Review Article**

# Homology in the Rate and Pattern of Eruption of Primate Dentition: A Narrative Review

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**Abstract**

Adult antemolar dentition of mammals may consist of both permanent and retained deciduous teeth. Certain animals, such as Homo sapiens and Tarsius, develop sequence homology of three sets of teeth. A technique for reconsidering dental homologies is presented, and a model of tooth loss is given, following a reassessment of dental homologies in most primates. An essential component of the theory of evolution is the study of homology and the discovery of related species, particularly phylogenetic reconstruction. Scopus, PubMed, Web of Science and Google Scholar were the electronic databases utilized to gather pertinent information that satisfied the eligibility requirements. The databases' key terms led to the discovery of 125 articles in total. Eighteen articles were discarded based solely on the article's title and abstract, and eighty-seven articles were eliminated because of duplication or irrelevant themes. There is a relationship between dental morphology and tooth function, however, physical similarities do not always imply homology. A conclusion was derived that, diet, life history, and phylogeny are the primary factors that influence the rate of tooth eruption.

**Keywords:** Dental homologies, Deciduous dentition, Deciduous, Permanent incisors, Canine, Primate dentition, Dental development.

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## INTRODUCTION

The teeth in humans, apes, monkeys, and lemurs are referred to as primate dentition. Variations in primate teeth can be attributed to dietary habits and ecological niche adaptation. Most primates have upper and lower jaws with the same number and variety of teeth, represented by the dental formula 2-1-2-3. They have molars, premolars, canines, and incisors, varying in size, form, and function. Primates who eat mostly plants have stronger jaws and bigger molars, but those who eat mostly meat or other animals may have more diversified dentition.

Depending on the situation, certain primates are termed precocial or altricial due to their extreme diversity in the rate of somatic and locomotor development[1]. Most prenatal and early postnatal dental developmental stages are poorly understood in primates. Since most primate species' dental follicles are not yet encased in bone, the eruption of permanent molars is almost insignificant at birth. The eruption of deciduous and permanent dentition has been hastened in primates with comparatively shorter gestations and/or earlier independence[2].

Dental development and eruption patterns may be taken separately and used as unique feeding independence tactics. Enhancing emergence and the morphogenesis of the permanent dentition, including replacement teeth, is the most often used technique in strepsirrhines. With very few exceptions, anthropoids delay the formation of all permanent teeth other than M1, and they speed up the mineralization of deciduous teeth[1]. The various feeding techniques used by various primate species are reflected in dental adaptations. Specifically, the occlusal aspect of the tooth crown frequently displays a diverse and complex array of morphological traits in the reconstruction of the primate's evolutionary development[3].

The dental eruption is a relatively noninvasive and accurate indicator of juvenile age. Furthermore, tooth eruption can be observed in nearly any type of material that preserves a jaw, including radiographs of living or deceased people, recent skeletons, fossil skeletons, and cadavers. This makes it possible to study tooth eruption in both the living and the dead, in the current or the earlier days[4]. Anthropological discussion surrounding the importance of human development led to the focus on teeth eruption in primates at the level of species.

Adolph Schultz (1935) launched a contemporary era of research on monkey tooth eruption. Schultz (1935) assembled all the available data on the periods during which primates sprout their teeth into a collection of essays research, paying close attention to each case study he came across[4].

Several studies were conducted in the past to compare the homology in the rate of development in humans and primates. The current narrative review is to analyze the present evidence on the rate of ageing in primates by reviewing the studies on the pattern of eruption of teeth in primates.

## Materials and method:

### Literature Search Strategy:

The relevant searches were conducted for this narrative review in Public Medline (PubMed), Scopus, Web of Science and Google Scholar digital data basis for articles written in the English language was conducted from inception to 2022. Literature search began in September 2023 including searching manually for missed-out articles.

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The following set of terms and Boolean operators [OR/AND] were used in the search. [Primate, dentition, Primate dentition, growth and development, Catarrhine, Platyrrhine,Deciduous dentition, Permanent dentition, dental homologies, odontogenesis, anthropoids]

**Eligibility Criteria**:

Only works that were published and provided a thorough explanation of the primate odontogenesis, growth and development of teeth were selected. All previous kinds of literature from the time of inception that studied fossil data or living models were included in the search strategy. Articles involving human models or fossils from sources other than primates, editorials or personal opinions, and articles that provided insufficient details about the data collection process were also disqualified.

**Data Extraction:**

After reading the entire article on their own, three reviewers considered the title, abstract, techniques, and major results. After being checked for accuracy and completeness, the data were extracted into a normal Microsoft Excel spreadsheet. The following information was obtained and arranged into columns of data: study author, publication year, heading, and conclusion.

**Study Selection:**

125 articles were found because of the keyword words in the databases. Eighty-seven articles were eliminated due to duplication or unrelated topics, while eighteen articles were eliminated based just on the article's title and abstract. Before being included in the collection, a comprehensive eligibility screening was conducted on just twenty full-text articles. Nine of those papers were eliminated from our thorough study because they had human sources (n = 3), editorials or personal opinions (n = 3), or insufficient information about the data collection process (n = 3). Finally, this review contained 11 papers. Researchers employed the literature search approach shown in Table 1 for this review.

**Table 1:** Strategy for literature search

| **Search methods** | **number of articles** |
|---|---|
| 1. Pub Med searches | 45 |
| 2. Web of Science searches | 34 |
| 3. Scopus searches | 18 |
| 4. Google scholar searches | 22 |
| 5. Manual searches | 6 |
| 6. Total number of searches in database[1,2,3,4,5] | 125 |
| 7. Total articles after duplicate removal | 38 |
| 8. Articles remaining after screening of tile and abstract | 20 |
| 9. Articles excluded after deep screening | 9 |
| 10. Total included articles | 11 |

**Table 2:** Included literature details

**Study Characteristics:**

| **Journal** | **Year** | **Authours** | **Inference** |
|---|---|---|---|
| AM. J. PHYS. ANTHROP., | 1977 | Philip d.gingerich et al | In primates, incisors are usually lost phylogenetically from back to front premolars are usually lost from front to back, and molars are usually lost from back to front. This general conclusion makes sense develop-mentally in that it is easily effected by sup-pression of the latest forming tooth buds, and it is supported by the available paleontological evidence. |
| AMERICAN JOURNAL OF PHYSICAL ANTHROPOLOGY | 1980 | Jeffrey h. schwartz et al | The transition from polyphyodonty to diphyodonty probably proceeded by a suppression of the competence of the presumptive dental tissues to generate successive sets of teeth. This process of tooth loss would also affect the number of teeth in a tooth row,as seen, for example, in *Tarsius*, which has *a* mixed antemolar dentition. |
| Folia primatology | 1982 | Pattrick Luckett et al | Enlargement of the anterior teeth is unlikely to be a homologous derived attribute . Continued retardation of deciduous tooth development at earlier stages might lead to inhibition of successional lamina formation which results in the absence of replacement tooth differentiation at these loci, leading to the presence of vestigeal bud in tarsius. |
| BOOK OF PHYSICAL ANTHROPOLOGY 37:177-231 (1994) | 1994 | B. holly smith et al | one of the most promising findings of the present study is that age of completion of the deciduous dentition is a fine index of the rate of maturation. Most primates complete the deciduous dentition within the first half year of life; thus, even studies of short duration can provide a useful index **of** growth rate of a species. |

| | | | |
|---|---|---|---|
| Folia Primato. l Review | 2004 | Joanna M. Setchell et al | The mandrill is one of the most sexually dimorphic primates, males completing their adult dentition 10 months earlier than females. males do not attain adult body size and appearance until several years after their complete adult dentition has emerged. That dental and bodily growth do not necessarily follow the same developmental patterns . |
| AMERICAN JOURNAL OF PHYSICAL ANTHROPOLOGY | 2007 | Emily Henderson et al | Platyrrhine dental eruption sequences are not related directly to body mass alone. That is, smaller animals are not necessarily ‘‘faster’’ and larger animals ‘‘slower’’ in relative molar eruption. Brain mass is the single best predictor of dental eruption sequence in platyrrhines. In fact, brain mass is the only variable that appears to predict both relative and absolute dental development in primates. |
| AMERICAN JOURNAL OF PHYSICAL ANTHROPOLOGY 1 | 2011 | Emily H. Guthrie et al | The dental eruption pattern in Tarsius is consistent with the food processing hypothesis in that the anterior dentition erupts early in the sequence facilitating the early weaning and independent juvenile foraging observed in this genus |
| *Anat Rec* | 2015 | Timothy D. Smith et al | one probable unifying characteristic of living primates: relatively advanced maturation of deciduous teeth and (commonly) M1 at birth. Beyond this, there is great diversity in the status of tooth eruption and maturation (dental stage) in the neonatal primate . The divergent patterns show that accelerating dental maturation or eruption are potentially independent strategies for later feeding independence. |
| Am J Phys Anthropol. 2017 November | 2017 | Timothy D. Smith et al | strepsirrhines with the shortest gestations have the largest deciduous RDV. Strepsirrhines with relatively long gestational times have larger permanent teeth. Our results on anthropoids are more tentative, but indicate that anthropoids may differ from strepsirrhines and tarsiers: anthropoids with long relative gestation have the smallest RDV of permanent molars. |

| | | | |
|---|---|---|---|
| Am J Phys Anthropol. | 2018 | Tesla A. Monson et al | dental eruption sequence is a far better predictor of phylogeny and will likely prove useful in phylogenetic hypotheses about relationships between extinct and extant mammalian taxa. The evolution of dental eruption sequence is likely driven by factors that significantly influence body size and mandibular symphyseal fusion. |
| Anat Rec | 2020 | Kelsey Paddock et al | Nearly all extant anthropoids have pronounced delays in mineralization of replacement teeth, especially premolars. dental germ volume of all strepsirrhines (and all primates) is positively correlated with head size (unsurprisingly, in absolute size, larger heads house larger teeth). This relationship is negative regarding maximum hydroxyapatite density. that dental mineralization and dental germ growth do not closely covary |

**Discussion**

There exists a correlation between dental morphology and tooth function; however, homology is not always inferred from morphological similarities alone. Morphologically, the canines of the lemurid or lorisid dental scrapers are most similar to the left and right lateral teeth of the indriid dental scraper. A high crest that extends from the tip to the base of the crown along the lateral border is what primarily unites them. There exists a correlation between dental morphology and tooth function; however, homology is not always inferred from morphological similarities alone.

Morphologically, the canines of the lemurid or lorisid dental scrapers are most similar to the left and right lateral teeth of the indriid dental scraper. A high crest that extends from the tip to the base of the crown along the lateral border is what primarily unites them[5]. The majority of extant strepsirrhines exhibit two unique developmental patterns that are demonstrated to be related to each other. Notably, every pattern incorporates both the upper and lower anterior premolars, connecting the development of the canine—the most caniniform upper tooth—with the premolar set as a whole[6].

The relationship between enamel organ, dental lamina and successional lamina was studied to learn about dental homologies[7]. Only humans and big apes usually stay toothless after a month of postnatal life, while many other primates have teeth that have already erupted at birth. The dentition erupts in a tightly integrated manner generally, but the initial few teeth provide unique insights into the life history of the species, perhaps indicating innate precociality[4].

Gingivae were exposed at birth in mandrills. The upper central incisor (i1) was the first tooth to erupt, appearing at 0.2 months in males and 0.4 months in females following birth (females). The entire array of deciduous teeth was evident by 6.4 months in males and 5.0 months in females. The teeth erupted in the following order: i1 i2 c p3 p4. There was no variation in the average age at emergence based on sex[8]. Tarsius's dental eruption sequence serves as another illustration of how biographical evolution in general and dental development, in particular, can be separated during evolution, allowing for the acceleration of certain aspects of development while delaying others. This makes it difficult to characterise total developmental stages as fast or slow[9,10,11].

When it comes to the eruption and development of persistent and replaceable teeth, strepsirrhines differ most from anthropoids in terms of dental maturation and eruption[12]. In all primates, there is an ambiguous association between the relative dental volumes (RDVs) of temporary or persistent teeth and the relative neonatal mass. Greater deciduous and permanent post canine teeth are substantially positively linked with relative palatal length (RPL), a measure of midfacial size[2].

## CONCLUSION

It has been stated that the main determinants of the rate of tooth eruption are diet, life history and phylogeny. Even in species with comparable lifespans, ontogenetic phases like "infancy" may not usually follow a similar duration when defined based on teeth eruption timetables. The length of gestation is one life history variable that has a complex relationship with dental growth, and it affects the development of permanent teeth differently from that of deciduous teeth. Mature teeth in infancy show adaptability even before they are used for mastication.

There are still significant gaps in our understanding of giant apes, colobus monkeys, folivorous cebids, gibbons, and lorises. Day-of-birth recordings or short-term longitudinal studies lasting only a few weeks or months may include incredibly useful life-history information for many species. All things considered, tooth eruption provides a great way to assess an individual's maturity as well as to compare the life cycles of different animals. It is necessary to recommend a procedure for re-evaluating dental homologies for upcoming research.

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**Conflicts of interest**

There are no conflicts of interest

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