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On the concept of heterodonty

SHIMADA, Kenshu*

Abstract

The term "heterodonty" has been described and defined in different ways. This study defines a heterodont dentition as one in which teeth are variable 1) in shape and size, 2) in size with a constant shape, or 3) in shape with a constant size. Function cannot be used as a criterion of heterodonty.

The basic mammalian dentition consists of four tooth classes: from mesial to distal in each jaw, incisors, canine, premolars and molars (e.g., Hillson, 1986). The underlying assumption of tooth-type identifications in mammals is that one can detect dental homologies among mammalian taxa. Some have attempted to trace dental homologies back to "mammal-like reptiles" (e.g., Ziegler, 1971; Osborn, 1973; Osborn and Crompton, 1973; Westergaard, 1980, 1983).

Dental homologies cannot be traced for mammals with "homodont" dentitions if the fossil record does not allow inferences about their dental evolution. Each tooth type can be identified in some fossil cetaceans, only because they retain some basic features characterizing heterodont dentitions of placental mammals (Peyer, 1968). Tooth identifications are impossible for modern toothed whales because of their increased tooth counts with a strong tendency toward homodonty (Peyer, 1968). Consequently, heterodonty permitted the idea of the possible presence of dental homology in mammals.

If "teeth" are defined loosely as hard structures occurring in the oral cavity or at the anterior portion of the digestive tract, "heterodonty" is not unique to mammals (and "mammal-like reptiles"). Depending on the definition of heterodonty, it is recognized in "agnathans" (lampreys: Potter and Hilliard, 1987), in chondrichthyans (many sharks: Compagno, 1984), in osteichthyans (*Sargus*: Parker and Haswell, 1964; Characidae: Bertin, 1958; *Chrysophys*: Komada, 1986), in amphibians (stegocephalians: Peyer, 1968), and in nonsynapsid reptiles (*Heterodontosaurus*: Crompton and Charig, 1962; *Uromastix*: Cooper *et al.*, 1970; notosuchid: Clark *et al.*, 1989). It can be argued that conodonts with a set of toothlike structures, consisting of several types of "elements" (Purnell and von Bitter, 1992; Purnell, 1993, 1995), are the oldest known chordates with heterodont dentitions (for the affinity of conodonts, see Aldridge and Purnell, 1996).

The terms "heterodonty" and "homodonty" have been described and defined in different ways. For example, in the classic work on comparative odontology, Peyer (1968: 17) described a heterodont dentition as one containing a number of distinguishable tooth categories, and a homodont dentition as one consisting "uniformly of teeth of similar shape". Edmund (1969: 124) described a heterodont dentition as one with teeth of "different sizes or shapes", and homodonty as a dentition consisting of teeth "approximately the same size and form". Hildebrand and Goslow (2001: 602) defined heterodont as "having several kinds of teeth", and homodont as "having one functional kind of teeth". Pough *et al.* (2002: 490) described heterodont as teeth "differentiated in size, form, and function", and homodont as teeth "virtually all the same size and shape, with no evidence of regionalization of function". Kardong (2002: 728) defined heterodont as a dentition "in which the teeth are different in general appearance throughout the mouth", and homodont as a dentition "in which the teeth are similar in general appearance throughout the mouth". Kardong's (2002) definitions may be sufficient to generalize a dentition, but

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* Environmental Science Program and Department of Biological Sciences, DePaul University, 2320 North Kenmore Avenue, Chicago, Illinois 60614, U.S.A.; and Department of Biological Sciences, University of Illinois at Chicago, 845 West Taylor Street, Chicago, Illinois 60607, U.S.A.

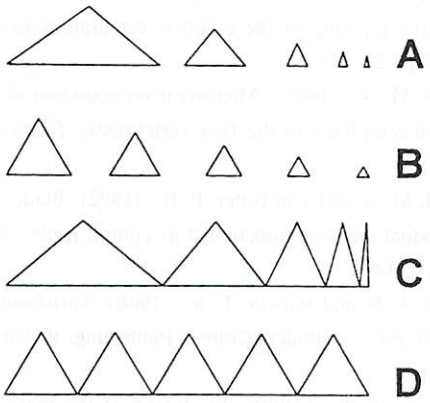

Fig 1. Types of heterodonty represented by hypothetical dentitions with five triangular teeth (in this example, tooth size = tooth height). A, shape-size heterodonty (variable shape and size); B, size heterodonty (variable size with constant shape); C, shape heterodonty (variable shape with constant size); D, homodonty (constant shape and size).

they are vague because of the ambiguity in the meaning of "appearance."

So, what makes the "appearance" of a dentition? The general appearance of dentitions stems from two components: shape and size (Fig. 1). A dentition is obviously heterodont, if both size and shape of teeth differ (Fig. 1A). However, a dentition can also be heterodont 1) in the absence of shape differences if size differs (Fig. 1B) or 2) in the absence of size differences if shape differs (Fig. 1C). Function, on the other hand, involves an interpretation of how each tooth works, and is derived secondarily from the size and/or shape of each tooth. Therefore, function is not a fundamental component that determines the "appearance" of a dentition, and it should not be used as a criterion of heterodonty and homodonty. Hence, heterodont (Figs. 1A-C) refers to a dentition with different sizes and/or different shapes of teeth, whereas homodont (Fig. 1D) is a dentition with uniform size and shape of teeth.

The traditional definition of heterodonty (or homodonty) often emphasizes shape, and not size (e.g., Peyer, 1968), possibly because the concept of heterodonty was developed initially for mammals. The use of terms such as "caniniform" and "molariform" in describing mammalian teeth exactly reflects the point that the shape is a primary variable traditionally defining heterodonty in mammals. Therefore, one may argue that mammalian dentitions are dominated by "shape heterodonty" (Fig. 1C). *Heterodontus*, a shark taxon with a heterodont dentition (Romer and Parsons, 1986, fig. 238), is an excellent example of "shape-size heterodonty" in nonmammalian vertebrates (Fig. 1A). However, the presence of many examples of variation only in tooth size in many nonmammalian vertebrates may indicate a possible dominance of "size heterodonty" in such vertebrates (Fig. 1B).

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