

## **THE DENTAL MODIFICATIONS IN ANCIENT UNTIL PRESENT INDONESIA A CHRONOLOGICAL EVIDENCE OF INDONESIAN RACIAL IDENTITY**

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### **Abstrak**

*Sejarah migrasi di Asia Tenggara telah menjadi subjek banyak spekulasi dengan memanfaatkan ciri-ciri morfologis rangka dan gigi manusia, perbandingan-perbandingan dan persebaran linguistic dan cultural, perbandingan-perbandingan genetika manusia, filogeni dan DNA kuno hewan-hewan dan tanaman-tanaman dan koevolusi bahasa dan genetika manusia. Menurut pola migrasi di Indonesia ini, kami telah mencoba juga untuk membangun hipotesis tentang sejaah rasial dan penghunian Kepulauan Indonesia sejak Neolitik sampai sekarang dari bukti modifikasi-modifikasi gigi yang pernah ditemukan di Indonesia. Penelitian ini bertujuan untuk menggambarkan modifikasi-modifikasi gigi yang pernah dilakukan di Indonesia berdasarkan bukti-bukti paleoantropologis-  
arkeologis. Di samping itu, penelitian ini juga telah menginvestigasi dan menunjukkan identitas rasial penduduk Indonesia dari Neolitik sampai sekarang. Bahan penelitian meliputi gigi-geligi tengkorak manusia dewasa yang berasal dari beberapa situs paleoantropologis-  
arkeologis di Jawa, Bali, Nusa Tenggara Timur, Sulawesi dan Papua, serta sampel gigi-geligi permanen isolatif populasi Bali modern. Metode-metode yang digunakan adalah metode deskriptif komparatif visual, dan penelusuran sumber-sumber pustaka arkeologis dan etnografis klasik. Sumber-sumber etnografis Indonesia yang*

*terkait dengan modifikasi-modifikasi gigi juga telah dihadirkan. Bukti-bukti ini telah diupayakan untuk menunjukkan kontinuitas modifikasi-modifikasi gigi di Indonesia. Fungsi-fungsi modifikasi gigi telah diupayakan untuk ditampilkan, baik yang terkait dengan ritus inisiasi maupun estetika. Para peneliti bermaksud untuk mengeksploitasi bahwa modifikasi-modifikasi gigi ini terkait dengan migrasi dan kronologi persebaran ras-ras manusia di Asia Tenggara ke Kepulauan Indonesia dan penghuniannya dari 4000 tahun yang lalu sampai sekarang. Ras-ras manusia ini adalah Australomelanesoid dan Mongoloid yang merupakan populasi-populasi utama yang menghuni kawasan ini.*

*Kata Kunci: modifikasi gigi, Indonesia, identitas rasial, Mongoloid, Australomelanesoid*

## **Introduction**

We will obtain a very broad knowledge when we always try to understand some aspects of human biology with all the practice with a look into the past. Glenner & Willey (1998) has asserted that:

“There are two ways of assessing the history of dentistry. One way is through historical documents and the other is through anatomical and archaeological specimens. Dental texts and journals provide a detailed perspective on the techniques and materials recommended, but they give only a partial story. Anatomical and archaeological specimens show that was actually being done rather than what was dictated by texts and authorities. These specimens, however, are rare and often poorly studied” (Glenner & Willey, 1998:75).

Interesting to consider what Jacob (1964) could have expected in his research result on finding of a human mandible from Anjar urn burial site, West Java:

“...we hope that further studies of archeological mandibles found in West and Central Java, and Bali, which hitherto have never been described, and further excavations in other parts of Indonesia to be carried out with special care to preserve skeletal remains, will shed much light on the evolutionary changes affecting the mandibles and dentition as well as on the origin of the Indonesians

and the migrational waves that occurred in western Pacific.” (Jacob, 1964: 425-426).

Here could be to associate that the archaeological and anatomical specimens, however, indicate more complexity and variety in dental modifications than period's dental literature. Dental modifications always have a very broad perspective (Williams & White, 2006). Why is that? Maybe we can answer with a simple, because this aspect of human biology has accumulated by their behavior in a very long period. The modification of human teeth has interested researchers in archaeology, ethnography, and anthropology since the early years of this century (mower, 1999). As awareness of the practice grew, through pioneering works in Americas, researchers began to see the importance of acknowledging the emerging patterns and intriguing inconsistencies demonstrated by dental remains altered deliberately during life. Larsen (1985) has been confirmed that non-dietary function is an important concern in the study of the human dentition and its role in adaptation. In fact, Reichart *et al.* (2008) have reported it. The dental mutilations were and are still common among people in Africa in 33 skulls from Cameroon which have been collected around the turn of the 20<sup>th</sup> century (anthropological collection, Berlin Museum of Medical History), were dental mutilations may result in alveolar bone pathology characterized by inflammatory changes such as periapical osteitis or formation of radicular cyst. The modifications to human teeth hold anthropological and social significance, and studying them helps to understand past and present human behavior from a geographic, cultural, religious, and aesthetic perspective (Gonzales *et al.*, 2010).

In paleoanthropological perspective, ancient humans are human populations had been living since the Late Pleistocene until several hundred years ago (Jacob, 1982, 1983). We can say as the study of ancient humans and their biological variation in the time and space. Like living people today and their ancestors hominids, they also live in and interact with its environment. They are the result of interaction between their genetics and environment. The genetics are genes that make up the genotype; and determine the characteristics, abilities, and direction of development. The human remains found in excavations and accidental findings in the field are their phenotype, which are the result of genotype and environment interactions. These phenotypes adapt to the environment in which they live. As cultural beings, they held bio-cultural adaptation; so in this case cooperation between archaeology and bioanthropology are very close (Indriati, 2001).

Culture also affects the biology, such as biology affects culture, and they exist together, both in human beings, as well as in society or prehistoric sites (Jacob, 1983).

Bioarchaeology is the study of prehistoric human behavior through the analysis of human skeletal remains from archaeological contexts (Indriati, 2001). It attempts to provide a biological perspective to archaeological examinations (Buikstra, 1997; Larsen, 1997), and central to bioarchaeological inquiry are the interaction between biology and behavior and the role of environment on health and lifestyle (Larsen, 2002). The study of human remains has generally been incorporated into biological anthropology; however, the bioarchaeological approach uses these methods and techniques to answer questions of archaeological significance (Torres-Rouff & Knudson, 2007). Using an interdisciplinary approach that incorporates methods and data from biological anthropology, archaeology, cultural anthropology, medical sciences, geography, history, and other related disciplines, bioarchaeologists analyze human adaptation and change (Buzon *et al.*, 2005). This approach enables more accurate assessment and interpretation of osteological and dental data (Perez *et al.*, 1997; Ubelaker, 1997; Ubelaker & Ripley, 1999; Bosch, 2000; Marcsik & Pap, 2000; Martin & Goodman, 2000; Steckel *et al.*, 2002; Armelagos & Van Gerven, 2003; Steckel, 2005; Walker 2005; Lambert, 2006; Pechenkina & Delgado, 2006; White *et al.*, 2006; Paine *et al.*, 2007). Frequently fragmented and poorly preserved, such ancient skeletons require extreme care during archaeological recovery and painstaking effort during reconstruction and analysis. The very rarity that makes such specimens inordinately valuable also places limitations upon the degree to which their attributes may be said to reflect a representative pattern for an extinct population (Buikstra, 1981). A more complete picture of the past results from combining multiple data sources and helps to counter the biases and limitations inherent in skeletal data (Goodman, 1993; Wood *et al.*, 1992). It allows for a unique opportunity to understand the dynamic interaction among environment, culture, and human biology (Martin & Goodman, 2000; Indriati, 2001).

As an integrative approach, bioarchaeological analyses are particularly appropriate for an examination of individual life histories (Torres-Rouff & Knudson, 2007). Larsen (2002) convinced that skeletons represent the most direct evidence of the biology past populations and their study provides insight into health and well-being, dietary history, lifestyle (activity), violence and trauma, ancestry, and demography. Therefore,

bioarchaeology affords the opportunity to discern the individual in prehistory as well as to provide unique insights into the individual and his or her agency, a crucial element in exploring societal structures (Meskell, 2000; Pechenkina & Delgado, 2006; Temple *et al.*, 2011).

More work that is contemporary has integrated concepts of dynamism and agency for local groups and views the process as one of reformulation. Cusick (1998) argues that acculturative models are particularly tools for undirected contact and syncretism. Acculturation studies in archaeology have generally focused on populations, however life history or osteobiographic studies can contribute to an understanding at the level of the individual (Torres-Rouff & Knudson, 2007). Lansing *et al.* (2007) explored linguistic and genetic variation in contact zone on the eastern Indonesian island of Sumba, where Neolithic Austronesian farming communities settled and began interacting with aboriginal foraging society's ca. 3500 years ago. Therefore, Knudson & Stojanowski (2010) looked at the bioarchaeological discipline like this with additional optimism, which as a discipline that bridges the biological and social sciences, bioarchaeology has much to contribute to a contextualized and theoretically sophisticated understanding of social identities. Even Tung (2008) has also given hope that bioarchaeology can also help to explain migration and diaspora populations within and between regions.

Bioarchaeological researches in Southeast Asia, especially with regard to human evolution and migration, increasingly attracting the interest of scientists. Tayles & Oxenham (2006) once said something like this:

“Despite the fame, or even notoriety, of some of the earliest hominin specimens in Asia. Southeast Asia as a region has been relatively invisible in the broader sweep of world prehistory and in the centres of bioarchaeological research in Europe and North America. Beyond the Indonesia fossils, Southeast Asia and the Southwest Pacific have unique characteristics which will mean that research on the area will not only clarify about regional prehistoric peoples but also contribute to an understanding of prehistoric human biology worldwide.” (Tayles & Oxenham, 2006:2).

Domett *et al.*, (2011) have reported the findings of intentional dental modification for the first time Cambodia in two late prehistoric sites, namely Phum Snay and Phum Sophy ca. 2500 to 1500 BP. The bioarchaeological research is relatively new for this region, and this study significantly adds to our reconstruction of past behaviors in mainland Southeast Asia. The skeletal samples combine both excavated material and large looted collections in the form of ossuaries. People from Phum Sophy and Phum Snay had similar rates of anterior maxillary dental ablation, 60 and 47%, respectively, and 21.4 and 7.7 %, respectively, in the mandible. Patterns of ablation most commonly involve the removal of the maxillary lateral incisors. Intentional filling was less common than ablation but affected Phum Snay and Phum Sophy individuals to a similar level (4-7%). Filing was also restricted to the anterior dentition, and a range of patterns were evident, many involving filing of the mesial and distal aspects of the crown of the upper and lower incisors and canines to give a pointed appearance. Patterns of ablation or filing were not strongly associated with a particular sex or age group. However, a limited number of ablation and filing patterns were exclusive to each site. They have also been discussed the significance of this practice in relation to rites of passage, status, community and family relationships, and trauma. Here shown suggesting a unique cultural behavior for this region.

This paper aims to describe the dental modifications that have been done in Indonesia basen on paleoanthropological-archaeological evidences, and especially use tool of bioarchaeological approach. On the other side, this research has also investigated and showed the racial identity of the Indonesian population from Neolithic to the present times. This study may have significance for health and forensic identification. The bioarchaeological approach uses these methods and techniques to answer questions of archaeological significance. Indonesian ethnographic sources related to dental modifications are also presented.

Paleoanthropological-archaeological evidences and the sources of this ethnographic literature have attempted to bring continuity dental modifications in Indonesia. The functions of dental modifications also have attempted to be expressed, whether in relation to the initiation rites and aesthetics. We also intend to exploit thst these dental modifications, which are a cultural product, related to migration and the chronology of the spread of human races from Southeast Asia to the Indonesian Archipelago and the peopling around 4000 years ago until now. We are flattered the arguments that have

been shown blench (2008) that a combination of archaeological finds, textual records and ethnographic practice make it possible to support particular historical trajectories in Southeast Asia. Some cultural practices have been associated with specific linguistic family, for example, is tattooed with the Austronesian speakers, as a means to define their cultural treasures, and, in turn, provide arguments for this diffusion practice (Bellwood, 2004). Mower (1999) further strengthen these statement that good preservation rate of teeth also provides the archaeologists with a source of information that may be the only remaining part of an interred individual, and this factor alone is a strong argument for a greater emphasis on this area of dental studies as a means of drawing conclusions regarding socio-cultural behavior in the past and approaching motivational factors in the interpretation. Mower (1999) also increasingly strengthens the efforts that this type of interpretative work is only possible with the assistance of studies conducted in related fields such as anthropology and ethnography.

We assume that human beings as biological products and processes and the environment, both a-biotic, biotic and socio-cultural environment, surely can not necessarily be viewed only as a purely biological or socio-cultural product and process. Often a single view of the phenomenon can thus potentially drown the facts in it are actually very helpful in providing a very broad and deep interpretations.

## **Material and Methods**

The research materials are permanent teeth of adult skull of Java, Bali, East Nusa Tenggara, Celebes, and Papua prehistoric population from some paleoanthropological-archaeological sites. Some permanent isolation teeth of modern Balinese population are also used as a comparison, although it is not being presented explicitly. The anatomical identification is based on standardization of physical anthropology and anatomy. Sequence of its antiquity, chronology of settlement and culture, and its biologic affinity were related to Jacob (1967, 1974), Sukadana (1970, 1979, 1981, 1984), and Boedhisampoerno (1982, 1985). Environmental and cultural context can give a broader inference (Schiffer, 1976). Destinction of environment and cultural practices will result in physical distinctions that manifested on its bone and teeth (Swedlund & Wade, 1972).

The first method is visual comparative descriptive research (Swedlund & Wade, 1972; Larsen, 1985; Hilson, 1996). These selected material are observed, classified, and compared, i.e. unmodified teeth were compared with modified teeth. Then, these teeth were compared by the modification treatment patterns. At this phase, we used modified teeth of modern population that its practice still being done in Bali. Here it was needed to emphasize those paleoanthropological-archaeological materials which come from prehistoric human remains is limited in quality and in quantity, which needed special treatment in its handling, analyzing, and interpretations (Jacob, 1967, 2000; Sukadana, 1983, 1984). The second method was browsed chronologically in previous such as archaeological reports and the first ethnographic reports that reported about that reported about practices of dental modifications, particularly in Nusantara/ Indonesian ethnic groups.

### **Result and Discussion: Indonesian Racial Identity**

Dental modifications have been done since thousand years ago in America, part of Asia especially eastern and southeastern parts, Pacific, and Africa (Uhle, 1886/1887; Lignitz, 1919/1920, 1921/1922; Faslicht, 1976; Briedenhann & Reenen, 1985; Sawyer & Allison, 1992; Hilson, 1996; Turner, 2000; Jones, 2001; Takenaka

*et al.*; Ellis & Arubaku, 2005; Adachi *et al.*, 2006; Coppa *et al.*, 2006; Dewhurst & Mason, 2008; L'abbe *et al.*, 2008; Gonzales *et al.*, 2010), and Europe (Arcini, 2005), even in remoted island as Carribea (Handler *et al.*, 1982), and Maldives (Fitton, 1993). Teeth have non-alimentary functions and as artifact of human behavior among some prehistoric populations (Molnar, 1972; Larsen, 1985; Miqnaire, 1987; Milner & Larsen, 1991). Ninozzi *et al.* (2008) described as non-alimentary tooth use in prehistory at Early Holocene in Central Sahara (Uan Muhuggiag, Tadfart Acacus, Libya). White *et al.* (1997) described a prehistoric Native American mandible from a Fremont site (ca. AD 1025) in Colorado has a colonial pit in the worn occlusal surface of the lower right canine. Natural causes for this modification are ruled out by the presence of internal striae, a finding confirmed by experimental replication. The canine was artificially drilled before the individual's death and is associated with a periapical abscess. This is one of a very few examples of prehistoric dentistry in the world, and the first from the American Southwest.



Mouth means as the main social organ (Scott & Turner, 1997). With mouth, people do not only communicate but also interact through smile. Smile or laugh means to show a series of teeth that means that social organ. That is why the teeth are always being the target of modification. Modified teeth are often the series of six upper and lower teeth consist of two left and right incisors and canines. Sometimes the first premolar is also modified. This is due to the six teeth that are obviously seen when people speak or smile.

There are some reasons to people modified their teeth. Von Jhering (1882) and Scott & Turner (1997) identified dental modifications are related to aesthetic functions. Finucane *et al.* (2008) reported the earliest securely dated evidence for intentional dental modification in West Africa from human remains 11 individuals were recovered from the sites of Karkarichikat Nord and Karkarichikat Sud in the Lower Tilemsi Valley of Eastern Mali in Late Stone Age (ca. 4500 – 4200 BP). The dental modification involved the removal of the mesial and distal angles of the incisor, as well as the mesial angles of the canines. The modifications did not result from task-specific wear or trauma, but appear instead to have been produced for aesthetic purposes. All of the filed teeth belonged to probable females, suggesting the possibility of sex-specific cultural modification. Haour & Pearson (2005) reported prehistoric dental modification in the region comes from Kufan Karawa, Niger (ca. AD 1300 – 1600), that the modification takes the form of interproximal grooving of the maxillary incisors resulting from task-related wear. According to this topic, Romero in 1970 wrote a scale of dental filing and its variation (Scott & Turner, 1997; Hilson, 1996). Concept of beauty, which is deeply related to modification of teeth, is very varied that depends on each culture. A culture considers that teeth reveal is beautiful and pretty, maybe the other culture does filing, chipping, staining, banding, and inseting. Another group of culture considers that their white teeth are not beautiful, but the black teeth that are beautiful so that they color their teeth. The most common habit in coloring teeth use beetle-nut-chewing.

The modifications of anterior teeth for cosmetic purposes have been documented in many cultures. These practices found in Africa, America, East Asia and Pacific (Molnar, 1972; Kennedy *et al.*, 1981; Vukovic *et al.*, 2009). Practice of the filing of anterior teeth for cosmetic purpose is the most common in Mesoamerica. In the research to Flores cranial series (Koesbardiati & Suriyanto, 2007a, 2007b), filing of the anterior teeth is found out in all individuals at the six archaeological sites. The filling teeth are the two incisors to left

and right canines. There is also found out other filling teeth at Liang Toge (LT), Liang X (LX), and Gua Alo (GA), that is labial grinded teeth. On labial filing, the surface of the teeth is filed horizontally so that causing extensively grooved surface. Teeth attenuation is done on upper and lower groove so that causing concavity impression on the surface of the teeth especially on the four maxillary incisors. Such labial filing is also found in Asia and Micronesia (Sangvichen, 1966; Ikehara-Quebral & Douglas, 1977) even in Europe (Arcini, 2006). At the both place, labial filling function aesthetically and for definite status.

Beside aesthetic function, modifications of teeth also function as initiation rite for male or female youths encountering mature age that alsomeans entering marriage (Wilken, 1912; Whittaker, 1984; Fitting, 1989; Sawyer & Allison, 1992; Takenaka *et al.*, 2001; Zumbroich, 2009), and means of status and belief (Baba & Kay, 1989; Drugan & Downer, 2005; Tayanin & Bratthall, 2006; Willis *et al.*, 2008). Tiesler (1999) indicated installing jadeite, hematite, pyrite, turquoise and different organic substances were used as obturation material in Classic Mayan inhabitants (Guatemala, South America) as sign maturation for their member (a certain person aged 15 old years). Takenaka *et al.* (2001) investigated five skulls (all male, young adult-mature) out of 49 Jomon skulls. They found the presence or absence of broken roots and root fragments (right and left I<sup>1</sup> - P<sup>1</sup>) in the alveolus resulting from ritual tooth ablation and from this it can be speculated that Jomon people used the traumatic method to knock out teeth during ritual tooth ablation. This ritual initiation is also done when a family encountering a mourning. The tradition of mourning is signed by mutilating teeth (Uhle, 1886/1887; Walken, 1912).

Tradition of dental modifications widely spreads in various tribes of Indonesia (von Jhering, 1882; Wilken, 1912). The tradition is done as aritual in human life time that is commonly done at time preparation for marriage age. There is also evidence indicating that dental modification is also done when there is a death in a family so that the moment is also considered as tradition of mourning. This indication is also seen in Kedu, Bengkulu, Sula Island, Selayar Island, and Alfuru at Minahasa (Wilken, 1912). The inhabitants are only allowed to do tradition of dental modification if one of the closest family's members had past away; and especially in Selayar Island, a women does the tradition of mutilating teeth (dental ablation) if her baby pass away in the same of or soon after the baby is born and in the same time of the day of the fiance's death. At such moment, they cut the mandibular (lower jaw) teeth. If it is done when the closest family member is still

alive, it is considered that it will cause deaths for the family members. The next patterns of modification are the common repeal that found in individual from Liang Bua (LB), Lewoleba (LL), and Melolo (ML) . The Extraction teeth (dental evulsion) are the left and right lateal incisor. According to the spoken tradition, such modification had been extinct from several years ago. They extracted their teeth as sign of mourning and initiation for youths that entering marriage age, or culturally for a boy who become adult. People states that the tradition in Manggarai is that the tooth is not extracted but it is broken (ablated) to the root of the tooth and then it is filed. The same pattern is also found in Polynesia (Wilken, 1972); and in Melanesia aswell as Australia (von Jhering, 1882). In the areas, broken and extracted teeth ritual is aimed as mourning ritual. Here is seen how tightthe rule of tradirion in this community.

Practice of dental modifications is known at prehistoric of Indonesia as astyle of culture that has been followed by some regions on the level agricultural began. Someskeletons from Gilimanuk (Bali) indicate ablating at incisors, canine and first molar teeth on upper jaw and lower jaw, on skeleton R. XXVII and R. XXXII (Soejono, 1977).Such pattern of modification is also found in Minahasa (Wilken, 1912). Dental modification are also existed in findings complex of the Flores and Around. It is reported that several individuals from various paleoanthropological-archaeological sites in Flores had tradition of dental modification with various patterns (Jacob, 1967; Sukadana, 1966, 1970, 1981, 1984; van der Plas, 2007; Koesbardiati & Suriyanto, 2007a). Du Bois (1944) noted, which the residents of Alor (an island opposite east of Flores) hold initiation to the youths entering marriage age. Extraction is done to both upper and lower jaw incisors. Part of this repeal, the tongue will be seen when the mouth opens, although the teeth is closed. This is related to individual attractiveness. However, Jacob (1967) states that the residents often grind their incisor teeth and fang teeth into sharp-pointed. The practice is done even opening the dentin. Sharping-pointed is also found in Bali, i.e. findings from prehistoric Semawang (Koesbardiati & Suriyanto, 2007a, 2007b). It is presumed that sharping-pointed teeth means as certain social status or as a membership of certain group (Whittaker, 1984; Haour & Pearson, 2005; Finucane *et al.*, 2008). The patterns of central incisors have been modified into a V-shape found at Iron Age skeletons from Pilanesberg site, South Africa (L'abbe, 2008).

Teeth-blackening (dental coloring) is a primitive method of caries prevention, and which was formerly an important life cycle event across in Southeast Asia (Flynn, 1977; Zumbroich, 2009). The life cycle event began to be practiced from around puberty as a preliminary to marriage that visually marking the transition from child to adult; and offering teeth blackener to a girl could, however, also be a very direct way to indicate sexual interest. Based on archaeobotanical reports from areca nut (*Areca catechu* L.) residues those were guessed as the ingredients of betel chewing aged 13000 BP (Zumbroich, 2007/2008). The oldest teeth with stains identified in Southeast Asia belong to the skeletal remains of an approximately 4500 year old Neolithic burial in the Duyong Cave on the west coast of Palawan Island, Philippines, though neither the botanical source nor the cultural context of these colorations has been explained with any certainty (Zumbroich, 2009).

Dentitions of 31 individuals excavated from Bronze Age site of Nui Nap (Thanh Hoa province, Vietnam) were examined for the presence of *Areca catechu* (betel nut) (Oxenham *et al.*, 2002). Blench (2008) confirmed that this is a common practice in Vietnam (an Austroasiatic-speaking people) based on archaeological and ethnographic evidences. Many of the teeth of the Vat Komnou cemetery (date between 200 BC and AD 400 or the early historic period in the Mekong delta, Angkor Borei, Cambodia) show evidence of betel staining (Pietruszewsky & Ikehara-Quebral, 2006). The one practice which most commonly contributed to darkened teeth in Southeast Asia was chewing a betel quid, typically prepared by wrapping slivers of the seed of the areca palm (*Areca catechu* L.) with slaked lime (*calcium hydroxide*) in a betel leaf (*Piper betle* L.) (Rooney, 1993; Zumbroich, 2009).

Dental coloring is also found in other areas such as Polynesia and Micronesia even in Indonesia Archipelago such as Sumatra, Nias, Borneo, Java, Madura, Bali, Flores, Timor, Papua, and other remote islands (Senn *et al.* 2009; Zumbroich, 2009). The coloring uses chalk, *pinang* (*Areca catechu*), *gambir* (*Uncaria gambir* Roxburgh) and *sirih* (*Piper betle*). Papuan inhabitants made alternative several plant species i.e. *openg* (*Exocarpus latifolius*), *tawal* (*Celastraceae* sp.), *sambiwal* (*Erythroxylum ecarinatum*), *ntuo* (*Cryptocaria nitida*) and *agya* (*Endiandra Montana*) (Susuarti, 2005; Zumbroich, 2009). The mixture of *sirih pinang* with saliva generate brownish red on the teeth. To smooth all over the teeth, it is used tobacco (*Nicotiana* sp., L.) stroked

all over the surface of the teeth. Once chewing *sirih pinang*, the stoke of the tobacco is done twice to five times. The intensity can leave carving on the teeth. Other variant that is found in Manggarai is using certain wood to black the teeth. Tradirion of coloring teeth is existed until nowadays as honor sign for guest and part of tradition in Manggarai (Suriyanto *et al.*, 2008). Tayanin & Bratthall (2006) reported that Kammu women in Laos and Vietnam Habitually paint their teeth black with *Cratoxylum formosum* and *Croton cascarilloides* wood that purposed to be beautiful and caries-free, and it now known only among the elderly although this practice existed for many generations. Suddasthira *et al.* (2006) also reported their experiment to that habitually practiced in Thailand people, this tradition was practiced around 5000 – 4000 years ago based on archeological remains. Nguyen (1990) and Nguyen (2006) observed and reported the habit of applying black lacquer to teeth is widespread in Vietnam and its effect on incidence of dental caries and its usefulness in caries treatment. In ancient migration and peopling in Southeast Asia, Zumbroich (2009) indicated for example i.e. empyreumatic oil of coconut is attested as a blackener for Austronesia speakers in island Southeast Asia, for Mon-Khmer speakers in Vietnam and for Daic speakers in Thailand, potentially indicating the diffusion of this approach over a wide area.

Von Jhering (1882) found tens pattern of dental modifications, but Hillson (1996) only found basically 7 pattern. Uhle (1886/1887) found 17 dental modification forms that dispersed in Indonesian ethnic groups. Broadly, Lignitz (1919/1920, 1921/1922) described African ethnics practiced the tradirion, both ethnographic and physical anthropological perspective, and indicated their 25 dental modifications. Mesmerize the description by Wilken (1912) mentioned areas in Indonesia also practiced this tradition; especially areas occupied ethnics have or mixed Mongoloid elements. Clearly, von Jhering (1882) described the tradition found in Africa, Indonesian Archipelago and surroundings have mongoloid elements, and Indian ethnics in America. The oldest dental modification had been finding in Asia (Artaria, 2009). The tradition also found in Javan living population at some decades ago, and the remains are still alive at isolated villagers (Lie, 1966; Sukadana, 1966; Suriyanto & Koesbardiati, 2007c). Pinborg *et al.* (2006) reported in Central Java and on the island of Bali 779 and 437 villagers respectively, and found in Java 81.1 % of the males and 99.2% of the females showed dental mutilations in the form of grinding the incisal and vestibular surfaces of the maxillary incisors and canines; while in Bali 91.3%

for males and 96.6 % for females. In Java as well as on the island of Bali most of the mutilations had been subjected to artificial staining (dental filing). They also have found a relief in Borobudur temple (built about AD 300) possibly depicting the performance of a dental mutilation. Together with the extraction, filing, and metal decorations of teeth, the process of teeth blackening was considered yet another form of dental mutilation (Romero 1970, Milner & Larsen 1991, Tayles, 1996).

Dental modifications indicated as cultural and biological affiliation (Koesbardiati & Suriyanto, 2007a, 2007b, 2007c). Milner & Larsen (1991) and White *et al.* (1997) called teeth as artefacts of human behavior. Von Jhering (1882) and Lignitz (1919/1920) documented amongst pre-colonial West African population as a sign of group affiliation, and Haour & Pearson (2005) was in fact thought such a reliable indicator of African culture that its identification in New World burials was argued to be the marker of recent African immigration. Here, the teeth also told to us about tale of migration and slavery (Handler, 1994; Tiesler, 2002; Wilford, 2006). Koesbardiati & Suriyanto (2007a, 2007b) is identified that there are two pattern of dental modification at Flores cranial series that presumed having different cultural background or it had been influenced by another culture. The first group is group of cultures with labial grinding teeth. The group consists of group of population from Northern Flores (Liang Toge, Liang X, Gua Alo) that have similarity of modification pattern with group of culture from Western Flores and western parts of Indonesia. For example, Balinese societies, as far as now, still hold teeth filing as part of belief and culture (Jensen & Suryani, 1996). On the other hand, pattern of dental modification with extracting is found in group of culture of Southern Flores (Liang Bua, Lewoleba, Melolo) that have similarity with culture of Adonara and Larantuka of Eastern Flores to Australia. As previously explained, culture of Alor (an island opposite east of Flores) shows pattern of teeth extracting with the same component of teeth. The comparison of dental modification on Flores's culture with other cultures outside Flores gives information on dynamics of cultural groups of Flores.

Australomelanesoid and Mongoloid are main populations that inhabit Indonesian region. Australomelanesoid and Mongoloid inhabitants have the dental modification methods and pattern, although exactly the first is influence mongoloidiation that more beginning in Indonesia region (Koesbardiati & Suriyanto, 2007a). Racial determination (=biological affinity) included important on Indonesian peopling history, paleoanthropology, human

genetics, archaeology and anthropology because on the present beginning racialization (ca. 15000 – 10000 years ago), gradually racial distribution changed, and there is an interconnected with many cultural aspects (Jacob, 2006a). Certainly, there are indicating that many cultural and biological aspects are unity (indriati, 2001; Richerson & Boyd, 2005; Molleson, 2007). That is clarified by Foley & Donnelly (2001), that the disciplines need integrative recitation from many disciplines, both social-cultural and natural-exacta sciences.

Some paleoanthropological findings in Indonesia indicated that there are two racial groups: Australomelanesoid and Mongoloid. It has been recognized that at the end of Late Pleistocene, Australomelanesoid inhabited Southeast Asia and dispersed to the eastern and southern part of Indonesia (Jacob, 1967, 1974, 2006a, 2006b; White & Allen 1980). Besides that, prehistoric migrations in Southeast Asia have been the subject of much speculation by using skeletal and dental morphological traits (Jacob, 1967a, 1967b, 1974; Pietrusewsky, 1981, 1992, 1994, 2006a, 2006b, 2007; Turner, 1987; Jacob & Supriyo, 1994, 2005; Matsumura & Majid, 1999; Matsumura & Hudson, 2005; Hanihara, 2006; Matsumura, 2006; Widiyanto, 2006; Koesbardiati & Suriyanto, 2007c; Matsumura *et al.*, 2008), linguistic and archaeological comparisons (Blust, 1996; Bellwood, 2000, 2006; Diamond & Bellwood, 2003; Szabo & O'Connor, 2004; Adelaar, 2005; Tryon, 2006; Spriggs, 1998, 2007), human genetic comparisons (Ballinger *et al.*, 1992; Melton *et al.*, 1995; Skykes *et al.*, 1995; Melton *et al.*, 1998; Lum *et al.*, 1998; Su *et al.*, 2000; Capelli *et al.*, 2001; Chow *et al.*, 2005; Cox, 2005), ancient animal genetics and Lapita cultural complex dispersal (Lum *et al.* 2006), phylogeny and ancient DNA of *Sus sp.* (Larson *et al.*, 2007), and language and human genetic co-evolution (Lansing *et al.*, 2007), and even combinations of these efforts (Cavalli-Sforza *et al.*, 1988; Nei, 1995; Oppenheimer & Richards, 2001a, 2001b; Hurles *et al.*, 2003; Bulbeck, 2008; Peterson, 2009; Donohue & Denham, 2010; Peng *et al.*, 2010). Other efforts have been made even against the bacteria in relation to knowing these migrations, with assumption that the pathogenic bacteria are always present in the human (population) body, and carried to where they move, and move from one place to elsewhere, and even continued to be transmitted to other populations in subsequent contacts either directly or indirectly (Moodley *et al.*, 2009; Renfrew, 2009; Yamaoka, 2009; Koesbardiati & Murti, 2011). At the end of the Late Neolithic and Paleometallic, the polarization of the racial became more apparent. The element of

Australomelanesoid were stronger in the east and south of Indonesia. On the other hand, the elements of Mongoloid developed stronger in western and northern part of Indonesia. Based on some characteristics of paleoanthropological populations, it indicates that the Mongoloid came from the mainland Asia and pushed the Australomelanesoid to the most eastern Indonesia (Jacob, 1967, 1974, 2006a, 2006b; Sukadana, 1970, 1981, 1984; Sukadana & Wangania, 1977; Glinka, 1978, 1981, 1993, 2008; Glinka & Koesbardiati, 2007; Koesbardiati & Suriyanto, 2007c).

According to the patterns of migration in Indonesia, the assumption can be built based on these patterns of dental modifications (Koesbardiati & Suriyanto, 2007a, 2007b, 2007c). The Patterns of dental modification that was disappeared earlier are the oldest patterns that have ever been practiced in Indonesia. Other side, the youngest patterns or the newest influence are the patterns that existed in longer time and it could be practiced until now. Population dynamic, intensity of population's interaction and isolated or un-isolated population, can influence this.

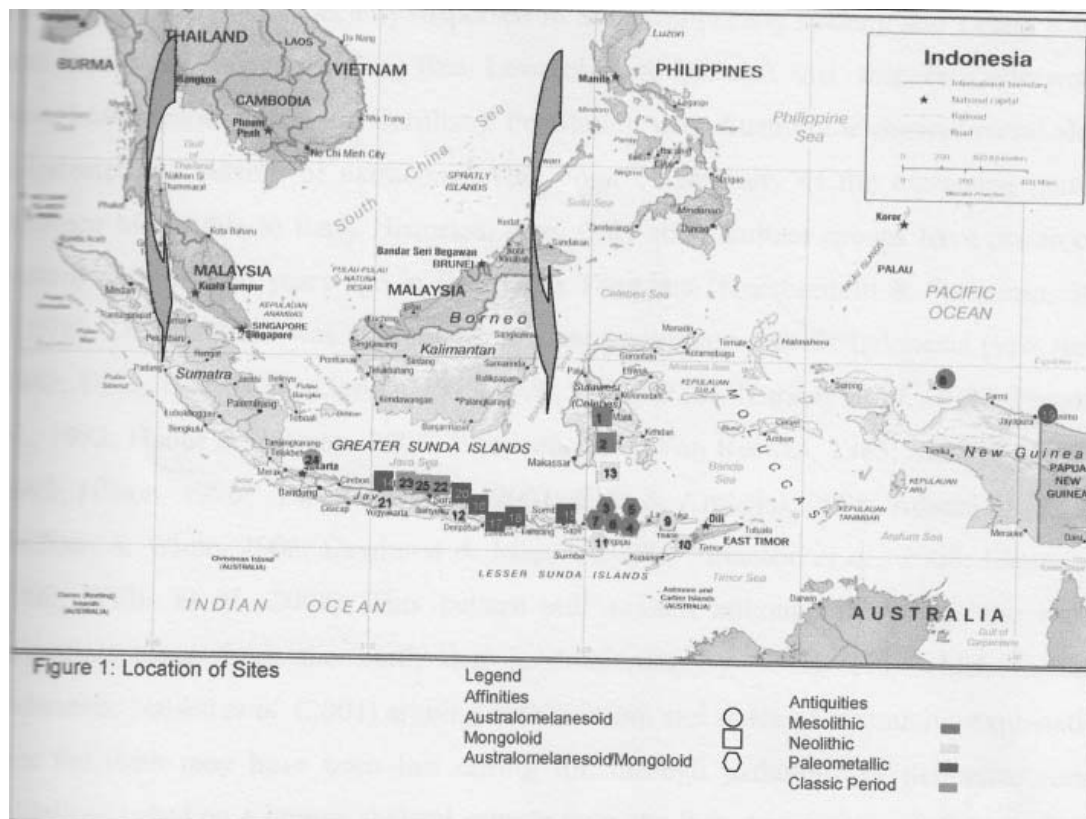
Table 1 and Figure 1 show the variety of pattern of dental modifications around Neolithic to present Indonesia. There are six patterns of dental modifications, which are practiced in Indonesia. There are occlusal dental filing, labial filing, labial, and lingual filing, and sharpening (dental ablation), extracting (dental evulsions) and blackening (dental coloring). Dental filings (dental ablations) are a common trait, involving the reshaping of the anterior teeth by filing into points, or by the removal of the incisive edges, and this process can lead to exposure of the dentine, resulting in medical complications; and dental evulsions often associated with initiation rites, and dental evulsions can involve the removal of any number of deciduous or permanent teeth; and dental colorings are a practice common in Southeast Asia, usually involving blackening or other such discoloration, thought to be derived from a desire to differentiate humans from animals (Hobart *et al.*, 1996; Whittington & Reed, 1998; Mower, 1999). The most common pattern is occlusal filing, followed by blackening, labial filing, extracting and sharpening.



**Table 1. The antiquities, biological affinities and patterns of dental modification in around Neolithic to present Indonesia**

No	Series	Antiquities <sup>1</sup>	Biological affinities <sup>2</sup>	Patterns of dental modification
1	Leang Cadang	Mesolithic	Mongoloid	Filing (occlusal I-C), extracting (maxilla I <sup>2</sup> -C, right/left), and blackening
2	Leang Karassa	Mesolithic	Mongoloid	Filing (occlusal I-C), extracting (maxilla I <sup>2</sup> -C, right/left), and blackening
3	Liang Momer	Mesolithic	Australomelanesoid/ Mongoloid	Filing (labial and occlusal I-C, right/left)
4	Liang Toge	Mesolithic (3550±525 BP)	Australomelanesoid	Filing (labial and/ lingual and occlusal I-C, right/left), and blackening, and sharpening (?)
5	Liang Bua	Mesolithic (3390±270 BP)	Australomelanesoid/ Mongoloid	Filing (occlusal I-C, right/left), extracting (maxilla I <sup>2</sup> -C, right/left), and blackening
6	Gua Alo	Mesolithic/ Neolithic	Australomelanesoid/ Mongoloid	Filing (labial I-C, right/left)
7	Liang X	Mesolithic/ Neolithic	Australomelanesoid/ Mongoloid	Filing (labial and occlusal I-C, right/left)
8	Biak	Mesolithic to Early Neolithic	Australomelanesoid	Filing (occlusal I-C, right/left)
9	Lewoleba	Early Neolithic (2990±160 BP)	Australomelanesoid/ Mongoloid	Filing (occlusal I-C), extracting (maxilla I <sup>2</sup> -C, right/left), and blackening
10	Gua Oelnaik	Early Neolithic	Australomelanesoid/ Mongoloid	Filing (occlusal I-C), extracting (maxilla I <sup>2</sup> -C, right/left), and blackening
11	Melolo	Neolithic	Australomelanesoid/ Mongoloid	Filing (occlusal I-C), extracting (maxilla I <sup>2</sup> -C, right/left), and blackening
12	Puger	Neolithic	Australomelanesoid	Filing (labial I-C, right/left), and sharpening
13	Selayar	Neolithic	Mongoloid	Filing (occlusal I-C, right/left)
14	Plawangan	Paleometallic	Mongoloid	Filing (labial and occlusal I-C, right/left), blackening, and sharpening
15	Ntoto Leseh	Paleometallic	Mongoloid/ Australomelanesoid	Filing (labial and occlusal I-C, right/left)
16	Gilimanuk	Paleometallic (1500 - 2000 BP)	Mongoloid	Filing (labial and/ lingual incisal I-C, right/left)
17	Semawang	Paleometallic	Mongoloid and Australomelanesoid	Filing (labial and occlusal I-C, right/left), blackening, and sharpening
18	Gunung Piring	Paleometallic	Mongoloid	Filing (occlusal I-C, right/left)
19	Sentani	Paleometallic	Australomelanesoid	Filing (occlusal I-C, right/left)
20	Muncar	Paleometallic (1500 - 2000 BP)	Mongoloid	Sharpening (I <sup>1</sup> -I <sup>2</sup> )
21	Wonosari	Neolithic to Megalithic	Australomelanesoid	Filing (occlusal I-C, right/left)
22	Slompretan	Early historical era (1000 BP)	Mongoloid/ Australomelanesoid	Filing (occlusal I-C), extracting (maxilla I <sup>2</sup> -C, right/left), and blackening
23	Bancar	Classic period (300 - 500 BP)	Mongoloid	Filing (occlusal I-C, right/left)
24	Kelor	Classic period (100 - 600 BP)	Australomelanesoid	Filing (labial and occlusal I-C, right/left), and blackening
25	Caruban	Classic-Islam period	Mongoloid/ Australomelanesoid	Extracting (I-C, right/left), and blackening

Notes: 1). Jacob (1967, 1974), Soejono (1969), Sukadana (1981, 1984), and Sukadana & Wangania (1977).  
 2). Jacob (1967, 1974), Sukadana (1981, 1984), and Sukadana & Wangania (1977), and also recent reobservation by the researchers.



Sharpening is the pattern that was practiced by the populations with the antiquity from Mesolithic Age (Liang toge) until Paleometallic Age (Puger, Plawangan, Semawang, Muncar). The pattern also found in Africa at Iron Age (Haour & Pearson, 2005; Finucane *et al.*, 2008; Labbe *et al.*, 2008). This tradition has been practicing in Mentawai, include Siberut Island (Koerniati, 2004). Considering the result of the research conducted by Sudoyo (Adi, 2006) that the possibility of Indonesian's gene pool was from Mentawai population, it is clear that sharpening could be assumed as one of the oldest pattern of dental mutilation in Indonesia. At that time, Australomelanesoid as the racial element in Indonesia (Jacob, 1967, 1974, 2006a, 2006b; Sukadana, 1970, 1981, 1983; Sukadana & Wangania, 1977; Glinka, 1978, 1981, 1993; Glinka & Koesbardiati, 2007) inhabited Indonesia. This tradition did not spread broadly in Indonesia, it could be caused by population isolation therefore sharpening was not continued successfully.

Extracting was pattern that could be contemporaneous with the sharpening. The pattern of extracting, especially dispersed in Sulawesi (Leang Cadang and Leang Karassa)

and East Nusa Tenggara (Liang Bua, Lewoleba and Melolo), that dispersed afterwards to Java Island (Slompretan and Caruban). Population with Australomelanesoid racial element dominated the pattern of extracting. The range of antiquity of the extracting pattern is between Mesolithic to Early Historical Age. Only some culture groups have practiced the pattern until several years ago in East Nusa Tenggara (Koesbardiati & Suriyanto, 2007a, 2007b). This tradition was also found in some population outside Indonesia (von Jhering, 1882; Uhle, 1886/1887; Lignitz, 1919/1920, 1921/1922; Kennedy *et al.*, 1981; Handler *et al.*, 1982; Haour & Pearson, 2005; Briedenhann & van Reenen, 1985; Sawyer & Allison, 1992; Hilson, 1996; Takenaka *et al.*, 2001; Ellis & Arubaku, 2005; Adachi *et al.*, 2006; William & White, 2006; Dewhurst & Mason, 2008; Finucane *et al.*, 2008; L'abbe *et al.*, 2008; Willis *et al.*, 2008). This pattern still existed although there was the wave of migration came from the north that is dominated by Mongoloid, which influenced Indonesia. Nelsen *et al.* (2001) arguing with caution, and states an alternative explanation is that the teeth may have been lost during life through pathology or deliberate removal (ablation) based on a human skeletal sample from the Iron Age cemetery of Noen U-Loke (ca 200 BC – 500 AD) in Thailand has a very high prevalence at 79 % of adults with at least one incisor missing in either maxilla or mandible.

The labial (incisal) filing pattern developed along the north Coast of Flores Island until Bali Island and Java Island. In this pattern, including labial (incisal) and lingual filing (bifacial ablation), as shown in Gilimanuk's series and Liang Toge's series. We also found this pattern on the sole Australomelanesoid individual (R. IV SMW/88), the individual is adult female based on the morphological characteristics, in Semawang's series. The range of the antiquity of this pattern was Mesolithic to Classic age. Based on the biological affinity, these populations were influenced by the mongoloidization (Jacob, 1967, 1974, 2006a, 2006b; Sukadana, 1970, 1981, 1984; Sukadana & Wangania, 1977; Glinka, 1978, 1981, 1993, 2008; Glinka & Koesbardiati, 2007; Koesbardiati & Suriyanto, 2007c). This pattern developed in the same period with the teeth-blackening pattern (Sangvichen, 1966; Flynn, 1977; Susiarti, 2005; Suddhasthira *et al.*, 2006; Koesbardiati & Suriyanto, 2007a, 2007b). The teeth blackening were more common and have been practicing until now compare to the labial (incisal) filing pattern (Lie, 1966; Sukadana, 1966; Nguyen, 1990; Susiarti, 2005; Suddhasthira *et al.*, 2006; Tayanin & Bratthall, 2006; Koesbardiati & Suriyanto, 2007a, 2007b, Suriyanto *et al.*, 2008; Zumbroich, 2009). It is assumed that

this pattern was influenced by the change of the meaning of sirih pinang chewing. Sirih pinang chewing means healthy teeth, in the other hand, sirih pinang chewing means also ritual and magic; and nowadays, sirih pinang chewing is just like addiction, and normally just old people do this tradition (Nguyen, 1990; Susiarti, 2005; Suddhasthira *et al.*, 2006; Tayanin & Bratthall, 2006). This can be found in all part of Indonesia, for example Java, Nusa Tenggara and so on.

Occlusal filing dispersed most broadly and in longest period. Its antiquity's range was from Mesolithic to early Historical Age. This pattern also found at prehistoric Japan (Takenaka *et al.*, 2001; Adachi *et al.*, 2006). This pattern has been also practicing until now although in small number, both in Indonesia (Koesbardiati & Suriyanto, 2007a, 2007b) or foreign countries, especially Africa and South America (Stewart & Groome, 1968; Handler *et al.*, 1982; Briedenhann & van Reenen, 1985; Miqnaire, 1987; Milner & Larsen, 1991; Sawyer & Allison, 1992; Fitton, 1993; Ikehara-Quebral & Douglas, 1997; Drugan & Downer, 2005). This tradition can be found in rural area of Java and Madura (Lie, 1966; Sukadana, 1966; Pinborg *et al.*, 2006). In Bali Island, occlusal filing was done in term of religious action (Hobart *et al.*, 1996; Jensen & Suryani, 1996). Considering this facts, it is assumed that occlusal filing was the most recent pattern of dental modifications that have been done intensively by various culture groups in Indonesia.

The pattern of dental modifications are not absolutely representation of certain culture groups, and these pattern could be a development or variant of the local culture (Koesbardiati & Suriyanto, 2007a, 2007b; Suriyanto & Koesbardiati, 2009). The difference and the similarity of the patterns of dental modification can show the migration dynamic of the certain culture groups (Koesbardiati & Suriyanto, 2007a, 2007b). Turner (2000) actually has also been suspected about the links among forms of dental modification in the evolution of culture, although only a glimpse in the face of evidence of human remains of post-archaic Indian culture in the American Southwest. This indicates that the patterns of dental modification are the important variable that be considered to determine migration dynamic and racial history. Based on the patterns of dental modification, that can be showed that the patterns of migration in Indonesia fit with the patterns of migration based on the metric and DNA results (Jacob, 1967a, 1976b, 1974, 2006a, 2006b; Sukadana, 1970, 1981, 1984; Sukadana & Wangania, 1977; Glinka, 1978, 1981, 1993; Ballinger *et al.*, 1992; Melton *et al.*, 1995; Sykes *et al.*, 1995; Melton *et al.*, 1998; Lum *et al.*,

1998; Su *et al.*, 2000; Adi, 2006; Glinka & Koesbardiati, 2007; Koesbardiati & Suriyanto, 2007c), and epigenetic results (Suriyanto *et al.*, 2006; Suriyanto & Koesbardiati, 2006). The domination of the Australomelanesoid of the whole Indonesia was changed by the Mongoloid that came commonly from the west and afterwards from the north of Indonesia (Jacob, 1974; Glinka, 1978, 1981, 1993, 2008; Suriyanto *et al.*, 2006; Suriyanto & Koesbardiati, 2006; Glinka & Koesbardiati, 2007; Koesbardiati & Suriyanto, 2007c).

The result has provided the views that can enrich the hypotheses relating to the dental modifications that have been developed previously. Temple *et al.* (2011) have done a recent research are still supporting a hypothesis that the identities associated with tooth ablation were unrelated to migratory patterns, and instead, possibly reflect kin-based social units, where achievement or age acted as a determinant of membership. This study has documented and interpreted patterns of identity in relation to dental ablation patterns at Yoshigo (Japan), a Late/Final Jomon period (3500-2500 years BP) site. Differences of these researches can be understood that the temple *et al.*'s research is only based on findings from one site, and just focus on one pattern of dental modification, namely dental ablation. Just to remind, that in addition to dental ablation, the basic pattern can still be found, namely dental evulsion, staining/ coloring/ blackening, and inlay. And just for additional information, that the use teeth as a tool to help some of the activities of everyday life can also be incorporated into dental modification (Water-Rist, 2010).

The use of teeth as tools provides clues to past subsistence patterns and cultural practices. Waters-Rist *et al.* (2010) have found the evidences of excavation work in Siberia. Five Holocene period hunter-fisher-gatherer mortuary sites from the southwestern region of Lake Baikal, Siberia, Russian Federation are observed for activity-induced dental modification to further characterize their adaptive regimes. Grooves on the occlusal of teeth are observed in 25 out of 123 individuals (20.3%) and were most likely produced during the processing of fibers from plants and animals, for making items such as nets and cordage. Regional variation in the frequency of individuals with occlusal grooves is found in riverine versus lakeshore sites. This variation suggests that production of material culture items differed, perhaps in relation to different fishing practices. There is also variation in the distribution of grooves by sex: grooves are found predominately in females, except at the Late Neolithic—Bronze Age river site of Ust'-Ida I where grooves are found exclusively in males. Occlusal grooves were cast using polyvinylsiloxane

and maxillary canine impressions were examined by scanning electron microscopy to determine striation patterns. Variation in striae orientation suggests that a variety of activities, and/or different manufacturing techniques, were involved in groove production. Overall, the variability in occlusal groove frequency, sex and regional distribution, and microscopic striae patterns, points to the multiplicity of activities and ways in which people used their mouths and teeth in cultural activities.

The dental modifications in the ancient Indonesia, which has multiple functions (initiation rite, aesthetics, etc.), once clarify the migration history of Indonesian population from Southeast Asia in prehistoric times. The *Homo sapiens sapiens*, which consisted of sub-species Mongoloid and Australomelanesoid, which is the large majority of the population hitherto Indonesia. The polytypic and polymorphic populations combined according to this time and space to pass their hybridization on Indonesian population complex, and this process will continue. Indonesian racial identity is a product of the process, especially in the ancient Indonesia.

## **Conclusion**

We described the dental modifications that have been done in Indonesia based on paleoanthropological-archaeological evidences, either in the form of isolated teeth and along the mandible and maxilla, and the skull. Indonesian ethnographic sources related to dental modifications were also presented. Paleoanthropological-archaeological evidences and the sources of ethnographic literature have attempted to bring continuity the dental modifications in Indonesia. The functions of dental modifications also have attempted to be expressed, whether in relation to the initiation rites and aesthetics. The researchers also intend to exploit that these dental modifications, which were a cultural product, related to migration and the chronology of the dispersion of human races from Southeast Asia to the Indonesian Archipelago and the peopling from 4000 years ago until now. The human races were Australomelanesoid and Mongoloid that is the main populations that inhabit this region. Based on the patterns of dental modification, that can be showed that the patterns of migration in Indonesia fit with the patterns of migration based on metrical, epigenetic, and DNA results. The domination of the Australomelanesoid of the whole Indonesia was changed by the Mongoloid that came commonly from the west and afterwards from the north of Indonesia.

Evidence of prehistoric dental modifications, either as a rite of initiation or aesthetics, can explain the history of racial identity of ancient Indonesian population. These efforts can be done because we assert that human biology affects culture and vice versa. Moreover, this culture, the dental modifications, was revealing traces as population migrations from the Southeast Asia to the Indonesian Archipelago. We hope that this research can synergize with particularly archaeological researches, and can synergize with each other research other aspects of human biology.

## DAFTAR PUSTAKA

- Adachi, N., Suzuki, S., Sakaue, K., Takigawa, W., Oshima, N. & Dodo, Y. 2006. Kinship analysis of the Jomon skeletons unearthed from a double burial at the Usu-Moshiri site, Hokkaido, Japan. *Anthropological Science* 144: 29 – 34.
- Adelaar, A. 2005. The Austronesian languages of Asia and Madagascar: a historical perspective. In: Adelaar & N. P. Himmelmann (eds.) *The Austronesian Languages of Asia and Madagascar*, pp. 1 – 42. Routledge, London.
- Adi, I, G. G. H. 2006. Gen yang berkisah. *National Geographic* (Indonesian edition) March ed.: 48 – 51.
- Arcini, C. 2005. The Vikings bare their filed teeth. *American Journal of Physical Anthropology* 28: 727 – 733.
- Armelagos, G.J. & van Gerven, D. P. 2003. A century of skeletal biology and paleopathology: contrasts, contradictions, and conflicts. *American Anthropologist* 105: 51 – 62.
- Artaria, M. D. 2009. *Antropologi Dental*. Yogyakarta: Graha Ilmu. Baba, S. P. & Kay, E. J. 1989. The mythology of the killer deciduous canine tooth in southern Sudan. *Journal of Pedodontology* 14: 48 – 49.
- Ballinger, S. W., Schuur, T.G., Torroni, A., Gan, Y.Y., Hodge, J.A., Hassan, K., Chen, K.- H. & Wallace, D. C. 1992 Southeast Asian mitochondrial DNA analysis reveals genetic continuity of ancient Mongoloid migrations. *Genetics* 130: 139 – 152.

- Bellwood, P. 2000. Prasejarah Kepulauan Indo-Malaysia, rev. ed. Tranlt. T. W. Kamil. Jakarta: Gramedia Pustaka Utama.
- Bellwood, P. 2006. Austronesian prehistory in Southeast Asia: homeland, expansion and transformation. In: P. Bellwood, J.J. Fox & D. Tryon (eds.) *The Austronesians: Historical and Comparative Perspectives*, pp. 103 – 118. The Australian National University Press. Canberra.
- Bellwood, P. 2004. The origins and dispersals of agricultural communities in Southeast Asia. In: I. Glover & P. Bellwood (eds.) *Southeast Asia: from Prehistory to History*, pp. 21 – 40. London: Routledge.
- Blench, R. M. 2008. The prehistory of the Daic (Taikadai speaking peoples) and the hypothesis of and Austronesian connection. *Paper presented at the 12<sup>th</sup> EURASEAA meeting*, 1 – 5<sup>th</sup> September, Leiden.
- Blust, R. 1996. Beyond the Austronesian homeland: the austric hypothesis and its implications for archaeology. *Transactions of the American Philosophical Society* 86: 117 – 140.
- Boedhisampoerno, S. 1982. Studi gigi geraham belakang subresen dari Gua Ulu Leang 2, Maros Sulawesi Selatan. *Berkala Bioantropologi Indonesia* 1: 21 – 31.
- Boedhisampoerno, S. 1985. Kerangka Manusia dari Caruban Lasem, Jawa Tengah. *Rapat Evaluasi Hasil Penelitian Arkeologi II*. Pusat Penelitian Arkeologi Nasional. Jakarta: Pusat Penelitian Arkeologi Nasional.
- Bosch, X. 2000. Look to the bones for clues to human disease. *The Lancet* 255: 1248.
- Briedenhann, S. J. & Reenen, J.F.Van. 1985. Tooth extraction and tooth mutilating oractices amongst the Herero—speaking peoples of South West Africa (Namibia). *Journal of Dentist Association of South Africa* 40: 531 – 536.
- Buikstra, J. E. 1977. Biocultural dimensions of archaeological study: a regional perspective. *Southern Anthropological Society* 11: 67 – 84.
- Buikstra, J. E. 1981. Mortuary practices, paleodemography and palaeopathology: a case study from the Koster site (Illinois). In: R. Chapman, I. Kinnes & K. Randsborg, (eds.). *The Archaeology of Death*, pp. 123 – 132. Cambridge University Press.



- Bulbeck, D. 2008. An integrated perspective on the Austronesian diaspora: the switch from cereal agriculture to maritime foraging in the colonization of Island Southeast Asia. *Australian Archaeology* 67: 31 – 51.
- Buzon, M. R., Eng, J. T., Lambert, P. M. & Walker, P. L. 2005. Bioarchaeological methods. In: H. D.G. Maschner, & C. Cippendale (eds.) *Handbook of Archaeological methods*, vol. II, pp. 871 – 918. Altamira Press, Walnut Creek.
- Capelli, C., Wilson, J.F., Richards, M., Stumpf, M. P. H., Gratrix, F., Oppenheimer, S., Underhill, P., Pascali, V. L., ko, T-M. & Goldstein, D.B. 2001. A predominantly indigenous paternal heritage for the Austronesian-speaking peoples or insular Southeast Asia and Oceania. *American Journal of Human Genetics* 68: 42 – 443.
- Cavalli-Sforza, L.L., Piazza, A., Menozzi, P. & Mountain, J. 1988. Reconstruction of human evolution: bringing together genetic, archaeological, and linguistic data. *Proceedings of the National Academy of Sciences USA* 85: 6002 – 6006.
- Chow, R. A., Caerio, J. L., Chen, S – J., Garcia-Bertrand, Rl. L. & Herrera, R. J. 2005. Genetic Characterization of four Austronesian-speaking populations. *Journal of Human Genetics* 50: 550-559.
- Coppa, A., Bondioli, L., Cucina, A., Frayer, D. W., Jarrige, J. F., Quivron, G., Rossi, M., Vidale, M. & Macchiarelli, R. 2006. Early Neolithic tradition of dentistry. *Nature* 440: 755 – 756.
- Cox, m. P. 2005. Indonesian mitochondrial DNA and its opposition to Pleistocene era origin of Proto-Polynesians in Island Southeast Asia. *Human Biology* 777: 179 – 188.
- Cusick, J. G. 1998. Historiography of acculturation: an evaluation of concepts and their application in archaeology. In: J. G. Cusick (ed.) *Studies in Cultural Contact: Interaction, Culture, Change, and Archaeology*, pp. 126 – 145. Center for Archaeological Investigations Southern Illionis University, Carbondale.
- Dewhurst, S. N. & Mason, C. 2008. Traditional tooth bud gouging in a Ugandan Family: a report involving three sisters. *International Journal of Paediatric Dentistry* 11; 292 – 297.

- Diamond, J. & Bellwood, P. 2003. Farmers and their language: the first expansions. *Science* 300: 597 – 603.
- Domett, . M., Newton, J., O'Reilly, D. J. W., Tayles, N., Shewan, L. & Beavan, N. 2011. Cultural modification of the dentition in prehistoric Cambodia. *International Journal of Osteoarchaeology*. DOI: 10. 1002/oa. 1245.
- Donohue, M. & Denham, T. 2010. Farming and language in Island Southeast Asia: reframing Ausronesian history. *Current Anthropology* 51: 223 – 256.
- Drugan, C. S. & Downer, M.C. 2005. Dental filling as an indicator of socio economic status. *Journal of Public Health* 27: 397-398.
- Du Bois, C. 1944. *The People of Alor : A Social-psychological Study of An East Indian Island*. University of Minnesota Press. Minneapolis.
- Ellis, J. & Arubaku, W. 2005. Complications from traditional tooth extraction in South-western Uganda. *Tropical Doctor* 35: 245 – 246.
- Faslicht S. 1976. *Tooth Mutilations and Dentistry in Pre-Columbian Mexico*. Quintessence Books, Berlin.
- Finucane, B. C., Manning, K & Toure', M. 2008. Prehistoric dental modification in West Africa – early evidence from Karkarichinkat Nord, Mali. *International Journal of Osteoarchaeology* 18: 632 -640.
- Fitting, W. 1989. Tooth mutilation in the scope of ritual mutilation. *Actual Odontostomatology* 42: 191 – 203.
- Fitton, J. S. 1993. A tooth ablation custom occurring in the Maldives. *British Dental Journal* 175: 299-300.
- Flynn, M. 1977. Black teeth: a primitive method of caries prevention in Souteast Asia. *Journal of American Dentist Association* 95: 96 -97.
- Foley, R. A. & Donnelly, P. 2001. Towards in integrated approach to human evolution. In: P. Donnelly & R. A. Folley (eds) *Genes, Fossils and Behavior: An integrated Approach to Human Evolution*, pp. 1-2. IOS Press, Amsterdam.

- Glenner, R. A. & Willey, P. 1998. Dental filling materials in the confederacy. *Journal of the History of Dentistry* 46: 71-75.
- Glinka, J. 1978. *Gestalt und Herkunft: Beitrag zur Anthropologischen Gliederung Indonesiens*. Verlag des Anthropos-Instituts, St. Augustin.
- Glinka, J. 1981. Racial history of Indonesia. In: I. Schwidetzky (ed.) *Rassengeschichte der Menschheit*, pp. 79 – 133. R. Oldenbourg Verlag, Munchen.
- Glinka, J. 1993. Reconstruction the past from present. *Paper for International Confrence on Human Paleoecology: Ecological Context Of the Evolution of Man*. Lembaga Ilmu Pengetahuan Indonesia, Jakarta.
- Glinka, J. 2008. Sejarah penghunian kawasan Indonesia. In: M.D. Artaria (ed.) *Manusia Makhluk Sosial Biologis*, pp. 163 – 172. Airlangga Unversity Press, Surabaya.
- Glinka, J. & Koesbardiati, T. 2007. Morfotipe wajah dan kepala di Indonesia: suatu usaha identifikasi variasi populasi. *Jurnal Anatomi Indonesia* 1: 41 – 46.
- Gonzalez, E. L., Perez, B.P., Sanchez Sanchez, J. A. & Acinas, M. M. R. 2010. Dental aesthetics as an expression of culture and ritual. *Brithis Dental Journal* 208: 77 – 80.
- Goodman, A. H. 1993. On the interpretation of health from skeletal remains. *Current Anthropology* 34: 281-288.
- Handler, J. S. 1994. Determining African birt from skeletal remains: a Note on tooth mutilation. *Historical Archaeology* 28: 113 – 119.
- Handler, J. S., Carrucini, R.S. & R. J. 1982. Tooth Mutilation in the Caribbean: evidence from a slave burial population in Barbados. *Journal of Human Evolution* 6: 297 – 313.
- Hanihara, T. 2006. Interpretation of craniofacial variation and diversification of East and Southeast Asians. In: Oxenham & N. Tyles (eds.) *Bioarchaeology of Southeast Asia*, pp. 91 – 111. Cambridge University Press, Cambridge.
- Haour, P. & Pearson, J. A. 2005. An instance of dental modification on a human skeleton from Niger, West Africa. *Oxford Journal of Arcaheology* 24: 427 – 433.

- Hillson, S. 1996. *Dental Anthropology*. Cambridge University Press, Cambridge.
- Hobart, A., Ramseyer, U. & Leeman, A. 1996. *The Peoples of Bali*. Blackwell, London.
- Hurles, M. E., Matisoo-Smith, E., Gray, R. D. & Penny, D. 2003. Untangling Oceanic settlement: the edge of the knowable. *Trends in Ecology and Evolution* 18: 531 – 540.
- Ikehara-Quebral, R. & Douglas, M. T. 1997. Cultural alteration of human teeth in the Mariana Island. *American Journal of Physical Anthropology* 28: 381 – 391.
- Indriati, E. 2001. Bioarkeologi: integrasi dinamis antara antropologi biologis dan arkeologi. *Humaniora* 3: 284 – 291.
- Jacob, T. 1967a. Racial identification of the Bronze Age human dentitions from Bali, Indonesia. *Journal of Dental Research* 5: 903 – 910.
- Jacob, T. 1967b. *Some Problems Pertaining to the Racial History of the Indonesian Region*. Drukkerij Neerlandia, Utrecht.
- Jacob, T. 1974. Studies on human variation in Indonesia. *Journal of National Medical Association* 66: 389 – 339.
- Jacob, T. 1982. Prospek penelitian paleoanthropologi di Indonesia. *Berkala Bioanthropologi Indonesia* 1: 47-55.
- Jacob, T. 1983. Perlindungan peninggalan paleoanthropologi. *Berkala Bioanthropologi Indonesia* 1: 37-49.
- Jacob, T. 2006a. *Manusia Makhluk Gelisah: Melalui Lensa Bioantropologi*. Muhammadiyah University Press, Surakarta.
- Jacob, T. 2006b. The problem of Austronesia origin. In: T. Simanjuntak, I. H. E. Pojoh & M. Hisyam (eds.) *Austronesian Diaspora and the Ethnogeneses of People in Indonesian Archipelago*, pp. 7 – 13. Jakarta: LIPI Press.
- Jacob, T. & Soepriyo, A. 1994. A preliminary palaeoanthropological study of the Gua Gunung Runtuh human skeleton. In: Z. Majid (ed.) *The Excavation of Gua Gunung Runtuh and the Discovery of the Perak Man in Malaysia*, pp. 48-69. Department of Museums and Antiquity Malaysia, Kuala Lumpur.

- Jacob, T. & Soepriyo, A. 2005. A paleoanthropological study of the Gua Gunung Runtuh skeleton. In: Z. Majid (ed.) *The Perak Man and Other Prehistoric Skeletons of Malaysia*, pp. 33 – 50. Universiti Sains Malaysia, Pulau Pinang.
- Jansen, G. D. & Suryani, L. K. 1996. *Orang Bali: Penelitian Ulang Tentang Karakter*. Bandung: Penerbit ITB.
- Jones, A. 2001. Dental transfigurements in Borneo. *British Dental Journal* 191: 98 – 102.
- Kennedy, K. A. R., Misra, V. N., Burrow, C. B. 1981. Dental mutilation from prehistoric India, *Current Anthropology* 22: 285 – 286.
- Knudson, K. J. & Stojanowski, C. M. 2010. New directions in bioarchaeology: recent contributions to the study of human social identities. *Journal of Archaeological Research* 16: 397 – 432.
- Koerniati, I. 2004. Mutilasi gigi anterior dengan terjadinya atrisi gigi posterior: suatu studi sosioantropologi kesehatan pada Suku Mentawai di Pulau Siberut. *Dissertation*. Universitas Airlangga, Surabaya. Unpublished.
- Koesbardiati, T. & Suriyanto, R. A. 2007a. Menelusuri jejak populasi morfologi pangur gigi-geligi: kajian pendahuluan atas sampel gigi-geligi dari beberapa situs purbakala di Jawa, Bali dan Nusa Tenggara Timur. *Humaniora* 19: 33 – 43.
- Koesbardiati, T. & Suriyanto, R. A. 2007b. Dental modification in Flores: a biocultural perspective. In: E. Indriati (ed.) *Recent Advances on Southeast Asian Paleoanthropology and Archaeology*, pp. 259 – 268. Laboratory of Bioanthropology and Paleoanthropology Faculty of Medicine Gadjah Mada University, Yogyakarta.
- Koesbardiati, T. & Suriyanto, R. A. 2007c. Australomelanesoid in Indonesia: a swinging like movement. *Jurnal Anatomi Indonesia* 2: 23 – 28.
- Koesbardiati, T. & Murti, D. B. 2011. New evidence of *Mycobacterium leprae* in Indonesia ancient human skeletal remains: a new clue of modern human dispersal in Indonesia? In: V. P. Kalanjati et al. (eds.) *Proceeding Book The Future of Anatomy: Clinical Anatomy, Biomolecular and Cellular Anatomy, and Anatomy in Radiology and Imaging*, pp. 336 – 340. Faculty of Medicine of Airlangga University, Surabaya.

- Lambert, P. M. 2006. Infectious disease among enslaved African Americans at Eaton's Estate, Warren County, North Carolina, ca. 1830 – 1850. *Memorias Instituto Oswaldo Cruz* 101 (Suppl. II): 107 – 117.
- Lansing, J. S., Cox, M. P. Downey, S.S., Gabler, B.M., Hallmark, B., Karafet, T.M., Norquest, p., Schoenfelder, J. W., Sudoyo, H., Watkins, J. C. & Hammer, M. F. 2007. Coevolution of language and genes on the island of Sumba, eastern Indonesia. *Proceedings of the National Academy of Sciences USA* 104: 16022 – 16026.
- Larsen, C. S. 1985. Dental modifications and tool use in the western Great Basin. *American Journal of Physical Anthropology* 67: 393 – 402.
- Larsen, C. S. 1997. *Bioarchaeology: Interpreting Behavior from the Human Skeleton*. New York: Cambridge University Press.
- Larsen, C. S. 2002. Bioarchaeology: the lives and lifestyles of the past people. *Journal of Archaeological Research* 10: 119 – 166.
- Larson, G., Cucchi, T., Fujita, M., Matisoo-Smith, E., Robins, J., Anderson, A. Rollet, B., Spriggs, M., Dolman, G., Kim, T-H., Nguyen, T. D. T., Randi, E., Doherty, M., Due, R. A., Bollt, R., Djubiantono, T., Griffin, B., Intoh, M., Keane, E., Kircah, P., Li, K-T., Morwood, M., Pedria, L. M., Piper, P. J., Rabett, R. J., Shooter, P., den Bergh, G. V., West, E., Wickler, S., Yuan, J., Cooper, A. & Dobney, K. 2007. Phylogeny and ancient DNA of Sus provides insights into Neolithic expansion in Island Southeast Asia and Oceania. *Proceedings of the National Academy of Sciences USA* 104: 4834 – 4839.
- L'abbe, E., Coetzee, F. P. & Loots, M. 2008. A description of Iron Age Skeletons from the Pilanesberg National Park, South Africa. *South Africa Archaeological Bulletin* 63: 28 – 36.
- Lie, G. L. 1996. Beberapa aspek pengasahan gigi di Indonesia terutama dari daerah Djawa Timur dan Madura. *Madjalah Kedokteran Gigi Surabaya* 1 – 4: 3- 15.
- Lignitz, H. 1919/ 1920. Die kunstlicten Zahnverstümelungen in Afrika im lichte der Kulturkreisforschung. *Anthropos* XIV – XV: 891 – 943.

- Lignitz, H. 1921/1922. Die kunstlichen Zahnverstümmelungen in Afrika im lichte der Kulturkreisforschung. *Anthropos* XVI – XVII: 247 – 264, 866 – 889.
- Lum, J. K., Cann, R. L., Martinson, J. J. & Jorde, L. B. 1998. Mitochondrial and nuclear genetic relationships among Pacific island and Asian populations. *American Journal of Human Genetics* 63: 613 – 624.
- Lum, J. K., McIntyre, J. K., D. L., Huffman, K. W. & Vilar, M. G. 2006. Recent Southeast Asian domestication and Lapita dispersal of sacred male pseudohermaphroditic ‘tuskers’ and hairless pigs of Vanuatu. *Proceedings of the National Academy of Sciences USA* 103: 17190 – 17195.
- Marsik, A. & Pap, I. 2000. Paleopathological research in Hungary. *Acta Biologica Szegediensis* 44: 103 – 108.
- Martin, D. L. & Goodman, A. H. 2000. Health conditions before Columbus: paleopathology of native North Americans. In: E. Rhoades (ed.) *American Indian Health*, pp. 19 – 40. Johns Hopkins University Press, Baltimore.
- Matsumura, H. 2006. The population history of Southeast Asia viewed from morphometric analyses of human skeletal and dental remains. In: M. Oxenham & N. Tyles (eds.) *Bioarchaeology of Southeast Asia*, pp. 33 – 58. Cambridge University Press, Cambridge.
- Matsumura, H. 2005. Bioanthropological significance of prehistoric human skeletal remains in Malaysia. In; Z. Majid (ed.) *The Perak Man and Other Prehistoric Skeletons of Malaysia*, pp. 425 – 446. Universiti Sains Malaysia, Pulau Pinang.
- Matsumura H. & Majid, Z. 1999. Metric analyses of the early Holocene human skeleton from Gua Gunung Runtuh in Malaysia. *American Journal of Physical Anthropology* 109; 327 – 340.
- Matsumura, H., Oxenham, M. F., Dodo, Y., Domett, K., Nguyen, K. T., Nguyen, L.C., Nguyen, K. D., Huffer, D. & Yamagata, M. 2008. Morphometric of late Neolithic human remains from Man Bac. Ninh Binh Province, Vietnam: key skeletons with which to debate the ‘two layer’ hypothesis. *Anthropological Science* 116: 135 – 148.

- Melton, T., Peterson, R. Redd, A.J., Saha, n., Sofro, A. S. M., Martinson, J. & Stoneking, M. Polynesian genetic affinities with Southeast Asian populations as identified by mtDNA analysis. *American Journal of Human Genetics* 57: 403 – 414.
- Melton, T., Clifford, S., Martinson, J., Batzer, M. & Stoneking, M. 1998. Genetic evidence for the Proto-Austronesian homeland in Asia: mtDNA and nuclear DNA variation in Taiwanese aboriginal tribes. *American Journal of Human Genetics* 63: 1807 – 1823.
- Maskell, L. 2000. Writing the body in archaeology. In: A. E. Routman (ed.) *Reading the Body: Representations and Remains in the Archaeological Record*, pp. 13 -21. University of Pennsylvania Press, Philadelphia.
- Milner, G. & Larsen, C. 1991. Teeth as artifact of human behavior: intentional mutilation and accidental modification. In: M. Kelley & C. Larsen (eds.) *Advances in Dental Anthropology*, pp. 357 – 378. Chichester, New York.
- Miquaire, D. 1987. Dental mutilations in exotic civilizations and their significance. *Journal of Canadian Dentist Association* 53: 831 -834.
- Molleson, T. 2007. A method for the study of activity related skeletal morphologies. *Bioarchaeology of the Near East* 1: 5 -33.
- Molnar, S. 1972. Tooth wear and culture: a survey of tooth functions among some prehistoric populations. *Current Anthropology* 13: 511 – 526.
- Moodley, Y. Linz, B., Yamaoka, Y., Windsor, H. M., Breurec, S., Wu, J.-Y., Maady, A., Bernhoft, S., Thiberge, J.-M., Phuanukoonnon, S., Jobb, G., Siba, P., Graham, D.Y., Marshall, B.J. & Achtman, M. 2009. The peopling of the Pacific from a bacterial perspective. *Science* 323: 527 – 530.
- Mower, J. P. 1999. Deliberate ante-mortem dental modification and its implications in archaeology, ethnography, and anthropology. *Papers from the Institute of Archaeology* 10: 37 – 53.
- Nei, M. 1995. The origin of human populations: genetic, linguistic, and archaeology data. In: S. Brenner & K. Hanihara (eds. ) *The Origin and Past of Modern humans as Viewed from DNA*, pp. 71-91. World Scientific, Singapore.



- Nelsen, K., Tayles N. & Dommet, K. 2001. Missing lateral incisors in Iron Age South-East Asians as possible indicators of dental adenesi. *Archives of Oral Biology* 46: 963 – 971.
- Nguyen, V. C. 1990. The habit of black lacquering of teeth and dental caries. *Czah Stomatology* 43: 600-6003.
- Nguyen, X.H. 2006. Betel-chewing in Vietnam: its past and current importance. *Anthropos* 101: 499 – 518.
- Ninozzi, S. Manzi, G., Ricci, F., di Lernia, S. & Tarli, S. M.B. 2008. Nonalimentary tooth use in prehistory: an example from Early Holocene in Central Sahara (Uan Muhuggiag, Tadfart Acacus, Libya). *American Journal of Physical Anthropology* 120: 225 – 235.
- Oppenheimer, S. & Richards, M. 2001a. Fast trains, slow boats, and the abcestry of the Polynesian Islanders. *Science Progress* 84: 157 – 181.
- Oppenheimer, S. & Richards, M. 2001b. Polynesian origins: slow boat to Melanesia? *Nature* 410: 166 – 167.
- Oxenham, M. F., Locher, C. Nguyen, L. C. & Nguyen, K. T. 2002. Identification of *Areca catechu* (betel nut) residus on the dentitions of Bronze Age inhabitants of Nui Nap, Northern Vietnam. *Journal of Archaeological Science* 29: 909 – 915.
- Oxenham, m. & Tyles, N. 2006. Introduction: Southeast Asian bioarchaeology past and present. In M. Oxenham & N. Tyles (eds.) *Bioarchaeology of Southeast Asia*, pp. 1 – 30. Cambridge University Press, Cambridge.
- Paine, R.R., Vargiu, R., Coppa, A., Morselli, C. & Schneider, E.E. 2007. A health assessment of high status Christian burial recovered from the Roman-Byzantine archaeological site of Elaiussa Sebate, Turkey. *Homo* 58: 173 – 190.
- Pechenkina, E. A. & Delgado, m. 2006. Dimensions of healt and social structure in the Early Intermediate period cemetery at Villa El Savador, Peru. *American Journal of Physical Anthropology* 131: 218 - 235.

- Peng, M.-S., Quang, H.H., Dang, K. P., Trieu, A.V., Wang, H.-W., Yao, Y.-G, kong, Q.-P. & Zhang, Y. –P. 2010. Tracing the Austronesian footprint in Mainland Southeast Asia: a perspective from mitochondrial DNA. *Molecular Biology and Evolution* 27: 2417 – 2430.
- Perez P. –J., Gracia, A., Martinez, I. & Arsuaga, J. L. 1997. Paleopathological evidence of the cranial remains from the Sima de los Huesos Middle Pleistocene site (Sierra de Atapuerca, Spain): description and preliminary inferences. *Journal of Human Evolution* 33: 409 – 421.
- Peterson, J. A. 2009. The Austronesian moment. *Taiwan Journal of Indigenous Studies* 2: 39 – 62.
- Pietrusewsky, M. 1981. Cranial variation in early Metal Age Thailand and Southeast Asia studied by multivariate procedures. *Homo-Journal of Comparative Human Biology* 32: 1 – 26.
- Pietrusewsky, M. 1992. Japan, Asia and the Pacific: a multivariate craniometric investigation. In: K. Hanihara (ed) *Japanese as A member of the Asian and Pacific Populations*, pp. 9 – 52. International Research Center for Japanese Studies, Kyoto.
- Pietrusewsky, M. 1994. Pacific-Asian relationships: a physical anthropological perspective. *Ocean Linguistics* 33: 407-429.
- Pietrusewsky, M. 2006a. A multivariate craniometric study of the prehistoric and modern inhabitants of Southeast Asia. East Asia and surrounding regions: a human kaleidoscope? In: m. Oxenham & N. Tyles (eds.) *Bioarchaeology of Southeast Asia*, pp. 59 – 90. Cambridge University Press, Cambridge.
- Pietrusewsky, M. 2006b. The initial settlement of remote Oceania: the evidence from physical anthropology, dalam T. Simanjuntak, I. H. E. Pojoh & M. Hisyam (eds.) *Austronesian Diaspora and the Ethnogeneses of People in Indonesian Archipelago*, pp. 320 – 347. Jakarta: LIPI Press.

- Pietrusewsky, M. 2007. The modern inhabitants of Island Southeast Asia: a radiometric perspective. In: E. Indriati (ed.) *Proceedings of the International Seminar on Southeast Asian Paleoanthropology: Recent Advances on Southeast Asian Paleoanthropology and Archaeology*, pp. 185 – 201. Laboratorium of Bioanthropology and Paleoanthropology, Faculty of Medicine, Gadjah Mada University, Yogyakarta.
- Pietrusewsky, M. & Ikehara-Quebral, R. 2006. The bioarchaeology of the Vat Komnouchemetry, Angkor Borei, Cambodia. *Indo-Pacific prehistory Association Bulletin* 26: 86-97.
- Pindborg, J.J., Moller, I.J. & Effendi, I. 2006. Dental mutilations among villager in Central Java and Bali. *Community Dentistry and Oral Epidemiology* 3: 190 – 193.
- Reichart, P. A., Creutz, U. & Scheifele, C. 2008. Dental mutilations and associated alveolar bone pathology in African skulls of the anthropological skull collection, Charite, Berlin. *Journal of Oral Pathology & Medicine* 37: 50 – 55.
- Renfrew, C. 2009. Where bacteria and language concur. *Science* 323: 467 – 468.
- Richerson, P. J. & Boyd, R. 2005. *Not by Genes Alone: How Culture Transformed Human Evolution*. The University of Chicago Press, Chicago.
- Romero, J. 1970. Dental mutilation trephination, and cranial deformation. In: R. Wauchope & T.D. Stewart (eds.) *Handbook of Middle American Indians: Physical Anthropology*, vol. 9, pp. 50-57. University of Texas Press, Austin.
- Rooney, D. 1993. *Betel Chewing Traditions in South-East Asia*. Oxford University Press, Kuala Lumpur.
- Sangvichen, S. 1966. Neolithic skeletons from Ban Ako, Thailand, and the problem of Thai origins. *Current Anthropology* 7: 234 -235.
- Sawyer, D.R. & Allison, M. J. 1992. Tooth mutilations in pre-Columbian Peru and Chile and modern-day Nigeria. *Annual Dentistry* 51: 24 -26.
- Schiffer, M. B. 1976. *Behavioral Archaeology*. New York: Academic Press.

- Scott, R. G., Turner II, C. G. 1997. *The Anthropology of Modern Human teeth*. Cambridge University Press, Cambridge.
- Senna, M. Baiwoga, F., Winmaia, J., Muellerb, I., Rogersonc, S. & Senna, N. 2009. Betel nut chewing during pregnancy. Madang province Papua New Guinea. *Drug and Alcohol Dependence* 105: 126-131.
- Soejono, R. P. 1969. On prehistoric burial methods in Indonesia. *Bulletin of Archaeological Institute* 7. Pusat Penelitian Purbakala dan Peninggalan Nasional, Jakarta.
- Soejono, R. P. 1977. Sistim-sistim penguburan pada akhir masa prasejarah di Bali. *Dissertation*. Universitas Indonesia, Jakarta. Unpublished.
- Spriggs, M. 2007. The Neolithic and Austronesian expansion within Island Southeast Asia and Into the Pacific. In: S. Chiu & C. Sand (eds.). *From Southeast Asia to the Pacific: Archaeological Perspectives on the Austronesian Expansion and the Lapita Cultural Complex*, pp. 104 – 125. Centres for Archaeological Studies Research and for Humanities and Social Sciences, Taipei.
- Spriggs, M. 1998. From Taiwan to the Tuamotus: absolute dating of Austronesian language spread and major sub groups. In: R. Blech & M. Spriggs (eds.) *Archaeology and Language II: correlating archaeological and linguistic hypotheses*, pp. 115 – 127. Routledge, London.
- Steckel, R. H. 2005. Young adult mortality following severe physiological stress in childhood: skeletal evidence. *Economics and Human Biology* 3: 314 – 328.
- Steckel, R. H., Rose, J. C. Larsen, C. S. & Walker, P. L. 2002. Skeletal health in the Western Hemisphere from 4000 B.C. to the Present. *Evolutionary Anthropology* 11: 142 – 155.
- Stewart, T. D. & Froome, J. R. 1968. The African custom of tooth mutilation in America. *American Journal of Physical Anthropology* 28: 31 – 42.
- Stuart-Macadam, P. 1998. Iron deficiency anemia: exploring the difference. In: A. Grauer & P. Stuart-Macadam (eds.) *Sex and Gender in Paleopathological Perspective*, pp. 45 – 63. Cambridge University Press, New York.

- Su, B. Jin, L. Underhill, P. Martinson, J., Saha, N., McGarvey, S. T., Shiver, M. D., Chu J., Oefner, P., Chakraborty, R. & Deka, R. 2000. Polynesian origins: insights from the Y chromosome. *Proceedings of the National Academy of Sciences USA* 97: 8225 – 8228.
- Suddhasthira, T., Thaweboon, S. Dendoung, N., Thaweboon, B. & Dechkunakorn, S. 2006. Antimicrobial activity of *Cratoxylum formosum* on *Streptococcus mutans*. *Southeast Asian Journal of Tropical medicine Public Health* 37: 1156 – 1159.
- Sukadana, A.A. 1966. Beberapa aspek pengasahan gigi di Indonesia terutama dari daerah Djawa dan Madura. *Madjalah Kedokteran Gigi Surabaya* 3: 1-4.
- Sukadana, A.A. 1970. Persamaan mutilasi dentisi pada kerangka-kerangka prasejarah dari Liang Bua, Lewoleba dan Melolo, serta beberapa tjabatatan anthropologis mengenai penemuan-penemuan itu. *Madjalah Kedokteran Gigi Surabaya* 3: 13 – 30.
- Sukadana, A.A. 1979. Perubahan-perubahan pada tulang dan gigi subfosil manusia dan aplikasinya dalam penentuan kronologi peninggalan itu. *Berkala Ilmu Kedokteran* 2: 57-68.
- Sukadana, A.A. 1981. Peninggalan manusia di Liang Bua dan hubungannya dengan penemuan di Lewoleba dan Melolo. *Berkala Bioanthropologi Indonesia* 1: 53-72.
- Sukadana, A.A. 1984. Studi politisme dan polimorfisme populasi pada beberapa peninggalan di Nisa Tenggara Timur. *Dissertation*. Universitas Airlangga, Surabaya. Unpublished.
- Sukadana, A.A. & Wangania, S. E. 1977. *Beberapa Hasil Penelitian Sisa-Sisa Kerangka Manusia di Jawa Timur*. Proyek ehabilitasi dan Perluasan Museum Jawa Timur, Surabaya.
- Suriyanto, R. A., Jacob, T., Aswin, S. & Indriati E. 2006. Kajian Perbandingan karakteristik epigenetic populasi tengkorak Paleometalik Gilimanuk (Bali) dan Liang Bua, Lewoleba, Melolo dan Ntodo Leseh (Nusa Tenggara Timur). *Humanika* 19: 43-64.

- Suriyanto, R. A., Hastuti, J., Rahmawati, N. T., Koeshardjono & Jacob, T. 2008. Acromiocristalis populasi pygmy Rampasasa (Kabupaten Manggarai, Pulau Flores, Propinsi Nusa Tenggara Timur). *Masyarakat Kebudayaan dan Politik* 3: 272 – 282.
- Suriyanto, R. A. & Koesbardiati, T. 2006. Karakteristik-karakteristik epigenetic dan metris upper viscerocranium manusia prasejarah Liang Bua, Lewoleba, Melolo dan Ntodo Leseh di Nusa Tenggara timur. *Journal Anatomi Indonesia* 1: 60 – 70.
- Susiarti, S. 2005. Jenis-jenis pengganti pinang dan gambir dalam budaya menginang masyarakat di kawasan Taman Nasional Wasur, Merauke, Papua. *Biodiversitas* 6: 217 – 219.
- Swedlund., A.C. & Wade, W.D. 1972. *Laboratory Methods in Physical Anthropology*. Prescott College Press, Prescott.
- Sykes, B., Leiboff, A. Low-Beer, J., Tetzener, S. & Richards, M. 1995. The origins of the Polynesians: an interpretation from mitochondrial lineage analysis. *American Journal of Human Genetics* 57: 1463 – 1475.
- Szabo, K. & O' Connor, S. 2004. Migration and complexity in Holocene Island Southeast Asia. *World Archaeology* 36: 621-628.
- Takenaka, M., Mine, K., Tsuchimoci, K. & Shimada, k. 2001. Tooth removal during ritual tooth ablation in the Jomon period. *Indo-Pacific prehistory Association Bulletin* 21: 49 – 52.
- Tayanin, G. L. & Bratthall, D. 2006. Black teeth: beauty or caries prevention? Practice and beliefs of the Kammu people. *Community Dentistry & Oral Epidemiology* 34: 81-86.
- Tayles, N. 1996. Tooth ablation in prehistoric Southeast Asia. *International Journal of Osteoarchaeology* 6: 333 – 345.
- Temple, D. H., Kusaka, S. & Sciulli, P.W. 2011. Patterns of social identity in relation to tooth ablation among prehistoric Jomon forages from the Yoshigo site, Aichi prefecture, Japan. *International Journal of Osteoarchaeology* 21: 323 – 335.

- Tiesler, V. 1999. Head shaping and dental decoration among the Ancient Maya: Archaeological and cultural aspects. *Paper presented at the 64 Meeting of the Society of American Archaeology*, Chicago.
- Tiesler, V. 2002. New cases of an African tooth decoration from colonial Campeche, Mexico. *Homo* 52: 277 – 282.
- Torres-Rouf, C. & Knudson, K. J. 2007. Examining the life history of an individual from Solcor 3, San Pedro de Atacama: combining bioarchaeology and archaeological chemistry. *Revista de Anthropologia Chilena* 39: 235 – 257.
- Tung, T. 2008. Life on the move: bioarchaeological contributions to the study of migration and diaspora communities in the Andes. In: H. Silverman & W. Isbell (eds.). *The Handbook of South American Archaeology*, pp. 671 – 680. Springer Science + Business Media LLC, New York.
- Turner, C. G. II. 1987. Late Pleistocene and Holocene population history of East Asia based of dental variation. *American Journal of Physical Anthropology* 73: 305 – 321.
- Turner, C. G. II. Dental transfigurement and its potential for explaining the evolution of post-archaic Indian culture in American Southwest. *Dental Anthropology* 14: 1.
- Tryon, D. 2006. Proto-Austronesian and the major Austronesian subgroups. In: P. Bellwood, J. J. Fox & D. Tryon (eds.) *The Austronesians: Historical and Comparative Perspectives*, pp. 19 – 42. The Australian National University E Press, Canberra.
- Ubelaker, D. H. 1997. *Skeletal Biology of Human Remains from La Tolita, Esmeraldas Province, Ecuador*. Smithsonian Contributions to Anthropology Nr. 41. Smithsonian Institution Press, Wanshington DC.
- Ubelaker, D. H. & Ripley, C. E. 1999. *The Ossuary of San Francisco Church, Quito, Ecuador: Human Skeletal Biology*. Smithsonian Contributions to Anthropology Nr. 42. Smithsonian Institution Press, Wanshington DC.

- Uhle, M. 1886/1887. Ueber die ethnologische Bedeutung der Malaiischen Zahnfeilung. *Abhandlungen und Berichte des Koniglichen Zoologischen Anthropologisch-Ethnographischen Museum zu Dresden*, pp. 1 – 18. Berlin.
- Van der Plas, M. 2007. A new model for the evolution of Homo sapiens from the Wallacean island. *PalArch's journal of Vertebrate Palaeontology* 1: 1-121.
- Von Jhering, H. 1882. Die Kunstliche Deformirung der Zahne. *Zeitschrift fur Ethnologie* XIV: 213 – 262.
- Vukofic, A., Bajsman, A., Zukic, S. & Secie, S. 2009. Cosmetic dentistry in ancient times – a short review. *Bulletin of International Association of Paleodontology* 3: 9 -13.
- Walker, P. L. 2005. Porotic hyperostosis in a marine-dependent Carolina Indians population. *American Journal of Physical Anthropology* 69: 345 – 398.
- Walker, P. L. & Hewlett, B. S. 1990. Dental health diet and social status among Central African foragers and farmers. *American Anthropologist* 92: 383 – 398.
- Water-Rist, A., Bazaliiskii, V.I., Weber, A., Goriunova, O. I. & Katzenberg, M. A. 2010. Activity-induced dental modification in Holocene Siberian hunter-fisher-gatherers. *American Journal of Physical Anthropology* 143: 266 – 278.
- White, J. P. & Allen, J. 1980. Melanesian prehistory: some recent advances. *Science* 207: 728 – 734.
- White, T. D., Degusta, D., Richards, G. D. & Baker, S. G. 1997. Prehistoric dentistry in the American Southwest: a drilled canine from Sky Aerie, Colorado. *American Journal of Physical Anthropology* 103: 409 – 414.
- White, C., Maxwell, J. Dolphin, A., Williams, J. & longstaffe, F. 2006. Patheocology and paleodiet in Postclassic/Historic Maya from Nothern Coastal Belize. *Memorias Instituto Oswaldo Cruz* 101 (Suppl. II): 35 – 42.
- Whittaker, D. K. 1984. Mutilated teeth. *Dental Update* 11: 555 – 562.
- Whittington, S.L. & Reed, D. M. 1998. *Bones of the Maya*. Smithsonian Institution Press, London.



- Widianto, H. 2006. Austronesian prehistory from the perspective of skeletal anthropology. In: T. Simanjuntak, I. H. E. Pojoh & M. Hisyam (eds.) *Austronesian Diaspora and the Ethnogeneses of People in Indonesian Archipelago*, pp. 174 – 185. Jakarta: LIPI Press.
- Wilford, J. N. 2006. At burial site, teeth tell tale of slavery. *The New York Times*, January 31.
- Wilken, G. A. 1912. *De verspreide geshiften van Prof. Dr. G. A. Wilken Verzameld door F. D. E. van Ossenbruggen*, deel I – IV. GCT van Dorp & Co., s'-Gravenhage.
- William, J. S. & White, C.D. 2006. Dental modification in the Postclassic population from Lamanai, Belize. *Ancient Mesoamerica* 17: 139 – 151.
- Willis, M. S., Harris, L. E. & Hergenrader, P. J. 2008. On traditional dental extraction: case reports from Dinka and Nuer en route to restoration. *Brithis Dental Journal* 204: 121.
- Wood, J. Milner, G., Harpending, H. & Weiss, K. 1992. The osteological paradox: problems of inferring prehistoric health from skeletal samples. *Current Anthropology* 33: 343 – 370.
- Yamaoka, Y. 2009. Helicobar pylori typing as a tool for tracking human migration. *Clinical Microbiology and Infection* 19: 829 – 834.
- Zumbroich, T. J. 2007/2008. The origin and diffusion of betel chewing: a synthesis of evidence from Southeast Asia and beyond. *Electronic Journal of Indian Medicine* 1: 63 – 116.
- Zumbroich, T. J. Teeth as black as a bumle bee's wings: the ethnobotany of teeth blackening in Southeast Asia. *Ethnobotany Reseach & Applications* 7: 381 – 398.