The Ibaloi fire mummies: the art and science of mummification in the Philippines

Mark B. Carascal1,2*, Ian Kendrich C. Fontanilla1, Maria Corazon A. De Ungria1,3

1Institute of Biology, University of the Philippines, Diliman Quezon City, Philippines, 1101
2Clinical and Translational Research Institute, The Medical City, Pasig City, Philippines, 1605
3DNA Analysis Laboratory, Natural Sciences Research Institute, University of the Philippines, Diliman, Quezon City, Philippines, 1101

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Abstract  The Ibaloi fire mummies are preserved ancient remains of Ibaloi, one of the indigenous peoples of the northern Philippines. The locals kept the traditional Ibaloi mummification through oral traditions, but the current generation no longer conducts the actual practice. We categorized the mummification steps into preprocessing, smoking, and postprocessing. The preprocessing involved a ‘saltwater purge,’ washing, positioning the body onto a ‘death chair,’ removing the epidermis, and ‘deworming.’ The smoking process, from which the name ‘fire mummy’ was derived, involved the smoking of a body under a low-lit woodfire. The postprocessing involved sun-drying and application of a plant concoction to the body. Notably, the traditional Ibaloi mummification process shares similarities with other mummification practices elsewhere. This paper provides a systematic review of the traditional Ibaloi mummification and highlights the essential physical and chemical processes involved in body preservation. We want to encourage more interdisciplinary studies on the Ibaloi fire mummies to identify potential applications of the traditional process in corpse preservation. We also hope to contribute to discourses with people from multicultural backgrounds to increase our understanding of the history and culture of ancient human settlements in the Philippines and the Asia-Pacific.

Key words: archeology, ethnobotany, mummification, paleohistology, Philippines

Introduction

Mummification is the process by which a corpse is preserved through the combined use of physical and chemical processes (Jackowski et al., 2008). Mummification can be done naturally under specific environmental conditions or artificially through the use of various interventions. Artificially mummified human remains provide rich sources of information about a community’s culture (Lynerrup, 2009; Cecchetto et al., 2017). In the Philippines, historians attributed artificial mummification practices to the Ibaloi, one of the indigenous peoples of Benguet Province in the Cordillera Region of northern Luzon. They are known to be traditional spirit worshippers from ancient times. A significant part of their traditional practices was to preserve the dead (locally referred to as shilus ni minatay) (Anacin, 2015). For the Ibaloi community, the body’s physical preservation is necessary so that dead members of the tribe remain in the group while their spirits join with the gods (Picpican, 2003; Datar et al., 2016). The community practiced traditional Ibaloi mummification until the late 19th century (Keith, 1981).

Meyer first reported mummification among the Ibaloi in 1885 (Meyer, 1885). However, there is no written record of the traditional Ibaloi mummification practices. Instead, the practice was passed down through the generations by local oral traditions. According to local accounts, the practice started with Apo Anno, an Ibaloi ancestor worshipped as a demigod who lived between 1100 and 1500 AD (Deter-wolf et al., 2016). According to local tales, a mountain goddess instructed Apo Anno to follow specific steps to preserve his body so that his spirit could join the gods (Pelila, 2020). Apo Anno, whose body was interred in a burial cave in Buguias, Benguet Province, is believed to be the first fire mummy in history (Picpican, 2003). The tale of Apo Anno became the basis for traditional Ibaloi mummification. Since then, locals and researchers have reported Ibaloi fire mummies in Baguio City and Buguias, Kabayan, La Trinidad, and Tuba in Benguet Province (Datar et al., 2016).

Historians coined the name ‘fire mummy,’ sometimes called Ibaloi or Kabayan mummy, and locally referred to as meking, because of the process of burning wood around the Ibaloi corpse seated on a ‘death chair’ (Picpican, 2003). The fire mummies are essential parts of the Ibaloi culture, hence their declaration as a Philippine cultural treasure in 1973 (Presidential Decree no. 260, 1973). Their care was assigned...
to the National Museum of the Philippines (Republic Act 4846). Inclusion of fire mummies and the Kabayan caves on the United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage List has been proposed (UNESCO, 2006) and is currently undergoing consideration. This review will describe the physical and chemical processes involved in the mummification process and its significance in Ibaloi culture. With the dearth of literature on traditional Ibaloi mummification, this paper aims to encourage more cultural and scientific studies on the Ibaloi fire mummies before these national treasures become lost over time due to natural causes or human interventions.

**Human Mummification and the Ibaloi Culture**

The traditional Ibaloi mummification process has been described in the literature (Keith, 1981; Datar et al., 2016). Unfortunately, historians found no written records of the traditional Ibaloi mummification process, which is known only from narratives passed down through the generations by oral traditions (Piombino-Mascalí et al., 2017). Mr. Baban Berong, the honorary Igorot curator of the Kabayan burial sites, provided information about the mummification processes, e.g. preprocessing, smoking, and postprocessing. The most important part of the traditional mummification process is the smoking process (Beckett et al., 2014).

The preprocessing starts immediately after death. Four liters of concentrated salt solution is forced orally into the body, a process called ‘saltwater purge’ (Keith, 1981; Beckett et al., 2014; Siao, 2014). The body is washed with cold water and plant materials to clean and disinfect the external body parts (Keith, 1981; Beckett et al., 2014, 2017). The corpse is seated on a high wooden chair called the ‘death chair’ (sangachil or sangadíl). The head of the corpse is tilted backward with the aid of a funerary blanket (kolebao or pinagpagan) or scarf (sinaluhbo), and the arms and legs are tied closely to the torso (Picpican, 2003; Beckett et al., 2014, 2017; Piombino-Mascalí et al., 2017). The overall orientation of the body resembles an almost-fetal position (i-asal). The body is secured in place by tying another blanket from the torso or lap to the death chair, followed by wrapping its entirety with a death blanket (Beckett et al., 2014; Siao, 2014). The death chair is tied to the stairs leading into a traditional Ibaloi house, with a jar placed under it to collect excess liquid from the body. After fluids have been drained, the body is removed from the death chair, and close relatives remove its epidermis (duduan). The body is again washed with cold water, rewrapped with the death blanket, and returned to the death chair. The body is ‘dewormed’ (begisan) by manually removing the worms and insect maggots infesting the skin of the corpse (Keith, 1981; Kohnen and Kohnen, 1986). The body, seated on the death chair, is positioned with a low woodfire directly lit below it to drive away flies and vermin (Beckett et al., 2014; Piombino-Mascalí et al., 2017). The fire also serves as a light source during the traditional rituals and evening festivities (Picpican, 2003). During the smoking process, rolled leaves of tobacco are lit to ‘smoke’ the mouth and face of the mummy, to expel worms from the body, and to preserve the internal organs (Aufderheide, 2003; Siao, 2014; Piombino-Mascalí et al., 2017; Beckett et al., 2017; Balangcad, 2018). When the body begins to shrink, plant concoctions are applied, and the body is placed under the sun to dry (Beckett et al., 2014; Piombino-Mascalí et al., 2017). In some accounts, the body is alternately sun-dried during the day and smoked during the night (Keith, 1981; Kohnen and Kohnen, 1986). The plant concoctions are applied to the body as preservatives, hardeners, and insect repellants (Keith, 1981; Siao, 2014). The fire mummy is then laid to rest in a wooden coffin (kalong) and placed inside the burial caves (Pelila, 2020). The traditional Ibaloi mummification process is summarized in Table 1.

The Ibaloi fire mummies were believed to be around 150–200 years old based on archaeological estimates (Beyer, 1947). Radiocarbon dating (RCD) analyses estimated the mummies to be around 500–800 years old (Picpican, 2003; Salvador-Amores, 2012). A separate RCD of a rib sample dated it to be about 185 ± 45 years old—a value closer to Beyer’s estimates (Beckett et al., 2017). Notably, the mummy of Apo Anno has not been subjected to RCD.

### Table 1. Summary of the important steps in traditional Ibaloi mummification, highlighting the physical and chemical processes involved

| Traditional Ibaloi mummification steps | Physical processes involved                        | Chemical processes involved       |
|---------------------------------------|---------------------------------------------------|----------------------------------|
| **Preprocessing**                     |                                                   |                                  |
| ‘Saltwater purge’                     | Potential dehydration of the body and fecal excretion | None                            |
| Washing                               | Removal of dirt and physical debris               | None                            |
| Sitting of the body on a ‘death chair’ | Body fluid draining                               | None                            |
| Wrapping the body                     | Body fluid evaporation                             | None                            |
| Removal of the epidermis and deworming| Prevents insect-related decomposition process      | None                            |
| **Smoking process**                   |                                                   |                                  |
|                                       | Enhanced dehydration, expulsion of parasites and worms | Antisepsis and arrested oxidation of soft tissues |
| **Postprocessing**                    |                                                   |                                  |
| Sun-drying of the body                | Complete desiccation of the body                  | None                            |
| Application of plant concoction to the body | Prevents insect-related decomposition process       | Antisepsis and potential hardening of the skin |
Physical Processes in Traditional Ibaloi Mummification

Based on the oral narratives, traditional Ibaloi mummification involved physical manipulations of the body. To find scientific proof to support this local belief, various archaeologists and anthropologists have studied the fire mummies over the years.

The saltwater purge step was the first presumptive physical process and was believed to preserve the body by inducing a laxative effect (Aufderheide, 2003). Researchers assumed that intracellular fluids were expelled from the digestive cavity, resulting in dehydration. The saltwater induced fecal excretion, reducing the gastrointestinal system’s bacterial load (Aufderheide, 2003). Some researchers disagree with these intuitive deductions because saltwater could not have reached the bowels through peristalsis because this body function stops after death (Beckett et al., 2017; Piombino-Mascali et al., 2017).

There is also no support for the belief that internal organs were removed through an anal route (Aufderheide, 2003). Although some mummies have enlarged anuses, the abdome’s actual radiographic studies revealed internal organs in different states of preservation still present inside the mummies. Video endoscopy studies did not reveal any remarkable findings (Beckett et al., 2017).

Physical examination of the mummies showed that they were of different sexes and ages (Piombino-Mascali et al., 2017). Smaller coffins in the Kabayan burial caves contained babies or small children (Datar et al., 2014; Siao, 2014). Hence, mummification was not exclusively reserved for the male hierarchy. It seems that mummification was a common practice for the ancient Ibaloi, although locals believe that only the community’s wealthy members could have afforded it (Picpican, 2003).

Another noticeable feature of the Ibaloi mummies was the body orientation. The oral traditions confirmed the seated, almost fetal body position, with arms and legs pulled up to the torso. Although most archaeologists and historians agree that the mummy’s position was more of a cultural practice, some hypothesized that it served to minimize damages to the mummies during transport to the burial site (Siao, 2014). Some authors also indicated that the body’s position contributed to faster desiccation of the body by allowing more efficient drainage of body fluids (Beckett et al., 2017; Piombino-Mascali et al., 2017). No scientific evidence was available to justify these claims.

The textile imprints on the mummies were presumed to be from the death blanket used to secure and wrap the mummies (Piombino-Mascali et al., 2017). The wrapping step likely induced the excretion of body fluids by wicking action, thereby increasing body fluid evaporation (Beckett et al., 2017; Piombino-Mascali et al., 2017). Fabric in the nostrils, ears, and mouth served to prevent flies and other insects from entering the body (Keith, 1981).

The presence of leather, beige to brown skin (some excessively blackened) with the outer skin layer detached from the subdermal tissues has been reported (Datar et al., 2014, 2016). This observation corroborated the drying and smoking steps of the mummification process. Other researchers conducted a paleohistological examination of the soft tissue samples from two Ibaloi fire mummies (Piombino-Mascali et al., 2017). Desiccated tissue samples were rehydrated and stained with Masson’s trichome and hematoxylin–eosin stains. The gross histology showed that the tissues’ external parts were tanned compared to the inner sections, and presumptive carbon particles were detected in the tissues’ collagen fibers. These findings were consistent with smoke exposure, which was an integral step in the traditional mummification process. The predominance of collagen and muscle fibers was similar to histologic observations in Egyptian mummies. Hence, the Ibaloi mummification process must have been adequate to preserve the body’s soft tissues against environmental challenges over a long period (Piombino-Mascali et al., 2017).

Other presumptive physical processes in traditional Ibaloi mummification include the blowing of smoke from tobacco (Nicotiana tabacum), sun-drying of the body, and removal of the epidermis. Several authors have questioned the role of blowing tobacco smoke because the smoke blown into the mouth could not have reached the internal organs and preserved these (Beckett et al., 2014; Piombino-Mascali et al., 2017). Meanwhile, sun-drying was believed to complete the desiccation process. The reason for detaching the epidermis was unclear (Aufderheide, 2003; Piombino-Mascali et al., 2017), whereas removing worms and insect maggots was believed to have delayed the insect-related decomposition process.

Chemical Processes in Traditional Ibaloi Mummification

Chemical processes are also crucial in traditional Ibaloi mummification. Plant extracts and woodfire smoke provided chemical compounds that aid in faster and more effective mummification of the bodies.

Researchers used ethnomonotony to identify the specific plant species used. During the washing step, the water contained a decoction of guava (Psidium guajava) leaves (Balangcod, 2018), which has antiseptic properties and likely contributed to the elimination of skin microbes (Balangcod and Balangcod, 2018) and delayed microbially induced tissue degradation. Gooseberry (Physalis minima) and cherry tomatoes (Solanum lycopersicum var. cerasiforme) were also used in the washing step, albeit their contribution to the mummification process was unclear (Balangcod, 2018).

Beyer described sablut (Beyer, 1947) as a concoction used by the locals in his early account, but its composition was not included in the report. Locals consistently mentioned four plant species, namely lima beans (Phaseolus lunatus), guava (Ps. guajava), and two locally endemic plants, tibig (Ficus nota) and besudak (Embelia philippinensis), as components for plant concoctions. These solutions were believed to have been used for washing the dead (Balangcod, 2018; Balangcod and Balangcod, 2018). Other accounts described hyacinth bean (Lablab purpureus) as another component of the mixture (Beckett et al., 2017). To confirm the roles of these various plants in the mummification process, local researchers tested plant extracts for antibacterial activi-
ity against common bacteria such as *Bacillus cereus*, *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Salmonella typhimurium* (Balangcod and Balangcod, 2018). Results revealed the active antibacterial properties of the plant extracts, which was consistent with the traditional beliefs of the Ibaloi community.

Chemical processes during the smoking step increased the rate of body fluid evaporation and enhanced dehydration, thus preserving the soft tissue collagen fibers (Beckett et al., 2011, 2014; Beckett and Nelson, 2015; Piombino-Mascali et al., 2017). Researchers suggested that the smoke produced from the woodfire prevented oxidation due to the presence of acids, aldehydes, and phenolic compounds with antioxidant properties (Beckett et al., 2017; Piombino-Mascali et al., 2017).

**Traditional Ibaloi Mummification and Global Practices**

Although mummification practices across different regions are incredibly diverse, some share common properties. For instance, the step of washing the corpse is a general procedure in mummification, which has been well described for Egyptian, Buddhist, and Palermo catacomb mummies. For Egyptians, corpses were washed immediately after death and before any processes (Tacons, 2005). In contrast, Buddhist and Capuchin monks washed the corpses after the ‘self-mummification’ step or after the opening of the sealed tombs (Gildow and Bingenheimer, 2002; Piombino-Mascali et al., 2010) that happened at a much later stage. In traditional Ibaloi mummification, washing was done not once but twice. A body would be washed before it was seated on the death chair, and again after the peeling of the epidermis at a later stage of the process.

Historians also commonly report that mummification involves a wrapping process. The presumed purpose of the wrapping step was to preserve the form and prevent external corruption of the body (Wade and Nelson, 2013). In the South Korean Joseon mummies, archeologists indicated that wrapping of the bodies played a role in cutting off oxygen exposure, thereby preventing tissue oxidation (Shin et al., 2018). Wrapping may also induce a wicking effect on excess body fluids, thereby promoting dehydration (Beckett et al., 2017; Piombino-Mascali et al., 2017).

The ‘saltwater purge’ step described in the Ibaloi mummification process has not been recorded elsewhere. However, there have been reports of similar processes. For instance, in Shingon Buddhism, self-mummification involved drinking a ‘special tea’ (sap of urushi or Chinese lacquer tree, *Toxicodendron vernicifluum*) just before death. The tea promoted vomiting and sickness, which the locals considered essential to purging the body of fluids, thereby promoting dehydration (Beckett et al., 2017; Piombino-Mascali et al., 2017). The usual sources of these resins were pine (*Pinus* sp.), juniper (*Juniperus communis*), and cedar (*Cedrus libani*) trees. Egyptians used these resins to dry the skin and polymerize unsaturated fatty acids that served as barriers between the external environment and the body tissues (Davies, 2011). They also used cassia (*Cinnamomum cassia*), onion (*Allium cepa*), and henna (* Lawsonia inermis*) as antiseptic agents on the skin. In the Ibaloi concoction, local accounts mentioned guava (*Ps. guajava*) as the main antiseptic component. In Buddhist mummification, historians described the application of lacquer sap (*T. vernicifluum*) in the later steps of maintaining the body’s form (Gildow and Bingenheimer, 2002; Travagnin, 2006). The literature described no similar plant material in traditional Ibaloi mummification, although we suspect that the plant concoction’s hardening effect may serve the same purpose. Ethnobotanical studies on traditional Ibaloi mummification revealed the use of unique and endemic Philippine plants to form the concoction in preserving human tissues. This knowledge may add to the array of plant materials that may have applications in corporeal preservation.

Smoking appeared to have been a common practice as well. The modern Anga of Koke Village, Papua New Guinea, mummify their dead by placing the body on a high chair over a smoky fire for up to 30 days (Beckett et al., 2011; Beckett and Nelson, 2015). The Chinchorro mummification of Chile also involved smoking the corpse as an essential step, although the exact process is unknown (Arriaza, 1995; Swenson, 2014). Similarly, there are reports of corpse desiccation by smoking and sun-drying in Indonesia by the Dani (Außerheide, 2003), and in Colombia by the Muisca (Martínez et al., 2010). In hot and humid climates, such as in the Philippines, Papua New Guinea, Chile, Indonesia, and Colombia, smoking was a critical process for mummification (Außerheide, 2003). Anthropologists described the ritualistic use of fire during the funerary rites of the ancient tribes in Queensland, Australia but not for the purpose of preserving the bodies since these were eventually cremated (Haddon, 1908; McConnel, 1937; Außerheide, 2003).

The closest process to Ibaloi mummification is that of the Angas of Papua New Guinea. Specifically, the steps of smoking the body on a ‘death chair,’ scraping off the mummy’s epidermis, and collecting of excess fluids in a jar are similar to the traditional Ibaloi steps (Beckett et al., 2011). Unlike the Ibaloi, the Anga: (1) use bark cloth instead of ritualistic cloth for wrapping the body; (2) position the body in an upright sitting position instead of the almost fetal position; and (3) use ochre clay instead of a plant concoction. To date, there is no explanation for these similarities between populations that are geographically separated over long distances.

According to the Austronesian expansion hypothesis, the Philippine groups share genetic affinities with that of Taiwanese, island Southeast Asians, and the Pacific groups based on Y chromosome DNA, mitochondrial DNA, and autosomal DNA analyses (Delfin, 2015). In particular, the Ibaloi show common ancestry with other Austronesian speaking groups as revealed by mitochondrial genome-wide analyses (Delfin et al., 2014; Ko et al., 2014). While some anthropologists have proposed that the practice of mummifi-
cation could have been shared among ancient civilizations and passed on to Polynesian travelers during widespread migration (Lack, 1963; Gross, 2016), the actual origin of the mummification practices among the Ibaloi is still unknown.

Applications of Traditional Ibaloi Mummification

The traditional Ibaloi mummification process demonstrates the ingenuity and knowledge of the ancient Ibaloi. The knowledge and principles reflected from traditional mummification processes may have some applications in handling the dead. Adopting some of the physical and chemical processes of traditional Ibaloi mummification, such as the saltwater purge and locally prepared plant concoctions, might reduce the cost of embalming processes in very rural areas with little or no access to standard embalming facilities. Natural history museums may be able to replicate traditional Ibaloi mummification to preserve essential specimens. Characterizing endemic Philippine plants used in the mummification process can identify new sources of natural compounds with antimicrobial properties. The knowledge may also be used in improving the current state of Ibaloi fire mummies, which are deteriorating due to fungal infestation (Datar et al., 2014).

Conclusion

In this review, we have presented the need for scientific and cultural investigations to shed light on some of the unanswered questions about the traditional Ibaloi mummification process. The mummification process shows the rich culture and technical knowledge of the Ibaloi community in preserving human remains. By highlighting the physical and chemical processes involved in this traditional mummification process, we identified the scientific basis for the Ibaloi’s successful preservation of their fire mummies for many years. The information gathered from studying the fire mummies provided exciting insights into the culture of the Ibaloi community. We hope that this review will encourage more interdisciplinary investigations of the Philippines’ well-preserved mummies, marrying the concepts of social and natural sciences in understanding the history and culture of ancient human settlements in the country. Moreover, we hope to open discussions on the state of the remaining Ibaloi fire mummies, preserved for so long but now undergoing rapid natural decomposition due to climate change.

Conflict of Interest

The authors declare no competing interest.

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Author Contribution

M.B.C. conducted the literature review and wrote the paper; I.K.F.C. and M.C.A.D.U. provided input, discussed the review, and revised and approved the manuscript’s final version.

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