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Cover Page Footnote
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ON THE MOUNTING OF A SKELETON OF AN ASIAN ELEPHANT, *Elephas maximus indicus* (Linnaeus, 1758)

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ABSTRACT: Processing and drying bones and mounting the skeleton of an elephant require major modifications of standard techniques and engineering innovations. A skeleton was supported by three 1.5-inch (3.81-cm) diameter galvanized iron (G. I.) pipes through which the weight was transmitted to a pedestal and distributed evenly to the ground. Mounting of the heavy skull, vertebral column, scapulae and ribs required special arrangements. The problems involved are discussed here.

INTRODUCTION

Mounted skeletons of elephants are rare. Perhaps the commercial value attached to the bones, their huge size and heavy weight, the scarcity of complete skeletons, and the toilsome mounting work involving aspects of engineering account for their rarity.

The literature on elephantine skeletons has been provided by Blair (1710), Beddard (1902) and Osborn (1936, 1942). Valuable information has been added by Garrod (1875), Miall and Greenwood (1878), and Shoshani and Eisenberg (1982) regarding the skeleton of the Asian elephant. Shoshani et al. (1982) have listed the wet and dry weights of all bones. Further, various methods for processing bones and articulating the skeleton of small mammals have been proposed by Reynolds (1913), Johan (1924), Green (1934), Borell (1938), Laurie and Hill (1951), and Mahoney and Ferguson (1965). Such methods require major modifications and innovations for mounting the skeleton of a giant mammal like the elephant. Moreover, the technical procedures for similar works exhibited in the Natural History Museums of London, New York, Madras and Calcutta are mostly undocumented [pers. comm., Kim Bryan, British Museum (Natural History), London, 1984]. Therefore, an attempt has been made to record and discuss the relevant experiences and problems encountered by the authors.

MATERIALS AND METHODS

The skeleton belonged to a domesticated Asian bull elephant, *Elephas maximus indicus* (Linnaeus) named "Ganesh," after a Hindu God who bears the human body and an elephant head. It lived in Hubli City (Karnatak State, India) until it died at the age of about 24 years from an accidental electrocution when it was in service of a religious institution. Prior to burial of the carcass, the tusks were cut at the base of the trunk (since there were no plans for recovery of the skeleton) and were sold. At the time of mounting, the tusks were allowed to protrude to the maximum extent. The carcass was buried in Black Cotton Soil (vertisol) which is characterized by high clay content and semettite group of metals, low rate of infiltration and low concentrations of microfauna.

Exhuming and processing of bones

In August of 1971, nearly 10 months after the burial, the body was exhumed. Surprisingly, it was still not fully decomposed. After a careful excavation the skeleton was recovered. Separation of bones from skin and flesh, especially at the manus and pedes regions, was difficult.

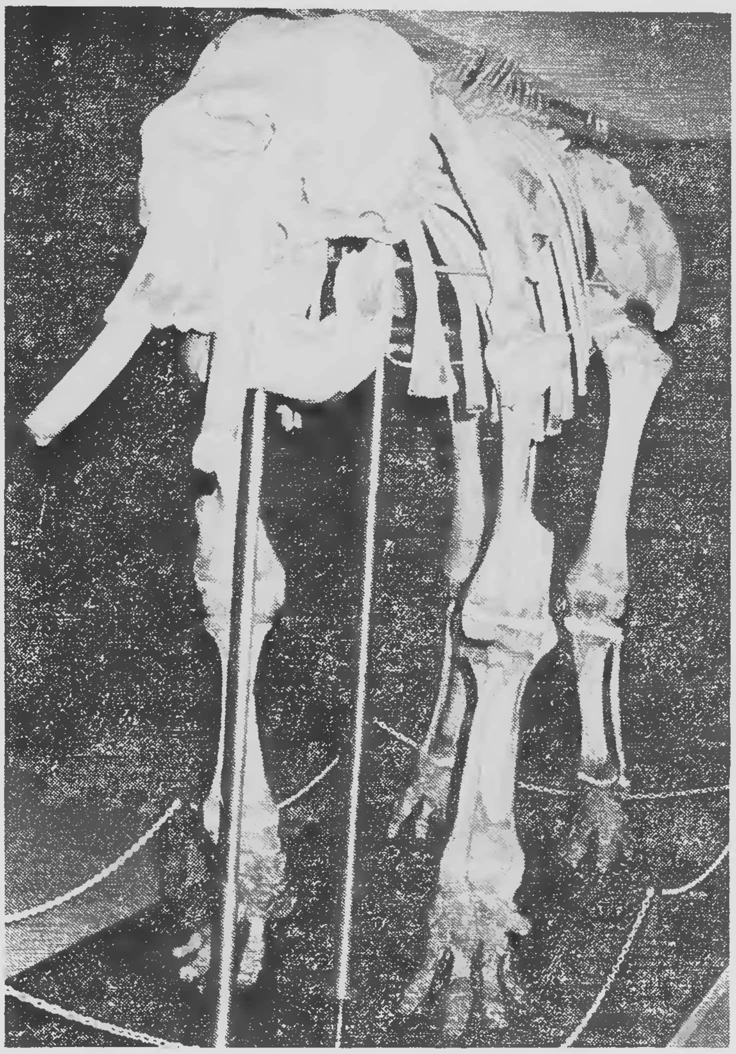
Drying the bones in the sun caused cracking. Chemicals like soluble-oil, petrol, and hydrogen peroxide were tried to dissolve fat from the bone marrow, but they proved inadequate for the purpose. However, continued drying of the bones in shade collected the fat at the ends of longer bones. The fat was removed by dipping the ends in dilute (between 1% and 3% depending on the amount of fat accumulation) sodium hydroxide ($NaOH$) or potassium hydroxide (KOH). While $NaOH$ dissolved the calcium from the bones, KOH gave better results. The duration of dip in KOH varied from 1-20 minutes depending on the amount of fat accumulated and the strength of KOH. In the meantime, all bones were coated with bleaching powder (sodium hypochlorite) paste for 24-48 hours to remove the scars. Repeated removal of fat, and bleaching, cleaned the bones. During the intervening period the bones were dried in a room with good ventilation, and were exposed to dermestid beetles. Nearly 20 months were required to cleanse and dry the bones and to remove their putrid smell.

The articulation and mounting

It was planned to use metal supports and internal joints through which the weight from top portions of the skeleton could be transferred to any one of the three Verticle Supporting Members (VSMs). The latter consisted of 1.5-inch (3.81-cm) diameter G.I. pipes supporting the skeleton respectively at the skull, pectoral and pelvic regions. Further, it was planned to interconnect the VSMs at shoulder- and hip-joint level through 0.5-inch (1.27-cm) diameter longitudinal pipes (Figs. 1 and 2). Articulation was conducted in the following order:

1. **Cranium:** A 3-inch (7.62-cm) wide thick-metal plate was fabricated to bear the weight of the cranium. It ran along the palate and up to the occipital condyles. Further, the center of gravity of the entire cranium was marked onto the plate, and the plate was rivetted to the cranium at the maxillaries and exoccipitals and then screwed to the tip of the first VSM at the marked center of gravity (Fig. 3).

2. **Mandible:** A second line demarcating the center of gravity of the lower jaw was drawn on the lower surface of the mandible. Another thick-metal plate, bent along this line, formed a stand to the lower jaw. The latter was toggled to the first VSM through a 2-inch (5.08-cm) diameter G.I. pipe welded to the stand (Fig. 3).



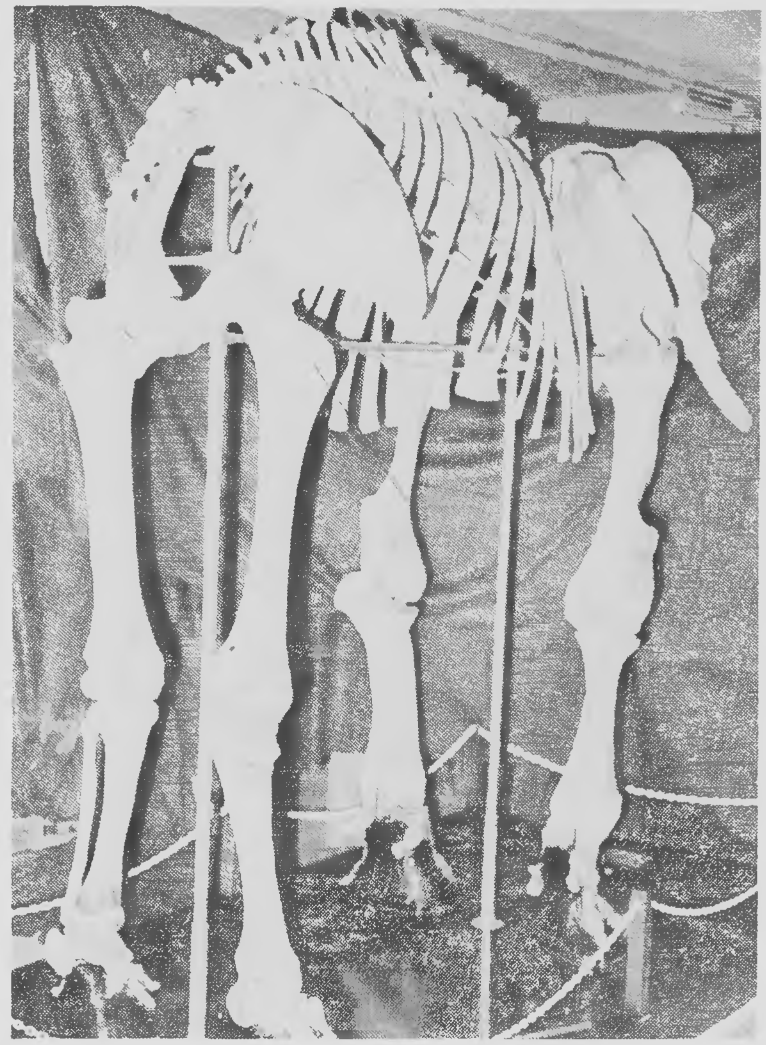
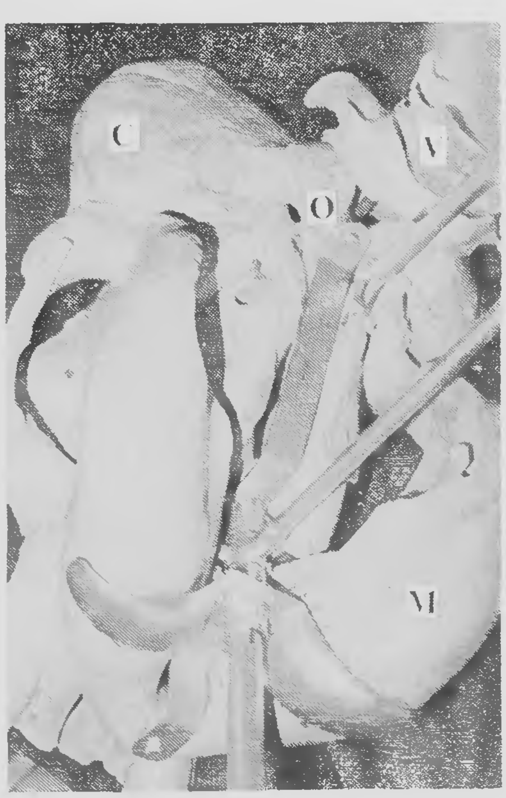


Figure 1 (left). Front view of the skeleton mounted at P. C. Jabin Science College, Hubli, India.

Figure 2 (right). Rear view of the skeleton shown in Fig. 1, depicting the Verticle Supporting Members (VSMs) interconnected with a longitudinal member.



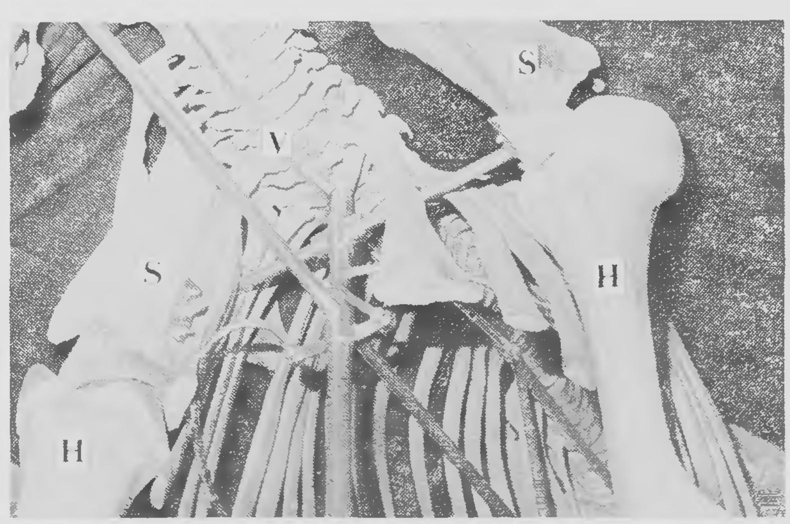
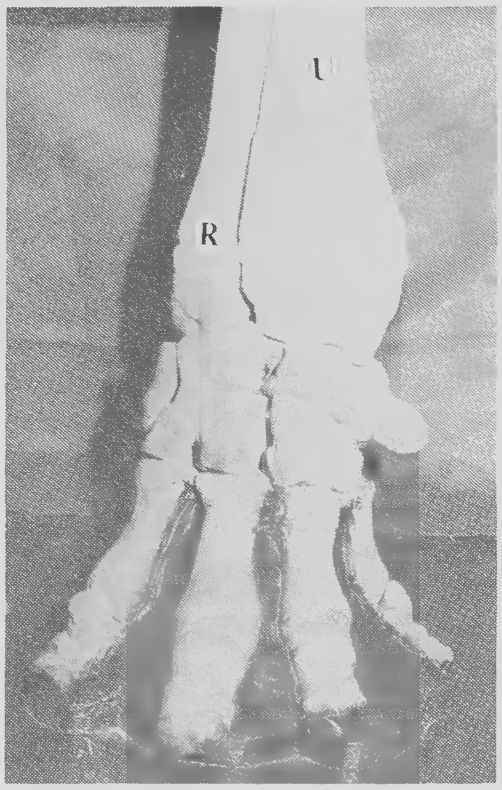


Figure 3 (left). Ventral view of the mounted skull: C = Cranium, O = Occipital condyle, V = Vertebral column, M = Mandible.

Figure 4 (right). Pectoral girdle and humeri: V = Vertebral column, S = Scapula, H = Humerus.



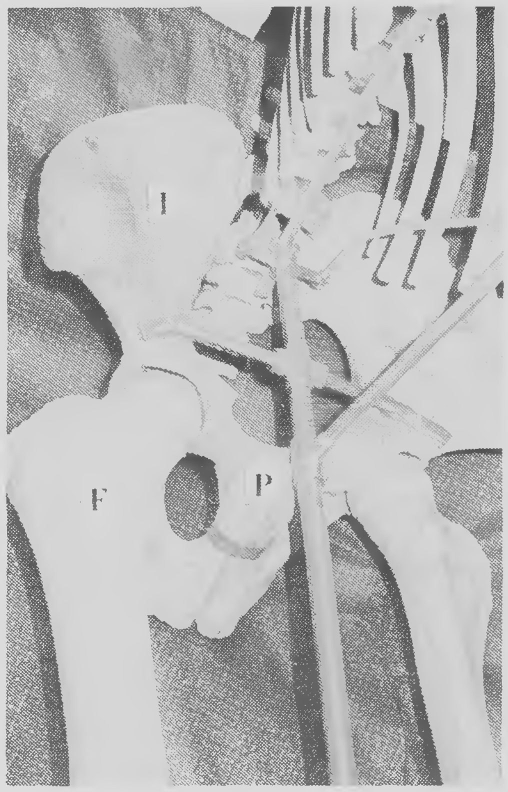
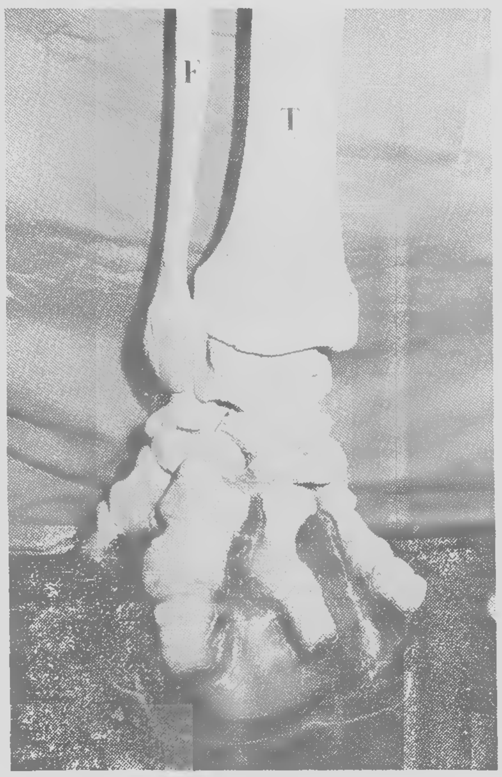


Figure 5 (left). Left manus and parts of foreleg bones: R = Radius, U = Ulna.

Figure 6 (right). Pelvic girdle and femora: I = Ilium, P = Pubis, F = Femur.



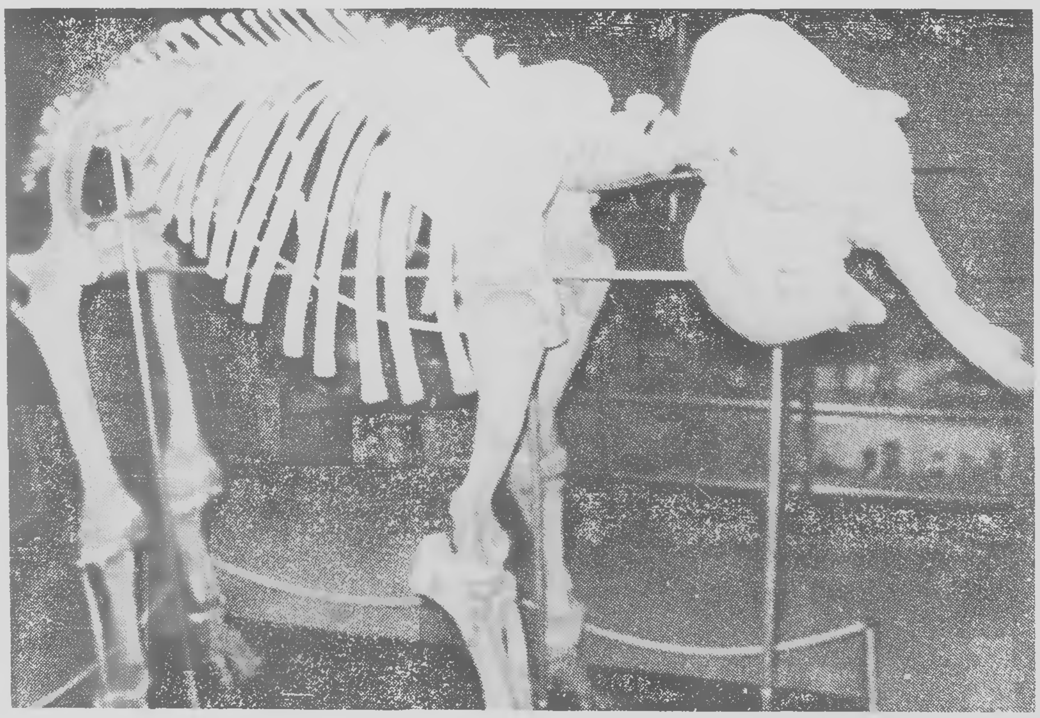


Figure 7 (left). Right pes and parts of hind leg bones: T = Tibia, F = Fibula.

Figure 8 (right). Profile view showing the three VSMs, interconnecting metals and the supports for the ribs.

The skull mounted on the first VSM was tested for tilting by holding it vertically on the floor. The height of the first VSM was adjusted by noting the position of the head from a live elephant in relation to the position of the vertebral column and scapulae.

3. **Vertebral column:** In order to articulate the vertebral column properly, individual vertebrae were tied together in position, the whole column was rested on the floor, and its shape was drawn on paper. A 0.5-inch (1.27-cm) diameter iron rod, prepared to the shape of the column and covered with rubber tubing, was passed through the neural canal. Subsequently, individual vertebrae were glued together with Araldite (Hindustan Ciba Gigy Ltd., Bombay, India). In addition, a continuous 1-inch (2.54-cm) wide metal strip bent to the shape also supported the column vertically. The vertebrae were rivetted to this strip at the bottom of their centra (Fig. 4).

The articulated vertebral column was mounted onto the second and third VSMs through half-moon shaped clips which helped it to remain in position. An additional small vertical support was also devised and was inserted inbetween the column at its highest point and the interconnecting longitudinal pipe. The vertebral column was also fastened to the skull by clamping the metal strip below the column to the metal plate that supported the cranium.

4. **Pectoral girdle and fore-limbs:** The scapulae were joined with a horizontal pipe. They were placed in their natural position with reference to a live elephant. The horizontal pipe was bolted to the second VSM at the appropriate height. The humeri were hung on the horizontal pipe by internal joints passing through the glenoid facets of the scapula (Fig. 4). The weight of the radii and ulnae was taken to the platform via iron rods which were passed through the center of the bones. Other bones at the carpus (wrist) and manus (palm) were held in position by a plaster of Paris mold that resembled the manus (Fig. 5). Plaster of Paris was also used to fill the cracks between the epiphyses and diaphyses on the long bones.

5. **Pelvic girdle and hind-limbs:** The pelves clipped together at the pubic region were fastened to a horizontal pipe which was further bolted to the third VSM. The weight of the femora was transferred to the horizontal pipe by way of internal joints passing through the acetabular facets (Fig. 6), whereas the weight of the tibiae and fibulae was passed down to the platform. Patellae were glued and rivetted at the patellar grooves. Tarsals, metatarsals, and phalanges were arranged in plaster of Paris molds to resemble pedes (Fig. 7).

6. **Ribs and sternum:** Two 0.5-inch (1.27-cm) diameter steel rods, connected to the second and third VSMs, were bent in such a way as to support all the ribs in position (Fig. 8). The ribs were glued at their articulation at the vertebral column and were rivetted from below to the respective rods with U-shaped clips. The sternum had lost its shape owing to crumbling and therefore was not fitted.

Construction of the pedestal

The skeleton was mounted on a wooden platform, measuring 297 cm long, 160 cm wide, and 2 cm high, and covered with plywood, details of which are given below. Three 2-foot long (60-cm) and two-inch (5.08-cm) diameter G.I. pipes were vertically welded to 2-foot x 1-foot (60-cm x 30-cm), heavy-metal plates. Further, the metal plates were bolted at their four corners to the two wooden logs which ran the whole length of the platform. The VSMs, inserted into 2-inch (5.08 cm) diameter pipes, rested vertically on the metal plates. To enhance stability, the longitudinal logs were crossed with four other logs which covered the full width of the platform. Thus, care was taken to distribute the weight of the skeleton evenly to the ground.

After confirming proper fitting, the skeleton was dismantled for final assembly. The cleaned bones were given a thin wax polish. The metal parts were galvanized. The final mounting was followed by construction of a plywood platform which concealed the wooden stand.

DISCUSSION

The carcass of the elephant was haphazardly buried in black soil with a low infiltration rate. As a result, recovery was difficult and the bones were unduly stained. In view of these hardships the following measures are suggested to facilitate the natural decay of a buried body and the bleaching of bones: 1) Burying the body in loose sandy soil, 2) making deep incisions at various places on the body, 3) removing hyoid apparatus and the sternum for separate processing, 4) cutting the skin at the abdomen and removing major portions of viscera, 5) placing lime, common salt and charcoal along with the carcass at the time of burial. The thick skin and hard muscles of the pachyderm render manual cleaning very cumbersome. Therefore, burial appears to be inevitable. Regarding the duration of burial, 8-10 months' time would be adequate provided the cartilaginous parts of the skeleton are spared for separate processing.

The huge size of elephant bones renders the chemical cleaning or enzyme treatment (Taylor, 1967) of them very costly. Moreover, the strength of such chemicals would be inadequate to penetrate the bones and clean the marrow. Therefore, the method employed in the present work appears to be cheaper and safer. The long duration required for such cleaning must be tolerated until faster methods for drying the bones are proposed.

In the standing posture, the highest point in the elephant skeleton would be the tip of the 11th thoracic vertebra. This was confirmed by having a few live domestic elephants stand in a relaxed position with their proboscis tips touching the ground. However, in some museum specimens (e.g., the Chengam elephant from the Natural History Museum, Madras, India), the skull is placed highly elevated and the height of the elephant is measured from this point. Whereas the shoulder height is considered as the standard for the height of an elephant, in a situation where the skull or the 11th thoracic vertebra are higher than natural on a mounted skeleton, the shoulder height can be obtained by aligning the tip of the scapulae with the tip of the 7th cervical vertebra.

The shoulder height of Ganesh's skeleton is 242.5 cm and the height at the tip of the 11th thoracic vertebra is 269.0 cm.

The pedestal, devised to distribute the weight of the skeleton evenly to the ground, enhances the stability and hence the "life" of the mounted skeleton. It may be noted that the mounted skeleton under discussion has not undergone any changes in the eleven years since its installation.

ACKNOWLEDGMENTS

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Editors' Note: The manuscript for this article arrived in our office while a team of people was working on cleaning the bones of "Iki" the elephant (see ELEPHANT NOTES AND NEWS in this issue) and thus we tried to degrease and bleach the bones as reported in this article. Unfortunately, when the bones were placed in "weak potassium hydroxide" (3 Molar KOH) solution, they became too soft and started to disintegrate. Some cracked severely upon reexposure to air. The use of chlorine bleaches, even in short immersions and in weak solutions, caused the bones' surface to flake off. We shall report our results with different chemicals at a later date.