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ARTICLE

# The Vertebral Formula of the African Sideneck Turtle *(Pelusios castaneus)*

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**SUMMARY**
An osteological analysis of the vertebral column of the African sideneck turtle (Pelusios castaneus), was carried out with the view of deriving its vertebral formula which could be useful in the comparative systematic anatomy of sea and freshwater turtles as well as in paleontological and archaeological investigations. A total of sixty five adult African sideneck turtles comprising twenty five females and forty males picked up at different times in various river banks in Ibadan, Nigeria, were used for the study. The average body weight of the turtles used for the study was 0.82 ±0.03kg. The curved carapace and plastron lengths of the turtles were 26.4 ±1.87cm and 19.3 ± 1.13cm, respectively. The turtle has eight cervical vertebrae of which the first seven (craniocaudally) were mobile and the last fused with the ventral surface of the carapace and articulated caudally with the first thoracic vertebra. The thoracic vertebrae were seven in number, the last thoracic vertebra articulated with the first sacral vertebra. Three sacral vertebrae were identified in the animals while 15 caudal vertebrae were constantly encountered in all the turtles. The vertebral column of the African side neck turtle consists of 33 vertebrae and its formula can be expressed as C8T7S3Cd15. This formula, the first of its kind in literature is therefore named as the African sideneck turtle vertebral formula (of Olukole) and therefore serves as baseline information on the vertebral column of the turtle.

**KEY WORD:** Anatomy; Carapace; Freshwater Turtle; Skeletal System; Vertebral Column.

## INTRODUCTION

African sideneck turtles are relatively small to medium sized freshwater turtles widely distributed in Africa (Anderson, 1995; Broadley and Boycott, 2009). The African sideneck turtle (Pelusios castaneus) is a freshwater turtle of the family Pelomedusidae, widely distributed in West Africa, occurring from Guinea and Senegal to northwestern Angola (Kirkpatrick, 1995).Turtles of the genus Pelusios are occasionally eaten by indigenous people, but their foul-smelling musk secretions probably serve to discourage more regular consumption. They are also low in demand for pet trade (Boycott and Bourquin,

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2000). In South-western Nigeria, the P. castaneus among other freshwater turtles are also high in demand for several tradomedical and fetish purposes.

The skeletal system of turtles can be divided into three: the skull, axial and appendicular skeletons. The axial skeleton of turtles is composed the carapace, vertebrae, ribs and the derivatives of the ribs while the appendicular skeleton includes the forelimbs (flippers in sea turtles), hind limbs and their supporting structures (Wyneken, 2001). The vertebral column of mammals had been described to consist of morphologically differentiated groups of vertebrae: cervical, thoracic, lumbar, sacral, and caudal (Burke et al., 1995; Levine et al., 2007) while that of turtles consists of the cervical, thoracic, sacral and caudal vertebrae (Sanchez-Villagra et al., 2007). The entire thoracic and sacral vertebrae are usually fused to the carapace of turtles while only the last cervical vertebra fuses with the carapace (Wyneken, 2001).

Studies on the conservation, nutrition and history of migration of the genus Pelusios had been documented (Broadley and Boycott, 2009). Recent research report on the genus Pelusios had been on blood parameters of the African sideneck turtle (Omonona et al., 2011). Studies on the vertebral formula of mammals had been well reported by a number of authors (Aimi, 1994; Burke et al., 1995; Hilderbrand and Goslow, 2001; Narita and Kuratani, 2005). The skeletal system of sea turtles had been documented by Wyneken (2001). There is the paucity of research reports on the basic anatomy of the skeletal system of the P. castaneus.

The search web literature showed that there is no information on the vertebral column of the P. castaneus. There is therefore the need to investigate the basic anatomy of the vertebral column of the P. castaneus. This study was therefore designed to investigate into the number and structural arrangement of the vertebrae of the P. castaneus with the view of deriving the vertebral formula of the turtle.

## MATERIALS and METHODS

A total of thirty adult P. castaneus comprising fifteen females and fifteen males picked up at different times in various river banks in Ibadan, Nigeria, were used for the study. The animals were kept in artificial ponds and were stabilized for 72 hours prior to the investigations carried out. They were fed with commercial fish pellets ad libitum. Standard body parameters were all determined using a Draper® 115 mm vernier caliper and metric tape. The body weight of the animals was taken with the aid of a Microvar® weighing balance. The turtles were anaesthetized using ketamine HCl at 25mg/kg body weight intramuscularly at the medial aspects of the thigh muscle and then sacrificed by cervical decapitation. The preparation of skeletons of the animals was obtained through hot water maceration (Sommer and Anderson, 1974). The inner parts of the carapace and bones were then washed with sodium hypochloride and detergent to expose the vertebral column. The arrangement and number of the bones of the vertebral column were investigated.

## RESULTS

The average body weight of the turtles used for the study was 0.82 kg (0.580 -1.20 kg). The mean curved carapace and plastron lengths of the turtles were 26.4 ± 1.87cm (20.3- 28.5 cm) and 19.3 ± 1.13cm (17.8-21.2 cm), respectively. There were 8 cervical vertebrae of which the first seven (craniocaudally) were mobile (figure 1) and the last fused with the inner surface of the carapace and articulated caudally with the first thoracic vertebra (figure 2).

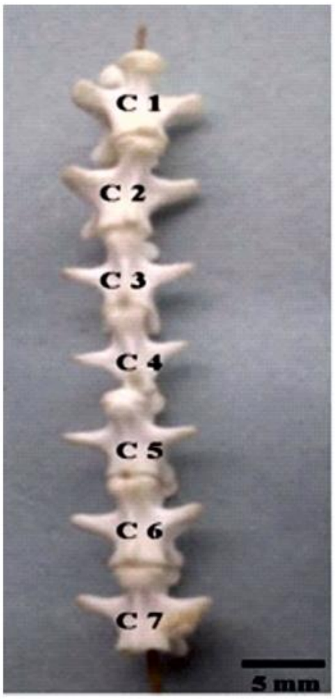


**Figure 1.** Dorsolateral view of the cervical vertebrae of the African sideneck turtle (Pelusios castaneus) showing the first seven (mobile) vertebrae. C1-C7: First to seventh cervical vertebrae.

In each of the turtles observed, there was the fusion of the dorsal vertebrae (the last cervical, the entire thoracic and the sacral vertebrae) with the ventral surface of the carapace. The ribs with the dermal bones form the pleurals while the neural bones lied ventral to the thoracic vertebrae. The

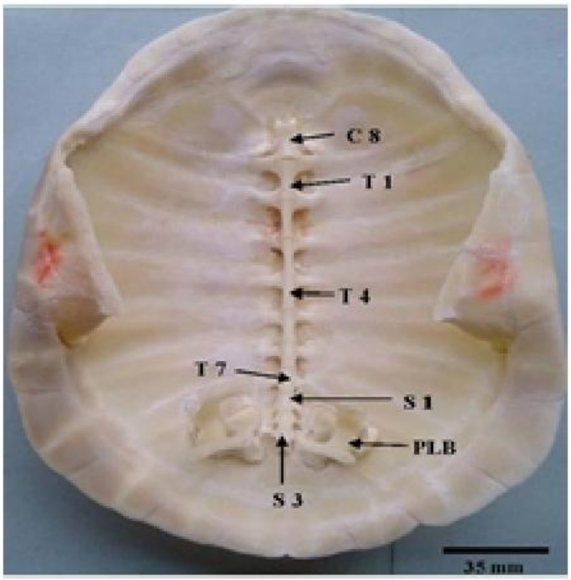


**Figure 2:**The ventral view of the carapace of the African sideneck turtle (Pelusios castaneus) showing the dorsal vertebrae and their relations. C8: Eighth cervical vertebra (fused to the carapace); T1to T7: First to seventh thoracic vertebra; S1 to S3: First to third sacral vertebra; PLB: Pelvic bone (fused to the carapace and relates medially with the lateral processes of the sacral vertebrae).

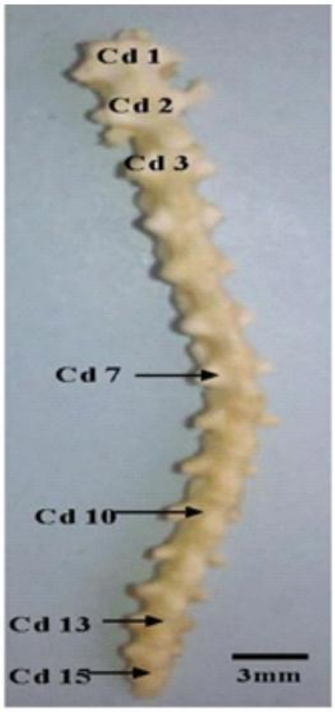


**Figure 3.** The dorsal view of the caudal vertebrae of the African sideneck turtle (Pelusios castaneus). Cd1 to Cd15: First to fifteenth caudal vertebra.

thoracic vertebrae were 7 in number and the last thoracic vertebra articulated with the first sacral vertebra (figure 2). The thoracic vertebrae decrease in length distally with their width decreasing cranially. Each of the thoracic vertebrae is composed of a separate dorsal arch and ventral vertebral body. The ventral body articulates bilaterally with a pair of ribs. In all the turtles studied, the rib heads were aligned with the junctions of

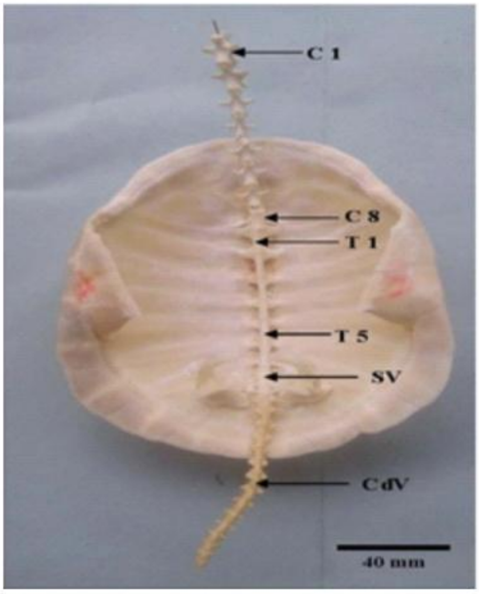


**Figure 4.** The ventral view of the carapace of the African sideneck turtle (Pelusios castaneus) showing the anatomical relations of the components of the vertebral column in the animal. C1 and C8: First and eighth cervical vertebrae respectively; T1 and T5: First and fifth thoracic vertebrae respectively; SV: Sacral vertebrae; CdV: Caudal vertebrae.

adjacent vertebral bodies.

There were 3 sacral vertebrae which jointly form attachment for the hip bones laterally on both sides of the median plane of the animals (figure 2). In all the turtles studied, the lateral processes of the sacral vertebrae were not fused with the carapace. These lateral processes were observed to form articulations with the ilium. A very prominent feature on each of the sacral vertebrae was the dorsal sacral foramen that accommodates vessels supplying the sacrum and the articulating hip joint. A total of 15 caudal vertebrae were consistently observed in all the animals regardless of size and sex (figure 3). However, the caudal vertebrae of the female were shorter than those of the males and decreased in size more distally than those of the males. In addition, the caudal vertebrae of the males had more extensive dorsal and lateral processes than those of the females. Hence, the vertebral column of the African sideneck turtle consists of 33 vertebrae and its formula can be expressed as C8T7S3Cd15 (figure 4). This formula, being the first of its kind in literature is therefore named as the P. castaneus vertebral formula (of Olukole).

## DISCUSSION

The knowledge of the arrangement and number of the bones of the vertebral column of the P. castaneus is important in the understanding of the normal gait of the animal and the types of motion permitted along the spine. Vertebral column biomechanics had been used to explain normal gait and pathologic stress on the spine of domestic animals (Levine et al., 2007). The number and arrangement of the cervical vertebrate of the P. castaneus are similar to that reported in the sea and freshwater turtles and the fusion observed between the last cervical vertebra and the carapace is typical of all turtles (Walker, 1973; Wyneken, 2001). This fusion could be related to the stability of the neck and spine thereby preventing the over-extension of the neck during motion. The vertebral arches of the successive cervical vertebrae have articulating processes with sliding joints that allow limited dorsal–ventral bending of the neck, but little twisting (Wyneken, 2001). However, the number of cervical vertebrae being constantly eight in turtles differentiates them from mammals where the number is constantly seven and has been almost fixed by certain mammalian specific developmental constraints (Zangerl et al., 1988). The number of mammalian cervical vertebrae has been reported to be constant at seven, irrespective of the neck length of different species (Narita and Kuratani, 2005).

The arrangement and articulations between the ribs and thoracic vertebral in the African sideneck turtle is similar to those of the Green turtle described by Wyneken (2001). Nevertheless, the number of thoracic vertebrae in the Green turtle and many sea turtles had been reported as ten unlike those of the P. castaneus being seven. This finding is not in conformity with the report of Wyneken, 2001 on the possession of ten thoracic vertebrae by sea turtles. The P. castaneus, like all turtles lack the lumbar vertebrae found in mammals (Wyneken, 2001; Sanchez-Villagra et al., 2007, 2009). The presence of the lumbar vertebrae in mammals may be responsible for the ability of mammals to twist their (trunk) unlike turtles whose twisting of the entire body is mainly by the neck. The number and arrangement of the sacral bones of the P. castaneus are similar to those reported in other turtles. Two to three sacral vertebrae had been reported by Wyneken (2001) in most sea turtles. Also, the number and morphological dispositions of the caudal vertebrae in the turtles studied are in conformity to previous report by Wyneken (2001) that turtles have 12 or more caudal vertebrae and that there exist a sexual dimorphism in the morphology of the caudal vertebrae in turtles. Male turtles usually have longer tail than their female counterparts, nevertheless, the study had shown that this longer length does not mean that the caudal vertebrae are more in the male than in the female; rather, they are longer.

The P. castaneus vertebral formula (of Olukole) derived by this study provides necessary information which could be of assistance in forensic anthropological studies as well as serving as a baseline data needed in the comparative osteology of sea and freshwater turtles; especially those of the family Pelomedusidae.

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