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Study Anatomy of Vertebrae Caudalis Asiatic Water Monitor (*Varanus salvator*)

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Abstract. Asiatic water monitor lizard (*Varanus salvator*) is a type of reptile that can be found in several countries on the Asian continent. In Indonesia this species can be found in the Sunda plain (Java, Bali and Nusa Tenggara) and Maluku (the Sula and Obi islands). Asiatic water monitor lizard is long tailed reptile. The functions of tail as a movement aid, to maintain balance, a place to store energy, sexual appearance, and reproduction. The caudalis vertebrae in asiatic water monitor lizard (*Varanus salvator*) has a structure consisting of centrum, processus, cotyle, condilus, and constriction area. To observe the caudal vertebrae in monitor lizards the experiment was done by cleaning all the sticky tissue, then observed using a stereo microscope with a magnification of 0.8X. The result showed that blood vessels and nerve tissue were protected by sturdy bones.

Keywords: Asiatic water monitor (*Varanus salvator*), macroanatomy, *Vertebrae caudales*.

INTRODUCTION

The genus of Varanus has more than 70 species spread across the continents of Africa, Eurasia and Australia (Conrad et al., 2012). According to André Koch & Wolfgang Böhme (2010); De Lisle., 2007; Del Canto., 2007 and Shine et al., 1996 in Mahfud et al., 2015, the genus varanus were spread from Sri Lanka, India, Bangladesh, Burma, Vietnam, Hainan (China), Malaysia, the Philippines and Indonesia. In Indonesia it spreads from the islands of Sumatra, Kalimantan, Flores and Sundanese islands (Java, Bali, Nusa Tenggara except Timor) (Mahfud et al., 2017), Celebes and Maluku. Asian monitor lizards (*Varanus salvator*) are generally diurnal (active during the day) (Uyeda et al., 2013). The activity starts from sunrise to sunset. Most of the activities are eating, swimming and reproducing. Those activities are common for the large reptiles (Karunarathna et al, 2017).

Adult *Varanus salvator* can reach ± 2.5-3 meters in length and weighs up to 20-50 kg (Shine et al., 1998; Waza, 2013 in Mahfud et al., 2015). Morphologically this animal has a long tail. Rectangular tail scales with the number of scales around the base of the tail totaling 106 scales (André Koch & Wolfgang Böhme, 2010). In reptiles the tail starts from the sacral vertebra to the tip of the tail, which is then called the caudal vertebra. The tail has several functions including as a balance tool, for swimming, fat storage, self-defense and reproduction tools (Etheridge, 1967).

In reptiles, vertebrates are divided into five types, namely, cervical vertebrae, thoracic vertebrae, lumbar vertebrae, sacral vertebrae, and caudal vertebrae (Withers & O'Shea, 1993; Kent, 1987). Conrad et al., (2012) suggested that each vertebra consists of condyle, crista prootica, precondylar constriction area, prezygapophysis, pseudozygosphene, and synapophysis.

MATERIALS AND METHODS

In this study, adult monitor lizards obtained from the river were used as the sample. Lizard tails were separated from the body and soaked in 40% formalin solution. Observation of vertebrae was done by removing the skin, flesh, muscles and all the tissues attached to the vertebrae. The data obtained in this research was the images of vertebral structures taken with digital camera. The images were analyzed for each of the parts and compared with the image from the literature.

RESULTS AND DISCUSSION

Based on observations that have been made, it showed that the type of caudal vertebrae in monitor lizards is procelous (figure 1). This type was similar with the one in *Lacerta vivipara* (Pratt., 1946 in Soesilo., 1982), Lygosoma laterale and Anolis carolinensis (Cox, 1969 in Soesilo, 1982), *Hemidactylus frenatus* (Rakhmiyati, 2012).

Procelous types can be found in some fish, amphibians and reptiles. The procelous shape has a

characteristic that is the concave on anterior surface while the posterior surface is convex (Romer., 1962; Messer, 1956; Kent & Carr, 2001) (figure 2).

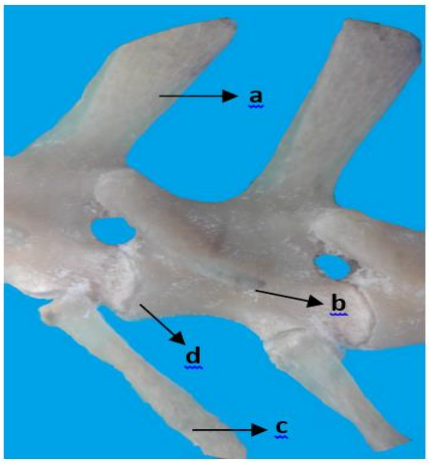

Figure 1. Whole tail vertebrae preparation of Asiatic Water Monitor Lizard (Varanus salvator). Magnification 0,8X, a. Processus dorsal; b. Processus transversal; c. Processus ventral; d. Intervertebra pad.

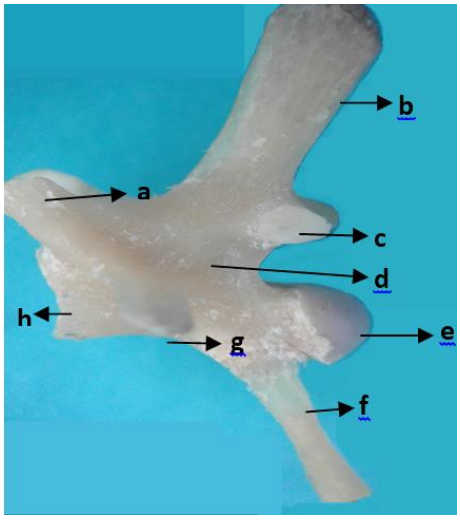

Figure 2. Caudalis vertebrae (transversal view). Magnification 0,8X. a. Prezygapophysis; b. Processus dorsal; c. Postzygapophysis; d. Precondylar constriction area; e. Condilus; f. Processus ventral; g. Processus transversus; h. Cotyle.

The surface of the condyle is very smooth because the surface is covered by white cartilage (figures 2 and 3). The dorsal side has a dorsal process as a dorsal muscle attachment site. On the right and left sides of the lateral transverse processus which is also used as a muscle attachment. The presence of muscle contractions causes the tail to move. The dorsal process is longer than the ventral process. When viewed from the side it is clearly seen that there is a narrowing area that located under the dorsal processus on the right and on the left side of neural canal.

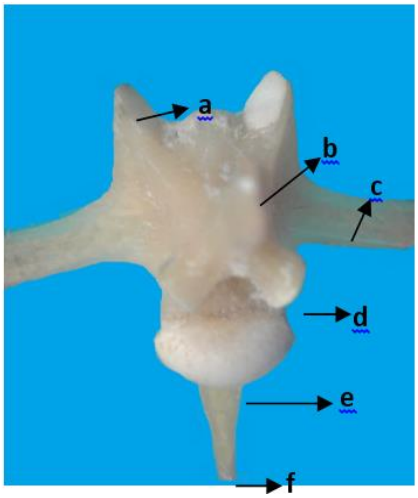

Figure 3. Caudalis vertebrae (dorsal view). Magnification 0,8X. a. Prezygapophysis; b. Processus dorsal; c. Processus transversus; d. Postzygapophysis; e. Condilus; f. Processus ventral.

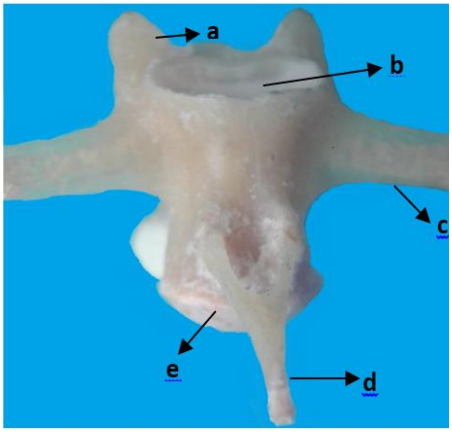

Figure 4. Caudalis vertebrae (ventral view). Magnification 0,8X. a. Prezygapophysis; b. Cotyle; c. Processus transversus; d. Processus Ventral; e. Condilus.

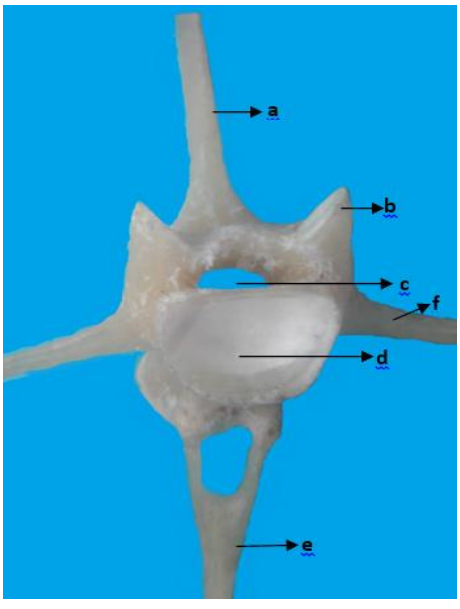

Figure 5. Caudalis vertebrae (anterior view). Magnification 0,8X. a. Processus dorsal; b. Prezygapophysis; c. Neural canal; d. Cotyle; e. Processus Ventral; f. Processus transversus.

Observations from the dorsal side showed that the length of the transverse process was similar between right and left side. Prezygapophysis is on the anterior side and the surface is not upright facing upwards but is slightly tilted face to face. Whereas postzygapophysis is on the posterior side and the surface faces the ventral but is tilted sideways so that it turns to each other (figure 3).

Figure 4 and 5 show that the cotyle surface is concave. This shape is very suitable because the cotyle performs as attachment site to the convex shape. The color of the cotyle surface is white.

The structure of the caudal vertebra in the Asian monitor lizard also has a neural canal on the dorsal side as a place for nerve tissue. It also has a caudal vein in its ventral process as a place of blood vessels in the tail (figure 5).

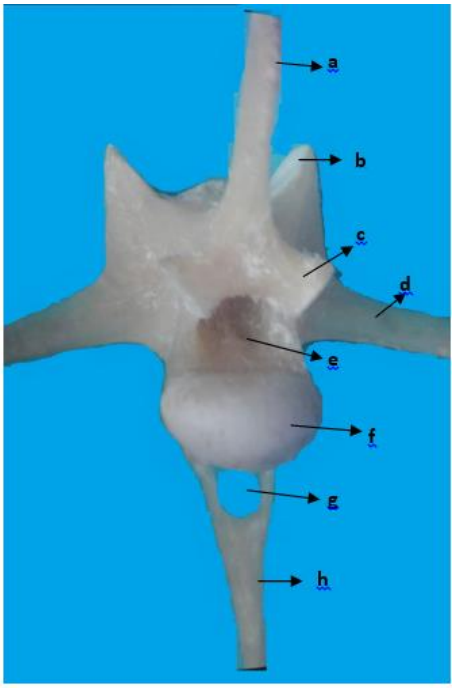

Figure 6. Caudalis vertebrae (posterior view). Magnification 0,8X. a. Processus dorsal; b. Prezygapophysis; c. Postzygapophysis; d. Processus transversus; e. Neural canal; f. Condilus; g. Cudal vein; h. Processus ventral.

The tail of the Asian monitor lizard (*Varanus salvator*) is very important organ, therefore blood vessels and nerves are protected by strong bones (figure 6). This is related to the function of the tail as a tool for balance when move.

Lizards (*Varanus salvator*) at the base of their tails which have a length of 50% of the total body length can produce sinusoidal oscillations. Skeletal muscle in the tail is a dynamic tissue and has functional properties. Heterogeneous functional properties are influenced by the diversity of the myosin isoforms and molecular components in a single muscle fiber. In the tail there are two types of muscle; axial muscle and the caudofemoral muscle which are the main retractors of the femur. The flat lateral processus bone structure is a suitable place of muscle attachment. The attachment was strong so that it can produce a tail motion that functions as a balance. In monitor lizards, one to four toes are arranged in parallel because the function are for climbing and digging (El-Bakry et al., 2013).

CONCLUSION

The caudal vertebrae in Asian monitor lizards were procelous type. The structure was very complex, which was consist of the dorsal process, ventral process, lateral processus, narrowing region, condyle, cotyle, neural canal, caudal vein, prezygapophysis and postzygapophysis. The tails of monitor lizards can produce sinusoidal oscillations that can be used when swimming.

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