# ELECTROCARDIOGRAPHIC PROFILE OF CAPTIVE MARBLED WATER MONITOR LIZARD (*Varanus marmoratus,* Weigmann, 1834)

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## ABSTRACT

**Electrocardiography is a very useful procedure for examination of cardiac disorders in animals. However, very few electrocardiographic (ECG) studies have been conducted on reptiles. ECG examination was conducted to obtain the baseline values of 14 captive marbled water monitor lizards (*Varanus marmoratus*) at a wildlife facility. The ECG values of the monitor lizards were compared according to gender (ten male and four female), length (nine small and five large) and weight (nine <2 kg and five 2 kg and above). Results of the study determined that the length of the animal positively affected the QRS segment. Gender and weight have no significant effect on the electrocardiographic parameters of the monitor lizards. The ECG profile obtained in the study can be used as a reference for examination of cardiovascular disorders in marbled water monitor lizards.**

Keywords: electrocardiography, heart, marbled water monitor lizards

## INTRODUCTION

Monitor lizards have become the focus of many conservation projects and are also rising in popularity as exotic pets. The marbled water monitor lizard (*Varanus marmoratus*) is a species endemic to the Philippines, commonly found in a number of islands in Luzon. Although they are still considered as least concern by the International Union for the Conservation of Nature (IUCN), their population is continuously threatened by human encroachment, hunting and the illegal pet trade (Gaulke *et al.*, 2009).

Major problems of captive monitor lizards usually involve internal and external parasites and injuries like rostral trauma and burns. Internal parasitism can cause appetite loss and weight loss, lethargy, bloating, constipation and vomiting. External parasites, like mites, on the other hand, can drain a significant amount of blood from the lizard, which leads to loss of appetite and weakening of the immune system. Captivity could also cause obesity due to lack of exercise, especially when their enclosures are not big enough. Obesity, in turn, could lead to cardiovascular problems in these captive varanids. Therefore, there is a growing need to study the

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various physiologic functions, behaviors and nutrition status of these animals in captivity which can affect their rehabilitation and overall survival.

Previous studies have proven the effectiveness of electrocardiography in diagnosing different cardiac problems in reptiles (Martinez-Silvestre *et al.*, 2003). The reptiles' electrocardiographic (ECG) waveforms have been determined to be similar to mammals. Usually, a deviation from normal values would mean a cardiovascular disease or defect is present in the animal (Morris *et al.*, 2003; Homoud, 2008).

This study was conducted to provide ECG profile of apparently healthy captive marbled water monitor lizards (*Varanus marmoratus*). Furthermore, the study characterized the profile of the monitor lizard's heart which could aid veterinarians in assessing and diagnosing cardiovascular problems in the species.

## MATERIALS AND METHODS

Fourteen apparently healthy marbled water monitor lizards were used in the study. They were classified according to: a) gender, male (n=10) or female (n=4); b) length, small (56-67 cm, n=9) or large (68-87 cm, n=5); and c) weight, light (<2 kg, n=9) or heavy (2 kg and above, n=5). The animals were restrained and visual stimuli were reduced by covering the eyes with a cloth.

Electrocardiographic examination was conducted by attaching the electrodes to the axillary and inguinal areas of the animal. The yellow electrode was attached to the axillary area of the left foreleg, red to the axillary area of the right foreleg, and black and green to the inguinal area of the right and left hindlegs, respectively (Figure 1). Alcohol was applied for better conduction of the electrical impulses. At least three replicates of standard long lead II waveform measurements were obtained.

Figure 1. Electrocardiographic examination and electrode placement on marbled water monitor lizard.

The different waveforms were identified and measured (Figure 2). The data obtained were compared by gender, length, and weight using the Wilks-Shapiro test, Student's t-test for normality distributed samples, and Mann-Whitney U test for not normally distributed samples.

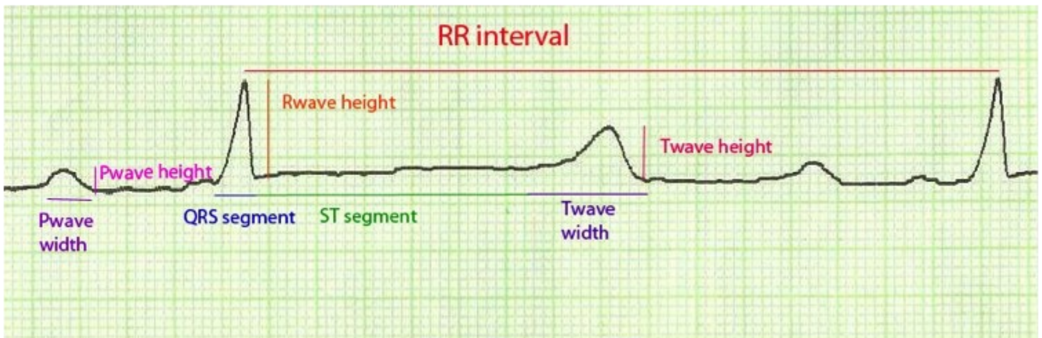


Figure 2. Electrocardiographihc reading of a marbled water monitor lizard showing the P-wave, QRS segment, and T-wave in 50 mm/sec paper speed.

## RESULTS AND DISCUSSION

The 14 marbled water monitor lizards used in the study had a mean snout to vent length (SVL) of 66.5±9.32 cm, mean heart girth of 27.86±6.99 cm, and mean weight of 2.06±1.5 kg. The animals also had a mean temperature of 28.15±1.38ºC.

The mean ECG measurements of the marbled water monitor lizards are shown in Table 1. They have the P, Q, R, S, and T-waves present similar to

Table 1. Mean±S.D. measurements of electrocardiographic parameters in marbled water monitor lizards.

| ECG parameters | Mean±S.D. |
|---|---|
| P-wave height (mV) | 0.19±0.04 |
| P-wave width (sec) | 0.09±0.04 |
| R-wave height (mV) | 0.7±0.24 |
| QRS segment Width (sec) | 0.1±0.04 |
| T-wave height (mV) | 0.26±0.14 |
| T-wave width (sec) | 0.16±0.09 |
| S-wave height (mV) | 0.06±0.03 |
| ST segment (sec) | 0.45±0.17 |
| RR interval (sec) | 2.24±2.22 |
| Heart rate (bpm) | 42.3±15.94 |

mammals (Kik and Mitchell, 2005). The P-wave also precedes the QRS complex as reported by Martinez-Silvestre *et al.* (2003) (Figure 2). Their P-wave width of 0.09 sec is longer compared to the width of other species, like the dog at 0.04 sec. This is due to the prolonged atrial filling in varanids compared to their rapid ventricular filling (Johansen and Burggren, 1984). The observed mean heart rate was 42.3 beats per minute (bpm), this is consistent with the findings of Seebacher and Grigg (2001) in *Varanus varius.* The values are also close to the reported values of Lastica *et al.* (2011) in a study done on reticulated pythons (49.46 bpm). The difference observed between the animals may be due to environmental factors like temperature at the time of collection (Seebacher and Grigg, 2001).

The mean ECG waveform (Figure 3) measurements between genders in Table 2 were not significantly different. This is in contrast with Lastica *et al.*'s (2011)


Figure 3. Electrocardiographic readings of male (A) and female (B) marbled monitor water lizards.

Table 2. Mean±S.D. electrocardiographic parameters of marbled water monitor lizards according to gender.

| ECG parameters | Female (n=4) | Male (n=10) |
|---|---|---|
| P-wave height (mV) | 0.167±0.047 | 0.196±0.041 |
| P-wave width (sec) | 0.074±0.021 | 0.101±0.048 |
| R-wave height (mV) | 0.645±0.272 | 0.718±0.231 |
| QRS segment width (sec) | 0.109±0.048 | 0.093±0.036 |
| T-wave height (mV) | 0.325±0.189 | 0.24±0.125 |
| T-wave width (sec) | 0.159±0.086 | 0.155±0.089 |
| S-wave height (mV) | 0.039±0.031 | 0.064±0.033 |
| ST segment (sec) | 0.534±0.145 | 0.419±0.179 |
| RR interval (sec) | 2.255±1.187 | 2.236±2.583 |
| Heart rate (bpm) | 40.98±13.91 | 42.83±17.36 |

findings in the ECG examination of reticulated pythons where there was significant difference in the R-wave height and ST segment width. The R-wave is indicative of a thicker ventricular mass which, in turn, suggests a bigger heart, and the longer ST segment indicates that it takes a longer time for the ventricle to repolarize (Meek and Morris, 2002). The differences may be caused by handling and environmental temperatures (Lastica *et al.*, 2011).

Lastica *et al.* (2011) reported that there was no significant difference between the heart rate of the male and female reticulated pythons. This is consistent with the result of this study which also found no significant difference between the genders of marbled water monitor lizards.

The mean ECG measurement according to SVL is seen in Table 3. The animals were divided into small or large and their ECG waveforms were compared

Table 3. Mean±S.D. electrocardiographic parameters of marbled water monitor lizards according to length.

| ECG Parameters | Length | |
|---|---|---|
| | Small (n=9) | Large (n=5) |
| P-wave height (mV) | 0.172±0.035[a] | 0.214±0.046[a] |
| P-wave width (sec) | 0.074±0.016[a] | 0.129±0.056[a] |
| R-wave height (mV) | 0.686±0.21 [a] | 0.718±0.289[a] |
| QRS segment width (sec) | 0.086±0.037[a] | 0.118±0.036[b] |
| T-wave height (mV) | 0.276±0.162[a] | 0.244±0.118[a] |
| T-wave width (sec) | 0.129±0.064[a] | 0.205±0.104[a] |
| S-wave height (mV) | 0.059±0.032[a] | 0.052±0.039[a] |
| ST segment (sec) | 0.420±0.172[a] | 0.509±0.177[a] |
| RR interval (sec) | 1.637±0.947[a] | 3.328±3.461[a] |
| Heart rate (bpm) | 48.33±12.83[a] | 31.45±16.35[a] |

*Values with different superscripts between small and large varanids are different ($P<0.05$).

(Figure 4). Among the different mean ECG measurements, only the mean QRS segment width between large (0.12±0.04) and small (0.09±0.04) animals was determined to be significantly different. This finding would indicate that the large animals' ventricular myocardium is significantly thicker than the small animals', and could be directly related to myocardial mass. ECG waveforms may be influenced by the myocardial mass and the thickness and properties of intervening tissues (Meek and Morris, 2002). The increased ventricular wall is also needed to initiate the animal's rapid ventricular filling (Johansen and Burggren, 1984).

The data in Table 4 yielded no significant differences of ECG measurements between weights, <2 kg and 2 kg and above (Figure 5). This is in contrast with the results of the study done on reticulated pythons (Lastica *et al.*, 2011) where there


Figure 4. Electrocardiographic readings of large (A) and small (B) marbled water monitor water lizards

was a strong, positive correlation between body weight and the RR interval and ST segment. It was stated by Johansen (1959) that the differences may be brought about by the degree of influence of the anatomy of the heart, intracardiac blood, and the animal's lifestyle which affect the contraction of the ventricles and, therefore, heart rate. In a study on unanesthetized snakes, Martinez-Silvestre *et al.* (2003) stated that background interference associated with skeletal muscle activity can alter the ECG waveforms.

Table 4. Mean±S.D electrocardiographic parameters of marbled water monitor lizards according to weight.

| | Weight | |
|---|---|---|
| | <2 kg (n=9) | 2 kg and above (n=5) |
| P-wave height (mV) | 0.183±0.033 | 0.189±0.048 |
| P-wave width (sec) | 0.073±0.009 | 0.102±0.049 |
| R-wave height (mV) | 0.848±0.184 | 0.638±0.233 |
| QRS segment width (sec) | 0.080±0.015 | 0.104±0.044 |
| T-wave height (mV) | 0.333±0.181 | 0.237±0.127 |
| T-wave width (sec) | 0.145±0.068 | 0.161±0.095 |
| S-wave height (mV) | 0.060±0.043 | 0.055±0.032 |
| ST segment (sec) | 0.469±0.169 | 0.445±0.183 |
| RR interval (sec) | 1.716±1.204 | 2.451±2.547 |
| Heart rate (bpm) | 50.93±8.62 | 38.85±17.20 |

*No significant differences between weight (P>0.05).


Figure 5. Electrocardiographic readings of >2kg (A) and 2 kg and above (B) marbled monitor water lizards.

The mean values of the ECG variables and their difference between different parameters were evaluated in this study. The electrical amplitude of the waveforms were all under 1.0 mV. The animals had a mean P-wave of 0.19±0.04 mV and 0.09±0.04 sec, R-wave of 0.7±0.24 mV, QRS segment of 0.1±0.04 sec, T-wave of 0.26±0.14 mV and 0.16±0.09 sec, S-wave of 0.06±0.03 mV, ST segment of 0.45±0.17sec, RR interval of 2.24±2.22 sec, and heart rate of 42.3±15.94 bpm. It was found that there was no significant difference between the ECG variables of the different genders and weights. However, there was significant difference in the QRS segment between the sizes. The QRS segment of the large animals was wider than the small animals, which indicates a larger ventricle.

The values in this study provide baseline information for marbled water monitor lizards in the Philippines and can be used for diagnostic examination of captive animals to assess their health status using electrocardiography. Further studies regarding echocardiography is recommended since comparing echocardiograms with electrocardiograms provide a better cardiovascular assessment. Establishment of clinical ECG profiles of different cardiovascular diseases and studies concerning the effect of different environmental and management factors is recommended.

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