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Electrocardiogram Research on the Chinese Alligator (*Alligator sinensis*)

HUIQING GU[1], RONGWEN RUAN[1] AND ZHENGDONG ZHANG[2]

[1]*Hangzhou Teachers College, Hangzhou, Zhejiang, China*
[2]*Anhui Research Center for Chinese Alligator Reproduction, Xuanzhou, Anhui, China*

Abstract. -This paper is a report on the determination and analysis of the electrocardiogram of the Chinese Alligator (*Alligator sinensis*) under conditions of different air temperatures all year round. From the determination and analysis mentioned above, we discovered that the electrocardiogram of the Chinese Alligator consists of a P wave, QRS waves and a T wave.

Key words: Reptilia, Crocodilia, Alligatoridae, *Alligator sinensis*, China, electrocardiogram.

Introduction

The Chinese Alligator *(Alligator sinensis)* is a species of crocodilian endemic to China. In 1987, we began to collect data about the electrocardiogram of Chinese Alligators under conditions of different air temperatures throughout the year at the Anhui Research Center of Chinese Alligator Reproduction. We hope that these data may be applied to studies on growth, reproduction, ecology, and physiology of Chinese Alligators. Here is the detailed report of the results.

Methods

The Anhui Research Center for Chinese Alligator Reproduction supplied nine 6 year-old adult female Chinese Alligators weighing 7.3 to 14.6 kg for the experiments. Using a XDH-3 hot-pen electrocardiograph made in China, we recorded I, II, and III standard limb leads with the standard voltage of 1 mv=10 mm at the paper passing speed of 25 mm per second. Laying on its back with four legs fixed to the operating table, the unanesthetized Chinese Alligator's electrocardiogram was determined by having four needle-like electrodes made by ourselves being placed at the four points beneath the skin which are relevant to standard limb leads after it calmed down.

Results

1). The amplitudes of Chinese Alligators' electrocardiogram waves are small. Electrocardiogram waves of I standard limb lead are so low, even the components of it can hardly be distinguished. Therefore the data used in this paper are all from the determination from the II standard limb lead.

2). The electrocardiogram of a Chinese Alligator basically consists of a P wave, QRS waves and a T wave (Fig. 1). Both the P wave and the R wave are positive, the T wave is reverse, and the QS waves are not clear.

3). The amplitude of the Q wave, which is made up of Pr and Pl is the smallest. The time continued, which is at an average of about 0.18 seconds, is short. The time difference between Pr and Pl is about 0.09 seconds. The crests of the P wave are round and the rate of appearance is moderate (Table 1). Data show that the P wave does not appear during the hibernating period (from the last-ten-day period of November to the last-ten-day period of April of the next year). The rate of appearance is the highest from May to June.

4). QRS waves are the main waves. The amplitude of the R wave is the greatest and the crests of it are pointed. The time continued, which is at on average about 0.14 seconds, is quite short. The rate of appearance is the highest (Table 1).

5). The amplitude of the reverse T

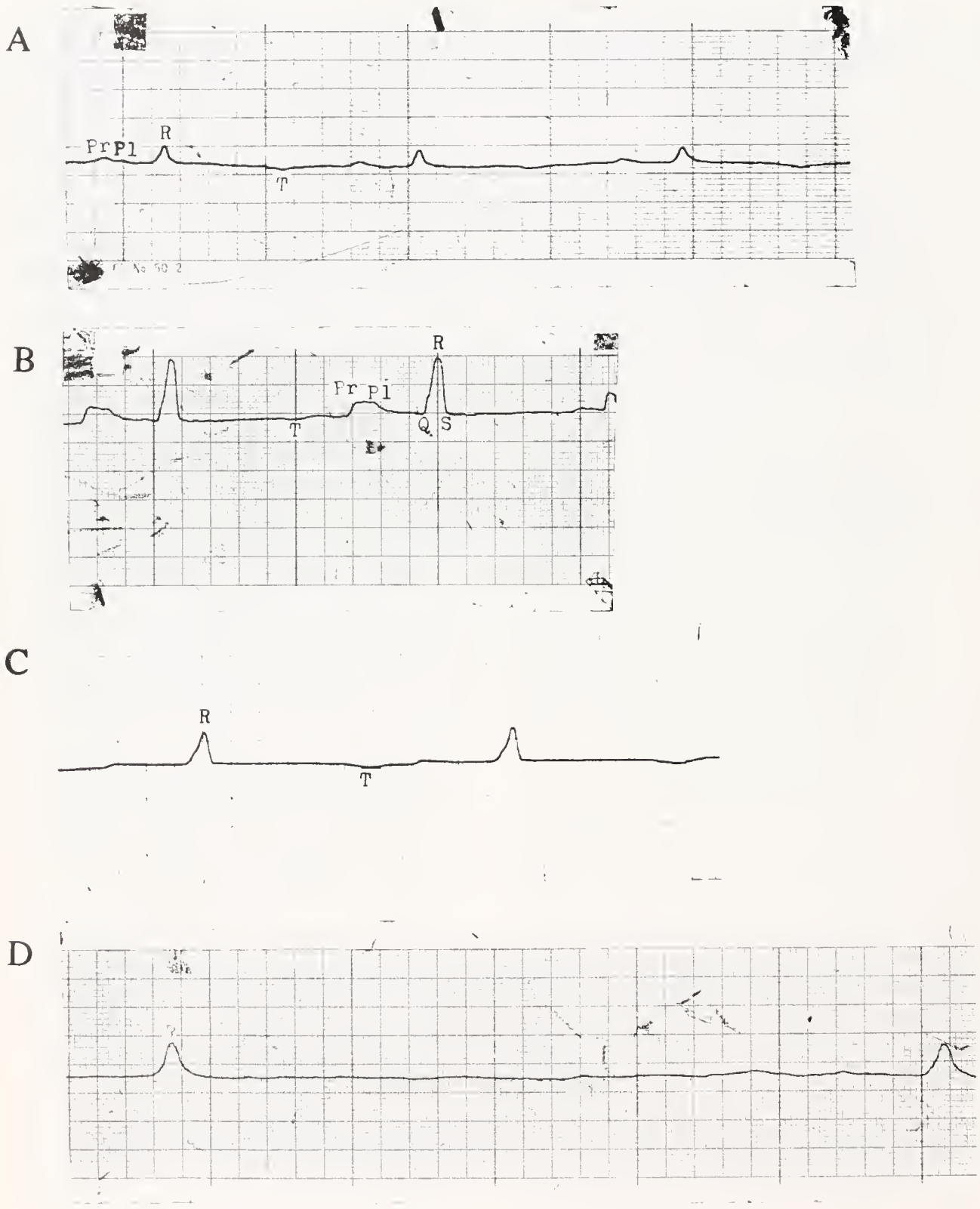

FIG. 1. The electrocardiogram of the Chinese Alligator (*Alligator sinensis*) under conditions of different temperatures as determined in 1988. A. April 8, 14° C. B. June 20. 21° C. C. Oct. 3, 16° C. D. Dec. 9, 4° C.

TABLE 1. Changes in the electrocardiogram of the Chinese Alligator at different temperatures.

	14°C (Apr. 8)	21°C (Jun. 20)	24°C (Sep. 13)	16°C (Oct. 3)	4°C (Dec. 9)
Amplitude (mv)	0.03	0.03	0.03	0.04	-
P Wave Time (s)	0.26	0.18	0.16	0.14	-
Rate of appearance (%)	0.02	96.40	100	87.14	0
Amplitude (mv)	0.19	0.28	0.37	0.35	0.25
R Wave Time (s)	0.12	0.12	0.13	0.24	0.32
Rate of appearance (%)	99	100	100	100	97
Amplitude (mv)	0.04	0.05	0.05	0.05	-
T Wave Time (s)	44	0.27	0.20	0.38	-
Rate of appearance (%)	0.02	98.11	97.06	83.56	0
Heart rate (frequency/min.)	9±13.72	17±7.64	31.09±2.79	13.00±2.37	6.89±0.51

wave, which is greater than the P wave and smaller than the R wave, is quite great. The time continued, which is an average ofabout 0.31 seconds, is the longest. The rate of appearance is the lowest (Table 1). The T wave does not appear during hibernation. The rate of appearance is the highest from May to June.

6). The heart rate is influenced by air temperature. The rate becomes faster when the temperature goes up and slower when the temperature goes down. We calculated the heart rate listed in table 1 from the formula: heart rate = 60(s)/average time between R and R (s) (Frequency/Minute).

7). We conclude that the electrical-axis is under normal conditions by range estimation.

Discussion

1). Though the Chinese Alligator is a kind of elementary cold-blooded vertebrate, its heart is divided into two atriums and two ventricles. Heart beating is started by the sinus venosus, so the components of the Chinese Alligator's electrocardiogram, which consists of a P wave, QRS waves and a T wave, is closely related to those of other vertebrates.

2). The P wave is distinctly divided into Pr and Pl (∩). The fact that there is a time difference between the beating of the left and the right atriums leads to this situation. It is similar to the situation that the crests of the P wave is level and flat in determining the electrocardiogram of *Elaphe carinata, Elaphe taeniura* and *Ptyas korros*. So we conclude that the two atriums of elementary vertebrates can not systole and diastole at the same time as in mammals, so there is only one P wave in electrocardiograms of mammals, while the P wave is divided into Pr and Pl in other vertebrates.

3). QRS waves are the reflection of the succession of several parts of the ventricle being excited one after another. From the fact that the rate of appearance of the R wave is the highest, we conclude that the ventricle is active all year round. Blood circulation was promoted by ventricle motion in order to maintain life even during hibernation. During that period, with the reduction of the Chinese Alligator's activities and a lowered metabolization, the amplitude of the P wave and the T wave becomes lower, so that it can not even be measured with an electrocardiogram.

4). More often than not, the main wave of the QRS waves and the T wave are of the same direction, showing that the part being excited earlier repolarized later, while the part being excited later repolarized earlier. But the fact that the T wave and the QRS waves are of different directions in the Chinese Alligator's electrocardiogram shows the muscle structure of its ventricles and the pressure change inside its ventricles when congested. This may be somewhat different from those of mammals.

5). The Chinese Alligator is cold-blooded, so air temperature has a great influence on its activities and its activities

depend largely on the external environment. When air temperature goes up, it becomes nimble, its heart rate quicker and its metabolization active; when the temperature goes down, it becomes sluggish, its heart rate gets slower and its metabolization drops.

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