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ACID-BASE STATUS OF BLOOD OF VARANUS GRISEUS AND UROMASTYX AEGYPTIUS

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ABSTRACT

1) A comparative study was carried out on the acid-base status of blood collected from five main blood vessels of two desert lizards, the monitor, *Varanus griseus,* and the dabb, *Uromastyx aegyptius.*

2) Blood of the monitor is somewhat more alkaline than that of the dabb.

3) Blood collected from the right systemic arches or from the dorsal aortae of both lizards has less acidic values than that from postcaval veins or pulmonary arches.

4) The study of the effect of low and high temperatures on the acid-base status revealed that pH values, as well as bicarbonate concentrations, differed slightly in both lizards with temperature change.

INTRODUCTION

Most reptiles achieved approximately the same relative alkalinity of their blood (Howell *et al.*, 1970; Jackson, 1971 and Rhan & Garey, 1973) and depended principally on anaerobic metabolism (Bennett, 1972 a,b). However, there are only a few reptiles which depend on aerobiosis, such as the lizard *Varanus gouldii* (Bennett, 1973) and the turtle *Pseudemys scripta* (Gatten, 1974). There are also various lizards, turtles and snakes which depend on aerobic and anaerobic metabolism simultaneously (Tucker, 1967 and Ruben, 1976 & 1979).

In general, blood relative alkalinity of poikilotherms remained constant with temperature change. On the other hand, blood pH is temperature dependent; as temperature increases, pH decreases (Reeves, 1969; Howell, 1970 and Wood & Moberly, 1970).

An exception to such a generalization presents the response of blood pH to temperature change in *Varanus gouldii* which does not correspond to that established for other poikilothermous vertebrates. Also the bicarbonate-carbonic acid system which constitutes the principal blood buffering, preventing pH alternation during activity, is not better developed in varanids than in other lizards. This is manifested by non-carbonic blood buffers, mainly protein buffers and non-protein thio groups (Bennett, 1973).

All previous studies were carried out on blood collected from the ventricle. The present study,

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however, is concerned with the acid-base status of blood obtained from the five main blood vessels of a varanid and an agamid lizard, in order to contribute additional information about the buffering system of reptilian blood.

MATERIALS AND METHODS

Two desert lizards, belonging to two different families, were used in this study: the monitor, *Varanus griseus* (F. Varanidae), and the dabb, *Uromastyx aegyptius* (F. Agamidae). Both are diurnal animals. The monitor is carnivorous and feeds on rodents and lizards, while the dabb is totally herbivorous.

Sampling of blood

The lizards were starved for at least one week before measurements of pH and bicarbonates were carried out. At the beginning of the experiment, one lizard at a time was anaesthetised by using chloroform and opened to expose the various blood vessels. Blood samples were taken from right and left systemic arches, dorsal aorta, postcaval vein and pulmonary arch by means of 1 ml tubercline syringe with a 20-27 gauge. Heparin was the only anticoagulant used for blood gas studies and small quantities (1,000 USP units of heparin per ml of blood) were found to give identical pH results; other anticoagulants were found to have marked effects on the blood. When taking blood samples, the needle is held in a horizontal position to the blood vessels to ensure that the blood flows into the syringe without coming into contact with the atmosphere. A small steel mixing flea was inserted into the syringe to permit stirring of the sample by using a magnetic collar; the syringe was sealed with a rubber cap and placed in ice water for a maximum period of one hour.

Analysis of blood gases

For blood gas analysis, the Corning 166 pH blood gas analyzer was used to measure pH and PCO_2. The apparatus incorporates a calculator which accurately computes values for plasma bicarbonate according to the Henderson Hasselbalch equation and total CO_2 from the relation: Total $CO_2 = 0.03\ PCO_2 + HCO_3^-$.

Each determination required only 0.15-0.2 ml blood.

For the study of the effect of different environmental temperatures on the acid-base status of blood, obtained from different blood vessels, the lizards were kept in plastic containers at 10, 25 and 35°C by using three incubators (Lotus) at 12:12 hour light/dark periods; they were kept at these experimental temperatures for at least one week.

RESULTS AND DISCUSSION

The study of the acid-base status of blood obtained from the five main blood vessels of the two desert lizards, the monitor *Varanus griseus* and the dabb *Uromastyx aegyptius*, kept at laboratory temperature (25°C), indicated that the measured pH values (Table 1) were between 7.248 and 7.294 for the monitor and between 6.802 and 7.102 for the dabb. These values are intermediates between the values of turtles and those of snakes and can be considered normal for reptiles, as previously postulated by Howell *et al.* (1970) and Howell and Rahn (1976). The present study also indicated that blood collected from the right systemic arches or from dorsal aortae of both lizards had less acidic values than that of the postcaval veins or pulmonary arches. These data reflect the phenomenon that ventilation is inversely proportional to the

Table (1)

Effect of temperature on pH of blood obtained from different blood vessels of the monitor *Varanus griseus* and the dabb *Uromastyx aegyptius*.

Blood vessel	pH ± δ								
	Low temp. (10°C)			Normal temp. (25°C)			High temp. (35°C)		
	Vara.	Urom.	tv.	Vara.	Urom.	tv.	Vara.	Urom.	tv.
Right systemic arch	7.560 ± 0.076	7.256 ± 0.081	2.74 X	7.294 ± 0.083	6.902 ± 0.040	4.26 XX	7.454 ± 0.120	6.799 ± 0.113	3.97 XX
Dorsal aorta	7.541 ± 0.019	7.154 ± 0.103	3.72 XX	7.282 ± 0.002	6.893 ± 0.036	10.81 XX	7.431 ± 0.092	6.728 ± 0.191	3.31 X
Left systemic arch	7.538 ± 0.198	7.108 ± 1.001	0.42	7.275 ± 0.188	6.802 ± 0.041	2.46 X	7.298 ± 0.090	6.698 ± 0.029	3.41 XX
Postcaval vein	7.398 ± 0.042	7.066 ± 0.019	7.22 XX	7.248 ± 0.060	6.716 ± 0.046	7.0 XX	7.269 ± 0.091	6.691 ± 0.123	4.24 XX
Pulmonary arch	7.349 ± 0.006	7.299 ± 0.007	5.42 XX	7.290 ± 0.012	7.102 ± 0.023	7.23 XX	7.362 ± 0.101	6.897 ± 0.018	4.56 XX

Number of animals = 6
δ = Standard deviation
X = Significant at $P < 0.05$
XX = Highly significant at $P < 0.01$
Vara. = *Varanus gresius*
Urom. = *Uromastyx aegyptius*

Table (2)

Effect of temperature on bicarbonate contente of blood obtained from different blood vessels of the monitor *Varanus griseus* and the dabb *Uromastyx aegyptius*.

Blood vessel	$HCO_3 \pm \delta$								
	Low temp. (10 C⁰)			Normal temp. (25 C⁰)			High temp. (35 C⁰)		
	Vara.	Urom.	tv.	Vara.	Urom.	tv.	Vara.	Urom.	tv.
Right systemic arch	54.7 ± 0.923	19.1 ± 1.918	19.4 XX	58.9 ± 2.292	13.4 ± 0.637	0.032	65.3 ± 2.111	12.9 ± 1.33	19.5 XX
Dorsal aorta	60.8 ± 1.910	14.3 ± 2.310	15.5 XX	54.2 ± 3.364	17.16 ± 0.348	10.95 XX	36.9 ± 2.021	25.1 ± 0.999	5.2 XX
Left systemic arch	60.6 ± 2.101	9.8 ± 1.301	20.5 XX	40.566 ± 2.490	12.9 ± 495	10.9 XX	39.9 ± 0.998	27.9 ± 2.112	5.1 XX
Postcaval vein	38.1 ± 1.098	9.1 ± 0.911	20.3 XX	37.85 ± 4.454	11.76 ± 0.889	5.75 XX	55.1 ± 1.23	22.0 ± 1.345	18.16 XX
Pulomonary arch	80.1 ± 1.341	17.1 ± 2.113	25.17 XX	69.27 ± 1.021	14.1 ± 0.921	39.9 XX	45.1 ± 2.112	9.9 ± 1.743	12.85 XX

Number of animals = 6
δ = Standard deviation
X = Significant at $P < 0.05$
XX = Highly significant at $P < 0.01$
Var. = *Varanus gresius*
Urom. = *Uromastyx aegyptius*

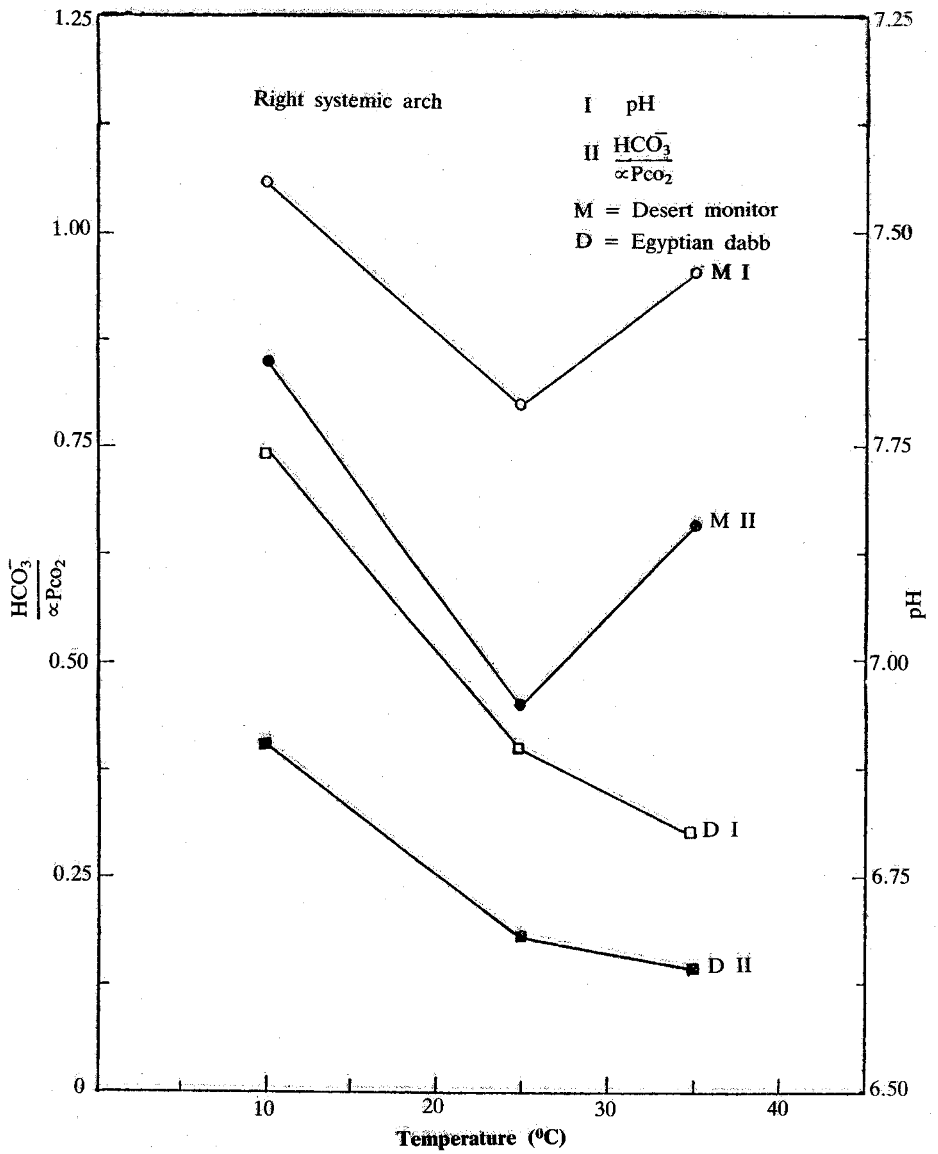

Fig. (1): Changes of pH and $HCO_3^-/\propto PCO_2$ of blood obtained from right systemic arches of the monitor, *Varanus griseus* and the dabb, *Uromastryx aegyptius* at different temperatures.
$\propto PCO_2 = 0.03\ PCO_2 = H_2CO_3$.

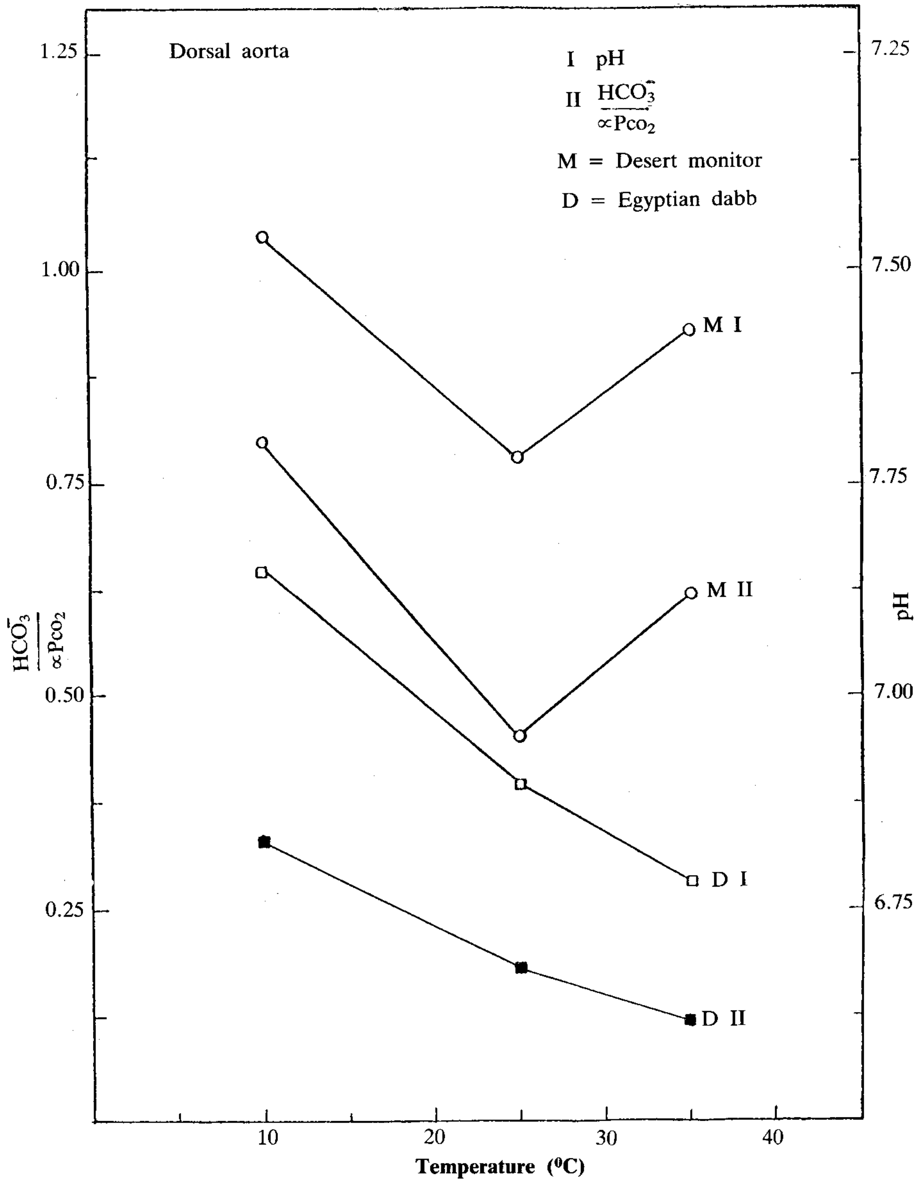

Fig. (2): Changes of pH and $HCO_3^-/\propto PCO_2$ of blood obtained from dorsal aortae of the monitor, *Varanus griseus* and the dabb, Uromastyx aegyptius at different temperatures.
$\propto PCO_2 = 0.03\ PCO_2 = H_2CO_3$.

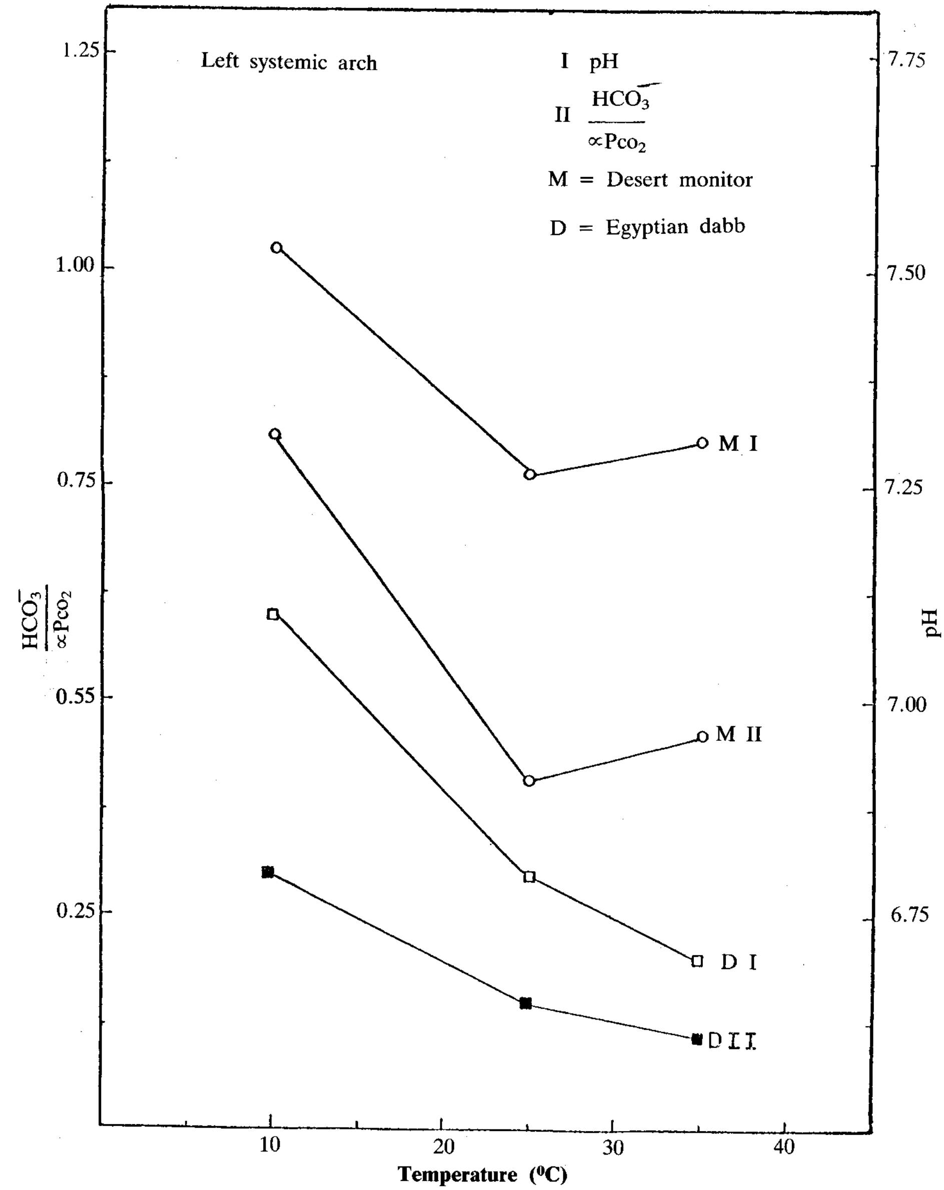

Fig. (3): Changes of pH and $HCO_3^-/\propto PCO_2$ of blood obtained from left systemic arches of the monitor, *Varanus griseus* and the dabb, *Uromastyx aegyptius* at different temperatures.
$\propto PCO_2 = 0.03\ PCO_2 = H_2CO_3$.

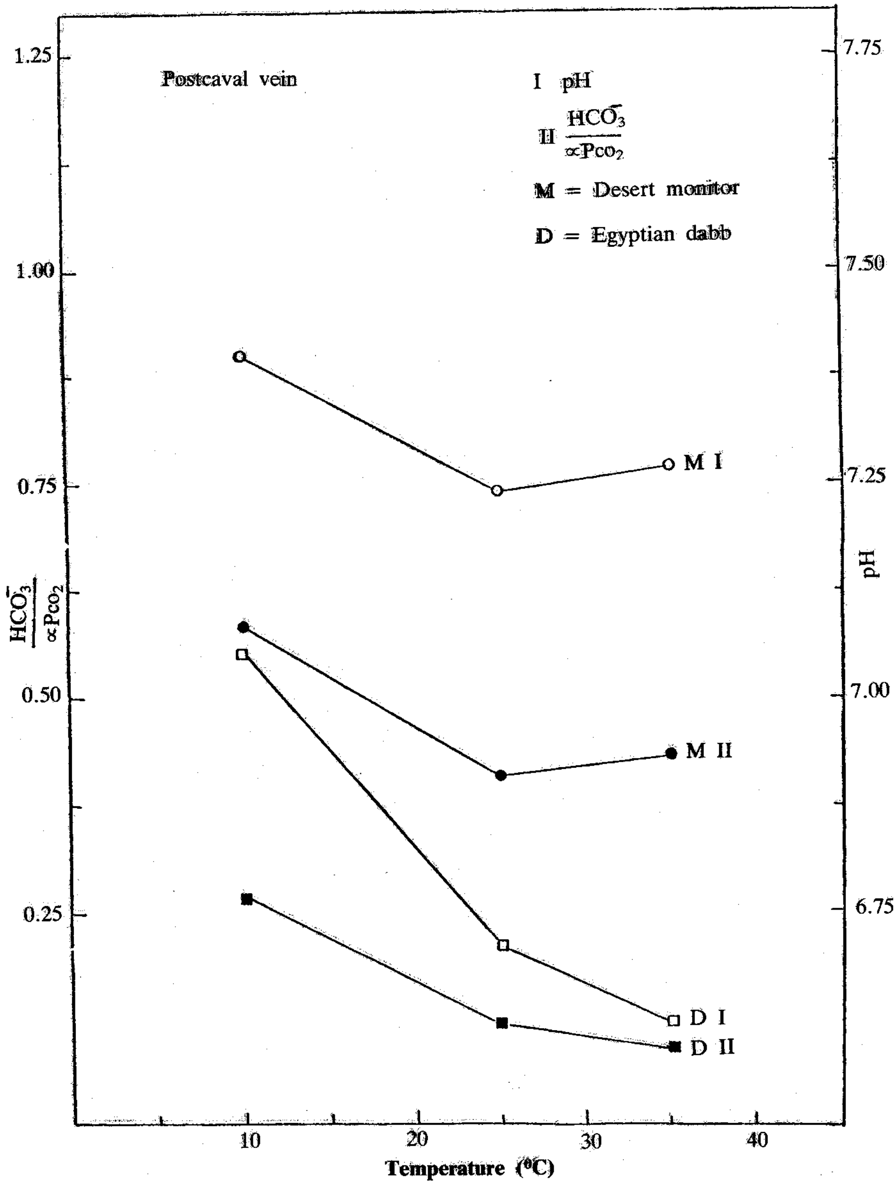

Fig. (4): Changes of pH and $HCO_3^-/\propto PCO_2$ of blood obtained from postcaval veins of the monitor, *Varanus griseus* and the dabb, Uromastyx aegyptius at different temperatures.
$\propto PCO_2 = 0.03\ PCO_2 = H_2CO_3$.

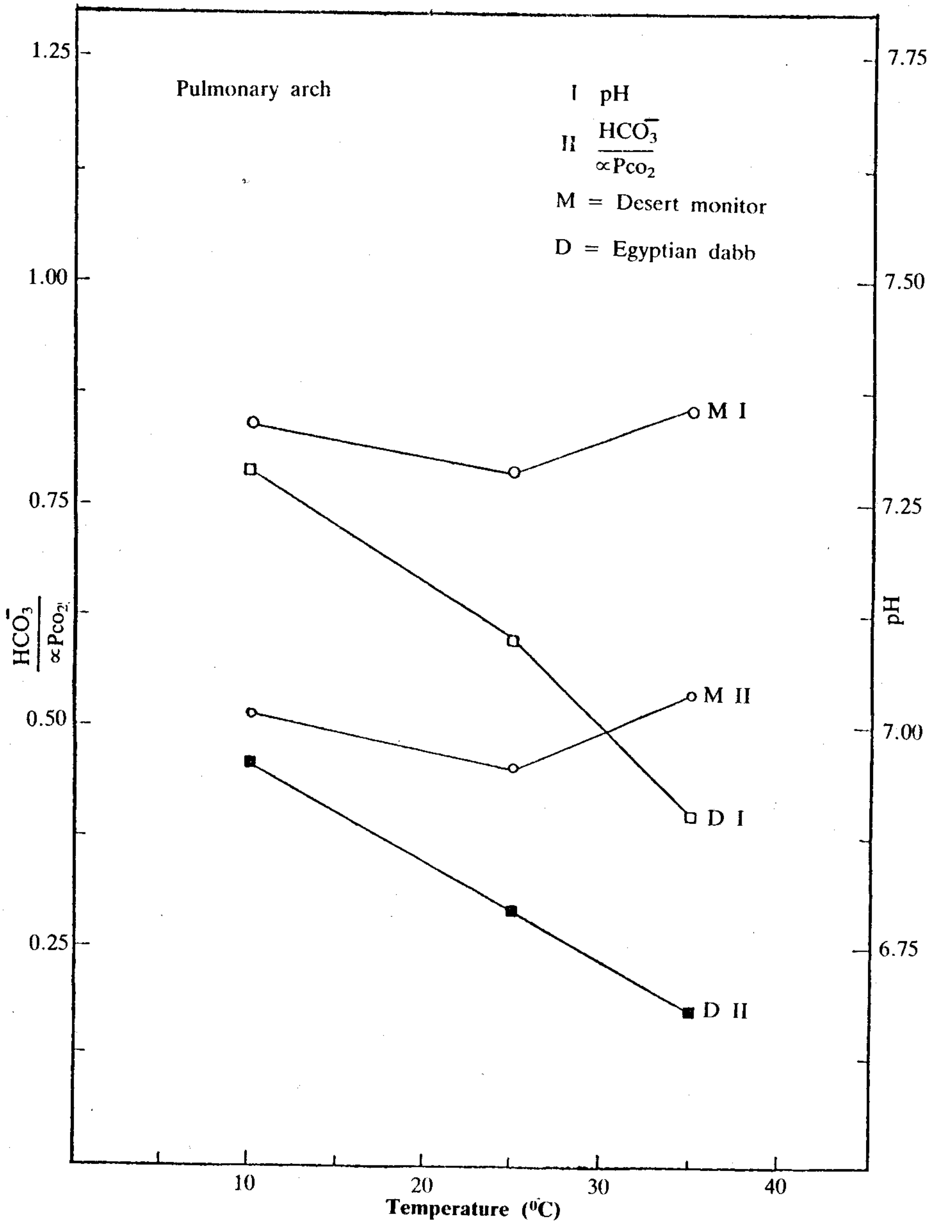

Fig. (5): Changes of pH and $HCO_3^-/\propto PCO_2$ of blood obtained from pulmonary arches of the monitor, *Varanus griseus* and the dabb, *Uromastyx aegyptius* at different temperatures.
$\propto PCO_2 = 0.03\ PCO_2 = H_2CO_3$.

PCO_2 and to $HC\bar{O}_3$ (Table II). This explanation may be sufficient for the dabb, but regarding the monitor, it was stated by Bennett (1972 a,b & 1973) that the physiological superiorities of *Varanus* were few but critical.

Calculation of $HC\bar{O}_3/H_2CO_3$ ratio using Henderson-Hasselbalch equation permits the comparison of acid-base status of the studied animals and showed only small variations in the case of the desert monitor, while the differences in the dabb were pronounced. This agrees with the results stated by Rahn and Gary (1973) for reptiles, that in spite of large differences in PCO_2 and $HC\bar{O}_3$ concentration, the animal achieved about the same relative alkalinity.

Since ectotherms do not maintain the constant pH when their body temperature changes, the present study is concerned with the effect of low (10^{0}C) as well as high (35^{0}C) temperature on buffering capacity of their blood (Figs. 1-5).

Comparing the acid-base status of blood, obtained from different blood vessels of both lizards, showed that as pH values differed slightly with temperature: (ΔpH/Δ^{0}C) = 0.004-0.017 for both lizards between 10-35^{0}C; the $HC\bar{O}_3$ concentration varied also among different blood vessels.

The slight variation in pH values of blood, observed in the studied lizards, was also discussed in other reptiles by Gans and Dawson (1976), who found that turtle's blood was affected by temperature changes and that, as temperature raised, pH fell and CO_2 tension increased in a linear fashion, while $HC\bar{O}_3$ concentration remained constant.

Howell *et al.* (1970) and Wood and Moberly (1970) also reported that blood relative alkalinity of poikilothermic vertebrates remained constant in the face of temperature and not blood pH. As temperature increased, the blood pH decreased. Similar changes were also observed for other ectotherms (Reeves, 1969).

As temperature increased, the $HC\bar{O}_3$ concentration increased in the dabb. This agrees with the Rubin's data for *Pseudemys* (1962), which states that the $HC\bar{O}_3$ level increased at a rate of 8%/10^{0}C as temperature increased from 10 to 20^{0}C. In the desert monitor, the $HC\bar{O}_3$ content decreased with increasing temperature.

The previous two cases disagree with the data obtained by Rahm and Garey (1973), stating that the differences in $HC\bar{O}_3$ concentration are probably negligible during acute changes in body temperature; they are also in disaccord with data by Gans and Dawson (1976) on *Chelydra,* stating that $HC\bar{O}_3$ concentration did not fall but was quite stable as the temperature increased.

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التوازن الحمضي ـ القاعدي لدم السحالى

الورل « فارناس جريسيس » والضب « بوروماستكس ايجبتياسي »

سعيد محمود عيسى ووفاء حشيش

اجريت دراسة مقارنة بين التوازن الحمضي ـ القاعدي لدم السحالي والذي جمع من خمس أوعية دموية رئيسية . وجد أن دم الورل اكثر قاعدية من دم الضب .

الدم الموجود في القوس الجهازى الأيمن وايضا في الأبهر الظهرى أكثر قاعدية من الموجود في الأوردة الجوفاء أو الأقواس الرؤية .

بدراسة تأثير الحرارة المنخفضة أو المرتفعة ، وجد ان الرقم الهيدروجيني وايضا تركيز البيكربونات يتأثران تأثيرا طفيفا بتغير درجة الحرارة .