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Life Cycle and Survival of *Hyalomma dromedarii (Acari:Ixodidae)* Under Laboratory Conditions

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دورة حياة قراد الجمال (هيلوما درومدارى) و تحملها للحرارة في المختبر

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خلاصــة: لقـد تمـت دراسـة دورة حياة قراد الجمال Hyalomma dromedarii على الأرانب عند درجة حرارة 25°م و 32°م ورطوبـة نسـبية 85 %. لقـد ثبـت من الدراسـة أن قراد الجمال ثنائي العائل وأنها أكملت دورة حياتها في 108-146 و 80-115 يوما علـى التوالي. ولقد وضح من الدراسة أيضا أن درجة الحرارة تؤثر تأثيرا كبيرا على طول فترة ما قبل وضع البيض و فـترة الحضـانة وفـترة الانسـلاخ. تـم وضع البيض و اليرقة الغير متغذية و الحورية المتغذية و الطور البالغ المتغذي والغير مـتغذي فـي درجـات حـرارة 25°م و 32°م و 38°م و 43°م و 48°م ورطوبـة نسـبية 85 % لمعـرفة طـول عمـر هذه الأطوار. أثبتـت الدراسـة أن البيض والحوريات المتغذية والطور البالغ المتغذي ماتت عند درجة حرارة 38°م بينما ماتت اليرقات الغير مـتغذية عند درجة حرارة 43°م. وقد انخفضت دورة حياة الطور البالغ الغير متغذي من 90-120 يوم تحت درجة حرارة 25°م إلـى 7-15 يـوم عـند درجـة حـرارة 43°م وقـد ماتـت عـند درجة حرارة 48°م. يتضح من هذه النتائج أن الطور البالغ الغير مـتغذي هـو الأكـثر مقاومـة للحـرارة وانـه يلعـب دوراً هاماً في اسـتمرارية دورة حياة القراد خلال فصل الصيف عندما تكون درجة الحرارة عالية والرطوبة منخفضة.

ABSTRACT: The life cycle of *Hyalomma dromedarii* Koch *(Acari:Ixodidae*) on rabbits at 25 and 32ºC was compared at 85% R.H. At these temperatures, it behaved as a two-host tick and completed its life cycle in 108-146 and 80-115 days, respectively. The preoviposition, incubation and moulting periods varied significantly and were influenced by temperature. The survival periods of different developmental stages of *Hyalomma dromedarii* at 25ºC, 32, 38, 43, and 48ºC at 85% R.H. were investigated. The eggs, engorged nymphs and engorged females died at 38ºC, and the unfed larvae died at 43ºC. The longevity of the unfed adults decreased from 90-120 days at 25ºC to7-15 days at 43ºC. They died at 48ºC. These results suggest that the survival periods of eggs, engorged nymphs and engorged females were significantly decreased with an increase in temperature. They were more susceptible to high temperature than unfed adults. The role of unfed adult in the continuity of the life cycle of the tick throughout the year is discussed.

Keywords: *Hyalomma dromedarii*, life cycle, survival, laboratory conditions.

The camel tick, *Hyalomma dromedarii* Koch (*Acari: Ixodidae*) is the most important tick infesting camels in Saudi Arabia (Badawi, 1994). The ecology and the biology of the camel tick has not been fully investigated. The availability of information on the effect of temperature and humidity on the rate of development and survival of the camel tick is essential for a rational control program. The current study was carried out to assess the life cycle of *H. dromedarii* and its survival at different temperatures under laboratory conditions.

Materials and Methods

Fully engorged females of *H. dromedarii* were obtained from a camel in Muzahmyia area (50 Km South of Riyadh City) and identified as *H. dromedarii* according to Hoogstraal (1956). They were put in an incubator at 28°C and 85% R.H. to oviposit. The emerged larvae, nymphs and adults were fed on white New Zealand tick-native rabbits.

Five white New Zealand tick-native rabbits were infested with approximately 200 larvae of *H. dromedarii*.

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The engorged nymphs dropped were weighed and the mean engorged weight was determined. The larval-nymphal feeding period was calculated as from attachment of unfed larvae to detachment of engorged nymphs. The engorged nymphs dropped were collected and divided into two groups, each consisted of 50 nymphs, then incubated at 25 and 32°C, respectively at 85% RH to moult and the moulting period was determined. In a second group consisting of 5 white tick-native rabbits, each rabbit was infested with 8 adults *H. dromedarii* (sex ratio 1:1). The replete females were collected after their detachment, weighed separately and the time taken to engorge was recorded (from attachment to detachment) and then divided into two groups and incubated at 25°C and 32°C, respectively to oviposit. The incubated ticks were observed daily from detachment until oviposition to determine the preoviposition period. Eggs were observed daily from initiation of oviposition until the eclosion of the first larva, to establish the incubation period. The weight and number of eggs laid per female as well as hatchability were recorded. The mean index of conversion efficiency (CEI) was calculated as follows:

CEI = [weight of eggs (mg) / weight of replete female (mg)] x 100

About 500 mg of viable eggs, 100 unfed larvae, 50 engorged nymphs, 30 unfed adults (sex ratio 1: 1) and 10 engorged females of *H. dromedarii* were incubated at 25, 32, 38, 43, and 48°C at 85% R.H. All these developmental stages were observed daily for their survival at these conditions. Eggs, engorged nymphs and engorged adults were considered as dead when they failed to hatch, moult or lay eggs, respectively. Unfed ticks were considered as dead when they did not react to mechanical or physical stimuli. For statistical analysis, the student's t-test and analysis of variance (Steel and Torrie, 1981) were used.

Results

LIFE CYCLE OF *H. DROMEDARII*: The results showed that at 25°C there was a two-host type of development during a period of 108-146 days. Almost half of this period was spent for egg development. The larvae remained attached to the host and dropped as engorged nymphs. The preoviposition and incubation periods at 25°C were 5-8 and 56-68 days, respectively (Table 1). The larval-nymphal feeding period was 11-16 days, and the nymphs required 14-24 days to develop into adults. The unfed females took 10-14 days to engorge on rabbits after which they dropped off to lay eggs.

At 32ºC, *H. dromedarri* behaved as a two-host tick and completed its life cycle in 80-115 days (Table 1). The larvae remained attached to the host for 11-16 days and dropped off as engorged nymphs. The nymphs required 10-15 days to moult to adults and remained for 6-7 days in the non-feeding stage. The unfed female took 10-14 days to engorge on rabbits and then dropped off to lay eggs. The preoviposition and incubation periods were 3-6 and 34-50 days, respectively. The results showed that the preoviposition, incubation and moulting periods of the tick at 25ºC were significantly longer than at 32ºC (P<0.05), while the feeding periods of the adults, nymphs and larvae on the host were not affected by temperature (P>0.05). At 25 and 32°C, the incubation periods were significantly longer than the preoviposition periods (P<0.001), larval-nymphal feeding periods (P<0.001) and adult feeding periods (P<0.001). At 25°C, the moulting period of the nymphs to adult was significantly longer than larval-nymphal feeding and adult feeding periods (P<0.05); while at 32ºC, the temperature had no effect on the length of the moulting period, larval-nymphal feeding period and adult feeding period (P>0.05).

Table 2 shows that the mean engorged weight of replete females at 25ºC was 981 ± 218 mg and the mean weight of egg mass laid was 588 ± 112 mg, which hatched into 8076 ± 989 eggs. The mean index of conversion

TABLE 1

Life cycle of Hyalomma dromedarii on rabbits under laboratory conditions.

Parameter	Time (days) Range (x ± sd)			
	25ºC		32ºC	
Preoviposition period	5-8	(6.6 ± 1.1)a	3-6	(4.3 ± 0.8)b
Incubation period	56-68	(62.0 ± 5.0)c	34-50	(42.0 ± 5.0)d
Hardening	6-8	(7.0 ± 0.8)a	6-7	(6.5 ± 0.4)a
Nymphal feeding period	11-16	(14.0 ± 1.8)e	11-16	(13.0 ± 1.7)e
Moulting of nymph	14-24	(19.0 ± 4.0)f	10-15	(12.0 ± 2.0)e
Female engorge	10-14	12.0 ± 1.7)e	10-14	(12.0 ± 1.8)e
Total	108-146	127.0 ± 13)g	80-115	(96.0 ± 11)h

x – mean value; sd – standard deviation
Means in a row followed by different letters are significantly different (P<0.05 – P<0.001).

TABLE 2

Feeding of Hyalomma dromedarii on rabbits at 25ºC.

Engorged wt (x ± sd mg)	981.0 ± 218
Weight of eggs (x ± sd mg)	588.0 ± 112
No. of eggs (x ± sd)	8076.0 ± 989
Hatchability (%)	99.0
Nymphal engorge wt (x ± sd mg)	395.0 ± 84
I.C.E.	0.6

x – mean value; sd – standard deviation
I.C.E. – Index of Conversion Efficiency.

TABLE 3

Survival of Hyalomma dromedarii under laboratory conditions in days (x ± sd) at different temperatures.

Stage	Temperature				
	25ºC	32ºC	38ºC	43ºC	48ºC
Eggs	40 -59 50 ± 8a*1	22-31 27 ± 3b*1	Died		
Unfed larvae	38-50 44 ± 4a	26-38 33 ± 6c	5-6 5.5 ± 0.4d	Died	
Engorged nymphs	15-23 19 ± 3e*2	10-15 12.5 ± 2f*2	Died		
Unfed adults	90-120 105 ± 13g	40-65 52 ± 10h	20-29 25 ± 3i	7-15 11 ± 3j	Died
Engorged adults	22-30 26 ± 3k*3	14-23 18 ± 3m*3	Died		

x – mean value; sd – standard deviation; *1 – then hatched; *2 – then moulted; *3 – then laid eggs.
Means in a row followed by different letters are significantly different (P<0.05 – P<0.001).

efficiency was 0.6. There was a strong positive correlation between the engorged weight and weight of eggs laid (r = 0.7164) and between engorged weight and number of eggs laid (r =0.6872).

Table 3 shows that all life stages of *H. dromedarii* survived normally at 25ºC and 32ºC, but the survival period of eggs at 25 ºC (50 ± 8 days) was significantly longer than at 32ºC (27 ± 3 days) (P<0.001). They died at 38ºC. There is a progressive significant decrease in survival period of unfed larvae with an increase in temperature. Their survival period decreased from 44 ± 4 days at 25ºC to 5.5 ± 0. 5 days at 38ºC (P<0.001). They died at 43ºC. The survival period of engorged nymphs at 32ºC was significantly shorter than that at 25ºC (P<0.05). The longevity of unfed adults decreased significantly from 105 ± 13 days at 25ºC to 11 ± 3 days at 43ºC (P<0.001). They died at 48ºC. The survival period of engorged females at 32ºC was significantly shorter than that at 25ºC (P<0.05). At both 25 and 32ºC, the survival periods of unfed adults were significantly longer than that of eggs (P<0.001), unfed larvae (P<0.001), engorged nymphs (P<0.001) and engorged adults (P<0.001).

Discussion

This study has shown that temperature is an important factor affecting the duration of preoviposition, incubation and moulting periods during the development of *H. dromedarii.* In general, high temperature increases the metabolic rate of poikilothermic organisms (Chapman, 1976), which in turn increases the rate of physiological processes involved in egg production resulting in a decrease in preoviposition and incubation period length. The results obtained in this study are similar to those reported by Hagras and Khalil (1988) and Ouhelli (1994) using *H. dromedarii*; Despins (1992) using *Dermacentor nitens;* and Sunder *et al.* (1999) using *Hyalomma anatolicum*. The duration of developmental periods of different stages in the life cycle of *H. dromedarii* observed in this study are longer than those reported by Delpy and Gouchey (1937) and Honzakova (1971) for *Hyalomma dromedarii*. These variations are probably due to differences in rearing conditions (host and temperature).

Different types of developments have been reported for *H. dromedarii.* In our study, *H. dromedarii* fed on rabbits behaved as a two-host tick. Das and Subramanin (1972) found that *H. dromedarii* fed on sheep or cattle have a three-host life cycle, but 60% of the population became a two-host tick when fed on rabbits. Ouhelli (1994) found that *H. dromedarii* was usually a three-host tick, but became a two-host tick when density on the host was high. Similarly, Latha *et al.* (1998) found that when young larvae of *H. marginatum* (three months old) were fed on rabbits, they behaved as a three host tick, while larvae older than four to six months behaved as a two host tick. From these studies it seems that the type of the host, rearing conditions, density and age of the larvae may influence the life cycle of the tick.

In arid zones, where *H. dromedarii* is widespread, low relative humidity has an inhibiting effect on egg development (Ouhelli, 1994). The peripheral layer of eggs shell was quite desiccated. This may help in egg development during short-lived periods of drought and stress under field condition. In this study, almost half of the life cycle was spent for egg development. This may be a survival mechanism that permits *H.dromedarii* to survive in arid zones.

Our study has revealed that eggs, engorged nymphs, and engorged females are more susceptible to high temperature than the unfed adult. Similar results were reported by Delpy and Gouchey (1937) who found that when *H. dromedarii* behaved as a three-host tick, unfed larvae and unfed nymphs resist dry atmosphere more than engorged stages.

In nature, the engorged female *Boophilus annulatus* (Say) (Hunter and Hooker, 1907) and *Ixodes ricinus* (L) (Milne, 1950) burrow a few centimeters below the ground surface to find favorable microhabitat for egg deposition and survival during dry season. In Saudi Arabia, probably during the dry season, the adult *H. dromedarii* live in burrows or burrow a few centimeters to find a favorable microhabitat that protects the eggs and emerging larvae against high temperature and low humidity.

Conclusions

The type and duration of *H. dromedarii* development were largely influenced by temperature and the host. The study has shown that unfed adult ticks were more resistant to high temperature than eggs, unfed larvae, engorged nymphs and engorged females. During the dry hot season the adult tick burrows a few centimeters below the ground surface to find a favorable microhabitat for its survival. Control measures using acaricides should be directed towards the adult stage. The spray of infested hosts at the onset of dry season is highly recommended. Further studies on the seasonal dynamics and host-vector relationship of the tick are required.

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