# LABORATORY INVESTIGATIONS ON THE LIFE-CYCLE OF RHIPICEPHALUS THEILERI BEDFORD & HEWITT, 1925 (IXODOIDEA: IXODIDAE)

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# Abstract

NEITZ, W. O., BOUGHTON, F. & WALTERS, H. S., Laboratory investigations on the life-cycle of *Rhipicephalus theileri* Bedford & Hewitt, 1925 (Ixodoidea: Ixodidae). *Onderstepoort J. vet. Res.* 39(2), 117-122 (1972).

Detailed data on the rearing of the progeny of a single *R. theileri* female for 7 generations at 25 to  $26^{\circ}$ C and 85 to 90% RH are presented in a series of tables and a figure. The average duration of the lifecycle is 491 days. The reason for the mortality rate of 96% of the immature stages in all batches during the prefeeding, feeding and premoulting stages is obscure.

### INTRODUCTION

The description of the adult stages of *Rhipicephalus* theileri as a distinct species and as a parasite of the Cape ground squirrel, hedgehog and silver jackal in the Orange Free State by Bedford & Hewitt (1925) and Bedford (1932) was followed by a survey on the distribution of this species and its hosts by Theiler (1947, 1962). Specimens submitted for examination consisted of mature and immature stages. In the absence of reference specimens of larvae and nymphae we were approached to rear *R. theileri* under laboratory conditions. The successful breeding made it possible to supply all the developmental stages for taxonomic studies.

The published data as well as additional information on the distribution of immature stages supplied by Dr. G. Theiler, Veterinary Research Institute, Onderstepoort (personal communication, 1971) are listed in Table 1. The zoological nomenclature of the mammals is based on that proposed by Roberts (1951). The records show that *R. theileri* is widely distributed in South and South West Africa but in Rhodesia it has so far only been recorded in a single locality. Ticks have frequently been taken off wild carnivores and rodents but only once from an ox and twice from dogs. According to Theiler (1971) the record of "Chelonia - Tortoise" (Theiler, 1962) as a host is an incorrect entry.

Theiler (1947) concludes from her survey that this tick is apparently never abundant. This remark prompted us to extend the breeding programme with the hope of obtaining an explanation for the relatively low incidence of this species in nature.

# MATERIALS AND METHODS

## 1. Origin of the tick

A single engorged *R. theileri* adult female, taken off a dog, was kindly supplied by Mr. J. S. Brown, P.O. Melville, Omaruru, South West Africa.

### 2. Tick breeding

The procedures for rearing three-host ixodid ticks described by Neitz, Boughton & Walters (1971), were employed. With the exception of the feeding periods, all the remaining developmental stages of R. theileri were maintained for 7 generations in the acaridarium at 25 to 26°C and 30 to 90% RH. The ticks were kept in glass tubes plugged with cotton wool and examined daily until metamorphosis had occurred. The dates of receipt, oviposition, hatching, infestation, detachment, moulting, the number of larvae, nymphae and imagines harvested and the identification numbers of the hosts were recorded in a tick register.

### 3. Tick hosts

All stages were fed on the ears of female rabbits varying in age from 6 to 9 months. Ear-bags, secured around the base of the ears with Unna's paste, were used to retain the ticks on the hosts. From the 3rd day after infestation the ear-bags were opened daily for the collection of detached ticks. These were sorted out into tubes and retained in the acaridarium for further observation. Each rabbit was used once only for tick-feeding.

### RESULTS

Details of the breeding results of 7 generations of R. *theileri* are listed in Tables 2 to 5. A summary of the results is presented schematically in Fig. 1.

Table 2 lists the observations on the duration of the oval, larval, nymphal and imaginal phases and those made on the number of immature and mature ticks harvested from each set of hosts. Table 3 gives the average duration of the 4 phases and the average numerical tick yield from individual hosts. In Table 4 appear the minimum, maximum and average durations of each phase used for determining the duration of the life-cycles. Table 5 records the numerical and percentage larval to nymphal, nymphal to imaginal and larval to imaginal decreases.

Data presented in these tables and figure are selfexplanatory so that it will be only necessary to consider the outstanding observations made on (a) the life-cycles and (b) the tick harvests.

# (a) Duration of the life-cycles

Table 2 shows that the progeny of the female, represented by 1 (F1), 2 (F2), 2 (F3), 1 (F4), 3 (F5), 1 (F6) and 1 (F7) batches were able to complete their life-cycles when maintained in the acaridarium over a period of 9 years.

Interesting observations are the wide variations in the duration of the oval phases and the feeding and premoulting periods even though the ticks had been maintained at constant temperature and relative humidity levels. The persistence of the adult feeding period for up to 26 days is the longest yet recorded for any of the laboratory bred *Rhipicephalus* spp.

It will be seen from Table 4 that no systematic attempts were made to determine the minimum and maximum duration of the prefeeding periods of the three stages. Had this been done the differences in the duration of the life-cycles would have been either greater or less. In all instances the lengths of the prefeeding periods were made to fit in with the laboratory routine and thus do not reflect the minimum hardening

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District         Locality)         Petrusburg         Petrusburg         Pilgrim's Rest         Pilcrobsdal         Rooidam)         Edenburg         Pacobsdal         Rooidam)         Luckhoff         Nganniland         Pacobsdal         Reserve)         Doutio         Petrusburg         (Palbank)         Jacobsdal         (Rooidam)         Gordonia         (Newrinen         River)         Outio         Petrusburg         River)         Petrusburg         Rooidami         Petrusburg         Runten         National Park         Gordonia         Ruinal         Ruinal         Ruinal         Ruinal         Runten         National Par	NAULT I TUDE	1.10545 alla uisiliduudi ol. Ampleepilains meneri Host				Region		
Ibit Interstering         Encode of Control providing (A. Smith) (= 4 advice framatic and discretion (C. Cuviet) · · · · · · · · · · · · · · · · · · ·	Class Order Family	Genus and species	Vernacular names	Tick stages and date of collection	Country	Province	District (Locality)	Authorities
nc         Advisor padafinant (G. Cuvici)         Current mongeose.         Start         TVL         Pligrim's Rest (Manuality providuality)           Cynticit providuation         Control cuvici)         Scalementar         30,1144         No         Constructions         Scalementar           Cynticit providuation         Control cuvici)         Scalementar         30,1144         No         Constructions         Scalementar           Control providuation         Control cuvici)         Scalementar         30,1144         No         Construction         Reaching           Control cuvici)         Control cuvici)         Scalementar         30,1144         No         Scalementar         Scal	Mammalia Lipotyphla Erinaceidae	(A. Smith) ( = $A$ telerix frontalis	South African hedgehog Krimpvarkie	50	RSA	OFS	Petrusburg	Bedford & Hewitt, 1925; Bedford, 1932
Cynictic principan (G. Cuvier)     Yealow mongoose     92, 5, 5, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,	Carnivora Viverridae	•	Water mongoose Kommetjiegatmuishond	LL, NN 18.7.57	RSA	TVL	Pilgrim's Rest (Newington)	Theiler, 1971
Cyniatin parialitar ogilyj (A. Smith)     Cellow mongoose     11, NN     RSA     OFS     Lackhoff       Cyniatin parialitar ogilyj (A. Smith)     Cellow mongoose     *LJ, NN     RSA     OFS     Lackhoff       Cyniatin opiny     Continue opiny     Seconcectert     *NN     Botswana     -     Nganihand       Cyniatin opiny     Continue opiny     Continue opiny     *NN     RSA     OFS     Lackhoff       Streads arrianta minitari     Thomas & Schwamn     *NN     SNA     -     Orangional       Streads arrianta minitari     Streads     *NN     SNA     OFS     Lachhoff       Streads arrianta minitari     Schwamn     *NN     SNA     OFS     Lachhoff       Streads     Schwamn     Streads     *NN     SNA     OFS     Lachhoff       Streads     Schwamn     Streads     *NN     SNA     OFS     Lachhoff       Streads     Schwamn     *Streads     *Streads     *Streads     Streads       Streads     Schwamn     *Streads     *Streads     Streads     Streads       Streads     Streads     *Streads     *Streads     Streads     Streads       Streads     *Streads     *Streads     *Streads     Streads       Streads     *Streads <td></td> <td>* * * * * * * *</td> <td>Yellow mongoose Geelmeerkat Rooimeerkat</td> <td>유요 *30.11.40 *30.11.41</td> <td>RSA</td> <td>OFS</td> <td>Edenburg (Vaalbank) Jacobsdal (Rooidam)</td> <td>Theiler, 1947</td>		* * * * * * * *	Yellow mongoose Geelmeerkat Rooimeerkat	유요 *30.11.40 *30.11.41	RSA	OFS	Edenburg (Vaalbank) Jacobsdal (Rooidam)	Theiler, 1947
Cyntrifi sp.     Vellow mongoose     *L, NN     RSA     OFS     Luckhoff       Contrast     *NN     Sariadis     *NN     Botswana     -     Sigminud       Sariadis arriadia arriadia infanti Thomas & Schwann     Substanteeckat $\frac{QQ}{2}$ RSA     OFS     Luckhoff       Sariadia arriadia arriadia infanti Thomas & Schwann     Substanteeckat $\frac{QQ}{2}$ RSA     OFS     Edenbry       Sariadia sp.     Suriadia sp.     *     *     NN     RSA     OFS     Edenbry       Sariadia sp.     Substanteeckat $\frac{QQ}{2}$ RSA     OFS     Edenbry     Netervision       Substantion     Substanteeckat $\frac{QQ}{2}$ NN     RSA     OFS     Edenbry       Substant     Substanteeckat $\frac{QQ}{2}$ NN     RSA     OFS     Edenbry       Substanteeckat $\frac{QQ}{2}$ $\frac{QQ}{2}$ NN     NO     Contonion		•	Yellow mongoose Geelmeerkat	99, 33, LL, NN 20.10.40	RSA	OFS	Edenburg (Vaalbank) Jacobsdal (Rooidam)	Theiler, 1947
Gelmeerkat     *NN     Botswana     -     Nearbork       Swriadta suriadta bunilloni Thomas & Schwann     Swr     -     Nearbork       Suriadta suriadta bunilloni Thomas & Schwann     Surietee     11, NN     SWA     -     Nearbork       Suriadta suriadta bunilloni Thomas & Schwann     Surietee     11, NN     SWA     -     Nearbork       Suriadta sp.     Suriadta sp.     Suriadta sp.     -     -     Nearbork       Suriadta sp.     Suriadta sp.     -     -     -     Nearbork       Suriadta sp.     Suriadta sp.     -     -     -     Nearbork       Suriadta sp.     -     -     -     -     -     Nearbork       Sockstertmeerkat     LL, NN     RSA     OFS     Fdenburg     Nearbork       Sockstertmeerkat     LL, NN     RSA     WCP     Cordonian     Nearbork       Camit familiaris Linn     -     -     -     -     -     -       Undper (Cynalopes) dama (A. Smith) [ = Vulper chama (A. Smith)]     SWA     MCP     Cordonian     -       Undper (Cynalopes) dama (A. Smith)     E     McL     Nearbork     Nearbork       Not stated     -     -     -     -     -       Not stated     -     -			Yellow mongoose	*LL, NN	RSA	OFS	Luckhoff	Theiler, 1962
*NN       SWA       -       Outo         Suricata stricata baniloni Thomas & Schwann       Stricate       *N       N       -       Outo         Suricata stricata baniloni Thomas & Schwann       Grastijemeerkat       LL, NN       RSA       OFS       Edenburg         Stricate       Stokstertmeerkat       LL, NN       RSA       OFS       Edenburg         Stokstertmeerkat       11, NN       RSA       OFS       Edenburg         Stokstertmeerkat       *30,11,40       "       "       "       "         Canit familiari Linn       Stokstertmeerkat       LL, NN       RSA       WCP       Gordain         Uubse (Cynalopes) chama (A. Smith) I = Vulper chama (A. Smith)       Stokstertmeerkat       LL, NN       RSA       -       Onterrus         Under (Cynalopes) chama (A. Smith) I = Vulper chama (A. Smith)       Stort       RSA       -       Onterrus         Ibor metonalar meanular (Schreber) (= Canit meanular Schreber)       Stokstertmeerkat       -       -       Onstruct         Not stated       .       .       35, 92       RSA       OFS       Pachof         Not stated       .       .       .       .       .       .       .       .         Ibor meanular meanular (Schr			Geelmeerkat	NN*	Botswana	1	Ngamiland (Shushong, Toteng)	Theiler, 1962
Surficate surfact antion       Surficate antion       Thomas & Schwann       Surficate       \$25,10,40       No       Valbank         Stokistermeerkat       \$11,5,NN       RSA       OFS       Edenburg         Stokistermeerkat       \$25,10,40       "       "       "       (Vaalbank)         Stokistermeerkat       \$11,40       "       "       "       "       "         Stokistermeerkat       11,5NN       RSA       WCP       Gotdonia       "				NN*	SWA	Ι	Outjo (Franzfontein Reserve)	Theiler, 1962
Suriate sp. $*30.11.40$ """"JacobsdalSuriate sp.Suricate $LL_{1}$ , NNRSAWCPGordoniaSuricate sp.Suricate $LL_{2}$ , NNRSAWCPGordoniaSuricate stat $LL_{2}$ , NNRSAWCPGordoniaCanit familiarie Linn.Dog $*2.60$ SWA-River)KurumanHond $LL_{2}$ , NNRSACPacturburgUnlips (C)malopex) chama (A. Smith) [= $Vulpes chama (A. Smith)$ ]Silver jackal $3.3$ SWA-OmalarieIbas mesomelar mesomelar (C-mais mesomelar Schreber)Silver jackal $3.5$ , $9.2$ RSAOFSPetrusburgIbas mesomelar mesomelar (Schreber) (= Canis mesomelar Schreber)Black-backed jackal $3.5$ , $9.2$ RSAOFSBushofNot stated.NNSWA-ReshafadsDu Toit'sNot statedNot stated.Not statedNot statedNNSWA-ReshafadsNot statedNNSWA-ReshafadsNot statedNot statedNot statedNot statedNot stated <td></td> <td>•</td> <td>Suricate Graatjiemeerkat Stokstertmeerkat</td> <td>♀♀ LL, NN *28.10.40 *16.11.40</td> <td>RSA</td> <td>OFS</td> <td>Edenburg (Vaalbank)</td> <td>Theiler, 1947</td>		•	Suricate Graatjiemeerkat Stokstertmeerkat	♀♀ LL, NN *28.10.40 *16.11.40	RSA	OFS	Edenburg (Vaalbank)	Theiler, 1947
Surieate sp.     LL, NN     RSA     WCP     Gordonia       Stokstertmeerkat     -     -     -     River)       Canis familiaris Linn     Dog     **12,60     SWA     -     Omaruru       River)     Hond     1, NN     RSA     -     Omaruru       River)     Hond     1, NN     RSA     -     Omaruru       River)     River)     SWA     -     Omaruru       River)     River)     River)     River)     River)       Maleidie     -     0     River)       River)     Silverigkas     -     OFS     Retrusburg       River)     -     33, 22     RSA     -     OFS     Retrusburg       Riverigkas     -     33, 22     RSA     OFS     Retrusburg       Riverigkas     -     33, 22     RSA     OFS     Retrusburg       Not stated     -     -     33, 22     RSA     OFS     Retrusburg       Not stated     -     -     -     -     -     -     Ruifoni       Not stated     -     -     -     -     -     -     -       Not stated     -     -     -     -     -     -     -				\$9 *30.11.40	٠,	"	Jacobsdal (Rooidam)	Theiler, 1947
Canis familiaris Linn       Dog       *Q12.60       SWA       -       Omaruru         Hond       LL, NN       RSA       -       Omaruru         Vulpes (C)malopex) chama (A. Smith) [ = Vulpes chama (A. Smith)]       Silver jackal       33       ECP       Adelaide         Thos meromelas meromelas (C)malopex) chama (Schreber)       Silver jackal       33       RSA       OFS       Petrusburg         Not stated       .       .       35       RSA       OFS       Boshof         Not stated       .       .       .       .       .       .       No         Not stated       .       .       .       .       .       .       .       .       .       .         Not stated       . <td></td> <td></td> <td>Suricate Stokstertmeerkat</td> <td>LL, NN —</td> <td>RSA</td> <td>WCP</td> <td>Gordonia (Vanzylsrus, Kuruman River)</td> <td>Theiler, 1971</td>			Suricate Stokstertmeerkat	LL, NN —	RSA	WCP	Gordonia (Vanzylsrus, Kuruman River)	Theiler, 1971
malopex) chama (A. Smith) [ = Vulpes chama (A. Smith)]       Silver jackal       55       RSA       OFS       Petrusburg         Cape Fox       -       -       -       RSA       OFS       Petrusburg         elas mesomelas (Schreber) (= Camis mesomelas Schreber)       Black-backed jackal       55, 92       RSA       OFS       Boshof         .       .       .       .       .       .       .       .       .         .       .       .       .       .       .       .       .       .       .         .<	Canidae	• • • • • • •	Dog Hond	*\$? *8.12.60 LL, NN	SWA RSA	ECP	Omaruru (Melville) Adelaide (Makazana)	Theiler, 1962 Theiler, 1971
elas mesomelas (Schreber) (= Canis mesomelas Schreber)     Black-backed jackal     55, 99     RSA     OFS     Boshof       Rooijakkals     -     Rooijakkals     -     Etosha Pan       NN     SWA     -     Etosha Pan        Jackal     -     RsA     WCP     Gordonia         Jackal     -     RsA     WCP     National Park         Jackal     -     RsA     WCP     Gordonia           NN     SWA     -     Rioinal Park             National Park     National Park		Vulpes chama	Silver jackal Cape Fox Silwerjakkals	50	RSA	OFS	Petrusburg	Bedford & Hewitt, 1925 Bedford, 1932 Theiler, 1947
		Thos mesomelas mesomelas (Schrebet) (= Canis mesomelas Schrebet)	Black-backed jackal Rooijakkals	đđ, 99 	RSA	OFS	Boshof (Du Toit's Kuilen)	Theiler, 1971
Jackal – RSA WCP Gordonia (Kalahari National Gensbok Park)			Jackal	NN	SWA	]	Etosha Pan National Park	Theiler, 1971
			Jackal		RSA	WCP	Gordonia (Kalahari National Gemsbok Park)	Theiler, 1971

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Theiler, 1962	Bedford & Hewitt, 1925; Bedford, 1932 Theiler, 1947 Theiler, 1947	Theiler, 1962	Theiler, 1962	Theiler, 1962	Theiler, 1947		Theiler, 1962	Theiler, 1962	Theiler, 1962	Theiler, 1971	Theiler, 1971	Theiler, 1971	Theiler, 1971	Theiler, 1971	Theiler, 1962	Adult males Adult females Additional data supplied by Theiler, 1971
Omaruru (Melville)	Bloemfontein (Glen) Bloemfontein (Elandsbult) Jacobsdal (Rooidam)	Gordonia (Kalahari Gemsbok Na- tional Park. Rooiputs, Nossob River. Ellis-Kolk)	Gordonia (Vanzvlerue)	Gibeon	Gobabis (Otjimukande 178	Reitz, 23)	Karibib	Windhoek (Onderkarem-	ba, Lrogress) Rehoboth (Tsumis 147)	Pilgrims's Rest	(Newington) Gwelo (Brockly Estate)	Port Alfred	Clanwilliam (Lamberts Bay)	Uniondale	Okahandja (Okahandja)	Adult males Adult females Additional data s
1	OFS "	WCP	WCP	I	I		]	I	1	TVL	I	ECP	WCP	ECP		₩ ₩ ₩ ₩ ₩
SWA	RSA "	8	RSA	SWA	66		SWA		£ £	RSA	Rhodesia	RSA	RSA	RSA	SWA	
**************************************	$\begin{array}{c} 36, \ 27\\ *15, 8, 21\\ *26, 8, 21\\ 22\\ +20, 10, 45\\ +20, 11, 41\\ *30, 11, 41\end{array}$	**	*LL, NN	*LL, NN	*NN *24.2.50		*LL, NN	* NN *17.2.50	* 99, NN *22.3.50	LL, NN 15.8.57	LL, NN 	NN 12.6.41	NN January, 1942	NN September, 1941	Z   Z *	frica
Ox Bees	Ground squirrel Waaierstertmeerkat		Ground squirrel Wasiersteartmeerbat	W aalutolut lilluur Ma			Ground squirrel	Waaierstertmeerkat		Smith's bush squirrel Yellow-footed squirrel	Geelpoot-eekhorinkie	Vlei otomys, Swamp rat Vleimuis	Vlei otomys Vleimuis	Bush otomys Boskaroomuis	Namaqua rock mouse Golden rat Namakwalandse klipmuis	RSA = Republic of South Africa SWA = South West Africa LL = Larvae NN = Nymphae
· · ·	· · · · · · · · · · · · · · · · · · ·		• • • • •							· · · · · · · · · · · · · · · · · · ·			· · · · · · · ·	•	· · · · · (4	RS SWS NI
Bos taurus Linn	Geostiurus inauris (Zimmermann) [= Geostiurus capensis Thomas = Xerus capensis [entink		Geosciurus sp				Geosciurus sp.			Paraxerus cepapi cepapi (A. Smith)         .           [= Paraxerus cepapi (A. Smith)]         .		Otomys irroratus Brants	Otomys sp.	Motomys sp.	Aethomys namaquensis namaquensis (A. Smith) (= Rattus namaquensis)	OFS = Orange Free State TVL = Transvaal ECP = Eastern Cape Province WCP = Western Cape Province
Artiodactyla Bovidae	Rođentia Sciuridae											Otomyidae			Muridae	Legend:

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Rhipicephalus
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uo
Observations
TABLE 2

Rearing of periods is	f ticks for 7 given in da	generatic ays. Total	ns (Gen) on number (1	Rearing of ticks for 7 generations (Gen) on rabbits (R). Duration of the pre-oviposition (Pre-ov), oviposition plus hatching (Ovip & Hatch), *prefeeding (Pref.), feeding (Feed), premoulting (Prem) periods is given in days. Total number (No) of ticks harvested from each host group is listed	R). Durati harvestec	ion of the p I from each	re-oviposi host grou	tion (Pre-c 1p is listed	ovipo	sition plus ]	hatching (C	Dvip & Ha	itch), *pre	feeding (P	ref.), feedii	ng (Feed),	premoult	ing (Prem)
Ratch			Oval	Oval phases		La	Larval phases	s			Nyn	Nymphal phases	cs			Imaginal phases	phases	
No.	Date	Gen	Pre- ov	Ovip & Hatch	Pref	Hosts	Feed	No.	Prem	Pref	Hosts	Feed	No.	Prem	Pref	Hosts	Feed	No.**
2521	3.12.60	1	13-21	47-50	80	2R	4-12	371	17	24	2R	4-12	160	17–18	47–149	4R	5-11	42 & 26
2591 2616	22.2.61 1.11.61	00	11–14 12	66–68 66	62 22	7R 2R	4-12 4-9	3074 305	20–21 17–18	171 343	5R 1R	5-14 8-12	249 42	35–36 26	11–14 226	4R 1R	8-17 10-14	42 & 42 4 & 4
2757 2758	2.2.63 4.2.63	<i>ოო</i>	15 11	92 56	183 183	1R 1R	5-10 4	216 18	14 20	37 32	2R 1R	6-12 5-12	46 18	27 32	175 346	1R 1R	11 4	1 & 1 1 & 1
2849	17.2.64	4	11-14	<mark>55-</mark> 59	55	2R	5-13	905	21	140	4R	4-13	419	33–36	318	3R	9–14	18 & 13
3005 3008 3009	3.12.65 3.12.65 6.12.65	ບບບ	7-14 9-10 13	53–54 47–61 43	38–66 59 59	4R 1R 2R	4-12 4-12 4-12	1147 1283 902	26–28 22 22	87 121–344 344	4R 2R 1R	4–14 6–12 8–12	292 258 6	17–25 23–24 25	243–244 218–515 117	4R 3R 1R	8–16 15–26 9	11 & 10 8 & 11 2 & 2
3106	28.6.67	9	5-15	49–66	40-46	2R	5-11	726	13	27-123	6R	4–15	603	21-23	69–196	7R	5-20	77 & 46

\*See comments in text \*\*42 & 26 = 42 females and 26 males

	Average	uic-span		401	TCL		
	vested	Av	I	366	71	12	
	No of ticks harvested	Total Sub-B	1	26	31	31	
		Total	I	9517	2206	372	
	Total	horrod	70	88	149	184	
vested	riod	Av		20	27	Ţ	
e ticks har	Premoultin period	Total Sub-B	1	25	31	I	
id mature		Total	1	498	831	Ι	
mature ar	Feeding	Av	1	8	10	11	
ber of im		Av	1	.60	112	173	
otal num	Prefeeding period	Total Sub-B	I	26	32	40	
TABLE 3 Average and total duration in days of the different developmental phases and total number of immature and mature ticks harvested	Pref	Total	1	1553	3586	6933	
	& iod	Av	58		1	1	
	Oviposition & hatching period	Total Sub-B Av	29	1	I	Ι	
different	O	Total	1668	1	]	I	
ays of the	period	Av	12	Ι	1	I	
ttion in da	Pre-oviposition period	Total Sub-B	30		1	1	hes
otal dura	Pre-ov	Total	354	I		Ι	Average Sub-batc
TABLE 3 Average and t	Develormental nhases	Levelopinental phases	Oval	Larval	Nymphal	Imaginal	Legend: Av = Average Sub-B = Sub-batches

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6 & 4

9-10

2R

21

21-25

113

7-16

3R

14

14

570

4-11

2R

70

63

12

2

6.3.68

3137

120

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			Periods		Total du	ration for e	ach phase
	Developmental phases	Min	Max	Av	Min	Max	Av
Oval	Pre-oviposition	5 43	21 92	12 58	48	113	70
Larval	Prefeeding	8 4 13	183 13 28	60 8 20	25	224	88
Nymphal	Prefeeding	14 4 17	344 16 36	112 10 27	35	396	149
Imaginal	maginal Prefeeding		515 26	173 11	15	541	184
	Total periods	123	1274	491	123	1274	491
Total periods excludin	ng prefeeding periods	Y.					146

TABLE 4 The possible minimum, maximum and average duration of the life-span in days of R. theileri based on that of the different developmental phases

Legend: Min = Minimum

Max = Maximum

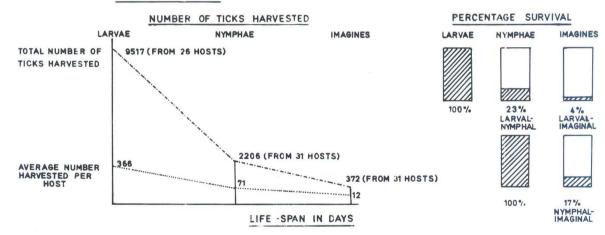
Av = Average

# TABLE 5 The numerical and percentage stage to stage decreases of ticks

No	o of ticks harvest	ed	N	lumerical decreas	se	Pe	rcentage decre	ase
L	N	I	L to N	N to I	L to I	L to N	N to I	L to I
9517	2206	372	7311	1834	9145	77	83	96

Legend: L = Larvae N = Nymphae I = Imagines

#### FIG. I - Life - cycle of Rhipicephalus theileri ACARIDARIUM (25-26°C. RH. 85-90%)



MIN. AV. MAX. MIN.AV. MAX. MIN.A	W. MAX MIN. AV. MAX. MIN. AV. MAX	MIN. AV. MAX. MIN. AV. MAX.	MIN. AV. MAX. MIN. AV. MAX. MIN. AV. MAX.
5 12 21 43 58 92 8 6	0 183 4 8 13 13 20 28	14 112 344 4 10 16	17 27 36 11 173 515 4 11 26
PRE- OVIPOSITION PI	RE- FEEDING PRE-	PRE- FEEDING	PRE- PRE- FEEDING
OVIPOSITION + HATCHING FEE	EDING MOULTING	FEEDING	MOULTING FEEDING
MIN. AV. MAX.	MIN. AV. MAX.	MIN. AV. MAX.	MIN. AV. MAX.
48 70 113	25 88 224	35 149 396	15 184 541
OVA	LARVAE	NYMPHAE	IMAGINES
	MIN.	AV MAX.	
1	123 4	91 1274	
		$\gamma$	

OVA - LARVAE - NYMPHAE - IMAGINES

SEE COMMENTS IN TEXT

# LABORATORY INVESTIGATIONS ON THE LIFE-CYCLE OF RHIPICEPHALUS THEILERI

or maximum survival periods for each stage. The results nevertheless show that there is a marked difference between the two extremes. Within these routine laboratory restrictions the prefeeding periods for larvae varied from 8 to 183 days, for nymphae from 14 to 344 days and for imagines from 11 to 515 days. The average duration of the life-cycle was 491 days, that of the total enforced prefeeding period 345 days which occupied a significant portion of the life-span.

# (b) Tick harvests

A total of 17 adult females was used for breeding. Egg production by a single female was estimated to vary approximately between 1500 to 2000. Hatching as judged from the large number of egg shells in relation to the small number of partially dehydrated eggs was good but the mortality rate of larvae during the prefeeding period was estimated to be more than 50%.

The number of immature and mature ticks harvested from each set of hosts (Table 2) and from individual animals (Table 3) varied a great deal. A variable number died during the feeding period and soon after detach-ment. As many as 1283 engorged larvae, 136 engorged nymphae and 12 replete adult females were harvested from individual animals. The average yield per animal was 366 larvae, 71 nymphae and 12 adults.

The numerical and percentage decreases from larval to nymphal, nymphal to imaginal and larval to imaginal stages are recorded in Table 5 and Fig. 1. The mortality rate was extremely high among the immature stages and the percentage decrease from larvae to imagines was 96%

Although large numbers of larvae, nymphae and adults were fed on 88 rabbits none of them showed any sign of illness other than small raised areas at the tickinfestation sites. Relatively few suppurated and healing was complete within 10 days after tick detachment.

### DISCUSSION AND CONCLUSION

The breeding results of *R. theileri* presented in Fig. 1 show that this species possesses features which make it possible for it to complete its life-cycle at 25 to 26°C and 85 to 90% RH.

The larval hatchings were good but reasons for the high mortality of the immature stages during prefeeding, feeding and premoulting stages are obscure. Furthermore, no explanation can be given for the marked differences between the minimum and maximum duration of the life-cycles.

The specified temperature and humidity levels for tick-breeding were maintained throughout the course of these studies. In contrast the climate in the natural habitats of hosts and ticks is subject to a great deal of variation. In mongoose, suricate, ground squirrel and jackal burrows it can be expected that the temperature and humidity levels would be stable but less so in the grass nests or shelters constructed over shallow holes or between rocks and in the intercurrent tunnels consisting of matted vegetation built by vlei and bush otomyses and Namaqua rock mice. Around the haunts the climate would vary according to the unpredictable combinations

of temperature, humidity and solar radiation from one season to another.

Although the tick-breeding results cannot be said to give a true reflection of the behaviour of ticks under all climatic conditions, they nevertheless do reveal hitherto unknown facts about the duration of the developmental phases which give an explanation for the survival of R. theileri under adverse conditions.

The micro-climate in the burrows, holes and grass structures would promote the development of ticks. The development of ticks exposed to adverse conditions around the haunts would in these circumstances be delayed. An extended duration of the developmental phases would offer additional protection to larval embryos and to engorged larvae and nymphae during the premoulting stage until the advent of warmer weather when hatching and moulting would occur under favourable conditions. The different tick stages would then be able to search for hosts in order to continue their development.

#### SUMMARY

1. The known distribution of R. theileri and its hosts in South and South West Africa and Rhodesia is presented in tabular form.

2. Attempts to rear this species for 7 generations at specified and constant temperature and humidity levels were successful.

3. Rabbits were used to feed the immature and mature stages.

4. A series of tables and a figure are included to show the duration of the four developmental phases and the number of ticks harvested.

5. Reasons for the high mortality among the immature and mature stages and the variation in the duration of the life-cycles of the tick batches are obscure.

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