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QUARANFIL VIRUS IN EXPERIMENTALLY INFECTED ARGAS (PERSICARGAS) ARBOREUS AND A. (P.) PERSICUS (IXODOIDEA : ARGASIDAE) DURING WINTERTIME IN EGYPT : EFFECT OF NATURAL AND CONTROLLED CONDITIONS OF TEMPERATURE AND RELATIVE HUMIDITY *

by Kawther M. EL KAMMAH ** and Kouka S. E. ABDEL-WAHAB ***

ABSTRACT: Experimental infection with Quaranfil (QRF) virus does not inhibit the development of Argas (Persicargas) arboreus or the related species A. (P.) persicus. Intake of a QRF virus-infected blood meal reduced the reproduction rate (number of larvae per female) in A. persicus but not in A. arboreus. Subsequent feeding on uninfected chicks in both species restored the reproduction rate to normal. Development of both species during wintertime almost stopped under simulated outdoor climatic conditions whether the ticks were infected or not. In A. arboreus adults and nymphs the virus was maintained throughout winter under constantly controlled conditions regulated to 30°C, 75 % RH, and 24 hr. photoperiod, or simulated outdoor climatic conditions. Two months after infection, QRF virus was recovered from A. arboreus regardless of temperature or humidity. Five months after infection, QRF virus was recovered under regulated climatic conditions from males and females; nymphs were not tested. Under simulated outdoor climatic conditions, the virus could be recovered from females and nymphs but not from males. Virus was not recovered during winter months from A. persicus held under simulated outdoor conditions either 2 or 5 months after infection. From those held under regulated climatic conditions, QRF virus was recovered 2 months after infection from males and females. Five months after infection, it was recovered only from males. It is concluded that QRF virus can survive inside infected A. arboreus ticks all winter regardless of atmospheric conditions. The virus is occasionally maintained by A. persicus ticks if protected from unfavourable conditions of wintertime in Egypt.

RESUME : L'infection expérimentale du virus Quaranfil (QRF) n'empêche pas le développement biologique de l'Argas (Persicargas) arboreus ou de l'espèce relative A. (P.) persicus. La prise du sang contaminé avec le virus QRF réduit la proportion de reproduction (le nombre des larves par femelle)
ARGAS
ARBOREUS
ARGAS
PERSICUS
CONDITIONS
CLIMATIQUES
dans le cas de l’A. persicus mais non pas dans le cas de l’A. arboreus. La nourriture consécutive sur des poussins non contaminés dans le cas des deux espèces rétablit la proportion de reproduction vers la normale. Le développement des deux espèces durant l’hiver s’arrête presque sous les conditions climatiques extérieures simulées, que la tique soit contaminée ou non. Dans le cas des adultes et de la nymphe d’A. arboreus, le virus a été maintenu constamment durant tout l’hiver à une température constante de 30°C, une humidité de 75% et un photopériodisme de 24 heures. Le virus QRF a été retrouvé deux mois après la contamination de l’A. arboreus, sans égard à la température ou à l’humidité. Le virus QRF a été retrouvé chez les mâles et les femelles, 5 mois après la contamination sous des conditions climatiques contrôlées, les nymphes n’ont pas été étudiées. Sous les conditions climatiques extérieures stimulées, le virus peut être retrouvé chez les femelles et les nymphes mais pas chez les mâles. Durant l’hiver le virus n’a pas été retrouvé chez l’A. persicus soumis aux mêmes conditions extérieures simulées même 2 ou 5 mois après la contamination. Le virus QRF a été retrouvé chez les mâles et les femelles soumis aux conditions contrôlées, 2 mois après la contamination. Il a été retrouvé seulement chez les mâles 5 mois après la contamination. Nous pouvons conclure que le virus QRF peut être retenu durant l’hiver dans la tique A. arboreus contaminée sans égard aux conditions atmosphériques. Le virus est quelquefois maintenu dans l’A. persicus s’il est protégé contre les conditions défavorables de l’hiver en Égypte.

INTRODUCTION

Quaranfil (QRF virus, a tick-borne virus isolated originally in Egypt from Argas ticks and from a febrile child’s blood sample (TAYLOR, HURLBUT, WORK, KINGSTON and HOOGSTRAAL, 1966), has been isolated many times from naturally infected Argas (Persicargas) arboreus collected throughout the year in Egypt (KAISER, 1966b). Argas (P.) arboreus ticks hibernate during wintertime when their principal host, Bubulcus i. ibis adults are rarely seen in Egypt (KAISER, 1966a, TAYLOR, HURLBUT, WORK, KINGSTON and HOOGSTRAAL, 1966, GUIRGIS, 1971). KAISER (1966c) concluded that QRF virus transovarial transmission did not occur from experimentally infected A. arboreus female to larvae. This conclusion indicated that an alternate maintenance mechanism for the virus must exist. Another natural infection cycle may include A. arboreus and domestic mammals as QRF antibodies were detected in goat, donkey, sheep and camel sera collected in Egypt (ABDEL WAHAS and IMAM, 1968) ; and from camels, buffaloes, pigs, dogs and donkeys (DAWISH et al. 1975). A side-chain cycle between domestic birds and QRF virus-infected A. arboreus may also exist to maintain the virus during the winter.

This paper explores the hypothesis that during the winter months QRF virus is either maintained inside the body of A. arboreus ticks, or is activated inside the related species, A. persicus, which does not hibernate during winter (EL HAMMAH and ABDEL WAHAS, 1979). Effects of QRF virus on the biological characteristics of both A. arboreus and A. persicus during wintertime are also reported.

MATERIALS AND METHODS

Tick feeding and rearing methods were described by KAISER (1966a). Specimens of Argas arboreus were collected on 13 October 1973 from the type-locality, Delta Barrage, Qalyub Governorate, Egypt, off trees inhabited by Bubulcus i. ibis (KAISER, HOOGSTRAAL and KOHLS, 1964). Specimens of A. persicus were collected on 5 October 1976 from chicken houses in Maadi, Cairo. Ticks of collections were tested for the presence of pathogenic organisms by inoculating randomly selected pooled tick samples
consisting of 10 males, 10 females, and 10 nymphs (N) from each collection, into suckling mice (SM), as described by KAISER (1966b). Both samples proved to be free of pathogenic organisms and the rest of the collections were used for the present experiments. Because field-collected *A. arboreus* ticks hibernate from November to April both in the laboratory and outdoors (KHALIL, 1974), the experiments commenced in November.

**Infection of ticks.** One-day-old chicks were infected with QRF virus strain AR1113 suckling mouse brain (SMB) passage 3. The virus, obtained from Yale Arbovirus Research Unit (YARU), New Haven, Connecticut, was cultivated in vero cells for one passage to prepare stock seed virus. Chicks were subcutaneously inoculated with \(10^6.25\) TCD\(_{50}\) (tissue culture cytopathic dose). By this method viremia develops to a peak by the 4th day after infection (ABDEL WAHAB, 1978). Ticks of each species were fed on chicks infected with QRF virus during the peaks of their viremias. A total of 90 males, 100 females, and 50 N of *A. arboreus*; 76 males, 64 females, and 78 N of *A. persicus* were infected. Infected ticks were segregated as follows: pairs of adult ticks, 1 male and 1 female, were placed in separate tubes; N were pooled in lots of 5 and were divided into 2 groups. One group was held in a room without air-conditioning or heating, and was subjected to normal daylight changes of daylight to simulate natural outdoor conditions. The other group was maintained in an insectary regulated at 30°C and 75 % RH and having a 24-h photoperiod. An uninfected batch of each species that had been fed on normal 1-day-old chicks was used as a control for either condition.

Normal blood meals were provided at intervals of 1 month for all adults and 2 weeks after molting for all N by placing ticks on uninfected 1-day-old chicks.

Observations were recorded for oviposition, hatching, molting, and any biological changes of all ticks.

**Virus detection.** It has previously been shown that following a viremic blood meal the incubation period for QRF virus in *A. arboreus* ranged from 23 to 95 days and in *A. persicus* from 47 to 86 days (KAISER, 1966c). In order to compensate for the expected slow rate of tick development during winter, we selected 62 days post-infection as the time for sampling tick tissues for virus. A 2nd sampling was made in April at 150 days postinfection, at which time *A. arboreus* is known to terminate its hibernation in nature (KHALIL, 1974). Samples of 3 males, 3 females, or 3 N from infected *A. arboreus* and *A. persicus* collected at 62 and 150 days post-infection were used. Samples were ground in 1 ml of neutral phosphate-buffered saline containing 0.4 % bovine plasma albumin (PBS-BA), centrifuged at 10,000 rpm and 4°C for one hour and the supernatant was inoculated intracerebrally (IC) into one-day-old suckling mice (SM) in 0.01-ml amounts. Virus induced encephalitis is reported as number of dead over total number of inoculated mice.

The presence or absence of QRF virus in SM brain suspensions was determined by a microtiter complement fixation test (CFT) described by KAISER (1966b). This test employed a crude antigen prepared from SM brain suspension, a hyperimmune mouse serum specific for QRF virus and 7 units of complement (CASEY and MARCHETTI, 1963).
RESULTS

Effect of Quaranfil virus infection on the development of «Argas» ticks under controlled conditions of temperature and relative humidity.

Argas (P.) arboreus. The reproduction rate, \( R \) (number of larvae per female), of field-collected females fed on blood infected with Quaranfil virus was 1 : 5, the same as that of field-collected females which fed on blood of normal chicks (Table 1). Following an infective blood meal, the frequency distribution of \( O \) shows that females produced a higher number of eggs were more than uninfected ones, but the low mean number of eggs (E) 8.2 ± SE3.36) was significantly lower (\( P < 0.05 \)) as compared to females fed on clean chicks (14.8 SE2.46). This low number of E was readily compensated for by the much higher percentage of hatched eggs (H) from infected ticks (92.6 %) than that from noninfected females (56.4 %), (Fig. 1a, and Table 1).

### Table 1: Effect of Quaranfil virus infection on the reproduction rate in Argas arboreus reared under regulated climatic conditions (30°C and 75 % RH).

<table>
<thead>
<tr>
<th>Condition</th>
<th>Month of feeding</th>
<th>No. fed</th>
<th>Oviposited</th>
<th>No. eggs per ♀</th>
<th>Preoviposition period (days)</th>
<th>Prehatching period (days)</th>
<th>Reproduction rate***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quaranfil virus-infected</td>
<td>Nov.*</td>
<td>50</td>
<td>66.0</td>
<td>8.2 (5-40)</td>
<td>10.1 (10-11)</td>
<td>92.6</td>
<td>1 : 5</td>
</tr>
<tr>
<td></td>
<td>Dec.**</td>
<td>25</td>
<td>96.0</td>
<td>24 (10-60)</td>
<td>10.4 (10-11)</td>
<td>85.4</td>
<td>1 : 8.3</td>
</tr>
<tr>
<td>Uninfected</td>
<td>Nov.**</td>
<td>35</td>
<td>62.9</td>
<td>14.8 (5-50)</td>
<td>13.6 (8-23)</td>
<td>56.4</td>
<td>1 : 2.4</td>
</tr>
<tr>
<td></td>
<td>Dec.**</td>
<td>34</td>
<td>73.5</td>
<td>9.0 (3-30)</td>
<td>15.6 (9-18)</td>
<td>35.6</td>
<td></td>
</tr>
</tbody>
</table>

* Ticks were infected with Quaranfil virus by feeding on viremic chicks during November, then fed on uninfected chick.
** Fed on normal chicks.
*** Number of larvae per female.

After these infected females were fed on normal chickens, the percentages of females ovipositing \( O \), as well as the E and R of the 1st laboratory generation increased from 66, 8.2 and 1 : 5 to 96, 24 and 1 : 8.3, respectively, (Table 1). Frequency distribution for \( O \) also shows the increase of females that layed more eggs than uninfected ones (Fig. 1b). Subsequent normal blood meals offered during February, March and April to both infected and noninfected females resulted in a similar pattern in both groups and the observed differences are considered as normal fluctuations, (Fig. 2).

Nymphs experimentally infected with QRF virus by feeding on viremic chickens molted to adults after 16 to 23 days. The control uninfected ones molted after 18 to 24 days. Thus, the nymphal development was apparently not affected by virus infection.

Argas (P.) persicus. Following the infective blood meal, frequency distribution of \( O \) shows the tendency of infected females to lay fewer eggs than uninfected ones, (Fig. 1c). Infected females produced \( O \), E and H slightly lower than those females fed on normal chicks (68.8, 18.3 and 75.0 compared with 83.3, 28.0, and 85.7, respectively). The R of these infected females was 1 : 7.5 compared with the R (1 : 20) of the uninfected females (Table 2). Following the first feeding of the infected A. persicus on normal host, \( O \) was raised from 68.8 % to 88.2 % and R was almost doubled from 1 : 7.5 to 1 :14.7.
Fig. 1. Frequency distribution histogram on the effect of Quaranfil virus infection on egg laying of *Argas (P.) arboreus* (A, B) and *A. (P.) persicus* (C, D) females under regulated climatic conditions (30°C, 75% RH, and 24 hour photoperiod).

### TABLE 2: Effect of Quaranfil virus infection on the reproduction rate in *Argas persicus* females reared under regulated climatic conditions (30°C and 75% RH).

<table>
<thead>
<tr>
<th>Condition</th>
<th>Month of feeding</th>
<th>No. fed</th>
<th>Oviposited</th>
<th>No. eggs per ♀</th>
<th>Preoviposition period (days)</th>
<th>% hatch</th>
<th>Prehatching period (days)</th>
<th>Reproduction rate***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infected</td>
<td>Nov.**</td>
<td>32</td>
<td>22</td>
<td>68.8</td>
<td>18.3 (10-30)</td>
<td>19.1</td>
<td>17 (7-31)</td>
<td>75.0</td>
</tr>
<tr>
<td></td>
<td>Dec.**</td>
<td>17</td>
<td>15</td>
<td>88.2</td>
<td>18.0 (5-50)</td>
<td>6.8</td>
<td>6 (6-9)</td>
<td>92.6</td>
</tr>
<tr>
<td>Uninfected</td>
<td>Nov.**</td>
<td>30</td>
<td>25</td>
<td>83.3</td>
<td>28.0 (5-70)</td>
<td>14.4</td>
<td>4 (4-27)</td>
<td>85.7</td>
</tr>
<tr>
<td></td>
<td>Dec.**</td>
<td>12</td>
<td>12</td>
<td>100.0</td>
<td>13.3 (5-50)</td>
<td>7.2</td>
<td>7 (7-8)</td>
<td>100</td>
</tr>
</tbody>
</table>

* See footnotes of Table 1.
As for the uninfected females reared on normal hosts, O was also raised, but the R dropped from 1:20 to 1:12.3. Frequency distribution of O in both conditions explain the close number of egg laying that resulted the close R., (Fig. 1d). Fluctuation was also observed in O, R, of both infected and uninfected females when reared on normal chickens during January to March, (Fig. 2).

As was observed in A. arboreus, experimental infection of nymphs with QRF virus did not affect nymphal development. Experimentally infected N molted to adults after 22 to 30 days, while uninfected N molted after 14 to 24 days.

Fig. 2. Effect of Quaranfil virus on the biological profile of Argas arboreus and A. persicus females reared under regulated climatic conditions (30°C, 75 % RH and 24 hour photoperiod).

- Effect of Quaranfil virus infection on the development of Argas ticks under simulated outdoor conditions.

Infected and uninfected A. arboreus held at simulated outdoor conditions fed only during November and March, when the mean daily temperature were 20.6° and 19.2°C. They did not feed during December through February, when mean daily temperatures were lower (Table 4). Mean relative humidities during this time apparently did not affect their feeding. The ticks that did not feed were found to be full of undigested blood. Ten and 30 eggs laid, respectively, by 2 infected A. arboreus females during November never hatched. It was also observed that winter conditions could completely inhibit metamorphosis of N into females regard-
less of the presence or absence of virus. The pre-molting periods of infected and uninfected nymphs were 63 to 70 days and 80 to 120 days, respectively.

Infected and uninfected *A. persicus* held under the above conditions during December to February could feed and digest their blood meals, but were unable to lay eggs or to maintain their reproductive rate. During November 10 of 32 infected females fed (31.3%) and oviposited (E, mean = 20, range = 5-30; H = 32.5%; R = 1:2). 14 of 30 females fed on clean chick blood (46.4%) and oviposited (E, mean = 18.9, range = 4-30; H = 1.0%; R = 1:0). The larvae produced by the uninfected females died within 24 h. after emergence. As observed with *A. arboreus*, the physiological development of the females was affected by the climatic conditions, but was unaffected by the presence or absence of QRF virus. The pre-molting periods of infected and uninfected nymphs were 32 and 36, respectively.

**Detection of Quaranfil virus in tick tissues**

After 62 days extrinsic incubation period (EIP), the presence of QRF virus in experimentally infected *A. arboreus* males, females, and nymphs was verified by the recovery of virus from the tick suspensions (see methods). The virus was detected in adults and nymphs regardless of temperature, relative humidity, or photoperiod and whether held under constant or outdoor conditions, (Table 3).

*A. persicus* ticks sampled and treated similarly were almost free of QRF virus except for 2 samples. These were one suspension of 3 males, and the other of 3 females from ticks held under controlled climatic conditions. They caused death of only one SM each out of an inoculated litter (Table 3). Samples of males, females and N of *A. arboreus* and *A. persicus* that were fed on normal chicks did not cause illness in SM.

As the EIP was extended to 150 days, the adult tick samples examined from *A. arboreus* held under constant and or simulated outdoor conditions contained less virus infectivity than 62 days EIP samples (Table 3). *A. persicus* adults and N held at outdoor simulated conditions were free of virus at this stage of EIP. Yet, trace infectivity of QRF virus was detected in adult male *A. persicus* (Table 3).

All experimentally infected N held at constant regulated temperature, humidity and photoperiod molted to adults by 150 days of EIP. Molting of infected N held at outdoor simulated conditions was arrested and therefore we were able to sample this stage again at 150 days of EIP. It was found that QRF virus infectivity was negligible in these N samples (Table 3). Similarly processed samples from males, females, and N of *A. arboreus* and *A. persicus* that were fed on clean chicks did not cause any manifestation of virus infection in inoculated SM.

**Table 3 : Quaranfil virus in *Argas arboreus* and *A. persicus* tissues 62 and 150 days following infection by feeding on viremic chicks.**

<table>
<thead>
<tr>
<th>Species*</th>
<th>Post-infection day</th>
<th>Regulated temperature and humidity</th>
<th>Outdoor temperature and humidity</th>
<th>No./Stage</th>
<th>D/L*</th>
<th>AST</th>
<th>No./Stage</th>
<th>D/L*</th>
<th>AST***</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>A. arboreus</em></td>
<td>62</td>
<td>3 σ</td>
<td>7/7</td>
<td>6.5</td>
<td>3 σ</td>
<td>5/5</td>
<td>6.5</td>
<td>62</td>
<td>3 N</td>
</tr>
<tr>
<td><em>A. persicus</em></td>
<td>62</td>
<td>3 σ</td>
<td>1/8</td>
<td>6.0</td>
<td>3 σ</td>
<td>0/6</td>
<td>—</td>
<td>62</td>
<td>3 α</td>
</tr>
<tr>
<td><em>A. arboreus</em></td>
<td>150</td>
<td>3 σ</td>
<td>2/7</td>
<td>7.0</td>
<td>3 σ</td>
<td>0/8</td>
<td>—</td>
<td>150</td>
<td>3 α</td>
</tr>
<tr>
<td><em>A. persicus</em></td>
<td>150</td>
<td>3 σ</td>
<td>2/8</td>
<td>10.0</td>
<td>3 σ</td>
<td>0/7</td>
<td>—</td>
<td>150</td>
<td>3 α</td>
</tr>
</tbody>
</table>

* Total number of experimentally infected ticks was : = 90 σ, 100 α, and 150N of *A. arboreus* ; and 76 σ, 64 α, and 78 N of *A. persicus*.

** Sukkling mice inoculated intracerebrally with 0.01 ml of tick tissue suspension : D = no. dead, L = total no. inoculated.

*** AST = average survival time after inoculation.

**Table 4 : Climatic conditions near Nasr city*, Egypt from November 1976 to April 1977 (from Meteorological department, Abbassia Station, Cairo).**

<table>
<thead>
<tr>
<th>Temperature °C</th>
<th>Mean</th>
<th>Range</th>
<th>Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov. 1976</td>
<td>20.6</td>
<td>10.1-36.0</td>
<td>65.7</td>
<td>38-88</td>
</tr>
<tr>
<td>Dec. 1976</td>
<td>16.1</td>
<td>8.3-28.3</td>
<td>63.9</td>
<td>48-92</td>
</tr>
<tr>
<td>Jan. 1977</td>
<td>14.2</td>
<td>5.4-24.8</td>
<td>67.1</td>
<td>35-92</td>
</tr>
<tr>
<td>Feb. 1977</td>
<td>17.3</td>
<td>8.6-29.6</td>
<td>60.0</td>
<td>24-96</td>
</tr>
<tr>
<td>Mar. 1977</td>
<td>19.2</td>
<td>6.3-28.8</td>
<td>59.5</td>
<td>33-96</td>
</tr>
<tr>
<td>Apr. 1977</td>
<td>22.1</td>
<td>12.8-38.2</td>
<td>46.7</td>
<td>13-78</td>
</tr>
</tbody>
</table>

* Name of area where this work was done.
DISCUSSION

This study shows that female *Argas arboreus* that were experimentally infected with QRF virus by feeding on infected chicks produced a low mean number of eggs (8.2) as compared to uninfected females (14.8). However, the percentage of females ovipositing in both groups was comparable (Table 1). The cause of this depressed physiology may be that the replication of QRF virus in tick tissue consumed energy or metabolites necessary for normal output of eggs. This lowered number of eggs would present a threat to the long-term survival of a QRF virus-infected tick population if not corrected by another mechanism. Such compensation of the physiology was observed in our study, as there was a tendency of individual infected females to lay higher number of eggs and a higher percentage of hatching of infected tick eggs (92.6%) than of uninfected ones (56.4%).

A further mechanism to ensure the survival of a QRF virus-infected tick population if not corrected by another mechanism. Such compensation of the physiology was observed in our study, as there was a tendency of individual infected females to lay higher number of eggs and a higher percentage of hatching of infected tick eggs (92.6%) than of uninfected ones (56.4%).

A further mechanism to ensure the survival of a QRF virus-infected tick line was observed. It was found that feeding those virus-infected female *A. arboreus* on a normal chick raised the percentage of females ovipositing, egg laying, egg hatching, and N molting in the 1st and 2nd laboratory generations (Table 1 and Fig. 1a, b).

The reproduction rate of QRF virus-infected *A. persicus* females was lower than that of uninfected females. As in the case with *A. arboreus*, feeding infected *A. persicus* on virus-free chicks raised both the percentage of ovipositing females and the reproduction rate, though the variations in the number of eggs laid was within normal biological fluctuations. This pattern was recorded again following the 2nd clean chick blood meal (Table 2, Fig. 1c, d).

Natural climatic changes affected *A. arboreus* and *A. persicus* differently. The reproduction rate was modified when virus-infected and uninfected *A. arboreus* were held under simulated natural environment. The ticks fed only during November and March when the temperature and daylight period were favorable; relative humidity apparently did not affect feeding. Thus regardless of the virus infection, the winter conditions completely stopped metamorphosis of N into adults. However it was noticed that the premolting periods of virus-infected nymphs was shorter (63-70 days) than that of uninfected ones (80-120 days). *A. persicus* ticks behaved slightly differently under the same weather conditions. Infected and uninfected females could feed and digest their blood meals but were unable to lay eggs or maintain their reproduction rate except for 10 infected females that laid few eggs (m. 22.5) during November. Also the premolting period of infected and uninfected nymphs was more or less the same (32 and 36 days, respectively).

Our results show that once the *A. arboreus* adults or nymphs become infected with QRF virus, the infection persists for 62 days EIP.

The detection of traces of virus infectivity after 150 days EIP in *A. arboreus* females whether held under controlled or outdoor conditions raises the possibility of virus survival over winter.

This finding verifies Kaiser's (1966b) results that adult *A. arboreus* females retains QRF for 23 to 95 days, while nymphs retained it for 88 days, and extends it to *A. persicus* experimentally infected with QRF virus. Whether the virus could become reactivated in adult tick tissues upon the intake of another blood meal when its migrant natural host *Bubulcus i. ibis* returns to the nesting areas should be verified by further work.

Still to be investigated is the possibility of a side chain for natural transmission of the virus between *A. arboreus* and/or *A. persicus* ticks and domestic birds or mammals in Egypt. The possible importance of the immature stages of
both ticks in transmitting QRF virus is stressed here, because their host range includes, besides avians, farm animals and man. Supportive evidence is the occurrence in nature of QRF virus human febrile infection (TAYLOR, HURLBUT, WORK, KINGSTON and HOOGSTRAAL, 1966) and the detection of antibodies to this virus in sera from farm animals (ABDEL-WAHAB and IMAM, 1968; DARWISH, IMAM, OMAR and EL KARAMANY, 1975). A comparable cycle of transmission of another arbovirus in Egypt may be operative: West Nile virus was isolated from wild Argas (A.) hermanni in summer and winter (SCHMIDT and SAID, 1964) and also from sick birds during wintertime (TAYLOR, HURLBUT, and RIZK, 1956). It is to be noted here that A. arboreus does not hibernate before November (KHALIL, 1974), while its principal migratory host, the egret, is rarely seen in Egypt earlier in August.

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