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Review Article

Biodiversity of vectors and vector-borne diseases in Sinai

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ABSTRACT

The Sinai peninsula has always been regarded as an important and unique part of Egypt due to its history and geographical situation. In resent years several ambitious developmental programs were planned and undertaken in Sinai. Among such programs is the "peace canal" project, which transfers water from the Nile to Sinai. Since this project is expected to lead to major changes in the flora and fauna in Sinai it was felt that the study of vectors and vector borne diseases would be of great value. The present paper reviews the results of several studies carried out by researchers at Suez Canal University and Ain Shams University on the vectors of certain vector-borne diseases in Sinai. The combined surveys revealed that potential invertebrate vectors were represented by twenty two species of mosquitoes, fourteen species of sand flies and eight species and four subspecies of ticks. Eight species and three subspecies of rodents were identified as possible reservoir species for vector-borne diseases. Distribution, association of different species, and the role of these insects as vectors of diseases, or the rodents as reservoir animals are discussed.

KEYWORDS: mosquitoes, sand flies, ticks, rodents, desert

INTRODUCTION

Sinai Peninsula has always been a very precious and special part of Egypt along the ancient and modern history as well. Forming the geographical junction between Africa and Asia, the total area of Sinai is about 60,000 km^2, which represents about 6% of the total area of Egypt. Its unique geographical and topographical

characteristics are home to a rich fauna and flora, including many endemic species.

Since the peace treaty was signed between Egypt and Israel about 15 years ago, several ambitious developmental programs have commenced in Sinai; the most important being "the peace canal project". This project (Fig.1) aims to transfer water from the Nile through pipes underneath the Suez Canal to cultivate about 400,000 acres of Sinai desert, east of the Suez Canal. The first stage of the peace canal is already functioning and the Nile water is now available to the east of lakes in Ismailia governorate. The goal of this stage aims at reclamation and cultivation of about 100,000 acres and the establishment of about 30 new settlements which could hold up to 200,000 new inhabitants. These dramatic changes to the environment may lead to changes in the biodiversity of pests affecting man and animal.

The biodiversity of vectors and vector borne diseases in Sinai were thoroughly studied at Suez Canal University and Ain Shams University during the last 15 years through a number of research projects (Appendix 1) and MSc and PhD degrees (Appendix 2).

Distribution of vectors of diseases in Sinai: The distribution of vectors of diseases, as well as reservoir animals were not studied in Sinai for several years due to the unstable conditions in the area. Following the establishment of Suez Canal University in 1976, and the return of civil administration to Sinai in 1981, several research projects and studies were started in Sinai to update the data on vector borne diseases. These studies comprised mosquitoes, sand flies, ticks and rodents. The results of those studies are summarized as follows.

Mosquitoes: A survey of mosquitoes in Sinai peninsula revealed the presence of 10 *Culex* species, 2 *Aedes* species, 2 *Culiseta* species, one *Uranotenia* species and 7 *Anopheles* species (Shoukry 1987).

The culicine species collected were: *Culex pipiens, Cx. Pusillus, Cx. sinaticus, Cx. theileri, Cx. univittatus, Cx. antennatus, Cx. laticinctus, Cx. mimeticus, Cx. arbieeni* and *Cx. Deserticola.* The distribution of the *Culex* species in Sinai is shown in table 1.

The two-aedine mosquitoes recorded in Sinai were *Aedes caspius* and *Aedes detritus*. The two *Culiseta* species recorded were *Culiseta longeriolata* and *Culiseta subochrea*. This was the first record of *C. subochrea* in Sinai. The only *Uranotoenia* species recorded in Sinai was *U. unguiculata*. The distributions of those groups of *Culicine mosqutoes* are shown in table 2.

The 7-anopheline mosquitoes recorded in Sinai were: *Anopheles phroensis, An. multicolor, An. tenebrosis, An. turkhudi, An. rupicolus, An. sergentii,* and *An. Superpictus.* The distribution of anopheline mosquitoes is shown in table 3.

The associations of the different mosquito species are shown in table 4. This pattern of association reflects unusual conditions since the most important factors governing this biodiversity are the water characteristics. The mosquito breeding sites in Sinai showed a wide range of vegetation abundance, PH value and water salinity (Shoukry 1987; Morsy 1988).

Some of the recorded mosquito species were specific to Sinai only, e.g. out of the 10 *Culex* species 5 were common in other parts of Egypt while the other 5 were restricted only to Sinai i.e. *Cx. laticinctus, Cx. mimeticus, Cx. sinaticus, Cx. arbeeni* and *Cx. deserticola.* Also, out of the 7 recorded *Anopheles* species, 4 were common in other parts of Egypt, while 3 species were found only in Sinai i.e. *An. rubicolus, An. superpictus* and *An. turkhudi* (Shoukry 1987).

Mosquitoes are known to be vectors of several vector borne diseases in Egypt e.g. malaria, filaria and Rift Valley Fever. Blood samples (733) collected from school children age between 6 and 15 years were all microscopically and serologically negative for malaria in Sinai (Shoukry 1987). The possibility of malaria in Sinai is anticipated, especially after construction of the peace canal and the establishment of the new settlements, which are expected to be inhabited by new immigrants coming from the Nile valley where some areas had a history of malaria endemicity. The same situation could be stated in case of filaria, which had no history in Sinai but could be introduced with the new inhabitants and the expected spread of *Cx. pipiens,* the main filaria vector in the Nile valley.

RVF was first recorded in Egypt in 1978 in Sharquia governorate (El-Akkad 1978; Immam & Darwish 1978; Meegan 1979) and, during the period from 1967 till 1973 when Sinai was occupied by Israel, most of the animals in Sinai were vaccinated against RVF as a protection measure. During the survey carried out by Shoukry (1987) 140 blood samples were collected and tested for antibodies of RVF. All these samples were from young goats and sheep, less than 2 years old, to avoid the presence of antibodies due to previously mentioned vaccination. From the 140 tested blood samples, 8 samples were positive (3 at 1/20, 3 at 1/40 and 2 at 1/160

titre). The two samples showing high titer (1/160) were collected from Rafah and Beer El-Abd in north Sinai. These two areas, when reexamined, revealed no other cases of RVF antibodies (Shoukry 1987). Earlier a number of human and sheep sera collected in Sinai proved positive for RVF virus (Meegan 1979; Darwish & Hoogstraal 1981). The spread of RVF virus to Sinai might have accrued through UN troop movements or wind-borne arthropods (Meegan 1979). The fact that *Cx. pipiens* was the chief, if not the only transmitter of RVF virus during the epizootic of 1978, (Hoogstraal 1978; Meegan *et al.* 1980; Darwish & Hoogstraal 1981) and the abundance of *Cx. pipiens* in Sinai (Shoukry 1987), it is therefore important to remain vigilant and routinely investigate the role of mosquitoes in vector-borne diseases transmission in Sinai.

Sand flies: Surveys of sand flies were carried out in three areas of Southern Sinai representing different ecological conditions and defined by altitude (El-Sawaf *et al.* 1987). Results revealed the presence of 14 species, namely: *Phlebotomus papatasi, P. bergeroti, P. alexandri, P. sergenti, P. kazerunti, P. orientalis, P. arabicus, P. major, Sergentomyia tiberiandis, S. adlere / clydei, S. schwilzi, S. Palestinensis, S. fallax* and *S. christophersi,*

Species composition showed a diversity influenced differences in altitude and the nature of habitat being wild or predomestic. Some of the above identified sand fly species are known vectors of leishmaniasis in different parts of the world as well as in Sinai. Wild rodents are known to act as reservoir and host animals of cutaneaus leishmaniasis in Sinai (Morsy *et al.* 1987a, b & c).

The status of sand fly biodiversity is different in North Sinai as only *P. papatasi* was repeatedly recorded in this region. Cutaneous leishmaniasis, has always been a problem in North Sinai (Morsy *et al.* 1987a & 1993). *Phlebotomus papatasi* showed a relatively long seasonal abundance in North Sinai (Merdan *et al.* 1992). Also, the susceptibility of sand fly species to maintain different species of *Leishmania* parasite led to the fact that *P. papatasi* was, the most likely species for transmitting leishmaniasis in Sinai (Morsy *et al.* 1992)

Ticks: The geographical distribution of ticks infesting farm animals in Sinai peninsula carried out by Shoukry *et al.* (1993) revealed the presence of 12 tick species and subspecies: *Hyalomma dromedarii, H. impeltatum, H. an. anatolicum, H. anatolicum excavatum, H. marginatum rufipes, H. marginatum turanicum, H. shulzei,*

Rhipicephalus sanguineus, R. turanicus, Boophilus annulatus, Onthinthodoros erraticus, and *Argas persicus*

The distribution of these species is shown in table 5. The former 10 species are hard ticks while the latter two are soft ticks. The survey of Shoukry *et al.* (1993) could be considered the first complete study in Sinai since most of the previous studies carried out in Sinai were mainly recording of the species present in particular parts of Sinai (e.g. Hoogstraal & Kaiser 1958; Feldman-Muhsam 1960; Rubina *et al.* 1994).

Shoukry *et al.* (1993) showed that camels were the most common domestic animals frequently infested by ticks in Sinai as, of 12 tick species recorded in Sinai, 8 were collected from camels. In contest, sheep and goats, although the most abundant farm animals in Sinai, were less infested by ticks when compared to camels. These animals were infested by *R. sanguineus* in North Sinai and by both *R. sanguineus* and *R. turanicus* in South Sinai.

Rodents: Survey of rodent species in Sinai carried out by Shoukry (1987) and published later by Morsy *et al.* (1988) revealed the presence of 11 species and subspecies of rodents : *Rattus norvegicus, Rattus rattus frugivorous, Rattus rattus alexandrinus, Mus musculus, Acomys cahirinus dimidiatus, Gerbillus pyramidum floweri, Gerbillus andersoni, Gerbillus gerbillus, Jaculus jaculus schlucteri, Meriones sacramenti* and *Eliomys quercinus* The distribution of those species is shown in table 6.

Rodents are known to play an important role as reservoir for certain vector-borne diseases. Commensal rodent species were rarely found infested with ticks except of some immature stages of *Rhipicephalus* and *Hyalomma* spp. (Shoukry *et al.* 1986 & 1993). The Egyptian greater *Gerbillus pyramiduim* was considered the most common wild rodent species in Sinai (Morsy *et al.* 1988); this species is known to act as a reservoir animal for certain rickettsial agents in Sinai (Shoukry *et al.* 1991).

In conclusion, it is clear from the present review that vector borne diseases together with their vectors and reservoir animals represent a real threat to future developmental projects in Sinai. The present situation of these group of animals should be updated after the construction and opening of the peace canal and the arrival of new inhabitants in the new settlements. The previously studied vector borne diseases should be restudied together with the parasitic disease

schistomiasis which the author expect to represent a real health problem in Sinai.

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Appendix (1): List of research projects carried out on vector borne diseases in Sinai.

1. Epidemiology and control of arthropod-borne diseases in Egypt. (NIH NIAID, U.S.A. and Ain Shams University Research Center for Vectors of Diseases, 1985-1994).

2. Epidemiology and control of vectors of diseases in Sinai. (Egyptian Academy of Science and Technology and Ain Shams Research Center for Vectors of Diseases, 1989-1992).

3. Biodiversity of pests affecting man and animals in east of lakes area, Sinai. (Ministry of Agriculture and Suez Canal University, 1993-1994).

4. Survey and control of arthropod vectors in new settlements in Sinai. (Ministry of Agriculture and Suez Canal University, 1994-1995).

5. Multidisciplinary study of parasitic diseases in new settlements in Sinai, Ain shams University, 1994-1995).

6. Some modern approaches for control of vectors of diseases in new settlements in Sinai (Ain Shams university, 1995-1996).

The impacts of outdoor resting habits on mosquito bionomics and vectorial capacity in filarial endemic and non-endemic areas, (Ain Shams university 1996-1997).

Appendix (2): List of M.Sc. and Ph.D. degrees carried in Sinai on vectors of diseases.

1. Soliman BA (1985) Field studies on Transmission of filaria by mosquitoes. MSc Thesis, Ain Shams Univ.
2. El-Bahrawy AF (1986) Biological and ecological studies one some rodents species in Ismailia governorate. PhD. Thesis, Suez Canal Univ.
3. El-Kady GA (1987). Ecological studies on rodents of North Sinai governorate. MSc. Thesis, Suez Canal Univ.
4. Morsy ZS (1987) Distribution and ecology of mosquitoes in Sinai, M.Sc. Thesis. Ain Shams Univ.
5. Soliman BA (1990) Studies on factors governing susceptibility of certain mosquito species to filarial transmission. PhD. Thesis, Ain Shams Univ.
6. Hassan MM (1990) Studies on aedine mosquitoes in Egypt, taxonomy of *A. caspius*. PhD. Thesis. Ain Shams Univ.
7. Wahba M (1991) Relation between sand flies and reservoir animals of Lishmaniasis in Sinai. PhD. Thesis, Ain Shams Univ.
8. Abdel-Mohsen A (1991) Ecological studies on ecto-parasites of rodents and their relation to typhus PhD. Thesis, Ain Shams Univ.
9. El-Kady GA (1991) Survey and ecology of ticks in Sinai. PhD. Thesis, Suez Canal Univ.

Table (1). Distribution of *Culex* species in Sinai (after Skoukry 1987)

Species	Localities
Cx. pipiens	Arish, Kosaimah, Godirate, Zowaid, Wadi Elhomer, St. Katherine
Cx. pusillus	Romanah, Beer Lehfin, Zowaid, Hamam Pharon, Ein Mousa, Tor
Cx. sinaticus	Godirate, St. Katherine
Cx. theileri	Zowaid, Rafah, Godirate, Firan, St. Katherine
Cx. univittatus	Zowaid, Rafah, Godirate
Cx, antennatus	Zowaid, Rafah, Godirate
Cx. laticinctus	Godirate, St. Katherine
Cx. mimeticus	Godirate
C.x. arbieeni	St. Katherine
Cx. deserticola	Godirate, Abou Redis, Firan, St. Katherine

Table (2). Distribution of other *Culicine* species in Sinai (after Skoukry 1987)

Species	Localities
Ae. caspius	Beer El Abid, Bardowil, Zowaid, Ain Mousa, Wadi Elhomer, Tor
Ae detritus	Beer El Abid, Zowaid
Cs longireolata	Arish, Zowaid, Rafah, Kosaimah, Godirate, Hamam

	Pharon, Firan, St. Katherine, Dahab, Nuwebah
Cs subocrea	Zowaid
Un. Ungiculata	Zowaid, Rafah

Table (3). Distribution of *Anopheles* species in Sinai (after Skoukry 1987)

Species	Localities
An. phroensis	Zowaid, Rafah, Godirate
An. multicolor	Romana, Beer El Abd, Bardowil, Zowaid, Kosaimah, Hamam Pharon, Tor
An. tenebrosis	Zowaid
An. turkhudi	Godirate, St. Katherina
An. rupicolus	Godirate, Firan, St. Katherina, Tor
An. sergentii	Rafah, Godirate, Firan, St. Katherina, Tor
An. Superpictus	Godirate

Table (4). Association of different mosquito species found in Sinai (after Shoukry, 1987)

Species	*An. pharoensis*	*A. multicolor*	*An. superpictus*	*An. rupiculus*	*An. turkhudi*	*An. sergentii*	*An. tenebrosus*	*Cx. univittatus*	*Cx. antennatus*	*Cx. pusillus*	*Cx. pipiens*	*Cx. theileri*	*Cx. deserticola*	*Cx. sinaticus*	*Cx. laticinctus*	*Cx. Mimeticus*	*Cx. arbieeni*	*Ae. caspius*	*Ae. detritus*	*Cs. longiarolata*	*Cs. subochrea*	*U. unguiculata*
An. pharoensis						x		x	x			x								x		
A. multicolor										x		x						x	x			
An. superpictus					x	x		x			x	x		x	x	x				x		
An. rupiculus						x								x		x	x					
An. turkhudi			x			x								x			x					
An. sergentii	x							x				x	x							x		
An. tenebrosus								x	x											x	x	x
Cx. univittatus		x				x			x		x		x							x	x	x
Cx. antennatus	x					x		x					x	x						x	x	x
Cx. pusillus		x																x				
Cx. pipiens																				X		
Cx. theileri		x	x			x		x					x	x		x				x		x
Cx. deserticola						x						x		x	x	x	x			x		x
Cx. sinaticus			x	x		x									x					x		
Cx. laticinctus						x						x		x		x	x			x		x
Cx. mimeticus			x			x								x						x		
Cx. arbieeni					x	x							x							x		
Ae. caspius		x								x												
Ae. detritus										x												
Cs. longiarolata	x	x	x			x		x	x		x	x	x	x			x				x	x
Cs. subochrea							x	x	x											x		x
U. unguiculata							x	x	x											x	x	

Table (5). Distribution of *Tick* species in Sinai (after Skoukry 1987)

Species	Localities
H. dromedarii	Most localities
H. impeltatum	Most localities
H. an. anatolicum	Most localities
H. an. excavatum	Most localities
H. m. rufipes	Arish, Beer Lehfin, Kosaimah
H. m. turanucum	Kosaimah, St. Katherine
H. schulzei	Arish, Beer Lehfin, Kosaimah, St. Katherine, Nuweibah
R. sanguineus	Most localities
R. turanicus	Firan, St. Katherine
B. annulatus	Arish
O. erraticus	Beer Lehfin
A. persicus	Firan, St. Katherine

Table (6). Distribution of *Rodent* species in Sinai (after Skoukry 1987).

Species	Localities
R. norvegicus	Arish, Abou Redis,
R. r. frugivorous	Arish, Zowaid, Tor
R. r. alexandrinus	Arish, Zowaid, Koaaimah, Tor
M. musculus	Arish, Koaaimah, Feran, St. Katherine
A. cahirinus dimidiatus	Feran, St. Katherine, Sharm El Sheikh
G. pyramidum floweri	Beer Lehfin, Zowaid
G. andersoni	Beer Lehfin, St. Katherine
G. gerbillus	Beer Lehfin
J. jaculus schlucteri	Arish, Koaaimah, St. Katherine
M. sacramenti	Beer Lehfin, Zowaid
E. quercinus	St. Katherine

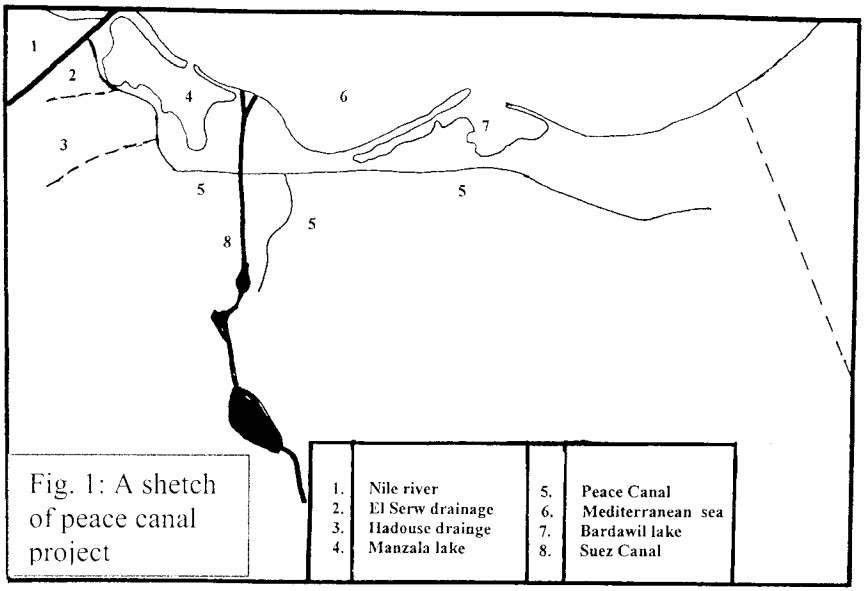

Fig. 1: A shetch of peace canal project

الملخص العربى

التنوع البيولوجى لناقلات الأمراض فى سيناء

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تعتبر شبة جزيرة سيناء جزء هام ومتميز من الأراضى المصرية نتيجة لوضعها التاريخى والجغرافى وفى السنوات الأخيرة بدأت عدة مشروعات تنموية طموحة فى سيناء ومن أهم هذه المشروعات مشروع ترعة السلام الذى يهدف إلى نقل مياه النيل إلى سيناء عبر أنفاق تمر اسفل قناة السويس ولما كان المشروع من المتوقع ان يؤدى إلى تغيرات هامة فى البيئة النباتية والحيوانية فى سيناء فقد رؤى أن دراسة نواقل الأمراض ستكون من الأهمية لمشروعات التنمية المستقبلية فى سيناء. والبحث المرجعى الحالى يهدف إلى تجميع الدراسات التى تمت فى هذا الشأن على مدى السنوات الأخيرة والتى قام بها مجموعة من الباحثين بجامعة قناة السويس وجامعة عين شمس على مجموعة من النواقل لعدد من الأمراض المنقولة بالحشرات ومفصليات الأرجل أشارت دراسات الحصر إلى تواجد عدد هام من نواقل الأمراض فى سيناء تمثلت فى ٢٢ نوعاً من البعوض، ١٤ نوعاً من ذباب الرمل، ٨ أنواع وأربعة تحت أنواع من القراد بالإضافة إلى ٨ أنواع وثلاثة تحت أنواع من الفئران والتى قد تمثل حيوانات خازنة لعدد من الأمراض المنقولة بمفصليات الأرجل . وقد تم مناقشة توزيع وانتشار هذه الأنواع وكذلك تواجدها معا فى نفس أماكن التوالد بالإضافة إلى دور هذه النواقل أو الحيوانات الخازنة فى نقل عدد من الأمراض الهامة