Potential mosquito vectors of Rift Valley Fever in Egypt , and subsequent control measures

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Rift valley fever

- **Rift Valley Fever (RVF) is an arthropod-borne disease of man and animals.**

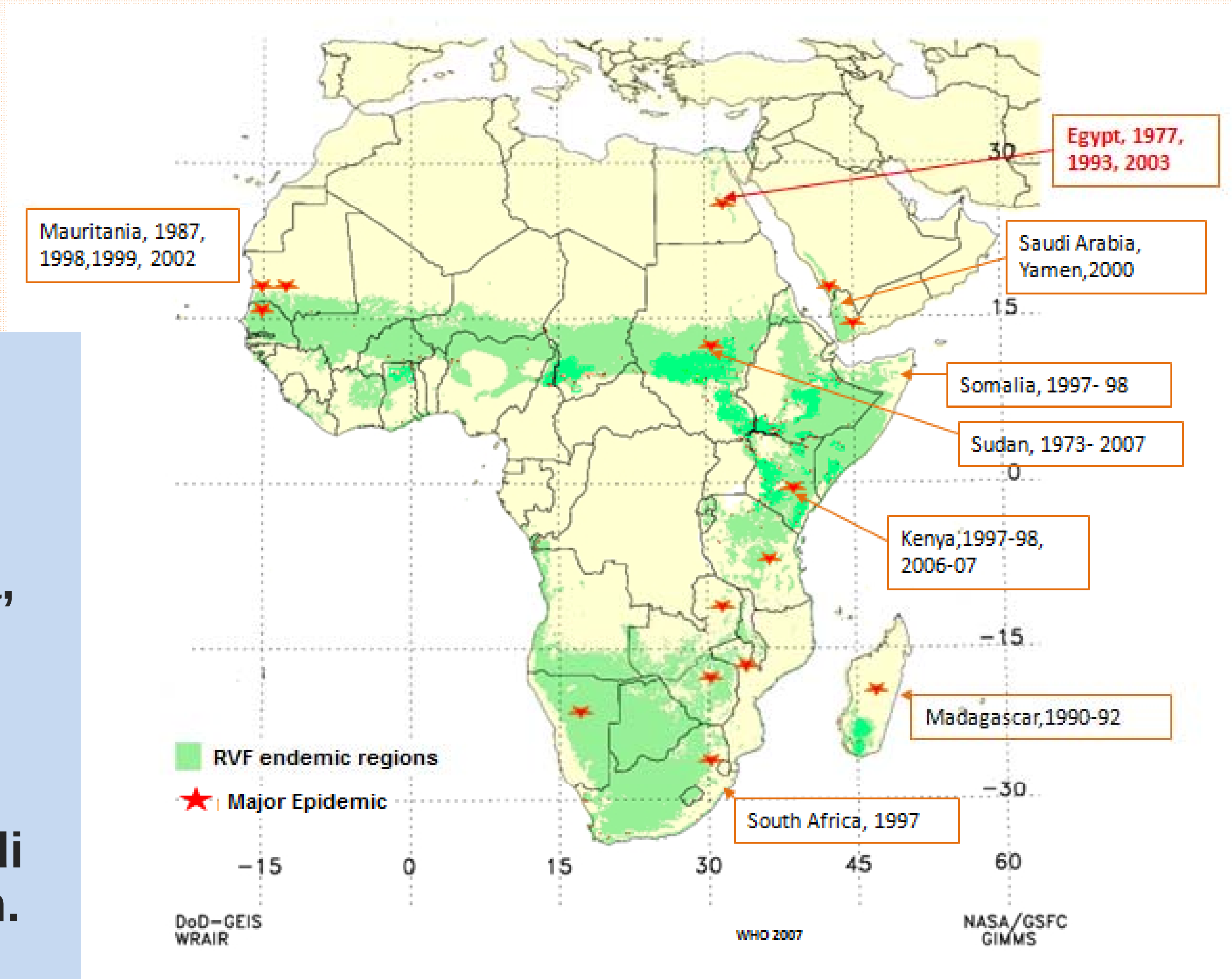
Patients suffering from RVFV, WHO

Kenya- 2006-07 Hanafi A

- **RVF virus is a member of the Phlebovirus genus, family Bunyaviridae and was first identified in 1931 in the Rift Valley of Kenya (WHO).**

Geographical Distribution, Major Outbreaks

- **Since 1930, outbreaks have been reported in North Africa, Mauritania, Kenya, Somalia and Tanzania and in September 2000, RVF cases were confirmed in Saudi Arabia and Yemen.**



- **No approved vaccine for human is yet available.**

- RVF is primarily transmitted from animal to animal/human by mosquitoes

- Several different species of mosquitoes are able to serve as vectors for transmission of the RVF virus.

EFSA 2005

Table 2: Arthropods infected with Rift Valley fever virus in nature (note: that these reports are less a reflection of vector specificity than of high levels of viraemia in host species combined with the vctors ability to become infected orally and transmit biologically)

Genus (Subgenus)	*Species*	*Locality (year)*	*Reference*
Anopheles (Anopheles)	*coustani*	Zimbabwe (1969)	McIntosh (1972)
		Madagascar (1979)	Clerc *et al.* (1982)
	fuscicolor	Madagascar (1979)	Clerc *et al.* (1982)
Anopheles (Cellia)	*christyi*	Kenya (1981-84)	Linthicum *et al.* (1985b)
	cinereus	South Africa (1974-75)	McIntosh *et al.* (1980a)
	pauliani	Madagascar (1979)	Clerc *et al.* (1982)
	pharoensis	Kenya (1981-84)	Linthicum *et al.* (1985b)
	squamosus	Madagascar (1979)	Clerc *et al.* (1982)
Culex (Culex)	*spp.*[4]	Madagascar (1979)	Clerc *et al.* (1982)
	antennatus	Nigeria (1967-70)	Lee 1979
		Kenya (1981-84)	Linthicum *et al.* (1985b)
	neavei	South Africa (1981)	McIntosh *et al.* (1983)
	pipiens	Egypt (1977, 1978)	Hoogstraal *et al.* (1979), Meegan *et al.* (1980)
	poicilipes	Senegal (1998)	Diallo *et al.* (2000)
	theileri	South Africa (1970)	McIntosh (1972)
		Zimbabwe (1969)	McIntosh (1972)
	tritaeniorhynchus	Saudi Arabia (2000)	Jupp *et al.* (2002)
	vansomereni		
		Kenya (1981-84)	Linthicum *et al.* (1985b)
	zombaensis	South Africa (1981)	McIntosh *et al.* (1983)
		Kenya (1981-84, 1989)	Linthicum *et al.* (1985b), Logan *et al.* (1991b)
Culex (Eumelanomyia)	*rubinotus*	Kenya (1981-84)	Linthicum *et al.* (1985b)
Eretmapodites	*chrysogaster*	Uganda (1944)	Smithburn *et al.* (1948)
	quinquevittatus	South Africa (1971)	McIntosh (1972)
		Kenya (1981-84)	Linthicum et al. (1985b)
Coquillettidia	*fuscopennata*	Uganda (1959)	Williams *et al.* (1960)

- **Biting flies: The phlebotomine sand flies , culicoides , stomoxids, simulids and ticks are competent vectors of RVF.**

Am. J. Trop. Med. Hyg., 42(2), 1990, pp. 185–188 (89-138)

TRANSMISSION OF RIFT VALLEY FEVER VIRUS BY THE SAND FLY, *PHLEBOTOMUS DUBOSCQI* (DIPTERA: PSYCHODIDAE)

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Laboratory Transmission of Rift Valley Fever Virus by *Phlebotomus duboscqi, Phlebotomus papatasi, Phlebotomus sergenti,* and *Sergentomyia schwetzi* (Diptera: Psychodidae)
Authors: Dohm, David J.; Rowton, Edgar D.; Lawyer, Phillip G.; O'Guinn, Monica; Turell, Michael J.
Source: Journal of Medical Entomology, Volume 37, Number 3, May 2000 , pp. 435-438(4)
Publisher: Entomological Society of America

Distribution of Mosquitoes in Egypt

Mosquito species

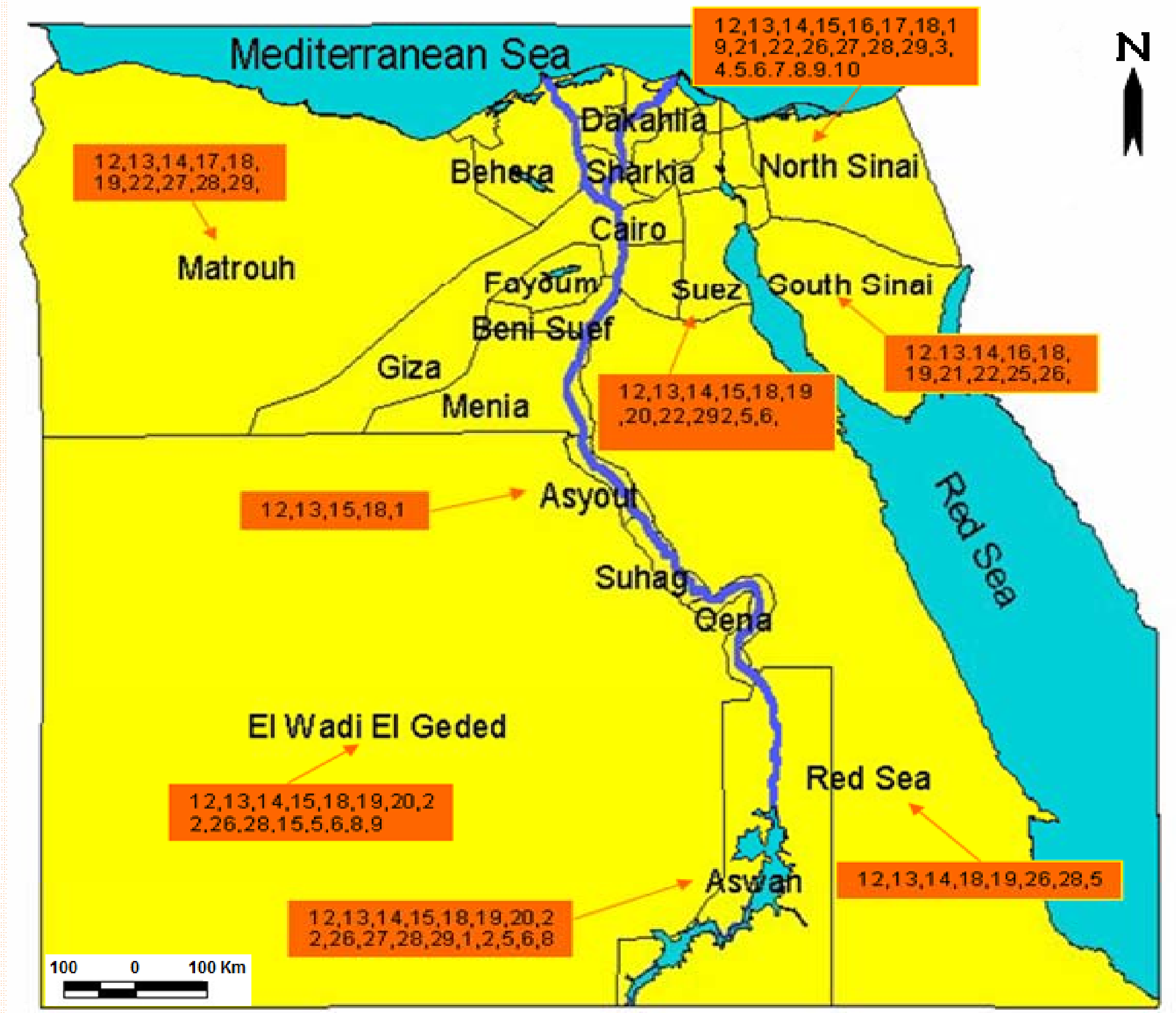
1-*Anopheles algeriensis*
2-*An. tenebrosus*
3-*An. dthali*
4-*An. hispaniola*
5-*An. multicolor*
6-*An. pharoensis*
7-*An. rupicolus*
8-*An. sergentii*
9-*An. superpictus*
10-*An. turkhudi*
11-*An. n.sp*

12- Aedes *caspius*
13- Ae. *detritus*

14-*Culex pusillus*
15-*Cx. antennatus*
16-*Cx. laticinctus*
17-*Cx. mimeticus*
18-*Cx. perexiguus*
19-*Cx. pipiens*
20-*Cx. poicilipes*
21-*Cx. sinaiticus*
22-*Cx. theileri*
23- *Cx. tritaeniorhynchus*
24-*Cx. adairi*
25-*Cx. arbieeni*
26-*Cx. deserticola*

27-*Cuilisita subochrea*
28-*Cs. longiareolata*

29-*Uranotaenia unguiculata*

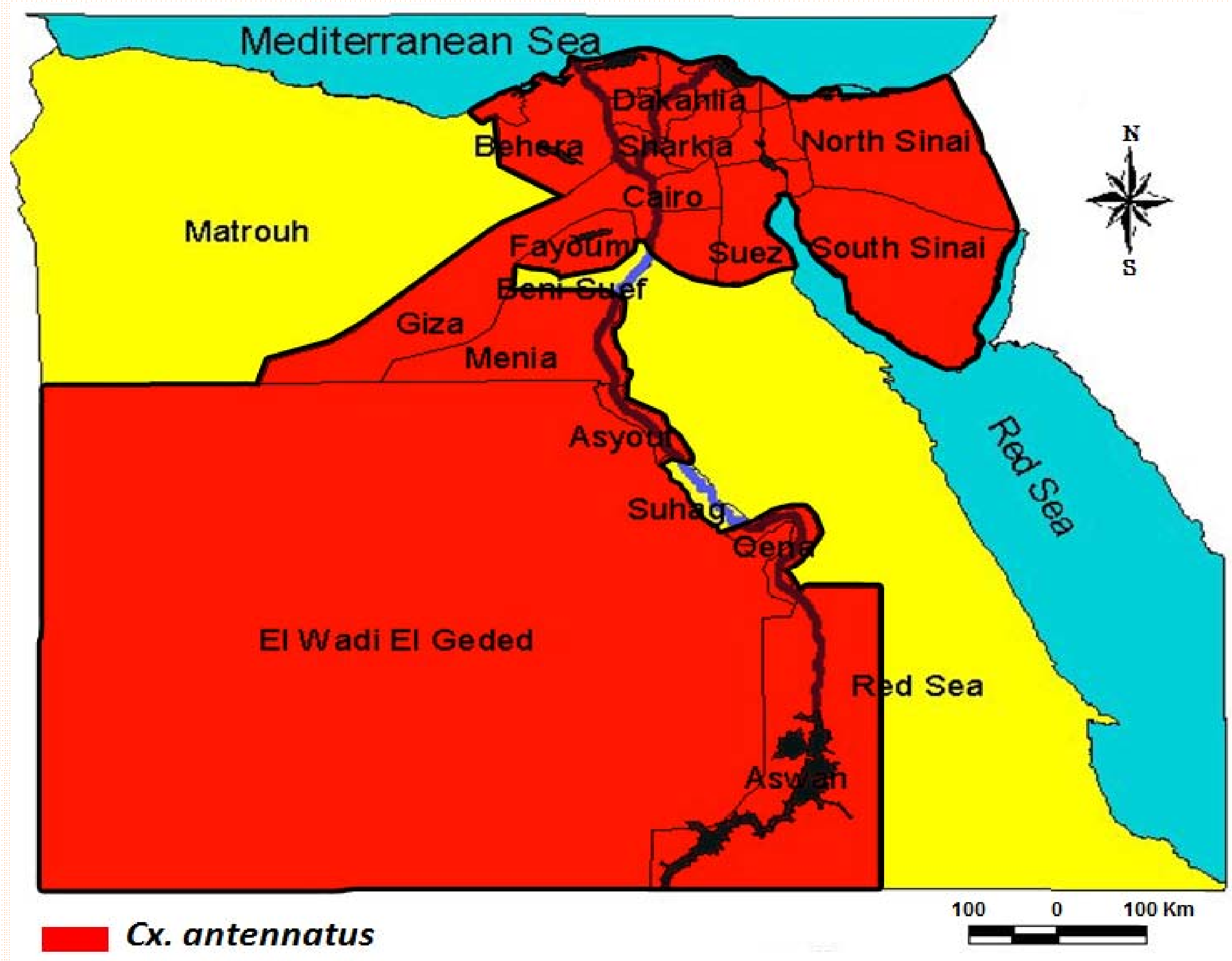


- The Egyptian mosquito fauna is consists of 29 species in 5 genera, wih *Culex pipiens* and *Cx antennatus* being the most abundant Culicine species.

Geographical distribution of *Culex antennatus* in Egypt

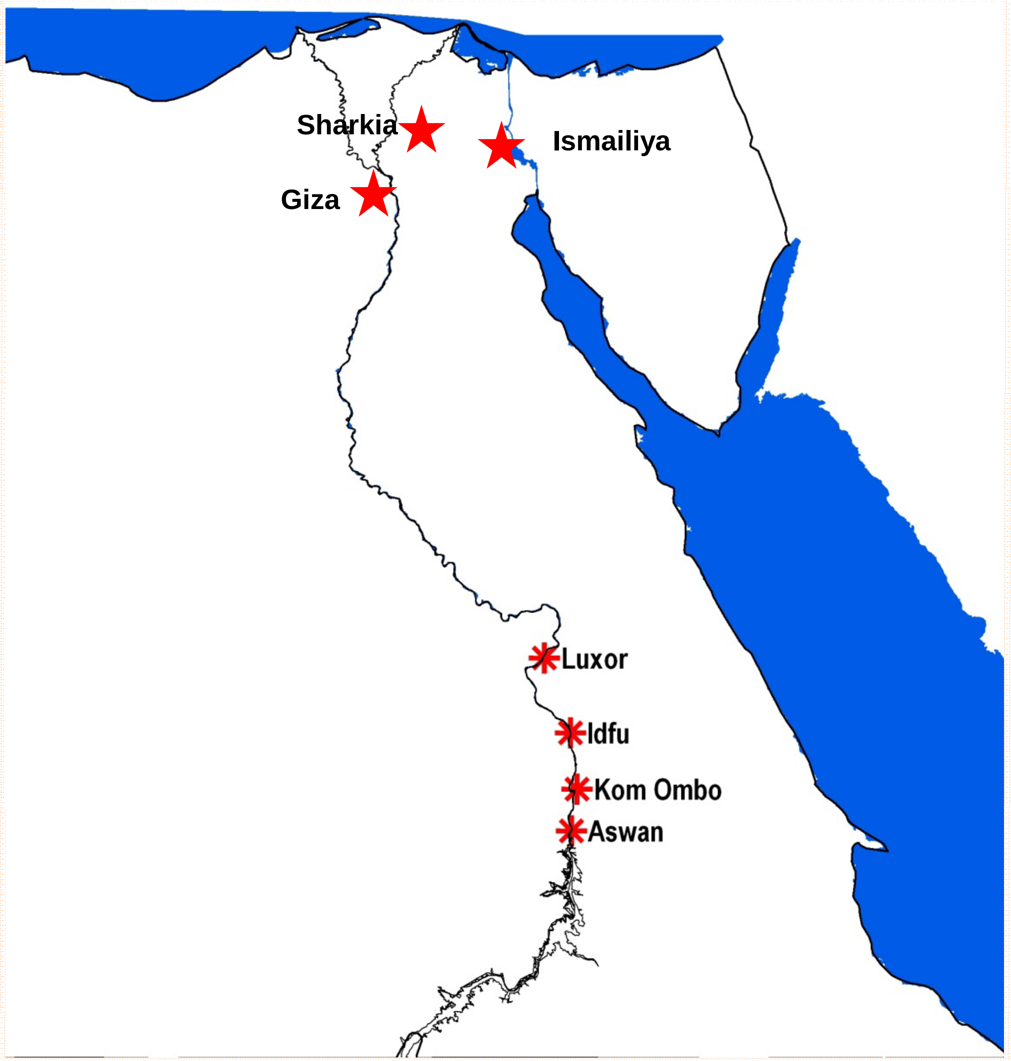
- *Cx. antennatus* is a widely distributed mosquito species in Egypt which appears to be restricted to the Nile Delta region.

- This species has been incriminated as a vector of West Nile Virus and *Wuchereria bancrofti* in Egypt



Egypt: 1977 Epidemic (Aug-Dec) and recurrence in 1978 (July-Dec)

- 600 fatalities.
- 200,000 cases.
- Many abortions and deaths were reported in sheep, goats, cattle, water buffalo and camels



Meegan et al 1979

Mosquito species collected from Rift Valley fever (RVF) epizootic areas in Egypt during 1977 and 1978

Species	Number collected: Nov–Dec 1977	Jan–Jun 1978	Jul–Dec 1978	No. mosquitoes	No. pools
Culex pipiens	9,742	4,349	38,538*	52,629	1,174
Culex univittatus	234	113	1,909	2,256	61
Culex antennatus	18	0	103	121	8
Anopheles pharoensis	0	0	37	37	4
Culiseta longiareolata	0	0	29	29	3
Miscellaneous spp.†	13	0	41	54	11

* Two strains of RVF virus isolated from these collections.
† Composed of *Culex pusillus* and *Aedes caspius*.

Am. J. Trop. Med. Hyg., 29(6), 1980, pp. 1405–1410

EXPERIMENTAL TRANSMISSION AND FIELD ISOLATION STUDIES IMPLICATING *CULEX PIPIENS* AS A VECTOR OF RIFT VALLEY FEVER VIRUS IN EGYPT*

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Cx. pipiens was the most dominant mosquito spp in the affected area

Egypt: 1993 Epidemic (Aug-Dec)

Similar to 1977 epidemic,

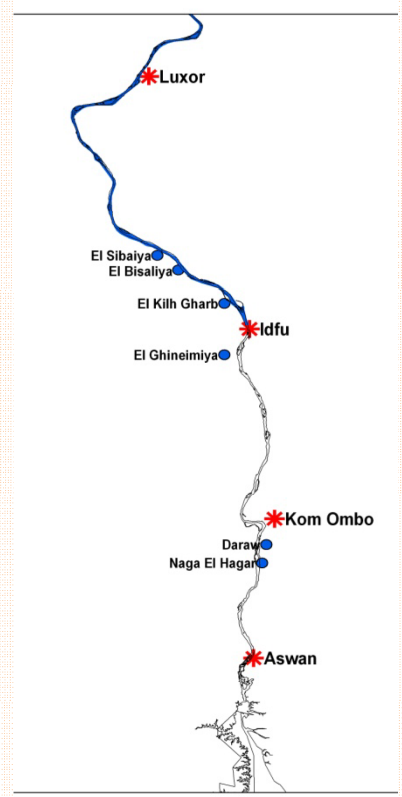
- Infection spread from South to North.
- Same seasonal patterns.
- First human case was associated with animal market.

→

Mosquitoes were collected using CDC light traps from 5 RVF affected villages in Upper Egypt, 9-24 August 1993.

Species	Total # Collected	% Species Composition	Total # of Pools	Number Blood-fed
NAG' EL-HAGAR VILLAGE (6 trap-nights)				
Cx. perexiguus	8,508	46.0	168	110
Cx. pipiens	5,226	28.3	105	146
Ae. caspius	2,699	14.6	78	126
Cx. antennatus	1,754	9.5	37	72
An. tenebrosus	173	0.9	6	0
An. pharoensis	56	0.3	4	3
Cx. poicilipes	37	0.2	0	0
Ur. unguiculata	21	0.1	1	0
An. sergentii	8	<0.1	0	0
An. multicolor	2	<0.1	0	0
SABIL ABU EL-MAGD VILLAGE (4 trap-nights)				
Ae. caspius	7,965	93.6	143	274
Cx. pipiens	401	4.7	5	15
Cx. antennatus	57	0.7	2	0
An. pharoensis	48	0.5	4	0
An. tenebrosus	39	0.5	2	0
Cx. poicilipes	2	<0.1	1	0
Cx. perexiguus	2	<0.1	0	2
Sand flies	84	N/A	2	0
EL-RAGHAMA VILLAGE (3 trap-nights)				
Ae. caspius	4,272	79.8	86	31
Cx. pipiens	1,038	19.4	22	47
Cx. perexiguus	22	0.4	0	0
Cx. antennatus	21	0.4	1	0
Sand flies	372	N/A	7	0
EL-GHONAYMIA VILLAGE (1 trap-night)				
Ae. caspius	1,059	43.5	20	7
Cx. antennatus	789	32.4	16	12
Cx. pipiens	298	12.2	7	3
Cx. perexiguus	212	8.7	4	0
Cx. poicilipes	24	0.9	1	0
An. tenebrosus	22	0.9	1	0
An. pharoensis	14	0.5	1	0
Ur. unguiculata	7	0.2	1	0
An. sergentii	5	0.2	0	0
An. multicolor	3	0.1	0	0
Sand flies	89	N/A	2	0

EL-NAGAGHRA VILLAGE (1 trap-night)				
Ae. caspius	329	65.1	3	0
Cx. pipiens	64	12.7	1	5
Cx. antennatus	62	12.3	1	1
Cx. perexiguus	45	8.9	1	0
An. pharoensis	3	0.6	0	0
An. tenebrosus	2	0.4	0	0



CDC light traps baited with CO_2

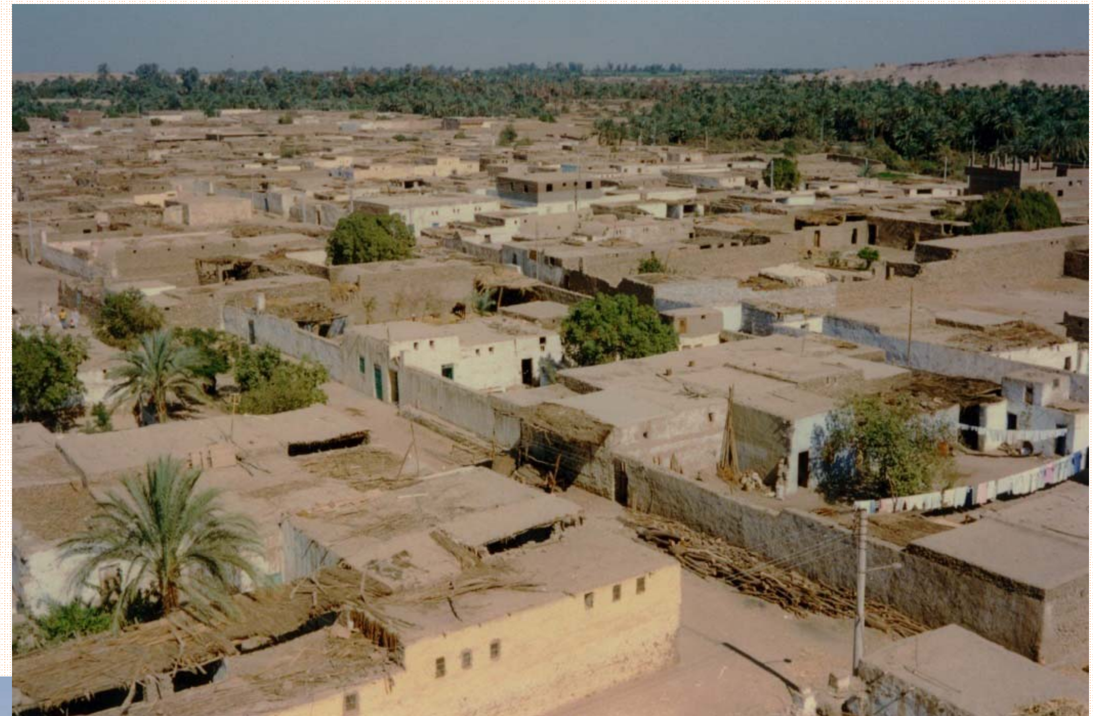
Overall numbers of mosquitoes collected via CDC-light traps, and number of pools processed for RVFV-isolation

Species	Total # Collected	% Species Composition	Total # Pools for RVFV-isol.
Ae. caspius	16,324	46.4	330
Cx. perexiguus	8,765	24.9	173
Cx. pipiens	7,027	19.9	144
Cx. antennatus	2,683	7.6	57
An. tenebrosus	243	0.7	9
An. pharoensis	118	0.3	9
Ur. unguiculata	27	<0.1	2
Cx. poicilipes	24	<0.1	1
An. sergentii	13	<0.1	0
An. multicolor	5	<0.1	0

TOTAL LIVE-PROCESSED (# POOLS)	35,229 (725)
TOTAL DEAD	5,766
TOTAL BLOOD-FED	859
NO. NOT POOLED	77
TOTAL MOSQUITOES COLLECTED	**41,931**

RVF virus was not isolated from these mosquitoes, only West Nile virus and 32 of other arboviruses.

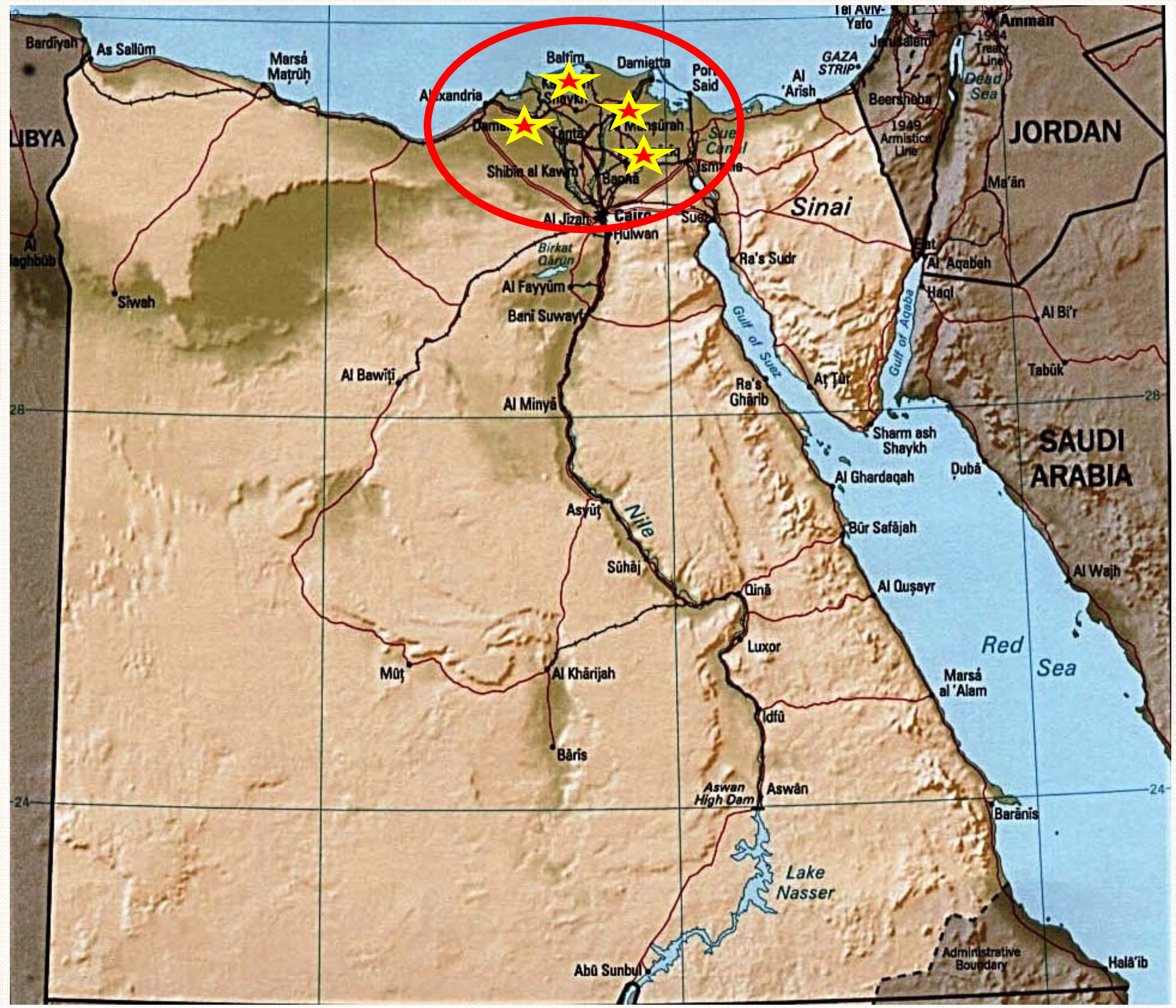
- Overhead view of Nag El-Hagar village, Aswan Governorate, with known RVF viral activity, Aug-Dec 1993



Egypt: 2003 Epidemic (Jun-October)

- During the summer of 2003, RVF cases suddenly began to appear within a cluster of 4 governorates (Kafr El-Sheikh, Beheira, Dakahliya, and Sharqiya) in the Nile Delta of Egypt.

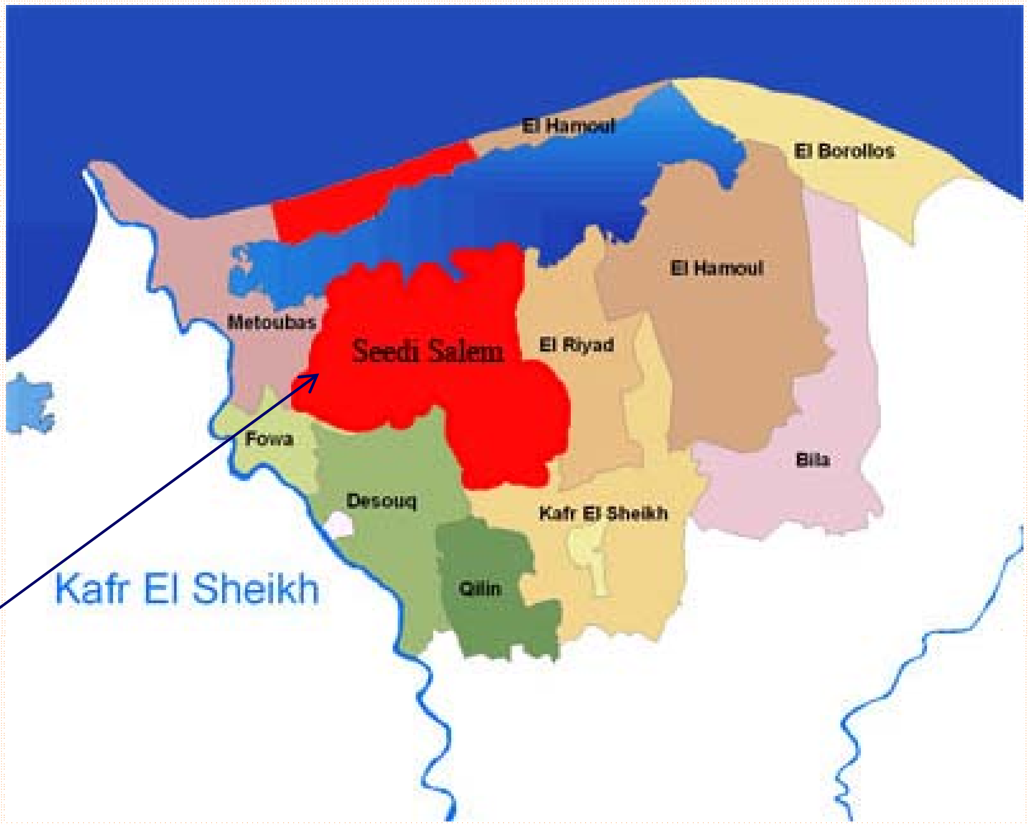
- Over the course of the outbreak, there were 191 suspected cases, 153 confirmed cases, and 74 deaths in the affected governorates.



Strangely, there was no evidence of RVF zoonotic disease among Egyptian livestock in the affected region.

Map of Kafr El-Sheikh governorate showing Seedi Salem district, one of the RVF endemic area

- In response to the outbreak, NAMRU-3 mobilized extensive resources (epidemiology, entomology, virology) to assist the Egyptian MOHP in an investigation to characterize the condition responsible for the outbreak.



- Mosquito surveillance was conducted in Seedi Salem district, Kafr El-Sheikh Governorate during August and September 2003, specifically in areas where numerous cases of RVF were reported.

- The district is generally an agricultural area bordering Lake Brullus and the Mediterranean Sea in Northern Egypt .

- The district is typically cultivated with rice during the summer season and wheat during the winter season under artificial irrigation. Seedi Salem has a human population of approximately 332,000 and is stocked with domestic animals including cattle, sheep goats and dogs,.

- Thirteen villages were selected in Seedi Salem district because of their prevalence of human cases.

Flooded rice fields along with the warm temperatures during the summer season encourage the high density of the mosquitoes in this region.

CDC Light traps placed around houses and animal shelters

The surveillance yielded 9179 mosquitoes, resulting in 297 mosquito pools which were subsequently processed for virus isolation in vero and BHK cell lines, and confirmed via PCR.

Species	No. mosquito collected	% collected	No. pools
Cx. antennatus	**8798**	**95.80%**	**208 pools***
Cx. pipiens	**102**	**1.10%**	**27 pools**
Cx. perexiguus	**6**	**0.06%**	**3 pools**
An. tenebrosus	**248**	**2.70%**	**41 pools**
An. pharoansis	**24**	**0.26%**	**17 pools**
Ae. detritus	**1**	**0.01%**	**1 pool**
Total	**9179**		**297 pools**

* Three pools (pool of 13 blood feed flies and 2 pools of 50 unfed flies) were positive for RVF.

- These results support the belief that *Cx. antennatus* has the ability to function as a viable vector of RVF in Egypt.

? What shall we do to prevent RVF epizootics/epidemics by vector control.?

? What shall we do in the event of outbreak.?

3 major methods of vector control:

- a) **Reduction of breeding source for larvae.**

  b) **Reduction in man-mosquito contact.**

  c) **Control of adult mosquitoes.**

Reduction of Breeding Source for Larvae

- Environmental management to eliminate mosquito larval habitats.

  1. Environmental modification.
  Long term physical transformation of vector habitat, eg. modifying the water management system.

- **Altered the strategy of water management system in the rice fields (alternate drying and wetting). This can be implemented with the co-ordination of the farmers.**

Reduction of Breeding Source for Larvae

- Environmental management to eliminate mosquito larval habitats.

1. Environmental modification.
Long term physical transformation of vector habitat, eg. modifying the water management system.

No standing water means no mosquitoes

The irrigation canal next to the rice field is an important breading site for mosquitoes.

Reduction of Breeding Source for Larvae

- Environmental management to eliminate mosquito larval habitats.

1. Environmental modification.
Long term physical transformation of vector habitat, eg. modifying the water management system.

❖ Provide for proper water drainage around the foundation of the building.

Reduction of Breeding Source for Larvae

- Environmental management to eliminate mosquito larval habitats.

1. Environmental manipulation.

Remove all sources of stagnant or standing water if possible.

❖ **Water storage tanks provide ideal breeding sites for mosquitoes in urban areas.**

Reduction of Breeding Source for Larvae

- **Eliminate mosquito larval habitats**.

❖ If standing water can't be completely eliminated, **mosquito larvicides** could be used to control mosquito larvae in the water.

-Temephos sand granules
-Insect growth regulators
-BT

Reduction in man-mosquito contact

- Self protection

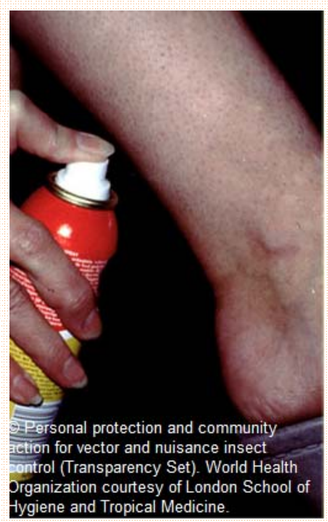
- Insecticide impregnated bed net.

- PermaNet.
- Oly set Standard permethrin bed net.

Reduction in man-mosquito contact

➢ Self protection

▪ Standard DEET Skin Repellent



Examples of Commercial Equivalents

Control of adult mosquitoes

- **Chemical treatment to control adult mosquitoes.**

- Insecticide can be applied as space spray (Ultra-low volume aerosols, thermal fogs, and in door residual spraying) to control adult mosquitoes.

Control of adult mosquitoes

- **Chemical treatment to control adult mosquitoes.**

- Treatment of livestock in the area with either a systemic insecticide such as **ivermectin** or a **topical insecticide** will also reduce the population of some of the potential vector species.

Control of adult mosquitoes

➢ **Chemical treatment to control adult mosquitoes.**

- In the event of an outbreak, reduction of potential insect vector populations should be attempted as rapidly as possible. Aerial spraying and ground application of insecticide as ultra low volume (ULV) fogs can be considered initially.

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