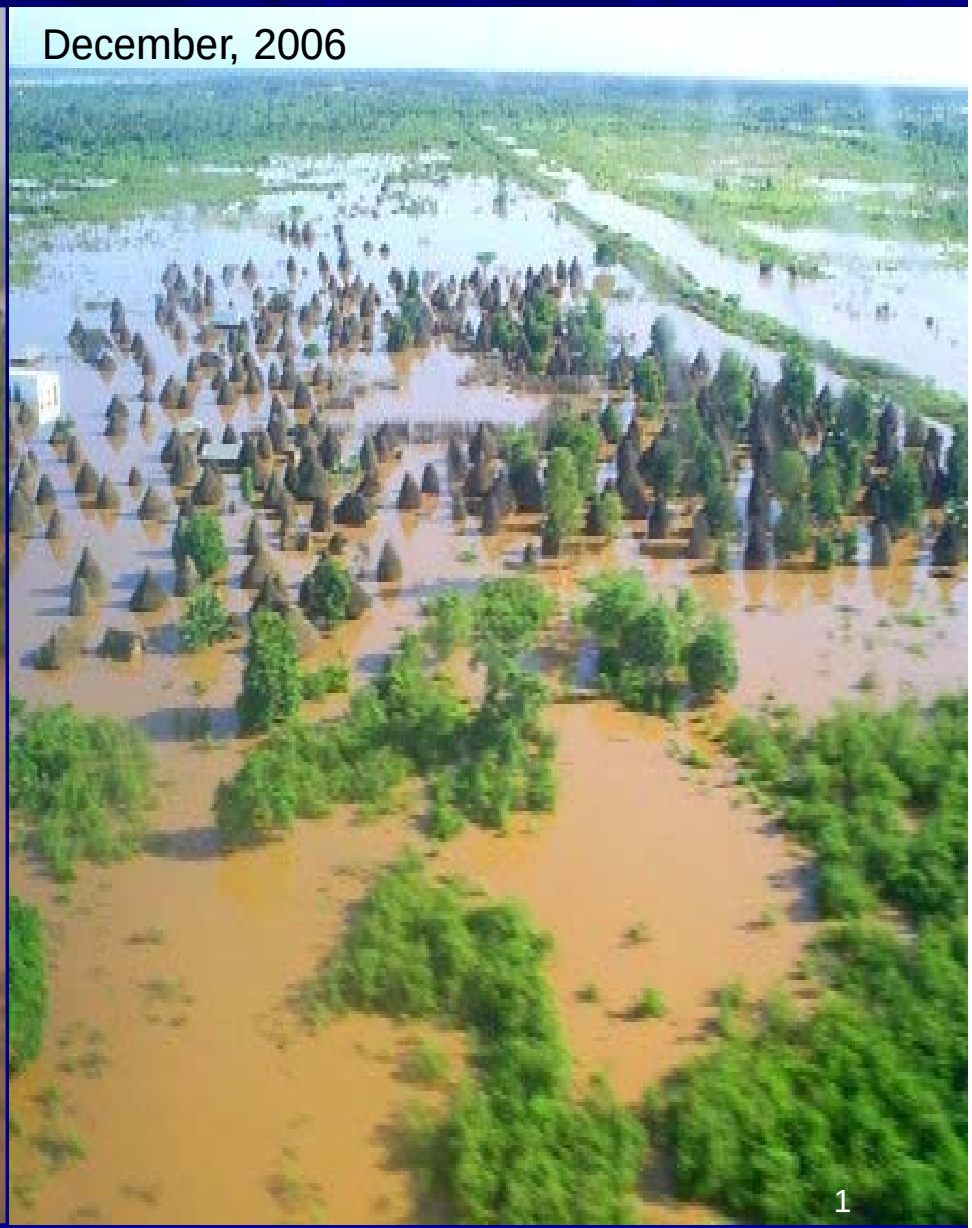
Rift Valley Fever Disease In East Africa

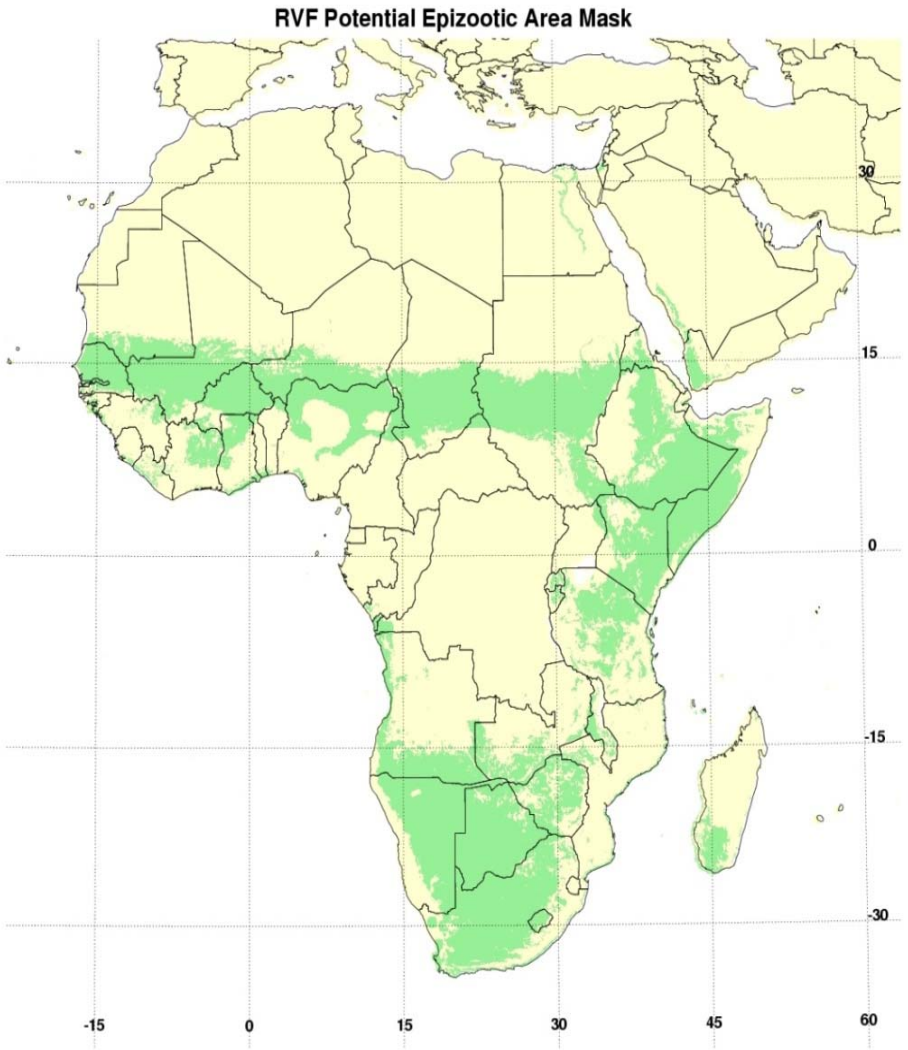
December, 1997

December, 2006

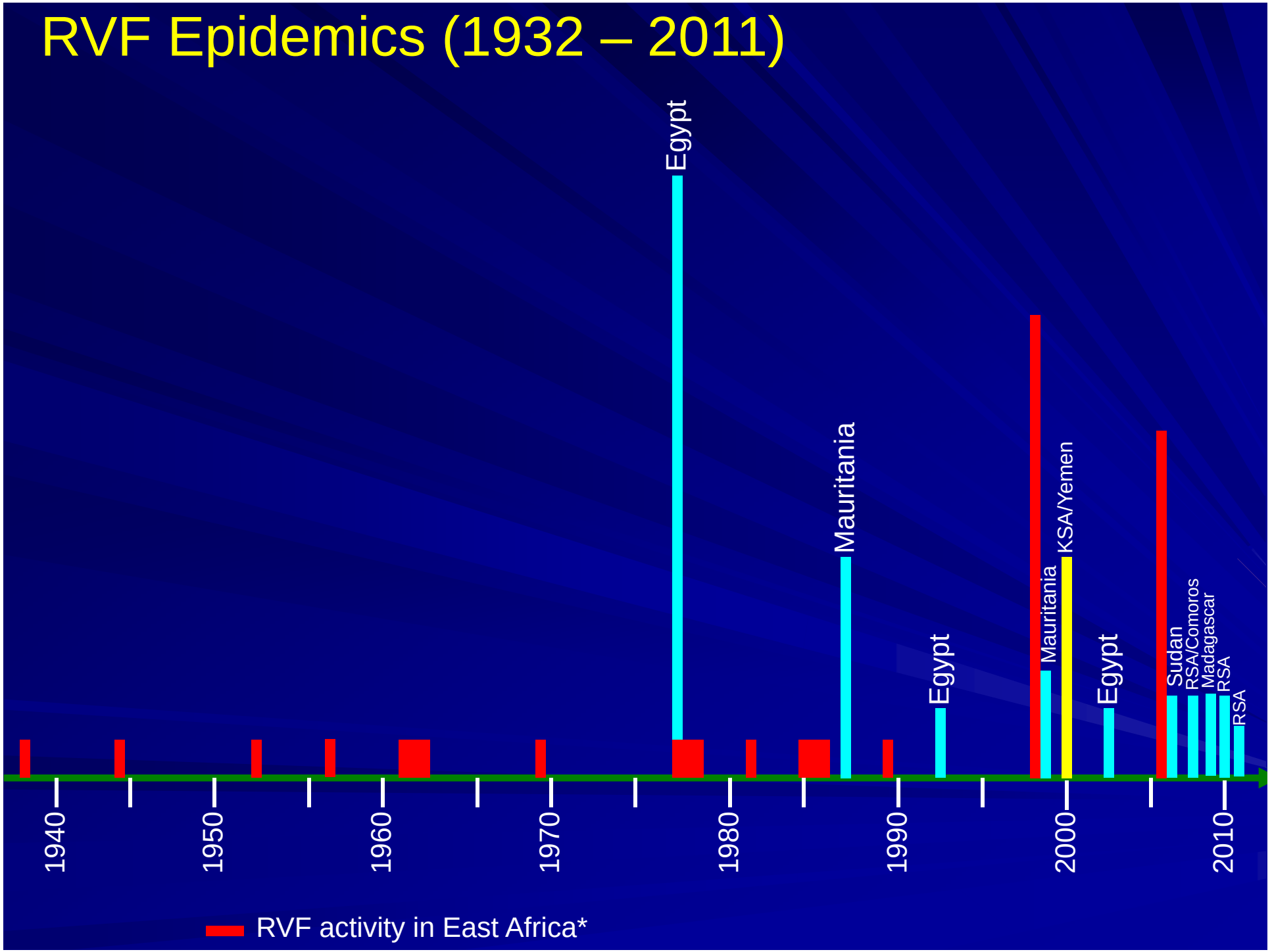


RVF Belt: Africa and Arabian Peninsula

- RVF – epizootics occur under favorable and persistent eco-climatic conditions
- Can be mapped – either as rainfall or vegetation – NDVI integrates all the required conditions
- Algorithm:
  - Mapping of potential epizootic areas – based on literature survey and climate variable thresholding= potential epizootic area mask (PEAM) – (C. J. Peters & K.J. Linthicum in Handbook of Zoonoses)
  - NDVI anomaly calculation -- + anomalies > 0.025 threshold (desert calibration) over 3 month period
  - Persistently + anomalies must have three month mean > 0.1
  - All “pixels” that meet this criteria and are within the PEAM are mapped to have conditions necessary for the occurrence of RVF activity



RVF Epidemics (1932 – 2011)

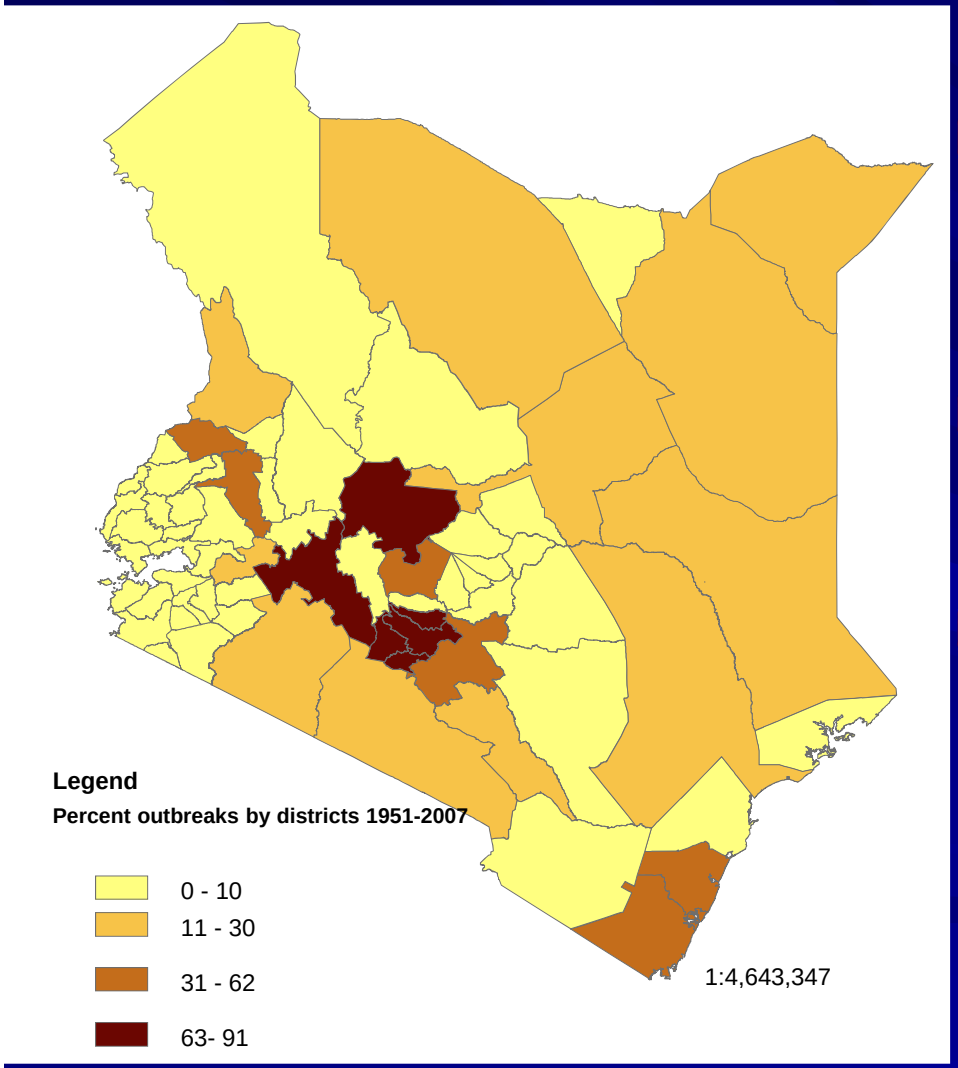


Recent Severe Human RVF Outbreaks

Year	Countries	Estimated Cases	Reported Cases	Deaths
1977	Egypt	200,000	18,000	598
1987	Mauritania	1500	300	224
1993	Egypt	1500	?	20
1997-98	Kenya, Somalia, Tanzania	89,000	?	458[1]
1998	Mauritania	300	150	7
1999	Mauritania	?	?	2
2000	KSA, Yemen	1500 2000	516 1087	87 121
2003	Egypt	300	148	27
2006-07	Kenya, Tanzania, Somalia	?	700 309 107	158 144 54
2007	Sudan	?	125+	60+
2008, 2009	Madagascar, RSA, Comoros	?	?	?
2010,2011	RSA	?	255	26

[1]Data available from Kenya only

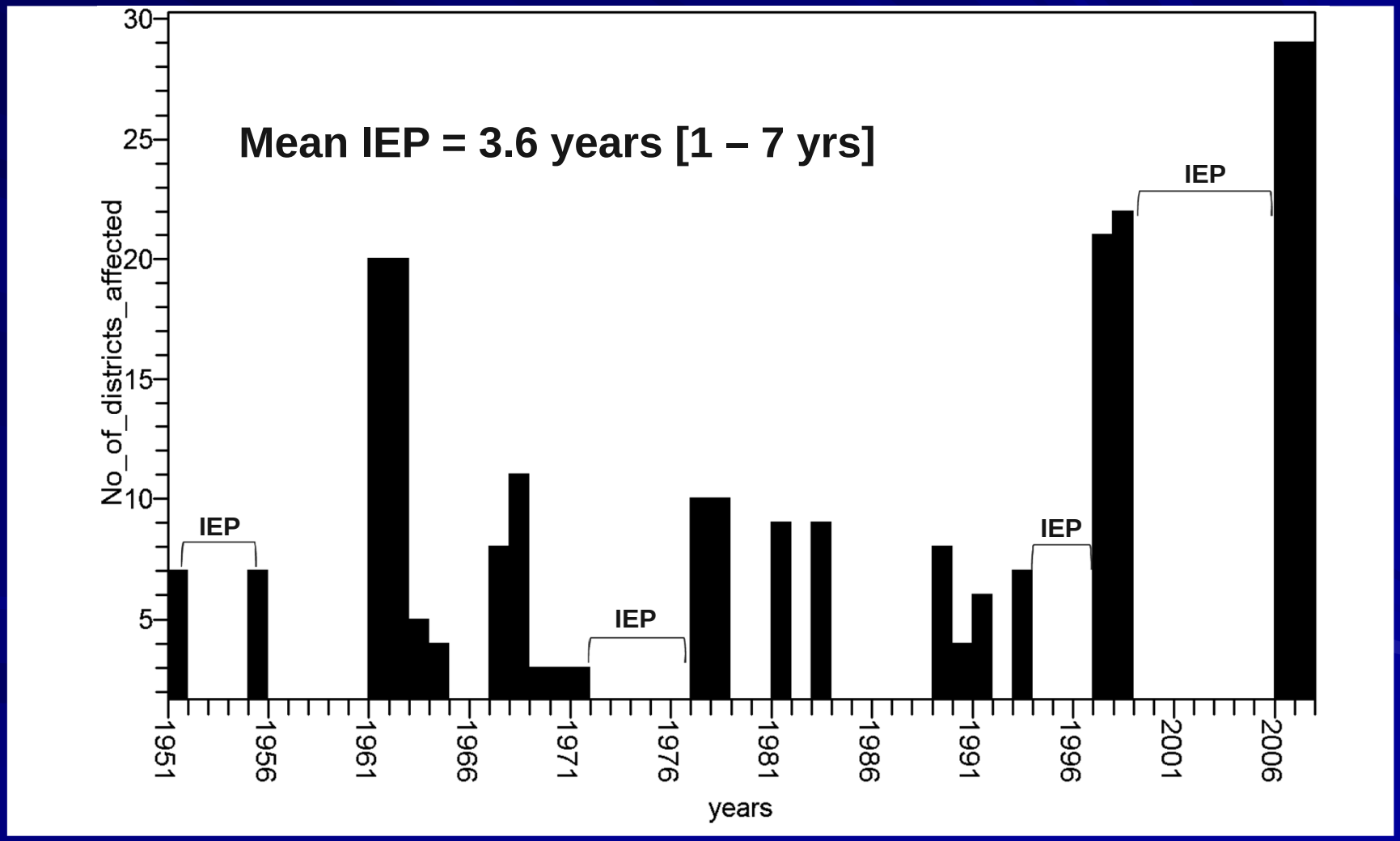
Disease History - Kenya 1952- 2007



- 6 of 8 provinces have reported RVF outbreaks (except Nyanza and Western provinces)
- 38/69 (55%) districts in Kenya had reported RVF by 2007
- Likelihood of a previously affected district being involved in future epizootic was fivefold higher

Murithi et al., Epi Infect 18, 1-9, 2010

History of RVF Epidemics: 1952-2007



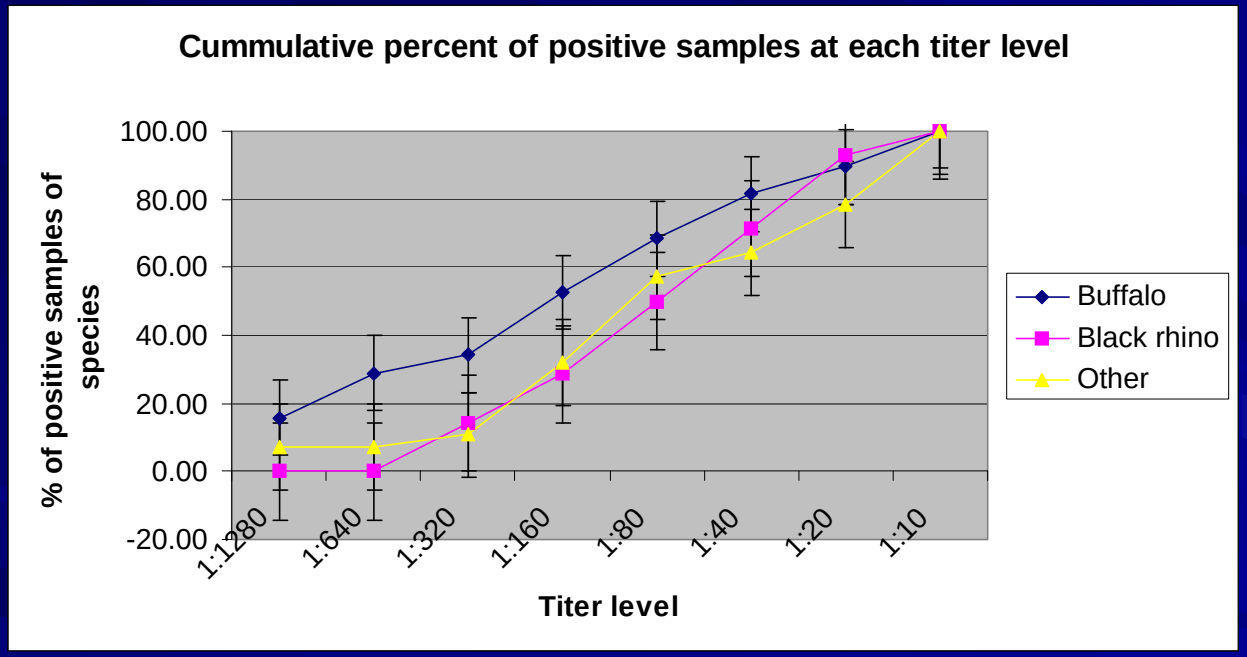
Murithi et al, Epidemiol Infect, May 2010.

Where is RVF virus maintained ?

1. Transovarially in *Aedes* mosquito spp

2. Endemicity. Cycling between wildlife, livestock and possibly humans within a permissive ecosystem, mediated by the appropriate vectors.

In wildlife



Evans et al, Epid Inf 8, 1-92007

Negative: Lions, giraffes, common zebras

9 of 17 species tested were positive

- Buffalos, Black rhinos,
- Thompson gazelles,
- Impalas, Elands, Kudus

Where is RVF virus maintained ?

In livestock : Kenya during the 1999 – 2006 IEP

	Sheep		Goats	
Year of birth	**No. tested**	**Percentage positive**	**No. tested**	**Percentage positive**
1999	12	25	5	0
2000	27	11	7	14
2001	17	29	7	0
2002	19	11	10	0
2003	17	18	17	0
2004	29	24	10	10
2005	63	17	15	0
2006	4	0	4	0
Total	**188**	**18***	**2/75**	**3**

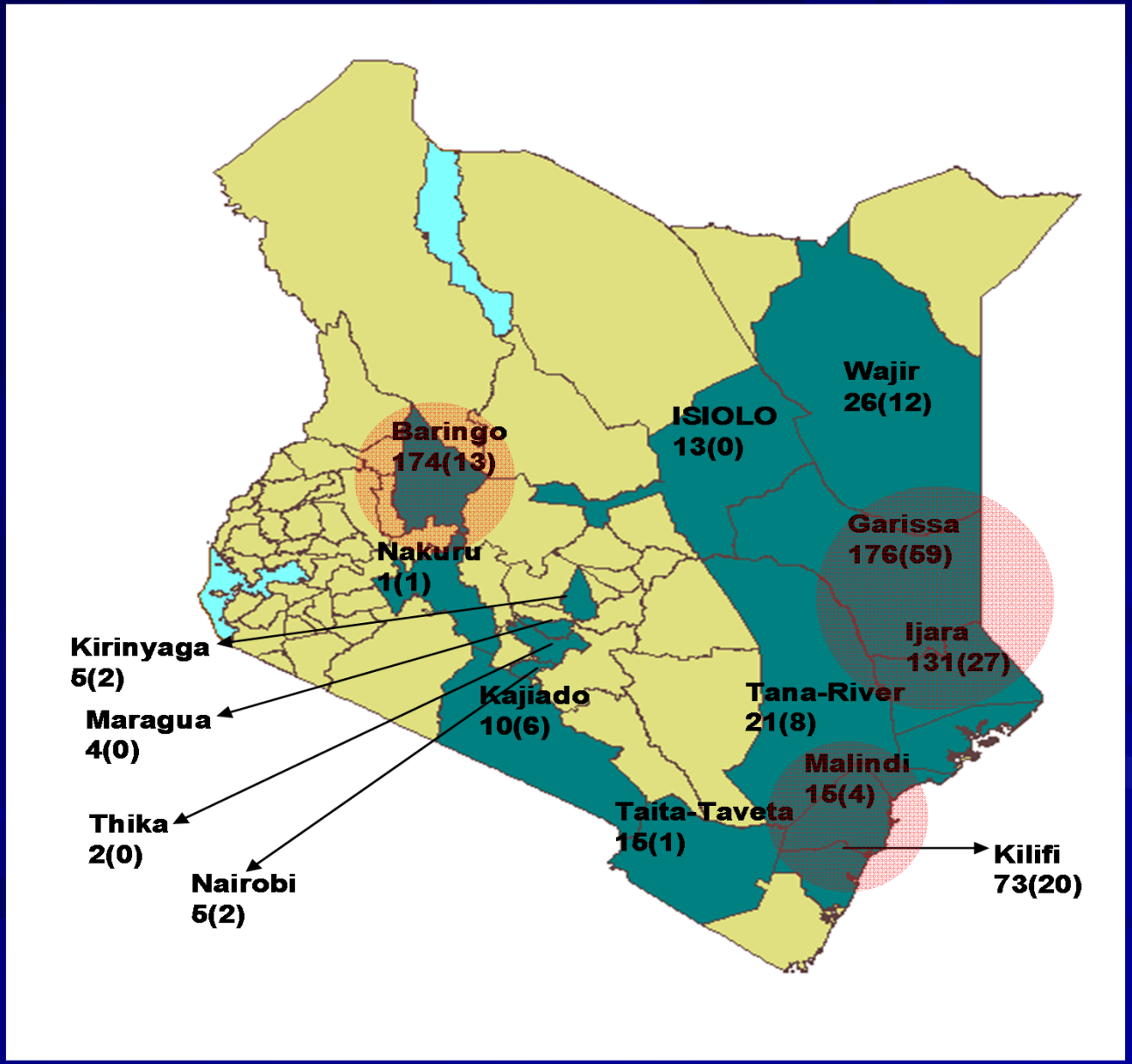
Rostal et al, Amer J Vet Res 71, 522-6, 2010

Garissa in Dec'06: Start of RVF Outbreak

2006-07 Outbreak
[as at December 31st, 2006]

- **Initial community reports early December 2006**
- **First Admissions in Garissa PGH 14/12/2006**
  - **From Shanta Abaq and Jarajila divisions in Garissa**
- **By Mid December 2006 spread to several locations in Garissa district**
- **By 17th December 12 cases with 11 deaths**
  - **Garissa and Ijara**
- **29th December spread to Tana River, Wajir and Kilifi**

Reported Human RVF Cases (Deaths) in Kenya



NEP

333 of 700 (45%) cases

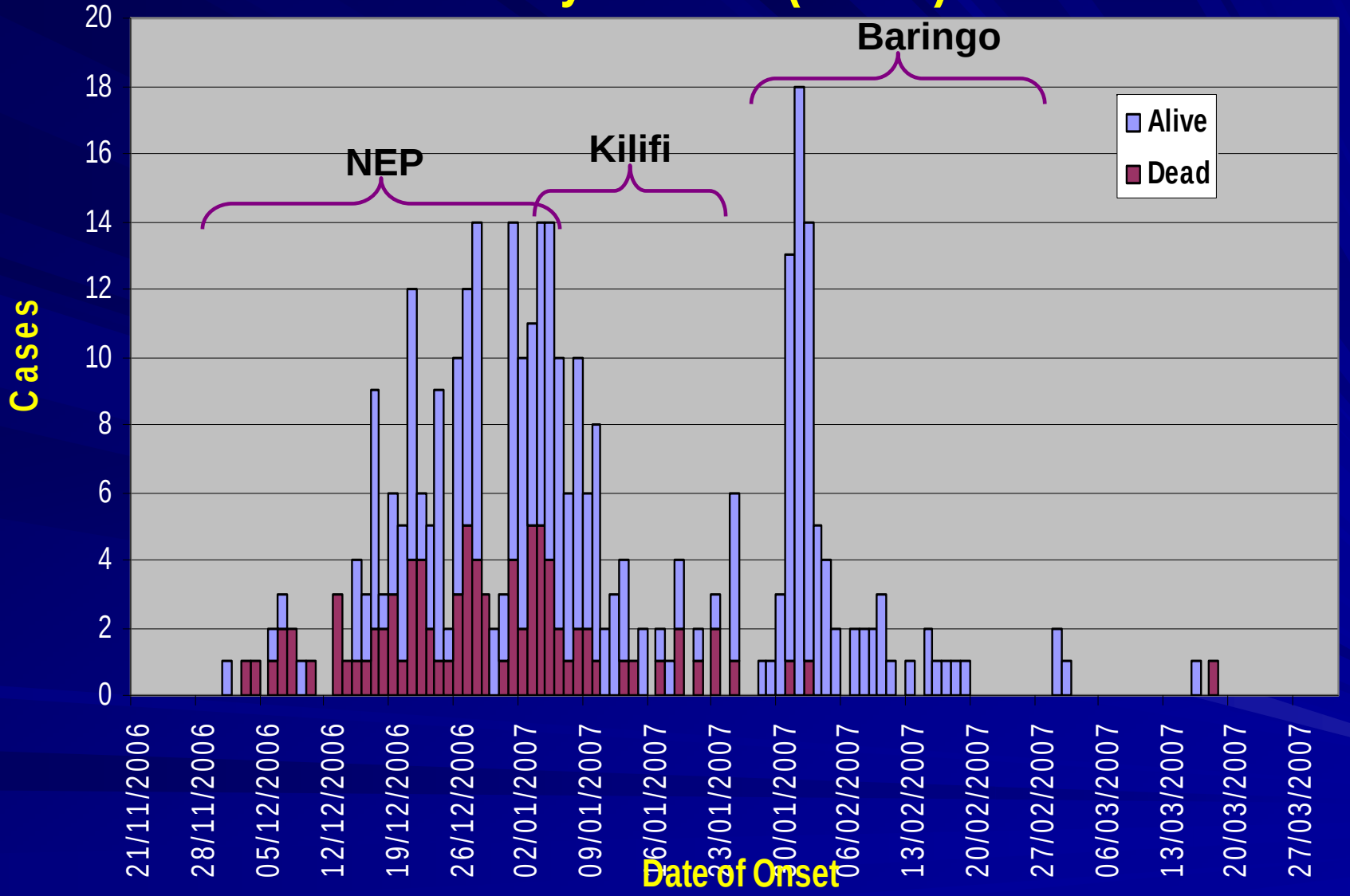
Baringo

174 of 700 (24.8%) Cases

Kilifi

73 of 700 (10.4%) cases

Confirmed and Probable Rift Valley Fever Cases , Kenya 2006/07(N=340)



RVF Outbreak Jan 2007: Livestock vaccination in NEP, Kenya

RVF Outbreak in Somalia

Somalia

- First case confirmed 20th January, 2007
- 4 of 19 samples from suspect/probable cases confirmed
- All cases reported in Central and South Somalia
- WHO Report: 107 reported cases, 54 (50.5%) deaths

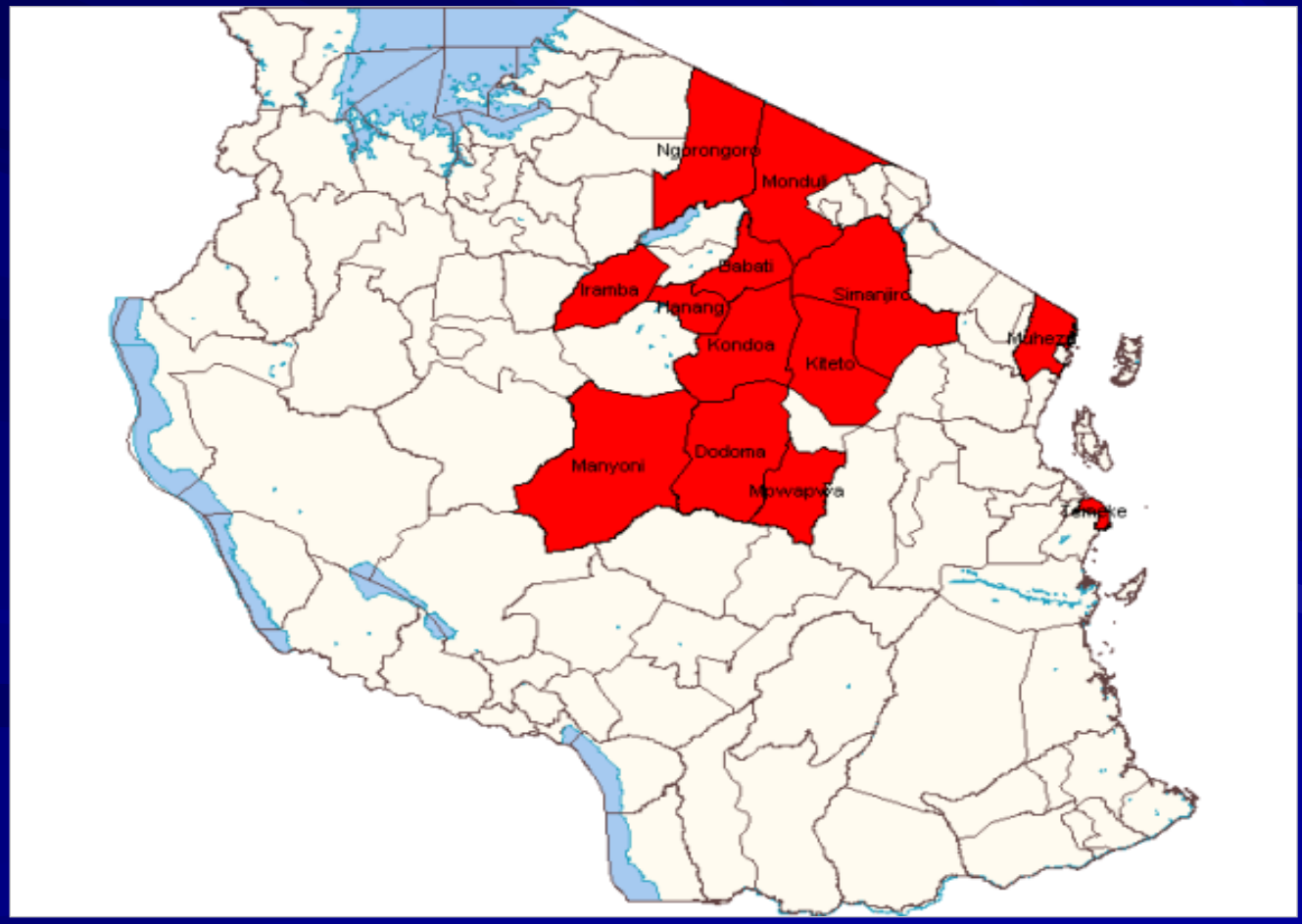
RVF Outbreaks in Somalia

First case confirmed 20th January, 2007

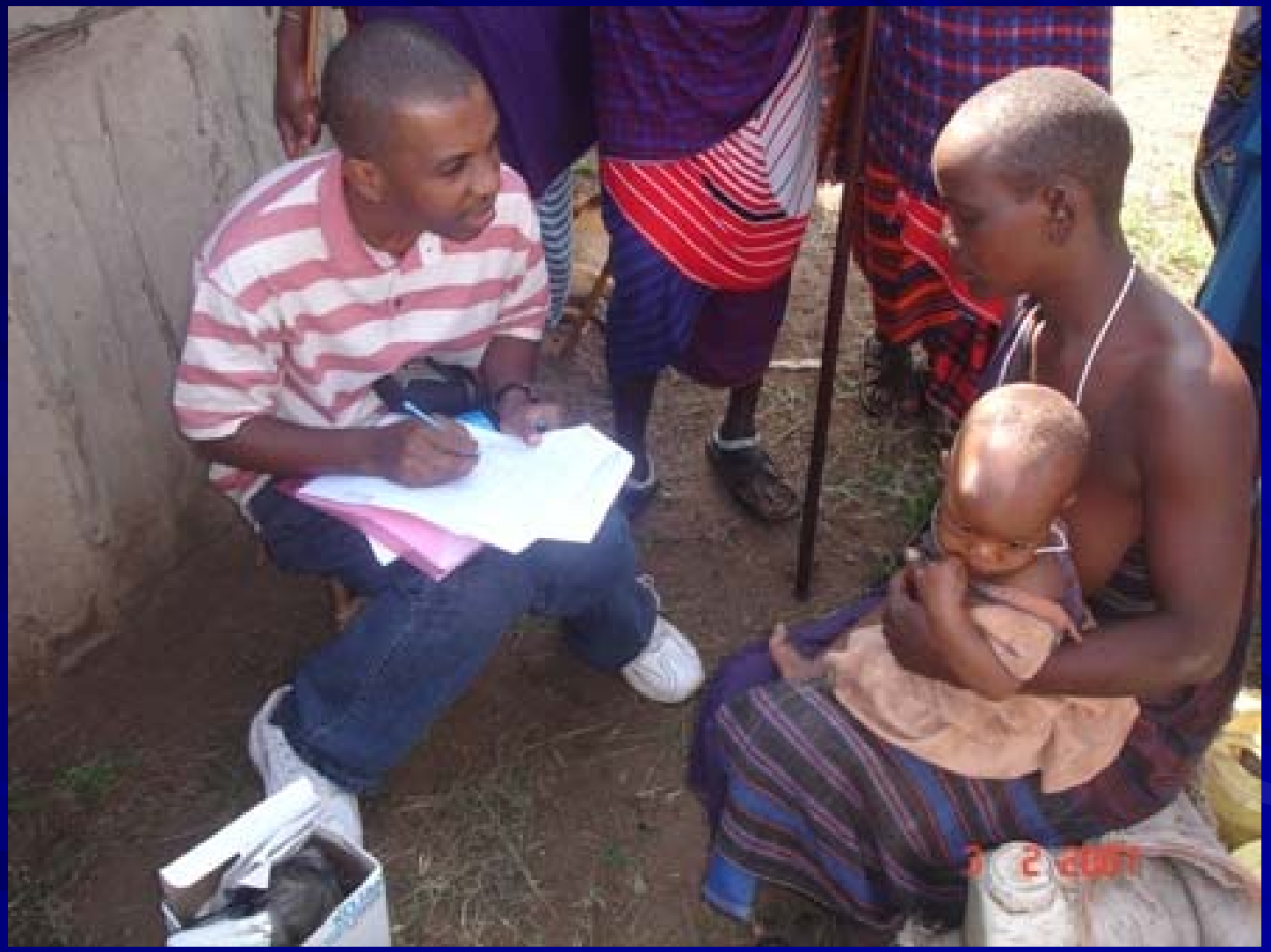
Total:107 cases, 54 (50.5%) deaths

RVF Outbreak in Tanzania

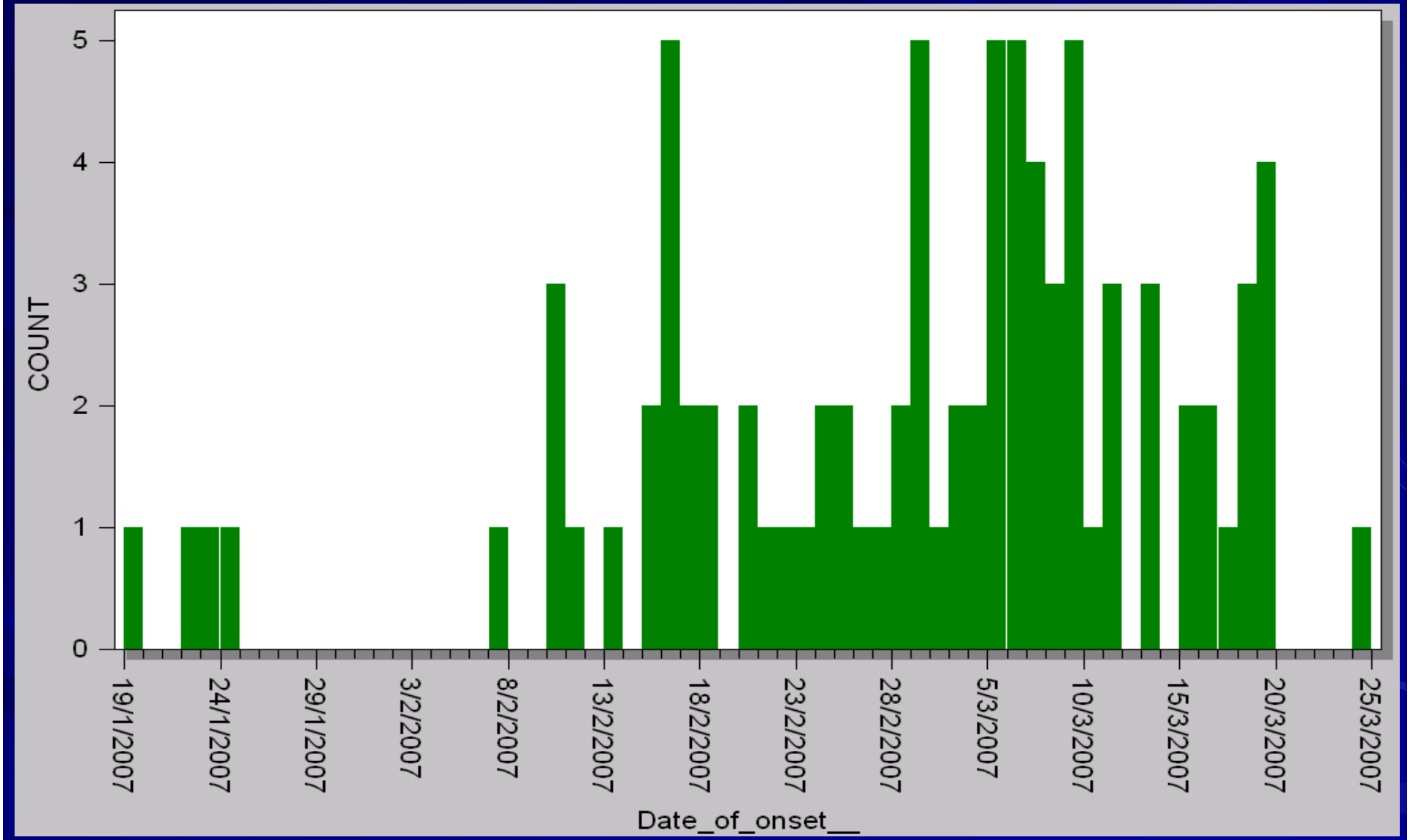
First case confirmed Feb 1st, 2007
Total: 309 cases, 144 deaths



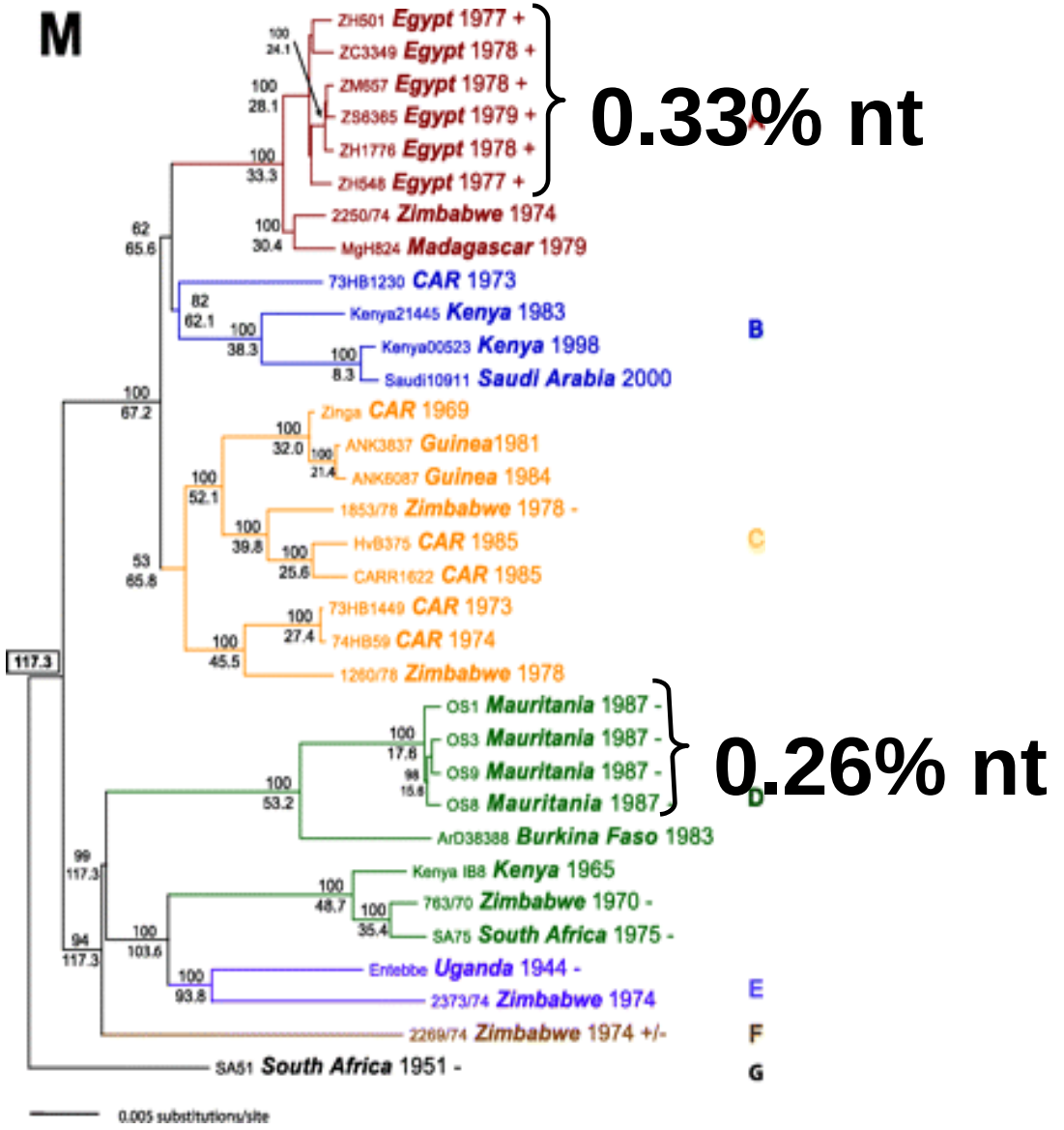
Tanzania RVF Outbreak: Case Finding



Tanzania RVF Outbreak: Epicurve



Minimal diversity in Naïve Ecology



Adapted from Bird BH, Khristova ML, Rollin PE, Ksiazek TG, Nichol ST, J Virol, 2007

Sequential RVF Epidemics in East Africa: How does the virus spread?

2006-2007 Epidemic

Region 1: Nov 26, 2006

Region 2: Dec 26, 2006

Regions 3,4: Jan 7, 2007

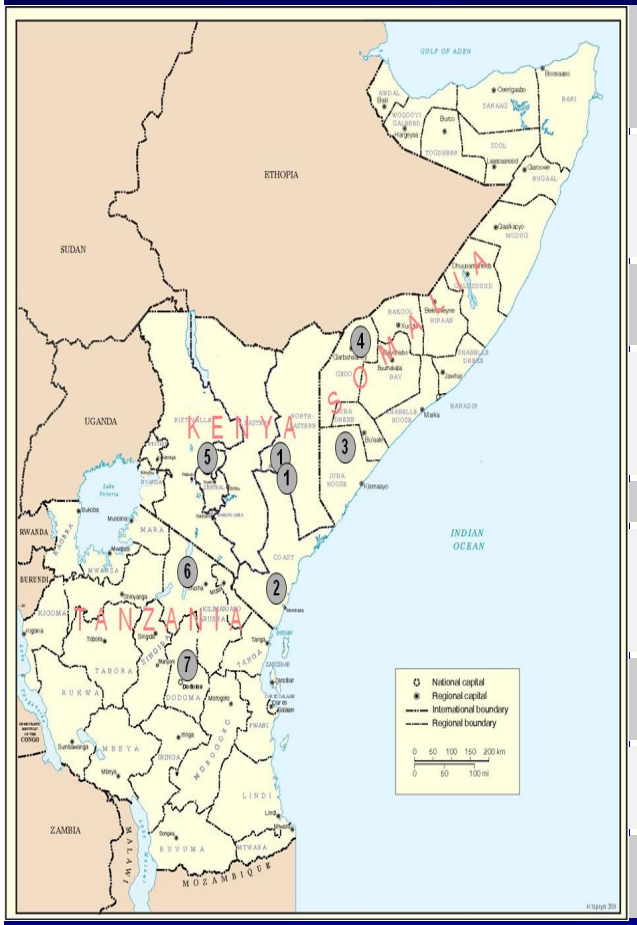
Region 5: Feb 5, 2007

Region 6: Jan 27, 2007

Region 7: Feb 1, 2007

Nderitu et al., J Inf Dis 203, 2011

History of 2006-07 RVF Isolates

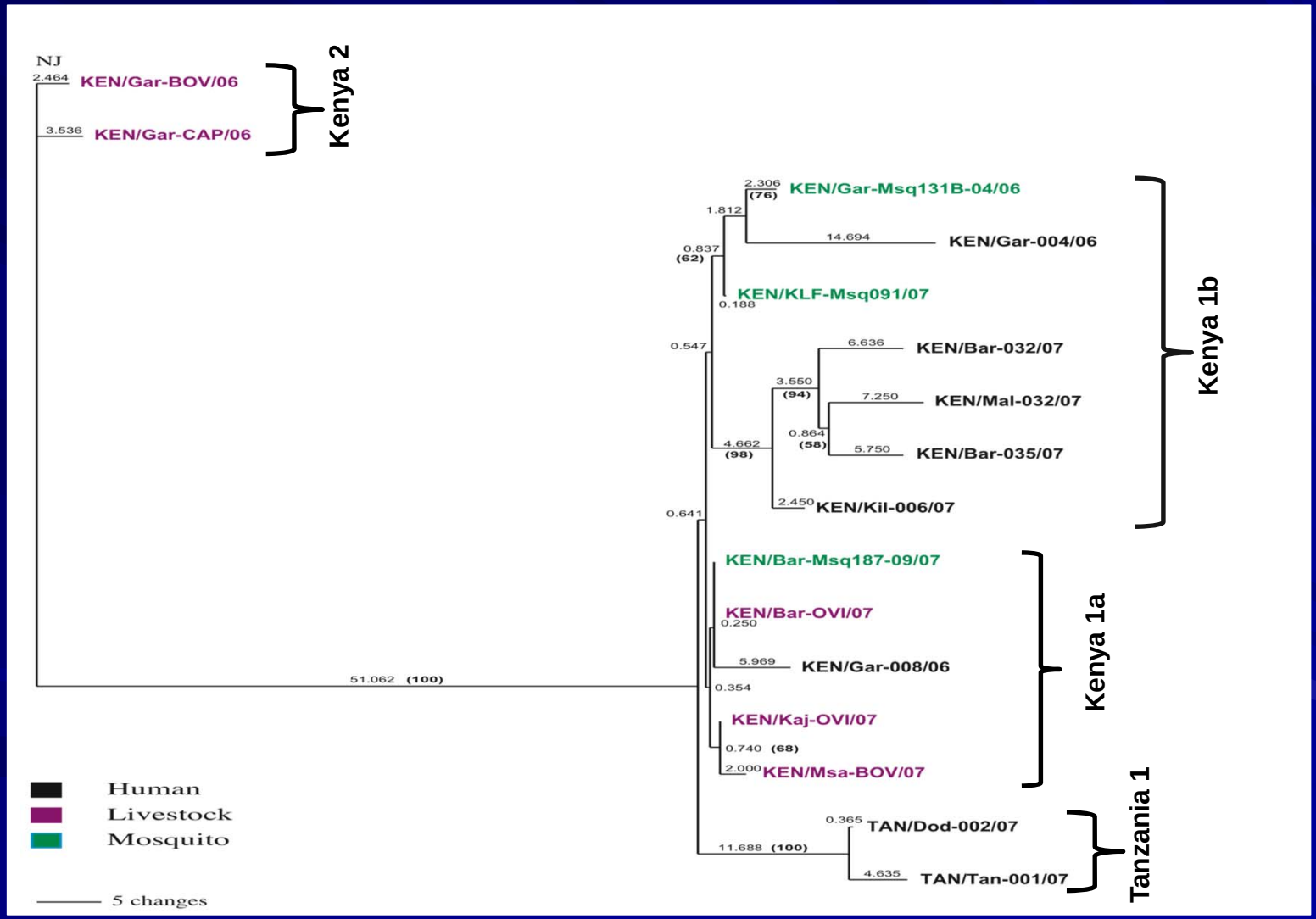


Virus strain	Date isolated	Isolated from	Location	Lab results of patient			History of animal contact
				RT-PCR	IgM	IgG	
KEN/Gar-004/06	12/24/06	Male, 50, serum, survived	Fafi-Jarajila	+	-	-	Yes
KEN/Gar-008/06	12/25/06	Male, 25, serum, died	Bura-Guujo	+	-	-	Yes
KEN/Kil-006/07	1/03/07	Female, 85, serum, survived	Bahari	+	-	-	Not available
KEN/Mal-032/07	1/07/07	Female, ??		+	+	-	Yes
KEN/Bar-032/07	2/06/07	Female, 14, serum, survived	Ilchamus	+	-	-	Yes
KEN/Bar-035/07	2/07/07	Male, 22, serum, died	Kiserian	+	+	+	Yes
TAN/Tan-001/07	2/10/07	Male, 30, liver, died	Tanga	+	-	-	Not available
TAN/Dod-002/07	3/01/07	Female, 55, liver, died	Dodoma	+	-	-	Not available

Note: Over 20 human isolates from Kenya and Tanzania. No isolate from Sudan

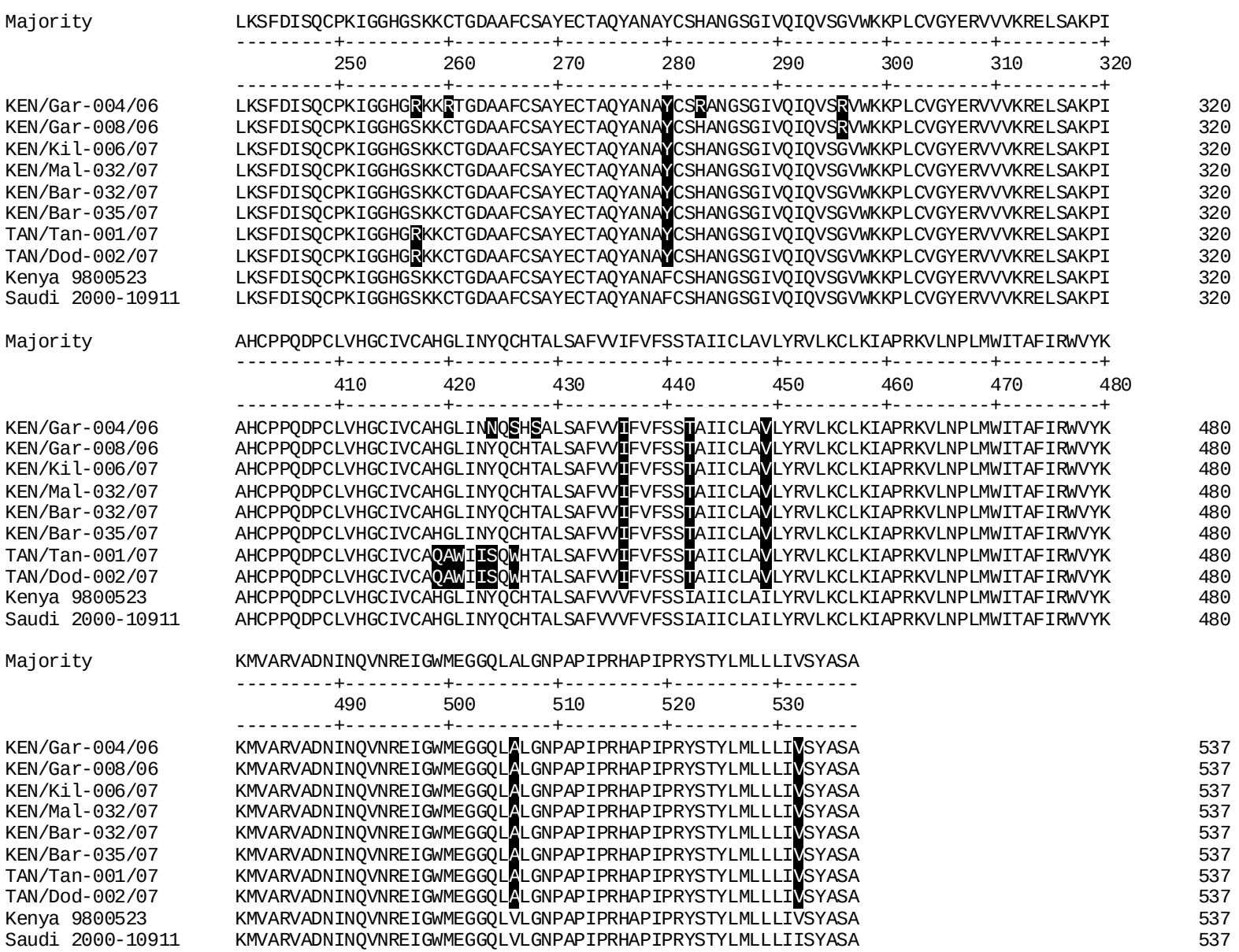
How do RVF Epizootics Spread?

Multiple lineages of RVF virus during one epidemic indicate spontaneous activation of resident virus



Nderitu et al., J Inf Dis 203, 2011; Bird et al, 2008

Genetic Fingerprinting - RVF G1 proteins (aa 241-537)



Conclusions

- Presence of different lineages of RVF both within a foci and across geographically different foci
- Finding support the concept of reemergence of resident populations of endemic viruses in each foci
- Study suggests that banning livestock movement alone, while important, may not prevent outbreaks in other permissive foci in a country