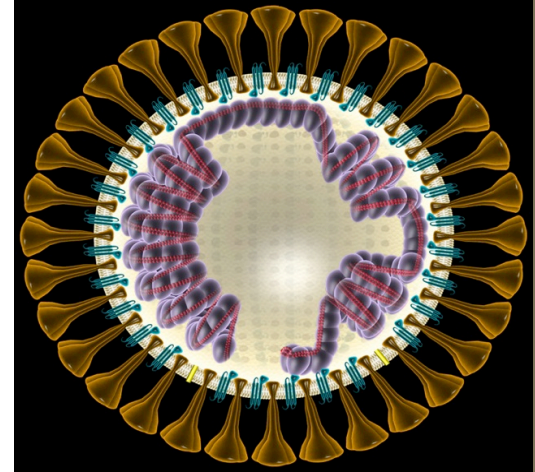


Virus Jumping:

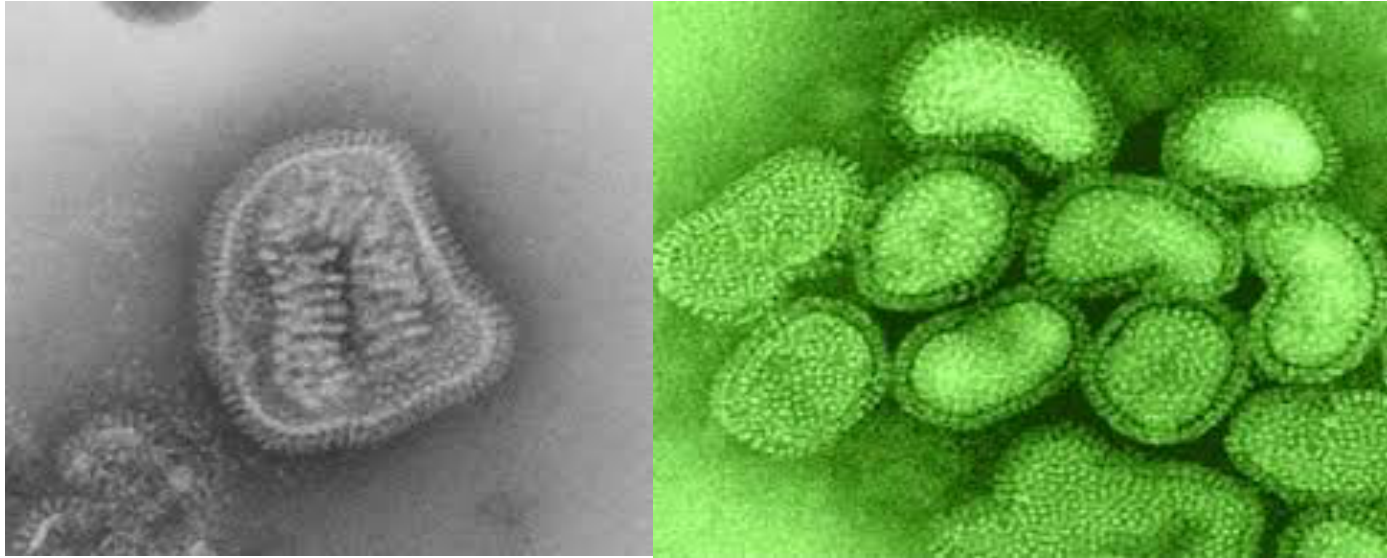


How Viruses Move from One Species to Another

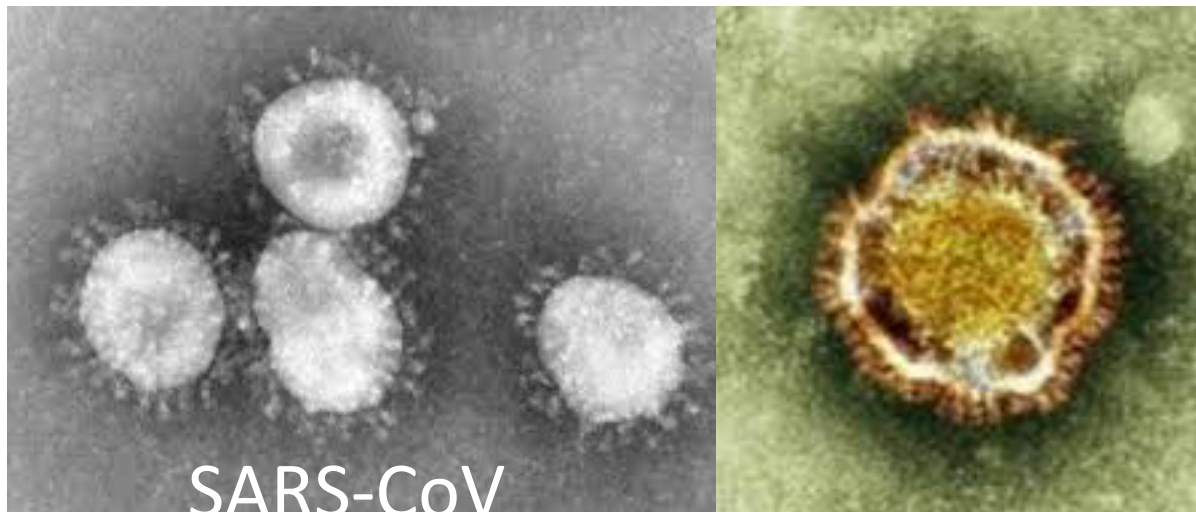
Megan W Howard
Biological Sciences
University of Alaska, Anchorage

Viruses

Influenza A



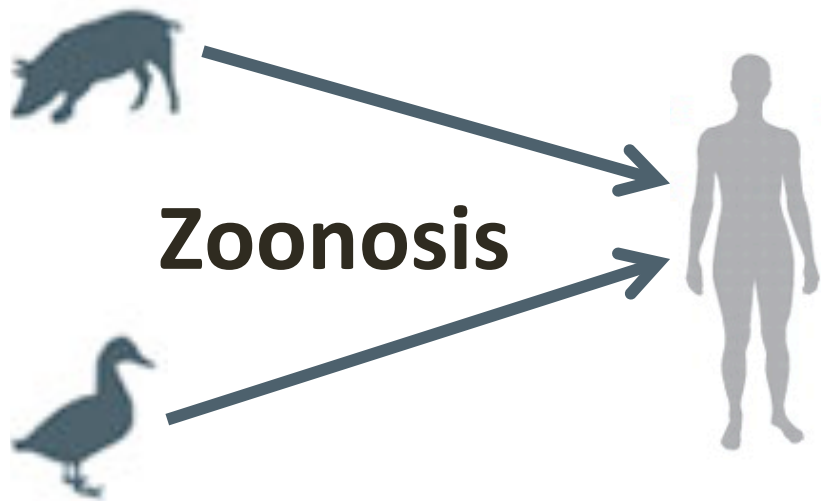
SARS coronavirus

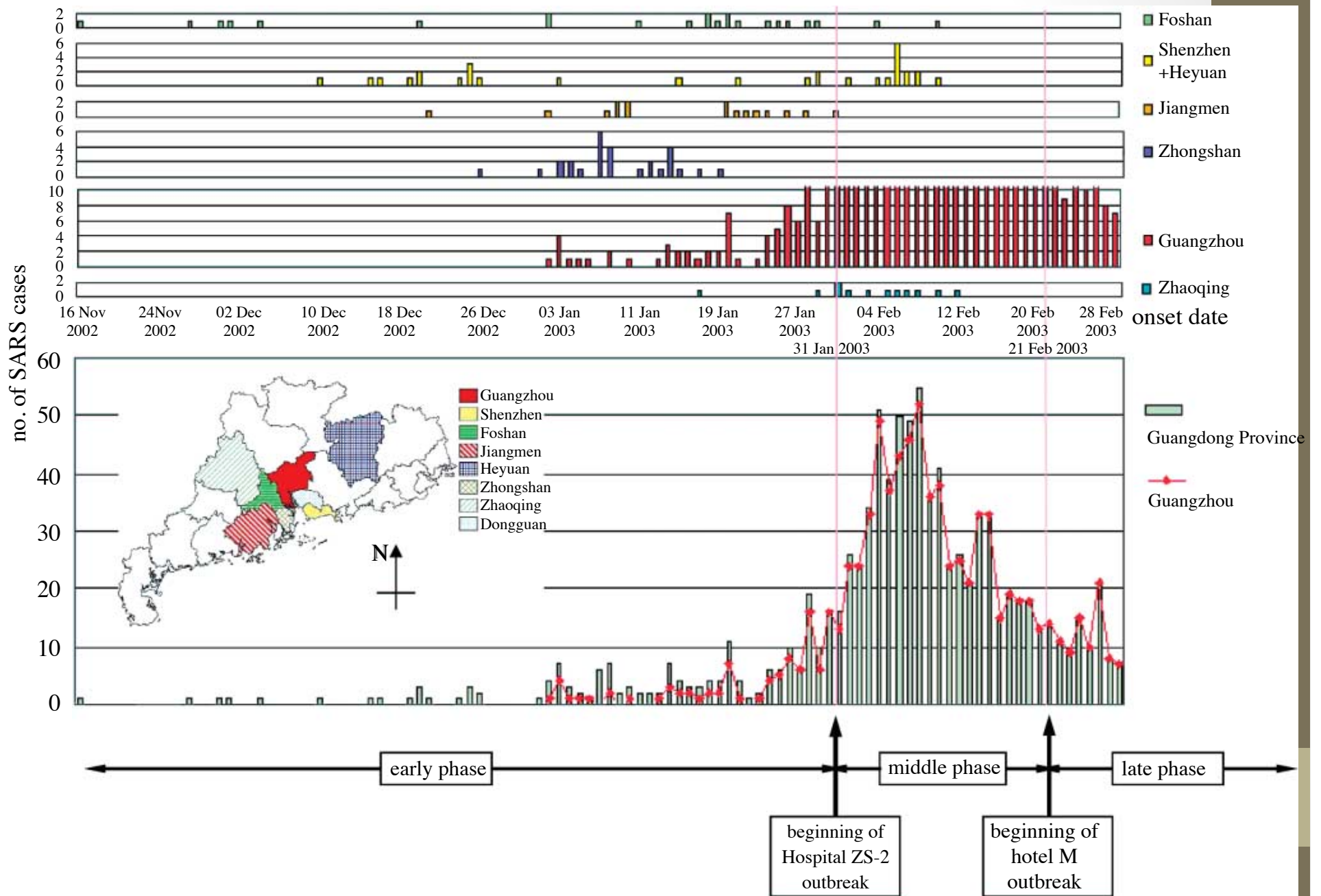


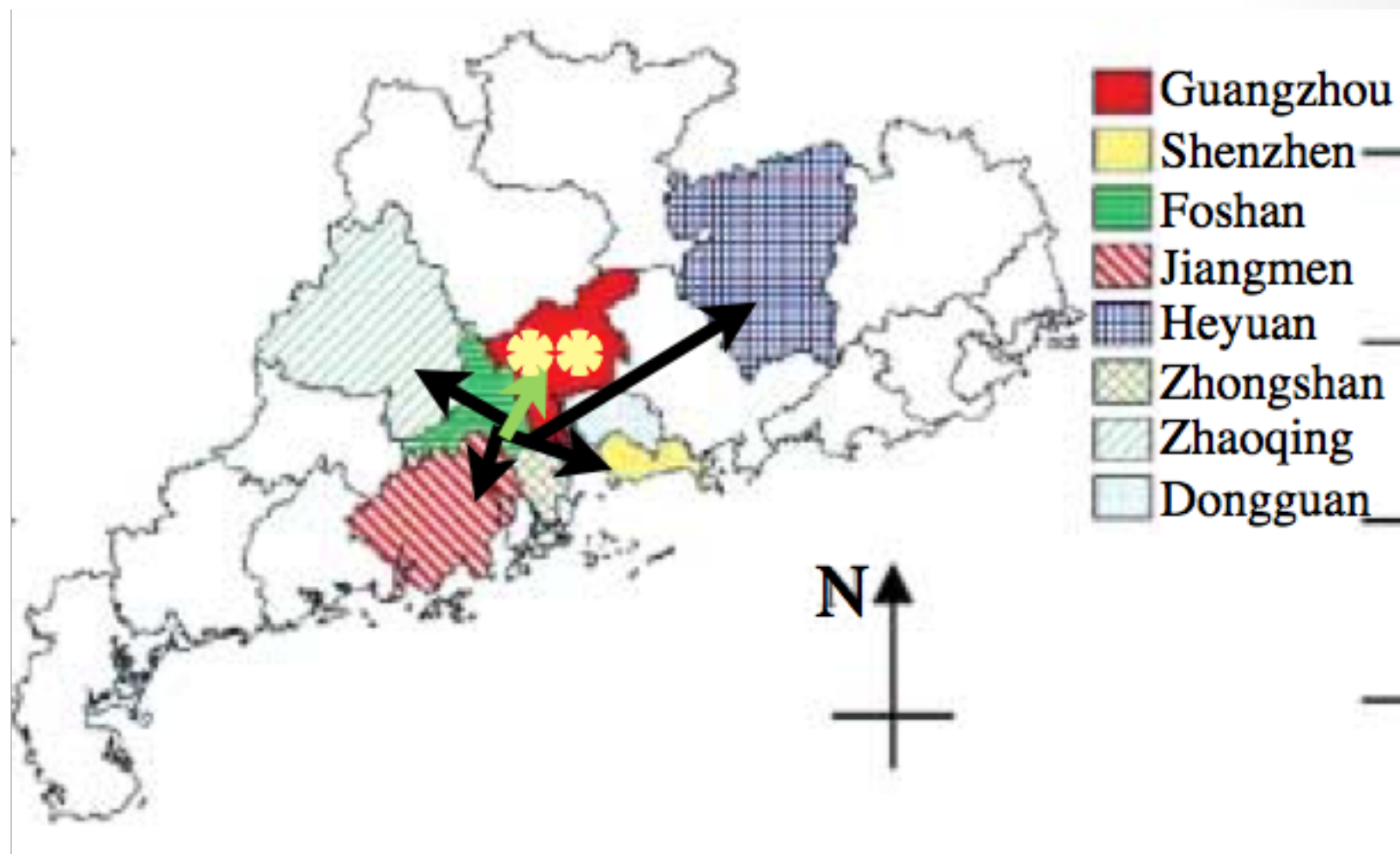
SARS-CoV

SARS-Coronavirus (SARS-CoV)

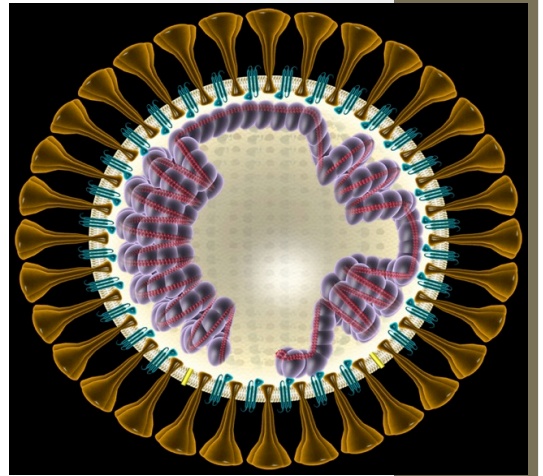
- 2002-2003, Guangdong province, China
- Atypical viral pneumonia
- >8000 cases, >800 dead. ~10% mortality
- SARS-like viruses in palm civet's, raccoon dogs, bats
- Antisera found in blood from before epidemic



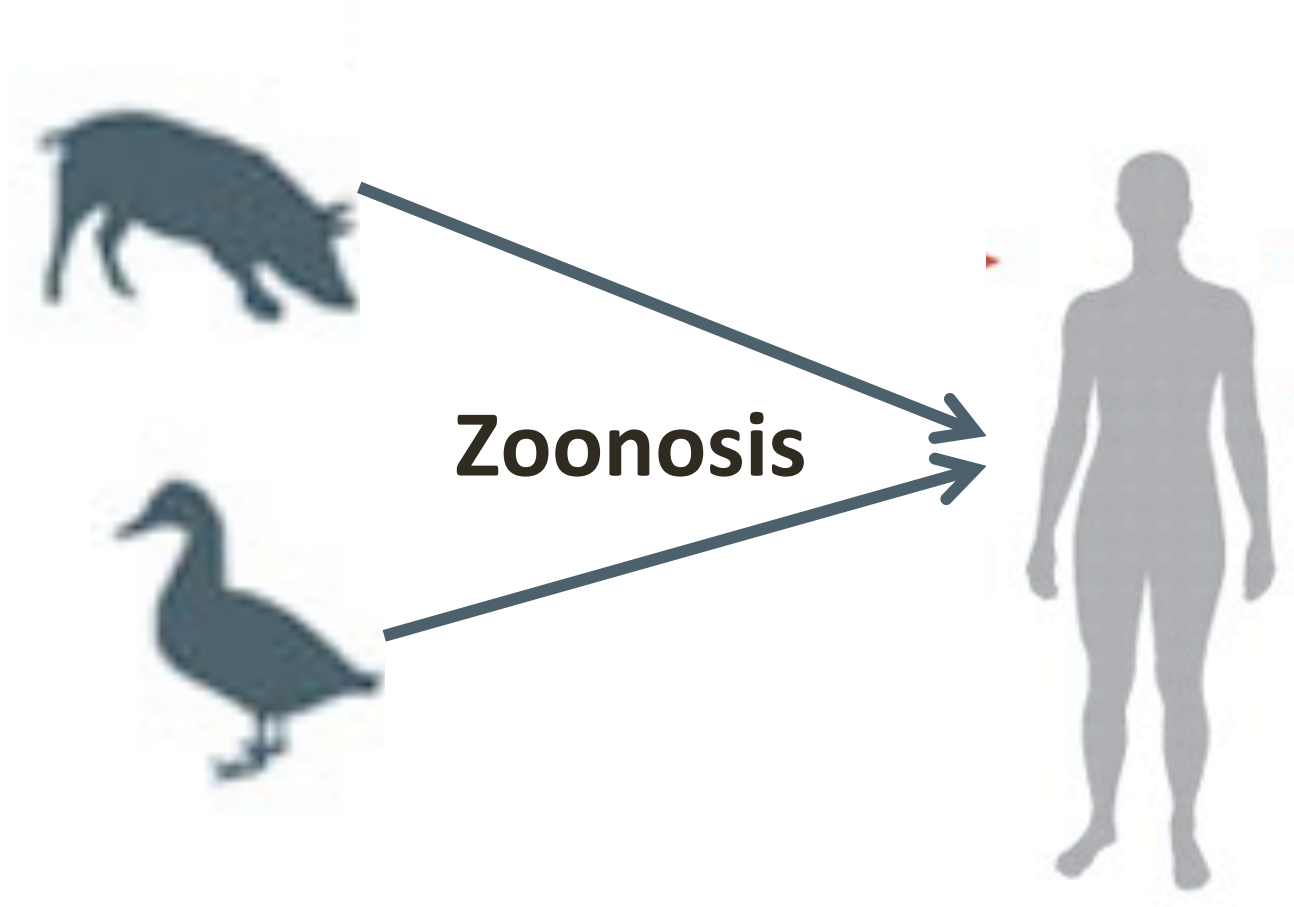


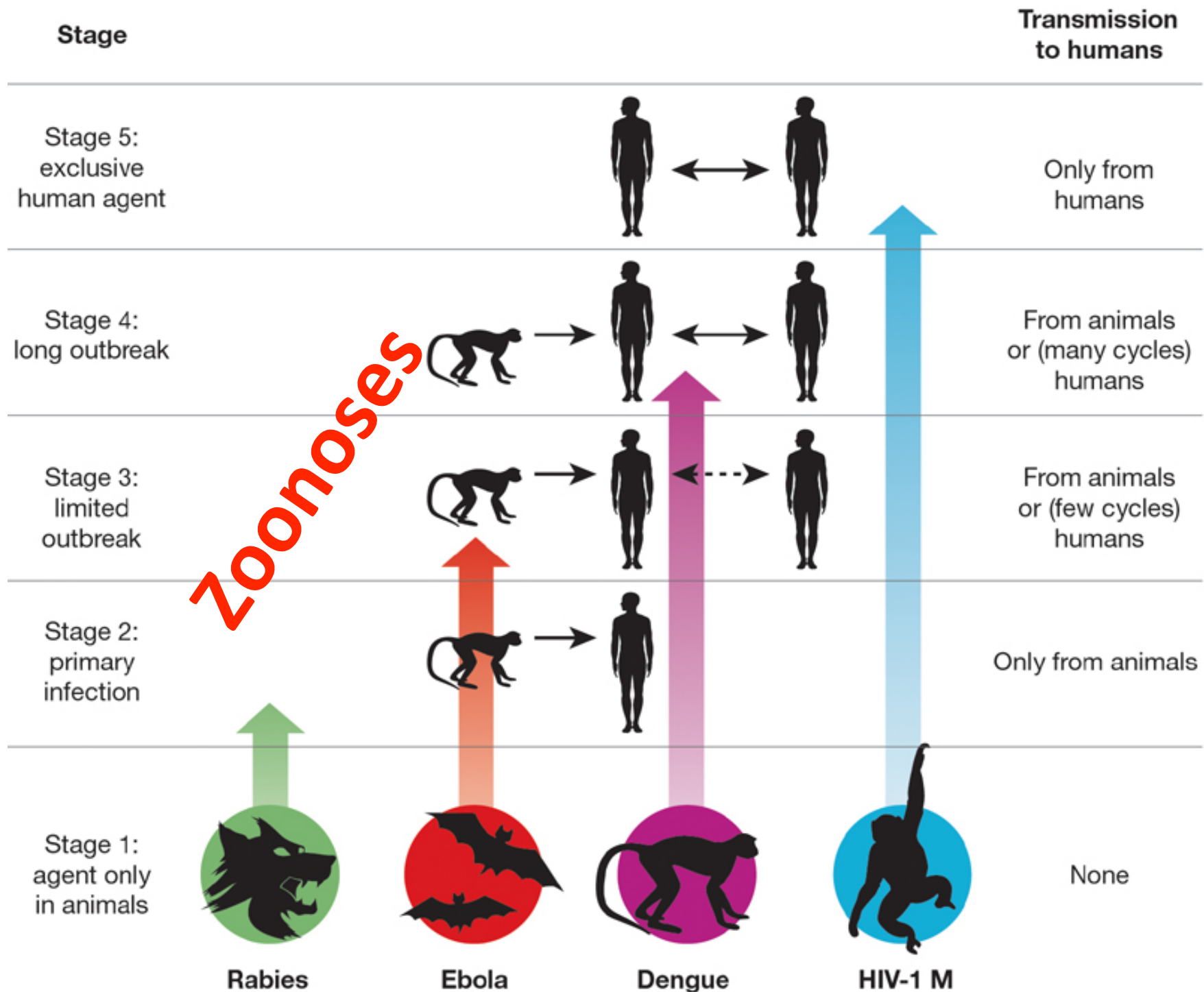


Zoonoses: 61-70% of all modern EIDs



Ebola
Rabies
Influenza
SARS
MERS





Zoonoses



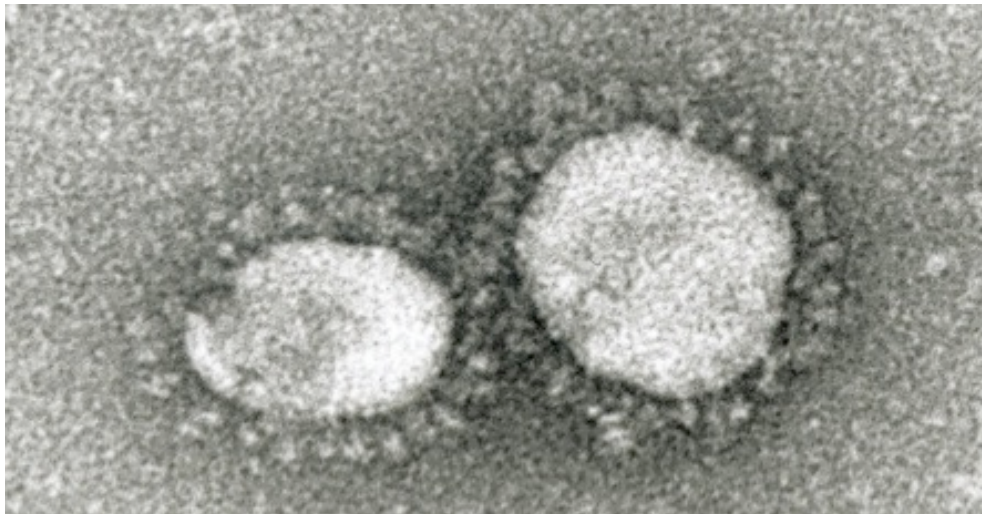
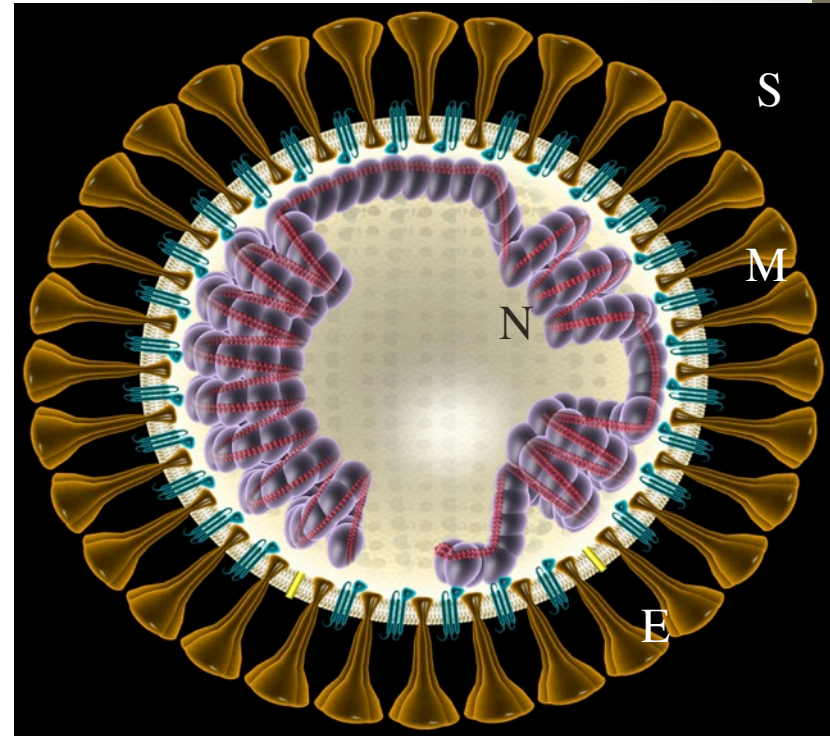
How do viruses jump?

or

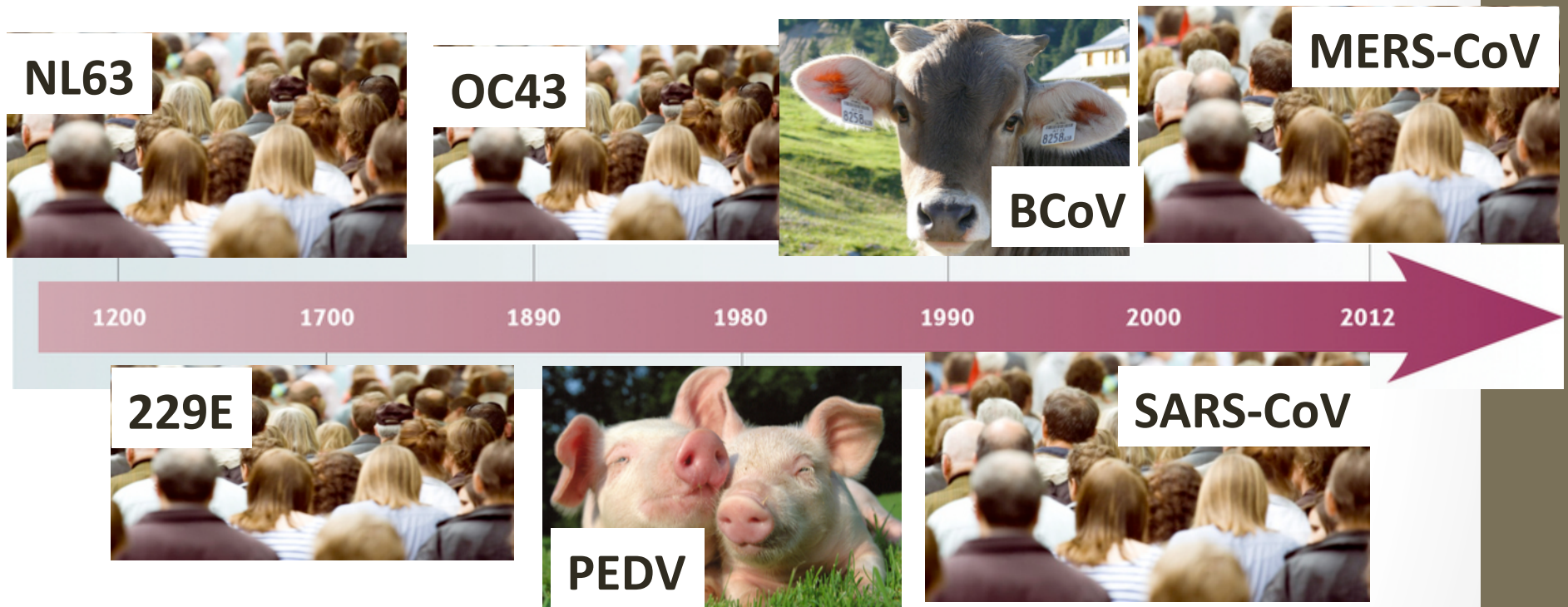
What causes interspecies
transmission

Coronaviruses

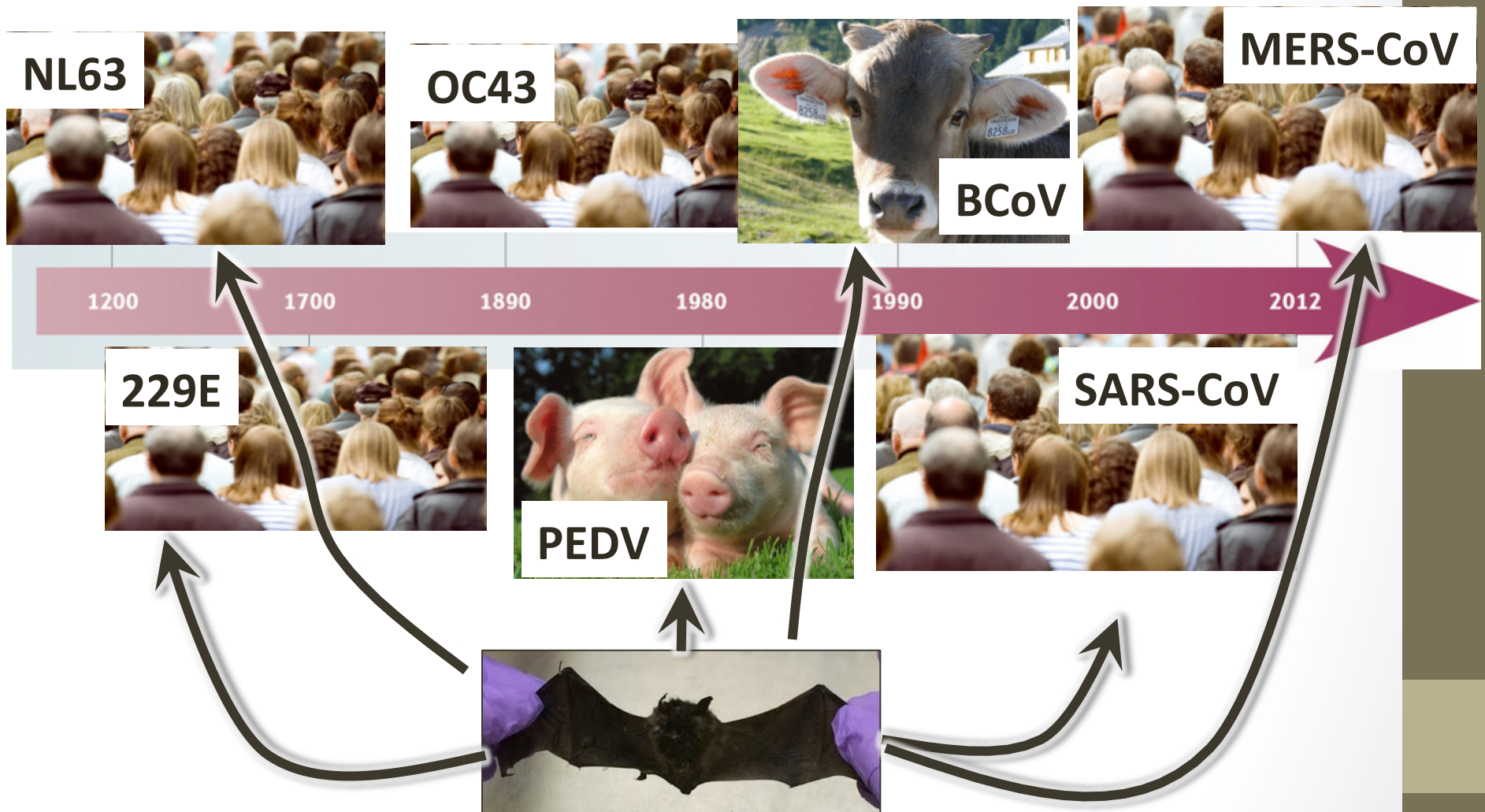
- +ssRNA viruses
- Ancestral CoV –
Insectivorous Bats
- Many spillovers ‘jumps’



Coronavirus Host Jumps

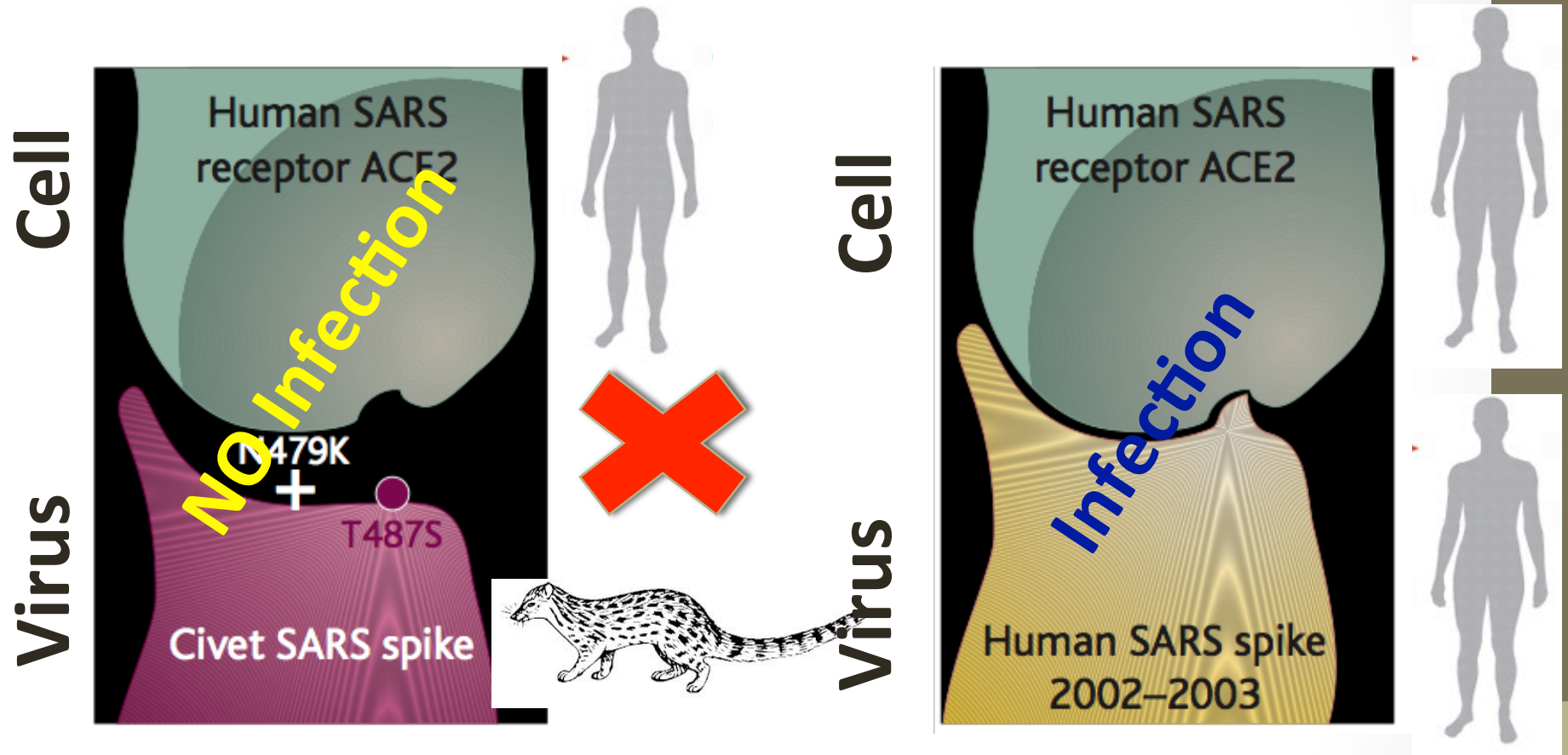


Coronavirus Host Jumps

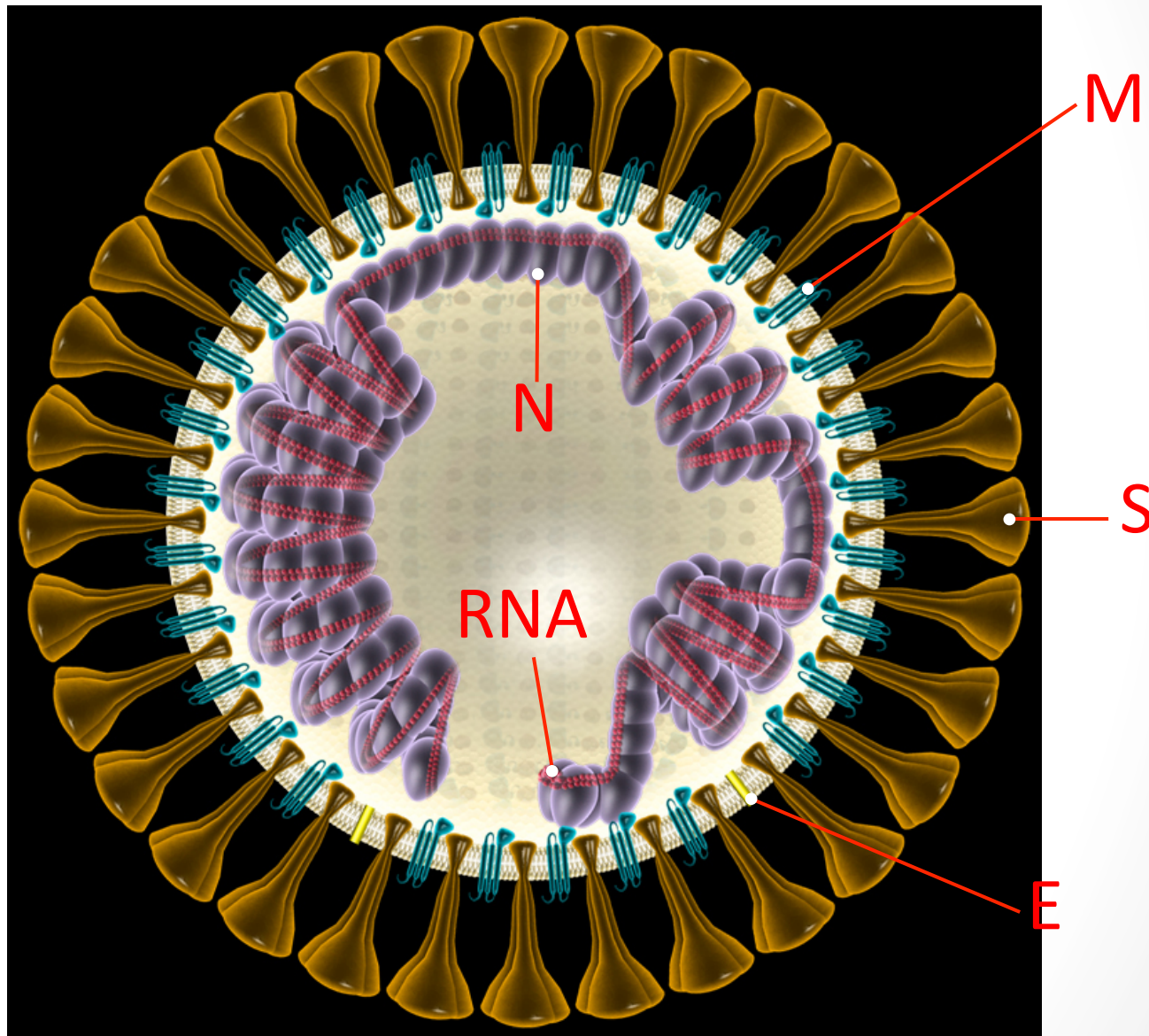


Graham and Baric. Nature Reviews Microbiology. 11, 836–848 (2013)

Coronaviruses jump hosts by binding different cells



Clues to the pandemic were in the anatomy



Coronavirus S

VERY large

~200 kDa

~200 A long X 70 A wide

Very variable

Mutations affect

receptor binding specificity

tissue tropism

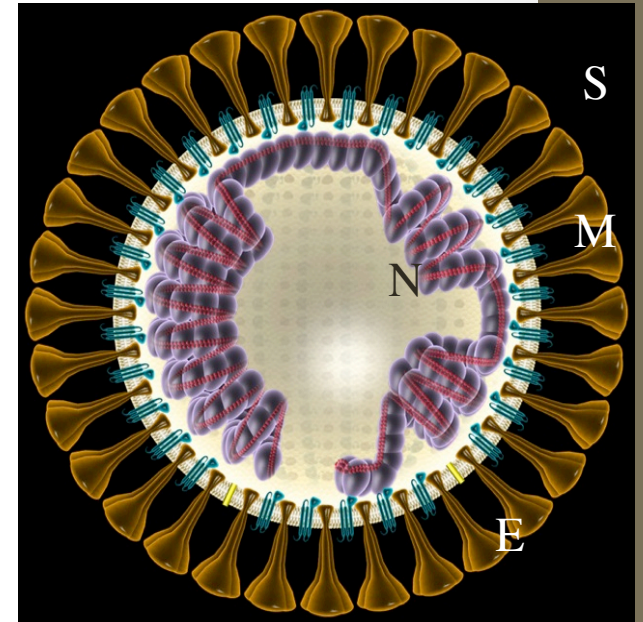
host range

triggering of conformational changes

membrane fusion activity

pH of fusion, site of entry

antigenicity



Clues to the pandemic were in the anatomy

Non-silent nucleotide changes in S genes of human and animal SARS-CoV isolates

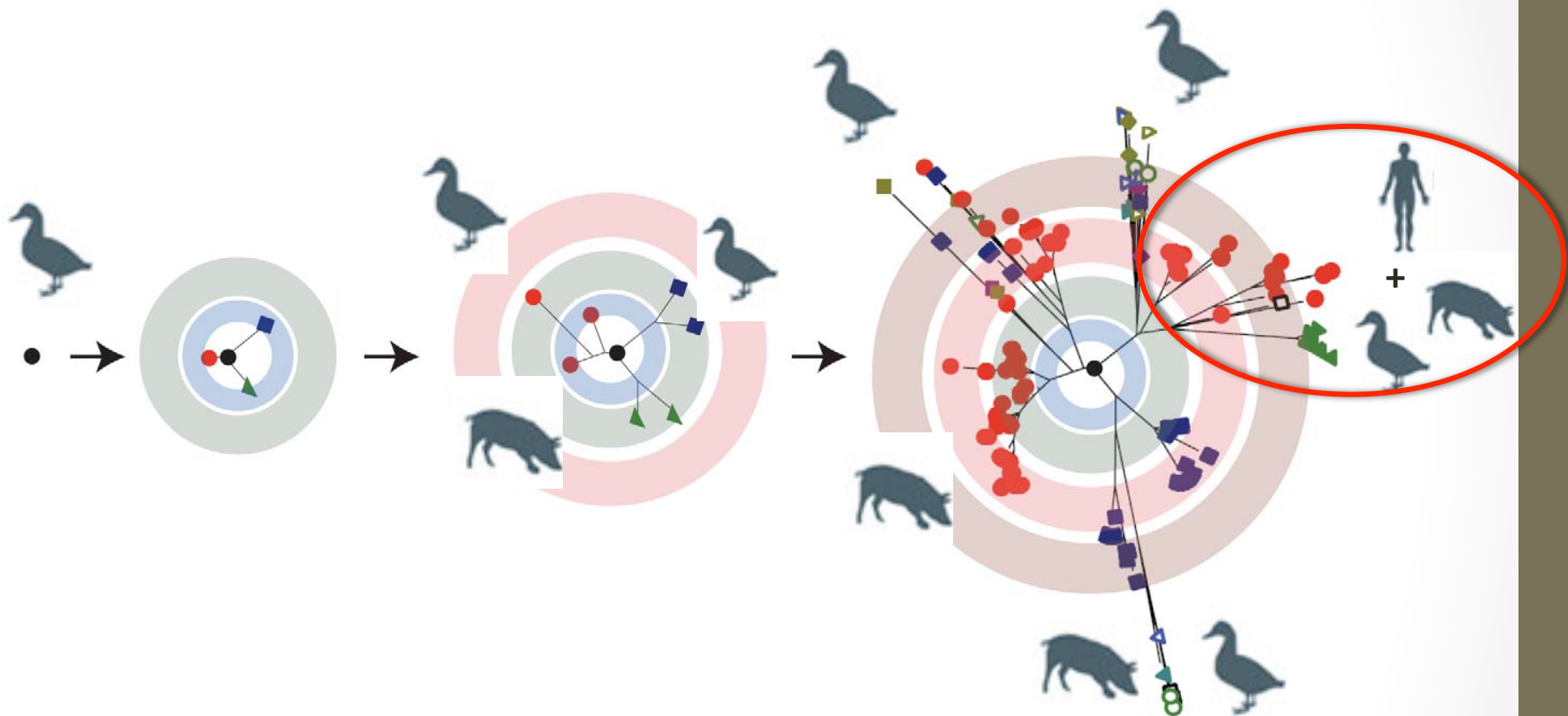
		Nucleotide residues																																			
		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
		1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
		6	6	6	6	7	7	1	1	1	2	2	2	4	5	5	5	6	9	9	9	0	1	2	2	4	5	6	7	7	8	8	1	1	3	5	
		2	9	9	9	0	0	3	5	9	0	0	5	0	0	0	5	4	1	3	7	0	4	0	9	7	7	1	0	3	0	5	5	9	6	5	
Virus		2	0	1	2	0	6	0	7	2	5	7	8	7	2	7	5	6	3	6	8	3	8	5	5	0	8	7	3	7	8	6	6	7	8	1	
Animal	SZ3	C	A	T	T	C	A	T	A	T	T	C	A	G	G	G	C	A	A	G	T	G	T	C	C	T	C	G	T	G	C	G	C	G	C		
	SZ16	C	A	T	T	C	A	T	A	T	T	C	A	G	G	G	C	G	A	G	T	G	A	T	C	C	T	C	G	T	G	C	G	C	T	C	
	SZ1	C	A	T	T	C	A	T	A	T	T	C	A	G	G	G	C	G	A	G	T	T	A	T	C	C	T	T	G	T	G	C	G	T	T	T	
	SZ13	C	A	T	T	C	A	T	A	T	T	C	A	G	G	G	C	G	A	G	T	G	A	T	C	C	T	C	G	T	G	C	G	C	T	C	
Human	GZ01	C	A	T	T	C	A	C	C	T	C	C	C	A	G	G	T	G	T	C	A	G	T	T	T	T	C	C	A	C	G	T	A	C	G	C	
	GZ43	C	-	-	-	G	A	T	C	T	C	C	C	A	G	G	T	G	T	C	T	G	T	T	T	C	C	C	A	C	G	C	A	C	G	C	
	GZ60	C	-	-	-	G	A	T	C	T	C	C	C	A	G	G	T	G	T	C	T	G	T	T	T	C	C	C	A	C	G	C	A	C	G	C	
	GZ50	T	A	T	T	C	A	T	C	C	C	C	C	G	A	A	T	G	T	C	T	G	T	T	T	T	C	C	A	C	G	C	A	C	G	T	
	CUHK-W1	C	A	T	T	C	A	T	C	C	C	C	C	G	A	A	T	G	T	C	T	G	T	T	T	T	C	C	A	C	T	C	A	C	G	T	
	HKU-36871	C	A	T	T	C	A	T	C	C	C	C	C	G	A	A	T	G	T	C	T	G	T	T	T	T	C	C	A	C	T	C	A	C	G	T	
	HKU-39848	C	A	T	T	C	G	T	C	C	C	T	C	G	A	A	T	G	T	C	T	G	T	T	T	T	C	C	A	C	T	C	A	C	G	T	
	HKU-66078	C	A	T	T	C	G	T	C	C	C	T	C	G	A	A	T	G	T	C	T	G	T	T	T	T	C	C	A	C	T	C	A	C	G	T	
	HKU-65806	C	A	T	T	C	G	T	C	C	C	T	C	G	A	A	T	G	T	C	T	G	T	T	T	T	C	C	A	C	T	C	A	C	G	T	
	Urban1	C	A	T	T	C	G	T	C	C	C	T	C	G	A	A	T	G	T	C	T	G	T	T	T	T	C	C	A	C	T	C	A	C	G	T	
	Tor2	C	A	T	T	C	G	T	C	C	C	T	C	G	A	A	T	G	T	C	T	G	T	G	T	T	C	C	A	C	T	C	A	C	G	T	

Interspecies Adoption?



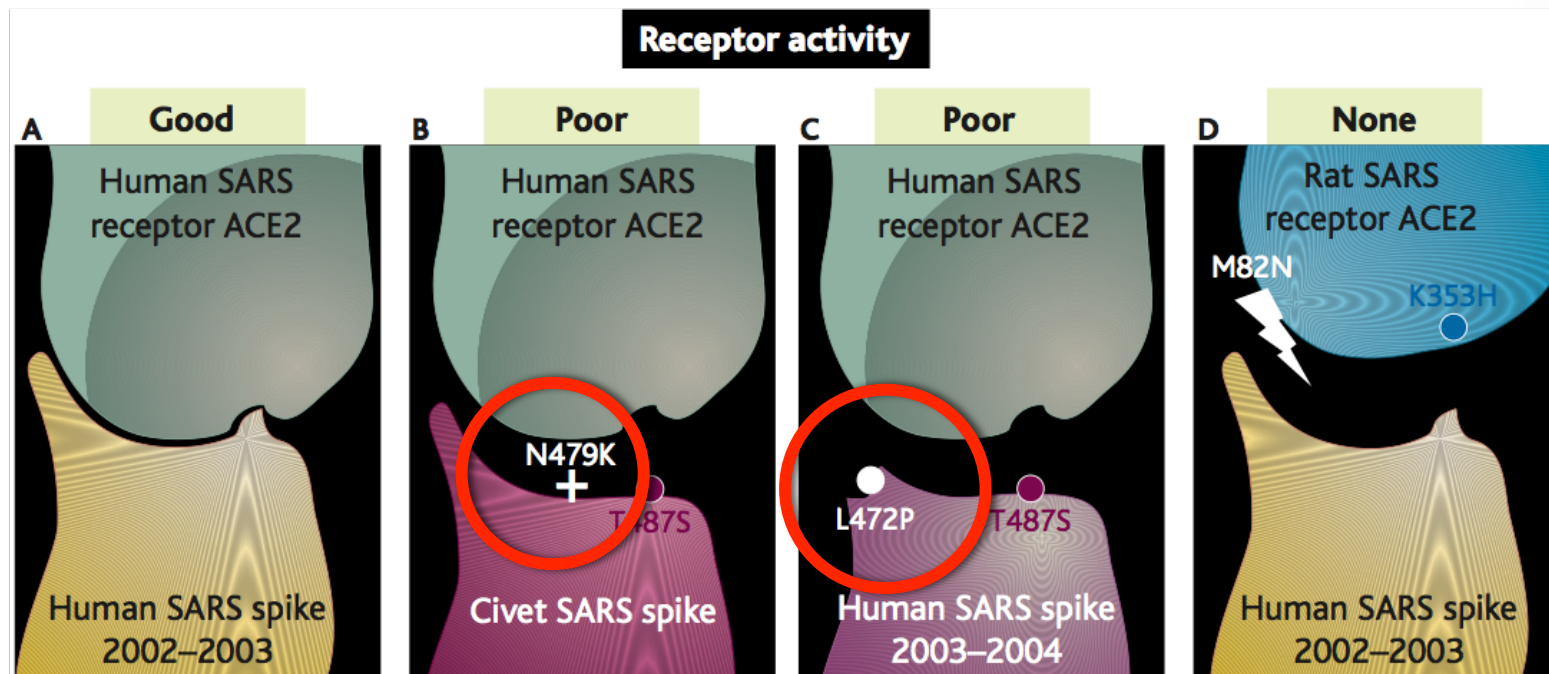
Quasispecies

A quasispecies is a group of viruses related by a similar mutation or mutations, competing within a highly mutagenic environment.



Moving to a new species = Selective Pressure

Small mutations over time can cause big changes!



**SARS
adapted to
humans**

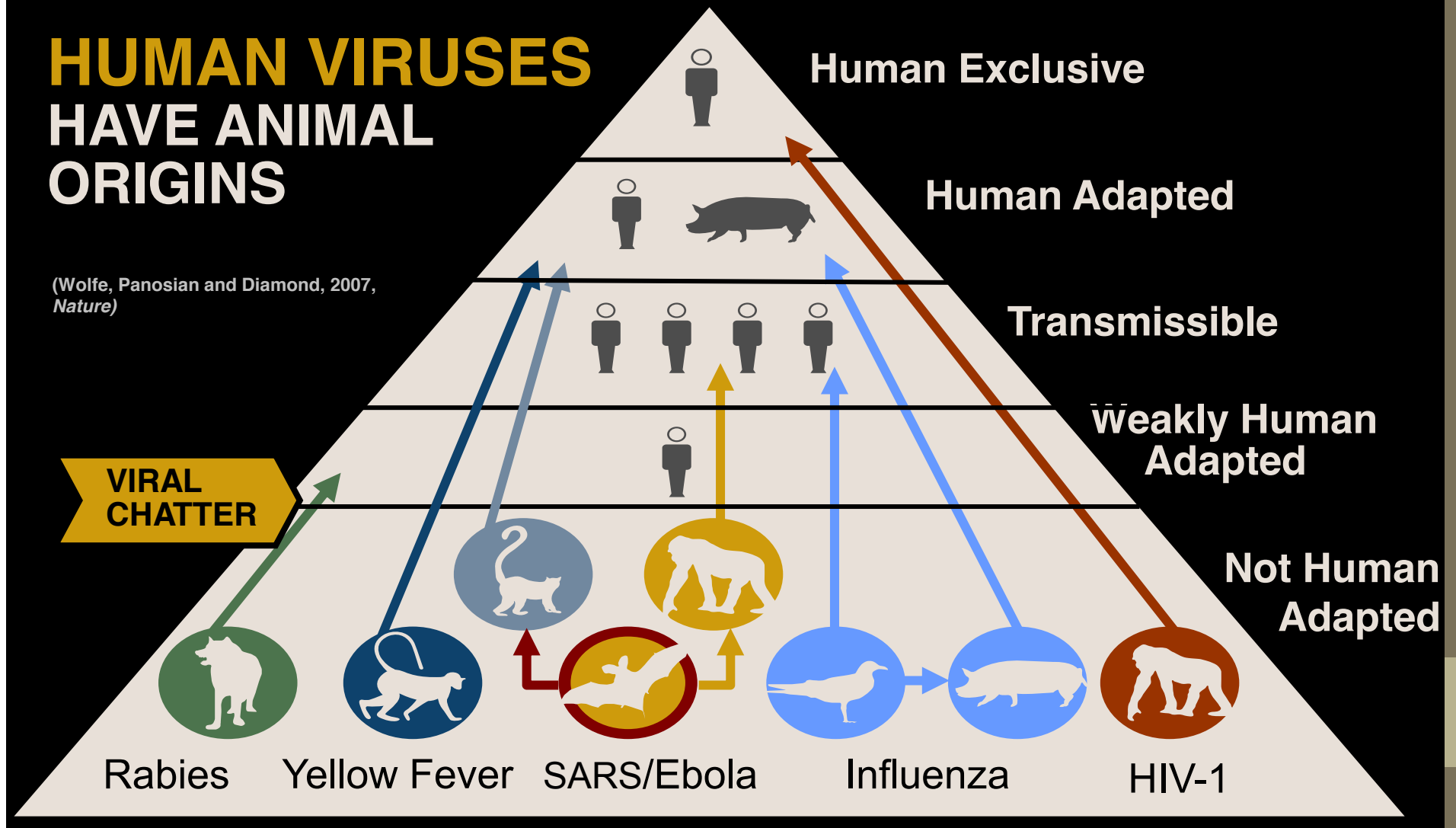


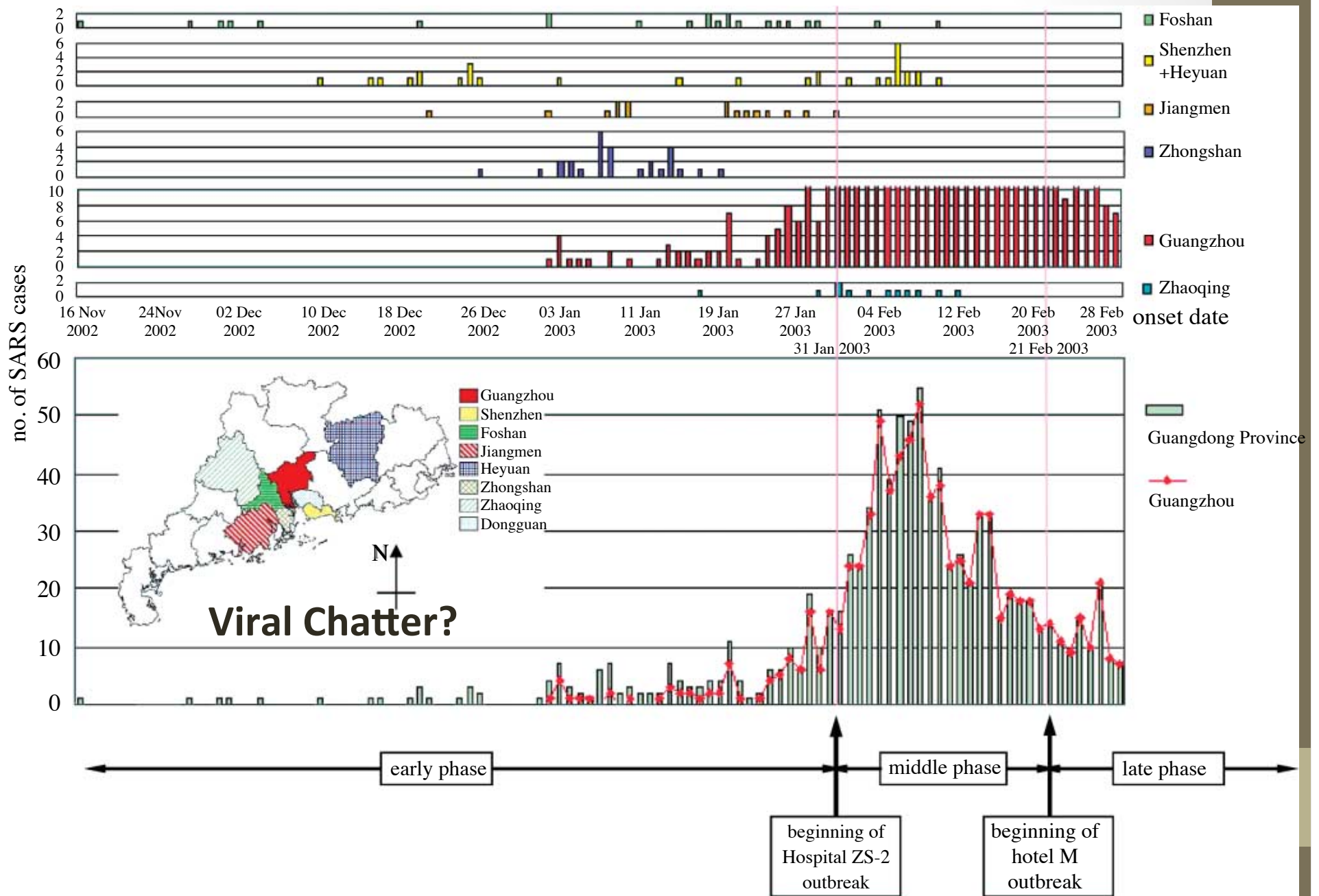
**SARS unable
to infect
humans**

Virus Chatter

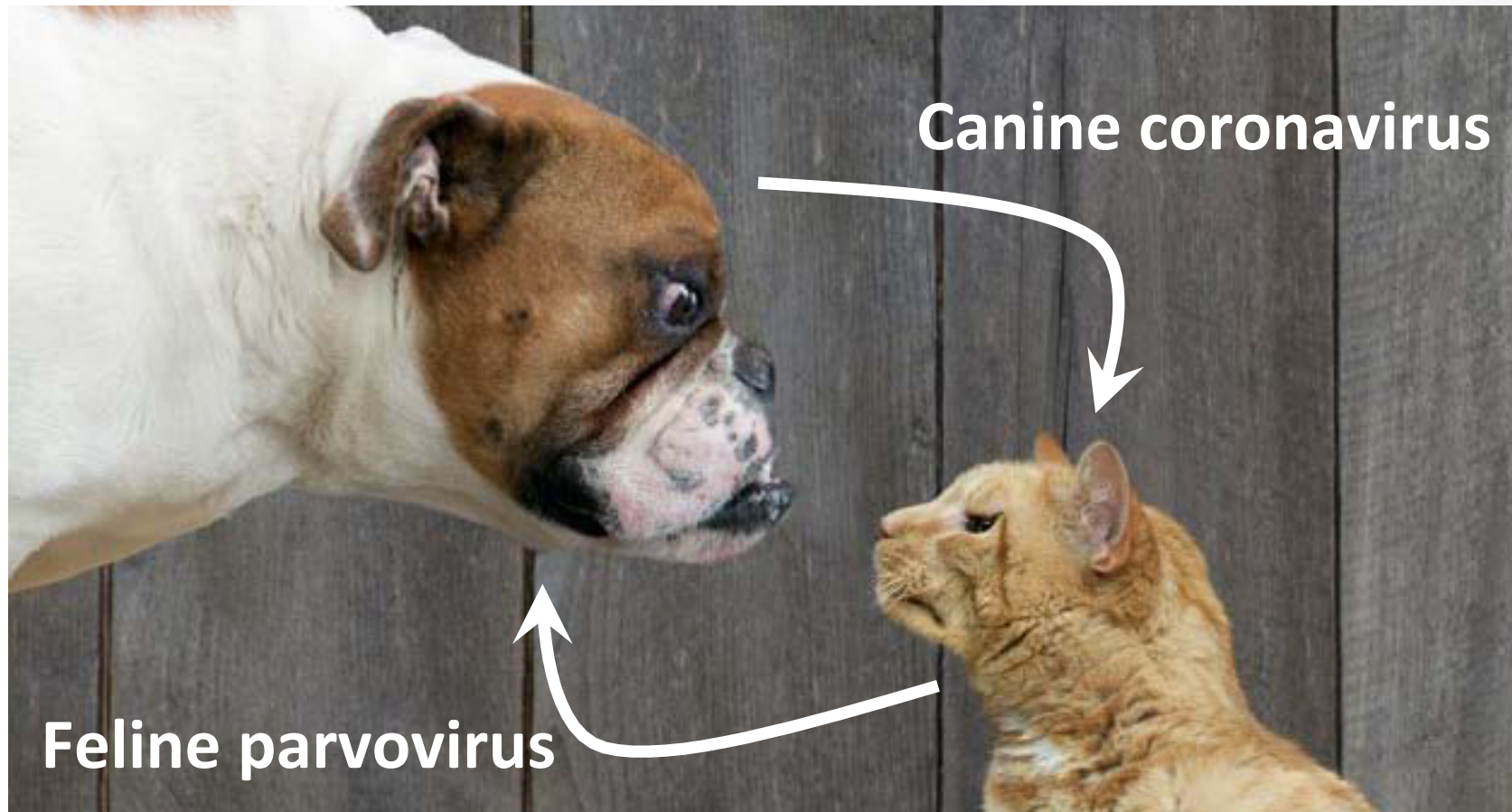
HUMAN VIRUSES HAVE ANIMAL ORIGINS

(Wolfe, Panosian and Diamond, 2007,
Nature)





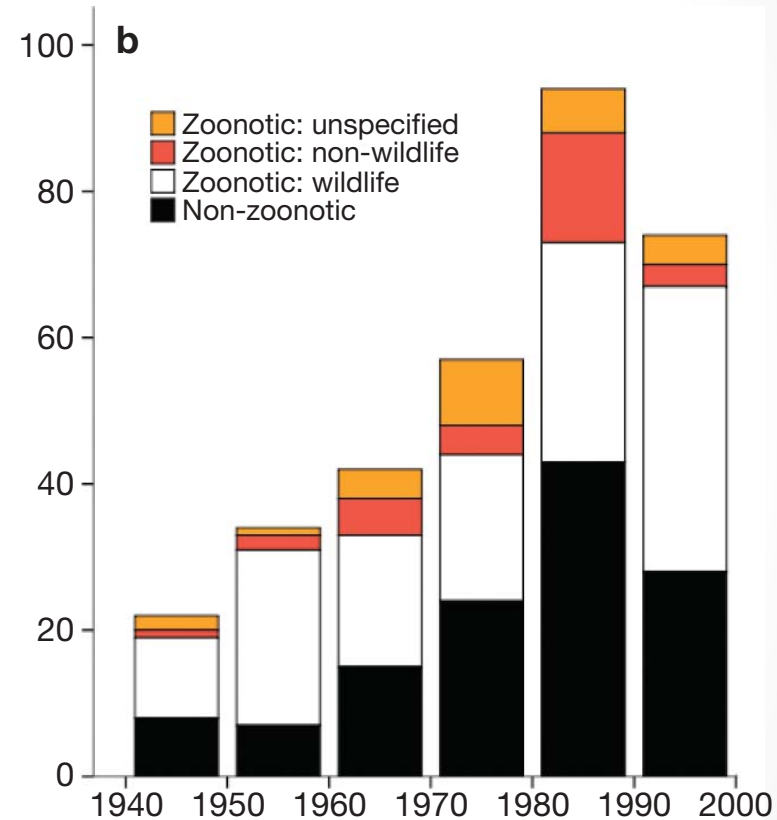
Interspecies movement!



Global trends in emerging infectious diseases

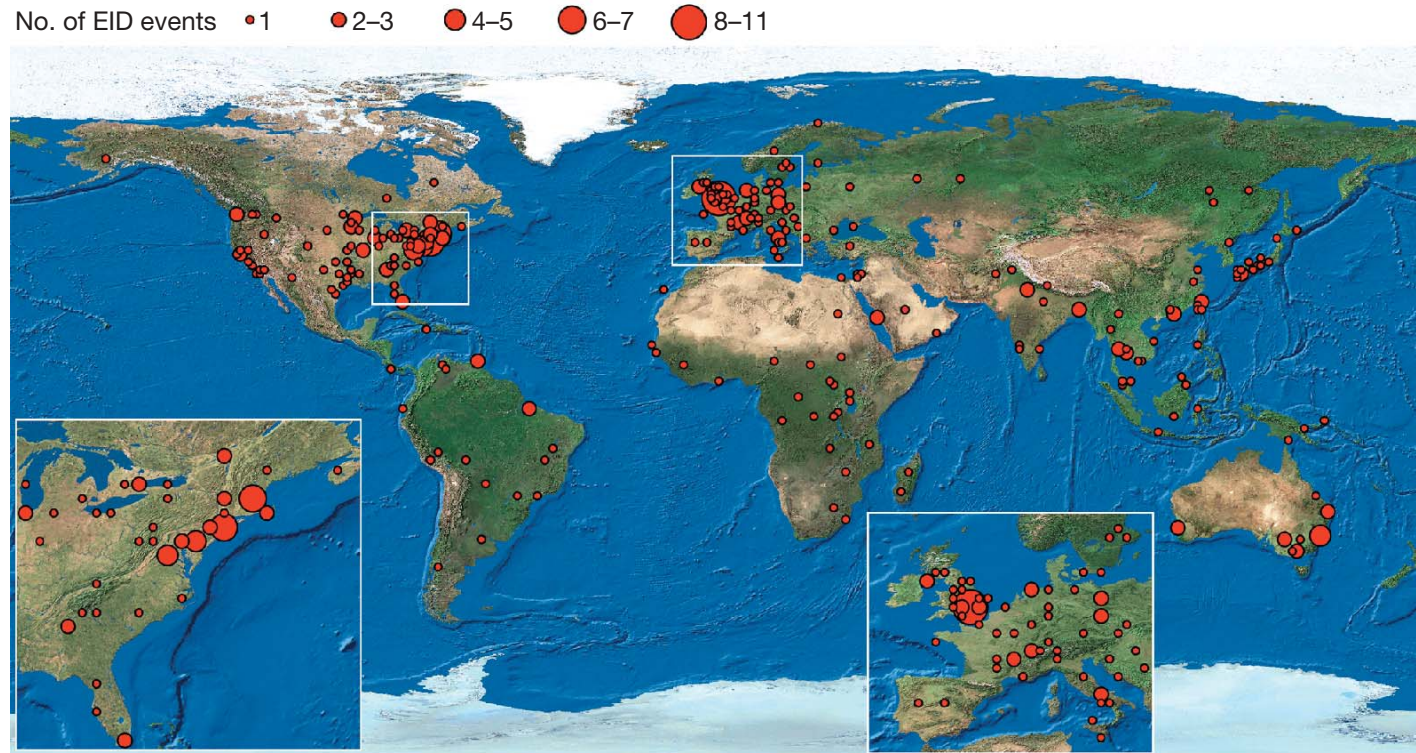
Kate E. Jones¹, Nikkita G. Patel², Marc A. Levy³, Adam Storeygard^{3†}, Deborah Balk^{3†}, John L. Gittleman⁴ & Peter Daszak²

Figure 1 | Number of EID events per decade. EID events (defined as the temporal origin of an EID, represented by the original case or cluster of cases that represents a disease emerging in the human population—see Methods) are plotted with respect to **a**, pathogen type, **b**, transmission type, **c**, drug resistance and **d**, transmission mode (see keys for details).

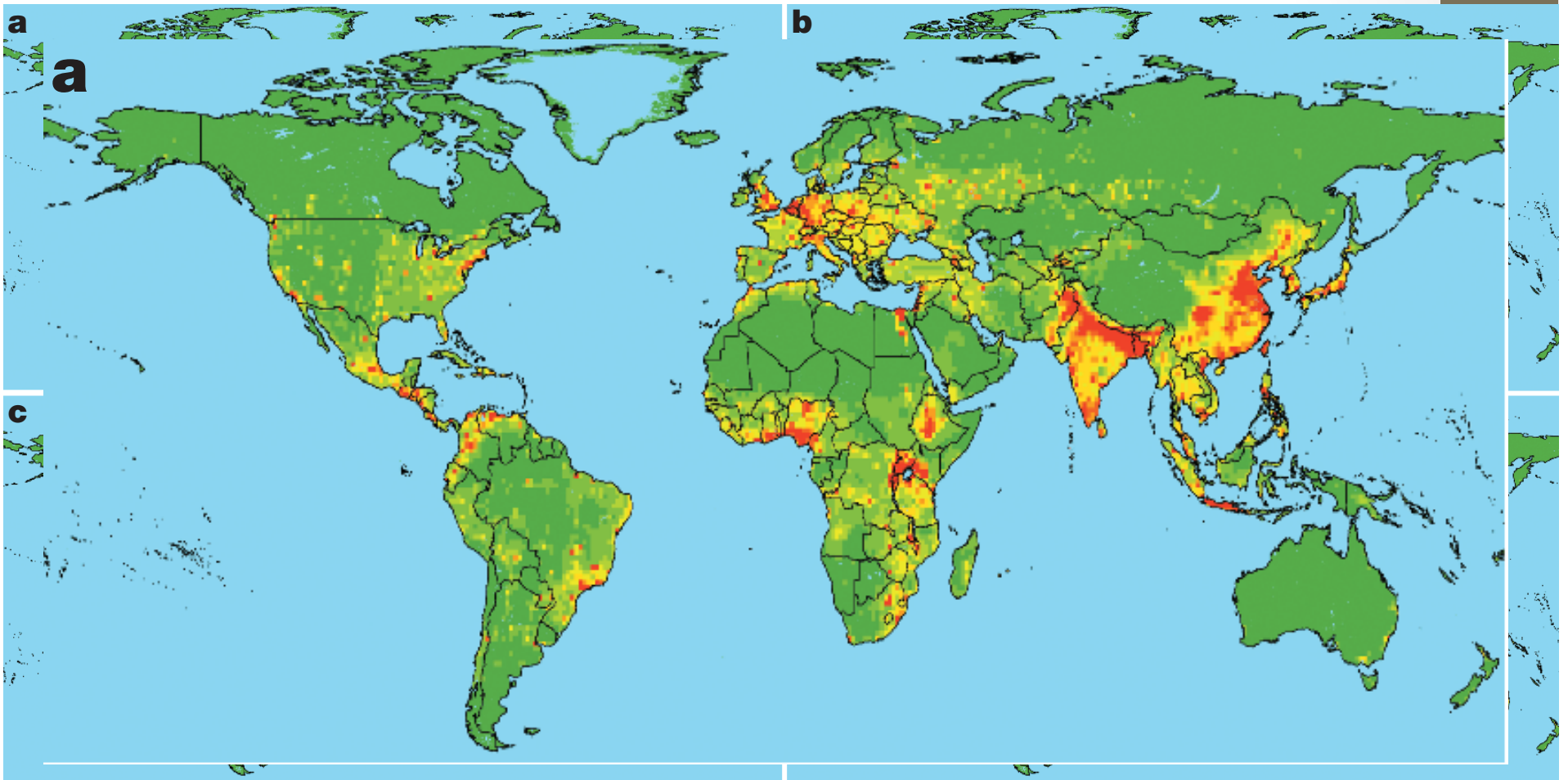


More interaction = more zoonoses?

- Why are we seeing more zoonoses now than ever before?
- Are there hot spots for zoonotic events?



Where is the Risk?



So what do we know now?

“EID events are dominated by zoonoses (60.3% of EIDs): the majority of these (71.8%) **originate in wildlife** (for example, severe acute respiratory virus, Ebola virus), and are **increasing significantly over time.**”

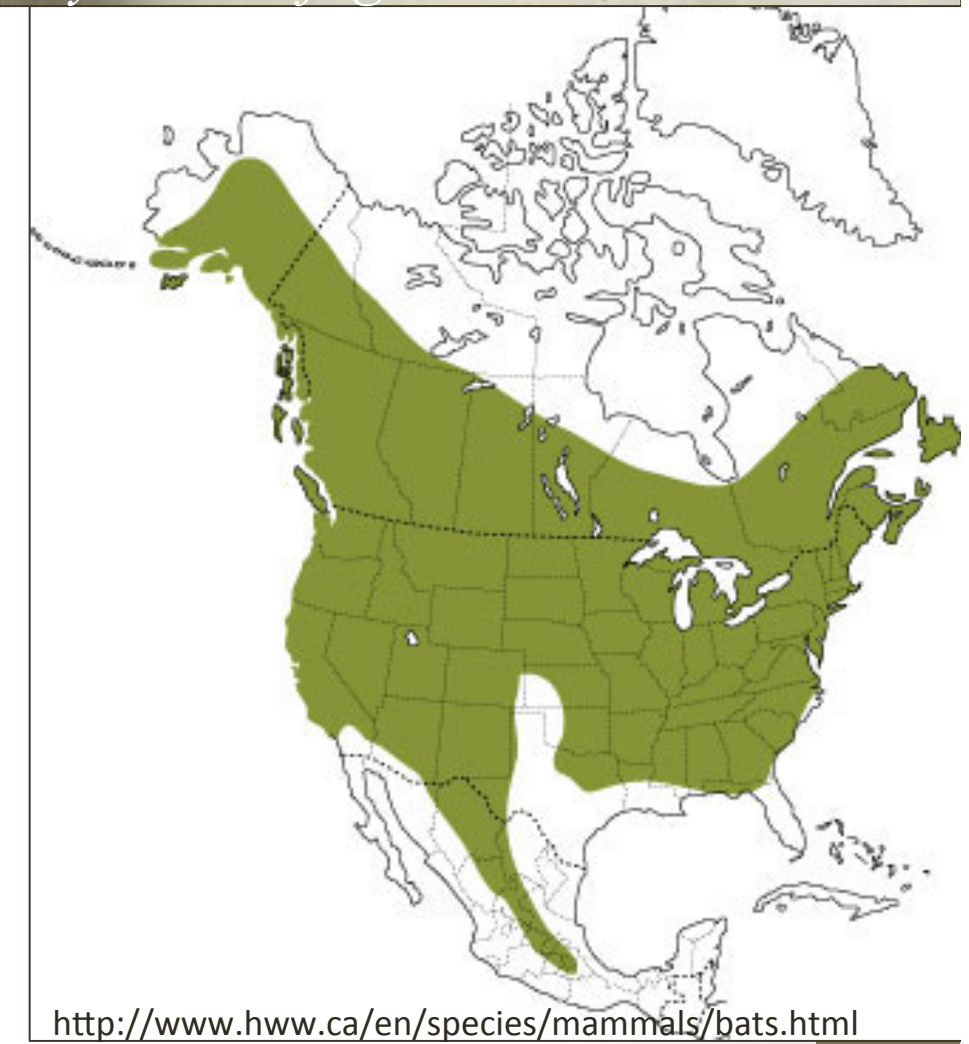
“EID origins are significantly correlated with socio-economic, environmental and ecological factors...”

Substantial number of zoonoses come from **Bats.**

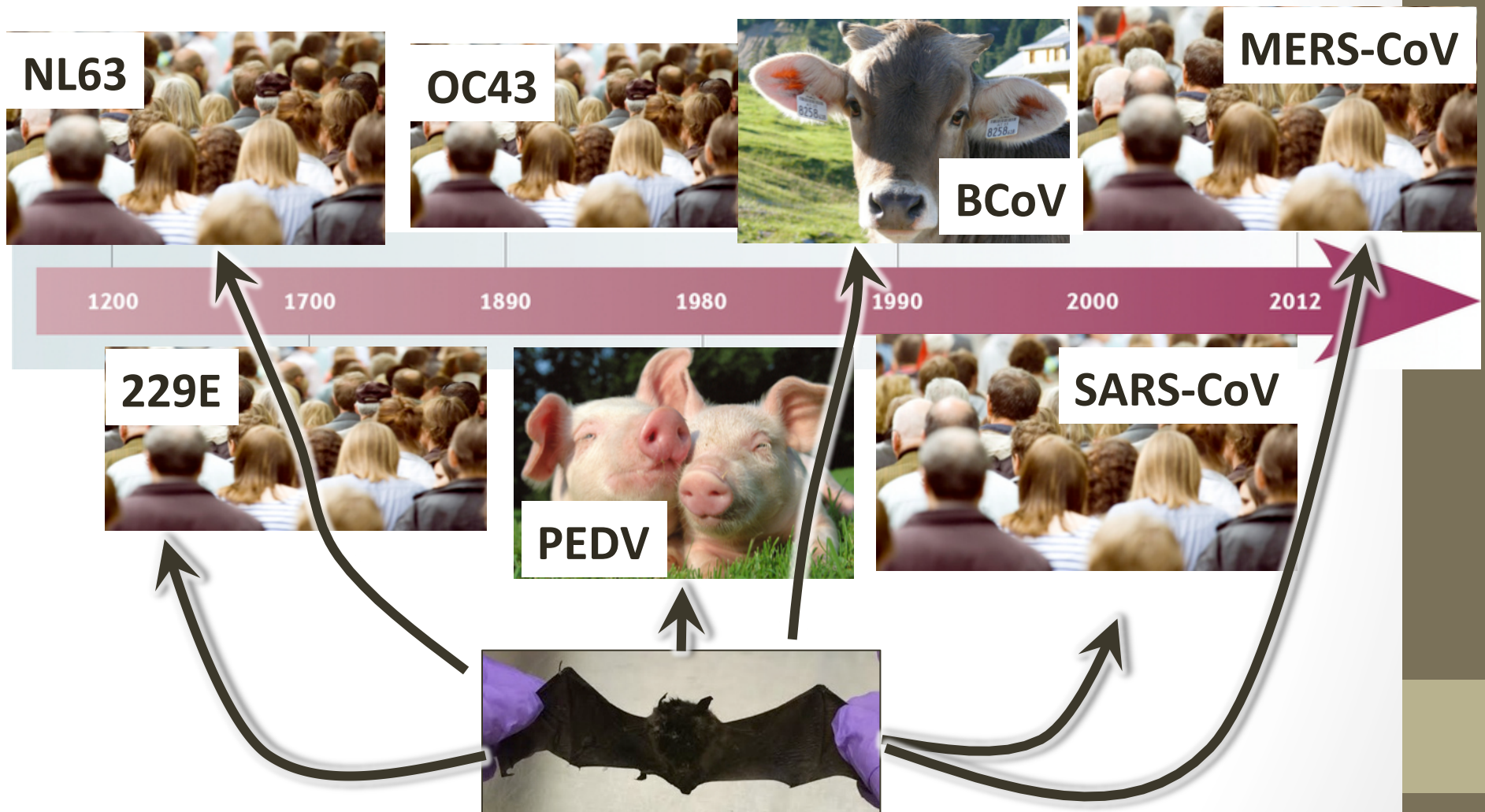
Why Bats?

- Flying mammal
- Ubiquitous
- Long-lived and High survivability
- 20% of all known mammal species
- Close association with humans
- Highly active immune system

Excellent Reservoir Host



Coronavirus Host Jumps

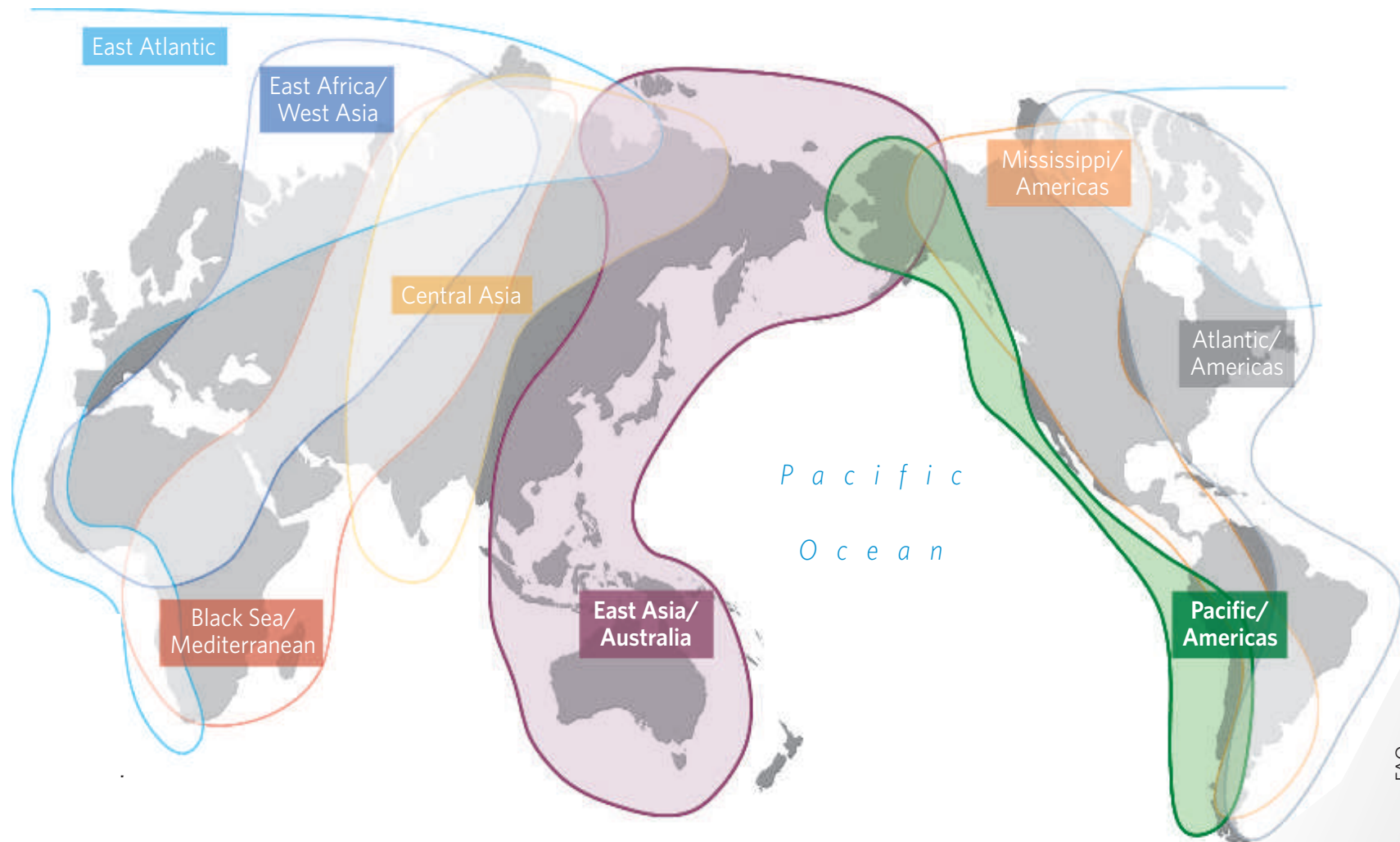


Graham and Baric. Nature Reviews Microbiology. 11, 836–848 (2013)

Virus Jumping in Alaska?



Adaptations happen where populations mix





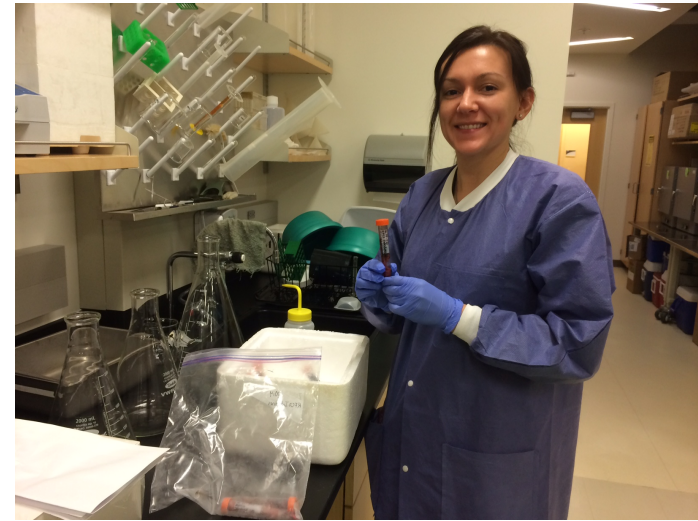
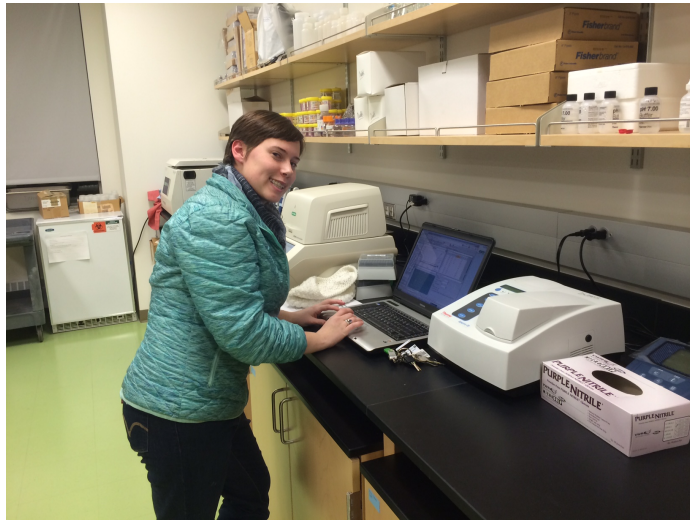
Alaskan Bats – *Myotis lucifugus*



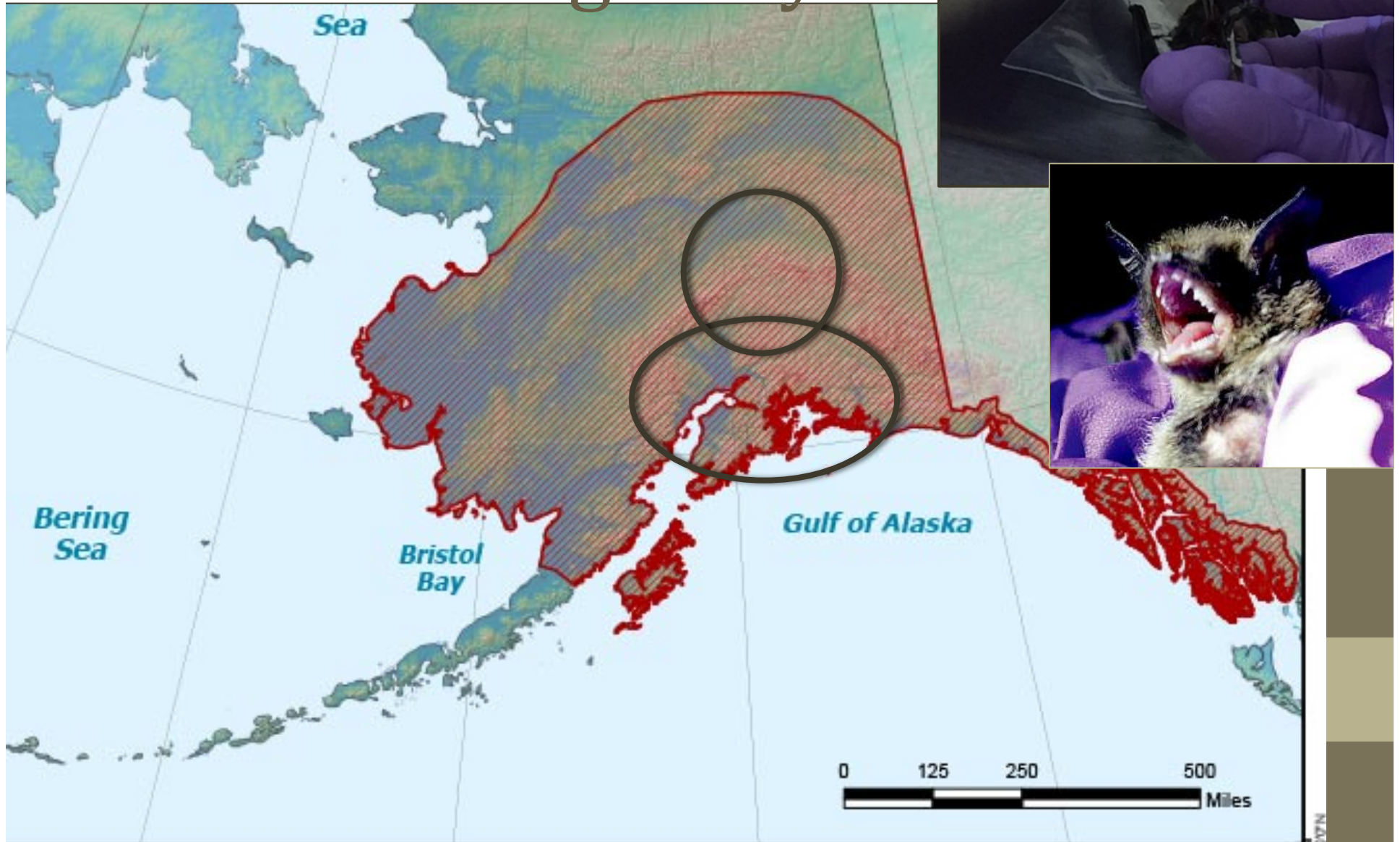
Photo: Gabor Csorba, HNHM

What does this mean in AK?

- Viral distribution in host species populations.
 - Insectivorous Bat populations



Samples from all across Alaska are being analyzed



Thanks:

Undergraduate
Students:

- Maegan Lange
- Melanie Wright
- Nathaneal Ray

Office of Undergraduate
Research and
Scholarship

Questions

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Chugach
 - Jessica Iles
- Alaska Department of
Fish and Game
 - Marian Snively
 - Dave Tessler