

MAPS



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DI PADOVA

# Epidemiologia ed evoluzione di PCV2: un vecchio, nuovo virus

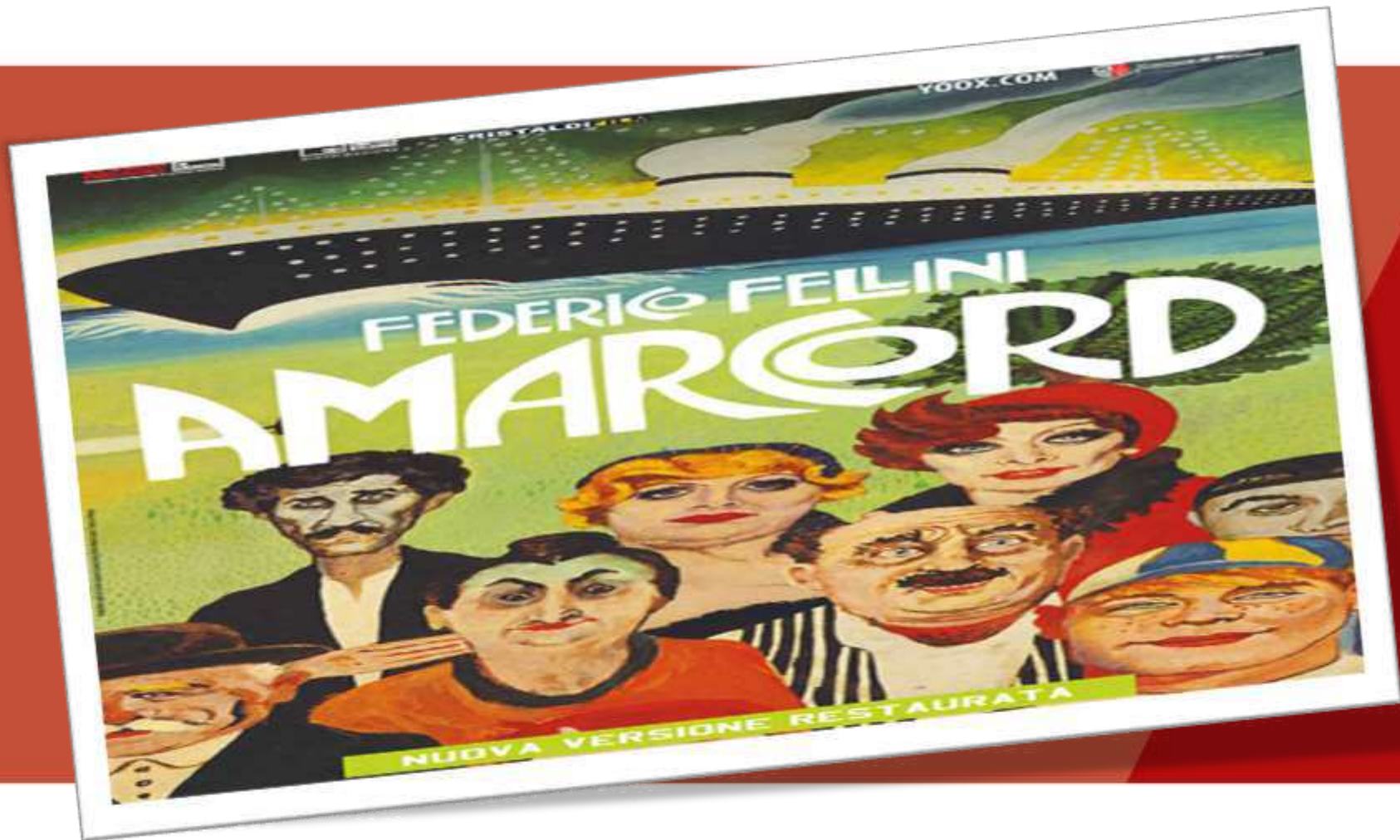
Giovanni Franzo

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XLVIII Meeting annuale SIPAS, Pescantina (VR) 30/31 Marzo 2023







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10722-538X/10/\$12.00 doi:10.1128/JVI.01789-10  
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# Sequences from Ancestral Single-Stranded DNA Viruses in Vertebrate Genomes: the *Parvoviridae* and *Circoviridae* Are More than 40 to 50 Million Years Old<sup>†</sup>

Vladimir A. Belyi,<sup>1</sup> Arnold J. Levine,<sup>1\*</sup> and Anna Marie Skalka<sup>2\*</sup>

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Genus: <i>Circovirus</i>	Species: <i>Circovirus</i>	0
Species: <i>Canine circovirus</i>	Genus: <i>Circovirus</i>	0
Species: <i>Canine associated circovirus 1</i>	Genus: <i>Circovirus</i>	0
Species: <i>Canine associated circovirus 2</i>	Genus: <i>Circovirus</i>	0
Species: <i>Canine associated circovirus 3</i>	Genus: <i>Circovirus</i>	0
Species: <i>Canine associated circovirus 4</i>	Genus: <i>Circovirus</i>	0
Species: <i>Canine associated circovirus 5</i>	Genus: <i>Circovirus</i>	0
Species: <i>Canine associated circovirus 6</i>	Genus: <i>Circovirus</i>	0
Species: <i>Canine associated circovirus 7</i>	Genus: <i>Circovirus</i>	0
Species: <i>Canine associated circovirus 8</i>	Genus: <i>Circovirus</i>	0
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Species: <i>Canine associated circovirus 12</i>	Genus: <i>Circovirus</i>	0
Species: <i>Canine associated circovirus 13</i>	Genus: <i>Circovirus</i>	0
Species: <i>Deer and bawler shaker virus</i>	Genus: <i>Circovirus</i>	0
Species: <i>Deer circovirus</i>	Genus: <i>Circovirus</i>	0
Species: <i>Canary circovirus</i>	Genus: <i>Circovirus</i>	0
Species: <i>Canine circovirus</i>	Genus: <i>Circovirus</i>	0
Species: <i>Chimpanzee associated circovirus 1</i>	Genus: <i>Circovirus</i>	0
Species: <i>Civet circovirus</i>	Genus: <i>Circovirus</i>	0
Species: <i>Duck circovirus</i>	Genus: <i>Circovirus</i>	0
Species: <i>Dik circovirus</i>	Genus: <i>Circovirus</i>	0
Species: <i>Zungaro zaffar circovirus</i>	Genus: <i>Circovirus</i>	0
Species: <i>Fish circovirus</i>	Genus: <i>Circovirus</i>	0
Species: <i>Ginea circovirus</i>	Genus: <i>Circovirus</i>	0
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Species: <i>Porcine circovirus 1</i>	Genus: <i>Circovirus</i>	0
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Species: <i>Porcine circovirus 3</i>	Genus: <i>Circovirus</i>	0
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Species: <i>Robert associated circovirus 1</i>	Genus: <i>Circovirus</i>	0
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Species: <i>Robert associated circovirus 6</i>	Genus: <i>Circovirus</i>	0
Species: <i>Robert associated circovirus 7</i>	Genus: <i>Circovirus</i>	0
Species: <i>Starling circovirus</i>	Genus: <i>Circovirus</i>	0
Species: <i>Swan circovirus</i>	Genus: <i>Circovirus</i>	0
Species: <i>Tek associated circovirus 1</i>	Genus: <i>Circovirus</i>	0
Species: <i>Tek associated circovirus 2</i>	Genus: <i>Circovirus</i>	0
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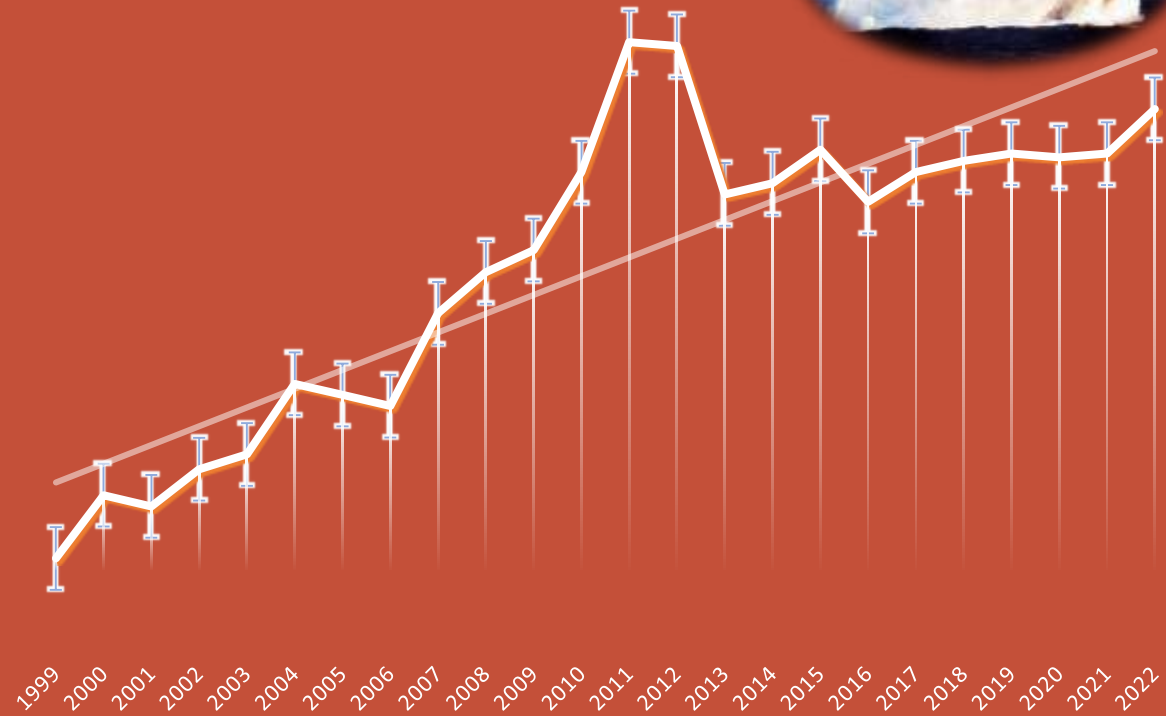
Species: *Porcine circovirus 1* Genus: *Circovirus*

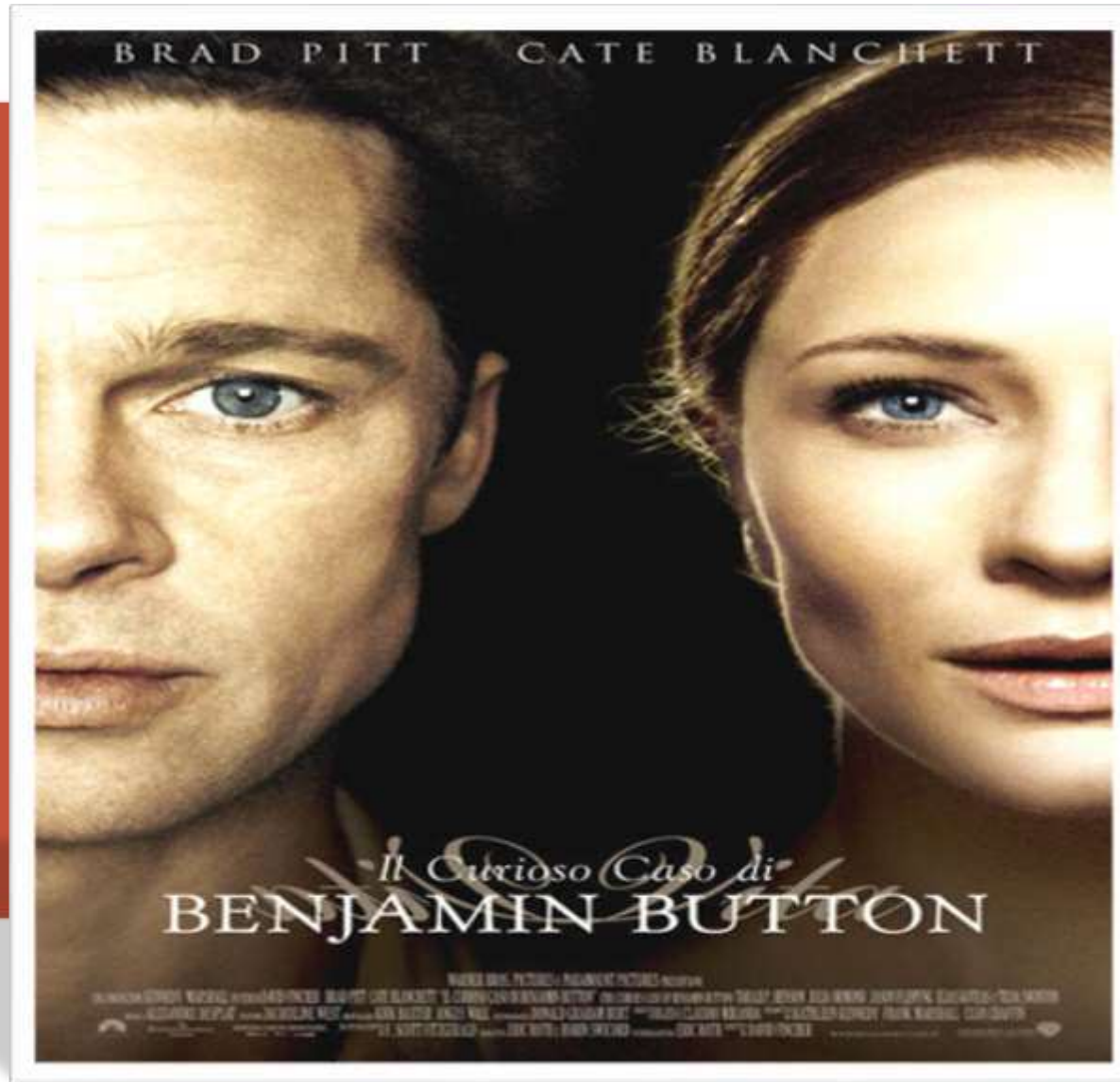
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Species: *Porcine circovirus 3* Genus: *Circovirus*

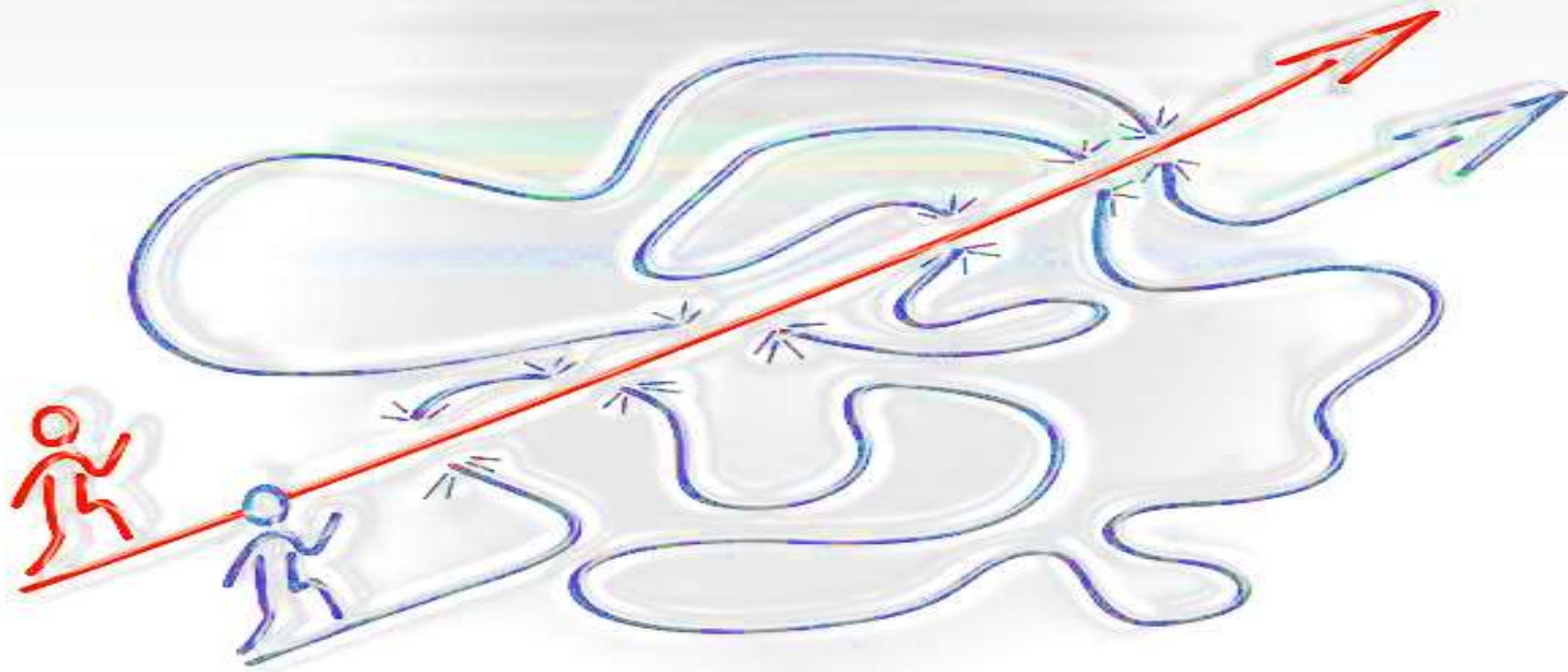
Species: *Porcine circovirus 4* Genus: *Circovirus*

PUBBLICAZIONI



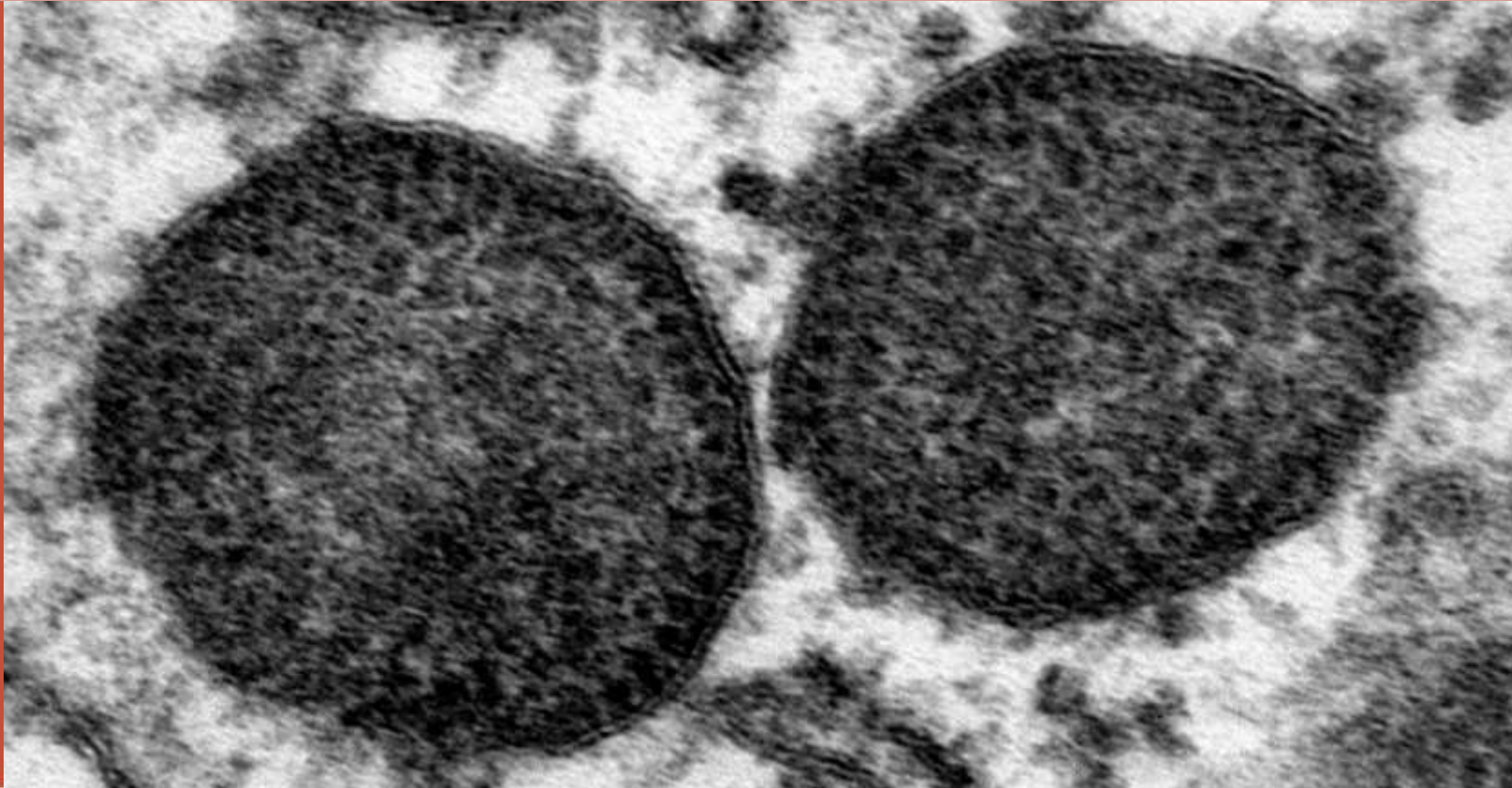


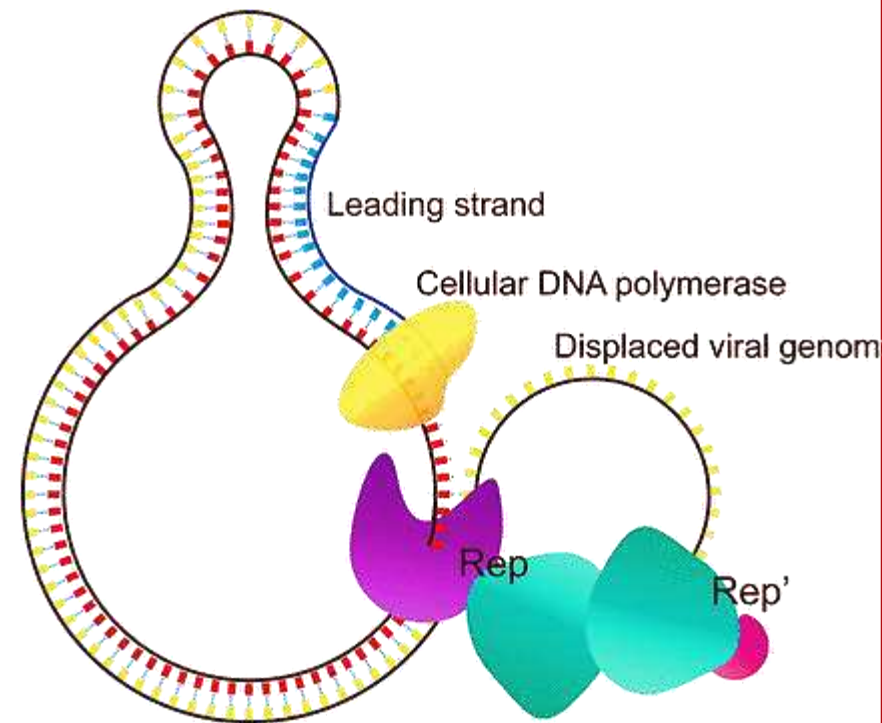
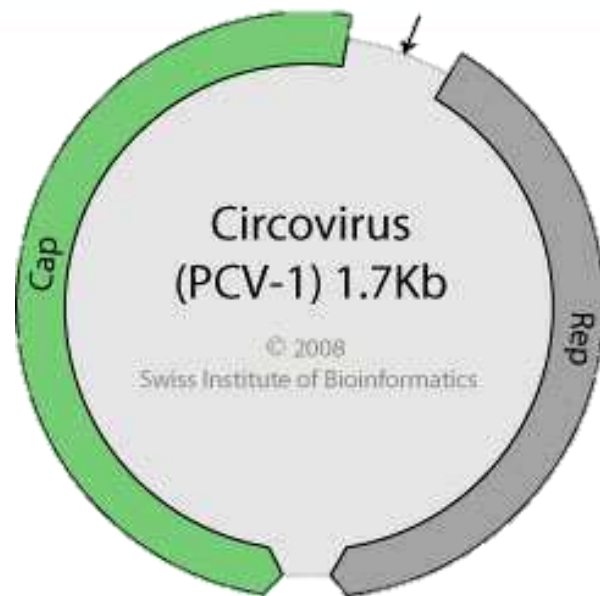
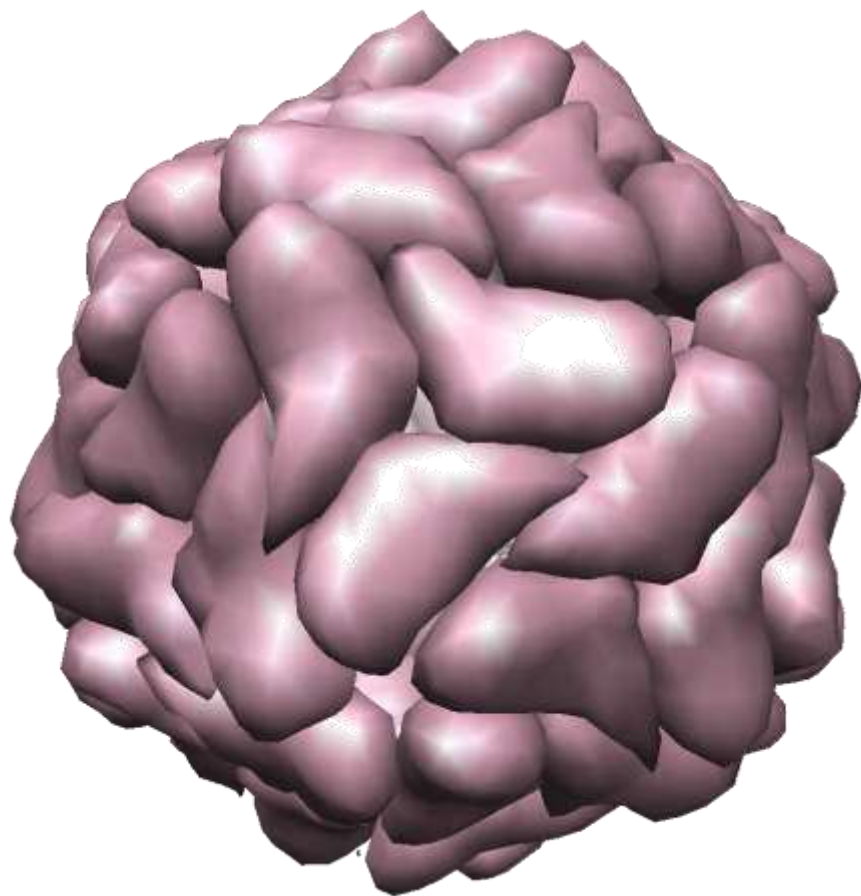


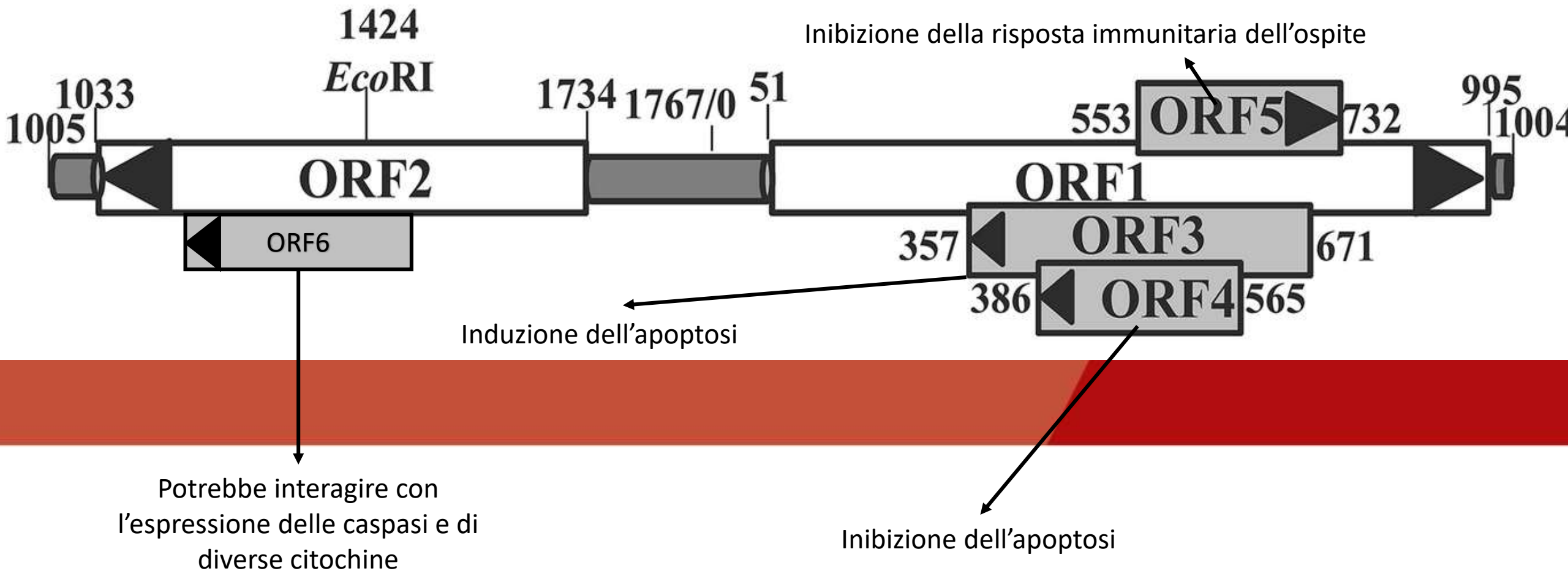


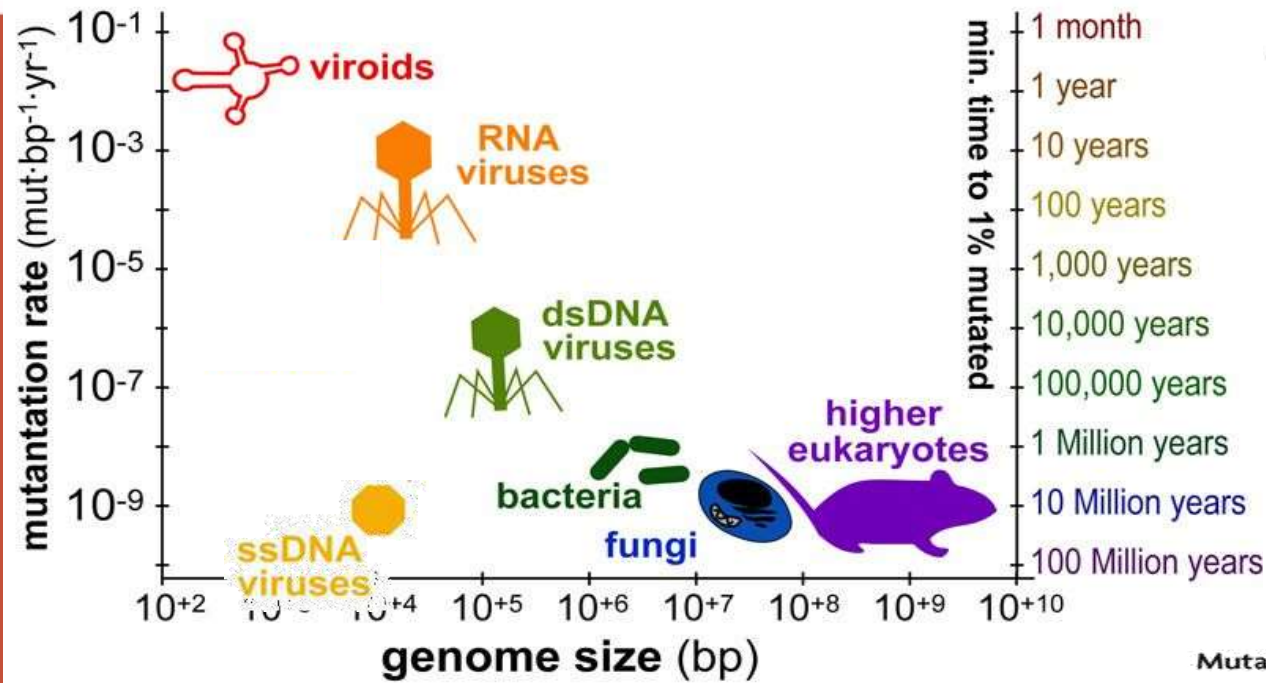


# Il virus

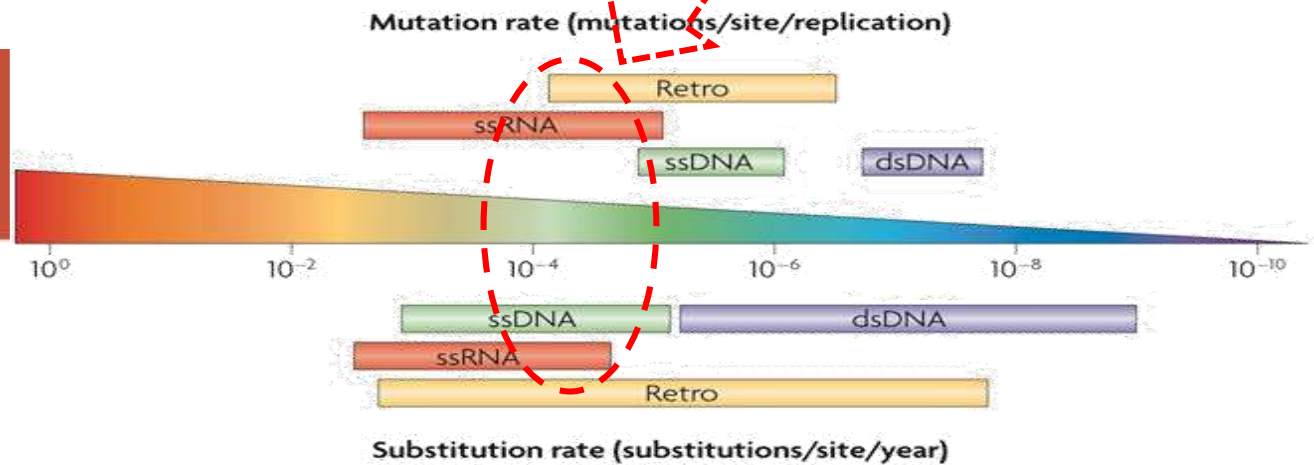








Genotype	tMRCA (95%HPD)	Gene	Substitution per site per year (95%HPD)
PCV2a	1964 (1948–1974)	ORF1	$5.45 \times 10^{-4}$ ( $3.69 \times 10^{-4} - 7.21 \times 10^{-4}$ )
		ORF2	$1.59 \times 10^{-3}$ ( $9.8 \times 10^{-4} - 2.31 \times 10^{-3}$ )
		Intergenic	$3.31 \times 10^{-4}$ ( $3.18 \times 10^{-4} - 5.16 \times 10^{-4}$ )
PCV2b	1973 (1952–1996)	ORF1	$3.12 \times 10^{-4}$ ( $1.23 \times 10^{-4} - 4.87 \times 10^{-4}$ )
		ORF2	$3.88 \times 10^{-4}$ ( $1.6 \times 10^{-4} - 5.95 \times 10^{-4}$ )
		Intergenic	$3.05 \times 10^{-4}$ ( $1.18 \times 10^{-4} - 4.97 \times 10^{-4}$ )
PCV2d	1958 (1935–1979)	ORF1	$4.89 \times 10^{-4}$ ( $3.41 \times 10^{-4} - 6.53 \times 10^{-4}$ )
		ORF2	$6.22 \times 10^{-4}$ ( $4.47 \times 10^{-4} - 7.94 \times 10^{-4}$ )
		Intergenic	$3.3 \times 10^{-4}$





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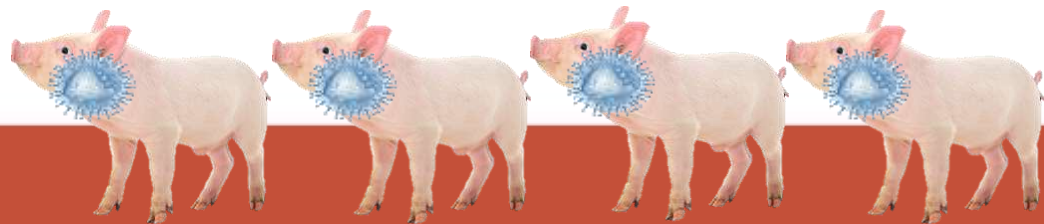
Porcine circovirus 2 (PCV-2) genetic variability under natural infection scenario reveals a complex network of viral quasispecies

Florencia Correa-Fiz<sup>1</sup>, Giovanni Frenzo<sup>2</sup>, Anna Lorente<sup>3</sup>, Joaquín Segalés<sup>1,2,4</sup> & Tuji K. Karaiman<sup>1,4\*</sup>

«Dentro» il maiale!

# MAPS

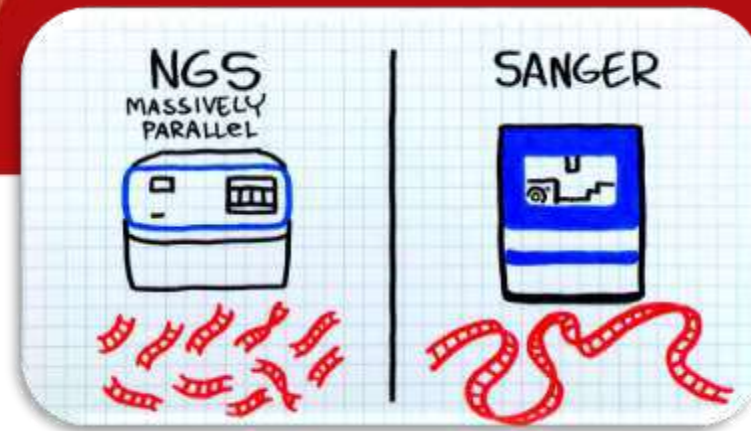
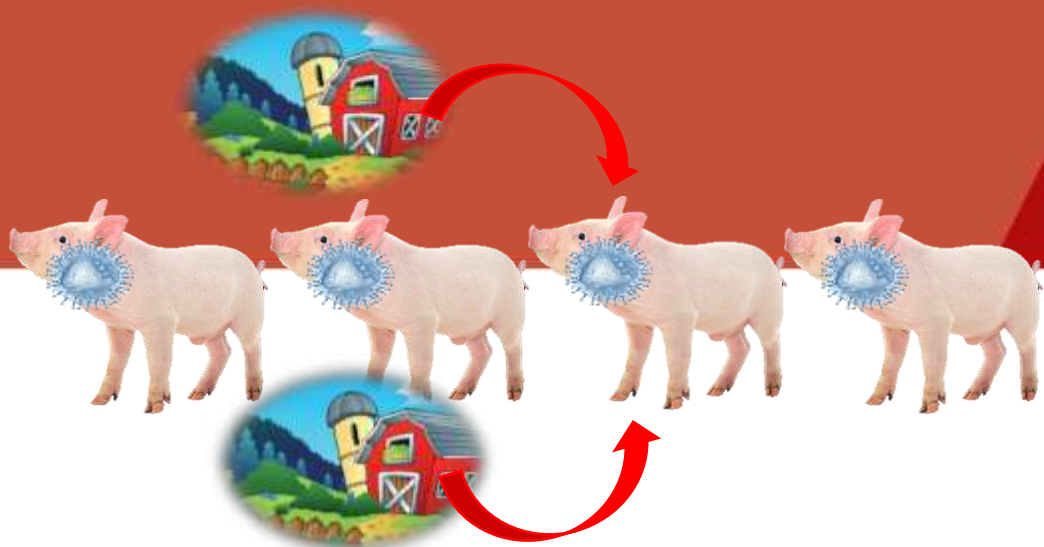
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B



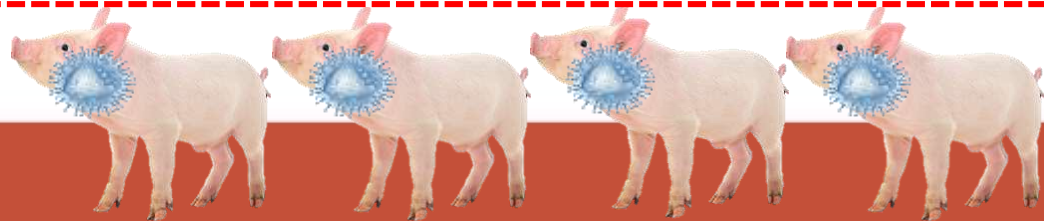
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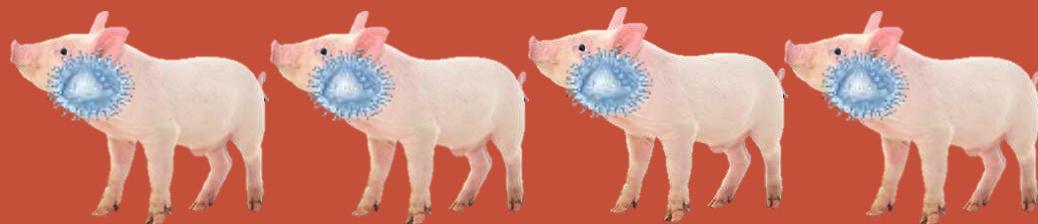


# MAPS

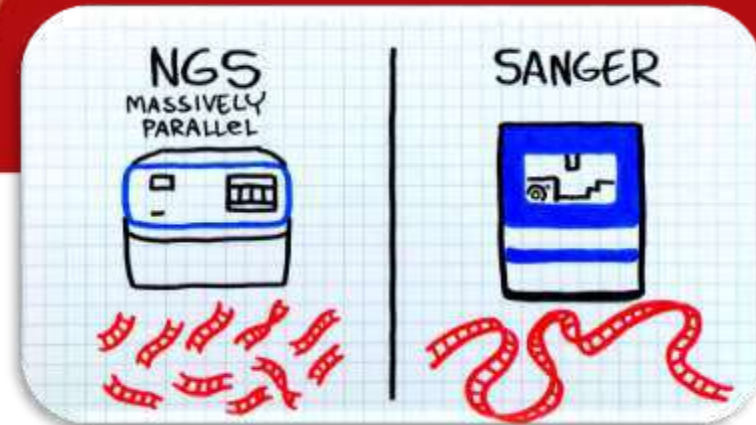
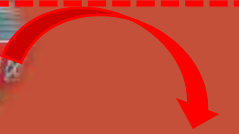
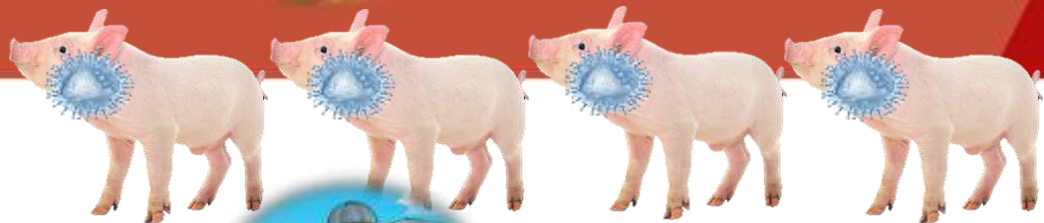
A



B



C



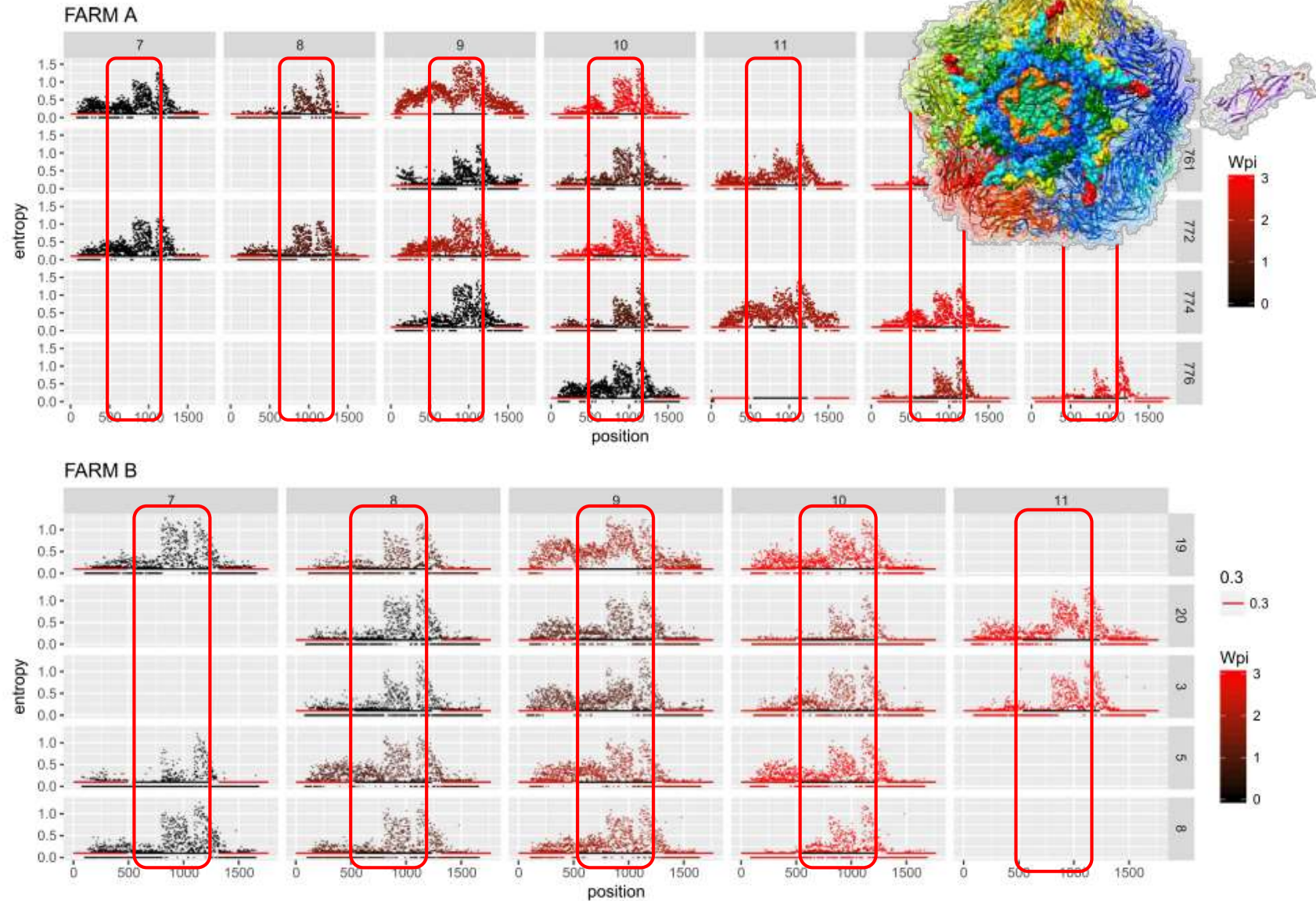
## PCV-2a

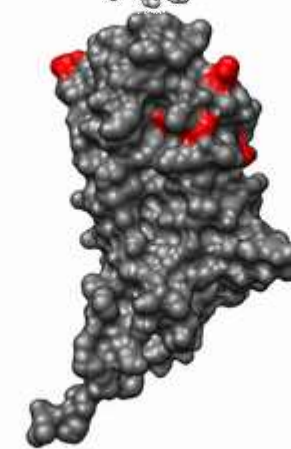
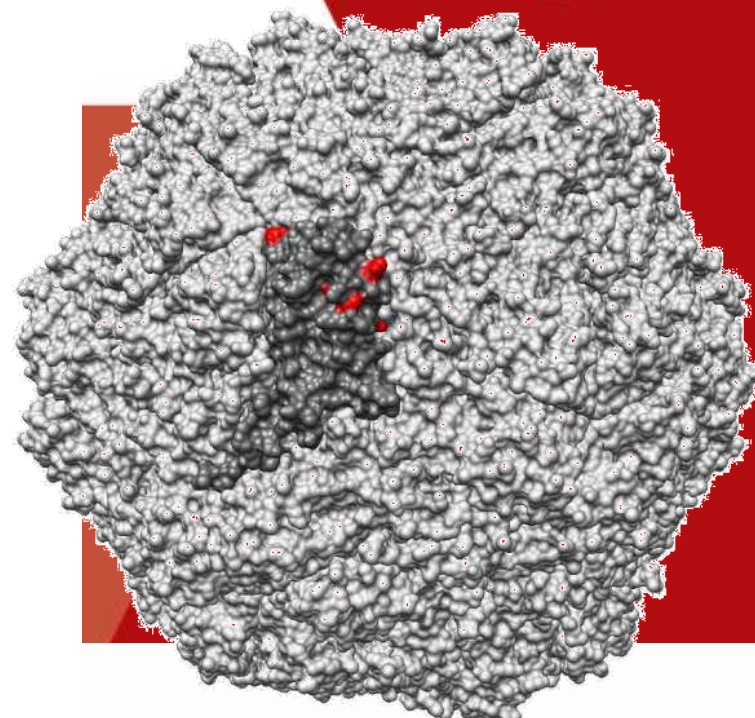
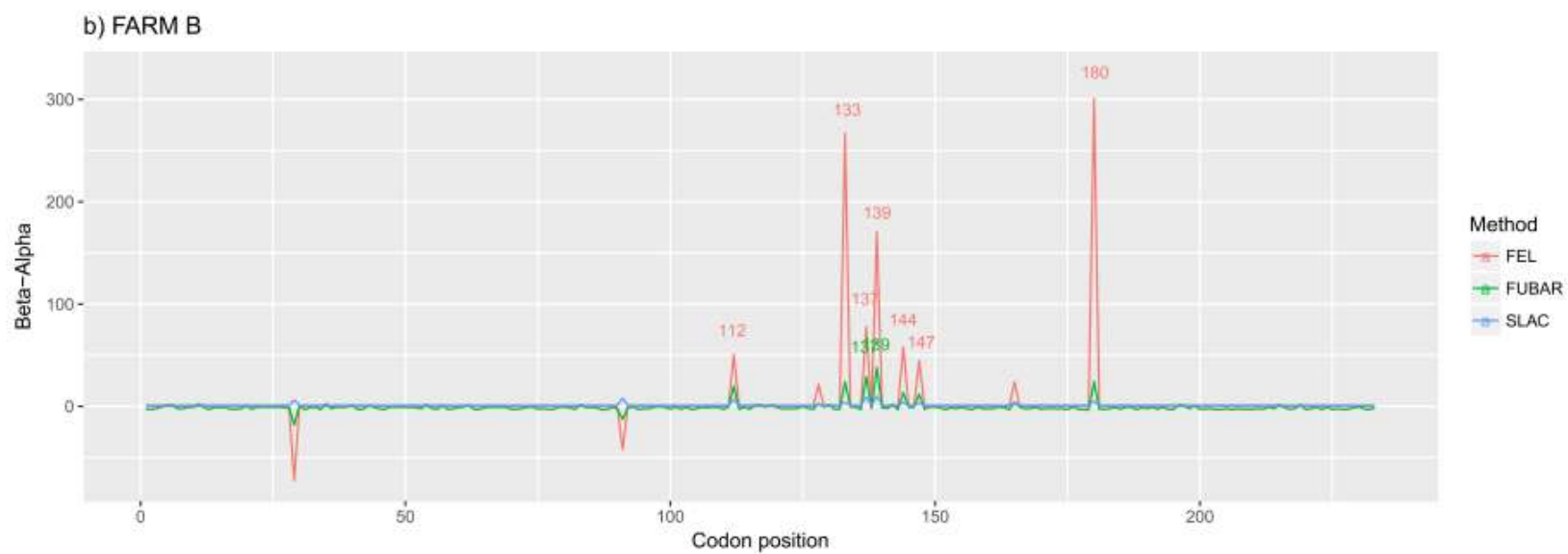
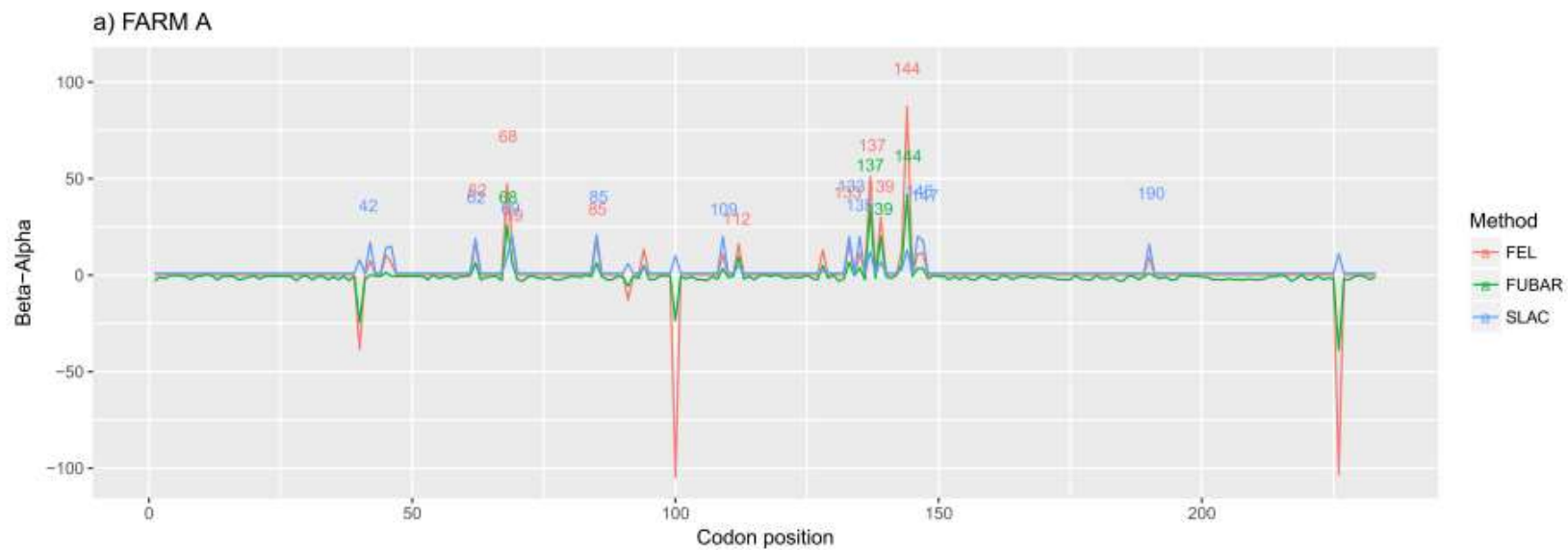
Valutata entropia per ogni  
posizione del genoma



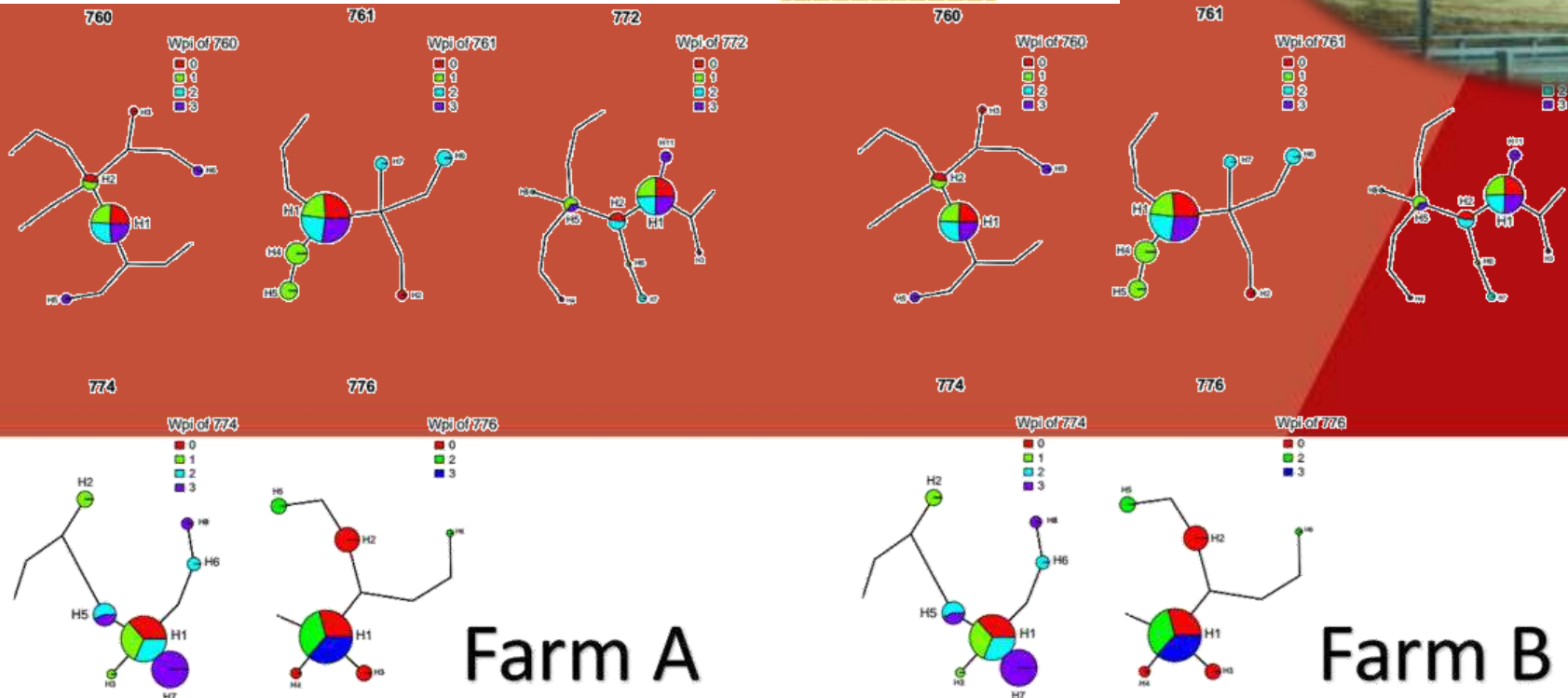
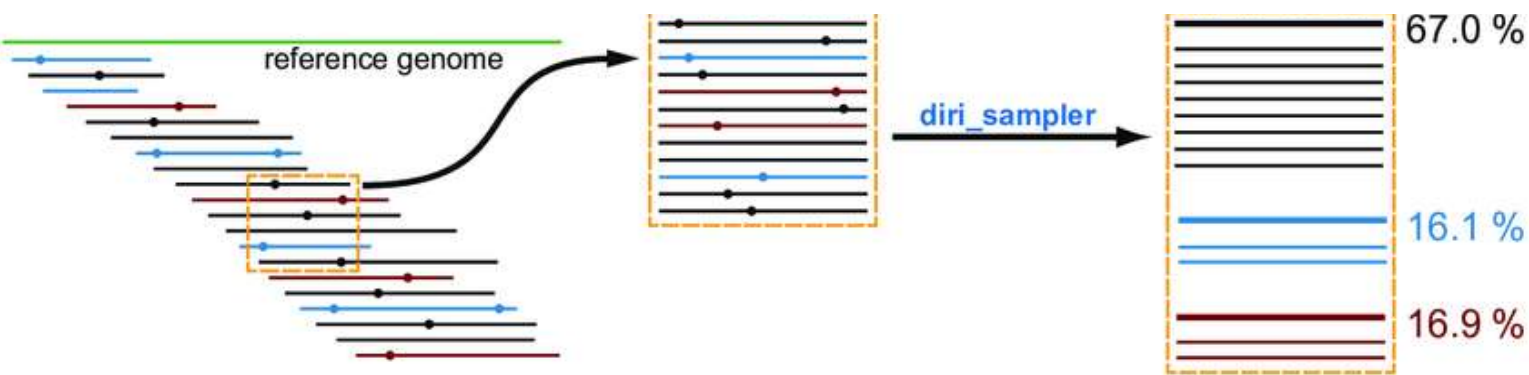
Definisce il grado di  
«disordine» di un sistema

Più è alta maggiore è la  
variabilità della popolazione  
virale in quella posizione

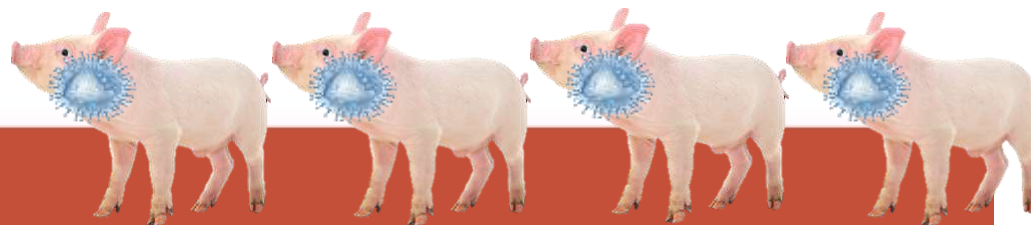




# Ricostruzione degli aplotipi virali



A

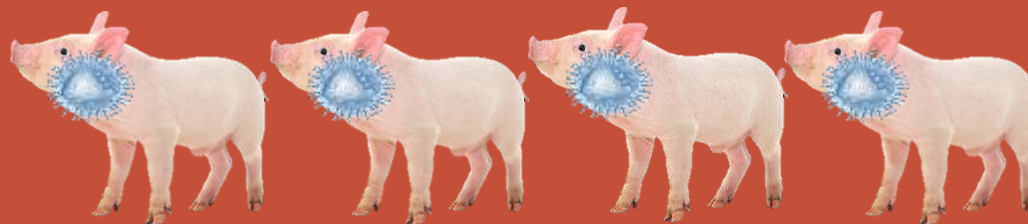


**OPEN** Porcine circovirus 2 (PCV-2) genetic variability under natural infection scenario reveals a complex network of viral quasispecies

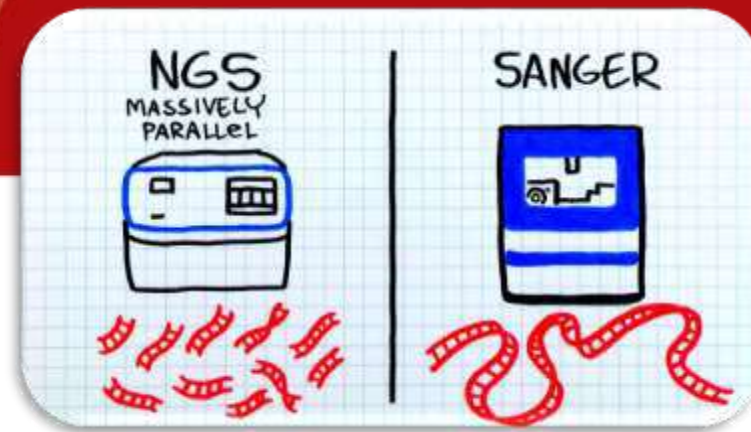
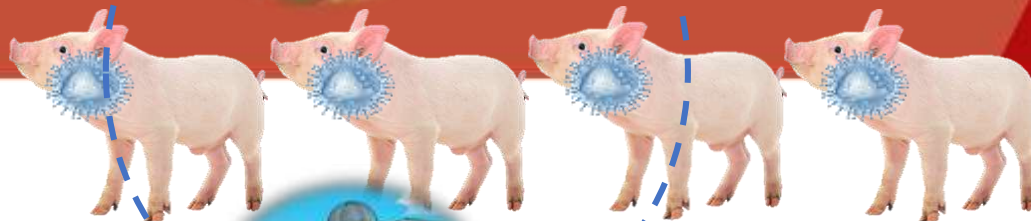
Received: 6 July 2018  
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Published online: 19 October 2018


Florencia Correa-Fiz<sup>1</sup>, Giovanni Franzo<sup>1</sup>, Anna Llorens<sup>1</sup>, Joaquim Segalés<sup>1,2</sup> & Tuja Kekkarainen<sup>1,4</sup>

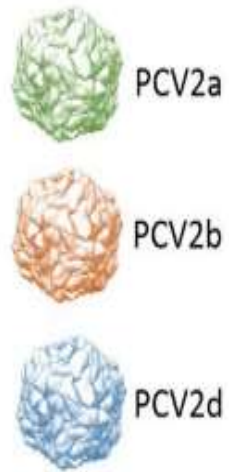
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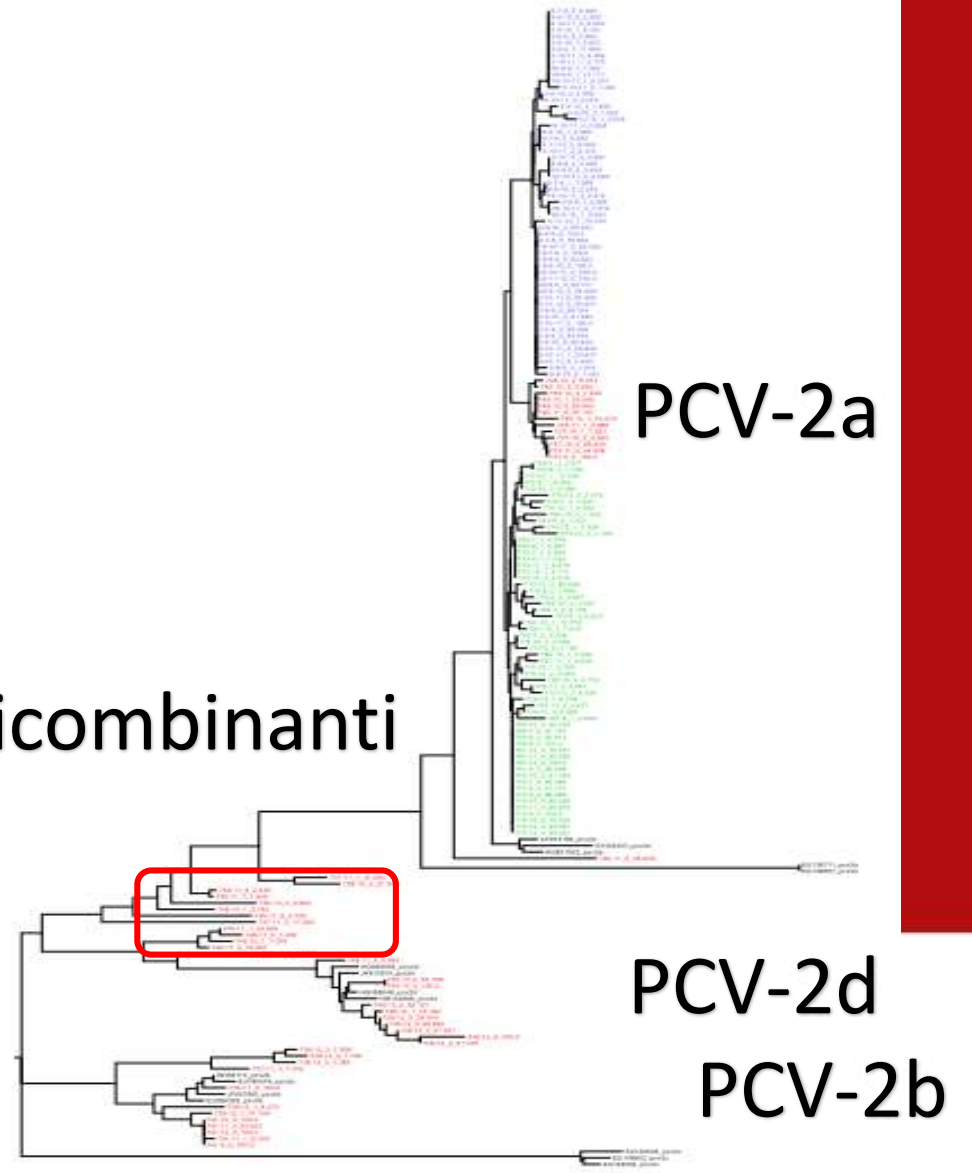
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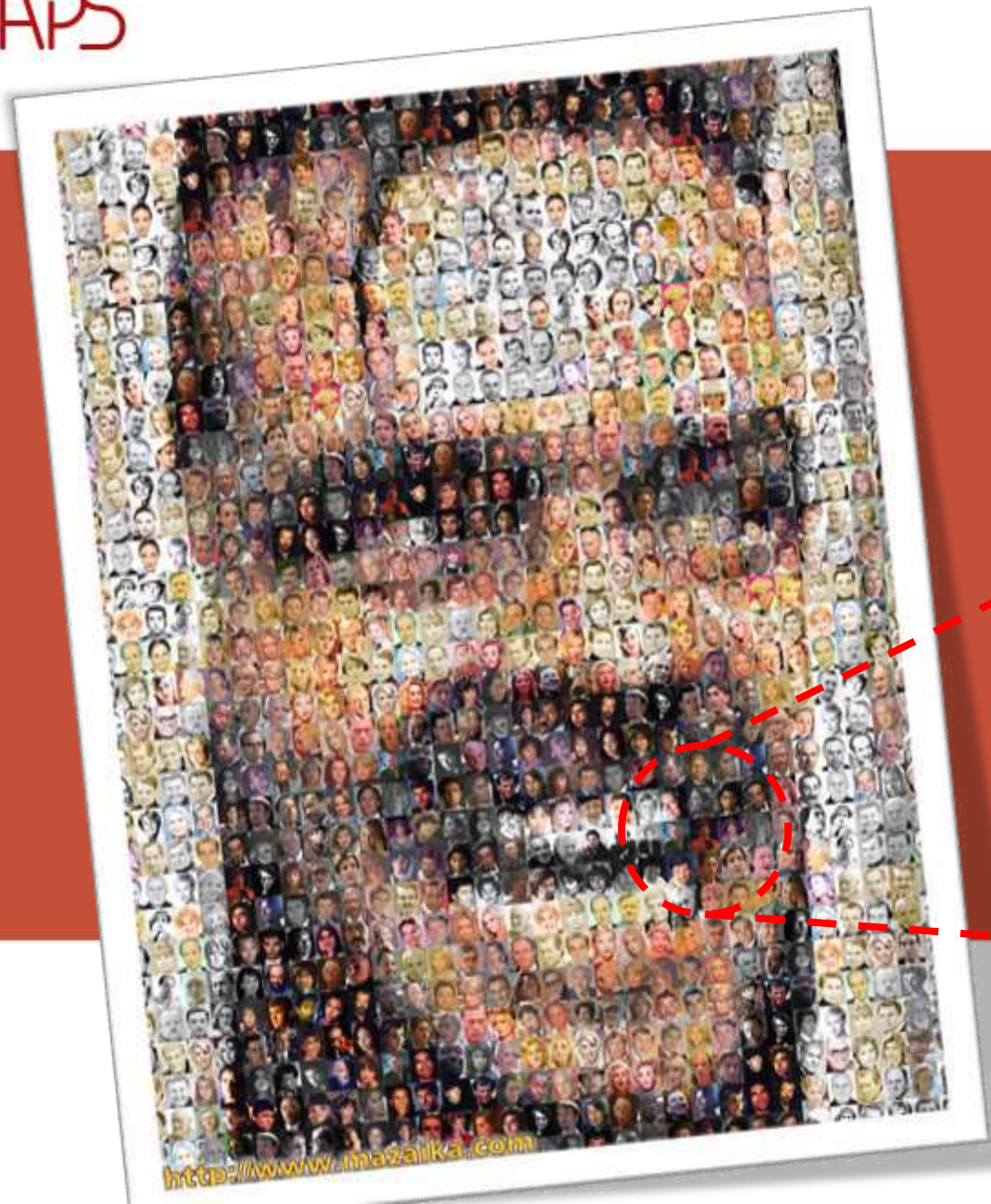
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741						
745						
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Ricombinanti

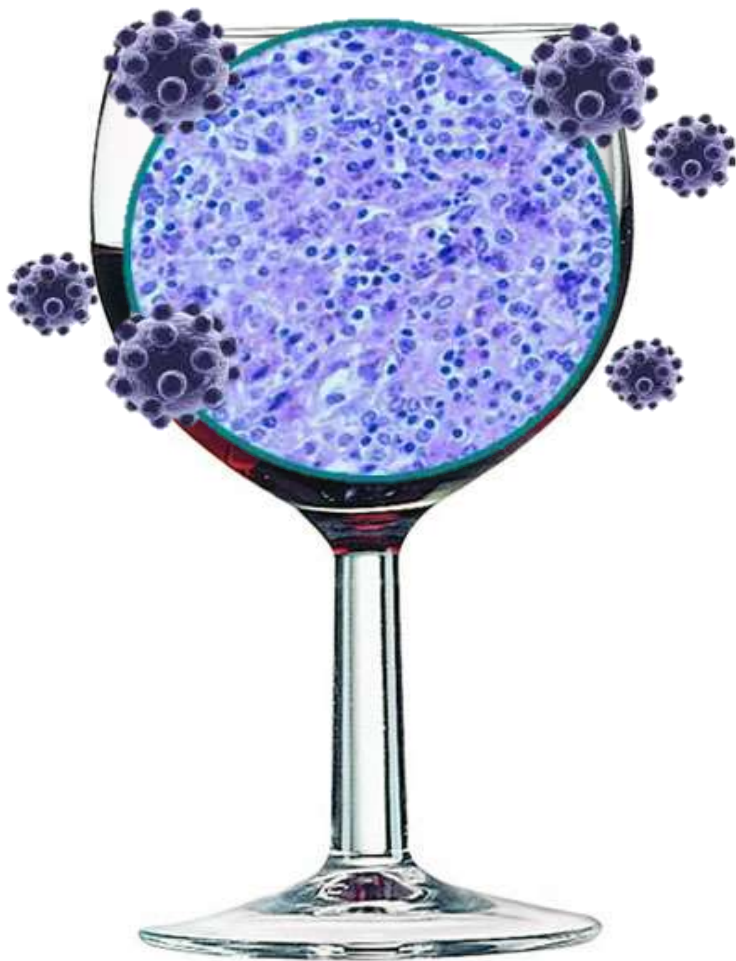




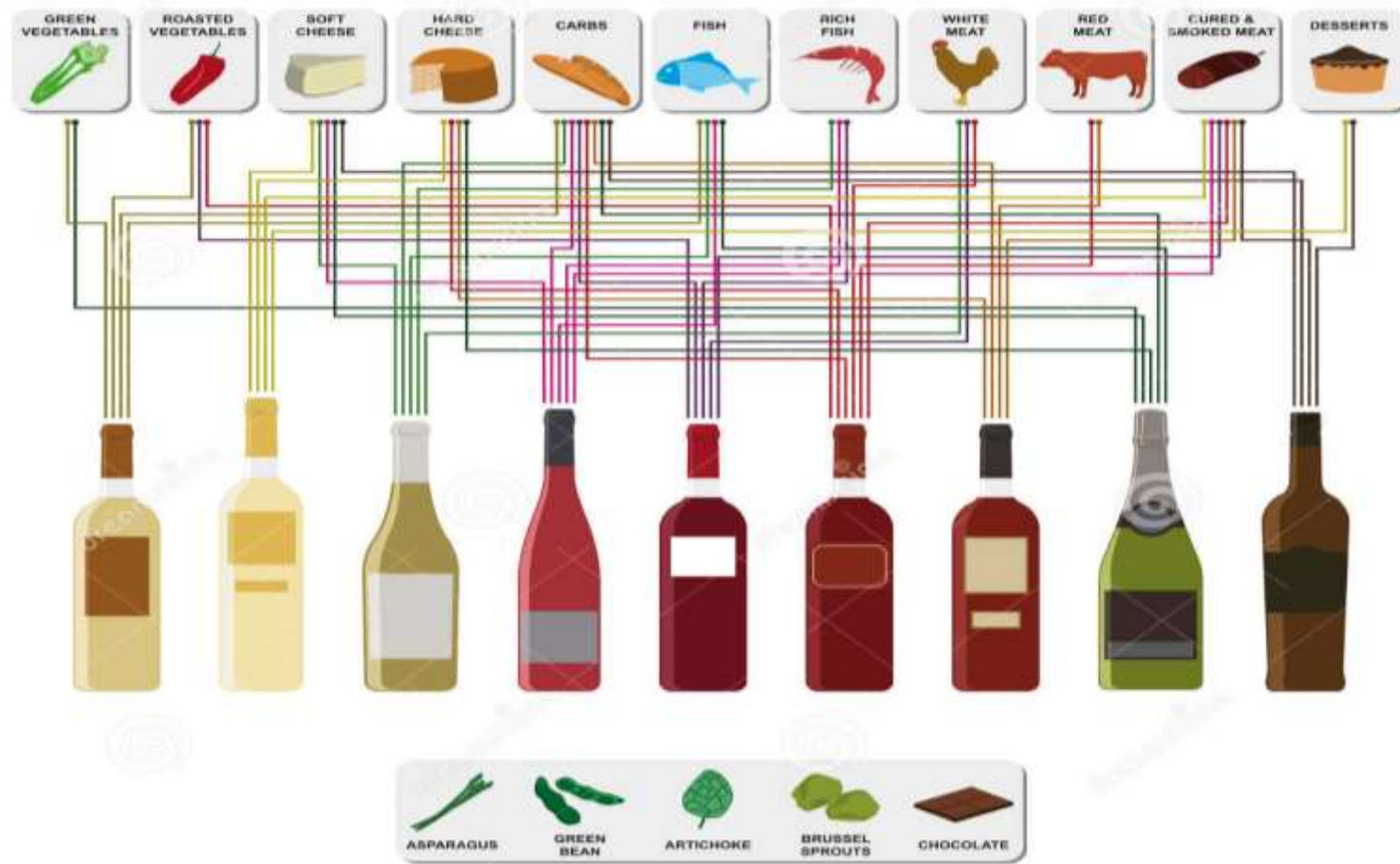








## PAIRING WINE & FOOD



FOODS THAT ARE HARD TO PAIR WITH WINE



# Genotipizzazione



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Veterinary Microbiology 128 (2008) 23–35

veterinary  
microbiology  
[www.elsevier.com/locate/vetmic](http://www.elsevier.com/locate/vetmic)

Franzo *et al. Virology Journal* (2015) 12:131  
DOI 10.1186/s12985-015-0361-x



RESEARCH Open Access



A proposal on porcine circovirus type 2 (PCV2) genotype definition and their relation with postweaning multisystemic wasting syndrome (PMWS) occurrence

L. Grau-Roma<sup>a,b,\*</sup>, E. Crisci<sup>a</sup>, M. Sibila<sup>a</sup>, S. López-Soria<sup>a</sup>, M. Nofrarias<sup>a</sup>,  
M. Cortey<sup>c</sup>, L. Fraile<sup>a</sup>, A. Olvera<sup>a</sup>, J. Segalés<sup>a,b</sup>

<sup>a</sup>Centre de Recerca en Sanitat animal (CRESA), Esfera Universitat Autònoma de Barcelona (UAB), Bellaterra 08193, Spain  
<sup>b</sup>Departament de Sanitat i d'Anatomia Animals, Facultat de Veterinària, Universitat Autònoma de Barcelona (UAB), Bellaterra 08193, Spain  
<sup>c</sup>Bofill i Codina 14, Calella de P. Girona, 17210, Spain

## Revisiting the taxonomical classification of Porcine Circovirus type 2 (PCV2): still a real challenge

Giovanni Franzo<sup>1†</sup>, Martí Cortey<sup>2†</sup>, Alex Olvera<sup>3</sup>, Dinko Novosel<sup>4</sup>, Alessandra Marnie Martins Gomes De Castro<sup>5</sup>, Philippe Biagini<sup>6</sup>, Joaquim Segalés<sup>7,8†</sup> and Michele Drigo<sup>1†</sup>

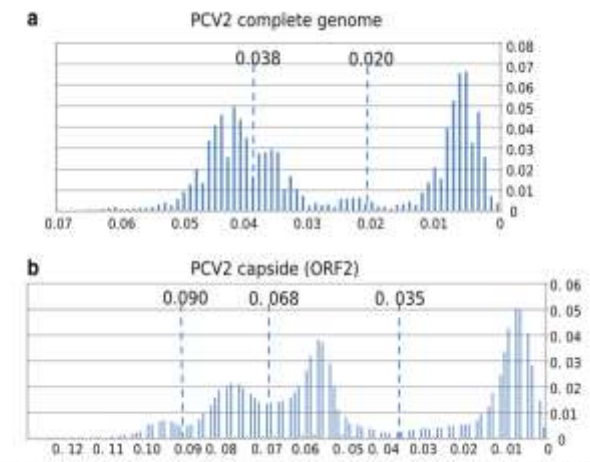
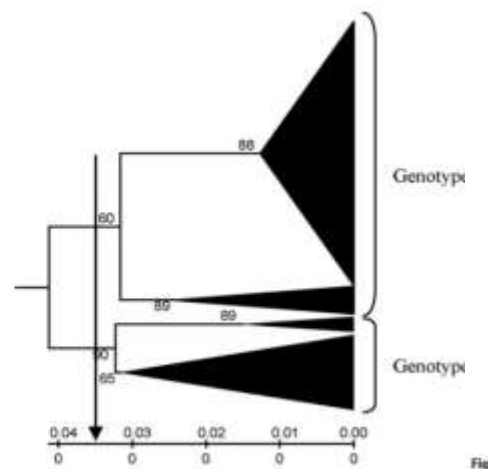
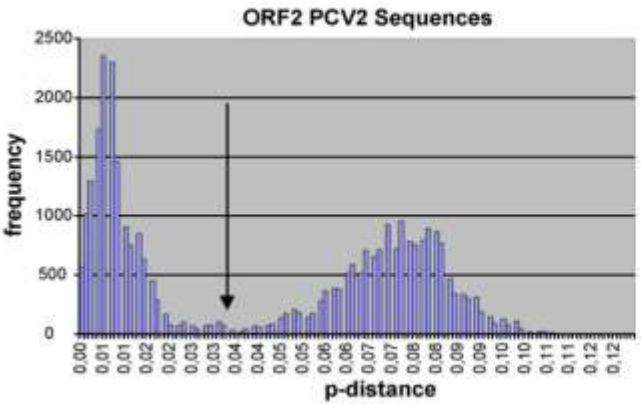


Fig. 2 PASC analysis of complete PCV2 genome database (a) and of ORF2 sequences (b). The percentage of pairwise p-distances comprised within a 0.01 p-distance interval is reported.

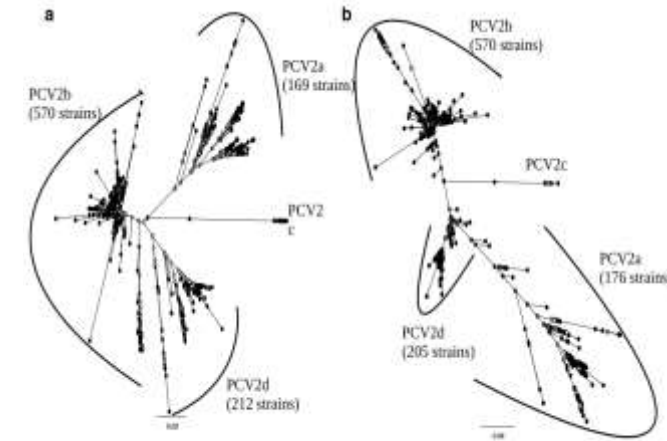


Fig. 1 Phylogenetic trees reconstructed using Neighbor Joining (a) and Maximum Likelihood (b) methods based on the ORF2 database after removing the recombinant strains detected by IHR. Bootstrap support has been reported using gray scale (ranging from white for bootstrap support = 0 to black for bootstrap support = 1).

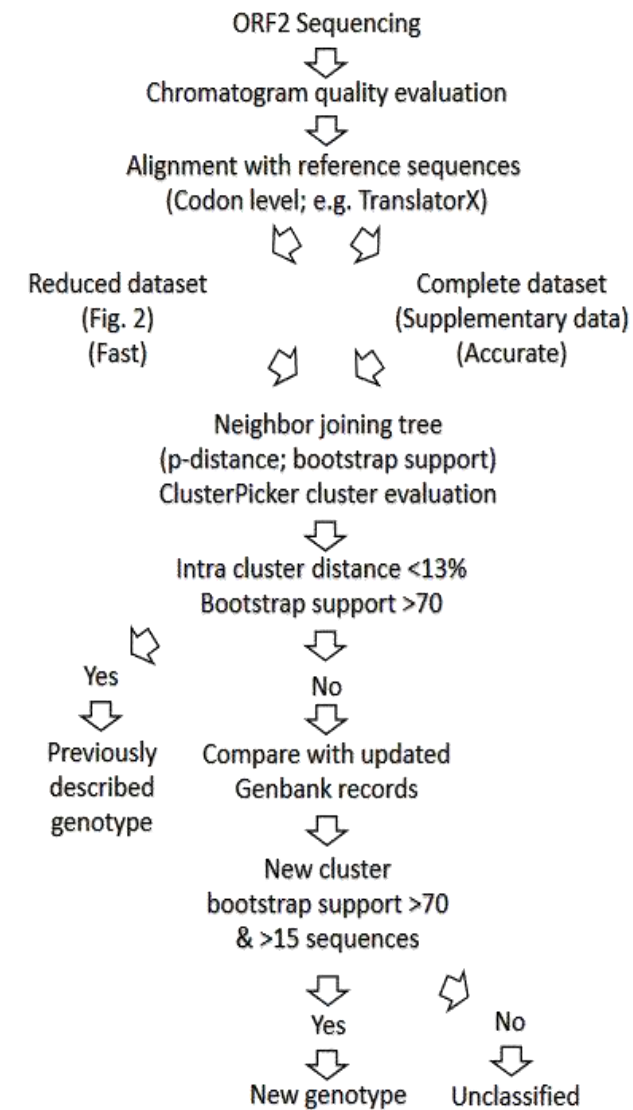
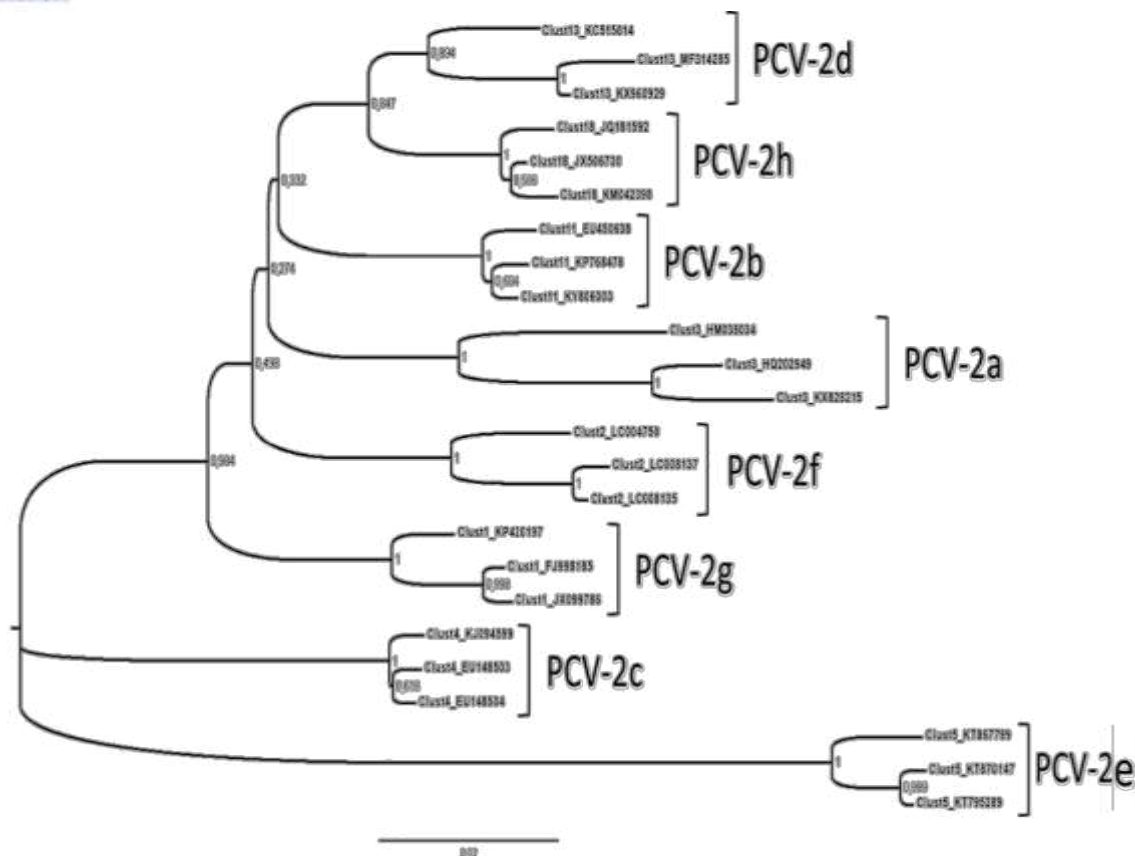
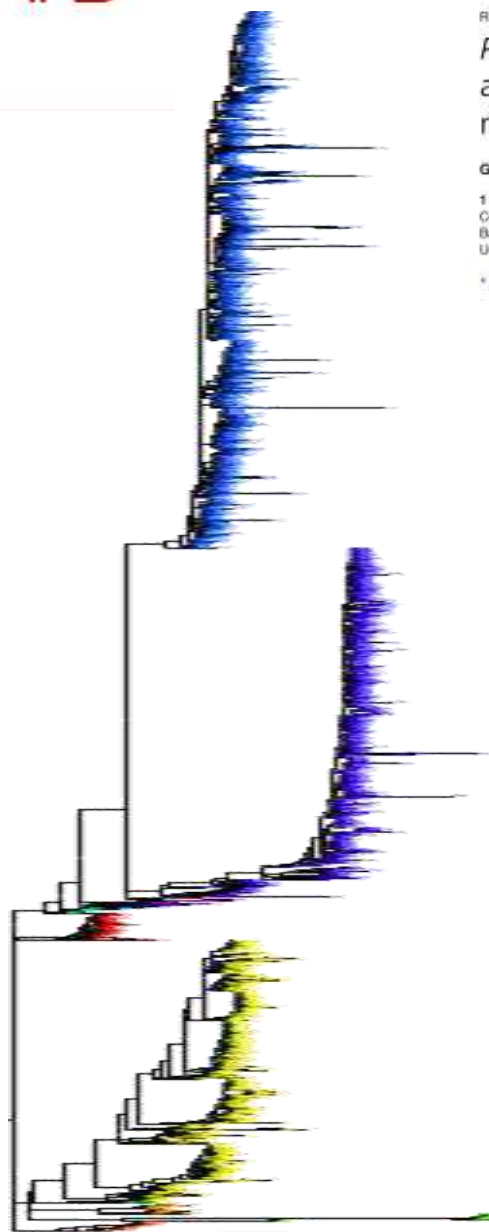
RESEARCH ARTICLE

Porcine circovirus 2 (PCV-2) genotype update and proposal of a new genotyping methodology

Giovanni Franzo<sup>1\*</sup>, Joaquim Segalés<sup>2,3</sup>

<sup>1</sup> Department of Animal Medicine, Production and Health, University of Padova, Legnaro, Italy, <sup>2</sup> UAB, Centre de Recerca en Sanitat Animal (CRESA, IRTA-UAB), Campus de la Universitat Autònoma de Barcelona, Bellaterra, Spain, <sup>3</sup> Departament de Sanitat i Anatomia Animals, Facultat de Veterinària, Universitat Autònoma de Barcelona, Bellaterra Spain

\* giovanni.franzo@unipd.it




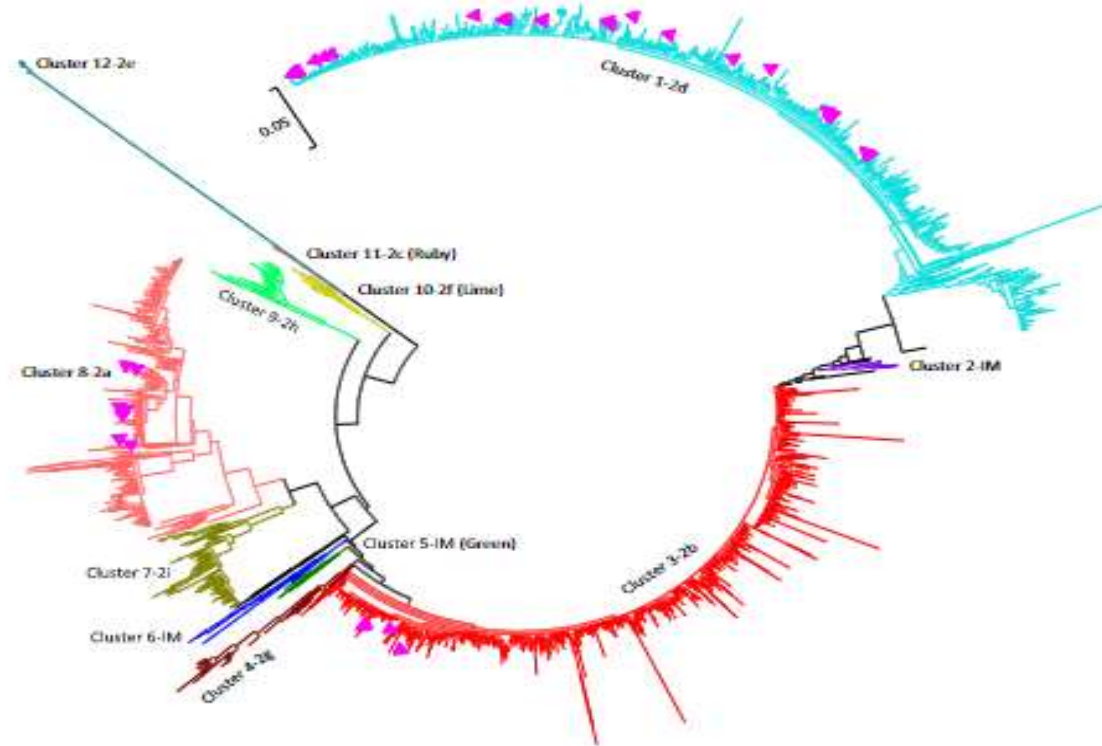
Received: 5 July 2019 | Revised: 2 December 2019 | Accepted: 18 December 2019  
DOI: 10.1111/tbed.13467

ORIGINAL ARTICLE

Journal of *Transboundary and Emerging Diseases* | WILEY

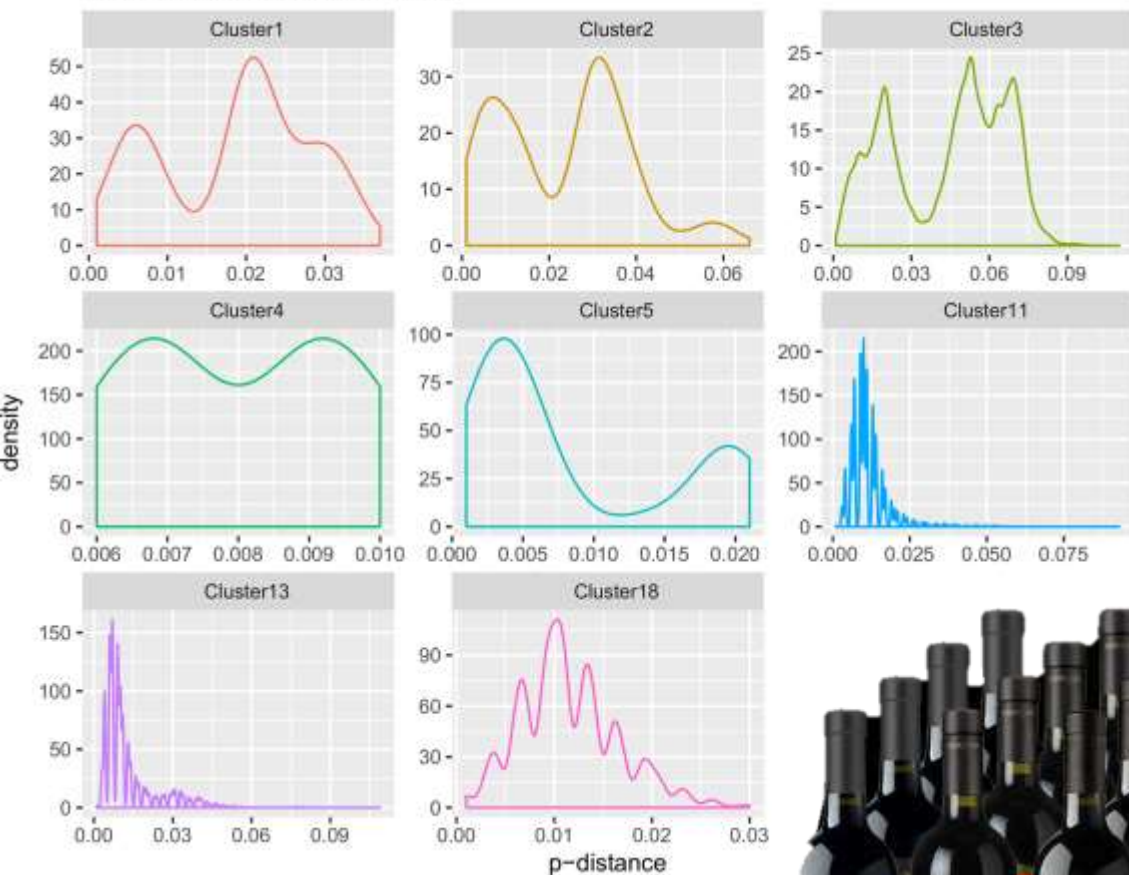
## Genetic diversity and prevalence of porcine circovirus type 3 (PCV3) and type 2 (PCV2) in the Midwest of the USA during 2016–2018

Yin Wang<sup>1,2</sup> | Lance Noll<sup>1</sup> | Nanyan Lu<sup>1,3</sup> | Elizabeth Porter<sup>1</sup> | Colin Stoy<sup>1</sup> |  
Wanglong Zheng<sup>1,4</sup> | Xuming Liu<sup>1,2</sup> | Lalitha Peddireddi<sup>1,2</sup> | Megan Niederwerder<sup>2</sup> |  
Jianfa Bai<sup>1,2</sup> 

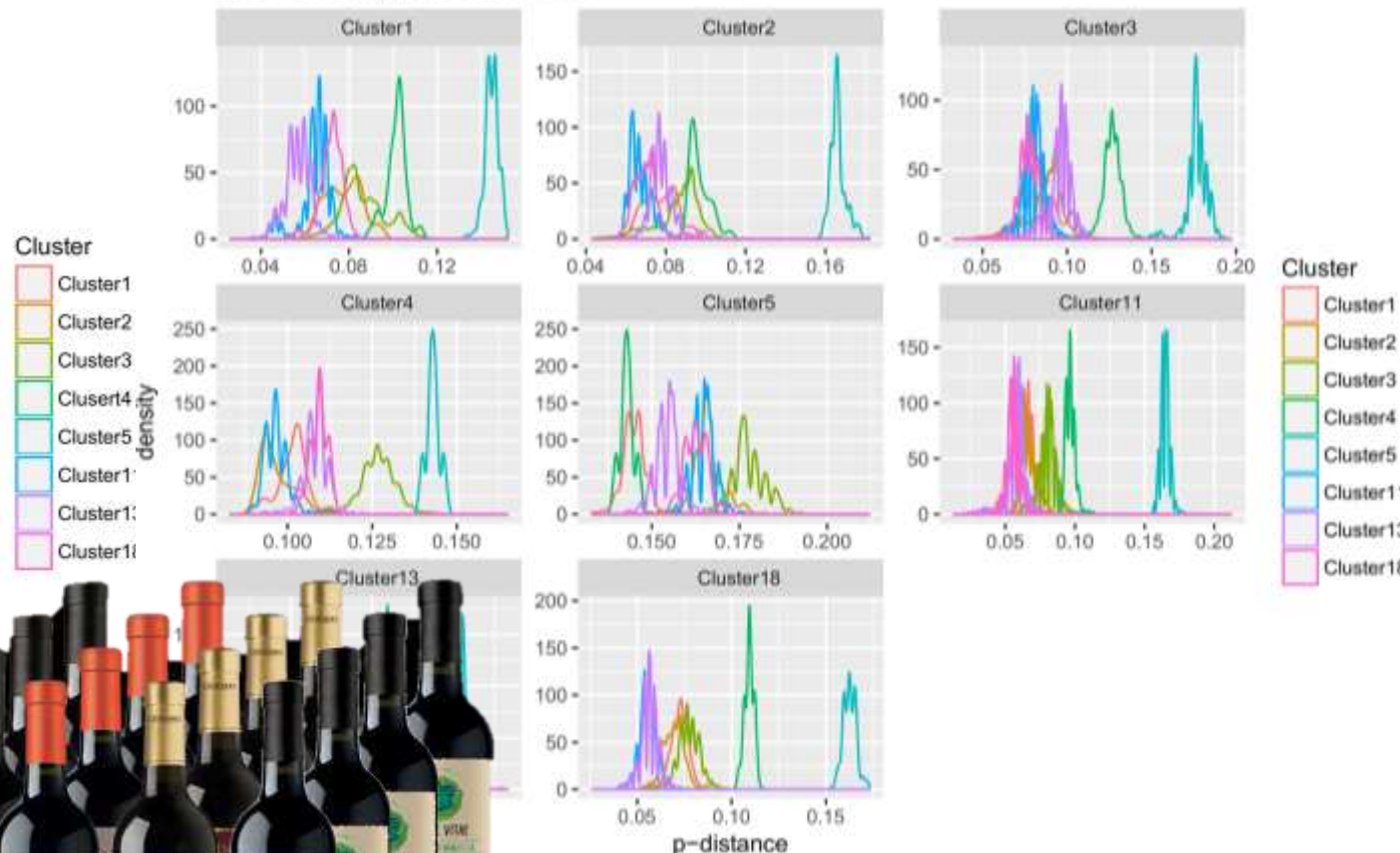




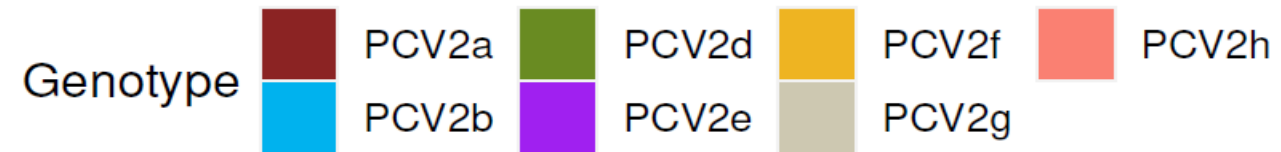
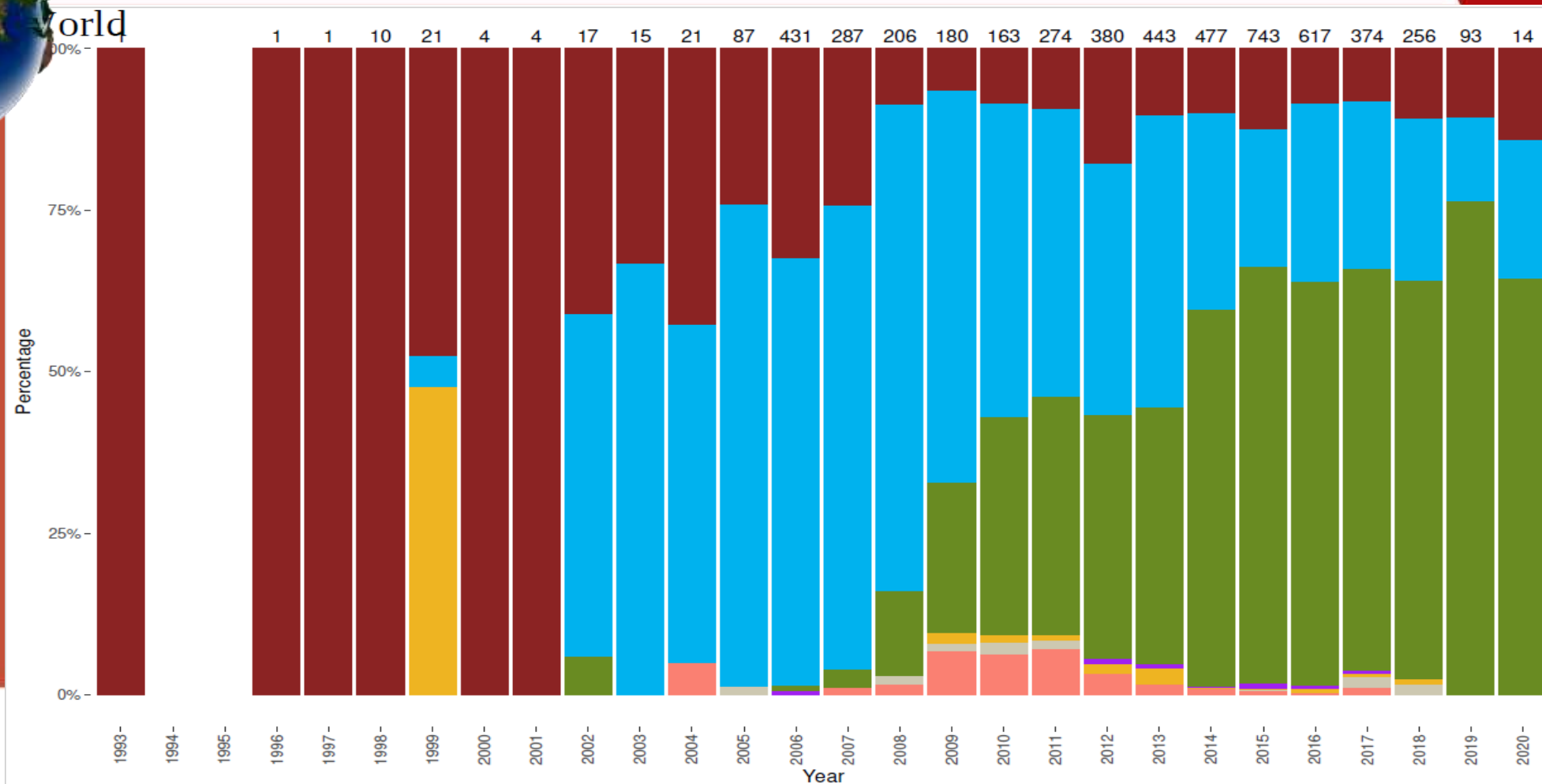
## Intra-Cluster genetic distance

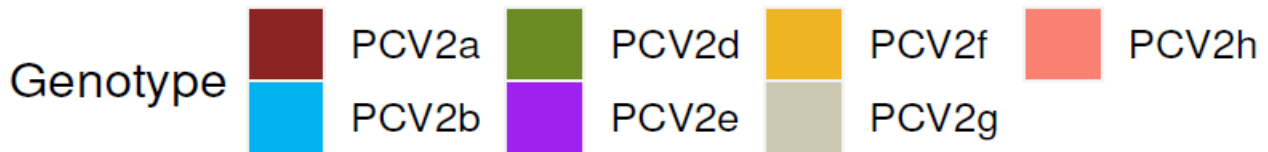
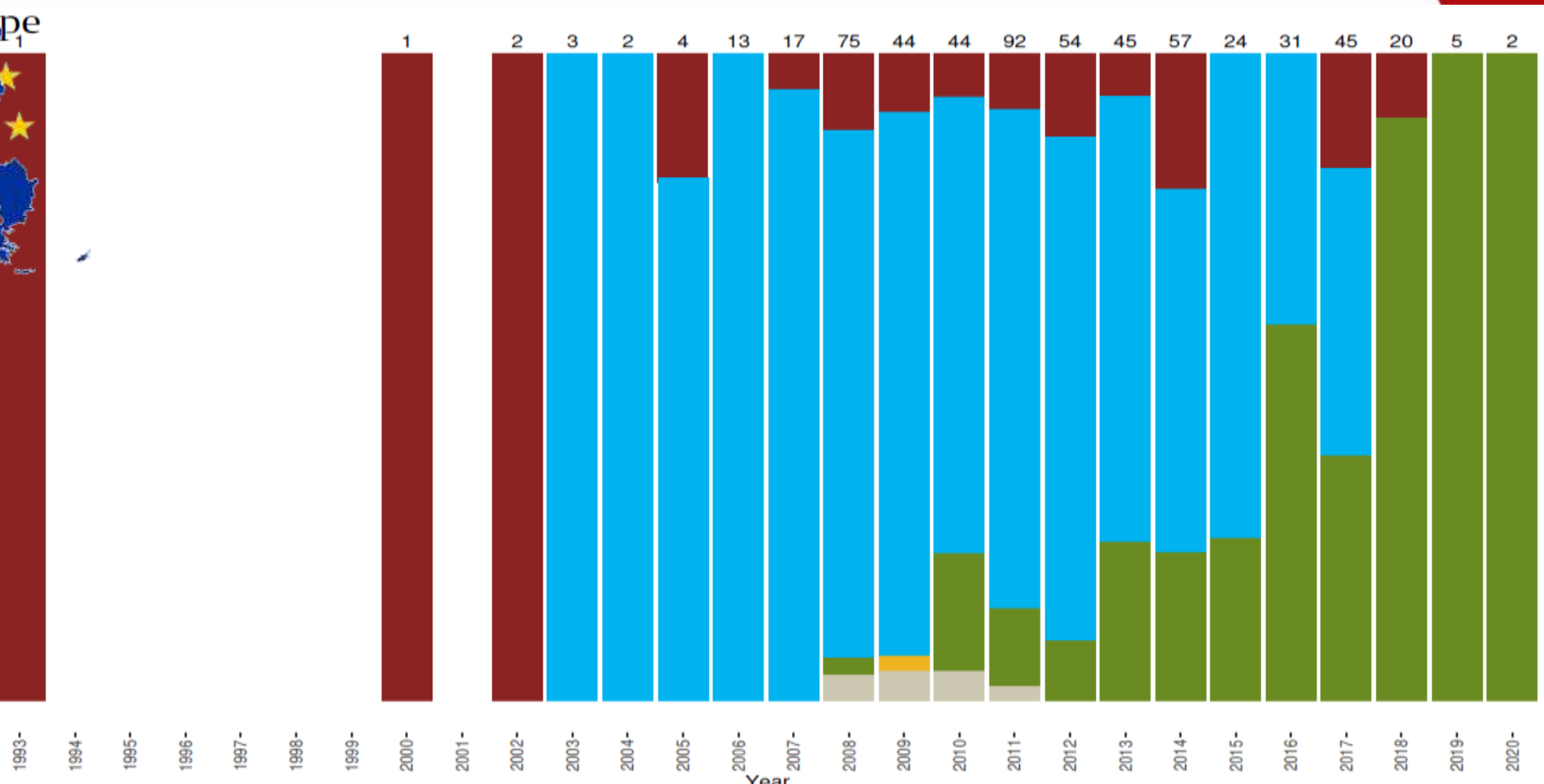
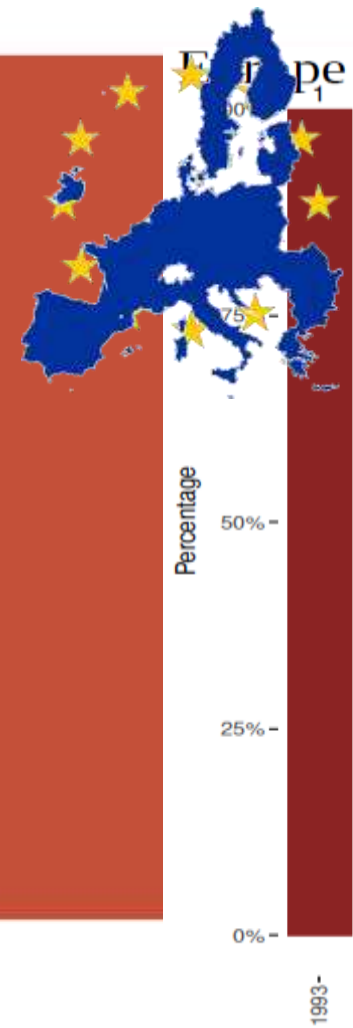


## Inter-Cluster genetic distance











Article

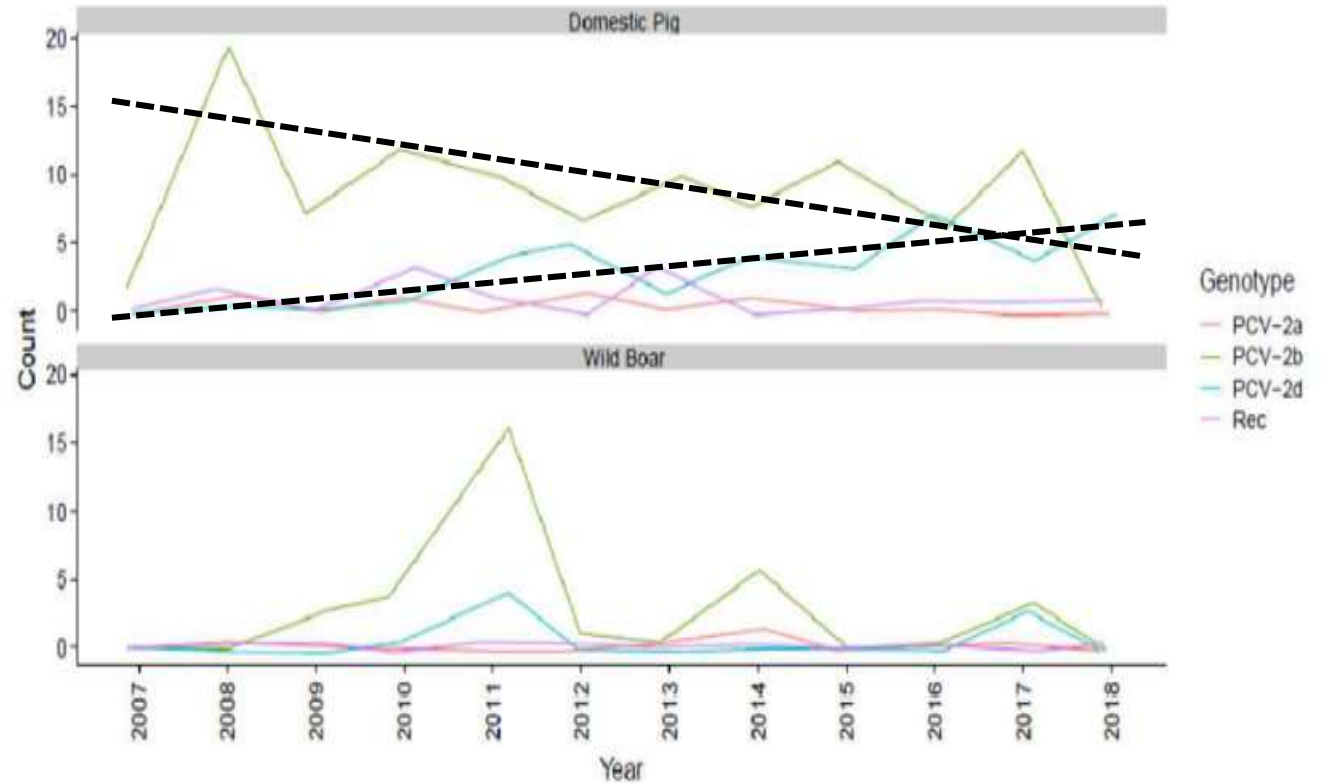
# Free to Circulate: An Update on the Epidemiological Dynamics of Porcine Circovirus 2 (PCV-2) in Italy Reveals the Role of Local Spreading, Wild Populations, and Foreign Countries

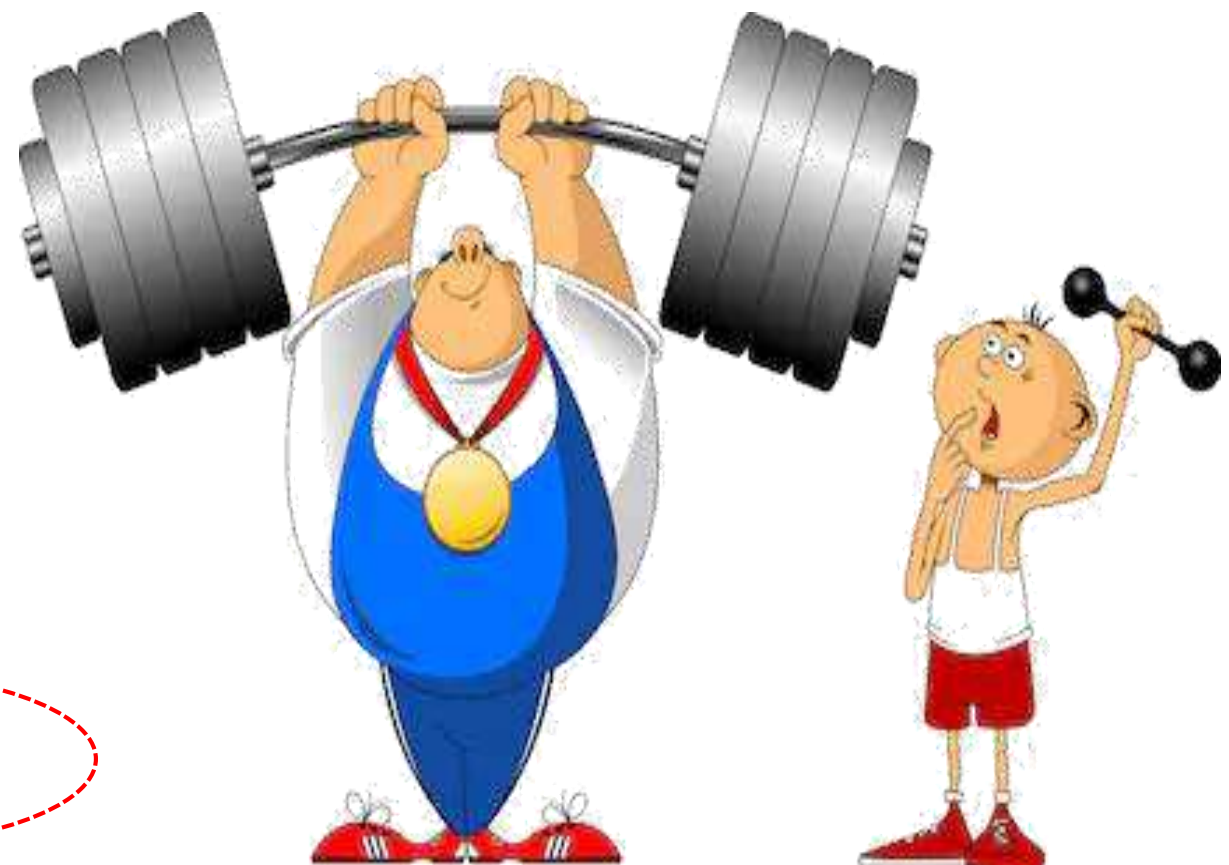
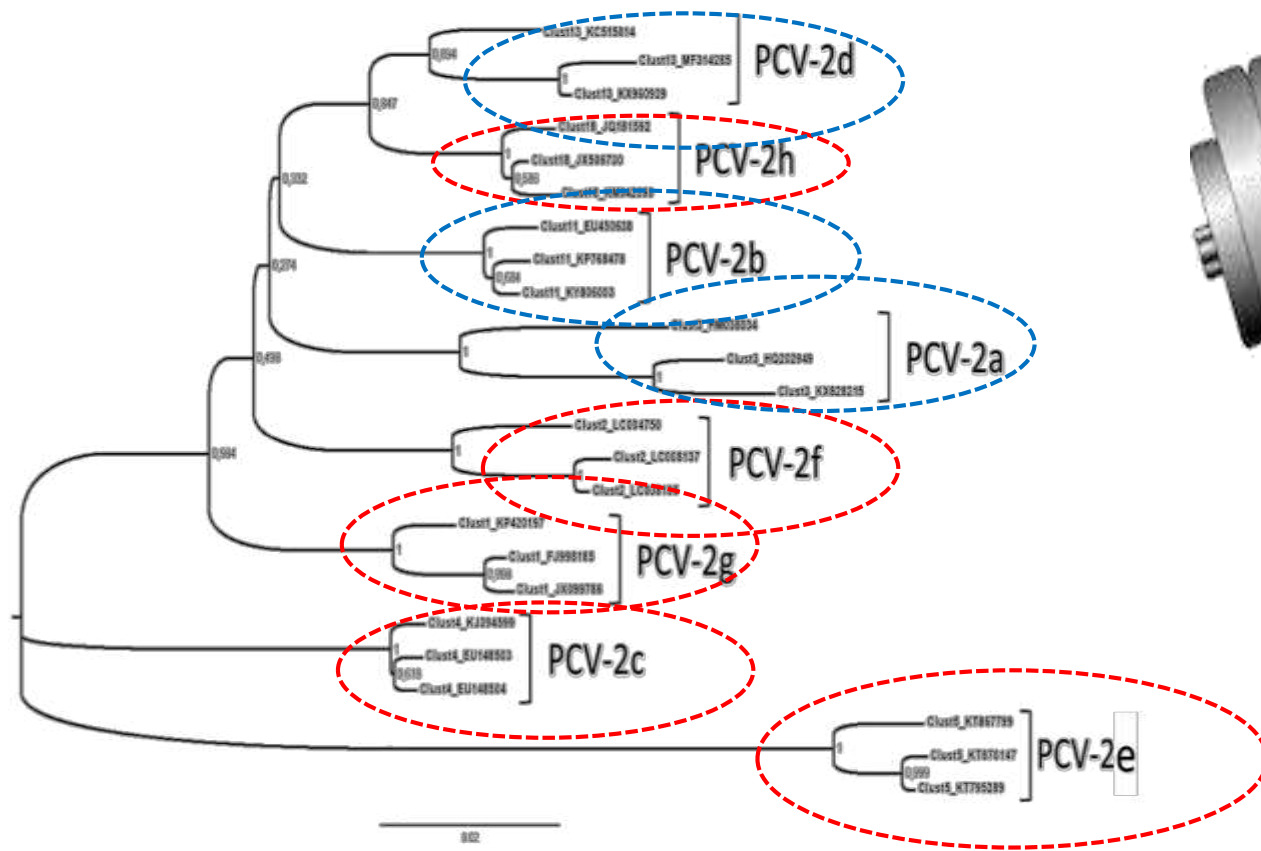
Giovanni Franzo <sup>\*</sup>, Susanna Tinello, Laura Grassi, Claudia Maria Tucciarone, Matteo Legnardi, Mattia Cecchinato, Giorgia Dotto, Alessandra Mondin, Marco Martini, Daniela Pasotto, Maria Luisa Menandro <sup>†</sup> and Michele Drigo <sup>†</sup>

Department of Animal Medicine, Production and Health (MAPS), University of Padua, 35020 Legnaro, PD, Italy

<sup>\*</sup> Correspondence: giovanni.franzo@unipd.it

<sup>†</sup> Maria Luisa Menandro and Michele Drigo contributed equally.







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Available online at [www.sciencedirect.com](http://www.sciencedirect.com)

Veterinary Microbiology 128 (2008) 56–64

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**veterinary  
microbiology**

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[www.elsevier.com/locate/vetmic](http://www.elsevier.com/locate/vetmic)

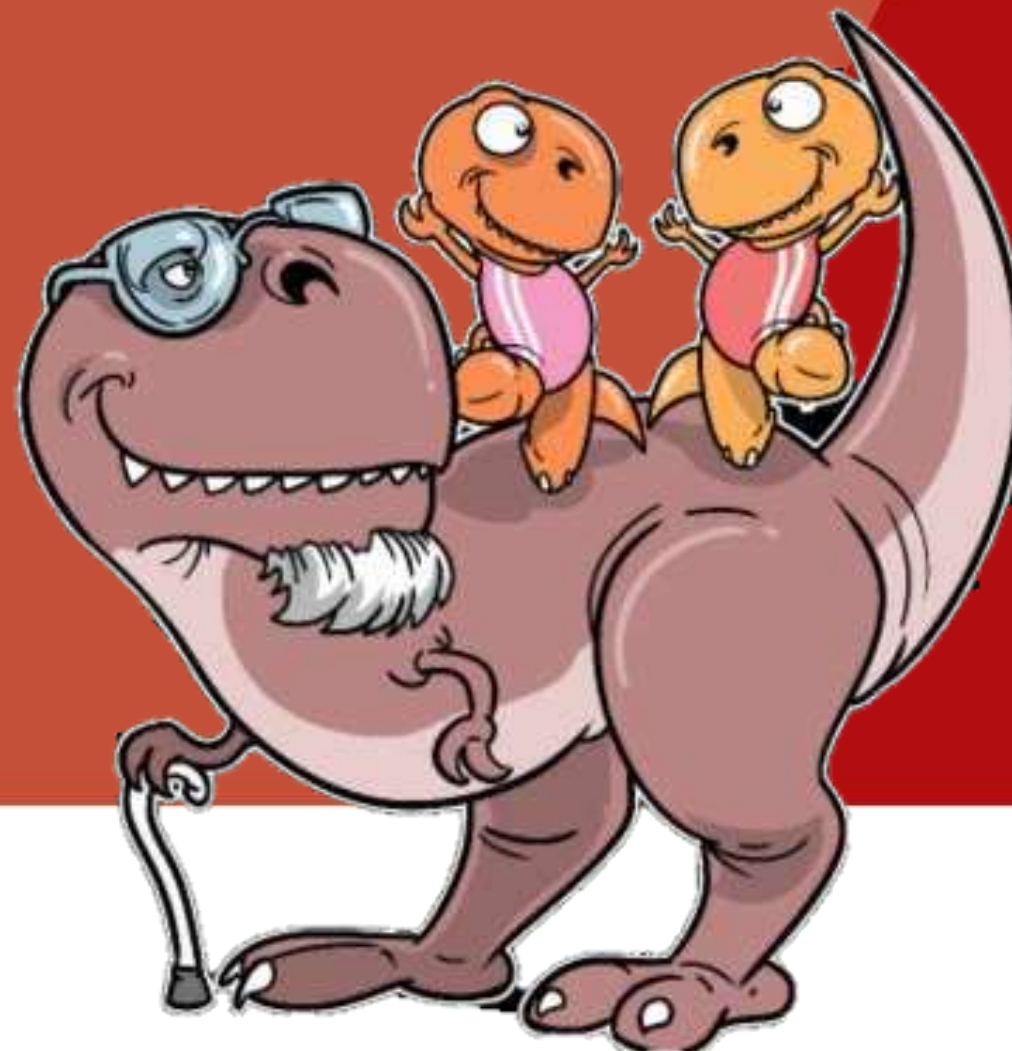
Genomic analysis of PCV2 isolates from Danish archives  
and a current PMWS case–control study supports  
a shift in genotypes with time

K. Dupont<sup>a</sup>, E.O. Nielsen<sup>b</sup>, P. Bækbo<sup>b</sup>, L.E. Larsen<sup>a,\*</sup>

<sup>a</sup> National Veterinary Institute, The Technical University of Denmark, Denmark

<sup>b</sup> Danish Meat Association, Kjellerup, Denmark

Received 23 May 2007; received in revised form 17 September 2007; accepted 26 September 2007



Veterinary Microbiology 178 (2015) 218–262

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Veterinary Microbiology

journal homepage: [www.elsevier.com/locate/vetmic](http://www.elsevier.com/locate/vetmic)



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Short communication

## Genetic characterisation of *Porcine circovirus* type 2 (PCV2) strains from feral pigs in the Brazilian Pantanal: An opportunity to reconstruct the history of PCV2 evolution

Giovanni Franzo<sup>a,\*</sup>, Martí Cortey<sup>b,1</sup>, Alessandra Marnie Martins Gomes de Castro<sup>c</sup>, Ubiratan Piovezan<sup>d</sup>, Matias Pablo Juan Szabo<sup>e</sup>, Michele Drigo<sup>d</sup>, Joaquim Segalés<sup>f</sup>, Leonardo José Richtzenhain<sup>g</sup>

<sup>a</sup> University of Padua, Padua, Italy

<sup>b</sup> The Pirbright Institute, Pirbright, Woking, UK

<sup>c</sup> Department of Preventive Veterinary Medicine and Animal Health, College of Veterinary Medicine, University of São Paulo, São Paulo, SP, Brazil

<sup>d</sup> Empresa Brasileira de Pesquisa Agropecuária – Embrapa Pantanal, Corumbá, MS, Brazil

<sup>e</sup> Laboratorio de Zoonosis, Faculdade de Medicina Veterinária, Universidade Federal de Uberlândia, MG, Brazil

<sup>f</sup> Centre de Recerca en Sanitat Animal (CReSA), IRTA 18194, Campus de la Universitat Autònoma de Barcelona, Departament de Sanitat i d'Anatomia Animal, Universitat Autònoma de Barcelona, 08193 Bellver, Barcelona, Spain

<sup>g</sup> Universitat Autònoma de Barcelona, 08193 Bellver, Barcelona, Spain



Archives of Virology  
https://doi.org/10.1007/s00705-021-05035-9

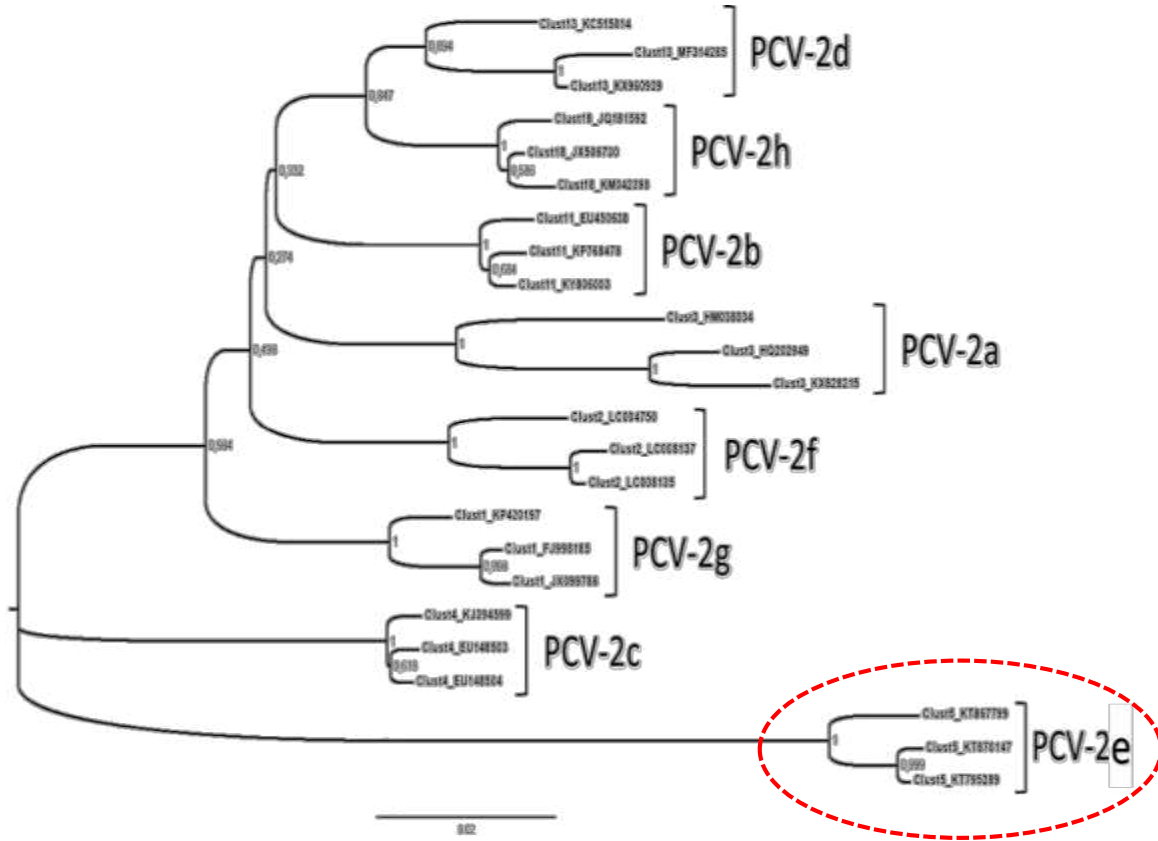
BRIEF REPORT

# Three different genotypes of porcine circovirus 2 (PCV-2) identified in pigs and warthogs in Namibia

Umberto Molini<sup>1,2</sup> · Giovanni Franzo<sup>3</sup> · Lené Gous<sup>1</sup> · Sjandré Moller<sup>1</sup> · Yvonne Maria Hemberger<sup>1</sup> · Bernard Chiwome<sup>1</sup> · Giuseppe Marruchella<sup>4</sup> · Siegfried Khaiseb<sup>2</sup> · Giovanni Cattoli<sup>5</sup> · William G. Dundon<sup>5</sup>

Received: 21 December 2020 / Accepted: 24 January 2021  
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The Veterinary Journal 279 (2022) 105787



Contents lists available at ScienceDirect

The Veterinary Journal

journal homepage: [www.elsevier.com/locate/tvjf](http://www.elsevier.com/locate/tvjf)



Short communication

## First detection of porcine circovirus type 2e in Europe

G. Franzo <sup>a,\*</sup>, M. Ustulin <sup>b</sup>, P. Zanardelli <sup>c</sup>, A. Castellan <sup>d</sup>, N. Villa <sup>c</sup>, A. Manfreda <sup>c</sup>, D. Vio <sup>b</sup>, M. Drigo <sup>a</sup>

<sup>a</sup> Department of Animal Medicine, Production and Health, University of Padova, Legnaro, PD, Italy

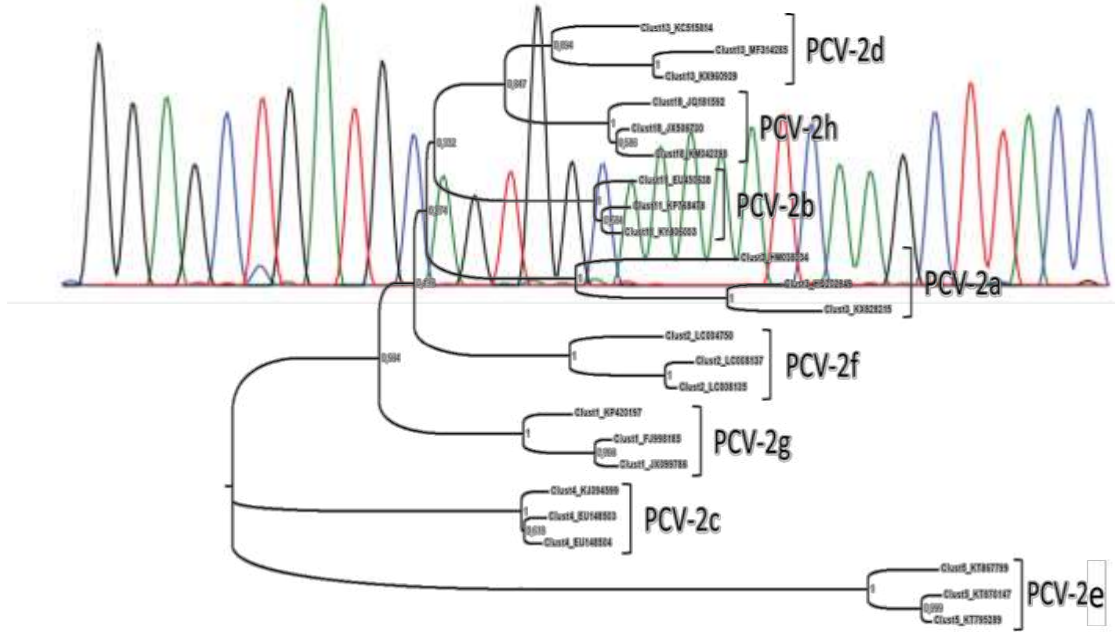
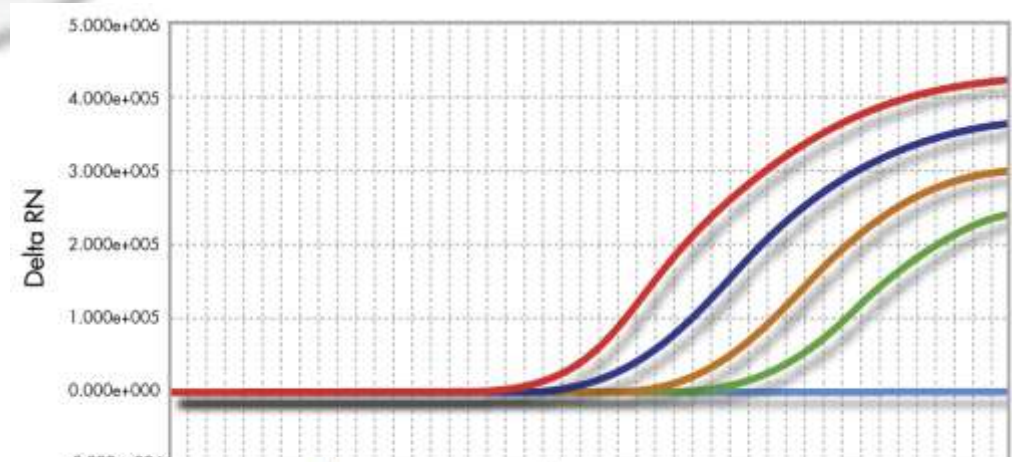
<sup>b</sup> Peripheral Diagnostic Laboratory of Pordenone, Istituto Zooprofilattico Sperimentale delle Venezie, C...

<sup>c</sup> Zoetis Italia s.r.l., Rome, RM, Italy

<sup>d</sup> Via Adige, 60, 36100 Vicenza, Italy



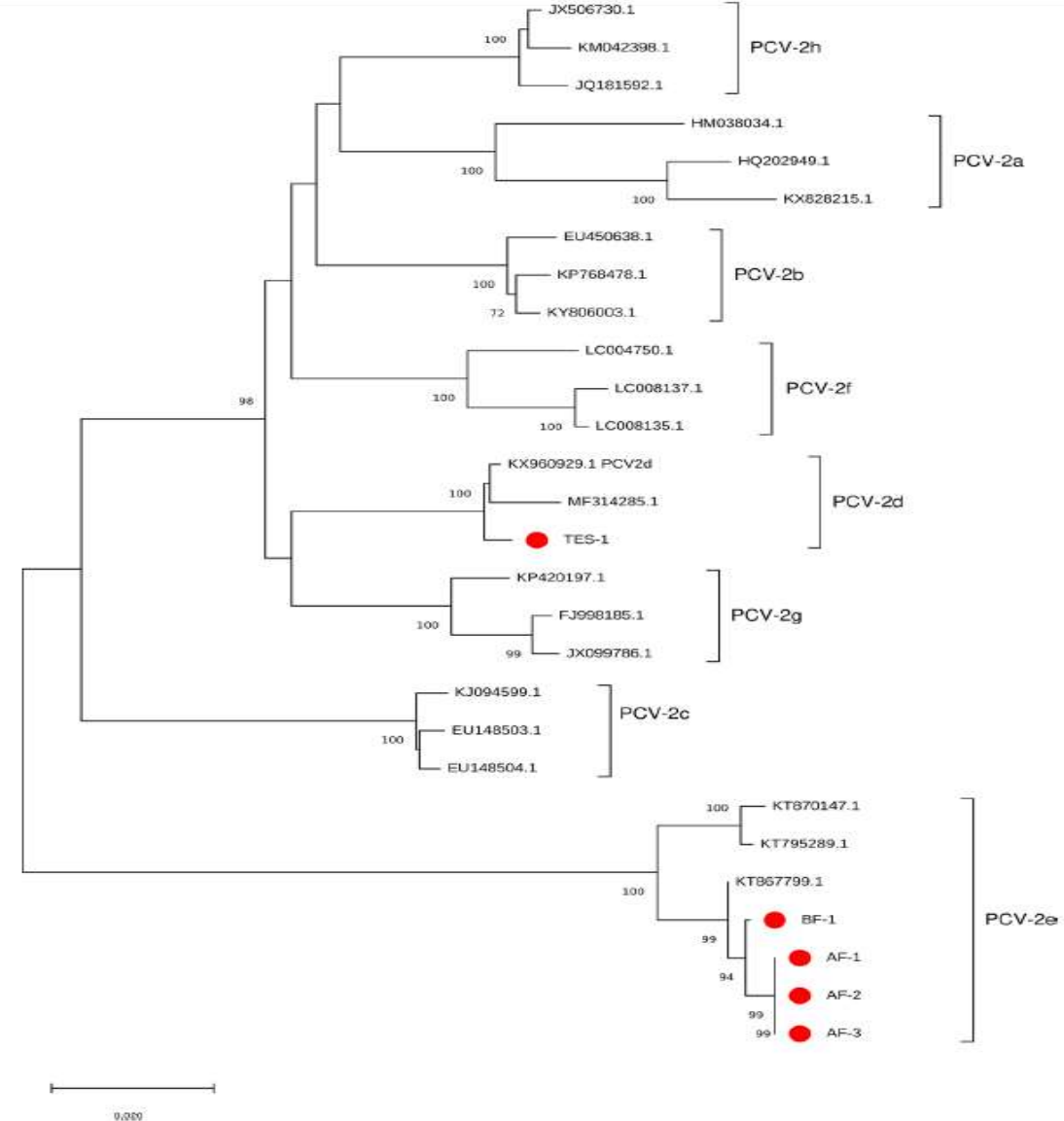


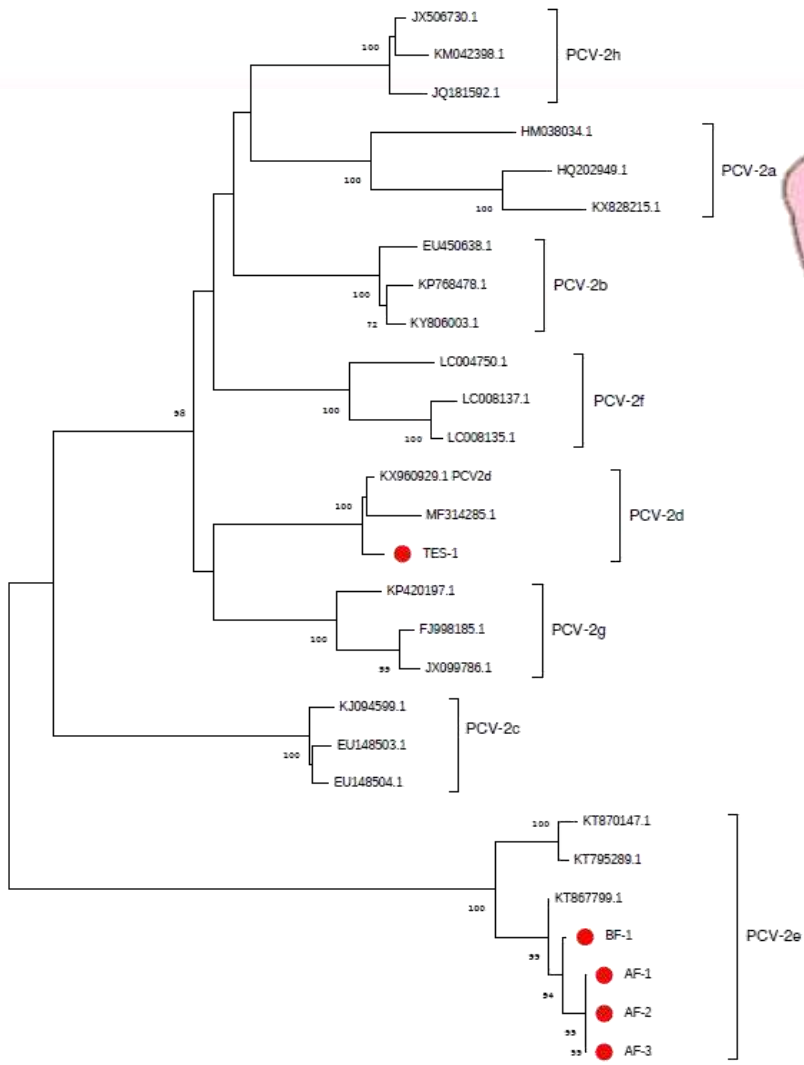


# Studio cross-sectional



- SCROFE
- SUINETTI





0.020



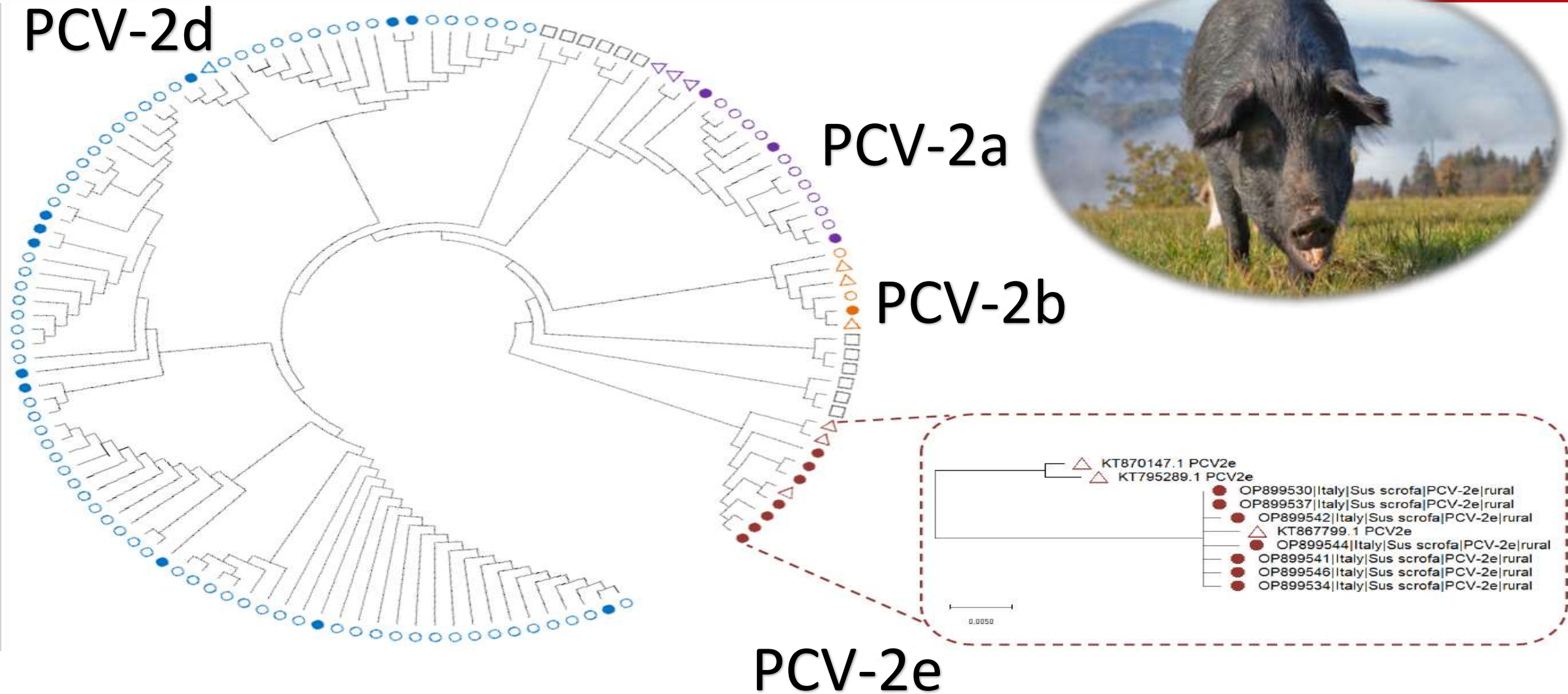
PCV-2d

PCV-2a

PCV-2b



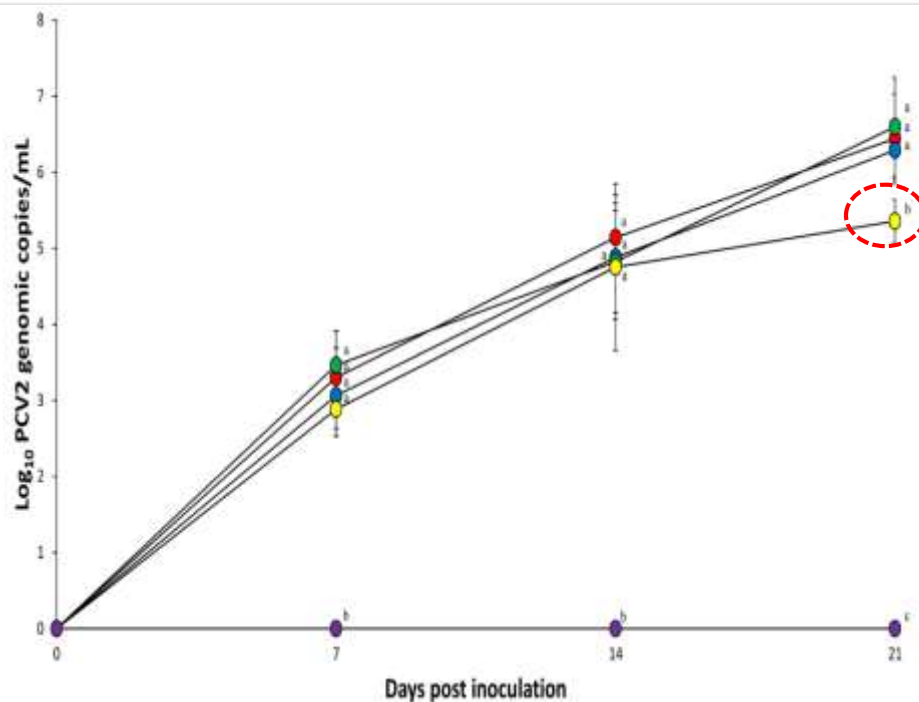
PCV-2e





## Comparison of pathogenicity of 4 porcine circovirus type 2 (PCV2) genotypes (2a, 2b, 2d, and 2e) in experimentally infected pigs

Hyejean CHO<sup>1)\*</sup>, Taehwan OH<sup>1)\*</sup>, Jeongmin SUH<sup>1)</sup>, Chanhee CHAE<sup>1)\*</sup>



J. Comp. Path. 2022, Vol. 100, 00–00

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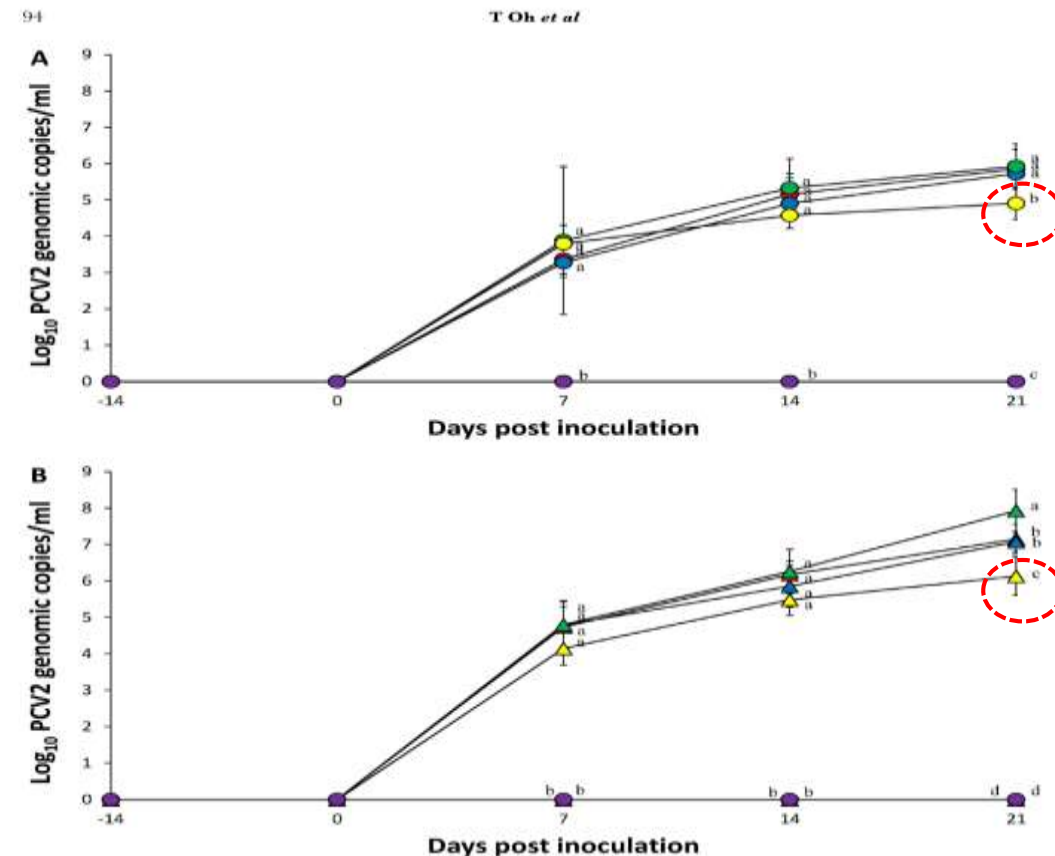
### EXPERIMENTALLY INDUCED DISEASE

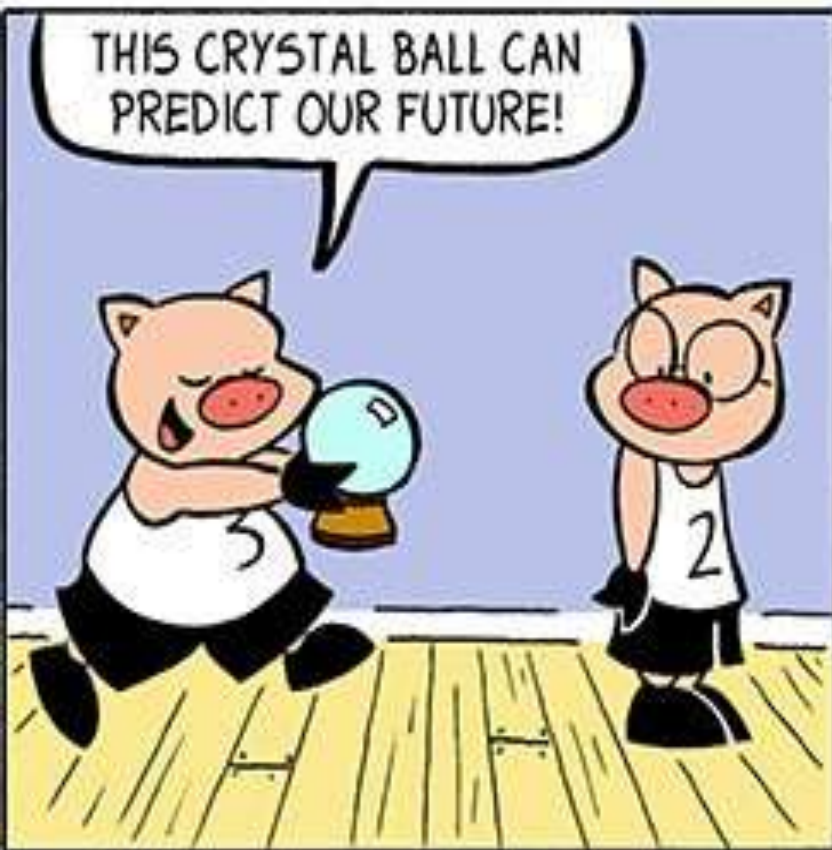
## Virulence Comparison of Four Porcine Circovirus Type 2 (PCV2) Genotypes (2a, 2b, 2d and 2e) in Pigs Single-Infected with PCV2 and Pigs Dual-Infected with PCV2 and *Mycoplasma hyopneumoniae*

Taehwan Oh<sup>\*</sup>, Hyejean Cho<sup>\*</sup>, Jeongmin Suh and Chanhee Chae

Department of Veterinary Pathology, College of Veterinary Medicine, Seoul National University, Seoul, Republic of Korea

T Oh et al





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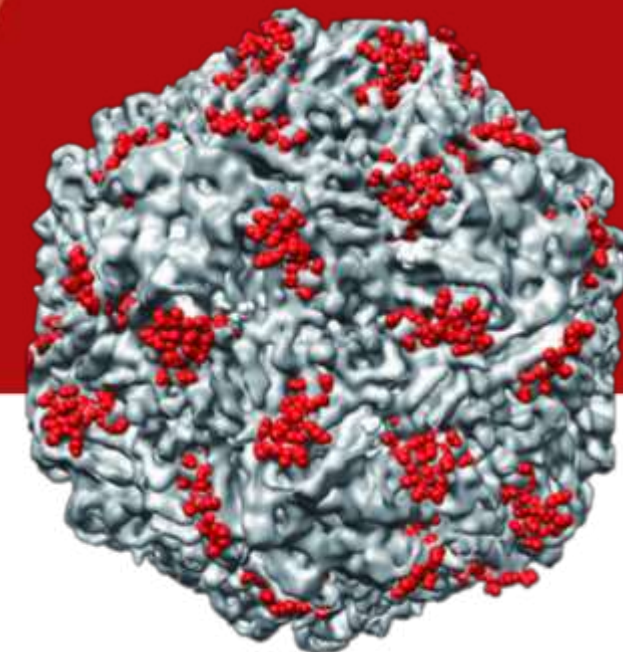
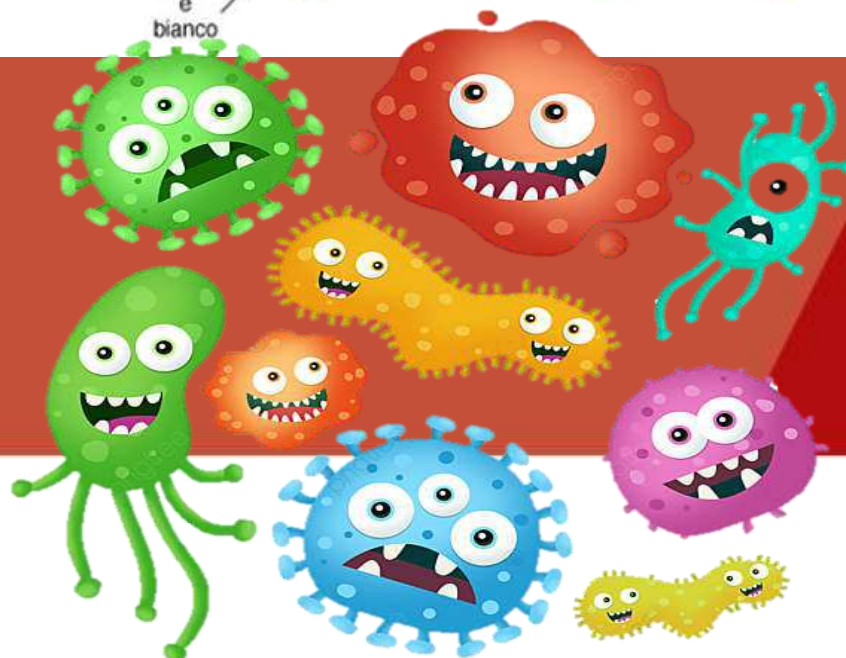
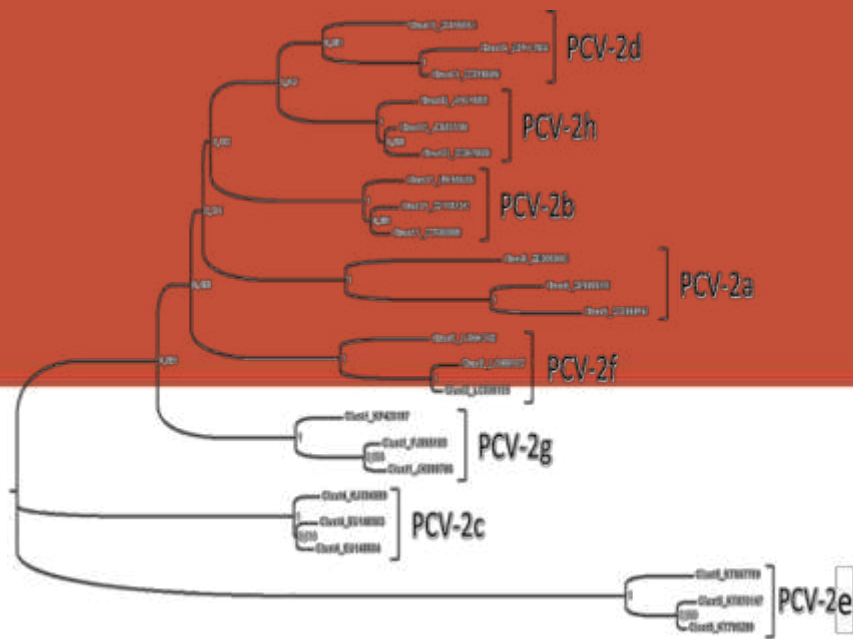
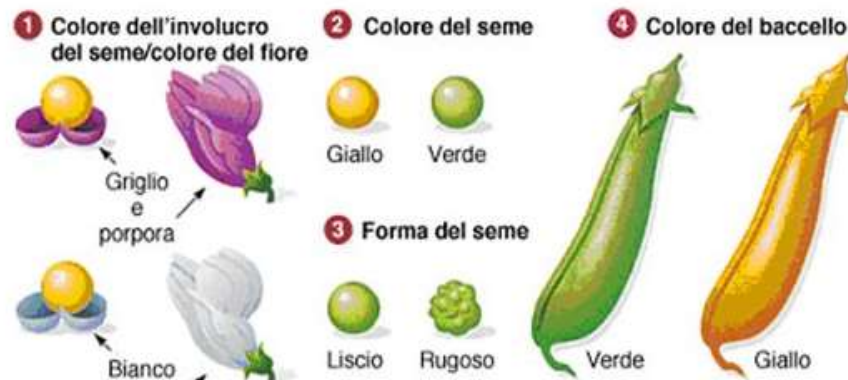
BONNET



“Sono convinto che non passerà molto tempo prima che il mondo intero riconosca i risultati del mio lavoro.”



GREGOR MENDEL

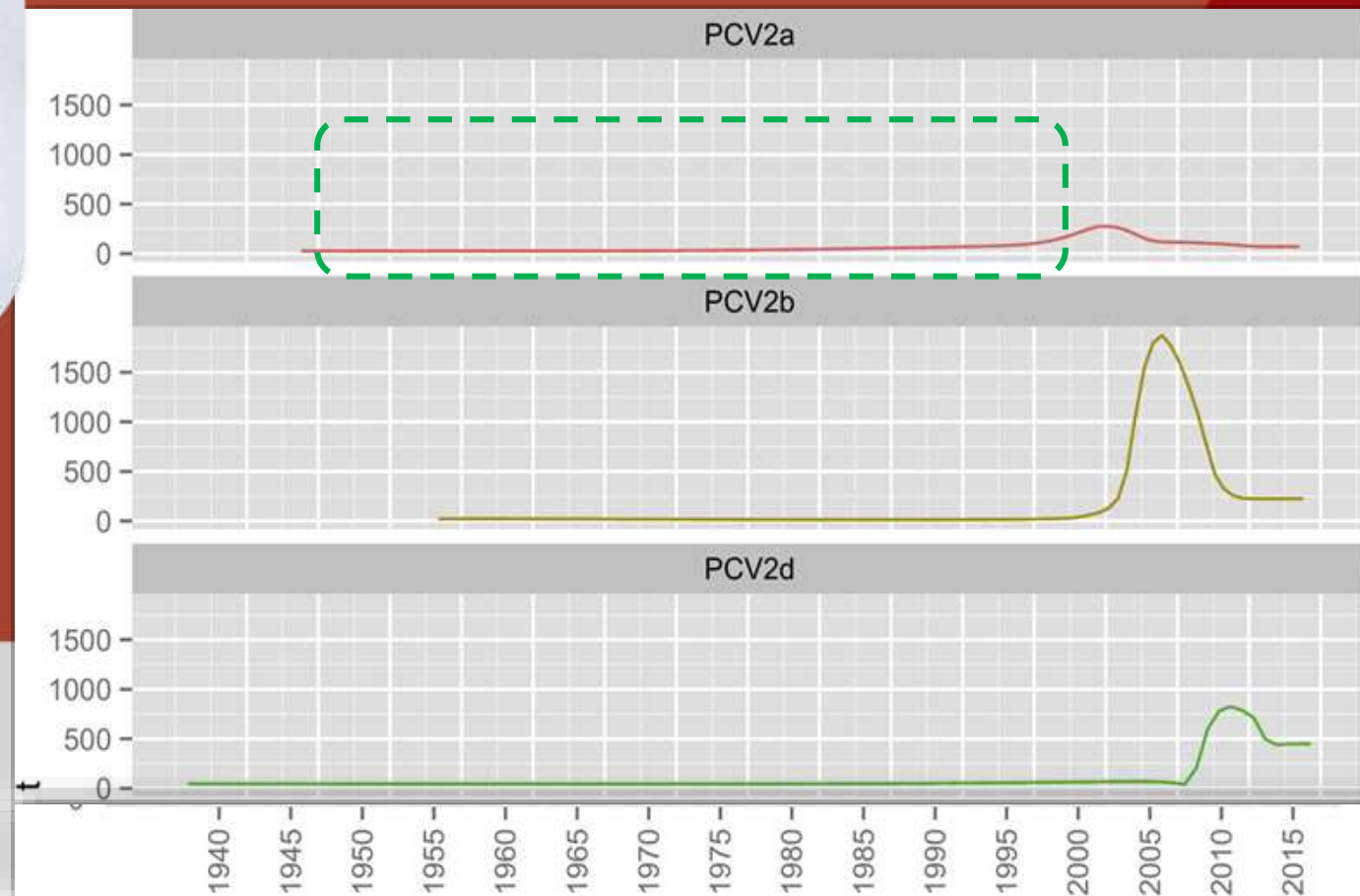




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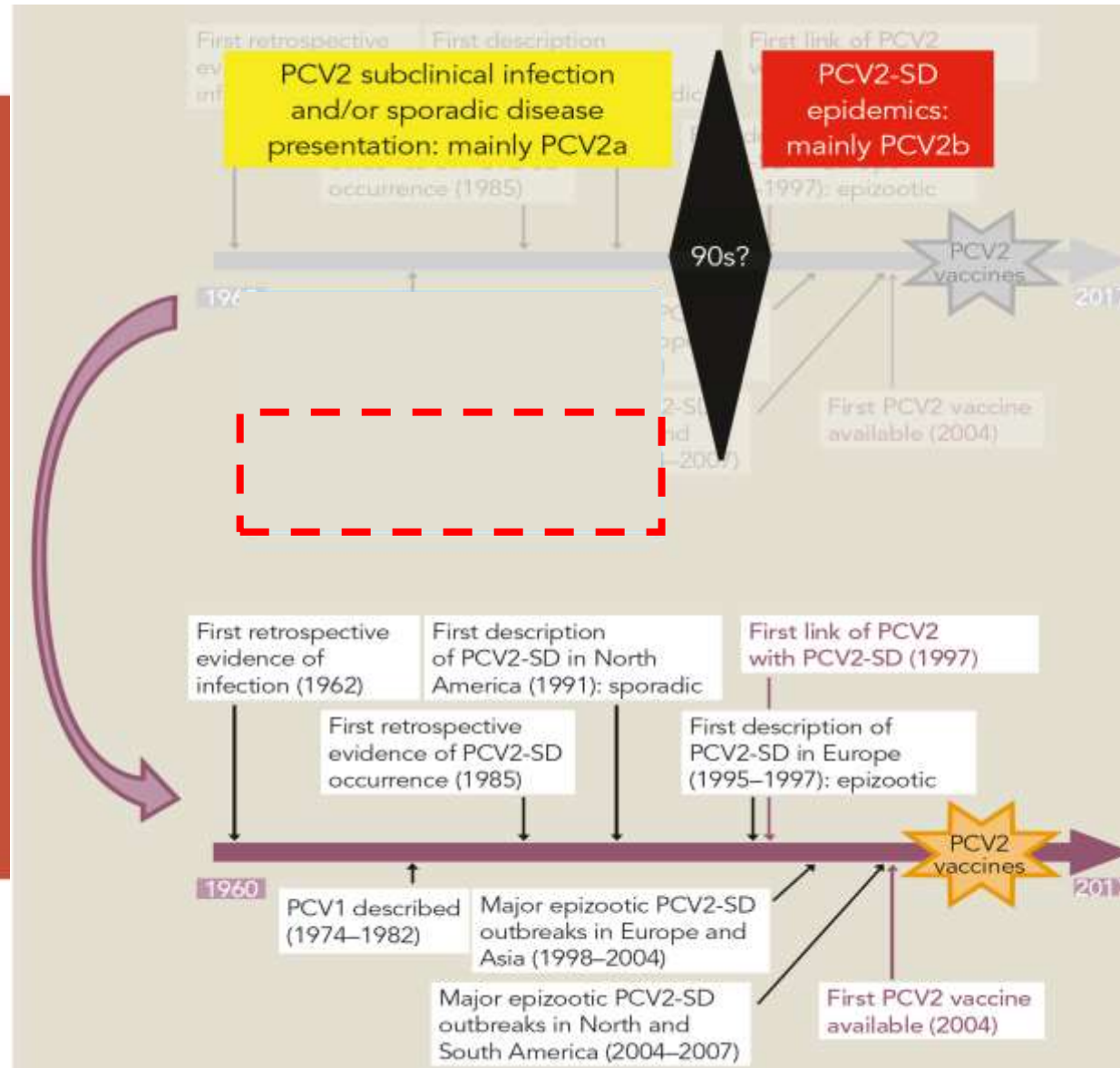


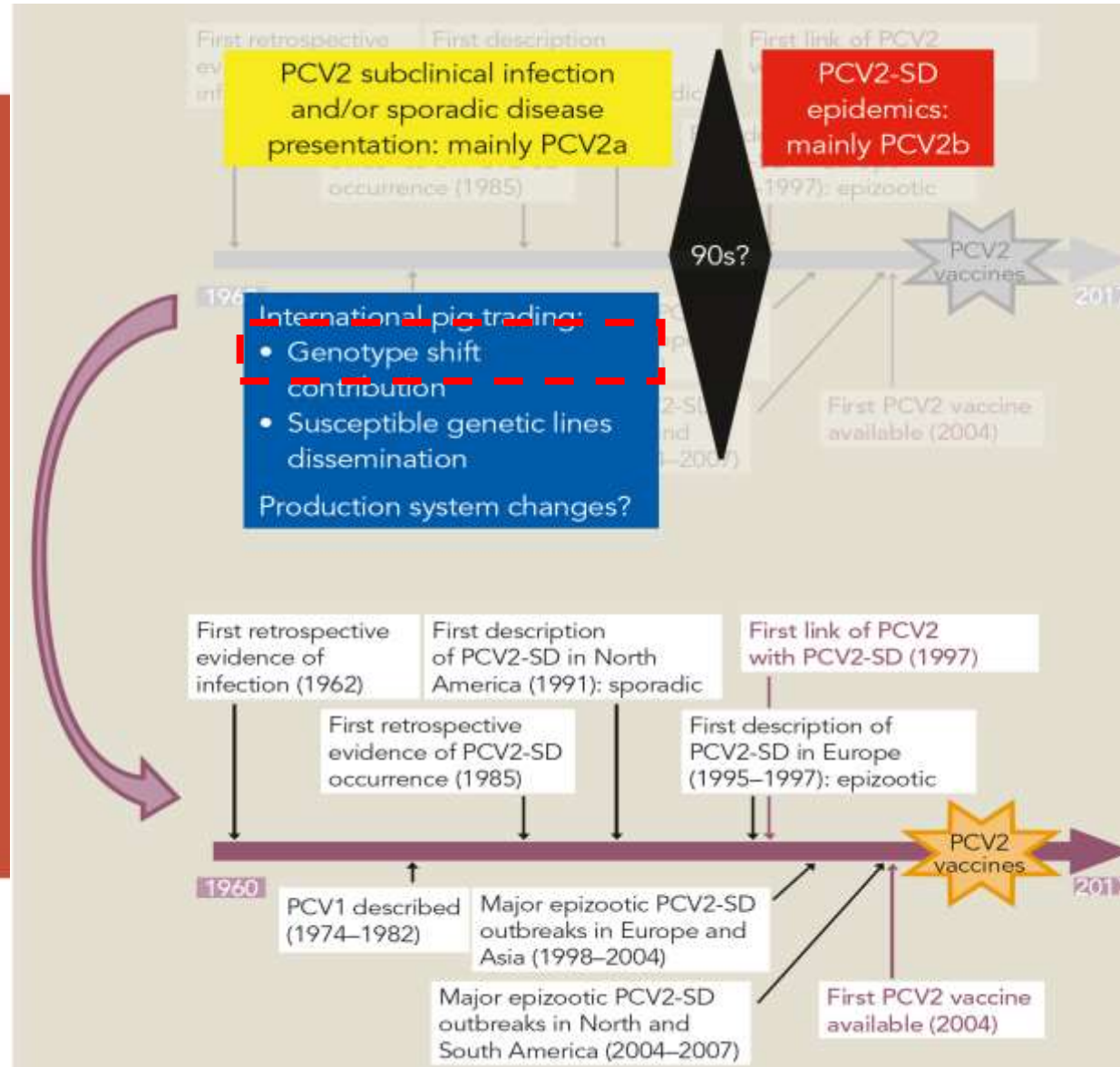
CONSEQUENCES!



**Genotype**

- PCV2a
- PCV2b
- PCV2d





MAD

THERE WILL BE

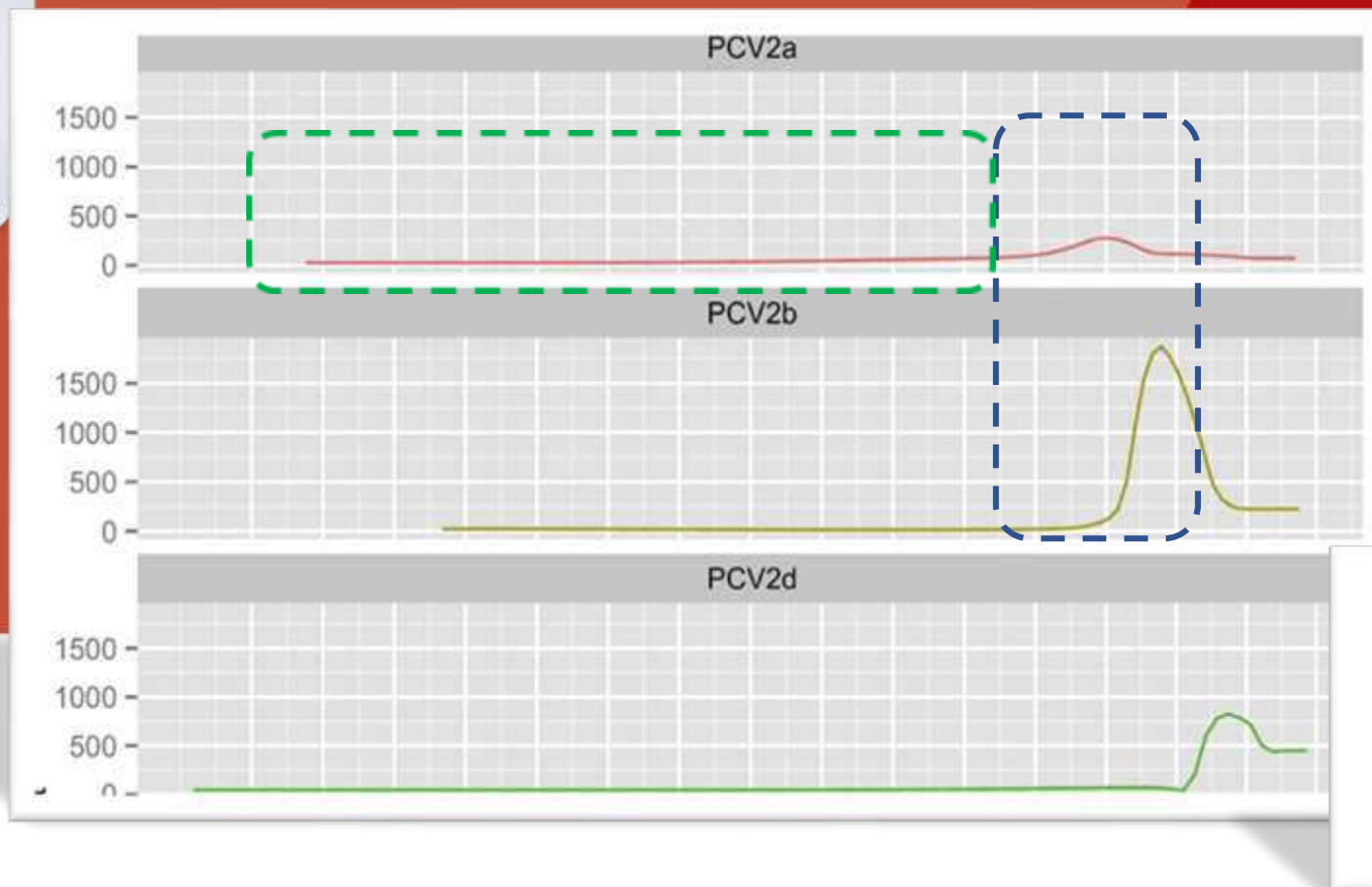


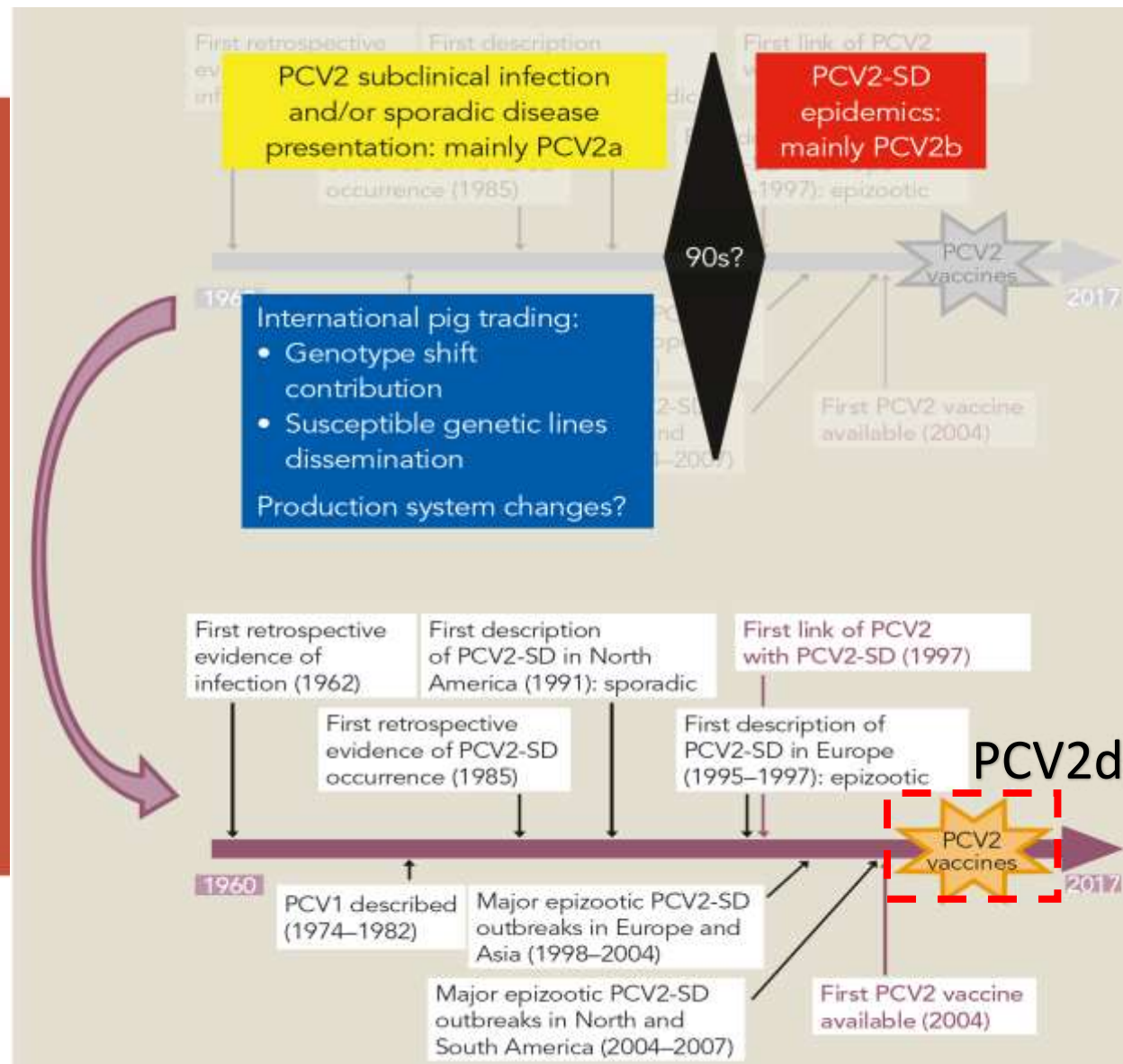
CONSEQUENCES!

1221-2021  
800  
ANNI



UNIVERSITÀ  
DEGLI STUDI  
DI PADOVA





MAD

THERE WILL BE

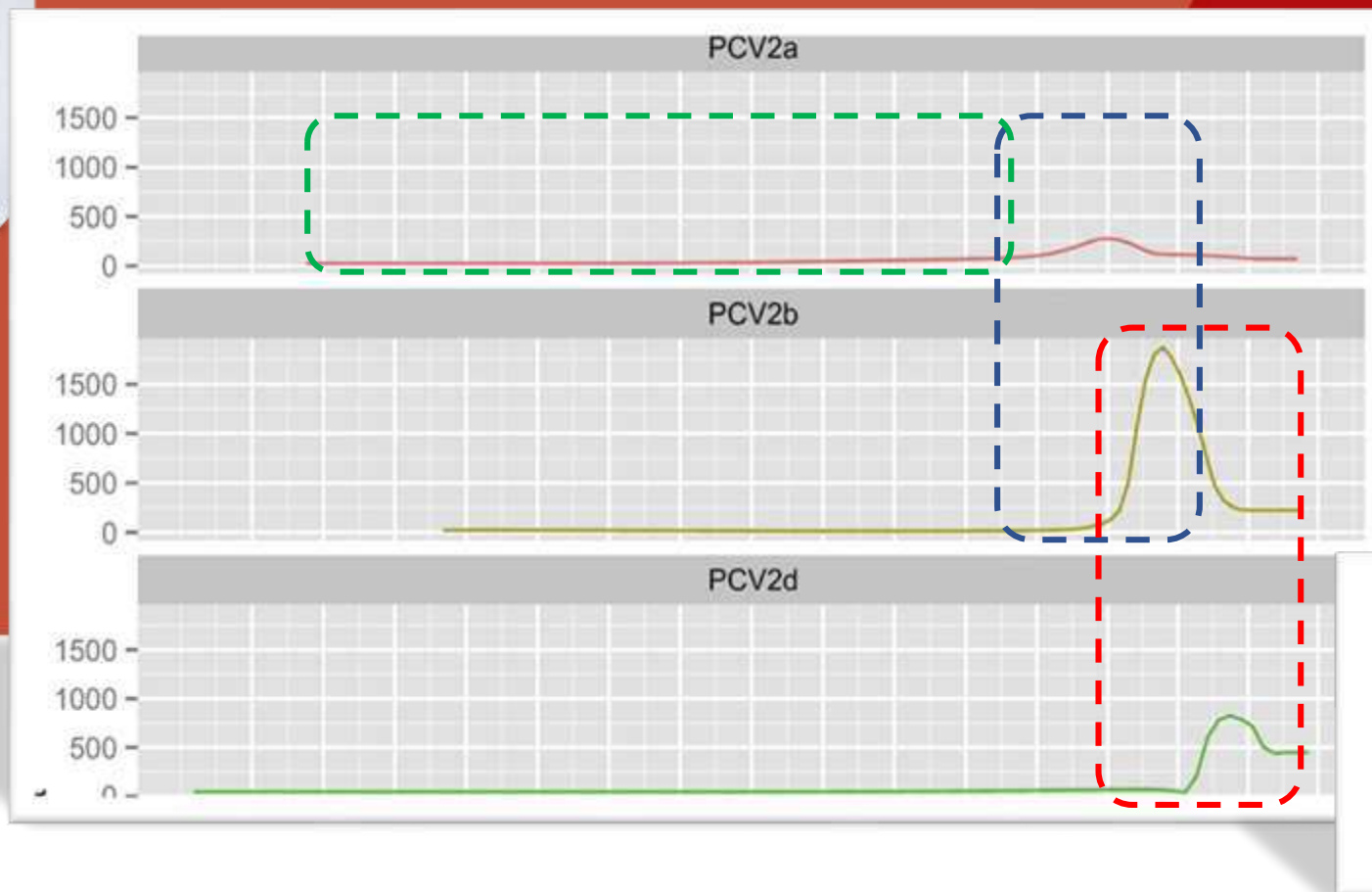


CONSEQUENCES!


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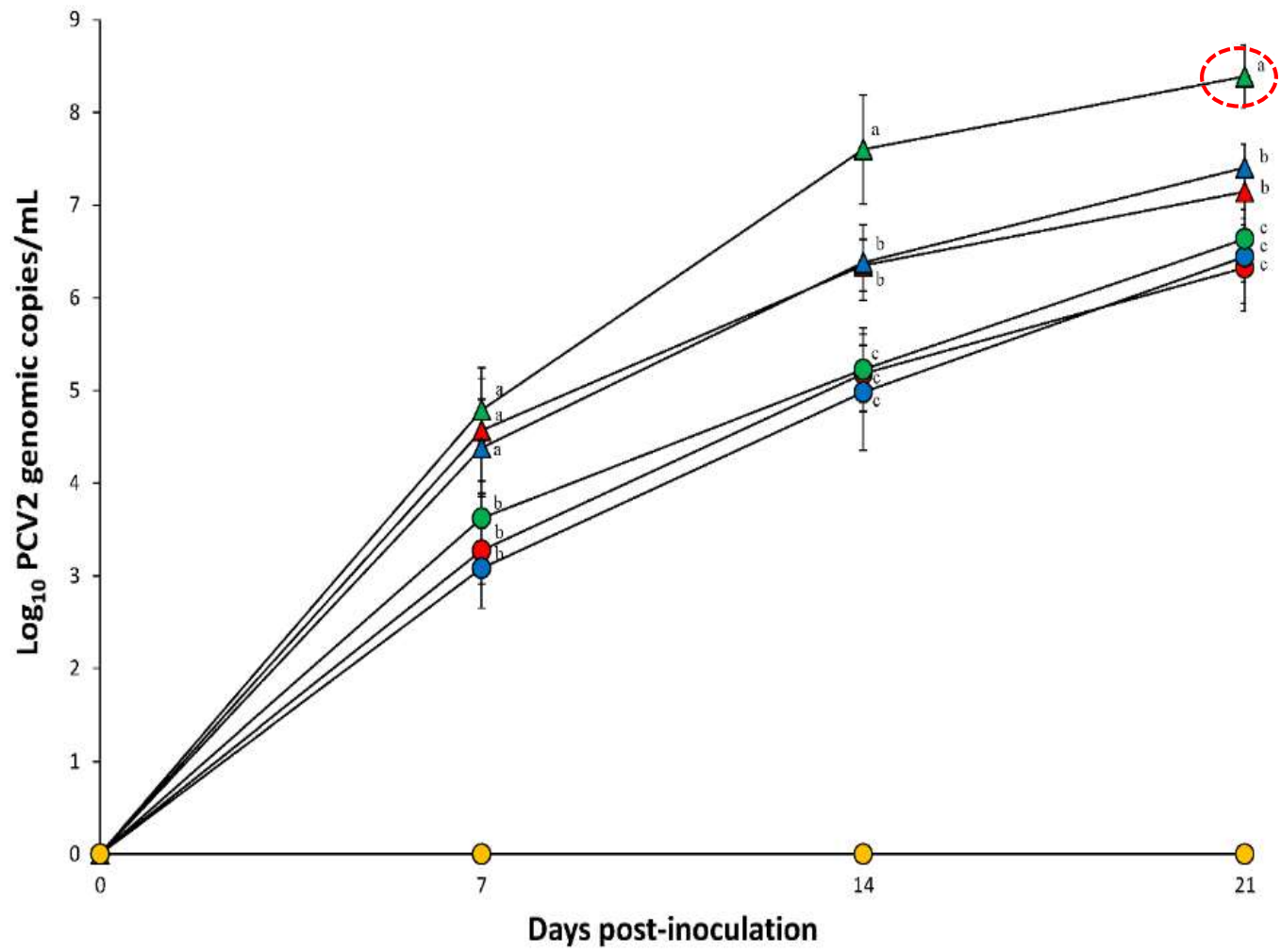


UNIVERSITÀ  
DEGLI STUDI  
DI PADOVA



Article  
**A Comparison of Virulence of Three Porcine Circovirus Type 2 (PCV2) Genotypes (a, b, and d) in Pigs Singularly Inoculated with PCV2 and Dually Inoculated with PCV2 and Porcine Reproductive and Respiratory Syndrome Virus**

Jeongmin Suh †, Taehwan Oh †, Keehwan Park, Siyeon Yang , Hyejean Cho and Chanhee Chae \*









# Vaccinazione

## Target

- ✓ Prevenzione PCVD
- ✓ Miglioramento performances in soggetti subclinici

Veterinary Microbiology 177 (2015) 43–52



Contents lists available at [ScienceDirect](#)

Veterinary Microbiology

journal homepage: [www.elsevier.com/locate/vetmic](http://www.elsevier.com/locate/vetmic)



Comparison of three commercial one-dose porcine circovirus type 2 (PCV2) vaccines in a herd with concurrent circulation of PCV2b and mutant PCV2b

Jiwoon Jeong<sup>1</sup>, Changhoon Park<sup>1</sup>, Kyuhyung Choi, Chanhee Chae<sup>\*</sup>

*Department of Veterinary Pathology, College of Veterinary Medicine, Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 151-742, Republic of Korea*



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Preventive Veterinary Medicine

journal homepage: [www.elsevier.com/locate/prevetmed](http://www.elsevier.com/locate/prevetmed)



Mixed treatment comparison meta-analysis of porcine circovirus type 2 (PCV2) vaccines used in piglets

N. da Silva<sup>a</sup>, A. Carriquiry<sup>a</sup>, K. O'Neill<sup>b</sup>, T. Opriessnig<sup>b,c</sup>, A.M. O'Connor<sup>b,\*</sup>

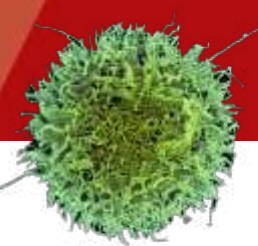
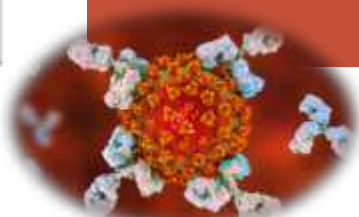
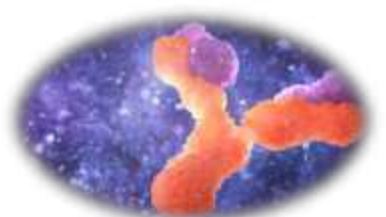
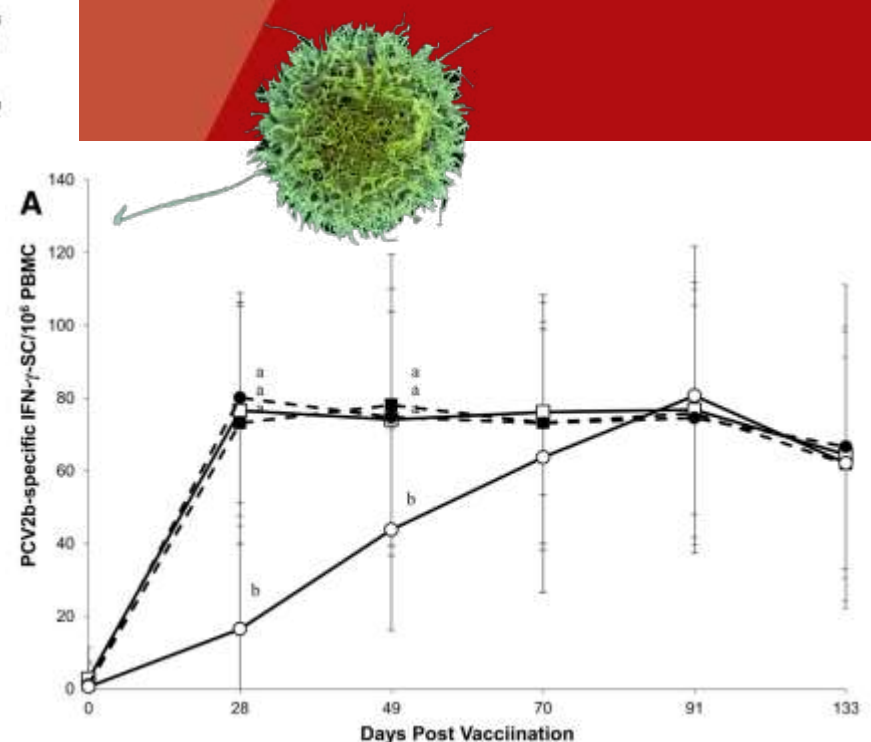
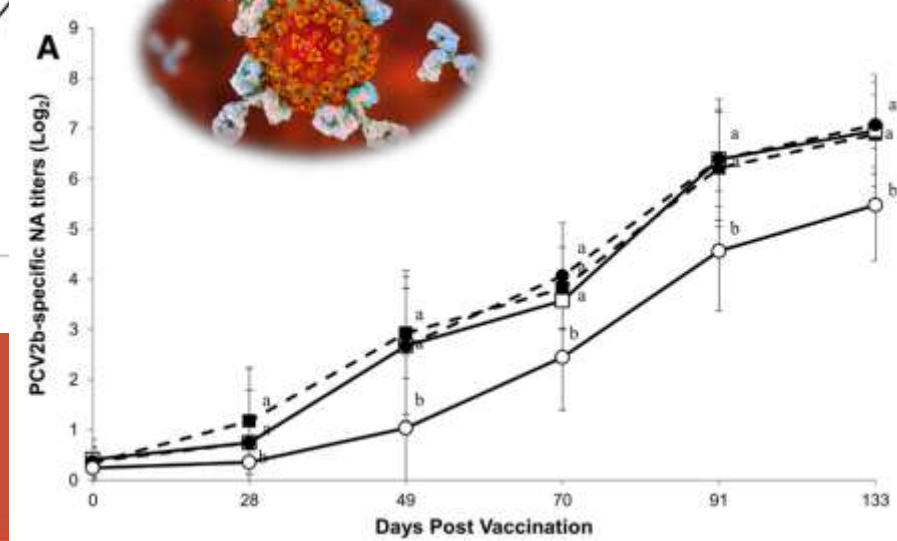
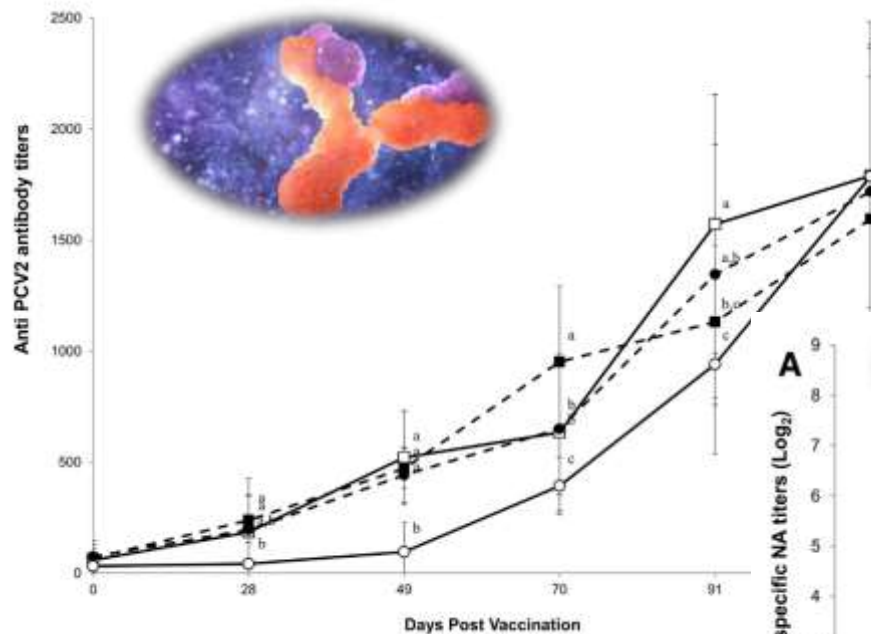
<sup>a</sup> Department of Statistics, Iowa State University College of Liberal Arts and Sciences, Ames, IA 50011, United States

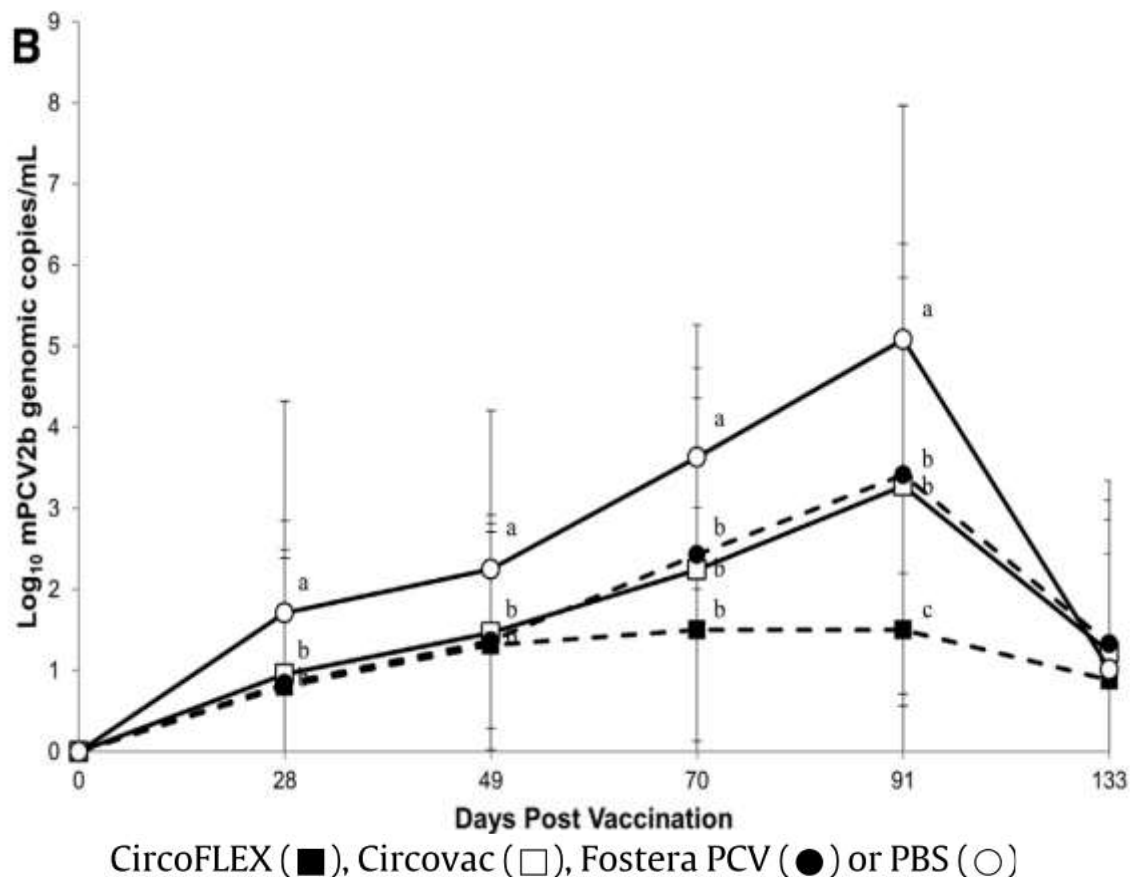
<sup>b</sup> Department of Veterinary Diagnostics and Production Animal Medicine, Iowa State University College of Veterinary Medicine, 1600 South 16th Street, Ames, IA 50011, United States

<sup>c</sup> The Roslin Institute and The Royal (Dick) School of Veterinary Studies, University of Edinburgh, Easter Bush, Midlothian EH25 9RG, Scotland, UK



CircoFLEX (■), Circovac (□), Foster PCV (●) or PBS (○)





		CircoFLEX	Circovac	Fostera PCV	Unvaccinated
ADG (weeks)	3-10	490.3 ± 28	491.4 ± 27	505.5 ± 30	490.4 ± 29
	10-16	656.8 ± 69 <sup>a</sup>	651.7 ± 71 <sup>a</sup>	626 ± 63 <sup>a</sup>	584.7 ± 79 <sup>b</sup>
	16-22	878.8 ± 136	871.8 ± 118	870.7 ± 89	836.9 ± 128
	3-22	663.2 ± 35 <sup>a</sup>	658.9 ± 33 <sup>a</sup>	657.1 ± 26 <sup>a</sup>	626.5 ± 32 <sup>b</sup>
Mortality		2/30	4/30	4/30	5/30
Prevalence of PCV2b-viremia (dpv)	28	1/28	0/28	2/28	1/28
	49	0/28	0/28	0/28	0/27
	70	0/28	0/28	1/28	0/27
	91	3/28	3/26	4/26	4/25
	133	0/23	0/21	0/21	0/20
Prevalence of mPCV2b-viremia (dpv)	28	6/28	6/28	6/28	9/28
	49	14/28	15/28	14/28	18/27
	70	15/28 <sup>a</sup>	16/28 <sup>a</sup>	16/28 <sup>a</sup>	25/27 <sup>b</sup>
	91	11/28 <sup>a</sup>	18/26 <sup>a,b</sup>	17/26 <sup>a,b</sup>	20/25 <sup>b</sup>
	133	6/23	7/21	7/21	5/20
Prevalence of PRRSV-viremia (dpv)	28	7/28	7/28	7/28	7/28
	49	12/28	14/28	12/28	14/27
	70	5/28	3/28	4/28	3/27
	91	3/28	3/26	4/26	4/25
	133	1/23	1/21	0/21	0/20
Prevalence	28	21/28	19/28	20/28	5/28
	49	28/28	28/28	28/28	10/27
	70	28/28	28/28	28/28	27/27
	91	28/28	26/26	26/26	25/25
	133	23/23	21/21	21/21	20/20
Lymphoid lesion (dpv)	91	0.33 ± 0.34 <sup>a</sup>	0.62 ± 0.55 <sup>a</sup>	0.86 ± 0.72 <sup>a</sup>	2.06 ± 0.65 <sup>b</sup>
PCV2-antigen (dpv)	91	7.08 ± 8.43 <sup>a</sup>	11.22 ± 9.55 <sup>a</sup>	13.42 ± 10.21 <sup>a</sup>	25.95 ± 14.23 <sup>b</sup>

Different letters (a and b) indicate significant ( $P < 0.05$ ) difference between groups.

Vaccine 34 (2016) 3738–3745

Contents lists available at ScienceDirect

Vaccine

journal homepage: [www.elsevier.com/locate/vaccine](http://www.elsevier.com/locate/vaccine)



A commercial PCV2a-based vaccine significantly reduces PCV2b transmission in experimental conditions

N. Rose<sup>a</sup>, M. Andraud, L. Bigault, A. Jestin, B. Grasland

<sup>a</sup>Arise, Laboratoire de Ploufragan-Plouzane, BP 53, 22440 Ploufragan, France  
 Université Bretagne Loire, Rennes, France



Veterinary Microbiology 189 (2016) 86–90

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Veterinary Microbiology

journal homepage: [www.elsevier.com/locate/vetmic](http://www.elsevier.com/locate/vetmic)



$R_0 = 5.1$  [95% CI 2.5 without vaccination]

National reduction in porcine circovirus type 2 prevalence following introduction of vaccination

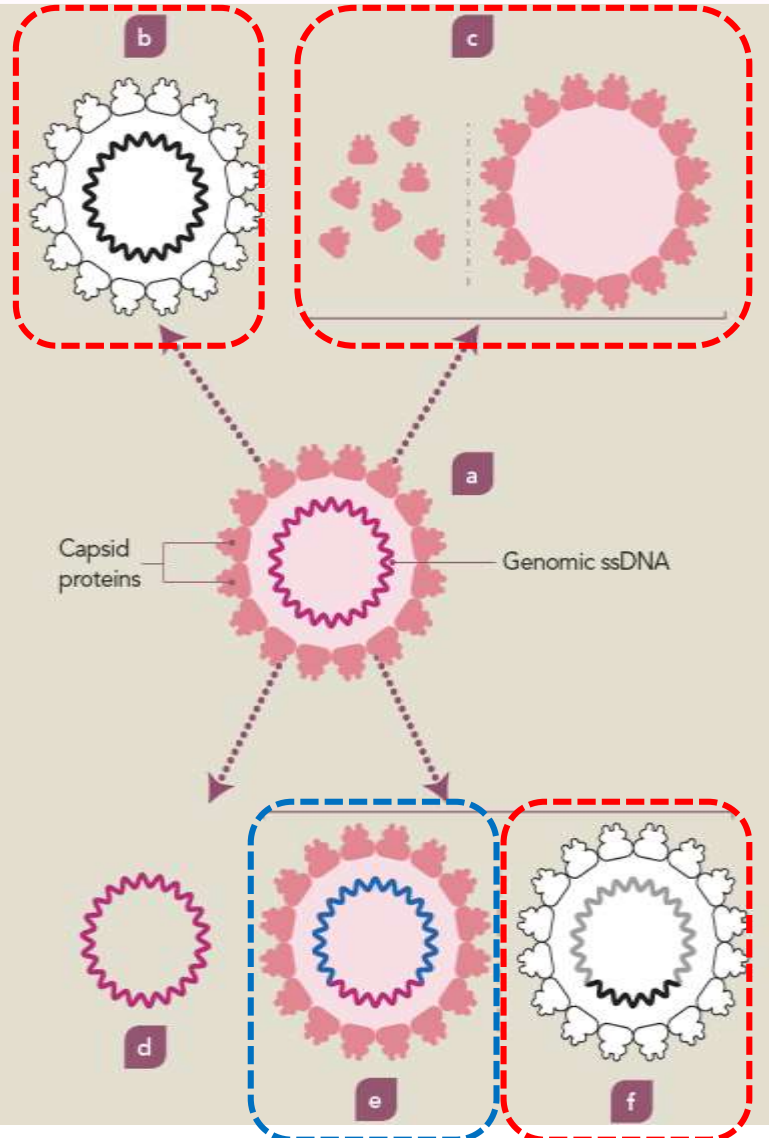
Cheryl M.T. Dvorak<sup>a,\*</sup>, Yan Yang<sup>a</sup>, Charles Haley<sup>b</sup>, Nikita Sharma<sup>a</sup>, Michael P. Murtaugh<sup>a</sup>

<sup>a</sup> Department of Veterinary and Biomedical Sciences, University of Minnesota, 1971 Commonwealth Ave, St. Paul, MN 55108, USA

<sup>b</sup> Centers for Epidemiology and Animal Health, USDA-APHIS-VS, 2150 Centre Avenue, Building B, MS 2E7 Fort Collins, CO, USA



# Vaccini



- a) Wild virus
- b) Inactivated
- c) Cap recombinant protein (free or in Virus Like Particles (VLP))
- d) DNA vaccine
- e) PCV2 chimeric (live)
- f) PCV2 chimeric (inactivated)

Altri vaccini sono stati sviluppati e usati in ristrette aree geografiche, specialmente nel sud-est asiatico e in Cina

Manufacturing company	Vaccine name	Antigen	Licensed for	Administration dosage		
Merial *	Circovac®	Inactivated PCV2a	Sows/ Gilts	2 mL, IM		
			Pigs	0.5 mL, IM		
Boehringer Ingelheim	Ingelvac® CircoFLEX	PCV2a Cap protein	Pigs	1 mL, IM		
			Sows/ Gilts	1 mL, IM		
MSD/Merck Animal Health	Porcilis® PCV	PCV2a Cap protein	Pigs	2 mL, IM		
	Circumvent™ PCV	PCV2a Cap protein	Pigs	2 mL, IM		
	Circumvent™ G2 PCV	PCV2a Cap protein	Pigs	1 (x2) or 2 mL, IM		
	Porcilis® PCV M Hyo †	PCV2a Cap protein	Pigs	2 mL, IM		
	Circumvent® PCV M †	PCV2a Cap protein	Pigs	2 mL, IM		
	Circumvent® PCV-M G2 †	PCV2a Cap protein	Pigs	1 (x2) or 2 mL, IM		
	Porcilis® PCV ID	PCV2a Cap protein	Pigs	0.2 mL (ID with IDAL device)		
	Zoetis	Suvaxyn® PCV	Inactivated recombinant PCV1 expressing the PCV2a Cap protein	Pigs	2 mL, IM	
Zoetis	Fostera™ PCV **	Inactivated recombinant PCV1 expressing the PCV2a Cap protein	Pigs	1 (x2) or 2 mL, IM		
			Suvaxyn® Circo+MH RTU †	Inactivated recombinant PCV1 expressing the PCV2a Cap protein	Pigs	2 mL, IM
			Fostera® PCV MH †	Inactivated recombinant PCV1 expressing the PCV2a Cap protein	Pigs	1 (x2) or 2 mL, IM

IM – intramuscular; ID – intradermal.  
 \* This product has been recently acquired by company CEVA (2017).  
 \*\* Named as Relsure™ PCV in some South and Central American countries.  
 \*\*\* The SPC (summary product characteristics) of the product indicates the following recommendations in relation to maternally derived antibodies (MDA): in the case of low to medium levels of MDA against PCV2, a single vaccination (2 mL) to pigs from an age of 3 weeks onwards is advised. When it is expected that higher levels of MDA against PCV2 are present, the following

# Vaccination Failure

Other side of the  
coin...

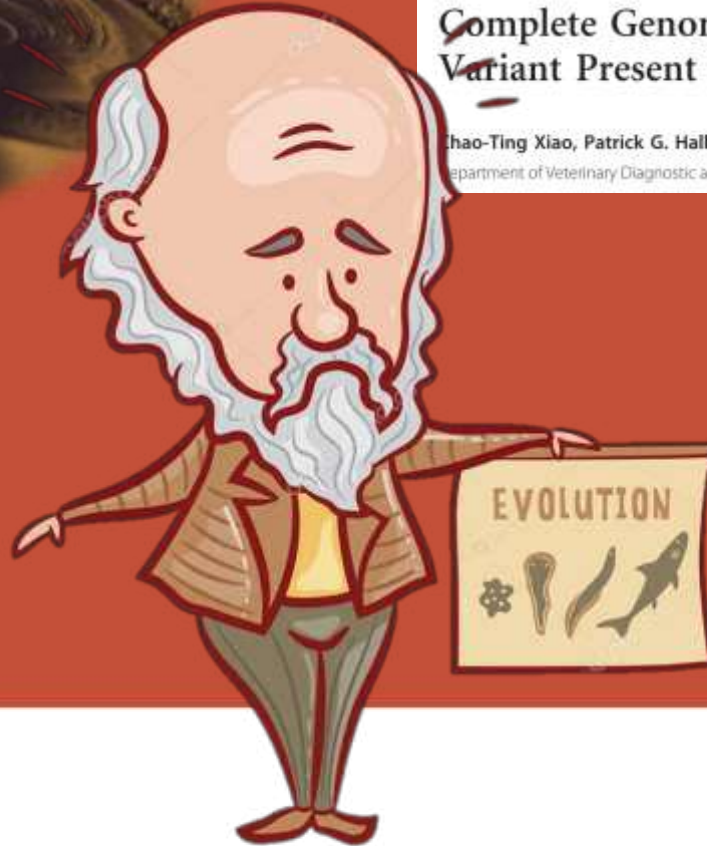


GENOME ANNOUNCEMENT

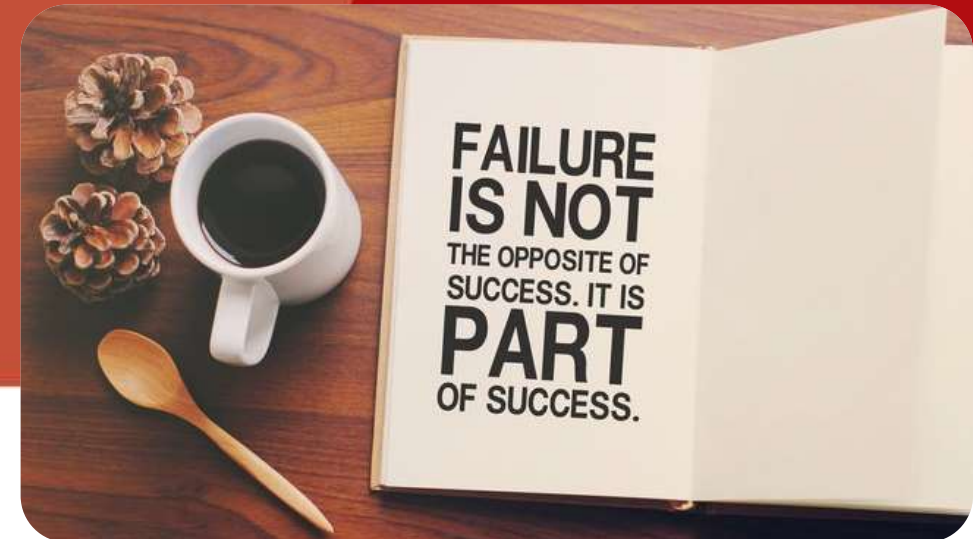
## Complete Genome Sequence of a Novel Porcine Circovirus Type 2b Variant Present in Cases of Vaccine Failures in the United States

Chao-Ting Xiao, Patrick G. Halbur, and Tanja Oprelšniĝ

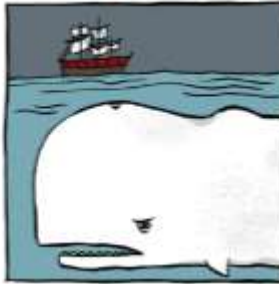
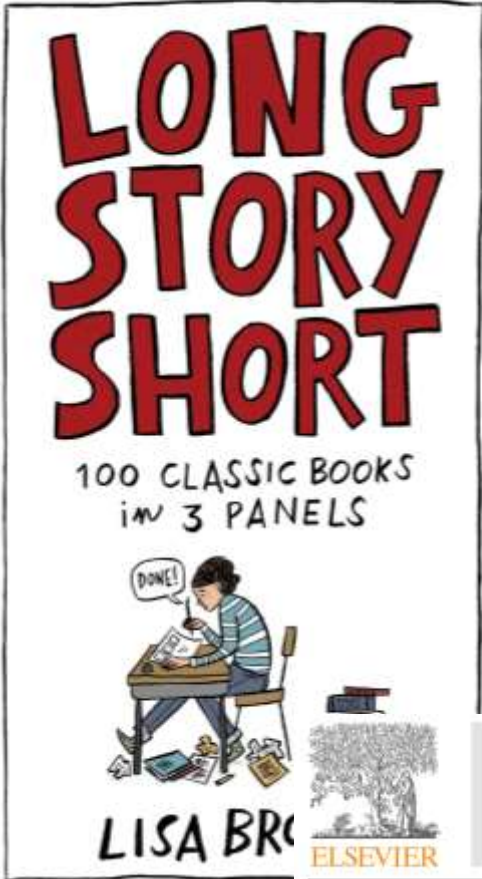
Department of Veterinary Diagnostic and Production Animal Medicine, College of Veterinary Medicine, Iowa State University, Ames, Iowa, USA



Charles Darwin



## In condizioni sperimentali...Si!



*Porcine circovirus* type 2a or 2b based experimental vaccines provide protection against PCV2d/porcine parvovirus 2 co-challenge

Tanja Opriessnig<sup>a,b,\*</sup>, Anbu K. Karuppanan<sup>b</sup>, Patrick G. Halbur<sup>b</sup>, Jay G. Calvert<sup>c</sup>, Gregory P. Nitzel<sup>c</sup>, Shannon R. Matzinger<sup>d</sup>, Xiang-Jin Meng<sup>d</sup>

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A commercial PCV2a-based vaccine significantly reduces PCV2b transmission in experimental conditions

N. Rose<sup>\*</sup>, M. Andraud, L. Bigault, A. Jestin, B. Grasland

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Université Bretagne Loire, Rennes, France



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Vaccine 32 (2014) 230–237



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Evaluation of a porcine circovirus type 2a (PCV2a) vaccine efficacy against experimental PCV2a, PCV2b, and PCV2d challenge

Kee Hwan Park<sup>1</sup>, Taehwan Oh<sup>1</sup>, Siyeon Yang, Hyejean Cho, Ikjae Kang, Chanhee Chae<sup>\*</sup>

Department of Veterinary Pathology, College of Veterinary Medicine, Seoul National University, Gwanak-ro 1, Gwanak-gu, Seoul, 08826, Republic of Korea



A commercial vaccine based on PCV2a and an experimental vaccine based on a variant mPCV2b are both effective in protecting pigs against challenge with a 2013 U.S. variant mPCV2b strain

Tanja Opriessnig<sup>a,b,\*</sup>, Priscilla F. Gerber<sup>a,c</sup>, Chao-Ting Xiao<sup>a</sup>, Mark Mogler<sup>d</sup>, Patrick G. Halbur<sup>a</sup>





«Vaccine failure»  
Or  
«Vaccination failure»





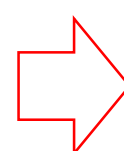
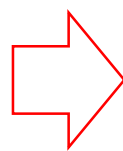


Comparison of three commercial one-dose porcine circovirus type 2 (PCV2) vaccines in a herd with concurrent circulation of PCV2b and mutant PCV2b



Jiwoon Jeong<sup>1</sup>, Changhoon Park<sup>1</sup>, Kyuhyung Choi, Chanhee Chae<sup>\*</sup>

<sup>1</sup>Department of Veterinary Pathology, College of Veterinary Medicine, Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 151-742, Republic of Korea



PCV2d



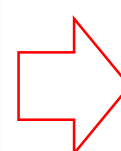
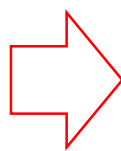


Comparison of three commercial one-dose porcine circovirus type 2 (PCV2) vaccines in a herd with concurrent circulation of PCV2b and mutant PCV2b



Jiwoon Jeong<sup>1</sup>, Changhoon Park<sup>1</sup>, Kyuhyung Choi, Chanhee Chae<sup>\*</sup>

<sup>1</sup>Department of Veterinary Pathology, College of Veterinary Medicine, Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 151-740, Republic of Korea

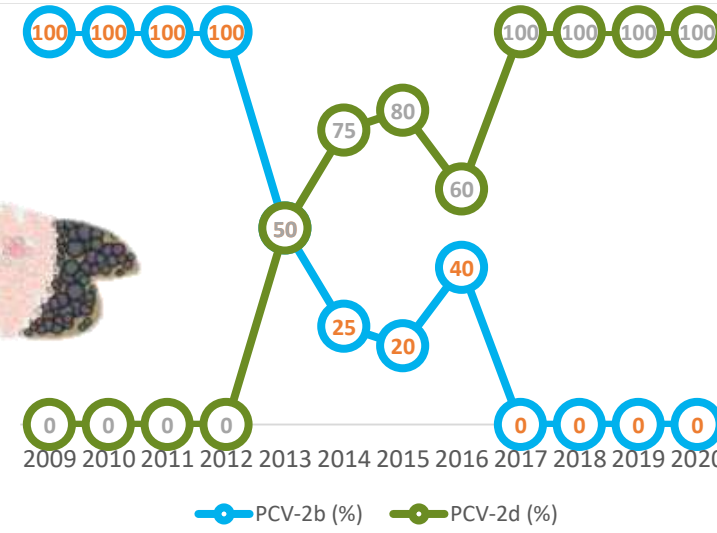
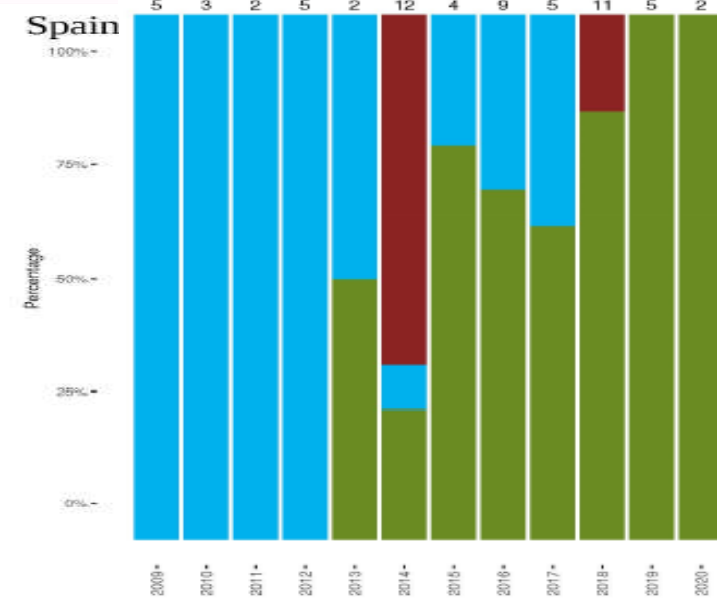
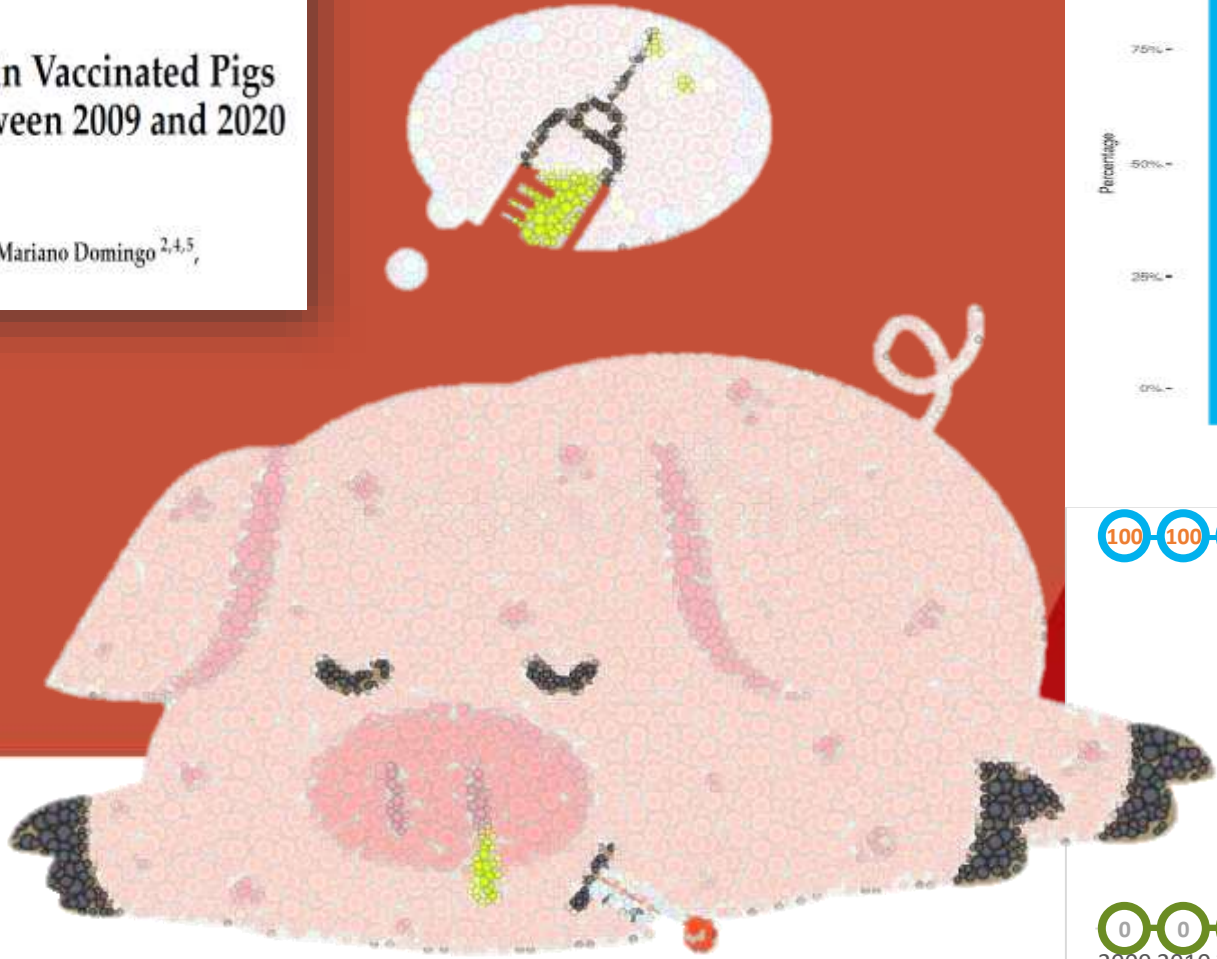


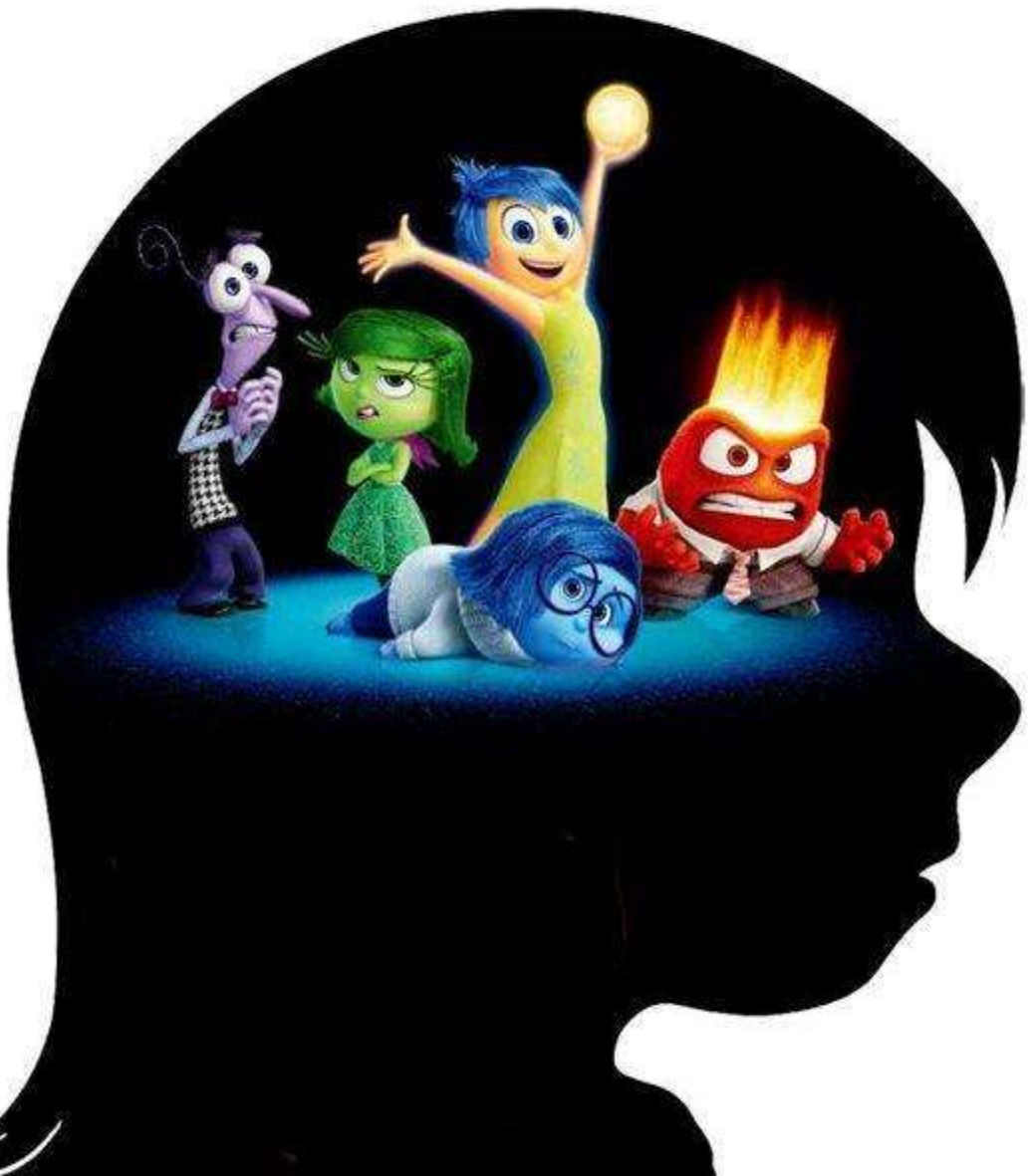
PCV2d



Article  
**Genotyping of Porcine Circovirus 2 (PCV-2) in Vaccinated Pigs Suffering from PCV-2-Systemic Disease between 2009 and 2020 in Spain**

Marina Sibila <sup>1,2,\*,†</sup>, Caterina Rocco <sup>1,2,†</sup>, Giovanni Franzo <sup>3</sup>, Eva Huerta <sup>1,2</sup>, Mariano Domingo <sup>2,4,5</sup>, José Ignacio Núñez <sup>1,2</sup> and Joaquim Segalés <sup>2,4,5</sup>





## Every possible emotional overlap in Inside Out

*Joy and Sadness make melancholy. But what do the other emotions add up to?*



# Immuno-escape???



## Immuno-escape



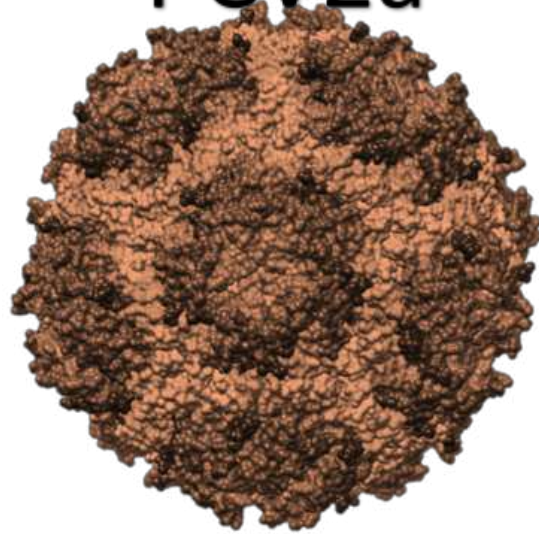
- Epitopi specifici
- Alcune evidenze sperimentali (singoli parametri)
- Variazione nella prevalenza di alcuni genotipi
  - Diminuzione PCV2a
  - Aumento(relativo) of PCV2-b and PCV2-d
  - Evoluzione su larga scala ;

## Porcine circovirus type 2 (PCV2) evolution before and after the vaccination introduction: A large scale epidemiological study

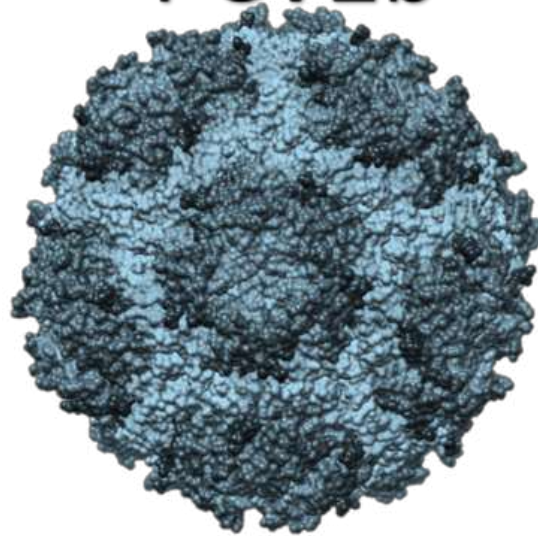
Received: 16 May 2016  
Accepted: 21 November 2016  
Published: 19 December 2016

Giovanni Franzo\*, Claudia Maria Tucciarone\*, Mattia Cecchinato & Michele Drigo

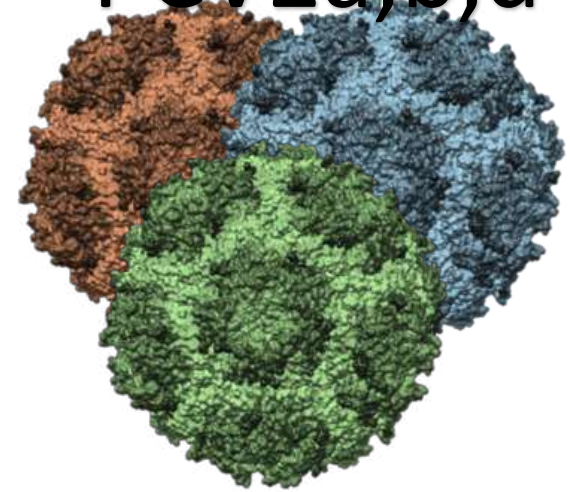
### PCV2a

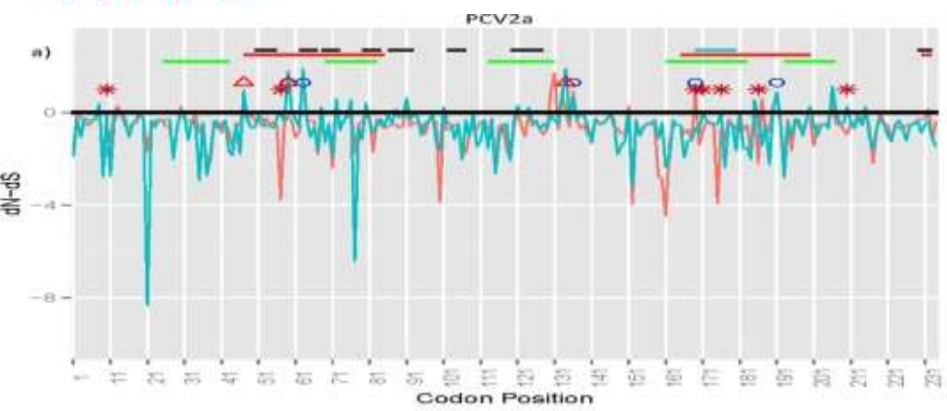


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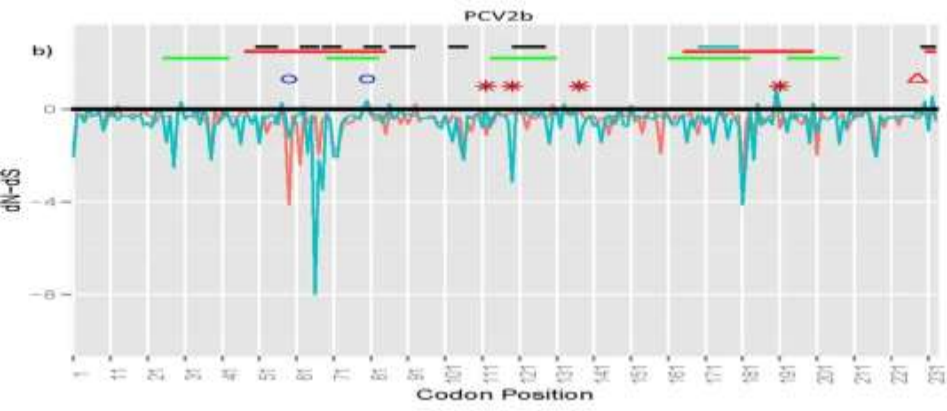


### PCV2a,b,d

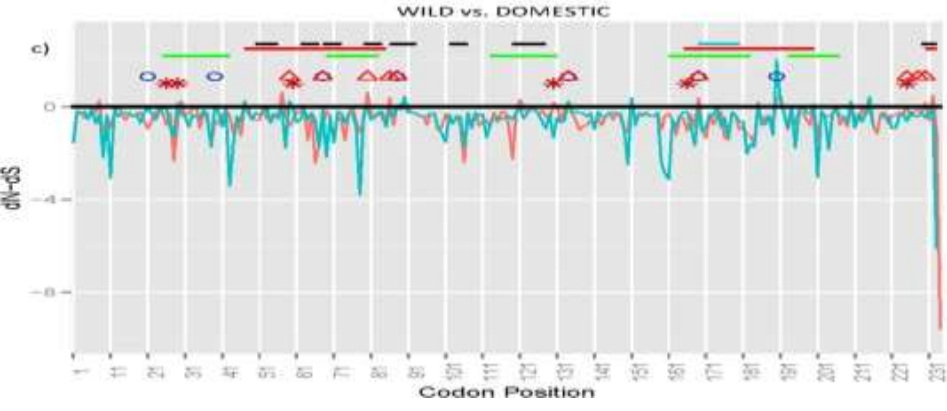




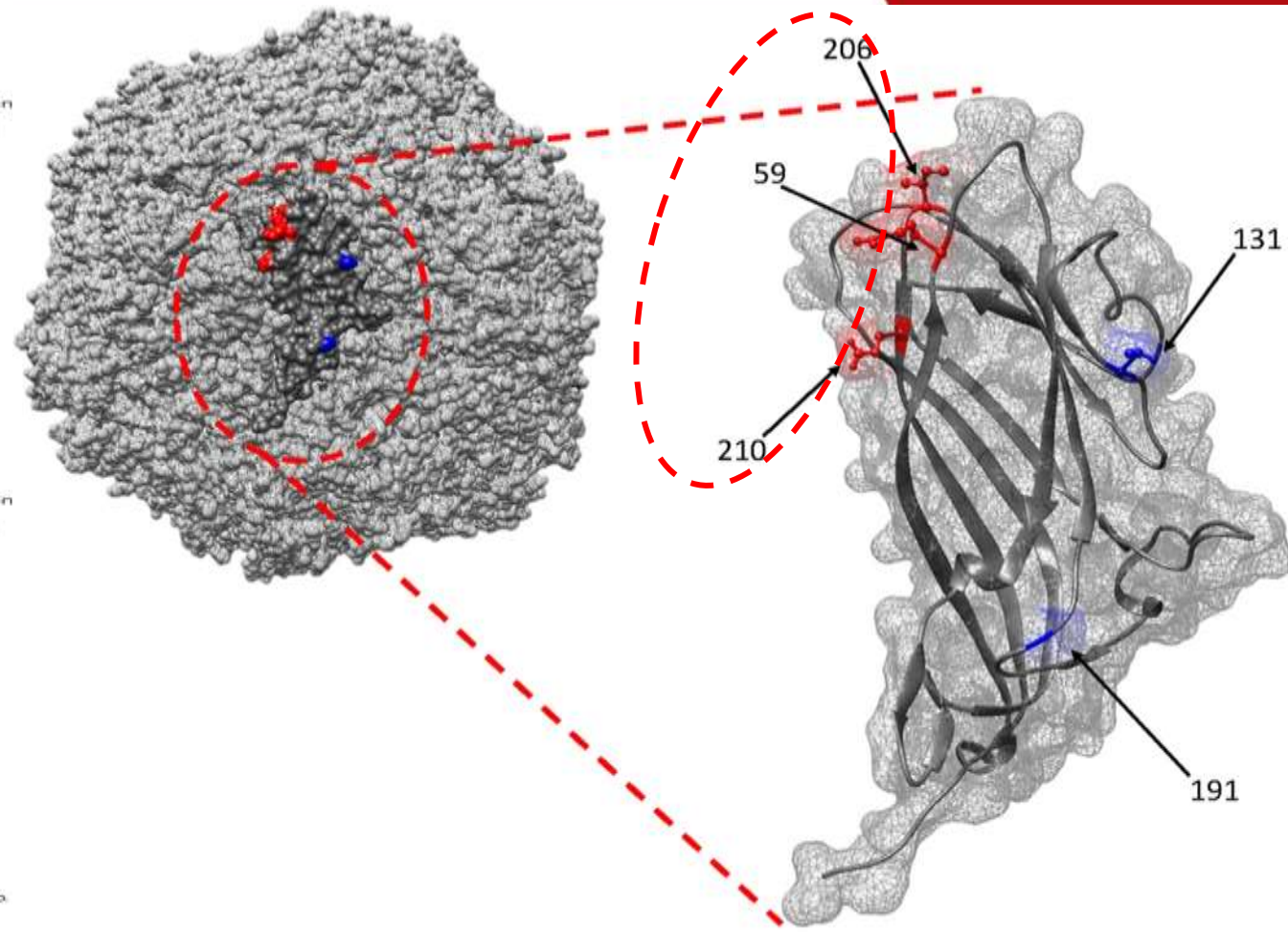
Species  
 — Before Vaccination  
 — Post Vaccination



Species  
 — Before Vaccination  
 — Post Vaccination

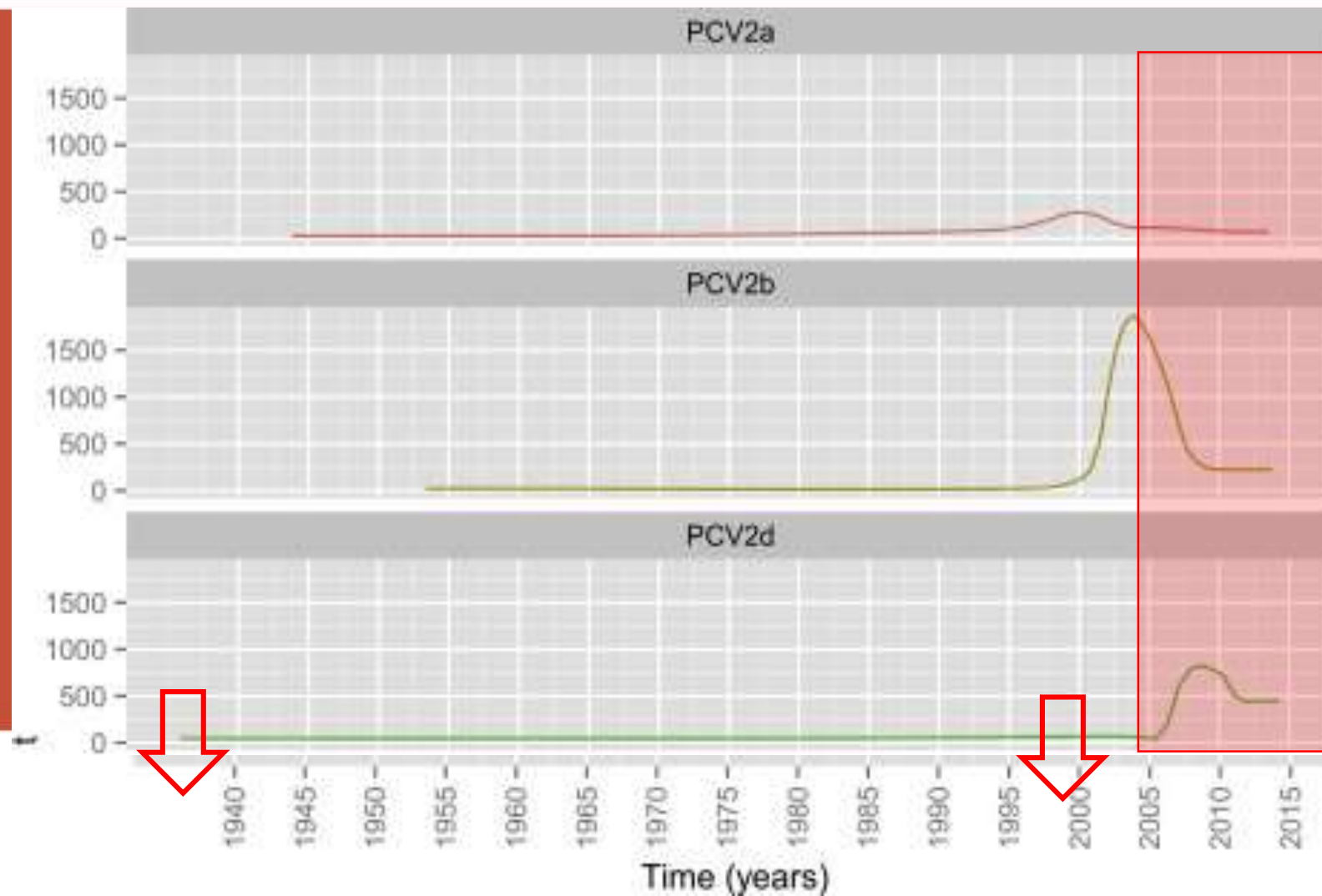


Species  
 — Domestic pig pop.  
 — Wild boar pop.

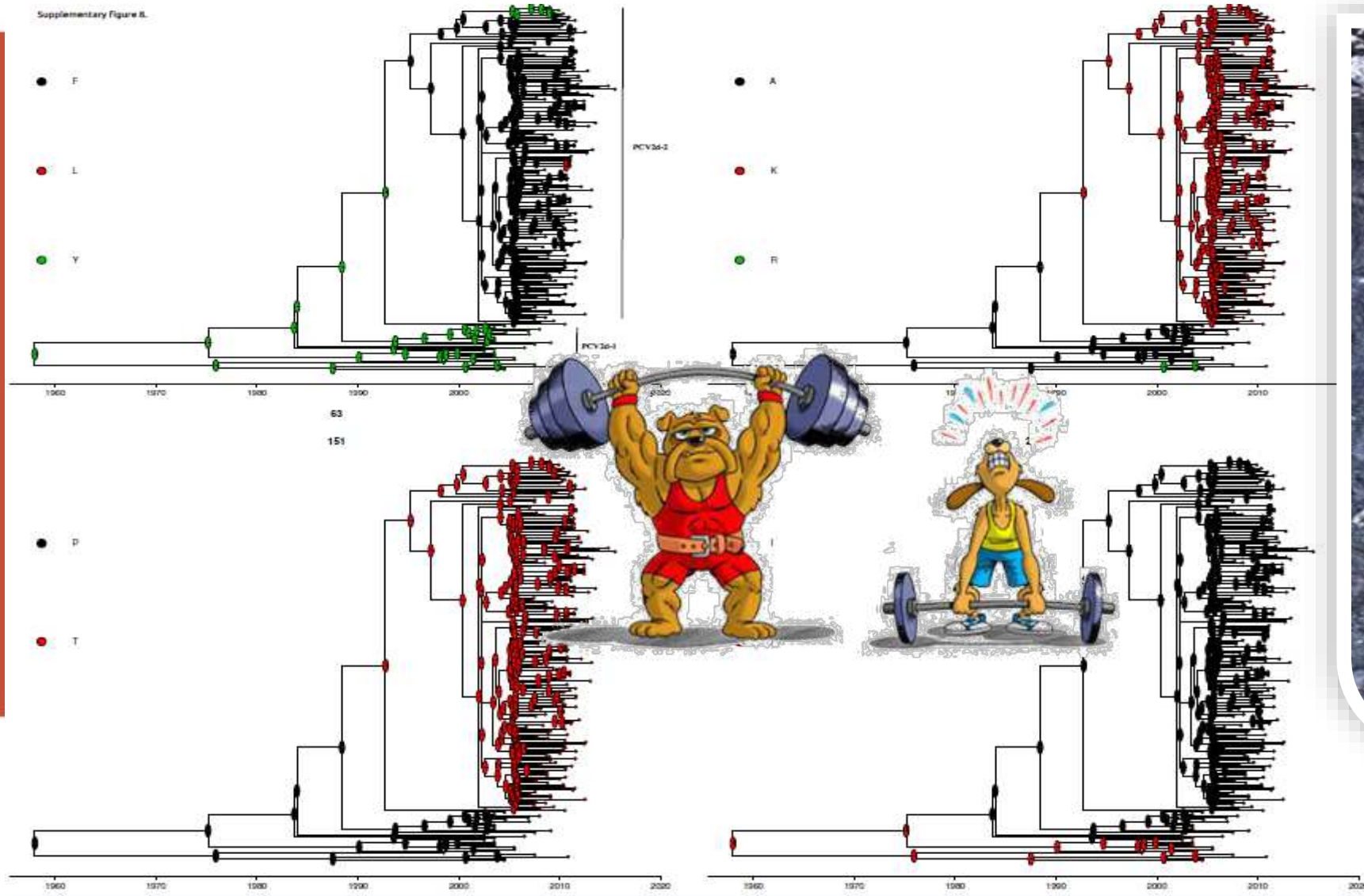




# PCV-2d???

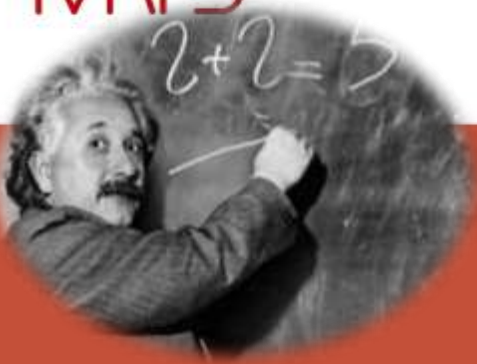


# PCV-2d



# Leaky vaccines





Vaccini efficaci in condizioni «ottimali»

- Condizioni sperimentali
- Vaccinazione eseguita correttamente
- Timing corretto
- ...

Nella pratica

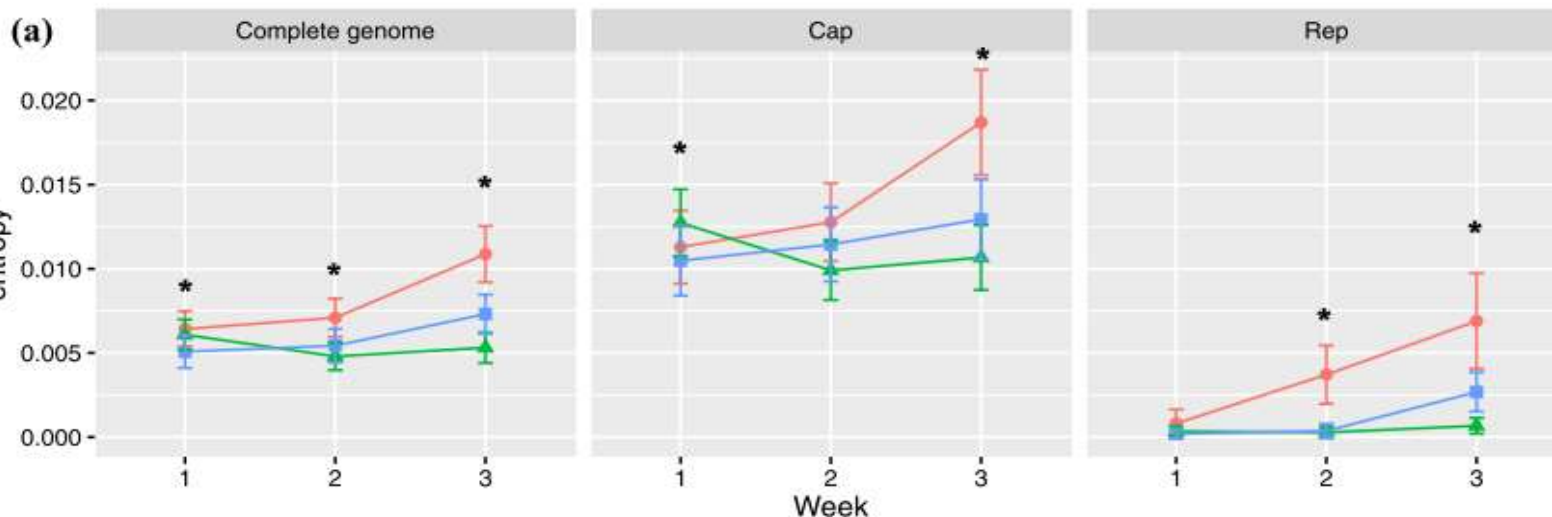
- Vaccino non gestito correttamente
- Coverage parziale
- Timing sbagliato
- Immunità declinante
- Animali stressati
- Coinfezione
- ...

Ceppo omologo

Ceppo eterologo

Protetti

Minor protezione  
( $e >$  replicazione)



Group    Group 1: PCV2-SD    Group 2: subclinical low

Group 3: subclinical high



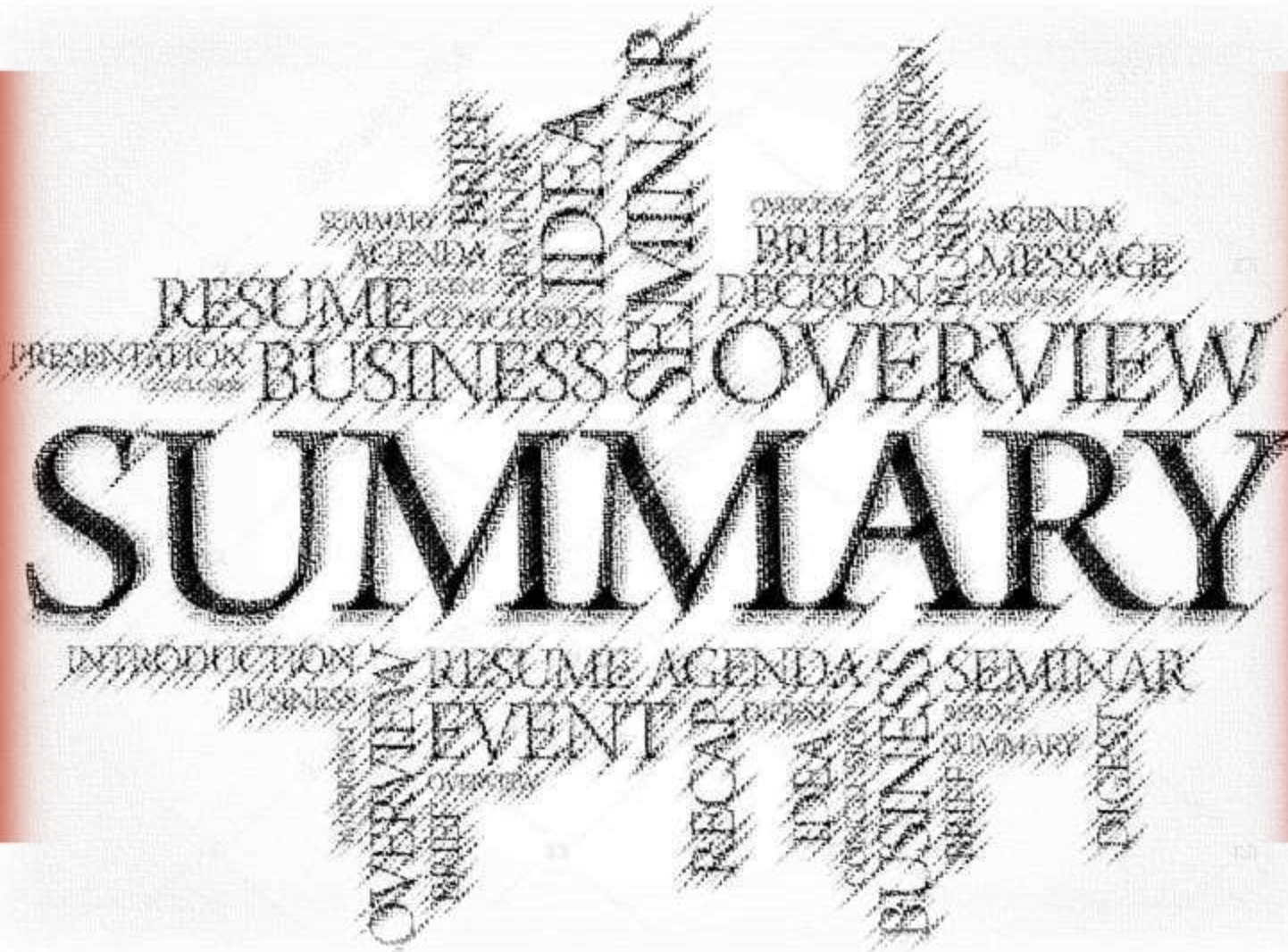
**Ne x s >> 1**

## scientific reports

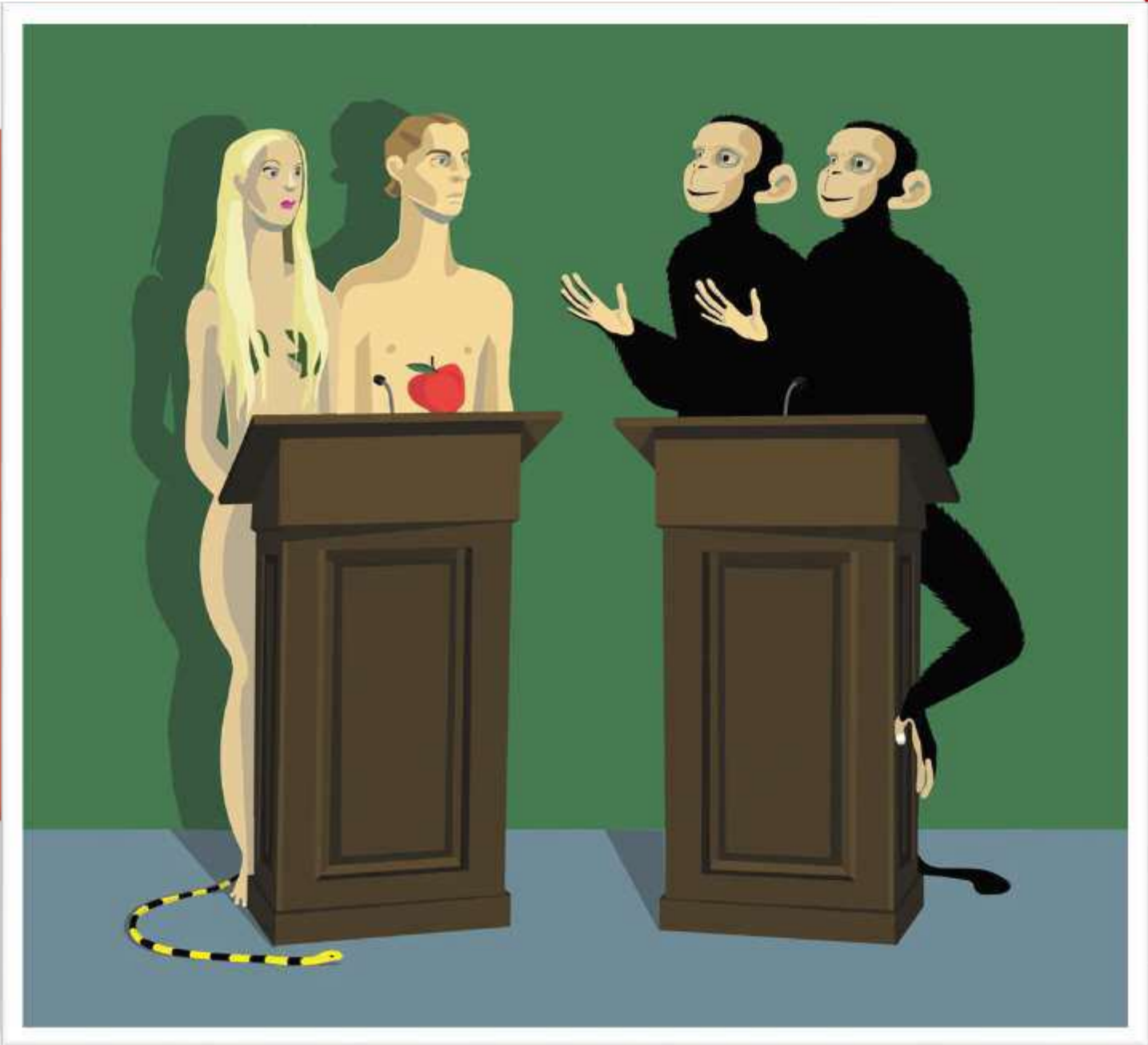
**OPEN** Porcine circovirus 2 (PCV2) population study in experimentally infected pigs developing PCV2-systemic disease or a subclinical infection

Florencia Correa-Fiz<sup>1,2,6,7</sup>, Giovanni Franzo<sup>5,6</sup>, Anna Llorens<sup>1,2</sup>, Eva Huerta<sup>1,2</sup>, Marina Sibila<sup>1,2</sup>, Tuija Kekkarainen<sup>1,5</sup> & Joaquim Segalés<sup>1,2,4</sup>







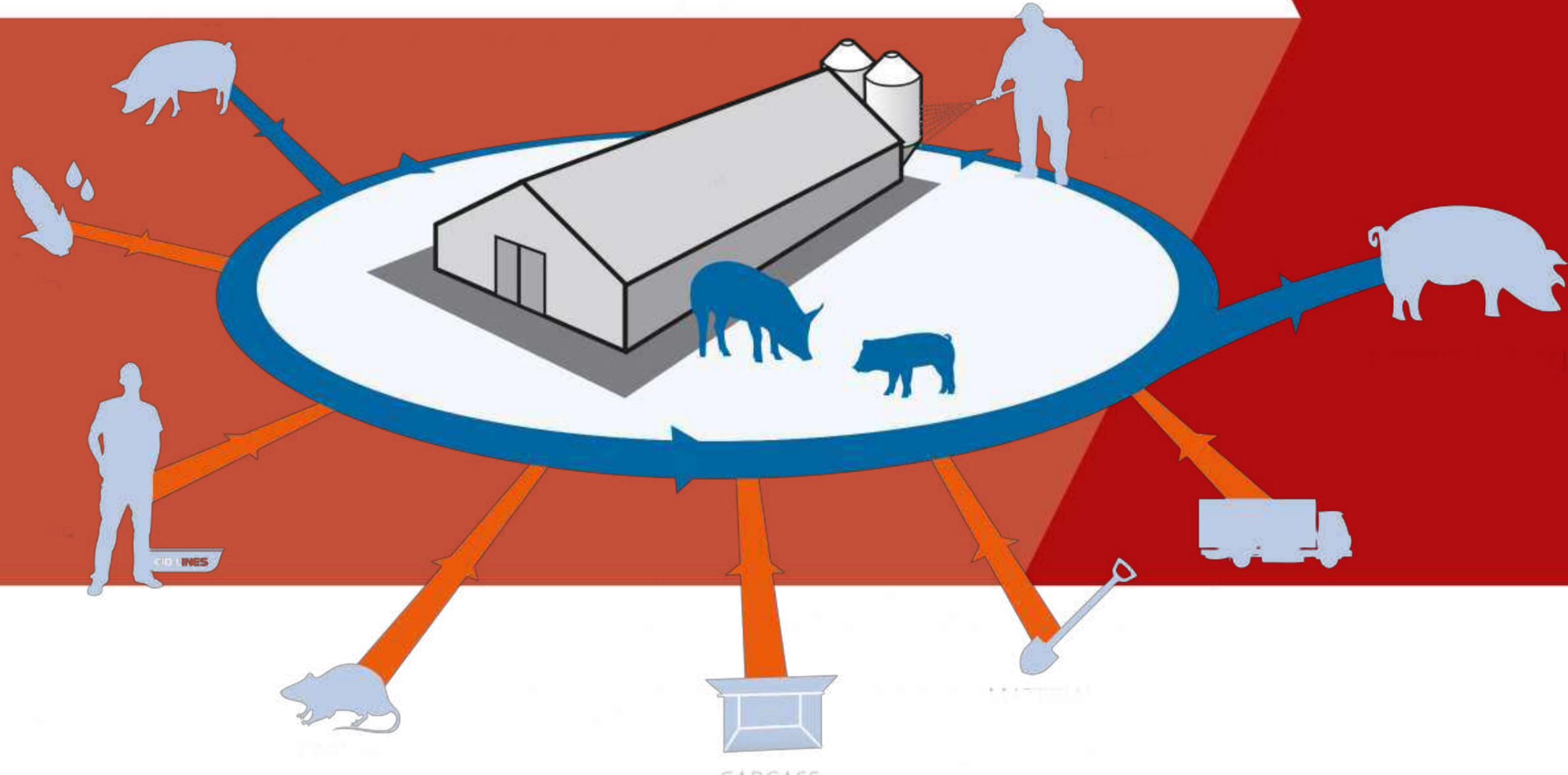






Ne x s >>1







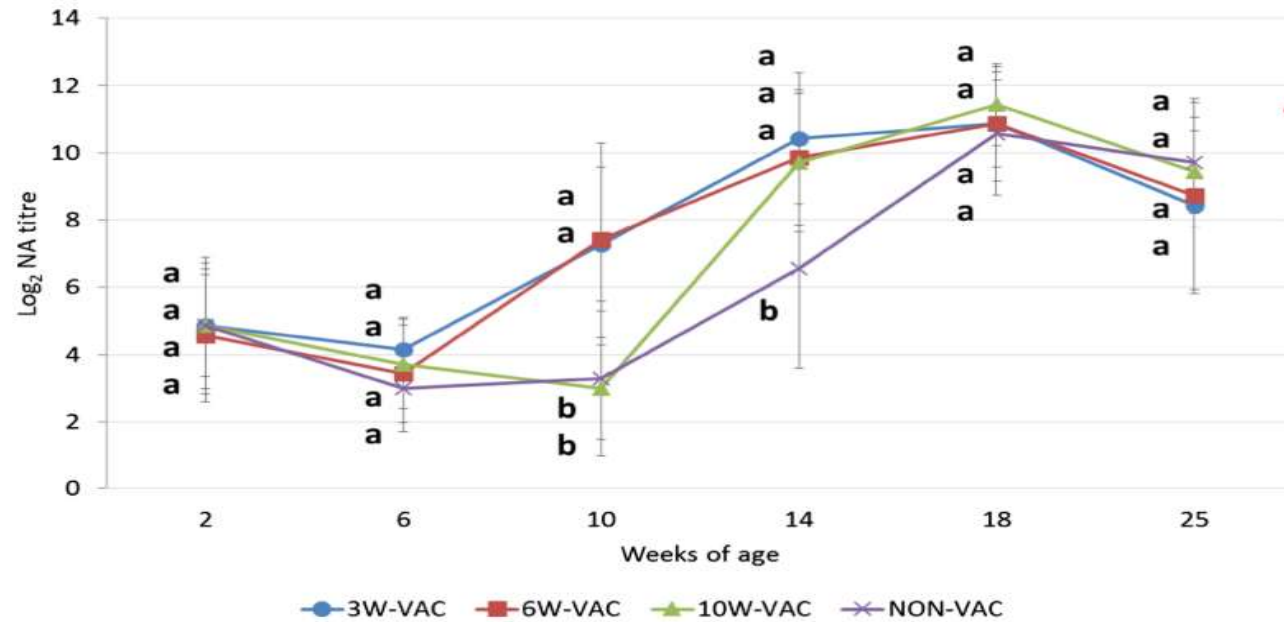
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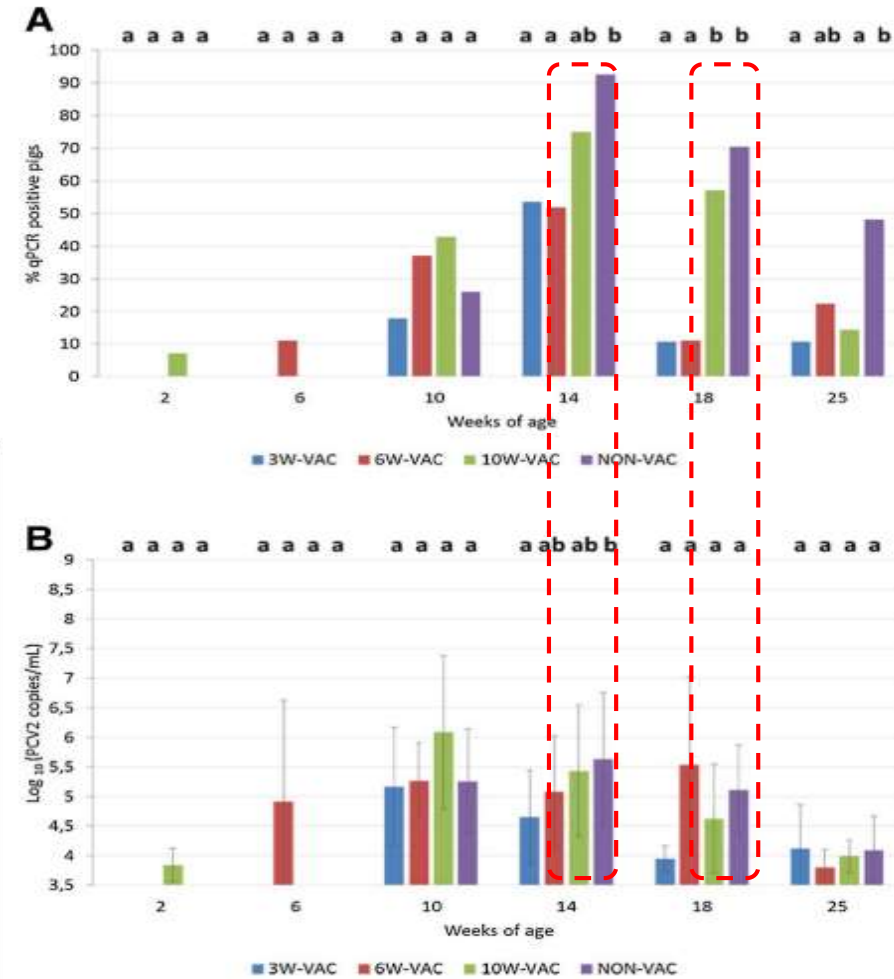


# Evaluation of natural porcine circovirus type 2 (PCV2) subclinical infection and seroconversion dynamics in piglets vaccinated at different ages

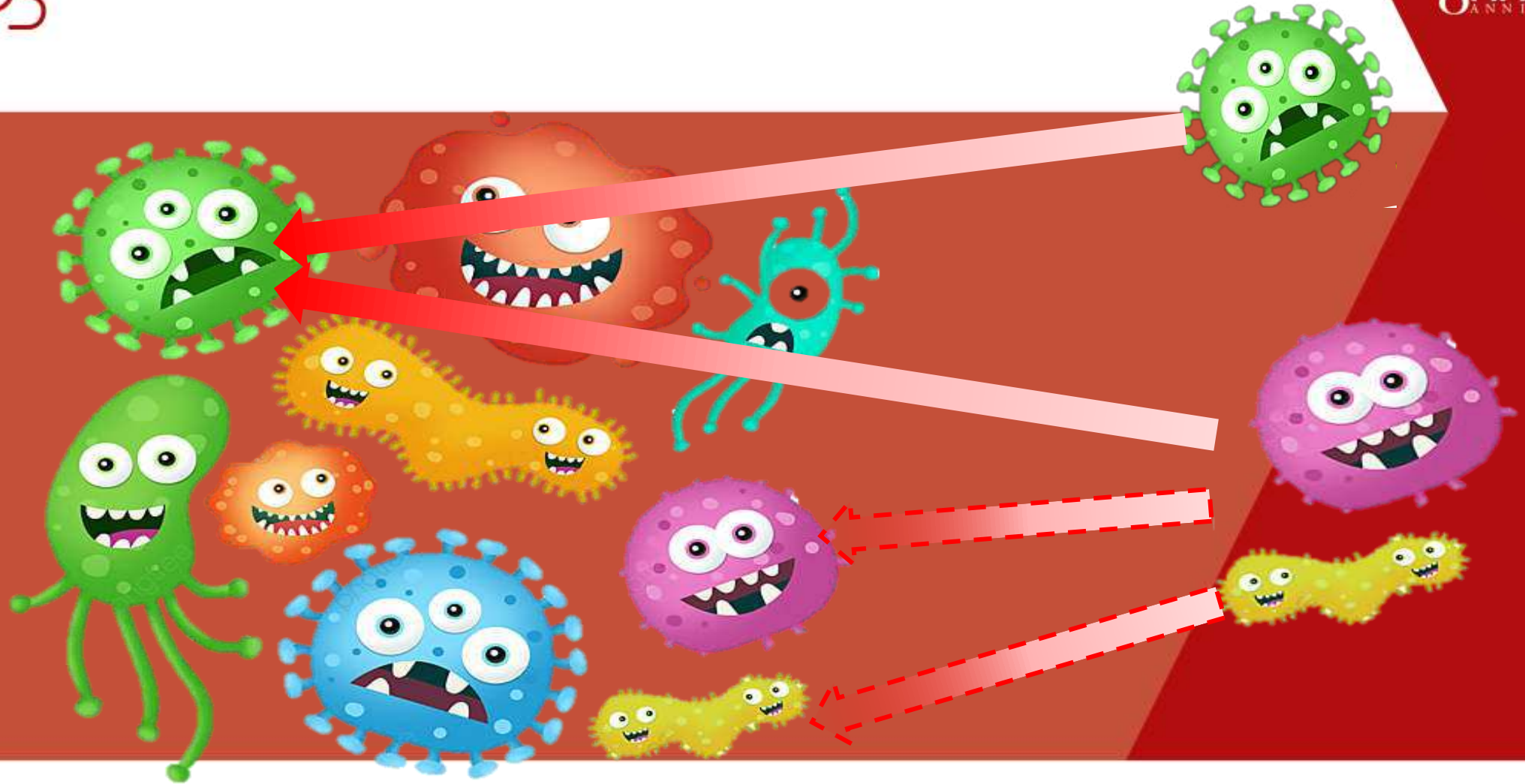
Salvador Oliver-Ferrando<sup>1,4</sup>, Joaquim Segalés<sup>2,3</sup>, Sergio López-Soria<sup>1</sup>, Antonio Callén<sup>4</sup>, Olivier Merdy<sup>5</sup>, François Joisel<sup>5</sup> and Marina Sibila<sup>1\*</sup>



**Figure 5** PCV2 NA titres (mean ± SD) in serum samples. Different letters in superscript mean statistically significant differences ( $p < 0.05$ ) among experimental groups at each sampling point.

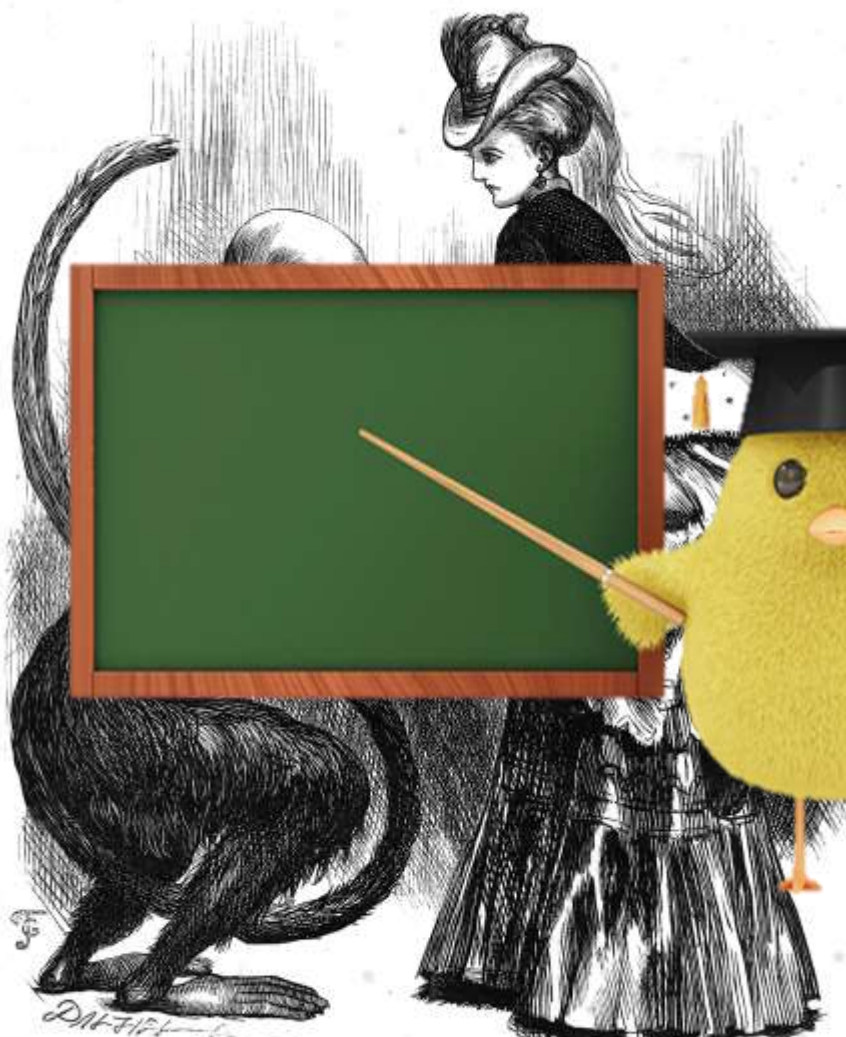


**Figure 1** Percentage of PCV2 qPCR positive pigs (A) and mean viral load (±SD) of qPCR positive serum samples (B). Different letters in superscript mean statistically significant differences ( $p < 0.05$ ) among experimental groups at each sampling point.



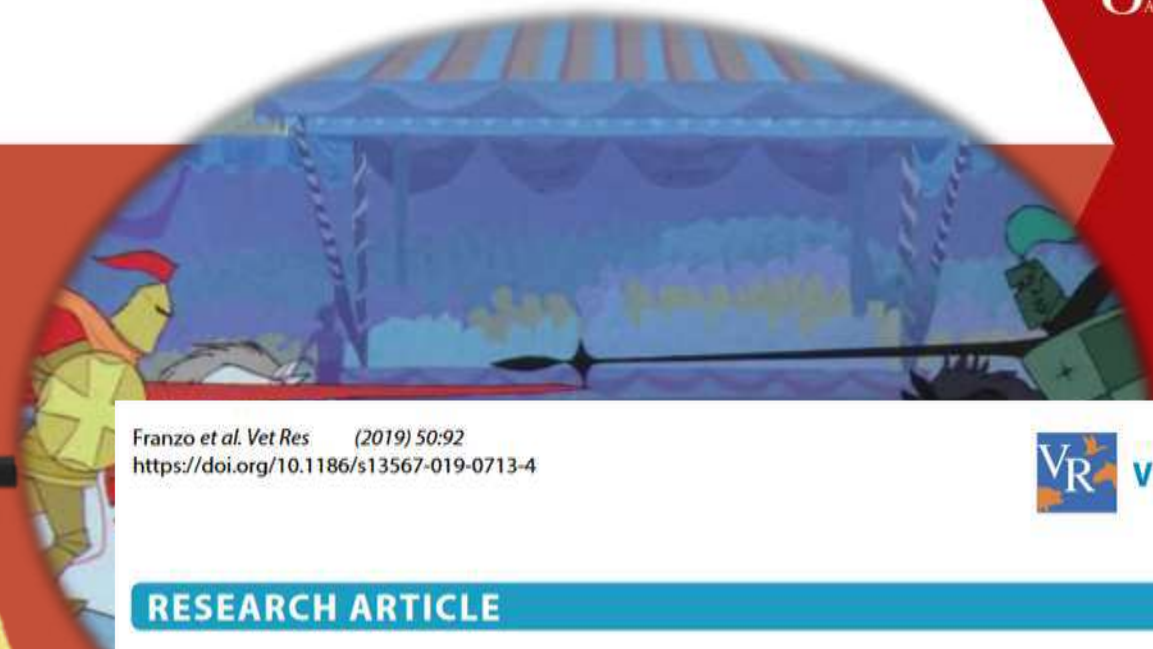


FUN.—NOVEMBER 16, 1872.



THAT TROUBLES OUR MONKEY AGAIN.

*Fox's descendant of Maria Assidua!*—"REALLY, MR. DARWIN, SAY WHAT YOU LIKE ABOUT MAN; BUT I WISH YOU WOULD LEAVE MY EMOTIONS ALONE!"



Franzo et al. *Vet Res* (2019) 50:92  
<https://doi.org/10.1186/s13567-019-0713-4>

VR VETERINARY RESEARCH

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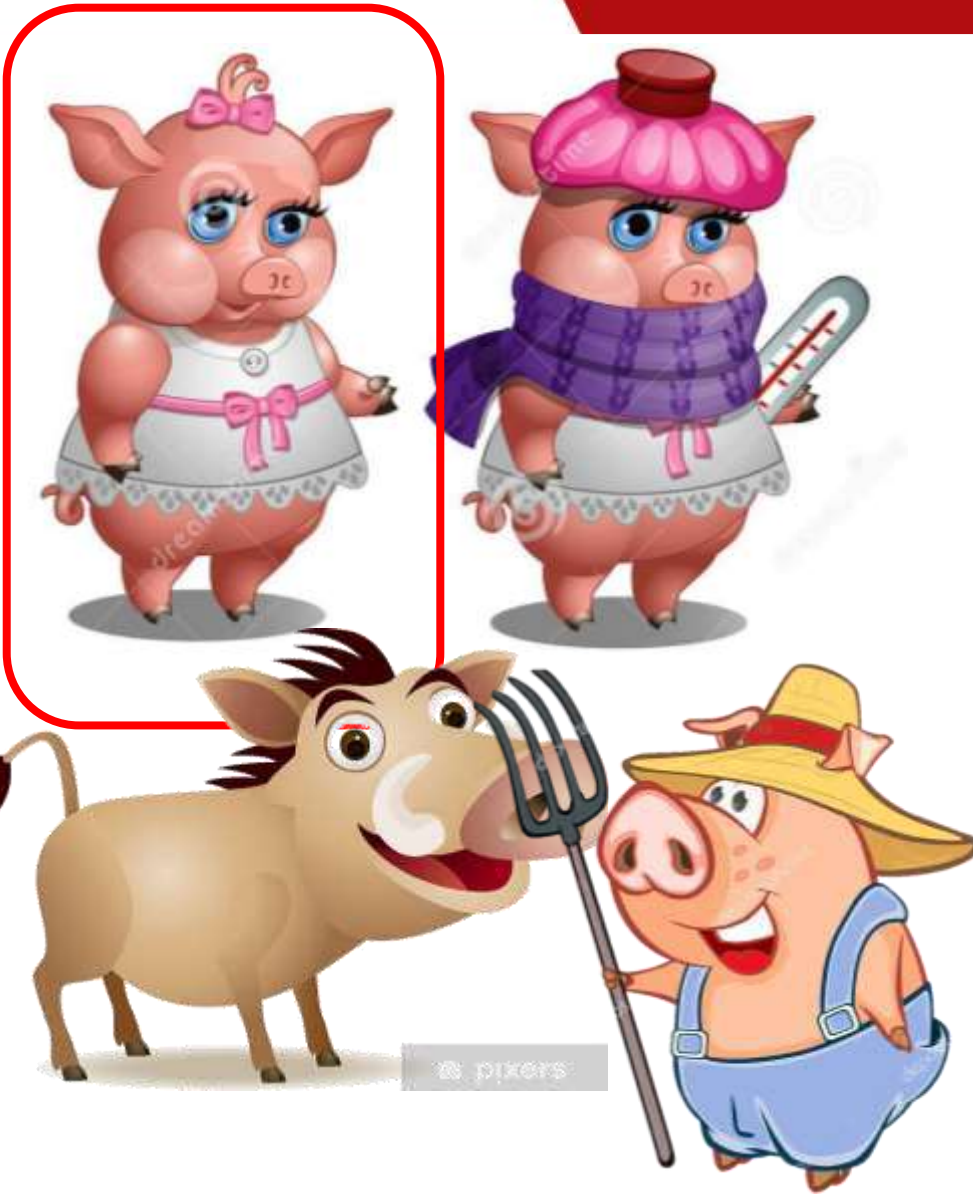


# Evolution of infectious bronchitis virus in the field after homologous vaccination introduction

Giovanni Franco<sup>††</sup>, Matteo Legnardi<sup>†</sup>, Claudia Maria Tucciarone, Michele Drigo, Marco Martini and Mattia Cecchinato



WHAT ARE YOU  
MISSING?



@pixers







## Three different genotypes of porcine circovirus 2 (PCV-2) identified in pigs and warthogs in Namibia

Umberto Molini<sup>1,2</sup>  · Giovanni Franzo<sup>3</sup>  · Lené Gous<sup>1</sup> · Sjandré Moller<sup>1</sup> · Yvonne Maria Hemberger<sup>1</sup> · Bernard Chiwome<sup>1</sup> · Giuseppe Marruchella<sup>4</sup>  · Siegfried Khaiseb<sup>2</sup> · Giovanni Cattoli<sup>5</sup> · William G. Dundon<sup>5</sup> 

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pathogens



Article

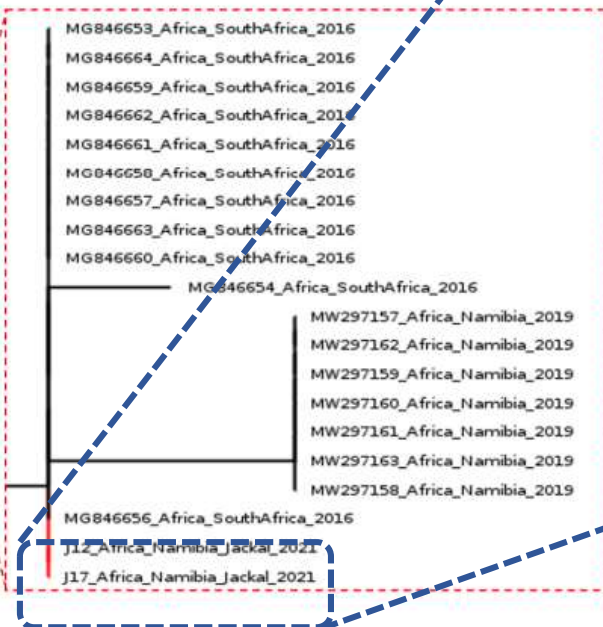
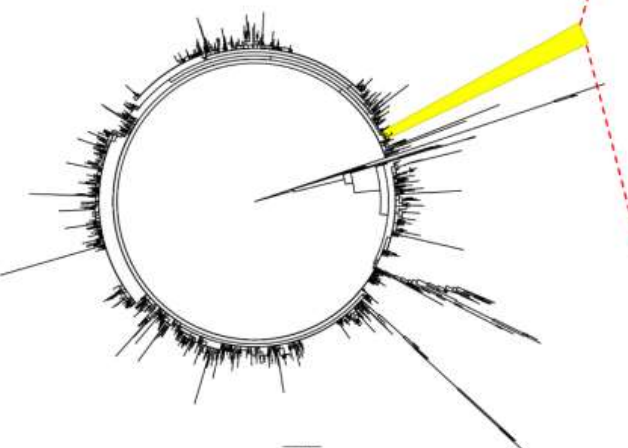
## The Oryx Antelope (*Oryx gazella*): An Unexpected Host for Porcine Circovirus-2 (PCV-2)

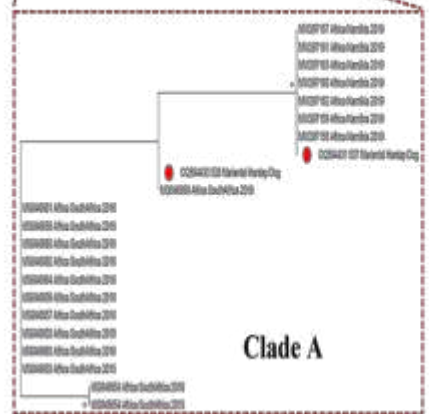
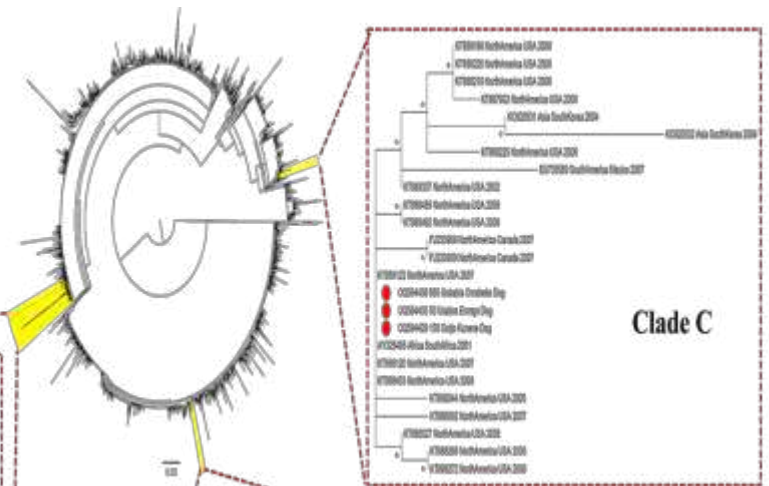
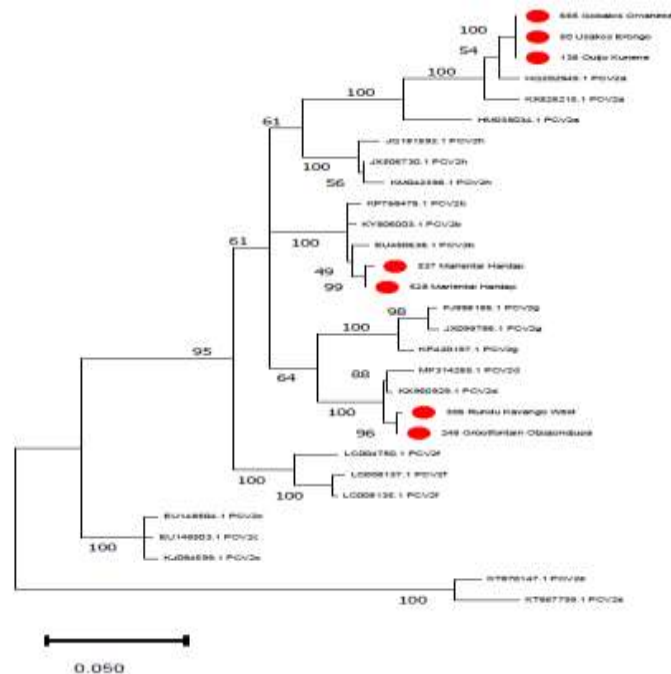
Umberto Molini<sup>1,2</sup>, Lauren Michelle Coetzee<sup>2</sup>, Maria Yvonne Hemberger<sup>1</sup>, Siegfried Khaiseb<sup>2</sup>, Giovanni Cattoli<sup>3</sup>, William G. Dundon<sup>3</sup>  and Giovanni Franzo<sup>4,\*</sup> 

Article

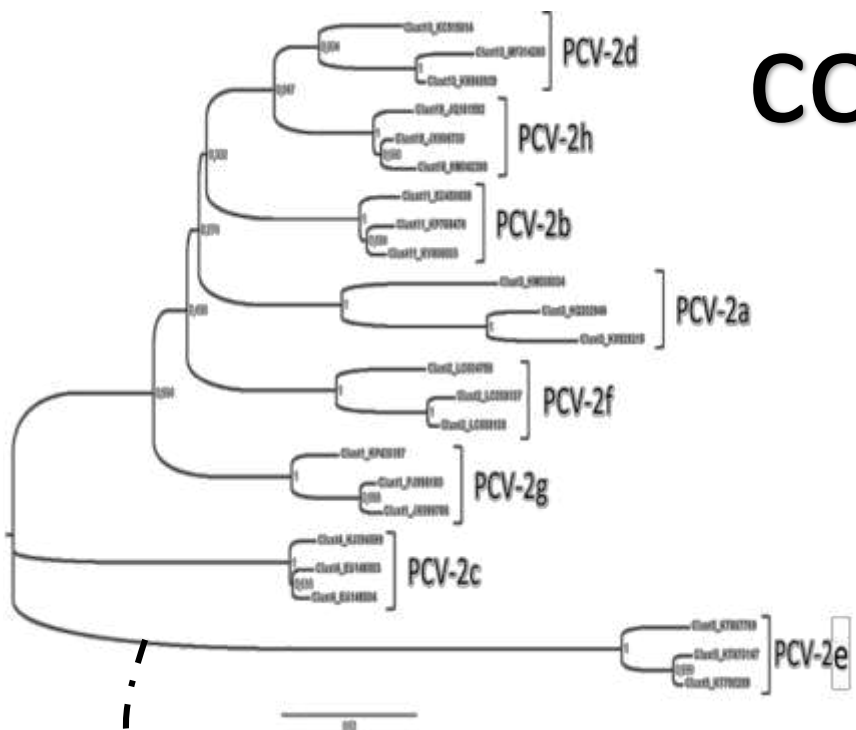
# Molecular Detection and Genetic Characterization of Porcine Circovirus 2 (PCV-2) in Black-Backed Jackal (*Lupulella mesomelas*) in Namibia

Umberto Molini <sup>1,2</sup>, Lauren Michelle Coetzee <sup>2</sup>, Leandra Van Zyl <sup>1</sup>, Siegfried Khaiseb <sup>2</sup>, Giovanni Cattoli <sup>3</sup>, William G. Dundon <sup>3</sup> and Giovanni Franzo <sup>4,\*</sup>





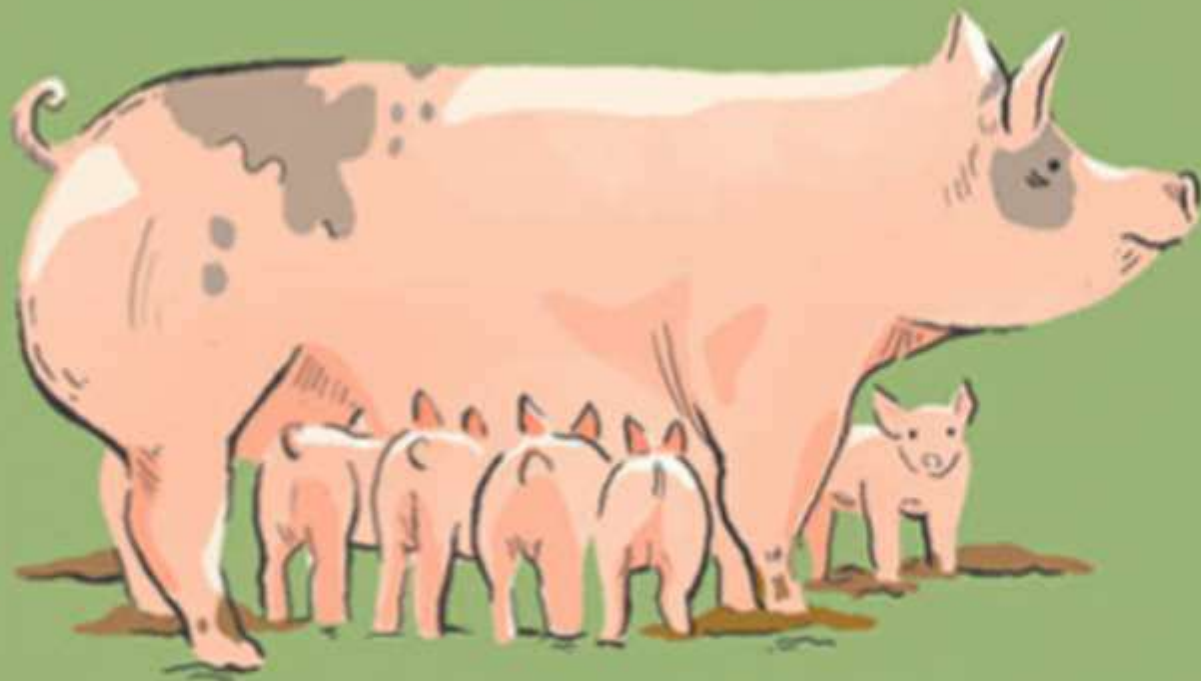
# Emergeranno nuovi genotipi? E come si comporteranno?



PCV-2???



THANKS



*sow* MUCH