Clostridium difficile and the "One Health" paradigm

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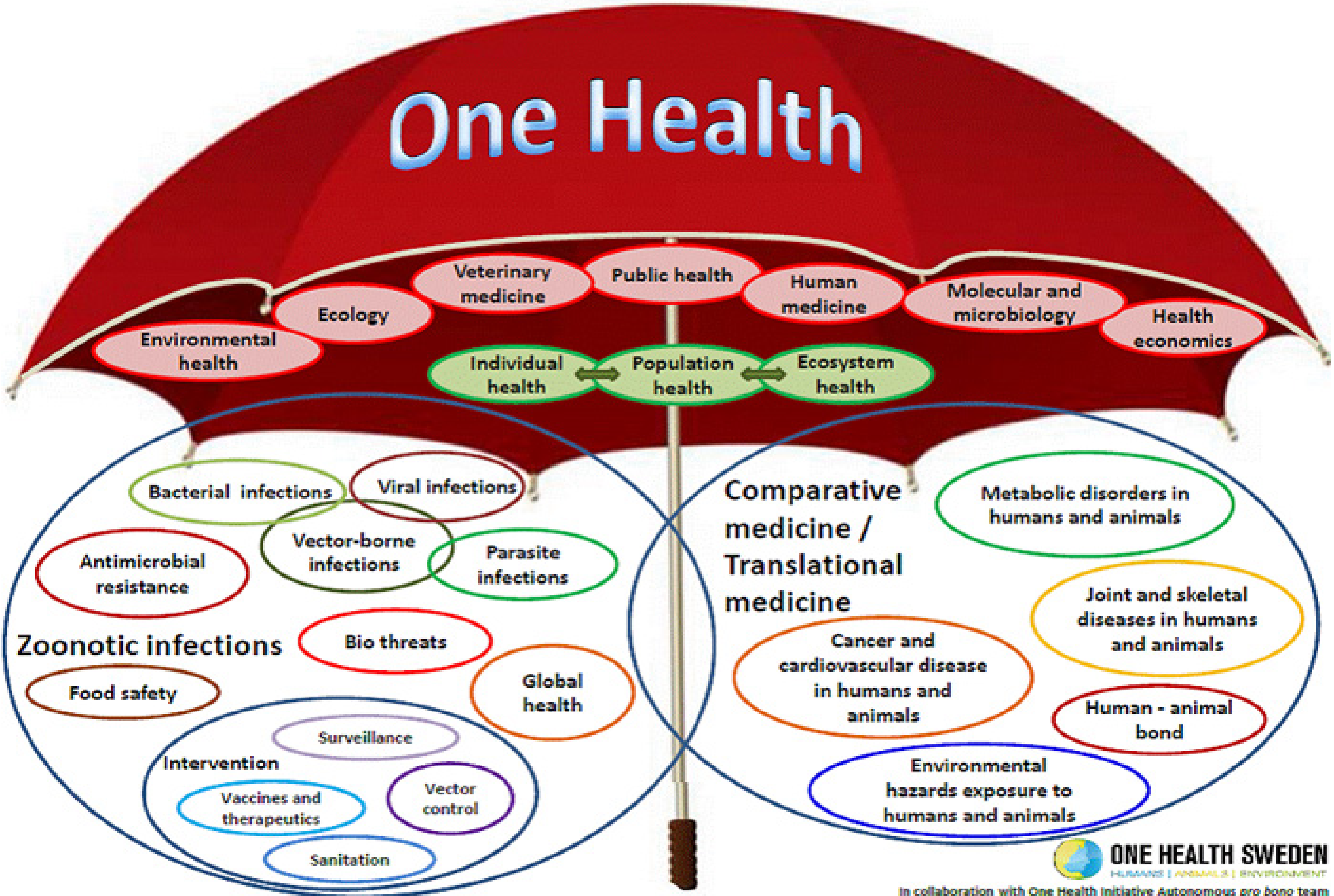
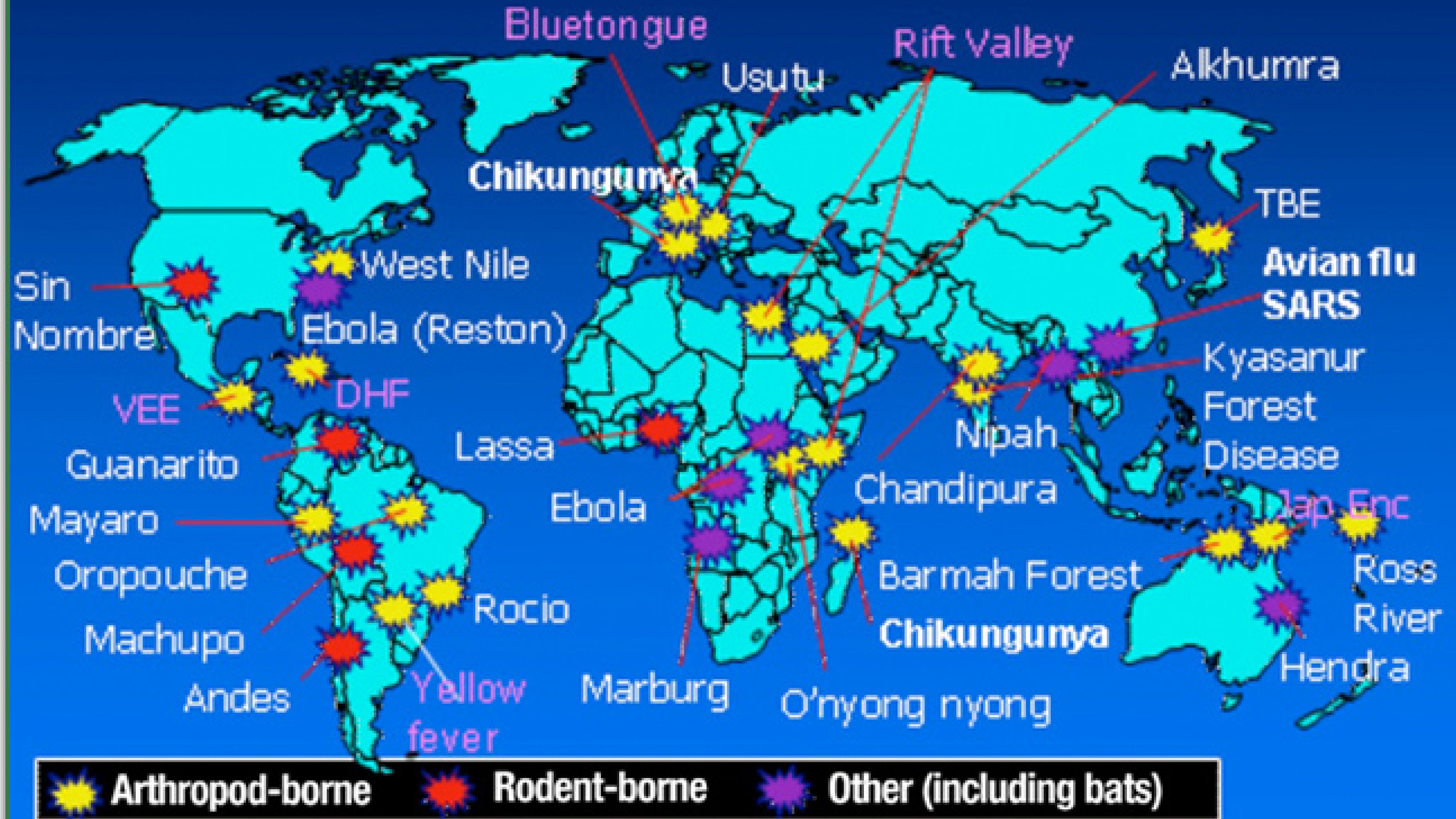
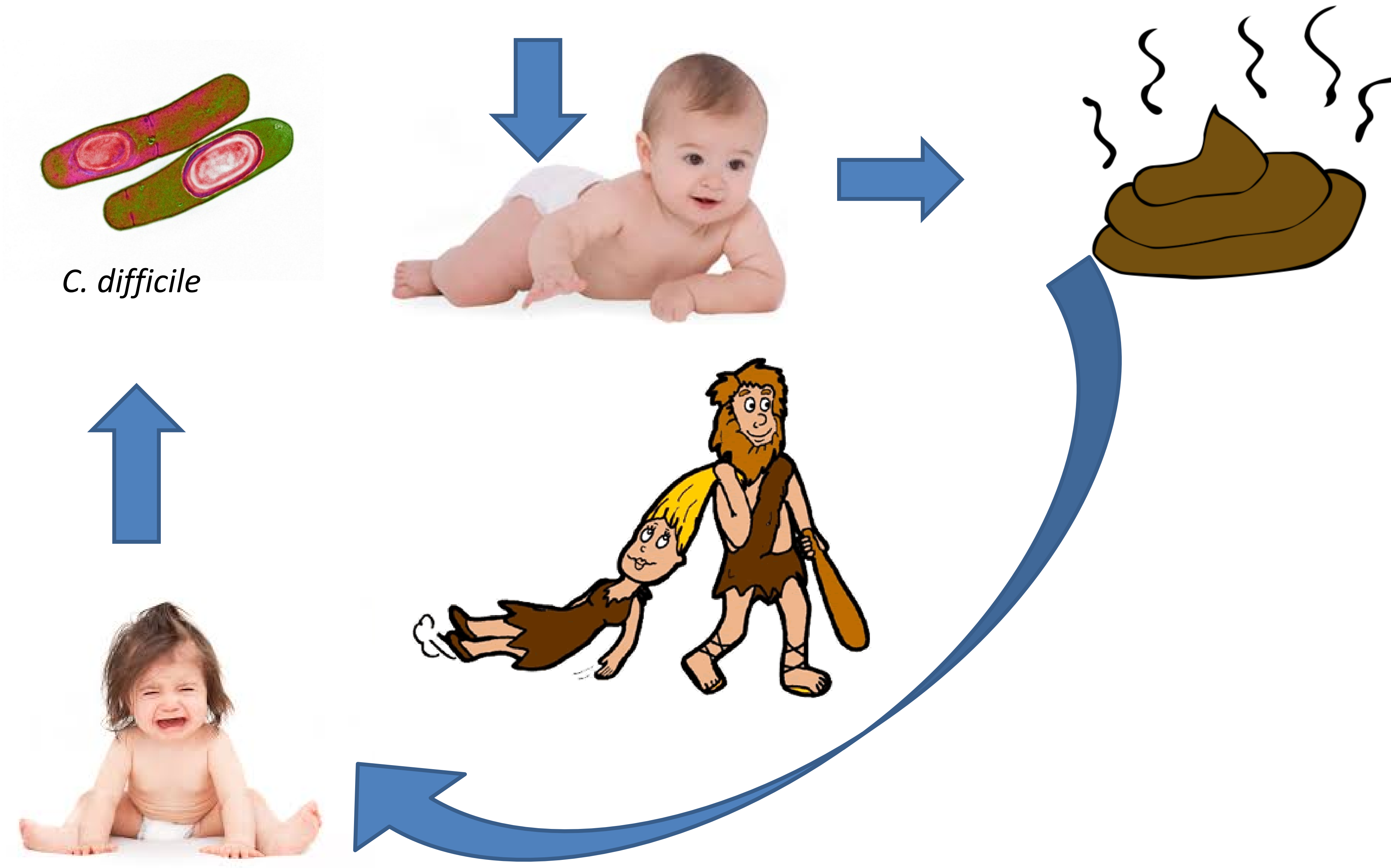
The One Health concept recognizes that the health of humans is connected to the health of animals and the environment.



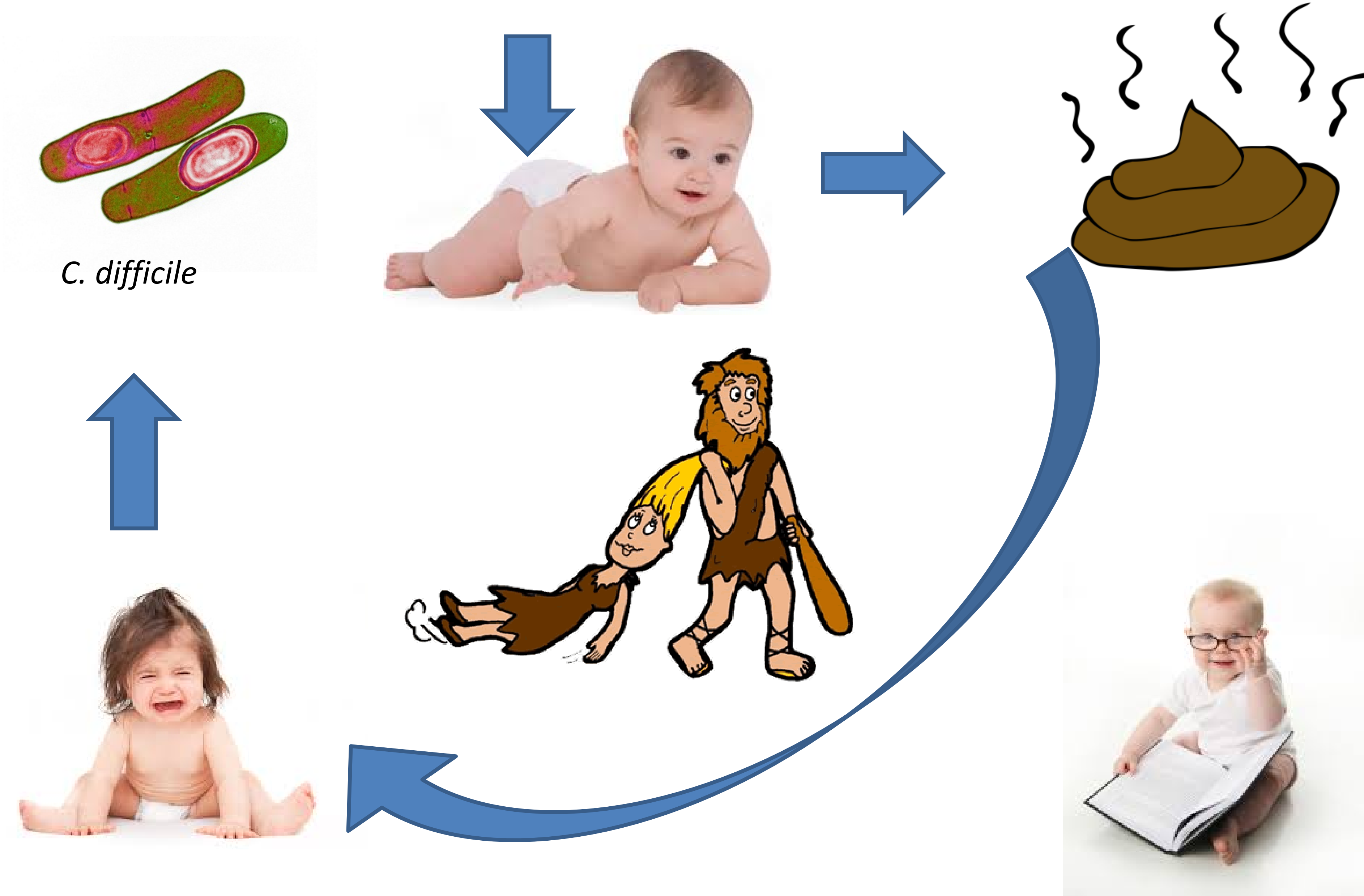
Emerging and Reemerging infections - 70% vector-borne or zoonotic



The natural history of *C. difficile*

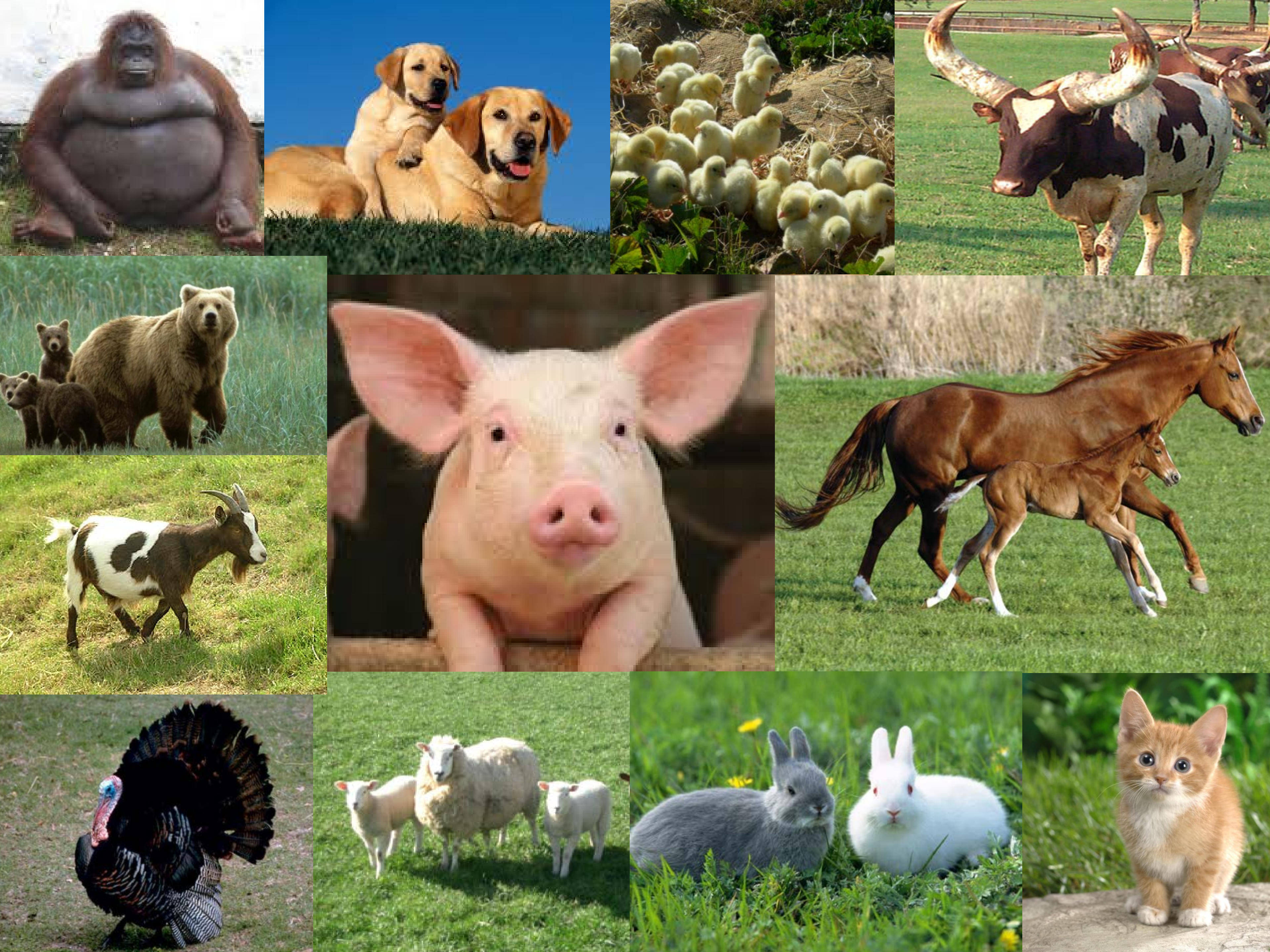


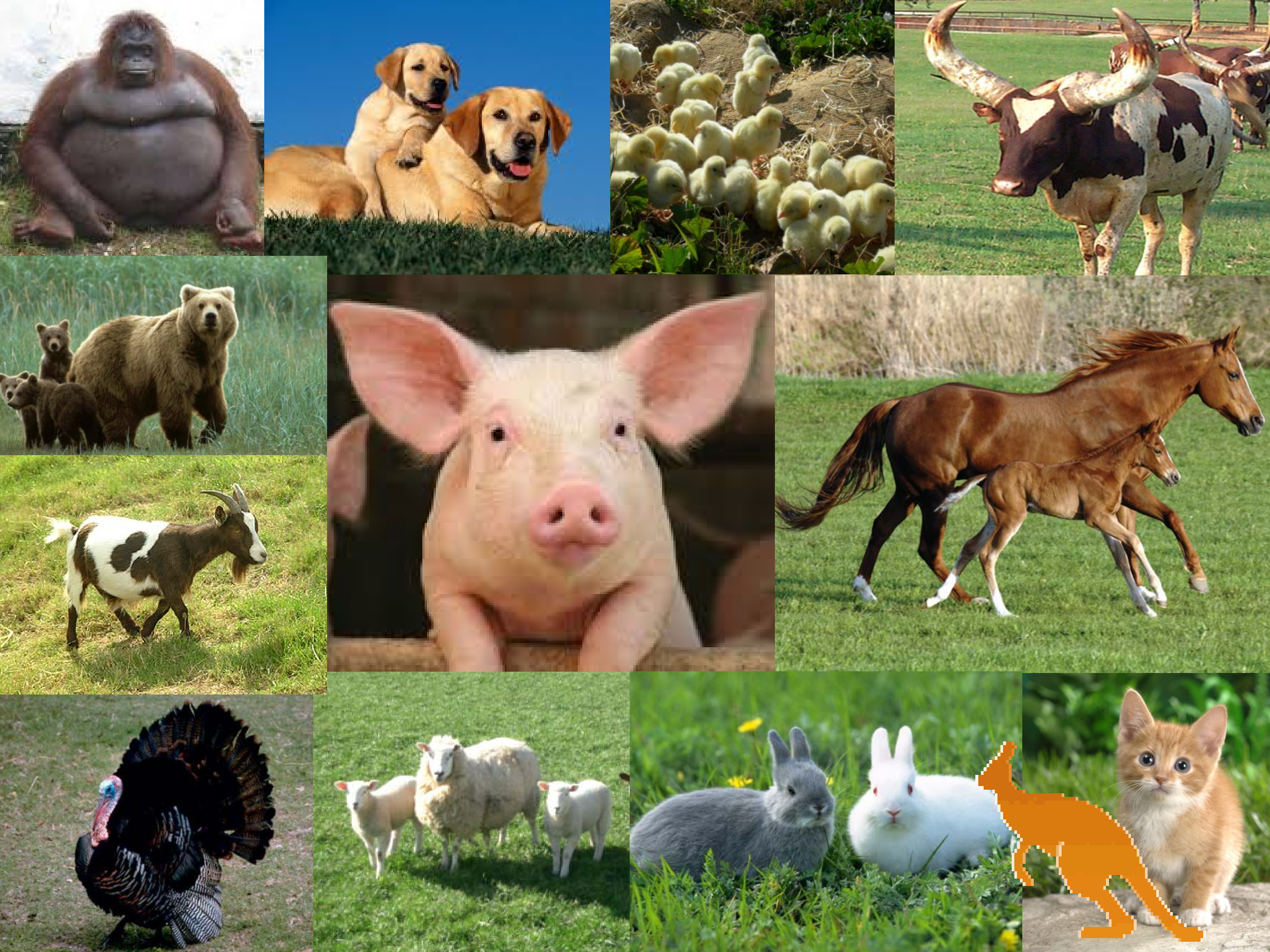
The natural history of *C. difficile*



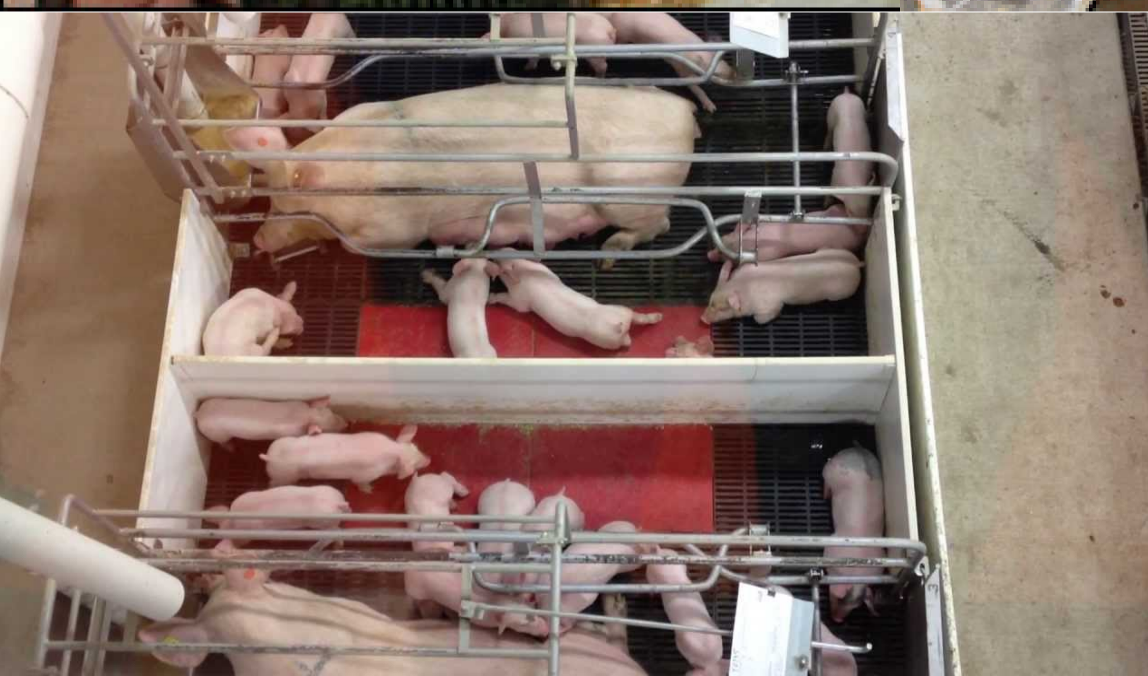
Risk factors for CDI ?

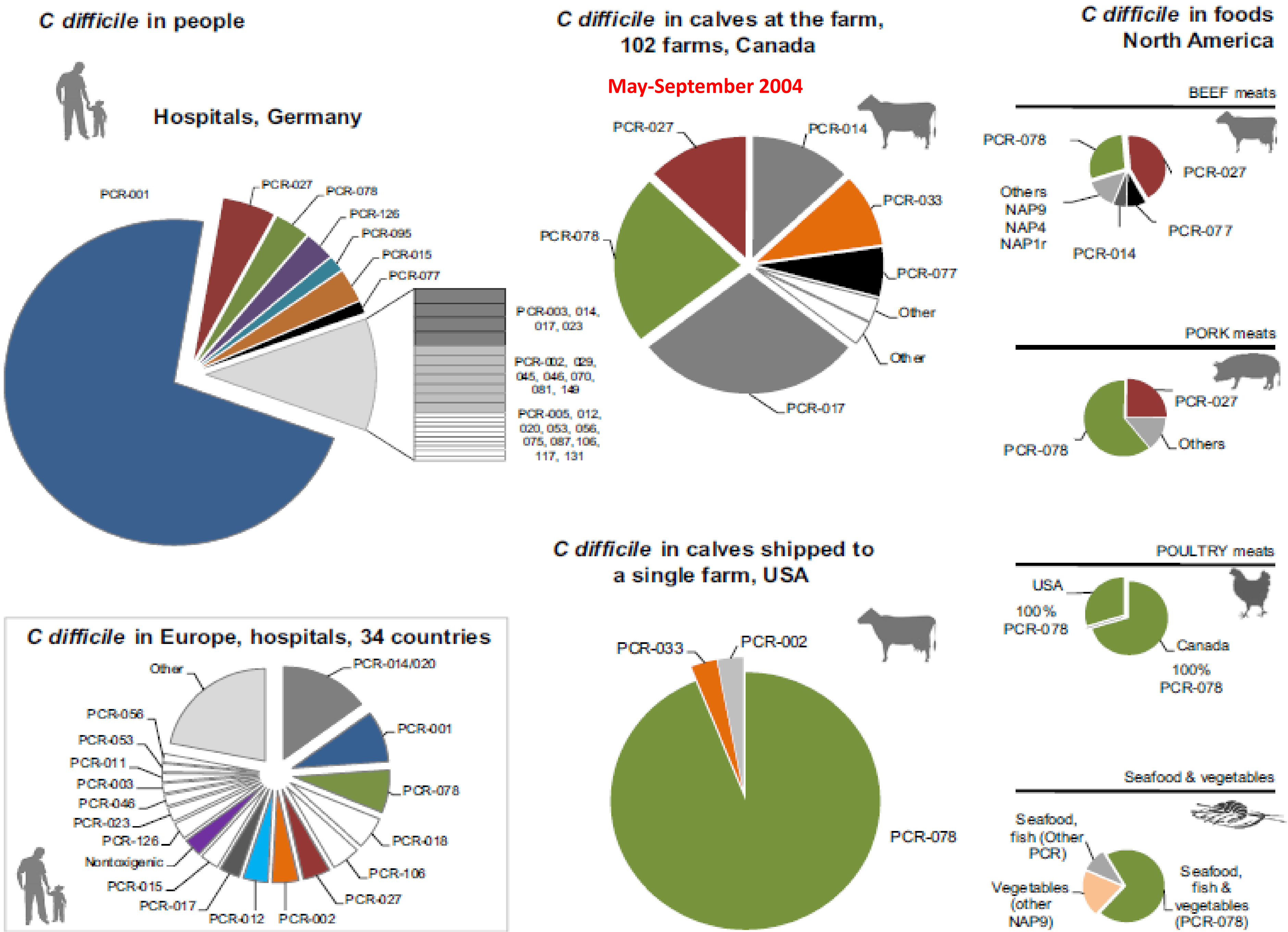
- Exposure to the organism
- Exposure to antibiotics – clindamycin, then cephalosporins, now ?fluoroquinolones
- Maybe others now?









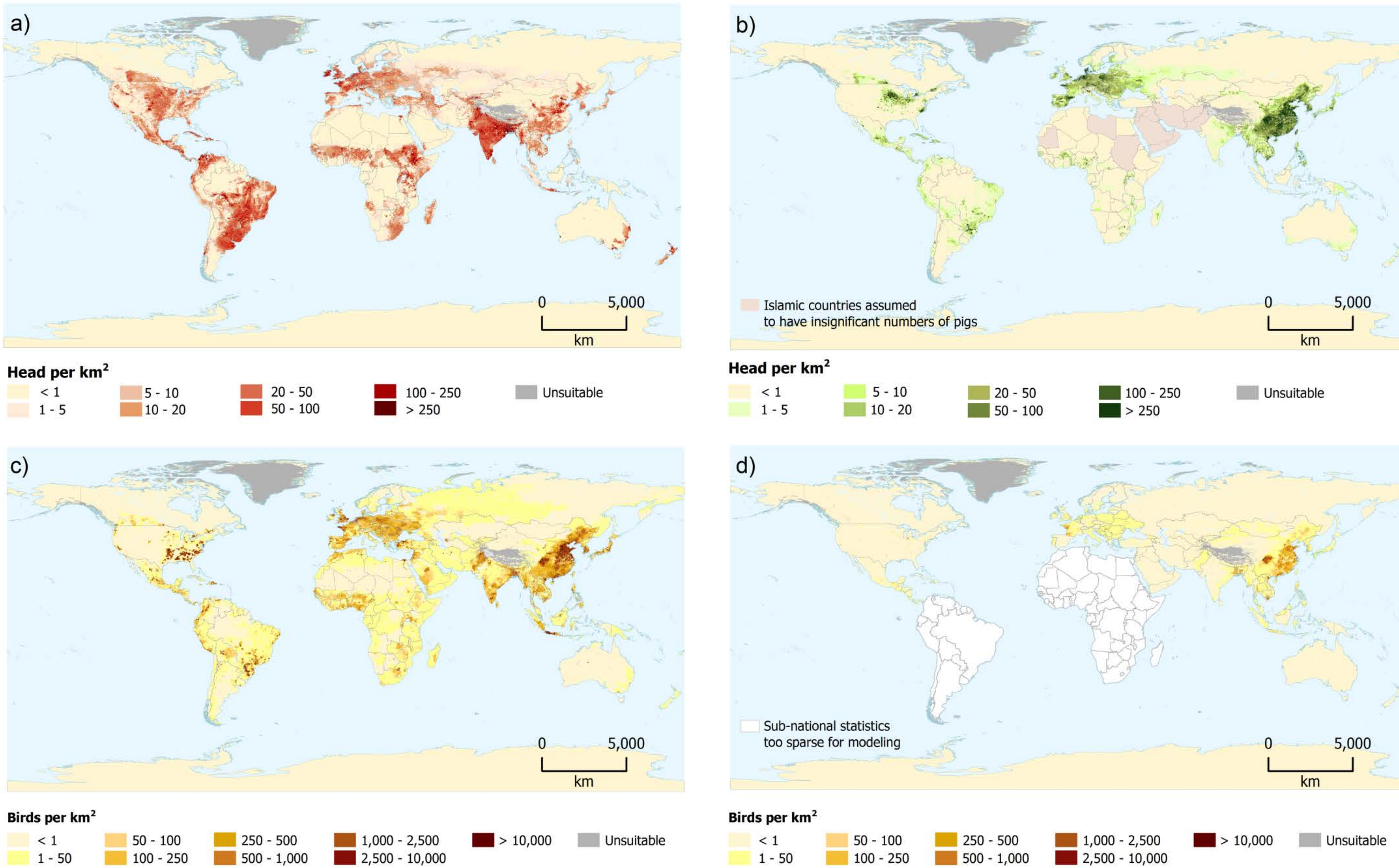



Infect Dis Clin N Am 27 (2013) 675–685

Contaminated vegetables

- Bakri *et al*. *Clostridium difficile* in ready-to-eat salads, Scotland. Emerg Infect Dis 2009;15: 817-8. (3/40 [7.5%] positive)
- Metcalf *et al*. *Clostridium difficile* in vegetables, Canada. Letts Appl Microbiol 2010; 51: 600-2. (5/111 [4.5%] positive)
- Al Saif and Brazier. The distribution of *Clostridium difficile* in the environment of South Wales. J Med Microbiol 1996; 45: 133-7.(7/300 [2.3%] positive)

Cattle | Pigs



Robinson TP, Wint GRW, Conchedda G, Van Boeckel TP, Ercoli V, et al. (2014) Mapping the Global Distribution of Livestock. PLoS ONE 9(5): e96084. doi:10.1371/journal.pone.0096084

Animal strains in Australia

- Ribotype 127 60%
- Ribotype 126 16%
- Ribotype 033 13%

5-7days old

- Ribotype 014 23%
- Ribotype 033 13%
- Ribotype QX009 12%
- Ribotype 237 10%

- Many new ribotypes from animals – CDT+

Knight *et al. Appl Environ Microbiol* 2013, 2014

Community acquired CDI

- *C. difficile* was the most common enteric pathogen detected.
- Most patients had only mild to moderate diarrhoea.
- In the majority of patients the diarrhoea was protracted.
- 80-85% of patients had received antimicrobial agents in the 3 months preceding onset of diarrhoea.
- Most treated successfully with metronidazole.

Riley et al. Diarrhoeal disease due to *Clostridium difficile* in general practice. *Pathology* 1991: 23: 346-349.
Riley et al. Community-acquired *Clostridium difficile*-associated diarrhea. *Clin Infect Dis* 1995: 20 (Suppl 2): S263-S265.

Ribotype 126 isolates, Western Australia

(Knight et al. J Med Microbiol Case Reports in press)

WA 0825	P12-8104895T	Fremantle Hospital	WA	Human	UK 126	2012	TVR-007	C00016308
WA 0853	P12-2190332T	Sir Charles Gairdner Hospital	WA	Human	UK 126	2012	TVR-008	C00016309
WA 1258	P12-7721139R	Princess Margaret Hospital	WA	Human	UK 126	2012	TVR-009	C00016310
WA 1665	P12-4382418R	Osbourne Park Hospital	WA	Human	UK 126	2012	TVR-010	C00016311
AI 0273	HCH 6		NSW	Bovine	UK 126	2012	TVR-011	C00016312
AI 0276	HCH 11		NSW	Bovine	UK 126	2012	TVR-012	C00016313

	C00016308	C00016309	C00016310	C00016311	C00016312	C00016313
C00016308	0	4452	4457	14	1393	1393
C00016309	4452	0	0	4452	4596	4597
C00016310	4457	0	0	4455	4593	4595
C00016311	14	4452	4455	0	1392	1391
C00016312	1393	4596	4593	1392	0	7
C00016313	1393	4597	4595	1391	7	0

2 identical human isolates

2 related bovine isolates

2 close human isolates

Anaerobe 30 (2014) 188–192

Contents lists available at ScienceDirect

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journal homepage: www.elsevier.com/locate/anaerobe

Clinical microbiology

Clostridium difficile ribotype 126 in southern Taiwan: A cluster of three symptomatic cases

Yuan-Pin Hung [a,c,d,1], Hsiao-Ju Lin [a,c,d,1], Bo-Yang Tsai [e], Hsiao-Chieh Liu [a,b], Hsiu-Chuan Liu [b], Jen-Chieh Lee [c], Yi-Hui Wu [f], Mark H. Wilcox [g], Warren N. Fawley [h], Po-Ren Hsueh [i], Pei-Jane Tsai [e,j,k,**], Wen-Chien Ko [c,*]


Area: 7,692,024 km²
BRISBANE, QLD
GERALDTON, WA
FREMANTLE, WA
3614 kms
Area: 20,000 km²
Area: 90,000 km²

SURVEILLANCE AND OUTBREAK REPORTS

Emergence and spread of predominantly community-onset *Clostridium difficile* PCR ribotype 244 infection in Australia, 2010 to 2012

D W Eyre (david.eyre@ndm.ox.ac.uk)[1,2,3], L Tracey[3,4], B Elliott[5], C Slimings[4], P G Huntington[6], R L Stuart[7], T M Korman[7], G Kotsiou[6], R McCann[4], D Griffiths[1], W N Fawley[8], P Armstrong[4], K E Dingle[1], A S Walker[1,2], T E Peto[1,2], D W Crook[1,2], M H Wilcox[8], T V Riley[5,9]

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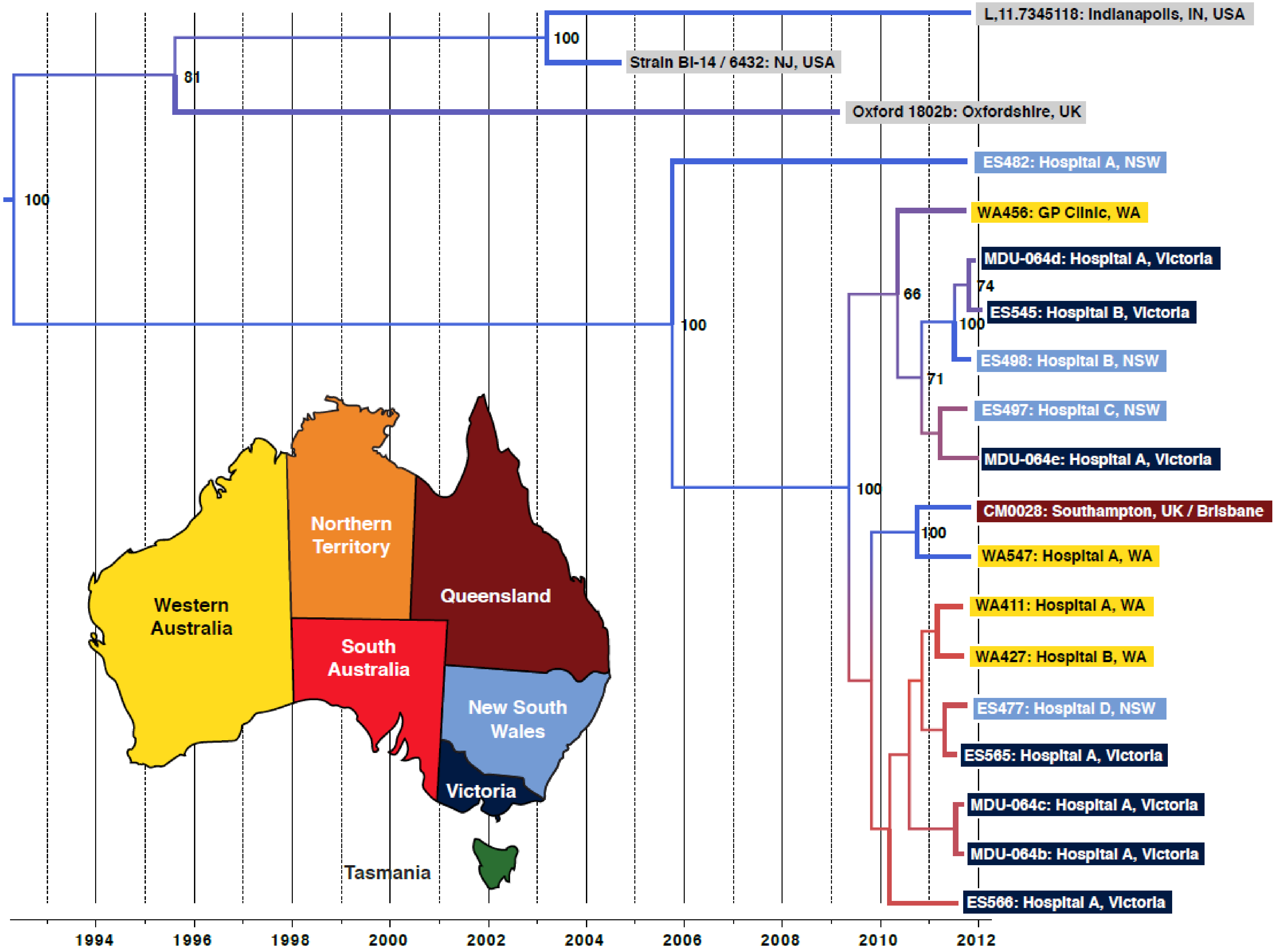
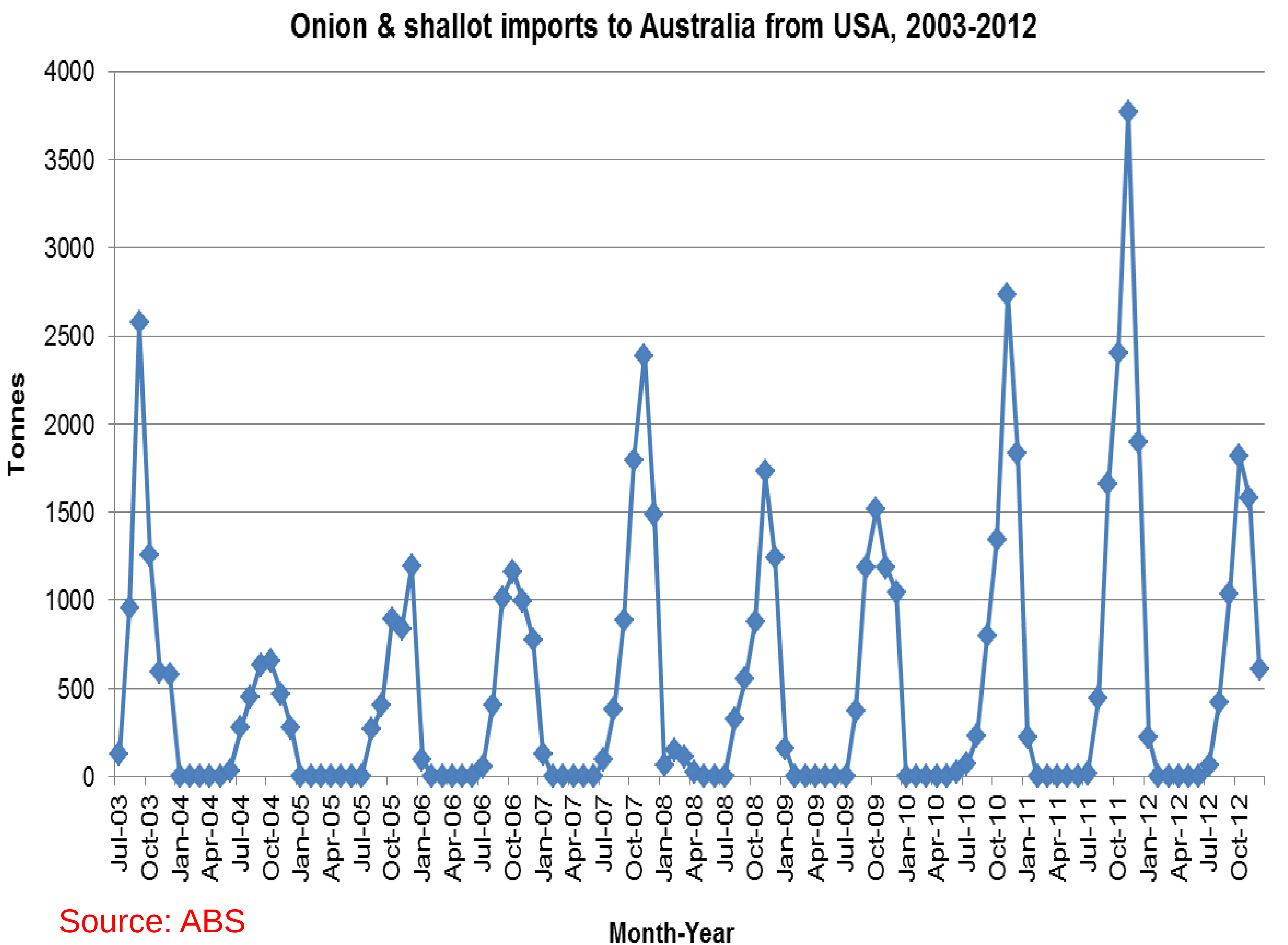
6. Microbiology, Pathology North, Royal North Shore Hospital, St Leonards, Australia
7. Monash Infectious Diseases and Monash University, Clayton, Australia
8. Department of Microbiology, Old Medical School, Leeds Teaching Hospitals NHS Trust and University of Leeds, Leeds General Infirmary, Leeds, United Kingdom
9. Microbiology and Infectious Diseases, PathWest Laboratory Medicine, Nedlands, Australia

Citation style for this article:
Eyre DW, Tracey L, Elliott B, Slimings C, Huntington PG, Stuart RL, Korman TM, Kotsiou G, McCann R, Griffiths D, Fawley WN, Armstrong P, Dingle KE, Walker AS, Peto TE, Crook DW, Wilcox MH, Riley TV. Emergence and spread of predominantly community-onset Clostridium difficile PCR ribotype 244 infection in Australia, 2010 to 2012. Euro Surveill. 2015;20(10):pii=21059. Available online: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=21059

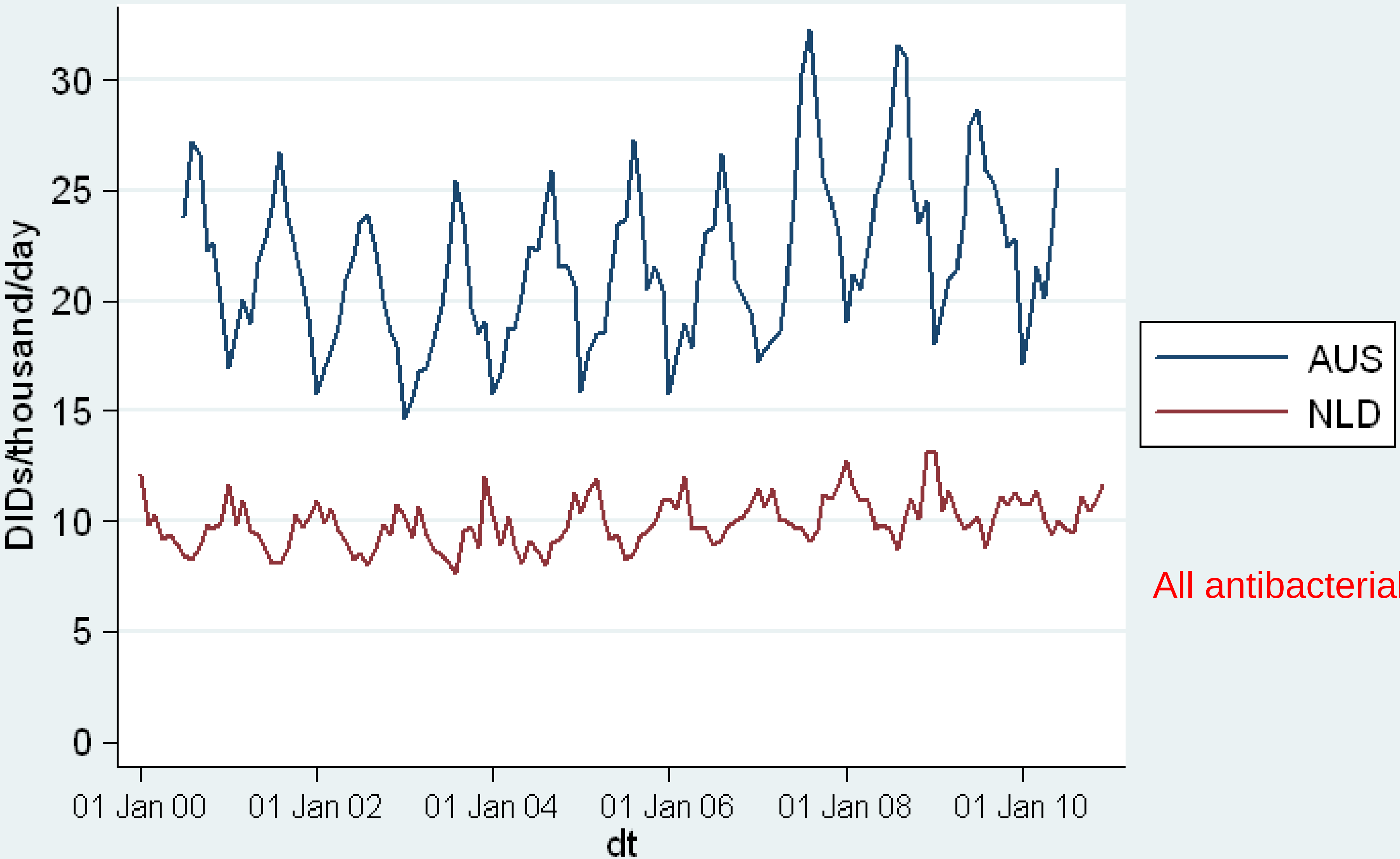

L,11.7345118: Indianapolis, IN, USA
Strain BI-14 / 6432: NJ, USA
Oxford 1802b: Oxfordshire, UK
ES482: Hospital A, NSW
WA456: GP Clinic, WA
MDU-064d: Hospital A, Victoria
ES545: Hospital B, Victoria
ES498: Hospital B, NSW
ES497: Hospital C, NSW
MDU-064e: Hospital A, Victoria
CM0028: Southampton, UK / Brisbane
WA547: Hospital A, WA
WA411: Hospital A, WA
WA427: Hospital B, WA
ES477: Hospital D, NSW
ES565: Hospital A, Victoria
MDU-064c: Hospital A, Victoria
MDU-064b: Hospital A, Victoria
ES566: Hospital A, Victoria
100
81
100
100
66
74
100
71
100
100
Northern Territory
Western Australia
Queensland
South Australia
New South Wales
Victoria
Tasmania
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012



Onion & shallot imports to Australia from USA, 2003-2012
Tonnes
4000
3500
3000
2500
2000
1500
1000
500
0
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05
Apr-05
Jul-05
Oct-05
Jan-06
Apr-06
Jul-06
Oct-06
Jan-07
Apr-07
Jul-07
Oct-07
Jan-08
Apr-08
Jul-08
Oct-08
Jan-09
Apr-09
Jul-09
Oct-09
Jan-10
Apr-10
Jul-10
Oct-10
Jan-11
Apr-11
Jul-11
Oct-11
Jan-12
Apr-12
Jul-12
Oct-12
Source: ABS
Month-Year

1a: J01: AUS vs NLD

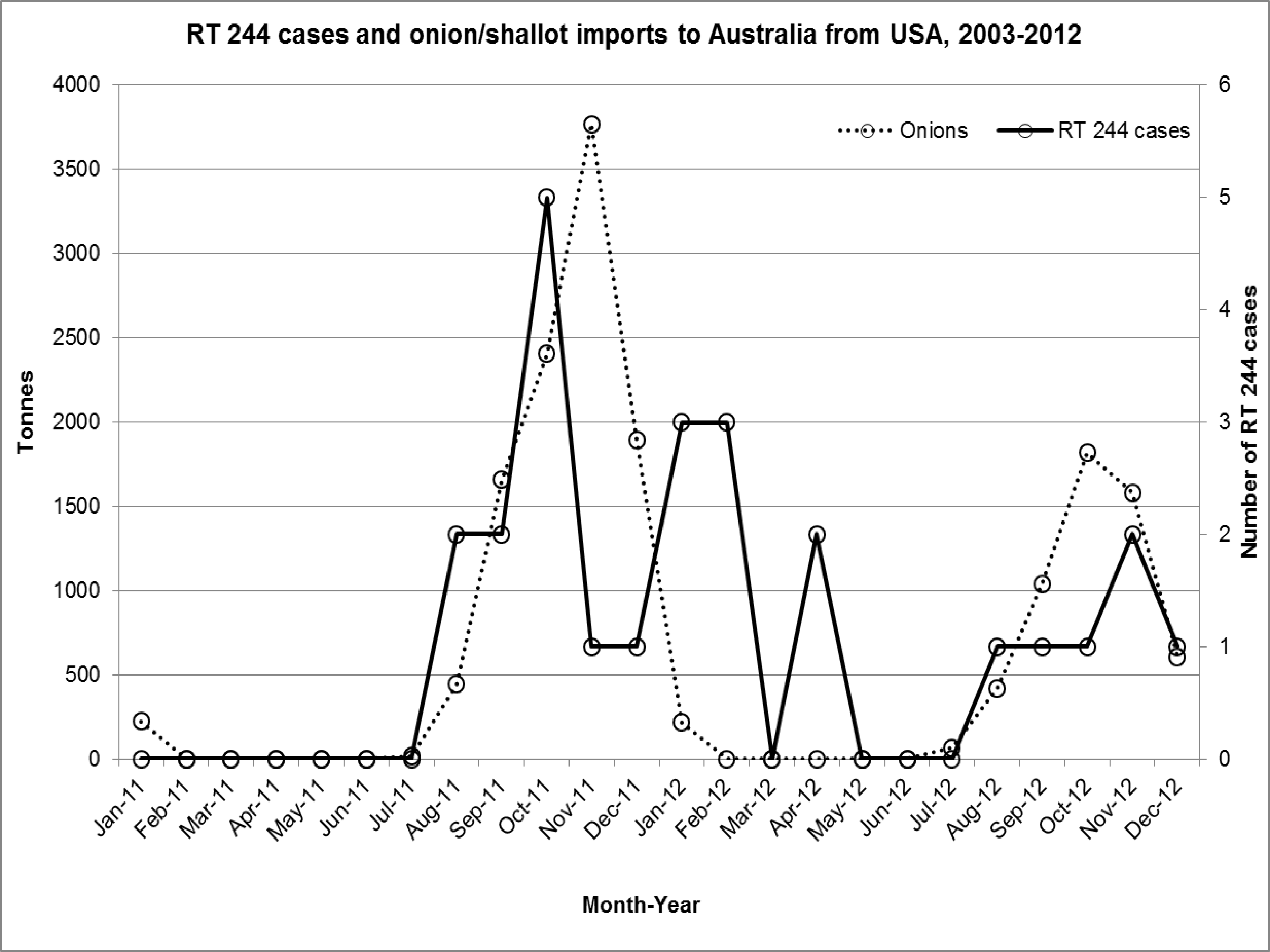
Generic prescribing indicators



All antibacterials

DUSC data: July 2000 - June 2010, GIP data January - December 2000-2010

Courtesy of John Turnidge



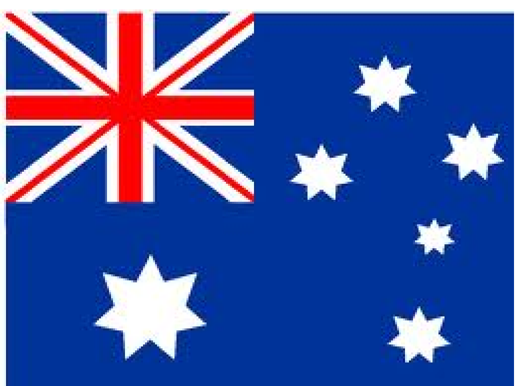
RT 244 cases and onion/shallot imports to Australia from USA, 2003-2012
Onions
RT 244 cases
Tonnes
Number of RT 244 cases
Month-Year
4000
3500
3000
2500
2000
1500
1000
500
0
6
5
4
3
2
1
0
Jan-11
Feb-11
Mar-11
Apr-11
May-11
Jun-11
Jul-11
Aug-11
Sep-11
Oct-11
Nov-11
Dec-11
Jan-12
Feb-12
Mar-12
Apr-12
May-12
Jun-12
Jul-12
Aug-12
Sep-12
Oct-12
Nov-12
Dec-12

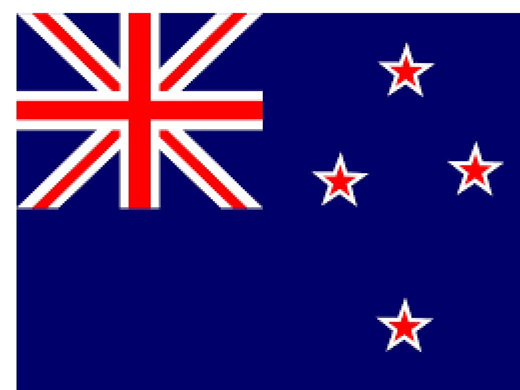
THE NEW ZEALAND MEDICAL JOURNAL
Journal of the New Zealand Medical Association

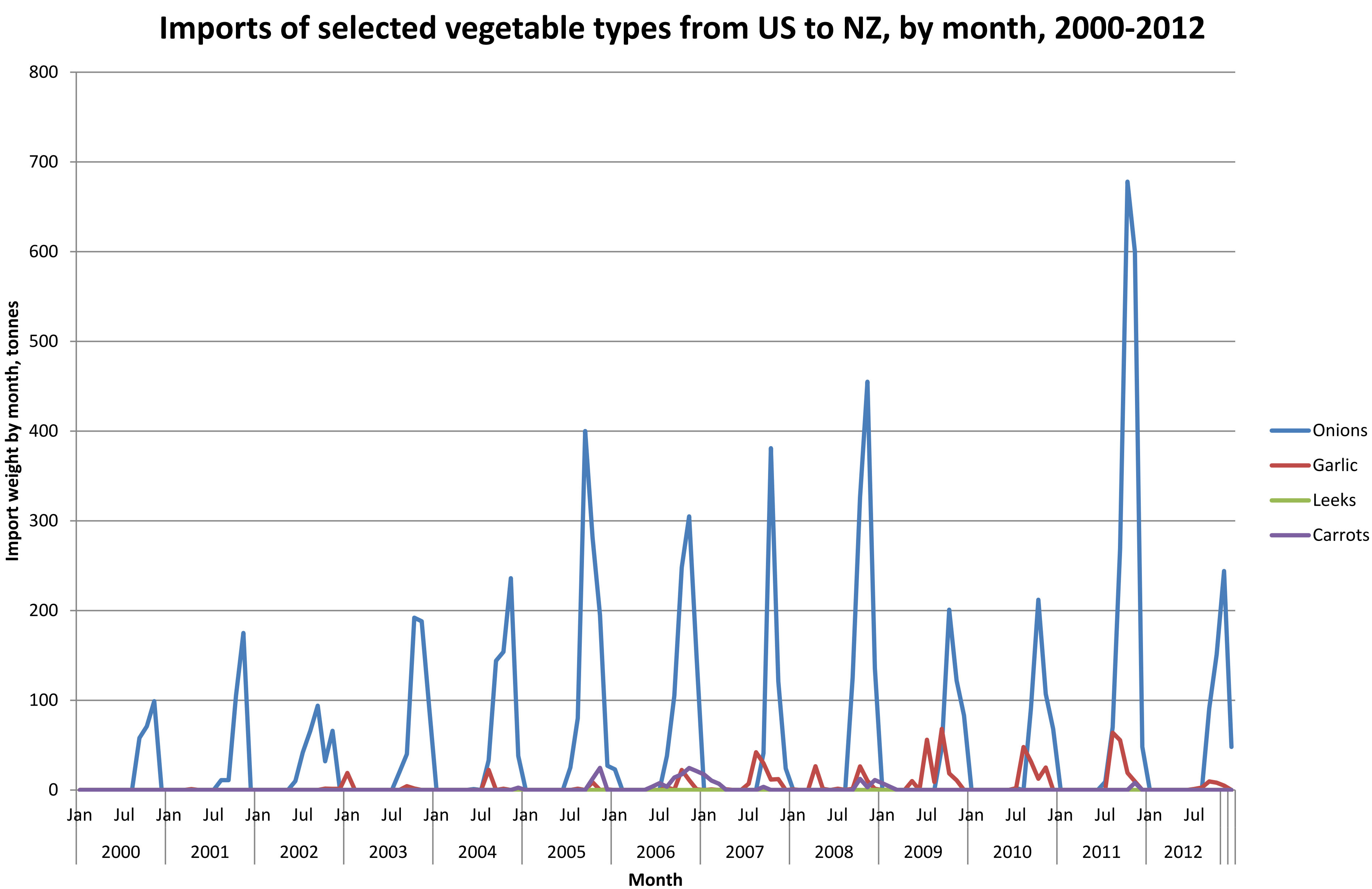
Severe *Clostridium difficile* infection in New Zealand associated with an emerging strain, PCR-ribotype 244

Mary N De Almeida, Helen Heffernan, Anne Dervan, Sarah Bakker, Joshua T Freeman, Hasan Bhally, Susan L Taylor, Thomas V Riley, Sally A Roberts

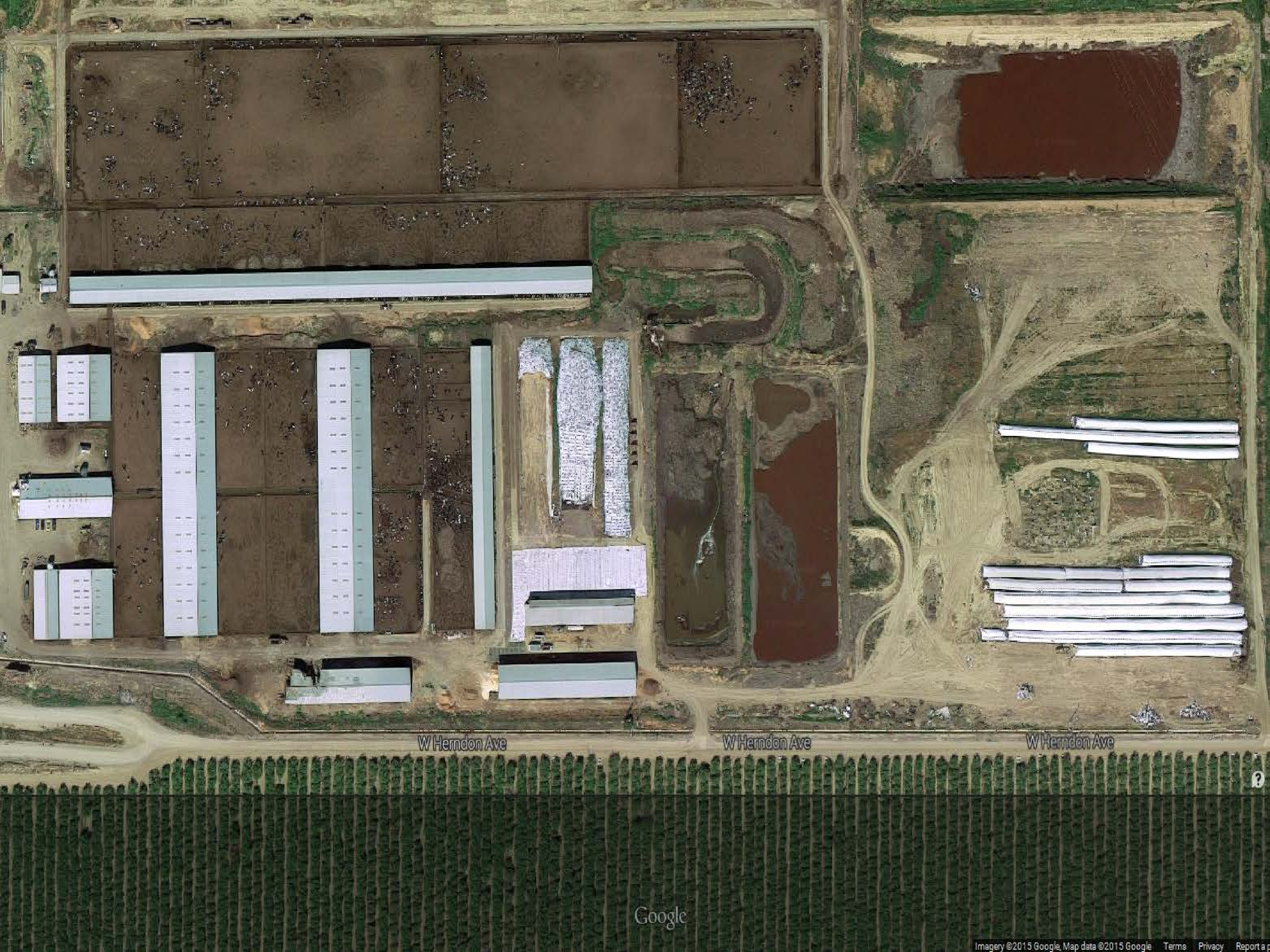
NZMJ 16 August 2013, Vol 126 No 1380; ISSN 1175 8716

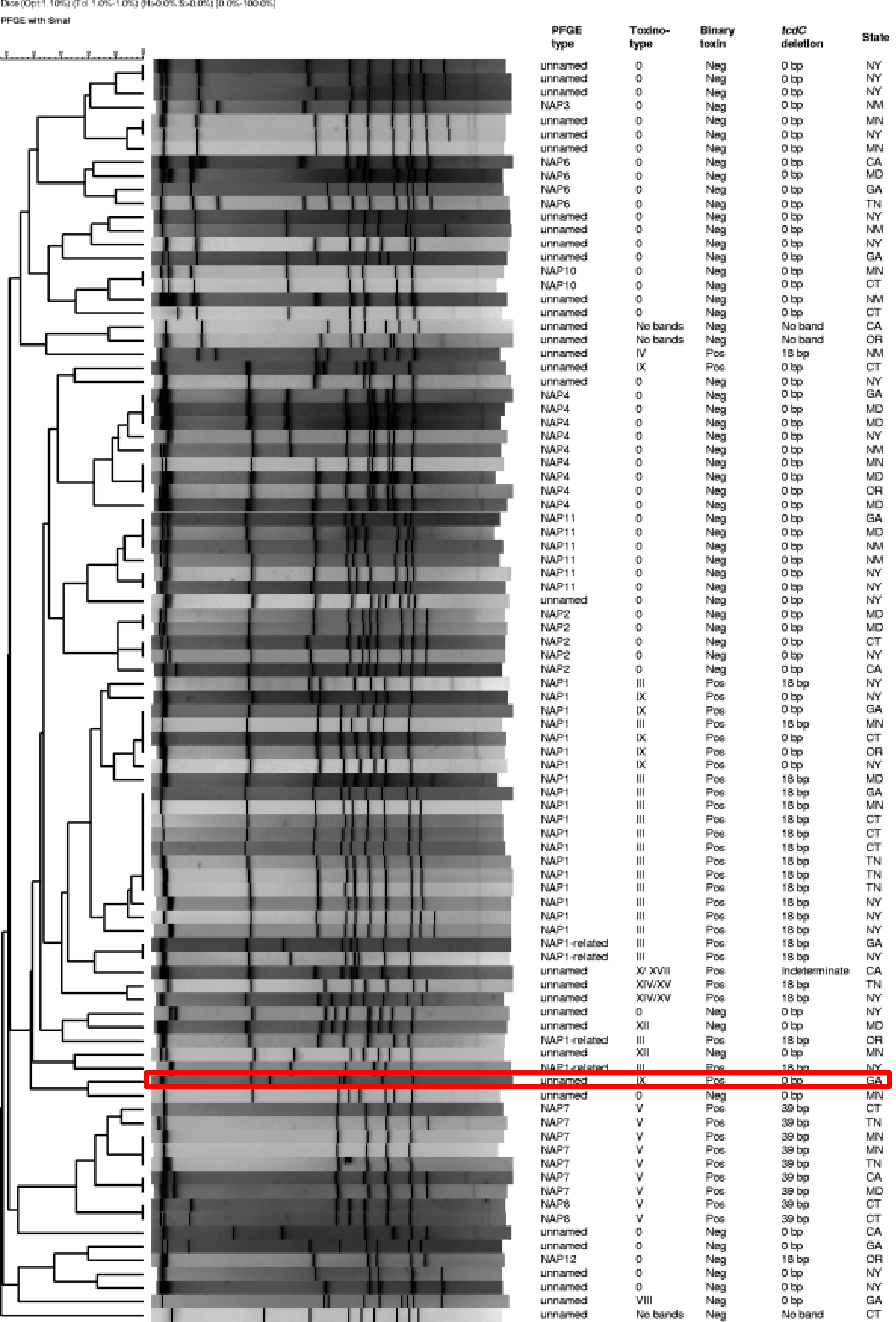




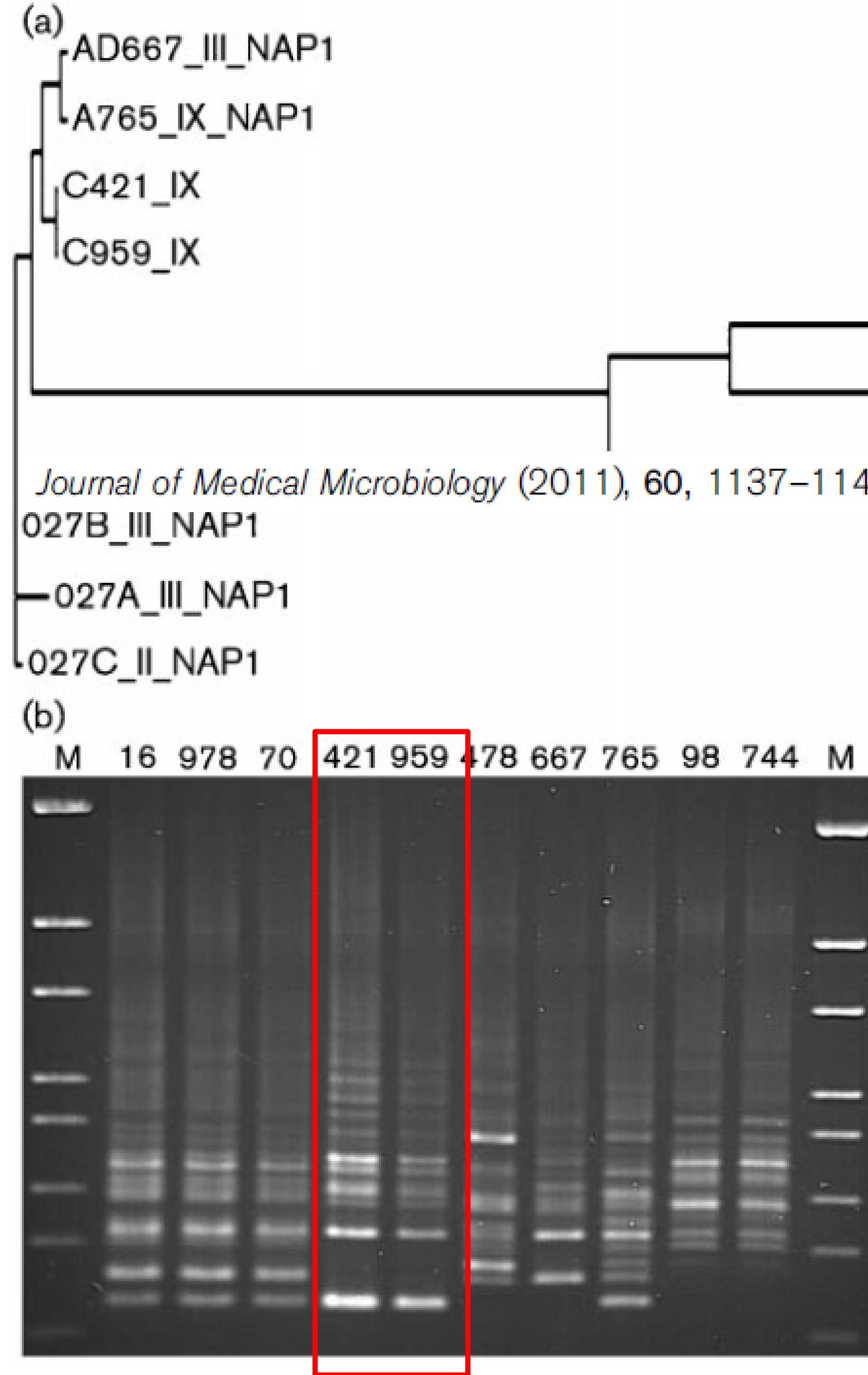

Imports of selected vegetable types from US to NZ, by month, 2000-2012
Import weight by month, tonnes
800
700
600
500
400
300
200
100
0
Jan
Jul
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Month
Onions
Garlic
Leeks
Carrots


W Nees Ave
W Nees Ave
385
5
West Side Fwy


W Herndon Ave
W Herndon Ave
W Herndon Ave
Google
Imagery ©2015 Google, Map data ©2015 Google
Terms
Privacy



PFGE with SmaI
PFGE type
Toxino-type
Binary toxin
tcdC deletion
State
unnamed 0 Neg 0 bp NY
unnamed 0 Neg 0 bp NY
unnamed 0 Neg 0 bp NY
NAP3 0 Neg 0 bp NM
unnamed 0 Neg 0 bp MN
unnamed 0 Neg 0 bp NY
unnamed 0 Neg 0 bp MN
NAP6 0 Neg 0 bp CA
NAP6 0 Neg 0 bp MD
NAP6 0 Neg 0 bp GA
NAP6 0 Neg 0 bp TN
unnamed 0 Neg 0 bp NY
unnamed 0 Neg 0 bp NM
unnamed 0 Neg 0 bp NY
unnamed 0 Neg 0 bp GA
NAP10 0 Neg 0 bp MN
NAP10 0 Neg 0 bp CT
unnamed 0 Neg 0 bp NM
unnamed 0 Neg 0 bp CT
unnamed No bands Neg No band CA
unnamed No bands Neg No band OR
unnamed IV Pos 18 bp NM
unnamed IX Pos 0 bp CT
unnamed 0 Neg 0 bp NY
NAP4 0 Neg 0 bp GA
NAP4 0 Neg 0 bp MD
NAP4 0 Neg 0 bp MD
NAP4 0 Neg 0 bp NY
NAP4 0 Neg 0 bp NM
NAP4 0 Neg 0 bp MN
NAP4 0 Neg 0 bp MD
NAP4 0 Neg 0 bp OR
NAP4 0 Neg 0 bp MD
NAP11 0 Neg 0 bp GA
NAP11 0 Neg 0 bp MD
NAP11 0 Neg 0 bp NM
NAP11 0 Neg 0 bp NM
NAP11 0 Neg 0 bp NY
NAP11 0 Neg 0 bp NY
unnamed 0 Neg 0 bp NY
NAP2 0 Neg 0 bp MD
NAP2 0 Neg 0 bp MD
NAP2 0 Neg 0 bp CT
NAP2 0 Neg 0 bp NY
NAP2 0 Neg 0 bp CA
NAP1 III Pos 18 bp NY
NAP1 IX Pos 0 bp NY
NAP1 IX Pos 0 bp GA
NAP1 III Pos 18 bp MN
NAP1 IX Pos 0 bp CT
NAP1 IX Pos 0 bp OR
NAP1 IX Pos 0 bp NY
NAP1 III Pos 18 bp MD
NAP1 III Pos 18 bp GA
NAP1 III Pos 18 bp MN
NAP1 III Pos 18 bp CT
NAP1 III Pos 18 bp CT
NAP1 III Pos 18 bp CT
NAP1 III Pos 18 bp TN
NAP1 III Pos 18 bp TN
NAP1 III Pos 18 bp TN
NAP1 III Pos 18 bp NY
NAP1 III Pos 18 bp NY
NAP1 III Pos 18 bp NY
NAP1-related III Pos 18 bp GA
NAP1-related III Pos 18 bp NY
unnamed X/ XVII Pos Indeterminate CA
unnamed XIV/XV Pos 18 bp TN
unnamed XIV/XV Pos 18 bp NY
unnamed 0 Neg 0 bp NY
unnamed XII Neg 0 bp MD
NAP1-related III Pos 18 bp OR
unnamed XII Neg 0 bp MN
NAP1-related III Pos 18 bp NY
unnamed IX Pos 0 bp GA
unnamed 0 Neg 0 bp MN
NAP7 V Pos 39 bp CT
NAP7 V Pos 39 bp TN
NAP7 V Pos 39 bp MN
NAP7 V Pos 39 bp MN
NAP7 V Pos 39 bp TN
NAP7 V Pos 39 bp CA
NAP7 V Pos 39 bp MD
NAP8 V Pos 39 bp CT
NAP8 V Pos 39 bp CT
unnamed 0 Neg 0 bp CA
unnamed 0 Neg 0 bp GA
NAP12 0 Neg 18 bp OR
unnamed 0 Neg 0 bp NY
unnamed 0 Neg 0 bp NY
unnamed VIII Neg 0 bp GA
unnamed No bands Neg No band CT



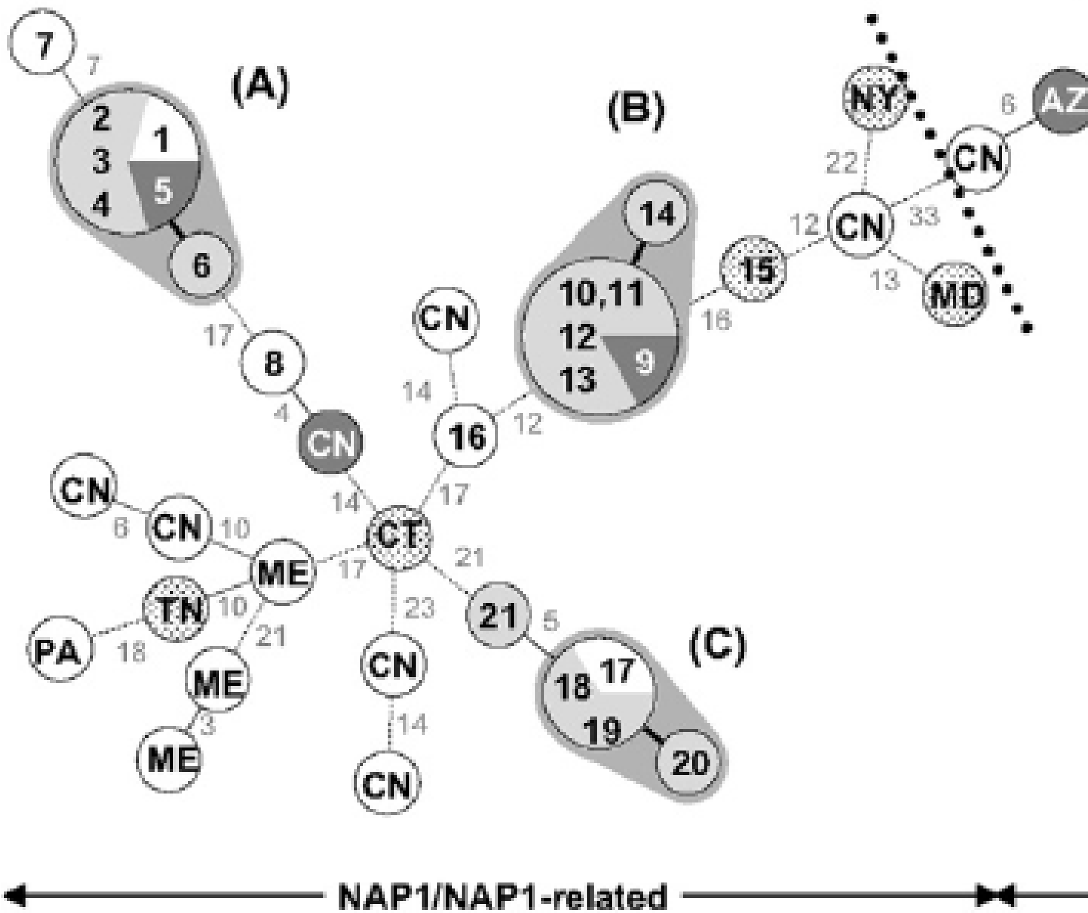
(a)
AD667_III_NAP1
A765_IX_NAP1
C421_IX
C959_IX
Journal of Medical Microbiology (2011), 60, 1137–114
027B_III_NAP1
027A_III_NAP1
027C_II_NAP1
(b)
M 16 978 70 421 959 478 667 765 98 744 M

Table. Source and characteristics of *Clostridium difficile* isolates obtained from retail meats sold in Tuscon, Arizona, USA, 2007*

Meat product	No. samples cultured	Total no. (%) positive	Ribotype	Toxinotype	Δ*tcdC*, bp†	PFGE type	No. (%) pos
Ground beef (uncooked)	26	13 (50)	027	III	18	NAP1	1 (3.8)
						NAP1-related	2 (7.7)
			078	V	39	NAP7	8 (30.8)
						NAP8	2 (7.7)
Summer sausage (ready to eat)	7	1 (14.3)	027	III	18	NAP1	1 (14.3)
Ground pork (uncooked)	7	3 (42.9)	027	III	18	NAP1-related	1 (14.3)
			078	V	39	NAP7	2 (28.6)
Braunschweiger (ready to eat)	16	10 (62.5)	027	III	18	NAP1	2 (12.5)
						NAP1-related	1 (6.2)
			078	V	39	NAP7	7 (43.8)
Chorizo (uncooked)	10	3 (30.0)	027	III	18	NAP1-related	1 (10.0)
			078	V	39	NAP7	2 (20.0)
Pork sausage (uncooked)	13	3 (23.1)	027	III	18	NAP1-related	1 (7.7)
			078	V	39	NAP7	2 (15.4)
Ground turkey (uncooked)	9	4 (44.4)	078	V	39	NAP7	4 (44.4)
Totals	88	37 (42.0)	027	III	18	NAP1	4 (4.4)
						NAP1-related	6 (6.7)
			078	V	39	NAP7	25 (27.8)
						NAP8	2 (2.2)

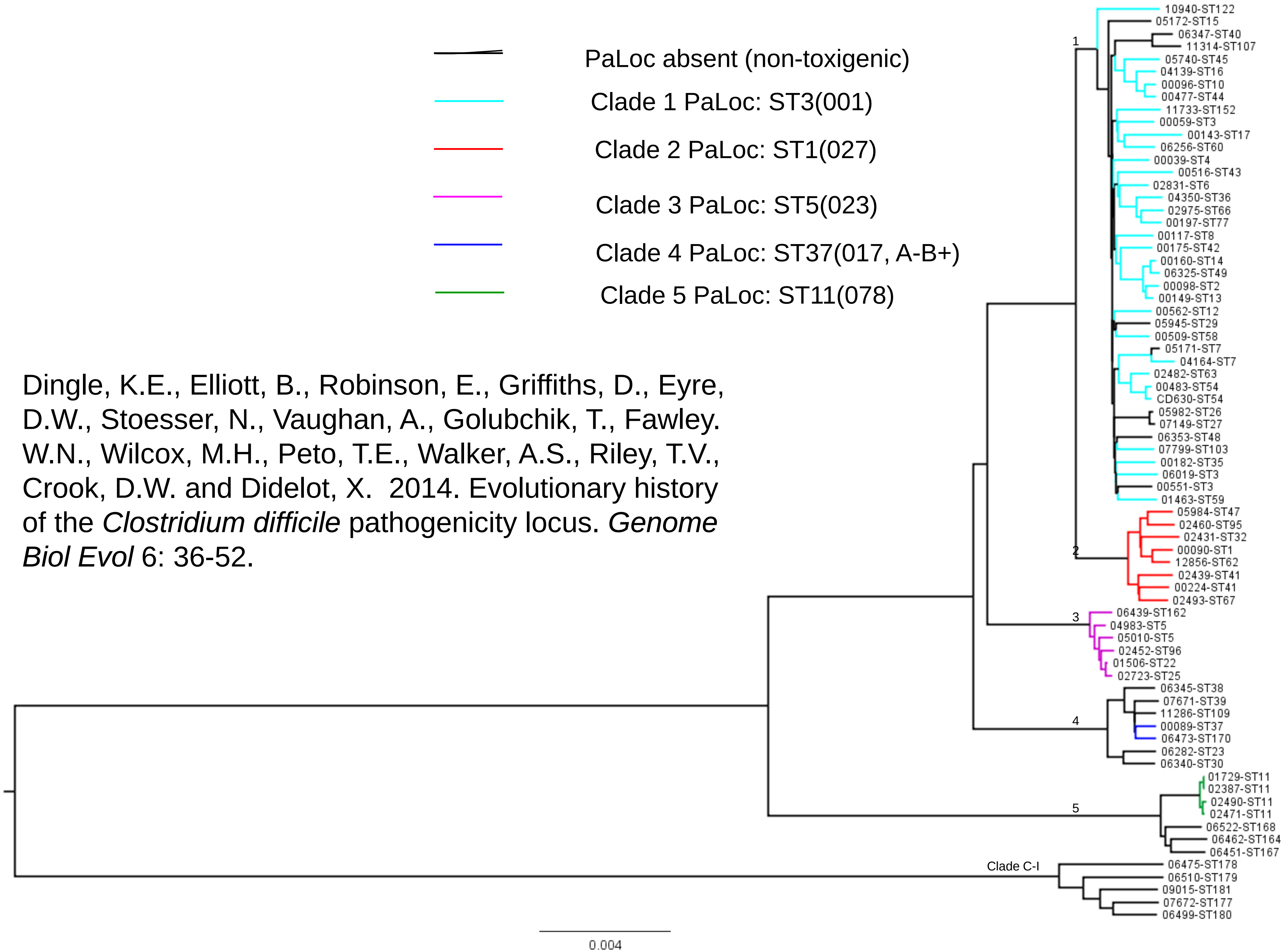
*All samples were positive for *cdtB*, which encodes the binding component of binary toxin. PFGE, pulsed-field gel electrophoresis.
†Deletions in *tcdC* regulatory gene.

Songer *et al*. *Emerg Infect Dis* 2009; 15: 819-821



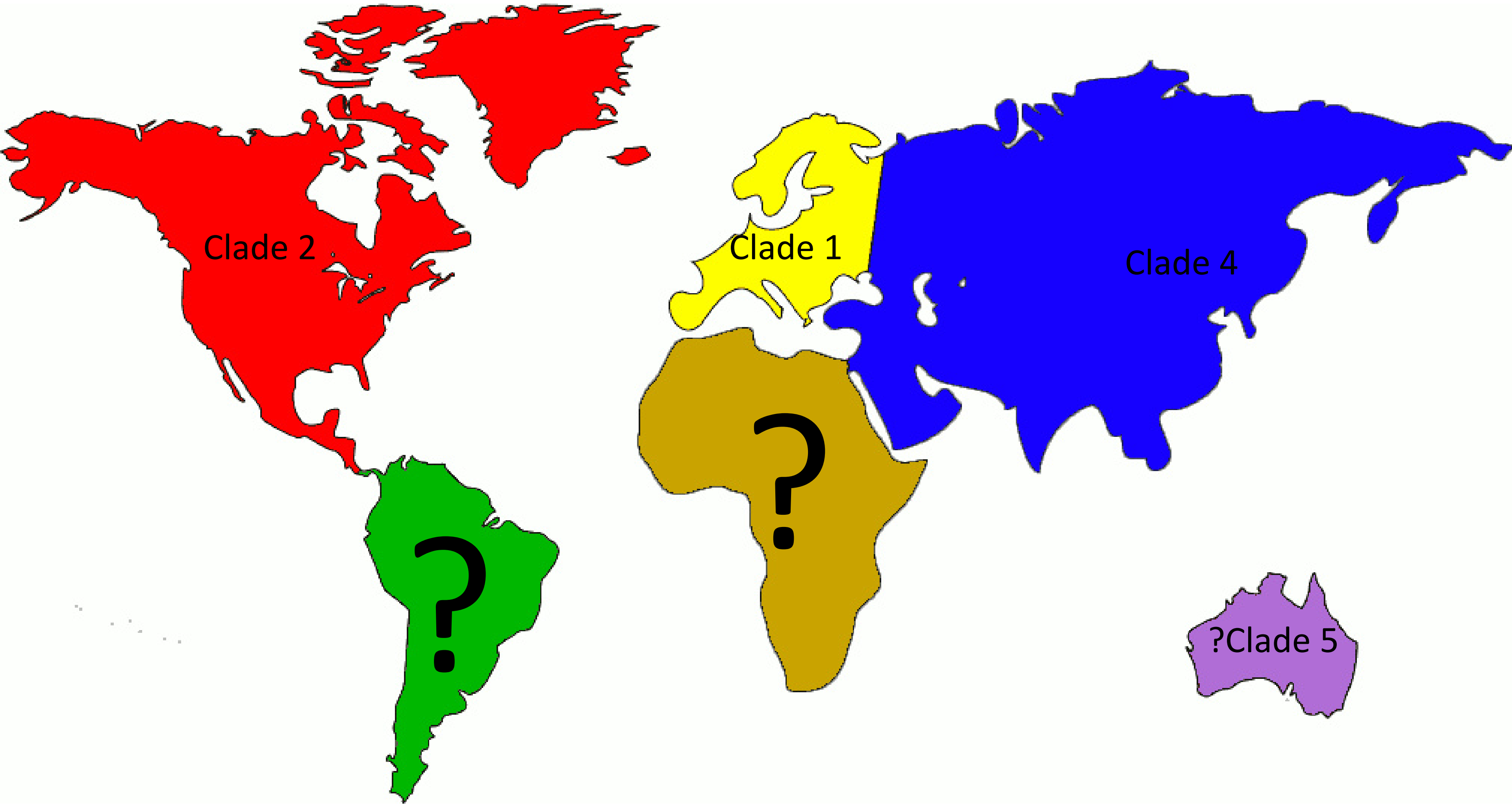
Molecular and epidemiologic information of selected study *C. difficile* isolates.

Cluster	No.	Source	Location	CDR4	CDR5	CDR6	CDR9	CDR48	CDR49	CDR60	tcdC	PFGE
A	1	Human	NJ	18	3	20	15	9	12	10	1	NAP1
	2	Braunschweiger	AZ	18	3	20	15	9	12	10	1	NAP1
	3	Ground beef	AZ	18	3	20	15	9	12	10	1	NAP1
	4	Braunschweiger	AZ	18	3	20	15	9	12	10	1	NAP1
	5	Bovine	AZ	18	3	20	15	9	12	10	1	NAP1



Dingle, K.E., Elliott, B., Robinson, E., Griffiths, D., Eyre, D.W., Stoesser, N., Vaughan, A., Golubchik, T., Fawley. W.N., Wilcox, M.H., Peto, T.E., Walker, A.S., Riley, T.V., Crook, D.W. and Didelot, X. 2014. Evolutionary history of the *Clostridium difficile* pathogenicity locus. *Genome Biol Evol* 6: 36-52.

Phylogeographical tropism of *C. difficile*



The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 SEPTEMBER 26, 2013 VOL. 369 NO. 13

Diverse Sources of *C. difficile* Infection Identified on Whole-Genome Sequencing

David W. Eyre, B.M., B.Ch., Madeleine L. Cule, Ph.D., Daniel J. Wilson, D.Phil., David Griffiths, B.Sc., Alison Vaughan, B.Sc., Lily O'Connor, B.Sc., Camilla L.C. Ip, Ph.D., Tanya Golubchik, Ph.D., Elizabeth M. Batty, Ph.D., John M. Finney, B.Sc., David H. Wyllie, Ph.D., Xavier Didelot, D.Phil., Paolo Piazza, Ph.D., Rory Bowden, Ph.D., Kate E. Dingle, Ph.D., Rosalind M. Harding, Ph.D., Derrick W. Crook, M.B., B.Ch., Mark H. Wilcox, M.D., Tim E.A. Peto, D.Phil., and A. Sarah Walker, Ph.D.

CONCLUSIONS

Over a 3-year period, 45% of *C. difficile* cases in Oxfordshire were genetically distinct from all previous cases. Genetically diverse sources, in addition to symptomatic patients, play a major part in *C. difficile* transmission. (Funded by the U.K. Clinical Research Collaboration Translational Infection Research Initiative and others.)

Animals slaughtered worldwide

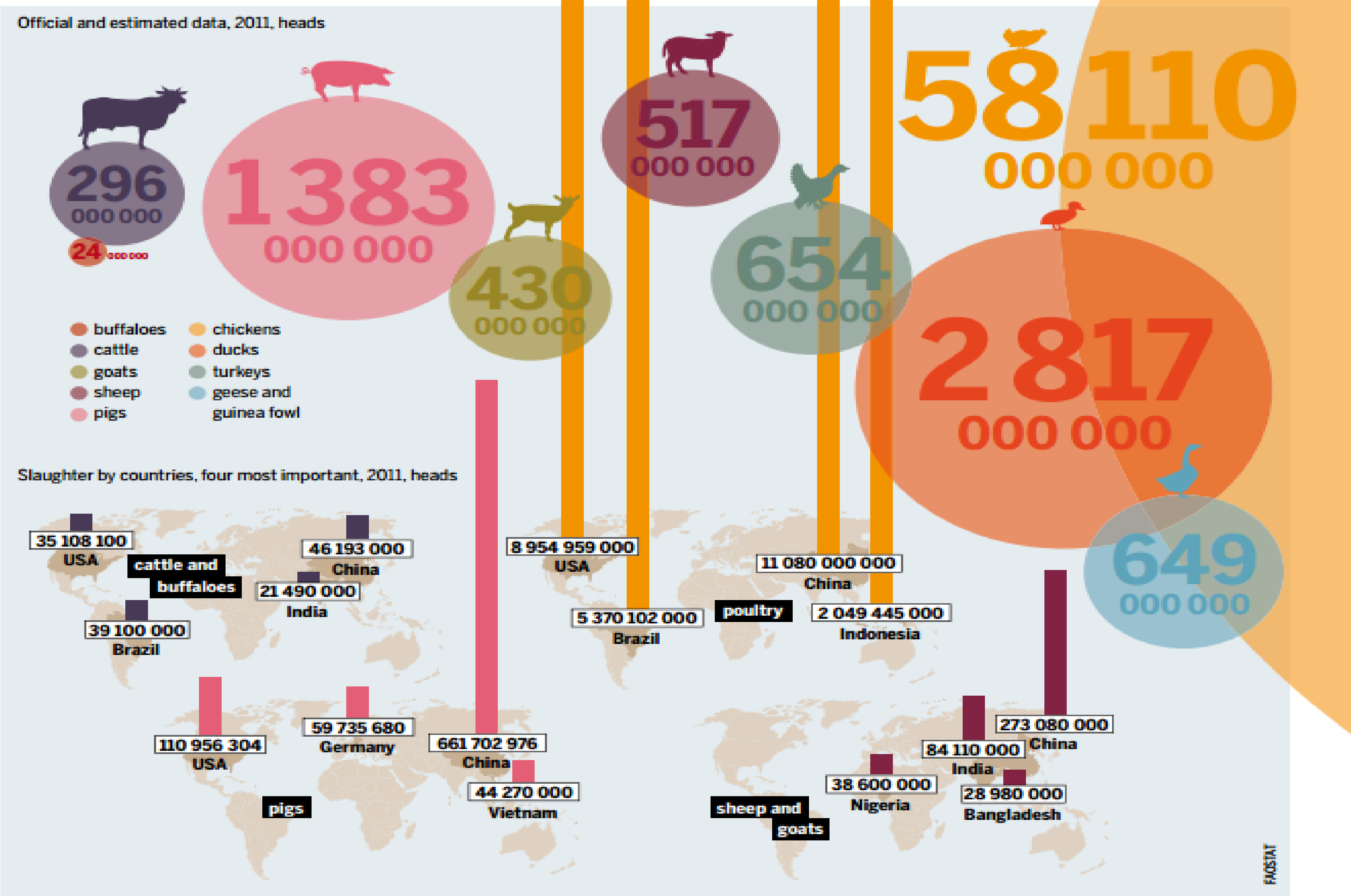


Table 1. Production of food animals (including export of live animals) and the production of meat and milk, Denmark

DANMAP 2006

Year	Broilers		Turkeys a)		Cattle (slaughtered)		Dairy cows		Pigs		Farmed fish	
											Fresh water	Salt water
	1,000 heads	mill. kg	1,000 heads	mill. kg	1,000 heads	mill. kg	1,000 heads	mill. kg milk	1,000 heads	mill. kg	mill. kg	mill. kg
1990	94,560	116	571	2.5	789	219	753	4,542	16,425	1,260	-	-
1992	107,188	137	761	5.4	862	236	712	4,405	18,442	1,442	35	7
1994	116,036	152	1,091	8.6	813	210	700	4,442	20,651	1,604	35	7
1996	107,895	149	961	9.3	789	198	701	4,494	20,424	1,592	32	8
1998	126,063	168	1,124	11.6	732	179	669	4,468	22,738	1,770	32	7
2000	133,987	181	1,042	10.3	691	171	636	4,520	22,414	1,748	32	7
2001	136,603	192	1,038	12.6	653	169	623	4,418	23,199	1,836	31	8
2002	136,350	190	965	11.5	668	169	610	4,455	24,203	1,892	32	8
2003	129,861	181	510	7.4	625	161	596	4,540	24,434	1,898	34	8
2004	130,674	181	55	1.0	632	165	563	4,434	25,141	1,965	34	9
2005	120,498	180	158	0.5	549	145	558	4,449	25,758	1,988	31	8
2006	105,888	163	32	0.1	509	140	563	4,492	25,763	1,957	-	-

Data from Statistics Denmark (www.dst.dk) and The Danish Directorate for Fisheries

a) From 2002, the export of live turkeys for slaughter increased. By 2004, 95% of all turkeys raised in Denmark were slaughtered abroad. For turkeys, data on export of live animals is not included in the table

Approx. 50% increase in numbers

Table 4. Trends in the estimated total consumption (kg active compound) of prescribed antimicrobials for production animals, Denmark

DANMAP 2006

ATC_{vet} group b)	Therapeutic group	1990	1992	1994	1996	1998	2000	2001	2002	2003	2004	2005	2006
QJ01AA	Tetracyclines	9,300 a)	22,000	36,500	12,900	12,100	24,000	28,500	24,500	27,300	29,500	30,050	32,650
QJ01CE	Penicillins, β–lactamase sensitive	5,000	6,700	9,400	7,200	14,300	15,100	16,400	17,400	19,000	20,900	22,250	22,600
QJ01C/QJ01DA	Other penicillins, cephalosporins	1,200	2,500	4,400	5,800	6,700	7,300	8,800	9,900	11,100	12,900	12,300	11,550
QJ01EW	Sulfonamides + trimethoprim	3,800	7,900	9,500	4,800	7,700	7,000	9,200	10,600	10,600	11,500	12,200	13,800
QJ01EQ	Sulfonamides	8,700	5,900	5,600	2,100	1,000	1,000	950	900	850	850	750	750
QJ01F/QJ01XX	Macrolides, lincosamides, pleuromutilins	10,900	12,900	11,400	7,600	7,100	15,600	18,400	19,200	20,700	24,200	22,350	22,050
QJ01G/QA07AA	Aminoglycosides	7,700	8,500	8,600	7,100	7,800	10,400	11,600	11,700	11,700	11,600	10,800	10,500
	Others c)	6,700	6,800	4,400	600	650	300	900	1,600	1,500	1,000	1,950	1,250
Total		53,400	73,200	89,900	48,000	57,300	80,700	94,700	95,900	102,500	112,500	112,650	115,150

1990-2000: Data based on reports from the pharmaceutical industry of total annual sales. (Data 1990-1994: Use of antibiotics in the pig production. Federation of Danish pig producers and slaughterhouses. N. E. Rønn (Ed.). 1996-2000: Danish Medicines Agency). Data 2001-2006: VetStat. For comparability between VetStat data and previous data, see DANMAP 2000. Only veterinary drugs are included. Veterinary drugs almost exclusively used in pets (tablets, capsules, ointment, eye/ear drops) are excluded. Dermal spray with tetracycline, used in production animals, is the only topical drug included

a) Kg active compound rounded to nearest 50 or 100

b) Only the major contributing ATC_{vet} groups are mentioned

c) Consumption in aquaculture was not included before 2001

Approx. 400% increase in penicillins, β-lactamase sens.
Other penicillins, cephalosporins 1000% increase

DANMAP 2006

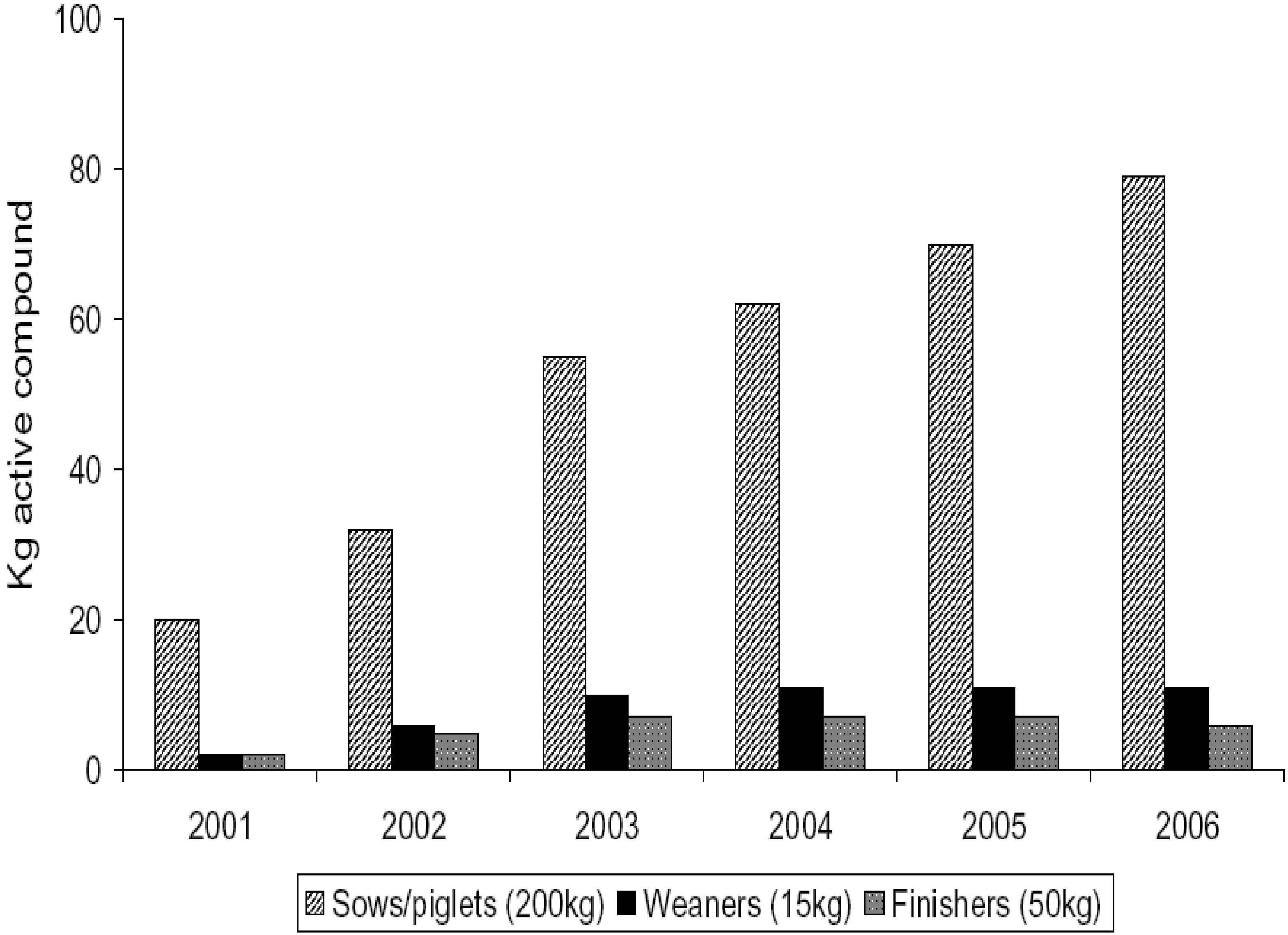


Figure 4 . Consumption of cephalosporins in pigs given as kg active compound from 2001 to 2006, Denmark

DanMap 2007

“This change in prescription habits suggests that the consumption of cephalosporins in pigs is changing from occasional prescription to more systematic prescription in herds producing 14-29% of the weaned pigs.”

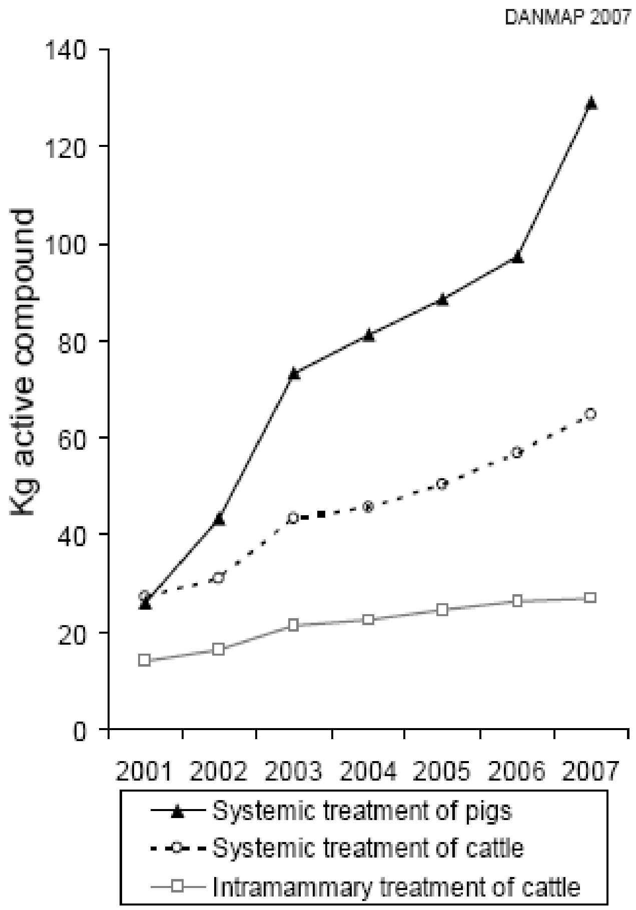


Figure 7. Use of 3rd and 4th generation cephalosporins in pigs and cattle, 2001-2007, Denmark

Antimicrobial use in the Australian pig industry: results of a national survey

D Jordan,[a]* JJ-C Chin[a], VA Fahy,[b] MD Barton,[c] MG Smith[d] and DJ Trott[e]

Table 2. Percent of pig herds (n = 197) reported as having used particular antimicrobials in the 12 months prior to survey and the route of administration of those drugs

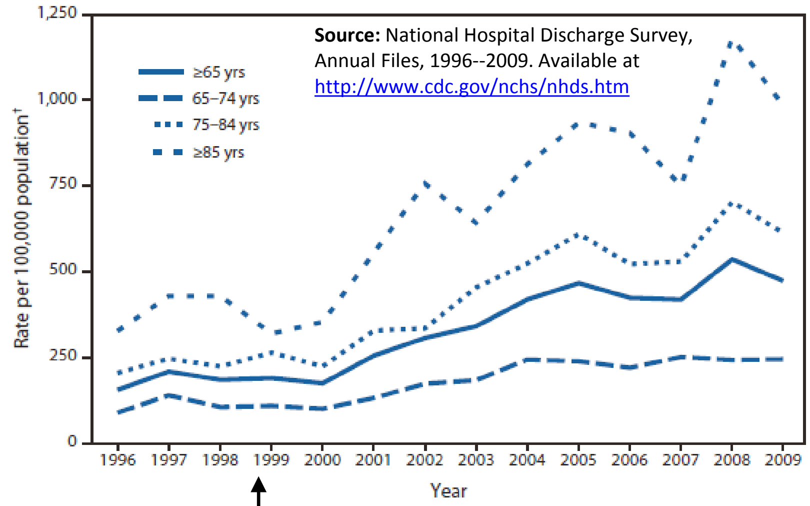
Antimicrobial	Importance rating for human health	Percent of herds within each category of use				
		Unanswered	Not used	Injection/oral	Oral only	Injection only
Apramycin/neomycin	Medium/low	1.0	47.3	2.5	42.1	7.1
Florfenicol (for respiratory disease)	Low	1.0	95.4	0.5	0.0	3.1
Florfenicol (for gut disease)	Low	2.5	93.4	0.0	0.5	3.6
Lincomycin and spectinomycin	Medium	2.0	64.5	6.1	19.3	8.1
Macrolide	Low	2.0	25.4	32.0	27.9	12.7
Penicillins[a]	Low	1.0	3.6	22.8	4.6	68.0
Ceftiofur	High	1.5	73.7	2.0	0.5	22.3
Tiamulin	Not yet rated	1.0	88.4	1.0	7.1	2.5
Olaquindox	Low	1.0	46.7	0.0	52.3	0.0
Virginiamycin	High	1.5	98.5	0.0	0.0	0.0
Dimetridazole	Medium	2.0	85.3	0.0	12.7	0.0
Sulfonamides	Low	2.0	28.9	5.6	10.7	52.8
Tetracyclines	Low	1.0	15.2	50.8	10.7	22.3
Other antimicrobials		3.1	86.2	0.0	7.6	3.1

[a]Includes amoxicillin and ampicillin.

Aust Vet J 2009;87:222–229

Covered about half the large herds in Australia in 2006.

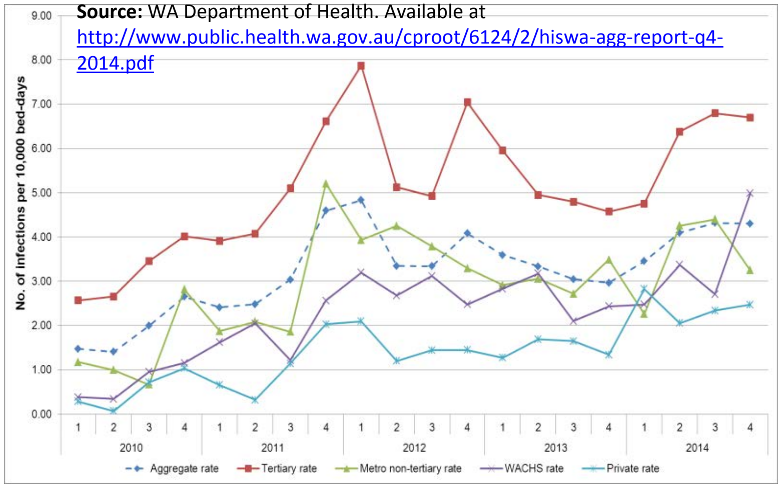
Ribotype 027 mutates to FQ resistance in 2 places independently (He *et al*. 2013)



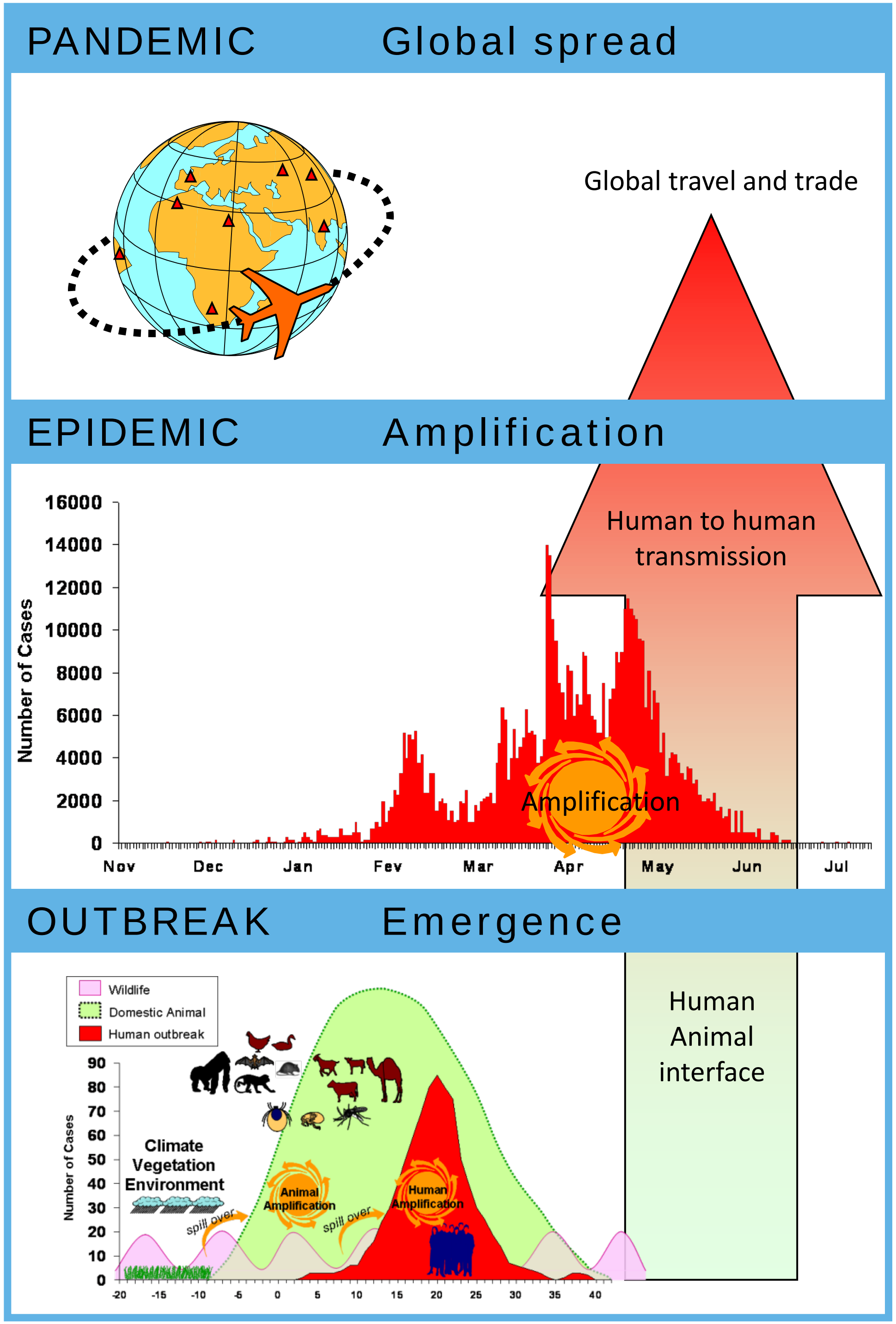
1990	1993/4	2000	2000s	2010s

Ceftiofur licensed for animal use in North America

Ceftiofur licensed for animal use in Australia



Global Alert &Response: the need for global surveillance



Globalization of pathogens

- Global travel: people, animals, vectors
- Global trade: animal and their products, vaccines, medical products, etc.

Amplification of pathogens

- Successful H2H transmission,
- Nosocomial transmission in health care centers
- New introduction from animals
- Urbanization
- Agricultural Intensification
- Technology And Industry

Emergence of pathogens

- Encroachment introduction, “Spill over”
- At-risk behaviour
- Human encroachment, Ex situ contact, Ecological manipulation
- Translocation of wildlife

Slide courtesy of Dr Pierre Formenty , WHO

Is *Clostridium difficile* a threat to Australia's biosecurity?

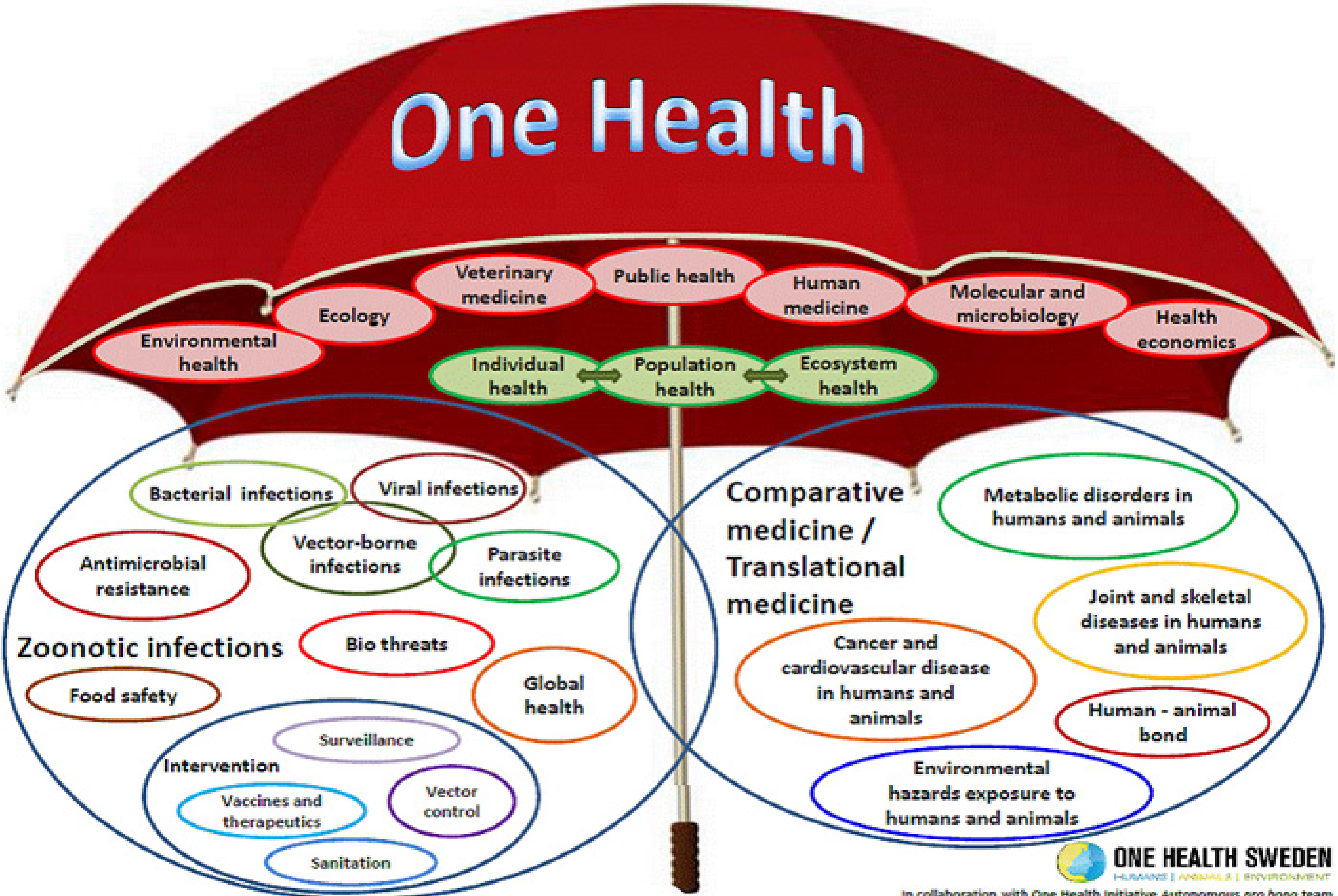
Thomas V Riley

Australia can benefit from lessons learned in the epidemic of C. difficile *infection in Europe and North America*

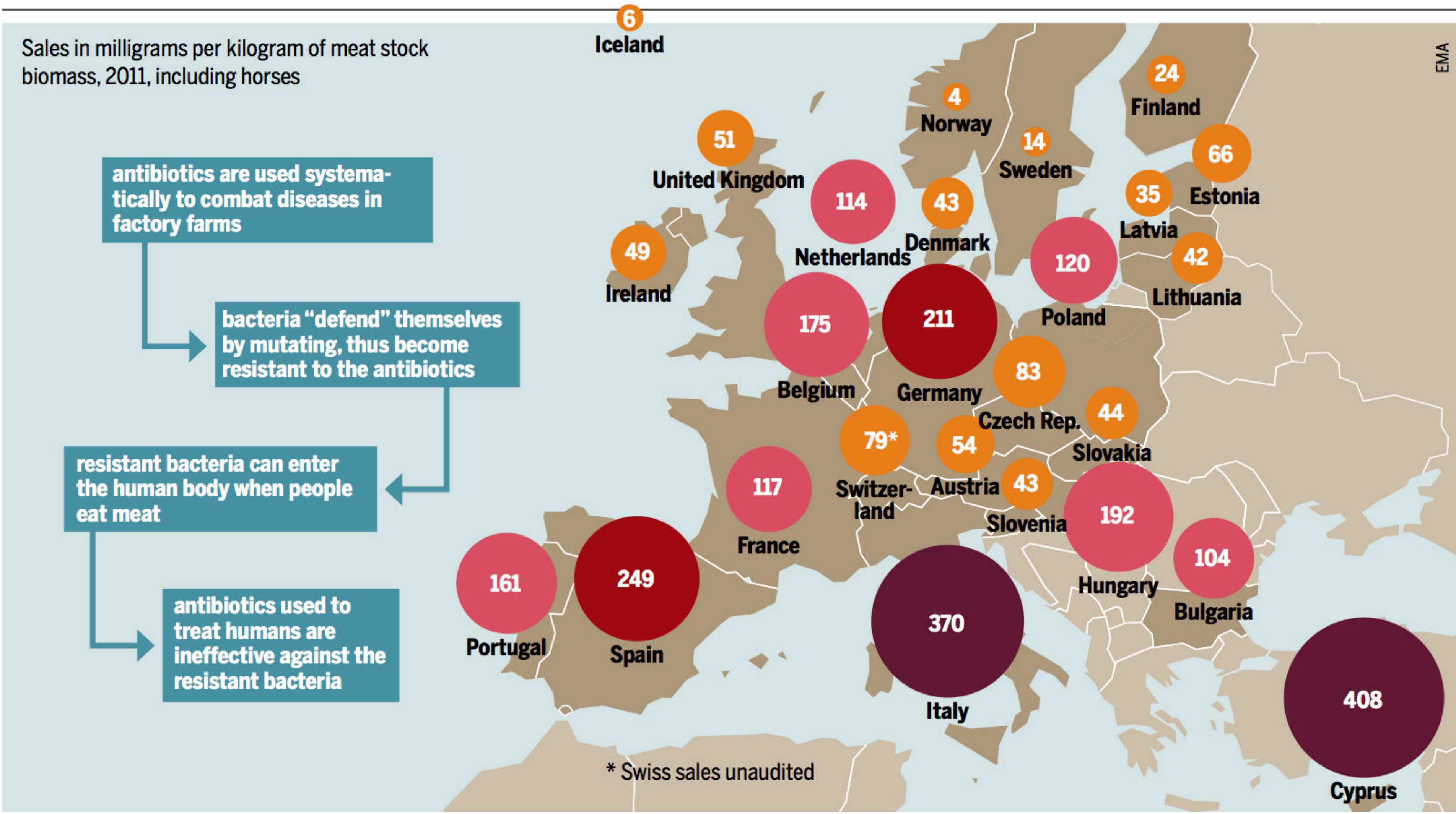
MJA • Volume 190 Number 12 • 15 June 2009

Every effort should be made to stop epidemic *C. difficile* from becoming established in our production animals. Unfortunately, the mere perception of *C. difficile* infection as a foodborne disease will damage the industry.

However, if cephalosporin use is driving *C. difficile* infection in animals overseas, then additional efforts to target cephalosporin use in veterinary medicine may be needed in Australia.


One Health
Veterinary medicine
Public health
Human medicine
Ecology
Molecular and microbiology
Environmental health
Health economics
Individual health
Population health
Ecosystem health
Bacterial infections
Viral infections
Vector-borne infections
Antimicrobial resistance
Parasite infections
Zoonotic infections
Bio threats
Food safety
Global health
Surveillance
Intervention
Vaccines and therapeutics
Vector control
Sanitation
Comparative medicine / Translational medicine
Metabolic disorders in humans and animals
Joint and skeletal diseases in humans and animals
Cancer and cardiovascular disease in humans and animals
Human - animal bond
Environmental hazards exposure to humans and animals
ONE HEALTH SWEDEN
HUMANS | ANIMALS | ENVIRONMENT
In collaboration with One Health Initiative Autonomous pro bono team

European sales of antimicrobial agents for food-producing animals



Clostridium difficile Infection in Humans and Piglets: A 'One Health' Opportunity

Michele M. Squire and Thomas V. Riley

Abstract *Clostridium difficile* causes infectious diarrhoea in humans and animals. It has been found in both diarrhoeal and non-diarrhoeal pigs, horses and cattle, suggesting a potential reservoir for human insection, and in 20–40 % of meat products in Canada and the USA, suggesting the possibility, albeit not proven, of food-borne transmission. Although it is not yet completely clear, it is likely that excessive antimicrobial exposure is driving the establishment of *C. difficile* in animals, in a manner analogous to human infection, rather than the organism just being normal flora of the animal gastrointestinal tract. PCR ribotype 078 is the most common ribotype of *C. difficile* found in pigs (83 % in one study in the USA) and cattle (up to 100 %) and this ribotype is now the third most common ribotype of *C. difficile* found in human infection in Europe. Human and pig strains of *C. difficile* are genetically identical in Europe confirming that a zoonosis exists. Rates of community-acquired *C. difficile* infection (CDI) are increasing world wide, a fact that sits well with the notion that animals are a reservoir for human infection. Thus, there are three problems that require resolution: a human health issue, an animal health issue and the factor common to both these problems, environmental contamination. To successfully deal with these recent changes in the epidemiology of CDI will require a 'one health' approach involving human health physicians, veterinarians and environmental scientists.

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Sunday, April 20, 2014
Finally! CFC Bans Ceftiofur Injections in Eggs & Chicks

The use of the powerful antibiotic Ceftiofur in chicks and eggs has finally been banned by Chicken Farmers of Canada ("CFC"). CFC's new rule takes effect on May 15th 2014.

CFC's private glacier must have melted a little recently. CFC, long ago frozen in administrative suspended animation, has finally decided to act for the good of Canadians. Previously, it seemed as if CFC would rather focus their efforts on themselves and their millionaire, greedy chicken farmer stakeholders.

Chicken farmers have a long history, over 60 years, of using drugs, chemical, and yes, even poisonous and cancer-causing arsenic in the chicken feed and water supply for their factory farmed foul chickens, This crazy scheme of the Chicken Mafia helps them to maximize their profits and reduce their business risk; regardless of the possible impact on people who would eventually eat their chicken as food. Sounds crazy, but it's true.

The Challenge of Regulating Agricultural Ceftiofur Use To Slow the Emergence of Resistance to Extended-Spectrum Cephalosporins

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November 2012 Volume 78 Number 22 Applied and Environmental Microbiology p. 7819–7821

Both the new FDA rule limiting cephalosporin use and Guidance for Industry number 209 attempt to directly address this issue but may be inadequate to effect change. As a result, the mass application of ceftiofur to food animals housed in intensively managed, population-dense environments in the absence of a strong veterinarian-client-patient relationship will almost certainly continue, leading to the further dissemination of extended-spectrum cephalosporin resistance among enteric pathogens.

The way forward

- Continue to try and engage the veterinarians in One Health
- Explain to farmers/industry groups what is going on
- Involve politicians
- Look for alternative agents/strategies
- Restrict cephalosporin use in human medicine
- Completely ban all cephalosporins from use in production animals

"Cephalosporins are the work of the devil, send to end the antibiotic era!"