



Von der Pest zur Enteritis – die etwas anderen Yersinien

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Yersinien

- benannt nach Alexandre Yersin
- Familie *Enterobacteriaceae*
- nahesten Verwandte: Serratien
- Wachstum bei 0 ! bis 42 °C, Opt. 28 °C
- Inaktivierung bei 70 °C
- unter 30 °C beweglich, *Y. pestis* unbeweglich !

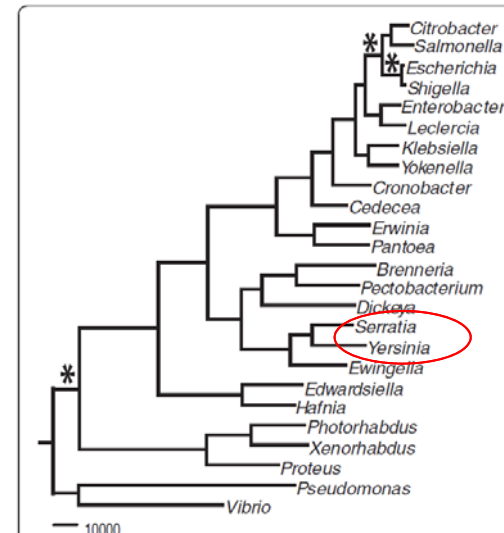


Figure 1 Phylogenetic reconstruction for the family of *Enterobacteriaceae*. Total evidence Maximum Likelihood tree (* indicates phylogenetic branching point for ancestral core metabolic models).

Baumler et al. BMC Syst Biol. 2013; 7: 46.

Die Gattung *Yersinia*

The Good



Y. aldovae (RG 1)
Y. aleksiciae (RG 2)
Y. bercovieri (RG 1)
Y. entomophaga (RG 1)
Y. frederiksenii (RG 2)
Y. intermedia (RG 2)
Y. kristensenii (RG 2)
Y. massiliensis (RG 1)
Y. mollaretii (RG 1)
Y. nurmii (RG 1)
Y. pekkanenii (RG 1)
Y. rhodei (RG 1)
Y. ruckeri (RG 1)
Y. similis (RG 2)
Y. enterocolitica
Biotyp 1A (RG 2)

The Bad



Y. enterocolitica (RG 2)
Biotypen 1B, 2, 3, 4, und 5
Serotypen O:3, O:5,27, O:8, O:9

Y. pseudotuberculosis (RG 2)



verursachen Yersiniosen

And The Ugly



Y. pestis (RG 3)



Pest, „Der Schwarze Tod“

Stammbaum der Yersinien

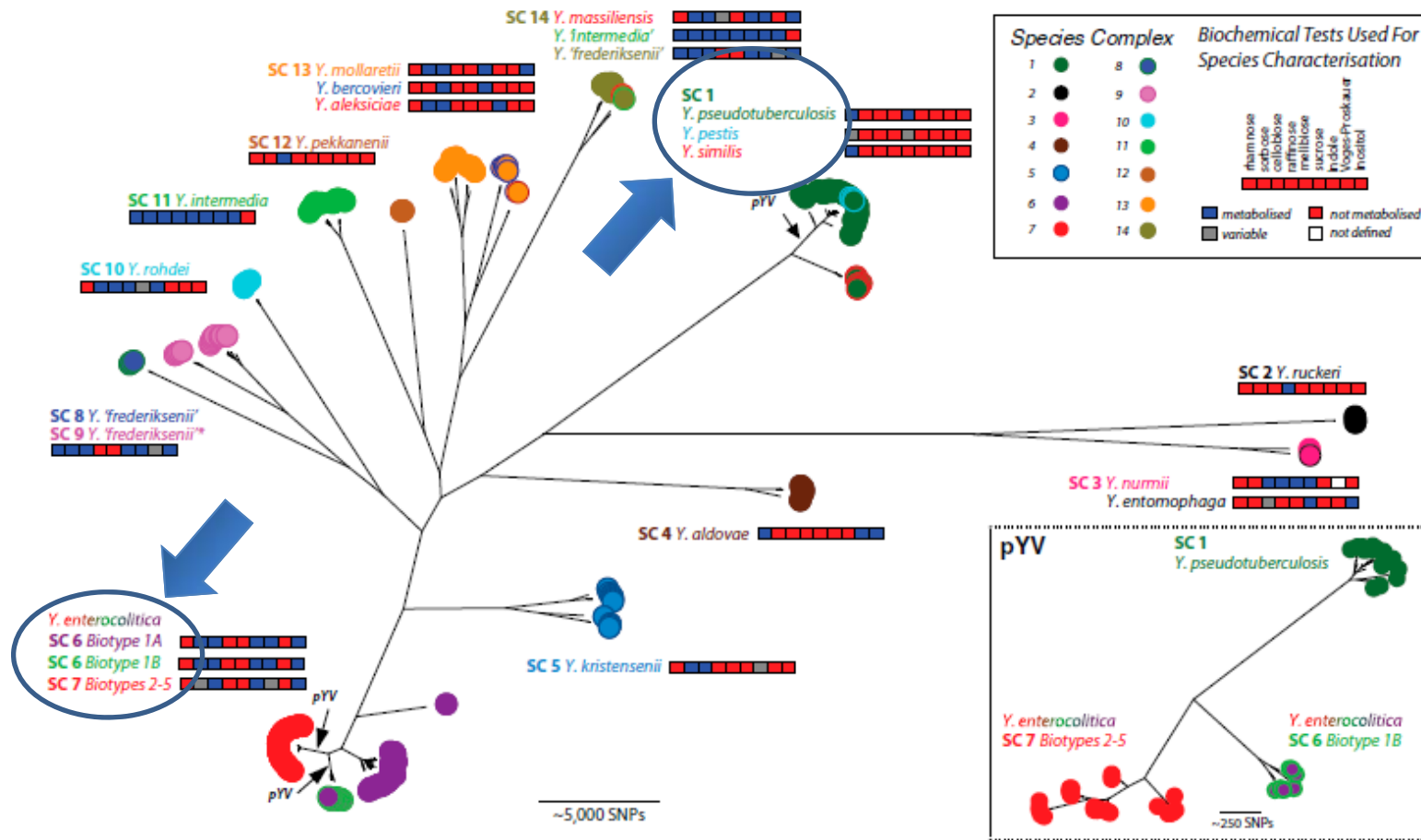
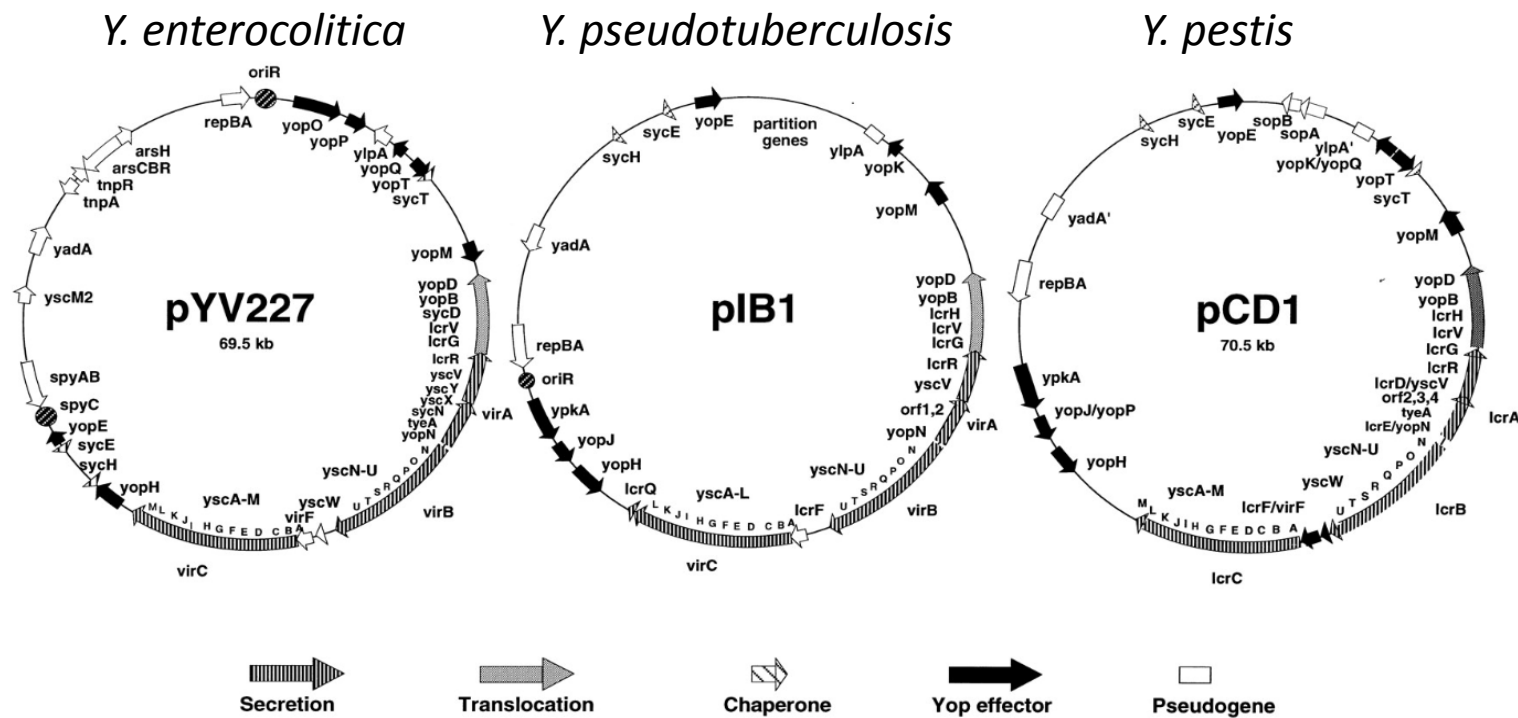


Fig. 1. The phylogeny of the genus *Yersinia* and the virulence plasmid pYV. Maximum-likelihood phylogenetic tree of the genus *Yersinia* based on the concatenated sequence of 84 housekeeping genes. Current species assignments based on biochemical typing (36) (color circle borders) are contrasted with the species complexes (colored circles) as allocated by BAPS. The SC for the *Y. frederiksenii* type strain (8) is depicted by an asterisk. Arrows show the independent acquisition events of the virulence plasmid pYV. The pYV plasmid tree for pathogenic *Y. enterocolitica* and *Y. pseudotuberculosis* samples is shown.

Virulenzfaktoren von Yersinien

Chromosom: *ail* (attachment invasion locus), *inv* (Invasin), *yst* (Enterotoxin)

Plasmid pYV (70 kb): Typ III-Sekretionssystem, Effektor-Proteine (Yops)

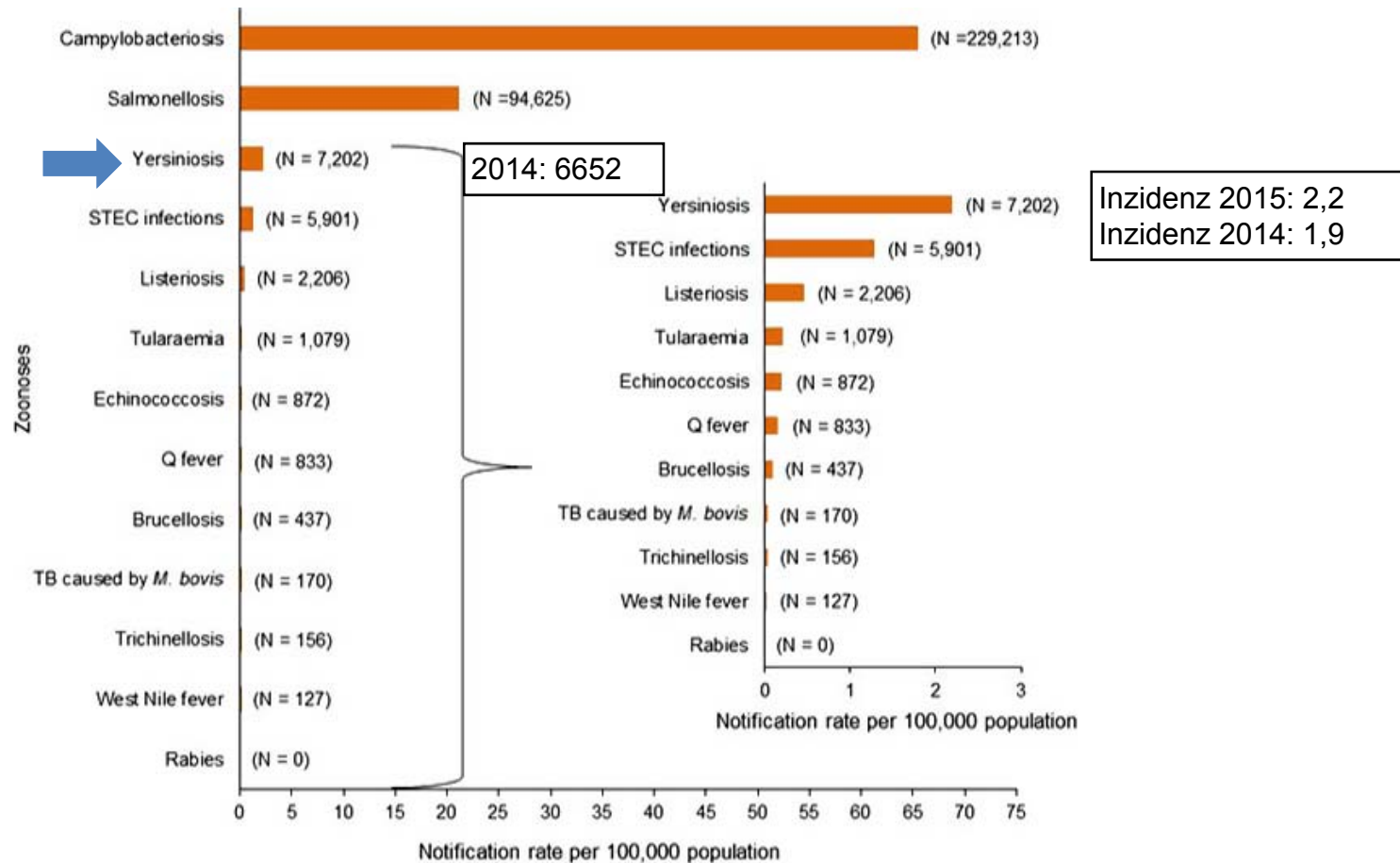


Cornelis et al., Microbiol Mol Biol Rev. 1998 Dec;62(4):1315-52.

Yersiniose (meldepflichtig)

- Fieberhafte **Darmentzündung**, meist hervorgerufen durch die Aufnahme kontaminierter (10^6 Yersinien?) Lebensmittel
- **Inkubationszeit** 4-7 Tage
- **Kleinkinder und über 30-Jährige**: Enteritis oder Enterokolitis (Durchfall, Fieber, Erbrechen)
- **Jugendliche und Erwachsene bis 30 Jahre**: Mesenteriale Lymphadenitis oder terminale Ileitis, ähnlich einer Blinddarmentzündung
- Bei **Immundefizienz**: Sepsis, Myokarditis
- **Folgeerkrankungen**: Reaktive Arthritis (HLA-B27-positiv) Erythema nodosum (Entzündung des Unterhautfettgewebes)

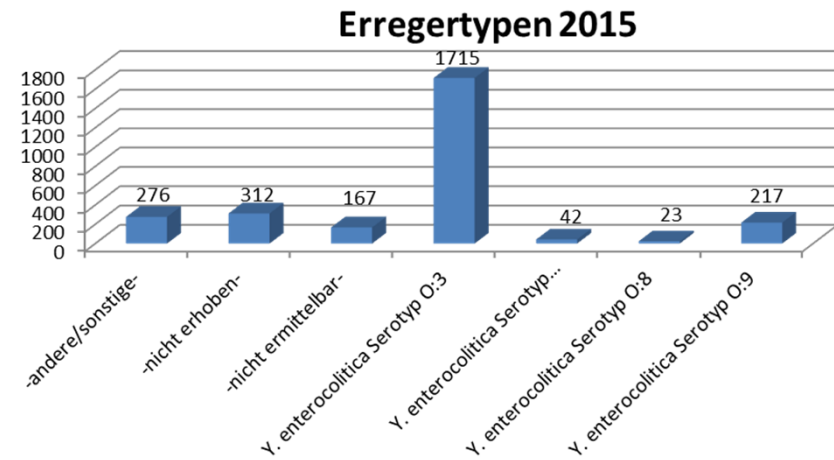
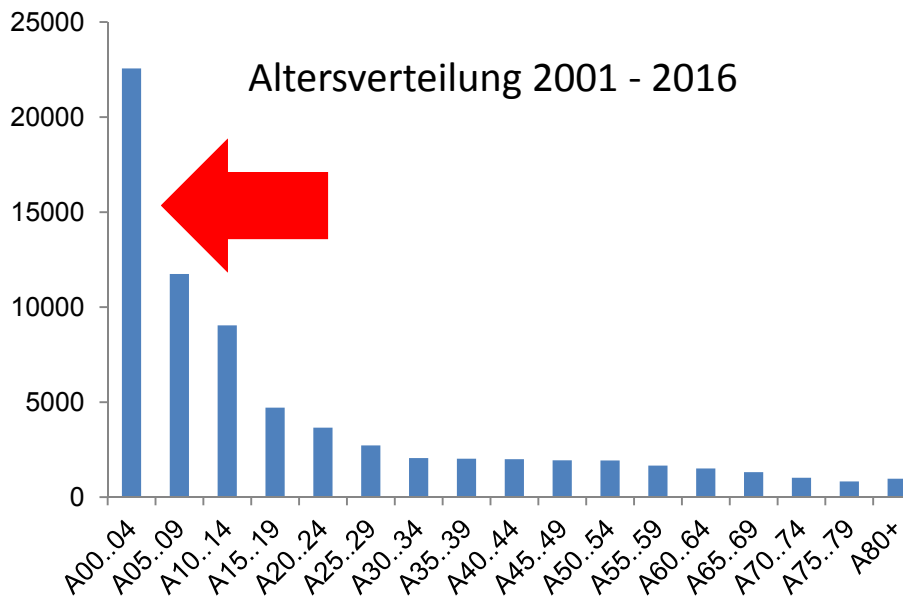
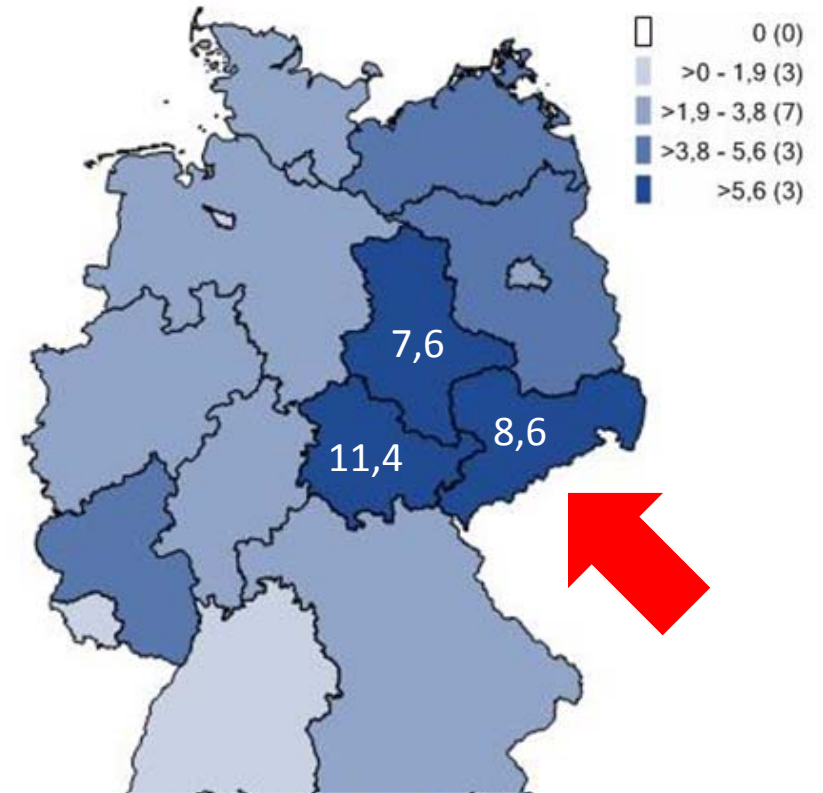
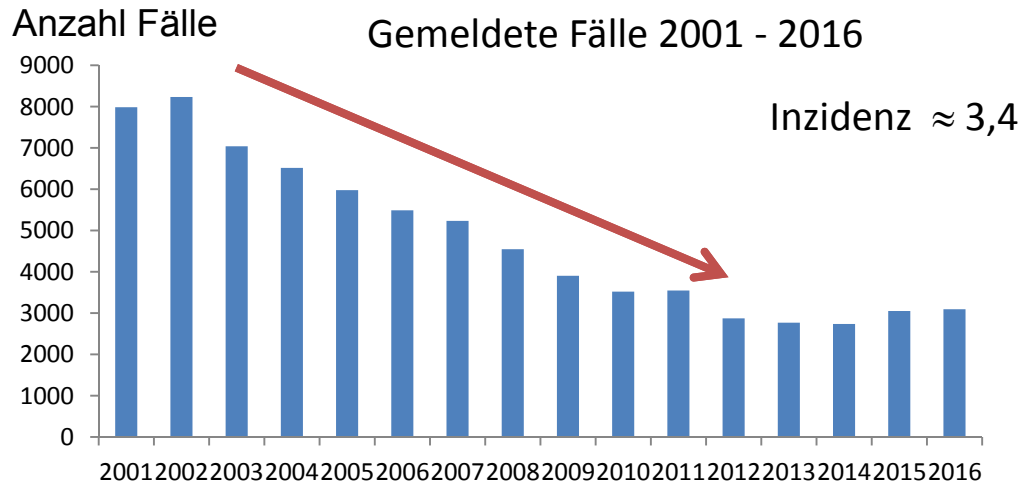
Yersiniosen in der EU 2015



The European Union summary report on trends and sources of zoonoses, zoonotic agents and food-borne outbreaks in 2015

EFSA Journal Volume 14, Issue 12, 16 DEC 2016 DOI: 10.2903/j.efsa.2016.4634
<http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2016.4634/full#efs24634-fig-0001>

Yersiniosen in Deutschland



Yersinien in Lebensmitteln



Nachweis pathogener Yersinien

- **Molekularer Nachweis (ISO/TS 18867)**

ail-real time-PCR; Achtung, es gibt auch Biotyp 1A-Stämme mit *ail*-Gen!

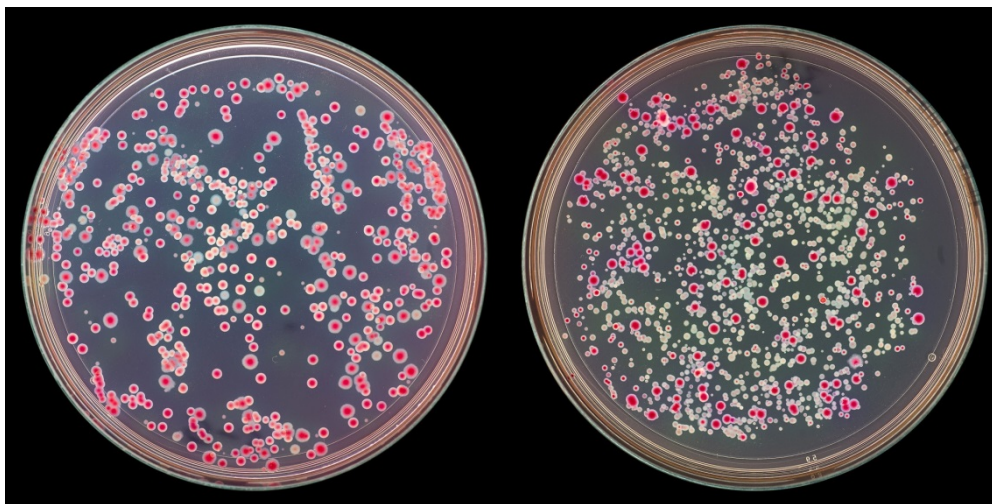
→ ggf. Test auf Pyrazinamidase und Äskulin-Spaltung durchführen

- **Kultureller Nachweis (ISO 10273, revidierte Fassung)**

Anreicherung durch Selektivmedien (ITC, PSB,)

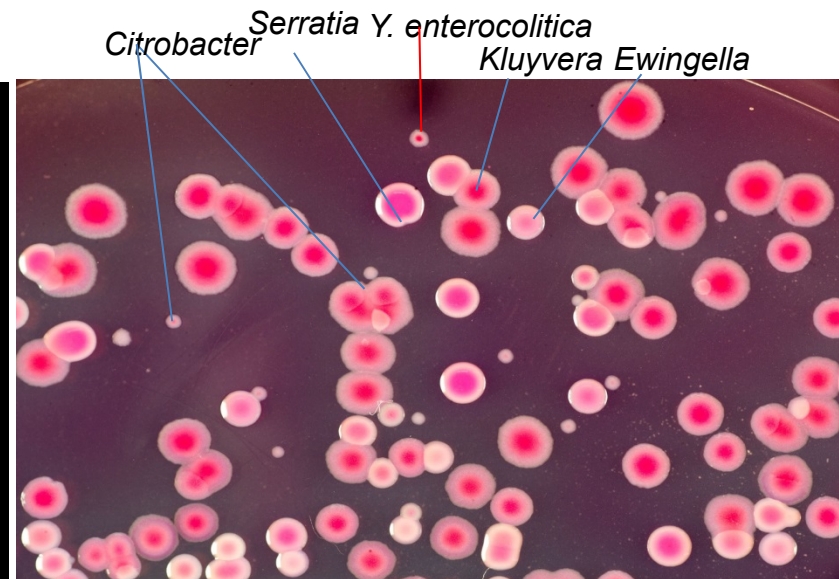
Plattierung der Bakterien auf CIN-Agar (**C**efsulodin, **I**rgasan, **N**ovobiocin)

Isolierung verdächtiger Kolonien



Hackfleisch

Salat



Hackfleisch

Prävalenz von *Y. enterocolitica* in Schweinen und Schweinefleisch-Produkten

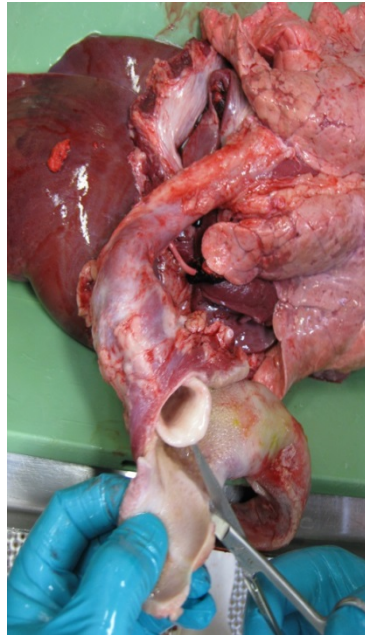
Nathues et al., 2013, **50 Schweine-Bestände** in Norddeutschland

48 % der Herden kulturell-positiv (93,3 % der Isolate B4/O:3)

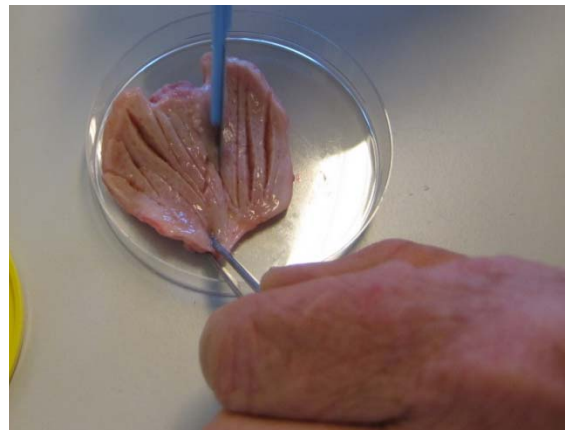
Messelhäuser et al., 2011, Proben aus dem Einzelhandel in Bayern

- 446 **Schweinefleischproben**, 18 % PCR-positiv, 10 % kulturell-positiv
- 255 **Hackfleisch-Proben** und andere **rohe Schweinefleischprodukte**, 6 % PCR-positiv, 3 % kulturell-positiv
- 129 **Schweinezungen**, 45 % PCR-positiv, 26 % kulturell-positiv

Häufiger Nachweis von *Y. enterocolitica* ($> 10^4$ KbE/g) in Tonsillen



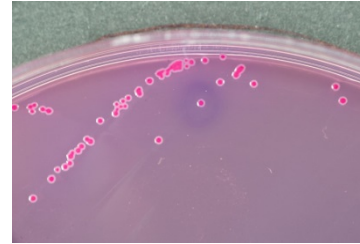
- **Schlachthygiene verbessern**
 - Abkneifen ungespaltener Köpfe
 - Desinfektion von Messern
 - Getrennte Entnahme von Organen (z. B. Leber)
- **Kopffleisch nur für erhitzte Fleischerzeugnisse verwenden**



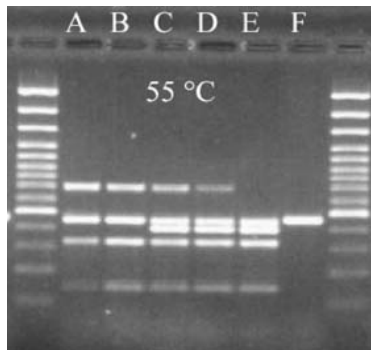
EFSA, 2009

Analyse von *Yersinia*-Isolaten im BfR

- Ausstrich auf CIN
- Isolierung einer Einzelkolonie
- Biochemie (große bunte Reihe)
- Serologie (O:3, O:5, O:8, O:9, O:27)



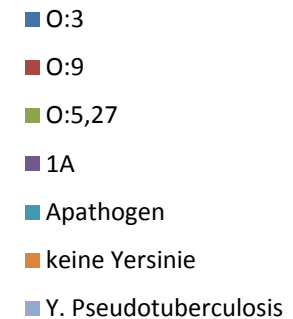
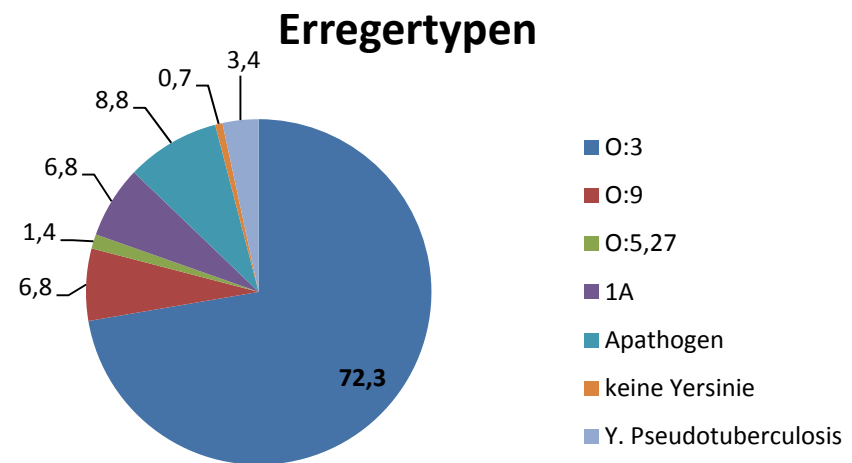
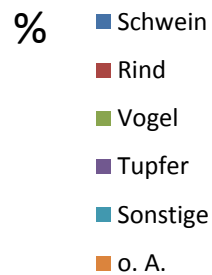
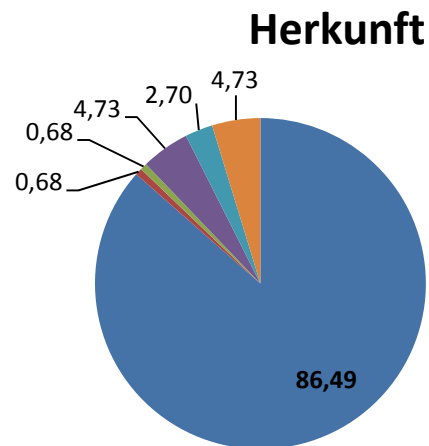
- Multiplex-PCR (Spezies, Serotyp (O:3, O:9, O:5,27), *ail*, pYV)



MALDI-TOF



Einsendungen 2016



LVUs 2016: PCR-Nachweis pathogener *Y. enterocolitica* in Hackfleisch
 2017: Kultureller Nachweis pathogener *Y. enterocolitica* in Hackfleisch

Tenazität von Yersinien in Rohwürsten



Fleischzerkleinern



Kuttern

Inokulation des Bräts *Y. enterocolitica*
(Biotyp 4, Serotyp O:3)

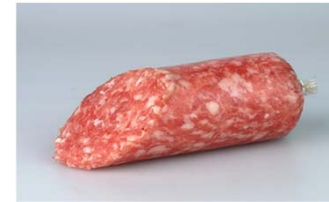


Wolfen



Reifung und **Lagerung**

gemäß produkt- und praxistypischer Programme in der Klimakammer



Zwiebelmettwurst

Schweinefleisch
Fertiggewürzmischung
Nitritpökelsalz (NPS) 24g/kg



Mettwurst I u. II

Schweinefleisch
Schweinespeck
NPS 24g/kg
Gewürze



Teewurst

Schweinefleisch mit 20% Fett
NPS 24 g/kg
Gewürze



Salami I GDL

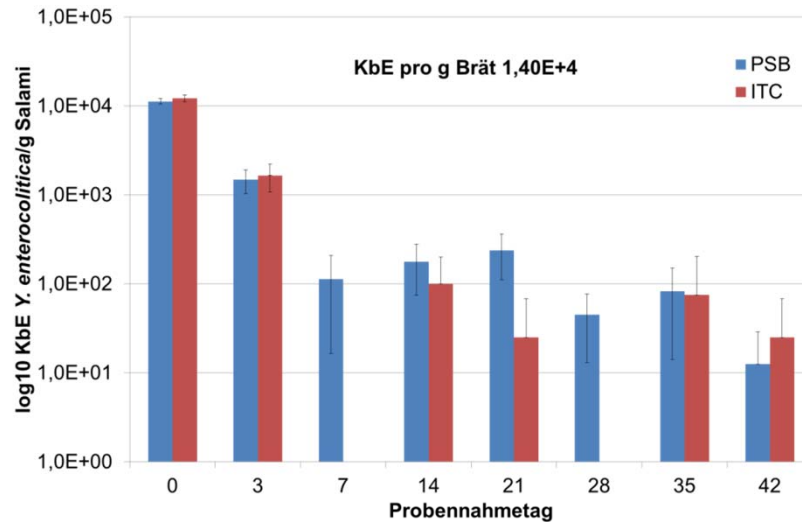
Schweinefleisch
Schweinespeck
NPS 28g/kg
Gluconodelta lacton 0,5 g/kg
Gewürze



Salami II SK

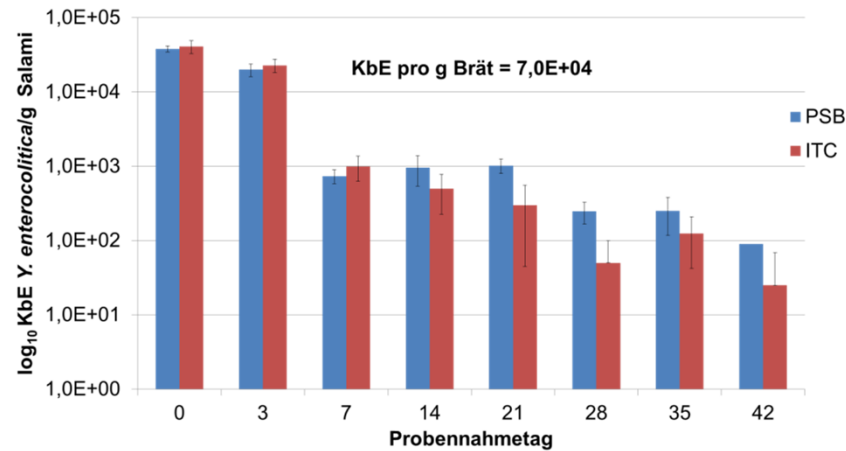
Schweinefleisch
Schweinespeck
NPS 28g/kg
Dextrose 3,0 g/kg
Biostart Plus 50 0,5 g/kg
Gewürze

Keimzahl von *Y. enterocolitica* in Salami bei einer Reifung von 42 Tagen



Beimpft mit:

$1,4 \times 10^4$ Yersinien/g



7×10^4 Yersinien/g

Nachweis von *Y. enterocolitica* in verschiedenen Rohwurstprodukten

Matrix	Untersuchungszeitraum	Nachweis
Zwiebelmettwurst	7 Tage	positiv
Mettwurst I	21 Tage	positiv
Mettwurst II	21 Tage	positiv
Teewurst	42 Tage	positiv
Salami I GDL	42 Tage	positiv
Salami II SK	21 Tage	negativ (nach 14 Tagen)

ZSP 2017: Untersuchung streichfähiger Rohwürste

Y. pseudotuberculosis, die große Unbekannte

SURVEILLANCE AND OUTBREAK REPORT

Outbreak of *Yersinia pseudotuberculosis* O:1 infection associated with raw milk consumption, Finland, spring 2014

Clinical and epidemiological research

EXTENDED REPORT

High frequency of reactive arthritis in adults after *Yersinia pseudotuberculosis* O:1 outbreak caused by contaminated grated carrots

SURVEILLANCE AND OUTBREAK REPORT

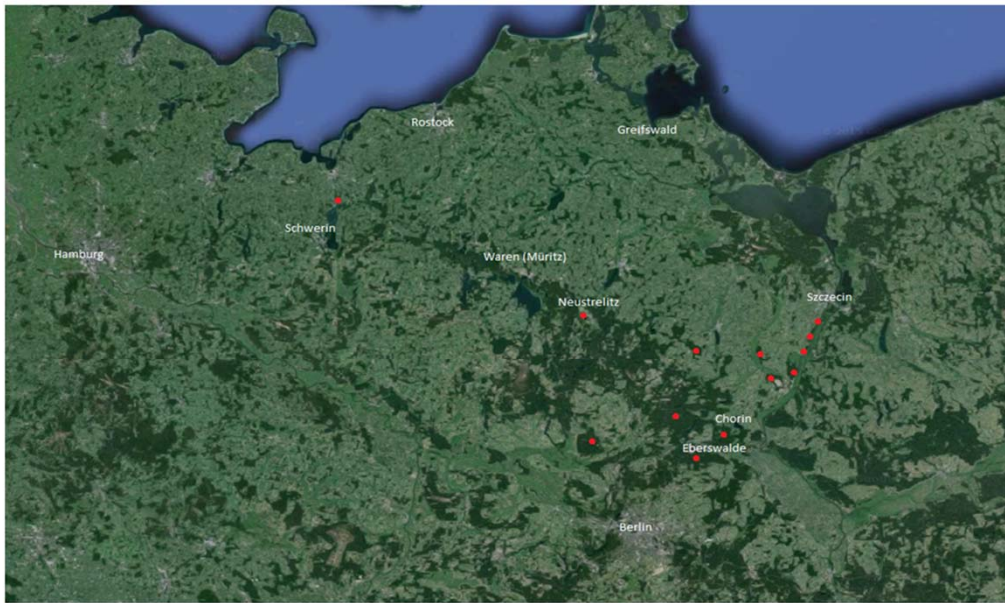
National outbreak of *Yersinia enterocolitica* infections in military and civilian populations associated with consumption of mixed salad, Norway, 2014

GBE

Genomic Insights into a Sustained National Outbreak of *Yersinia pseudotuberculosis*

In 2014, a sustained outbreak of yersiniosis due to *Yersinia pseudotuberculosis* occurred across all major cities in New Zealand (NZ), with a total of 220 laboratory-confirmed cases, representing one of the largest ever reported outbreaks of *Y. pseudotuberculosis*.

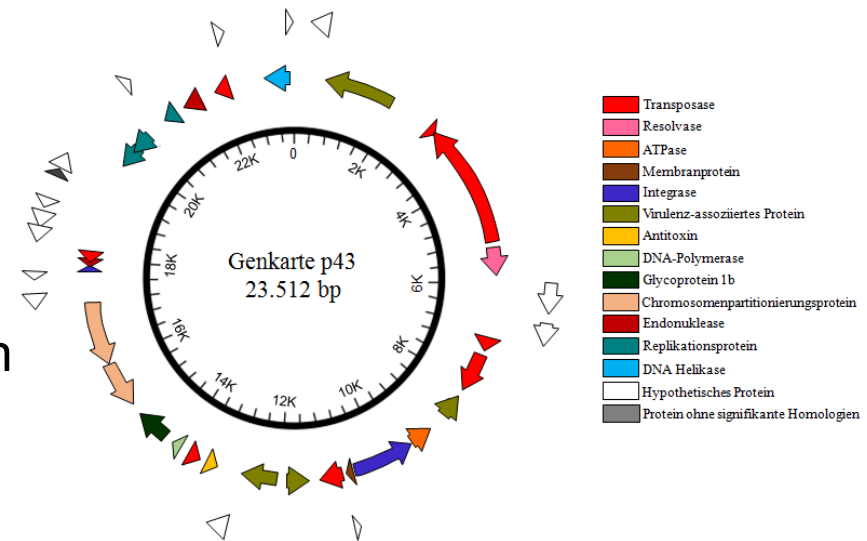
Prävalenz von *Y. pseudotuberculosis* in Wildschweinen in Brandenburg



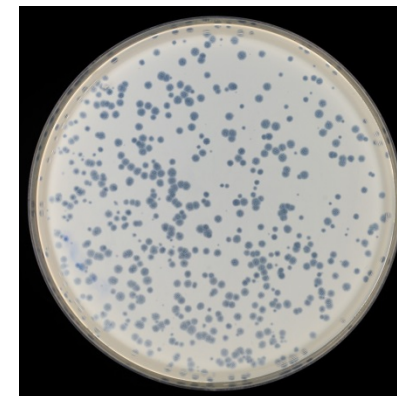
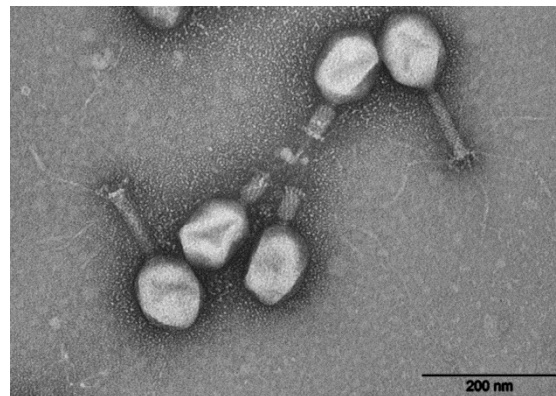
- → Reviere sowohl von der Landesforst Brandenburg als auch Eigenjagdreviere
- → Jeweils ein Jagdrevier im Nationalpark „Unteres Odertal“ und im Biosphärenreservat „Schorfheide-Chorin“
- → 2 Wildhandelsbetriebe mit einem Einzugsgebiet über gesamt Brandenburg und Mecklenburg-Vorpommern

Mobile genetische Elemente bei *Y. pseudotuberculosis*

- kleines Virulenzplasmid-Derivat
- konjugatives Plasmid
- Plasmide mit unbekannter Funktion



Bakteriophagen

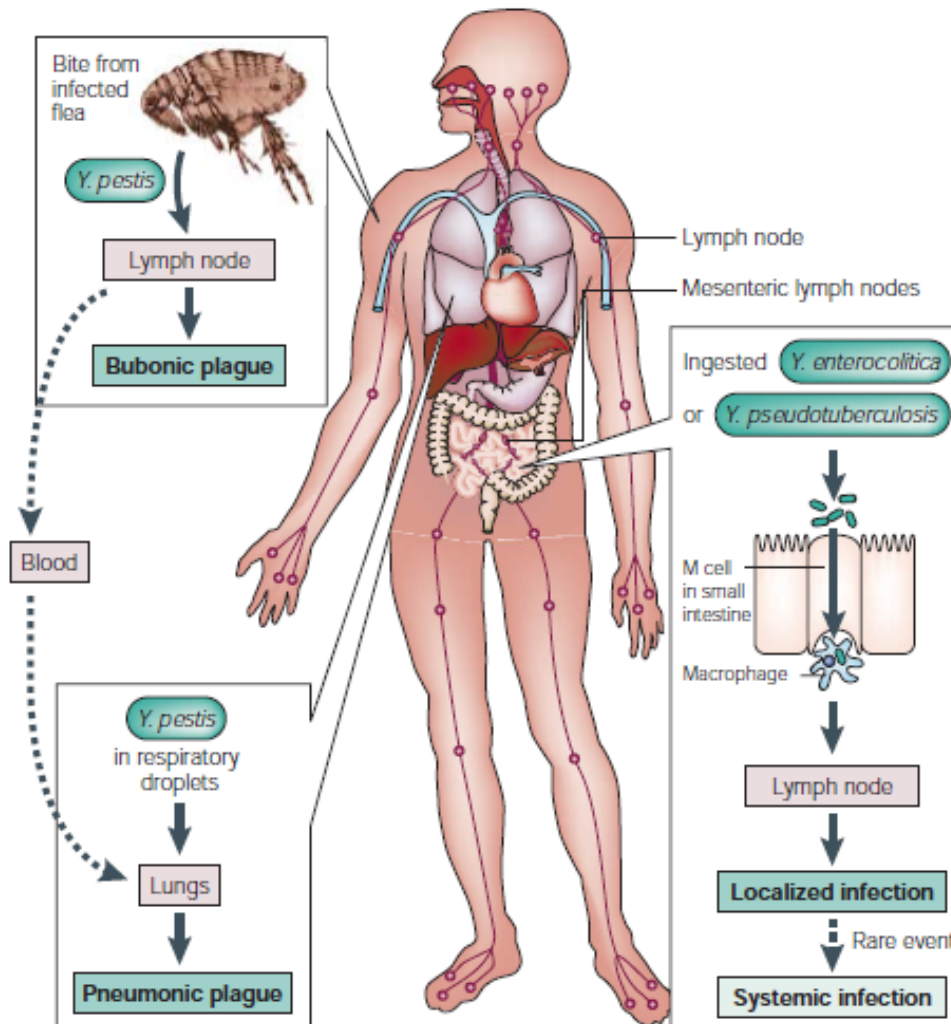


Infektionswege bei der Pest und Yersiniose

Pest

Floh wird von *Y. pestis* nicht abgetötet,
Y. pestis ist Urease-negativ !

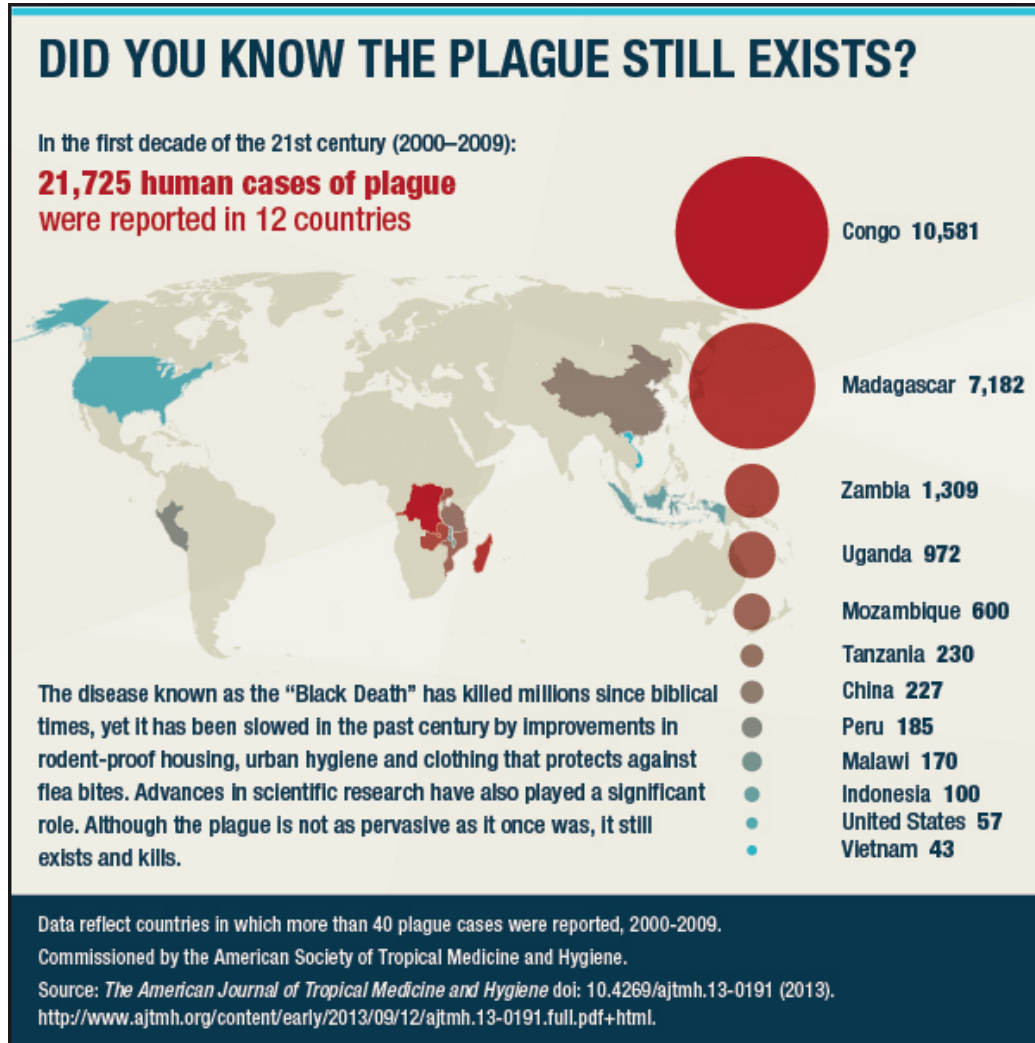
Bakterien bilden Biofilm, der den Weg zum Magen blockiert.



Yersiniose

Figure 2 | Steps in the transmission of the pathogenic yersiniae in humans. *Y. pestis* has a
McNally et.al., 2016, Nature Reviews Microbiology 14:177-90

Weltweit gemeldete Pestfälle 2000-2009



Stefan Hertwig, 29.03.2017, ÖGD Fortbildung

Monday, M

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Fears of a mass BUBONIC PLAGUE outbreak in Russia: Thousands given emergency vaccinations after boy contracts the disease

- A ten-year-old boy caught the Bubonic Plague while skinning a marmot
- He was hunting with his grandfather and cut himself with a knife
- Authorities have taken 17 people into quarantine including six children
- Vaccine is being rushed to remote Kosh-Agach in the Altai Mountains

By WILL STEWART IN MOSCOW FOR MAILONLINE
 PUBLISHED: 08:42 GMT, 14 July 2016 | UPDATED: 14:49 GMT, 14 July 2016

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Bubonic plague 'could return to the UK'

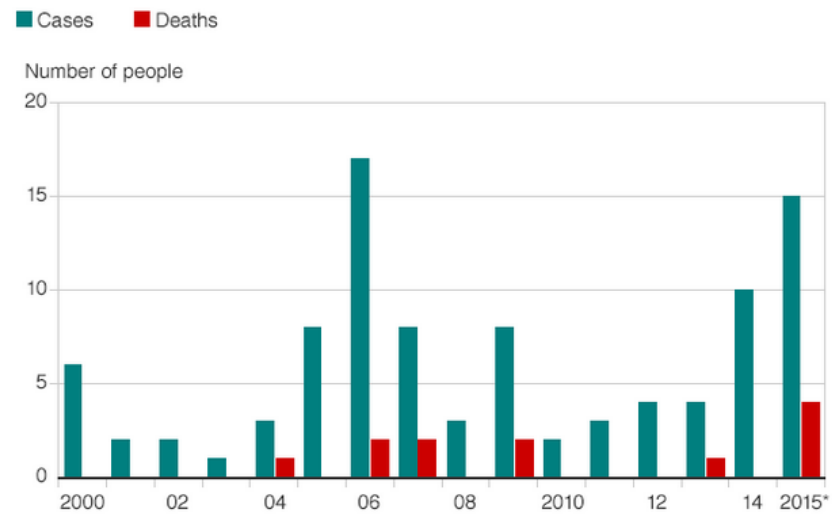
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Black rats have reappeared in some parts of the UK
 Climate changes and increasing globalisation could bring back the diseases of the Middle Ages, an expert has warned.

Pestfälle in den USA

Human plague cases and deaths in the US

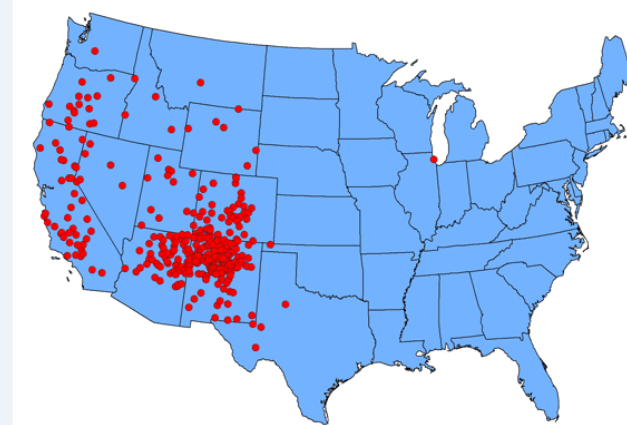


*to October

Source: CDC



Reported cases of human plague--United States, 1970-2012



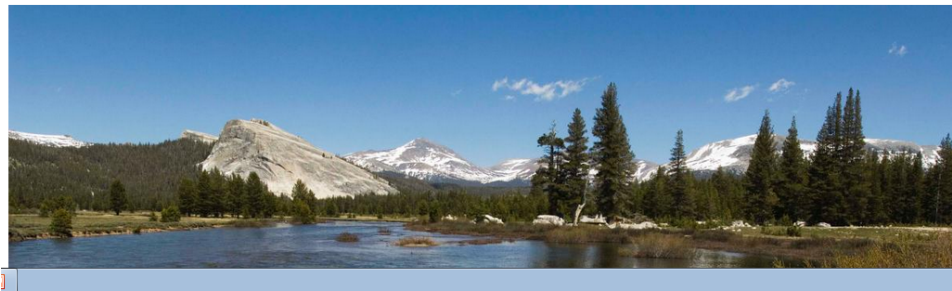
1 dot placed in county of exposure for each plague case

Plague Warning Closes Campground in Yosemite

Risk of deadly disease is low, but squirrel deaths in park raise alarm.

By Rachel A. Becker, National Geographic

PUBLISHED AUGUST 18, 2015



Utah man dies of bubonic plague in fourth US death this year

Fourth fatality out of 12 cases adds up to highest death rate in 15 years, but health authorities say risk remains very small overall



☑ Prairie dogs in Utah can carry the plague, according to health authorities. Photograph: Rick Bowmer/AP

MailOnline Wednesday, Apr 22

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Colorado traces three cases of rare airborne form of PLAGUE back to prairie dogs

- The four total cases near Denver are the first plague 'cluster' since 1923
- Three of the four cases are airborne the pneumonic form of the plague
- All cases have been traced to the first victim's dog, which dropped dead shortly before the owner was diagnosed
- All four are expected to recover

By JOSHUA GARDNER
PUBLISHED: 19:55 GMT, 20 July 2014 | UPDATED: 14:49 GMT, 21 July 2014

Health officials in Colorado are on high alert as the first cases of plague in a decade have been reported in the state over the last week and three of them are a rare airborne form of the disease.

Three cases of plague have surfaced since July 11, when a man with pneumonic plague—the deadliest form of the illness—became the first in the state diagnosed with it since 2004.

The more recent cases have all been traced back to that man's dog, which dropped dead shortly before its owner was diagnosed.

So where did the dog pick up the plague? In all likelihood, from prairie dogs.

Or at least, their fleas.

When the prairie dogs actually die, the fleas need somewhere to go. So once there is a prairie dog die-off, the fleas are out looking for somewhere to get a meal from. Jennifer House of the Colorado Department of Public Health and Environment says.

MailOnline Wednesday, Apr 22

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Squirrel infected with the BUBONIC PLAGUE closes major US campgrounds

- This is the third positive test in the area since 2007
- Campgrounds have been closed for at least seven days
- US plague cases number in the single digits annually

By RYAN GORMAN
PUBLISHED: 13:37 GMT, 28 July 2013 | UPDATED: 16:43 GMT, 28 July 2013

A plague-infected squirrel has forced the closure of numerous Los Angeles campgrounds. Routine testing of a squirrel trapped July 16 revealed this week that it had fleas carrying the bubonic plague, forcing the closure of a handful of campgrounds in Los Angeles, according to officials.

Known as the Black Death, the disease killed millions across Europe during the Middle Ages. This is the third such case in the past six years.

Of the four reported cases in Los Angeles since 1964, none have been fatal after being treated with antibiotics.

Scroll down for video



Yersinien in Lebensmitteln: Empfehlungen zum Schutz vor Infektionen

Stellungnahme Nr. 002/2013 des BfR vom 18. Januar 2013

Der Verzehr von Lebensmitteln, die mit Yersinien verunreinigt sind, kann zu Magen-Darm-Infektionen führen. Auslöser der sogenannten Yersiniose sind die Spezies *Y. enterocolitica* und *Y. pseudotuberculosis*. Yersinien sind Stäbchenbakterien, die in der Umwelt weit verbreitet sind. Hauptreservoir für *Yersinia enterocolitica* ist das Schwein, die Bakterien sind daher auch in rohem Schweinefleisch zu finden. Für *Yersinia pseudotuberculosis* sind vermutlich Wildtiere das wichtigste Reservoir.

Im Jahr 2011 wurden in Deutschland rund 3400 Infektionen mit Yersinien gemeldet, die meisten Infektionen wurden durch *Y. enterocolitica* ausgelöst. Damit gehören Yersiniosen – nach Infektionen mit *Campylobacter* und Salmonellen – zu den häufigsten bakteriellen Magen-Darm-Erkrankungen in Deutschland. Besonders häufig sind Kinder bis zum Alter von drei Jahren betroffen, da das Immunsystem in diesem Alter noch nicht vollständig entwickelt ist. Der größte Risikofaktor für eine Infektion mit Yersinien ist der Verzehr von rohen Schweinefleischerzeugnissen, beispielsweise als Mett oder Hackepeter.

DANKE FÜR IHRE
AUFMERKSAMKEIT