Emerging Infectious Diseases - *Escherichia coli* O157:H7, Non-O157's and O104:H4

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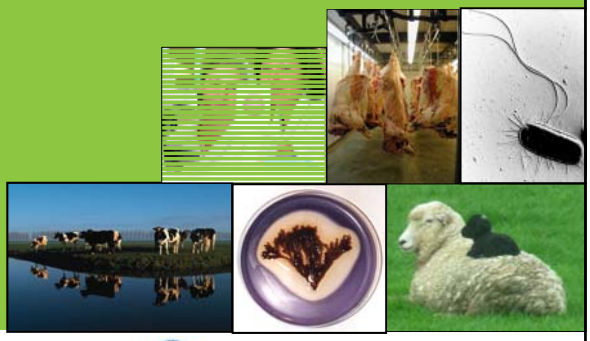

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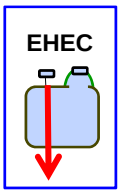
Traditional Sources of *E. coli* O157:H7

Outbreaks or sporadic cases……..



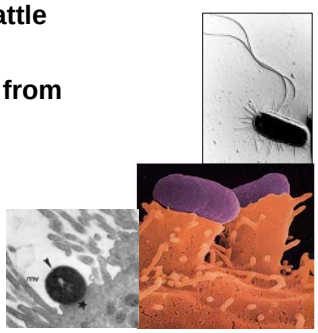
Associated with ingestion of undercooked ground meat

In recent times, more often associated with salad vegetables, raw milk and contaminated water

Ruminant reservoirs, both sheep and cattle

Animal associated transfer, particularly from young animals

High stocking rates in feedlots



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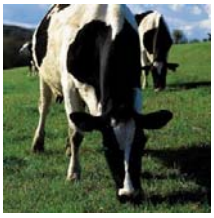
Ruminants as a Source

- **Common inhabitant of the gastrointestinal tract of ruminants, especially cattle**
- **Young animals tend to be higher risk**
- ***E. coli* O157:H7 carriage is asymptomatic and often transient**
- **Intermittent and variable shedding but can get persistent shedders**
  - **Seasonal, age, diet, stress etc affects shedding rates.**
- **STEC appear to be a part of the microbiota of healthy ruminants**
  - **8.7 - 35.2% cattle STEC positive**
  - **32.1 - 66.7% sheep STEC positive**



Entry into the food chain…….

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STEC in New Zealand Ruminants

- **On farm recto-anal mucosal swabs of cattle & sheep (Manawatu & Rangitikei)**
  2003 - 187 healthy cattle & 132 healthy sheep sampled for STEC
  - 27.3% cattle and 65.9% sheep positive for STEC
  - Direct selection on CT-SMAC & TBX with no IMS selection for O157
  - **3 sheep: *eae*-positive STEC** (O26:H11, O84:H-)
  - **19 cattle: *eae*-positive STEC** (O5:H-, O26:H11, O84:H-, O84:H2)

  (Cookson et al., 2006)

- **STEC O157 quantitative risk assessment from bobby calves**
  2005 - 160 calves sampled prior to slaughter
  - 17 (11%) faecal samples positive for O157
  - 69 (43%) hide samples positive for O157 (Mills et al., 2006)

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Other Sources and Other STECs

- **Familial transmission**
- **Other foods**
- **Environmental**
- **Human reservoirs?**

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Infections by non-O157 STECs to 2008

Year	Month	State	*E. coli* Serogroup	Other pathogens	Setting	Vehicle (confirmed or suspected)	with ill food worker(s)?	Total ill*	Reported hospitalizations*	HUS reported
1990	Apr	Ohio	O111		Home/family outbreak	Unknown	Unknown	5	1	Yes
1994	Feb	Montana	O104		Home	Pasteurized milk	No	18	4	No
1998	Oct	Montana	O121		Camp	Unknown	Unknown	8	0	No
1999	Jun	Texas	O111		Camp	Salad bar, ice from barrel	No	55	2	Yes

Illness attributed to non-0157s per year in US

36,700 illness
1100 hospitalisations
30 deaths

2007	Apr	North Dakota	O111		Elementary school	Person-to-person	No	6	1	No
2007	Jul	North Dakota	O111		Private home (wedding reception)	Ground beef	No	23	0	No
2007	Jul	Colorado	O121, O26, and O91		Correctional facility	Pasteurized American cheese, margarine	Yes	135	19	No
2007	Oct	New Hampshire	O45		Fair (petting zoo)	Animal contact	No	5	0	No
2008	Aug	Oklahoma	O111		Restaurant	Unknown	Yes	344	71	Yes
2008	Sept	Minnesota	O111		Daycare	Person-to-person	No	3	0	No

What about *E. coli* O157:H7 infections in New Zealand?

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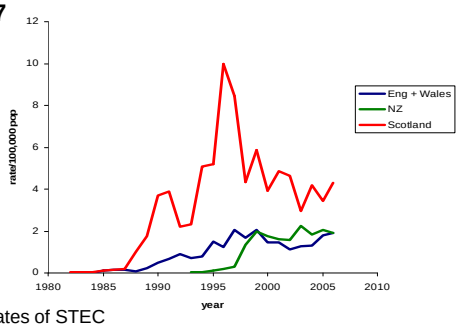
In New Zealand…….

- **Identification of foodstuffs as vehicle of *E. coli* O157:H7 infection extremely rare**
- **No large outbreaks of STEC infection**
- **Infection rates similar to those of England & Wales but less than Scotland**
- **~ 90% STEC isolates O157:H7**



Infection rates of STEC O157 in Great Britain and New Zealand

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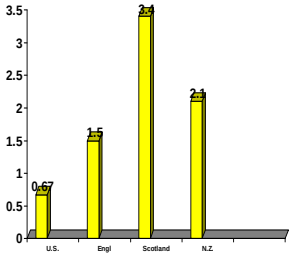
Human Cases in New Zealand?

First case - 1993 an 11 month old boy from Whakatane with HUS

D+HUS in under 15s /100,000



In NZ, it tends to be sporadic and rural rather than associated with food

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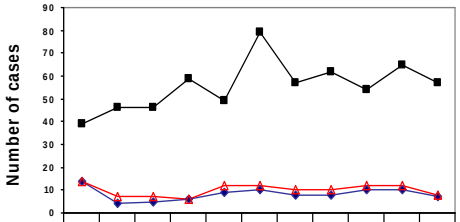
Cases in New Zealand



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
D+HUS	14	4	5	6	9	10	8	8	10	10	7
total HUS	14	7	7	6	12	12	10	10	12	12	8
Paed VTEC	39	46	46	59	49	79	57	62	54	65	57

Figure 1. Number of Paediatric VTEC cases & HUS in New Zealand, 1998-2008 (Personal Communication. Wong 2009 Presentation)

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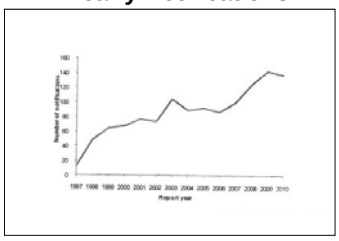
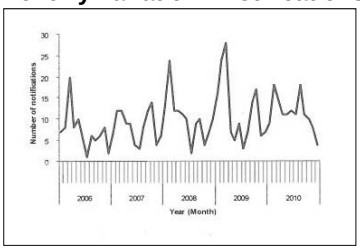
In 2010……

Yearly Notifications



Monthly Variation - Notifications



Continuing to increase in numbers with clear seasonal trends

5 outbreaks – 4 were person to person
- 1 may be also food associated

Of 128 confirmed cases 115 wereO157:H7, 13 cases were non-O157

Most cases reported in 1- 4 yr age group with 4 cases reported as HUS

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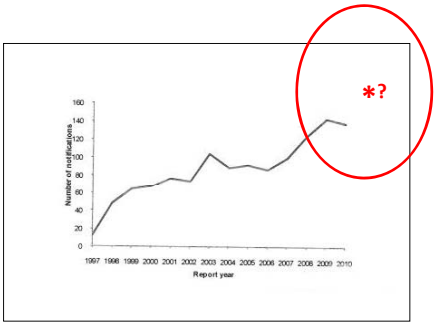
So far in 2011…….

Significant rise in notifications

183 (2011) compared to 130/100,000 (2010)



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Genetics and Genomes of STECs

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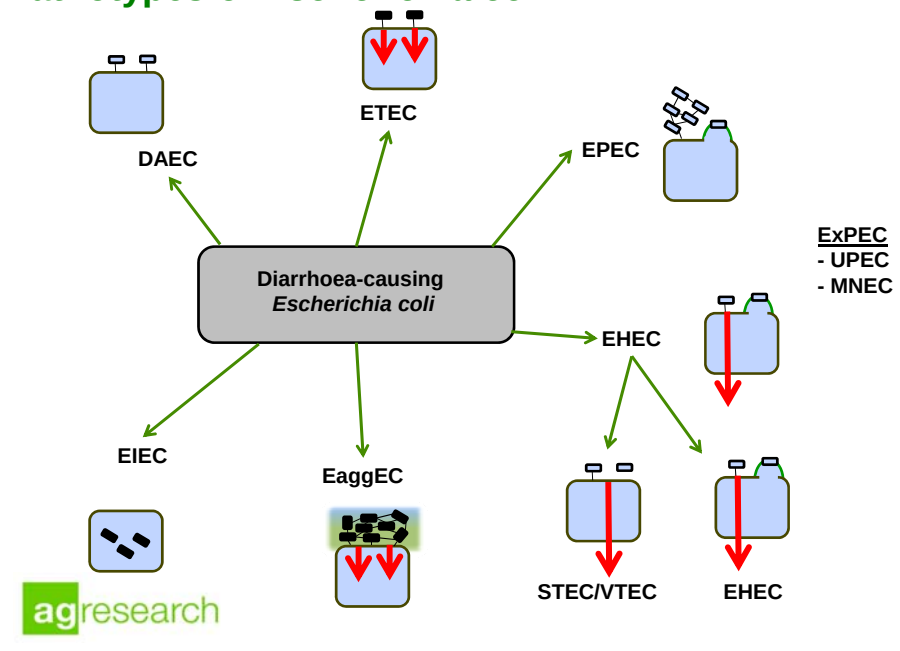
Pathotypes of *Escherichia coli*



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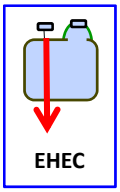
Defining *E. coli* O157:H7

STEC: shiga-toxin producing *E. coli*

Haemorrhagic colitis
HUS (Haemolytic-uremic syndrome)
TTP (Thrombotic thrombocytopenic purpura)

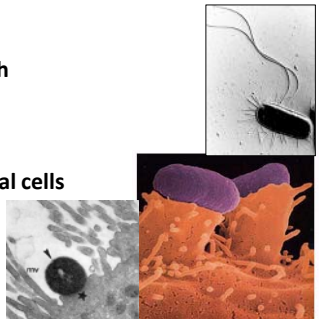


Possess either one or both Stx1 and Stx2 toxins

- **found on lysogenic lambda bacteriophage**
- ***stx1* identical to that found in *Shigella dysenteriae***
- **toxins inhibit protein synthesis leading to cell death**

Outer membrane protein intimin (*eae*)

- **attaching and effacing (AE) lesions on host epithelial cells**
- **in the absence of *eae*, *iha* promotes adhesion**



Antibiotic resistance - none

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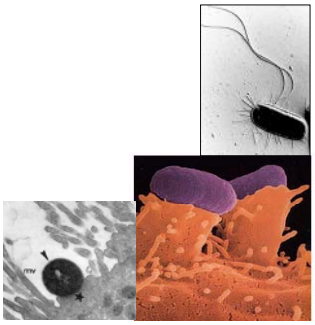
Other STEC Virulence Factors

- **haemolysin**
- **serine protease**
- **catalase peroxidase**
- **Saa adhesin**
- **SubA toxin**



- **STEC/*E. coli* genome made up of a mosaic of 'foreign' DNA acquired through horizontal gene transfer, phage insertion**

- **Virulence genes flanked by transposable/insertion elements**
  - **often inserted into large plasmids, common in STEC & other *E. coli* pathotypes**

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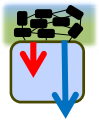
E. coli O104:H4

As of July 1st – 4121 cases reported, 845 HUS and 50 deaths

Predominant involvement of adult women in initial stages of outbreak

Average age of afflicted decreased

O104:H4 Germany



Severe neurological complications – encephalopathy and epileptic seizures

High mortality rate *cf* O157 (20% (HUS) and 6% (Death))

EHEC strain which until this outbreak was very rare

Other documented cases were in Korea, Germany, Finland and France

Previous German HUS case – closely related but does not appear to be the same strain

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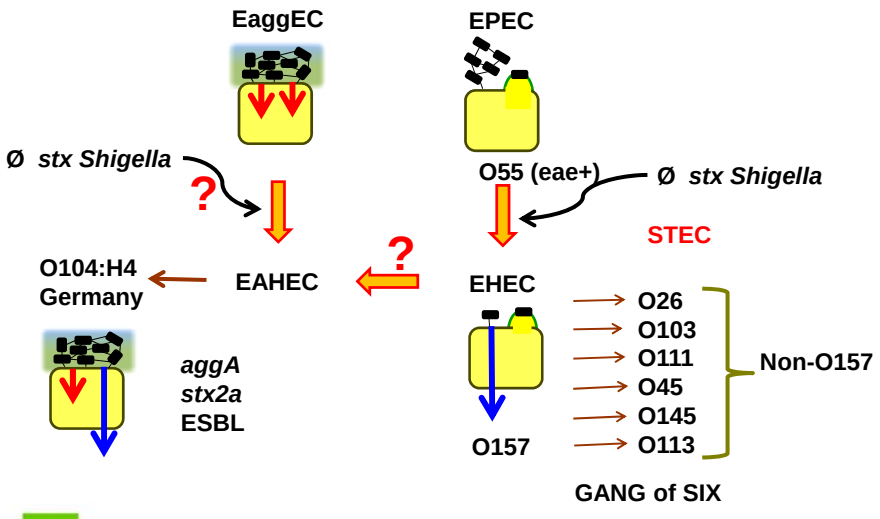
SOURCE -Fenugreek seeds

Origins of HUS causing *Escherichia coli*



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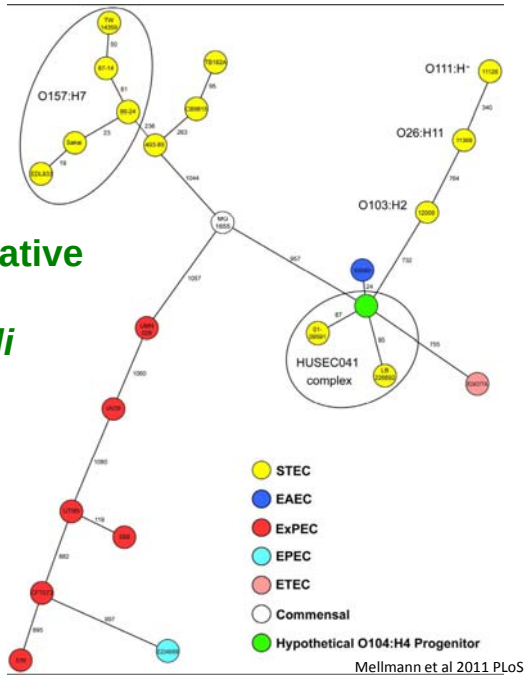
Core genome comparative analysis of pathogenic *E. coli*



Mellmann et al 2011 PLoS

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Relatedness of O157 Isolates and Epidemiology

Isolate and characterise O157 and non-O157 from a range of sources

- **environmental**
- **bovine**
- **clinical**

Serotyping to confirm isolate but need genotyping and sequencing to get source attribution

- **MLST**
- **Pulse Field Gel Electrophoresis**
- **Insertion Site Mapping**
- **Others?**

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