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Characterizing the health risks of Shiga toxin-producing Escherichia coli (STEC)

FAO/WHO STEC Expert Group



FAO/WHO STEC Report - chronology

- **2015** – request to FAO and WHO by the 47th session of Codex Committee on Food Hygiene
- **2016** – 1st FAO/WHO STEC Expert Group meeting, Geneva.
- **2017** – 2nd FAO/WHO STEC Expert Group meeting, Rome.
- **2018** - “Shiga toxin-producing *Escherichia coli* (STEC)” Report of a Joint FAO/WHO Expert meeting.
- **2018** – “Hazard identification and characterization: Criteria for categorizing Shiga toxin-producing *Escherichia coli* (STEC) on a risk basis”, General Interest Paper – J. Food Protection.



STEC Expert Group & participants

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2nd FAO/WHO STEC Expert Group meeting, Rome



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FAO/WHO STEC Report summary is available

CODEX ALIMENTARIUS COMMISSION



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Agenda Item 3a

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JOINT FAO/WHO FOOD STANDARDS PROGRAMME

CODEX COMMITTEE ON FOOD HYGIENE

Forty-ninth Session

Chicago, Illinois, United States of America, 13 - 17 November 2017

**PROGRESS REPORT ON THE JOINT FAO/WHO EXPERT MEETINGS ON MICROBIOLOGICAL RISK
ASSESSMENT (JEMRA) AND RELATED MATTERS**

Prepared by FAO and WHO



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Shiga toxin-producing *Escherichia coli* (STEC) and food: attribution, characterization, and monitoring

REPORT



Focus of FAO/WHO STEC report

- 1. Global burden of STEC foodborne disease**
 - Poster P002
- 2. Criteria for hazard identification and characterization**
- 3. Current monitoring programs and methodologies that are available.**



Criteria for hazard identification and characterization

Complex pathogenicity –

- Many virulence & putative virulence factors; PAIs
- Key traits for pathogenesis - adherence factor and *Stx*

• Adherence factors –

- **Well recognized** – *eae*, *aggR*
- **Putative** - *saa*, *sab*, *paa*, *efa1*, *ompA*, *lpfA*, *toxB* and the LAA PAI.

• Stx types and subtypes

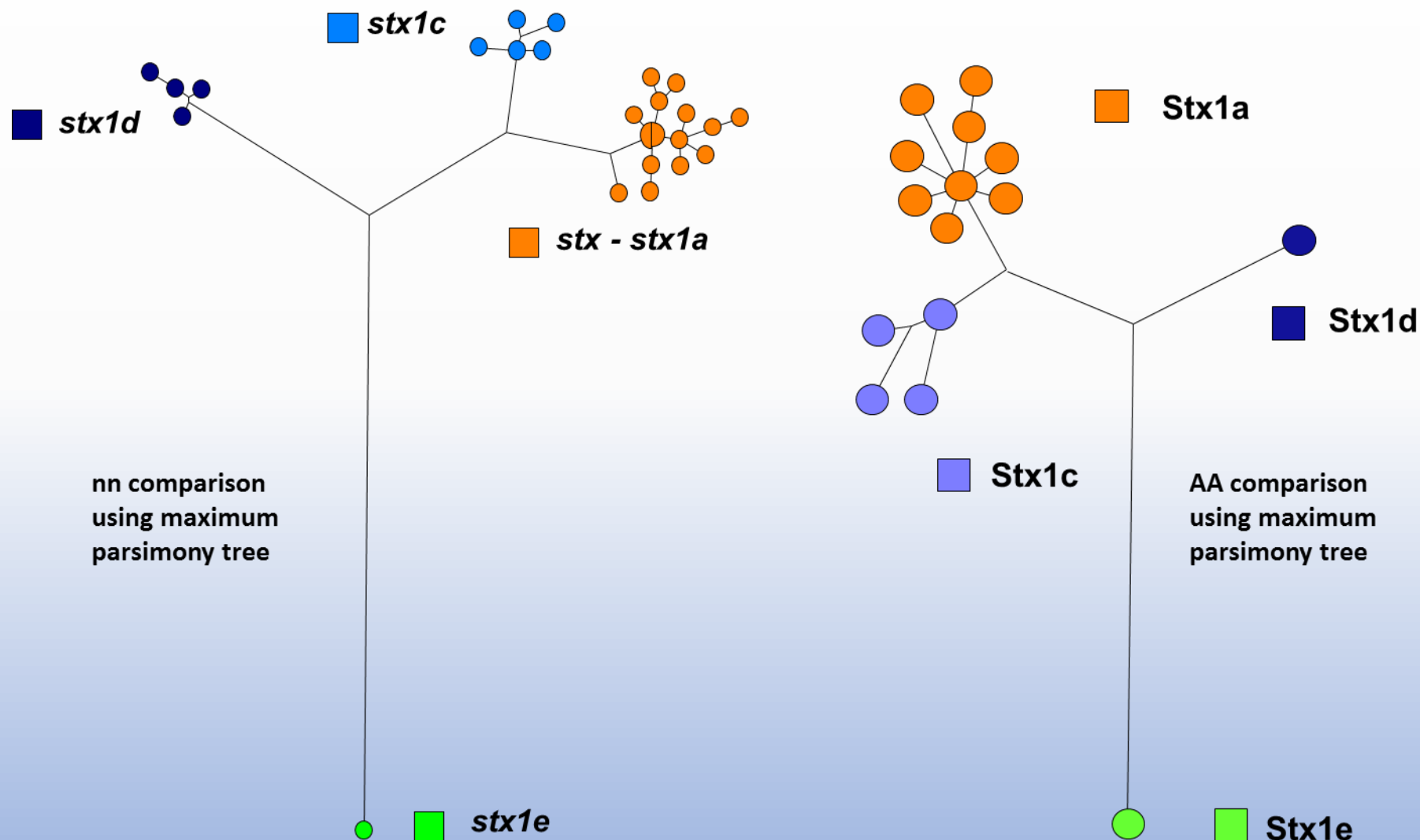
- Stx1a, 1c, 1d, 1e; Stx2a, 2b, 2c, 2d, 2e, 2f, 2g, 2h, 2i, 2j, 2k, 2l ... and more?
- All have risk & potential to cause diarrhea
- HUS – Stx2a + *eae* or *aggR*

Stx2d – depending on phage type, insertion site, other factors

Other Stx subtypes – depending on host, antibiotics, other factors



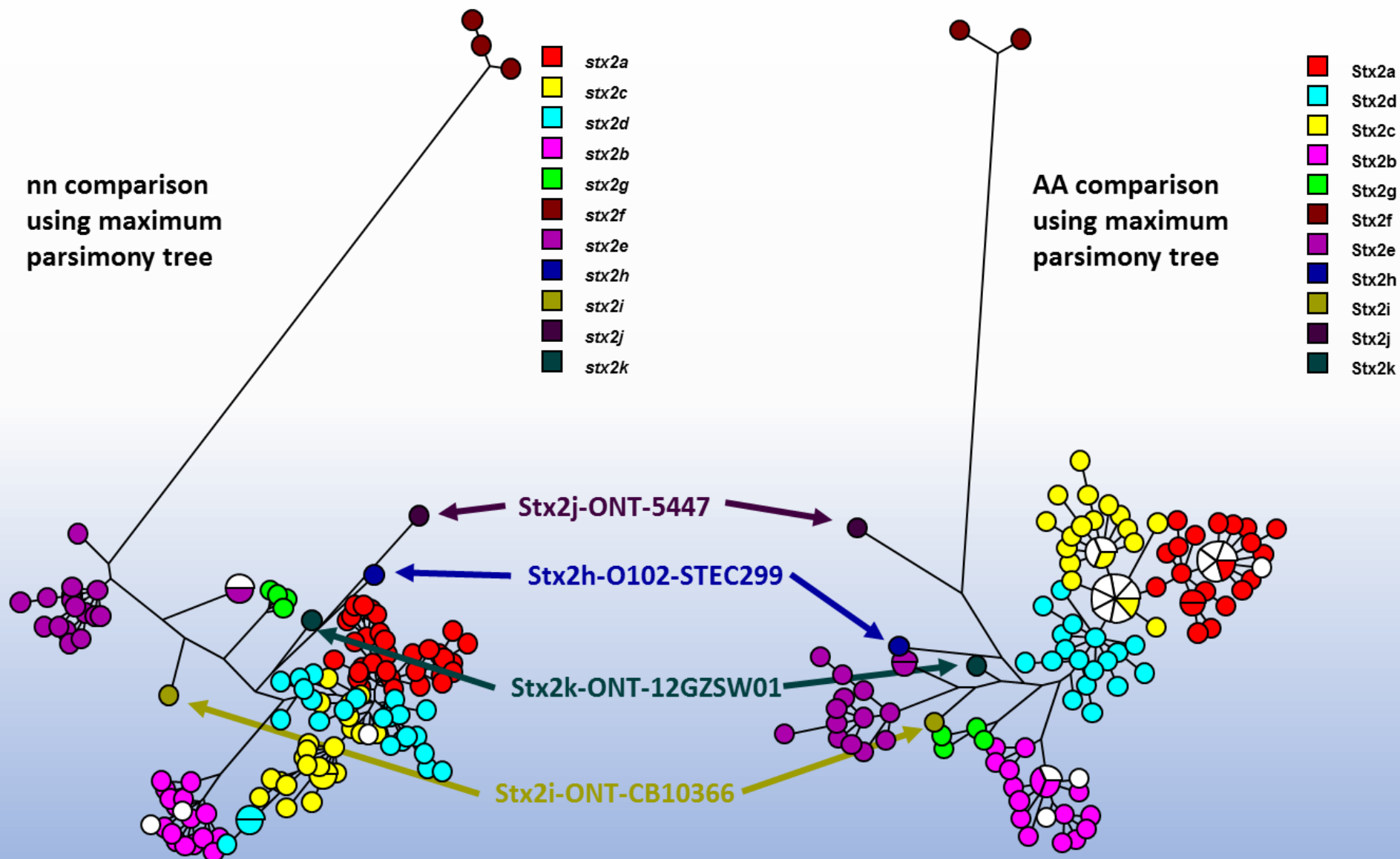
Stx – Stx1 family tree



Stx1e-E-cloacae-M12X01451



Stx2 family tree





Criteria for hazard identification and characterization

- **Serotypes and regional diversity**

- *E. coli* - ~184 O and 53 H types
- STEC - ~470 serotypes; > 100 implicated in illness
- Geographic clustering? eg: SFO157, O45:H19
 - Global dissemination - trade, travel, animal migration, etc.
- Change in toxin-profile eg: O26:H11 (Stx1 to Stx2 only)
- Same serotype but different virulence factors eg: O104:H4

- **Serotype**

- useful in ID and epi investigations
- does not predict pathotype or health risk.



Criteria for hazard identification and characterization

- **Other factors in virulence characterization**

- **Horizontal gene transfer - diversity**

- Stx-producing enterics
 - Hybrids – EAEC/STEC (O59:H19, O104:H4, O111:H2/H21, O127:H4);
EPEC/STEC (O26:H11, O55:H9, O55:H7)
ExPEC/STEC (O80:H2, O2:H6)
ETEC/STEC (O101:NM, O159:HUT, O15:H16)

- **Dose-response**

- Stx – not produced in foods
 - Clinical outcome – vary with dosage; vary with serotypes

- **Human factors**

- susceptibility, asymptomatic carriers, varying severity - twins & family members
 - affects disease outcome



Conclusion points

- Adherence - critical for STEC pathogenicity (*eae* & *aggR*)
- 16 or more Stx subtypes – all have potential to cause D
- some may cause BD or HUS depending on strain/host factors
- *stx_{2a}* in *eae* or *aggR* (+) strains = HUS
- *stx_{2d}* may cause severe disease – depends on many factors
- Serotype not = pathotype
- Horizontal gene transfer – new and hybrid pathogens
- Dosage and host factors affects disease outcome



*STEC virulence genes – potential for D, BD & HUS**

<u>Level</u>	<u>Trait</u>	<u>Potential for:</u>
1	<i>stx2a + eae</i> or <i>aggR</i>	D/BD/HUS
2	<i>stx2d</i>	D/BD/HUS**
3	<i>stx2c + eae</i>	D/BD
4	<i>stx1a + eae</i>	D/BD
5	Other <i>stx</i> subtypes	D^

* Depending on other factors; eg: host, antibiotic, etc

** Depend on Stx2d variant, strain background, other factors

^ Some subtypes caused BD/HUS on rare occasions; depend on host



STEC - strategies/positions proposed by others

- **U.S. National advisory committee for Microbiological Criteria for Foods (NACMCF).**
 - Top priority: Stx2a + *aggR* or *eae*
- **U.S. FDA – STEC SOP (2018)**
 - Top priority: Stx2a + *aggR* or *eae* (any serotype)
 - Process - detect & isolate all STEC ; characterize for health risk.
- **CEN TAG18 – revision of ISO/TS 13136 – method for STEC in food and feed.**
 - Part 1 – detect & isolate all STEC
 - Part 2 – characterize



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Thank you

Questions?

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