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Prevalence of *Erysipelothrix rhusiopathiae* in tonsils of domestic pigs and wild boars in Sweden

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Short Report

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Abstract

Erysipelothrix rhusiopathiae (ER) causes erysipelas in multiple animal species and may persist in the environment or be carried asymptomatically. Tonsils are a recognized reservoir in domestic pigs. This study aimed to determine the prevalence of ER in tonsils of healthy Swedish fattening pigs and wild boars. Tonsils were collected from 200 fattening pigs at slaughter from ten abattoirs across Sweden in 2017, with one pig per herd sampled. Wild boars were sampled during hunting in the county of Östergötland during the year 2018. Cultures were performed using selective media and isolates were confirmed as ER by MALDI-TOF MS. ER was recovered from 6/200 pig tonsils (3.0%), all originating from three abattoirs in southern Sweden. ER was isolated from 45.5% of tonsils from wild boar.

Whole-genome sequencing revealed a high diversity among the isolates with no dominant clones.

Overall, these results indicate that that Swedish breeding practices, including indoor rearing of fattening pigs, age-segregated rearing, sow vaccination, enhanced biosecurity, and restricted straw access largely prevent colonization by ER aligning with the low occurrence of clinically diagnosed erysipelas in such herds. For wild boars, the high isolation rate may suggest that wild boar could act as a reservoir and potential source of the infection for domestic animals. The potential zoonotic risk should also be considered.

Findings

Erysipelas, caused by the bacterium ER, occurs in pigs worldwide and may affect various other species, including humans. Human infections are uncommon and mainly associated with occupational exposure, such as farming and slaughterhouse work [1–3].

In domestic pigs (*Sus scrofa domesticus*), erysipelas typically presents as an acute febrile disease with characteristic cutaneous lesions. A subacute form produces milder clinical signs, whereas a chronic form is mainly associated with arthritis and endocarditis [4, 5]. The bacterium is highly susceptible to penicillin, and early antibiotic treatment usually results in recovery within 24–36 h. Vaccination provides effective protection for 6–12 months when correctly administered [4]. Carriers and pigs with acute erysipelas can shed the organism in their excretions (urine, feces) and secretions (saliva, nasal mucus) for extended periods of time and ER can persist in the environment for extended periods, allowing indirect transmission [2, 4, 6].

Earlier studies have suggested that 30–50% of clinically healthy pigs may carry ER, particularly in the tonsils and other lymphoid tissues, thereby acting as a reservoir [5, 7]. However, a Swiss study reported a very low prevalence, with all 250 tonsil samples from healthy pigs at slaughter testing negative [8].

Erysipelas is not notifiable in Sweden, and comprehensive national incidence data are lacking. Nevertheless, sporadic outbreaks are reported, particularly in outdoor finishing systems, likely due to the environmental persistence of this ubiquitous bacterium [9].

The wild boar (*Sus scrofa*) is a close relative to the domestic pig. Farmed wild boar may be affected by septicemic erysipelas [10, 11]. In addition, serological studies have indicated that wild boar are exposed to ER [12–14]. Little is however known on the possible carrier state in wild boar. An Italian study found that ER could be isolated from 34.2% of tonsils from hunted free-living wild boar [15].

To assess whether healthy Swedish domestic pigs carry ER in their tonsils, tonsil samples were collected from 200 apparently healthy fattening pigs at slaughter in 2017, with 100 in the spring and 100 in the autumn. Samples were aseptically collected by official veterinarians at 10 abattoirs, which in 2016 were reported to slaughter 88% of all pigs in Sweden according to statistics from the Swedish Board of Agriculture. The number of samples per abattoir was proportional to slaughter volume in 2016, and one pig per herd was sampled.

Sampling of wild boars was concentrated to the county of Östergötland where hunters volunteered to take tonsil samples from hunted wild boar in 2018. For all hunted wild boar in the study, data on geographical location (municipality level), sex, age group (piglet, yearling or adult) and slaughter weight were collected.

Tonsil samples were sent from abattoirs and hunters by overnight mail to the Swedish Veterinary Agency (SVA). For bacteriological analysis, approximately 1 × 1 cm of tissue (Fig. 1) was inoculated in 5 mL broth containing 0.2 mg/mL sodium azide and 5 µg/mL crystal violet, and incubated at 37°C for 48 h. One loopful (approximately 10 µL) of the broth was subsequently spread on horse blood agar plates containing 400 µg/mL kanamycin and 50 µg/mL neomycin and incubated at 37°C for 48 h [16]. Growth of *E. rhusiopathiae* was confirmed by colony morphology and MALDI-TOF MS (Bruker Daltonics, Bremen, Germany).

All isolates recovered from fattening pigs (n = 6), together with a subset of isolates from wild boar (n = 28), were subjected to whole-genome sequencing using the Illumina MiSeq platform. The resulting sequence data were used for genomic comparison of isolates from multiple European countries as previously described [17]. Serotyping by *in silico* PCR was repeated for the present publication with primers targeting a wider range of ER serotypes [18].

Out of 200 tonsil samples from fattening pigs, ER was detected in six (3%), coming from three different abattoirs. At the abattoir level, prevalence varied between 5% and 17%. (Table 1 and Fig. 2).

Table 1
Isolation of *Erysipelothrix rhusiopathiae* from pig tonsils at 10 Swedish abattoirs in 2017

Abattoir	Tonsils (n)	ER-isolates (n)	Positive (%)
A	26	0	0
B	36	0	0
C	6	0	0
D	60	3	5
E	12	2	17
F	6	0	0
G	4	0	0
H	26	0	0
I	20	1	5
J	4	0	0

Samples were submitted from 180 wild boar. Ten of these were from wild boar hunted in municipalities outside Östergötland. Tonsil tissues were included in 167 of these samples and 76 (45.5%) were positive for ER. As age data did not correspond with data on slaughter weight this was excluded from the study. Results on municipality level can be found in Table 2. To the best of our knowledge this is the first study of presence of ER in wild boar tonsils in northern Europe. A previous Swedish study indicated that 18% of hunted wild boar were seropositive for ER, these animals were however hunted in other parts of the country [13]. The high isolation rate suggests that wild boar may act as reservoir of ER constituting a risk for domestic animals, especially those reared with outdoor access or under less stringent biosecurity.

Table 2
Isolation of *Erysipelothrix rhusiopathiae* from tonsils from hunted Swedish wild boar in 2018

	Slaughter weight ≤ 30 kg				**Slaughter weight 30kg**				
	Male		**Female**		**Male**		**Female**		
Municipality	Tonsils (n)	ER-isolates (n)	Tonsils (n)	ER-isolates (n)	Tonsils (n)	ER-isolates (n)	Tonsils (n)	ER-isolates (n)	Total Tonsils (n)
Boxholm	1	0	0	0	0	0	0	0	1
Finspång	2	0	0	0	0	0	1	0	3
Katarineholm	2	2	0	0	0	0	0	0	2
Linköping	8	3	3	0	14	7	12	4	37
Norrköping	17	10	7	4	24	14	14	8	62
Nyköping	1	0	2	1	1	0	0	0	4
Söderköping	12	5	9	2	17	7	12	4	50
Valdemarsvik	3	3	1	1	0	0	1	1	5
Västervik	0	0	0	0	1	0	2	0	3
Total (n)	46	23	22	8	57	28	42	17	

Overall, both pig and wild boar isolates were highly diverse in terms of SNP profile, with no indication of dominant clones [17]. Wild boar isolates were predominantly clade 2 (86%) with a smaller number of clade 3 (7%) and clade 1 (7%) isolates. The most common *in silico* serotype among wild boars was 2 (39%) followed by 9 (21%), 5 (18%), 6, 1b, and non-typeable (each 7%). In contrast, most pig isolates were clade 1 (67%), with the remainder clade 2. Among pig isolates, 11 was the most common serotype (50%), followed by 5, 9, and 4 (each 17%). To our knowledge, ER clade 1 has not previously been recovered from pigs or wild boars. Clade 1 isolates differ from other clades in virulence gene content and carry distinct variants of the Spa gene, which is involved in pathogenesis. Thus, clade 1 may be widespread among wild and domestic animals but overlooked due to limited sampling of asymptomatic hosts. Serotypes 2 and 1b which were recovered from wild boars are considered associated with ER disease outbreaks but did not occur in domestic pigs. There was no overlap between these serotypes and clade 1.

Historically, 30–50% of healthy pigs have been reported as subclinical carriers of ER, a prevalence comparable to that observed in Swedish wild boars in the present study. In contrast, only 3% of slaughter pigs tested positive, indicating a markedly lower prevalence in domestic production. Consistent with previous findings [19, 20], these results suggest that Swedish production practices including indoor housing, age-segregated rearing, sow vaccination, strict biosecurity measures, and limited straw usage effectively reduce colonization by ER. This is reflected in the low frequency of clinical erysipelas observed in Swedish pig herds.

The comparison with wild boars highlights the influence of ecological and management factors on ER epidemiology. Wild boars, exposed to diverse environmental sources and frequent contact with conspecifics, appear to maintain a higher baseline prevalence, suggesting their role as a natural reservoir for ER. They also carry a higher proportion of strain with characteristics associated with clinical disease in porcine hosts, i.e. clades 2/3 and serotypes 2/1b. In contrast, the controlled conditions in domestic pig production substantially limit opportunities for transmission, thereby minimizing both subclinical carriage and clinical disease. These findings underscore the importance of species-specific management

strategies in shaping the epidemiology of ER and emphasize the effectiveness of current Swedish husbandry practices in maintaining herd health.

Declarations

Authors' contributions

MZ, EB, and HE initiated and jointly designed the study. RS analysed the genomic characteristics of ER in this study. MZ served as the main investigator and lead author of the manuscript, with assistance from the other authors. All authors have read and approved the final version of the manuscript.

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Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request. Sequence data are available from the European Nucleotide Archive (https://www.ebi.ac.uk/ena) under project accession number PRJEB34817.

Consent for publication

Not applicable.

Ethics approval

This study did not require official or institutional ethical approval. The animals were handled according to high ethical standards and national legislation governing the slaughter of pigs. Sampling was limited to tonsil collection from animals' post-mortem at abattoirs and tonsils from wild boars at hunting.

Prior publication

Parts of these data were previously published in the Proceedings of the 10th European Symposium of Porcine Health Management, Barcelona, Spain, May 9th - 11th 2018 and the Proceedings of the 11th European Symposium of Porcine Health Management, Utrecht, Netherlands, May 22nd - 24th 2019.

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Figures

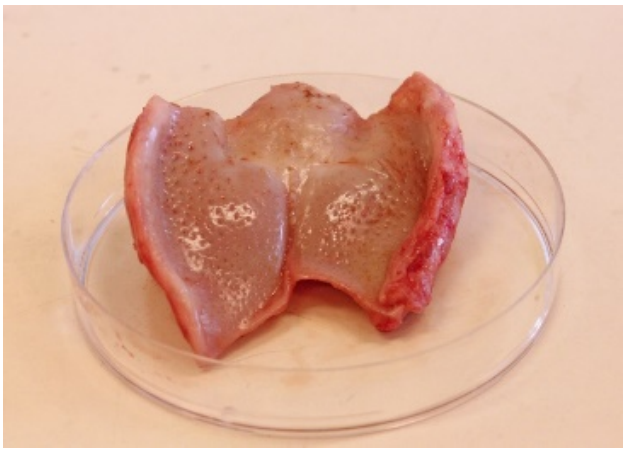


Figure 1

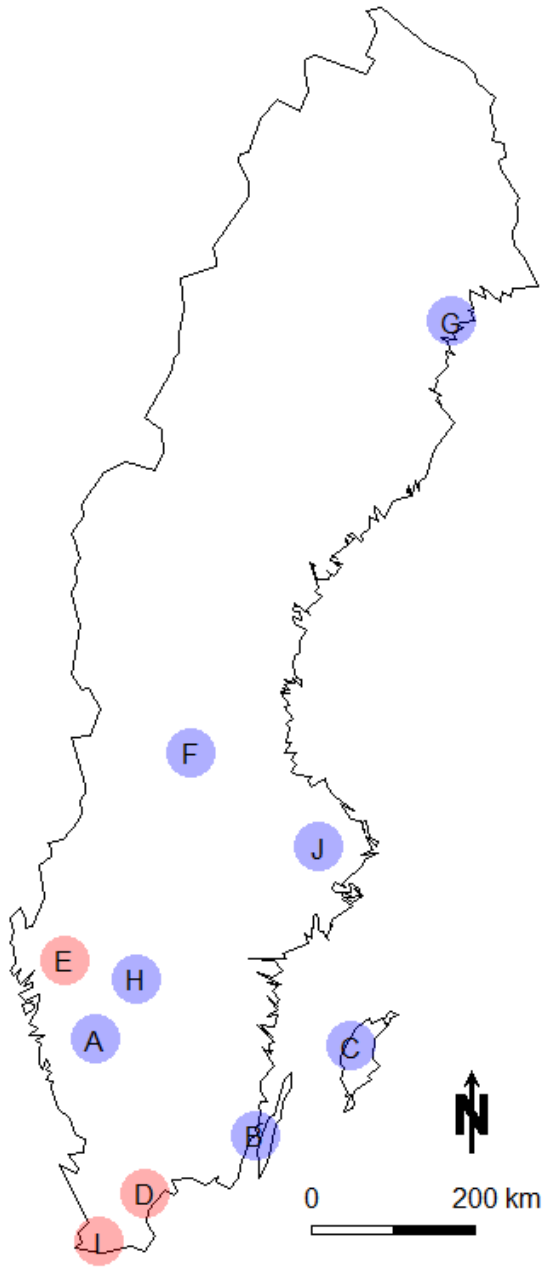


Figure 2

Locations of Swedish abattoirs with *Erysipelothrix rhusiopathiae* in tonsils; red circles positive, blue negative