First detection of sarcoptic mange in free-ranging wild boar (*Sus scrofa*) in Switzerland

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Abstract

In Switzerland sarcoptic mange is frequent in free-ranging wild carnivores but until recent years no cases had been recorded in wild ungulates. Since 2010, cases have been observed in wild boar in the cantons of Solothurn, Tessin and Thurgau. Here, we report the detection of mange-like skin lesions in wild boars by photo-trapping and the post-mortem findings in 6 culled animals presenting different stages of the disease. Potential sources of infection include mangy red foxes, outdoor domestic pigs and wild boars from surrounding countries. Disease spread in the wild boar population may become relevant not only for wildlife but also for domestic pig health in the future if piggeries' biosecurity is insufficient to prevent interactions with wild boar.

Keywords: disease emergence, pathology, photo-trapping, *Sarcoptes scabiei*, wild boar

Erster Nachweis der Sarkoptesräude bei freilebenden Wildschweinen (*Sus scrofa*) in der Schweiz

In der Schweiz ist die Sarkoptesräude bei freilebenden Wildkarnivoren weit verbreitet aber bis vor kurzem waren bei Wildungulaten keine Fälle registriert worden. Seit 2010 wurde Räude bei Wildschweinen in den Kantonen Solothurn, Tessin und Thurgau beobachtet. Hier beschreiben wir den Nachweis von räudeähnlichen Hautveränderungen bei Wildschweinen mit Fotofallen und die post-mortalen Befunde bei 6 erlegten Tieren mit verschiedenen Stadien der Erkrankung. Räudige Füchse, Freilandschweine und Wildschweine aus Nachbarländern stellen mögliche Infektionsquellen dar. Die Ausbreitung der Krankheit in der Wildschweinpopulation könnte zukünftig von Bedeutung für die Hauschweingesundheit werden, wenn die Betriebsbiosicherheit ungenügend ist, um Wechselwirkungen mit Wildschweinen vorzubeugen.

Schlüsselwörter: Fotofallenüberwachung, neuauftretende Krankheit, Pathologie, *Sarcoptes scabiei*, Wildschwein

Introduction

Sarcoptic mange is a contagious skin disease known to affect a wide range of domestic and wild mammals (Pence and Ueckermann, 2002) and is caused by the burrowing mite *Sarcoptes scabiei*, which shows a certain degree of host specificity (Rasero et al., 2010; Gakuya et al., 2011). Transmission mainly occurs directly (by prolonged skin-to-skin contact) but also indirectly, since mites may survive for several weeks in humid and cold environments (Bornstein et al., 2001). Clinical signs vary according to species, age, immunocompetence, other physiological functions of the host and the infective dose (Bornstein et al., 2001; Pence and Ueckermann, 2002; Alasaad et al., 2013; Nimmervoll et al., 2013).

Sarcoptic mange affects free-ranging populations of several wild ungulate and carnivore species in many European countries (Bornstein et al., 2001; Pence and Ueckermann, 2002; Rasero et al., 2010; Alasaad et al., 2011; Oleaga et al., 2011). In species such as the red fox (*Vulpes vulpes*), Iberian ibex (*Capra pyrenaica*) or Alpine chamois (*Rupicapra r. rupicapra*), it causes high mortality (Bornstein et al. 2001; Alasaad et al., 2011; Oleaga et al., 2011; Oleaga et al., 2013). In contrast, in wild boar sarcoptic mange is not associated with high mortality despite high morbidity (Boch and Schneidawind, 1988; Ippen et al., 1995; Bornstein et al., 2001, Rasero et al., 2010). Numerous cases have already been reported in European wild boar (Pence and Ueckermann, 2002; Rasero et al., 2010). Nonetheless, so far in wild boar the

disease has been poorly described (Wetzel und Rieck, 1972; Boch and Schneidawind, 1988; Ippen et al., 1995; Mignone et al., 1995).

In Switzerland, sarcoptic mange has been present for several decades in domestic pigs (Zimmermann and Kircher, 1998) and in the red fox, occasionally affecting other wild carnivores such as the Eurasian lynx (*Lynx lynx*), the stone marten (*Martes foina*) and other mustelids (Ryser-Degiorgis et al., 2002; Ryser-Degiorgis and Capt, 2003) and frequently domestic dogs. However, until recently it had not been observed in wild ungulates. Here, we describe the first detected cases of sarcoptic mange in wild boar in Switzerland.

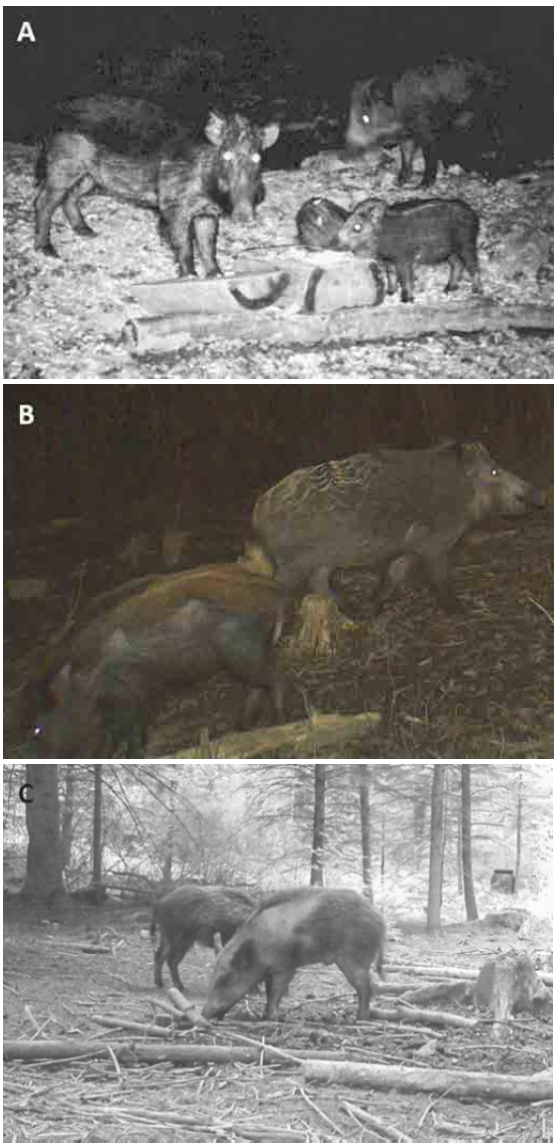

Figure 1: Detection of wild boars by photo-trapping presenting mange-like lesions in the canton of Solothurn in March 2010 (A) and March 2011 (B), and in the canton of Thurgau in June 2014 (C). Courtesy of Alex Hofer (A, B) and Sandro Wellauer (C).

Field observations

In late March 2010, a group of free-ranging wild boars presenting signs of severe focal-extensive alopecia was detected by photo-trapping by a hunter in the canton of Solothurn (Fig. 1A). Pictures were sent to the Centre for Fish and Wildlife Health (FIWI, University of Bern) and a presumptive diagnosis of sarcoptic mange was made. During the following weeks, 3 wild boars of the affected group (SO 1-3) were culled and submitted to the FIWI for a post-mortem investigation, and sarcoptic mange was confirmed.

Subsequently, further cases have been detected in the same region as well as in other areas of Switzerland. In March 2011, an adult female and a juvenile with extensive alopecia from the same family group were detected by photo-trapping in Solothurn (Fig. 1B). In December 2011, a suspicion of sarcoptic mange was raised on 2 hunted wild boars, a subadult male (TI1) and an adult female (TI2) sampled in the field in the canton of Tessin during epidemiological surveys on other pathogens. A skin sample was collected from one of them (TI1) for further analysis. Furthermore, local hunters indicated to have observed more wild boars with similar signs. In February 2014, 4 juveniles presenting skin lesions were detected by photo-trapping in the same region as SO1-3 and one of them was culled and submitted to the FIWI for necropsy (SO4). Finally, in June 2014, a group of wild boars with regionally extensive alopecia consistent with sarcoptic mange-associated lesions was detected by photo-trapping in the canton of Thurgau (Fig. 1C).

Post-mortem investigations

The age of the 6 wild boars examined post-mortem was determined by body size, weight and coat color (Hebeisen et al., 2008). There were 2 juveniles (one male: SO2, shot on 01.04.2010 and one female: SO4, 25.02.2014), 2 subadult males (SO1, 23.03.2010; TI1, 04.12.2011), and 2 adult females (SO3, 07.04.2010; TI2, 08.12.2011). All animals had good body condition apart from SO1, whose body condition was moderate. Mites were detected on 5 investigated cases either by skin scraping (SO1, SO2) or by isolation of mites by placing pieces of skin in Petri dishes under a 40W electric light bulb overnight (Bornstein, 1995) (SO3, SO4, TI1). All mites were identified as *S. scabiei* by light microscopy based on specific morphologic features (Sloss and Kemp, 1978).

A gross necropsy was performed on the 4 cases from Solothurn, while for TI1 and TI2 no organs were available and skin lesions could only be briefly assessed when open carcasses were submitted to official controls in the fields. Skin and selected inner organs were collected for

histological examination from four animals (SO1-4). Tissues were fixed in 10% buffered formalin, processed, embedded in paraffin, sectioned at 5µm, stained with hematoxylin-eosin and Giemsa (skin only) according to the current protocol adopted by the Institute of Animal Pathology (ITPA, University of Bern) and examined by light microscopy. The number of mast cells, eosinophils and approximate total number of inflammatory cells were estimated by calculating the average cell counts obtained in 5 randomly selected high-powered fields (HPF, 40x).

SO2 did not show macroscopic skin changes but all other animals presented chronic severe skin lesions affecting in particular the ventral part of the body and the limbs. In SO1, which was the most severely affected, skin lesions were well demarcated, characterized by alopecia, marked lichenification and thick crusts, and affecting the ventral part of the head, breast and abdomen and all four extremities down to the metacarpus and metatarsus (Fig. 2A and 3A). SO3 presented similar but slightly less extensive lesions (alopecia of the ventral abdomen and the proximo-medial part of the limbs along with thick crusts on the flanks). In SO4 severe alopecia was affecting mainly the hind limbs and the lumbal region, while it was only mild on the forelimbs and head (Fig. 2B). Additionally, a multifocal moderate lymphadenomegaly (prescapular, subiliacal and inguinal superficial) was observed in SO4. TI1 had thick crust and alopecia extending over the ears (Fig. 3B) and TI2 presented a thickened skin with hair rarefaction on the ventral part of the abdomen and moderate alopecia on both flanks.

Histologically, all cases presented intralesional mites, spongiosis, acanthosis, parakeratotic hyperkeratosis, pustules and serocellular crusts of the epidermal layer, whereas mixed inflammatory infiltrate and edema were seen in the superficial dermis. The severity of mite infestation and of skin lesions was variable. The extent of the inflammatory infiltrate was comparable in the 4 investigated cases (SO1-SO4: 68-84 cells/HPF) but varied in composition. It included eosinophils (dominant cell type in SO1 and SO3: 42 and 48 cells/HPF, respectively), lymphocytes and plasma cells (dominant cell type in SO2 and SO4), histiocytes and mast cells (2-11 cells/HPF). Besides the predominant infiltration with eosinophils, the most prominent features in SO1 were multifocal perivascular infiltrations of lymphocytes, plasma cells, macrophages and a small number of neutrophils. In other wild boars there was also moderate ectasia of the apocrine gland adenomers (SO2, SO4) and hyperplasia and hypertrophy of the sebaceous glands with vacuolization of the cytoplasm (SO4). A range of unrelated tissue changes including mild interstitial nephritis, verminous pneumonia and a minimal myocarditis were also seen in SO1-4.

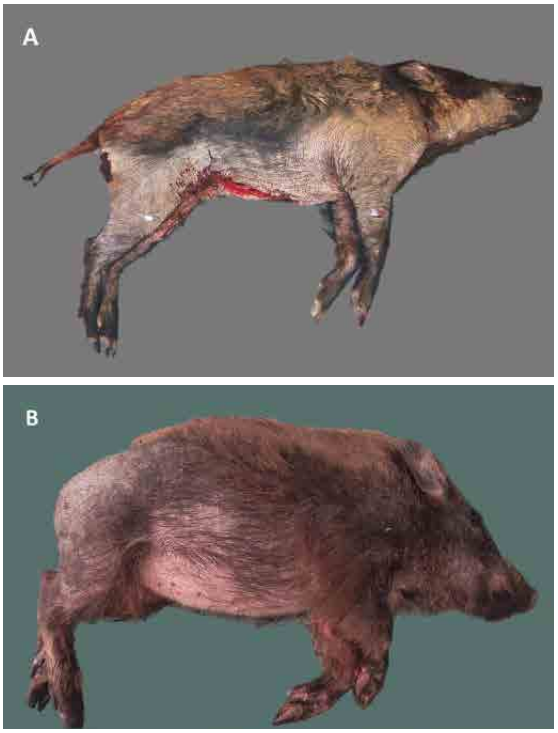

Figure 2: A. Wild boar SO1, presenting extensive and chronic lesions of sarcoptic mange. Altered skin areas, characterized by alopecia and thickening, are sharply demarcated from the normal skin and localized mainly ventrally, including the four limbs and the ventral part of the head. B. Wild boar SO4, presenting mange lesions localized mainly ventro-caudally but also affecting the head. Extensive alopecia and erythema were particularly present on the hind limbs and the lumbal region.

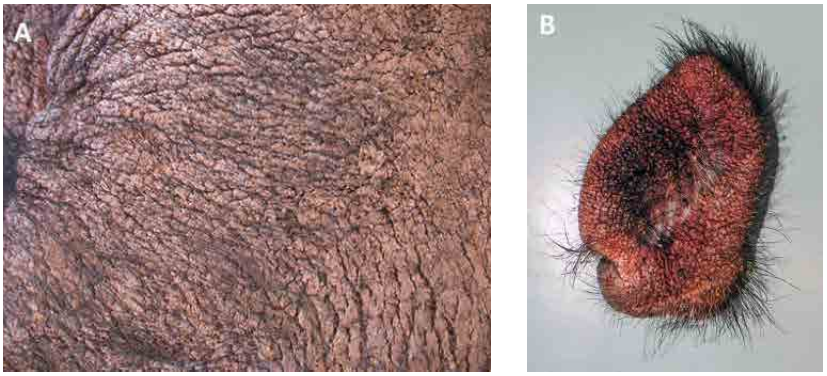

Figure 3: Close up of mange lesions in wild boar presenting extensive alopecia, lichenification and crusts. A. Axillar region of wild boar SO1. Crusts are partially covered by mud. B. Ear of wild boar TI1.

Discussion

Sarcoptic mange occurs worldwide in domestic swine and causes high economic losses (Bräunig, 2004; Damriyasa et al., 2004). In wild boar, cases have been reported in internationally available articles (Mignone et al. 1995; Bornstein et al., 2001; Pence and Ueckermann, 2002; Rasero et al., 2010). Nevertheless, despite general

clinical observations in captive animals described in the German literature (Wetzel and Rieck, 1972; Ippen et al., 1995), sarcoptic mange has been poorly documented in wild boar.

The lesions described here were typical for the early stage or alopecic/hypersensitivity form of sarcoptic mange (SO2: mild, localized alopecia only) as well as for the chronic stage or hyperkeratotic form (SO1, SO3, SO4: regionally extensive alopecia, crust formation and lichenification) described in domestic pigs, captive wild boars and other wildlife species (Wetzel and Rieck, 1972; Boch and Schneidawind, 1988; Ippen et al., 1995; Bornstein et al., 2001; Pence and Ueckerman, 2002; Goyena et al., 2013; Nimmervoll et al., 2013). In captive wild boars lesions have been reported as usually beginning in the head region then spreading via scratching to the lower part of the trunk and limbs, especially in the area of the joints (Wetzel and Rieck, 1972; Boch and Schneidawind, 1988; Ippen et al., 1995). In our cases we observed a great variation in the distribution of skin lesions but overall the localization pattern in wild boar seems to be more ventrally localized than in other species, such as the red fox (Nimmervoll et al., 2013). Domestic pigs often develop hyperkeratotic lesions on the lower limbs and it has been proposed that higher exposure of lower body parts to moisture and to direct skin contacts with conspecifics may contribute to this lesion pattern (Goyena et al., 2013).

Interestingly, eosinophils were the predominant cell type in the inflammatory infiltrate in both early and chronic lesions, whereas mast cells were few and hyperkeratosis was not marked. Furthermore, the affected wild boars were principally in good body condition despite extensive chronic lesions and to our knowledge, no mange-associated mortality has been observed in the wild boar population so far. This is in accordance with the pathological and epidemiological features of mange in domestic pigs (Zimmermann and Kircher, 1998; Bräunig, 2004; Goyena et al., 2013) but it contrasts with those in other species such as the red fox, in which mange is usually fatal and chronic lesions are characterized by a severe mast cell infiltration in the nearly absence of eosinophils, by severe hyperkeratosis, high mite burdens and secondary infections (Nimmervoll et al., 2013). Overall, our findings converge with former observations suggesting that the eosinophilic response may play a major role in the ability of the host to cope with the mite infestation while mast cells are overrepresented in severe and fatal cases (Nimmervoll et al., 2013). In captive wild boar, it has been proposed that mange is mostly subclinical and often goes unrecognized and that clinical signs develop when animals are immune-compromised (malnutrition, endoparasites, disease, suckling period) (Wetzel and Rieck, 1972; Boch and Schneidawind, 1988; Ippen et al., 1995). However, there was no evidence of the role of predisposing factors in the cases reported here.

The first cases of mange observed in wild boar in Switzerland have been detected thanks to photo-traps set by hunters and the transmission of this information to the FIWI by the local hunting authorities. Camera-trapping, participatory approaches and syndromic surveillance are useful tools for early detection and monitoring of wildlife diseases such as mange (Oleaga et al., 2011; Chen et al., 2012; Ryser-Degiorgis, 2013), which is easily recognizable thanks to typical, macroscopically visible skin lesions. Such a surveillance approach is particularly useful in free-ranging wildlife when mortality rates are low and carcasses are not available for post-mortem analyses.

The new detection of sarcoptic mange in Swiss wild boar raises the question, whether it has already been present in the local wild boar population but not been previously recognized, or has been newly introduced. Before the cases of 2010 in Solothurn no case had been mentioned in wild boar for at least 30 years (Ryser-Degiorgis and Capt, 2003), suggesting a real emergence of mange. Three options may be considered for the source of infection.

First, considering the spread of sarcoptic mange in the red fox in Switzerland during the past decade, wild boar may have been infected through contact with foxes. In Europe *Sarcoptes* mite populations are divided in three major genetic clusters depending on the hosts, with herbivore-, carnivore- and omnivore-derived mite populations (Rasero et al., 2010), and until recently transmission of mites among these taxa has been considered as unlikely. However, mangy foxes have been often considered as a likely source of infection for other animals including other wild carnivores, domestic horses and mountain hares (*Lepus timidus*) (Mörner, 1992; Bornstein et al., 1995; Mörner et al., 2005; Ryser-Degiorgis et al., 2002; Domínguez et al., 2008) and recent studies including genetic investigations of mite populations have suggested that cross-transmission may occur (Rasero et al., 2010; Alasaad et al., 2013, Oleaga et al., 2013). Furthermore, prey-to-predator mite transmission has newly been documented (Gakuya et al., 2011). The fox is not known as a wild boar prey but the wild boar is a scavenging species, especially during winter (Melis et al., 2006) when mange-associated mortality tends to increase (Wetzel und Rieck, 1972; Ippen et al., 1995; Alasaad et al., 2011; Oleaga et al., 2011), i.e., direct contact of wild boar with dead mangy fox is possible.

Second, wild boar could have been infected by domestic pigs kept outdoor as direct contacts between wild boar

and domestic pigs including mating are known to occur (Wu et al., 2012). These interactions are believed to have increased as a consequence of the wild boar population growth and the development of outdoor pig farming (Wu et al., 2011) and mange remains a common disease in hobby piggeries. Such a domestic-wild transmission hypothesis has previously been proposed for the origin of mange in Southern chamois (*Rupicapra pyreneica parva*) in Spain (Lavín et al., 2000).

Third, since all cases were detected in cantons close to the country border and wild boars do not not respect political borders (Fischer et al., 2004; Hebeisen, 2007), wild boar populations of the surrounding countries could have been a source of infection, particularly knowing that cases have been reported in Germany (https://jagderleben.landlive.de/boards/thread/21091/page/1/), France and Italy (Rasero et al., 2010).

In conclusion, sarcoptic mange now occurs in wild boar in Switzerland and has been detected in three very distant cantons. Despite early attempts to eliminate the affected animals in Solothurn the disease has been repeatedly observed in this region in the course of the past four years. Sarcoptic mange is a highly contagious disease and it is likely that it will further spread in the wild boar population in the future. This perspective is relevant for both wild boar and domestic pig health, as wildlife may act as source of mange mites and other pathogens for domestic animals (Menzano et al., 2007). Interactions between wild boar and domestic pigs represent a risk for disease transmission in both directions and the need for better biosecurity on pig farms has to be taken seriously.

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Special thanks go to the hunters and hunting authorities of the cantons of Solothurn and Thurgau for their vigilance and for submitting these interesting cases. We also thank the hunting authorities and game-wardens of Tessin for their contribution to sample collection, as well as all hunters, game-wardens and hunting inspectors who contribute yearly to the questionnaire survey on sarcoptic mange. Stéphanie Rossteuscher and Petra Roosje provided information on the occurrence of sarcoptic mange in domestic animals in Switzerland (in pigs and dogs, respectively). Christyn John Bailey improved the English language.

Première détection de gale sarcoptique chez des sangliers (*Sus scrofa*) en liberté en Suisse

La gale sarcoptique est fréquente chez les carnivores sauvages en liberté en Suisse mais, jusqu'il y a peu, aucun cas n'avait été enregistré chez des ongulés sauvages. Depuis 2010 des cas ont été observés chez des sangliers dans les cantons de Soleure, du Tessin et de Thurgovie. Nous rapportons ici la détection de lésions cutanées compatibles avec de la gale chez des sangliers par piégeage photographique ainsi que les observations post-mortem chez 6 animaux abattus présentant différents stades de la maladie. Les sources d'infection potentielles incluent des renards galeux, des porcs domestiques élevés en plein air et des sangliers de pays voisins. L'expansion de la maladie au sein de la population de sangliers pourrait gagner en importance dans le futur non seulement pour la santé de la faune sauvage mais aussi pour celle des porcs domestiques si la biosécurité des exploitations porcines est insuffisante pour prévenir les interactions avec les sangliers.

Prima segnalazione di rogna sarcoptica nei cinghiali selvatici (*Sus scrofa*) in Svizzera

In Svizzera, la rogna sarcoptica e osservata di frequente nei carnivori selvatici, ma fino all'epoca recente non erano stati registrati casi in ungulati selvatici. A partire dal 2010, diversi casi sono stati segnalati nei cantoni di Soletta, Ticino e Turgovia. In questo articolo descriviamo la presenza di lesioni compatibili con la rogna nei cinghiali detettate grazie all'uso della fototrappola insieme ai reperti anatomopatologici rappresentativi dei diversi stadi della malattia in sei individui abbattuti. Fonti potenziali d'infezione sono considerate le volpi, i maiali allevati all'aperto e i cinghiali selvatici dei paesi confinanti. La diffusione della malattia nei cinghiali selvatici può diventare rilevante non solo per gli animali selvatici stessi, ma, in futuro, anche per la salute dei maiali domestici se nelle porcilaie la biosicurezza sarà insufficiente a prevenire le interazioni tra maiali e cinghiali selvatici.

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