Health Effects of Patagial wing Tags in Red Kites (*Milvus milvus*) in England

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Abstract

Patagial wing tags are commonly used for identification of red kites (*Milvus milvus*) for post-release monitoring, as they are easy to apply, affordable, permanent and are apparently safe. The red kite was successfully reintroduced in the United Kingdom in the second half of the 20th century and post-release health surveillance has been achieved through radio and satellite tracking, monitoring nest sites and pathological investigation of red kites found dead. This study reports on pathological findings associated with the use of patagial wing tags in three of 142 (2.1%) of wing-tagged red kites examined post-mortem since the beginning of the reintroduction project in 1989. In these three red kites the presence of the patagial wing tags was associated with inflammatory lesions. Further surveys of the effects of patagial wing tags on red kites and other birds are advocated and the future use of patagial wing tags in raptors should be carefully monitored.

Keywords: Red kite - free-ranging wildlife – marking device – passive surveillance – patagium – skin lesion

The red kite (*Milvus milvus*) is a diurnal Accipitridae recently re-classified from “Near Threatened” to “Least Concern” by the IUCN Red List as the decline of the European metapopulation has been compensated in recent years (BirdLife International 2015, BirdLife International 2021). At the end of the 19th century, the red kite became extinct in England and Scotland due to human persecution (Smart et al. 2010); while, a successful, collaborative, reintroduction program initiated in 1989 has revived the species (Mattsson 2022). The Disease Risk Analysis and Health Surveillance (DRAHS) team at the Institute of Zoology (IoZ), Zoological Society of London (ZSL) conducted post-release health surveillance through post-mortem examinations (PMEs) of red kites found dead; a recommended component of work to assess the success of reintroductions.

The patagial (wing) tag used for red kite monitoring in the UK is a piece of water-proof textile wrapped around the leading edge of the wing and fastened to the patagium by piercing the skin and securing the tag with a plastic eyelet and plastic rivet (Wallace et al. 1980, Stiehl 1983) (Figure 1). This type of marking is preferred among many others used on free-living wild birds (Murray and Fuller 2000; Varland et al. 2007) as these tags are inexpensive, easily applied and long-lasting (Kochert 1983). More importantly, they have proved to be a valuable tool for scientists to identify birds, and to monitor their behaviour and biology for long-term studies and surveillance programs (Smallwood and Natale 1987, Murray and Fuller 2000, Varland et al. 2007). However, the existing guidelines should be followed with great care in applying these wing tags, as piercing bones, muscles, tendons, and blood vessels must be avoided (Smallwood and Natale 1987, Varland et al. 2007).

Some studies have previously linked patagial tags with skin abrasion (Calvo and Furness 1992, Varland et al. 2007), increased mortality (Martin and Major 2010) and other adverse effects at a population level such as mating and breeding interference (Smallwood 2016); while other studies report no negative effects (Kochert 1983, Smallwood and Natale 1987). In raptors, these tags have been associated with open wounds in peregrine falcons (*Falco peregrinus*) and prairie falcons (*F. mexicanus*) (Sherrod et al. 1982, Kochert 1983). A recent study reported mild to severe skin abrasions and inability to fly in Cape vultures (*Gyps coprotheres*) following improper placement of patagial tags and provided precise guidelines to ensure a safe tagging in this species by avoiding all vital structures of the wing (Hirschauer et al. 2019). Therefore, the use of patagial markers needs careful consideration as these markers can impact the health and welfare of individual birds (Kochert 1983, Calvo and Furness 1992, Murray and Fuller 2000, Varland et al. 2007). However, to date, ill-health has not been reported in red kites fitted with wing tags.

After observing a suspected chronic and necrotic dermatitis associated with patagial tags in red kite 188/19, found dead in 2018, we reviewed the pathological findings from 335 red kites found dead and submitted DRAHS, ZSL, between 1989 and 2019. Post-mortem examinations were conducted

following a standardised protocol, including systematic inspection of external and internal organs, combined with routine sampling and additional diagnostic tests depending on gross findings (Molenaar et al. 2017). Tissues of lesions suitable for histopathology (case 188/19), was fixed in 10% buffered formalin. After fixation, the specimen was sectioned and stained with haematoxylin and eosin for microscopic examination. Here, we report the first detection and two additional cases of pathological lesions associated with the wing tags in three, out of 142, red kites found dead and fitted with patagial tags. We discuss the pathological findings and evaluate the potential negative short and long-term health impact of these markers on red kites and other birds.

Red kite 188/19, which had been tagged as a fledgeling in 2004, was found dead on a footpath on 31 August 2018 in Deene, Northamptonshire, received at IoZ on the 11 September 2018, and immediately frozen at -20 C until the examination on 13 September 2018. This adult female was carrying a patagial tag on both wings (Figure 2).

The carcass weighed 918.6g and was deemed ‘fresh’. Feathers located between the patagial tags and the skin on the dorsal surface of both wings were matted with dried serosanguinous fluids. On the dorsal and ventral skin surfaces of both wings, between the patagial tag and skin, there were locally extensive, poorly demarcated, dark green to black malodorous friable skin lesions and the texture of the skin in these areas was wet and slimy. The lesions extended along the right wing from the proximal third of the radius-ulna to the carpal joint for approximately 130 mm, and along approximately 65 mm of the proximal shaft of the radius-ulna on the left wing. On the latter area, the skin was ruptured, and hundreds to thousands of dipterous eggs were present in the underlying tissue which also appeared black (Figure 3). The skull presented a complete, semi-circular fracture of the parietal bone extending from the left to the right orbit. Internally, the orbital wall was fractured, and the subcutaneous tissues overlying the skull fracture were haemorrhagic. The oesophagus contained organic material resembling the intestines and a claw of a small bird.

Histopathology of the lesioned skin of both wings was hindered by a moderate to severe degree of autolysis and many degenerated parasites (interpreted as the fly larvae seen on gross pathology) and areas of skin with only moderate autolysis showed a non-specific mild, mononuclear inflammatory infiltrate.

The organic content found in the upper gastrointestinal tract indicated the animal ate shortly prior death, while the skull fracture is consistent with an acute, severe, fatal traumatic event. In fact, collision is a likely aetiology and is commonly described as a cause of mortality in red kites (Wildman et al 1998; BirdLife International 2021). The marked macroscopic changes to the wings in contrast with the condition of the other organs and tissues, suggested the wing lesions occurred ante-mortem. The black coloration and the presence of serosanguinous fluids on the left wing are suggestive of inflammation, recent haemorrhage and potentially a necrotic process (King 2013). However, it is unclear whether this suspected disease may have affected the bird's ability to escape from a potentially dangerous situation, such as an imminent collision.

Red kite 112/03 was found entangled in a wire fence on 1 February 2003 in Harewood Yard, Harewood. The carcass was submitted on 3 February 2003 and was refrigerated at IoZ until PME on 5 February 2003. It was archived in -20C freezer and defrosted for re-examination on 25 June 2019. This juvenile bird of undetermined sex due to autolysis was carrying patagial tags on both wings. The bird weighed 755g and was emaciated. In the reviewed PME report, it was described a wing laceration approximately 100 mm long on the leading edge of the right patagium, the wound and the related flank covered in dried blood, which was believed to have been associated with death, possibly in addition to shock and dehydration. During the re-examination, the feathers surrounding the right wing lesion were plucked which revealed a locally extensive and poorly demarcated severe black skin lesion, suspected subcutaneous haemorrhage, both dorsally and ventrally. On the dorsal aspect, the lesion extended on the right wing for approx. 41 mm on the distal third of the radius-ulna. Ventrally, the right wing showed a similar focal area of suspected necrosis, measuring 28 x 15 mm. On the left

wing, the tag covered a locally extensive, firm and raised, black skin lesion surrounding the identified piercing wound from the patagial tag's rivet pin, which extended for approx. 25 x 14.5 mm on the dorsal aspect and had a diameter of 10 mm ventrally (Figure 4).

According to the submitter – a project officer of the Yorkshire red kite project – the bird had flown into the wire-mesh fencing (a 'pig-wire' with a mesh of around 100 – 120 mm^2) while flying out and low from a piece of woodland and that the right-wing tag appeared to have been caught in the fence.

On the first examination, no clear evidence was found that suggested a link between the presence of the wing tag and the laceration, and it remained uncertain whether the poor body condition might have contributed to hitting the fence and being unable to escape or whether the injuries contributed to death. The laceration was in the same area of the right wing as the apparently chronic lesion associated with the patagial tag, but it is not known if the pre-existing lesion increased the susceptibility of the red kite to suffer the laceration.

Red kite 52/11 was found dead on 16 January 2011 in a grazed field with nothing suspicious at the site. The carcass arrived at IoZ on 26 January 2011 and the PM was performed on the same day. This subadult red kite was in good body condition, the carcass weighed 1020g and had severe signs of autolysis which hindered sex determination. A re-examination was performed on 25 June 2019 because the PM report included a note regarding missing feathers and evidence of skin excoriation over the right lateral aspect of the mid-right ulna.

On re-examination, the feathers on the ventral surface of the right wing, between the wing tag and the skin, were matted with dry, paste-like yellowish material. The skin in this same area showed a focal circular raised and demarcated, pink lesion surrounding the area where the patagium was pierced by the tag's rivet (Figure 5). The diagnoses contributing to death were undetermined.

The macroscopic findings in these three cases are suggestive of localised inflammation of the wing tissues, likely causing a certain degree of discomfort. The associated accumulation of exudate

commonly derives from a proliferative response of the immune system (Smits et al. 1999, Martin et al. 2006), that in birds can be clinically shown with the presence of dried yellow, caseous debris (Montali 1988, Huchzermeyer and Cooper 2000, Schmidt 2003). Similarly, any tissue trauma, such as that caused by a plastic rivet piercing the wing web of a raptor, may result in local leucocythaemia.

The skin tag-associated lesions described in this report were not considered the primary cause of death in any of the three cases, although they would have been painful and a stressor for the kites and therefore are of concern. In red kite 188/19 the black colouration of the left-wing skin and presence of serosanguinous fluids were suggestive of inflammation associated with the wing tag which was confirmed on histopathology. In 112/03 there were gross signs of inflammation associated with the wing tag which appeared to have pre-dated the laceration of the patagial skin. In 52/11 there was an accumulation of caseous exudate on the skin in association with the patagial wing tag.

While negative effects of patagial tags appear to be rare in red kites, some cases may go unnoticed because the scanning surveillance method adopted cannot detect all red kites which die. It may be possible to gain a better understanding of the magnitude of the effects of these markers by collaborating with stakeholders in the avian health and management fields, utilising existing networks more effectively to gather long term information on the health effects of tags in alive birds. Hazard-specific surveillance (Hoinville et al. 2013) might improve early detection of lesions, reducing stress and avoidable pain, improving the welfare of red kites, and we would encourage those commencing new wing-tagging projects in red kites to investigate options.

The pathological lesions associated with the use of patagial tags were observed in 2.1% (3/142) of reintroduced red kites fitted with these marking devices in England, a previously undescribed condition in this species. Using monitoring data on wing tagged versus ringed red kites, it could help determine if life expectancy differs significantly between birds tagged in the different manners and may also help clarify if deployment length is a risk factor for developing wing tag-related lesions, as is the case for harness-mounted radio-transmitters (Peniche et al. 2011).

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Figure 1. Technical drawing of a wrap-around wing tag.

Figure 2. Patagial wing tags removed from left wing (white) and right wing (yellow) of the red kite 188/19.

Figure 3. Red kite 188/19. (A) Dorsal view of the right wing showing poorly demarcated and friable skin lesions under the patagial wing tag, extending from the distal third of the radius-ulna to the carpal joint on the dorsal aspect of the right wing. The tag was removed from the wing and the feathers plucked. (B) Dorsal view of left wing showing a skin lesion under the patagial wing tag on the dorsal aspect of the left wing. The tag was removed from the wing and the feathers plucked.

Figure 4. Red kite 112/03. (A) Ventral view of the leading edge of the right patagium on the right wing. On the left, the white textile of the tag secured on the wing by the plastic rivet; centrally, an accumulation of dried blood overlying the apparent recent skin laceration. (B) Site of the laceration on the leading edge of the patagium on the dorsal aspect of the right wing after removal of the patagial wing tag and plucking of the feathers. Centrally, an accumulation of dried blood. (C) Focal dark-black skin lesion suspected subcutaneous haemorrhage (thick arrow) and reddening skin (thin arrow)

on the ventral aspect of the patagium of the right wing. The wing tag was displaced laterally on the left of the picture and the feathers plucked. (D) Locally extensive, firm and black skin lesion (double arrow) below the piercing hole (singe arrow) of the patagial wing tag, dorsally on the left wing. The tag was removed, and the feathers plucked. (E) Locally extensive skin lesion around the piercing hole (arrow) of the patagial wing tag, ventrally on the left wing. The tag was removed, and the feathers plucked.

Figure 5. Red kite 52/11. (A) The ventral aspect of the right wing after the accumulation of dry, paste-like yellowish material (black arrow) was dislodged from the underlying skin and the segment of the patagial wing tag (thick orange arrow) revealing focal circular raised area of pink-coloured skin (thin orange arrow) surrounding the piercing hole for the tag. (B) The focal circular raised and marked pink-coloured lesion surrounding the piercing hole of the patagial wing tag on the ventral aspect of the right wing after removal of all paste-like yellow material.