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## Ectoparasites and Skin Lesions in Wild-Caught Spotted-Tailed Quoll (*Dasyurus maculatus*) (Marsupialia: Dasyuridae)

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**ABSTRACT:** Ectoparasites were collected from 32 wild spotted-tailed quolls (*Dasyurus maculatus*) trapped in the Tuggolo State Forest, New South Wales, Australia, during February and March 2005. Species collected included 2 ixodid ticks, 2 sarcoptiform mites, and 5 fleas from the families Pygiopsyllidae and Stephanocircidae. The presence of a mange-like skin condition was observed in several of the animals during trapping, evidenced by pruritic dermatitis and alopecia on the limbs, tail, rump, and face. A biopsy taken of the muzzle region of a male quoll displaying mange-like features and subsequent histological examination revealed the presence of marked acanthosis, hyperkeratosis, and eosinophilic infiltration. *Uropsylla tasmanica* larvae were observed encapsulated by collagenous fibrous tissue. *Dasyurochirus* nr. *major* mites encapsulated in eggs were also observed attached to hair on the skin surface of the biopsy material. The histological evidence supports the proposition that the mange-like condition is the combined result of multiple ectoparasite infestations and environmental stressors.

**KEY WORDS:** Ectoparasite, mite, flea, tick, marsupial, quoll, disease.

Ectoparasites can be found on the external surfaces of many animals, where they subsist on skin secretions or blood, often to the detriment of their host (Samuel et al., 2001). The negative impact of such infestations has been well documented in a number of host–parasite scenarios, including bird and bat populations (Brown and Brown, 1986; Dick et al., 2003), rodents, and other small mammals (Krasnov et al., 2006; Lareschi et al., 2006). A number of studies have documented these associations in Australian native species, primarily specific case studies describing pathological infestations of captive animals (O’Callaghan et al., 1994; Vogelnest et al., 2000; Skerratt, 2003).

The dasyurid, *Dasyurus maculatus* (Kerr, 1792), the spotted-tailed quoll, is a carnivorous marsupial whose habitat includes the eastern coastal regions of southern Queensland, New South Wales, Victoria, and Tasmania, Australia (Belcher, 2003; Belcher and Darrant, 2004). The species is listed as vulnerable, having suffered significant population declines since European settlement (Lunney and Mathews, 2001). Dasyurid marsupials are host to a variety of native and introduced parasites (Obendorf, 1993), some of which

cause nodular lesions (Nutting and Woolley, 1965; Canfield et al., 1990; Holz, 1998) and premature death (Oakwood and Spratt, 2000; Körtner et al., 2004), and heavy ectoparasite burdens have been the suspected cause of larger population declines (Batey, 1907; Mansergh, 1983). Hematological and skin abnormalities have also been described in response to infestation with a range of tick species, the chewing louse *Boopis uncinata*, and the fleas, *Xenopsylla vexabilis* and *Uropsylla tasmanica* (Obendorf, 1993; Oakwood and Spratt, 2000). The latter is the only flea species known to have an endoparasitic larval stage, during which, the larvae burrow into the skin causing ulceration, primarily around the face, ears, limbs, and groin (Obendorf, 1993).

This study aimed to both identify ectoparasite species collected from a population of free-living spotted-tailed quolls in northern New South Wales and to describe the pathology of a mange-like condition observed in this animal.

### MATERIALS AND METHODS

#### Study site and sample collection

Samples were collected from a total of 32 spotted-tailed quolls (*Dasyurus maculatus*) (24 males and 8 females), trapped in the Tuggolo State Forest (31°23’S; 151°36’E) in the New England tablelands of northeast New South Wales, Australia, during February and March 2005.

All animals were trapped as part of routine population monitoring by National Parks and Wildlife, New South

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**Table 1. Ectoparasites recovered from 32 wild, trapped Spotted-tailed Quolls in northeast New South Wales, Australia, in 2005.**

Arthropod species	Number
Siphonaptera—fleas	
Family Pygiopsyllidae	
<i>Acanthopsylla rothschildi rothschildi</i> (Jordan and Rothschild 1922)	10
<i>Pygiopsylla hoplia</i> (Jordan and Rothschild 1922)	10
<i>Uropsylla tasmanica</i> (Rothschild 1905)	5*
Family Stephanocircidae	
<i>Stephanocircus dasyuri</i> (Skuse 1893)	103
<i>S. harrisoni</i> (Traub and Dunnet 1973)	1
Acari—ticks	
Family Ixodidae	
<i>Ixodes holocyclus</i> (Neumann 1899)	
Adults	7 male and 47 female
Nymphs	59
<i>I. tasmani</i> (Neumann 1899)	
Adults	71 female
Acari—mites	
Family Sarcoptidae	
<i>Dasyurochirus</i> nr. <i>major</i> (Fain and Domrow 1973)	12
<i>Myocoptes musculus</i> (Koch 1844)	1

\* Total counts for adult *U. tasmanica*; larvae were too numerous to count.

Wales. Animals were examined macroscopically for ectoparasites; specimens were collected and placed immediately into 70% ethanol for transport to the laboratory for identification. Most of the animals were observed to have a mange-like skin condition of varying severity, and a lesion biopsy was taken from the muzzle of an affected adult male, fixed in 10% formalin at the site of collection, and transported to the laboratory for histological analysis.

### Ectoparasite identification

Tick and flea species were viewed with a dissection microscope and identified morphologically with the use of published keys (Roberts, 1970; Dunnet and Mardon, 1974). All mite species were mounted on slides in Hoyer's gum-choral media (Krantz, 1978), viewed under a compound microscope, and identified using morphological keys, specific publications (Fain, 1972; Fain and Domrow, 1972; Domrow, 1992), and with the assistance of Dr. B. Halliday, Australian National Insect Collection, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Canberra. Prevalence and mean intensity of infestation are reported (Margolis et al., 1982).

### Tissue preparation and histology

The skin biopsy was prepared for histology by dehydration in a graded ethanol series and was then embedded in paraffin wax per standard protocols (Bancroft and Stevens, 1982).

Paraffin blocks were sectioned at 7  $\mu$ m, and the sections were mounted on slides, dried overnight, and stained with hematoxylin and eosin using routine techniques.

## RESULTS

### Ectoparasite identification

The number and identity of fleas, ticks, and mites collected from trapped spotted-tailed quolls are shown in Table 1. No lice were found on any animals.

The tick species recovered included 54 adult (7 male and 47 female) and 59 nymphal *Ixodes holocyclus* Neumann 1899 (Acarina: Ixodidae) and 71 adult female *Ixodes tasmani* Neumann 1899 (Acarina: Ixodidae) (Roberts, 1970). The prevalence of adult and nymphal *I. holocyclus* was 31.6% and 15.8%, respectively, whereas the prevalence of adult *I. tasmani* was 23.7%. The mean intensity of infestation was 3.53 for *I. holocyclus* and 2.22 for *I. tasmani*.

Two species of astigmatid mites were identified (Acari: Astigmata). Twelve nymphal specimens of the genus *Dasyurochirus*, tentatively identified as *Dasyurochirus* nr. *major* of the family Atopomelidae (Fain and Domrow, 1972), were found in large numbers in proximity to the site of the lesion biopsy. The mite measured 82.5  $\mu$ m in width and 212.5  $\mu$ m in length. In addition, 1 specimen of *Myocoptes musculus* (Claparede, 1869) was also found at the lesion biopsy site.

Five species of flea (Insecta: Siphonaptera), representing the families Pygiopsyllidae and Stephanocircidae, were recovered. *Acanthopsylla rothschildi rothschildi* and *Pygiopsylla hoplia* had a mean prevalence of 5.3% and 7.9%, respectively. Only 1 specimen of *Stephanocircus harrisoni* (prevalence 2.6%) was collected from 1 quoll, indicating that these 3 flea species will parasitize these animals opportunistically and are not abundant parasites on this dasyurid species. *Stephanocircus dasyuri* was the most prevalent (21%) and had the highest mean intensity (3.22) of the adult flea species collected ( $n = 103$ ), with a mean prevalence of 13.5 fleas per quoll. Flea larvae were collected from the head, groin, hind legs, tail, and underbelly regions of the trapped animals and were identified as *Uropsylla tasmanica* Rothschild 1905 (Dunnet and Mardon, 1974). *Uropsylla tasmanica* was highly prevalent (too numerous to count) because all animals had larvae infestations on their hind area. The groin, rump, and hind legs appear to be the main area of infestation for the larvae, with varying levels of infestation ranging from small patches of in these regions to almost the entire skin area. Adult *U. tasmanica* were much less



**Figure 1.** A male spotted-tailed quoll (*Dasyurus maculatus*) trapped in Tuggolo State Forest, New South Wales, Australia. Note the large, mange-like lesion and alopecia evident on the masseter region.

prevalent, with only 5 fleas collected from 2 animals in this study, despite all animals having larvae at varying stages of development. The sexes of the fleas were not determined.

#### Macroscopic appearance of skin lesion

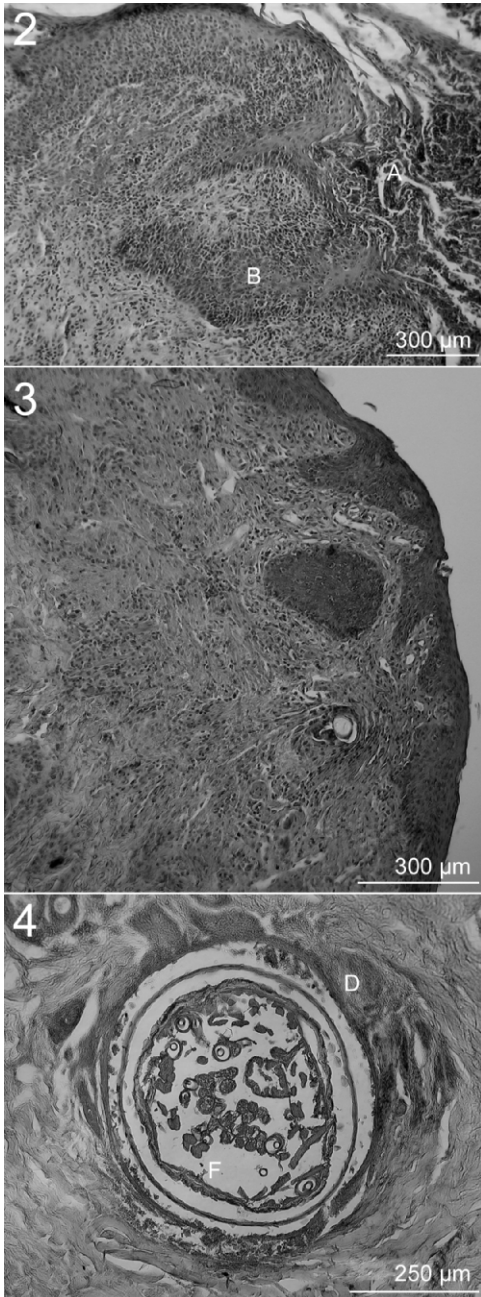
Of the 32 animals trapped, 28 (87.5%) showed signs of the mange-like condition. The condition appeared to become more prevalent and severe as the animals aged because the 4 unaffected quolls were juveniles. The severity of the condition varied in animals from mild conditions, with only signs on the face, to more severe conditions, involving severe alopecia on the face, stomach, and limbs, with the face the most noticeable region affected (Fig. 1). All affected areas showed marked alopecia, erythema, and edema, and the affected dermis displayed vesicular pruritus and vasculitis. Lichenification and hyperkeratosis were observed in a thickened epidermis, along with thick, grey-brown encrustations, as deep as 7–10 mm. Thick erythematous eruptions around edematous tissue were observed and

presumed to be due to self-induced trauma from scratching.

#### Histological appearance of the skin lesion

Sections of the mange-like lesion showed evidence of hyperkeratosis, parakeratosis, and acanthosis (Fig. 2), compared with the surrounding unaffected skin (Fig. 3). The dermal layer and subcutaneous tissue displayed leukocyte infiltration, mainly eosinophils, and collagenous fibrous tissue.

Cross-sections of *U. tasmanica* flea larvae were observed throughout both the histological sections (Fig. 4), measuring 500–600  $\mu\text{m}$  in diameter. The external tegument of the larvae was 17.5  $\mu\text{m}$  thick and layered with spines measuring 7.5–12.5  $\mu\text{m}$  long. The tegument separated the larvae from the surrounding dermis by 25.0–62.5  $\mu\text{m}$ . Within the flea larvae, spiracles, measuring 12.5–37.5  $\mu\text{m}$  in diameter, were observed with internal trachea visible at 5–12.5  $\mu\text{m}$  in diameter. The cells surrounding the flea larval tunnels had 2 layers. The first keratotic epidermal layer was 25–62.5  $\mu\text{m}$  thick and composed of tightly packed,



**Figures 2–4.** Histological sections. **2.** Muzzle biopsy of a male spotted-tailed quoll with a mange-like condition showing acanthosis, parakeratosis, and hyperkeratosis (A) of the epidermis and chronic inflammatory cell infiltrations of dermis (B), including eosinophils. **3.** Unaffected skin taken from a male spotted-tailed quoll. **4.** Cross-section of an *Uropsylla tasmanica* flea larva (F) is shown within the dermis (D) surrounded by collagenous fibrous tissue.

walled-off epidermal cells and debris. The second, less-uniform layer displayed a combination of dermal infiltrate, cellular debris, and areas of fibrous tissue.

Immature *D. nr. major* mites, 212.5  $\mu\text{m}$  long and 82.5  $\mu\text{m}$  wide, were detected in the surface lesion layer. In each instance, the mites were encased in thin-walled eggs and attached to hair shafts (Fig. 5). At no time, were mites observed in association with the hair follicles themselves, and there was no evidence of damage to the surrounding follicles or sebaceous glands. Mites were not observed in cross-section.

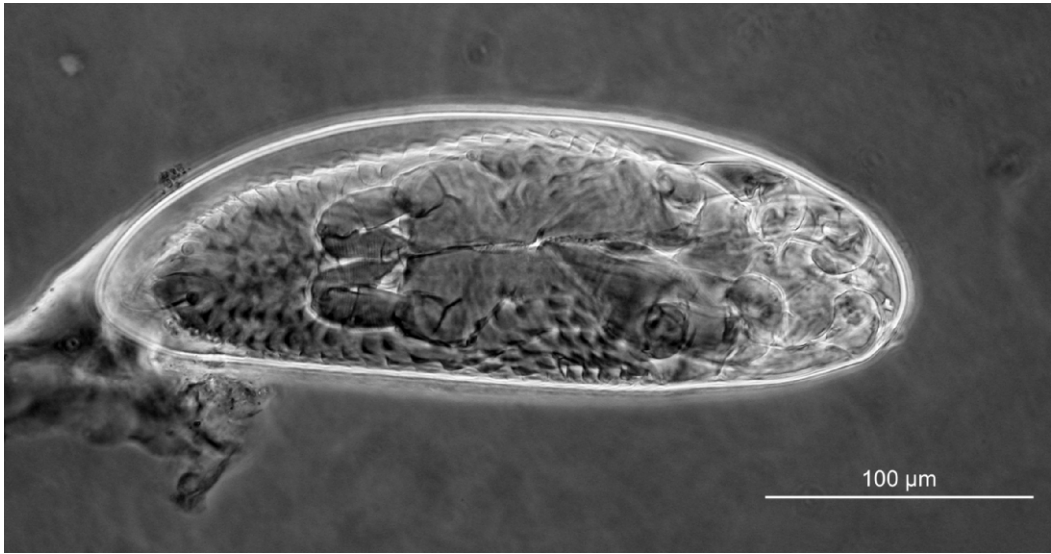
## DISCUSSION

This is the first survey of ectoparasites collected from free-living spotted-tailed quolls and the first description of the pathology of a mange-like condition and the associated histology of the flea larvae (*Uropsylla tasmanica*).

Three species of the genera *Ixodes* (Acarina: Ixodidae) have previously been reported infesting spotted-tailed quolls (Roberts, 1970). In this study, only 2 tick species, *I. holocyclus* and *I. tasmani*, were detected. Both of these species are known vectors of disease agents (Gemmell et al., 1991; Graves and Stenos, 1993), and heavy infestations have also been documented to have health implications in other marsupial species (Beveridge and Baker, 1976; Gemmell et al., 1991; Spencer and Canfield, 1994). The paralysis tick, *I. holocyclus*, was the most common tick observed in this study, although *I. tasmani*, the common marsupial tick, is the most frequently encountered species found infesting native marsupials in Australia, with the largest host record of all the Australian Ixodidae (Roberts, 1970; Murdoch and Spratt, 2005). The low numbers of *I. tasmani* may be due to the preference of this tick species for arboreal dens in larval or nymphal life stages (Murdoch and Spratt, 2005). The spotted-tail quoll most frequently uses ground den sites, although it sometimes resides in tree hollows (Jones et al., 2001).

It is unlikely that the observed mange-like condition is due primarily to tick attachment, given the prolonged exposure of the spotted-tailed quoll to all life stages of *I. holocyclus* and frequent infestation. However, allergic responses and associated inflammation and irritation could be a contributing factor to the observed condition.

Only 2 host-specific sarcoptiform mites (Acarina: Sarcoptiformes) have been previously described infesting the spotted-tailed quoll, *D. major* and *Labidopygus australiensis* (Fain and Domrow,



**Figure 5.** *Dasyurochirus major* enclosed within an egg. Note the tapered end of the egg displays fixative materials used for attachment to the host hair shaft.

1972). In this study, only early life stages of *D. major* were detected, and there is insufficient evidence to indicate that the life cycle of the mite is completed on this host or that the spotted-tailed quoll is a true host for this species.

A number of other transitional or opportunistic mites have previously been documented on the spotted-tailed quoll, including 2 trombiculid species commonly found infesting birds (Domrow, 1992; Jones et al., 2001). Demodectic mites associated with nodule formation have been recorded in captive spotted-tailed quolls (Holz, 1998) and in wild *Antechinus stuartii* (Nutting and Woolley, 1965).

The mite *Diaboliopsis sarcophilus* has been described in association with cases of alopecia and localized inflammation of the rump and tail regions of the Tasmanian devil *Sarcophilus harrisii* (Obendorf, 1993). In this study, this mite species was absent from the mange-affected biopsy and the rumps and tails of other animals affected by the condition. The mite *Myocoptes musculus* was, however, observed in the biopsy material. Infestation by this mite is well known for causing "Myocoptic mange" in rodents, an allergic condition that results in the development of pruritic lesions, skin thickening, accumulation of eosinophils, and a chronic wasting condition that persists after the successful removal of the infestation (Jungmann, Guenet, et al., 1996; Jungmann, Freitas, et al., 1996). Considering that, in this study, only 1 specimen was recovered, it is likely to be an

accidental transfer from the primary host, *Mus musculus*, a common prey item of the spotted-tailed quoll. However the possibility that this is a new host record for this mite species should not be discarded.

Seven species of fleas (Insecta: Siphonaptera) have been previously detected on the spotted-tailed quoll (Dunnet and Mardon, 1974), including *Acanthopsylla rothschildi* and *Pygiopsylla hoplia*, both of which were observed at low levels in this study and are known generalist species (Dunnet and Mardon, 1974). These low levels of infestation, along with the observed low levels of the species *Stephanocircus harrisoni* suggest quolls may have become parasitized via interactions with prey or common habitat usage.

*Stephanocircus dasyuri* was the most common flea recorded in this study, which is consistent with the original recording of this species on this host (Dunnet and Mardon, 1974). It is worth noting, however, that this flea also has a large host and geographic range (Dunnet and Mardon, 1974).

Large numbers of *Uropsylla tasmanica* were detected in this study, and its larvae were observed in the tissue biopsy from the mange-like affected site. This flea species is known to parasitize the genus *Dasyurus* and another member of the family Dasyuridae, the Tasmanian devil (Williams, 1991). It is the only flea known to spend its entire life cycle on the host. *Uropsylla tasmanica* has a unique endoparasitic larval stage (Williams, 1986; 1991), in which eggs are

glued onto the host, and the hatched larvae use specialized spines to penetrate the epidermal surface and anchor themselves to evade host grooming (Williams, 1986; Williams, 1991). The flea also produces anesthetic secretions to aid in this process (Williams, 1986). Consistent with our observations of both the gross mange-like condition and the histological responses, *U. tasmanica*-larvae infested areas commonly develop localized inflammation. However, secondary infection, leading to irritation (Williams, 1986), promotes self-trauma and alopecia (Obendorf, 1993). Severe alopecia was observed in many of the animals in this study, as was localized inflammation; however, heavily infested regions around the tail and rump area did not always display any outward signs of inflammation. Delayed hypersensitivity and edema have been recorded in response to mandibular gland secretions associated with heavy infestation by a number of flea species (Boughton et al., 2006). These secretions result in a persistent, nonspecific inflammatory response destroying surrounding tissue and causing significant long-term damage and loss of body mass (Boughton et al., 2006). Such a response could explain the severity of damage seen in this study.

The spotted-tailed quoll, like other dasyurids, has a short and intense existence, with few individuals surviving beyond their first year of life (Körtner et al., 2004). This short lifespan is characterized by high levels of stress hormone production and possible associated decline in immunological capacity. This situation lends itself to infestation by ectoparasites, increases in secondary infections, and increased mortality as the animal ages (Dickman and Braithwaite, 1992; Obendorf, 1993; Oakwood and Spratt, 2000; Krasnov et al., 2006). In this study, we observed high levels of infestation particularly by the flea species *U. tasmanica*. Although it cannot be definitively claimed that this was the cause of the mange-like condition, our observations are consistent with such a conclusion and would appear to support previous indicative data (Obendorf, 1993; Krasnov et al., 2006).

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