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The possible role of eye-frequenting flies in the transmission of *Mycoplasma conjunctivae*

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Infectious keratoconjunctivitis of small domestic and wild ruminants, a very common ocular disease in the Swiss Alps, might be transmitted by flies. In the present study, the possible role of eye-frequenting insects in the transmission of *Mycoplasma conjunctivae* was evaluated. Insect specimens were caught in the fields in the proximity of domestic sheep (*Ovis ammon* f. dom.), free-ranging chamois (*Rupicapra rupicapra rupicapra*) and Alpine ibexes (*Capra ibex ibex*), in order to determine which flies live in the vicinity of these three susceptible Caprinae species. Four genera of Muscidae were identified as potential vectors of *M. conjunctivae*: *Hydrotaea*, *Musca*, *Morellia*, and *Polieta*. The study revealed that a transmission of *M. conjunctivae* by flies should be considered but further investigations under laboratory conditions are required to assess the hypothesis of a vectorial transmission of *M. conjunctivae*.

Key words: Caprinae, Diptera, infectious keratoconjunctivitis, *Mycoplasma conjunctivae*, disease transmission, vector

INTRODUCTION

Infectious keratoconjunctivitis (IKC) is an ocular disease which commonly affects small domestic ruminants (JONES, 1991; GIACOMETTI *et al.*, 1997), as well as free-ranging chamois and Alpine ibex (GAUTHIER, 1991; GIACOMETTI *et al.*, 1997). *Mycoplasma conjunctivae* has been implicated as etiological agent by several authors (NICOLET & FREUNDT, 1975; JONES *et al.*, 1976; TROTTER *et al.*, 1977; TER LAAK *et al.*, 1988; GIACOMETTI *et al.*, 1998). Mycoplasmal IKC is highly contagious in a herd (BAAS *et al.*, 1977), and an interrelationship in wild ruminants and domestic sheep has been considered (DANIEL & CHRISTIE, 1963; NICOLET & FREUNDT, 1975; GIACOMETTI *et al.*, 1997). However, the ways of disease transmission remain unclear.

Rare anecdotal reports describe physical contacts between animals of different Caprinae species (HUBOUX, 1994). However, during a systematical study on interspecific encounters in the Swiss Alps (DEGIORGIS *et al.*, submitted) physical contacts between sheep, chamois and ibexes have been recorded only once, suggesting a transmission of *M. conjunctivae* by other ways than contact. Furthermore, IKC occurs during winter and summer, indoors and in the field, but has a more epidemic character and affects more animals during the warm, summer months (MITSCHERLICH, 1943; VAN HALDEREN *et al.*, 1994). Therefore, spread of *M. conjunctivae* by eye-frequenting flies might be a way of intra- and interspecific disease transmission, as postulated by MITSCHERLICH (1943).

A large number of non-hematophagous flies present a considerable importance in human and veterinary medicine as carriers of various pathogen agents (RHODAIN & PEREZ, 1985). Indeed, many Diptera species are accused of transmitting and disseminating ocular diseases: *Musca domestica* and *Musca sorbens* have been implicated in the transmission of epidemic conjunctivitis (caused by various bacteria), and *Musca autumnalis* has been suspected as vector of bovine keratoconjunctivitis (RHODAIN & PEREZ, 1985; WILLIAMS *et al.*, 1985). *Musca sorbens* stays in large numbers around the eyes, nose and mouth, or on wounds; it has been reported as carrier of *Chlamydia trachomatis*, which causes severe keratoconjunctivitis in man (RHODAIN & PEREZ, 1985). Furthermore, several *Musca* species work as intermediate hosts for the eyeworm of mammals, *Thelazia* sp. (KETTLE, 1990; RHODAIN & PEREZ, 1985; MEHLHORN *et al.*, 1993). Flies can be observed in the environment of livestock, feeding frequently on lachrymal discharge. The sheep head fly (*Hydrotaea* sp.) for example swarms around the head of the host feeding at wounds, at the eyes (Fig. 1) and mouth (WALKER, 1994).

In order to investigate whether flies might play a role in transmission of infectious keratoconjunctivitis of small domestic and wild ruminants, entomological investigations were carried out. The purpose of the present study was to determine which flies live in the vicinity of sheep (*Ovis ammon* f. dom.), chamois (*Rupicapra r. rupicapra*) and Alpine ibex (*Capra i. ibex*) on summer pastures, in order to choose appropriate insect species to perform laboratory experiments.



Fig. 1. *Hydrotaea irritans* on the right eye of a chamois affected with infectious keratoconjunctivitis.

Tab. 1. Diptera identified from the samples collected during summer 1996 and 1997. Identifications are mostly based on females and remain tentative in some cases. Nomenclature according to MERZ *et al.* (1998).

Family	Species	Samples											
		C1	C2	I1	S1	S2	S3	S4	S5	S6	S7	S8	S9
Anthomyiidae	<i>Zaphne</i> sp. undetermined	x											
Calliphoridae	<i>Calliphora vomitoria</i> (Linnaeus)	x	x			x	x	x	x	x	x		x
	<i>Calliphora</i> sp.			x									
	<i>Lucilia caesar</i> (Linnaeus)						x		x			x	
Drosophilidae	<i>Drosophila</i> sp.												x
Fanniidae	<i>Fannia</i> sp.							x	x	x	x	x	x
Muscidae	<i>Azelia</i> sp.												x
	<i>Dasyphora pratorum</i> (Meigen)									x			
	<i>Eudasyphora zimini</i> (Hennig)		x										
	<i>Helina</i> sp.	x											
	<i>Hydrotaea dentipes</i> (Fabricius)								x	x			x
	<i>Hydrotea ignava</i> (Harris)												x
	<i>Hydrotaea irritans</i> (Fallén)			x				x		x	x		
	<i>Hydrotaea militaris</i> (Meigen)									x			
	<i>Hydrotaea pandellei</i> Stein									x			
	<i>Hydrotaea similis</i> Meade							x				x	x
	<i>Hydrotaea</i> sp.												x
	<i>Musca autumnalis</i> De Geer							x	x	x	x	x	
	<i>Morellia podagrica</i> (Loew)							x	x	x	x	x	
	<i>Morellia</i> sp.	x			x								
	<i>Myospila</i> sp.	x											
	<i>Phaonia</i> sp.											x	
	<i>Polietes domitor</i> (Harris)									x	x		
	<i>Polietes lardarius</i> (Fabricius)			x				x		x			
	<i>Thricops</i> sp. undetermined									x			
Piophilidae	<i>Liopiophila varipes</i> (Meigen)				x					x			x
Sarcophagidae	<i>Sarcophaga caerulescens</i> Zetterstedt		x										
Sphaeroceridae	<i>Sphaerocera curvipes</i> Latreille									x			
Tabanidae	<i>Hybomitra</i> sp.				x								
	<i>Tabanus</i> sp.							x		x			

Samples:	Host	Locality	Altitude	CH-coordinates	Date
C1	Chamois	Wyssgräter/Vals/GR	2620 m	728.950/157.700	21.08.96
C2	Chamois	Mulebergwald/St.Stephan/BE	1560 m	597.100/152.850	16.07.97
I1	ibex	Val Martscha/Innerferrera/GR	2200 m	752.080/153.280	29.08.96
S1	Sheep	Val Madris/Avers/GR	2280 m	757.550/146.150	26.07.96
S2	Sheep	Val Madris/Avers/GR	2500 m	758.320/145.750	26.07.96
S3	Sheep	Val Madris/Avers/GR	2560 m	758.200/145.100	26.07.96
S4	Sheep	Les Cerniettes/Charmey/FR	930 m	578.400/160.750	16.07.97
S5	Sheep	Flösch/Lenk/BE	1880 m	598.030/145.975	21.07.97
S6	Sheep	Chenaussanne/Montbovon/FR	1130 m	566.550/144.825	24.07.97
S7	Sheep	Chenaussanne/Montbovon/FR	1130 m	566.550/144.820	31.07.97
S8	Sheep	Beauregard/Estavannens/FR	980 m	574.200/158.450	21.08.97
S9	Sheep	Schafbärgli/Oberwil i.S./BE	1890 m	601.140/171.375	02.09.97

MATERIAL AND METHODS

Specimens were collected in alpine and subalpine regions of three Swiss cantons during summer 1996 and 1997 (Tab. 1). Insects were caught on the summer pastures in the proximity of sheep, chamois and ibex affected with IKC. In the sheep,

flies were taken either from stones close to animals (for example near a salt lick), or on immobilized or dead animals. Free-ranging ruminants with IKC-symptoms were shot by state game-keepers (except a young chamois found dead in the summer of 1997); the insects, especially those around the eyes of the affected animals, were caught just after shooting.

The flies were put in a small box containing pieces of tissues moistened with ethyl acetate. The insects were then either directly pinned and dried (specimens 1996), or put in a hermetic container filled with 70 % alcohol (specimens 1997). The fly species were then determined by an entomologist (E. OBRECHT).

RESULTS

Many of the flies dried in 1996 were damaged, making species determination impossible. In 1997, the preservation of the insects in alcohol was satisfying, permitting species determination of male flies with certainty. Unfortunately, most flies of the samples were females, and female cyclorrhaphan flies are often almost impossible to determine to species level.

However, 24 flies were determined in 1996 and 123 in 1997, and several Diptera could be identified from chamois, ibex and sheep. Nine different families are represented (Tab. 1), and four genera were found as well in domestic as in wild ruminants: *Hydrotaea*, *Morellia*, *Polietes*, and *Calliphora*.

DISCUSSION

From nine identified families of Diptera, four are classified as insects of medical and veterinary importance: Muscidae, Calliphoridae, Sarcophagidae, and Tabanidae. However, Calliphoridae and Sarcophagidae are flies associated with carrion, and Tabanidae are blood-sucking flies. Therefore, only four genera of Muscidae can be considered as potential vectors of *M. conjunctivae*: *Hydrotaea*, *Musca*, *Morellia*, and *Polietes* are the only identified flies whose feeding habits make a transmission of ocular pathogens possible (HAMMER, 1941). Except *Musca*, they were collected as well from domestic as from wild ruminants. However, it is probable that *Musca* flies also feed on chamois and ibex.

Musca autumnalis was identified many times with certainty. Interestingly, *M. autumnalis* has been implicated as vector of bovine infectious keratoconjunctivitis by several authors (STEVE & LILLY, 1965; CHENG, 1967; BROWN & ADKINS, 1972; ARENDS *et al.*, 1982; GERHARDT *et al.*, 1982). Its feeding habits and ability to fly long distances in a short time make it an ideal vector for agents of infectious keratoconjunctivitis within a herd, but also between widely separated herds (WILLIAMS *et al.*, 1985). Furthermore, the rough spines on its mouthparts can damage eye tissue and predispose it to an infection (WILLIAMS *et al.*, 1985).

In cattle, flies seem to play a role as vectors but do not appear as a necessary factor for transmission. The situation is possibly similar for IKC, as already suspected by MITSCHERLICH (1941; 1943). Excessive lachrymation is an attractive source of proteins, salt and water for insects (BÄNZIGER, 1972a; BÜTTIKER & MEYER, 1974; NICOLET & BÜTTIKER, 1975; WILLIAMS *et al.*, 1985), and flies' feeding habits include constant changing of hosts grazing close to each other. Furthermore, insects have been suspected to be vectors of mycoplasmas by several authors (BÄNZIGER, 1972b; DANIELS, 1973; NAYAK & BHOWMIK, 1990; GOUWS *et al.*, 1995). Since mycoplasmas cannot survive a long time in the environment (NICOLET, 1985), they have to be transmitted in a short delay from one susceptible host to the next. However,

the presence of mycoplasmas in the gut of eye-frequenting moths has been suspected (BÄNZIGER, 1972b), and further investigations are required to determine if mycoplasmas survive, and maybe multiply, in the gut of flies.

As a conclusion, a transmission of *M. conjunctivae* by flies should be considered, but the epidemiological significance of this transmission is unclear. It is probable that flies play a role as accessorial vectors. The occurrence of IKC during cold months excludes the fly as the only route of disease transmission. However, this role might be of primary importance in interspecific transmission on alpine meadows, and further investigations under laboratory conditions are required to assess the hypothesis of a vectorial transmission of *M. conjunctivae*. Furthermore, other aspects of flies as a predisposing factor for IKC should also be mentioned: eye-frequenting insects may provoke irritation (favoring an infection), and they can carry various bacteria which might secondarily infect the eyes and aggravate the symptoms of conjunctivitis caused by *M. conjunctivae*.

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ZUSAMMENFASSUNG

Die infektiöse Keratokonjunktivitis der kleinen Haus- und Wildwiederkäuer, eine in den Schweizer Alpen häufig vorkommende Augenkrankheit, könnte durch Fliegen übertragen werden. In dieser Studie wurde die mögliche Rolle von Augen besuchenden Insekten bei der Übertragung von *M. conjunctivae* untersucht. In der Nähe von Schafen, Gamsen und Steinböcken wurden Insekten gefangen, um das Artenspektrum in der Umgebung dieser drei empfänglichen Caprinae-Arten zu erfassen. Vier Gattungen von Muscidae wurden als mögliche Vektoren von *M. conjunctivae* identifiziert: *Hydrotaea*, *Musca*, *Morellia* und *Polietes*. Die Untersuchung zeigte, dass eine Übertragung von *M. conjunctivae* durch Fliegen in Betracht gezogen werden sollte. Weitere Untersuchungen unter Laborbedingungen sind aber nötig, um die vermutete vektorielle Übertragung von *M. conjunctivae* zu klären.

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