VARIATION IN THE CHAETOTAXY AND DENTICULATION OF *SARCOPTES SCABIEI* (ACARINA : SARCOPTIDAE) FROM WILD CANIDS

BY

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INTRODUCTION

The systematics of the genus *Sarcoptes* has involved considerable controversy. FAIN (1968) studied variability within this genus and concluded that there was only a single, highly variable species, *S. scabiei*. Furthermore, he surmised that the varieties of *S. scabiei* that infect lower mammals represent strains from man that have lost their ability to permanently reinfect humans. In contrast, KUTZER (1970) recognized 9 species of the genus *Sarcoptes*. The form from canids was recognized as a distinct species, *S. canis*. Most authors refer to this form as *Sarcoptes scabiei* var. *canis*. FAIN (1968) noted several cases of reduction or duplication of setae during an extensive study of specimens from many hosts. After examining representative specimens of *S. scabiei* from wild canids from epizootics currently in progress in New York and Western Canada, it was found that anomalies in chaetotaxy occurred with a much greater frequency than previously recorded. The present study reports the frequency of these anomalies and attempts to assess the value of idiosomal chaetotaxy and the pattern of denticulation in the systematics of the species.

METHODS AND MATERIALS

Mites were obtained from a red fox (*Vulpes fulva*) from the New York epizootic and a red fox (*V. fulva*), a coyote (*Canis latrans*), and 3 wolves (*Canis lupus*) from the epizootic in Alberta. These hosts were in the terminal stage of, or had succumbed to, sarcoptic mange. Males and immature stages of the mites were not studied. Females were mounted in Hoyer's medium and examined by brightfield microscopy. Chaetotaxy and denticular pattern were studied from figures drawn with the aid of a Leitz drawing tube.

RESULTS

The morphometrics of specimens examined in this study in general conform to those described for *S. scabiei* from canids by FAIN (1968) and KUTZER (1970). However, of 184 specimens

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examined 113 (61 %) demonstrated one or more anomalies in chaetotaxy. Arrangement and nomenclature of the dorsal setae are illustrated in Fig. 1. The frequency of supernumerary setae and the loss of specific setae on the dorsal idiosoma is shown in Table 1. Anomalies of the dorsal chaetotaxy involved the duplication of setae l_3, l_4, and l_5 and loss of d_1, d_3, l_3, l_4, and l_5. In addition to variation in setal numbers, aberrancies in size and shape of the large dorsal setae and their bases were noted. On one specimen from the red fox (New York) there was a unilateral aberrancy in the size and shape of l_1 (Fig. 6-7) while on a second specimen from the same host l_1 was subequal in size. Abnormally shaped bases on setae sci, l_1, and d_1 were frequently noted on specimens from New York foxes. The anterior portion of the base on these specimens was often elongated thereby making the base pyriform (Fig. 3) rather than elliptiform in shape (Fig. 4). The anterior elongation was sometimes partially separated by a sclerotized constriction (Fig. 9) from the posterior portion of the base on which the seta was located. Other variations of the setal base are illustrated in Fig. 5 and 8. Abnormal setal bases were found on only one specimen from the coyote and were absent on specimens from the red fox and wolves from Canada.

TABLE 1. — Duplication and absence of dorsal idiosomal setae on *Sarcoptes scabiei*.

Host	No. Mites Examined	Number Abnormal	Single Duplications			Single Absences					Duplication l_1 Absences d_3
			l_3	l_4	l_5	d_1	d_2	l_3	l_4	l_5	
Coyote (Canada)	102	5			1	2		1		1	
Red Fox (New York)	58	12		7	2	1	1		1		1
Red Fox (Canada)	4	1	1								
Wolf (Canada)	20										
Total	184	18	1	7	3	3	1	1	1	1	1

Characteristically, the dorsal and midlateral opisthosoma of *S. scabiei* has a regularly recurring pattern of scalelike, linear to triangular sclerotizations which represent outgrowths of the striae of the cuticle (Fig. 1). These outgrowths are usually referred to as denticles (FAIN, 1968). The pattern of denticulation showed little variation on specimens from the various hosts in the present study. There were no distinct nude or bare areas within the denticular region. However, on 17 of 58 specimens (29 %) from the red fox (New York) there was a small area in Region B (the area internal to setae d_1, d_2, l_2, and d_3) where from 1 to 4 rudimentary denticles or sclerotized striae were found (Fig. 1). Denticulation of this type was found on 6 of 102 specimens (6 %) from the coyote and 1 of 4 specimens (25 %) from the Canadian red fox. These areas were not observed on specimens from the wolves. The occurrence of rudimentary denticles or thickened striae Region B conforms closely to the rare from of *S. rupricaprae* illustrated by KUTZER (1970 ; Fig. 15). Denticle counts on specimens from different hosts had values that fall within a common range. The average counts of dorsal and lateral denticles were 165 (range 156-177 ; n = 10), 165 (range 160-169 ; n = 4), 161 (range 152-164 ; n = 5) and 157 (range 147-164 ; n = 10) on mites from the coyote, red fox from Alberta, wolf, and red fox from New York, respectively.

The arrangement and nomenclature of the ventral setae are shown in Fig. 2. One or both

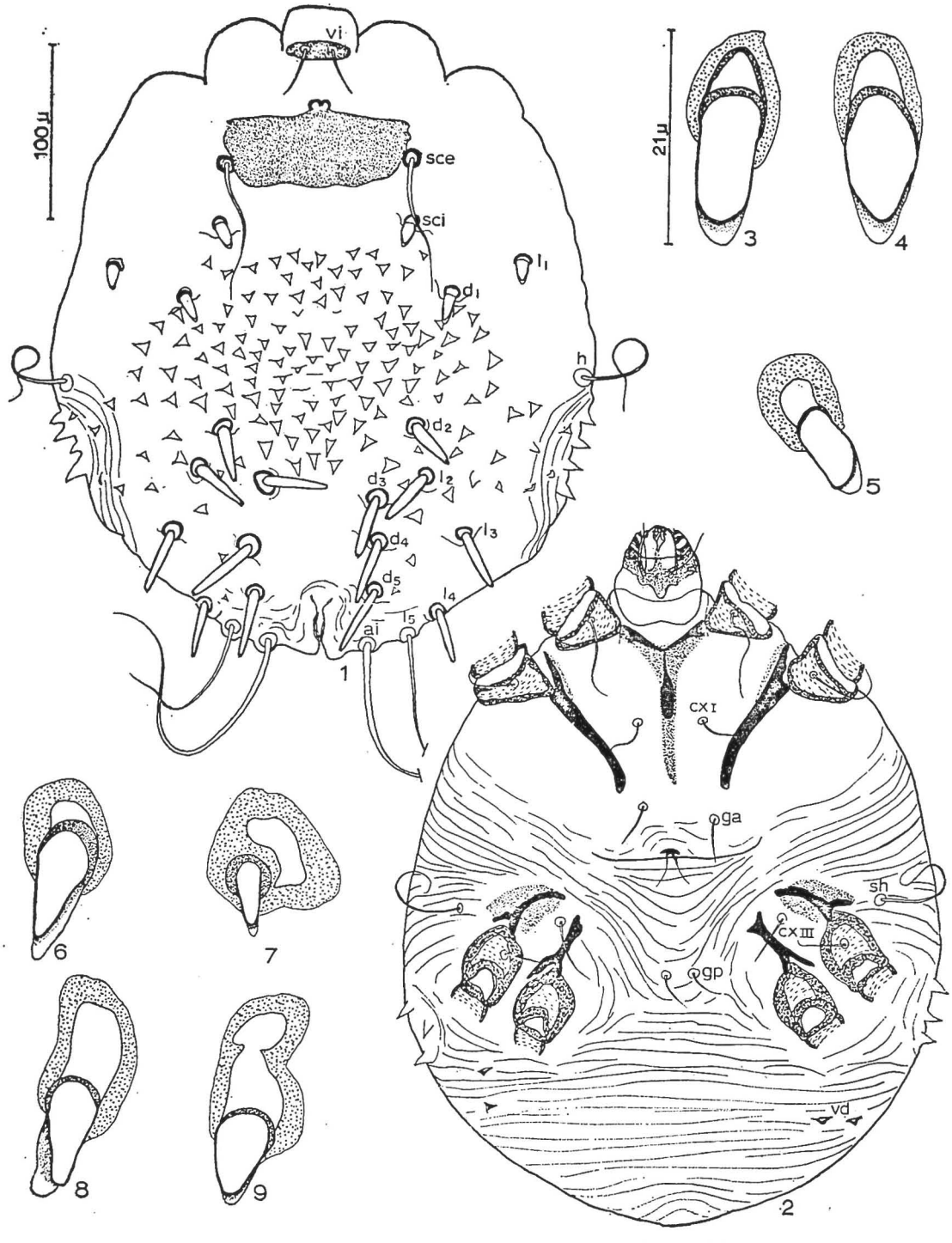

FIG. 1-9 : Chaetotaxy and denticulation of *Sarcoptes scabiei* from wild canids. — (1) Dorsal idiosoma, (2) ventral idiosoma, (3) seta d_1 with pyriform base, (4) seta d_1 with elliptiform base, (5) seta sci with atypical shape, (6-7) normal and abnormal setae l_1, respectively, on a specimen from a New York Fox, (8) seta l_1 with elongate base, (9) seta l_1 with subdivided base. (sce-scapular external, sci-scapular internal, d-dorsal, l-lateral, h-humeral, sh-subhumeral, ai-anal internal, cx-coxal, ga-genital anterior, gp-genital posterior, vd-ventral denticles).

of the anterior genital (ga) and posterior genital (pg) setae were frequently absent (Table 2). Sixty-five of 102 specimens (64 %) from the coyote showed the loss of one or more of the ventral setae. No duplications of the ventral setae were noted. On three specimens from the coyote and three from the red fox (New York) the two posterior genital setae were subequal. On one specimen each from the coyote and red fox (New York), respectively, one of the posterior genital setae was set laterally from its normal position.

TABLE. 2. — Absence of genital setae on *Sarcoptes scabiei.*

Host	No. Mites Examined	Number Abnormal	Abseces						
			ga		gp		Both ga	Both gp	One gp
			One	Both	One	both	One gp	One ga	One ga
Coyote (Canada)	102	65	16	6	25	4	4	3	7
Red Fox (New York)	58	14	7		4		1		2
Red Fox (Canada)	4	2	1					1	
Wolf (Canada)	20	6	1		5				
Total	184	87	25	6	34	4	5	4	9

Differences were noted in the occurrence and relative development of ventral denticles on specimens from different hosts. Fifty-three of 58 specimens (91 %) from the red fox (New York) had 1 to 4 well-developed denticles per side as compared with only 15 of 58 specimens (25 %) from the coyote. Denticles on specimens from the red fox (Canada) and wolf were rudimentary. On specimens from the coyote the denticles often appeared only as localized striatal thickenings. Right-left distribution of the denticles was asymmetrical and differences of 1 or 2 denticles per side were often noted.

There was no variation in the chaetotaxy of the terminal segments of the legs. However, four specimens from the coyote and 2 specimens from the Canadian red fox had a unilateral loss of the seta on trochanter III. One specimen from the coyote and 1 specimen from the wolf had a unilateral loss of the seta on coxa I. No anomalies in leg chaetotaxy were noted on the specimens from the red fox from New York.

The occurrence of multiple anomalies on a single specimen is characterized by a specimen from the red fox (New York) which had a bilateral loss of gp, unilateral loss of ga, and a unilateral loss of the seta on trochanter III. Other examples include a specimen from the coyote which had a unilateral loss of ga and gp and loss of l_3 and a specimen from the red fox (New York) which had a loss of d_3 and duplication of l_4.

DISCUSSION

FAIN (1968) divided the denticulate area of the dorsum into 4 regions (A, B, C, and D). KUTZER (1970) recognized 3 groups of *Sarcoptes* on the basis of the development and pattern of the denticles in Region B. *Sarcoptes canis, S. rupricaprae,* and *S. cuniculi* reportedly had

a complete and well-developed denticulation in Region B and were thus grouped together. *Sarcoptes canis* was differentiated from the other species of its group by the size of the idiosoma, presence of ventral denticles, and shape of the podosomal plate. KUTZER (1970) recognized that the denticles of Region B were not always well developed and that specimens would occasionally exhibit only rudimentary denticles or thickened striae in a localized area of Region B (e. g., *S. rupricaprae*, normal and rare form, his fig. 15). Our observation that the " rare form " of denticulation may be found on a considerable percentage of the mites from canids suggests that Kutzer's groups are based on a character which exhibits considerable variation and that there is no distinct boundary between those " species " with well-developed and complete denticulation and those having nude or bare areas. The observation that ventral denticles were absent on some specimens from canids further indicates that this criterion cannot be used to differentiate *S. canis* from other " species " of the group. Thus, it is concluded that the characters used by KUTZER (1970) for differentiating the various forms of *Sarcoptes* are not valid. Therefore, until additional evidence is presented the conclusion of FAIN (1968) that there is but a single species, *Sarcoptes scabiei*, must stand.

Variations in chaetotaxy of *S. scabiei* have been reported rarely despite the intensive study given this species. BUXTON (1921 *a*) found no anomalies on *S. scabiei* var. *equi*. In a later study of *S. scabiei* var. *hominis* (Buxton, 1921 *b*) a unilateral duplication of sce was reported. FAIN (1968) found only 18 specimens that exhibited anomalies after examination of a large number of *S. scabiei* from various hosts. These anomalies were absences, duplications, and aberrant sizes, shapes, or placement of setae. The only anomaly on specimens from canids was a unilateral loss of ai and an atypical placement of l_5 on a specimen from a fox.

Chaetotaxy is generally considered as stable and of significance in acarine systematics. However, studies on other arthropods such as *Drosophila melanogaster* have shown that formation of setae is under genetic control with a number of genes involved (LEE and WADDINGTON, 1943). The present study indicates that the genetics controlling formation of certain setae on *S. scabiei* is not stable. The alterations of the genetic material that produce these anomalies apparently do not hinder the ability of the mites to successfully infect and survive on their canid hosts. The frequency of anomalies in the mite population is probably determined by the genetic constitution of the founders that originally infected the host.

The high frequency of chaetotaxic anomalies observed herein may be a result of the lessening of selection pressure and the subsequent proliferation of individuals such as occurs during an epizootic. The studies of FORD (1971) indicate that variability within a species increases during those times when selection pressure eases and the population increases in numbers. Genotypes that would normally be selected against can survive and new genetic combinations can arise within the population. Some of the new genetic interactions may be advantageous and will be retained when stricter selection is restored and the population begins to decrease in size. Considered in this sense, epizootics and the subsequent decline of mite populations may provide opportunities for the evolution of the species. Alternatively, anomalous individuals may be a consequence of many generations produced over a short period of time from a restricted gene pool (a few founders forming the initial infection on an individual host). Assuming the genes for anomalies have been in gene pool for a long period of time the variation occurring in certain populations of mites may be a result of considerable inbreeding over a short period of time on an individual animal regardless of the population epizootic. This could only be substantiated by examination of specimens of mites collected from periods between epizootics. Regardless of the origin for their development of a means of expressing phenotypic characteristics, should the genes for setal loss or duplication (and their pleiotropic effects) become fixed in the population

the acarien systematist would be faced with the decision of whether the forms represent a " new species ". Obviously, more study is needed to determine the extent of variation in acarien chaetotaxy and the genetics which control its formation.

Abstract

Specimens from epizootics of *Sarcoptes scabiei* in red foxes (*Vulpes fulva*) from New York, U.S.A., and red foxes (*V, fulva*), coyotes (*Canis latrans*), and wolves (*Canis lupus*) from Alberta, Canada were examined for variations in chaetotaxy and denticulation. A high frequency of setal anomalies (duplications, absences, and modified bases) was found on specimens from all hosts. It is suggested that the conditions associated with epizootics allow for increased phenotypic variability in this character and that the numerical fluctuations of populations during epizootics provide an opportunity for the genetic alteration of these mites.

The central region of the dorsum is typically covered with large, well developed denticles. However, on some specimens a small area with only rudimentary denticles or sclerotized striae is present. On many specimens ventral denticles are lacking. The implications of these observations on denticulation are discussed in relation to the current systematics of the genus *Sarcoptes*.

Résumé

Des Acariens de l'espèce *Sarcoptes scabiei* récoltés chez *Vulpes fulva* de New York, U.S.A., et le même hôte, *Canis latrans* et *Canis lupus* d'Alberta, Canada, sont exminés du point de vue de la variation sur la chaetotaxie et les écailles de l'idiosoma. Une grande fréquence d'anomalies dans la chaetotaxie des Acariens est observée chez tous les hôtes. Il est possible que les conditions relatives a l'épidémie augmentent la variabilité phénotypique de ce caractère et que les fluctuations numériques des populations pendant l'épidémie soient une occasion pour que se produise la modification génétique de ces Acariens.

La variation des écailles dorsales et ventrales est discutée en relation avec la systématique actuelle du genre *Sarcoptes*.

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