MORPHOLOGICAL VARIATION IN THREE POPULATIONS OF THE ANTARCTIC MITE, *STEREOTYDEUS MOLLIS* W. & S. (ARTHROPODA : ACARINA)[1, 2]

BY

D. A. Pittard,[3] L. A. Roberts,[3]

AND

R. W. Strandtmann[3].

Abstract.

Intraspecific variation of *Stereotydeus mollis* was evaluated for 18 characters from males and females of three apparently isolated populations. Sexual dimorphism was significant for length of the genital flap and length of four setae : external humeral, scapular, and anals I and II. Of these, the genital flap length provided the most effective criterion for separating the sexes. Analysis of variance indicated significant interpopulational variation. Results of T-tests and Chi-Square supported the view that the Cape Royds (Island) population was divergent from the two mainland populations studied.

Introduction.

More than 30,000[4] species of mites have been described and diagnosed on the basis of various morphological characters. In the process of description, information on intraspecific variation is usually based on only a limited number of individuals from one collection. This is not surprising in view of the difficulty of obtaining material and the large number of mite species to be described. There are few if any reports, therefore, relating to inter-/or intrapopulational variation of free-living mite species. One of the more extensive discussions of intraspecific morphological variation may be found in the study by Goksu, et al. (1960) on laboratory reared *Trombicula*. The recent studies on numerical taxonomy of Acarina (Funk, 1964 ; Moss, 1967) because of the scope of their problem (overall phenetic similarity of numerous species) generally fail to provide any estimate of morphological variation within populations or between populations of the same species.

In preliminary studies of the structure of Antarctic populations, we deemed it important to obtain some estimate of intraspecific variation both within and between geographically iso-

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3. Address : Texas Tech University, Lubbock, Texas 79409, U.S.A.

4. This estimate is based on a card file of *ca* 4000 generic names compiled by one of us (RWS). It assumes an average of less than 10 species per genus.

lated populations. For this initial study, we chose the free-living, soft-bodied mite, *Stereotydeus mollis* Womersley and Strandtmann (1963)found in suitable habitats in Victoria Land, Antarctica, between latitudes 75° and 79° S. It is more fully described in a companion paper by PITTARD (Pacific Insects, in press). The present study considers variation in 18 morphological characters of adult males and females of *S. mollis* from three populations and provides an estimate of the extent of individual and sexual variation within the three populations as well as limited information on geographic variation in this species.

LOCATION AND DESCRIPTION OF HABITATS.

The three populations chosen for study are located in south Victoria Land within the McMurdo Sound area, Antarctica (Fig. 1). Two samples were taken from continental populations, i.e., Cape Roberts (77°03'S by 163°10'E) and Wright Valley (77°30'S by 162°15'E). The third sample was collected at Cape Royds on Ross Island, approximately 35 miles from the continent at 77°33''S by 166°10'E.

JANETSCHEK (1967) divides the soils of south Victoria Land into two general types : the " Chaliko—system " or barren gravel system which is composed of bare ground and microphytic vegetation (fungi) ; and the " Bryosystem " composed of visible or macrophytic vegetation including algae, lichens, and mosses. At Cape Royds, the substrate is composed entirely of volcanic rock and ash, is extremely bare, and may be considered a chalikosystem. The thick and wides-

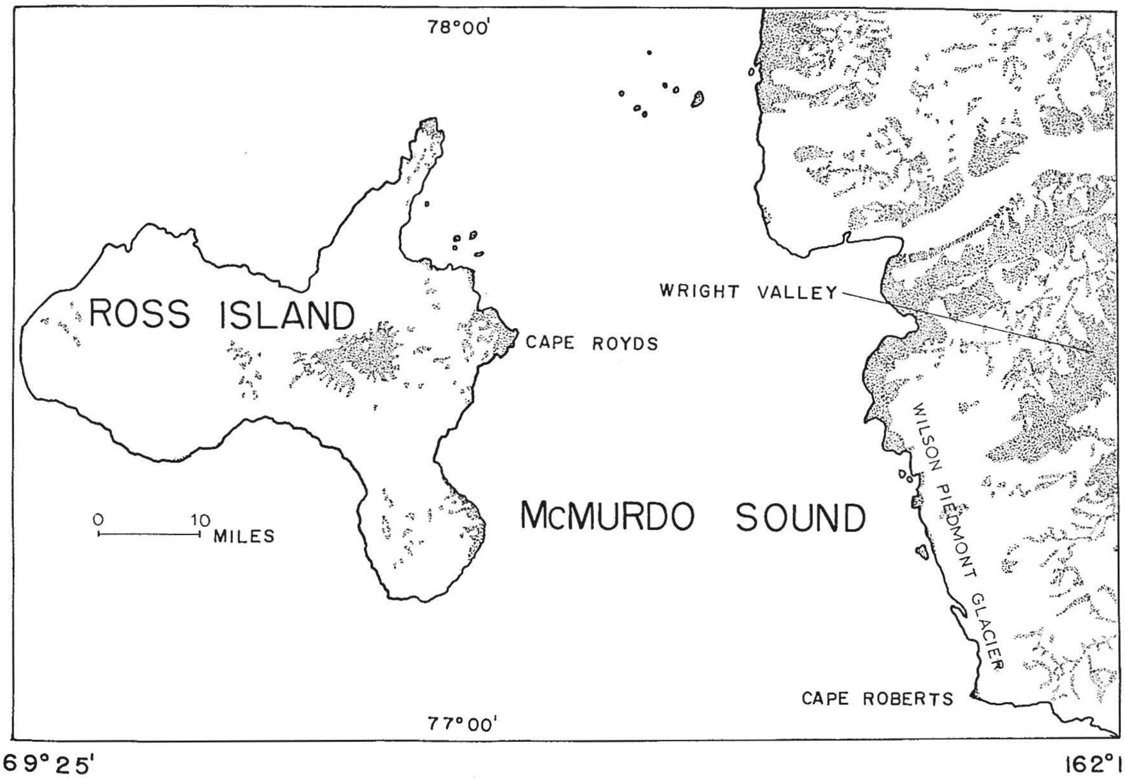

FIG. 1 : Cape Royds, Wright Valley, and Cape Roberts were sampling locations for present study. Stippling indicates exposed land surfaces. The extent of snow and ice coverage is represented by white areas.

pread growth of algae and moss at Cape Roberts constitutes a Bryosystem, while the substrate within the study area in Wright Valley could be considered an intermediate between the two systems.

Arthropods inhabiting all three locations include the Collembolan, *Gomphiocephalus hodgsoni* Carpenter, and two species of mites, *Stereotydeus mollis* Womersley and Strandtmann and *Nanorchestes antarcticus* Strandtmann. At Cape Roberts a third species of mite, *Tydeus setsukoae* Strandtmann was found in isolated areas.

At all collection sites, *S. mollis* was invariably found under small stones located at or near a source of melt water. Humidity appeared to be a critical factor in determining distribution or at least abundance within a given area.

Methods.

The most efficient collection technique involved aspirating individual specimens into a small vial containing 70 % ethyl alcohol. To minimize bias all populations were randomly sampled at least two times within an eight week period during the 1966-67 austral summer. The range of each population was limited by the availability of moisture and the area of exposed surface ; therefore, randomness of selection could be approximated within a relatively small area.

The specimens recovered were kept in 70 % ethyl alcohol before being cleared in warm Nesbitt's solution for approximately 12 hours. Each mite was then removed and mounted in Hoyer's medium. After drying the slides, adult males were separated from females by the presence of a sperm sac in the male. Such a segregation rendered each sample series homogeneous as to life stage, sex, and location. Measurements of 50 adult males and 50 adult females from each geographical location were analyzed statistically.

Measurements included the lengths of the idiosoma, the genital plate, and the following setae : trichobothrium, external vertical, scapular, external humeral, and the first, second, and third anals. Meristic characters studied were the number of setae on the genital plates, each of the coxae, and the trochanters. The position and name of each character is shown in Figure 2 A and B. All 18 characters were selected on the basis of presumed taxonomic significance and ease and reliability of measurements. Although variation of these characters is assumed to be an indirect indication of the genetic variation of each population, there is no analysis in the present study that bears on the question of whether the observed differences are genetic rather than environmental.

All measurements, counts, and drawings were made with the aid of an American Optical phase-contrast microscope equipped with an ocular micrometer.

Means, standard deviations, standard errors, and coefficients of variability were calculated for each of the nine continuous characters. Measurements of males and females within each population were compared using Students' t-test and Chi-Square. Analysis of variance for each character within either sex was carried out to determine whether any character would exhibit morphometric differences among the three populations. For consistency in treatment of the continuous characters, t and F values are presented in the tables. However, normal curve statistics may have little meaning for those characters with particularly low ranges relative to the units of measurement (Table 3). For this reason Chi-Square tests were also made and we have indicated the few cases in which the two tests gave conflicting estimates of significance. Sexual and geographic differences are statistically inferred on the basis of a 95 per cent confidence level.

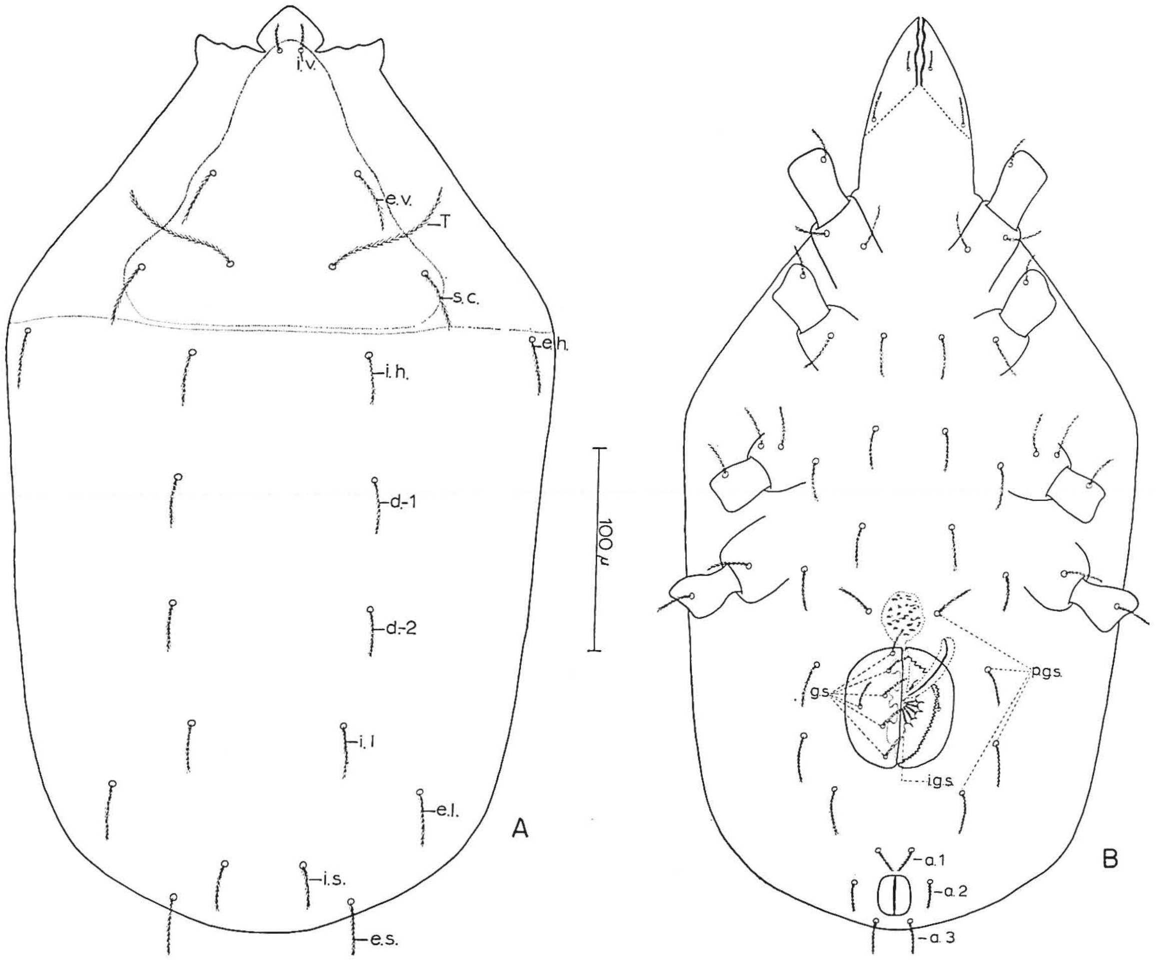

FIG. 2 : *Stereotydeus mollis*, male.

A. Dorsum ; d-1 = dorsal 1, d-2 = dorsal 2, e.h. = external humeral, e.l. = external lumbar, e.s. = external sacral, e.v. = external vertical, i.h. = internal humeral, i.l. = internal lumbar, i.s. = internal sacral, i.v. = internal vertical, sc = scapular, T = trichobothrium.

B. Venter ; a1, a2, a3 = Anals 1, 2, 3. g.s. = genital setae ; i.g.s. = internal genital setae ; p.g.s. = paragenital setae.

All computations were done on the IBM 7040 and 360/50 computers in the Computer Center, Texas Tech University. The programs used were written at the Health Science Computing Facility of the University of California at Los Angeles (Biomedical Programs) and the Brigham Young University Computer Research Center.

RESULTS.

Individual Variation of Continuous Characters.

Variation of each of the nine continuous characters within each population as indicated by coefficients of variation (C. V.) is shown in Table 1. Idiosomal and genital flap lengths are by this criterion the least variable of the measurements for males and females from all three populations. Although the remaining characters exhibit moderate variability, they do not

Table 1.

Character lenth	Roberts					Wricht					Royd					F	
	X (μ)	S.E.	MAX	MIN	C.V.	X (μ)	S.E.	MAX	MIN	C.V.	X (μ)	S.E.	MAX	MIN	C.V.	RATIO	P [1]
Males																	
Idiosomal	434.0	2.25	460	380	3.6	439.2	2.77	480	400	4.4	420.0	3.14	470	380	5.2	13.09	.01
Genital Plate	63.1	.37	70	58	4.1	63.4	.32	70	58	3.6	62.3	.41	72	58	4.7	2.36	NS
Trichobothrium	48.8	.36	54	45	5.1	48.1	.41	54	43	5.9	47.0	.28	52	45	4.2	6.51	.01
External Vertical	26.5	.22	29	22	5.9	26.0	.20	29	22	5.3	26.5	.33	34	20	8.9	1.02	NS
External Humeral	27.7	.25	36	25	6.4	27.3	.23	32	22	5.8	27.2	.29	34	25	7.4	1.06	NS
Scapular	29.1	.25	34	25	6.1	29.5	.30	34	27	7.2	29.3	.27	34	25	6.5	.57	NS
Anal I	15.6	.12	16	14	5.3	15.6	.13	18	14	5.7	15.8	.14	18	14	6.0	.68	NS
Anal II	15.9	.12	18	14	5.3	15.9	.11	18	14	5.0	16.0	.11	18	14	4.7	.53	NS
Anal III	16.4	.13	18	14	5.5	16.6	.14	18	14	6.0	16.4	.12	18	14	5.3	.95	NS
Females																	
Idiosomal	444.6	2.38	490	410	3.7	441.0	2.87	490	390	4.6	435.8	2.74	470	400	4.4	2.74	NS
Genital Plate	83.8	.51	90	72	4.2	84.8	.54	90	70	4.4	82.8	.51	92	76	5.3	3.64	NS
Trichobothrium	47.8	.36	52	43	5.3	47.8	.32	54	45	4.7	47.7	.39	52	38	5.7	.03	NS
External Vertical	25.1	.25	29	20	7.0	25.1	.26	29	22	7.2	25.7	.23	29	22	6.3	1.87	NS
Externam Humeral	25.9	.27	29	20	7.3	26.2	.25	29	22	6.8	25.7	.23	27	22	6.4	1.10	NS
Scapular	28.1	.29	32	22	7.3	28.3	.31	32	22	7.7	27.4	.22	32	25	5.7	2.66	NS
Anal I	14.5	.12	16	14	6.1	14.8	.15	18	14	7.1	15.3	.18	18	11	8.2	6.12	.01
Anal II	15.0	.14	16	14	6.7	15.1	.14	16	14	6.6	15.3	.18	18	11	8.0	1.02	NS
Anal III	15.3	.15	18	14	6.7	15.4	.14	18	14	6.4	16.0	.15	18	14	6.5	5.55	0.1

1. Probability of obtaining the observed variance given that the three groups are samples of a single statistical population.

vary consistently among populations or between sexes within the same population. The coefficients of variation for continuous characters measured in this study are comparable to those previously obtained for insect populations (MAYR et al., 1953 ; SOKOL, 1952). The average coefficients are 5.60, 5.75, and 6.05 for the Cape Roberts, Wright Valley, and Cape Royds populations respectively.

Individual Variation of Meristic Characters.

Individual variation is minor among 8 meristic characters, *i. e.* the setae number on each of the coxae and trochanters. Where variation occurred, Chi-square tests did not indicate significant differences between populations or between sexes. In the original description of *S. mollis* (Womersley and Strandtmann, 1963), coxae I, II, III, and IV were reported to have 3, 1, 4, and 3 setae respectively and trochanters I through IV one seta each (1, 1, 1, 1). In our study, four of these eight values did not vary in samples from any population. However, two males and two females from Cape Roberts (out of 100 individuals measured) had five rather than four setae on Coxa III and the number of trochanter setae was only slightly more variable. Two rather than one setae were observed on trochanters I, III, and IV in the following specimens from Cape Roberts and Wright Valley :

	Cape Roberts (100 mites)	Wright Valley (100 mites)
Trochanters I	1 male	
Trochanters III	1 male	2 females
Trochanters IV	1 female	2 females

Trochanters II did not vary in any population nor did trochanters I, III, or IV in the Cape Royds population.

Setation on each of the two genital flaps was more variable, although again not significantly different between populations or sexes. Although most males and females possess six setae on each flap, the number observed ranges from five to seven in each of the continental populations and 5 to 8 at Cape Royds. To give some indication of the variability, the per cent occurrence of flaps possessing 5, 6, 7, and 8 setae have been calculated for each population and are presented in Table 2.

TABLE 2 : GENITAL FLAP SETATION.

Genital setae	Cape Roberts		Wright Valley		Cape Royds	
number	♂	♀	♂	♀	♂	♀
5	1 %	—	2 %	1 %	1 %	1 %
6	93 %	95 %	90 %	95 %	87 %	90 %
7	6 %	5 %	8 %	4 %	9 %	7 %
8	—	—			3 %	2 %

Sexual Variation.

A t-test was employed for comparison of males and females within each population for each of 9 continuous characters (Table 3). All populations exhibit significant sexual dimorphism in the length of the genital flap and four setae : external humeral, scapular, and anals I and II. Of these, the genital flap length shows the most effective quantitative criterion for separating the sexes.

The lengths of the external vertical and third anal setae are significantly dimorphic in the Cape Roberts and Wright Valley populations while males and females from Cape Royds are only marginally different for the same two characters. Trichobothrium length exhibits no significant dimorphism in any population.

TABLE 3 : SEXUAL VARIATION.

Character	Cape Roberts		Wright Valley		Cape Royds	
	t-value	P	t-value	P	t-value	P
Idiosomal length	3.24	.01	.45	NS	3.79	.001
Genital plate length	32.99	.001	34.19	.001	31.12	.001
Trichobothrium length	1.90	NS	1.82	NS	.81	NS
External vertical length	4.11	.001	2.91	.01	1.88	NS
External humeral length	5.05	.001	3.31	.01	4.16	.001
Scapular length	5.01	.001	2.86	.01*	3.11	.01
Anal I length	5.72	.001	4.18	.001	2.23	.05**
Anal II length	4.51	.001	4.40	.001	3.86	.001
Anal III length	5.56	.001	5.79	.001	1.84	NS

* Chi Square P = 0.1 (NS)
** Chi Square P = 0.5 (NS)

Geographic Variation.

The presence of geographic variation was inferred on the basis of an analysis of variance, applied separately to males and females, comparing each of nine continuous characters in three populations. (All F values are presented in Table 1). Idiosomal and trichobothrium length among males, and length of anal setae I and III among females exhibited significant interpopulational variation. Characters exibiting marginal significance and therefore of possible future interest include idiosomal and scapular lengths in females and genital flap length in both sexes. T-tests between populations were used to test the hypothesis that the island population differed significantly from the mainland populations (see discussion). All t-values are given in Table 4. Cape Roberts and Wright Valley (the mainland populations) showed no significant differences. In the characters for which analysis of variance indicated significant interpopulational variation (idiosomal and trichobothrium length for males ; anal setae I and III for females) t-tests supported the hypothesis that the island population was significantly different from either of the mainland populations. Chi-square tests (computed because they were more appropriate for the characters exhibiting low ranges) agreed in full with the t-test.

TABLE 4 : STUDENT T-TEST FOR MEAN DIFFERENCES IN POPULATIONS n = 50.

	C. Roberts/Wright Valley		WrightValley/C. Royds		C. Royds/C. Roberts	
	t	p	t	p	t	p
MALES						
Idiosomal length	1.45	NS	4.58	.001	3.26	.01
Genital plate length	.57	NS	2.08	.05	1.47	NS
Trichobothrium length	1.12	NS	2.29	.05	3.81	.001
External vertical length	1.60	NS	1.08	NS	.49	NS
External humeral length	1.18	NS	.27	NS	1.31	NS
Scapular length	1.06	NS	.49	NS	.59	NS
Anal I length	.40	NS	.89	NS	1.31	NS
Anal II length	.24	NS	1.06	NS	1.29	NS
Anal III length	1.09	NS	1.27	NS	.18	NS
FEMALES						
Idiosomal length	.97	NS	1.30	NS	2.42	.02
Genital plate length	1.36	NS	2.61	.02	1.36	NS
Trichobothrium lenth	.00	NS	.20	NS	.19	NS
External vertical length	.12	NS	1.75	NS	1.65	NS
External humeral length	.92	NS	1.50	NS	.50	NS
Scapular length	.47	NS	2.27	.05	1.80	NS
Anal I length	1.23	NS	2.15	.05	3.39	.01
Anal II length	.39	NS	.98	NS	1.33	NS
Anal III length	.59	NS	2.71	.01	3.23	.01

DISCUSSION AND CONCLUSIONS.

Sexual Dimorphism.

External sexual dimorphism in *Stereotydeus mollis* has not previously been noted. However, in this study males and females differed significantly for five of the nine continuous characters measured. Most of the morphological differences between the sexes are statistical ones with considerable overlap in measurements. Hence, genital flap length appears to be the only effective criterion for distinguishing males and females without permanently mounting the mite. (See methods) Even here, measurement without permanent mounting would be difficult.

Intrapopulational and Interpopulational Variation.

In order to obtain a reasonable estimate of variation within Antarctic mite populations of *S. mollis*, we have limited the present study to three populations from which large numbers of mites were collected (Cape Roberts and Wright Valley in Victoria-land and Cape Royds on Ross Island). Interpopulational variation was moderate for the nine characters measured. (CV ranged from 3.6 % to 8.2 %). Idiosomal length and genital plate length were generally less variable than setal lengths which may in part reflect the difficulty of accurately measuring setal length.

Some information on interpopulational variation was obtained. Analysis of variance indicated significant differences among the three populations studied with regard to several morphological characters (idiosomal and trichobothrium length in males, length of anal setae I and III in females). T-tests in turn provided support for the hypothesis that this interpopulational difference was due to differences between mainland (Victoria-Land) and island (Ross Island) populations. The Ross Island population is separated from the mainland populations in a direct line by 40 miles of sea and ice. *Stereotydeus mollis* populations, however, extend southward in Victoria-Land through Miers Valley to Lake Morning and are found on the northern tip of Brown Peninsula and Black Island. Traveling this circular route, the maximum distance between mainland and island populations is less than 30 miles. Hence, the possibility exists that in comparing the Cape Royds and Victoria-Land populations we are observing the two extremes of a continuous distribution. A follow-up study now in progress will compare measurements of the twelve to twenty populations from which smaller numbers of mites have been collected.

Inextricably tied to the problem of variation in antarctic mite populations is the question of dispersal of mites in this area. Mite populations in Victoria-Land (for example the Cape Roberts population) are often isolated by several miles (in this case ten or more) of glacial ice. Within the valleys, *S. mollis* populations are limited to areas of high moisture content supplied by glacial melt so that they are separated by dry land which appears to be as formidable a barrier to movement of this and other mite species as glacial ice. Since mite populations are found wherever there is moisture and algal growth, and because of the barriers to movement over land, dispersal of acarines (like that of insects in Antarctica) has been considered by some to be mainly by air. While air traps have yielded a number of insects representing at least 8 orders, (GRESSIT, LEECH and O'BRIEN, 1960) there is as yet no positive record of acarina collected by this method. GRESSIT, et al. (1961) reported three acarines collected in wind traps aboard ship in the Antarctic area, but all notations of such collections have a question mark appended, indicating (we assume) that identification was uncertain. The lack of evidence for wind dispersal of acarines may be due to the collection method which is probably not satisfactory for capturing the small Antarctic mite species.

There has been little consideration of birds as possible agents of mite dispersal in this region, however, the skua (*Catharacta maccormicki*) is the only bird which reaches the southernmost areas in which this mite occurs. While dispersal on the feet or feathers of this bird, or in materials carried by it, may seem highly unlikely, this possibility should not be overlooked. In addition to the current study of Victoria-Land populations of *S. mollis*, additional attempts to collect mites via air nets and plate glass surfaces are planned which may shed further light on the question of dispersal mechanisms and hence provide some information on the problem of gene flow rate between populations.

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