Acarina Occurring in Domestic Animal Manure¹

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ABSTRACT

A total of 211 samples from 92 different farms in New York State were collected from manure of dairy cattle, horses, sheep, chickens, and ducks. Macrochelidae, Uropodidae, Parasitidae, Oribatidae, and Laelaptidae were collected in that order of abundance. Seven species of Macrochelidae were found, in order of abundance: *Macrocheles muscaedomesticae* (Scopoli, 1772), *M. medarius*

(Berlese, 1889), *M. subbadius* (Berlese, 1904), *Glyptolaspis confusa* (Foà, 1900), *M. glaber* (Müller, 1804), *M. matrius* (Hull, 1925), and *M. robustulus* (Berlese, 1904). These seven species are illustrated. The first four were common in manure from dairy cattle, the last three rare. In chicken manure *M. muscaedomesticae* was usually the only macrochelid species found.

Mites are common in manure and increased house fly (*Musca domestica* L.) production results from destroying the natural mite population in dairy cattle manure (Axtell, 1963). Several species of the family Macrochelidae (Acarina: Mesostigmata) are predacious on house fly eggs and first-instar larvae. One species, *Macrocheles muscaedomesticae* (Scopoli, 1772), has been investigated as a possible biological control agent for the house fly (Filipponi 1955, Rodriguez and Wade 1961, Wade and Rodriguez 1961). The rates of predation on house fly eggs and first-instar larvae by four of five species of Macrochelidae found in manure in New York State were reported by Axtell (1961).

The only comprehensive survey of the mite fauna of manure was by Leitner (1946a, 1946b), working in Europe. Hyatt (1956) reported the mite fauna of bullock manure in England. A survey of the mites found in domestic animal manure in New York State was conducted during the period June 1959 to January 1962. The present report summarizes the results of that survey with particular emphasis on the Macrochelidae.

MATERIALS AND METHODS

COLLECTION.—Manure samples were collected in 4-liter paper containers having an aluminum foil lining. In the case of calf pen manure (straw-bedded) each container held 70 to 110 grams dry weight and 700 to 1000 grams wet weight. Mammal manure was collected from the top 5 to 10 cm. of accumulated manure, since mites were observed to occur mostly in this outer layer. The mites were extracted from each sample into 70% ethyl alcohol by a modified Tullgren funnel, with a 150-watt reflector flood bulb suspended about 18 cm. above the upper surface of the manure. The alcohol containing mites was poured into a 9-cm. petri dish whose bottom was marked into a grid of squares 4 mm. on a side. Counts were made under a binocular dissecting microscope providing magnifications of 9×, 27×, and 54×. Aliquots of the mites were cleared by

heating in 85% lactic acid and were mounted in Hoyer's medium on glass slides. All mounted specimens were examined under a phase-contrast microscope.

IDENTIFICATION.—Samples of males and females of *Glyptolaspis confusa* (Foà, 1900), *Macrocheles muscaedomesticae* (Scopoli, 1772), *M. subbadius* (Berlese, 1904), and *M. robustulus* (Berlese, 1904) were identified by Alessandro Filipponi, Istituto di Sanità, Rome, Italy. Filipponi (1961) established the following synonymies: (1) *Macrocheles robustulus* (Berlese, 1904) = *Holostaspis subbadius* var. *robustus* Berlese, 1904, = *Nothrolaspis punctillatus* Willmann, 1939, = *Macrocheles rothamstedensis* Evans and Browning, 1956; and (2) *Macrocheles subbadius* (Berlese, 1904) = *Holostaspis subbadius* Berlese, 1904, non *Macrocheles subbadius* (Berlese) of Evans and Browning, 1956, Bregetova and Koroleva, 1960.

Species referred to in this report as *M. muscaedomesticae* (Scopoli, 1772), *M. glaber* (Müller, 1804), *M. medarius* (Berlese, 1889), and *M. matrius* (Hull, 1925) conform to the descriptions by Evans and Browning (1956) and Bregetova and Koroleva (1960). *M. robustulus* (Berlese, 1904) conforms to the descriptions for *M. rothamstedensis* by Evans and Browning (1956) and for *M. punctillatus* (Willmann) by Bregetova and Koroleva (1960). *M. subbadius* (Berlese, 1904) conforms to specimens furnished by Filipponi, who compared these forms with the type specimen, and differs from the descriptions by Evans and Browning (1956) and Bregetova and Koroleva (1960) mainly by having short, stout, smooth D1 dorsal setae instead of slender, plumose-tipped D1 setae as shown by those workers. *G. confusa* (Foà, 1900) conforms to the description by Filipponi and Pegazzano (1960). In addition to the chaetotaxy of the dorsal shield, the major diagnostic characters for these species are the patterns on the ventral shields of the adult females (figures 1 to 7). All figures are oriented on the page so that the anterior end of the mite is nearest the top of the page. The lengths of the sternal and ventri-anal plates were measured along the medial axis on the specimens photographed.

RESULTS

A total of 211 samples from 92 different farms in New York were collected from manure of dairy cattle, horses, sheep, chickens, and ducks. Seven

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species of Macrochelidae were found (table 1). *M. muscaedomesticae* and *M. medarius* were collected from all five types of manure, and *G. confusa* from all types except horse. However, only two samples of horse manure were collected. The other species of Macrochelidae were less widely distributed among

the manure types. Among the non-Macrochelidae, Parasitidae and Uropodidae were most widely distributed. Parasitids were observed in the laboratory feeding on house fly eggs.

Most of the samples were from dairy cattle manure (136 samples from 79 barns) as shown in

FIG. 1.—*Macrocheles muscaedomesticae* (Scopoli, 1772). A, sternal plate (length, 221μ); B, ventri-anal plate (length, 338μ) and genital plate.

FIG. 2.—*Macrocheles glaber* (Müller, 1804). A, sternal plate (length, 216μ); B, ventri-anal plate (length, 338μ) and genital plate.

table 1. Some barns were sampled more times than others. Table 2 shows the proportion of dairy cattle barns and proportion of samples in which each category of mites was found. Among the species of Macrochelidae, *M. muscaedomesticae* was most common. *M. medarius*, *M. subbadius*, and *G. confusa*

ranked second, third, and fourth, respectively, in frequency of occurrence on either a per barn or per sample basis. The other species of Macrochelidae were relatively uncommon. Parasitidae and Uropodidae were the most common families of non-Macrochelidae found in dairy cattle manure.

FIG. 3.—*Macrocheles subbadius* (Berlese, 1904). A, sternal plate (length, 150μ); B, ventri-anal plate (length, 225μ) and genital plate.

FIG. 4.—*Macrocheles matrius* (Hull, 1925). A, sternal plate (length, 174μ); B, ventri-anal plate (length, 300μ) and genital plate.

Since extraction of the mites from some dairy cattle manure samples was incomplete, further analysis of the collection data was based on 110 samples taken from 60 barns and processed under uniform conditions assuring complete drying of the manure.

As shown in table 3, *M. muscaedomesticae* and *M. megatrius* occurred in more samples and in greater numbers than did other macrochelids. *M. glaber*, *M. matrius*, and *M. robustulus* were present in few samples and in low numbers, while *G. confusa* and

FIG. 5.—*Macrocheles robustulus* (Berlese, 1904). A, sternal plate (length, 188μ); B, ventri-anal plate (length, 285μ) and genital plate.

FIG. 6.—*Macrocheles megatrius* (Berlese, 1889). A, sternal plate (length, 103μ); B, ventri-anal plate (length, 141μ) and genital plate.

Table 1.—Acarina found in manure in New York State.

Species or family	Occurrence in Different Types of Manure ^a						
	Dairy Cattle ^b			Horse	Sheep	Chicken	Duck
	I	A	P				
Macrochelidae:							
<i>G. confusa</i>	+	+	+	0	+	+	+
<i>M. muscaedomesticae</i>	+	+	+	+	+	+	+
<i>M. medarius</i>	+	+	+	+	+	+	0
<i>M. subbadius</i>	+	+	+	+	+	0	0
<i>M. glaber</i>	+	+	+	0	0	0	+
<i>M. matrius</i>	+	0	0	0	0	0	0
<i>M. robustulus</i>	+	0	0	+	+	0	+
Parasitidae	+	+	+	+	+	+	+
Uropodidae	+	+	+	0	+	+	0
Laelaptidae	+	0	0	0	+	+	0
Oribatidae	+	+	+	0	+	0	0
Acaridae	+	+	0	0	+	+	0
Trombididae	0	0	0	0	0	+	0
Dermanyssidae	0	0	0	0	0	+	0
Pachylaelaptidae	0	0	+	0	0	0	0
Number of farms sampled	79	4	8	2	2	8	2
Number of samples taken	136	11	36	2	4	19	3

^a + = present in one or more samples, 0 = not present in any sample.

^b I = inside barn, A = outdoor piles, P = pasture.

M. subbadius were intermediate in abundance. Among the non-Macrochelidae, Parasitidae and Uropodidae were most abundant on the basis of the uniformly processed samples.

The families of Acarina in dairy cattle manure ranked in order of abundance were: Macrochelidae (79), Uropodidae (15), Parasitidae (2), Laelaptidae (1) and Oribatidae (0). The numbers in parentheses are the numbers of samples out of 110 in which that family was more abundant than any other family. The species of Macrochelidae in dairy cattle manure ranked in order of abundance were *M. muscaedomesticae* (54), *M. medarius* (23), *M. subbadius* (5), *G. confusa* (3), *M. glaber* (1), *M. matrius* (0), and *M. robustulus* (0). The numbers in parentheses are the numbers of samples out of 110 in which that species was the most abundant macrochelid present. In 34 of the 110 samples there were either no Macrochelidae present or two or more

Table 2.—Frequency of occurrence of Acarina in 136 samples of dairy cattle manure from inside 79 barns in New York State.

Species or family	Occurrence	
	Percentage of barns	Percentage of samples
Macrochelidae:		
<i>G. confusa</i>	13.9	12.5
<i>M. muscaedomesticae</i>	73.4	68.4
<i>M. medarius</i>	50.6	53.7
<i>M. subbadius</i>	22.8	17.6
<i>M. glaber</i>	8.8	8.1
<i>M. matrius</i>	3.8	2.9
<i>M. robustulus</i>	3.8	2.2
Parasitidae	55.7	41.2
Uropodidae	49.4	43.4
Laelaptidae	19.0	11.0
Acaridae	11.4	9.6
Oribatidae	8.8	5.1

species occurred in equal numbers in the alcohol extractions.

Female macrochelids were usually more abundant than the males. Accurate counts of males were kept only for *M. muscaedomesticae*. Out of a total of 110 samples, 74 contained this species. Of these 74, fe-

FIG. 7.—*Glyptolaspis confusa* (Foà, 1900). A, sternal plate (length, 329 μ) and genital plate; B, ventri-anal plate (length, 493 μ).

Table 3.—Abundance of mites in 4-liter samples of dairy cattle manure, based on 110 samples from inside 60 barns in New York State.

Species or family	Number of samples containing numbers of mites within the indicated ranges ^a						
	0	1–10	11–30	31–50	51–100	101–300	301–600
Macrochelidae:							
<i>M. muscae-domesticae</i>	38	35	11	9	6	8	3
<i>M. medarius</i>	48	31	13	5	8	3	2
<i>M. subbadius</i>	90	12	3	2	0	2	1
<i>G. confusa</i>	95	10	3	0	2	0	0
<i>M. glaber</i>	101	7	1	0	0	0	0
<i>M. matrius</i>	107	3	0	0	0	0	0
<i>M. robustulus</i>	107	3	0	0	0	0	0
Parasitidae	66	32	7	3	0	0	0
Uropodidae	56	27	5	4	2	5	1
Oribatidae	105	4	0	0	1	0	0
Laelaptidae	105	4	0	0	0	0	0

^a Females of Macrochelidae and both sexes of other families were counted.

males occurred in 72 and males in 46. In 69 of these samples females were more abundant than males while the converse was true in only 5 samples.

As manure ages in the absence of dairy cattle, an increase in the numbers of Oribatidae and Uropodidae and decrease in the numbers of Macrochelidae was observed inside barns and in piles of manure outdoors.

The largest mite populations were observed in all types of manure during the summer months (June to September), which is also the time of greatest house fly breeding. Smaller numbers of macrochelids were collected from manure inside certain dairy barns during the other months of the year. During all months, *M. muscaedomesticae* and *G. confusa* were repeatedly collected from dairy cattle manure in an outdoor pile to which fresh manure was added daily. *M. medarius* and *M. muscaedomesticae* were collected from pasture manure during the winter (January and February), but larger numbers were found in the summer months.

DISCUSSION

Although the results of the survey of macrochelids in manure demonstrated that the most abundant species are usually *M. muscaedomesticae* and *M. medarius*, the less common species may be abundant on occasions. *G. confusa* often achieved large numbers, as did *M. subbadius*. In one collection, *M. glaber* was abundant and the only macrochelid present. It is reasonable to expect *M. muscaedomesticae* and *M. medarius* to be usually present in dairy cattle manure and *M. subbadius* and *G. confusa* will often accompany these species or replace one. In chicken manure *M. muscaedomesticae* is usually, but not exclusively, the only macrochelid present. The possibility exists that low numbers of additional species of Macrochelidae exist in manure in New York State.

Among the factors affecting the abundance of macrochelids in manure are the extent of manure accumulation and phoresy. Routine removal of manure from dairy cattle calf pens or from under caged chickens is seldom complete and small pockets of mites remain. This is probably the major source of new mite population development and is assisted by the influx of adult female macrochelids phoretic on flies and beetles. Continued addition of feces by the animals is conducive to macrochelid increase. This may be due to nutritional advantages of manure itself or due to the continued attractiveness of the fresh manure for fly oviposition, resulting in continual provision of fly eggs and larvae for the mites to feed on.

The presence of seven species of Macrochelidae in manure suggests that more than one species are important predators of the house fly. Certain Parasitidae may also be important predators since large numbers were collected and they were observed in the laboratory to feed on house fly eggs. The biology of these species should be studied further to provide a basis for evaluating the feasibility of utilizing mites in conjunction with chemicals to control house fly breeding in manure.

REFERENCES CITED

- Axtell, R. C. 1961. New records of North American Macrochelidae (Acarina: Mesostigmata) and their predation rates on the house fly. *Ann. Entomol. Soc. Amer.* 54(5): 748.
1963. Effect of Macrochelidae (Acarina: Mesostigmata) on house fly production from dairy cattle manure. *Jour. Econ. Entomol.* 56(3): 317–21.
- Bregetova, N. G., and E. V. Koroleva. 1960. The macrochelid mites (Gamasoidea, Macrochelidae) in the USSR. (In Russian, with English summary.) *Parazit. Sb. Zool. Inst.* 19: 32–154.
- Evans, G. O., and E. Browning. 1956. British mites of the subfamily Macrochelinae Trägårdh (Gamasina-Macrochelidae). *Bull. Brit. Mus. (Nat. Hist.), Zool. Ser.* 4(1): 1–55.
- Filipponi, A. 1955. Sulla natura dell'associazione tra *Macrocheles muscaedomesticae* e *Musca domestica*. *Riv. Parassitol.* 16(2): 83–102.
1961. Personal communication.
- Filipponi, A., and F. Pegazzano. 1960. Acari del genere *Glyptotholaspis* nom. nov. pro *Macrocheles* (*Macrocheles*) Berl., 1918 (Mesostigmata, Macrochelidae). *Redia* 45: 133–71.
- Hyatt, K. H. 1956. A collection of mites from stable manure. *Entomol. Monthly Mag.* 92: 36–38.
- Leitner, E. 1946a. Zur Kenntnis der Milbenfauna auf Dungerstätten. *Zentralbl. Gesamtgeb. Entomol.* 1(3): 75–95.
- 1946b. Zur Kenntnis der Milbenfauna auf Dungerstätten. *Ibid.* 1(5–6): 129–56.
- Rodriguez, J. G., and C. F. Wade. 1961. The nutrition of *Macrocheles muscaedomesticae* (Acarina: Macrochelidae) in relation to its predatory action on the house fly egg. *Ann. Entomol. Soc. Amer.* 54(6): 782–8.
- Wade, C. F., and J. G. Rodriguez. 1961. Life history of *Macrocheles muscaedomesticae* (Acarina: Macrochelidae), a predator of the house fly. *Ann. Entomol. Soc. Amer.* 54(6): 776–81.

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