EFFECT OF LOW TEMPERATURE ON THE SURVIVAL OF SOME STORED PRODUCTS MITES [1]

BY

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Over 90 species of mites are known to infest stored products in Canada (Sinha, 1963). Of these, only *Acarus siro* L. and *Glycyphagus destructor* (Schr.) occur commonly as pests of stored grain in the Prairie Provinces. Heavy mite infestations in stored grain often occur along the surface and the top two feet of grain bulks. In midwinter, during January and February, the temperature of experimental grain bulks in Manitoba has fluctuated between 1° C. and — 18° C. along the first two feet. Grain samples taken at various depths throughout the year indicated that high mortalities of certain species of mites occur during the winter months. On the other hand, certain species can survive. The present investigation is a part of a long-term ecological project on the population dynamics of mites and microorganisms in grain bulks. Laboratory experiments were undertaken to compare the susceptibilities of commonly occurring mites to — 18 ± 1° C., the lowest temperature recorded near the surface layer of a 500 bushel experimental grain bulk (13.5 metric tons).

METHODS AND MATERIALS

The experiments were conducted between 1958 and 1962 ; the live mites were collected from farm granaries located at various points in Manitoba and Saskatchewan. The numbers of mites tested for each species are given along with their feeding categories : grain or grain dust feeders : *Acarus siro* (800), *Glycyphagus destructor* (550) ; mycophagus or scavangers : *Caloglyphus berlesei* (100), *Kleemania plumosus* (400), *Leiodinychus krameri* (200) ; predaceous : *Cheyletus eruditus* (100), *Tydeus*

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interruptus (100), *Haemogamasus pontiger* (100), *Haemolaelaps casalis* (80), *H. glasgowi* (200). The particulars of the field populations reared under laboratory conditions and the replicates and number of mites of each species used in each of the four exposure periods in the experiments are given in Table 1. All mites were reared in wheat, oats, or grain debris in which they occurred in the field. Only mobile adults, nymphs, and larvae were used. Batches of mites were introduced

TABLE 1.

Conditions of the mites used for exposures to —18 ± 1° C. after they were collected from farm granaries in Manitoba and Saskatchewan

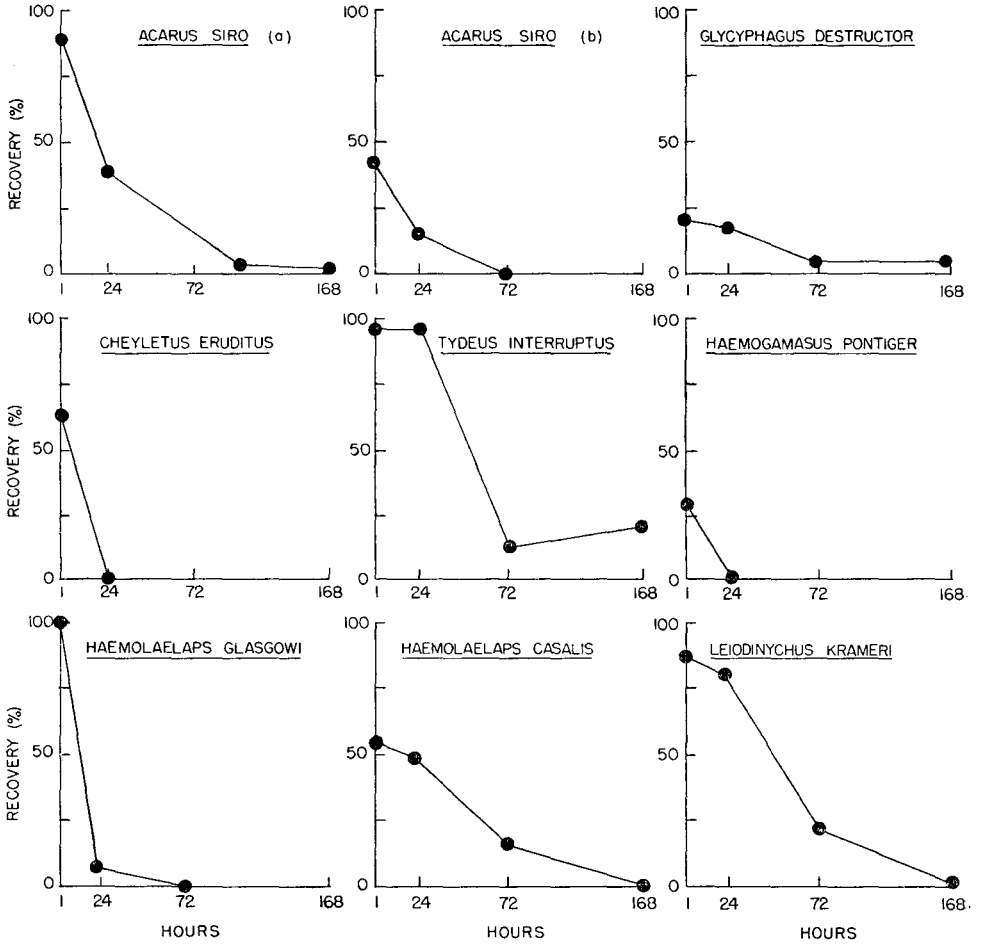
Species	Age of Culture, Days	Rearing Temp., °C.	Grain Water Content, %	Reps. per Exposure Period	No. of Mites per Rep.
Suborder SARCOPTIFORMES					
Acaridae					
Acarus siro L. (a)	730	6 ± 2	15.2	10	10
Acarus siro L. (b)	365	21 ± 2	15.2	10	10
Caloglyphus berlesei (Mich.)	2	21 ± 2	15.0	5	10
Glycyphagidae					
Glycyphagus destructor (Schr.)	14	10 ± 1	14.5	10	10
				25	1
Suborder TROMBIDIFORMES					
Cheyletidae					
Cheyletus eruditus (Schr.)	7	10 ± 1	13.8	25	1
Tydeidae					
Tydeus interruptus (Thor)	2	10 ± 1	14.6	25	1
Suborder MESOSTIGMATA					
Aceosejidae					
Kleemania plumosus Oud.	60	21 ± 2	15.0	10	10
Haemogamasidae					
Haemogamasus pontiger (Berl.)	6	21 ± 2	15.0	5	5
Laelaptidae					
Haemolaelaps glasgowi (Ew.)	3	10 ± 1	14.6	5	10
Haemolaelaps casalis (Berl.)	30	10 ± 1	15.6	20	1
Uropodidae					
Leiodinychus krameri (Can.)	7	21 ± 2	16.0	5	10

in empty one-dram glass vials stoppered with cotton plugs. All mites were conditioned at 10 ± 2° C. for 24 hours, and at 2 ± 2° C. for one hour before and after exposure to — 18 ± 1° C. for periods ranging from one to 168 hours. The relative humidities of the rearing cabinets in which the control and test mites were kept ranged from 50 to 85 per cent. Each mite was examined under a stereo-microscope to determine its ability to move and recover after each exposure period.

Appropriate controls were kept, during each experiment, in empty glass vials stoppered with cotton plugs under conditions specified in Table 1.

Results

Caloglyphus berlesei died in the first hour whereas *Kleemania plumosus* was killed within the first 24 hours of exposure. The ability of the remaining nine



1. Fig. 1. — Percentage of mites which survived the exposures to — 18 ± 1°C. for varying lengths of time.

species of mites to withstand exposure to — 18 ± 1° C. for varying lengths of time is summarized in Fig. 1.

Fig. 1 shows that one per cent of the culture (a) of *Acarus siro*, which was reared in oats at 6 ± 2° C. for two years (Table 1), could recover after exposure of 168 hours, but none of the same species, culture (b) (Table 1), reared for one year at 21 ± 1° C., recovred after 72 hours of exposure at — 18 ± 1° C.

Tydeus interruptus, Leiodinychus krameri, Glycyphagus destructor and *Acarus siro* were the most cold hardy and survived for more than 168 hours at — 18 ± 1° C. Of these species, only *T. interruptus* showed 20 per cent recovery ; less than five per cent of the remaining species recovered after 168 hours.

The controls of all species of mites except *Caloglyphus berlesei* survived for 168 hours. The *C. berlesei* controls died after 24 hours possibly due to a low (55 ± 2 %) relative humidity in the rearing cabinet.

Discussion

Ushatinskaya (1954) studied the effect of temperatures of — 14° C., — 15° C. and — 16° C. on the mobile stages of *Acarus siro, Glycyphagus destructor* and *Cheyletus eruditus* in grain under wooden warehouse conditions in Moscow, U.S.S.R. She observed that at — 15° C., 100 per cent mortality of the adults, nymphs, and larvae of *Acarus siro, Glycyphagus destructor*, and *Cheyletus eruditus* was obtained in 24, 72, and 144 hours respectively. Our results are at variance with her findings. There was some survival of adults, nymphs and larvae of *A. siro* and *G. destructor* when exposed to — 18 ± 1° C. for 24, 72, and 168 hours. However, our results show that adults, nymphs, and larvae of *Cheyletus eruditus* were all killed within 24 hours. Such differences in results may be due to the differences in strains, the effect of preconditioning, sample size, or methods.

The monthly grain samples each weighing 150 g., collected from the surface, one and two-foot levels of an experimental grain bulk (500 bushel) during February 1962 yielded a maximum of two *Glycyphagus destructor*, 12 *Cheyletus eruditus*, and 30 *Acarus siro*. The number of the mites per sample for the same species was many times higher in samples collected from the same locations during the fall of 1961 (Sinha, unpublished data). Although present in diminishing numbers, the adults of *Cheyletus eruditus* were the most commonly encountered mites during the peak of the winter season. This may be explained by the fact that the species had been acclimatized for three winters and it had the additional advantage of being a predator of *A. siro* and *G. destructor* which also did not multiply in January and February.

In a winter survey of grain bulks and hot spots (Sinha, 1961) on farms in Manitoba during 1958-59, *Tydeus interruptus, Haemolaelaps casalis, H. glasgowi, A. siro, G. destructor* and *C. eruditus* were obtained in moderate to small numbers from grain samples collected at — 10 to 18° C. and 13 to 15 per cent water content.

In the light of the information obtained from the present work the presence and the relative abundance of these species in samples taken at subzero temperatures can be explained.

Heavy infestations by mites often occur along the top two feet in small grain bulks on farms in Manitoba. Variations in outdoor temperature greatly affect this part of the bulk. During January and February it is not uncommon to have cold spells with prolonged subzero weather in the Prairie Provinces of Canada. The daily changes in temperature and its effect on the grain along the top foot of a 500 bushel wheat bulk stored in an unheated wooden granary in Winnipeg

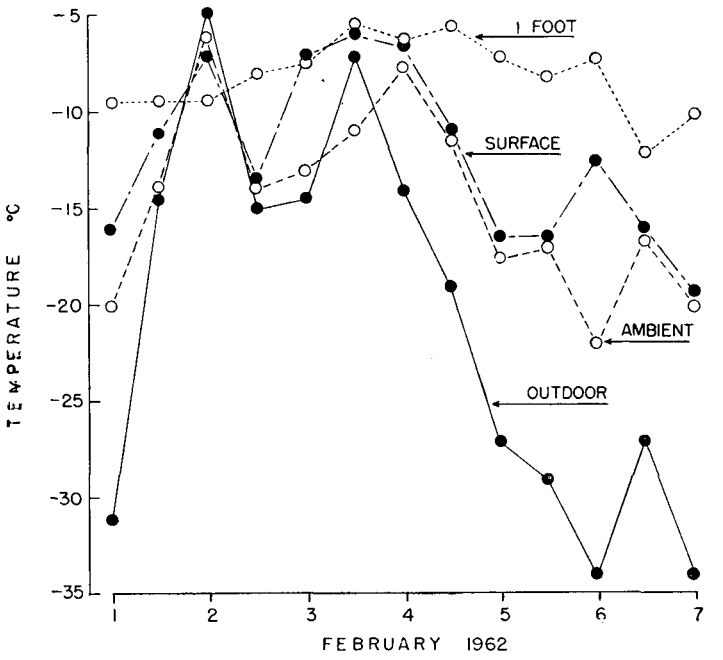


FIG. 2. — Temperature of the outdoor and ambient air, and the grain in 500 bushel (13.5 metric tons) in an unheated wooden granary in Winnipeg, Manitoba during a coldspell in 1962.

are illustrated in Fig. 2 during one such cold spell in the first week of February 1962. The temperature of the grain at one foot level fluctuated between — 5 to — 12° C. during that week ; the temperatures along the surface were as low as — 19° C. and showed greater fluctuation. It is possible that any prolonged cold spell of this magnitude will cause heavy losses of most species of mites except possibly, *Tydeus interruptus*. Continued low temperature for several weeks may cause 100 per cent mortality. The probability of some of the mobile forms migrating downward and thus avoiding cold and escaping death would depend on the abruptness with which the atmospheric cooling takes place during any winter. A mite usually loses its mobility long before its thermal death point is reached.

USHATINSKAYA (1954) has shown that hypopal stages of *Glycyphagus destructor* are less susceptible than the adults, nymphs, and larvae when exposed to — 15° C. Although our laboratory study did not include such stages we have occasionally encountered hypopal stages of *Glycyphagus destructor* at — 18° C. in grain bulks.

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SUMMARY

The ability of the major acarine grain pests, *Acarus siro* L., *Glycyphagus destructor* (Schr.), and eight other mites occurring in farm granaries in Manitoba and Saskatchewan, to recover from exposures to — 18 ± 1° C. was tested with mites collected from the field during 1958-62. Laboratory experiments showed that 20 per cent of *Tydeus interruptus* Thor, four per cent of *Glycyphagus destructor*, one per cent *Acarus siro* L. and two per cent of *Leiodinychus krameri* (Can.) survived — 18 ± 1° C. for seven days, 17 per cent of *Haemolaelaps casalis* (Berl.) for three days, ten per cent of *H. glasgowi* (Ew.), for one day, 63 per cent of *Cheyletus eruditus* (Schr.), six per cent of *Kleemania plumosus* Oud., and 28 per cent of *Haemogamasus pontiger* (Berl.) for one hour, and *Caloglyphus berlesei* (Mich.) for less than one hour.

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