Number of mites in stored grain, straw and hay related to the age of the substrate (Acari)

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Monthly samples of grain, straw and hay were collected from four farms during one year and analyzed for their contents of live storage mites. Hay contained the highest number of storage mites but the major species of all three kinds of substrate were the same.

The relative abundance of the species varied with the age of the substrate. The youngest substrates were dominated by *Lepidoglyphus destructor* (Schrank, 1781) and *Tyrophagus longior* (Gervais, 1844). Later *Acarus siro* L., *Cheyletus eruditus* (Schrank, 1781) and *Tarsonemus* sp. (undescribed) occurred. Latest in the succession was *Tydeus* spp.

The water activity of the samples of grain, straw and hay was measured and it appeared that the densities of mites were not positively correlated with the humidity of the substrates (r = -0.024, 0.075 and -0.403 for grain, straw and hay, respectively).

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Storage mites are found in stored grain, straw and hay where the crops, preferably due to a wet climate, are insufficiently dried before storage. Such humid substrates are attacked by various micro-organisms, and the mites feed on microfungi associated with the degrading substrates (Hallas & Gravesen, 1987).

Our present knowledge of how and why the densities of such storage mites vary with time is scanty. It is difficult to interpret estimates of natural mite population densities due to large standard deviations. Sinha & Wallace (1973) studied natural populations in grain and stated "It appears that irregular fluctuations are more the rule than the exception among stored-product mites".

The aim of the present study was to map the mite densities in grain, straw and hay at four farms where the farmers were allergic to stored-product mites. We hoped to find a simple correlation between the patients' exposition for the mites and the strength of their allergic symptoms. We did not find such a correlation but achieved a knowledge of how the number of mites and their specific composition may vary with the age of the substrate.

Material and methods

The four farms are situated in a rural district west of Århus, Denmark. The farmers were instructed to take samples from the crops in use on the farm on the study day. They were asked to take three random samples from the inside of bales of hay and straw. Samples of grain were taken by hand from a depth of about 15 cm. No further instruction was given to the farmers. The study took place between September 1986 and August 1987, and the samples were taken monthly.

For each sample water activity was calculated (Relative Humidity divided by 100), using simple calibrated hair hygrometers allowed to equilibrate for two hours at room temperature with the samples in polyethylene bags. Mites were extracted using Berlese funnels (Haarløv, 1947) with 90% lactic acid coloured by traces of Lignin Pink as collecting fluid. The mite sample was washed with tap water and about 100 specimens were mounted on slides with Hoyers medium and subsequently identified by phase contrast microscopy (× 100). Hughes' (1976) monograph was used as the main identification support. The rest of the mites were counted three times through a 10% window in a Petri dish under a stereo-lupe by × 25. The concentration of mites were expressed as (live) specimens per kg of dried substrate.

Results

Nearly all specimens of mites (97.7, 92.7 and 99.1 percent in viz. grain, straw and hay) were identified to six species or categories of species. Due to their number and high frequencies we consider them to be genuine members of the community of mites in dry grass. They are: *Acarus siro* L. (s.l., thus including *A. farris* (Oud.)), *Tyrophagus longior* Gervais, *Lepidoglyphus destructor* (Schrank), *Cheyletus eruditus* (Schrank), *Tarsonemus* sp. (an undescribed species) and *Tydeus* spp.

In the grain samples, *A. siro* and *L. destructor* were most numerous (viz. 41.2 and 33.2% of the specimens). In straw, *T. longior* constituted 28.5%, *L. destructor* 25.8% and *Tarsonemus* sp. 23.0%. Hay samples contained 35.2% of *Tarsonemus* sp. and 28.7% *L. destructor*. No house-dust mites (*Dermatophagoides* spp.) were found. A general trend was that the lowest densities of mites were found in grain samples and that hay samples contained most mites. This may be a consequence of differences in surface area between the substrates as our estimates were made upon the basis of weight. From the mean water activity values grain samples were slightly more humid (0.751 ± 0.034) than straw samples (0.713 ± 0.042) and hay (0.712 ± 0.034), but this small difference seemed to be of less importance to mite densities than the assumed differences in surface between the substrates. Table 1 shows the monthly average throughout a year.

Table 1. Average density of mites in grain, straw and hay.

Tabel 1. Gennemsnitlig koncentration af mider i korn, halm og hø.

Age	Grain		Straw		Hay	
months	n	mites/kg	n	mites/kg	n	mites/kg
0	0	-	0	-	3	0
1	9	339	12	3967	6	938
2	12	1146	12	2681	0	-
3	12	5799	11	10819	9	17770
4	12	11089	12	5774	3	3208
5	8	1162	12	1848	6	2214
6	9	1062	12	2167	9	44007
7	9	1144	12	4666	9	8415
8	9	255	12	4298	9	18976
9	9	14218	12	2753	9	3066
10	6	2257	12	4061	9	11908
11	6	633	11	765	9	10232
12	6	6620	12	10814	9	18158
13	3	773	3	7729	3	6904
14	0	-	0	-	9	29402

The relative abundance of the six taxa of mites varied much from sample to sample, but the mites occurred in a specific order during the storage period. *Lepidoglyphus destructor* and *Tyrophagus longior* dominated in the first part of the study period, and *Acarus siro, Cheyletus eruditus* and *Tarsonemus* sp. occurred later. In the oldest substrates *Tydeus* spp. became numerous.

There was no positive correlation between the actual number of mites and the water activity at the time of sampling. The correlation coefficients were -0.024 for grain, + 0.075 for straw and -0.403 for hay.

Discussion

The storage mites are to be considered as indicators of basic microbial processes connected with normal degradation of dried

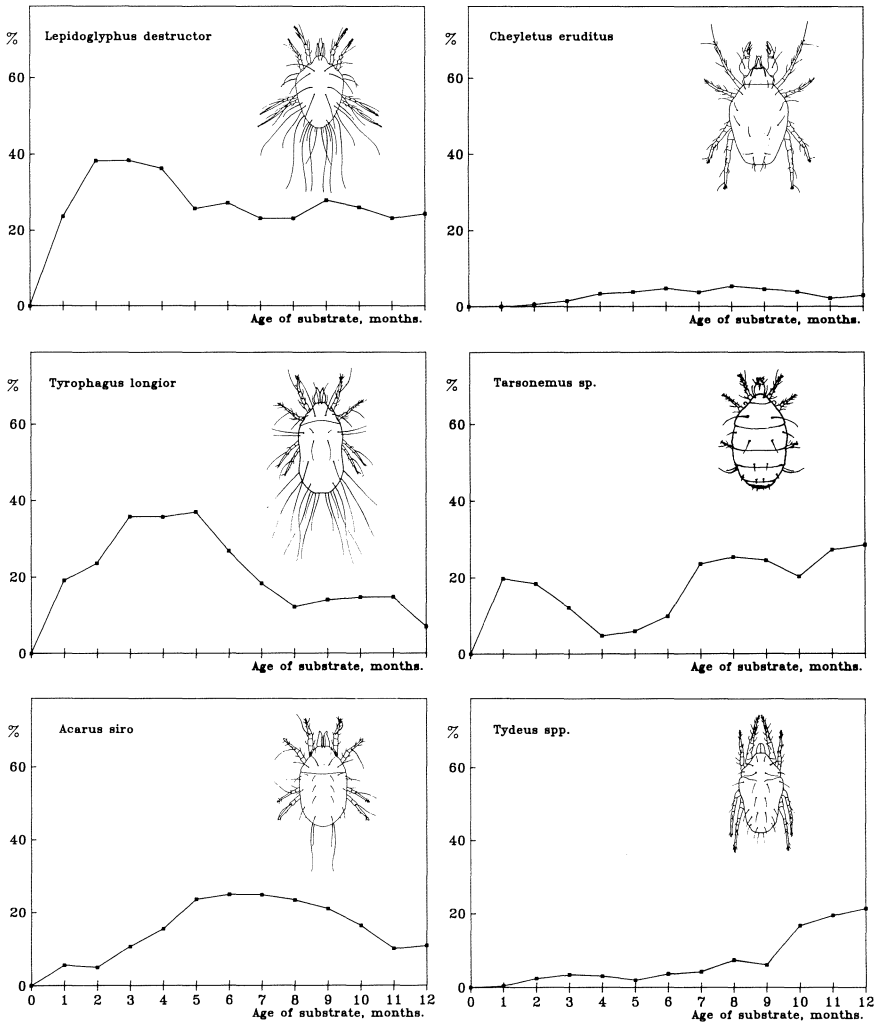

Fig. 1. The percentual composition of mites in dry grass substrates, shown as averages for grain, straw and hay combined. Figures are smoothed by means of a three-points average to show the general trends. *Fig. 1. Den procentiske sammensætning af miderne i tørrede græs-substrater. Her vist som en kombination af middelværdier for korn, halm og hø. Kurverne er jævnet med et tre-punkts flydende middeltal for at tydeliggøre de generelle tendenser.*

grass because the mites feed on the fungi. The occurrence of mites in grain, straw and hay is therefore the end product of chain of events in the substrates. The succession of microorganisms as well as their relations to humidity and mites has yet to be examined.

It is known, however, that the microfungi are situated before the mites in the succession (Hallas & Gravesen, 1987). These microfungi, having their own succession, may serve as food for *T. longior, L. destructor* and *A. siro.* The status of *Tarsonemus* sp. and *Tydeus* spp. is not clear, but as they are stylet feeders (thus they are confined to ingest liquid food) they might be predators of other mite species late in the succession. *Cheyletus eruditus* is a predator. The overall specific composition of mites in our study showed minor differences between the substrates. Such differences might merely reflect differ-

ences in storage conditions rather than differences of the kind of substrate.

Hallas & Gravesen (1987) investigated the succession of mites in stored hay in Iceland related to a decreasing carbon/nitrogen ratio (for increasing biological age). They found the following order of appearance: *L. destructor, C. eruditus, A. siro* s.l., *Tarsonemus* sp. and *Tydeus* spp. *T. longior* was absent in their material. Apart from the reverse order of *C. eruditus* and *A. siro* s.l., this is in accordance with the present results for Danish grain, straw and hay.

Cusack et al. (1975) found that the concentrations of mites in grain and feedstuff were positively correlated with the moisture contents of the substrates (r ranging from 0.29 to 0.89). This is different from our findings but might be a possible result of co-correlation with the previous moisture contents. Mites do multiply as a direct or indirect consequence of higher humidity, but it takes time to multiply. Therefore a delayed response to humidity is a reasonable expectation.

The prevention of degradation of grain, straw and hay is favourable for economic and medical reasons. With our present knowledge we can avoid mites in different ways. Humidity regulation is one of them, but it is expensive to heat the stores sufficiently in a cold, temperate climate. Another possibility is to control the fungal infestation, thus preventing the selective loss of dry matter and removing the entire basis for the succession of mites. Initiatives directed against the mites only are likely to be unsuccessful. If the mites' consumption of microfungi is prevented, the substrate will become mouldy. If mites are controlled too late, their bodies and faeces will still be liberated by handling of the substrate resulting in a health hazard to man and animals.

Dansk sammendrag

Som led i en undersøgelse af allergi hos landmænd blev der indsamlet månedlige prøver af korn, halm og hø. Prøverne blev analyseret for indhold af mider. Det viste sig, at der var flest mider i høet. Vandaktiviteten blev målt, men der var ingen positiv korrelation mellem fugtighed og mideindhold - sandsynligvis fordi mider har en forsinket respons på fugtighed.

Midefaunaens sammensætning varierede meget fra prøve til prøve, men til gengæld var der så mange prøver, at vi kunne påvise en generel tendens i artssammensætningen. Først dominerer miderne *Lepidoglyphus destructor* og *Tyrophagus longior.* Populationerne af *Acarus siro* og *Cheyletus eruditus* kommer langsommere igang, medens arterne *Tarsonemus* sp. og *Tydeus* spp. først opnår deres maximum population sent i lagerperioden (se Fig. 1).

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