SPIDER MITE WEBBING II. THE EFFECT OF WEBBING ON EGG HATCHABILITY

BY

A. Hazan [1], U. Gerson [1] and A. S. Tahori [2].

Abstract

Removal of eggs of the carmine spider mite, *Tetranychus cinnabarinus* (Boisduval) from the webbing into which they are deposited significantly reduces egg hatchability under very low (0-38 %) as well as very high (100 %) relative humidity conditions, at 24°C and 30°C. Hatch is not affected at intermediate humidities. Two web-associated mechanisms whereby the egg may be protected by the silk or fecal pellets deposited thereon are postulated.

Résumé

Le transfer des œufs de l'acarien rouge *Tetranychus cinnabarinus* (Boisduval) à partir de la toile sur laquelle ils sont déposés, réduit leur éclosion. La réduction est significative dans des conditions d'humidité relative réduite (0-38 %) et élevée (100 %) à 24 et 30°C. L'éclosion n'est pas affectée quand l'humidité est intermédiaire. Deux mécanismes associés à la toile, et pouvant protéger les œufs sont proposés. Ces mécanismes se trouveraient dans la soie et dans les pelotes fécales.

Introduction

In the first part of this series we (Hazan *et al* ; 1974 *b*) reported on some quantitative and ecological aspects of the webbing (or silk) of the carmine spider mite *Tetranychus cinnabarinus* (Boisduval). The eggs of this mite are always deposited on or under the webbing, indicating some connection between these phenomena. We showed that silk secretion and egg production were significantly correlated under all experimental conditions tried. This in turn suggested that some benefit may accrue to the eggs from the silk. Here we report on experiments exploring the effect of egg separation from silk on egg hatchability.

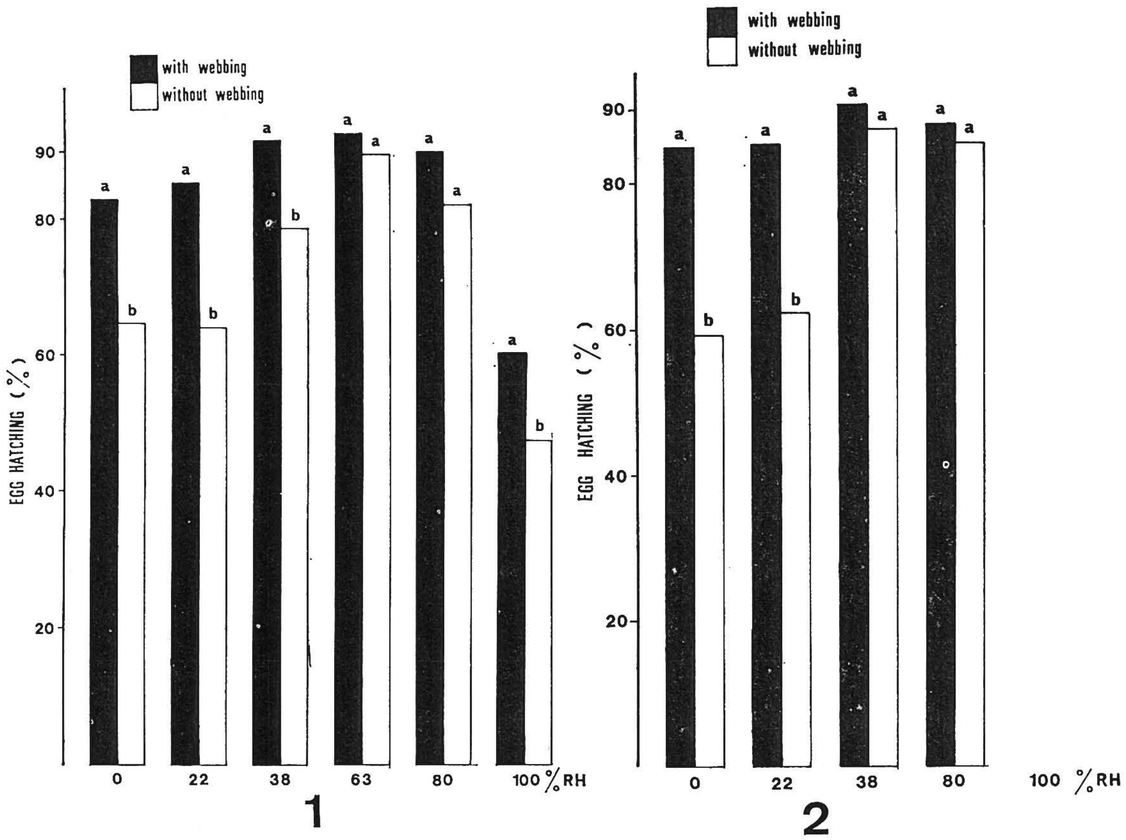
Techniques

The carmine spider mite was reared on bean leaves (Hazan *et al.*, 1974 *a*). About 30 young (3-7 days old) females were placed on leaves at 30°C and allowed to oviposit overnight. Such females produce nearly 10 eggs/night at that temperature (Hazan *et al.*, 1974 *a*). The females were discarded and about half the night's eggs were carefully removed from the webbing by means of entomological pins. The eggs were placed onto fresh bean leaves or filter paper and

1. The Hebrew University of Jerusalem, Faculty of Agriculture, Rehovot.
2. Israel Institute for Biological Research, Ness Ziona, Israel.

Acarologia, t. XVII, fasc. 1, 1975.

kept in Munger cells (Hazan *et al.*, 1974 *b*). The remaining eggs were left as controls within their associated silk on the original leaves, which were placed in similar cells. The cells were kept in desiccators maintaining desired (0 ; 22 ; 38 ; 63 ; 80 and 100 %) relative humidities by means of appropriate salt solutions (Winston and Bates, 1960). About 100-200 eggs (evenly divided between treatment and control) were employed for each humidity tested. Experiments were run at 24°C and 30°C, egg hatch being recorded daily. Results for removed eggs placed on fresh leaves and on filter paper were similar and therefore pooled.



Figs. 1-2 : 1) The effect of carmine spider mite webbing on egg hatchability at 30°C and various relative humidities (identical letters on columns denote means which are not significantly different at the 5 % level, using Duncan's multiple range test) ; 2) The effect of carmine spider mite webbing on egg hatchability at 24°C and various relative humidities (identical letters on columns denote means which are not significantly different at the 5 % level, using Duncan's multiple range test).

Data for the construction of life tables of the carmine spider mite were obtained from Hazan *et al.* (1974 *a*), who included detailed methods for computing such data. Only two parameters will herein be compared, namely net oviposition rate (R_o) and the intrinsic rate of increase (r_m). R_o is an estimate of the number of times a single female will reproduce itself (during one generation) under conditions of unlimited food supply and protection from natural enemies, at any particular combination of physical conditions (Nickel, 1960). r_m is the actual rate of increase of a population under specified constant environmental conditions, in which space and food supply are unlimited and animals of different species are excluded (Andrewartha and Birch, 1954).

Results

Egg hatchability was significantly reduced after removal from webbing under conditions of 30°C combined with zero, 22 or 38 % RH as well as under conditions of 100 % RH (Fig. 1). Similar results were obtained at 24°C (Fig. 2), except that no eggs hatched under saturation conditions. Hatch percentages of web-covered eggs were similar under both temperature conditions at the relative humidities tested (except at 100 %). The similar egg mortality observed at the intermediate humidities for removed and untouched eggs refutes the possibility that egg manipulation may have caused the differences found at low and high humidities.

The long-term deleterious effect of webbing removal on mite populations can be demonstrated by incorporating some egg mortality values into life tables already available for *T. cinnabarinus* (Hazan *et al.*, 1974 *a*). The effect of separating eggs from their associated silk (through egg mortality) on net oviposition rate (R_o) and on the intrinsic rate of increase (r_m) at 24°C and 0 % RH, and at 30°C combined with 0 % RH or 22 % RH, are presented in Table 1.

Table 1.

Net oviposition rate (R_o) and intrinsic rate of increase (r_m) of the carmine spider mite under different temperatures and relative humidities (RH), with and without webbing.

	24°C 0 % RH		30°C 0 % RH		30°C 22 % RH	
	with webbing	without webbing	with webbing	without webbing	with webbing	without webbing
R_o	13.20	7.69	6.70	3.09	27.77	20.64
r_m	0.164	0.140	0.183	0.105	0.305	0.276

Discussion

We (Hazan *et al.*, 1974 *b*) postulated that the very close correlation obtained between amounts of silk secreted and number of eggs deposited may have a selective advantage for the mite. The data presented herein support that theory, but only in regard to mites kept under very low or very high relative humidities. This suggests a mechanism which may release water vapours into the ambient atmosphere under one set of conditions, while capable of absorbing such vapours under a different set.

Two complementary, humidity-regulating mechanisms are postulated. The first involves the mite's white fecal pellets, which are commonly deposited on the webbing. These pellets probably contain guanine surrounded by a proteinaceous membrane, like the accompanying black fecal pellets (Gasser, 1951 ; McEnroe, 1963). Former observations (Hazan *et al.*, 1974 *b*) have shown that the pellets tend to distend under high humidity conditions and to shrink as soon as the humidity decreases. Such changes are strongly suggestive of hygroscopic activity, and we argue that the pellets, by absorbing or releasing water vapours, assist in regulating the humidity in the eggs' immediate vicinity.

The other postulated humidity-regulating mechanism is the webbing produced by the mite. This webbing is a protein (Hazan *et al.*, 1975), and protein fibers are known to have high moisture-absorbing capacities (Borasky, 1963 ; Brown and Menkart, 1963). Low humidities induce the production of large amounts of webbing, into which eggs are then deposited. These eggs are in close contact with the silk which may release to them some of the required humidity. The small amounts of silk and pellets produced at 100 % RH (HAZAN *et al.*, 1974 *b*) are probably insufficient to absorb enough moisture to prevent total egg mortality at 24°C. On the other hand, the more rapid embryonic development at 30°C apparently saves many eggs.

Our results in regard to egg mortality at 24°C agree with those of HARRISON and SMITH (1961), who exposed eggs (without webbing) of *Tetranychus "telarius"* (L.) to 100 % RH at 25°C. But these authors did not experiment with silk-covered eggs, nor did they report on egg hatch under conditions of 100 % RH and higher temperatures.

We do not know the significance of silk for the other life stages, all of which produce it these stages replace silk too quickly to judge the effect of its removal. Webbing is important but not essential for egg survival, since at least half the eggs hatched in its absence. These, however, are results obtained in the laboratory. The actual significance of the silk for spider mite egg survival under field conditions remains unknown.

ACKNOWLEDGEMENT

We wish to thank Dr. C. W. SCHAEFER, University of Connecticut, U.S.A., for editorial help.

REFERENCES

ANDREWARTHA (H. G.) and BIRCH (L. C.), 1954. — The Distribution and Abundance of Animals. — The University of Chicago Press, Chicago, 782 p.

BORASKY (R.), 1963. — Introduction : Some important aspects of protein fiber research. In : « Ultrastructure of Protein Fibers » (BORASKY, R., Ed.), pp. 1-3. Academic Press, New York and London.

BROWN (A. E.) and MENKART (J.), 1963-Physical, chemical and mechanical properties of protein fibers. In : " Ultrastructure of Protein Fibers " (BORASKY R., Ed.), pp. 5-17. Academic Press, New York and London.

GASSER (R.), 1951. — Zur Kenntnis der gemeinen Spinnmible *Tetranychus urticae* Koch. I. Mitteilung : Morphologie, Anatomie, Biologie und Oekologie. — Mitt. Schw. Entomol. Gess., **24** : 217-262.

HARRISON (R. A.) and SMITH (A. G.), 1961. — The influence of temperature and relative humidity on the development of eggs and on the effectiveness of ovicides against *Tetranychus telarius* (L.) (Acarina : Tetranychidae). — New Zealand J. Sc., **4** : 540-549.

HAZAN (A.), GERSON (U.) and TAHORI (A. S.), 1974 *a*. — Life history and life tables of the carmine spider mite. — Acarologia, **15** : 414-440.

HAZAN (A.), GERSON (U.) and TAHORI (A. S.), 1974 *b*. — Spider mite webbing. I. The production of webbing under various environmental conditions. — Acarologia, **16** : 68-84.

HAZAN (A.), GERTLER (A.), TAHORI (A. S.) and GERSON (U.), 1975. — Spider mite webbing. III. Solubilization and amino acid composition of the silk protein. — Comp. Biochem. Physiol., **51** B : 457-462.

MCENROE (W. D.), 1963. — The role of the digestive system in the water balance of the two-spotted spider mite (*Tetranychus telarius* (L.)). — Adv. Acarol., **1** : 225-231.

NICKEL (J. L.), 1960. — Temperature and humidity relationships of *Tetranychus desertorum* Banks with special reference to distribution. — Hilgardia, **30** : 41-100.

WINSTON (P. W.) and BATES (D. H.), 1960. — Saturated solutions for the control of humidity in biological research. — Ecology, **41** : 232-237.