Morphology and biology of the gall mite *Eriophyes tiliae tiliae* Pgst. (Acarina, Trombidiformes, Eriophyidae).

by JETTE THOMSEN

Abstract: *Eriophyes tiliae tiliae* Pgst. which causes galls on *Tilia platyphylla* Scop. has been studied during the course of a year. By scanning electron microscopic investigations some morphological differences between the mites described by Keifer (1952) and the mites from the Botanical Garden of Copenhagen are illustrated.

An account of the moment of the gall initiation, the larva development, the dispersal and the wintering is given.

Introduction

Galls are growth abnormalities in plants, formed under the influence of parasitic organisms such as bacteria, fungi, nematodes, mites and insects.

The Eriophyid mite is a unisexual herbivore measuring from 0.08 to 0.2 mm. Among the 1000 known species, about 50 % cause galls. A characteristic feature in the Eriophyid galls is a heavy growth of hairs from the epidermis of the plant, but otherwise the galls often show some variation. Some appear as a hair felt, others as an involution of the plant organ, and some are pouch-shaped protuberences.

Material and methods

The aim of this investigation has been to describe the morphology and biology of *Eriophyes tiliae tiliae* Pgst. (after Buhr, 1965) which causes the formation of horn galls on *Tilia platyphylla* Scop. Regarding the anatomy of the galls, see Thomsen (1975). This gall mite has been treated by Keifer (1952) under the name of *Eriophyes tiliae typicus* (Pgst.), Nalepa in a work with detailed drawings, and by Farkas (1965) under the name of *Eriophyes tiliæ* Nalepa in a key which includes schematic drawings of shield and anterior part.

During the period of a year fixations of mites from the Botanical Garden of Copenhagen have been carried out regularly. Further, the distribution of the mite in 200 buds, in 1000 galls and in a number of leaves has been examined.

Eriophyes tiliae tiliae *Pgst.*

For the morphological examination and determination of the mite in a light microscope, Keifer's (1952) three-step recipe for fixation and embedding has been used. Furthermore, the mites have been fixed in glacial acetic and abs. ethanol, 31/94, freeze-dried in benzol, coated with coal and gold and photographed in a Cambridge Stereoscan 600.

Morphology

According to Baker & Wharton (1952), the Eriophyid mite can be devided into three sections. See Fig. 1, showing Keifer's (1952) drawing of examples of the morphology of the Eriophyid mites.

1. Gnathosoma is the section of the body carrying the mouth parts. The mouth opening is surrounded by the pedipalps – rostrum – and inside of these by the chelicera. The latter appear as a spike-formed apparatus which seems well suited for penetration of plant cells.
2. Propodosoma is a shield-formed section provided with two pairs of legs in all stages of development.
3. Hysterosoma, which constitutes the greater part of the body, is cross-ringed and carries setae. Most often small warts – microtubercles – are found on the rings. The genital opening, which is placed in the anterior of hysterosoma, is covered by a transversally placed plate – the genital coverflap. In the female mite the flap opens backward, and in the male forward. The anal opening is in the posterior part of hysterosoma.

The morphological investigation of *Eriophyes tiliae tiliae* has been carried out on adult females from the population in the Botanical Garden and from control localities in the neighborhood of Copenhagen. There appears to be morphological differences between these mites and those described in the above works by Keifer and Farkas. See Table 1, which includes characters in mites described by Keifer as well as those from the Botanical Garden. Among the most important differences can be mentioned: the number of body rings, morphological differences in the posterior rings of the body, differences in the length of setae on the legs and differences in the number of secondary rays in the featherclaws (Figs. 2–7).

Biology

The Eriophyid mites have two different types of life cycles. The more simple cycle applies one type of female which is capable of reproducing asexually – as well as sexually after being fertilized by male spermatophore (Oldfield & Newell, 1973). The development from egg to adult mite

Table 1. Comparison of characters of adult females of *Eriophyes tiliae tiliae* described by Keifer (1952) and from the population in the Botanical Garden, Copenhagen.

	Mites according to Keifer, 1952	Mites from the Botanical Garden	Photographs of mites from the Botanical Garden
setae on rostrum	proximal	distal	Fig. 2.
shield: form and pattern	identical		Fig. 2.
1st leg: setae length on femur, patella, tibia, tarsus	correspond		Fig. 3.
2nd leg: seta length on femur, patella, tarsus	app. 1/2 × femur	app. 1/3 × femur	Fig. 3.
	app. 3 × patella	app. 1 × patella	
	both app. 2 × tarsus	inner app. 1/2 × tarsus outer app. 4 × tarsus	
proximal rays on 4-ray featherclaws	1, 1, 1 secondary rays	1,2, 1 secondary rays	Fig. 4.
microtubercles: form and position	oval, in the middle of the ring	drop-formed, close to back edge of the ring	Fig. 5.
form of bodyrings from 3rd ventral seta	correspond to the others	wider than the others microtubercles: dorsal, weaker ventral, longer	Fig. 6.
number of longitudinal scorings on genital coverflap	6	8–10	Fig. 7.
number of bodyrings	75	65–71	

involves two larva stages, in which the larvae resemble the adults, but differ from these in regard to size by having fewer microtubercles and lacking the genital coverflap. Some of the females survive the unfavorable period by searching out protected areas on the plants.

In 1942 Keifer discovered an alternation in some species between proto-

gynous females of the type mentioned above, which together with males live and reproduce during the summer, and deutogynous females with a deviating appearance. These do not reproduce during the season of hatching, but winter, and not until the following year do they start a new population.

Year cycle of Eriophyes tiliae tiliae.

During the months of January to March the mites are found in the buds under the outer cataphyels, often many together. In these areas the cataphyll cells die and appear as brown spots. The mobility of the mites is dependent on the temperature.

In the latter part of April, when the buds start swelling, the mites move to the other cataphylls and on to the lowermost foliage leaves. In late April when the leaves start bursting, the first gall initials can be observed, each one with an adult female. The initials are placed on those parts of the leaves which are protected against the light. During the early weeks each mite is able to start several gall initials and as a result a mite is no longer to be found in each initial.

Around May 12 the first eggs are present in the galls. However, eggs or mites are never seen in greenish galls measuring 1 mm or less. These galls must be considered as given up by the mites. The other galls are reddish and measure 1–3 mm. In the largest galls, eggs are always present and often mites as well, while in galls of lesser size, eggs may be found even without the mite itself being present.

Circa 10 days later the first larva stages appear and around June 1 the second larva stage is present. In the middle of June, when the galls measure app. 1 cm, the first generation of both sexes has developed, however, with the females predominating.

In July and August many mites leave the galls and can be found around the gall opening, in groups of hairs on the leaf, sometimes in the abandoned initials and freely on the abaxial side of the leaf. Simultaneously the mites reproduce in the galls, in each of which several hundred may be found.

In September both females and males begin to enter the buds, while living mites still remain in the galls. The mites do not necessarily enter the buds placed in the axils of the gall-bearing leaves, but often those buds of 4–5 mm to be found distally in the shoot system.

In October before defoliation there are no more living mites left in the galls. But the mites live on in the buds and reproduce as long as the tem-

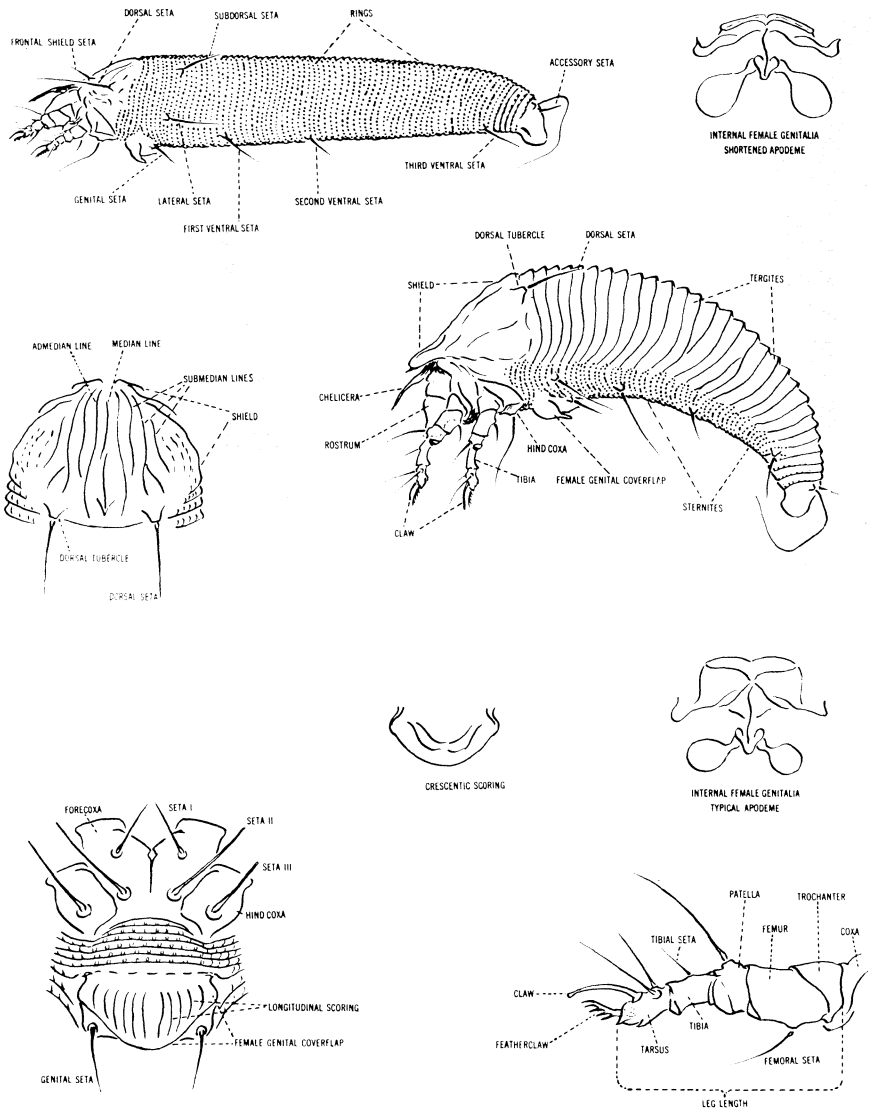


Fig. 1. H. H. Keifer's figure showing example of the morphology of the Eriophyid mites. Originally published by the University of California Press; reprinted by permission of The Regents of the University of California.

perature permits, according to Domes (1957) above 11°C. However, less than 1/4 of the mites found in the buds in fall survive until the following spring.

Discussion

The morphological differences between the mites treated by Keifer and those from the Botanical Garden may be attributed to racial variation.

Since the females found throughout the year are of the same morphological type, *Eriophyes tiliae tiliae* belongs to the group of mites with a simple life cycle. Under favorable conditions they are, however, able to reproduce in the buds. The malformation of the buds consists only in a necrosis of those cataphylls under which many mites are found.

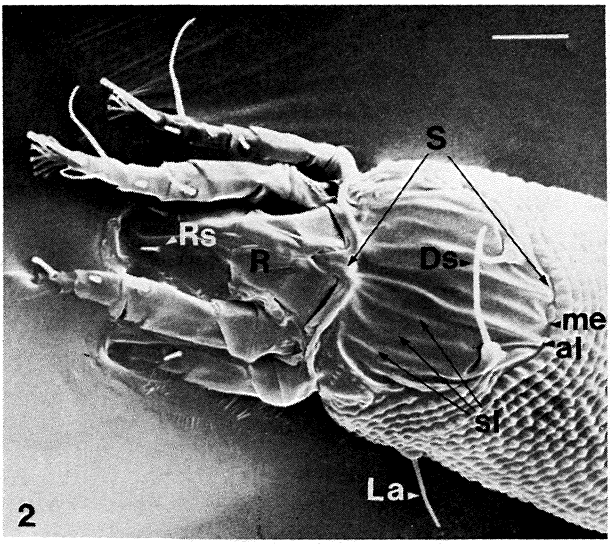
As is the case with *Eriophyes macrorhynchus* Nal. examined by Meyer (1952), it must be assumed that *E. t. tiliae* can initiate and sustain several galls, so that the galls most often visited become the more vigorous. However, in order to attract the mites, the gall must have reached a certain developmental stage at a certain time, otherwise the mite will give up the gall which will then follow another developmental pattern (Thomsen, 1975).

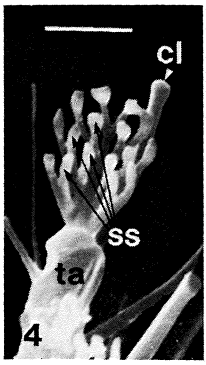
It must be assumed that the dispersal to new hosts can take place during July and August when the mites are found freely on the leaf and can be carried away by the wind or insects.

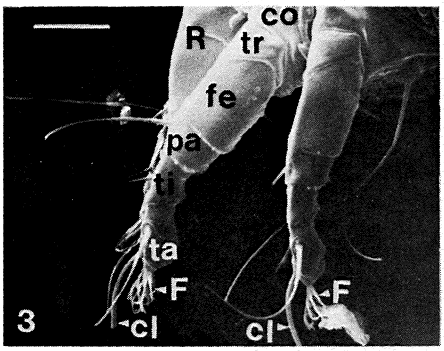
Fig. 2–7. *Eriophyes tiliae tiliae* Pgst.

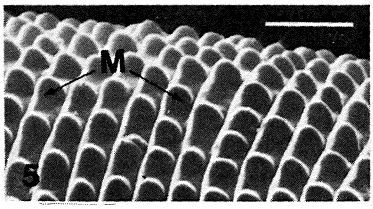
Fig. 2. Shield and rostrum shown from the dorsal side. Form and pattern of the shield, and the distal setae on rostrum can be seen; scale 10 μ. Fig. 3. 1st. and 2nd leg shown laterally. The length of the leg segments and setae can be seen; scale 10 μ. Fig. 4. Featherclaw from the 1st leg shown from the ventral side, where the number of secondary rays are seen; scale 4 μ. Fig. 5. Detail of the dorsal hysterosoma. The front part to the right. The microtubercles are drop-formed and placed close to the back edge of the rings; scale 4 μ. Fig. 6. Oblique view from the ventral side of the posterior part of the body. From the 3rd ventral seta the body rings are wider than the others; while the dorsal microtubercles are weaker, the ventral ones are longer; scale 10 μ. Fig. 7. The front part shown from the ventral side. The female coverflap with longitudinal scorings is seen; scale 10 μ.

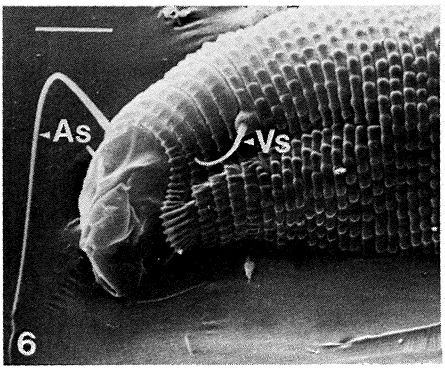
Explanations of symbols: al, amedian line; As, accessory seta; C, chelicera; cl, claw; co, coxa; Ds, dorsal seta; F, featherclaw; fc, fore coxa; fe, femur; Gc, genital coverflap; hc, hind coxa; La, lateral seta; ls, longitudinal scoring; M, microtubercles; me, median line; pa, patella; R, rostrum; Rs, rostrum seta; S, shield; sl, submedian lines; ss, secondary rays; ta, tarsus; ti, tibia; tr, trochanter; Vs, 3. ventral seta.

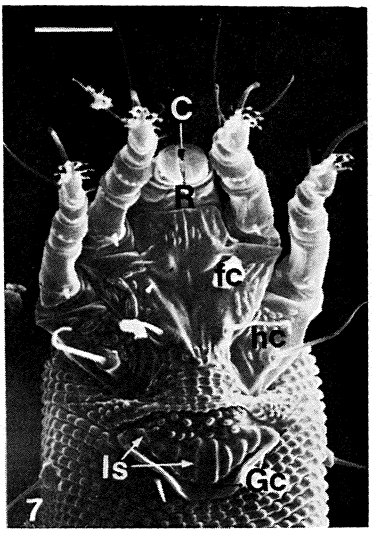

S
Rs
R
Ds
me
al
sl
La
2


cl
ss
ta
4


co
R
tr
fe
pa
ti
ta
F
F
cl
cl
3


M
5


As
Vs
6


C
R
fc
hc
ls
Gc
7

Acknowledgements

I wish to thank lecturer J. Kristiansen for inspiring advise during my work. I have received valuable technical assistance from Mr. B. W. Rasmussen, Mr. H. E. Jensen and Mr. S. Å. Svendsen. For correction of the English translation I am indebted to Mrs. K. Petersen. In addition I am grateful to The Regents of the University of California for permission to use the figure by H. H. Keifer.

Literature

Baker, E. W. & Wharton, G. W., 1952: An Introduction to Acarology. New York, 465 pp.

Buhr, M., 1965: Bestimmungstabellen der Gallen (Zoo- und Phytocecidien) an Pflanzen Mittel- und Nordeuropas. Jena, 1572 pp.

Domes, R., 1957: Zur Biologie der Gallmilbe *Eriophyes gracilis* Nalepa. *Z. ang. Ent.*, 41: 411–424.

Farkas, H., 1965: Spinnentiere Eriophyidae (Gallmilben). In P. Brohmer, P. Ehrmann und G. Ulmer, *Die Tierwelt Mitteleuropas*, 3: 1–155. Leipzig.

Hall, Jr., C. C., 1967: The Eriophyoidea of Kansas. *Kans. Univ. Sci. Bull.*, 47: 601–676.

Keifer, H. H., 1942: Eriophyid studies XII. *Bull. California Dept. Agr.*, 31: 117–129.

– 1952: The Eriophyid mites of California (Acarina: Eriophyidae). *Bull. California Insect Survey*, 2: 123 pp., 198 pls.

Meyer, J., 1952: Édification de galles multiples par une méme fondatrice et peuplement des galles *d'Eriophyes macrorhynchus* Nal. sur Acer pseudoplatanus. *C. R. Acad. Sc. Paris*, 235: 1428–1430.

Oldfield, G. N. & Newell, I. M., 1973: The Role of the Spermatophore in the Reproductive Biology of Protogynes of *Aculus cornutus* (Acarina: Eriophyidae). *Ann. Entomol. Soc. Am.*, 66: 160–169.

Proeseler, G. & Eisbein, K., 1968: Elektronenmikroskopische Untersuchungen zur Morphologie der Gallmilben (Eriophyidae). *Biol. Zbl.*, 87: 609–615.

Thomsen, J., 1975: Development and Histology of Galls on *Tilia platyphylla* caused by *Eriophyes tiliae tiliae*. *Bot. Tidsskrift*, 69: 262–270.

Whitmoyer, R. E., Nault, L. R. & Bradfute, O. E., 1972: Fine Structure of Acarina: Eriophyidae. *Ann. Entomol. Soc. Am.*, 65: 201–215.

Sammendrag:

Morfologi og biologi hos galmiden *Eriophyes tiliae tiliae* Pgst. (Acarina, Trombidiformes, Eriophyidae).

Eriophyes tiliae tiliae, som forårsager galler på *Tilia platyphylla* er blevet fulgt gennem et år. Midernes fordeling i 200 knopper, i 1000 galler samt på blade er blevet undersøgt.

Til den morfologiske undersøgelse i et Scanning elektron mikroskop (Cambridge Stereoscan 600) er miderne blevet fikseret i iseddikesyre og abs. alkohol 31/94, frysetørret i benzen og coated med kul og guld.

Der viste sig at være morfologiske forskelle mellem miden, som Keifer (1952) har undersøgt og miderne fra bestanden i botanisk have. Se tabel 1. Som de vigtigste forskelle

kan nævnes: forskel i antal kropsringe, morfologisk forskel i den bageste del af kroppen, forskel i længden af benenes setae samt forskel i antal af sekundære stråler i de såkaldte »featherclaws«. Forskellene kan være udtryk for racemæssig variation (fig. 2–7).

Da det er den samme morfologiske type af hunner, der findes året igennem, hører *Eriophyes tiliae tilae* til gruppen af mider med en simpel livscyklus, (Keifer 1942).

Fra oktober til sent i april findes miderne under de ydre knopskæl. Misdannelserne i knopperne består kun af en necrose af cellerne i knopskællene, under hvilke der er mange mider.

Når knopperne folder sig ud sidst i april, bliver gallerne initieret af voksne hunner. Det må antages, at *Eriophyes tiliae tiliae* på samme måde som *Eriophyes macrorhynchus*, der er undersøgt af Meyer (1952), kan starte og holde flere galler i gang. Dog skal en galle til et bestemt tidspunkt være i et bestemt udviklingsstadie for at virke tillokkende på miderne, ellers opgives gallerne og følger et andet udviklingsmønster (Thomsen, 1975).

Omkring 12. maj blev de første æg observeret, og ca. 10 dage senere første larvestadie, omkring 1. juni findes andet larvestadie og i midten af juni første voksne generation med hanner og hunner.

I juli og august forlader mange mider gallerne og kan findes frit på bladet eller i hårgrupper; det må antages, at spredning til ny vært kan finde sted på dette tidspunkt.

I september opsøger både hanner og hunner knopperne, oftest de der måler 4–5 mm, og som er distalt lokaliseret i skudsystemet.

Miderne kan formere sig i knopperne, afhængig af temperaturen. Det er imidlertid under 1/4 af de mider, der findes i knopperne om efteråret, der overlever til om foråret.

Author's address:
Institute of plant Anatomy and Cytology,
University of Copenhagen, Sølvgade 83,
DK - 1307 Copenhagen K, Denmark.

Mindre meddelelse

Interessegruppen for biologisk bekæmpelse af skadedyr

Interessegruppen for biologisk bekæmpelse af skadedyr blev dannet ved et møde den 11. september 1975 på Zoologisk Institut, Den kgl. Veterinær- og Landbohøjskole.

Ved biologisk bekæmpelse af skadedyr forstås i snæver betydning anvendelse af skadedyrets parasitter, prædatorer (rovdyr) og patogener som forebyggelses- eller bekæmpelsesmidler. Interessegruppen omfatter imidlertid også personer, som arbejder med insektbekæmpelse ved hjælp af andre alternative metoder til den gængse kemiske bekæmpelse. Det drejer sig i første række om udnyttelse af udviklingshæmmende stoffer (f. eks. juvenilhormoner) og signalstoffer (f. eks. seksuelle duftstoffer), men også forskere, som beskæftiger sig med indflydelsen af kemiske og kulturtekniske metoder på nyttefaunaen, kan være med i gruppen.