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GIORGIO NUZZACI, ENRICO DE LILLO
Istituto di Entomologia agraria, Università degli Studi di Bari, Italy

Perspectives on Eriophyoid mite research*

ABSTRACT

The authors deal briefly with the current status of knowledge on Eriophyoidea (Acari, Prostigmata), which are obligatory phytophagous mites and attack many crops of economic value, and focus their attention on some points that they consider valuable guidelines for future scientific progress.

Key words: Acarology, gall making, vagrants, morphology, anatomy, physiology, life history and reproductive strategies, ecology, plant pathogen transmission, taxonomy and systematics.

INTRODUCTION

Eriophyoids were at first not recognized as agents of plant deformations, which were, instead, often thought to be of fungal nature (LINDQUIST & AMRINE, 1996). In the 1737 very tiny organisms were, for the first time, recorded in association with these deformations, but the taxonomy and systematics of this group began only in 1884 with the sudies by Nalepa (CANESTRINI, 1892). Nalepa, who published extensively until 1929 (NEWKIRK, 1984), laid the foundation for knowledge on the Eriophyoids with the first work on the external and internal morphology of *Trisetacus pini* (Nal.) (NALEPA, 1887) and subseguent systematic papers. Afterwards, Keifer, from 1938 to 1982, made significant efforts to better define the morphology, systematics and biology of the group providing a standard description still more or less utilized to the present. An innovative and consistent aid was contributed by scanning electron microscopy which permitted more detailed observations improving light-microscope morphological and functional interpretations (the first scanning micrograph was published by EISBEIN & PROESELER, 1967).

Eriophyoidea are considered to be highly specialized mites (LINDQUIST & OLDFIELD, 1996); they are the smallest phytophagous arthropods (100-300 µm

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The subjects of the present paper are also the results of the previous and current studies in different aspects made by both authors.

more frequently) and usually appear worm-like. They are adapted to obligate phytophagy, attack all plant parts, except the roots, and most of them have been collected mainly on a single host or on a few, closely related species, developing on selected tissues (OLDFIELD, 1996a). Even though they are generally mild plant parasites (SABELIS & VAN RIJN, 1996) they attack many crops all over the world, they cause damage to relevant economically important plants. Thanks to their small size, many of them can enter into very narrow and sheltered spaces on the host, in contrast with other arthropods, and they are able to induce growth deformations.

Keifer (JEPPSON *et al.*, 1975), in "Mites injurious to economic plants", presented a first important and valuable survey on the eriophyoids providing a brief, general and basic approach to the group and to the most economically important species.

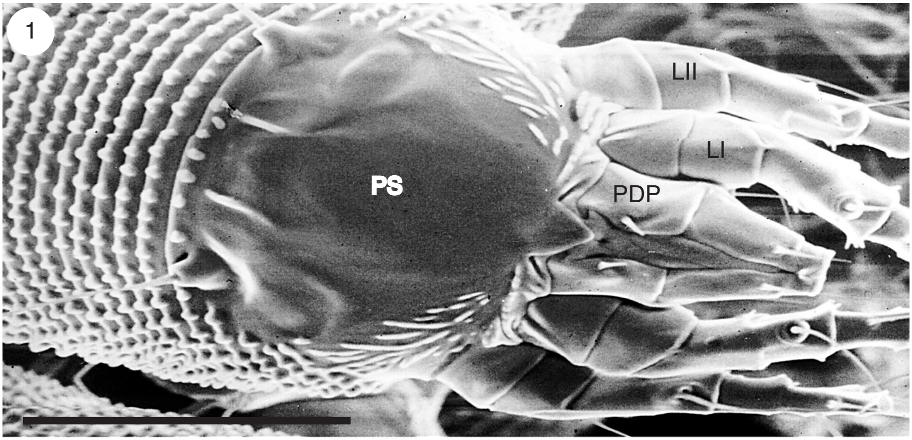
The recently published volume 6 of the World Crop Series entitled "*Eriophyoid Mites - Their Biology, Natural Enemies and Control*" (LINDQUIST *et al.*, 1996) presents the efforts of many contributors in dealing with the contemporary state of knowledge on these mites with the aim to realize an updated text meeting the competences of researchers specialized in various fields. On this occasion, based on remarks expressed in the above-mentioned book and of our experience on this group, we would like to point out some unresolved questions and poorly understood aspects.

MORPHOLOGY AND ANATOMY

As in most acarine taxa, our knowledge concerning the external and even more the internal morphology of eriophyoid mites is still limited owing to the technical problems in microscopical studies of these small mites. The anatomical data presently available have been obtained working mainly on the adults of a few species, and often showing notable differences in interpretation.

Morphologically speaking, eriophyoids are highly specialized mites whose body organization is very simplified and unique among the Acari: they exhibit remarkable reduction of many structures, absence of some structures as stigmata, third and fourth pairs of legs in all instars, opisthosomal lyrifissures, claws, and many setae of the body and appendages, etc. In addition a much greater diversity in external structures are displayed among the taxa.

Mainly on the basis of Nalepa's and Keifer's studies, a terminology of the external structures was developed which has not been adequately compared with that of other groups. Only recently, showing the advantages (applicability to all Acariformes families, international usage, easiness of application,



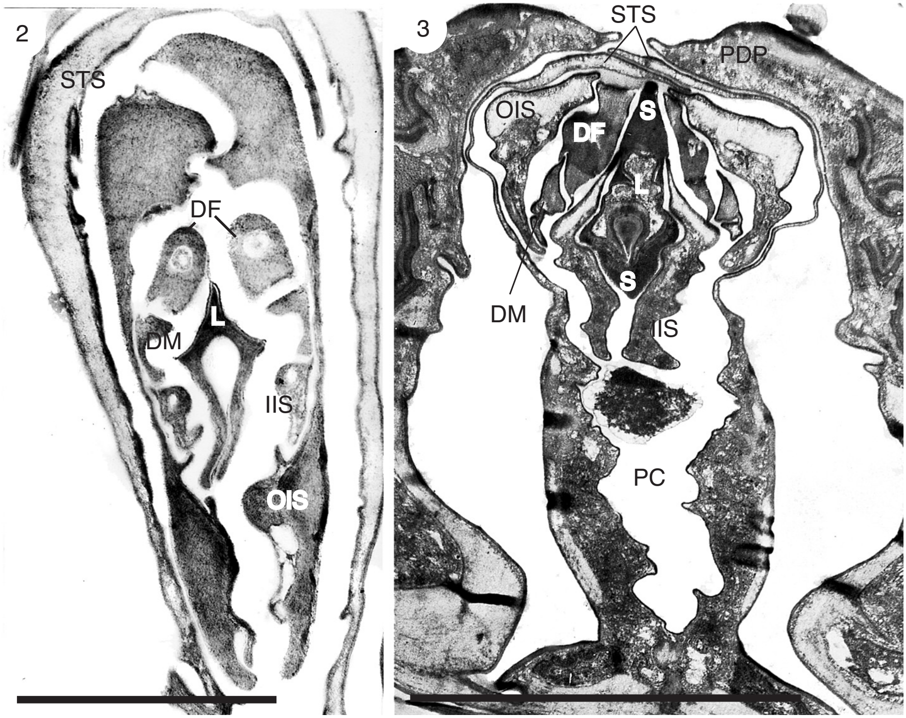


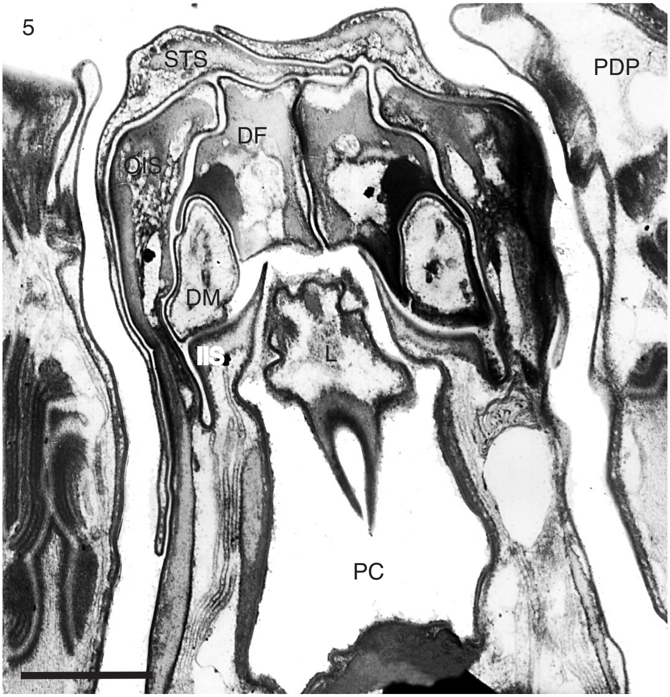
Fig. 1 - SEM micrograph of *Aceria caulobius* (Nalepa): dorsal view of the gnathosoma and prodorsal shield. Scale bar = 20 µm. Figs 2-3 - TEM micrographs, transverse sections of gnathosoma at various levels: 2) distal section of *Diptacus hederiphagus* Nuzzaci, 3) proximal section of *Phytoptus avellanae* (Nalepa); scale bar = 1 µm. Abbr.: DF, digitus fixus; DM, digitus mobilis; IIS, inner infracapitular stylet; L, labrum; LI, leg I; LII, leg II; OIS, outer infracapitular stylet; PC, preoral cavity; PDP, pedipalp; PS, prodorsal shield; S, saliva; STS, stylet sheath.

etc.), Lindquist (1996a) proposed to apply Grandjean's terminology to eriophyoid morphology and tried to establish the homologies of structures with those of other Acariform mites. Of course many proposed homologies need to be confirmed by further data, as in the case of the inner infracapitular or auxiliary stylets (are they lateral lips?), of the motivator, etc.

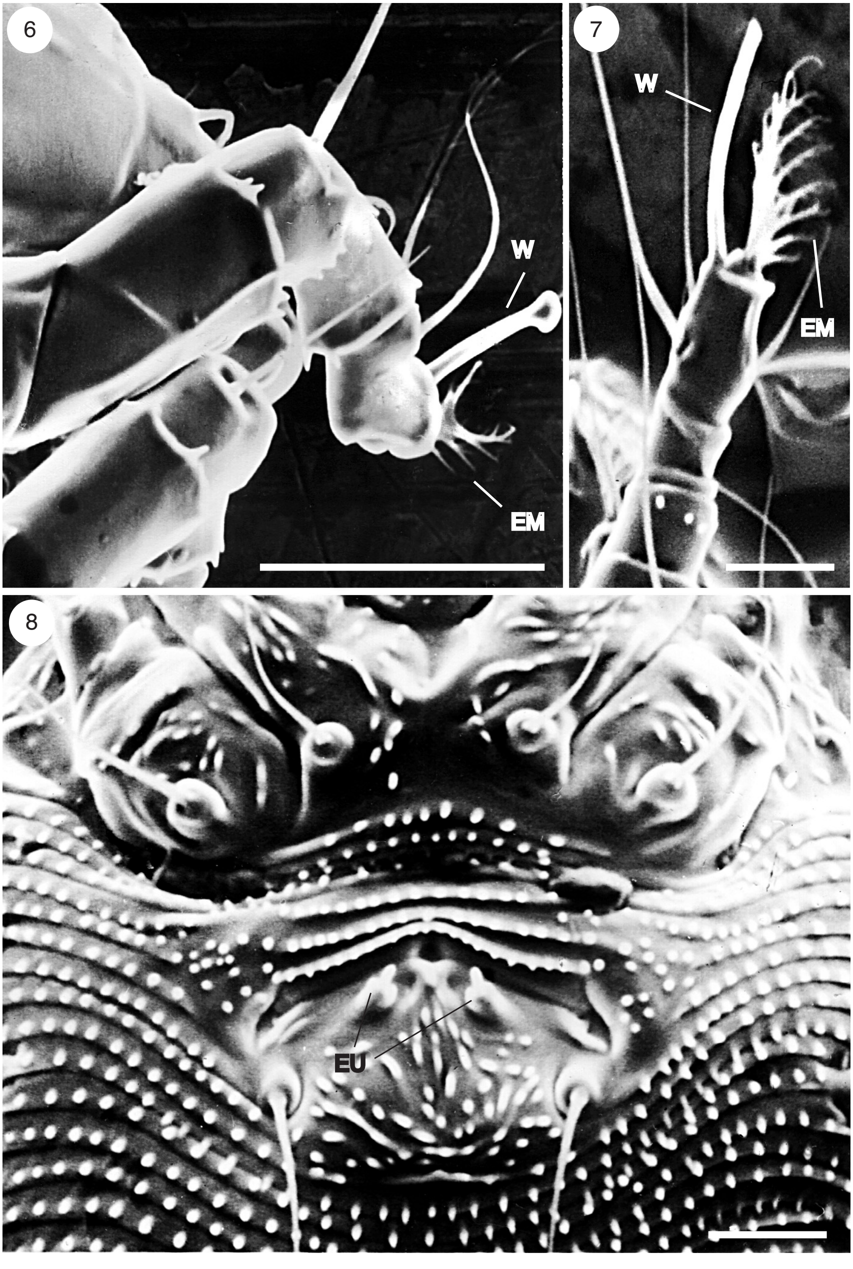
The specialized mouthparts have form and function not found elsewhere and are thought to be a consequence of obligate phytophagy (LINDQUIST & OLDFIELD, 1996; LINDQUIST, in press). They are considerably modified with respect to other mites and are generally composed of 9 stylets (figs 1-5): 2 pairs of cheliceral origin (fixed and movable digits), 2 pairs of infracapitular origin and the unpaired labrum (AMRINE *et al.*, 1994; NUZZACI & ALBERTI, 1996). A few studies have denoted the cheliceral shaft subdivision and further investigations should verify this structure and possible differences in other genera and subfamilies (LINDQUIST, 1996a).

The central and peripheral nervous system have been described in few species; the synganglion of the central nervous system is a compact mass divided into a supraoesophageal and a suboesophageal ganglia, but the interpretations on perineurium and neural lamellae appear to be discordant. Regarding the sensorial system, though many presumed sensorial structures have been observed using light microscopy, their nature and function is often incompletely studied or hypothetical. Nuzzaci and Alberti (1996) detected some mechanoreceptor units and assumed that there are also some chemoreceptors, but, unfortunately, for most of them no ultrastructural studies have given functional evidence: cheliceral stylets and outer infracapitular stylets contain dendritic elements of undescribed receptors (figs 2, 5); the small peg located at the posterior margin of the palptarsus is actually innervated and could be a contact chemoreceptor; the tarsal solenidion on legs I-II (erroneously named "claw" for a long time) (figs 6-7) is a sensillum and the position close to the substrate and its presence in all known Eriophyoidea suggest a probable chemoreceptive function (NUZZACI & ALBERTI, 1996; LINDQUIST & OLDFIELD, 1996). Other possible chemoreceptors are the "lateral tibial spur" (LINDQUIST, 1996a) and the peg-like eugenital setae in the male genital region (fig. 8). Moreover, the dorso-lateral convex eye-like projections (fig. 9) on the prodorsal shield have not been studied in detail (LINDQUIST & OLDFIELD, 1996).

The prodorsal shield (more commonly called "dorsal shield") covers the dorsal part of the propodosoma and its surface ranges from nearly smooth to variously ornamented with evident and distinct cuticular ridges forming patterns or networks (figs 1, 10-13). These sculptures, commonly used in taxonomic studies, have been supposed to be correlated with the extrinsic muscles



Figs 4-5 - TEM micrographs, transverse sections of gnathosoma proximal part: 4) *Trisetacus juniperinus* (Nalepa), the structures indicated with the arrows were described as duct (Nuzzaci, 1979) but they could be dendritic sheaths, 5) *Phytoptus avellanae* (Nalepa); scale bar = 1 µm. Abbr.: DF, digitus fixus; DM, digitus mobilis; IIS, inner infracapitular stylet; L, labrum; M, motivator; NC, nervous cell; OIS, outer infracapitular stylet; PC, preoral cavity; PDP, pedipalp; STS, stylet sheath.



Figs 6-8 - SEM micrographs: 6) legs I and II of *Diptacus hederiphagus* Nuzzaci, 7) tibia and tarsus of *Aceria tamaricis* (Trotter), 8) genital male region of *Vasates euphorbiae* Petanovic. Scale bar = 5 µm. Abbr.: EM, empodium; EU, eugenital setae; W, tarsal solenidion.

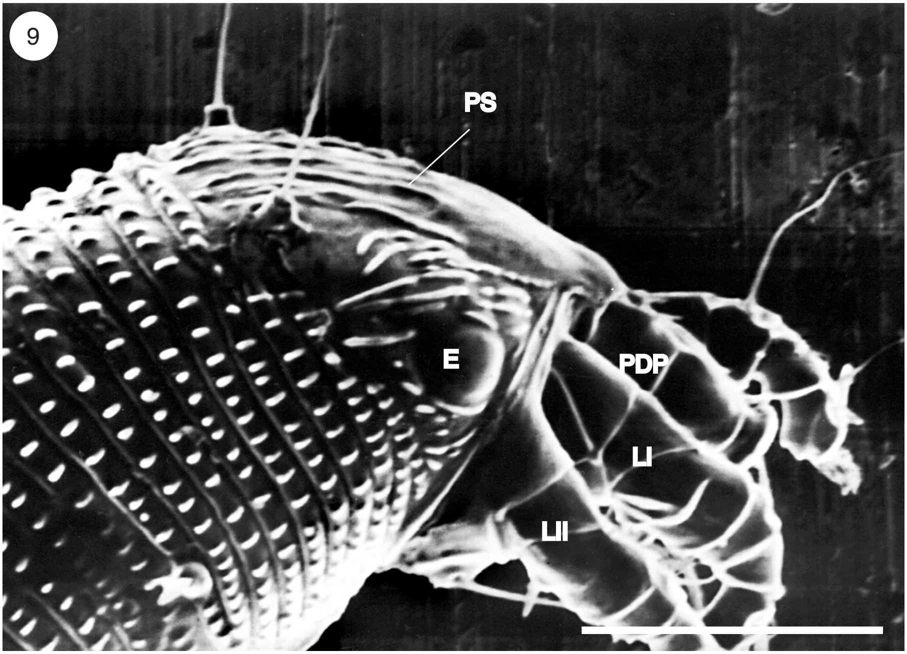
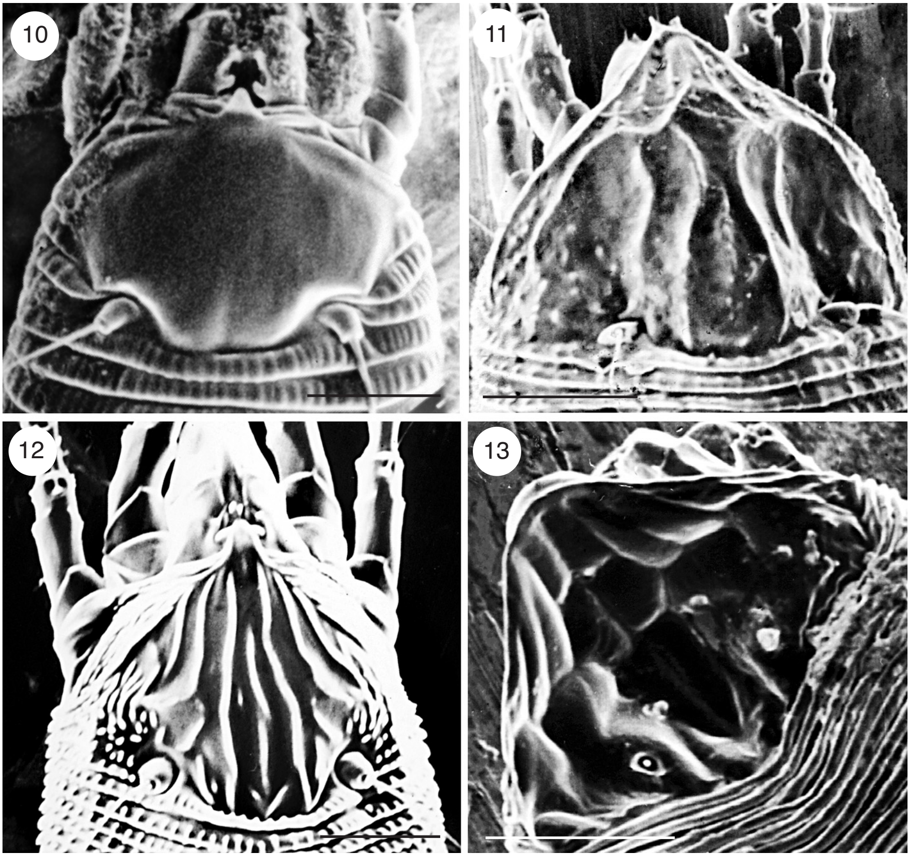


Fig. 9 - SEM micrograph of the anterior body region in dorso-lateral view of *Colomerus vitis* (Pagenstecher). Scale bar = 20 µm. Abbr.: E, eye-like projection; LI, leg I; LII, leg II; PDP, pedipalp; PS, prodorsal shield.

of the pedipalps and chelicerae (Shevchenko, 1970; Nuzzaci & Alberti, 1996) as well as the pit-like depressions ("glandular pits") frequently present in *Ditrymacus* spp., *Trisetacus* spp. and *Acathrix* sp. (fig. 14), which are assumed to be integumental thickeninge for muscle insertions (Lindquist, 1996a).
Three prosomal glands have been found associated with the gnathosoma: one unpaired ("tracheal trunk"), placed in front of the synganglion, and a pair of podocephalic glands located laterally. A pair of anal glands flanks the rectal sac. Until now, no further glands have been described and there is little information on the anal lobes and web-like, wax and liquid secretory structures.
The digestive tract is composed of the foregut, midgut and rectum but the distinctiveness of the constricted region between the anterior and posterior midgut is so far not distinguished in the available ultrastructural observations.
The circulatory system is not yet well defined, the body fluid is supposed to be moved by means of body muscle activity, and the blood compounds and cells need to be studied (Nuzzaci & Alberti, 1996).
A further clarification is needed for the morphology and function of the female and male genitalia for egg and sperm development. In particular, the



Figs 10-13 - SEM micrographs of the prodorsal shield of 10) *Aceria tamaricis* (Trotter), 11) protogyne of *Aculus fockeui* (Nalepa & Trouessart), 12) *Aceria ficus* (Cotte), 13) *Diptacus gigantorhynchus* (Nalepa). Scale bar = 20 µm.

origin and activity of the nutritive cells ("follicle cells" of Nuzzaci & Scalera Liaci, 1975), the importance of the oviduct epithelial cells in vitellogenesis, the process of egg shell formation, the sequence of spermatogenesis, sperm morphology, and the capacitation process, i.e. the transformation of the sperm cells prior to the fertilization, should be ascertained (Alberti & Nuzzaci, 1996; Nuzzaci & Alberti, 1996).

Finally, nothing is known about possible differences between protogyne and deutogyne anatomy, as well as between juvenile stases, and the embryonic development has received very little attention.

Fig. 14 - SEM micrograph of the *Ditrymacus athiasella* Keifer. Scale bar = 50 µm. The arrows indicate the prodorsal pits.

PHYSIOLOGY

The physiology of eriophyoids has been mainly presumed on the basis of a morphological and anatomical approach, and many aspects are completely unknown. No information is available regarding the functional features of different parts of the digestive system, water-balance, neuro-hormones and pheromones; the function of the sensilla is conjectural. These need basic research and detailed analysis.

Eriophyoids feed by piercing and sucking mainly on meristems and epidermal cells by means of short stylets, apart from diptilomiopids which, instead, may pierce into the parenchyma, using longer stylets (ROYALTY & PERRING, 1996). The piercing activity is more or less well understood; the stylets, by the action of the pedipalp muscles and motivator, penetrate the plant cells and inject saliva into the wound. In the contrast, the ingestion mode is not clearly established (LINDQUIST, 1996a; NUZZACI & ALBERTI, 1996; WESTPHAL & MANSON, 1996). Usually, feeding causes light physical and physiological injuries to the health of the plant in contrast with spider mites (WESTPHAL & MANSON, 1996). In general hosts may be more (in case of vagrants) or less (rust mites) undamaged or display specific reactions (gall, erineum, blister, leafrolling, stunting, rosetting, "witches' broom" and other distortive growths) and rarely are so severely damaged that they die (Lindquist & Oldfield, 1996; Oldfield, 1996b; Royalty & Perryng, 1996; Westphal & Manson, 1996).

Determination of the eriophyoids' feeding effects is not completely understood. The salivary gland complex appears to be involved (Westphal & Manson, 1996): the secretion of the unpaired gland is supposed to work as saliva or as a lubricant in facilitating stylet movement; the paired glands are most likely true salivary glands. Few and fragmentary are the studies on the chemical nature of the saliva and its impact on plant physiology (concentration changes of auxins, auxin regulators and other substances like plant nutrients, protein content, other phyto-hormones, etc., found in host plant tissues affected by mites) (Oldfield, 1996b; Royalty & Perring, 1996). Also the function of other gland structures has not been ascertained: the anal glands could be involved in attachment of the anal sucker to the substrate or in a possible pheromone release; the nature and role of pheromones are completely unknown.

Finally, few reports explain the role of photoperiod in diapause (Sapozhnikova, 1982), and a wide range of studies could give more explanation on the diapause manifestation.

LIFE HISTORY STRATEGIES

The eriophyoid life cycle starts with the egg, continues with two immature stases (larva and nymph) and ends with the adult male and female (Lindquist, 1996a; Manson & Oldfield, 1996). As far as we know, the stases egg, larva and nymph have always been found in the group, while one or more type of adults have been pointed out, even if few species have yet been examined in any detail. To our knowledge, the life cycle may be (Manson & Oldfield, 1996):

a) "simple or direct" with a male and a female present throughout the year;
b) "deuterogynous" with two morphologically distinct forms of female (the protogyne or primary form and the deutogyne or secondary or hibernating form) and only one form of male (similar to the protogyne in appearance);
c) "atypical deuterogynous" which is characterized by several different morphological forms of deuterogyny reported in a few instances.

Unfortunately, the immature stases of many species have not been described or studied, the males have not always been found and few life cycle reports have been carried out on tropical species. Deuterogyny is common in eriophyoids living on deciduous plants and much less frequent on eriophyoid species found on evergreen and tropical plants. So, deuterogyny could be a survival means against adverse environmental conditions (Manson & Oldfield, 1996).

Concerning developmental time, reproduction parameters, sex ratio, longevity and other biological aspects in relation to climate and host plants, there is a scarcity of data on various species (Allen *et al.*, 1995) and, often, only provisional values may be obtained on the intrinsic rate of increase, a mite population model and other ecological aspects and their subsequent meaning (Sabelis & Bruin, 1996).

Wind and perhaps phoresy are the main means for eriophyoid dispersal. Usually several specimens of unknown species may be found on sticky traps and the hypothesis that they are mainly protogynes requires more support. Wind and phoresy offer several disadvantages (different mortality risks during transportation, doubtful success in colonizing new hosts) and advantages but their frequency, the physiological mechanisms and the factors that induce this behaviour, and the selection mode of the dispersal means are not well understood (Sabelis & Bruin, 1996).

REPRODUCTIVE STRATEGIES

The reproduction of eriophyoids occurs by means of indirect sperm transfer and facultative parthenogenesis. The first method consists of deposition of a sperm droplet by the males at the tip of a stalk or spermatophore. The sperm droplet is picked up by the females and stored inside the spermathecae. Concerning the male habit, the mode (habitat-related and or partner-related deposition) and the time of spermatophore release, the male behaviour in guarding of pharate female nymphs and defending the territory until the female's emergence, the orientation of one or more males close around a quiescent female nymph appear to respond to the principle of maximizing the probability of reproductive success (Oldfield & Michalska, 1996). As regards the female habits, the factors involved and influencing insemination need further critical studies: effect of environmental conditions on spermatophore viability, attractiveness of viable and unviable spermatophores towards virgin females, insemination from one or more sperm droplets at the same time (suggested by a larger spermatheca than sperm sac) or after the exhaustion of spermatozoa stored inside the spermatheca (Oldfield & Michalska, 1996). An asymmetrical sperm storage for some Diptilomiopidae and Eriophyidae living on dicotyledonous plants and a symmetrical sperm storage in some Phytoptidae and Eriophyidae found on monocotyledonous plants have been found but the significance is unknown (Oldfield & Michalska, 1996).

The very few investigations on eriophyoid parthenogenesis, in laboratory trials, have provided evidence only for arrhenotoky (Helle & Wysoki, 1996; Lindquist & Oldfield, 1996) and the karyological study by Helle and Wysoki (1983) on eggs of Phytoptidae, Eriophyidae and Diptilomiopidae has revealed a haplo-diploid cycle, confirming a parthenogenetic behaviour, without provi-

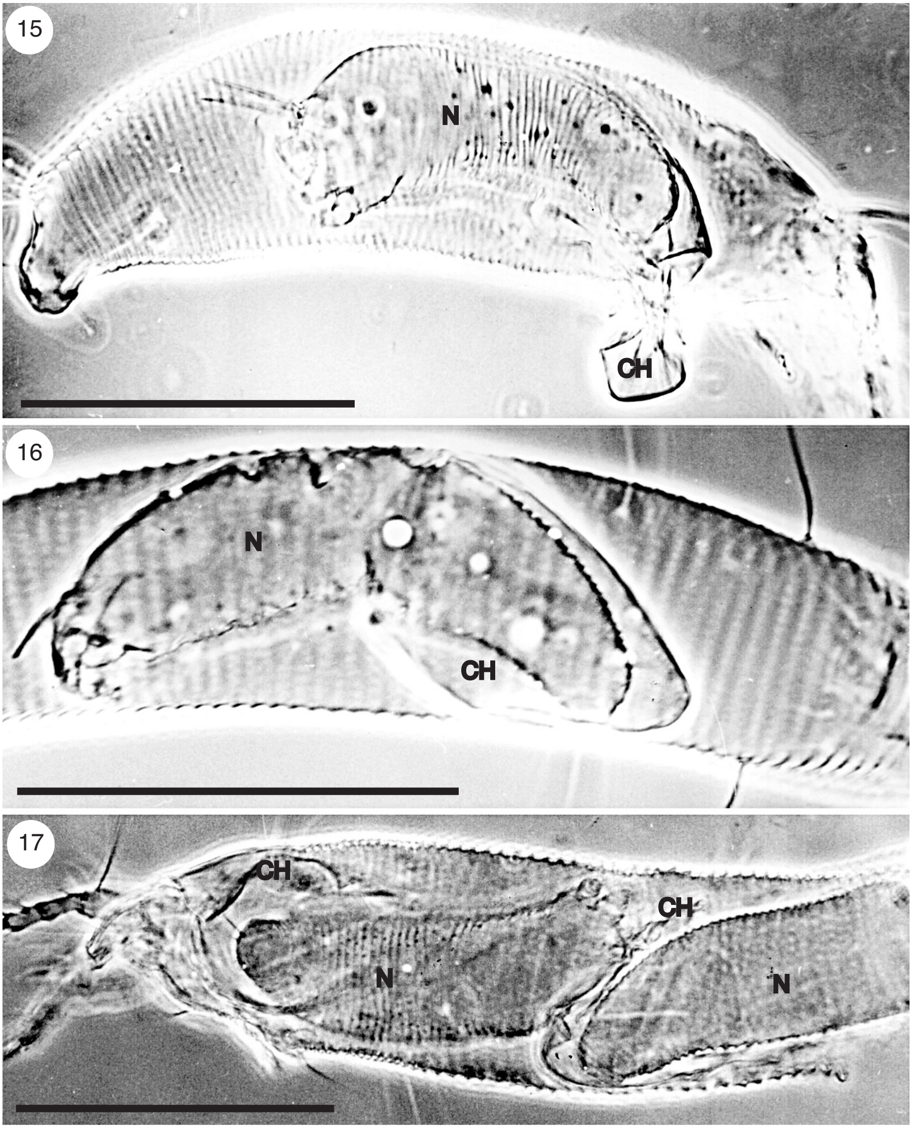


Fig. 15-17 - Light micrographs of ovoviviparous females of 15) *Aceria baccharices* Keifer, 16) *Aceria caulobius* (Nalepa), 17) *Aceria stefanii* (Nalepa). Scale bar = 50 µm. Abbr.: CH, chorion; N, nymph.

ding further data on arrhenotoky or thelitoky. In addition, ecological observations have shown seasonal fluctuations in sex ratio but its relationship to parthenogenesis and its role are not elucidated.

Finally, an ovoviviparous behaviour has been pointed out in few species (figs 15-17). The frequency and factors involved in this phenomenon remain to be investigated. At present, it is thought to be obligatory in *Metaculus mangiferae* (Attiah) and this could confirm a possible trend towards a shortening of the life cycle; the senescence effects could be, also, another explanation (Lindquist & Oldfield, 1996; Manson & Oldfield, 1996).

ECOLOGY

Few attempts to delineate the role of eriophyoids with regard to their ecological relationships among phytophagous mites and different trophic levels have been made.

In recent years the interest in eriophyoids as control agents for plant pests (Cromroy, 1978; Boczek, 1995; Rosenthal, 1996) has been growing on the basis of their monophagy and causing reduction in weed growth and reproduction ability (Sabelis & Bruin, 1996). Actually, few species have been applied with success, as for example *Aceria chondrillae* (Canestrini) against *Chondrilla juncea* L. in Australia, *Aceria malherbae* Nuzzaci against *Convolvus arvensis* L. in Texas. Several others have showed a potential use in weed control and are the object of studies especially in USDA laboratories (tab. 1).

Recently, attempts to detect and produce host plant resistance to the mites have been made, but little is known about the biochemical and morphological means of defense involved; an improvement of the knowledge on application of this strategy in integrated pest management is required (Westphal *et al.,* 1996; Harvey *et al*., 1995a, 1995b).

Eriophyoids are particularly suited, in shape and size, to move and live in narrow spaces or remote plant deformations - refuges of gall-making eriophyoids - (Lindquist & Oldfield, 1996; Royalty & Perring, 1996; Sabelis & Bruin, 1996). In such a way they generally escape from predators (mainly Phytoseiidae and Stigmaeidae) that are unable to enter into the eriophyoid niches because of their larger shape and size. In contrast, the so-called vagrant or free-living eriophyoids, and even gall-inhabiting mites during migration, have no protection from predators (Sabelis, 1996; Sabelis & Bruin, 1996; Sabelis & Van Rijn, 1996). Sabelis and Bruin (1996) attempted to explain the role and importance of eriophyoids as prey and searched for reasons that have not caused a unidirectional evolution towards non-vagrant forms of eriophyoids.

Tab. 1 - Some of the eriophyids at present studied for biological weed control in USDA laboratories (courtesy of dr. R. Sobhian, European Biological Control Laboratory, USDA, Montpellier, France).

Eriophyid species	Host plants
Aceria acroptiloni Kovalev & Shevtchenko	*Acroptilon repens* (L.)
Aceria balasi Farkas	*Crupina vulgaris* Cass.
Aceria centaureae (Nalepa)	*Centaurea aspera* L., *C. diffusa* Lam.
Aceria drabae (Nalepa)	*Cardaria draba* (L.)
Aceria salsolii de Lillo	*Salsola australis* Brown, *S. kali* L.
Aceria sp.	*Isatis tinctoria* L.
Aceria tamaricis (Trotter)	*Tamarix gallica* L., *T. ramosissima* Ledeb.
Aceria thessalonicae Castagnoli	*Centaurea diffusa* Lam.
Cecidophyes galii (Karpelles)	*Galium aparine* L., *G. spurium* L.
Phyllocoptes nevadensis Roivainen	*Euphorbia cyparissias* L., *E. esula* L.

Unfortunately, the hypotheses of the authors have been supported by scant data that only partially explain this phenomenon and the extraordinary behaviour of a free-living eriophyoid, *Rhyncaphytoptus ulmivagrans* Keifer, recently pointed out by Michalska and Kropczynska (in press), could be a first proof. Various experiments have pointed out that many phytoseiid mites are able to survive, develop and reproduce on a diet exclusively composed of eriophyoids (main prey) or partly so (alternative prey). In a few instances, laboratory rearings were not successful and a possible inadequate nutritional quality was suspected (SABELIS, 1996). At present the data on the effects of different eriophyoid diets on phytoseiid life history are still too limited to permit a meaningful comparison with other diets and to correctly evaluate the role of eriophyoids in prey-predator relationships. Moreover, the prey preferential feeding of some phytoseiids, their different degree of adaptation and preference, the biological reasons of this phenomenon, the predation risks of gall-inhabiting eriophyoids when they are protected inside refugees or outside them, the impact of other natural enemies on eriophyoid populations, and their possible application in mite management should all be ascertained (WAITE & GERSON, 1994; JAMES *et al.*, 1995; PERRING & MCMURTRY, 1996; SABELIS & VAN RIJN, 1996).

PLANT PATHOGEN TRANSMISSION

Among the phytophagous mites, only a few species of the family Eriophyidae have been ascertained as vectors of certain disease agents (especially viruses) of great economic importance to several herbaceous and woody crops (LINDQUIST & OLDFIELD, 1996; OLDFIELD & PROESELER, 1996). Available evidence indicates a high degree of host specificity (a virus is transmitted by just one eriophyid species) in the relationships between eriophyid vector and disease agent and may be related to the ability of the virus to reach the salivary glands passing through the midgut. The transmission of Wheat streak mosaic virus (WSMV) by means of *Aceria tulipae* Keifer[1] has received much attention: a circulative mode of transmission of this virus is supposed on the basis of the presence of virus particles in the gut lumen, in the haemocoel and salivary glands and on the basis of studies on the infectivity of the adults. Indeed, the relationships between viruses and eriophyids, evidence of the presence of other plant pathogens inside tissues of eriophyid vectors, the transmission mechanism and often the identities of most of woody perennial causative agents still remain to be investigated (OLDFIELD & PROESELER, 1996).

REARING

Biological and ecological features of eriophyoids are often really difficult to understand in field observations and need laboratory rearings. These are easy to obtain for vagrant species but commonly are not successful for non-vagrant species that are more fastidious in requirements to feed on undifferentiated host cells (OLDFIELD & PERRING, 1996). Attempts to solve the rearing obstacles mainly for non-vagrant species might be made by the use of tissue cultures, as proposed by Oldfield and Perring (1996).

TAXONOMY AND SYSTEMATICS

The current classification into families, subfamilies and tribes doesn't correspond to the patterns of evolution and adaptation of the group to their hosts and is merely artificial. Presently, there are about 3000 species, mainly from areas of Europe and North America while the eriophyoid fauna of tropical and subtropical regions is poorly known, sheltering many new eriophyoid taxa (AMRINE & STASNY, 1994; LINDQUIST & AMRINE, 1996; OLDFIELD, 1996a). Therefore, the study of the fauna in these areas and the application of cladistic analyses are suggested by Lindquist and Oldfield (1996) and Lindquist (1996b) as means for improving the classification of the group. First rather superficial attempts of cladistic analyses have been recently made by Hong and Zhang (1996).

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[1] *A. tosichella* Keifer is now being used correctly in place of *A. tulipae*; *A. tosichella* is the recognized species on wheat (Oldfield, *in litteris*).

Our opinion, in accordance with Lindquist and Amrine (1996), is to arrange the eriophyoid information in a computerized database: the archive could be world wide, easy to utilize, and could contain the large amount of data presently available.

Finally the application of molecular techniques to isolate and examine part of the ribosomal DNA (PCR amplification) represents a useful method in identifying and distinguishing species retained close from a morphological point of view (Fenton *et al.*, 1995; Fenton *et al.*, in press).

CONCLUSIONS

This brief review points out that many basic and applied aspects on eriophyoid mite research are scattered and need further exploration, even if the study of these mites has made steady progress during the last two decades. A restricted list of recommended topics that could be promoted for future research are:

1) more deeply anatomical investigations are needed for almost all systems such as the nervous system, including endocrine functions, sensory structures, reproductive organs, anatomical differences between deutogyne and protogyne, male and female, immature stases and adult for better understanding the functional morphology of this group and to support homologies;

2) ascertain some physiological and biological aspects: the feeding mechanism with particular attention to the salivary coumpounds involved in biochemical mechanisms inducing galls, russeting, edge-rolling, deformations, and other alterations on plants; the possible kinds of life history strategies and reproductive behaviour; biological parameters; dispersal. Improved rearing techniques could be useful for studying reproduction, development, behaviour and life-history strategies;

3) identify and select promising candidates in weed control estimating their potential effectiveness;

4) gain further insight concerning the role and importance that eriophyoid populations play in food chains, particularly as main and secondary food for predators;

5) investigate the relationship between eriophyoids and plant pathogens (virus, and mycoplasma) for determining the mechanisms by which transmission occurs;

6) organize a database containing information on the original description and illustration, biogeography, habit, hosts, references, etc., that may be easily and quickly available, becoming a useful instrument for the researchers.

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RIASSUNTO

Prospettive di ricerca sugli Acari Eriophyoidea

Gli autori riportano in breve lo stato attuale delle conoscenze sugli Eriophyoidea (Acari, Prostigmata), acari fitofagi obbligati che attaccano molte colture di interesse economico.

Aspetti che richiedono ulteriori approfondimenti di ricerca sono:

1) l'anatomia della maggior parte degli organi nei diversi stadi di sviluppo, e le differenze tra le forme svernanti (deutogine) e le forme primaverili estive (protogine);

2) le modalità di induzione delle malformazioni sulle piante, la definizione del ciclo biologico in moltissime specie e l'attitudine alla trasmissione dei virus e micoplasmi;

3) l'efficacia di utilizzazione degli eriofidi nella lotta contro le piante infestanti;

4) il ruolo degli eriofidi nelle catene alimentari di acari predatori;

5) l'organizzazione di un archivio su supporto ad uso informatico.

Parole chiave: Acarologia, galligeni, vaganti, morfologia, anatomia, fisiologia, strategie rirpoduttive, ciclo vitale, ecologia, trasmissione di patogeni vegetali, tassonomia e sistematica.

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