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Taxonomy, distribution, and host specificity of a gall-making mite, *Aceria tamaricis* (Trotter) (Acari: Eriophyoidea), associated with *Tamarix gallica* L. (Parietales: Tamaricaceae) in southern France***

ABSTRACT

A population of *Aceria tamaricis* (Trotter), found in galls collected on *Tamarix gallica* L. from southern France, has been compared to samples used for the redescription of the species by CASTAGNOLI (1992), pointing out the morphological differences, and to the other species found until now on *Tamarix* spp., making some taxonomic considerations.

The host specificity study reveals that *A. tamaricis* almost always infests *T. gallica* while it does not attack *T. aphylla* (L.) Carsten from USA, *T. parviflora* D.C. from France and *T. ramosissima* Ledeb from USA.

In addition, observations are presented on the biology and distribution of the mite in southern France.

Key words: morphology, weeds, biological control.

INTRODUCTION

Tamarix species, especially *T. gallica* L. which is known as French or common tamarisk, are widely distributed in southern France, particularly in the Camargue area southeast of Montpellier. These shrubby trees are widespread in sunny habitats, mainly on sandy soils, such as coastal dunes along the sea and river banks. Numerous natural enemies have been found on *Tamarix* spp. in southern France. Many of them appear to be useful for the biological control of *Tamarix* spp. in the USA where *T. ramosissima* Ledeb. has been classified as one of the ten worst noxious weeds and their growth characteristics make them very difficult to control by either mechanical or chemical means (FRASIER & JOHNSEN, 1991).

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A gall-making eriophyid mite, at the beginning of this study considered as new for science and after a recent review (CASTAGNOLI, 1992) identified as *Aceria tamaricis* (Trotter), was found on *T. gallica* in southern France and is considered as a potential agent for biological control of *Tamarix* spp.

Up to now, eight eriophyid species have been found on *Tamarix* spp. They cause different kinds of symptoms: twig and leaf deformations were reported as caused by *Aculus? arbosti* (Cotte)[1] on *Tamarix africana* Poiret in France (COTTE, 1924) and by *Aceria tamaricis* (Trotter) on *Tamarix* sp. in Asia Minor (TROTTER, 1901) and in Greece (CASTAGNOLI, 1992); bud galls by *A. dioicae* (Keifer) on *T. dioica* Roxburgh in Pakistan (KEIFER, 1979); leaf deformations by *Eriophyes? strobilobius* Dçbski on *T. nilotica* (Ehrenb.), *Eriophyes? synchytrioides* Dçbski and *Eriophyes? tetragynae* Dçbski on *T. tetragyna* Ehrenb. in Egypt (DÇBSKI, 1918); twig and flower deformations by *A. tlaiae* Trabut on *T. articulata* Vahl in Morocco (TRABUT, 1917). *Vasates immigrans* (Keifer) was found simply vagrant on *T. gallica* L. in California (KEIFER, 1940).

The purposes of the present contribution were to point out some morphological details of *A. tamaricis* found in France compared to Asia Minor and Greece populations, to study some of its bioecological aspects, and in particular to determine its host specificity and its geographical distribution in southern France.

MATERIAL AND METHODS

TAXONOMIC STUDIES

Galls were collected at Cacharel, 3 km East of Saintes Marie de la Mer (Camargue) on October 15 and 31, November 15, and December 1, 1991; at Montferrier, north of Montpellier on December 1, 1991; and at Aigues Mortes on July 12, 1992 and March 30, 1993.

Dried and living eriophyids were prepared using the usual methods applied for light microscopy (JEPPSON *et al.*, 1975) and scanning electron microscopy observations (NUZZACI & VOVLAS, 1976; NUZZACI *et al.*, 1991).

HOST SPECIFICITY STUDIES

[1] The name genus of the eriophyids here listed is according to AMRINE & STASNY (1994). The question marks indicate that the name genus can not be ascertained because the description of the species is obscure, incomplete or absent.

Plants of various local *Tamarix* species and US plants, grown from cuttings, and galls generally coming from Camargue were used. The following studies were carried out:

TEST I - Twelve *T. gallica* plants, cultivated in a pot of 25 cm diameter, were infested with 20 galls on February 4, 1992. The galls were opened to allow the mites to move to the new plants, and were placed on the green branches. The plants were in good condition and had new branches, up to 25 cm long. The mean temperature was 15.5°C (range 9-22) and the mean relative humidity (RH) was 55.76% (range 22-84). The plants were checked on March 2, 1992.

TEST II - *Tamarix* cuttings were grown and allowed to develop suitable new branches. On March 30 and 31, 1992, the following plant species were infested with the mite:

- *T. aphylla* (L.) Carsten from USA,
- *T. gallica* L. from France (as control plants),
- *T. parviflora* D.C. from France,
- *T. ramosissima* Ledeb from USA.

The plants were in good condition and two replicates of each species were made. The method of infestation was the same as for TEST I. The plants were kept for 24 hours in the laboratory and were covered with transparent plastic covers to increase humidity. Then they were kept in an unheated greenhouse at a mean temperature of 14.5°C (range 6-34) and a mean RH of 77.6% (range 35-97). The plants were checked on April 30, 1992.

TEST III - *T. aphylla*, *T. gallica*, and *T. ramosissima* were infested on August 8, 1992 with a sample of the mites collected on *T. gallica* in Aigues Mortes (five replicates per species), and another five plants were infested on August 11, 1992 (total ten replicates per species). The same method as for TEST I was used for the infestation of plants. These were covered for three days with a transparent plastic tube with two holes covered with nylon screen for aeration, and were sprayed daily with water to provide high humidity. They were kept in a shady place outdoors. The plants were checked on September 14, 1992.

TEST IV - Branches of *T. ramosissima*, *T. parviflora*, and *T. gallica* as a control plant were brought into contact with the branches of a well-infested *T. gallica* to verify if the mites would move from the infested plant to an uninfested one. All were potted plants and in good condition. The test was started

in mid July, 1992.

TEST V - Small cages were placed around four individual branches of *T. ramosissima* and four individual branches of *T. gallica* in pots. The air was saturated to 100% RH by passing it through a water container before blowing it into the cages. The cages consisted of round transparent plastic containers (9 cm in diameter, 8 cm long) with an air inlet and three screened outlets. A small aquarium aeration pump was used to pass the air through the cages which were lined up in series. The plants were kept in a greenhouse without modifying the climatic conditions; the temperature was 21±3°C. Field collected galls, with numerous mites in each, were opened and placed on the tips of the branches in each cage. The experiment started on September 8, 1993, and the plants were checked regularly for gall formation until October 5, 1993.

FIELD OBSERVATIONS

They were made on *T. gallica* plants at Cacharel, 2-3 times per month, from October, 1991 to September, 1992.

GEOGRAPHICAL DISTRIBUTION

The data were collected from six locations in southern France during August and September, 1992. Fifteen trees were checked at each location and each tree was searched for about six minutes for the presence of galls. Every 20 meters, the next tree was checked. The mite also was found on *T. gallica* near Sigean, but no data were collected at that site.

RESULTS

The population of the galls collected in France was briefly described to compare it with galls from Greece and Asia Minor.

Protogyne (figs. 1, 2) - Wormlike, yellowish, 125-190 µm long, 35-50 µm wide (range of 10 specimens). Gnathosoma 15-18 µm long; chelicerae 13-15 µm long, bent ventrally. Dorsal shield 17-22 µm long, 16-25 µm wide, semicircular, with a 2 µm long rounded lobe over the gnathosoma. A small pit is centrally located on the rear shield margin. Dorsal tubercles on the rear shield margin 15-19 µm apart, with dorsal setae 31-40 µm long, directed posteriad. Foreleg 20-26 µm long, empodium 7-rayed. Hindleg 20 µm long. Coxae smooth. Opisthosoma with 44-53 rings, completely microtuberculate.

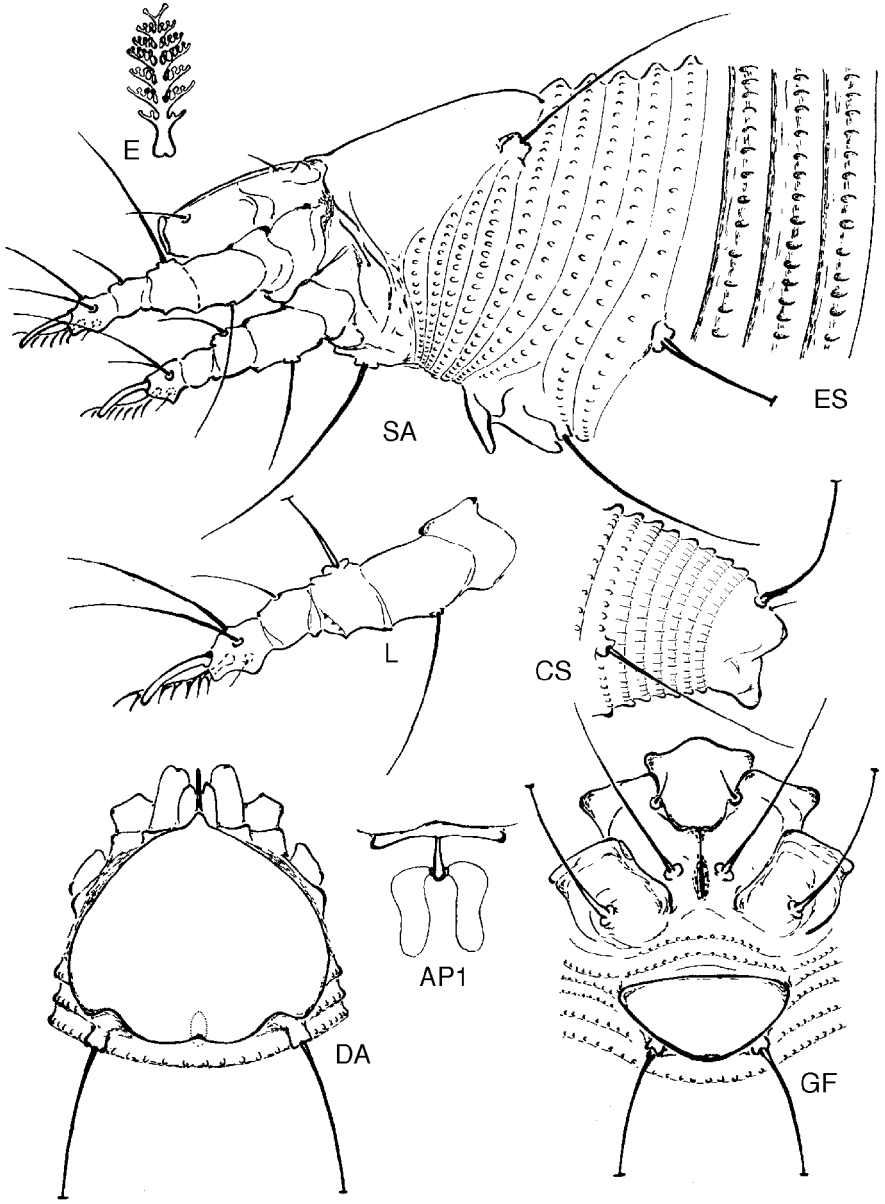

Fig. 1 - Semischematic drawings of *Aceria tamaricis* (Trotter) protogyne; abbrev.: AP1, internal female genitalia; CS, lateral view of caudal section; DA, dorsal view of anterior section; ES, lateral view of tergite-sternite region; E, empodium; GF, coxae and epigynum; L, foreleg; SA, lateral view of anterior section.

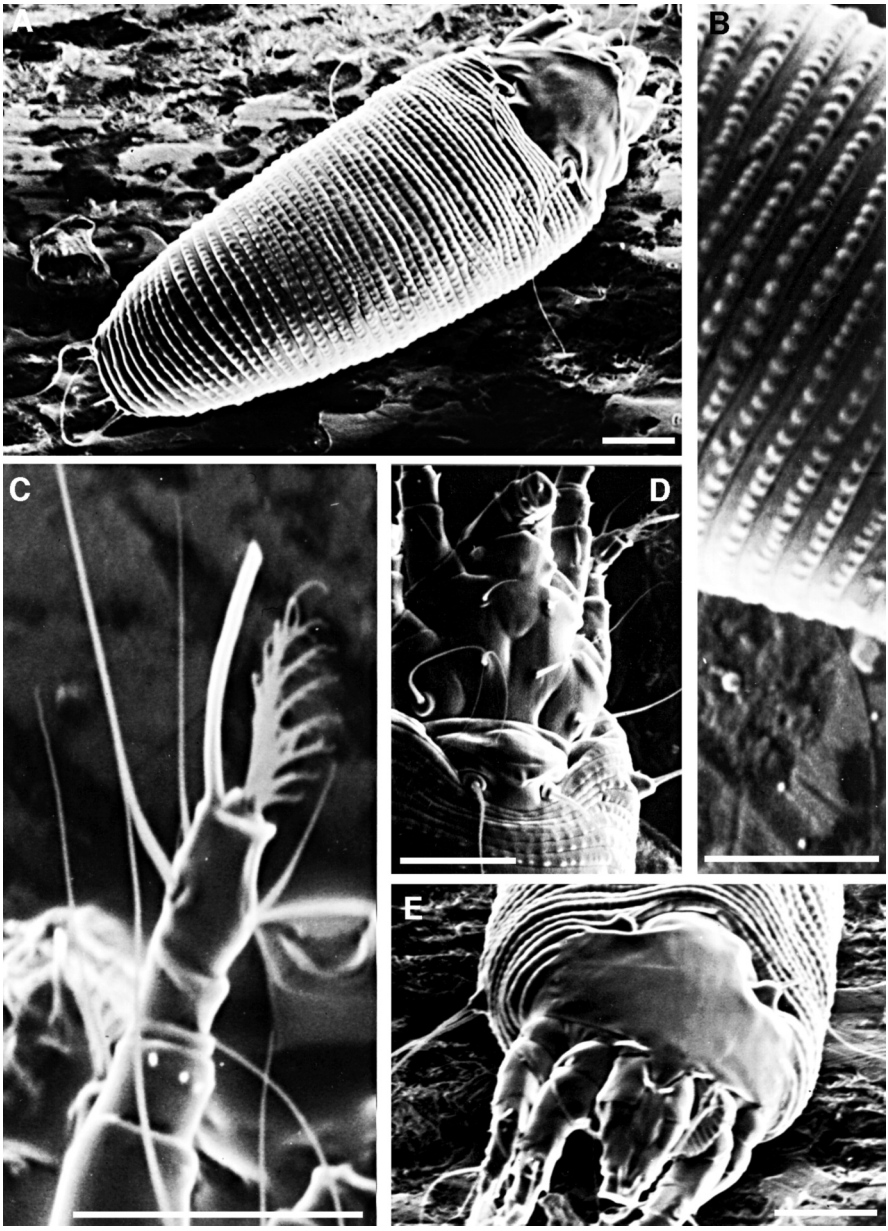

Fig. 2 - Scanning electron micrographs of *Aceria tamaricis* (Trotter) protogyne: A) dorsal view; B) detail of the microtubercles; C) detail of the foreleg; D) coxae and epigynum; E) detail of the dorsal shield. Scale bar = 10 μm.

Microtubercles elliptical. Lateral setae 30-40 µm long, first ventral setae 35-55 µm long, second ventral setae 30-40 µm long, third ventral setae 25-35 µm long. Last 5 rings with elongated tubercles. Caudal setae 65-75 µm long, distally very thin, accessory setae 3 µm long. Genitalia 7-9 µm long, 14-15 µm wide; epigynum smooth; genital setae 7-9 µm apart, 25-35 µm long.

Deutogyne - Almost similar to the protogyne; it has less marked and more elongated microtubercules.

Male - Similar to the protogyne.

Relation to the host plant

Galls were observed usually on the apex of new twigs during the spring and were present throughout the year. The galls are 2-5 mm long and 1-1.5 mm in diameter, elongated, conical or irregularly shaped. They are produced owing to an abnormal growth of the leaves. In particular the basal part of the leaves become longer and wider, twice the size of normal leaves and their inner surfaces have many irregularities; generally the distal part is longer and relatively thin. The leaves look like scales and are very close together. Large populations of mites at all stages plus their eggs were found between the deformed leaves and between the bases of the leaves and the stem.

HOST SPECIFICITY

TEST I - Well developed galls were found on the test plants.

TEST II - New galls were seen only on one *T. gallica* plant (control). No galls were found on the other plants.

TEST III - Gall formation occurred only on three *T. gallica* plants.

TEST IV - On September 14, 1992, one well developed gall was found on *T. ramosissima* and a few galls were found on *T. gallica* (control).

TEST V - No gall formation occurred on any of the plants. However, when the branches were checked under a stereomicroscope, living mites were found on all of them, except one.

FIELD OBSERVATIONS

The galls were present during all visits. During the winter months most trees lost their leaves. However green leaves were left on some trees and many galls, full of mites, could be found on them. In early spring, when new

growth occurs, the mites attack them. The fate of the mites that fall to the ground along with the infested leaves is unknown. Young galls are green, turn to purple or yellowish, and finally dry out. The yellowish and dried galls are normally empty or contain numerous tarsonemids, including an undescribed species of *Acaronemus* (Acari: Tarsonemidae) quite probably predaceous on the eriophyids (Lindquist, pers. com.), while the others contain numerous eriophyids in various stages as well as their eggs, sometimes associated with the tarsonemids. Fifty field collected galls were examined under a stereomicroscope on September 8, 1993. Ten of them contained only predators, nineteen only the eriophyids, seventeen both *Acaronemus* sp. and eriophyids, and four were empty.

Distribution in southern France

The mite was found in five of seven natural populations of *T. gallica*, which were inspected in southern France (fig. 3). No data were collected at Sigean. The degree of infestation at various locations and between individual plants was variable (tab. 1).

Location	Date	Number of trees, with degree of infestation, based on the number of galls per tree				
		High (>100)	Moderate (21-100)	Low (6-20)	Very low (1-5)	None (0)
Aigues Mortes	21/8	3	1	5	0	6
Cacharel	24/8	0	3	8	4	0
La Grande Motte	24/8	1	3	3	8	0
Mejanes	24/8	4	6	4	1	0
Maguelonne	24/8	0	0	0	0	15
Agde	15/9	0	0	0	0	15

Table 1: Degrees of infestation of *Tamarix gallica* L. by *Aceria tamaricis* (Trotter) in southern France, 1992 (15 trees checked at each location).

DISCUSSION

Recently, the morphology of the protogyne and deutogyne of *A. tamaricis* has been correctly ascertained studying Trotter's original material from Asia Minor and galls from Greece by Castagnoli (1992). It has been revealed that, on the contrary from Trotter's description, *A. tamaricis* does not have any lines on the dorsal shield. All of the essential morphological characters, i.e. shape and pattern of the dorsal shield, size and shape of the lobe over gnathosoma, number of the opisthosomal rings, absence of ribs on the epigy-

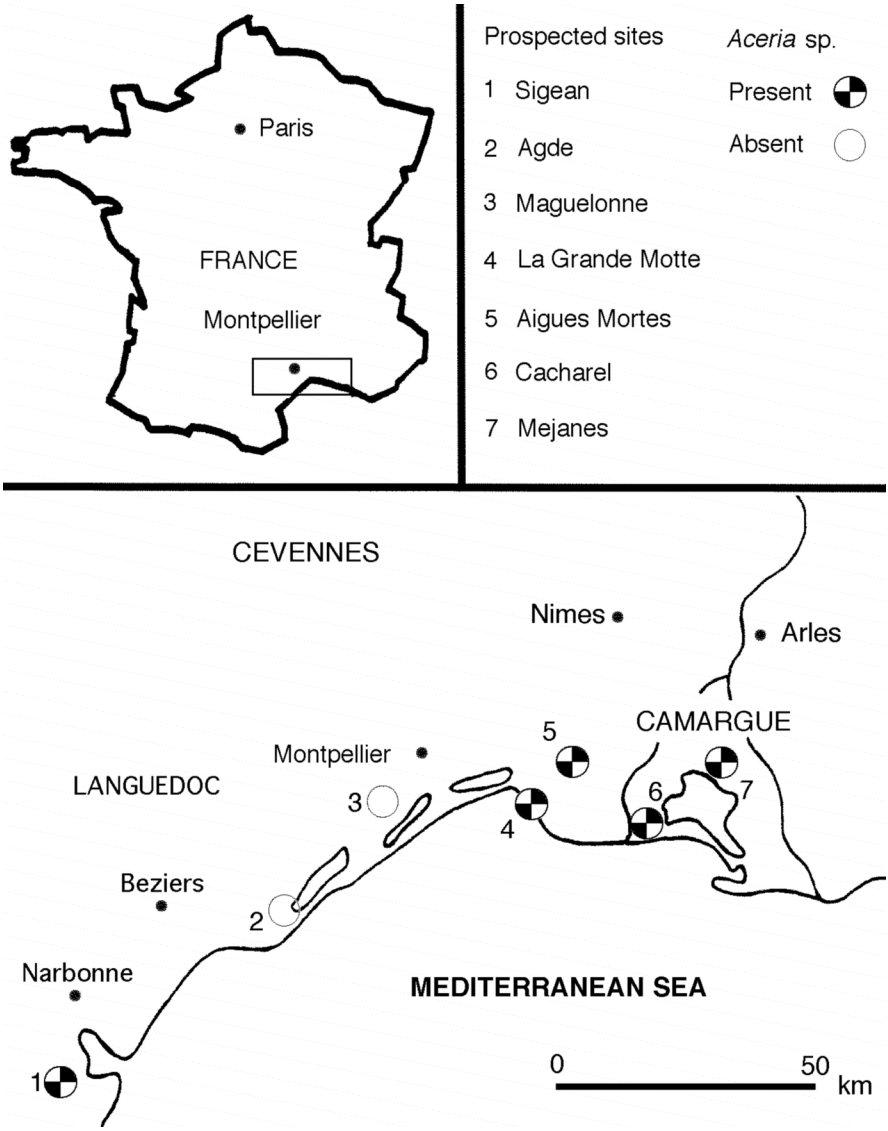

Fig. 3 - Locations where *T. gallica* L. plants were examined for presence of *Aceria tamaricis* (Trotter).

num, etc., of the population collected in southern France are similar to the description given by Castagnoli (1992). The more significant differences regard the shape and size of the microtubercles, fewer empodium rays, a different length of the lateral, ventral and genital setae, the length proportion

between ventral I/lateral setae and ventral II/ventral I setae, a shorter body. These morphological differences, however, can be considered within the limits of the intraspecific variability and therefore not enough to create a new species. The morphology of the galls from France also differs from the galls found in Greece (both were collected by the junior author). The mature galls from Greece are like hard knots 4-8 mm diameter (CASTAGNOLI 1992), and are more or less round, while the galls found in France are smaller, softer and often elongated.

A review of available information on the eriophyid species found until now on *Tamarix* spp. revealed that there are no morphological descriptions and no illustrations of all species, particularly for Dçbski's species, but for which there are the descriptions of the deformations on the plants. Therefore a comparison of *A. tamaricis* with Dçbski's species on the basis of their morphological details was not possible, but the leaf deformations observed in France on *T. gallica* appeared very similar to those made by *E.? strobilobius*. In addition, *A. dioicae* is very similar to *A. tamaricis* in regard to measurements, the number of the rings and some other details. The dorsal shield of *A. dioicae* shows two rear margin lobes on the inner side of each dorsal tubercle and two lateral lobes below the dorsal tubercles which are not recognizable in *A. tamaricis*. Moreover *A. dioicae* has been reported causing small bud galls without any other explanations or illustrations.

The host specificity studies show that *T. gallica* was almost always infested by *A. tamaricis*, especially in test I during February and less in the other months. Particularly in test V during September, the mite was able to spread but the plants were not receptive. On the other hand, no galls were found on the other species, except for one case on *T. ramosissima* in test IV.

CONCLUSIONS

On the basis of the morphological observations, *A. tamaricis*[2] seems very similar to *A. dioicae* in regard to the morphological aspect of the mites, and very similar to *E.? strobilobius* in regard to the symptoms caused in the host.

On the basis of the field observations and tests it seems that the mite found on *T. gallica* in southern France does not attack *T. ramosissima* and *T. aphylla* from the USA, and *T. parviflora*. We presume that the mites migrate from old galls to new buds during the early spring, and overwinter as female

[2] Attempts to obtain the original materials of *A. dioicae* or new material from the original Egyptian localities were not successful.

populations, such as for other gall-making eriophyids.

The importance of the *Acaronemus* sp. was not ascertained.

It is likely that near the centre of origin of *T. ramosissima* in Central Asia there is an eriophyid mite that would attack this species in the USA. *Aceria* mites from other parts of the world might also attack the US plants, especially mites from the southern parts of the former USSR. The Flora Europaea (TUTIN *et al.*, 1964) reports *T. ramosissima* from the southern part of the former USSR (southwestern region, Crimea, southeastern region); it is not reported in the Flowers of Europe (POLUNIN, 1969) or in the Flora of Turkey (DAVIS, 1975). We suggest that there be exploration for gall mites on *T. ramosissima* in its native area and they be tested against *T. ramosissima* from the USA.

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RIASSUNTO

TASSONOMIA, DISTRIBUZIONE E SPECIFICITÀ DI UN ERIOFIDE GALLIGENO, *ACERIA TAMARICIS* (TROTTER) (ACARI: ERIOPHYOIDEA), ASSOCIATO A *TAMARIX GALLICA* L. (PARIETALES: TAMARICACEAE) IN FRANCIA MERIDIONALE

Sono riportate le caratteristiche morfologiche di una popolazione di *Aceria tamaricis* (Trotter), galligeno su *Tamarix gallica* L. in Francia meridionale, e confrontate con quella utilizzata per la ridescrizione della specie eseguita da CASTAGNOLI (1992), evidenziando le differenze, e con le altre specie finora note su *Tamarix* spp.

Lo studio della specificità ha rilevato che *A. tamaricis* infesta quasi sempre *T. gallica* mentre non attacca *T. aphylla* (L.) Carsten, *T. parviflora* D.C. e *T. ramosissima* Ledeb.

Sono state eseguite, inoltre, osservazioni sulla biologia e distribuzione geografica in Francia meridionale.

Parole chiave: morfologia, infestanti, controllo biologico.

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