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The Gall Species of Quercus Suber Leaves in Cork Oak of Northeastern Algeria

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ABSTRACT

The observation of the cork oak leaves revealing the existence of very numerous and diversified spectacular structures, is called the galls. We studied these in two regions of Northeast of Algeria: the cork oaks of El-Kala and Souk-Ahras. Preliminary results show the presence of four frequent species during two years of study, 2015 and 2016: Dryomyia lichtensteini, Neuroterus saltans, Neuroterus minutulus, and Eriophyes species. We counted up to 40 galls / leaves; the lesions were located mainly in the first and second class of leaves with 1-5 and 6-10 galls / leaves, respectively. The other classes are poorly represented. We also found some specific associations with the same leaf N. minutulus and N. saltans in two study areas rating 46.15% for El-Kala and 87.5% in Souk-Ahras. Other associations exist and vary with the region and year of harvest.

Keywords: *Quercus suber, leaves, Galls, El-Kala, Souk ahras*

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INTRODUCTION

The cork oak hosts and nourishes a very diverse fauna where insects play a vital role. They lower the quality of this forest species by causing considerable damage. They attack each part of the tree: fruit, stem, root, buds and leaves (Villement and Fraval 1991). This is the case of galls, a vegetative formation from an abnormal growth of the plant. It is also defined as a fruit resulting from the combined action of two distinct organisms, or two independent genetic heritages coming locally in intimate interaction (Mani 1964; Dajoz 1980; Giuntoli 1985; Pujade-Villar 1986; Mayer 1987; Shorthouse and Rohftitsch 1992; Dauphin 1994; Buss 2003). A gall formation might be due to various organisms: bacteria, fungi, or animals. The mites and insects, which are the main animals responsible for the formation of galls, are called cécedozaires (Dajoz, 1998).

The galls are found on many plants, almost 50% of them known in the northern hemisphere are located on trees of the Fagaceae family and especially on oaks and beeches. The various organs are gained with varying frequencies. On the oaks, 2% of galls are found on the flowers, 4% on acorns, 5% on roots, 22% on buds and about 63% on leaves (Dajoz 1998). This insect diverts and consumes the nutrients and photosynthetic products of the cells or phloem of the host plant (Bagatto et al. 1996; Stone and Schönrogge 2003). Galls can also cause primitive decline of host plant organs. For example, infected leaves or needles fall prematurely (West and Shorthouse 1982; Williams and Whitham 1986; Bagatto et al. 1996), fruits abort (Stone and Schönrogge 2003), and seeds become sterile (West et al. 1996). We present the preliminary results on the galligenic species that attack the leaves of the cork oak in the forests of northeastern Algeria. These galls might be responsible, directly or indirectly, for the health status of these stands. We identify and evaluate the different gall species as well as their density and coexistence on the same affected leaf.

MATERIAL AND METHODS

2.1. Presentation of study areas

The cork oak leaves were harvested during 2015 and 2016 in the cork oak forest of North-Eastern Algeria: El-Kala and Souk-Ahras.

El-Kala is located in the far northeast of Algeria, in the sub-humid bioclimatic stage during warm winter. The existence of exceptional natural wealth, the multitude of plant and animal species, the juxtaposition of different ecosystems (marine, dune, lacustrine and forest) were in the awareness of the region classification. El Kala National Park with 76,438 ha area is located between 36 ° 55 'and 36 ° 90' N and 08 ° 16 'and 08 ° 43' E. Belonging to the northeastern part of the Algerian Tell, the El Kala National Park is limited to the North by the Mediterranean Sea, to the East by the Algerian-Tunisian border and to the South by the Medjerda mountain.

Souk-Ahras is located in northeastern Algeria (36 ° 17'11 "N, 7 ° 57'4" E). This one is limited to the Northeast through El Tarf, to the northwest through Guelma, to the south through Tébessa, to the southwest through Oum El Bouaghi and to the East through Tunisia. This forest (12000 ha) covers 12.47% of the cork oak forests in Algeria. The cork oak forest is located in the north of the Souk-Ahras composing of five states. Ouled

Bechih forest with 6582 ha area mainly is made of cork oak and zeen oak. The Fedj Mecta forest with 683 ha area is made of cork oak and zeen oak.

2.2. Method of evaluating galls on leaves

We identified and described the galls on the cork oak leaves, noted the number of galls per leaf in classes (Adjami 2016), counted total number of galls, species, and galls' species. We also calculated the cohabitation rate of them at the level of the same leaf (Table 1).

Table 1: Grade classes of number of galls per leaf

Category	Number of galls per leaf
C1	1-5 G
C2	6-10 G
C3	11-15 G
C4	16-20 G
C5	21-40 G

RESULTS:

3.1. Description of galls:

The galls found at the level of the cork oak leaves are growths affecting the lower face of the limb and the veins with blister formation in different shapes and sizes depending on the species. Several gall species can attack leaves either individually or in combination.

3.2. Number of galls per leaf:

We harvested leaves of up to 40 galls at El Kala. The highest rate of gall infestation was observed at first class leaves (1 to 5 galls per leaf) for two study fields, El-Kala (76.13%) and Souk-Ahras (75%). , 41%). Leaves belonging to the second class (6 to 10 galls per leaf) showed approximately similar rates for these leaves, i.e. 17.23% and 18.44%, respectively. A few leaves belonged to the 3rd and 4th class (Figure 1).

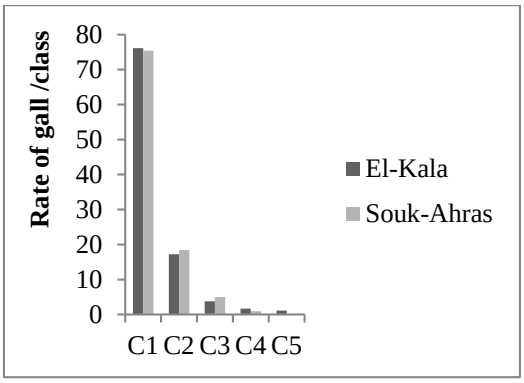

Figure 1: Evaluation of the galls density at the level of the cork oak leaves in El-Kala and Souk-Ahras oak forests

3.3. Distribution of gall species per leaf:

On the leaves harvested at the El Kala cork oak, we identified four species of gall, the most frequent attacks were those of Dryomyia lichtensteini. In 2015, the impact of this species was significant, it got to 93.04%, however, there was a sudden decrease in the following year, i.e. 18.26%. There was also the presence of Neuroterus saltans, which affected 6.95% of leaves in 2015, while there was a remarkable increase in 2016 (33.04%). Neuroterus minutulus was absent during 2015 and appeared weak in 2016 (2.6%). It is worth noting that the sudden appearance of Eriophyes sp climbed up in 2016 with a significant percentage of 46.08% (Figure 2).

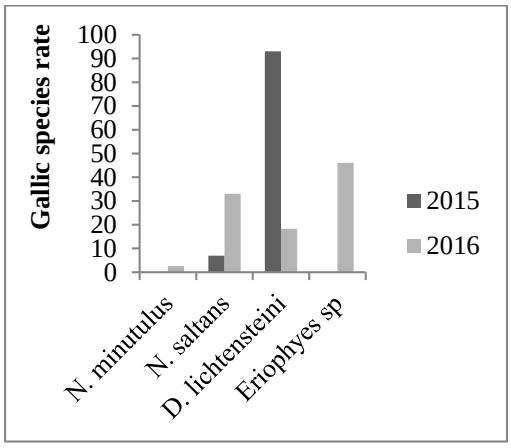

Figure 2: Distribution rate of gall species in the leaves of the El Kala cork oak

At the level of the cork oak leaves of the Souk-Ahras region, there was an abundance of D. lichtensteini developing at the rate of 80.93% in 2015; however, a sudden decline was observed in this species at the rate of 65.1% in the following year. N. saltans was present at 14.42% in 2015, and decreased to 3.6% in the second season of observation. The presence of Eriophyes sp was reported in 2016 at 31.25%. Eriophyes sp was absent in 2015 while N. minutulus was absent in 2015 (Figure 3).

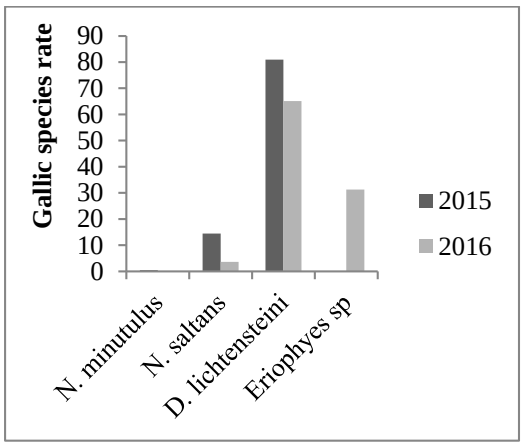

Figure 3: Distribution of the gall species in the leaves of the cork oak of Souk-Ahras

3.4. Galls associations:

The different galls found at the level of cork oak leaves could develop in association with the same leaf. The cohabitation of certain species of galls was observed in the leaves of the El Kala oak trees, where N. minutulus and N. saltans are found, occupying almost half of the leaves harvested at 46.15%. The presence of N. saltans and D. lichtensteini in the same leaf rated 30.77%, whereas the association of N. minutulus and D. lichtensteini was reported at 23.07% (Figure 4).

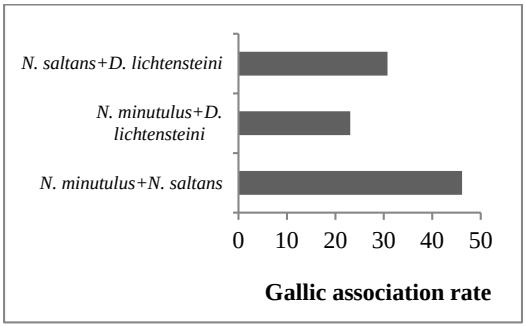

Figure 4: Association of gall species at the cork oak leaves of the El-Kala region

On the leaves of Souk-Ahras forests, a strong association of N. minutulus and N. saltans (87.5%) was seen; the other one was reported by D. lichtensteini and Eriophyes sp, (12.5 %). No other association of galls has been observed in the forests of this region (Figure 5).

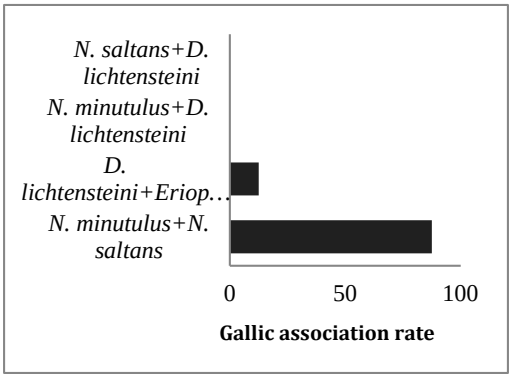

Figure 5. Association of gall species at the cork oak leaves of the Souk-Ahras region

DISCUSSION AND CONCLUSION

The insects most involved in the formation of galls are the Cynipid Hymenoptera and the Trehidae, the Diptera Cécidomydes and the Homoptera Chermesides. Other orders just play a secondary role. Two main families of gall mites are Tarsonemids and Eriophyds. Gallic insects and mites are interesting because of their original biology and very complex development cycle. Some species are harmful (Dajoz, 1998).

The galls of the leaves are very frequent: it can be a fold of the margin of the blade, of flattened structure (Macrodiplosis pustularis on oak) or by winding, with or without thickening (Triozaalacris on laurel). The presence of the parasite at a point on the lower limb can lead to the formation of a pouch that encloses the animal (Tetraneura elms) and has a mechanism of spontaneous opening allowance of the departure of parasites.

Often the parasite is included in a limb hypertrophy, more or less spherical, without orifice, unilateral (Cynips quercusfolii oaks) or bilateral (Pontania proxima willow) and the parasite must force an exit hole. Another typical case is the numerous "podded" galls, which form a thickened fold at the level of the midrib containing the larvae. (Dauphin, 2012).

The leaf examination allowed us to identify 4 species on Quercus suber trees in our EL-Kala and Souk-Ahras study areas at different rates depending on the region and year, Dryomyia lichtensteini, Neuroterus saltans, Neuroterus minutulus and Eriophyes sp. The most abundant gall is D. lichtensteini Mediterranean distribution in the shape of a small irregularly ovoid pouch hard, greenish, covered with a fine white pubescence and located on the underside of the limbus (Villement & Fraval 1991). According to Ghanem, it is caused by Diptera (Cecidomyidae), the large number of leaves attacked by this species does not affect the general appearance of forests (2014).

Neuroterus minutulus, found in the lower part of the leaves, is thrilling to collect. It has been recently found on Q. suber and Q. afares for the first time in Tunisia. (Pujade-Villar et al. 2011). In Tunisia, the species is locally abundant, contrary to what we found in Algeria, a poorly represented species (5%). On the other hand, Neuroterus saliens has been reported on Q. suber in Algeria (Marchal, 1897, Pujade-Villar et al., 2010) and in Tunisia. It presents a heterogonic cycle in which sexually generated galls are formed in young people buds and are stuck to deformed acorns and those of the asexual generation are reported on leaves of the cork oak. This species is more frequent than N. minutulus and its number increased in 2015, especially in El-Kala cork oak at a rate that exceeds a quarter of the leaves, but decreases in Souk-Ahras to almost 4%. This species is reported in some central European countries still on Q. cerris (Pujade-Villaret al, 2012). All Eriophyides are not galligenic, but often form cecidia in small pockets, or in coiling, or a pilous hypertrophy of buds. Their galls can affect all plant organs, except the roots (Dauphin, 2012).

The species Eriophyes sp. (Eriophydae) has been reported in the main cork oak forests of the Maghreb (De Lepiney and Mimeur 1932). In 2015, it appeared suddenly and significantly in El Kala and affected almost half of the leaves, however, in Souk-Ahras its presence did not exceed a quarter of the leaves. Eriophyes sp. causes on the leaves of the cork oak almost hemispherical blisters, up to 5mm in length. They correspond on the lower side to depressions furnished with simple long cylindrical hairs, first whitish then brownish. Often blisters are numerous and contiguous, or confluent, and the leaf curls (Villement & Fraval 1991). Midge can include up to 100 cecidia, Benia (2010), galls are sometimes numerous (up to 40) on the same leaf is the case of D. lichtensteini (Villement et Fraval1991; Daas 2016) counted up to 15 galls. In some cases, galls cover 80 to 90% of the leaf surface and such a density explains the appearance of intra and interspecific competition, especially around water, which plays an important role in the formation of galls. In our study, we fond the presence of several galls at the level of the same leaf of different species or the same species that can be achieved up to 40 galls per leaf in El-Kala and Souk-Ahras, whose results are almost Similar.

We also noted a cohabitation of some species, the most important being the presence of two Cynipidae together on the same leaf. Indeed, N. minutulus and N. saltans settle on almost 50% of the leaves of El Kala and more than 80% in Souk-ahras. Another cohabitation concerns the presence of Cynipidae and Cécidomyidae together, N. saltans and D. lichtensteini, or N. minutulus and D. lichtensteini. These two categories of associations are found only at the level of the leaves of the El Kala. For the cohabitation of two different families of Diptera and mites (Cecidomyidae and Eriophyidae) D. lichtensteini and Eriophyes are reported respectively only at Souk-Ahras.

According to Askew (1961), when many species exploit the same resource, competition can be avoided by resource sharing through spatial distribution of the stand.

Competition is reduced by the mode of distribution of galls, Neuroterus numismalis is more abundant near the top of trees and on the leaves in the periphery of the crown, Neuroterus laeviusculus settles mainly near the base and near the trunk and Neuroterus lenticularis occupies an intermediate position. When the three species coexist on the same leaf, the galls of N. numismalis are concentrated towards the apex, those of N.

laeviusculus towards the base and those of N. lenticularis towards the center. We have found, in a preliminary way, that the cohabitation of the gall species on the same family as for the Cynipidae (N. minutulus and N. saltans), their presence is more important than that of the species which belong to different families. This is confirmed by Askew (1961), when he studied the position of 3 species of Neuroterus that coexist together, making a dispersion and a specific position on the same leaf, indicating nutrient sharing. The analysis of the position of the galls on the leaves reveals a subtle but effective sharing of resources.

Insects' galls are in direct competition with the organs or tissues of its host plant, which often provide the essential energy for gall formation, feeding and complete development of its occupant (Bagatto et al. 1996; Stone and Schönrogge 2003). This plant compensates for this lack of energy by increasing its photosynthesis (Bagatto et al. 1996). The insect diverts and consumes the nutrients and photosynthetic products of the cells or phloem of the host plant (Bagatto et al. 1996; Stone and Schönrogge 2003).

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