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Research Article

Chronology of Gall's emergence of *Dryomyia lichtensteini* F.Löw, 1878 (Diptera: Cecidomyiidae) and its effect on *Quercus ilex*'s Sanitary state in Setif (Algeria)

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ABSTRACT

In the last years, an insect is detected on the foliage of *Quercus ilex* trees in Algeria (North-East region). *Dryomyia lichtensteini* F.Löw, 1878 (Diptera: Cecidomyiidae), The Chronology of Gall's emergence of *Dryomyia lichtensteini* and its field infestation rate were followed since 2014, in evergreen oak plantation in the Algerian North-East Region (Setif). Some statistical methods of Gall's emergence of this pest and its effect on *Quercus ilex*'s Sanitary state are reviewed and discussed. For each study area (North-South-East-West), 10 trees were marked. 30 leaves of each tree were removed, so it is 300 leaves for each site, which were analyzed. This study is based on the number of galls observed. In order to highlight the degree of attack of pests. The outputs were made from November 2014 to November 2016, due to one output per month.

Keywords: *Quercus ilex*, Cecidomyiidae, gall inducers, Algeria

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1. INTRODUCTION

Quercus ilex L., known as holm oak or evergreen oak, is a broadleaved tree or shrub, which can grow up to 25 m. It is characterised by coriaceous dark green leaves with a woolly lower side, and small acorns. It is native to the centralwestern Mediterranean basin, where it represents the dominating species in woodlands and maquis vegetation. It is a shade-tolerant species regenerating under the canopy cover, but it is also a vigorous root re-sprouting species. In Europe it thrives in meso-Mediterranean bioclimates, where it is not too dry, forming well-structured forests rich in species. Managed principally as coppice forests, its hard wood has been used for the production of charcoal, firewood, railway sleepers and small tools. In the Iberian Peninsula the holm oak woodlands are historically managed as pastures with large isolated trees where livestock feeding on the grass and acorns. Fungal pathogens can create severe damage especially to drought suffering trees. As other oaks it is also damaged by several defoliating lepidopterans. For millennia Mediterranean holm oak forests have suffered for human activities, which have exploited, modified the species mixture and in many cases replaced woodlands with agriculture and urban areas ¹.

The natural distribution of holm oak occurs principally in the central-western part of the Mediterranean basin, covering

from Portugal and Morocco, to the Aegean Islands and western Turkey, expanding also northward up to northern Italy and France. It also occurs in a few localities in Anatolia on the coast of the Black Sea ^{2,3}.

Despite its robustness, this tree is subject to many factors including degradation, for some time, that of parasitic insects that mostly is fatal.

An insects was detected on the foliage of *Quercus ilex* trees in Algeria (North-East region): *Dryomyia lichtensteini* F.Löw, 1878 (Diptera: Cecidomyiidae). This insect is gall inducer and cause damages mainly to *Quercus ilex* trees.

Larvae develop in galls on leaves of *Quercus ilex* L. (Fagaceae). The gall is egg-shaped or hemispherical on the lower part with an opening on the upper side of the leaf. One generation develops a year ⁴.

The midge opens by the upper surface of the leaves; we observe a slightly curved elongated cleft whose thick border has at one of its ends a small opening ⁵.

These galls, the midge, are in the form of small ovoid pouches of 3x2 mm and about 2 mm high. Generally, a leaf carries several galls (up to 100), and when they are too many leaves can look distorted. The development of each gall is induced

and fed by secretions produced by a reddish larva about 0.25mm long (one larva by gall).

Dryomyia lichtensteini, by its repeated attacks, could lead to photosynthesis slows down, deformations of the leaves and young stems and to reduction of tree growth, but this gall is not considered a real threat to the oak grove.

2. MATERIALS AND METHODS

2.1. Study area

Our study concerns the Algerian North-East region (Setif). two areas were chosen to translate continentality gradient in the region. Beni Aziz is the first area located in north. [36° 28'N 5° 39'E], in the bioclimatical sub-humid with warm winter (precipitation of 700 mm / year), the second area is Ouled Tebben in the South [35° 48'N 5° 06' E], is located in the semi-arid with temperate winter (precipitation of 350 mm / year).



Figure 1: Location map of the study area and sampling sites.

2.2. Sampling Method of leaves

First, after exploration, we selected the most affected trees, second, we organized the samples of each tree, we respected the orientation (North-South-East-West). For each study area 10 trees were marked. 30 leaves of each tree were removed, so it is 300 leaves for each site, which were

analyzed. This study is based on the number of galls observed, on both sides of the leaves. In order to highlight the degree of attack of pests. The outputs were made from November 2014 to November 2016, due to one output per month.

2.3. Statistical Methodology

2.3.1. Time series

We used the method of time series that connects the time with the number of galls.

($Y = a X + b$) is a linear function determines the relationship between two variables one is dependent ($Y =$ number of galls) and the other is independent variable ($X =$ time)

2.3.1. Sanitary state

The examination of the Summit

Consists in visually assessing the vitality of the trees of the site and consequently the sanitary state of the forests. According to ^{6,7}, examination of the *Summit* reveals two main symptoms: Defoliation (leaf loss) and discoloration (abnormal staining). These are considered as true indicators of vitality.

This study was done in November 2015 to November 2016 in accordance with the chronology of Gall's emergence of *Dryomyia lichtensteini*, to show its effect on the sanitary state of *Quercus ilex*.

The defoliation:

It represents the possible leaf deficit of the studied trees compared to a reference tree presenting an "ideal" state in the station considered in the functional part of the crown (Figure.2). It indicates the state of vitality of forest stands and therefore the primary productivity of forests.

According to ⁸, defoliation is a widely used indicator in Europe for assessing the sanitary state of forest trees.

According to ⁹, it is noted in the summer season by examining the branches of the tree by assigning one of the following classes corresponding to a sanitary category (Table 1).

Table 1: Defoliation Rating Classes and Major Categories of Trees Affected

| Class | % of foliage affected | Signification of classes | Class | Sanitary category |
|-------|-----------------------|---|-------|-------------------|
| 1 | 0-10 % | Undefoliated tree | 1 | sanitary tree |
| 2 | 15-25 % | Defoliated weak tree | | |
| 3 | 30-60 % | Moderately defoliated or moderately depressing tree | 2 | weakened tree |
| 4 | 65-95 % | Tree heavily defoliated or wither | 3 | dying tree |
| 5 | 100 % | Dead or dry tree | 4 | dead tree |

The discoloration: reflects a change from the color usually observed on the foliage of *Quercus ilex* (glossy dark green). It is noted in relation to foliage present. In order to evaluate the discoloration, we proceed as follows: we cut the crown in 4

equal areas, it is estimated how much of the foliage in each zone is colored abnormal and we sum the 4 zones to define the evaluation (Table 2) ¹⁰.

Table 2: Classes of leaf discoloration

| Classes | Proportion of foliage discolored | Signification of classes | Category of coloring |
|---------|----------------------------------|--------------------------|----------------------|
| 1 | 1 - 10 % | No discoloration | Normal color |
| 2 | 15 - 25 % | weakly discolored | Abnormal color |
| 3 | 26 - 60 % | Moderately discolored | |
| 4 | > 65 % | Severely discolored | |
| 5 | 100% | Very severely discolored | |

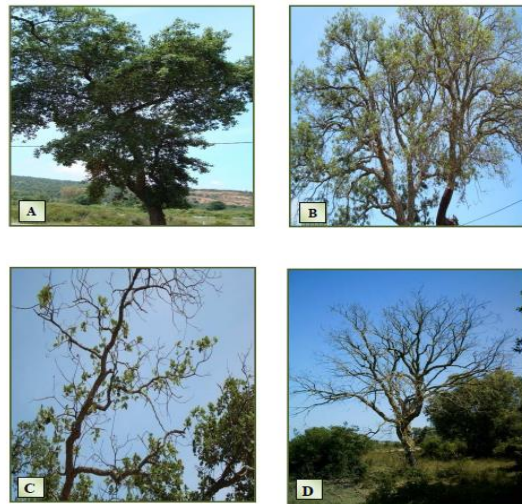


Figure 2: The main categories of trees affected according to the proportions of foliage affected. (A): sanitary tree (defoliation class 1), (B): weakened tree (defoliation class 2), (C): Dying Tree (Defoliation Class 3), (D): Dead Tree (Defoliation Class 4)

3. RESULTS AND DISCUSSION

3.1. Chronology of Gall's emergence of *Dryomyia lichtensteini*

The statistical study which deals with the number of galls caused by *Dryomyia lichtensteini* allowed us to obtain the following results (Table 3).

Table 3: Statistical results

| average study areas | <i>Dryomyia lichtensteini</i> | | |
|------------------------|-------------------------------|------------------------------|------------------------------|
| | Total number of galls | Total average (galls / leaf) | Total average (galls / tree) |
| Beni Aziz | 100080 | 13,34 | 400,32 |
| Ouled Tebben | 107795 | 14,37 | 431,18 |

Representing the results as graphs in relation to time (time series) and for each region the following curves (Fig : 3).

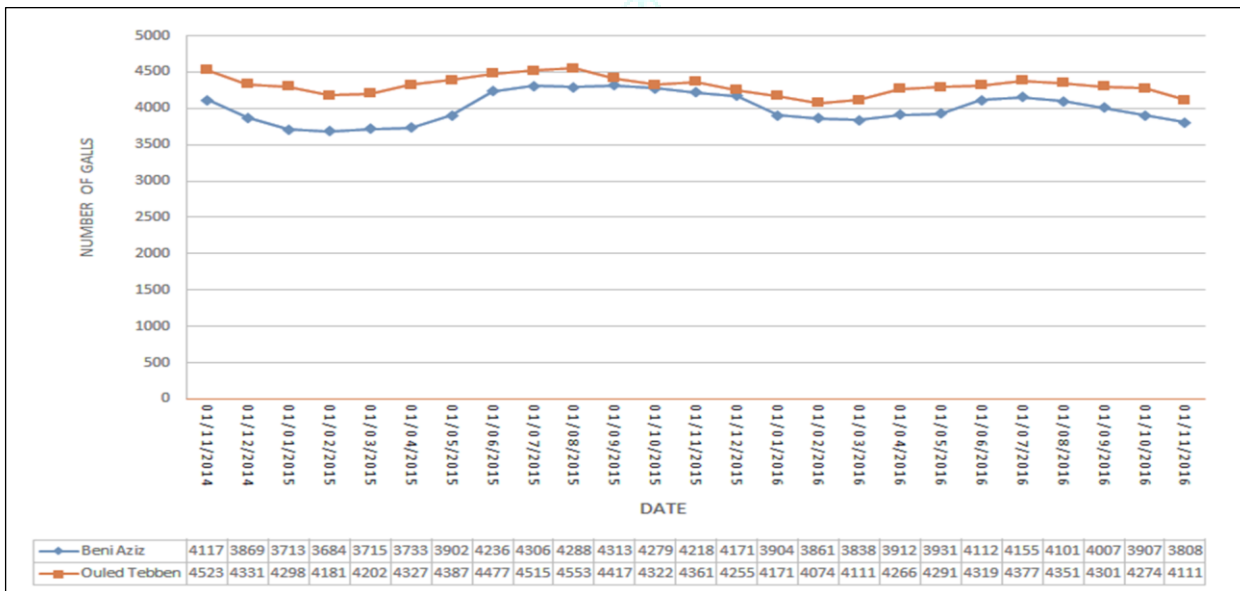


Figure 3: Chronology of the growth of galls *Dryomyia lichtensteini* of two areas.

The figure 2 shows the variations in the number of galls *Dryomyia lichtensteini*, According to the graphs obtained for each area, we notice that the number of galls increases in Ouled Tebben and decreases in Beni Aziz. But for the all areas of growth starts in spring and continues almost throughout the summer period.

The highest Infestations of galls were recorded in the region Ouled Tebben (107795 galls) with an average of (14, 37 galls

/ leaf) and (431, 18 galls / tree), followed by Beni Aziz (100080 galls) with an average of (13,34 galls / leaf) and (400,32 gall / tree).

These results correspond to the precipitation gradient from the driest area to the wettest. We observe three peaks of many galls (Spring, early Summer, early Autumn), each corresponding to a generation. autumn and spring show each time a considerable number of galls. The number of galls is

not stable throughout the year is *Dryomyia lichtensteini* because the most affected leaves fall with the damage done by the larvae, which suck the sap that nourishes the leaves. The number of galls remain low throughout the cold period because the leaves have fallen and galls have not been renewed by *Dryomyia lichtensteini*. Strong attacks induce desiccation of leaves and their fall with no cases of tree mortality has been registered

3.2. State of the Summit

Table 4: Rate of defoliation of study sites Ouled Tebben and Beni Aziz

| Classes of defoliation (%) | 2015 | | | | 2016 | | |
|----------------------------|-------------|----------------|---------------|------------|-------------|----------------|---------------|
| | C1 (≥ 25 %) | C2 (30 – 60 %) | C3 (65 -90 %) | C4 (100 %) | C1 (≥ 25 %) | C2 (30 – 60 %) | C3 (65 -90 %) |
| Beni Aziz | 70 | 27.33 | 3.66 | - | 78 | 20 | 2 |
| Ouled Tebben | 58.5 | 33.5 | 8 | - | 64,5 | 31,5 | 4 |

3.2.2. Evaluation of the discoloration.

In 2015, the site of Beni Aziz has less discoloration than Ouled Tebben with 88.5% of the sample trees with less than 10% discolored leaves. The site Ouled Tebben is the most affected by discoloration for 22.5% of trees with 25%

3.2.1. Evaluation of defoliation

The sanitary status of the sample trees is based on the overall examination of each tree on the site. The site of Ouled Tebben is most affected by leaf loss; in 2015 we recorded 58.5% with 25% defoliation and in 2016 decreases to 4% with 65-90 % defoliation. In 2015 the site of Beni Aziz is the less affected by defoliation, the loss at this site does not exceed 70% with 25% defoliation but in 2016 exceeds by 2% with 65-90 % defoliation (Table 4).

discoloration. In 2016 The Beni Aziz site remains the one with the least discoloration than Ouled Tebben with 98% of the sample trees having less than 10% discolored leaves, The Ouled Tebben site is the most affected by discoloration for 9% of the trees with less than 25% discoloration (Table 5).

Table 5: Rate of decoloration of study sites Ouled Tebben and Beni Aziz

| Classes of discoloration (%) | 2015 | | 2016 | |
|------------------------------|--------------|---------------|--------------|---------------|
| | C1 (0 -10 %) | C2 (15 -25 %) | C1 (0 -10 %) | C2 (15 -25 %) |
| Beni Aziz | 88.5 | 11,5 | 98 | 2 |
| Ouled Tebben | 77,5 | 22,5 | 91 | 9 |

4. CONCLUSIONS

Quercus ilex is an important species in Algeria. This resistant tree is still a matter of many degradation factors including those of insects.

Invasive species reported in *Dryomyia lichtensteini* is becoming more numerous and are demonstrated considerable ability to multiply. Sometimes after a very short period of time, they are able to colonize many countries, resulting in a real danger regarding to these trees in heavy infestations.

Our main objective was to try to make a statistical study by counting galls of *Dryomyia lichtensteini* galls on leaves of *Quercus ilex*. And this study has allowed us to know the damage rate *Dryomyia lichtensteini* and its effect at *Quercus ilex*'s Sanitary state

The statistical analysis of the results allows us to observe three peaks of many galls (Spring, early Summer, early Autumn), corresponding to the precipitation gradient from the driest area to the wettest.

Gall's emergence of *Dryomyia lichtensteini* effect on *Quercus ilex*'s sanitary state, most affected trees had a negative effect on the sanitary state of *Quercus ilex*. Currently, no control measure available against this species, except some observed parasitoid entomophageneda *Mesopolobus lichtensteini* of *Dryomyia lichtensteini* in the same gall.

The results obtained through our surveys and observations during the years 2015 and 2016 at the two *Quercus ilex* sites in Beni Aziz and Ouled Tebben, we were able to identify the sanitary state of the two sites, this one shows that Beni Aziz is better than Ouled Tebben in parallel with the number of

galls (the number of galls in Ouled Tebben more than Beni Aziz), but good sanitary state in general on both observation stations.

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