

Taxonomic Diversity and Structure of Malacofauna in Stations *Lavandula Angustifolia* L. (Lamiaceae) in the Garden's Park of Tlemcen (Northwest Algerian)

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SUMMARY

The Tlemcen region is located in northwest Algeria and is characterized by a semi-arid bioclimate. An approach to the diversity of the malacofauna associated with *Lavandula angustifolia* was carried out in three stations in the gardens of Tlemcen Park from February to June 2015. The specific richness of Gastropods is 7 divided between two families: that of Helicidae and that of Subulinidae. The first includes two sub-families including that of Helicinae and that of Helicellinae and the second is represented by a single species. Two species are constant (*Euparypha pisana* and *Rumina decollata*), four are accessory and only one species is accidental. The relative importance of snails fluctuates between stations and between months and seasons. In February, in the first station, the specific richness is the highest equal to 6. The malacological richness is zero in June in the three stations. The largest numbers are found in the first station. *Euparypha pisana* (Helicidae) has a frequency of 80% and an abundance of 0.46 in the second station. The majority of malacological species are collected from the surface of the soil.

Keywords: *Lavandula angustifolia*, malacofauna, diversity, bioecology, seasons, months, vertical distribution, gardens of Tlemcen Park (Algerian N.O.).

INTRODUCTION

Regarding the work on faunistics in the Tlemcen region, several of them have been undertaken on different species of host plants. In fact, in the steppe region located south of Tlemcen, a bioecological study on the fauna of *Stipa tenacissima* L. (Poaceae) including in particular Gastropods (KHELIL, 1984) preceded a publication on Arthropods in the same region (KHELIL, 1989). Bioecological studies on fauna were subsequently undertaken on *Ampelodesma mauritanicum* in the Tlemcen region by DAMERDJI and ADJLANI, 1999 and (DAMERDJI, 2002b), on the doum *Chamaerops humilis* still around Tlemcen by (DAMERDJI, 2002a) and (DAMERDJI and BOUHELLOU, 2002a). On Thyme, *Thymus ciliatus* Desf. (Labiatae) a study is made on the malacofauna by (DAMERDJI, 2010). On Genet (Fabaceae), a malacological study was carried out by (DAMERDJI, 2008). On the other hand, in the area of the Tlemcen Mountains and mainly in the gardens of the Tlemcen Park, very little work on faunistics has been carried out.

Authors have worked on the taxonomy and biogeography of Gastropods from the Iberian Peninsula and the Balearic Islands (GOMEZ, 1988); (ALTONAGA et al., 1994); (PUENTE, 1997). Other authors have carried out studies on terrestrial molluscs in very specific regions such as the valley of Najerilla (ORTIZ DE ZARATE, 1991) the municipality of Valencia (ONDINA, 1988); (MARTINEZ, 1999). GOMEZ (1988) drew up a catalog of species from the Iberian region. BIGOT and AGUESSE, (1984) deal with variations in the structure of 7 Mediterranean ecosystems highly characteristic of the Rhône delta (Camargue).

On malacofauna proper, (DAMERDJI, 1996) focuses on a bioecological study in the steppe zone of the Tlemcen region, a work that the author completes at the level of the Tlemcen Mountains (DAMERDJI, 1997a) and taking into account the impact of edapho-climatic factors on the shellfish characteristics of the terrestrial malacological population in the same region (DAMERDJI, 1997b). Again, no work has been done on Gastropods living on *Lavandula angustifolia*. This gap justifies the present work.

METHODOLOGY

Three parts are presented, the first concerns the choice of plant material, the second the presentation of the study stations and the third the methodology adopted which includes first the field work and then the techniques used to exploit the results obtained.

Choice of plant material

Thanks to the diversity of Mediterranean flora, the Algerian mountains covered by a green carpet for much of the year, among this vegetation: lavender. These shrubs are famous for their fragrant flowers and for their aromatic, evergreen foliage.

The term *officinalis* comes from the different applications of lavender in traditional medicine. The root is taproot, can grow to a depth of 4 m, and form a large, densely branched woody system at depth. The stems have a length which varies from 15 to 20 cm are short, erect, very branched. The leaves are simple, narrow and leathery, stalkless, bluish-green in color and arranged in opposite pairs. They present adaptations allowing them to reduce their transpiration (leaves with a blade rolled up from below, sunken stomata). The bracts are yellowish brown with 5-7 very distinct main veins. The flowers are shortly stalked and arranged in spikes of six or ten groups. The corolla is clearly bilabiate. Each flower is complete and independent of the others, its composition is: 4 sepals, 4 petals, 4 stamens and the ovary divided into 4 cells. The calyx is provided with hairs which contain the anthocyanin, a product thought to be responsible for coloring the flowers, a color which determines the chemical composition of the essential oil of lavender. This color varies from purple to pale blue. Intensely colored flowers that appear richer in fragrance are generally valued more because it is under the cuticle of the flower that the essential oil collects. Flowering takes place in June-August.

Used as a medicinal plant, its consumption is highly recommended. It is poisonous and may contain alkaloids. The most used parts are: the flowers, the leaves are dried in the shade. In aromatherapy, it is a panacea in itself, as it treats the most common and varied ailments. Lavender is calming and antispasmodic, useful for calming feverish coughs of the flu and asthma. It promotes sleep, soothes migraines. It relieves rheumatism. *Lavandula angustifolia* is well known for personal hygiene.

Lavender lives in sunny places and locations, in drained limestone soils, poor and dry, light sandy or a little cool. It accommodates a variety of soil types, except those that are excessively wet. All parts of the plant show excellent adaptation to a dry and arid environment. It also appreciates soils with a neutral or alkaline pH. It is propagated by sowing the seeds in spring or fall, lavender is found in the wild. It can be cultivated. In Algeria, we find at the entrance to gardens, parks, companies, schools and cultivated areas.

According to GUIGNARD and DUPONT (2007), the systematic position of officinal lavender is as follows:

Branch Spermaphytes

Subphylum. Angiosperms

Class. Eudicots

Subclass. Asteridae

Order. Lamiales

Family. Lamiaceae

Genus *Lavandula*

Genus-species *Lavandula angustifolia* L. = *Lavandula officinalis* L.

French name: Officinal lavender, True lavender, Fine lavender, Common lavender, female lavender, Italian spikenard, False spikenard, Wardrobe.

Arabic name: Khzama

Choice of study stations

The choice of stations is made taking into account the presence but above all the abundance of lavender. Other factors were taken into consideration (altitude, slope).

Station 1:

This station is located northeast of the garden with an exposure of 34 ° 51'55.27'N North and 1° 19'05.11'west. It represents a slope of about 0.8%, with an approximate altitude of 1024 m and a recovery rate equal to 75%. The plant species which dominate station 1 are: *Lavandula angustifolia* L. (Lamiaceae); *Euonymus japonicus* L. (Celastraceae); *E.latifolius* L. Mill. (Celastraceae); *Rosa canica* L. (Rosaceae); *Platycladus orientalis* (L.) Franco (Cupressaceae).

Station 2:

This station is located in the same location as the previous one but across the road with 34 ° 51'.55, 25 'North 1 ° 19'06.44' West exposure. It represents a slope of about 0.8% with an approximate altitude of 1023 m and a recovery rate ranging between about 45-50%. The dominant plant species are: *Lavandula angustifolia* L. (Lamiaceae); *Euonymus japonicus* L. (Celastraceae); *Salvia officinalis* L. (Lamiaceae); *Pinus halepensis* Mill. (Pinaceae); *Cupressus sempervirens* L. (Cupressaceae).

Station 3:

Located south of the park garden with exposure 34 ° 51'48.99" North and 1 ° 19'09. 08" West. It represents about 0.8% with an approximate altitude of 1024 m and a recovery rate of up to 45%. The recovery rate is slightly lower compared to the 2 previous stations. The plant species which dominate station 3 are: *Lavandula angustifolia* L. (Lamiaceae); *Salvia officinalis* L. (Lamiaceae) and *Santolina incana* L. (Asteraceae).

The following table shows the characteristics of the three stations studied.

Table 1: Abiotic and biotic data from the three stations surveyed

Prospected Stations	Altitude	Slope	Exposure	Recovery Rate
Station1	1024m	0.8%	North-East	75%
Station 2	1023m	0.8%	North-East	45-50%
Station 3	1024m	0.8%	South	45%

From a bioclimatic point of view, the stations studied are part of the semi-arid stage with moderate winter.

METHODOLOGY

In the field, 14 samples have been taken from February to June 2015. The samples are brought back to the laboratory where the living individuals and the empty shells are separated. These are put in plastic bags. Small species are kept in tubes, usually glass. The morphological and anatomical characters do not have the same importance from a systematic point of view. However, the shape, size, coloring and ornamentation of the shell are taken into account, as many morphological differences can help in the determination. In addition, the anatomical features, in particular of the genital system, remain decisive criteria for the identification of species. In this regard, the morphological description is based on the biosystematic study of terrestrial Pulmonary Gastropod Molluscs of the Tlemcen region drawn up by DAMERDJI (1990).

Ecological indices

Among the ecological composition indices used to exploit the results, it is necessary to mention the frequency of occurrence, abundance or centesimal frequency.

The frequency of occurrence of a species is the ratio expressed as a percentage of the number of samples where this species is noted to the total number of samples taken:

$$F = \frac{P_a}{P} \times 100$$

F is the frequency of occurrence of the species. Pa is the total number of samples containing the species considered. P is the total number of samples taken. In terms of consistency (DAJOZ, 1985) distinguish three groups. Species in the first group are referred to as constant when they are found in 50% or more of the surveys carried out in the same community. Those of the second group are incidental because they are only present in 25 to 49% of samples. Finally, accidental species have a frequency of occurrence of less than 25%.

The relative abundance of a species corresponds to the ratio of the number of individuals of the same species to the total number of individuals of all species:

$$A_{rel} = \frac{N_a}{N_a + N_b + N_c + N_{...}} \times 100$$

A_{rel} is the relative abundance of the species under consideration. N_a , N_b , N_c , are the numbers of individuals of species a, b, c.

Relative abundance provides information on the importance of each species relative to all species present.

The density of a stand is the number of living individuals of all species per unit area.

$$D = \frac{N}{P}$$

D = Density of the species. N = Total number of individuals of a harvested species "a" in the stand considered. P = Total number of samples taken from the stand considered.

Of the ecological structure indices only the Shannon-Weaver diversity and fairness indices are used. The calculation of this index makes it possible to evaluate the faunal diversity of a given environment and to compare between them, the fauna of different environments even when the numbers of individuals collected are very different (DAJOZ, 1985).

The Shannon-Weaver and distribution indices are expressed by the following formulas:

$$H' = - \sum q_i \log_2 q_i$$

$H'_{max} = \log_2 S$ (S = number of species)

H' = Diversity index expressed in bits

H'_{max} = Maximum diversity expressed in bits

Equitability (E) is defined as the ratio of calculated diversity to maximum diversity.

$$E = \frac{H'}{H'_{max}}$$

RESULTS

The results relate to the inventory of Gastropods collected from officinal lavender, their relative seasonal and monthly importance, the calculation of ecological indices and the vertical distribution of these species.

Diversity of malacological species collected from *Lavandula angustifolia*

Based on the classification of (GERMAIN, 1969a and 1969b) a systematic list of species found on lavender is established.

The results concerning the inventory of malacological species are recorded in the following list.

List of species of pulmonary gastropods recorded on *Lavandula angustifolia* in 3 stations

Helicidae

Helicinae

Macularia hieroglyphicula Michaud, 1833

Archelix punctata Müller, 1774

Archelix polita punctatiana Gassies, 1856

Archelix lactea Michaud, 1831

Euparypha pisana Müller, 1774

Helicellinae

Helicella (Cernuella) virgata Da Costa, 1778

Subulinidae

Rumina decollata

During our outings, which lasted from February to June 2015 in the 3 stations surveyed, we encountered 32 animal species. They are grouped into several classes which are: Gastropods, Annelids, Crustaceans, Arachnids, Myriapods and Insects (HELLOU, 2015). The specific richness of Gastropods is 7. They are divided between 2 families: Helicidae and Subulinidae. As for the 1st family, there are 6 species. The Helicidae family has two sub-families: Helicinae with five species belonging to 3 genera namely: *Macularia*, *Archelix*, *Euparypha*, that of Helicellinae with a single species belonging to the genus *Helicella*. The second family is represented by a single species, *Rumina decollata*.

Variations of Gastropods found on *Lavandula angustifolia* according to the seasons

The results obtained are given in the following figure:

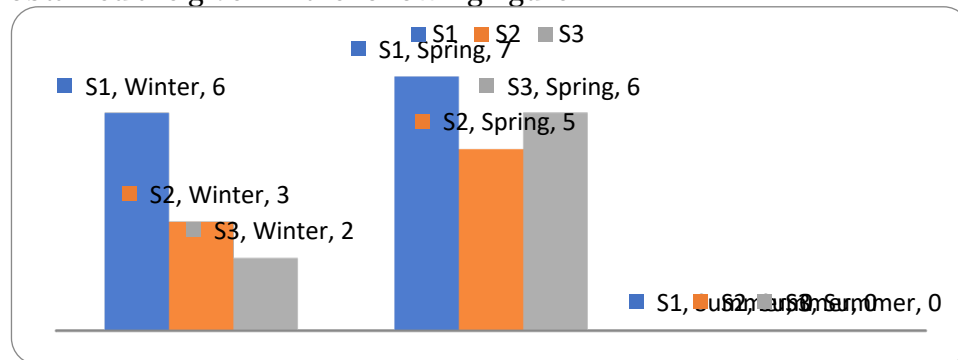


Fig. 1- Seasonal importance of Gastropods according to the specific richness in the 3 stations

In winter, stations 1 and 2 have 6 and 3 malacological species respectively.

The malacological richness is equal to 2 in the third station. In spring, Gastropods are important in the 1st station with richness equal to 7. The 3rd station has six species. In summer, the climatic conditions becoming drier, the stations do not contain any species.

Monthly variations in the wealth of Gastropods

The results for the monthly importance of Gastropods are given in the following figure.

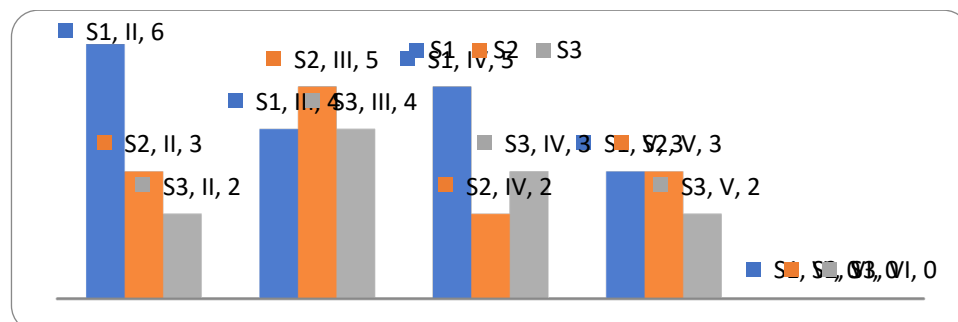


Fig. 2- Monthly importance of Gastropods according to the specific richness in the 3 stations

At first glance, the Gastropods seem to be present during the various months of prospecting except in June. In February, the first station had a malacological richness equal to 6. In June, we did not take any samples in each of the 3 stations.

Monthly variations in the number of snail individuals recorded on *Lavandula angustifolia* in the three stations

The results obtained are shown in Figure 3. They show the importance of the snails month by month, in the 3 stations.

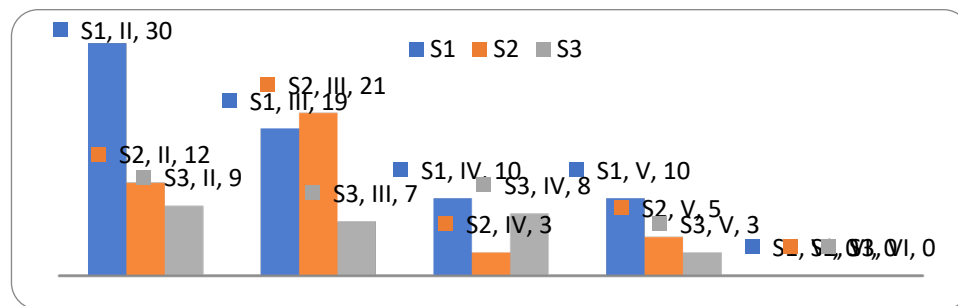


Fig. 3- Monthly importance of Gastropods according to the numbers in the 3 stations

They have a workforce that varies during the different months of prospecting. The fluctuations are between 30 individuals in February and 3 in May. In March, we collected 21 shells. It should be noted that the Gastropods are totally absent in the three stations during the month of June.

Exploitation of the results by ecological indices

All of the inventoried malacological species are taken into account for the calculation of ecological indices. The results concerning the ecological indices are placed in table 2.

Application of frequency of occurrence to snail species

Two species are constant with regard to *Euparypha pisana* (Helicidae) and *Rumina decollata* (Subulinidae), four species are accessory: *Macularia hieroglyphicula*, *Archelix punctata*, *A. lactea* and *Helicella virgata* (Helicidae) and one species is accidental namely *Archelix polita punctatiana*.

Relative abundance of snails

In the present case, this criterion sheds light on the biology of the malacofauna collected from lavender.

Table 2: Relative abundance, frequency of occurrence and density of malacological species observed in the 3 stations

Stations	Station1			Station2			Station3			Moy. (F%)	Classe of constance
Malacological species	F%	A%	D	F%	A%	D	F%	A%	D		
<i>Macularia hieroglyphicula</i>	40	0.04	0.3	30	0.12	0.5	10	0.04	0.1	26.67	Accessory
<i>Archelix punctata</i>	80	0.12	0.8	00	00	00	00	00	00	26.67	Accessory
<i>Archelix polita punctatiana</i>	20	0.03	0.2	50	0.12	0.5	00	00	00	23.33	Accidental
<i>Archelix lactea</i>	50	0.09	0.6	30	0.07	0.3	10	0.04	0.1	30	Accessory
<i>Euparypha pisana</i>	70	0.36	2.5	80	0.46	1.9	100	0.48	1.3	83.33	Constant
<i>Helicella virgata</i>	20	0.23	1.6	40	0.12	0.5	20	0.07	0.2	26.67	Accessory
<i>Rumina decollata</i>	50	0.09	0.9	40	0.10	0.4	60	0.37	1	50	Constant

Diversity or Shannon - Weaver index

The data in Table 3 allow us to calculate the SHANNON-WEAVER index in the 3 stations.

Table 3: Numbers, indices (H', H' max, E) of the different malacological species encountered in the three stations

Stations	Station 1	Station 2	Station 3
Number	69	41	27
Species present	7	6	5
H' (in bits)	2.41	2.23	1.67
H' max (in bits)	2.81	2.58	2.32
E	0.86	0.86	0.72

The Shannon-Weaver index is high at station 1. It is equal to 2.41 at this station. The lowest value equal to 1.67 is observed in the third station. Seven species are present in the first station, six species in the second and in the third station 5 species.

Distribution index applied to snail species

E: fairness greater than 0.5 tends towards 1 for each of the three stations studied. The population of Gastropods is in equilibrium. The 3rd station is slightly less balanced compared to the other two stations (E = 0.72). Therefore, the numbers of different species tend to be in equilibrium with each other.

Vertical distribution of Gastropods on *Lavandula angustifolia*

The following table shows the vertical distribution of Gastropod species on officinal lavender.

Table 4: Distribution of malacological species collected from the different strata of common lavender

Genus- species	Root	Surface of	stem
<i>Macularia hieroglyphicula</i>		+	
<i>Archelix punctata</i>		+	
<i>Archelix polita punctatiana</i>		+	
<i>Archelix lactea</i>		+	
<i>Euparypha pisana</i>		+	+
<i>Helicella virgata</i>		+	+
<i>Rumina decollata</i>		+	

+: Presence of the species

* At the root level

We did not find any malacological species.

* At ground level

This pedofauna is made up of mollusks which remain a particularly characteristic group of this stratum. We find *Macularia hieroglyphicula*, *Archelix punctata*, *A.polita punctatiana*, *A.lactea*, *Euparypha pisana* (Helicinae, Helicidae) and the species *Helicella virgata* (Helicellinae, Helicidae) as well as *Rumina decollata* (Subulinidae).

* At the level of the rod

There are 2 gastropods at the stem level. We found: *Euparypha pisana* and *Helicella virgata*. Gastropods manufacture their epiphragms to be able to survive in extreme conditions.

* At leaf level

Very rare are the species encountered in this leaf layer of lavender.

DISCUSSION

On *Calycotome spinosa* in 2008, DAMERDJI recognized 21 malacological species while (DAMERDJI, 2010) observed 19 on *Thymus ciliatus*. On *Rosmarinus officinalis* (Rosemary) there are 18 species of Gastropods (DAMERDJI et al., 2005).

In addition in the mountains of Tlemcen, (DAMERDJI 1997a) collected 27 species of snails. Likewise in the steppe zone located south of Tlemcen, DAMERDJI in 1996 had 15 species forming part of the malacofauna whereas (KHELIL, 1984) had noted only one with *Leucochroa candidissima*. This species currently called *Sphincterochila candidissima* is particularly fond of limestone rocks (DAMERDJI, 1990). The latter shows a strong morphological adaptation for its thick and white test which must protect it from the high temperatures which can be rife in these lawns; it closes in summer by a horny epiphragm, under the shelter of which it enters into diapause. The bioecology of the malacofauna found in 2 stations (Hafir and Zarifelt) of the Tlemcen Mountains indicates the presence of 34 species in Hafir and 19 species in Zarifelt during the years 1999 and 2000. Certain particular conchological characters whose size and color distinguish them. species likely to rise in altitude (DAMERDJI, 2004a). During this same period, a study on the distribution of malacological species from the coast (Ghazaouet), via Tlemcen (urban center), the mountains (Hafir and Zarifelt), Maghnia (plain) to the

southernmost zone and steppe (El-Aricha) made it possible to identify 5 common species in these different ecosystems: *Sphincterochila candidissima* (Sphincterochilidae); *Archelix lactea*, *A. punctata* and *A. zapharina* (Helicidae); and *Rumina decollata* (Subulinidae).

It should be noted that 20 species are considered to be specific including 14 Helicidae (DAMERDJI, 2004b). For example, the 5th ecosystem considered (the steppe zone), we find 2 species of Helicidae (*Archelix bailloni* and *Helicella lemoinei*).

In his quantitative ecology essay on the Invertebrates of the Camargue Sansouire, (BIGOT, 1965) indicates the number of species of molluscs collected in the main environments of the Camargue. In Sansouire, the specific richness is estimated at 8. Abiotic and biotic factors remain important in the variation in the size of the shells of *Sphincterochila candidissima* (DAMERDJI, 2001). This species has a high abundance in a xerophilic environment as in El-Aricha. This is, however, linked to the degradation of the environment (DAMERDJI, 1997b). *L.candidissima* is much localized in the Camargue where he is known from the area of the Tour du Valat and its surroundings (AGUESSE and BIGOT, 1962). The population of *L. candidissima* in the Camargue tends to show a clear detachment of the coils of its shell (ALTES, 1956). ENGEL (1957) reports its presence mainly in low and salty Sansouire with *Arthrocnemum glaucum*.

On the other hand, *E. pisana* is common throughout the Camargue where its tests are gathered under *Salicornia fruticosa* and harbor numerous invertebrates (AGUESSE and BIGOT, 1962).

On the other hand, it has been demonstrated the impact of edapho-climatic factors on the shellfish characteristics of the population of terrestrial gastropods in the Tlemcen region (DAMERDJI, 1997b). According to BIGOT, 1957 a large fauna representing the major part of the orders of invertebrates and almost all the orders of insects known in the Camargue, took refuge in the empty shells. These tests indeed play a big role as shelters. The fauna finds an ideal refuge there against the low temperatures of winter and against the heat wave. These tests are also used as a source of food, even as a place of spawning and metamorphosis. In 1971, SACCHI studied the comparative ecology of pulmonary gastropods from Mediterranean and Atlantic dunes.

At the same time, it should be noted that (DAMERDJI, 2002a) observed that in winter, the specific richness of snails is high on *Chamaerops humilis* with 12 species. In addition, *Macularia hieroglyphicula* also in winter on Diss (DAMERDJI, 2002b). On Rosemary, fluctuations occur between 125 individuals in April and 31 in December (DAMERDJI et al., 2005).

The phenomenon of "clusters" is an adaptive mark pushed towards the environment for species that are not very resistant in the isolated state. It manifests itself every year in the Rhône delta over at least 2 or 3 weeks and sometimes over several months (BIGOT and AGUESSE, 1984).

On Rosemary, (DAMERDJI et al., 2005) found a high diversity index in the 3rd station which decreased in the 1st station. The largest number is *Euparypha pisana* with 137 individuals in the 1st station and 212 individuals in the 3rd station. DAMERDJI et al. (2005) observed the highest distribution in the 3rd station at Romarin.

At ground level, the majority of inventoried Gastropods are found there. *Macularia*, *Archelix* (Helicidae) and *Milax gagates* are counted among the pedofauna (DAMERDJI and ADJLANI, 1999). At the level of the Diss stem, 4 species of Gastropods are noted. These species use this part of the plant to make their epiphragm and settle there (DAMERDJI, 2002b). Only the species *Euparypha pisana*, difficult to recognize with its polymorphism, is found on the stipe of the doum (DAMERDJI, 2002a).

On the diss, we found 2 species of Helicidae considered being phytophagous. According to KHELIL (1989), individuals of *Leucochroa candidissima* are consumers of alfa foliage. On the Doum, the leaf surface being rough, the Gastropods manufacture their epiphragms to be able to survive in extreme conditions.

CONCLUSION

The bioecological study of the malacological fauna of *Lavandula angustifolia* in the 3 stations of the gardens of the park of Tlemcen, allowed us to inventory 7 species during the samples taken between February and June 2015. In spring, station 1 has a wealth maximum specificity equal to 7. Gastropods are found everywhere except during the month of June. In terms of numbers, this is the 1st station and in February we meet the maximum number of samples. Of the 7 malacological species analyzed, 2 are constant, 4 are accessory and only one is accidental.

The calculation of the SHANNON-WEAVER index varies between 1.67 and 2.41 bits. It is the highest in the 2nd station. The distribution (between 0.72 and 0.86) indicates a balance between the numbers of the different species present. As regards the distribution of Gastropods on true lavender, all of the species inventoried are found on the ground. Finally, if a certain number of results were released during this study, many points remain to be clarified, in particular the relationship between the trophic level and the malacofauna which is listed there.

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