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Taxonomic diversity and structure of gastropods in stations *Euonymus japonicus* L. (Celastraceae) in the garden's park of Tlemcen (Northwest Algerian)

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Abstract

The Tlemcen region is located in northwestern Algeria and is characterized by a semi-arid bioclimate. An approach of the diversity of the malacofauna associated with *Euonymus japonicus* was carried out in three stations belonging to the garden of the Park of Tlemcen from February to June 2015. The specific richness of the Gastropods is of 4 distributed between two families: that of Helicidae and that of Subulinidae. The first includes 3 species divided between two sub-families including that of Helicinae and that of Helicellinae. One species is accessory and the other 3 are accidental. The relative importance of snails varies by station and by month and season. In May and June and in the three stations, the malacological wealth is zero. In April, the species richness is relatively important in the 2nd station with a value equal to 3. *Euparypha pisana* (Helicidae) has a frequency of 30% in the station 1 and has an abundance of 0.34% in this same station. *Rumina decollata* has a frequency of 30% in station 1 and 20% in the second and third stations.

Key words: *Euonymus japonicus*, malacofauna, diversity, bioecology, vertical distribution, Tlemcen Park gardens.

Introduction

With regard to faunistics work in the Tlemcen region, several of them have been undertaken on different species of host plants. Indeed, in the steppe region south of Tlemcen, a bioecological study on the fauna of Stipa tenacissima L. (Poaceae) including gastropods (Khelil,1984) preceded a publication on arthropods in the same region (Khelil, 1989). Bioecological studies on fauna are subsequently undertaken on Ampelodesma mauritanicum in the Tlemcen region by Damerdjl and Adjlani, 1999 and (Damerdji, 2002b), on the doum *Chamaerops humilis* always around Tlemcen by (Damerdji, 2002a) and (Damerdji and Bouhellou, 2002a). On Thyme, *Thymus ciliatus* Desf. (Labiatae) a study is made on malacofauna by (Damerdji, 2010). On the Genet (Fabaceae), a malacological study is carried out by (Damerdji, 2008). On the other hand, in the Monts de Tlemcen area and mainly in cultivated areas, very little work has been done on faunistiques.

Authors have worked on the taxonomy and biogeoraphy of the gastropods of 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 particular areas such as the Najerilla Valley (Ortiz De Zarate, 1991) the municipality of Valencia (Ondina, 1988) ; (Martinez, 1999). Gomez (1988) compiled a catalog of species from

the Iberian region. Bigot and Aguesse, (1984) deal with the structural variations of 7 highly characteristic Mediterranean ecosystems of the Rhône delta (Camargue).

On malacofauna proper, (Damerdji, 1996) examines a bioecological study in the steppe zone of the Tlemcen region, work that the author completes at the Tlemcen Mountains (Damerdji, 1997a) and taking into account the impact of edapho-climatic factors on the conchyliological characters of the terrestrial malacological stand in the same region (Damerdji, 1997b). Again, no work has been done on the gastropods living on *Euonymus japonicus*. This gap justifies the present work.

Material and methods

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

Choice of plant material

Plants belonging to the family Celastraceae with more or less eight hundred and fifty species are established mainly in temperate zones classified in more than eighty genera. The plants of the Celastraceae family include the class of well known charcoals. They concern trees and shrubs as well as creepers. The plants of the family Celastraceae have foliage decorated with stipules, with simple leaves and alternating opposite and whole seeing and whose inflorescence is collected in terminal or axillary cyme. The hermaphrodite or unisexual flowers are regular and often go unnoticed. They give a fruit which according to the species can vary in form, but as a rule they are dehiscent capsules.

The Japanese charcoal (Euonymus japonicus) is a shrub of pruned hedges, remarkable for its evergreen and shiny foliage, its decorative autumn fruition and its compact habit. The genus Euonymus, by its Greek roots, means "well-named" and the species is called japonicus, because the plant is native to Japan. The French name "charcoal" comes from the Latin "fusus" meaning spindle, it is widely grown in gardens, brightly colored fruits and variegated foliage.

The charcoal of Japan is defined and differs from other charcoals by the morphology of its flowers.

The leaves of the charcoal are persistent and leathery. The blade is ovoid, olive green shiny on the top and light green matte on the underside. Its edges are crenellated. The veins are clearly visible and the petiole is short. The leaves are opposite and persistent. They are slightly serrated, thick dark green, 2.5 to 7 mm long, very waxy (ORWA, 2009). The discrete flowers in white clusters, each with four green petals 6-10 mm. The flower is regular, hermaphrodite or rarely unisexual. The plant is then monoecious or dioeciously (ORWA, 2009). It is often a loculicidal capsule, sometimes lobed, but sometimes a fleshy fruit, drupe or berry, the grains are often provided with a red aril, and sometimes winged (PELT, 2010).

As its name suggests, the hard wood of the charcoal was used to make bobbins, small pieces of wood used to spin wool or linen, or to create the lace its wood, by reduction in charcoal, was also used in plastic art. The charcoal pencil, made of willow wood today, makes sketches known as charcoals.

The charcoal tree of Japan was introduced in Europe in the early nineteenth century, where it was widely introduced in public gardens, especially because of its resistance to urban air pollution.

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

- Phylum Spermaphytes
- Subphylum Angiosperms
- Class. Eudicots
- Subclass Enasterids I
- Order.Celastrales
- Family. Celastraceae
- Genus. *Euonymus*
- Genus-species *Euonymus japonicus* L. (*Evonymus*)
- French name: fusain; charcoal

Choice of study stations

The choice of stations is made taking into account the presence but especially the abundance of *Euonymus* japonicus. Three stations cultivated by this introduced plant are chosen in the gardens of the Tlemcen Park.

Station 1:

This is part 1 of the National Park Garden with an exposure 34 ° 51'54.90'' Norrth 1 ° 19'09.03'' West. It represents an altitude of about 1024m and a recovery rate not exceeding 50%. The plant species that dominate station 1 are: *Euonymus japonicus* (Celastraceae); *Lavandula angustifolia* (Lamiaceae); *E. latifolus* (Celastraceae) and *Rosa canina* (Rosaceae).

Station 2:

This is part 2 in the National Park Garden with an exposure 34 ° 51'.56.11'' North 1 ° 19'18.35'' West It is characterized by an altitude of about 1022 m and a recovery rate between 50 and 60%. The dominant plant species are: *Euonymus japonicus*, *E.latifolus* (Celastraceae); *Lavandula angustifolia* (Lamiaceae); *Cupressus sempervirens* (Cupressaceae).

Station 3:

This is part 3 in the National Park Garden with an exposure 34 ° 52'00.54'' North 1 ° 19'07.86'' West. It represents an altitude of 1023 m with a recovery rate ranging between 60 to 70%. The plant species that dominate Station 3 are: *Euonymus japonicus* (Celastraceae); *Salvia officinalis* (Lamiaceae); *Pinus halepensis* (Abietaceae); *Lavandula angustifolia* (Lamiaceae).

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

Table 1: Abiotic and Biotic Data of three prospected stations

Prospected stations	Slope	Altitude	Exposure	Recovery rate
Station1	0.8%	1024m	Southwest	40-50%
Station 2	0.8%	1022m	East	50%-60%
Station 3	0.8%	1023m	East	60-70 %

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

Methodology

In the field, 10 samples are taken from February to June 2015. The samples are taken back to the laboratory where live individuals and empty shells are separated. These are put in plastic bags. Small species are kept in tubes usually made of glass. The morphological and anatomical characters do not have the same importance from the systematic point of view. However, the shape, size, coloring and ornamentation of the shell are taken into account as many morphological differences that can help in the determination. In addition, the anatomical characteristics, in particular of the genitals, remain determining criteria for the identification of the species. In this respect, the morphological description is based on the biosystematic study of the Molluscs Gastropods Pulmonées terrestrial of the region of Tlemcen drawn up by Damerdji (1990).

Ecological Indices

Among the ecological indices of composition used to exploit the results it is necessary to mention the frequency of occurrence, the 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 recorded 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 taken into consideration. P is the total number of samples taken. In terms of constancy (DAJOZ, 1985) distinguishes three groups. Species in the first group are considered constant when they are found in 50% or more of the surveys in the same community. Those in the second group are accessory because they are only present in 25 to 49% of the 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 this same species to the total number of individuals all species combined:

$$A_{rel} = \frac{Na}{Na + Nb + Nc + N...} \times 100$$

A_{rel} is the relative abundance of the species considered. Na, Nb, Nc, is the numbers of individuals of species a, b, c.

Relative abundance provides information on the importance of each species in relation 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 species harvested "a" in the stand considered.

P = Total number of samples taken in the stand under consideration.

Of the ecological structure indices only the Shannon-Weaver Diversity Indices and Fairness are used. The calculation of this index makes it possible to evaluate the faunistic diversity of a given environment and to compare the faunas of different environments, even when the numbers of individuals harvested are very different (DAJOZ, 1985).

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

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

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

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

Results

The results concern the inventory of gastropods harvested on charcoal, their relative seasonal and monthly importance, the calculation of ecological indices and the vertical distribution of these species.

Diversity of Malacological Species Harvested from Euonymus japonicus

Based on the classification of (GERMAIN, 1969a and 1969b) a systematic list of species found on charcoal is established. The results concerning the inventory of malacological species are recorded in the following list.

List of species of pulmonary gastropods recorded on Euonymus japonicus in 3 stations

- Helicidae
- Helicinae
- *Euparypha pisana* Müller, 1774
- *Eobania vermiculata* Müller, 1774
- Helicellinae
- *Helicella* (*Cernuella*) *virgata* Da Costa, 1778
- Subulinidae
- *Rumina decollata* Linnaeus, 1758

We met during our trips that stretch from February to June 2015 in the 3 stations prospected 47 animal's species. They are grouped into several classes which are: gastropods, annelids, crustaceans, arachnids, myriapods and insects (BELABED, 2015). The specific richness of gastropods is 4. They are divided into 2 families: Helicidae and Subulinidae. The family Helicidae comprises two subfamilies: Helicinae with 2 species belonging to 2 genera namely: *Euparypha* and *Eobania* and that of Helicellinae with the species *Helicella virgata*. That of Subulinidae is represented by *Rumina decollata* present in the 3 stations.

Seasonal variations of gastropods found on Euonymus japonicus

The results obtained are given in the following figure.

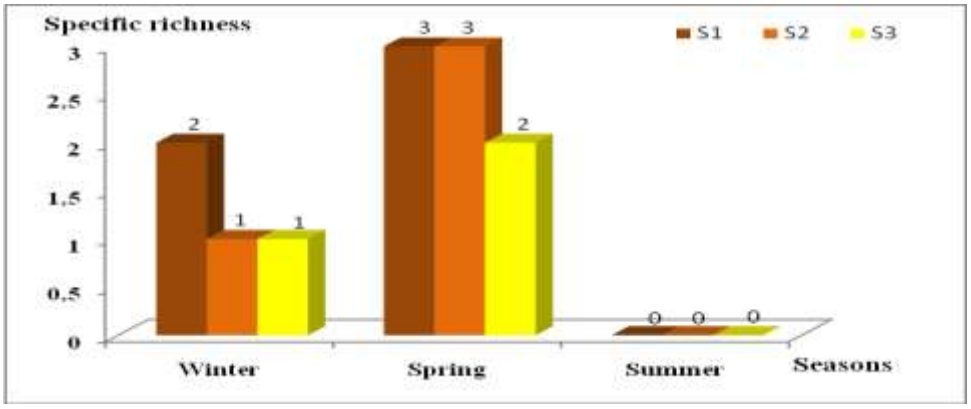

Fig. 1: Seasonal importance of gastropods according to species richness at the 3 stations

In winter, stations 2 and 3 contain 1 malacological species each. The malacological wealth is equal to 2 in the first station.

In the spring, the gastropods are relatively important in the 1st and 2nd stations with a wealth equal to 3. The 3rd station has two species. In summer, weather conditions become drier, the stations do not include any malacological species.

Monthly variations of gastropod wealth

The results concerning the monthly importance of gastropods are given in the following figure.

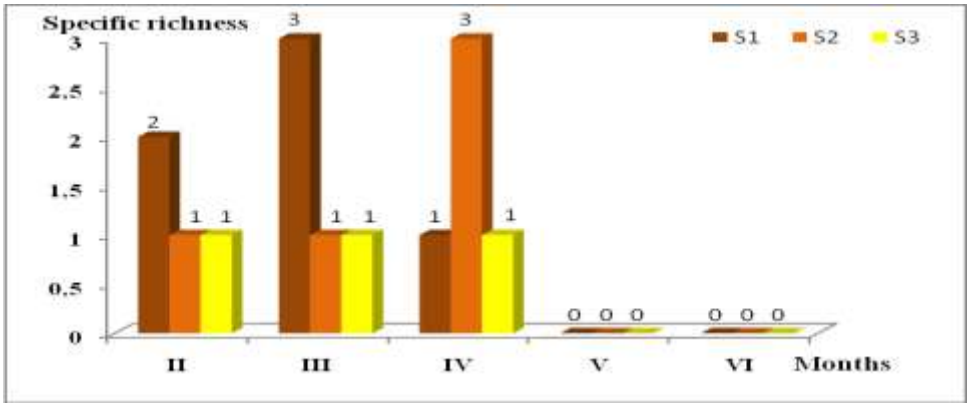

Fig. 2: Monthly importance of gastropods according to species richness in the 3 stations

At first sight, the gastropods seem to be present in the first three months of prospection. The malacological wealth is zero in the three stations in May and June. The second station has 3 species in April. We have only one species in the 3rd station in February, March and April respectively.

Monthly variations in the number of snail individuals recorded on Euonymus japonicus at the three stations

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

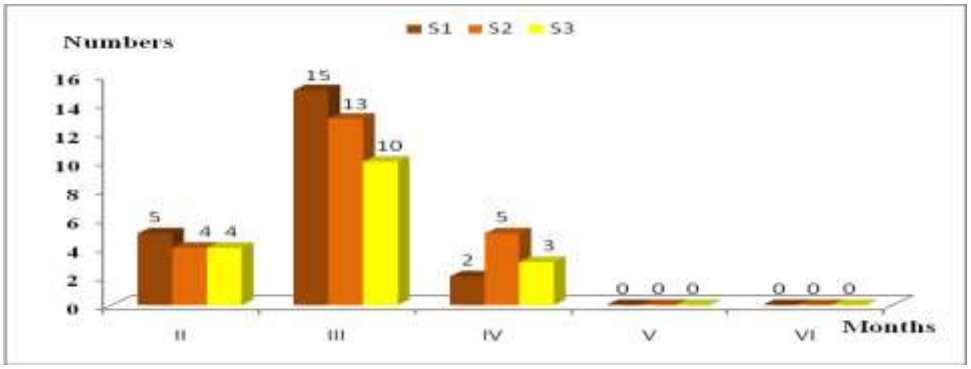

Fig. 3: Monthly importance of gastropods according to numbers at the 3 stations

They vary in size during the first three months of exploration. Fluctuations occur between 15 individuals in March and 2 in April. It should be noted that Gasteropods are absent at the three stations in May and June.

Exploitation of results by ecological indices

All inventoried malacological species are taken into consideration for the calculation of ecological indices. The results for ecological indices are shown in Table 2

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Application of frequency of occurrence to snail species

An accessory species (*Euparypha pisana*) and three accidental species are counted, including an accidental one in *Rumina decollata*.

Relative abundance of snails

In this case, this criterion sheds light on the biology of malacofauna harvested on charcoal.

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

Stations	**Station1**			**Station2**			**Station3**			**Moy. (F%)**	**Classe of constance**
Malacological species	A%	F%	D	A%	F%	D	A%	F%	D		
Euparypha pisana	0.34	30	1.7	0.38	30	1.9	0.28	20	1.4	26.66	Accessory
Eobania vermiculata	1	10	0.1	0	0	0	0	0	0	3.33	Very accidental
Helicella virgata	0	0	0	1	20	0.1	0	0	0	6.66	Very accidental
Rumina decollata	0.5	30	0.4	0.12	20	0.1	0.37	20	0.3	23.33	Accidental

Diversity Index or Shannon – Weaver

The data in Table 3 allow us to calculate the Shannon-Weaver index in the 3 stations.

Table 3: Number, species present, indices (H ', H' max, E) of the different malacological species found in the three stations

Stations	**Station 1**	**Station 2**	**Station 3**
Number	22	22	17
Species present	3	3	2
H' (en bits)	0.65	0.63	0.61
H' max (en bits)	1.58	1.58	1
E	0.41	0.39	0.61

The Shannon-Weaver index is high 1. It is 0.65 in this station. The lowest value equal to 0.61 is observed in the

third station. Three species are present in the first and second stations and two species in the third station.

Equirepartition index applied to snail species

E: equitability less than 0.5 tend to 0 for the first and second stations. The population of gastropods is in imbalance. The third station is balanced with respect to the other two stations (E = 0.61). Therefore, the numbers of different species tend to be in equilibrium with this other station.

Vertical distribution of gastropods on *Euonymus japonicus*

The following table shows the vertical distribution of gastropod species on charcoal.

Table 4: Distribution of malacological species collected on the different strata of the charcoal

Genus species	Root	Surface of area	stem	Leaves
Euparypha pisana		+	+	
Eobania vermiculata		+		
Helicella virgata			+	
Rumina decollata		+		

+: Presence of the species

* At the root level

No malacological species have been found in this subterranean stratum.

* At the level of the soil surface

This soil is made up of molluscs, which remain a particularly characteristic group of this stratum. Here we find *Euparypha pisana*, *Eobania vermiculata* (Helicinae, Helicidae) and *Rumina decollata* (Subulinidae).

* At the stem

Gastropods are 2 species in the stem. These are: *Euparypha pisana* and *Helicella virgata*. The gastropods make their epiphragms to survive in extreme conditions.

* At the leaf level

Very few individuals are encountered in this foliar stratum of charcoal.

Discussion

On Calycotome spinosa in 2008, DAMERDJI recognized 21 malacological species while (DAMERDJI, 2010) observed 19 on *Thymus ciliatus*. On *Rosmarinus officinalis* (Rosemary) are counted 18 species of gastropods (DAMERDJI et al., 2005). In the Tlemcen Mountains, (DAMERDJI 1997a) harvested 27 species of snails. Similarly in the steppe zone south of Tlemcen, DAMERDJI in 1996 has 15 species that are part of the malacofauna whereas (KHELIL, 1984) noted only one with *Leucochroa candidissima*. This species, currently known as *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 that can prevail in these lawns; it is closed in summer by a horny epiphragm, from which it enters diapause. The bioecology of 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. Some particular conchyliological characters whose size and color distinguish species likely to rise in altitude (DAMERDJI, 2004a). During this same period, a study on the distribution of malacological species from the coast (Ghazaouet), through Tlemcen (urban center), the mountains (Hafir and Zarifelt), Maghnia (plain) to the southernmost zone and steppe (El-Aricha) has identified 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 specific including 14 Helicidae (DAMERDJI, 2004b). As an example, the 5th ecosystem considered (the steppe zone), we find 2 species of Helicidae (Archelix bailloni and Helicella lemoinei).

In his essay on quantitative ecology on Invertebrates of Camargue Sansouire, (BIGOT, 1965) indicates in number of species the molluscs collected in the main areas of the Camargue. In Sansouire, the species richness is estimated at 8. The abiotic and biotic factors remain important in the variation of the size of the shells of *Sphincterochila candidissima* (DAMERDJI, 2001). This species has a strong abundance in xerophilic medium 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 it is known from the area of the tower of Valat and its surroundings (AGUESSE and BIGOT, 1962). The population of L. candidissima from the Camargue tends to show a distinct detachment of the turns of its shell (ALTES, 1956). ENGEL (1957) reports its presence mainly in the low and salty saltwort in *Arthrocnemum glaucum*.

On the other hand, E. pisana is common throughout the Camargue where its tests accumulate under the

Salicornia fruticosa and harbor many invertebrates (AGUESSE and BIGOT, 1962). On the other hand, the impact of edapho-climatic factors on the conchyliological characteristics of the terrestrial gastropod population in the Tlemcen region has been demonstrated (DAMERDJI, 1997b). According to BIGOT, 1957 a large fauna representing most of the orders of Invertebrates and almost all orders of insects known in the Camargue, took refuge in empty shells. These tests play a big role as shelters. The fauna finds an ideal refuge against the low temperatures of the winter and against the heat wave. These tests are also used as a source of food, or even a place of spawning and metamorphosis. In 1971, SACCHI studied the comparative ecology of the pulmonate gastropods of the Mediterranean and Atlantic dunes. At the same time, it should be noted that (DAMERDJI, 2002a) found that in winter, the species richness of snails is high on *Chamaerops humilis* with 12 species. In addition, *Macularia hieroglyphicula* also in winter on the 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 to the isolated state. It occurs every year in the Rhone delta for at least 2 or 3 weeks and sometimes for several months (BIGOT and AGUESSE, 1984).

On Rosemary, (DAMERDJI et al., 2005) find the index of high diversity in the 3rd station which decreases in the 1st station. The largest population is *Euparypha pisana* with 137 individuals in the 1st station and 212 individuals in the 3rd station. DAMERDJI et al., (2005) found the highest equidistribution in the 3rd Rosemary station.

At the level of the soil surface, the majority of inventoried gastropods are found. *Macularia*, *Archelix* (Helicidae) and *Milax gagates* are counted among the soil fauna (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 diss, we found 2 species of Helicidae considered phytophagous. According to KHELIL (1989), individuals of *Leucochroa candidissima* are consumers of alfalfa foliage. On the Doum, the leaf surface being rough, gastropods manufacture their epiphragms to be able to subsist under extreme conditions.

Conclusion

The bio-ecological study of the Malacological fauna of *Euonymus japonicus* in the 3 stations of the gardens of the Tlemcen Park, allowed us to inventory 4 species during the samples taken from February to June 2015. In the spring, the stations 1 and 2 have a specific richness of 3. Gasteropods are found everywhere except during the months of May and June. In effective, it is the 1st station and in March where we meet the maximum of samples. Of the 4 malacological species analyzed, *Euparypha pisana* is accessory and the other three are accidental.

The calculation of the SHANNON-WEAVER index varies between 0.61 and 0.65 bits. It is the highest in the 1st station. The equidistribution (between 0.39 and 0.61) indicates an imbalance between the numbers of the different species present particularly in stations 2 and 1. As for the distribution of gastropods on charcoal, 3 species are found on floor.

Finally, while a number of results have emerged during this study, many points remain to be clarified, particularly the relationship between the trophic level and the malacofauna identified therein.

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