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Full Length Research Paper

Circulating entomofaune in orchards of apple trees in the region of the Aures (Eastern - Algeria)

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In the Aures Area (Eastern Algeria), the protection of apple trees orchards against pests is essentially based on massive use of chemicals. To evaluate its impact on beneficial, a study of the entomologic biodiversity, evaluated through its regularity at the families scale has been carried out and a description of the beneficial fauna has been realised. Sampling procedures was achieved by bimonthly beating from April to October 2003 and by mowing of the inter-raw in spring and in the beginning of summer. A convergence between the result issued from the beating and the mowing of the inter-raw is noticed as for the effectives, and then superior biomass for the orchard 1 of Fesdis .An entomological wealth increased of some functional groups (Coccinellidae, Syrphidae, predator bugs and Forficulidae) in the herbaceous cover of this orchard's inter-raw, is not accompanied by insects stocking richer of apple tree due to the factor of high aphid effectives. The diversity index H, of Species Evenness Index E (weak values), Simpson's diversity index D (high value) calculated for the stocking of apple tree of orchard 1; interpret this group abundance and don't permit to characterize this orchard. The observed differences between the three orchards can be related to the production mode (Organic substance supply and mechanical maintenance of the raw for the orchard of Fesdis) and to the chemical protection (orchards of Bouhmama and Ichemoul) and are in relation to the structure of the beneficial fauna.

Key words: Apple, tree (*Malus communis*), entomofauna, biodiversity, beneficial arthropods, pests-C.

INTRODUCTION

Aures is a mountainous area located at the Algerian East. In the sight of the intensification of the mountain and hill farming, significant surfaces used for the apple orchards in this area where the culture of the Apple trees constitutes an interesting gainful employment.

In addition, this culture suffers from the attack of several pests in particular the carpocapse (*Cydia pomonella*) which causes on the skin of the fruit the formation of an opening partly blocks by brownish sawdust leading to the heart of the fruit which will end up falling even before maturity and the ashy plant louse (*Dysaphis plantaginea*) whose damage is observed known the sheets which are rolled up longitudinally to the bottom then yellow and necroses. It results from it from this damage of the considerable losses of harvest in quantity and more particularly of quality (depreciation of the fruit).

In addition, the protection of the orchards with vocation commercial in the area of Aurès is currently only assured by one preventive and intensive chemical fight. However, the misuse of the pesticides by the farmers in particular with the choice of the medicinal agro products, the active matters, the amounts applied, the frequency of the treatments, the equipment of treatment etc, caused the pollution of these ravagers, other secondary ravagers, and diseases on this culture, the destruction of auxiliary fauna as well as the pollution of the environment. With an aim of build-

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Table 1. Climatic data recorded in 2003.

Month	Average temperature		Precipitation	
	Batna	Khenchela	Batna	Khenchela
January	5.3	6.4	81.4	110.0
February	4.4	5.7	8.7	66.0
March	8.5	9.6	8.6	26.2
April	14.1	13.7	73.4	88.8
May	18.9	18.2	19	17.6
June	24.7	24.0	8.6	41.7
July	29.0	28.6	0	11.0
August	27.0	26.9	48.2	5.9
September	21.3	21.2	32.6	37.9
October	17.8	18.8	89.2	81.8
November	10.7	11.3	31.4	19.0
December	6.3	6.6	32.2	44.3
Total Average	15.7	15.9	433.3	550.2

ing a pest-destroying campaign based on good practices of integrated fight adapted in our area, the present study was undertaken in order to evaluate the impact of chemical protection against the two devastating insects already quoted for the biocenose of the apple tree and its vegetable environment (covered herbaceous and it inter row of the orchard) by distinguishing the procession from associated auxiliaries.

For that, three orchards of apple tree of the area of Aures have summers chosen, including two commercial (treaties chemically) and a non-commercial orchard (untreated chemically).

Within this framework, the measurement of the bio entomological biodiversity and the abundance of the auxiliary groups intervening in the regulation of the ravagers of the apple tree are studied.

MATERIALS AND METHODS

Biotope of study

Description of the stations: Batna and Khenchela constitute most of the area of Aures. They are characterized by a bad distribution of precipitations and high estival temperatures. For the year of study 2003, the climatic data of the weather stations of Batna and Khenchela are taken into account.

The monthly averages of the temperatures and precipitations during this year are indicated in Table 1. Thus, we notice that the temperatures vary from one month to another in 2003 and are characterized by one cold period in February with average temperatures of 4.40°C for Batna and 5.70°C for Khenchela. The pluviometric mode is also irregular during this year. The most rainy month is January with average values of 81.4 mm for Batna and 110 mm for Khenchela.

Our study was led in three orchards of apple tree which were left again on three stations, Located Fesdis and Ichemoul with Batna and the station of Bouhmama located at Khenchela.

The orchards of studies were selected according to the following criteria:

i.) Orchards representative in the area of Aures.
ii.) Accessibility with the ground.
iii.) Their floristic diversity.
iv.) The selected orchards are ecologically different (Table 2).

Thus, orchard 1 of Fesdis is a non-commercial orchard; however it does not undergo any chemical protection against the pests compared to the orchards 2 of Bouhmama and 3 of Ichemoul which are related to commercial. Thus enables us more particularly to make an approach on the impact of plant health protection on Entomofaune the auxiliaries on the level of these three apple orchards of the area of Aures.

Description of the orchards of study: Orchard 1 of Fesdis: it is to 500 m in the east of the commune of Fesdis and to 12 km in North East of Batna at an altitude of 1646 m (35° 59' N;6° 20' E.) was installed in 1996, of rectangular form and a surface of 1,225 ha.

It includes/understands on the whole 422 trees of apple tree, distributed on 6 varieties whose Golden delicious is most dominant with 217 trees. The remainder of the varieties is represented by Reine of Rennet, Hana, Red Golden, Starkrimson and the Cardinal variety. All these varieties are led in the free form of 4 x 4 m of espacement). En more culture of apple tree the orchard includes / understands 46 olive-trees *Olea europea sativa*, 13 fig trees *Ficus carica*, 12 peach tree *Prunus persica*, 10 apricot trees *Prunus armeniaca* and 04 plum trees *Prunus domestica* and it is surrounded by a line of breeze wind, composed of cypress *Cypre-sus sempervineses* and Eucalyptus.

The ground of the orchard has a moderately calcareous argillaceous texture whose pH is basic. It is a badly maintained orchard. The farming operations are summarized in a spreading of manure of farm, in the clothes industry of basins and drains all with length the vegetative period and in a mechanical weeding between the rows. The chemical treatments miss almost.

Orchard 2 of Bouhmama: it is located at 6 km of Daïra de Bouhmama and at 50 km of Khenchela. It rises to 1076 m of alti-tude (35° 29' N; 6° 71' E) and of a surface of 1500 m^2. It includes the whole 256 trees of apple trees planted since 1990 whose va-riety Golden delicious is most dominant representing 147 trees. The remainder is represented by other varieties with knowing Starkrimson, Royal Official reception, Cardinal and Red Golden.

The trees are in form free, distant of 4 m out of 5m. in addition to the culture of the apple tree, the orchard includes another speculations of which the number is unimportant, that is to say 4 peach tree *P. persica*, 3 pomegranates *Punica granalum*; 5 Fig trees *F. carica*; 10 apricot trees *P. armeniaca* and 7 Vitis vines *Will vinifera*. Small pieces are also devoted to the market gardening (wing, onion, pepper, tomato and zucchini).

The ground of the orchard is of texture argillaceous, little Salée, calcareous and fairly rich in organic matter. The maintenance work

Table 2. Biotic and abiotic data of the three orchards of study.

Orchards of studies	Botanical richness	Altitude (m)	Chemical fight
Orchard 1 (Fesdis station)	36	1646 m	- Absence of Chemical protection - Mechanical Weeding
Orchard 2 (Bouhmama station)	23	1076 m	- Reduced chemical Fight (3 interventions per year) - Bio target attackers: carpocapse, acarina red and yellow, tavelure and oïdium - Chemical weed control
Orchard 3 (Ichemoul station)	15	2066 m	- intense chemical fight (9 interventions) - Bio target attackers: carpocapse, louse of San Jose, ashed plant louse, green plant louse and tavelure - Chemical weed control

is practised each year on this orchard with knowing the irrigation, the size, chemical weed control and fertilization of the ground by organic manures and manures once in November.

The chemical treatments against the bio-attackers target are carried out at a rate of 3 chemical interventions lasting per year. The pesticides utilized in 2003 are: the pirimor 75 g/hl pulverized on April 25; Vectra 10 sc 40 ml/hl and Baybay (used on May 15 and Folimat 50 IF 1 ml/l (July 5).

Orchard 3 of Ichemoul: This orchard is located in agricultural perimeter EL Hammam in the area of Ichemoul at 52 km at the south-east of Batna. It rises with 2066 m altitude (35° 30' E; 6° 46' N) and a surface of 1 ha occupies. The orchard includes the whole 317 trees of apple tree, planted since 1985 whose variety Golden delicious is in a majority with 149 trees; other varieties are Red Golden, Starkrimson and Royal Official reception. The plantations are distant 5 m out of 5m. In addition to the culture of the apple tree, the orchard includes 14 apricot trees *P.armeniaca* 14 pêchers *P. Persica*; 8 plum trees *P. domestica*, 1 quince tree *Cydonia oblonga* and 32 stocks of Vitis vines *Will vinifera* planted in line of centers of the orchard. The ground of the orchard is of texture argilo-limestone rich in organic matter. By the fact that it is has an orchard related to commercial typically, it is clean and is well maintained. As regards the plant health treatments they are applied each year in an intensive way, that is to say 9 chemical interventions per year, repartiés in 2003 as follows:

Punch (7.5 ml/hl) used on April 20
White oil and Dursban (1.5 l/hl + 15 ml/hl) used the May 17 i
Punch + Kelthane (7.5 ml/hl + 100 ml/hl) on May 25
Penstyl(100 ml/hl) on June 10
Dursban 4* (150 ml/hl) on June 20
Dursban 4* +Penstyl (15 ml/hl + 100 ml/hl) on July 5
DURSBAN 4* (15 ml/hl) on August 9
White oil (1.5 ml/hl) used 5 and 25 December.

Techniques of sampling

Method of beating (Colas, 1974; Fauvel, 1981)

The method of beating, mainly used at the time of this study, is practiced according to the frequency of 14 taking away for each orchard, at a rate of a beating every 15 days of April to October 2003. With each control, 100 branches are beaten; that is to say 2 branches by trees on a total of 50 trees chosen randomly.

Method of mowing (Roth, 1963)

The method of mowing to the net herbaceous cover of the inter-row is carried out at a rate of 70 blows per statement; that is to say 3 statements on the whole in spring and at the beginning of summer of the year 2003.

These two methods of study made it possible to sample a broad spectrum of insects in the foliation of the apple tree and the herbaceous layer of the inter-row of the orchard.

The identification of the captures is carried out on the level of the kind and the species for the majority of the families with the assistance of specialized taxonomists. Various documents are also consulted (Balachowsky, 1962; Chinery, 1983; Chouinard et al., 2000; Perrier, 1927; Pihan, 1977; Stanek, 1973; Zahradnik, 1984).

All the insects identify, are preserved in limp of collection and kept at the laboratory of entomology of the department of agronomy of Batna's University.

For the study of diversity, the indices of diversity of Shannon, Shannon-Weiner and Simpson are used. Our objective is to present and evaluate the limits of these indices on a family scale of the settlements of auxiliaries and phytophagous (plant-eating) of the foliation of the apple tree, sampled by beating monthly bi- according to the following formulas:

*Indice of diversity of Shannon:
In accordance with Pielou (1975)
$H' = - \sum pi \log2 pi$ (pi = relative Frequency of the species.
Indice of diversity of Shannon - Weiner:

In accordance with Weesi Belemsobgo (1997).
$E = H'/H' max$ ($H' max = \log2 S$).
H' max = maximum Diversity
S = Diversity total

*Indice of diversity of Simpson:

Table 3. Number of individuals of the various functional groups sampled by mowing in the trios orchards.

Functional group	P. C.		P. Hym	P. Dip.	P. Bugs	Nev.	Forficula
Orchards	Coccinelle	Other C.P					
Orchard 1	35	65	9	47	16	6	15
Orchard 2	10	27	32	16	5	20	0
Orchard 3	4	23	20	3	2	10	0

P.C. = Predator Coleoptera – P.Hym = Predator Hymenoptera
P.Dip = Predator Diptera -P.Bugs = Predator Bugs –Nev. = Nevroptera.

In accordance with Magurran (2004).
D = ∑ Neither (Nor - 1/NR (N-1)
Nor = many individuals of the species given.
NR = number total individuals.

For the statistical analysis, we used the factorial correspondences analysis. For our case, the AFC was carried out to describe the processions of auxiliaries of herbaceous cover, sampled by mowing in the 3 studied orchards. The independent variables are the numbers of individuals by auxiliary's functional group and the observations are the three orchards (Table 3).

For the factorial analysis of correspondence we used the software (SAS, 2002) and to evaluate the diversity of the entomological settlement of the foliage we used the software (Microsoft Office Excel, 2003).

For the ecological and statistical analyzes, the auxiliaries of the orchard were gathered tax some functional (Reboulet, 1999).

RESULTS

Entomological diversity of the apple tree

The analysis of the taxonomic groups collected by beating was carried out for the office plurality of manpower of the statements from April at October for the year 2003. The plant louses are the principal phytophagous ones listed, which is confirmed by the visual observations of the branches and sheets. The total staffs complement the phytophagous ones and auxiliaries sampled by beating in all three orchards are high. One counts 1689 individuals including 213 auxiliaries, left again in 1055 individuals including 125 auxiliaries for orchard 1. 511 individuals including 62 auxiliaries for orchard 2 and 123 individuals including 26 auxiliaries for orchard 3. Orchards 1 and 2 generally present high manpower related to important populations of the aphid plant louse, this goes hand in hand with less a H' diversity whose values are seen close in orchards 1 and 2 (Figure 1).

The results of the equitability between the families are identical E = 0.25 in orchards 1 and 2, explaining why the settlement is heterogeneous and is relatively unbalanced (Daget, 1976), compared to the orchard 3 where the equitability is high E = 0.61. The indices of Simpson D are high and almost identical in orchards 1 (D = 0.65) and 2 (D = 0.63) and low in orchard 3 (D = 0.33) what testifies an abundance of the plant louse aphid in orchards 1 and 2. The richness of the settlement of the auxiliaries (many families) is fairly high in orchard 1. This goes with an index of diversity of Shannon of the auxiliary families H' raised more. The equitability of auxiliary families Eaux is high in the three orchards. The index of Simpson of auxiliary families Daux is weak and similar of one orchard to the other (Figure1).

More in detail, the groups of auxiliaries present diverge from one orchard to another (Figure 2).

We can distinguish:

i.) An absence of ladybirds in the orchard 3 which can be explained by a less presence of the plant louses due to the use of aphicides. Indeed, according to Hemptinne and Dixon (1997) and Boisclair and Estevez (2006), the female of ladybird lays its eggs only according to the capacity of the colony of plant louse to be able to ensure the complete development of the larvae.
ii.) A less abundance of predatory bugs in orchard 3 and the dipterous predatory ones, mainly of the Syrphidae which miss almost can be explained by the reduction in potential preys (plant louses). The populations of taxed entomophagous were already correlated with the abundance of the aphidian preys (Francis et al., 2003).
iii.) In orchard 1, a presence characteristic of predatory of regulation such Forficulidae, completely absent in orchards 2 and 3; with an important presence of the other groups of auxiliaries: Predatory bugs and other predatory Coleoptera.
iv.) The preponderance of the hymenoptera groups and nevroptera is noted for orchards 2 and 3 whereas they constitute only 15% of the total staff complement for orchard 1.

Entomological settlement sampled in the herbaceous cover of the inter-row

The total staff complements and auxiliaries sampled with

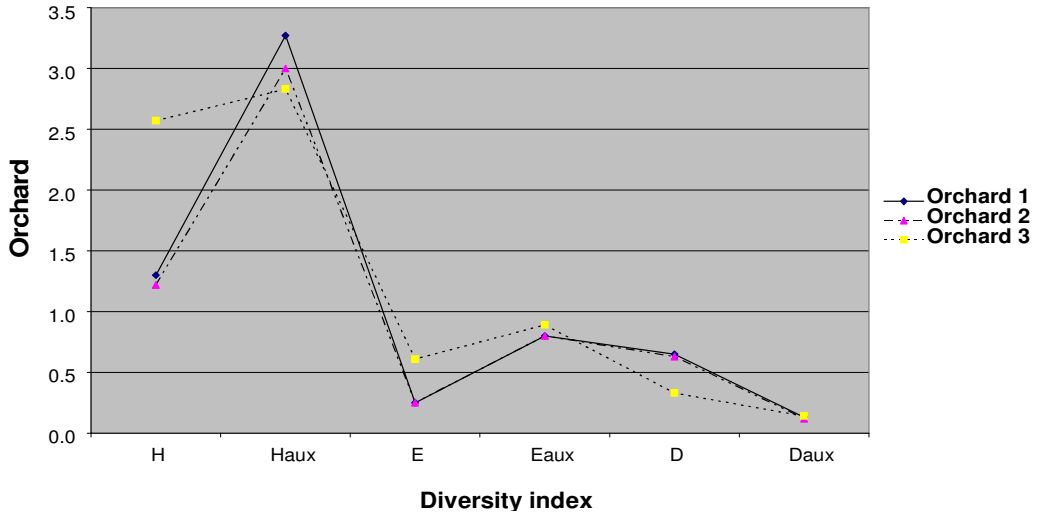

Figure 1. Variation of diversity index by orchard applied to the entomological population registered with bimonthly beating in 2003.
H = Shannon's diversity index calculates at the family level - Haux = Shannon's diversity index calculates at the family level on the beneficial population
E = Eveness at the family level - Water = beneficial's Eveness at the family level. D = Simpson index calculated at the family level - Daux = Simpson index calculated on the beneficial at the family level

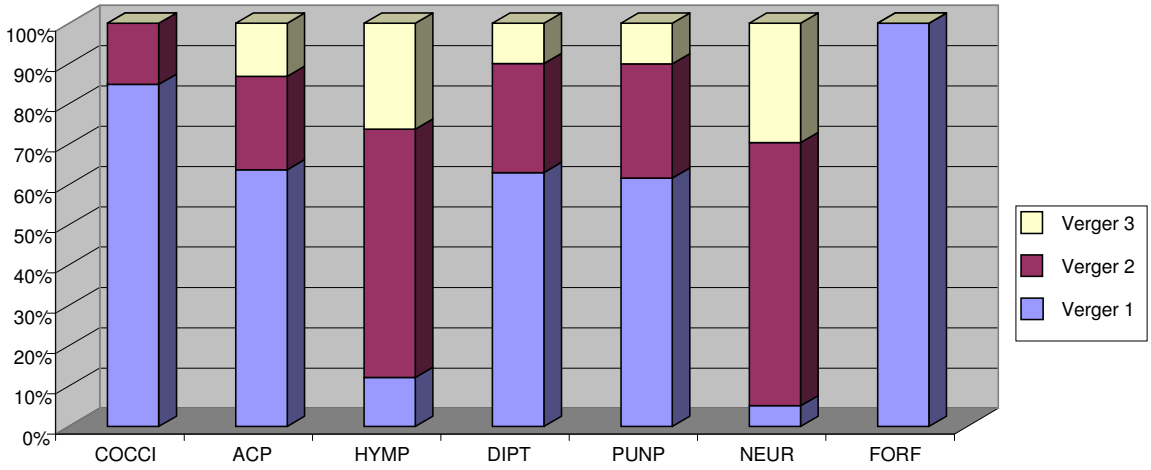

Figure 2. Importance of the auxiliaries collected by bimonthly beating from April to October 2003 in the three orchards of apple trees. COCCI = Coccinellidae – ACP = auther other predator Coleoptera – HYMP = Hyménoptera parasitoids DIPT = Diptera predator – PUNP = Bugs predator – NEUR = Neuroptera Forficulidae.

the net to mowing in all orchard's threes are high with 1190 individuals including 364 auxiliaries. The principal phytophagous ones sampled are the plant louses for the statements of at the end of May and June, then the cicadelles ones later in season. Orchard 1 of Fesdis lodges proportionally more plant louses than the orchards of Bouhmama and Ichemoul.

The following characteristics are raised for the settlements of sampled insects:

The total staffs complement and of collected auxiliaries are higher in orchard 1 (709 individuals including 198 orchard 2 and 147 individuals with 60 auxiliaries for orchard 3).

The richness of the families for the total settlement and the procession of auxiliaries is higher in orchard 1 (48 collected families, including 20 auxiliaries for orchard 1 auxiliaries; 334 individuals including 106 auxiliaries for 37 families including 15 auxiliaries for orchard 2 and 27 fami-

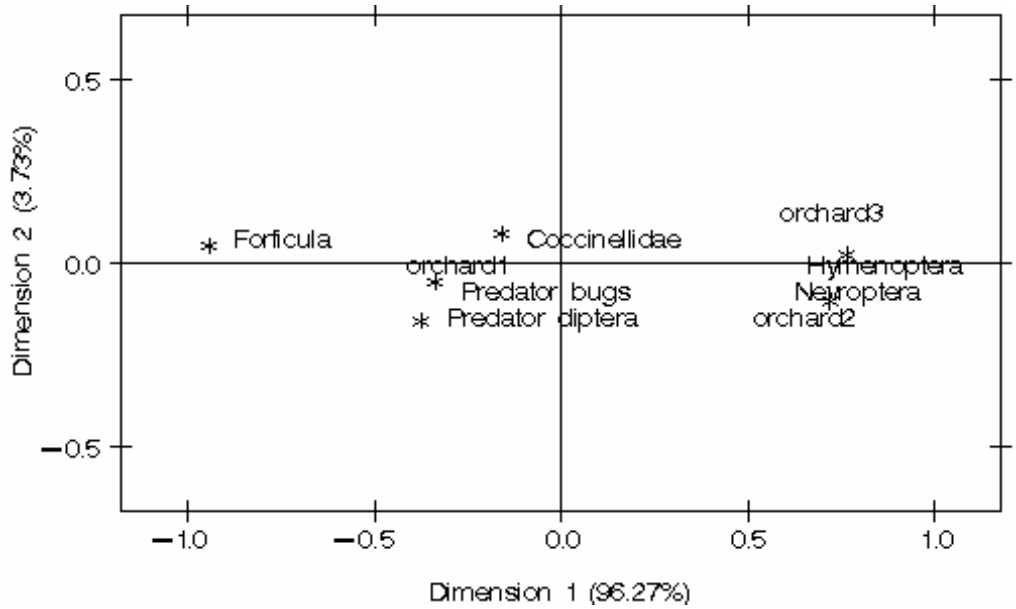

Figure 3. Representation of the auxiliary's functional groups and the three orchards in the AFC plan. Coccinellidae=Lady birds predators and other Coleoptera predators

lies including 11 for orchard 3). The number of families of phytophagous is of 29, 25 and 17 families respectively for orchards 1, 2 and 3.

A multivariable analysis (Figure 3) was carried out to describe the processions of auxiliaries of the three orchards. The analysis was restricted with the first two principal components which account for 96, 27% and 3, 73% of total variability (figure 3). Axis 1 is defined by the difference in abundance of Hymenoptera parasitoids and Nevroptera on the one hand (positive side) and the ladybirds, of, predator bugs and Forficulidae and predatory bugs (negative side). Axis 2 individualizes the group of the ladybirds (positive side) of that of predator Diptera and of the group of the predator bugs (negative side). Orchard 1 is always projected in the left part of the plan defined by axes 1 and 2, its procession of auxiliaries remains articulated around the ladybirds and of Dipterous predatory being accompanied by a presence characteristic of predatory bugs and forficules almost absent in orchards 2 and 3. Orchards 2 and 3, are projected in the right part of the plan and are seen close for a proportion high to Hymenoptera parasitoids and Nevroptera.

The procession of auxiliaries of orchard 1 is characterrized in particular by Figure 3:

A less presence of Hymenoptera parasitoïdes and Nevroptera being accompanied by an increased presence of predatory Bugs; Ladybirds of and of Dipteral predatory. The presence of forficules which is absent from orchards 2 and 3 is also a characteristic.

DISCUSSION

According to our results resulting from beating and the mowing of the inter-raw, we can note a convergence relative to manpower and thus a higher biomass for orchard 1 (used no treatment) compared to orchards 1 and 2 (treaties). On the other hand, an entomological richness increased in the herbaceous cover of the inter-row of this orchard is not accompanied by a settlement of pledged insects richer to the apple tree. The rise in manpower of plant louses, the indices of diversity and equitability calculated for the settlement of the apple tree of the orchard, values often weak for H' and E and value raised for the index of Simpson D, translate mainly the abundance of these groups and do not allow to characterize the orchard1. The differences observed between orchards led according to various modes of production includeing chemical protection and certain ways farming (organic matter contribution and weeding on the row) are relating to the structure of the procession of auxiliaries. Thus the presence characteristic of predatory of regulation the such Forficulidae in orchard 1, which are almost absent in orchards 2 and 3, is to be put in connection with the maintenance procedures of the ground on the row (mechanical in orchard 1 and chemical weeding in or-chards 2 and 3). The botanical richness of the herbaceous layer is on the other hand higher in orchard 1 (assembly the Composaceae prevalent ones and the various adventitious ones). The increase in vegetable diversity involves incre-

ase in the diversity of phytophagous and consequently of their predatory and parasitic (Tilman, 1997a).

The studies of the relations between vegetable environment of the cultures and animal communities go from the scale of the piece to that of the landscape (Burel, 1989; Fournier and Loreau, 2001).

The majority presence of the others let us tax with auxiliaries in orchard 1 (predatory Ladybirds, Dipterans and predatory bugs) slightly represented in orchard 3 and to a lesser extent in orchard 2, is thus likely to testify to disturbances related to the chemical intervention almost absent in orchard 1 and important in orchard 3 compared to orchard 2. Thus, our observations are in agreement with those of Debras (2007), which showed that the plant health treatments are major elements affecting the settlement of the orchards.

In addition, qualified Hymenoptera and Nevroptera of aeroentomofaune by Kozar (1992) constitute only one small proportion of the procession of auxiliaries of orchard 1. It is possible to explain this situation, accord-ing to our observations and those of Defrance et al. (2006) to the abundance of other taxonomic groups. Se-veral studies showed that the reduction of the abundance of predatory results from the predation will intra guild (Denno et al., 2004; Erbilgin et al., 2004; Rosenheim, 2005). In end, even if the regulation of the ashy plant louse is not allowed by the action of the auxiliaries in this orchard. The orchard 1, point of disjunction of the groups of varied auxiliaries and thus a settlement of auxiliaries more balanced. The listed functional groups comprise the many ones tax general practitioners (polyphagous),

Potentially regulators of various ravagers during time, contrary to the orchards 2 and 3, centred on the independent groups “ubiquists” Hymenoptera and Nevroptera, whose other groups of auxiliaries could not thus develop normally because of the disturbances related particularly to the chemical intervention more marked on orchard 3 compared to orchard 2.

Conclusion

The populations of insects resulting from semi-monthly beating and mowing fluctuate and are of a qualitative nature in terms of representative ness of tax and the functional groups with auxiliaries as orchard 1 testifies some to Fesdis (no commercial orchard). These results can be put in relation to the mode of production (contribution of organic matter and mechanical maintenance of row 1) and that of the chemical intervention (completely absent). These results do not make it possible to characterize the orchard of Fesdis. One the other hand, the control of the devastating ace the insufficient ashen aphid in orchards 1 and 2 in compared to the orchard 3, constitute has brake to the production and its regularity in spite of the abundance of the auxiliaries in orchard of Fesdis and chemical intervention in orchards Ichemoul and of Bouhmama. This encourages us to think that in the near future, we could support the fight integrated in our area of study. However, of the complementary studies on the bio-ecology of the ashen aphid and others devastating of the apple tree are in progress.

Appendix 1

List auxiliary insects collected by semi-monthly beating in the three orchards of study in 2003

Order	Number of individuates
Coleoptera	
Chrysomelidae	
Entomoscelis rumicis (Fabricius, 1787)	5
Coccinellidae	
Coccinella septempunctata (Linné, 1758)	12
Coccinella algerica (Kovar, 1977)	5
Semiadalia notata (Laicharting, 1781)	3
Adonia variegata (Goeze, 1777)	6
Cleridae	
Trichodes alvearius (Fabricius, 1792)	10
Silphidae	
Silpha granulata (Thunberg, 1794)	7
Cantharidae	
Cantharis lateralis (Linné, 1758)	6
Cantharis sp Staphylinidae	1
Esp1 ind Histeridae	2
Hister quadrimaculatus (Linné)	1
Hister sp	2
Hymenoptera	
Formicidae	
Cataglyphis bicolor (Fabricius, 1793)	4
Messor barbara (Linné, 1767)	15
Camponotus sp1 Chrysididae	7
Chrysis trimaculata (Foerster, 1853)	13
Chrysis sp	1
Scoliidae	
Scolia hirta (Schrank, 1781) Ichneumonidae	6
Ophion sp Sphecidae	1
Sceliphron sp Eumenidae	1
Eumenes arbustorum (Panzer, 1799)	1

Hemiptera

Reduviidae *Reduvius sp*	33
Anthocoridae	
Anthocoris nemorum (Linné, 1761)	4

Diptera

Syrphidae	
Syrphus corollae (Fabricius, 1794)	12
Syrphus balteatus (De Geer, 1776)	4
Syrphus sp	2
Esp1 ind	1
Esp2 ind	1
Tachinidae	
Tachina fera (Linné, 1761)	3

Dictyoptera

Mantidae	
Iris oratoria (Linné, 1758)	2
Rivetina fasciata (Thunberg, 1815)	2
Mantis relegiosa (Linné, 1758)	2
Empusa pennata	1

Dermaptera

Forficulidae	
Forficula auricularia (Linné, 1758)	20
Neuroptera	
Chrysopidae	
Chrysoperla carnea (Stephens, 1836)	11
Chrysoperla affinis (Navàs, 1927)	6

Appendix 2

List auxiliary insects collected by mowing of the inter-row in the three orchards of study in 2003

Order	**Number of individuates**
Coleoptera	

Chrysomelidae

Entomoscelis rumicis (Fabricius, 1787)	14

Coccinellidae

Coccinella septempunctata (Linné, 1758)	22
Coccinella algerica (Kovar, 1977)	9
Semiadalia notata (Laicharting, 1781)	2
Adonia variegata (Goeze, 1777)	7
Hyperaspis sp	3
Scymnus apetzi (Mulsant, 1846)	5

Cleridae

Trichodes sp	4
Trichodes alvearius (Fabricius, 1792)	31
Silphidae	
Silpha granulata (Thunberg, 1794)	23
Cantharidae	
Cantharis lateralis (Linné, 1758)	23
Cantharis sp	6
Staphylinidae	
Esp1 ind	5
Histeridae	
Hister quadrimaculatus (Linné)	4
Hister sp	5

Hymenoptera

Chrysididae	
Chrysis trimaculata (Foerster, 1853)	14
Chrysis sp	3
Scoliidae	
Scolia hirta (Schrank, 1781)	16
Ichneumonidae	
Ophion sp	7
Sphecidae	
Sceliphron destillatorium (Illiger, 1807)	1
Sceliphron sp	3

Eumenidae

Eumenes unguiculata (Villers, 1789)	1
Eumenes arbustorum (Panzer, 1799)	4
Ectemnius spinipes (A.Morawitz, 1866)	3

Vespidae

Vespula germanica (Fabricius, 1793)	1
Polistes gallicus (Linné, 1767)	8

Hemiptera

Reduviidae	
Reduvius sp	16

Diptera

Syrphidae	
Syrphus corollae (Fabricius, 1794)	26
Syrphus balteatus (De Geer, 1776)	13
Syrphus sp	8
Esp1 ind	2
Esp2 ind	3

Asilidae	
*Asilus barbarus (*Linné, 1758)	3
Tachinidae	
Tachina fera (Linné, 1761)	10
Esp3 ind	2

Dermaptera

Forficulidae	
Forficula auricularia (Linné, 1758)	15

Neuroptera

Chrysopidae	
Chrysoperla carnea (Stephens, 1836)	24
Chrysoperla affinis (Navàs, 1927)	11
Chrysoperla sp	1

Odonata

Coenagrionidae	
Ischnura graellsii (Rambur, 1842)	3
Enallagma sp	3

REFERENCES

Balachowsky A (1962). Entomologie appliquée à l'agriculture Tome I, Coléoptères. Masson et Cie. pp. 146-229.

Boisclair J, Estevez B (2006). Lutter contre les insectes nuisibles en agric. Bio. : intervenir en harmonie face à la complexité. Phytopro. 87: 83-90.

Burel F (1989). Landscape structure effects on Carabid bettles spatial patterns in Western France. Landscape Ecol. 24: 215-226.

Chinery M (1983). Les insectes d'Europe. Bordas, p. 380

Chouinard G, Firlej A, Vanoosthuyse F et Vincent C (2000). Guide d'identification des Ravageurs des pommiers et leurs ennemis naturels. IRDA et Saint-Laurent Québec, p. 69.

Colas G (1974). Guide de l'entomologiste. Boubée, Paris, (2-3): 59-70.

Daget J (1976). Les modèles mathématiques en écologie. Masson. Paris, p. 170.

Debras JF (2007). Rôles fonctionnels des haies dans la régulation des ravageurs : Le cas du psylle Cacopsylla pyri L. Dans les vergers du Sud – est de la France. Thèse de doctorat, Université d'Avignon et des Pays de Vaucluse, p. 240.

Defrance H, Sauphanor B, Imon S (2006). Entomofaune du verger de pommiers. Arboriculture Biologique- INRA Gotheron (2006). pp. 47-50.

Denno RF, Mitter MS, Langellotto GA, Gratton C, Finke DI (2004). Interractions between a hunting spider and a Web- builder: Consequences of intraguild predation and cannibalism for Prey suppression. Eco. Ento. 29: 566-577.

Erbilgin N, Dahlsten DI, Chenp Y (2004). Intraguild interactions between generalist Predators and an introduced parasitoid of Glycaspis brimble combei (Homoptera- Psylloidea) Bio. Control 31: 329- 337.

Fauvel G, Rambier A, Balduque-Martin R (1981). .La technique du battage pour la Surveillance des ravageurs en cultures fruitière et florale. Agronomie 1(2): 105-113.

Fournier E, Loreau M (2001). Respective rolles of recent hedges and forest patch remnants in the maintenance of ground-bettle (Coleoptera-Carabidae) diversity in an agriculture landscape. Landscape Eco. 16:17-32.

Francis F, Colignon P, Haubruge E (2003). Evaluation de la présence des syrphidae (Diptera) en cultures maraîchères et relation avec les populations aphidiennes. Parasitica 59: 129-139.

Hemptinne JI, Dixon AFG (1997). Are aphidophagous ladybirds (Coccinellidae) prudent Predators? pp. 151- 159 in B. Kromp., P. Meindl (éds.). Entomological Research in organic Agriculture. Biol. Agric. Hortic. 15: 1- 4.

Kozar F (1992). Organisation of arthropod communities in agroecosystems. Acta phytopathol. E ntomol. Hung., 27: (1- 4), pp. 365- 373.

Magurran AE (2004). Measuring Biological Diversity Blackwell Scientific, Malden, MA.

Microsoft Office Excel (2003). Microsoft® Office Excel 2003 (11.8220.8221) sp_3.

Partie de Microsoft Office Professional .Edition 2003.Copyright© 1985-2003 Microsoft Corporation.

Perrier R (1927). Hyménoptères. In la faune de la France. Delagrave. Paris, Tome VII, p. 211.

Pielou EC (1975). Ecological diversity. Wiley, New York.

Pihan JC (1977). Je reconnais les insectes. France, Tome I et II : 427 et. p.156.

Reboulet JN (1999). Les auxiliaires entomophages. Reconnaissance, méthodes d'observation, intérêt agronomique. ACTA Association de coordination Technique Agricole, Paris.

Rosenheim JA (2005). Intraguild predation of Orius tristicolor by Geocoris spp., and the Paradox of irruptive Spider mite dynamics in California cotton. Biological Control 32: 172-179.

Roth M (1963). Comparaison des méthodes de capture en écologie entomologique. Rev. Pathol. Veg. Emtomol. Agric. Fr., 42(3): 177-179.

SAS (2002). Statistical Analysis Soft Ware. Version 9.00. SAS Institute Inc., Cary, Nc, USA. Stanek v.j. 1973. Encyclopédie illustrée des insectes. Trad. Française by Griind, Paris, p. 548.

Tilman D (1997a). The influence of functional diversity and composition on ecosystem Processes. Science 277: 1300-1302.

Weesi P, belemsobgo V, (1997|). Les rapaces diurnes du ranch de gibier de Nazinga (Burkina. Faso). Liste commentée, analyse du peuplement et cadre biogéographique. Alauda, 65(3): 263- 278.

Zahradnik J (1984). Guide des insectes. Hâtier, France, p. 31