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RESEARCH

Entomofauna of Ziban Oasis, Biskra, Algeria

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ABSTRACT. An inventory was carried out at five stations in the oasis of Ziban, an oasis that is characterized by its high-quality dates, in order to study the relationships between the oasis ecosystem and its insect fauna. Specimens were sampled using pitfall traps containing ethylene glycol as a preservative. In total, 115 arthropod species were collected during 5 months of survey. These species belonged to 61 families, 17 orders, and 4 classes (12 orders from Insecta, 3 from Arachnida, 1 from Chilopoda, and 1 from Malocostraca). The most represented insect orders were Coleoptera (44.42%), Hymenoptera (20.86%), and Lepidoptera (7.87%). Represented in the collections were phytophagous, omnivorous, and predator/parasite species. Given the large number of species collected, and the largely unknown relationships existing between the various ecological groups, this study is a first step in the description of the oasis entomofauna.

RESUMEN. Dans les oasis des Ziban, cinq stations qui se caractérisent par la haute qualité des dattes produites, ont fait l'objet d'un inventaire, afin d'étudier les relations entre l'écosystème oasien et l'entomofaune qui y habite. Les exemplaires ont été échantillonnés en utilisant des pièges à fosse (pitfall traps) faits avec des demi-bouteilles en plastique contenant des agents conservateurs à base d'éthylène glycol. Pendant les cinq mois d'inventaire, 115 espèces ont été collectées, appartenant à 61 familles et 17 ordres de différentes classes : douze Insecta, trois Arachnida, un Chilopoda et un Isopoda. Les ordres d'insectes les plus représentés sont les Coléoptères (44,42%), les Hyménoptères (20,86%) et les Lépidoptères (7,87%), tous compris dans les 3 principaux groupes écologiques des phytophages (41,73%), des zoophages (36,52%) et des omnivores (21,73%). Dans cet écosystème oasien, parmi les zoophages les plus importants il y a des prédateurs (Coléoptères) et des parasitoïdes très utiles dans la lutte biologique; les Diptères ou les Hyménoptères. Quoi qu'il en soit, en dépit du grand nombre des espèces collectés et les relations existantes entre les différents groupes écologiques, notre étude n'est que le début de la description exhaustive de toute l'entomofaune présente dans les oasis, qui mérite d'être poursuivie.

Key Words: ecological group, ecosystem, insect, inventory

In the hot and dry climate of the oasis ecosystem, specialized insects find optimal conditions for their development. Their ecology is of crucial importance to oasis ecosystem function and very often they are economically important as pests of crops, vectors of disease, beneficial components of food webs, or vital components of pollination systems.

Despite some scattered scientific observations conducted throughout the country, there is still a shortage of information on biological diversity of insects in the Algerian Ziban oasis ecosystem. The latest inventory was conducted by LeBerre (1978) on the species of insects present in the oasis ecosystems in Algeria (Ziban).

Date palm, *Phoenix dactylifera* Linnaeus 1753 (Arecales: Arecaceae), is a primary crop of the oasis ecosystem. Given the arthropod pests of date palm, it is essential to have an inventory of the species and, when possible, alternative pest control methods that take into account of the fragility of the ecosystem and the health of the environment and date consumers. The date economy is often confronted with the problem of chemical residues, so alternative methods of pest control may be beneficial.

Materials and Methods

The study was conducted at the Ziban oasis, located in the east of Algeria, south of the Aurès Mountains. At 114 m above the sea level, latitude 34° 51′00″ N and longitude 5° 44′00″ E, the region of Biskra (Ziban) was selected as a site for this study because it is one of the most important areas of date production in Algeria. The survey was conducted in five oases (Fig. 1): Ain Ben Noui, Tolga, El Ghrous, Ouled Djellel, and Sidi Okba, which are sites that produce the highest quality "Deglet Nour" dates in Algeria.

Pitfall traps were used for collecting specimens (Fig. 2). These traps were constructed out of plastic containers with holes in the bottom, with a cover of wire mesh and stones placed approximately 2.5 cm above the plastic container in order to protect the traps from rainfall and prevent mammal species from entering.

Four traps were maintained at each site beginning the first of February until the end of June. The traps were visited every week. In situations where ground vegetation is minimal, traps can be left for shorter periods (a week) or more without any effects on captured specimens (Greenslade 1973). Traps were located in four opposite directions in order to cover all the insect movement in each station (Fig. 3).

Captured insects were collected weekly and transferred to the laboratory, where they were counted and examined. Insects were then sorted, pinned or point mounted, and labeled. Insects were identified to order, family, and in most cases to species. The identification of insects to the genus or species level was made at the University of Biskra and Centre de Recherche Scientifique et Technique sur les Régions Arides based on their reference collection and texts (Chinery 1993). Some of the prepared and identified species were sent to Algerian entomologists or F. Porcelli for confirmation.

Results and Discussion

The pitfall traps yielded a total of 1,524 arthropods (Fig. 4). The mean number of specimens sampled per site was highest for the

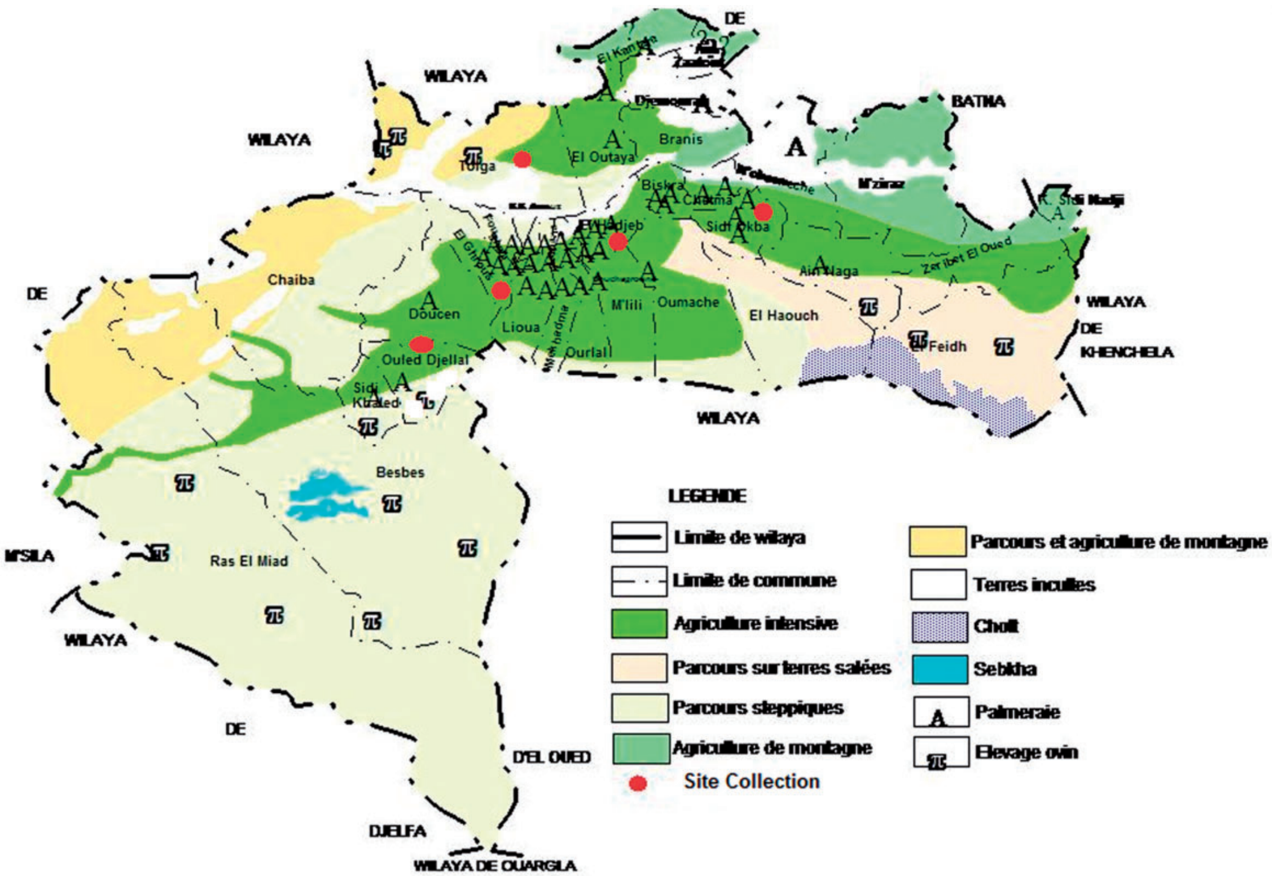

Fig. 1. Map of collection locations.

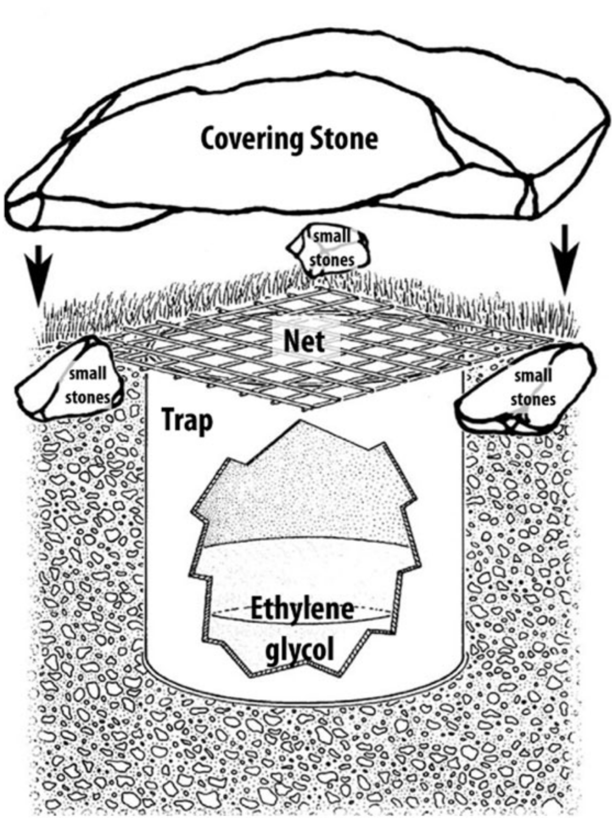

Fig. 2. Design of the pitfall traps.

El-Ghrous station (352 specimens), followed by Tolga (335), Ain Ben Noui (333), Ouled djellel (257), and finally Sidi Okba (247). Greenslade and Greenslade (1977) proposed that vegetation can have as high as a threefold influence on the diversity (species richness), carrying capacity, and structural complexity of the habitat. The slight variation in numbers from our study may be explained by the diversification of flora during the spring period in which insects were collected. Insects may be using the oasis habitats to search for prey, for an alternative source of food, for a microclimate more favorable than the cultivated field, to find a refuge or a hibernation site, or to find an undisturbed site for larval development (Maisonhaute 2009).

Coleoptera was the order with the most specimens (677), followed by Hymenoptera (318) and Lepidoptera (120). The other orders were represented by 3–26 specimens. Ye and Li (2003) conducted a similar work in Singapore in three different ecosystems, and found that the dominant orders in their pitfall traps were Coleoptera, Hymenoptera, and Lepidoptera. Thus, the design of the pitfall trap could be biased toward these arthropods. Another possible explanation for such observations may be explained by the functional role of crawler arthropods (Didham et al. 1998). Pitfall traps have been shown to be highly efficient in studies of the occurrence and activity of invertebrates active on the ground surface, especially beetles and spiders (Greenslade and Greenslade 1971, Luff 1975). Spence and Niemelä (1994) and Niemela (1996) examined five different methods of sampling and found that pitfall trapping caught the large-bodied individuals (e.g., Coleoptera and scorpions), whereas smaller sized species were caught in litter washing.

The efficiency of pitfall traps played an important part in the experimental setup. Factors such as the size (20 cm diameter), material of the cup (plastic bottles), and depth of the trap (20 cm) exclude certain arthropods that are too big to be captured by this type of trap (Luff 1975, Work et al. 2002), e.g., Lepidoptera and Odonata.

Fig. 3. Traps located in four directions.

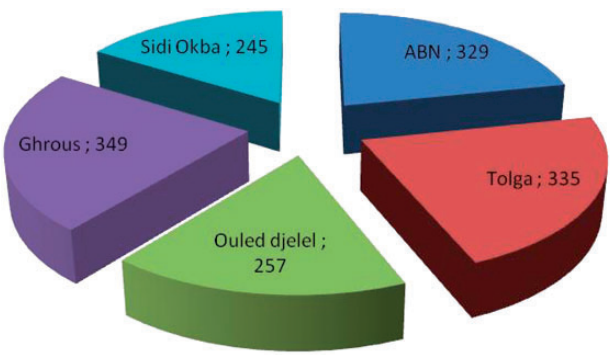

Fig. 4. Number of arthropods collected at each site.

Maehara (2004) and Scudder (2000) disagree with this explanation, and believe that their possibility to be captured depends on their activities on the surface and does not depend on the size of the containers used (Luff 1975). In our study, this may be one of the reasons that explain the relative abundance of certain arthropods (i.e., Coleoptera, Orthoptera, and Diptera) present in large number in certain oases (Spence and Niemelä 1994).In total, 115 species in 17 orders of arthropods were identified. This included 12 orders of class Insecta, 3 of Arachnida, 1 of Chilopoda, and 1 of class Malocostraca. These data are presented in Table 1. In class Insecta, 51 families and 103 species were identified (Fig. 5).Coleoptera represented the highest percentage of insects found (44.42%), followed by Hymenoptera (20.86%) and Lepidoptera (7.87%). The most speciose beetle families were Carabidae, Tenebrionidae, and Coccinellidae. The next most speciose order was Hymenoptera, with the families Vespidae, Apidae, and Formicidae, followed by Lepidoptera (families Pieridae and Nymphalidae) and Heteroptera (Miridae and Pentatomidae). The other orders were represented by 1 Neuroptera (Chrysopidae) and 2 Dermaptera (Forficulidae: Labridae).

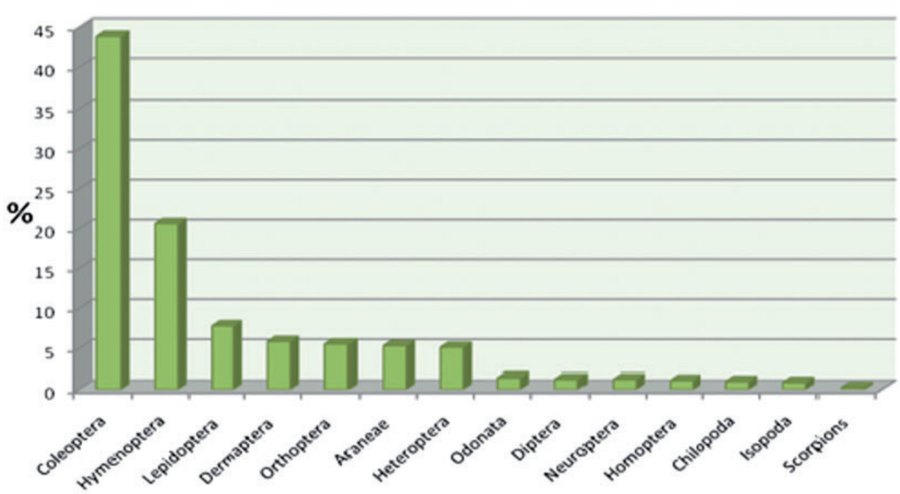

Fig. 5. Percentages of total insects collected according to order.

Table 1. Species collected by pitfall traps in oasis ecosystems

Class	Order	Family	Species	Ecological role			Months				
				Phytophagous	Zoophagous	Omnivorous	Feb.	Mar.	April	May	June
INSECTA	**COLEOPTERA**	Cetoniidae	*Tripinota (epicometis) hirta* (Poda, 1761)		X			■	■	■	■
			Tropinota squalida (Scopoli, 1783)	X				■	■	■	■
		Coccinellidae	*Psyllobara viaintiduopunctata* (Linné, 1758)	X					■	■	
			Coccinella septempunctata (Linné, 1758)		X				■	■	■
		Buprestidae	*Agrilus scythicus* (Królik and Janicki, 2005)		X						■
		Tenebrionoidea	*Pimelia payraudi* (Latreille, 1829)	X	X			■	■	■	■
			Diaperis maculata (Olivier, 1791)						■	■	■
			Gonocephalum granulatum nigrum (Küster, 1849)		X		■	■	■	■	■
			Blaps sp.		X		■	■	■	■	■
			Coelocnemis obesa (LeConte, 1851)								
		Aderidae	*Anidorus sanguinolentus* (Gotz, 1783)		X						
		Carabidae	*Calosoma inquisitor* (Linné, 1758)			X		■	■	■	
			Carabus sp.		X	X	■	■	■		
			Brachinus explodens (Duftschmid, 1812)		X				■	■	■
			Lophyra flexuosa (Fabricius, 1787)		X			■	■	■	■
			Anthia duodecimguttata (Bonelli, 1813)		X			■	■	■	
		Dasytidae	*Psilothrix viridicoerulea* (Geoffroy, 1758)		X			■	■	■	
		Scarabaeidae	*Macrodactylus subspinosus* (Fabricius, 1775)		X			■	■	■	■
			Anomala marginata (Fabricius, 1792)	X							■
		Curculinidea	*Larinus* sp.	X			■				
			Liophloeus tessulatus (Müller, 1776)							■	■
		Chrysomelidae	Clytra sp.					■	■	■	
		Meloidae	*Mylabris bipunctata* (Linné, 1767)					■	■	■	
	HYMENOPTERA	Vespidae	Polistes sp.	X	X		■	■	■	■	■
		Colletidae	Colletes sp.	X				■	■		
		Megachilidae	*Megachile rotundata* (Fabricius, 1787)	X	X			■	■		
		Ichneumonidae	*Dusona* sp.		X			■	■		
			Netelia sp.		X			■	■		
		Scoliidae	*Megascolia maculata* (Drury, 1773)	X	X			■	■		
		Apidea	*Apis mellifera* (Linnée, 1758)	X				■	■	■	
			Xylocopa violacea (Linné, 1758)	X				■	■		
		Formicidae	*Formica incerta* (Buren, 1944)	X			■	■			
			Camponotus sp.			X	■	■	■	■	
			Messor barbara (Linné, 1797)			X		■	■	■	
		Myrmicinae	*Solenopsis invicta* (Buren, 1972)		X			■	■		
		Pompilidae	*Arachnospila minututa* (Dahlbom, 1842)		X			■	■	■	
		Braconidae	*Phanirotoma* sp.		X					■	■
	HEMIPTERA	Pentatomidae	*Codophila varia* (Fabricius, 1787)	X						■	■
			Nezara viridula (Linné, 1758)	X						■	■
			Perillus Bioculatus (Fabricius, 1775)	X						■	■
			Acrosternum heegeri (Fieber, 1861)	X						■	■
			Dolycoris baccarum (Linné, 1758)	X						■	■
			Eurydema ornata (Linnée, 1758)	X						■	■
			Ancyrosoma leucogrammes (Gmelin, 1790)	X					■	■	
			Pentatoma rufipes (Linné, 1758)	X	X				■	■	■
			Carpocorpuris purpureipennis (DeGerr, 1773)	X					■	■	
		Miridae	*Stenotus binotatus* (Fabricius, 1794)	X				■	■	■	
		Lygaeividae	*Oxycarenus lavaterae* (Fabricius, 1787)		X		■	■	■		
		Cydnidae;	*Sehirus luctuosus* (Mulsant and Rey, 1866)							■	■
		Stenocephalidae	*Dicranocephalus Albipes* (Fabricius, 1781)		X		■	■	■		

(continued)

Table 1. Continued

Class	Order	Family	Species	Ecological role			Months				
				Phytophagous	Zoophagous	Omnivorous	Feb.	Mar.	April	May	June
	DIPTERA		*Sphaerophoria scripta* (Linné, 1758)		X		■	■	■		
		Syrphidae	*Cheilosia variabilis* (Panzer, 1798)					■	■		
			Syrphus vitripennis (Meigen, 1822)		X		■				
			Melanostoma mellinum (Linné, 1758)		X			■	■		
		Tipulidae	*Tipula paludosa* (Meigen, 1830)				■	■	■		
			Dusona sp.	X	X			■	■		
		Bombyliidae	*Systoechus vulgaris* (Loew, 1863)	X	X			■	■		
		Asilidae	Neoitamus sp.	X	X				■	■	
		Berytidae	*Metatropis rufescens* (Herrich-Schäffer, 1835)			X			■	■	
		Tachinidae	*Peleteria varia* (Fabricius, 1794)		X		■				
	LEPIDOPTERA	Sphingidae	*Hyles lineate* (Fabricius, 1775)	X			■	■	■		
		Noctuidae	*Mythimna vitellina* (Hübner, 1808)							■	■
			Lacanobia aliena (Linné, 1767)							■	■
			Orthosia gothica (Linné, 1758)	X						■	■
		Nymphalidae	*Pararge aegeria* (Linné, 1758)					■	■	■	
			Araschnia levana (Linné, 1758)	X				■	■	■	
			Vanessa cardui (Linné, 1758)	X				■	■	■	■
			Danaus plexippus (Linné, 1758)	X				■	■		
		Pieridae	*Pontia daplidice* (Linné, 1758)	X			■	■	■	■	
			Pieris rapae (Linné, 1758)	X			■	■	■	■	
			Lycaena helle (Denis and Schiffermüller, 1775)	X				■	■	■	
			Euchloe simplonia (Freyer, 1829)	X				■	■	■	
		Lycaenidae	*Glaucopsyche melanops* (Boisduval, 1828)	X						■	
			Polyommatus semiargus (Rottemburg, 1775)	X						■	
		Sphingidae	*Macroglossum stellatarum* (Linné, 1758)	X						■	
		Geometridae	*Idaea fuscovenosa* (Goeze, 1781)	X						■	■
		Gelechiidae	*Tuta absolota* (Meyrick, 1917)	X						■	■
			Euchloe (*Elphinstonia*) *lessei zagrosicus* (Bernardi, 1957)	X						■	■
	HOMOPTERA	Aphidedae	*Aphis gossypii* (Glover, 1877)	X				■	■	■	■
			Myzus percicae (Sulzer, 1776)	X				■	■	■	■
			Rhopalosiphum padi (Linné, 1758)	X				■	■	■	■
			Hyadaphis foeniculi (Passerini, 1860)	X				■	■	■	■
		Diaponosiphinae	*Therioaphis trifolii* (Monell,1882)	X				■	■	■	■
	ODONATA	Libellulidae	*Sympetrum sanguineum* (Muller, 1764)		X			■	■	■	■
			Sympetrum vulgatum (Linné, 1758)		X			■	■	■	■
		Coenagrionidae	*Coenagrion* sp.		X					■	■
			Ischnura elegans (Vander Linden, 1820)		X					■	■
	DERMAPTERA	Labidridae	*Labidura riparia* (Pallas, 1773)				■	■	■	■	■
		Forficulidae	*Forficula sanguineum* (Linné, 1758)		X		■	■	■	■	■
	EPHEMEROPTERA	Baetidea	*Clpeon dipterum* (Linné, 1761)		X			■	■	■	
	NEUROPTERA	Chrysopidae	*Chrysopa oculata* (Say, 1839)		X			■	■	■	
	ORTHOPTERA	Acrididae	*Chorthippus* sp.	X				■	■	■	■
			Aiolopus strepens (Latreille, 1804)	X				■	■	■	■
			Acrida turrita (Linné, 1758)	X				■	■	■	■
			Chorthippus biguttulus (Linné, 1758)	X				■	■	■	■
			Melanoplus bivittatus (Say, 1825)					■	■	■	■
			Acrotylus insubricus (Scopoli, 1786)	X					■	■	■
		Gryllidae	*Gryllus bimaculatus* (De Geer, 1773)	X	X					■	■
	MANTODAE	Mantidae	*Mantis religiosa* (Linné, 1758)		X					■	■
			Sphodromantis viridis (Forskal, 1775)		X					■	■

(continued)

Table 1. Continued

Class	Order	Family	Species	Ecological role			Months					
				Phytophagous	Zoophagous	Omnivorous	Feb.	Mar.	April	May	June
ARACHNIDA	**ARANEAE**	Lycocidae	*Trochosa terricola* (Thorell, 1856)		X		■	■	■	■	■
		Dysderidae	*Dysdera westringi* (Cambridge, 1872)		X		■				
		Thomisidae	*Thomisus* sp.		X				■	■	■
		Araneidae	*Agalenatea redii* (Scopoli, 1763)		X					■	■
			Argiope bruennichi (Scopoli, 1772)							■	■
			Argyope lobata (Pallas, 1772)							■	■
		Theridiidae	*Latrodectus* sp.		X		■				
	SOLPUGIDA	Daesiidae	*Syndaesia* sp.								■
	SCORPIONES	Buthidae	*Buthiscus bicalcaratus* (Birula, 1905)		X					■	■
		Scorpionidae	*Androctonus bicolor* (Hemprich and Ehrenberg, 1828)		X					■	■
ISOPODA	**ONISCIDAE**	Porcellionidae	*Porcellio scaber* (Latreille, 1804)			X	■	■	■	■	■
CHILOPODA	**GEOPHILOMORPHA**	Scutigeridae	*Centipede*			X		■	■		

A, Phytophagous; B, Zoophagous; C, Omnivorous; 2, February; 3, March; 4, April; 5, May; 6, June.

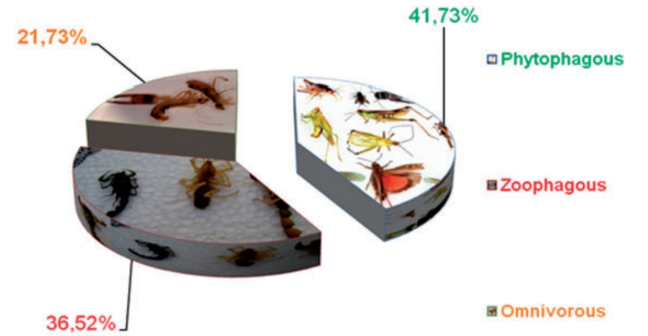

Fig. 6. Percentages of collected insects according to feeding guilds.

For the class Arachnida, orders Araneae (Lycosidae), Solfugidae (Daesiidae), and Scorpions (Scorpionidae) were the three most common orders collected, represented by several species.

Of the 115 species collected, 6 are listed by the Ministry of Land, Environment and Tourism as protected species in Algeria: *Apis melifera* L. (Hymenoptera: Apidae), *Xylocopa violacea* L., *Syrphus* sp. (Diptera: Syrphidae), *Mantis religiosa* L. (Mantodea: Mantidae), *Chrysopa carnea* (Say) (Neuroptera: Chrysopidea), and *Polistes gallicus* (Hymenoptera: Vespidae) (Ministère de l'Aménagement du Territoire, de l'Environnement et du Tourisme 2009). Their inclusion in the list might be due to their importance as predator or parasitic species that have a positive effect on the regulation of crop pests or a beneficial effect on the environment.

Figure 6 presents a breakdown of the percentage of species based on feeding guilds (i.e., phytophagous, predators/parasites, and omnivores). Among the collected insects, there were a number of serious plant pests, including aphids (Homoptera) and the gelechiid moth, *Tuta absoluta* (Meyrick) (Lepidoptera:Gelechiidae), which is a newly recorded species (Guenaoui 2008). A number of beneficial insects, including predators (Syrphidae and Cocconellidae) and parasites (Tachinidae) were also collected. Among the most important predators and parasites collected in the oasis ecosystems were ladybird beetles, *Coccinella septempunctata* L. (Coleoptera: Coccinellidae); lacewings, *Chrysopa oculata* (Say) (Neuroptera: Chyrsopidae); praying mantids, *M. religiosa*; and dragonflies, *Sympetrum sanguineum* (Muller) (Odonata: Libellulidae). The parasitic fly species *Peleteria varia* F. (Diptera: Tachinidae) and the parasite *Megascolia maculata* (Drury) (Hymenoptera: Scoliidae) were also collected.

The third group found in the pitfall traps was the beetles, *Pimelia* sp. (Coleoptera: Tenebrionidae), *Brachinus explodens* (Duftschmi) (Carabidae), and the ant *Messor barbarous* L (Hymenoptera: Formicidae).

In our study, it was found that relationships between organisms living in the same agroecosystem can be modified if the relationship is disrupted by the unavailability of a link. In trophic food chain, we can find predator and prey at different levels (Fig. 7), while parasites and their hosts can be on the same plants (Raffel et al. 2008). In our study, the large number of predatory Coleoptera present in all stations between March and May may help regulate aphid populations. Aphids also can be eaten by several other insects that could be present in and around the oasis (e.g., *C. oculata*). The dragonfly family Libellulidae was well represented in the oasis ecosystems and may play a major role in the regulation of predator species. The presence of the Araneae in Tolga and El Ghrous is very interesting and can explain the species diversification in this region. Starting with the information collected during this survey, an oasis ecosystem chain can be built.

An IPM program is applied in order to reduce pest damage by taking into account the health of people, environment, and beneficial organisms (Dufour 2001). The goal of Integrated Pest Management (IPM), from our standpoint, is to maintain a balanced ecosystem (a healthy environment) that results in high economic, environmental, and social

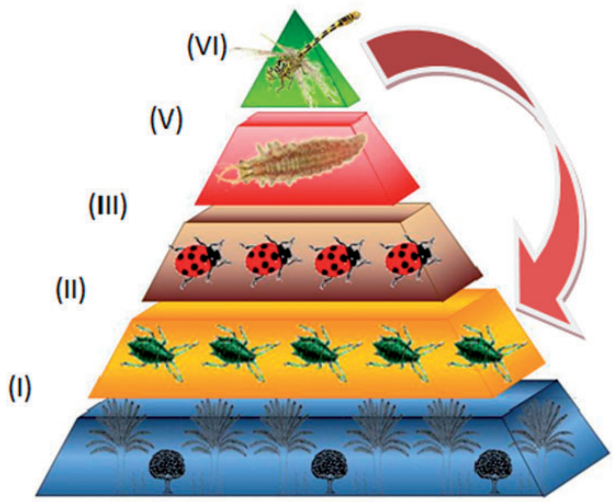

Fig. 7. Trophic levels.

benefits (Dufour 2001). The objectives of the ecosystem analysis are to make decisions about how to manage the oasis ecosystem and how to achieve the goals of IPM.

An IPM program was established in the oasis ecosystem by Doumandji-Mitiche and Doumandji (1990). They showed a 45.3% success rate with the release of the parasitoid *Trichogramma embryophagums*, a parasite of *Ectomylois ceratonae*, in an oasis ecosystem in southwest Algeria. Another program was carried out in some oases of southeast Algeria where the Institut National de Protection des Végétaux released sterilized males of *E. ceratonae* in 1999 and obtained a significant reduction in worm infestations of dates. Quinlan and Dhouibi (2008) released the biological control agents *Bracon hebetor* and other parasitoids and predators against the date moth.

Positive results were achieved in the oasis ecosystems of southwest Algeria by Idder and Pintureau (2008), who used the ladybird beetle, *Stethorus punctillum*, as a predator of the mite *Oligonychus afrasiaticus.* Other predators present in Algeria will have to be tested in order to establish a method of biological control suited to sufficiently protect the palm plantings.

This inventory is the first step in setting up an IPM program within the oasis ecosystem based on the correct identification of species and an understanding of the ecological roles at play in trophic food chain.

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