

# First record of new species and phenotypes of ladybird (Coleoptera: Coccinellidae) in citrus orchards in Morocco

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An inventory of ladybird species living in citrus groves was conducted in the Gharb and Loukkos areas (northern Morocco) during 2000-2006, using the following methods: beating, yellow sticky traps, pitfall traps, and visual observation. All trophic groups were represented, including aphidophagous, coccidophagous, aleyrodophagous, acaridophagous, phytophagous and mycetophagous ladybirds. The Moroccan citrus inventory yielded species richness (36 species and 21 genera) and new records for Coccinellidae. The following genera were recorded: *Chilocorus*, *Adalia*, *Rodolia*, *Hippodamia*, *Coccinella*, *Platynaspis*, *Scymnus*, *Stethorus*, *Harmonia*, *Exochomus*, *Hyperaspis*, *Brumus*, *Rhyzobius*, *Cryptolaemus*, *Oenopia*, *Cleitostethus*, *Pharoscymnus*, *Propylea*, *Nephus*, *Henosepilachna* and *Psyllobora*. On citrus, *Chilocorus bipustulatus*, *Adalia decempunctata*, *Rodolia cardinalis*, *Coccinella septempunctata*, *Hippodamia variegata* and *Stethorus punctillum*, were the most common, whereas the phytophagous and mycetophagous trophic groups were each represented by only one species each, *Henosepilachna elaterii* and *Psyllobora vigintiduopunctata*, respectively. Several new phenotypes were discovered among some species of ladybird beetles, particularly *A. decempunctata*, with 30 phenotypes.

**Keywords:** citrus, ladybirds, inventory, Morocco.

## [Nouvelles espèces et phénotypes des coccinelles (Coleoptera:Coccinellidae) en vergers d'agrumes au Maroc]

Un inventaire des espèces de coccinelles hébergeant les vergers d'agrumes a été réalisé dans les régions du Gharb et du Loukkos (nord du Maroc) entre la période 2000-2006, utilisant les méthodes: frappage, pièges jaunes englués, pièges au sol et l'observation visuelle. Tous les groupes trophiques ont été représentés incluant les coccinelles aphidiphages, les coccidiphages, les aleurodiphages, les acaridiphages, les phytophages et les mycétophages. Une grande richesse spécifique (36 espèces et 21 genres), de nouvelles espèces de coccinelles ont été trouvées au niveau des vergers d'agrumes au Maroc. Les genres suivants ont été enregistrés: *Chilocorus*, *Adalia*, *Rodolia*, *Hippodamia*, *Coccinella*, *Platynaspis*, *Scymnus*, *Stethorus*, *Harmonia*, *Exochomus*, *Hyperaspis*, *Brumus*, *Rhyzobius*, *Cryptolaemus*, *Oenopia*, *Cleitostethus*, *Pharoscymnus*, *Propylea*, *Nephus*, *Henosepilachna* et *Psyllobora*. Sur agrumes, *Chilocorus bipustulatus*, *Adalia decempunctata*, *Rodolia cardinalis*, *Coccinella septempunctata*, *Hippodamia variegata* et *Stethorus punctillum*, ont été les espèces les plus communes, par contre, les groupes trophiques phytophage et mycethophage ont été représentés respectivement par une seule espèce chacune, *Henosepilachna elaterii* et *Psyllobora vigintiduopunctata*. Plusieurs nouveaux phénotypes ont été détectés parmi quelques espèces de coccinelles, particulièrement pour *A. decempunctata*, avec 30 variants.

**Mots clés:** agrumes, coccinelles, inventaire, Maroc.

## 1. INTRODUCTION

Natural enemies, particularly ladybird, play an important role in the control of pests in many crops. Their effective role in controlling pests has been reported by several authors (Smirnov, 1956; Ipert, 1971, 1974, 1999; Quilici, 1981; Katsoyannos, 1993; Obrycki and King, 1998; Heinz *et al.*, 1999; Magro and Hemptinne, 1999; Michaud, 2004). Coccinellidae contains approximately 4,200 species; of which 90% are considered beneficial predators (Ipert, 1999) and this number is actually much higher, more like 6,000 (Canepari, 2009).

With the exception of Smirnov (1956), there is little information available regarding the ladybirds of Morocco, especially those associated with citrus. Knowledge of these useful enemies is necessary for any integrated pest management program, and this work serves to improve IPM on Moroccan citrus by identifying new, common and variable ladybird in the Gharb and Loukkos areas.

## 2. MATERIALS AND METHODS

Several varieties of citrus orchards were observed during this study: Clementine, Navel, Maroc late, Washington sanguine, Marisol, Nova, salustiana, and lemon. Seven primary citrus-producing regions in the Gharb and Loukkos areas were sampled from 2000 to 2006: Sidi Slimane, Sidi Kacem, Sidi Adelaaziz, Belksiri, Allal Tazi, El Menzeh (Gharb) and Larrache (Loukkos). The beating method, yellow sticky traps, pitfall traps, and visual observation were the monitoring techniques used for catching ladybirds. Species identification was facilitated by keys published by Fursch (1987 a and b, 1989, 1990) and confirmation of most species and phenotypes (dissected male genitalia) was also done.

## 3. RESULTS

Thirty-six species of ladybirds divided among 21 genera were recorded from this region (Table 1). These species belong to the following genera: *Adalia*, *Chilocorus*, *Coccinella*, *Stethorus*, *Hippodamia*, *Rodolia*, *Cryptolaemus*, *Rhyzobius*, *Exochomus*, *Cleitostethus*, *Brumus*, *Hyperaspis*, *Oenopia*, *Platynaspis*, *Scymnus*, *Harmonia*,

*Pharoscymnus*, *Nephus*, *Propylea*, *Henosepilachna* and *Psyllobora*. Aphidophagous and coccidophagous ladybirds were the most abundant, followed by aleyrodophagous and acaridophagous. The only two non-predaceous groups were represented only by one species in each group: phytophagous (*Henosepilachna elaterii*) and mycetophagous (*Psyllobora vigintiduopunctata*).

Several species are recorded for the first time in citrus orchards in Morocco: *Adalia decempunctata*; *Brumus quadripustulatus forma floralis*; *Harmonia quadripunctata*; *Henosepilachna elaterii*; *Exochomus nigromaculatus*; *Hippodamia variegata*; *Hyperaspis pumila*; *Hyperaspis algericas*, *Oenopia doublieri*; *Propylea quatuordecimpunctata*; *Psyllobora vigintiduopunctata*; *Coccinella transversalis* and *Scymnus apetzi*.

Ladybirds collected most often were *C. bipustulatus*, *A. decempunctata*, *R. cardinalis*, *H. variegata* and *Stethorus punctillum*. Those species less collected were *E. nigromaculatus*, *Oenopia conglobata*, *H. pumila*, *H. algericas*, *Cleitostethus arcuatus*. Some species, such as *Rhyzobius chrysoloides*, *Pharoscymnus setulosus*, *Scymnus suturalis*, *S. biguttatus*, *S. pallidivertis*, *S. biguttatus*, *S. levaillanti*, *Nephus quadrimaculatus*, *Hyperaspis reppensis* and *Rhyzobius litura* had not been reported in citrus orchards in the previous few years.

Many species exhibit a great deal of color variation (Table 1). Some species like *A. decempunctata*, *C. bipustulatus*, *R. cardinalis*, *H. quadripunctata*, *A. bipunctata*, *E. nigromaculatus*, *S. apetzi*, *H. variegata*, showed that there were at least two phenotypes, particularly for *A. decempunctata* which had 30 new phenotypes. In this latter case, the morph *A. decempunctata* form *decempustulata*, was the most common form encountered, whereas the typical form (ten spots) of the species was very rare.

The *A. decempunctata* form *decempunctata*, has 19 phenotypes which differ in the number of elytral spots, in the ground coloration and in the size of the spot, while *A. decempunctata* form *decempustulata* also 11 phenotypes which differ in

the structure of the drawing elytrale (connecting spots) and coloration.

#### 4. DISCUSSION AND CONCLUSIONS

This inventory of coccinellid species in the Gharb and Loukkos areas will help improve IPM in Moroccan citrus orchards. Taking into account climate conditions, it was not surprising to find such a great diversity of ladybirds on Moroccan citrus. Collection records from Moroccan citrus (36 species, 21 genera) indicate that several species and various ladybird groups frequent the orchards. Other locations around the world tend to have a similar diversity of ladybirds, for example, records from Manitoba (Canada) show 65 species (27 genera) collected there (Wise et al. 2001), while Hodek and Honek (1996) recorded 78 species (37 genera) in Poland, 71 species in eastern Germany,, and 67 species (33 genera) in the eastern Ukraine (Hodek and Honek, 1996). Citrus in Portugal bore 38 species (Magro et al., 1999). In this survey, all trophic groups were represented; the aphidophagous and coccidophagous species would seem to be the most common, followed by the aleyrodophagous and acaridophagous species. Two other non-predatory groups, phytophagous and mycetophagous ladybirds are represented by only

one species, *H. elaterii* and *P. vigintiduopunctata*, respectively. Species such as *R. chrysomeloides*, *P. setulosus*, *H. reppensis*, *C. transversalis*, *O. conglobata*, *S. suturalis*, *R. litura* and *S. biguttatus*, *S. pallidivertis*, *S. levaillanti*, *N. quadrimaculatus* were rare. The first three species were reported in citrus orchards in the Gharb area (Abbassi, 1990) while *C. transversalis* is a first record (A. Rizqui "Domaine Agricole" Morocco, pers. comm.). The other species were observed by Smirnoff (Smirnoff, 1956). Currently only *C. bipustulatus*, *A. decempunctata*, *R. cardinalis*, *H. variegata* and *S. punctillum* are recorded from these two areas, with the two first species considered to be abundant (Smaili et al. 2006). Some species of ladybirds exhibited many morphological phenotypes, and this is most commonly observed in *A. decempunctata*, with 30 phenotypes of which the *decempustulata* predominated in citrus orchard.

These various ladybirds found on citrus are useful species and their conservation is important. Many ways in which the beneficial ladybird fauna of the citrus orchard could be enhanced, by using cover crops, reducing, timing or selecting pesticides for less impact on the beneficial species. Those which are recognized to be effective can be reared and released in the context of integrated pest management on citrus.

**Table 1:** Coccinellid species and trophic tendencies recorded from Moroccan citrus orchards.

Species	Number of variants	Possible tendency
<b>Predators</b>		
<i>Adalia decempunctata</i> form <i>decempunctata</i> (Linnaeus 1758)	19	AP
<i>Adalia decempunctata</i> form <i>decempustulata</i> (Linnaeus 1758)	11	AP
(Coccinellinae, Coccinellini)		
<i>Adalia bipunctata</i> (Linnaeus 1758)	2	AP
(Coccinellinae, Coccinellini)		
<i>Harmonia quadripunctata</i> (Pontoppidan 1763)	3	AP
(Coccinellinae, Coccinellini)		
<i>Exochomus nigromaculatus</i> (Goeze 1777)	2	Co/AP
(Chilocorinae, Chilocorini)		
<i>Hippodamia variegata</i> (Goeze 1777)	3	AP
(Coccinellinae, Hippodamiini)		
<i>Chilocorus bipustulatus</i> (Linnaeus 1758)	2	Co/Al
(typical form and form <i>iranensis</i> )		
(Chilocorinae, Chilocorini)		
<i>Rodolia cardinalis</i> (Mulsant 1850)	4	Co
(Ortaliinae, Noviini)		
<i>Coccinella septempunctata</i> (Linnaeus 1758)	1	AP
(Coccinellinae, Coccinellini)		
<i>Coccinella transversalis</i> (Fabricius 1781)	1	AP
(Coccinellinae, Coccinellini)		

<i>Platynaspis luteorubra</i> (Goeze 1777) (Chilocorinae, Platynaspidini)	1	Co
<i>Scymnus apetzii</i> (Mulsant 1846) (Scymninae, Scymnini)	2	AP/Co
<i>Scymnus subvillosus</i> (Goeze 1777) (Scymninae, Scymnini)	1	AP/Co
<i>Scymnus suturalis</i> (Thunberg 1795) (Scymninae, Scymnini)	1	Co
<i>Scymnus sp.</i> (Scymninae, Scymnini)	1	AP
<i>Stethorus punctillum</i> (Weise 1891) (Scymninae, Stethorini)	1	Ac
<i>Oenopia doublieri</i> (Mulsant 1846) (Coccinellinae, Coccinellini)	1	AP/Co
<i>Oenopia conglobata</i> (Mulsant 1758) ssp. <i>conglobata</i> (Coccinellinae, Coccinellini)	1	AP/Co
<i>Hyperaspis pumila</i> Mulsant (SharafMe 1987) (Scymninae, Hyperaspidini)	1	AP/Co
<i>Hyperaspis algericas</i> (Crotch 1874) (Scymninae, Hyperaspidini)	1	Co/AP/Al
<i>Hyperaspis reppensis</i> (Herbst 1783) (Scymninae, Hyperaspidini)	1	Co
<i>Cleitostethus arcuatus</i> , (Rossi 1794) (Scymninae, Scymnini)	1	Al
<i>Brumus quadripustulatus</i> fr. <i>floralis</i> (Motschulsky 1837) (Chilocorinae, Chilocorini)	1	Co/Al
<i>Rhyzobius lophantae</i> (Blaisdell 1892) (Coccidulinae, Coccidulini)	1	Al/Co
<i>Rhyzobius litura</i> (Fab. 1787) (Coccidulinae, Coccidulini)	1	Co/Al
<i>Rhyzobius sp.</i> (Coccidulinae, Coccidulini)	1	Co/Al
<i>Cryptolaemus montrouzieri</i> (Mulsant 1853) (Scymninae, Scymnini)	1	Co
<i>Scymnus biguttatus</i> (Muls 1850) (Scymninae, Scymnini)	1	Co
<i>Scymnus interruptus</i> var. <i>laetificus</i> (Goeze 1777) (Scymninae, Scymnini)	1	Co
<i>Scymnus pallidivertis</i> (Muls 1853) (Scymninae, Scymnini)	1	Co
<i>Scymnus levaillanti</i> (Mulsant 1850) (Scymninae, Scymnini)	1	Co/AP
<i>Rhyzobius chrysomeloides</i> (Herbst 1792) (Coccidulinae, Coccidulini)	1	Co//AP/Al
<i>Pharoscymnus setulosus</i> (Chevrolat 1861) (Sticholotidinae, Sticholotidini)	1	Co/Al
<i>Propylea quatuordecimpunctata</i> (Linnaeus 1758) (Coccinellinae, Coccinellini)	4	AP
<i>Nephus quadrimaculatus</i> (Herbst 1783) (form <i>Pulchellus</i> and form <i>Quadrinaculatus</i> ) (Scymninae, Scymnini)	2	Co
<b>Phytophagous</b>		
<i>Henosepilachna elaterii</i> (Rossi 1794) (Epilachninae, Epilachnini)	2	Ph

**Mycetophagous***Psyllobora vigintiduopunctata* (Linnaeus 1758)

I

My

(Coccinellinae, Halyziini)

AP: aphidophagous; Co: coccidophagous; Al: aleyrodophagous; Ac: acaridophagous; Ph: phytophagous; My: mycetophagous. "Hippodamiini" is probably not recognized as a legitimate tribe.

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**References**

- Abbassi M. (1990). *Contribution à la lutte biologique contre les homoptères ravageurs des citrus au Maroc*. Thèse de doctorat, Faculté des Sciences agronomiques de Gembloux, Belgique, 185 p.
- Canepari C. (2009). New data on some Coccinellidae (Coleoptera) from the Mediterranean Region. *Zootaxa* **2318**, p. 394-399.
- Heinz K.M., Brazzle J.R., Parrella M.P., Pickett C.H. (1999). Field evaluation of augmentative releases of *Delphastus catalinae* (Horn) (Coleoptera : Coccinellidae) for suppression of *Bemisia argentifolii* Bellows-Perring (Homoptera: Aleyrodidae) infesting cotton. *Biological Control* **16**, p. 241-251.
- Fursch, H. (1987a). Neue afrikanische Scymnini Arten (Coleoptera:Coccinellidae) als Fressfeinde von Manihot-schädlingen. *Revue de Zoologie Africaine*, **100** (4), p. 387-394.
- (1987b). Übersicht über die Genera und Subgenera der Scymnini mit besonderer Berücksichtigung der Westpalaearktis (Coleoptera:Coccinellidae). *Entomologisches Abhandlungen Staatliches Museum für Tierkunde Dresden* **51**(4), p. 57-74.
- (1989). Newsletter for Systematic research in Coccinellids. *Universität Passau* **1**(1), p. 1-42.
- (1990). Taxonomy of Coccinellids. *Coccinella* **2**, p. 04-18.
- Hodek I. & Honek A. (1996). *Ecology of Coccinellidae*. Kluwer Academic Publisher, Dordrecht, 464 p.
- Iperti G. (1971). L'emploi des coccinelles dans la lutte contre le puceron noir de la betterave *Aphis fabae* Scop. *Extrait de Parasitica*, Tome **Xxvii**, N°4, p. 94-102.
- (1974). Les principaux auxiliaires entomophages coléoptères. Les coccinelles. Les organismes auxiliaires en vergers de pommier. *OILB/srop* 1974, p. 111-121.
- (1999). Biodiversity of predaceous coccinellidae in relation to bioindication and economic importance. *Elsevier. Agriculture, Ecosystems and Environment* **74**, p. 323-342.
- Katsoyannos P. (1993). IPM for citrus insect pest in northern Mediterranean countries. *FAO Plants Protection Bulletin* **41**, p. 177-197.
- Magro A. & Hemptinne J.L. (1999). The pool of coccinellids (Coleoptera coccinellidae) to control coccids (Homoptera: Coccoidea) in portuguese citrus groves. *Boletín de Sanidad Vegetal. Plagas* **25**, p. 311-320.
- Michaud J.P. (2004). Natural mortality of Asian citrus psyllid, *Diaphorina citri* (Homoptera: Psyllidae) in central Florida. *Science Direct. Elsevier Biological Control* **29**, p. 260-269.
- Obrzycki J.J. & King T.T. (1998). Predaceous coccinellidae in biological control. *Annual Review of Entomology* **43**, p. 295-321.
- Quilici S. (1981). *Etude biologique de Propylea quatuordecimpunctata* L. (Coleoptera, coccinellidae). Efficacité prédatrice comparée de trois types de coccinelles aphidiphages en lutte biologique contre les pucerons sous serre. Diplôme de Doctorat. 3<sup>ème</sup> Cycle entomologique, 257 p.
- Smaili M.C. & Wadjiny J. (2006). Allocation du temps, prédation et satiété chez onze phénotypes d'*Adalia decempunctata* (Coleoptera, Coccinellidae) sur le puceron noir de l'oranger *Toxoptera aurantii* Boyer de Fonscolombe (Homoptera, Aphididae) sur agrumes. In AMPP (Ed.). *Proceedings du 6ème congrès de l'Association Marocaine de Protection des Plantes*, Rabat, 2006, p. 29-30.
- Smirnoff W. A. (1956). Observation sur les prédateurs et parasites des cochenilles nuisibles du Maroc et sur leurs ennemis. *Ministère de l'Agriculture et des Forêts, Service de la Défense des Végétaux* **11**, p. 1-60.
- Wise I.L., Turnock W.J. & Roughley R.E. (2001). New records of coccinellid species for the Province of Manitoba. *Proceedings of the Entomological Society of Manitoba* **57**, 6 p.

(19 ref.)