CONTRIBUTION TO THE KNOWLEDGE OF THE COCCINELLIDAE (INSECTA: COLEOPTERA) FAUNA FROM THE AZORES ISLANDS

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An updated list of the Coccinellidae species of the Azores archipelago is presented. New records for S. Miguel: *Nephus* (*Sidis*) *hiekei*; Sta. Maria: *Rodolia cardinalis*; S. Jorge: *Stethorus punctilium*, *Clitosthetus arcuatus*, *Scymnus nubilus*, *N.* (*Sidis*) *hiekei*; Pico: *R. cardinalis*; Graciosa: *C. arcuatus*, *S.* (*Scymnus*) *interruptus*, *N.* (*Sidis*) *hiekei*, *Lindorus lophantae* and *R. cardinalis*; Corvo: *S. nubilus*, *N.* (*Sidis*) *hiekei* and *Coccinella undecimpunctata*. Regressions of species richness against area of the islands and distance from the nearest mainland were performed. No statistical significant correlation between species richness against area was found but a statistical significant negative correlation between the number of species and the distance from the nearest mainland was obtained. The results are, in part, in accordance with the predictions of MACARTHUR & WILSON'S (1967) equilibrium theory of island biogeography, relating differences in the diversity within Azorean islands with isolation.

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INTRODUCTION

Information on community characteristics, mainly diversity, has remained a central issue in ecology. Measures of diversity are frequently seen as indicators of the stability and maturity of the community and the well being of ecological systems. Diversity can be divided into two components: the variety or species richness and the relative abundance of species or heterogeneity (MAGURRAN 1991). Diversity measures can be a useful tool in environmental monitoring and conservation management (MAGURRAN 1991), and used to evaluate how far the impact of immigration, extinction and environmental factors, namely human activity, can affect their components. Thus all information concerning history of the community, such as the permanence of community in time, is very important.

According to the MACARTHUR & WILSON'S (1967) equilibrium theory of island biogeography, the number of species on islands balances regional processes governing immigration against local processes governing extinction. The immigration rate of new species to the island will be dependent on the potential mainland colonists and distance from the source and the extinction rate increases with the number of species already present on the island. The extinction rate, through competition between species on islands, increases more rapidly as species diversity increases. According to the same model, small and more isolated islands are thought to support fewer species. However, many factors not included in the model, other than extinction and immigration, could explain the variation on the number of species on islands such as elevation, number of soil types, substrate types, plant species richness, number of habitats, habitat diversity, structure and heterogeneity (BORGES 1992; BORGES & BROWN 1999).

The Azorean beetle fauna consist of 537 species and subspecies, belonging to 309 genera and 52 families (BORGES 1990a). One of the most diverse families, the Coccinellidae, includes 12 genera and 22 species (BORGES 1990a, 1992). The knowledge of Coccinellidae faunal composition in the ecosystems, including agro-ecosystems, is very important because this family includes many predators used as natural enemies in biological control. Of the predatory species most feed on either aphids or coccids, with few feeding on both types of prey. Some species feed on others phytophagous species as mites, aleyrodids, ants, chrysomelid larvae, cicadellids, pentatomids, fungi and psyllids (DIXON 2000; HODEK & HONEK 1996). Thus the food of ladybirds beetles in a particular region is likely to reflect the faunal composition of the potential prey in that area (DIXON 2000).

The aims of this work are twofold: (i) to contribute to the knowledge of the biological control agents of the Coccinellidae family, in the Azores archipelago, and to test (ii) the theory of island biogeography, namely the species-area hypothesis, which predicts that assemblages will be more species rich on larger islands and the distance hypothesis, which predicts that assemblages of more isolated islands are thought to support fewer species.

MATERIALS AND METHODS

Sites and sampling

The study areas were the islands of the Azorean archipelago. This archipelago, located in the North Atlantic, is formed by nine volcanic islands which are distributed into three groups: the western group with Corvo and Flores; the central Group with Faial, Pico, São Jorge, Graciosa and Terceira; and the oriental group with São Miguel and Santa Maria. Santa Maria is the southernmost island (37°N, 25°W), and Flores is the westernmost (31°W). The northernmost is Corvo (39.7°N). The distance between Corvo and Santa Maria, the farthest apart, is about 615 Km. The distance from the mainland is 1584 Km for São Miguel, the nearest one, and 2152 for Flores, the farthest one. The largest island is São Miguel (757 km^2) with highest mountain of the oriental group (1103 m) and the smallest is Corvo (17 km^2). All archipelagos from north Atlantic, Azores, Madeira, Canary and Cape Verde, are called Macaronesia. The climate feature of the Azores has low thermal amplitude with high precipitation and humudity. The mean monthly temperature changes regularly during the year: with a maximum in August and a minimum in February, the mean annual temperature being 17.5°C (BORGES 1990a).

Several expeditions were carried out to several Azorean islands between 1996 and 1999 and the number of stations visited on each island were: Santa Maria (21), Pico (11), São Jorge (18), Graciosa (11), Flores (9) and Corvo (1). Random collections were also made from material of São Miguel, Terceira and Faial. Depending on the type of vegetation, we used direct observation, beating and sweeping methods, collecting the ladybirds beetles using a suction tube aspirator, with a sampling effort of one hour per plot. The collected specimens were preserved in 70 % alcohol and afterwards mounted and classified. The specimens collected were deposited in the Coccinellid Collection, Ecology Section of the Biology Department of the Azores University (ref.-CC UA-SE-Aç).

Data analysis

Linear regression analysis were used to model the values of the total number of species and the geographical variables commonly used as explanatory variables in ecology and biogeographical work: area of the island and distance from the nearest mainland. Log_{10} transformed geographical variables and number of species were used i) to overcome non-constant variance, and non-linearity of the data, ii) because higher values of r^2 were consistently when using the log-log model and iii) the residuals appeared to show no pronounced patterns in the log-log model (see BORGES & BROWN 1999). ANOVA was used to test the acceptability of the model. Regression, correlation and ANOVA were performed using the SPSS (Version 11.5).

RESULTS

Coccinellidae faunal composition: A bibliographic revision of all Coccinellidae species previously recorded is presented on Table 1, with

Table I.

List of coccinelid species collected in the Azores islands. Legend: 1 DROUËT (1859); 2 TARNIER (1860); 3 DROUËT (1861); 4 CROTCH (1867); 5 UYTTENBOOGAART (1930 in FÜRSCH 1966); 6 MÉQUIGNON (1942); 7 UYTTENBOOGAART (1947 in FÜRSCH 1966); 8 FÜRSCH (1966); 9 SERRANO (1982); 10 ISRAELSON (1984); 11 ISRAELSON (1985); 12 RAIMUNDO & ALVES (1986); 13 GILLERFORS (1986); 14 FÜRSCH (1987); 15 SERRANO & BORGES (1987); 16 BORGES & SERRANO (1989); 17 BORGES (1990b); 18 SOARES et al. (1999); 19 BORGES (1990a); and 20 Present survey. Legend: * Synonym of *Scymnus* (*Scymnus*) *levaillanti* Mulsant.

Subfamilies	Tribes	Genus	Species	S. Miguel	St. Maria	Terceira	Graciosa	S. Jorge	Pico	Faial	Flores	Corvo	Unkwnon
Chilocorinae	Chilocorini	*Chilocorus*	*C. bipustulatus* (Linnaeus)	6, 7, 12, 20	4,								8
Scymninae	Scymnini	*Stethorus*	*S. punctillum* Weise	6, 8, 9, 14, 20	4, 8, 19			9, 20		4, 8, 19			8
		Clitosthetus	*C. arcuatus* (Rossi)	14, 20			20	20					8
		Scymnus	*S.* (*Scymnus*) *interruptus* (Goeze)	8, 12, 20	8, 9, 14, 20	16, 20	20	16, 20	11, 20	13, 20	11	19	
			S. haemorrhoidalis Herbst.		15								
			S. rubromaculatus (Goeze)										7, 8, 14
			S. (*Pullus*) *subvillosus* (Goeze)	6	9	4,16		9		4, 8			8
			S. (*Pullus*) *suturalis* (Thunberg)		13, 14								
			S. nubilus Mulsant*	12, 13, 20	13, 20	16, 20	16, 20	20	13, 20	13, 20	13, 20	20	14
			S. mimulus mimulus Capra & Fursch										14
		Nephus	*N. bisignatus bisignatus* (Boheman)		13, 14								
			N. flavopictus (Wollaston)	7, 9, 20		15		6, 9					5, 8, 14
			N. (*Sidis*) *helgae* Fursch		13, 14								
			N. (*Sidis*) *hiekei* Fursch	20			20	20				20	
		Pharoscymnus	*P. decemplagiatus* (Wollaston)										8
Coccinellinae	Coccinellini	*Adalia*	*A. bipunctata* Linnaeus	12						8			
			A. decempunctata (Linnaeus)	3, 12, 20	3	3	3	1, 3	3	3	1, 3	3	1, 4, 6, 8, 2
		Coccinella	*C. septempunctata* Linnaeus		4	15							8, 9
			C. undecimpunctata Linnaeus	1, 3, 4, 12, 20	1, 3, 9, 12, 20	4, 20	8	9	19	8	4, 8	8, 17, 20	7, 8, 2
		Eriopis	*E. connexa* (Germar)	19									
		Myrrha	*M. octodecimguttata* (Linnaeus)		10, 13								
	Hippodamiini	*Hippodomia*	*H.* (*Adonia*) *variegata* (Goeze)										8, 10
			H. (*Semiadalia*) *undecimnotata* (Schneider)	12									
Coccidulinae	Coccidulini	Lindorus	*L. lophantae* (Blaisdall)	10, 12, 20	10		20				19		
		Rhizobius	*R. litura* (Herbst.)	1, 3, 4, 6, 8, 9, 20	10	1, 3, 4, 6, 8,	16			1, 3, 4, 6, 8			2
			R. chrysomeloides (Herbst)	10, 20									
	Noviini	*Rodolia*	*R. cardinalis* Mulsant	9, 12, 18, 20	8, 20	9, 20	20	9, 20	20		17	19	8
			Species richness	17	16	9	9	10	5	7	6	6	

the present study the number of species recorded for the Azorean archipelago has increased to 27. From the total number of species recorded, 51.85% belong to the *Scymninae* subfamily, in which *Scymnini* is the more important tribe, 29.6% are Coccinellinae, 14.8% are Coccidulinae and 3.7% are Chilocorinae with a single species recorded (Table 1). New records for each island includes: São Miguel: *Nephus (Sidis) hiekei* Fürsch; Santa Maria: *Rodolia cardinalis* Mulsant; São Jorge: *Stethorus punctilium* Weise, *Clitosthetus arcuatus* (Rossi), *Scymnus nubilus* Mulsant, *N. (Sidis) hiekei*; Pico: *R. cardinalis*; Graciosa: *C. arcuatus*, *S. (Scymnus) interruptus* (Goeze), *N. (Sidis) hiekei*, *Lindorus lophantae* (Blaisdall) and *R. cardinalis*; Corvo: *S. nubilus*, *N. (Sidis) hiekei* and *Coccinella undecimpunctata* L. (Table 1). *N. (Sidis) hiekei* is recorded from the archipelago for the first time. It was found in the islands of São Miguel, Graciosa, São Jorge and Corvo (Table 1). This species was also recently recorded for the first time in Madeira Island (Soares et al. *in press*).

Systematic and main features of *N. (Sidis) hiekei*

Family: Coccinellidae
Subfamily: Scymninae
Tribe: Scymnini Costa, 1849
Genus: *Nephus* (*Sidis*) Muls., 1850
Subgenus: *Sidis* Muls. 1850,
Spec. Trim. Sec., P. 975
Nephus (*Sidis*) *hiekei* Fürsch 1965
(Fürsch 1965)

Host records: (1 individual) Rabo de Peixe 16.VIII.98 (on gramineas) Coccinellid Collection ref. CC-UA-SE-Aç-SMG. no 12; (3 individuals) Topo 26.VII.98 (on *Arundo donax* L. and *Tamarix* sp.), Coccinellid Collection CC-UA-SE-Aç SJ no 6; (1 individuals) Santa Cruz da Graciosa 31.VII.98 (on *Arundo donax* L.), Coccinellid Collection ref. CC-UA-SE-Aç-GR. no 6; (1 individuals) Vila Nova do Corvo 30.VI.98 (on *Zea mays* L.), Coccinellid Collection ref. CC-UA-SE-Aç-CRV. no 3.

Main morphological characteristics: In figure 1 the dorsal aspect and shape of the elytra and spermatheca is presented. Adult body shape is elongated and thin. 1.8 mm length. Colour varying between brown and black. Elytron with longitudinal yellow marks on most part of its surface, with a slightly expanded apical margin (Raimundo 1992).

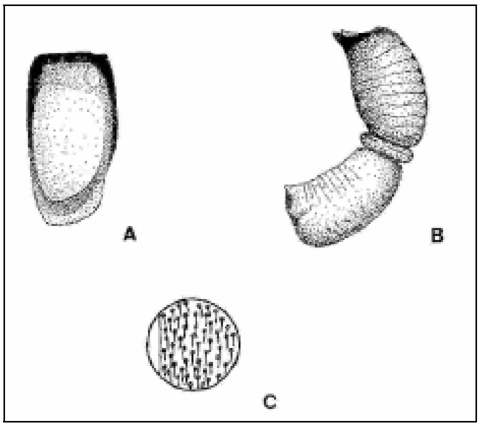

Fig. 1. *Nephus (Sidis) hiekei*: Dorsal aspect (A) and shape (C) of the elytra and spermatheca (B).

Feeding habits: Planococcus citri Risso [Homoptera: Pseudococcidae] (Raimundo 1992).

Geographical distribution: Greece, Spain, Israel, Lebanon (Fürsch 1965, 1967), Portugal mainland (Raimundo 1992) and Madeira Island (Soares et al. *in press*).

New records per island (including information on localities and hosts)

Santa Maria: Rodolia cardinalis Mulsant: (1 individual) Anjos 25.VII.2001 (in wood with *Acacia melanoxylon* R. Br.); (4 individuals) Barreiro da Faneca 25.VII.2001 (in wood with *Acacia melanoxylon* R. Br. and *Pinus* sp.); (6 individuals) Malbusca 26.VII.2001 (in wood with *Acacia melanoxylon* R. Br.); (19 individuals) Farropo 28.VII.2001 (on *Citrus* sp.); (12 individuals) Farropo 30.VII.2001 (on *Citrus* sp.); Coccinellid Collection ref. CC-UA-SE-Aç-SMA.

São Jorge: S. nubilus (4 individuals) Velas 23.VII.1998 (on Zea mays L.) Coccinellid Collection ref. CC-UA-SE-Aç-SJG no 1;

Stethorus punctilium Weise (6 individuals) Queimadas 24.VII.1998 (on *Zea mays* L.) Coccinellid Collection ref. CC-UA-SE-Aç-SJG no 2; and *Clitosthetus arcuatus* (Rossi) (2 individuals) Queimadas 24.VII.1998 (on *Citrus* sp.) Coccinellid Collection ref. CC-UA-SE-Aç-SJG no 5.

Pico: R. cardinalis (1 individuals) Madalena 29.VII.1997 (in *Citrus* sp.) Coccinellid Collection ref. CC-UA-SE-Aç-PIC and (1 individual) Areia Larga 31.VII.1997 (in mixed woods) Coccinellid Collection ref. CC-UA-SE-Aç-PIC no 4.

Graciosa: R. cardinalis (20 individuals) Praia 29.VII.1998 (on *Citrus* sp.) Coccinellid Collection ref. CC-UA-SE-Aç-GRC no 2; *C. arcuatus* (4 individuals) Guadalupe 30.VII.1998 (on *Brassica* sp.) Coccinellid Collection ref. CC-UA-SE-Aç-GRC no 3; *S.* (*Scymnus*) *interruptus* (Goeze); (2 individuals) Guadalupe 30.VII.1998 (on *Citrus* sp.) Coccinellid Collection ref. CC-UA-SE-Aç-GRC no 4; and *Lindorus lophantae* (Blaisdall) (20 individuals) Praia 29.VII.1998 [on *Pittosporum tobira* (Thunb.)] Coccinellid Collection ref. CC-UA-SE-Aç-GRC no 5.

Corvo: Coccinella undecimpunctata L. (1 individual) Vila Nova do Corvo 4.VII.1997 [on *Azorina vidalii* (Wats.) Feer (?)] Coccinellid Collection ref. CC-UA-SE-Aç-CRV no 1; and *S. nubilus* (55 individuals) Vila Nova do Corvo 4.VIII.1997 (on *Zea mays* L.) Coccinellid Collection ref. CC-UA-SE-Aç-CRV no 2.

Impact of area and distance from the nearest mainland on Coccinellidae species richness:

Regressions of species richness against the area of the islands and the distance from the nearest mainland are presented on Figures 2 and 3, respectively. The results revealed no statistical significant correlation between species richness against area (r= 0.36; ANOVA: F= 1.02; P= 0.347) and thus an area-effect does not seem to occur. On the other hand, a statistical significant negative correlation between the number of species and the distance from the nearest mainland was obtained (r= 0.73; ANOVA: F= 8.13; P= 0.025).

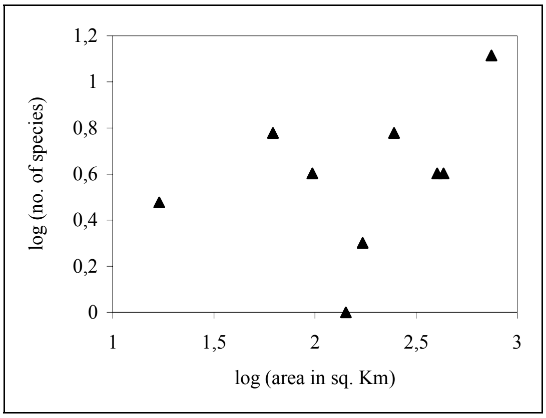

Fig. 2. Relationship between the logarithm of the number of species and the logarithm of area of Azorean islands (log y = 0.224 log x + 0.0884).

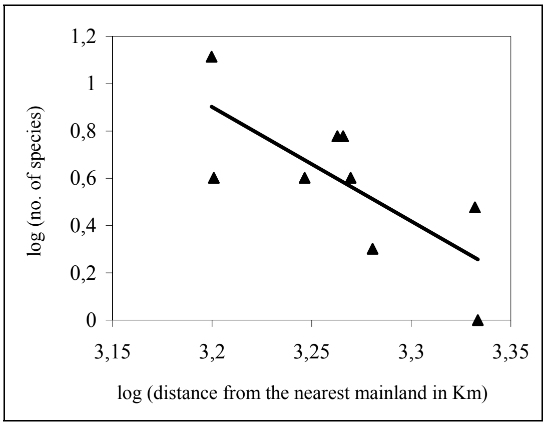

Fig. 3. Relationship between the logarithm of the number of species and the logarithm of distance from the nearest mainland in km (log y = -4.835 log x + 16.37).

DISCUSSION

A literature survey on the faunal composition of the Azorean Coccinellidae shows a continuous addition of new species to the archipelago since DROUËT (1859). Some authors, however, did not include field collections of species already reported. This could result either from (i) previous works were of the faunistic type and their objectives were the description of new species or to indicate new discoveries to the archipelago (BORGES 1992), (ii) low sampling effort in each survey or (iii) species extinction in the Azorean ecosystems as a result of human activity. The large-sized coccinellids reported in early studies, *C. septempunctata*, *H. variegata* and *A. bipunctata* were not observed during our surveys. For instance, some of those species can be found in specific ecosystems such as cereal fields in Central Europe. BORGES (1992) stressed the influence of human activity, as the cause of the poor Azorean beetle fauna. In our opinion, the absence of some species previously reported can be also related to the change in the ecosystems, including the agro-ecosystems, due to the changes in land-use observed over the years. In our opinion (i) the alteration of cultural practices lead to the extinction of food chains (tri-thropic relations) in which some predators were included and (ii) the importation of vegetative material to agriculture also contributed to the introduction of new predators leading to an alteration in the faunal composition and community structure of the Coccinellidae fauna of the Azores.

The results obtained in the regressions of species richness against area of the islands and distance from the mainland are, in part, in accordance with the prediction of MACARTHUR & WILSON'S (1967) equilibrium theory of island biogeography, that lower diversity in Azores could be related to isolation. Our results agree with the results obtained by BORGES (1992) and BORGES & BROWN (1999) that is the existence of a significantly negative correlation between total species (of pasture arthropod assemblages) and the distance from the nearest mainland. Our results are, for this reason, consistent with the hypothesis that isolated islands are expected to have low biodiversity. Concerning the correlation between total species against the areas of islands our results are also consistent with the previous authors; the absence of a significant correlation between the variables. Other factors than extinction and immigration, could explain the variation on the number of species on islands such as elevation, soil types, substrate types, plant species richness, number of habitats, habitat diversity, structure and heterogeneity (BORGES 1992; BORGES & BROWN 1999). Having in mind the fact that the biggest and less isolated islands, as São Miguel, Terceira and São Jorge, present a higher number of ecological niches, including natural habitats and agro-ecosystems due to more dynamic and intensive agricultural practices, it seems possible that those factors could also explain the trends of the correlations obtained between species richness against area of the islands and distance from the mainland.

Besides faunal studies it is very important to characterise the distribution and abundance of the entire coccinellid community. Exhaustive sampling programmes must be carried out in order to evaluate seasonal and annual community structure. The knowledge of species diversity in Azores can be a useful tool in environmental monitoring and conservation management, and can be used to evaluate how far the impact of immigration, extinction and environmental factors, namely human activity, may affect their components.

REFERENCES

BIELAWSKY, R. 1963. Coccinellidae (Coleoptera) von Madeira. *Commentationes Biologicae* 25 (2): 72-102.

BORGES, P.A.V. 1990a. A checklist of Coleoptera from the Azores with some systematic and biogeographic comments. *Boletim do Museu Municipal do Funchal* 42 (220): 87-136.

BORGES, P.A.V. 1990b. Estudo preliminar dos coleópteros (Insecta, Coleoptera) da ilha das Flores. *Relatórios e Comunicações do Departamento de Biologia* 18: 47-61.

BORGES, P.A.V. 1992. Biogeography of the Azorean Coleoptera. *Boletim do Museu Municipal do Funchal* 44 (237): 5-76.

BORGES, P.A.V. & V.K. BROWN 1999. Effect of islands geological age on the arthropod species richness of the Azorean pastures. *Biological Journal of the Linnean Society* 66: 373-410.

BORGES, P.A.V. & A.R.M. SERRANO 1989. New records of the Coleopterous fauna (Insecta) from the Azores. *Boletim do Museu Municipal do Funchal* 41 (209): 5-24.

CANEPARI, C. 2001 The identity of *Nephus levaillanti* (Coleoptera:Coccinellidae). *Bollettino della Societa Entomologica Italiana* 133 (3): 207-211.

CROTCH, G.R. 1867. On the coleoptera of the Azores. *Proceedings of the Zoological Society of London* 1867: 359-391.

DIXON, A.F.G. 2000. *Insect Predator-Prey Dynamics: Ladybirds Beetles & Biological Control*. Cambridge University Press, Cambridge. 257 pp.

DROUËT, H. 1859. Coléoptères Açoréenes. *Revue et Magasin de Zoologie* 11: 243-259.

DROUËT, H. 1861. *Élements de la faune açoréenne*. J. B. Baillière & Fils, Libraires de l'Académie de Médecine, Paris. 245 pp.

FÜRSCH, H. 1965. Die palaearktischen arten der *Scymnus bipunctatus*-Gruppe und die europäischen Vertreter der undergattung *Sidis*. *Mitteilungen Münchener Entomologischen Gesellschaft.* 55: 178-213.

FÜRSCH, H. 1966. Die coccinelliden der Azoren. *Boletim do Museu Municipal do Funchal* 20: 29-33.

FÜRSCH, H. 1967. *Scymnus* (*sidis*) *hiekei* Fürsch, als feind von *Pseudococcus citri* Risso. *Entomophaga* 12: 309-310.

FÜRSCH, H. 1987. Die Scymninae der Kanaren, Azoren und Madeiras. *Acta Coleopterologica* 3: 1-14.

GILLERFORS, G. 1986. Contribution to the coleopterous fauna of the Azores. *Boletim do Museu Municipal do Funchal* 38 (172): 16-27.

HODEK, I. & A. HONEK 1996. *Ecology of Coccinellidae*. Kluwer Academic Publishers, Dordrecht. 464 pp.

ISRAELSON, G. 1984. Coleoptera from the Azores. *Boletim do Museu Municipal do Funchal* 36 (161): 142-161.

ISRAELSON, G. 1985. Notes on the coleopterous fauna of Azores, with description of new species of *Atheta* Thomson (Coleoptera). *Boletim do Museu Municipal do Funchal* 37 (165): 5-19.

MACARTHUR, R.H. & E.O. WILSON 1967. *The theory of island biogeography*. Princeton University Press, Princeton. 203 pp.

MAGURRAN, A.E. 1991. *Ecological diversity and its measurement*. Chapman and Hall, Cambridge. 179 pp.

MEQUIGNON, A. 1942. Catalogue des Coléoptères Açoréens. *Annales de la Société Entomologique de France* CXI Paris. 11 : 1-66

RAIMUNDO, A. 1992. Novas espécies de *Scymnini* para a fauna de coccinelídeos de Portugal. Actas do V Congresso Ibérico de Entomologia. *Boletim da Sociedade Portuguesa de Entomologia* 3 (3): 373-384.

RAIMUNDO, A.A.C. & M.L.G. ALVES 1986. *Revisão dos coccinelídeos de Portugal*. Universidade de Évora, Évora. 103pp.

SERRANO, A.R.M. 1982. Contribuição para o conhecimento do povoamento, distribuição e origem dos Coleópteros do arquipélago dos Açores (Insecta, Coleoptera). *Boletim do Museu Municipal do Funchal* 36 (147): 67-104.

SERRANO, A.R.M. & P.A.V. BORGES 1987. A further contribution to the knowledge of the Coleoptera (Insecta) from Azores. *Boletim do Museu Municipal do Funchal* 39 (187): 51-69.

SOARES, A.O., R.B. ELIAS & H. SCHANDERL 1999. Population dynamics of *Icerya purchasi* Maskell (Homoptera: Margarodidae) and *Rodolia cardinalis* Mulsant (Coleoptera: Coccinellidae) in two citrus orchards of São Miguel island (Azores). *Boletin de Sanidad Vegetal de Plagas* 25:459-467.

SOARES, A.O., R.B. ELIAS & A. RAIMUNDO *in press*. New records of Scymnini (Coleoptera: *Coccinellidae*) to Madeira Island. *Boletim do Museu Municipal do Funchal.*

SPSS Inc, 2003: SPSS Base 11.5 for Windows User's Guide. Chicago, Illinois.

TARNIER, M.F. 1860. Insecte Coléoptère. Pp. 87-96 in: A. MORELET (Ed.). *Iles Açores. Notice sur l'Histoire Naturelle des Açores, suivie dune descriptions des Molusques terrestres de cet archipel.* Paris 216 pp.

UYTTENBOOGAART, D.L. 1930. Contributions to the knowledge of the fauna of the Canary-Islands. *Tijdschrift voor Entomologie*, 73:211-235

UYTTENBOOGAART, D.L. 1947. Coleoptera (excl. Staphylinidae et Hydrophilidae) von Azoren und Madeira. *Commentationes Biologicae Societas Scientiarum Fennica*, VIII: 12.

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