International Journal of Farm Sciences **5(3)** : 179-189, 2015

Measuring diversity and density of insect pollinators on coriander, C*oriandrum sativum* L by different sampling methods

MANJU DEVI, HARISH KUMAR SHARMA and KIRAN RANA

Department of Entomology, Dr YS Parmar University of Horticulture and Forestry Nauni, Solan 173230 Himachal Pradesh, India

Email for correspondence: manjupanwer@gmail.com

ABSTRACT

The diversity and abundance of insect visitors on coriander, *Coriandrum sativum* L were studied at Dr YS Parmar University of Horticulture and Forestry Nauni, Solan. A total of 39 insect visitors belonging to 31 genera under 18 families and 8 orders were found to visit the coriander bloom. Order Diptera formed 94 per cent of the insect visitors in scan sampling; *Episyrphus balteatus* and other syrphids were significantly higher. Relative abundance (by scan sampling) and diversity (by sweep net method) in general were statistically higher at 1000 h than at 1200 and 1500 h.

Keywords: Diversity; insect pollinators; dipterans; coriander

INTRODUCTION

Pollinators provide an essential ecosystem service that results in the out-crossing and sexual reproduction of many plants. There are more than 20000 pollinating bee species in the world as well as numerous other insect and vertebrate pollinators. The role of pollinators in cross pollination of important agro-horticultural crops is well recognized. The important insect pollinators include honey bees, solitary bees (*Xylocopa, Andrena, Halictus*), bumble bees, stingless bees (*Trigona, Melipona*) and dipterans flies (*Syrphus, Bombilius*). Insects mainly belonging to the orders of Hymenoptera, Lepidoptera, Coleoptera, Diptera, Hemiptera etc are the most common and dominant pollinators in various regions. The pollinators are usually known to live in equilibrium with nature. Among the insect hymenopterans (largest and diversified assemblages of beneficial insects with nearly 250000 described species) are highly evolved and constitute the most important group of pollinating insects. Even in hymenoptera bees belonging to the super family Apoidea containing an estimated 25000 described species including wasps, ants, chalcids, ichneumons, sawflies etc belonging to 250 genera and 11 families are regarded as the most important group of insect pollinators. Bees are responsible for almost 80 per cent of pollination and their role in enhancing crop yield is well recognized (Teale 1957). Bees collect pollen and nectar from flowers for food (Ollerton et al 2011). Without pollinators production of crops may decrease drastically (Gallai et al 2009).

Coriander is used as a strip crop to attract pollinators in order to facilitate pollination of major crops. This strip crop planting is important in determining the occurrence and abundance of pollinators in a locality (Pywell et al 2005). Keeping in view the attractiveness of coriander to various insect pollinators the main goal was to study the pollinator diversity of coriander bloom.

MATERIAL and METHODS

Studies on the insect pollinator diversity and density on coriander, *Coriandrum sativum* L were conducted during 2012-2013 at farm of Seed Technology and Production Centre, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, HP situated at 30.51^0 N latitude, 77.11^0 E longitude and 987 m amsl. The diversity of insect visitors on coriander was recorded by fluorescent pan traps, scan sampling and sweep net captures methods. Pan traps of florescent yellow, blue and white colour were used. Twenty four bowls eight of each colour were used. These bowls were placed in three lines the colours alternated throughout the transect. Traps were placed prior to 0900 h in the morning and removed after 1500 h. Observations were recorded at onset of bloom, full bloom and end of bloom during three sunny days. The scan sampling was done by walking slowly along a set path in between rows. Number of insect visitors was recorded on 100 umbels in each of the 4 plots located in the experimental site on 3 sunny days. The insect visitors were counted by looking at individual umbel one by one in sequence. The net sweeps were taken by transect walks between the ground flora. Five insect collection net sweeps were taken at all the random five spots equally distributed in the crop area. Observations for scan sampling and sweep net were recorded during different day hours (1000, 1200 and 1500 h) at onset of bloom, full bloom and end of bloom.

RESULTS and DISCUSSION

Pollinator diversity

The observation on insect visitors collected by different sampling methods in coriander field revealed that 39 insects belonging to 31 genera under 18 families and 8 orders were observed (Table 1, Plate 1). Hymenopteran visitors belonged to five families namely Apidae (4), Megachilidae (1), Sphecidae (1), Halictidae (6) and Formacidae (1). *Apis mellifera*, *A cerana*, *Ceratina* sp and *Ceratina sexmaculatus* represented the family Apidae. Megachilidae (*Megachile* sp), Sphecidae,

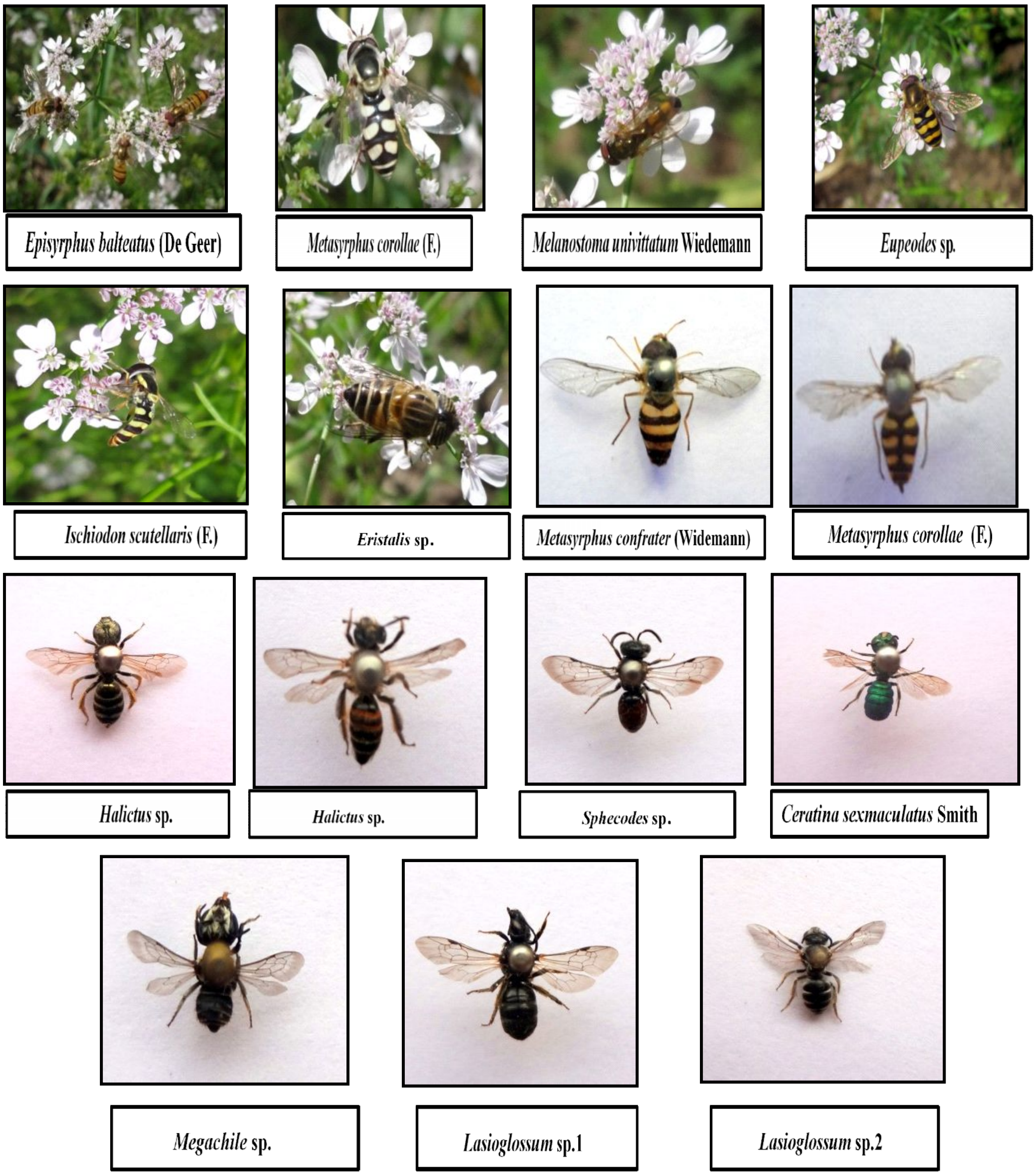

Plate 1. Important insect pollinators on C*oriandrum sativum*

Table 1. Insect visitors to coriander crop collected by different sampling methods

Order	Family	Scientific name
Hymenoptera	Apidae	*Apis mellifera* L
		Apis cerana F
		Ceratina sp
		Ceratina sexmaculatus Smith
	Megachilidae	*Megachile* sp
	Sphecidae	Unidentified specimen
	Halictidae	*Halictus* sp 1
		Halictus sp 2
		Halictus sp 3
		Sphecodes sp
		Lasioglossum sp 1
		Lasioglossum sp 2
	Formacidae	Unidentified specimen
Diptera	Syrphidae	*Episyrphus balteatus* (De Geer)
		Sphaerophoria indiana Bigot
		Scaeva pyrastri (L)
		Metasyrphus corollae (F)
		Betasyrphus serarius (Wiedemann)
		Eupeodes frequens (Matsmurs)
		Metasyrphus confrater (Wiedemann)
		Ischiodon scutellaris (F)
		Melanostoma univittatum Wiedemann
		Eristalis sp 1
		Eristalis sp 2
	Tephritidae	*Bactrocera* sp
	Calliphoridae	*Chrysomya megacephala* (Fabricius)
	Muscidae	*Musca* sp
Lepidoptera	Pieridae	*Colias electo edusina* Feldar
		Pieris brassicae L
	Noctuidae	*Helicoverpa armigera*
Coleoptera	Coccinelidae	*Hippodamia* sp
		Coccinella septempunctata
	Tenebrionidae	*Tribolium castaneum*
Hemiptera	Pentatomidae	*Nezara viridula*
		Bagrada sp
Thysanoptera	Thripidae	*Thrips* sp
Odonata	Corduliidae	*Macromia magnifica*
Orthoptera	Tettigonidae	*Neoconocephalus* sp
	Acrididae	*Schistocerca Americana*

Halictidae (*Halictus* sp, *Sphecodes* sp and *Lasioglossum* sp) were also collected. Dipteran dominated the insect visitors; eleven species were from family Syrphidae (*Episyrphus balteatus, Sphaerophoria indiana, Scaeva pyrastri Metasyrphus corollae, Betasyrphus serarius, Eupeodes frequens, Metasyrphus confrater, Ischiodon scutellaris Melanostoma univittatum,* and *Eristalis* sp) and one species each from Tephritidae (*Bactrocera* sp), Calliphoridae (*Chrysomya megacephala*) and Muscidae (*Musca* sp). Among lepidopteran *Colias electo edusina* and *Pieris brassicae* (family Pieridae) and *Helicoverpa armigera* (Noctuidae) were also recorded. Insect from order Coleoptera, Hemiptera, Thysanoptera, Odonata and Orthoptera were also sampled in the field. In the past study Chaudhary and Singh (2007) reported 34 species of insects belonging to 18 families and 8 orders on coriander bloom in Haryana. Koul et al (1989) have also reported large number of insect species (Isoptera, Hymenoptera, Orthoptera, Diptera, Hemiptera, Lepidoptera and Coleoptera) on coriander bloom.

Pollinator Density

Observations on pollinator density were recorded by fluorescent pan traps, scan sampling and sweep net methods of sampling insect pollinators. The sampled insects were arranged in seven different groups viz hive bees, *Episyrphus balteatus*, other syrphids, wild bees, other dipterans, lepidopterans and other insect visitors (Table 2). An individual species was kept as separate group amongst various syrphids because of its dominance. The results thus obtained for each of sampling method are given in Table 2.

The number of insect visitors counted using the three sampling methods is given as under:

Fluorescent pan traps

The data collected on insects trapped in coriander field during different flowering stages by pan traps (Table 3) reveal that during the onset of bloom significantly less number of insects were trapped (0.30 insects/trap) as compared to full bloom and end of bloom (0.60 and 0.67 insects/trap respectively). Insect visitors trapped were same at end of bloom and full bloom stage. This can be due to lack of flora at end of bloom and the insect visitors got attracted towards fluorescent pan traps and were sunk into them.

The data further showed that irrespective of flowering stage the number of other dipterans trapped was maximum (1.76/trap) followed by *E balteatus* (1.32/ trap). The higher number of other pollinators belonged to other syrphids (0.25) and wild bees (0.24) which were however statistically on par. Less number of trapped insects included hive bees (0.01/trap), lepidopterans (0.01/trap) and other insect visitors (0.10/trap) (differences non-

Table 2. Insect groups collected using three sampling methods

Insect group	Sampling method used		
	Florescent pan trap	Scan sampling	Sweep net
Hive bees	*Apis cerana, A mellifera*	*Apis cerana, A mellifera*	Absent
Episyrphus balteatus	*Episyrphus balteatus*	*Episyrphus balteatus*	*Episyrphus balteatus*
Other syrphids	*Sphaerophoria indiana, Scaeva pyrastri, Metasyrphus corollae, Eupeodes frequens, Metasyrphus confrater, Ischiodon scutellaris, Melanostoma univittatum, Eristalis* sp	*Sphaerophoria indiana, Scaeva pyrastri, Metasyrphus corollae, Betasyrphus serarius, Eupeodes frequens, Melanostoma univittatum, Eristalis* sp, *Ischiodon scutellaris*	*Sphaerophoria indiana, Eristalis* sp, *Melanostoma univittatum, Ischiodon scutellaris*
Wild bees	*Halictus* sp, *Lasioglossum* sp, *Sphecodes* sp, *Megachile* sp, *Ceratina sexmaculatus*	*Halictus* sp, *Megachile* sp, *Ceratina sexmaculatus*	*Halictus* sp, *Ceratina* sp
Other dipterans	*Musca* sp, *Bactrocera* sp, *Chrysomya megacephala*	*Musca* sp, *Chrysomya megacephala*	*Musca* sp, *Chrysomya megacephala*
Lepidopterans	*Helicoverpa armigera, Colias* sp, *Pieris brassicae*	*Pieris brassicae, Helicoverpa armigera*	Absent
Other insect visitors	*Nezara viridula, Bagrada* sp, *Hippodamia* sp, *Coccinella septempunctata, Tribolium castaneum, Macromia magnifica, Schistocerca americana, Thrips* sp	*Nezara viridula, Bagrada* sp, *Hippodamia* sp, *Coccinella septempunctata*	*Bagrada* sp, *Hippodaemia* sp, *Coccinella septempunctata*

significant). In Egypt El-Berry et al (1974) also reported that the syrphids comprised of 79 per cent of the insect visitors to coriander bloom.

Scan sampling

The data on insect visitors and different stages of flowering showed that insect visitors were statistically higher at full bloom (33.65/100 umbels) compared to onset of bloom (23.80/100 umbels) and end of bloom (24.39/100 umbels) (Table 4). *E balteatus* was the dominant insect visitor and its activity varied significantly at full bloom, end of bloom and onset of bloom being 191.00, 135.00 and 148.00/100 umbels respectively. Other syrphids were significantly more at full bloom (33.92/100 umbels) compared to onset and end of bloom (11.83 and 24.75/100 umbels respectively). Chaudhary and Singh (2007) also observed that Diptera was the most diverse group of floral visitors on coriander with 15 species contributing 47.8 per cent of the total visitors. Eight species of the syrphid flies constituted 35.2 per cent of the total floral visitors and *E balteatus* was the most dominant (19.2%).

Hive and wild bee activity was observed quite low which did not vary significantly during different flowering stages. The low activity of hive bees was possibly due to their preference for other competing flora blooming in the vicinity. Similar observations have been made by Anon 2013 in the same habitat where very poor activity of *A mellifera* was reported on radish bloom.

Sweep net

Insect visitors were statistically higher at full bloom (3.47/5 sweeps) than at onset of bloom and end of bloom statistically same to each other being 1.56/5 sweeps (Table 5). *E balteatus* was the dominant insect visitor and its activity varied at full bloom, end and onset of bloom (9.53, 4.33 and 5.00/5 sweeps respectively). Other dipterans were significantly more at full bloom (4.33/5 sweeps) compared to end of bloom (2.73) and onset of bloom (2.33). Hive bees and lepidopterans were absent when sampled by sweep net method. These variations might be due to the methodology rather than presence or absence of particular flower visitors. The result of present investigations is in contrast to observation of Westphal et al (2008) who reported that species composition of pan trap samples was very similar to the species composition of samples collected during transect walks.

The present findings revealed that the relative abundance (by scan sampling) and diversity (by sweep net method) in general were statistically more at 1000 h than at 1200 and 1500 h (Fig 1). Chaudhary and Singh (2007) observed that insect visitors population on coriander bloom peaked from 1100 to 1500 h and declined gradually afterwards to cease completely at 1800 h.

Table 3. Insects trapped in coriander field during different flowering stages in fluorescent pan traps

Insect visitor	# insects/trap during			Mean
	Onset of bloom	Full bloom	End of bloom	
Hive bees	0.00 (0.71)	0.01 (0.72)	0.01 (0.72)	0.01 (0.71)
E balteatus	0.18 (0.83)	2.02 (1.58)	1.76 (1.50)	1.32 (1.30)
Other syrphids	0.00 (0.71)	0.31 (0.90)	0.45 (0.97)	0.25 (0.86)
Wild bees	0.20 (0.84)	0.29 (0.87)	0.22 (0.84)	0.24 (0.85)
Other dipterans	1.71 (1.45)	1.49 (1.39)	2.09 (1.60)	1.76 (1.48)
Lepidoptera	0.00 (0.71)	0.01 (0.72)	0.01 (0.72)	0.01 (0.71)
Other insect visitors	0.03 (0.72)	0.08 (0.76)	0.18 (0.82)	0.10 (0.77)
Mean	0.30 (0.85)	0.60 (0.99)	0.67 (1.02)	

$CD_{0.05}$ Blooming period: (0.09), Insect visitors: (0.13), Blooming period x insect visitors: (0.23)

Figures in parentheses are $\sqrt{x+0.5}$ transformed values

Table 4. Abundance of insect visitors on coriander during different flowering stages measured by scan sampling

Insect visitors	# insects during		
	Onset of bloom	Full bloom	End of bloom
Hive bees	0.25 (0.84)	0.67 (1.04)	0.33 (0.87)
E balteatus	148.00 (12.15)	191.00 (13.79)	135.92 (11.65)
Other syrphids	11.83 (3.49)	33.92 (5.85)	24.75 (5.00)
Wild bees	0.58 (1.00)	1.67 (1.42)	0.42 (0.91)
other dipterans	0.83 (1.09)	1.67 (1.44)	1.33 (1.27)
Lepidopterans	0.33 (0.88)	0.83 (1.08)	0.50 (0.93)
other insect visitors	4.75 (2.24)	5.83 (2.50)	7.50 (2.79)
Mean	23.80 (3.10)	33.65 (3.87)	24.39 (3.35)

$CD_{0.05}$ Blooming period x insect visitors: (0. 32)

Figures in parentheses are $\sqrt{x+0.5}$ transformed values

Table 5. Diversity of insect visitors on coriander during different flowering stages by sweep net

Insect visitors	# insects during		
	Onset of bloom	Full bloom	End of bloom
E balteatus	5.00(2.29)	9.53(3.11)	4.33(2.16)
Other syrphids	0.27(0.84)	3.13(1.78)	0.60(1.01)
Wild bees	0.00(0.71)	0.07(0.74)	0.07(0.74)
other dipterans	2.33(1.57)	4.33(2.12)	2.73(1.69)
other insect visitors	0.19(0.81)	0.30(0.85)	0.07(0.74)
Mean	1.56(1.24)	3.47(1.72)	1.56(1.27)

$CD_{0.05}$ Blooming period x insect visitors: (0.27)
Figures in parentheses are x $\sqrt{+0.5}$ transformed values

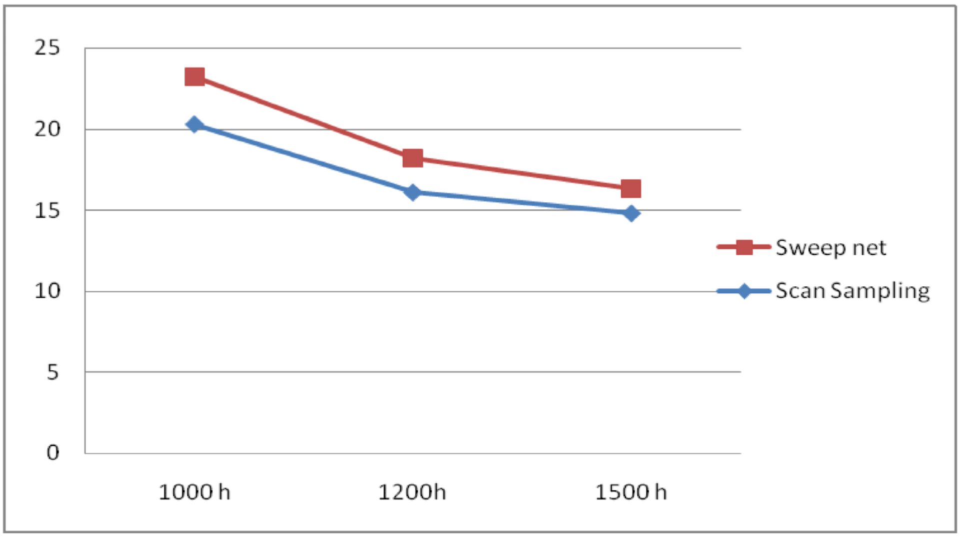

Fig 1. Abundance and diversity of insect visitors on coriander during different day hours

Insect visitors sampled by different sampling methods indicated that for sampling pollinator diversity all the methods have to be collectively employed as no single method is fully reliable. Pan traps have several known biases in catching less number of bumble bees and honey bees (Tolar et al 2005). On the other hand pan traps are beneficial for catching small bee species that are often missed during transect walks, low in cost, reliable and simple to use. These can be used to attract pollinators in the absence of bloom and have no collector bias hence to characterize local bee fauna there is need to supplement pan trapping protocols with the other sampling methods.

CONCLUSION

The observations on diversity of insects by different sampling methods (fluorescent pan traps, scan sampling and sweep net) showed that large number of insect visitors was found visiting coriander bloom. Dipteran pollinators were dominant amongst various pollinators and syrphids formed largest composition *E balteatus* being dominant. The insect visitors were more abundant at full bloom stage. The insect activity peaked at forenoon (1000-1200 h) and declined thereafter. All the three methods namely fluorescent pan traps, scan sampling and sweep net method are essential for determining pollinator diversity as no single method was fully reliable.

ACKNOWLEDGEMENTS

Authors are thankful to AICRP on honey bee and pollinators for providing financial and technical help. Authors are also thankful to Dr Debjani Dey (Principal scientist, IARI, New Delhi) for identification of insect pollinators.

REFERENCES

Anonymous 2013. Biennial report. All India Coordinated Research Project on Honey Bees and Pollinators, Chaudhary Charan Singh Haryana Agriculture University, Hisar, Haryana, India.

Chaudhary OP and Singh J 2007. Diversity, temporal abundance, foraging behaviour of floral visitors and effect of different modes of pollination on coriander (*Coriandrum sativum* L). Journal of Spices and Aromatic Crops **16(1):** 8-14.

El-Berry AR, Gawaad AAA, Moustafa MAK and El-Gayar FH 1974. Pollinators other than honey bees visiting certain vegetable plants in Egypt. Zeitschrift Fur Angewandte Entomologie-Journal of Applied Entomology **76:** 113-119.

Gallai N, Salles JM, Settele J and Vaissiere BE 2009. Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. Ecological Economics **68:** 810-821.

Koul AK, Hamal IA and Gupta SK 1989. Pollination mechanism in *Coriandrum sativum* (Apiaceae). Proceeding, India Academy of Science (Plant Science) **99(5):** 509-515.

Ollerton J, Winfree R, Tarrant S 2011. How many flowering plants are pollinated by animals? Oikos **120:** 321-326.

Pywell RF, Warman EA, Carvell C, Sparks TH, Dicks LV and Bennett D 2005. Providing foraging resources for bumble bees in intensively farmed landscape. Biological Conservation **121:** 479-494.

Teale EW 1957. Insect friends. Dodd Mead and Co, New York, 96p.

Tolar TR, Evanas EW and Tepedino VJ 2005. Pan traps for bees (Hymenoptera: Apiformes) in Utah's west desert: the importance of colour diversity. Pan Pacific Entomologist **81:** 103-113.

Westphal C, Bommarco R, Carre G, Lamborn E, Morison N, Petanidou T, Potts SG, Roberts SPM, Szentgyorgyi H, Tscheulin T, Vaissiere BE, Woyciechowski M, Biesmeijer JC, Kunin WE, Settele J and Dewenter IS 2008. Measuring bee diversity in different European habitats and biogeographical regions. Ecological Monographs **78:** 653-671.

Received: 12.2.2015 ***Accepted: 17.5.2015***