SPIDER DIVERSITY ATTRIBUTES IN A CULTURAL LANDSCAPE DOMINATED BY FIELD CROPS AND FRUIT ORCHARDS IN THE KONKAN REGION OF MAHARASHTRA

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ABSTRACT

A study was undertaken to explore the spider diversity of important agro-ecosystems (rice, finger millet, cashew and mango) in the Konkan region of Maharashtra. Standard-time visual sampling was done with spatial and temporal replication from June 2010 to March 2011. A total of 4035 individual spiders were recorded. They belonged to 141 species, 70 genera and 21 families. The families Araneidae and Salticidae were the dominant families overall. A total of 29, 35, 69 and 98 species were recorded in rice, finger millet, cashew and mango, respectively. The completeness of the surveys was found to be as high as 87% in mango and as low as 49% in finger millet on the basis of proven reliable estimators of species richness. Simpson's index of dominance showed a mango (0.119) > rice (0.103) > finger millet (0.081) > cashew (0.054) trend. On the other hand, the Shannon diversity index showed a cashew (3.41) > mango (3.02) > finger millet (2.81) > rice (2.73) trend. Beta diversity indices for combinations showed a high spatial turnover between field crops and orchards. But within each group, there was considerable overlap in the composition underlining the value of a heterogeneous landscape in maintaining spider diversity.

INTRODUCTION

Spiders—belonging to the order Araneae, the seventh largest order of the animal kingdom—are small invertebrate animals distributed throughout the world. The total number of described species of spider from all over the world is 43,244. They belong to 3879 genera under 111 families (Platnick 2012). In India, there are 1442 spider species in 361 genera belonging to 59 families (Siliwal *et al.* 2005). Spiders have been known to occupy almost every terrestrial habitat (Preston-Mafham and Preston-Mafham 1993) including cultural habitats.

As a land use, agriculture has contributed to modification and destruction of natural habitats of spiders. Apart from the usual natural factors, spider diversity in agro-ecosystems is influenced by farming activities such as tillage, irrigation, fertilization, weeding, crop establishment and pesticide application (Parris 2001) and inherent properties such as monoculture and intensification (Rypstra *et al*. 1999, Oberg 2007, Abhilash and Singh 2009). One underlying reason is the lower levels of vegetation diversity compared with natural habitats. Yet, numerous spider species have been successful in occupying various agro-ecosystems to a large extent (Young and Edwards 1990). Studying and exploring spiders in agro-ecosystems is essential for two reasons.—first, they represent an important component of animal diversity of a given site, and second, they contribute to an increased yield by controlling insect pest populations.

Worldwide, the spider fauna in agricultural landscapes has been studied extensively for its composition and population densities (e.g. Bishop & Riechert 1990, Marc et al 1999, Lee & Kim 2001, Sebastian *et al.* 2005, Sudhikumar *et al*. 2005 etc.). Similarly, some work has also been done in fruit orchards in other countries (Marc and Canard 1997, Brown *et al*. 2003, Tavares 2007, Monzo *et al*. 2011 etc.), but very little has been done in India (Sugumaran *et al*. 2007).

The Konkan, which is a part of the famous Western Ghats-Sri Lanka biodiversity hotspot, is speculated by the authors to hold a rich diversity of spiders. However, very little documentation of the spider diversity of this region exists in the literature (Pradhan 2006). There is a complete lack of published reports on the spider diversity and abundance in agricultural fields in this region. We present here results of a study of spider diversity in an agriculture-dominated landscape in the Konkan. The study landscape was assumed to be simplistic (as in the dominant agricultural pattern in Konkan), comprising two crop systems (rice, finger millet) and two orchard systems (cashew, mango) for the purposes of landscape-level attributes of spider assemblages.

STUDY SITE

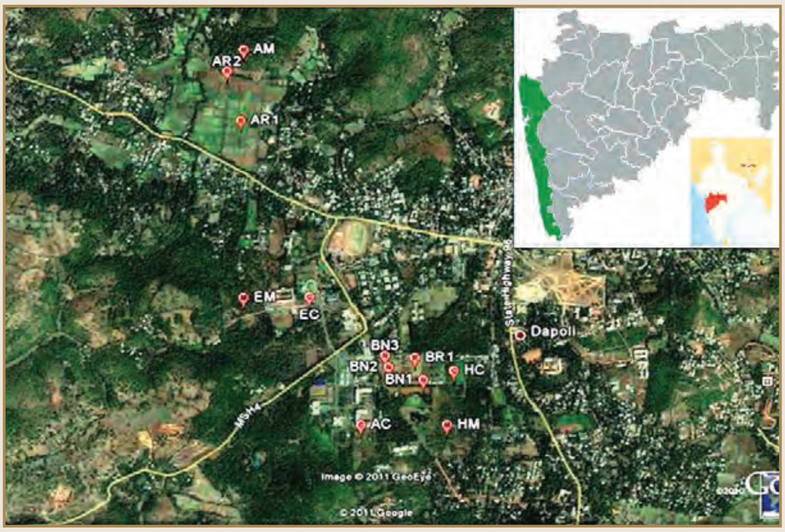
The Konkan is a coastal belt of land sandwiched between high hills of the Western Ghats in the east and the Arabian Sea in the west. The terrain is mostly hilly, fragmented by several short rivers originating in the Sahyadris and rushing to the Arabian Sea. Some areas in the region have coastal plains. The altitude varies from sea level to over 1000 m above MSL. The major landforms include coastal plains, creeks and estuaries, forested slopes, grassy hilltops and precipitous mountainsides. Agricultural land uses include flooded and upland paddies and finger millet on the hill-slopes and fruit orchards in the hills. A large proportion of land (>40%) is covered with forests (FSI 2011). The forests are mostly dry deciduous and moist deciduous mixed forests.

The region is characterized by a humid climate with over 3500 mm average annual rainfall and moderate temperatures ranging from as low as 7.5°C to as high as 38.5°C. The average relative humidity ranges from 55% to 100%. During the study period, the maximum and minimum temperatures ranged from 31°C to 32°C and from 18°C to19°C, respectively. The total rainfall received during the period of study was 4801.3 mm in 149 rainy days. The intensity of rainfall was higher during July and September. The relative humidity during the crop period ranged from 95% to 71.2%.

The Konkan region is famous for its rice (*Oryza sativa*) cultivation. In addition, finger millet (*Elusine corocana*) is also cultivated on hill-slopes. Recently, the area under cultivation of horticulture crops such as mango (*Mangifera indica*) and cashew (*Anacardium occidentale*) has also increased. In the Konkan region, rice, finger millet, cashew and mango are cultivated on 4.13, 0.47, 1.75 and 1.75 lakh ha, respectively (Magar *et al*. 2006, www.maccia.org.in, www.shivrai.co.in).

The main campus of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth in Dapoli, was selected for a landscape-level study of spider diversity. A map of the Konkan region showing the study site is presented in Fig1.

Figure 1.



The campus is spread over 200 ha. Various departmental farms cultivate different crops and maintain orchards

METHODS

SAMPLING FOR SPIDERS

A sample in the field crop was 15 minutes of visual search at a random location, usually restricted to an area of 1 m^2. Following Sebastian *et al*. (2005), the area around each plant in the area was searched for spider webs, and all plant parts were examined for spiders by a visual search and using the hand picking method. A sample in an orchard was 30 minutes of visual search of and around a fruit tree. Spiders were recorded by web visualization and using the branch collecting and hand picking methods. The ground under the canopy of the sample tree, the bark of its main stem and primary branches, and the foliage up to a height of 2 m above the ground were thoroughly searched for spiders. Each crop field was sampled every week from the first week of July 2010 to the first week of November 2010. Each orchard was sampled once every fortnight from the first fortnight of June 2010 to the last fortnight of March 2011. Four samples were collected from each field during one sampling instance.

After one reference spider was collected, others closely matching it were not collected. But those presenting confusion over identity in the field were collected for further exploration. The collected spiders were preserved in 70% ethanol, as suggested in Marc *et al*. (1999), with proper labeling, and deposited in the collection of the College of Forestry, Dapoli.

IDENTIFICATION OF SPIDERS

Even the latest checklists of Indian spiders have fewer than 1500 spiders (Siliwal *et al*. 2005)—less than 5% of the world's spiders. Compared with other megadiverse countries, this is only a small fraction. Thus, it seems that the spider fauna of India is inadequately explored. Further, there is a lack of elaborate identification keys, making it difficult for lay workers to fully identify species with certainty. In this study, the available reference material (Sebastian and Peter 2009, Proszynski 2009, Barrion and Litsinger 1995) was used, and online resources (www.southindianspiders.org, www.spidersofcentralindia.org etc.) were also referred to. The help of Dr. G. N. Vankhede of SGB University, Amravati, and Dr. S. K. Jose of Deva Matha College, Kuravilangadu, Kerala, was taken for identification of spiders on the basis of specimens and/or photographs. The individuals were put into uniquely coded morphospecies until further identification was possible.

INVENTORY COMPLETENESS

Inventory completeness is an important aspect of biodiversity inventories. It is defined as the ratio of observed to estimated species expressed as a percentage. A staggering number of species estimators based on presumably incomplete inventories are available (Walther and Martin 2001). However, according to them, Chao1, Chao2, Jackknife1 and Jackknife2 are the most reliable. The values of these estimators for spider assemblage in each of the agro-ecosystem were calculated using the EstimateS software package (Colwell 2009). This software also calculated the numbers of singletons (species with only one individual) and doubletons (species with only two individuals). The range of per cent completeness was calculated by dividing the observed species richness by each estimator. Along with these, the average number of individuals per sample and the average number of species per sample were also calculated for each agro-ecosystem. The sampling intensity is also considered as a measure of inventory completeness. It was calculated as the number of individuals collected per species.

SPECIES DIVERSITY

The diversity of a community is assessed in terms of its species richness—the observed number of species—first and foremost. Since inventories are always incomplete, the estimated number of species, calculated as described in the previous section, is a more reliable measure of the species richness. In addition, diversity indices such as Simpson's index (D) and Shannon's index (H') are used to explore the apportionment component of the diversity of a community (Magurran 2004). Simpson's index shows whether a community is dominated by one or a few species. Shannon's index, on the other hand, assesses the heterogeneity of species abundances within a community. Various transformations are available for easy interpretation of D and H', like 1/D, 1-D and 1/H'. But it was decided to use the straightforward calculated figures. Thus, a higher value of D in the results indicates a high dominance of one or few species, making the community less diverse. On the other hand, a higher value of H' indicates a high degree of heterogeneity within the community and hence higher diversity.

The diversity of a community within a given habitat is alternatively termed as the alpha diversity; that between two habitats within a landscape is termed the beta diversity (Whittaker 1972 as adopted in Magurran 2004). The species richness, D and H' all represent the alpha diversity of spider communities in particular agro-ecosystems. Whittaker's β values were also calculated for pairs of agro-ecosystems. The results of this analysis are presented as the spatial turnover at the species and family levels between pairs of agro-ecosystems. The higher the value of Whittaker's ***β*** is, the higher the turnover between those two communities, indicating minimal compositional overlap.

RESULTS

In this study, a total of 4035 individual spiders were recorded. These were identified, as far as possible, to the species level using the techniques described in the previous section. After exhausting all the available resources for identification, it was determined that these belonged to 141 species under 21 families. Of these, 65 species could be identified to the species level with certainty. The remaining species could be identified up to the genus level (67) or the family level (9). A checklist of the spider species recorded in this study is given in Appendix I. The dominant families were the families Araneidae and Salticidae, with 35 and 34 species, respectively. Similarly, the maximum number of species was also recorded in the families Araneidae (15) and Salticidae (16).

A summary of the observations is provided in Table 1. Mango agro-ecosystems had the highest observed species richness, whereas rice had the lowest. However, they cannot be compared validly because of the completely different types of habitats and sampling units. Thus, between mango and cashew agro-ecosystems, mango was more species-rich, with 98 species, compared with 69 in cashew. Similarly, between rice and finger millet, finger millet was more species-rich, with 35 species, compared with 29 in rice agro-ecosystems. Similar trends were observed in the case of the number of genera. In terms of the number of families, rice and finger millet had the same number. However, cashew had only two thirds of the families recorded in mango.

Table 1.

Summary of observations on spiders in major agro-ecosystems of Konkan region

Agroecosystem	Sampling unit	N	Individuals	Families	Genera	Species	D	H'
Rice	Quadrant	204	526	7	14	29	0.103	2.73
Finger millet	Quadrant	192	423	7	19	35	0.081	2.81
Cashew	Tree	240	743	14	43	69	0.054	3.41
Mango	Tree	240	2343	21	60	98	0.119	3.02
Total		4035	21	70	141			

The ranges of per cent completeness based on the minimum and maximum estimates for each system are presented in Table 2. For comparison, the values of the observed species richness, sampling intensity, singletons and doubletons are also provided in the same table. The sampling intensity was found to be highest in mango and lowest in cashew. The combined proportion of singletons and doubletons with observed species richness ranged from 34% in the case of rice and 41% in the case of cashew. Two commonly used diversity indices were also worked out for each agro-ecosystem and are presented in Table 1.

The compositions of spider families in different systems under study are presented in Table 3. Rice and finger millet agro-ecosystems had equal numbers of families recorded. Whereas the family Thomisidae was found only in rice, the family Oonopidae was found only in finger millet. The remaining six families were shared by these two agro-ecosystems. The family Tetragnathidae was dominant in rice, with 7 species. On the other hand, the families Araneidae and Salticidae were the dominant families in finger millet, with 13 species each. Similarly, the family Araneidae was the dominant family in both cashew and mango orchards (21 and 26 species, respectively), followed by the family Salticidae (16 and 21 species, respectively). The families Corinnidae, Ctenidae, Filistatidae, Miturgidae, Philodromidae and Sparassidae were the rare spider families in the landscape, with only one species each and found only in one agro-ecosystem, i.e. mango orchards. None of the families were found exclusively in cashew orchards.

To note the contribution these varied ecosystems make to the spider assemblages of the landscape, the beta diversity was explored. The beta diversity values (Whittaker's ***β***) were worked out at the family and species levels. The values are presented in Tables 4 and 5, respectively.

Table 2.

Comparison of observed spider species richness with various estimates for assessment of inventory completeness in agro-ecosystems under study

Parameters	Rice	Finger millet	Cashew	Mango
No. of individuals	526	423	743	2343
Individuals/sample	2.58	2.20	3.10	9.76
Observed species richness	29	35	69	98
Species per sample	1.81	1.74	2.24	4.29
Sampling intensity	18.14	12.09	10.77	23.91
Singletons	6	12	17	22
Doubletons	4	2	11	14
Chao1	34	71	82	115
Chao2	34	53	85	113
Jackknife1	35	47	88	120
Jackknife2	37	55	96	126
Completeness (%)	78-85	49-75	72-84	78-87

Table 3.

Composition of spider families in important agro-ecosystems of Konkan region

Family	Rice	Finger millet	Cashew	Mango	Total
Araneidae	5	13	21	26	35
Clubionidae	-	-	1	1	1
Corinnidae	-	-	-	1	1
Ctenidae	-	-	-	1	1
Filistatidae	-	-	-	1	1
Gnaphosidae	-	-	1	1	2
Hersiliidae	-	-	1	1	1
Lycosidae	6	2	3	2	6
Miturgidae	-	-	-	1	1
Nephilidae	-	-	1	2	2
Oonopidae	-	1	-	1	1
Oxyopidae	1	2	6	5	7
Philodromidae	-	-	-	1	1
Pholcidae	-	-	1	1	1
Pisauridae	-	-	1	2	2
Salticidae	6	13	16	21	34
Sparassidae	-	-	-	1	1
Tetragnathidae	7	3	4	4	9
Theridiidae	2	1	9	10	15

Thomisidae	2	-	3	6	10
Uloboridae	-	-	1	9	9
No. of families	7	7	14	21	21

Table 4.

Contribution of different agro-ecosystems to landscape-level diversity of spider families in terms of beta diversity

Agroecosystems	Total families	Common families	Exclusive to first system	Exclusive to second system	Turnover (***β***)
Rice-finger millet	8	6	1	1	0.1429
Rice-cashew	15	6	1	8	0.4286
Rice-mango	21	7	0	14	0.5000
Finger millet-cashew	15	6	1	8	0.4286
Finger millet-mango	21	7	0	14	0.5000
Cashew-mango	21	14	0	7	0.2000

Table 5.

Contribution of different agroecosystems to landscape-level diversity of spider species in terms of beta diversity

Agroecosystem	Total species	Common species	Exclusive to firstsystem	Exclusive to second system	Turnover (***β***)
Rice-finger millet	54	10	19	25	0.6875
Rice-cashew	88	10	19	59	0.7959
Rice-mango	118	9	20	89	0.8583
Finger millet-cashew	86	18	17	51	0.6538
Finger millet-mango	115	18	17	80	0.7293
Cashew-mango	110	57	12	41	0.3174

DISCUSSION

INCOMPLETE IDENTIFICATION

It is clear that identification of spider individuals to species level was not possible in this study. The identification carried out by the first two authors was vetted by two spider taxonomists. And still the identification was incomplete. But high levels of incomplete identification are frequent in spider studies. For example, Jose *et al*. (2008) reported 7 species identified up to the family level and 39 up to the genus level from a total of 147 species. Similarly, Uniyal and Hore (2009) reported 65 species—among 160—that were identified only up to the genus level. Pearce *et al*. (2004) also could identify only 28 up to the species level, 50 up to the genus level and 24 to the family level. This is because of a lack of useful reference material for identification and the time required for conventional taxonomic work.

The solution to this problem is to use a morphospecies approach. A morphospecies is a group of organisms thought to be of one species only on the basis of their apparent morphological features (Derraik *et al*. 2002). Although Derraik *et al*. (2002) themselves pointed out that unreliable body colour, sexual dimorphism and indistinct immatures made the morphospecies approach less reliable in the case of spiders, Hore and Uniyal (2008a) recommended the morphospecies approach in the case of poorly known and species-rich taxa such as spiders in studies in India. The cautionary principle here is to always remember that the estimates of diversity might be slight over- or underestimates with the morphospecies approach (Derraik *et al*. 2010).

INVENTORY COMPLETENESS

Chao *et al*. (2005) emphasized the fact that recording all species in a species-rich assemblage with a large proportion of rare species was literally impossible due to sampling limitations. But the objective of any diversity study is always near-complete surveys, based on which further valid inferences can be drawn. This completeness of surveys is usually understood on the basis of proportion of estimated species that are actually recorded (Uniyal and Hore 2009). There are dozens of species richness estimators, out of which the Chao and Jackknife estimators were found to be the least biased and most precise in the case of bird inventories (Walther and Martin 2001). Hore and Uniyal (2008b) used Chao1 and Jackknife2 estimators for assessing the completeness of spider inventories in India's Terai Arc Conservation Area.

In the present study, the minimum completeness was recorded in finger millet (49-75%), whereas relatively high completeness (72-87%) was recorded in the other three agroecosystems. Whereas Chao1 estimated the highest species richness for finger millet, Jackknife2 estimated the highest values for the other three agroecosystems. Hore and Uniyal (2008b) obtained completeness estimates for spider inventories that varied from 56% to 92% in different forest vegetation types. Taking a cue from them, it was concluded that the present study had fairly complete surveys in rice, cashew and mango but the surveys were less complete in finger millet.

DIVERSITY IN INDIVIDUAL SYSTEMS

Barrion and Litsinger (1995) recorded 342 species of spider from rice fields in South Asian and Southeast Asian countries. They also showed that the spider diversity of rice fields in irrigated wetlands was higher than that of rain-fed wetlands. Sebastian *et al.* (2005) collected 92 species of spider from irrigated rice fields in the Kharif and Rabi seasons in 2002-03 at six sites at different altitudes in two districts of Kerala. Sudhikumar *et al*. (2005) also recorded 94 spider species from lowland rice fields in Kerala over 2 years in four cropping seasons. The low species richness in the rice agroecosystem noted in the present study could be attributed to the fact that sampling was carried out during only one season and the extent of the study site in terms of area and altitude was limited. Employing different sampling techniques for different groups of spiders might have been a better strategy. A similar situation was found in the finger millet agroecosystem. However, this is perhaps the first record of the spider species associated with finger millet. The species richness was not much higher than that of the rice agroecosystem, probably because of the above-mentioned reasons.

Sugumaran *et al.* (2007) found a species richness of 13 in fruit trees in the horticultural research station at Yercaud, in Tamil Nadu. In the present study, a species richness several times higher was recorded in both the cashew and mango ecosystems. In fact, Sugumaran and colleagues collected spiders by net-sweeping in addition to hand-picking. They have not mentioned their study period or sampling intensity, thus making it difficult to compare the species richness values. The present work is also, perhaps, the first systematic report of spiders associated with cashew and mango agroecosystems.

The value of Simpson's index of dominance (D) in rice was relatively higher than that in finger millet, meaning there was a very high dominance of a few spider species in the rice ecosystem. Similarly, D in mango was much higher compared with cashew, indicating that the spider assemblage in the mango agroecosystem was dominated by a few species, whereas that in cashew had a comparatively large number of rare species. The value of Shannon's index (H') similarly indicated a higher diversity in finger millet and cashew compared with rice and mango, respectively. It is an interesting observation that even though the mango ecosystem had a higher species richness, it showed lower diversity compared with the cashew ecosystem.

CONTRIBUTION TO LANDSCAPE-LEVEL DIVERSITY

Whittaker's β gives an idea about the compositional dissimilarity between two sets of taxon assemblages. It is also called the spatial turnover. In spiders, the family is a very useful taxon for comparison of different habitats because identification at the genus and species levels is very complicated and almost always incomplete. Churchill (1998) even described how spider families could be used as cost-effective indicators of ecological change and disturbance in tropical Australia. We found that the highest turnover of spider families was between mango and agricultural crops (0.50), followed by that in cashew and agricultural crops (0.43). The lowest turnover was recorded between pairs of agricultural crops and horticultural crops (0.14 and 0.20, respectively).

When the beta diversity was worked out at the species level, it was found that the maximum turnover was between rice and mango systems (0.86) and the minimum turnover was between cashew and mango systems (0.32). Thus, a vast proportion of the spider assemblage diversity at the landscape level was contributed by horticultural crop orchards, but a high level of compositional dissimilarity existed between agricultural and horticultural crops. This was indicative of the important contribution of agricultural crops to the spider diversity in the landscape. This was a clear indication of the existence of distinct assemblages in agricultural crops, in contrast with horticultural crops. Interestingly, however, the spider assemblage in finger millet was somewhat closer to that in cashew, compared with rice.

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APPENDIX I

Checklist of species recorded in important agroecosystems of Konkan region. Plus sign indicates presence of that species in a particular agroecosystem. A total of 141 morphospecies belonging to 21 families were recorded.

Sl. no.	Code	Morphospecies	Rice	Finger millet	Cashew	Mango
Araneidae						
1	Aran	*Arachnura angura*			+	+
2	Ra3	*Araneid1*	+			
3	Na8	*Araneid2*		+		
4	Armi	*Araneus mitificus*			+	
5	Arne	*Araneus nexcelsus*				+
6	Aransp1	*Araneus sp1*		+		
7	Aransp2	*Araneus sp2*				+
8	Arae	*Argiope aemula*	+	+		
9	Arpu	*Argiope pulchella*	+		+	+
10	Arsp	*Argiope sp1*				+
11	Cyco	*Cyclosa confusa*		+	+	+
12	Cyhe	*Cyclosa hexatuberculata*		+	+	+
13	Cyin	*Cyclosa insulana*		+	+	+
14	Cyku	*Cyclosa kumadai*		+	+	+
15	Cymu	*Cyclosa mulmeinensis*			+	+
16	Cysp1	*Cyclosa sp1*		+	+	+
17	Cysp2	*Cyclosa sp2*			+	+
18	Cysp3	*Cyclosa sp3*			+	+
19	Cysp4	*Cyclosa sp4*				+
20	Cersp	*Cyrtarachne sp1*		+		
21	Cyci	*Cyrtophora citricola*		+	+	+
22	Cyrsp	*Cyrtophora sp1*			+	+
23	Erla	*Eriovixia laglaisei*			+	+
24	Ersa	*Eriovixia sakiedaorum*			+	+
25	Ersp	*Eriovixia sp1*				+
26	Gesu	*Gea subarmata*				+
27	Laar	*Larinia argiopiformis*	+		+	+
28	Nebe	*Neoscona bengalensis*			+	+
29	Nemu	*Neoscona mukerjei*	+	+	+	+
30	Nena	*Neoscona nautica*		+	+	
31	Nesp1	*Neoscona sp1*		+		
32	Nesp2	*Neoscona sp2*			+	
33	Nesp3	*Neoscona sp3*				+
34	Pade	*Parawixia dehaani*				+
35	Thbr	*Thelacantha brevispina*			+	+

Clubionidae						
36	Clsp1	*Clubiona sp1*			+	+
Corinnidae						
37	Caze	*Castianeira zetes*				+
Ctenidae						
38	Ctsp	*Ctenus sp1*				+
Filistatidae						
39	Prsp	*Pritha sp1*				+
Gnaphosidae						
40	Gnsp	*Gnaphosa sp1*			+	
41	Posp	*Poecilochroa sp1*				+
Hersiliidae						
42	Hesa	*Hersilia savignyi*			+	+
Lycosidae						
43	Hiag	*Hippasa agelenoides*	+	+	+	+
44	Lyma	*Lycosa mackenziei*	+		+	
45	Lysp	*Lycosa sp1*	+			
46	Paps	*Pardosa pseudoannulata*		+	+	+
47	Pasp2	*Pardosa sp1*	+			
48	Pasp1	*Pardosa sp2*	+			
Miturgidae						
49	Chesp1	*Cheiracanthium sp1*				+
Nephilidae						
50	Hemu	*Herennia multipuncta*				+
51	Nepi	*Nephila pilipes*			+	+
Oonopidae						
52	Opin	*Opopaea indica*		+		+
Oxyopidae						
53	Hasp2	*Hamataliva sp1*			+	+
54	Hasp1	*Hamataliva sp2*			+	
55	Hasp3	*Hamataliva sp3*			+	+
56	Oxbi	*Oxyopes birmanicus*	+	+	+	+
57	Oxdi	*Oxyopes dineshi*				+
58	Oxja	*Oxyopes javanus*		+	+	+
59	Oxsh	*Oxyopes shweta*			+	
Philodromidae						
60	Tisp	*Tibellus sp1*				+
Pholcidae						
61	Utat	*Uthina atrigularis*			+	+
Pisauridae						
62	Pesp	*Perenethis sp1*				+
63	Pigi	*Pisaura gitae*			+	+
Salticidae						
64	Aste	*Asemonea tenuipes*			+	+
65	Bral	*Brettus albolimbatus*				+

66	Caba	*Carrhotus barbatus*		+		
67	Car	*Carrhotus sp1*	+	+	+	+
68	Cavi	*Carrhotus viduus*	+	+	+	+
69	Caxa	*Carrhotus xanthogramma*		+		+
70	Chla	*Chrysilla lauta*		+		
71	Chve	*Chrysilla versicolor*			+	+
72	Epin	*Epeus indicus*			+	+
73	Epsp	*Epeus sp1*			+	+
74	Epau	*Epocilla aurantiaca*			+	+
75	Euo	*Euophrys sp1*		+		
76	Habr	*Harmochirus brachiatus*				+
77	Haad	*Hasarius adansoni*				+
78	Hyse	*Hyllus semicupreus*			+	+
79	Masp	*Marpissa sp1*				+
80	Mebi	*Menemerus bivittatus*			+	+
81	Myin	*Myrmarachne inermichelis*			+	+
82	Myja	*Myrmarachne japonica*		+	+	
83	Mysp	*Myrmarachne sp1*			+	+
84	Pisp	*Phidippus sp1*				+
85	Phsp	*Phintella sp1*	+	+		
86	Phvi	*Phintella vittata*		+	+	+
87	Plpa	*Plexippus paykulli*		+		
88	Rhsp1	*Rhene sp1*			+	+
89	Rhsp2	*Rhene sp2*			+	+
90	Rs1	*Salticid1*	+			
91	Rs2	*Salticid2*	+			
92	Rs4	*Salticid3*	+			
93	Rs5	*Salticid4*	+			
94	Ns6	*Salticid5*		+		
95	Ns7	*Salticid6*		+		
96	Ns9	*Salticid7*		+		
97	Tedi	*Telamonia dimidiata*			+	+
Sparassidae						
98	Olmi	*Olios milleti*				+
Tetragnathidae						
99	Lede	*Leucauge decorata*	+	+	+	+
100	Tece	*Tetragnatha ceylonica*			+	+
101	Teco	*Tetragnatha cochinensis*	+			
102	Teex	*Tetragnatha extensa*	+	+		
103	Tema	*Tetragnatha mandibulata*	+	+	+	+
104	Tesp1	*Tetragnatha sp1*	+			
105	Tesp3	*Tetragnatha sp2*			+	+
106	Tesp2	*Tetragnatha sp3*	+			
107	Tevi	*Tetragnatha viridorufa*	+			

Theridiidae						
108	Aclu	*Achaearanea lunata*			+	+
109	Achsp1	*Achaearanea sp1*			+	
110	Achsp2	*Achaearanea sp2*				+
111	Anex	*Anelosimus exiguus*			+	+
112	Arbo	*Argyrodes bonadea*				+
113	Argsp1	*Argyrodes sp1*			+	+
114	Argsp2	*Argyrodes sp2*				+
115	Arfl	*Ariamnes flagellum*	+			
116	Arisp1	*Ariamnes sp1*			+	+
117	Arisp2	*Ariamnes sp2*			+	
118	Chsp	*Chrysso sp1*			+	+
119	Col	*Coleosoma sp1*		+		
120	Rosp	*Romphaea sp1*	+			
121	Thesp1	*Theridion sp1*			+	+
122	Thesp2	*Theridion sp2*			+	+
Thomisidae						
123	Amfo	*Amyciaea forticeps*				+
124	Thosp1	*Diaea sp1*	+			
125	Misp	*Misumena sp1*			+	
126	Oxsp1	*Oxytate sp1*			+	+
127	Oxsp2	*Oxytate sp2*				+
128	Oxsp3	*Oxytate sp3*				+
129	Resp	*Regillus sp1*	+			
130	Thosp2	*Thomisus sp1*			+	
131	Thosp3	*Thomisus sp2*				+
132	Xysp	*Xysticus sp1*				+
Uloboridae						
133	Ulsp1	*Uloborus sp1*			+	+
134	Ulsp2	*Uloborus sp2*				+
135	Ulsp3	*Uloborus sp3*				+
136	Ulsp4	*Uloborus sp4*				+
137	Ulsp5	*Uloborus sp5*				+
138	Ulsp6	*Uloborus sp6*				+
139	Ulsp8	*Uloborus sp7*				+
140	Ulsp9	*Uloborus sp8*				+
141	Ulsp7	*Zosis geniculata*				+