Journal of Biological Control, 26 (3): 222–229, 2012

Research Article

Diversity of spider fauna in upland rice agroecosystem at Gudalur valley in Tamilnadu

B. VINOTHKUMAR

Hybrid Rice Evaluation Centre, Tamil Nadu Agricultural University, Gudalur 625 518, Tamilnadu, India
E-mail: drbvinothkumar@gmail.com

ABSTRACT: The diversity of spiders and impact of pest population on spider density has been studied in the upland rice agroecosystem in Bharathy variety at Hybrid Rice Evaluation Centre, Tamil Nadu Agricultural University, Gudalur, The Nilgiris during Kharif 2010 and 2011. Three aspects, population of spiders and pests in different rice establishment techniques, diversity of spider species in different rice establishment techniques and impact of pest density on the population of spiders were studied. A total of 11 species of spider from 7 different families were observed from all the three different techniques of upland rice crop at different days after transplantation. Among the spider species, *Lycosa pseudoannulata* was higher in early growth stage and *Tetragnatha javana* was predominant in later stages of the crop. Population of brown plant hopper, green leaf hopper and stem borer showed significant positive impact on *L. pseudoannulata* and *Oxyopes javanus* population. Regression analysis revealed that 97 percent of *L. pseudoannulata*, 72 percent of *O. javanus*, 94 percent of *T. javana* and 80 percent of *Clubiona* sp. population depends on the incidence of pests in the upland rice ecosystem. Diversity indices revealed that diversity of spider was more in the direct sown method than transplanting and seedling throwing method.

KEY WORDS: Biodiversity, spiders, upland rice, diversity indices, *Lycosa pseudoannulata*

(Article chronicle: Received: 3-1-2012 Revised: 1-9-2012 Accepted: 14-9-2012)

INTRODUCTION

Biological control appears to be the most promising control measure against rice insect pests. Recently, efforts have been made to control agricultural pests with natural predators. Spiders (Arthropoda: Chelicerata: Arachnida: Araneae) are the most abundant natural predators in agro-ecosystems (Marc *et al.,* 1999; Nyffeler and Sunderland, 2003; Tahir and Butt, 2008). Spider predation is not limited to adult insects only but, includes the egg, larval and nymphal stages as well (Harwood and Obrycki, 2006). In addition to killing pest directly they cause mortality of pest by dislodging them from plants or trapping them in their webs (James *et al.,* 2004). They can achieve equilibrium in pest control after which their own numbers are suppressed by their territoriality and cannibalism (Riechert and Lockley, 1984). Agricultural entomologists recognised the importance of spiders as a major factor in regulating pest, considered as important predators and serve as a buffer to limits the initial exponential growth of prey population (Nyffeler, 2000; Chatterjee *et al.,* 2009). Moreover, researchers have expressed that spiders in rice field can play an important role as predators in reducing planthoppers and leafhoppers (Visarto Preap, 2001; Sahu *et al.,*1996; Bhattacharya, 2000; Mathirajan, 2001; Sebastian *et al.,* 2005). According to Bhatnagar *et al.* (1982) and Peter (1988), the crop having more insects or insect visitors always had more spiders. Unfortunately, this useful natural biological control group has been overlooked and has been documented poorly in the biological literature of upland rice at Nilgiri district of Tamil Nadu.The present study was carried out to document the population of spiders and pests in different methods of planting system in the rice fields.

MATERIALS AND METHODS

The present study was carried out in the rice variety Bharathy cultivated at the Hybrid Rice Evaluation Centre, Tamil Nadu Agricultural University, Gudalur, Nilgiri District, Tamil Nadu during Kharif 2010 and 2011. The study area was located at an altitude of 1072 M (76°302E/ 11.50°N) and receives more than 2000 mm rainfall annually. The observations were made in the rice fields at three different establishment techniques (treatments), namely transplantation, direct seed sowing and seedling throwing. Crop was established in an area of 0.2 ha for each technique. The observations were made once in a week during 7.00 am to 9.00 am after 42 days of transplanting (DAT) rice up to the harvest of the crop. The number of spiders and pests found in the field was recorded through net sweeping and visual observations. Ten number of sweeps (ten times) was uniformly carried out in all the treatments. Other management practices such as fertilizer application and weed management were followed uniformly for all the treatments as per the crop production guide (2005) except plant protection measures. Pearson's correlation coefficient was used to determine the association between the spiders and pests. The SPSS software (Version 10.0) was used for the data analysis. Diversity indices (species richness, evenness and diversity) were calculated by using the formulae given below.

Species richness (Margalef (1958) index) $R = \frac{S - 1}{\text{In } (n)}$

Diversity index (Simpson's (1949) index) $ë = \sum_{i=1}^{s} Pi^2$

Evenness index (Alatalo, (1981) index) $E = \frac{(1/ë) - 1}{e^H - 1}$

Where,

S – Total number of species in a community, n – Total number of individuals observed, P_i – Proportion of individuals belonging to the i^{th} species.

RESULTS AND DISCUSSION

A total of 8 species of spider from 7 different families *viz., Lycosa pseudoannulata* Boes & Stand (Lycosidae), *Tetragnatha javana* Thorell (Tetragnathidae), *Argiope* sp. (Araneidae), *Plexippus* sp. (Salticidae), *Oxyopes javanus* Thorell, *Oxyopes rufisternum* Thorell (Oxyopidae), *Thomisus* sp. (Thomisidae) and *Clubiona* sp. (Clubionidae) were observed from three different treatments of upland rice crop during Kharif 2010 at different days after transplantations. During Kharif 2011, a total of 11 species of spiders from 7 different families *viz.*, *L. pseudoannulata* , *T. javana*, *Thomisus* sp., *Plexippus* sp. *O. javanus*, *O. rufisternum, Argiope* sp. *Clubiona* sp. *Neoscona rumfi* Thorell (Araneidae), *Pardosa birmanica* Simon (Lycosidae) and *Leucauge decorata* Blackwell (Tetragnathidae) were observed from three different treatments of upland rice crop at different days after transplantations. Among them, *L. pseudoannulata, O. javanus, O. rufisternum, Plexippus* sp., *Thomisus* sp., *P. birmanica* and *Clubiona* sp. were hunting spiders. *Argiope* sp., *L. decorata, N. rumfi* and *T. javana* were the orb web weavers.

The population of spiders in different establishment techniques of rice during different days after transplantation in Kharif 2010 are given in Table 1. The results indicated that *L. pseudoannulata* and *T. javana* were the major spider species observed throughout the study period in all the establishment techniques. *L. pseudoannulata* was observed maximum at 75 DAT in transplanted crop, whereas it was maximum on 90 DAT in direct sowing and seedling throwing technique. It was the predominant spider in all the three establishment techniques. The population of *T. javana* was observed at 60 DAT in transplanted crop and 45 DAT in other techniques and it existed till the harvest. During harvesting period, its population was maximum compared to other species. *O. javanus*, *O. rufisternum* and *Thomisus* sp. were observed at later stages of the crop but after harvest, these species were not noticed.

The impact of different establishment techniques in upland rice on the population of spiders during Kharif 2011 is given in Table 2. In the transplantation technique, spiders were not observed after 105 DAT due to harvesting of the crop. Higher Deputation of *L. pseudoannulata* was observed during the crop stage (60-75 DAT). Whereas *T. javana* population was found to be more during later stages of the crop. *O. javanus* was found almost throughout the cropping season. In direct sowing method, nearly all the species of spiders were present throughout. *L. pseudoannulata* was observed to be more during 75 – 90 DAT, *T. javana* was predominant during 105 – 130 DAT, *O. javanus* and *P. birmanica* was the maximum at 75 DAT, *Thomisus* sp. was predominant during 90-130 DAT, *L. decorata, Argiope* sp. Showed highest number at 130 DAT. In seedling throwing method, *L. pseudoannulata* was found to be more during 75 – 90 DAT, followed by *T. javana* during 90 – 105 DAT, *Clubiona* sp. at 90 DAT. *N. rumfi* was found only in direct seed sowing technique whereas, *P. birmanica* and *L. decorata* were recorded in direct sowing and seedling throwing techniques.

The incidence of pests *viz.* BPH, GLH, leaf folder and stem borer in different establishment techniques were recorded and is presented in Table 3 and 4. The population of spiders were correlated with pest population. Correlation matrix showing the relationship between the

Table 1. Spider population in different establishment techniques of upland rice ecosystem during Kharif 2010

Name of the spider	45 DAT	60 DAT	75 DAT	90 DAT	105 DAT	130 DAT	140 DAT
Transplantation							
Lycosa pseudoannulata	2	6	10	5	6	H	H
Tetragnatha javanas	0	4	3	8	6	H	H
Oxyopes javanus	0	0	1	2	1	H	H
Oxyopes rufisternum	0	1	2	2	0	H	H
Argiope sp.	1	1	0	1	0	H	H
Thomisus sp.	0	2	1	2	0	H	H
Direct sowing							
Lycosa pseudoannulata	2	6	12	16	8	7	5
Tetragnatha javanas	1	1	2	3	1	4	5
Oxyopes javanus	2	0	1	4	1	2	2
Oxyopes rufisternum	0	2	1	3	2	0	0
Clubiona sp.	0	1	2	3	0	0	0
Argiope sp.	3	1	1	1	2	0	0
Plexippus sp.	0	0	0	2	1	2	0
Thomisus sp.	1	0	2	1	2	1	1
Seedling throwing							
Lycosa pseudoannulata	3	6	8	10	6	7	H
Tetragnatha javanas	2	2	1	6	2	4	H
Oxyopes javanus	0	1	2	0	1	0	H
Oxyopes rufisternum	0	2	2	1	0	0	H
Argiope sp.	1	1	2	2	0	0	H
Thomisus sp.	0	2	0	1	4	0	H

H – Crop harvested, DAT – Days after transplantation

spiders and pest population is furnished in Table 5. The results infer that, population of BPH, GLH and stem borer showed significant positive impact on *L. pseudoannulata* population with a correlation coefficient (r) of 0.83, 0.81 and 0.88 respectively. The result of multiple regression analysis showed a R^2 value of 0.97 indicating that 97 per cent of the variation in *L. pseudoannulata* population was influenced by population of BPH, GLH and stem borer. The multiple regression equation fitted with pest population to predict the *L. pseudoannulata* population is $Y = 0.016 + 1.2X_1 - 0.61X_2 + 2.42\ X_4$ where, X_1 – population of BPH, X_2 – population of GLH, X_4 – population of stem borer. The impact of pest population on *O. javanus* was similar as that of *L. pseudoannulata*. However, the impact of BPH population was not significant. The results of multiple regression analysis showed a R^2 value of 0.72 indicating that 72 per cent of the variation in *O. javanus* population was influenced by population GLH and stem borer. The multiple regression equation fitted with pest population to predict the *O. javanus* population is $Y = 0.005 - 0.29X_2 + 1.11X_4$ where, X_2 – population of GLH, X_4 – population of stem borer. The population of *T. javana* exerted a significant positive association with BPH (r = 0.94) and

Table 2. Spider population in different establishment techniques of upland rice ecosystem during Kharif 2011

Name of the spider	45 DAT	60 DAT	75 DAT	90 DAT	105 DAT	130 DAT	140 DAT
Transplantation							
Lycosa pseudoannulata	3	8	11	6	4	H	H
Tetragnatha javanas	2	8	10	12	5	H	H
Oxyopes javanus	1	2	6	7	3	H	H
Oxyopes rufisternum	0	2	1	2	0	H	H
Clubiona sp.	0	1	2	2	0	H	H
Argiope sp.	0	2	1	1	2	H	H
Plexippus sp.	0	1	1	3	0	H	H
Thomisus sp.	0	2	0	4	1	H	H
Direct sowing							
Lycosa pseudoannulata	6	10	12	12	10	7	5
Tetragnatha javanas	2	6	10	11	14	12	8
Oxyopes javanus	0	2	4	2	0	0	1
Oxyopes rufisternum	0	2	0	1	3	1	0
Clubiona sp.	1	1	4	2	1	2	0
Argiope sp.	0	1	1	1	2	3	0
Plexippus sp.	0	0	2	3	0	2	0
Thomisus sp.	2	4	5	8	9	7	4
Neoscona rumfi	1	0	2	0	3	2	0
Pardosa birmanica	0	0	3	2	1	2	1
Leucauge decorata	0	0	1	1	2	3	0
Seedling throwing							
Lycosa pseudoannulata	1	3	11	11	9	7	H
Tetragnatha javanas	0	4	5	8	7	6	H
Oxyopes javanus	0	2	2	1	2	0	H
Oxyopes rufisternum	0	2	1	2	0	3	H
Clubiona sp.	1	2	1	4	2	2	H
Argiope sp.	1	1	2	0	2	0	H
Plexippus sp.	0	0	2	1	2	2	H
Thomisus sp.	0	3	1	1	3	0	H
Pardosa birmanica	0	0	2	1	2	0	H
Leucauge decorata	0	1	2	2	1	0	H

H – Crop harvested, DAT – Days after transplantation

Table 3. Pest population in different establishment techniques of upland rice ecosystem during Kharif 2010

Name of the spider	45 DAT	60 DAT	75 DAT	90 DAT	105 DAT	130 DAT	140 DAT
Transplantation							
Brown plant hopper	0.52	0.98	1.24	0.86	0.27	H	H
Green leaf hopper	0.97	1.34	3.51	2.1	1.12	H	H
Leaf folder	1.23	3.48	8.45	12.34	15.27	H	H
Stem borer	2.34	2.1	1.68	1.64	0.94	H	H
Direct sowing							
Brown plant hopper	1.34	2.67	4.61	7.64	5.24	5.81	4.63
Green leaf hopper	5.67	8.24	6.21	5.92	4.37	2.24	3.62
Leaf folder	2.14	3.22	5.94	13.24	15.62	16.27	18.32
Stem borer	1.16	1.82	2.27	4.23	3.54	2.38	2.41
Seedling throwing							
Brown plant hopper	0.22	0.42	0.94	1.38	2.54	2.22	H
Green leaf hopper	1.04	1.54	2.21	2.54	1.85	2.62	H
Leaf folder	0.4	1.12	4.57	8.29	8.29	14.24	H
Stem borer	0.64	1.28	1.54	2.18	2.89	2.24	H

H – Crop harvested, DAT – Days after transplantation

leaf folder (r = 0.80). However, the impact of GLH and stem borer was not significant. The results of multiple regression analysis showed a R^2 value of 0.94 indicating that 94 per cent of the variation in *T. javana* population was influenced by population of BPH and leaf folder. The multiple regression equation fitted with pest population to predict the *T. javana* population is $Y = -0.24 + 1.41X_1 + 0.094\ X_3$ where, X_1 – population of BPH, X_3 – population of leaf folder. The population of stem borer showed significant positive impact on the population of *Clubiona* sp. with a correlation coefficient (r) of 0.80. However, the impact of BPH, GLH and leaf folder was not significant. The result of multiple regression analysis showed a R^2 value of 0.63 indicating that 63 per cent of the variation in *Clubiona* sp. population was influenced by population of stem borer. The multiple regression equation fitted with pest population to predict the *Clubiona* sp. population is $Y = -0.93 + 0.86\ X_4$ where, X_4 – population of stem borer. The impact of pest population on all other spider species was not significant (Table 5). Results of the diversity analysis is furnished in the Table 6. The diversity indices *viz.,* species richness, species diversity and species evenness were more in the direct sown upland rice than other method hence it is informed that the diversity of spider was more in the direct sown method than transplanting or seedling throwing method.

Spiders have a very significant role to play in the ecology by being exclusively predatory and thereby regulate insect populations. The present study clearly reveals that the spiders are effective biocontrol agents in rice ecosystem. The spider population always shows fluctuation with the crop stages and pest population. *L. pseudoannulata, T. javana* and *O. javanus* were observed throughout the study period. Among all spiders *L. pseudoannulata* was higher in early growth stage and *T. javana* was predominant during later stages of the crop. The occurrence of spiders at different days after transplantation in the field indicated that the spiders ensured protection of the crop from phytophagous insects. The results of the present study is similar to the findings of Sahu *et al.* (1996). They have reported that the population of *L. pseudoannulata* in rice ecosystems varied from 10 to 32% and it was maximum at 95 and 110 DAT and lowest at 140 DAT. Sigsgaard *et al.* (1999) reported that the highest population of *L. pseudoannulata* was found during the first 35 DAT as observed in this

Table 4. Pest population in different establishment techniques of upland rice ecosystem during Kharif 2011

Name of the spider	45 DAT	60 DAT	75 DAT	90 DAT	105 DAT	130 DAT	140 DAT
Transplantation							
Brown plant hopper	1.35	2.67	6.27	4.85	3.22	H	H
Green leaf hopper	3.12	6.27	8.52	5.82	2.37	H	H
Leaf folder	2.4	5.8	12.9	18.2	20.7	H	H
Stem borer	0.96	2.38	5.26	4.21	1.67	H	H
Direct sowing							
Brown plant hopper	1.92	3.26	4.85	6.76	4.22	3.67	2.21
Green leaf hopper	3.29	5.81	8.64	6.01	4.62	3.57	2.67
Leaf folder	4.6	8.5	10.9	15.2	19.4	22.7	24.1
Stem borer	2.46	4.52	5.37	3.37	2.12	0.62	0.48
Seedling throwing							
Brown plant hopper	0.84	3.87	5.29	5.42	3.62	2.27	H
Green leaf hopper	2.34	4.25	6.24	4.67	4.67	4.2	H
Leaf folder	1.4	3.7	8.9	16.4	19.7	21.8	H
Stem borer	0.58	4.28	7.32	3.28	1.84	1.12	H

H – Crop harvested, DAT – Days after transplantation

study. The present observations are also in agreement with the findings of Heong *et al*. (1992), where orb weavers, especially *Tetragnatha* sp. was the most abundant spider in the early stage of irrigated rice crop. Overall population of spiders in three different techniques were also computed and the results indicated that the direct seed sowing method have more percentage of spiders. Hence, this technique can be adopted for upland rice establishment. All the spiders showed positive correlation with rice pests. While, *Argiope* sp. showed negative correlation with BPH *O. rufisternum*, *Clubiona* sp. and *Argiope* sp. showed negative relationship with leaf folder. This result is similar to the findings of Sahu *et al*. (1996) who reported that *L. pseudoannulata* preferred more *S. incertulas* and *C. medinalis*. Sigsgaard *et al*. (1999) reported that the spider density was less when the planthopper and leaf hopper densities were high. According to Riechert and Bishop (1990), the increase in spiders' density could decrease the pest population and pest damage. Diversity of spider was more in the direct sown method than transplanting and seedling throwing method.

REFERENCES

Alatalo RV. 1981. Problems in the measurement of evenness in ecology. *Oikos,* **37**: 199–204.

Bhatnagar RR, Prasad B, Agrawal RA, Wadhi SR, Bhanotar RK. 1982. *Agricultural Entomology*, All India scientific writer's publishers, **1**: 90–119.

Bhattacharya S. 2000. Biodiversity of spiders in the rice field of Kalyani, West Bengal, India. *Res J Chem Environ.* **4**(2): 75.

Chatterjee S, Isaia M, Venturino E. 2009. Spiders as biological controllers in the agroecosystem. *J Theor Biol.* **258**: 352–362.

Crop Production Guide. 2005. Department of Agriculture, Tamil Nadu Agricultural University, Coimbatore, 394 p.

Heong K, Aquino G, Barrion A. 1992. Population dynamics of plant and leaf hoppers and their natural enemies in rice ecosystems in the Philippines. *Crop Prot.* 4:371-379.

Table 5. Correlation matrix between spiders and pests found in the field

Spider species	BPH	GLH	LF	SB
Lycosa pseudoannulata	0.83*	0.81*	0.18	0.88**
Tetragnatha javanas	0.94**	0.22	0.80*	0.28
Oxyopes javanus	0.73	0.79*	0.09	0.84*
Oxyopes rufisternum	0.46	0.66	-0.16	0.72
Clubiona sp.	0.67	0.72	-0.06	0.80*
Argiope sp.	-0.13	0.37	-0.57	0.52
Plexippus sp.	0.69	0.18	0.40	0.29
Thomisus sp.	0.66	0.02	0.68	0.15
Pardosa birmanica	0.67	0.62	0.16	0.73
Leucauge decorata	0.70	0.43	0.30	0.57
Neoscona rumfi	0.05	–0.09	0.16	0.02

* – significant at 5% level, ** – significant at 1% level

James TC, Kyle JH, Forrest D. 2004. Spider effects on planthopper mortality, dispersal and spatial population dynamics. *Ecology*, **85**(8): 2134–2143

Marc P, Canard A, Ysnel F. 1999. Spiders (Araneae) useful for pest limitation and bioindication. *Agric Ecosyst Environ.* **74**: 229–273.

Margalef R. 1958. Temporal succession and spatial heterogeneity in plankton. In: Buzzatti Traverso and Berkeley,A.A. (Eds.) *Perspectives in Marine Biology,* University of california, 323–349 pp.

Mathirajan VG. 2001. Diversity and predatory potential of spiders in Cotton and Rice ecosystem applied with Thiamethoxane. Ph. D. Thesis. TNAU, Coimbatore, 3.140 p

Nyffeler M. 2000. Ecological impact of spider predation: A critical assessment of Bristowe's and Turnbull's estimates. *Bull Br Arachnol Soc.* **11**(9), 367–373.

Nyffeler M, Sunderland DK. 2003. Composition, abundance and pest control potential of spider communities in agroecosystem. A comparison of European and U.S. studies. *Agric Ecosyst Environ.* **95**: 579–612.

Peter C. 1988. New records of natural enemies associated with BPH, *N lugens*. *Curr Sci.* **57**(19): 1087–1088.

Riechert SE, Bishop. 1990. Prey control by an assemblage of generalist predators: spiders in garden test system. *Ecology*, **71**: 1441–1450.

Riechert SE, Lockley T. 1984. Spiders as biological control agents, *Ann Rev Entomol.* **29**: 299–320.

Sahu S, Shatrughnga R, Sing Kumar, Pawan. 1996. Host preference and feeding potential of spiders predaceous in insect pests of rice. *J Entomol Res.* **20**(2): 145–150.

Sebastian PA, Mathew MJ, Pathummal Beevi, John Joseph S, Biju CR. 2005. The spider fauna of the irrigated rice ecosystem, in central Kerala, India. *J Arachnol.* **33**: 247–255.

Sigsgaard L, Villareal S, Gapud V, Rajotte E. 1999. Predation rates of *Atypena formosana* (Arachea Liny phiidae) on brown planthopper, and green leafhopper. *IRRN. Notes,* **24**(3): 38.

Simpson EH. 1949. Measurement of diversity. *Nature,* **12**: 638–688.

Tahir HM, Butt A. 2008. Activities of spiders in rice fields of central Punjab, Pakistan. *Acta Zool Sinica.* **54** (4): 701–711.

Table 6. Spider diversity in different establishment techniques of upland rice ecosystem

Treatment	DAT	Kharif 2010				Kharif 2011			
		N_0	R	λ	E	N_0	R	λ	E
Transplanting	45	2	0.43	0.22	0.95	3	0.78	0.28	1.03
	60	5	1.38	0.25	1.01	8	1.62	0.34	0.95
	75	5	1.28	0.26	1.09	7	1.57	0.29	1.11
	90	6	1.64	0.30	1.12	8	1.74	0.40	1.03
	105	3	0.83	0.29	0.99	5	1.21	0.24	1.23
Direct sowing	45	5	1.31	0.25	1.05	5	1.24	0.32	1.12
	60	5	1.34	0.30	1.12	7	1.65	0.36	0.92
	75	7	1.71	0.34	1.03	10	1.91	0.46	1.14
	90	8	1.78	0.36	1.11	10	1.98	0.43	1.33
	105	7	1.67	0.49	1.00	9	1.87	0.36	1.16
	130	5	1.39	0.32	1.13	10	1.90	0.48	1.38
	140	4	1.00	0.38	1.23	5	1.34	0.40	1.03
Seedling throwing	45	3	0.93	0.26	0.84	3	0.87	0.22	0.98
	60	6	1.62	0.38	1.11	8	1.64	0.29	1.03
	75	5	1.37	0.30	0.96	10	1.89	0.46	1.02
	90	5	1.44	0.28	1.04	9	1.85	0.42	1.05
	105	4	0.98	0.31	0.91	9	1.76	0.33	0.90
	130	2	0.49	0.33	0.90	5	1.21	0.31	1.07

N_0 – Number of species, R – Species richness (Margalef index), DAT – Days after treatment, E – Evenness of species, λ – Species diversity (Simpson – Yule index)

Visarto Preap, Zalucki MP, Jahn GC, Nesbite HJ. 2001. Effectiveness of brown planthopper predators: population suppression by two species of spider, *Pardosa pseudoannulata* (Araneae: Lycosidae) and *Araneus inustus* (Araneae: Araneidae). *J Asia Pacific Entomol.* **4**(2): 93–97.