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Impact of *Parawixia dehaani* (Doleschall, 1859) on the population dynamics of the kleptoparasitic spider *Argyrodes flavescens* O. Pickard-Cambridge, 1880 – A case study

Impatto di *Parawixia dehaani* (Doleschall, 1859) nella dinamica delle popolazioni del ragno cleptoparassita *Argyrodes flavescens* O. Pickard-Cambridge, 1880 – Un caso di studio

Jobi J. Malamel

Division of Arachnology, Department of Zoology, Sacred Heart College, Thevara, Cochin, Kerala 682 013, India; e-mail: jomaljoseph@yahoo.co.in

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Ambalaparambil V. Sudhikumar

Centre for Animal Taxonomy and Ecology, Department of Zoology, Christ College, Irinjalakuda, Kerala, 680 125, India; e-mail: avsudhi@rediffmail.com

Abstract

Argyrodes flavescens O. Pickard-Cambridge 1880 is a kleptoparasite; normally both sexes together inhabit in the webs of large web building spiders. We also investigated the factors that influence the relationship between *Argyrodes flavescens* and host spider *Parawixia dehaani* (Doleschall, 1859). Field surveys were conducted to examine how the size of the host and its web affect the abundance of *Argyrodes flavescens* and the impact of *Parawixia dehaani* to attract the kleptoparasite *Argyrodes flavescens* to its webs. Our data on the kleptoparasitic behavior of *A. flavescens* on the webs of orb web weaving spider *P. dehaani* show that larger webs spun by larger *P. dehaani* accommodated more *A. flavescens* and comparatively small webs hosted less species.

Key-words: *Argyrodes flavescens*, cosmopolitan, host, kleptoparasite, *Parawixia dehaani*.

Riassunto

Argyrodes flavescens O. Pickard-Cambridge 1880 è un cleptoparassita; normalmente entrambi i sessi insieme abitano nelle ragnatele dei ragni costruttori di grandi ragnatele. Noi investigammo anche i fattori che influenzano la relazione tra *Argyrodes flavescens* ed il ragno ospite *Parawixia dehaani* (Doleschall, 1859). Indagini sul campo vennero condotte per esaminare quanto la dimensione dell'ospite e della sua ragnatela influenzano l'abbondanza di *Argyrodes flavescens* e l'impatto di *Parawixia dehaani* nell'attrarre il cleptoparassita *Argyrodes flavescens* nelle sue tele. I nostri dati sul comportamento cleptoparassita di *A. flavescens* sulle tele orbicolari del ragno *P. dehaani* mostrano che le tele più grandi tessute dai più grandi *P. dehaani* accolgono più *A. flavescens* e comparativamente piccole tele ospitano meno specie.

Parole chiave: *Argyrodes flavescens*, cosmopolita, ospite, cleptoparassita, *Parawixia dehaani*.

Introduction

Argyrodes Simon 1864 is a large, cosmopolitan theridiid genus often called kleptoparasites that rely almost exclusively on host spiders. The members of the genus show a variety of foraging modes which usually involve exploiting other spiders, either by using their webs, stealing their food, or preying on them directly (Henaut *et al*., 2005). The cosmopolitan spider genus *Argyrodes* has attracted interest worldwide because of the gregarious nature of many of its species (Fig. 1B), even forming mixed species groups around other spider's webs (Miyashita, 2002). The abundance of this spider group mainly depends on the availability of the webs of their hosts. Spider species *Argyrodes flavescens* O. Pickard-Cambridge 1880 is a kleptoparasite normally both sexes together inhabit in the webs of large web building spiders. They always live in close association with large orb weaving spiders, since the large web provides variety of resources as food for their existence (Exline & Levi, 1962). On Pathiramanal Island, located in the southern part of India, *A. flavescens* O. Pickard-Cambridge 1880 is commonly found and the preliminary observations revealed that a large number of the species was found on the orb webs of *Parawixia dehaani* (Doleschall, 1859, Fg.1 A, B). *P. dehaani* commonly known as abandoned web spiders construct a vertical orb web and many of the webs look abandoned and with damaged portions. The spider hides underneath of the leaves nearby its web during its daytime and very well camouflaged with the substratum (Fig. 1 C-F). When disturbed, it falls onto the ground and exhibits catalepsy with legs retracted close to the body.

We study the kleptoparasitic-host interactions of these two spider species and how the population of *A. flavescens* changes in accordance with size and the conditions of the web of *P. dehaani*. In this present paper a contribution to the discussion is made by analyzing the data between number of the kleptoparasite, size of the host as well as size of the web,

and resulted in a positive significant correlation between these selected variables. Though a strong relationship between *Nephila* spp. spiders and this *Argyrodes* species has been observed and appears to be cosmopolitan (Rypstra, 1981; Koh & Li, 2002; Whitehouse *et al*., 2002), there has been no previous information to date on the interaction between *A. flavescens* and *P. dehaani*. So this study is a first step toward to understanding the behavioural interactions between *A. flavescens* and *P. dehaani*.

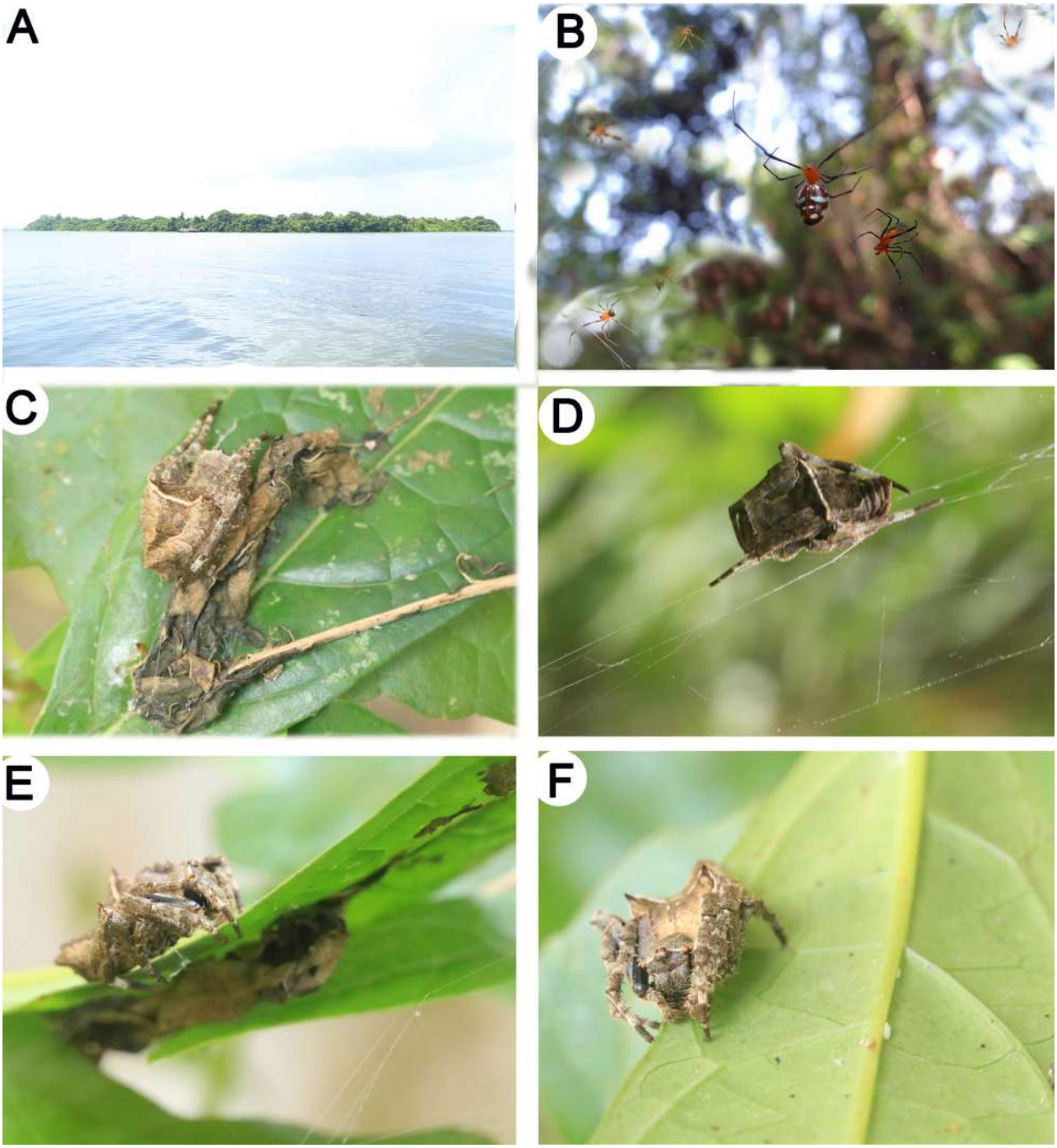

Fig. 1. Field photos. **A**, collecting locality. **B**, natural history of *Argyrodes flavescens*. **D-F**, different specimens of *Parawixia dehaani.*

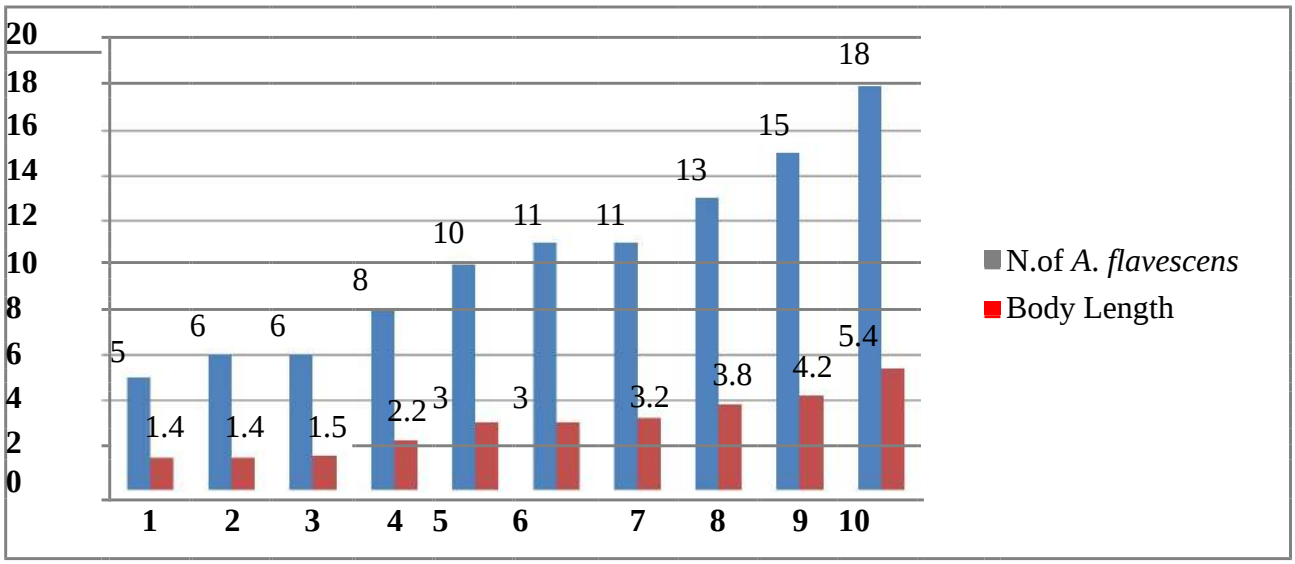

Fig. 2. Correlation between the size of *Parawixia dehaani* (cm) and n. of *Argyrodes flavescens* per web.

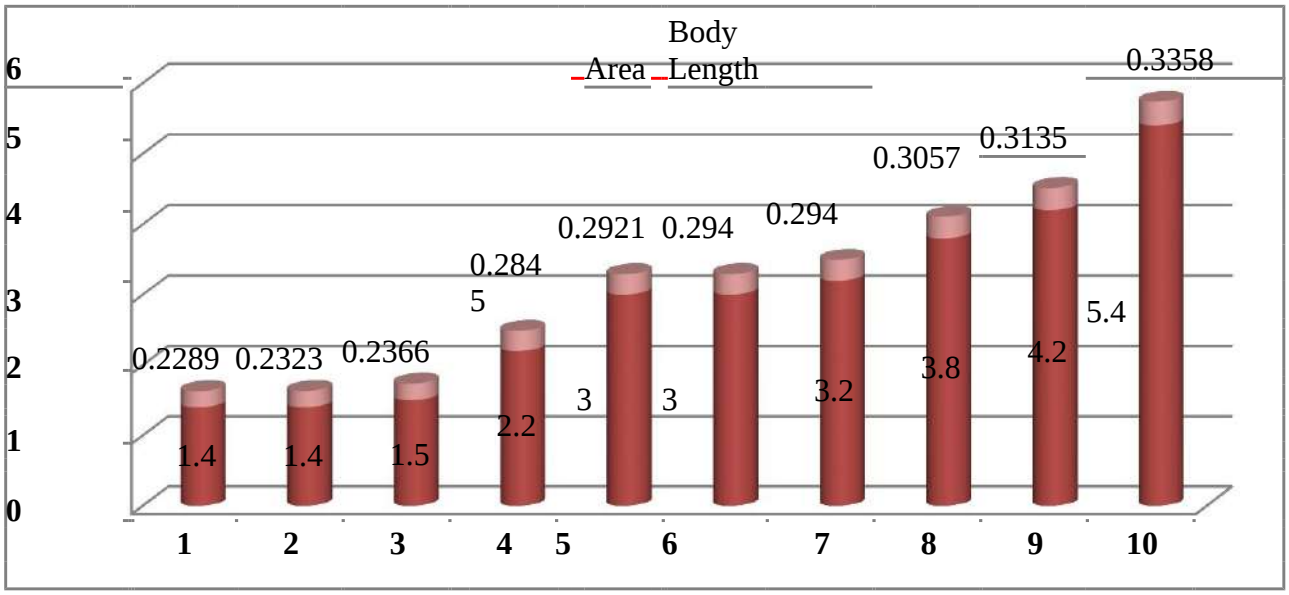

Fig. 3. Correlation between the size (cm) and web area (m²) of *P. dehaani*.

Methods

The specimens were collected as part of the documentation of spiders from Pathiramanal Island (Fig. 3A), which is part of Vembanad lake, a Ramsar Site located in the Alappuzha District of Kerala State in South India. It is a small island (9° 37' 07.11'' N, 76° 23' 04.95'' E; 4 m. altitude) with an area of almost 1 km² on the backwaters of Alappuzha, and it is a

haven for hundreds of rare birds migrating from different parts of the world. We conducted field surveys between 8.00 in the morning to 12 in the noon from October 2015 to January 2016. The field study aimed to determine how the web size of *P. dehaani* influences the population density of the *A. flavescens*. During the study, we searched the entire area for the Pathiramanal Island for the webs of *P. dehaani* (only adult female) and the association of the *A. flavescens* up to a height of 3 m above ground level. For each *P. dehaani* sighted, we collected the following data: body length (cm), web size of *P. dehaani*, numbers of *A. flavescens* in the webs of *P. dehaani*. To measure the size of the specimen (*P. dehaani*) the body length was measured (in cm) from the clypeus to the end of the abdomen excluding the spinnerets. We only considered the perfect webs with its owner for our study. To determine the web size of *P. dehaani*, we measured the maximum horizontal and vertical diameters (cm) of each web sighted excluding the anchoring threads. The specimens are deposited in a reference collection housed at the Division of Arachnology, Department of Zoology, Sacred Heart College, Thevara, Cochin, Kerala, India (ADSH).

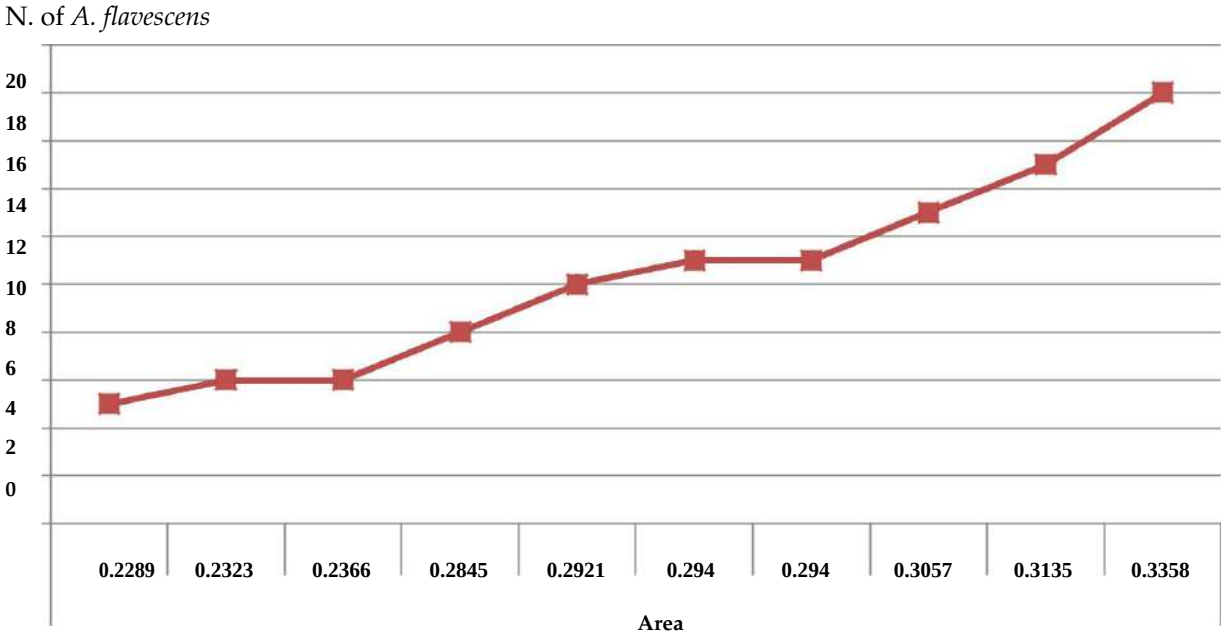

Fig. 4. Correlation between the web area (m2) of *P. dehaani* and no. of *A. flavescens* per web.

Statistical analysis

The area of the webs were calculated using the formula, = 2, where is a constant = 3.14, radius, r = ½ of the width. Pearson's correlation coefficient (excel) was used to determine the association between the body length (*P. dehaani*) and number of *A. flavescens*, body length and web area of the *P. dehaani* as well as web area (*P. dehaani*) and numbers of *A.*

flavescens. The data regarding these variables are represented as mean values. Graphs were plotted to show the correlations between the selected parameters.

Results and observations

A. flavescens (N = 103) were observed in association with *P. dehaani* in the Pathiramanal Island although other large web building species were present, including *Cyrtophora unicolor* (Doleschall, 1857), *Cyrtophora moluccensis* (Doleschall, 1857), *Leucauge granulata* (Walckenaer, 1841), etc. The maximum number of *A. flavescens* found in the host web was 18 with the average number of 10.3 per web. The mean and standard deviation of the body length and web area of *P. dehaani* and number of *A. flavescens* (Mean±SD) collected from the web were calculated and the data set on a total of 103 from 10 webs of *P. dehaani* were analysed using Pearson correlation test to check the relationship between body length and web area, body length and number of *A. flavescens* as well as web area and number of *A. flavescens* (Table. 1). In the field observation, we never spot the *P. dehaani* in the web, but they were always seen besides the leaves of anchoring threads or on the anchoring threads. We collected maximum specimens from the perfect gigantic webs with its owner. Despite the abandoned and damaged webs were high in number, we did not consider it for the study. We noticed that the abundance of *A. flavescens* specimens depends upon the availability of the webs of *P. dehaani*. It is also examined that in accordance with the size of the host spider, the webs were spun small and large indicates that size of the host spider also strongly influence in the abundance of *A. flavescens*. The webs built in shaded areas were seen as not damaged with their owners and yielded more number of kleptoparasites. The Pearson correlation coefficient of the different variables like body length (*P. dehaani*) and number of *A. flavescens* ($Rp = 0.99$, $n = 10$, $P < 0.05$), body length and web size ($Rp = 0.95$, $n = 10$, $P < 0.05$) as well as web size and number of *A. flavescens* ($Rp = 0.99$, $n = 10$, $P < 0.05$) were positively correlated (Table 1).

Discussion

This is the first study on the klepto parasitic interaction between *A. flavescens* and *P. dehaani*. Our study demonstrates that webs of *P. dehaani* significantly biased the population of *A. flavescens*. These observations suggest that the occurrence of the web of *P. dehaani* is crucial to the presence of *A. flavescens*. It is also noticed in the study area that the presence or absence of the *A. flavescens* depends on the presence or absence of the webs of *P. dehaani*. Examining the variation of population dynamics of *A. flavescens* in the Island, it depends on the host availability which seems to be the only way to estimate the strength of associations between the host and kleptoparasite at the population level. These close

associations lead to the inference that population dynamics of *A. flavescens* is highly dependent on host availability, to confirm the presence and large size of the *P. dehaani* apparently increased the population of *A. flavescens* and the small sized hosts significantly reduced the population of *A. flavescens* (Fig. 2). The study also reports that there is a correlation between the size and web area of the *P. dehaani* and in accordance with the size of the host spider, the web area significantly increased or decreased resulting in the high and low rate of *A. flavescens* respectively (Fig. 3). Larger webs are more accessible for *A. flavescens* searching for their shelter since these spider group living parasitizing the large vertical webs. Different authors reported that in accordance with the size of the host spider, webs get larger so that they can trap more food material irrespective of their needs. Our study revealed that less food resources and small web area do not influence more *A. flavescens* to small sized webs.

Web damage is one of the key factors which reduce the availability of *A. flavescens* in Pathiramanal Island. The consequences of web damage create a large fitness cost on spiders due to both reduced prey capture and the extra cost of repair (Chmiel *et al*., 2000; Tew *et al*., 2015). Damage can occur through the silk stealing of kleptoparasites which will decrease food materials as well as web area and allow the insects escape through the holes. The climatic factors like High rainfall, temperature and wind seem to be the key reasons for the web damage and these factors imposing relatively large aerodynamic drag forces which can break the radial and anchor threads resulting in the partial fall down of the web (Lin *et al*., 1995; Zaera *et al*., 2014). Our data from field study on the kleptoparasitic behavior of *A. flavescens* on the webs of orb web weaving spider *P. dehaani* shows that larger webs spun by larger *P. dehaani* accommodated more *A. flavescens* and comparatively small webs hosted less species (Fig. 4). Another factor we observed is *A. flavescens* takes the advantage from the host web and *P. dehaani* has never been observed to prey, attack on *A. flavescens*, its juveniles and eggs. Since this relationship results benefit for one without affecting the existence of the other, which can be considered as a kind of commensalism. Here the commensal *A. flavescens* take advantages from the larger host *P. dehaani* in the form of nutrients, shelter, support, etc., the host is substantially unaffected. Wrapped prey that are removed by *A. flavescens* from the webs of *P. dehaani* receiving different kleptoparasitic load and which will help directly assess the kleptoparasitic relationship between *P. dehaani* and *A. flavescens*.

We also tested why this kleptoparasitic species seemed to be associated with the host spider *P. dehaani*. Observations from the field study disclosed that small preys are sufficiently gathered in the webs of *P. dehaani* rather than any other web found in the Pathiramanal Island. Because the *A. flavescens* consumed small preys that accumulated in the web whereas larger and heavier food material were absorbed by the host spider *P. dehaani*. It is also evident *A. flavescens* more depend on the webs of *P. dehaani* not only due

to small preys but high rate of food accessibility, no predation risk and they are able to have sufficient food due to little competition from *P. dehaani*. It is reported that host choice of a kleptoparasitic organism among various host species is mainly focused on the least risky factors from the part of the host species. When a kleptobiotic organism has a choice of various host species, it will opt for the least risky host that presents the highest rate of availability of food items (Henaut *et al*., 2005) which indicates that *P. dehaani* is a species with such characteristics to interact with *A. flavescens*. The field study provides a base line understanding of the population variation, host relationship and the foraging mode of *A. flavescens* inhabiting in the webs spun by *P. dehaani*. However, a removal experiment is absolutely inevitable to determine the mode of interaction between these spiders. A long term field study focusing the removal of either the kleptoparasite or the host will provide an accurate result of the association between them. Considering the climatic factors like high rainfall, temperature and wind as well as the anthropogenic effects on the island which destroy the host web, a tireless effort is needed to protect thereby retaining the ecology of the island.

No.	**Variables**	**Mean±SD**	**Pearson Coefficient (Rp)**
1	Body lenth of *P. dehaani* and No. *A. flavescens*	2.91±1.33 (Body length) 10.3±4.22 (*A. flavescens*)	0.99
2	Body length of *P. dehaani* and web area	2.91±1.33 (Body length) 0.28±0.04 (Web area)	0.95
3	Web area and no. of *A. flavescens*	0.28±0.04 (Web area) 10.3±4.22 (*A. flavescens*)	0.95

Table 1. Statistical analysis of different variables.

Conclusion

This study investigated the host relationship of the kleptoparasitic spider *A. flavescens* in natural habitats. We selected to focus on *A. flavescens* since it is common species in Pathiramanal Island and like other theridids, it shows variation in their behavior. While there are studies on the host relationship of *A. flavescens* with another spiders, no record on the association with *P. dehaani*. However, the actual relationship between *A. flavescens* and *P. dehaani* and the potential impact of *P. dehaani* on the abundance of *A. flavescens* are not clear from our study, we suggest that, the host relationship between *A. flavescens* on *P. dehaani* is an ideal and effective method to investigate the potential impact of these

interactions because both species are very abundant in Pathiramanal Island enabling the field observations to be made relatively easily.

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