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Spiders controlling mosquitoes (*Aedes aegypti, Culex quinquefasciatus, Anopheles stephensi)*: A comprehensive research

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Abstract
Spiders constitute one of the most important components of the generalist predator fauna, very well known for keeping check on outbreaks of insect populations. Spiders are well known for their web architecture and potential as bio-control agents. Numerous researches have shown that the spider species usually consume mosquitoes. But our research shows that any spider species feeds and controls the mosquitoes that spread the diseases such as malaria, dengue, and Chickungunya. There is need therefore to develop at different scales, models that incorporate different biological factors for the successful establishment of effective biological control of mosquitoes by spiders. We conclude from these co-relative studies that for efficient prey capture *Hippasa agelenoides, Herennia multipuncta, Leucauge decorata, Viciria minima,* where the role of mesh width depends on the biology of prey. The present paper describes the role of spiders in controlling vectors as Mosquitoes.

Keywords: malaria dengue chickungunya spider vector

Introduction
Mosquitoes are a major nuisance and spread of disease in modern times. Whatever we do, we use various artificial methods to destroy it, such as naturally occurring spiders. Vector-borne diseases are infections transmitted by the bite of infected arthropod species, such as mosquitoes, ticks, bugs, sand flies, and black flies [1]. Malaria afflicts 36% of the world population, i.e. 2020 million in 107 countries and territories situated in the tropical and tropical regions. Of the 2.5 million reported cases in the South East Asia, India alone contributes about 70% of the total cases [2]. Developing more effective ways to manage mosquitoes using their natural enemies, "biological control" is critical for two reasons. First, mosquitoes continue to be a major health problem in almost all tropical and subtropical countries in this present era of climate change. They are responsible for transmitting pathogens which cause life-threatening diseases such as malaria, yellow fever, dengue fever and filariasis. Recently, new threats of viral diseases such as Zika and Chikungunya and dengue spread by mosquitoes have also emerged [3]. Biological control has a very positive role to play in the integrated control methodologies in which both pesticides and fish or other biotic agents have their own roles. Spider has largely overlooked as predators of mosquitoes and its larvae in various ecosystems [4]. In addition, the pesticides we use can kill other beneficial organisms. Chemical pesticides also poison the soil's yield and the environment. The use of biological control means of mosquitoes has so far shown promising results, although this approach needs more elaborate research. Spiders have a wide insect host range and thus can act as biological control agents of insect pests. Therefore, a search for new environmentally friendly control measures was initiated and agents that act directly on mosquitoes' life cycle, their feeding patterns and the ability of adult forms to spread diseases are needed. This paper reviews research that has explored possibilities of using mosquito-predator relationships in the control of mosquitoes as vectors of disease causing pathogens specifically highlighting the potential use of spiders [5]. Several biological mosquito control techniques that have been used include the direct introduction of parasites, pathogens and predators to target mosquitoes [6]. Several researchers have explored a number of predators as biological control agents of mosquitoes.

These predators may have limited effect on eradicating populations of mosquitoes, but the role of mosquitoes as a prey species is an important consideration for their control [5]. Mermithid nematodes parasitizing mosquitoes have substantial potential for vector control [7, 8]. Mermithid nematodes, such as *Diximermis peterseni* [9], *Romanomermis iyengari* [10], and *Strelkovimermis spiculatus* [11] were evaluated for the development of biological control of mosquitoes. All mermithid nematodes were observed to infect the larval stages of their hosts. Other hand, Spider venoms have been shown to contain complex mixtures of a number of different types of molecules, such as neurotoxins [12] and necrotic and antimicrobial peptides [13]. Also, spider toxins have recently emerged as interesting tools for exploring new antiparasitic targets [14, 15]. In new research state that Psalmopeotoxin I (PcFK1) [15], a peptide isolated from the venom of the tarantula *Psalmopoeus Cambridge*, has been recently shown to possess strong anti plasmodial activity against the intra-erythrocyte stage of *Plasmodium falciparum* in vitro. Malaria constitutes the most widespread infectious disease, affecting over 300 million people [16, 2]. However, spider ankles are the best way to kill mosquitoes. These spiders are one of the most challenging of scientific research. Behavior of jumping spiders and found that they possess an innate predisposition to adopt *Anopheles*-specific prey-capture behavior [17]. Our research here is directly carried out by selecting mosquitoes to feed the spiders. In addition to examining how many mosquitoes there are in each diet, we also report the results of the study on which species kill more mosquitoes.

Materials and methods

The study was conducted at Bharathiar University, Coimbatore district. The study area type's maximum and minimum temperature recorded in winter and summer were 18^0C and 9^0C and 25^0C, represent and average relative humidity 23% to 88%, Pressure 1007 mbar to 1018mbar. All mosquito larvae collected from different locations of Coimbatore. The present study was conducted from April to November 2019.

Spider and mosquitoes collection

Bushes tree trunks, forest floor, foliage and grass lands were all searched for the adults mosquitoes and spiders and collected by using various methods such as hand picking, pitfall trapping, sweep netting, cryptic methods. Collected mosquitoes and spiders were preserved and identified by using standard reference. Hence, different larvae are reared in a separate plastic container. Container height 30 cm width 12 cm. Every plastic container was separated by mesh in the middle of the container. The mesh has three to five holes, which has used for adult mosquitoes came out on the mesh from water. Only one spider living in the mesh for analyses the feeding of mosquitoes. Those same methods in every container have different spider species.

All containers are covered with wooden board. Every 30 minutes should examine the number of spiders feeding. It examines what kind of mosquitoes feed by different spider species. The identification of spiders was done following Tikader method, as well as a pictorial guide [18, 19] and identification of mosquitoes was done following [20], after this the experiments were conducted and studied the predatory potential of spiders on mosquitoes and its larvae in the laboratory, at room temperature, and the average consumption rate was calculated.

Result and discussion

In experiment was conducted to study of the predatory of 6 families on larvae and adults of 3 different mosquitoes (Table 1). Spiders were collected from different habitats of the study area and maintained in the experimental setup, made by plastic container and covered by wooden boards. In the wooden board contain with micro holes. Each was provided one species of spider. At first, equal quantity of mosquito larvae was introduced in all 8 experimental setup. Every 30 minutes the readings were taken and the average consumption rate of each spider family of mosquito's larvae was calculated. The same experiment was repeated for adult mosquitoes.

Maximum number of *Aedes aegypti* mosquitoes eaten by all spider species. *Hippos agelenoides* species were captured *Aedes aegypti* 8 in number. *Leakage decorate* captured *Culex Quinque*faciatus 8 in number. *Viceroy minima* has captured and eaten 7 *Anopheles stephensi*. Other spiders eat less than 5 in number. Spiders have largely been overlooked as predators of mosquitoes and its larvae in various ecosystems, yet they play an important role as stabilizing agents or regulators of insect populations in agro-forest and other terrestrial ecosystems [21]. The spider families included Oxyopidae, Lycosidae, Nephilidae, Salticidae, Tetragnathidae and Thomisidiea. Their results also sowed the spider families based on consumption of adults of mosquitoes (Table 1). Jackson and Nelson (2012) [22] discovered that *E. Culicivora* preyed on mosquitoes, especially females engorged after a blood meal. Generally, Salticidae like *E. Culicivora* have unique, complex eyes and an ability to see prey in remarkably fine detail [23, 24]. There is no doubt that spiders can only control mosquitoes more than other ankles. And this research can only help spiders to control mosquito-borne diseases more accurately. Jackson and Cross (2015) [25] also explain that while many spiders eat mosquitoes, a spider is not automatically a mosquito specialist if it eats mosquitoes, or even if it primarily eats mosquitoes. Instead, specialization pertains to predators being adaptively fine-tuned to specific types of prey. The selected mosquito species are disease-causing organisms in India. Our research clearly demonstrates that spiders are the right solution to destroy this. It is the duty of each to save these spider species properly. In addition, the best way is to protect the spider's habitat from any harm (Table 2 and 3) (Figure 1, 2, 3 and 4).

Table 1: List of selected spider species in family wise.

S. No	Family	Species
1	Oxyopidae (Thorell, 1870)	*Peucetia viridana*
2	Lycosidae (Sundevall, 1833)	*Hippasa agelenoides*
3	Nephilidae (Simon, 1894)	*Nephilengys malabarensis*
		Herennia multipuncta
4	Salticidae (Blackwall, 1841)	*Phintella vittata*
		Viciria minima
5	Tetragnathidae (Menge, 1866)	*Leucauge decorata*
6	Thomisidae (Sundevall, 1833)	*Thomisus rigoratus*

Table 2: List spider species that captured Aedes aegypti, Culex quinquefasciatus and Aniphles stephensi in numbers

S. No	Species	*Aedes aegypti*	*Culex quinquefasciatus*	*Anopheles stephensi*
1	*Peucetia viridana*	5	3	2
2	*Hippasa agelenoides*	8	5	5
3	*Nephilengys malabarensis*	3	2	4
4	*Herennia multipuncta*	5	7	6
5	*Phintella vittata*	2	5	5
6	*Viciria minima*	7	2	7
7	*Leucauge decorata*	6	8	4
8	*Thomisus rigoratus*	4	2	5
Total		40	34	38

Table 3: Total number of mosquitoes captured by spiders species

S. No	Species	Total no of Mosquitoes
1	*Peucetia viridana*	10
2	*Hippasa agelenoides*	18
3	*Nephilengys malabarensis*	9
4	*Herennia multipuncta*	18
5	*Phintella vittata*	12
6	*Viciria minima*	16
7	*Leucauge decorata*	18
8	*Thomisus rigoratus*	11

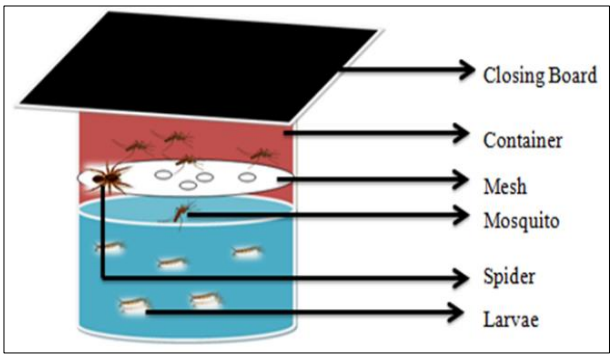

Fig 1: Start of test: test spider in predator chamber and walks down to prey chamber.

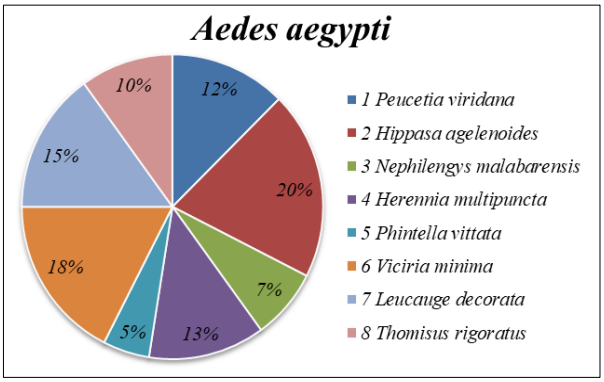

Fig 2: Percentage consumption of mosquitoes *Aedes aegypti* by spider species.

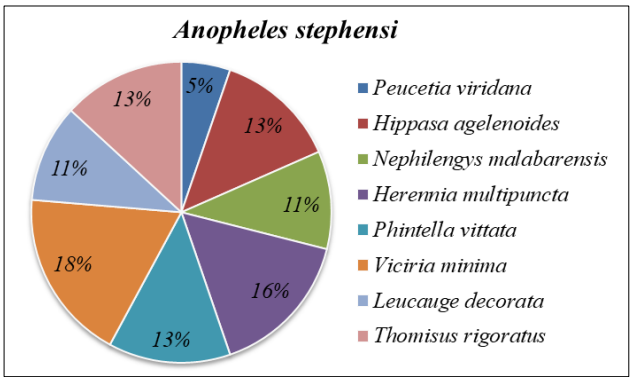

Fig 3: Percentage consumption of mosquitoes *Anopheles stephensi* by spider species.

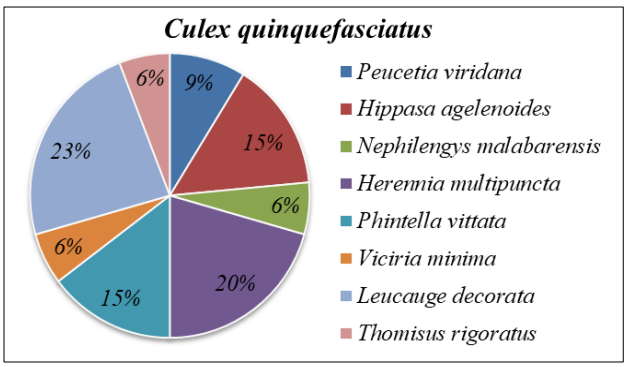

Fig 4: Percentage consumption of mosquitoes *Culex quinquefasciatus* by spider species.

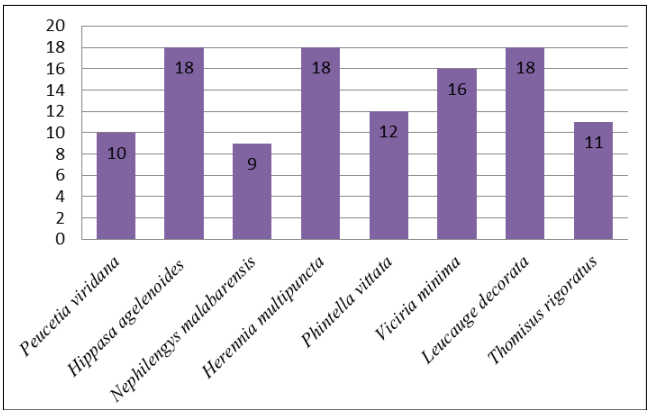

Fig 5: List spider species that captured total mosquitoes in numbers

Conclusion

This research has shown that spider predation could be of great ecological significance in suppressing mosquito populations. Management of spider populations could provide the additional control of adult mosquitoes needed to reduce the transmission of mosquito-borne diseases. The question to be asked is on the possibility of utilizing spiders for biological control in, especially throughout Asia. There is need therefore to develop at different scales, models that incorporate different biological factors for the successful establishment of effective biological control of mosquitoes by spiders. Methods of monitoring effectiveness of control and highlighting and solving potential problems before releases need to be developed. Arachnologists suggest that spiders could become of greater importance, if it were possible to increase the numbers of spiders. This is only possible if all of the spider researcher and enthusiasts scientists participate and implement it, not only integrated pest management. The research confirms that the last spiders are the only ones that can control the mosquitoes.

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References

1. Confalonieri U, Menne B, Akhtar R, Ebi KL, Hauengue M, Kovats RS *et al*. Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Parry ML, Canziani of, Palutikof JP, van der Linden PJ, Hansson CE (eds). Cambridge University Press, Cambridge, UK, 2007, 391-431.
2. Snow RW, Guerra CA, Noor AM, Myint HY, Hay SI. Theglobal distribution of clinical episodes of Plasmodium falci-parum malaria. Nature. 2005; 434:214-217.
3. Chandra G, Bhattacharjee I, Chatterjee SN, Ghosh A. Mosquito control by larvivorous fish. Indian J Med Res. 2008; 127:13-27.
4. Krishna KL, Kritika T, Trigunayat M. Spiders in mosquito control. International Journal of Environmental Engineering and Management, 2013, 331-338.
5. Jenias N, Silvia D, Phelex M. The future of mosquito control: The role of spiders as biological control agents: A review. International journal of Mosquito research. 2017; 5(1):06-11.
6. Eldridge BF. The Biology and Control of Mosquitoes in California, California Department of Public Health Vector Control Technician Certification Training Manual. Sacramento, California, 2008, 84.
7. Platzer EG. Biological Control of Mosquitoes with Mermithids. Journal of Nematology. 1981; 13(3):257-262.
8. Kobylinski KC, Massamba S, Black WIV, Foy BD. Mermithid nematodes found in adult Anopheles from southeastern Senegal. Parasites & Vectors. 2012; 5:131.
9. Petersen JJ, Willis OR. *Diximermis peterseni* (Nematoda: Mermithidae): A potential biocontroagent of Anopheles mosquito larvae. Journal of Invertebrate Pathology. 1974; 24(1):20-23.
10. Santamarina MA, Perez PR, Martinez TSH, Canton LE, Ambrosio GF. The *Romanomermis iyengari* parasite for *Anopheles pseudopunctipennis* suppression in natural habitats in Oaxaca State, Mexico. Revista Panamericana de Salud Publica. 1999; 5:23-28.
11. Sanad MM, Shamseldean MSM, Elgindi AEY, Gaugler R. Host penetration and emergence patterns of the mosquito-parasitic mermithids *Romanomermis iyengari* and *Strelkovimermis spiculatus* (Nematoda: Mermithidae). J Nematol. 2013; 45:30-38.
12. Escoubas P, Diochot S, Corzo G. Structure and pharmacology of spider venom neurotoxins. Biochimie. 2000; 82:893-907.
13. Corzo G, Escoubas P. Pharmacologically active spider peptide toxins. Cell. Mol. Life Sci. 2003; 60:2409-2426.
14. Silva J, Daffre S, Bulet P. Isolation and characterization of gomesin, an 18-residue cysteine-rich defense peptide from the spider *Acanthoscurria gomesiana* hemocytes with sequence similarities to horseshoe crab antimicrobial peptide of the tachyplesin family. J Biol. Chem. 2000; 275:33464-33470.
15. Choi SJ, Parent R, Guillaume C, Deregnaucourt C, Delarbre C, Ojcius DM *et al*. Isolation and characterization of Psalmopeotoxin I and II: Two novel anti-malarial peptides from the venom of the tarantula *Psalmopoeus cambridgei*. FEBS Lett. 2004; 572:109-117.
16. Snow RW, Trape JF, Marsh K. The past, present and future of childhood malaria mortality in Africa. Trends Parasitol. 2001; 17:593-597.
17. Ximena JN, Robert RJ, Godfrey S. Use of Anopheles-specific prey-capture behavior by the small juveniles of *Evarcha culicivora*, a mosquito-eating jumping spider. The Journal of Arachnology. 2005; 33:541-548.
18. Levi LR. Spider and their kin. St. martins press, Newyork, 2002.
19. Sebastian PA, Peter KV. Spiders of India, University Press publication, 2009.
20. Leopoldo M, Rueda. Pictorial keys for the identification of mosquitoes (Diptera; Culicidae) associated with Dengue Virus Transmission. Zootaxa. 2004; 589:1-60.
21. Lawania KK, Trigunayat K, Trigunayat MM. Spiders in Mosquito Control. International Journal of Environmental Engineering and Management. 2013; 4(4):331-338.
22. Jackson RR, Nelson XJ. *Evarcha culicivora* chooses blood-fed Anopheles mosquitoes but other East African jumping spiders do not. Medical and Veterinary Entomology. 2012; 26:233-235.

23. Harland DP, Li D, Jackson RR. How jumping spiders see the world. In How animals see the world: Comparative Behavior, Biology, and Evolution of vision (eds Lazareva O, Shimizu T, Wasserman EA.). Oxford University Press, New York, USA, 2012, 133-164.
24. Land MF, Nilsson DE. Animal eyes. 2nd Ed. Oxford University Press Oxford, UK, 2012, 33-55.
25. Jackson RR, Cross FR. Mosquito-terminator spiders and the meaning of predatory specialization. Journal of Arachnology. 2015; 43:123-142.