CEPF SMALL GRANT FINAL PROJECT COMPLETION REPORT

Organization Legal Name:	-
Project Title:	Tarantula (Araneae: Theraphosidae) spider diversity, distribution and habitat-use: A study on Protected Area adequacy and conservation planning at a landscape level in the Western Ghats of Uttara Kannada district, Karnataka
Date of Report:	18 August 2011
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CEPF Region: The Western Ghats Region (Sahyadri-Konkan and Malnad-Kodugu Corridors).

2. Strategic Direction: To improve the conservation of globally threatened species of the Western Ghats through systematic conservation planning and action.

The present project aimed to improve the conservation status of two globally threatened (Molur et al. 2008b, Siliwal et al., 2008b) ground dwelling theraphosid species, *Thrigmopoeus insignis* and *T. truculentus* endemic to the Western Ghats through systematic conservation planning and action.

Investment Priority 2.1 *Monitor and assess the conservation status of globally threatened species with an emphasis on lesser-known organisms such as reptiles and fish*.
The present project was focused on an ignored or lesser-known group of spiders called Tarantulas/ Theraphosid spiders and provided valuable information on population status and potential conservation sites in Uttara Kannada district, which will help in future monitoring and assessment of conservation status of the two globally threatened theraphosid species *T. insignis* and Near Threatened *T. truculentus.*

Investment Priority 2.3. *Evaluate the existing protected area network for adequate globally threatened species representation and assess effectiveness of protected area types in biodiversity conservation.*
The surveys carried out during this project were purported to gather data of the presence and evaluate the population status of the two theraphosid species in and around the Protected Areas (Dandeli WS, Anshi NP), a Reserved Forest(Karwar RF) and three proposed Conservation Reserves (ALTMCR, BCR and HCR), located in the Sahyadri-Konkan and Malnad-Kodugu corridors. The collected information will contribute to the assessment of the adequacy of representation of the two threatened theraphosid species in these protected areas and the effectiveness of the different protected area types in the Western Ghats biodiversity conservation.

Investment Priority 2.4 *Support interdisciplinary efforts to analyze and disseminate biodiversity data*

Beside the main focus (which was on theraphosid spiders), information on other spider fauna (mygalomorphs araneomorphs) in the area was also gathered during the surveys carried out under this project, which will support other efforts aimed to analyze and disseminate biodiversity data of the region.

Grant Amount: $ 8770.00

Project Dates: 1 September 2009 to 31 August 2010 with an extension of two months till 31 October 2010.

Implementation Partners for this Project (please explain the level of involvement for each partner):

This project was sanctioned under individual grant and grantee was Manju Siliwal. The project was mostly carried out independently by Manju Siliwal, but later for a few months was also assisted by Neha Gupta, M.Sc. student, Guru Gobind Singh Indraprastha University, Delhi for collection of data in the field.

Conservation Impacts

Please explain/describe how your project has contributed to the implementation of the CEPF ecosystem profile.

2.1 Monitor and assess the conservation status of globally threatened species with an emphasis on lesser-known organisms such as reptiles and fish.

- Four globally threatened species (*Chilobrachys fimbriatus* Pocock, 1899, *Poecilotheria striata* Pocock, 1895, *Thrigmopoeus insignis* Pocock, 1899 and *Thrigmopoeus truculentus* Pocock, 1899) were assessed for their population and threat status in the region during the project. Threat status of *P. striata* and *T. insignis* will be down-listed from Vulnerable to Near Threatened.

- Identified three sites (Kulgi, Potoli and Anshi) having exceptionally high abundance of Taruntulas during the project. These areas are recommended for future monitoring of the spider populations.

- The three proposed conservation areas, Dandeli Hornbill Conservation Reserve (CR), Bedthi Conservation Reserve (CR) and Aghanashini LTM Conservation Reserve (CR) proposed by B.L. Hegde were surveyed. And all the globally threatened species targeted for the present project like *C. fimbriatus, P. striata, T. truculentus* and *T. insignis* were found in existing protected areas, Anshi NP, Dandeli WLS and aforesaid three proposed conservation areas. Also, a list of mygalomorph spiders was provided to include in the amendment of proposed aforesaid three conservation Reserves (Annexure VI). Therefore, population of

these globally threatened species found in protected areas and conservation reserves of Utttara Kannada will be conserved.

2.3 *Evaluate the existing protected area network for adequate globally threatened species representation and assess effectiveness of protected area types in biodiversity conservation.*

As far as globally threatened species of spiders are concerned in Uttara Kannada district, number of protected areas and proposed conservation reserves (Dandeli Hornbill CR, Bedthi Hornbill CR and Aghanashini LTM CR) are adequate to conserve threatened species population. Threatened species, *Thrigmopoeus insignis*, *T. truculentus*, *P. striata* and *C. fimbriatus* were recorded in conservation reserves though their number were less as compared to protected area (it is based on personal observation as sampling in conservation reserves were random and therefore cannot be statistically compared with protected areas - Dandeli WLS and Anshi NP data). But if the protection level is increased by declaration of these areas as conservation areas, population of these spiders will recover. The proposed conservation reserves in corridors in Uttara Kannada district will help in movement of spiders between different areas provided their habitat does not deplete due to anthropogenic pressure.

Protected areas were found to be adequate in supporting high diversity of mygalomorph including globally threatened species, *Thrigmopoeus insignis*, *T. truculentus*, *Poecilotheria striata*, and *Chilobrachys fimbriatus.* High number of these spiders (except for *P. striata*) were encountered in protected areas (Fig. 1). Reserve forests and teak plantations adjoining the protected areas were also benefited from its high level of protection and therefore, supported good percentage of species in reserve forest and plantation (majority teak plantations) adjoining the protected area. Species diversity and number declined drastically in agriculture and human habitation despite of being close to protected area or within protected area. This shows that mygalomorphs prefers protected areas and reserve forests and also level of disturbance determines the stability of population and diversity of species (Fig. 3).

Mygalomorphs in general are poor at dispersal but large-bodied spiders with wider distribution range shows that if contiguous undisturbed habitat is provided then males and juvenilies can migrate to a long distance. *T. insignis* having narrow distribution range in comparision to the its sister species *T. truculentus* because the type locality of *T. insignis*, i.e. Karwar is highly disturbed and fragmented due to mining, anthropogenic pressure, habitat degradation and fragmentation and therefore, could not disperse very far. Therefore, the proposed conservation reserve will serve also corridors for distribution of *T. insignis* and hopefully the species will recover.

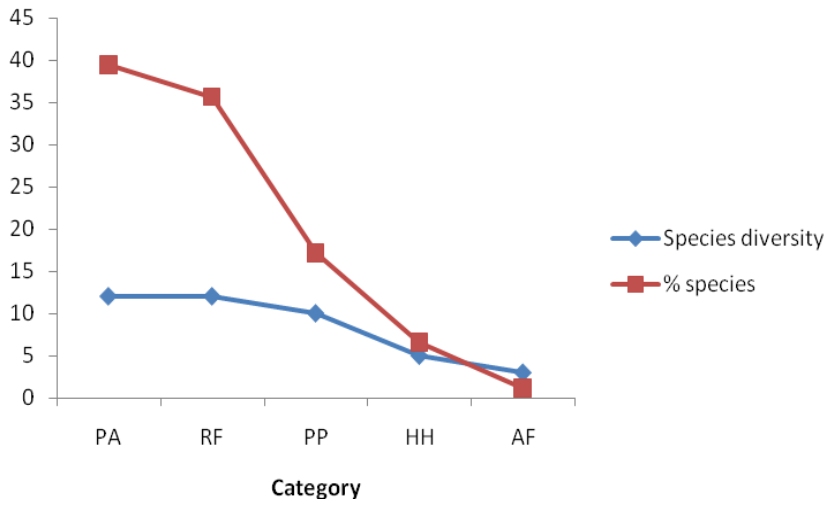

Figure 1. Species diversity and species number in percentage across different land use categories.

2.4 Support interdisciplinary efforts to analyze and disseminate biodiversity data

- Added 11 species of mygalomorph spiders to the faunal list of the conservation priority areas (Dandeli Hornbill CR, Bedthi CR, Aghanashini LTM CR).

- Raw data (list of spiders) has been submitted to the Western Ghats Biodiversity Portal (WGBP).

- A checklist of spiders (about 175 spp.) of Dandeli WLS and Anshi NP (Dandeli and Anshi Tiger Reserve) will be published in peer-reviewed journal and this information has already been conveyed to the Karnataka Forest Department).

- New species and new record information will be published in peer-reviewed national and international journals.

- Poster was prepared on tarantulas of Western Ghats that were listed in IUCN Red List (Annexure IV) and distributed to 2650 persons and/through over 100 agencies that would deem the information useful (Annexure V).

- IUCN listings for the respective species will be updated as publications will be published (at present submitted to the journals), it is likely that in the next amendment (2012) the changes in the species status will be reflected on IUCN Red List website.

Please summarize the overall results/impact of your project against the expected results detailed in the approved proposal.

Population assessments of threatened species:

The population assessments for seven species of theraphosids, *viz*., *Chilobrachys fimbriatus, Thrigmopoeus truculentus, T. insignis, Poecilotheria striata, Plesiophrictus sp.* (new species), *Euphrictus sahyadri* sp. nov., *Euphrictus sp.* (new species) were carried out during the present project. Of these seven species, based on previousthreat assessment, four species were listed under the IUCN Red List 2008, with *P. striata* and *T. insignis* categorized as Vulnerable (Siliwal et al. 2008a,b), *T. truculentus* categorized as Near Threatened (Molur et al. 2008b) and *C. fimbriatus* categorized as Least Concern (Molur et al. 2008a).

The present project revealed that the two globally threatened species (*Poecilotheria striata* and *Thrigmopoeus insignis)* were having much wider distribution range than previously reported. Therefore, both these species now qualify for down-listing from Vulnerable to Near Threatened. These changes in the threat status will be highlighted through publications, based on which IUCN Red List status for *P. striata* and *T. insignis* will be updated. The threat status of *T. truculentus* and *C. fimbriatus* remains the same, Near Threatened and Least Concern respectively (but assessments reaffirming status will recorded into IUCN), though habitat degradation, fragmentation and pet trade remain major threats to these species also.

The population assessment of the newly discovered species, *Plesiophrictus* sp., *Euphrictus sahyadri* and *Euphrictus* sp. will be based on the information available from the present project and will be published along with new descriptions.

Ecology (Figs. 2-3):

A detailed ecological study on mygalomorph spiders was carried out for the first time in Western Ghats and India through this project. Fairly good populations of large-sized tarantulas were found in protected areas (except for *P. striata*) and nearby reserve forests and teak plantations. They are microhabitat specific, like *T. insignis* was found in areas with high canopy cover (all habitat average 43.5%) and moderate ground cover (all habitat mean 35%) and low rock cover (all habitats mean 5.48%), therefore, they are more susceptible to the change in habitat in protected areas (Fig. 2). However, *P. striata* was recorded more in plantations than protected areas which could be because of high canopy cover (mean 54.70% in PA) and availability of more places to hide during the daytime in protected areas than plantations like teak (Fig. 2). In general, the area otherwise supports fairly good population of this species; locals encountered this species quite often while cutting bamboo or in their houses during monsoon. As expected, agriculture and human habitation were least preferred habitats by mygalomorphs except for *Plesiophrictus* sp., which were encountered more in human habitation were surrounded by forest. Again, it could be because of small-size mygalomorph and small

size silken burrow they prepare which needs very small place for hideouts like behind tree barks, bricks, crevices in rocks or wall or any substrate, etc. and therefore, it can be missed out during the transects carried out in the protected areas. Overall the recorded mygalomorphs had consistently occurred in protected areas and reserve forests with few exceptions (Figs. 2-3).

Diversity and density of mygalomorphs in Karwar FD was much less than Anshi-Dandeli Tiger Reserve, since Karwar FD doesn't have any protected area and consists of degraded and fragmented reserve forests. In contrast, Dandeli consists of two protected areas, Dandeli WLS and Anshi NP which contained more of mixed forests than mono-plantations. Moreover, amongst the protected areas, significant variation in the diversity and density of mygalomorphs was found across different habitats. The undisturbed habitats like evergreen forests of Anshi NP and moist deciduous patches in Ulvi, supported large-bodied tarantulas including *Thrigmopoeus* spp., and *Plesiophrictus* sp., whereas others including, deciduous forests, mixed forests, dry forests supported a variety size-genera of mygalomorphs, like *Idiops* spp., *Tigidia* sp., *Euphrictus* spp., *Indothele* sp. However, *Chilobrachys fimbriatus* and *Idiops* sp. were found in most of the habitat types. They were found to be highly adaptable, although their encounter rates were higher in protected areas than in agriculture fields and human habitation.

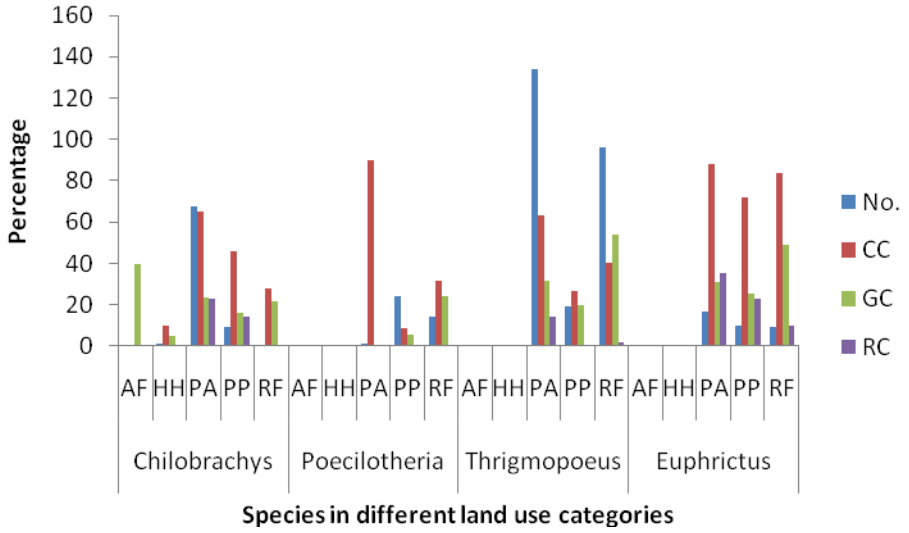

Fig. 2. Large-sized tarantulas micro-habitat preference in different land use categories (AF-Agriculture forest, HH-Human habitation, PA- Protected area, RF-Reserve Forest, No.- Individual sighted in percentage, CC- Canopy cover, GC-Ground cover, RC- Rock cover)

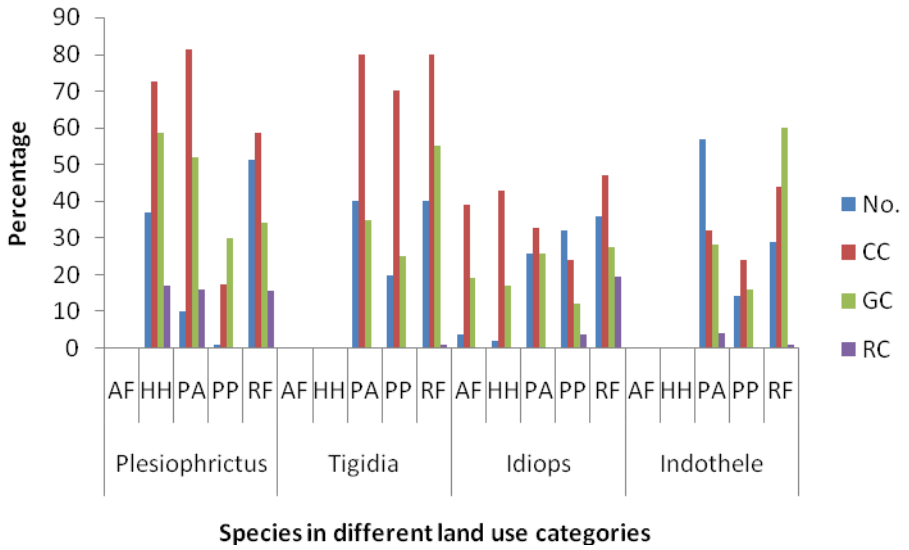

Fig. 3. Micro-habitat preference in different land use categories by small–sized mygalomorphs (Abbreviations as in Fig. 2)

New species and new records:

As far as mygalomorphs are considered, the Western Ghats have been relatively well studied, as compared to the other parts of the country,. Of the 80 species of mygalomorph spiders, 31 species have been described from Western Ghats. At the initial stage of the project, we did not expect any new species of any large-bodied spider from the area, though we had anticipated of finding some small-sized mygalomorphs from the area. But we found many interesting records and new species from the project area. This shows that these primitive spiders are poorly studied and if an intensive survey is carried out in any area there is high probability of finding a new species. Similarly, among araneomorph spiders, many new discoveries have been made by the project from this area, which will be published in peer-reviewed journals.

During the present survey, we found eight new species of mygalomorphs and many araneomorph spiders (exact numbers unsure as their taxonomy is currently being studied thoroughly). The new mygalomorph spiders belong to the genera, *Euphrictus* (two species), *Plesiophrictus* (two species), Theraphosidae; *Tigidia* (one species), Barychelidae; *Idiops* (two species), Idiopidae; *Indothele* (one species), Dipluridae.

Interestingly, two African origin genera *Tigidia* and *Euphrictus* were found in the Western Ghats and are likely to be Gondwana relicts. The genus *Tigidia* was thought to be endemic to Madagascar and Mauritius Islands and the genus *Euphrictus* is endemic to Central and Western Africa. Finding these genera in the Western Ghats has opened up new aspect to spider studies in India. These genera seem to be an ideal to study evolutionary lineage of the group and also to test different hypotheses of the Gondwana theory (Sahni 1984, Briggs 2003, Datta-Roy & Karanth 2009, Kunte in press).

While carrying out taxonomic work, it was found that one of the reported genera (name not disclosed) of Theraphosid was misidentified and a new genus will be erected to fit this genus. This will be published in a peer-reviewed journal.

Prior to the present project in Uttara Kannada, the northern most distribution range of *P. striata* was Mysore, Karnataka (ref: cit). During the present survey, this species was observed in different locations of Uttara Kannada district, Karnataka. Therefore, the distribution range of this species now extends to the northern part of Western Ghats by ca. 400km off Mysore. Because of increase in the distribution range, the species threat status should change from Vulnerable to Near Threatened, and action is being taken to this effect. It is also possible that *P. striata* has much more wider distribution range but intensive surveys are required to confirm this.

A checklist of spiders (about 175 spp.) of Dandeli and Anshi Tiger Reserve (published in peer-reviewed journal and also provided to Karnataka Forest Department) was also prepared during this project. Of the araneomorph spiders recorded, many new species to science will be described by the grantee with many new records for the Karnataka state and also to India.

Awareness amongst locals:

During the surveys it was realized that local people of the Uttara Kannada district were not much aware of the resting sites/burrows of theraphosid spiders. Most of the locals had seen these spiders in forest areas. However, locals of Kulgi reported theraphosid (*Poecilotheria* sp.) sightings quite often in their houses during rains,when males mature and leave their burrows and wander in search of a female and at times, they entered houses or human settlement area. Out of the fear of getting bitten by the spider, locals killed the tarantula on sight inside their houses or in forest while cutting bamboo. We educated the locals that tarantula bites were not fatal to human being and therefore there was not need of killing these spiders. Instead they could chase spiders out of the house with a broom or a stick. Many locals agreed not to kill spiders henceforth. Various other myths and misconceptions related to theraphosid spiders were also cleared.

A poster on tarantulas of Western Ghats that were listed in IUCN Red List (Annexure IV) was designed and 3000 copies of it were printed. Of which, 2656 copies of tarantula poster were distributed to all the offices of the forest department in Western Ghats, CEPF grantees, paper mill in Dandeli, Environment & Forest Ministry office, Wildlife Week 2010 and Animal Welfare Fortnightly 2011 organizers throughout India to create awareness about conservation of these spiders (Annexure V). Remaining copies will be distributed along with education packets created by Zoo Outreach Organisation for Wildlife Week 2011.

Please provide the following information where relevant:

Hectares Protected:
Not applicable.

Species Conserved:

Four species of theraphosids, *Chilobrachys fimbriatus* Pocock, 1899, *Poecilotheria striata* Pocock, 1899, *Thrigmopoeus truculentus* Pocock, 1899 and *T. insignis* Pocock, 1899 will have their IUCN Redlist status re-assessed to better converve them. As of now, according to the IUCN (2008), three of these species are threatened with extinction *P. striata* and *T. insignis* are Vulnerable (Siliwal 2008a,b); *T. truculentus* is Near Threatened (Molur *et al*., 2008b) and *C. fimbriatus* is Least Concern (Molur *et al*., 2008a).

Corridors Created:

No corridors was created or proposed for spiders

Describe the success or challenges of the project toward achieving its short-term and long-term impact objectives.

1. Collected information on globally threatened tarantulas and based on this information, the threat status of *Poecilotheria striata* and *Thrigmopoeus insignis* in the IUCN Redlist will be updated. If similar studies were carried out in different parts of Western Ghats then it would have given more information on many other threatened species and would be possible to also carry out threat assessment for all these species.

2. There was lack of clarity on protected area and reserve forest boundaries of Dandeli WLS and nearby areas due to which, it was difficult to demark study area during the initial phase. Also, understanding vegetation types from old maps (toposheets) of Uttara Kannada was also not very useful.

3. *Thrigmopoeus* complex: Differentiating burrows of *T. insignis* and *T. truculentus* in field was challenging. It was only under a stereomicroscope that the anatomical difference in spermathecae structure helped in differentiating these two species. In the field, this differentiation was almost impossible since both the species are strikingly similar morphologically except of the size (*T. truculentus* was slightly smaller than *T. insignis*) which again was not a reliable identification character, often misleading in differentiating subadults or juveniles of these spiders. For publications, we will be considering them as *Thrigmopoeus* complex group.

4. Finding female of *Euprhictus* sp. was quite challenging as they do not construct the usual burrow like theraphosid spiders, but a different specialized burrow. Though they were very common in the areas where females of other theraphosid species were found, they remained unnoticed due to their specialized burrowing habits.

Were there any unexpected impacts (positive or negative)?

1. Finding the unexpected *P. striata* in the project area proved that the species had much wider distribution range than the previous reports.

2. Finding two genera that are Gondwana relict has made the project very exciting and proved that there is much more to discover about these spiders in Western Ghats.

Lessons Learned

Describe any lessons learned during the design and implementation of the project, as well as any related to organizational development and capacity building. Consider lessons that would inform projects designed or implemented by your organization or others, as well as lessons that might be considered by the global conservation community.

Project Design Process: (aspects of the project design that contributed to its success/shortcomings)

While designing the project, it was assumed that both the project areas could be managed by one researcher but after starting the project it was realized that if in the project two researchers were involved then it would have been possible to carry out field work in two places at the same time.

Project Implementation: (aspects of the project execution that contributed to its success/shortcomings)

Grantee was very much aware of the project area and assumed that there was sufficient data on diversity of spiders from the project area and therefore, the present project was more designed to understand the habitat use by tarantulas. But on starting the project, it was realized that:

1. No area is surveyed thoroughly in India as far as mygalomorphs are concerned. Finding eight new species and two new records of Gondwana relict genera for India proved that more time spent sampling systematically in the field would fetch more new information on these spiders.

2. After starting the project, it was also realized that genus *Thrigmopoeus* is a complex and there is a need to carry out molecular genetics to unravel out this taxanomic complex. But as molecular genetic studies are expensive and not budgeted in the project, we could not do it in the present project. Therefore, queries related to taxonomy of some of the theraphosid spiders remain unanswered. However, molecular tasks will be accomplished with new funds in near future.

Other lessons learned relevant to conservation community:

There is a huge potential to find many new species of mygalomorph spiders from the Western Ghats, since many areas remain unsurveyed for non-charismatic groups such as spiders, rodents, reptiles, amphibians are concerned.

ADDITIONAL FUNDING

Provide details of any additional donors who supported this project and any funding secured for the project as a result of the CEPF grant or success of the project.

Not applicable

Donor	Type of Funding*	Amount	Notes
Wildlife Information Liaison Development Society	A	$500	In kind, time and shared resources
Zoo Outreach Organisation	A	$ 500	In kind, time and shared resources

Additional funding should be reported using the following categories:

A *Project co-financing (Other donors contribute to the direct costs of this CEPF project)*

B *Grantee and Partner leveraging (Other donors contribute to your organization or a partner organization as a direct result of successes with this CEPF project.)*

C *Regional/Portfolio leveraging (Other donors make large investments in a region because of CEPF investment or successes related to this project.)*

Sustainability/Replicability

Summarize the success or challenge in achieving planned sustainability or replicability of project components or results.

1. With publications from the present project, discovery of new species and records for India, it will popularize the spider study amongst the researcher in the Western Ghats. Two students (Rajesh Sanap and Zeeshan Mirza) from Mumbai, have started mygalomorph surveys in Western Ghats of Maharashtra after hearing about the exciting results we were getting in Uttara Kannada. They also found two species of *Tigidia* sp. (Gondwana relict) from Western Ghats in Tamil Nadu and their finding is being published together with our findings.

2. Without sustainable funds, local people are not motivated to carry on monitoring of tarantulas in the project area. Some of the CEPF projects were coming up with innovative ideas by which locals can take up the task of conserving the local biodiversity without any funds from external sources. If these ideas work out practically then similar ideas can be tried out for spider monitoring. A few local boys, who were trained by us to locate spiders in the wild, can initiate monitoring of the spider population. But as they are engaged in other works, they are not motivated to take it up full time or periodically.

3. With the discovery of Gondwana relict species during the project, will lead to another project for testing different Gondwana hypotheses (Sahni 1984, Briggs 2003, Datta Roy & Karanth 2009).

Summarize any unplanned sustainability or replicability achieved.

We didn't expect the presence of Gondwana relict spiders in the project sites, let alone/or even in the Western Ghats. The discovery of two of them has for sure increased chances of researchers taking up studies on these spiders in the Western Ghats. More spider research taking place in Uttara Kannada, Karnataka (and Western Ghats as a whole) will further increase the chances of getting more ecological and biological information on the newly discovered Gondwana relicts, and could very well lead to discovery of new species.

Safeguard Policy Assessment

Provide a summary of the implementation of any required action toward the environmental and social safeguard policies within the project.

Not applicable for this project

Performance Tracking Report Addendum

CEPF Global Targets

(Enter Grant Term)

Provide a numerical amount and brief description of the results achieved by your grant.
Please respond to only those questions that are relevant to your project.

Project Results	Is this question relevant?	If yes, provide your numerical response for results achieved during the annual period.	Provide your numerical response for project from inception of CEPF support to date.	Describe the principal results achieved from July 1, 2007 to June 30, 2008. (Attach annexes if necessary)
1. Did your project strengthen management of a protected area guided by a sustainable management plan? Please indicate number of hectares improved.	No			Please also include name of the protected area(s). If more than one, please include the number of hectares strengthened for each one.
2. How many hectares of new and/or expanded protected areas did your project help establish through a legal declaration or community agreement?	No			
3. Did your project strengthen biodiversity conservation and/or natural resources management inside a key biodiversity area identified in the CEPF ecosystem profile? If so, please indicate how many hectares.	No			
4. Did your project effectively introduce or strengthen biodiversity conservation in management practices outside protected areas? If so, please indicate how many hectares.	No			
5. If your project promotes the sustainable use of natural resources, how many local communities accrued tangible socioeconomic benefits? Please complete Table 1below.	No			

If you answered yes to question 5, please complete the following table.

Table 1. Socioeconomic Benefits to Target Communities

Please complete this table if your project provided concrete socioeconomic benefits to local communities. List the name of each community in column one. In the subsequent columns under Community Characteristics and Nature of Socioeconomic Benefit, place an X in all relevant boxes. In the bottom row, provide the totals of the Xs for each column.

Name of Community	Community Characteristics								Nature of Socioeconomic Benefit												
									Increased Income due to:												
	Small landowners	Subsistence economy	Indigenous/ ethnic peoples	Pastoralists/nomadic peoples	Recent migrants	Urban communities	Communities falling below the poverty rate	Other	Adoption of sustainable natural resources management practices	Ecotourism revenues	Park management activities	Payment for environmental services	Increased food security due to the adoption of sustainable fishing, hunting, or agricultural practices	More secure access to water resources	Improved tenure in land or other natural resource due to titling, reduction of colonization, etc.	Reduced risk of natural disasters (fires, landslides, flooding, etc)	More secure sources of energy	Increased access to public services, such as education, health, or credit	Improved use of traditional knowledge for environmental management	More participatory decision-making due to strengthened civil society and governance.	Other
Total																					

If you marked "Other", please provide detail on the nature of the Community Characteristic and Socioeconomic Benefit:

Additional Comments/Recommendations

- Even though the information gathered from the present project is from a small area in a short period, it is quite motivating to initiate more intensive work on spiders in the Western Ghats. Therefore, similar level studies should be taken up in other priority areas in the Western Ghats.
- Present study also raises some evolutionary questions which can only be answered through molecular genetics. Therefore, molecular analyses on large-bodied spiders should be initiated to understand the evolutionary linkages of Indian tarantulas with tarantulas of rest of the world.
- For long-term conservation of tarantulas and other biodiversity in the Western Ghats (including Uttara Kannda), there is a need to develop self-sustained strategies for the conservation of biodiversity by involvement of local people and support of the state forest department, without any or minimal dependence on external resources or agencies.
- The type locality of *T. insignis* is Karwar but during the present survey only in one site (Shirvae Reserve Forest range) they were recorded in Karwar, rest of all the reserve forests were degraded and habitat was not favoring *T. insignis*. Though, *T. insignis* was recorded in Kulgi, Yellapur and nearby areas but its number was very less. Apart from three proposed conservations reserves (Dandeli Hornbill CR, Bedthi Hornbill CR, Aghanashini LTM CR), an additional conservation reserve in Karwar (Shirvae forest range) would have been ideal to form a contiguous habitat and much needed to save the critically endangered species in the type locality.

Information Sharing and CEPF Policy

CEPF is committed to transparent operations and to helping civil society groups share experiences, lessons learned, and results. Final project completion reports are made available on our Web site, www.cepf.net, and publicized in our newsletter and other communications.

Please include your full contact details below:

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Attachments:

Annexure I. List of publications expected from the present project

Annexure II. List of spiders submitted to Western Ghats Biodiversity Portal project

Annexure III. M.Sc. Dissertation report of Ms. Neha Gupta

Annexure IV. Poster on Tarantulas of Western Ghats

Annexure V. Tarantula poster distribution list

Annexure VI. List of mygalomorphs recorded in different sites in Uttara Kannada, Karnataka

PUBLICATIONS

Full length papers

1. Siliwal, M., N. Gupta, R. Sapan, Z. Mirza and R. Raven. A new species of the genus *Tigidia* Simon 1892 (Araneae, Barychelidae) from the Western Ghats of Karnataka, India. *Journal of Threatened Taxa.* (Accepted).
2. Gupta, N., M. Siliwal and S.K. Das. Habitat preference and burrow characteristics of a trapdoor spider (*Idiops sp.*) in the Western Ghats of Uttara Kannada, Karnataka, India. *Journal of Threatened Taxa*. (in prep)
3. Siliwal, M. and R. Raven. First record of the genus *Euphrictus* (Araneae, Theraphosidae) with the description of three new species from the Western Ghats of Karnataka, India. *Invertebrate Systematics*. (in prep)
4. Gupta, N., M. Ganeshkumar, S.K. Das and M. Siliwal. Description of a new species of trapdoor spider of the genus *Idiops* from Northern Western Ghats of Maharashtra, India. *Zootaxa*. (in prep)
5. Siliwal, M. and R. Raven. Description of new genus of the family Theraphosidae from India. *Zootaxa*. (in prep)
6. Siliwal, M., N. Gupta and R. Raven. Description of new species of the genus *Plesiophrictus* (Araneae: Theraphosidae) from Karwar, Uttara Kannada, Karnataka. *Journal of Arachnology*. (in prep).
7. Siliwal, M., N. Gupta and R. Raven. Description of new species of the genus *Indothele* (Araneae: Dipluridae) from Uttara Kannada, Karnataka. *Journal of Arachnology*. (in prep).
8. Siliwal, M. and N. Gupta. Checklist of spiders of Uttara Kannada, Karnataka. *Journal of Threatened Taxa.* (in prep)
9. Siliwal, M. and N. Gupta. Habitat use by mygalomorph spiders in Uttara Kannada, Karnataka. *Journal of Threatened Taxa.* (in prep)

Small notes

1. Siliwal, M., N. Gupta and S. Molur. The striated parachute spider *Poecilotheria striata* Pocock, 1895 (Araneae: Theraphosidae): a note on range extension, taxonomy and conservation status. *Journal of Threatened Taxa (submitted).*
2. Siliwal, M. Interesting observations on Theraphosid spiders in Uttara Kannada District of Karnataka. *Journal of Arachnology.*(in prep)

M.Sc. thesis

M.Sc. dissertation of Ms. Neha Gupta on 'the habitat preference and burrow characteristics of a trapdoor spider (*Idiops sp.*) in the Western Ghats of Uttara Kannada district of Karnataka, India' submitted to The Guru Gobind Singh Indraprastha University, Delhi, July 2010. (Was part of Tarantula project funded by CEPF-ATREE Western Ghats Small Grants Program). (Annexure III)

Remarks: Please note that authors (including seniority order) and journal names in the proposed publication are tentative and could change at the final stage of submission.

HABITAT PREFERENCE AND BURROW CHARACTERIZATION OF A TRAPDOOR SPIDER (*Idiops* sp.) IN THE WESTERN GHATS OF UTTARA KANNADA, KARNATAKA, INDIA

Submitted in partial fulfilment of the requirement of the degree of

MASTER OF SCIENCE

IN

BIODIVERSITY AND CONSERVATION

By

Neha Gupta

January - July 2010

School of Basic and Applied Sciences

Guru Gobind Singh Indraprastha University

Kashmere Gate, Delhi

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DECLARATION

I, undersigned hereby declare that the dissertation entitled "*Habitat preference and Burrow characteristics of a Trapdoor spider (Idiops sp.) in the Western Ghats of Uttara Kannada, Karnataka, India*" was written and submitted by me, is my original work and I have not copied it from any dissertation, report or book while preparing the dissertation.

Neha Gupta

Ms. Neha Gupta

Date: 15 July 2010

GGSIPU, Delhi

CERTIFICATE

The author of the dissertation Ms. Neha Gupta was assigned the topic entitled "*Habitat preference and Burrow characteristics of a Trapdoor spider (Idiops sp.) in the Western Ghats of Uttara Kannada, Karnataka, India*" under our supervision and guidance in partial fulfilment of the requirement of the degree in Master of Science in Biodiversity and Conservation from Guru Gobind Singh Indraprastha University, Delhi.

We certify that the observations embodied in the dissertation and all original work in that connection was done by Ms. Neha Gupta under our supervision and this dissertation work was not presented in part on full to any other University or Institution for the award of any other degree or diploma to the best of my knowledge and belief.

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Rita Singh 16/7/2010

Dr. Rita Singh
Programme Co-ordinator
M.Sc. Biodiversity and Conservation
Date: 15th July 2010

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Neha Gupta

OBJECTIVES

I. To understand habitats and microhabitats preference by the trapdoor spider in Uttara Kannada district, Karnataka.

II. To understand the pattern of distribution (demography) of the species across different habitats (semi-evergreen forest, moist deciduous forest, mixed forest, teak plantations, agriculture fields and settlement areas).

III. To study burrow characteristics and variations in it with the change in ecological parameters and across different habitats.

ABSTRACT

The members of the family Idiopidae (order Araneae) are trap door spiders and are mainly ground burrowing forms. They construct a tubular burrow with the walls covered in silk and have a cork-shape lid at the entrance to the burrow, used as a door. The outer surface of the lid or the door is covered with soil particles and other dry vegetation debris depending on the surroundings in order to camouflage, and are very often difficult to locate or go unnoticed due to this. I carried out a study investigating the habitat preference and burrow characterisation of an *Idiops* sp. across various habitats in Dandeli Wildlife Sanctuary and nearby reserve forests of the southern Western Ghats. This study was carried out from January, March -April 2010 and spiders were sampled using 5 m^2 qaudrats. In all 313 plots were sampled across different locations and habitat types. Ecological and burrow parameters were recorded for each spider. High number of quadrats sampled in the mixed forest had presence of burrows and appeared to occur scattered. While, in the human settlements, teak plantations and agriculture density of burrows was high, and this was as a result of clustering of the species. The study also showed that spiders occurred in open and exposed habitats with low canopy and vegetation cover. Also, significant variations were found in the burrow characteristics (burrow diameter, burrow depth and lid thickness) across the different habitat types.

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LIST OF MAP ANDTABLES

INTRODUCTION

The seventh most species rich animal order, Araneae (Phylum: Arthropoda, Class: Arachnida) is represented by spiders with a total of 41,719 species belonging to 3,802 genera and 109 families (Platnick, 2010). The order has been divided into two sub-orders, viz. Orthognatha and Labidognatha. The suborder Orthognatha consists of primitive spiders (Mygalomorphs) characterized by the vertical movement of chelicerae and the presence of two pairs of book lungs, whereas, the suborder Labidognatha consists of modern spiders (Araneomorphs) characterized by horizontal movement of chelicerae and the presence of only one pair of book lungs (Kaston, 1972; Tikader, 1987; Barrion & Litsinger, 1995, Siliwal *et al.*, 2005). The Mygalomorphs (suborder Orthognatha) are primitive spiders and are widely distributed throughout the world, represented by 2,732 species belonging to 322 genera and 15 families. Out of these only 82 species under 24 genera and 8 families have been recorded from India (Platnick, 2010).

The present day genera of the family Idiopidae were previously placed under the sub-family Idiopeae Simon, 1889 of the family Ctenizidae. Raven (1985) elevated the sub-family Idiopeae to the family status and relimited it (Platnick, 2010). The family Idiopidae is presently comprises of three sub-families (*viz.*, Idiopinae, Arbanitinae and Genysinae), 22 genera and 303 species in the world (Platnick, 2010). Amongst all mygalomorphs, it is the fourth most species rich family in the world, after the families Theraphosidae, Nemesiidae and Barychelidae (Platnick, 2010). In India, it is the second most species rich family (after the family Theraphosidae), comprising of 3 genera and 11 species (Platnick, 2010) (Table 1).

Since the British period, the Western Ghats have been a major center for spider studies, especially mygalomorph group. A total of 29 species of the 82 Indian mygalomorphs have been reported from the Western Ghats, out of which the family Idiopidae is represented by two genera and three species *viz.*, *Heligmomerus prostans* (Simon, 1892), *Idiops bombayensis* (Siliwal *et al.*, 2005), *I. constructor* (Pocock, 1900) from this region and of these the former two species are endemic to the Western Ghats.

The members of the genus *Idiops* Simon, 1889 are commonly referred as 'front-eyed trapdoor spiders' because a pair of anterior lateral eyes is located far from the rest of the eyes

on or near clypeal edge. This genus is represented by 90 species in the world and has been reported from South and Central America, Africa, India and West Australia (Dippenaar-Schoeman, 2002; Platnick, 2010; Siliwal *et al.*, 2010). In India, it is represented by 7 species out of which, two species, *Idiops constructor* (Pocock, 1900) and *Idiops bombayensis* (Silwal, Molur & Biswas, 2005) have been reported from the Western Ghats (Platnick, 2010). *Idiops constructor* (Pocock, 1900), which is commonly known as the Chingleput trapdoor spider is endemic to India and has been recorded from the parts of Andhra Pradesh (Eastern Ghats) and Maharashtra and Tamil Nadu (Western Ghats). Whereas, *Idiops bombayensis* (Pocock, 1900), which is commonly known as the Bombay trapdoor spider is endemic to the Western Ghats and has been, so far, known only from the type locality, Mumbai (=Bombay), Maharashtra, India (Molur & Siliwal, 2004). It is mainly due to the fact that in the past, for about a century, studies on this group of spider in the Western Ghats have not been carried out. Also, another possible reason for trapdoor spiders to remain poorly studied is their highly camouflaging burrows that are difficult to locate even at close distance when their trapdoor is closed (Siliwal, 2009).

The members of the family Idiopidae are mostly fossorial (Dippenaar-Schoeman, 2002). They make silken burrows in ground and the entrance of their burrow is closed with a hinged lid/door. Along with legs, they use spines on the chelicerae (referred as rastellum) to excavate the soil for constructing a burrow (Dippenaar-Schoeman, 2002). They are nocturnal and lead a solitary life confined to their burrows. These spiders (especially females) can spend their whole life in a single burrow except when the burrow is either destroyed or disturbed, and or when there is no chance of expansion of the burrow to accommodate the growing spider. Only male trapdoor spiders on maturation leave their burrows and lead a nomadic life wandering in search of mates and occupy temporary hideouts during the day (Siliwal, 2009). They have poor eye sight and depend largely on vibrations. Their burrows are surrounded with fine threads of silk that are connected to the inside layer of burrow and through vibrations of these silken threads they sense the presence of prey or predator (Siliwal, 2009). These specialized burrows not only serve as an escape from adverse microclimatological surface conditions but also serve as a well camouflaged site, defending the spider against probable predators, nesting and a hideout to ambush prey. These spiders make burrows with single entrance and thus, very much depend on their strength to defend themselves from the predator or intruder (Siliwal, 2009).

There have been very few studies on trapdoor spiders in general including *Idiops* in the world. Studies which have been carried out in the past were a brief notes on natural history, ecology and behaviour of trapdoor spiders of the family Ctenizidae, Microstigmatidae, Idiopidae, Antrodiaetidae, Cyrtaucheniidae (Moggridge, 1873; Atkinson, 1886a, b, c; Baerg, 1928 ; Main, 1957, 1982; Buchli,1969; Gertsch ,1979; Coyle, 1981, 1985; Coyle *et al* ., 1985; Decae, 1991; Coyle & Wendell, 1994; Bond & Coyle, 1995; Leroy & Leroy 2005). These studies were restricted to few small locations in Australia, Central America, Germany and South Africa and U.S.A. Amongst all the genera of the trapdoor family Idiopidae, the only genus *Misgolas* Karsch, 1878 from Australia has been studied for foraging and distribution (Bradley, 1996). However, so far, no ecological or behavioural studies have been carried out on any of the *Idiops spp.* Similarly, studies in India on trapdoor spiders in the past were restricted to taxonomy and therefore, information on natural history, ecology and behaviour is lacking (Molur & Siliwal, 2004; Siliwal *et al*., 2005, 2010; Siliwal & Molur, 2007). It is likely that cryptic spiders like trapdoor may remain unnoticed and their conservation status remains data deficient for years, though in wild they may be highly threatened with extinction. Ecological and behavioural studies on trapdoor spiders in India are much needed to conserve these 'not-so-easy-to-notice' spiders.

Therefore, the present study was carried out to understand the distribution and abundance of the trapdoor spider (*Idiops sp.*) across various habitats and burrow characterization in Dandeli WLS and nearby reserve forests. It is the first time this kind of information is being gathered for an Indian trapdoor spider.

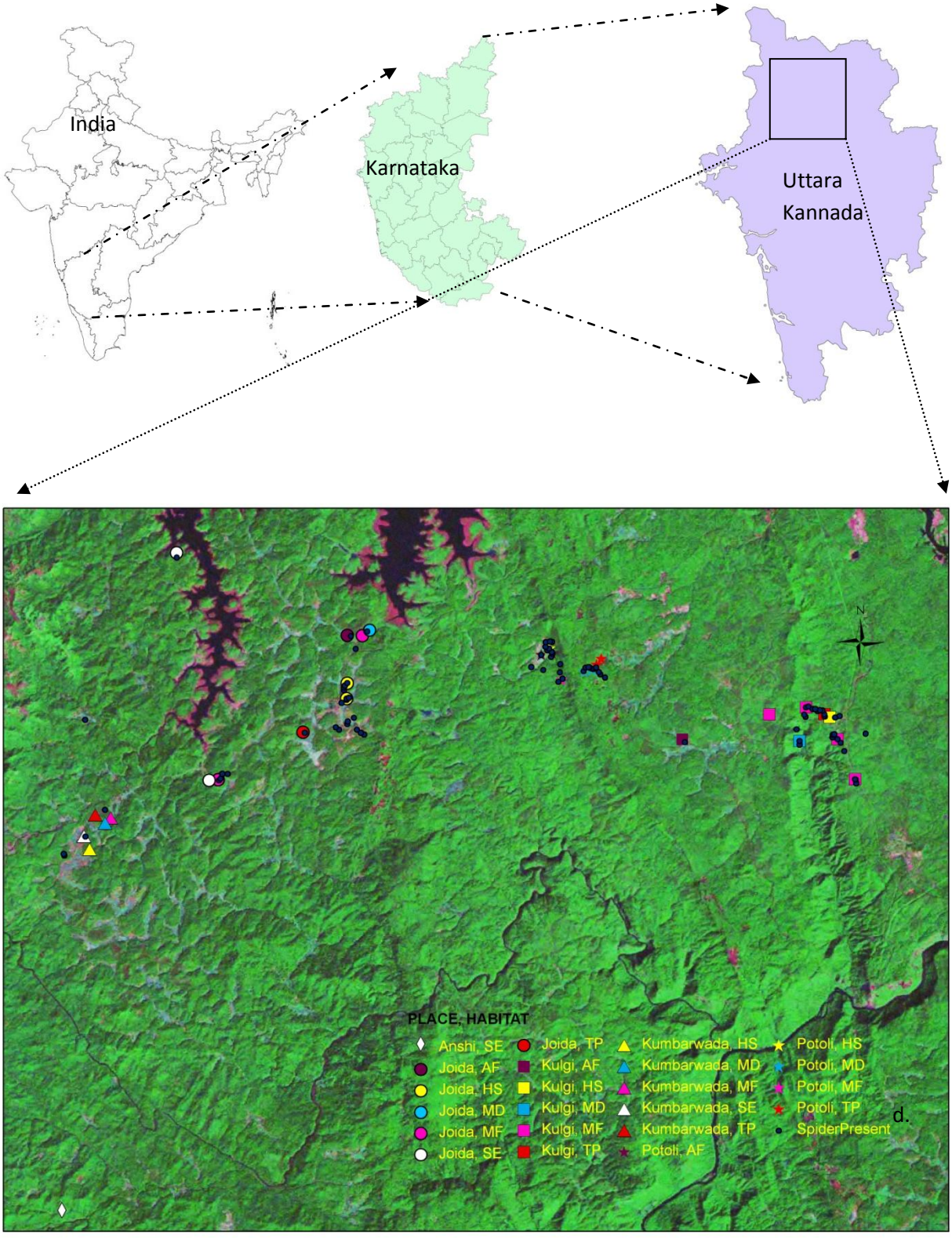
MATERIALS AND METHODS

STUDY AREA

The Western Ghats is one of the thirty-four biologically diverse hotspots, identified worldwide, with remarkably high level of endemism (http: //www. biodiversityhotspots.org). Therefore, the study was conducted in the Western Ghats region of the Uttara Kannada district (13º55' to 15º32' N latitudes; 74º05' to 75 º 05’ E longitudes) of Karnataka. The district shares boundaries with Goa and Belgaum, towards the north Dharwar, Haveri, and Shimoga, towards the east, and Udupi, towards the south, and covers a total geographic area of 10,291 square kilometres. The Arabian Sea borders it on the west creating a long continuous, though narrow coastline, of 120 km.

The Uttara Kannada district comprises of 11 taluks namely, Karwar, Sirsi, Joida, Batkal, Kumta, Ankola, Haliyal, Honnavar, Mundgod, Siddapur, and Yellapur. Each of these taluks has a fixed area under control, out of which five sites were chosen for the study, viz. Kulgi, Potoli, Kumbarwada, Joida and Anshi. From every site, six different types of habitats (see below) were selected for sampling. Topographically, the district has been divided into three zones, hills, plains and coastland. The study sites were, however, confined to the north eastern zone, most of which constitute ridge of hills. The elevation of study sites seldom exceeded 600m (Gadgil, 2004). The Uttara Kannada district has a tropical climate. The rainfall is received mostly between the months June and September, and ranges from 350 cm (near the coast) to 500 cm (along the hills). The eastern side of the district receives about 120 cm of average annual rainfall (Bhat *et al.,* 2000).

According to the revised classification of Indian forest types given by Champion & Seth (1968), the forest of the district North Karnataka is tropical moist deciduous type which comprises of closed high (30-36m or more) forest with characteristic bamboo undergrowth. When the bamboo is locally absent, then evergreens are commonly better developed. The dominant species in these forests are mostly deciduous and only sometimes evergreen.



Map 1. Study area showing different locations and spider presence across various habitats.

The study area falls under the Northern Evergreen Zone (Daniels *et al.*, 1989) in which the moist deciduous type and semi- evergreen forest predominate the forested area. The site Kulgi falls under the north-eastern taluk Haliyal and is situated adjacent to the Ambikanagar township, in the heart of the Dandeli Wildlife Sanctuary. The forest in this area was either moist deciduous or mixed type; no evergreen or semi-evergreen patches were observed. The other two sites, Potoli and Kumbarwada fall under the taluk Supa of the district. The forest in these sites was predominantly moist deciduous, accompanied by occasional patches of semi-evergreen type.

The Uttara Kannada district supports fairly good forested areas, and there are two protected areas, viz., Dandeli WLS and Anshi NP present in the district. These protected areas along with the adjoining reserve forest form the Dandeli-Anshi Tiger Reserve and are well protected in this region.

HABITAT TYPES

A total of six types of habitats viz., moist deciduous forest, mixed forest, semi-evergreen forest, teak plantations, human settlements and agriculture fields were sampled in each of the selected five areas of the district.

1. Mixed forest: The mixed forests was partially open type (20-40% density), comprising of dry and moist deciduous trees. The undergrowth in these forests was low to moderate (less than or equal to 40%) and canopy cover was more significant (40-50%). The upper canopy of the forest was typically leafless, but significant expansion of leaves and flowering of deciduous species in lower strata was observed. This was probably because of very high temperature and increased day-length conditions during the months, March-April, which lead to an increase in the rate of photosynthesis, thereby favouring leaf flush and flowering.

2. Moist deciduous forest: The moist deciduous forests comprised of deciduous species mainly, though there was a good sprinkling of evergreens in the understorey, in some of the patches. Some of the moist patches were predominated by bamboo. The

undergrowth (20-60%) and canopy cover (40-60%) were variably significant in the plots sampled in these forests.

3. Semi-evergreen forest: The semi-evergreen forest patches were lush green, closed type (above 80% density) in some of the areas and medium density forest (40-80% density) in others. They were usually present in pockets, often merging with moist deciduous type, and therefore distinguishing them was difficult sometimes. Lianas and climbers, cinnamon, cane, palm, jackfruit, mango trees were common in these forests.

4. Teak plantation: The teak plantations sampled were all secondary, monocultured for economic considerations perhaps. They were usually present as small discontinuous patches which often merged with mixed or deciduous forest.

5. Human settlement areas: The areas of human settlements, large or small, were also sampled in all the study sites. The houses adjoining agriculture fields were usually thatched and constituted a small settlement, but in some places pukka houses and buildings (government buildings, banks etc) occurred adjoining agriculture fields.

6. Agriculture fields: The agriculture fields, usually present between forest patches and near human habitation, were probably given place by clearing patches from continuous stands of forests. The fields sampled were paddy fields, coconut and banana plantations or, dry fields with 1-10% crop cover.

SAMPLING METHODS

The study was carried out for two months (60 days) in January, March-April 2010 in Dandeli WLS and nearby reserve forests, Uttara Kannada, Karnataka. The searching and sampling efforts were carried out during morning hours, 07:00 to 13:00 hours. On an average two

people were involved in sampling efforts, with an average time of 20 minutes spent in each quadrat. And a total of 210 man hours were spent for the study.

Five different locations were selected in the study area, Dandeli WLS and nearby reserve forests (Map 1). In each of these locations, six different types of habitats were identified for the study (Map 1, Table 4). Though the sampling sites were not very far from each other except for Anshi, it was difficult to get all types of listed habitats in all the locations and therefore, out of the six habitats, one or few habitat(s) are absent in few locations. For example, Potoli and Kulgi semi-evergreen type of forest was not found, whereas, in Anshi, only semi-evergreen type of forest was dominantly present. Therefore, the study was carried out in the available habitats in the given area (Map 1).

Sampling techniques

In each habitat plots, quadrats of size 5m × 5m each were randomly laid with a minimum interval of 250 m between subsequent quadrats. The number of quadrats was decided based on the size of the plot. For easy reference in the field, 20 quadrats per square kilometre of area (which is 5% of the total area) was considered good for quantification of the data and to understand the distribution of trapdoor spiders across the habitat plot. Around 70 quadrats were laid in each location, in the study area, except, Anshi, where only 20 quadrats were laid (Table 3). During the survey in Anshi, not a single spider was recorded in 20 quadrats and therefore, further survey was considered to be insignificant in the same semi-evergreen habitat type. Additionally, there was logistic problem at Anshi and therefore, much time could not be devoted and only one type of habitat was covered.

The area of the quadrat was defined by marking boundaries or edges of the quadrat with a red ribbon with measurement markings of 5m interval. The quadrat was then thoroughly checked for the presence of burrows by systematic searching which involved examination of the most probable or, likely microhabitats within the quadrat, followed by the examination of rest of the area of the quadrat. The suspected microhabitats were actively searched by first removing the leaf litter, if any, with the help of a broom stick, and then sweeping or scratching away the soil cover up to a few millimetres using a scraper to know the presence of trapdoor burrows. Gentle scratching often led to the opening of the lid of burrows and many a times when the scratching action was vigorous it led to the detachment

of the lid. When the trapdoor burrows were not located with the help of scraper and visual search, further confirmation of their absence in the quadrat (especially in very hard soil) was done by removing a big soil lump with a spade. By this method, all the spider burrows (if present) could be located. This method was dominantly practiced only in the areas where no evidence of trapdoor spiders was found or at the time of excavation/collection of a trapdoor burrow / spider. It was usually avoided as the method leads to destruction of active burrows and displacement of spiders.

The number of occupied as well as unoccupied burrows were counted in each quadrat and morphometry like burrow diameter, height and depth, burrow angle, lid diameter and its thickness (if, present) for each burrow was measured. The burrows with spider were considered active burrows and burrows with no spider were considered empty burrows but were still recorded on the datasheet for burrow characterization data. A few burrows were excavated to examine their orientation, shape and collect spider for confirmation of the species. Burrow and lid shapes were drawn on a sheet to understand their different shapes and sizes.

From each plot, few adult specimens were collected in polypropylene plastic vials (50ml) or micro-centrifuge tubes (2ml capacity) for confirmation of the species. Each vial was labelled with date and place of collection, quadrat number (like, Q1, Q2...Qn) and a habitat code (a,b,c...), which was keyed to the burrow measurements and all other observations noted in the field datasheet. A few females, found with their egg sacs, were collected in separate vials and labelled. At times exuvia found inside excavated burrows were also collected for confirmation of the genus. After bring the spiders at the base camp, pictures of all the spiders were taken with the help of Lumix FZ28 camera, after which, all the collected specimens including egg sacs were preserved in 70% alcohol (ethyl alcohol) with a proper label to the vial. Identification of the species was done by dissecting and examining the female spermathecae and male palp organ under a stereomicroscope and comparing various taxonomic characters with the descriptions of known species (Pocock, 1900, Gravely, 1915, 1935, Raven, 1985, Siliwal *et al.*, 2010).

The burrow characterization was followed by habitat and microhabitat characterization which involved noting down ecological parameters like, canopy cover, vegetation cover, rock cover, aspect, bund height, soil type and texture. The canopy, vegetation and rock cover observations were based on visual estimation. The aspect,

elevation, latitude and longitude readings were taken at the center of each quadrat, using the Etrex high sensitivity GPS (Global Positioning System).

The natural history information including habitat and burrow characterization presented in the report is based on all spiders observed during the study (n= 430, including, juveniles, sub-adults and adult females).

ANALYSIS

Habitat characterization:

For habitat characterization only active burrows were considered for analysis to reduce the ambiguity in analysis. To see the habitat preference by trapdoor spider different habitat variables like mean canopy cover, vegetation cover, rock cover and bare ground, and altitude for all active burrows were compared across different habitats. Further, the spider density was calculated and compared across all habitat types.

Burrow characterization:

The burrow parameters were analyzed using the software, SPSS, Statistical Package for Social Sciences, version 15. The female and juvenile burrow diameter, depth and lid thickness data was tested for normality by one sample Kolmogorov-Smirnov test, followed by testing for the level significance through the Mann-Whitney U test. Similarly, the difference in structure of female and juvenile burrows was also tested across different habitats, using Kruskal-Wallis H test. On the basis of these tests, the trapdoor spiders burrow characteristics were explained.

RESULTS

TAXONOMY

The spider was initially identified as *Idiops bombayensis* (Siliwal *et al.*, 2005) based on the spermatheca structure of female spider, which was similar to that of species *I. bombayensis* but when the male specimen collected from the study area was compared with that of *I. bombayensis*, the shape of its tibial spines did not match with *I. bombayensis*. It is likely to be a new species but further confirmation needs to be done by comparing the collected specimens with other known *Idiops spp*. and it will be published separately in a peer reviewed journal. Therefore, in this thesis the trapdoor spider has been referred as *Idiops sp.*

ABUNDANCE

During the study, burrows occupied by adult and/or nesting females, juveniles and sub-adults were found. Males are usually wanderers and difficult to locate in burrows and therefore, only one sub-adult male spider was found and collected from its burrow, which later moulted to a male in the vial. The *Idiops sp.* was found in all habitats sampled during the study, with maximum occurrences in agriculture fields, while least in semi-evergreen forest habitat type (Table 4). The species occurred in 82 of the total 313 quadrats laid. A total of 554 burrows were found in the study area, out of which 430 were active burrows (Table 4). High number of active burrows (n= 101) were recorded in agriculture fields, followed by mixed forests and teak plantations (n=87), whereas, least number of burrows (n= 9) was recorded in semi-evergreen forest. Maximum number of burrows (n=121), were found in human settlement areas, whereas minimum number of burrows (n= 9) were found in semi-evergreen forests (Table 4). The spider density was highest in human settlement areas (0.103/sq. m), followed by teak plantations (0.084/sq. m), agriculture fields (0.064/sq. m), mixed forest (0.05/sq. m), moist deciduous forest (0.02/sq. m) and least density was recorded in semi-evergreen forest (0.006/sq. m) (Table 4).

HABITAT CHARACTERIZATION

The results show that the preferred canopy cover ranged from 10-29% except for the semi-evergreen, where 60% of canopy cover was recorded with occurrence of only 9 spiders (Table 5). The vegetation cover, rock cover and bare ground are characteristics of habitat surrounding the burrows and their comparison shows that habitat surrounding of the burrows were largely bare ground, ranging from 73-90%, except for the semi-evergreen habitat type where percent bare ground was low. Instead, in semi-evergreen habitat the percent vegetation cover was exceptionally high (53.5%) (Table 5). The rock cover was insignificant across all habitat types (Table 5). The maximum number of burrows were found on south facing slopes, south-east (n= 90) and south-west (n= 112) (Table 6). This may be due to the reason that the general aspect of the locations under study area was south.

BURROW CHARACTERIZATION

Burrow structure/ morphology:

The *Idiops sp.* constructed simple tube-like burrows with a 'D'-shaped trapdoor. All occupied or, active burrows possessed fresh silk-lining and were attached with a hinged lid, but in unoccupied old burrows the silk was worn-out (or, completely degraded) and lid was generally missing.

The architecture of door of burrows of the *Idiops sp.*was variable. The species was found to construct two types of doors, "cork"-shaped door and "wafer"-type door. The "cork"-type door was very thick (3-7 mm), rigid and bevelled to fit the opening exactly. This type of lid possessed a higher degree of silk lining on the inner lid surface and claw and fang marks on the inner surface silk were clearly visible. Amongst all the burrows, a common pattern of silk thread arrangement was observed on the inner lining in the lid, silk threads were always knitted in a direction parallel to the hinge, on the under surface of the lid. The other type of trapdoor was thin (1-2.5 mm), "wafer"-type door, which appeared to be an easily constructed sheet of silk and soil adhering on the outerside. This type of door possessed a lower degree of silk lining, drawn in 'D'-shape, appearing to be more delicate and non-rigid.

The top of the door, irrespective of the thickness of door, was usually found to be rough, covered with dry or green moss which made burrows highly camouflaging with their surroundings, and helped in fooling prey as well as predators, thereby, making it a very effective trap and shelter. The extra debris extending from the edges of the upper surface of the lid adds to the sensing radius of the burrow. The lid, sometimes, also possessed a small raised 'cuff' or, 'hook' carved as a mound of soil particles mixed with some debris, like dry moss or grass. The place of attachment of lid to the burrow entrance was in directions, left, right, up or down, with respect to the observer. The entrance rim of the burrow was either levelled with the outer surface of the substrate or, extended up to a few millimetres (1-4 mm) above it. This silk-lined extension was usually wider in cork-type lids and perhaps served to provide physical support to the lid.

Further, all excavated burrows were observed to possess one of the three types of shapes, straight, gently curved and C-shape. This was probably determined by the soil texture and root network of plants in the microhabitat.

Burrow and bund height:

The trapdoor burrows were found on steep (90°) as well as on gentle slopes (45°) and vertical flat ground (less than 10°). Out of total 430 active burrows 357 burrows were present on steep slopes (90°), 52 burrows on vertical surface (less than 10°) and 21 burrows on gentle slopes (45°) (Table 7). On steep slopes, they were located at an average height of 0.8 m, on vertical surfaces at an average height of 0.1m and on gentle slopes at an average height of 0.9 m (Table 7). On vertical/steep slopes (90°) in open and exposed habitats, like periphery of an agriculture field and human habitation, a congregation of trapdoors was observed. However, such congregation of trapdoors was not observed on flat ground in all the habitats and on slopes (gentle to steep) in closed canopy habitats, like semi-evergreen forests and part of mixed forests.

The trapdoor burrows were found at different heights ranging from 0 to 1.8 m on various substrates like vertical bunds (height range: 0.9 to 3.7 m), soil deposits at the base of tree trunks (height range: 0.1 to 1.2 m) and flat ground (height: 0.0m). They were also occasionally observed on termite hills (height range: 0.3 to 0.7 m) and tree trunks with soil deposits (height range: 0.2 to 1.2 m).

Burrow diameter, burrow depth and lid thickness:

The burrow diameter ranged from 2 to 18 mm and the depth of burrows ranged from 10 to 185 mm among the observed active burrows. The burrow diameter was found to be almost constant throughout the descending depth of the burrow but burrows of most of the gravid or nesting females gradually wider at the bottom, where female sat holding its egg-sac.

It was expected that diameter of female and juvenile burrows would be different but, it was not known that their burrow depths and lid thickness would have any difference. Therefore, the Mann-Whitney U test was performed and it was found that the female burrow diameter, burrow depth and lid thickness were all significantly different from juvenile burrow diameter, burrow depth and lid thickness. The burrow diameter is perhaps in proportion of the body size of spider, and hence, the mean diameter of female burrows (78.5 mm) was more than the mean diameter of juvenile burrows (29.2 mm). Similarly, the mean depth of female burrows (72.6 mm) was more than the mean depth of juvenile burrows (35.7 mm) and the mean lid thickness of female burrows (60.2 mm) was more than the mean lid thickness of juvenile burrows (49.3 mm) (Table 8). However, in the present study, information on body size could not be taken due to time constraints, and therefore, these need to be further confirmed.

The difference in structure of female and juvenile burrows was also tested across different habitats, using Kruskal-Wallis H test which showed that differences in female burrow diameter, depth and lid thickness were significant but differences in juvenile burrow diameter, depth and lid thickness were not significant.

The mean diameter of female burrows was higher, 11.2 mm and 9.9 mm, in open habitats like, human settlements and agriculture respectively than the mean diameter of female burrows, 6.6 mm and 8.5 mm, in closed habitats like, semi-evergreen forest and mixed forest respectively (Table 8). This variation in burrow diameter seems to be irrespective of the habitat type and instead relates to their body sizes.

The mean depth of female burrows, 77.9 mm and 74.2 mm, was found to be more in open habitats, like human settlements and teak plantations respectively than the mean depth of female burrows, 40.4 mm and 70.5 mm, in closed habitats like semi-evergreen forest and mixed forest respectively. Similarly, the mean lid thickness of female burrows, 2.3 mm and 2.8 mm, was found to be more in human settlements and mixed forest respectively as

compared to the mean lid thickness of female burrows, 1.4 mm and 1.5 mm, in semi-evergreen and moist deciduous forest respectively (Table 8). The differences in juvenile burrow diameter, depth and lid thickness were not significant across different habitats because probably, the burrow morphology varies at every stage of development (moult).

ASSOCIATED SPECIES

The species *Idiops sp.* was not found to be syntopic (living side by side with other species or with any other mygalomorph spider). This non-syntopic behaviour of trapdoor spiders is supported by the Gause's Hypothesis of Competitive Exclusion, according to which, complete competitors cannot co-exist. Only once, an active juvenile burrow and an empty burrow were observed with a species belonging to the family Dipluridae and, a few empty burrows of the species were also located in close proximity with *Plesiophrictus* and *Thrigmopoeus* species.

DISCUSSION

ABUNDANCE

The high spider density in human settlements was because of clumped distribution of spiders in these areas, and moreover, these settlements are located inside forest (Wildlife Sanctuary and Reserved forest). Similar observations were also recorded in *Ummidia* trapdoor spider (Ctenizidae) from Costa Rica, where majority of burrows were also located on the non-forested grounds or, very young secondary growth forest (Bond & Coyle 1995). It is probably that trapdoor spiders in general prefer drier/open areas over wet/closed canopy areas. In present study, it is reflected by the presence of least number of burrows/density in semi-evergreen and moist deciduous forest (Table 4). Though their densities were found to be high in human settlements, agriculture fields and teak plantations, which is mainly because of clumping/congregation of burrows in small patches, but overall the distribution in these habitats was low. But when distribution of spiders across various quadrats is considered then the most preferred habitat seems to be mixed forest as spiders were present in 50% of the total quadrats laid. Whereas, spiders were found in only18%, 23% and 27% of total quadrats laid in agriculture fields, teak plantations and human habitations respectively (Table 4).

HABITAT CHARACTERIZATION

Canopy Cover:

The result shows that the preferred canopy cover ranges from 10-20%, as depicted by highest number of burrows (Table 5). With increase in canopy cover the number of burrows decreased (Table 5). When the canopy cover is high the soil moisture increases due to less penetration of sunlight and probably these trapdoor spiders do not prefer such microhabitats. This could be one of the reasons for low number of burrows in moist deciduous and semi-evergreen habitats (Table 5). It is also reflected in results by presence of high number of burrows in dry and open areas, like human settlements, teak plantations, agriculture and mixed forest (Table 5).

Vegetation Cover:

The *Idiops sp.* were found more in habitats with low vegetation cover, ranging from 10 to 30%, which could be due to ease of construction and later widening of burrows. With increase in vegetation cover, the network of roots in soil increases which could obstruct the construction and widening of burrows. This is further supported by the presence of least number of burrows in semi-evergreen forest where the vegetation cover was high (Table 5).

BURROW CHARACTERIZATION

Burrow structure/ morphology:

The upper surface of the trapdoor burrow lid in *Idiops* were having dry moss and soil particles, it is a general camouflaging behaviour and is found to be common in trapdoor spiders of the family Idiopidae as well as other families like Ctenizidae, Barychelidae and Nemesiidae (Bond & Coyle, 1995). Addition to this, it is likely that there are some variations in lid characteristics amongst the genera and families. Bond and Coyle (1995) reported presence of irregular tabs of silk along with the plant material on the upper surface of the burrow lid of *Ummidia* trapdoor spider. However, such tabs of silk were not observed in the *Idiops*. Also, function of these tabs of silk is not known.

The inner surface of the trapdoor burrow lid in *Idiops* were found to be covered with silk and this silk lining was not always continuous with the door hinge or entrance rim. Whereas, studies on *Ummidia* trapdoor reported that inner surface of the burrow lid was covered with a thick layer of silk, which was continuous with the entrance rim and burrow lining (Bond & Coyle 1995. Moreover, the direction of the attachment of the lid with burrow was tilted well away from the horizontal and only some were horizontal or, vertical (Bond & Coyle 1995). Whereas, in *Idiops sp.* most of the burrow lids were attached to the burrow either horizontally or vertically and rarely tilted.

Interestingly, active burrows of Idiops were also found in the forest fire line. Main (1981) also reported similar observations in *Anidiops villosus* (Rainbow, 1914), spiders in their burrow were found during the fire and the post-fire environment, with reduced shade and litter (Main 1995). During the present study, few burrows of *Idiops sp.* were also found in fire line areas of forest, which probably indicates the high degree of protection provided by trapdoor burrows against environmental threats, like fire.

Burrow and bund slope

There could be some correlation between burrow and bund slope and probably it is related to the habitat and soil morphology. *Ummidia* sp. burrows were found only on steep slopes (60-90°) of earthen banks and never sighted on gentle slopes or level ground. Their apparent preference for steep banks was the result of heavy rains experienced by them in Costa Rica (Bond & Coyle 1995). Whereas, in the present study, the *Idiops* sp. was found to occur on both, steep slopes (90°) and gentle slopes (45°) or level ground. Though, the preference was steep and gentle slopes (Table 7). This was probably due to soil type and amount of rainfall in this area. Data on soil morphology and rainfall data is not available for this area and therefore, cannot correlate these parameters in detail. However, high number of burrows occurred on bunds and such location perhaps allowed the spider to escape from excess rain water which may otherwise easily flood into the vertical burrows.

Burrow diameter, burrow depth and lid thickness

The diameter of burrow seems to be in proportion to the body size of spider so that the spider can easily enter or exit and conveniently capture its prey. And therefore, burrow diameter of female burrows was greater than the diameter of juvenile burrows (Table 8). Coyle (1971) stated that in most Antrodiaetids and many other burrowing mygalomorphs, the posterior end of the burrow is mostly larger in diameter than the rest of the burrow, possibly an adaptation to allow space for turning around, ensnaring prey, molting, keeping egg-sacs, and spiderlings. But in *Ummidia* spp., the burrow diameter was found to be fairly constant throughout each burrow's length (Gertsch, 1979; Bond & Coyle, 1995). In case of the *Idiops* sp., considerable variation was observed in the burrow diameter of gravid or, nesting females, throughout the burrow length of some trapdoor burrows. No such variation is reported to occur in any of the trapdoor spiders.

The depth of female burrows was found to be significantly greater in open and exposed habitats (Table 8) which may be due to the reason that these spiders construct deeper burrows with thick cork-shaped lids in open and exposed areas to escape excess heat and high

temperature, in contrast to the closed or covered areas, where temperature is more or less stable.

The lid thickness of burrows across different habitats was found to be varying in accordance to the microhabitat conditions (Table 8). The lids of burrows in open and exposed areas were found to be thicker than in covered microhabitats, which may be in response to the external microclimatological conditions. The thicker lids probably help the spider to escape excess heat and to maintain a constant suitable temperature inside the burrow during hot and dry summers. Decae (1991) also found that burrows in open, exposed and dry habitats were deeper and had thick, tightly fitting lids than burrows found in more shady, humid forest habitat where trapdoors were thin and flexible. Similarly, Main (1976) also reported in the Australian trapdoor spider genus *Aganipinnae* (family: Idiopidae) that the morphology of burrows differed across different habitats.

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Table1: List of members of the family Idiopidae reported from India.

S.No.	SPECIES
1	*Idiops designatus* O. P.-Cambridge, 1885
2	*Idiops fortis* (Pocock, 1900)
3	*Idiops fossor* (Pocock, 1900)
4	*Idiops garoensis* (Tikader, 1977)
5	*Idiops madrasensis* (Tikader, 1977)
6	*Idiops bombayensis* (Pockock, 1900)
7	*Idiops constructor* (Pocock, 1900)
8	*Heligmomerus prostans* (Simon, 1892)
9	*Heligmomerus barkudensis* (Gravely, 1921)
10	*Heligmomerus biharicus* (Gravely, 1915)
11	*Scalidognathus montanus* (Pocock, 1900)

Table 2. List of some plant species occurring in the moist deciduous forest of North Karnataka (Champion & Seth, 1968)

Floristic Group	Plant's Name
Top canopy trees	*Adina cordifolia*, Grewia tiliaefolia, Madhuca indica, Dillenia pentagyna, Cinnamomum sp., Litsea sp., Olea dioica*, etc.
Second storey trees	*Emblica officinalis, Xylia xylocarpa, Zizyphus rugosa, Cyclea, Acacia concinna* etc.
Bamboos	*Bambusa arundinacea, Dendrocalamus strictus.*
Shrubs	*Tabernaemontana*

*the species is particularly characteristic of the type of forest

Table 3. Total number of quadrats sampled in each location

S. No.	Location	Total no. of quadrats
1	Kulgi	76
2	Potoli	64
3	Joida	85
4	Kumbarwada	68
5	Anshi	20

Table 4. Density of spiders recorded in the six different habitat types

S. No.	Habitat Category	Total quadrats	Quadrats with spiders	No. of female burrows	No. of male burrows	No. of juvenile burrows	Total active burrows*	Total area covered (sq.m)	Density (per sq. m)	No. of nesting females	No. of empty burrows
1	Mixed forest	66	33	41	0	46	87	1,650	0.05	5	27
2	Moist deciduous forest	41	10	11	0	14	25	1,025	0.02	2	21
3	Semi-evergreen forest	55	4	46	0	55	9	1,375	0.006	12	0
4	Teak plantation	41	11	7	0	2	87	1,025	0.084	0	0
5	Human settlements	47	13	41	1	45	121	1,175	0.103	0	0
6	Agriculture fields	63	11	42	0	79	101	1,575	0.064	1	76
	Total	**313**	**82**	**188**	**1**	**241**	**430**	**7,825**	**0.055**	**20**	**124**

Table 5. Total number of active burrows and mean canopy, vegetation and rock cover

Habitat type	Total active burrows	Elevation range	Canopy cover (%)	Vegetation cover (%)	Rock cover (%)	Bare ground (%)
Mixed forest	87	490-655	18.0	22.6	0.2	77.2
Moist deciduous forest	25	468-631	28.8	22.4	0.1	77.4
Agriculture fields	101	522-615	12.0	10.8	0.3	88.8
Semi-evergreen forest	9	521-682	59.8	53.5	0.1	46.4
Teak plantation	87	499-626	10.4	26.0	0.0	73.4
Human settlements	121	497-634	16.9	9.7	0.0	90.3

Table 6. Number of burrows in different aspects

S. No.	Burrow Aspect	Total no. of active burrows
1	E	18
2	N	8
3	NE	60
4	NW	77
5	S	4
6	SE	90
7	SW	112
8	W	4

Table 7. Total number of active burrows on different slopes.

Slope of bund (in degree)	Total active burrows	Bund height (m)	Burrow height on bund (m)
90	357	1.2	0.8
45	21	1.2	0.9
Less than 10	52	0.2	0.1

Table 8. Mean burrow diameter & depth for 10 female and 10 juvenile burrows in each habitat type.

S. No.	Habitat	Female			Juvenile		
		Burrow diameter (mm)	**Burrow depth (mm)**	**Lid thickness (mm)**	**Burrow diameter (mm)**	**Burrow depth (mm)**	**Lid thickness (mm)**
1	Mixed forest	8.5 ± 2.6	70.5 ± 18.0	2.8 ± 3.3	4.1 ± 0.9	45.5 ± 6.4	1.3 ± 0.4
2	Moist deciduous forest	8.8 ± 3.5	72.9 ± 42.2	1.5 ± 0.8	4.5 ± 1.1	39.3 ± 7.4	1.4 ± 0.5
3	Agriculture fields	9.9 ± 3.3	67.5 ± 23.5	1.2 ± 0.3	4.3 ± 0.7	45.0 ± 8.5	1.5 ± 0.4
4	Semi-evergreen forest	6.6 ± 2.1	40.4 ± 11.6	1.4 ± 0.5	5.0 ± 1.4	47.5 ± 10.6	1.8 ± 0.4
5	Teak plantation	9.6 ± 1.6	74.2 ± 33.1	2.6 ± 1.1	4.1 ± 1.3	38.7 ± 5.7	1.4 ± 0.5
6	Human settlements	11.2 ± 1.9	77.9 ± 32.6	2.3 ± 1.1	4.1 ± 0.7	42.0 ± 5.4	1.4 ± 0.5

PLATE 1

A. Mixed forest.

B. Semi-evergreen forest.

PLATE 2

A. Teak Plantation

B. Agriculture field

PLATE 3

A. Female with an egg-sac

B. Female with an egg-sac in its excavated burrow

PLATE 4

A. Trapdoor spider in its burrow

B. Cluster of trapdoor burrows

PLATE 5

A. Excavated trapdoor burrows at the base of tree trunk

B. Sampling within a quadrat area

Chilobrachys fimbriatus Pocock,1899
Fimbriated Striated Burrowing Spider
Least Concern

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Haploclastus kayi Gravely, 1915
Parambikulam Large Burrowing Spider
Endangered

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Thrigmopoeus insignis Pocock,1899
Notable Large Burrowing Spider
Vulnerable

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Thrigmopoeus truculentus Pocock,1899
Karwar Large Burrowing Spider
Near Threatened

Red Listed Western Ghats Tarantulas

Only females are depicted

Poecilotheria regalis Pocock,1899
Regal Parachute Spider
Least Concern

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Poecilotheria striata Pocock,1895
Striated Parachute Spider
Vulnerable

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Poecilotheria rufilata Pocock,1899
Reddish Parachute Spider
Endangered

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WILD / ZOO Poster # 34 (August 2010)

CRITICAL ECOSYSTEM PARTNERSHIP FUND

Project Title: Tarantula (Araneae: Theraphosidae) spider diversity, distribution and habitat-use: A study on Protected Area adequacy and conservation planning at a landscape level in the Western Ghats of Uttara Kannada district, Karnataka
Grantee name: Dr. Manju Siliwal

List of Mygalomorph spiders from different project sites of Uttara Kannada District

- **Mygalomorph spiders for Anshi National Park**
  - *Thrigmopoeus insignis* Pocock, 1899
  - *Thrigmopoeus truculentus* Pocock, 1899
  - *Chilobrachys fimbriatus* Pocock, 1899
  - *Euphrictus sahyadri* (new species and new record)
  - *Eurphrictus* sp. (new species)
  - *Idiops* sp. (new species)
  - *Plesiophrictus* sp. (new species)
  -
- **Mygalomorph spiders for Dandeli Wildlife Sanctuary**
  - *Poecilotheria striata* Pocock, 1899
  - *Thrigmopoeus insignis* Pocock, 1899
  - *Thrigmopoeus truculentus* Pocock, 1899
  - *Chilobrachys fimbriatus* Pocock, 1899
  - *Euphrictus sahyadri* (new species and new record)
  - *Eurphrictus* sp. (new species)
  - *Tigidia sahyadri* (new species, new record)
  - *Indothele* sp. (new species)
  - *Idiops* sp. (new species)
  - *Plesiophrictus* sp. 1(new species)
  - *Plesiophrictus* sp. 2 (new species)

- **Mygalomorph spiders for Dandeli Hornbill Conservation Reserve**
  - *Poecilotheria striata* Pocock, 1899
  - *Thrigmopoeus insignis* Pocock, 1899
  - *Thrigmopoeus truculentus* Pocock, 1899
  - *Chilobrachys fimbriatus* Pocock, 1899
  - *Euphrictus sahyadri* (new species and new record)
  - *Eurphrictus* sp. (new species)
  - *Tigidia sahyadri* (new species, new record)
  - *Indothele* sp. (new species)
  - *Idiops* sp. (new species)

- **Mygalomorph spiders for Bedthi Hornbill Conservation Reserve**
  - *Thrigmopoeus truculentus* Pocock, 1899 (Near Threatened)
  - *Chilobrachys fimbriatus* Pocock, 1899 (LC)
  - *Indothele* sp. (new species)
  - *Idiops* sp. (new species)
  - *Plesiophrictus* sp. (new species)

- **Mygalomorph spiders for Aghanashini LTM Conservation Reserve**
  - *Thrigmopoeus truculentus* Pocock, 1899 (NT)
  - *Chilobrachys fimbriatus* Pocock, 1899 (LC)
  - *Idiops sp.* (new species)
  - *Plesiophrictus* sp. (new species)