The Rufford Foundation
Final Report

Congratulations on the completion of your project that was supported by The Rufford Foundation.

We ask all grant recipients to complete a Final Report Form that helps us to gauge the success of our grant giving. The Final Report must be sent in **word format** and not PDF format or any other format. We understand that projects often do not follow the predicted course but knowledge of your experiences is valuable to us and others who may be undertaking similar work. Please be as honest as you can in answering the questions – remember that negative experiences are just as valuable as positive ones if they help others to learn from them.

Please complete the form in English and be as clear and concise as you can. Please note that the information may be edited for clarity. We will ask for further information if required. If you have any other materials produced by the project, particularly a few relevant photographs, please send these to us separately.

Please submit your final report to jane@rufford.org.

Thank you for your help.

Josh Cole, Grants Director

Grant Recipient Details	
Your name	Tomás M. Rodríguez Cabrera
Project title	Ecology and conservation of the endemic scorpion genus *Tityopsis* in native forests of western Cuba (II)
RSG reference	19261-2
Reporting period	April, 2016–April, 2017
Amount of grant	£5000
Your email address	tomasmichel.rodriguez@gmail.com
Date of this report	April 12th, 2017

1. Please indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
To continue gathering crucial information on the ecological requirements and distribution of the different *Tityopsis* species				- We completed a large dataset on the habitat requirements of *Tityopsis* across the entire distribution range of the genus and on all the threats both natural and anthropogenic affecting the different populations. - We initially proposed to apply ecological niche modelling to assess the potential distribution and future trends of each *Tityopsis* species. However, our original classification into different morpho-species following traditional taxonomy might change after genetic analysis, which would introduce some errors when delimitating species boundaries and impose some bias to ecological niche modelling. Therefore, we decided to do this work after having obtained the genetic results, once we have a clearer big picture on the species boundaries.
To collect tissue samples for further genetic studies				- Over 150 tissue samples for further genetic studies are currently awaiting permits to be shipped to a lab at Eastern Connecticut State University, Willimantic, Connecticut, USA, where they will be sequenced.
To continue developing a campaign to raise awareness and promote the long-term conservation of these scorpions and associated habitat in Cuba				- We brought our education work to other important protected areas and local communities not covered during the first project. - We reduced some costs of education activities in order to save money for an unforeseen expedition to Isla de la Juventud.

2. Please explain any unforeseen difficulties that arose during the project and how these were tackled (if relevant).

After the experience of the first project this second one presented even less difficulties.

We saw the opportunity to carry out an expedition to Isla de la Juventud, the second largest island of the Cuban Archipelago, and we did not miss that chance. Because of the shared geology and past land connection (Quaternary) between western mainland Cuba and Isla de la Juventud, many groups have representatives on this island that is why we suspected *Tityopsis* could exist there. However, despite our intensive and extensive search all across the island, we were unsuccessful in finding evidences of the presence of the genus there.

3. Briefly describe the three most important outcomes of your project.

1) We revisited most localities covered during the first project and other new ones not previously visited by us and/or represented in museum collections only. We collected both ecological data and a total of 154 tissue samples for further genetic studies, from 54 localities representative of the entire *Tityopsis* range (averaging five samples per locality); about 50 samples over the 100 ones originally proposed. We also collected critical biotic and abiotic variables, particularly in new localities and those ones visited only during the dry season in the first project. We corroborated *Tityopsis* habitat preferences: despite they can tolerate some levels of habitat disturbance, they can't occur in completely deforested areas. Scorpions in this genus shelter mainly under rocks and in the leaf litter (occasionally in caves), and are strongly dependent on a high relative humidity (> 85%) and shaded situations (> 75% canopy coverage). However, during this project we found the first population inhabiting in dry serpentine shrubwood (northeast of Mayabeque province), an open primary vegetation with high average hours of daily sunshine (relative humidity < 40% and canopy coverage 25-30%), kind of atypical according to our observations on *Tityopsis* so far. This population is pending of genetic analysis to confirm its taxonomic identity. During our trip to Isla de la Juventud we were unsuccessful in finding *Tityopsis*, but instead we discovered the first population for this island of another endemic scorpion (*Heteronebo bermudezi*), which served to fill important distribution gaps and amend its taxonomy. With this last finding the number of Cuban scorpion species raised to 56 (91% endemic). We also obtained the first data on the diet of *Tityopsis*: one specimen from the Santa Cruz river canyon, Sierra del Rosario, was found preying on a centipede (Geophilomorpha) and another from Guanahacabibes Peninsula was found preying on a bug (Cydnidae). This can help in estimating the importance of prey availability and abundance for the occurrence of *Tityopsis* in a particular habitat. With all this ecological data we are almost ready to implement ecological niche modelling, but only after the genetic results, once we know well the species distribution boundaries.

2) We collected a sample of 10 immature females from a population suspected to exhibit a parthenogenetic reproductive mode (Guanahacabibes Peninsula). They were taken to captivity and kept isolated in separate containers with towel paper as

substrate, and relative humidity was kept above 90%. We offered an appropriate-sized mealworm once a week. All the females underwent the last moult and reached adulthood. After a few months (about 3 months during the summer) they showed clear signs of full pregnancy. Although some of them died before having birth, probably because of some parameters out of our control, this is a strong evidence of a parthenogenetic reproductive mode, joined to the fact that all individuals found so far in that population were females. Other populations like that from Zapata Swamp could be in a similar situation. As pointed out in our Final Report of the first project, a parthenogenetic reproductive mode imposes an extra threat for the species, because of a reduced genetic variability and thus more vulnerability to stochastic events. We corroborated that the main threats affecting *Tityopsis* populations is habitat and microhabitat loss by many different causes: 1) deforestation, 2) increase of touristic activity, 3) the continuous advance of human settlements, 4) the soil alteration and probable predation by domestic and feral pigs, 5) forest fires, and probably 6) climate change.

3) We continued our educative campaign in local communities and protected areas of western Cuba, making emphasis in those ones not included during the first project. We also produced and distributed posters and colour field guides promoting the knowledge and conservation of *Tityopsis* and other Cuban endemic scorpions. Additionally, we made an oral presentation of the project's results in the annual regional symposium "BiodiverSOS 2016", hold at the Sancti Spíritus Botanical Garden, central Cuba, and distributed educative material to most participants.

4. Briefly describe the involvement of local communities and how they have benefitted from the project (if relevant).

Most people in this country are able to recognise 2-3 scorpion species out of the 56 at the most. This second project helped us to continue teaching local community people about the diversity and importance of Cuban scorpions and how to protect them. Now people from some of the most important areas for *Tityopsis* at least know that some kind of tiny scorpion inhabiting the forests surrounding them is very important to keep the balance in natural ecosystems. Also, they learned that the venom of other Cuban endemic scorpion, *Rhopalurus junceus*, is being used in pharmacology to relieve cancer pain in humans. However, continuation is the key for success in terms of education, and this work laid the foundations to jump from a regional campaign to a national awareness-raising campaign to preserve Cuba's scorpion fauna. This campaign will include the use of audio-visual aids in the future to improve the reach of our conservation message.

5. Are there any plans to continue this work?

Yes. We plan to extend this work to other regions of Cuba and include other endemic scorpions with similar conservation problems as *Tityopsis*, such as most species in the endemic forest-dwelling genus *Alayotityus* (eight species restricted to eastern Cuba), the monotypic endemic genus *Cryptoiclus* (known from a single locality near Baracoa, eastern Cuba), and most species in the genera *Microtityus*, *Cazierius*, *Centruroides*, and *Rhopalurus*.

6. How do you plan to share the results of your work with others?

We are currently preparing an article to be published in a peer reviewed journal formally describing all new species of *Tityopsis* discovered during these two projects funded by The Rufford Foundation. Also, once we have the genetic results we will analyse and publish another article on the phylogeny and phylogeography of the genus *Tityopsis*, combined with ecological niche modelling. Finally, once the taxonomy of the genus is clear and we know well the distribution boundaries of the different species, we will reassess the conservation status of each one and propose their inclusion in the IUCN Red List. This way local and national wildlife conservation authorities will be able to implement management actions that includes *Tityopsis* and its associated habitat (primary forests) as important targets for conservation within the National System of Protected Areas of Cuba.

7. Timescale: Over what period was The Rufford Foundation grant used? How does this compare to the anticipated or actual length of the project?

The 2nd RSG grant was used during a 1-year period, starting in April 2016 and ending in April 2017. This matches perfectly with the anticipated length of the project, although we had less activity in the field during the last driest months.

8. Budget: Please provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used.

Item	Budgeted Amount	Actual Amount	Difference	Comments
1 battery replacement for laptop computer	£ 40	£ 40	0	
2 External Hard Disk Device (1Tb)	£ 160	£ 80	£ 80	We purchased only one HDD in order to save money to help in purchasing a new cell phone with GPS
1 Cascade Internal Frame Pack (85L)	£ 80	£ 80	0	
1 Sierra Design Zilla 3-Season Tent	£ 100	£ 100	0	
Shipping of tissue samples	£ 150	£ 150	0	Tissue samples are still pending of permits, when the moment comes (hopefully within the few next months) the money for doing so is save
Travel costs (ticket travel costs, car rent, driver service)	£ 600	£ 800	£ -200	We reallocated some money from education activities for the expedition to Isla de la Juventud

Housing	£ 500	£ 700	£ -200	We reallocated some money from education activities and fuel allowances for the expedition to Isla de la Juventud
Fuel allowances	£ 700	£ 580	£ 120	We looked for the cheapest options in order to save money for the expedition to Isla de la Juventud
Food	£ 650	£ 900	£ -250	We reallocated some money from education activities for the expedition to Isla de la Juventud
Communications	£ 150	£ 150	0	
Internet costs and software	£ 270	£ 270	0	
Education material (i.e., field guides, posters)	£ 1000	£ 500	£ 500	We reduced the costs related to printing in order to save money for other unforeseen activities
Tax for bank transfer and currency exchange (6% of the total budget)	£ 300	£ 519 (10%)	£ -219	The currency exchange rate rapidly dropped since I sent my application to the moment of the grant reception and from that date on
Contingences	£ 300	£ 300	0	Unforeseen costs were related to compensate the currency exchange rate drops and to help in purchasing a new cell phone with GPS
LG cell phone with GPS		£ 125	£ -125	For replacement. The cell phone purchased during the first project to be used as GPS got broken during a field trip
Total	£ 5000	£ 4994	£ 6	

- Currency exchange rate according to the National Bank of Cuba at the moment of application (15 December 2015): £ 1 = 1.4683 CUC (Cuban Convertible Units).
- Currency exchange rate according to the National Bank of Cuba at the moment of grant reception (11 April 2016): £ 1 = 1.3635 CUC (Cuban Convertible Units).
- Tax for bank transfer: £ 34.54 (0.7% of the grant).
- Amount received: £ 4,965.46.
- I kept only £ 1,150 at the moment of reception, the rest of the grant (£ 3,815.46) was changed to CUC (5,200 CUC). Then the currency exchange rate rapidly dropped during 2016 to about £ 1 = 1.2 CUC. The £ 1,150 initially kept as such had to be changed under this last rate: 1,380 CUC. For a total of 6,580 CUC. Total lost because of currency exchange drops: 761.5 CUC = £ 518.6 (10% of the total budget; calculated from the original currency exchange rate).

9. Looking ahead, what do you feel are the important next steps?

We will formally describe all new species of *Tityopsis* in a peer reviewed journal, as well as important information on their natural history and conservation status. This information will be distributed through the Web of Science (WoS) and in every protected area across the distribution range of the genus *Tityopsis*. After that, we will focus our conservation efforts particularly in those *Tityopsis* species with bigger conservation problems, together with other Cuban endemic scorpions.

The tissue samples collected during this project will allow achievement of the first molecular phylogenetic analysis of this Cuban endemic genus. We will also assess for the first time the population genetic structure within *Tityopsis* and will corroborate species boundaries, which is crucial to delimitate conservation units.

Together with molecular analysis we will apply ecological niche modelling to predict potential distribution areas of each *Tityopsis* species and test possible population trends under different future climate change scenarios.

We plan to extend both our research and educative work to other regions of Cuba and include other endemic scorpions with similar conservation problems as *Tityopsis*, such as most species in the also endemic forest-dwelling genus *Alayotityus* (eight species restricted to eastern Cuba), the monotypic endemic genus *Cryptoiclus* (known from a single locality near Baracoa, eastern Cuba), and most species in the genera *Microtityus*, *Cazierius*, *Centruroides*, and *Rhopalurus*.

One of the main goals of this program for the conservation of Cuban endemic scorpions is to gather enough information as to publish "The Red Book of the Scorpions of Cuba", which will serve as a guide for national and international conservation authorities to elaborate effective action plans that guarantee their long-term conservation.

10. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did The Rufford Foundation receive any publicity during the course of your work?

We used The Rufford Foundation logo in every public presentation, poster and field guide we made and distributed during the project period. Also, with the previous consent of both the RSGF and The Mohamed bin Zayed Species Conservation Fund's (MBZ) boards, we are now using some of the equipment obtained with the funds of The Rufford Foundation in another project funded by MBZ also on the conservation of Cuban endemic scorpions: "Ecology and conservation of endemic burrowing scorpion's genus Didymocentrus in central Cuba". So, The Rufford Foundation and The Mohamed bin Zayed Species Conservation Fund shared their logos in every public presentation, poster and field guide resulting from this other project. Also, we properly acknowledged The Rufford Foundation in the paper we recently published reporting the scorpion genus Heteronebo for the first time on Isla de la Juventud.

11. Please provide a full list of all the members of your team and briefly what was their role in the project.

We also acknowledge all those people that facilitated our work in the field during the project: Raimundo López-Silvero, Rosario Domínguez, Armando Longueira, my son Alejandro M. Rodríguez and all those people from protected areas and local communities.

During this project I had the opportunity to collaborate with the grantee Sheila Rodríguez Machado (17653-1), leading a project on Cuban endemic fish. We developed education activities with community people at the Biosphere Reserve Guanahacabibes, westernmost tip of Cuba.

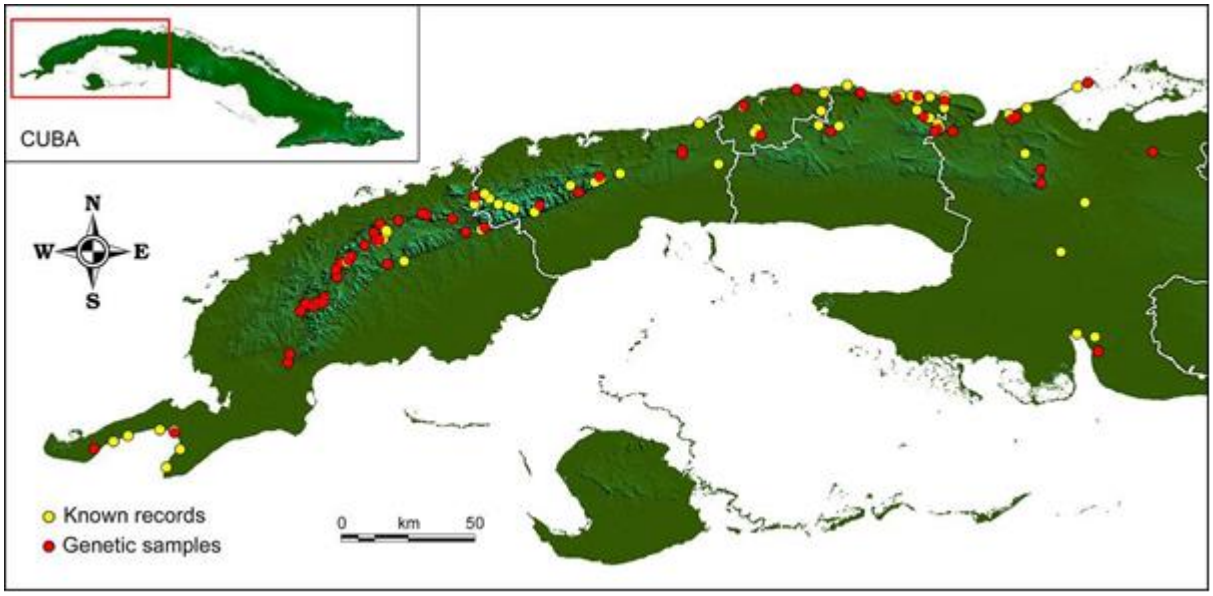
12. Any other comments?

We specially thank one of our referees, Dr Rolando Teruel (BIOECO), who followed very close the progress of our project and made us useful suggestions. Indeed, we published together the paper reporting Heteronebo for Isla de la Juventud and are currently collaborating in describing all the new species of Tityopsis.

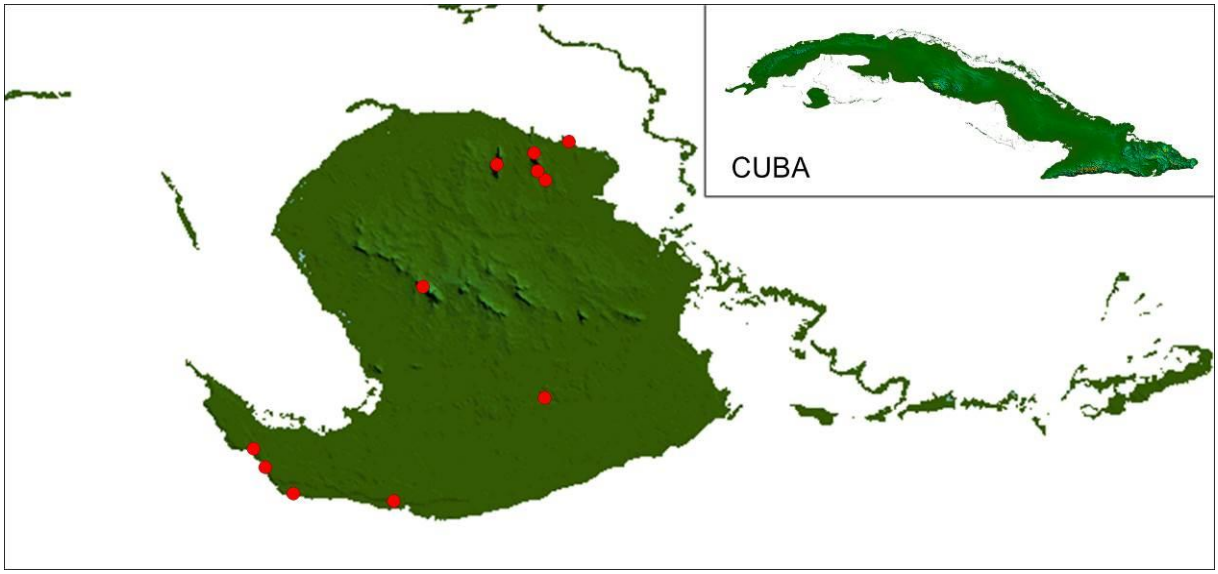
Finally, we wish to thank The Rufford Foundation for supporting this second project, which constitutes another very important step toward the conservation of Cuban endemic scorpions. I really hope the situation with Cuba normalises so we can continue working together.

Appendix

Appendix I. Map of western Cuba depicting the distribution of the endemic scorpion genus Tityopsis, updated after this project. Genetic samples averaged 3-5 per locality.



Appendix II. Map depicting the localities visited during the expedition to Isla de la Juventud, the second largest island of the Cuban archipelago.



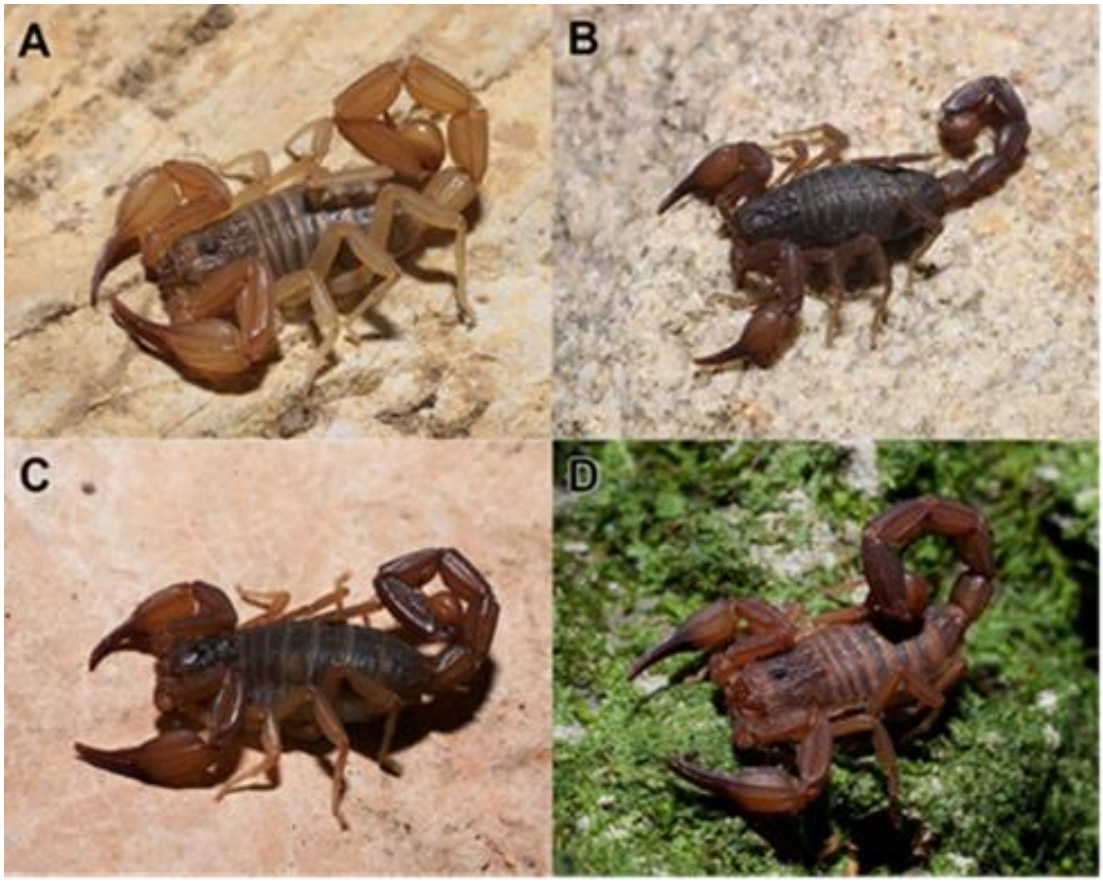
Appendix III. Tissue samples of Tityopsis collected during this project, currently awaiting permits to be shipped to the USA so they can be sequenced for genetic studies.

Appendix IV. Typical forest habitat of Tityopsis in Matanzas province (two above) and the project leader searching for scorpions (two below).

Appendix V. Dry serpentine shrubwood at Cuabales de Galindo, northeast of Mayabeque province (left), the first record of Tityopsis in this type of soil and vegetation, and female of Tityopsis from that locality (right).

Appendix VI. Landscape of the dry serpentine shrubwood at Cuabales de Galindo, northeast of Mayabeque province (above) and the project leader searching for scorpions in this type of vegetation (below).

Appendix VII. Different Tityopsis species from Pinar del Río province (A-C) and Matanzas province (D): A) T. inaequalis from Viñales, B) Tityopsis new species from the slaty soils of Sierra de los Órganos, C) Tityopsis new species from Guane, and D) Tityopsis new species from Sierra de Bibanasí.



Appendix VIII. First dietary cases in the genus Tityopsis: preying on a bug (Cydnidae) at La Bajada, Guanahacabibes Peninsula (left), and preying on a centipede (Geophilomorpha) at the Santa Cruz river canyon, Sierra del Rosario (right).

Appendix IX. The project leader searching for Tityopsis in different localities of western Cuba.

Appendix X. Captive group of Tityopsis under study of reproductive biology, particularly of parthenogenesis (left), and a full pregnant female from Guanahacabibes Peninsula a few months after having reached adulthood (right).

Appendix XI. Female of Tityopsis from Sierra de Guane, Pinar del Río province, carrying its offspring in first instar (left) and second instar (right).

Appendix XI. Education work with local communities (two above) and presentation of the project's results at the annual regional symposium "BiodiverSOS 2016", hold at the Sancti Spíritus Botanical Garden, central Cuba (two below).

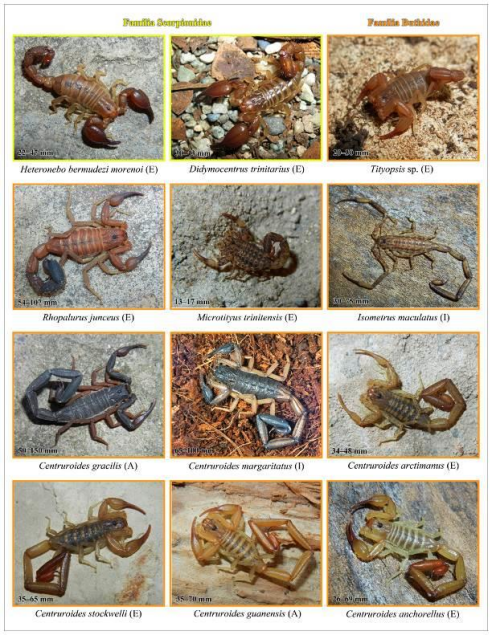
Appendix XIII. Education activity with Biology undergraduates at the Central University of Las Villas, Villa Clara province, showing the results of both this project an another one on the burrowing scorpion genus Didymocentrus, cofounded by The Mohamed bin Zayed Species Conservation Fund.

Educative Material Produced and Distributed During the Project

Poster "Endemic Scorpions of the Genus Tityopsis", in two formats: 20 x 24 in and 12x 16 in.

Poster "Scorpions of South-Central Cuba" (24 x 32 in), in collaboration with The Mohamed bin Zayed Species Conservation Fund.

Poster "Scorpions of the Genus Didymocentrus" (20 x 24 in), in collaboration with The Mohamed bin Zayed Species Conservation Fund.



Field guide on the scorpions of south-central Cuba, in collaboration with The Mohamed bin Zayed Species Conservation Fund.