

Technical Report

Use of Leafhoppers as Biodiversity Indicators in Endangered Forests of the Sierra Madre Del Sur, Mexico

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Introduction

Leafhoppers are a wide insect family widespread around the world but some of these inhabit specific habitat with unique environmental conditions. Mexico one of the richest countries in biodiversity housed innumerable conditions that favor leafhoppers even with endemic genera and species only known in specific regions such as the Sierra Madre del Sur. The Sierra Madre del Sur is widely covered by dense threatened vegetation running along its distribution in isolated areas as Mountain Cloud Forest, Tropical Dry Forest, Pine/Oak Forest, and Rain Forest. No inventory of exclusive endemic leafhoppers within the Sierra Madre del Sur is known so far. Using their potential and specificity to inhabit healthy forest we evaluate this insect family as a model for indicators of conservation.

Materials and methods

Sampling

We followed common quantitative and not-quantitative methodologies to sampling leafhoppers as shown below:

Quantitative

- a) Entomological sweep net
- b) Entomological aspirator
- c) Motorized vacuum

No quantitative

- d) Malaise trap
- e) Flight interception trap
- f) Light trap

Sites of the study were developed-in Michoacán, Guerrero, and Oaxaca states of Mexico. To collect data 11 days were spent each occasion of sampling, 13 times in total.

Insect identification

Two steps were used for taxonomic identification:

1. By eye in fieldwork. Specimens were taken alive using entomological aspirator and identified, counted and labeled in notebook.
2. Taxonomic determination. Using notes of species already determined by eye, four specimens as maximum were collected when possible and stored in 99% ethanol, then males were dissected to corroborate identity in fieldwork, in case of females only generic level is reached and all species were deposited in the Entomological collection of the University of Guadalajara.



Adilson collection with entomological aspirator in Guerrero. © Jose Guillermo



Collecting leafhoppers with entomological sweep net in El Chilar, Santa Maria Zoquitlan, Oaxaca.
© Karina Machuca



Adilson collecting using light trap in Michoacán. © Emmanuel Limon

Results

Of five steps to develop in the project, the first until third are completed, fourth and five are processed for disseminating and publish in scientific journals. Methodology was divided in two sections, phase 1 was successfully completed and phase two is running actually work to be published.

Sampling

a) Leafhopper data

We recorded 1,052 observations of strict-endemic leafhoppers alive from Sierra Madre del Sur. In case of specimens alive, the data were taken by eye and fourth specimens were collected of each species in fieldwork to be submitted to the molecular process.

b) Sampling time scale

Our project was planned to finish it until January 2020, but invaluable help by communities involved working with us in the Sierra Madre del Sur did more success than we can be expected. Also, we spent more time with people than we thought and we were more able to take data than we believed in the project, upper of 70% that we expected. The communities provided us a full-access in almost the whole region and the remarkable support by guides during our duty was efficient every time. We were able to end the fieldwork on July 30, 2019.

c) Area studied

In our initial proposal we included 21 sites of three states: Michoacán, Guerrero and Oaxaca, but invaluable help of communities we sampled 75 sites of 45 municipalities (255% more than we expected initially running the project), see Appendix 1.

Identification of leafhoppers samples

Of 1,052 specimens observed belonging from 35 genera and 36 species, only 68 individuals were collected (Appendix 2).

According with our data, seven species are considered as subject of special protection by habitat reduction of the Mountain Cloud Forest, eleven as data deficient inner Tropical Dry Forest and eighteen no present any risk so far.

Habitat conditions

On each site we wrote notes to generate our dataset to be included in the analysis. Photos of sites sampled were taken.

a) Conservation

- Status of the zone sampled.
- Perturbation of zone.
- Conditions of habitat.
- Availability of resources.

b) Vegetation

- Density of vegetation.
- Kind of vegetation.
- Checklist of plant species *in situ*.

c) Relevant notes

- Scale of risk.
- Personal observations.
- Influence of human activity.



Site of study El Romerito, Mountain Cloud Forest, Guerrero. © Adilson.



Botanist Juvenal Aragon taking samples of plants.

Workshops in local communities

Five official workshops were developed in local communities, Sept 12, Nov 02, and Dec 10 in 2018 and Feb 25 and May 17 in 2019. Subsequently during each fieldwork we organized a small practical activities before go to the mountains.



Our guide Esteban Sierra with his family and Diego and Adilson Pinedo in Yoloxochilt, Guerrero.
© Adilson



Adilson setting up malaise trap with students. © Miguel Vásquez



Morning walking with guides in Cococingo, Guerrero. © Adilson

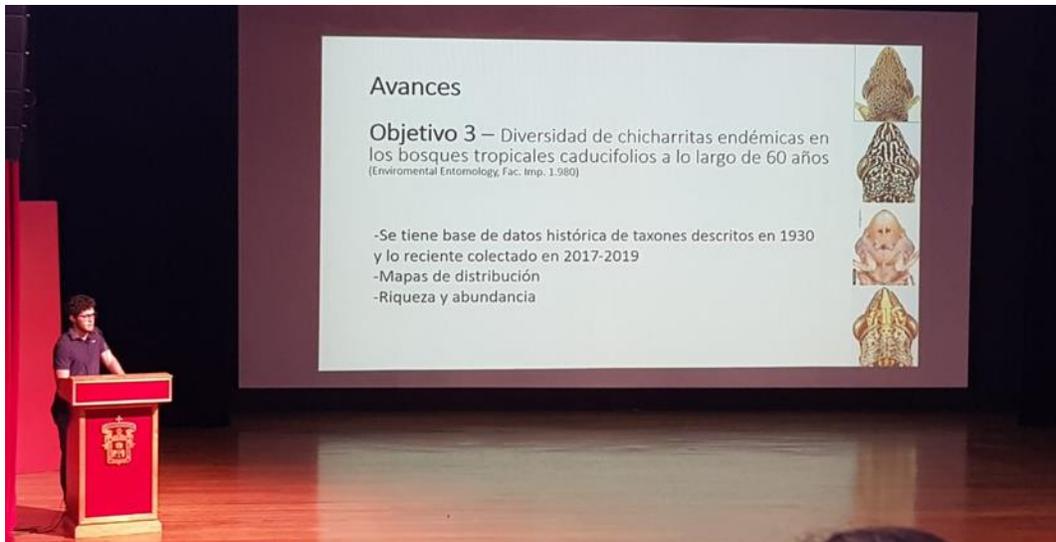
Disseminate notes

One note was already published in Boletín de la Asociación Mexicana Sistemática de Artrópodos [in Spanish]

Talks in National and International events

Three times I talked about the project and showed progress in and success using leafhoppers as model in endangered forest of Sierra Madre del Sur, Mexico, always on behalf of my teamwork and the Rufford Fund

1. October 18, 2018–XX Symposium of Zoology of the University of Guadalajara
2. June 11, 2019–XI Latin American Congress and LIV National Congress of Entomology
3. July 11, 2019–Annual Meeting of Doctorate in Sciences in Biosystematic, Ecology and Management of Natural and Agricultural Resources



Explanation of objective 3 of the project, talk in Annual Meeting of Doctorate in Sciences in Biosystematic, Ecology and Management of Natural and Agricultural Resources, Autlan de Navarro, Mexico. © Rosaura Torres

Scientific publications

Three manuscripts are being developing so far, one includes molecular data recovered from samples taken during our fieldwork, second is including our dataset of condition of the habitat, diversity analysis, and endemism and last is species descriptions.

Future plans

Still work is waiting to be developed, and communities demand more assistance to better understanding of resources using forest and herbivore insects. We planned continue working with communities closely.

Acknowledgements

This project was successfully developed with help by communities in the Sierra Madre del Sur, also their kind support and hospitality during our fieldwork, it never be done without them. To all people involved directly to the project, and insatiable support by Rufford Fund for the opportunity to develop this research.

Team work

- Adilson Pinedo, (University of Guadalajara).
- Gustavo Moya Raygoza (University of Guadalajara).
- James N. Zahniser (USDA, APHIS, PPQ, Washington, USA).
- Liberato Portillo (University of Guadalajara).
- Mildred Torres (University of Enrique Diaz de Leon).
- J. Guillermo Rodríguez (University of Simón Bolívar).
- Edith Blanco Rodríguez (Colegio de Postgraduados, Edo Mexico, Mexico)
- Institute of Botanic of the University of Guadalajara

Appendix 1. Sites sampled

Num	Code site	Coordinates
1	MEXOAX30	16°10'22"N, 96°30'22"W
2	MEXOAX31	16°11'52.012" N, 96°32'4.733"W
3	MEXOAX32	15°49'56.0"N, 96°20'17.4"W
4	MEXOAX33	15°57'18.3"N, 96°04'33.4"W
5	MEXOAX34	16°18'17.4"N, 95°30'16.9"W
6	MEXOAX35	16°26'08"N, 95°52'54.1"W
7	MEXOAX36	16°25'40"N, 95°58'16.8"W
8	MEXOAX37	16°36'52.3"N, 96°23'22.5"W
9	MEXMIC44	19°58'49.51"N, 103° 1'10.59"W
10	MEXGUE56	17°33'37.9"N, 099°41'27.9"W
11	MEXGUE57	17°33'08.2"N, 099°41'58.6"W
14	MEXGUE60	17°32'44.4"N, 099°37'55.0"W
15	MEXGUE61	17°21'19.22"N, 99°27'13.37"W
17	MEXGUE99	18°35'09.1"N, 099°40'22.8"W
18	MEXGUE10 0	18°09'23.3"N, 099°38'41.9"W
19	MEXGUE10 1	18°11'19.4"N, 99°40'36.6"W
20	MEXGUE10 2	18°14'02.7"N, 099°40'38.9"W
21	MEXGUE10 3	18°10'59.6"N, 099°40'24.1"W
22	MEXGUE10 4	18°13'32.0"N, 99°41'37.9"W
23	MEXGUE10 5	18°13'45.3"N, 099°40'36.2"W
24	MEXGUE10 6	18°12'48.7"N, 099°39'46.9"W
25	MEXGUE10 7	18°19'17.2"N, 099°36'54.6"W
26	MEXGUE10 8	18°21'49.0"N, 099°29'03.9"W
27	MEXGUE10 9	18°21'27.0"N, 99°24'39.7"W
28	MEXGUE11 0	18°14'53.9"N, 099°29'09.8"W
29	MEXGUE11 1	18°13'20.5"N, 099°28'48.9"W
30	MEXGUE11 2	18°11'57.3"N, 99°24'31.4"W
31	MEXGUE11 3	18°08'01.9"N, 099°21'23.4"W
32	MEXGUE11 4	18°07'37.0"N, 099°20'33.2"W
33	MEXGUE11 5	18°08'56.0"N, 099°24'29.4"W
35	MEXGUE11 7	18°17'31.6"N, 099°28'27.1"W
36	MEXGUE11 8	18°15'13.4"N, 099°23'05.2"W
37	MEXGUE11 9	18°14'27.6"N, 099°23'08.5"W
38	MEXGUE12 0	18°14'39.5"N, 099°23'15.3"W
39	MEXGUE13 0	18°12'48.7"N, 099°39'46.9"W
40	MEXGUE13 1	18°35'09.1"N, 099°40'22.8"W
41	MEXOAX13 2	16°38'53.1"N, 096°04'53.7"W
42	MEXOAX13 3	16°40'01.6"N, 95°52'47.4"W
43	MEXOAX13 4	16°39'30.00"N, 95°49'40.90"W
44	MEXOAX13 6	16°21'22.6"N, 95°22'24.2"W
45	MEXOAX13 7	16°38'27.3"N, 96°04'06.8"W
46	MEXOAX13 8	16°23'59.5"N, 95°46'45.3"W
47	MEXOAX13 9	16°36'35.6"N, 95°58'36.9"W
48	MEXOAX14 1	16°33'29.7"N, 96°21'40.9"W
49	MEXOAX14 2	17°01'35.2"N, 96°43'10.0"W
50	MEXOAX14 3	17°05'36.9"N, 97°24'36.4"W
51	MEXGUE14 5	17°54'42.4"N, 99°19'27.4"W

52	MEXGUE14 6	16°49'08.7"N, 98°40'05.9"W
53	MEXGUE14 7	16°49'20.2"N, 98°41'15.8"W
54	MEXGUE14 8	16°48'46.8"N, 98°40'25.3"W
55	MEXGUE14 9	16°49'12.9"N, 98°40'39.3"W
56	MEXGUE15 0	17°58'51.7"N, 99°34'05.0"W
57	MEXGUE15 1	16°49'06.3"N, 98°39'16.3"W
58	MEXGUE15 2	17°54'42.4"N, 99°19'27.4"W
59	MEXOAX16 6	17°37'39.48"N, 96°21'47.11"W
60	MEXOAX18 9	16°49'05.8"N, 96°21'24.9"W
61	MEXOAX19 0	16°49'05.9"N, 96°21'25"W
62	MEXOAX19 1	16°42'08.4"N, 96°19'27.5"W
63	MEXOAX19 2	16°34'38.3"N, 96°20'55.9"W
64	MEXOAX19 3	16°24'46.0"N, 95°04'39.7"W
65	MEXOAX19 4	16°23'13.9"N, 95°04'40.1"W

66	MEXOAX19 5	17°03'15.3"N, 94°39'31.9"W
67	MEXOAX19 6	17°02'36.7"N, 94°40'01.2"W
68	MEXOAX19 7	16°23'54.5"N, 95°46'56.7"W
69	MEXOAX19 8	16°24'24.3"N, 95°42'35.9"W
70	MEXOAX19 9	16°32'51.7"N, 95°56'58.7"W
71	MEXOAX20 0	16°49'05.7"N, 96°21'24.9"W
72	MEXMIC204	19°52'53.9"N, 101°24'40.3"W
73	MEXMIC205	19°33'50.6"N, 102°21'28.3"W
74	MEXMIC206	19°57'06.0"N, 102°22'53.3"W
75	MEXOAX20 7	17°32'51.7"N, 101°10'22.9"W
76	MEXMIC208	18°20'25.4"N, 102°21'44.1"W
77	MEXMIC209	18°43'40.3"N, 103°24'19.9"W
78	MEXOAX21 0	18°09'54.9"N, 97°00'59.6"W
79	MEXOAX21 1	17°11'25.2"N, 97°45'08.9"W

Appendix 2. Leafhoppers observed in fieldwork.

	Genus	specie	Num. Observed	Num. Collected	Date of collect known	Micro-endemic of SMSr	Status NOM-059
1	<i>Crassana</i>	<i>marginella</i>	59	2 ♀, 2 ♂	1941	X	data deficient
2	<i>Crassana</i>	<i>goniana</i>	37	2 ♀, 2 ♂	1941	X	data deficient
3	<i>Costamia</i>	<i>venosa</i>	89	2 ♀, 2 ♂	1941	X	data deficient
4	gen_sp1		3	2 ♀, 2 ♂	-	-	-
5	<i>Ollarianus</i>	<i>muesebecki</i>	190	1 ♂	1941	-	-
6	gen_sp2	-	1	1 ♂	-	-	-
7	<i>Mesamia</i>	<i>ruptura</i>	59	1 ♂	1941	X	data deficient
8	gen_sp3	-	15	1 ♀	-	-	-
9	<i>Bardana</i>	<i>depressa</i>	25	1 ♂	1945	X	Special protection
10	<i>Pseudaligia</i>	<i>mexicana</i>	2	1 ♂	1941	X	data deficient
11	<i>Duocrassana</i>	<i>longula</i>	59	1 ♂	2016	X	data deficient
12	<i>Norvellina</i>	<i>denotata</i>	1	2 ♀, 2 ♂	1943	-	-
13	gen. nov. 1	sp.nov.	10	2 ♀, 2 ♂	-	X	-
14	<i>Stoneana</i>	<i>marthae</i>	2	2 ♂	1936	X	Special protection
15	<i>Acunusus</i>	<i>nigriviridis</i>	25	2 ♂	1941	X	data deficient
16	<i>Cocrassana</i>	<i>sexvarus</i>	4	2 ♀, 2 ♂	2017	-	-
17	<i>Angulanus</i>	<i>incisurus</i>	4	1 ♀	1941	X	-
18	<i>Devolana</i>	sp.nov.	1	1 ♂	-	X	Special protection
19	<i>Pseutettix</i>	<i>mexicana</i>	7	1 ♀	1941	-	data deficient
20	<i>Renonus</i>	<i>rubraviridis</i>	2	1 ♀, 1 ♂	1939	X	data deficient
21	gen_sp4	-	38	1 ♀	-	-	-
22	<i>Eutettix</i>	sp1	47	1 ♀	1941	-	-
23	<i>Eusora</i>	<i>fenestrata</i>	3	2 ♀, 2 ♂	1900	X	Special protection
24	<i>Retusanus</i>	<i>punctatus</i>	2	2 ♂	1941	X	Special protection
25	<i>Spinulana</i>	<i>varigata</i>	6	2 ♂	1941	X	Special protection
26	<i>Alladanus</i>	<i>mexellus</i>	2	1 ♀	1941	-	data deficient
27	gen_sp5	-	25	1 ♀	-	-	-
28	gen_sp6	-	19	1 ♀	-	-	-
29	gen_sp7	-	4	2 ♀, 2 ♂	-	-	-
30	gen_sp8	-	59	1 ♀	-	-	-
31	<i>Conversana</i>	<i>conversa</i>	3	1 ♀	1938	X	data deficient

32	<i>Aligia</i>	<i>mexicana</i>	13	1 ♀	1941	-	-
33	gen. nov. 2	sp.nov.	3	1 ♂	-	X	Special protection
34	<i>Knullana</i>	<i>plummeri</i>	12	1 ♂	1939	-	-
35	<i>Spangbergiella</i>	<i>mexicana</i>	205	1 ♂	2016	-	-
36	<i>Jiutepeca</i>	<i>zamorana</i>	16	1 ♀	1941	X	-