ORIGINAL RESEARCH

The use of toxic agrochemicals in El Huaje, Zentla, Veracruz, México, and their role during the Zafra (harvest) and the attempts to control the mosquito *Stegomyia aegypti*.

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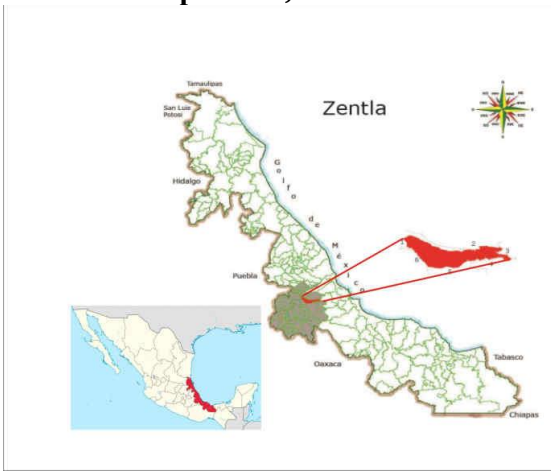
Abstract

In this paper we describe the population of El Huaje, Veracruz México. This village is inhabited by Italo-Mexicans. They work in the yearly Zafra (*sugar cane harvest*) and in chemical measures aimed to reduce the effects of the mosquito *Stegomyia aegypti*. **Structure:** This is a qualitative and multi-disciplinary study. **Objectives**: To describe the processes of cultivating sugar cane and the efforts made to contr ol the *Stegomyia aegypti* mosquito, both via agrochemicals. During this study the investigators ed ucated the local population on the use of agrochemicals. **Period of study:** January 2016 to December 2017. **Primary data sources:** Information was collected through in-depth interviews, *in situ* observation, audio and video recordings, and notes made "on site" as well as photographs and health questionnaires. **Conclusion**: The population of El Huaje is exposed to chronic agro-toxicity caused by the intensive use of agrochemicals. These chemicals are used in the sugar cane harvest as well as in the control of the mosquito: *Stegomyia aegypti*. **Key Words:** Agrochemicals, Agricultural crops, *Stegomyia (Aedes) aegypti* mosquito.

Map Zentla, Veracruz



Source: http://ceieg.veracruz.gob.mx/

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Received: November 14, 2020.
Accepted: April 21, 2020.
Conflict of interest: none.

Introduction

The circumstances in which people are born, grow up, live, work and age are decisive for understanding their state of health. Health is not just a function of medical care and of medicines; it also includes the supply of agro-chemicals and proper education regarding their use (1).

This paper examines the living conditions of the residents of El Huaje, Veracruz México, a rural Italian/Mexican community with a medium degree of marginalization (3). Residents of El Huaje experience chronic exposures to contamination by agrochemicals, which are used for both planting and harvesting sugar cane. One of these agrochemicals, **paraquat**, is prohibited in several countries (4),

These chemicals are also used to control (*Stegomyia aegypti*,) a mosquito formerly known as *Aedes*. (5); Mosquitos spawn and breed in places where there is inadequate water storage and conservation of water for animal consumption and planting.

Context and References

Chemical substances are used in agriculture to improve production (fertilizers) or fight pests such as insects, fungi, spiders, etc. Pesticides are chemical substances used to control, prevent, or destroy pests that affect agricultural plantations. Some pesticides, although they cannot be seen or otherwise detected, enter the body through the skin and/or when workers breath or swallow them (4).

Toxicity is an inherent feature of a chemical substance that can produce undesirable effects in health: this includes injuries that affect function and diminish the capability of response to risk factors and stress. (7)

Some pesticides, although are invisible or odorless, are able to enter the target organism through the skin; when they are breath or swallowed. (4) Consequently, such exposure can affect organisms in various ways, thus are considered toxic agents. Depending on the lapse of time between the exposure and the appearance of the toxic effect, they are divided into two groups: **acute toxicity,** when the exposure is 24 hours or less, and **chronic**, when the exposure is greater than 24 hours. (8)

Pesticides (a substance used for destroying insects or other organisms harmful to cultivated plants or to animals). They are used throughout the world in order to control pests and to control those vectors which affect humans and animals. Consequently, these chemicals are amongst the most common substances to which humans are exposed. (9). Studies in diverse countries have confirmed that excessive use of agrochemicals can contaminate humans, plants, and animals. (8, 9)

National and International Experiences

There is abundant national and international scientific evidence in the field of pesticides. In the "La Pila" micro-basin, in Colombia, it was determined that a major risk factor for local farmers were the use and handling of agrochemicals. (10)

This pollution was associated with diseases, including the destruction of flora, fauna, and natural resources produced mainly by the use of agrochemicals (11).

In Venezuela, high levels of pollution have been demonstrated both in the local environment as well as in human exposures.

In Argentina, there is evidence of contamination of the aquatic biota and humans, (e.g. behavioral alterations in young humans). This was contamination was caused either by the application of pesticides or by leaching flows.

There have been concerns regarding the following pesticides: cypermethrin, chlorpirifos, endosulfan and glyphosate. *Organophosphate use (POFs)* was demonstrated by the investigators. Levels of toxins at this level are likely to be cytotoxic and (in the case of glyphosate: genotoxic). They pose a potential risk to human health and the environment (9). In Costa Rica, studies made to characterize hydro/geologically the San Blas River found high levels of therbutilazine, amethrin, carbendazim, diuron and nitrates. These were considered to be a persistent danger to the aquifer (12)

Agrochemicals in Mexico.

Cases of agrochemical contamination have been documented in Mexico. In 1990, in the Yaqui Valley, Sonora, agrochemicals were reported in the blood of the umbilical cord of babies (sons of day laborers), and a high incidence of leukemia was noted amongst children in these rural regions.

In Mexicali, in 2005, pesticides which had been banned, restricted, or barred in the United

States continued to be used despite their toxicity and harm to human health. Although these pesticides were not recommended by the U.S. Environmental Protection Agency (EPA), they continued to be used on local crops. For instance, **paraquat** was used in some vegetables in the valley, despite it's being singled out in the "Tragic Dozen" campaign as an extremely dangerous compound and the cause of hundreds of deaths.(4) In the State of Mexico in 2007, acute poisoning was found in agricultural workers in rural areas caused by pesticides (14).

In Veracruz and Puebla (2012), a study of mother-child dyad found levels of organo-chlorinated pesticides (HCB, DDT and a, b, g-HCH) which had accumulated in the human adipose tissue of pregnant women, in maternal blood serum, and umbilical cord serum (15).

In 2018, a study determined that Mexican farmers keep on using highly toxic pesticides. The continuous use of these toxins (historical and current use) is related to detrimental effects on terrestrial and coastal ecosystems. It also refers to hematological, hormonal alterations, genetic damage, behavioral alterations and cellular damage to agricultural workers and their families: children were the most vulnerable group when exposed to toxins. And traces of this chemicals were also documented in foods such as milk, vegetables, and grains (16).

Study

Methods

Participants: Italian/Mexican cane-cutting males, aged between 25 and 81. The study included their wives, sons, and daughters, if they were interested in joining the study and offered their informed consent by writing.
Study period: January 2016 - 2017.

Objectives

1) To describe the process of sowing and harvesting sugar cane.
2) To describe the epidemiological control processes used to reduce the *Stegomyia aegypti* mosquito, using agrochemicals.
3) To explain the effect of the two previously described processes on the health of the inhabitants.

Hypothesis

Chronic exposure to agrochemicals leads to negative health outcomes for the inhabitants of El Huaje.

Design

Qualitative evaluation: Analyze the characteristics and problems from the perspective of the subjects involved. Based on their description, judgments were made as to why and how the subjects may want to improve their lives, in order to improve practice (17, 18, 19).

Information gathering: In-depth interviews, on-site observation, a self-administered questionnaire to gather information on living conditions, work and health, also audio and video recordings, written field notes and photographs. With a view to begin field work we requested the support of a person from the local community, who guided us in understanding the community, and introduced us to the local inhabitants and the local authorities.

In-field chores were a) counseling on chronic disease control techniques and b) collecting information. This counseling was given as follows:

- In-field health promotion activities were offered in order to gain the trust and confidence of the locals and to gather some health status information.
- Health education on diabetes, hypertension, and oral health.
- Dental care with cleansing services, cavity treatment and the rehabilitation through prothesis.
- Vital signs and capillary glucose levels measurements.
- Blood group and type determination of every participant.
- Triglycerides' level determination in subjects with high body mass level or overweight.

By this means, observation and data analysis were contrasted with in-depth interviews and the questionnaire. During this process, interviews were conducted with the study participants, a questionnaire questionnaire was administrated, and photographs were collected from families and the community; information was derived both those provided by informants and those obtained by the researchers. Analysis sessions were conducted

among the researchers to identify the main topics. The coding was done manually as proposed by Miles and Huberman (20).

Ethical Considerations

The Project was approved by a Bioethical and Biosecurity Commission.

Results: Contamination by agro-toxins

El Huaje: an italo-mexican city The Context:

El Huaje is characterized by its particular origins; the inhabitants' ancestors are immigrants from the northern regions of Italy, and the southern region of the Austro-Hungarian Empire in the late nineteenth century.

In 1882, 503 Italians (21, 22) immigrated to Mexico. Even though at least one-third of its inhabitants are of Italian descent, few speak their original language,(Italian), or other dialects (23). Thus, El Huaje remains a mixture of three cultures: pre-Hispanic, Spanish, and Italian (22).

El Huaje has a population of 336 inhabitants: 161 males and 175 females. The fertility rate is 2.58 children per woman. 5.95% of the population is illiterate (6.21% of men and 5.71% of women). The average scholarity of school is 5.54 (5.24 in men and 5.81 in women). 0.89% of the population is indigenous, and 0.30% of the population speaks an indigenous language. 62.50% of the population over the age of 12 is employed (60.87% of men and 64.00% of women). There are 103 homes, of which 96.30% have electricity, 95.06% have piped water, 88.89% have outdoor latrines, 81.48% radio, 90.12% television, 81.48% refrigerator, 43.21% washing machine, 38.27% car, 2.47% personal computer, 55.56% cell phone, but no landline or internet"(24).

El Huaje is in a semi-arid region and during the dry season, El Huaje has high temperatures. and suffers droughts. The average temperature is 26 degrees centigrade, which is thought to be high. "*La Zafra*" involves planting, cultivating & harvesting sugar, which is the primary product made in El Huaje, secondarily they produce corn, kidney beans and coffee beans. (25)

The Zafra: main economic activity, but also, the main source of toxicity

Sugarcane production is one of the most important economic activities in the world (26). Mexico is the seventh sugar world producer (27). Veracruz is Mexico's largest domestic sugar producer and contributes almost 40% of the sweetener consumed in the country (28). Since the Zafra is El Huaje's main economic activity (29), the inhabitants of El Huaje live in adverse conditions of health and survival, due to the way they produce sugar.

The *Zafra* is coordinated from December to May by engineers and carried out by peasant farmers. It is organized within an industrial model called a sugar mill. Generally, the labor is done as follows:

1. The Zafra starts with the preparation of the planting field: Bushes that are on the ground are repaired, useless ones are removed, and new ones are sown. All this process requires the use of chemical fertilizers.
2. As the sugar cane plant grows, herbicides, pesticides, and fertilizers are systematically applied to the ground and/or the plant itself. The preparation and application of these chemicals for agriculture are carried out by the farmers and in agreement with instructions given by the sugar mill representatives.
3. The chemicals are distributed by the mill's representatives who use large tanks which spread pesticides. These tanks are hand operated. In most cases the explicit warnings on the product labels are ignored; either the representatives forget them, or the farmers do not give them the according importance.
4. For cutting and harvesting, the sugar mill organizes farmers into groups, called crews. Regular crews are organized by immediate neighbors.
5. Field workers begin their journey by 5:00 o'clock, they are taken to the cutting area and cutting starts by 5:30.
6. By 11:00 people collect their lunch. This is also taken to the cane fields and will be consumed there by 13:00. Field works end by 18:00.

7. Before cutting the sugar cane, the fields are burned down in order to optimize the harvest. Even though the proper farm equipment is available, cutting is done by hand using a large blade called "machete"; a single worker can cut between 5 and 7 tons of sugar cane per day.

Through our observations, it was clear that the farmers (who prepare and use the agrochemicals) performed a lot of risky behaviors. Some of them include:

1) The agrochemicals are dissolved in water, because they are delivered as a soluble powder. This mixture is made at home using buckets that are washed in the river, so remains are deposited in running waters, that are later used by other inhabitants of the region for personal grooming, washing clothes, and even human and animal consumption.
2) The mixture and preparation of agrochemicals are done wearing everyday clothes. This means that when workers come home in the evening, they are still wearing contaminated clothing. They are frequently exhausted. This fatigue forces them to eat their dinner with their working clothes. Thus, the lack of water means that workers often go to sleep without bathing.
3) When the field workers' dirty clothes need to be washed, they are mixed together with all the family members' clothes.
4) Bags and recipients that are used to contain agrochemicals, are commonly washed in the river to be reused for storage of family objects, or food for human and animal consumption.
5) Here is a list of some of the agrochemicals commonly used by the farmers during the period of study, commercial and chemical names/components are specified:

Fertilizers:

1. Commercial name: Urea A 46-00-00, chemical name: Carbamida.
2. Commercial name: YaraBela- Nitromag, chemical name: Amonia nitrate.

Herbicides:

1. Commercial name: Paraquat, chemical name: Dichlorine 1,1'-dimetil-4,4'-bipiridile
2. Commercial name: Diuron, chemical name: 3-(3,4-Diclorofenil)-1,1-dimetilurea

Insecticides:

1. Commercial name: Lucambda 7 CE (lambda cyhalorina), chemical name: Imidacloprid.

"Painful urination": a disease by agrochemicals

By using agro-chemicals, and without following necessary precautions, farmers are subject to negative consequences for their health. For example, they may develop a urinary condition of unknown origin; this illness is called by the workers as the "*urine disease*." The signs and symptoms of "painful urination" have been reported and categorized as moodiness, despair, discomfort, and nervous alterations. (30) These symptoms are particularly severe in hot weather.

There are no known treatments for "painful urination". Unfortunately, "painful urination" does not appear in any medical catalogue of diseases. Doctors often treat this disease by using dehydration according to the signs and symptoms: thirst, dry mouth and mucous membranes; fatigue, lightheadedness, tachycardia, dry skin, less frequent and lower volume urinations, concentrated and dark urine. However neither water or rehydrating serums does not help the patients. Instead, in many cases it causes them a more intense discomfort.

Potential Treatments for painful urination: comments by community

- Cold bottled water: "Water can eliminate the pains of painful urination". However, taking water from a pit increases the signs and symptoms of "painful urination."
- Hot coffee facilitates urination and contains substances that generate biological activity. These substances include adenine (a vasodilator & diuretic), asparagine (also a diuretic). (32) Asparagine provided significant relief.
- Cold Beer "relaxes the body and allows workers to complete a full day of work." This drink is also refreshing because of its water content, and its low levels of carbonic gas. It contains all important vitamins of the group B, in addition to diuretic properties. (33)
- Phenazopyridine: This medication provides a sense of relief. The usual dose is one pill every 8 hours; some take the medication more frequently (every 8 hours and/or every time

there is pain). This medication has an antiseptic effect which offers short acting pain relief. The medication should be taken along with other medicines and under the supervision of a physician.. Otherwise, its pain relief is only transitory. (34)

Control of the Stegomyia aegpti mosquito: drought, chikungunya, agrochemical poisoning

Other sources of water contamination are the pesticides used to control the *Stegomyia aegypti* mosquito, which is also a vector for the zika virus and chikungunya. Farmers conserve water for use by animals and during the harvest. In Veracruz, México, *2,103 (35)* cases of zika infection were confirmed through 31st December 2018. Our team of researchers witnessed the evolution of a mother and her 2-year-old son who suffered from chikungunya and were diagnosed at the local health facility.

To understand the context, El Huaje is a semi-arid community with periods of water scarcity and high temperatures. Cisterns are used to store water for several months of the year, a condition that can promote the spread of the *Stegomyia aegypti* mosquito; the mosquito vector is found in immature stages in the water, especially in containers. (36, 37).

National and international organizations have proposed actions to avoid the propagation of the zika virus and chikungunya. In the best of circumstances, these measures have generated hopes that these diseases can be addressed.

Unfortunately, these hopes have not been realized. For example, the Mexican Government (38) and the PAHO/WHO (39) propose the following actions:

1. To frequently wash buckets, swimming pools, tubs, cisterns, animal drinkers and containers that can collect water.

   However, this suggestion cannot be applied to El Huaje because of the lack of water, a scarce resource, which would make it difficult to follow the rules outlined above. If the rules were followed, other needs -such as the demands of the sugar fields and access to sufficient water - would have to be neglected. Paradoxically, it is by conserving water to meet these primary needs that the community has built their own "jagüeyes" (large water collectors), which have encouraged the proliferation of the *Stegomyia aegypti* mosquito.
2. The use of open air water deposits, such as ponds and containers, can serve as a mosquito breeding grounds. This is also not practical in El Huaje because the use of containers worsens the lack of water for animal consumption and for irrigation.
3. To make sure tanks and water containers are covered and sealed to avoid allowing mosquitos to find places apt to spawn.

This is not suitable in the case of El Huaje because their local tanks have a capacity of 420 m3, or greater, which would require local tanks at a prohibitive cost for covers high economic cost. Covers would also be difficult to place, as several men are required each time they had to remove or place the covers. The tanks need to be opened, so that animals can drink water freely.

These are the three situations in which insecticides, insect repellents and larvicides (for mosquito control) are used. There is no evidence that this has already occurred in El Huaje but given the high usage of larvicides and experience in other countries, it is likely that the use of larvicides will continue to be a major source of abuse of agrochemicals.

Conclusions

1. The population of El Huaje suffers from various diseases related to agrochemicals. They are observed when farmers use toxic products to work in the cane fields and neglect proper hygienic measures. Economic issues exacerbate this cycle on a chronic basis.
2. Chemical substances used during the Zafra and as the control mechanism for ***Stegomyia aegypti*** mosquito have doubled the toxic exposure for Mexican farmers.
3. Families in El Huaje must decide from two pathways, exposing themselves to various diseases related to water storage consequences and crop production's agrochemical extensive use, or losing their main income and living exposed to ***Stegomyia aegypti*** mosquito proliferation and its implications.
4. Paraquat, a highly toxic agrochemical, is used in El Huaje all through the cultivation of sugarcane.
5. Although in Costa Rica Diuron is considered a

major threat to the San Blas River basin, it is also used in El Huaje for sugarcane cultivation.

6. Peasants in El Huaje suffer from "painful urination", which is related to the chronic exposure to agrochemicals, these substances are inhaled, swallowed and absorbed through the skin.
7. Even though "painful urination" is not accepted as a medical disease, two very dissimilar communities (genetically and socioculturally), seem to have been affected: Italo-Mexicans from El Huaje and Afro-Mexicans from El Manantial, Cuitláhuac, both in the Mexican state of Veracruz. (40).

Their testimony is evidence of the same health effects, featured as an exclusive social disease of the sugarcane farmers.

For ethical reasons, the study of the toxic effects of agrochemicals on humans is carried out with experimental models, so evidence in humans is restricted (8). The empirical data presented in this document calls on us not to bypass the living and working conditions of people living in El Huaje, Zentla Veracruz, and to prevent and address the consequences generated by the chronic toxicity of the agrochemicals they use for survival.

Our appreciation to

Funds from "Programa de Apoyo a Proyectos de Investigación e Innovación Tecnológica (PAPIIT)" and from "Programa de Apoyos para la Superación del Personal Académico (PASPA)".

Both programmes belong to the "Dirección General de Asuntos del Personal Académico (DGAPA)" at the Universidad Nacional Autónoma de México (UNAM), as part of the project "Antropología de la Región de las Grandes Montañas, Veracruz. Diversidad poblacional y contextos histórico-sociales" (Code: UNAM-DGAPA-PAPIIT IG400416).

The authors would like to thank National School of Nursing and Obstetrics (ENEO-UNAM) for a sabbatical postdoctoral residence. As to Verónica Bravo Almazán, Rosa María Ostiguín Meléndez PhD, Virginia Reyes Audiffred PhD, and Rosa Amarilis Zárate Grajales MS, and finally to Demetrio Ángel Martínez López for their contributions in carrying out this study.

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