Ecological Questions 33 (2022) 4: 77–85 http://dx.doi.org/10.12775/EQ.2022.032

Extreme environments as reservoirs of invasive plants: the case of the garbage dump in Huehuetlan El Grande, Puebla, Mexico

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Received: 26 Febuary 2021 / Accepted: 4 June 2022

Abstract. The study aimed to highlight the role of extreme environments (so-called because of the high accumulation of nutrients and other harmful products) as sites of reservoirs of invasive plants, taking as an example the community „dump" of the municipal seat of Huehuetlan el Grande, Puebla, Mexico. The results show that 56 species belonging to 52 genera and 25 families were found; the families with the highest number of species were Asteraceae and Solanaceae. The species found are from 30 different countries, being America and Ecuador with a greater number of records. According to the origin of sites, use, industrial possibilities and, if they are wild or cultivated species, it was found that there were 14 species on the roadside: 11 weeds, 9 cultivated, 8 forage, one with industrial possibilities and one threatened. The correlation analysis showed that only the number of species vs. precipitation had significant differences. It is a fact that the conditions of the „community garbage dump" represent an opportunity for invasive species to survive and persist in the seed bank, waiting for adequate conditions to germinate and settle in increasingly larger areas, favored by the growing deterioration that human activity has caused in recent years.

Key words: community garbage dump, invasive species, disturbed habitats, wild.

1. Introduction

Invasive plants are those that are distributed geographically in occupied areas, establishing new populations where, even altering biodiversity and habitat (Radosevich et al., 2007). The concept of invasive plant refers to plants that are in the same places, in which are altered by man; this coincides with what Baker (1991) mentions that the disturbance of habitat by man is the essence for the life of invasive plants.

Because of their life history, these species can be classified as annual, biannual or perennial. Another characteristic that makes them successful is that they present different biological characteristics such as: short juvenile period, rapid population growth, small seeds, high seed production, high initial germination and rapid dispersion; this allows them to rapidly colonize the habitat and displace the native species (Rejmánek & Richardson, 1996).

In the ecological context it can be said that invasive plants are "pioneers during the process of succession", and cultivated fields are habitats that have suitable characteristics for their proliferation (Altieri & Liebman, 1988). In this way, whatever the origin of invasive plants is, they are an integral component of the agroecosystems and strongly influence their organization and functioning (Altieri & Liebman,

1988). Most invasive plants have characteristics of adaptation to altered environments, which gives them an advantage to colonize sites where conditions are unfavorable (Harlan & de Wet, 1965; Harlan, 1992).

The introduction of invasive plants into new habitats has been voluntary and involuntary, partly because humans have dispersed them as ornamentals (Baker, 1991; Radosevich et al., 2003). Therefore, they are incorporated and interfere with the native vegetation (Felix & Owen, 2001). It has been estimated that the introduction of invasive plants has been about 10%, in some places in England, Germany and France, and only 1% in the Netherlands (Radosevich et al., 2007), but in other places there are examples where invasive plants have been a plague, as in the case of Australia, where *Opuntia stricta* (Haw) Haw has displaced native vegetation, and previously there were no members of the Cactaceae family. The success of invasive plants can also be explained by the fact that native species are under stress (for example, overgrazing can cause the appearance of an invasive species, Odum & Sarmiento, 1998).

Thus, invasive species cause losses to agriculture in the United States of America with about 8-10 billion dollars per year, while losses in forests are difficult to be estimated, but it is believed that 30% of the reduction in woody species in the first stage can be occupied by invasive plants (Radosevich et al., 2007). As Rejmánek & Richardson (1996) indicate that around 2000 vascular plants found in North America are not native. In other countries, 40–50% of invasive species are reported (Atkinson & Cameron, 1993). In Australia, up to 200 species of harmful plants are reported (Hobbs & Humphries, 1995; Parsons & Cuthbertson, 1992).

Invasive species, by definition, are highly competitive and can persist in many ecosystems. These characteristics are stimulated by extrinsic factors (soil, land use and climate) responsible for the growth and persistence of invasive plants. Thus, it is known that in general, the variation in soil types affects the establishment and growth of plants, but also given the interactions that are established, the presence of invasive plants will also determine the establishment of native plants. The change in land use, degradation or modification in many of the ecosystems by man, have direct effects on the invasion, since the increase in the frequency of fire, nitrogen consumption or allelopathic chemicals makes these sites become ideal places for invasive species. The climate can also direct the growth of biotic and abiotic thresholds in the ecosystems, changing the habitat over short periods through drought, seasonal cold and floods; in this way the climate favors the invasion of the species into a habitat, that is why edaphic processes, such as topography and altitude, influence the climate, favoring the establishment and development of invasive species (Radosevich et al., 2007).

Sites with a high concentration of nutrients in the soil, called patches of vegetation, with high density and diversity of plants have been found in arid areas; these sites are called "islands of fertility". They have been considered basic units of the functioning of the ecosystem, regulating at a local scale the amount of nitrogen, carbon and phosphorus that enters, stores and transforms in the soil, influencing the productivity and diversity of ecosystem species according to the type of island that is formed, and thus determining the plant-soil interaction (Perroni, 2007). Likewise, the daily activities of humans have created disturbances in the different natural ecosystems since pre-Hispanic times (Harlan, 1992).

Until now, this is due to the social organization and the population increase, generating waste that can be extremely polluting and placing them in sites that have been opened for this purpose (called sanitary landfills, controlled landfills, or open-air dumps; SEMARNAT, 2020). Therefore, the aims to highlight the role of extreme environments (due to the high accumulation of nutrients and other harmful products) as sites of reservoirs of invasive plants, taking as an example the communal "dump" of the headwaters of the Municipality of Huehuetlan El Grande, Puebla, Mexico.

2. Materials and methods

The study was carried out in the "dump" of the main head of the municipality of Huehuetlán El Grande, Puebla. The municipality is located 46 km south of the city of Puebla and has an area of 264.08 km^2, it is included in the physiographic province of the Sierra Madre del Sur, sub-province of the sierras and valleys of Guerrero, which is a part of the Sierra del Tentzo, belonging to the basin of the Atoyac River. The soils are rendzinas and lithosols of medium textural class. The climate corresponds to type BS1 (h`) w (w) ig, warm semi-dry with rainfall in summer, the average annual rainfall is 650 mm (Köppen climate classification modified by Garcia, 2004). The vegetation is *Quercus* L. forests associated with shrub secondary vegetation and the presence of *Brahea dulcis* J. Cooper palms, the predominant vegetation is made up of species that make up the dry tropical forest. There is seasonal agriculture and the cattle that exist are bovine, porcine, equine, goat and poultry (Martínez-Moreno et al., 2015).

The study area is located at 19° 45' N 98° 41' W and at an altitude of 1500 m it has an area of 7000 m^2. The study was conducted for one year (2018) with visits every 7 days. At each visit the presence-absence of the species that were in the "dump" of the community was noted and temperatures were recorded using a maximum and minimum thermometer (Brand Duplex, USA) placed in the study area. The species collected were identified and a comparative table was

prepared, where the greatest amount of information was obtained from Rzedowski et al. (2005) and bibliographic records from Merlín-Uribe et al. (2014). With the rainfall and temperature data throughout the year, a correlation analysis was performed using the number of species that appeared each month. These data were analyzed through a correlation analysis using the NCSS 10 (2015) statistical package. Photographs were taken and botanical collections were carried out for identification. In addition, to know if any of the species that appeared in the dump was in the Low Caducifolia Jungle next to the site, a 100-meter search was carried out around the dump.

3. Results

With the presence-absence records, 56 total species belonging to 52 genera and 25 families were found, the families with the largest number of species were Asteraceae and Solanaceae with 8 species each, and 13 families only had 1 species. Regarding the number of species by genus *Gomphrena*, *Chenopodium*, *Ipomoea*, *Cucurbita*, *Datura* and *Solanum*, they presented 2 species each, while the species *Gomphrena globosa* presented 2 varieties (cultivated and wild, Table 1). The scientific names of the plants were updated according to The Plant List (IPNI, 2021). The species found are from 30 different countries, with the Americas and Ecuador having the largest number of records (Table 2). According to the type of habitats, use and, if they are wild or cultivated species, it was found that there were 14 species on roadsides, 11 weeds, 9 cultivated, 8 forage, 1 with industrial possibilities and 1 threatened according to standard 059 of SEMARNAT (2020) (Table 2). The highest number of species appeared in June (28), July (44), August (43), September (43), October (46), and November (38) (Table 1). The correlation analysis showed that only the number of species vs. precipitation, had significant differences ($P = 0.01$, $R = 0.47$), not being significant for the number of species vs. temperature ($P = 0.31$ and $R = 0.10$, Figure 1). As for the 100-meter route around the dump, no species were found that were only inside the dump.

4. Discussion

In the community garbage dump 56 species were found, where a high number (25 species) comes from different continents, but mostly from the tropical and subtropical regions of America and Africa. In our study, it was also found that most of them are plants considered ruderal, weeds, or ornamentals, which are typically found alongside roads, disturbed sites and vacant land, and behave like weeds; some are cultivated, medicinal and forage, among others. This was to be expected given that other studies have reported that disturbed sites are often invaded by opportunistic plants with these characteristics (Hobbs & Schimel, 1984). In the case of Mexico, the introduction of these species has been voluntary and involuntary, partly because humans have dispersed them initially as ornamentals (Baker, 1991; Radosevich et al., 2003), to be later discarded in the dumpster, where they find an opportunity to prosper as they are free of competitors. In the case of cultivated species, their presence could be explained by the fact that a "tianguis" (weekly mobile market) is held every week in human settlements, where these species are thrown away, if they are not sold, to the community garbage dump where in raining days' germination and increased abundance of these species activates. This is consistent in what was found in the correlation analysis, where the correlation between invasive species and precipitation was significant. It is worth mentioning that the community garbage dump is a disturbed site immersed in the low deciduous forest, altering the environment and thus encouraging invasive species such as *Acacia cochliacantha* Humb. & Bonpl. ex Willd, *Leonotis nepetifolia* (L.) R.Br., *Melia azedarach* L., *Prosopis juliflora* (Sw.) DC., *Nicotiana glauca* Graham and *Ricinus communis* L., all of them from different continents, except *Acacia cochliacantha* and *Prosopis juliflora* that are from Mexico. These species thrive in disturbed sites and abandoned land, because, due to their origin, they are organisms that can be established successfully in sites with highly variable conditions, which gives them a huge presence in places where conditions are unfavorable (Harlan & de Wet, 1965; Harlan, 1992). The success of invasive species may depend on the type of disturbance carried out by man. So, conditions such as poor soil management, uncontrolled fire or transportation by corridors, may favor different types of invasive species and therefore cause various effects on the movement of native species. On the other hand, it is important to mention that to the current community garbage dumps arrive not only organic waste but also inorganic, often containing very toxic substances, such as batteries, plastics, styrofoam, syringes and expired medicines, among others, generating pollution at the level of atmosphere and soil. The dangerous situation about this is that the garbage dump also represents a place where cattle (cattle and goats) of the region's settlers come to forage the different species that appear on the site, being able to ingest these substances and, therefore, reach the human consumption (Lodoño-Franco et al., 2016).

It is remarkable that in this site a species (*Zinnia elegans* Jacq.) has been discovered in the status of "threatened" according to the NOM ECOL-059-2001, although it is used in the ornamental form that is commercialized in the local market. Something that seems interesting is that when making a tour around the dump (a diameter of 100

Table 1. Presence and absence of families, genera and species registered in the garbage dump in the municipal capital of Huehuetlan El Grande, Puebla, Mexico throughout the year 2018

Family / Genus / Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Acanthaceae/*Thunbergia alata* Sims											x	
Amaranthaceae/*Amaranthus hybridus* L.					x	x	x	x	x	x	x	x
Amaranthaceae/*Gomphrena globosa* L. variety cultivada									x	x	x	
/*Gomphrena globosa* L. variety silvestre									x	x	x	
Asteraceae/*Bidens odorata* Cav.					x	x	x	x	x	x	x	
Helianthus annuus L.							x	x	x			
Parthenium hysterophorus L.						x	x	x	x	x		
Sanvitalia procumbens Lam.						x	x	x	x	x	x	
Simsia amplexicaulis Pers.							x	x	x	x	x	
Sonchus oleraceus L.										x	x	
Tithonia tubaeformis A. Gray							x	x	x	x	x	
Zinnia elegans Jacq.							x					
Brassicaceae/*Lepidium virginicum* L.										x	x	x
Cannaceae/*Canna edulis* Ker Gawl.							x	x	x	x		
Chenopodiaceae/*Chenopodium album* L.							x	x	x	x		
Chenopodium ambrosioides L.							x	x	x	x	x	x
Convolvulaceae/*Ipomoea arborescens* (Humb. & Bonpl. Ex Willd.) G.Don						x	x	x	x	x	x	
Ipomoea purpurea (L.) Roth						x	x	x	x	x	x	x
Cucurbitaceae/*Citrullus lanatus* (Thunb.) Matsum. & Nakai	x				x	x	x	x				x
Cucumis melo L.							x	x	x	x	x	
Cucurbita argyrosperma hort. Ex L.H.Bailey					x	x	x	x	x	x	x	
Cucurbita moschata Duchesne ex Poir.					x	x	x	x	x	x	x	
Euphorbiaceae/*Cnidoscolus urens* (L.) Arthur				x	x	x	x	x				
Euphorbia pulcherrima Willd.						x	x					
Ricinus communis L.	x	x	x	x	x	x	x	x	x	x	x	x
Fabaceae/*Dalea foliolosa* (Ait.) Barneby			x	x	x	x	x	x	x	x	x	
Desmodium paniculatum (L.) DC.							x	x	x	x	x	x
Phaseolus vulgaris L.					x	x	x	x	x			
Lamiaceae/*Leonotis nepetifolia* (L.) R.Br.	x	x	x	x	x	x	x	x	x	x	x	x
Salvia tiliifolia Vahl							x	x	x	x	x	
Leguminosae/*Acacia cochliacantha* Humb. & Bonpl. Ex Willd.	x	x	x	x	x	x	x	x	x	x	x	x
Malvaceae/*Anoda cristata* (L.) Schltdl.							x	x	x	x	x	x
Malva parviflora L.								x	x	x	x	
Malvastrum spp. A.Gray										x	x	
Meliaceae/*Melia azedarach* L.	x	x	x	x	x	x	x	x	x	x	x	x
Mimosaceae/*Prosopis juliflora* (Sw.) DC.	x	x	x	x	x	x	x	x	x	x	x	x
Nyctaginaceae/*Boerhavia coccinea* Mill.							x	x	x	x	x	x
Papaveraceae/ *Argemone ochroleuca* Sweet							x	x	x	x	x	x
Pedaliaceae/*Proboscidea louisianica* (Mill.) Wooton & Standl.					x	x	x	x	x	x	x	
Sesamum indicum L.										x	x	
Plantaginaceae/*Plantago lanceolata* L.												x
Poaceae/*Digitaria sanguinalis* (L.) Scop.						x	x	x	x	x		
Saccharum officinarum L.					x							x
Setaria adhaerens (Forssk.) Chiov.						x	x	x	x	x		
Zea mays L.					x	x	x	x	x	x		
Portulacaceae/*Portulaca oleracea* L.					x	x	x	x	x	x		

Table 1 (continued)

Family / Genus / Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Resedaceae/*Reseda luteola* L.										x		
Solanaceae/*Capsicum annuum* L.							x	x	x	x		
Datura inoxia Mill.						x	x	x	x	x	x	x
Datura stramonium L.						x	x	x	x	x	x	x
Licopersicum esculentum Neck.						x	x	x	x	x	x	x
Nicotiana glauca Graham	x	x	x	x	x	x	x	x	x	x	x	x
Physalis philadelphica Lam.	x				x	x	x	x	x	x	x	x
Solanum americanum Mill.								x	x	x	x	x
Solanum rostratum Dunal								x	x	x	x	
Urticaceae/*Urtica dioica* L.							x					
Verbenaceae/*Lantana camara* L.							x					
TOTAL SPECIES PER MONTH	8	6	7	8	19	28	44	43	43	46	38	21

Table 2. Species found in the „garbage dump" of Huehuetlan El Grande, Puebla, Mexico during the year 2018

Species	Origin	Distribution	Place of provenance
Acacia cochliacantha Humb. & Bonpl. ex Willd	Mexico	Low Caducifolia Jungle	Disturbed places
Amaranthus hybridus L.	America	Temperate and Tropical Regions of the Old World	Weeds, abundant in disturbed and cultivated lands
Anoda cristata (L.) Schltdl.	Mexico	Arizona, Texas to Bolivia	Weeds, abundant in disturbed lands
Argemone ochroleuca Sweet	Mesoamerica	South of U.S.A. to Mexico	Disturbed places and roads, vacant lots or towns, fields planted or abandoned
Bidens odorata Cav.	México and Guatemala	Nuevo León to Guatemala	It is found in agricultural fields, roadsides, disturbed places and secondary communities in general
Boerhavia coccinea Mill.	South of U.S.A. to South America, also in the Antilles	Tropical and subtropical regions of the world	Dry places, mainly disturbed
Canna edulis Ker Gawl.	Mexico, Central America, South America and the Antilles	Tropical and subtropical regions of the world	Swampy, disturbed lands, close to streams of water, used as ornamental, the leaves are used to wrap tamales and seeds to make necklaces
Capsicum annuum L.	Tropical America, South of the U.S.A, almost all of Mexico, Central America, the Antilles and North of South America	High Perennifolia and Superennifolia Jungle, Low Caducifolia Forest and Deciduous Forest	It is sown throughout the world
Chenopodium album L.	Eurasian region	Cosmopolitan	Land rich in nitrogen and vacant land
Chenopodium ambrosioides L.	America	Old world tropics	Segetal and ruderal although it is also cultivated
Citrullus lanatus (Thunb.) Matsum. & Nakai	Pakistan	Cosmopolitan	Cultivated
Cnidoscolus urens (L.) Arthur	Native to tropical America	Mexico-Brazil	Common weeds in disturbed areas and dry forests, perennial crops, paddocks and roadsides
Cucumis melo L.	Africa	Tropical and subtropical regions	Cultivated with medicinal properties such as diuretic, food, demulcent, emetic and purgative (root)
Dalea foliolosa (Ait.) Barneby	Mexico to Honduras	Pine-Encino Forest, Low Caducifolia Forest and Xerophilous Scrub	It is found in plots and seasonal crops, along roadsides and vacant lots, tepetate and caliche lands. It affects corn crops. The goats eat this plant
Datura inoxia Mill.	Mexico	Tropical and Subtropical Parts of the Old World	Next to roads, puddles and streams and vegetation of Coastal Dunes, weeds in cotton, has medicinal and poisonous properties, is cultivated as an ornamental and there are improved varieties
Datura stramonium L.	Mexico	Temperate and tropical regions of the world	Segetal and ruderal

Table 2 (continued)

Species	Origin	Distribution	Place of provenance
Desmodium paniculatum (L.) DC.	East Asia, Mexico and Brazil	Temperate and tropical regions of the world	Food of birds and livestock (nutritional supplement)
Digitaria sanguinalis (L.) Scop.	Asian	Temperate and tropical regions of the world	Weeds in cultivated areas and secondary vegetation uncultivated lands, roadsides, in open disturbed places, in humid or dry habitats; grass, paddocks, farming plots, plantations, open or disturbed areas; It can be a serious problem on irrigated land. Forage
Euphorbia pulcherrima Willd.	South of Mexico and perhaps of Guatemala	Temperate and tropical regions of the world	Ornamental, ruderal and roadsides
Gomphrena globosa L.	Central and South America, Australia and Southeast Asia	Tropical America	Pastures and Thickets
Helianthus annuus L.	Southeast of U.S.A. and North of Mexico	Caribbean and Oceania, Europe, Africa and Asia	Cultivated
Ipomoea purpurea (L.) Roth	America	Parts of North America, Oceania, hottest parts of Europe, Africa and Asia, Matorral Xerófilo, Pastizal. Encino and Eucalyptus forest	Segetal and ruderal, affects several crops, is used as ornamental and honey
Lantana camara L.	South of U.S.A. and the Antilles to South America	Low Caducifolia Jungle, Xerophilous Scrub and Grasslands	Ruderal in cultivated lands, grasslands, abandoned fields, banks of plots and roads, affects several crops and is of beekeeping and ornamental importance
Leonotis nepetifolia (L.) R.Br.	Tropical Africa	Many parts of Tropical America	Banks of roads, ornamental, medicinal and honey
Lepidium virginicum L.	Mesoamerica	The Americas, the Antilles, the Pacific and Eurasia	Cultivation fields, ruderal on roadsides, around houses, bird food, salads complement, pungent flavor, it is used as chelite and animal fodder
Lycopersicum esculentum Neck.	The Andes	From Mexico to South America	Cultivated and wild
Malva parviflora L.	Europe and adventitia in America	Mexico's valley	Weeds, ruderal, segetal, roadside, near rooms and in rubble
Malvastrum spp. A. Gray	Mexico and Central America	Arizona to Argentina	Weeds and disturbed sites
Melia azedarach L.	South and East Asia	Subcaducifolio Tropical Forest	Often cultivated in parks, gardens and family gardens, it is also found in areas of secondary vegetation derived from the tropical sub-deciduous forest
Nicotiana glauca Graham	Tropical America and probably South America	Low Caducifolia Jungle, Pine-Encino, Xerophilous Scrub	Ruderal, common on the banks of roads and highways, near rivers and streams, close to crops and courtyards, medicinal (soothe pain, decongest respiratory tract), occasional ornamental
Parthenium hysterophorus L.	East of Mexico and the Antilles	Tropical deciduous and subdeciduo forest	On roadsides, paddocks, railroad tracks, occasionally in cultivated fields. Medicinal (against fever and neuralgia). It contains in its stems and leaves the alkaloid parthenin which makes it toxic for cattle, since it acts on the circulatory system decreasing the percentage of hemoglobin and the coagulant properties of the blood
Phaseolus vulgaris L.	The Tropics of America	Low Caducifolia Jungle, Pine-Encino Forest	Stony and scrub, edible
Physalis philadelphica Lam.	Mexico	Cultivated and feral in various parts of the world	Irrigation crops, sowings, banks of ditches, roads and areas with humidity, appears in several crops, the fruit is edible, fodder and medicinal
Plantago lanceolata L.	Eurasia	Almost cosmopolitan	Ruderal, wastelands, irrigation channels, gardens. Associated with several crops. Medicinal use (astringent and mild emollient, infusion is used for pharyngeal catarrhs). It causes allergies because of its pollen. Resistant to herbicides such as 2,4D, MCPA and 2,4-DB

Table 2 (continued)

Species	Origin	Distribution	Place of provenance
Portulaca oleracea L.	Probably Mexico	Tropical and temperate regions of the world	Segetal and ruderal, edible and medicinal (diuretic, refreshing, laxative, against diseases of the bladder and liver and to soothe renal pains). It has a high content of antioxidants and Omega-3 fatty acids
Proboscidea louisianica (Mill.) Wooton & Standl.	East of U.S.A. to Texas and central Mexico	Jamaica and Watermelon Crops	Disturbed sites and in crop fields
Prosopis juliflora (Sw.) DC.	Mexico	Arid and semi-arid regions	Cultivated, it grows wild in tropical deciduous forest. It has a restorative effect
Reseda luteola L.	European	Pino-Encino Forest	Ruderal and segetal, It has harmful effects on several crops, it is used as a yellow dye to dye in the textile, honey industry
Ricinus communis L.	Africa	Warm Areas of Mexico	Ruderal and cultivated, very toxic seeds
Saccharum officinarum L.	Southeast Asia and New Guinea	Cultivated	Cultivated for sugar production, as juice, production of alcoholic beverages such as Ron, Aguardiente and La Cachaza
Salvia tiliifolia Vahl	America	South of U.S.A. to Colombia, Ecuador and Peru	Gardens, roadside, in vegetables and crops. Harmful effect in crops such as coffee, beans, corn, mangoes. Little consumed by cattle, edible and medicinal
Sanvitalia procumbens Lam.	Mexico and Guatemala to Costa Rica	Pino-Encino Forest, Xerófilo Scrub and Low Caducifolia Jungle	Segetal and ruderal, pumpkin weeds, scourer, beans, tomatoes, legumes, forage, mango, melon, sorghum and tomato. Ornamental
Sesamum indicum L.	India and Africa	Cultivated	Food as oil
Setaria adhaerens (Forssk.) Chiov.	North East Africa	In crops	Weeds in crops and would be very much in vine crops on roadsides and fields. It is found in alfalfa and corn. Spikes are stuck in people's clothes and animal hair
Simsia amplexicaulis Pers.	Mexico	Mexico-Guatemala, in Bosque de Pino-Encino	Segetal and ruderal, abundant in cultivation of seasonal, forage, honey and medicinal corn. Susceptible to herbicides such as phenoxyacetic and atricine
Solanum americanum Mill.	America	South of Canada to South America, Xerophilous Scrub	Ruderal and segetal weeds. Edible
Solanum rostratum Dunal	Mexico	North to Central America	Ruderal and sometimes as segetal, affects several crops. Medicinal, forage and honey. Toxic for cattle
Sonchus oleraceus L.	Europe	The Mediterranean and Western Asia	Ruderal and segetal, affects several crops, edible plant, latex can be an alternative in the industry, medicinal liver problems, forage and clorsulfuron resistant
Tagetes erecta L.	Mesoamerica (Mexico and Central America	In Low Caducifolia Jungle, wild forms	Segetal, disturbed vegetation, weeds in corn, ornamental, medicinal purposes, food supplement of birds and used as a plant in rituals worldwide
Thunbergia alata Sims	East Africa	Wild in the Humid and Dry Tropics and in Temperate Regions is cultivated	Cultivated as ornamental, ruderal, weeds and plantations. Invasive in Colombia. It is found in crops such as citrus, mango, bananas or coffee trees
Tithonia tubaeformis A. Gray	Mexico to Honduras and El Salvador	Forest Pine-Encino and Low Caducifolia Jungle	Segetal and ruderal, it affects some crops, fodder for domestic animals, it is used in religious ceremonies and as medicinal
Urtica dioica L.	Canada to Mexico	Cosmopolitan	It is located on the shore of plots and roads, roads, gardens, vacant places. Medicinal (against arthritis). Edible young leaves
Zea mays L.	Mexico	Cultivated	Edible
Zinnia elegans Jacq.	Central Mexico	Encino Forest, Deciduos Tropical Forest	It is located on roadsides, pastures and abandoned fields, it is ornamental. It is included in the NOM ECOL-059-2001. It is considered threatened

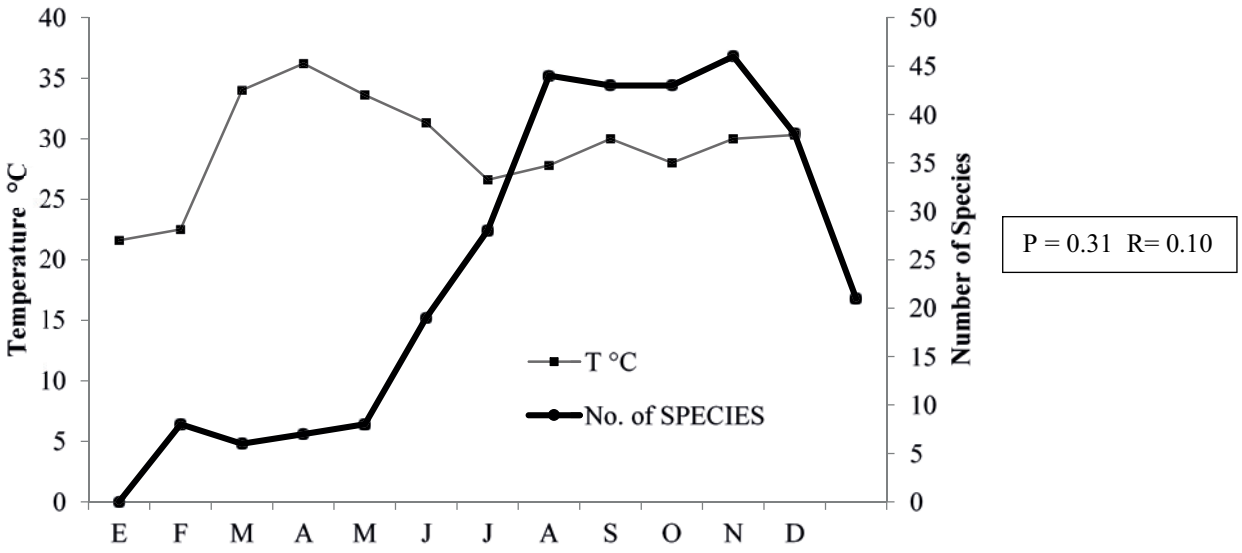

Figure 1. Precipitation record (mm) and temperature (°C) joined with the number of species that were presented in the "dump" over a year (2018), in Huehuetlan El Grande, Puebla, Mexico. In the boxes, probability (P) and R are presented for each environmental variable with reference to the number of species in each month

m), no individuals of the species that appear in the dump were found, except for some of them that are typical of the surrounding vegetation, such as *Acacia cochliacantha*, *Dalea foliolosa*, *Ipomoea purpurea*, *Lantana camara*, *Nicotiana glauca*, *Sanvitalia procumbens*, which represent 10.7% of all species within the community dump. This could be related to the fact that shade and competition conditions generated by the native species of the lowland Caducifolia have not allowed the establishment of invasive plants that require open spaces for their accelerated life cycles.

These sites can become seed reservoirs for threatened species, such as *Zinnia elegans*. It is a fact that the conditions of the "community garbage dump" represent an opportunity for invasive species to survive and persist in the seed bank, waiting for adequate conditions to germinate and settle in increasingly larger areas, favored by the growing deterioration that human activity has caused in recent years. This in the future may end up displacing the native species that do not have, under these conditions, any chance to survive.

5. Conclusions

In the communal "dump" of the Municipality of Huehuetlan El Grande, Puebla, Mexico. The number of invasive species is high in the garbage dump and the flora of the study area is represented mostly by ruderal and segetal species. The greatest number of species appeared in June, July, August, September, October and November. The correlation analysis showed that only the number of species vs. precipitation had significant differences. It is a fact that the conditions of the "community garbage dump" represent an opportunity for invasive species to survive and persist in the seed bank, waiting for adequate conditions to germinate and settle in increasingly larger areas, favored by the growing deterioration that human activity has caused in recent years. This in the future, may end up displacing native species that have no chance to survive under these conditions.

References

Altieri M.A. & Liebman M., 1988, Weed management in agroecosystems: ecological approaches. CRC Press Inc., Boca Raton, Florida, USA, 354 pp.

Atkinson I.A.E. & Cameron E.K., 1993, Human influence on the terrestrial biota and biotic communities of New Zealand. Trends in Ecology & Evolution 8(12): 447–451. https://doi.org/10.1016/0169-5347(93)90008-D

Baker H.G., 1991, The continuing evolution of weeds. Economic Botany 45(4): 445–449.

Felix J. & Owen M.D.K., 2001, Weed seedbank dynamics in post conservation reserve program land. Weed Science 49(6): 780–787.

García E., 2004, Modificaciones al sistema de clasificación climática de Köppen. Universidad Nacional Autónoma de México, Instituto de Geografía, México.

Harlan J.R. & de Wet J.M.J., 1965, Some thoughts about weeds. Economic Botany 19(1): 16–24. https://doi.org/10.1007/BF02971181

Harlan J.R., 1992, Crops & Man. 2a edition, American Society of Agronomy, Madison, Wisconsin, USA, 284 pp.

Hobbs N.T. & Schimel D.S., 1984, Fire effects on nitrogen mineralization and fixation in mountain shrub and grassland communities. Journal of Range Management 37(5): 402–405.

Hobbs R.J. & Humphries S.E., 1995, An integrated approach to the ecology and management of plants invasions. Conservation Biology 9(4): 761–770. DOI: 10.1046/j.1523-1739.1995.09040761.x

IPNI, 2021, Índice internacional de nombres de plantas. The Royal Botanic Gardens, Kew, Harvard University Herbaria and Australian National Botanic Gardens. Retrieved from http://www.ipni.org

Lodoño-Franco L.F., Lodoño-Muñoz P.T. y Muñoz-García F.G., 2016, Los riesgos de los metales pesados en la salud humana y animal. Biotecnología en el Sector Agropecuario y Agroindustrial 14(2): 145–153. http://dx.doi.org/10.18684/BSAA(14)145–153

Martínez-Moreno D., Méndez-Salamanca A., Basurto-Peña F.A. y Rodríguez-Ramírez T., 2015, Venta de plantas útiles en el mercado de Santo Domingo Huehuetlán el Grande, Puebla, México, [in:] G. Gutiérrez-Mayen, H.R. Eliosa-León, D. Martínez-Moreno, y D. Martínez-Vázquez (eds), Contribución al conocimiento de la biodiversidad del sur del estado de Puebla. Benemérita Universidad Autónoma de Puebla, México, p. 1–27.

Merlín-Uribe Y., Villamil-Echeverri L., Martínez-Cruz J., Ramírez-García E., Ayala-Barajas R., Astier-Calderón M. y Gavito-Pardo M.E., 2014, Biodiversidad útil: Plantas e insectos benéficos asociados al cultivo de aguacate de Michoacán. Universidad Nacional Autónoma de México, 99 pp. Retrieved from https://www.ciga.unam.mx/publicaciones/images/abook_file/Biodiversidad.pdf

NCSS 10, 2015, Statistical Software NCSS, LLC. Kaysville, Utah, USA.

NOM ECOL-059-2001 (Norma Oficial Mexicana), 6 de marzo de 2002, Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo. Diario Oficial de la Federación, México.

Odum E.P. y Sarmiento F.O., 1998, Ecología: el puente entre sociedad e historia. McGraw-Hill Interamericana, México, 343 pp.

Parsons W.T. & Cuthbertson E.G., 1992, Noxious weeds of Australia. Inkata Press Melbourne Australia, 692 pp.

Perroni Y., 2007, Islas de fertilidad en un sistema árido: Nutrimentos en el suelo y su relación con la diversidad vegetal. Tesis Doctoral, Instituto de Ecología, Universidad Nacional Autónoma de México.

Radosevich S.R., Holt J.S. & Ghersa C.M., 2007, Ecology of weeds and invasive plants: Relationship to agriculture and natural resource management. Wiley-Interscience, New Jersey, 472 pp.

Radosevich S.R., Stubbs M.M. & Ghersa C.M., 2003, Plant invasions: process and patterns. Weed Science 51(2): 254–259. https://doi.org/10.1614/0043-1745(2003)051[0254:PIPAP]2.0.CO;2

Rejmánek M. & Richardson D.M., 1996, What attributes make some plant species more invasive?. Ecology 77(6): 1651–1661. https://doi.org/10.2307/2265768

Rzedowski G.C. de J. Rzedowski y colaboradores, 2005, Flora fanerogámica del Valle de México. Instituto de Ecología y Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, Pátzcuaro (Michoacán), México, 1406 pp.

SEMARNAT, 2020, Informe del medio ambiente. Residuos. Secretaría del Medio Ambiente y Recursos Naturales. Retrieved from https://apps1.semarnat.gob.mx:8443/dgeia/informe18/tema/cap7.html