

## TRADITIONAL KNOWLEDGE OF MEXICAN CONTINENTAL ALGAE

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**ABSTRACT.**— A catalog of the knowledge and uses (medicinal, nutritional, soil improvement, phytopathology, industrial, agricultural and cattle ranching) of the Mexican continental algae is presented. Two of the 56 ethnic groups registered in Mexico, the Nahuatl (State of Mexico) and the Maya (Yucatan) are the ones with the most uses and information about this resource. The taxonomic groups most used are the following classes: Cyanophyceae (8 spp.), Chlorophyceae (9 spp.), Bacillariophyceae (2 spp.), Xanthophyceae (1 sp.), Charophyceae (2 spp.) and Rhodophyceae (1 sp.).

**Key words:** freshwater algae, Mexico, etymology, uses.

**RESUMEN.**— Se presenta un catálogo sobre el conocimiento y aprovechamiento ficológico de las algas continentales mexicanas, el cual incide en diferentes aspectos: alimentación, medicina, fitopatología, de mejoramiento del suelo y pecuario y usos industriales. De los 56 grupos étnicos registrados para México, son el náhuatl (Estado de México) y maya (Yucatán) los que presentan un mayor conocimiento y utilización del recurso. Las clases taxonómicas encontradas fueron las Cyanophyceae (8 spp.), Chlorophyceae (9 spp.), Bacillariophyceae (2 spp.), Xanthophyceae (1 sp.), Charophyceae (2 spp.) y Rhodophyceae (1 sp.).

**RÉSUMÉ.**— Nous présentons un panorama général de l'emploi ethnobotanique des algues continentales mexicaines, ainsi comme leur utilisation dans la nutrition, la pharmaceutique, l'amélioration du sol, phytopathologie et l'industrie. Des cinquante-six cultures connues au Mexique, ce sont les Maya et le Nahuatl qui présentent la plus grande tradition dans l'usage de cette ressource. Les groupes taxonomiques avec le plus grand nombre de régistres sont les Cyanophyceae (8 spp.), suivies des Chlorophyceae (9 spp.), Bacillariophyceae (2 spp.), Xanthophyceae (1 sp.), Charophyceae (2 spp.) et Rhodophyceae (1 sp.).

### INTRODUCTION

Several ancient Mexican cultures developed in close relation to water. Examples

of these cultures are the Nahuatl from the Valley of Mexico, the Purepechas from Patzcuaro, Michoacan and the Maya from the Yucatan Peninsula. These cultures valued the natural wealth of their homelands and knew how to use it. But not only did the Mexican indigenous ancestors appreciate the natural resources, the Spanish conquerors who arrived later left testimonies of the many virtues they found on the land of Anahuac<sup>1</sup> and other regions.

The objective of this research is to provide information related to the uses and names of the continental algae from pre-hispanic and post-hispanic times to the present day. The autochthonous and vernacular nomenclature was our first source of information about the uses of continental algae. This research, written as a catalog, is a guide to the understanding of the vernacular nomenclature of algae as well as their geographical distribution, habitat, and uses. Such concepts, including etymology, have been well documented. This article registers the different vernacular names in Nahuatl and Maya languages; it includes ancient and modern Spanish, scientific names, and some recent research on some of the algae.

#### METHODOLOGY AND FORMAT

The information about algae found in this research and reflected in the bibliography was obtained by reviewing historical sources: ancient manuscripts, dictionaries, and recent publications. The data herein reported also include the authors' direct observations. Additional information from some herbariums was included.

The catalog's structure consists of six sections for each name. The first section consists of information related to autochthonous and vernacular (common) nomenclature, etymology, and other names. The second section documents the chronology of available information from the 16th century to the present; textual paragraphs taken from facsimiles or recent re-editions can be found in this section. Taxonomic information, generally down to species, is included, although in some cases only an interpretation of its taxonomic identity is given. The updating of biological nomenclature (shown between brackets [...]) is presented according to Ortega (1984) and Silva et al. (1996), except for the Cyanophyceae which follows Komárek and Anagnostidis (1989) and Anagnostidis and Komárek (1988). The third section indicates Mexican distribution: state, in alphabetical order, followed by a colon, then the municipality [Mpio.:] and localities. Where possible, we include a voucher number of a herbarium specimen with the name of the collector or collectors, the number of the collection, the date and herbarium's official registration number with its acronym or initial, according to the *Index Herbariorum* (Holmgren et al. 1990). The fourth section indicates the habitat according to the type of environment, substrate or biological relationship. If no information exists, we specify 'not provided'. The fifth section provides the uses of the algae, or the existing research regarding these uses (in human or animal nutritional, medicine, industry, soil improvement, and so on), and the nature of the finished product. The sixth section, or notes, has been included in many of the paragraphs as a means of explain problems regarding taxonomy, nomenclature or uses. We append a literature list on algae.

## CATALOGUE

Common name: *Algafil*.

Etymology: Spanish. Commercial name.

Chronology: Mendoza and Pino (1964) did research with *algafil* and identified it as *Chlorella* sp.

Distribution: Not provided.

Habitat: Not provided.

Uses: Increases the pigmentation in egg yolks of Leghorn hens.

Note: Byproduct of fermentation. Commercially prepared by Abbot de Mexico, S.A. laboratories. Not produced in Mexico anymore.

Common name: *Amoxtle* (Figure 1).

Etymology: Nahuatl, *amox-tli*, writing book (Karttunen 1992:11).

Other names: *amomoxtle*, *amoxtle*, *gelatina de agua* 'water jelly'.

Chronology: Sahagún in 1571 (1971:221, fo. 220) writes: "There are *urronas*<sup>2</sup> floating in the water, called *tecuitletl* or *acuitletl* or *açoquitl* or *amomoxtle*, of a light blue color; when thick, you spread it on ashes on the floor and make 'cakes'. You can toast it and eat it." ("Hay unas *urronas*, que se crían sobre el agua, que se llaman *tecuitletl* o, *acuitletl*, o *açoquitl*, o *amomoxtle*, son de color azul claro, después que está bien espeso, y grueso, cógenlo, tiendenlo en el suelo sobre ceniza y después hacen unas tortas de ello y tostadas las comen.")

Ortega (1972:93, 95) claims that, "Someone from that place [Zumpango Lake] told us it was called *gelatina de agua* 'water jelly' or *amoxtle*." Ortega named it *Nostoc commune* Vaucher ex Bornet et Flahuault.

Castello Yturbide et al. (1986:73, 190), quoting Mrs. Guadalupe Sánchez, from Tláhuac, D.F.: "Diega, my grandmother, had a canoe, she would row among the *chinampas* 'floating gardens' to collect *amoxtle*: she was the only one who knew how to prepare it. She died in 1966." ("Mi abuelita Diega tenía su canoa, se iba remando entre las *chinampas* a recoger el *amoxtle*; sólo ella lo sabía preparar. Murió en 1966.")

Distribution: State of Mexico: Laguna de Zumpango, M.M. Ortega 65, 12 Oct. 1970 (MEXU 86).

Habitat: Floating on the lagoon.

Uses: Edible.

Note: It is no longer eaten by the people of Zumpango. It is still used in Bolivia (Halperin 1967) and Perú (Aldave-Pajares 1969). The Zumpango lake was dried out and re-filled with recycled water.

Common name: *Chilacaxtle* (Figure 2).

Etymology: The original Mexican term for it is not known; nevertheless, Karttunen (1992:3, 51, 52) mentions the terms: *chilach-tli*, seed of the chili pepper plant; *ach-tli*, possessive of *-achyo*, seed.; *chil-li*, chili pepper. Possibly, seed of the chili pepper.

Other names: *Chilacastle*, *chilacascle*.

Chronology: Robelo (*chilacascle*, 1941:384) and Santamaría (*chilacastle*, 1978:491) consider it to be a plant that grows on the surface of *acequias* 'causeways' and stagnant water: *Azolla caroliniana* Willdenow [*Azolla filiculoides* Lamouroux].



FIGURE 1.— *Amoxtle* [*Nosctoc commune* Vaucher ex Bornet et Flahault] water jelly floating on the Zumpango Lake.

Espinoza Abarca et al. (1985:61-62) collected this plant in Mixquic, D.F. in December, 1980; it was used as green manure and was identified as *Azolla filiculoides* Willdenow in symbiotic association with *Anabaena azollae* Strasburger [*Trichormus azollae* (Strasburger) Komárek et Anagnostidis].

Distribution: Federal District: causeways near the town of Mixquic. Michoacán: Mpio. Morelia: Morelia, G. Arsene 3177, 4 Oct. 1909 (MEXU 185015, 186276, as *chilacaxtli*).

Habitat: Gutters, causeways.

Uses: Green manure.

Note: There is confusion between the terms *chilacastle* and *chichicastle*. Bravo Hollis (1930:7) indicates that the first term is used both for *Azolla* and for *Lemna*, and it is used as duck food. But Lot et al. (1999:37) attribute the term only to *Lemna gibba* Linnaeus whose vernacular name is: *chilacastle*, *lenteja* and *lentejilla*, terms used in the Federal District, and used as duck food and as manure on the *chinampas*. Martínez (1979:284) says the term *chichicastle* refers to *L. gibba*. For Espinoza Abarca et al. (1985), *Azolla filiculoides* is a plant that captures atmospheric Nitrogen through its symbiosis with *Anabaena*. The oldest reference to *chilacaxtli* is found on a herbarium sample collected by G. Arsene (a priest) in 1909 and identified as *Azolla caroliniana*, a synonym of *Azolla filiculoides*. Surely, the *chilacaxtli* or *chilacastle* is used as green manure [*Azolla*] and *chichicastle* [*Lemna*] as duck food. It is easy to be confused because *Azolla* and *Lemna* frequently grow together and tend to intertwine (Bravo 1930:7).



FIGURE 2.— *Chilacastle* floating on the canals of Mixquic, Xochimilco, D.F. (March 23, 1972).

Common name: *Cuculin* (Figures 3, 4).

Etymology: Possibly a Nahuatl term. Orozco y Berra (1798:153) indicates that *cuculito del agua* 'water cuculito' is a derivation of the Mexican term *cuculin*. Robelo (1941:362) states that the *cocolli* is a corn and bean *tamal*<sup>3</sup>, prepared with honey and used by the Indians of the Valley of Mexico during religious ceremonies.

Other names: *Cuculito del agua, cocol, cocolin, cocol de agua* 'water cocol'.

Chronology: Molina in 1555 (1966:328) states that the name *cuculin*, means water viscosity or edible thing which grows among certain aquatic plants.

Hernández between 1571-1575 (1959:395) writes: "For the Indians, *cocolin*, a strong smelling manure, is a brown substance produced in the Mexican lake, which floats on the water and looks and smells like slime, from where the name comes. Indians sell it and use it as food when they are extremely hungry because it has a fetid smell and is not a good thing to eat." ("Llaman los indios *cocolin* o sea cieno de olor fuerte, a cierta sustancia parda que produce el lago mexicano, que flota sobre el agua y es semejante al limo y de olor parecido también, de donde le viene el nombre. Lo venden los indios y lo emplean en sus comidas para saciar su gula de cualquier manera, pues exhala un olor fétido y es alimento dañino.")

Orozco y Berra (1798:153) writes: "The Indians call it water foam and it is eaten today under the name of *cuculito de agua* 'water cuculito' which is a derivation of the Mexican word *cuculin*." ("Los indios le llaman espuma del agua y consumen el producto actualmente con el nombre de *cuculito del agua* palabra estropeada del mexicano *cuculin*.")

Ortega (1972:91, 93, figs. 14-19) identified it as *Phormidium tenue* (Meneghini) Gomont and *Chroococcus turgidus* (Kützinger) Nägelli, in his writings on Lake Texcoco and in his observations in markets in Coyoacan, the Merced, Zumpango, Cuautitlán, Tláhuac, Xochimilco, Xaltocan and Texcoco. The author says that while in the markets, the fishmongers [women] told us that they sold *tamales* (Figure 4) called *cocol de agua* 'water cocol' made of a sort of gel found on the water and that we thought was the original *tecuitate*.

Castelló Yturbide et al. (1986:74) gathered information from Doña Juana García in Xaltocan, State of Mexico: "In Xaltocan, they say that the *acocol* is some kind of foam which is gathered from the water in baskets, it is cleaned and mixed with some herbs, salt, and dried chili pepper; corn leaves are then spread into this mixture. They are steam cooked, just as *tamales* are, this is why they are called *tamales de lodo* 'mud tamales'. We would eat them on their own or with something else." ("En Xaltocan, dicen que el *acocol* es espuma que se cría en la superficie del agua, se saca con una canasta, se lava, se muele con epazote y chile seco, se le pone sal y la masa se extiende en hojas de maíz. Luego se cuece al vapor, como los *tamales*, por eso llaman tamales de cocol de lodo. Los comíamos solo o en guisado.")

Distribution: State of Mexico: Mpio. Ecatepec: surrounding small causeways of the Texcoco lake [the "Caracol"], F. González leg. M.M. Ortega 64, 5 Nov. 1971 (MEXU 100); external canals of the Caracol [Sosa Texcoco Company], J.L. Godínez, 24 August. 1982 (MEXU 1246), Sept. 1982 (MEXU 1493, 1494).

Habitat: On *tequesquite* soil<sup>4</sup> of the canals and small causeways of the Texcoco lake.

Uses: Edible. Due to its nutritional importance, some authors did research on its general chemical composition (Salcedo Olavarrieta et al. 1978a), protein (Salcedo Olavarrieta et al. 1978b) and some inorganic elements (Godínez et al. 1984). Its nutritional value did not lie in the proteins but in the inorganic elements such as calcium and iron.

Preparation of the product: Ortega (1972:93) said that: "Fishermen from Xaltocan gather the *cocol* from water puddles and canals once it is mature or when the layer of algae is thick enough. It is collected by hand or with very fine nets woven the old Mexican fashion. The algae is carefully washed to get rid of the mud, then it is minced in *molcajetes*<sup>5</sup> and seasoned with herbs [*Chenopodium ambrosioides* Linnaeus] or parsley [*Petroselinum hortense* Hoffman], slices of green chili pepper [*Capsicum annum* L. var. *acuminatum* Fing] or *guajillo* chili [*C. annum* L. *longum* Sendt.] and animal fat; it is finally steam cooked and covered with corn leaves. This dish, when steamed, becomes brownish red, has a strong smell and a "damp" taste. It is eaten with *tortillas* 'flat corn cakes' and *mole*<sup>6</sup>, and it is quite nice."

Note: Castelló Yturbide et al. (1986:74) wrote that the *tamales* can still be found in Tonatitla, and added: "During the 70's it was still possible to buy these *tamales* with the fishmongers in markets in Cuautitlan, Xochimilco and Texcoco." During a trip near the Texcoco canals and markets (November 17, 1984), J.L. Godínez found no traces of this product. It is very possible that they no longer exist, just as Ortega (1972) indicated: "In Xochimilco (November 15, 1970), an old lady and some vendors told us that the *cocol* has not been seen for approximately eight years, that it is quickly disappearing due to water pollution [by sewage] and because the lake is now dry."



FIGURE 3.— *Cocolin* [*Phormidium tenue* (Meneghini) Gomont] collected from the Sosa Texcoco canals (October, 1982).

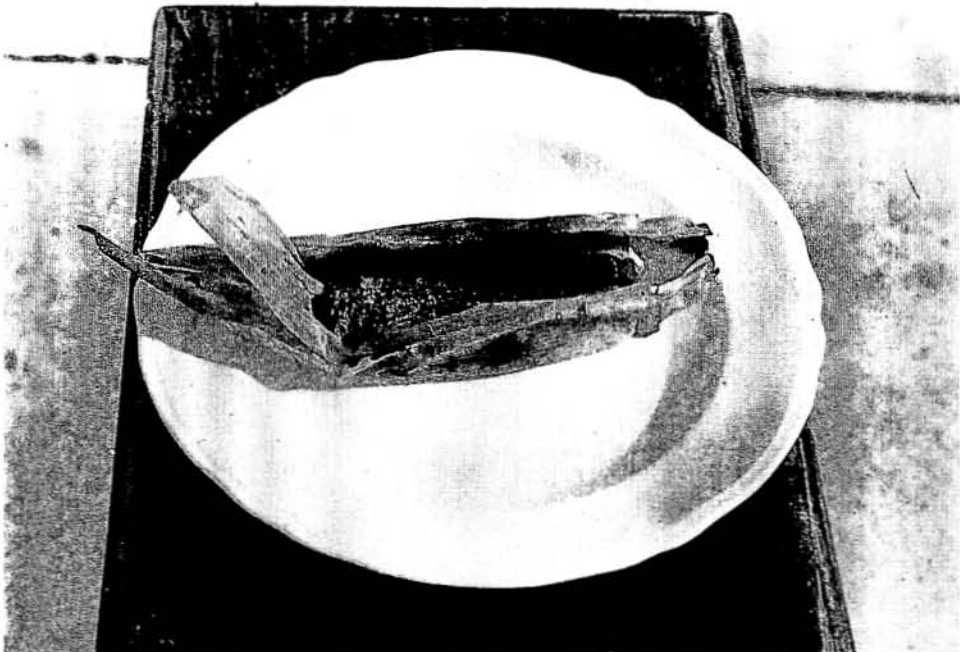


FIGURE 4.— *Tamal* made of *cocolin*.

Common name: *Conferva*.

Etymology: Linnean name, meaning, "made of free filaments" (Stearn 1992:389).

Chronology: Ponce de León (1909:20) named it *Conferva chantransia* Linnaeus [*Lemanea fluviatilis* (Linnaeus) C. Agardh].

Distribution: Sinaloa.

Habitat: Not provided.

Uses: Not provided.

Common name: *Chonak*.

Etymology: *Chonak*, very damp thing, *ovas* 'algae' (a very fine filamentous aquatic plant) of the lake, freshwater filamentous slime, filamentous substance growing in stagnant water (*Diccionario Maya Cordemex* 1980:107).

Other names: *Choonakil*, *ucho*"*nakilha*, water *ovas* (*Diccionario Maya Cordemex* 1980:107).

Chronology: Ortega et al. (1995:xvii) interpret these names as Chlorophyceae algae.

Distribution: Yucatan Peninsula.

Habitat: Freshwater.

Uses: Not provided.

Note: *The Diccionario de la Lengua Española* (1970:954) indicates that *ova*, from the Latin *ulva*, refers to unicellular [pluricellular] green algae, which can consist of simple or branched filaments, or large and leafy blades, or narrow, like bands, growing in the sea, rivers or ponds, floating on the water or fixed to the bottom by rootlike appendixes. "Ova de río" refers, therefore, to freshwater algae [possibly filamentous Chlorophyceae, Cladophoraceae] and "ova marina" to algae with laminar expansions or tubular hollow bands, almost always branched, found in sea and brackish water [possibly Ulvales such as *Enteromorpha* and *Ulva*].

Common name: *Diatoma de copos* 'diatoms tufted'.

Etymology: Spanish. *Diatoma* refers to diatom, common name for an algae of the class Bacillariophyceae; *copos* refer to tuft or clot.

Chronology: Martínez Gracida (1891:24) named it *Conserva* [*Conferva*] *pectinalis* O.F. Müller [*Fragilaria diophthalma* (Ehrenberg) Ehrenberg].

Distribution: Oaxaca.

Habitat: Not provided.

Uses: Not provided.

Common name: *Diatoma erguida* 'stiff diatom'.

Etymology: Spanish. *Diatoma* refers to diatom, common name for an alga of the class Bacillariophyceae; *erguida* means stiff.

Chronology: Martínez Gracida (1891:24) named it *Conserva* [*Conferva*] *striatum* [*striatula*] J.E. Smith [*Fragilaria striatula* (J.E. Smith?) Lyngbye].

Distribution: Oaxaca.

Habitat: Not provided.

Uses: Not provided.

Common name: *Espirulina* 'Spirulina' (Figure 5).

Etymology: Spanish. From the Latin *spira*, each of the turns of a spiral. Common name for a member of the class Cyanophyceae or blue-green algae.



Chronology: Since 1967, after the recognition of the existence of *Spirulina geitleri* De Toni in lake Texcoco, Sosa Texcoco Company, in collaboration with the French Institute of Petroleum, studied and cultivated *Spirulina* for twenty years (Sosa Texcoco 1976:6). Research on Mexican *Spirulina* during the 1970s and 1980s was extensive. The bibliography can be consulted in Ortega (1987).



FIGURE 5.— Products made of *Spirulina*.

Distribution: State of Mexico: Mpio. Texcoco: Evaporador Solar El Caracol.<sup>7</sup>

Habitat: It is found in water plankton in canals from "El Caracol."

Uses: Human and animal dietary supplement. High content of proteins, minerals and vitamins. Santillán (1982:42) indicates that more than 50 products were elaborated with *spirulina* (capsules, tablets and powdered *Spirulina*). Ortega (1987:175) states that they reached a production of almost 1000 tons per year. The algae were exploited, by semi-natural cultivation, by Sosa Texcoco until 80's. During the 1990 this company gradually ceased its production. For more information see Santillán (1982) and Ortega et al. (1995:186-190).

Common name: *Iximha*.

Etymology: Maya language. *Ixim*, corn; *ha*, water: water corn (*Diccionario Maya Cordemex* 1980:275).

Chronology: Doctor Román Sabas Flores (in Brioso Vasconcelos 1923:544) describes it as follows: "The plant known in the peninsula as *Ixinha* [*Iximha*] is *Chara gymnopus* A. Braun [*Chara zeylanica* Klein ex Wildenow]."

Distribution: Yucatán: Izamal. Veracruz.

Habitat: In deep natural ponds and other natural deposits of permanent water.

Uses: Research on harmful insects (Hoffman and Sámano-Bishop 1938a, 1938b; Peláez 1947) has found a relationship between some algae and the larvae of organisms such as *Anopheles pseudopunctipennis* and *A. albimanus* Wied., which are malaria vectors in regions of Oaxaca, Veracruz and Yucatan. The effect of the algae on these larvae was first observed by medial doctor Lisandro Dorantes (in Brioso Vasconcelos, 1923:544) in *cenotes* 'doline', deep natural ponds in Yucatan. Brioso Vasconcelos (1923:546) tried the lethal effect of the algae on larvae of five species of *Chara* [*Ch. fragilis*, *Ch. foetida*, *Ch. contraria*, *Ch. hispida*], including *Chara gymnopus*. He cultivated the algae in order to control the spread of malaria (by *Aedes calopus* and *Culex* sp. mosquitoes) during the anti-malaria campaigns in Veracruz and Yucatan. Dr. Connor (in Brioso Vasconcelos 1923:546) underlines the presence of an active ingredient in *C. gymnopus* which destroys the mosquitoes' larvae in barrels and tanks.

Common name: *Lama* 'slime'.

Etymology: Spanish. From the Latin *lama*, soft, loose and sticky slime, of a dark color, found at the bottom of the sea or rivers, or at the bottom of places where there is, or has been, water for a long time. Algae or "ova" of slimy places or puddles (*Diccionario de la Lengua Española* 1970:784).

Chronology: González Coss (1872:314) called it *Conferva fontinalis* Linnaeus [*Vaucheria fontinalis* (Linnaeus) Christensen] and *Conferva rivularis* Linnaeus [*Cladophora rivularis* (Linnaeus) van den Hoek].

González (1876:32) called it *Byssus flos-aquae* Linnaeus [*Anabaena flos-aquae* Brébisson ex Bornet et Flahault]; *Conferva bullosa* Linnaeus [*Cladophora glomerata* (Linnaeus) Kützing var. *crassior* (C. Agardh) van den Hoek] and *Conferva rivularis* Linnaeus [*Cladophora rivularis* (Linnaeus) van den Hoek].

Martínez Gracida (1891:24) called it *Conserva* [*Conferva*] *bullosa* Linnaeus [*Cladophora glomerata* (Linnaeus) Kützing var. *crassior* (C. Agardh) van den Hoek], *Conserva* [*Conferva*] *flosaquae* [*flos-aquae*] (Linnaeus) Roth [*Anabaena flos-aquae* Brébisson ex Bornet et Flahault], *Conserva* [*Conferva*] *pectinalis* O.F. Müller [*Fragilaria diaphthalma* (Ehrenberg) Ehrenberg], *Conserva* [*Conferva*] *rivularis* [*rivularis*]

Linnaeus [*Cladophora rivularis* (Linnaeus) van den Hoek] y *Conserva* [*Conferva*] *striatum* [*striatula*] [*Fragilaria striatula* (J.E. Smith?) Lyngbye].

Castañeda (1933:142) called it *Spirogyra*, and Bravo Hollis (1936:219) called it *Spirogyra flavescens* (Hassall) Kützing. The *Enciclopedia Universal Ilustrada* (tomo 29:359) describes this slime as a: "Plant growing in Michoacan that seems to be *Microspora fontinalis* De Toni [*Rhizoclonium hieroglyphicum* (C. Agardh) Kützing], freshwater green algae."

Distribution: Guanajuato: Silao. Hidalgo: Mpio. Actopan: La Peña. Jalisco. Michoacán. Nuevo León: Monterrey. Oaxaca.

Habitat: Freshwater.

Uses: Not provided.

Note: *Lama* or slime is a name given to many species of algae.

Common name: *Lama de Comanjilla*.

Etymology: Spanish. Toponym, see *lama*.

Chronology: González Coss (1872:314) called it *Ulva labergutiformis* [*labyrinthiformis*] Gmelin [*Spirulina labyrinthiformis* (Linnaeus) Gomont].

Distribution: Guanajuato: Silao.

Habitat: Not provided.

Uses: Not provided.

Common name: *Lama del topo* 'mole slime'.

Etymology: Spanish. Toponymic, see *lama*.

Chronology: González (1876:32) called it *Oscillatoria calida* (C. Agardh) González [*Phormidium calidum* (C. Agardh) Gomont ex Gomont].

Distribution: Nuevo León: Monterrey: El Topo Ranch.

Habitat: In 40° C water source.

Uses: Not provided.

Common name: *Lama larga* 'long slime'.

Etymology: Spanish, see *lama*.

Chronology: Martínez Gracida (1891:24) called it *Conserva* [*Conferva*] *lutescens* (Vaucher) De Candolle [*Zygnema lutescens* (Vaucher) C. Agardh].

Distribution: Oaxaca.

Habitat: Not provided.

Uses: Not provided.

Common name: *Mancha de la hoja* 'leaf spot'.

Etymology: Spanish.

Chronology: Martín (1947:156) called it *Cephaleuros virescens* Kunze.

Distribution: Chiapas: on the riverbanks of the Grijalba River. Tabasco-Chiapas.

Veracruz: Mpio. Tezonapa: near Tezonapa in El Palmar.

Habitat: Parasite of *Hevea brasiliensis*.

Uses: Not provided.

Note: Ortega (1984:238) indicates that this alga lives on leaves of old trees and young plants. She also states that the "leaf spot" produced by the alga causes relatively little harm.

Common name: *Nitla* (Figure 6).

Etymology: Possibly of Nahuatl origin. *Nitla*, indefinite pronoun which refers to things (Siméon, 1988:549).

Chronology: Ortega et al. (1995:190) considers it to be *Prasiola mexicana* J. Agardh.

Distribution: State of Mexico: Mpio. Ocuilan de Arteaga: la Cañada river, G. Garduño, 4 Feb. 1981 (IZTA 106), Aug. 1982 (IZTA 68), Nov. 1983 (IZTA 67), 7 Nov. 1983 (IZTA 120), 24 Oct. 1986 (IZTA 84).

Habitat: Grows on river rocks.

Uses: Medicinal (used as cough suppressant and to stop nose bleed).

Preparation of the product: As cough suppressant, a liter of water with some bits of algae. To stop nosebleed, it is put directly on the forehead.

Common name: *Salivazo de la Luna* 'moon spit'.

Etymology: Spanish. *Salivazo* 'large spit', amount of saliva that is expelled from the mouth all at once.

Ponce de León (1909:20) named it *Nostoc commune* Vaucher ex Bornet et Flahault.

Distribution: Sinaloa.

Habitat: Not provided.

Uses: Not provided.

Common name: *Surrupa*.

Etymology: Unknown meaning



FIGURE 6.— *Nitla* or *Prasiola mexicana* J. Agardh collected from the Ocuilan River, State of Mexico (December 18, 1981).

Chronology: Ponce de León (1909:20) named it *Conferva chantransia*? [*Lemanea fluviatilis* (Linnaeus) C. Agardh].

Distribution: Sinaloa.

Habitat: Not provided.

Uses: Not provided.

Note: Ortega (1984:62) states that its identification is doubtful.

Common name: *Tachak*.

Etymology: Maya language. *Ta"chak, lama* 'slime', green and slippery thing. It appears over the soil after much rain (*Diccionario Maya Cordemex* 1980:751).

Chronology: Ortega (1984:36) and Ortega et al. (1995:xvii) refer to it as *Nostoc verrucosum* Vaucher ex Bornet et Flahault.

Distribution: Yucatán: Mpio. Izamal: Aguada Chulumbay, 9 miles W. of Izamal.

Habitat: On land

Uses: Not provided.

Common name: *Tecuitlatl* (Figures 7-9).

Etymology: Nahuatl language. Siméon (1988:453) mentions that the suffix *tetl* means "stone" and *cuitlatl* "excrement": excrement of stones. Karttunen (1992:73) speaks of *te-tl*, stone or gem; *cuitlatl*, excrement, excrescence, residue: "excrescence or residue of stones." In relation to the names of towns such as Tláhuac, Cuitláhuac [or Cuitlahuatzin, Aztec king], Cuitlahuacan and Tecuitlatongo, Ortega (1972:87) writes that they are all toponyms of the term "algae." There seems to be doubt about the suffixes *tetl* and *teotl*; if the latter one is joined to other words, it acquires the meaning "sacred," "marvelous," "strange," and "surprising." Robelo (1941:245) wrote, "Their name for gold was *costicteocuitla* or yellow excrement of the gods," and for silver, *iztac-teocuitlak* or "white excrement of gods." Robelo includes the name Tecuitlapan, *teocui-tla-a-pan*: *teocuitla*, gold; *atl*, water and river; *pan*, in "The river of gold." If the termination *teotl* was thought to be *tetl*, the meaning of *tecuitaltl* is completely different; it might mean "sacred excrement" and this could lead us to surmise that the ancient Mexicans considered this product to be a valuable mineral, just as did Hernández (1959).

Other names: *Tecuitate*.

Chronology: Tezozomoc in 1598 (Alvarado Tezozómoc, 1944:62) states: "On some days Mexican women would go to the market to sell fish, frogs, *axayactatl*, seawater flies, *izcahuitle*, *tecuitlatl* and other things which came from the lake, and all kinds of ducks." ("Donde otros días las mujeres de los mexicanos iban al mercado de Xochimilco a vender pescado, ranas, *axayáctatl*, moscas del agua salada, *izcahuitle*, *tecuitlatl* y otras cosas salidas de la laguna y patos de todo género.")

Benavente in 1541 (Benavente, 1903) states: "On the water of the Mexican lake grows a kind of powdered slime, and at certain times of the year, when it becomes thicker, the Indians fish it out of the water with very fine nets until their canoes are full of it; then the slime is put over sand to dry. They then prepare a sort of cake, thick as a finger. Afterwards it is cut in pieces like thick bricks and the Indians eat much of it and enjoy it. It is sold by many vendors in markets. It tastes like salt." ("Críanse sobre el agua de la laguna de México unos como limos muy molidos, y a cierto tiempo del año que están más

cuajados, cógenlos los indios con unos redejoncillos de malla muy menuda, hasta que hinchen los acales ó barcos de ellos, y á la ribera hacen sobre la tierra ó sobre arena unas eras muy llanas con su borde de dos ó tres brazas en largo y poco menos de ancho, y échanlos allí á secar; echan hasta que se hace una torta de gordor de dos dedos y en pocos días se seca hasta quedar de un gordor de un ducado escaso; y cortada aquella torta como ladrillos anchos, cómenlo mucho los indios y tiene se bueno anda esta mercaduria por todos los mercaderes de la tierra, como entre nosotros los que son de la salsa de los indios es bien sabroso, tiene un saborcillo de sal.”)

López de Gómara in 1552 (1988:115-116) writes: “With very fine nets they periodically sweep the lake and collect a powdered thing which grows in the lakes of Mexico; this thing becomes thicker, but it is not a grass, nor is it dirt. Rather, it is something resembling slime. There is a lot of this slime, and they collect much of it. They make cakes like bricks with it, the way they do bricks of salt, and they take it to markets, near and far, and sell it. They eat this thing as if it were cheese. It tastes like salt, and with *chilmolli*<sup>8</sup> it tastes quite good. They say that birds are so attracted to this slime that sometimes in winter the lake is completely covered by it...” (“Con redes de malla muy menuda barren en cierto tiempo del año una cosa molida que se cría sobre el agua de las lagunas de México, y se cuaja, que ni es yerba, ni tierra, sino como cieno. Hay de ello mucho y cogen mucho; y en eras, como quien hace sal, lo vacían y allí se cuaja y seca. Hácenlo tortas como ladrillos, y no sólo las venden en el mercado, más llevánlas también a otros fuera de la ciudad y lejos. Comen esto como nosotros el queso, y así tienen un saborcillo de sal, que con *chilmolli* es sabroso. Y dicen que a este cebo vienen tantas aves a la laguna, que muchas veces por invierno la cubren por algunas partes...”)

Santa Cruz c. 1555 (Apenes 1947, pl. 2) did the plan of the City and Valley of Mexico, also known as the Upsala Map (Figure 7). Ortega (1972:89) analyzed this map, and wrote, in relation to the algae: The Upsala map is interesting not only as a geographical document but also for its many references to the human activities near the lakes and Valley of Mexico in general. Many traditions and activities continue to exist just as they did many years ago, but many others, such as the gathering of *tecuítlatl*, tend to disappear... Fishermen collecting a kind of foam from the water can still be seen (Figure 7). Someone pulls a net to the shore of the lake. They still collect *ahuauhtle* and *cocol* from the borders of the lake. Other aspects such as bird hunting are more evident. To the right, the isle of Xaltocan can be seen, with a bear in the middle. Today, Xaltocan is a small town located on saltpeter soil, where the lake is only a memory. Nevertheless, they still prepare *tamales* made of small fish and of *cocol de agua* or *water cocoles*. Fishermen bring this product to markets in Mexico City. *Cocoles* can be found in water puddles, canals in Texcoco and sometimes in Zumpango.

Díaz del Castillo in 1568 (1964:159) wrote: “There were fish vendors (women) selling small loaves of bread made from a kind a slimy substance they collect from that large lake and when it thickens they make bread that tastes a little like cheese...” (“Pues pescaderas y otros que vendían unos panecillos que hacen de una como lama que cogen de aquella gran laguna, que se cuaja y hacen panes de ello que tienen un sabor a manera de queso...”)



FIGURE 7.— Detail of the Upsala Map (16th century). In the upper left hand corner, people collecting algae can be seen.

Sahagún in 1571 (1971:221, fo. 220) wrote: "There are some *urronas* growing on the water which are called *tecuitlatl* (Figure 8) or *acuitlatl* or *açoquitl* or *amomoxtli*, they are light blue, and when they are thick enough, the people spread this thing over ashes and afterwards they make "cakes" which are toasted and eaten (Figure 9)." ("Hay unas *urronas*, que se crían sobre el agua, que se llaman *tecuitlatl* o, *acuitlatl*, o *açoquitl*, o *amomoxtli*, son de color azul claro, después que esta bien espeso, y grueso, cogenlo, tiendenlo en el suelo sobre ceniza y después hacen unas tortas de ello y tostadas las comen.")

Hernández between 1571-1575 (Hernández 1649, 1959:408-409) wrote: "The *tecuitlat*, a substance much like mud growing in some places of the Mexican lake, floats to the surface from where it is collected with nets or shovels. Once out of the water, the Indians make small 'cakes' which are put to dry on fresh herbs until completely dry and afterwards these cakes are kept for about a year as if it were cheese. These cakes are eaten when needed, with roasted corn or with the popular *tortillas*. Each area where this slime is collected provides the owner with good profits. It tastes like cheese, and this is how the Spaniards call it, although it is not as good as cheese, it smells a little like mud, it is of a green color which turns black, it can be eaten only in small quantities and only instead of salt or to give some flavor to corn. Tortillas made of this slime are not good: Spaniards, who eat almost anything, especially in these lands, do not eat these tortillas." ("Brotta el *tecuitlat*, que es muy parecido al limo, en algunos sitios del lago mexicano, y gana el punto la superficie de las aguas de donde se saca o barre con redes o se apila con palas. Una vez extraído y secado un poco al sol, le dan los indios forma de pequeñas tortas; se ponen entonces otra vez al sol y sobre yerbas frescas hasta que se seca perfectamente, y se guarda luego como el queso por sólo un año. Se come cuando es necesario

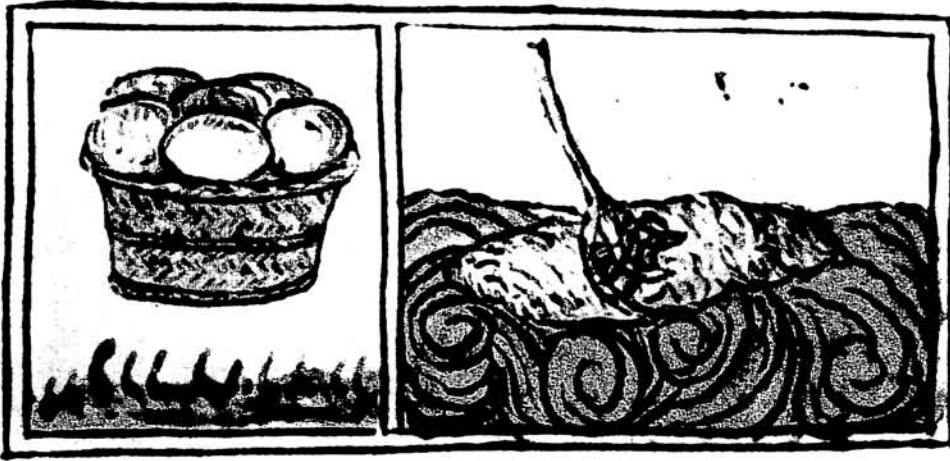


FIGURE 8.— Images from the *Florentine Codex* interpreted by Ortega (1972:87). Tenate or basket made of woven *ixtle* and palm leaves, with small loaves of bread made of *ixcahuítl*. Below, filaments of the alga *tecuítlatl*; also, the fish spear used by fishermen to collect the foamy substance or *tecuítlatl* may be seen.



FIGURE 9.— Images from the *Florentine Codex* interpreted by Ortega (1972:87) and Dibble and Anderson (1963:fig. 227). Two blue-green plates (in the original) prepared with *tecuítlatl*.

con maíz tostado o con las comunes tortillas de los indios. Cada venero de este limo tiene su dueño particular, a quien rinde a veces una ganancia de mil escudos de oro anuales. Tiene sabor de queso, y así lo llaman los españoles, pero menos agradable y con cierto olor a cieno; cuando reciente es azul o verde; ya viejo es de color de limo, verde tirando a negro, comestible sólo en pequeña cantidad, y esto en vez de sal o condimento del maíz. En cuanto a las tortillas que hacen de él, son alimento malo y rústico, de lo cual es buena prueba el hecho de que los españoles, que nada desprovechan de lo que sirve al regalo del paladar, sobre todo en estas tierras, jamás han llegado a comerlas”).

Pomar in 1582 (Pomar and Zurita, 1941) wrote: “...neither fish nor birds reproduce here, and those birds which come from Florida in winter eat a small fish which can be found almost all year round, and a kind of food called *tecuítlatl* made



of green slime that grows in the lake. Cakes are made of this, they are dark green, and the Spanish call them dirt cheese." ("...no se crían peces ni aves y las que vienen de Florida durante el invierno toman un pescadillo que se mantiene casi todo el año y un género de comida llamado *tecuítlatl* que hacen de unas lamas verdes que cría [la laguna] lo cual hecho tortas y cocido, queda con un color verde oscuro, que llaman los españoles queso de tierra.")

Clavijero between 1780-1781 (1945:354) wrote: "They not only ate living things, they also ate a slimy substance which floated on the water; they would collect it and make some cakes which would be dried and kept and would be used instead of cheese. They would call this substance *tecuítlatl*." ("Comían no solamente de las cosas vivientes, sino aun de cierta substancia limosa que sobrenadaba en el lago, la cual recogían, secaban un poco al sol y hacían de ella unas tortas que volvían a secar y guardaban para que les sirviese de queso, cuyo sabor remeda. Daban a esta substancia el nombre de *tecuítlatl*.")

Ehrenberg (1854:373, 374) analyzed several ancient Mexican documents. In a chapter of *The Edible and Medicinal Soils in Mexico* ("*Las tierras comestibles y medicinales de México*") he wrote, "In descriptions of Mexico we find news about mineral substances, some of which are eaten there for their taste, or for their medicinal properties." Research on the composition and structure of these substances might be very interesting and we might learn more about them. After analyzing the meaning of the *tecuítlatl* in the writings of Bernal Díaz del Castillo and Hernández, the author wrote that cakes made from this substance were bad food, which is evident because the Spaniards ate everything with good flavor, but they had not eaten any of this. The description could refer to *Oscillarias*<sup>9</sup> and polygastric<sup>10</sup> with a silica shell which emerge (in small clots) to the surface—in springtime—, from the bottom of stagnant water. One has to imagine isolated puddles in a swamp.

Ancona (1933:55) writes: "Floating on the lake, but preferably on puddles and canals which are still found during the dry season, green slimy masses of *Vaucheria* and Cyanophyceae of the genera *Oscillaria* and *Nostoc* can be found; the slimy secretion of the latter ones is favored by the *Gyrinus* flies and even by the corixids (water bugs), a fact we could appreciate when we dissected their stomachs." This might be what Clavijero referred to when he wrote about a foamy substance which was collected and eaten by ancient Mexicans, because we have never found eggs of the *ahuautle*<sup>11</sup> which stick to the Cyanophytes.

Ortega (1972:86) wrote: "It is evident that the *tecuítate* is an important nutritious element for the poor peoples of the Anahuac." Several authors mention this product as part of a simple tradition practiced on a daily basis.

Distribution: Valley of Mexico [Texcoco and Zumpango].

Habitat: Lakes. Massive algae growth.

Uses: Edible.

Note: In Chad Lake, Africa, the French Petroleum Institute studied *Spirulina platensis* that had been consumed by local population (Léonard 1966:127). While, in Mexico, some authors (Prieto 1985:263; Castelló Yturbe et al. 1986:73) surmised that the *tecuítlatl* was *Spirulina maxima*, a blue-green algae, present in highly alkaline waters, such as those of Lake Texcoco. Nevertheless, Ehrenberg

(1854) was the first scientist who discovered that algae (*Oscillarias* and diatoms) were the main component in this Mexican product. Ortega (1987:174) wrote that the vulgar name of *tecuítlatl*, which had been directly recorded from various informants in the Valley of Mexico, actually belongs to blue-green freshwater algae, which includes the *Phormidium tenue* or *cuculito del agua* 'water cuculito'. Farrar (1966:341) writes, based on historical facts, that the inhabitants of Tenochtitlan ate large amounts of blue-green algae [Cyanophyceae] of unknown species. He also states that, today, there are large quantities of Cyanophyceae closely related to toxic algae such as *Microcystis* and *Anabaena*. In spite of all this, it appears that *tecuítlatl* is being eaten with no harm to human health. It is possible that changes to the environment caused by urban growth have radically altered the natural habitat of the Valley of Mexico, and edible species have been substituted by toxic ones.

Common name: *Tízatl* 'white dirt' (Figures 10, 11).

Etymology: Nahuatl language. *Tíza-tl*, a type of varnish or white dirt (Molina 1944:113; Siméon 1988:546; Karttunen 1992:241). Robelo (1902:167) wrote, "Spanish for *tiza* or *tizar*, an Aztec word composed of *tízatl* (white dirt) a mixture of fossil microorganisms." Corominas and Pascual (1983:512) included the definition, "some white powder that silver craftsmen and other persons use to clean gold and silver jewelry." The word *tiza* is absent from the dictionaries of the classic period as well as from ancient editions. It can be found in the 1843 edition, but the definition says, "ashes of a deer's antlers, to which in 1869, is added white dust used as marker, which can be used to clean metals." Today, the word *tiza* is very well known in places where Spanish is spoken, especially as a name for limestone and chalk, and it is used to write on waxed surfaces, on cloth, etc. The terms *tiçatl*, varnish or white dust, can be found in the Nahuatl Dictionary by Molina in 1571 [Molina 1966:508], together with the word *tiçayoa*, 'to be full of varnish' or 'of white dirt,' and *tiçauia*, 'to varnish with white varnish,' from where the Mexican name *Tizapan* comes. In Mexico, the word *tiza* is used, and also *tizar*, which is a more refined word... and *tizate* is used in other places. The sound of this last word is like that of many Aztec words (tomate, petate, metate, achiote, etc.) although sometimes the original accentuation is kept and the ending *tl* is eliminated. Ximénez in 1615 (1888:282) describes in detail the shape and elaboration of the Mexican *tiçatlalli* (of the term *tlalli*, dirt). If we had not had this information we would have believed that, given that coal can be used in the same way, its name would have been used for white chalk, and we would have supposed that the term came from *tizo*, *tizon*, which comes from the Latin *titio*, *-onis*: chalk burnt almost completely...these terms undoubtedly come from *titio*, as well as *atizar*, but we have renounced the use of this etymology. In Asturias, the term "tiz" is used for *tiza*, white natural or artificial stone, which is a combination of the Mexican term *tiza* and the local synonym *xiz* [gis], from *gypsum*.

Other names: *Tetízatl* (*tetl*, rock; *tízatl*, white dirt), *tizatllalli* (*tlalli*, clay), *tisar*, *tizate*, *tiza*, *tierra blanca* 'white dirt', *tierra de diatomeas* 'diatomaceous dirt', *diatomita* 'diatomite', 'diatom dust'. *Chimáltízatl* (*chimalli*, escudo: specular stone). *Atízatl* (*a-tl*, water: *agua-tízatl*). The verb "entizar," to paint with "tiza" or chalk. Robelo (1941:37) writes: *Tiza-a-pan* (*tiza*, *tízatl*; *atl*, water; *pan*, in:

in water of tiza). The *Diccionario Porrúa* (1995:3503-3504) includes *Tizatlán* (tiza, *tízatl*; *tlalli*, clay: over on clay). It is an archeological place, its population belonged to the Cholultec [Tlaxcala] culture. In other parts of the world, the term "tripoli" referred to siliceous deposit formed mainly of frustules of diatoms. Today it means "diatomite" (Díaz Lozano 1917:9; Hernández Velasco 1955:36).

Chronology: Hernández between 1571-1575 (1959:408) and Ximénez in 1615 (1888:282-283) wrote: "The *tetízatl* or *tízatl* stone is a white stone used by painters, which is burnt to ashes until it turns white. It is, nevertheless, less white and shiny than the *chimaltízatl*." ("El *tetízatl* o piedra *tízatl* es una piedra blanca que usan los pintores, calcinada, para dar el color blanco. Es sin embargo de blancura menos luminosa que el llamado *chimaltízatl*.") Hernández (1959:410) also wrote: "The *tizatllalli* or white dirt is extracted from deposits in the lake...it is kneaded like potter's clay to form small round objects which become white when in contact with fire. It looks much like our mineral *albayalde* 'white lead' but ours is made from lead and vinegar; this one is produced spontaneously and is extremely white in some places of New Spain. It is cold, dry and clean but it does not irritate the skin, and it cures skin rashes. It is also useful for curing ulcers on sexual parts of the body, and can be used to paint things white. It is so soft, that Mexican women put it on cotton threads to make weaving easier." ("Se saca también de mina lacustre el *tizatllalli* o tierra blanca, se amasa como barro, se hacen de él bolas pequeñas, y puesto al fuego adquiere poco a poco color blanco. Es tan semejante a nuestro albayalde, que podría llamarse con razón albayalde mineral, pues en tanto que el nuestro suele hacerse de plomo suspendido sobre vinagre, éste se produce espontáneamente y de un color blanquísimo en algunos lugares de esta Nueva España. Es de naturaleza fría, secante y deterativa sin ninguna irritación, y, como aquél, cura espolvoreado las rozaduras de los niños. Sana también admirablemente las úlceras de las partes sexuales, y sirve para teñir de blanco cualesquiera cosas. Es de tal suavidad, que las mujeres mexicanas, untando con él sus dedos, les dan la tersura apropiada para hilar más fácilmente el algodón.")

Sahagún in 1571 (1971:372, fo. 221) wrote: "Women use this clay to weave, and it is sold in markets...there are stones in this land, from which varnish is made, they are called *tetízatl* (Figures 10, 11): stones that come from streams near Tulan [Tula, state of Hidalgo]; they use these stones to varnish the "jicaras" (small drinking cup). There is also another called *chimaltízatl*, which is found near Uastepec (Oaxtepec, state of Morelos). They pull them out as if they were stones, then they cook them. These stones are similar to "yeso de Castilla" or chalk. They are sold in the *tianguis*.<sup>12</sup>" ("Hay greda usarla mucho, las mujeres para hilar y venderse en los *tianguis* llamarse *tízatl*... Hay piedras en esta tierra, de que se hace el barniz, llamanlas *tetízatl*: son piedras que se hacen en los arroyos hacia Tulan, usan mucho: de las piedras para embarnizar las jicaras. Hay también, otra de las que se llama *chimaltízatl*, hacense hacia Uastepec [Oaxtepec, state of Morelos], sácanlas, como de pedrova [stones], para labrar: estas piedras cuécenlas primero, son como yeso de Castilla, véndansen en los *tianguis*.")



FIGURE 10.— Image from the *Florentine Codex* interpreted by Dibble and Anderson (1963:fig. 820). Preparation of *tizatl*.



FIGURE 11.— Image from the *Florentine Codex* interpreted by Dibble and Anderson (1963:fig. 821). Preparation of *tetizatl*.

Clavijero between 1780-1781 (1945:315) states: "The white part of the mineral stone called *chimaltízatl*, once it is burnt to ashes, or of the *tizatlalli*, which is a mineral soil found in the lake, which is kneaded with mud and made into balls; when cooked, it becomes white just as the "albayaide" from Spain." ("El blanco de la piedra mineral *chimaltízatl* después de calcinada, o del *tizatlalli*, que es una tierra mineral que se halla en la laguna la cual amasada como lodo y reducida a pelotas, recibe con la acción del fuego un color blanco semejantísimo al del albayaide de España.")

Del Barco in XVIII century (1973:156-157) writes: "The Cerro Colorado of Mulegé is famous because it has gold; there is a deposit of fossil matter which is called *tiza* in New Spain. It is a very fine dust, very soft, just like flour. It is whiter than chalk, and it is used to paint churches and houses. But its white color is

so intense that it is mixed with dark *agua-cola*<sup>13</sup> to make it less white so it will not be painful to the eyes. It is used in New Spain to clean silver, because it leaves it as if it were new." ("En el cerro Colorado de Mulegé, de que dejamos dicho, que tiene fama de mineral de oro, se halla una veta de aquel fósil que en Nueva España llaman *tiza*. Y es una especie de finísimo polvo, que se saca en pequeños terrones de la veta, los cuales, tomándolos con los dedos, fácilmente se deshacen en un sutilísimo polvo, que excede en la suavidad aun a la harina floreada, según lo percibe el tacto. Es más blanco que el yeso, y en lugar de este se valen en algunas partes de la *tiza* para blanquear las casas e iglesias. Mas su blancura es tanta que, para mitigarla y que no ofenda a la vista, se procura que el *agua-cola*, con que se mezcla para este efecto, sea de color obscuro. Los plateros usan en la Nueva España de la *tiza* para limpiar la plata; y aun en las casas particulares se valen de ella para lo mismo. Porque con gran facilidad la limpian dejándola como nueva.")

Ehrenberg (1854:372, 373) wrote that *tisar* of Mexico is a white sandy mixture, it is made almost entirely of shells of diatoms, and the predominant forms are *Eunotia gibberula* and *E. zebrina*, *Synedra capitata* and *Biblarium emarginatum*.

Díaz Lozano (1917:10) wrote that the *tizate* or *tizar* used in Mexico comes from Ixtlahuaca and in lesser amounts from Tlalnepantla and Texcoco, and it is made of fossil diatoms.

Epifania Cortés, from "Rancho Cuauhtenáhuatl," Huautla, Hidalgo, mentioned, in 1992, that this product is sold in markets of the state of Hidalgo, as round stones to be eaten by those with stomach cramps, vomits and by pregnant women who want to eat chalk (Figure 12).

Roberto Rico Montiel (August 27, 1996, pers. com.) said that the inhabitants of Tizatlán still use the name *tizar* when referring to diatoms.

Distribution: Baja California Sur: Mpio. Mulegé: Cerro Colorado de Mulegé. Hidalgo: Huautla: Rancho Cuauhtenáhuatl. State of Mexico: Ixtlahuaca, between the valleys of Toluca and Lerma; Cerro de Sultepec, Texcoco lake. Tlaxcala: Tizatlán.

Habitat: Fossil matter, possibly from ancient aquatic environments.

Uses: Medicinal (colic, vomiting, and for pregnant women who have the urge to eat chalk). Díaz Lozano (1917:10) writes that the quality of the *tizate* improves when it is repeatedly washed and burnt. It is used to polish metals, woodwork, ivory, marble, etc. It is also used in the manufacture of toothpaste, music records, and as absorbent material in filters and varnishes previously dissolved in soda (see Hernández Velasco 1955). In 1985, the Mexican industry produced 45,781 tons of diatomite, mainly used by sugar mills, beer factories and in the building industry; some of it was also exported (*Enciclopedia de México* 1987).

Note: There have been controversies about the origin of the term *tizal* (is it a mineral or does it come from deposits of diatoms?). Prieto's (1985:261, 262, 263) interpretation was that there was a mineral origin for the term *tizal* and other similar names, which were included in F. Hernández's work. From *chimaltízatl* or specular stone,<sup>14</sup> he writes that it could be the anhydrite or common chalk used as building material. The *tetízatl* could refer to chalky stone or calcium carbonate, which today is the source chalk and a white material which, when hydrated, is used to paint the facades of houses in some regions. It could also



FIGURE 12.— Epifania Cortés, from “Rancho Cuauhtenahuatl”, Huautla, Hidalgo (1992), eating *tizatl*.

mean chalk, or hydrate anhydrite, or hydrate calcium sulfate. The *tizatlalli*, or white soil or dirt, is similar to the *albayalde*, or to basic lead carbonates called "cerusita" or "ceruse" and has been used as the base in white paint. Preto (1985) is doubtful of the medicinal uses, stating that it might be talcum powder, a very common mineral which cannot melt, is of leafy texture, and is very soft. Also, Dibble and Anderson (1963:243-244) did a similar interpretation of these names, which were included in *Florentine Codex*. Nevertheless, Ehrenberg (1854, 1869, the original quotes are in German) was the first scientist who demonstrated that the *tízatl* is made of diatoms, although he too, just as Prieto (1985), had doubts about its medicinal uses. Ehrenberg (1854:374) also did a translation of Hernandez' work which he analyzed in his 1869 research (pp. 2, 4, 5, 6): "There is a kind of clay called *atizal*, white or whitish, it is mixed with clay and turned into *adobes* 'building material', it is not good for anything else." He also writes: "I had to inform about the elements conforming this dirt, white as snow, but without knowing where it came from or where it had been extracted from. It was formed by polygastric, mostly Bacillariophytes [Bacillariophyceae], of 38 recognizable species. After more experiments and research on this white powdery substance (like flour), published in *Microgeologie* (Ehrenberg 1854), the number of forms found in this Mexican substance called *tisar* went up to 115 organic species, their drawings can be found on table 33, figures 7-17. Workers for Mr. Castillo told him that the Indians around the Ixtlahuaca area, between the Valley of Toluca and Lerma, sell this type of clay for different purposes. According to Dr. Buckhart, Dr. Castillo says that the Indians use the *tisar*, which they call *tizate*, for different things, but especially as polish for metals, cutlery, etc. They wash the *tisar*, and make round things with it, which are then taken to the market. In Europe, they use the polishing schist (black-blue rock) for the same purposes. Painters also use it to paint walls in rooms, to prepare the walls before applying the color...the *tiza* is formed by very fine and fragile particles, like dust, but with sharp edges ...it forms flat white deposits which the indians collect and wash. But there are some layers of *tiza*, which are so pure that do not need to be washed...of what can be seen from Dr. Castillo's information, the Indians wash the dirt that is going to be sold, they make white balls with it. It can also be thought that they make ornaments with these balls, which they sell. And as the stone that was sent to me is natural and not artificial, and has no adhesive material. I am sure the natives do not make the balls with loose dirt but with stones, just as they find it. They sculpture, and they sell it. If the stone is turned to powder, it is impossible to shape it without using something like clay to join the particles. Besides, the name *tiza* is an old name, while the idea that white dirt is organic is new. *Tízatl* and *tizatlalli* mineral dirt which gave ancient Mexicans their white pain when they added clay and kneaded it." It is possible that there was a mix-up with the term at the beginnings of the 20<sup>th</sup> century or even before that. When C. Ehrenberg received a sample from Antonio del Castillo (a Mexican geologist) (Ehrenberg 1876:119), there was doubt about the nametag on the sample. The tag said "*tiza* from Toluca," yet was it porous stone or microorganisms? Today, several authors have reconfirmed that the origin is from diatoms (Rico-Montiel et al. 1993).

On the other hand, Castelló Yturbide et al. (1986:104) wrote about the tradition of eating dirt, which is religious in origin. Sahagún (1971:appendix of book II, p. 175) claimed: "They would touch the dirt with one finger which they would then put in their mouth, or they would touch their tongue with it; they would say they were eating dirt, as a gesture of reverence to their gods..." ("Tocaban la tierra con el dedo y luego lo llevaban a la boca, o a la lengua; a esto llamaban comer tierra, hacíanlo con reverencia de sus dioses...") Castelló Yturbide et al. (1986:104) confirmed that even though this custom was forbidden in 1625, it was currently still possible to buy bread made from dirt in several places in Mexico (Jalisco and Michoacán). Bread made from dirt is used as a cure for diseases or sadness or to satisfy the whimsical appetite of pregnant women who feel the urge to eat dirt. It has been said that if they eat common dirt, they would deliver a "dirt eating child."

Common name: *Tripilla*.

Etymology: Spanish. Refers to guts.

Chronology: Ortega (1984:294) gives this name to *Nitella* sp.

Distribution: Michoacán: Mpio. Pátzcuaro: Patzcuaro Lake.

Habitat: Bentic in lakes.

Uses: Not provided.

Common name: *Tsil*.

Etymology: Maya language. *Ts'il*, water slime (*Diccionario Maya Cordemex* 1980:885).

Other names: *Luk* and *mum*, mud, slime found at the bottom of lakes and puddles (*Diccionario Maya Cordemex* 1980:464, 540).

Chronology: Ortega et al. (1995:xvii) gives this name to several algae.

Distribution: Yucatan Peninsula.

Habitat: Freshwater.

Uses: Not provided.

Note: It could possibly be a reference to algae of the Cyanophyceae and Chlorophyceae classes.

Common name: *Tzau*.

Etymology: Maya language. *Tzau*, slimy (freshwater) place or freshwater excrement? ("mojonera de agua dulce") (Ortega, 1984:36).

Chronology: Ortega (1984:36) and Ortega et al. (1995:xvii) named it *Nostoc verrucosum* Vaucher ex Bornet et Flahault.

Distribution: Yucatán: Mpio. Izamal: Aguada Chulumbay, 9 miles W. of Izamal.

Habitat: In water puddles.

Uses: Not provided.

Common name: *Undina*.

Etymology: Spanish. Refers to *undicola*, something that lives on these water waves (*Enciclopedia Universal Ilustrada* 1929, tomo 65:997).

Chronology: Ponce de León (1909:20) called it *Nostoc commune* Vaucher ex Bornet et Flahault.

Distribution: Sinaloa.

Habitat: Not provided.

Uses: Not provided.



Common name: *Verdín*.

Etymology: Spanish. The first green color acquired by grasses or plants that have not reached maturity. Green layer of cryptogamous plants that grow in fresh-water, especially in stagnant water... (*Enciclopedia Universal Ilustrada* 1929, tomo 67:1448).

Chronology: Ponce de León (1909:20) called it *Conferva chantransia*? [*Lemanea fluviatilis* (Linnaeus) C. Agardh].

The *Enciclopedia Universal Ilustrada* (1929, tomo 67:1448) states that the common name refers to *Conferva rivularis* Linnaeus [*Cladophora rivularis* (Linnaeus) van den Hoek] and to other green algae.

Distribution: Sinaloa.

Habitat: On damp soil and stones.

Uses: Not provided.

Note: *Verdín* is a name, which refers to green algae (Chlorophyceae). There is doubt about the identity of *Conferva chantransia*.

Common name: *Xkomha*.

Etymology: Maya language. "Short thing in the water" (Ortega 1984:232). The *Diccionario Maya Cordemex* (1980:165, 334) states: *kom*, valley or cliff, to sink; *ha*, water; possibly something sunken in the water or thing found at the bottom of the water.

Chronology: J.E. Tilden (in Millspaugh 1896:286; Standley 1930:192) named it *Microspora amoena* (Kützing) Rabenhorst.

Distribution: Yucatán: Izamal, in (water) deposit tanks, G.F. Gaumer 571, Jan.-Dec. 1895 (US, BM, *vide* Millspaugh 1896:286).

Habitat: In (water) deposit tanks.

Uses: Not provided.

Common name: *Yaxkoxmal*.

Etymology: Maya language, *Ya"yk"oxmal*, "Threads of the lake" ("ovas de laguna"), a genus of aquatic plant (*Diccionario Maya Cordemex* 1980:973). It also refers to *lama* 'slime' or *moho verde* 'green mold' which grows on damp and shady soil, "into which the feet slide easily" (Álvarez 1980:228).

Chronology: Ortega et al. (1995:xvii) consider it an algae belonging to the Cyanophyceae class.

Distribution: Yucatan Peninsula.

Habitat: On land.

Uses: Not provided.

Note: The *Diccionario de la Lengua Española* (1970:954) indicates that *ova*, from the Latin *ulva*, refers to any unicellular [pluricellular] green algae, with simple or branched filaments, or with large and foliaceous, or narrow and bandlike blades, which grow in the sea, rivers or ponds, floating on the water or fixed to the bottom by radicular appendixes. "Ova de río" refers, therefore, to fresh-water algae [possibly filamentous Chlorophyceae] and "ova marina" to algae with laminar expansions or hollow tubular bands, almost always branched, found in sea and brackish water [possibly Ulvales such as *Enteromorpha* y *Ulva*].

TABLE 1.— Knowledge of Mexican freshwater algae.<sup>1</sup>

| Taxa  | Mexican distribution (State) | Common names  | Century   | Uses                                      |
|---|------------------------------|---|---|---|
| <b>CYANOPHYCEAE</b>   |                              |   |   |   |
| <i>Trichormus azollae</i> (Strasburger) Komárek <i>et</i> Anagnostidis <sup>2</sup> | Distrito Federal, Michoacan  | <i>Chilacaxtli</i> , <i>Chilacastle</i> , <i>chilacascle</i>  | 20 <sup>th</sup>  | Soil improvement                          |
| <i>Anabaena flos-aquae</i> Brébisson <i>ex</i> Bornet <i>et</i> Flahault            | Nuevo León, Oaxaca           | <i>Lama</i> 'slime'   | 19 <sup>th</sup>  |   |
| <i>Nostoc commune</i> Vaucher <i>ex</i> Bornet <i>et</i> Flahault                   | State of Mexico, Sinaloa     | <i>Amoxtli</i> , <i>amoxtle</i> , <i>amomoxtli</i> , <i>gelatina de agua</i> 'water jelly', <i>salivazo de la luna</i> 'moon spit', <i>undina</i> | 16 <sup>th</sup> , 20 <sup>th</sup>                                       | Food                                      |
| <i>Nostoc verrucosum</i> Vaucher <i>ex</i> Bornet <i>et</i> Flahault                | Yucatan                      | <i>Tachak</i> (slime, green and slippery thing), <i>tzau</i> (fresh water excrement?)   | 20 <sup>th</sup>  |   |
| <i>Phormidium calidum</i> (C. Agardh) Gomont <i>ex</i> Gomont                       | Nuevo León.                  | <i>Lama del topo</i> 'mole slime'   | 19 <sup>th</sup>  |   |
| <i>Phormidium tenue</i> (Meneghini) Gomont <sup>4</sup>                             | State of Mexico              | <i>Cuculin</i> (water viscosity), <i>cuculito del agua</i> 'water cuculito', <i>cocol</i> , <i>cocolin</i> , <i>cocol de agua</i> 'water cocol'   | 16 <sup>th</sup> , 18 <sup>th</sup> , 20 <sup>th</sup>                    | Food, mineral supplement (Ca and Fe)      |
| <i>Spirulina geitleri</i> De Toni   | State of Mexico              | <i>Espirulina</i> 'spirulina'   | 20 <sup>th</sup>  | Food, human and animal protein supplement |
| <i>Spirulina labyrinthiformis</i> (Linnaeus) Gomont                                 | Guanajuato                   | <i>Lama de comanjilla</i>   | 19 <sup>th</sup>  |   |
| Oscillatoriales ("Oscillarias"), Cyanophyceae                                       | Valley of Mexico             | <i>Tecuítlatl</i> , <i>tecuítate</i> (stone residue)  | 16 <sup>th</sup> , 18 <sup>th</sup> , 19 <sup>th</sup> , 20 <sup>th</sup> | Food                                      |
| Cyanophyceae  | Yucatan Peninsula            | <i>Tsil</i> 'water slime', <i>yaxkoxmal</i> (threats of lake)   | 20 <sup>th</sup>  |   |
| <b>RHODOPHYCEAE</b>   |                              |   |   |   |
| <i>Lemanea fluviatilis</i> (Linnaeus) C. Agardh                                     | Sinaloa                      | <i>Conferva</i> , <i>surrupa</i>  | 20 <sup>th</sup>  |   |
| <b>BACILLARIOPHYCEAE</b>  |                              |   |   |   |
| <i>Fragilaria diophthalma</i> (Ehrenberg) Ehrenberg                                 | Oaxaca                       | <i>Diatoma de copos</i> 'diatom tufted', <i>lama</i>  | 19 <sup>th</sup>  |   |
| <i>Fragilaria striatula</i> (J.E. Smith?) Lyngbye                                   | Oaxaca                       | <i>Lama</i> 'slime', <i>diatoma erguida</i> 'stiff diatom'  | 19 <sup>th</sup>  |   |

|  |   |   |                                     |  |
|--|---|---|-------------------------------------|--|
| Bacillariophyceae (fossil diatome)   | Baja California Sur, State of Mexico, Hidalgo, Tlaxcala | <i>Tízatl</i> (white dirt), <i>tizatlalli</i> , <i>tefízatl</i> , <i>chimaltízatl</i> , <i>tizar</i> , <i>tizate</i> , <i>atízatl</i> , <i>tiza</i> , <i>tierra blanca</i> 'white dirt', <i>diatomita</i> 'diatomite', <i>tierra de diatomeas</i> 'diatomaceous dirt' | 16th -20 <sup>th</sup>              | Paints, medicinal, cotton spinning, filters, polishing and industrial uses |
| <b>XANTHOPHYCEAE</b>   |   |   |                                     |  |
| <i>Vaucheria fontinalis</i> (Linnaeus) Christensen   | Guanajuato  | <i>Lama</i> 'slime'   | 19 <sup>th</sup> , 20 <sup>th</sup> |  |
| <b>CHLOROPHYCEAE</b>   |   |   |                                     |  |
| <i>Cephaleuros virescens</i> Kunze   | Chiapas, Tabasco, Veracruz                              | <i>Mancha de la hoja</i> 'leaf spot'  | 20 <sup>th</sup>                    | Phytopathology   |
| <i>Chlorella</i> sp.   |   | <i>Algafil</i>  | 20 <sup>th</sup>                    | Gives color to eggs' yolk  |
| <i>Cladophora glomerata</i> (Linnaeus) Kützing var. <i>crassior</i> (C. Agardh) van den Hoek | Nuevo León, Oaxaca                                      | <i>Lama</i> 'slime'   | 19 <sup>th</sup>                    |  |
| <i>Cladophora rivularis</i> (Linnaeus) van den Hoek  | Guanajuato, Nuevo Leon, Oaxaca, Sinaloa                 | <i>Lama</i> 'slime', <i>verdin</i>  | 19 <sup>th</sup> , 20 <sup>th</sup> |  |
| <i>Microspora amoena</i> (Kützing) Rabenhorst  | Yucatan   | <i>Xkomha</i> (thing found at the bottom of the water)  | 19 <sup>th</sup>                    |  |
| <i>Prasiola mexicana</i> J. Agardh   | State of Mexico   | <i>Nitla</i>  | 20 <sup>th</sup>                    | Cough suppressant, nasal hemorrhages                                       |
| <i>Rhizoclonium hieroglyphicum</i> (C. Agardh) Kützing                                       | Michoacan   | <i>Lama</i> 'slime'   | 20 <sup>th</sup>                    |  |
| <i>Spirogyra flavescens</i> (Hassall) Kützing  | Jalisco   | <i>Lama</i>   | 20 <sup>th</sup>                    |  |
| <i>Zygnema lutescens</i> (Vaucher) C. Agardh   | Oaxaca  | <i>Lama larga</i> 'long slime'  | 19 <sup>th</sup>                    |  |
| Chlorophyceae [filamentous]  | Yucatan Peninsula                                       | <i>Chonak</i>   | 20 <sup>th</sup>                    |  |
| <b>CHAROPHYCEAE</b>  |   |   |                                     |  |
| <i>Chara zeylanica</i> Klein ex Willdenow  | Veracruz, Yucatan                                       | <i>Iximha</i> (water corn)  | 20 <sup>th</sup>                    | Control of mosquito larvae <sup>3</sup>                                    |
| <i>Nitella</i> sp.   | Michoacan   | <i>Tripilla</i> (small guts/innards)  | 20 <sup>th</sup>                    |  |

<sup>1</sup> The taxa (class) sequence in Table 1 is done according to Silva et al. (1996) and is in alphabetical order from the class onwards. The "division" category is omitted, as the organization of the "classes" within the "divisions" can be treated in different ways and no consensus has been reached.

<sup>2</sup> With its symbiont *Azolla filiculoides* Lamouroux [fern].

<sup>3</sup> Other species used: *Chara contraria* A. Braun ex Kützing, *C. hispida* Linnaeus, *C. foetida* A. Braun [*C. vulgaris* Linnaeus] and *C. fragilis* Desvaux [*C. globularis* Thuillier].

<sup>4</sup> Associated with *Chroococcus turgidus* (Kützing) Nägeli.

## CONCLUSION

Results are given in Table 1. We registered 23 species. The families with the highest diversity were Cyanophyceae (8 spp.) and Chlorophyceae (9 spp.). On the other hand Bacillariophyceae (2 spp.), Xanthophyceae (1 sp.), Charophyceae (2 spp.) and Rhodophyceae (1 sp.) were the families with the lowest diversity. Species of *tízatl* are not included in the Bacillariophyceae class, as there are many and with many variations depending on the locality of origin.

People from the fifteen states in Mexico know about algae. This knowledge is reflected in the many common names (48) and uses (5) given to these organisms. Algae are used for human and animal consumption (nutritional), for medicinal and health purposes, in agriculture (soil improvement and phytopathology) and cattle ranching activities; they are also used for industrial purposes. The fact that many of the common names could not be related to a particular use could be a reflection of the loss of the resource.

Of the 56 ethnic groups (Instituto Nacional Indigenista 1990) in 32 states in Mexico, the Nahuatl (State of Mexico) and the Maya (Yucatan) are the ones that reflect the most knowledge and uses of continental algae. People in Oaxaca, Sinaloa and Yucatan also possess information regarding algae. Research related to the recovery of continental Mexican algae and their uses will be crucial in the future.

## NOTES

<sup>1</sup> *Anáhuac*: From the Nahuatl term *Atl*: water, and *nahuac*: near to: near the water. It designates the Valley of Mexico where there used to be large lakes (Macazaga Ordoño 1979:27).

<sup>2</sup> *Urrona*: Small animals that thrive on the water's surface. The origin of the word is unknown (Santamaría 1959:1101).

<sup>3</sup> *Tamal*: From the Aztec term *tamalli*. Dough made of corn meal and porks' fat, of a thick consistency, which is wrapped in corn or banana leaves, sometimes with meat. The dough of the algae *tamal* is made of algae and is wrapped in corn leaves (Santamaría 1959:1000).

<sup>4</sup> *Tequesquite*: From the Nahuatl term *tequizquitl*: efflorescent stone, and *tetl*: stone and *quizquitl*: to spontaneously emerge. It is natural salt made of caustic soda "sesquicarbonates" and sodium chloride. It is an effervescent residue appearing when water evaporates from brackish lakes (Cabrera 1984:134).

<sup>5</sup> *Molcajete*: From the Aztec term *molli*: *salsa* 'sauce', and *caxitl*: small box. Small stone mortar with three small "feet," used to crush and prepare species such as chile, to prepare sauces, etc. Used to crush the *tejolote* (Santamaría 1959:732).

<sup>6</sup> *Mole*: From the Aztec term *molli*: *salsa* 'sauce' or cooked meal. Famous and special meal prepared with chile sauce and sesame seeds, with turkey meat (Santamaría 1959:733).

<sup>7</sup> *Evaporador Solar El Caracol* 'Solar Vaporizer': Spiral shaped water canals in Texcoco (State of Mexico), with a diameter of 3200 m and a surface of 850 hectares. *El Caracol* is a large "evaporation machine" which uses solar energy and, due to its particular location, – 2240 m above sea level – solar radiation and evaporation are extremely efficient. *Spirulina* algae grow naturally in the external canals of *El Caracol*. Cultivation of *Spirulina* in Mexico

was successful due to factors such as: solar radiation, adequate temperature and availability of alkaline waters. The industrial growth of the algae has been optimized by the Sosa Texcoco Company.

<sup>8</sup> *Chilmolli*: From the Nahuatl term *chilli*: chile and *molli*: *salsa* 'sauce': meal made of chile peppers, meat and vegetables (Cabrera 1984:70).

<sup>9</sup> *Oscillarias*: In the 19<sup>th</sup> Century, the Oscillarias belonged to the group of the green algae; today they belong to the Cyanophyceae (Oscillatoriales) or blue-green algae (Ortega 1987:174).

<sup>10</sup> *Poligastric*: These microscopic algae belonged to the diatoms. Today it belongs to the Bacillariophyceae group (Ortega 1987:174).

<sup>11</sup> *Ahuautle*: From the Nahuatl term: *atl*: water; *huautli*: "mijo" seed: water seeds. It is a sort of caviar or tiny eggs deposited by small flies (*Coriza mercenaria*, *C. femorata*) on plants which grow near lakes. When dried and turned into pulp, they are edible (Cabrera 1984:30).

<sup>12</sup> *Tianguis*: From the Aztec term *tianquiztli*: market; market square or market in general. By extension, it means the selling and buying which took place in the past, on a certain day of the week, in several towns and which still takes place in some small towns in Mexico (Santamaría 1959:1042).

<sup>13</sup> *Agua-cola*: Strong, transparent and sticky paste obtained by boiling pieces of animal skin, and which, when dissolved in hot water, is used as glue (*Diccionario de la Lengua Española* 1970:319).

<sup>14</sup> Specular stone ("piedra especular"): Diaphanous or transparent stone with mirror like qualities.

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#### LITERATURE CITED

- ALDAVE-PAJARES, AUGUSTO. 1969. Cushuro: algas azul-verdes utilizadas como alimento en la región altoandina Peruana. Boletín de la Sociedad Botánica de La Libertad 1:5-43, 3 láms.
- ALVARADO TEZOZOMOC, FERNANDO. 1944. Crónica Mexicana. Editorial Leyenda, México, D.F.
- ÁLVAREZ, CRISTINA. 1980. Diccionario Etnolingüístico del Idioma Maya Yucateco Colonial. Mundo Físico. Universidad Nacional Autónoma de México, México, D.F.
- ANAGNOSTIDIS, KONSTANTINOS and JIRI KOMÁREK. 1988. Modern approach to the classification system of Cyanophytes 3- Oscillatoriales. Archiv für Hydrobiologie, Suppl. 80:327- 472.
- ANCONA, LEOPOLDO. 1933. El ahuatele de Texcoco. Anales del Instituto de Biología, Universidad Nacional Autónoma de México 4:51-69.
- APENES, OLA. 1947. Mapas Antiguos del Valle de México. Instituto de Historia, Universidad Nacional Autónoma de México, México, D.F.
- BENAVENTE, TORIBIO DE (also known as Motolinia). 1903. Memoriales. México.

- BRAVO HOLLIS, HELIA. 1930. Las lemnáceas del valle de México. *Anales del Instituto de Biología, Universidad Nacional Autónoma de México* 1:7-32.
- . 1936. Observaciones florísticas y geobotánicas en el Valle de Actopan. *Anales del Instituto de Biología, Universidad Nacional Autónoma de México* 7:169-233.
- BRIOSO-VASCONCELOS, ANGEL. 1923. The algae of the genus *Chara* and mosquito larvae. *Journal of Public Health Nation's Health* 13:543-546.
- CABRERA, LUIS. 1984. *Diccionario de Aztequismos*. Ediciones Oasis, México.
- CASTAÑEDA, ALFONSO MANUEL. 1933. *La Flora del Estado de Jalisco*. Tipografía Jaime. Guadalajara, Jalisco, Mexico.
- CASTELLÓYTURBIDE, TERESA, MICHEL ZABÉ, and IGNACIO PIÑA LUJÁN. 1986. Presencia de la Comida Prehispánica. Fomento Cultural Banamex, A.C., México, D.F.
- CLAVIJERO, FRANCISCO JAVIER. 1945. *Historia Antigua de México*. Tomo II. Editorial Porrúa, México, D.F.
- COROMINAS, JOAN and JOSÉ A. PASCUAL. 1983. *Diccionario Crítico Etimológico Castellano e Hispánico*. Vol. V. Editorial Gredos, Madrid.
- DEL BARCO, MIGUEL. 1973. *Historia Natural y Crónica de la Antigua California*. Universidad Nacional Autónoma de México, México, D.F.
- DÍAZ DEL CASTILLO, BERNAL. 1964. *Historia Verdadera de la Conquista de la Nueva España*. Thrid edition. Editorial Porrúa, México, D.F.
- DÍAZ LOZANO, ENRIQUE. 1917. Diatomeas fósiles mexicanas. *Anales del Instituto Geológico de México* 1:1-27.
- DIBBLE, CHARLES E. and ARTHUR J.O. ANDERSON. 1963. *Florentine Codex*. Book 11 - Earthly things. Translated from the Aztec into English, with notes and illustrations. The School of American Research and the University of Utah.
- DICCIONARIO DE LA LENGUA ESPAÑOLA. 1970. 19<sup>th</sup> edition. Real Academia Española, Madrid.
- DICCIONARIO MAYA CORDEMEX. 1980. *Maya-español, español-maya*. Ediciones Cordemex, Mérida.
- DICCIONARIO PORRÚA DE HISTORIA, BIOGRAFÍA Y GEOGRAFÍA DE MÉXICO. 1995. Sixth edition. Editorial Porrúa, México, D.F.
- EHRENBERG, CHRISTIAN G. 1854. *Mikrogeologie*. Verlag von Leopold Voss, Leipzig.
- . 1869. Über Mächtige Gebirgsschichten Vorherrschend aus Mikroskopischen Bacillarien unter und bei der Stadt Mexiko. *Königl. Akademie der Wissenschaften, Berlin*.
- . 1876. De la toba fitolitaria del Valle de Toluca. *La Naturaleza* (1<sup>a</sup>. serie) 3:118-132.
- ENCICLOPEDIA DE MÉXICO. 1987. Vol 4. Enciclopedia de México and Secretaría de Educación Pública, México.
- ENCICLOPEDIA UNIVERSAL ILUSTRADA EUROPEO-AMERICANA. n.d. Tomo 29. Hijos de J. Espasa, Editores, Barcelona.
- . 1929. Tomo 65, 67. Espasa-Calpe, Madrid.
- ESPINOSA ABARCA, A. SERGIO, SERGIO PALACIOS MAYORGA and MARTHA M. ORTEGA. 1985. Estudio sobre el crecimiento de *Azolla filiculoides* en medios de cultivo en suelos de arrozal del Edo. de Morelos, México, bajo condiciones de invernadero. *Revista Latinoamericana de Microbiología* 27:61-69.
- FARRAR, W.V. 1966. Tecuitlatl: a glimpse of Aztec food technology. *Nature* 5047(211):341-342.
- GODÍNEZ, JOSÉ LUIS, MARTHA M. ORTEGA and GUADALUPE DE LA LANZA. 1984. Study of the edible algae of the Valley of Mexico. IV. Analysis of some inorganic elements. *Nutrition Reports International* 30:1279-1285.
- GONZÁLEZ, ELEUTERIO. 1876. Apuntes que pueden servir de base para la formación de la flórua de la Ciudad de Monterrey y sus inmediaciones. *La Naturaleza (México)* 3:31-35.
- GONZÁLEZ COSS, JESÚS. 1872. Flórua de la ciudad y partido de Silao. *Boletín de la Sociedad de Geografía y Estadística, segunda época* 4:301-316.
- HALPERIN, DELIA R. DE. 1967. Cianofíceas marinas de Puerto Deseado (Provincia de Santa Cruz, Argentina). II. *Darwiniana* 14:273-338. [+14 pls.].

- HERNÁNDEZ, FRANCISCO. 1649. *Rerum Medicarum Novae Hispaniae Thesaurus sev Plantarum Animalium Mineralium Mexicanorum Historia*. Extypographio Vitalis Mascardi, Roma.
- . 1959. Historia Natural de la Nueva España. Pp. 408-410 in *Obras Completas*, tomo III, Germán Somolinos d'Ardois (editor). Universidad Nacional Autónoma de México, México, D.F.
- HERNÁNDEZ VELASCO, ARIEL J. 1955. Las diatomitas mexicanas y su empleo industrial. *Boletín de la Sociedad Geológica de México* 18:34-53.
- HOFFMANN, CARLOS C. and AMELIA SÁMANO BISHOP. 1938a. Nota acerca de los criaderos invernales de *Anopheles albimanus* Wied., en los pantanos de Veracruz. *Anales del Instituto de Biología, Universidad Nacional Autónoma de México* 9:193-199.
- and ———. 1938b. Los criaderos invernales de *Anopheles pseudopunctipennis* en el estado de Oaxaca. *Anales del Instituto de Biología, Universidad Nacional Autónoma de México* 9:181-192.
- HOLMGREN, PATRICIA K., NOEL H. HOLMGREN and LISA C. BARNETT. 1990. *Index Herbariorum*. Part I: The Herbaria of the World. Eighth edition. New York Botanical Garden, New York.
- INSTITUTO NACIONAL INDIGENISTA. 1990. Mapa de los Grupos Indígenas de México. Subdirección de Investigación, Instituto Nacional Indigenista, México.
- KARTTUNEN, FRANCES. 1992. *An Analytical Dictionary of Nahuatl*. University of Oklahoma Press, Norman.
- KOMÁREK, J. and K. ANAGNOSTIDIS. 1989. Modern approach to the classification system of Cyanophytes 4-Nostocales. *Arch. Hydrobiol. Suppl.* 82:247-345.
- LÓPEZ DE GÓMARA, FRANCISCO. 1988. *Historia de la Conquista de México*. Editorial Porrúa, México, D.F.
- LÉONARD, J. 1966. The 1964-65 Belgian trans-Saharan expedition. *Nature* 209 (5019): 126-128.
- LOT, ANTONIO, ALEJANDRO NOVELO RETANA, MARTHA OLVERA GARCÍA and PEDRO RAMÍREZ GARCÍA. 1999. Catálogo de angiospermas acuáticas de México. Hidrófitas estrictas emergentes, sumergidas y flotantes. Cuadernos del Instituto de Biología, Universidad Nacional Autónoma de México 33:7-161.
- MACAZAGA ORDOÑO, CÉSAR. 1979. *Nombres Geográficos de México*. Editorial Cosmos, México, D.F.
- MARTIN, W.J. 1947. Diseases of the *Hevea rubber tree* in Mexico 1943-1946. *Plant Disease Reporter* 31:155-158.
- MARTÍNEZ, MAXIMINO. 1979. Catálogo de Nombres Vulgares y Científicos de Plantas Mexicanas. Fondo de Cultura Económica, México, D.F.
- MARTÍNEZ GRACIDA, M. 1891. *Flora y fauna del Estado Libre y Soberano de Oaxaca*. Imprenta del Estado de Oaxaca, Oaxaca.
- MENDOZA DE FLORES, CARMEN and JOHN A. PINO. 1964. Efecto pigmentante de 3 fuentes de xantofilas sobre la yema de huevo. *Técnica Pecuaria* 3:20-23.
- MILLSPAUGH, CHARLES F. 1896. *Contribution II to the coastal and plain flora of Yucatan*. Publication Field Columbian Museum, Botanical Series 1:277-339.
- MOLINA, ALONSO DE. 1944. *Vocabulario en Lengua Castellana y Mexicana*. Editorial Cultura Hispánica, Madrid.
- . 1966. *Vocabulario Nahuatl-Castellano, Castellano-Nahuatl*. Second edition. Ediciones Colofón, México, D.F.
- OROZCO Y BERRA, MANUEL. 1798. *Memoria para la Carta Hidrográfica del Valle de México*. Edición facsimilar del arquitecto Juan Cortina Portilla, México.
- ORTEGA, MARTHA M. 1972. Estudio de las algas comestibles del Valle de México. *Revista Latinoamericana de Microbiología* 14:85-97.
- . 1984. *Catálogo de Algas Recientes Continentales de México*. Universidad Nacional Autónoma de México, México.
- . 1987. Doce años de ficología en México. Pp. 155-186 in *Contribuciones en Hidrobiología*, Samuel Gómez and Virgilio Arenas (editors). Universidad Nacional Autónoma de México, México, D.F.

- \_\_\_\_\_, JOSÉ LUIS GODÍNEZ, GLORIA GARDUÑO and MARÍA GUADALUPE OLIVA. 1995. Ficología de México. Algas continentales. AGT Editor, México, D.F.
- PELÁEZ, DIONISIO. 1947. Estudios de la vegetación en relación con el paludismo. Boletín Epidemiológico de México 11:71-88.
- POMAR, JUAN BAUTISTA and ALONSO DE ZURITA. 1941. Relaciones de Texcoco y de la Nueva España. Editorial Salvador Chávez Hayhoe, México.
- PONCE DE LEÓN, RAMÓN. 1909. Ligeros Apuntes Sobre la Flora del Estado de Sinaloa. Talleres Tipográficos de Julio G. Arce, Culiacán.
- PRIETO, CARLOS. 1985. Los minerales de la Nueva España. Pp. 259-264 in Comentarios a la Obra de Francisco Hernández. Universidad Nacional Autónoma de México, México, D.F.
- RICO-MONTIEL, ROBERTO, GLORIA VILA CLARA, ROGER CASTILLO and MARCO ANTONIO ZENTENO. 1993. Methodologic proposal for lacustrine sediment analyses applied to Tlaxcala diatomite, Mexico. Verhandlungen der internationalen Vereinigung für theoretische und angewandte Limnologie 25:1072-1074.
- ROBELO, CECILIO A. 1902. Nombres Geográficos Mexicanos del Estado de Veracruz. Estudio Crítico Etimológico. L.G. Miranda Imp., Cuernavaca, México.
- \_\_\_\_\_. 1941. Diccionario de Aztequismos o sea Jardín de las Raíces Aztecas. Palabras del Idioma Náhuatl, Azteca o Mexicano, Introducidas al Idioma Castellano bajo Diversas Formas. Third edition, Ediciones Fuente Cultural, México, D.F.
- SAHAGÚN, BERNARDINO, DE. 1971. Códice Florentino. Gobierno de la República, México, D.F. [facsimil de 1571].
- SALCEDO-OLAVARRIETA, NATALIA, MARTHA M. ORTEGA, MARÍA E. MARÍN-GARCÍA and CONCEPCIÓN ZAVALA-MORENO. 1978a. Estudio de las algas comestibles del Valle de México. II. Análisis químico comparativo. Revista Latinoamericana de Microbiología 20:211-214.
- \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_. 1978b. Estudio de las algas comestibles del Valle de México. III. Análisis comparativo de aminoácidos. Revista Latinoamericana de Microbiología 20:215-217.
- SANTAMARÍA, FRANCISCO JAVIER. 1959. Diccionario de Mejianismos. First edition. Editorial Porrúa, México, D.F.
- \_\_\_\_\_. 1978. Diccionario de Mejianismos. Third edition, Editorial Porrúa, México, D.F.
- SANTILLÁN, CLAUDIO. 1982. Mass production of *Spirulina*. Experientia 38:40-43.
- SILVA, PAUL C., PHILIP W. BASSON and RICHARD L. MOE. 1996. Catalogue of the Benthic Marine Algae of the Indian Ocean. University of California Press, Berkeley.
- SIMÉON, RÉMI. 1988. Diccionario de la Lengua Náhuatl o Mexicana. Seventh edition. Siglo Veintiuno Editores, México, D.F.
- SOSA TEXCOCO, S.A. 1976. Sosa Texcoco, S.A. Departamento de Espirulina, Proteínas y Derivados. Folleto impreso con la asistencia económica del Instituto Mexicano de Comercio Exterior, México, D.F.
- STANDLEY, PAUL C. 1930. Flora of Yucatan. Field Museum of Natural History, Botanical Series 3:157-492.
- STEARNS, WILLIAM T. 1992. Botanical Latin: History, Grammar, Syntax, Terminology and Vocabulary. Timber Press, Portland, Oregon.
- XIMÉNEZ, FRANCISCO. 1888. Cuatro Libros de la Naturaleza y Virtudes Medicinales de las Plantas y Animales de la Nueva España (extracto de las obras del Dr. Francisco Hernández). Imprenta y Litografía en la Escuela de Artes, Morelia, México.