NOTES ON ECONOMIC PLANTS

Traditional use of A'kub (*Gundelia tournefortii*, Asteraceae), in Israel and the Palestinian Authority area.—*Gundelia tournefortii* L., a perennial spiny herb of Irano-Turanian origin, (A'kub or Ka'ub-*Arabic*), may also be found in segetal and post segetal open plant formations of the Mediterranean regions of Israel and surrounding countries (*1*), (*2*), (*3*) and (*4*). A'kub plants develop a rosette following the autumn (October–November) rains and bolt during February–April. The young heads, while still at ground level are consumed as a fresh or cooked artichoke-like vegetable by several ethnic groups in the Palestinian Authority, Israel and surrounding countries (Muslims, Christians, Druse and Spharadi Jews). The decline of *G. tournefortii* populations caused by an increased demand due to human population growth, and by modern transportation (as aid for gatherers) threatens this wild plant (*5*). As a result, the picking of this plant in Israel is now restricted by law to domestic use only (*5*).

The use of this plant is probably quite ancient (more than 2000 years old) (*6*) and (*7*). Despite the fact that this old tradition still prevails in the Middle-East, the only mention, we are aware of, regarding the use of A'kub as human food in the economic botany literature is a four lines article in Sturtevant's Notes on Edible Plants (*8*). Therefore, we hereby provide a short description of the way in which A'kub is currently utilized in Israel and the Palestinian Authority area.

As hemicryptophytes, *G. tournefortii* plants have a thick perennial rootstock from which new growth arises each season. Following the autumn rains and during the winter to late spring, according to the rainfall and temperature profile of the season, the plants develop a new rosette. The lobed leaves are characterized by their spines and have either a red, yellow or purple central vein. The leaves are usually smooth, but we have found several tomentose populations in several locations across Israel and the Palestinian Authority area. The rosette diameter may reach 50–60 cm. On Mt. Hermon, at elevations of ca. 2000 m above sea level, in sectors covered by snow during the winter, *G. tournefortii* plants begin their rosette development when the Negev populations are near flowering. During late winter to early spring, after the rosette is established, the plants develop a central stem bearing about a dozen inflorescence branches. In large specimens, the total plant height, including this branched inflorescence, may reach 50 cm. Each of the inflorescence branches ends with a compound spiny ovoid head 4–8 cm in diameter (*5, 9*). Upon maturation, the above-ground parts of the plant dry, and later in the season (late-spring to early summer) they become detached from the root, and disperse their fruits as they are rolled by the wind over large distances (a tumbleweed) (*10*). We visited a large number of A'kub populations before, during and after the clipping season. In a number of locations, fully mature plants ready to disperse their fruit (and few already rolling in the wind) were observed side by side with relatively green plants bearing immature fruit. No habitat variation could account for the wide phenological range observed at any one location. We suppose that a short but intensive clipping pressure, operating for millennia during the mid-spring, may have served as a selection agent favoring both very early-bolting and very late-bolting genotypes. Under such a clipping regime, genotypes with extreme phenology are more likely to disperse their fruits.

The young inflorescence heads are removed before bolting by inserting a knife, and clipping the stem base a bit below ground level. The fresh heads, and occasionally also the bases of the rosette leaves (*13*), are trimmed to remove the (still short and soft) head thorns (Fig. 1) and are marketed on the very same day. No refrigerated delivery is known to us. Due to intensive clipping around Arab villages and a decline of *G. tournefortii* populations, groups of gatherers drive distances of more than 100 km to find locations where this wild plant is still abundant. Commercial picking takes place during the early morning, to ensure arrival at the local village market during the afternoon. Our observations indicate that, in Israel and the Palestinian Authority, A'kub collection is done mainly by groups of women from Arab villages. Occasionally we have met elderly Druse (men) collecting A'kub alone in the Golan.

Economic Botany 53(2) pp. 217–223. 1999

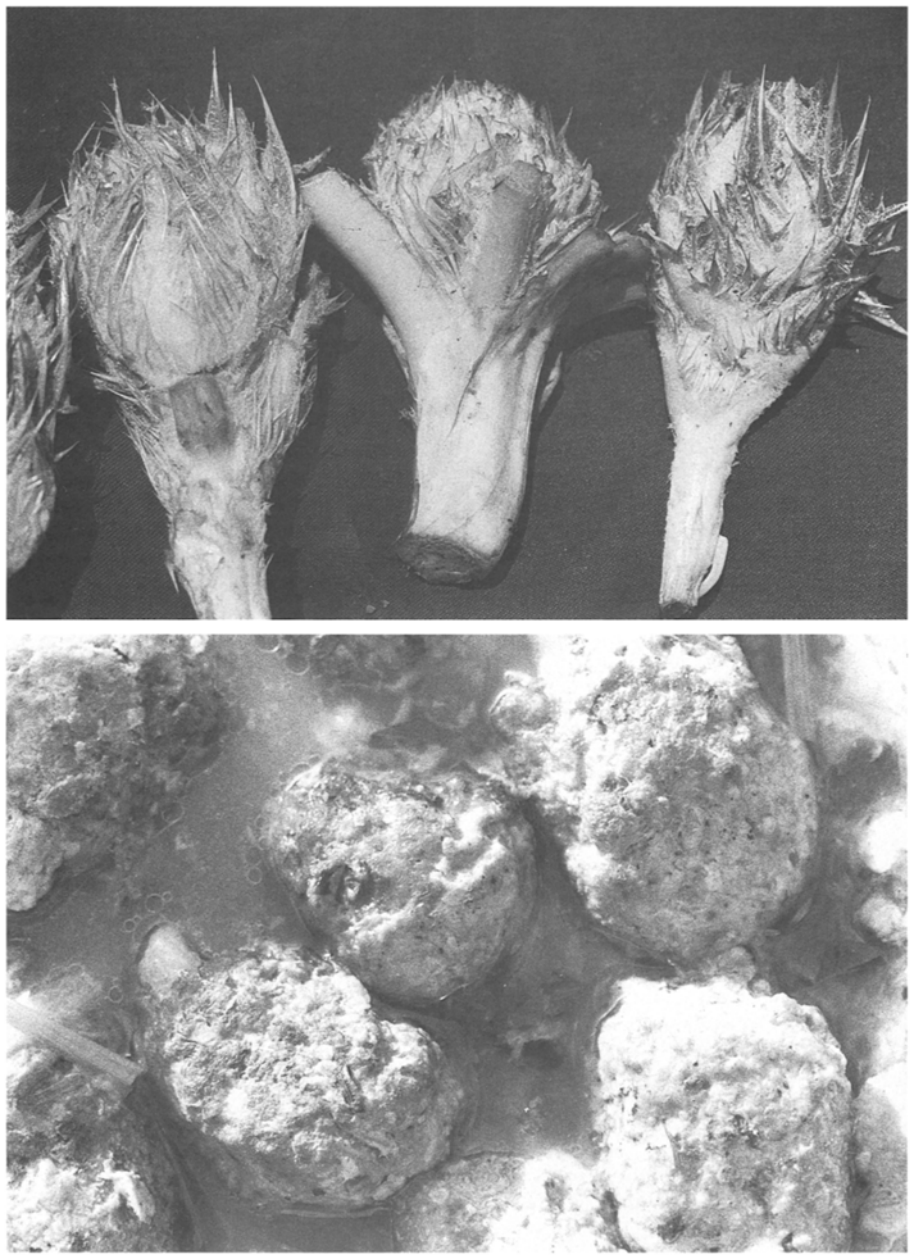

Fig. 1. *Gundelia tournefortii* heads, fresh above, simmering in sauce, below.

According to Kaplan et al. (*5*), a group of five to nine collectors may gather 4000–12 000 heads. Kaplan et al. (*5*) did not mention the time required to collect this number of heads, therefore we attempted to evaluate their figures. A team of three inexperienced collectors gathered 84 heads (2.5 Kg) in 3.5 hours in an area where previous groups had removed a considerable number of heads. After cleaning and trimming the inedible parts (mainly spines and stem bases), 1.1 kg of the collected 84 heads remained ready for cooking. In the Wadi-Nisnas market in Haifa, and in Arab villages of northern Israel, the price of A'kub heads may amount to U.S. $ 4.00 per kg. According to local sources, the price of A'kub heads in the Hebron district (Pa-

lestinian Authority) is less than U.S. $ 1.50 per kg. With such prices and with a short clipping season A'kub does not have a significant role in the economy of the Arab villagers in Israel and the Palestinian Authority, but rather serves as a traditional supplement to the diet and may contribute some cash seasonally.

In desert parts of Israel mature A'kub plants are sometimes used as fodder for camels (*11*), and in Central Anatolia, plants are also collected and dried for winter fodder (*12*). In Iranian Kurdistan, *G. tournefortii* straw was reported to have been used in preparing dung cakes (*11*). A'kub achenes contain edible seeds (*12*). During the late sixties, following the 1967 war, some export of fresh A'kub heads from Israel to the Gulf emirates developed (*13*). In Jordan A'kub is sold along highways in the northern part of the country as well as in certain stores in Amman (*1*). In Syria A'kub is a seasonal commodity in the Hamadia Sook of Damascus (*1*) and most probably in other major cities and along country roads as well. The time-consuming collection, the relatively short season (at any one location) and the need for fast delivery to target markets all dictate a short commerce season. The most popular (in northern Israel) A'kub dish is prepared as follows: the clean heads are covered with mincemeat, fried briefly in oil, and then, later on simmered in a lemon juice based sauce (Fig. 2). Additional traditional cooking recipes have recently been published in Israel (*13, 15*). A recent modern use of dry A'kub plants in Israel is as an ornamental plant, and as such the dry plants are sometime dyed in different colors.

The economic value of A'kub might increase should spineless types be available for planting. A considerable variation in the spine size exists in populations growing across Israel and the Palestinian Authority, however, at present, no data is available regarding its environmental and genetic components. We have initiated a selection and breeding program aimed at identifying such types. We assume that commercial cultivation of spineless A'kub could provide a source of income to many small farmers in a rather low investment. Such initiative might contribute to the well being of many households in Israel, the Palestinian Authority, and probably in Jordan and Syria as well. In addition to its economic potential, A'kub cultivation may assist in conserving this ancient tradition as well as contribute to nature protection by minimizing clipping from the wild. However, due to the perennial habit of A'kub no quick results could be expected from such an initiative.

Acknowledgments. The authors thank Dr. L. A. Morrison and Mrs. Susan Lev-Yadun for their useful comments on the manuscript, an anonymous reviewer for data on A'kub marketing in Jordan and Syria and Prof. L Kaplan for bringing reference No. 8 to our knowledge.

Literature Cited. (*1*) Anonymous. 1998. Information provided by one of the referees. (*2*) Post, G. E., and J. E. Dinsmore. 1933. Flora of Syria, Palestine and Sinai. Vol. 2. American Press, Beirut. (*3*) Zohary, M. 1962. Plant life of Palestine, Israel and Jordan. The Ronald Press Company, New York. (*4*) Zohary, M. 1973. Geobotanical foundations of the Middle East. Gustav Fischer Verlag, Stuttgart. (*5*) Kaplan, D., D. Pevzner, M. Galilee, and M. Gutman. 1995. Traditional selective harvesting effects on occurrence and reproductive growth of *Gundelia tournefortii* in Israel grasslands. Israel Journal of Plant Science 43: 163–166. (*6*) Babylonian Talmud. Beitza 34a (Hebrew, Aramaic). (*7*) Feliks, J. 1968. Plant world of the Bible. Massada, Ramat Gan (Hebrew). (*8*) Hedrick, U. P. (ed.) 1919. Sturtevant's notes on edible plants. State of New York—Department of Agriculture, 27th annual report; Vol. 2, part II, pp. 296. J. B. Lyon Company, Albany. (*9*) Classen-Bockhoff, R., H. A. Froebe, and D. Langerbeins. 1989. The inflorescence of *Gundelia tournefortii* L. (Asteraceae). Flora 182: 463–479. (*10*) Ridley, H. N. 1930. The dispersal of plants throughout the world. L. Reeve & Co. Ltd., Ashford. (*11*) Bailey, C., and A. Danin. 1981. Bedouin plant utilization in Sinai and the Negev. Economic Botany 35: 145–162. (*12*) Feinbrun-Dothan, N. 1978. Flora Palaestina. Vol. III. The Israel Academy of Sciences and Humanities, Jerusalem. (*13*) Abu-Ruken, S. 1977. Wild plants collected in Israel and shipped to the Gulf Emirates. Teva Vaaretz 19: 253–255 (Hebrew). (*14*) Danin, A., and U. Plitman. 1967. Men and vegetation in Iran. Teva Vaaretz 10: 49–50 (Hebrew). (*15*) Krispil, N. 1987. A bag of plants. Yaa'ra, Jerusalem (Hebrew).

—*Simcha Lev-Yadun, Department of Natural Resources, Agricultural Research Organization, The Volcani Center, P.O. Box 6, Bet Dagan 50250, Israel; Shahal Abbo, Department of Field Crops, Vegetables and Genetics, Faculty of Agricultural, Food and Environmental Quality Sciences, The Hebrew University of Jerusalem, Rehovot 76100, Israel.*

***Euclea divinorum* (Ebenaceae) bark is a high-potential tanning material.**—*Euclea divinorum* Hiern. (Ebenaceae) is a widespread and locally-abundant shrub or tree in Eastern and Southern Africa. We have employed it successfully in producing leather and believe it has potential as a sustainable source of natural tannin for local vegetable tanning enterprises.

In pastoral areas of Africa such as Arusha and Mara Regions, Tanzania, hides of cattle and skins of goats and sheep exist in surplus and are under-utilized as an income generating resource for local people. Although pastoralists such as Maasai preserve hides by rubbing in fat they do not have traditions of true leather tanning. Vegetable tanning using locally-available barks has been practiced in East Africa at least since the earliest European contact and provides a potential means of income generation in situations where populations are adapting to changing economic and ecological conditions. For such activities to be viable they need to i) minimize reliance on purchased inputs, ii) produce products that are sufficiently novel that they can enter a market niche distinct from those of large-scale commercial tanners, and iii) be environmentally friendly.

In considering locally-available alternatives to commercially available mimosa or black wattle extracts (*Acacia mearnsii,* Fabaceae) we were impressed by the high tannin content of *E. divinorum* in relation to other common local trees (*1*). We have reported total phenolic and water soluble phenolic contents of 122.7 + 25.5 mg/g and 77.1 + 9.8 mg/g respectively and tannin by protein precipitation of 94.0 + 0.9 mg/g from bark of this species. The tannin content of *E. divinorum* and other *Euclea* species was noted previously and use of the root in Tanzania as a black dye for mats or for chewing to impart a red color to the mouth reported (*2*). *Euclea divinorum* is used medicinally and as a dietary additive by Maasai (*1*), Batemi (*3*), Luo (*4,5*) and other people in the areas where we have worked in Western Tanzania and Kenya and is known locally by various names (*6,7*) including *olkinyei* (Maa), *msanganetu* (Batemi)(*3*) and *akado* or *ochol* (Luo) (*5*).

We collected and dried bark of *E. divinorum* (LEP 47; specimen deposited at NAI, University of Nairobi) from Ololosokwan, Loliondo Division, Ngorongoro District, Arusha Region (Latitude: 1°53′S; Longitude: 35°22′E). In order to produce a tannin liquor, dried bark was boiled in water on a charcoal burner. Using a Baumé (Bé) hydrometer (*8*) the strength of the liquor was determined as 7 Bé (specific gravity (s.g.) 1.0501) after approximately one and a half hours. The reaching of this strength is rapid in comparison to other locally-available barks, the best of which available to us, *Acacia nilotica* (L). Del., only reached 3 Bé (s.g. 1.0209) after replacing the bark with a second quantity and boiling again. Although 2 Bé (s.g. 1.0138) is sufficient for tanning, the advantage of the higher strength reached with *E. divinorum* is that less bark can be used to tan a given quantity of leather. Moreover, the leather produced from *E. divinorum* is a deep red color that provides an aesthetically-pleasing alternative to black wattle and other available barks.

East African *Acacia* species have been the subject of previous efforts to find alternatives to black wattle (*9*). In our experience leather from *Acacia nilotica* is an attractive dark brown and as predicted by Mugedo and Waterman (*9*) is softer than that produced from other barks including *E. divinorum.* However, the latter species is higher in phenolics and in tannin and, with a high tannin:non-tannin ratio among extractable phenolics of 2.4, ranks with the most promising East African *Acacias* in terms of tanning potential.

The quality of the leather from *E. divinorum* coupled with its production from an indigenous African plant gives it a degree of novelty that can be important for entering markets in Europe and North America. These features may be enhanced by drawing attention to the potential advantages of the species from an environmental perspective. This shrub or tree is widespread and locally-abundant. The successional dynamics of *Acacia-Euclea* savannahs appear to depend on the browsing of *Acacia nilotica* and other *Acacia* species by large mammals (*10*), and in savannah areas where elephants are no longer present, *Euclea* thickets tend to dominate to the detriment of wildlife and pastoralism. Beentje (*6*) comments that *E. divinorum* is "often a weed of pastures, due to its phenomenal power of coppicing and root suckering." These qualities would make this species less subject to overexploitation than the various *Acacias,* indeed exploitation of this weedy species could offer en-

vironmental advantages for improving pastoral lands in many areas of East Africa.

As an alternative to purchased inputs for leather making, *E. divinorum* would, depending on local abundance and labor requirements, seem to be economically viable in many areas over its range. While the trunks are slower-growing than many *Acacias* (*10,11*), they can reach 15 m and greater than 10 cm in diameter and have a thick bark. The availability of its bark, its tanning properties and its ecology would appear to make leather production with *Euclea divinorum* a useful complement to livestock rearing in the modern pastoral economy.

Literature Cited. (*1*) Johns, T., R.L.A. Mahunnah, P. Sanaya, L. Chapman, and T. Ticktin. Saponins and phenolic content of plant dietary additives of a traditional subsistence community, the Batemi of Ngorongoro District, Tanzania. Journal of Ethnopharmacology. In press. (*2*) Watt, J. M., and Breyer-Brandwijk, M. G. 1962. The medicinal and poisonous plants of Southern and Eastern Africa, 2nd ed. E and S Livingstone Ltd, Edinburgh. (*3*) Johns, T., E. B. Mhoro, P. Sanaya, and E. K. Kimanani. 1994. Herbal remedies of the Batemi of Ngorongoro District, Tanzania: a quantitative appraisal. Economic Botany 48:90–95. (*4*) Johns, T., J. O. Kokwaro and E. K. Kimanani. 1990. Herbal remedies of the Luo of Siaya District, Kenya: Establishing quantitative criteria for consensus. Economic Botany 44:369–381. (*5*) Kokwaro, J. O., and T. Johns. 1998. Luo biological dictionary. East African Educational Publishers, Nairobi. (*6*) Benntje, H. J. 1994. Kenya trees, shrubs and lianas. National Museums of Kenya, Nairobi. (*7*) Johns, T., E. B. Mhoro, and F. C. Uiso. 1996. Edible plants of Mara Region, Tanzania. Ecology of Food and Nutrition 35:71–80. (*8*) Mann, I. 1960. Rural tanning techniques. FAO Development Paper No. 68, Food and Agriculture Organization of the United Nations, Rome. (*9*) Mugedo, J. Z. A., and P. G. Waterman. 1992. Sources of tannin: alternatives to wattle (*Acacia mearnsii*) among indigenous Kenyan species. Economic. Botany:55–63. (*10*) Smith, T. M., and P. S. Goodman. 1987. Successional dynamics in an *Acacia nilotica-Euclea divinorum* savannah in Southern Africa. Journal of Ecology 75:603–610. (*11*) Bryant, -J. P., I. Heitkonig, P. Kuropat, and N. Owen-Smith. 1991. Effects of severe defoliation on the long-term resistance to insect attack and on leaf chemistry in six woody species of the southern African savanna. American Naturalist 137:50–63.

—Mieke van Grinsven, ASILIA Ltd, Arusha, Tanzania. Moringe L. Parkipuny, Loliondo, Tanzania. Timothy Johns, School of Dietetics and Human Nutrition, Macdonald Campus, McGill University, Ste. Anne de Bellevue, Quebec, Canada, H9X 3V9.

Acuitlacpalli or *Sagittaria macrophylla* (Alismataceae): a Mexican endemic hydrophyte and a threatened food resource.—Acuitlacpalli or *Sagittaria macrophylla* Zucc. (=*S. mexicana* Steud) is one of 19 species of Mexican Alismataceae (*1*). The leaves and tubers have been used as a food, at least since the early Spanish colonial period. The aim of this study is to bring attention both to the traditional use of the tubers, which are sold in local markets, and to the need for conservation of the plant.

Acuitlacpalli is an endemic emergent hydrophyte of Mexico that grows in wetlands of the basin of the Valley of Mexico and upper drainage of Río Lerma (*2,3,4,5*). Between 1865 and 1994, only 20 habitat localities had been recorded. Growth of the world's largest metropolis (Mexico City) has destroyed this plant's habitat resulting in reduced populations and distribution range. This once common species with edible tubers, is now near extinction (*6*). The name acuitlacpalli derived from the nahuatl: *atl* = agua (water), *cuitlac* = planta (plant), excreción (excretion) and *palli* = barro negro (black clay) (7). Locally the plant is called "apatlol," "apaclol," "aplacolillo," "cucharilla," "hoja flecha" or "cola de pato", which are based upon the characteristic form of the leaves (*8*). Records of its use date back to the sixteenth century (*9*). The Mexican Indians of the past recognized this spreading herb which grew at the edge of the water, the leaves of which were cooked and eaten by the "señores" ("tlatoque" or leaders) (*9*). Today the leaves are used only as forage. The edible tubers are called "papas de agua" because of their shape and consistency, which are similar to those of (solanum) potatoes (*10*). In the past the tubers were called "cacatextli" (*11*), also of nahuatl derivation: *cacatl* = paja or planta (straw or plant) and *textli* = harina (flour).
ough of economic value, this species is poorly understood. Specimens that included the starchy tubers were lacking from herbarium collections. Until recently, the geographic range of the species had not been documented. Recent efforts to document its range indicate that most popula-

tions are heavily impacted by human activities and the species is in danger of extinction (*6*).

The botanical description is available in *Flora Neotropica* and *Flora Fanerogámica del Valle de México* (*1,4*).*S. macrophylla* is distinguished from *S. latifolia* var. *latifolia* which occurs in the same region by the length of the peduncle of the pistillate flower (4–15 cm long) and the obovate achenes (2.9–3.5 mm long and 1.8–2.6 mm wide) with dorsal wing (0.2–0.8 mm wide) and erect subapical beak (0.4–1.1 mm long) (*2,4*).

Only a general aspect of the plant's growth habit and ecology is known. First leaves are formed at the beginning of May. Flowering occurs from July to October with peak flowering in September. Fruits are formed from August to November. Vegetative reproduction is by means of short stolons (average five for plant) that have squamous colorless nodal leaves, terminating in a bud from which a new erect plant is formed (Fig.1). Late in September, tubers form at the ends of the stolons. These will separate from the parent plant which later dies with arrival of the cold season. During winter the tubers remain dormant and in spring a new plant potentially will sprout from each. In Mexico only *S. macrophylla* tubers have been reported as edible, although other species also produce tubers (*10*). The tubers are white, ovoid with horizontal rings of squamous leaves, greenish and brown, measuring 12 mm in average length and 10 mm in diameter. Chemical composition (as percentage) of these tubers is shown in Table 1.

Fig. 1. Acuitlacpalli, *Sagittaria macrophylla*: A) habit, B) seed, and C) tuber. Illustration by Felipe Villegas.

TABLE 1. CHEMICAL COMPOSITION OF *SAGITTARIA MACROPHYLLA* TUBERS.

Nutrients	Dry (%)	Fresh (%)
Crude protein	17.71	8.75
Ether extract	1.19	0.59
Ash	2.81	1.39
Crude fiber	2.14	1.06
Nitrogen free extract	76.15	37.65
Moisture	—	50.56

The tubers which are collected from November to April are eaten by people of central México, especially in the of Río Lerma region. The fresh tubers, which have a bitter flavor, are boiled over coals. They are sold in the local market thus representing a product of commercial value in the towns of Almoloya de Juarez, Almoloya del Río, Lerma, Toluca and Villa Victoria in the state of México. In 1997 the price was $30.00 (Mexican pesos) per Kg, or five tubers for $5.00.

Sagittaria macrophylla is of local economic and cultural importance in the Valley of Mexico, but, current patterns of human activities threaten the wetland habitats where this species occurs and extinction is likely. Measures to guard against its extinction are needed, but such measures will require greater knowledge of the biology and ecology of the species than is currently available.

Acknowledgment. We thank Dr. Robert Bye from the Jardín Botánico at the Instituto de Biología, Universidad Nacional Autónoma de México for assistance with revision of the manuscript. The figure was drawn by Felipe Villegas, Instituto de Biología at the Universidad Nacional Autónoma de México. Thanks to Javier Manjarrez for logistic support and to the anonymous

reviewers for comments. Financial support was provided by the UAEM (grant 1225/97).

Literature Cited. (*1*) Haynes, R., and L. B. Holm-Nielsen. 1994. Flora Neotropica: Alismataceae. 64:1–112. (*2*) Lot, A., A. Novelo, and P. Ramírez-García. 1986. Listados Florísticos de México V. Angiospermas acuáticas mexicanas 1. Instituto de Biología, UNAM. México; (*3*) Bogin, C. 1955. Revision of the genus *Sagittaria* (Alismataceae). Memoirs of New York Botanical Garden 9(2):179–233; (*4*) Novelo, A., and A. Lot. 1990. Alismataceae. Pages 28–30 *in* J. Rzedowski, and G. C. de Rzedowski. Flora Fanerogámica del Valle de México. Vol. III. Instituto de Ecología. México; (*5*) Smith, J. G. 1894. A revision of the North America species of *Sagittaria* and *Lophotocarpus*. Missouri Botanical Garden Reprints 6:1–37; (*6*) Olmsted, I. 1993. Wetlands of Mexico. Pages 637–678 *in* D. F. Whigham, D. Dykyjova and S. Heimy, eds., Wetlands of the World I. Inventory ecology and management. Kluwer Academic. Dordrecht, Netherlands; (*7*) Urbina, D. M. 1903. Plantas comestibles de los antiguos mexicanos. Anales del Museo Nacional de México 2ª Epoca. Tomo 1:503–591; (*8*) Martínez, M. 1979. Catálogo de Nombres Vulgares y Científicos de Plantas Mexicanas. Fondo de Cultura Económica. México; (*9*) Sahagún, B. 1926. Códice Florentino. Talleres Gráficos del Museo de Antropología, Historia y Etnografía; (*10*) Martínez, M., and E. Matuda. 1979. Flora del Estado de México. Tomo III. Biblioteca Enciclopédica del Estado de México. México; (*11*) Lot, A., and G. Miranda-Arce. 1983. Notas sobre las interpretaciones botánicas de plantas acuáticas representadas en códices mexicanos. Pages 85–96 *in* J. F. Peterson, Imágenes de Flora y Fauna en Culturas Precolombinas: Iconografía y Función. BAR International Series 171.

—*Carmen Zepeda, Facultad de Ciencias, Universidad Autónoma del Estado de México. Instituto Literario 100, Colonia Centro, C.P. 50 000. Toluca, Estado de México, México; e-mail: carmenz@mail.ibiologia.unam.mx,* and *Antonio Lot, Instituto de Biología, Universidad Nacional Autónoma de México, C.P. 04510. México, D.F., México; e-mail: loth@servidor.unam.mx*