Eelgrass (Zostera marina L.) in the Gulf of California: Discovery of Its Nutritional Value by the Seri Indians

Abstract. Zostera marina *occurs in the northern Gulf of California. The grain of eelgrass is harvested in the spring and formed an important part of traditional Seri diet and culture. This is the only known case of a grain from the sea being used as a human food source. Eelgrass has considerable potential as a general food resource for mankind. Its cultivation would not require fresh water, pesticides, or artificial fertilizer.*

The Seri Indians of Sonora, Mexico, are one of the last hunting and gathering peoples (*1–3*). Although the information content in their culture is rapidly decaying through acculturation, some of the older people can describe traditional knowledge and practices with clarity (*4, 5*). Our studies of the Seri reveal that the seeds of eelgrass were an important traditional food source. In this report we describe the involvement of the Seri with this plant.

Zostera is cosmopolitan and consists of about a half-dozen poorly defined species. *Zostera marina* occurs in extensive pure stands along the coasts of North America and Eurasia. Zosteraceae is one of the few groups of fully submerged marine flowering plants (*6*).

The reproductive plant of *Z. marina* has long slender leafy stems. Increasing water temperatures in spring are associated with the death and disjunction of the upper stem, which bears the fruit, and this results in flotation (*6*). The fruit is a flask-shaped utricle, about 3.0 to 3.5 mm long and 1.0 to 1.5 mm in diameter. The single seed nearly fills the thin-walled utricle. Each spadix bears 5 to 11 seeds.

There are a few scattered mentions of eelgrass in the Gulf of California (*7*) and in the literature on the Seri (*8*); the documentation, however, is poor. The role of eelgrass in Seri culture demonstrates that the plant has long been in the Gulf, even though it is not mentioned in botanical surveys of the region. To unambiguously illustrate the importance of this plant in Seri culture, key Seri words (*9*) and knowledge associated with it are included here.

The Seri know of eelgrass at Kino Bay, in the Infiernillo channel, and at El Desemboque (Fig. 1). It is abundant in the Infiernillo. The Seri claim that earlier in this century there was a great growth of eelgrass in the bay at Desemboque, but that by the 1940's it had disappeared. In spring 1970 it began to reappear at Desemboque.

The month of April corresponds approximately to the Seri moon or month known as *Xnois i?aat íiSSaaX* '*Xnóis* when-there-is moon'—that is, when eelgrass grain is ready for harvesting (*8, 9*). A certain species of duck which dives to feed on the plant is called *Xnóis kakáasso* '*Xnóis* the-foreteller,' because when seen diving, it is said to foretell the season of the eelgrass. A small rock islet, Marito de Turner, off the southeast shore of Turner's Island (Fig. 1) is called *?ast Xnóis* 'rock *Xnóis*' (*Xnóis* rock). The fact that a month of the year, a duck, and a geographic landmark take the name of this plant is testimony to the antiquity of the use of eelgrass in Seri culture.

The seed was one of the most important traditional foods of the Seri and is still occasionally harvested. The ripe fruit, *Xnóis*, is harvested in April or early May by both men and women. It is usually not harvested until the plant is floating loose in great masses close to shore. At such times the people wade into the water, often to their chests, to pull in bunches of the long strands hand over hand. A person who harvests *éaS*, the floating plant, is called *kapóee*. It is a time of happiness, with much shouting and laughter, and "everyone gets wet." It is a time of warm and pleasant weather.

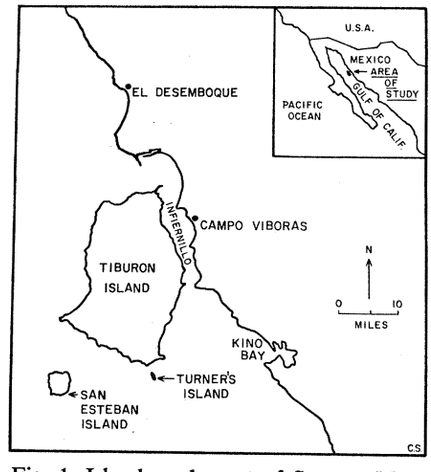

Fig. 1. Islands and coast of Sonora, Mexico, in the region of present-day Seri occupation. (Scale, 10 miles ≈ 16 km.)

One who harvests *?atám*, the growing plant, is called *kotám*. The growing plant is generally harvested only when one is "in a hurry" to eat the seeds.

The eelgrass is spread along the beach to dry, and seaweed and debris are picked out. The action of throwing away this debris is called *káaptX*. The plant requires several days to dry. Then, after the dampness of the morning is gone, the job of separating the grain begins. Women sit with great bunches of eelgrass placed on deerskins, canvases, or cloths, or in baskets or other receptacles. They thresh it with wooden clubs. It is then rolled between the palms to loosen the fruit. Children may sit with their mothers and help with the harvest.

After the fruit is collected, it is winnowed to remove the relatively large amount of leaves, twigs, and debris. Winnowing is accomplished by tossing the fruit into the air and allowing the debris to blow away.

The grain is prepared by women. Traditionally a portion of the grain was stored in pottery ollas to be eaten during the time of fall rains. The toasted grain, called *Xnois ?apá??a* '*Xnóis* toasted,' is much preferred over the natural untoasted grain which is called *Xnois ?apánna* '*Xnóis* haired.' Traditionally it was toasted in a wide-mouthed pottery vessel or in a large sherd, and then poured into a basket or sea turtle shell, and pounded to break open the hard fruit or utricle. The chaff is separated from the seed by a second winnowing, which is also done by tossing the seed and chaff into the air. Finally the seeds are ground on a metate. The flour is placed in a basket and the basket tapped on a stick to bring the remaining chaff to the surface at the edge of the basket, where it is allowed to spill onto the ground, leaving the pure flour in the basket.

The flour is cooked in water and made into either a thick or a thin gruel. Since it has little flavor (like most flours), it is eaten with other food, usually sea turtle oil or honey. *Xnois kóinim* 'eelgrass-seeds mix' is made by grinding the seeds of *cardón* (*Pachycereus pringlei*), a giant columnar cactus, with eelgrass seeds. The Seri state that *cardón* seeds are rich in oil and add a good flavor to the eelgrass (*10*).

The Seri report that eelgrass is a favorite food of sea turtles, and is extensively grazed primarily by the green sea turtle, *Chelonia mydas*. Preliminary analysis of stomach contents of specimens of *Chelonia* from the Infiernillo region confirms the fact that these turtles feed on eelgrass (*11*). Seri turtle hunters often seek their prey near eelgrass beds. According to the Seri, turtles feeding on eelgrass have sweet, well-flavored meat; while those found off the west coast of Tiburon Island which eat algal seaweeds are *kʔéemt* 'stinking' (*11*).

Eelgrass is primarily a food for the Seri; however, other uses for it figure in their culture. A child suffering from diarrhea is said to recover if he is fed *Xnóis*. Eelgrass is piled over a house frame for shade and roofing. A basket or sea turtle shell lined with eelgrass provides a bed on which meat is placed in order to keep it clean.

Dry eelgrass was formerly used to stuff a mule deer or desert bighorn sheep scrotum to make a ball for children to play with. In the past, dolls were often fashioned from bundles of eelgrass (*éaS*) bound into a cross with strips of cloth. Like most Seri dolls and figures, it is faceless and of haunting simplicity (see cover).

We know of no other case of the grain of an ocean plant being used as a human food resource (*12*). The cosmopolitan distribution of *Zostera* in shallow coastal waters enhances its possible significance as a food plant. The protein and starch contents of the seed compare favorably with those of major terrestrial economic grains (*13*). It has an unusually low fat content, which may have certain nutritional advantages (*13*). Prejudices against strong and unfamiliar flavors do not present a complication since the flour is bland. *Zostera* possesses positive environmental value as a crop plant because fresh water, artificial fertilizer, and pesticides would be unnecessary.

Note added in proof: Fieldwork in the Seri region in late June 1973 revealed the presence of *Ruppia maritima* in shallow seawater. However, we can conclusively state that the Seris do not utilize *Ruppia*.

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References and Notes

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7. E. Y. Dawson, *Syst. Zool.* **9**, 93 (1960). J. Steinbeck and E. F. Ricketts [*Sea of Cortez* (Viking, New York, 1941), p. 261] report *Z. marina* in extreme southwest Sonora, Mexico.
8. In a little-known, privately printed publication, Davis [C. R. Quinn and E. Quinn, Eds., *Edward H. Davis and the Indians of the Southwest United States and Northwest Mexico* (Elena Quinn, Downey, Calif., 1965), p. 164] briefly described the use of "a green grass growing on the sea bottom," which can only be *Zostera*. E. Y. Dawson [*Desert Plant Life* **16**, 132 (1944)] claimed that the Seri ate the seeds of *Ruppia*. Dawson's specimens from the Infiernillo channel, Tiburon Island (deposited at the Los Angeles County Museum of Natural History), which were originally determined as *Ruppia maritima* L., are in fact *Zostera marina*. We have found no evidence of *Ruppia* in the present Seri region. Kroeber (*2*) mentioned "eel-grass sea-weed" in the Seri calendar and "the edible 'seeds' of eel-grass." E. Moser and M. B. Moser [*Vocabulario Seri* (Serie de Vocabulario Indigenas No. 5, Instituto Linguistico de Verano, Mexico, D.F., 1961)] translate *Xnóis* as *Zostera marina*. In retrospect, previous brief allusions to the consumption of seaweed, marine grasses, or *Ruppia* by the Seri [Davis, Dawson, Griffen (*4*), Kroeber (*2*), and McGee (*3*)] certainly refer to *Z. marina*. The Seri do not eat algal seaweeds.
9. For a description of Seri phonemes see E. W. Moser and M. B. Moser, *Linguistics* **16**, 50 (1965). Standard phonemic conventions are used here.
10. Analysis of *cardón* seeds by W. W. Turner, Jr. (Efco Laboratories, Tucson, Arizona) showed: protein, 22.59 percent; crude fat, 32.06 percent; and starch, 0.95 percent. See (*13*) for methods. The high fat content complements the low fat content of eelgrass seeds (*13*).
11. Further information on Seri knowledge of eelgrass as it relates to sea turtle hunting and biology is included in a manuscript in preparation by R. Felger, E. Moser, and P. Regal.
12. The fleshy roots and leaf bases of *Z. marina* are occasionally eaten and used as flavoring [N. C. Turner and M. A. Bell, *Econ. Bot.* **25**, 63 (1971)].
13. A preliminary analysis of the seed by W. W. Turner, Jr., showed: protein, 13.20 percent; crude fat, 1.01 percent; and starch, 50.9 percent. The seeds were separated from the husks with mortar and pestle, and fractionation through a 20-mesh Tyler sieve yielded 57.8 percent seeds and 42.2 percent husks by weight. For the methods of analysis see: (protein) W. Horowitz, Ed., *Official Methods of Analysis of the Association of Analytical Chemists* (Association of Analytical Chemists, Washington, D.C., ed. 11, 1970), sections 42.014–42.016; (fat) *ibid.*, section 7.048; (starch) W. W. Turner, Jr., *J. Ass. Offic. Anal. Chem.* **52**, 956 (1969). The sample was collected at Campo Viboras (Fig. 1). A more extensive nutritional analysis is merited, and ideally this would survey various populations.
14. We are grateful to the Seri, who taught us information recorded in this report. We thank Jean Russell and Alexander Russell for their continuing generosity. Partial assistance for initial phases of this work was provided by a grant from the Office of Naval Research [ONR-N0014-67-A-0209-003(NR 104-897)] through Dr. Donald A. Thomson, University of Arizona.

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Human Perception of Illumination with Pulsed Ultrahigh-Frequency Electromagnetic Energy

Abstract. *A psychophysical study of the perception of "sound" induced by illumination with pulse-modulated, ultrahigh-frequency electromagnetic energy indicated that perception was primarily dependent upon peak power and secondarily dependent upon pulse width. The average power did not significantly affect perception. Perceived characteristics of pitch and timbre appeared to be functions of modulation.*

Field tests with radar indicate that humans and cats perceive low-power pulse-modulated, radio-frequency (rf) energy (*1–3*). Human subjects reported that they perceived "sounds" that were in the nature of buzzes and hisses. The energy perceived was not acoustic energy; rather, it was electromagnetic (EM) energy in the ultrahigh-frequency (UHF) band of the spectrum. These findings can be related to other reports of sensory and behavioral phenomena associated with illumination with low-power rf energy. Analytical reviews of these and other reports and implications of the reviewed reports that bear on our understanding of information transfer and storage in living organisms can be found in the literature (*3–5*).

In the field tests with radar, A.H.F. determined the portion of the EM spectrum that was effective in inducing the "sounds" and the approximate thresholds. Perception occurred when the subject was illuminated with energy from approximately that portion of the EM spectrum defined as the UHF band, that is, from 0.3 to 3 Ghz (*6*). This is the portion of the spectrum at which EM energy passes into and through the head. At higher frequencies the energy is largely absorbed by the skin, and at