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Zostera asiatica Miki on the Pacific Coast of North America[1]

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ABSTRACT: *Zostera asiatica* Miki is reported from Tomales Bay to Santa Monica, California. It occurs from 5 to 17 m below mean lower low water. Plants have wide blades (12.0 to 18.4 mm wide) with tips notched to deeply notched. Freshly collected mature seeds have smooth seed coats. Flowering at most locations occurs in August; seeds occur in September and October. This is the first record of the species in the eastern Pacific and brings to six the number of seagrass species in the northeastern Pacific.

A WIDE-BLADE *Zostera* occurs in the subtidal from −5 m mean lower low water (MLLW) to −17 m MLLW from Tomales Bay, Sonoma County, in the north to Santa Monica Bay, Los Angeles County, in the south (Figure 1). Since the distribution of these plants was either in deep water in Tomales Bay or offshore, and since the flowering phenology was normally displaced into late summer (except for the Monterey Bay population), we suspected that the plants represented *Z. asiatica* Miki. When fruiting specimens with seeds were collected off the Corral Canyon site west of Santa Barbara, California, a confirmation of the species was possible.

MATERIALS AND METHODS

Leaf widths were measured to the nearest 0.1 mm with an ocular micrometer (Bausch and Lomb). Leaf width was measured 10 cm above the sheath on the oldest leaf of 10 terminal vegetative shoots.

Monthly collections were made at Isla Vista at the University of California at Santa Barbara from 1976 through 1979. We made a collection of plants in the extreme southeast corner of Monterey Bay on 11 May 1987. A Scuba dive was made in the Corral Canyon area on 26 September 1988.

RESULTS AND DISCUSSION

The plants from Isla Vista composed a large meadow in water 14 m deep. This population produced flowers in August and seeds in late September and October. Inshore eelgrass produced flowers in March and seeds from May to June. In late 1988 we conducted a study of the dried seeds of the Isla Vista population for seed coat morphology. Several seeds from herbarium material were soaked in water. *Z. marina* seeds have 20 to 25 distinct longitudinal ridges on the coat. The ridging on the Isla Vista seeds was either not distinct or was faint to the unaided eye.

Plants in Monterey Bay were restricted to water 5 m deep to at least 12 m deep. Leaves in the field ranged from 2 to 3 m long. Flowering stalks were present on 11 May 1987. No seeds were present.

Plants in the Corral Canyon area were in water 12 to 17 m deep. Patches were found throughout this depth. Several fruiting stalks were collected on 26 September 1988. All fresh seeds examined had smooth seed coats. Seed dimensions were uniform (4.0 mm long; 2 mm wide). After preservation in 5% formalin solution, many seed coats displayed a faint ridging on some portions, but parts of the seed coats were smooth (Figure 2).

Craig Barilotti (pers. comm., 18 October 1988) related that the species is common throughout the central California area. At Gaviota (Figure 1) it occurs in very large patches and is a competitor with kelp for bottom space. Rim Fay (pers. comm., 19 October 1988) observed 12 m^2 of the species in Santa Monica Bay in water 12 to 13 m deep.

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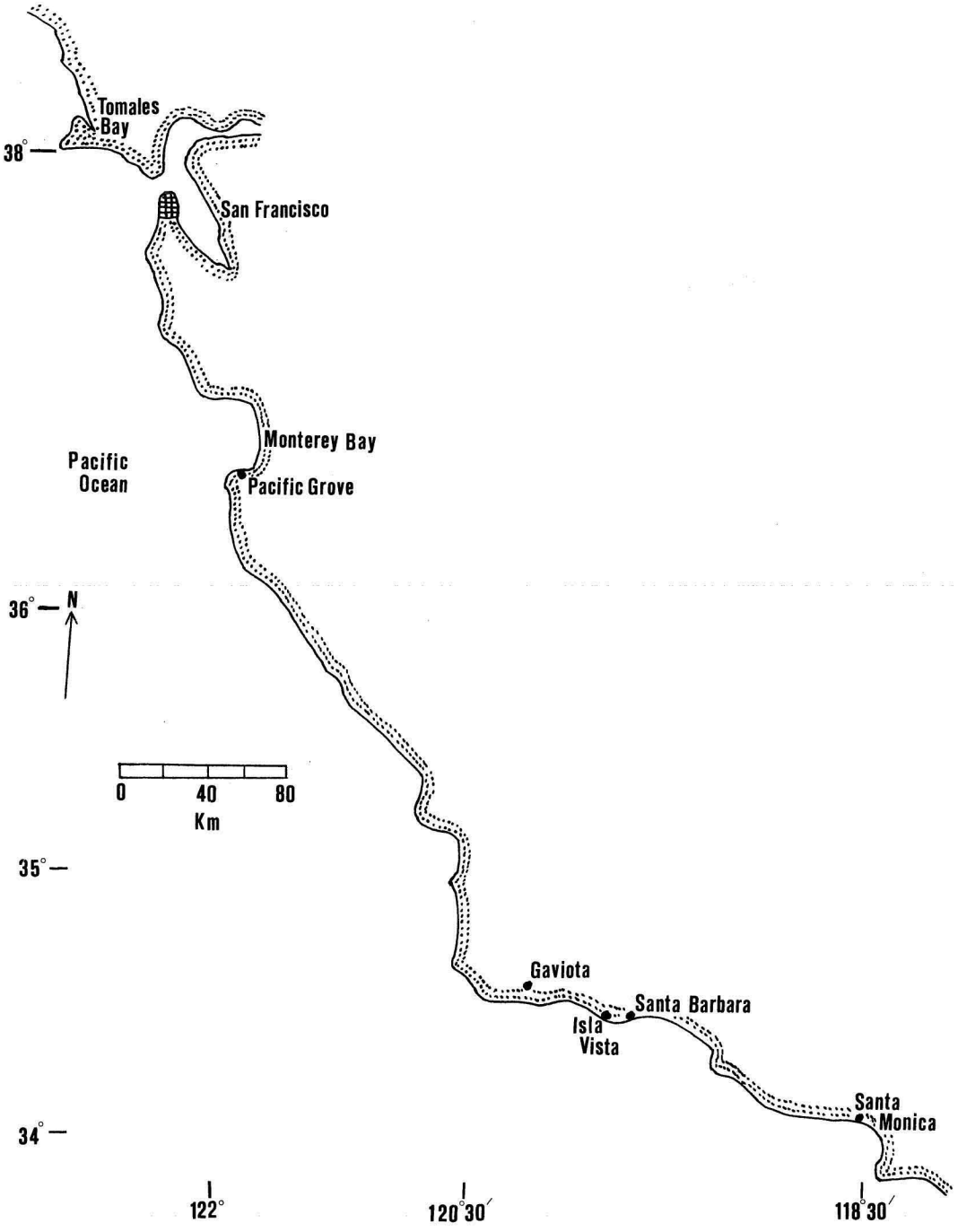

FIGURE 1. Distribution of *Zostera asiatica* in California.

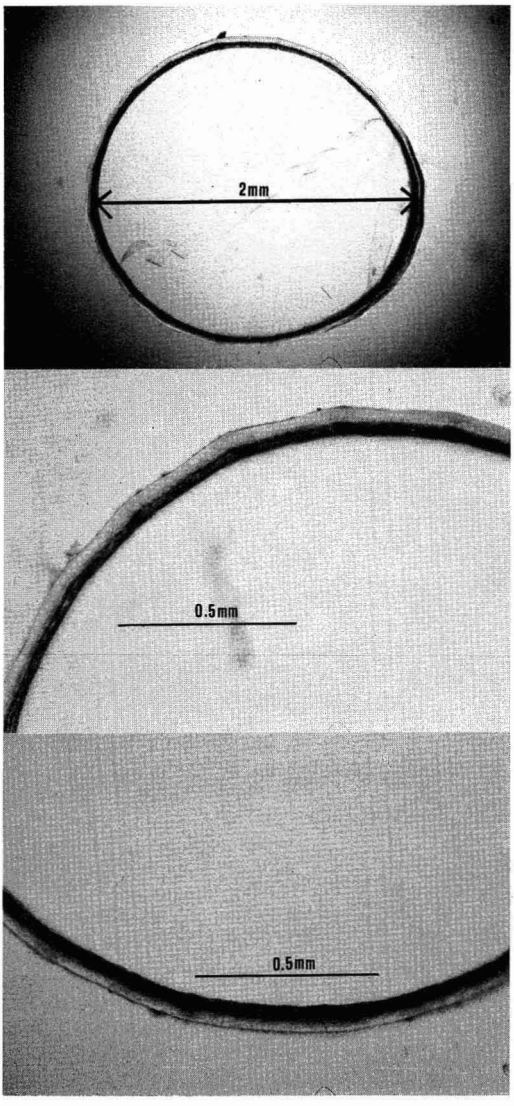

FIGURE 2. Cross section (three views) of fruit wall of *Z. asiatica* from Corral Canyon, west of Santa Barbara, California.

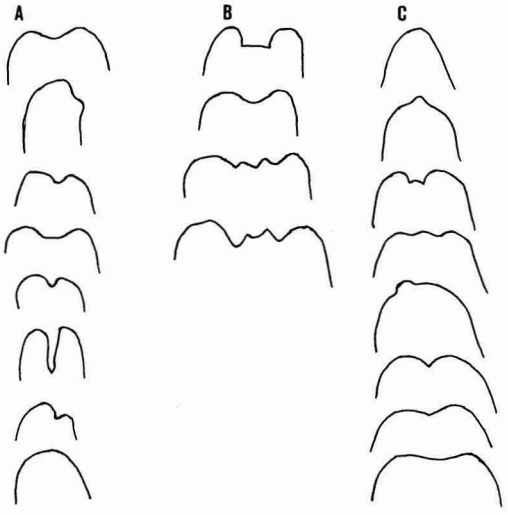

FIGURE 3. Leaf tips of *Z. asiatica*: (*A*) plants collected at Isla Vista off the Marine Laboratory, University of California at Santa Barbara, 14 March 1978, leaves 7 to 14.2 mm wide (from dried herbarium specimens); (*B*) plants collected in the southeast corner of Monterey Bay, Pacific Grove, California, 11 May 1987, leaves 12.2 to 16.2 mm wide; (*C*) plants collected off Corral Canyon, west of Santa Barbara, 26 September 1988, all leaves > 15 mm wide.

Most leaf tips on some populations are notched (Isla Vista at Santa Barbara; Monterey Bay), while only occasional leaf tips are notched on others (Tomales Bay; Corral Canyon west of Santa Barbara) (Figure 3). Notched leaf tips are a conspicuous feature on these plants. Eelgrass leaf tips are predominantly obtuse, but occasionally may appear mucronate. The unnotched leaf tips on the *Z. asiatica* populations were obtuse and were identical with those of eelgrass. It is conceivable that pollen from eelgrass inshore or, in the case of Tomales Bay, adjacent to the *Z. asiatica* populations may reach the stigmas of the *Z. asiatica* populations, resulting in a mixed percentage of obtuse leaf tips on *Z. asiatica* populations. Obtuse leaf tips may occur on the same leafy shoot as leaves with notched tips.

Typically, eelgrass leaves vary in width from 1.5 to 12 mm. Oldest leaves of terminal vegetative shoots of these *Z. asiatica* populations vary in width from 12.0 to 18.4 mm when fresh (average 15.0 to 15.88 mm). Populations of *Z. asiatica* appear to be restricted along this section of coastline to water deeper (-5 to -17 m MLLW) than that in which eelgrass is found. Flowering phenology is usually later in the year as compared to eelgrass (except for Monterey Bay) (Table 1). The smooth, unridged seed coat of *Z. asiatica* is the best indicator of the species.

TABLE 1

POPULATION CHARACTERISTICS OF *Zostera asiatica* IN NORTH AMERICA

LOCATION	DATE OF COLLECTION	WATER DEPTH (m)	LEAF WIDTH (mm)	FLOWERING PHENOLOGY
Tomales Bay (SE tip of Hog Island)	7 August 1987	5	12.0–18.0 ($\bar{x}$ = 15.88)	Plants sterile
Monterey Bay (extreme SE corner near shore)	11 May 1987	5–12	12.1–18.4	Flowering ($\bar{x}$ = 15.7)
Gaviota	—	12–13	—	—
Corral Canyon (west of Santa Barbara)	26 September 1988	12–17	14.6–17.1 ($\bar{x}$ = 15.8)	Seeds
Isla Vista (west of Santa Barbara; at Univ. of Cal.)	1976–1979 (monthly collections)	14	8–14 (from dried herbarium specimens)	Flowering on 8 August 1978; seeds on 18 September 1978 and 20 October 1978. All fruiting stalks gone in November 1978
Abuta; Iburi Province, Hokkaido, Japan (sheet no. 501798, UC Berkeley Herbarium)	21 August 1982	—	14.5–15.4 ($\bar{x}$ = 15.0) (dried herbarium specimens)	Plants sterile
Wakanai, Hokkaido, Japan (sheet no. 503178, UC Berkeley Herbarium)	5 August 1932	—	—	Seeds

We conclude that the wide-bladed *Zostera* found from Tomales Bay to Santa Monica Bay is *Z. asiatica* Miki. This decision is based on its restriction to deep water, its wide blade, the notched characteristic of many of the vegetative leaf tips, the smooth seed coat, and the flowering and seed phenology (excepting the Monterey Bay population; Table 1). All these characteristics, morphological and behavioral, are listed in Miki (1932) as characteristic for *Z. asiatica*. Figure 4 shows preserved vegetative and fruiting specimens of *Z. asiatica*.

Chromosome number, taken from root tips, is $2n = 12$. All 10 *Zostera* species are identical in chromosome number.

This record brings the list of seagrasses on the Pacific coast of North America to six species (three species of *Zostera*; three species of *Phyllospadix* [Phillips and Menez 1988]) (Table 2). Miki (1932) reported *Z. asiatica* from two locations on Hokkaido in northern Japan, from the northeastern coast of Korea, and from Sakhalin and the Kuril Islands in the USSR.

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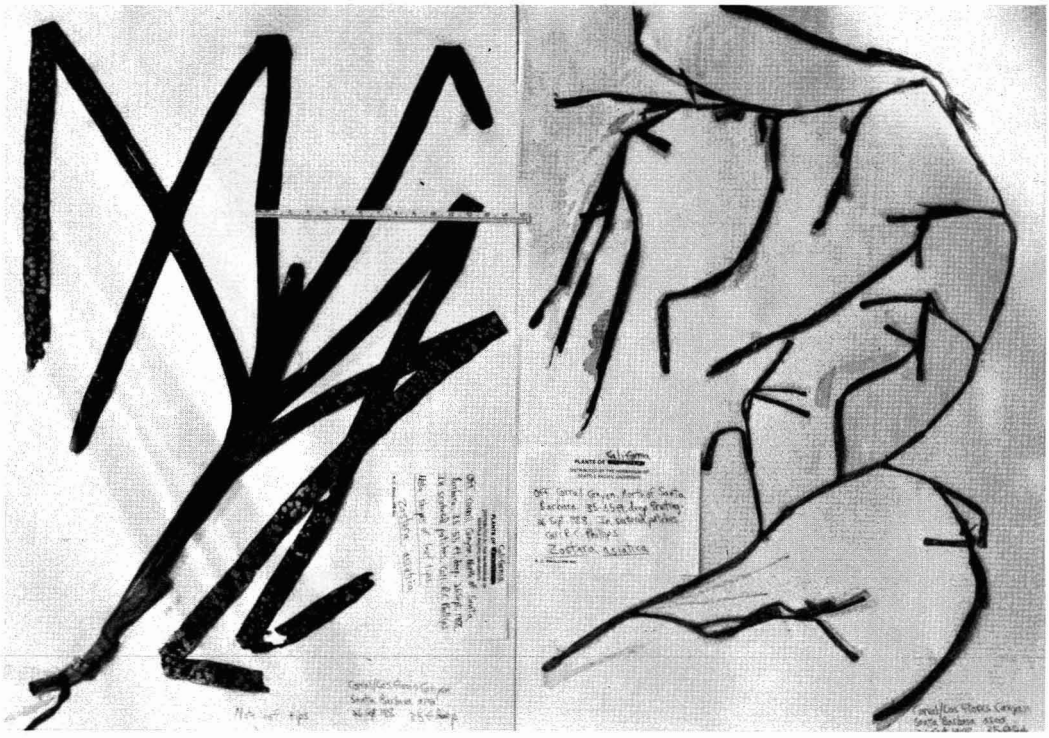

FIGURE 4. Herbarium specimens of *Z. asiatica*: *left*, vegetative specimen; *right*, fruiting specimen.

TABLE 2

SEAGRASS SPECIES ON THE PACIFIC COAST OF NORTH AMERICA

SPECIES	DISTRIBUTION
Zostera L.	
marina L.	Arctic Circle in Alaska to the tip of Baja California and at several sites in Sonora, Mexico on the east shore of the Sea of Cortez
japonica Ascherson & Graebner	Southern British Columbia, Canada to Cape Arago in southern Oregon
asiatica Miki	Tomales Bay, California, north of San Francisco, to Santa Monica Bay, near Los Angeles, California
Phyllospadix Hooker	
scouleri Hooker	Sitka, Alaska to the Tropic of Cancer, Baja California
torreyi S. Watson	North tip of Vancouver Island, British Columbia, Canada to the Tropic of Cancer, Baja California
serrulatus Ruprecht ex Ascherson	Chirikof Islands, southwest of Kodiak, Gulf of Alaska to Cape Arago in southern Oregon

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