use in the field, since a smaller tank has to be refilled frequently and cylinders that hold more than 6.8 kg are heavy and unwieldy. The primary handwheel valve extends 9 cm above the tank. A high pressure, steel-braided hose (600+ psi) runs from the primary valve to a secondary handwheel valve. Though a pressure regulator could be added, the combination of the two valves and the hose can be used to regulate the gas flow and is less cumbersome than a regulator. The primary valve is closed after releasing enough carbon dioxide to fill the hose. The gas in the hose can then be dispensed as needed by opening and closing the secondary valve, whose small opening adequately controls the rate of flow. The secondary valve also enables a researcher to operate the device without assistance. A secondary hose, made of any low pressure tubing, leads from the secondary valve to a container, which is placed over the specimen to be anesthetized. The container can be varied to meet the changing demands of different substrates. Since the total weight of the anesthetizer is a little over 6.8 kg, it can be carried conveniently in a daypack. The apparatus has performed successfully in tests on diverse species of spiders and other arthropods found on a variety of substrates.

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F. Christopher Baptista, *Dept. of Biol. Sci., Northern Arizona Univ., Flagstaff, AZ 86011.*

AQUATIC MACROPHYTES OF THE UPPER SAN MARCOS RIVER, HAYS CO., TEXAS

Fed by the second-largest spring system in Texas, the San Marcos River arises from a series of openings along the Balcones fault zone at San Marcos, Hays Co., Texas, and flows approximately 110 km southeastward across the Gulf Coastal Plain to join the Guadalupe River near Gonzales, Gonzales Co., Texas. The springs that feed the river issue from several large fissures and numerous smaller openings along the San Marcos Springs Fault and exhibit the greatest flow dependability of any spring system in the southwestern United States. Fluctuations in the underlying Edwards aquifer cause the flow rate to vary, but the springs have never ceased flowing in historical times (Ogden et al., 1986).

The headwaters of the San Marcos River have been dammed since 1849, forming a small reservoir known as Spring Lake. Below the dam, the river is a clear, rapidly-moving stream 5 to 15 m wide and up to 4 m deep that flows over a firm gravel bottom with many shallow riffles alternating with deep pools. As defined here, the upper San Marcos River comprises the 7.5 river km between the Spring Lake dam and the stream's confluence with the Blanco River in southeastern Hays Co.

Projections of the U.S. Fish and Wildlife Service indicate that, with increased population growth and water usage in the region, the Edwards aquifer will be reduced to a critical degree within the next 25 to 50 years, possibly causing the San Marcos springs to cease flowing. This, coupled with increased human impacts such as sewage pollution and recreational use of the river, can be expected to have deleterious effects on the aquatic community. It is therefore important to document the flora of the upper San Marcos River to serve as a baseline against which future changes can be assessed.

Although the aquatic and riparian vegetation of Spring Lake was examined by Watkins (1930), Devall (1940), and Bruchmiller (1973), very few published studies of the river's vegetation are available. Vries (1913) commented upon some of the more abundant river plants, and Hannan and Dorris (1970) reported on succession in a macrophyte community. However, the present study represents the first complete listing of the aquatic macrophytes of the upper San Marcos River.

This study is based on collections of aquatic macrophytes from the upper San Marcos River deposited in the University of Texas herbaria (LL, TEX; herbarium acronyms from Holmgren et al., 1981) and the Southwest Texas State University herbarium (recently designated as SWT) as well as on personal observations and collections. A listing of aquatic macrophytes (not including riparian species) from the

TABLE 1—Aquatic macrophytes collected from the upper San Marcos River, Hays Co., Texas.

Division	Family	Species	Status[1]
Bryophyta	Hypnaceae	*Amblystegium riparium* (Hedw.) B.S.P.	N, C
	Ricciaceae	*Riccia fluitans* L.	N, U
Pterophyta	Parkeriaceae	*Ceratopteris thalictroides* (L.) Brongn.	I, O
	Salviniaceae	*Azolla caroliniana* Willd.	N, C
Anthophyta	Acanthaceae	*Hygrophila lacustris* (Schlecht. et Cham.) Nees	N, U
	Alismataceae	*Sagittaria platyphylla* Engelm.	N, C
	Araceae	*Pistia stratiotes* L.	N, U
	Ceratophyllaceae	*Ceratophyllum demersum* L.	N, C
	Haloragaceae	*Myriophyllum brasiliense* Camb.	I, C
		Myriophyllum heterophyllum Michx.	N, O
		Myriophyllum spicatum L.	I, O
	Hydrocharitaceae	*Egeria densa* Planch.	I, C
		Hydrilla verticillata (L. f.) Royle	I, C
		Vallisneria americana Michx.	N, O
	Lemnaceae	*Lemna minor* L.	N, C
		Spirodela polyrhiza (L.) Schleid.	N, C
		Wolffia papulifera Thomps.	N, C
	Lentibulariaceae	*Utricularia gibba* L.	N, O
	Najadaceae	*Najas guadalupensis* (Spreng.) Magnus	N, O
	Nymphaeaceae	*Cabomba caroliniana* Gray	N, C
		Nuphar luteum (L.) Sibth. et Sm.	N, C
	Onagraceae	*Ludwigia repens* Forst.	N, C
	Poaceae	*Zizania texana* Hitchc.	N, O
	Pontederiaceae	*Eichhornia crassipes* (Mart.) Solms	I, O
		Heteranthera liebmannii (Buch.) Shinners	N, O
	Potamogetonaceae	*Potamogeton crispus* L.	I, O
		Potamogeton illinoensis Morong	N, C
		Potamogeton nodosus Poir.	N, C
		Potamogeton pectinatus L.	N, U
	Scrophulariaceae	*Limnophila sessiflora* Bl.	I, U
	Zannichelliaceae	*Zannichellia palustris* L.	N, U

[1] N = native; I = introduced; C = common (found in relatively large numbers throughout the study area); O = occasional (found in relatively small numbers throughout the study area); U = uncommon (restricted to one or a few locations in the study area).

upper San Marcos River and information on their origin and abundance is presented in Table 1. Nomenclature follows Correll and Johnston (1970).

As Table 1 indicates, the upper San Marcos River supports a diversity of aquatic vegetation. Twenty-three of the 31 species collected from the study area are native taxa, the most abundant being *Potamogeton illinoensis* Morong and *Sagittaria platyphylla* Engelm., both of which form extensive mat-like stands. Many of the native species, however, are being displaced by encroaching exotic taxa or otherwise adversely affected. The endemic Texas wild rice, *Zizania texana* Hitchc., has been decreasing in abundance due to a variety of factors (Emery, 1966, 1977) and has exhibited a 59% decline in population size over the last 10 years (Vaughan, 1986). *Hygrophila lacustris* (Schlecht. et Cham.) Nees, *Potamogeton pectinatus* L., *Riccia fluitans* L., and *Zannichellia palustris* L. are each known from only one or two localities within the study area. *Pistia stratiotes* L., reported as being abundant by Vries (1913), Watkins (1930), and Devall (1940), has not been collected since 1975 and may have been eliminated from the upper river by spring floods.

Eight of the species in Table 1 are introduced taxa, the most abundant being *Hydrilla verticillata* (L. f.) Royle, an aquatic weed that forms extremely thick mats on the river bottom in water depths ranging from 0.5 to 2.0 m. Other common introduced species include *Egeria densa* Planch., *Eichhornia crassipes* (Mart.) Solms, *Myriophyllum brasiliense* Camb., and *M. spicatum* L. *Potamogeton crispus* L.,

reported by Correll and Johnston (1970) as uncommon in Texas, is well-established in a few areas of the river.

The upper San Marcos River is the only Texas locality for two additional non-native species, *Ceratopteris thalictroides* (L.) Brongn. and *Limnophila sessiliflora* Bl. Hannan (1969) documented the introduction of *C. thalictroides* into the river by a local aquarium plant supply company; it is highly probable that the other non-native species were similarly introduced.

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David E. Lemke, *Dept. of Biol., Southwest Texas State Univ., San Marcos, TX 78666.*

WIND DISPERSAL OF *ARCEUTHOBIUM AMERICANUM* POLLEN

Dwarf mistletoes (*Arceuthobium* sp.) are obligate parasites of conifers, which take water and nutrients from their hosts. This parasitism causes reduction in tree growth and quality and kills trees (Hawksworth and Wiens, 1972). The pollination biology of *Arceuthobium* is poorly understood, with little consensus as to the relative importance of pollination by wind (anemophily) versus insects (entomophily) in these dioecious plants. Several characteristics, including sessile anthers, spinose pollen grains, pollen clustering, and nectaries, suggest entomophily (Stevens and Hawksworth, 1970; Hawksworth and Wiens, 1972; Brewer et al., 1974; Gregor et al., 1974; Baker et al., 1985). Based on his research with *Aceuthobium douglasii* and *Arceuthobium strictum*, Player (1979) considers plants of the genus to be primarily wind pollinated. Penfield et al. (1976) conclude that both pollination mechanisms function complementarily to one another.

There is also disagreement as to the distance that pollen of *Arceuthobium* is dispersed. Gregor et al. (1974) recorded pollen dispersal of only about 1 m for *Arceuthobium americanum* Nutt. ex Engelm. in