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Pollen Evidence of the Prehistoric Presence of Cattail (*Typha* :Typhaceae) in Palo Verde National Park, Costa Rica

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Prior to 1980, seasonal freshwater marshes along the lower Río Tempisque in what is today Palo Verde National Park provided critical habitat for tens of thousands of resident and migratory waterbirds comprising some 60 species (McCoy & Rodríguez 1994). However, in the 1980s dense stands of emergent aquatic cattails (*Typha domingensis* Pers.) began to develop in the marshes, filling in formerly open wetlands and greatly reducing aquatic bird habitat and bird populations. The proliferation of cattail in Palo Verde marshes has been attributed to the removal of cattle in 1980, after the area was granted protected status in 1977 (McCoy & Rodríguez 1994). Cattle had formerly grazed within the marshes and had kept them open through grazing and trampling of the vegetation. Since the late 1980s a great deal of attention has been devoted to reopening the marshes, through burning and disking cattail and other aquatic plants, and through the reintroduction of cattle grazing (McCoy & Rodríguez 1994, Jiménez & González 2003, González undated, Trama undated, Trama *et al.* undated)

The rapid spread of cattail at Palo Verde and the difficulty of controlling the plant led to the use of the word "invasion" to describe its proliferation after 1980 (e.g., Hurtado 2004, Trama *et al.* undated), and to the description of cattail as an "invasive species" in the marshes (Jiménez *et al.* 2001, González undated). However, *Typha domingensis* at Palo Verde National Park appears not to fit the common definition of an invasive species as an exotic (non-native) species that proliferates after being introduced by human action to an area or ecosystem in which it was not formerly present (Ecological Society of America 2004). Although Cochard and Jackes (2005, citing personal communication with M. Quesada) referred to *Typha domingensis* as a "Eurasian weed" introduced into wetlands of Palo Verde National Park in the late 1970s, Costa Rica lies within the apparent natural range of the species, which presently extends from the southern or central United States to Argentina (Crow 2002, Solomon undated). Hammel (2000) lists *Typha domingensis* as the single species of *Typha* present in Costa Rica, and notes that it occurs in the lowlands of both coasts, in dry and humid climates but always in swampy habitats. On the Pacific slope it extends from northern Guanacaste Province (Rincón de la Vieja National Park) to the Osa Peninsula near the Panamanian border. Hartshorn (1983) and McCoy and Rodríguez (1994) mentioned the presence of cattail in the Palo Verde marsh prior to the changes in land management that are thought to have fostered its invasion of park wetlands.

This report extends the temporal record of the presence of *Typha* in marshes of the lower Tempisque River basin based on the analysis of pollen grains in prehistoric sediments of the Bocana marsh in Palo Verde National Park (10° 20.8′ N, 85° 16.8′W). Located 7 km east of the field station operated by the Organization for Tropical Studies, between Cerro el Roble and Fila Catalina at the terminus of Quebrador la Mula, the Bocana marsh occupies a natural topographic depression with internal drainage (Jiménez *et al.* 2003). In March 1997 we recovered several short sediment cores from the marsh using a manually-operated Colinvaux-Vohnout locking piston corer (Colinvaux *et al.* 1999). Our objective was to obtain material to carry out a detailed study of vegetation and fire history based on pollen and charcoal assemblages in the sediments, as we have done at lakes and wetlands elsewhere in Costa Rica (Horn

1993, 2006, and references therein, Kennedy 1998). With the coring equipment we had available we were unable to obtain a complete, continuous core suitable for analysis of environmental change over the Holocene. However, the material we did obtain provides "slice of time" information on past vegetation, documenting the presence of *Typha* and other aquatic plants at the site more than four thousand years ago.

The *Typha* pollen grains were identified in samples from depths of 36 and 52 cm in a core section collected beginning approximately 70 cm below the sediment/water interface. The pollen samples were processed using standard methods (KOH, HCl, HF, Acetolysis; Berglund 1986) and mounted on microscope slides in silicone oil for examination at 400×. An AMS radiocarbon date of 4010 ± 60 14-C years BP (Beta-111208) obtained on a 70 mg fragment of charcoal taken from a depth of 35.5–37.5 cm in the same core section provides a timeframe for the samples. Based on the CALIB 5.0 radiocarbon calibration program (Stuiver & Reimer, 1993) and the calibration dataset of Reimer *et al.* (2004), this radiocarbon age corresponds to a calendar age between 4290–4800 years BP (or 2340–2850 BC; 2-sigma calibrated age range in both cases). The pollen samples we examined were deposited at or prior to this time.

The *Typha* pollen grains occur in the samples as solitary grains (monads), as expected for *Typha domingensis* (Hammel 2000), rather than as tetrads of four grains as found for the species *Typha latifolia* in the northern United States and Canada (Kapp *et al.* 2000). Solitary grains of *Typha* may not be distinguishable from pollen grains of *Sparganium*, but this genus is not represented in Costa Rica (Gómez 1984) so we are confident of our identification. The grains are monoporate with a reticulate exine, with a diameter of ca. 25 µm. They closely resemble reference pollen of *Typha* in our collection as well as grains on pollen slides from surface sediments of modern *Typha domingensis* wetlands in the Dominican Republic.

Very large (>110 µm) and morphologically distinct spores of the aquatic fern *Ceratopteris* are present in both of the samples that contain *Typha* pollen. These may derive from *Ceratopteris pteridoides* or C. *thalictroides*, which occur today in park marshes (Crow 2002). Pollen of *Rhizophora* (red mangrove) is abundant in the samples, possibly indicating that the marsh had a more direct connection with the Tempisque River and its fringing mangrove swamps prior to 4000 years ago than it does today. Microscopic charcoal fragments are also common in the samples and indicate local or regional fires.

Although most definitions of invasive species restrict the term to introduced species that proliferate and cause damage to ecosystems in which they were not originally present, some management agencies have adopted broader definitions, based on experience with problematic native plants. For example, the online glossary for the Mississippi National River and Recreation Area, a unit of the U.S. National Parks system, defines an invasive species as a "Species that, once established, is difficult to get rid of. They are often exotic, but there are native invasive species as well." (Mississippi National River and Recreation Area undated). In his discussion of cattail management, Apfelbaum (1985) did not use the term "invasive" but he noted that *Typha* species "can behave like aggressive introduced weeds" even in natural communities in which they are native. This characterization seems highly applicable to *Typha domingensis* in Palo Verde National Park. Our pollen results confirm that the plant is native to marshes of the lower Tempisque River basin. Amidst the vast literature on invasive exotic species, and depending on the definition of "invasive" that one adopts, cattail in Palo Verde may provide a unique tropical example of a *native* "invasive" plant.

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