

Appendix E. Noteworthy Species

High Andean

Laguna Toro

No rare species were observed at Laguna Toro, but, the population of *Myriophyllum quitense* (Haloragaceae) at this site was noteworthy for possessing some unusual characteristics. Numerous individuals (ca. 5-10% of the population) of *M. quitense* were noted with leaves arrayed in 5-merous whorls. By contrast, *M. quitense* typically possesses leaves in 4-merous (occasionally 3-merous) whorls (Orchard 1981). *M. quitense* is extremely common in Andean aquatic habitats, and has a very broad distribution, ranging along the Andes from Tierra del Fuego to Venezuela, with disjunct populations in Mexico, the Northwestern United States, and British Columbia (Ritter and Crow 1998). Nevertheless, leaves in 5-merous whorls have only been reported for the species from a single herbarium specimen from North America (Orchard 1981), and, more recently, from Cochabamba's Laguna Alalay (Ritter and Crow 1998).

Laguna Larati

Two species at Laguna Larati, *Ludwigia peploides* (Onagraceae) and *Potamogeton illinoensis* (Potamogetonaceae), were noteworthy for their presence in a high altitude habitat. *Ludwigia peploides*, an extremely widespread species (Raven 1963), is fairly common in wetlands in the Valles Secos and at lower elevations. The population at Laguna Larati represented the highest elevation at which this species was encountered in Bolivia. *Potamogeton illinoensis* is also widely distributed, ranging from Canada to Argentina (Novelo R. and Lot H. 1994b), but this species apparently has only been reported for Bolivia from three populations: Laguna Larati, Laguna Volcan, and a wetland in the Santa Cruz area.

Río Candelaria

The sole noteworthy species noted at Río Candelaria was the cosmopolitan weed *Sagina procumbens* (Caryophyllaceae). A small population of *S. procumbens* was observed growing on a sand bars in the river channel at Río Candelaria. Although this species is

extremely widespread (Gleason and Cronquist 1991), its presence in the Río Candelaria apparently constitutes a new record for Bolivian, albeit not a terribly interesting one.

Chulichuncani Laguna

The sole species of note at the Chulichuncani Laguna was *Amphibromus scabrivalvis* (Poaceae), an aquatic grass with lax semi-floating culms. *A. scabrivalvis* was common in the shallow end of the system, growing in depths of up to ca. 0.5 m. Although this species has a fairly broad distribution in high elevation areas in the southern half of South American (Renvoize 1998), this was the sole system in which *A. scabrivalvis* was encountered during fieldwork in Bolivia.

Valles Secos

Laguna Alalay

No rare species were observed at Laguna Alalay, but a few species were noteworthy. The populations of two semi-aquatic grasses, *Leptochloa uninervia* (Poaceae) and *L. fascicularis* (Poaceae) represented the highest elevation known for these species (Neil Snow, pers. com.). Additionally, the population of *Myriophyllum quitense* was noteworthy for possessing an unusual semi-terrestrial growth form. Although semi-terrestrial forms are known for various species of *Myriophyllum*, this was apparently the first record of this growth-form for *M. quitense* (Ritter and Crow 1998). As with the population at Laguna Toro, the *M. quitense* at Laguna Larati was also noteworthy for possessing leaves in 5-merous whorls and for the presence of 5-merous flowers and fruits (Ritter and Crow 1998).

Río Guadalquivir Wetland

Two species at the Río Guadalquivir wetland were noteworthy. The watermilfoil, *Myriophyllum aquaticum* (Haloragaceae), a widespread aquatic weed previously unknown for Bolivia, was abundant in small pools and on seasonally inundated sediment bars (see Ritter and Crow 1999). A second noteworthy species, *Oenothera tarijensis* (Onagraceae), an herb endemic to this region, was present along the transition from wetland to upland.

Río Mizque Wetland

Although this system possessed the richest flora of the Valles Secos sites, no rare or noteworthy species were observed.

Irrigation Canal at Tiquipaya

No rare or noteworthy species were observed.

Cloud Forest

See Chapter 3.

Chapare

See Chapter 4.

Andean Piedmont

Bermudez Curichi.

A number of noteworthy species were encountered in the Bermudez Curichi. The shrub *Ludwigia martii* (Onagraceae), which was abundant in the transition between basin and upland, constituted a new country record. Three submersed macrophytes, *Apalanthe granatensis*, *Mayaca longipes*, and *Bacopa aquatica*, were also of interest as they have rarely been reported for Bolivia.

Viru Viru Wetland

Despite this system's rich flora, the only species of note encountered at the Viru Viru Wetland was the robust emergent fern *Acrostichum danaeifolium* (Pteridaceae). This species is generally associated with mangrove communities in brackish water (Tryon and Tryon 1982), but is occasionally known to occupy freshwater sites in central and upper Amazonia. Although *A. danaeifolium* was previously known for Bolivia, Tryon and Tryon (1982) listed only a single population for the country.

White-water Floodplain

Riberalta Ciénaga

Two noteworthy species were encountered at this system, *Diospyros nur* (Ebenaceae) and *Tetralocularia pennellii* (Convolvulaceae). The voucher specimen of *Diospyros nur*, an

arborescent species that was common in various parts of the Riberalta Ciénaga, was designated as the holotype for the species (Wallnöfer 1999). The genus *Tetralocularia* is said to be endemic to the swamps of Colombia's Magdalena Valley (Gentry 1993), but this species was collected at the Riberalta Ciénaga and at various wetlands in Parque Noel Kempff Mercado (see the Chiquitanía, below).

Laguna Tumi Chuqua

Although Laguna Tumi Chuqua possessed a relatively small flora (34 sp.) two noteworthy species were observed. *Potamogeton pusillus* (Potamogetonaceae) has a cosmopolitan distribution (Novelo R. and Lot H. 1994b), but in Bolivia this species was typically encountered in High Andean systems. The population at Laguna Tumi Chuqua represented the sole population of *P. pusillus* encountered in the Amazonian lowlands. The second noteworthy species *Ludwigia hyssopifolia* (Onagraceae) possesses a pantropical distribution (Zardini and Raven 1991); however, in the New World it appears to be more typical of Central America and northern South America. The population of *L. hyssopifolia* at Laguna Tumi-Chuqua apparently represented one of only a few collections of this species from Bolivia.

Laguna Suarez

Despite the rich flora at Laguna Suarez, no rare or particularly uncommon species were encountered.

Other Systems in the White-water Floodplain

The submersed macrophyte *Syngonanthus anomalus* (Eriocaulaceae) was collected from a stream in the area around Guayaramerin. This represented just the second known locality for this species in Bolivia. Two species of Podostemaceae were collected from the Río Iténez at Guayaramerin. One, a putative *Mourera* species, would represent a new genus for Bolivia, if confirmed. At the time of this writing, the identity of the second species has yet to be determined.

Chiquitanía

Concepción Wetland

Three species at this system were noteworthy, *Ludwigia martii* and *Ludwigia torulosa* (Onagraceae), and an unidentified species of *Carex* (Cyperaceae). *L. martii* was previously known only from one other site in Bolivia (the Curichi at Bermudez). *L. torulosa* is broadly distributed in the Neotropics, ranging from Mexico to Brazil (Zardini and Raven 1991), but this species has only been reported for a few systems in Bolivia (including two other study sites, the Cuatro Vientos Palm Swamp and the La Toledo Curichi). The species of *Carex* collected at the Concepción wetland represented the lowest elevation at which I encountered this genus in Bolivia.

Huanchaca Arroyo

A number of species from the Huanchaca Arroyo were noteworthy. Two bladderworts, *Genlisea guianensis* and *Utricularia nana* (Lentibulariaceae), represented new country records, with the former the first record for the genus in Bolivia (Ritter and Crow 2000). The diminutive herb *Siphanthera foliosa* (Melastomataceae), which was previously known for Bolivia from only two other populations (F. Almeda, CAS, pers. com.), was collected here and at a stream at the base of the Serranía de Huanchaca. One of the species of *Xyris* collected at this site was not completely identified at the time of this writing. I was unable to match it to specimens, nor did it appear to match any descriptions in the literature. Most likely, it corresponds to one of the six undescribed species of *Xyris* listed for Parque Nacional Noel Kempff Mercado by Killeen and Schulenberg (1999).

La Toledo Curichi

Species of note at the La Toledo Curichi were *Cyrtopodium paludicolum* (Orchidaceae), *Ludwigia torulosa* (see notes for the Concepción Wetland), and *Tetralocularia pennellii* (Convolvulaceae). *Cyrtopodium paludicolum* was noteworthy for being a wetland representative of a genus that is normally associated with rock outcroppings and other xeric habitats. Although *C. paludicolum* was common on floating mats in the wetlands of Parque Nacional Noel Kempff Mercado, this species does not appear to have been

collected elsewhere in Bolivia. The genus *Tetralocularia* is said to be endemic to the swamps of Colombia's Magdalena Valley (Gentry 1993). Nevertheless, this species was common on floating mats at the La Toledo Curichi, Bahia Toledo, and in other wetlands in the El Refugio/La Toledo area.

Bahía Toledo

This system contained three species of note: *Operculina hamiltonii* and *Tetralocularia pennellii* (see notes for the La Toledo Curichi), and *Cyrtopodium paludicolum* (see notes for the La Toledo Curichi). All three species were noteworthy for having rarely been collected in Bolivia.

Río Paraguá

Rare or noteworthy species encountered at the Río Paraguá study areas were: *Egeria najas* (Hydrocharitaceae), *Nymphaea oxypetala* (Nymphaeaceae), and *Websteria confervoides* (Cyperaceae). *Egeria najas*, a submersed macrophyte, is endemic to South America, with a distribution ranging from Brazil southwards to Argentina and Paraguay (Cook 1984). This species appears to have rarely been collected in Bolivia, as Cook did not cite any Bolivian specimens of *E. najas* in his monograph of the genus. Frey (1995), however, did list this species for Laguna Cáceres in the Bolivian Gran Pantanal.

Nymphaea oxypetala, another South American endemic, was previously known from only a few sites (Wiersema 1987). The population at the Río Paraguá represented the first record of this rare species in Bolivia, although, additional populations have since been encountered in both the Parque Nacional Noel Kempff Mercado area and in the Bolivian Pantanal (Ritter *et al.* 2000).

Websteria confervoides, an aquatic sedge with an unusual, submersed habit, is broadly distributed throughout the Tropics and Subtropics (Adams 1994e). Nevertheless, there appear to have been few other collections of this species from Bolivia.

Cuatro Vientos

Cuatro Vientos possessed a number of rare or noteworthy species: *Calyptracarya luzuliformis* (Cyperaceae), *Cyrtopodium paludicolum* (see notes for the La Toledo

Curichi), *Diospyros yomomo* (Ebenaceae), *Isoëtes panamensis* (Isoëtaceae), and *Ludwigia torulosa* (see notes for the Concepción Wetland).

Calyptrocarya luzuliformis is widely distributed, ranging from Costa Rica to Brazil (Gómez-Laurito 1994). Nevertheless, the population at Cuatro Vientos appeared to be the first record for *C. luzuliformis* in Bolivia. *Diospyros yomomo* (Ebenaceae), is a recently-described arborescent species (Wallnöfer 1999) known only from this system. *Isoëtes panamensis* is another widely distributed species, ranging from Central America to Brazil and Paraguay (Hickey 1995), however, there appear to have been few collections from Bolivia. *I. panamensis* was also noteworthy as the sole representative of this genus collected in the lowlands.

Lago Caimán

Noteworthy species were *Cyrtopodium paludicolum* (see notes for the La Toledo Curichi), *Egeria najas* (see notes for the Río Paraguá), *Floscopa glabrata* (Commelinaceae), *Limnophila* sp. nov. (Scrophulariaceae), *Nymphaea jamesoniana* (Nymphaeaceae), *Operculina hamiltonii* (see notes for Bahía Toledo), and *Websteria confervoides* (see notes for the Río Paraguá).

Floscopa glabrata possesses a fairly broad distribution, ranging from Costa Rica to Brazil and Paraguay (Hunt 1994). Nevertheless, the population at Lago Caimán constituted one of the few records of this species in Bolivia. *Nymphaea jamesoniana* is another widespread species (Wiersema 1987), nevertheless, the population at Lago Caimán represented the first record for this species in Bolivia (Ritter *et al.* 2000).

The population of the undescribed species of *Limnophila* was particularly interesting, as it represented the second record for this genus in South America. The first record for this species was from collections I made from the Río Iténez, approximately 20 km south of Lago Caimán). When this species is eventually described, however, the material from Lago Caimán will most likely be designated as the holotype, as both flowers and fruits were present (only fruits were present at the Río Iténez site).

Additional Systems in Parque Noel Kempff Mercado

A number of additional noteworthy species were present in this national park. Two noteworthy species of *Utricularia* were collected in the inundated savannas surrounding Flor de Oro. One of these, *U. simulans*, represented a new country record. The second species, *Utricularia* cf. *guyanensis*, putatively represented another country record, but more work needs to be done to confirm this determination. A few other species collected in these savannas, e.g., *Acisanthera limnobios* (Melastomataceae), *Bacopa myriophylloides* (Scrophulariaceae), *Limnosipanea spruceana* (Rubiaceae), and *Philodice hoffmannseggii* (Eriocaulaceae), were known from only a few other collections from Bolivia.

The inundated savannas around La Toledo also supported a number of noteworthy species. Three species, *Eriocaulon melanocephalum* (Eriocaulaceae) and *Benjaminia reflexa* and *Lindernia brachyphylla* (Scrophulariaceae) had apparently only been known for Bolivia from one or two additional localities. Another species of note was an aquatic species of *Bacopa*, which apparently represents a heretofore undescribed species.

Parque Nacional Noel Kempff Mercado was also rich in species of Podostemaceae. Two species, *Tristicha trifaria* and cf. *Podostemum*, were collected in the Río Iténez. The former represented a new genus record for Bolivia. If the putative *Podostemum* is indeed a member of that genus, it would also represent a new genus record for the county. A third species in the Podostemaceae, *Apinagia pilgeri*, was collected in the waterfall Arco Iris, at the base of the Serranía de Huanchaca. This represented a new species record for Bolivia. Large numbers of rheophytes were observed growing on rocks in the Río Paucerna during overflights of the Serranía de Huanchaca. Many of these were undoubtedly members of the Podostemaceae, a family which has been particularly poorly collected in Bolivia. Regrettably, it was not possible to gain access to these areas from the ground.

Gran Pantanal

See Chapter 5.

Outlying Sites

Laguna Volcan

A number of noteworthy species were encountered at Laguna Volcan. The population of *Nymphaea lingulata* (Nymphaeaceae), which was abundant at this system, represented the first record for this species in Bolivia (Ritter *et al.* 2000). The submersed macrophyte *Potamogeton gayii* (Potamogetonaceae) was abundant at Laguna Volcan. Its presence at this system also represented a new country record (R. R. Haynes, UNA, pers. com.). A small population of *Nymphoides verrucosa* (Menyanthaceae) were also noted. This species was previously known for Bolivia from just two other sites (Galán de Mera and Navarro 1989), and the population at Laguna Volcan apparently represented the northernmost known limit of its distribution.

Two common wetland herbs *Echinodorus bolivianus* and *E. paniculatus* (Alismataceae), which were present in low abundance along the edges of the basin, were noteworthy for their presence at such a high elevation site. The herb *Hydrocotyle verticillata* (Apiaceae), which was common in one part of the system, has apparently only been collected a few other times in Bolivia.

Yolosa Wetland

No species of note were encountered at the Yolosa wetland. Nevertheless, a population of the “rockweed”, *Apinagia boliviana* (Podostemaceae), was encountered in the Río Coroico, a few kilometers below the point where the Río San Juan enters this system. A second population of *A. boliviana* was collected in the Río Huarinilla, a few kilometers above its juncture with the Río Coroico. This species is endemic to Bolivia (Van Royen 1951).

Cristalmayu Wetland.

No rare or noteworthy species were encountered.

Laguna Yaguacua.

No rare or noteworthy species were encountered.

Appendix F. Annotated Checklist of Species Associated with Wetlands in the Bolivian Cloud Forest Region

An annotated checklist of species encountered in wetlands in the Bolivian Cloud Forest, including life-form, abundance, habitat, specimen citations, and distribution. Site abbreviations are as follows: CHB - Chimpa Huata Bog, INC - Incachaca Pond, LKE - Laguna Khonchu East, LKW - Laguna Khonchu West, CP - Corani Pampa Marsh, SSM - Serranía de Siberia Marsh, GC - auxiliary collections from other Cloud Forest wetland habitats. Voucher specimens: NHA and LPB, with additional duplicates (when available) at BOLV and MO. Two wetland bryophytes were also observed in the Cloud Forest systems. These are listed here, but were not included in the calculations of floristic similarity (Chapter 3), as only vascular species were considered in these calculations.

Bryophytes

Ricciaceae

Riccia fluitans L. *sl.* Free-floating aquatic liverwort. LKE, LKW (Occasional). *Ritter 1570, Ritter & Crow 2206.* Nearly cosmopolitan. Said to characteristically occur in eutrophic water (Cook 1974). In Bolivia, we have encountered *R. fluitans* only in the Cloud Forest.

Sphagnaceae

Sphagnum costa-ricense Crum & Crosby. Floating, mat-forming macrophyte. CHB, GC (common to abundant). *Ritter & Oldcorn 2677, 2683, 2688.* Common in pools, stream and river edges and in damp areas along trails.

Pteridophytes

Azollaceae

Azolla cf. *caroliniana* Willd. Free-floating macrophyte. INC (occasional to abundant). *Ritter 1554.* Encountered in wetlands throughout Bolivia, ranging from elevations of <100 to >3300 m. Abundance fluctuated significantly seasonally, with the greatest abundance observed during wetter portions of the year.

Equisetaceae

Equisetum bogotense Kunth. Emergent herb. INC, CP (occasional to common). *Ritter 1848, Ritter & Crow 2286.* Widely distributed in the Neotropics (Hauke 1995). In Bolivia, *E. bogotense* is common along the edges of rivers and streams and in marshes in the high elevation zones (Valles Secos, Puna, and Bosque Nublado).

Isoëtaceae

Isoëtes herzogii U. Weber. Submerged herb. LKE, LKW, GC (abundant). *Ritter et al.* 1274, *Ritter & Crow* 2201, 2209. Often forming very dense populations.

Angiosperms

DICOTYLEDONS

Apiaceae

Eryngium ebracteatum Lam. Emergent herb. GC (locally abundant). *Ritter & Wood* 2868. Generally, more characteristic of lowland systems. A single population was observed in the Cloud Forest, where it was growing in a sedge-dominated marsh.

Hydrocotyle leucocephala Cham. & Schltdl. GC (locally abundant). *Ritter & Hartman* 2730. Trailing emergent herb. Generally restricted to system edges and shallow water. Also collected at a lower elevation pond in the transition between the lower montane and piedmont zones.

Hydrocotyle pusilla A. Rich. Trailing, emergent herb. CHB, INC, CP (rare to locally abundant). *Ritter* 1290, *Ritter & Wood* 1717, *Ritter & Ritter* 1851, *Ritter & Oldcorn* 2689. In Bolivia, characteristically encountered in relatively high elevation systems. Along system edges or on *Sphagnum* mats.

Hydrocotyle ranunculoides L.f. Trailing, emergent herb, at times forming weak floating mats. INC (abundant in shallow water). *Ritter & Nash* 1329. Widespread, ranging from the United States to southern South America (Kahn *et al.* 1993). In Bolivia, *H. ranunculoides* occurs in aquatic habitats at elevations ranging from the lowlands to >3500 m.

Asteraceae

Acmella repens (Walt) L. C. Rich var. *beccabunga* (DC.) R. K. Jansen. Herb. INC (common). *Ritter* 1552, 2123. A weedy species, more characteristic of terrestrial habitats. Occasionally observed along the edges of wetlands in both the wet montane and dry-valley regions.

Adenostemma brasiliense Cass. Herb. CP, GC (common to frequent) *Ritter* 1849, *Ritter & Wood* 3383. Distributed throughout the Neotropics, generally growing in wet, shaded habitats (Cabrera 1974).

Ageratum conyzoides L. Herb. GC (common). *Ritter* 923. A common weedy species, originally from tropical America, now spread to all the warm regions of the globe (Cabrera 1977). Commonly grows in waste ground, in wet, disturbed habitats, and as a garden weed (Williams 1976). Frequently encountered in systems in the Valles Secos Interandinos.

Baccharis juncea (Lehm.) Desv. Herb. INC (occasional in shallow water along the edge of the system). *Ritter* 1556. Characteristic of disturbed soil along the edges of wetlands in drier habitats (*e.g.*, the Valles Secos) where it can dominate large areas.

***Baccharis trimera* (Less) DC.** Perennial. CHB, LKE (occasional, on the bog mat at CHB; on hummocks and in standing water in depths up to about 0.3 m at LKE). *Ritter & Crow 2197, 2203*. Generally characteristic of terrestrial habitats in somewhat drier, high elevation habitats.

***Conyza bonariensis* (L.) Cronquist.** Herb. CP (locally common on sand bars in the stream that ran through the marsh). *Ritter & Ritter 1850*. Pantropical weed (Williams 1976), originally from South America, now distributed throughout the world (Cabrera 1974).

***Cotula australis* (Sieb. ex Spreng) Hook. f.** Trailing, emergent herb. GC (along the edge of one river, growing in shallow water in quiet water, directly downstream from a boulder). *Ritter 1374*. A widespread species, naturalized in many parts of the world (Dillon 1980). In Bolivia, commonly associated with high elevation marshes.

***Cotula mexicana* (DC.) Cabr.** Diminutive, creeping herb. LKE, occasional in shallow water, and in formerly inundated areas. *Ritter 1251, Ritter et al. 1275*. Widely distributed in the Neotropics, from Mexico to Costa Rica and from Colombia to Costa Rica (Dillon 1980). As with, *Cotula australis*, *C. mexicana* is more commonly associated with high elevation marshes.

***Erechtites valerianaefolia* (Wolf.) DC.** Herb. Coarse, weedy species. CP (a few individuals in saturated soil along the edge of the system). *Ritter & Ritter 1846*. Widespread in montane habitats throughout northern South American. Apparently well-adapted to disturbed habitats.

***Galinsoga quadriradiata* Ruiz & Pavón.** Emergent herb. CP, GC (stream edges and marshy habitats). *Ritter & Ritter 1852*. Weedy species, with a nearly cosmopolitan distribution (Mabberly 1997).

***Gamochaeta americana* (Miller) Wedd.** Emergent herb. CP, GC (occasional). *Ritter & Ritter 1837, 1856*. Widespread (the Antilles to Tierra del Fuego) in the Americas (Cabrera 1977). More characteristic of terrestrial habitats, occurring both in disturbed and undisturbed soils (Williams 1976).

Brassicaceae

***Cardamine bonariensis* Juss. ex Pers.** Emergent herb. INK, LKE, CP (rare to common). *Ritter & Crow 1102, 2097, Ritter et al. 1276, Ritter 1370*. Cosmopolitan weed. Frequently observed in wetland habitats in the Cloud Forest, Valles Secos and Puna

Callitrichaceae

***Callitriche albomarginata* Fassett.** Submerged macrophyte with floating upper leaves. INC, LKE, CP, GC (generally abundant, growing in shallow water. *Ritter & Crow 1094, 2098, 2204, Ritter 1283, 1372, 1566.* Also occasionally encountered in high elevation (Puna) aquatic habitats, and in trailside streams and pools.

***Callitriche heteropoda* Engelm. ex Hegelm.** Submerged macrophyte with floating upper leaves. CHB, LKW, GC (fairly abundant, in shallow water). *Ritter 1220, Ritter & Ritter 1458, Ritter & Crow 2215, Ritter & Oldcorn 2685.* More characteristic of higher elevation (Puna) aquatic habitats.

Caryophyllaceae

***Cerastium nutans* Raf.** Trailing, emergent herb. CP (locally abundant along the edges of the system). *Ritter 1289, 1862.*

Crassulaceae

***Crassula venezuelensis* (Steyer.) Bywater & Wilkins.** Diminutive, submerged macrophyte. CHB, INC, LKW (in shallow water, and in pockets of open water along the edge of the *Sphagnum* mat at CHB). *Ritter 1260, 1373, 1551, Ritter & Wood 1720, Ritter & Crow 2218, Ritter & Oldcorn 2676.* An interesting aquatic member of a genus generally associated with harsh terrestrial environments. Very common in high elevation (Puna) aquatic habitats.

Cucurbitaceae

***Cyclanthera cordifolia* Cogn.** Climber. CP (occasional). *Ritter 1736, 1861.* Also noted growing in drier habitats (road cuts) in the same general area as CP. Apparently most commonly associated with forested montane habitats.

Elatinaceae

***Elatine* aff. *peruviana* Baehni & Macbr.** Diminutive, submerged macrophyte. LKW (abundant in shallow water). *Ritter & Crow 2217.* Distribution limited to Peru and Bolivia (Schmidt-Mumm and Bernal 1995).

***Elatine triandra* var. *andina* Fassett.** Diminutive submerged macrophyte. INC. Abundant in shallow water. *Ritter & D. Nash 1325, Ritter 1547, Ritter & Wood 1719.* A very widely distributed species, occurring in Eurasia, North America and South America (Gleason and Cronquist 1991). In South America, known from Bolivia, Peru (Macbride 1941), Chile, and Argentina (Bacigalupa 1970). Variety *andina* was originally described from Sorata, Bolivia.

Lamiaceae

***Stachys petiolosa* Briq.** Herb. INC (a small number of individuals grew in saturated sediment in the center of the outflow channel, in the midst of a large population of *Heteranthera reniformis*, Pontederiaceae). *Ritter 1369.* Widely distributed in South America (Crespo and Burkart 1978).

Lentibulariaceae

***Utricularia gibba* L.** Free-swimming macrophyte (*sensu* Cook 1990). CHB, LKE, LKW (locally abundant to common). *Ritter 1261, 1561, 1565, Ritter & Crow 2195, 2202, 2216.* Very widely distributed, from southern New England to the Antilles, Central America and South America and in the Old World. Ubiquitous in aquatic habitats in the Bolivian lowlands.

Lythraceae

***Cuphea setosa* Koehne.** Herb. GC (a streamside marsh in saturated soil alongside the channel. Locally abundant, forming a dense community). *Ritter & Hartman 2729.*

Nyctaginaceae

***Colignonia rufopilosa* Kuntze.** Arching, suffrutescent semi-climber. CP (in saturated soil alongside the stream, with a few individuals rooted in the channel). *Ritter & Ritter 1844.* An Andean genus (Bohlin 1988), whose members are characteristically found in terrestrial habitats.

Onagraceae

***Fuchsia* sp.** Arching, semi-climbing shrub. CP (locally abundant). *Ritter & Ritter 1847.* A terrestrial species that was observed in a single wetland (CP).

***Ludwigia peruviana* (L.) Hara.** Emergent shrub. GC (common in a small streamside marsh; also occasionally noted growing in wet roadside ditches in the area). *Ritter & Hartman 2728.* A weedy, fairly ubiquitous species. Frequently encountered in wetland habitats over a wide range of elevations (in Bolivia, ca. 100-2200 m).

Oxalidaceae

***Oxalis spiralis* Ruiz & Pavón ex G. Don.** Decumbent herb. CHB, LKW, CP, GC (occasional to common; system edges, alongside streams, and on *Sphagnum* mats). *Ritter & Crow 1096, 2211, Ritter 1858, Ritter & Oldcorn 2686.* Common in the cloud forest habitats of Central America and northern South America (Lourteig 1980). *Oxalis spiralis* is said to be favored as a cultivar in these areas and is frequently grown in hanging pots (Burger 1980; Lourteig 1980).

Plantaginaceae

***Plantago australis* Lam.** Herb. CP, GC (occasional to common; in saturated soil along system edges at CP, and under similar conditions in a riverside marsh in the same general area). *Ritter 924, 1857.* Typically a terrestrial, weedy species. Widely distributed, ranging from the southern United States to the Patagonia region of Argentina (Tolaba and Fabbroni 1998).

***Plantago rigida* Kunth.** Cushion-forming, perennial herb. CHB (occasional; growing on small hummocks along the edge of the system). *Ritter 1222.* Frequently can be a dominant in high elevation bogs and swamps (Rahn 1984). Based on site descriptions from specimens at the Missouri Botanical Garden, *P. rigida* has been most often encountered in much higher (4000-4500 m) habitats in Bolivia.

Polygonaceae

***Polygonum hydropiperoides* Michx.** Emergent herb. INC, CP, GC (common to frequent). *Ritter & D. Nash 1334, Ritter 1859, Ritter & Wood 2702*. Fairly widespread, with a distribution from southern Canada (Gleason and Cronquist 1991) to central Argentina (Cialdella 1989). In Bolivia, *P. hydropiperoides* is most often encountered in lowland aquatic systems.

***Polygonum punctatum* Elliot.** Emergent herb. LKW (locally abundant in shallow water). *Ritter 2219*. Widespread, reaching from southern Canada to South America (Gleason and Cronquist 1991), and common in the tropical and subtropical regions of South America (Cialdella 1989). In Bolivia, *P. punctatum* is frequently encountered in lowland wetland habitats and in wetlands in the Valles Secos Interandinos.

Ranunculaceae

***Ranunculus flagelliformis* Smith.** Creeping herb. CHB, INC, LKW, CP, GC. (occasional to abundant). *Ritter 920, 1287, 1853, Ritter & Crow 2192, 2220, Ritter & D. Nash 1333, Ritter & Ritter 1459*. Fairly widespread in South America, from Brazil and Bolivia south to the northern half of Argentina (Lourteig 1951). Characteristic of river and stream edges and seasonally inundated habitats (Molero 1985).

***Ranunculus psychrophilus* Wedd.** Trailing, emergent herb. CHB, LKE, LKW (occasional to abundant; on bog mats and in shallow water, up to ca. 20 cm). *Ritter 1219, 1254, 1258, 1571, Ritter et al. 1271, Ritter & Crow 2194, 2205*. Distribution limited to Bolivia and northern Argentina, at elevations greater than 2000 m (Lourteig 1951).

***Ranunculus sarmentosus* Griseb.** Trailing, emergent herb. CHB, CP, GC (occasional to locally abundant). *Ritter & Crow 1099, Ritter 1286, 1854, Ritter & Oldcorn 2691*. Distribution restricted to high elevation sites in Bolivia and Argentina (Lourteig 1951).

Rubiaceae

***Coccosypselum* sp.** Trailing herb. LKW (locally abundant; growing on *Sphagnum* and on the marshy area around the inlet of the stream that feeds this system; only sterile individuals were encountered). *Ritter & Crow 2210*. Occasionally observed along trails and in low areas in the Cloud Forest.

Scrophulariaceae

***Calceolaria aquatica* A. Br. & Bouché.** Emergent herb. INC, CP, GC (occasional). *Ritter 1281, 1544, 1281, 1860, Ritter & Ritter 1457*. Endemic to the Departamento of Cochabamba, where it occurs along stream beds and in other wet sites, in montane habitats between 2000-3700 m (Molau 1988).

***Limosella* cf. *aquatica* L.** Diminutive emergent herb. INC (occasional in shallow water; all individuals were sterile). *Ritter & D. Nash 1330*. In Bolivia, more typical of higher elevation wetlands.

***Mimulus glabratus* Kunth.** Trailing perennial, at times more or less erect and emergent. INC, GC (occasional in shallow water). *Ritter 1553*. In Bolivia, more typical of higher elevation wetlands. Distributed from the southern United States to Bolivia (Grant 1924).

***Veronica peregrina* L. var. *xaladensis* (H.B.K.) Pennell.** Herb. INC (common in shallow water and in formerly inundated areas). *Ritter 1371*. Widely distributed in the western hemisphere and cultivated worldwide (Edwin 1971).

***Veronica serpyllifolia* L.** Herb. INC, GC (low abundance). *Ritter & Crow 1100, Ritter 1555*. A high-altitude species, well adapted to alpine meadows (Edwin 1971).

Urticaceae

***Pilea dauciodora* (R. & P.) Wedd.** Trailing herb. GC (locally abundant wherever encountered). *Ritter 1456*. Growing alongside streams and waterfalls and in wet soil alongside trails. In this study, only encountered in the Yungas below La Paz.

MONOCOTYLEDONS

Commelinaceae

***Commelina* sp.** Emergent herb. INC (growing in shallow water along on edge of the system). *Ritter & Wood 1718*. Possibly *C. diffusa*, a fairly common species in Bolivian wetlands, however, only sterile individuals were present.

Cyperaceae

***Carex bonplandii* Kunth.** Emergent herb. CHB, LKE, SSM (occasional; growing on the bog mat and in partially submerged conditions). *Ritter 1259, 1264, 1569, Ritter et al. 1273, Ritter & Crow 2198, Ritter & Wood 2898*. A widespread species, from Arizona to Bolivia, characteristically found in cloud forests, thorn scrub and swamps (Chater 1994).

***Carex lemmaniana* Boott.** Emergent herb. CHB, CP, SSM (common to abundant; growing on the bog mat and in partially inundated conditions). *Ritter 1282, Ritter & Oldcorn 2678, Ritter & Wood 2900*. Distributed from Mesoamerica to Bolivia, and characteristically occurring in wetlands and páramos (Chater 1994).

***Carex purdiei* Boott.** Emergent herb. CHB, CP (occasional to abundant). *Ritter 1221, 1284, Ritter & Ritter 1845*. Distributed from southern Mesoamerica to Bolivia, and characteristically occurring in cloud forests, páramos, and inundated areas (Chater 1994).

***Cyperus hermaphroditus* (Jacq.) Standley.** Herb. CP, GC (generally present in low abundance). *Ritter 1285*. Widespread species (Mexico to Costa Rica), generally characteristic of well-drained, disturbed or undisturbed soils (Adams 1994a).

***Cyperus tabina* Steudel ex Boeckeler.** Emergent herb. SSM, GC (low abundance in shallow water at the former; encountered during general collecting in roadside habitats in the Cloud Forest, growing under a variety of soil and moisture conditions). *Ritter & Wood 2897*. Fairly widely distributed in the Neotropics, where it is adapted to terrestrial and wetland habitats (Adams 1994a).

***Eleocharis acicularis* (L.) Roemer et Schultes.** Emergent herb. CHB, INC, LKE, CP, GC (generally abundant). *Ritter 1292, Ritter & D. Nash 1332, Ritter & Crow 2200, Ritter & Oldcorn 2684.* Extremely widespread (North America to South America, Europe), characteristically found in wet montane habitats (Socorro González E. 1994).

***Eleocharis albibracteata* Nees et Meyer ex Kunth.** Emergent herb. CHB (growing sparsely on the bog mat). *Ritter & Oldcorn 2680.* Fairly widely distributed in the Neotropics, characteristic of subalpine meadows (Socorro González E. 1994).

***Eleocharis* cf. *geniculata* (L.) Roemer et Schultes.** Emergent herb. INC (common in shallow water and in seasonally inundated areas). *Ritter 1550.* Widespread in the tropics and subtropics.

***Eleocharis montana* (Kunth) Roemer et Schultes.** Emergent herb. SSM (fairly abundant in shallow water). *Ritter & Wood 2870, 2899.* Widespread: United States and the Antilles to South America (Socorro González E. 1994). Known to occur in a variety of forested and unforested semiaquatic and wetland habitats (Socorro González E. 1994). In Bolivia, *E. montana* characteristically occurs in wetlands in the Valles Secos.

***Isolepis inundata* R. Br.** Emergent herb, at times viviparous. CHB, LKE, LKW (common to locally abundant; growing on *Sphagnum*, in shallow water and along the edges of streams). *Ritter et al. 1270, Ritter 1216, 1563, 1568, Ritter & Crow 2191, 2213.* Widespread in the Neotropics, and also occurring in Australia, New Zealand, and Indonesia, at elevations from 2200-3200 m (Adams 1994b).

***Kyllinga brevifolia* Rottb.** Herb. INC (common, in shallow water and in formerly inundated areas). *Ritter 1548.* Widespread, more or less terrestrial, weedy species, commonly found in disturbed soil in grass dominated habitats (Adams 1994c).

***Pycreus niger* (Ruiz & Pavón) Cuf.** Herb. CHB, INC, SSM. (rare to common; growing on *Sphagnum* or in shallow water). *Ritter 1549, 1562, Ritter & Wood 2901.* Widespread semi-aquatic species. In the new world, distributed from the southern United States to Argentina (Adams 1994d).

Juncaceae

***Juncus ebracteatus* E. Meyer.** Herb. CHB (abundant, on the bog mat). *Ritter 1559.* Widely distributed in the Neotropics, at elevations of 1800-4000 m (Balslev 1996). Well-adapted to wetland habitats.

***Juncus effusus* L.** Herb. CP, GC (locally abundant; along river edges and in riverine marshes). *Ritter 1291, 1843, Ritter & Ritter 1835.* A cosmopolitan species, often growing in disturbed sites (Balslev 1996).

***Juncus fuscocapitatus* Balslev.** Herb. SSM (common; growing along the edges of the pond). *Ritter 2896.* Known only from Bolivia and Peru, where it grows in wet seepages and swampy soils at elevations of 2650-4000 m (Balslev 1996).

***Juncus microcephalus* H.B.K.** Herb. CHB, INC, LKE, LKW, CP, GC (occasional to abundant). *Ritter 1215, 1255, 1262, 1288, 1564, Ritter et al. 1272, Ritter & Crow 2099, 2196, 2212, 2214, Ritter & Wood 2871*. An extremely polymorphic species (Balslev 1996), *J. microcephala* is widely distributed throughout the highland habitats of the Neotropics.

***Juncus pallescens* Lamarck** Herb. GC (locally abundant in a small, stream-fed marsh). *Ritter 928*, (Balslev 1996). Distributed along the Andes from central Ecuador to Chile, and in eastern South America from Rio Grande do Sul (Brazil) to Buenos Aires (Argentina) (Balslev 1996).

***Juncus stipulatus* Nees & Meyen ex Meyen.** Herb. CHB, SSM (present in low abundance in shallow water and in marshy, edge habitats). *Ritter 1545, Ritter & Wood 2902*. Distributed along the Andes from Colombia to Tierra del Fuego (Moore 1983). *Juncus stipulatus* is said to grow in a variety of habitats, ranging from roadsides to bogs (Balslev 1996).

Lemnaceae

***Lemna valdiviana* Phil.** Diminutive, free-floating herb. LKE (locally abundant). *Ritter 1567, 4081*. Distributed throughout the tropical, subtropical, and warm temperate regions of the New World (Landolt 1996). Common in Bolivian lowland aquatic habitats, *L. valdiviana* was the sole species of Lemnaceae that I encountered in the Cloud Forest.

Poaceae

***Agrostis* cf. *lenis* Roseng., B. R. Arill. & Izag.** Herb. CHB, GC, (only a few individuals present wherever encountered). *Ritter & Ritter 1836, Ritter & Oldcorn 2681*. Said to favor wet, shaded sites (Renvoize 1998).

***Agrostis perennans* (Walt.) Tuck.** Herb. CHB, LKW (occasional to common). *Ritter 1217, 1256, 1257, 1572, Ritter & Crow 2193*. According to Renvoize (1998), in Bolivia this species characteristically occurs in páramos and humid sites, on rocky, forested slopes.

***Deschampsia caespitosa* P. Beauv.** Herb. CHB (locally abundant, forming hummocks on the bog mat). *Ritter 1218, 1263, 1560, Ritter & Crow 2199, Ritter & Oldcorn 2679*. A European species. Introduced in South America (Renvoize 1998). Based on label data from the Harvard Herbaria, in South America this species appears to be frequently associated with wet habitats.

***Poa annua* L.** Herb. INC, CP (occasional in shallowly inundated areas). *Ritter & D. Nash 1331, Ritter 1855*. Cosmopolitan, primarily terrestrial, introduced weedy species that characteristically occurs on disturbed sites (Renvoize 1998).

Pontederiaceae

***Heteranthera reniformis* C. Presl.** Emergent herb, at times the stems becoming more or less floating. INC (abundant in shallow water, and in the inflow channel). *Ritter 1546*
Ritter & D. Nash 1335. A widely distributed species, from Connecticut to the Antilles, Central America and South America. In Bolivia, generally associated with lowland and lower montane aquatic habitats.

Appendix G. Species Associated with Wetlands in the Chapare Region

Key to Abundances: A, Abundant; F, Frequent; C, Common; O, Occasional; R, Rare; L.A., Locally Abundant. Key to Habit: Habit: H, Herb; HE, Epiphytic Herb; HT, Trailing Herb; HA, Annual Herb; HP, Perennial Herb; HA/P, Annual or Perennial Herb; HF-F, Free-Floating Herb; HS, Submersed herb; HSA, Suspended Aquatic Herb; HF-S, Herb with floating stems and/or petioles; FM-F, Floating Mat-forming Herb; RFL, Rooted macrophyte with floating leaves; S, Shrub; TU, Understory Tree; T, Tree; C, Climber. Life-forms were as could be determined from descriptions in the literature, live material, and herbarium specimens.

SPECIES	<u>Habit</u>	Mariposa Wetland	Ivirgarsma Marsh	Senda F Curichir	Villa Tunari Pond	Sinahota Pond	Valle de Sajta Curichi	Puerto Villarroel Laguna	General Collecting
PTERIDOPHYTES									
Lycopodiaceae									
<i>Lycopodium clavatum</i> L.	HT	O	L.A.	—	—	—	—	—	—
Hymenophyllaceae									
<i>Trichomanes rigidum</i> Sw.	H	—	—	—	—	—	—	—	N.N.
Marattiaceae									
<i>Danaea elliptica</i> J. E. Smith	H	—	—	—	—	—	—	—	N.N.
Pteridaceae									
<i>Ceratopteris pteridoides</i> (Hook.) Hieron	HF-F	—	—	—	—	—	F	—	A
<i>Pityrogramma calomelanos</i> (L.) Link	H	—	O	—	—	—	—	—	—
Salviniaceae									
<i>Salvinia minima</i> Baker	HF-F	—	—	—	—	—	F	—	—
Thelypteridaceae									
<i>Thelypteris interrupta</i> (Willd.) Iwatsuki	H	—	C	—	—	—	—	—	—
<i>Thelypteris serrata</i> (Cav.) Alston	H	C	C	—	R	—	—	—	—
<i>Thelypteris</i> sp.	HP	—	L.A.	—	—	—	—	—	—
DICOTYLEDONS									
Acanthaceae									
<i>Hygrophila costata</i> Nees	HA/P	—	—	—	—	—	—	—	L.A.
<i>Justicia comata</i> (L.) Sw.	H	—	—	—	A	—	—	—	L.A.
Anacardiaceae									
<i>Tapirira guianensis</i> Aubl.	T	—	—	—	—	—	—	—	N.N.

SPECIES	Habit	Mariposa Wetland	Ivirgatsma Marsh	Senda F Curichir	Villa Tunari Pond	Sinahota Pond	Valle de Sajia Curichi	Puerto Villarroel Laguna	General Collecting
Apocynaceae									
<i>Mandevilla hirsuta</i> (Rich.) K. Schum.	C	O	—	—	—	—	—	—	—
<i>Odontadenia geminata</i> (Hoffmanns.) Müll. Arg.	C	R	—	—	—	—	—	—	—
<i>Prestonia</i> aff. <i>acutifolia</i> (Benth.) K. Schum.	C	—	—	O	—	—	—	—	—
<i>Rhabdadenia macrostoma</i> (Benth.) Müell. Arg.	C	—	—	—	—	—	O	—	—
Asclepiadaceae									
<i>Cynanchum montevidense</i> Spreng.	C	—	—	—	—	—	—	—	N.N.
<i>Tassadia</i> cf. <i>grazielae</i> Fontana	C	A	L.A.	—	—	—	—	—	—
Asteraceae									
<i>Barrosoa confluentis</i> (B. L. Rob.) R.M. King & H. Rob.	HP	—	R	—	—	—	—	—	—
<i>Eclipta prostrata</i> (L.) L.	HA/P	—	—	—	—	R	—	—	—
<i>Erechtites hieracifolia</i> (L.) DC.	HA	—	O	—	—	—	—	—	—
<i>Mikania congesta</i> DC.	C	—	—	C	—	—	—	—	—
<i>Mikania psilostachya</i> DC.	C	F	—	—	—	—	—	—	—
<i>Tessaria integrifolia</i> Ruiz & Pavón	T	—	—	—	—	—	—	—	A
Begoniaceae									
<i>Begonia fischeri</i> Schrank	H	—	O	—	—	—	—	—	—
Boraginaceae									
<i>Cordia tetrandra</i> Aubl.	T	—	—	—	—	—	—	—	N.N.
Cabombaceae									
<i>Cabomba furcata</i> Schultes & Schultes.f	HS	—	—	—	—	—	—	—	A
Campanulaceae									
<i>Centropogon cornutus</i> (L.) Druce	HP	L.A.	C	—	—	—	—	—	—
Clusiaceae									
<i>Calophyllum brasiliense</i> Cambess.	T	—	—	—	—	—	—	—	N.N.
<i>Vismia</i> sp.	T	—	R	—	—	—	—	—	—
Convolvulaceae									
<i>Ipomoea</i> cf. <i>phillomega</i> House	C	—	O	—	—	—	—	—	—
Chrysobalanaceae									
<i>Hirtella triandra</i> Sw.	T	—	—	—	—	—	—	—	N.N.
Dilleniaceae									
<i>Davilla nitida</i> (Vahl) Kubitzki	C	—	R	—	—	—	—	—	—
Erythroxylaceae									
<i>Erythroxylum coca</i> Lam.	S	—	R	—	—	—	—	—	—
Euphorbiaceae									
<i>Caperonia palustris</i> (L.) St.-Hil.	HA/P	—	—	O	—	—	—	—	C

SPECIES	Habit	Mariposa Wetland	Ivirgatsma Marsh	Senda F Curichir	Villa Tunari Pond	Sinahota Pond	Valle de Sajia Curichi	Puerto Villarroel Laguna	General Collecting
Fabaceae									
<i>Aeschynomene rudis</i> Benth.	HP	—	—	—	—	—	—	—	A
<i>Desmodium adscendens</i> (Sw.) DC.	C	C	C	—	—	—	—	—	—
Indet.	H	C	—	—	—	—	—	—	—
<i>Inga umbellifera</i> (Vahl) Steud. ex DC.	T	—	—	—	—	—	—	—	N.N.
<i>Mimosa pigra</i> L.	S	—	—	—	—	—	—	—	F
<i>Phaseolus</i> sp.	C	R	C	—	—	—	—	—	—
<i>Zygia cauliflora</i> (Willd.) Killip ex Record	T	—	—	O	—	—	—	—	—
Haloragaceae									
<i>Myriophyllum mattogrossense</i> Hoehne	HS	—	—	—	—	—	—	—	L.A.
Lamiaceae									
<i>Hyptis atrorubens</i> Poir.	H	L.A.	—	—	—	—	—	—	—
<i>Hyptis brevipes</i> Benth.	HP	—	—	—	—	O	—	—	—
<i>Hyptis lacustris</i> St.-Hil. ex Bentham	HP	—	O	—	—	—	—	—	—
Lentibulariaceae									
<i>Utricularia gibba</i> L.	HSA	—	O	—	—	—	—	—	—
Loranthaceae									
<i>Phthirusa pyrifolia</i> (Kunth) Eichler	P	C	O	—	—	—	—	—	—
Lythraceae									
<i>Cuphea melvilla</i> Lindl.	S	—	—	—	—	—	—	F	—
Malvaceae									
<i>Hibiscus sororius</i> L.	HP	—	—	—	—	—	—	O	—
<i>Pavonia fruticosa</i> (Miller) Fawcett & Rendle	HP	—	—	—	O	—	—	—	—
Melastomataceae									
<i>Aciotis acuminifolia</i> (Mart. ex DC.) Triana	HA	O	L.A.	—	—	—	—	—	L.A.
<i>Aciotis caulialata</i> (Ruiz & Pavón) Triana	H	O	—	—	—	—	—	—	—
<i>Clidemia capitellata</i> (Bonpl.) D. Don	S	—	N.N.	—	—	—	—	—	—
<i>Clidemia</i> cf. <i>biserrata</i> DC.	S	C	—	—	—	—	—	—	—
<i>Miconia ampla</i> Triana	S	A	R	—	—	—	—	—	—
<i>Miconia tomentosa</i> (L. C. Rich) D. Don	S	—	R	—	—	—	—	—	—
<i>Miconia</i> sp.	S	O	—	—	—	—	—	—	—
<i>Tococa</i> aff. <i>macrophysca</i> Spruce ex Triana	S	L.A.	—	—	—	—	—	—	—
Myrtaceae									
<i>Eugenia florida</i> DC.	TU	—	—	—	—	—	—	—	N.N.
<i>Psidium guajava</i> L.	TU	—	—	—	O	—	—	—	—

SPECIES	Habit	Mariposa Wetland	Ivirgatsma Marsh	Senda F Curichir	Villa Tunari Pond	Sinahota Pond	Valle de Sajia Curichi	Puerto Villarroel Laguna	General Collecting
Nymphaeaceae									
<i>Nymphaea amazonum</i> Mart. & Zucc. ssp. <i>amazonum</i>	RFL	—	—	—	—	—	—	—	C
<i>Nymphaea glandulifera</i> Rodschied	RFL	L.A.	—	—	—	—	—	—	—
Ochnaceae									
<i>Sauvagesia erecta</i> L.	HA	C	C	—	—	—	—	—	—
Onagraceae									
<i>Ludwigia affinis</i> (DC.) Hara	H	—	—	—	—	—	—	—	R
<i>Ludwigia decurrens</i> Walt.	H	—	O	—	—	—	—	—	L.A.
<i>Ludwigia inclinata</i> (L.f) Gómez	H	—	—	C	—	—	—	—	A
<i>Ludwigia latifolia</i> (Benth.) Hara	S	—	—	—	—	—	—	—	O
<i>Ludwigia leptocarpa</i> (Nutt.) Hara	HP	—	—	—	—	—	O	O	C
<i>Ludwigia nervosa</i> (Poiret) Hara	S	A	A	C	—	—	—	—	—
<i>Ludwigia octovalvis</i> (Jacq.) Raven	HP	—	—	C	—	C	—	—	—
Piperaceae									
<i>Piper pilirameum</i> C. DC.	S	C	O	—	—	—	—	—	—
Polygonaceae									
<i>Polygonum ferrugineum</i> Wedd.	HP	—	—	—	—	—	—	—	L.A.
<i>Polygonum hydropiperoides</i> Michx.	HP	C	O	—	—	F	—	—	A
<i>Polygonum meisnerianum</i> Cham. & Schltdl.	HP	—	—	—	—	—	—	—	L.A.
<i>Polygonum punctatum</i> Elliot	HA/P	—	—	—	—	—	A	F	—
<i>Triplaris americana</i> L.	T	—	—	—	—	—	—	—	N.N.
Rubiaceae									
<i>Borreria ocymifolia</i> (Willd.) Bacig. & E.L. Cabral	HA/P(?)	—	—	—	—	—	—	—	L.A.
<i>Coccocypselum hirsutum</i> Bartl. ex DC.	H	L.A.	—	—	—	—	—	—	—
<i>Genipa americana</i> L.	T	—	—	—	—	—	—	—	N.N.
<i>Oldenlandia lancifolia</i> (Schumach.) DC.	HA/P(?)	O	O	C	C	F	—	—	F
<i>Palicourea riparea</i> Benth	S	—	—	O	—	—	—	—	—
<i>Palicourea triphylla</i> DC.	S	—	R	—	—	—	—	—	—
<i>Psychotria poeppigiana</i> Muell.-Arg.	S	F	—	—	—	—	—	—	—
<i>Sabicea novogratensis</i> K. Schum.	C	A	O	C	—	—	—	—	0
<i>Sabicea villosa</i> Willd. ex Roem. & Schult.	C	—	—	—	—	—	—	—	N.N.
<i>Spermacoce tenuior</i> L.	H	—	—	—	L.A.	—	—	—	—
Sapindaceae									
<i>Paullinia pinnata</i> L.	L	—	—	O	—	—	—	—	—
Scrophulariaceae									
<i>Lindernia</i> sp.	HA	—	—	—	—	L.A.	—	—	—
<i>Torenia thourarsii</i> (Cham. & Schltd.) O. Kuntze	HA	O	R	—	—	—	—	—	C

SPECIES	Habit	Mariposa Wetland	Ivirgatsma Marsh	Senda F Curichir	Villa Tunari Pond	Sinahota Pond	Valle de Sajia Curichi	Puerto Villarroel Laguna	General Collecting
<i>Scoparia dulcis</i> L.	H	—	—	—	—	—	—	—	N.N.
Sphenocleaceae									
<i>Sphenoclea zeylanica</i> Gaetrn.	HA/P	—	—	—	—	—	—	—	R
Vitaceae									
<i>Cissus erosa</i> L.C. Rich.	CL	—	—	—	—	—	—	—	L.A.
MONOCOTYLEDONS									
Alismataceae									
<i>Echinodorus cf. subalatus</i> (Mart.) Grisebach	HP	—	—	O	—	—	—	—	—
Araceae									
<i>Pistia stratiotes</i> L.	HF-F	—	—	—	—	—	—	—	N.N.
Commelinaceae									
<i>Commelina</i> sp.	H	N.N.	—	—	—	—	—	—	—
Costaceae									
<i>Costus arabicus</i> L.	HP	—	F	—	—	—	—	—	—
<i>Costus scaber</i> Ruiz & Pavón	H	—	—	—	—	—	—	—	N.N.
Cyperaceae									
<i>Calyptrocarya glomerulata</i> (Brogn.) Urban	HP	L.A.	—	—	—	—	—	—	—
<i>Cyperus aggregatus</i> (Willd.) Endl.	HP	—	—	—	—	—	—	—	L.A.
<i>Cyperus haspan</i> L.	HP	F	R	—	—	—	—	—	—
<i>Cyperus luzulae</i> (L.) Retz	HP	—	O	C	C	—	—	—	—
<i>Cyperus meyenianus</i> Kunth	HP(?)	R	C	O	—	—	—	—	—
<i>Cyperus surinamensis</i> Rottb.	HA/P	—	—	—	—	F	—	—	—
<i>Diplacrum longifolium</i> (Griseb.) C. B. Clarke	HP	F	—	—	—	—	—	—	—
<i>Diplasia karatifolia</i> L. C. Rich.	HP	R	—	—	—	—	—	—	—
<i>Eleocharis acutangula</i> (Roxb.) Schultes	FM-F	—	A	—	—	—	—	—	—
<i>Eleocharis elegans</i> (Kunth) Roemer & Schultes	HP	—	—	—	—	—	—	—	O
<i>Eleocharis interstincta</i> (Vahl.) Roemer & Schultes	HP	A	—	—	—	—	—	—	—
<i>Fimbristylis dichotoma</i> (L.) Vahl.	HA/P	—	L.A.	—	—	—	—	—	C
<i>Fimbristylis littoralis</i> Gaudich.	HA	—	—	—	—	—	—	—	F
<i>Oxycaryum cubense</i> (Poepp. & Kunth) Lye	FM-F	—	O	—	—	—	—	—	—
<i>Scleria cyperinoides</i> Clark	HP	C	—	—	—	—	—	—	—
<i>Scleria macrophylla</i> J. S. Presl. & C. Presl	HP	L.A.	—	C	—	—	—	—	C
<i>Scleria microcarpa</i> Nees ex. Kunth	HP	—	—	O	A	—	—	—	—
Eriocaulaceae									
<i>Tonina fluviatilis</i> Aublet	HP	A	—	—	—	—	—	—	—
Heliconiaceae									
<i>Heliconia marginata</i> (Griggs.) Pitt	HP	—	—	—	—	—	A	—	—

SPECIES	Habit	Mariposa Wetland	Ivirgatsma Marsh	Senda F Curichir	Villa Tunari Pond	Sinahota Pond	Valle de Sajia Curichi	Puerto Villarroel Laguna	General Collecting
Hydrocharitaceae									
<i>Apalanthe granatensis</i> (H. & B.) J. E. Planchon	HS	—	—	A	—	—	—	—	—
<i>Limnobium laevigatum</i> (H. & B. ex Willd.) Heine	HF-F	—	—	—	—	—	—	—	N.N.
Limnocharitaceae									
<i>Limnocharis flava</i> (L.) Buchenau	HA/P	—	—	—	—	—	—	—	R
Orchidaceae									
<i>Campylocentrum minutum</i> C. Schweinf.	HE	—	O	—	—	—	—	—	—
<i>Epidendrum schomburgkii</i> Lindl.	HE	R	—	—	—	—	—	—	—
<i>Trizeuxis falcata</i> Lindl.	HE	—	C	—	—	—	—	—	—
Poaceae									
<i>Acroceras zizanioides</i> (H.B.K.) Dandy	HA/P	—	—	—	—	—	—	—	A
<i>Andropogon bicornis</i> (L.) Forsk.	HP	O	O	—	—	—	—	—	—
<i>Andropogon selloanus</i> (Hackel) Hackel	HP	O	—	—	—	—	—	—	—
<i>Axonopus fissifolius</i> (Raddi) Kuhlman	HP	—	—	—	—	R	—	—	—
<i>Coix lacryma-jobi</i> L.	H	—	—	—	—	—	—	—	L.A.
<i>Echinochloa colona</i> (L.) Link	HA	—	—	—	—	—	—	—	O
<i>Gynerium sagittatum</i> (Aubl.) Beauv.	HP	—	—	—	—	—	—	—	A
<i>Hemarthria altissima</i> (Poir.) Stapf & C.E. Hubb.	HP	—	—	—	—	—	—	—	L.A.
<i>Homolepis aturensis</i> (H.B.K.) Chase	HP	C	—	—	—	—	—	—	—
<i>Hymenachne amplexicaulis</i> (Rudge.) Nees	HP	—	—	—	—	—	—	—	A
<i>Hymenachne donacifolia</i> (Radd.) Chase	HP	—	—	F	—	—	—	—	—
<i>Hyparrhenia rufa</i> (Nees) Staph.	HP	—	F	—	—	—	—	—	—
<i>Luziola bahiensis</i> (Steudl.) A. Hitchc.	HP	O	—	—	—	—	—	—	—
<i>Panicum dichotomiflorum</i> Michx.	HP	—	—	—	—	F	—	—	—
<i>Panicum grande</i> Hitchcock & Chase	HP	C	—	—	—	—	—	—	—
<i>Panicum hylaeicum</i> Mez.	HP	L.A.	—	—	—	—	—	—	—
<i>Panicum laxum</i> Sw.	HP	—	—	—	C	—	—	—	—
<i>Panicum mertensii</i> Roth	HP	—	—	—	—	—	—	C	—
<i>Panicum pilosum</i> Sw.	HP	O	—	—	C	—	—	—	L.A.
<i>Panicum polygonatum</i> Schrader	HP	A	L.A.	—	—	—	—	—	—
<i>Panicum schwackeanum</i> Mez.	H	F	—	—	—	—	—	—	—
<i>Panicum stoloniferum</i> Poir.	HP	—	—	—	C	—	—	—	—
<i>Paspalum repens</i> Bergius	H	—	—	—	—	—	—	—	N.N.
<i>Paspalum conjugatum</i> Bergius	H	—	—	—	—	—	—	—	N.N.
<i>Steinchisma hians</i> (Elliot) Nash ex Small	HP	C	—	—	—	—	—	—	—

SPECIES	<u>Habit</u>	Mariposa Wetland	Ivirgatsma Marsh	Senda F Curichir	Villa Tunari Pond	Sinahota Pond	Valle de Sajia Curichi	Puerto Villarroel Laguna	General Collecting
Pontederiaceae									
<i>Eichhornia crassipes</i> (Mart.) Solms-Laubach	HFS	—	—	—	—	—	—	—	N.N.
<i>Eichhornia diversifolia</i> (Vahl.) Urban	HFS	—	—	—	—	—	—	—	R
<i>Pontederia rotundifolia</i> L.f	HFS	—	—	A	—	—	—	—	—

Appendix H. Species Associated with the Study Sites of the Bolivian Pantanal

Specimens without a reference to a study site were from general collecting, from references in the literature, or from herbarium specimens. Key to Habits: H, Herb; HE, Epiphytic Herb; HT, Trailing Herb; HA, Annual Herb; HP, Perennial Herb; HA/P, Annual or Perennial Herb; S-WP, Sub-woody Perennial; HF-F, Free-Floating Herb; HS, Submersed herb; HSA, Suspended Aquatic Herb; HF-S, Herb with floating stems and/or petioles; FM-F, Floating Mat-forming Herb; RFL, Rooted macrophyte with floating leaves; S, Shrub; TU, Understory Tree or "Treelet"; T, Tree; C, Climber. Life-forms were as could be determined from descriptions in the literature, live material, and herbarium specimens.

Species	Habit	Laguna Cáceres	Laguna Uberaba	Laguna La Gaiba	Laguna Mandioré	Puesto Gonzalo
PTERIDOPHYTES						
Marsileaceae						
<i>Marsilea crotophora</i> D. M. Johnson	RFL	+			+	
Pteridaceae						
<i>Ceratopteris pteridoides</i> (Hook.) Hieron	HFF	+			+	
<i>Pityrogramma calomelanos</i> (L.) Link	H	+	+			
Salviniaceae						
<i>Azolla caroliniana</i> Willd.	H			+		
<i>Azolla mexicana</i> C. Presl.	HFF				+	
<i>Salvinia auriculata</i> Aubl.	HFF	+	+	+	+	+
<i>Salvinia minima</i> Baker	HFF	+	+			
DICOTYLEDONS						
Acanthaceae						
<i>Justicia laevilinguis</i> (Nees) Lindau	H	+		+	+	+
Amaranthaceae						
<i>Alternanthera aquatica</i> (D. Par.) Chodat	H	+				
<i>Alternanthera philoxeroides</i> (Mart.) Griseb.	HFS	+				+
<i>Pfaffia glomerata</i> Pedersen	H	+	+			
Apiaceae						
<i>Hydrocotyle ranunculoides</i> L.f	H	+	+	+	+	
Apocynaceae						
<i>Rhabdadenia pohlii</i> Müell. Arg.	C	+				+
<i>Thevetia bicornuta</i> Müell. Arg.	S	+				
Asclepiadaceae						
<i>Cynanchum montevidense</i> Spreng.	C	+			+	
<i>Sarcostemma clausum</i> (Jacq.) Schult. in Roem. & Schult.	C			+		
Asteraceae						
<i>Barrosoa candolleana</i> (Hook. & Arn.) R. M. King & H. Rob.	HP					
<i>Barrosoa confluentis</i> (B. L. Rob.) R. M. King & H. Rob.	HP	+	+	+	+	
<i>Eclipta prostrata</i> (L.) L.	HA/P	+				

Species	Habit	Laguna Cáceres	Laguna Uberaba	Laguna La Garba	Laguna Mandioré	Puesto Gonzalo
<i>Enhydra anagallis</i> Gardner	H	+		+	+	
<i>Erechtites hieraciifolia</i> (L.) Raf. ex DC.	HA	+		+		+
<i>Lepidaploa remotiflora</i> (L. C. Rich) H. Rob.	H				+	
<i>Melanthera latifolia</i> (Gardner) Cabrera	H	+			+	
<i>Mikania cordifolia</i> Willd.	C			+		
<i>Mikania micrantha</i> Kunth	C	+	+	+	+	+
<i>Pacourina edulis</i> Aubl.	H	+			+	
<i>Vernonanthura brasiliensis</i> (L.) H. Rob.	S		+	+		
<i>Wedelia aurantiaca</i> (Grisebach) ined.	H		+	+		
Bignoniaceae						
<i>Anemopaegma chrysanthum</i> Dugand	L	+				
<i>Tabebuia insignis</i> (Miquel) Sandwith	T		+			
Cabombaceae						
<i>Cabomba furcata</i> Schultes & Schultes.f	HS	+				+
Capparaceae						
<i>Cleome spinosa</i> Jacq.	H	+				
Chrysobalanaceae						
<i>Couepia uiti</i> Benth	T				+	
Clusiaceae						
<i>Rhedia brasiliensis</i> (Mart.) Planch. & Triana	T			+	+	
Combretaceae						
<i>Combretum lanceolatum</i> Pohl	S	+		+	+	+
Convolvulaceae						
<i>Aniseia martinicensis</i> (Jacq.) Choisy	C	+		+	+	
<i>Ipomoea alba</i> L.	C	+				
<i>Ipomoea carnea</i> Jacq. ssp. <i>fistulosa</i> (Choisy) Austen	PH	+	+	+	+	+
<i>Ipomoea chiliantha</i> Hallier f.	C	+	+		+	
<i>Ipomoea rubens</i> Choisy	C	+				
<i>Ipomoea subrevoluta</i> Choisy	C		+			
<i>Merremia umbellata</i> (L.) Hall f.	C	+				+
<i>Stictocardia tiliifolia</i> (Desr.) Hallier f.	C	+				
Cucurbitaceae						
<i>Cayaponia podantha</i> Cogn.	C	+				
<i>Melothria pendula</i> L.	C	+				
Indet.	C	+				
Euphorbiaceae						
<i>Alchornea castaneifolia</i> (Willd.) A. Juss.	S	+	+		+	
<i>Caperonia castaneifolia</i> (L.) A. St.Hil.	HFS	+	+	+	+	+
<i>Caperonia palustris</i> (L.) SaintHilaire	HA/P	+				
<i>Croton argenteus</i> L.	S	+				
<i>Phyllanthus fluitans</i> Müell. Arg.	HFF	+			+	
Fabaceae						
<i>Aeschynomene fluminensis</i> Vell.	SWP		+			
<i>Aeschynomene sensitiva</i> Swartz	H	+	+	+		+
<i>Albizia inundata</i> (Mart.) Barneby & J.W. Grimes	T	+				
<i>Bauhinia bauhinioides</i> (Mart.) J.F. Macbr.	T	+				

Species	Habit	Laguna Cáceres	Laguna Uberaba	Laguna La Garba	Laguna Mandioré	Puesto Gonzalo
<i>Bauhinia corniculata</i> Benth	T	+				
<i>Bergeronia sericea</i> Micheli	T	+			+	
<i>Calopogonium velutinum</i> (Benth.) Amshoff	C	+	+			
<i>Camptosema paraguariense</i> (Chodat & Hassl.) Hassl.	C	+				
<i>Dioclea burkartii</i> Maxwell	C	+	+	+		
<i>Discolobium pulchellum</i> Benth.	S	+	+			
<i>Macroptilium lathyroides</i> (L.) Urb.	H	+				
<i>Mimosa pigra</i> L.	S		+			
<i>Mimosa weddelliana</i> Benth.	S	+				
<i>Mimosa xanthocentra</i> C. Martius	S	+	+	+	+	
<i>Neptunia natans</i> (L.f.) Druce	HFS	+			+	+
<i>Neptunia plena</i> (L.) Benth.	S				+	
<i>Senna pendula</i> (H. & B. ex Willd.) H. S. Irwin & Barneby	S	+	+			
<i>Senna splendida</i> (Vogel) H. S. Irwin & Barneby	S			+	+	
<i>Sesbania exasperata</i> Kunth	S	+		+		
<i>Vigna luteola</i> (Jacq.) Benth.	C	+		+	+	
<i>Vigna peduncularis</i> Fawc. & Rendle	C	+				
Lamiaceae						
<i>Hyptis recurvata</i> Poit.	HP		+			
Lentibulariaceae						
<i>Utricularia breviscapa</i> Wright ex Grisebach	H	+				
<i>Utricularia foliosa</i> L.	HSA	+				+
<i>Utricularia gibba</i> L.	HSA	+	+			+
<i>Utricularia hydrocarpa</i> Vahl	HSA	+				
Lythraceae						
<i>Cuphea carthagenensis</i> (Jacq.) J. F. Macbr.	H	+				
Malvaceae						
<i>Hibiscus furcellatus</i> Lam.	SWP	+	+			
<i>Hibiscus sororius</i> L.	SWP	+				
<i>Malachra rudis</i> Benth.	SWP	+				
<i>Pavonia vitifolia</i> Hochr.	SWP	+	+			
Melastomataceae						
<i>Rhynchanthera novemnervia</i> (Martius) DC.	S	+	+	+		
Myrtaceae						
<i>Calyptanthus paniculata</i> Ruiz & Pavón	T				+	
<i>Myrcia fallax</i> (Rich.) DC.	TU			+		
Indet. # 1	TU	+				
Indet. # 2	TU	+				
Nymphaeaceae						
<i>Nymphaea amazonum</i> Mart. & Zuccarini ssp. <i>pedersenii</i> Wiersema	RFL	+				+
<i>Nymphaea belophylla</i> Trickett	RFL	+				
<i>Nymphaea gardneriana</i> Planchon	RFL	+				
<i>Nymphaea oxypetala</i> Planchon	H	+				+
<i>Victoria amazonica</i> (Poepp.) Sower	RFL	+			+	
Onagraceae						
<i>Ludwigia affinis</i> (DC.) Hara	HA/P	+				

Species	Habit	Laguna Cáceres	Laguna Uberaba	Laguna La Garba	Laguna Mandioré	Puesto Gonzalo
<i>Ludwigia decurrens</i> Walt.	H				+	
<i>Ludwigia grandiflora</i> (Michaux) Greuter & Burdet	S	+	+	+		+
<i>Ludwigia helminthorrhiza</i> (Mart.) Hara	HFS	+	+	+	+	+
<i>Ludwigia leptocarpa</i> (Nutt.) Hara	SWP				+	+
<i>Ludwigia nervosa</i> (Poirot) Hara	S		+	+		
<i>Ludwigia sedoides</i> (H. & B.) Hara	HP		+			+
<i>Ludwigia tomentosa</i> (Cambess.) H. Hara	S		+			
Passifloraceae						
<i>Passiflora misera</i> H.B.K.	C	+				
Piperaceae						
<i>Piper fuliginum</i> Kunth	S		+			
Polygonaceae						
<i>Coccoloba ovata</i> Benth	S				+	
<i>Polygonum acuminatum</i> Kunth	H	+	+	+	+	+
<i>Polygonum ferrugineum</i> Wedd.	HP			+		+
<i>Triplaris gardneriana</i> Wedd.	T	+		+	+	
Rubiaceae						
<i>Psychotria carthagenensis</i> Jacq.	SWP			+		
<i>Rudgea cornifolia</i> (Kunth) Standl.	TU			+		
<i>Simira rubescens</i> (Benth.) Bremek. ex Steyerl.	TU			+		
<i>Sphinctanthus hasslerianus</i> Chodat	SWP	+				
Sapindaceae						
<i>Paullinia pinnata</i> L.	L	+	+		+	
<i>Sapindus saponaria</i> L.	TU			+		
Scrophulariaceae						
<i>Alectra aspera</i> (Cham. & Schltdl.) L. O. Williams	H			+		
<i>Bacopa salzmännii</i> (Benth.) Edwall	H		+			
<i>Bacopa stricta</i> (Scrad.) Edwall	H	+				
Solanaceae						
<i>Solanum americanum</i> Mill.	HP	+				
Sphenocleaceae						
<i>Sphenoclea zeylanica</i> Gaetrn.	HA/P	+			+	
Sterculiaceae						
<i>Byttneria filipes</i> Mart.	SWP	+	+	+	+	+
<i>Melochia arenosa</i> Benth.	SWP	+	+	+	+	
Verbenaceae						
<i>Lippia alba</i> (Miller) N.E. Brown	SWP	+				
<i>Phyla nodiflora</i> (L.) Greene	H	+				
<i>Stachytarpheta cayennensis</i> (L. C. Rich) Vahl	S			+		
<i>Stachytarpheta elatior</i> Schrad. ex Schult.	H	+				
Vitaceae						
<i>Cissus spinosa</i> Camb.	C	+	+	+	+	+
<i>Cissus verticillata</i> (L.) Nicholson & C. E. Jarvis	C	+				

Species	Habit	Laguna Cáceres	Laguna Uberaba	Laguna La Garba	Laguna Mandioré	Puesto Gonzalo
MONOCOTYLEDONS						
Alismataceae						
<i>Echinodorus grandiflorus</i> ssp. <i>aureus</i> (Fassett) Haynes & HolmNiels.	H		+			
<i>Echinodorus paniculatus</i> Micheli	H	+				+
<i>Sagittaria rhombifolia</i> Chamisso	H		+			
Araceae						
<i>Pistia stratiotes</i> L.	HFF	+		+	+	
Arecaceae						
<i>Bactris major</i> Jacq.	T	+				
<i>Copernicia alba</i> Mor. ex Mor. & Britt.	T	+		+	+	
Cannaceae						
<i>Canna glauca</i> L.	H					
Commelinaceae						
<i>Commelina erecta</i> Chapm.	H			+		
Cyperaceae						
<i>Cyperus gardneri</i> Nees ex. Mart.	H	+				
<i>Cyperus giganteus</i> Vahl.	H	+	+			
<i>Cyperus haspan</i> L.	HP	+	+			
<i>Cyperus rotundus</i> L.	H	+				
<i>Eleocharis acutangula</i> (Roxb.) Schultes	FMF		+			
<i>Eleocharis elegans</i> (Kunth) Roemer & Schultes	HP		+			
<i>Eleocharis minima</i> Kunth	H	+	+			
<i>Fuirena umbellata</i> Rottb.	FMF		+			
<i>Oxycaryum cubense</i> (Poepp. & Kunth) Lye	FMF	+	+	+	+	+
<i>Rhynchospora gigantea</i> Link.	HP		+	+		
<i>Rhynchospora trispicata</i> (Nees) Schrad. ex Steud.	HP	+				
<i>Scleria flagellumnigrorum</i> P. Bergius	HP			+		
<i>Torulinium odoratum</i> (L.) Hooper	H	+	+		+	
Hydrocharitaceae						
<i>Egeria najas</i> Planchon	HS	+				
<i>Limnobium laevigatum</i> (H. & B. ex Willd.) Heine	HFF	+	+		+	
Lemnaceae						
<i>Lemna aequinoctialis</i> Welw.	HFF				+	
<i>Lemna valdiviana</i> Phil.	HFF			+	+	
<i>Wolffia columbiana</i> Karsten	HFF				+	
<i>Wolffiella lingulata</i> (Hegelm.) Hegelm.	HFF			+	+	
<i>Wolffiella oblonga</i> (Phil.) Hegelm.	HFF				+	
Limnocharitaceae						
<i>Limnocharis flava</i> (L.) Buchenau	HA/P		+			
Marantaceae						
<i>Thalia geniculata</i> L.	H	+	+			+
Najadaceae						
<i>Najas podostemon</i> Magnus	HS					+
Poaceae						
<i>Andropogon bicornis</i> (L.) Forsk.	HP	+	+	+		+
<i>Cynodon dactylon</i> (L.) Pers.	H	+				

Species	Habit	Laguna Cáceres	Laguna Uberaba	Laguna La Garba	Laguna Mandioré	Puesto Gonzalo
<i>Echinochloa polystachya</i> (Kunth) Hitchc.	H	+	+	+	+	
<i>Eriochloa punctata</i> (L.) Desv.	H	+				
<i>Hymenachne amplexicaulis</i> (Rudge.) Nees	HP	+	+	+	+	+
<i>Hymenachne donacifolia</i> (Raddi) Chase	HP	+				
<i>Imperata tenuis</i> Hack	H	+	+	+	+	+
<i>Leersia hexandra</i> L.	H	+	+	+	+	+
<i>Leptochloa panicoides</i> (J. Presl) Hitchc.	H				+	
<i>Luziola subintegra</i> Swallen	H	+				
<i>Oryza alta</i> Swallen	H			+	+	
<i>Oryza rufipogon</i> Griffiths	H	+	+			
<i>Panicum dichotomiflorum</i> Michx.	HP	+	+			
<i>Panicum elephantipes</i> Nees ex Trin.	H	+		+	+	
<i>Panicum laxum</i> Sw.	HP			+		+
<i>Paspalum repens</i> Bergius	FMF	+		+	+	+
<i>Paspalum wrightii</i> Hitchc. & Chase	H	+				
<i>Setaria parviflora</i> (Poir.) Kerguélen	H	+				
Pontederiaceae						
<i>Eichhornia azurea</i> (Sw.) Kunth	HFS	+	+	+	+	+
<i>Eichhornia crassipes</i> (Mart.) SolmsLaubach	HFS		+	+	+	+
<i>Pontederia cordata</i> L. var. <i>ovalis</i> (Mart. in Roemer & Schultes) Solms	H		+	+	+	
<i>Pontederia rotundifolia</i> L.f	HFS	+	+	+	+	+
<i>Pontederia subovata</i> (Seubert in Martius) Lowden	H	+				
<i>Pontederia triflora</i> (Endl. ex Seub.) Agost. & Velásquez	HFS		+			

Appendix I. Phytogeography

"If philosophy is the devil's whore, as Martin Luther once quipped, then biogeography and biological systematics are fast becoming Old Nick's bordello."

- R. Craw, "Panbiogeography: Methods and Synthesis in Biogeography"

Introduction

During the evolution of this project, it became obvious that the species-distribution data that were being compiled could potentially be used to investigate a range of phytogeographic questions. The work of Crovello (1981) and McLaughlin (1994) was particularly useful in directing this aspect of the research. The wetland species database compiled for this study (Ritter 2000) contained a wealth of information, and could likely have served as the basis for a number of chapters. Time limitations, however, limited the analysis of these data to a few, broadly drawn examples. These examples, along with some brief notes, are presented here.

Site-level Phytogeographic Patterns

Initially, floristic relationships at the site-level were examined using similarity matrices. Results of these analyses were generally unsatisfactory. Many of the study sites were sufficiently depauperate such that calculated indices of similarity gave a poor representation of the actual floristic associations. Furthermore, the Bolivian wetland flora contained a large number of common, widespread species, and in some cases these undoubtedly served to elevate calculated floristic similarities between some sites. Site-level comparisons were limited to study sites within the same region, but had all 46 sites been compared in a single similarity matrix the results would likely have been confounding, if not misleading.

More meaningful results were obtained using Detrended Correspondence Analysis (DCA). In an ordination by DCA of the 46 study sites (Figure I.1), sites from each region were almost always grouped in close proximity in ordination space. The sole exceptions were two sites from the Chapare region which possessed particularly depauperate floras (see Chapter 4 for an elaboration).

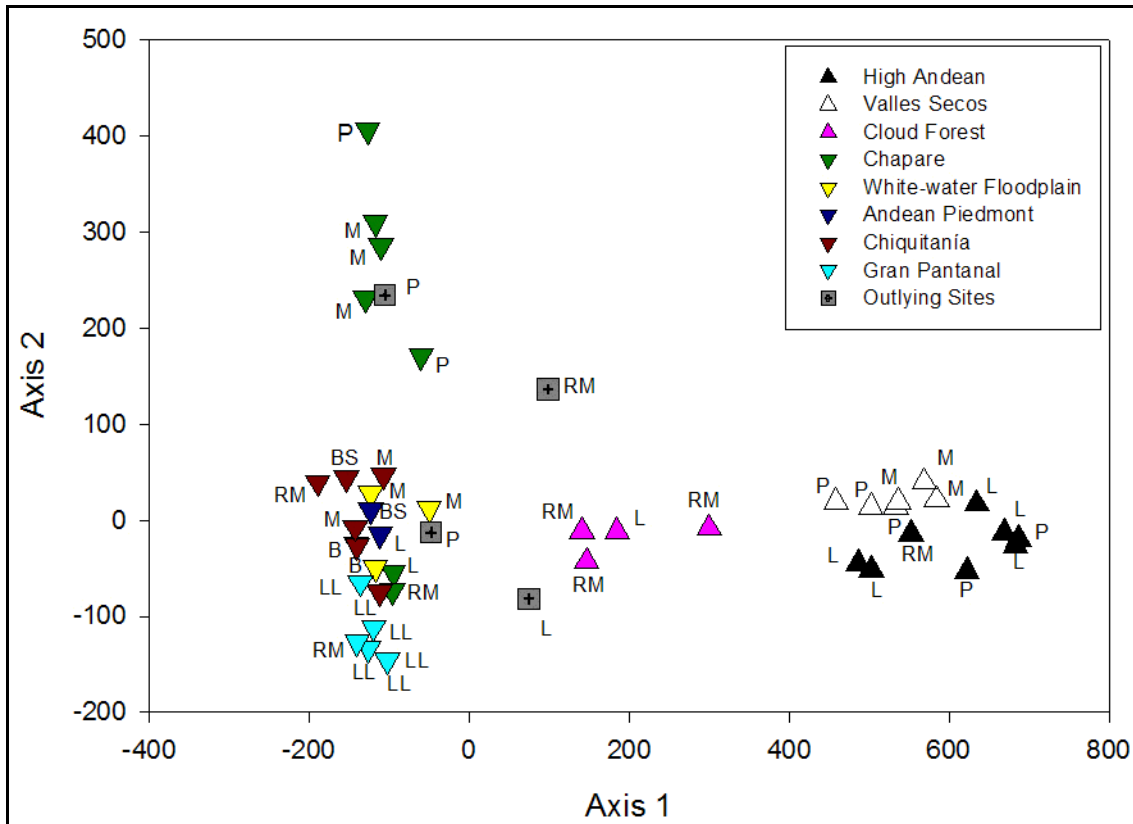


Figure I.1. Ordination of the 46 Bolivian study sites by Detrended Correspondence Analysis (DCA). Key to wetland types: B- bahía; BS - basin swamp; L - small lake (< 500 ha); LL - large lake (> 500 ha); M - marsh; P - pond; RM - riparian marsh.

As noted in Chapter 6, seasonal fluctuations in floristic composition, which are characteristic of wetlands in the Neotropical lowlands, can affect estimates of site-level biodiversity. Likewise, these fluctuations can also affect calculated floristic similarities. An example of the magnitude of these seasonal differences can be found in the work of Prado *et al.* (1994) in the Brazilian Gran Pantanal. As noted, the authors sampled from a 2500 m² study plot during the course of a year, with sampling scheduled during each of the four hydrologic seasons. The data presented by Prado *et al.* (1994) were compiled and analyzed using Sørensen's Index (Table I.1). Floristic similarities within the site varied from 74.0-88.2% during the year (Table I.1). In like manner, calculated floristic similarities from two systems that had been sampled during different hydrologic seasons could vary by 10-25% simply because of seasonal differences in species composition. It should be emphasized, however, that the preceding example should not be interpreted as

representing the average magnitude of seasonal changes in floristic composition in Neotropical wetlands, as it was based on a single study.

Table I.1. Seasonal^A changes in species-richness and floristic similarities (Sørensen's Index) in a 2500 m² study plot in the Northern Brazilian Pantanal. Data compiled from Prado *et al.* (1994).

	Seca	Enchente	Cheia	Vazante
Seca	36	27	24	27
Enchente	76.1	35	29	29
Cheia	71.6	87.9	31	30
Vazante	74	80.6	88.2	37

A. Seasons are as follows: 1) *seca*: the dry season; 2) *enchente*: the period of flooding associated with the beginning of the rainy season; 3) *cheia*: the high water period, which begins approximately 3-4 months after the onset of the rainy season and which is maintained by daily rains; and, 4) *vazante*: the transition to the dry season during which water levels drop rapidly and rainfall is diminished, but does not cease completely.

Regional-Scale Phytogeographic Patterns

At the regional scale, similarity matrices were of greater utility than at the study-site scale. Nevertheless, ordination (DCA) was more instructive for representing overall floristic relationships among OGUs. For example, based on calculated floristic similarity (Sørensen's Index) the Andean Piedmont wetland flora was most similar to the Gran Pantanal (61.7%, Table I.2). When viewed within the context of floristic relationships among all regions, however, the Andean Piedmont was seen to be much more strongly associated with the other lowland Bolivian regions (*e.g.*, the Chiquitanía, White-water Floodplain, and the Chapare) than with the Gran Pantanal (Figure I.2).

The position of the eight Bolivian regions in an ordination by DCA (Figure I.2) was, in most cases, in accordance with the generalization that floristic affinities will be strongest between adjacent regions. An exception was the position of the Gran Pantanal relative to that of the Chiquitanía. Although these regions are geographically contiguous they were disjunct in ordination space, forming the axile endpoints of the second axis (Figure I.2). The distribution of the eight regions along the first axis appeared to be strongly correlated

with elevation (Figure I.2), a relationship that was also discernible from the similarity matrix (Table I.2).

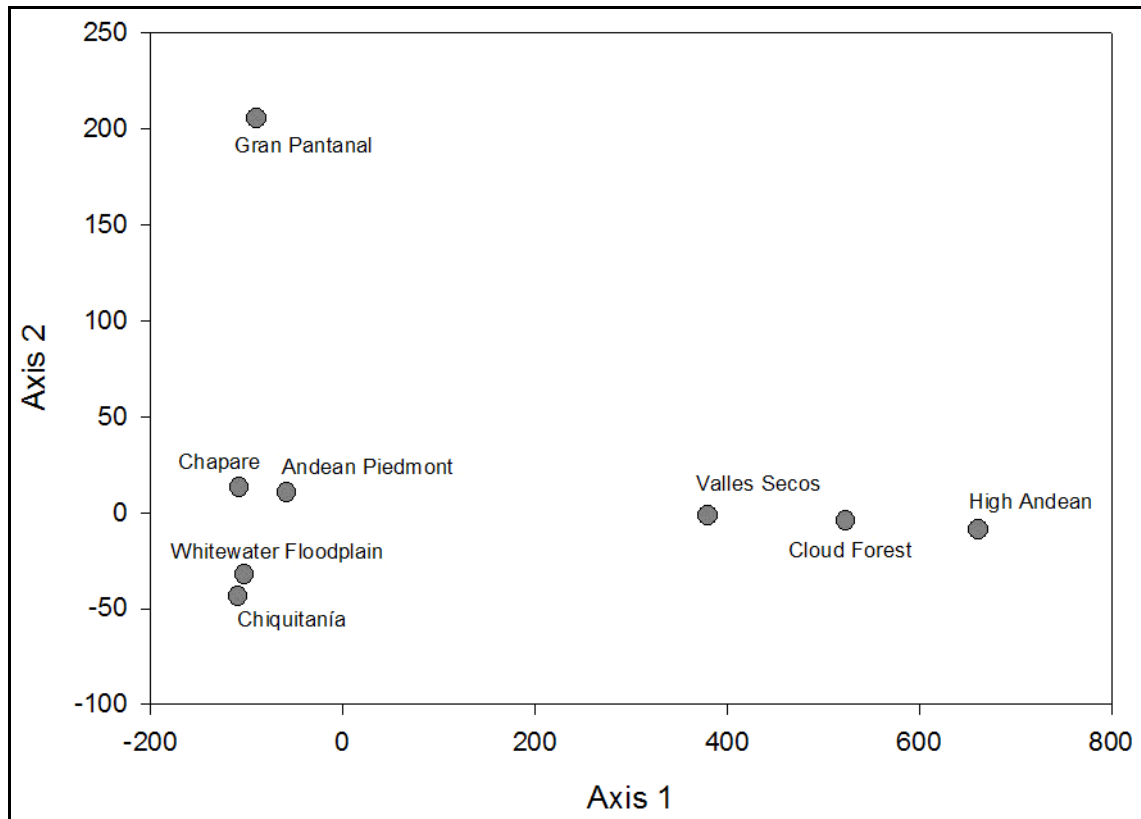


Figure I.2. Ordination of the Bolivian Regions by Detrended Correspondence Analysis.

At the macroregional scale, floristic similarities (Sørensen's Index) between OGUs were astonishingly high, ranging from 48.9-79.3% (Table I.3), with floristic similarities between the two most geographically disjunct OGUs (Bolivia and Mexico) greater than 50% (51.3%, Table I.3). In order to examine relative differences in floristic similarities calculated from wetland floras versus those calculated from terrestrial floras, indices of similarity (Sørensen's Index) were calculated for five Neotropical OGUs (Costa Rica, Panama, Ecuador, Peru, and the Guianas; Table I.4). These were selected because their species checklists were considered to be relatively complete. The "terrestrial flora" was considered to be all species not listed in the wetland species database. The wetland species data from Table I.3 was compiled for these five OGUs and was re-ordered to

match the presentation of the OGU in Table I.4 (Table I.5). Floristic similarities for the terrestrial floras ranged from 17.2-50.8% (Table I.4), whereas those for the wetland floras ranged from 53.3-78.5% (Table I.5). In all but one instance (Costa Rica and Panama), floristic similarities between OGUs were at least twice as high for the wetland flora as for the terrestrial flora. The elevated floristic similarities of the wetland flora can be attributed to a large portion of the Neotropical wetland species being widely distributed. Additionally, a great many of these species must be sufficiently common throughout their ranges so that their presence has been noted during the relatively small amount of botanical research that has been conducted in Neotropical wetlands.

An ordination by DCA ordered the 11 OGUs into three groups, with Mexico and Ecuador occupying disjunct positions (Figure I.3). Groupings were: 1) Bolivia, Brazil and Peru; 2) Colombia, The Guianas, and Venezuela; and, 3) all Central American countries (Figure I.3). As with the ordination of the Intra-Bolivian regions (Figure I.2), there was a strong tendency for geographically proximal OGUs to be located in close proximity in ordination space.

In the three chapters which focused on biodiversity and phylogeographic affinities of three particular Bolivian regions (Chapters 3, 4, and 5), the utility of Frequency Analysis in mesoregional-scale investigations was demonstrated. This approach also was instructive in macroregional-scale studies. To demonstrate, the relative contributions of species classes to overall similarity were calculated between Bolivia and the other 10 OGUs considered in the preceding macroregional floristic comparisons. Frequencies between Bolivia and four OGUs (Brazil, Colombia, Ecuador, and Peru) were graphed (Figure I.4). These were selected because they showed the strongest floristic similarities (Sørensen's Index., Table I.3) to the Bolivian flora. Floristic similarities between Bolivia and the four OGUs were fairly equitable, ranging from 62.1-70.8% (Table I.3). Of these, the greatest similarity (70.8% Table I.3) was between Bolivia and Peru, although this was scarcely higher than that between Bolivia and Brazil (66.9%, Table I.3). Likewise, in the ordination by DCA (Figure I.3), Bolivia occupied a position in ordination space approximately equidistant from Peru and Brazil. It was evident from the Frequency Analysis (Figure I.4), however, that Bolivia and Brazil shared a greater proportion of

“rarely shared species” (*i.e.*, species restricted to 2-3 OGUs) than did Bolivia and Peru (Figure I.4).

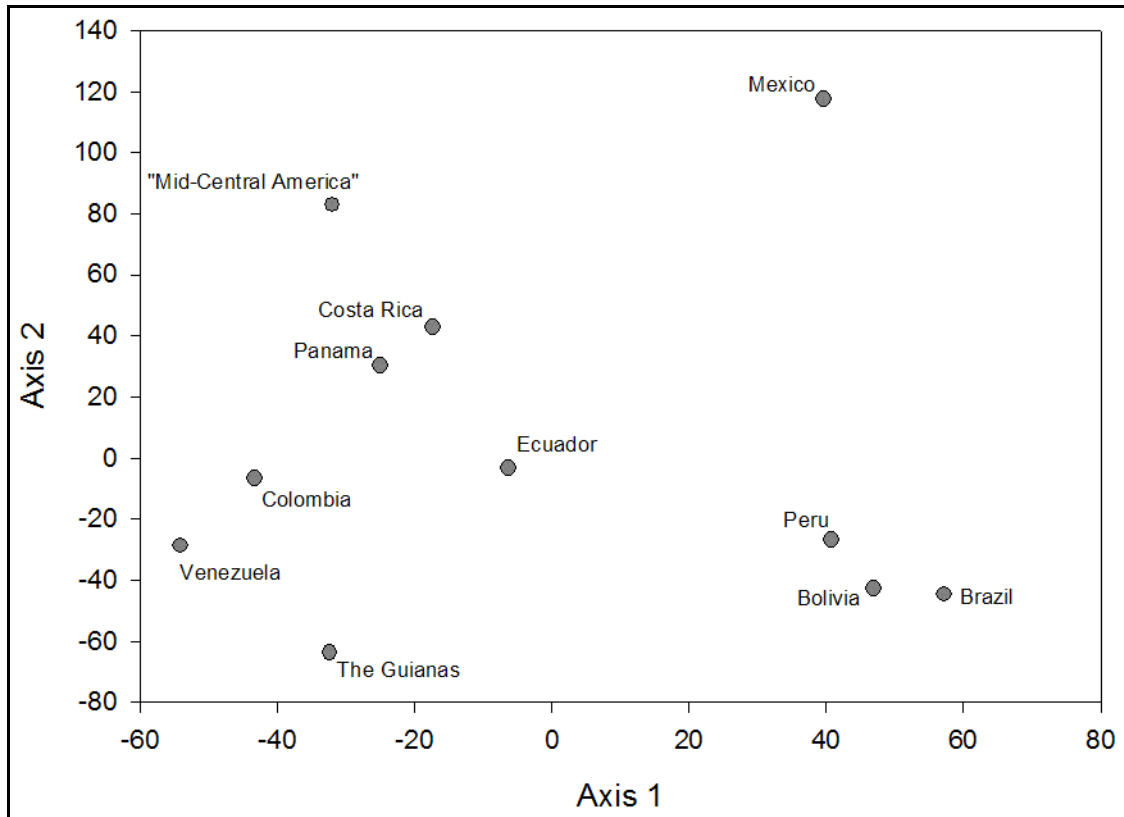


Figure I.3. Ordination of the Neotropical OGUs by Detrended Correspondence Analysis (DCA).

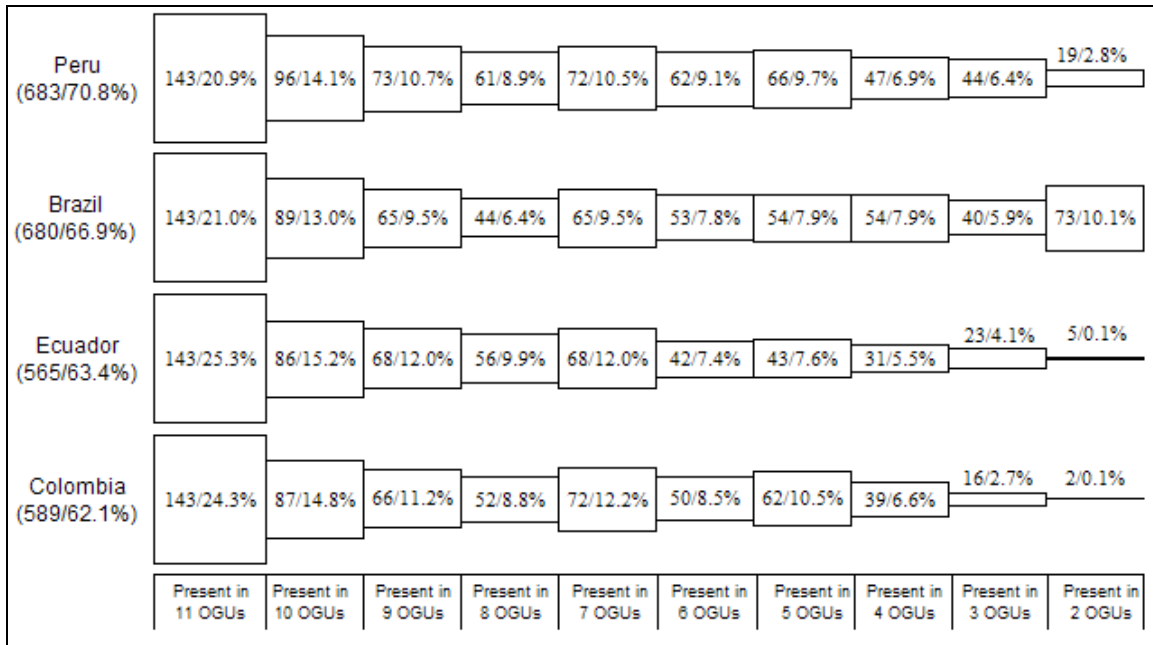


Figure I.4. Frequency of species shared between Bolivia and selected OGUs. Figures below the OGU name indicate the number of species present in both the OGU and Bolivia, followed by floristic similarity (Sørensen's Index). Boxes correspond to species classes (i.e., the number of OGUs in which the species was present) as indicated by the key along the bottom of the figure. The vertical dimension of each box is proportional to the number of species that it represents. Values associated with the boxes indicate the number of species in that class that occurred in both the OGU and Bolivia, followed by the percentage that this portion of the flora contributed to the total species shared between the OGU and Bolivia.