

## A Biological Survey of the Cordillera Mosevenes, Bolivia

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The Cordillera Mosevenes (FIGURE 1) is about 130 km long, 20-25 km wide and rises up to an elevation of 2050 m. It is located in the Department of Cochabamba and because of its inaccessibility probably contains the largest completely uninhabited and biologically unexplored areas of the Bolivian Andes. With an estimated annual rainfall of 4000-7000 mm, the Cordillera Mosevenes is one of Bolivia's most humid regions. Mean annual temperatures range from approximately 25°C at 300 m to 12°C at the summit. Although parts of this mountain chain belong to the reserves Isiboro-Sécure and Altamachi, a biodiversity survey was urgently needed to provide land managers with the necessary information to help protect the region.

Our survey took place from August 28 through September 29, 2003, and included a multidisciplinary team of experienced tropical biologists including Dr. Manuel Macía, Iván Jimenez, Juan Fuertes, ourselves (botany), Dr. Eric Yensen, Teresa Tarifa, Fernando Guerra (masto zoology), Dr. Sebastian K. Herzog (ornithology), Dirk Embert (herpetology), and Caroli Hamel (entomology). A major aim of the survey was to describe the biological diversity of the Cordillera Mosevenes and to compare the data with other regions influenced by humans.

The starting point of this expedition was the city of Cochabamba: After a three-day stay for the logistical organization, where approximately 1 ton of equipment had to be packed, our group of 11 scientists was brought by bus to the small village of Tablas Montes. From there we flew by helicopter of the Bolivian air force to our target area (16°13'S, 66°24'W) in Isiboro Sécure National Park. We landed at the shore of a lagoon situated in the middle of a montane rain forest at 1300 m elevation (FIGURE 2). This approximately 90 m long and 30 m wide lagoon was probably formed by a landslide some decades ago, as indicated by the half-decomposed tree trunks standing in the water.

After setting up camp in immediate proximity to the lagoon, several paths were cut into the surrounding forest to allow easier access to study areas. These paths led from elevations of 1200 m up to a ridge at 1600 m, and included a mosaic of three different forest types. While the steeper hillsides were mostly covered with younger forests and bamboo thickets, the less steeply inclined areas were covered by older forest stands with 20-25 m and in few cases also 35 m tall trees whose horizontal branches were densely covered with epiphytic bromeliads, orchids and ferns (FIGURE 3). The low ridge forest differed from these two forest types mainly by the presence of thick moss mats (FIGURE 4).

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Figure 1.  
View over the  
montane forest  
of the Cordillera  
Mosevenes.

Photograph by M. Kessler.

Figure 2.  
Bolivian Air  
Force helicopter  
landing at the  
lagoon shore.

Photograph by T. Krömer.



Figure 3. Branch  
of wild fig tree  
covered with  
vascular epiphytes.

Photograph by T. Krömer.



Figure 4. Stunted ridge tree covered with moss mats.

Photograph by M. Kessler.

Figure 5. Epiphyte sampling using single rope technique.

Photograph by T. Krömer.



Figure 6. Processing of the collected plants at the camp.

Photograph by D. Embert.

Figure 7. Living collection of orchids near the camp.

Photograph by T. Krömer.



For the botanical studies, we constructed 20 sampling plots with a size of 20 x 20 m each, and focused on inventories of the following plant groups: Acanthaceae (acanthus), Araceae (aroids), Bromeliaceae (bromeliads), Cactaceae (cacti), Arecaceae (palms), and Pteridophytes (ferns). In addition, epiphyte species were recorded in nine of these plots, including mostly Orchidaceae (orchids), Piperaceae (peperomias), and Ericaceae (tropical blueberries), which were sampled by climbing into the crowns of nine large trees using the single-rope-technique (FIGURE 5). The method we used for the epiphyte sampling was recently described by Gradstein et al. (2003). After our daily work in the plots, we botanists usually came back to the camp heavily-loaded for the "processing", i.e., sorting, numbering, and pressing of the collected plants (FIGURE 6).

During the fieldwork, we collected almost 1000 plant specimens, among them 31 species of aroids, 16 bromeliads, 3 cacti, ca. 120 orchids, and approximately 200 ferns. Since most orchids were not in bloom, the collected plants were kept alive (FIGURE 7) for transport to the greenhouses of the *Fundación Amigos de la Naturaleza* (FAN) in Santa Cruz for later identification by the Bolivian orchid specialist R. Vásquez.

The 16 bromeliads found belonged to seven different genera (TABLE 1) of which *Guzmania* (7 species) was the most diverse. We can compare these numbers with two other study areas surveyed by Krömer (2003) in La Paz department, namely Sapecho situated at 600-1200 m elevation in submontane forests, and Cotapata at 1600-2200 m in montane forests. For *Guzmania*, Mosetenes had more species than either Sapecho (5 species) or Cotapata (4). However, both of the other sites had a higher total species number (even without considering terrestrial bromeliads), with 20 and 21, respectively. At Sapecho, nine bromeliad species, including the two genera *Aechmea* (3) and *Weraubia* (2), were found that were not recorded either at Mosetenes or at Cotapata. On the other hand, at Cotapata there were nine species of *Tillandsia*, a genus almost completely lacking at Mosetenes (1 species).

Most bromeliad species in Mosetenes were epiphytic, but some species in the open ridge forest, e.g., the colorful *Guzmania squarrosa* (FIGURE 8) or *Tillandsia asplundii*, also frequently grew on the ground. Only two obligatory terrestrial species were recorded, *Fosterella* cf. *albicans* and *Pitcairnia* sp. Most epiphytic bromeliads showed a wide (500-1000 m) or very wide (> 1000 m) elevational amplitude (TABLE 1). Only *Guzmania madisonii* and *Pitcairnia* cf. *riparia*, until now only known in Bolivia from two and three collections, respectively, have ranges of less than 500 m (Krömer et al. 1999, Krömer 2003).

We expected to find some new species in such a remote area, although we have so far been unable to identify one of the *Pitcairnia* species. So far, none of the bromeliads are endemic for Bolivia, rather, apart from *Fosterella* cf. *albicans*, which can also be found in northwestern Argentina, most species are relatively widespread and occur in the montane forests along the

TABLE 1. List of the bromeliad species found in the study area of Mosetenes with indications to life-form (ep = epiphytic, ter = terrestrial), elevational range in Bolivia and distribution in the Neotropics [ARG = Argentina, BOL = Bolivia, BRA = Brazil, COL = Colombia, EC = Ecuador, GUY = Guyana (incl. Suriname and French Guiana), MAm = Central America (Costa Rica and Panama), PER = Peru, VEN = Venezuela].

Bromeliad Species	Life-form	Elevational Range in Bolivia (m)	Distribution in the Neotropics
<i>Fosterella</i> cf. <i>albicans</i>	ter	900-2150	ARG, BOL
<i>Guzmania killipiana</i>	ep	1150-2500	BOL, ECU, PER
<i>Guzmania madisonii</i>	ep	1200-1400?	BOL, ECU
<i>Guzmania marantoides</i>	ter (ep)	1300-2650	BOL, PER
<i>Guzmania melinonis</i>	ep	300-1400?	BOL, BRA, COL, ECU, GUY, PER, VEN
<i>Guzmania roezlii</i>	ep	550-1450	BOL, BRA, COL, ECU, GUY, PER, VEN
<i>Guzmania sphaeroidea</i>	ep	1150-1500	BOL, COL, ECU, VEN
<i>Guzmania squarrosa</i>	ep (ter)	1100-1600	BOL, COL, ECU, GUY, PER, VEN
<i>Mezobromelia pleiosticha</i>	ep	850-1600	BOL, COL, ECU, GUY, PER, VEN
<i>Pitcairnia</i> cf. <i>brittoniana</i>	ter (ep)	1200-1700	BOL, COL, ECU, GUY, MAm, PER, VEN
<i>Pitcairnia</i> cf. <i>riparia</i>	ep	1300-1600	BOL, ECU, PER
<i>Pitcairnia</i> sp.	ter	-	-
<i>Racinaea schumanniana</i>	ep	1050-2700	BOL, COL, ECU, MAm, PER, VEN
<i>Racinaea spiculosa</i>	ep	300-2500	BOL, BRA, COL, ECU, GUY, MAm, PER, VEN
<i>Tillandsia asplundii</i>	ep (ter)	1350-2500	BOL, ECU, PER
<i>Vriesea heterandra</i>	ep	600-1550	BOL, ECU, COL, VEN

Andes of Bolivia to Venezuela (TABLE 1). Some species can also be found in the Amazonian lowland forests of Brazil and Guyana or even north to Costa Rica. This confirms that epiphytic bromeliads (in contrast to their terrestrial relatives) usually have quite wide distribution ranges caused, among other reasons, by highly efficient dispersal mechanisms (e.g., tiny winged seeds, bird-dispersed berries) which represent adaptations to their canopy habitat (Kessler 2002). In contrast, the (mainly) terrestrial genera *Fosterella* (27 species/19 endemics), *Greigia* (8/6), *Pitcairnia* (15/8), and *Puya* (57/47) show especially high numbers of endemic species in Bolivia (Krömer et al. 1999, Ibisch et al. 2002, Will et al. submitted).

Fortunately, we had mostly good weather (only two rainy days) during the three weeks in the field, although for the elevation of 1300 m it was relatively cold with nightly minimum temperatures of ca. 6°C. These low temperatures were caused by cold subpolar air fronts, called *sures* or *surazos*, which influenced the weather at the time of our stay. In addition, we were lucky to have neither accidents nor serious problems with stinging insects or poisonous snakes, such as the coral snake (FIGURE 9). The only large animals we observed were a deer, capuchin monkeys, and several opossums



Photograph by T. Krömer.

Figure 8.  
*Guzmania  
squarrosa*  
growing on the ground  
in the open  
ridge forest.



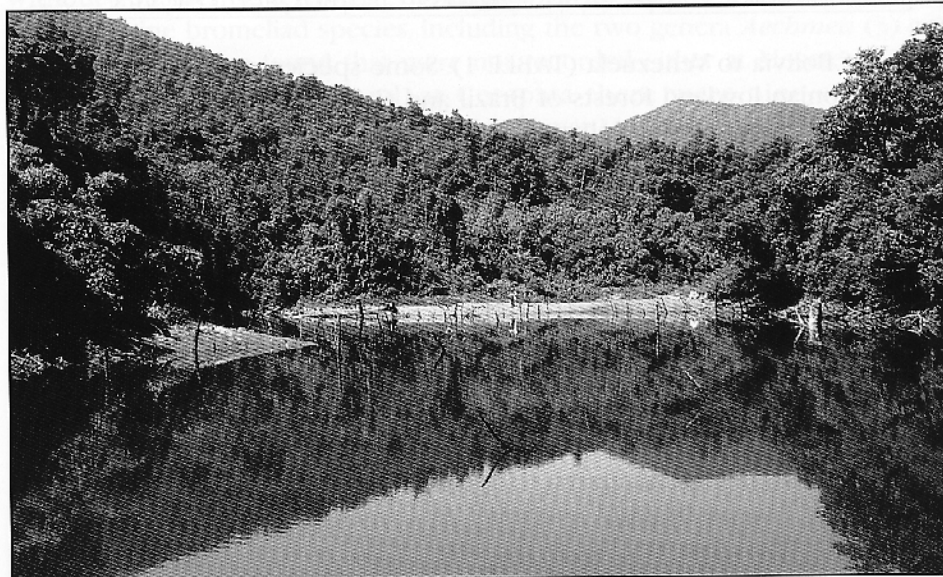
Photograph by D. Embert.

Figure 9. Coral snake.



Photograph by  
D. Embert.

Figure 10.  
Opossum  
freed from  
the trap.



Photograph by T. Krömer.

Figure 11. View over 'Laguna Carachupa.'

(Spanish: *carachupa*), which ran into the positioned traps many times, but were freed again the next morning (FIGURE 10). However, one of the greatest surprises of our study was the relative paucity of large mammals such as the Andean bear, peccaries, spider monkeys, tapirs, or large cats. Besides innumerable insects, including an impressive variety of colorful butterflies, the fauna of the study area consisted mainly of the numerous birds and frogs, who pleased us with their vociferous "concert" in the morning as well as at night.

Our return flight into civilization was delayed by three and a half days because of political uprisings since our helicopter was diverted to La Paz. We were very relieved to finally return, even though it was difficult to depart the idyllic "*Laguna Carachupa*" (FIGURE 11).

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### Literature Cited

Gradstein, S.R., Nadkarni, N.M., Krömer, T., Holz, I. & N. Nöske. 2003. A protocol for rapid and representative sampling of vascular and non-vascular epiphyte diversity of tropical rain forests. *Selbyana* 24: 105-111.

Ibisch, P.L., Vásquez, R., Gross, E., Krömer, T. & M. Rex. 2002. Novelties in Bolivian *Fosterella* (Bromeliaceae). *Selbyana* 23: 204-219.

Kessler, M. 2002. Environmental patterns and ecological correlates of range-size among bromeliad communities of Andean forests in Bolivia. *The Botanical Review* 68: 100-127.

Krömer, T. 2003. Diversität und Ökologie der vaskulären Epiphyten in primären und sekundären Bergwäldern Boliviens. Cuvillier Verlag, Göttingen.

Krömer, T. 2004. Biologische Erkundung der Cordillera Mosestenes, Bolivien. *Die Bromelie* 1/2004: 18-22.

Krömer, T., Kessler, M., Holst, B.K., Luther, H.E., Gouda, E.J., Ibisch, P.L., Till, W. & R. Vásquez. 1999. Checklist of Bolivian Bromeliaceae with notes on species distribution and levels of endemism. *Selbyana* 20: 201-223.

Will, B., Luther, H.E., Krömer, T. & M. Kessler (submitted). Three new species and two new records of *Greigia* Regel (Bromeliaceae) from Bolivia. *Selbyana*.