

Chapter 2

The Systematics and Distributions of the Marmosets (*Callithrix*, *Callibella*, *Cebuella*, and *Mico*) and Callimico (*Callimico*) (Callitrichidae, Primates)

Anthony B. Rylands, Ademar F. Coimbra-Filho, and Russell A. Mittermeier

Abstract The New World primate family Callitrichidae includes seven genera of marmosets, tamarins, lion tamarins and callimico. They are small, arboreal, diurnal, insectivore/frugivores of the forests, chaco, and scrub of tropical Central and South America. Some 60 species and subspecies of the family Callitrichidae are now recognized, 22 of which are considered to be marmosets, the “short-tusked” genera with dental and behavioral adaptations for tree-gouging and exudate-feeding. The marmosets are divided into four taxonomic groups, which we recognize as genera: *Callithrix* (eastern Brazilian marmosets of the Jacchus-group), *Cebuella* (the Amazonian pygmy marmosets), *Callibella* (the Amazonian dwarf marmoset), and *Mico* (the Amazonian marmosets of the Argentata-group). Studies over the last decade have demonstrated that Goeldi’s monkey or callimico is a sister species to these marmosets. Here we review the most recent information concerning the taxonomy of these 23 species and what is known of their geographic distributions in the wild.

Resumen La familia de primates del Nuevo Mundo Callitrichidae incluye siete géneros de marmosetas, tamarinos, tamarinos leones y calimicos. Son primates pequeños, arbóreos, diurnos, insectívoros/frugívoros del bosque, chaco y monte de Centro y Sudamérica tropical. De las 60 especies y subespecies de la familia Callitrichidae se reconocen actualmente, 22 de las cuales son consideradas como marmosetas, el género “colmillo corto” con adaptaciones dentales y de comportamiento para excavación en árboles y alimentación de exudados. Las marmosetas son divididas en cuatro grupos taxonómicos, los cuales reconocemos como géneros: *Callithrix* (marmosetas del este de Brasil del grupo *Jacchus*), *Cebuella* (marmosetas pigmeas Amazónicas), *Callibella* (marmosetas Amazónicas enanas) y

A.B. Rylands (✉)
Center for Applied Biodiversity Science, Conservation International,
1919 M Street NW, Washington, DC, 20036, USA
e-mail: a.rylands@conservation.org

Mico (marmosetas del grupo *Argentata*). Los estudios en la última década han demostrado que los calimicos (o monos Goeldi) son una especie hermana de estas marmosetas. En el presente estudio revisamos la información más reciente concerniente a la taxonomía de estas 23 especies y lo que se conoce de sus distribuciones geográficas en estado silvestre.

Resumo A família Callitrichidae de primatas do Novo Mundo inclui sete gêneros de sagüis e micos. Eles são pequenos, arbóreos, de hábitos diurnos, frugívoros/insetívoros ocorrendo em florestas, chaco e cerrado da América Central e Sul tropical. Cerca de 60 espécies e subespécies da família Callitrichidae são reconhecidas, 22 das quais são consideradas sagüis e micos dos gêneros de “presas-baixas” com adaptações dentais e comportamentais para raspar árvores e comer exudatos. Este grupo é dividido em quatro grupos taxonômicos que nós reconhecemos como gêneros: *Callithrix* (sagüis do leste brasileiro do grupo jacchus), *Cebuella* (sagüi-leãozinho amazônico), *Callibella* (o sagüi amazônico anão) e *Mico* (o sagüis amazônicos do grupo argentata). Estudos desta última década têm demonstrado que o mico de Goeldi ou callimico é uma espécie irmã dos outros sagüis. Aqui nós revemos a informação mais recente relacionada a taxonomia destas 23 espécies e o que nós sabemos das suas distribuições geográficas na natureza.

2.1 Introduction

The marmosets, tamarins, lion tamarins, and callimico of the family Callitrichidae comprise a remarkable radiation of small, arboreal, diurnal, variously gum-feeding, insectivore (faunivore)/frugivores of the forests, chaco, and scrub of tropical Central and South America. In 1977, Hershkovitz published his groundbreaking opus reviewing and synthesizing the taxonomy and distributions and all that was known of the morphology and biology of the family. He recognized 46 species and subspecies, 12 of which were marmosets (*Cebuella* and *Callithrix*). Some 60 species and subspecies of the family Callitrichidae are now recognized, 22 of which are marmosets (Rylands et al. 2000; Groves 2001, 2005). The differences in these numbers arise from the description of new species and subspecies, the recognition of the validity of some forms discounted by Hershkovitz (1977), the elimination of a subspecies of saddleback tamarin (*Saguinus fuscicollis*) resulting from evidence that it was a hybrid (Peres et al. 1996), and the inclusion of *Callimico goeldii* (Hershkovitz listed it as a separate family, the Callimiconidae) (see Table 2.1). These 60 callitrichids represent some 30% of the extant New World primates (Rylands et al. 2000).

In the case of the marmosets, seven new forms have been described since 1977, and we recognize three forms which Hershkovitz (1977) did not – (tentatively) a subspecies of the pygmy marmoset (*Cebuella pygmaea niveiventris* Lönnberg, 1940); Wied's black-tufted-ear marmoset (*Callithrix kuhlii* Coimbra-Filho, 1985) considered by Hershkovitz (1977) to be a natural hybrid; and Snethlage's marmoset

Table 2.1 The New World marmosets and callimico

| Species | Common name |
|--|-------------------------------------|
| Family Callitrichidae | |
| Subfamily Callitrichinae | |
| <i>Callithrix</i> Erxleben, 1777 | Atlantic forest marmosets |
| <i>Callithrix jacchus</i> (Linnaeus, 1758) | Common marmoset |
| <i>Callithrix penicillata</i> (Geoffroy Saint-Hilaire, 1812) | Black-tufted-ear marmoset |
| <i>Callithrix kuhlii</i> Coimbra-Filho, 1985 | Wied's black-tufted-ear marmoset |
| <i>Callithrix geoffroyi</i> (Humboldt, 1812) | Geoffroy's tufted-ear marmoset |
| <i>Callithrix aurita</i> (Geoffroy Saint-Hilaire, 1812) | Buffy-tufted-ear marmoset |
| <i>Callithrix flaviceps</i> (Thomas, 1903) | Buffy-headed marmoset |
| <i>Callibella</i> Van Roosmalen and Van Roosmalen, 2003 | Dwarf marmoset |
| <i>Callibella humilis</i> (Van Roosmalen et al., 1998) | Black-crowned dwarf marmoset |
| <i>Cebuella</i> Gray, 1866 | Pygmy marmosets |
| <i>Cebuella pygmaea pygmaea</i> (Spix, 1823) | Western pygmy marmoset |
| <i>Cebuella pygmaea niveiventris</i> Lönnberg, 1940 | Eastern pygmy marmoset |
| <i>Mico</i> Lesson, 1840 | Amazonian marmosets |
| <i>Mico argentatus</i> (Linnaeus, 1766) | Silvery marmoset |
| <i>Mico leucippe</i> (Thomas, 1922) | Golden-white bare-ear marmoset |
| <i>Mico melanurus</i> (Geoffroy Saint-Hilaire, 1812) | Black-tailed marmoset |
| <i>Mico marcai</i> (Alperin, 1993) | Marca's marmoset |
| <i>Mico intermedius</i> (Herskovitz, 1977) | Aripuanã marmoset |
| <i>Mico emiliae</i> (Thomas, 1920) | Snethlage's marmoset |
| <i>Mico nigriceps</i> (Ferrari and Lopes, 1992) | Black-headed marmoset |
| <i>Mico</i> cf. <i>emiliae</i> [Rondônia] ^a | Rondônia marmoset |
| <i>Mico humeralifer</i> (Geoffroy Saint-Hilaire, 1812) | Black-and-white tassel-ear marmoset |
| <i>Mico chrysoleucus</i> (Wagner, 1842) | Golden-white tassel-ear marmoset |
| <i>Mico mauesi</i> (Mittermeier et al., 1992) | Maués marmoset |
| <i>Mico saterei</i> (Silva and Noronha, 1998) | Sateré marmoset |
| <i>Mico manicorensis</i> (Van Roosmalen et al., 2000) | Manicoré marmoset |
| <i>Mico acariensis</i> (Van Roosmalen et al., 2000) | Rio Acari marmoset |
| <i>Callimico</i> Miranda Ribeiro, 1912 | Goeldi's monkey |
| <i>Callimico goeldii</i> (Thomas, 1904) | Goeldi's monkey |

^aNot yet formally described

(*Mico emiliae* [Thomas, 1920]), considered by Herskovitz (1977) to be merely a dark form of the silvery marmoset, *Callithrix argentata argentata* (Linnaeus, 1766) (now in *Mico*).

The predominant classification for the platyrrhines in the twentieth century was based on their separation into two families, the Callitrichidae (*Cebuella*, *Callithrix*, *Saguinus* and *Leontopithecus*) and Cebidae (the remaining genera), with *Callimico* being placed in either of the two, or in its own family (Dollman 1933; Hill 1957; Herskovitz 1977). This system was maintained in all of the major syntheses published till the 1980s (e.g., Simpson 1945; Hill 1957, 1960, 1962; Cabrera 1957; Napier and Napier 1967; Herskovitz 1977). It was the

morphological studies of Rosenberger (1981, 1984; see also Rosenberger et al. 1990) that initiated a major change in thinking regarding the higher taxonomy of this group. His thesis involved placing the marmosets, tamarins and callimico in a subfamily (Callitrichinae), in a redefined Cebidae, which otherwise included squirrel monkeys (*Saimiri*) and capuchin monkeys (*Cebus*), the two comprising the Cebinae. This arrangement and the slight variations of it were subsequently amply reinforced and justified by a spate of genetic studies (e.g., Schneider et al. 1993, 1996; Harada et al. 1995; Nagamachi et al. 1996, 1999; Schneider and Rosenberger 1996). All established platyrrhine classifications today accept the affinity of *Cebus*, *Saimiri* and the marmosets, tamarins and callimico. Some place them in separate families (Rylands et al. 2000) and others, as subfamilies of the Cebidae (Groves 1993, 2001, 2005).

Hershkovitz (1977) recognized just two genera of marmosets – one species of pygmy marmoset (*Cebuella pygmaea*) and three species of what he called “true marmosets” – *Callithrix argentata*, with three subspecies; *C. humeralifer*, also with three subspecies forming the “Argentata-group” in the Amazon; and *C. jacchus*, with five subspecies forming the “Jacchus-group” in central and eastern Brazil, and the Brazilian Atlantic forest. However, the pygmy marmoset’s diminutive size led him to believe that “the ancestral form of *Cebuella* must have stemmed from near the very base of the ancestral callitrichid stock” (p 450), indicating that it was no more closely related to the “true marmosets” than it was to the tamarins (*Saguinus*) and lion tamarins (*Leontopithecus*). He believed, as such, that it was a “false marmoset.” Considerable discussion in the 1970s and 1980s concluded, however, that small size in callitrichids is derived rather than primitive (Leutenegger 1973, 1980; Ford 1980; Rosenberger 1981, 1984), and morphological affinities (especially in the dental adaptation for tree-gouging and gum-feeding) and numerous genetic studies have placed *Cebuella* as a close sister species to the Amazonian marmosets, even to the extent of questioning its status as a separate genus (Rosenberger 1984; Rosenberger and Coimbra-Filho 1984; Natori 1986, 1994; Natori and Shigehara 1992; Barroso 1995; Moreira et al. 1996; Schneider and Rosenberger 1996; Schneider et al. 1996; Barroso et al. 1997; Tagliaro et al. 1997, 2001; Porter et al. 1997; Canavez et al. 1999a). As such, Rosenberger (1984) proposed a single genus (*Callithrix*) with subgenera for *Cebuella*, the Amazonian *Callithrix* (Argentata-group), and the eastern Brazilian *Callithrix* (Jacchus-group). This was not upheld, however, in the classification presented in Rosenberger et al. (1990). Groves (2001) followed the recommendation of Rosenberger (1984) in grouping all the marmosets in the genus *Callithrix*, with the following subgenera: *Cebuella* for the pygmy marmosets, *Mico* for the Amazonian marmosets (Argentata-group), and *Callithrix* for the eastern Brazilian marmosets (Jacchus-group) (Table 2.2).

Groves’ (2005) most recent listing separated out the dwarf marmoset as the subgenus *Calibella* [*sic*]. Intermediate in size between the pygmy marmoset and the “true marmosets,” it was first described by van Roosmalen et al. (1998) in the genus *Callithrix*. Further research provided evidence, however, for its classification in a distinct genus, *Calibella* van Roosmalen and van Roosmalen, 2003.

Table 2.2 A comparison of recent taxonomies of the marmosets and callimico according to Hershkovitz (1977), Groves (1993, 2001, 2005), Mittermeier et al. (1988), Rylands et al. (1993), Rylands et al. (2001) and Rylands (this paper)

| Hershkovitz (1977) | Mittermeier et al. (1988), Rylands et al. (1993) | Groves (1993, 2001, 2005) | Rylands et al. (2000), this paper |
|---|--|---|---|
| Family Callitrichidae | Family Callitrichidae | Family Cebidae | Family Callitrichidae |
| Atlantic forest marmosets – Jacchus-group | Atlantic forest marmosets – Jacchus-group | Subfamily Callitrichinae ^a | Subfamily Callitrichinae |
| <i>Callithrix jacchus jacchus</i> | <i>Callithrix jacchus</i> | Subgenus <i>Callithrix</i> – Atlantic marmosets | Atlantic forest marmosets – Jacchus-group |
| <i>Callithrix jacchus penicillata</i> | <i>Callithrix penicillata</i> | <i>Callithrix jacchus</i> | <i>Callithrix jacchus</i> |
| | <i>Callithrix kuhlii</i> ^b | <i>Callithrix penicillata</i> | <i>Callithrix penicillata</i> |
| <i>Callithrix jacchus geoffroyi</i> | <i>Callithrix geoffroyi</i> | <i>Callithrix kuhlii</i> ^b | <i>Callithrix kuhlii</i> ^b |
| <i>Callithrix jacchus aurita</i> | <i>Callithrix aurita</i> | <i>Callithrix geoffroyi</i> | <i>Callithrix geoffroyi</i> |
| <i>Callithrix jacchus flaviceps</i> | <i>Callithrix flaviceps</i> | <i>Callithrix aurita</i> | <i>Callithrix aurita</i> |
| | | <i>Callithrix flaviceps</i> | <i>Callithrix flaviceps</i> |
| | | Subgenus <i>Calibella</i> – Dwarf marmoset | Dwarf marmoset |
| Pygmy marmoset | Pygmy marmoset | <i>Callithrix humilis</i> ^c | <i>Calibella humilis</i> ^c |
| | | Subgenus <i>Cebuella</i> – pygmy marmosets | Pygmy marmosets |
| <i>Cebuella pygmaea</i> | <i>Cebuella pygmaea</i> | <i>Callithrix pygmaea pygmaea</i> | <i>Cebuella pygmaea pygmaea</i> |
| | | <i>Callithrix pygmaea niveiventris</i> | <i>Cebuella pygmaea niveiventris</i> |
| Amazonian marmosets – Argentata-group | Amazonian marmosets – Argentata-group | Subgenus <i>Mico</i> – Amazonian marmosets | Amazonian marmosets – Argentata-group |
| <i>Callithrix argentata argentata</i> | <i>Callithrix argentata argentata</i> | <i>Callithrix argentata</i> | <i>Mico argentatus</i> |
| <i>Callithrix argentata leucippe</i> | <i>Callithrix argentata leucippe</i> | <i>Callithrix leucippe</i> | <i>Mico leucippe</i> |
| <i>Callithrix argentata melanura</i> | <i>Callithrix argentata melanura</i> | <i>Callithrix melanura</i> | <i>Mico melanurus</i> |
| <i>Callithrix humeralifer intermedius</i> | <i>Callithrix humeralifer intermedius</i> | <i>Callithrix intermedia</i> | <i>Mico intermedius</i> |
| | <i>Callithrix emiliae</i> | <i>Callithrix emiliae</i> | <i>Mico emiliae</i> |
| | <i>Callithrix nigriceps</i> | <i>Callithrix nigriceps</i> | <i>Mico nigriceps</i> |
| | | <i>Callithrix marcai</i> | <i>Mico marcai</i> |

(continued)

Table 2.2 (continued)

| Hershkovitz (1977) | | Mittermeier et al. (1988), Rylands et al. (1993) | Groves (1993, 2001, 2005) | Rylands et al. (2000), this paper |
|---|---|--|--------------------------------|--------------------------------------|
| <i>Callithrix humeralifer humeralifer</i> | <i>Callithrix humeralifer humeralifer</i> | <i>Callithrix humeralifer humeralifer</i> | <i>Callithrix humeralifera</i> | <i>Mico humeralifer</i> |
| <i>Callithrix humeralifer chrysoleuca</i> | <i>Callithrix humeralifer chrysoleuca</i> | <i>Callithrix humeralifer chrysoleuca</i> | <i>Callithrix chrysoleuca</i> | <i>Mico chrysoleucus</i> |
| | | | <i>Callithrix mauesi</i> | <i>Mico mauesi</i> |
| | | | <i>Callithrix saterei</i> | <i>Mico saterei</i> |
| | | | <i>Callithrix manicorensis</i> | <i>Mico manicorensis</i> |
| | | | <i>Callithrix acariensis</i> | <i>Mico acariensis</i> |
| | | | | <i>Mico cf. emiliae</i> ^d |
| Family Callimiconidae | | | | |
| <i>Callimico goeldii</i> | <i>Callimico goeldii</i> | <i>Callimico goeldii</i> | <i>Callimico goeldii</i> | <i>Callimico goeldii</i> |

^aGroves (2001) used the name Hapalinae Gray, 1821. Groves (2005) reverted to Callitrichinae (see Brandon-Jones and Groves 2002)

^bArgued by Hershkovitz (1977) to be a hybrid of the forms *penicillata* and *geoffroyi*

^cListed in the genus *Callithrix* by Rylands et al. (2000) and Groves (2001). Groves (2001) listed it in the subgenus *Mico*, whereas Groves (2005) placed it in the subgenus *Calibella* [sic]. The genus *Callibella* was described by Van Roosmalen and Van Roosmalen (2003)

^dThis form was described as *C. emiliae* by de Vivo (1985). See text on *Mico melanurus* and Rylands et al. (1993)

Aguiar and Lacher (2003, see also Chapt. 18 this volume) found it to be distinct from all other marmoset and tamarin taxa in its cranial and mandibular morphology. In their genetic analysis, van Roosmalen and van Roosmalen (2003) found that the marmosets were clearly separated into Amazonian (*Callibella*, *Cebuella* and *Mico*) and eastern Brazilian (*Callithrix*) clades. *Callibella* was basal in the Amazonian marmoset clade, with *Cebuella* branching off subsequently, followed by the radiation of “true marmosets” of the Argentata-group.

Both morphological and genetic studies have suggested that the pygmy marmoset is more closely related to the Amazonian marmosets than the Amazonian marmosets are to the Atlantic forest marmosets (Tagliaro et al. 1997, 2001; Chaves et al. 1999; Ford and Davis Chapt. 21 this volume; but see Marroig and Cheverud Chapt. 17 this volume). The same, it seems, is true for the dwarf marmoset (van Roosmalen and van Roosmalen 2003; Aguiar and Lacher 2003, Chapt. 18 this volume; Ford and Davis Chapt. 21 this volume). For this reason, to avoid paraphyly, neither *Cebuella* nor *Callibella* should be recognized as distinct genera, unless *Mico* (for the Amazonian Argentata-group marmosets) is as well (Groves 2004). Rylands et al. (2000) were of the opinion that *Cebuella pygmaea* should be distinguished as a distinct genus and for this reason raised all the subgenera of Groves (2001, 2005) to full genera (Table 2.1).

Napier and Napier (1967) placed *Callimico* firmly in the Callitrichidae and, although Hershkovitz (1977) gave it its own family (Callimiconidae), there is now ample evidence that *Callimico* and the marmosets, tamarins and lion tamarins form a monophyletic group. Rosenberger (1981) placed *Callimico* in its own tribe, the Callimiconini, in the Callitrichinae. It was thought to be basal to the callitrichids (for reviews see Ford and Davis 1992; Martin 1992; Pastorini et al. 1998), the evidence coming from morphological and physiological data, even though immunological (Cronin and Sarich 1978) and genetic evidence (Seuáñez et al. 1989) had hinted that it was, in fact, a sister group to *Callithrix*. Rosenberger (1984) and Martin (1992) considered this unlikely, largely due to the unique system of twinning. Rosenberger (1984) wrote that a *Callimico*-*Callithrix* sister-grouping “requires the diphyly of the callitrichins, the parallel evolution of dizygotic twinning, third molar loss, and hypocone reduction in *Callithrix*, or a less likely series of reversals in the genus *Callimico*,” and he concluded that “neither scenario seems possible” (p 173). Subsequent genetic evidence, however, has repeatedly confirmed the findings of Cronin and Sarich (1978) and Seuáñez et al. (1989). Pastorini et al. (1998), Chaves et al. (1999), Canavez et al. (1999a, b) and Neusser et al. (2001) all demonstrated that *Callithrix* (sensu Groves 2005) and *Callimico* were more closely related to each other than *Saguinus* or *Leontopithecus* are to *Callithrix* (for review see Pastorini et al. 1998, and Cortés-Ortiz Chapt. 1 this volume). Schneider and Rosenberger (1996) placed *Callimico* in the Tribe Callitrichini with the other callitrichin genera. Note that placing *Callimico* in a separate subfamily is not valid due to the sister grouping of *Callimico* and *Callithrix* (unless *Saguinus* and *Leontopithecus* are also separated out at the subfamily level; see Groves 2004).

2.2 Distributions and Some Notes on the Taxonomy of the Species

Here, we provide brief accounts of the distributions and some taxonomic notes for callimico and each of the marmosets listed in Table 2.1. The distributions are mapped in Figs. 2.1–2.5.

2.2.1 Genus *Callithrix* Erxleben, 1777

2.2.1.1 *Callithrix jacchus* (Linnaeus, 1758) Common Marmoset

Type locality: America, restricted to Pernambuco, Brazil, by Thomas (1911) (Hershkovitz 1977).

The common marmoset occurs in the scrub forest (forest patches in dry caatinga thorn scrub) and the Atlantic forest to the north-east of Brazil, in the states of Alagoas, Pernambuco, Paraíba, Rio Grande do Norte, Ceará, Piauí, Maranhão,

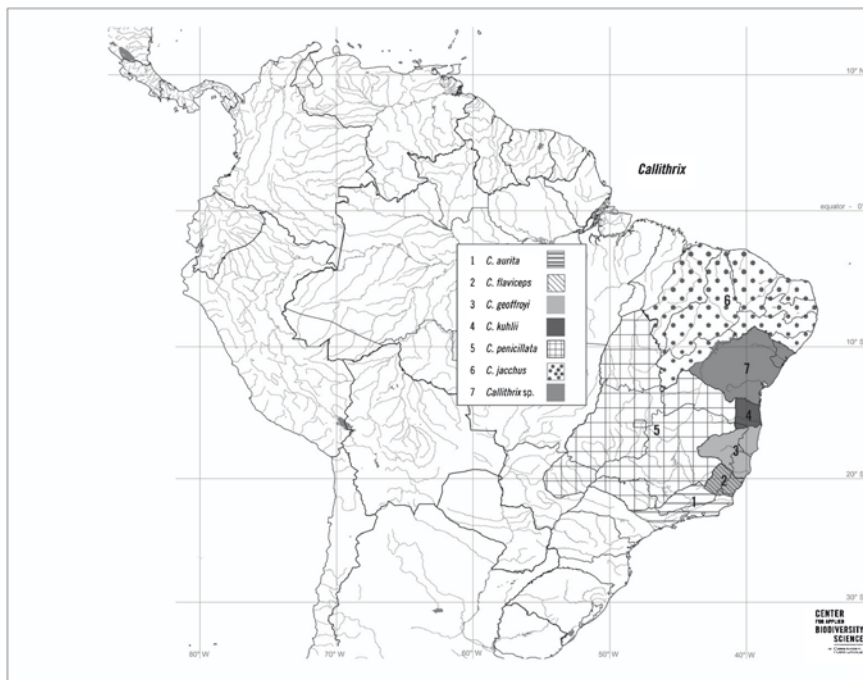


Fig. 2.1 The distributions of the Jacchus-group marmosets: *Callithrix jacchus*, *C. penicillata*, *C. kuhlii*, *C. geoffroyi*, *C. aurita*, and *C. flaveiceps*

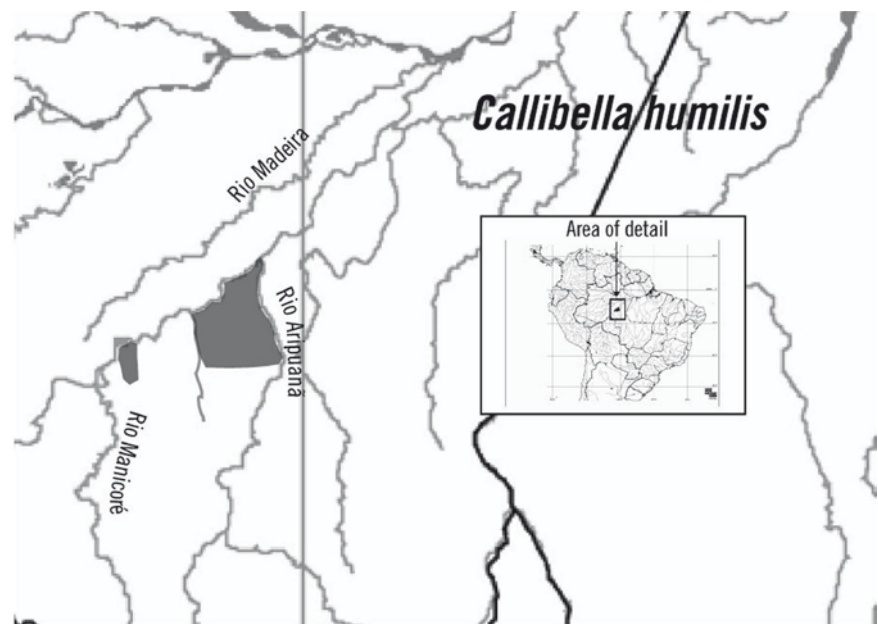


Fig. 2.2 The distribution of the dwarf marmoset, *Callibella humilis*



Fig. 2.3 The distributions of the pygmy marmosets: *Cebuella pygmaea pygmaea* and *C. p. niveiventris*

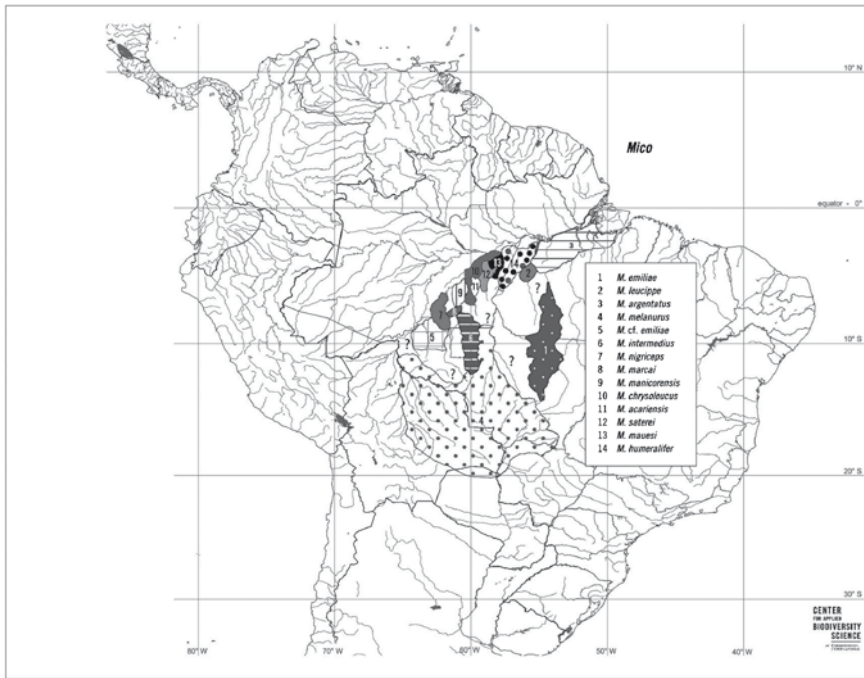


Fig. 2.4 The distributions of the Argentata-group marmosets: *Mico argentatus*, *M. leucippe*, *M. melanurus*, *M. intermedius*, *M. emiliae*, *M. nigriceps*, *M. marcai*, *M. humeralifer*, *M. chrysolaucus*, *M. mauesi*, *M. saterei*, *M. manicorensis*, *M. acariensis* and *M. cf. emiliae*

Bahia, and possibly northeastern Tocantins, originally extending south as far as the Rio São Francisco and its west (left) bank tributary, the Rio Grande (about 11°30'S). Hershkovitz (1977) indicated that it also probably extends north-west into the state of Maranhão, to the left bank of the Rio Parnaíba and the Serra do Valentim (Hershkovitz, 1977). Hershkovitz (1977) extended the distribution no further west than the middle reaches of the Rio Grande (left bank) and the upper Rio Parnaíba (right bank), with a lacuna between these points and the Rio Tocantins. Silva (1999) reported on localities in Maranhão and Piauí marking the northwestern limit to its range, and determined that, as Hershkovitz (1977) had indicated, it extends to the left bank of the Rio Parnaíba, probably as far as the interfluvium of the Rios Itapecurú and Mearim, south of the city of São Luis. The black-handed tamarin, *Saguinus niger*, occurs to the west. Fleisher (2001) recorded *C. jacchus* in the Serra das Mangabeiras at the headwaters of the Rio Parnaíba in Piauí, approximately 10°S, 46°W. South of the Serra das Mangabeiras it is possible that the Serra Geral de Goiás marks the divide with *Callithrix penicillata* (the black-tufted-ear marmoset) to the west.

It has spread into numerous other regions as a result of introductions outside of its original range, south of the Rio São Francisco, accompanying the destruction and degradation of the Atlantic coastal forest and its associated ecosystems (Coimbra-Filho and Câmara 1996). Introduced and recent populations include



Fig. 2.5 The distribution of callimico, *Callimico goeldii*

those in the state of Sergipe and the north and north-east of Bahia, including the “Recôncavo da Bahia” (Alonso et al. 1987), the state of Rio de Janeiro in south-east Brazil (Coimbra-Filho 1984; Ruiz-Miranda et al. 2000), and the Ilha de Santa Catarina in southern Brazil (Santos et al. 2005). They have also established themselves in Buenos Aires. Alonso et al. (1987) indicated that the Recôncavo da Bahia shows a relatively narrow zone of mixing between *C. penicillata* and *C. jacchus*. Coimbra-Filho et al. (1991/1992) and Coimbra-Filho and Câmara (1996), however, have shown that this region was originally forested, and argue that the destruction of the natural vegetation over vast areas since the European discovery of Brazil in 1500, along with frequent and repeated introductions, certainly of *C. jacchus* but probably also of *C. penicillata*, has resulted in a confused picture of hybrids between these species and between *C. penicillata* and Wied’s black-tufted-ear marmoset, *C. kuhlii* (see Coimbra-Filho et al. 1993). They argue that pure *C. kuhlii* was the original form occurring there.

2.2.1.2 *Callithrix penicillata* (Geoffroy Saint-Hilaire, 1812) Black-Tufted-Ear Marmoset

Type locality: Brazil, restricted to Lamarão, Bahia. Restriction of type locality attributed to Thomas (1904) by de Ávila-Pires (1969) and to Thomas (1911) by Groves (2001). The exact locality of “Lamarão, near Bahia” is a little confused

(the city of Salvador was called Bahia in the past). In the distribution map of Hershkovitz (1968, p 567), Lamarão is placed in the north-central region of the state of Bahia on the uppermost reaches of the Rio Itapicurú (locality 292 in Hershkovitz [1968, p 567], and was listed as locality 292d, “Lamarão, upper Rio Itapicurú, 10°46’S, 40°21’W, 490 meters, *Callithrix penicillata penicillata*, A. Robert, May–June, 1903, at 300 meters” by Hershkovitz [1975, p 168, 1977, p 937]). Napier (1976, p 8) gave the coordinates for the type locality as “10°45’S, 40°20’W, 300 meters,” probably read from the map of Hershkovitz (1968). Kinzey (1982) gives the same coordinates as those of Hershkovitz (1977), which place this locality about 320 km north-west as the crow flies from what was Bahia, today the city of Salvador, capital of the state of Bahia. De Vivo (1991) made no reference to the location of Lamarão. We have been unable to identify, however, any reference to a “Lamarão” on the upper Rio Itapicurú (e.g., Brazil IBGE 1972). A town called Lamarão, however, does exist on the railway-line midway between the towns of Água Fria (south) and Serrinha (north), 11°45’S, 38°53’W, north-west of Salvador, about 140 km as the crow flies (Vanzolini and Papavero 1968; Brazil IBGE 1972). Paynter and Traylor (1991) also give this as the locality that Alphonse Robert visited in 1903: “Lamarão, Bahia, 291 m, on railroad 140 km NW of Salvador, eastern Bahia.” An atlas in the British Museum (*Stieler’s Hand-Atlas*, Gotha: Justus Perthes 1905) was used by Oldfield Thomas, and it contains numerous annotations in his own hand. He underlined the town of Lamarão, indicating the probability that this is the correct locality where Alphonse Robert collected the series of *C. penicillata* that he studied and that comprise the type series for the species.

C. penicillata has a very wide distribution, occurring in the cerrado region of east central Brazil, in the states of Bahia, Minas Gerais, Goiás, the south-west tip of Piauí, Maranhão and the north of São Paulo, north of the Rios Tieté and Piracicaba (Hershkovitz 1977). In the north, it would seem that it is restricted to the south of the Rio Grande and Rio São Francisco (*C. jacchus* occurring to the north of the Rio Grande), although de Vivo (1991) identified two skins in the Museu Nacional, Rio de Janeiro, from the north-east coast of Maranhão, at Miritiba (now called Humberto dos Campos), which, he indicated, extends its range right through eastern Maranhão, along the left bank of the Rio Parnaíba. The large gap (some 850 km) between the next northernmost locality to the south (Canabrava, Rio Tocantins, Goiás, locality 275a of Hershkovitz 1977, p 490) and this northern Maranhão locality indicates that they were probably introduced animals. They were not located by Hershkovitz (1977) and were presumed by him to be *C. jacchus*, following de Ávila-Pires (1969). Silva (1999) carried out surveys in Maranhão and Piauí and did not report the occurrence of *C. penicillata*, only *C. jacchus*. The western limits of its range would seem to be marked by the Rio Araguaia, south from around 8°S in the region of the Serra das Cordilheiras, extending into the northeast of the state of Mato Grosso Sul, east of the Serra de Maracaju to the level of the Rios Pardo or Taquaraçu, the west (right) bank tributaries of the Rio Paraná.

Surveys in the north of the state of Minas Gerais have shown that *C. penicillata* extends its range through the region between the upper Rio São Francisco and the

Rio Jequitinhonha, along the western slopes of the Serra do Espinhaço. *C. penicillata* occurs on both sides of the Rio Jequitinhonha as far east as the Rio Araçuaí, a south (right) bank tributary of the upper Jequitinhonha, beyond which it is restricted to the north of the river, with *Callithrix geoffroyi* (Geoffroy's marmoset) occurring to the south (Rylands et al. 1988), the result of a recent introduction (around 1975) in the vicinity of Belmonte (Coimbra-Filho, unpubl. data). *C. penicillata* is typically of the cerrado region of Minas Gerais (in the central, south-west, west, and north of the state). Those parts originally covered by the Atlantic coastal forest in the east and south-east (the Zona da Mata) are the domain of *C. geoffroyi*, *C. flaviceps* (the buffy-headed marmoset), and *C. aurita* (the buffy-tufted-ear marmoset) that occurs in part of the Rio Doce valley. However, with the destruction of the forest, and also resulting from introductions (misguided release of confiscated animals), *C. penicillata* is taking a hold, and probably replacing, other species in numerous localities east and south of its original range (see, e.g., Olmos and Martuscelli 1995). This is happening in the Rio Doce State Park, and is possibly also the case of *C. penicillata* reported by de Vivo (1991; see also Coimbra-Filho, 1984) from the Itatiaia National Park straddling the border of the states of Rio de Janeiro and Minas Gerais. In both cases *C. aurita* is the species naturally occurring in the area.

2.2.1.3 *Callithrix kuhlii* Coimbra-Filho, 1985 Wied's Black-Tufted-Ear Marmoset

Type locality. Near the mouth of Rio Belmonte (= Rio Jequitinhonha) Bahia, Brazil (Hershkovitz 1977).

De Vivo (1991) argued that individual and clinal variation in pelage color of *C. penicillata* invalidated any separation of these coastal forest marmosets of southern Bahia. Hershkovitz (1977) argued that it is a hybrid of *C. penicillata* and *C. geoffroyi*. However, these marmosets are distinct from *C. penicillata* in their pelage color in both infants and adults (Coimbra-Filho 1985), and experimental hybrids reared at the Rio de Janeiro Primate Centre (CPRJ) failed to produce any forms similar to *C. kuhlii* (Coimbra-Filho 1984; Coimbra-Filho et al. 1993). Hybrid *geoffroyi* × *penicillata* in the wild, notably along the Rio Piracicaba, southeastern Minas Gerais, vary in their mix of characters and do not approximate to *C. kuhlii* (Passamani et al. 1997). The *kuhlii* phenotype does not show the intermediate characters of a *C. geoffroyi* × *C. penicillata* hybrid (it is closer in appearance to the former species than the latter) and is constant throughout its known range, where it has been observed. Natori (1990) studied the dental morphology (postcanine) of *C. kuhlii*, *C. penicillata*, and *C. geoffroyi* and, on these grounds, also argued that *C. kuhlii* is not a hybrid but a distinct species. *Callithrix kuhlii* is also quite distinct from other Jacchus-group marmosets in cranial morphology (Marroig et al. 2004) and vocalizations (Mendes 1997b, Mendes et al. Chapt. 3 this volume).

Callithrix kuhlii occurs between the Rio de Contas and Rio Jequitinhonha in southern Bahia, just entering the northeasternmost tip of the state of Minas Gerais

(Santos et al. 1987; Rylands et al. 1988). The western boundary is not well known, but is undoubtedly defined by the inland limits of the Atlantic coastal forest. I. B. Santos (in Rylands et al. 1988) observed hybrids of *C. penicillata* and *C. kuhlii* in the region of Almenara, Minas Gerais, the left bank of the Rio Jequitinhonha (16°41'S, 40°51'W).

Surveys in 1986/1987 by Oliver and Santos (1991) demonstrated the presence of forms intermediate in appearance between *C. kuhlii* and *C. penicillata* north from the Rio de Contas, along the coast up to the regions of Valença and Nazaré, just south of the city of Salvador (Mittermeier et al. 1988). Individuals observed by Rylands near Nazaré, just south of the city of Salvador, lacked the white frontal blaze, and, although retaining the pale cheek patches typical of *kuhlii*, were paler grey. A photograph of the marmoset from Valença, Bahia, north of the Rio de Contas, is provided in Mittermeier et al. (1988, p 19). The variation in pelage coloration of the marmosets in this region is considerable, but Coimbra-Filho et al. (1991/1992) showed that true *C. kuhlii* extended north through coastal Bahia into the state of Sergipe as far as the Rio São Francisco, in the recent past. The present-day confusion has arisen from the widespread forest destruction, most marked and nearly total in Sergipe, and the introductions and invasions of *C. jacchus* and *C. penicillata*.

2.2.1.4 *Callithrix geoffroyi* (Humboldt, 1812) Geoffroy's Marmoset

Type locality: Brazil, restricted to near Victoria, “between the Rios Espírito Santo and Jucú” by Cabrera (1957), who attributes the restriction of the type locality to Wied-Neuwied (1826). Hershkovitz (1977) notes that the names of these rivers are synonyms.

Geoffroy's marmoset occurs in the state of Espírito Santo and the forested eastern and northeastern part of Minas Gerais, in the north as far as the Rios Jequitinhonha and Araçuaí and in the south to near the state border of Espírito Santo and Rio de Janeiro (de Ávila-Pires 1969; Hershkovitz 1977; Coimbra-Filho 1984; Rylands et al. 1988). The populations just south of the Rio Jequitinhonha resulted from animals released near its mouth, at Belmonte, around 1975 (Coimbra-Filho 1986c). From there it spread eastward, and today it occurs in the gallery forests throughout the region of dry thorn scrub (*caatinga*) of the middle reaches of the river (Rylands et al. 1988). De Vivo (1991) limits it to the east of the Serra do Espinhaço in Minas Gerais. It has been recorded from the eastern slopes of Serra do Cipó, a southerly section of the Serra do Espinhaço range, at an altitude of 1274 m (Oliveira et al. 2003). Hybrid populations of *C. penicillata* and *C. geoffroyi* have been observed in some parts of the Serra da Piedade along the Rio Piracicaba, affluent of the upper Rio Doce, where the Atlantic coastal forest gives way to the cerrado (Coimbra-Filho et al. 1993; Passamani et al. 1997). The range of *C. geoffroyi* overlaps with *C. flaviceps* (see below) in southern Espírito Santo (south of the Rio Doce) and south-east Minas Gerais. *C. geoffroyi*, however, is generally restricted to lowland areas, below 500–700 m, and *C. flaviceps* to altitudes above

400–500 m (Coimbra-Filho 1971; Coimbra-Filho et al. 1981). Hershkovitz (1977) asserted that the highest recorded locality for *C. geoffroyi* is Santa Teresa, 659 m above sea level, but Mendes (1993, 1997a) has observed mixed bands of *C. geoffroyi* and *C. flaviceps* at altitudes of 800 m. Hybrid populations have been recorded for intermediate elevations (Mendes 1993, 1997a).

2.2.1.5 *Callithrix aurita* (Geoffroy Saint-Hilaire, 1812) Buffy-Tufted-Ear Marmoset

Type locality: Brazil, restricted to the vicinity of Rio de Janeiro, Guanabara, by Vieira (1944) (Hershkovitz 1977).

Coimbra-Filho (1986a, 1986b, 1990, 1991; Coimbra-Filho et al. 1993) has argued that *C. aurita* and *C. flaviceps* are so closely related that they should be considered subspecies. Close similarities exist in their dental morphology (Natori 1986), behavior, pelage (infants of the two forms are practically identical in appearance), and vocalizations (Mendes 1997b, c, Mendes et al. Chapt. 3 this volume). Evidently, hybrid *C. aurita* and *C. flaviceps* can be found in Carangola, Minas Gerais (Ferrari and Mendes 1991; Coimbra-Filho et al. 1993). Ferrari et al. (1996b) studied and reviewed the ecology and behavior of *C. aurita* and *C. flaviceps* groups and concluded that, although they are undoubtedly very similar, the “comparison appears to have done more to re-emphasize the enormous flexibility underlying the behavioral ecology of the marmosets as a whole than clarify the relationships between these two taxa in particular” (p 167).

Callithrix aurita occurs in the montane rain forests of south-east Brazil, in the southern part of the state of Minas Gerais, the state of Rio de Janeiro, and the east and north-east of the state of São Paulo (see Coimbra-Filho 1986b; Olmos and Martuscelli 1995; Brandão and Develey 1998; Ferrari et al. 1996b). Hershkovitz (1977) marks the northern limit in Minas Gerais as the Rio Muriaé, but it also occurs to the north in the Rio Doce State Park in Minas Gerais (Mittermeier et al. 1982), and hybrids (with *C. flaviceps*) have been recorded at Carangola in the Serra do Brigadeiro, Minas Gerais (Ferrari and Mendes 1991; Cosenza and de Melo 1998). Hershkovitz (1977) indicated the southeasternmost locality to be the Rio Ribeira de Iguapé in São Paulo. Olmos and Martuscelli (1995), however, failed to find evidence for this. They reported that extensive fieldwork (1982–1995) in such localities as the Fazenda Intervalles State Park, Alto Ribeira State Park, Ilha do Cardoso and Carlos Botelho, and the Jureia Ecological Station and the municipalities of Juquitiba and Miracatú in the Serra da Paranapicaba, consistently failed to find *C. aurita*. They proposed the southern limit to be near the city of São Paulo, north of the junction of the Rios Pinheiros and Tietê. The Rio Tietê forms the southernmost boundary, and the most southerly record is close to Ipanema (23°26'S, 47°36'W), today Araçoiaba da Serra (the type locality for *Leontopithecus chrysopygus*). From there it extends west between the upper reaches of the Rios Tietê/Piracicaba. Again the exact limits are unclear, but believed by Olmos and Martuscelli (1995) to be the junction of these two rivers.

Brandão and Develey (1998) carried out surveys to understand better the range of *C. aurita*. Although generally believed to be largely montane in its range (600–1200 m according to Olmos and Martuscelli [1995] and 500–800 m according to Rylands [1994]), museum specimens have been collected in the foothills of the Serra do Mar, south of Rio de Janeiro: Pedra Blanca, municipality of Parati at 80 m, and Mambucaba, municipality of Angra dos Reis at 100 m (Brandão and Develey 1998). Coimbra-Filho (1991) and Mendes (1993) also indicated that it occurred elsewhere in lowland Rio de Janeiro, including the north-east, but is, probably, extinct there today. All recent records are montane. Brandão and Develey (1998) carried out extensive surveys of the lowland coastal forests of São Paulo and Rio de Janeiro and were unable to obtain evidence of the species' existence anywhere except at Mambucaba, where they found one in captivity and observed a group at 165 m.

This marmoset has been recorded north of the Rio Paraíba do Sul at the following sites: Mogi-Guaçu (Rio Mogi-Guaçu) by R. A. Mittermeier (unpubl.) and Muskin (1984); Alfenas, upper Rio Grande, in Minas Gerais (Hershkovitz 1977; Muskin 1984); Vargem Grande, São Paulo (Muskin 1984); Fazenda Monte Alegre, Monte Belo, Minas Gerais (Muskin 1984) and in the vicinity of Viçosa, Minas Gerais (Mendes 1993); Serra do Capanema, Rio de Janeiro (21°03'S, 42°03'W) (Mendes 1993); Fazenda João Abdo, Rio de Janeiro (21°27'S, 41°56'W) (Mendes 1993). The westernmost locality shown by Hershkovitz (1977, p 490) is Boracéia, north-east of Bauru, on the upper Rio Tieté (22°10'S, 48°45'W), but Olmos and Martuscelli (1995) found this to be an outlier and suggested that the locality really refers to the Boracéia Biological Station near the headwaters of the Rio Tietê.

2.2.1.6 *Callithrix flaviceps* (Thomas, 1903) Buffy-Headed Marmoset

Type locality: Engenheiro Reeve (now Rive), municipality of Alegre, southwestern Espírito Santo, eastern Brazil, altitude 500 m (Hershkovitz 1977).

As discussed in the case of *C. aurita*, Coimbra-Filho (1986a, 1986b, 1990) has argued that *C. flaviceps* could well be considered a subspecies of *C. aurita*. The distribution of *C. flaviceps* is described by Hershkovitz (1977), Coimbra-Filho et al. (1981), and Coimbra-Filho (1986a). It occurs in the Serra da Mantiqueira in southern Espírito Santo, south of the Rio Doce at least to the state boundary with Rio de Janeiro (and, in the past, possibly in the north of the state of Rio de Janeiro, in the municipalities of Natividade, Porciuncula and the north of Bom Jesus do Itabapoãna when they were forested). It extends west into eastern Minas Gerais in scattered localities in the highly fragmented forests of the Rio Manhuaçu basin as far as Manhuaçu (40°02'W), as noted by Coimbra-Filho (1986a) and Coimbra-Filho et al. (1981). Ferrari and Mendes (1991) and Mendes (1993) reviewed the distribution of *C. flaviceps*. Hirsch (2003; Hirsch et al. in prep.) obtained records in Minas Gerais which have extended its known range somewhat to the north and west, toward the east (right bank) of the Rio Doce (Fazenda Saet [19°43'S, 42°26'W] and the Fazenda do Eraldo A. Alves [19°45'S, 42°25'W], both at an

altitude of 270 m, and about 10 km from the east bank of the Rio Doce, in the municipality of Pingo d'Água). Hirsch (2003) also refers to two localities which would extend the range a little further south in Minas Gerais, but they have still to be confirmed and may be hybrids with *C. aurita* (the left bank of the Rio Matipó, municipality of Abre Campo, and the Córrego Jurumirim, the left bank of the Rio Casca, municipality of Rio Casca).

2.2.2 Genus *Callibella* Van Roosmalen and Van Roosmalen, 2003

2.2.2.1 *Callibella humilis* (Van Roosmalen et al., 1998) Dwarf marmoset

Type locality: West bank of the lower Rio Aripuanã, one kilometer south of the settlement of Nova Olinda, 41 km southwest of the town of Novo Aripuanã, Amazonas state, Brazil. The region is located in south-central Amazonia, Brazil, south of the Rio Amazonas, and east of the Rio Madeira. Coordinates 05°30'63"S, 60°24'61"W. Altitude 45 m (van Roosmalen et al. 1998).

According to van Roosmalen et al. (1998) and van Roosmalen and van Roosmalen (2003), the dwarf marmoset has a very restricted range along the west bank of the Rio Aripuanã, from its mouth, just southwest of the town of Novo Aripuanã, south at least to the village of Tucunaré, and west, along the right bank of the Rio Madeira to the mouth of the Rio Maturá, and the right bank of the Rio Uruá. They speculated that the southern limit is probably marked by the headwaters of the Rios Mariépauá and Arauá. An isolated population was also found along the middle of Rio Atininga, about 50 km southwest of the presumed southern limit of the main population, about 10 km east of the Rio Manicoré. The range of *Callibella humilis* is entirely within that hypothesized for *Mico manicorensis* (the Manicoré marmoset).

2.2.3 Genus *Cebuella* Gray, 1866

2.2.3.1 *Cebuella pygmaea pygmaea* (Spix, 1823) Western Pygmy Marmoset

Type locality: Tabatinga, Rio Solimões, Amazonas, Brazil (Napier 1976; Hershkovitz 1977).

Although da Cruz Lima (1945) and Napier (1976) recognized the two subspecies of pygmy marmoset listed here, Hershkovitz (1977) did not, and they were generally ignored until van Roosmalen and van Roosmalen (1997) argued for their validity. The difference is mainly in the color of the underparts. Van Roosmalen and van Roosmalen (1997) described the ventral surface of the Spix's type specimen as ochraceous, whereas that of *niveiventris* Lönnberg, 1940, is whitish in the chest, belly and inner side of the arms and legs. Napier (1976) distinguished the two

The basis for recognizing *niveiventris* is discussed in the text on *C. p. pygmaea* above. Following van Roosmalen and van Roosmalen's (1997) hypothesis, the eastern pygmy marmoset would be the form south of the Río Solimões-Amazonas-Marañon and east of the lower Río Huallaga and middle to upper Río Ucayali. Aquino and Encarnación (1994) indicated a larger range in Peru, occupying the entire Amazonian lowlands and Andean foothills east of the Río Mayo and the Río Huallaga above the Río Mayo, and including the Río Pachitea and the Río Ucayali basins, south to the upper Río Purus and the basins of the Río Madre de Dios and Río de las Piedras and the Río Tambopata. From there it extends east into northern Bolivia to the region of Cobija (Freese et al. 1982; Buchanan-Smith et al. 2000). In Bolivia, Izawa (1979) and Izawa and Bejarano (1981) confined it to the north and west of the Ríos Orthon and Manuripi, northern tributaries of the Río Madre de Dios. Although Brown and Rumiz (1986) doubted that it occurred as far south as the Río Manuripi and limited its distribution to the north of the Río Tahuamanu, Buchanan-Smith et al. (2000) confirmed its presence south of the river along the Río Muyumanu. The easternmost record obtained by Buchanan-Smith et al. (2000) was at Santa Rosa on the Río Abunã. Its presence in northern Bolivia indicates that it should occur in parts of eastern Acre, including the Ríos Acre and uppermost Abunã, not indicated by Hershkovitz (1977). This was confirmed by Bicca-Marques and Calegario-Marques (1995). Van Roosmalen and van Roosmalen (1997) observed pygmy marmosets between the lower Ríos Purus and Madeira, and indicated a range extending south at least to the Río Ipixuna (a right bank tributary of the Río Purus). The Río Abunã is a left bank tributary of the Río Madeira, so it is reasonable to believe that pygmy marmosets occur throughout the interfluvium of the Ríos Purus and Madeira south to the Río Abunã. The southernmost locality reported so far is the Manu National Park, approximately 12°S (Soini 1988).

2.2.4 *Genus Mico Lesson, 1840*

As discussed above, the genus *Mico* recognized here includes all of the Amazonian marmosets along with the black-tailed marmoset (*M. melanurus*), which were formerly considered members of the genus *Callithrix* in the Argentata-group as defined by Hershkovitz (1977).

2.2.4.1 *Mico argentatus* (Linnaeus, 1771) Silvery Marmoset

Type locality: Pará, Brazil, restricted by de Carvalho (1965) to Cametá, left bank of lower Río Tocantins (Hershkovitz 1977). (Note: *argentata* used with the feminine genus "*Callithrix*" is here changed to *argentatus* to agree with the masculine *Mico*.)

Mico argentatus occurs south of the Río Amazonas, in relatively flat, lowland forest, between the mouth of the Río Tocantins in the east and the Ríos Tapajós

and Cuparí (an eastern tributary) in the west (Ferrari and Lopes Ferrari 1990; Ferrari and Lopes 1996; Pimenta and Silva 2005), extending south to the Rio Irirí as far as the lower Rio Curuá (Hershkovitz 1977). Ferrari and Lopes Ferrari (1990) (see also Ferrari 1993a; Ferrari and Lopes 1996) argued that its restricted range (lowland floodplain) east of the Rio Tocantins is due to habitat differences and sympatry with the black-handed tamarin *Saguinus niger* (a wider ranging species extending west to the Rio Xingú and east to the Rio Parnaíba). Ferrari (1993b) indicated that *S. niger* has the competitive edge in the forests on the relatively nutrient-poor soils of the Brazilian Shield, and that *M. argentatus* was a “newcomer” resulting from a Holocene range expansion of the genus. The southernmost record listed by Hershkovitz (1977) is the type locality, Maloca, upper Rio Curuá, of an individual with a “blackish crown and grayish brown back” described by Thomas (1920) as *Hapale emiliae*, illustrated by da Cruz Lima (1945) as *Callithrix emiliae* (Snethlage’s marmoset), and recognized tentatively here as a separate species. Da Cruz Lima (1945) pointed out that *emiliae* “bears a closer resemblance to the form *melanura* of Mato Grosso than to the typical form of the marginal river zone of the Amazon.” De Ávila-Pires (1986) also argued for the validity of *Callithrix argentata emiliae* on the basis of specimens obtained further south, on the Rio Peixoto de Azevedo (see *M. melanurus* and *M. emiliae* below). *Mico argentatus* does not occur south of Belo Monte on the Rio Xingú (Transamazon highway) and is restricted to the north of the Tucuruí dam reservoir on the Rio Tocantins (Ferrari and Lopes Ferrari 1990; Ferrari and Lopes 1996). This restricts the range of *M. argentatus* well to the north of the mouth of the Rio Irirí on the eastern bank of the Xingú, with the southern limits being somewhere between the Rios Cuparí and Irirí to the west of the Rio Xingú, as indicated by Hershkovitz (1977; see also Martins et al. 1988).

2.2.4.2 *Mico leucippe* (Thomas, 1922) Golden-White Bare-Ear Marmoset

Type locality: Pimental, right bank of the Rio Tapajós, below mouth of Rio Jamanxim, Pará, Brazil (Hershkovitz 1977).

Mico leucippe was considered by de Carvalho (1959) to be a subspecies of *Callithrix chrysoleuca*, but it was placed as a subspecies of *C. argentata* by Hershkovitz (1977). It is similar to *M. argentatus*, predominantly white, but with a tail and feet of pale gold. The face and ears are largely unpigmented (Hershkovitz 1977). It is known only from a small area in the state of Pará, between the Rios Cuparí and Tapajós (right bank of the Rio Tapajós), south to the Rio Jamanxim (Hershkovitz 1977; Pimenta and Silva 2005).

2.2.4.3 *Mico emiliae* (Thomas, 1920) Snethlage’s Marmoset

Type locality: Maloca, upper Rio Curuá, upper Rio Irirí, Rio Xingú, Pará, Brazil (Thomas 1920).

This marmoset, named by Thomas (1920) as *Hapale emiliae*, was considered a dark form of *Callithrix argentata argentata* by Hershkovitz (1977). It was recognized by da Cruz Lima (1945), Cabrera (1957) and Hill (1957), however, as a distinct subspecies of *C. argentata*, and de Ávila-Pires (1986) also argued its validity on the basis of three skins obtained from the Rio Peixoto de Azevedo, well to the south of the type locality. Cabrera (1957) described its distribution as the south of the state of Pará, possibly entering contiguous parts of the state of Mato Grosso. De Ávila-Pires (1986) was more exact, indicating that it occurs south from the Rio Irití (*C. a. argentata* occurring to the north – confirmed by Martins et al. 1988), at least as far south as the southern (left) margin of the Rio Peixoto de Azevedo, an eastern tributary of the Rio Teles Pires. Martins et al. (1988) recorded it on the left bank of the Rio Irití, south from its mouth. Pimenta and Silva (2005) recorded it from the Serra do Cachimbo and the right bank of the upper Teles Pires, a significant extension of the range to the west. The southern limits would evidently not be beyond the headwaters and upper Rio Paraguai, approximately 14°30'S, where *M. melanurus* has been registered for a number of localities (Hershkovitz 1977; de Vivo 1985). De Ávila-Pires (1986) suggested that the Rio Teles Pires marks the western limit of its range. Martins et al. (1988) indicated that *C. emiliae* is limited to the west (left) bank of the lower Rio Irití, with an undescribed *C. argentata* subspecies occurring between the Rios Irití and Xingú. These authors also indicated that no marmoset occurs east of the Rio Xingú above the mouth of the Rio Irití. The distribution of *Mico emiliae* has been confused somewhat by its alignment with a similar, if slightly darker, form in the state of Rondônia by de Vivo (1985), referred to here as *Mico* cf. *emiliae* (also discussed in the text on *M. melanurus*).

2.2.4.4 *Mico melanurus* (Geoffroy Saint-Hilaire, 1812) Black-Tailed Marmoset

Type locality: Brazil, restricted to Cuyabá (= Cuiabá) by Allen (1916) (Hershkovitz 1977). (Note: *melanura* used with the feminine genus “*Callithrix*” is here changed to *melanurus* to agree with the masculine *Mico*.)

The most widespread of the Argentata-group marmosets, *M. melanurus* is the only one to occur naturally outside of Brazil, extending south as it does through the Pantanal of Mato Grosso into Bolivia and Paraguay. Hershkovitz (1977) indicated the Rio Tacuarí in Brazil and the headwaters of the Río Mamoré in Bolivia as the southern limit of its distribution, but Stallings and Mittermeier (1983) and Stallings (1985) recorded it also from the northeastern Paraguayan chaco, extending the known range to approximately 20°S. In Bolivia, it occurs east of the Río Mamoré, in the Departments of Beni and Santa Cruz (Brown and Rumiz 1986).

According to Hershkovitz (1977), in Brazil it occurs to the east of the Rio Madeira, from the mouth of the Rio Aripuanã extending south to beyond the Rio Guaporé and west to the Rio Roosevelt (Hershkovitz 1977). However, field research and the discovery of a number of distinct new marmosets has modified the range he

proposed. No evidence has been forthcoming for its occurrence between the Rios Aripuanã and Roosevelt (the range of *M. intermedius*, the Aripuanã marmoset). It does occur on the east bank of the Rio Aripuanã, north at least to 10°S, and probably west to the Rio Juruena, or the Rio Teles Pires, where de Ávila-Pires (1986) predicted that it would meet the range of the form *M. emiliae*. Hershkovitz's (1977) proposal for its occurrence west of the Rio Aripuanã-Roosevelt was based on three localities. The first was the Foz do Rio Castanho (near the junction of the Rios Roosevelt, Guariba, and Aripuanã in the state of Amazonas) (locality 197b, p 569, Hershkovitz 1977). This is the type locality of the distinct form *M. marcai* (Marca's marmoset) described by Alperin (1993). According to de Vivo (1985), the marmosets at the other two localities indicated by Hershkovitz (1977: 214b, mouth of the Rio Jiparaná, upper Rio Madeira; and 214c, Urupá, Rio Jiparaná) would not be the form *melanura*, but *Callithrix* (= *Mico*) *emiliae* based on their similarity (although they are darker) to the marmosets from the Rio Curuá, in Pará (the type locality of *M. emiliae* [Thomas 1920]). The "*Callithrix emiliae*" of de Vivo (1985), however, occurs to the west of the range of *M. melanurus* and, if aligned with the *Callithrix emiliae* of Thomas (1920), listed by da Cruz Lima (1945), Cabrera (1957), and de Ávila-Pires (1986), it would indicate a disjunct distribution, being separated by typical *M. melanurus* between the Rios Aripuanã and Juruena (or Teles Pires). The Rondônia marmoset of de Vivo (1985, 1991) is distinct from *melanurus* in its paler color (less brownish dorsum) and the lack of the distinct pale thigh stripe. It is listed below as *Mico* cf. *emiliae*.

2.2.4.5 *Mico marcai* (Alperin, 1993) Marca's Marmoset

Type locality: Mouth of the Rio Castanho (= Rio Roosevelt), a left bank tributary of the Rio Aripuanã, state of Amazonas, Brazil (Alperin 1993). Alperin (2002) discusses the type locality.

This form was first described as *Callithrix argentata marcai* Alperin 1993, from three skins in the Museu Nacional, Rio de Janeiro. It is distinct from *Mico leucippe* and *M. argentatus* in having a marked coloration of the mantle; from *M. melanurus*, in not having the white patches on the hips, and the white patch on the forehead; and from *M. emiliae*, in having pale hands and feet, and the dark brown forehead. It is known only from these specimens, collected by the Rondon Commission in April 1914. Its range is unknown but probably extends south along the left bank of the Rio Roosevelt and at least part of the way north to meet, somewhere, the southern limits of the range of *M. manicorensis* (the Manicoré marmoset). Ferrari (1993c, 1994) reported the collection of an adult female "*C. emiliae*" on the east bank of the Rio dos Marmelos opposite the Tenharin Indian settlement (on the west bank, 07°57'S, 62°03'W). (For the correct location of Tenharin, see Ferrari 1994.) Ferrari (1993c) said it was easily distinguished from *M. nigriceps*, the black-headed marmoset (collected on the west bank at the same location) by the lack of pigmentation on the facial skin. It would seem that Ferrari (1993c) presumed the identity of this animal to be *C. emiliae* based on de Vivo (1985,

1991) who stated that *C. emiliae* occurred on the left (west) bank of the Rio Aripuanã: a belief arising from his interpretation of the identity of the marmoset of the Rio Castanho, here listed as *Mico marcai* (Alperin, 1993). The true identity of the marmoset from the east bank of the Rio dos Marmelos at Tenharin, however, has yet to be determined in the light of this.

2.2.4.6 *Mico intermedius* (HersHKovitz, 1977) Aripuanã Marmoset

Type locality: Near the mouth of Rio Guariba, the left bank of Rio Aripuanã, south-eastern Amazonas, Brazil (HersHKovitz 1977).

M. intermedius is similar to *M. melanurus* in aspects such as the distinct pale thigh stripe, similarly colored hindquarters, dark crown (just a little paler than *melanurus*), and the lack of an ear-tuft (it has a rudimentary tuft from behind the pinna and not the well-developed tuft from within and around the pinna as in *Mico humeralifer*, the Santarém marmoset). The face is variably depigmented (some individuals have quite dark-greyish faces), the forequarters are paler, and varying parts of the tail are pale off-white rather than black. It occurs between the Rios Roosevelt and Aripuanã, including the entire basin of the Rio Guariba. *M. intermedius* and *M. melanurus* are not sympatric between the Rios Aripuanã and Roosevelt as was indicated by HersHKovitz (1977). The exact southern limits are not known, but they are probably around the headwaters of these two rivers.

2.2.4.7 *Mico nigriceps* (Ferrari and Lopes, 1992) Black-Headed Marmoset

Type locality: Lago dos Reis (7°31'S, 62°52'W, = Lago Paraíso), 17 km east of Humaitá, Amazonas, Brazil, on the Trans-Amazon highway BR-230 (right, or east, bank of the Rio Madeira) (Ferrari and Lopes 1992; Ferrari 1993c, 1994).

This marmoset is darker than the form *M. cf. emiliae* described by de Vivo (1985) from adjacent Rondônia, and differs in the pigmentation of the face and ears, pheomelanization of the forelimbs, mantle and ventrum, a brown rather than grey dorsum, an orange/russet coloration of the posterior limbs, and pale hips and upper thighs. It is known from two localities separated by little more than 50 km, the paratype locality being Calama (8°03'S, 62°53'W), Rondônia, Brazil (right or east bank of the Rio Madeira), east of the Rio Jiparaná. This marmoset is believed to occur between the Rio dos Marmelos in the north and east, the Rio Madeira in the west and the Rio Jiparaná in the south, in the state of Rondônia, Brazil. Ferrari (1993c) reported on the capture of two adult male *M. nigriceps* at the Tenharin Indian settlement, on the west bank of the Rio dos Marmelos (07°57'S, 62°03'W). (The location of Tenharin on the map, Fig. 2.1, in Ferrari [1993c] was incorrect. The correct location was shown in Ferrari [1994].) Ferrari and Lopes (1992) and Ferrari (1993c) argued that it is unlikely to extend further west than the Rios Madeira and Jiparaná, or east to the Rios

Aripuanã and Roosevelt, and the southeastern limits are defined by an area of savanna vegetation at the headwaters of the Rio dos Marmelos and along the middle of Rio Jiparaná.

2.2.4.8 *Mico cf. emiliae* (de Vivo, 1985) Rondônia Marmoset

Type locality: This marmoset was first described by de Vivo (1985) as *Callithrix emiliae* (Thomas, 1920), the type locality of which is Maloca, upper Rio Curuá, upper Rio Irirí, Rio Xingú, Pará, Brazil. As argued here (see also the text on *M. melanurus*), we consider it a distinct form yet to be given a type specimen (and, as such, a type locality). De Vivo (1985; map 1, p 104) refers specifically to four localities for his definition of *C. emiliae*: the type locality of *Hapale emiliae* Thomas, 1920 (locality 11); the Foz do Rio Castanho (locality 10; subsequently attributed to *M. marcai* by Alperin 1993); Ji-paraná, Rondônia (10°52'S, 61°57'W) (locality 13); and Nova Brasília, Rondônia (10°52'S, 61°57'W) (locality 14). The last two are candidates for the type locality.

De Vivo (1985) was the first to alert the scientific community to this marmoset of the state of Rondônia, Brazil. De Vivo (1985) provided a detailed description of a specimen from Nova Brasília. He believed it was *Callithrix emiliae* (Thomas, 1920), being similar in pelage color if just a little darker. The Foz do Rio Castanho specimens, later described as *Callithrix argentata marcai* by Alperin (1993), De Vivo said were similar, and indicated, as a result, that it occurred east of the Rio Madeira and north to the west (left) bank of the Rio Aripuanã to the mouth of the Rio Roosevelt. De Vivo (1985) made no mention of the two other localities indicated by Hershkovitz (1977: 214b, mouth of the Rio Jiparaná, upper Rio Madeira; and 214c, Urupá, Rio Jiparaná), but his map indicated that they would also be “*C. emiliae*.” The discovery of *M. nigriceps* (Ferrari and Lopes, 1992) means that the range of de Vivo’s (1985) “*C. emiliae*” is restricted to the left bank of the Rio Jiparaná.

It is almost certain that these Rondônia marmosets should be considered a new species, similar to, but distinct from, both *M. emiliae* and *M. melanura*. Nagamachi et al. (1996, 1997, 1999) analysed the karyotype, and Sena et al. (2002) carried out a phylogenetic analysis of mitochondrial cytochrome oxidase II gene sequences that substantiated the distinctiveness of de Vivo’s Rondônia marmoset. They reported a range delimited to the north and west by the Rios Mamoré-Madeira, and Jiparaná and to the south by the Serra dos Pacáas Novos, where they indicated it may be parapatric with *M. melanura*, which is “typically found in the savannah-like, rather than rainforest ecosystems, that predominate in southern Rondônia” (p 81). Ferrari et al. (1995) failed to find any evidence of the occurrence of marmosets during surveys of the Guajará-Mirim State Park in west central Rondônia. Likewise no marmosets were recorded at Pimenta Bueno on the upper Rio Jiparaná (Ferrari et al. 1996a). The range of this marmoset is evidently much smaller than previously thought. Conversely, the saddleback tamarin, *Saguinus fuscicollis weddelli*, once believed to be restricted to the west of the Rio Madeira (Hershkovitz 1977), was found at both localities. Ferrari et al. (1996a)

pointed out that this indicates a much larger range in this portion of the Amazon than that portrayed by Rylands et al. (1993), and discussed the contrasting habitat preferences and competitive abilities of the two species (see also Lopes and Ferrari 1994) similar to that recorded by Ferrari and Lopes (1996) for *M. argentatus* and *Saguinus niger*.

2.2.4.9 *Mico humeralifer* (Geoffroy Saint-Hilaire, 1812) Santarém Marmoset

Type locality: Brazil, restricted to Paricatuba, the left bank of the Rio Tapajós, near the mouth, Pará, Brazil (Hershkovitz 1966).

Field research since the publications of Hershkovitz (1977) and Rylands et al. (1993) has divided up and diminished the supposed distribution of the Santarém marmoset. Hershkovitz's (1977) range is now shared by four marmosets, being occupied by *M. mauesi* (the Maués marmoset), *M. saterei* (the Sateré marmoset), and *M. acariensis* (the Rio Acari marmoset) besides *M. humeralifer*. According to our current understanding, *M. humeralifer* occurs south of the Rio Amazonas, between the Rio Maués (and possibly its tributary, the Rio Parauari) in the west and the Rio Tapajós in the east. The southern limit is not known, but it may be in the region of the Rio Paracari. The southernmost locality for the Santarém marmoset plotted by Hershkovitz (1977) was Vila Braga (4°25'S) on the Trans-amazon highway, just north of the Amazônia National Park. A pale orange-brown marmoset very similar to *M. humeralifer* obtained from the Rio Aripuanã in the northern part of the range was photographed by Mittermeier et al. (1988, p 20) in the collection of the Belém Primate Centre. This may well be a new and as yet unregistered species.

2.2.4.10 *Mico chrysoleucus* (Wagner, 1842) Golden-White Tassel-Ear Marmoset

Type locality: Borba, lower Rio Madeira, Amazonas, Brazil (Hershkovitz 1977). (Note: *chrysoleuca* used with the feminine genus "*Callithrix*" is here changed to *chrysoleucus* to agree with the masculine *Mico*.)

M. chrysoleucus is almost completely white, with an unpigmented face and long white ear-tufts. The body is pale gold to whitish and the tail, fore- and hindlimbs are golden to orange. Very little known, it occurs in a sliver south of the Rio Amazonas, between the Rios Madeira and lower Aripuanã in the west and the Rio Canumã (= Cunumã) in the east (Hershkovitz 1977; Silva and Noronha 1996). It occurs on the north (left) bank of the Paraná Urariá (*M. mauesi* occurs on the opposite side of the Urariá). Silva and Noronha (1996) observed *M. chrysoleucus* at Santa Bárbara, on the left bank of the Rio Canumã. The southernmost locality is Prainha, a short distance north of the mouth of the Rio Roosevelt, on the east (right) bank of the Rio Aripuanã. It is probable that Prainha is near the southern limit to

its distribution, which may be marked by the headwaters of Rio Sucundurí, Serra do Sucundurí toward 8°S.

2.2.4.11 *Mico mauesi* (Mittermeier et al., 1992)

Maués Marmoset

Type locality: West bank of the Rio Maués-Açú, directly across the river from the town of Maués, Amazonas state, Brazil. Located in central Brazilian Amazonia, south of the Rio Amazonas and between the Rio Madeira and the Rio Tapajós (3°23'S, 57°46'W) (Mittermeier et al. 1992).

In the original description, the Maués marmoset was known only from the immediate vicinity of the type locality, but local people informed that it occurred along the Rio Maués to the south of the type locality and to the west as far as the Paran  Urari  and Rio Abacaxis (Mittermeier et al. 1992). Silva and Noronha (1995) reported a further locality: Santa Maria, on the right of the lower Rio Abacaxis, municipality of Nova Olinda do Norte, state of Amazonas (3°54'S, 58°46'W). They also obtained reports of *M. mauesi* occurring in the vicinity of the town of Abacaxis, on the right bank of the Rio Abacaxis (3°55'S, 58°45'W), a few kilometers downriver from Santa Maria. It was reported not to occur at S o Jo o on the left bank of the Rio Marimari, near its confluence with the Rio Abacaxis (3°57'S, 58°48'W), or at two other localities on the west bank of the Rio Abacaxis. Silva and Noronha (1995) reported the occurrence of a bare-eared marmoset on the west bank of the Rio Abacaxis, which they later described (1998) as *Callithrix saterei*.

2.2.4.12 *Mico saterei* (Silva and Noronha, 1998) Sater  Marmoset

Type locality: Mouth of the Rio Canum , the right bank of the lower Rio Canum , in front of its confluence with the Paran  Urari  (3°59'50.8"S, 59°05'36.7"W).

M. saterei occurs in the interfluvium of the Rios Abacaxis (in the east) and Canum -Sucunduri (in the west), right bank tributaries of the Rio Madeira. It is a most unusual-looking marmoset, which lacks ear-tufts despite being surrounded by marmosets displaying extravagantly hirsute pinnae (*humeralifer*, *chrysoleucus* and *mauesi*). *M. acariensis* occurs on the opposite (left) bank of the Canum -Sucundur , and *M. mauesi*, on the opposite (right) bank of the Rio Abacaxis. The lack of ear tufts is significant when considering Hershkovitz's (1977) original separation between the bare-ear marmosets (subspecies of *argentata*) and the tassel-ear marmosets (subspecies of *humeralifer*). The black-tailed marmoset and the marmosets east of the Rio Tapaj s are certainly largely or entirely bare-eared, but so too are the forms recently discovered in the interfluvium of the Tapaj s and Madeira (*sateri*, *nigriceps*, *manicorensis*, the Rond nia "*emiliae*," and *marcai*). *M. intermedius* and *M. acariensis* have small thin tufts growing from around, not within, the pinna. A notable aspect of *M. saterei* is the distinctive pale thigh stripe, shared most particularly with *melanurus*, *intermedius*, and *acariensis*, and hinted at by the hip patch in *mauesi* and *humeralifer* to the north of *sateri*. Only the

entirely pale *M. chrysoleucus* lacks it (see Van Roosmalen et al. 2000, Fig. 2.3). These marmosets all occur between the Rio Roosevelt-Aripuanã-Madeira and the Rio Tapajós.

2.2.4.13 *Mico manicorensis* (Van Roosmalen et al., 2000) Manicoré Marmoset

Type locality: Seringal São Luis, east bank of the middle Rio Madeira, in the vicinity of the town of Manicoré, state of Amazonas, Brazil. This region is located in south central Amazonia, Brazil, south of the Rio Amazonas, east of the Rio Madeira, and west of the lower Rio Aripuanã. Coordinates for the type locality are 05°50'28"S, 61°18'19"W, altitude 45 m (van Roosmalen et al. 2000).

The Manicoré marmoset is known from the west bank of the lower Rio Aripuanã from the mouth, west as far as the Rio Manicoré, and south toward its headwaters. Despite the map provided by van Roosmalen et al. (2000), it evidently does not reach the confluence with the Rio Roosevelt – the type locality of *M. marcai*. The southern limits are probably marked by the headwaters of the Rio Maturá or Rio Arauá, about 7°S.

2.2.4.14 *Mico acariensis* (Van Roosmalen et al., 2000) Rio Acarí Marmoset

Type locality: A small settlement on the right bank of the lower Rio Acarí, close to the confluence with the Rios Sucundurí and Canumã, state of Amazonas, south central Amazonia, Brazil. Coordinates for the type locality are 05°07'08"S, 60°01'14"W (Van Roosmalen et al. 2000).

Mico acariensis has not been observed in the wild, but according to local settlers it is known from the right bank of the lower Rio Acarí, and it presumably occurs through the interfluvium of the Rios Acarí (in the west) and Sucundurí (to the east), south perhaps to a contact zone with *M. melanurus* between the Rios Aripuanã and Juruena.

2.2.5 *Genus Callimico Miranda Ribeiro, 1912* *Callimico* or *Goeldi's monkey*

2.2.5.1 *Callimico goeldii* (Thomas, 1904) *Callimico* or *Goeldi's Monkey*

Type locality: Rio Iaco, Acre, Brazil.

This is a monotypic genus, but speculation persists regarding the possibility of there being more than one species or subspecies. Väsárhelyi (2002) examined the genetic structure of the founder stock of captive callimicos and concluded that more than one cryptic subspecies or species may be represented. *Callimico goeldii* occurs in the upper Amazon from the Rio Caquetá in Colombia, south through the

Peruvian Amazon and the extreme western Amazon of Brazil into the Pando region of northern Bolivia (Herskovitz 1977). Herskovitz (1977) predicted that it should occur in the Ecuadorian Amazon, but none have been found there to date. Despite its wide range, *callimico* is notoriously patchy in its distribution and is evidently absent over a large part of the locality. In Colombia, it occurs from the base of the Cordillera Oriental of the Andes in the Department of Putumayo between the Ríos Putumayo and Caquetá east at least to the mouth of the Río Cahuinari, a right bank affluent of the Caquetá. It is not known to occur in the Colombian trapezium (Hernández-Camacho and Cooper 1976; Defler 2004). In Peru, it is evidently limited largely to the eastern Amazon. Herskovitz (1977) mapped numerous localities south of the Río Napo, along the lower and middle of the Río Ucayali and the Río Tapiche. The westernmost locality given by Herskovitz (1977, map p 864) is on the Río Marañon, but it is listed in the gazetteer as “Apaga (Rio), enters Río Putumayo from south at approximately 4°42'S, 77°10'W, P Soini, April 1970, sight record.” The coordinates would seem to be right, but the description of the locality wrong, and the Río Marañon is excluded from the distribution map of Aquino and Encarnación (1994). They have *callimico* definitely occurring only south of the lower Ucayali (from the mouth of the Rio Blanco), extending to both sides of the Ucayali at about 6°S, and south along the Andean foothills to the Ríos Pachitea and Madre de Dios. *Callimico* occurs in the Manu National Park (Aquino and Encarnación 1994). From there it extends east into extreme northern Bolivia, north of the Río Tahuamanu (Buchanan-Smith et al. 2000; Christen and Geissmann 1994). Christen and Geissmann (1994) reported seeing *callimico* south of the Río Nareuda, indicating it occurs in the south as far as the Río Muyumanu. Buchanan-Smith et al. (2000) found no evidence of its occurrence south of the Tahuamanu-Nareuda. *Callimico* occurs in a small part in the south-west Brazilian Amazon in the state of Acre, through the Serra do Divisor south of the upper Río Juruá to the Río Gregório (state of Amazonas), to the Río Iaco (above the Río Acre) on the south (right) bank of the upper Purus, and into the Madeira basin along the Río Abunã in the state of Rondônia (Herskovitz 1977; Ferrari et al. 1999; Lopes and Rehg 2003).

2.3 Some Reflections and a Summary

The last three decades have seen some major changes in the way we perceive and catalogue the South American tamarins, marmosets, and *callimico*. Herskovitz (1977) summarized our understanding of this group in the late 1970s with *Cebuella* as a primitive ancestral form (his interpretation being that the evolutionary tendency in this group of primates was to increase in size), *Callimico* as an outgroup family of its own, and three species of “true” marmosets – *Callithrix argentata* with three subspecies, *C. humeralifer* with three, and *C. jacchus* with five. Adjustments to this taxonomy came from the realization that the group as a whole was tending to decrease, not increase, in body size (Ford 1980; Leutenegger

1980; Martin 1992), from genetic studies, both karyological and molecular that provided us with revealing insights as to the affinities and differences of the various forms, from morphological studies validating the classification of the Atlantic forest marmosets as species (and the validity of the form *kuhlii*), and from the discovery of numerous new species. We have now come to recognize a diversity of marmosets that is more comparable to that of *Saguinus* than was previously documented by Hershkovitz (1977). Hershkovitz recognized the existence of 12 marmosets (including *Cebuella*) and 33 tamarins of the genus *Saguinus*. Groves (2005), on the other hand, was able to list 21 marmosets (placing *Mico*, *Cebuella* and *Callibella* as subgenera of *Callithrix*) and 32 tamarins. It was the exploration of the Tapajós-Madeira interfluvium that brought to light eight previously unknown marmosets since the description of *Callithrix* (now *Mico*) *intermedius* by Hershkovitz (1977). Further surveys will probably reveal yet more in the coming years. No “new” species of tamarin has been described since *Saguinus nigricollis hernandezi* Hershkovitz, 1982.

As pointed out to us by Susan Ford, it is curious that the pygmy marmoset, *Cebuella*, the dwarf marmoset, *Callibella*, and callimico have failed to produce the diversity of forms that characterize *Callithrix*, *Mico*, and *Saguinus*. This is in part dependant on our vision as to the generic separation of these forms and what comprises a “marmoset radiation” – for Groves (2001, 2005) the question would have no meaning because the pygmy marmosets and the dwarf marmosets are a component of the marmoset radiation, not a separate radiation in themselves. How we classify these animals inevitably affects the way we attempt to explain their evolution and adaptive radiations.

It would seem evident that while all have evolved to occupy the niche of a small arboreal faunivore-frugivore, their evolutionary diminution in size being associated with an increased breeding rate, one of the key gauges to our understanding of this group is their capacity to substitute fruits for plant exudates – something which undoubtedly evolved in an ancestral montane (as opposed to lowland) form in south-east Brazil, that suffered periodic (or even a generalized) scarcity in fruits, and which is today represented by the forms *Callithrix aurita* and *C. flaviceps*. Extreme specialization in tree-gouging to obtain gums evolved twice: *Callithrix jacchus* and *C. penicillata* in highly seasonal and dry forests of the north-east and central Brazil and *Callibella* and *Cebuella pygmaea* in the Amazon (Rylands 1984). The forces driving these two extremes of specialization were, of course, different. For *C. jacchus* and *C. penicillata*, it allowed them to occupy highly seasonal and dry forests in central and north-east Brazil, that lack fruits for long periods of the year. For the pygmy and dwarf marmosets, it was the occupation of a niche that could avoid competition with tamarins (saddleback and moustached), or other marmosets, in the case of *Callibella* – parapatric or sympatric speciation. Their diminutive size and minute home ranges exclude any possibility of their having access to their preferred fruits year round.

The case of *Callimico* (and what must have been the loss of the callithrichid twinning unique in mammals, if we are to believe the conclusions of the geneticists) remains a mystery, but the answer, if it is available to us, will be found in a profound

understanding of the forest's resources – what its habitat has to offer in space and time, in dispersion and abundance, that *Callimico* has specifically evolved to exploit. Its enigmatically patchy distribution may well be a reflection of a habitat (sensu lato) abundant in the past and now disappearing (Izawa 1979).

Acknowledgments ABR is most grateful to Susan Ford, Lesa Davis and Leila Porter for their invitation to participate in the symposium “Advances in Marmoset and Goeldi's Monkey (*Callimico*) Research: Anatomy, Behavioral Ecology, Phylogeny, and Conservation,” during the 74th Annual Meeting of the American Association of Physical Anthropologists, Milwaukee, Wisconsin, USA, 6–9 April 2005. Our thanks are also due to Kimberly Meek, Center for Applied Biodiversity Science at Conservation International, for drawing the maps.

References

- Aguiar JM, Lacher TE Jr (2003) On the morphological distinctiveness of *Callithrix humilis* Van Roosmalen et al., 1998. *Neotrop Primates* 11(1):11–18
- Aguiar JM, Lacher Jr TE (this volume) Cranial morphology of the dwarf marmoset *Callibella* in the context of callitrichid variability. In: Ford SM, Porter LM, Davis LC (eds) *The smallest anthropoids: The marmoset/callimico radiation*. Springer Press, New York pp 355–380
- Allen JA (1916) Mammals collected on the Roosevelt Brazilian Expedition, with field notes by Leo E. Miller. *Bull Am Mus Nat Hist* 35(30):559–610
- Alonso C, de Faria DS, Langguth A, Santee DF (1987) Variação da pelagem na área de intergraduação entre *Callithrix jacchus* e *Callithrix penicillata*. *Rev Brasil Biol* 47(4):465–470
- Alperin R (1993) *Callithrix argentata* (Linnaeus, 1771): considerações taxonômicas e descrição de subespécie nova. *Bol Mus Para Emílio Goeldi Sér Zool* 9(2):317–328
- Alperin R (2002) Sobre a localidade tipo de *Mico marcai* (Alperin, 1993). *Neotrop Primates* 10(3):126–128
- Aquino R, Encarnación F (1994) Primates of Peru/Los primates del Perú. *Prim Rep* (40):1–127
- Barroso CML (1995) Filogenia molecular da subfamília Callitrichinae (sensu Rosenberger 1981). Universidade Federal do Pará, Belém, Doctoral Thesis
- Barroso CML, Schneider H, Schneider MPC, Sampaio I, Harada ML, Czelusniak J, Goodman M (1997) Update on the phylogenetic systematics of New World monkeys: further DNA evidence for placing the pygmy marmoset (*Cebuella*) within the genus *Callithrix*. *Int J Primatol* 18(4):651–674
- Bicca-Marques JC, Calegario-Marques C (1995) Updating the known distribution of the pygmy marmoset (*Cebuella pygmaea*) in the state of Acre, Brazil. *Neotrop Primates* 3(2):48–49
- Brandão LD, Develey PF (1998) Distribution and conservation of the buffy-tufted-ear marmoset, *Callithrix aurita*, in lowland coastal Atlantic forest, south-east Brazil. *Neotrop Primates* 6(3):86–88
- Brandon-Jones D, Groves CP (2002) Neotropical primate family-group names replaced by Groves (2001) in contravention of Article 40 of the International Code of Zoological Nomenclature. *Neotrop Primates* 10(3):113–115
- Brazil IBGE (1972) Brasil. Carta Internacional do Mundo ao Milionésimo. Departamento de Documentação e Divulgação Geográfica e Cartográfica, Fundação Instituto Brasileiro de Geografia e Estatística (IBGE), Ministério do Planejamento e Coordenação Geral, Rio de Janeiro. Scale 1:1,000,000
- Brown AD, Rumiz DI (1986) Distribución de los primates en Bolivia. In: de Mello MT (ed) *A primatologia no Brasil–2*. Sociedade Brasileira de Primatologia, Brasília, pp 335–363
- Buchanan-Smith HM, Hardie SM, Caceres C, Prescott MJ (2000) Distribution and forest utilization of *Saguinus* and other primates of the Pando Department, northern Bolivia. *Int J Primatol* 21(3):353–378

- Cabrera A (1957) Catalogo de los mamíferos de América del Sur. Rev Mus Argent Cienc Nat Bernardino Rivadavia 4(1):1–307
- Canavez FC, Moreira MAM, Simon F, Parham P, Seuánez HN (1999a) Phylogenetic relationships of the Callitrichinae (Platyrrhini, Primates) based on beta2-microglobulin DNA sequences. Am J Primatol 48(3):225–236
- Canavez FC, Moreira MAM, Ladasky JJ, Pissinatti A, Parham P, Seuánez HN (1999b) Molecular phylogeny of New World primates (Platyrrhini) based on beta2-microglobulin DNA sequences. Molec Phylogen Evol 12(1):74–82
- Chaves R, Sampaio I, Schneider MPC, Schneider H, Page SL, Goodman M (1999) The place of *Callimico goeldii* in the callitrichine phylogenetic tree: Evidence from von Willebrand Factor Gene Intron II sequences. Mol Phylogen Evol 13:392–404
- Christen A, Geissmann T (1994) A primate survey in northern Bolivia, with special reference to Goeldi's monkey, *Callimico goeldii*. Int J Primatol 15(2):239–274
- Coimbra-Filho AF (1971) Os sagüis do gênero *Callithrix* da região oriental brasileira e um caso de duplo-hibridismo entre três de suas formas (Callithricidae, Primates). Rev Brasil Biol 31:377–388
- Coimbra-Filho AF (1984) Situação atual dos calitriquídeos que ocorrem no Brasil (Callitrichidae–Primates). In: de Mello MT (ed) A Primatologia no Brasil. Sociedade Brasileira de Primatologia, Brasília, pp 15–33
- Coimbra-Filho AF (1985) Sagüi-de-Wied *Callithrix kuhli* (Wied, 1826). FBCN/Inf Rio de Janeiro 9(4):5
- Coimbra-Filho AF (1986a) Sagüi-da-serra *Callithrix flaviceps* (Thomas, 1903). FBCN/Inf Rio de Janeiro 10(1):3
- Coimbra-Filho AF (1986b) Sagüi-da-serra-escuro *Callithrix aurita* (É. Geoffroy, 1812). FBCN/Inf Rio de Janeiro 10(2):3
- Coimbra-Filho AF (1986c) Sagüi-de-cara-branca *Callithrix geoffroyi* (Humboldt, 1812). FBCN/Inf Rio de Janeiro 10(3):3
- Coimbra-Filho AF (1990) Sistemática, distribuição geográfica e situação atual dos símios brasileiros (Platyrrhini–Primates). Rev Brasil Biol 50:1063–1079
- Coimbra-Filho AF (1991) Apontamentos sobre *Callithrix aurita* (É. Geoffroy, 1812) um sagüi pouco conhecido. In: Rylands AB, Bernardes AT (eds) A primatologia no Brasil–3. Sociedade Brasileira de Primatologia e Fundação Biodiversitas, Belo Horizonte, pp 145–158
- Coimbra-Filho AF, Câmara I de G (1996) Os limites originais do bioma mata atlântica na região Nordeste do Brasil. Fundação Brasileira para a Conservação da Natureza, Rio de Janeiro
- Coimbra-Filho AF, Mittermeier RA, Constable ID (1981) *Callithrix flaviceps* (Thomas, 1903) recorded from Minas Gerais, Brazil (Callitrichidae, Primates). Rev Brasil Biol 41(1):141–147
- Coimbra-Filho AF, Rylands AB, Pissinatti A, Santos IB (1991/1992) The distribution and conservation of the buff-headed capuchin monkey, *Cebus xanthosternos*, in the Atlantic forest region of eastern Brazil. Primate Conserv 12–13:24–30
- Coimbra-Filho AF, Pissinatti A, Rylands AB (1993) Experimental multiple hybridism among *Callithrix* species from eastern Brazil. In: Rylands AB (ed) Marmosets and tamarins: systematics, ecology, and behaviour. Oxford University Press, Oxford, pp 95–120
- Cortés-Ortiz L (this volume) Molecular phylogenetics of the Callitrichidae with an emphasis on the marmosets and *Callimico*. In: Ford SM, Porter LM, Davis LC (eds) The smallest anthropoids: The marmoset/callimico radiation. Springer Press, New York pp 3–24
- Cosenza BAP, de Melo FR (1998) Primates of the Serra do Brigadeiro State Park, Minas Gerais, Brazil. Neotrop Primates 6(1):18–20
- Cronin JE, Sarich VM (1978) Marmoset evolution: the molecular evidence. In: Gengozian N, Deinhardt F (eds) Primates in Medicine, vol 10. S Karger, Basel, pp 12–19
- da Cruz Lima E (1945) Mammals of Amazônia, vol. 1. General introduction and primates. Contribuições do Museu Paraense Emílio Goeldi de História Natural e Etnografia, Belém do Pará
- de Ávila-Pires FD (1969) Taxonomia e zoogeografia do gênero '*Callithrix*' Erxleben, 1777 (Primates, Callithricidae). Rev Brasil Biol 29(1):49–64

- de Ávila-Pires FD (1986) On the validity of and geographical distribution of *Callithrix argentata emiliae* Thomas, 1920 (Primates, Callithricidae). In: de Mello MT (ed) A primatologia no Brasil—2. Sociedade Brasileira de Primatologia, Brasília, pp 319–322
- de Carvalho CT (1959) Sobre a validez de *Callithrix leucippe* (Thos.) (Callithricidae, Primates). Pap Avuls Dept Zool Sec Agric S Paulo 13(27):317–320
- de Carvalho CT (1965) Comentários sobre os mamíferos descritos e figurados por Alexandre Rodrigues Ferreira em 1790. Arq Zool 12:7–70
- de la Torre S (2000) Primates de la Amazonía del Ecuador/Primates of Amazonian Ecuador. Sociedad para la Investigación y Monitoreo de la Biodiversidad (SIMBOE), Quito
- de Vivo M (1985) On some monkeys from Rondônia, Brasil (Primates: Callitrichidae, Cebidae). Pap Avuls Zool S Paulo 4:1–31
- de Vivo M (1991) Taxonomia de *Callithrix* Erxleben, 1777 (Callitrichidae, Primates). Fundação Biodiversitas, Belo Horizonte
- Deffler TR (2004) Primates of Colombia. Tropical Field Guide Series, Conservation International, Washington, DC
- Dollman G (1933) Primates. Ser. 3. British Museum (Natural History), London
- Ferrari SF (1993a) The adaptive radiation of Amazonan callitrichids (Primates, Platyrrhini). Evolución Biológica 7:81–103
- Ferrari SF (1993b) Ecological differentiation in the Callitrichidae. In: Rylands AB (ed) Marmosets and tamarins: systematics, behaviour and ecology. Oxford University Press, Oxford, pp 314–328
- Ferrari SF (1993c) An update on the black-headed marmoset, *Callithrix nigriceps* Ferrari and Lopes, 1992. Neotrop Primates 1(4):11–13
- Ferrari SF (1994) The distribution of the black-headed marmoset, *Callithrix nigriceps*: A correction. Neotrop Primates 2(1):11–12
- Ferrari SF, Lopes Ferrari MA (1990) A survey of primates in central Pará. Bol Mus Para Emílio Goeldi sér Zool 6(2):169–179
- Ferrari SF, Lopes MA (1992) A new species of marmoset, genus *Callithrix* Erxleben 1777 (Callitrichidae, Primates) from western Brazilian Amazonia. Goeldiana Zoologia (12):1–3
- Ferrari SF, Lopes MA (1996) Primate populations in eastern Amazonia. In: Norconk MA, Rosenberger AL, Garber PA (eds). Adaptive radiations of neotropical primates. Plenum Press, New York, pp 53–67
- Ferrari SF, Mendes SL (1991) Buffy-headed marmosets 10 years on. Oryx 25(2):105–109
- Ferrari SF, Lopes MA, da Cruz Neto EH, Silveira MAES, Ramos EM, Ramos PCS, Tourinho DM, Magalhães NFA (1995) Primates and conservation in the Guajará-Mirim State Park, Rondônia, Brazil. Neotrop Primates 3(3):81–82
- Ferrari SF, Iwanaga S, da Silva JL (1996a) Platyrrhines in Pimenta Bueno, Rondônia, Brazil. Neotrop Primates 4(4):151–153
- Ferrari SF, Corrêa HKM, Coutinho PEG (1996b) Ecology of the southern marmosets (*Callithrix aurita* and *Callithrix flaviceps*) – how different, how similar? In: Norconk MA, Rosenberger AL, Garber PA (eds) Adaptive radiations of neotropical primates. Plenum Press, New York, pp 157–171
- Ferrari SF, Iwanaga S, Ramos EM, Messias MR, Ramos PCS, da Cruz Neto EH (1999) Expansion of the known distribution of Goeldi's monkey (*Callimico goeldii*) in south-western Brazilian Amazonia. Folia Primatol 70:112–116
- Fletcher K (2001) Primates of the Chapada das Mangabeiras, Piauí, Brasil: a northern extension to the range of *Alouatta caraya*. Neotrop Primates 9(1):19–22
- Ford SM (1980) Callitrichids as phyletic dwarfs and the place of Callitrichidae in the Platyrrhini. Primates 21:31–43
- Ford SM, Davis LC (1992) Systematics and body size: implications for feeding adaptations in New World monkeys. Am J Phys Anthropol 88:415–468
- Ford SM, Davis LC (this volume) Marmoset postcrania and the skeleton of the dwarf marmoset, *Callibella humilis*. In: Ford SM, Porter LM, Davis LC (eds) The smallest anthropoids: The marmoset/callimico radiation. Springer Press, New York pp 411–448

- Freese CH, Heltne PG, Castro RN, Whitesides GH (1982) Patterns and determinants of monkey densities in Peru and Bolivia, with notes on distributions. *Int J Primatol* 3(1):53–90
- Geoffroy Saint-Hilaire É (1812) Tableau des quadrumanes, ou des animaux composant le premier ordre de la classe des mammifères. *Annls Mus Hist. Nat Paris* 19:85–122
- Groves CP (1993) Order Primates. In: Wilson DE, Reeder DM (eds) *Mammal species of the world: a taxonomic and geographic reference*, 2nd edn. Smithsonian Institution Press, Washington, DC, pp 243–277
- Groves CP (2001) Primate taxonomy. Smithsonian Institution Press, Washington, DC
- Groves CP (2004) The what, why and how of primate taxonomy. *Int J Primatol* 25(5):1105–1126
- Groves CP (2005) Order Primates. In: Wilson DE, Reeder DM (eds) *Mammal species of the world: a taxonomic and geographic reference*, vol 1, 3rd edn. Johns Hopkins University Press, Baltimore, pp 111–184
- Harada ML, Schneider H, Schneider MPC, Sampaio I, Czelusniak J, Goodman M (1995) DNA evidence on the phylogenetic systematics of New World monkeys: support for the sister-grouping of *Cebus* and *Saimiri* from two unlinked nuclear genes. *Molec Phylogen Evol* 4(3):331–349
- Hernández-Camacho J, Cooper RW (1976) The non-human primates of Colombia. In: Thorington RW Jr, Heltne PG (eds) *Neotropical primates: field studies and conservation*. National Academy of Sciences, Washington, DC, pp 35–69
- Hershkovitz P (1966) On the identification of some marmosets Family Callithricidae (Primates). *Mammalia* 30(2):327–332
- Hershkovitz P (1968) Metachromism or the principle of evolutionary change in mammalian tegumentary colors. *Evolution* 22:556–575
- Hershkovitz P (1975) Comments on the taxonomy of Brazilian marmosets (*Callithrix*, Callitrichidae). *Folia Primatol* 24:137–172
- Hershkovitz P (1977) *Living New World monkeys (Platyrrhini)* with an introduction to primates, vol 1. Chicago University Press, Chicago
- Hershkovitz P (1982) Subspecies and geographic distribution of black-mantle tamarins *Saguinus nigricollis* Spix (Primates: Callitrichidae). *Proc Biol Soc Wash* 95(4):647–656
- Hill WCO (1957) *Primates: comparative anatomy and taxonomy III*. Edinburgh University Press, Edinburgh, Hapalidae
- Hill WCO (1960) *Primates: comparative anatomy and taxonomy IV*. Cebidae part A. Edinburgh University Press, Edinburgh
- Hill WCO (1962) *Primates: comparative anatomy and taxonomy V*. Cebidae part B. Edinburgh University Press, Edinburgh
- Hirsch A (2003) Avaliação da fragmentação do habitat e seleção de áreas prioritárias para a conservação dos primatas na bacia do rio Doce, Minas Gerais, através da aplicação de um sistema de informações geográficas. Universidade Federal de Minas Gerais, Belo Horizonte, Doctoral thesis
- Hirsch A, Toledo PP, Brito BFA de, Rylands AB (In preparation) New records enlarge the geographic distribution of *Callithrix flaviceps*
- Humboldt [FH]A (1812) Tableau synoptique des singes de l'Amérique. In: Humboldt [F H]A, Bonpland A [JA]. *Recueil d'observations de zoologie et d'anatomie comparée, faites dans l'océan Atlantique, dans l'intérieur du nouveau continent et dans la mer du sud pendant les années 1799[–]1803*. Premier volume. Deuxième partie. Observations de zoologie et d'anatomie comparée. Schoell and Dufour & Co, Paris, 368pp
- Izawa K (1975) Foods and feeding behaviour of monkeys in the upper Amazon basin. *Primates* 16(3):295–316
- Izawa K (1979) Studies on the peculiar distribution pattern of *Callimico*. *Kyoto Univ Overseas Res Rep New World Monkeys* (1979):23–41
- Izawa K, Bejarano G (1981) Distribution ranges and patterns of nonhuman primates in western Pando, Bolivia. *Kyoto Univ Overseas Res Rep New World Monkeys* (1981):1–12
- Kinzey WG (1982) Distribution of primates and forest refuges. In: Prance GT (ed) *Biological diversification in the tropics*. Columbia University Press, New York, pp 455–482

- Leutenegger W (1973) Maternal-fetal weight relationships in primates. *Folia Primatol* 20:280–294
- Leutenegger W (1980) Monogamy in callitrichids: A consequence of phyletic dwarfism? *Int J Primatol* 1(1):95–98
- Lönnberg E (1940) Notes on marmosets. *Ark Zool* 32A(10):1–22
- Lopes MA, Ferrari SF (1994) Foraging behavior of a tamarin group (*Saguinus fuscicollis weddelli*) and interactions with marmosets (*Callithrix emiliae*). *Int J Primatol* 15(3):373–387
- Lopes MA de OA, Rehg JA (2003) Observations of *Callimico goeldii* with *Saguinus imperator* in the Serra do Divisor National Park, Acre, Brazil. *Neotrop Primates* 11(3):181–183
- Marroig G, Cropp S, Cheverud JM (2004) Systematics and evolution of the Jacchus group of marmosets (Platyrrhini). *Am J Phys Anthropol* 123:11–22
- Marroig G, Cheverud JM (this volume) Size and shape in callimico and marmoset skulls: allometry and heterochrony in the morphological evolution of small anthropoids. In: Ford SM, Porter LM, Davis LC (eds) The smallest anthropoids: The marmoset/callimico radiation. Springer Press, New York pp 331–353
- Martin RD (1992) Goeldi and the dwarfs: the evolutionary biology of the small New World monkeys. *J Hum Evol* 22:367–393
- Martins ES, Ayres JM, Valle MBR do (1988) On the status of *Ateles belzebuth marginatus* with notes on other primates of the Irirí river basin. *Primate Conserv* (9):87–91
- Mendes SL (1993) Distribuição geográfica e estado de conservação de *Callithrix flaviceps* (Primates: Callitrichidae). In: Yamamoto ME, de Sousa MBC (eds) A primatologia no Brasil – 4. Universidade Federal do Rio Grande do Norte (UFRN), Sociedade Brasileira de Primatologia, Natal, pp 139–154
- Mendes SL (1997a) Hybridization in free-ranging *Callithrix flaviceps* and the taxonomy of the Atlantic forest marmosets. *Neotrop Primates* 5(1):6–8
- Mendes SL (1997b) Padrões biogeográficos e vocais em *Callithrix* do Grupo *Jacchus* (Primates, Callitrichidae). Universidade Estadual de Campinas, Campinas, São Paulo, Doctoral thesis
- Mendes SL (1997c) Vocalizations in Atlantic forest marmosets, *Callithrix*. *Neotrop Primates* 5(4):116–117
- Mendes SL, Vielliard JME, De Marco Jr P (this volume) The vocal identity of the *Callithrix* species (Primates, Callitrichidae). In: Ford SM, Porter LM, Davis LC (eds) The smallest anthropoids: The marmoset/callimico radiation. Springer Press, New York pp 63–84
- Mittermeier RA, Coimbra-Filho AF, Constable ID, Rylands AB, Valle CMC (1982) Conservation of primates in the Atlantic forest region of eastern Brazil. *Int Zoo Yearb* 22:2–17
- Mittermeier RA, Rylands AB, Coimbra-Filho AF (1988) Systematics: species and subspecies – an update. In: Mittermeier RA, Rylands AB, Coimbra-Filho AF, da Fonseca GAB (eds) Ecology and behavior of neotropical primates, vol 2. World Wildlife Fund, Washington, DC, pp 13–75
- Mittermeier RA, Schwarz M, Ayres JM (1992) A new species of marmoset, genus *Callithrix* Erxleben, 1777 (Callitrichidae, Primates), from the Rio Maués region, state of Amazonas, Central Brazilian Amazonia. *Goeldiana Zoologia* (14): 1–17
- Moreira MAM, Almeida CAS, Canavez F, Olcio R, Seuánez HN (1996) Heteroduplex mobility assays (HMAs) and analogous sequence analysis of a cytochrome *b* region indicate phylogenetic relationships of selected callitrichids. *J Hered* 87:456–460
- Muskin A (1984) Field notes and geographic distribution of *Callithrix aurita* in eastern Brazil. *Am J Primatol* 7:377–380
- Nagamachi CY, Pieczarka JC, Barros RMS, Schwarz M, Muniz JAPC, Mattevi MS (1996) Chromosomal relationships and phylogenetic and clustering analyses on genus *Callithrix*, group *argentata* (Callitrichidae, Primates). *Cytogenet Cell Genet* 72:331–338
- Nagamachi CY, Pieczarka JC, Schwarz M, Barros RMS, Mattevi MS (1997) Comparative chromosomal study of five taxa of genus *Callithrix*, group *Jacchus* (Platyrrhini, Primates). *Am J Primatol* 41(1):53–60
- Nagamachi CY, Pieczarka JC, Muniz JAPC, Barros RMS, Mattevi MS (1999) Proposed chromosomal phylogeny for the South American primates of the Callitrichidae family (Platyrrhini). *Am J Primatol* 49:133–152

- Napier PH (1976) Catalogue of the primates in the British Museum (Natural History). Part I. Families Callitrichidae and Cebidae, British Museum (Natural History), London
- Napier JS, Napier PH (1967) A handbook of living primates. Academic Press, London
- Natori M (1986) Interspecific relationships of *Callithrix* based on dental characters. *Primates* 27(3):321–336
- Natori M (1990) Numerical analysis of the taxonomical status of *Callithrix kuhli* based on the measurements of the postcanine dentition. *Primates* 31(4):555–562
- Natori M (1994) Craniometrical variations among eastern Brazilian marmosets and their systematic relationships. *Primates* 35(2):167–176
- Natori M, Shigehara N (1992) Interspecific differences in lower dentition among eastern Brazilian marmosets. *J Mammal* 73(3):668–671
- Neusser M, Stanyon R, Bigoni F, Wienberg J, Müller S (2001) Molecular cytotaxonomy of New World monkeys (Platyrrhini)—Comparative analysis of five species by multi-color chromosome painting gives evidence for a classification of *Callimico goeldii* within the family of Callitrichidae. *Cytogenet Cell Genet* 94(34):206–215
- Oliveira L de C, Câmara EMVC, Hirsch A, Paschoal AMO, Alvarenga RM, Belarmino MG (2003) *Callithrix geoffroyi* (Primates Callitrichidae) and *Alouatta caraya* (Primates: Atelidae) in the Serra do Cipó National Park, Minas Gerais, Brazil. *Neotrop Primates* 11(2):86–89
- Oliver WLR, Santos IB (1991) Threatened endemic mammals of the Atlantic forest region of south-east Brazil. Wildl Preserv Trust Special Scientific Report 4:1–125
- Olmos F, Martuscelli P (1995) Habitat and distribution of buffy tufted-ear marmoset *Callithrix aurita* in São Paulo State, Brazil, with notes on its natural history. *Neotrop Primates* 3(3):75–79
- Passamani M, Aguiar LMS, Machado R, Figueiredo E (1997) Hybridization between *Callithrix geoffroyi* and *C. penicillata* in southeastern Minas Gerais, Brazil. *Neotrop Primates* 5(1):9–10
- Pastorini J, Forstner MRJ, Martin RD, Melnick DJ (1998) A reexamination of the phylogenetic position of *Callimico* (Primates) incorporating new mitochondrial DNA sequence data. *J Molec Evol* 47(1):32–41
- Paynter RA Jr, Traylor MA Jr (1991) Orinithological gazetteer of Brazil, vol 1, A–M. Harvard University, Cambridge, MA, Museum of Comparative Zoology
- Peres CA, Patton JL, da Silva MNF (1996) Riverine barriers and gene flow in Amazonian saddle-back tamarins. *Folia Primatol* 67(3):113–124
- Pimenta FE, Silva JS Jr (2005) An update of the distribution of primates of the Tapajós-Xingu interfluvium, Central Amazonia. *Neotrop Primates* 13(2):23–28
- Porter CA, Czelusniak J, Schneider H, Schneider MPC, Sampaio I, Goodman M (1997) Sequences of the primate epsilon-globin gene: Implications for systematics of the marmosets and other New World primates. *Gene* 205(1–2):59–71
- Rosenberger AL (1980) Gradistic views and adaptive radiation of platyrrhine primates. *Z. Morph Anthropol* 71(2):157–163
- Rosenberger AL (1981) Systematics: the higher taxa. In: Coimbra-Filho AF, Mittermeier RA (eds) Ecology and behavior of neotropical primates, vol 1. Academia Brasileira de Ciências, Rio de Janeiro, pp 9–27
- Rosenberger AL (1984) Aspects of the systematics and evolution of the marmosets. In: de Melo MT (ed) A primatologia no Brasil. Sociedade Brasileira de Primatologia, Brasília, pp 159–180
- Rosenberger AL, Coimbra-Filho AF (1984) Morphology, taxonomic status and affinities of the lion tamarins, *Leontopithecus* (Callitrichinae, Cebidae). *Folia Primatol* 42:149–179
- Rosenberger AL, Setoguchi T, Shigehara N (1990) The fossil record of callitrichine primates. *J Hum Evol* 19:209–236
- Ruiz-Miranda CR, Affonso AG, Martins A, Beck B (2000) Distribuição do sagüi (*Callithrix jacchus*) nas áreas de ocorrência do mico-leão-dourado (*Leontopithecus rosalia*) no estado do Rio de Janeiro. *Neotrop Primates* 8(3):98–101
- Rylands AB (1984) Exudate-eating and tree-gouging by marmosets (Callitrichidae, Primates). In: Chadwick AC, Sutton SL (eds) Tropical rain forest: The Leeds Symposium. Leeds Philosophical and Literary Society, Leeds, UK, pp 155–168

- Rylands AB (1994) Sagüi-da-serra-escuro, *Callithrix aurita* (É. Geoffroy, 1812). In: da Fonseca GAB, Rylands AB, Costa CMR, Machado RB, Leite YLR (eds) Livro vermelho dos mamíferos brasileiros ameaçados de extinção. Fundação Biodiversitas, Belo Horizonte, pp 47–54
- Rylands AB, Spironelo WR, Tornisiello VL, Lemos de Sá RM, Kierulff MCM, Santos IB (1988) Primates of the Rio Jequitinhonha valley, Minas Gerais, Brazil. *Primate Conserv* 9(1):100–109
- Rylands AB, Coimbra-Filho AF, Mittermeier RA (1993) Systematics, distributions, and some notes on the conservation status of the Callitrichidae. In: Rylands AB (ed) Marmosets and tamarins: systematics, behaviour and ecology. Oxford University Press, Oxford, pp 11–77
- Rylands AB, Schneider H, Langguth A, Mittermeier RA, Groves CP, Rodríguez-Luna E (2000) An assessment of the diversity of New World primates. *Neotrop Primates* 8(2):61–93
- Santos CV, Luz KP, Sant'anna FS (2005) As três espécies de primates do gênero *Callithrix* (*C. jacchus*, *C. penicillata* e *C. geoffroyi*) introduzidos na Ilha de Santa Catarina – SC: a importância de pesquisa na implantação do manejo. In: Sociedade Brasileira de Primatologia (ed) Programa e livro de resumos: XI Congresso Brasileiro de Primatologia. Pontifícia Universidade Católica do Rio Grande Sul, Porto Alegre, 13–18 February, 2005, p 59
- Santos IB, Mittermeier RA, Rylands AB, Valle C (1987) The distribution and conservation status of primates in southern Bahia, Brazil. *Primate Conserv* 8(1):126–142
- Schneider H, Rosenberger AL (1996) Molecules, morphology, and platyrrhine systematics. In: Norconk MA, Rosenberger AL, Garber PA (eds) Adaptive radiations of neotropical primates. Plenum Press, New York, pp 3–19
- Schneider H, Schneider MPC, Sampaio I, Harada ML, Stanhope M, Czelusniak J, Goodman M (1993) Molecular phylogeny of the New World monkeys (Platyrrhini, Primates). *Molec Phylogenet Evol* 2(3):225–242
- Schneider H, Sampaio I, Harada ML, Barroso CML, Schneider MPC, Czelusniak J, Goodman M (1996) Molecular phylogeny of the New World monkeys (Platyrrhini, Primates) based on two unlinked nuclear genes: IRBP Intron 1 and epsilon-globin sequences. *Am J Phys Anthropol* 100:153–179
- Sena L, Vallinoto M, Sampaio I, Schneider H, Ferrari SF, Schneider MPC (2002) Mitochondrial COII gene sequences provide new insights into the phylogeny of marmoset species groups (Callitrichidae, Primates). *Folia Primatol* 73(5):240–251
- Seuánez HN, Forman L, Matayoshi T, Fanning TG (1989) The *Callimico goeldii* (Primates, Platyrrhini) genome: karyology and middle repetitive (LINE-1) DNA sequences. *Chromosoma* 98:389–395
- Silva Jr JS (1999) Novos dados sobre ocorrências e uso de habitat pelo sagüi-do-nordeste, *Callithrix jacchus* (Primates: Callitrichidae). In: Sociedade Brasileira de Primatologia (ed) Livro de resumos: IX Congresso Brasileiro de Primatologia. Museu de Biologia Mello Leitão, Santa Teresa, 25–30 July 1999, p 77
- Silva Jr JS, Noronha M de A (1995) A new record for *Callithrix mauesi* Mittermeier, Schwarz and Ayres, 1992. *Neotrop Primates* 3(3):79–81
- Silva Jr JS, Noronha M de A (1996) Discovery of a new species of marmoset in the Brazilian Amazon. *Neotrop Primates* 4(2):58–59
- Silva Jr JS, Noronha M de A (1998) On a new species of bare-eared marmoset, genus *Callithrix* Erxleben, 1777, from central Amazonia, Brazil (Primates: Callitrichidae). *Goeldiana Zoologia* (21):1–28
- Simpson GG (1945) The principles of classification and a classification of mammals. *Bull Am Mus Nat Hist* 85:1–350
- Soini P (1988) The pygmy marmoset, genus *Cebuella*. In: Mittermeier RA, Rylands AB, Coimbra-Filho AF, da Fonseca GAB (eds) Ecology and behavior of neotropical primates, vol 2. World Wildlife Fund, Washington, DC, pp 79–129
- Spix J (1823) Simiarum et Vespertilionum Brasiliensium species novae ou Histoire Naturelle des Espèces Nouvelles de Singes et de Chauves-souris observées et recueillies pendant le voyage dans l'intérieur du Brésil. Typis Francisci Seraphici Hubschmanni, Monachii

- Stallings JR (1985) Distribution and status of primates in Paraguay. *Primate Conserv* (6):51–58.
- Stallings JR, Mittermeier RA (1983) The black-tailed marmoset (*Callithrix argentata melanura*) recorded from Paraguay. *Am J Primatol* 4(2):159–163
- Tagliaro CH, Schneider MPC, Schneider H, Sampaio IC, Stanhope MJ (1997) Marmoset phylogenetics, conservation perspectives, and evolution of the mtDNA control region. *Mol Biol Evol* 14(6):674–684
- Tagliaro CH, Schneider MPC, Schneider H, Sampaio IC, Stanhope MJ (2001) Molecular studies of *Callithrix pygmaea* (Primates, Platyrrhini) based on Transferrin intronic and ND1 regions: implications for taxonomy and conservation. *Genet Mol Biol* 23(4):729–737
- Thomas O (1904) New *Callithrix*, *Midas*, *Felis*, *Rhipidomys*, and *Proechimys* from Brazil and Ecuador. *Ann Mag Nat Hist* 14(7):188–196
- Thomas O (1911) The mammals of the tenth edition of Linnaeus: An attempt to fix the types of the genera and the exact bases and localities of the species. *Proc Zool Soc Lond* 1911:20–158
- Thomas O (1920) On mammals from the lower Rio Amazonas in the Goeldi Museum, Pará. *Ann Mag Nat Hist* 9(6):266–283
- Thomas O (1922) On the systematic arrangement of the marmosets. *Ann Mag Nat Hist* 9(9):196–199
- Van Roosmalen MGM, Van Roosmalen T (1997) An eastern extension of the geographical range of the pygmy marmoset, *Cebuella pygmaea*. *Neotrop Primates* 5(1):3–6
- Van Roosmalen MGM, Van Roosmalen T (2003) The description of a new marmoset genus, *Callibella* (Callitrichinae, Primates), including its molecular phylogenetic status. *Neotrop Primates* 11(1):1–10
- Van Roosmalen MGM, Van Roosmalen T, Mittermeier RA, Fonseca GAB (1998) A new and distinctive species of marmoset (Callitrichidae, Primates) from the lower Rio Aripuanã, state of Amazonas, central Brazilian Amazonia. *Goeldiana Zoologia* 22:1–27
- Van Roosmalen MGM, Van Roosmalen T, Mittermeier RA, Rylands AB (2000) Two new species of marmoset, genus *Callithrix* Erxleben, 1777 (Callitrichidae, Primates), from the Tapajós/Madeira interfluvium, south central Amazonia, Brazil. *Neotrop Primates* 8(1):2–18
- Vanzolini PE, Papavero N (1968) Índice dos topônimos contidos na carta do Brasil 1: 1 000 000 do IBGE [Fundação Instituto Brasileiro de Geografia e Estatística]. Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP), São Paulo [Preface dated December 1967]
- Vàsàrhelyi K (2002) The nature of relationships among founders in the captive population of Goeldi's monkey (*Callimico goeldii*). *Evol Anthropol* 11(suppl 1):155–158
- Vieira C da C (1944) Os símios do estado de São Paulo. *Pap Avuls. Dept Zool Sec Agric S Paulo* 4:1–31
- Wied-Neuwied M (1826) Beiträge zur Naturgeschichte von Brasilien, vol. 2. Landes-Industrie-Comptoirs, Weimar, p 620

The Smallest Anthropoids

The Marmoset/Callimico Radiation

Ford, S.M.; Porter, L.M.; Davis, L.C. (Eds.)

2009, XXII, 508 p. 94 illus., Hardcover

ISBN: 978-1-4419-0292-4