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RICHNESS, STRUCTURE AND VEGETATION RELATIONSHIPS OF THE WOODY LAYER IN AN UPPER MONTANE FOREST IN CAPARAÓ NATIONAL PARK, MINAS GERAIS STATE, BRAZIL

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The upper montane forest (UMF) or "cloud forest" is a phytophysiognomy characterized by vegetation with a woody structure and a generally continuous canopy, composed mostly by shrub and tree species (Doumenge *et al.* 1995). These species predominantly have low height and are sclerophyllous, with tortuous branches, numerous branches from the base, diminutive coriaceous leaves, often covered by epiphytes (Doumenge *et al.* 1995). Since they are found in environments with biotic and abiotic peculiarities (*e.g.*, frequent clouds, differentiated composition and structure of vegetation, high humidity), they are considered to be indicators of susceptibility to possible climate change (Foster 2001).

This phytophysiognomy is also globally recognized for its environmental benefits, such as maintenance and protection of freshwater watersheds, acting in the regulation of the flow of rivers and springs (Hostettler 2002). In addition, these forests contain a high level of endemism (Bruijnzeel *et al.* 2010, Aceves *et al.* 2011).

In the scientific literature, there are few studies on plant biodiversity in the different existing UMFs and the floristic relationships among them (Luna-Vega *et al.* 2001, Bubb *et al.* 2004, Bertoncello *et al*. 2011). Regarding the lack of studies in this type of vegetation in Brazil, Martinelli (2007) indicated the existence of several areas that are priorities for conducting vegetational studies, because they are regions with few botanical collections and little information about floristic and structural ecology.

Although the Caparaó Range (Minas Gerais and Espírito Santo states) lies within a protected area (Caparaó National Park - PNC) and is included in a priority area for conservation of biodiversity (MMA 2008), there are few studies related to its flora (*e.g.*, Mazine & Souza 2008, Forster & Souza 2013). We conducted a floristic and structural survey of the woody component in this UMF to characterize the vegetation structure of the community. In addition, we evaluated the differences and floristic similarities between vegetation of the same phytophysiognomy in other localities, based on literature data.

PNC covers 31,800 hectares and those in charge of its management encourage scientific research and tourist visits. The studied site is located in Macieira (20º28'47 ''S; 41º49'47''W, approximate coordinates), near Aurélio and Farofa waterfalls, between the altitudes of 1,849 and 1,960 m a.s.l.. The study area is inserted in the physiognomy of the UMF (IBGE 2012). However, in the study area the patches of forest are dispersed like islands amidst upland fields.

Ten Transects (P1, P2, P3, P4, P5, P6, P7, P8, P9 and P10) of 0.1 ha each (50 ×2m) were systematically distributed, spaced about 50 meters apart, and used to measure vegetation structure (Gentry 1988). In each transect, diameters and total heights were measured for all living woody individuals with diameter at breast height (DBH) ≥ 2.5 cm. Reproductive and vegetative botanical materials were collected from all individuals sampled for identification. Fertile samples were

sent to taxonomists for identification and the waste material was compared to those from the BHCB herbarium collection and virtual collections available at species link (splink.org.br) and *Herbário Virtual Reflora* (http://floradobrasil.jbrj.gov.br/reflora/herbarioVirtual/). The botanical families of angiosperms were updated using the system proposed by APG III (The Angiosperm Phylogeny Group 2009), and the classification of Lycophyte and ferns followed Smith *et al.* (2006). Species names, synonyms and correct authorship of species were verified following *Lista de Espécies da Flora do Brasil 2020* (http://floradobrasil.jbrj.gov.br).

The parameters of the horizontal structure and the Shannon diversity index were calculated following Brower *et al.* (1998). The ten sampling units were compared in relation to species abundance in each unit using correspondence analysis (CA). Species lists of UMF from six other localities in Paraná, Minas Gerais and São Paulo states (Portes *et al*. 2001, França & Stehmann 2004, Meireles *et al*. 2008, Valente *et al*. 2011, Pompeu *et al*. 2014, Meireles & Shepherd 2015; Table 1) were used in non-metric multidimensional scaling (NMDS) using the Bray-Curtis dissimilarity index to obtain the floristic similarity between locations. In NMDS, we considered only the woody component, including tree ferns. Synonyms were checked and species with inaccurate identification were excluded from the analysis. The phytosociological structure was analyzed using the Fitopac 2.1.2.85 software, and CA and NMDS were performed using the Past 3.07 software (Hammer *et al*. 2001).

We sampled 394 individuals belonging to 40 species, 21 families and 32 genera. The families Asteraceae (8 spp.), Melastomataceae (5), Myrtaceae (4) and Solanaceae (3) were the richest ones. The importance of these families in montane and upper montane vegetation was reported by Oliveira-Filho & Fontes (2000) to be a response to the altitudinal gradient. Beside altitude, biotic and

Table 1. Structural parameters and floristic richness of some upper montane vegetation in southern and southeastern Brazil. Nsp - number of species; DM - average diameter (cm); DMA - maximum diameter (cm); HM - average height (m); HMA - maximum height (m); AB - basal area ($m^2.ha^{-1}$); DT - total density ($ind.ha^{-1}$); H' - Shannon index ($nats.ind^{-1}$).

Locate	Elevation (m a.b.sl.)	Nsp	DM	DMA	HM	HMA	AB	DT	H'	Authors
Serra da Mantiqueira, MG (CAM)	1,900	70	-	-	-	-	48.12	2001	2.90	França & Stehmann (2004)
Monte Verde, MG (SMV)	1,820-1,940	64	10.22	52.20	6.33	14.00	37.68	3403	3.40	Meireles *et al.* (2008)
Quatro Barras, PR (MMC)	1,200-1,420	24	9.11	28.01	4.79	8.00	41.87	4830	2.28	Portes *et al.* (2001)
Itamonte, MG (SMI)	1,890-1,925	89	-	-	-	-	33.00	2083	3.49	Pompeu *et al.* (2014)
Serra Negra, MG (SNN)	1,300	84	-	-	-	-	38.25	3428	3.42	Valente *et al.* (2011)
Serra Fina, SP/ MG (SFCA)	1,200-1,575	24	3.55	17.00	5.38	13.00	29.85	1782.7	4.26	Meireles & Shepherd (2015)
Caparaó National Park, MG (PNC)	1,849-1,960	40	9.52	44.72	5.38	20.00	37.82	3560	2.79	This study

abiotic elements are crucial in the distribution of abundance and species richness in upper montane and cloud forests (Vázquez & Givnish 1998, Hernández *et al*. 2012).

In the horizontal structure of vegetation in PNC (Table 2), the species *Myrsine coriacea* (14.68%) and *Symplocos falcata* (14.02%) were the most important in the phytosociological sampling, mainly because they had the greatest density values on the vegetation (15.17% and 17.7%, respectively) and were the only species observed in all sampling units. The basal area was found to be 37.82 $m^2.ha^{-1}$ and the density was 3,560 ind. ha^{-1}. These values are consistent with those found for other upper montane forests studied in the southeast and south of Brazil (Table 1).

The Shannon diversity index obtained was 2.79 $nats.ind^{-1}$, and it was influenced mainly by species richness. The abundance of each species showed low uniformity, despite the apparently high evenness index (0.76), because 64.3% (229 ind.) of individuals were concentrated in only five species.

The distribution of species abundance in the evaluated transects was variable and CA (Figure 1) showed a strong association between P1, P2, P3, P4 and P8. These sampling units were related mainly to the shared species *Symplocos falcata* (Sf), *Prunus myrtifolia* (Pm), *Myrsine coriacea* (Mc) and *Leandra aurea* (La). P5 and P7 transects were associated with the species *Escallonia bifida* (Eb) and *Weinmannia* cf. *pinnata* (Wp), whereas P10 was associated with *Roupala montana* (Rm) and P9 with *Fuchsia regia* (Fr). These associations correspond to narrowing interactions of species with characteristics of their environment, such as differentiated microclimate, exposure to sunlight, moisture, soil chemistry and structure, dispersal ability and competition (McCain & Grytnes 2010).

The NMDS analysis showed strong floristic links between three locations in the Serra da Mantiqueira (CAM, SNV and SMI), possibly due to geographical proximity (Figure 2). PNC, SFCA, MMC and SNN showed no floristic

Table 2. Phytosociology of the upper montane forest in Caparaó National Park, Minas Gerais state, Brazil. N - number of individuals; K - number of sampling units; DA - absolute density ($ind.ha^{-1}$); DR - relative density (%); DoA - absolute dominance ($m^2.ha^{-1}$); DoR - relative dominance (%); FA - absolute frequency; FR - relative frequency (%); VI - importance value (%); CN - collector number; JPFZ - João Paulo Fernandes Zorzanelli; VIES - Herbário VIES.

Species	N	K	DA	DR	DoA	DoR	FA	FR	VI	CN
Myrsine coriacea (Sw.) R.Br. ex Roem. & Schult.	54	10	540	15.17	7.72	20.41	100	8.47	14.68	JPFZ 765 (VIES)
Symplocos falcata Brand	63	10	630	17.7	6.01	15.89	100	8.47	14.02	JPFZ 1465 (VIES)
Escallonia bifida Link & Otto	38	8	380	10.67	6.57	17.37	80	6.78	11.61	JPFZ 1464 (VIES)
Roupala montana Aubl.	47	6	470	13.2	5.2	13.75	60	5.08	10.68	JPFZ 854 (VIES)
Dicksonia sellowiana Hook.	27	8	270	7.58	3.78	9.99	80	6.78	8.12	JPFZ 838 (VIES)
Weinmannia cf. *pinnata* L.	13	7	130	3.65	1.72	4.55	70	5.93	4.71	-
Fuchsia regia (Vell.) Munz	15	6	150	4.21	0.37	0.98	60	5.08	3.42	-
Leandra aurea (Cham.) Cogn.	15	5	150	4.21	0.4	1.06	50	4.24	3.17	-
Clethra scabra Pers.	7	4	70	1.97	0.56	1.48	40	3.39	2.28	-
Prunus myrtifolia (L.) Urb.	5	4	50	1.4	0.71	1.88	40	3.39	2.22	-
Symplocos pentandra Occhioni	3	3	30	0.84	0.86	2.27	30	2.54	1.88	JPFZ 850 (VIES)

Continue...

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Species	N	K	DA	DR	DoA	DoR	FA	FR	VI	CN
Cyathea corcovadensis (Raddi) Domin	3	3	30	0.84	0.81	2.14	30	2.54	1.84	-
Vernonanthura hilairiana (Gardner) A.J. Vega & M. Dematteis	6	4	60	1.69	0.12	0.32	40	3.39	1.80	JPFZ 1117 (VIES)
Myrcia montana Cambess.	4	4	40	1.12	0.18	0.48	40	3.39	1.66	-
Myrceugenia ovata (Hook. & Arn.) O. Berg	5	3	50	1.4	0.19	0.50	30	2.54	1.48	-
Verbesina glabrata Hook. & Arn. Hook. & Arn.	4	3	40	1.12	0.08	0.21	30	2.54	1.29	JPFZ 1467 (VIES)
Solanum cf. *rufescens* Sendtn.	6	2	60	1.69	0.1	0.26	20	1.69	1.21	JPFZ 1116 (VIES)
Ilex aff. *microdonta* Reissek	3	3	30	0.84	0.04	0.11	30	2.54	1.16	-
Baccharis calvescens DC.	5	2	50	1.4	0.11	0.29	20	1.69	1.13	JPFZ 1463 (VIES)
Eremanthus cf. *erythropappus* (DC.) MacLeish	1	1	10	0.28	0.6	1.59	10	0.85	0.91	-
Myrcia sp.	2	2	20	0.56	0.15	0.40	20	1.69	0.88	-
Myrtaceae	1	1	10	0.28	0.54	1.43	10	0.85	0.85	-
Drimys brasiliensis Mires	2	2	20	0.56	0.09	0.24	20	1.69	0.83	-
Miconia caudigera DC.	3	1	30	0.84	0.24	0.63	10	0.85	0.77	-
Tibouchina gardneriana (Triana) Cogn.	4	1	40	1.12	0.12	0.32	10	0.85	0.76	JPFZ 1123 (VIES)
Miconia sp.	4	1	40	1.12	0.04	0.11	10	0.85	0.69	-
Leandra sp.	1	1	10	0.28	0.16	0.42	10	0.85	0.52	JPFZ 1469 (VIES)
Gaylussacia caparoensis Sleumer	2	1	20	0.56	0.02	0.05	10	0.85	0.49	JPFZ 855 (VIES)
Asteraceae	2	1	20	0.56	0.01	0.03	10	0.85	0.48	-
Vernonia sp.	1	1	10	0.28	0.1	0.26	10	0.85	0.46	-
Agarista oleifolia (Cham.) G.Don.	1	1	10	0.28	0.05	0.13	10	0.85	0.42	JPFZ 858 (VIES)
Rhamnus sphaerosperma Sw.	1	1	10	0.28	0.03	0.08	10	0.85	0.40	-
Psychotria vellosiana Vell.	1	1	10	0.28	0.03	0.08	10	0.85	0.40	-
Cestrum cf. *axillare* Vell.	1	1	10	0.28	0.03	0.08	10	0.85	0.40	-
Mikania sp.	1	1	10	0.28	0.02	0.05	10	0.85	0.39	-
Euplassa semicostata Plana	1	1	10	0.28	0.02	0.05	10	0.85	0.39	-
Clematis affinis A.St.-Hil.	1	1	10	0.28	0.01	0.03	10	0.85	0.39	-
Solanum swartzianum Roem. & Schult.	1	1	10	0.28	0.01	0.03	10	0.85	0.39	-
Maytenus evonymoides Reissek	1	1	10	0.28	0.01	0.03	10	0.85	0.39	-
Vernonanthura phosphorica (Vell.) H.Rob.	1	1	10	0.28	0.01	0.03	10	0.85	0.39	-
TOTAL	356	10	3560	100	37.82	100	1180	100	100	-

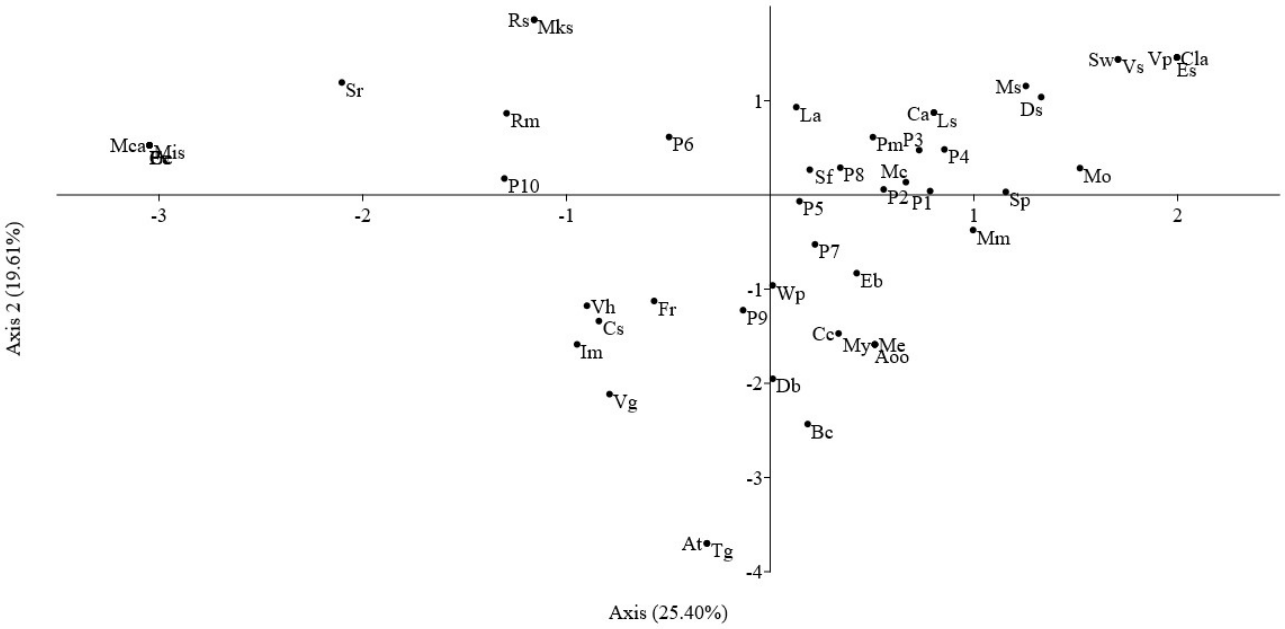

Figure 1. Correspondence analysis between species abundance and samples unities (P1, P2, P3, P4, P5, P6, P7, P8, P9 and P10) in an upper montane forest in Caparaó National Park, Minas Gerais state, Brazil.

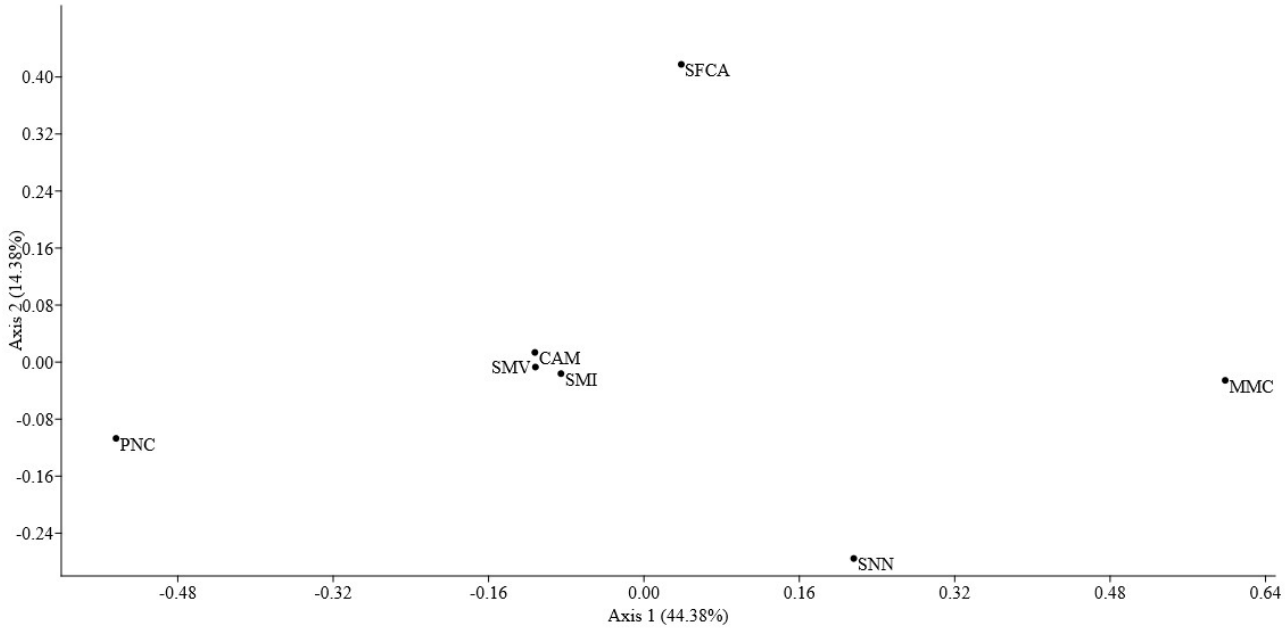

Figure 2. NMDS analysis based on Bray-Curtis similarity index (UPGMA), from the compilation of seven listing data. Where: CAM- Serra da Mantiqueira, MG; SMV- Monte Verde, MG; SMI- Itamonte, MG; MMC-Quatro Barras, PR; SNN-Serra Negra, MG; SFCA- Serra Fina, MG/SP; PNC-Caparaó National Park, MG (this study). Stress: 11.53%.

relationships among themselves, nor with the Serra da Mantiqueira group because of geographical distance and, in some cases, because they have endemic species and low species richness, like SFCA and PNC (Meireles & Shepherd 2015). Geographical distance and endemism level are not the only factors responsible for the low similarity observed in PNC. Probably the geographic

isolation (Malanson *et al*. 2015) and inherent factors in the geological formation (Noce *et al*. 2007) of the Serra do Caparaó can act together forming distinct vegetation communities in the complexes of the Serra da Mantiqueira and Serra do Mar. This floristic disparity can be also explained by the peculiarity of the vegetation where the UMF in PNC occurs, like islands amidst upland fields, restricting the dispersion processes (Baselga *et al*. 2012), a fact also associated with the isolation of these patches.

Despite the floristic differences related to the species level, the species composition at the genus level found in PNC resembles that of other places evaluated and other UMFs located in southern Bahia, as well as in other areas of the southern and southeastern regions of Brazil. Several of these genera are also shared with neotropical mountains in the Andes and Central America, such as *Weinmannia*, *Tibouchina*, *Myrsine, Drimys* and *Leandra*, evidence corroborated by Fiaschi & Pirani (2009).

Although belonging to an integral conservation area, the UMF in PNC deserves more attention regarding conservation strategies, given that the park is open to the public and its vegetation presents several peculiarities, such as unique endemic species and low floristic relationship at species level with other vegetation of the same phytophysiognomy. Other studies, to investigate the association of vegetation with soil characteristics, climate, gradient features, cloud frequency, proximity and geographical isolation, at the local and regional levels, should be performed to clarify several questions concerning the disparities in the flora observed.

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REFERENCES

Aceves, T. T., Meave, J. A., Espinosa, M. G., & Marcial, N. R. 2011. Tropical Montane Cloud Forests: current threats and opportunities for their conservation and sustainable management in México. Journal of Environmental Management, 92, 974-981. DOI: 10.1016/j.jenvman.2010.11.007

Baselga, A., Lobo, J. M., Svenning, J. C., & Araújo, M. B. 2012. Global patterns in the shape of species geographical ranges reveal range determinants. Journal of Biogeography, 39, 760-771. DOI: 10.1111/j.1365-2699.2011.02612.x

Bertoncello, R., Yamamoto, K., Meireles, L. D., & Shepherd, G. J. 2011. A phytogeographic analysis of cloud forests and other forest subtypes amidst the Atlantic forests in south and southeast Brazil. Biodiversity and Conservation 20: 3413-3433.

Brower, J. E., Zar, J. H., & Von Ende, C. N. 1998. Field and laboratory methods for general ecology. 4th ed. New York: McGraw-Hill: p.273.

Bruinjzeel, L. A., Kappelle, M., Mulligan, M., & Scatena, F. N. 2010. Tropical Montane Cloud Forests: state of knowledge and sustainability perspectives in a changing world. In: L.A. Bruinjzeel, F.N. Scatena & L.S.Hamilton (Eds.), Tropical Montane Cloud Forest: science for conservation and management. pp.691-740. Cambridge University Press.

Bubb, P., May, I., Miles, L., & Sayer, J. 2004. Cloud Forest Agenda. Cambridge: UNEP-CMC: p.36.

Doumenge, C., Gilmour, D., Pérez, M. R., & Blockhus, J. 1995. Tropical Montane Cloud Forests: conservation status and management issues. In: L.S. Hamilton, J.O. Juvik & F.N. Scatena (Eds.), Tropical Montane Cloud Forests. pp. 24-37. New York: Springer Verlag.

Fiaschi, P., & Pirani, J. R. 2009. Review of plant biogeographic studies in Brazil. Journal of Systematics and Evolution, 47(5), 477-496. DOI: 10.1111/j.1759-6831.2009.00046.x

Forster, W., & Souza, V. C. 2013. Laeliinae (Orchidaceae) do Parque Nacional do Caparaó, Estados do Espírito Santo e Minas Gerais, Brasil. Hoehnea, 40(4), 701-726.

Foster, P. 2001. The potential negative impacts of global climate change on tropical montane cloud forests. Earth-Science Reviews, 55, 73-106. DOI: 10.1016/S0012-8252(01)00056-3

França, G. S., & Stehmann, J. R. 2004. Composição florística e estrutura do componente arbóreo de uma floresta altimontana no município de Camanducaia, Minas Gerais, Brasil. Revista Brasileira de Botânica, 27(1), 19-30.

Gentry, A. H. 1988. Changes in plant community diversity and floristic composition on environmental and geographical gradients. Annals of Missouri Botanical Garden, 75(1), 1-34.

Hammer, O., Harper, D. A. T., & Ryan, P. D. 2001. PAST: Paleontological Statistics software package for education and data analysis. Paleontologia Electronica 4(1): 9pp.

Hernández, L., Dezzeo, N., Sanoja, E., Salazar, L., & Castellanos, H. 2012. Changes in structure and composition of evergreen forests on an altitudinal gradient in the Venezuelan Guayana Shield. Revista de Biología Tropical, 60(1), 11-33.

Hostettler, S. 2002. Tropical Montane Cloud Forests: a challenge for conservation. Bois et Forêts des Tropiques, 274(4), 19-31.

Instituto Brasileiro de Geografia e Estatística - IBGE. 2012. Manual técnico da vegetação brasileira. 2th ed. Rio de Janeiro: Manuais Técnicos em Geociências: p.271.

Leoni, L. S., & Chautems, A. 2004. Flora fanerogâmica do Parque Nacional do Caparaó: Gesneriaceae. Pabstia, 15, 1-11.

Luna-Vega, I., Morrone, J. J., Ayala, O. A., & Organista, D. E. 2001. Biogeographical affinities among neotropical cloud forest. Plant Systematic and Evolution, 228, 229-239.

Martinelli, G. 2007. Mountain biodiversity in Brazil. Revista Brasileira de Botânica, 30(4), 587-597.

Mazine, F. F., & Souza, V. C. 2008. Myrtaceae dos campos de altitude do Parque Nacional do Caparaó – Espírito Santo/Minas Gerais, Brasil. Rodriguésia, 59(1), 57-74.

McCain, C. M., & Grytnes, J. A. 2010. Elevational gradientes in species richness. In: Encyclopedia of Life Sciences (ELS.). Chichester: John Wiley & Sons, Ltd.

Meireles, L. D., Shepherd, G. J., & Kinoshita, L. S. 2008. Variações na composição florística e na estrutura fitossociológica de uma floresta ombrófila densa alto-montana na Serra da Mantiqueira, Monte Verde, MG. Revista Brasileira de Botânica, 31(4), 559-574.

Meireles, L. D., & Shepherd, G. J. 2015. Structure and floristic similarities of upper montane forests in Serra Fina mountain range, southeastern Brazil. Acta Botanica Brasilica, 29(1), 58-72. DOI: 10.1590/0102-33062014abb3509

Ministério do Meio Ambiente (MMA). 2008. Áreas prioritárias para a conservação, uso sustentável e repartição de benefícios da biodiversidade brasileira**.** 2nd ed. Brasília, DF: Ministério do Meio Ambiente: Secretaria de Biodiversidade e Florestas.

Noce, C. M., Pedrosa-Soares, A. C., Silva, L. C., & Alkimim, F. F. 2007. O embasamento arqueano e paleoproterozóico do orógeno Araçuaí. Geonomos, 15(1), 17-23.

Oliveira-Filho, A. T., & Fontes, M. A. L. 2000. Patterns of floristic differentiation among Atlantic Forests in southeastern Brazil and influence of climate. Biotropica, 32(4b), 793-810. DOI: 10.1646/0006-3606(2000)032[0793:POFDAA]2.0.CO;2

Pompeu, P. V., Fontes, M. A. L., Santos, R. M., Garcia, P. O., Batista, T. A., Carvalho, W. A. C., & Oliveira-Filho, A. T. 2014. Floristic composition and structure of an upper montane cloud forest in the Serra da Mantiqueira Mountain Range of Brazil. Acta Botanica Brasilica, 28(3), 456-464. DOI: 10.1590/0102-33062014abb3239

Portes, M. C. G. O, Galvão, F., & Koehler, A. 2001. Caracterização florística e estrutural de uma Floresta Ombrófila Densa Altomontana do Morro do Anhangava, Quatro Barras – PR. Revista Floresta, 31(1;2), 22-31.

Sanchez, M., Pedroni, F., Eisenlohr, P. V., & Oliveira-Filho, A. T. 2013. Changes in tree community composition and structure of Atlantic rain forest on a slope of the Serra do Mar range, southeastern Brazil, from near sea level to 1000 m of altitude. Flora, 208, 184-196, 2013. DOI: 10.1016/j.flora.2013.03.002

Scatena, F. N., Bruijnzeel, L. A., Bubb, P., & Das, S. 2010. Setting the stage. Pages 3-11 In: L.A. Bruijnzeel, F.N. Scatena & L.S. Hamilton (Eds.), Tropical Montane Cloud Forests Science for Conservation and Management. pp. 3-11. Cambridge University Press, UK.

Smith, A. R., Pryer, K. M., Schuettpelz, E., Korall, P., Schneider, H., & Wolf, P. G. 2006. A classification for extant ferns. Taxon, 55(3), 705-731.

The Angiosperm Phylogeny Group. 2009. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. Botanical Journal of the Linnean Society, 161, 105-121.

Valente, A. S. M., Garcia, P. O., Salimena, F. R. G., & Oliveira-Filho, A. T. 2011. Composição, estrutura e similaridade florística da Floresta Atlântica, na Serra Negra, Rio Preto – MG. Rodriguésia, 62(2), 321-340.

Vázquez, J. A. G., & Givnish, T. J. 1998. Homogenization dynamics of the fish assemblages in Neotropical reservoirs: comparing the roles of introduced species and their vectors. Journal of Ecology, 86, 999-1020.

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