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5 **Growth-survival trade-off in shrub saplings from Neotropical mountain grasslands**

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23 ABSTRACT

24 The growth-survival trade-off plays a central role in the coexistence of species-rich
25 plant communities. While recurrently described in forest tree communities primarily limited
26 by light availability, this trade-off is still poorly documented in grassland and savanna
27 vegetation. In this comparative study we planted in a quartzitic degraded site eight-month-old
28 saplings of eleven shrub species native from constrained mountain grassland (Brazilian
29 rupestrian grassland). We measured the relative growth rate (RGR) during a 30-week time
30 interval, leaf water potential under dry and wet conditions, and related these traits to the
31 species survival. The interspecific comparison between the saplings performance clearly
32 showed the classic growth-survival trade-off. The RGR expressed in stem diameter and
33 aboveground biomass explained respectively 62 and 40% of the variation in saplings survival
34 one year after planting, and respectively 65 and 44% of the variation in survival 4.5 years
35 after planting. This trade-off was not related to either leaf water potential or final size in
36 aboveground biomass and basal stem diameter. Our results corroborate the view that the
37 growth-survival trade-off is universally applicable, even in non-forest communities such as
38 grasslands and savannas subjected to severe nutritional deficiency, pronounced seasonal
39 drought, and high light incidence. The environmental differences in micro-habitats that
40 compose rupestrian grasslands should distinctly favour species with contrasting strategies of
41 growth and survival, thus contributing to niche partitioning and coexistence in this species-
42 rich ecosystem.

43

44 *Keywords:* ‘fast-slow’ plant economics spectrum; relative growth rate; resource-use strategy;
45 rupestrian grasslands; sapling survival.

46 **1. Introduction**

47 Growth rate and survival are two fundamental components related to plant fitness.
48 Slow-growing plants exhibit generally a set of traits such as high longevity (at the individual
49 and plant module level), well-developed capacity to accumulate reserves, more efficient
50 resorption of nutrients during organ senescence, and major investments in secondary
51 defensive compounds (Chapin et al., 1993; Aerts and Chapin, 2000; Willby, et al. 2001). In
52 this sense, several lines of evidence point to the existence of a primary axis of specialization
53 in the world flora that opposes, on the one hand, the ability to rapidly acquire resources and,
54 on the other hand, the ability to retain and conserve these resources (acquisitive and
55 conservative extremes, respectively), composing the world-wide ‘fast-slow’ plant economics
56 spectrum (Grime et al., 1997; Wright et al., 2004; Ordoñez et al., 2009; Grime and Pierce,
57 2012; Reich, 2014). The trade-offs subjacent to this single economics spectrum are frequently
58 invoked to explain coexistence in species-rich plant communities, allowing the partition of
59 niches along multiple resource availability gradients (i.e., related to nutrients, water,
60 luminosity, or space), thus favouring different strategies in heterogeneous environments
61 (Kneitel and Chase, 2004; Baraloto et al., 2005; Sterck et al., 2006; Wright et al., 2010).

62 The mechanisms behind these trade-offs vary depending on the overarching
63 environmental factors to which plant communities are subjected (e.g. nutrient, light, or water
64 limitation, and recurrent perturbation such as fire). However, while the trade-off between
65 growth and survival seems to be universally applicable (see, Fine et al., 2006), this
66 phenomenon is only widely and recurrently documented in tree species, and in forest
67 communities primarily limited by light availability, such as tropical forest tree species
68 (Kitajima, 1994; Dalling and Hubbell, 2002; Wright et al., 2003, 2010; King et al., 2006;
69 Poorter and Bongers, 2006; Myers and Kitajima, 2007; Poorter et al., 2008; Russo et al.,
70 2008; Suzuki et al., 2009), and in temperate forests (Walters and Reich, 1996; Seiwa, 2007;

71 Bigler and Veblen, 2009). The scarcity of such studies in ecosystems subjected to different
72 selective pressures and dominated by herbaceous and shrubby life forms (e.g., grasslands and
73 savannas) makes it uncertain whether the trade-off between growth and survival is a common
74 phenomenon in systems which are distinct from closed-canopy forest communities.

75 Among the most ancient grassy ecosystem of the world are the rupestrian grasslands
76 (also known as *campos rupestres*), which is a unique ecosystem that occurs mainly on the
77 peaks and ridges of the mountains that comprise the Espinhaço mountain range in
78 southeastern Brazil (Veldman et al., 2015; Silveira et al., in press). Rupestrian grasslands
79 exhibit the classical features of OCBILs: very old, climatically buffered, infertile landscapes
80 (Hopper et al., in press), and as such, this ecosystem is of recognized importance in the
81 worldwide conservation scenario due to its enormous biodiversity (5011 vascular plant
82 species distributed in 66,447 km²) and large proportion of endemism (some dominant families
83 endemism rates ranging from 60 to 80%, such as Velloziaceae and Eriocaulaceae) (Silveira et
84 al., in press). The vegetation that predominantly consists of a dominant herbaceous *stratum*
85 interspersed with some small evergreen sclerophyllous shrubs is subjected to strong
86 environmental stresses mainly due to the extremely infertile soils of quartzite and sandstone
87 origin, pronounced seasonal drought, intense light, and strong and constant winds (de
88 Carvalho et al., 2014; Negreiros et al., 2014b; Le Stradic et al., 2015; Oliveira et al., 2015;
89 Silveira et al., in press).

90 The present study aimed to test the existence of a negative relationship between
91 relative growth rate (RGR) and survival of shrubs species adapted to constrained
92 environmental conditions occurring in rupestrian grasslands (i.e., high light incidence,
93 extremely low nutrient availability, and recurrent fire; Veldman et al., 2015; Silveira et al., in
94 press). It was expected that species with lower growth rate would have greater survival rates
95 due to higher investments in functions that increase retention and conservative use of acquired

96 resources (Aerts and van der Peijl, 1993, Arendt, 1997; Grime and Pierce, 2012). In order to
97 investigate the possible factors involved in the growth-survival trade-off, we examined the
98 relationship between water stress resistance and the growth and survival rates of species.
99 Since rupestrian grasslands are subjected to a pronounced seasonal dry period, we expected
100 that drought tolerance could be a strong determinant of sapling establishment (Markesteijn
101 and Poorter, 2009; Assis et al., 2011).

102

103 **2. Material and methods**

104 *2.1. Study area and selected species*

105 This study was carried out in the Reserva Natural Vellozia (19°17'46"S, 43°35'28"W,
106 approximate altitude 1,200 m a.s.l.) located in the Morro da Pedreira Environmental
107 Protection Area, Serra do Cipó, southern portion of the Espinhaço mountain range, Minas
108 Gerais, Brazil, where rupestrian grasslands predominates. The local climate is considered
109 mesothermal (Cwb according to Köppen classification), markedly seasonal, with two well-
110 defined seasons: one hot and rainy (between November and April) and the other dry and
111 colder (between May and October), with annual precipitation of 1,534 mm and a mean annual
112 temperature ranging from 15.1 to 20.7°C (Alvares et al., 2013; data from Santana do Riacho
113 municipality).

114 Among the sympatric and native shrubs from rupestrian grassland that occur in the
115 vicinity of the study area, we selected eleven species belonging to six different families:
116 *Dasyphyllum reticulatum* (DC.) Cabrera (Asteraceae); *Jacaranda caroba* (Vell) A. DC.
117 (Bignoniaceae); *Chamaecrista semaphora* (HS Irwin & Barneby) HS Irwin & Barneby
118 (Fabaceae: Caesalpinioideae); *Calliandra fasciculata* Benth. var. *bracteosa* (Bentham)
119 Barneby (Fabaceae: Mimosoideae); *Mimosa foliolosa* Benth. ssp. *pachycarpa* (Bentham)
120 Barneby (Fabaceae: Mimosoideae); *Collaea cipoensis* Fortunato (Fabaceae: Papilionoideae);

121 *Diplusodon hirsutus* (Cham. & Schltd) DC. and *Diplusodon orbicularis* Koehne (Lythraceae);
122 *Heteropterys byrsonimifolia* A. Juss. (Malpighiaceae); *Marcetia taxifolia* (A. St.-Hil.) DC.
123 (Melastomataceae); *Tibouchina heteromalla* (D. Don) Cogn. (Melastomataceae). These
124 shrubs are relatively abundant in the study area, and produce a high number of viable seeds
125 (see Le Stradic et al., 2014).

126

127 2.2. Experiment preparation

128 Seeds of each species were collected manually in the field from mature fruits in more
129 than ten adult individuals per species. Seeds that did not present signs of predation,
130 pathogens, or malformation have been selected. At the end of November 2002 (Fig. 1),
131 selected seeds were sown directly into prepared substrate (one seed per container) contained
132 in black polyethylene bags (8 cm in diameter and 20 cm deep). For the four Fabaceae species
133 dormancy breaking by mechanical scarification was necessary. The substrate used for
134 growing the saplings was composed of equal parts of subsoil, peat, and an organic compound
135 (consisting of tanned equine manure with sawdust at a 1:1 proportion), following Negreiros et
136 al. (2009). For acidity correction and nutritional enrichment, 2 dm³ of CaCO₃ and 1 dm³ of
137 NPK (4:14:8) in 360 dm³ of substrate were added. The resulting compound was thoroughly
138 mixed until homogenized and used to fill the containers. For a detailed description of the
139 greenhouse phase, and chemical and granulometric characterization of the saplings cultivation
140 substrate, see Negreiros et al. (2009). During five months saplings grew in a greenhouse with
141 50% of shade and were irrigated by micro-aspersion for 15 minutes, three times a day,
142 receiving a total of 17.5 mm of water per day. At the end of April 2003 (end of the rainy
143 season; Fig. 1) saplings were transferred to the open air with gradual reduction of water
144 supply in order to be acclimated before being planted in a permanent site.

145 At the end of July 2003 (peak of the dry season; Fig. 1), 96 saplings of each species
146 were planted in an approximately 0.5 ha site degraded by the removal of gravel for road
147 construction, and located close to the greenhouse (for chemical and granulometric details
148 about the soil of the degraded area where the saplings were planted, see Negreiros et al.,
149 2009). For each species, six 4 m² plots, positioned randomly in the degraded area, were
150 allocated. In each plot, 16 saplings of the same species were planted in a regular spacing of
151 0.5 m between individuals, totalling 96 saplings per species. Four plots were designated for
152 survival monitoring, while two plots were intended for destructive samplings of aboveground
153 biomass and other measures (see details in section 2.3). Since the planting was carried out in
154 the dry season, the plants were irrigated with sprinklers for 15 minutes every 10 days, during
155 the first two months.

156

157 *2.3 Evaluation of growth and water potential*

158 For the calculation of RGR, destructive samplings were made in aboveground biomass
159 of saplings in two dates: on the date of planting, and 30 weeks after planting (February 2004;
160 Fig. 1). In each sampling, eight saplings of each species had their stem diameters at ground
161 level measured with a digital calliper (0.01 mm of precision). In order to determine the shoot
162 dry biomass, the aboveground parts of the plants were cut, dried in oven at 70°C until
163 constant weight was reached, and weighted in analytic scale (precision of 0.001 g) according
164 to Chiariello et al. (1989). The RGR in aboveground biomass (RGR_{biomass}) and in stem
165 diameter (RGR_{diameter}) of each species was calculated according to Hunt (1982): RGR_{biomass}
166 $(\ln W_2 - \ln W_1) / (t_2 - t_1)$; $RGR_{\text{diameter}} (\ln D_2 - \ln D_1) / (t_2 - t_1)$, where W_2 and D_2 are, respectively, the
167 average aboveground dry weight, and the average stem diameter at the end of the evaluation
168 (30 weeks after planting); W_1 and D_1 are, respectively, the average dry weight, and the
169 average diameter on the date of planting; t_2 and t_1 are, respectively, the final and initial time of

170 evaluation (with a 30-week interval). The average values of aboveground dry biomass and
171 stem diameter at 30 weeks after planting were used as indicators of the final plant size.

172 For determination of the plant water potential, the predawn leaf water potential (Ψ_{pd})
173 was measured in plants with a portable Scholander pressure bomb (PMS-600, Covalis,
174 Oregon, USA) between 3 and 5 a.m. in vertically oriented leader twigs (Scholander et al.,
175 1965). This technique has been widely used to infer plant water stress in different situations
176 (Saha et al., 2008). The measurements were made in the field, on the main branch of eight
177 saplings per species (immediately after cutting of the branch), at the end of the dry season
178 (Ψ_{dry} ; early October 2003) and during the rainy season (Ψ_{wet} ; December 2003; Fig. 1). These
179 two dates were chosen to compare the water potential of plants in conditions of apparent
180 water stress (Ψ_{dry}), and in the absence of such stress (Ψ_{wet}). The difference between the water
181 potential in the rainy and dry season (in MPa) was used as an indication of the degree of
182 susceptibility of the species to water deficit, with higher values indicating greater stress.

183

184 *2.4. Survival monitoring*

185 In August 2004 (1 year after planting; Fig. 1) sapling survival of plants in the
186 monitoring plots was recorded in the four plots dedicated to the survival monitoring per
187 species. Additionally, we obtained the survival after 4.5 years of the planting (February 2008)
188 from the study of Le Stradic et al. (2014), which reported the survival for the same plots after
189 the completion of the initial study reported here. Survival monitoring was calculated as the
190 percentage of living individuals relative to the total number of planted individuals ($n = 64$ per
191 species).

192

193 *2.5. Statistical analyses*

194 To achieve the assumptions of normality, the values of final aboveground dry biomass
195 and final basal stem diameter were transformed logarithmically. Since survival after 1 year
196 and after 4.5 years showed a negative skewness, these variables were reflected prior to and
197 after the transformation (square root), according to Quinn and Keough (2002). The values of
198 survival after 1 and 4.5 years were treated as dependent variables. In order to identify the
199 main axes of trait variation (RGR, final size, and water potential) a principal component
200 analysis (PCA) was made. Varimax rotation was applied to the eigenvectors to simplify the
201 interpretation of retained components. The correlation between the species coordinates in the
202 two main axes and the dependent variables was examined. Additionally, linear regression
203 analyses were employed to obtain the relationship between the measured plant traits and the
204 dependent variables (Quinn and Keough, 2002).

205

206 **3. Results**

207 The 11 species assessed in this study showed a wide range of values in the measured
208 traits (Table 1). The two main components of the PCA corresponded to 80.5 % of the total
209 trait variation measured in plants (Fig. 2). The positive side of PCA axis 1 corresponded to
210 species with larger final size (i.e. greater biomass and diameter at 30 weeks after planting) and
211 more resistant to water deficit (i.e. minor water potential variation between rainy and dry
212 seasons). On the other hand, the PCA 2 axis separated on the positive side the species with
213 larger RGR in biomass and diameter. This axis correlated negatively with the survival
214 recorded after 1 year ($r = -0.695$; $p < 0.05$) and 4.5 years ($r = -0.742$; $p < 0.01$) of planting on
215 degraded area (Fig. 2). Confirming this trend, we found a negative relationship between the
216 survival (either 1 and 4.5 years after planting) and the RGR of plants (based on stem diameter
217 and aboveground biomass). The RGR in diameter and biomass explained, respectively, 62.2
218 and 40.1 % of the variation in sapling survival 1 year after planting (Fig. 3a-b). Similarly, the

219 RGR in diameter and biomass explained, respectively, 65.0 and 43.8 % of the variation in
220 survival 4.5 years after planting (Fig. 3c-d).

221

222 **4. Discussion**

223 The interspecific comparison of growth and survival rates of the rupestrian grasslands
224 shrubs planted in degraded area showed that, in general, slow-growing species had higher
225 survival rates, whereas fast-growing species presented higher mortality rates. This observation
226 is in agreement with the classical predictions of resource economics strategies (Aerts and van
227 der Peijl, 1993; Grime et al., 1997; Reich, 2014) and confirms the central hypothesis of this
228 study, that the growth survival trade-off is also evident in shrubs from low nutrient and high
229 light environments.

230 There are a large number of examples of trade-off between growth rate and survival in
231 animals (Mangel and Stamps, 2001) whereas almost all examples pertaining to this trade-off
232 in plants are restricted to tree species' seedlings, saplings, and young plants from closed
233 canopy ecosystems (e.g., Kitajima, 1994; Dalling and Hubbel, 2002; Wright et al., 2003,
234 2010; Poorter and Bongers, 2006; Poorter et al., 2008). In these environments, the dynamics
235 of disturbances that create clearings lead to gradients of light availability that distinctly
236 benefit species along a continuum ranging from shade-tolerant species (with slow growth and
237 high survival rates in low light situation) to pioneer species (with rapid growth and high
238 mortality rates in a situation of greater luminosity). The mechanisms underlying this trade-off
239 relate to differences in the relative investment in defences against herbivores and pathogens,
240 in the density of woody structures, and in traits related to the leaf economics spectrum (King
241 et al., 2006; Poorter and Bongers, 2006; Sterck et al., 2006; Myers and Kitajima, 2007). Even
242 in these forest environments where light availability plays a key role, there are indications that

243 factors related to moisture and soil fertility also influence the growth and survival rates of the
244 species (Pearson et al., 2003; Russo et al., 2008).

245 Since stressful conditions may be caused by a lack or excess of light, water, nutrients,
246 or temperature (Grime, 1977), it is expected that in several habitats with different selective
247 pressures it can be possible to detect this negative relationship between growth and stress
248 tolerance. Correspondingly, Loehle (1998) reports a trade-off between the growth rate in
249 height and tolerance to freezing as a probable cause of the northern and southern limits in tree
250 species. Also, Perez-Ramos et al. (2013) reported greater survival and resistance to water
251 stress in grasses from the conservative extreme of the plant economics spectrum. There are
252 evidences that the plant economics spectrum is largely independent from the growth form,
253 taxonomic affinity, characteristics of the environment, and geographic location (Reich et al.,
254 1999; Wright et al., 2004, Díaz et al., 2016). Therefore, it is likely that the rarity of reports of
255 trade-off between growth and survival in herbaceous or shrubby communities is simply a
256 result of the scarcity of studies of this nature in open ecosystems (e.g., deserts, grasslands and
257 savannas). Despite being rare, there are some scattered examples in the literature showing the
258 trade-off between growth and survival in non-forest communities, such as in annual plants of
259 the Sonoran Desert, USA (Angert et al., 2009), in perennial plants of smaller height that form
260 rosettes (Metcalf et al., 2006) and in the shrub species of semi-arid Karoo, South Africa
261 (Wiegand et al., 2000). Although the large-scale study of Lind et al. (2013) did not evaluate
262 mortality of plants, it showed evidences that in grassland ecosystems, there is effectively a
263 trade-off between growth and investment in anti-herbivore defences, thus reinforcing the
264 universality of the growth-defence trade-off (Fine et al., 2006).

265 The precise factors that caused mortality in the saplings were not evaluated in this
266 study, but the causes ranged from pathogens and insect herbivores to physiological stresses,
267 since the saplings grew protected from disturbances such as trampling or burning. Therefore,

268 the survival of the evaluated shrubs may be linked to relative investments in conservative
269 traits, with higher survival in species that maximize defensive traits and/or tolerance to
270 stresses.

271 While seasonal water deficit was expected to act as a strong force in structuring
272 rupestrian grasslands communities (Porembski & Brathlott, 2000; Negreiros et al., 2014b;
273 Silveira et al.; in press), our study showed that water stress resistance plays a minor role in the
274 survival of planted shrubs, which imply that other factors are involved to structure such plant
275 communities. All evaluated species were relatively resistant to water deficit in the dry season,
276 since these species showed a very low difference between the water potential in rainy and dry
277 seasons. Other factors might play a more important role for structuring rupestrian grassland
278 communities, such as phosphorus deficiency or fire (Le Stradic et al. 2015; Oliveira et al.,
279 2015; Silveira et al., in press). However, since we measured only a small subset of rupestrian
280 grassland flora, future studies including more species are needed to confirm this trend. The
281 size of plants at the end of evaluation was also weakly coupled with the growth-survival
282 trade-off. Accordingly, large-scale comparative studies (e.g. Pierce et al., 2013, Díaz et al.,
283 2016) suggest that size related traits (both whole plant and leaf traits) vary independently in
284 relation to plant economics spectrum traits (e.g. RGR, specific leaf area, leaf dry matter
285 content, and leaf toughness).

286 The negative relationship between growth and survival has been well documented in a
287 situation that compares survival in stressful conditions (lack of luminosity) and growth in
288 favourable conditions (adequate luminosity). However, environmental heterogeneity is not a
289 pre-requisite to the detection of the growth-survival trade-off, since this trade-off can also be
290 detected in the same habitat and environmental condition (see, Russo et al., 2008). Similarly,
291 in our study the sympatric shrubs adapted to chronic limited resources showed distinct growth
292 and persistence abilities even though these shrubs grew in homogenous and semi-controlled

293 environment. On the other hand, the interplay between intraspecific variability and
294 environmental heterogeneity allows the existence of the growth-survival trade-off even in the
295 intraspecific scale (e.g., Seiwa, 2007; Negreiros et al., 2014a).

296 Strong environmental stresses (e.g., extreme nutritional deficiency, high luminosity,
297 and pronounced seasonal drought) imply that plant species present variations in trait
298 responses to these edaphic conditions. However, in addition to these life history singularities,
299 there are countless variations in micro relief and soil texture that modify water, microclimatic,
300 and nutritional regimes in reduced spatial scale that generate and support a very complex
301 vegetation mosaics (de Carvalho et al., 2014; Le Stradic et al., 2015, Silveira et al., in press).
302 Thus we argue here that the interaction between this rich environmental heterogeneity and the
303 intrinsic position of rupestrian grassland species into the ‘fast-slow’ plant economics
304 spectrum must play a fundamental role in the mechanisms responsible for niche partitioning
305 and coexistence of the enormous diversity of species in this ecosystem (Silveira et al., in
306 press).

307

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318

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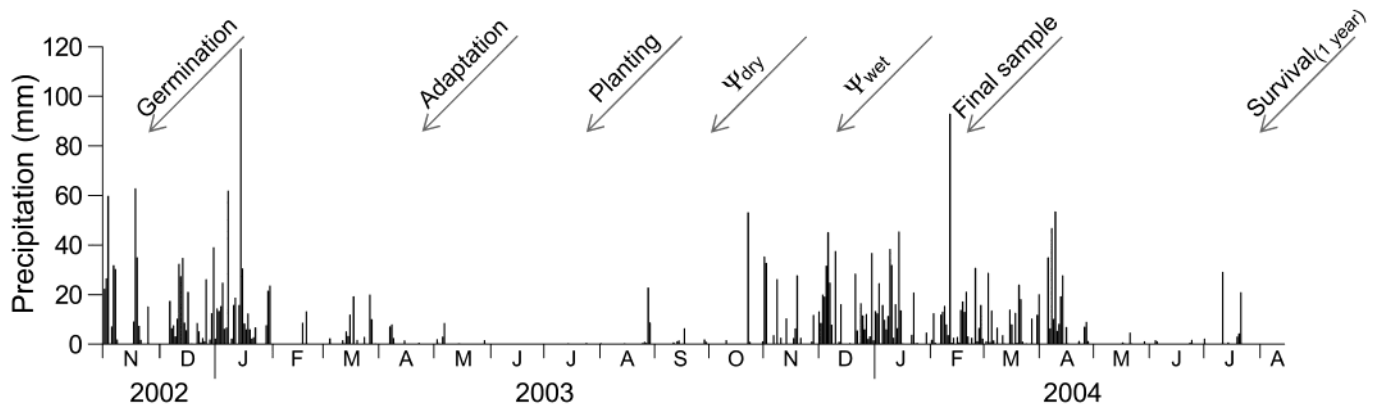


Fig. 1. Daily values of precipitation (mm) during the study period (October 2002 to September 2004), in Serra do Cipó, MG, Brazil. Data obtained from the Meteorological Database for Education and Research (BDMEP) of the National Institute of Meteorology (INMET), meteorological station of Conceição do Mato Dentro, MG, Brazil, located approximately 30 km away from the study area. Vertical dashed lines indicate the dates of the experimental main stages. **Germination:** seeds put in the greenhouse to germinate; **Adaptation:** sapling transferred from the greenhouse to open air; **Planting:** sapling planting in degraded areas and initial measurements of aboveground biomass and stem diameter; **Ψ_{dry}** and **Ψ_{wet}**: water potential measurements in the dry and rainy season, respectively; **Final sample:** measurements of aboveground biomass and stem diameter 30 weeks after planting; **Survival_(1 year):** evaluation of survival one year after planting.

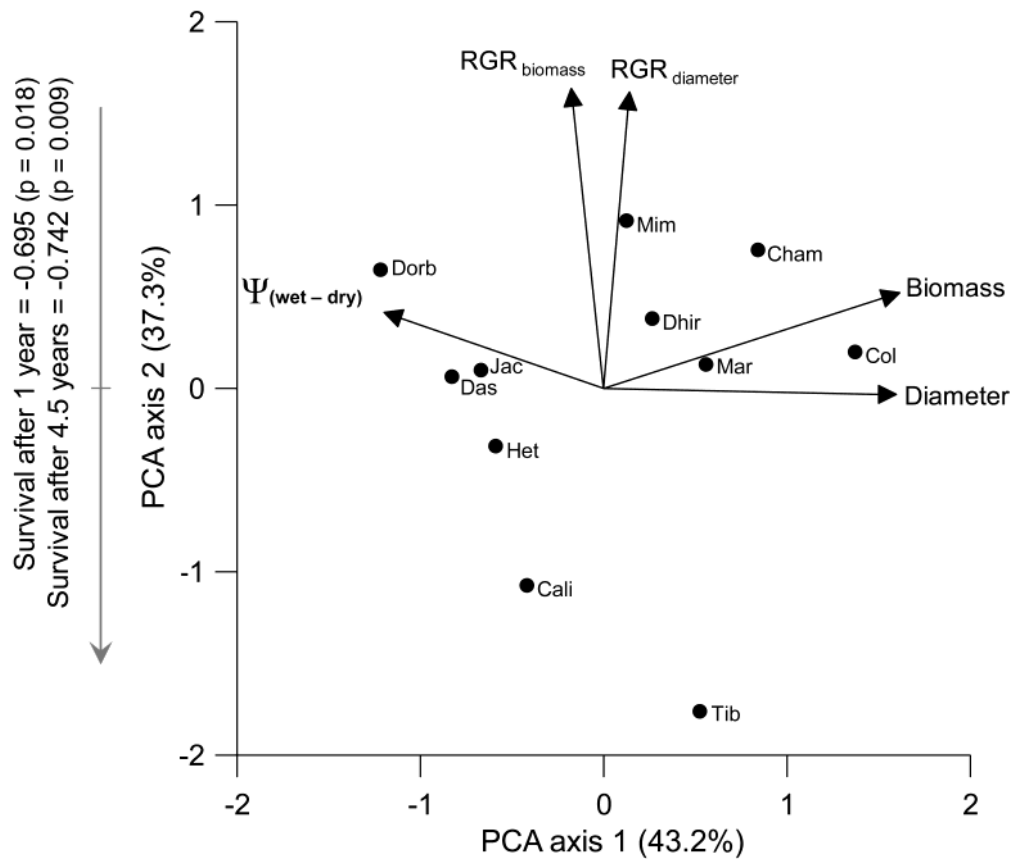


Fig. 2. Principal component analysis (PCA) on the matrix of 11 shrub species (points) \times 5 mean traits (arrows) evaluated in plants grown in degraded quartzitic site in Serra do Cipó, MG, Brazil. Eigenvalues are indicated in brackets on each axis. Biomass and Diameter: average sapling final size in aboveground biomass and stem base diameter at 30 weeks after planting; $\Psi_{(wet-dry)}$: difference between mean leaf water potential (pre-dawn) in the rainy and dry seasons; Survival_(1 year) and Survival_(4.5 years): survival rate at 1 and 4.5 years after planting (n = 64 individuals per species); $RGR_{biomass}$ and $RGR_{diameter}$: relative growth rate in biomass and diameter, respectively, estimated in the time interval between 0 and 30 weeks after planting. Transformation of variables was indicated where applicable. $\sqrt_{refl.}$: Square root applied to reflected variable (see details in section 2.5). Significant Pearson correlations ($\alpha = 0.05$) between two principal axes retained in the PCA and dependent variables (survival after 1 and 4.5 years after planting) are shown. See Table 1 for species abbreviation codes.

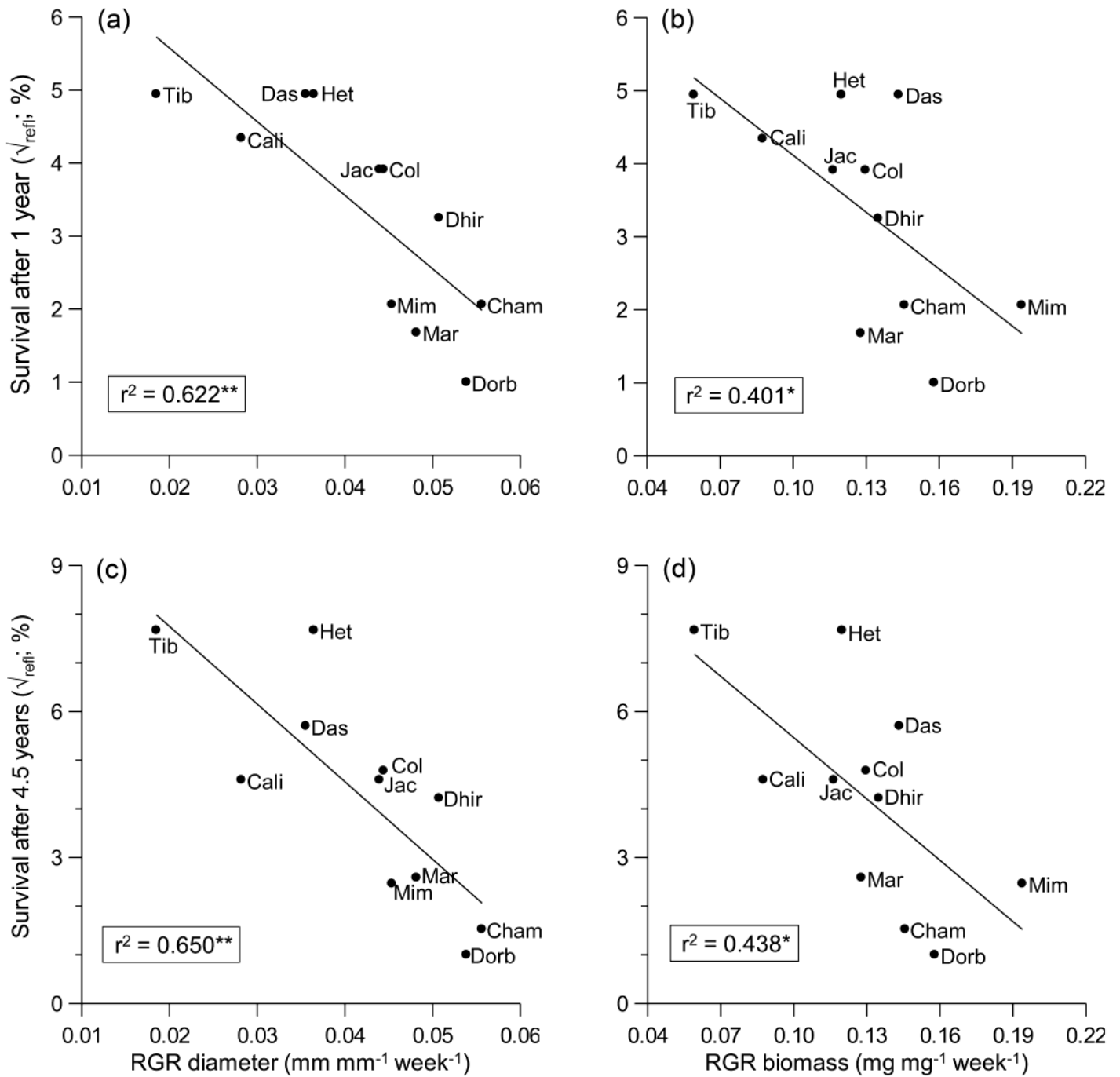


Fig. 3. Relationship between survival 1 year after planting in degraded quartzitic area and: (a) relative growth rate in stem diameter ($\text{RGR}_{\text{diameter}}$); (b) relative growth rate in aboveground biomass ($\text{RGR}_{\text{biomass}}$). Relationship between survival 4.5 years after planting and: (c) $\text{RGR}_{\text{diameter}}$ and (d) $\text{RGR}_{\text{biomass}}$. Transformation of the variables was indicated where applicable. $\sqrt{\text{refl.}}$: Square root applied to reflected variable (see details in

section 2.5). The regression line, the coefficient of determination and significance of the relationship are shown. *: $p < 0.05$, **: $p < 0.01$. Points represent the mean trait value for each species ($n = 11$). See Table 1 for species abbreviation codes.

Table 1.

Parameters measured in rupestrian grassland shrubs saplings planted in a degraded quartzitic area in Serra do Cipó, MG, Brazil. The values refer to the mean \pm standard error (n = 8 individuals per species). **cod.**: species abbreviation codes. **Biomass** and **Diameter**: respectively, aboveground dry weight and stem diameter at ground level of the saplings 30 weeks after planting. Ψ_{dry} and Ψ_{wet} : Leaf water potential (pre-dawn) measured respectively, at the end of the dry season and at the peak of the rainy season. $\Psi_{(\text{wet} - \text{dry})}$: difference between mean water potential in the rainy and dry seasons; **RGR_{biomass}** and **RGR_{diameter}**: respectively, relative growth rate in aboveground biomass and in stem diameter, estimated in the time interval between zero and 30 weeks after planting; **Survival_(1 year)**: percentage of survival one year after planting (n = 64 individuals per species).

Species	cod.	Biomass (g)	Diameter (mm)	Ψ_{dry} (MPa)	Ψ_{wet} (MPa)	$\Psi_{(\text{wet} - \text{dry})}$ (MPa)	RGR _{biomass} (mg mg ⁻¹ week ⁻¹)	RGR _{diameter} (mm mm ⁻¹ week ⁻¹)	Survival _(1 year) (%)
<i>Dasyphyllum reticulatum</i>	Das	13.8 \pm 1.4	5.5 \pm 0.5	-0.72 \pm 0.04	-0.20 \pm 0.05	0.52	0.143	0.036	100.0
<i>Jacaranda caroba</i>	Jac	11.1 \pm 2.2	8.7 \pm 0.1	-1.04 \pm 0.09	-0.32 \pm 0.06	0.72	0.116	0.044	96.9
<i>Chamaecrista semaphora</i>	Cham	65.2 \pm 12.5	10.3 \pm 0.7	-0.37 \pm 0.02	-0.23 \pm 0.02	0.14	0.146	0.056	85.9
<i>Calliandra fasciculata</i>	Cali	8.2 \pm 3.8	6.4 \pm 1.1	-0.47 \pm 0.04	-0.27 \pm 0.01	0.20	0.088	0.028	98.4
<i>Mimosa foliolosa</i>	Mim	27.7 \pm 11.7	8.8 \pm 1.9	-0.43 \pm 0.01	-0.15 \pm 0.05	0.27	0.194	0.045	85.9
<i>Collaea cipoensis</i>	Col	106.3 \pm 10.7	13.8 \pm 0.5	-0.23 \pm 0.03	-0.14 \pm 0.01	0.09	0.130	0.044	96.9
<i>Diplusodon hirsutus</i>	Dhir	26.3 \pm 3.5	8.5 \pm 0.7	-0.47 \pm 0.04	-0.29 \pm 0.03	0.18	0.135	0.051	93.7
<i>Diplusodon orbicularis</i>	Dorb	5.5 \pm 2.4	3.8 \pm 0.6	-0.58 \pm 0.06	-0.30 \pm 0.06	0.28	0.158	0.054	76.6
<i>Heteropterys byrsonimifolia</i>	Het	11.6 \pm 1.1	5.4 \pm 0.8	-0.63 \pm 0.06	-0.35 \pm 0.10	0.28	0.120	0.036	100.0
<i>Marcetia taxifolia</i>	Mar	28.8 \pm 3.4	9.0 \pm 0.7	-0.30 \pm 0.04	-0.28 \pm 0.02	0.02	0.128	0.048	82.8
<i>Tibouchina heteromalla</i>	Tib	17.7 \pm 3.1	9.8 \pm 0.7	-0.14 \pm 0.01	-0.13 \pm 0.02	0.01	0.059	0.019	100.0