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# Co-father relationships among the Suruí (Paite) of Brazil

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Partible paternity refers to the conception belief that children can have multiple fathers (“co-fathers”) and is common to indigenous cultures of lowland South America. The nature of social relationships observed between co-fathers reveals information about the reproductive strategies underlying partible paternity. Here we analyze clan, genealogical, and social relationships between co-fathers for the Suruí, an indigenous horticultural population in Brazil. We show that co-fathers roughly assort into two separate categories. In the affiliative category, co-father relationships are amicable when they are between close kin, namely brothers and father-son. In the competitive category, relationships are more likely of avoidance or open hostility when between more distant kin such as cousins or unrelated men of different clans. Results therefore imply multiple male mating strategies, including both cooperative and competitive contexts, under the rubric of partible paternity. The complexities of partible paternity institutions add to our knowledge of the full range of cross-cultural variation in human mating/marriage arrangements and speak to the debate on whether or not humans should be classified as cooperative breeders.

2 **Co-father relationships among the Suruí (Paite) of Brazil**

3

4 Running title: Suruí co-fathers

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17 **Abstract**

18

19 Partible paternity refers to the conception belief that children can have multiple fathers (“co-fathers”)  
20 and is common to indigenous cultures of lowland South America. The nature of social relationships  
21 observed between co-fathers reveals information about the reproductive strategies underlying partible  
22 paternity. Here we analyze clan, genealogical, and social relationships between co-fathers for the Suruí,  
23 an indigenous horticultural population in Brazil. We show that co-fathers roughly assort into two  
24 separate categories. In the affiliative category, co-father relationships are amicable when they are  
25 between close kin, namely brothers and father-son. In the competitive category, relationships are more  
26 likely of avoidance or open hostility when between more distant kin such as cousins or unrelated men  
27 of different clans. Results therefore imply multiple male mating strategies, including both cooperative  
28 and competitive contexts, under the rubric of partible paternity. These complexities of partible  
29 paternity institutions add to our knowledge of the full range of cross-cultural variation in human  
30 mating/marriage arrangements and speak to the debate on whether or not humans should be classified  
31 as cooperative breeders.

32

33 Keywords: Partible paternity, multiple fathers, reproductive strategies, cooperative breeding, Amazonia

34

35 **Introduction**

36

37 Partible paternity refers to the concept that children can have more than one genitor (Beckerman et al.,  
38 1998). In contrast to the realities of sexual reproduction, conception under partible paternity is thought  
39 to be a cumulative process that involves seminal inputs from multiple men in the production of  
40 offspring. Such an outlook on reproduction is accompanied by polygynandrous mating and  
41 institutionalized forms of extramarital relationships in addition to marital bonds (Beckerman &  
42 Valentine, 2002). Intriguingly, partible paternity appears almost exclusively in lowland South America  
43 where it is nearly ubiquitous in the Arawá, Carib, Macro-Jê, Pano, and Tupi language families (Walker  
44 et al., 2010). At last count, we know of 61 societies across Greater Amazonia with traditional beliefs in  
45 partible paternity and only 24 with singular paternity beliefs. Ethnographic descriptions of partible and  
46 singular paternity cultures suggest important differences in sociosexual dynamics between these two  
47 categories of societies, particularly in the degree to which female sexual autonomy and extramarital  
48 relationships are tolerated (Beckerman & Valentine, 2002; Walker et al., 2010).

49

50 Where relevant information is available, some amount of investment by secondary fathers towards the  
51 mother and putative offspring has been noted for a number of partible paternity societies (e.g., Alès,  
52 2002; Beckerman & Lizarralde, 2013; Beckerman & Valentine, 2002; Crocker, 2002; Hill & Hurtado,  
53 1996; Kensinger, 2002). Among Barí horticulturalists of Colombia and Venezuela, unmarried women  
54 recruited greater numbers of secondary fathers for their children than married women (Beckerman &  
55 Lizarralde, 2013), suggesting a strategy aimed at maximizing male investment by women without a  
56 long-term mate. In the Ache hunter-gatherers of Paraguay, co-fathers were more likely to live together  
57 in the same band, as well as more likely to be related than men who were not co-fathers, suggesting  
58 that women chose co-fathers who were more likely and more able to invest in themselves and offspring  
59 (Ellsworth et al., 2014). In a milieu of unreliable paternal investment, provisioning and other forms of  
60 assistance by co-fathers could have important consequences for female reproductive success and child  
61 survival. Studies examining the effects of co-fathers among the Ache and Barí have shown that, where  
62 co-fathers invest in putative children and/or their mothers, this investment leads to higher rates of  
63 survival for children with multiple fathers (Beckerman & Lizarralde, 2013; Beckerman et al., 1998;

64 Beckerman & Valentine, 2002; Hill & Hurtado, 1996). That investment by secondary fathers drives  
65 this effect of increased survivorship of children with multiple fathers is supported by both Ache and  
66 Bari data where children with two fathers had the highest survival prospects, while children who did  
67 not have secondary fathers but whose siblings did, did not show increased odds of survival (Beckerman  
68 & Lizarralde, 2013; Hill & Hurtado, 1996).

69  
70 Cooperative breeding is a social system in which individuals help care for offspring that are not their  
71 own at the expense of their own direct reproduction (Emlen, 1991). This definition is often extended to  
72 include care from all non-maternal helpers, including putative fathers (Hrdy, 2000, 2009), and those  
73 whose direct reproduction is not affected such as sub-adults (Kramer, 2005) and grandparents (Hawkes  
74 et al., 1997) even in systems like humans with low reproductive skew. While extensive cooperation in  
75 humans has led a number of authors to espouse cooperative breeding as an apt description of human  
76 systems (Mace & Sear, 2005; Hill & Hurtado, 2009; Kramer, 2010; Hill et al., 2011; Sear & Coall  
77 2011; Meehan et al., 2013), there is the issue that many human adults appear to be primarily concerned  
78 with their own reproduction and that much human behavior is clearly related to competitive breeding,  
79 including male-male competition, status striving, manipulation, and conflicts of interest even within  
80 families (Strassmann, 2011; Strassmann & Garrard, 2011). Partible paternity has been used as an  
81 example of cooperative breeding (Hrdy, 2000, 2009), but perhaps more caution is warranted in clearly  
82 determining the underlying motivation of actual individual behaviors. After all, are partible paternity  
83 practices generally cooperative or competitive or both?

84  
85 Our focus here on co-fathers is driven by a previous emphasis on mothers where partible paternity  
86 appears to make logical sense if she can garner investment from multiple mates, choosing co-fathers in  
87 ways that maximize the likelihood and amount of investment in themselves and their offspring. With  
88 regard to men, the benefits are less obvious; why for example do men tolerate being cuckolded and risk  
89 costly investment in the care of other men's children? It is hypothesized that benefits may derive from  
90 increased mating access to more females, and, by extension, greater chances of siring offspring with  
91 multiple females (mate competition hypothesis). Another hypothesized benefit to men of partible  
92 paternity is the establishment and strengthening of alliances or kinship bonds between men who are co-  
93 fathers of the same children (male alliance hypothesis). This hypothesis predicts that co-fathers will  
94 have affiliative types of relationships such as being close relatives or friends but is complicated by the  
95 fact that women with latitude to choose mates may also often do so in ways that minimize jealousy  
96 between co-fathers. Regardless, only the male alliance hypothesis can be classified as cooperative  
97 breeding, while mate competition cannot.

## 98 99 **Materials and Methods**

### 100 101 *Ethnographic background*

102  
103 The Suruí (endonym Paiter) are Tupi-Mondé speaking horticulturalists in the states of Rondônia and  
104 Mato Grosso, Brazil. The Suruí made first peaceful contact with outsiders in 1969. Today there are  
105 over 1,200 Suruí living in at least 12 villages with some that are far from one another making it  
106 difficult to visit, although some men do occasionally travel to distant villages. Suruí social structure has  
107 4 exogamous patrilineal clans (Bontkes & Merrifield, 1985; Mindlin, 1991).

108 Yvinec lived with the Suruí for 17 months in 2005-2007 and 2013. The genealogy for the Suruí  
109 represents 75 percent of the total population in 2005 (Yvinec, 2011) and is available online at  
110 KinSources (<http://kinsources.net>). It contains 926 total individuals and 389 marriages that span

111 approximately 7 generations. According to Yvinec's (2011) latest count, the Kaban clan includes  
112 almost 50% of the whole population, the Gamir about 30%, Gamep 15%, and only a few Makor people  
113 are left. Research was conducted after verbal consent and authorized by the Brazilian Minister of  
114 Science and Technology (MCT, portaria n° 129 de 09/03/2005), the National Center for Research  
115 (CNPq, processo CMC 052/2004) and by the National Foundation of the Indian (FUNAI, n°  
116 25/CGEP/05, processo CMC 2905/04).

117  
118 With the ability to leverage at least some control over selecting mates, Suruí women likely had some  
119 latitude in the assignment of co-fathers for their offspring. The Suruí are tolerant of adulterous  
120 relationships only to a point though as husbands have been known to beat their wives if they hear about  
121 an affair. Suruí women are known to seek out attractive men as lovers, but they do not always choose  
122 fathers directly once the child is born as they have to deal with rumors and accusations from the fathers  
123 and others. When multiple fathers are from different clans, children are usually considered to belong to  
124 the clan of the primary father but debates about their clan membership often arise. The primary father,  
125 generally the man married to the mother, is assumed to be the genetic father in the genealogy.

126  
127 There is no definitive statement of conception by the Suruí. The father is often said to “make most of  
128 the child”, the mother “only a little”, and some co-fathers are said to have made more than others.  
129 Fathers are said to transmit to their children through sexual conception some general skills associated  
130 with their clan such as being a good warrior or shaman. We know of 53 individuals with multiple  
131 fathers (only about 6% of the total population); of these only 6 individuals had 3 co-fathers, while 47  
132 had 2 co-fathers.

133  
134 Co-fatherhood among the Suruí refers to several different situations. 1) A man has a wife who has an  
135 affair with another man who gets her pregnant; the husband keeps the wife and raises the child. 2) A  
136 man has a wife, but during early pregnancy she has an affair (late pregnancy sexual activity is  
137 prohibited in theory), and the husband keeps the wife and raises the child. 3) A man has a wife, but  
138 during pregnancy another man “takes” the wife and raises the child or the wife can be “given” by her  
139 first husband to the second. The Suruí mention that an elder brother or a father “lent” or “gave” a wife  
140 to a younger brother or son because the latter lacked a spouse. The identity of co-fathers and the  
141 attribution of primary versus secondary father may be well known to everybody, including the child, or  
142 can only be rumored and refused by the child. The co-fatherhood of an individual can be evoked in  
143 quite different ways, sometimes in a humorous way in his or her presence or in a pejorative way behind  
144 his or her back.

145  
146 For most (40 of 64) co-father dyads there is no information on their social relationships because they  
147 died long ago or were little known to Yvinec. For 24 of the co-father dyads, it was straightforward to  
148 assess the status of the relationship. Co-father relationships were organized into one of the following  
149 categories: 1) amicable (“got along”, such as men who are political allies, friends, or live together), 2)  
150 avoidant (e.g., some men moved villages because of a dispute), or 3) openly hostile (“did not get  
151 along”, such as one man who threatened to kill a co-father and another who requested a sorcery  
152 assault). The latter two categories are often directly related to jealousy over sexual relationships. In one  
153 notable dispute, a man was shot at by a distant cousin of another clan as a threat because of an  
154 adulterous affair (both were later named co-fathers); the threatened man was then given a wife by his  
155 father to put an end to the adultery and avoid more fighting.

156  
157 *Data analysis*

158

159 To calculate relationships between co-fatherhood, genetic relatedness, and clan membership, three  
160 square similarity matrices were calculated for the 446 total men in the genealogy. Data on co-fathers  
161 includes all known co-father dyads in the Suruí population ( $n = 64$ ). A co-fatherhood matrix codes all  
162 co-father pairs as 1 and all other pairs as 0. Clanship was coded in a similar fashion with 1 as  
163 pertaining to the same clan and 0 otherwise. A genetic relatedness matrix was calculated using Hagen's  
164 Descent software (<http://code.google.com/p/descent>) which uses formulas from Wiggans and  
165 colleagues (1995). For our analyses, we used multiple regression on distance matrices (MRM, using  
166 the ecodist package in R; Goslee & Urban, 2007). For regression coefficients, MRM uses permutation  
167 tests of significance, and for the following analyses, we used 10,000 permutations per model. First,  
168 single predictor models were used to assess the relationships between all three matrices. Next, we  
169 regressed co-fatherhood on clanship and relatedness.

170

## 171 Results

172

### 173 *Genetic relatedness of co-fathers*

174

175 Average relatedness of the 64 co-father pairs is 0.129 (95% bootstrapped confidence interval 0.084 –  
176 0.178), or around first cousin on average, and 61% are from the same clan. The average relatedness of  
177 random men alive recently is approximately a half-first cousin (0.057, 95% bootstrapped confidence  
178 interval 0.048 – 0.066). Therefore, average co-fathers are about twice as related as expected by chance.  
179 Figure 1 compares the relatedness of co-fathers pairs to random men and shows that co-fathers actually  
180 comprise slightly more unrelated (or low relatedness up to 0.01) dyads than expected by chance.  
181 Moreover, in the category of relatedness from 0.01 to 0.1, there are *less* co-fathers than expected by  
182 chance. In fact, the only category where co-fathers show higher relatedness than expected by chance is  
183 in the top category of 0.5 relatedness where 17% of all co-father dyads are father-son ( $n = 5$ ) or full  
184 brothers ( $n = 6$ ).

185

186 Suruí co-fathers are about twice as related to one another on average than expected by chance ( $r = 0.13$   
187 versus 0.06). Ache co-fathers are also about twice as related than expected by chance ( $r = 0.04$  versus  
188 0.02, Ellsworth et al., 2014). The Ache and Suruí genealogies are similar in size, quality, and depth.  
189 The primary difference is that the Suruí have a combination of more close kin marriages and higher  
190 polygyny which creates an intensive kinship network, while the Ache have few kin marriages and low  
191 polygyny which creates an extensive kinship network (Walker & Bailey, 2014; Bailey et al., 2014;  
192 Walker, 2014). In the Suruí, avunculate marriages between uncle and uterine niece are prescribed and  
193 cousin marriages are common; 20% of all Suruí marriages are between couples with at least first  
194 cousin relatedness ( $r \geq 0.125$ ), while this value is less than 1% for the Ache. Suruí have a high level of  
195 polygyny with an average of 1.63 wives per married man, whereas for the Ache it is 1.04 which creates  
196 many more paternal sibs in the Suruí. As illustrated in Figure 1, the kin bias among co-fathers in the  
197 Ache emerges for kinship relationships with relatedness over 0.1, whereas for the Suruí the kin bias is  
198 only visible for closer kin with relatedness of 0.5 (i.e., brothers and father-son), perhaps because  
199 baseline genealogical relatedness is much higher in the Suruí.

200

### 201 *Co-fatherhood, genetic relatedness, and clan membership*

202

203 Results of the single predictor models showed that the relatedness matrix significantly predicted co-  
204 fatherhood ( $B = 0.012$ ;  $p = 0.001$ ). Clanship also predicted co-fatherhood ( $B = 0.009$ ;  $p = 0.012$ ). When



205 co-fatherhood was regressed on both clanship and relatedness, the effect of relatedness remained  
206 significant ( $B = 0.011$ ;  $p = 0.005$ ), but the effect of clanship became borderline statistically significant  
207 ( $B = 0.006$ ;  $p = 0.068$ ), indicating co-father relatedness is not only a byproduct of co-fathers coming  
208 from the same clan.

209

### 210 *Social relationships between co-fathers*

211

212 There are roughly two separate categories of co-fathers (Table 1). In the affiliative category, co-father  
213 relationships are amicable among men of the same clan often including close kin relationships such as  
214 brothers and father-son ( $n = 8$  total with no exceptions). In the competitive category, relationships are  
215 of avoidance or open hostility amongst more distant kin (i.e., cousins including patrilineal,  
216 matrilineal, parallel, and cross, and uncle-nephew pairs, all brother's son) and unrelated men of  
217 different clans ( $n = 13$  total with 3 exceptions).

218

219 While we do not have a way to systematically estimate the base rate of different relationships among  
220 all men, we surmise that brothers and father-sons generally get along even if they are not co-fathers,  
221 especially when they live together or live close to one another. The Suruí have an explicit ideology of  
222 solidarity between father and son and between brothers which likely holds back the expression of  
223 jealousy when they are co-fathers. We also surmise that sexual jealousy between cousins and  
224 nonrelated co-fathers likely makes them hostile or to avoid each other much more than expected by  
225 chance.

226

### 227 **Discussion**

228

229 We show that some Suruí men share parentage as a form of mate or wife giving, while others appear to  
230 poach on one another for access to more mates. Co-father relationships are amicable when they are  
231 between close kin but are more likely to be of jealousy, avoidance, or open hostility when they are  
232 between more distant kin or unrelated men of different clans. Results therefore imply multiple male  
233 mating strategies, both cooperative and competitive, underlying partible paternity practices by Suruí  
234 men.

235

236 In a previous study, our assumption was that most Ache co-fathers that were of first or second cousin  
237 relatedness or higher had amicable relationships (Ellsworth et al., 2014). However, these new results  
238 with the Suruí suggest that most cousins and even uncles and nephews have hostile or avoidant  
239 relationships. The Ache also appear to have two categories of co-fathers with some that tended not to  
240 like one another and were traditionally enemies at club fights. Some Ache men mentioned that they  
241 wanted to club other men who had sex with their wives and that some co-fathers were generally  
242 despised. Ache men with more primary fatherhood also have more secondary fatherhood. Whether or  
243 not this is because the man's mate value causes opportunities for more fatherhood, a competition-based  
244 model best explains this result. That said, some co-father relations among the Ache were affiliative in  
245 nature as evidenced by higher levels relatedness and higher probability of co-residence, consistent with  
246 a male alliance hypothesis. Examples of close kin sharing paternity appear widespread in other  
247 paternity partible societies, including the Curripaco (Valentine, 2002), Guajá (Cormier, 2003), Matis  
248 (Erikson, 2002), Wanano (Chernela, 2002), and Yanomamö (Alès, 2002). Formal friendship ties also  
249 exist between co-fathers in the Araweté (Viveiros de Castro, 1992), Canela (Crocker, 2002), and Arara  
250 (Walker et al., 2010).

251



252 Partible paternity in the Ache and Suruí (and likely many other societies) offers good examples for  
253 why we should exercise caution in labeling humans as cooperative breeders based on certain behaviors  
254 such as partible paternity. As we have documented here, that label would be applicable only to the  
255 affiliative co-fathers and potentially explainable by kin selection, but not to the competitive co-father  
256 relationships which are characterized by mate competition. There is the nuance that most partible  
257 paternity behaviors from the women's perspective may in fact be cooperative breeding but from the  
258 men's perspective often take the form of male-male competition and lead to hostile relationships  
259 between co-fathers. Men competing with one another for mates are clearly not sacrificing their own  
260 reproduction to invest in other men's children.

261  
262 In conclusion, our study supports divergent strategies regarding the benefits of partible paternity. Our  
263 results are consistent with the male alliance hypothesis for some dyads where fatherhood is shared  
264 between closely related men with amicable relations. Just as often our results also support the mate  
265 competition hypothesis. These inherent complexities of partible paternity institutions add to our  
266 knowledge of the full range of cross-cultural variation in human mating and marriage tactics. They also  
267 show how the same cultural trait of partible paternity simultaneously includes aspects of both  
268 competitive and cooperative breeding.

269  
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## 276 277 REFERENCES

- 278  
279 Alès C. 2002. A story of unspontaneous generation: Yanomami male co-procreation and the theory of  
280 substances. In: Beckerman S, Valentine P, eds. *Cultures of multiple fathers: The theory and practice of*  
281 *partible paternity in lowland South America*. Gainesville, FL: University Press of Florida, 62-85.  
282  
283 Bailey DH, Hill KR, Walker RS. 2014. Fitness consequences of spousal relatedness in 46 small-scale  
284 societies. *Biology Letters* 10:20140160.  
285  
286 Beckerman S, Lizarralde R, Ballew C, Schroeder S, Fingelton C, Garrison A, Smith H. 1998. The Bari  
287 partible paternity project: Preliminary results. *Current Anthropology* 39:164-167  
288  
289 Beckerman S, Valentine P. 2002. *Cultures of multiple fathers: The theory and practice of partible*  
290 *paternity in lowland South America*. Gainesville, FL: University Press of Florida.  
291  
292 Beckerman S, Lizarralde R. 2013. *The Ecology of the Bari: Rainforest horticulturalists of Latin*  
293 *America*. Austin: University of Texas Press.  
294  
295 Bontkes C, Merrifield WR. 1985. On Suruí (Tupian) social organization. In: Merrifield WR, ed. *South*  
296 *American kinship: eight kinship systems from Brazil and Colombia*. Dallas: The International Museum  
297 of Cultures, 5-34.  
298

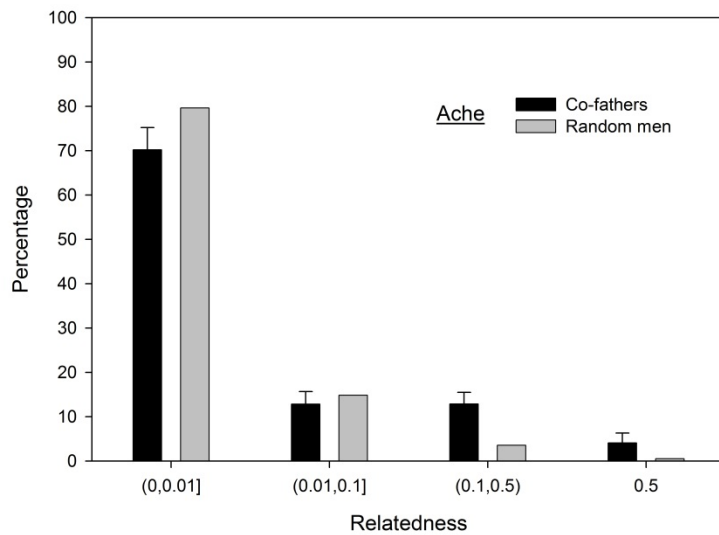
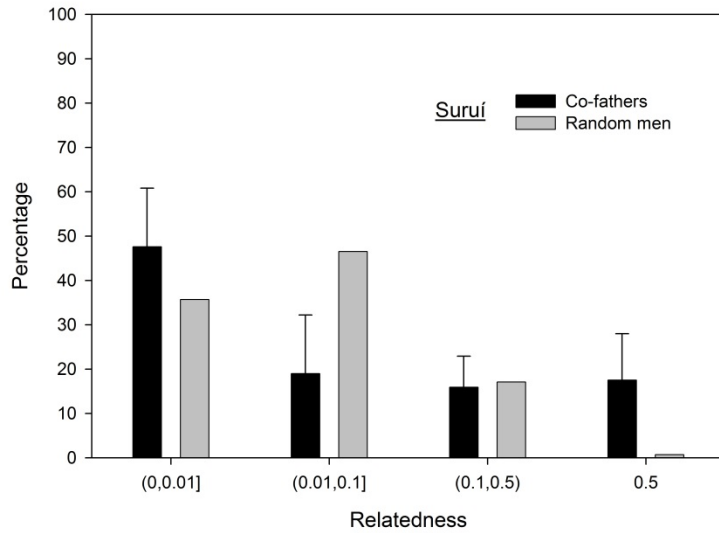
- 299 Chernela J. 2002. Fathering in the Northwest Amazon of Brazil: Competition, monopoly, and partition.  
300 In: Beckerman S, Valentine P, eds. *Cultures of multiple fathers: The theory and practice of partible*  
301 *paternity in lowland South America*. Gainesville, FL: University Press of Florida, 160-176.  
302
- 303 Cormier L. 2003. *Kinship with monkeys: the Guajá foragers of eastern Amazonia*. New York:  
304 Columbia University Press.  
305
- 306 Crocker WH. 2002. Canela “other fathers”: Partible paternity and its changing practices. In:  
307 Beckerman S, Valentine P, eds. *Cultures of multiple fathers: The theory and practice of partible*  
308 *paternity in lowland South America*. Gainesville, FL: University Press of Florida, 86-104.  
309
- 310 Ellsworth RM, Bailey DH, Hill KR, Hurtado AM, Walker RS. 2014. Relatedness, co-residence, and  
311 shared fatherhood among Ache foragers of Paraguay. *Current Anthropology* 55:647-653.  
312
- 313 Emlen ST. 1991. Evolution of cooperative breeding in birds and mammals. In: Krebs JR, Davies NB,  
314 eds. *Behavioural ecology: an evolutionary approach*. Oxford: Blackwell Scientific, 301–337.  
315
- 316 Erikson P. 2002. Several fathers in one's cap: Polyandrous conception among the Panoan Matis  
317 (Amazonas, Brazil). In: Beckerman S, Valentine P, eds. *Cultures of multiple fathers: The theory and*  
318 *practice of partible paternity in lowland South America*. Gainesville, FL: University Press of Florida,  
319 123-136.  
320
- 321 Goslee SC, Urban DL. 2007. The ecodist package for dissimilarity-based analysis of ecological data.  
322 *Journal of Statistical Software* 22:1-19.  
323
- 324 Hawkes K, O'Connell JF, Blurton Jones NG. 1997. Hadza women's time allocation, offspring  
325 provisioning, and the evolution of long postmenopausal life spans. *Current Anthropology* 38:551-577.  
326
- 327 Hill K, Hurtado AM. 1996. *Ache life history: the demography and ecology of a foraging people*. New  
328 York: Aldine De Gruyter.  
329
- 330 Hill K, Hurtado AM. 2009. Cooperative breeding in South American hunter-gatherers. *Proc. R. Soc. B*  
331 276:3863-3870.  
332
- 333 Hill KR, Walker RS, Bozicevic M, Eder J, Headland T, Hewlett B, Hurtado AM, Marlowe F, Wiessner  
334 P, Wood B. 2011. Co-residence patterns in hunter-gatherer societies show unique human social  
335 structure. *Science* 331:1286-1289.  
336
- 337 Hrdy SB. 2000. The optimal number of fathers: evolution, demography, and history in the shaping of  
338 female mate preferences. *Ann. N Y Acad Sci* 907:75-96.  
339
- 340 Hrdy SB. 2009. *Mothers and others*. Cambridge MA: Harvard University Press.  
341
- 342 Kensinger K. 2002. The dilemmas of co-paternity in Cashinahua society In: Beckerman S, Valentine P,  
343 eds. *Cultures of multiple fathers: The theory and practice of partible paternity in lowland South*  
344 *America*. Gainesville, FL: University Press of Florida, 14-26.  
345

- 346 Kramer KL. 2005. Children's help and the pace of reproduction: cooperative breeding in humans.  
347 *Evolutionary Anthropology: Issues, News, and Reviews* 14:224-237.  
348
- 349 Kramer KL. 2010. Cooperative breeding and its significance to the demographic success of humans.  
350 *Annual Review of Anthropology* 39:417-436.  
351
- 352 Mace R, Sear R. 2005. Are humans cooperative breeders? In: Volland E, Chasiotis A, Schiefenhovel W,  
353 eds. *Grandmotherhood: The evolutionary significance of the second half of female life*. New  
354 Brunswick NJ: Rutgers University Press, 143-159.  
355
- 356 Meehan CL, Quinlan R, Malcom CD. 2013. Cooperative breeding and maternal energy expenditure  
357 among Aka foragers. *American Journal of Human Biology* 25:42-57.  
358
- 359 Mindlin B. 1991. Surui. In: Wilbert J, ed. *Encyclopedia of World Cultures: South America*. Boston: G.  
360 K. Hall, 312-314.  
361
- 362 Sear R, Coall D. 2011. How much does family matter? Cooperative breeding and the demographic  
363 transition. *Population and Development Review* 37:81-112.  
364
- 365 Strassmann BI. 2011. Cooperation and competition in a cliff-dwelling people. *Proceedings of the*  
366 *National Academy of Sciences* 108:10894-10901.  
367
- 368 Strassmann BI, Garrard WM. 2011. Alternatives to the grandmother hypothesis. *Human Nature*  
369 22:201-222.  
370
- 371 Valentine P. 2002. Fathers that never exist: Exclusion of the role of shared father among the Curripaco  
372 of the northwest Amazon. In: Beckerman S, Valentine P, eds. *Cultures of multiple fathers: The theory*  
373 *and practice of partible paternity in lowland South America*. Gainesville, FL: University Press of  
374 Florida, 178-191.  
375
- 376 Viveiros de Castro E. 1992. *From the enemy's point of view: humanity and divinity in an Amazonian*  
377 *society*. Chicago: University of Chicago Press.  
378
- 379 Walker RS, Flinn MV, Hill KR. 2010. Evolutionary history of partible paternity in lowland South  
380 America. *Proceedings of the National Academy of Sciences USA* 107:19195-19200.  
381
- 382 Walker RS, Bailey DH. 2014. Marrying kin in small-scale societies. *American Journal of Human*  
383 *Biology* 26:384-388.  
384
- 385 Walker RS. 2014. Amazonian horticulturalists live in larger, more related groups than hunter-gatherers.  
386 *Evolution & Human Behavior* 35:384-388.  
387
- 388 Wiggans GR, Van Raden PM, Zuurbier J. 1995. Calculation and use of inbreeding coefficients for  
389 genetic evaluation of United States dairy cattle. *Journal of Dairy Science* 78:1584-1590.  
390
- 391 Yvinec C. 2011. Les monuments lyriques des Surui du Rondônia (Amazonie méridionale): chants,  
392 événements et saviors. D. Phil. Thesis, University of Paris.

393  
394

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397 Figure 1. Frequency distribution of the relatedness between co-fathers for the Suruí (top) and Ache  
398 (bottom) with bootstrapped 95% confidence intervals as compared to random pairs of men.  
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401

| Relatedness category    | Get along | Do not get along or avoidant | Unknown relationship |
|-------------------------|-----------|------------------------------|----------------------|
| Unrelated               | 1         | 3                            | 28                   |
| Cousin and Uncle-Nephew | 2         | 10                           | 6                    |
| Brother and Father-Son  | 8         | 0                            | 6                    |

402

403

404 Table 1. Social relationships between co-fathers of different relatedness categories.