1   *Genetic and Cultural Kinship among the Lamaleran Whale hunters*

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Abstract

The human ability to form large, coordinated groups is among our most impressive social adaptations. Larger groups facilitate synergistic economies of scale for cooperative breeding, economic tasks like group hunting, and success in conflict with other groups. In many organisms, genetic relationships provide the structure for sociality to evolve via the process of kin selection, and this is the case, to a certain extent, for humans. But assortment by genetic affiliation is not the only mechanism that can bring people together. Affinity based on symbolically mediated and socially constructed identity or *cultural kinship* structures much of human ultrasociality. This paper examines how genetic kinship and two kinds of cultural kinship—affinal kinship and descent—structure the network of cooperating whale hunters in the village of Lamalera, Indonesia. Social network analyses show that each mechanism of assortment produces characteristic networks of different sizes, each more or less conducive to the task of hunting whales. Assortment via close genetic kin relationships (r=0.5) produces a smaller, denser network. Assortment via less close kin relations (r=0.125) produces a larger but less dense network. Affinal networks are small and diffuse; while lineage networks are larger, discrete,

35 and very dense. The role that genetic and cultural kinship play for

36 structuring human sociality is discussed in the context of these results.

37

Introduction

39   Kin selection and reciprocity,both direct and indirect, are well-known

40 evolutionary mechanisms that are hypothesized to produce sociality. Often,

41 social behavior is conceived as a series of dyadic interactions between

42 individuals in reciprocal or nepotistic relationships (Trivers, 2006) focusing

43 analyses on the individual and away from the socio-structural context of the

44 groups in which people live. This view constrains analysis and works to

45 remove from consideration a wide range of questions and answers

46 concerning the evolution of human sociality. To avoid this problem, instead

47 of examining altruism *per se*, this paper will examine the social structure

48 that supports the formation ofgroups of substantial size. Both kin selection

49 and reciprocity differ in important ways but share the common principle that

50 each involves positive assortment so that cooperators are more likely to

51 interact with each other than with others(Fletcher & Doebeli, 2006, 2009;

52 Pepper, 2007; Taylor & Nowak, 2007; Wilson & Dugatkin, 1997). The

53 nonrandom, assortative interactions fundamental to the evolution of sociality

54   can be considered a group's social structure—defined as the content, quality,

55   and patterning of the relationships between individuals (Hinde, 1976).

56   Reserving reciprocity for another day, this paper will focus on the role of

57   kinship, both genetic and cultural, for providing the structure necessary for

58   the developmentof the size and complexity that characterizes humans

59   groups.

60   Genetic kinship is a relationship that arises as a result of mechanisms of

61   genetic inheritance. Genetic kin are related 'by blood' and share genetic

62   material through common descent. In sexual organisms, offspring have a

63   50% probability of sharing any particular allele with a parent as well as a

64   50% probability with full siblings. Preferential assortment according to

65   genetic relatedness provides structure that facilitates nepotistic cooperation

66   in humans and other species via kin selection. Hamilton in his well-known

67   equation argued that altruism could evolve between close kin because the

68   likelihood of sharing an allele for altruism is greater between close kin

69   (Hamilton, 1964).

70   Kin selection requires a mechanism of kin recognition so that association

71   can be nonrandom(Hepper, 1991). The eusocial insects are the classic

72   example of kin-selected sociality where kin are identified via phenotypic

73   matching of chemical compounds (Lahav, Soroker, Hefetz, & Vander Meer,

74   1999; Ratnieks, 1988; Ratnieks & Wenseleer, 2005). Kin selection can also

75   take advantage of the fact that those individuals with whom one is

76   ontogenetically close are likely to be genetic kin. The developmental

77   familiarity that results from intimate mother-offspring associations among

78   mammals allows kin to identify one another and develop both sexual

79   aversion and helpful tendencies (Lieberman, Tooby, & Cosmides, 2007).

80   Siblings, for example, identify each other based on their own associations

81   with their mother and observations of a similar close relationship between

82   the other and their mother(Chapais, 2008). Behavioral regularities create a

83   context where individuals learnto identify genetic kin among conspecifics.

84   Assorting according to the degree of genetic relatedness, however, is not

85   the only way that cooperators find each other(Fletcher & Doebeli, 2009). It

86   is increasingly clear that culture plays a key role in structuring human social

87   behavior beyond the level of the family to create cooperative groups in ways

88   that genetic kinship cannot (Alvard, 2003a; Boyd & Richerson, 1985;

89   Chapais, 2008; Durham, 1991; Henrich & McElreath, 2003). Cultural kinship

90   consists of relationships that are *socially created* rather than genetically

91   inherited. People organized via cultural kinship do not necessarily rely on

92   behavioral regularities of face-to-face society to learn structure but rather

93   learn relationships by means of *culturally inherited normative regularities*

94   that are often symbolically marked(Chapais, 2008). Cultural kinship

95   involves being part of a group, like a lineage or a nation for example, whose

96   members are not all personally known or even physically present (Dunbar,

97   2008; Fiske & Taylor, 2008). For people, recognition as a group member is

98   not necessarily based on a behaviorally shared developmental history but on

99   shared normative regularities generated from a culturally inherited identity.

100   When individuals in complex social groups share

101   intentions with one another repeatedly in particular

102   interactive contexts, the result is habitual social practices

103   and beliefs that sometimes create what Searle (1995) calls

104   social or institutional facts: such things as marriage, money,

105   and government, which only exist due to the shared

106   practices and beliefs of a group.(Tomasello, Carpenter, Call,

107   Behne, & Moll, 2005:670)

108   For example, Americans learn the norm from their parents and others

109   that national identity is given to persons born within a certain geographic

110   area and identified by ostensibly difficult-to-fake markers; this belief

111   isshared by almost everybody in the group. People so identified enjoy a

112   cooperative relationship not afforded to others. The identities are socially

113 constructed (Searle, 1995), but as real as genetic relationships as they guide

114 behavior.

115   Many types of cultural kinship are identified by genealogical markers,

116 perhaps because they are difficult to fake, but they may or may not match

117 genetic categories based on degree of relatedness, something often noted by

118 social anthropologists in their critiques of evolutionary approaches (Sahlins,

119 1976). Sometimes different types of genetic kin are merged into a single

120 cultural category (Parkin, 1997). For example, ego's mother and mother's

121 sisters are referred to by the same term in societies with bifurcate merging

122 kinships systems. In other cases, kin of equivalent genetic relatedness are

123 referred to by different terms and treated differently accordingly. Lineage

124 systems identify a certain subset of genetic kin as kin and the balance as not

125 kin. The marriageability of cross cousins versus parallel cousins is a good

126 example a culturally inherited normative regularity. Cultural kinship often

127 uses such genetic relationships as a reference point, but in many cases

128 people regularly create fictive kinship or kinship-like relationships in the

129 absence of any actual genealogical relationships (Draper & Haney, 2005;

130 Parkin, 1997). For example, affinity is referenced by birthplace or birthdatein

131 the case of pantribal sodalities (Service, 1962). Affinal kin are a type of

132 fictive kin linked to Ego via marriage (see discussion in Chapais, 2008)

133 andare not usually closely related genetically. Affinal kin can share a

134 common interest in genetic descendants(Dow, 1984) but are considered a

135 cultural relationship because the connection is socially created rather than

136 genetically inherited.

137   It is useful to think about the selective advantages provided by social

138 structures organized by cultural kinship that are not provided by assortment

139 via genetic kinship. Humansclearly form large segmented hierarchical

140 networks of nested social units (Hill, Bentley, & Dunbar, 2008; Silk, 2007).

141 This is especially noticeable in the political structures of more complex

142 societies. If one looks closely it is apparent in the segmented lineage

143 systems of tribal groups and in the supra-band organization of foragers

144 where amalgamation of bands or local groups form higher order levels that

145 can also be called a tribe[1]. If we look beyond hunter-gathers, sociality scales

146 up to include structures that organize sometimes millions of members in

147 chiefdoms, states, corporations and religious groups (Johnson & Earle,

148 2000). It has beenproposed that it is difficult for genetic kinship to

149 structuresuch large groups because in the absence of extreme reproductive

150 skew and high levels of endogamy, as groups become larger the average

151 degree of relatedness between members drops rapidly(Aviles, Fletcher, &

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[1] Traditionally this term is reserved for food producing people (Sahlins, 1968)

152 Cutter, 2004; Campbell, 1983; Lukas, Reynolds, Boesch, & Vigilant, 2005;

153 Richerson & Boyd, 1999). In addition, the non-transitive nature of genetic

154 kinship produces conflicts of interest among relatives(Alvard, 2003b). Only

155 full siblings share identical kinship networks; the genetic kinship networks of

156 other relatives overlap, but are not identical; more on this below.

157   Relationships of cultural kinship are not constrained by the structural

158 limitations of genetics. One important hypothesis is that the structure

159 provided by cultural kinship facilitates the formation of large and more

160 complex groups in ways that genetic kinship cannot (Richerson & Boyd,

161 2005). People in larger groups can do many things together that cannot be

162 done alone or in smaller groups. Hierarchical social structures can bring

163 large numbers of people into coordinated action, for example, to

164 cooperativelyhunt big game or to manage herds of animals(Kelly 2000).

165 Notably, larger groups provide numerical advantages in conflict with other

166 groups (Alexander, 1979, Bowles 2009; Kelly 2000).

167   To see how both the hypothesized limitations of genetic kinship and the

168 benefits of cultural kinship obtain ethnographically, this paper will examine

169 how the two types of kinship work to produce the sociality associated with

170 Lamaleran whale hunting groups. This paper examines how close genetic

171 kinship (r=0.5, 0.25 and 0.125) and two kinds of cultural kinship—affinal

172   kinship and lineage identity—structure the network of cooperating whale

173   hunters in the village of Lamalera, Indonesia. Both size, and complexity—as

174   measured by network density, will be calculated for the groups produced via

175   each organizing principle. *Density* is the number of actual links in a network

176   or network component divided by the number of maximum number of links

177   possible. A c*omponent* is a portion of a network in which all actors are

178   connected, directly or indirectly, by at least one link.

179   The number of components produced by astructuringprinciple is a

180   measure of fragmentation of the population(Borgatti, 2006). The more

181   fragmentation, the more difficult it is for groups of sufficient size to come

182   together in collective action. Less fragmentationmeanslarger groups, but

183   coordinated collective action requires more than adequate group size; it also

184   requires a shared senseamong members concerning how to behave; this is a

185   characteristic of dense groups.Cooperation is often the best decision if actors

186   can find others to *trust*(Alvard & Nolin, 2002; Fehr, Fischbacher, & Gachter,

187   2002; Ostrom, 1998; Skyrms, 2004), where trust is defined as a shared

188   understanding that the others are playing by the same set of rules. "…trust

189   enables people to deal with their ignorance of the future and so act in a

190   purposeful, goal-driven fashion even in the face of radical uncertainty"

191   (Lewis, 2008:183). Members of dense networks are connected through more

192 direct, reciprocated relationships that enable them to share information, act

193 collectively, and trust one another (Buskens, 1998; Coleman, 1990).

194 Members of dense networks tend toward homogeneity of thought, identity,

195 and behavior (Wasserman and Faust 1994). Denser groups can suffer less in

196 terms of transaction costs (Jonsson, 2001) because members are likely

197 share institutional norms of behavior (Husted, 1994; White, 2004). While

198 the usefulness of density has been questioned when examining larger

199 groups, it has been shown to be a more valuable measure of what is termed

200 structural cohesion when examining subgroup components as is the case

201 here (Friedkin, 1981).

202   Life table simulations predict an expected average number of different kin

203 types for a person of a given age in a population with age specific rates of

204 birth and death (Goodman, Keyfitz, & Pullum, 1974). Generally, a middle-

205 aged individual has more distantly related kin (r=0.125) than close kin

206 (r=0.50) and therefore networks among hunters created with links of

207 increasing degrees of genetic relatedness should be increasingly smaller;

208 that is, the population of hunters structured by close kin ties will be

209 fragmented to produce more and denser components. As discussed below,

210 while genetic relationships are not necessarily transitive, lineage identity is a

211 transitive relationship, and will result, of course, in dense networks. Affinal

212 kin relationships are not necessarily transitive either and should result in

213 smaller,less dense components similar to genetic kin networks.

214 **Lamalera**

215   In 1999, when the data for this paper were collected, the people of

216 Lamalera, Indonesia, were among the last subsistence whale hunters on the

217 planet. The village of ~1,200 people relied largely on the sperm whales,

218 other marine mammals, and ray that the community's men cooperatively

219 hunted from a fleet of traditional, 11m long, whaling vessels called *téna*.

220 Barnes (1996) provides a detailed ethnography of the site. Nolin (2008)

221 provides a description of recent changes in Lamaleran subsistence.

222   The Lamalerans are foragers but their social structure is more complex

223 than one might imagine for a group of hunter-gathers. There are a number

224 of different ways that relationships between people create the social

225 structure in the lives of the Lamalerans—only some ways are useful for

226 organizing hunts. Like all human societies, relationships of genetic kinship

227 create nuclear and extended families that form the foundation of

228 reproductive life. The Lamalerans also belong to the Lamaholot ethnic group

229 that recognizes a region-wide distinction between Demon and Paji villages

230 who have maintained a heated and violent adversarial relationship for

231 hundreds of years (Barnes, 1996). The village has a relationship with the

232 larger Indonesian nation and consists formally of two administrative units

233 (*désa*), Lamalera A and Lamalera B, corresponding to the upper and lower

234 villages. This distinction may reflect a traditional moiety system and is

235 expressed in the physical location of the boat houses on the beach—upper

236 village to the east, lower village to the west. Each village is administratively

237 further subdivided into several wards which are in turn divided into two to

238 four neighborhoods. The ward and neighborhoods are paralleled by structure

239 provided by the religious divisions within the Catholic parish, each with its

240 own layperson as head. The village is also divided into twenty-one major

241 named patrilineal clans, the larger of which are further divided into named

242 sub-clans or lineages. The lineages form corporate groups that maintain the

243 whaling operations(Alvard & Nolin, 2002). These lineages are one of the

244 cultural kinship structures examined below.

245   In terms of hunting, on a day-to-day basis each corporation is more or

246 less able to bring together a group of men (mean group size = 10.8) to

247 pursue whales. Previous work found that a core group of men associate

248 regularly with each of the 20 téna and cooperate during the course of a

249 hunting season (Alvard, 2003b; Alvard & Nolin, 2002). In order to identify

250 the men for each group, an affiliation matrix was created that indicated the

251 number of times that each man hunted with each other on the same boat on

252 the same day. The matrix was subjected to a multidimensional scaling

253 analysis which results in observable groups of men that were easily

254 associated with each of the téna. A k-means cluster analysis confirmed the

255 group assignments. These 20 clusters represent groups of men that

256 regularly cooperate with one another for the purposes of hunting.

257   Previous analysis found that, in contrast to the expectations of kin

258 selection theory, genetic kinship explains little of the variation in men's

259 affiliations in these 20 hunting groups independent of lineage identity

260 (Alvard, 2003b). Subsequent research has confirmed this result with data

261 from 2007 (Nolin, this volume). These results, which in part motivated this

262 paper, suggest that genetic kinship may be less important as a principle for

263 organizing cooperation in sizable human groups than previously thought,

264 and that cultural kinship—socially constructed and culturally transmitted

265 identities like patrilineages—may play a larger role than is generally

266 appreciated.

267 ***Methods***

268   Details on methods can be found in Alvard (2003b); the most germane

269 points are reviewed here. Most of the analyses focus on a sample of 189 of

270 the 290 men who hunted—the same sample of regular hunters used in the

271 earlier paper. Crew identifications were collected for each of the 853 hunts

272 observed over the course of the 80 hunt-days that occurred between May 3

273 and August 5, 1999. From the 390 resident males in the village over the

274 age of 11.8 years (the age of the youngest person in the hunter sample),

275 two hundred and ninety men hunted for a total of 9,041 man-days. The

276 sample was limited to men for whom pedigrees were complete back to

277 grandparents (ensuring genetic kinship resolution to r=0.125), for whom

278 lineage identity was known and for whom affinal kin could be identified.

279 These filters produce a sample of 220 men. Finally, the 189 man sample

280 includes only regular hunters. This is done by excluding men who fell below

281 the tenth percentile in terms of the total number of days hunted. Men who

282 hunted 6 days or more during the field season are included.

283   There is no reason to think that the cultural and genetic kinship networks

284 formed by men for whom pedigrees and lineage membership are not known

285 will differ from the men who are in the sample. While the question of how a

286 man's individual network makes him more or less likely to be a regular

287 hunter will be examined elsewhere, the analyses below will also examine

288 aspects of non-hunters' networks to learn if they differ in any way that might

289 bear on the conclusion of the analysis. From the group for whom pedigree

290   and lineage data are known, there are 101 men who hunted less than six

291   days and who will be considered non-hunters.

292   Network analysis was used to examine aspects of social

293   structure(Borgatti, Mehra, Brass, & Labianca, 2009; Wasserman & Faust,

294   1994; Wey, Blumstein, Shen, & Jordan, 2008). The network analyses were

295   done using UCINET software (Borgatti, Everett, & Freeman, 2002). The

296   network graphs were produced using NETDRAW software (Borgatti, 2002).

297   Network analysis has theimportant advantagethat rather than simply

298   examining qualities of individuals, it allows examination of the

299   *structuralrelationships* between people. Network analysis is also conducive

300   to graphical examination. In the parlance of network analysis, individual

301   hunters are the nodes which are connected by lines which represent, in this

302   case, kinship relationships between the hunters. For the analysis here,

303   genetic kin relations where r=0.5, 0.25 and 0.125 are examined. Two types

304   of affinal kin are examined: brothers-in-law are defined asEgo's wife's

305   brother (full or half) or Ego's sister's husband. A father-in-law is defined as

306   Ego's wife's father; a son-in-law is the converse. One additional kind of

307   cultural kinship is examined. A lineage relationship exists when two men

308   share membership in a given lineage, a trait inherited from fathers.

309   The network analysis examines selected structural aspectsof the group

310   using two common network measures. The first is network component

311   number and size. A component is a subgroup within the larger group formed

312   by the particular relationship under examination. As shall be demonstrated,

313   for example, lineage relationships divide the group into 32 components.

314   Density is the number of actual links in a network or sub-network divided by

315   the number of maximum number possible $p,$ where $p = ((N*N)-N)/2.$

316   Density can be measured for the entire network as well as its components

317   and will be presented here as a percentage. A dense network is one that

318   has many relationships between members given the number of possible

319   relationships. Sparser networks have fewer links between members. For a

320   network with N actors, the minimum number of ties is N – 1(Wasserman &

321   Faust, 1994).

322   ***Results***

323   ***r=0.5***

324   Within the sample of 189 hunters, there are 17,776 potential

325   relationships ($p = ((N*N)-N)/2 = 17,766$). There were 115 r=0.50

326   relationships consisting of sibling (N=64) and father-son (N=51)

327 relationships.[2]Close kin links are rare, and make-up only 0.6% of the total

328 potential relationships (Figure 1). Figure 2A shows the networks of men

329 who are related by r=0.5. These are relationships of direct lineal descent

330 and full sib-ships. Sixty-six men do not have such relationships within the

331 N=189 group. Within the group, the 115 r=0.5 relationships form 41

332 subgroups or components with 2 or more members; the average size of the

333 components is 3.1. Density for subgroups where N>2 was 79%[3]. Density

334 does not equal 100% because these networks are not closed; in this case

335 this means that there are not r=0.5 relationships between each member of

336 the component. Brothers and sons are related to Ego, but not to each other

337 at r=0.5. To the extent this is the case, the network is less dense. As

338 discussed below, networks of r=0.5 relationships are denser, however, than

339 networks of less closely related people. Table 1 presents the descriptive data

340 for each network.

341 *r=0.25*

342   There were 88 relationships where r=0.25; these included avuncular

343 relationships (38 paternal uncles; 47 maternal uncles), one pair of paternal

344 half siblings and two pairs of double cousins; there were no grandson-

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[2]There was one sibling pair whose parents also were full siblings where r=0.75.

[3] Density measures are given for subgroups greater than two because density for groups less than two always equals 1.0.

345 grandfather relationships (see Figure 2B). These r=0.25 relationships form

346 21 N>1 components (97 men have no relationships at r=0.25). Component

347 size ranged from 2-17 with a mean of 4.38 men, an average size that is

348 significantly larger than for r=0.5 components (t=2.1, p=0.039). Mean

349 density for N>2 groups = 50%, significantly less than for r=0.5 components

350 (t=4.2, p=0.00016)

351 *r=0.125*

352 There were 173 relationships where r = 0.125. The majority (N=160) of

353 these were cousin dyads, the largest group of kin given the resolution of the

354 data (see also Figure 2C). Included in the r=0.125 group are eight half-

355 avuncular relationships and five others. There were approximately the same

356 number of isolates, men with no cousins, as there were men who had no

357 r=0.50 kin; but for the r=0.125 relationship there were half as many

358 subgroups (20 components) formed with a mean size that was twice as large

359 (3.07 men versus 6.25 men; t=3.57, p=0.00718). There is no significant

360 difference in component size compared to r=0.25 groups (t=1.32.

361 p=0.1922). The mean density of these groups is 62%, the same as for

362 r=0.25 components(t=0.06, p=0.95)and significantly less dense than for

363 r=0.5 components (t=4.29, p=0.000125).

364   Finally, there are sixty-four r=0.0625 half-cousin relationships in the

365   sample. As mentioned in the methods section, the pedigrees were complete

366   for the sample of 189 to the grandparental generation. For some men,

367   additional pedigree data were available and r values for additional

368   relationships were calculated. The analysis will be limited to relationships

369   where r ≥0.125, but the full network dataset will be used for illustrative

370   purposes in Figure 2D where the entire kin structure for the 189 man

371   sample. All genetic kinship relations from r=0.5 to r = 0.125 are included in

372   the graph as well as the links that are known where r < 0.125. Thirteen men

373   have no genetic kin in the network. One can easily discern clumps of kin

374   who are more densely connected to one another than to other individuals in

375   the group. Panels A, B, and C in Figure 2 show the same network with

376   various values of r providing the structure. Figure2A shows the r=0.5 links.

377   Many men do not have close kin and form isolates. Figure 2B adds the

378   r=0.25 links which work to bring together some components and closes

379   some of the components. Lastly, panel C adds the 0.125 links.

380   Figure 2 graphically demonstrates the point, made in the text, that

381   genetic kinship is not conducive to organizing larger groups. Close kin

382   (Panel A) produce small, relatively dense networks. Adding less closely

383   related kin to the network (Panels B & C) increases group size (there are

384 fewer components) but any strength of kin selection is diluted as conflicts of

385 interest increase with increasing number of weak ties (Panel D).

386

387 *Affinal Kin*

388   For affinal kin, relationships are limited, of course, to men who are

389 married. In the sample, 122 of the 189 men were married (64.5%). Only 5

390 fathers-in-law, son-in-law pairs existed in the 189-man sample. The small

391 number of father-in-law relationships is probably related to the advanced

392 age of fathers-in-law.   The age of married (N = 122, 45.8 years) versus

393 unmarried (N = 67, 22 years) hunters differed significantly (t=-14.6, p

394 <0.000). Married hunters are older and have old father-in laws unlikely to

395 be hunters themselves. The mean age of the hunting fathers-in-law was

396 57.9 years (N=5); the age of nonhunting fathers- in-law (N=21) was 68.7

397 years (t=-0.317, p=0.002).

398   Brother-in-law relationships were more common with 50 full-sib pairs

399 (where brother-in-law is full sib to wife) and one additional half-brother-in-

400 law for a total of 51 (mean age = 44.3 years). Nineteen N>1 components

401 are formed with a mean size of 3.68 members. These affinal networks are

402   smaller and not very dense (N>2 density = 42%). See Figure 3 for the

403   brother-in-law network.

Lineage

405   There were 633 lineage relationships; 39 lineages are present with a

406   range in component size of 1–15 men (Figure 4). While genetic relationships

407   are not transitive, the social identity based on a lineage relationship is

408   transitive. In other words, not all hunters in a particular r=0.5 network

409   wererelated by r=0.5, but all members of a particular lineage network share

410   the same lineage. This means that lineage networks are maximally dense at

411   100% and are significantly denser than the most dense kin-based network,

412   r=0.5 (t=4.7, p=0.000019). In addition, most of the relationships are

413   within the larger lineages since the number of relationships within a network

414   increases exponentially with the number of members. A hypothetical lineage

415   with 10 members has 45 relationships; while a lineage with 30 members has

416   435 relationships. The mean group size for lineage-based components >1

417   was 5.68 men, significantly larger than for r=0.5 groups (t=4.21, p =

418   0.000073) but no different from sizes of r= 0.125 or r=0.25 groups (t=0.45,

419   p = 0.65; t=1.29, p=0.201 respectively).

Discussion: Genetic versus cultural kinship

421   It is clear from the network analysis that different types of relationships

422   generate social structure that varies in significant ways. This paper

423   examined two simple measures of structure: group size and density.

424   Genetic and cultural kinship each produce characteristic networks of different

425   size and density and the expectations discussed above are

426   generallysupported. Among the group of Lamaleran whale hunters,

427   networks of close kin are dense, but the groups that are formed this way are

428   small. Networks of less closely related kin, like cousins, are larger but less

429   dense.

430   What do these results have to say about the problems with genetic kin

431   structuring large groups? The results characterizethe problem of genetic

432   kinship as a mechanism for creating larger coordinated groups. As

433   mentioned above, it is difficult for large groups of closely related individuals

434   to form and when they do conflicts of interest among group members exist.

435   The conflicts of interest emerge from the fact that only full sibs have

436   identical genetic kin networks. This problem is expressed by the tradeoff

437   between group size and density for genetic kinship as indicated by Figure

438   5.,which reflects the common feature of networks that density often declines

439   with network size (Friedkin, 1981). Note that the minimum number of ties

440   in a network of size N is N-1 and that the density of theminimal network

441 declines with network size. Since full siblings have identical kin ties,

442 networks of siblings are maximally dense but are limited in size by

443 reproductive constraints. In Lamalera, there were no sibships of sufficient

444 size to form a crew. While dyadic genetic relationships are symmetric—

445 meaning that ego is as genetically related to kin as kin are to ego—genetic

446 relationships in groups are not transitive. In r=0.5 networks, for example,

447 Ego is equally related to his brother and his own son, but ego's brother and

448 son are less closely related to each other as uncle and nephew than either

449 isto Ego. Cousins are another example of this conflict of interest. In an out-

450 bred population, Ego is equally related to his maternal and paternal cousins,

451 but these two cousins may not be related to each other at all (Alvard,

452 2003b).

453 　　In contrast, the lineage networks are larger and maximally dense.

454 Lineage systems like those at Lamalera have long been hypothesized to be

455 important for organizing tasks that involve coordination of moderately sized

456 groups for collective actionlike whale hunting (Ember, Ember, & Pasternak,

457 1974; Kuper, 1982; Sahlins, 1961; Van den Berghe, 1979). Cronk and

458 Gerkey (2007)describe identity by descent as 'absolute'. One is either a

459 member or not of a particular descent group. This means that relationships

460 defined by descent *are* transitive. If person A and person B belong to the

461   same lineage, and A and C belong to the same lineage then B and C belong

462   to the same lineage. Accordingly, if A and B belong to the same lineage but

463   A and C do not, then neither do B and C share lineage identity.

464   It should be noted that these patterns observed in Lamalera are not only

465   characteristic of the hunters' network. There was no significant difference in

466   the frequency of r = 0.5, 0.25, 0.125 or 0.0 kin within the hunters' network

467   (N=189) and the nonhunters' network (N=101; Chi square=0.1, p=0.99).

468   Nor was there a difference in the frequency of lineage versus nonlineage

469   members for the two networks (Chi square=0.001, p=0.99). Individual men

470   in Lamalera are not more or less likely to hunt because they are embedded

471   in lineage networks. Rather, the point is that coordinated collective action,

472   like big game hunting, is facilitated by social structure that enables larger

473   and denser groups to form than can be formed by genetic kinship.

474   Affinal kin networks among the Lamalera whale hunters are an interesting

475   anomaly; they are small yet not very dense, characteristics not conducive to

476   producing large scale structure.Comparison with work done on Yanomamö

477   social structure, however, suggests that the importance of different

478   structural relationships may be contextual. Analysis of the well-

479   knownYanomamö axe fight found that genetic kinship explained the most

480   variation in affiliation (15%) between the two factions described by Chagnon

481 (Chagnon & Bugos, 1979); nothing was explained by lineage identity, while

482 around 2% of the variation was explained by affinal relationships (Alvard,

483 2009).

484 The Yanomamö results motivated examination of affinal structure in

485 Lamaleran whale hunting crews, which was unexamined in the original

486 analysis (Alvard 2003b).Since it was learned that affinal kin ties form

487 relatively small, sparse networks among hunters, it was predicted that they

488 would not play an important role in affiliation among crews. Indeed, a QAP

489 regression analysis finds that affinal kin relationships explain no additional

490 variance in affiliation among whale hunters beyond that provided by lineage

491 (Table 2).The size of the standardized regression coefficients indicates that

492 the effect of lineage on affiliation is much greater than either the effect of

493 genetic kinship, as was the case in the original test, or affinal kinship.

494 One might ask about the seemingly contradictory results for the Lamalera

495 and the Yanomamö cases. One speculative reason that affinal kin were

496 more important is perhaps because the Yanomamö factions included men

497 *and* women. During the axe fight, numerous men and women sided with

498 their spouses and spouses' relatives against their natal kin. Close genetic kin

499 ties among agnatic sib groups, combined with affinal links between the

500 groups provided by marriageformed the key structural aspects in the axe

501   fight. Among the Yanomamö, once a pattern of reciprocal exchange between

502   lineage segments is established, close local affinal and nuclear family ties

503   appear to trump more general lineage affiliations in the absence of stronger

504   selective forces that favor strong lineage identity(Chagnon, 1979; Chagnon,

505   1980). As will be discussed below, bilateral affinal ties are structural

506   elements absent in nonhuman primate societies and thought by some to be

507   key building blocks for human sociality (Rodseth et al. 1991b). Its

508   irrelevance for structuring Lamalera whaling crews suggests that it is not an

509   adaptive solution to all cooperative problems.

510   Likewise, it does not appear that higher order structure necessarily "short

511   circuits" kin selection for people as subgroups of close kin or families are

512   almost always embedded within large human societies (Davis and Daly

513   1997). One answer may be that different mechanisms of assortment trump

514   others depending on the adaptive social problem (Alvard, 2009).Lineages

515   are not an important principle of social organization among the Yanomamö

516   (Van den Berghe, 1979). This reasoning is supported by analyses of the axe

517   fight and the village that show that genetic relatedness and affinal ties beat

518   lineage loyalties in many village fission events(Chagnon, 1979).

519   On the other hand, strong cultural kinship structure may exist to the

520   extent that highly coordinated behavior provides benefits. TheLamalerans'

521   big game hunting subsistence strategymight be impossible withoutthe

522   lineage structure that creates large cohesive and coordinated groups.In the

523   parlance of game theory, coordination games are characterized by common

524   interest among players(Skyrms, 2001). Coordination is a type of cooperation

525   where the benefits provided by the actor accrue to the group as a whole; in

526   this context there is no motivation to cheat as there would be in the well-

527   known prisoner's dilemma game(Poundstone, 1992). The classic example is

528   the pure coordination involved in choosing which side of the street to drive

529   on. Driving on the right is as good as driving on the left as long as everyone

530   drives on the same side. Any particular solution is a culturally inherited

531   normative regularity.

532   Structure produced by culturally inherited identity works to reduce

533   conflicts of interest that can develop between kin in sizable groups. Cohesive

534   or dense social structure works to reduce the transaction costs associated

535   with solutions to common coordination problems because group members

536   have shared notions of the rules (Sugden, 1986). As mentioned above,

537   density is conducive to group cooperation because it can enable a normative

538   environment facilitating trust (Coleman, 1990). Cooperative hunting is the

539   sort of coordination problem whose solution is facilitated by the ability of

540   people to establish and communicate behavioral norms. The ability to

541 identify and associate preferentially with others who share social norms has

542 immense adaptive value in terms of synergistic rewards—even if they come

543 at a nepotistic cost(Alvard & Nolin, 2002). One key to the success of a

544 coordinated task like cooperative hunting is each participant's shared

545 understanding and expectations of both their own role in the collective action

546 and the roles of the other participants. Put simply, cooperative hunting is

547 mutually beneficial to participants as long as hunters associate with others

548 who can be trusted to share ideas of what constitutes normative behavior

549 (Alvard, 2002). Group members are those who can be trusted to follow the

550 rules.

551 **Conclusion: Primates**

552 The significance of understanding the structural components of human

553 sociality becomes more apparent when examined in comparative light. The

554 idea that much of our human uniqueness lies within our primate heritage is

555 exemplified by the synthetic work of a number of primatologists who have

556 directed their attention to human social structure(Rodseth, Smuts, Harrigan,

557 & Wrangham, 1991; Rodseth & Wrangham, 2004). Chapais (2008), for

558 example, argues that the basic building blocks of human sociality are

559 present in living nonhuman primates. He reconciles Levi-Strauss' idea of

560 reciprocal exogamy—the exchange of women between kin groups into what

561 he refers to as the "exogamy configuration". Like many before him, Chapais

562 points to the pair bond as the key to human sociality (Lovejoy, 1981;

563 Washburn & Lancaster, 1968); and while he discusses its origins, he is

564 particularly interested in its consequences, which he argues to be kinship as

565 we know it in the modern human sense—cultural kinship rather than strictly

566 genetic kinship. Enduring pair bonds allow offspring to recognize their

567 fathers and thus each other as siblings. Primary agnates, father-son and

568 fraternal sibling bonds emerge and providestructure unknown in nonhuman

569 primates. In addition, exogamy or dispersal in the context of enduring pair

570 bonds creates links between siblings in *different* groups and their mates,

571 creating bilateral recognition of affines. These affinal relationships provide

572 links between local groups toproduce an order of complexity also not seen in

573 other primates (Rodseth, Smuts, et al., 1991). A femalecan pacify relations

574 between her affines in her mate's group and her ownconsanguinealkin from

575 her natal group. In this way, affinal brotherhoods can be linked by

576 reciprocal exogamy. Such complexity is unique in integrating local groups

577 through bonds of kinship and affinity.Affinal kinship is the most basic of

578 cultural kinship relationships, and it sets the stage for the creation of tribal

579 level complexity.

580   Rodseth, Wrangham and colleagues (1991) note that exogamy in

581 humans tends to enhance and expand social networks, while dispersal

582 usually diminishes networks in nonhuman primates. This is because, they

583 argue, there is a 'release' from proximity" a phrase coined by Gamble in his

584 hypothesis about how modern human behavior developed in the Paleolithic

585 (Gamble, 1998; Roebroeks, 2001). Where previously, social interactions

586 were face to face with those who are personally known, with the advent of

587 language one can imagine being part of a group, like a lineage for example,

588 where members are not all personally known or even physically

589 present(Dunbar, 2008; Fiske & Taylor, 2008). As noted above, the number

590 of potential relationships in a network increases exponentially with group

591 size. On such larger social scales, relationships in networksare difficult to

592 maintain. Among nonhuman primates, relationships are maintained via day-

593 to-day physical interactions like grooming (Dunbar, 1996; Lehmann,

594 Korstjens, & Dunbar, 2007). The higher-order groups that characterize

595 human sociality, like Lamalera lineages,are not maintained by day-to-day

596 physical interactions. In fact, while members of a Lamaleralineage often

597 personally know one another well, they do not *necessarily*do so—yet they

598 trustone other with their lives during whale hunts.

599   The release of proximity is conceptually related to the linguistic ability

600   of displacement (Trask, 1999), or what is called sometimes called mind-

601   reading or imagination (Bloom, 2002; Gergely, Egyed, & Kiraly, 2007;

602   Marwick, 2003). The neurophysiology of this process may be related to

603   recently discovered mirror neurons (Frank, 1987). Displacement is the

604   ability to refer to things that are not physically present, objects that in fact

605   do not physically exist, or even more importantly, in the creation of

606   categories of things like kinship identities. These things can have names or

607   symbolic tags (clan names or totems for example) that are linked to shared

608   culturally inherited normative regularities like marriage rules or hunting

609   rules. These tags areused by individuals to identifyone another, make

610   predictions about intent, and to make decisions about cooperative partners

611   in coordination game contexts. In many instances, the relationships exist at

612   birth – that is, they are genealogical. One is a Jew if one's mother is a Jew.

613   One is a Takriti if one's father is a Takriti. One is an American if one is born

614   in America.

615   Cultural kinship is a way of managing social information, of

616   categorizing and creating a heuristic that generates the trust required to

617   solve the real life cooperative dilemmas analogous to the coordination

618   games mentioned above. Trust is one way to describe the understanding and

619 behavioral expectations each person in a team has towards the others

620 (Bowles & Gintis, 2004) and this paper suggests that the structural nature of

621 cultural kinship—large dense networks—creates a situation conducive to

622 trust in a way that genetic kinship fails to do, at least in the context of the

623 larger groups that make human sociality unique. The challenge

624 forevolutionary anthropologists is to appreciate these higher-order

625 structuring mechanisms alongside genetic kinship and understand in what

626 sort of contexts they are favored.

627

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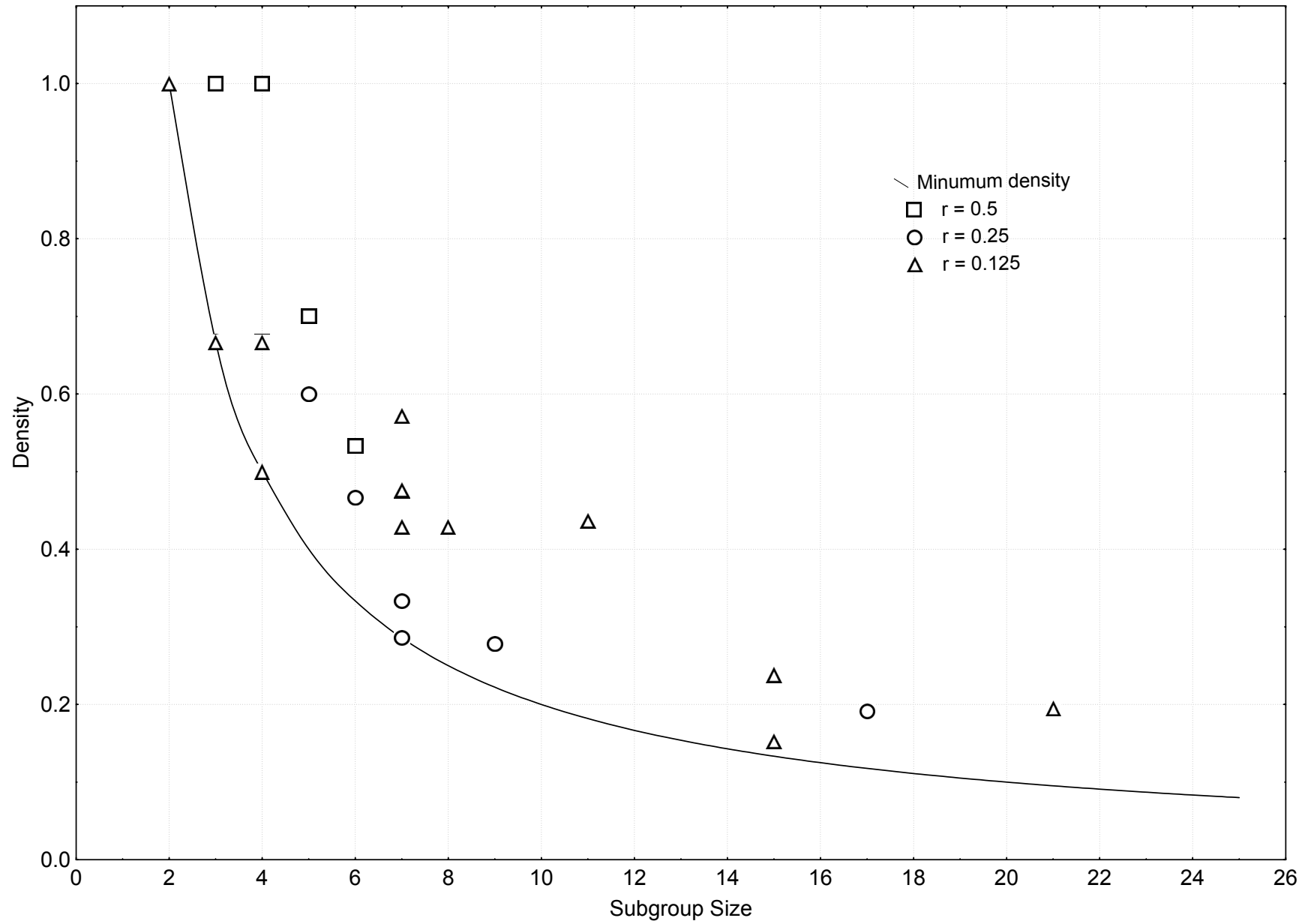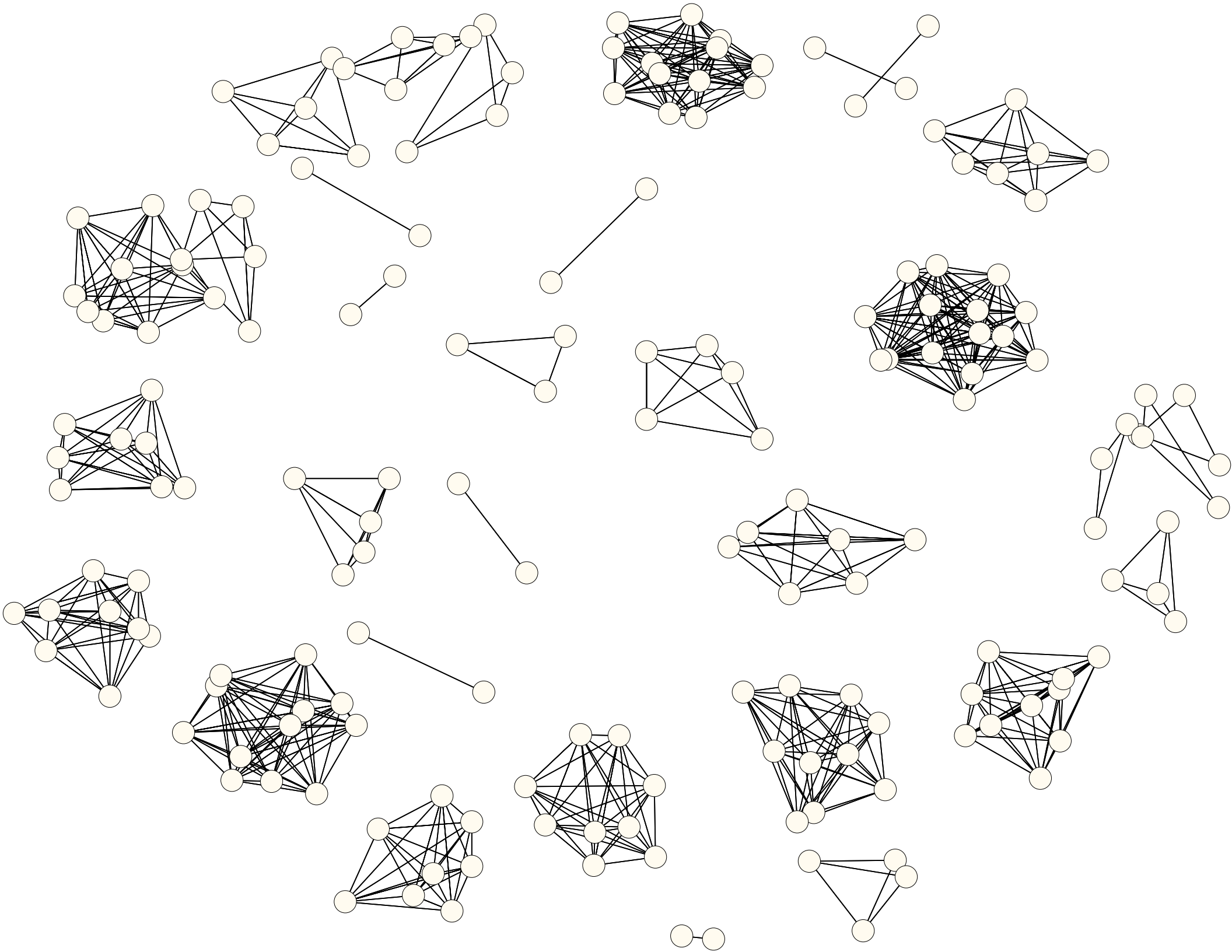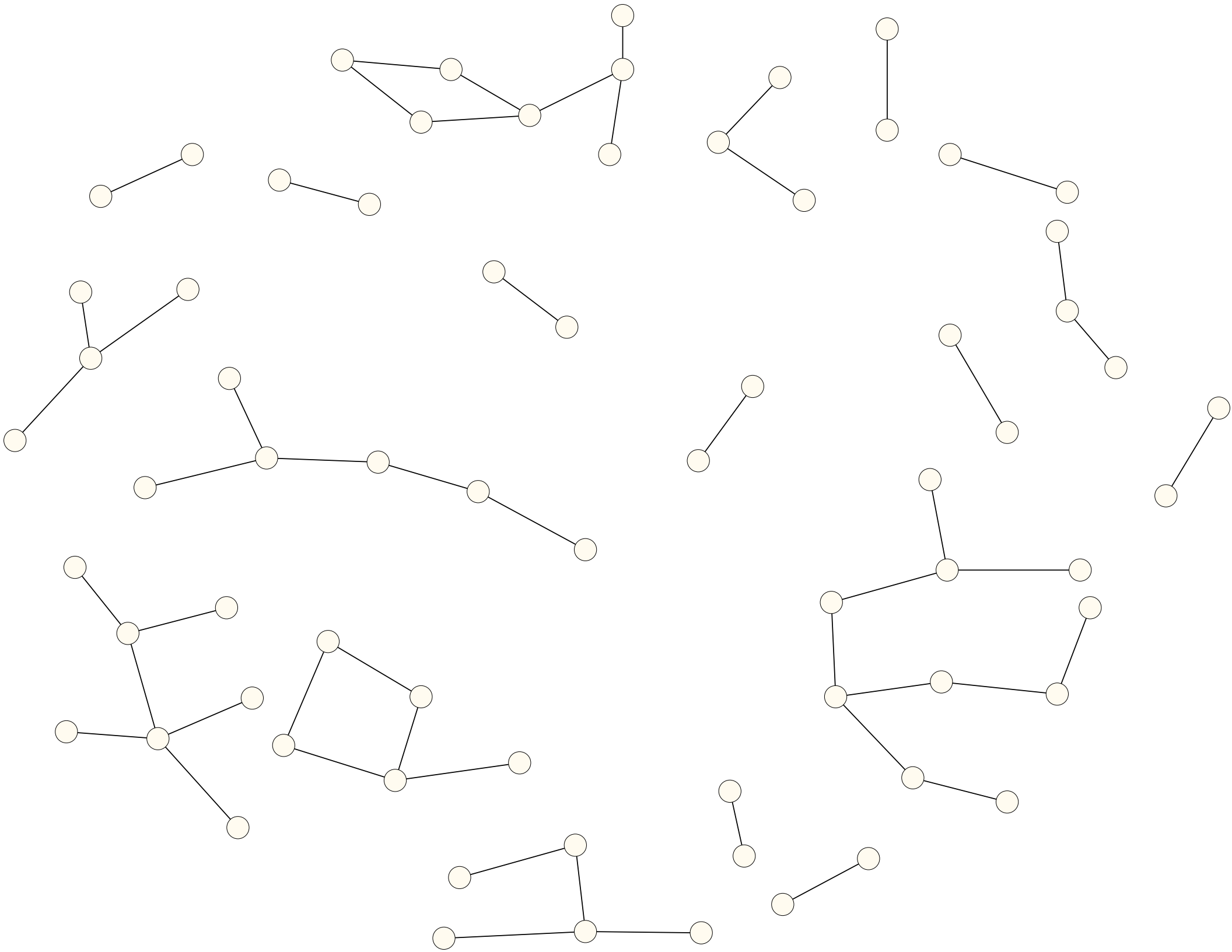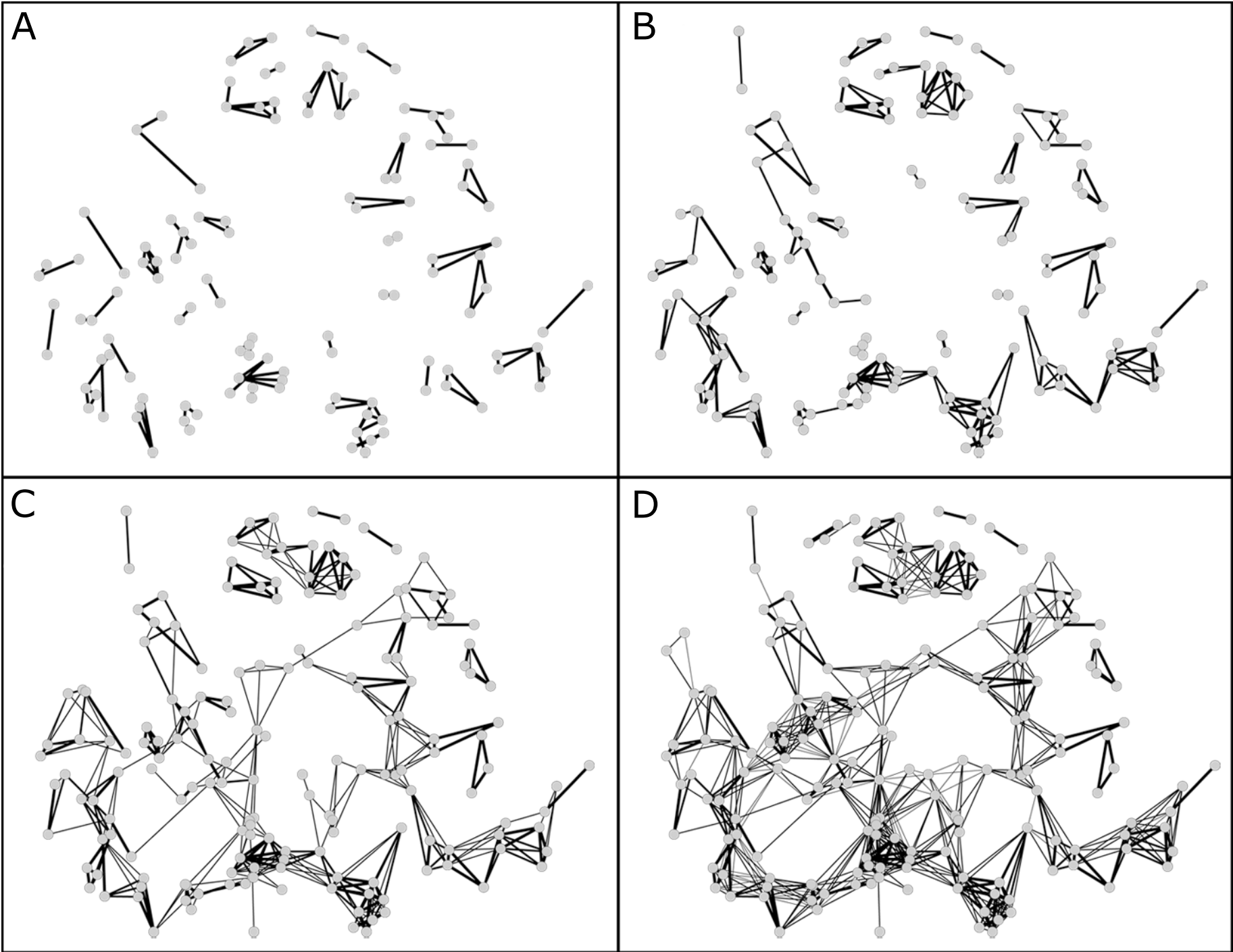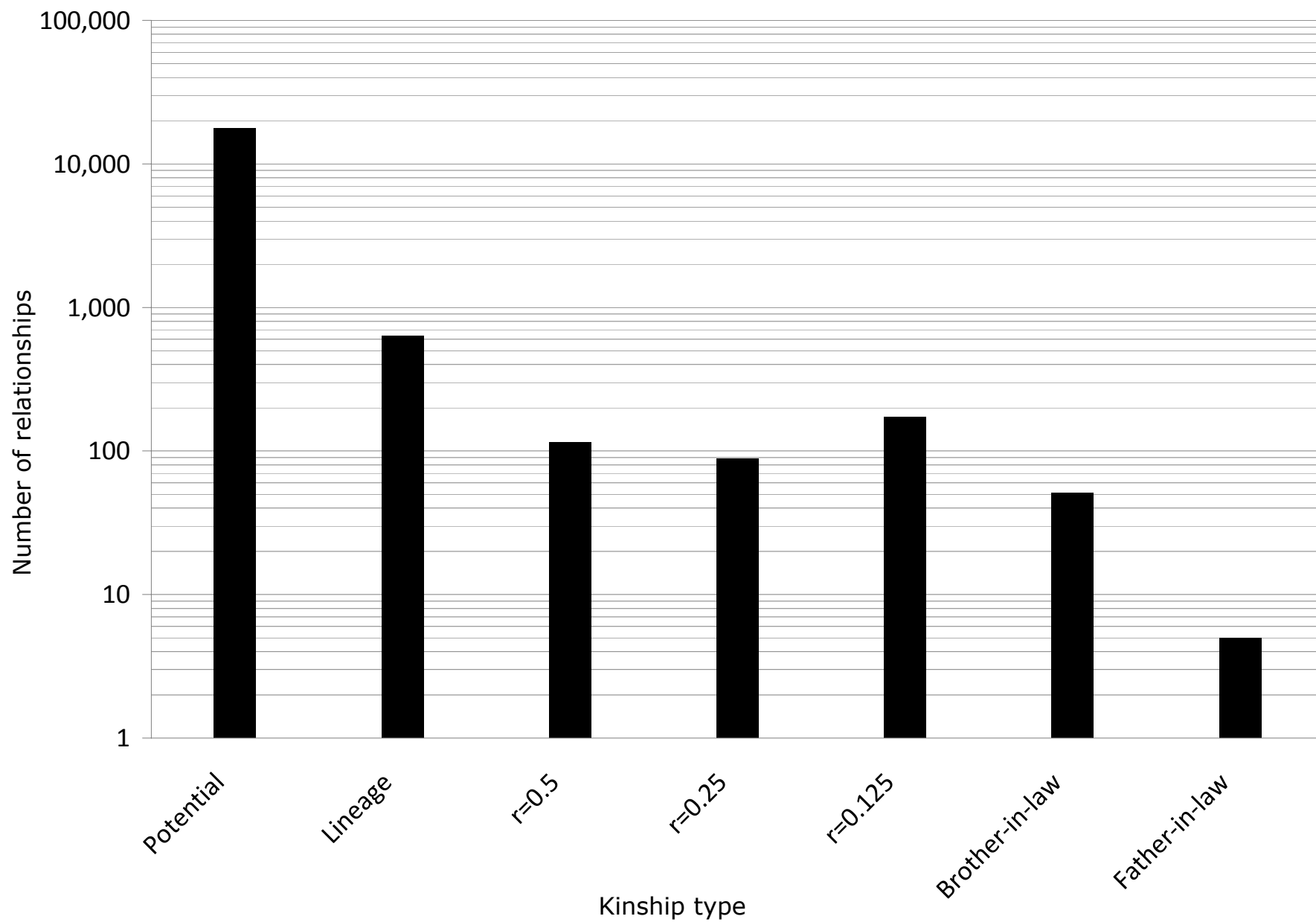
Network	Number links	Number isolates	Number Components (sized N>1)	Mean Component size (sized N>1)	Range Component size (sized N>1)	Mean Density By component N>2
r=0.5	115	66	41	3.07	2-7	0.79
r=0.25	88	97	21	4.38	2-17	0.50
r=0.125	173	64	20	6.25	2-21	0.50
Brother-in-law	51	119	19	3.68	2-10	0.42
Father-in-law	5	179	5	2.00	2	n/a
Lineage	633	7	32	5.68	2-15	1.00

Table 1. Descriptive data for networks.

Independent variables	Standardized regression coefficient	P value	R^2
Lineage	0.3215	<0.000	10.3

Independent variables	Standardized regression coefficient	P value	R^2
Kinship	0.0631	<0.000	10.7
Lineage	0.2925	<0.000	

Independent variables	Standardized regression coefficient	P value	R^2
Kinship	0.0632	<0.000	10.7
Lineage	0.2926	<0.000	
Affinal	0.0152	0.005	

Table 2. Matrix multiple regression analyses results. The top panel presents results with crew affiliation as the dependant variable and the single independent variable of lineage membership. Middle panel presents results where kinship is added as a second independent variable (results are from Alvard 2003). The bottom panel presents results where affinal kinship is added. Neither genetic kinship nor

affinal kinship explains variance in affiliation among whaling crews

independent of lineage.