

Topoi

The Origins of Multi-Level Society

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Abstract

There is a very striking difference between even the simplest ethnographically known human societies and those of the chimps and bonobos. Chimp and bonobo societies are closed societies: with the exception of adolescent females who disperse from their natal group and join a nearby group (never to return to their group of origin), a *pan* residential group is the whole social world of the agents who make it up. That is not true of forager bands, which have fluid memberships, and regular associations with neighbouring bands. They are components of a larger social world. The open and fluid character of forager bands brings with it many advantages, so the stability of this more vertically complex form of social life is not difficult to explain, once it establishes. But how did it establish, if, as is likely, earlier hominin social worlds resemble those of our close *pan* relatives in the suspicion (even hostility) of one band to another? How did hominin social organisation transition from life in closed bands, each distrustful of its neighbours, to the much more open social lives of foragers? I will discuss and synthesise two approaches to this problem, one ecological, based on the work of Robert Layton and his colleagues, and another that is organised around an expansion of kin recognition, an idea primarily driven by Bernard Chapais. The paper closes by discussing potential archaeological signatures both of more open social worlds, and of the supposed causal drivers of such worlds.

1. Open and Closed Social Worlds

This paper aims to explain and approximately date a transition in hominin social organisation from the closed social world of chimp residential groups (and to a lesser extent, of bonobo groups) to the much more open social world of even the simplest human societies. In pursuit of this aim, the paper begins with the contrast between open human groups and closed *pan* societies, and with the great importance of that difference. That contrast poses a puzzle. Once established, the relative stability of open human social organisation is not difficult to explain. However, it is challenging to see how an open organisation could originate if the ancestral form of social life was one of distrust and suspicion towards those outside the band. This paper combines two existing proposals to sketch a response to this puzzle, while also reflecting on the methodological challenges of identifying changes in hominin social organisation over deep time.

First, the *pan*-human contrast, and the idea of a “simple” human society. My notion of simplicity is borrowed from Ray Kelly, who draws an important distinction between simple and segmented forager societies. Segmented societies have institutions (clans, associations through ritual associations and the like) that support a powerful and explicit sense of shared corporate identity than transcends the boundaries of the residential group; that is, the band, or

overnight camp, consisting of individuals and families that associate on a daily basis. Simple forager societies like the Hadza or San do not, and hence lack mechanisms that support collective action at larger social scales than the residential group (Kelly 2000). Yet even these simplest of ethnographically known forager bands, though similar in size to those of chimps and bonobos¹, contrast profoundly with *pan* residential groups.

Let me state the contrast compactly, and then elaborate. In contrast to the closed social worlds of the pan species, and especially the chimps, even unsegmented forager societies contrast in: (i) social and temporal scale. These foragers recognise more individuals as part of their community. Moreover, that recognition does not require near-daily interaction and reinforcement. (ii) Unlike pan groups, the community as a whole is partitioned into relatively stable units that are the locus of daily interaction and routine cooperation. (iii) However, there is relatively free movement between these associations of daily interaction. (iv) Even unsegmented forager communities have much more elaborated family and kinship relations than do the pan species; (v) Human communities are “symbolically marked”. They typically have a distinctive name for themselves, and a narrative that explains their identity and right to place; they often have distinctive insignia (characteristic forms of dress, hair-style and the like); often distinctive rituals; often a distinctive language or dialect; often distinctive and explicit norms, including norms about engagement with others in the community. I do not think these contrasts form a package deal that emerged all at once, so in my view the distinction between the closed social world of the chimps, and the open social world of human foragers is a gradient; not a dichotomy. That will be important in the final section. Let me now add a little flesh to these bare bones.

1. These bands are residentially fluid and socially open; indeed, to such an extent that Frank Marlowe, in writing about the Hadza, argued that the standard concepts of male or female philopatry simply do not apply to forager bands, given their fluidity of residence (Marlowe 2010). Individuals and their families move in and out of these bands fairly freely and regularly, and without prejudice to opportunities to return. Mothers will move in or out to visit their daughters and daughters-in-law (especially after the birth of a grandchild); conflicts are often settled by moving away. In general, residence is open-textured and negotiable. This residential fluidity co-occurs with (and perhaps depends on) the fact that agents in these bands have established horizontal affiliative connections to agents who live in other bands; connections mediated by reciprocity, kinship, or ritual connections of some kind². Forager bands are not closed social worlds, both in the sense that movement in and out is an established practice, and because friendly social connections are maintained across bands. Pan groups are much more closed, in both these senses. In both species, the male is philopatric. Most adolescent females disperse. After an initial period in which they probe their reception in a neighbouring residential group, they do not return, and in almost all

¹ That said, it is important to recognise the considerable variation in group size, in both the pan and the hominin lineages.

² Ritual connection can be surprisingly important. For example, in many Australian aboriginal cultures, connection through the same Dreamtime figure is an important social tie, for it counts as one way of being from the same place (Meggitt 1962).

chimpanzee residential groups that have been extensively studied³, civil social interaction takes place only within the group (Stanford 2018). When chimp groups meet one another at the fringes of their respective territories, there is mutual cool suspicion, or worse. That is either not true, or much less true, of bonobos. There is evidence that when bonobo communities encounter one another, females quite often initiate affiliative interactions across the community boundary, while the males remain mutually but passively suspicious (Furuichi 2011). Female dominance, built on the fact that only female bonobos readily form coalitions, seems to keep male wariness from escalating into overt hostility. If this difference between chimps and bonobos in their inter-group relations is due to the fact that male chimps form coalitions and male bonobos do not, the ancestral hominin condition was very likely chimp-like. For large and medium game hunting almost certainly involved male coalitions. The high velocity projectile weapons that make solitary and small party hunting possible are not part of the record until about 100 kya or later (O'Driscoll and Thompson 2018).

2. Bands are nested in larger social wholes (perhaps with several levels above the band). A band is nested in communities composed of bands which share a common, mutually and explicitly recognised identity. That identity typically includes a shared name; distinctive (though perhaps not exclusive) rights to a territory and the resources in it; often a shared and distinctive ritual life, often with a distinctive language or dialect, even though many of the communities will be multi-lingual (Evans 2017). It is often the unit of intermarriage, with many of the pairings taking place within this broader but linked community. Bands are not kin groups, but there are extensive kin connections within and across bands (Hill, Walker et al. 2011). Social trust is often high within the community, but much more contingent beyond it. Even those agents who are members of simplest human cultures, in which the band is the largest unit of collective action, live in vertically complex, multi-level communities. These simple forager societies are composed of open, residential groups nested in a larger unit, with movement and social intercourse between them (Wiessner 2002, Wiessner 2014). Chimp and bonobo groups are not nested in larger communities. This seems to be something of a contrast between great apes and monkeys. For some species of baboon and old world monkeys do seem to have daily foraging associations nested in larger groups that typically amalgamate at safer sleeping sites, though it is not clear to what extent the agents in these larger aggregations recognise one another, rather than passively tolerate other groups and their members at these safer sites.

3. Bands are largely composed of families. They are structures of kin groups, families, though many contain an unattached adult or two as well. There are some small scale, pre-state communities not primarily structured by kinship into family units, with the conjugal family being the primary social, economic and reproductive unit from which the band or village is built. There are villages when men live and sleep together, apart from their wives, with this male coalition forming the dominant association in the social life of the village. But

³ The far western Tai community seems to be a partial exception. Males patrol, but lethal violence between groups is much rarer. Patrols sometimes seem targeted on establishing an association with females from a neighbouring group, and there is just a hint of the bonobo practice of sex as a way of managing intercommunity tensions in these patrol to female encounters: see ((Stanford 2018) p 78).

lives organised around male coalitions arise only in highly conflicted environments, as a response to permanent and serious external threat (Rodseth 2012). There is good reason to suspect that this form of social existence is both atypical and late-evolving, as external threats of such intensity are a relatively recent feature of human life (Sterelny 2016).

In general, then, ethnographically known forager life is a life in a family, co-resident with a small group of other families, but embedded in extensive, explicitly recognised, and normatively important kinship networks. There is astonishing cultural variation in kinship systems, but as Bernard Chapais has emphasised, there are important common features as well. In particular, (i) a focal agent, ego, recognises both maternal and paternal kin (though they may not be equally important); (ii) affines (in-laws) are recognised as kin: the brother of ego's wife, for example, is kin; (iii) though cooperation is certainly not restricted to kin interactions, kin are often preferentially chosen in cooperative activities; (iv) some kinship relations generate life-long bonds; (v) kin recognition, affiliation, and obligation does not require co-residence; (vi) kin recognition interacts with mate choice; some kin are blocked as partners. Quite often, other kin are preferred partners⁴. (vii) Explicitly recognised kinship networks are always extensive: always going beyond primary kin (parents, sibs, offspring) and very often, perhaps always, going beyond secondary kin (the primary kin of ones' primary kin). The open texture of band residence and these extensive, complex and enduring kinship networks are mutually reinforcing, once both are established (Chapais 2008, Chapais 2013, Chapais 2014).

Kinship plays some role in *pan* social worlds but a much less extensive role. Their mating practices obscure the paternity of a mother's offspring, so paternity-based kinship relations are not clearly recognised in either species, or if recognised, they do not play a major role in structuring the social environment. Yet in both species, the males are philopatric and adolescent females typically disperse. A mother is unlikely to breed in the same group as her own mother, and she is not much more likely to co-reside with her female sibs. Indeed, given the long inter-birth intervals, it is not obvious that sisters would recognise one another if a younger sister migrated in five years or more after the arrival of the first. A further consequence is that grandmothers are not typically co-resident with their granddaughters. Brothers do co-reside, and sometimes do form strong bonds. However, the long interbirth interval has the further consequence that in many situations, brothers will not be one another's first choice as social allies. A newly adult chimp, looking to push his way up the dominance hierarchy, would get no benefit from his younger brother's support. Even less if that brother was not the next-born, though brothers can and do become valuable allies as they move into their prime years. So while the chimp mother-son link is an enduring bond, and one that leads to affiliation and support between brothers, kinship networks are attenuated compared to their role in AMH (= Anatomically Modern Human) societies (Lehmann 2008).

In my view, it is difficult to overstate the importance of these contrasts in social organisation. Over short time frames, the open-texture of bands, and the fact that in most forager societies

⁴ Sometimes equally distant kin, with parallel cousins blocked, and cross-cousins preferred.

bands periodically come together,⁵ has important benefits. These meta-band assemblages enhance informed mate choice and outbreeding: both formal pairing and, no doubt, less formal genetic exchange. They are information markets, as members of the community share gossip, information about local conditions, and information about developments beyond their territory. In some cases, there is probably material exchange as well. In Aboriginal Australia, for example, stingray barbs (used as projectile points (Marwick 2003)) made their way deep inland, through exchange within and across community boundaries. They are occasions to renew and reinforce social ties with individuals in other bands. Especially amongst those foragers living in unpredictable habitats, these connections are an important form of social insurance, making it possible to shift one's locus of operation in tough times (Wiessner 2002). These aggregations are an occasion for dispute resolution; sometimes through formal mediation; sometimes by just providing opportunities for disputing parties to shift away from one another. Finally, while these aggregations do not guarantee that the option of collective action at scales larger than the individual band is available, they are an essential precondition of such larger scale collective action.

Arguably, over longer time scales, the network of linked bands is even more important. Very likely, the transition to a more open social world was a critical factor in powering innovations in technology and technique. For perhaps two million years, hominins have been adept at social learning. Central aspects of their foraging economy depended on the mastery of quite complex technology (Acheulian stone work, for example) and extensive natural history knowledge. But judging from archaeological indicators, until relatively recently the pace of change was puzzlingly slow. From the invention of stone tools over 3 mya to about 800 kya, the only major change seems to have been the addition of Acheulian tools to cobble and flake technology. These are the famous handaxes and large cutting tools. At about 800 kya, we see evidence of more sophisticated methods for making these large cutting tools, the first hints of hafted tools (Kuhn 2019), and a reasonably unambiguous signal of domesticated fire (Gowlett and Wrangham 2013). At about 500 kya, there is much clearer evidence of hafted tools, and the first instances of still more skilled stone-working techniques, Levallois techniques (Wilkins and Chazan 2012, Wilkins, Schoville et al. 2012). These involve extensive pre-shaping of a stone core before a flake is struck off, giving the artisan much more control over the final form of the flake. There is some pick up of the pace of innovation in the second half of the Pleistocene, but as the record stands, it seems that through much of the Pleistocene our hominin ancestors could reliably retain core skills while stable innovation — innovations that established over enough space and time to become a routine part of technical competence — was rare.

Over about the last 150 k years of human evolution, the picture changes, and over that period, the pace of technological change accelerated markedly, though not evenly, and with many innovations disappearing temporarily from the record. Adam Powell, Stephen Shennan, Joseph Henrich and their colleagues have argued that this change is the archaeological

⁵ In some cases in seasons of plenty; in other, more arid habitats, around permanent water and the resources that water supports.

signature of much more reliable retention of culturally acquired information mediated by changes in human social networks (Henrich 2004, Powell, Shennan et al. 2009, Henrich, Boyd et al. 2016)⁶. These theorists use both formal models and ethnographic data to argue that these changes depended on an expanded social network. Most importantly, in small groups, crucial skills are easily lost by demographic accident (Premo and Kuhn 2010). Moreover, size makes specialisation possible (Ofek 2001)⁷, though certainly not inevitable, and specialisation probably increases the innovation rate. Finally, larger networks may make social learning more reliable by providing more and better models. So as a consequence of these expanded social networks, cultural learning became cumulative in an increasing number of human communities in three distinct but mutually supporting senses. First, there was incremental improvement in existing technical capacities: simple wooden spears acquired stone tips and barbs, as the techniques of hafting and of fine-grained control of stone shape were acquired and passed on (though as noted above, some of these innovations have a much deeper history; perhaps as deep as 500 kya (Kuhn 2019)). Second, the scope of cultural learning expanded; for example, through the more systematic exploitation of bone and horn, or through the exploitation of new resources (like those from the sea). Third, cultural learning became combinatorial, with agents assembling new tools (and new skills) by combining old elements into new uses (see especially (Muthukrishna and Henrich 2016)). We do not know the order of acquisition of the bow and arrow complex, snares and sprung traps, and fire bows. But these all exploit the interaction of mechanical energy and cordage, and once a culture has one, the steps to the others are short.

In my view, there is an important additional factor that underwrites the importance of these open social worlds, and the expanded networks they make possible. To the extent that networks are closed, that sharply constrains the prospects of an innovation surviving long enough to be archaeologically visible. Especially in earlier periods of hominin evolution, we are likely to find archaeological traces only of widespread and persisting technologies and practices. The record of near-stasis in technical capacity between 3.2 mya and 800 kya shows that innovations rarely established and spread; not that there was almost no innovations. Any innovation is extremely vulnerable to stochastic loss while confined to the band in which it first established (Premo and Kuhn 2010). For an innovation to establish to the point of visibility, it must be exported from its point of origin, and that export is sharply constrained if there exists a general pattern of hostility and suspicion between groups; a pattern typical of great apes and likely therefore to have characterised at least early hominin social lives. While forager bands were largely closed, innovations were unlikely to spread by adult-to-adult interactions across community boundaries. So how could they spread? Chimps and bonobos are characterised by male philopatry and subadult female dispersal; that is therefore the most likely early hominin pattern. It follows that the only innovations at all likely to expand beyond the point of origin were those acquired by subadult females, and ones which could be

⁶ It should be noted though that these ideas remain controversial: (Collard, Vaesen et al. 2016, Vaesen, Collard et al. 2016).

⁷ The Tiwi provide an example of this in miniature, as the large households of polygynous men provide those males with the opportunity to specialise in the production of elaborated carved ritual objects, and in the composition of new songs and dances (Hart and Pilling 1960).

expressed by those females, at high enough frequency and salience for them to spread in the groups that they join. This is a very serious filter on the spread of innovation, especially as there is some suggestion that female chimps do not express feeding innovations in residential groups that they join (Luncz and Boesch 2014), though there does seem to be one example of a female immigrant bringing in an ant-fishing technique that established ((Stanford 2018) p 168). Hence the relaxation of that filter through the establishment of a more open network structure was necessary for the late Pleistocene acceleration in innovation.

In brief: the expanded social networks that humans enjoy have major benefits over many time frames. These benefits help explain the persistence of these more open networks. Some cooperative arrangements are profitable but fragile, because those profits are too easily hijacked by a few individuals. But the profits of an open society do not seem readily monopolised by the few. That said, while the contrast between explaining the origins and explaining the stability of multi-level communities is real, we should not be naive about forager social life. Relations between communities are often fraught, and within communities there is plenty of scope for conflict and violence ((Boehm 2012, Fry 2013). Social complexity can decrease, not just increase (Sheehan, Watts et al. 2018). Jared Diamond and James Scott have both written about the conditions through which social complexity shrinks (Diamond 2005, Scott 2017). While their targets are much larger social units than forager residential groups and the communities they comprise, the target of this paper, no doubt forager communities do splinter through external stress and internal conflict. Their stability is *relatively* less puzzling than the initial formation of these more complex social units. But they are only relatively more stable, and given the many potential conflict points in human life, that relative stability also requires explanation, as we shall see in the next section. Even so: supposing we are successful in explaining relative stability, that does not explain origins. If early hominin bands were as mutually hostile and untrusting as contemporary chimp groups, how did that change? The target of this paper is to explain that change: to explain the formation of communities of the kind exemplified by unsegmented foragers. Most humans have lived, probably since the Holocene, in still more complex social worlds. That further expansion of complexity poses additional issues that are beyond the scope of this paper (Seabright 2010).

2. The Origins of an Open Society: An Ecological Model

As noted in section 1, once formed, the stability of multi-level forager society is less difficult to explain. The reproductive advantages of access to a larger network of potential partners; the exchange of information about conditions in the region; the flow of local gossip; opportunities for limiting the costs of conflict; are all profitable forms of cooperation, and forms of cooperation that do not pose much of a temptation to defect. But it is one thing to explain the stability of multi-level forager society; it is a different matter to explain and identify its origins. If the ancestral condition of hominin sociality was analogous to that of chimps (and to a lesser extent bonobos), divided into mutually suspicious bands, how did multi-level band society emerge? Robert Layton and colleagues finesse this question. Putting their idea crudely, the metaband forager community corresponds to a chimp or bonobo

residential group, and thus to the band of early hominin evolution. That metaband community is the result of expansion: there are more people in a forager community than there were in early hominin bands. And from fractionation: hominin communities did not just expand, they acquired internal organisation. According to Layton and his colleagues, these changes were driven by changes in foraging practices (Layton 2008, Layton and O'Hara 2010, Layton, O'Hara et al. 2012)

Layton and his colleagues begin their analysis from a composite picture of ethnographic foragers, a picture with two key characteristics. First, meat forms an important part of their diet (though with very significant variation⁸). Second, their population densities are low, as a consequence of chasing meat, both as hunters and scavengers. As with other apex predators, most of whom will scavenge if they can, the prey populations on which they depend require large ranges. Of course, density varies with habitat type. Exceptionally challenging environments like the Australian western desert and the high arctic support as few as one forager to 100 square kilometres; the most productive environments perhaps one forager per square kilometre, though most are well below the high figure. It is noteworthy that forager density is significantly less than chimp density in the regions in which they overlap. The exploitation of large game and the space this requires drives Layton and colleagues' causal model of the evolution of vertical complexity. Forager bands are the descendants of ephemeral chimp alliances and foraging parties. As hominins became efficiently bipedal; as they shifted to a more meat-based diet; as encephalisation allowed community size to shift up, the overall territory patrolled and loosely controlled by a community became considerably larger than the daily foraging range of individuals in the community. It became increasingly difficult, and eventually simply impossible, for the community to reform on a nightly basis. What were once ephemeral and ad hoc groups of males and females foraging together (in part for safety, in part for collective effort in hunting and gathering) became a more stable locus of daily interaction and sharing. Sustained interaction in a small, fairly stable group made trust and hence cooperation possible. For the high variance in the success of meat chasing made daily or near-daily pooling of catches an important buffer against even a modest run of bad luck. Formerly ephemeral foraging and hunting associations became the central experience of social association, trust and cooperation. Yet the community-level organisation does not disappear. In most places, seasonal variation allows the bands to come together at least briefly, and neighbouring overnight camps encounter each other with some regularity.

An essential part of this idea is that community size expanded in concert with these changes in foraging practice. What would explain the shift towards a larger community; one that acquires structure as it expands? At the beginning of this transition, the community and the residential group, the unit of daily interaction, are the same. By the end of it, the community is larger but consists of a network of residential groups. Layton and colleagues point to encephalisation and to Dunbar's well-known hypotheses linking relative neocortical size to group size (Gamble, Dunbar et al. 2014). But even if we accept Dunbar's views about the

⁸ From a low of 10% (though only in one season) through to 87%.

cognitive and neural demands of building a social map in densely networked groups, neocortical volume acts as a constraint on maximum group size, a constraint that is relaxed as that volume goes up. Encephalisation makes it *possible* for more encephalised hominins to live in larger groups, but it does not identify a selective advantage accruing to life in a larger group. What else might? Cooperation and the control of inhibition were also part of this foraging revolution. A shift to an economy of hunting (with short range, low velocity weapons) requires cooperation, selecting against intractably competitive and bullying personality types. Moreover, as Travis Pickering has pointed out, an economy of hunting also selects for self-control, for being able to inhibit impulse (Pickering 2013). Male chimps could not sit in close proximity in concealed silence for hours, waiting to spring an ambush. These changes would also tend to reduce conflict costs that otherwise rise with increasing group size. But while these factors also help make larger groups possible, they do not positively select for a larger community. Nor, probably, would the dangers of predation. Weaponised and cooperative foragers are probably under less threat. Moreover, there are likely to be diminishing returns in the extent of protection as numbers increase (Jordan, van Schaik et al. 2013). In any case, predator defence is the job of the residential group, not the larger community, and residential groups may not have increased in size over this transition. We need to explain the change in community size, not of residential group size. However, one advantage of size is better buffering against chance demographic fluctuations. In smaller groups, sex ratios and age profiles could easily become unbalanced. Other, perhaps critical, advantages of size, if coupled with the expansion of the group's territory and with friendly relations between the nascent bands, are the informational, risk management, and conflict resolution benefits discussed above. Weapons change the selective pressures acting on early hunting hominins in comparison to those acting on chimps. The evolutionary rationale for chimp mutual hostility is probably a struggle for resources (Wrangham 1999). But even if that is true of chimps — even if selection drives their conflict — I have argued elsewhere that weapons change the cost-benefit payoffs for intergroup hostility, and that attempts to seize neighbouring resources are rarely worth their costs (Sterelny 2016). So there are selective advantages for these nascent bands in maintaining affiliative relations with one another as they come to interact less regularly. Selection may well have favoured default inter-group hostility in the ancestors of chimps; it would not have typically favoured defaults of hostility and aggression between armed bands of foragers. If this transition began relatively early in hominin evolution, perhaps with the erectines, then the demographic and informal conflict resolution advantages were probably initially most important. The informational exchanges made possible by a larger and spatially expanded social world depend on fairly sophisticated communicative tools, and these probably arrived somewhat later in hominin evolution.

In summary, there are important open questions about this ecological model. One is identifying the selective pressures driving community size up. Most critically, it needs to be integrated with some view of the role of women (and gathering). Given the high variance of hunting success, the expansion into the predator niche seems possible only if there are fall-back foods (Wrangham 2017). These have typically been provided by women, though other options are possible. As one reader pointed out, foraging tasks might be structured by age rather than gender. How is gathering organised and cooperatively coupled to hunting, and

how does that impact on issue of territory size, coordination and cooperation? If the great apes are any guide, most lethal violence is initiated by males. Perhaps all lethal violence between groups is male-driven. Would a combination of gathering fallback foods within the context of an overall dietary shift towards carnivory exacerbate or ameliorate tensions between the males in nascent bands? The provision of fallback foods within this ecological context would tend to reduce contact frequency between nascent bands, as they begin to space out, chasing game. For these fallbacks are of lower quality, and hence they are worth harvesting only if travel distance are shorter, in comparison to high valued resources ((Kelly 2013) chapter 4). If suspected trespass is likely to be a source of friction, it is less likely to be provoked by gathering. On the other hand, if regular interaction helps keep bonds alive, gathering parties are less likely to contribute positively to re-establishing links of familiarity.

While serious questions are open, the analysis has one important and very appealing feature. The problem of explaining the initial steps away from inter-band hostility disappears. As a hominin community shifts to greater carnivory, its domain of operation expands so that it reaches a point in which the different foraging parties are sometimes too far from one another to re-unite at an evening camp, for sharing and safety. A form of association that exists but plays a relatively minor role in *pan* community life, an ephemeral foraging party, very gradually becomes much more important through its greater stability and its importance as the locus of immediate cooperation in foraging, sharing, childcare and safety at night. It transitions into a band. As it expands demographically and spatially, the community develops an internal structure. Nascent bands are intermediate between the community as a whole, and individuals and their immediate families. We swap the very difficult problem of explaining how bands with independent and largely hostile histories establish trust, for the much easier problem of explaining how trust is maintained between groups who initially knew each other; whose frequency of interaction has declined; yet who can continue to interact in mutually beneficial ways. But that is still a problem. In the chimp case, when a group fractures, the males in each descendant group do become mutually hostile ((Stanford 2018) chapter 4).

In summary: community size and range size gradually expand, as cognitive, motivational and ecological constraints on size loosen, and because there are positive advantages to size. But as the territory and the community expands, travel time constraints force the group to fractionate. Above a certain threshold, the community as a whole can no longer regularly reform. But less frequent interaction remains both possible and beneficial.

3. An Erectine Transformation?

Suppose Layton and co's conjecture is right, and the shift to the carnivore niche triggered a shift to a more vertically complex community structure. When did this happen? Layton and co-workers take this transition to be at least as deep in time as the Heidelbergians. But Henry Bunn, Travis Pickering and colleagues have developed a persuasive case that targeted medium-game hunting dates from about 1.8 mya, roughly coinciding with the emergence and rapid geographic expansion of the erectines (Bunn and Pickering 2010, Pickering and Bunn 2012, Bunn and Gurtov 2014). Now it is one thing to hunt; another for hunting to be so

central to the foraging economy that it structures a group's use of space, thus initiating the downstream social consequences of that use. But if Layton and his colleagues are right about the relationship between encephalisation, hunting, and group size, and Bunn and friends are right about the origins of hunting, some of the foundations of a more open social environment were being built in the first half of the Pleistocene. Arguably, one such foundational element was a change in kin recognition. It is true that the persistence of civil relations between nascent bands as the community expanded and agents in different foraging groups interacted (much) less frequently is less puzzling than the breakdown of hostility and its replacement by civility. Even so, the ecological model still needs to explain that persistence, and kin connection is one plausible mechanism, and that makes the origins of pair bonding relevant. As Bernard Chapais has repeatedly urged, the evolution of pair bonding and male provisioning in the hominin lineage will automatically lead to more extensive kinship networks, for it will lead to at least some recognition of paternal kin. In a pair bonded mating system, and in particular one in which a father provisions his family, a focal individual will recognise as kin his/her father, and those that the father regularly and intimately interacts with; perhaps some of his sibs; perhaps his parents. While it is difficult to date with confidence the establishment of pair-bonding and male support, considerations about the increasing cost of children finger the erectines as the likely taxon in question. Kit Opie and Camilla Power develop a persuasive case that erectine mothers needed support, and that fathers probably provided some of that support (Opie and Power 2008).

Their argument begins with their estimates of the cost of children to chimps, and the key point is that chimp offspring costs seem close to the limits of what a great ape mother can afford without assistance. Their baseline assumption is that female chimps have a reproductive span of about 20 years and interbirth intervals of 5.6 years. Those estimates yield a lifetime reproduction of 3.4 infants. There is not much room for exogenous mortality with those demographic limits. There is little doubt that encephalised erectine babies would be more expensive than chimp babies, and those costs would be further exacerbated if, and to the extent that, erectine babies were more altricial, and had to be carried as erectine mothers moved bipedally across their larger home ranges. Could erectine mothers be proportionally more productive, given what is surmised about their habitats and foraging capacities? We can attempt to use information about the foraging returns of ethnographically known foragers to estimate the productivity of erectine foragers, but the inference is murky. AMH infants are more expensive than erectine infants. Moreover, the estimated lifetime productivity of forager mothers averages at about 5, whereas erectine female productivity might have been lower, perhaps around the chimp average of 3.4. So perhaps erectine mothers had fewer and cheaper infants to support. On the other hand, AMHs have better technology and better food processing capacities (full control of fire), so they were significantly more efficient as foragers. In principle, those efficiency gains might be counterbalanced if erectines lived in more productive environments, but that too is difficult to assess. The defenders of the grandmother hypothesis tend to assume those environments tended towards seasonal aridity

(and hence the importance of USOs)⁹. But erectines spread across the world. They were not confined to a USO-rich environment.

Nothing decisive emerges from these considerations, but Opie and Power give us some traction on this issue with the aid of quantitative modelling, though inevitably those models depend on some assumptions that are difficult or impossible to test independently. In this case, they make the following life history assumptions: (i) age at first birth averages 16.8; at that time, life expectancy is 45; (ii) last birth at 33, for an average of 12 post-reproductive years, making support from a grandmother possible; (iii) children wean at 5, provide some of their own resources from 5-9, and are self-sufficient at 9. On these assumptions, we get the following table, in which Opie and Power explore the consequences of different interbirth spacings, and hence total productivity (2008, p. 176). It is clear from the table that if these life history assumptions, and the estimate of daily calorie needs, are even approximately correct, erectine mothers foraging without help could not support a stable population, let alone one that expanded over much of the world.

Offspring no	Interbirth Interval	Energy Required Kcal/day	Exceeds female Forager average %	Exceed average in peak years
2	9	2291	=	0
4	5	2546	+11.1	+22.7 (9 yrs)
5	4	2777	+21.2	+ 31(15 yrs)
6	3	2951	+28.8	+47.4 (12 yrs)

If indeed erectine mothers needed support, it is most unlikely that all that support could have come from a grandmother or other female relatives, even if erectine females were philopatric and they lived with their female siblings and mother. Some would not have living grandmothers; some grandmothers would have to balance demands from more than one daughter/child combination. Most sisters would have children of their own to support. They were likely to be able to support one another by the exchange of services (creching, for one) but not with net food contributions, though they might have managed risk by sharing food. Brothers are unlikely to have been in a position to help. If females were philopatric, presumably males dispersed. The best guess is that some form of male support was needed as well as female support. That does not necessarily imply pair bonding with paternal provisioning in return for paternity certainty¹⁰. Something akin to the parable paternity of some South American forager groups might be an alternative possibility, with the males

⁹ Somewhat counter-intuitively, such environments are often quite good for foragers, since plants invest more of their biomass in parts of the plant humans can consume, such as “USOs”; i.e. Underground Storage Organs like tubers and corms.

¹⁰ Indeed, they are rather sceptical about this possibility, because they do not see how paternity could be certain enough for this to be a reasonable deal for males. That, however, depends on the character of male foraging: if they forage in a single group, or a couple of groups, they automatically police one another. Moreover, despite the threat, at least some ethnographically known foragers keep the risks to within tolerable limits.

collectively pooling and dividing their kills, and then sharing with the mothers, perhaps approximately in proportion to the amount of sexual access each has had to them. Still, pair bonding in humans is a dominating feature of our mating system, and if it did indeed evolve in response to the great cost of hominin children, then the erectines and the early Pleistocene is a plausible taxon and time.

4. The Origins of an Open Society: Kinship

Pair-bonding and its time of origin is important for a second reason: Bernard Chapais presents an alternative account of the origins of multi-level society; an account based on the expansion of kinship, an expansion founded on pair-bonding. On his account, the vertical complexity of human social life is built up largely by aggregation. Chapais begins his analysis by noting three unusual and important features of human kinship. First, human social organisation is unusual in combining multi-male, multi-female groups with predominantly monogamous, predominantly long-term mating arrangements. Human family arrangements are predominantly (serially) monogamous. Though most recorded societies permit polygyny, even in those societies, the modal number of wives is one. Second, humans typically recognize a lot of kin as kin (including individuals with whom they share no genetic relationship). Human kinship networks are very rich, especially compared to the two *pan* species. Moreover, recognised kinship comes with a positive bias towards affiliation and cooperation. Third, kin recognition, and affiliation, is not tied to co-residence: kin relationships are recognised across groups, and the exchange of mating partners between groups combined with the continued affiliation of those kin reinforces tolerance, and more active cooperation, across groups.

There is a fourth difference which Chapais tends to downplay, but which is necessary to his picture of transitions in social organisation. He thinks that pair bonding established relatively early in hominin evolution, and that alone, without the evolution of new cognitive or cultural capacities, facilitated the emergence of a much richer system of kin relations. It is true that in human life, the domain of kin recognition expanded greatly. But it is also true that the mechanisms of kin recognition have been transformed. The *pan* species notice (some of) their kin. AMHs notice that they notice their kin. In discussing primate kinship, Chapais emphasises the power of familiarity-based mechanisms to generate kin recognition accreting around the core relationship between mother and child. That bond is associative, based on repeated positive interactions. But as Chapais points out, the strength and persistence of this relationship, together with social referencing, builds further affiliative interactions. If the child's mother has regular affiliative interactions with her own kin — her siblings, her mother, her other children — those interactions shape the child's social experience of her own mother's kin. If the mother treats them as allies and supports, all else equal, so will the child. More so, if the positive bond between the mother and her kin motivates positive interaction with the child. Through this mechanism of differential association, primates can recognise kin and interact in discriminating ways with them, without knowing they are recognising kin or having the concept of kin.

This mechanism is important, but in my view, insufficient to explain the kinship bonds on which Chapais relies in his account of band aggregation. Chapais develops a picture of the interaction of kinship and social organisation in his 2008, supplemented in a series of papers (Grueter, Chapais et al. 2012, Chapais 2013, Chapais 2014). In his view, the evolutionary shift to a more open social world was ancient and preceded language, for it did not depend on any of the distinctive cognitive and cultural innovations of late hominin evolution. He suggests that the shift away from a situation of mutual hostility and regular aggression needed only two changes to pan-like social words: (i) circumstances in which neighbouring bands could meet without immediate hostility and/or immediate retreat from the encounter, and (ii) established pair-bonding. He envisages the following scenario. Suppose adjacent bands do meet at their respective borders without immediate conflict. Since females disperse, individuals in each group have kin in the other group. These kin connections are potential routes to tolerance, but in chimps and bonobos this is a weak force for peace, for these individuals recognise only matrilineal kin. Mothers might recognise their daughters. Perhaps opposite sex siblings will sometimes recognise one another, though long inter-birth intervals will mean that only adjacent siblings in the birth order will have spent much time with one another. Even supposing the ties of affiliation survive migration and separation, the bridges of tolerance between groups are few and weak, for most are female/female linkages, and that will not damp down male aggression. This all changes with pair-bonding. For pair bonding adds the recognition of patrilineal kin, and affiliation with patrilineal kin, through the same mechanisms of familiarity — of repeated affiliative interaction — that build mother-centred kin recognition and affiliation. Fathers (and perhaps even father's brothers and the fathers' father) will recognise their kin in the adjoining group. Fathers will recognise their daughters and (if interactions were frequent enough, their daughters' offspring). Brothers will recognise their paternal sisters (half-sisters, in polygynous pair bonds) in other groups. There are a lot more bridges of tolerance between the groups, and more of them involve adult males inhibiting tendencies to aggression.

The basic suggestion is plausible: if bands came into contact at their boundaries without aggression, kin-kin interaction across band boundaries could damp down aggression and suspicion. Likewise, the more kinship bridges of tolerance there are, the more plausible it is that kinship links could build, or sustain, tolerance between bands. Further, if tolerance begins to establish, it could be built incrementally. If mutual kin recognition kept encounters between adjacent bands free of open outbreaks of aggression and violence, that in itself would reduce the likelihood of violence even from those outside these kinship bridges. The more tolerant interactions there are, the more likely the next interaction will be tolerant, as arousal levels on encounter will be lower, and the more frequent group on group encounters will be, for each band will be less inclined to avoid areas where encounter is possible. However, kin-based peacemaking presupposes more extensive changes from pan-like cognition and social life than Chapais supposes. As a stand-alone model of the emergence of multi-level communities, his picture depends on a lot of fragile assumptions. Let me detail those.

First, it requires the ties of affiliation built by regular and affiliative interaction to survive migration and separation, perhaps over long intervals. Perhaps that is possible. Second, Chapais' model assumes that the typical interaction between groups involves the whole group (or most of it), for as he pictures the interaction, on both sides it is multi-female, multi-male, with a mixed age range. Here we see the influence of baboons as his model of early hominins, where residence groups often do forage as a single unit. But if these early hominins had a pronounced fission-fusion social organisation (as chimps often do), and especially if females and juveniles avoided boundary areas, this is unlikely to be the modal form of encounter. In most chimp groups, larger foraging parties are male dominated, and females often restrict their foraging to core areas of the group territory ((Stanford 2018) chapter 2; thanks to Ron Planer for pressing this point). Moreover, if these changes in kinship recognition are in the context of the erectine shift to carnivory then, as we saw in section 2, back-up resources are critical, and it is therefore unlikely that erectine bands foraged as a single multi-age, multi-gender unit. Third, pair bonding *plus male provisioning* is probably needed to generate a regular pattern of positive interaction between fathers and their children. Chapais sharply distinguishes the evolution of hominin pair-bonding from the paternal support of partner and offspring: this development he takes to be significantly later. However, for paternal kin recognition and affiliation to be built by long experience of positive interaction, we need something like a family economy — perhaps an extended family economy — with resource pooling and communal eating. That would sustain regular, positive interaction. If a group of matrilineal and patrilineal kin share and eat together, that really would build a long pattern of positive experiences that might well build strong social emotions; ones that might survive the shift to a new group. On the other hand, if males and females lead essentially separate economic lives, it is much less likely that there will be this strong history of positive interaction building enduring attachment. That is particularly true of the relationship between the children of the pair bond and the father's kin. Without a shared family economy of some kind, there is no reason to expect this to be a close network with regular and positive interaction. Here again we see the influence on Chapais of a baboon model of early hominin foraging. There is much less fuel for the mechanisms of familiarity if females and males forage separately in a fission-fusion context, each feeding as they go. These doubts are magnified if, as Chapais suspects, these pair-bonds are in the context of polygyny. In that case a daughter's experience of her father may well mostly be one of his aggressive segregation of her mother from other males. Her mother is as likely to show fear of her father as positive affect.

Finally, while pair bonding together with some form of family economy may well create potential bridges, familiarity-based mechanisms are probably not enough to realise that potential. Kinship ties must be enduring. They are with living humans, but not just through mechanisms of familiarity. Our ties do not depend only on repeated reinforcement by daily or almost daily interaction. Close kinship bonds are durable over long separation, even in cases where months or even years pass between meetings. The stability of these bonds is likely to depend on episodic and autobiographical memory providing agents with vivid and emotionally charged memories; memories which sustain those ties. It is even possible that language is necessary for autobiographical memory (Jablonka 2017), and hence for the

stability of these bonds over long periods of time. I am even more sceptical of the idea that familiarity-based mechanisms suffice for the recognition of affine kinship relations. Chapais supposes that pair-bonding, with no further expansion of hominin cognitive or emotional machinery, builds the recognition of affine kin in adjacent bands, and he regards this as of especial importance because it leads to mutual tolerance between adult males in adjoining bands. His idea is that when a father's daughter migrates to another band, she will form a pair-bond in that band. When the father's group meets that band, he will recognise not just his daughter as kin, and her offspring as kin, he will treat her mated pair male as kin; as affine kin. However, if enduring emotions of recognition and affiliation are built by histories of regular positive interaction, the father will have no such history of interaction with the affine male. Moreover, in contrast to the daughter's children, we would expect that the mate, a stranger male, will trigger the default of aggression or wary suspicion due to strange male. As before, this model of familiarity building ties with affine kin is hard to reconcile with a fission-fusion ecology. It presupposes that residential groups forage together as a single though structured collective, with family groups ("One Male Units") identifiable within the collective, so the distinctive pair bond between daughter and stranger male is overt. It is a baboon model of hominin life.

It is one thing to propose a scenario in which occasional meetings between the groups are relatively peaceful, with some positive interactions between direct kin, and standoffishness but not direct aggression between the rest. It is quite another to propose a scenario in which interaction histories between direct kin in different groups are so frequent and positive that a father in one group has an interaction history in the other which builds first tolerance, then comfort, then affiliation with his daughter's children through these simple mechanisms of association and reinforcement. That is even less likely with his daughter's adult male partner or other affines. Affine kin are widely dispersed, and many individuals rarely interact even with notionally close affine kin. The sisters of a woman's partner may be scattered across a number of different bands. Systematic affine kin recognition depends on being able to track and to identify to others genealogical ties, and hence requires symbolic and linguistic capacities that probably evolved late. Moreover, if affine kinship is built even in part by positive interaction histories, those histories are a consequence, not a cause, of peaceful interactions between bands.

Instead of seeing kin connection as an aggregating mechanism, I suggest that these kin-based supports of tolerance are best seen as one mechanism through which the proto-bands of a spatially and demographically expanding community stay civilly connected. They help stabilise peace between nascent bands. As a main driver of the origins of multi-level communities, the kinship model has three flaws. One is the lack of a satisfactory account of an initial phase of non-aggressive encounters that allows separated kin to recognise one another and re-connect. A second is the under-estimation of the cognitive and emotional prerequisites of forging affiliative kin relations, and maintaining them over separation. This is not a minor point. In this model, these kin connections play an early and foundational role that helps explain the later evolution of cognitively rich and culturally variable features of human social life, including its elaborated form of kinship. If extended kinship networks

depend on distinctively human cognitive and cultural traits, they cannot play this early, foundational, pre-linguistic role. A third point, and the most important, is that the mechanism, even as advertised, does not explain the emergence of communities; of prelinguistic “primitive tribes”, as Chapais names them. Imagine that bands were laid out spatially on a grid. If kinship worked as Chapais conjectures, each band would become tolerant of its neighbours. Likewise, each of *those* neighbours would become tolerant of its *further* neighbours, and so on. But there is no mechanism to build clusters of bands, richly connected within the cluster, and with few or no connections beyond the cluster. Nothing builds a higher order organisation¹¹. Of course, in many circumstances, the real spatial layout of bands is not grid-like. We could get clusters of bands with strong kin-mediated links to one another, but few or no links outside the cluster if that cluster was enclosed by physical, biological or behavioural barriers that made migration outside that cluster rare. Under such circumstances, the groups of bands would become a local network. Perhaps more often we will get partial separation, with dispersal in one or a few directions impeded by rivers, hills, wetlands and lakes, arid zones. The point though is that in many circumstances Chapais’ affiliation building mechanism, seen as the primary driver, even if it works as advertised, would not divide the population of bands into distinct communities.

5. An Interim Proposal

In the light of the discussion in the last section, the positive proposal of this paper is to supplement Layton and colleagues’ ecological model of a spatially and demographically expanding community with a kinship-based account of continued civil interaction between the emerging bands of a single community. In sections 1 and 2, I explained the selective benefits of multi-level communities once established, together with Layton’s model of the initial formation of those communities. However, that model lacked any proximate mechanism to explain continued affiliation as nascent bands interacted less frequently. An expansion of recognised kin relations helps fill that gap. In addition, as explained in sections 2 and 3, erectine hominins were selected for increasing social tolerance and impulse control. For these were essential elements of an economy based substantially on cooperation and cooperative hunting. So continued affiliation is explained by a general reduction in reactive aggression (Wrangham 2019), combined with the expansion of positive affiliation based on the richer set of kinship ties identified by Chapais. The proposal has important virtues: the evolutionary and cognitive mechanisms on which it rests are independently plausible: the effect on carrying capacity and the use of space of a niche shift to apex predation; the social and motivational effects of mutual kin recognition; the cognitive and motivational precondition of ambush hunting. Some of the key events are independently supported in the historical record: hominin carnivory; life history changes; the expanded use of space.

¹¹ This is true even if we accept Chapais’ elaboration of his model, with affine kin recognition leading to sister exchange between brothers-in-law. That might lead to stronger ties between nodes of kin in different bands. But it will still be true that while one affine-to-affine alliance links one kin node to the east, another will build links to the west. There is no mechanism that builds congruence in the out-connections of the different families in a single band.

Can we test the proposal more directly against the archaeological record? Perhaps. If more open social networks depended on changes in subsistence and a shift to hunting and a more meat-based diet, the archaeological and palaeontological record suggests that the ecological and kinship-based foundations of a multi-level society were in place amongst erectine foragers, or perhaps (if erectine hunting was a sporadic supplement to their diets), the more clearly apex hunters, the Heidelbergians (Stiner 2002). Layton and his colleagues suggest that there is independent evidence of these open networks amongst the Heidelbergians. Their idea is that long distance raw material transport is a proxy for such open networks. They exploit information from ethnography to identify the likely upper bounds on forager daily movement in the deep past. When raw material movement regularly and comfortably exceeds the ethnographically and energetically plausible daily movement of a band, that suggests a social world that is open enough for material resources to flow through one band to another, or for bands to allow other agents into or through their territory to harvest stone or ochre (Layton and O'Hara 2010, Layton, O'Hara et al. 2012). This proxy suggests a quite deep origin of open-textured social organisation, perhaps with the Heidelbergians (about 800 kya). That meshes reasonably well with direct evidence for hunting, especially if we take into account the fact that these measures of distance should be seen as minimum measures. As Stephen Kuhn points out, they are straight-line distances between source and discard, and hence make no allowance for either topography or travel with the tool. That consideration perhaps makes this proxy align better with the archaeological signals of hunting.

This argument is persuasive, though some caution is needed. In general, we need to be very careful in projecting ethnographically supported patterns into the deep past. However, daily movement and range size depend on fundamental and long conserved features of hominin morphology. How far and fast can we walk? How energetically expensive are those movements, compared to the value of the resources they bring? In this case we can use ethnographic data as a rough guide to ancient hominin patterns. It is also true that daily camp sites move, and so the increasing distance between raw material source and discarded tool might instead be evidence that later Pleistocene hominins invested enough in their tools to want to carry them as they shifted across their annual, as distinct from their daily, range. Kelly's synthesis of forager mobility data shows that here, as elsewhere, there is a lot of variability in forager life, but that many groups travelled hundreds of kilometres over a year ((Kelly 2013) Table 4.1). These annual ranges tend to be larger in more seasonal environments, so if raw material movement correlates with seasonality, we might see that as evidence of tool transport¹² rather than of open borders. Even so, expanded territories of this kind are not physically defensible by a band-size group, so movement patterns that involve moving base camp over 100+ kilometres a year probably themselves require open social worlds in which bands are networked, and where territories are defended socially rather than physically.

¹² The same is true (as Ron Planer has pointed out to me) if there is evidence of regular repair on tools found far from their source materials.

In section 1, I suggested that one very important consequence of an open social world is its effect on innovation. By opening information channels between residential groups, the spread of an innovation from its source is less constrained. Moreover, innovations are less likely to be lost through demographic bad luck. A shift to a more open social world should be signalled by an increase in the innovation rate. As the record stood in about 2012, there seemed few signs of an innovation spike with the evolution of the Heidelbergians. For example, Lawrence Barham's review of hafted technology saw few signs of hafting before 200 kya. As noted in section 1 though, the record is changing, and there are now important innovations dated to about 800 kya, and others to about 500 kya. Obviously, the distinction between closed and open social worlds is not the only factor relevant to the rate at which innovations establish robustly enough to be archaeologically visible. For example, April Nowell has argued for the importance of life history characteristics, suggesting that Mid-Pleistocene hominins had a more abbreviated time as juveniles, and less support for experimentation (Nowell and White 2010). Even so, if the hybrid model is right, we would expect further evidence of some congruence between an increase in the tempo of innovation, an expansion of raw material movement distance, and evidence of carnivory having a central place in the hominin foraging economy. With luck, isotope evidence might even give us some direct evidence of the movement of people, not just materials. There is evidence from strontium in australopithecine teeth that males matured where they died and females did not (Grueter, Chapais, et al. (2012) p1020). For strontium is a marker of the geological location at which individuals matured. If other chemical signatures of diet or natal location can be developed, we would expect a shift to more open social worlds to correlate with chemical signatures of more variation in diet and geographic origin. If the hybrid model is on the right track, and chemistry cooperates, we would expect chemical signals of more diverse origins to approximately line up with increases in innovation, obligate carnivory, and expanded raw material movement.

It is also important to recall that the distinction between open and closed social worlds is graded rather than absolute. That may help explain an apparent anomaly in timing. We have just seen that two plausible independent signals of the establishment of open networks fit roughly with the direct evidence of the change in subsistence patterns that, according to this model, explains those networks. But another signal suggests a much later date. Clive Gamble has argued that certain mobility patterns depend on the emergence of durable social networks and of an agent trusting that they have a stable place in that durable network (most extensively in (Gamble 2013)). These networks allow a release from proximity: an agent, or a group of agents, can travel and forage independently of their community, knowing that when they re-join that community, they will still be recognised as part of it, with their social capital intact. Gamble very plausibly suggests that the elaboration of recognised and enduring kinship connections across the community was at least an important facet of network durability, a suggestion supported by Robin Dunbar's work showing that affiliation and support through friendship connection requires those friendships to be actively maintained, whereas that is much less true of kin connection. Gamble supposes that planned migration requires durable social networks to support there-and-back mobility as communities move into new areas, and suggests that the final, late Pleistocene, out-of-Africa expansion involved

planned migration of this kind. While there does not seem much data to support this, Gamble seems to be on much stronger ground in arguing that the human penetration of very challenging ecosystems would have been impossible without these stabilised social networks, for this penetration depended on temporally extended, slow-beat, fission-fusion cycles. Arid lands and the high northern latitudes support very low population densities, typically (especially in arid lands) with very small overnight camps of just a few families. In these low productivity environments, the population has to be highly dispersed in order harvest enough resources for their daily needs. In the medium to long run, these tiny groups would not be economically, demographically, or informationally sustainable without stable connections to a larger network. Foragers in such environments are especially dependent on the opportunities for risk-management, social exchange and information sharing these larger networks made available. The problem for the hybrid model is that humans began to exploit these environments only in the late Pleistocene; that is, over about the last 50 k years.

How might we respond to this lack of clean fit between the model's predicted dates of a multi-level community and this aspect of the historical record? Here is one possibility. It is one thing to have a form of multi-level society in which there is mutual tolerance between bands, some residential flexibility, and occasional aggregation into a larger community when seasonal abundance permits it. This form of multi-level society would be enough to secure the benefits of informational and sexual exchange, and informal conflict control, allowing conflicting individuals to move away from one another. However, the social networks that allow the penetration of ultra-challenging environments probably require more than this. Penetration of these environments probably requires explicit and acknowledged mechanisms of reciprocation that allow individuals in one band to call on support, and expect to get it, in the face of serious trouble. They require active cooperation across bands, not just tolerance. In turn, these mechanisms depend on cognitive and culture tools that were likely to be available only to contemporary and near-contemporary hominins: language, explicit norms, ritual and shared ritual identity (Sterelny 2014, Sterelny 2018). The Hxaro exchange system of Southern Africa is a paradigm: a system of mutual gift exchange which signals and supports the existence of these networks of emergency support (Wiessner 2002). It is one thing to suppose that the Heidelbergians, say, lived in a social world that was much more networked and open than those of the *pan* species. It is quite another to suppose that they had the cultural tools needed to establish the stable reciprocation networks likely needed for mutual support in hostile environments. Networks of bands that were mutually tolerant, and occasionally came together in (fairly) peaceful aggregations were almost certainly precursors to communities that conceived of themselves as a single people, connected by shared norms, rituals, foundation myths and (often) distinct languages or dialects. Communities with these characteristics were probably necessary for life in arid deserts and the high arctic¹³.

¹³ Thanks to Anton Killin, Ron Planer and the audience of the evolution of kinship workshop at the ANU for feedback on an earlier version of this paper. I would also like to thank the referees of the last version for their very constructive feedback. As always, it is a pleasure to acknowledge the Australian Research Council for their support for my research on human cognitive and social evolution.

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