# Upscaling forager mobility and broadening forager relations

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## Introduction: The problem of upscaling local mobility

Ethnography has taught us to mistrust models of mobility that are purely resource-driven: We know that foragers often move for social reasons and rather anchor their moves in a region than to randomly move all over the place driven by ecological necessity. But the ethnographic models of mobility also have their limitations since they beg the question as to how things change in terms of long-term processes such as human movement out of Africa. Moreover, the ethnographic models tend to create a fundamental rift and bipolar opposition between small-scale foragers and larger populations with little indication as to how one could transform into the other.

In this chapter we report on some results from agent-based simulations that allow us to envisage a move from local to cross-regional mobility and a shift from small-scale mobility to larger-scale dispersal. We revisit the fission-fusion pattern and suggest how it can be reconceived so that it connects to out-of-region migration. We simulated how kinship rules influence population size and suggest how such simulations can help us explain moves from small to larger and from latent to actual wider networks. Finally, we discuss how hunter-gatherer ways of perceiving their environment and their social relationships can be reconciled with scenarios in which hunter-gatherers can upscale their mobility and broaden their social relationships without a categorical break with their modes of perception.

The collaborative research centre from which this contribution arises was entitled "Our way to Europe" and several case studies were conducted on present-day hunter-gatherers (in central African rainforest environment, in east African savanna environments and in southern African semi-desert en-

vironments[1]). These case studies strengthen the ethnographic record of human mobility which also serves as a baseline when modelling mobility of the past. However, to simply take cases of present-day African hunter-gatherers as analogues for the past has its limits since these groups are in fact people who did not move to Europe and have shown no inclination to do so. Their mobility is not one of inter-continental travel, it is not even one of far-distance and cross-regional migration. At the same time, when seeking to make the ethnography of contemporary people productive for questions of long-term dispersal, it seems likely that the evidence from today's African hunter-gatherers and their mobility patterns may be more relevant to processes in the distant past than the typical intercontinental migration of today which is conditioned by nation states and modern travel infrastructures. What would anthropological models of African foragers need to look like that try to explain how a large-scale intercontinental move emerged against the backdrop of the mobility patterns that we find wide-spread in small-scale societies that are observed today? How did a movement to Europe emerge from societies that were mobile but not migratory in the narrow recent sense?

## The conventional models of fission-fusion dynamics

Why do we need "special" models to deal with human expansion out of Africa in the first place? After all, there are highly technical general models of mobility in existence (see Widlok 2016, 2017a). Most of these are rational choice models which claim wide applicability across time and space. For hunter-gatherer studies Optimal Foraging Theory (OFT) is a well-known example of these types of models (Winterhalder & Smith 2000). OFT has been used to model not only forager mobility across the world and back deep into time (see Kelly 1995), but they have also been employed to very different forms of mobility, for instance the movements of visitors who "appropriate" an exhibition space in a museum (Widlok and Eghbal-Azar 2012).

Most natural scientists implicitly or explicitly adhere to such rational choice models which they often consider to be "culture-free" as these models claim to tap into universal rational strategies such as "least effort for maximal returns". However, there are good reasons to question whether these rational choice models are indeed universal or culture-free. To begin with, these models have emerged in a particular cultural situation, enlightenment

1 See https://www.sfb806.uni-koeln.de/index.php/projects/s-supraregional-systems/e3

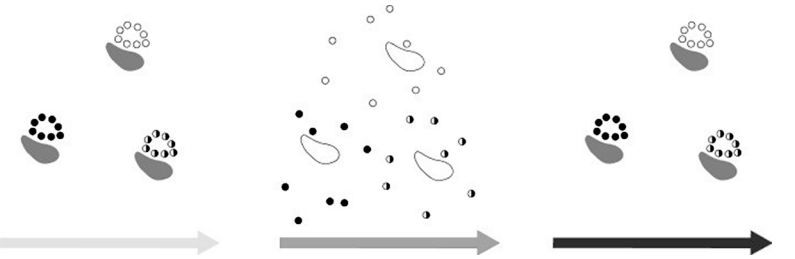
Europe, which was predicated economically and politically on an expansionist, imperial and growth-oriented culture. The "frontier" notion of humans constantly striving for better living space has its origin in the colonization of America, in particular the American West, which is a very specific cultural situation (see Brody 2001). In this case the people moving were the desperate poor, exported or fled from Europe, with no home to return to, with not much to lose, with no particular attachment to the new land they had come to live on, with contempt towards the indigenous people already living there and at least in part driven by an ideology of superiority, of "multiply and occupy" (see Turner 1893 for details on the American frontier). It is these very specific cultural conditions – repeated by settler communities in other places, notably Australia and southern Africa – that brought about the rationalist "optimal" foraging paradigm: The insecure existence of the frontier explorers depended on their being able to occupy "free" land wherever they found it. It also depended on their ruthlessness to exterminate or expunge any locals, and on their determination to move always forward and never backward. Not only was this group subscribing to an ideology that makes them search for "ever greener pastures" elsewhere, what Brody (2001) has identified as a general agriculturalist bias towards the world. Treating land and space as a resource has subsequently been amplified considerably by "the great transformation" that made land an item of markets and capital investments, disembedded from its previous social institutions and cultural meanings (see Polanyi 1944). The explorer-colonizer-capitalists readily exchange one place to stay for another one if the opportunity arises. This is still true for many descendants of European settlers in Africa and elsewhere up until today. Our research in Namibia shows that indigenous Africans often tend to cling to a particular piece of land although they find it difficult to make ends meet living off that land, while the descendants of European settlers, despite a prevalent discourse of attachment to the soil, frequently migrate (again) or switch economic pursuits if the opportunity arises. In a comparative perspective this latter attitude towards the land is a rather peculiar and maybe even "weird" constellation (see Henrich et al. 2010) driving a very particular expansive movement. Nevertheless, until now climate and natural resource models (see the HEP Human Potential as introduced by Klein et al. 2021) adopt this cultural stance. Biased by the European experience of the last few hundred years these models assume that people will move into a new habitat if it is available to them. Moreover, they assume that the hunting

and gathering agents of the first move out of Africa will exhibit the same "rationality" as we find it realized in the colonial expansive movement.

A recurrent way of characterizing the difference between expansionist migratory movements of the (post)colonial era and hunter-gatherer contexts is an emphasis on the fission-fusion pattern found in hunter-gatherer mobility. The pattern has been described in detail elsewhere (for Africa see Barnard 1992, Blackburn 1996, Widlok et al. 2012, for a general overview see Marlowe 2005) and is depicted schematically in Figure 1. It is noteworthy that environmental features play a role in this pattern but not in a simple deterministic way. Barnard (1992), for instance, has highlighted that some foraging groups in southern Africa are in fission mode during the wet season (with water sources being abundant) and in fusion mode during the dry season (when people congregate at few permanent waterholes) but that the opposite also occurs in neighbouring groups: In extremely dry regions like the central Kalahari the environment only allows fusion in the wet season when there are sizable water sources at all, while the dry season requires groups to split up into smaller fractions. The pattern has also been observed for hunter-gatherers outside Africa, outside the tropics and subtropics. Here the fission-fusion pattern is even more marked given the considerable seasonal variation in resource availability (Wengrow and Graeber 2015). It has also been noted that despite the environmental dimension just sketched there are considerable social implications to this fission and fusion pattern as it may allow people to alternate between more hierarchical and centralized forms of group formation and more egalitarian and decentral ones (see Wengrow and Graeber 2015). Moreover, splitting and (re-)uniting occurs amongst foragers throughout the year and often also for non-ecological reasons, primarily for reasons to do with conflicts and conflict-resolution (Widlok 2016, 2017a, 2017b). As a whole the fission-fusion pattern explains why many hunter-gatherers can survive in very marginal environments and it is above all an explanation for the limited mobility which brings them back more or less in circles as they move between a number of possible sites within a region. Although hunter-gatherers of today, and of the recent past, would typically establish new abodes a little distance away from huts that were built in the past when returning after a year or two, their mobility is largely one of re-visiting places within a region and within a lifetime and not one of out-migration as found in the established frontier models.

However, the fission-fusion model has also received some criticism recently (see Bird et al. 2019) because not only is it commonly interpreted as an

*Figure 1: The conventionally idealized fission-fusion pattern across three stages, persons group around waterholes, they disperse and re-aggregate in the following season.*



environmental deterministic mobility pattern but one that follows the changing local distribution of resources over time. In other words the fission-fusion model fits the image of relatively isolated small-scale societies that react to local environmental changes but which remain largely unaffected by larger scale networks. It also provides no prospect of how human populations could have broken out of this dynamic equilibrium pattern that they have inherited from non-human primates (see Dunbar et al. 2014, and as a critique Wengrow and Graeber 2015 and Graeber and Wengrow 2021: 279).

In our project we have investigated two ways of re-evaluating the fission-fusion model in terms of the relevance of larger scale networks. One is the embedding of the fission-fusion dynamic into that of (larger) developmental cycles (Widlok et al. 2012) and one is to revisit the model in the light of detailed ethnography. A key challenge was to account for any directional movement that would take foragers outside and beyond their home region. In the ethnographic record such directional migrations among foragers have only been observed in situations of colonial pressure, displacement and resettlement where groups were forced out of an area either by the colonialists themselves or by other African groups who had previously been pushed out of the area they were occupying (see Weig 2013). How can a model that successfully represents the resilience of land-based regional mobility that reproduces occupancy over time account for the fact that apparently in some cases there has been a transformation of that pattern into an "outward" movement, however slow and haphazard this may have been? Are the mechanisms that govern fission and fusion sufficient to account for a wider dispersal as well? How can we conceptualize such a dispersal that still preserves the hunter-gathers'

ties to their environment, their perception of the environment as one that is "giving" (Bird-David 1990)? We have given a partial answer by connecting the fission-fusion model with the idea of "adaptive cycles" (Widlok et al. 2012). The adaptive cycle idea allows us to see how a circular, homeostatic fission-fusion movement may be turned into an upward or downward spiral through external effects such as environmental change that may impact the system differently in different phases of the developmental cycle and lead to some transformation within an overall reproduction. Here we report on another part of the answer which uses agent-based simulations for observing long term spatial effects of fission and fusion movements that are generated from within the social system, in particular through the social dynamics of searching for appropriate marriage partners.

## The Changing Group Composition Model

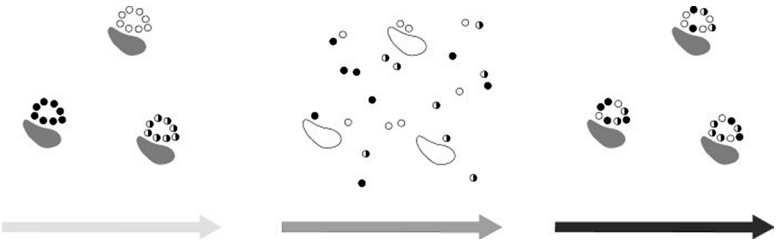
In optimal forager models, which are adapted from animal behaviour studies, individual agents need someone, anyone, to marry (or mate) in order to reproduce. And they need someone with whom to economically cooperate. Again, this could be anyone. In real life situations of hunter-gatherers the situation is more complex. People are restricted to whom they can marry (to be discussed below); they are also restricted with whom they reside and collaborate. These restrictions channel various options to engage in social relations, facilitating some forms of living with one another and restraining others. Ethnographers usually emphasize that in comparison with many agriculturalists the hunter-gatherer mode of life allows for considerable flexibility in group composition and individuals make ample use of this flexibility as they "vote with their feet", making use of their freedom to move away. There is a degree of mutuality, collaboration, and support so that the social system of most ethnographically documented African hunter-gatherers is by and large geared against specific social obligations that would lock individuals in specific households and village communities of the type that characterize agricultural systems in Europe (see Sabean 1990).

Hunter-gatherer mobility is also embedded in social bonds that constrain but also enable their shifts in residence – bonds that are dispensable for explaining the behaviour of non-human animals for which models of OFT have first been developed. Kinship in the human settings is largely performative, which means that individuals can forge and select some links (and allow others to lapse) through their actions such as frequent visiting, assisting, gift-

exchange and sharing. Marriage ties, too, can be dissolved fairly easily and most people have more than one partner in the course of their lives. But in contradistinction to non-human contexts, social ties such as marriage or siblinghood do inform the residential patterns of hunter-gatherers (Woodburn 1968). Individuals (re)adjust carefully to the social expectations but also to the requirements of particular situations. Even children from an early age onwards have some control of who they live with, many end up spending a great deal of time with their grandparents. Hunter-gatherer bride service arrangements involve staying with parents-in-law for a while but unlike the bride wealth payments common in agricultural systems this does not create lasting dependencies of the more junior on the more senior ones. Beyond the regularities of kinship, people in these societies also undergo great trouble to maintain particular friendships, for instance through gift-exchange partnerships across time and space (Wiessner 1982).

In other words, despite a large degree of flexibility, it does matter for people with whom they share a camp. For a long time this basic fact has been overlooked when theorizing about the fission-fusion pattern. All that counted was the overall number of residents in a local camp at any one point in time (see Figure 1). The numbers seemed to even out roughly in each season which makes the system appear to be locked in homeostasis. The ensuing pattern looks more stable and immune to transformations than it actually is. When we re-introduce the identity of individuals to the model, a very different picture emerges. In Figure 2 we have "specified" camp members through colour coding. Here, despite a stable growth and decline cycle, there is considerable change in the actual composition of these groups as only a few of the "original" people reconvene at a place in the next fission or fusion phase of the cycle. From the perspective of any one individual in such a fission and fusion system there are therefore considerable changes with every "seasonal" move. Even if the size of the local group returns to its seasonal "normal", the size of the group any one has lived with (and may return to live with in the future) has actually increased. Given the high flexibility and high permeability of local groups, individuals come to live together with a much higher number of diverse individuals over time than at any one point in time because the cards are shuffled again in each season. The net effects of this pattern is that the individual networks are reaching much further than the places that the person him- or herself has been visiting because former co-residents (at the same time potential co-residents to be) are spread across a larger area and individuals can activate the larger networks if necessary.

*Figure 2: The refined fission-fusion pattern in the Changing Group Composition Model: persons around waterholes disperse and re-aggregate in different compositions across seasons.*



This more realistic type of modelling solves an issue that has been puzzling researchers for considerable time: Despite living in small groups, very small groups indeed at times of the year, the groups that people identify with and that they can rely on in terms of searching for partners (in marriage, in exchange, and in collaboration) is actually much larger. The local organization is not to be confused with the social organization (Bird et al. 2019: 98). The former comprises who is with whom at any given point in time while the latter includes the "expansive and virtual patterns in ties that comprise networks of social interaction" (Bird et al. 2019: 98). Those networks may be extensive networks of gift-exchange as in the San *hxaro* system (see Wiessner 1982), networks of ritual affiliation, or yet other links but the effect is the same: Even when only living together in camps of around 25 individuals, the number of people one is in direct or indirect contact with over a lifetime can be at around 1000, and an average adult may be in contact with well over 300 other adults and, for instance, their particular styles of working a tool (Bird et al. 2019: 97-8). The ensuing large networks are also used to transport items (material objects but also religious cults or mythical themes) across whole continents (see Bird et al. 2019). These links make the society also much more resilient to environmental, ecological, or demographic crises than a very small local group could ever be. What is more: The established idea that small residential groups are recruited out of homogeneous "small-scale societies" turns out to be a serious distortion in the light of evidence that small foraging groups more often than not consist of affines and not of close blood relatives or spouses (Bird et al. 2019: 102). As is the case with indigenous Australians, even when only

very few individuals come together in foraging groups or hearth groups, it is not uncommon at all to have several dialects, ritual affiliations, and diverse links to many places in an open network beyond ethnic or linguistic groups represented (see Bird et al. 2019). Therefore, Bird et al. (2019) conclude that this makes "small" foraging groups in fact large and complex. It also makes them inherently "outward" looking, not only when looking for spouses or new patches to forage, as they are genuinely connected in a wide network. The implications are far reaching in that transgenerationally forager groups with little material accumulation can be said to accumulate the social capital of being connected. Moreover, we will have to give up the idea that large scale mobility of small groups due to their size will have to be channelled through external environmental factors. Given that foragers are aware of a much larger number of fellow humans and their environmental effects than what their local group size suggests, they also orient their movements accordingly. Bird et al. (2019) are able to show this with regard to burning practices (to enable better hunting of certain species). These practices shape the land at a large scale and feed back into the decisions in small foraging bands to move (or stay). In this context a piece of land that carries traces of being shaped by humans through burning (possibly across generations) can be more attractive than seemingly "free" land that has received less attention and is less well prepared for foraging activities. An adequate depiction of a "human existence potential" (HEP, see above) would need to include the effects of such large-scale transgenerational networks and land-uses on hunter-gatherer decision-making.

The other important feature that emerges from this enhanced model of changing compositions is that it lays the foundation for transformations in other ways. It lays the foundation of creating larger settlements, if the conditions are right, since the larger network that is already there in a dispersed fashion could in principle concentrate at a single place. An example for this are the ritual men initiation camps of San groups that were held in winter every few years and could encompass well over 200 persons (Lee 1979: 365). Other renowned examples are the Nambikwara with seasonal hilltop villages comprising several hundred people, and the larger seasonal settlements of the Inuit and the Great Plains Indians (see Wengrow and Graeber 2015, Graeber and Wengrow 2021). It also lays the foundation for an out-migration of sorts, if the conditions are right and even without any ideology of "looking for greener pastures elsewhere" or some assumed "Wanderlust". It would suffice to create such a movement out of an aggregated effect of people following the pattern that they have been following anyway, namely re-convening in newly

composed groups under conditions that may create some sort of drift across local groups with every move. If individuals, for whatever reason, were choosing to live with people they had lived with before, except that they choose those who happened to be at the extreme end of a known and frequented area, this could easily have the cumulative effect of a drift-type movement – without any particular changes to the economy, the ideology or the socio-political make-up of the group being necessary. Add to the picture that in every generation, and from an early age on, there is considerable flexibility in choosing where to live (see above) and a transformation can ensue simply through reproducing the established and entrenched rules.

Thus, the pattern of changing the composition of local camps in a fission and fusion dynamic could lead to such a drifting "migration" without disrupting the established system and without assuming that hunter-gatherer adopted an expansionist mode of living or mind-set similar to that of agropastoral farmers or frontier settlers.

## Adding marriage rules to the model

However, up to this point we have only shown that fission and fusion dynamics are compatible with transformations. But why should such transformations be likely to occur? We propose that in addition to environmental conditions, there are social reasons that may drive transformations. More specifically we have in mind the effect of marriage rules.

While we have no way of knowing which marriage rules exactly foragers of the past have followed, it is very unlikely that early Homo sapiens had no such rules at all because marriage rules are one of the few and best-researched human universals that do characterize human life across time and space (see Antweiler 2007: 7). We therefore have made these rules part and parcel of our agent-based modelling in which we simulate hunter-gatherer mobility and sociality (see Henn forthcoming). Marriage rules do differ culturally, not only with regard to what exactly the restrictions entail (e.g., whom one may marry and have sexual relations with) but also with regard to who the preferred marriage partners are. Whatever the exact rules are, the important point to realize is that the introduction of any rule immediately and considerably enlarges the demographic size a group (or a social network) needs to reproduce successfully.

One of the key features to distinguish human kinship systems is whether "cousins" (the children of the siblings of one's parents) are considered siblings

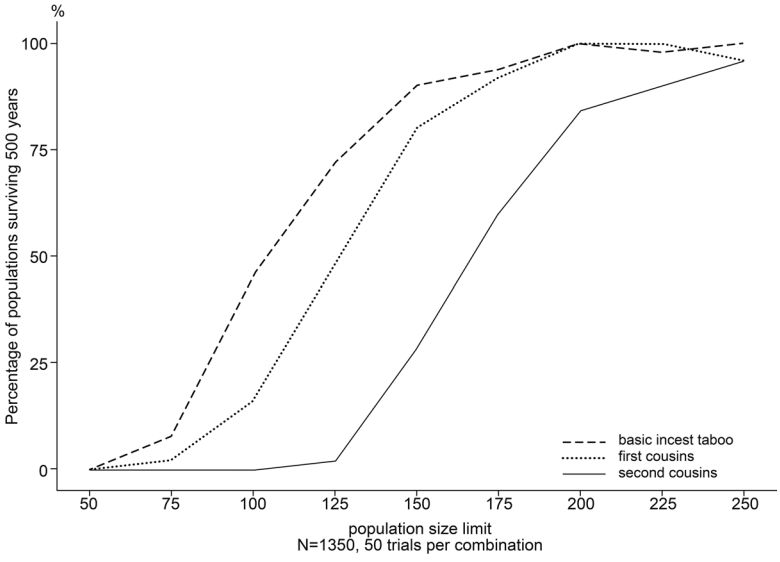
and marriageable or not. At times only cross cousins (children of MB and FZ) are considered cousins while parallel cousins (children of MZ and FB) are not. In other systems all cousins are considered cousins and equally marriageable – or all of them may be considered siblings and therefore non-marriageable. With regard to marriage preferences again sometimes cross cousins are considered preferred marriage partners and sometimes it is parallel cousins, and sometimes marriage beyond all first cousins is considered desirable. Whatever the detailed rules that restrict the choice of potential marriage partners in one way or another, our point is that individuals always need a much larger group to choose from.

For individual persons, marriage rules always entail the need for a larger personal network: As marriage rules exclude certain others as possible spouses, individuals have to look for spouses further away in terms of kin relatedness and space. For populations, marriage rules entail that in order to be demographically viable – to be resilient against stochastic fluctuations – they need to be larger.

Among contemporary social groups there is a wide array of residential and marriage rules, and we cannot know for sure which of these cultural rules were applied and followed by the people who lived during the first human dispersal between source area and sink area on the way from Africa to Europe at various stages in the past. At the same time, as sketched above, human variation is limited in this domain allowing us to model several possible scenarios and outcomes with the help of agent-based simulations. Introducing such rules allows us to see the (unintentional) long-term effects of individual choices. Running a model that simulates the effects of marriage patterns over 500 years, Stephan Henn (Henn forthcoming) is able to show the cumulative effects of what may appear to be rather unspectacular and small differences in marriage rules in terms of population dynamics. As pointed out above there are marriage and incest prohibition rules in all human societies, but they vary in a fashion that can be modelled – and thereby to see long-term consequences for population dynamics, and potentially also for migration. Henn compared three different artificial societies a) one with a basic incest rule (no marriage to siblings and parents); b) one with more complex rules, namely no marriage with first cousins; and c) one prohibiting marriage with second cousins (see Figure 3). The three societies differ in the number of individuals they must minimally comprise if they want to have a fair chance of survival (i.e. 75% of the simulated societies survive 500 years) over many generations given stochastic fluctuations in fertility and mortality. Results show

a minimum population size of 125 for societies with first-cousin prohibition and a minimum population size of almost 200 individuals for second-cousin prohibition. A near to 100% survival rate is only achieved at even larger numbers. It is worthwhile remembering that this is the survival of a group under good and stable ecological conditions since no ecological crises have yet been factored in. These population sizes are far beyond the number of forager resident groups that were reported in the ethnography of Africa and beyond, which number only about 25 (Hamilton et al. 2001). Thus, the simulation of population dynamics, enhanced by marriage rules, provides sufficient reason to assume that residential groups cannot be self-sufficient but will always have to be part of a larger network. We can continue along these lines by enhancing the simulation further through not only including marriage rules but also the post-marriage resident rules that are usually an integral part of marriage regulations.

*Figure 3: Minimal population sizes simulated with three different basic marriage prohibitions in place.*




If we add mobility and residency to the simulation by means of a patrilocal post-marriage rule and if we further assume that the rule was followed

without exception it only takes a few generations before people become concentrated at a few places (see Henn forthcoming). This socially motivated mobility entails a spatial distribution that deviates from an ideal free distribution – one that only takes (non-social) resources into account. The simulation suggests that in this case, different sites for habitation would be sought when resources become depleted, and some resource-rich places to live in between major settlement sites could remain unoccupied. These abandoned places could later become inviting for others who are switching residence after getting married. Thus, whatever marriage rule exists in such a small-scale environment, we can safely assume that it would inevitably lead to considerable mobility. The model allows us to go one step further: Given that a good chance for group survival only exists if there is a larger network around a residential group that is big enough for individuals to find a marriage partner, there is a major incentive for maintaining regional networks beyond individual residential groups. Going beyond the regular roaming area for searching for a partner is a necessary strategy in such contexts and settling elsewhere with that partner and the offspring becomes an option. But again, no break of existing mobility rules is required as people could simply use the flexibility and permeability that the fission and fusion system already provides. Personal network ties provide individuals and families with opportunities to link up to different residential groups in the region, equally small and equally flexible like the ones they originate from. There is no need to assume climate crises or other ecological problems that force people to migrate. Henn's simulation suggests that finding an appropriate marriage partner is reason enough for a considerable amount of mobility. The result is not that individuals undertake intercontinental migration, but that there is a regular incentive for a good proportion of the group in each generation (!) to move beyond the area in which they were brought up. Over a few generations mobility across regions can emerge from a pattern of localized mobility. While there are different estimations as to how quickly migration out of Africa took place (see Litt et al. 2021), all estimations suggest that it took many more generations than what our simulation would suggest as minimally necessary for such an emergent directional mobility. Over time any marriage rule will lead to people leaving the group to find partners elsewhere: they will move even if they live in the most splendid natural environment and favourable climate conditions, and they may move even if the place they move to is less favourable in terms of natural resources. Finding an appropriate partner may easily trump having a more varied diet on your plate. The internal social drivers that we propose here

are sufficient to explain a gradual "move" out of Africa. There is no need to assume environmental disasters or an ideology of Wanderlust or of exploration and exploitation as a driving force. Post-nuptial (post-marital) residence rules add to the mobility induced by marriages. Again there is at this stage no way of telling what particular combination of residence rules that are found today was applied by any particular hunter-gatherer group of the past. They could have been matrilocal (near the maternal family), patrilocal (near the paternal family), uxorilocal or virilocal (near the wife's or the husband's home place) or neolocal (a residence independent of descent). But again, it is likely that some such rule was applied, and we can model what happens when various rules are being followed. For instance, the more a group sticks to a patrilocal post-marital residence rule, the less people become dispersed, and ultimately they all end up in one single place. The more a group extends the bride service rule, the more people become dispersed, and extended exchange between residential groups will ensue.

We do not deny that external drivers of mobility can play a role, but we feel the need to emphasize that endogenous dynamics may suffice. Humans are very much social beings whose interdependence cannot be factored out without missing a central piece of what makes us human.

## Conclusions: Upscaling as a forager technique

What we have seen so far is that firstly, that fission-fusion patterns can be read and transformed to be non-homeostatic rather than be always confined and static. We have also seen, secondly, that with the cultural establishment of marriage rules there is a systematic incentive for agents to seek opportunities for expanding their networks. All this, it could be argued, merely shows that a major shift from small-scale to larger-scale societies (in terms of their mobility pattern) is possible within the hunter-gatherer spectrum. However, that would still make it a considerable cultural shift where quantity changes in the scale of social networks, if you like, lead to quality changes in terms of social relationships and sociality. Crudely summarizing Nurit Bird-David (2017) on this point, her argument is that there is a major cultural shift between the plurirelational persons in small-scale forager settings and the standardized mereological individuals (based on generic part-whole relationships) in larger settings, a shift that prohibits upscaling our terms and models. Or, to put it differently, modellers may be tempted to upscale features of forager society (including mobility) where the ethnography suggests qualitative thresholds

below which relationships are categorically different and therefore resist upscaling. The argument is not only that scale influences social form (see Barth 1978) but more radically that small-scale may intrinsically inhibit "upscalability" and the practice of scaling itself. The issue is whether hunter-gatherers are engulfed in this small-scale world or whether their world may be said to always include the local group as well as the larger network at the same time. The larger structures need not manifest themselves as large gatherings of people, but they can still be evident and effective as in the virtual communities evoked in the firelight talks described by Wiessner (2014).

Where do we go from here in the light of what we have presented in this contribution? Attempts to simulate forager mobility in a way that is concurrent with present-day ethnography does not stop at marriage rules and residence rules. It is one of the typical features of such models (and of simulating artificial societies more generally, see Epstein and Axtell 2011) from the "bottom up" that they can incorporate ever new features of that ethnography which are not visible in the archaeological record. So far our simulations have placed foragers in an environment that is equipped with renewable resources but which is otherwise "empty". But hunter-gatherer specialists have noted for some time that such an assumption of an "empty" environment is likely to be a misrepresentation (see Marshall-Thomas 2006, Widlok 2019). Hunter-gatherers see other species not only as resources but as partners with whom they engage with. One could go as far as saying that what we have presented here is but one modality of "finding a partner", i.e. in this case a marriage partner. But a more complete picture would have to find ways to also include the search for other, non-human partners – which is different from treating plants and animals as passive and unrelated "resources". It has been pointed out that pre-colonial movements in Africa were not predicated on the European illusion (or fantasy) cultivated over centuries that people were moving into unoccupied territory, empty space (see Kopytoff 1987). This is even more so the case for the African foragers who are very likely not to separate the human domain from that of other species. There is ample evidence across the board that hunter-gatherers include other species into "the social". They not only entertain special relationships with many other species (see Widlok 2019 on the relation between San and lions) but more generally they consider non-humans to be part of the social world, of being legitimate occupants of land and of being social partners (see Sahlins 2017). Models that rely on calculations of the "Best Potential Path" and "Human Existence Potential" (see Klein 2021) are blind to any obstacles that are not based on physiography or climate,

disregarding spirits and other species: Where foragers will see other species (not only game species) or non-human beings to either disable or enable their moves, path, routes and their existence at large, these models simply draw a line from A to B superimposing their own cultural ontology which is very selective in recognizing what can constitute an obstacle or a path. Even in an apparently underpopulated environment, the number of social relations that matter is in any case larger than the number of humans in a group, amplified by the fact that humans have also got relations with other beings in that environment. Whether this makes forager societies inherently more hierarchical (as Sahlins 2017 claimed) or not, it makes them certainly more populous.

However, future research on scale would need not only to rethink the number and kind of agents that need to be taken account of. Apart from quantity it would also need to reconsider the quality of relationships between these agents. As mentioned above, Bird-David (2017) suggests that only in large-scale "mereological" societies people recognize "types" of humans (or other beings) where small-scale foragers see plurirelational beings. But again the question is how the former could have developed out of the latter.

Along the lines of the argument that we have developed above we would hypothesize that hunter-gatherer social systems also provide prototypical examples of how generalizable relations emerge out of particularist relations. One of the features that Henn's simulation will eventually include is a way of modelling the effect of "name-sakes": While European philosophers and linguists tend to draw a sharp line between personal names and generic types, the naming system of the San, for instance, brings together both. Since there is only a limited number of personal names available that get "re-cycled" over generations, every person is both, the plurirelational self that Bird-David depicts but also, at least latently, a representative of a named category. As Henn (forthcoming) is able to show in his simulations, this, too has an immediate long-term effects in terms of mobility, social aggregation and dispersal because name-sakes shape the preferences that influence individual decision-making and mobility. Having the same name as an older San identifies a younger person with the older one and their kin relations, overriding all genealogical relationships of the younger one but those of the nuclear family (Lee 1986). Naming-relationships are an important attractor for producing the "colourful" fission-fusion pattern that we have outlined above. As with the San, Name-sake relationships influence marriage options. Since, for instance, the sister of my name-sake becomes my sister, she becomes non-eligible as a marriage partner. Personal naming systems provide the cognitive

bridge towards classificatory systems with avoidance rules of the kind that we have outlined above. They allow a "plurirelational" system to move towards a "mereological" system. It remains to be seen whether this shift correlates with the shift from regional to outward mobility as we have discussed above. What it hints at, though, is that despite living in small numbers at any one time, hunter-gatherers themselves make use of upscaling in terms of "techniques of the intellect" (see Levinson 2020). They recognize people (and including non-humans) in their environment as members of generalized groups, as well as in terms of kinship relations, and this entails extensive mobility practices.

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## References

Antweiler, C. 2007. *Was ist den Menschen gemeinsam? Über Kultur und Kulturen*. Darmstadt: Wissenschaftliche Buchgesellschaft.

Barnard, A. 1992. *Hunters and Herders of Southern Africa: A Comparative Ethnography of the Khoisan Peoples*. Cambridge: Cambridge Univ. Press.

Barth, F, (ed.) 1978. *Scale and social organization*. Oslo: Universitetsforl.

Bird, D. and Bliege Bird, R., Codding, B., Zeanah, D. 2019. Variability in the organization and size of hunter-gatherer groups: Foragers do not live in small-scale societies. *Journal of Human Evolution* 131: 96-108.

Bird-David, N. 2017. Before nation: Scale-binding anthropology and foragers worlds. *Current Anthropology* 58/2: 209-226.

———.1990. The Giving Environment: Another Perspective on the Economic System of Gatherer-Hunters. *Current Anthropology* 31/2: 189-96.

Blackburn, Roderic H. 1996. "Fission, Fusion, and Foragers in East Africa: Micro- and Macroprocesses of Diversity and Integration among Okiek Groups." In: S. Kent (ed.), *Cultural Diversity among Twentieth-Century Foragers: An Afri-can Perspective*, Cambridge: Cambridge University Press, pp. 188-212.

Brody, H. 2001. *The other side of Eden: Hunter-gatherers, farmers and the shaping of the world*. London: Faber.

Dieckmann, U. (ed.) 2021. *Mapping the Unmappable? Cartographic Explorations with Indigenous Peoples in Africa*. Bielefeld: transcript.

Dunbar, R., et al. 2014. "The road to modern humans: Time budgets, fission-fusion sociality, kinship and the division of labour in hominin evolution." In: R. Dunbar et al. (eds.), *Lucy to Language*, Oxford: Oxford University Press, pp. 333-55.

Eggert, M. 1998. Archäologie und Analogie: Bemerkungen zu einer Wissenschaft vom Fremden. *Mitteilungen der Anthropologischen Gesellschaft in Wien* 128: 107-124.

Epstein, J. and R. Axtell. 2011. *Growing artificial societies: Social science from the bottom up*. Cambridge: MIT Press.

Gladwin, C. 1989. *Ethnographic decision tree modeling*, vol. 19 of Qualitative Research Methods Series. Newbury Park: Sage.

Graeber, D. and D. Wengrow 2021. *The dawn of everything. A new history of humanity*. New York: Farrar, Straus and Giroux.

Hamilton, M., B. Milne, R. Walker, O. Burger, and J. Brown. 2007. The complex structure of hunter–gatherer social networks, *Proceedings of the Royal Society B: Biological Sciences* 274: 2195-2203.

Henn, S.. Forthcoming. *Placing decisions in context: the emergence of hunter gatherer social networks*. PhD dissertation, University of Cologne.

Henrich, J. and S. Heine, A. Norenzayan. 2010. The weirdest people in the world? *Behavioral and Brain Sciences* 33: 61-135.

Kelly, R. 1995. *The foraging spectrum: Diversity in hunter-gatherer lifeways*. Washington: Smithonian Inst. Press.

Kent, S. (ed.) 1996. *Cultural diversity among twentieth-century foragers: an African perspective*. Cambridge: Cambridge Univ. Press.

Klein, K. & Ch. Wegener, I. Schmidt, M. Rostami, P. Ludwig, S. Ulbrich, J. Richter, G. Weniger, Y. Shao. 2021. Human existence potential in Europe during the Last Glacial Maximum. *Quaternary International*, 581-582: 7-27.

Kopytoff, I. 1987. The internal African frontier: the making of African political culture. In: I. Kopytoff (ed.) *The African frontier: the reproduction of traditional African societies.* Bloomington: Indiana University Press, pp. 3-84.

Lee, R. B. 1979. *The!Kung San: Men, women, and work in a foraging society*. New York: Cambridge University Press.

———. 1986. !Kung kin terms, the name relationship, and the process of discovery. In: M. Biesele, P. Wiessner, R. B. Lee, & R. Gordon (eds.), *The Past and future of!Kung ethnography: Critical reflections and symbolic perspectives: Essays in honour of Lorna Marshall*. Hamburg: Buske, pp. 77-102.

Levinson, S. 2020. *On 'Technologies of the Intellect'*. Goody Lecture 2020: Max Planck Institute for Social Anthropology.

Litt, Th., J. Richter; F. Schäbitz (eds.). 2021. *The Journey of Modern Humans from Africa to Europe*. Stuttgart: Schweizerbart Science Publishers.

Marlowe, F. 2005. Hunter-Gatherers and Human Evolution. *Evolutionary Anthropology* 14/2: 54-67.

Marshall-Thomas, E. 2006. The Lion/Bushman relationship in Nyae Naye in the 1950s. In: J. Solvay (ed.), *The politics of egalitarianism: Theory and Practice*. Oxford: Berghahn Books, pp. 119-130.

Polanyi, K. 1944. *The great transformation*. New York: Rinehart.

Sabean, D. 1990. *Property, production, and family in Neckarhausen, 1700-1870*. Cambridge: Cambridge University Press.

Sahlins, M. 2017. The original political society. *Hau: Journal of Ethnographic Theory* 7/2: 91-128.

Turner, R. 1893. *The Significance of the Frontier in American History.* In: R. Billington (ed.), Frontier and Section: Selected Essays. Englewood Cliffs, N.J: Prentice-Hall, pp. 28-36

Weig, D. 2013. *Motility and relational mobility of the Baka in North-Eastern Gabon*. PhD dissertation University of Cologne, available online. Köln: Universitäts- und Stadtbibliothek.

Wengrow, D. and D. Graeber. 2015. Farewell to the 'childhood of man': ritual, seasonality, and the origins of inequality. *Journal of the Royal Anthropological Institute* 21/3: 597-619.

Widlok, Th. 2021. *Hunter-gatherer mobility.* In: Th. Litt, J. Richter; F. Schäbitz (eds.), The Journey of Modern Humans from Africa to Europe. Stuttgart: Schweizerbart Science Publishers, pp. 41-51.

———. 2019. Human-lion relations. In: Th. Breyer and Th. Widlok (eds.), *The situationality of human-animal relations.* Bielefeld: transcript, pp. 203-219.

———. 2017a. "The decision to move: being mobile and being rational in comparative anthropological perspective." In: P. Meusburger, B. Werlen, and L. Suarsana (eds.), *Knowledge and Action*. Cham: Springer Open, pp. 253-65.
———. 2017b. "Die eigene und die fremde Mobilität." In: M. Wunsch and G.-C. Weniger (eds.), *2 Millionen Jahre Migration: Wie(so) wir darüber forschen und reden*. Mettmann: Neanderthal Museum, pp. 64-71.
———. 2016. Moving between camps: towards an integrative approach to forager mobility. *Hunter Gatherer Research* 1/4: 473-494.
———. 2000. "On the other side of the internal African frontier: relations between Herero and 'Bushmen'". In: M. Bollig and J.-B. Gewald (eds.), *People, Cattle and Land*. Köln: Köppe, pp. 497-522.
Widlok, Th. and A. Aufgebauer, M. Bradtmöller, R. Dikau, Th. Hoffmann, I. Kretschmer, K. Panagiotopoulos, A. Pastoors, R. Peters, F. Schäbitz, M. Schlummer, M. Solich, B. Wagner, G.-C. Weniger, A. Zimmermann. 2012. Towards a theoretical framework for analysing integrated socio- environmental systems. *Quaternary International* 274: 259-272.
Widlok, Th. and K. Eghbal-Azar. 2012. Potentials and limitations of mobile eye tracking in visitor studies: evidence from field research at two museum exhibitions in Germany. *Social Science Computer Review* 31/1: 103-118.
Winterhalder, B. and Smith, E.A. 2000. Analyzing adaptive strategies: Human behavioral ecology at twenty-five. *Evolutionary Anthropology*, 9: 51-72.
Wiessner, P. 2014. Embers of society: Firelight talk among the Ju/'hoansi Bushmen. *Proceedings of the National Academy of Sciences*, 111/39: 14027-14035.
———. 1982. "Risk, reciprocity and social influences on !Kung San economies." In: E. Leacock and R. Lee (eds.), *Politics and history in band societies*, Cambridge: Cambridge Univ. Press, pp. 61-84.
Woodburn, J. 1968. "Stability and Flexibility in Hadza Residential Groupings", In: R. Lee and R. de Vore (eds.), *Man the hunter*. Chicago: Aldine, pp. 103-110.

## Comment by Robert L. Kelly

Widlok and Henn seek to help answer the question: How did a migration to Europe emerge from societies that were mobile but not migratory in the narrow recent sense?

Their answer rejects approaches to mobility that privilege environment and subsistence, and consequently optimal foraging theory. They claim that ethnography "has taught us to mistrust models of mobility that are purely resource-driven" even though I would claim that ethnography has actually provided abundant support for such models (Kelly 2013) – at a certain scale of analysis. They also cancel foraging models because they "emerged in a particular cultural situation, enlightenment Europe, which was predicated economically and politically on an expansionist, imperial and growth-oriented culture." A migratory wave into Europe is likewise rejected as merely reflecting a Eurocentric bias toward a culture that was "ever seeking greener pastures". Given this reasoning, should we cancel everything the enlightenment achieved? Surely not. And is it possible that the causal arrows go the other way: perhaps the imperialistic, expansionistic, growth-oriented culture of Enlightenment Europe was a product of those tendencies and capacities captured by optimal foraging models, an ever-present desire and intent to maximize advantage.

In fact, there is good justification for believing that optimal foraging models capture something fundamental about humanity that led our species to colonize nearly the entire globe while living as hunter-gatherers.

The biological capacity for culture (whatever it is) must have been driven by natural selection: an organism with such a capacity outcompeted conspecifics without it. Why? At its heart, culture is a model of how life is supposed to operate. But life never operates the way we want it to, there is always a disconnect, sometimes greater than at others, between how we think life should be lived and how life is actually lived. A conscious organism will likely strive to make life-as-it-is-lived closer to life-as-it-should-be-lived. Such an organism will have a selective advantage because it will always be consciously seeking "greener pastures": new knowledge, such as medicinal uses of plants, and new land (and, in the Paleolithic case, whose resources are untouched). Therefore, the capacity for culture might imply that restless exploration might very well be an adaptive feature of the human psyche. A feature, incidentally, that would be stymied among modern foragers living within boundaries imposed by the nation-state in the colonial and post-colonial world.

The real question is whether the models, whatever their origin, offer some insight and understanding of hunter-gatherer mobility. Ethnographic data suggest they do (Kelly 2013); studies using the Ideal Free Distribution, for example, show that people do move into a new habitat if they perceive the

benefit to be worth the cost of doing so, and climate-induced environmental change coupled with population growth play roles in that process.

The purpose here is to use an agent-based model to see what effect marriage practices have on forager outward migration (because it is clear foragers did migrate). In effect, this chapter sees migration as an emergent phenomenon, something that arose unintentionally from another set of intentional behaviors.

Henn's efforts show that the fission-fusion pattern results in a mixing of people, such that, through the relationships developed, an individual's social network reaches to more geography than any individual has personally reached. And these linkages "make society also much more resilient to environmental, ecological or demographic crises than a very small local group could ever be." I agree – in fact, this is something anthropology has suspected since the 1966 Man the Hunter conference.

More to the point, the fission-fusion model that results in recombined local groups, comprised largely of affines, "lays the foundation for an outmigration of sorts, *if the conditions are right* …" (Emphasis added). Those conditions would seem to be crucial, but they are not explicated here. Instead, "If individuals, for whatever reason, were choosing to live with people they had lived with before, except that they choose those who happened to be at the extreme end of a known and frequented area, this could easily have the cumulative effect of a drift-type movement." So, migration would be random, in both direction and timing. This proposal could also be simulated and compared to empirical cases to see if it could (for example) account for the (rapid) rate at which the New World was apparently colonized (even taking different colonization times into account). My guess is the answer would be no.

The marriage model also argues that the simple operation of a system in which people seek mates within a system of any rules (patrilocal, matrilocal …), combined with a fission-fusion model, will eventually produce mobility. The agent-based model shows that people will become geographically concentrated and at some point unoccupied places will "become inviting." There is a lot wrapped up in that claim, a lot that probably has to do with the effects on foraging return rates of slow population growth coupled with climate-induced environmental change (something for which the Ideal Free Distribution model is suited). There are two scales that need to be merged into a single model here to evaluate how cultural practices could result in unintentional migration. That model should respect the effects of those cultural practices, such as marriage, and one that respects the material needs of a dynamic pop-

ulation responding to a dynamic foraging environment. I shall look forward to that.

## References

Kelly, Robert L. 2013. *The Lifeways of Hunter-Gatherers*. Cambridge: Cambridge University Press.