Origins of an Outlying Acacia

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Introduction

In early 1998, I was leading a survey in Dakoro *arrondissement*[1], central Niger, which involved asking about local tree diversity and this brought me to the fine specimen shown over called *fárár ƙáyà* ('white thorn') in the local Hausa dialect[2]. The tree was situated not far from a then dry seasonal pond beside an international livestock trail and was easily identifiable to the species level as *Acacia sieberiana* DC. I was told by my guides that it had arrived during the severe famine of 1984-85 called El Bohari after the incumbent president of Nigeria, who closed his country's borders thereby hindering vital cross-border trade and coping strategies. Though I never got to cross-check this information, it seems a tenable date.

This tree turned out to the only example of its kind reported (present or extinct) in all the 11 villages surveyed. Additional tree diversity data for the region is fragmentary but so far, the nearest documented example identified is 130 km to the south though undocumented specimens at around 90 km have been reported to me. A few years after my visit to this tree I lived in the nearby conjoined villages where it was growing and got to know a lot more about the local landscape and the mobilities of the people living there. My research touched on local livestock mobilities only in terms of animal-meditated nutrient transfers and the social relationships around some of these. It was evident though that at the landscape level the factors shaping animals movements conferred on certain fields a greater probability of receiving such transfers. In other words place in the landscape also mattered.

Dynamic mapping of animal-mediated nutrients across the local landscape would be a fascinating means to explore the relative importance of place and social relationships in shaping these transfers. This is a complicated research task but impressions are starting to appear through work in western Niger (see for example Hiernaux & Ayantunde (2004) and Schlect *et al.* 2006). Beyond a soil nutrient focus on livestock, animal mobilities also play an integral part in shaping, and being shaped by, vegetation patterns. One aspect of this is actively mediating seed dispersal and the closer one looks, the importance of livestock in shaping plant geographies in the Sahel becomes ever more complex. Pulling back to focus only on one remarkable tree perhaps makes it easier to see how the myriad processes occurring in the landscape, (biotic, climatic, geomorphic, social and locational) can interact and manifest themselves in the vegetation. This note is an attempt to critically explore some ideas about how one such tree, still living in 2013, got to be growing in its locality. It is not, it must be stressed, an empirical study in any form as very few established facts are yet known about this particular tree. The contention is however that by considering a single and probably exceptional tree, we may get to better appreciate the scales and histories of connectivities within Sahelian landscapes.

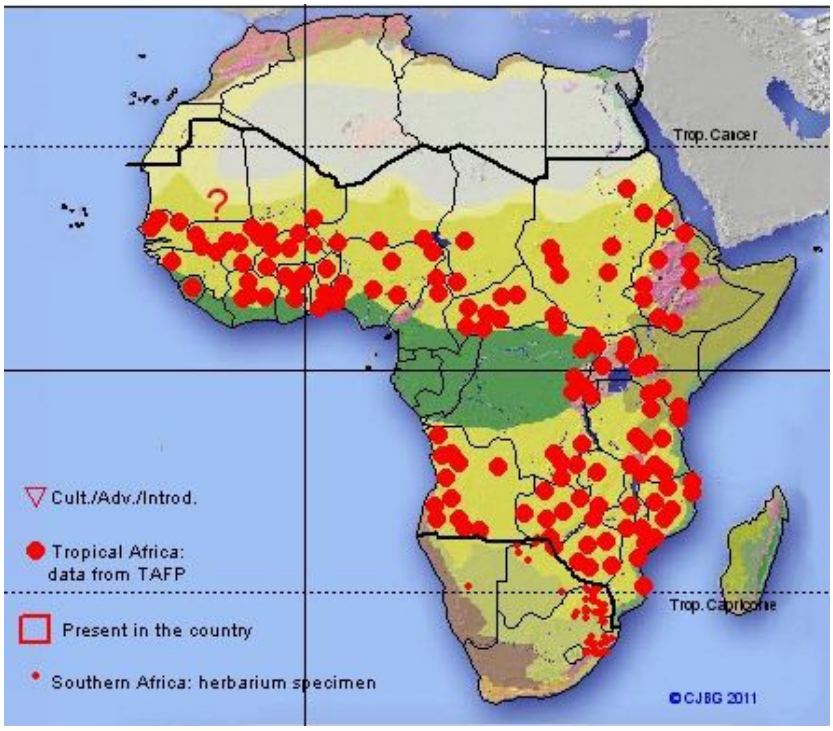
1 This has since been elevated to a *département*. Henceforth, I use the term Dakoro to refer to this large administrative area (see Figure 3) in contradistinction to Dakoro town, which I will specify.

2 This name is also used for *Acacia seyal* in Hausaphone Niger (Peyre de Fabregues, 1979, Luxereau & Roussel, 1997) which also has pale long thorns, but I only came across the name *erehi* for this species.

The Biogeography of *Acacia sieberiana*

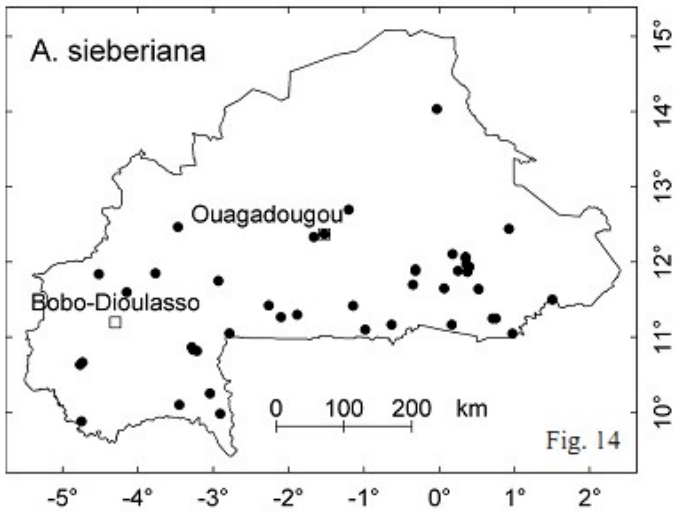
At the continental scale, *Acacia sieberiana* is widespread in Sub-Saharan Africa as shown in Figure 1, which is probably the best available distribution map but is far from complete and has a rather too coarse degree of precision (+/- 2° latitude & longitude).

Figure1: Distribution *of Acacia sieberiana*
Source: http://www.ville-ge.ch/musinfo/bd/cjb/africa/details.php?langue=an&id=176999



At a finer scale more relevant to understanding the distribution of this tree species in Niger, for which no published maps have been found, Wittig *et al.*'s (2004) map for neighbouring Burkina Faso (Figure 2) is more helpful.

Figure 2: Distribution of *Acacia sieberiana* in Burkina Faso
Source: Wittig *et al.* (2004: 24)



Wittig *et al.* note that their assembled data in Figure 2 confirm the view of an earlier author that *Acacia sieberiana* generally needs annual rainfall in the 800-1000 mm range, which explains its rarity in the Sahel where it is only found in wet locations. Their northernmost outlier is near Dori, which has been called the "the town of ponds" in the Liptaako which as a region, benefits from a number of wetlands, including some that are permanent (Ouedraogo, 1997). Further north, the species has disappeared from the famous Mare d'Oursi (Ganaba & Guinko, 1998).

Average annual rainfall at Dori—always an uncertain metric in the Sahel given wide inter-annual variations—for 1959-1998, was 485.7 mm (Roncoli *et al.* 2003). The comparable figure for Dakoro town is 343.8 mm, though there are some uncertainties about these data—see Manvell (2005: 65). Thus in most years (29 out of 40 in the 1959-1998 period if the figures are to be believed) the outlier is even below the 400 to 800 mm annual rainfall threshold that von Maydell (1990) gives for this species. However, as soil water conditions may be decoupled from rainfall and still provide the necessary growing conditions, as presumably pertains for the northernmost West African records shown in Figure 1, it is necessary to look closer at the setting of the Dakoro specimen.

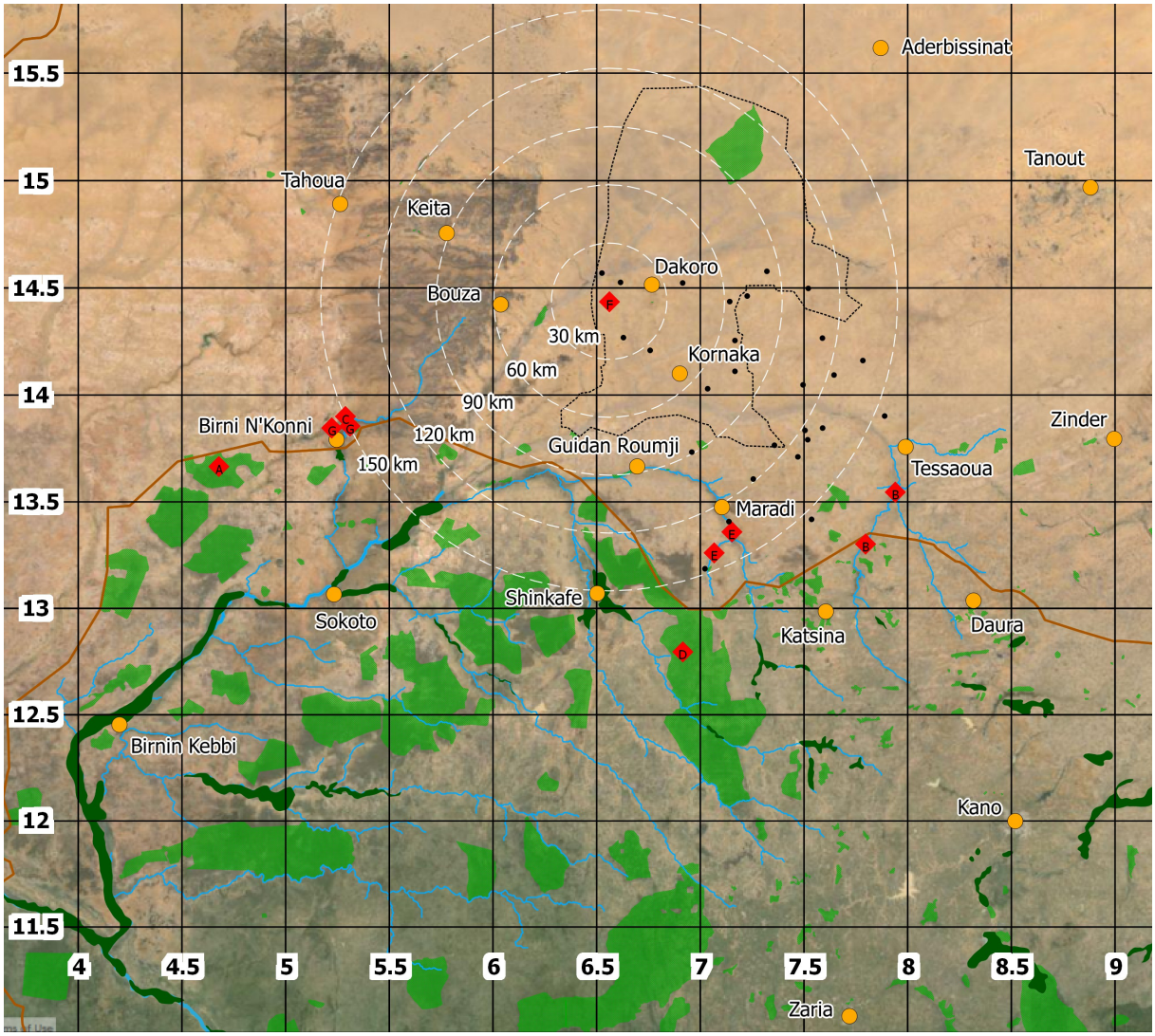
Figure 3 shows the location of the Dakoro outlier in relation to the nearest documented specimens as well as the location of 27 village territories where it was not recorded as currently present in woody species inventories. Of these 27, 20 include information on past presence and *Acacia sieberiana* was only recorded in one of these (see Appendix A for details). The coverage of this data it must be emphasised are incomplete with notably no information for two quarter degree grid squares to the west. They do however suggest that the species is rare above the 14° parallel. The map also shows that eight out of ten of the known localities are definitely near watercourses, which is par for this species in the Sahel (Maydell, 1990) as well as in the Sudan zone of Nigeria where it is a typical stream-side tree (Keay, 1959).

There are no flowing watercourses in Dakoro—the traces of a valley network discernible on the satellite image base map[3] are fossilised and probably haven't flowed since the mid-Holocene, c.6-5,000 years ago (Talbot, 1980 & Kröpelin et al. 2008). The only possible exception north of the 14° parallel is the Maggia to the west, which rises near Bouza in the Ader-Doutchi massif. This is a seasonal river that flows intermittently between July and September (NNJC/CMNNC 2007) and may not exhibit any surface flow in its upper catchment—the five flow stations that have operated on this river in Niger are all south of the 14° parallel (*ibid.*) Focussing attention on the importance of rivers in the distribution of *Acacia sieberiana* in the northern part of its range, draws attention to the gap in records along the Goulbi Maradi near Guidan Roumji, just under 90 km south of the outlier. There are known to be some isolated specimens in the valley around here (Yamba Boubacar *pers comm.* 14th October, 2013), but more precise information is not available.

3 The main ones that can be seen are the Tarka north of Dakoro town which runs dry all the way to its confluence with the Rima in Nigeria and the Goulbi'n Kaba which rises in Katsina State as the Tagwai river but flowing north peters out near the border to become fossilised once it reaches Tessaoua and remains so as it arcs round west to join the Tarka and Rima.

Figure 3: Nearest Records of *Acacia sieberiana* records in relation to the Dakoro outlier

Sources: Tree localities (RED diamonds) A = Atiku *et al.* 2011, B = Fairbairn 1939, C = Gonzales *et al.* (2012), D = Keay 1949, E = Luxereau & Roussel 1997, F= Manvell 1998, G = Roussel 1999, BLACK dots = negative occurrences (see Appendix A for sources). GIS data: Image (Google Earth), Protected Areas (GREEN) from World Database on Protected Areas (IUCN & UNEP, 2010) for Nigeria and Tarchiani *et al.* (2008) for forêts classées in Niger. Rivers (BLUE) edited from HydroSHEDS (via FAO's geonetwork). The borders of Dakoro *département* are shown with a hatched black line.



An important point to note about the records shown in Figure 3 is that three of them (diamonds B and D) are old. In 1936, André Aubréville, Inspecteur Principal des Eaux et Forêts de l' A.O.F. remarked:

> "L'Acacia Sieberiana est un des plus grands acacias de l'A.O.F. Il dépasse fréquemment 20 mètres de haut. Son fût lisse, de couleur bistre, est assez caractéristique. C'est une espèce exclusive du bord des cours d'eau très abondante à Maradi même, dans le petit bois du poste qui occupe un ancien lit colmaté du goulbi." (1936: 19-20)

Today within the confines of the national agricultural research station at Tarna, just south of Maradi, the species can still be described as abundant in a small relict forest (Yamba Boubacar *pers comm.* 14th October, 2013). However, outside such protected areas, the situation is very different and mirrors a Sahel-wide phenomena of increasing modification and destruction of riparian forests (see for example Sambaré *et al. (*2011) for Burkina Faso and Thomas (1996) for northern Nigeria). Key factors behind these changes relate to the evolution of lowland agriculture in the context of episodic droughts and population pressure. Roussel (1999) elaborates on some[4] of the important details that contextualise these changes in central Niger where these forests have been largely replaced by market gardens, orchards and agro-forestry parklands. Though he notes that in some instances the diversity of these new production sites is higher than it was originally and that some tree species, such as *Acacia nilotica,* have in some places increased, his observations for *Acacia sieberiana* are far less positive. In the Ader Doutchi between 1984 and 1994 he found that the remaining specimens were no longer reproducing (Roussel, 1999: 23). No further details are provided (is this due to senescence?) but it may highlight a critical problem where isolated specimens still persist as they do in some market gardens where they have been afforded protection (Luxereau & Roussel, 1998: 76).

Specific Conditions of the Outlier

The Dakoro outlier grows beside a seasonal pond and a livestock corridor, two landscape features that may be vital for this story and require examination in turn.

1. The Seasonal Pond

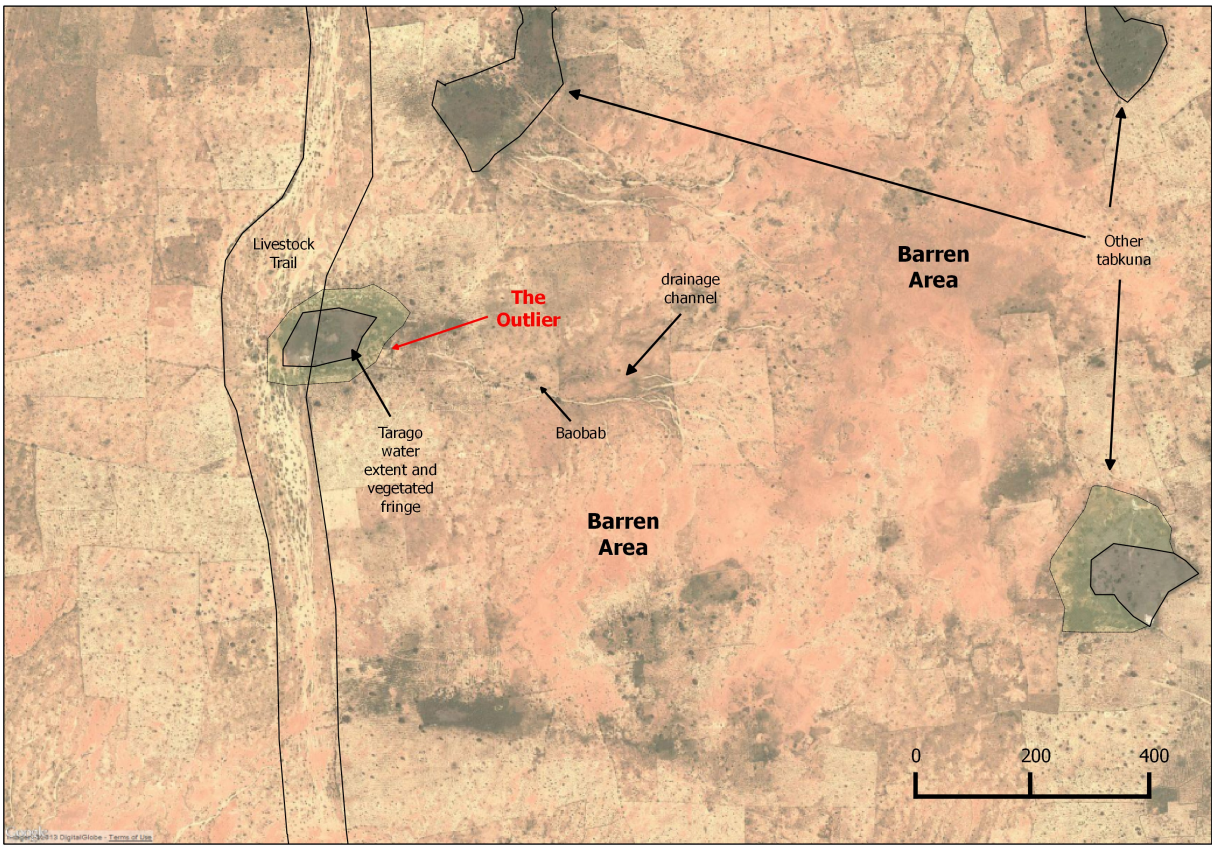
The pond is known locally as Tarago (etymology unknown) and is one of many wetlands within the village *karkara* (lands). It is described in the local Hausa dialect as a *tabki* (plural *tabkuna*) which distinguishes it from similar lowland areas without standing water but still the accompanying thicker vegetation, which are called *fadama* (plural *fadamu*). The extent of standing water in Tarago at about 1 ha is not exceptional compared to c. 13 ha. for the largest one in the *karkara*. Infilling of the local wetlands occurs largely by overland flow and with the generally flat topography, sheet flow is dominant. The *tabkuna* start to fill when the rains have properly set in around June-July and it is the larger ones that retain surface water the longest (in 2001 and 2002 these had all dried on the surface by the end of November).

For woody vegetation in and around wetlands at these latitudes, surface water duration may be less significant than subsequent soil water retention. There was for example a

4 Though Roussel notes the importance of the development of water management infrastructure, such as wells and dams, in relation to these changes, he doesn't go into detail. Issiaka *et al.* (2012: 52) note that the construction of the Jibya dam in Nigeria in 1989 has seen unsteady flow in the Goulbi Maradi and a reduction in the flooded area. Likewise, Peltier *et al.* (2008) report that irregular flows of the Goulbi'n Kaba near Tessaoua were linked to two new dams upstream in Nigeria. Such factors may have consequences for the vivacity of riparian trees such as *Acacia sieberiana*.

local *fadama* with a typical flooded wetland tree, *Mitragyna inermis,* growing in it. Though no data are available on the soil moisture retention characteristics of the local wetlands, it is interesting to note that Tarago was one of only two local wetlands were I observed recession cultivation, i.e. crops such as cowpea planted as the water dries out. This may though have more to do with the motivation of the particular landowner than any uniqueness of this pond. Another potential factor explaining the soil water properties of this site is its nearness to a large barren area of about 50 ha which clearly forms part of its catchment as can be seen in Figure 4. Rainfall rapidly runs off this area and has formed clearly incised drainage channels to Tarago as well as other nearby *tapkuna*. The combination of local micro-topography and soil characteristics presumably results in greater water infiltration than ponding. These conditions adjacent to a livestock corridor that links the northern pastures to Nigeria, have provided the circumstances for resting or drinking animals to defecate and tread seeds into the humid soil.

Figure 4: The Local Setting of the Outlying *Acacia sieberiana*
Image Source: Google Earth



An important distributional question in light of imperfect knowledge of tree diversity in the region is whether the above conditions are in anyway unique and likely to provide alternative habitats for *Acacia sieberiana* in the absence of large watercourses. Examination of both Google Earth imagery and the 1:200,000 maps (sheets ND-32-VII→IX & XIII→XV) indicates that *tabkuna* are notably less frequent in the dunelands

to the east of this outlier as far as the uplands of Damergou (Tanout) and Damageram (Zinder). To the south west however, the elevation increases slightly to the Doutchi Zana uplands which results in a thinning sand cover that is more susceptible to longitudinal deflation, in other words areas where the wind is able to remove loose material to reveal subsurface deposits of compact soils and/or gravely material[5]. These barren areas aid surface water run-off and help fill the numerous wetlands identifiable in the area. Though perhaps less than 20 of these have surface water covering more than 10 ha, the case of the *Acacia sieberiana* at Tarago suggests water extent, though easier to detect, is not necessarily the key factor for supporting extra-limital vegetation. Given that no documentation on tree diversity studies in this area has been found, it would seem unwise to discount the possibility that there may be, or may have been, other specimens growing there. Whether of course they are candidate parents for the outlier would depend on their abundance circa 1984-5 as well as the conditions for the necessary transport mechanisms/occasions.

2. The Livestock Trail

The history of the livestock trail next to Tarago is not known beyond a few scant facts. It was only officially demarcated with concrete posts in the local landscape around 2000-01. Prior to this date, aerial photographs from 1955 and 1975 indicate that a clear narrow track already occupied its current position. The trail is now demarcated with a width of 50-100 metres from at least the Tarka valley in the north all the way south to Guidan Roumji and onwards to the Nigerian border. It is joined by various shorter trails that link it to villages (and their wells) as well as to frequently delimited grazing areas. It also links up with other major trails but a detailed map showing the regional network has not been found.

The route of the livestock trail in question may have its origins as a shortest distance link between favourable seasonal ponds that join two parts of the 'natural infrastructure' of the ancient valley network. These are Kwari'n Sarki ('the valley of the king') just to the north, which is a left bank tributary of the Tarka, with a branch of Kwari'n Amouré to the south, which is part of the Goulbin Kaba drainage system. The route may also have been shaped by colonial and post-colonial policies and some information on these is important to contextualise the trail around the time the seed of the outlier was dispersed.

Maurice Vilmin (1955), a colonial administrator who served for many years in the area, described four 'voies d'evacuation (transhumance et exportation)' in Dakoro that were used in the rainy season and three others used in the dry season. His description and map are not detailed enough to see how these align with today's route, but it is interesting to note that the colonial government had already constructed three 'abattoirs sechoirs' not too far along the trail beside Tarago (at Korohane to the north, and at Banjani and Boudou to the south). They had also purposefully installed five

5 More precise details of this geomorphological explanation for more wetlands to the southwest, along with a map, can be seen in Manvell (2010) pages 3-5.

cement wells along the subdivision's dry season trails, which may or may not have included the cement wells at these three localities. The route of the livestock trail perhaps already existed where this infrastructure was placed—and some botanical evidence for this will be mentioned later—or it may have shifted to it. The key point is that on the eve of independence[6], livestock corridors in Niger were actively being developed to facilitate livestock movement through farmlands, a policy which waned in the following decades.

In the post independence years, the farmlands of central Niger continued to expand at many scales for diverse reasons, among which population increase and technology change (especially the adoption of the iler/hilaire and animal drawn traction) stand out. Remaining unclaimed peripheral land was gradually brought into production, often at the expense of grazing lands and sometimes the access trails to them. The 1955 aerial photograph of the Tarago area shows no fields in the vicinity, the 1975 image is of poorer quality but shows they are getting closer but is nothing like the contemporary situation shown in Figure 4—more details of the closure of the local farming frontier can be found in Manvell (2005).

Government apathy towards these land use changes favoured the farmers and a 1961 law that fixed the northern limit of agriculture was blatantly ignored and farming within livestock trails became commonplace. Roland Hammel (2005) recounts the shocking bias prevalent in the administration at the time of the 1984-5 famine. Through a life history case study of a WoDaaBe family from north Dakoro, he explains how a delegation of seven pastoral groups went to see the sous-prefet of Dakoro when they realised how bad the 1984 rains were to ask permission to head south through the farmlands that were already dry and abandoned. This was refused. The family in question nevertheless headed south and this is their story of their return north:

> "C'est au début de l'hivernage 85 que nous sommes arrivés à Egguidi [22 km south of Guidan Roumji and 8 km from the Nigerian border]. Nous avons reçu 2 fois de l'aide alimentaire de Caritas. Nous avons attendu que les animaux récupèrent, et vers le milieu de l'hivernage, nous sommes repartis vers le nord, par le couloir de passage de Guidan Roumji. Nous avons eu beaucoup de peine à suivre le couloir qui était bouché par des champs. Nous nous sommes faufilés entre les champs jusqu'à Aje Koria. Nous avons eu très peu de mortalité dans notre cheptel." Hammel (2005: 185)

To give some figures to the encroachment problem, Fauquet (2005: 175) reports how an international livestock trail that was delimited in 1968, which links the northern Dakoro pastures with the Nigerian border at Bangui through eastern Madoua *arrondissement*, was found in 1989 to contain more than 600 fields. It was not until 1998 that international donors became interested in farmer-herder issues and the

6 On the 29th October, 1959, Ordonnance n°59-183 created a national commission charged with marking out these livestock corridors (Fauquet, 2005: 174).

problem of livestock trails (Hammel, 2005: 103). The first trail that was demarcated as a result of this interest was the one between Dakoro and Guidan Roumji (for details of the project see also Mansour, 2001).

Figure 5: Recession cultivation at Tarago, 20th December, 2001

The cattle trail beside Tarago, as we will see, may or may not have been directly implicated in the arrival of the outlier. It does however connect up distant grazing lands and offers the possibility of seed dispersal by livestock over different scales. What is important to realise when thinking about this dispersal function is that the trail has an overlaid social history that has shaped its route and continues to influence its accessibility.

Figure 5 shows recession agriculture at Tarago in 2001 but what this practice means in terms of continuing livestock access and connectivity is not clear. It may actually indicate a process of accommodation since I don't think there was any rainy season use of this *tapki* (in 11 others in the *karkara,* small parcels of rice are grown). Sowing was observed 75 days previously when there was still some water but this may have been inconsequential as there are larger ponds not too far along the trail. To understand the farmer's motivations here, one should really frame them in terms of their particular land access opportunities. My understanding is that the grandfather who first cleared

this land came rather late to the village (1950s), so it may already have been a marginal location. The surrounding area is also reported to have seen a lot of wind erosion particularly around the time of El Bohari, which has altered farming opportunities as has the general reduction in rainfall since the late 1960s which has limited sorghum production in the more clayey soils found here (see Manvell, 2005 for more details). The point is that the trail and the possibilities it offers for seed dispersal are shaped by a whole series of social and environmental histories and associated micro-processes of land use changes occurring along its route, and more especially at the specific sites along it where animals may stop to drink or rest. The sum of these processes may be leading to greater channelling of animals today than ever before, with implications for seed dispersal patterns. Unfortunately though no details of the traffic on these trails either now or in the past are known to exist.

Two Theories on the Establishment of the Dakoro Outlier

The primary[7] seed dispersal mechanism of *Acacia sieberiana* is endozoochory and with the limited number of wild ungulates and elephants in the region under examination, domestic livestock are the most likely dispersal agents. A logical theory for the arrival of the Dakoro outlier is via the gut of an animal that had fed on a pod of this tree. It is over the question of where the pod was eaten that permits the differentiation of two origin theories: beneath the mother tree to the south ('eaten at source') or nearer to the resulting tree via other means of seed movement ('transported feed'). Both theories require critical examination on several points, some of which are overlapping.

- ***Identification of the Transporting Animal***

Strangely, the palatability of *Acacia sieberiana* pods for livestock is reported to be limited in West Africa but to increase towards the east of its range in places like Sudan and Somalia (Burkill, 1995). It has even been suggested that this geographical variability may be due to edaphic or phenological factors (*ibid.*). Though there is evidence that some pods may contain elevated levels of cyanogenic glycosides (Ngwa *et al.* 2004) a population-wide assessment is lacking. Burkhill has it seems overlooked some West African evidence apart from his one vague reference to pods being sold to fatten sheep in what is presumably northern Ghana. In the centre-east of Burkina, for example, Devineau (1999) notes older research showing how this tree has invaded fallow lands thanks to the excrement of wandering herds and it must be for the same reasons that it has been noted as widespread in the cattle tracks south of Kano (Jackson, 1970).

That said there have also been some animal feed studies in northern Nigeria where the palatability of *Acacia sieberiana* pods is ambiguous. Salih (1992) clearly states that only the leaves of *alluki*—a common Fulfulde name for this species which he fails to identify —were consumed by Fulani herds in Gidan Magajia grazing reserve, southwest of Lake

7 Hydrochory is probably a secondary mechanism (Tybirk, 1991)

Kainji. Bayer (1990) does not include this species in the list of browse species ranked by Fulani pastoralists at Kurmin Biri grazing reserve, southeast of Kaduna, but it might not have been present. In the nearest study to the outlier so far located, a comparison between an unspecified Katsina location (probably around Dutsin-Ma) and Shika, north of Zaria, de Leeuw (1975) frustratingly doesn't discriminate between which parts of *A. sieberiana* are consumed but indicates that this species is browsed by sheep and not cattle at Shika only. For the Kainji Lake National Park, Okaeme *et al.* (1988) mention it only as a browse plant.

The foregoing secondary sources do not really help identify which of the six species of domestic livestock found in Dakoro could potentially have ingested, transported and disseminated the seed of the outlier. Sheep and cattle might appear to the most likely candidates but nothing is known about the preferences of the other four. Successful endozoochory requires the seed to remain viable after passage through the carrier which depends on the interaction between gut and seed morphology (Razanamandranto *et al.* 2004). As experiments to determine seed recovery rates are complicated, ecologists have tried to predict seed survival rates on the basis of more easily measurable variables relating to the carrier and the seed. For example, various studies have suggested that the greater the body mass of the animal, the higher the rate of intact seeds passing through (see Razanamandranto *et al.* 2004 for discussion). In approximate descending order of average body weight the six candidate dispersers are camel, horse, cattle, donkey, sheep and goat. Other studies have suggested an inverse relationship between seed size and recovery (*ibid*.) and in this regard, *Acacia sieberiana* seeds are considered to be large (Tybirk, 1991: 60) but with thick and hard coats (*ibid*. p.29 & Mohammed, 2013: 167) so may be more resistant. Clearly good comparative data on survival rates of *Acacia sieberiana* seeds consumed by these six domestic animals, preferably whilst they are on the move, is required to address this question. In the mean time, my hunch is that the question can be narrowed to just three species since horses, donkeys and camels were, and still are, numerically less significant than cattle, goats and sheep—some albeit questionable population estimates for livestock numbers in Dakoro in 1984 also support this (see Appendix B).

- ***The time of dispersal***

Assuming the information about the tree's arrival is accurate[8], it is useful to try and deduce more about the timing of dispersal. The El Bohari famine was set in motion for the regional farming population by the catastrophic rains of 1984 which saw half the amount usually fall (Swinton, 1988). For pastoralists, this greatly compounded already difficult conditions stemming from poor rains in the northern pastures in 1983 (Hammel, 2005). When somebody uses a famine as an historical reference point it is important to distinguish the timing of the event that causes it (here the 1984 rains for many farmers) and the following period of extreme hardship (through to at least the

8 The height of the outlier can be estimated at 11.5 m on the basis that it is 6.5 times the estimated average height of the men (c. 1.78 m) in the image. Gautier *et al.* (2002) show a growth chart of a seven year old tree in northern Cameroon which attained over 5 m. This suggests the outlier was on a feasible growth trajectory in what it should be recalled is a nutrient rich, well-watered spot.

1985 harvest). I didn't attempt this, but it can perhaps be reasoned that it is more likely that the seed would have had a greater chance of becoming established in the 1985 rainy season, which saw rainfall totals near or even above average[9] in some places in Dakoro. Only a dendrochronological study of the outlier might provide an answer to this uncertainty and even if this were possible, it would probably be best to analyse a cross-section rather than a core which would require felling the tree. Though Nicolini *et al.* (2010) did manage to detect annual rings in *Acacia seyal* trees in the Keita valley to the west, there is no guarantee it would be revealing with this species in the outlier specimen.

The assumption that the seed started to germinate in the rains of 1985 may not help determine when it was actually deposited at Tarago as this could have happened at an earlier date. Tybirk (1991) reports that little is known about seed banks of Sahelian acacias and mentions just one relevant study (Sabiiti & Wein, 1987) which happens to be of *A. sieberiana* in Uganda where many viable seeds were found in the upper soil layer under the canopy, but fire was an important element in aiding germination. The duration of the viability of seeds on the ground and those that have passed through an animal's gut may well be very different. A counter argument to extended dormancy whatever the dispersal mechanism, is that this increases the chance of seed predation by invertebrates such as the larvae of bruchid beetles (see Tybirk, 1991: 19 for a partial list of known seed pests hosted by this tree).

The phenology of *Acacia sieberiana* may however provide some temporal context for the timing of dispersal. The only information known about when this tree bears fruit is from observations in northern Cameroon (Gautier *et al.* 2002), which indicate a fruiting season beginning in November and tailing off in April, i.e. a period of 5-6 months. Fallen pods may of course remain under a tree for an extended period and in this regard it is also worth noting that this acacia sprouts in the middle of the dry season which makes it attractive to herders when other fodder sources are scarce—careful examination of the photograph of the outlier reveals that is has been lopped for this purpose. One can perhaps then assume that it is unlikely that come the end of the dry season many pods will remain under a tree and therefore, discounting inter-seasonal dormancy possibilities, the seed of the outlier arrived in the November 1984 to July 1985 period. Under the eaten at source theory however this period can be contracted as it requires animals to move from south to north (assuming no west to southwest parent populations). Most, but certainly not all[10] animal movements in this direction concerns livestock on transhumance on their annual return from dry season

9 The rainfall record for the three stations in Dakoro (Dakoro town, Kornaka and Sabon Machi) is of uneven quality and all started at different periods (1948, 1959 and 1978 respectively). Even if it was better quality, one would then have to decide when to start the recent period from as there are for example reasons to exclude data from the wetter 1960s.

10 For example, the head of one of my case study households recounted that in response to the famine he had migrated down to near Kaura Namoda, then in Sokoto State, where after three months he got enough money together to send sorghum to his parents back home. He did this by finding some Bugaje (descendants of former Tuareg captives) at Shinkafe market from a settlement near home who transported it back for him on camel.

grazing to the south to the northern pastures and this typically takes place around May-July.

One implication of a May-July 1985 date for the eaten at source theory is that livestock numbers, both locally and passing through the area, would have been much reduced in comparison to preceding years. Livestock population figures in Niger, as elsewhere, always need to be critically examined. By way of an indication of this reduction, Marie-Claire Rey (1989) who did her dissertation fieldwork in Dakoro in late 1988, notes that losses of more than 75% reported to her by herders and agro-pastoralists were partially corroborated by the figures for freely available cattle vaccinations from the Service de l'Arrondissement des Ressources Animales (Dakoro). But as we have seen earlier, some herders had few losses. She also notes, citing Frelastre (1986), that unlike the 1973 drought, the reduction of animals in Dakoro was not only down to animal mortality but also de-stocking as well as longer term emigration of pastoralists to Nigeria. The numbers of potential seed dispersing animals at this time will never be known but it is possible to refine our focus in terms of animal mobility patterns.

- ***Livestock movements at the hypothesised time of dispersal***

I do not have anything like the required information to adequately convey conditions in Dakoro around the time of the early rains in 1985 when those who had stayed or returned from migration, were attempting to restart farming and/or continue livestock raising under the duress of the ongoing El Bohari famine. These conditions would undoubtedly have shaped animal movements at a variety of scales. Notwithstanding this lacuna, a basic distinction can be made between the likely movements of locally owned animals and those of animals transiting through the area.

Under the eaten at source theory, only some of the locally owned animals are potential dispersal candidates and even then this is perhaps unlikely. This group concerns the locally owned cattle, which, barring the resident milch animals, under normal circumstances were/are entrusted with Fulbe herders to be taken to the northern pastures in the rains, returning afterwards to the *karkara* where they graze on crop residues and are kept overnight on the owners' fields. In early 2002, one of the herders in charge of these animals negotiated with the owners to take the herd north to the Tarka valley because his concerns about local grazing resources. Adaptation to the available forage resources would also have happened in 1985 but where the animals were taken is not known. One of the Fulbe herders in 2001-02 had been providing this service in the village for about 30 years having first been on transhumance with the Hausa owners who used to do this themselves. Strong bonds of trust build up over the preceding years may have allowed for extraordinary movements of the resident cattle herds south at this time, that is unless other means of feeding them were found locally.

In terms of transiting animals heading north at the hypothesised time of dispersal, in normal years these could be distinguished as the animals that complete an annual transhumance between rainy season pastures in the north and dry season grazing areas

in the south. However, many areas used in the dry season are north of the Goulbi'n Maradi and thus outside where *Acacia sieberiana* is found today (with the exception of the unknown status of the wetlands around Doutchi Zana)—see Appendix C for a dated[11] but perhaps indicative map of these areas from Mainet (1965). The habitual use of these areas was, at least in the past, often underpinned by social relationships and exchanges between particular farmers and herders linked to the importance of the animals soil-nutrient inputs. There were also an unknown number of transhumant herders who routinely took their animals further south each dry season into northern Nigeria. In normal years, these herders could be considered the most likely to have been the drovers of the transporting animal under the eaten at source theory.

1985 was clearly not a normal year. Nomadic herders and their animals who ordinarily remained year round in the pastoral zone were also forced south—though as we have seen the administration didn't always make this easy[12]. To give one example of how exceptional these movements were, in March 1998, just prior to taking the photograph of the outlier, about 20 km to the south, I met a group of Bororo nomads from Abalak who had left their usual area because of a combination of poor rains and hostilities with neighbouring Arabs. They said they hadn't been this far south since El Bohari which they had spent in Aguie *arrondissement* to the south-east where they had engaged in farming. Nomadic and transhumance herders alike who were able to keep some of their animals alive probably all had to search for new dry season grazing areas. Consequently, northward return movements were likely to have been very different in 1985. Hammel's earlier cited example highlights the challenges of those return movements that tried to follow the livestock trails.

- ***Seed Retention and Livestock Travel Distances***

For the eaten at source theory, working out where the founding seed may have been consumed requires combining seed retention data with typical travel distances for animals on the move. There are however some problems with the available data.

In the 1960s, G.E. Wickens set up an experiment at the University of Khartoum in which a steer was fed a known quantity of *Faidherbia (Acacia) albida* seeds. It was then noted that 66% of seeds were excreted undamaged during the fifth and sixth day following ingestion. This led him to assume that for this tree species "animal dispersal can occur along a probable radius of 100 miles from the source" (Wickens, 1969: 193). Similar experiments have since been conducted with different domestic animals and Sahelian tree seeds but as far as I am aware, none have looked at excretion rates for *Acacia sieberiana* and perhaps more importantly, none with animals actually on the move. Danthu *et al.* (1996) for example looked at the passage of seeds of seven Sahelian tree species stall fed to sheep, goats and cattle. In terms of retention times they found that the cattle passed most grains on the second to fourth days but carried on doing so

11 The *Pastoral Atlas of Central Niger* (Swift & Campbell, 1984) is probably more relevant if it shows dry season grazing areas of the transhumant pastoralists using the project area. It has not yet been seen.

12 To what extent the supposedly closed Nigeria borders influenced these movements is not known.

beyond seven days. In contrast the sheep expelled their seeds on the second and third days whereas the goats did so over a slightly longer period (first to fourth day). Germination rates for the excreted seeds varied by species and animal but only one species (*Acacia senegal*) showed zero germination after passage through sheep and goats (it was little better for cows at just 2%). They also found limited influence of retention times on seed germination rates. Therefore, in the absence of specific data for *Acacia sieberiana* and accepting that germination rates may nonetheless vary, potential source areas can be inferred from travel distances on the debatable assumption that animals on the move digest and excrete as they do when stall fed.

In my Dakoro study site, a local cattle trader regularly hired drovers to take his purchases down to Shinkafe market in Nigeria. The straight line distance of 135 km was said to be completed in 3 ½ to 4 days, which equates to a daily average of 33.75-38.5 km. This however is very purposeful, time dependent cattle movement and is probably faster than the majority of transhumance and nomadic movements which are slowed by mixed species herds, and pack animals. Adriansen & Nielsen (2005: 184) report trekking distance of up to 25 km per day on transhumance and figures calculated from maps in Greenough (2012) suggest figures nearer 10 km with significant halt days in between. Daily travel distances depend on a variety of factors such as health of the herd, water availability and information of grazing resources ahead. Hard evidence of longer daily treks sustained for the duration of experimentally derived seed retention periods (2-3 days for sheep, 1-4 for goats and 2-7+ for cattle) are wanting. Danthu *et al's* (1996) claim that viable seeds can be transported in extreme cases by livestock in the Sahel more than 200 km therefore remains highly speculative. Their lower figures of 50-80 km on the basis of daily transhumance distances of 15-30 km are however probably more reasonable. Table 1 collates some of the above distance assumptions.

Table 1: Potential Distances Travelled by Livestock at Different Sustained Daily Speeds in Relation to Seed Retention Times

Number of Days Seeds Retained	Sustained Daily Travel Distances				
	10km	15km	20km	25km	30km
1	10	15	20	25	30
2	20	30	40	50	60
3 SHEEP	30	45	60	75	90
4 GOATS	40	60	80	100	120
5	50	75	100	125	150
6	60	90	120	150	180
7 CATTLE	70	105	140	175	210
8	80	120	160	200	240
9	90	145	180	225	270

Looking at Table 1, and bearing in mind that the nearest known *Acacia sieberiana* today is about 90 km from the outlier, the following can be surmised with full recognition of the shortcomings of the data it is deduced from:

- A sheep would have had to travel at the fastest sustained daily speed to have deposited the seed within its maximum 3 day retention window

- A goat travelling at a slightly slower sustained daily speed could have done so within its 4 days retention period

- A cow at a more gentle sustained daily speed could have done so in 7-8 days but for the majority of seeds ingested to be dispersed (days 2-4), it would have to travel at faster speeds

From the above it could be concluded that a cow was the most likely seed transporter. and a sheep the least likely. However, it is perhaps not so wise to discount sheep especially given the albeit limited evidence that they may have the greatest preference for *Acacia sieberiana* pods. One particular reason for keeping sheep in the frame is the existence in the region of specialist sheep herders who are renowned for their long annual transhumance movements but as far as I can see have not been the subject of any detailed research. These are called in French simply '*Peuls moutonniers*' and are more specifically referred to in the scant literature on them as the Ud'aen (e.g. Dupire, 1975 and Mainet, 1965), which may or may not be how they self-identify and may not indeed cover all sheep specialist groups[13]. Bonte (1969: 36-7) with reference to the Ader Doutchi region to the west of the outlier provides this information about them:

> "Peul Moutonniers : Les Peuls pratiquant l'élevage du mouton vivent surtout au Nigeria de Sokoto au Nornou [sic Bornou] (Udaen).
>
> L'on ne trouve pas de groupes nomades moutonniers dans la région ; cependant, dès le début de la saison des pluies, ils remontent à l'Est de Madaoua vers les pâturages sales du Fako Maidoullou et Marendet. Leur passage est l'occasion d'importantes ventes de mil sur les marches. Ils font subir des dégâts aux cultures et les sédentaires s'en plaignent beaucoup.
>
> Certains groupes de Peul nomades ou semi-nomades de l'Ader entreprennent depuis quelques années l'élevage du mouton, dans la région de Madaoua et de Konni. Ils possèdent d'importants troupeaux (quelques centaines de bêtes). Leur cycle de transhumance les amené en saison séché très au Sud du Nigeria et en hivernage plus au Nord que les pasteurs bovins pour trouver des pâturages appropriés.

13 Dupire (1975: 77) acknowledges that Bouzou may also only herd sheep on transhumance.

> Cette forme d'élevage leur assure un niveau de vie supérieur à celui des autres Peul car le rendement est meilleur et la commercialisation plus facile."

On one memorable early evening in October 2001, I saw a tight flock of sheep raising dust in that sublime Sahelian light before dusk as they were being driven at speed along the cattle trail beside Tarago. Later I was later told that these belonged to *Peuls moutonniers* and one of the Fulbe village shepherds informed me that these people are more mobile than cattle herders and they keep nine different varieties of sheep. He also said that when several families get together, they may even hold races in which the men run ahead and a chosen ram follows. Maybe the flock I saw was just being hurried along to get to the evening camp before dark, but it would certainly be helpful to know whether their sustained travel distances could make them serious long distance dispersal candidates. The feeding habits of their different sheep varieties would also be useful to know, especially as the Uda/Ouda/Oudah breed that the Uda'en are sometimes associated with, is reported to have a very particular diet. In northern Cameroon, Gautier *et al.* (2005: 329) note that "Ouda sheep are said to accept only ligneous fodder; they reject all other dry fodder such as dry herbs or stems". Without doubt, more research is need on these highly mobile herders and their sheep.

- **Evidence for an alternative 'transported feed' theory**

The uncertainties around the deductions made from Table 1 could also mean that a direct animal transport from mother tree to Tarago may not be a tenable theory. What evidence is there then for the counter transported feed theory?

The only partial evidence I have found of transported fodder sales in Dakoro in the 1984-5 period come from Hammel (1985) who notes (page 185) that a certain trader from Maradi had bought up all animals still standing in Kornaka in the 1984 rains and then fed them at great expense. Earlier he is more specific about where those involved in these purchases were getting fodder from as well as the social changes that resulted from this activity (page 86):

> "Quelques riches commerçants eurent l'idée d'investir en prenant de gros risques. Achetant les bovins pour quelques poignées de mil à des éleveurs affamés et désemparés, ils purent en sauver une partie à grands renforts d'achats de fourrages au Nigéria et ils constituèrent ainsi des troupeaux important qui prospérèrent dans les années suivantes. Nombre d'éleveurs ruinés se retrouvèrent employés de ces commerçants durant les 20 années qui suivirent, sans espoir de retrouver un niveau de vie indépendant en raison des conditions de quasi servilité dans lesquels ils étaient contraints de travailler, sans salaires autre que l'accès au lait des femelles et quelques vivres de subsistance."

Though *Acacia sieberiana* pods are very unlikely to have been part of this forage, which probably included cotton seeds and cowpea hay, it might nevertheless have had an effect in stimulating a wide-reaching market in open-access, wild fodder alternatives among people desperate for cash to buy food. Two additional snippets of information support this possibility. Rey (198: 59) describes a trade in forage in Dakoro town as a recent phenomena which was exerting a notable pressure on these resources in a 20 km radius around the town. From my own studies on migration in the community neighbouring the outlier, El Bohari was also the period that an income-earning opportunity from selling hay was said to have been 'discovered' along the Gagere river in Sokoto State by those who had left on distress migration (*cin rani*). In this context, it is not too difficult to imagine that someone returning from migration to an area where *Acacia sieberiana* grows, as presumably it does along the Gagere, brought back a few pods to sell. Certainly those families who had left on *cin rani* to this region were maintaining some intermittent contact with those back home which might have informed them about such an income-generating opportunity.

Final Thoughts

This note has not managed to answer the beguilingly simple question that it set out to address. Yet it has, hopefully, managed to convey the importance of some of the myriad processes that would have shaped this acacia's arrival. Whilst these processes have ultimately occurred at the seed level, they are nevertheless enmeshed in much wider dynamics at the socio-environmental interface. As it seems likely that these processes were shaped by a particularly pivotal event in regional history, the arrival of this tree can also be seen as part of a much more momentous story.

Within the Dakoro landscape are other, sometimes older outlying trees with similar connectivity stories to tell that link up different places with particular times. Most obvious among these are the baobabs (*Adansonia digitata* L.) some of whom have dimensions suggesting an age in excess of 100 years. Indeed one stands just 240 metres away from the outlier, and whilst of not especially remarkable dimensions, it, or another now deceased appears, as do several others, on the 1:200,000 map series based on aerial photography from the 1950s. Their stories are also tied up with livestock, though in a somewhat different way[14], and they are a common feature of FulBe migration routes across West Africa (Blench, 2000). Reading the social histories of many of these older baobabs would probably be a challenge today given their age, but other research methods such as population genetics, might provide some insights into land use and environments in northern Gobir in the 19th century. Other, more common trees of course may have hidden connectivity stories that genetic analysis might uncover.

14 The flesh of the fruit is both eaten and used to thicken milk by pastoralists resulting in seeds being discarded around their encampments (Blench, 2000).

As far back as 1936, André Aubréville was puzzled by what seemed to him to be a disconnection between two wetlands on the same transhumance route. One a hundred kilometres north of Tessaoua had a pure stand of *Acacia arabica* (a synonym for *A. nilotica* var. *adansonii*) whereas the other near Aderbissinat was populated only be *Acacia nilotica* (presumably var. *tomentosa*). Wistfully he reasons:

> "Certainement les boisements d'espèces biologiquement soudanaises qui peuplent encore aujourd'hui les dépressions du Sahel, furent autrefois reliés entre eux comme l'étaient les cuvettes dont ils demeurent les prisonniers." (Aubréville, 1936: 69)

Clearly seed dispersal connections between Sahelian wetlands still persist but Aubréville's attention to varietal differences could be relevant to uncovering more about these. Unbeknown to me at the times I was in the vicinity of the outlier, two varieties of *Acacia sieberiana* have been recognised in the region[15], (the nominate *sieberiana* DC and *villosa* A.Chev), both of which have been recorded in Zamfara Forest Reserve at Point D on Figure 3 (Keay, 1946: 364). Though varietal identification may not help in determining the origins of the outlier because they can co-locate, more information may lurk in the genes of the pod shown below, which I collected on my first visit to this most interesting tree.

15 I am indebted to Joyce Lowe for drawing this to my attention,

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Appendix A: Sources of Data for Localities without *Acacia sieberiana* as shown in Figure 3

NB, Seven villages do not have historical data provided in the sources (these are marked with an asterisk*). One village, Dan Sounsou, reportedly had this species growing in 1960 but it had disappeared by 2000 (pers comm. Patrick Gonzalez, 15th Ocotber, 2013).

Village	Department	Source
*Dan Koulou	Mayahi	Awaïss (2000)
*Jirataoua	Madarounfa	Awaïss (2000)
*Magami	Ague	Awaïss (2000)
*Sharken Hawsa	Mayahi	Awaïss (2000)
Dan Sounsou	Mayahi	Gonzalez et al. (2012)
Agalai	Mayahi	Joet etal (1998)
Dan Amarai	Mayahi	Joet etal (1998)
Goumza	Mayahi	Joet etal (1998)
Guidan Awaje	Mayahi	Joet etal (1998)
Janrwa	Mayahi	Joet etal (1998)
Sono	Mayahi	Joet etal (1998)
Tinkirana	Mayahi	Joet etal (1998)
*Batchaka	Dakoro?	Larwanou et al (2010)
*Koda	Dakoro	Larwanou et al (2010)
*Moulmouchi	Madarounfa	Larwanou et al (2010)
Danzabo	Dakoro	Manvell (1998)
Ganda Samou	Dakoro	Manvell (1998)
Goundoumawa	Dakoro	Manvell (1998)
Guidan Ango Labo	Dakoro	Manvell (1998)
Guidan Boey	Dakoro	Manvell (1998)
Guidan Chaybou	Dakoro	Manvell (1998)
Howaltchi	Dakoro	Manvell (1998)
Mallamawa	Dakoro	Manvell (1998)
Rouga Jaho	Dakoro	Manvell (1998)
Zongon Alway	Dakoro	Manvell (1998)
Dan Indo	Guidan Roumji	Wezel & Haigis (2000)
Serkin Hatchi	Guidan Roumji	Wezel & Haigis (2000)

Sources for Appendix A:

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Appendix B: Livestock Estimates for Dakoro

Animal	1983	1984	1987
Cattle	121,200	123,018	76,260
Sheep	77,000	80,080	301,514
Goats	230,000	235,750	
Camels	3,350	3,417	3,006
Horses	7,450	7,570	nd
Donkeys	9,000	9,180	nd

Sources: 1983 & 1984 figures cited by Rey (1989) and originate from the Service de l'Arrondissement des Ressources Animales (SARA-Dakoro). The 1987 figures are cited by Hammel (2005) and come from Patrick Paris's (1988/9) *Rapport de fin d'Activité du Projet Elevage Niger Centre Est* (PENCE).

Appendix C: Map of Pastoral Movements in Central Niger from Mainet (1965: 17)

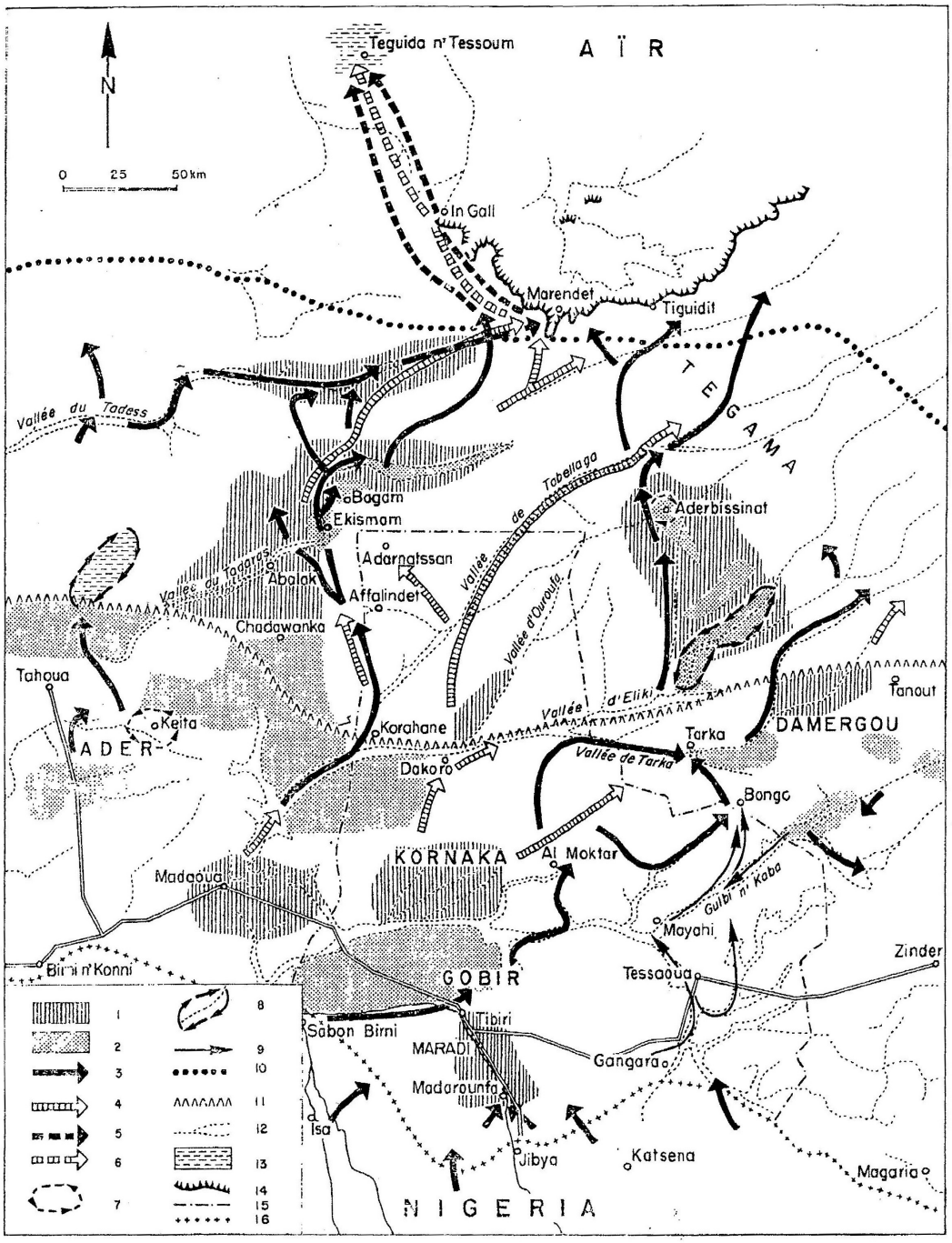

Fig. 8. — Les mouvements pastoraux dans le Niger Central (carte établie d'après M. Dupire, in **Peuls nomades** et complétée par l'auteur pour les autres ethnies).
A. - Terres de parcours en saison sèche. 1. Bouzou et Touareg. — 2. Peul et Bororo.
B. - Parcours d'hivernage. I. Les aires de nomadisme. — 3. Peul et Bororo. — 4. Bouzou et Touareg.
II. Les déplacements de transhumance. a) vers les terres salées et les oasis. — 5. Peul et Bororo. — 6. Bouzou et Touareg. b) à partir de points fixes. — 7. Mares. — 8. Vallées. c) et pratiqués par des cultivateurs éleveurs. — 9. Transhumance des cultivateurs arachidiers.
C. - Légende complémentaire. 10. Limite septentrionale des pâturages. — 11. Limite Nord des cultures (limite **légale**). — 12. Vallées sèches. — 13. Terres salées. — 14. Falaise gréseuse de Tiguidit. — 15. Limite de la circonscription d'Elevage de Maradi. — 16. Limites d'Etats.