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Interactions Between Chimpanzees (*Pan troglodytes schweinfurthii*) and Cattle (*Bos taurus*) in the Issa Valley, Western Tanzania

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Abstract: Wildlife habitats are being degraded globally due to human activities. Pastoralism in Africa has been described as a major threat to habitats and a source of wildlife-livestock interactions and conflict. Chimpanzees in particular are affected by the use of land for livestock, most notably where cattle trample terrestrial food sources and may act as potential reservoirs of disease. Yet, despite extensive study of wild chimpanzees across their distribution, no detailed behavioural observations of chimpanzee-cattle interactions have been described. We report ten direct chimpanzee-cattle encounters that occurred from 2019-2021 in the Issa valley, Tanzania. We observed more interactions in the dry season, and these prompted more vigilance by chimpanzees than wet season interactions. The distance between chimpanzees and cattle may also affect chimpanzee behavioural responses. Our observations suggest that (1) chimpanzees remain vigilant but otherwise only minimally change their behavioural reactions towards cattle in ways that depend, at least in part, on chimpanzee party composition, with males reacting more overtly than females and (2) chimpanzees exhibit more aversive behaviour when cattle are accompanied by herders and dogs.

Key words: Great ape, cattle, wildlife conflict, conservation, East Africa

INTRODUCTION

Human activities are the leading cause of global deforestation and biodiversity loss (Johnson *et al.* 2017). The resulting footprint of these pressures affects wildlife distribution and abundance, increases the likelihood of disease transmission between humans and wildlife (Pongsiri *et al.* 2009), and often contributes to wildlife relying on marginal habitats (Haddad *et al.* 2015). Great apes are at risk from such anthropogenic activity due to their extended interbirth intervals and slow life history (Hockings *et al.* 2015).

The conversion of great ape habitat to agricultural land has affected all ape species and, in Africa, chimpanzees (*Pan troglodytes*) are particularly vulnerable, prompting them to forage on crops and compete with humans for often scarce resources (Hockings & Sousa 2013; Krief *et al.* 2014; Waller & Pruetz 2016; Garriga *et al.* 2019; McLennan *et al.* 2019). Just as forest-conversion often results in human-wildlife conflict, so does livestock maintenance. Cattle herding is known to degrade savanna ecosystems, resulting in increased

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bushland and invasive species that exploit the rapid loss of indigenous plants (Hudak 1999; Tobler *et al.* 2003). Livestock-wildlife conflict is a common conservation challenge, especially across Africa. In fact, initiatives are already in place in some areas to assess mixed (cattle-wildlife) land use given the increase in livestock-wildlife interactions (Baloi & Chaminuka 2017).

While carnivore-livestock conflict is well known to conservationists (Lyamuya *et al.* 2016; Ugarte *et al.* 2019) across Africa, there has been minimal attention to primate-livestock interactions. Livestock has been discussed as a threat to wild chimpanzees in the context of disease transmission, e.g., *Cryptosporidium* (Parsons *et al.* 2014) and anthrax (Leendertz *et al.* 2004). However, despite the growing threat of livestock grazing to chimpanzee habitat (Ndiaye *et al.* 2018), chimpanzee-livestock interactions have not yet been well documented, with only isolated observations or unconfirmed reports to date (Kormos *et al.* 2003; Matsuzawa *et al.* 2012; Hockings & McLennan 2016). Moreover, little is known of chimpanzee responses to herders or their livestock, even though in some areas cattle herding is identified as a primary threat to entire ecosystems (Morgan *et al.* 2011; Chancellor *et al.* 2020). A recent study from Gishwati, Rwanda, which concentrated on chimpanzee-cattle conflict, revealed one of the ongoing threats towards the local chimpanzee community was illegal cattle grazing (Chancellor *et al.* 2020). The authors reported that community conservation programs resulted in a reduction in grazing and increase in chimpanzee population over a 10-year period. Another study, on chimpanzee foraging behaviour in Fongoli, Senegal – an area with permanent human settlements – found an increase in chimpanzee anti-predatory behaviour as well as an increase in adult males in parties that range close to human presence (Lindshield *et al.* 2017). Furthermore, anti-predatory behaviours were more often exhibited to humans, rather than cattle presence. Given that humans pose a direct threat to chimpanzees in this area (Pruetz & Kante 2010), it may be that both at Fongoli and Gishwati, chimpanzees fear humans more than the livestock they accompany. Both studies described here report on chimpanzee-livestock sympatry, but in neither do they detail observed interactions between these species.

Here we describe ten observations of interactions between cattle and wild eastern chimpanzees (*P. t. schweinfurthii*) from the Issa Valley in western Tanzania. We contextualise our descriptions against a growing threat to chimpanzee habitat in Tanzania from livestock herding, and the increased likelihood of future chimpanzee-livestock interactions.

We hypothesize that party size, the number of chimpanzees present in a subgroup of the community (van Lawick-Goodall 1968, Sakura 1994), and composition influence chimpanzee responses towards cattle. Specifically, we predicted that larger parties and those with more males would show less aversive behaviour (lower rates of vigilance, avoidance) than smaller parties and those with fewer males. In chimpanzees, larger parties are generally more aggressive and incur less risks during aggressive encounters (for example, with neighbouring communities), which is especially true for males (Manson *et al.* 1991; Langergraber *et al.* 2017). We also hypothesize that proximity matters, with chimpanzees increasingly vigilant when cattle were close (within 100 meters) compared to when they were far.

METHODS

Study area

The Issa Valley study site covers ~ 85 km^2 and is located in the Tongwe West Forest Reserve, western Tanzania, about 100 km east of Lake Tanganyika. The entire region is characterized as a mosaic, miombo woodland with rocky outcrops, interspersed with thin strips of riparian forests, and seasonally inundated grasslands, spread across a series of valleys and plateaus. There is a wet season (October to April), which includes nearly all annual rainfall (mean = ~1250 mm) (McLester *et al.* 2019a) and a dry season (May to September) (Piel *et al.* 2015). The dry season is marked by the prevalence of annual grass fires that burn > 75% of the landscape (Piel & Stewart unpublished data).

Besides chimpanzees, the study area also hosts six other diurnal primate species and numerous other medium-large mammal species (reviewed in Piel *et al.* 2019). Since the onset of permanent research in the area in 2008, we have regularly documented human activity in the study area (Piel *et al.* 2015).

Study subjects

The Issa chimpanzees have been under systematic study since 2008, and one community has been habituated since summer 2018, when nest-to-nest follows began. On average, chimpanzees are followed 20-25 days/month, with focal and party scan data collected on behaviour and ecology. As of July 2021 (shortly after the last observation reported here), the community was comprised of 29 individuals: seven adult males, seven adult females, and six subadults

(three males, three female). We estimated adults to be > 15 year old, adolescents 7–15 year old, juveniles 4–7 year old, and infants < 4 year of age (following Pruetz *et al.* 2015).

Behavioural data

We used focal animal sampling of individuals in parallel to scan sampling of parties as well as *ad libitum* sampling of behaviours of interest (Altmann 1974) to obtain details of behaviour on an individual and group level. When chimpanzee-cattle interactions were observed (including if research teams were with chimpanzees and audibly detected cattle), we focused observations on vigilance (standing bipedally, looking in the direction of cattle), avoidance (changing bearing of travel, circle around, or leaving the area) and hiding (keeping still and silent) behaviour, as well as alarm-calling from the focal individual and *ad libitum* sampling of individuals who exhibited these behaviours.

We estimated distances between cattle and chimpanzees. Party size comprised the number of all chimpanzees within the group including infants and juveniles and was sampled every 15 minutes (following Anderson *et al.* 2002). If one individual had not been seen since the last scan it was excluded from the party size. In all 10 of our observations, all individuals were visible to the observers. When possible, observers went to the site of the cattle location (once the cattle had left) to get a better estimation of the distance. Observers also noted the presence of herders and dogs with the cattle. As herders in the area usually flee from researchers when they see them (Fryns, pers. obs.), it is possible they were present (and detected by chimpanzees), though concealed to researchers (c.f. Table 1).

Cattle Monitoring

All cattle observations were opportunistic. From 2009-2019, research teams were comprised of two (and occasionally three) people per team, with each team assigned to a specific task, e.g., behavioural follows of chimpanzees or other concurrent research projects (e.g., baboon follows, phenology, etc.). Additionally, between 2008-2016, once per month, a research team would spend three days conducting reconnaissance walks in one of four areas along the perimeter of the core study area, ~25km from the base station in each cardinal direction. All teams followed the same data collection protocols, and recorded data on all human activity, including type, number, and estimated age of disturbance (1-fresh (within 24h), 2-recent (2-4 days), 3-old (> 4 days). Cattle herding signs were considered separate events if they were documented to be more than 100 m away from each other; these included corrals, cattle prints or faeces, and direct observations of cattle (with or without human herders). To assess interaction rates over time, we first controlled for research effort. We divided the number of cattle observations per year by the total number of research teams for that year. This provided us an observation/effort figure that we could then compare across years. Only years where search effort was available were used (2014 – 2015 and 2017 – 2019).

RESULTS

Observations

Below we describe three chimpanzees-cattle interactions between August 2019 – July 2021, focusing on chimpanzee behavioural reactions (see Table 1). Details of an additional seven can be found in the Supporting Online Material (see http://www.primate-sg.org/african_primates/). We focus here on examples that most reveal the diversity in chimpanzee response behaviour. Eight of the interactions occurred in the mid to late dry season (July – October), when annual fires had already burned through the landscape (Figure 1) and new grass shoots provided forage for cattle. For the two wet-season observations, grasses had already reached at least 1 m high (Figure 2). All cases occurred on plateaus in either woodlands or riparian forests (Figure 3). Chimpanzee behaviours ranged from seemingly no reaction to climbing into or higher in trees, travelling in the opposite direction, or deviating their path to avoid the herd as well as remaining silent throughout. In cases where human presence was confirmed, chimpanzees reacted with the most avert behaviours and even presented reassurance behaviour (e.g., embrace) acts. Across interactions, we observed no display behaviours.

Observation 1

On 5 August 2019 at 16:28, researchers were following ten chimpanzees (two adult males, two adult females, two sub-adult males, three juveniles and one infant) in riparian forest. While the chimpanzees were still in the forest, cattle vocalized from > 300 m but there was no evidence that chimpanzees changed their behaviour in response to hearing the cattle. Shortly thereafter, at the same time that the chimpanzee party began travelling towards and through a nearby grassland, researchers heard cattle again from the same direction. The cattle were likely further east, while the chimpanzees were travelling south-west. All observable chimpanzees

Table 1. Summary of the chimpanzee-cattle observations recorded, method of detection by researchers, and estimated distance between cattle and chimpanzees. Observations are numbered chronologically.

Observation number	Date	Season	Chimpanzee location	Chimpanzee Response	Party Size	Number of Adult Males	Detection	Estimated distance	Burnt Area	Chimpanzee location vegetation type	Presence of herders	Presence of dogs
1	August 2019	Dry	Terrestrial	Vigilance	10	2	Auditive	> 300 m	Yes	Forest	-	-
2	October 2019	Dry	Terrestrial	Vigilance/ Avoid	9	4	Auditive	< 100 m	Yes	Woodland	-	-
3	October 2019	Dry	Arboreal	Vigilance	5	0	Auditive	> 100 m	Yes	Forest	-	-
4	March 2020	Wet	Arboreal	No visible reaction	3	0	Auditive / Visual	< 100 m	No	Woodland	-	-
5	April 2020	Wet	Arboreal	No visible reaction	1	0	Auditive	> 300 m	No	Woodland	-	-
6	September 2020	Dry	Terrestrial	Vigilance	14	4	Auditive	> 200 m	Yes	Woodland	-	-
7	September 2020	Dry	Terrestrial	Vigilance/ Avoid	13	6	Auditive / Visual	< 100 m	No	Woodland	Yes	Yes
8	October 2020	Dry	Arboreal	Vigilance/ No visible reaction	9	7	Auditive	> 300 m	Yes	Forest/ Woodland	-	-
9	October 2020	Dry	Arboreal/ Terrestrial	Vigilance/ Avoid	13	4	Auditive / Visual	< 50 m	Yes	Forest/ Woodland	Yes	Yes
10	July 2021	Dry	Arboreal/ Terrestrial	Vigilance/ Avoid	8-10	5	Auditive / Visual	< 100 m	Yes	Grassland/ Forest	-	-

Figure 1. Charred landscape after the annual fires. Photograph by @GMERC.

Figure 2. Wet season landscape with tall grass. Photograph by @GMERC.

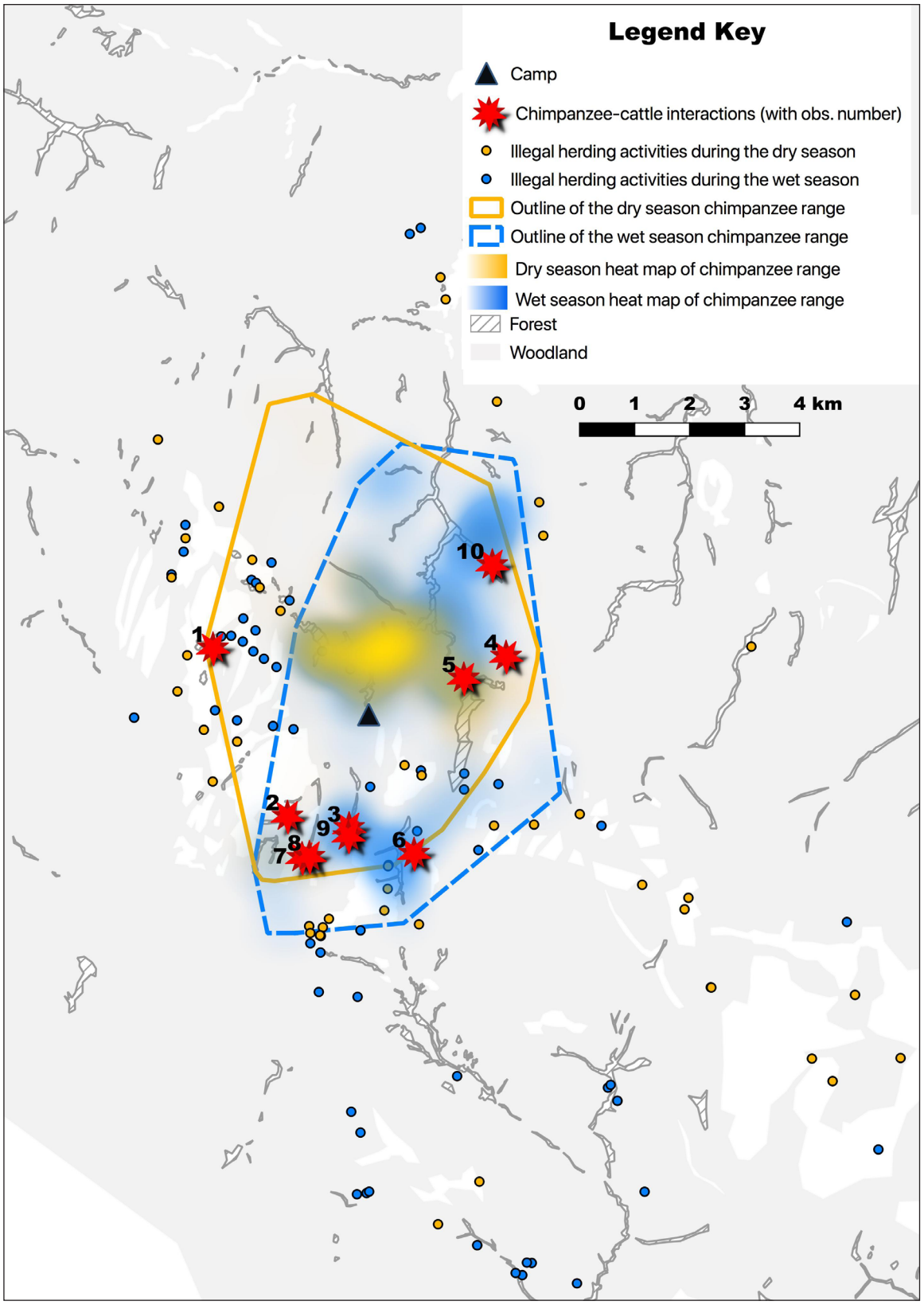

Figure 3. Map of the locations of the chimpanzee-cattle interactions relative to the chimpanzee dry and wet season ranging, with added heat maps and other encounters with cattle. Heat maps show the intensity of occupancy in wet and dry seasons, with darker colour indicating higher intensity use.

looked in the direction of the cattle calls, some were vigilant, and the party seemed to increase travel speed. At least one individual, an adult female, stood bipedally looking towards the direction of the cattle vocalizations. The chimpanzees then continued their (south-west) route.

Observation 4

On 25 March 2020 at 12:55, researchers were with a party of four chimpanzees (two adult female chimpanzees, one infant (< one month old) and a juvenile). While the chimpanzees fed on fruits in a *Ficus* sp. tree, a herd of cattle passed and vocalized less than 100 m away. The adult chimpanzees looked in the direction of the cattle vocalisations but showed no strong reaction. It is unclear if the chimpanzees saw the cattle, although from their height in the tree (10 m) we suspect that they did. The juvenile left the tree via the ground only to immediately climb another tree about 50 m away (in the same direction as the cattle sounds) but was not vigilant. It is therefore difficult to assess if his movement was due to the cattle or not. The chimpanzees were resting before the cattle vocalisations and showed no signs of behavioural change. One hour passed with no audible or visual signs of cattle, until the cattle passed again 100 m away from the chimpanzees who were still in the same tree. Once again, no clear behavioural responses were observed.

Observation 7

On 22 September 2020 at 17:13, researchers were following a mixed group of thirteen (six adult males, two adult females, two subadult males, one subadult female, two juveniles) travelling south through burnt woodland. Abruptly, the party stopped walking and ran quickly, stopping near a raised rocky outcrop. After a few minutes, researchers heard cattle vocalizing in the same direction that the chimpanzees were travelling and from < 100 m away. The chimpanzees remained vigilant, standing bipedally to look from the raised rocks. Some began grooming, and one adult male began walking the same direction as previously, stopping about 30m ahead, where he sat and self-groomed. Some individuals stayed near the rocks, vigilant, regularly standing bipedally and looking ahead, whilst others in the party groomed. After a few minutes, the previously mentioned male suddenly startled and ran back to the main party. Individuals embraced, and some silently ran back the way they came, a mother carrying her five-year-old on her back. Males were piloerect, and briefly looked back in the direction of the cattle, before continuing in the opposite direction. At the same time, 17:26, researchers saw a man and a large dog (*Canis familiaris*) walking parallel to the party (but far beneath the rock outcrop) towards the cattle vocalizations, about 100m away. Neither the man nor the dog noticed the researchers or chimpanzees present. After a few seconds, the remaining (chimpanzee) males hurried after the rest of the party and they all returned silently to the forest, crossed and continued in the original direction of travel. Whilst travelling away from the cattle/man/dog, all chimpanzees stopped regularly to stand bipedally or cling on trees to listen/look back in the direction they had come, and all were silent. The party fissioned at 17:50 and was subsequently lost.

Cattle Monitoring

From 2014 to 2019 (excluding 2016), researchers documented 76 (mean: 15.2 ± 12 per year) observations of cattle presence. Overall, since 2014, there has been a decline in both the total number and rate of encounters with cattle/herders annually and we found no discernible spatial pattern (Table 2; Figure 3).

Table 2. Total number of observed herding events counted per year with the total number of researcher teams per year.

Year	Cattle Herding Events	Annual researcher teams	Encounter rate
2014	31	883	0.035
2015	25	1091	0.022
2017	3	945	0.003
2018	8	1329	0.006
2019	6	1341	0.004

DISCUSSION

Chimpanzee responses

The interactions that we described here suggest that Issa chimpanzees are familiar with cattle and while they sometimes remain vigilant of them, chimpanzees minimally alter their behaviour in response to cattle presence. With habituation complete only in 2018, we have no longitudinal data on chimpanzee-cattle interactions, which may otherwise reveal whether their familiarity to cattle is a recent phenomenon. Although to date we have observed only 10 interactions, we attempt to make sense of the variable chimpanzee responses to the presence of cattle.

We expected that party size and composition would influence chimpanzee responses, with individuals in larger parties and adult males less aversive to cattle. This is not what we observed, where two observations of small parties (n = 3 and n = 1 individual) revealed individuals that were seemingly unperturbed by the cattle. Chimpanzees did show more aversion to cattle when they were in close proximity, which is what we predicted, although like all these patterns, more observations are needed to confirm this tendency. In five observations, we observed cattle closer than 100 m from chimpanzees (observation 2, 4, 7, 9, 10; see Table 1). In only one of the five observations (observation 4; see Table 1) did we not observe a behavioural reaction from chimpanzees. This was the smallest party and the only observation (of the five) in which the party did not include any adult males. On two occasions, researchers observed herders and dogs together with cattle and both times, chimpanzees exhibited the clearest sign of aversion, changing travel direction nearly 180°, likely to avoid an encounter, and remaining vigilant the entire time that cattle were visible.

Chimpanzees may associate cattle with people or possible with domestic dogs, which often accompany the herders/herds, and have threatened (Giuliano and Mason, pers. obs.) and killed (Piel & Stewart 2019) Issa chimpanzees in the recent past. If either association were the case, we would predict behavioural responses to be independent of season or even party size/composition. Further observations and data are needed to identify whether the more aversive chimpanzee behaviours described here are in response to the presence of people, dogs, or other factors.

There is no evidence that the herders who we encountered were targeting areas where chimpanzees were present. Instead, it is more likely that both species (chimpanzees and cattle) are attracted to important food sources, especially in the woodlands: chimpanzees to feed on e.g., *Parinari* fruit and *Julbernardia* flowers and cattle to graze on new shoots of grass. Despite the low risk of chimpanzee-cattle interactions (see Table 2), herder/cattle landscape use carries risks for chimpanzees. These risks are threefold.

First, to protect cattle at night, herders cut down woodland trees and build temporary corrals (Figure 4). We lack data on which tree species are targeted for these corrals, but chimpanzees rely on many woodland species for both nesting (Stewart *et al.* 2011) and feeding (Piel *et al.* 2017), and so it is possible that this contributes to resource loss for chimpanzees. Second, cattle-borne diseases are common in Tanzania (Kivaria 2006), and whilst no pathogens have yet been shown to infect both cattle and chimpanzees in Tanzania, this does not preclude possible transmission of diseases (Parsons *et al.* 2014) or cattle serving as vectors for known pathogens (reviewed in Bengis *et al.* 2002). Each interaction between chimpanzees and cattle potentially increases the risk of disease transmission, which can be deadly to chimpanzees (Leendertz *et al.* 2004; Parsons *et al.* 2014). It is unclear if chimpanzees could be aware of this risk. In the case of the Issa chimpanzees, it is unlikely they perceive this risk as, to our knowledge, they have never been affected by a cattle-borne disease. However regardless of the perception of the threat by chimpanzees, it remains as a predominant risk. Relatedly, herders themselves could serve as vectors, transmitting respiratory or other pathogens to chimpanzees with whom they share the landscape (Boesch 2008; Kooriyama *et al.* 2013).

Finally, herders spend long periods in remote areas, often living nearly entirely off the natural products (e.g., milk) of their cattle (Sieff 1997). Whereas there is minimal evidence that herders engage in poaching in Tanzania, armed cattle herder groups in Kenya and Central African Republic are well known to trade in wildlife as part of their nomadism in remote areas (Lombard 2016). In these extreme cases, chimpanzees may be vulnerable to capture or poaching (Piel *et al.* 2017) and thus may avoid nomad routes.

Concerning seasonality, our observations suggest that chimpanzees are more likely to react to cattle in the dry season than in the wet season, but as party sizes were also smaller in the wet season, we cannot yet be confident in what is driving variability in behaviour. Dry season fires result in increased visibility across the landscape, which may allow chimpanzees to detect cattle earlier, but

Figure 4. Abandoned corral by Tanzanian herders. Photograph by @GMERC.

also increase their perceived risk (Hoare 2019). Charred landscapes increase exposure of animals to predation (Figure 1) and so chimpanzees may perceive greater risk given the lack of vegetation to conceal their presence, especially since the cattle are frequently accompanied by people and domestic dogs (see above).

The interaction locations themselves could also account for the different responses, as these dry season interactions were also observed closer to the (chimpanzee) community boundary (Figure 3). Chimpanzees are known to modify behaviour depending on whether they are in the core or periphery of their territory, reducing risky behaviour, such as producing loud calls, in high-risk areas near boundaries (Wilson *et al.* 2007). These community boundary limits also coincide with areas where most illegal herding activities have been recorded (see Figure 3; compared to the chimpanzees' core range area). These locations are also more disturbed than the core study area. Lindshield *et al.* (2017) reported an increase of anti-predatory behaviours in proximity to areas with human activities in Senegalese chimpanzees. As such, Issa chimpanzees may already be vigilant in these peripheral areas and thus their state of alertness might drive their initial behaviours (vigilance and avoidance) towards potentially non-threatening heterospecifics like cattle.

While in three observations we did not observe a notable behavioural reaction from the chimpanzees and in other observations the reactions were mild (i.e., vigilance), there may still have been physiological stress reactions. In this sense, hormonal analysis of individuals before and after a cattle interaction might reveal an increase in stress hormone levels (Creel *et al.* 2009).

Monitoring effort

Our cattle-encounter data suggest a decrease in cattle presence within the Issa chimpanzee home range over the last few years. There are two likely explanations for this. First, researcher presence deters illegal human activity across Africa (Campbell *et al.* 2011; Laurance 2013), including in western Tanzania (Piel *et al.* 2015). It could be the case that after the establishment of the permanent research station in 2008, herders began using alternative areas for forage. Second, with the habituation of baboons (Johnson *et al.* 2015), red-tailed monkeys (McLester *et al.* 2019b), and more recently, chimpanzees (Giuliano *et al.*, in press), researcher attention has shifted from peripheral surveys and transects to focal follows of primates that live within the core study area. As a result, there is a lower likelihood of research teams encountering cattle and herders, which prefer the peripheral areas that offer flatter areas with better forage, compared to the steeper valleys and riparian forests preferred by chimpanzees and guenons (McLester *et al.* 2019b). Although possible, it is unlikely the overall numbers of cattle and herding activity within the ecosystem

is declining. In fact, in Tanzania, grazing land is becoming scarcer for cattle forage (Makoye 2014; Walwa 2020) and the cattle industry is increasing (Engida *et al.* 2015). Herders are being forced to find new rangelands to sustain their herds. As growing numbers of people and livestock compete with wildlife for key ranging, food, and water resources, chimpanzee-livestock interactions are likely to increase in the coming years across chimpanzee distributions in Tanzania and other areas facing the same challenges.

Chimpanzees face a myriad of threats across their distribution, most notably habitat loss, poaching, and disease (Hockings *et al*. 2015). Whilst cattle and cattle herders are not generally considered a direct threat currently, decreasing anthropogenic and herding activities specifically have been associated with an increase in chimpanzee abundance as seen in Gishwati, Rwanda (Chancellor *et al.* 2020). At Issa, more research is needed to make sense of the relationship between herding and chimpanzee behaviour and ecology. Observations like the ones presented here will help researchers and conservationists alike better understand the relationship between these two species.

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