frontiers | Frontiers in Human Dynamics

TYPE Hypothesis and Theory
PUBLISHED 02 July 2024
DOI 10.3389/fhumd.2024.1389009

OPEN ACCESS

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RECEIVED 20 February 2024
ACCEPTED 30 May 2024
PUBLISHED 02 July 2024

CITATION
Kanne K, Haughton M and Lash R (2024) Common animals: sedentary pastoralism and the emergence of the commons as an institution.
Front. Hum. Dyn. 6:1389009.
doi: 10.3389/fhumd.2024.1389009

Common animals: sedentary pastoralism and the emergence of the commons as an institution

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Animal husbandry was of fundamental consequence in the planning and development of larger and more permanent communities. Pastoralism is often assumed to be highly mobile when considering social institutions and political formations, despite the diversity of husbandry practices that are either wholly, or largely, tethered to relatively sedentary social aggregations. Key tenets of more settled animal husbandry are intensive social relations between people, and between people, animals, and landscapes. This entails reciprocal, multispecies cooperative efforts to decide how to utilize pastoral resources, choose where to settle, and how to organize settlements with an eye for the animals. Yet, scholars have rarely considered how the logistics and social dynamics of pastoralism shaped the transition to sedentism and, particularly, the development of collective forms of governance in prehistory. In this paper, we re-center pastoralism in narratives of settling down, in order to recognize the critical ways that relations with animals shaped how humans learned to move and dwell in emergent grazing landscapes. We take an institutional approach to the concept of "the commons," demonstrating the dynamics through 19th-century Irish *rundale*, then draw on case studies from Southern Scandinavia and the Carpathian Basin to consider the commons as a multispecies institution which resulted in variable sociopolitical formations of the European Bronze Age.

KEYWORDS

sedentarization, human/animal relations, the commons, Bronze Age, pastoralism, institutions, collective action

Introduction

"The archaeological record is fundamentally a record of cooperative human, and indeed nonhuman, endeavors" (Black Trowel Collective et al., 2024, p. 6).

We settled down with animals. People and animals, alongside plants and other vital entities, cooperated in choreographies of mutual niche-creation manifesting in emplaced multispecies cohabitations. The earliest fortified settlement of Amnya in Siberia (c. 6000 cal BC), emerged from predictable, mass-harvesting of migratory elk and reindeer, and locally rich aqua- and avifauna, enabling large, permanent habitations (Piezonka et al., 2023). Defensible surpluses requiring protection may have fostered extra-group conflict and territoriality, but encouraged intra-group collectivity through monumental construction. Intensively partitioned pasturing of livestock at the Trypillia mega-settlement of Maidanetske (3960–3650 cal BC) in Ukraine needed intra-community cooperation to manage effectively, potentially fostering social cohesion and more collective governance (Makarewicz et al., 2022).

In the European Bronze Age, emergent grazing landscapes developed as open heathlands in Denmark (Haughton and Løvschal, 2023), as divided field systems in southern Britain and Northern France (Fleming, 1998; Evans et al., 2016; Oosthuizen, 2016a; Marcigny and Peake, 2021; Randall, 2021), and as communal pastures accessed from byre houses shared by people and animals in the Netherlands (Arnoldussen and Fokkens, 2008). Presently, half of all habitable land belongs to agriculture, with nearly 80% of it used for livestock (Ritchie et al., 2019). Animal husbandry is the single greatest cause of deforestation (Parlasca and Qaim, 2022), a trajectory with prehistoric roots. The massive land clearance undertaken for agropastoralism reached a global scale by the 1st millennium BC (Boivin et al., 2016; Stephens et al., 2019).

These examples illustrate the difference that animals made to how sedentarization unfolded. More permanent settlements were co-constructed with animals. Forms of social and spatial organization developed which accounted for and responded to their presence, resulting in conjointly inhabited landscapes. Competing interests and mutual affordances had to be recognized and mediated. While agriculture is not a prerequisite for sedentism, domestication processes had particular effects on the socioeconomics of settling down. No longer limited by seasonal and environmentally specific animal abundance, possibilities of residential permanency were reconceived within the biosocial parameters of livestock. Manuring made marginal landscapes into productive arable land, habitable year-round. Harvested fields became winter grazing, supporting greater population densities of people and animals. Livestock surpluses could be monopolized by aspiring leaders (Arbuckle, 2012, 2014a,b; Price and Makarewicz, 2024), though this was not necessarily the case in prehistory pursuant to the institutional dynamics of common-pool pasturage, or "the commons" (Ostrom, 1990).

The commons are foundational to collective action theory in archeology (e.g., Blanton and Fargher, 2016, p. 40; Carballo and Feinman, 2023, p. 6), but how animals participated in this institution remains untheorized. The eternal commons are envisioned as community managed pasturelands for livestock, typically associated with historic, sedentary societies. Commons are materialized expressions of multidirectional relations between animals, people, plants, landscapes, environments, and material culture. They necessitate regular negotiation and cooperation on how to sustainably work these common pool resources. For sedentism to occur in societies heavily reliant on livestock, practical household and community decisions were made about how to rear animals to ensure settled life. Consequently, the commons were present in prehistory (Oosthuizen, 2013, 2016a,b; Haughton and Løvschal, 2023), and remain an enduring institution that persists today. While commons have long been considered a collective action solution to "cooperation problems" *among* humans, they can also be viewed as emerging from "cooperator problems" *between* humans and animals in co-evolutionary domestication processes.

In this paper, we take an institutional approach to the commons that emerged in processes of domestication and sedentarization. Institutions are "organizations of people that carry out objectives using regularized practices and norms, labor, and resources" (Holland-Lulewicz et al., 2020, p. 1). Should institutions include nonhumans? We think so, and extend participation in the commons to the domesticated animals on which it relies, for, and with whom, they were created. Our analysis is grounded in a simple premise about the logistics of animal husbandry: interactions with livestock constitute regularized, routinized, embodied practices and norms that require coordinated labor so that both people and animals can survive through mutual dependence. Generally speaking, the labors of animal husbandry include many tasks that are easier, safer, more efficient, and more effective when undertaken through the cooperation of animals, people, groups and the environment.

We center the analysis of sedentism in the taskscapes (*sensu* Ingold, 1993; Hammer, 2014) of animal husbandry, that is, the cycles of daily and seasonal work that sustains the entwined livelihoods of humans and animals. The logistics of keeping domesticated animals alive in the landscape must have played a significant role in configuring social relations and political organization during the emergence of sedentism. By extension, animals can make the difference as participants in collective action, which may have ramifications for the kinds of governance possible. Interspecies collaborations, and their resultant intra-community arrangements, formed the basic building blocks of self-governance, ones which were, and are, often "keystone institutions" of human societies (*sensu* Holland-Lulewicz et al., 2022).

In this paper, we present the recently shifting views of human/animal relations and domestication processes, and then describe how the commons developed as an institution from these processes in the social dynamics of settling down with animals. We illustrate how this institution informs and articulates with various forms of governance, using Irish *rundale* of the 19th century to introduce the dynamics of the commons, then the Bronze Age cases from Europe to examine how this institution instantiated new forms of spatially embedded social relationships between people and animals that were ultimately materialized as the commons as sedentism expanded, and explore how this related to political institutions (Figure 1).

Rather than chronicling the roles animals played in human settling down, we are concerned here with the critical difference that animals made. How was the story of sedentarization changed by the needs, concerns, and actions of animals? This approach reveals how animals shape human lifeways, and forms of settlement and social organization, without falling into a trap of focusing on the agency or intentions of animals in human/animal relations. We are concerned here with how things unfolded, rather than foregrounding particular types of relations. We do not wish to romanticize human-animal relations of the past, but to open our analyses through thinking differently about laboring together. The human domination of animals is an important part of the narrative. In foregrounding the difference that animals made, we do not intend to suggest that human/animal relationships were always (or indeed ever) equal, supportive, or necessarily caring. The affordances for violence provided by proximity to and domination of animals by humans is an equally important part of the history of settling down.

Poco and other theoretical animals

In his masterwork on human cooperation, Blanton (2016, p. 61) describes an example of interspecies sociality:

> My cat Poco, from his experience, is quite good at gauging whether or not I'll respond positively to his begging to be taken out for a walk, to be fed, or to be played with, depending on what I'm doing and what time of day it is (although he sometimes

FIGURE 1
Locations of case study sites.

> violates his own social algorithm when he wakes me at 5:00 a.m. instead of the allowable 6:00). Poco also uses specific ritualized movements and sounds to communicate his intentions—to be fed, brushed, played with, and so on—and to which he knows I will normally respond, a simple and direct form of social intelligence.

Though used here to consider how cooperation is wired in primate sociality, Poco and Rich effectively demonstrate with this relatable example what most pet owners know: that domesticated animals have a repertoire of routinized movements, sounds, and gestures that elicit reactions and compel humans to respond with relatively predictable behaviors.

These mundane interspecies social interactions are possible because of domestication processes, where individuals of different species make the other aware of their needs and intentions, a sociality crucially important to the organization and management of grazing herds. Companion animals have gotten much attention lately for their cognition and communication skills with humans, but this has only begun to influence domestication theory and archeology (c.f. Bogaard et al., 2021; Zeder and Lemoine, 2023). Farm animal cognition was not taken seriously until even more recently (Grimm, 2023), with far fewer scholars employing new ideas about the rich, complex sociality of large domesticates (but see Brusgaard et al., 2019; Randall, 2021). Livestock are acutely attuned to human emotional states, faces, voices, and gestures (reviews in Le Neindre et al., 2017; Nawroth et al., 2019). Discriminating and recognizing individual people, perceiving human emotions, interpreting humans' attentional state and goals, referential communication (perceiving human signals and signals between humans), and social learning have been well established in livestock species (Jardat and Lansade, 2022). Beaujouan et al. (2021, p. 1), find that,

> …the human–animal relationship is a process built through communication and regular interactions between two "partners" who know each other. The goal is to understand how each partner perceives the other according to their multimodal sensory world and their cognitive and emotional capacities, and to predict the outcome of future interactions.

Research of human/animal relations in archeology has undergone radical reconceptualization with posthumanist, multispecies archeologies, dissolving Cartesian binaries, de-centering the human, and considering relational ontologies inclusive of nonhumans as critical to our interpretations of the past (reviews in Boyd, 2017; Birch, 2018; Cucchi and Arbuckle, 2021; Fuller et al., 2022). Jettisoning a domestication as domination model (Bogaard et al., 2021, p. 59–61), animals have been successfully recast as co-participants in past societies. Domestication relationships are mostly viewed as cooperative and reciprocally reinforcing (Shipman, 2010; Mlekuž, 2013; Allentuck, 2015; Zeder, 2015; Anderson et al., 2017; Halperin,

2017, p. 286; Losey et al., 2018; Stépanoff and Vigne, 2018; White and Fijn, 2020; Bogaard et al., 2021, p. 10). They are negotiations between people and animals (alongside plants, landscapes, and material culture) about the terms of mutual, if not necessarily symmetrical, benefits. The causality has moved toward seeing reciprocity in co-constructing niches (Zeder, 2016, p. 333). Relational approaches find agency moving from everywhere in such treaties, "undermining human exceptionalism as the principal driving force in the construction of our world" (Halperin, 2017, p. 286).

Sedentism and domestication processes were entwined in mutual niche construction binding people and livestock together. Early Holocene (c. 11700 BP) people and wild boar at Hallan Çemi in southeastern Turkey shared permanent settlements after pigs took up residence in novel anthropogenic environments of the village (Zeder and Lemoine, 2023). Hunted wild goats became early managed goats in permanent villages of the Zagros Mountains of western Iran (c. 8200 cal BC; Daly et al., 2021). Penned, they left hoofprints on mudbricks nearly a millennium before skeletal markers of domestication were identified, while demographic profiles and aDNA indicate regular mating with goats from nearby villages. New methods in soil micromorphological analyses, and livestock fecal indicators, reveal complex social and spatial arrangements that occurred during the settlement of cows and people at Neolithic Çatalhöyük, where increased proximity and management preceded a major settlement expansion (Portillo et al., 2019). Early, intensive horse domestication processes, including directed breeding, milking, riding, and management at Botai, Kazakhstan (c. 3500 BC), enabled people to live year-round in permanent villages without agriculture (Outram et al., 2009; Outram, 2023).

Domestication can be readily understood through an institutional approach. In domestication processes, people and animals solve cooperator problems to carry out objectives using regularized practices with norms governing labor and resources. There are rules of good behavior (e.g., respectful communication, timely provision of adequate food), contingent cooperators (e.g., cows letting down milk only for preferred milkers), and punishment of "free riders" (e.g., culling fractious animals). Furthermore, considering domestication as an institution, as well as a process, situates it within other social and political formations.

Animals should have moved beyond existing as passive resources for human exploitation in archeological theory. However, this view has not consistently been taken up, and less successfully employed to understand how and why human societies change and vary, largely because operationalizing such theory beyond single cases is difficult (but see Brusgaard et al., 2019; Kanne, 2022). Though research in archeology on sedentism, collective action, and governance have developed sophisticated theory that absorbs much of the critiques of the past several decades (Angelbeck and Grier, 2012; Blanton and Fargher, 2016; Feinman and Carballo, 2018; Green, 2021, 2022; Holland-Lulewicz, 2021; Blanton et al., 2022; Nicholas and Feinman, 2022; Carballo and Feinman, 2023; Green et al., 2024), animals remain mute in most archeological theory. Excising western ontologies of dominance is critical in analyses of the past (Black Trowel Collective et al., 2024). As archeological theory has been making space for non-western ontologies in evaluating institutional formations (Blanton and Fargher, 2016; Kowalewski and Birch, 2020; Kowalewski and Heredia Espinoza, 2020; Holland-Lulewicz et al., 2022), we bring animals into the theoretical fold when we consider the socioeconomics of settling down, and the character of institutions and sociopolitical formations that develop from sedentarization.

The "third science revolution" (Kristiansen, 2014) has positively impacted the ways in which we can understand the past lives of domesticates and human/animal relationships through increasingly high-resolution, multiproxy analyses, including genetics (reviews in Frantz et al., 2020; Scarsbrook et al., 2024), dietary and mobility stable isotopes (review in Kinaston, 2023), geometric morphometrics (GMM; review in Evin et al., 2022), fecal biomarkers and soil micromorphology (Elliott and Matthews, 2023). However, theoretical hamstrings remain in understanding how pastoralism relates to governance and inequality. The roles of animals in political institutions have generally been couched in subsistence, featuring more recently in political economic models (Arbuckle, 2012, 2014a,b; Nicodemus, 2014; Grossman and Paulette, 2020; Kanne, 2022; Caramanica et al., 2023; Price and Makarewicz, 2024), and discussions of complexity (deFrance, 2009; Frachetti, 2012; Gaastra et al., 2020; Adcock, 2022; Ventresca Miller et al., 2022).

Archeologists examining the intersections between subsistence, sedentism, and political formations have also been limited by comparative studies of the cross-cultural variation that divided subsistence into typological categories (foraging, horticultural, pastoral, and agricultural) in a social evolutionary framework that severed animal husbandry (pastoralism) from crop agriculture (farming). An artifact of typological thinking and coding in the Human Relation Area Files and the Standard Cross-Cultural Sample, food producing economies were either agricultural or pastoral, but not both (Murdock and White, 1969). Consequently, cross-cultural studies finding high inequality among pastoralists (e.g., Borgerhoff Mulder et al., 2009, 2010), utilize relatively recent ethnographic cases from mobile pastoralists in marginal environments, not sedentary or tethered pastoralists, or agropastoralists. Haynie et al. (2021), utilizing variables that account for agropastoralism, find that heritable social class is related to the presence of large domesticates, but not hereditary political succession, intergenerational transmission of wealth, or inequality, while environmental variables in agropastoralism indirectly influenced inequality, at odds with earlier research. Those modeling inequality place animals as critical forms of heritable wealth creating greater income disparities (c.f. Kohler et al., 2017), similarly conflate subsistence with residency. This leaves us with a poor understanding of past societies in resource rich, or well managed landscapes that practiced less-mobile forms of pastoralism, where the unequal stockpiling of herd wealth could be subject to community sanctions *or* used to consolidate power.

Animal husbandry in archeology

Animal husbandry, or pastoralism, has received growing attention from archeologists in recent decades (Frachetti, 2012; Makarewicz, 2013; Carrer et al., 2015; Honeychurch and Makarewicz, 2016; Arbuckle and Hammer, 2019; Ventresca Miller et al., 2019; Costello, 2020; Given, 2020; Marston et al., 2022; Rouse et al., 2022; Honeychurch et al., 2023; Reinhold et al., 2023), though discussions have focused on more mobile forms of transhumance, historical periods, or particular regions, like the Eurasian Steppe. Transitions from nomadic hunter-gatherer lifestyles to sedentary agriculture are now accepted to be neither unidirectional, sudden nor universal.

Agropastoralism is recognized to have played a significant role in subsistence strategies from prehistory to today (Stevens and Fuller, 2012; Feinman and Neitzel, 2023; Thompson, 2023a). Nevertheless, pastoralism remains under-theorized and under-discussed, particularly in European prehistory. There seems to be an assumption that we know what pastoralism generally looks like, and that it is less complex than, and perhaps even a "failure" of, true agriculture (e.g., Stevens and Fuller, 2012) or that it represents a backwards movement, as epitomized by Iversen's (2016) neo-evolutionary concept of "de-neolithization."

Pastoralism does place movement at its center, though Cribb (1991) recognized that this need only relate to herds, a strategy he terms "transhumance." Human mobility, on the other hand, exists on a scale from sedentary to nomadic. While the division this model makes between human and animal movement may be unhelpful (Costello, 2020, p. 11), the notion of a sliding scale between fully nomadic and fully sedentary is supported by ethnographic evidence. Pastoral groups are strikingly variable and flexible in both mobility patterns and procurement strategies (Chang and Koster, 1986; Marshall and Hildebrand, 2002; Bernbeck, 2008; Frachetti, 2012; Porter, 2012; Honeychurch and Makarewicz, 2016). Recent research increasingly documents sedentary or semi-sedentary pastoralism in areas thought to comprise only nomadic groups (Chang, 2017; Haruda, 2018; Ventresca Miller et al., 2020; Rouse et al., 2022).

While "pastoral mobility" relates to the phenomenon broadly, "transhumance" implies a fixed or semi-permanent base returned to over successive seasons, most often winters (Costello, 2020). "Nomadic pastoralism" implies that no such base was used. Pastoralism can also operate where human communities are fully sedentary, and sedentism can be considered part of the repertoire of mobile pastoralism (Honeychurch and Makarewicz, 2016). Demanding pasture, pastoralism is structured and repetitive (Costello, 2020; Randall, 2021). However, this is often taken to imply a linear out-and-back pattern, as in seasonal shifts between uplands and lowlands (e.g., Aldred, 2020), rather than more stationary commons. In other contexts, routes may be much more variable. The basic interactive networks may endure for millennia, though mobility patterns and level of investment in particular locales are much more flexible (Frachetti, 2012).

There is significant variability, too, in the social configurations of mobility, with flexibility in group composition and access to territory (Cribb, 1991; Salzman, 2002, p. 249). More mobile pastoralism may have herding groups comprised of small numbers of people (specialized or otherwise), a subgroup of a community, or entire household groups (Costello and Svensson, 2018). Ethnographically-known pastoral communities exhibit variation in social organization, both from one another and, on a seasonal basis (Graeber and Wengrow, 2021). Though thought of as simple tribal social arrangements, pastoral communities are capable of social arrangements as complicated as any other economic formulation (Porter, 2012).

Livestock were central in transitions to sedentism, and cooperation to live with them was seemingly inherent to efforts of early urbanization. Sedentary or tethered animal husbandry is one of the most common forms of pastoralism in the past and present. In areas where the soil quality and environment permit, or can be improved with manuring, livestock can graze in nearby pastures year-round, either overnighting there, or returning daily to pens in the settlement. Animals can also be moved in a more transhumant way, alternating seasonally between pastures with herders guarding the flocks, while maintaining year-round settlements. In such cases, herding is often allocated to certain groups defined by age, sex, or class. Taking into account the ethology and biology of individual animals and the herd, we think more sedentary animal husbandry led many people in prehistory to site settlements with respect to combined needs of animals, people, and the landscape; organize settlements and labor in sensible ways with livestock to manage pasturage resulting in commons; and, through the management of the commons, organize governance of societies around such resources, which may have led to a generally more collective ethos than previously considered.

Cooperative, common, and collective animals

"The idea of consensus can be a useful way for thinking about the relationality of humans and nonhumans in ongoing entanglements of people and landscapes" (Halperin, 2017, p. 286).

Constant intra- and interspecies dialogs are required to settle an area, and in long-term residency. Just as people's interpersonal relationships have been neglected in narratives of settling down (Feinman and Neitzel, 2023, p. 101,436), so too have relationships with animals. We propose that "the commons" offers an institutional framework to redress this imbalance. Commons thinking offers a flexible model for addressing the shared management of resources which are not owned by any one individual or group. As originally outlined by Ostrom (1990), they are rule-bound institutions governing clearly delimited resources according to "rational actor" logics (see Blanton, 2016, p. 31–44). More recent work has extended the framework to large scale, poorly delimited resources (e.g., Moritz, 2016) and explicitly anti-capitalist configurations (e.g., Caffentzis and Federici, 2014; Chatterton and Pusey, 2020). We argue that the commons can be considered a durable institution (*sensu* Holland-Lulewicz, 2021), wherein participants act together to meet their objectives according to a shared set of rules or expectations governing communication, labor, and resource use. Animals partake socially and physically in the development and maintenance of the commons, making and following rules about its use, while laboring in the commons growing offspring and bodies that produce milk, wool, meat, and traction, thus regulating how their labor is shared, thus governing the extent to which different grazing regimes can be used. As such, animals are participants in the institutions of the commons.

To recognize the role animals play in these institutions, we briefly explore the properties which define institutions: *resources and funding, durability, scale, activities and events, labor and work, formality, participants and membership, overlap with other institutions, organizational structure, naming, knowledge,* and *objectives and outcomes* (Holland-Lulewicz, 2021, p. 3–7). Livestock require fodder and water, protection from predators, shelter based on terrain and climate, and management practices that observe species-specific biology and behaviors, including individual, age, sex, herd, and life-course dynamics, such as breeding, gestation, birth, lactation, and death (see Randall, 2021, p. 54–56; Fuks et al., 2022, p. 6–15). Archeologists are comfortable with the idea that animals can be *resources and funding*, but people are also *resources* for animals, through the provisioning and protection they demand, along with the

resources of the land and environment that allow both to flourish, where commonly held pastures are built through reciprocal *labor*. Pastoral commons arise from these needs and require additional labor, through initial clearing, routine, and seasonal management *activities*. At times, they have a known *scale* or extent, the boundaries of which can be visible archeologically, or inferred through catchment analysis and stocking rates, and can be *durable* for centuries, even millennia (Oosthuizen, 2016a,b). At other times, commons may be so large that maintaining clear boundaries becomes impossible (Haughton and Løvschal, 2023). Historical commons have *names* for the institution, such as *rundale* or *runrig* (Gardiner et al., 2020).

Human responses to livestock's biosocial needs are evident in the routinized ways people communicate with them, through multi-sensory, embodied language (*sensu* Maran et al., 2016) allowing efficiency and safety in routine animal work, like catching, leading, feeding, watering, herding, penning, milking, shearing, doctoring, riding, driving, and dispatching. This is co-joint *labor*. Animals and people do things and move together, where there are proper ways to communicate respectfully. Ignoring respectful communication incites violence, and increases the odds of injury. The individual and species-specific, culturally, and contextually directed rules of communication and engagement are embodied practices that have to be taught to all participants: *knowledge* every person and every animal must know (Losey et al., 2021; Sharifian et al., 2023). Such communicative, practical norms of labor are institutionalized. People can be further monitored and evaluated by the quality and well-being of their livestock, a highly visible social signal giving testimony to their character.

Pastoralism, and the commons particularly, demands face-to-face negotiation, involving intense cooperation networks established between people and between animals and people (Fijn, 2011; Gardner, 2016; Honeychurch and Makarewicz, 2016; Burentogtokh, 2017; Thomas et al., 2018). K*nowledge* of proper relationships between people and animals, herd and herder, is embedded and transmitted in social relationships within families and herding groups, along with the wider community (Mlekuž, 2013; Bumochir et al., 2020; Sharifian et al., 2023). Decisions about where to herd, when to put animals on specific tracts of pasture, and which to cull, are informed by the kinds of animals herded, the ultimate resources to be taken from them, and who is available within the labor pool to get all of this done (Zeder and Lemoine, 2023). Beyond this, social relationships requiring animal exchange, animal products or labor, *events* such as weddings and feasting, along with interpersonal human/animal relationships that alter the course of more practical associations, can elicit alternative decisions that supersede more prosaic concerns.

The *organizational structure* is collective for the commons, but families or herding groups may identify different segments or be represented by selected participants with institutional knowledge and skill. Decision making at the household level about who is appropriate to do what with which animals are culturally dependent, but often are by divisions of sex, age, kinship status, class, and ability. Decisions about appropriate husbandry and management strategies, and enforcement of such norms, must work within the parameters set by domesticated livestock: what the makeup of the herd is, which species are present, the numbers of each, their sex and their ages, what they eat, and how much, how much water they require, individual personalities, and so on. Households cooperate to pool *labor*, organizing herding groups to meet livestock needs, requiring coordination beyond individuals or close kin. Honeychurch (2014, p. 294, 295) describes these organizational tendencies of pastoralists, including a willingness to distribute decision-making, a capacity for higher levels of autonomy in related communities, and a political emphasis on inclusiveness. As a result, pastoralist societies were organized institutionally with some affordances toward collective governance.

Næss (2021) highlights *labor* constraints as the reason that herders cooperate and form herding groups on commonly grazed landscapes, which is especially important in mobile pastoralism on open landscapes, requiring near constant human presence. In mixed herds, different kinds of livestock have different graze and water requirements, varying by season, landscape, predator and theft threats. Mixed and single species herds, dry and milk herds, male and female ones, mother/offspring pairs, and juvenile groups are some possible configurations of managing livestock informed by their biological needs, alongside human requirements of them, often requiring collaboration above the household, changing daily, seasonally, and in the participants' lifetimes. "Pastoralism is thus practised in a web of potential cooperative relationships; relationships that can be actualized and discontinued depending on social context and environment. Cooperative networks thus contract or extend depending on the circumstance" (Næss, 2021, p. 6).

Chazin (2023) helpfully introduced the concept of "animal labor" within herding practices, circumventing human exceptionalism through examples from Late Bronze Age settlements in the South Caucasus (c. 2500–1500 BC). Herds and herders coordinated *labor* together as a "key form of action that created and maintained the culturally and historically specific forms of value that shaped social worlds and political authority" (Chazin, 2023, p.3). Zooarcheological and biogeochemical analyses documented the expansion of a range of carcass and secondary products arising from extending birth seasonality, which compelled significant effort on the part of sheep, and demanded different labor from the people to attain it. This commanded intensive interventions and additional work from both parties, possibly strengthening interspecies social relations, as they would be in close bodily contact during all seasons, which may have, "led to a sense that humans and their flocks were a joint social "unit," formed out of co-mingled genealogies and joint (re)production" Chazin (2023, p. 12).

Material correlates identify, define, and characterize institutions at multiple levels (Holland-Lulewicz, 2021), locating the commons at regional to local scales. Prehistoric settlement patterns may attend to practical animal management on common institutions (Ombashi and Løvschal, 2023), so that they can be accessed equitably, and with respect to neighboring common institutions. Physical management of domestic livestock was important, including the *resources* of penning and handling facilities, as well as the droveways, fields, and pastures. We further suggest this materiality records the commons as *spatially embedded social relationships* inscribed on landscapes through the regular, patterned co-labor of people and animals, resulting in "animal architectures" (Anderson et al., 2017). With a human and an animal eye view, Randall (2021, p. 56–59) terms these animal architectures the infrastructures of the commons, which make the institution possible and identify it materially.

In a series of landmark papers, Oosthuizen (2013, 2016a,b) deftly interrogated the commons through a property rights approach, following Ostrom (1990, p. 90–102), outlining possible material

correlates of the commons that attest to its *durability*, *scale, activities*, and *events* (Oosthuizen, 2013, p. 721–725). For prehistoric Britain, this includes earthworks (ditches, hedges), with open areas within them, not subdivided so there is equity in pasture access; small habitation sites in uplands where transhumance was practiced seasonally, such as a stock pen at Lower Hartor Tor in Dartmoor; herds that exceed the size that single farmsteads could have managed, as at Casterly Camp, Wiltshire (Cunliffe, 2004, p. 246); and evidence for seasonal gatherings or feasting in open pasture, where meetings could be held by common rights-holders to discuss management issues that arise, coinciding with seasonal round-ups of livestock on more open ranges. Following these conditions, Oosthuizen (2016a, p. 722) finds that the "governance of at least some British prehistoric arable and pasture may well have been undertaken collectively within CPrR [Common Property Regimes]" without assuming strictly egalitarian political formations are inherent to the commons. Even in prehistory, individual farmsteads with quality agropastoral land at the same time as commons were used, could lead some to accumulate more wealth than others.

The implications following the identification of the commons are similar to other institutions, like the *overlap* with other groups or governing institutions. The *durability* of the commons is due to "the meta-structures underlying conceptions of and practice in relation to the governance of common pool resources" (Oosthuizen, 2016a, p. 726). That is, the commons as an institution have an underlying logic based on human/animal organizational principles leading to its stability and repeatability over time, or a "framework" (Ostrom, 1990). This accounts for the endurance of the commons in a number of places, as well as the landscapes that contain them, like the Danish heathlands and British commons, though they passed through many different types of political and common institutions.

Collective action theory and common animals

"Collective action theory seeks to understand how people overcome cooperation problems associated with the production and use of communal resources" (Thompson, 2023b, p. 509).

Settling down with animals provokes cooperation problems in terms of how to balance the biosocial demands of livestock (fodder, water, protection) with the needs and wants of all the members of the community reliant upon them. The commons as an institution are organized to solve the inherent cooperation problems of sedentary or tethered pastoralism, including the risk of overexploitation of pasture as a resource with high subtractability (Ostrom et al., 1994, p. 4). Critical to this process is that members of commonage groups comply with using the commons sustainably so that it secures the success of the group, agree that such usage will be monitored, and are assured that those who deviate from the rules agreed upon by the group will be sanctioned or excluded from the benefits derived from it (Blanton and Fargher, 2016, p. 40–41; Ostrom et al., 1994, p. 3).

Collective action theory in anthropological archeology highlights that more collectively governed societies have a greater reliance on local production of goods, including agropastoral products, more communally owned and managed land, greater social homogeneity, and a greater expenditure on public goods (Carballo and Feinman, 2023, p. 16; Table 1), including land clearing, ditch construction, and commons maintenance. The more leaders rely on local labor and production, the greater voice all participants have (Levi, 1988; Blanton and Fargher, 2016). Decisions to cooperate rely on group size, the degree of social heterogeneity, the frequency of face-to-face interactions, the public benefits, the extent to which reputation and reciprocity matter, and the group members' abilities to monitor and sanction free riders (DeMarrais and Earle, 2017, p. 183–185; Olson, 1965; Ostrom, 1990, p. 90; Ostrom and Walker, 2000, p. 438–439).

That labor is the primary reason herders cooperate (Næss, 2012, 2021), divulges possible solutions to collective action problems. Cooperation decreases overall labor input from each household, increases the possibility of extra-pastoral production, and decreases the risks of animal loss from lack of labor, predation or theft. Cooperation is only effective up to a point as the costs of cooperating in herding lead to greater levels of conflict and increased grazing

TABLE 1 Measures of collective action in the commons.

Measures of collective action in the commons	Evaluation criteria
Group size	Population estimates
Social homogeneity	The degree that material culture, such as pottery, house size, mortuary practices, and grave goods are similar or different
Communal labor	Group efforts such as land clearance, ditch or enclosure building, commons maintenance
Boundaries	If the commons are unenclosed, partially enclosed, as in infield-outfield system, or completely open
Livestock > household	If households have more livestock than they could manage
Commons seasonality	If the commons are utilized year-round or only seasonally
Arable agriculture to pastoralism	The ratio of arable agriculture compared to pastoralism for subsistence
Domesticated species abundance	The relative abundance of domesticated species from the fauna or historical records
Species products	How many different kinds of primary and secondary products produced to evaluate how many of types of herds present
Settlement type	Farmstead, hamlet, small village, large village
Land quality/commons management	Land quality to stocking rates; the effort required to maintain graze, and if seasonal or rotational movements are required
Levels of bureaucracy/ leadership	How nested the institution of the commons was in governance or if the commons management provided social structure
Extent of the trade of animals or secondary products	Evidence for the exchange or trade of animals or secondary products or if most products consumed locally
Land or Labor Limited	The degree to which land or labor constrain pastoralism
Excludability	How easily non-members may be excluded from the commons
Subtractability	How easily the commons can be overexploited

pressures. The scale is important. Herding groups tend to be small, and composed of closely related kin, with regular face-to-face communication. Thus, monitoring and punishment of rule-breakers (free-riders) are possible.

Ebersbach (2010, 2013) finds if pasture is an unlimited resource, it belongs in common to the lineages or herding groups using it. There is a tendency for herders reliant on cattle, or other large domesticates like horses, to cooperate more because they require different handling than small stock (Ebersbach, 2010, 2013). Seasonal movements to pastures, and multiple secondary products require additional labor from people and animals, such as dairying, milk processing, wool processing, hay making, and traction, resulting. in a number of different "subsystems" of animal management that can only be handled above the household level, including up to the whole village, which can provide a blueprint for community leadership. Following Chazin's (2023) logic, this requires greater coordination and labor from *animals themselves* to cooperate with people in pastoral rounds. Daily and seasonal routines are multispecies taskscapes, increasing the frequency of interactions and the intimacy of relationships with people. These are the spatially embedded social relationships between people, animals, plants, and the environment that produce the commons.

The commons are not just a "shared resource," but dynamic multispecies landscapes with many participants. Agency of people at multiple scales has been highlighted as intrinsic to collective action (DeMarrais and Earle, 2017, p. 183), but the agency of animals has not. Considering collective action through the institution of the commons in sedentary societies requires recognizing contributing parties at multiple scales, including the animals, who cooperate, labor in, and make it. Their biosocial needs and affordances shape time and space, life, community, and governance. Animals were participants in the commons, and, by extension, may also be in collective action. Reciprocal learning between herders and animals is key to commons success (Molnár, 2017, p. 522). Gosden (2013, p. 112) documents how sheep hold knowledge about particular landscapes that mediates between people and place through the process of "hefting-on." Here, young ewes become attached to a particular tract of land (heft), by socialization from the older ewes, thereby organizing the work routines of shepherds who herd them, and the landscapes where they reside. Animal knowledge in pastoralism, includes epigenetic transmission, but also animals learning the land and herders, where livestock carry knowledge over generations (Sharifian et al., 2023, p. 7).

Varying kinds of leadership and political institutions may have developed out of collective action problems solved through commonage arrangements and management because of the negotiations required to maintain them. If, as in the commons, animals and land are horizontally distributed, collective action is probable; if animal wealth can be monopolized, inequality, and hierarchical social organization can ensue (Feinman and Neitzel, 2023, p. 6). There is clear historical and archeological evidence where pastoralism and the commons have funded polities, kingdoms, and empires, where the more collective commons are subsumed into hierarchical institutions. For example, in post-Roman Iberia, the commons affected the ways polities and territories were ordered and governed at the local and supra-local scales, social inequality was marked in differential access to the commons, and its control was central to the development of medieval political authority (Carvajal Castro, 2021, p. 339). In medieval England, commons persisted in shifting sociopolitical contexts (Banham and Faith, 2014, p. 157), and were likely a factor in the territorial organization of kingdoms (Oosthuizen, 2011). Thus, the commons can play a role in local and supra-local sociopolitical organization as a multi-layered institution that articulates within a "constellation of institutions" (Holland-Lulewicz, 2021).

Model of collective action in the commons and its impacts on governance

How can archeologists assess the role of animals, the extent of collective action, and the relevant sociopolitical formations within the commons as institutions? The following variables enable evaluation of collective action in the commons (Table 1). We suggest that communities with small group size, high social homogeneity, regular communal labor for commons management, herds greater than single households could manage, year-round commons grazing, less arable agriculture than pastoralism, more large animals, and more types of secondary products (meaning more classes of animals needed to be kept apart), they will tend to be more collectively governed. The greater number of people working with animals in daily tasks increases cooperative efforts of the animals, and increases their effects on the common's character and organization. Land limited arrangements would have a greater risk of overexploitation, while labor limited commons would have difficulty in producing a large surplus of pastoral products.

The variability in commonage is based on its scale, quality of land, type of pasture management, the boundedness of the community, and levels of bureaucracy and trade. Those on poor quality land, with bounded farmsteads, with clear leaders, and nested in more bureaucracy, with large group sizes, will be less collectively governed. Here, the commons can be part of a hierarchical system of political organization, yet remain an institution where collective action among commoners persists. When individual farmsteads sharing commons become enclosed, even if land has been distributed equitably to begin with, there is a greater potential for sociopolitical inequality.

Case studies

We explore the commons across three case studies to suggest under which circumstances sedentary agropastoralist societies tend toward more or less collective. These case studies were selected because they have sedentary agropastoralism, and each author has long-term research sited in these regions, providing comparisons of how sedentary pastoralism and the commons were organized in variable landscapes. Following Hammer's (2014) reading of Ingold (1993), we situate our analyses through the taskscapes of sedentary pastoralism of the commons as they unfold in the combined activities of people and animals. Based on the available environmental, zooarcheological, material, and spatial evidence, we envision how animal husbandry would have operated on a daily and seasonal basis, creating the commons and defining its character in order to assess its effects on social organization.

Rundale: imagining the commons

> When all the potatoes were dug and pitted (stored in pits) the winter season was in full blast and as there were no proper hedges dividing the different holdings, many of which were in *rundale*, the whole land became a commonage until next Patrick's Day. Cattle and sheep were free to roam over miles of tillage lands without fear of molestation by the owners of the soil, and even to the present day the practice exists but in a gradually decreasing degree as the years roll by. [Michael Corduff of Rossport, county Mayo. National Folklore Collection 1253: 107 (in Yager, 2002, p. 157, 158)].

Rundale refers to a regime of landholding and agropastoralism found in western Ireland in the 19th and 20th century (Aalen et al., 1997, p. 79–82; Yager, 2002; Bell and Watson, 2008, p. 24–27; Slater and Flaherty, 2009; Flaherty, 2015). Developed to sustain crop and animal husbandry within marginal environments through common resource management by a collective of tenant farmers, it bears comparison with collective farming systems from similar historic and environmental contexts, such as Scottish *runrig* and Northern English open-field farming (Gardiner et al., 2020). Our purpose in considering rundale here is not to present it as an ancient survival or as an ideal model for prehistoric forms of land management. Instead, we hope to illustrate how the labor demands of agropastoral regimes can influence settlement forms and social relations. In particular, rundale demonstrates the potential for commons to be subsumed within more hierarchical forms of sociopolitical organization; the role of animals in both encouraging and straining forms of collective action and commonage maintenance; and the articulation of commonage management with other social categories and institutions, such as kinship, ritual, gender, age, class, ritual, and cosmology. Rundale was undoubtedly a multi-species affair, an undertaking structured by the affordances of the potato, the biosocial needs of livestock, and human capacities for collective action within densely populated but ecologically marginal landscapes.

Irish rundale developed against the backdrop of colonial inequality and the propagation of the potato as a subsistence crop. With the most fertile land reserved for market agriculture, landless tenant farmers, predominantly Catholic, were forced to make a livelihood in marginal land. Because of its hardiness and nutritional value, potato cultivation, supplemented with animal husbandry, generated unprecedented population growth in formerly the least densely settled areas of the west (Aalen et al., 1997, p. 85, 86; Feehan, 2012). As such, 19th-century rundale accompanied substantial intensification of settlement, and sometimes, the expansion of sedentary agriculture into new areas. As Whelan (1994, p. 64) puts it, "Cooperative management, agreed land use and a joint labor system for certain tasks was a sophisticated ecological adjustment to using a fragile environment where technology and capital were limited but labor was unrestricted."

Flaherty (2015, p. 25, 26) outlines features related to settlement location and morphology, land tenancy, demographics, local governance, and agricultural practice that are, when co-present, diagnostic of rundale. Typically, households of tenant farmers lived within a nucleated village (*clachan*), with a nearby infield for arable cultivation and a more remote outfield for common pasture (Figure 2). The infield was undivided and plots worked by individual households scattered to ensure fair distribution of risk and quality land. Plots were used for rotations of potato and grain crops and periodically redistributed among the collective (perhaps every 1–3 years). After every autumn harvest, the infield reverted to pasture, where every household's livestock could roam freely. Cattle and sheep were most prominent alongside pigs and goats. The taskscapes of the infield-outfield system engendered particular kinds of interactions between people and livestock, which varied seasonally, and directly affected how social networks shifted with animal bodies.

The grazing of animals on the stubble of the infield restored the infield to commonage while providing essential fertilizer for the subsequent year. In late spring, livestock were driven to the outfield and kept away from crops during the growing season. In some cases, a particular subsection of the community—especially adolescent women—would undertake seasonal transhumance and live with livestock in upland settlements known as "*booleys*" (Costello, 2020). Traveling with livestock to upland areas was necessary for the daily collection of milk and the production of dairy products, particularly butter.

This cycle of labor was managed collectively under a joint tenancy agreement, in which the village as a whole rented the land from a landlord and provided bulk rent payments. In many cases, a local headman known as *an rí*, "the king," served as an intermediary with estate agents, adjudicated disputes, and negotiated the redistribution of arable plots and commonage rights, sometimes among a council of elders (Danachair, 1981; Slater and Flaherty, 2009, p. 13, 14; Yager, 2002, p. 158, 159). Regulation of the number of livestock on the commonage was particularly important to prevent overgrazing. Other common pool resources in rundale included seaweed (used for fertilizer), woodland, and turf (used for fuel).

Rundale shares features identified by Ostrom (2000, p. 149–153) as design principles of potentially durable self-organizing resource regimes. For example, rundale systems had clear "boundary rules" determining which people and animals participated in the regime and who was excluded. In many cases, this was limited to the households living within a village cluster. Local rules constrained resource exploitation according to specific local conditions: when, where, and how many animals could graze the commonage. Participants in the regime had some say in shaping these rules. Through consultation with local councils and "kings," villagers had the ability to negotiate and adapt these rules to new circumstances, adjudicate disputes, and punish rule-breaking. Not everyone held equal voice: male heads of households and those with larger kin-networks likely held greater sway. Finally, collaboration was nested within multiple social scales, with individuals collaborating within households, households collaborating within kin-networks, and kin-networks collaborating within the overarching rundale system. However, rundale systems were also subsumed within a hierarchical political economy, in which outside authorities (estate agents and landlords) considered the rule-making rights of tenants and collective landholding to be inimical to improvement and the collection of rent (Knight, 1836, p. 59, 93).

Analyses of rundale often highlight its fundamental connection to potato cultivation, but the role of animals as participants in the institution is worth greater consideration. The successful interaction of the arable and pastoral components of rundale relied on controlling the timing and location of where animals ate and where they defecated. Grazing animals are liable to trespass at times of scarcity and when insufficiently monitored, potentially upsetting local rules governing seasonal land use. Privately

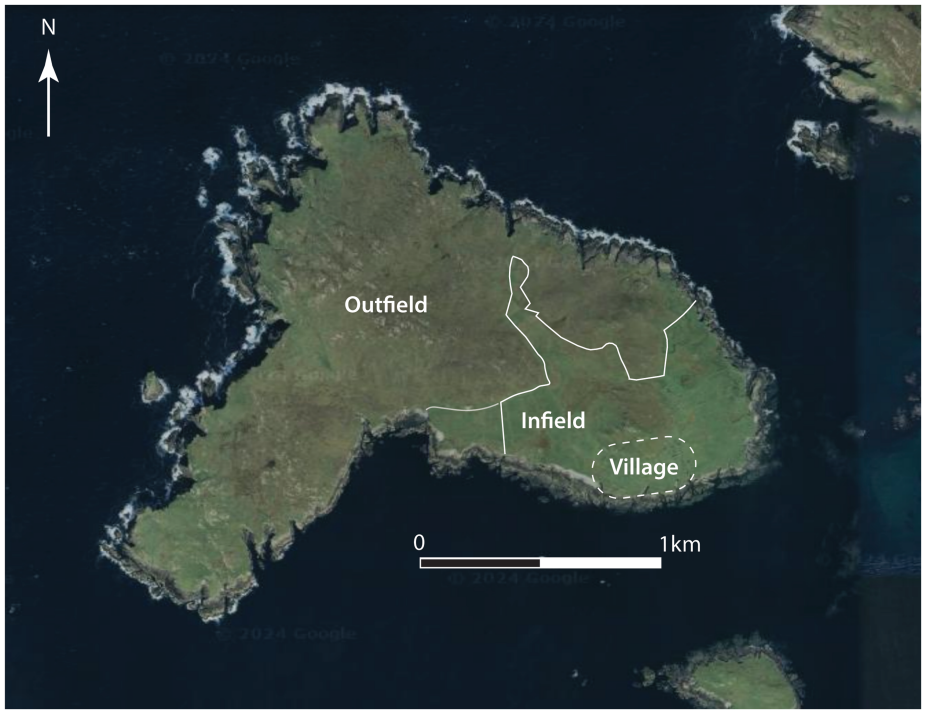

FIGURE 2
Aerial image of Inishark Island, Co. Galway, off the west coast of Ireland. The historic village settlement on the island developed from the mid-18th century and was evacuated in 1960. Documentary records and folklore suggest that this village was under rundale prior to the mid-19th century. An Ordnance Survey Map produced in 1838 shows the settlement organization at the time. The dashed white line shows the approximate extent of the village cluster, which in 1838 consisted of 30 buildings (houses and outbuildings) for around 200 people. The village was surrounded on either side by an undivided infield. This was used for potato and cereal crops, but reverted to common pasture after the harvest. The solid white line shows the boundary wall dividing the infield from the outfield on the 1838 Map. The outfield was used for common pasture throughout the growing season.

owned animals destroying crops in the infield was a recipe for conflict. Such animals might find themselves punished (run off the land or culled) and leave their owners vulnerable to censure or retribution. Summers with poor growth and hard winters could leave livestock with insufficient pasturage in the outfield, requiring supplemental fodder, including in some cases, the provisioning of vital food-stuffs more typically used for human consumption, including potatoes and maize meal (Horne, 1873, p. 52, 53). The feasibility of rundale and the maintenance of human livelihoods were fundamentally entwined with the needs and behaviors of livestock.

Moreover, the logistics and lived-experience of managing livestock shaped the complexion of social relations within rundale. As Costello (2017) demonstrates, *booleying* represented an important forum for social learning in which young people could enjoy a degree of freedom from social surveillance, negotiate social ties, and get to know prospective marriage partners. Based on participant observation among livestock farmers on Inishbofin Island, Ireland, Lash (2019, 2020) argued that farmwork generates a degree of intersubjectivity among humans and animals, that is, a shared embodied knowledge of one another and the possibilities afforded by their encounters. This is characterized by a sensitivity to bodily comportment and a capacity to predict and elicit desired behaviors through gestures, calls, and coordinated action (Figure 3).

The application of embodied knowledge in farmwork can generate cooperation as well as interpersonal conflict. The shared experiences and know-how to manage animals might have buttressed ties of kinship, locality, class, and age-group affiliation. On the other hand, mismanagement of livestock, disputes over boundary demarcation, commonage rights, and trespass could generate disputes within rundale regimes (Connell, 1950, p. 78). In his study of conflict in County Mayo in the early 19th century, McCabe deems trespass "the archetypal difficulty of rundale" and the major motive for assaults in cases recorded in the petty sessions of local courts (McCabe, 1991, p. 134). Animals were individual household property nevertheless reliant on both cooperative labor and common pool resources. The daily and seasonal work of animal husbandry generated repeated opportunities for both the maintenance and fracturing of collective bonds.

The labor demands of rundale relied on cooperation, but could not simply ensure harmonious collective action. The presence of other social institutions enhanced the feasibility of commons management within rundale regimes. The most obvious of these is kinship, as collectives of tenants were typically composed of closely related households. Yet, ties of kinship could also spur competition and conflict. Shared conventions of ritual and belief in the supernatural also reinforced adherence to collective regimes. Some scholars have suggested that associations between boundaries and otherworldly forces, such as fairies, embedded a moral code in the landscape, threatening supernatural censure for the transgression of conventions of land-use (Catháin and O'Flanagan, 1975, p. 267, 268; Slater and Flaherty, 2009, p. 15, 16). On Inishark Island, Lash (2023, 2024) argue that a rundale regime in the early 19th century was sustained in part by a parallel system of ritual commonage, in which

FIGURE 3
A group completes the gathering of sheep on Inishark Island in 2017. Uninhabited since 1960, the entire island is now used as commonage by farmers from the neighboring island of Inishbofin and the nearby mainland. Gathering sheep free to roam the entire breadth of the island (c. 2.5 km^2) requires a great deal of coordination and mutual awareness between gatherers and dogs, often while spaced a great distance from one another.

monuments associated with a local saint cult relied on collective stewardship and could punish mis-use of common resources for individual needs. Rundale developed in adaptation to specific ecological and political economic conditions, but its feasibility relied on articulating agropastoralism with other social institutions that could encourage collective action.

Emergence of the commons: heathland expansion in Northern Europe

"Settling down" in the Northern European forests involves something of a contradiction. Many of these landscapes were settled in ways which afforded, and indeed required, mobility. Deforestation proceeded irregularly, characterized primarily by emerging landscapes of pasture, and limited areas of crop production. Small meadows within the forest provided grazing for animals prior to clearance (Vera, 2000), likely selected for further clearing as pasture emerged in a piecemeal fashion (Odgaard, 1994; Haughton and Løvschal, 2023). This process occurred across Northern Europe, with growing patches of grass and heath pasture developing through later prehistory (Løvschal and Damgaard, 2022).

A key example of this occurred in Western Denmark, where the sandy soils of Central and Western Jutland supported growing expanses of heathland. Initial populations of livestock were apparently grazed within forests from the fourth millennium BC, with a seeming preponderance of cattle (Johannsen et al., 2016). The third millennium BC brought the first lasting clearances, with patches of heathland appearing Western Jutland's sandy soils, and some areas oscillating between heathland and forest (Odgaard, 1994). The expansion is associated with new landscape practices—both the regular burning required to keep heather vegetation palatable for animals and to prevent forest succession (Gimingham, 1993), and new practices of burial mound construction. Corded Ware pottery accompanied the dead under small, low barrows, built in heathland zones, often constructed from heathland turfs, and arranged in linear formations (Andersen, 1998; Hübner, 2004).

This instantiated a system of interconnected communities managing growing tracts of pasture, within a zone of constant ancestral presence. Critically, however, this was a world which compelled movement – both to access and to maintain the pastoral resource. Unlike rundale, which developed under population pressure, Danish Bronze Age settlements clustered away from heathland areas (Haughton and Løvschal, 2024; Figure 4), and mobility of both sheep and, presumably later in the year, cattle, can be inferred. The heavy reliance on animals for food and clothing (Sørensen, 1997; Frei et al., 2017; Skals, 2020) compelled movement of at least some people throughout the Neolithic and Bronze Age. During the initial expansion of heathlands in the Middle Neolithic (2850–2350 BC), the lack of permanent houses suggests this may have been of the entire, or most of the, human community (Haughton and Løvschal, 2023). By the Early Bronze Age (1700–1100 BC), substantial longhouses and associated crop production suggest that a portion of the community were sedentary. Nevertheless, the heathland pasture in western Jutland was maintained, and in fact continued to expand, while further barrows continued to be built in this realm, demonstrating the frequency of return.

In these landscapes, the taskscapes of daily life were strongly structured by the needs of animals, plants, and the ancestors (Haughton and Løvschal, 2024). Herds of cattle and sheep pulled the human community in different directions, with some people traveling with animals into the heathland pasture, and animals presumably bringing people together for larger tasks – such as gathering animals off the heath, and the managed burning of the pastoral resource. Households may have operated relatively independently on a daily basis, taking charge of their own small herds within the heathland, or perhaps pooling the resources of several households together for the summer months. Both animals and people must have traveled from home bases

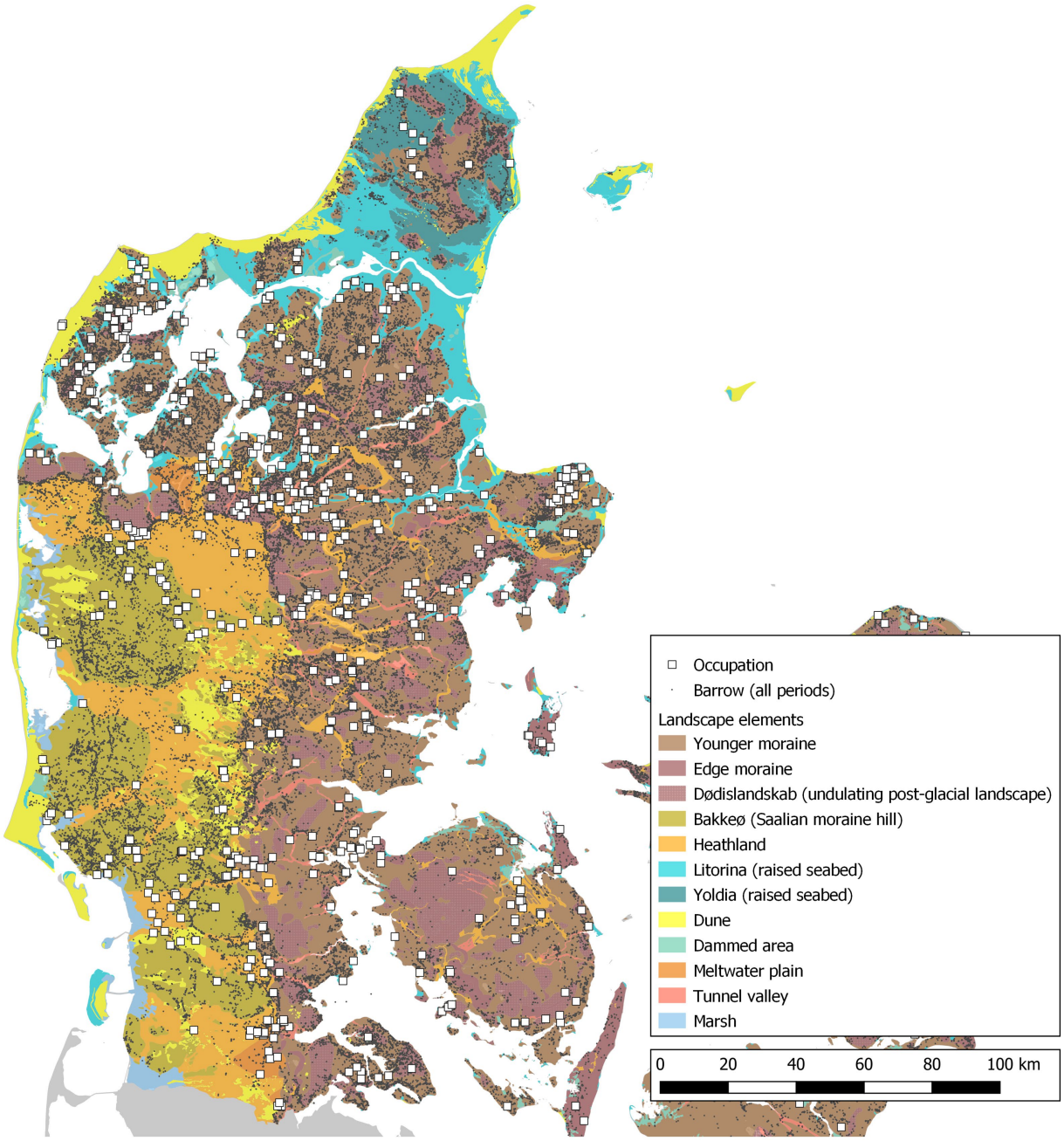

FIGURE 4
Map of Heathlands in Central and Western Jutland, showing settlements clustering beyond the heathland zone, and barrows within and bordering the heathland. Data from Institut for Agroøkologi, Aarhus Universitet and Slots-og Kulturstyrelsen.

in the early summer, and the distances involved (Figure 4) suggest that many herders would have been separated from the homestead for some time. Given the poor preservation of animal remains and the mobility inherent in the system, assessing herd size is difficult, but two pieces of evidence point toward the relative independence of household communities. Firstly, settlements were generally small, often consisting of single or paired farmsteads. In some areas, such as Thy in the northwest (Bech et al., 2018) or the banks of the Kongeå river in the south (Holst and Rasmussen, 2013), farmstead densities approached 0.5–1 per km^2, but this was rare and still indicates relative independence. Secondly, the construction methods for heathland barrows suggest small working groups, acting with relative independence though to a shared overall plan (Holst and Rasmussen, 2012). The "nested, decentralized" (Holst and Rasmussen, 2012, p. 269) organization of barrow construction may be a good model for organization in the heathland, with relatively independent herder groups operating within the landscape, but with a shared overall goal.

Unlike the rundale, this was not a system with significant space pressure. Indeed, the heathlands were vast, open and uncontrollable. Collective action in these arenas has many similarities with the expectations established in Ostrom's (1990) design principles for commoning, yet there are significant divergences too. Most notably, the sheer scale and mobility of this system leaves no scope to argue for a tightly controlled resource to which access could practically

be limited. Instead, obligations and responsibilities in these pastures seem to have been secured by the critical presence of the ancestral dead. Barrow construction was a critical point for inter-community cooperation (Holst and Rasmussen, 2012), and this seems to have extended into the pastoral system which they supported, a kind of "ancestral commons" (Haughton and Løvschal, 2023, 2024). The similar presence of ritual elements within the rundale system (Lash, 2023, 2024) is a reminder that collective action may rely more frequently on cosmological forces than is generally recognized.

Barrow construction was particularly important not just in fostering community cooperation, but also in strengthening the ideological precepts that underlay landscape management. Another crucial activity which brought communities together in these landscapes was the prescribed burning of aged heathland. This was a necessary practice to stop forest succession and to preserve palatability of heather for animals. It requires specialist knowledge to carry it out and to assess when the conditions required it (Gimingham, 1993). As the visual language of barrows depends on an open landscape to maintain visibility, the needs of animals and the needs of ancestors were one and the same.

As such, the trajectory of settling down and the creation of Danish heathlands was one which was guided and constrained by animals. Heavy involvement in animal tasks, such as taking herds out to pasture or engaging in the long and largely sedentary process of producing woolen textiles, significantly affected both how people experienced the annual cycle and created the opportunity for lines of social difference in the population. While these may have been articulated in human terms, they were, at least in significant part, the result of relations with and demands of animals.

Collective animals: the Bronze Age Carpathian Basin

"I see the grass through the mouths of my animals," a Hungarian proverb told to Molnár (2017, p. 522).

With a lengthy period of stable grasslands ideal for animal husbandry (Röpke, 2021, p. 248), pastoralism was the backbone of Middle Bronze Age "tell" societies in the Carpathian Basin (MBA: 2000/1900–1500/1450 cal BC; Bartosiewicz, 2013; Gál, 2017; Vretemark and Sten, 2020). One such region was the Benta Valley, lying southwest of Budapest, running northwest from the MBA tell of Százhalombatta-Földvár on the west bank of the Danube (Figures 5, 6). Százhalombatta was one of many multi-layered settlements built on loess promontories along the Danube and Tisza rivers and their tributaries, the subject of ongoing excavation for 35 years (Poroszlai, 2000; Poroszlai and Vicze, 2000, 2005). As excavation has been focused on the densely populated village, pastoralist practices have been only vaguely outlined. Further consideration is required to explore how animal husbandry was organized between people and animals on the landscape, or between nearby communities, and how it affected social relations and political formations.

Previous research suggested that Százhalombatta was the center of a "chiefdom-like" polity with a three-tiered settlement pattern in the Benta Valley, where pastoralism was the domain of "unfortified, satellite" settlements that provided livestock for "fortified" centers as tribute, "as ready cut-out pieces" (Earle and Kristiansen, 2010, p. 222; Figure 5). However, the recent synthesis of zooarcheology at Százhalombatta indicates otherwise. Sheep were dominant (possibly wooly sheep in the later MBA, Sabatini et al., 2019, p. 4,919), followed by multipurpose meat, dairy, and draught cattle, pigs, dogs (Vretemark and Sten, 2020), and horses (Kanne, 2018, 2022). All body parts for cattle, ovicaprids, and pigs were recovered in the village; all ages of animals present, from neonates to very old animals; and dogs gnawed these bones (Vretemark and Sten, 2020). Not only slaughter and processing occurred at Százhalombatta, but livestock breeding was very near to the village, with some animals possibly housed within or abutting the enclosure, like dairy and transport animals. Many livestock survived into old age. People would have had long-term, regular interactions with known individuals. Novel, quotidian, and close relationships between people and animals, were changing the dynamics of human-animal labor, adding to the expectations of collaboration between all parties, including riding horses, shearing sheep, and driving and milking cattle. Though no penning has been found on the tell, nor evidence of animals within households (Kovács et al., 2020; Sørensen et al., 2020, p. 15), over half the tell was lost to clay extraction. New methods to discern animal habitation elsewhere have not yet been applied, though phosphorus analysis from the center of the village to outside of the ditch documented high levels of human/animal activity, with the highest results at 2 m and 50 m outside it (Füleky et al., 2015), consistent with close animal occupation.

Rather than exclusively supported by smaller villages, commoning of livestock for the households at Százhalombatta-Földvár is a probable scenario, occurring very near the settlement in the Benta Valley (Figure 5). The valley was dominated by grasslands and pastoralism, supported by arable agriculture, with lush grazing areas on its slopes (French, 2010, p. 46, Plate 2.4). Unlike the more marginally sited commons of Irish rundale and Bronze Age Denmark, four fertile landscapes, including floodplain, the floodplain and forested margin, the slopes, and the hills beyond, provided excellent grazing for different times of the year (French, 2010). Animal remains excavated from the tell document sizable herds, with an estimated 90 cattle, 160 caprines, and 90 pigs slaughtered annually for the 300 residents (Vretemark, 2010, p. 168). To maintain viable breeding populations, the living-stock required to feed and supply the tell with secondary products likely numbered between 750 to several thousand animals. A "truncated catchment area" is assumed for Százhalombatta as the Danube halved the typical catchment radius. While true, possible stocking rates on the rich floodplains and hilly meadows are considerably lower than even a 2.5km^2 area could sustain[1] (c.f., Stobbe et al., 2016; Figure 6).

Labor, not land, was limited. The number of livestock, and many different herd classes, required supra-household assistance. As in rundale, this was an arena for building and maintaining collaborative

1 The Benta Valley sites lie on extremely fertile loess chernozem soils within the four zones outlined above. Following Stobbe et al. (2016) for roughly comparable sites and environment, a catchment of 250ha (2.5km^2), Százhalombatta could maintain from 1,526 LSU at 0.16/LSU/ha (LSU=Livestock Unit: 1 LSU=1 dairy cow, 0.8 horse, 0.1 ovicaprid, 0.5 breeding sow) to 500 at 0.5/LSU/ha, and with a 400ha catchment (4km^2), 2,500 at 0.16/LSU/ha and 800 at 0.5/LSU/ha. Fording animals across the Danube to Csepel Island, where there were no MBA villages could be another possibility, given the rich floodplain grazing. Moving stock via barges to grazing lands and in trade is considered to have been practiced from the Neolithic (e.g., Case, 1969; Cummings and Morris, 2022).

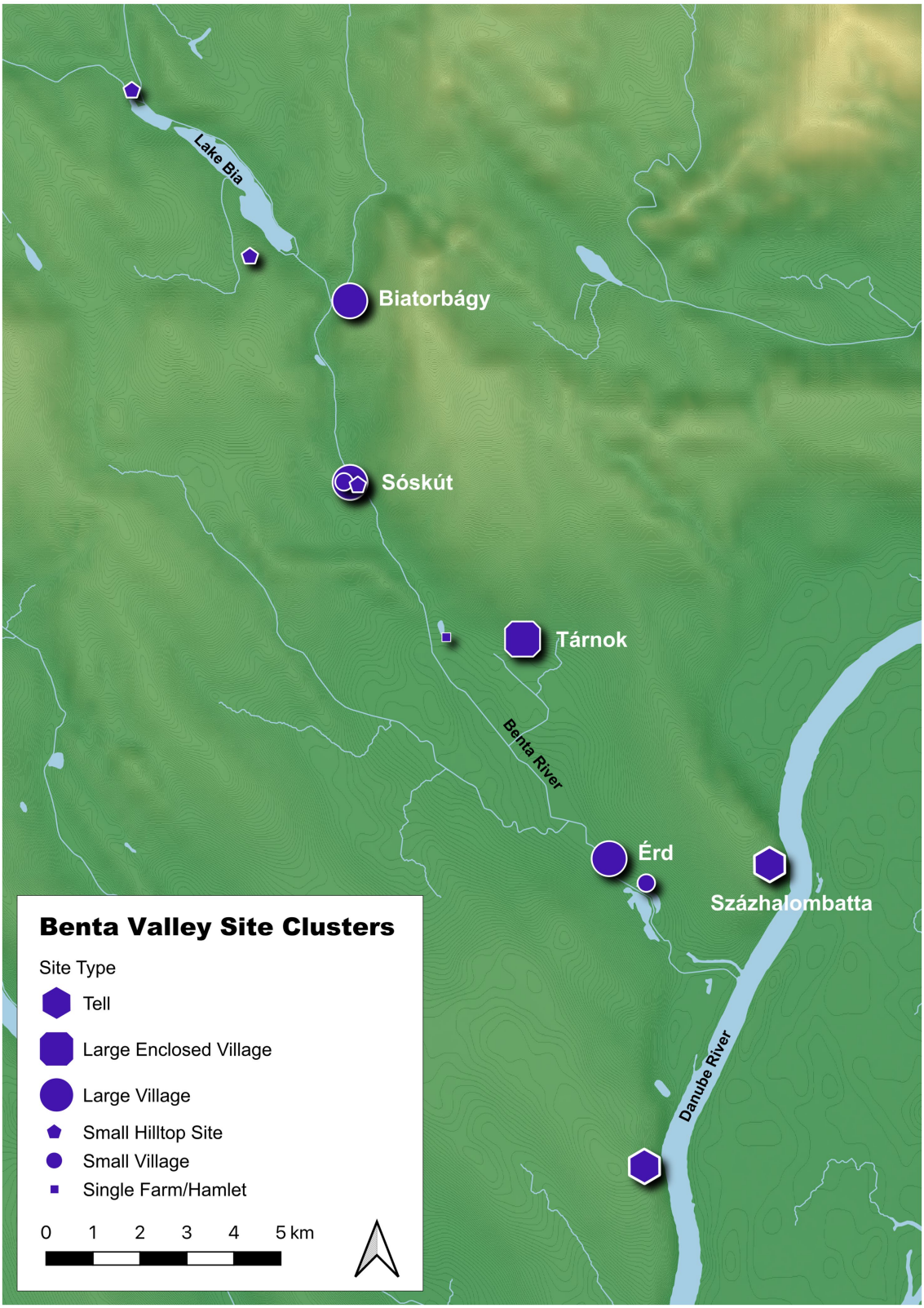

FIGURE 5
Map of sites in the Benta Valley, based on Kanne's maps in Earle and Kristiansen (2010). Site types also from Earle and Kristiansen (2010), updated to reflect recent research (Szeverényi and Kulcsár, 2012; Szeverényi et al., 2017; Kulcsár et al., 2020). The even distribution of these site clusters with ample open grazing between them, suggests commons surrounding each, probably within the 4 km distance for water suggested for sheep (8 km for cattle) or a catchment of roughly 4 km (Stobbe et al., 2016).

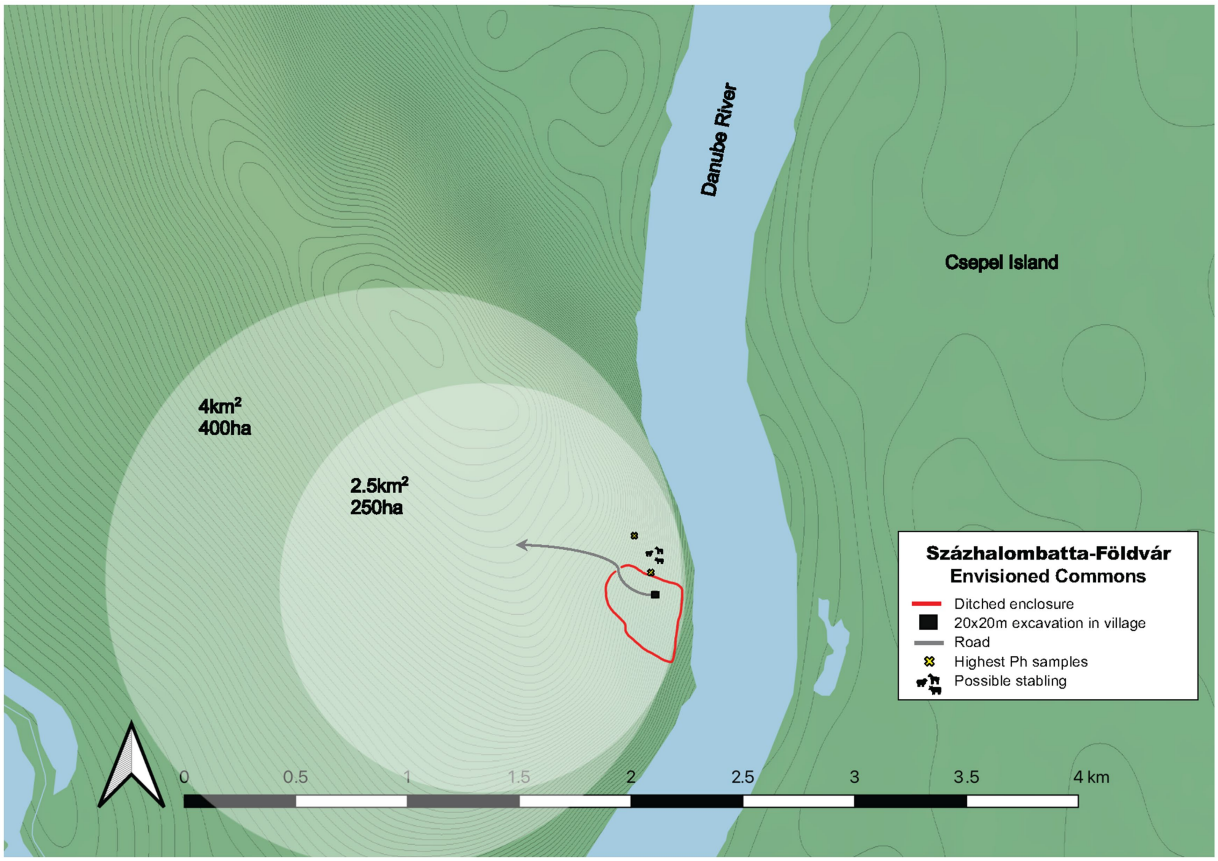

FIGURE 6
Envisioned commons at Százhalombatta-Földvár. Circles represent catchment areas of 4 km^2 or 400 ha and 2.5 km^2 or 250 ha, which could have been arranged in a number of ways to provide fresh graze for the multiple herd classes at the tell without encroaching on other settlement's commons up the Benta Valley. These commons could have supported between 1,526 LSU at 0.16/LSU/ha (LSU, Livestock Unit: 1 LSU = 1 dairy cow, 0.8 horse, 0.1 ovicaprid, 0.5 breeding sow) to 500 at 0.5/LSU/ha, and with a 400 ha catchment (4 km^2), 2,500 at 0.16/LSU/ha and 800 at 0.5/LSU/ha. Fording animals across the Danube to Csepel Island, where there were no MBA villages could be another possibility, given the rich floodplain grazing. Moving stock via barges to grazing lands and in trade is considered to have been practiced from the Neolithic (e.g., Case, 1969; Cummings and Morris, 2022).

social relationships based around herding, affording ample opportunities to monitor others for compliance with commoning arrangements. The daily taskscapes of pastoralism included protecting livestock in common pastures from predators and thieves, probably with dogs and horses, milking dairy animals, and moving working and dairy livestock to and from pasture, from stabling either abutting or possibly within the enclosure. Face-to-face interactions organized routine, repeat journeys for people and animals, dividing labor by herd divisions of species, age, and class, while others trained, rode, and drove traction animals. Animals with complementary preferences, like cattle and sheep, grazed together, further split between dry and milk herds, young and breeding stock. Pigs would have been left to roam the forest at the margins of the floodplain, with herders moving other stock based on breeding cycles, just before slaughter, and seasonally between the low ground and agricultural fields in the winter, and hills and slopes from spring to autumn. A reliable network of cooperating herders pooling labor utilized the unenclosed common grazing areas outside of the ditch on the sloping hills and floodplain in the Benta Valley, and along or maybe across the Danube onto Csepel Island, perhaps in an infield-outfield system (Figure 6).

Given large villages, about 5 km apart from each other up the Benta Valley, with population estimates up to 1,700 people in 50 km^2, a sophisticated system of commoning agreements between communities must have been in place to maintain the relative peace that lasted for centuries (Figure 5). Effective management of common grazing needed leadership from each herding group, and from each village to organize, matching the mortuary evidence of senior members of the society buried with slightly more grave goods than others, perhaps heading a segmentary organization (Laabs, 2023). Mortality profiles and mobility isotopes demonstrate that a few horses were imported and exported from the Benta Valley, ridden by adolescents and adults of both sexes for herding and travel (Kanne, 2022). Exchange of livestock, mates, and goods must have been important to secure ties between herding groups, between communities, and with extra-regional trading partners. This is borne out by evidence of regional and supra-regional exchange in distinctive pottery and horses. Százhalombatta received bronze, amber, and other goods in long-distance trade (Earle and Kristiansen, 2010; Kristiansen and Earle, 2015; Vandkilde, 2016; Ling et al., 2018).

Recent interpretations of tell societies finds they were more heterogeneous and decentralized politically, with less evidence for social differentiation in house size, material culture, or mortuary practices, or of elite control of agropastoral surplus, horses, bronze production, or craft specialization (Bartelheim, 2009; Sørensen, 2010; Earle et al., 2011; Kienlin, 2015; Klehm and Nyíri, 2016; Kienlin et al., 2017; Dani et al.,

TABLE 2 Measures of collective action in the case studies.

Measures of collective action in the commons	Rundale Ireland	EBA Jutland	MBA Hungary
Group Size	Small	Mostly small	Small
Social Homogeneity	High	Moderate–High	High
Communal Labor	Seasonal	Seasonally High	High
Boundaries	Infield-Outfield	None in heathland	Partial
Livestock > household	Equal	Greater than	Greater than
Commons seasonality	Year round and seasonal	Seasonal	Year round
Arable agriculture to pastoralism	Arable farming is primary, but interdependent with pastoral farming	Secondary to arable farming	Secondary to arable farming
Domesticated species abundance	Primarily cattle with sheep, goats, and pigs	Primarily cattle and sheep/goat, abundances unclear	Caprine heavy, multiple cattle and caprine classes, pigs, horses, dogs
Species products	Meat, dairy, wool, traction	Meat, dairy, wool, traction surplus for trade	Meat, dairy, wool, traction, surplus for trade
Settlement type	Village	Single or paired farmstead	Village
Land quality/commons management	Marginal/Intensive	Marginal/Extensive	Excellent/Mid-range
Levels of bureaucracy/leadership	An Ri (king) and local council, external authorities including estate agent, landlord, and judicial courts	No evidence for bureaucracy; local leadership possible	Achieved leadership, levels of bureaucracy low, but trade and craft suggest different occupations
Extent of the trade of animals or secondary products	Trade within the village and larger markets	Extensive, long-distance trading of wool or sheep	Between households, herding groups, villages, region, extensive, long-distance
Land or Labor Limited	Land	Labor initially; land later	Labor
Excludability	High	Low	Medium
Subtractability	High	High	Medium

2018, 2019; Fischl, 2018; Jaeger, 2018; Quinn and Ciugudean, 2018; Duffy et al., 2019; Găvan, 2019; Kanne, 2022; Laabs, 2023). Three-tiered settlement hierarchies for tell polities cannot be taken as evidence for unequal relations between settlements, regional political consolidation, or control of trade and craft production (Duffy, 2015; Gogâltan, 2017). Rather than necessarily defensive, large ditched enclosures also occur on large single-layer settlements, like Tárnok (Earle et al., 2014; Kienlin et al., 2017; Jaeger, 2018; Dani et al., 2019). Ditches may have held symbolic meaning for defining the community (Szeverényi and Kulcsár, 2012; Gogâltan, 2017), aided in keeping livestock in or out of the village, and managing marshy environments, as they are accepted to do in Britain (Randall, 2021) and the Netherlands in the Bronze Age (Arnoldussen and Fokkens, 2008). Ditch construction needed communal labor, as did the extensive clearance of the landscape for pastoral use (Magyari et al., 2010, p. 296). A roadway with wheel ruts, presumably from ox-drawn wagons, led into Százhalombatta, and provided access beyond it (Vicze et al., 2014). Like the ditch, the road was rebuilt several times with communal labor to maintain this public good. The road, ditch, and commons were co-jointly produced and inhabited animal architectures important for identifying, organizing, and creating this more-than-human community.

Discussion

With these cases, we centered our analyses on the taskscapes of sedentary animal husbandry to reveal the spatially embedded social relationships resulting in the commons as an institution. As modeled, collective action was realized variably in each case, and affected the ways they were governed (Table 2).

Rundale relied on the management of common resources by collectives of tenants engaged in agropastoralism generating products for subsistence and rent. Villages under rundale were small-scale networks of collective action subsumed within a wider system of colonial and capitalist extraction. Inequalities of wealth and influence existed within rundale villages, yet these were relatively small and homogenous social units, composed of households linked through shared descent, religion and cosmology, and conventions of sociality, indicating a degree of excludability. The viability of collective action in rundale relied partly on its articulation with other social institutions, particularly kinship, ritual, and reciprocity. While the system focused on the staple subsistence crop of potatoes, arable and pastoral taskscapes were interdependent and reliant on common resources. Headmen adjudicated disputes and helped negotiate the use and redistribution of land because of its high subtractability in these marginal landscapes. With partible inheritance and high population densities, land was more limited than labor. This, and the perennial problem of animal trespass, could challenge the stability of collective action and generate conflict. Nevertheless, constraints and control exerted by external authorities—estate agents, landlords, and colonial governance—accounted for the vulnerability of rundale villages, most notoriously the great hunger of the mid-19th century, and the subsequent erosion of collective agriculture and joint-tenancy agreements.

The heathlands of Bronze Age Denmark skew to the other end of the spectrum, where excludability was nearly impossible. The communal

labor of barrow building and commons maintenance required collective action between people and between people and animals, whose routines layered the landscape with routes of remembrance and rebirth for grazing. This coordination required households to manage activities over long distances, split between sedentary and pastoral tasks for portions of the year. Indeed, the settlement pattern seems to contradict the coordination necessary for heathland maintenance and barrow construction, indicating that households were generally relatively independent, and group size was small. Nevertheless, they clearly cooperated to produce and maintain the vast heathland resource. The critical difference was the permanent presence of the ancestral dead, providing a strong coercive force to encourage particular behaviors (Haughton and Løvschal, 2024). Otherwise, these landscapes are devoid of evidence for leadership or control, and any form of administrative bureaucracy. Animals played pivotal roles in both maintenance and expansion of heathland keeping growing shrubs and trees under control for a time, before the older, unpalatable heather necessitated burning, and both motivating further expansion and, in the case of cattle at least, probably causing it by disrupting trees. Given the vast scale of the grazing landscape, this was a labor-limited system, at least in its initial instantiation. However, the very practices which gave the system its persistence also impinged upon it: barrows, usually constructed from heathland turf, devoured large areas of pasture (Holst and Rasmussen, 2013). Ultimately, a decentralized system, originally labor-limited, was transformed into an unsustainable land-limited one, vulnerable to increasing inequalities.

In the MBA Benta Valley, excludability was possible, while subtractability was less than the other cases, remaining sustainable for centuries. Nucleated villages and enclosed settlements within 5-10 km of each other, and the number of livestock of different classes, necessitated coordination within households, between herding groups, and between neighboring communities, leading to the more communal ethos evident in houses, material culture, and burial. Labor was limiting; land was not. The commons was an institution that organized social and spatial relationships. Collective governance perhaps emerged from the institutional commons, reinforced by the communal labor required for ditch digging and road building and maintenance. The benefits of herding cooperatively freed some household members for other activities, either related to livestock products, like milk and wool processing, to arable agriculture, pottery making, and long-distance trade. In the terminal MBA (1600–1500/1450 cal BC), increasing trade and bronze hoarding in rivers and fording sites suggests there may have been some aiming to assert political authority, and society was becoming more hierarchically and centrally organized (Polányi, 2022). However, the tells were depopulated before reorganizing in the Late Bronze Age.

Summary

Animals made sedentism possible from at least the beginning of the Holocene (Zeder and Lemoine, 2023). To settle down with animals was, and is, inescapably social. The relational sociality required by domestication, and in "secondary product" processes, requires interspecies communication and coordinated labor, resulting in practical norms between people and animals that are institutionalized in the commons. Different kinds of social, spatial, political organizations develop from the increased proximity and close interactions with livestock throughout the Neolithic into the Bronze Age. Collective action is hard, but so is pastoralism. The commons arise as a solution to cooperator problems between people and animals, which leads to distinctly animal directed and oriented solutions for settlement planning and labor, requiring collective action, such as those in the Danish heathlands and surrounding nucleated settlements in the Carpathian Basin, both of which had long periods of more decentralized, collective political formations that lasted until the latter centuries of the second millennium BC.

Through the interdependencies of regular co-labor, the durability of the commons as institution, as well as its typical features, were etched on landscapes, embedded in genetic and isotopic signatures in bones and teeth of people and livestock, and connected by their shared genealogies and histories. Daily, seasonal, and yearly life cycles of animals informed the taskscapes of agropastoralism, structuring settlement patterns, social relations, and political authority. The brief examples we have presented demonstrate how this co-laboring can produce subtly different forms of collective action in different communities, a legacy not just of environmental conditions but also of social formations. New forms of spatially embedded social relationships emerged in sedentarization and the ensuing commons. The embodied know-how of raising animals offers opportunities for both reiterating and fracturing social bonds. Labor arrangements of the commons allow for other activities to occur, such as craft specializations, which could fund emergent political economies.

Sedentary animal husbandry was more likely to be embedded in and induce inequality when fewer people had more livestock, especially in land limited areas. When dispersed or differentially placed farmsteads did not rely on neighbors to manage grazing and water resources, some people could amass more livestock than less well-placed neighbors. At the end of the Bronze Age, land became increasingly demarcated with linear boundaries, enclosed farmsteads, and field divisions in southern Scandinavia (Løvschal and Holst, 2014), and became defended within heavily fortified settlements in the Carpathian Basin (Szeverényi et al., 2017; Molloy et al., 2020). Though in southern Scandinavia, this newly demarcated landscape was initially equally distributed to mitigate inequalities, the conditions were created where differentiation became possible, a double-edged materiality that could engender collective governance, but also make hierarchical authority achievable (Løvschal, 2020). Increasingly formalized land tenure in northwest Europe in the Bronze Age (Løvschal, 2020, p. 371, 372) became regularized across Europe, with later prehistoric land demarcation corresponding to increasing social hierarchy (Griffiths et al., 2022), placing the commons in societies with more exclusionary rule. As property rights were asserted, land and animals were owned by fewer people, or commons became part of extractive systems of land tenure. Our reappraisal of the trend in Bronze Age sedentism with respect to animal management follows recent efforts illustrating the differences between labor- and land-limited economies, the latter of which are associated with greater persistent wealth disparities (Bogaard et al., 2019).

Concluding thoughts

Animals made a critical difference in settling down. The institutional commons develop with sedentism to meet animal requirements in particular landscapes, and, through its organization, fundamentally affects the spatial and sociopolitical organization of complex societies. Animals are participants in this institution, and

can be participants in collective action because they demand coordination and cooperation in labor and cohabitation. These institutional requirements induce collective action, initially resulting in more collectively governed and decentralized societies, as in the earlier Bronze Age examples, or be a collective (and also extractive) institution couched in more vertically arranged political institutions, as the case of 19th-century Irish rundale, and later Bronze and Iron Age institutions.

New methods can aid in understanding sedentary animal husbandry and the dynamics of commons in prehistory. Ancient DNA, alongside mobility and dietary isotopes, have the potential to link animals and people together in migration, exchange, travel, genealogies, and social relationships. Establishing livestock presence within prehistoric commons, and distinguish activity areas and movements on the landscape, is improving rapidly with high-resolution techniques. As such, holistic conceptualizations accounting for multidirectional cooperation between people and more other-than-human actors, should be attempted.

Flying back and forth from Ireland, England, Denmark and further to the States and eastern Europe, we look down at the striking volume of land occupied by domesticated crops, largely to feed animals, along with the open pastures and hedgy, stony patchworks of pastures enclosing cattle, horses, sheep and goats. The landscape is utterly dominated by domesticates; the biomass of just cattle, pigs, and chickens vastly outnumbers the biomass of people and all wild species (Bar-On et al., 2018). This begs the question, whose landscapes are we living in? Is it the people concentrated in areas organized with eyes to markets and transport? Or is it the animals, whose needs take up the majority of habitable land? The point is that it's *our* landscape, *our* world—the one that we negotiated and managed into existence together.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

KK: Conceptualization, Writing – original draft, Writing – review & editing. MH: Writing – original draft, Writing – review & editing. RL: Writing – original draft, Writing – review & editing.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. KK was supported by the European Research Council (ERC) under the European Union's Horizon Europe Research and Innovation Program (grant agreement no. 101055195). MH was supported by the ERC under the European Union's Horizon 2020 Research and Innovation Program (grant agreement no. 853356). RL was supported by an Irish Research Council Postdoctoral Fellowship (GOIPD/2021/160).

Acknowledgments

KK wishes to thank Rich Blanton, Poco, Lane Fargher, and Verenice Heredia Espinoza for long conversations about collective action and institutions from our shared time at Purdue University, the ANSOC team, especially Joanna Brück. MH thanks the ANTHEA project team, particularly Mette Løvschal. RL would like to thank Simon Murray, Tommy Burke, and John Burke for sharing their time and their farmwork. He is grateful to all the people on Inishbofin who have shared their experiences of farming with him.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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