



Domestication Through Dingo Eyes: An Australian Perspective on Human-Canid Interactions Leading to the Earliest Dogs

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Abstract

I develop an understanding of the dingo's relationship with Aboriginal people through a synthesis of historical, ethnographic, and archaeological literature and Indigenous perspectives to better conceptualise the interactions between Eurasian Palaeolithic humans and wolves leading to domestication of dogs. Human-wolf interactions leading to domestication were likely initiated by people capturing wolf pups to rear at home; this was likely followed by the adult wolves residing in or around the camp in at least a commensal fashion. The dingo's case demonstrates that even millennia of commensal association between humans and a wild canid do not necessarily result in phenotypically visible domestication. Hence, it is apparent that careful, ongoing management involving direct selection was required in the development of dogs from wolves.

Keywords Domestication · Dogs · Dingo · Aboriginal · Palaeolithic · Australia

Pathways to Dog Domestication

The specific origin of domestic dogs remains elusive and contested. It is widely accepted that dogs were domesticated from a now-extinct population of *Canis lupus*, that this occurred no earlier than the Upper Palaeolithic (~45,000—11,700 years BP) in a specifically Eurasian context, but other aspects remain highly contentious. Particularly controversial is the specific mode of human-wolf interaction through which domestication occurred.

Two schools of thought dominate this debate. Human-initiative models argue that human agency was essential, suggesting that people initiated interactions with wolves and subsequently managed them in-camp, possibly to regularly harvest material resources (Germonpré et al. 2018), or by a desire to parent and keep “pets” (Serpell 2021). Management by humans involved directly (culling) and/or indirectly applied (captive) selective pressures that led to domestication (Clutton-Brock 1995; Germonpré et al. 2018; Morey 2010).

Self-domestication models, conversely, argue wolves approached human settlements to scavenge food or simply

from curiosity. The friendliest and least-fearful canid individuals were able to exploit an advantageous niche in and around camps. Continual adaptation to and reproduction within this niche isolated them from wild conspecifics and resulted in domesticated dogs. No human agency other than tolerating wolves' presence was necessary (Coppinger and Coppinger 2001; Derr 2012; Driscoll et al. 2009; Lorenz 1954; Pierotti and Fogg 2018).

The Use and Limits of Ethnographic Analogy

These perspectives are argued as though mutually exclusive inspiring ongoing debates (Mech 2019; Pierotti and Fogg 2018). Many of the discussion points are analogies derived from interpretations of human behaviour around wolves as informed by ethnographic and ethnohistorical descriptions of traditional societies.

Notably, the human-initiative model is founded on recorded accounts of recent Eurasian traditional cultures collecting and then rearing wolf pups within the confines of their settlements. Here the intended outcome was the slaughter of the reared wolf to obtain meat and other material (Germonpré et al. 2018). A main critique of self-domestication models observed tendencies of the same traditional cultures to consistently actively discourage the unrestricted movements of unfamiliar wolves near

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residential spaces, and deny them access to stored foods (Germonpré et al. 2018).

If the Palaeolithic predecessors of recent Eurasian cultures shared similar tendencies, the consequences for domestication are obvious—they favour a scenario in which humans had to carefully and actively manage the wolves with which they interacted, however motivated. Developing perspectives on dog domestication indeed appear to increasingly favour human-initiative models, at least, for the crucial formative stage of dog domestication.

However, these ethnographic analogies fail to explain a crucial aspect of canid domestication: reproduction under human influence or selection. Reared wolves were dispatched before this could occur, and indeed breeding wolves in captivity – ostensibly a more secure way to ensure ongoing access to their resources—was never a desired outcome. For material purposes, new wolf pups could always be obtained from the wild.

Human-initiative models must therefore allow for camp-reared wolves to survive to reproductive age, and be free enough to breed with their fellows, but this reintroduces the element of danger posed by adult wolves habituated to associate humans with food. Serpell (2021) recently addressed this discrepancy, arguing the purpose of keeping Palaeolithic wolves was not desire for food but for pet-keeping and companionship, ergo facilitating survival into adulthood. Presumably this incorporated some effort to prevent adult wolves from escaping while allowing them freedom enough to interact with humans and one another.

Although many emphasise the danger posed by adult wolves even where socialised, it must be remembered that pre-domestication management of the many important early domesticates' forbears – large ungulates in particular – also involved risk of severe physical injury (e.g., Scott et al. 2019). Ancient peoples nonetheless accepted these risks and worked to mitigate them to maintain access to an advantageous resource. Serpell (2021) argues that danger posed by roaming camp-dwelling wolves was minimised by employing careful, direct socialisation – essentially raising them as children.

The emerging picture of dog domestication thus revolves around a hunter-gatherer culture that captured wolf pups and reared them in-camp, permitted them to mature to adulthood and allowed mobility for them to reproduce with one another, while managing the responsibilities of keeping adult wolves around. This scenario finds many parallels with the relationship between Australian Aboriginal society and dingoes.

The Dingo and Its Potential for Insights into Dog Domestication

The dingo (*Canis dingo* or *Canis familiaris*; cf. Jackson et al. 2019 and Smith et al. 2019) is a canid native to Australia.

The vast majority of dingoes live in the wild, but the small number living with Aboriginal people can be envisaged as the most primitive of extant dogs. Their relationship with Aboriginal people has potential to provide rare insight into the nature of dog domestication as a case study of the interactions between a medium-sized wild canid and relatively unspecialised mobile hunters and foragers and their outcomes.

Dingoes exhibit several “primitive” phenotypic traits typical of wild carnivores that are rare/absent in domestic dogs (Smith et al. 2019) but are otherwise similar in appearance and genetic relation to East Asian domesticated dogs (Zhang et al. 2020). Scholars disagree on whether this indicates their ancestors arrived as domesticated “true” dogs which subsequently escaped and established a long-term feral population, or as a “tamed” wild canid that had only experienced “unconscious selection” and expanded naturally into Australian wild landscapes (Ballard and Wilson 2019; Jackson et al. 2019; Smith et al. 2019).

To date, there is no morphological nor genetic evidence that dingoes constitute a direct continuity of Asian wolf, as opposed to their demonstrably strong relation to Chinese dogs dating to the early Neolithic (Zhang et al. 2020). Similarly, there is no evidence for wild canids beyond the China-Vietnam border area (unrelated dholes and jackals notwithstanding) (Wang et al. 2016), leaving a lack of candidates for a proximate population that could have been “tamed” and translocated to Australia. Dingoes are best understood as primitive East Asian dogs that are unique in having avoided admixture from other dog lineages until very recently, but nevertheless carry a signature of human association that distinguishes them from Asian *C. lupus* (Bergström et al. 2020).

Dingoes have accordingly featured in discussions of domestication as stand-ins for early dogs, with their appearance, behaviour, and relationship with humans seen as analogous to the processes of their domestication (Coppinger and Coppinger 2001; Koler-Matznick 2016; Manwell and Baker 1984; Pierotti and Fogg 2018). However, these studies largely focus on dingoes' behaviour as tame camp-dwelling animals, without considering the implications of their interactions with their wild conspecifics.

Effectively, dingoes have been chosen as an analogue for “dogs” specifically, rather than the wild-living canids they were domesticated from. In this regard, there has been no full appreciation of how dingoes may add to the broader picture of dog domestication. This is remarkable given that the Aboriginal-dingo relationship is the most relevant well-recorded example of long-term “domestic” interactions between a wild canid and hunter-gatherers.

While abundant ethnographic material from northern Eurasia and North America records the rearing of captive wolves that all eventually became food. Moreover, these societies are fundamentally different in already having had stable populations of true domestic dog, with little apparent desire to actively rear and manage wolves in-camp for life. Taming of various South American canids by local dog-lacking foragers is known (Stahl 2013), but these are distantly related animals outside of *Canis* with greatly different ecologies to wolves, dogs, and dingoes.

I here use ethnohistorical and archaeological literature to establish a more holistic understanding of the overall relationship between Australian Aboriginal people and dingoes, both tame and wild. I compare and contrast the salient aspects of this relationship with current discussions concerning interactions between Upper Palaeolithic humans and wolves to provide insights into the setting that led to the domestication of the first dogs.

The fact that dingoes never became domesticated into “dogs” we would recognize—stable, self-perpetuating populations of predominantly domestic residence, with a noticeably different phenotype – is of particular interest considering the possibility that they may have had an easier pathway to this outcome by virtue of having earlier experienced human selection if not domestication. By examining the nature of their interactions with Aboriginal people in this light, I hope to reach a greater understanding of what conditions or evolutionary mechanisms *were* necessary to produce dogs from wolves.

Australian Aboriginal Interactions with Wild Dingoes

Molecular modelling suggests that Australian Aboriginal people first encountered dingoes c.5500 years ago, likely through direct interaction with overseas contacts (Koungoulos and Fillios 2020b), and soon thereafter sizeable wild populations had been established. This is evidenced in the large number of sub-fossil specimens from southern Australia (Gollan 1982) that are of wild rather than human-associated origin. Wild dingoes constituted the vast majority of *Canis* in Australia well into the historical period after European occupation, when domestic relationships with dingoes relied almost entirely on interactions with the wild population.

Consumption

Interaction with wild dingoes occurred frequently during their use as a source of meat – their primary resource (Fig. 1 and Table 1). Adult dingoes were typically tracked to their dens and speared or clubbed. Dingoes were generally prepared for consumption by roasting in earth ovens, as was typical for other large mammals. Pups were also eaten, and dens were specifically sought out during whelping season (Tindale 1974). Importantly, some pups encountered at these times were collected

Fig. 1 Dingoes as sustenance amongst the Pitjandjara, Central Australia, 1933. Left: Hunter returns with a captured dingo. Right: Boy holding newly killed dingo pup. After Tindale (1972)



Table 1 Uses of dingo in historical Aboriginal Australian culture

Element & usage	Notes on usage	References
Meat		
Whole carcass	Cooked in earth oven, continent-wide. Generally gutted and had hair singed off before placed in oven	Barrallier 1897; Carter 1911; Curr 1886; Eyre 1845; Grey 1841; Krefft 1865; Lucas 1888; Smyth 1878
Haunch	Preserved in winter by hanging from tree	Russell 1840
Puppy	Consumption often restricted to old men	Beveridge 1883; Horne and Aiston 1924; Parker 1905
Kidney fat	Used as skin lotion	Sturt 1848
Skin		
Cloak	Possible but unverified, source may have confused another animal's skin	Peron 1809
Earring	Tassel form	Allen and Corris 1977
Necktie	Used to hang baskets from	Youlden 1853
Storage-bag ornament	Tassel with hair left on	Carnegie 1898
Water-container	Hair-inside, sealed at limbs with kangaroo sinew	Curr 1886; Magarey 1895
Hair		
Spear-thrower	Tuft used as ornamentation	Philip 2016
Beard ornament	Hung from the beard	Philip 2016
Hair ornament	Tufts bound with plant fibre/sinew	Philip 2016
Tail		
Headband	Particularly common in eastern Australia	Beckler 1867; Bundock 1978; Fraser 1892; Hodgkinson 1845; Meston 1895; Palmer 1903; Petrie 1904; Roth 1897, 1900
Necklace	Affixed to a string and hung around the neck	Love 1917
Armband	Also refers to wristband	King 1827
Hunger-belt	Worn to help endure hunger whilst undertaking stealthy operations and unable to forage	Smyth 1878
Hair ornament	Possibly affixed to hair or worn as "headband" above	Collins 1798; Nind 1831
Beard ornament	Usually white tip twisted into beard	Helms 1896; Schürmann 1879
Headband ornament	Affixed to headband	Basedow 1907
Teeth		
Hair ornament	Tied to hair or affixed with gum, often alongside parts of other animals	Atkinson 1863; Fraser 1892; Hodgkinson 1845; Phillip 1789
Necklace	Several teeth strung along cord	Philip 2016
Belt ornament	Corrobboree waist-belt decoration	Philip 2016
Spear-thrower	Used as spur that holds the spear in place	Philip 2016
Bone		
Knucklebone ornament	Affixed to locks of hair such that one hung over each side of the head	Roth 1897

to be reared as companions, forming the tame camp-dwelling population.

Some Aboriginal groups reported taboos, totemic restrictions, or general dislike of consuming dingo meat, and for these groups the acquisition of pups was presumably a practice not connected to obtaining food (Bates 1925; Dawson 1831; Hamilton 1972; Kolig 1978; Meehan et al. 1999; Meggitt 1965; Smith and Litchfield 2009; Tindale 1974). For instance, some Central Australian groups prohibited harming female dingoes and pups, only permitting the harvesting of adult males (Howe 1993).

Dingo remains are relatively common in Australian archaeological assemblages. Aside from deliberately buried individuals, these are found associated with remnants of other food species and most likely also represent remnants of meals. (e.g., Balme et al. 2018; Megaw 1965; Westell and Wood 2014). Remains of newborn individuals (Lampert 1971) provide an archaeological correlate for the historical practice of dingo-pup collection. However, the consistently low representation of dingoes in studied faunal assemblages (often a single element) indicates they were never a staple food.

Secondary Resources and Cultural Utility

Dingo body-parts were used in utilitarian and ceremonial roles. Philip (2016) described their incorporation in Aboriginal cultural objects collected from the late 1800s to early 1900s and currently held in international museum collections. As with meat, dingo parts were sourced from wild individuals (Table 1). Tails were incorporated in waist bands, arm bands, head bands, or worn on the head or beard, especially in male ceremonial contexts, and appear to be the most common and widespread part used. Dingo skins were used as water-containers in the arid central regions, and elsewhere cut into strips and worn as tassels, neckties, or earrings. Utilisation of teeth was common, mostly as ornaments affixed to hair, but also in the manufacture of ornaments, charms, and spear-throwers.

Dingo bone was apparently very rarely used, with the best-known example a knucklebone pendant worn over the head in parts of Queensland (Roth 1897). Archaeological instances of culturally modified dingo remains are also extremely rare and limited to burning and butchery, with no examples of tool or ornaments yet identified.

Tame Dingoes and Domestic Interactions

Captured wild dingo pups were reared in-camp as companions. Existing reviews of ethnohistorical literature find very little evidence of continuity between consecutive generations of camp-dwelling dingoes (Smith and Litchfield 2009). Rather, once they reached sexual maturity they left the camp to live and reproduce within the wild.

The rearing process seems to have not exerted sufficient selection pressure to affect wild offspring born to parents formerly raised in camps in any visible manner. Unusual-looking pups were more likely to be initially chosen for rearing and indeed pelages rare in the wild (e.g., spotted) were sometimes observed in tame dingoes (Howe 1993; Johnson 1964; Tindale 1974) but not to exclusion of the predominant types (yellow/ginger).

There is no evidence that wholly wild dingoes approached occupied Aboriginal camps to scavenge or otherwise interact with people (i.e., anthrophilic, Hulme-Beaman et al. 2016), in what seems a clear contradiction of self-domestication models. However, it may be that any so interested were discouraged by the presence of already tame dingoes that monopolised waste resources available for scavenging.

Management

Tame dingoes were by most accounts lavished with attention and affection. They were kissed and caressed (Berndt

and Berndt 1942; Dahl 1926; Hamilton 1972; Lumholtz 1889; White 1915) and carried on shoulders or around the waist when tired (Lindsay 1935; Lumholtz 1889; White 1915). Many slept in people's beds (Basedow 1903; Berndt and Berndt 1945; Horne and Aiston 1924; Petrie 1904; Smyth 1878) while others had their own purpose-built shelters (Dawson 1881; Memmott 2007; O'Connell 1987). In the Kimberley, walled "puppy-pens" were constructed from circular stone arrangements (Davidson 1954; Love 1936).

Dingoes, and later dogs, were treated in many ways as members of the human community. They were conferred magical protections (Hamilton 1972; Tindale 2000), groomed for parasites (Hamilton 1972; Lumholtz 1889), tended when ill (Basedow 1925; McLaren 1926), and afforded distinguished funerary and/or burial rites upon death (Dawson 1934; Love 1936; Musharbash 2017; Stretton 1893; Taunton 1903; Thompson 1985; Wells 1963). Perhaps most notably, tame dingoes were integrated into social-organisation systems, being assigned skin-names which identified their kinship status and its corresponding rights and responsibilities (Smith and Litchfield 2009).

In many accounts women are mentioned as the immediate companions and primary caretakers of tame dingoes, particularly juveniles (Fig. 2). Attesting to this are widespread accounts of Aboriginal women suckling juvenile dingoes (Berndt and Berndt 1942, 1945; Grey 1841; Krefft 1865; Lang 1861; McLaren 1926; Mitchell 1838; Roth 1900, 1902; Stretton 1893; Taunton 1903; Thomson 1947; White 1915). European observers explained this as fulfilling a surrogate-child role in older and childless women, or to prevent pregnancy in younger women.

However, an Aboriginal perspective (Parkhurst 2015: 36) is that dingo-nursing was necessary for pups' nutrition because they were taken before being weaned, and was also a bonding experience that served in their socialising and taming. The closeness of such arrangements reflects a special relationship between young dingoes and Australian Aboriginal women as seen in traditional societies elsewhere (Hamlyn-Harris 1918). In contrast, favourable perspectives from Aboriginal men on tame dingoes are rare and appear to mainly involve individuals considered useful hunting assistants (e.g., Berndt and Berndt 1945; Lumholtz 1889).

Children also played a major role in the management and socialising of dingoes, as demonstrated in recent anthropological work amongst the Warlpiri people (Musharbash 2017). "Rough play" and disciplinary behaviour by children towards young dogs – their constant companions – was taught and encouraged, even though it could result in injury or fatality for pups. From the Warlpiri perspective, this served to instil in camp-dwelling canines a healthy respect for people to prevent aggressiveness towards community

Fig. 2 Photographs of Aboriginal people with dingoes and dogs. Clockwise from top left: Woman from Mornington Island (QLD) nursing dingo pups (after Hamyln-Harris 1918); Women from the Everard Ranges (SA) carrying young dingoes around their waists (after White 1915); Hunter near Mt. Conner (NT) returns with kangaroo and camp dog (after Mountford 1940); Pintubi (NT) men with young dingoes used for hunting (Long 1957 via Northern Territory Library)



members of all ages. “Rough play” was earlier mentioned by others (Hamilton 1972; Kolig 1978).

This disparity may be linked to dingo involvement in hunting differing according to sex of human hunters involved (see below). Incorporation of dingoes into men’s hunting, typically of large macropods, could greatly increase risk of failure outside specific conditions where they were useful. Accordingly tame dingoes were often intentionally excluded from accompanying hunting expeditions and left with the women and children, whom they helped capture smaller-bodied game. This may have been more opportunistic and less nutritionally rewarding but required lower risk management and energy investment (Koungoulos and Fillios 2020b). As a result, tame dingoes spent much of the average day in the care of women and their children.

Expectations of correct behaviour continued to be enforced throughout the tame dingo’s life in camp. Outside of the puppy-pens used in the Kimberley (Davidson 1954), to prevent young dingoes leaving the camp their legs were variously bound (Lindsay 1935; Nind 1831) and their feet broken (Birtles 1939; Duncan-Kemp 1933) or “chopped” (Walshe 1995). They could be driven away with sticks/stones from hunting trips or ceremonies (Gould 1980; Hamilton 1972). Premolars and molars were sometimes removed to allow seizing and holding of game (Dahl 1926) but not consumption, and dingoes could be conditioned to drop game with a pinch to the hind leg (White 1918).

Misbehaving individuals were punished with physical discipline, ranging from essentially token blows to

severe beatings (Gould 1969; Hamilton 1972; Howe 1993; Thomson 1928). However, individuals could only discipline their own dingo. Physical reprimands or even disrespectful words towards someone else’s often provoked interpersonal conflicts in both internal Aboriginal social interactions and those with Europeans (e.g., Harney 1959; Thomson 1931). Moreover, unwarranted antagonism such as teasing, withholding sustenance, or torture of tame dingoes, including one’s own, was considered immoral and subject to punishment (Howe 1993).

Provisioning

It is widely recognised that tame dingoes were not well-provisioned by human companions (Meggitt 1965; Smith and Litchfield 2009). Visitors frequently commented on the perpetual hunger of dingoes and dogs occupying Aboriginal camps (Thomson 1928, 1934, 1935, 1947; Tindale 1974), and noted strong visual differentiation from wild conspecifics due to their poorer nutritional state (Mitchell 1838) and smaller size (Smith 1839). Historical observations indicate that provisioning most often consisted of meal scraps, especially bones (Curr 1886; Love 1936; Nind 1831; Smyth 1878; Thomson 1928; White 1972), but pups were sometimes specifically provisioned with pulverised meat or fish (Thomson 1947). Dingo bone damage is noted in several Late Holocene Australian archaeological faunal assemblages (Koungoulos et al. 2018).

Pups were usually weaned off provisioned food as they reached adolescence. Like most pets, they pestered people for food and attempted to consume reachable edible items, necessitating the use of high “storage tables” to prevent theft of food and water in some areas (Horne and Aiston 1924; Memmott 2007). Where provisioning did not continue into adulthood, the exceptions were individuals regarded as particularly good hunters (Berndt and Berndt 1945; Coghlan 1898; Gould 1969, 1980; Lockwood 1972; Meehan et al. 1999; White 1972) or vigilant guardians (Musharbash 2017). Food pestering and thievery no doubt worsened with the larger, permanent populations of domestic dogs that came to inhabit Aboriginal settlements, despite the availability of external food sources such as flour, vegetables, and tinned meat.

Tame dingoes are notable for independently hunting small animals (Hackett 1937; Hayden 1975; Howe 1993; Finlayson 1943; Lockwood 1962; Nind 1831) and were freely permitted to roam to do so. Some predatory behaviour is not unusual in dogs, but free-ranging dogs generally suffer malnutrition, while dingoes (and closely related New Guinea Singing Dogs) are unique in being able to sustain stable populations without reliance on anthropogenic resources for food and recruitment (Gompper 2013). It is probable that this behaviour was encouraged by absence of sufficient food for provisioning or scavenging. That they might not return one day was accepted as natural (Fijn 2018; Kolig 1978; Macintosh 1975).

Consumption of Tame Dingoes

A common concern in explanations of the association of Aboriginal people and dingoes is their potential to perform utilitarian tasks (Smith and Litchfield 2009). These are discussed extensively in the published research (Balme and O’Connor 2016; Koungoulos and Fillios 2020a,b; Manwell and Baker 1984; Smith and Litchfield 2009), which finds that for most positive “functions” attributed to dingoes they incurred additional, sometimes substantial, costs against what was often a negligible benefit.

The consumption of captive-reared canids is directly relevant to discussions of canid domestication. Obtaining primary/secondary resources was not an outcome of rearing and managing tame dingoes and cannot be considered a utilitarian function of this practice. The consumption of tame as opposed to wild dingo specifically was abhorred by all Aboriginal groups, this being only resorted to at times of immense dietary stress and always with great sadness and regret (Beveridge 1883; Tindale 1974).

This was rooted in a common pre-contact philosophical conceptualisation of tame dingoes as part of human society. Interpreted as beings which straddle the human and natural worlds (Kolig 1978), dingoes feature widely in

Aboriginal lore as figures whose actions serve to instruct human society in traditional law and in proper, moral behaviours (Musharbash 2017; Parker 2006). This often occurred through demonstrating reprehensible actions, e.g., sexual pairings in violation of kinship structures; gluttony; and generally disruptive, unpredictable conduct, and their repercussions.

It was widely held that supernatural retributions awaited those who harmed tame dingoes (Howe 1993). Specific historical instances in which lightning, sickness, and car accidents struck perpetrators are detailed by Russell (1840) and Kolig (1978), with their communities accepting a causal link between the two events. Punishments for the *consumption* of tame dingoes, as communicated through lore, were extreme: one offending tribe was “obliterated” by torrential rains/landslides after butchering another’s hunting dogs (Gresty 1941), and in another case several large camps were “wiped out” after eating someone’s favoured dingo (Berndt and Berndt 1964). Restrictions against consuming tame dingoes were thus not only informed by broader philosophical outlooks but explicitly warned against in law.

The Status and Fate of Tame Dingoes

Camp-dwelling dingoes as described in ethnohistorical literature were not domesticated in any sense evident in behaviour or physical phenotype (Zeder 2015). A label of commensal, including any variants (Hulme-Beaman et al. 2016) is also difficult to accept as accurate of their position since this was only true for a short portion of a tame dingo’s life. Historical Aboriginal-dingo relationships can be broadly characterised as interactions between humans and a wild animal.

However, Brumm (2021) contends that adult tame dingoes may have remained in the immediate vicinity of camps, and that they/their offspring continually associated with Aboriginal people. Captive-reared individuals perhaps lacked the social, foraging, and other skills to survive in the wild usually imparted by their parents and siblings, resulting in some dependency on the relatively safe, reliable environment in and around camps where others like them resided.

Brumm (2021) suggests this created lingering, commensal sub-populations of “not truly wild” dingo around camps: a distinct “ecotype” from which captive-reared populations were drawn. He points to evidence from modern contexts in which dingoes habitually scavenging the reliable food-wastes dumped by remote mining camps have exhibited altered ecologies, including genetic isolation and inbreeding, increased reproductive success, increases in size, and tolerance of direct human interaction (Newsome et al. 2013, 2014; Newsome and Van Eeden 2017) though waste-resources of traditional Aboriginal camps were far less abundant and dense.

This proposed relationship most closely matches the description of synanthropic commensalism by Hulme-Beaman et al. (2016: 2): “species that continue to live in areas that are occupied and altered by humans” including “species not dependent on, or even particularly benefiting from humans,” but which “show a changed lifestyle associated with living in close proximity with humans (affecting breeding cycles, territorial behaviour, foraging behaviour, diet, etc.)”

Such a relationship is not easily demonstrable through ethnohistorical literature, where descriptions of camp-dwelling dingoes focus on pups and juveniles, with little to no mention of their lifestyle (altered or not) beyond these early stages. If a commensal arrangement with dingoes such as that described by Brumm (2021) existed, it may have collapsed due to major disruptions associated with colonisation (Hiscock 2008). Subsequent decades saw cessation of dingo-keeping altogether amid widespread adoption of European dogs (Koungoulos and Fillios 2020a), further obscuring examinations.

Commensalism, however, may be visible in the archaeological record. Dingo burials, representing tamed individuals, are common in south-eastern Australia (Pardoe 1996). Their study has been limited to date, as many are associated with human burials and subject to cultural sensitivities. However, of those that Gollan (1982) examined, many were older than the age at which they would be expected, based on ethnohistorical evidence, to have ceased direct human association (~ 12 months) (Fig. 3).

Intriguingly, Gollan (1982) further noted that two juvenile/young adult dingo burials from the southeast coast exhibited significantly reduced overall size and altered craniodental proportions, most notably reduction of auditory bullae and molar teeth. These are phenotypic developments taken elsewhere as indicative of domestication in canids (Morey 1992). These traits could signal that synanthropic commensalism exposed tame dingoes to the selection



Fig. 3 Right hemimandible of a Late Holocene dingo buried in Curcarrung 5 rockshelter, south of Sydney. Arrows denote the heavily worn regions of the carnassial molar that indicate the advanced age of an individual buried in a coastal rock shelter midden site near Sydney (Megaw 1965)

pressures of an anthropogenic environment, in a manner consistent with early stages of domestication.

Most other individuals (adults > 1.5yo) examined by Gollan (1982) were indistinguishable from known wild dingoes, indicating the evidence that commensal arrangements with Aboriginal people progressed towards domestication is at best equivocal. Reduced size could plausibly result from malnutrition during growth (Platt and Stewart 1968) rather than genetic selection.

The rare and isolated nature of unusual pre-contact dingo phenotypes suggests they occurred under conditions not yet well-understood, rather than being a predictable outcome of mainstream socio-cultural-environmental factors. Nonetheless, their exclusive occurrence in archaeological contexts strongly implicates human influence.

Discussion: How Can Dingoes Inform Palaeolithic Dog Domestication?

Many aspects of the Australian Aboriginal-dingo relationship clarify Palaeolithic dog domestication. There are some fundamental differences between contexts and outcomes that affect its suitability in terms of direct analogy, but these also help understanding of the necessary circumstances resulting in the production of a dog from a wolf.

Wild Resource Exploitation as the Foundation of Human-Wolf Interactions

The foundation for interactions between humans/people and wild canids leading to a “domestic” association can be understood as progressing from human exploitation of a wild animal resource primarily for meat and secondarily for products for manufacturing purposes.

Wild canid remains notably increase in their frequency in the Upper Palaeolithic deposits in Europe and East Asia, indicating focused exploitation of wolves for meat, fur, teeth, and bone products (Camarós et al. 2016; Collard et al. 2016; Germonpré et al. 2017; Wilczyński et al. 2020; Wojtal et al. 2012; Zhang et al. 2020). This pattern has been interpreted as evidence of more frequent and intensive interactions between humans and wild canids developing in this period (Germonpré et al. 2018), characterised by specialized hunting of canids occurring prior to the emergence of the first agreed-upon morphologically recognisable domestic dogs (Janssens et al. 2019).

Recent discourse on Palaeolithic dog domestication has challenged proposed modes of “self-domestication” initiated by adult wolves, instead identifying human collection of wolf pups followed by in-camp rearing as a crucial step towards domestication (Germonpré et al. 2018; Serpell 2021). The Aboriginal practice of tracking dingoes to their

dens to obtain pups – some for eating in the short-term and others for rearing in the long-term—provides a basic model for the initiation of contact with juvenile wolves during hunting expeditions for food and/or secondary products.

Motivation of Captive Management

Recent perspectives on dog domestication reference human desire for meat/secondary resources to explain captive-rearing facilitating domestication, which occurred potentially as an unintended by-product (Germonpré et al. 2018; Horard-Herbin et al. 2014; Pang et al. 2009). Much of this speculation is informed by the ethnography of recent northern Eurasian traditional societies, in which the rearing, killing, and eating of captive wild carnivores itself was a common ritual activity, sometimes motivated by beliefs concerning the spirits of animals and their renewal (Germonpré et al. 2018).

This was not a normal feature of the Australian setting, occurring only as the result of very dire nutritional circumstances and causing great distress. If ongoing physical captivity and regular harvesting were necessary features of the dog domestication process, the society responsible presumably maintained no spiritual or philosophical beliefs prohibiting consumption of tamed canids, unlike Aboriginal foragers.

Appreciation of tame dingoes was overwhelmingly emphasised in juveniles. All dingo pups were valued regardless of differences in personality, and were carefully managed and well-provisioned, with efforts also taken to prevent their straying from camp. In contrast, most young adult camp dingoes/dogs were considered useless if not proven hunters or guards. Although tolerated and permitted to live in the camp, most were not deliberately provisioned. Subsequently begging/thieving was a persistent annoyance, and the adult dingoes' eventual return to subsist in the wild was encouraged.

Applying these observations to Eurasian dog domestications, it is conceivable that communities spared captive-reared wolf pups collected with the initial intent of harvesting for this same non-utilitarian purpose of companionship. Here too the agency of women and children likely played an important role. Women and children were likely the main companions of tamed canids, and perhaps influenced decisions to keep favoured individuals into adulthood/breeding age rather than disposal when the age for primary/secondary product yields was reached.

One of the oldest agreed-upon dogs, a ~14,200 year-old individual from Bonn-Oberkassel (Germany), as a young animal was cared for by people through severe illness until its death at approximately 6–7 months old, and was not eaten but afforded a distinguished burial alongside at least one human. It could not have offered any utilitarian benefit during its life and likely was valued primarily as a companion (Janssens et al. 2018).

Given the focus of companionship-related values perceived for dingo pups, it could also be that Palaeolithic humans selected not only against aggressive tendencies but also for the retention of juvenile traits. This outcome occurs in many other mammalian domesticates, suggesting it may have been achieved regardless of human intentions. Nevertheless, people might have favoured puppy-like traits in captive wolves if a primary motivation in sparing them was companionship, especially offered by juveniles.

Commensalism as the Product of Captive Wolf-Rearing

With reference to pathways to domestication recently described by Serpell (2021), Aboriginal-dingo interactions as portrayed by Brumm (2021) may have achieved a commensal relationship through cross-species adoption of dingo pups initiated by humans, then maintained by ongoing residence nearby of these individuals in adulthood. An arrangement like this – notably, lacking direct control over the mobility of formerly captive-reared adults – could have served as an early stage of the domestication process for Palaeolithic wolves.

Extensive osteometry, tooth-wear, and dietary isotopic data suggest that a sub-population of Palaeolithic Eurasian wolf was differentiated from conspecifics through anthropogenic influence. Whether these represent incipient dogs (Germonpré et al. 2009; Prassack et al. 2020) or not (Janssens et al. 2019) is widely debated, but there is general agreement that they at least constitute a different ecotype (Baumann et al. 2021; Bocherens et al. 2015; Perri et al. 2016). Interpreting them as commensals—wolves were raised by humans that remained in the vicinity of camps upon maturity—is one way to reconcile these conflicting perspectives.

Concerns over risks for human safety posed by wolves habituated to human attention/handouts existing in a commensal fashion (Germonpré et al. 2018; Koler-Matznick 2016; Serpell 2021) were not held for formerly tamed dingoes, most obviously because their smaller size posed a lesser physical threat. Moreover, they were carefully socialised from a very young age and specifically habituated to rough handling by children. Dingoes were taught not to harm their humans, and vice versa.

Interestingly, Palaeolithic wolves as possible commensals were smaller than conspecifics (Morey 2014), with substantially reduced size also noted for the first widely recognised dogs that emerge in the late Upper Palaeolithic in Europe (e.g., Bosch et al. 2020; Boudadi-Maligne et al. 2012; Napierala and Uerpmann 2012; Pionnier-Capitan et al. 2011). Whatever the specific cause, such as lifestyle or genetic factors, or both, early European and Siberian dogs have a significantly reduced size and/

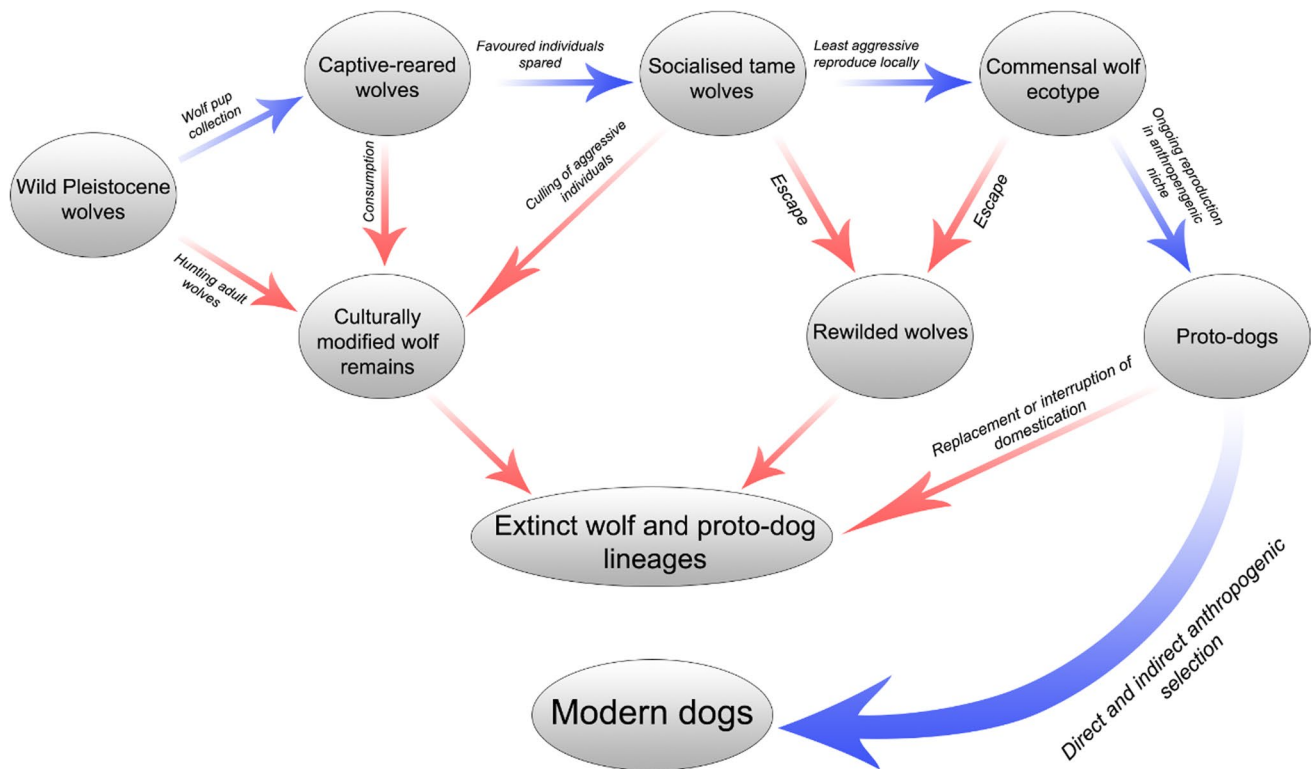


Fig. 4 Flowchart of proposed dog domestication process

or altered morphology. Accordingly, many argue the process of domestication must have begun considerably earlier, perhaps between 20–30,000BP in the north (Ameen et al. 2019; Boschin et al. 2020; Boudadi-Maligne et al. 2012; Coppinger and Coppinger 2001; Galibert et al. 2011; Napierala and Uerpmann 2012; Perri et al. 2021; Pionnier-Capitan et al. 2011; Pitulko and Kasparov 2017).

From the dingo example, it seems feasible that an “early period” of human association with wolves preceding domestication could have been commensal, initiated by humans taking pups and rearing them in captivity, followed by loose commensal association as the adult socialised wolves moved freely but resided nearby. This is contingent on Palaeolithic communities’ willingness to manage wolves in such a manner when faced with risks to safety. Careful socialisation combined with smaller body-size could have served to ease these concerns, as would a willingness to dispatch individuals considered dangerous.

Conclusion

Understanding the Aboriginal-dingo relationship in many ways informs the situational context of Palaeolithic dog domestication. Of particular importance is that the primary motivation for rearing dingoes was a desire for companionship, especially of juveniles. This was also probably

a key aspect in the Palaeolithic domestication of dogs that aided its progression beyond simple exploitation of wolves for meat and materials, and in which women and children were likely of particular importance.

But despite Aboriginal-dingo relations extending to commensalism and spanning several millennia, they never resulted in the development of domesticated “dogs,” or a “re-domesticated” dingo. A most informative aspect of this case-study, therefore, is that rather greater degrees of influence over reproduction and/or more intensive, deliberated selection were likely required in the arrangement between Palaeolithic forager and wolf to produce dogs.

I suggest this was likely facilitated through active culling of captive-reared individuals that were unacceptably aggressive during their socialisation, through to adulthood when they may have resided in the camp or nearby in a commensal fashion. Culling-based selection is more likely to have been a practice in the Eurasian setting, where it was not in the Australian due to the differential risk posed by the natural body size of the canids in question.

Smaller individuals, being less dangerous, were probably less likely to be culled, favouring reduced body-size in the earliest dogs. Surviving individuals breeding in or nearby human camps produced litters also bearing favoured, or tolerable, characteristics. Over generations this resulted in friendlier, smaller, canids – “proto-dogs” – that were increasingly dependent on the camp and its resources (Fig. 4).

Ongoing unconscious selection eventually produced landraces and selection for specific functions produced modern breed-types. Generic village dogs later emerged as the anthropogenic niche's resources changed through economic transitions to agriculture. Some developments in dog diversity may also be attributed to the involvement of varying local subspecies of *Canis lupus* during domestication and through later crossbreeding.

Distinctions between understanding of Aboriginal-dingo relations before and after colonisation imply a degree of fragility in early phases of dog domestication, wherein disruptions were liable to risk a rapid loss of "progress" towards domesticated status and result in re-wilding of the proto-domestic population. If domestication began and ended through disruption sporadically during the late Palaeolithic, it might explain ostensibly "dog-like" traits in Palaeolithic canids that are genetically unrelated to modern dogs and thus considered extinct lineages (e.g., Ovodov et al. 2011).

The case-study of the dingo and its relationship with Aboriginal people suggests that puppy-collection and rearing served as the starting point of domestic interactions between people and wild canids. This may have led to a commensal relationship in which tamed canids resided in or around camps under close management and subject to some level of anthropogenic selection. However, a lack of evidence for the Aboriginal-dingo relationship resulting in a stable, self-perpetuating domestic population of "dogs" suggests a further degree of human deliberation, involving active and multi-generational influence over reproduction, was likely a necessary condition in the transition from wolf to dog.

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Declarations

Research Involving Human and Animal Participants No human or animal participation was involved.

Conflict of Interest I acknowledge that I have no potential conflicts of interest affecting this work, and that no human or animal participation was involved.

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