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Edited by

Sophie Bergerbrant
Serena Sabatini

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Human-Thing Evolution: the Selection and Persistence of Traits at Çatalhöyük, Turkey

Ian Hodder

Abstract: This paper argues that it is possible to develop a non-biological evolutionary selectionist position based on the ideas of entanglement and fittingness. Entanglement is defined as the sum of four relations of dependence: human dependence on things, things on things, things on humans, and humans on humans. It can also be defined as the dialectic of dependence and dependency. Fittingness derives from the ways in which humans and things afford each other in relation to abstractions and embodied feelings about what is appropriate. In order to illustrate and clarify the theoretical approach, the example is provided of long-term change of cultural traits at Çatalhöyük, a 9,000-year-old Neolithic village in central Turkey. The increases and decreases at the site of cooking pottery, clay balls, house size and sandy bricks are interpreted in terms of changing entanglements, fittingness and contingent interactions.

Keywords: Entanglement, evolution, fittingness, Neolithic, Çatalhöyük

Introduction

This paper argues that it is possible to develop a non-biological evolutionary selectionist position based on the ideas of entanglement and fittingness (Hodder 2012). In this paper I will show how long-term trends in the occurrence of traits at the Neolithic-Chalcolithic site of Çatalhöyük in central Turkey can be explored within this framework. With particular reference to the introduction of pottery, the approach explains cultural shifts not in terms of reproductive fitness or modes of transmission, but in terms of entanglement within a suite of practical, material and social processes. This approach allows a long-term perspective as advocated by Kristian Kristiansen even if it does so from a position different from the social evolutionary framework with which he is most closely associated.

Kristian's work has often focused on the evolution of chiefdoms, complex societies and the Bronze Age. But he has also engaged with and countered the application of biological evolutionary approaches in the discipline. He argued that the notion that replicative success of artefacts operates according to principles of natural selection is highly dubious (Kristiansen 2004a). He lamented the way in which biological evolutionary approaches have contributed to the development of divisions and incommensurable camps in archaeological theory. He emphasized the need to focus on historical accounts of societies and material culture in their specificity, employing micro- and macro-scales of analysis and interpretation. He questioned whether a phylogenetic model for cultural affiliation, splitting and descent can have any explanatory value given that the reasons for phylogeny in later prehistory are complex products of multiple social factors. To reduce all this complexity to reproductive or replicative success seemed inadequate (Kristiansen 2004b: 120). In conclusion, 'Darwinian concepts of selection, inheritance, costs and benefits, and so on can only be understood with reference to specific cultural and social contexts' (Kristiansen 2004a: 82). This paper is an attempt to both recognize the value of some form of evolutionary perspective in archaeology while at the same time accepting Kristian's rejection of reductionism. By adopting his stance concerning the importance of multiple factors, not just reproductive, that conspire in specific historical contexts to 'select for' certain traits, a non-reductive approach can be attained. It is not enough to gloss these selective processes in terms of 'replicative success' or 'modes of transmission'; rather, the ways in which humans and things are entangled themselves produce a selective web within which certain traits persist or decrease.

Homo faber

There has been a long tradition of scholars, including Gordon Childe (1951), Hannah Arendt (1958) and Henri Bergson (1912), who have focused on humans as creators and makers of tools. It is this tool-making ability that defines us. Indeed, for many evolutionary psychologists and cognitive scientists today, it was tool making that drew out and made possible our sapient character (Clark 1997). It can further be argued that human nature and society emerge from within networks of humans and things (Latour 2005).

The co-dependence of humans and things has come to be a key concept in many areas of archaeological research, although rarely in the integrated way to which Kristian has aspired. For example, archaeologists have come to take for granted that humans are dependent on things to survive economically, to interact socially and to compute cognitively. Although there are many differences between material culture studies (e.g. Miller 1987), materiality studies (e.g. Meskell 2005) and cognitive processual archaeology (e.g. Renfrew 1998), all these approaches have explored the very thorough ways in which human social and cognitive life depends on things, especially on those things made by humans. Archaeologists have also built up information about how things depend on each other. We know that sets of equipment are needed to complete tasks and that things are deployed in sequence – the *chaînes opératoires* of French technology studies (e.g. Lemonnier 1993) or the behavioural chains and interactions studied by Schiffer (1987). So things depend on chains and networks of other things, but they also depend on humans to be procured, produced, maintained, serviced and discarded. The costs and benefits of looking after and managing animals as things have been most effectively studied in Human Behavioral Ecology (Bird & O'Connell 2006), and within Behavioural Archaeology there has been experimental work that explores the labor and energy flows involved in making and maintaining artifacts (Schiffer 1987). Humans depend on things, things depend on other things, and these complexes of things depend on humans. Humans too depend on other humans in their management of things. Thus we can say that humans and things are thoroughly entangled (Hodder 2012). So entanglement is the sum of four relations of dependence: human dependence on things, things on things, things on humans, and humans on humans.

In terms of this necessary entanglement, humans appear very 'thingly'. This statement has implications for the form of evolutionary theory used by archaeologists. It has seemed appropriate to adopt theories from evolutionary biology in so far as humans are seen as biological entities. The human biological organism and its genes evolve like other organic beings. But if humans are both biological and 'thingly', does this not change the picture? After all, non-biological things do not evolve in the same way as biological entities. Rather, they are transformed chemically or physically; they decay and rebuild. Archaeologists know that carbon 14 decays, but the 6 protons and 6 neutrons of carbon 12 are, for most intents and purposes, stable. Atoms are combined and recombined in numerous cycles. The rock cycle involves changes from magma to igneous rock to sedimentary rock to metamorphic rock. The life cycle of mountains involves build up, erosion and weathering, redeposition and uplift. The water cycle involves steam from volcanoes joining water in the atmosphere that falls as precipitation that flows as river and groundwater into the sea where the water evaporates and condenses. A star has a life cycle starting from a nebula and transforming into a red giant and a red dwarf and a white dwarf. While one may talk loosely of the evolution of the landscape, or of the universe, it is not the case that the process involves the survival of the fittest rock or mountain, or the fittest water molecule or the fittest carbon atom. Geology is a historical science that charts the transformation of matter.

Material things and dead organic things transform in non-Darwinian ways. Things as we encounter and perceive them are stages in the transformation of matter and energy; they are always in the process of combining, re-combining, transformation and decay. It follows then that if humans are 'thingly' they too must get caught in the processes and vitalities of matter. Matter is involved in its own set of interactions, not just ecological but also physical, chemical, radioactive etc. Humans are set within a material world that is always changing according to its own rules and historical contingencies. From the human point of view, things are unruly, unpredictably leading to unexpected contingent events. The unacknowledged conditions and unintended consequences of human action play a large part in human endeavours. The co-dependence of humans and things draws humans into the lives of things and into their transformations. It is not just that things create a material niche in which humans evolve. It is also that this niche transforms too according to its own non-Darwinian processes. The niche is unstable, drawing and entrapping humans into particular forms of action and response (for niche theory see Kendal et al. 2011).

Is it possible, then, to develop an evolutionary theory that takes the 'thingly' nature of *Homo faber* into account? There is certainly a need within a discipline devoted to the study of the greatest expanses of human cultural practice to debate various forms of evolutionary theory. Evolutionary theory in archaeology allows study of the long term, and it also allows the exploration of theories that are less human centred than those approaches that have dominated the social and humanistic sciences over recent decades. Kristiansen (2004a) argued that accounts of agency in archaeology needed to be tempered with approaches that incorporated larger-scale processes. While, in my view, it would be going too far to disavow the importance of human agency in evolutionary change, there is also a value in exploring evolution from the point of view of things themselves (Dunnell 1980; Shennan 2008: 78). Darwinian theory provides a potential source of ideas about variation, adaptation, selection and persistence that might be applied to the study of change within human-thing entanglements.

Entanglement, fittingness and evolution

A key strut of evolutionary theory, along with variation and inheritance (transmission), is differential fitness leading to selection. Fitness is often defined in terms of reproductive success and this notion has often been translated in the cultural realm as replicative success (Boyd & Richerson 1985; Shennan 2008). I have argued above that human-thing entanglement creates a tight skein of dependencies between humans and things. Taut entanglements may themselves be seen as the selective environments within which traits are selected and reproduced. The evolution of traits within these entanglements depends on technologies, economies and institutions. Reproductive success may be a product of and may to some extent be involved in the evolution of entanglements, but the primary factors leading to selection of traits emerge from the tautness of the specific entanglements themselves. It is thus possible to countenance a non-reductive evolutionary theory embedded in the specifics of particular historical contexts, as argued by Kristiansen.

We can, then, move from differential fitness to differential fittingness. The latter is a broader term that derives from the notion that things are 'fitting' in relation to each other and in relation to abstractions and embodied feelings about what is appropriate. I have described fittingness as having three components (Hodder 2012): affordance, abstraction and resonance. By affordance (see also Gibson 1986; Knappett 2005) I mean how the parts in an entanglement allow other parts to function in relation to some end. Affordances and functions are always tied to abstractions (ideas, thoughts, words) and they resonate within embodied practices. New traits are selected for if they are 'fitting' within these three realms.

It may be helpful to provide an example. Figure 1 is a 'tanglegram' outlining the entanglement in which clay was situated at Çatalhöyük. The relationships identified in the diagram refer to the earlier part of the sequence at the site. The diagram is not simply a network; rather it is a diagram concerning dependence. Each arrow stands for 'depends on' using two possible definitions. Some dependence or dependences (plural) are one way. These are often enabling or productive relationships. Thus midden depends on clay (clay or marl was spread over middens, maybe to clean them up or level them) but clay does not depend on midden; mortar depends on midden (midden is the main constituent of much mortar at the site) but midden does not depend on mortar; painting depends on the house (in which it is located) but not vice versa (since houses exist and stand at the site without paintings); the use of pigment depends on the landscape from which ochres and minerals were obtained but the landscape does not depend on pigments; burial depends on personal artifacts (as grave items) but personal artifacts do not depend on burial (since they were not made especially for burial).

A two-way dependence or co-dependence is indicated by a two-way arrow. These relationships may be mutual dependences but

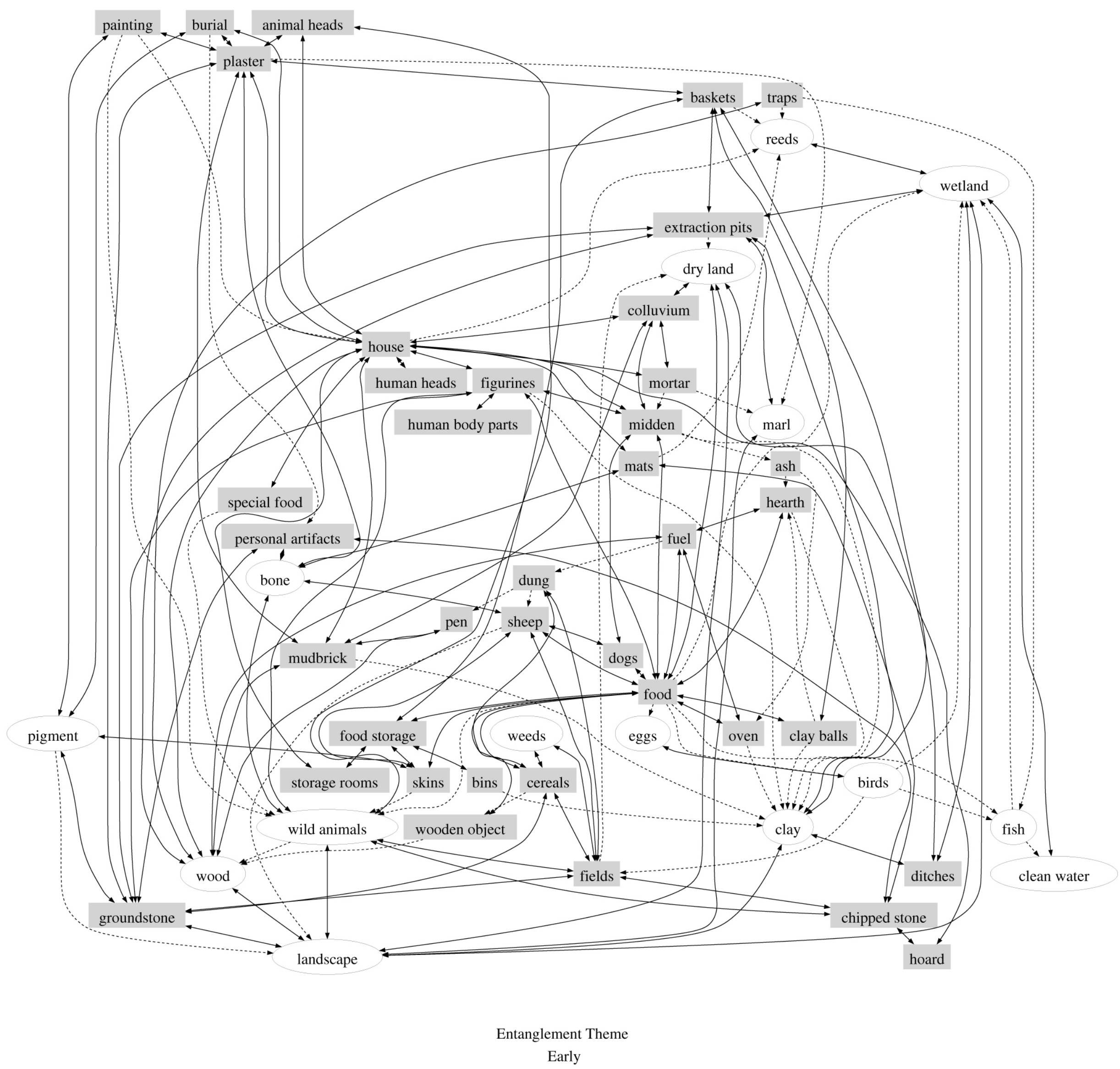

Fig. 1 Clay entanglements in the first part of the sequence of occupation at Çatalhöyük.

they may often involve dependency or dependencies (plural) in the sense of constraint or restriction. Dependency here refers to the way in which (as in psychological or World System discourse) the development of one entity is held back by another. Thus middens depend on dogs (to keep them clean from vermin) and dogs depend on midden (as space to live in since they were not allowed in houses) but dogs also add to the problem of midden by defecating on them; houses depend on midden (to be clean of refuse) and also middens depend on houses (for the refuse that constitutes them) but middens add to the problem of houses because they build up around houses causing erosion of walls and creating dirt beside houses; groundstone depends on landscape (as source) and landscape depends on groundstone (groundstone axes that cut down trees etc) but cutting down trees and obtaining rock change the landscape so that both trees and appropriate rock may be less available; cooking food depends on clay balls (before cooking pots were introduced) and clay balls depend on cooking (otherwise they would have no function) but the type of cooked food that is possible is constrained by the use of clay balls; house building needs wood and trees and it might be thought that trees and wood do not need houses but the persistence of trees in the landscape depends on how intensively this resource is exploited for buildings. In all these relationships there is both reliance and constraint. Indeed, entanglement can be defined as the dialectic of dependence and dependency.

The entanglement shown in Figure 1 includes affordances, abstractions and resonances. For example, middens and dogs afforded each other, and both dogs and middens were involved in abstractions to the effect that 'refuse and dogs are not allowed in houses', the floors of which were kept scrupulously clean. Fresh human excretion was also deposited in outside midden and it seems reasonable to argue that there were embodied resonances between dirt, dogs and excretion.

It is possible then to argue that the selection and persistence of any particular trait within the entanglements of Çatalhöyük depended on the particular and changing sets of dependences and dependencies within them. I want, as examples, to take three temporal trends through the sequence of Çatalhöyük in

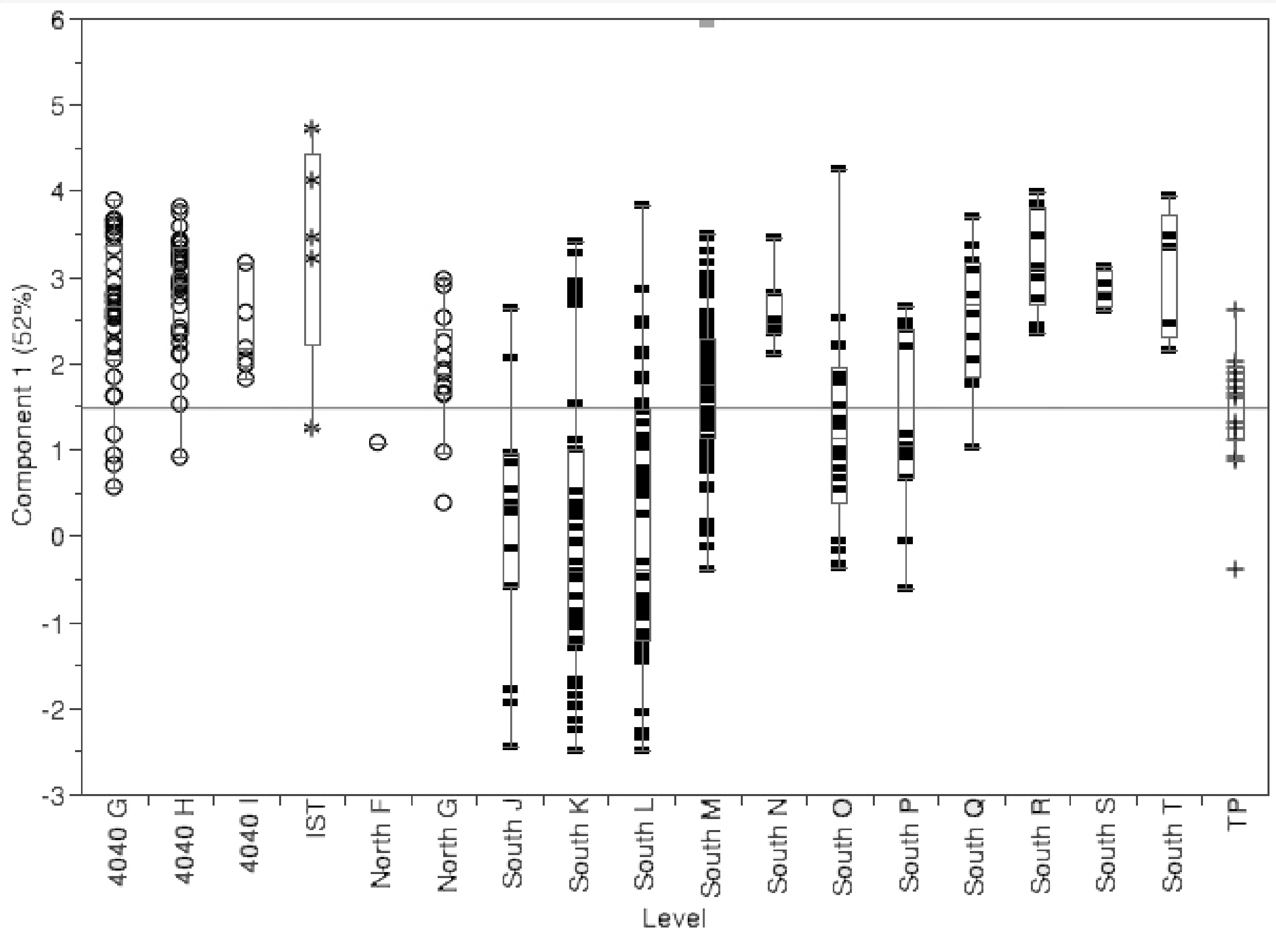

Fig. 2 Temporal changes in mudbrick composition from all areas (n= 358).

order to demonstrate the ways in which the fittingness of traits changes through time. The three trends are the gradual change in brick composition, the gradual increase in pottery and the gradual increase in house size. Discussion of these three trends will draw us into consideration of a wider range of human-thing transformations.

In terms of brick composition, Love (2013) used principle components analysis of four variables: sand-sized particles, organic and carbonate content and magnetic susceptibility in order to examine changes through time (Fig. 2). For the purposes of this discussion, it is the longer South sequence that is of interest. In the South levels a gradual change can be seen from dark-colored, organic-rich clays to sandy silt materials. Why did this change occur? Why were sandier bricks selected for over time?

In Figure 3 some of the decision-making regarding choice of brick composition is outlined as well as some of the contingent events that resulted, increasing the entanglements. Starting on the left in the diagram, we have excavated the quarry pits near the site from which alluvial clay was obtained to make the mudbricks used in the earliest levels at the site. The clays were smectitic and thus were particularly prone to expansion and contraction in wet and dry conditions. As a result the walls of buildings were very unstable and we have much evidence that they frequently buckled, bent and collapsed (Hodder 2006). Humans were thus entangled in a dependency on mudbrick. They had to endlessly manage the swelling and cracking of the clay walls. A number of solutions were found, including doubling walls, building houses immediately adjacent to each other so that the rain could not penetrate to the walls, and building wooden frames within the houses to provide support (Hodder 2007). Another solution was to gradually use sandier bricks that held together more effectively in the stresses and strains of expansions and contractions. Doherty (2013), as a result of extensive coring of the landscape, suggests that the sandier bricks partly came from colluvial material that built up around the mound, but also by digging through the alluvial clays and marls around the site to reach deeper sandier material.

An unintended consequence of the digging of deeper quarry pits around the mound may have been the expansion of the reed *Phragmitis australis*. Ryan (2013) has identified a major increase in the densities of phragmites in phytolith assemblages from Level South P onwards, following on from the initial use of sandy bricks and in parallel with a continued increase in the sandy inclusions in bricks in the upper levels of the site (Fig. 2). One explanation for this marked increase in phragmites reeds is that the quarrying (and other factors to be discussed below) disturbed the local wetlands around the site and encouraged this invasive and aggressive species. The increase in phragmites would have led to a drop in the water level and a decrease in local biodiversity – a biodiversity which the inhabitants of Çatalhöyük had utilized for a variety of resources from eggs and fish to water birds (Hodder 2005). This decrease in biodiversity and the spread of phragmites had to be managed and responded to. So humans had become entangled in things and processes that demanded greater labour and input.

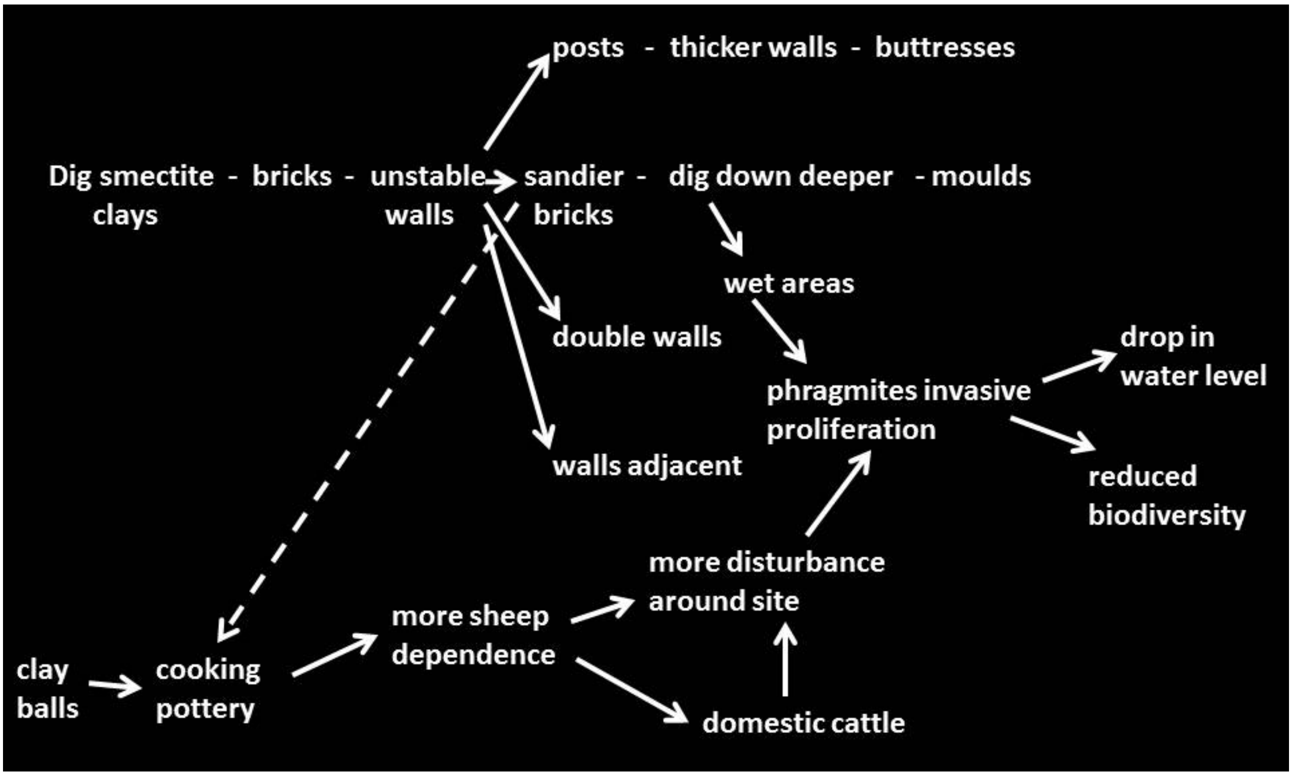

Fig. 3 Some decisions and contingent responses through the sequence at Çatalhöyük.

It would have been difficult to 'go back' and try and get out of the entanglement. Humans depended on the quarry pits to get the material to build houses, so they just had to deal with the implications. Besides, they had a dependence relationship with the phragmites reeds as well as a dependency relationship. The needed the reeds for roofing and matting, even if they had then to manage and cut back the reeds as they proliferated and decreased biodiversity.

So we can see how sandy bricks were selected for because they afforded various functions in a contingently changing set of dependences and dependencies. But other sequences too were entangled in these changes. As the bricks changed from organic to sand tempered, so too the pottery changed from organic to grit tempered. In Figure 4 the gradual increase in densities of pottery through time is shown. Pottery was introduced early on in the Çatalhöyük South sequence, initially at very low densities. The earliest pottery is organic tempered and there is little evidence that it was used extensively for cooking. However, by South M grit tempered cooking pottery became more common and there was a gradual increase in the density of pottery through the upper levels at the site (Fig. 4). While there is evidence of plant phytoliths in some pots (Ryan 2013), our clearest evidence is that the pots were used for processing the products of ruminants, mainly sheep meat, fat and grease (Pitter et al. 2013).

In the earliest levels at the site we have much evidence that, prior to the introduction of cooking pottery, cooking was achieved with the aid of clay balls that were fired and kept by the oven. They would then be heated and either be placed in baskets containing liquid in order to heat and boil the liquid, or food would be placed directly on them (Atalay 2005). As cooking pottery increased in density at Çatalhöyük, so the density of clay balls decreased (Fig. 5). Why did clay balls decrease and cooking pots increase? Once again the answer lies in a specific set of entanglements. Atalay (ibid.) has shown that cooking with stones or clay balls is very efficient. The disadvantage of the process is that the balls have to be frequently removed from the container and renewed. The cook has to be vigilant and present. The advantage of cooking pots is that they can be left on the hearth. The pot almost cooks for the human, acting as a delegate. The cook thus has more time to take on other tasks. Why might having more time in the house while cooking have been important?

Figure 6 shows that the size of houses gradually increased through time. There is a general process throughout Anatolia and the Middle East for houses to increase in size and internal complexity from the tenth to the seventh millennia BC (Flannery 1972; Byrd 1994). At Çatalhöyük specifically, burial, rituals, storage and a wide range of productive tasks took place inside the house (including cooking, plant and bone processing, obsidian production, bead manufacture). Through time houses seem to become more independent and productive, even taking over adjacent midden areas as yards where activities could take place (Hodder 2007). As the numbers of activities in houses increased there would have been a premium on tools that allowed multi-tasking. In such a context cooking pots would have been selected for in the place of clay balls. So the increase in cooking pottery was entangled with house size; the two variables were selected for in relation to each other within the entanglements surrounding clay and cooking. It may be the case too, that the shift to sandier sources of bricks was linked in some way to the contemporary shift to sand tempered cooking pottery.

The increased use of cooking pottery would have allowed the increased and more effective processing of sheep products. While

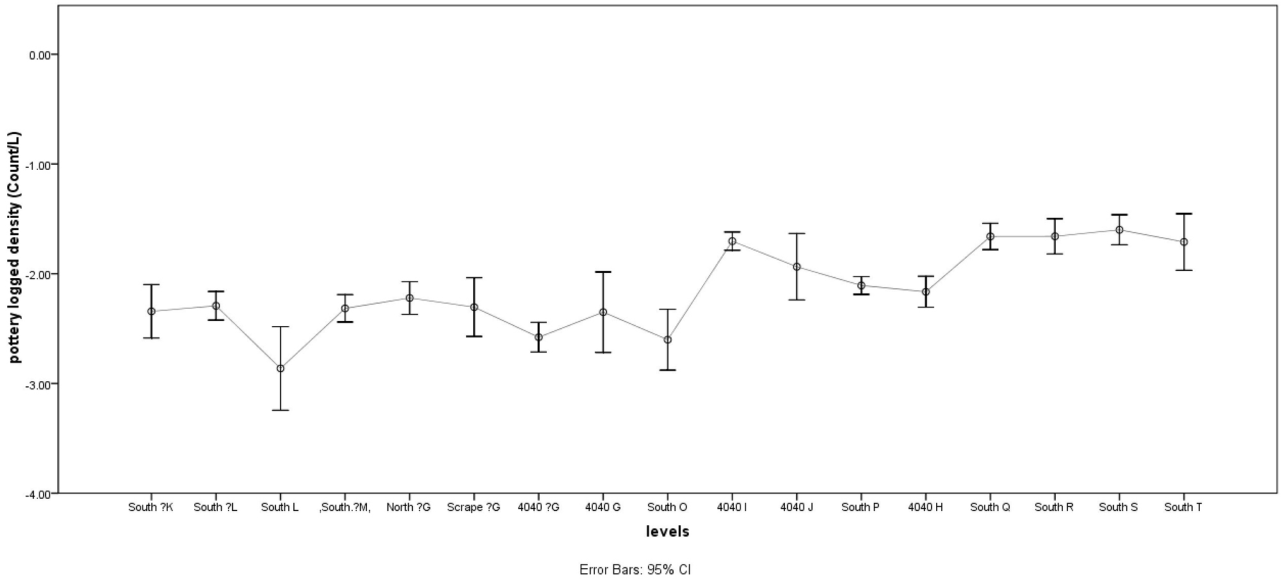

Fig. 4 The increasing density of pottery through time at Çatalhöyük (in South and other parts of the site).

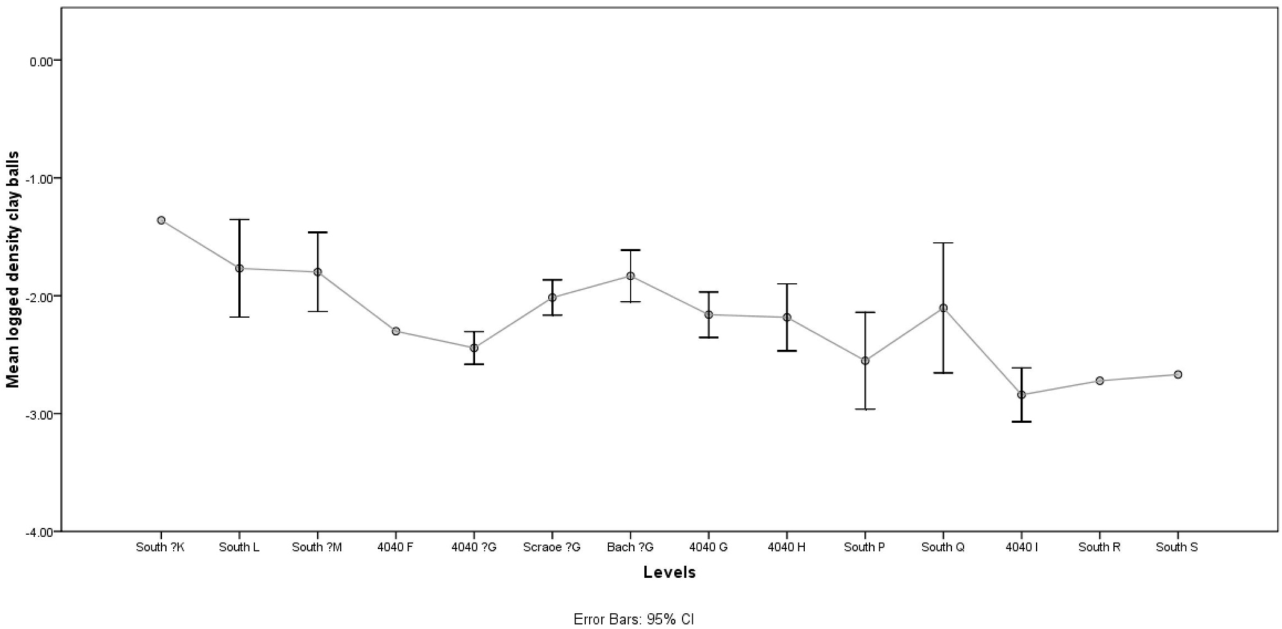

Fig. 5 The decreasing density of large clay balls through time at Çatalhöyük (in South and other parts of the site).

domestic sheep are numerically an important resource throughout the sequence at Çatalhöyük, the density of sheep bones increases dramatically around Level South P. Sheep were dependent on pottery for the processing of their meat, fat and grease, and the prevalence of pottery was itself partly dependent on its use for sheep product processing. But these dependence relations also led, perhaps unwittingly, to dependencies. The increase in sheep herding would have required that some parts of the flocks were kept near the site at least for part of the year. Close to the site they would have caused disturbance as they grazed or fed on fodder, encouraging the spread of phragmites. So, again, humans would have had to work harder to manage both the increased sheep flocks and their effects near the site. And they were also trapped into the process of digging or expanding their quarry pits in order to obtain clays and sands to make pottery.

We can see in these examples the gradual entrapment of humans and things in the web of entanglement. Another example is provided by cattle, or more specifically wild bulls. In Figure 1, wild animals are shown linked to many parts of the tanglegram, including the house in which animal heads and horns were placed as bucrania on walls and pedestals. The paintings recovered

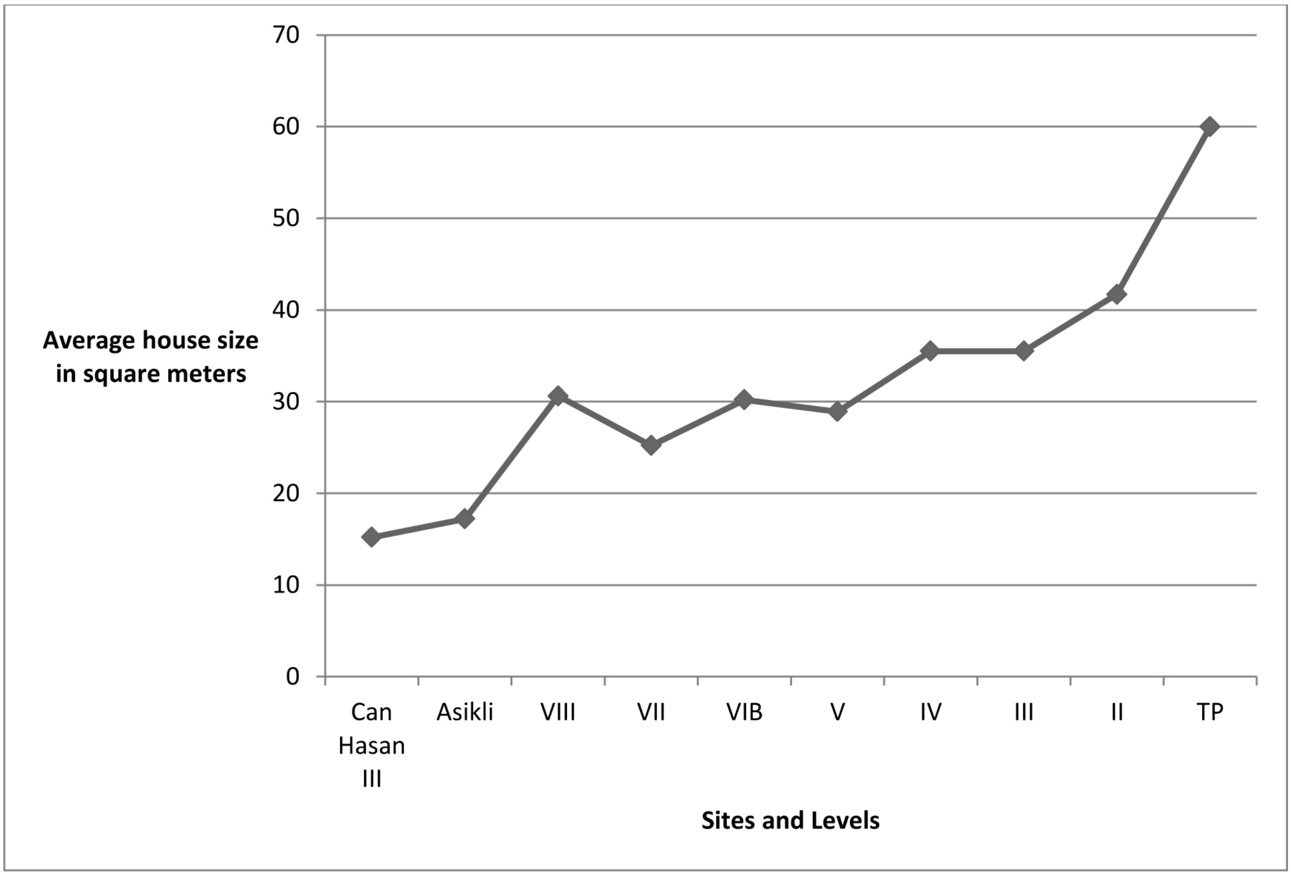

Fig. 6 The average size of houses in levels at Çatalhöyük (Levels VIII to II – using the Mellaart data, and TP) and at other sites in central Anatolia.

from upper levels at the site show collective rituals in which wild animals were teased and baited (Hodder 2006). We have on-site evidence that wild animals were involved in feasting. In particular wild bulls were preferentially used in feasting (Russell & Martin 2005) in contrast to sheep that were more common in daily consumption. So it is clear that wild animals, and especially cattle and in particular bulls, were important in terms of meat intake; but they also played a central role in social feasting and in ritual within houses. We have evidence that installations were sometimes retrieved from earlier houses, and we have evidence that stacks of wild bull horns were accumulated in certain houses or were arrayed along benches. It seems likely that the bucrania and horns acted as markers that memorialized social events and feasts. Humans thus depended on wild cattle for calories, for creating community structure, and for establishing ritual and history.

This ritual, social and symbolic system reached its apogee in Levels South M-O, after which it declined. There are fewer installations in houses in the upper levels of the site. Levels South M-O are also the phases in which population reached its maximum at Çatalhöyük (perhaps up to 8,000 inhabitants), and the analysis of human remains indicates this is both the period of highest fertility and the period of greatest stress and strain on the human body (Hillson & Larsen 2013). As population increased, so the human dependence on wild bulls for calories, community and history also increased, and we see the increased prevalence of bull horns and installations in houses.

Humans were thus caught within a particular heavy dependence on wild bulls. The bulls afforded meat, but also the opportunity for social gatherings and the creation of history. They were also involved in abstractions – for example, both human heads and bull heads were plastered and were kept and handed down across generations. The refleshing of bull heads using plaster may also have resonated with other examples of re-plastering as, for example, in the frequent renewal of wall plasters. So bulls were fitting within a rich set of affordances, abstractions and resonances. These entanglements between humans and bulls seem to have been foundational, so much so that they inhibited the adoption of competing traits. As Arbuckle (2013) has shown, domestic cattle were adopted earlier to the east, south and west of Çatalhöyük. Central Anatolia stubbornly resisted adoption in the early seventh millennium BC. This trait was not adopted because it was not fitting within the social, economic and ritual systems that depended on wild bulls.

But as we have seen, stresses and strains were emerging at Çatalhöyük in South M-O. The entanglements around wild bulls required large labour inputs (as seen in the paintings and in the sizes of some collections of bones amassed in feasting). This was an expensive way to maintain communities and histories. In South P we see the adoption, at last, of domestic cattle. As a result there were many changes in the upper levels of the site, including a decrease in installations in houses, more use of cattle in daily consumption and more use of sheep in feasts. Cattle were little used for milk production (Pitter et al. 2013), but the increased processing of cattle meat for daily consumption would have contributed to the increased size of houses, and the control of large amounts of meat on the hoof would have allowed houses to be more independent (as indeed we do see, as argued above).

Some cattle through part of the year would have been kept near the site, adding to the disturbances that encouraged the spread of phragmites. The adoption of domestic cattle occurred at the same time as the major increase in the density of sheep bones on the site, in the period around South P. it is possible that the increased investment in herding sheep meant there was less labour available for the collective rituals surrounding wild bulls. The greater investment in sheep herding may have facilitated the start of cattle herding (see Fig. 3).

We can trace the threads of the entanglements at Çatalhöyük. Some of the linkages I have made are more secure than others, but all are based on evidence such as temporal coincidence (the contemporaneity of the switch to sand-tempered bricks and pottery or the coincidence of the increase in sheep herding and the adoption of cattle herding). Other links are made because we know that pots were used for processing sheep or because we know of the ecology of phragmites. Behavioural archaeology has provided evidence for the greater efficiency of grit tempered pottery in cooking in comparison to organic tempered pottery (Skibo et al. 1989). Experimental and ethnoarchaeological research has shown the effectiveness and limitations of cooking with clay balls (Atalay 2005) in comparison to pottery. On the whole, archaeologists are adept at following human-thing and thing-thing interactions and dependencies.

Using these established archaeological techniques it is possible to explore the ways in which human-thing entanglements transform over time. Humans often seem drawn along by the vicissitudes of unruly things. Walls expand, shrink and collapse, thus setting off a train of interactions that are channeled within the tight skein of entanglements. An aggressive type of reed expands when disturbed. It becomes difficult to maintain wild bull feasting as labour is drawn into more intensive herding. In all these ways we see that contingent events set off chain reactions within entanglements. But the reactions that catch on and are adopted depend on the specific sets of dependences and dependencies. Domestic cattle were initially not adopted given the heavy human dependence on wild cattle for meat, community and history. In many aspects wild bulls created the fabric of social existence at Çatalhöyük; the adoption of more easily available domestic cattle would have undermined that fabric. But cooking pottery was adopted in the context of increasing labour and time demands within the house and in the context of digging deeper to obtain sandier clay for bricks. Sandier bricks were adopted to help hold up the increasingly large and independent houses, themselves increasingly large and independent partly because of labour- and time-saving devices such as cooking pottery, and later because of the greater independence of houses afforded by domestic cattle.

Reproductive success has not played a role in this account of the transmission of traits. The evidence at present intimates that the Çatalhöyük houses may not have been machines for the reproduction of genes. Using tooth morphology as a proxy measure for genetic distance, Marin Pilloud (Pilloud & Larsen 2011) has demonstrated that individuals buried beneath the floors of houses were not more closely related to each other than individuals in the population as a whole. Since production and perhaps sheep and cattle ownership were house-based at Çatalhöyük, it is difficult to argue that sandier bricks or cooking pottery or larger houses were selected for in relation to reproductive success. The assignment of individuals to productive units at Çatalhöyük may have been very complex and fluid. It is difficult to see how one could explore the notion of a link between the adoption of traits and reproductive success. The same is true of attempts to explain the increasing frequencies of cooking pots, sandy bricks and large houses in terms of cultural transmission and replicative success. Even if it was possible in some way to establish the modes of transmission used in the replication of these traits through time, these processes of transmission are in my view swamped by the dominance of the entanglements within which they would have taken form. In the end it is neither reproductive success nor mode of transmission that produce the sequences of cultural change through time. Rather it is the overall fittingness within entanglements, the entrapping of humans and things in their dependences and dependencies, that determines the selection of traits. Some entanglements do promote reproductive success, and we have seen that the social system focused on wild bulls was associated with increased population and increased fertility. But there were also accompanying stresses and strains that led to shifts in the entanglements and the selection of new traits (such as domestic cattle). In the end it is the entanglement itself in its interaction with contingent events in biological and material worlds that leads evolution in specific directions.

Conclusion

One important aspect of evolutionary theories is variation. I have argued here that things are always going wrong, running out, dying out, being unruly along the strings of entanglements. It may seem inadequate to try and develop a theory of long-term change that is based on ‘things going wrong’, but this is a core component of Darwinian explanations of evolutionary change where spontaneous gene mutations create variability. Things do not go wrong randomly for the most part. Things have their own temporalities so the timing of when they cause problems or back-ups or bottle-necks may seem random to humans. Things have their own relationships and interactions so that how things go wrong is structured to some degree. Humans also produce their own immediate variability as they engage with others and with things within the entanglements. So contingent variation is an important part of human-thing evolution.

But we run into greater problems when approaching a second aspect of evolutionary theory: inheritance and transmission. While humans do of course learn from those around them, they are also prone to tinker and transform. They often seem tradition-bound, and yet they just as easily invent traditions. Whether they do or do not copy and repeat what is around them depends. And so we are taken immediately into all the dependences and dependencies within human-thing and thing-thing relationships. Humans work within a corpus of things around them that they refer to, but the factors affecting whether they copy or not include whether they can afford to copy and whether the copies are consistent both abstractly and in terms of bodily resonance. The tautness of the entanglements, the degree of entrapment, influence what is inherited and transmitted. People can rarely afford to copy prestigious people (context bias) or stick to the imitation of a successful role model (indirect bias) or copy more effective solutions (results bias). Whether they can try out their own solutions (guided variation) depends.

Similar concerns surround the third aspect of evolutionary theory: differential fitness. In evolutionary theory this fitness usually means reproductive success within specific environments, measured in terms of survival of offspring down several generations, efficiency of resource acquisition, or success in replication as successful people are copied. While all these factors must be relevant, to greater or lesser extents in different contexts, they are themselves embedded in entanglements of humans and things that are complex and entrapping. Rather than focus on fitness, I have suggested that the more inclusive term of fittingness be used. This incorporates affordances, abstractions and resonances that are woven together and influence whether a trait is likely to survive or not. A trait may be fitting and survive in such an entanglement regardless of whether it enhances reproduction, efficiently acquires resources or is used by successful people. Fittingness itself is an adequate framework within which traits are or are not selected, prosper, persevere and die out. Fittingness is a heterogeneous matrix: it does not require a reductive moment. It allows a non-reductive evolutionary theory.

In describing the transformation of human-thing entanglements through time it has become clear that some sort of engagement with Darwin-inspired approaches is useful as they deal with the long term and de-centre from humans to the things that get selected for. But two of the struts of these theories, selection and transmission, seem more acceptable if reworked within a theory of human-thing entanglement. These shifts in focus lead, in a way that I hope Kristian would approve, to a non-reductive theory of change that explores innovation and the selection of traits in relation to the tautness of heterogeneous entanglements rather than in relation solely to reproductive success, resource acquisition and the transmission of information from successful individuals.

Ian Hodder: ihodder@stanford.edu

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