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The origins of sedentism: Climate, population, and technology

Gregory K. Dow*, Clyde G. Reed

Department of Economics, Simon Fraser University, Canada

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ABSTRACT

For most of the time that anatomically modern humans have existed, small mobile foraging bands followed natural resources. Starting around 15,000 years ago, communities of sedentary foragers began to emerge. This transition has been detected archeologically in numerous regions of the world, including southwest Asia and Japan. In these cases and others, the transition to sedentary foraging occurred several millennia before the transition to agriculture. We develop an economic model of this process that combines climate change, population growth, and technical progress. Better climate led to a larger population for Malthusian reasons, and in some cases this led to technological innovation. A novel insight from our theory is that technological change caused a ratchet effect that made sedentism persist even in cases where climate subsequently deteriorated.

1. Introduction

From the origins of anatomically modern humans until after the last glacial maximum around 21,000 years ago, almost everyone lived in small, mobile foraging bands (all dates are in calibrated radiocarbon years before present except where stated). These bands probably had no more than about 25–30 members. Starting around 15,000 years ago, foragers in some regions such as southwest Asia and Japan began to develop large permanent settlements. The transition to sedentary foraging predated agriculture by several millennia and accelerated with the onset of the Holocene 11,600 years ago, which brought a warmer, wetter and more stable climate. The best evidence for early sedentism comes from temperate zones. Among recent hunter-gatherer societies, those located in tropical rainforests and the Arctic have tended to remain the most mobile (Kelly, 2013).

Sedentism can be defined in various ways and is a matter of degree, so we need to clarify our use of this term. First, it is important to recognize that mobile foraging groups do not just move at random across the landscape. A common pattern involves the use of seasonally shifting base camps on a regular annual cycle, with hunting and gathering on trips away from each seasonal base camp. When anthropologists and archeologists refer to 'sedentism', they often mean the use of settlements that are at least partially occupied year-round. The evidence used by archeologists to infer sedentism at a site includes the presence of plants and animals from all four seasons; the presence of species that flourish when in frequent

* Corresponding author. Tel.: +1 778 782 5502; fax: +1 778 782 5944.
E-mail address: gdow@sfu.ca (G.K. Dow).

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contact with humans (e.g., mice, rats, and sparrows); large investments in dwellings, earthworks, ceremonial structures, or monuments; increases in burials; and site-specific investments in food processing and storage facilities.

While we accept these indicators of sedentism, we require more than simply the year-round occupation of a site. A time period in our model is defined to be one human generation. We are therefore interested in the conditions under which adult children stay in the same location as their parents, even when facing multi-year environmental shocks that reduce the abundance of local food resources. We say that a community is sedentary if it is robust to such negative shocks over periods lasting decades or centuries. This time frame is appropriate for the archeological data available to test our theory: it provides a sufficient time for major structures to be built, for burial practices to evolve, for technical and institutional innovations to occur, and so on.

The emergence of large permanent communities was a massive transition relative to the ancestral lifestyle of small mobile bands. This transition had several interrelated effects including population growth, technological innovation, greater dietary breadth, the evolution of property rights, and investments in fixed assets. In turn, these factors were fundamental to the emergence of agriculture, inequality, warfare, the state, and long run economic growth. Understanding the origins of sedentism (as defined in this paper) is therefore crucial for understanding these later economic events.

It is especially important to recognize that the transition to sedentary foraging was distinct from the later transition to farming and requires a distinct theoretical explanation. In some regions of the world (e.g., southwest Asia), the transition to sedentary foraging was followed by a pristine agricultural transition, but only after a lag of several thousand years. In other parts of the world (e.g., Japan and the northwest coast of North America), sedentary foraging did not lead to the indigenous development of agriculture. However, even without agriculture, sedentary foraging often led to inequality and warfare (see Dow and Reed, 2013, on inequality, and Dow et al., 2014, on warfare). Where pristine agricultural economies did emerge, sedentary foraging appears to have been a necessary first step for several reasons: first, because it stimulated regional population growth; second, because high agricultural productivity required ongoing labor inputs from nearby residents; and third, because the resulting output had to be defended.

It is evident from ethnographic data that group sizes among sedentary foragers are much larger than for nomadic foragers (Kelly, 2013:171–2). Using original data from Keeley (1988, 1991), Rowley-Conwy (2001:40–44) shows that ethnographically known foragers fall into two very distinct groups: one cluster with low sedentism that has low population relative to natural productivity, low use of food storage, and low stratification; and another cluster with high sedentism that has opposite features. A classic example of the latter is provided by societies on the northwest coast of North America (see Ames and Maschner, 1999). Such societies illustrate Kelly's (2013:104) observation that sedentary foraging led to "social hierarchies and hereditary leadership, political dominance, gender inequality, and unequal access to resources".

What caused mobile foragers to become sedentary foragers? A common answer involves direct effects of nature. The idea is that people are mobile when the location of food resources is constantly shifting, or when important resources are not available all in one place. People become sedentary when nature provides a sufficiently rich and reliable assortment of resources at a single location.

We don't doubt that this is part of the story, but it is far from the whole story. As we will see in Section 2, sedentism was not just a matter of existing people settling down in one place. It was accompanied by regional population growth, larger settlement sizes, exploitation of new food resources, and technological innovation. These changes often included more use of plant or aquatic foods as compared with prey animals; investments in fixed food processing tools such as mortars and ovens, as well as storage facilities; and durable forms of housing (Kelly, 2013:122–128). Such innovations likely emerged over centuries. Why were mobile foragers who initially lacked these techniques nevertheless attracted to sedentism? How can we explain the recurrent pattern of population growth, greater dietary breadth, and technical change?

We develop a formal model that addresses these questions. We consider a region with many individual production sites, where the weather at each site can be good or bad. Good weather is associated with abundant food resources and bad weather is associated with scarce food resources. In our model, a climate regime is defined by the probability distribution over weather conditions (temperature, precipitation, etc.) at each site. For a given climate these random draws are independent across sites and time periods, so a site that is good in one period can be bad in the next period. A change in climate refers to a change in the probability distribution for these weather events. The rate of sedentism is the fraction of the local population that remains in place when a site switches from good to bad weather. This is our measure of how robust communities are to natural shocks.

The shift from the last glacial maximum to the Holocene involved both better mean weather and decreased variance in weather (Woodward, 2014, chs. 8–9). Given this climate change, three causal mechanisms could have led to a positive rate of sedentism. First, in the short run the lower variance would have reduced the productivity difference between good and bad sites, so the existing regional population could spread out into sites that previously would not have been used. Thus when a site switched from good to bad under the new climate regime, some residents would remain in place.

Second, in the long run the improved mean would have led to population growth through Malthusian dynamics. Even if the lower variance in weather was not sufficient to cause sedentism by itself, a higher regional population could lead to some use of bad sites and therefore a positive sedentism rate. Neither of these two mechanisms requires technical change, and each is reversible in the sense that if climate reverts to its earlier mean and variance, the sedentism rate will eventually return to its original level.

The third causal mechanism involves technological innovation. We assume that agents can use two methods of food collection. We will refer to these metaphorically as 'hunting' (a shorthand term for mobile methods) and 'gathering' (shorthand