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The domestication of human birth

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ABSTRACT – *Observations of the burial places of newborns at the prehistoric site at Lepenski Vir (Serbia) revealed the possibility that deliveries took place inside houses that were heated. Warm houses provided a thermally stable environment which, in turn, could solve the problem of thermoregulation, that is critical for the survival of babies. In this study it is shown that the creation of these good conditions for giving birth could have been an important step in human evolution that could have led to a demographic expansion.*

IZVLEČEK – *Opazovanja prostorov s pokopi novorojenčkov na prazgodovinskem najdišču Lepenski Vir (Srbija), so pokazala možnost, da se je rojevanje dogajalo znotraj ogrevanih hiš. Ogrevane hiše so zagotavljale termalno stabilno okolje, kar je morda rešilo problem termoregulacije, ki je odločilen za preživetje otrok. V tej študiji prikažemo, da je lahko ustvarjanje dobrih pogojev za rojevanje pomemben korak v človeški evoluciji in je lahko pripeljal do demografske ekspanzije.*

KEY WORDS – *Lepenski Vir; human birth; thermo-regulation; domestication*

Introduction

During the entire evolution of humans, the process of giving birth has been a key factor in their survival. The low human population that existed up to the Neolithic indicates that living conditions were very hard and that Palaeolithic populations were capable of maintaining only simple reproduction, without significant population growth. The way of life during the Palaeolithic age, cold climate, and high daily fluctuation of air temperature were detrimental to giving birth and for taking care of newborns. With the Neolithic came the first demographic expansion, but it is still not well understood what caused it. In this study, we attempt to show that it may have been caused by improved conditions of parturition.

It is well established that in the past and the present, different cultures have created good conditions for giving birth and for neo-natal care (*Cressy 1997; Jordan 1993; Priya 1991*). Thus, there are no reasons to believe that during the prehistoric period, humans had a different approach to these important aspects of their life. However, little attention has been paid in the archeological literature to this problem (*Beausang 2000.69–70*), and hence there is no developed methodology for investigating it. Recent studies by O'Donnell could be very helpful in finding material proof for establishing such a methodology (*O'Donnell 2003; 2004.165*). Her investigation of various aspects of parturition show that it always includes: 1) thermal regulation to ensure the viability of the newborn infant; 2) a defined spatial location; 3) support and companionship; 4) mobility, in order for the mother to negotiate the process; 5) attention to the pre- and post-natal environment; and 6) ritual and symbolism in the psychological negotiation of the process.

In this study, we consider thermal regulation and the defined spatial location as key factors for successful birth and neo-natal care. Our working hypothesis is that developments in early houses, as the defined spatial location for birthing, brought about dramatic improvements in the conditions for birth and child-care because one of the functions of those houses appears to have been that they served as places where women gave birth and where babies and infants were cared for. Our analysis was based on data obtained from the archaeological site at Lepenski Vir, located in the Danube Gorges (Serbia), with the Mesolithic phase at around 7500 Cal BC and the Early Neolithic phase at 6300–5500 Cal BC (*Bonsall et al. 2000; Borić 2002; Cook et al. 2002*). We provide two sets of evidence that indicate that the prehistoric women in the Danube Gorges had good conditions for giving birth, and could have enjoyed reproductive success – first, that those women gave birth inside houses that have been discovered at Lepenski Vir and other archaeological sites in the Danube Gorges; second, that those houses were heated and thus could have provided favourable conditions, including thermoregulation, for survival of newborns.

'Maternity ward'

The only reliable piece of evidence that a birth had taken place at a given prehistoric site is the skeleton of a newborn baby found at the location (Fig. 1). After the lifting of house floors in 1970, 41 infant skeletons were found at Lepenski Vir (Figs. 2 and 3) (*Borić and Stefanović 2004; Stefanović and Borić in press*). The largest number of skeletons (28) were aged from 38 to 40 gestational weeks (babies at the age of birth) (Fig. 4). Six skeletons were of slightly younger, and can be explained as premature. The remainder were somewhat older, i.e., newborns that lived a few weeks or months. DNA-based sex identifications of 33 sampled newborn skeletons show that 19 of the newborns were males and 14 were females (*Čuljković et al. in press*). The pattern concerning the newborn burials is that all of them were placed exclusively in the rear of the houses (in 19 houses). Burial pits were either cut through the limestone floors or dug immediately off the floor edge, often between the construction stones surrounding the floor. Taken together, these pieces of evidence suggest that births took place inside these houses. The possibility that women gave birth outside the house and that children who did not survive were taken back and buried inside the house does not seem tenable. For example, it was found that some children who were buried inside the house had survived several months after birth. Thus, the presence of child skeletons under the floors of the houses indicates that the birth took place in the house, and that babies that survived their birth continued to live in those houses. In other words, at Lepenski Vir, the houses served as 'maternity wards' and the birth event became domesticated.

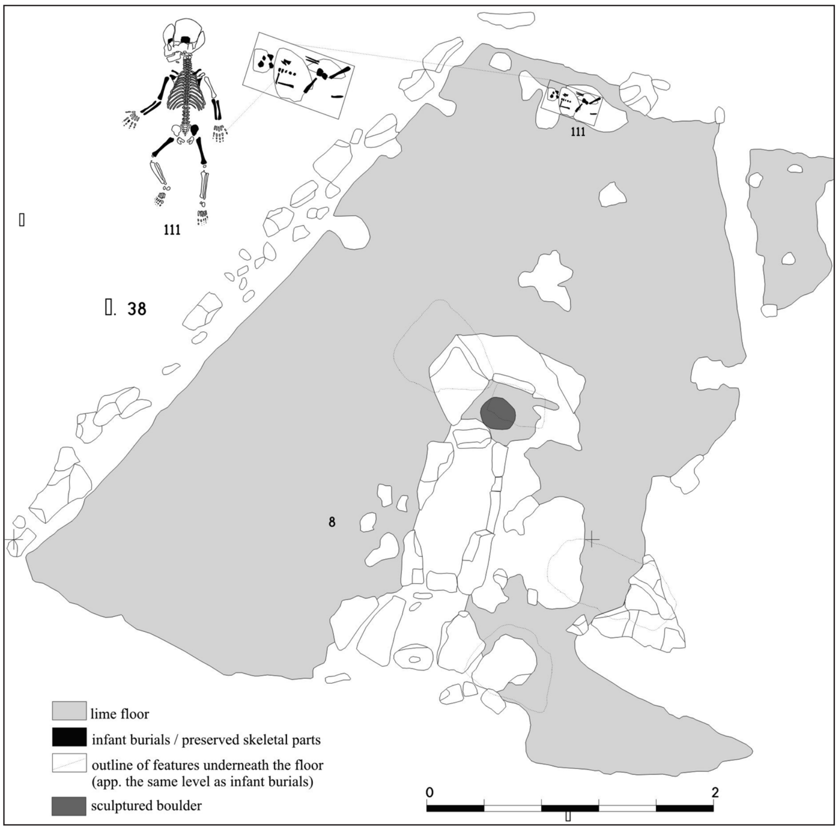

Fig. 1. House No. 38 from Lepenski Vir with a rectangular hearth inside and with newborn burial No. 111. The burial was placed in a pit that was cut through the lime floor. The skeleton belongs to a newborn girl (38–40 gestational weeks), found on her back, (supine) with legs splayed outwards, in a S–N orientation (after* Stefanović and Borić in press.Fig. 5*).

Heated Houses, Thermo-regulation and Baby Care

In each of the houses examined, there were hearths in the centres of the houses, of more or less rectangular shape, constructed from limestone slabs placed vertically (Fig. 5). According to Radovanović, hearths are the "most conspicuous architectural feature" of the Danube Gorges (*Radovanović 1996*). Is there any connection between hearths and babies? We be-

Fig. 2. Grave 98, newborn-girl (35–37 gestational weeks) House No. 19. The skeleton is flexed on the left side in a NW–SE orientation (photo: Department of Archaeology, Faculty of Philosophy, University of Belgrade).

lieve there is, and it is highly significant. A hearth means heat, and a hearth in the house means a warm house, which is essential for survival of newborn babies. There have been no studies or analyses that could show how the houses in the Danube Gorges were heated, or what room temperature could be achieved in them.

Interestingly, however, in many of the houses, burned limestone blocks were found, while no other evidence of fire, such as tar or ash, was present. This suggests that the stone blocks were heated outside of the houses and then brought inside and placed in the rectangular hearths as a source of heat. To show plausibility of the idea that the limestone blocks could provide heat to the houses, we carried out basic heat transfer calculations. We estimate that hot limestone blocks heated to 100 °C could raise the room temperature from 10 °C to a comfortable 20–30 °C (see Appendix). This, as we explain below, was sufficient to prevent and offset hypothermia among newborns. It is noteworthy that the system for heating houses described above was more probably used at older sites, such as Vlasac. At more recent sites, such as Lepenski Vir, the heating system appears more advanced. Houses had a rectangular hearth in the centre, with an approach platform, and an outdoor fireplace connected with the hearth through a funnel-like hole, suggesting some kind of 'central heating system' (Fig. 5).

One of the most critical features in the survival of newborns is temperature regulation. Even today, thermo-regulation is one of the most important and challenging aspects of the neonatal care (*Weber on-line*). The transition from the intra-uterine to the extra-uterine environment is accompanied by a substantial temperature change that compromises the baby's thermoregulatory abilities. If the delivery does not take place in a warm and thermally stable environment, during the first 10–20 minutes following birth the newborn may lose enough heat for its body temperature to fall by 2–4 °C , with even greater falls in the ensuing period if proper care is not given (*Adamsons and Towell 1965; Dahm and James 1972; Smales and Kime 1978*). Consequently, the baby will develop hypothermia, i.e., a body temperature below normal. If the neonate's body temperature is less than 36.5 °C, it enters a state of cold stress, a condition that results in many complications and often causes death (*Neonatal Thermo-regulation Guidelines for Practice 1997; Ellis et al. 1996*). Although today we know of about twenty symptoms of cold stress (*Thermal protection and/ or management of neonatal hypothermia and hyperthermia on-line*), the first of them, when the body is cold to the touch, was certainly something that prehistoric peoples had often experienced; and they knew that it could be altered by warming up. It is well known that for a baby to survive hypothermia, it has to be warmed up such that in addition to

Fig. 3. Grave 103, newborn-boy (38–40 gestational weeks), House No. 19. The skeleton is on his back (supine), with contracted legs in S–N orientation (photo: Department of Archaeology, Faculty of Philosophy, University of Belgrade).

Fig. 4. A skeleton of a newborn-boy (38–40 gestational weeks), Grave 114, House No. 36. The estimated gestational age of infants from Lepenski Vir was made according to the maximal length of both/either femur and/or humerus which give precision of ± 2 weeks. (photo: Paleoanthropological collection, Faculty of Philosophy, University of Belgrade).

skin-to-skin contact, it has to be in a room with an air temperature from 25 °C (in the case of mild hypothermia) up to 38 °C (in the case of intensive hypothermia (*Thermal protection of the newborn: a practical guide on-line, Silverman et al. 1958; Johanson et al. 1992*).

Such conditions could be hardly achieved during the prehistoric period, especially when babies were born in the open. It is very likely that prehistoric people used skin-to-skin contact to warm up their babies. This method is effective only if babies stay close to their mothers' bodies throughout the day, and if the air temperature does not fall below 25 °C (*Karlsson 1996; Färdig 1980; Acolet et al. 1989; Christensson et al. 1992; Singh et al. 1992*). Since women from Lepenski Vir gave birth and took care of their newborns inside houses that were heated, deliveries took place in a thermally stable environment which, in turn, led to a higher rate of survival of newborns. In addition to providing favourable thermal conditions, these prehistoric houses offered some other advantages for giving birth. For example, they were of small dimensions (from 5.5 to 28 m^2) (*Radovanović 1996*), and could be easily illuminated from inside, a condition that is very important for delivering babies (e.g., for severing the umbilical cord, and for cleaning the baby and the mother immediately after the delivery). Since, like other primates, humans usually give birth at night, delivering a baby in a lighted house could make it easier for the mother and those who attended her during delivery. There are also important psychological advantages to giving birth in a sheltered, warm, and lighted place, which we do not address in this study. Taken together, all these aspects of giving birth inside the house show that the prehistoric people of the Danube Gorges region provided favourable conditions for the survival of their newborns.

It is reasonable to assume that the domestication of birth occurred in all regions where humans built houses. As a consequence of these improved birth and aftercare conditions, it is very likely that infant mortality was substantially reduced, which, in turn, contributed to the first human population expansion. Furthermore, if the prehistoric people of the Danube Gorges indeed experienced a demographic expansion, then they were most probably the founders of the later agricultural Starčevo and Vinča cultures. This, in turn, could mean that there was a strong pre-Neolithic nucleus of people in the Balkans that had emerged from an autochthonic population of hunters-gatherers.

Fig. 5. Rectangular limestone hearth from house No. 4 (photo: **Srejović and Babović 1983.175*****). At Lepenski Vir, houses had a rectangular hearth in the centre with an approaching platform and with an outdoor fireplace connected with the hearth through a funnel-like hole, suggesting a possibility of a 'central heating system'.***

Summary

Data obtained from Lepenski Vir indicate that at the beginning of the Neolithic there existed good conditions for giving birth and neonatal care. Women gave birth inside warm houses that, in turn, helped to solve one of the most important problems in the survival of newborn infants, thermo-regulation. Evidence from Lepenski Vir indicates that women in this region were "sedentary mothers", and therefore, the act of giving birth became domesticated. This lead to a reduction in infant mortality and, consequently, to population growth.

Appendix

We used the following heat transfer equation

$$m_B c_B (T_B - T_R) = m_A c_A (T_R - T_A)$$

where m_B, c_B and T_B are mass, heat capacity and the initial temperature of the limestone blocs, m_A, c_A and T_A are mass, heat capacity and the initial temperature of the air inside the house, respectively, and T_R is the temperature of heated room air. This equation describes heat transfer from a heated limestone block (T_B) to a cold air temperature (T_A) inside the room. The heat transfer takes place until the room temperature raises to equilibrium value (T_R), after which a heat balance is established. All other heat losses are ignored.

It is assumed that the limestone blocks are heated to T_B = 100 °C = 373 °K, and that the initial room temperature is T_R = 10 °C = 283 °K. The mass of the block is assumed to be m_B = 1 kg. To calculate the mass of air inside the house (m_A), we assumed for simplicity that the dimension of the house is 2x2x2m, i.e., 8m^3. Since the air density is 1.29 kg/m^3, it follows that m_A = 1.29 kg/m^3 x 8m^3 = 10.32 kg. The heat capacities of limestone and air are obtained from engineering tables: c_B = 850 J/kg °K and c_A = 716 J/kg °K, respectively. By substituting these values in the above equation, we obtained the room temperature of a heated house: T_R = 19.3 °C. By placing two limestone blocks inside the house, the temperature could be raised to T_R = 26.8 °C.

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