Did *Homo erectus* sensu lato live in western Europe during the Early Pleistocene? An ecological approach to a vexing question

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Manuscript received: 7 April 2021, accepted 22 April 2021

Multiple sites in Europe dated around 1.8-1.7 Ma ago yield a characteristic larger mammal fauna consisting of proboscideans, rhinoceroses, cervids, bovids, equids and predatory and scavenging carnivores. Part of this fauna originates from a migratory out-of-Africa event, *c*. 2.0 Ma ago. Lithic artefacts are being found in several of these localities, while in one locality, Dmanisi (Georgia), remains of *Homo erectus* (*sensu lato*) are also present. The presence in localities such as Chilhac (France), Pirro Nord 13 (Italy), and possibly West Runton 'Stone Bed' (England) of a Middle to Late Villafranchian mammal fauna (MVMF/LVMF) in association with stone tools and in a context dated or correlated to an age around 1.8-1.7 Ma, makes us hypothesize that *Homo erectus* (*sensu lato*) lived in (north)western Europe during this time-frame, and that early humans formed an integral part of the Late Villafranchian Mammal Fauna. The *ex-situ* finds in Liessel and Mill-Langenboom (The Netherlands) suggest potential evidence for human presence there too.

Key words: Late Villafranchian, mammal communities, early humans, Dmanisi, Chilhac, West Runton

Introduction

The timing of the arrival of early humans in Western Europe has been subject of publications and debates for many years (*e.g.*, Roebroeks & Van Kolfschoten, 1995; Arzarello & Peretto, 2010; Toro-Moyano *et al*., 2013; Muttoni *et al*., 2013, 2018; Carotenuto, *et al.* 2016; Roebroeks *et al*., 2018). Palaeontologists and palaeoanthropologists traditionally rely on two sources of information: actual fossils (skulls, teeth, bones) or traces left by early humans in the form of stone implements, butchering marks on skeletal elements of animals used for food, or the like.

A consensus about the arrival of humans is lacking, although the timing of the presence of early humans in Europe has been pushed back from around 0.5 Ma in the 1990's (Roebroeks & Van Kolfschoten, 1995) to roughly around 1.5-1.6 Ma (*e.g*., Arzarello *et al*., 2007, Crochet *et al.,* 2009, Arzarello & Peretto, 2010, Martinez *et al*., 2010, Garcia *et al*., 2011, Toro Moyano *et al*., 2013). Some of these results are disputed (*e.g*., by Madurell *et al*., 2012), but concern mainly records from the western Mediterranean, the Italian and Iberian peninsulas. However, since the discovery of human remains in Eurasia dated 1.77-1.85 Ma in Dmanisi, Georgia (Gabunia *et al*., 2000a, 2000b; Lordkipanidze *et al*., 2007) and 2.12 Ma in Shangchen, China (Zhu *et al*., 2018), the question becomes relevant whether or not hominids (early humans) also lived in Western Europe prior to 1.5-1.6 Ma. Although no definitive solution can be provided until the discovery of undisputed hominid fossils, we feel that the discussion can be stimulated by using another approach, based on faunistics. Hominids are mammals, larger mammals, and as such they formed part of an ecosystem in which many other species found an existence. Here we will describe this ecosystem in terms of faunal composition and landscape, after which we will explore indications for the possible presence of early humans in faunal associations in Western Europe, including *ex-situ* associations of fauna and hominid artefacts in two sites in The Netherlands.

During intervals of the Early Pleistocene, Europe was inhabited by particular yet characteristic sets of large and small mammals, the so-called Villafranchian Mammal Faunas. As a result of invasions from either central or eastern Asia, and/or Africa, and facilitated by a favour-

able climate, these mammal faunas expanded from the British Isles in the West to the Caucasus region, and beyond, in the East. Around 2.0 million years ago, an African influx brought species like *Panthera gombaszoegensis* (Kretzoi, 1938), *Pachycrocuta brevirostris* Gervais, 1850 (see Rook & Martínez-Navarro, 2010), and *Homo erectus* (Dubois, 1894) to Europe (Figure 1). This latter migration is often termed the first 'Out of Africa' event for hominins (Carotenuto *et al.,* 2016, but see also Zhu *et al*., 2018 for a possible earlier event). These newly arrived species joined an abundant mammal fauna that was already existing, and together they formed the so-called Late Villafranchian Mammal Fauna (hereafter LVMF). The LVMF lived in an ecosystem stretching from the present UK to the Caucasus region, where a forested environment with large open spaces and some open water was present. Abundant fossil remains of this LVMF are found in many localities in the region mentioned above. An unsolved question, however, is whether or not, and if so to what degree, *Homo erectus* (*sensu lato*, see *e.g.* Terhune *et al*., 2017) formed part of the LVMF. Even if *Homo erectus* was present, the chance of preservation is very small, hence indirect indicators of its presence are important to outline their distribution.

In Dmanisi, Georgia, a rich and typical LVMF is found in combination with (a) several specimens of *Homo georgicus* Gabounia, de Lumley, Vekua, Lordkipanidze & de Lumley, 2002 (= *Homo erectus* - *sensu lato*) and (b) lithic artefacts, within (c) a well dated stratigraphical context. This combination of fauna, hominids, stone tools and accurate datings provides the palaeoecological framework for the interpretation of similar, though less rich, localities in Europe. Examples of these are localities in France, Italy, the Netherlands and England, where lithic artefacts have been found in association with an LVMF but without evidence of hominid fossil remains. The presence of these artefacts was overlooked or even denied (*e.g.*, Raynal *et al*., 1995). This position appears no longer tenable, and the question then arises who made these artefacts when no actual dental or skeletal remains of (early) hominins were found in the same sedimentary context as the LVMF.

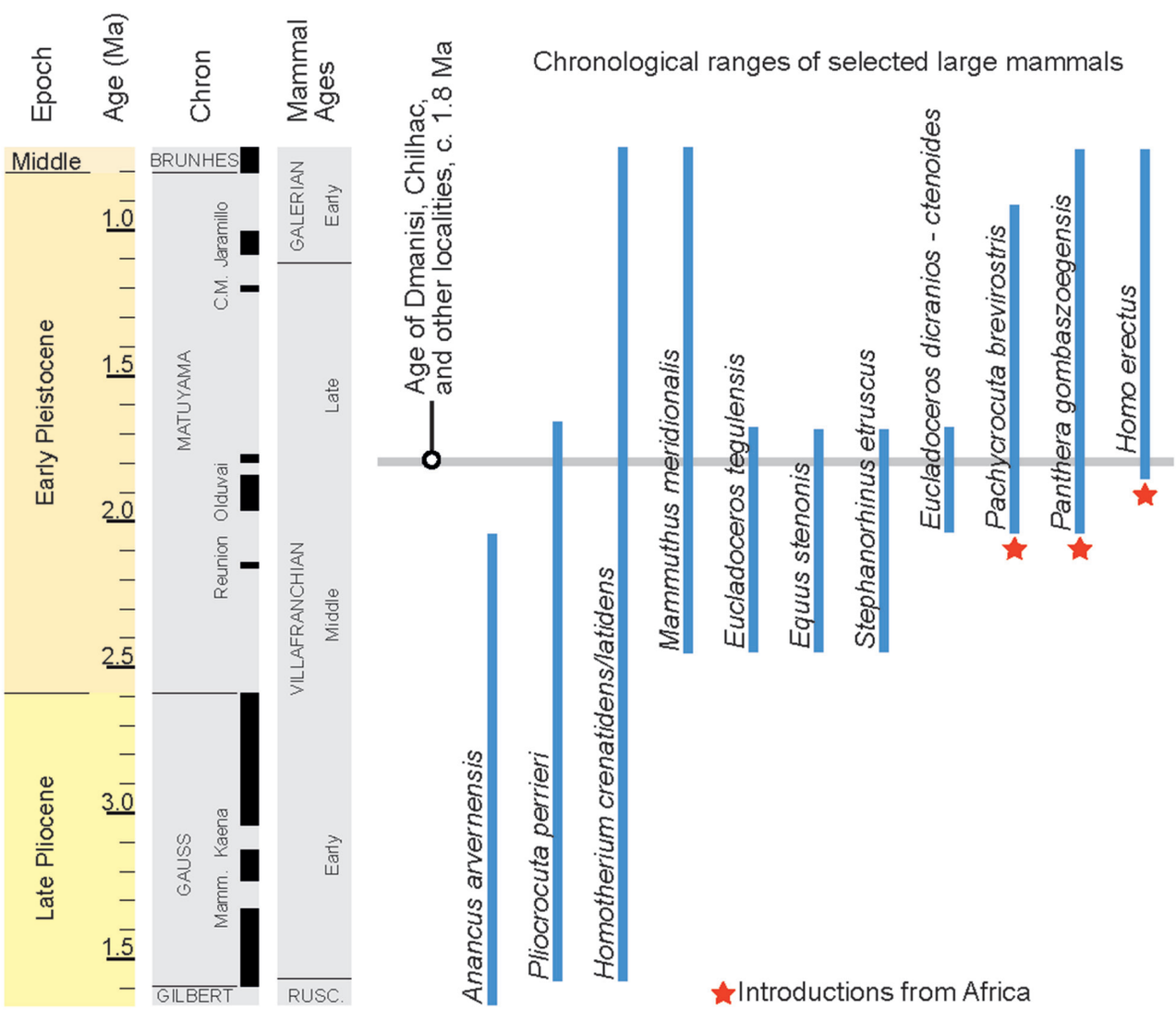

Figure 1. Range chart showing ranges of selected typical Late Villafranchian large mammal species comprising the LVMF, including early *Homo* (*H. erectus*).

Figure 2. Map of Europa showing the localities mentioned in the text. 1: West Runton 'Stone Bed' (UK), 2: Mill-Langenboom and Liessel (the Netherlands), 3: Chilhac (France), 4: Pirro Nord 13 / Gargano (Italy), 5: Dmanisi (Georgia).

Here we review the preserved fossil and lithic content of several European Villafranchian localities (Figure 2) and their absolute or relative datings. This review summarizes published data and attempts to fit them in an ecological framework; it leads us to a hypothesis that we present here, that is that *Homo erectus* (*s.l.*) was an integral part of the LVMF in the temperate regions of Europe.

The framework of Villafranchian mammal faunas

The Late Pliocene and Early Pleistocene (c. 3.58 Ma – 0.78 Ma) is biostratigraphically subdivided in four distinct faunal associations (Hilgen *et al*., 2012; Pillans & Gibbard, 2012; Krijgsman *et al*., 2018). These are, respectively, the Early Villafranchian Mammal Fauna (EVMF, here considered ranging from the Gilbert/Gauss boundary *c*. 3.58 Ma to the Gauss/Matuyama boundary *c*. 2.58 Ma); the Middle Villafranchian Mammal Fauna (MVMF, here considered ranging from the Gauss/Matuyama boundary *c*. 2.58 Ma to the beginning of the Olduvai Normal, 1.94 Ma) and the Late Villafranchian Mammal Fauna (LVMF, here considered from the beginning of the Olduvai Normal, 1.94 Ma to the end of Jaramillo Normal, *c*. 1.00 Ma). The LVMF is further subdivided into two subfaunas: the LVMF/Late Villányian-Early Biharian fauna (hereafter LVMF1), ranging from the beginning of the Olduvai Normal, 1.94 Ma to *c*. 1.6 Ma; and the LVMF/Early Galerian-Early Biharian fauna (LVMF2), from *c.* 1.6 Ma to the end of Jaramillo Normal, *c*. 1.00 Ma (Pillans & Gibbard 2012, Krijgsman et al. 2018). See also Sardella *et al*. (1998) for a detailed overview of Villafranchian mammal faunas in Italy.

Here, we focus on the faunal composition of the LVMF1 (MN 17-MQ1; 1.94-1.6 Ma), which is coeval with the confirmed presence of the genus *Homo* Linnaeus, 1758 outside Africa. Within western Eurasia, the faunas of the Villafranchian ecosystem are regionally known under a variation of names such as 'Dmanisi fauna' (in Georgia; Lordkipanidze *et al*., 2007), 'Chilhac fauna' (France; Boivin *et al*., 2010), or 'Tegelen fauna' (The Netherlands; Hoek Ostende & De Vos, 2006) and 'Oosterschelde fauna' (The Netherlands; Scager *et al*., 2017), to name but a few. Due to regional biogeographic and palaeoecological differences, and because species may have long stratigraphic ranges, species from the MVMF and/or the LVMF2 may be included in faunal lists of the LVMF1.

The characteristic assemblage of large mammal species for the LVMF1 was summarized by Krijgsman et al. (2018) and consists of the following taxa: the proboscidean *Mammuthus* (or *Archidiskodon*) *meridionalis* (Nesti, 1825), perissodactyl *Stephanorhinus etruscus* (Falconer, 1868), cervids *Eucladoceros orientalis* (Radulesco & Samson, 1967) and *Megaloceros stavropolensis* Titov & Shvyreva, 2016, carnivores *Panthera gombaszoegensis*, and the scavenger *Pachycrocuta brevirostris*; last occurrences of bovids *Gazellospira*

torticornis (Aymard, 1845), *Palaeotragus* sp., and *Gallogoral* sp., and carnivores *Nyctereutes megamastoides* (Pomel, 1842), *Vulpes alopecoides* (Forsyth-Major, 1877), and *Lynx issiodorensis* (Croizet & Jobert, 1828); and first occurrences of bovid genera *Bison* Hamilton-Smith, 1827, *Capra* Linnaeus, 1758, *Praeovibos* Staudinger, 1908, *Soergelia* Schaub, 1951, and *Pontoceros* Vereshchagin, Alekseeva, David & Baigusheva, 1971 (Krijgsman *et al*., 2018 and references therein). As expected, there are many herbivores in addition to carnivores (including top predators), and scavengers. Small mammal taxa used as criteria for assigning a fauna to the LVMF1 are the arvicolids *Mimomys pliocaenicus* (Forsyth Major, 1889) – *M. osztramosensis* Jánossy & van der Meulen, 1975, in addition to *Mimomys* gr. *reidi-pusillus*, *Kislangia rex* Kormos, 1934, *Borsodia newtoni* (Forsyth Major, 1902) - *arankoides* (Alexandrova, 1976) and the first occurrence of *Allophaiomys deucalion* (Kretzoi, 1969) (see Krijgsman *et al*., 2018). A rather similar list can be extracted from Rook & Martínez-Navarro (2010), which list contains, among other, herbivores *Mammuthus meridionalis*, *Stephanorhinus etruscus*, *Equus stenonis* Cocchi, 1867, *Eucladoceros dicranios* (Nesti, 1841) – *E. ctenoides* (Nesti, 1841), *Gallogoral meneghini* (Rütimeyer, 1878), *Gazellospira torticornis*, and *Sus strozzii* Forsyth Major, 1881, and carnivores *Canis* ex gr. *etruscus* Forsyth Major, 1877, *Panthera gombaszoegensis*, *Homotherium crenatidens* Fabrini, 1890 – *H. latidens* (Owen, 1846), and the scavenger *Pachycrocuta brevirostris*. The list of species may show regional variations, but is generally consistent throughout Europe and (at least) western Asia. This LVMF1 fauna is our palaeoecological reference for further reasoning.

Reference locality: Dmanisi

Dmanisi (Georgia, 41° 19′ N, 44° 21′ E, situated on the threshold between Afro-Arabia, western Asia and Europe) is especially known for its rich sample of early *Homo* (*Homo erectus* - *sensu lato* or *Homo georgicus*; see Gibbons, 2013 for a taxonomic evaluation). So far, 5 skulls have been found (Lordkipanidze *et al*., 2013). The site is located underneath medieval ruins, and archaeological excavations of a medieval castle started as early as 1936. In 1983 archaeologists discovered fossil animals exposed in the cellars of a medieval dwelling, among which remains of a rhinoceros. That was unexpected, as certainly no rhinoceroses were living in that area during medieval times. The Georgian palaeontologist A. Vekua subsequently identified a tooth as to be originating from an Early Pleistocene rhinoceros, *Dicerorhinus etruscus etruscus* (now *Stephanorhinus etruscus*; dmanisi.ge). One year later, excavators discovered the first stone tools (see dmanisi.ge for reference). Since then, some 7,000 bones of Villafranchian mammals have been excavated in Dmanisi, in addition to more than 10,000 stone artefacts (Biagi, 2013). Cutmarks showing butchering of animal carcasses by humans (Lordkipanidze *et al*., 2007) show a direct interaction between man and the fauna and prove a hunting or scavenging life-style.

In Dmanisi itself, in addition to *Homo georgicus* (= *H. erectus* (*s.l.*)), material has been found of, amongst other, the herbivores *Mammuthus meridionalis*, *Stephanorhinus etruscus*, *Equus stenonis*, *Palaeotragus priasovicus* Godina & Baiguscheva, 1985, *Cervalces* cf. *gallicus* (Azzaroli, 1952), *Eucladoceros* aff. *tegulensis* Dubois, 1904, *Pseudodama nestii* (Azzaroli, 1947), *Bison* (*Eobison*) *georgicus* (Bukhsianidze, 2005), *Gallogoral meneghini*, *Capra* sp. and *Pontoceros* sp., and the carnivores *Homotherium crenatidens*, *Megantereon whitei* (Broom, 1937), *Panthera onca* (L., 1758) ssp. *georgica* Hemmer, Kahlke & Vekua, 2010, *Lynx issiodorensis*, *Ursus etruscus* Cuvier, 1823, and scavenger *Pachycrocuta brevirostris* (Gervais, 1850) or *P. perrieri* (Croizet & Jobert, 1828); (Gabunia *et al*., 2000a; Lordkipanidze *et al*., 2007; Krijgsman *et al*., 2018). A lagomorph (cf. *Hypolagus brachygnathus* (Kormos, 1930)), voles (*Mimomys pliocaenicus* and *M. reidi* Hinton, 1910), porcupine (*Hystrix refossa* Gervais, 1852), and an ostrich (*Struthio dmanisiensis* Burchak-Abramovich & Vekua, 1990) have furthermore been found (Vekua 1995; Gabunia *et al*., 2000a; Lordkipanidze *et al*., 2007).

The fauna of Dmanisi thus constitutes a typical LVMF1 (Table 1). Dmanisi not only yielded skulls and postcranials of *Homo erectus* (*s.l.*), but also an abundant Palaeolithic industry (Baena *et al*., 2010; Mgeladze *et al*., 2011; Figure 3A). The environment is reconstructed as a combination of dense to open forest, shrub landscape and tree savanna with some open grasslands (Lordkipanidze *et al*., 2007).

A basalt layer dated 1.85 Ma (1.8-1.9 Ma) showing a normal magnetic polarity is situated underneath the fossiliferous strata, that were deposited quickly after deposition of the basalt layer (Gabunia *et al*., 2000a). This underlying basalt is correlated with the end of the palaeomagnetic Olduvai Subchron. Slightly higher up in the section, the fossiliferous interval containing tools, fauna and human fossils, shows a palaeomagnetic reversal that is correlated with the Matuyama Chron. This indicates that the age of the fossils is about 1.8 or 1.7 million years; Ferring *et al.* (2011) bracketed the date to 1.85-1.78 Ma. This is supported by the faunal association. The rhinoceros (*Stephanorhinus etruscus*) and the vole (*Mimomys pliocaenicus*) as well as the rest of the fauna (LVMF1) indicate an Early Pleistocene age. It can therefore be concluded that the Dmanisi hominid and the lithic industry associated with it are of an Early Pleistocene age, dated at roughly 1.8 million years. For our line of reasoning, it is of importance to conclude that Dmanisi has yielded (1) a typical LVMF1, (2) a radiometrically constrained age of *c.* 1.8 Ma, (3) remains of *Homo erectus* (*s.l.*), and (4) an Early Palaeolithic industry with associated butchering marks on the animal bones. Early humans formed part of the mammal fauna.

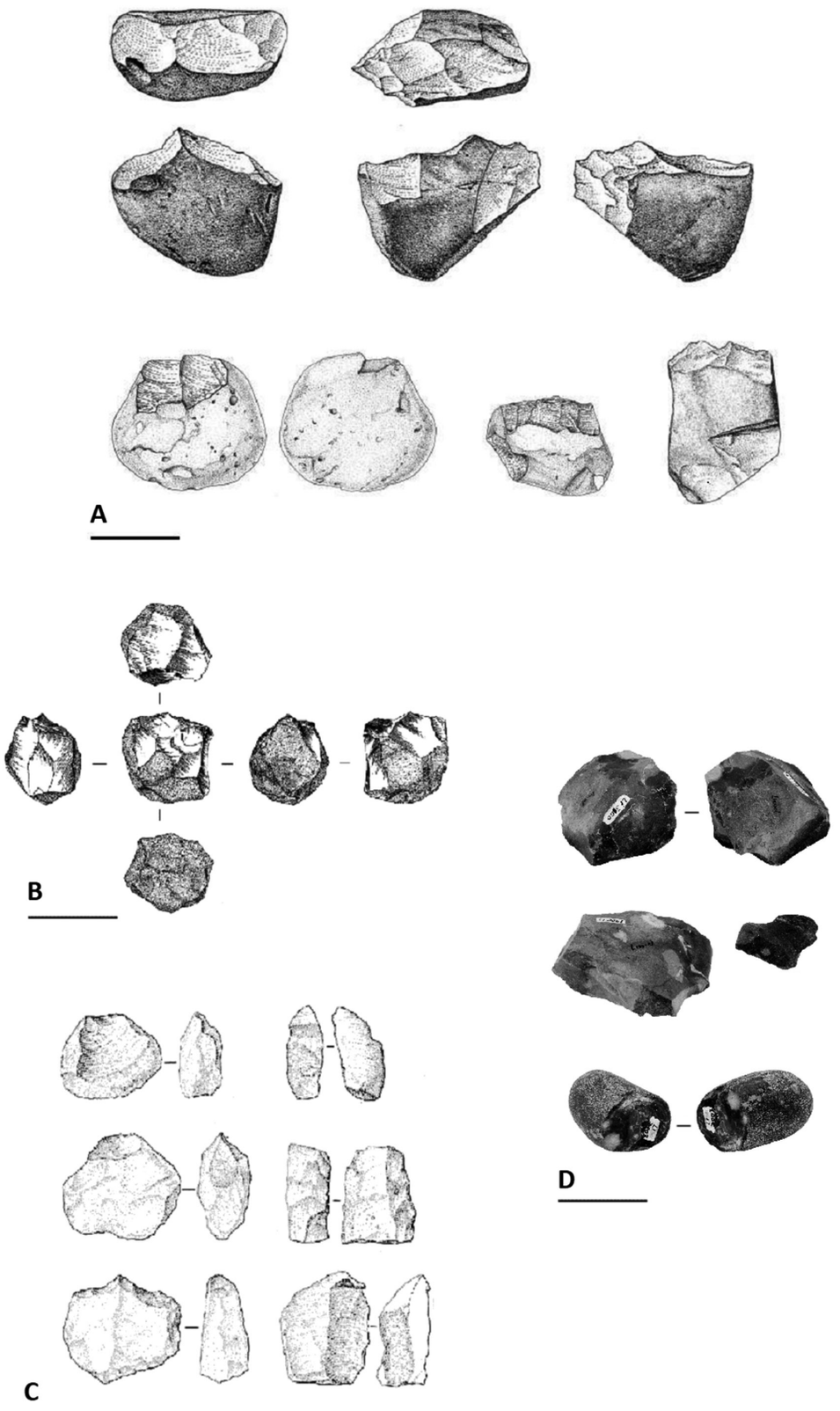

Figure 3. Examples of lithic artefacts from A: Dmanisi, bifacial chopper core (upper right) and unifacial cores (upper left and below), after Mgeladze *et al*. (2011); B: Pirro Nord 13, flint core with four striking platforms, after Arzarello *et al*. (2007); C: Chilhac, choppers (left), a flake (upper right), a scraper (centre right) and a core (lower right), after Guth & Chavaillon (1985); D: Liessel, flake core (above, coll. Museum Klok & Peel, inv. nr Li3000), Clacton type flake (centre left, coll. Museum Klok & Peel, inv. nr Li3001), Clacton type flake (centre right, coll. Museum Klok & Peel, inv. nr Li3002), chopper tool (below, coll. Museum Klok & Peel, inv. nr Li3003). Scale bars 5 cm.

Towards the West: LVMF1 localities with a confirmed lithic industry

Chilhac

Chilhac (45° 9′ N, 3° 27′ E) is the name of a small series of outcrops near the village of Chilhac (Département de Haute-Loire, France). The Chilhac sites relevant here (named CH2 and CH3) are known since the late nineteenth century for their well-preserved Early Pleistocene (*i.e.*, Villafranchian) fossils, in association with lithic (pebble) artefacts. These artefacts provide evidence for the presence of hominins, even though their fossilized remains have so far not been found. The complexity of the deposits has long hampered a good stratigraphic interpretation, but the discovery of superposed lava flows on top of the sediments allowed for establishing a minimum age.

Early excavations without clear in-situ context are labelled Chilhac 1 (CH1); later excavations are known as CH2 and, since discoveries in 1969, as CH3. Faunistically, CH2 and CH3 are the same (Boivin *et al*., 2010). The faunal list (see also Table 1) of Chilhac contains 16 mammal taxa, of which most notable are: *Mammuthus meridionalis*, *Anancus arvernensis* (Croizet & Jobert, 1828) (ssp. *A. a. chilhacensis* Boeuf, 1992), *Stephanorhinus etruscus*, *Equus stenonis*, *Eucladoceros ctenoides*, *Cervus philisi* Schaub, 1941 (= *Metacervoceros rhenanus* (Dubois, 1904)), *Gallogoral meneghini*, *Gazellospira torticornis*, *Pachycrocuta perrieri*, *Homotherium crenatidens*, and a porcupine *Hystrix* sp., among others. The Chilhac fauna is therefore a characteristic LVMF1. Two Proboscidean species co-occur in Chilhac: southern mammoth *Mammuthus meridionalis* (a primitive form) and the mastodon *Anancus arvernensis* (Boivin *et al*., 2010).

As early as 1974, lithic artefacts (pebble tools) were discovered in the CH3 locality (Guth, 1974; Guth & Chavaillon, 1985; for an example see Figure 3C). Chilhac 3 (CH3) has an age presumed to be around 1.8-1.9 Ma, a date ‘arrived at through palaeontological comparisons

	West Runton	Liessel	Mill-Langenboom	Chilhac 2/3	Dmanisi	Pirro Nord 13
Anancus arvernensis		x	x	x		
Mammuthus* (or *Archidiskodon*) *meridionalis	x			x	x	
Cervus* (or *Metacervoceros*) *philisi / C. rhenanus		x	x	x	x	
Eucladoceros ctenoides / E. orientalis / E. tegulensis	x		x	x	x	
Leptobos* sp. *(L. elatus)			x			
Equus* sp. *(E. stenonis, E. robustus)			?	x	x	x
Stephanorhinus* (or *Dicerorhinus*) *etruscus / kirchbergensis	x	x	x	x	x	
Homotherium crenatidens / latidens				x	x	x
Pachycrocuta* (or *Pliocrocuta*) *perrieri / brevirostris				x	x	x
Ursus* sp. *(e.g., U. etruscus)			x	x	x	
***Panthera onca / gombaszoegensis / P.* sp.**			x		x	
Mimomys pliocaenicus / praepliocaenicus	x				x	
Mimomys reidi	x				x	
lithic artefacts / pebble tools	x	x	x	x	x	x
***Homo erectus* (*sensu lato*)**					x	
references	1	2	3,4	5	6,7	8

references

1 Lagerweij *et al*., 2009
2 Peters, 2009
3 Peters, 2013
4 Peters *et al*., 2015
5 Boivin *et al*., 2010
6 Gabunia *et al*., 2001a
7 Lordkipanidze *et al*., 2007
8 Arzarello *et al*., 2007

Table 1. Occurrence of selected LVMF mammal taxa, lithic artefacts and *Homo erectus* (*sensu lato*) in the Early Pleistocene / Late Villafranchian mammal localities discussed in the text.

and extrapolation from absolute dates on a lava flow close to the site' (Raynal *et al*., 1995). Thus we have an undisputed association of Villafranchian mammals and stone tools in a context dated around 1.8-1.9 Ma. As Guth (1974) rightfully concluded: "*Le gisement villafranchien de Chilhac (...) vient de livrer d'indubitables galets aménagés, témoins de l'existence en Europe d'un Hominidé dès le tout début du Quaternaire*." (transl.: The locality of Chilhac has yielded undoubtedly worked stones, proving the existence in Europe of a hominid from the very beginning of the Quaternary onward.)

We therefore conclude here that, at least in Chilhac 3, we encounter (1) a typical LVMF1, (2) an absolute age of roughly around 1.8 Ma, and (3) an early Palaeolithic industry. The only missing aspect, when compared to Dmanisi (see above) are (4) the remains of *Homo erectus* (*s.l.*).

Pirro Nord 13 (Italy)

Pirro Nord 13 is located on the Gargano peninsula (Province of Puglia, Italy; 41° 45′ N, 15° 25′ E). An LVMF was described from this site, containing, among other, *Mammuthus meridionalis*, *Stephanorhinus* cf. *S. hundsheimensis* Toula, 1902, *Equus altidens* von Reichenau, 1915, *Bison* sp. (or *Bison degiulii* Masini, 1989), *Canis mosbachensis* Soergel, 1927, *Pachycrocuta brevirostris*, *Ursus etruscus*, *Homotherium crenatidens*, *Megantereon whitei*, and *Hystrix refossa* (Arzarello & Peretto, 2010, Chelli Cheheb *et al*., 2019). It is considered a typical LVMF (Arzarello & Peretto, 2010). Lithic artefacts are also present (Arzarello *et al*., 2007; see Figure 3B for an example), proving the co-occurrence of early *Homo* with the LVMF in southern Italy as well. The locality is dated 1.7 Ma or somewhat younger (Arzarello *et al*., 2007), leading these authors to conclude that "The new discovery from Pirro Nord changes the chronology of the first arrival of hominids in Europe and offers new perspectives in the debate about the human dispersal in the Early Pleistocene."

The Pirro Nord site was summarized as follows by Van der Geer *et al*. (2011): "After the uplift of the foreland, the Gargano became again populated, but this time by a balanced mainland fauna, recognized by typical members of the Early Pleistocene Eurasian fauna. A second major phase of superficial karst development led to the deposition of cave sediments in which fossils belonging to this biozone are found. The megafauna included the giant hyena (*Pachycrocuta brevirostris*), sabre-toothed cats (*Homotherium latidens*, *Megantereon* sp.), the giant cheetah (*Acinonyx pardinensis*), the Mosbach wolf (*Canis mosbachensis*), a stenoid horse (*Equus altidens*), a bison (*Bison degiulii*), and a large-sized gelada (*Theropithecus* sp.). The fauna is further characterised by several micromammals, amongst others, a vole (*Allophaiomys ruffoi* (Pasa, 1947)), a shrew (*Episoriculus gibberodon* (Petényi, 1864)), and a large porcupine (*Hystrix refossa*). A small number of flint lithic artefacts, ascribed to *Homo erectus*, were found in association with this fauna, as reported by Marta Arzarello *et al*. (2006) [*sic*, should be 2007, JR]. They suggest that this is the first evidence for humans in Europe, pre-dating the evidence from Atapuerca in Spain and roughly contemporaneous with Dmanisi in Georgia, but this needs further verification."

Pirro Nord 13 combines (1) a LVMF, (2) an age of somewhat younger than 1.7 Ma (~ 1.3-1.6 according to Chelli Cheheb *et al*., 2019), and (3) an early Palaeolithic industry. Cut marks and intentional bone breakage have been reported, testifying of human presence (Chelli Cheheb *et al*., 2019). Here again, the missing aspect are (4) the actual remains of *Homo erectus* (*s.l.*).

In the extreme West: LVMF1 localities with a possible lithic industry

Mill-Langenboom and Liessel

Two localities with ex-situ finds of LVMF1 faunas and possibly associated lithic artefacts are situated in the province of Noord-Brabant (the Netherlands). Both are commercial subaquatic sandpits: 'De Kuilen' near Mill-Langenboom (51° 42′ N, 5° 43′ E) and 'Hoogdonk' near Liessel (51° 25′ N, 5° 49′ E). In both these pits, small but interesting associations have been discovered of Villafranchian mammals in association with a lithic industry. These possible Palaeolithic implements have been shortly characterized and illustrated in Peters (2009, 2013).

Fossil mammals were regularly found in sand dredged from (the now abandoned) commercial sandpit 'de Kuilen' near Mill-Langenboom (hereafter Mill-Langenboom). In Mill-Langenboom Pliocene glauconitic sands were mined from *c*. 7 to 20 m depth using a suction dredger. All finds are thus *ex situ*, but appear to belong to a coherent, Villafranchian fauna. In the locality, where active quarrying has stopped in 2015 and that has since been transformed into a recreational lake, the compact sediments were loosened with the aid of a water jet attached to the suction inlet of a dredger. These sands were then suction-dredged, transported through pipes and temporarily stored in large depots at the lake side, from where amateur and professional collectors have recovered vast quantities of fossils: most notably shark teeth, but also molluscs and bones of (marine) birds, marine mammals and a suite of terrestrial mammals of Villafranchian age (Wijnker *et al*., 2008).

So far the following terrestrial mammal species have been recorded from Mill-Langenboom (Table 1): *Anancus arvernensis* (Croizet & Jobert, 1828), *Hipparion* ex gr. *crassum* Gervais, 1859, *Stephanorhinus* cf. *etruscus, Tapirus* sp., *Leptobos* cf. *etruscus* (Falconer, 1868)*, Gazella borbonica* Alberdi *et al*., 1997, *Cervus rhenanus* (the most abundant of the land mammals in the locality, Peters, 2013), *Eucladoceros ctenoides*, *Sus strozzii*, *Sus* cf. *arvernensis* (Croizet & Jobert, 1828), Artiodactyla indet., *Eucyon* sp., *Pannonictis ardea* (Gervais, 1852), *Panthera gombaszoegensis*, and *Ursus* sp. Furthermore,

Castor fiber L., 1758 and the rare perissodactyl *Chalicotherium* sp. (Mol *et al*., 2011; Peters, 2013; Peters & De Vos, 2012a, 2012b; Peters *et al*., 2015; De Vos & Wijnker, 2006; Wessels *et al*., 2012). Some older (Pliocene) species were probably redeposited: *Hipparion* ex gr. *crassum*, and *Chalicotherium* sp. (Peters, 2013). Here too we have a typical LVMF, with possibly some redeposited specimens of older (EVMF?) origin.

The first Palaeolithic implement, a handaxe (a 'biface triangulaire'), was found near Mill in the 1950's and described two decades thereafter by Stapert (1977). This biface is probably not older than 0.9 – 0.7 Ma, as no earlier bifaces are so far described from western Europa (Mgeladze & Moncel, 2016). It can therefore not be included in our present line of reasoning. But since then, three more handaxes and a scraper were found by fossil collectors in the suction-dredged sediments and first depicted by Peters (2013: 121-125) in his book on the locality. The implements have been fashioned from flint of Belgian origin, that was transported by the river Meuse to the eastern Noord-Brabant region. These river deposits are part of the Beegden Formation and made up of moderate to very coarse-grained sands and gravels. Their age can range from Late Pliocene to Late Pleistocene but, according to Doppert *et al*. (1975), in the Liessel and Mill-Langenboom area most probably have a Middle Pleistocene age. This conclusion does however not conform with the observed presence of a Villafranchian (Early Pleistocene) mammal fauna; see also Wijnker *et al.* (2008) for an assessment of the stratigraphy of the locality. Redeposition may have played a role; see also Slupik *et al*., 2013 and Mayhew *et al*., 2014 for similar redepositional phenomena related to the LVMF Oosterschelde Fauna from the Netherlands.

A second and still commercially active sand pit is near the village of Liessel, also in the province of Noord-Brabant. It is operated by the firm 'Hoogdonk bv'. Much like in Mill-Langenboom, a suite of marine mammals (mostly Cetacea) and terrestrial mammals has been discovered. The following terrestrial mammal association has so far been described: *Mammut borsoni* (Hays, 1834) and *Anancus arvernensis* (Peters *et al*., 1991; Braber *et al*., 1999), *Cervus rhenanus* and possibly also *C. cusanus* Croizet & Jobert, 1828 (Peters, 2009), *Stephanorhinus* sp. (*S. etruscus* or *S. jeanvireti* Guérin, 1972; Peters, 2009). The recorded species are either of EVMF or MVMF age (*M. borsoni* and *C. cusanus*) or belong to the LVMF. Redeposition cannot be excluded. The ecosystem of Liessel during the Early Pleistocene is reconstructed as a forested environment with large open spaces and the presence of estuarine open water (Peters, 2009: 86-87). A rather similar environment was reconstructed for Mill-Langenboom (Peters, 2013: 131).

The simultaneously sampled lithic industry found in Liessel consists thus far of thirteen artefacts (Peters, 2009). Most striking object is a 'biface lancéolé' handaxe that is however probably younger than 1.8 Ma (as stated above, the oldest bifaces are reported from western Europe by around 0.9 – 0.7 Ma; Mgeladze & Moncel, 2016); but other presumably older finds include a chopper, a billhook, a possible drill, and a flake tool. Flake tools (Figure 3D) are the result of striking off pieces from a core stone; suitable pieces can be used for cutting or scraping activities. The chopping tool (Figure 3D, lowermost) was produced by decapitation of a flintstone rounded by transportation in the Meuse river.

Thus, both localities in Noord-Brabant, Mill-Langenboom and Liessel, have yielded (1) a sample of Villafranchian terrestrial mammals and (2) a number of flint implements has been found. Unfortunately, these have not yet been studied by archaeologists, for which reason there is no absolute confirmation these were made by humans. The flint implements appear to represent various ages, but are mostly of Palaeolithic origin. However, due to the sediment processing (3) an absolute age estimate for the findings is not available, and, finally, (4) fossils of the makers of the lithic objects are missing from the samples.

West Runton 'Stone Bed'

The West Runton 'Stone Bed' located in East Anglia, UK (52° 94′ N, 1° 24′ E), contains Villafranchian mammals found in association with a rich collection of Palaeolithic implements. Locality details were published by Lagerweij *et al.* (2009) in a journal that is usually considered to be an 'amateur' magazine and in Dutch language, for which reason the presented lithic industry appears to have been overlooked by the professional archaeological community. The authors reported abundant lithic artefacts in association with yet a typical LVMF in the 'Stone Bed', that has a pre-Pastonian age, which is correlated with the late Tiglian, *c.* 1.9-1.8 Ma (although Preece *et al*., 2020 arrive at a somewhat older age of 2.2-2.1 Ma). It is to be regretted that these implements have not yet been properly studied by specialists. Yet the artefacts have been provisionally studied in 2009 by Dr Rebecca Scott (London), who wrote *"I think it's so important that we continue to check and question everything, and do believe that we will soon find clear and incontrovertible evidence for humans in Europe at this early date."* (A. Cardol, *in litt*., April 21, 2021), and in 2011 by prof. Gerhard Bosinski (Toulouse). Bosinski first wrote on March 14, 2011: *"I received the publication Apan/Extern 13* [= Lagerweij *et al*., 2009 – the authors]*, concerning the finds from West Runton, East Anglia. Thank you so much. Of course I am very interested in this material. Is there a possibility to look on these artefacts?"*, and subsequently studied the material on May 20, 2011. He separated the material into two groups, (a) material that would have been accepted when found in an enclosed context but could be open to doubt, and (b) material that he considered indisputably of Early Palaeolithic human origin; after which he concluded human presence: *"der Mensch war da."* (A. Cardol, *in litt*., April 21, 2021).

The West Runton species list includes *Mammuthus meridionalis*, *Stephanorhinus etruscus*, *Eucladoceros cte-*

noides and *E. sedgwicki* (Falconer, 1868), *Cervalces gallicus*, *Trogontherium cuvieri* Fischer, 1809, *Lemmus* sp., *Mimomys pliocaenicus*, *M. reidi*, *M. blanci* van der Meulen, 1973, *M. newtoni* Forsyth Major, 1902, *M. pitymyoides* Jánossy & van der Meulen, 1975, the shrew *Beremendia fissidens* (Petenyi, 1864), which is also present in the contemporaneous Dutch LVMF reference locality of Tegelen and the water moles *Desmana thermalis* Kormos, 1930 and *Galemys kormosi* (Schreuder, 1940), both also found in Tegelen. The authors reconstructed a mixed landscape, partly forested with open areas and the presence of open water. West Runton 'Stone Bed' thus provides us with (1) a LVMF, (2) a correlation with an age of at least *c*. 1.9-1.8 Ma, and (3) stone implements that still require further study for confirmation. The information provided by Lagerweij *et al*. (2009) suggests that the presence of early humans during the Early Pleistocene might even have stretched into present-day England. The discovery by Ashton *et al*. (2014) of human footprints dated between 1.0 and 0.78 Ma at Happisburgh, also in East Anglia, already pushed the date of human arrival at the British Isles to a much earlier date than previously assumed.

Discussion

The mentioned mammal faunas from Dmanisi, Chilhac 3, Pirro Nord 13, Mill-Langenboom, Liessel, and West Runton all consist of a typical Late or Middle/Late Villafranchian (MVMF/LVMF1) mix of species (see Table 1). The depositional and taphonomical circumstances are different, but the reconstructed palaeoecological setting is comparable: a forested environment, with open patches and interspersed bodies of water (rivers, streams or lakes), inhabited by a rich suite of larger and smaller mammals including proboscideans, rhinoceroses, deer, bovids and various carnivores among which hyaenas and sabretooth cats. Of these localities, Dmanisi in Georgia is the most complete one, with mammals, early *Homo*, an abundant lithic industry and reliable absolute dates. Chilhac in France lacks the fossils of hominins, but contains a LVMF faunal assemblage, a lithic industry and it has a good set of age data. Similar conclusions apply to Pirro Nord 13. Mill-Langenboom and Liessel (the Netherlands) and West Runton 'Stone Bed' (UK) both contain LVMF faunas and (as yet unconfirmed) lithic implements, but there the early humans and the absolute age data are absent.

During the Early and early Middle Pleistocene interglacials much of western Eurasia was covered by a wooded environment with open spaces and bodies of water were present. It is in this ecosystem that the Middle and Late Villafranchian mammal faunas (MVMF and LVMF) thrived. This environment and its fauna ranged geographically from western Europe to at least as far east as Georgia. Despite obvious regional differences in faunal composition, the overall appearance of the fauna is similar all over the continent: we observe one or two proboscideans, one or two rhinoceroses, a large and a small deer, large and small bovids, one or two horse species, and (evidently less abundant) carnivores such as hyaena, wolf, bear, and (even rarer) apex predators such as sabretooth tiger. Early hominids, although extremely rare, were part of these faunas. Their presence is testified by the dental or skeletal remains themselves (Dmanisi), and otherwise by lithic implements they produced and left behind as testimony of their existence (Pirro Nord, Chilhac, likely Mill-Langenboom, Liessel and West-Runton).

One human being, once deceased, leaves no more than a maximum of one skull, one lower jaw, thirty-two permanent teeth (plus twenty taphonomically more vulnerable deciduous teeth) and one postcranial skeleton, but during its lifetime might have produced thousands of stone (flint, basalt) implements. So far, five human skulls have been discovered in Dmanisi, while this site yielded over 10,000 stone artefacts (Biagi, 2013), which is a ratio of 1: >2,000. Hence, the chance of finding stone tools without finding the actual producer of these artefacts, is enormous. Moreover, *Homo* has an ecological role as an opportunistic top predator and/or scavenger (Lordkipanidze *et al*., 2007). Any natural ecosystem can sustain only a small population of hominins, when compared to large herbivores (Artiodactyla, Perissodactyla or Proboscidea).

Homo erectus (*sensu lato*) originated in Africa and started moving out of Africa around 2.0-1.9 Ma, but probably even as early as 2.2-2.1 Ma, during a faunal exodus that also included apex predator *Panthera gombaszoegensis* and scavenger *Pachycrocuta brevirostris* (Rook & Martínez-Navarro, 2010). They migrated most probably via the Levantine corridor (Carotenuto *et al*., 2016), leading them in first instance to the Caucasus region and from there further on to either Europe (westward, eventually reaching Fuente Nueva, southern Spain, 1.35 Ma ago) or Asia (eastward, reaching the southern Chinese loess plateau 2,12 Ma ago and eventually reaching Sangiran, Java, 1.51 Ma); see Carotenuto *et al*. (2016), Zhu *et al*. (2018), and Bettis *et al*. (2009). Since their first appearance out of Africa, *Homo* and accompanying carnivores thus became part of, and integrated into, the earlier Villafranchian mammal fauna then living in Eurasia. Humans hunted or scavenged the mammals present as part of their diet. Butchering marks testifying this behaviour were recorded from Dmanisi (Lordkipanidze *et al*., 2007) and Pirro Nord 13 (Chelli Cheheb *et al*., 2019). Dmanisi is a rare locality in that is has both implements *and* human fossils. From other sites, most notably Chilhac and Pirro Nord 13, but also Liessel, Mill-Langenboom and West Runton 'Stone Bed', we have implements but no human body fossils.

Implements do not appear spontaneously and out-of-the-blue, they were made by humans. The supposition once suggested that the lithic industry from Chilhac and adjacent localities was 'made' by geological processes and not by humans (Raynal *et al*., 1995), is not tenable. One could imagine one or two such *tephrofacts* or *geofacts*

(terms used by Raynal *et al*., 1995) to have spontaneously arisen by accident through breakage or cleavage during deposition in a high-energy environment, but not a collection of several dozens of such artefacts. The presence in Western Europe of a lithic industry older than 0.5 Ma has long been denied. Roebroeks & Van Kolfschoten (1995) dismissed all artefacts dating from before 0.5 Ma, denying their human-made origin. Yet, Roebroeks & Van Kolfschoten (1995: 306) acknowledge the find in Chilhac 3 of 46 true lithic ('indisputable') artefacts, but subsequently dispute an Early Pleistocene age of these tools, despite the clear stratigraphical context of the artefacts with the Villafranchian mammal fauna. Raynal *et al.* (1995) show and discuss a large collection of lithic artefacts from the region of Chilhac (including other localities in close vicinity, such as Blassac-les-Blanches, Soleilhac and La Sauvetat), and consider all these items to be *geofacts* or *tephrofacts*. These terms pertain to implement-like stones that are, however, not shaped by human action, but by geological processes (hence the term 'geofacts'), and most notably by volcanic activity (hence 'tephrofacts'). When comparing human-made artefacts and tephrofacts, Raynal *et al*. (1995) used criteria published earlier (from references cited in Raynal *et al*., 1995), of which they *"have discarded some", "calibrated some of the non-metrical observations",* and *"added some of our own weight"*. They then write *"In the case of a principal component analysis, taking all the characteristics except the number of flake scars into account,* ***no true distinction*** *can be made between tephrofacts and humanly produced objects."* (Raynal *et al*., 1995, p. 134; bold by present authors).

The primitive nature of these supposed artefacts was thus interpreted as having been caused by natural processes, and not by early humans, although no difference could be noticed. Subsequently, Raynal *et al*. (1995) considered all implements from Chilhac and adjacent localities to be 'tephrofacts', and not artefacts of human activities. We consider the Chilhac (Blassac, *etc.*) artefacts as true objects of human production, as Guth (1974) already proposed half a century ago, and no 'tephrofacts', 'geofacts' or other such spontaneous formations.

Ever since the 1995 overview in the volume 'The earliest Occupation of Europe' (Roebroeks & Van Kolfschoten, 1995), the presence of true and much older artefacts in Europe has been widely acknowledged; *e.g.*, by Bourguignon *et al.* (2016a, 2016b) who described indisputable tools from a context dated around 1.2 Ma in southern France.

Homo erectus (*sensu lato*) can ecologically be considered an opportunistic hunter-scavenger or even a carnivore (Ben-Dor *et al*., 2021). The same applies to another presumed top predator, *Homotherium* spp. (*H. crenatidens, H. latidens*), a felid co-occuring together with early *Homo* in nearly all Villafranchian faunas. Both *Homo* and *Homotherium*, if present, are found in relatively low or extremely low numbers. It cannot be excluded that these taxa remain below the detection threshold; they are only rarely encountered (*e.g.*, Reumer *et al*., 2003). Yet, hominids and sabretooth cats may occur together in Villafranchian faunal associations, both in Europe and elsewhere, *e.g.* in Dmanisi (Krijgsman *et al*., 2018) and – although further away – in the slightly younger Sangiran locality on Java (Bettis *et al*., 2009). This latter locality was characterized by the presence of moist grasslands combined with open woodland, to be gradually replaced after 1.5 Ma by riparian forests, savanna and (again) open woodland (Bettis et al. 2009). *Homotherium* has also been observed in the Villafranchian of the Netherlands (*viz*. in Oosterschelde, Hooijer, 1962).

Conclusion

We observe multiple sites in northwestern Europe with accumulations of lithic artefacts in context with, or close proximity to, well-dated or well-correlated Villafranchian mammal faunas, showing that early hominids *Homo erectus* (*sensu lato*) were an integral member of the Early Pleistocene ecosystem in Europe, already as early as around 1.8-1.7 Ma ago. This applies to Dmanisi (the only locality where hominid fossils were found) and to other parts of Europe. The presence in localities such as Chilhac (France), Pirro Nord 13 (Italy), Liessel and Mill-Langenboom (the Netherlands) and West Runton 'Stone Bed' (England) of a Late Villafranchian mammal fauna (LVMF1) in association with stone tools and in a context dated or correlated to an age around 1.8-1.7 Ma, makes us hypothesize that *Homo erectus* (*sensu lato*) lived in northwestern Europe, *i.e.*, in France, England and in the Netherlands, during this time-frame.

Acknowledgements

We are grateful to Anne Schulp for critical yet supportive remarks and for designing Figure 1. Dick Mol, Frank Wesselingh and anonymous reviewers provided useful comments that greatly improved the manuscript. André Cardol provided useful information. Photographs of the Liessel implements were made by Cor van de Ven.

Author's contributions

JdV and JWFR conceived the theory, NP provided material, JWFR, NP and JdV wrote the paper.

Conflict of interest

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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