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Enigmatic plant-working tools and the transition to farming in the Rhine/Meuse Delta

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This paper represents an attempt to address the transition to farming through a long-term study of plant microwear traces on flint tools. We report on a series of archaeological research projects which show the presence of a specific type of siliceous plant-working flint tool in the Mesolithic and Early Neolithic of the Rhine/Meuse Delta region that disappears when the first evidence for crop growing appears in the archaeological record. A long-running programme of experimentation has shown that these plant traces are related to plant craftwork. The disappearance of tools displaying traces of this particular type of plant-working at the time agriculture starts to take hold in this region has led us to argue that this craft was related in some way to subsistence, probably a change in subsistence technology. We show that microwear studies of plant polish on tools offer a complimentary and often overlooked form of evidence to more traditional methods of studying the Neolithisation process.

1 Introduction

Microwear analysis of a series of Dutch flint assemblages dating to the Mesolithic and Neolithic appears to show the disappearance of a specific type of wild plant polish found on unretouched blade and flake tools as agriculture takes hold in the Rhine/Meuse delta region. The disappearance of these wild plant working tools at a time that crop growing takes hold leads us to believe that this microscale evidence for plant-working may add to a much larger debate regarding the timing and speed of transition from hunter-gathering to fully agricultural subsistence economies in Northwest Europe (*e.g.* Huisman and Raemaekers 2014; Armit and Finlayson 1992; Whittle and Cummings 2007 and references therein; Smits *et al.* 2010). While rarely considered as a means of investigating the transition, microwear analysis of flint tools has revealed evidence for a change in the way people were interacting with their environment, in turn affecting tool selection and use. As a technique, we show that microwear studies of plant polish on tools offers a complimentary and often overlooked form of evidence to more traditional methods of studying the Neolithisation process, for example zooarchaeology, archaeobotany, settlement and the adoption of pottery.

The specific type of microwear polish that is the focus of this research has been frequently observed on Mesolithic and Early Neolithic assemblages in the Lower Rhine Basin, at sites such as Hardinxveld-Giessendam Polderweg and De Bruin (Van Gijn, Beugnier *et al.* 2001; Van Gijn, Lammers *et al.* 2001), Leeuwarden Hempens/N31 (Noens 2011), Swifterbant (Bienenfeld 1986; Van Gijn 2010; Devriendt 2014), Hoge Vaart (Peeters *et al.* 2001) and Brandwijk (Van Gijn 2010) (fig. 1). Most commonly, it has been identified on unretouched blades with a regular, straight to often slightly concave edge of approximately 30 degrees on average (fig. 2). The polish discussed here is oriented in a transverse to slightly oblique direction, indicating that the tools were used to scrape or plane. The polish is semi-invasive, meaning

Figure 1 Dutch Mesolithic and Early Neolithic sites containing flint tools with transverse siliceous plant polish

the worked material is soft, with either the ventral (mostly) or dorsal surface displaying a more invasive polish than the other, denoting the leading face. Appearing in a continuous band along the edge, this polish has a high degree of linkage. The polish is usually distributed, if well developed, along a length of 1-1.5 cm of the edge. It is the smoothness and brightness of the polish that suggests that the tool has been used to work a siliceous plant material. However, it should be stressed that there is some variation in the polish, especially regarding its topography (fig. 3). One variation is flat with a higher density of striations, the other is smoother and has a more undulating topography with lesser and finer striations. Occasionally we encounter this variability on the same edge of a tool.

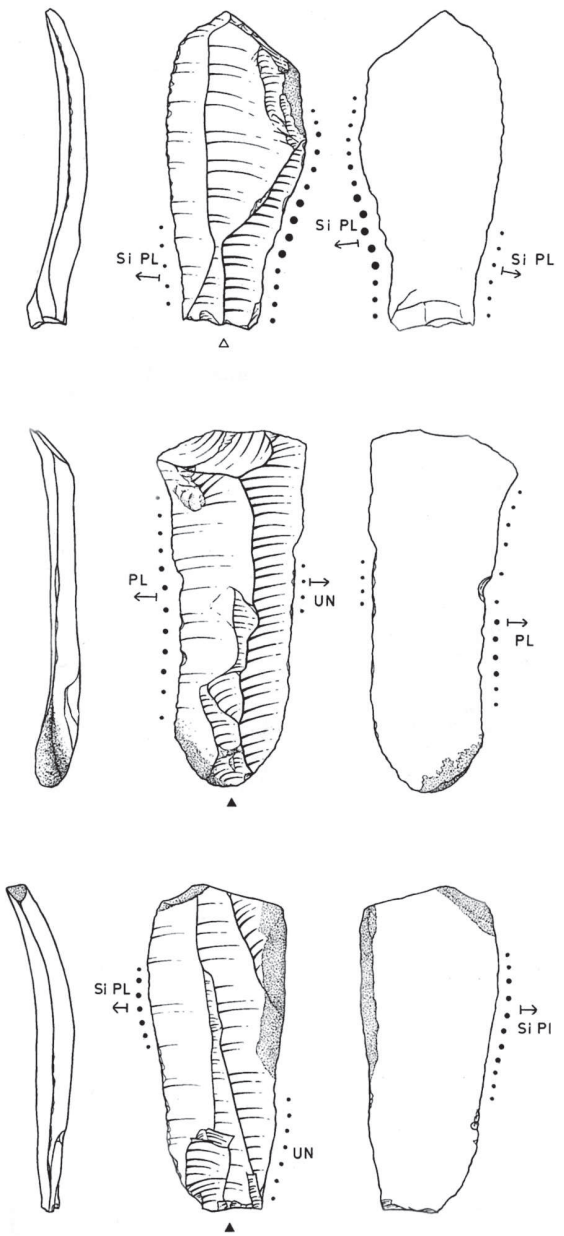

Figure 2 Illustration of unretouched blades from Hardinxveld Polderweg showing the distribution of transverse siliceous plant (si PL) polish (Van Gijn *et al*. 2001a)

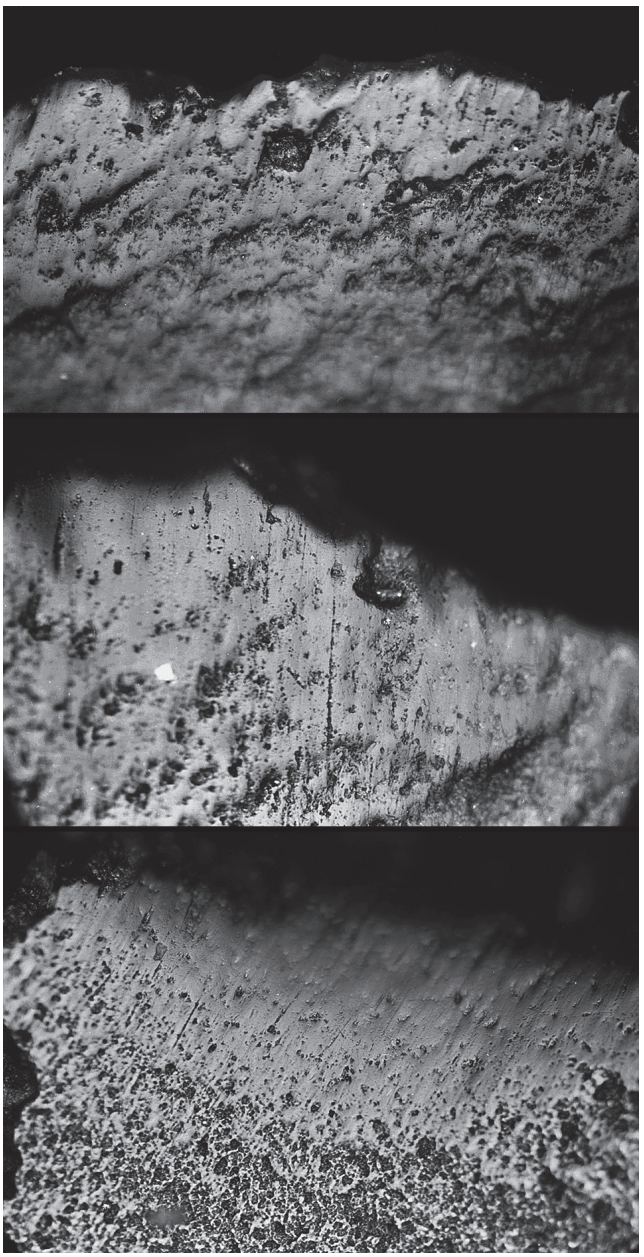

Figure 3 Variation in transverse siliceous plant polish on unretouched blades from Hardinxveld-Polderweg (200x) (Van Gijn *et al*. 2001a)

A combination of experimental research with processing various types of siliceous plants and an extensive microwear study of a range of sites from different chronological periods, encompassing the 8th - 4th millennium, has shown that this polish is likely to be linked to a plant based craft; a craft that may have been vital to the Mesolithic and Early Neolithic occupants of the Lower Rhine basin, but appears to have lost its relevance somewhere between 4000-3750 cal BC. In this paper we present the results of a long running programme of experimental research on plant-working tools, evaluate the existing evidence from the Netherlands, place our data into its European context, and finally, discuss the implications of our findings.

2 Recognising limitations in our methodologies

It is important to be clear that while microwear analysis may enable us to interpret the general contact material and motion in which a tool was involved, it rarely provides conclusive evidence for the exact task carried out or the specific end product made (Van Gijn 1990). Microwear analysts rely on experimental reference collections to compare traces with those seen on archaeological tools. Experiments thus form a critical element of microwear studies. It should be stressed that this reliance on experiments also constitutes an important methodological weakness: when experimentally produced wear traces and archaeologically developed ones match sufficiently we infer a similar function. This is an inferential leap which assumes that such traces are exclusively linked with specific activities (Van Gijn 2010, 31–33) For example, traces from working wood can show extensive similarities to those formed from working antler or other non-siliceous plants (Van den Dries and Van Gijn 1997). Also, repetitive use and repair of a tool is not always easy to recognise. It is with these limitations in mind that we present our research.

3 Plant working traditions in Holocene Northwest Europe

For close to twenty-five years, there has been ongoing debate amongst microwear analysts concerning enigmatic types of microwear polishes that are most commonly recognised on flint blades and flakes dating to the Mesolithic and Early Neolithic of Northwest Europe. The geographical distribution of blades and flakes with plant polish is broad: encompassing most of Northwest Europe, including Denmark, Britain and France (*e.g.* Juel Jensen 1994; Crombé and Beugnier 2013; Hurcombe 2007; Gassin *et al.* 2013; Guéret 2013). Most analysts who have encountered these smooth and bright polishes agree that they are the result of siliceous plant-working activities (Juel Jensen 1994; Van Gijn, Lammers *et al.* 2001; Van Gijn, Beugnier *et al.* 2001; Hurcombe 2007; Gassin *et al.* 2013; Guéret 2013), however, exactly what plant and what activity it relates to is uncertain as the variation in polishes has not yet been experimentally replicated. Typically these traces are interpreted as being related to craftwork, but the use of tools with this polish in plant food procurement has also been suggested (Van Gijn 2010). During the early Holocene we see the emergence of different polishes most likely associated with working plants, often found in association with denticulated blades and flakes, often referred to as microdenticulates. The polish associated with these tools is described by Juel Jensen (1994, 61) as an asymmetrical polish: the non-contact surface has a highly reflective, vitreous, metallic polish with few striations. The contact surface has more variation and shows a bright smooth polish with perpendicular striations. Sometimes this side displays an almost hide-like polish, with heavy rounding, pitting abrasion and striations. The combination of the two polish types then closely resembles what has been called "polish 23" in an LBK context (Van Gijn 1990). In Britain, microdenticulates with slightly concave curved edges are known from a range of early and middle Neolithic site-types, but their presence declines in the late Neolithic (Hurcombe 2007, 45). In Denmark, they are known to occur in Late Mesolithic Kongemose, Early Ertebølle and TRB contexts (Juel Jensen 1994).

Another type of tool, notched blade forms, occurring in the 7th and 6th millennium BC, were used on wood but also to scrape siliceous plants (Gassin *et al.* 2013). In Northern France, at the Mesolithic site of Beg-an-Dorchenn, microwear analysts conducted experimental work, drawing on earlier studies of Caspar *et al.* (2005) to make a case for notched 'Montbani blades' or 'bladelets' as siliceous plant and plant fibre scraping tools (Guéret 2013; Guéret *et al.* 2014). Two main variants – the scraping of rigid plant material, i.e. arrow shafts (resulting in marginal polish) and the scraping of pliable vegetal fibres (producing a more invasive polish) were further identified. Their results reaffirm those from a comparable study of 42 used Montbani bladelets from nine Late Mesolithic sites over a broad region from North Belgium to South France (Gassin *et al.* 2013), which was extended to include North Africa (Gassin *et al.* 2014), suggesting these types of tools were part of a broad geographical tradition of plant-working.

In the delta areas of the Rhine and Meuse the morphology of the flakes and blades involved in plant-working substantially differ from the microdenticulates and notched tools in that they are typically un-retouched. Guéret (2013) has documented the same unretouched flakes and blades in the Scheldt basin of Belgium (a.o. the sites of Doel and Verrebroek) and northern France (Noyen-sur-Seine). These blades and flakes displaying siliceous plant polish are slightly concave, sometimes straight. It is the shape of the worked edge that shows similarities to the Scandinavian

microdenticulates (Juel Jensen 1994) as well as the British Early/Middle Neolithic serrated forms (Hurcombe 2007, 45), but the fine denticulation is lacking.

Not only do we see morphological variation across North-western Europe in the types of tools selected for siliceous plant-working, the wear traces themselves also vary. Firstly, there are significant differences in the motion that was executed: the French notched pieces display slightly diagonal directionality and the microdenticulate blades from Ageröd V, Scania, often display traces of siliceous plant working that are longitudinal, therefore indicating a different motion and task (Juel Jensen 1994). In contrast, as mentioned, unretouched blades and flakes from the Mesolithic and Early Neolithic sites in the basins of the Rhine/Meuse/Scheldt are nearly always used in a transverse or slightly oblique motion associated with scraping or planning. Secondly, the polish on these unretouched flakes and blades never displays the undulating, highly smooth polish typical for many microdenticulates. They also never have a two sided polish. Yet, there are variations in the polish topography and distribution and some of these variations are also visible in other regions: a good example is the comparable wear traces on a blade from Hardinxveld Polderweg with a blade from the Belgian Early Mesolithic site of Verrebroek (see Beugnier 2007, figure 7).

It is apparent that a high degree of complexity arises when trying to grapple with comparisons and differences in plant-working evidence at this very broad inter-regional scale. Variations are subtle. It also remains to be seen how useful this geographical scale of analytical comparison is when microwear analysis as a method will always retain a degree of subjectivity (van Gijn 2014) and when comparisons are frequently made on the basis of photographs. Perhaps more critically, in attempting to identify such broad spatial and chronological patterns in plant-working traces we should consider whether in by doing so we are potentially obscuring vital differences – differences that may reveal intimate insights into regionally-specific or even site-specific practices. For this reason we want to focus the remainder of this paper on the transverse siliceous plant polish on unmodified blade and flake forms that shows continuity over a long period of time in the Dutch Rhine/ Meuse Delta region, but which curiously comes to an end as the Middle Neolithic commences.

4 Flint plant-working tools in the Dutch Mesolithic and Neolithic

Comparative microwear evidence indicates that the same type of wild plant-working activities was practiced at Mesolithic and early Neolithic wetland sites in the Netherlands. Although often associated with the Late Mesolithic, these plant-working tools occur in earlier periods as testified by the recently excavated Early Mesolithic sites of Yangtze Harbour (Sier *et al.* 2014) and Ede Kernhem (Crombé and Beugnier 2013), as well as at sites dated as late as *c.* 4200 cal BC (Swifterbant S2-4) (Bienenfeld 1986; Van Gijn 2010) (fig. 4a-c).

During the Early Neolithic Swifterbant culture, dated in the 5th millennium BC, people were still mainly hunter-fisher-gatherers, although towards the end of this millennium they had access to agricultural resources and even practised crop growing in the later phases (Cappers and Raemaekers 2008; Huisman and Raemaekers 2014). A small number of artefacts from the type sites of Swifterbant, were studied for microwear. These sites contained numerous unmodified blades that displayed transversely or obliquely oriented plant polishes (Devriendt 2014; Van Gijn 2010). The characteristic unretouched blades and flakes with transverse or slightly obliquely oriented plant polish are also encountered at various Early Neolithic B (4900-4200 cal BC) wetland sites like Hoge Vaart (Peeters *et al.* 2001), and Brandwijk (Van Gijn 2010). Their presence in these early Neolithic sites shows a strong continuity with the Middle and Late Mesolithic, and the more recent evidence from Yangtze Harbour (Sier *et al.* 2014), Ede-Kernhem (Crombé and Beugnier 2013) and Swifterbant N23 (Siebelink *et al.* 2012), dating to the Early and Middle Mesolithic. Remarkably, these traces are completely absent in the Middle Neolithic sites of the Hazendonk culture (3750-3400 cal BC) like Schipluiden (Van Gijn *et al.* 2006), Wateringen 4 (Raemaekers *et al.* 1997), and Ypenburg (van Gijn and Verbaas 2008): a period for which we have the first conclusive evidence for local cropping in the Rhine/ Meuse basin (Louwe Kooijmans and Jongste 2006). This absence cannot be attributed to differences in taphonomy or different selection procedures, as the plant working traces in question can be seen with the naked eye and are still visible even if the piece shows signs of heating or moderate patination.

The apparent disappearance of this very typical tool with equally prominent traces is interesting as these latter sites provide undoubted evidence for local production of cereal crops, albeit on a small scale, in this delta region (Out 2009). The recent evidence for tilled fields at the site of Swifterbant, dating to the later phases of occupation, c. 4000 BC (Huisman and Raemaekers 2014), suggests that somewhere between 4000 BC (when we still have these plant working tools at Brandwijk and Swifterbant S2-4) and 3750 BC, when they have vanished at Schipluiden (van Gijn *et al.* 2006), Ypenburg (van Gijn and Verbaas 2008) and Wateringen 4 (Raemaekers *et al.* 1997), the shift to agricultural practices gradually made these blades with straight or slightly concave profiles used for plant processing

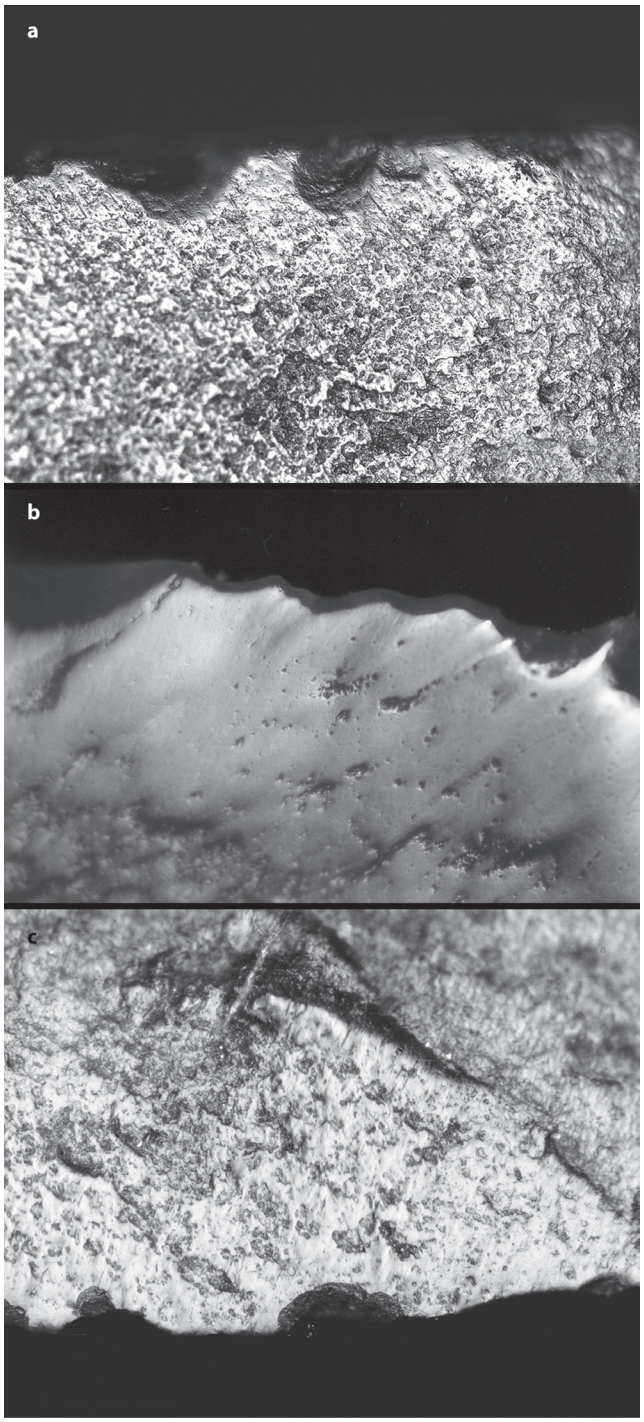

Figure 4 Plant working traces on unmodified flakes or blades from: a Yangtze Harbour (200x); b Swifterbant (S-2) (100x); c Brandwijk (200x) (photo's © Laboratory for Artefact Studies)

obsolete. It is, however, important to point out that no sites have been identified for the period 4000-3800 cal BC, making it difficult to assess the rate at which these tools go out of use. The fact that they disappear as agriculture begins to take hold in the delta area may provide a clue as to which activity lies behind the development of these characteristic plant processing traces. Most likely we have to search for a change in subsistence, with the transverse plant polishes associated with a technology connected to an important Mesolithic (and Early Neolithic) food source that was gradually becoming less important as a reliance on domesticated cereals increased.

It should be stressed that the disappearance of these typical plant processing traces in the Middle and Late Neolithic, so ubiquitous in the Late Mesolithic and the early Neolithic Swifterbant period, does not mean that plants were no longer being worked. On the contrary – in several sites of the Vlaardingen culture (3400-2600 cal BC) pointed flakes, having a very different working edge from the unretouched blades and flakes, were used to split semi-hard plant materials like thin branches of willows or other types of softer wood (Van Gijn 1990). It may well be possible that these tools were used to make the fish traps that we find at the site of Vlaardingen for example during the Middle and Late Neolithic, showing that wild plants continued to be important as a source of food and raw materials for craft activities in these wetlands (Van Gijn 2010).

5 Experimental research on subsistence and craft plant-working tools

On the basis of the palaeobotanical evidence (Out 2009) we conducted a number of experiments using replica unretouched blades and flakes on consumable and craftwork plants. Tubers of common reed (*Phragmites australis*), *Typha angustifolia/latifolia* (bulrush), *Equisetum* (horsetail), *Nymphaea alba* (white water lily) and *Nuphar lutea* (yellow water lily) were peeled (peeling can also create a transverse polish) with replicas of these blades. These tubers contain a lot of starch (Wood 1997, 381) and may have constituted an important food resource in some regions during the Mesolithic (Zvelebil 1994). However, the resulting experimental polish does not match the archaeological traces. Cooking experiments with tubers of horsetail indicate that it is actually far easier and tastier to roast the tubers directly in the fire than peeling them in advance of cooking, with well charred outer skin peeling off easily before consumption. Hazelnuts (*Corylus avellana*) which have become synonymous with the Mesolithic were split using blades. We also experimented with raking the seeds of wild grasses (fig. 5). On the basis of their charred state at the Hardinxveld sites tubers of *Ranunculus ficaria* (*Lesser celandin*e) and

water chestnuts (*Trapa natans)* were probably consumed (Bakels *et al*. 2001).

It is, however, difficult to conceive of a way that flint tools would be useful in the collection or processing of any of the aforementioned plant foods. In fact, few wild plants gathered for consumption would actually require the use of a flint tool. We have therefore concluded that direct use of these blades and flakes for procurement of plants is not sensible. For this reason we turned our attention to plants used in craftwork, which we believe is the likely source of the archaeological polish.

The experimental craft activities carried out with unretouched blanks included the scraping of various siliceous plants including reeds (fig. 6), *Juncus* (rushes), bulrush, horsetail and *Urtica* (nettles). In addition we scraped the bark of *Salix* (willow stems), *Tilia* (lime), hazel, and *Cornus Sanguinea L.* (dogwood). De-barking different types of soft wood like brambles, lime, willow, hazel and dogwood resulted in a wood polish with the correct directionality but with a very different texture, distribution and coalescence (fig. 7). By scraping the fresh stems of the reeds/grasses a series of breaks are created, making the stems more pliable after drying so that they could be included in matting, basketry and twining. If the stems are not made pliable when fresh, they easily break when bent or twisted in a dry state. Although the archaeological and experimental traces still do not entirely match, this activity has produced the closest parallel (see fig. 6). It is still unclear what the variation in polish between our reference collections and the artefacts reflects. Possibilities include different plant taxa, modes of working, the addition of minerals/dyes, or even differences in the state of the plants, in particular their water content at the season of harvest.

6 Conclusion

The fact that this type of plant-working tool disappears in a period during which agriculture becomes established as part of the subsistence system suggests that these tools were in some way or another involved in subsistence related activities. Whether this was the actual procurement or processing of plant materials for consumption, or whether we need to think of the production of a craft item or facility to procure a particular type of food, is not possible to ascertain at the moment. The fact that they are absent in contemporaneous Mesolithic sites like Hattemerbroek (Verbaas *et al*. 2011), a site located on the Pleistocene uplands, suggests that these tools were involved in a task that was closely connected to inhabiting a wetland environment. It is on this basis that we propose that these tools were involved in a craft activity requiring wetland plant(s), most likely fresh reeds. We further suggest that this craft may relate to fishing activities; however, this theory remains largely hypothetical, and given the evidence for fish remaining a major component of the Middle Neolithic diet in this region (see Smits *et al*. 2010) what we may in fact be seeing is a change in fishing technologies. What is clear is that at this microscopic level it has been possible to see how plants played an essential component of hunter-gatherer daily activities in the wetland environment of the Rhine/Meuse/Scheldt Delta region, with a common tradition of plant-working, using the same tool forms, continuing over several millennia. It is such long term traditions in tool use, and the subtle changes that take place through time that microwear analysis can reveal, thereby contributing towards a better understanding of the Neolithisation process (see also Van Gijn 2015). These studies provide crucial information on the development of agriculture, the impact this had on the composition of toolkits, and the activities people carried out as part of their daily routines.

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Figure 5 De-husking grass seeds with a flint blade and the resulting polish (100x) (photo's © Laboratory for Artefact Studies)

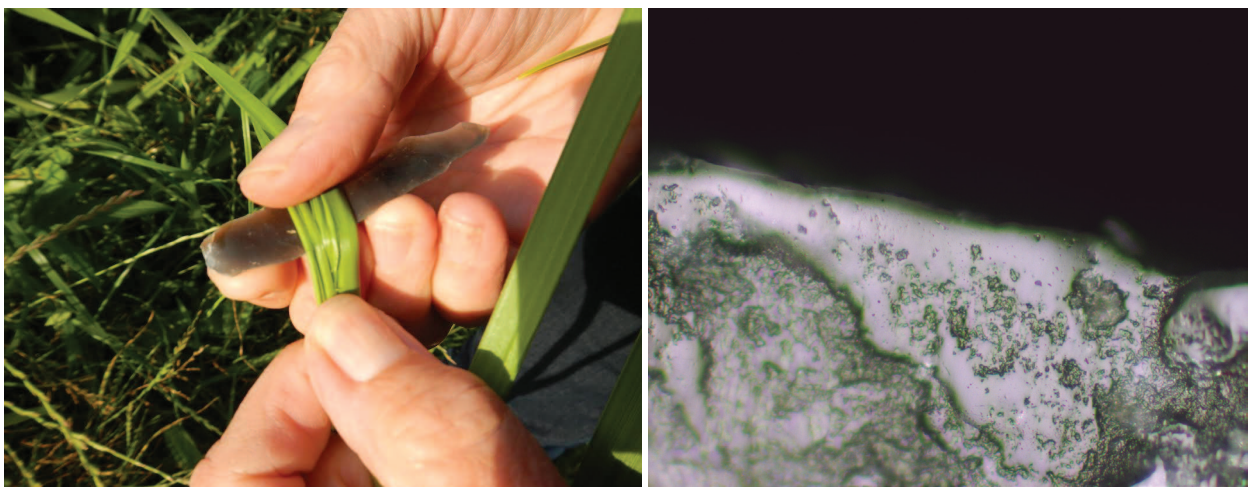

Figure 6 Planing fresh Phragmites with a flint blade and the resulting polish (200x) (photo's © Laboratory for Artefact Studies)

Figure 7 Scraping fresh willow and resulting polish (100x) (photo's © Laboratory for Artefact Studies)

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