Archaeobotanical evidence of *Triticum timopheevii* from late Neolithic and Copper Age Croatia

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Introduction - This paper presents a detailed examination of finds of 'new glume wheat' (NGW), recognised as a member of the *Triticum timopheevii* wheat group, at Late Neolithic sites in Croatia. Increasing evidence of this morphotype from prehistoric sites across Europe, as well as comparative studies of modern Timopheev's wheat, provide a range of comparative material. Using morphometrics this study re-examines grains and spikelet bases previously identified as NGW within the late Neolithic settlements of Velištak (Dalmatia), Sopot, and Ravnjaš (Slavonia), and late Neolithic/Eneolithic Slavča (Slavonia).

Study sites

The archaeological site of Velištak is situated in the Velim Valley to the north of Vodice in northern Dalmatia, Croatia (Fig. 1). Radiocarbon dates suggest that the settlement was founded sometime after 5000 cal BC and lasted until 4700 cal BC (McClure et al. 2014.1027, T.1). A large quantity of classic Hvar culture pottery has been recovered, along with tools made of animal bone, knapped and polished stone, as well as jewellery and polished shells (*Spondylus gaederopus*) (Podrug 2010; 2013). Archaeobotanical remains were collected during excavations from a range of features, including occupations layers, fireplaces and pit fills (Reed and Podrug 2016). Overall, seed density was low, and preservation was generally poor. Cereals were the most recovered plant remains at the site, accounting for 94% of the identified assemblage. Of the cereal grains, 93% of the remains were of barley (*Hordeum vulgare* ssp. *vulgare*), totalling 879 grains, although 838 of these were recovered from a pit. Emmer (*Triticum dicoccum*) and einkorn (*Triticum monococcum*) grain and chaff were also identified, along with one NGW spikelet, and several possible identifications of NGW.

Sopot is situated 3km south-west of Vinkovci, on the right bank of the river Bosut (Fig. 1). The tell site is elliptical, measuring 113 x 98m, and is 3m deep. Three phases of Sopot culture have been

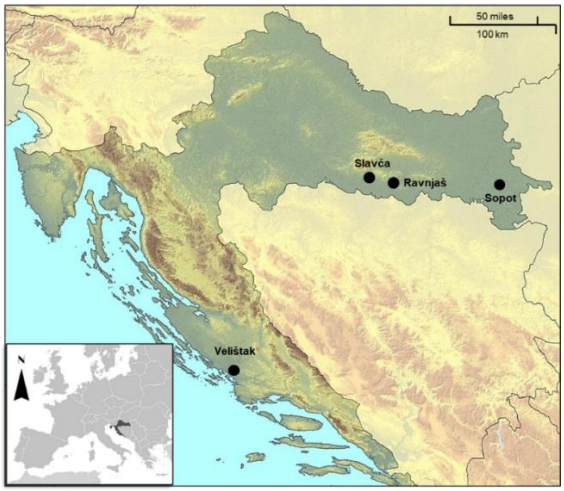

Figure 1. Map showing the sites of Velištak, Slavča, Ravnjaš and Sopot.

identified at the site dating from 5050–4780 cal BC to 4340 and 3997 cal BC, as well as an early Neolithic Starćevo settlement dated to 6060–5890 cal BC (Krznarić Škrivanko 2011; Obelić et al. 2004). Overall, seed density was low, and preservation was generally poor. Cereals were the most recovered plant remains at the site, accounting for 81% of the identified assemblage (Reed et al. 2017). Of the cereals, einkorn represented 37% and emmer 28% of the grain recovered, with only 8% barley. A large number of chaff remains were recovered, although many were fragmented making identification difficult. NGW grains (21 grains) and chaff (1 spikelet

base) were identified from 9 of the 114 samples examined (Reed et al. 2017). The grains had previously been identified as spelt (*Triticum spelta*) grains (Reed 2013), but without diagnostic spelt glume bases and the identification of a NGW glume base these identifications were later changed.

The prehistoric site of Slavča (Nova Gradiška-Slavča) is located approx. 1.5 km north of the centre of Nova Gradiška (Fig 1.). The site is a fort type, on a flat plateau at the point where the southern slopes of Psunj exceed the Posavina Plain. At an elevation of 240.61m, it offers a strategic position commanding the surrounding area. The site is a multi-layered prehistoric settlement with Sopot and Brezovljani type Sopot culture occupation, illustrating the transition from the late Neolithic to the early Eneolithic (Sopot IV). The site was also occupied through the Eneolithic with evidence of the Lasinja, Kostolac and Vućedol cultures (Skelec 1997). Carbon dates have been taken from Sopot levels dating to 5210–4950 cal BC and 4960–4340 cal BC, as well as 4250–4030 cal BC associated with Sopot IV (Mihaljević 2013a). Overall, seed density was relatively high, although this was due to large numbers of chaff remains found in the samples, but preservation was generally poor (Reed 2017; Reed et al. 2017). Cereals were the most recovered plant remains at the site, accounting for 98% of the identified assemblage. However, the presence of cereal grain was very low, with only a scattering of grains of emmer, einkorn, and barley. Interestingly the site had a huge amount of cereal chaff, many of which could be identified to emmer and einkorn, with nine glume bases identified to NGW from two of the samples.

Ravnjaš (Nova Kapela-Ravnjaš) is located on the upper slopes of the Požega hill, north-west of the village of Nova Kapela. Excavations have revealed a phase II Sopot culture tell settlement and in particular a burnt down house (SJ022). The rectangular house was oriented north-south, consisting of two rooms containing a large amount of burnt material and large quantities of household items, including millstones pottery and lithics. Carbon dates indicate a range of 4970 to 4690cal BC (Mihaljević 2013b). Overall, seed density was low, and preservation was generally poor (Reed et al. 2017). Cereals were the most recovered plant remains at the site, accounting for 96% of the identified assemblage. Of the cereals, einkorn represented 31% and emmer 23% of the grain recovered, with only 3% barley. A large number of chaff remains were recovered, although many were fragmented making identification difficult. Of the NGW, eight grains were identified from four samples, as well as one spikelet base and several indeterminate spikelets (Reed et al. 2017). Previously the grains were identified as spelt grains (Reed 2013), but without diagnostic spelt glume bases and the identification of NGW glume bases these identifications were later changed.

Methods

Recent studies have highlighted the usefulness of morphometric analysis as an alternative or addition to traditional archaeobotanical methods to address differences within and between plant species and their remains (Portillo et al. 2019). The application of statistical analyses to size and shape variables can help refine and enhance taxanomic resolution and enables analysis of form in a comparable way. To examine the presence of NGW at the study sites, grains identified as NGW or *Triticum* sp. were photographed in dorsal and lateral view, and spikelet bases of einkorn, emmer, NGW and *Triticum* sp. were photographed in abaxial view using a stereomicroscope with a digital camera. For the grains three measurements were selected: total length (L), breadth (B) and height (H) (Fig. 2). For

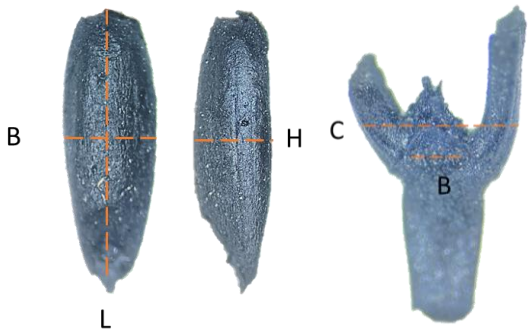

Figure 2. Measured dimensions of grains and spikelet bases. Total length (L), breadth (B) and height (H), and width of the disarticulation scar (B) and width of spikelet base (C).

the spikelet bases two measurements were selected: the width of the disarticulation scar (B) and width of spikelet base (C) (Fig. 2). Measurements were collected using ImageJ v.1.8.0, an open-source image analysis program (https://imagej.nih.gov/ij/download.html). Measurements were repeated three times and the average taken to try and control for human error.

Measurements were also collected from published data as comparison. This included the average dimensions of einkorn, emmer, and NGW spikelet bases from late Bronze Age Stillfried, Austria (Kohler-Schneider 2003). Average dimensions of NGW grains recently measured from Neolithic Çatalhöyük, Turkey (Roushannafes et al. 2022), and emmer, einkorn and NGW spikelet bases from Çatalhöyük were measured from illustrations in Bogaard et al. (2013). The average dimensions of emmer, NGW and spelt grains from Bronze Age Feudvar, Serbia, were included (Kroll 2016). Spelt grains from Iron Age Gomolava were also measured from figures in Medović et al. (2021) for comparison. Finally, measurements were taken of the illustrations of NGW identified by Jones et al. (2000) at three Bronze Age sites in northern Greece. However, all comparative data measurements taken from published figures will be viewed with a certain amount of caution due to possible errors in measurements.

Results

NGW grains were identified from Sopot and Ravnjaš in the past, however, many of the grains were slightly fragmented and did not allow measurements to be accurately taken. From Sopot six grains identified as NGW/spelt were successfully measured, and nine grains identified as either NGW/spelt, or NGW/emmer were measured from Ravnjaš. At Velištak, two grains identified as emmer were also selected as they had a flatter appearance. Plotting the L:H and L:B values of the grains, there was a clear clustering of the Feudvar, Stillfried and Çatalhöyük NGW grains to the right of the graph, while emmer and spelt plotted to the left (Figure 3). The grains from Ravnjaš and Velištak cluster with the emmer and spelt grains, however, for Sopot one grain clusters with the NGW and two grains plot away from the

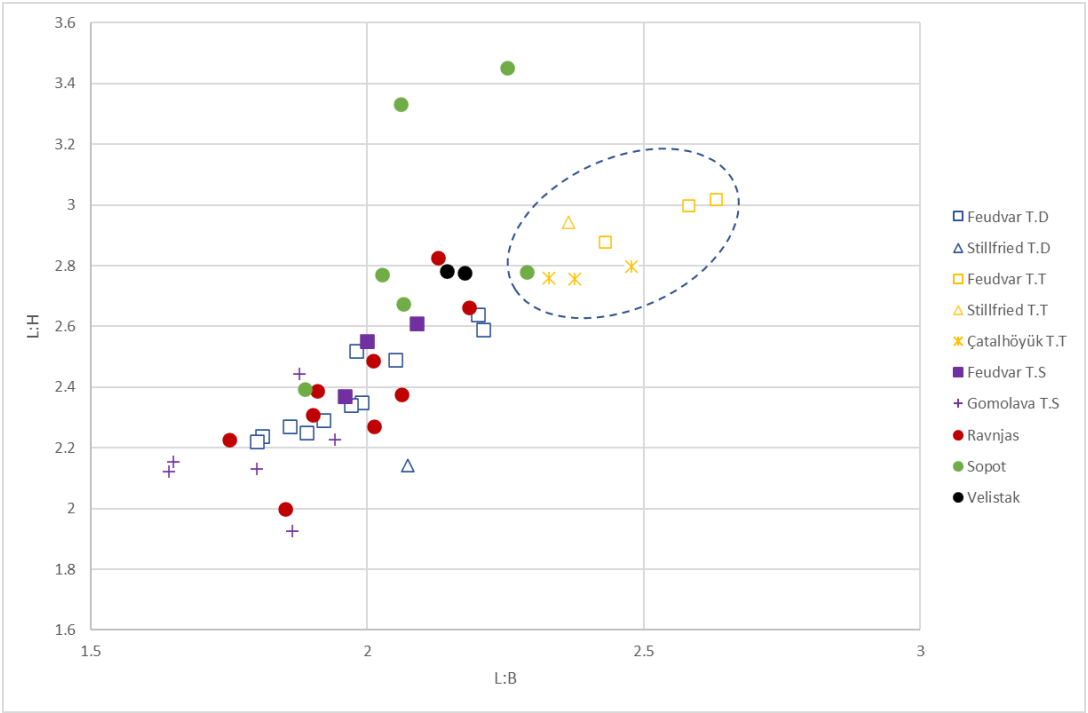

Figure 3. Graph showing the length:height and length:breadth values (mm) of emmer (Triticum dicoccum – T.D), NGW (Triticum timopheevii – T.T) and spelt (Triticum spelta – T.S) grains from comparative sites and the grains measured from Velištak, Ravnjaš and Sopot.

group towards the top of the graph. These two grains are wider than the comparative NGW but have a similar flat or slightly concave ventral side (Figure 4, 5), while the grain that plots near the comparative NGW grains is slimmer but looks more like emmer.

(a)

(b)

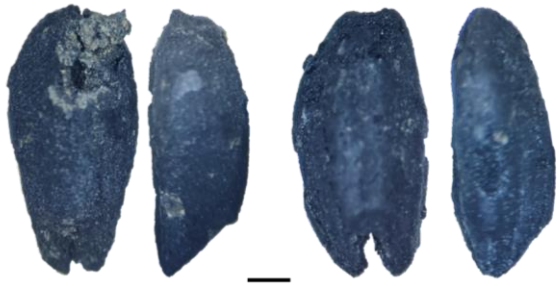

Figure 4. Carbonised (a) Triticum cf. timopheevii grains from Sopot (Block 5, SJ6, □H6), (b) Triticum dicoccum grains from Veliš tak (Sample U-185). Scale = 1 mm

The comparative spikelet measurements were plotted to determine where the clusters would be in the plot (Figure 6). It showed that einkorn spikelets cluster to the top/middle left, emmer to the bottom right and NGW centre right. However, when we plot the spikelets identified previously as einkorn and emmer from Sopot, Slavča and Veliš tak with the spikelets that were identified as possible NGW we see three groups forming (Figure 7). As with the comparative material einkorn clusters to the top/middle left. In contrast, the emmer spikelets cluster to the bottom centre of the plot, while grains that cluster to the top right are similar to the NGW comparative material. This suggests that emmer spikelet bases at the Croatian sites are generally narrower than the comparative sites, while the NGW spikelets from Croatia are wider than the emmer from the same region.

Looking at the Croatian material (Figure 7), we see that Sopot has one spikelet and for Slavča two spikelet bases identified as possible NGW, clustering in the NGW area of the plot. We also see two spikelet bases from Slavča previously identified as emmer (Figure 8) clustering in the NGW area of the plot. For Veliš tak, we see one spikelet cluster with einkorn, two with emmer, and one with NGW. For Ravnjaš, we see two spikelets cluster with einkorn, one with emmer, and two with NGW.

Figure 5. Triticum timopheevii grains from Bronze Age Feudvar (W3063). Scale = 1 mm

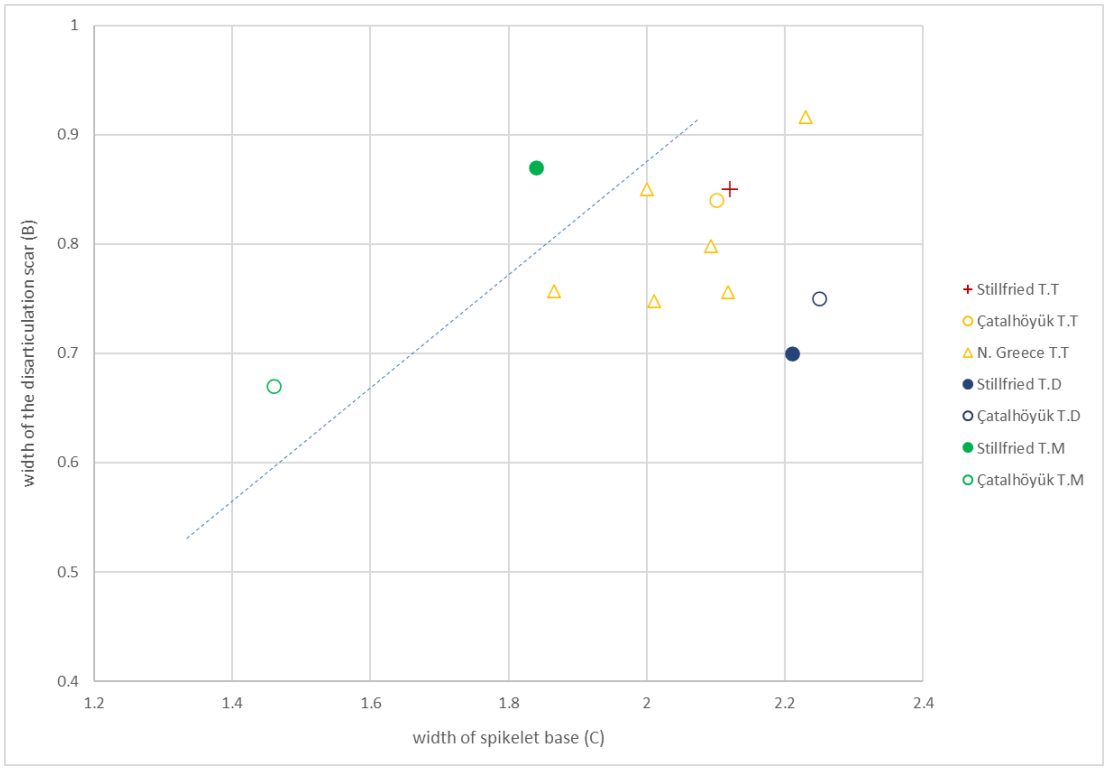

Figure 6. Graph plotting the width of the disarticulation scar (B) and width of spikelet base (C) (mm) of emmer (Triticum dicoccum – T.D), einkorn (Triticum monococcum – T.M) and NGW (Triticum timopheevii – T.T) spikelets from comparative sites.

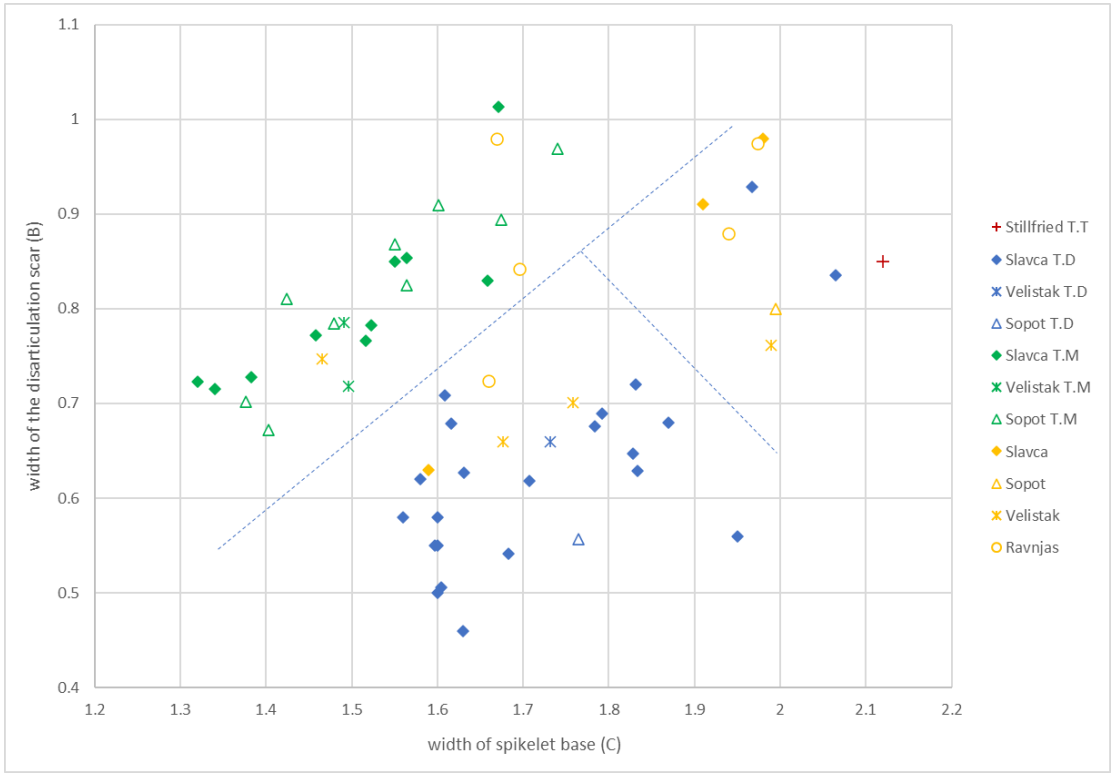

Figure 7. Graph plotting the width of the disarticulation scar (B) and width of spikelet base (C) (mm) of emmer (Triticum dicoccum – T.D), einkorn (Triticum monococcum – T.M) and NGW (Triticum timopheevii – T.T) spikelets measured from Velištak, Slavča, Ravnjaš and Sopot and the comparative site Stillfried.

Kohler-Schneider (2003), based on the spikelet's identified from Stillfried, suggested an identification index, calculated as the percentage of the width of the articulation scar and the width of the spikelet fork. It's unclear if this index suggests spikelets are NGW if they fall between the einkorn (47.2%) and emmer (31.4%) values or whether the closer you are to the value the more likely the identification. Nevertheless, if we apply this to the spikelet's measured here (Table 1), we see generally that einkorn spikelets range from 60.6% to 47.2%, although three possible NGW spikelets are found within this range. For emmer the spikelets generally range from 28.2% to 44.1%, although again we see three possible NGW spikelets between 40.1% and 40.5%. The spikelets identified as NGW range from 38.3% to 49.5%.

Conclusion

Grains and spikelets previously identified as NGW at four Late Neolithic sites in Croatia have been re-assessed using morphometrics. This method proved useful in understanding the assemblages, as the identification of cereal grain and chaff can be difficult. For the grain's examined from Sopot, Ravnjaš and Veliš tak, it was clear that most of the grains were probably either spelt or emmer. Two outlier grains from Sopot had some similarities with NGW but were wider in breadth than the comparative material, putting a question mark on the identification of NGW. The grain from Sopot that plotted closer to the comparative NGW looked like emmer, being wider than the comparative NGW grains, but was slightly longer. Again, a question mark should be put on this on the identification of NGW from the grains alone.

The spikelet bases plotted into three clusters, suggesting that eight spikelets had similarities with NGW. At Ravnjaš, although no grains correlated with NGW, two spikelet bases clustered with the NGW comparative sites. These came from a pit feature (sample 32, SJ28, □ J/24), which contained a large amount of fragmented glume bases that were difficult to identify to species. At Veliš tak only one spikelet base from U49, a pit feature, was identified as NGW, while the remaining spikelets clustered with either einkorn or emmer. Again, no grains were identified as NGW from Veliš tak. For Slavča, no NGW grains were identified, but four spikelet bases were identified as NGW; one from sample U129 (SJ7), a pit feature dating to the late Neolithic Sopot culture, two from sample U169 (SJ123), a pit feature dating to the Sopot/Kotolac culture and one from sample U9 (SJ(22)23) a pit feature that dates to the middle Eneolithic Lasinja culture. Overall, the results suggest that it is possible that NGW was present at the Croatian sites, however, these identifications should be viewed with caution as the number of remains are so low.

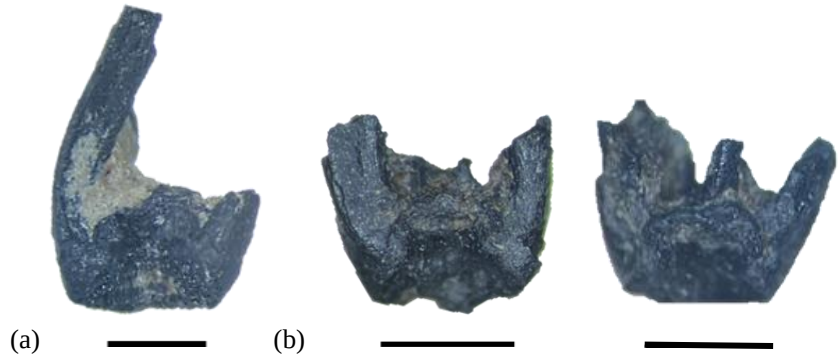

Figure 8. NGW spikelet base from (a) Ravnjaš, and (b) Slavča. Scale = 1 mm

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