Volume XVII • Issue 1/2026 • Pages 37–47

INTERDISCIPLINARIA ARCHAEOLOGICA
NATURAL SCIENCES IN ARCHAEOLOGY
homepage: http://www.iansa.eu

Yellow for the Miners? A Bulk Find of *Reseda luteola* L. from a Bronze Age Copper Mining Site

Thorsten Jakobitsch[1*], Marlies Verena Außerlechner[2], Andreas G. Heiss[1], Silvia Wiesinger[1,3], Peter Trebsche[2]

[1]*Austrian Archaeological Institute, Austrian Academy of Sciences, Dominikanerbastei 16, 1010 Wien, Austria*
[2]*Department of Archaeologies, University of Innsbruck, Innrain 52A, 6020 Innsbruck, Austria*
[3]*Department of Classics, University of Graz, Universitätsplatz 3, 8010 Graz, Austria*

ARTICLE INFO

Article history:
Received: 18th April 2025
Accepted: 15th October 2025

DOI: http://dx.doi.org/10.24916/iansa.2026.1.3

Key words:
Bronze Age
copper mining
dyeing plant
textile and leather working
weld
Reseda luteola

ABSTRACT

Archaeobotanical analyses of flotation samples from the Bronze Age mining site Prigglitz-Gasteil in Austria revealed a bulk find of charred seeds of the dye plant *Reseda luteola* L. (weld), of the Resedaceae family. The find securely dates to the 9th century BCE, *i.e.* the Late Urnfield Culture. Although *Reseda luteola* can also occur as a weed, its dominance in the sample rather indicates intentional growing. This paper discusses the biology and the economical uses of weld, and aims to clarify the rationale for the occurrence of weld in the Bronze Age mining context. Dyeing with weld requires pre-mordanting with inorganic compounds such as copper or ferrous sulphates. These metal compounds were abundantly available at the site, where copper ores were extracted from an opencast mine. While the mass find of *Reseda luteola* cannot provide a proof in the strict sense, in all probability it represents evidence for its use as a dyeing plant in the Alpine region as early as the 9th century BC.

1. Introduction

Evidence of yellow dyeing plants is generally scarce in the archaeobotanical record of central Europe. In this paper, we present an extraordinary mass find of dyer's weld seeds (*Reseda luteola* L.), which was discovered in a Late Bronze Age (ca 1050–780 BC) copper mining site at Prigglitz-Gasteil in Austria.

Excavations at the copper mining site at Prigglitz-Gasteil in south-eastern Lower Austria (Figure 1) were carried out from 2010 to 2014. The site is located on the eastern slope of the Gahns Mountain at ca. 700–730 m above sea level in the district of Neunkirchen. It extends over an area of approximately 3 hectares and comprises a large opencast copper ore mine, adjacent mining dumps and settlement terraces created on the dumps and nearby (Trebsche and Weixelberger, 2022; Trebsche *et al.*, 2022). In the mining camp or settlement, copper ore was beneficiated and alloyed with tin, and bronze objects produced in casting workshops (Mödlinger and Trebsche, 2021; Mödlinger *et al.*, 2021; Haubner *et al.*, 2023). Besides the metallurgical activities, there is also evidence for butchering, cooking, bone and antler working, as well as textile and leather working (Trebsche and Pucher, 2013). According to a series of 75 radiocarbon dates, the site was occupied circa from 1050 to 780 BC, which corresponds with the Late Urnfield Culture in Eastern Austria (Trebsche, 2015; Trebsche and Weixelberger, 2022).

Considering the context of this mass find of *Reseda luteola* seeds found within a Late Bronze Age mining settlement immediately next to copper ore mines, we aim at clarifying the presence and possible use of dyer's weld. Did it grow naturally at the site, together with other ruderals that occur on disturbed soils? Or was the weld grown intentionally to be used as a plant resource? And finally: Was it used as a dye plant in the Late Bronze Age mining settlement? We are going to discuss these questions considering the context of the *Reseda luteola* finds, the working process of dyeing textiles and leather, and evidence for other activities related

*Corresponding author. E-mail: thorsten.jakobitsch@oeaw.ac.at

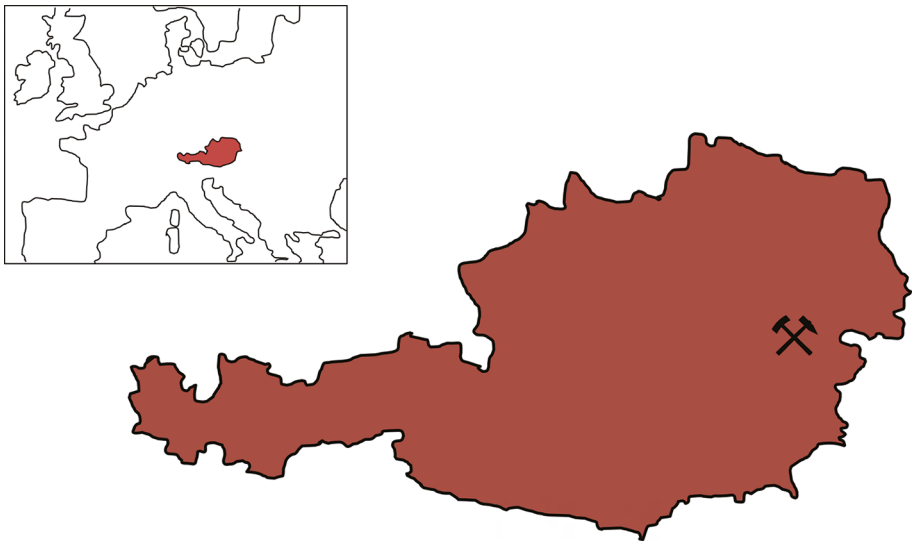


Figure 1. Map of Austria, indicating the location of the Bronze Age mining site Prigglitz-Gasteil (T. Jakobitsch).

to textile and leather working at the site. Before drawing our conclusions, we start with the identification and dating of the weld remains, describe this plant and its use for dyeing and other purposes, and provide an overview of evidence of dyer's weld in prehistoric central Europe.

2. Materials and Methods

During excavation, the sampling strategy for sediment samples followed systematically, and all stratigraphic units (SU) were sampled with soil volumes of 10 to 20 litres. A total sum of 310 sediment samples (4,793.5 litres) was gained for archaeobotanical analyses and analysis of micro-refuse. The samples were processed with the flotation method using sieves with mesh sizes of 2 mm, 1 mm and 0.5 mm. Charred plant material was sorted out using a stereoscopic microscope with magnifications ranging from 6.3× to 63×. Charred plant seeds were identified using carpological literature (*e.g.* Bertsch, 1941; Berggren, 1981; Anderberg, 1994; Cappers *et al.*, 2006) and the seed reference collection at the Austrian Archaeological Institute (OeAW–OeAI). The data were collected using ArboDat 2016 (Kreuz and Schäfer, 2004; Bittmann *et al.*, 2016) and data analysis was done using Microsoft Excel. A more detailed description of archaeobotanical methods is provided by Heiss *et al.* (2021). Charcoal analysis was carried out with 1,000 charcoal fragments recovered from the sediment samples. Details on the methods are given in Jakobitsch *et al.* (2022).

Charred seeds of a *Reseda* species were recovered from two samples (T3-08D/SU 413 and T4-04/SU 1205). The bulk find with 1028 seeds comes from a thin burnt layer (SU 1205), documented as an inclusion within a thicker layer of coarse mining debris (SU 1204), which was deposited on Terrace T4 in phase T4-10 between the building phases T4-11 and T4-09, both with remains of wooden buildings and hearths. SU 413, which contained three *Reseda* seeds, is a layer deposited on Terrace T3 containing typical settlement debris like pottery sherds, animal bones and burnt clay. It was probably redeposited from Terrace T2 above and accumulated on T3 between two building phases.

The *Reseda* seeds were studied in detail with a stereoscopic microscope (Olympus SZX-10) for their morphological features and size. In addition, the seed coat (testa) surface was observed using the Hitachi TM4000+ II Scanning Electron Microscope. The archaeobotanical material was compared with the modern carpological reference collection at the Austrian Archaeological Institute (OeAW–OeAI). Seeds of *Reseda luteola* from five different representative collections (accessions) were used for a comparison of morphological traits and testa surface comparison. Eventually, the charred seeds were identified as the dyeing plant *Reseda luteola* L. and clearly differentiated from the similar species *Reseda lutea* L., which is a common weed.

Initially, the seeds had been believed to derive from a mediaeval sample, possibly dating to the 11th century AD. For this reason, the find was not included in either of the recently published archaeobotanical publications covering the Bronze Age phases of the site (Heiss *et al.*, 2021, Jakobitsch *et al.*, 2022). To finally determine the absolute chronology of the seeds, three seeds from sample T3-08D/SU 413 and five seeds from sample T4-04/SU 1205 were sent to the Poznań Radiocarbon Laboratory for radiocarbon dating by Accelerator Mass Spectrometry. Results were calibrated using OxCal 4.4 (Bronk Ramsey, 2021) and the IntCal20 calibration curve (Reimer *et al.*, 2020).

3. Results

A total amount of 7,022 charred plant remains were recovered from 1,459 litres of sediment (171 studied samples). Of these, 48% (3,392 remains) could not be identified due to poor preservation. Nevertheless, numerous finds of cultivated plant seeds/fruits provided enough data for a detailed analysis of the food habits of the miners at the site. Evidence shows that the miners were supplied with agricultural products by external groups. Details on the identified plant seeds/fruits

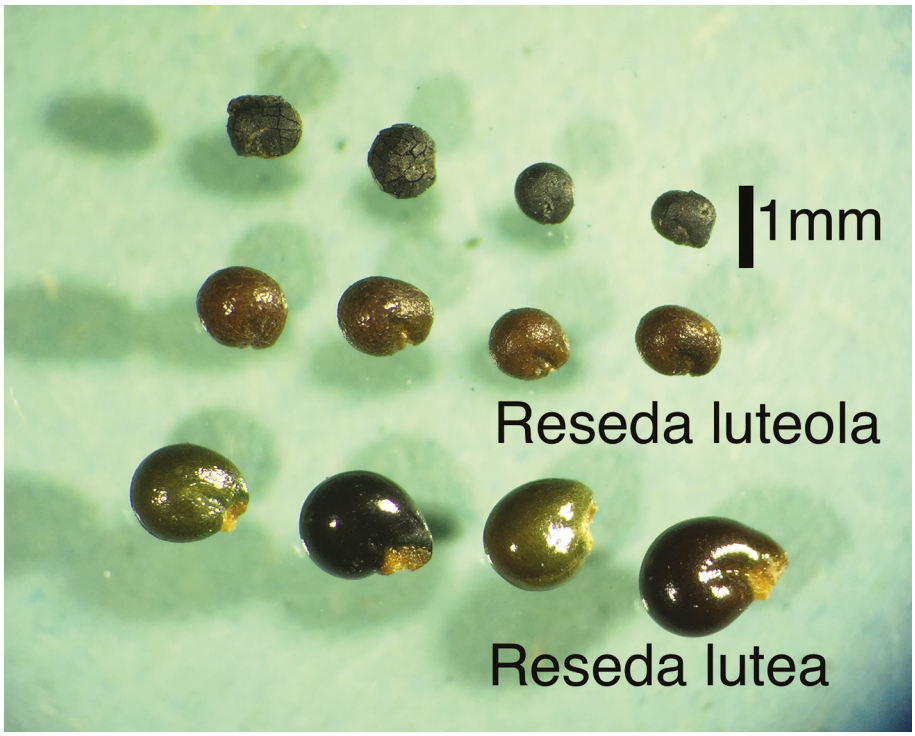


Figure 2. Charred seeds of *Reseda luteola* (top), found in the Bronze Age layers of Prigglitz-Gasteil, in comparison to modern seeds of *Reseda luteola* and *Reseda lutea* (T. Jakobitsch).

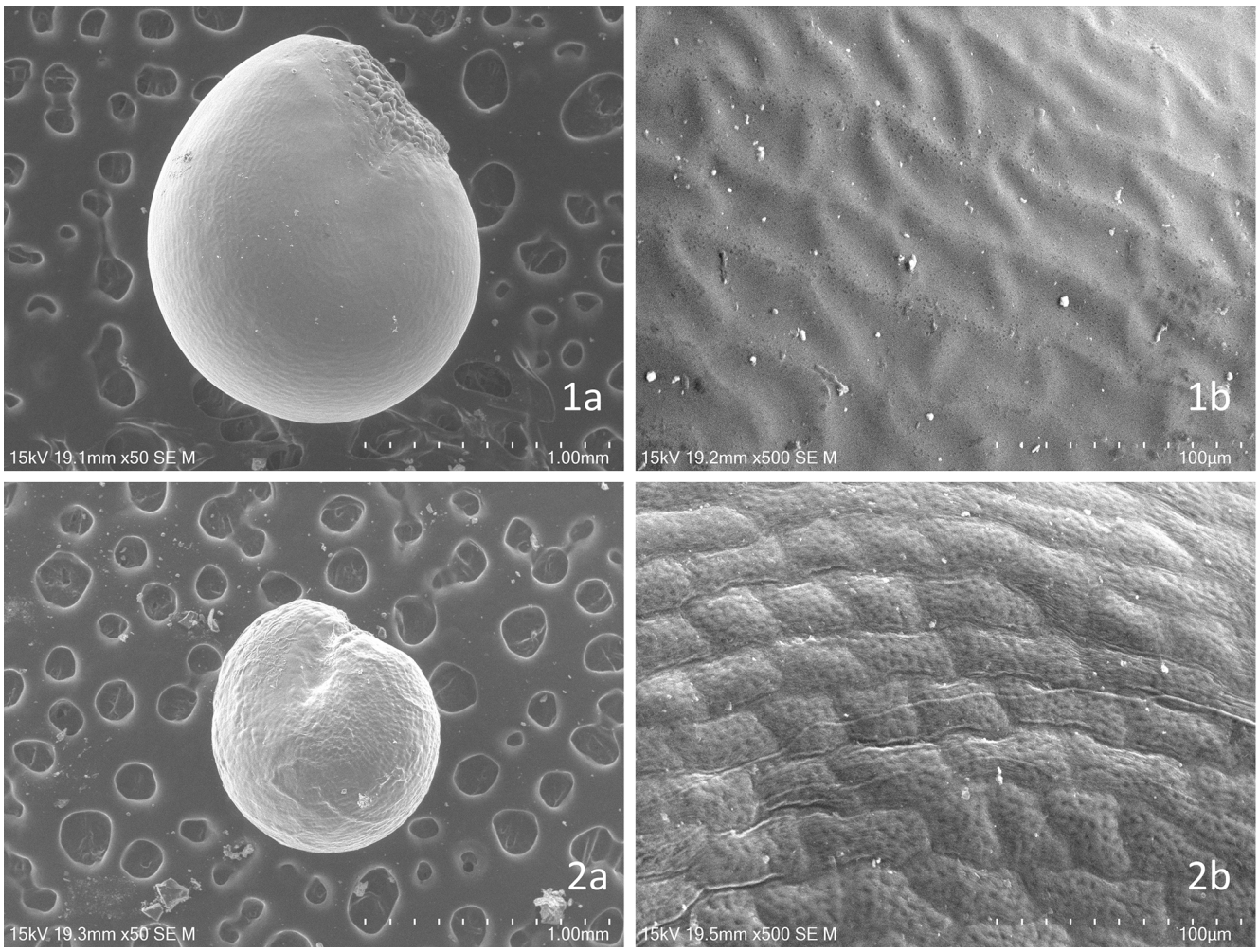


Figure 3. SEM-Micrographs of modern *Reseda* sp. seeds: 1a) *Reseda lutea* seed, 1b) *Reseda lutea*, detail of reticulate seed testa with smooth intercostal fields; 2a) *Reseda luteola* seed, 2b) *Reseda luteola*, detail of reticulate seed testa with porous intercostal fields (T. Jakobitsch and A. G. Heiss).

and processed foods can be found in Heiss *et al.* (2021).

Charcoal analysis revealed 966 identified fragments of 17 different woody taxa. *Fagus sylvatica* and *Pinus* type *sylvestris* are the dominant species in the assemblages; however, light demanding species such as *Populus* and *Salix* occur in considerable numbers, giving evidence for a pioneer vegetation that arose due to the mining activities. For more details, see Jakobitsch *et al.* (2022).

Radiocarbon dating of the *Reseda luteola* seeds verified that they were indeed from the Late Urnfield period: five seeds from the bulk find sample no. 2358/SU 1205 (sample code GAST78, lab code Poz-125902) with 2720±35 BP radiocarbon age were calibrated to 898–831 BCE (1ς 68.3%), while the three seeds from sample no. 681/SU 413 (sample code GAST79, lab code Poz-125903) resulted in a radiocarbon age of 2690±80 BP, cal. 924–796 BCE (1ς 68.2%).

The morphological analysis of the charred seeds matched them unequivocally to the species *Reseda luteola* in shape and size. The charred seeds are significantly smaller than recent *Reseda lutea* seeds and just slightly smaller than *Reseda luteola* seeds (Figure 2). Apart from their size, the most prominent differentiation is the conspicuous aril in *Reseda lutea* which is missing in *Reseda luteola* (*cf.* Anderberg, 1994), as well as in the charred seeds. The additional analysis of testa cellular patterns with Scanning Electron Microscopy confirmed the identification and differentiated them clearly from seeds of the species *Reseda lutea*. Both species have a glossy smooth surface with a light reticulate pattern. While the intercostal fields in this pattern are smooth in *Reseda lutea*, they show a fine porous surface in *Reseda luteola* (Figure 3), which is still visible in many charred seeds.

While the three seeds of *Reseda luteola* from sample T3-08D SE 413 were found associated with seeds of taxa from various habitats, the bulk find of *Reseda luteola* seeds (T4-04 SE 1205) was mainly associated with the taxa of ruderal communities (Table 1).

3.1 General description and ecology of *Reseda luteola*

Reseda luteola (dyer's weld) is an annual or biennial herbaceous plant, forming a rosette of oblong-lanceolate leaves on the ground (Figure 4) before growing 50 to 150 cm in height, with bright-yellow flowers arranged in an upright raceme (Hegi, 1919; Cardon, 2007). Dyer's weld blooms in May/June and the fruiting takes place from July to September (Körber-Grohne, 1987; Fischer *et al.*, 2008; Bussmann *et al.*, 2020).

The fruit of *Reseda luteola* is an upright subpetiolated capsule of about 4 mm height and 5 mm width (Figure 4). The capsule is subglobose, hexagonal and becomes narrower towards the base (Hegi, 1919). It contains numerous minute seeds that are obovate or subreniform, also described as mitaform (mitten-shaped), where the cotyledonary lobe and the radicular lobe are of unequal size and shape. In *Reseda luteola* the radicle lobe is slightly longer than the cotyledonary lobe. The seeds range in size from 0.8 to 1.1×0.7 to 0.9 mm. The seed surface is highly glossy and smooth, with fine areoles of 0.02–0.04 mm in diameter. The aril is missing in *Reseda luteola*, while it is present in the slightly bigger seeds of *Reseda lutea* (Anderberg, 1994; Bojňanský and Fargašová, 2007). The 1000 seeds weight is 0.268 g (Hegi, 1919).

According to Ellenberg (1982), both *Reseda lutea* as well as *Reseda luteola* are components of perennial ruderal communities. *Reseda luteola* is considered a weak character species of the phytosociological association Onopordion acanthi (cottonthistle communities), a thermophilic and relatively drought resistant perennial community. The alliance Onopordetum acanthi, a type of the association Onopordion acanthii, can be found on warm spots around villages from south-eastern to central Europe. Other taxa in this community are *Onopordon, Carduus, Cirsium* and *Echinops* species. Their occurrence is especially bound to villages with livestock husbandry, since these plants are avoided by grazing animals.

Reseda luteola can also occur as an arable weed in fields and gardens, in gappy weed communities on dumps, in



Figure 4. Left: *Reseda luteola* forming a rosette of oblong-lanceolate leaves before flowering. Right: The fruit of *Reseda luteola* is an upright subpetiolated capsule (T. Jakobitsch).

Table 1. Archaeobotanical finds of the samples T3-08D SE 413 and T4-04 SE 1205. While the three seeds of *Reseda luteola* from sample T3-08D SE 413 were found associated with speĕcies from various habitats, the bulk find of *Reseda luteola* seeds (T4-04 SE 1205) is mainly associated with ruderals (S. Wiesinger and T. Jakobitsch).

	chronology	**924 – 796 BCE**	**898 – 831 BCE**
	site, area	**PRIG Fl. 3 PRIG**	**PRIG Fl. 8 PRIG**
	volume (l)	**24**	**8**
	sample	**T3-08D SE 413**	**T4-04 SE 1205**
cultivated plants			
Cerealia indet.	seed/fruit	5	2
Cerealia indet.	ACO	2	–
Panicum miliaceum	seed/fruit	5	–
Setaria italica	seed/fruit	2	9
Triticum monococcum/dicoccum	glume	1	–
grassland			
Fragaria vesca	seed/fruit	3	–
cf. Fragaria vesca	seed/fruit	5	–
Trifolium spec.	seed/fruit	1	–
Verbena officinalis	seed/fruit	4	–
ruderals			
Atriplex spec.	seed/fruit	3	–
Chenopodiaceae (Amaranthaceae p.p.)	embryo	3	62
Chenopodium album	seed/fruit	15	–
Chenopodium cf. glaucum	seed/fruit	–	1
Chenopodium polyspermum	seed/fruit	2	–
Chenopodium spec.	seed/fruit	10	49
Fallopia dumetorum	seed/fruit	2	–
Galium aparine	seed/fruit	1	–
Hyoscyamus niger	seed/fruit	–	–
Polygonum aviculare agg.	seed/fruit	2	–
Reseda luteola	seed/fruit	3	1028
Sambucus cf. ebulus	seed/fruit	2	–
Solanum luteum/nigrum	seed/fruit	1	43
Solanum luteum/nigrum	fruit	–	2
coniferous forest			
Abies alba	leaf/needle	88	4
Picea abies	leaf/needle	9	–
forest edges/forest clearings/shrubbery			
cf. Atropa bella-donna	seed/fruit	1	–
cf. Corylus avellana	seed/fruit	1	–
Rosa spec.	seed/fruit	4	–
Rubus caesius	seed/fruit	1	–
Rubus fruticosus agg.	seed/fruit	7	–
Sambucus nigra	seed/fruit	2	–
unassignable taxa			
Bromus-Typ	seed/fruit	1	–
cf. Pinaceae	cone	1	–
Galium spec.	seed/fruit	3	1
Panicum/Setaria	seed/fruit	1	–
Plantago major s.l.	seed/fruit	–	40
Poaceae	seed/fruit	5	–
Polygonaceae	embryo	1	38
Potentilla spec.	seed/fruit	32	–
Solanum spec.	seed/fruit	1	–
indeterminata			
Indeterminata	seed/fruit	94	58
Indeterminata	vegetative	–	1
Indeterminata	fruit	–	4
Indeterminata	pericarp	3	15
Indeterminata	leaf/needle	1	–

quarries, waste heaps, on clearings, dry hills, riverbanks, railways and harbours and other ruderal habitats (Willerding, 1986; Körber-Grohne, 1987; Oberdorfer, 2001; Fischer *et al.*, 2008; Fleischhauer *et al.*, 2014; Bussmann *et al.*, 2020). Karg and Weber (2019) note that in the Alps it can be found up to an elevation of about 1300 m asl, and according to Oberdorfer (2001), *Reseda luteola* belongs to xeric ruderal vegetation and prefers dry and warm, alkaline, nutrient-rich, stony to pure clay soils.

3.2 Harvesting and processing *Reseda luteola* for dyeing purposes

There is some disagreement about which part of the plant contains the highest amount of dye compounds. Cardon (2007) mentions that according to recent studies the highest concentration of colourant can be extracted from the leaves, the flowers, and the fruits. Other authors mention that the flowers are richest (Hegi, 1919; Karg and Weber, 2019), while according to Prinz (2014) the seeds contain the highest levels.

Weld is ready to harvest when the seeds start to mature (Wiesner, 1873; Hegi, 1919; Körber-Grohne, 1987). It is advised to carefully pull the whole plant from the soil when 80–85% of the flowers have matured into capsules, taking care that not too many seeds are lost during harvest. After harvest the plants are dried by hanging them in bundles (Cardon, 2007). They are preferably dried at temperatures ranging from 40°C to 100°C without exposure to sunlight which negatively effects the colour quality (Prinz, 2014).

The main component in weld's yellow dye is luteolin, an organic compound from the group of flavones, which is a sub-group of the flavonoids (from the Latin word *flavus*, meaning yellow), a secondary metabolite in plants (Körber-Grohne, 1987; Cardon, 2007; Zohary *et al.*, 2013). The luteolin content can vary between 2 and 3.2%, summing up to a yield of 100 to 181 kg per ha, depending, of course, on the variety of *Reseda luteola*. In the Late Bronze Age to Iron Age salt mine of Hallstatt, Austria, dyed textiles have been exceptionally well preserved. Chemical analysis (HPLC-PDA) identified luteolin, a key yellow dye compound in *Reseda luteola*, in some Bronze Age and in many Iron Age fabrics. Since luteolin occurs in multiple dye plants and no direct archaeobotanical evidence has been found at Hallstatt, the exact botanical source remains undetermined (Hofmann-de Keijzer *et al.*, 2013). Weld was used in mediaeval to modern times to dye silk, wool, cotton, linen and esparto in yellows and greens, or, in combination with other dyes, in colours like olive, cinnamon, hazel, dead leaves, musk and others (Cardon, 2007). Apart from that, it was also used in paints and artist's colours (Hofmann, 1992).

Any use of weld to dye textiles needs a pre-treatment in the form of mordanting the fibres with various inorganic compounds such as alum, copper sulphate or ferrous sulphate. Alum is the most widely used mordant, creating a highly acidic solution that has a brightening effect but damages wool when the temperature is exceeding 30°C. It is also possible to produce mordants from plant material. Ferrous sulphate for instance can be replaced by a solution created by boiling plant materials with a high tannin content (oak galls, *Rumex* sp. or *Alnus glutinosa*) in an iron vessel. According to various mediaeval to modern recipes, wool was dyed in different shades of yellow after mordanting with alum and red tartar. For dyeing vegetable fibres like linen and cotton, it is advised to mordant the fibres before dyeing with alum, then put the textile in a dye-bath with about the same quantity of weld as the fibres, and process the dyed fibres in a second mordanting with copper sulphate, before boiling them in a soap bath and rinse them. Adding a smaller amount of weld to the dye-bath results in lighter yellows, whereas dark and strong yellows are obtained by adding more of the herb; however, other variables such as fabric material, duration of soaking and temperature of the dye-bath can also influence the colour (Cardon, 2007; Prinz, 2014).

3.3 Other uses of *Reseda luteola*

Due to its high content of the flavonoid luteolin, *Reseda luteola* has recently been of interest in pharmacological studies. Luteolin has shown to have antiproliferative, pro-apoptotic, anti-inflammatory and antioxidative properties (Woelfle *et al.*, 2010; Yildirim *et al.*, 2013). Despite the flavonoid content, ethnomedicinal uses of weld are not frequently reported. Some cases are recorded from the Balkans, mainly from Serbia, where *Reseda luteola* is used for its flavonoids and sulphuric glycosides (Marković *et al.*, 2019), and from Bosnia and Herzegovina, where the plant is used to cure snake bites (Redžić, 2007). Another ethnomedicinal record from Morocco describes the use of weld as a digestive agent, although it is said to be rarely used (Nassiri *et al.*, 2016). Hegi (1919) mentions the use of dyer's weld seed oil as a quickly drying varnish. The oil was further used as fuel for lamps (Prinz, 2014).

3.4 Archaeobotanical records of *Reseda luteola* from the Neolithic to the Iron Age in central Europe

Dyer's weld is native to the eastern Mediterranean and south-west Asia, but it was introduced to central, western and northern Europe early, with literary sources pointing to a domestication prior to the 1st millennium BCE (Körber-Grohne, 1987; Hofmann, 1992; Fischer *et al.*, 2008; Zohary *et al.*, 2013; Prinz, 2014).

The first mention of weld in an archaeobotanical context was made by Oswald Heer in his famous report about the plant remains of the Swiss pile dwellings (Heer, 1865). He found some seeds in the pile dwelling of Wetzikon-Robenhausen (Lake Pfäffikon). Heer does not rule out that the plant might have grown there naturally; however, the flourishing use of flax in the pile dwelling suggests a use of weld for dyeing fibres in yellow. The pile dwelling was dated to the Neolithic, its uppermost layers bordering the Bronze Age (Heer, 1865). This chronology has been verified by radiocarbon dating in later times. Recent investigations by Altorfer *et al.* (2001) into the Neolithic textile craftsmanship

at Wetzikon-Robenhausen further support the hypothesis that dyeing played an integral role in fibre production, reinforcing the idea that weld was purposefully used alongside flax processing.

Lundström-Baudais (1978) mentioned another late Neolithic lakeshore settlement at Brise-Lames in the Bay of Auvernier (Lake of Neuchâtel). Seeds of *Reseda luteola* occurred at a frequency of 17% in the samples, and the author associates them with ruderal plants and weeds of cultivation, mentioning the possible use of the plant as a dye (Lundström-Baudais, 1978).

Märkle (2000) found seeds of weld in another Swiss lakeshore settlement at Lake Neuchâtel. In the pile dwelling Concise-sous-Colachoz she found a small quantity of *Reseda luteola* seeds in Cortaillod-culture layers (dendrochronological dates 3709 BCE and 3701 BCE). The use of weld as a dye was questioned, since only a low quantity had been found.

Further *Reseda luteola* seeds were recovered from the lakeshore settlement Seefeld at Lake Zürichsee, from archaeological layers dating to the Horgen Culture (3179–3158 BCE) and the Corded Ware Culture (2705–2689 BCE), providing further evidence from well-dated Late Neolithic contexts (Schibler *et al.*, 1997). More Swiss pile dwelling finds are known from Zürich Parkhaus Opéra, from layers 13 (dendro date 3176–3153 BCE) and from layer 14 (dendro date around 3090 BCE) as well as from Yverdon, Avenue des Sports (Vaud, Switzerland; dendro dating 2765–2730 BCE and 2626–2530 BCE), from where one charred *Reseda luteola* seed and 9 uncharred ones are also known (see list in Karg and Weber, 2019, 108–109).

Only one find of weld – a single charred seed – is known from the Bell Beaker period Csepel group (2500–1500 BCE) settlement Albertfalva in Hungary (Gyulai, 2003; Endrődi *et al.*, 2008). The authors did not mention any possible use of the plant, but associated weld with arid meadows and cereal crop weeds (Gyulai, 2003) as well as with winter crop weeds (Endrődi *et al.*, 2008).

The only other Bronze Age evidence in Europe for *Reseda luteola* is known from Fangade, Sète (Hérault) in Mediterranean France, which dates to 1375–1055 BCE. A total of 28 seeds were recovered from 9 out of 11 samples. The author did not exclude its use as a dye, although weld could also have been introduced involuntarily as a crop weed (Bouby, 2000).

From Iron Age contexts, *Reseda luteola* seeds and pollen are known from Germany: seeds were recovered in Hochdorf from the late Hallstatt period and the early La Tène period (Stika, 1995) as well as in Fellbach-Schmiden from the late La Tène period (Körber-Grohne, 1999). Evidence of dyer's weld pollen was detected from content residues that derive from honey or honey-based products like mead from Iron Age Hochdorf, Hohmichele and Glauberg (Rösch, 1999).

A summary of later finds of weld from the Roman period onwards, including evidence from other parts of Europe, is given by Wiethold (2008) as well as by Kroll (2005).

4. Discussion

As already mentioned at the beginning, the remains of dye plants are notoriously underrepresented in the archaeobotanical record. Without written sources and without the preservation of dyed textiles, it is very hard to prove their actual use for the dyeing of textiles or other materials.

In prehistoric central Europe, *Reseda luteola* has only rarely been found in the form of seeds – either subfossil or charred – or as pollen, up to now. Some authors mention the use of weld as a dye (Heer, 1865; Lundström-Baudais, 1978; Bouby, 2000; Märkle, 2000). Others do not even consider this possibility (Schibler *et al.*, 1997; Gyulai, 2003; Endrődi *et al.*, 2008). Even for later historic epochs, when written sources clearly mention the use of weld for dyeing, the archaeobotanical evidence of seeds alone is not regarded as proof (*e.g.*, Knörzer, 1984). Similarly, the detection of luteolin pigments in a dyed product is not sufficient to indicate the use of dyeing weld, because almost all yellow dyeing plants contain luteolin in at least small quantities (Hofmann-de Keijzer *et al.*, 2013; Hartl *et al.*, 2015). The only unambiguous evidence for *Reseda luteola* being used as a dyeing plant in an archaeological context was reported from early mediaeval York, where seeds of weld were found together with the vegetative remains of other well-known dyeing plants such as *Isatis tinctoria* (Tomlinson, 1985).

Despite these obstacles, we want to discuss the possible use of weld as a dye in Late Bronze Age Prigglitz-Gasteil, considering this hitherto unique bulk find of charred weld seeds and bearing in mind the limited preservation conditions in a dry-sediment settlement.

In the case of the mining site Prigglitz-Gasteil, the plant remains associated with the bulk find of *Reseda luteola* seeds suggest a ruderal vegetation. The weld seeds were found together with the diaspores of other ruderals, such as numerous seeds of Amaranthaceae, Polygonaceae, *Plantago major*, and seeds as well as two fruits of *Solanum luteum vel nigrum* (Table 1).

As *Reseda luteola* is known to be a weed that occurs on dumps, in quarries, waste heaps, clearings, dry hills, riverbanks and other ruderal habitats (Willerding, 1986; Körber-Grohne, 1987; Oberdorfer, 2001; Fischer *et al.*, 2008; Fleischhauer *et al.*, 2014; Bussmann *et al.*, 2020), the mining dumps at the site of Prigglitz-Gasteil provided an ideal space for it to grow naturally or to be grown by humans. The huge number and dominance of *Reseda luteola* seeds suggest that it was intentionally cultivated for its economic value. At the Late Brone Age site of Prigglitz-Gasteil it could represent either a direct cultigen or a feral population from previous cultivation.

Considering the taphonomy, the ruderal plants growing on the mining dumps ended up as a charred bulk find because they were burnt either accidentally or intentionally. An accident could have happened during the processing of the dyeing plant, *i.e.* during the drying of plants over a fire or in a kiln/furnace. The remains of the dyeing weld could also have been intentionally burnt after using them for dyeing,

in order to prevent domestic animals from eating the plants mixed with a metallic mordant.

Pre-industrial recipes for dyeing textiles with weld always required mordanting the fibres with inorganic compounds such as alum, copper sulphate or ferrous sulphate (Cardon, 2007; Prinz, 2014), and it seems only logical to have a dyeing workshop nearby the source of these raw materials. Since there is no evidence of the use of alum for dyeing textiles (not even for tanning leather) in prehistoric central Europe (Hartl *et al.*, 2015, p.587; Ruß-Popa, 2019, p.321), we have to consider other mordants. Traditional recipes mention the use of plant mordants, iron mordants, copper mordants or fermentation techniques (Hartl *et al.*, 2015). In the Late Bronze Age mine of Prigglitz-Gasteil, copper and iron ores (mainly chalcopyrite and siderite, along with malachite, azurite and limonite) were easily available (Mödlinger *et al.*, 2021). From chalcopyrite ($CuFeS_2$), ferrous sulphate and/or copper sulphate can be produced as a mordant. Although this technology is not directly documented for prehistoric epochs, Hartl *et al.* (2015, p.588) considered it a possible technique for the dyeing of the textiles found in the Hallstatt salt mine. Hence, all ingredients for dyeing – the plant dye and the metal ingredients for the mordant – were available at Prigglitz-Gasteil, providing ideal conditions for dyeing and even at a larger scale.

The questions of when and how the different "recipes" for mordanting were first discovered are as yet unsolved. As the earliest prehistoric textiles containing luteolin date to the Bronze Age and Iron Age – more precisely to the periods of ca 1600–1200 and 850–350 BC of the Hallstatt salt mines (Hofmann-de Keijzer *et al.*, 2013, p.137) – we might even consider a connection between copper ore mining and the "invention" of the dyeing recipe/technique using metallic mordants. At the Prigglitz-Gasteil site, metal (iron and copper) ores are omnipresent in the mine, sulfidic copper ores were smelted into metallic copper, and puddles of brownish water enriched with iron or copper salts can be observed everywhere on the dumps. Prigglitz-Gasteil or any other Bronze Age copper mine might have been the place where people experimented with the abundant dyeing plants during the Bronze Age, seeking and finding a process to improve the quality (*i.e.* the colour fastness) of the dyed product (*cf.* Hartl *et al.*, 2015, p.588).

One argument in support of this hypothesis is provided by the archaeological finds from the mining settlement Prigglitz-Gasteil which not only attest to metal production, but also to other mining-related activities (such as butchering, meat processing, bone and antler working). There is clear evidence for textile or leather working in the form of five sewing needles made of animal bones or bronze (Figure 5), two bone piercers and six bronze double-pointed awls. The number of tools appears to be quite high in relation to the small part of the settlement area (less than ca 2%) that has been investigated so far. There is no indication of textile production – neither of plant fibres nor of wool – at the Prigglitz-Gasteil site, even though the production of yarn and woven fabrics usually leaves behind ceramic spindle whorls and loom weights (Grömer, 2016). Apart from the textiles, there is ample evidence for the use of fur and leather at other prehistoric Alpine copper mining sites, for example, at the Bronze Age Kelchalm near Kitzbühel in Tyrol (Ruß-Popa, 2019). The prehistoric salt mines provide the best conditions for the preservation of leather objects such as the famous leather carrying bags from Hallstatt (Barth, 1992; Ruß-Popa, 2018; 2019). In the Late Bronze Age smelting site of Mauk A in Radfeld, Tyrol, there is even evidence for leather working in the form of a bronze sewing needle – with heavy usewear indicating leather rather than textile working (Grömer *et al.*, 2017, pp.332–333 Figure 11B/3–5).

Coming back to Prigglitz-Gasteil, the archaeozoological analysis of the animal bones showed that domestic pigs, cattle and sheep were slaughtered at the site (Trebsche and Pucher, 2013). It is reasonable to assume that also the hides of the slaughtered animals were processed to produce leather



Figure 5. Four sewing needles made of animal bones and one made of bronze from the mining site Prigglitz-Gasteil (D. Fehlmann).

and thereof clothes, shoes, straps, water containers, carrying bags for the transport of copper ore, bellows for operating the smelting furnaces, *etc.* And it is not hard to imagine that these leather objects once were as colourful as the textiles, although evidence for dyed leather is still very rare because prehistoric leather artefacts have not yet been investigated for colour pigments as intensively as the textiles from mining sites. At least, one leather object from the Iron Age salt mine at Dürrnberg in Salzburg was dyed with luteolin (personal communication Gabriela Ruß-Popa, 17.05.2024).

To sum up, our ideas on the "invention" of the mordanting process and the possible dyeing of leather artefacts at Prigglitz-Gasteil remain quite hypothetical at the moment. However, they are intended to stimulate and encourage further systematic investigation of possible evidence in this field.

5. Conclusion

While the mass find of *Reseda luteola* cannot provide a proof in the strict sense, in all probability it represents evidence for its use as a dyeing plant in the Alpine region as early as the 9th century BC. We conclude that the co-existence of ore mining and leather/textile processing is not only logical but also symbiotic. This association not only ensures the availability of essential resources for leather and textile processing but also contributes to the economic viability and sustainability of both industries in the long term.

Acknowledgements

Our thanks go to Michael Konrad, who flotated the sediment samples from Prigglitz.

This paper was written as part of the project "Life and Work at the Bronze Age Mine of Prigglitz", funded by the Austrian Science Fund (FWF): P30289-G25.

References

ALTORFER, K., HUBER, R., and MÉDARD, F., 2001. Taucher, Thesen und Textilien. Neue Untersuchungen zum jungneolithischen Textilhandwerk in den Feuchtbodensiedlungen von Wetzikon-Robenhausen (Kanton Zürich). *Plattform*, 9/10: 78–93.

ANDERBERG, A.L., 1994. *Atlas of seeds and small fruits of Northwest-European plant species with morphological descriptions. Part 4. Resedaceae–Umbelliferae.* Stockholm: Swedish Natural Science Research Council.

BARTH, F.E., 1992. Zu den Tragsäcken aus dem Salzbergwerk Hallstatt. *Archaeologica Austriaca*, 76, 121–127.

BERGGREN, G., 1981. *Atlas of seeds and small fruits of Northwest-European plant species with morphological descriptions. Part 3. Salicaceae–Cruciferae.* Stockholm: Swedish Natural Science Research Council.

BERTSCH, K., 1941. *Früchte und Samen. Ein Bestimmungsbuch zur Pflanzenkunde der vorgeschichtlichen Zeit. Handbücher der praktischen Vorgeschichtsforschung 1.* Stuttgart: Ferdinand Enke.

BITMANN, F., MENNEGA, M., and KREUZ, A., 2016. *Archäobotanisches Datenbankprogramm ArboDat 2016.* Wilhelmshaven: Niedersächsisches Institut für historische Küstenforschung.

BOJŇANSKÝ, V., and FARGAŠOVÁ, A., 2007. *Atlas of seeds and fruits of Central and East-European flora: the Carpathian Mountains region.* Dordrecht: Springer Science & Business Media.

BOUBY, L., 2000. Production et consommation végétales au Bronze final dans les sites littoraux languedociens. *Bulletin de la Société Préhistorique Française*, 97(4), 583–594.

BRONK RAMSEY, C., 2021. *OxCal 4.4 Manual.* Online. Available from: https://c14.arch.ox.ac.uk/oxcal/OxCal.html

BUSSMANN, R.W., BATSATSASHVILI, K., and KIKVIDZE, Z., 2020. *Reseda luteola* L. *Reseda lutea* L. RESEDACEAE. In: K. Batsatsashvili, Z. Kikvidze, and R. Bussmann, eds. *Ethnobotany of the Mountain Regions of Central Asia and Altai. Ethnobotany of Mountain Regions.* Cham: Springer, pp. 1–3. https://doi.org/10.1007/978-3-319-77087-1_116-1

CARDON, D., 2007. *Natural Dyes: Sources, Tradition, Technology and Science.* London: Archetype Publications.

CAPPERS, R.T.J., BEKKER, R.M., and JANS, J.E.A., 2006. *Digitale zadenatlas van Nederland / Digital Seed Atlas of the Netherlands.* Groningen Archaeological Studies, 4. Eelde: Barkhuis.

ELLENBERG, H., 1982. *Vegetation Mitteleuropas mit den Alpen in ökologischer Sicht.* Stuttgart: Eugen Ulmer.

ENDRŐDI, A., GYULAI, F., and REMÉNYI, L., 2008. The roles of the environmental and cultural factors in the everyday life of Bell Beaker–Csepel Group. *Millenni. Studi di Archeologia Preistorica*, 6, 235–256.

FISCHER, M.A., OSWALD, K., and ADLER, W., 2008. *Exkursionsflora für Österreich, Liechtenstein, Südtirol.* 3rd ed. Linz: Biologiezentrum der Oberösterreichischen Landesmuseen.

FLEISCHHAUER, S.G., SPIEGELBERGER, R., and GUTHMANN, J., 2014. *Enzyklopädie Essbare Wildpflanzen. 2000 Pflanzen Mitteleuropas. Bestimmung, Sammeltipps, Inhaltstoffe, Heilwirkung, Verwendung in der Küche.* 2nd ed. Aarau/München: AT Verlag.

GRÖMER, K., 2016. *The Art of Prehistoric Textile Making – The development of craft traditions and clothing in Central Europe.* Veröffentlichungen der Prähistorischen Abteilung, 5. Wien: Verlag des Naturhistorischen Museums Wien.

GRÖMER, K., GOLDENBERG, G., BANCK-BURGESS, J., GLEBA, M., HOFMANN-DE KEIJZER, R., VAN BOMMEL, M.R., JOOSTEN, I., MEHOFER, M., NICOLUSSI, K., and TÖCHTERLE, U., 2017. Textilreste aus einem spätbronzezeitlichen Bergbaurevier bei Radfeld in Nordtirol – Sekundärnutzung von Stoffen zur Abdichtung. *Praehistorische Zeitschrift*, 92(2), 322–341. https://doi.org/10.1515/pz-2017-0014

GYULAI, F., 2003. *Archaeobotanical Remains and Environment of Bell-Beaker Csepel-Group.* BAR International Series, 1155, Oxford: Archaeopress, 277–282.

HARTL, A., VAN BOMMEL, M.R., JOOSTEN, I., HOFMANN-DE KEIJZLER, R., GRÖMER, K., RÖSEL-MAUTENDORFER, H., and RESCHREITER, H., 2015. Reproducing colourful woven bands from the Iron Age salt mine of Hallstatt in Austria: An interdisciplinary approach to acquire knowledge of prehistoric dyeing technology. *Journal of Archaeological Science: Reports*, 2, 569–595. https://doi.org/10.1016/j.jasrep.2015.04.004

HAUBNER, R., STROBL, S., and TREBSCHE, P., 2023. Materialographic investigations of plate slags from the Late Bronze Age copper production site of Prigglitz-Gasteil (Lower Austria). *Journal of Archaeological Science: Reports*, 48: 103838. https://doi.org/10.1016/j.jasrep.2023.103838

HEER, O., 1865. *Die Pflanzen der Pfahlbauten.* Neujahrsblätter der Naturforschenden Gesellschaft in Zürich, 1866. Zürich: Zürcher und Furrer.

HEGI, G., THELLUNG, A., SCHMIDT, E., MARZELL, H., HOFMANN, H., PFENNINGER, E.R., HAJEK, K., and KOTZIAN, F., 1919. *Illustrierte Flora von Mittel-Europa. Mit besonderer Berücksichtigung von Österreich, Deutschland und der Schweiz. Band IV, 1. Hälfte. Dicotyledones (II. Teil).* Wien: A. Pichler's Witwe & Sohn.

HEISS, A.G., JAKOBITSCH, T., WIESINGER, S., and TREBSCHE, P., 2021. Dig out, Dig in! Plant-based diet at the Late Bronze Age copper production site of Prigglitz-Gasteil (Lower Austria) and the relevance of processed foodstuffs for the supply of Alpine Bronze Age miners. *PLoS ONE*, 16(3), e0248287. https://doi.org/10.1371/journal.pone.0248287

HOFMANN, R., 1992. Färbepflanzen und ihre Verwendung in Österreich. *Verhandlungen der Botanisch-Zoologischen Gesellschaft in Österreich*, 129, 227–269.

HOFMANN-DE KEIJZER, R., VAN OMMEL, M.R., JOOSTEN, I., HARTL, A., PROAÑO GAIBOR, A., HEISS, A.G., KRALOVSKY, R., ERLACH, R., and DE GROOT, S., 2013. The colours and dyeing techniques of prehistoric textiles from the salt mines of Hallstatt. In: K. Grömer, A. Kern, H. Reschreiter, and H. Rösel-Mautendorfer, eds. *Textiles from Hallstatt. Weaving Culture in Bronze Age and Iron Age Salt Mines.* Archaeolingua, 29. Budapest: Archaeolingua, 135–162. https://doi.org/10.13140/2.1.1559.0403

JAKOBITSCH, T., WIESINGER, S., HEISS, A.G., FALTNER, F., OEGGL, K., GRABNER, M., and TREBSCHE, P., 2022. Wood use and forest management at the Late Bronze Age copper mining site of Prigglitz-Gasteil in the Eastern Alps – A combined anthracological, archaeological, and palynological approach. *Journal of Archaeological Science: Reports*, 46, 103673. https://doi.org/10.1016/j.jasrep.2022.103673

KARG, S., and WEBER, E., 2019. *Heilsam, kleidsam, wundersam. Pflanzen im Alltag der Steinzeitmenschen.* Darmstadt: Wissenschaftliche Buchgesellschaft.

KNÖRZER, K.H., 1984. Textilpflanzenfunde aus dem mittelalterlichen Aachen. *Decheniana*, 137, 226–233.

KREUZ, A., and SCHÄFER, E.-M., 2004. 1,4 Millionen auf der Bank. Das hessische Datenarchiv für archäobotanische Großreste ArboDat. *hessenARCHÄOLOGIE*, 2003, 170–174.

KROLL, H., 2005. *Literature on archaeological remains of cultivated plants 1981–2004.* Online. Viewed 12/01/2022. Available from: https://web.archive.org/web/20200223182410/http://www.archaeobotany.de/

KÖRBER-GROHNE, U., 1987. *Nutzpflanzen in Deutschland. Kulturgeschichte und Biologie.* Stuttgart: Konrad Theiss.

KÖRBER-GROHNE, U., 1999. Der Schacht in der keltischen Viereckschanze von Fellbach-Schmiden (Rems-Murr-Kreis) in botanischer und stratigraphischer Sicht. In: G. Wieland, ed. *Die keltischen Viereckschanzen von Fellbach-Schmiden (Rems-Murr-Kreis) und Ehningen (Kreis Böblingen).* Stuttgart: Konrad Theiss, 85–149.

LUNDSTRÖM-BAUDAIS, K., 1978. Plant remains from a Swiss Neolithic lakeshore site: Brise-Lames, Auvernier. *Berichte der Deutschen Botanischen Gesellschaft*, 91(1), 67–83.

MÄRKLE, T., 2000. Die Wildpflanzen der Cortaillod-moyen-zeitlichen Besiedlung von Concise-sous-Colachoz, Kt. Waadt, Schweiz. *Archäologische Informationen*, 23(2), 277–280.

MARKOVIĆ, M., STANKOV-JOVANOVIĆ, V., and SMILJIĆ, M., 2019. Medicinal flora of the Vidlič Mountain in Serbia. *The University Thought – Publication in Natural Sciences* 9(1), 17–26. https://doi.org/10.5937/univtho9-17725

MÖDLINGER, M., and TREBSCHE, P., 2021. Work on the cutting edge: metallographic investigation of Late Bronze Age tools in southeastern Lower Austria. *Archaeological and Anthropological Sciences*, 13, 125. https://doi.org/10.1007/s12520-021-01378-1

MÖDLINGER, M., TREBSCHE, P., and SABATINI, B., 2021. Melting, smelting, and recycling: A regional study around the Late Bronze Age mining site of Prigglitz-Gasteil, Lower Austria. *PLoS ONE*, 16(7): e0254096. https://doi.org/10.1371/journal.pone.0254096

NASSIRI, L., ZARKANI, S., DAOUDI, A., BAMMOU, M., BOUIAMRINE, E. H., and IBIJBIJEN, J., 2016. Contribution à l'élaboration d'un catalogue ethnobotanique de la commune rurale d'Aguelmous (Province de Khénifra, Maroc). Contribution to the establishment of ethno botanical catalog of Aguelmous (Khenifra, Morocco). International *Journal of Innovation and Applied Studies*, 17(2), 373–387.

OBERDORFER, E., 2001. *Pflanzensoziologische Exkursionsflora für Deutschland und angrenzende Gebiete*. 8th ed. Stuttgart: Eugen Ulmer.

PRINZ, E., 2014. *Färberpflanzen. Anleitung zum Färben. Verwendung in Kultur und Medizin.* 2nd ed. Stuttgart: Schweizerbart.

REDŽIĆ, S., 2007. The ecological aspect of ethnobotany and ethnopharmacology of population in Bosnia and Herzegovina. *Collegium Antropologicum*, 31(3): 869–890.

REIMER, P.J., AUSTIN, W.E.N., BARD, E., BAYLISS, A., BLACKWELL, P.G, BRONK RAMSEY, CH., BUTZIN, M., CHENG, H., EDWARDS, R.L., FRIEDRICH, M., GROOTES, P.M., GUILDERSON, T.P., HAJDAS, I., HEATON, T.J.,, HOGG, A.G., HUGHEN, K.A., KROMER, B., MANNING, S.W., MUSCHELER, R., PALMER, J.G., PEARSON, CH., VAN DER PLICHT, J., REIMER, R.W., RICHARDS, D.A., SCOTT, E.M., SOUTHON, J.R.,TURNEY, CH.S.M., WACKER, L., ADOLPHI, F., BÜNTGEN, U., CAPANO, M., FAHRNI, S.M., FOGTMANN-SCHULZ, A., FRIEDRICH, R., KÖHLER, P., KUDSK, S., MIYAKE, F., OLSEN, J., REINIG, F., SAKAMOTO, M., SOOKDEO, A., and TALAMO, S., 2020. The IntCal20 Northern Hemisphere Radiocarbon Age Calibration Curve (0–55 cal kBP). *Radiocarbon*, 62(4), 725–757. https://doi.org/10.1017/RDC.2020.41

RÖSCH, M., 1999. Evaluation of honey residues from Iron Age hill-top sites in south-western Germany. Implications for local and regional land use and vegetation dynamics. *Vegetation History and Archaeobotany*, 8, 105–112. https://doi.org/10.1007/BF02042848

RUAS, M.P., 2000. Cultures, importations et alimentation d'apres les semences. In: G. Berthaud, ed. *Mazieres-en-Mauges gallo-romain (Maine-et-Loire). Un quartier avocation artisanale et domestique.* Angers: ARDA/AFAN, 199–226.

RUSS-POPA, G., 2018. Der Gebrauch von Schaffell in der mitteleuropäischen urgeschichtlichen Bekleidung. *Annalen des Naturhistorischen Museums in Wien, Serie A*, 120, 157–176.

RUSS-POPA, G., 2019. Von Fellsteinen und Lederwämsen: Kleidungsfragmente aus Leder und Fell aus Hallstatt und von der Kelchalpe bei Kitzbühel in der Studiensammlung des Instituts für Urgeschichte und Historische Archäologie der Universität Wien. In: P.C. Ramsl, K. Rebay-Salisbury, and P. Trebsche, eds. *Schichtengeschichten. Festschrift für Otto H. Urban.* Universitätsforschungen zur prähistorischen Archäologie, 328. Bonn: Dr. Rudolf Habelt, 313–325.

SCHIBLER, J., HÜSTER-PLOGMANN, H., JACOMET, S., BROMBACHER, C., GROSS-KLEE, E., and RAST-EICHER, A., 1997. Ökonomie und Ökologie neolithischer und bronzezeitlicher Ufersiedlungen am Zürichsee. Monographien der Kantonsarchäologie Zürich, 20. Egg/Zürich: Direktion der öffentlichen Bauten des Kantons Zürich.

STIKA, H.P., 1995. Ackerbau und pflanzliche Nahrungsmittel zur Keltenzeit in Südwestdeutschland. In: J. Biel, ed. *Fürstensitze, Höhenburgen, Talsiedlungen. Bemerkungen zum frühkeltischen Siedlungswesen in Baden-Württemberg.* Archäologische Informationen aus Baden-Württemberg, 28. Stuttgart: Landesdenkmalamt Baden-Württemberg, 80–87.

TOMLINSON, P., 1985. Use of vegetative remains in the identification of dyeplants from waterlogged 9th–10th century AD deposits at York. *Journal of Archaeological Science*, 12(4), 269–283. https://doi.org/10.1016/0305-4403(85)90033-0

TREBSCHE, P., 2015. Zur Absolutdatierung der urnenfelderzeitlichen Kupfergewinnung im südöstlichen Niederösterreich. *Archäologisches Korrespondenzblatt*, 45(1), 41–59. https://doi.org/10.11588/ak.2015.1.34520

TREBSCHE, P., and PUCHER, E., 2013. Urnenfelderzeitliche Kupfergewinnung am Rande der Ostalpen. Erste Ergebnisse zu Ernährung und Wirtschaftsweise in der Bergbausiedlung von Prigglitz-Gasteil (Niederösterreich). *Praehistorische Zeitschrift*, 88(1–2), 114–151. https://doi.org/10.1515/Pz-2013-0004

TREBSCHE, P., and WEIXELBERGER, G., 2022. A mining subsidence event around 920 BC in the Late Bronze Age copper mine of Prigglitz-Gasteil (Lower Austria). *Archäologisches Korrespondenzblatt*, 52(1), 41–64. https://doi.org/10.11588/ak.2022.1.94322

TREBSCHE, P., SCHLÖGEL, I., and FLORES-OROZCO, A., 2022. Combining geophysical prospection and core drilling: Reconstruction of a Late Bronze Age copper mine at Prigglitz-Gasteil in the Eastern Alps (Austria). *Archaeological Prospection*, 29(4), 557–577. https://doi.org/10.1002/arp.1872

WIESNER, J., 1873. *Die Rohstoffe des Pflanzenreiches. Versuch einer technischen Rohstofflehre des Pflanzenreiches.* Leipzig: Wilhelm Engelmann.

WIETHOLD, J., 2008. La gaude – Une plante tinctoriale importante de l'époque médiévale et du début de la période moderne. *Les Nouvelles de l'archéologie*, 114, 52–58.

WILLERDING, U., 1986. *Zur Geschichte der Unkräuter Mitteleuropas.* Göttinger Schriften zur Vor- und Frühgeschichte, 22. Neumünster: Karl Wachholtz.

WOELFLE, U., SIMON-HAARHAUS, B., MERFORT, I., and

SCHEMPP, C.M., 2010. *Reseda luteola* L. extract displays antiproliferative and pro-apoptotic activities that are related to its major flavonoids. *Phytotherapy Research*, 24(7), 1033–1036. https://doi.org/10.1002/ptr.3069

YILDIRIM, A. B., KARAKAS, F. P., and TURKER, A. U., 2013. *In vitro* antibacterial and antitumor activities of some medicinal plant extracts, growing in Turkey. *Asian Pacific Journal of Tropical Medicine*, 6(8), 616–624. https://doi.org/10.1016/S1995-7645(13)60106-6

ZOHARY, D., HOPF, M., and WEISS, E., 2013. *Domestication of Plants in the Old World.* 4th ed. Oxford: Oxford University Press. https://doi.org/10.1093/acprof:osobl/9780199549061.001.0001