Recalibrating grave-good chronologies: new AMS radiocarbon dates from Late Bronze Age burials in Lika, Croatia

Emily Zavodny[1,*], Brendan J. Culleton[2], Sarah B. McClure[2], Douglas J. Kennett[2] & Jacqueline Balen[3]

Grave-good typologies have traditionally formed the basis for chronological frameworks in many areas of the world, including the Lika region of Croatia. Here, the authors report the first AMS radiocarbon dates from Late Bronze Age Lika (c. 1200–800 BC)—a period assumed to be synonymous with the emergence of the local Iapodian culture. Comparisons between the absolute dates and the relative chronological assignments of key burial contexts show inconsistencies between the dating methods that lead the authors to propose an alternative narrative for Iapodian emergence and socio-political reorganisation at the end of the Bronze Age.

Keywords: Croatia, Bronze Age, Iron Age, Iapodian, radiocarbon dating, burials

Introduction

Archaeologists are interested in long-term trends of socio-political, economic and cultural organisation, but the potential of studies to interpret material and structural changes in the archaeological record can be limited by imprecise or inaccurate dating methodologies. The increased use of high-precision accelerator mass spectrometry (AMS) radiocarbon dating has been a boon to the discipline, allowing researchers to settle old questions and controversies, while posing new ones. Yet, these studies also highlight the need to re-examine old chronologies and typologies systematically, and to test them with new scientific methods (e.g. Bayliss *et al.* 2007; Whittle & Bayliss 2007; Lee *et al.* 2013; Vega Brown *et al.*

[1] *Department of Anthropology, University of Central Florida, Orlando, FL 32816, USA*
[2] *Department of Anthropology, Pennsylvania State University, University Park, PA 16802, USA*
[3] *Arheološki muzej u Zagrebu, Trg Nikole Šubića Zrinskog 19, Zagreb 10000, Croatia*
[*] *Author for correspondence (Email: emily.zavodny@ucf.edu)*

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2013). The auditing of relative chronologies is especially important in South-eastern Europe, where a long tradition of carefully constructed artefact typologies underpins larger cultural-historical interpretations of the prehistoric record (e.g. Childe 1925; Gimbutas 1963). Many typologies in the northern Balkans also borrow extensively from foundational German chronologies (Reinecke 1902; Müller-Karpe 1959) created in the early twentieth century, despite a growing recognition of their incomplete nature or inappropriateness for use in other geographic areas (Stockhammer *et al.* 2015).

In the Lika region of Croatia, archaeological research over the past century has focused predominantly on Late Bronze and Iron Age burials, resulting in tightly ordered grave-good typologies that are the primary means of establishing a local chronology (Figure 1). The beginning of this relative chronology is tied to the appearance of distinct materials and objects in the Late Bronze Age (*c.* 1200–800 BC), which are thought to be the earliest evidence of a newly developed and cohesive culture—the Iapodians. No systematic AMS radiocarbon dating, however, has been conducted to test these sequences; hence, the chronology here remains unchanged since it was first defined by Drechsler-Bižić in 1987. This article tests current hypotheses concerning cultural development in Lika by comparing new AMS radiocarbon dates with relative chronological assignments of key burial contexts from the earliest period of the Iapodian typology and chronology. The results demonstrate inconsistencies between reported relative and absolute dates, suggesting that the initial emergence of the Iapodian culture was not as rapid or widespread as previously believed. These findings emphasise the care with which burial-

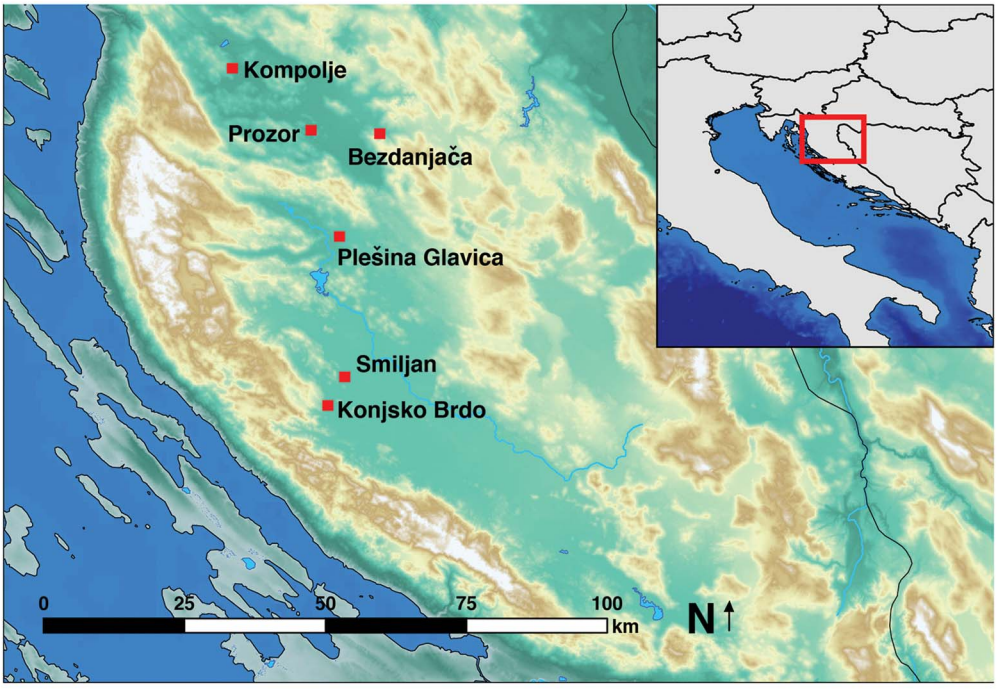

Figure 1. Map of the study area showing the sites sampled or mentioned in the text.

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based typologies must be used when explaining wider cultural processes, and further highlight the need for continuous re-evaluation of old chronological models as new data emerge.

Grave goods as relative chronological markers

Burials are highly recognisable archaeological features, and their association with comparatively elaborate and rich artefacts has long made them ideal points of comparison for dating purposes. Many of the earliest relative chronologies are therefore based almost exclusively on material retrieved from closed burial contexts (e.g. Reinecke (1902) and Müller-Karpe (1959) in Central Europe; Montelius (1885) in Scandinavia), and researchers continue to use these frameworks to build regional sequences. Although useful, these relative chronologies are susceptible to many of the critiques levelled at typologies in general, including: 1) the definition and acceptable range of variation within a type (Chapman 2003); 2) the ability to perceive or predict changes in type over time accurately (Plog & Hantman 1990; Buck *et al.* 1996; Fowler 2017); 3) whether typologies can actually be representative of a culture or time period (Feinman & Neitzel 1984; Fowler 2017); and 4) the ability of current theory to deal with these issues (Sørensen 2015). Furthermore, burials represent the culmination of many different social, political and economic processes at any single moment in time. Mortuary practices are also often conservative in nature, changing only incrementally over long periods of time (O'Shea 1984; Parker Pearson 1999). Thus, chronologies constructed solely from grave goods may capture different temporal scales of cultural change in comparison to material from other site types.

Resolving these potential discrepancies is of considerable importance in regions where the appearance of novel grave-good styles and forms are used as evidence for the development of socio-political complexity. In Lika, Late Bronze Age stylistic changes in fibulae, jewellery and other burial objects are considered to be evidence of regional socio-political and cultural reorganisation by an emergent Iapodian culture. Until now, however, the relative chronology used to date these important processes, and the archaeological interpretations built upon it, has not been tested with AMS radiocarbon dating.

Relative chronology of prehistoric Lika

Previous archaeological research in Lika has focused predominantly on Late Bronze and Iron Age cemeteries, in part due to their greater frequency in comparison to earlier sites (Kolak & Šušnjić 2008; Zavodny 2017). These cemeteries and accompanying hillforts are attributed to the Iapodians, the name given to Lika's inhabitants by classical writers during the Roman expansion into Illyricum, at the end of the Iron Age (*c.* 35 BC). While very little is known about the identity of the Iapodians and how they organised their daily lives, their grave goods have been tightly sequenced in numerous typological studies and used to explain their emergence as a distinct regional culture in Lika. While the temporal and regional evolution of fibulae has been the most intensively studied, typologies for buttons, pins and other jewellery have also been created (e.g. Vejvoda 1962; Marić 1968; lo Schiavo 1970; Drechsler-Bižić 1976, 1987; Težak-Gregl 1981; Bakarić 1986; Balen-Letunić 1990, 1996; Hiller 1991; Raunig 1992; Palavestra 1993; Teßmann 2001; Pabst 2009, 2011; Teržan 2011; Drnić & Tonc 2015; Tonc 2015).

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Drawing on these different typologies, Drechsler-Bižić (1983a & b, 1987) proposed an authoritative chronology of Iapodian cultural development that it is still in use today with very few alterations (Figure 2). Phase 1 begins at the start of the Late Bronze Age (1200 BC), when novel grave-good types first appear at Bezdanjača cave (Drechsler-Bižić 1980) (Figure 1). Although Bezdanjača was an active burial site throughout the Middle Bronze Age, most grave goods were ceramics stylistically similar to those found throughout Bronze Age Central and South-eastern Europe. It was only at the start of the Late Bronze Age that more bronze objects and the first-recorded amber bead in Lika appear in Bezdanjača—presumably representing evidence of a new and distinct regional burial ritual. In phase 2, material differences between Lika and its neighbours become more pronounced. Novel grave-good types (e.g. fibulae and caps) and decoration styles are considered truly 'Iapodian', and were probably designed and fashioned in local workshops (Drechsler-Bižić 1987; Balen-Letunić 2004). The following phases (3–7) of the Iapodian cultural sequence (Figure 2) are divided according to perceived changes in these initial forms, the development of unique

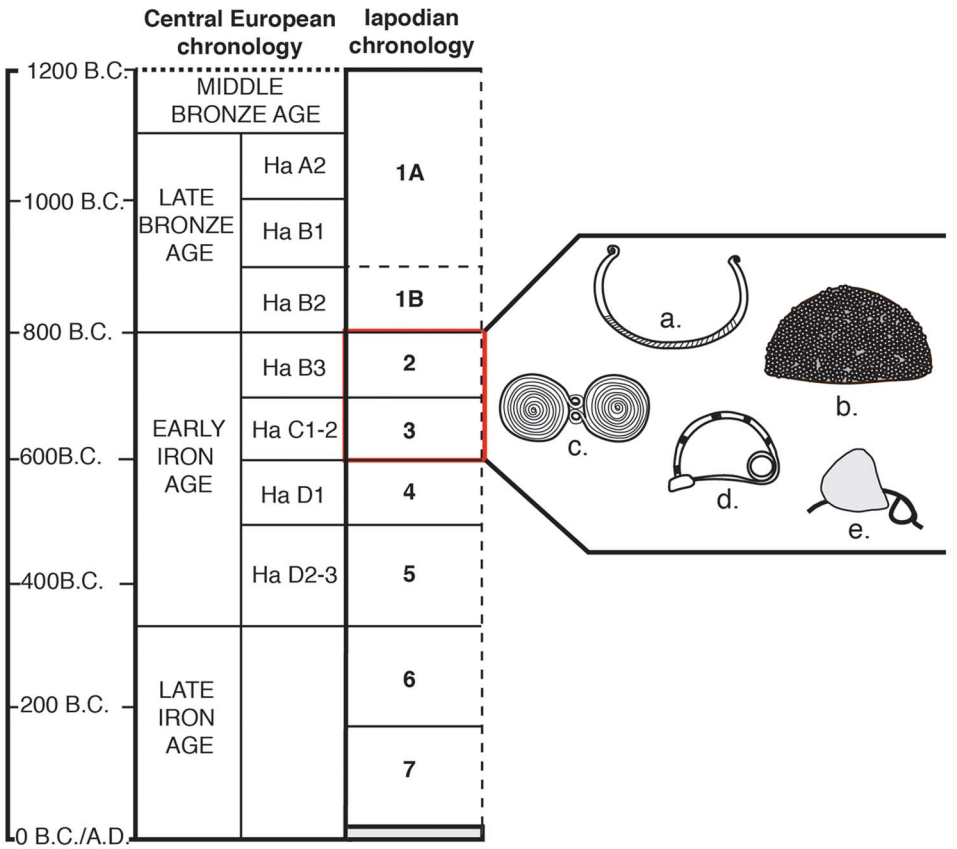

Figure 2. Iapodian and Central European chronologies for Late Bronze and Iron Ages, with selected materials associated with the Bronze–Iron Age transition (phases 2–3): a) torc necklace; b) type 1 cap; c) spiral spectacle fibula; d) smooth bow one-loop fibula; and e) one-loop fibula with amber bead (adapted from Drechsler-Bižić 1987: 391–441).

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ornamentation and increased frequency of amber and glass objects in burials. The Iapodian cultural sequence ends with the Roman conquest of Lika (*c.* 35 BC) and the subsequent incorporation of the region into the larger province of Illyricum.

The typology of a new culture at the Bronze–Iron Age transition

The first 'Iapodian' grave goods appear at the Bronze–Iron Age transition, between approximately 800 and 600 BC (phases 2–3; Figure 2). These novel types represent an assumed departure from earlier pan-Balkan material styles and the emergence of a new and distinct cultural identity at the end of the Bronze Age. This reorganisation is suggested to have occurred swiftly and uniformly across Lika (Drechsler-Bižić 1987), but this argument rests on the tautological assumption that the established relative chronology can be used to date grave-good types accurately and, concurrently, that these same types can also be used to define that relative chronology. High-precision AMS radiocarbon dating of burials associated with phase 2 and 3 grave goods is needed in order to test the current relative chronology, and to clarify the broader processes that led to the formation of the Iapodian culture at the Bronze–Iron Age transition.

Due to their high frequency and observable diachronic changes in style and production, fibulae are the most important objects for the relative dating of burial contexts in Lika. Drechsler-Bižić's (1987) Iapodian chronology begins with the appearance of spiral spectacle and one-looped simple arch fibulae at the end of the Bronze Age (phase 1). The earliest spiral spectacle fibulae are made from two discs of spiralled bronze wire. These are connected by another wire bent into a figure of eight, and fitted with a simple needle and catch clasp (Figure 2c). This style was first identified at the Kompolje necropolis and dated to the late tenth century BC at the earliest (Drechsler-Bižić 1983a: 385). Also called the Kompolje type, this first spiral spectacle form continues throughout phase 2, before a modified version appears at the beginning of phase 3 (Drechsler-Bižić 1987; Bakarić 2004: 362–63; Pabst 2009, 2011). The bronze, arched one-loop fibula form is subdivided according to variation in bow decoration. The smooth bow form—or type B—also appears in Lika near the end of the Bronze Age (*c.* 900 BC) and persists until the end of phase 3 (Figure 2d; Drechsler-Bižić 1976; Bakarić 1989). Arched one-loop fibulae decorated with a single amber bead appear primarily during phase 3 (Figure 2e), but may have continued to be buried as grave goods until the end of the fourth century BC (Bakarić 1989, 2004: 364; Olujić 2007; Bakarić 2017).

Other grave goods considered indicative of the Bronze–Iron Age transition are ornate caps or head coverings. The first iteration of these objects—type 1 or calotte caps—are assigned primarily to phase 2 and the beginning of phase 3 (*c.* 800–650 BC; Figure 2b; Drechsler-Bižić 1968, 1987). They are adorned with small bronze buttons; sub-variants were additionally decorated with larger bronze buttons or woven bronze chains along the edge (Figure 2b; Drechsler-Bižić 1968). In some contexts, these caps have also been found alongside heavy bronze torcs that were probably pinned to the top of caps (Teßmann 2001; Balen-Letunić 2004). Preliminary analysis of preserved fragments of one of these caps from grave 51 at Kompolje demonstrates that at least some of these objects are made from finely worked young sheep or goat leather (Jablonski *pers. comm.*). Calotte (type 1) caps are also usually associated with one or more of the following items: simple spiral spectacle fibulae of Kompolje type,

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one-looped fibulae, bronze torcs or bronze pins (Drechsler-Bižić 1968; Bakarić 1986; Pabst 2009, 2011). The co-occurrence of spiral spectacle fibulae and caps in graves dates to phase 2 (Figure 2) and is thought to represent a standard Iapodian female suite of goods (Drechsler-Bižić 1968; Bakarić 1986; Pabst 2009, 2011). This assemblage was found with burials GKP-07 and KO-22 from this study.

Materials and methods

Human skeletal remains from previous excavations at the necropoli of Kompolje, Konjsko Brdo, Plešina Glavica, Prozor and Smiljan are curated at the Archaeological Museum in Zagreb (AMZ) and Lika Regional Museum in Gospić (Figure 1). Although preserved human remains from Lika are rare, we were able to sample remains from ten burials traditionally assigned to phases 2 and/or 3—due either to direct association with sequenced grave-good types, or assumed contemporaneity with other typologically dated burials. During analysis, we discovered that Smiljan burials 2 and 17 each contained two individuals, denoted here as A and B.

Samples were prepared using standard procedures at the Penn State Human Palaeoecology and Isotope Geochemistry Laboratory, before being sent to the Keck Carbon Cycle AMS facility at the University of California Irvine for radiocarbon dating. Detailed methodology is provided in the online supplementary material (OSM). Given the probability that humans exploited aquatic resources from nearby rivers and seasonal lakes, it is possible that our dates are influenced by an unknown freshwater reservoir effect. While future environmental and stable isotope research is required to quantify this effect, we suggest that any resulting offsets are likely to be small, as there is no archaeological or palaeodietary evidence for significant human consumption of aquatic resources during the Bronze and Early Iron Ages in Lika (Zavodny *et al.* 2017). Samples from this study also have stable carbon and nitrogen isotope values consistent with a strictly terrestrial diet (see the OSM).

Simulations of typology-based chronological periods

To provide our new AMS radiocarbon dates with better contextual information, we used OxCal (v.4.2.4; Bronk Ramsey 2014) to simulate the expected duration of each artefact type, according to previous typological studies. We assume that each type is normally distributed over its assigned phase and that transitions between types and phases are gradual (Lee *et al.* 2013). We find the alternative possibility—that types were uniformly distributed over 100-year segments before abruptly dropping out of the archaeological record—much less probable. Following previous studies (Van Strydonck *et al.* 2004; de Mulder *et al.* 2007), we also assume that the duration of a typological phase represents a median calendar date with a 2σ range. Phase 2 of the Iapodian chronology, for example, spans 800–700 BC and is entered into OxCal as calendar date 750 BC±25 years (1σ = 25 years).

Results

Calibrated AMS radiocarbon dates are reported in Table 1 and Figure 3. Although all burials are typologically assigned to phases 2 and 3 (*c.* 800–600 BC), our results show

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Table 1. Calibrated AMS radiocarbon dates of burials using OxCal v.4.2.4 (Bronk Ramsey 2009, 2014) and IntCal13 (Reimer *et al.* 2013).

Site	Lab ID	Burial #	Age & sex	Type I caps	Spiral spectacle fibulae	Arched 1-loop fibulae	UCIAMS Lab #	^{14}C BP	2σ cal BC
Kompolje	KO-22	22	Adult	X	X		169825	2590±20	810–770 (95.4%)
	KO-119	119	Adult				169826	2735±15	915–830 (95.4%)
	KO-197	197	Adult	X		X	172393	2505±20	780–730 (20.9%) 695–540 (74.5%)
Konjsko Brdo	KB-01	n/a	Adult Female			X	158544	2480±20	770–535 (95.1%) 530–520 (0.3%)
Plešina Glavica	GKP-06	6	<18				179815	2705±15	900–815 (95.4%)
	GKP-07	7	Adult	X	X		181718	2710±15	900–815 (95.4%)
Prozor	PR-06	6	Adult				169827	2460±15	755–680 (41.5%) 675–605 (20.3%) 600–480 (32.8%) 445–430 (0.8%)
Smiljan	SM-01	4	Juvenile	X			169831	2560±15	800–765 (95.4%)
	SM-2A	2	Adult		X		173184	2560±20	805–750 (90.3%) 685–665 (2.7%) 610–590 (2.4%)
	SM-2B	2	Juvenile		X		172394	2505±20	780–730 (20.9%) 695–540 (74.5%)
	SM-17A	17	Adult Female	X			169836	2535±15	795–745 (63.2%) 685–665 (11.5%) 640–585 (18.4%) 580–565 (2.3%)
	SM-17B	17	Juvenile	X			174939	2545±20	800–745 (69.8%) 685–665 (8.4%) 640–585 (14.7%) 580–560 (2.5%)

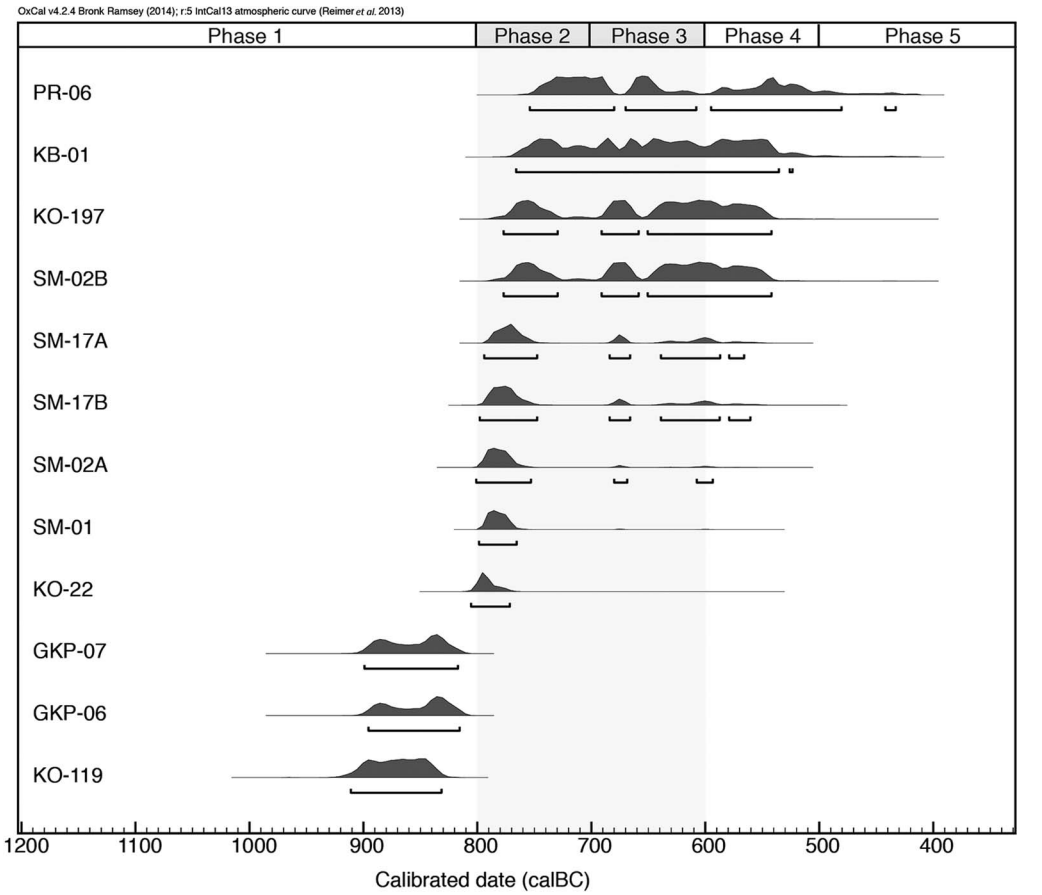

Figure 3. Calibrated AMS radiocarbon dates of burials with phase 2–3 grave-good types.

a wider distribution of absolute dates than expected (Figure 3). Burials from Plešina Glavica (900–815 cal BC at 95.4% confidence) and Kompolje (915–830 cal BC at 95.4% confidence) pre-date phase 2 entirely, while other burials have date ranges that extend into phase 4 or later. To characterise these discrepancies more thoroughly, we plotted the calibrated dates from burials with diagnostic grave goods (discussed earlier) against the estimated duration of these goods according to current typological chronologies (Figure 4).

Type I caps

Type I caps are associated with five burial contexts (six individuals) from Kompolje, Plešina Glavica and Smiljan (Table 1). Although the provenance of the type I cap from burial 17 at Smiljan has recently been questioned, we include the two AMS radiocarbon from this context in our analyses because the burial is still typologically dated to phases 2 and 3 on the basis of other grave goods from Smiljan (Bakarić 1986).

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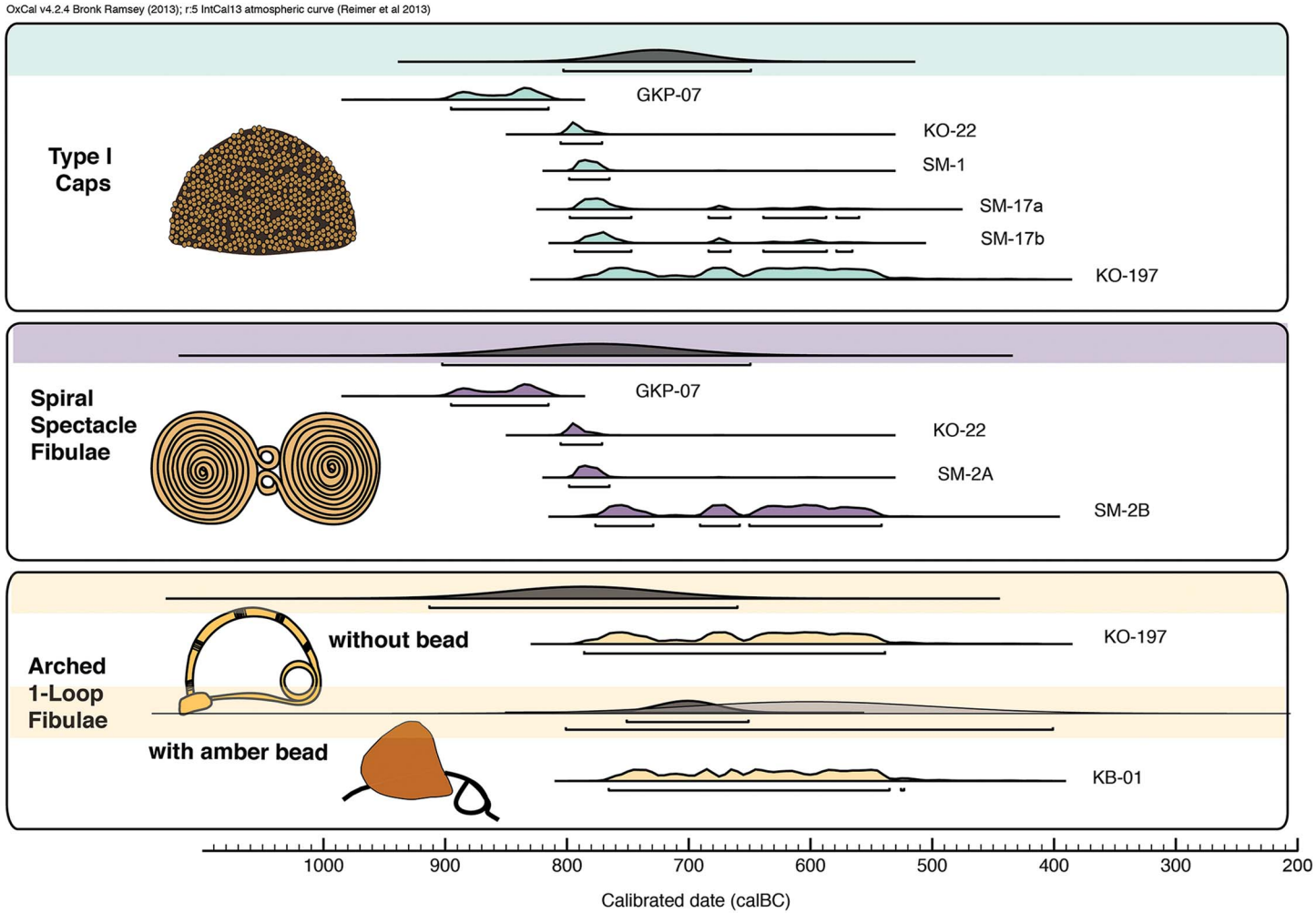

Figure 4. Calibrated AMS radiocarbon dates for burials associated with distinctive Late Bronze and Early Iron Age artefact types. Modelled distributions for each estimated typological phase duration are black (grey distribution is Bakarić's (2017) proposed extended phase for one-looped fibulae with amber bead).

AMS radiocarbon dates fall between 900–540 cal BC (95.4% confidence) and within the range of error for the simulated time span of this type (Figure 4). Three of the five burial contexts, however, pre-date the expected peak in type 1 cap popularity (*c.* 700 BC) by at least a century. This pattern remains the same even if we remove the dates from burial 17 at Smiljan as a conservative measure.

Spiral spectacle fibulae

Spiral spectacle fibulae (Kompolje type) are associated with three burial contexts (four individuals) from Kompolje, Plešina Glavica and Smiljan (Table 1). AMS radiocarbon dates fall between 900–540 cal BC (95.4% confidence) and within the estimated typological phase distribution for this type (Figure 4).

Arched one-loop fibulae

Arched one-loop fibulae are associated with one burial from Kompolje (no bead) and one burial from Konjsko Brdo (amber bead; Table 1). Regrettably, AMS radiocarbon dates from these burials overlap with the Hallstatt Plateau—a known effect in the calibration curve that stretches dates into long and flat ranges, rendering them largely uninformative (Hajdas 2008). We note, however, that while the calibrated AMS radiocarbon date for the smooth bow variant from Kompolje grave 197 extends beyond the simulated type period (780–540 cal BC at 95.4% confidence), there is a high probability that the date falls between 695 and 540 cal BC (74.5% confidence). If this is the case, this example of a smooth bow one-looped arch fibula falls later than expected, corresponding with phases 3 or 4.

Additionally, while Balen-Letunić (2004) and Olujić (2007) suggest that the popularity of arched one-loop fibulae decorated with a single amber bead peaked in phase 3, Bakarić (2017) argues that this form endured for a much longer period of time (*c.* 800–400 BC). Both typological distributions are depicted in Figure 4 for comparison with the dated burial from Konjsko Brdo. While our date (770–520 cal BC at 95.4% confidence) appears to support a more extended period of use for this fibula type, the effects of the Hallstatt Plateau restrict our interpretive ability. Further absolute dating is necessary to support either phase assignment with confidence.

Limitations of grave goods as valid chronological markers

The traditional Iapodian cultural chronology is based on the stylistic and typological evolution of certain grave goods. Although our sample is necessarily small because of Lika's poor skeletal preservation, our AMS radiocarbon dates show that at least some of these dating sequences are probably incorrect or poorly defined. The majority of sampled burials with type I caps, for instance, date to almost a century earlier than expected. The effect of the calibration curve is such that AMS radiocarbon dates are usually overrepresented on flatter parts of the curve (e.g. the Hallstatt Plateau) and are less likely to occur on areas with a steeper slope. The fact that most of the type I cap dates fall on a steep part of the calibration curve that pre-dates their modelled distribution peak suggests that there is a meaningful difference between the model and reality, which requires further exploration. Conversely, it

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could be that both absolute and relative modelled dates for arched one-loop fibulae are imprecise and inconclusive.

Potential relative chronological inaccuracies are especially alarming, given that many burials without any grave goods are often dated based on their assumed contemporaneity with furnished burials. Of our sample, burials from Kompolje (KO-119), Plešina Glavica (GKP-06) and Prozor (PR-06) possessed none of the grave goods tested in this article, but have been traditionally dated to the same transitional period of phases 2 and 3 (Table 1). While Prozor burial PR-06 appears to fall within this time frame, the two burials from Kompolje and Plešina Glavica pre-date phase 2 by at least a century (Figure 3).

Furthermore, while chronologies constructed from grave-good typologies often combine different artefact classes when defining and dating phases to combat the issues presented above, we find that this approach fails when small inaccuracies or imprecisions are compounded by the combination of multiple errors. Type 1 caps and Kompolje-type spiral spectacle fibulae are expected to co-occur in female graves during phase 2 (*c.* 800–700 BC; Drechsler-Bižić 1968; Bakarić 1986; Pabst 2009, 2011), and they do so at Plešina Glavica (GKP-07) and Kompolje (KO-22). Our radiocarbon AMS dates, however, contradict typological expectations. The date from the Kompolje burial straddles the very beginning of phase 2, but the Plešina Glavica burial pre-dates the beginning of this phase by at least a century. Consequently, not only does the grave-good combination of cap and fibulae appear earlier than expected at Plešina Glavica, it also persists for a longer period than assumed (i.e. by more than a century). The sites of Kompolje and Plešina Glavica are located in neighbouring valleys, but are separated by mountains that could have slowed the transmission of goods and/or the standardisation of burial customs (Zavodny 2017). These findings suggest that the new 'Iapodian' material culture was not distributed rapidly and uniformly over the landscape, as previously argued. Instead, it is more probable that local groups adopted these new types over several hundred years as their individual circumstances changed. This led to small stops, starts and reversals in the spread of the 'Iapodian' culture throughout Lika.

If grave-good-based relative chronologies are to be used successfully in Lika or elsewhere, each included type must be rigorously tested using AMS radiocarbon dating. Our results suggest that certain types of grave goods are more appropriate as relative dating proxies than others. Arched one-loop fibulae, for example, are one of the earliest forms attributed to the Iapodian culture and, in theory, are well suited for chronology building. They are easily sorted into types according to decoration style and occur frequently in the archaeological record. Furthermore, they can be cross-referenced with similar forms in neighbouring regions to establish dates of appearance and duration in Lika (Drechsler-Bižić 1976; Bakarić 1989). While these characteristics were ideal for mapping artefact distributions in the past, they are less suited for precise chronology construction in the present. Our new AMS radiocarbon determinations were unable to date these contexts precisely because of the interference of the Hallstatt Plateau, but the multiple simulated typological spans for arched one-loop fibulae were also unhelpful in precisely or accurately dating burials.

Conversely, burials with spiral spectacle fibulae date to within a restricted time period; of the grave goods tested for this article, these fibulae perform the best as relative chronological markers. This is presumably because the spiral spectacle fibulae type was more restricted geographically, occurring only in Lika (Drechsler-Bižić 1987). Relative chronologies constructed

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from less frequent and/or geographically restricted types are probably more precise and accurate than types that are more widespread and abundant. Future studies should examine this pattern more thoroughly.

Conclusion

Although typology-based relative chronologies and models have a long history in European archaeology (e.g. Childe 1925; Gimbutas 1963; Papazoglou 1969), there is a growing recognition that reliance on these cultural-historical frameworks can obscure more nuanced processes that might better explain cultural development in later prehistory. Current archaeological interpretation of 'Iapodian' cultural development, for instance, hinges on the group's emergence as a cohesive and materially distinct culture at the start of the Iron Age. Until now, this argument has relied on a relative dating scheme based on grave-good typologies. New radiocarbon dates and modelling from multiple burial contexts from the Bronze–Iron Age transition, however, indicate that the materials attributed to these earliest phases are not as uniformly distributed as previously thought. Instead, some fibulae and jewellery types persisted over longer periods of time than expected, while others appeared earlier than predicted in the archaeological record. These inconsistencies between absolute and relative dates suggest that there may have been more regional variation in the adoption and spread of a novel Iapodian material culture—contradicting previous arguments for the rapid genesis of this group. In fact, the 'Iapodians', as they have been defined traditionally, probably did not even exist at this time. Our results show only a gradual trend towards regional cultural and socio-political homogenisation by the Early Iron Age, rather than the expected florescence of cultural development that would signal the beginning of a unified cultural entity. Recent absolute chronological studies in other areas have reached similar conclusions, reversing long-standing narratives about the spread of new technologies, peoples and materials in Bronze and Iron Age Europe. New findings from southern Germany, for example, suggest that the adoption of bronze-working technology was not rapid and ubiquitous, but varied significantly between groups, taking centuries to be integrated fully across the region (Stockhammer *et al.* 2015).

Our results add to the call for more systematic testing of these older chronological frameworks and the typologies that underpin them (Bayliss *et al.* 2007; Whittle & Bayliss 2007; Vega Brown *et al.* 2013; Stockhammer *et al.* 2015). Chronologies that rely on artefact types from single contexts, such as burials, are especially vulnerable to the problems discussed above, as they are distinct from material and organisational changes found in non-funerary contexts and are therefore likely to be unrepresentative of cultural groups as a whole. As such, they are less suited to answer fine-grained questions about cultural development. Advances in technology and methodology, however, now allow us to observe cultural change in high resolution. Archaeologists must continue to evaluate their interpretive frameworks through the application of new data, such as radiocarbon dates, combining artefact types from different contexts to create more robust dating frameworks and cultural sequences.

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Supplementary material

To view supplementary material for this article, please visit https://doi.org/10.15184/aqy.2018.184

References

Bakarić, L. 1986. Rezultati novih istraživanja u Smiljanu. *VAMZ* 19: 129–40.

– 1989. Grob 154 iz Kompolja. *VAMZ* 22: 5–18.

– 2004. The Iapodes, in D. Balen-Letunić (ed.) *Ratnici na razmeđu istoka i zapada*: 357–84. Zagreb: Arheološki muzej Zagreb.

– 2017. Japodi, in L. Bakarić (ed.) *Japodi zaboravljeni gorštaci*: 21–60. Zagreb: Arheološki muzej Zagreb.

Balen-Letunić, D. 1990. Perle s tri lice pronađene na području Like. *VAMZ* 23: 49–60.

– 1996. Figuralno ukrašene trapezoidne pojasne kopče tipa Prozor. *VAMZ* 28–29: 23–28.

– 2004. Japodi, in D. Balen-Letunić (ed.) *Ratnici na razmeđu istoka i zapada*: 212–57. Zagreb: Arheološki muzej Zagreb.

Bayliss, A., A. Whittle & M. Wysocki. 2007. Talking about my generation: the date of the West Kennett long barrow. *Cambridge Archaeological Journal* 17: 85–101. https://doi.org/10.1017/S0959774307000182

Bronk Ramsey, C. 2009. Bayesian analysis of radiocarbon dates. *Radiocarbon* 51: 1023–45. https://doi.org/10.1017/S0033822200034093

– 2014. OxCal v.4.2.4. Released 2014 September 5. Oxford Radiocarbon Accelerator Unit (ORAU). Available at: https://c14.arch.ox.ac.uk (accessed 13 December 2018).

Buck, C., W. Cavanagh & C. Litton. 1996. *Bayesian approach to interpreting archaeological data*. Chichester: Wiley.

Chapman, R. 2003. *Archaeologies of complexity*. London: Routledge. https://doi.org/10.4324/9780203451779

Childe, V.G. 1925. *The dawn of European civilization*. New York: A.A. Knopf.

de Mulder, G., M. Van Strydonck, M. Boudin, W. Leclerq, N. Paridaens & E. Warmenbol. 2007. Re-evaluation of the Late Bronze Age and Early Iron Age chronology of the western Belgian urnfields based on ^{14}C dating of cremated bones. *Radiocarbon* 49: 499–514. https://doi.org/10.1017/S0033822200042429

Drechsler-Bižić, R. 1968. Japodske kape i oglavlja. *VAMZ* 3: 29–51.

– 1976. Porijeklo lučnih jednopetljastih fibula u Japoda. *Godišnjak Centra za balkanološka ispitivanja Akademije nauka i umjetnosti Bosne i Hercegovine* 13: 143–51.

– 1980. Nekropola brončanog doba u pećini Bezdanjači kod Vrhovina. *VAMZ* 12: 27–78.

– 1983a. Japodska kulturna grupa, in A. Benac (ed.) *Prajstorija jugoslavenskih zemalja 4*: 374–89. Sarajevo: Centar za Balkanološka Ispitivanja.

– 1983b. Srednje brončano doba u Lici i Bosni, in A. Benac (ed.) *Praistorija jugoslavenskih zemalja 4*: 242–70. Sarajevo: Centar za Balkanološka Ispitivanja.

– 1987. Japodska grupa, in A. Benac (ed.) *Praistorija jugoslavenskih zemalja 5*: 391–441. Sarajevo: Centar za Balkanološka Ispitivanja.

Drnić, I. & A. Tonc. 2015. Kasnolatenske i ranocarske fibule s japodskog prostora. *Prilozi Instituta za arheologiju u Zagrebu* 31: 181–214.

Feinman, G. & J. Neitzel. 1984. Too many types: an overview of sedentary prestate societies in the Americas. *Advances in Archaeological Method and Theory* 7: 39–102. https://doi.org/10.1016/B978-0-12-003107-8.50007-4

Fowler, C. 2017. Relational typologies, assemblage theory and Early Bronze Age burials. *Cambridge Archaeological Journal* 27: 95–109. https://doi.org/10.1017/S0959774316000615

Gimbutas, M. 1963. European prehistory: Neolithic to the Iron Age. *Biennial Review of Anthropology* 3: 69–106.

Hajdas, I. 2008. Radiocarbon dating and its applications in quaternary studies. *Quaternary Science Journal* 57: 2–24.

Hiller, G. 1991. Zur japodischen und liburnischen Früheisenzeit Nordwestjugoslawiens.

Unpublished PhD dissertation, Institut für Ur-und Frühgeschichte in Heidelberg.

Kolak, T. & D. Šušnjić. 2008. Problemi istraživanja i zaštite arheoloških lokaliteta na ličkom području, in T. Kolak (ed.) *Arheološka istraživanja u Lici i Arheologija pećina i krša*: 209–20. Zagreb: Hrvatsko arheološko društvo.

Lee, S., C. Bronk Ramsey & A. Mazar. 2013. Iron Age chronology in Israel: results from modeling with a trapezoidal Bayesian framework. *Radiocarbon* 55: 731–40. https://doi.org/10.1017/S003382220005788X

lo Schiavo, F. 1970. *Il grupo liburnico-Japodico per una definizione nell' ambito della protostoria balcanica*. Rome: Accademia Nazionale dei Lincei.

Marić, Z. 1968. Japodske nekropole u dolini Une. *GZM* 23: 5–80.

Montelius, O. 1885. *Om tidsbestämning inom bronsåldern: med särskildt afseende på Scandinavien*. Stockholm: Kongl. Boktryckeriet.

Müller-Karpe, H. 1959. *Beiträge zur Chronologie der Urnenfelderzeit nördlich und sündlich der Alpen*. Berlin: Walter de Gruyter & Co.

Olujić, B. 2007. *Povijest Japoda Pristup*. Zagreb: Srednja Europa.

O'Shea, J. 1984. *Mortuary variability: an archaeological investigation*. Orlando (FL): Academic Press.

Pabst, S. 2009. Population movements on the Balkan peninsula at the beginning of the Early Iron Age and the question of the ethnogenesis of the Macedonians. *Jahrbuch des Deutschen Archäologischen Instituts* 124: 1–74.

– 2011. Die grossräumige Ausbreitung der Brillenfibeln am Übergang von der Bronze- zur Eisenzeit- Kommunikationswege und soziale Hintergründe, in U. Dietz & A. Jockenhövel (ed.) *Bronzen im Spannungsfeld zwischen praktischer Nutzung und symbolischer Bedeutung*: 199–234. Stuttgart: Franz Steiner.

Palavestra, A. 1993. *Praistorijski ćilibar na centralnom i zapadnom Balkanu*. Beograd: SANU Balkanološki Institut.

Papazoglou, F. 1969. *Srednjobalkanska plemena u prerimsko doba: Tribali, Autarijati, Dardanci, Skordisci i Mezi*. Sarajevo: Akademija nauka i umjetnosti Bosne i Hercegovine, Centar za balkanološka ispitivanja.

Parker Pearson, M. 1999. *The archaeology of death and burial*. Sutton: Phoenix Mill.

Plog, S. & J. Hantman. 1990. Chronology construction and the study of prehistoric culture change. *Journal of Field Archaeology* 17: 439–56.

Raunig, B. 1992. Figuralne predstave u kulturi praistorijskih Japoda. Unpublished PhD dissertation, University of Belgrade.

Reimer, P.J. *et al.* 2013. IntCal13 and Marine13 radiocarbon age calibration curves 0-50,000 years cal BP. *Radiocarbon* 55: 1869–87. https://doi.org/10.2458/azu_js_rc.55.16947

Reinecke, P. 1902. Zur Kenntnis der La Tène-Denkmäler der Zone nordwärts der Alpen, in *Festschrift zur Feier des fünfzigjährigen Bestehens des Römisch-Germanischen Centralmuseums zu Mainz*: 53–109. Mainz: Philipp Von Zabern.

Sørensen, M. 2015. 'Paradigm lost'—on the state of typology within archaeological theory, in K. Kristiansen, L. Šmejda & J. Turek (ed.) *Paradigm found: archaeological theory present, past and future*: 84–94. Oxford: Oxbow.

Stockhammer, P., K. Massy, C. Knipper, R. Friedrich, B. Kromer, S. Lindauer, J. Radosavljević, F. Wittenborn & J. Krause. 2015. Rewriting the Central European Early Bronze Age chronology: evidence from large-scale radiocarbon dating. *PLoS ONE* 10: e0139705. https://doi.org/10.1371/journal.pone.0139705

Teržan, B. 2011. Japodske tropetljaste fibule (Iapodian three-looped fibulae). *Prilozi Instituta za arheologiju u Zagrebu* 27: 111–22.

Tessmann, B. 2001. Schmuck und Trachtzubehor aus Prozor, Kroatien. Ein Beitrag zur Tracht im japodischen Gebiet. *Acta Praehistorica et Archaeologica* 33: 28–151.

Težak-Gregl, T. 1981. Certosa fibule na centralnom japodskom području. *VAMZ* 14: 25–48.

Tonc, A. 2015. Protopovijesne zajednice na sjevernom dijelu istočne obale Jadrana i njezinu zaleđu. Unpublished PhD dissertation, Filozofski fakultet Sveučilišta u Zagrebu.

Van Strydonck, M., A. De Moor & D. Bénazeth. 2004. ^{14}C dating compared to art historical dating of Roman and Coptic textiles from Egypt. *Radiocarbon* 46: 231–44. https://doi.org/10.1017/S0033822200039552

Vega Brown, M., N. Craig, B. Culleton, D. Kennett & G. Lindo. 2013. AMS radiocarbon dates from Prehispanic fortifications in the Huaura Valley, central coast of Perú. *Radiocarbon* 55: 1–12. https://doi.org/10.2458/azu_js_rc.v55i1.16047

https://doi.org/10.15184/aqy.2018.184 Published online by Cambridge University Press

Vejvoda, V. 1962. Japodske dvokrake igle. *VAMZ* 2: 115–24.

Whittle, A. & A. Bayliss. 2007. The times of their lives: from chronological precision to kinds of history and change. *Cambridge Archaeological Journal* 17: 21–28. https://doi.org/10.1017/S0959774307000030

Zavodny, E. 2017. New approaches to cultural change and continuity at the Bronze–Iron Age transition in Lika, Croatia. Unpublished PhD dissertation, Pennsylvania State University.

Zavodny, E., B. Culleton, S. McClure, D. Kennett & J. Balen. 2017. Minimizing risk on the margins: insights on Iron Age agriculture from stable isotope analyses in central Croatia. *Journal of Anthropological Archaeology* 48: 250–61. https://doi.org/10.1016/j.jaa.2017.08.004

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