Multidisciplinary insight into late Roman rural settlement on the northeastern Adriatic coast of Croatia: Island of Rab case study

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Abstract: Results of multidisciplinary research conducted on the island of Rab (Northeastern Adriatic, Croatia) are presented with particular focus on late Roman rural settlements and their economic activities. The settlement in Podšilo bay, Lopar peninsula, is analyzed in more detail, providing evidence on a vibrant local community engaged in diversified craft activities and the exploitation of local land and marine resources. Along with the specificities of its layout and organization, this site also presents unique possibilities to study environmental factors that influenced its setup and economy, but also its demise, tentatively placed within the 6th century AD.

Keywords: Northeastern Adriatic, Roman province Dalmatia, Roman rural settlement, pottery production, archeological geophysics, geoarcheology, ground penetrating radar, magnetometry

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The island of Rab is located in the northeastern Adriatic, more precisely in the southern part of the Kvarner gulf just a few kilometers off the coast. It is, at 93 m², one of the mid-sized islands of the archipelago [*Fig. 1*]. The northeastern karst part of the island is mostly barren and uninhabited, while the southwestern part

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Since 2017, archeological research on the island of Rab is jointly led by Ana Konestra (Institute of Archaeology, Zagreb) and Fabian Welc (Institute of Archaeology, UKSW, Warsaw), in collaboration with Anita Dugonjić (Archaeological Museum in Zagreb) and with the participation of independent researchers and students.

is densely overgrown with maquis, olive groves, vineyards and oak forest, and is the location of most of the island's settlements.

The island of Rab is mentioned by Greek and Roman geographers and other historic sources under the name of Arba or Arva (Starac 2000; Suić 2003). Numerous epigraphic finds from the modern town of Rab testify to the development, in the first centuries AD, of the island's only urban center, the *municipium* Arba, situated probably on the spot of an earlier Iron Age hillfort. The Roman rural settlements, which developed in various parts of the island, have been mapped and studied in a more systematic way only in the last few years (see Jurković et al. 2012; Lipovac and Šiljeg 2012; Čaušević-Bully and Bully 2015; Lipovac Vrkljan and Konestra 2015; Welc at al. 2017).

Mapping and documenting the archaeological evidence on the island of Rab, undertaken in 2013 and continued over the next few years by the Institute of Archaeology in Zagreb, is aimed at creating a base for further analytical and methodological approaches (Lipovac-Vrkljan et al. 2017: 315–316). The archaeological survey was designed to fill a gap in the record as, until recently, only a few sites had been excavated in part and there had been no comprehensive field reconnaissance of potential archaeological sites

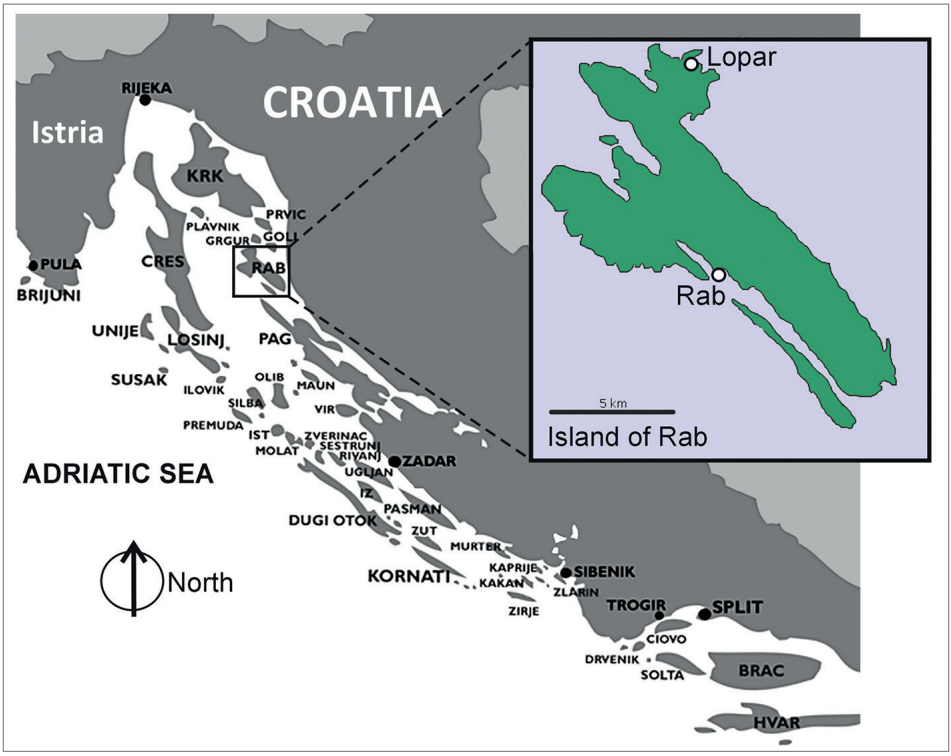
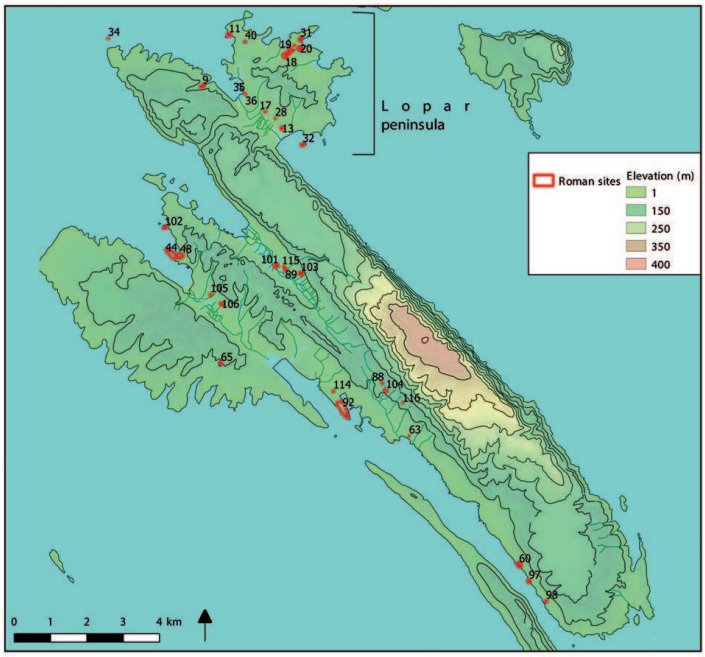


Fig. 1. Location of the island of Rab, town of Rab and Lopar peninsula within which the Podšilo bay archaeological site is located (Illustration F. Welc)



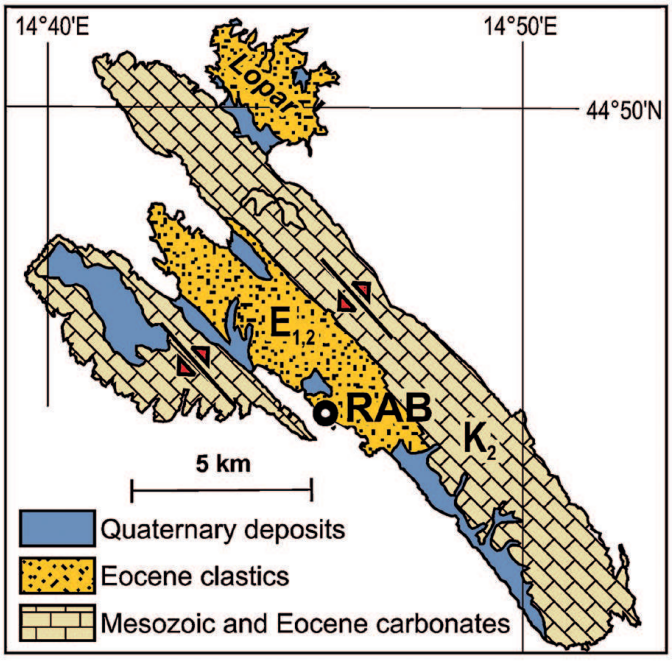


Fig. 2. Spatial distribution of Roman archaeological sites on the island of Rab (Rab Project archive/ image A. Konestra, base map DGU/JU ZPP-PGŽ)
Fig. 3. Simplified geological map of the island of Rab (After Marjanac, Marjanac 2007, modified by F. Welc)

(Rizner 2012 with earlier bibliography). The present survey project thus affords a diachronic view of settlement and land-use on the island, supporting as well a period-specific settlement pattern analysis. Many previously unknown archaeological sites spanning from the Bronze Age to the late medieval period were identified and documented, and the large number of sites from the Roman period—previously there were just a few sites known apart from ancient Arba and only two of these had been partly investigated (Skelac and Radić Rossi 2006; Rizner 2012; Jurković et al. 2012; Čaušević-Bully and Bully 2015)—in particular led to a better understanding of how settlement development proceeded on the island in Roman times. Finally, this research also determined the spatial distribution of the sites on the island shores and inland (Lipovac Vrkljan et al. 2017) [*Fig. 2*].

In 2016, geophysical and geoarchaeological surveys as well as trial trencheing were implemented on selected newly discovered sites, thanks to a collaboration between the Institute of Archaeology of Cardinal Stefan Wyszyński University in Warsaw and the Institute of Archaeology in Zagreb, and with the participation of the Archaeological Museum in Zagreb. Research has focused since on the newly discovered Roman rural sites on the island (Konestra et al. 2017; Lipovac Vrkljan et al. 2017; Welc et al. 2017; Konestra et al. 2018), and in particular on sites located in the northern part of the Lopar peninsula [see *Fig. 1*]. The combination of geological and archaeological features in the area of Podšilo bay has allowed a multidisciplinary approach to be fully implemented there, yielding results indicative for site layout as well as for the environmental setting and economy.

LOCAL GEOMORPHOLOGICAL AND GEOLOGICAL SETTING

In general, the island of Rab features large flysh plains where alluvial deposits have created suitable soil for cultivation, while the hilly parts of the island are characterized by carbonates and thus karst. From a structural point of view, Rab Island belongs to the External Dinarides (Vlahović et al. 2005) [*Fig. 3*]. The geology of the island is relatively simple; it consists of two anticlines and two synclines. Cretaceous carbonate rocks are the oldest outcrops and they are overlain uncomfortably by Eocene carbonates referred to as a 'flysch' (Marjanac and Marjanac 1991; 2007). Eocene clastics comprise an older unit, which is a marly sandy formation and a younger one referred to as the Lopar Sandstones. The latter consists of sandstone packages divided by bioturbated sandy marls. Because sandstones are more resistant to weathering processes, they usually stand out in relief forming the Lopar peninsula elevation and another long morphological elevation that extends along the Supetarska-Barbat syncline (Muldini-Mamužić 1962; Mamužić and Milan 1973).

In the Lopar area, the youngest Quaternary deposits are composed of characteristic reddish-brown sands, which are referred to also as Quaternary diluvium. These deposits uncomfortably cover the Lopar Sandstones series (Mamuzić et al., 1969; Marjanac and Marjanac 2016)

[*Fig. 4*]. Lopar sands are characterized by good sorting, rounded grains and the absence of a lime component that is proof of long periods of transport. The sands must have been in all probability derived from older flysch sediments. At Lopar, the thickness of these layers may reach even 6 m (Mamuzić and Milan 1973).

In the near-shore part of the Lopar area [see *Fig. 4*], the subsurface layers, both of natural and anthropogenic origin, are exposed almost always in a secondary (disturbed) context, which is evidenced by numerous ceramic fragments and other traces of human activity observed in natural exposures. The material seems to be relocated and mixed during mass movement processes, suggesting that slope activity was initiated in the past and is still active (Welc et al. 2017).

Natural springs, some permanent, others active only during spring, winter and late autumn, appear in some number on the island (Kovačić 2013). There is no doubt that these sources of water, strictly associated with the local underground karst hydrological system, were the base of human settlement in the past and are still a very important water source for the modern inhabitants of the island (Terzić et al. 2010). Two major springs are known from the Lopar peninsula [*Fig. 5*]. One is known as the Ciganka spring and was once used as a water-supply source for the public; it has dried up in recent times. The spring located in Podšilo bay is still active, especially during the winter. Its water is characterized by high mineraliza-

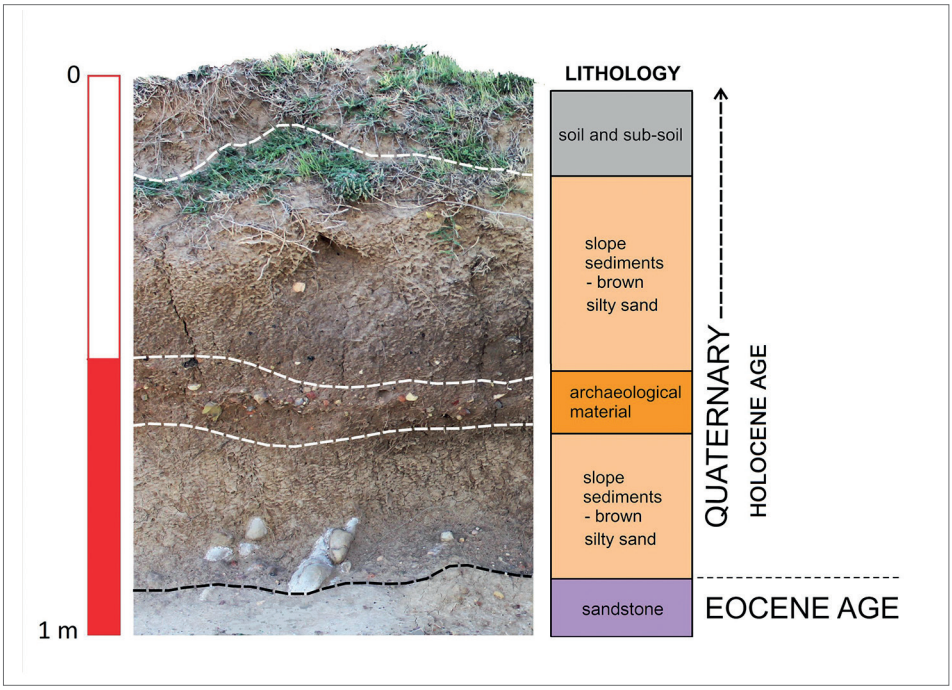


Fig. 4. Lithology of the Lopar/Podšilo area documented in one of the natural exposures (After Welc et al. 2017).

tion. Consequently, the springs in Lopar and Podšilo bay should be considered as mineral waters, because they contain more than 1 g/L of dissolved solids. It is interesting to note that spring water temperatures are slightly higher than the annual mean temperature of the Lopar area (Kovačić 2013).

METHODOLOGY AND RESULTS OF AN INTEGRATED APPROACH TO ROMAN RURAL SETTLEMENT IN PODŠILO BAY

Podšilo bay is a deep inlet in the northeastern part of Lopar peninsula with a hinterland featuring a gently sloping plain crossed by a stream springing a few hundred meters to the west of the shore of the bay. Today, the area of the bay is mostly covered by maquis vegetation and is used as pastureland. The bay's geology is determined by severe erosional processes, which have created landslides and exposures, resulting also in a dispersal of the archaeological material. Moreover, the layout of the bay as seen today was radically different in Antiquity. The most characteristic morphological feature of this area is an erosion stream valley, which cuts the bay into two parts. Numerous natural terraces of various surfaces testify to a still active ground subsidence (Welc et al. 2017) [*Fig. 5*].

Fig. 5. Podšilo bay: 1 and 2 – low terraces with remains of Roman architecture, surveyed with geophysical methods; 3 – Roman kilns located on the northern shore of the bay; 4 – location of the spring (Rab Island Project archive/aerial view G. Skelac, processing F. Welc; inset, after Kovačić 2013, modified by F. Welc))

The location of a Roman settlement in Podšilo bay was suggested after the excavation of a Roman pottery kiln on the northern shore of the bay [*Fig. 6*]. The wider area of the bay was then surveyed (Lipovac Vrkljan and Šiljeg 2010; 2013), revealing scatters of eroded archaeological material, such as pottery sherds, glass, tegulae and mortar debris. Their origin was often difficult to pin down due to the said erosional processes. Stone piles and dry-stone enclosures containing limestone foreign to the bay's sandstone bedrock have also been detected, signaling the presence of architectural remains. The data prompted a multi-method geophysical survey of selected areas of the bay. The first season has already yielded architectural remains on both the northern and southern slopes (Welc et al. 2016) [see *Fig. 6*]. It was established that modern enclosures do not stand on ancient remains and that the flat, uneroded areas located on higher ground are the most promising areas for finding architectural remains. All scatter areas and their full extensions were intensively reconnaissance, the mapping results being extremely useful for further geophysical survey planning. Also, it allowed further collection of finds, among which iron slag was identified, while a geological survey revealed the presence of iron ore, presumably used locally for smelting iron in antiquity [*Fig. 7*].

Further multi-method geophysical surveys were conducted on some of the accessible flat areas where scatters of finds had suggested a fairly complex architectural settlement pattern [see *Fig. 5*]. The magnetic and GPR methods were used for the purpose of locating Roman architectural remains and ascertaining their vertical stratigraphy as well as hori-

Fig. 6. Roman kiln excavated in 2009 on the northern shore of Podšilo bay (Rab Island project archive/photo A. Konestra)

zontal extent. Magnetic and GPR methods were used in the geopysical survey. Magnetometry is the most common geophysical method used in archaeological surveying (Fassbinder 2005; Aspinall et al. 2008; Gaffney 2008). Typically, fluxgate-type magnetometers are used to detect small changes in the Earth's magnetic field caused by concentrations of ferric minerals in the soil and by magnetic or magnetically susceptible materials buried beneath the surface (Fassbinder 2015). At Podšilo, a Bartington Grad 601 system with a single gradiometer was used. Data were then processed and filtered to produce maps, using TerraSurveyer software. A MALA/ABEM Groundexplorer ground-penetrating radar system with a center frequency of 450 MHz was used for GPR data collection. During processing, ReflexW software was used. In the next step, the data were resampled

Fig. 7. Iron ore in Podšilo bay: above, natural exposure of the ore; below, 1 – sample of iron ore from the natural exposure; 2 – iron slag found in Podšilo bay; 3 – fragment of a solid iron object excavated in Podšilo bay (Rab Island project archive/photos F. Welc)

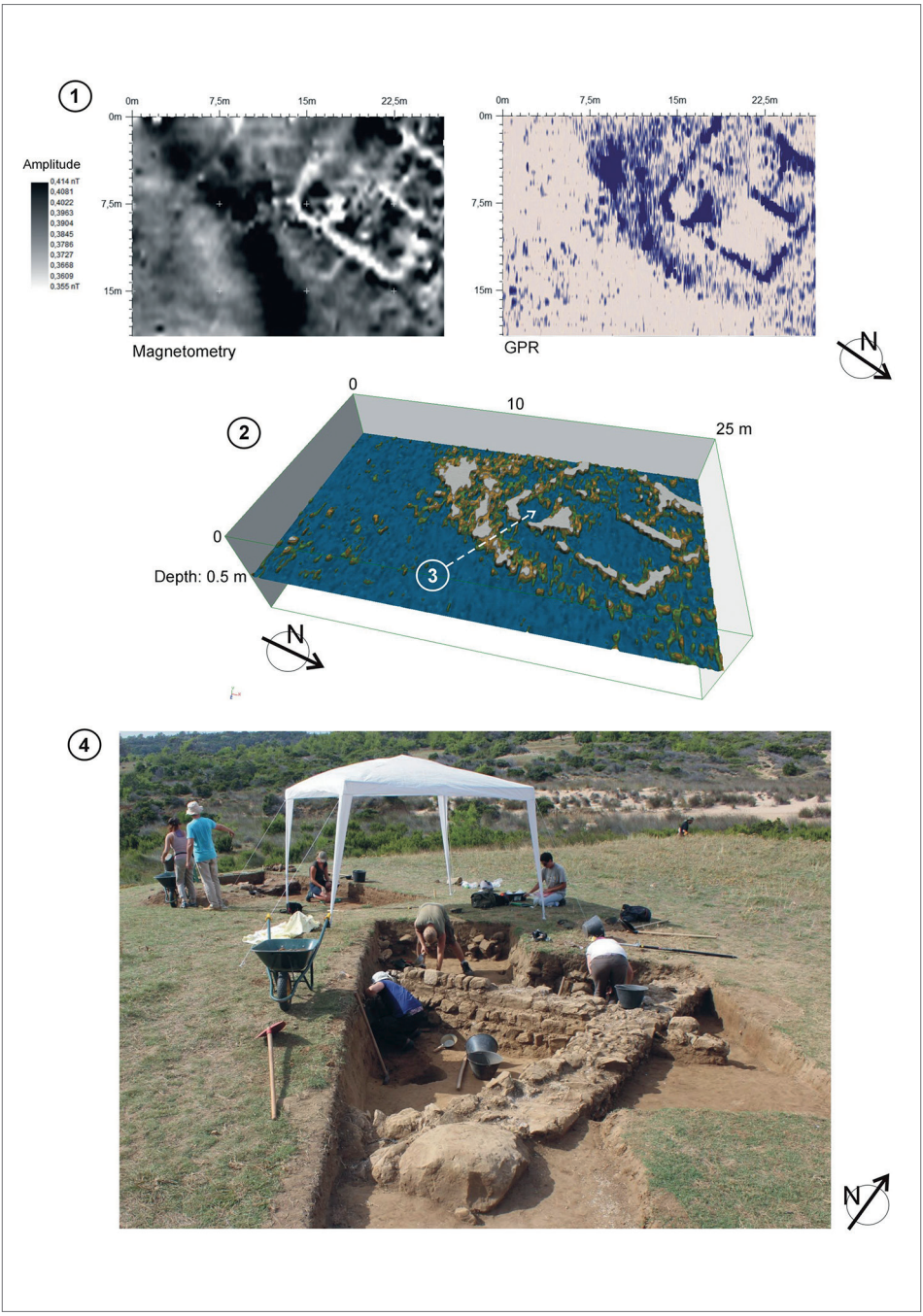


Fig. 8. Large Roman building in Area 1 in Podšilo Bay: 1 – magnetic and GPR mapping; 2 – three-dimensional view based on GPR data; 3 – location of Trench 1, covering the southeastern corner of the building; 4 – stone masonry walls bonded in mortar revealed in excavation (Rab Island project archive/photo and images F. Welc)

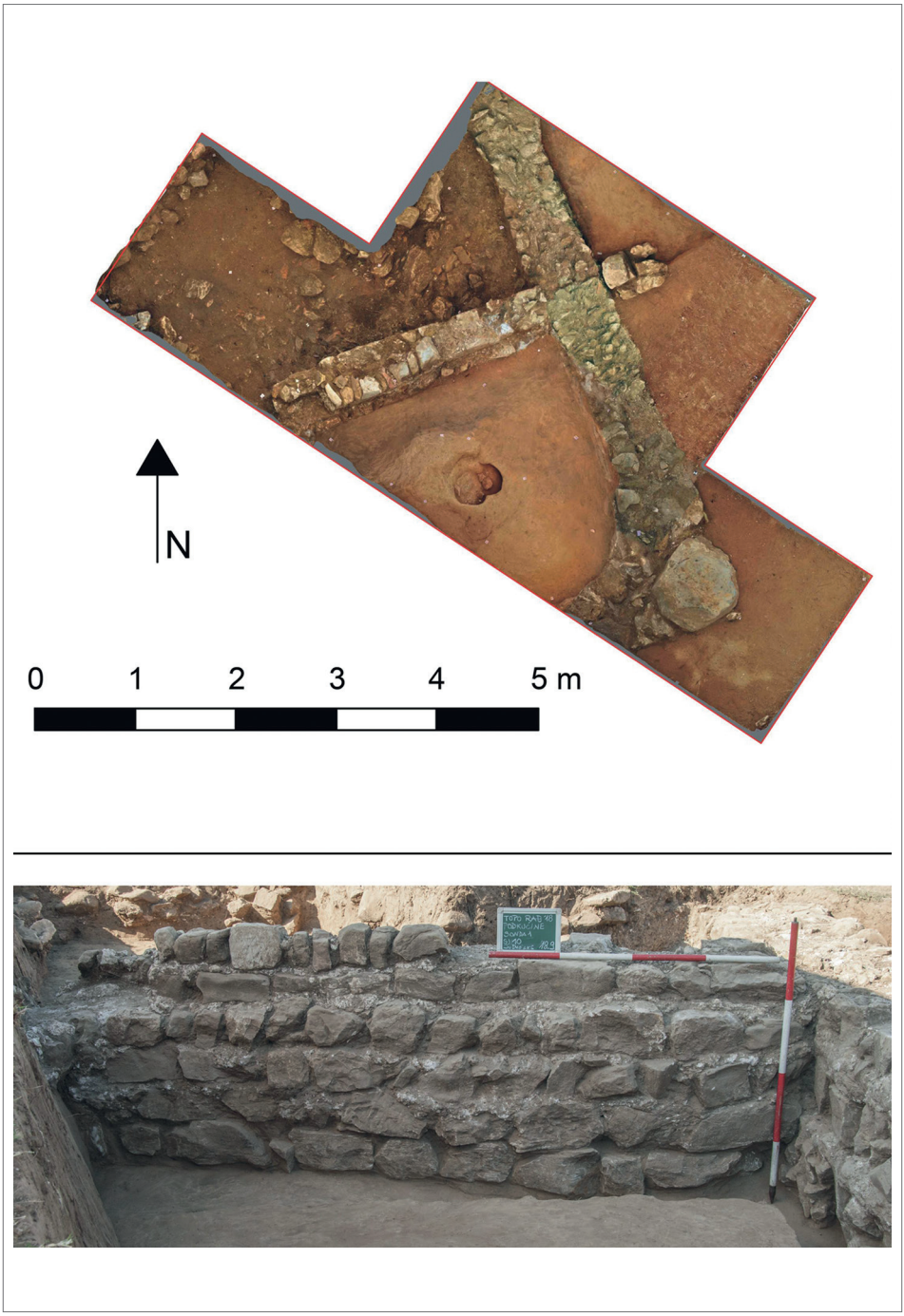


Fig. 9. Photogrammetric plan of the excavated corner of the building (note posthole inside the structure) and close-up of the face of the partition wall (Rab Island project archive/photos and orthophoto K. Rabiega)

from the reflection profiles to produce quasi 3D block-diagrams using the Reflex View 3D data interpretation module (on application of GPR in archaeology, see, e.g., Conyers 2013; 2016).

Architectural remains have been identified in three of the investigated areas, while gradiometer measurements established the presence of an additional pottery kiln next to the one excavated in 2009 (Lipovac Vrkljan and Šiljeg 2010; Welc 2018). Analyses of geophysical results allowed the location of test trenches designed to assess the state of preservation of the architectural remains and stratigraphy to be selected. The main trench on the southern slopes of the bay was situated in a way to intersect the southeastern corner of a square building identified in the GPR survey (Trench 1) [*Fig. 8*].

Fig. 10. Perimetral (foreground) and partition wall (background) of the Roman building (Trench 2) (Rab Island project archive/photo F. Welc)

The geophysical surveys have mapped the layout of a building raised on wide foundations. The relatively high resolution of the GPR and magnetic images is the result of a strong contrast between the soil and the massive, partly limestone walls of the building. The results of the excavation confirmed the layout of the building as detected by the GPR measurements and determined the precise nature of this set of anomalies. They also showed the poor preservation of the remains, but even so, considered together with the associated finds, the discoveries have led to a series of conclusions.

First, the building in question, measuring roughly 11 m by 11 m, contained a series of partitions, one of which created the enclosed space in its southeastern corner, confirming the complex layout of the interior as revealed by the GPR survey [*Fig. 9*]. Moreover, although the walls are preserved mostly as foundations, the building technique is coherent throughout the complex and, where preserved, the elevations present regular rows of sandstone and limestone, forming two wall faces, the stones of which are sometimes roughly shaped into more regular blocks, a feature present in the foundations of the dividing walls as well [*Fig. 10*]. The thickness of the perimetral wall foundation, between 0.80 m and 1.00 m, could indicate a building with at least one upper floor. Two fragments of column bases recovered from the fill of a pit [*Fig. 11*] may suggest a colonnade or portico, although the location of such a feature is still elusive; considering the diameter of 0.40 m, these columns could

have been of a substantial height. The preserved fragment of the base includes the lower part of the shaft, a fillet and a torus, while the plinth seems to have been destroyed in antiquity; traces of it are preserved only on the smaller fragment [see *Fig. 11*].

Additional features, such as a pit and several holes, two of which are to be interpreted as postholes, could be linked to a subsequent remodeling of the complex or indicate a second phase of use of the site. Alternatively, some of the postholes could be interpreted as supporting holes for features used during construction [*Fig. 9*], i.e., a scaffolding, especially when they are dug into the geological layer. Although no traces of pavements were preserved *in situ*, finds of chunks of *opus signinum* might indicate its use as a pavement or as a base for more elaborate floors (or they might have originated from a cistern or basin).

Small finds recovered from the excavation, mostly comprising pottery, glass and metal, helped to determine the chronology of at least the last phase of use of this complex [*Fig. 12*], the nu-

Fig. 11. Column base fragments found in the excavated southeastern corner of the Roman building (Rab Island project archive/photos K. Rabiega, A. Konestra)

mismatic finds in particular, which all but one can be dated to the second half of the 4th century AD. The pottery indicates a somewhat longer time of use of the complex, spanning from the 3rd to at least the 5th, and possibly the first half of the 6th century AD, as indicated by African cooking ware forms H 23, H 196, H 197 late variants, several late African red-slipped ware types: H 80B, H 67, H 91 (Hayes 1973; Bonifay 2004: 171–173, 211–213, 225–227), coarse-ware casseroles and pots of northern Italian make (Cavalazzi and Fabbri 2015: 21–25, Pl. 1:1–5; Cavalazzi and Ficara 2015: 55), and Late Roman 3 and Spatheion 1 or 2 amphorae (Pieri 2005: 94–101; Bonifay 2004: 474). In any case, none of the finds so far could be linked to the early Roman phase (1st–early 2nd century AD).

INTERPRETING THE LATE ROMAN SETTLEMENT IN PODŠILO BAY IN A BROADER ADRIATIC CONTEXT

The eastern Adriatic (Roman Histria, part of the Italic Regio X, and the province of Dalmatia) has a long history of research on Roman rural settlement (usually identified as villae), enabling a definition of typologies and, for Histria, of

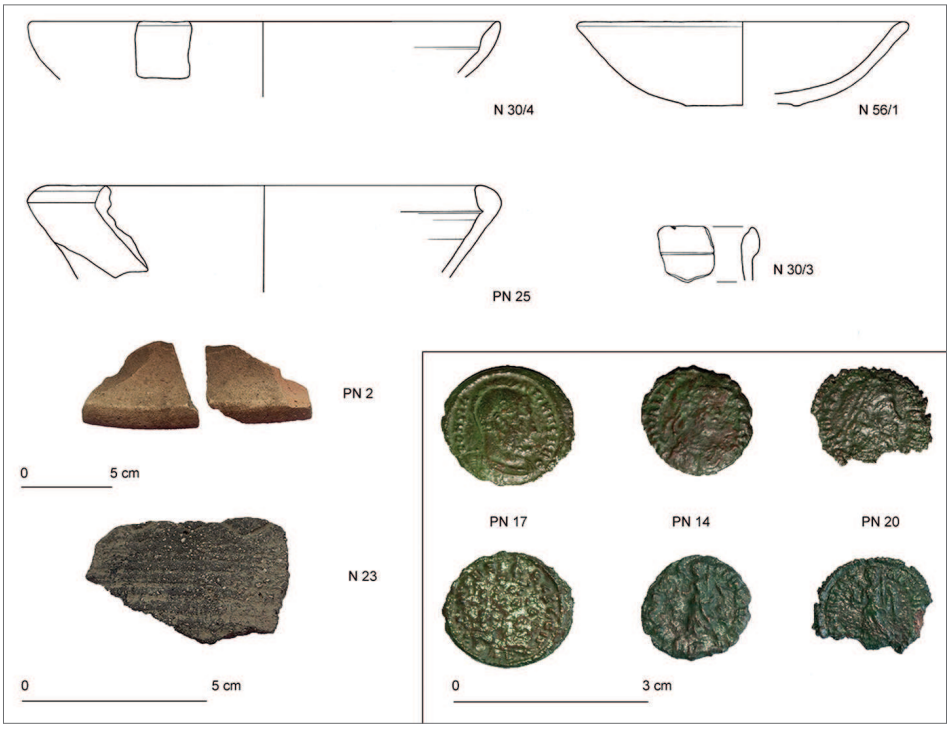


Fig. 12. Selected examples of late Roman pottery and coins found during excavations (Rab Island project archive/drawing B. Nowacki, photo A. Konestra)

basic economic activities (Matijašić 1998; Begović and Schrunk 2002 with earlier bibliography) [see *Fig. 13*]. Nevertheless, very few sites have been excavated in recent times and/or in their total extent; exploration is usually restricted to the main residential–industrial buildings or buildings forming larger complexes with structurally interconnected parts, i.e., the senatorial villas of Histria, where units are organized around a central courtyard or a longitudinal portico (Matijašić 1998: 300–305; Busana 2002: 104–140). For the time being, it is difficult to assess whether some of the known rural sites had several detached buildings forming a larger settlement.

Therefore, the site at Podšilo bay presents a unique occurrence, but is difficult to interpret due to a lack of regional parallels. Nevertheless, there are some similarities from other Dalmatian insular contexts, the first being that of the Korintija

Fig. 13. Sites mentioned in the text (Illustration F. Welc)

fortification on the northeastern shores of the nearby island of Krk, more precisely Bosar, a site interpreted as the *suburbium* of the said fortification, and located in Mala luka bay [*Fig. 13*]. Traditionally, the settlement is connected chronologically and functionally with the late antique fortification located on higher ground to the east of it; it comprised a series of separate building complexes, including at least two churches (Faber 1986/1978: 121–127; Tomičić 1986/1987: 148–151; Šiljeg 2008). Small-scale excavations have thus far not provided a definitive chronological framework for this site, while some production activities are assumed on the basis of glass raw material finds (Šiljeg 2008).

The second example is that of Lastovo island, where a Roman rural settlement, primarily devoted to agricultural production, was partly excavated in the 1970s in the locality of modern Ubli [see *Fig. 13*]. The Roman rural settlement, developed in the hinterland of a deep bay, presents a series of detached architectural units, several with remains of wine or olive presses, while others should be interpreted as residential buildings (Jeličić-Radonić 2001). Although the settlement presumably developed in the early centuries AD, finds indicate a vibrant late antique phase (Jeličić-Radonić 2001: 216–217), when a church was also erected within the settlement.

However, if the settlement in Podšilo started indeed at a later date and if the identified architecture did form separate sectors, such as smaller units located at a certain distance from one another, parallels could be sought also in the late antique settlements (Vučepolje, Banjače, Konjsko and others) which developed in

the Dugopolje area in the hinterland of Salona (capital of the province of Dalmatia, today's central Dalmatia) [see *Fig. 13*]. Their time-span is even shorter than the one proposed for the site in Podšilo, and their layout and thus their internal functioning is still poorly understood due to the rescue nature of the excavations (Borzić and Jadrić 2007; Ožanić Roguljić et al. 2018; Katić 2007; 2018). Also, especially the site at Banjače, shows radically different construction techniques as its architecture consists of exclusively dry stone walls (Ožanić Roguljić et al. 2018: 141). These sites have been linked to herding and farming communities established in the fields located below the numerous late antique fortifications that protected the hinterland of Salona (Katić 2018); it is a very different context than the one of Rab Island, but in some of them traces of various craft activities have been tentatively identified (Katić 2007; 2018).

Parallels have been sought in the western Adriatic as well, in particular in the Upper Adriatic and the Po valley area, where a series of sites identified as farms demonstrate layouts similar to that of the building under scrutiny (for example, San Pietro in Cariano and Boschi S. Anna in the Verona area) (Busana 2002 : 99–104), yet again these sites do not present additional structures in their environs which would indicate a similar spatial organization as the settlement in Podšilo bay.

The site in Podšilo shows a substantial difference when compared to most of the aforementioned eastern Adriatic ones, that is, the presence of confirmed production of ceramic building material, i.e. *tegulae* and imbrices (Lipovac Vrkljan and Šiljeg 2012). The productive sector of the site is located on the northern shore of the bay, at a certain distance from the core units of the settlement, a common practice detected elsewhere on rural sites (Vennarucci et al. 2018: 594–595) and which, along with the presence of at least two, although small kilns, might indicate that the production was carefully planned.

It can thus be supposed that production was not devoted solely to meeting the needs of the settlement, but that its output could have been marketed (Lipovac Vrkljan and Konestra 2018: 25). The poor preservation of the kilns and even more so of the area surrounding them, precludes an analysis of other workshop features, to the point of not being able to confirm their existence. The economic vocation of the rural settlement in Podšilo bay may also be indicated by the numerous fragments of iron slag, mainly concentrated in a few areas of the northern slope of the bay, which could suggest mixed production at the site (Vennarucci et al. 2018). Preliminary results of mass-spectrometry analysis of the iron ore samples, slag fragments and an iron object found in the Podšilo area, made in the laboratory of the Cardinal Stefan Wyszynski University in Warsaw, show significant similarities in their chemical composition, apparently confirming the acquisition of ore and the local production of iron objects in Roman times. Finally, finds of fishing net weights created by folded rectangular lead plates and probably used for cast nets (type PLIX2/Galili L23; Bernal Casasola 2010: 112–114; Galili et al. 2002: 184, 187–188, 197–198, Fig. 2;), along with finds of seashell, are indicative of the exploitation of marine resources, so far the only evidence of foodstuff procurement or production.

CONCLUDING REMARKS

The research has demonstrated a much more complex pattern of settlement of the island of Rab in Roman times than previously assumed. Different types of settlements, conveniently called villae (for terminological issues, see Habermehl 2013: 10–11), have been observed, among which the site in Podšilo bay (Lopar peninsula) stands out as typologically peculiar. Although preliminary, the results of the research in Podšilo bay give unique insight into the rural economy of the later Roman period in this region of the northeastern Adriatic. There is no doubt that the main and most important factor that sustained settlement in the bay was access to permanent fresh water. During the Roman period, at least two streams fed the bay area with fresh water, one of which is still active. Access to water enabled the development of local craft production, as evidenced by the two pottery kilns discovered to date. Traces of iron slag might indicate the presence of iron smelting/smithing furnaces, while outcrops of local ore delivered enough material to produce iron items for local needs. Suitable areas for agricultural activities, the latter still elusive in the archaeological record, could have occupied the terraces to the north and west of the bay, meeting the needs of at least the inhabitants. Nevertheless, the import of foodstuffs is attested by the numerous fragments of North African and Eastern Mediterranean amphorae. The use of imported limestone as building material on the site, in the architectural structures as well as later, reused in dry stone walls, indicates the existence of a quarry in the karst areas surrounding Lopar, either on mainland Rab or on the two small islands of St Grgur and Goli, located just off its northeastern coast.

The presence of imported materials, along with finds of fishing net weights and shells, could support the presence of docking or even more elaborate harbor facilities existing in the bay in antiquity.

The open questions presented here should be answered by the ongoing research. Geophysical surveys will focus on tracing other parts of the settlement, such as funerary areas, possible church building etc. The nature of individual structures will be established by excavation. Also, questions regarding production and economy will be tackled in order to better understand their possible correlations, while landscape reconstruction will give a better understanding of the environment in which the site was established and which today appears to be heavily modified. A more precise dating of the structures and of the last phases of occupation will contribute to a reconstruction of its development and in particular its decline, certainly linked to widespread political, economic and social changes that characterized late antiquity, among which environmental changes, including hydrological ones (Welc 2019), could have played an important role.

A comprehensive analysis of several Roman rural sites on the island, on the grounds of chronologically sensitive material and architectural features, will place the site in Podšilo bay within the settlement pattern of the island and allow it to be compared in consequence with other areas of the Adriatic.

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https://doi.org/10.5604/01.3001.0013.6898

References

Aspinall, A., Gaffney, C.F., and Schmidt, A. (2008). *Magnetometry for archaeologists*. Lanham, MD: AltaMira

Begović, V. and Schrunk, I. (2002). Rimske vile Istre i Dalmacije, I. dio: pregled lokaliteta (Roman villas in Istria and Dalmatia, part I: site overview). *Prilozi Instituta za arheologiju u Zagrebu*, 19, 113–130 (in Croatian)

Begović, V. and Schrunk, I. (2003). Rimske vile Istre i Dalmacije, II. dio: tipologija vila (Roman villas in Istria and Dalmatia, part II: typology of villas). *Prilozi Instituta za arheologiju u Zagrebu*, 20, 95–112 (in Croatian)

Bernal Casasola, D. (2010). Fishing tackle in Hispania: reflections, proposals and first results. In T. Bekker-Nielsen and D. Bernal Casasola (eds), *Ancient nets and fishing gear. Proceedings of the international workshop on "Nets and fishing gear in Classical Antiquity: a first approach", Cádiz, November 15–17, 2007* (pp. 83–137). Cádiz: Universidad de Cádiz, Servicio de Publicaciones

Borzić, I. and Jadrić, I. (2007). Novi prilozi arheološkoj topografiji dugopoljskoga kraja (New contributions to the archeological topography of the Dugopolje region). *Archaeologia Adriatica*, 1(1), 145–173 (in Croatian)

Busana, M.S. (2002). *Architetture rurali nella Venetia romana*. Rome: L'Erma di Bretschneider

Čaušević-Bully, M. and Bully, S. (2015). Archipel du Kvarner (Croatie). Prospection-inventaire des sites ecclésiaux et monastiques: campagne 2014. *Chronique des activités archéologiques de l'École française de Rome*. Retrieved from http://journals.openedition.org/cefr/1405 (accessed: 20.12.2019)

Cavalazzi, M. and Fabbri, E. (2015). Ceramiche da cucina di V-VII secolo dallo scavo del porto di Classe (RA). In E. Cirelli, F. Diosono, and H. Patterson (eds), *Le forme della crisi: produzioni ceramiche e commerci nell'Italia centrale tra Romani e Longobardi (III–VIII sec. d. C.). Atti del convegno, Spoleto-Campello sul Clitunno, 5–7 ottobre 2012* (pp. 21–28). Bologna: Ante Quem

Cavalazzi, M. and Ficara, M. (2015). Importazioni e cultura materiale in età tardoantica nell'*Ager Decimanus*. In E. Cirelli, F. Diosono, and H. Patterson (eds), *Le forme della crisi: produzioni ceramiche e commerci nell'Italia centrale tra Romani e Longobardi (III–VIII sec. d. C.). Atti del convegno, Spoleto-Campello sul Clitunno, 5–7 ottobre 2012* (pp. 53–61). Bologna: Ante Quem

Conyers, L.B. (2013). *Ground-penetrating radar for archaeology* (3rd ed.). Lanham: AltaMira Press

Conyers, L.B. (2016). *Ground-penetrating radar for geoarchaeology*. Hoboken, NJ: John Wiley & Sons

Faber, A. (1986–1987). Osvrt na neka utvrđenja otoka Krka od vremena prethistorije do antike i srednjeg vijeka (The strategic role of the islands of Krk from antiquity to the Middle Ages). *Prilozi Instituta za arheologiju u Zagrebu*, 3/4, 113–140 (in Croatian with English summary)

Fassbinder, J.W.E. (2005). Methodische Untersuchungen zur Magnetometerprospektion von Viereckschanzen. In P. Neumann-Eisele (ed.), *Viereckschanzen: rätselhafte Bauwerke der Kelten* (pp. 11–22). Kelheim: Archäologisches Museum

Fassbinder, J.W.E. (2015). Seeing beneath the farmland, steppe and desert soil: magnetic prospecting and soil magnetism. *Journal of Archaeological Science*, 56, 85–95

Gaffney, C. (2008). Detecting trends in the prediction of the buried past: a review of geophysical techniques in archaeology. *Archaeometry*, 50(2), 313–336

Galili, E., Rosen, B., and Sharvit, J. (2002). Fishing-gear sinkers recovered from an underwater wreckage site, off the Carmel coast, Israel. *The International Journal of Nautical Archaeology*, 31(2), 182–201

Habermehl, D. (2013). *Settling in a changing world: villa development in the northern provinces of the Roman empire*. Amsterdam: Amsterdam University Press

Jeličić-Radonić, J. (2001). Rimsko naselje u Ublima na Lastovu (Roman settlement at Ubli on Lastovo). In B. Čečuk (ed.), *Arheološka istraživanja na području otoka Korčule i Lastova: znanstveni skup Vela Luka i Korčula, 18.–20. travnja 1991* (pp. 197–220). Zagreb: Hrvatsko Arheološko Društvo (in Croatian with English summary)

Jurković, M., Brogiolo, G.P., Turković, T., Chavarria Arnau, A., and Marić, I. (2012). Kaštelina na otoku Rabu – od rimske vile do ranobizantske utvrde (Kaštelina on the island of Rab – from a Roman villa to a Byzantine fortress). In J. Andrić and R. Lončarić (eds), *Rapski zbornik* II (pp. 1–14). Rab: Ogranak Matice Hrvatske (in Croatian)

Katić, M. (2007). Zaštitna arheološka istraživanja na Jadranskoj autocesti (Protection excavations at the Adriatic Highway). In V. Kusin (ed.), *Dalmatinska zagora – nepoznata zemlja: Galerija Klovićevi Dvori, Zagreb, 4. rujna–21. listopada 2007* (pp. 619–621). Zagreb: Republika Hrvatska, Ministarstvo Kulture, Galerija Klovićevi Dvori (in Croatian)

Katić, M. (2018). Castella qui sunt super civitatem Salonitanam. *Vjesnik za arheologiju i historiju dalmatinsku*, 111(1), 245–279

Konestra, A., Šegvić, N., Androić Gračanin, P., and Starac, R. (2017). Arheološka topografija otoka Raba: geofizička, sondažna i topografska istraživanja u 2016. godini (Archaeological topography of the island of Rab: geophysics, trial excavations and topographic research in 2016). *Annales Instituti Archaeologici*, 13(1), 103–110 (in Croatian with English summary)

Konestra, A., Welc, F., Dugonjić, A., Androić Gračanin, P., Šegvić, N., and Rabiega, K. (2018). Terenski pregledi, geofizička i sondažna istraživanja projekta „Arheološka topografija otoka Raba" u 2017. godini (Field reconnaissance, geophysical survey and trial excavations within the project "Archaeological topography of the island of Rab" in 2017). *Annales Instituti Archaeologici*, 14(1), 121–126 (in Croatian with English summary)

Kovačić, M. (2013). Geothermal properties of the northern part of the island of Rab. *Geologia Croatica*, 66(1), 29–37

Lipovac Vrkljan, G. and Šiljeg, B. (2010). Lopar-Podšilo, archaeological rescue excavation of a Roman kiln in 2009. *Annales Instituti Archaeologici*, 6(1), 69–69

Lipovac Vrkljan, G. and Šiljeg, B. (2012). Prilog antičkoj topografiji otoka Raba – rimska keramičarska peć na Loparu (Contribution to the ancient topography of the island of Rab – Roman pottery kiln on Lopar). *Senjski zbornik*, 39(1), 5–33 (in Croatian)

Lipovac Vrkljan, G. and Konestra, A. (2015). Project "Archaeological topography of the island of Rab" – results of field survey in the City of Rab area in 2014 and

exhibition "Archaeological topography: a journey through the history of Lopar." *Annales Instituti Archaeologici*, 11(1), 132–132

Lipovac Vrkljan, G. and Konestra, A. (2018). Approaching the Roman economy of province Dalmatia through pottery production – the Liburnia case study. In G. Lipovac Vrkljan and A. Konestra (eds), *Pottery production, landscape and economy of Roman Dalmatia: interdisciplinary approaches* (pp. 14–36). Oxford: Archaeopress

Lipovac Vrkljan, G., Konestra, A., and Šegvić, N. (2017). Felix Arba – reconstructing urban and rural economic capacities through GIS. In A. Plosnić Škarić (ed.), *Mapping urban changes* (pp. 314–335). Zagreb: Institute of Art History

Mamužić, P. and Milan, A. (1973). *Osnovna geološka karta SFRJ 1:100000. Tumač za list Rab L33–144*. Zagreb–Beograd: Institut za geološka istraživanja, Savezni geološki zavod

Marjanac, T. and Marjanac, L. (1991). Pleistocene glacial and periglacial deposits on Middle Adriatic coast. In *Abstracts IAS 12th Regional Meeting, Bergen*

Marjanac, T. and Marjanac, L. (2007). Sequence stratigraphy of Eocene incised valley clastics and associated sediments, island of Rab, northern Adriatic Sea, Croatia. *Facies*, 53(4), 493–508

Matijašić, R. (1998). *Gospodarstvo antičke Istre: arheološki ostaci kao izvori za poznavanje društveno-gospodarskih odnosa u Istri u antici, I. st. pr. Kr. – III. st. posl. Kr.* (The economy of Roman Istria: archaeological remains as sources for the socio-economic relations in Istria in antiquity, 1st century BC – 3rd century AD). Pula: Žakan Juri (in Croatian)

Muldini-Mamužić, S. (1961). Mikrofaunističko istraživanje eocenskog fliša otoka Raba (Microfaunal study of the Eocene flysch of the island of Rab). *Geološki vjesnik*, 15(1), 143–159 (in Croatian)

Ožanić Roguljić, I., Miloglav, I., and Tončinić, D. (2018). Archaeological excavations of the Banjače site. *Opuscula Archaeologica*, 39/40(1), 135–149

Rizner, M. (2012). Arheološka topografija otoka Raba (Archaeological topography of the island of Rab). In J. Andrić and R. Lončarić (eds), *Rapski zbornik* II (pp. 37–42). Rab: Ogranak Matice Hrvatske (in Croatian)

Šiljeg, B. (2008). Arheološko istraživanje lokaliteta Mala luka i Baška na Krku 2007 (Archaeological exploration of the Mala Luka and Baška sites on the island of Krk in 2007). *Annales Instituti Archaeologici*, 4(1), 84–87 (in Croatian)

Skelac, G. and Radić Rossi, I. (2006). Lokalitet: Punta Zidine. *Hrvatski arheološki godišnjak*, 2/2005, 272–274 (in Croatian with English summary)

Starac, A. (2000). *Rimsko vladanje u histriji i liburniji: društveno i pravno uređenje prema literarnoj, natpisnoj i arheološkoj građi* II. *Liburnija* (Roman rule in Istria and Liburnia: Social and legal regulation according to literary, epigraphic and archaeological material II. Liburnia). Pula: Arheološki muzej Istre (in Croatian)

Suić, M. (2003). *Antički grad na istočnom jadranu* (An ancient city in the eastern Adriatic) (2nd ed.). Zagreb: Goldrn Marketing (in Croatian)

Terzić, J., Peh, Z., and Marković, T. (2010). Hydrochemical properties of transition zone between fresh groundwater and seawater in karst environment of the Adriatic

islands, Croatia. *Environmental Earth Sciences*, 59(8), 1629–1642

Tomičić, Ž. (1986–1987). Novija ranosrednjovjekovna istraživanja Odjela za arheologiju (New investigations of early mediaeval sites conducted by the Department of Archaeology). *Prilozi Instituta za arheologiju u Zagrebu*, 3/4, 141–174 (in Croatian)

Vennarucci, R.G., Van Oyen, A., and Tol, G. (2018). Una comunità artigianale nella Toscana rurale: il sito di Marzuolo. In V. Nizzo and A. Pizzo (eds), *Antico e non antico: scritti multidisciplinari offerti a Giuseppe Pucci* (pp. 589–597). Milan–Udine: Mimesis

Welc, F. (2018). Geoarchaeology of pottery workshop sites in Roman Dalmatia. In G. Lipovac Vrkljan and A. Konestra (eds), *Pottery production, landscape and economy of Roman Dalmatia: interdisciplinary approaches* (pp. 62–70). Oxford: Archaeopress

Welc, F. (2019). Geoarchaeological evidence of late and post-antiquity (5th–9th c. AD) climate changes recorded at the Roman site in Plemići Bay (Zadar region, Croatia). *Studia Quaternaria*, 36(1), 3–17

Welc, F., Mieszkowski, R., Lipovac Vrkljan, G., and Konestra, A. (2017). An attempt to integration of different geophysical methods (magnetic, GPR and ERT); a case study from the late Roman settlement on the island of Rab in Croatia. *Studia Quaternaria*, 34(1), 47–59