



HAL
open science

The Long-distance Trade of Iron in the Early Roman Empire: the Case Study of Gallia Narbonensis. An Updated Synthesis

Long Luc, Christian Rico

► **To cite this version:**

Long Luc, Christian Rico. The Long-distance Trade of Iron in the Early Roman Empire: the Case Study of Gallia Narbonensis. An Updated Synthesis. 19th International Congress of Classical Archaeology, Martin Bentz and Michael Heinzelmann, May 2018, Bonn-Cologne, Germany. pp.159-172, 10.11588/propylaeum.896.c11653 . hal-02053596

HAL Id: hal-02053596

<https://univ-tlse2.hal.science/hal-02053596v1>

Submitted on 17 Jan 2025

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License

Archaeology and Economy in the Ancient World



25

Ancient Mining Landscapes

Panel 4.2

Frank Hulek
Sophia Nomicos (Eds.)

**Proceedings of the
19th International Congress of Classical Archaeology**

Cologne/Bonn, 22 – 26 May 2018

Archaeology and Economy in the Ancient World

Edited by

Martin Bentz and Michael Heinzelmann

Volume 25



CONTENTS

Frank Hulek – Sophia Nomicos Ancient Mining Landscapes: The Example of Laurion	1
Effie Photos-Jones – George E. Christidis Solfataric Alum Exploitation during the Greco-Roman Period: Some Considerations on its Nature, Enrichment, and Preparation for Market	19
Raphael A. Eser – Fabian Becker New Insights into an Old Iron Mining Landscape: Elba Island	35
Michael Bode – Norbert Hanel Roman Brass Ingots from a Shipwreck near Aléria/Corsica – New Evidence on Brass Production in Gallia Lugdunensis	55
Nerantzis Nerantzis – Sabine Nodin – Stratis Papadopoulos The Organization of Mining and Metal Production in Aegean Thrace from the Archaic to the Roman Period	65
Eva Steigberger – René Ployer Noricum – Economic Factors in the Alps	85
David Quixal Santos Minería y metalurgia en el Este de la Península Ibérica durante los siglos IV–I a. C.: el caso concreto del territorio ibérico de Kelin	97
Linda R. Gosner Subsidiary Industries and Cross-Craft Production in the Roman Mining Landscapes of Southwest Iberia	113
Regula Wahl-Clerici Considerations on the Profitability of Roman Gold Mining in the Northwest of the Iberian Peninsula during the 1 st and 2 nd Centuries AD	129
Alfred M. Hirt Mining and Territory at Carthago Nova	149
Luc Long – Christian Rico The Long-distance Trade of Iron in the Early Roman Empire: the Case Study of Gallia Narbonensis. An Updated Synthesis	159

The Long-distance Trade of Iron in the Early Roman Empire: the Case Study of Gallia Narbonensis. An Updated Synthesis

Luc Long – Christian Rico

Since iron is the most common metal on Earth, it has been the most used all throughout history, and accompanied the development of ancient human societies from the moment they controlled its metallurgy.¹ Among non-precious metals, iron was traded over long distances by sea. However, it was poorly studied for a long time. As fig. 1 shows, there are very few spots where iron ingots have been documented or reported for the Roman period. Many of these are isolated finds, out of context, and for a long time we lacked complete iron in ship cargoes. Do single and isolated finds of iron bars only reveal a local trade, from port to port? As iron could be produced at least everywhere, it seems obvious that the market's supply depended firstly on local or regional resources. Actually, this idea is not completely satisfactory. We must also take into account the minimal interest that divers and archaeologists paid for a long time to such a rough material, which is poorly preserved over long periods underwater. It is also possible that iron loads have been neglected during many underwater explorations and

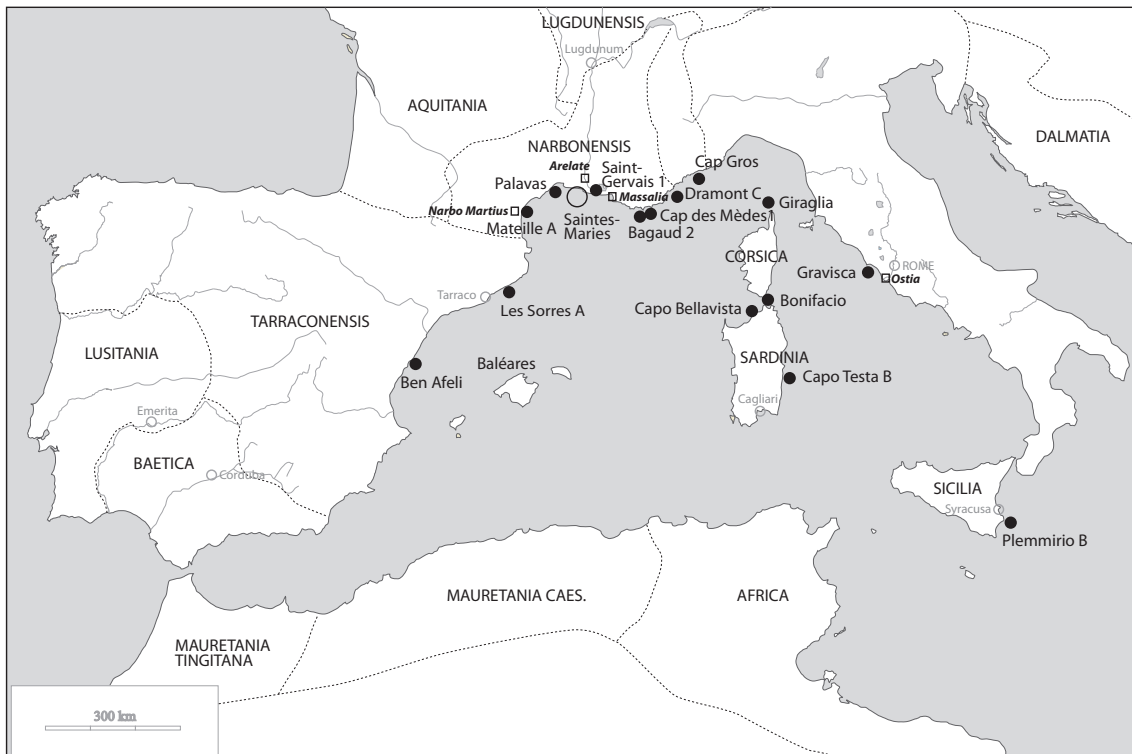


Fig. 1: Iron bar finds in the Western Mediterranean until the Saintes-Maries finds.

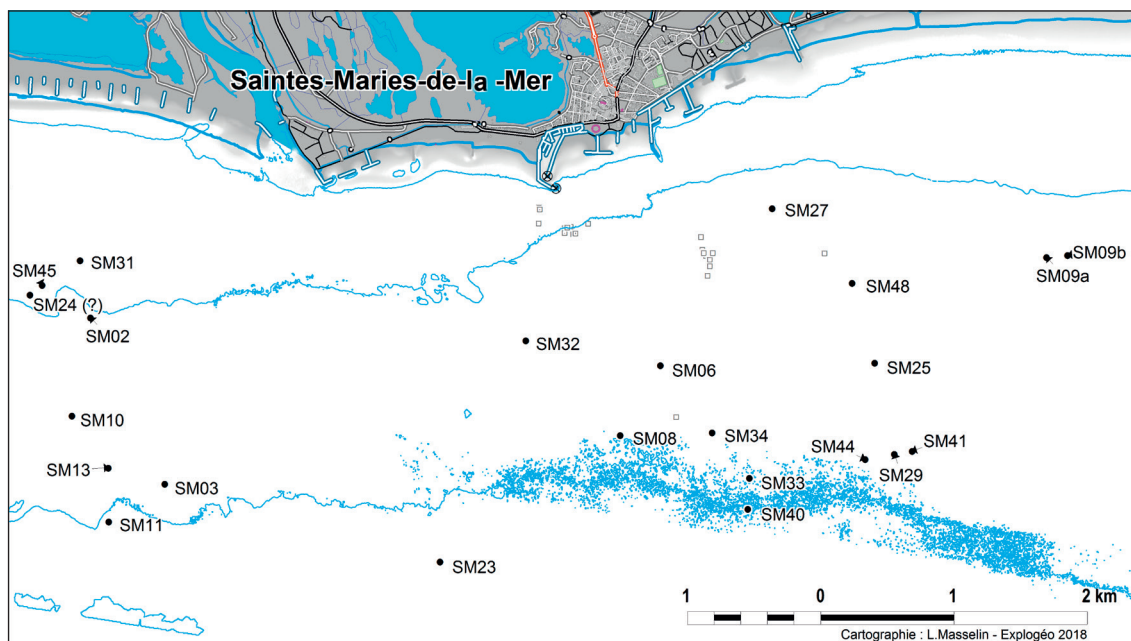


Fig. 2: Map of the iron-loaded shipwrecks off Les Saintes-Maries-de-la-Mer.

never been reported. We can also suppose that because of the physical characteristics of iron, part of the material may have partly or totally disappeared.

Since the end of the 1980s, archaeological surveys off Saintes-Maries-de-la-Mer in Southern France, off the mouth of the river Rhône (fig. 2), have totally changed our perception of the Roman maritime trade in iron. In what properly looks like a maritime cemetery, with more than a hundred wrecks identified from several historical periods, no less than twenty-three of these appear to be partly or completely loaded with iron bars (table 1). Conscious of the importance and interest, as well as the originality of the first discoveries, the French ministry of Culture gave support to Luc Long, from the Department of Underwater Archaeology of the same Ministry, to carry out systematic surveys of the zone. His aim was to locate and identify new shipwrecks to obtain chronological elements and, more generally, to produce original data that could help us to better know the importance of the sites, the composition of the cargoes, and their origin.

The aim of this paper is to present an updated synthesis of how we can currently reconstruct the Roman maritime trade of iron, mainly from the discoveries at Les Saintes-Maries-de-la-Mer.

Wreck	Year of discovering	Typology of iron bars	Chronology
SM 2	1991	Types 1L and 4C	1 st quarter of I st c. CE (amphorae Haltern 70 and Dr. 2–4 from Tarraconensis)
SM 3	1992	Types 1L et 2M	0–60 d.C. (Terra sigillata Drag. 15a)
SM 6	1995	Types 1L, 2M, 3, 4C, 5 and 6	2 nd half of I st c. BCE (Campanian black-ware Morel 2270)
SM 8	1995	Type 2M	1 st half of I st c. CE (amphora Dr. 7–11)
SM 9	1989	Types 1L, 2M, 3 and 4C	1 st quarter of I st c. CE (same stamps IVL // EROTIS reported in SM 2)
SM 10	1996	Types 1L and 4C	No data
SM 11	1996		No data
SM 23	2003	Type 2	No data
SM 24	1998	Types 1L, 2M and 4L	Mid I st c. CE terra sigillata Drag. 29b (between 40 and 90 CE)
SM25	2003	Type 2M	No data
SM27	2005	Bars and iron nails in buckets	No data
SM29	2015	Types 2M and 3M	Italic terra sigillata Goudineau 32b (<i>Conspectus SIG-IT</i> 31.1), from last years of I st BCE and 30
SM31	2015	Type 7L	Pascual 1 or Dressel 2/4 from Tarraconensis, I st s. c CE
SM32	2015	Types 2M, 5LM	Fragments of Dressel 2/4 and Dressel 20, I st s.c. CE
SM33	2016	Type 2M	No data
SM34	2018	Types 1M and 4C	No data
SM40	2016	Type 2M	No data
SM41	2015	Type 8C	Pascual 1 amphora handle, Italic terra sigillata, from 30 BCE to 50 CE
SM42	2016	Rough iron blooms and rare type 1M and 2M bars	No data
SM44	2018	Type 2M	No data
SM45	2018	No data	Not studied at the moment
SM48	2018	Type 4C	Not studied at the moment

Table 1: The different wrecks with iron freight from Les Saintes-Maries.

The Shipwrecks, the Iron Cargoes, and Their Chronology

Twenty-three shipwrecks loaded with iron bars are listed (table 1) at the little watering-place at a depth of 12/18 meters (fig. 2). Part of them have yet been published, as Saintes-Maries (or SM) 2, 3, 6, 8, 9 and 10.² Others, discovered in the last ten years, have only been presented briefly and their study is still in progress (SM11, 13, 23, 24, 25, 27, 29, 31, 32, 33, 34, 40, 41, 42, 44, 45, 48).³ Accordingly, information is unequal. None of the shipwrecks have been completely excavated. They can be easily identified by sometimes large and massive blocks of iron bars brought together by corrosion and often dislocated in several pieces by the nets of the fishermen. Very little is known about the ships themselves, their capacities and the additional freight they could possibly have carried along with the iron bars. Among them, the better known are SM2, SM9 and SM10 that seem quite different. Finds from SM10 suggest a relatively small ship, not more than 9–10 meters long, with a load of 5–6 tons of iron. In front of it, SM9 and SM10 are bigger and heavier ships. SM2 is supposed to be 15–18 m long, for a load of about 20 to 50 tons of iron. The cargo consisted also of 40 Spanish amphorae, principally Dr. 2–4 type. SM9 is more impressive, measuring approximately 18 meters long, and with its freight estimated at no less than 100 tons of iron. In a few of them, like SM2, archaeological explorations have revealed other goods, like amphorae, which are of interest in order to date the wreck. In others, the existence of some materials or artefacts close to the corroded blocks of bars are helpful to define their chronology (see, for instance, in table 1, SM3 and SM6). For all the others, the similarity of the composition of the iron freights in each of them argues for the assumption that they are all Roman ships. Therefore, they probably belong to the same historical period, from the mid-1st century BC to middle or end of the 1st century AD. As we shall see, many bars bear stamps and some of these are found in multiple vessels, which indisputably reinforces the proposed chronology.

The Iron Bars: Typology and Epigraphy

In most of the wrecks, fragments of the cargoes were removed from water. With the support of a crane, one or several blocks, of more or less importance, were withdrawn from the sea, so that a large number of pieces could be studied in detail. Indeed, the dismantling of the blocks showed that the larger blocks were composed of hundreds of bars, and the smaller ones made up of tens of blocks. They were usually well-preserved, and belonged to different types.

The current typology was published for the first time in 1997,⁴ then completed in 2006.⁵ It is an open typology, as some subtypes of the six main groups identified are not yet archaeologically attested. The main forms were defined by measuring the section of the bars and the ratios between their width and thickness. For each of the six groups, we have defined three subtypes according to the length of the bars (table 2). “C” stands

Form	Designation	Dimensions width × thickn. (in cm)	Weight	Wreck
1	Flat and rectilinear bar	$4 \pm 1,3 \times 2 \pm 0,5$		
1C	short			<i>Ben-Afeli ? Cap Gros ?</i>
1M	medium	Long. 54–61	2,5–4,2 kg	<i>SM3 SM9</i>
1L	long	Long. 74–138,5	3,9–11,7 kg	<i>SM2 SM9 SM10 SM24 Capo Testa B?</i>
2	Thin bar, square section	$3,5 \pm 0,5 \times 2,5 \pm 0,5$		
2C	short			–
2M	medium	Long. 40–71	1,5–5 kg	<i>SM6 SM8 SM9 SM23 SM25 SM27 Bagaud 2? St-Gervais 1</i>
2L	long			<i>Ben-Afeli</i>
3	Thin and heavy bar	$4 \pm 0,5 \times 3,5 \pm 0,5$		
3C	short	Long. 30–38		<i>SM6 SM8</i>
3M	medium			–
3L	long	Long. 85		<i>SM24</i>
4	Massive bar, square section	$6 \pm 1,8 \times 5 \pm 1,5$		
4C	short	Long. 20,8–29,9	2–7 kg	<i>Capo Bellavista? Bagaud 2 SM2 SM6 SM9 SM10 SM24</i>
4M	medium			–
4L	long	Long. 76–191	22–33 kg	<i>SM24</i>
5	Short bar	Close to form 3 $5 \pm 0,5 \times 3,5$		
5C	short	Long. 26–31	2,9–3 kg	<i>SM6 Bonifacio</i>
5M	medium			–
5L	long			–
6	Flat plate with rounded ends	$10 \pm 0,5 \times 3,7 \pm 0,7$		
6C	short	Long. 27–33	4,4–8,2 kg	<i>SM6, Mateille A</i>
6M	medium			–
6L	long			–
7	Long and very fine bar	$149 \times 1,3–1,4$ (section)		<i>SM31</i>
8	Short and round flat plate	$11/12$ (diameter) × $4,2/4,4$ (thickness)	1,7–2,8 kg	<i>SM41</i>

Table 2: Iron bar typology.

for “courte” (“short” in French), which pertains to bars no longer than 40 cm. “M” stands for “medium” bars, between 40 and 75 cm. “L” stands for “long”, with a length ranging from 75 cm and onwards. Since the publication of the typology, the new finds off the mouth of the Rhône river have afforded some new data to complete it; two new types were identified. Table 2 presents an updated synthesis of the typology (see also fig. 3).

Among all these forms, 1L, 2M, and 4C forms are the most commonly documented at present. Despite their differences, all are standardized and normalized artefacts and we can assume that such a normalization was imposed by the market. Surely the general form, long or short massive bars, was suitable either for transport or storage. Nevertheless, it seems obvious that the different forms responded to different uses by the blacksmiths, who had to transform the bars at the end stage into manufactured artefacts. It is of course difficult to assign one or several precise and specific destinations to each of the different forms and subtypes (e.g. 4L bars for heavy and massive objects, like anchors, or flat 1L bars for chariot wheel tires). Smaller bars were convenient for a large number of artefacts, weapons, tools, and all sorts of everyday objects. The market, and surely the traders, seemed to have had a certain influence over the work of the metallurgists. But we don't know much about the whole organization of it, as we completely lack original textual data. Indeed, although the iron bars from Saintes-Maries revealed a rich epigraphic corpus, none of the documented marks can be assigned to the specific commercial steps of iron's “chaîne opératoire”.

Among the Saintes-Maries shipwrecks, SM2, 3, 6, 9, 10, 24, 33, 40 and 41 have afforded stamped bars; the number of stamps roughly depends on the size of the corroded blocks removed from the sea. Until then, we had very little information on the epigraphy of iron bars. Only three stamps were documented: FERRO in Ben Afeli (Northwestern Spain), HAEDVI in Palavas (France), and SATVRNINI in Bonifacio (Corsica). We now have no less than 21 stamps or groups of stamps, and, as we shall see, many bars bear combinations of two, three and even four stamps (see table 3). The corrosion and the smallness of the stamps do not always make it easy to read the inscriptions they contain. Some of them remain totally illegible. The marks are of two types: small rectangular stamps 20/30 mm long and 5/7 mm wide; circular stamps of no more than 9/10 mm diameter. The latter appear systematically associated with rectangular stamps. Both types are in negative and have inscriptions in relief. They were made by a matrix that was surely stamped at the end of the shaping process in the same workshops. Thus, we can relate these marks with the production stage of the metal. In the same series, stamps or groups of stamps are located in the same position, either on one or the other side of the bar, or in the central part of it. The regularity of these markings, and the care given to their making, reinforce the production-stage interpretation of the stamps. At the moment we do not have any archaeological evidence that iron blooms were transported directly from the metallurgical centres where they were produced to secondary workshops to be transformed into ingots. Thus, we can closely connect the stamps to the smelting sites.

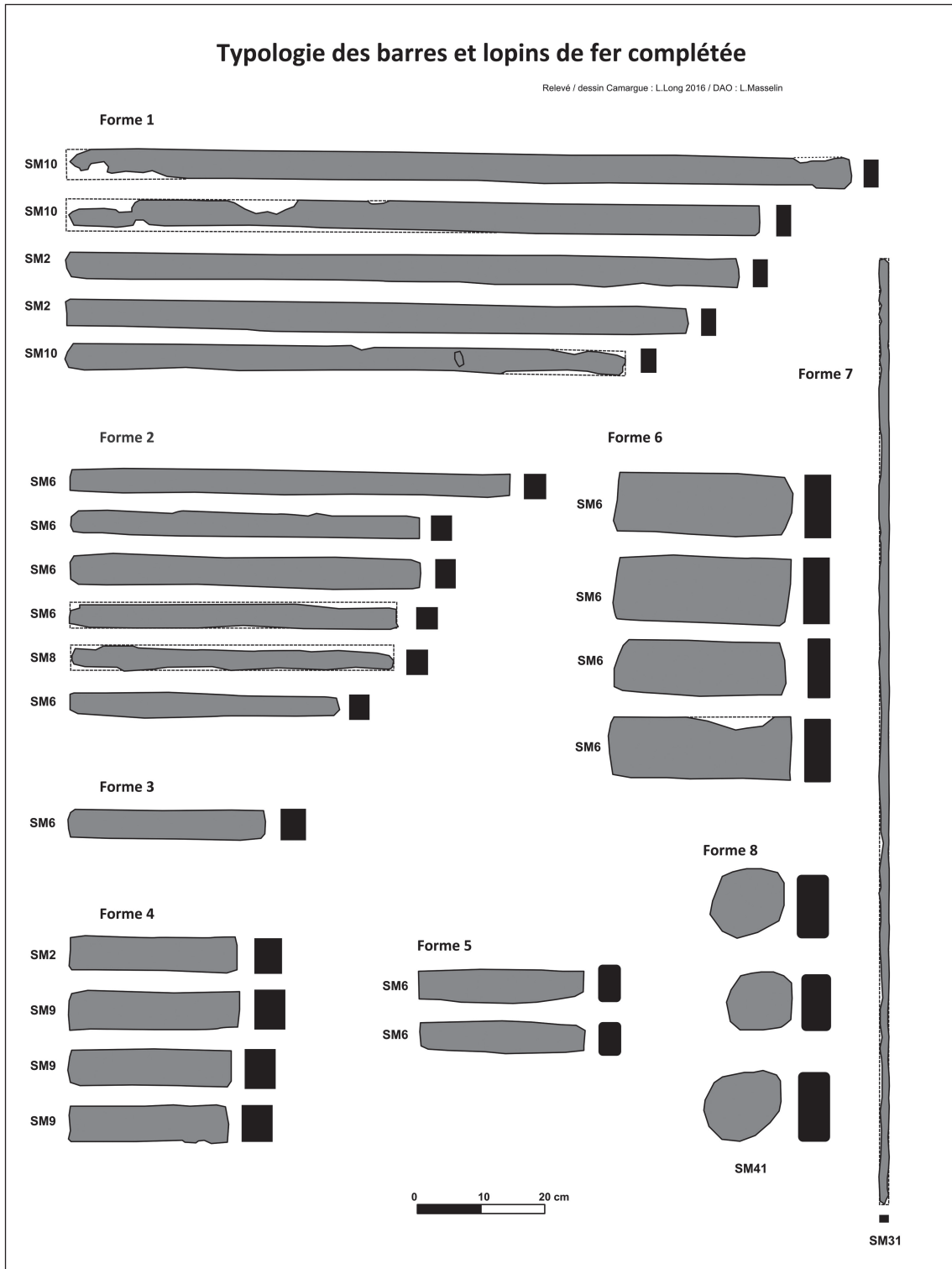


Fig. 3: Typology of the Saintes-Maries iron bars (completed 2016).












Combination	Stamp	Form	Location	Wreck
1 	C. RVTILI CAVLI (?) I[---]CI ; CAECI ; T. COR ; T. AFRAN GALLICVM LICIN PORC{...} ?	2M 4C 4C	right side central	SM 6 SM 9 SM 9 SM 33 & 40 SM 40
2 	[---] // [.]AT[2M	central	SM 6
3 	[---]MI // [---]MI	2M	central	SM 9
4 	FAL (?) // CAECI	4C	central	SM 9
5 	CAECI // H MARI // S	4C 1 or 2	central	SM 9 SM 3
6 	<i>(unidentified stamps)</i>	2M	central or one or another side	SM 9
7a 	MAXIMI // MAXIMI // [---]	1L	central	SM 10
7b 	Q CATO // Q CATO // TEREN	1L	central	SM 10
8 	FVLVIOR // FVLVIOR MANI ? // [MANI ?] <i>(unidentified stamps)</i>	4C 4L 3L	central both sides central	SM 10 SM 24 SM 24
9 	IVL // EROTIS (twice repeated) <i>(unidentified stamps)</i>	1L - 4C 4C 4L	left side one or another side	SM 2 SM 9 SM 24
10 	S // LEPIDI // N <i>(ancora)</i>	4C	left side right side	SM 2

Table 3: Stamps and combinations of stamps documented on iron bars from the Saintes-Maries-de-la-Mer.

They give personal names, often abbreviated, usually in the genitive, as C. RVTILLI, CAECI, FVLVIOR(um), MARI, LEPIDI, MAXIMI. Sometimes, combinations of stamps give the complete name of an individual, as Q. CATO // TEREN for *Q(uintus) Teren(tius) Cato*, or IVL // EROTIS for *Iul(ii) Erotis*. Circular stamps generally bear a single letter, as H (in the group CAECI // H), S (group MARI // S), and S and N in the association S // LEPIDI // N. The meaning of them is uncertain, but we can suppose they are the initials of names, *nomina gentilicia* or *cognomina*. For instance, concerning the group S // LEPIDI // N, one of the two single letters could be a *praenomen* (Sextus or Numerius), with the other as the initial of the *nomen*. In any case, all these stamps, either rectangular or circular, were made at the same moment, and refer to the same person. What has not been explained to a satisfactory degree is the meaning of the different combinations of stamps. At the moment, ten of these are documented (see table 3). The fact that some of these combinations are used by several producers, as occurs on SM 5 and 8, could be interpreted as evidence that they worked in the same mining area. But it cannot be decreed as a rule. For instance, as analytics showed, stamps of Lepidus and Iulius Eros were reported in the same wreck (SM9); their workshops were in the same area, in the Montagne Noire in Narbonne's hinterland. However, each of them adopted a different combination of stamps to individualize their own products.

***Ferrum Gallicum*. About the Provenance of the Saintes-Maries Iron Bars**

GALLICVM. This is the very latest, and important, find in Les Saintes-Maries, which occurred during the archaeological campaign carried out in summer 2018. This campaign focused on two wrecks, SM33 and SM40, both known since 2016. Both wrecks gave then 2M type bars bearing stamps, and one mentioned a possible [LI]CIN(ius).PORC[---]. The new survey produced two fragments of iron bar marked with this original stamp, repeated twice on each of them, and containing an adjective neuter instead of a personal name (fig. 4a–b). GALLICVM could not be interpreted in any other way than to mean (*ferrum*) *Gallicum*. Such an appellation is completely original for iron. On the other hand, it is documented for Roman lead, and especially for German lead, on ingots with moulded marks mentioning GERMANICVM (Rena Maiore), PLVMB(um) GER(manicum)/GERM(anicum) (SM1, Fos-sur-Mer), or (*plumbum*) GER(manicum)/GERM(anicum) (Tongeren, Île-Rousse, Fos).⁶ As the stamp is only documented in a fragment of bar at SM40, it is not possible to link it to the producer known by the fragmentary stamp [LI]CIN PORC[---]. If both stamps could be associated, we can imagine that it was the way for the workshop to certify the real origin of the metal. The stamp GALLICVM would appear to be a label of quality destined for the traders rather than for the consumers (i.e. black-smiths). Was this label necessary for the producer to distinguish its products from iron from others places (i.e. non-Gallic places), in the context of tough competition between iron from different mining areas? Surely it is too early to assert

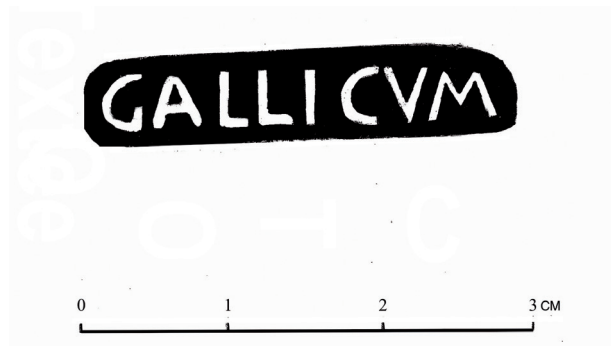


Fig. 4: a-b: Stamp GALLICVM (SM40).

this, as our knowledge on global iron trade in Roman times is limited at present. We especially lack information about which areas had enough resources to support a long-distance maritime trade in iron, and could have played a singular role in it, as we have for other metals. At the same time, data are scarce about the archaeological contexts of most of the shipwrecks from Les Saintes-Maries. We lack information about the possible freight that completed the iron cargoes and very few of them had additional artefacts. These could indicate a possible origin of the wrecked ships which could be, in some cases, the same as the iron's origin. A helpful alternative exists with the geochemical tools developed in the last three decades to trace ancient ferrous materials. They have been tested with success since the beginnings of the century on several iron bars from Les Saintes-Maries.

Among elemental analyses on slag inclusions, the most common geochemical method currently used is to establish the chemical signature of ancient iron;⁷ as part of this, trace element analyses provided the best results for some of the iron cargoes of Les Saintes-Maries. Recently, another but less-destructive method, based on iron isotopes, was tested on some of the same bars analysed by the trace element method.⁸ Indeed Fe isotopes provide a more constrained signature than trace elements because of the negligible contamination of the smelting device during iron ore reduction. This method not only confirmed the results obtained by trace element analyses but also gave new and more certain information about the provenance of some bars that the first method failed to establish concretely.⁹

Thirteen bars were analysed in 2001 and 2009 from 4 shipwrecks, (SM2, SM6, SM9 and SM10), the chronology of which falls between the mid-1st century BC and the mid-1st century AD. Trace element analyses revealed three main groups, each with homogeneous chemical signatures. The first is composed by form 2C bars, none of them marked; the second, long bars of 1L type and 4C bars all bearing the stamps IVL // EROTIS. The third group corresponds to 4C ingots stamped with S // LEPIDI // N. A fourth group seems to be distinguished, but the chemical signature is more heterogeneous. A single bar, of 1L type, does not fit with one or another of the previous groups. The respective chemical signatures of these groups were compared with those established for some ancient ferrous mining districts. The 2nd and 3rd group present a signature that perfectly matches with the composition range of the ore established for the Montagne Noire, close to Narbonne. This was one of the Gauls' main iron mining districts in Roman times, active from the second quarter of the 1st century BC to mid-3rd century AD, with an iron production estimated at no less than 100,000 tons.¹⁰ Furthermore, iron isotope analyses confirm these results, and they suggest the same origin for the bars of the 4th group, for which trace element analyses did not indicate a definite provenance. On the other hand, both the trace element and iron isotopes analyses coincided in setting apart group 1 (2M type bars), which has chemical signatures different from those of the Montagne Noire. In short, geochemical analyses show that the iron submerged off Les Saintes-Maries comes from at least two different areas. One is the huge iron district of

the Montagne Noire; analyses of this material have allowed us to link two producers (Iulius Eros and Lepidus), known by the stamps they use to mark their products. The other district is still to be archaeologically identified. And the way to do this will be by increasing the number of analyses on archaeological devices (ore, slag) from other mining areas not only in Southern Gaul but anywhere. These other analyses must come from places with enough resources to have played a role in a long-distance trade. In addition to these studies, there needs to be an increase in trace element and Fe isotope analyses on the iron bars from Les Saintes-Maries. The main objective is to complete the current database chemical signatures and to finally identify the main sources of the Roman maritime trade in iron.

In Conclusion

Surely, twenty years after the first finds off Les Saintes-Maries-de-la-Mer, we are still at the very beginnings of the research and far from proposing a precise view of the Roman maritime trade in iron. But much progress has been made from the archaeological and the archaeometrical point of view. The Saintes-Maries-de-la-Mer finds confirm the existence of an organized maritime trade of iron as exists for others metals. Part of this trade was surely based in one of the main commercial harbour of Southern Gaul, *Narbo Martius* (Narbonne), where the production, or at least part of the production of the workshops located in the Montagne Noire converged. Now we need to specify whether or not iron from other contemporary mining areas close to Narbonne (like those of the Corbières and the Eastern Pyrenees) used Narbo's facilities for their export. But we also need to do the same for more distant iron mining areas, like the ones documented in Central Gaul, which could have exported at least part of their production to the Mediterranean. The aim is to reconstruct the different networks that existed to supply the Roman Mediterranean market with iron.

What was the final destination of the iron submerged off Les Saintes-Maries? The location of the wrecked ships suggests that if not all, at least part of them sank when trying to engage themselves in the river Rhône, or when unloading their iron cargoes onto fluvial crafts. Surely, this iron would have normally reached important cities towards the Rhône valley, like Arles (*Arelate*) and Lyon (*Lugdunum*), from where part of the metal could have been redistributed to other places. Was one of these places the military market of the Northern provinces? We cannot exclude it, as the Roman *gladius* found on SM9 could indicate the presence of a Roman official in charge of iron bars destined for the army.¹¹

More generally, this is one of the great stakes for future investigations, that of the markets for the iron produced in distant and specialized mining areas and, at the same time, the whole organization of its trade.

Notes

- ¹ Mangin dir. 2003.
² Long 1997; Long et al. 2002.
³ Long – Duperron 2015; 2016.
⁴ Long 1997, 84.
⁵ Coustures et al. 2006.
⁶ Raepsaet-Charlier 2011, 187–191.
⁷ Coustures et al. 2006; Baron and Coustures 2011.
⁸ Milot 2016.
⁹ Coustures et al. 2006; Baron – Coustures 2011; Coustures et al. 2016; Milot et al. 2016.
¹⁰ Fabre et al. 2016.
¹¹ Long et al. 2002, 175.

Image Credits

Fig. 1: C. Rico. – Fig. 2: L. Long and L. Masselin. – Fig. 3: © Luc Long. – Fig. 4a–b: © Luc Long. – Table 1–3: L. Long and C. Rico.

References

Baron – Coustures 2011

S. Baron – M.-P. Coustures, Lingots de plomb et barres de fer des épaves romaines des Saintes-Maries-de-la-Mer (Bouches-du-Rhône, France): Questions de traçabilité comparée, *RAN* 44, 2011, 71–98.

Coustures et al. 2006

M.-P. Coustures – Chr. Rico – D. Béziat – D. Djaoui – L. Long – C. Domergue – F. Tollon, La provenance des barres de fer romaines des Saintes-Maries-de-la-Mer. Étude archéologique et archéométrique, *Gallia* 63, 2006, 243–261.

Coustures et al. 2016

M.-P. Coustures – D. Béziat – Chr. Rico, Le fer de la Montagne Noire: derniers résultats des études de traçabilité, in: Fabre et al., 2016, 369–385.

Fabre et al. 2016

J.-M. Fabre – Cl. Domergue – Fr. Dabosi (eds.), Le fer romain de la Montagne Noire. *Martys* 2: les débuts. 25 années de recherches pluridisciplinaires (1988–2013), *RAN Suppl.* 43 (Montpellier 2016).

Long 1997

L. Long, Inventaire des épaves de Camargue, de l’Espiguette au Grand Rhône, Des cargaisons de fer antiques aux gisements du XIX^{ème} siècle. Leur contribution à l’étude du paléorivage, in: Actes du colloque Crau, Alpilles, Camargue, Histoire et Archéologie, Groupe archéologique arlésien (Arles 1997) 59–115.

Long – Duperron 2015

L. Long – G. Duperron, Nouvelles données sur le commerce maritime à l’embouchure du Rhône de Saint-Ferréol (Saintes-Maries-de-la-Mer, B.-d-R.), du VI^e au I^{er} s. av. J.-C., in: F. Olmer – R. Roure (eds.), Les Gaulois au fil de l’eau. Actes du colloque de l’AFEAF de Montpellier (8–11 mai 2013), Ausonius Mémoires 39 (Bordeaux 2015) 905–924.

Long – Duperron 2016

L. Long – G. Duperron, Navigation et commerce dans le delta du Rhône durant l’Antiquité: bilan des recherches sur le port fluvial d’Arles et ses avant-ports maritimes, in: C. Sanchez – M.-P. Jézégou (eds.), Les ports dans l’espace méditerranéen antique, Actes du colloque de Montpellier, 22–24 mai 2014, RAN Suppl. 44 (Montpellier 2016) 193–199.

Long et al. 2002

L. Long – Chr. Rico – Cl. Domergue, Les épaves antiques de Camargue et le commerce maritime du fer en Méditerranée nord-occidentale (I^{er} siècle avant J.-C. – I^{er} siècle après J.-C.), in: M. Khanoussi – P. Ruggeri – C. Vizmara (eds.), L’Africa romana. Lo spazio marittimo del Mediterraneo occidentale: geografia storica ed economia. Atti del XIV convegno di studi, Sassari, 7–10 dicembre 2000 (Rome 2002) 161–188.

Mangin 2003

M. Mangin (ed.), Le fer, collection “Archéologiques”, éditions Errance (Paris 2003).

Milot 2016

J. Milot, Utilisation des isotopes du fer pour le traçage des métaux anciens: développement méthodologique et applications archéologiques (Ph.D. Diss., University of Toulouse 3-Paul Sabatier 2016).

Milot et al. 2016

J. Milot – Fr. Poitrasson – S. Baron – M.-P. Coustures, Iron isotopes as a potential tool for ancient iron metals tracing, JASc 76, 2016, 9–20.

Raepsaet-Charlier 2011

M.-Th. Raepsaet-Charlier, Plumbum Germanicum. Nouvelles données, L’Antiquité Classique 2011, 80, 185–197.