Roman Navigation in Venice Lagoon: the Results of Underwater Research

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Venice lagoon formed part of a network of inland waterways used for navigation in the northern Adriatic, an almost continuous system of lakes, river-mouths and canals, at least partly pre-Roman in origin. The *fossae* which cross the present lagoon are the continuation of a complex system of natural watercourses and artificial canals between Ravenna and Aquileia. Two Roman buildings discovered on the present San Felice canal could be interpreted as providing navigational assistance at points linking the sea and inland routes.

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In ancient times, Venice lagoon formed part of a network of inland waterways used for navigation in the northern Adriatic, an almost continuous system of lakes, river-mouths and canals. This network was in parallel to sea-routes and provided an alternative to maritime navigation, offering on the one hand the advantage of avoiding the risks of the sea and being able to travel even during bad weather and in the winter, and, on the other, of a direct link between maritime ports and the hinterland. According to ancient sources, it was possible to travel from Ravenna as far as Altino through these inland waterways without ever going out to sea (Pliny, *NH* III, 16, 119–21), but it was probably possible to go much further, as far as Aquileia (Fig. 1).

To sail through the rivers, canals and lagoons of the low plain, it was obviously necessary to use flat- or nearly-flat-bottomed craft with shallow draught. When the area of water was large enough and environmental conditions permitted, sails could be used. Otherwise, the craft were propelled by oars, poles and above all a towpath, with the boat being towed by a thick rope from the land by men or animals proceeding along the embankments or banks. Cassiodorus (*Variae*, XII, 24) describes the use of this technique for internal navigation in the Venezie during the 6th century AD. The practice of towing could also provide an interpretation for the distinctive Roman structures characteristic of the Venice lagoon and known as 'road-embankments' (*argini-strade*) (Canal, 1998: 75–80; Fozzati and Toniolo, 1998).

Referring to our particular geographic context, Livy (X, 2, 12) recalls that at the time of Cleonimus' incursions during the Paduan campaigns (302-301 BC), having travelled by the rivers as far as the Malamocco coast, the Paduans attacked the Spartan condottiere moving around on board 'fluviatiles naves, ad superanda vada stagnorum apte planis alveis fabricate' (riverboats constructed specifically with a flat bottom to navigate in the shallow waters of the lagoons). According to the grammarian Servius, writing between the end of the 4th and beginning of the 5th centuries AD (Comm. in Verg. Georg. I, 262), river-craft known as lintres were used in the inland waterways of the Venezie from Ravenna to Altino. These were used not just for transport and trade, but also for hunting, fowling and agriculture, reminiscent of an environment and way of life which survived until recent times, and is still to some extent alive today in the lagoons, marshes and network of canals and rivers of the low-lying plain along the northern Adriatic coast. The Latin term *linter* is generally used to describe light, slim craft, either dugout or planked, with a flat bottom, designed for inland navigation (Medas, 1997: 272, 275). Other evidence, again from the post-classical period, comes from Isidore of Seville (Orig. XIX, 25), who refers to



Figure 1. Location map.

the use of *lintres* on the Po and in the marshes, and Sidonius Apollinaris (*Epistulae*, I, 5, 5–6), who recalls the use of *lintres* in the canals of Ravenna.

This is confirmed by archaeological evidence from wrecks discovered along the coast and in inland waterways between Ravenna and Aquileia. Examples include the early-5th-century-AD wreck found near Theodoric's Mausoleum at Ravenna (Medas, 2003); the late-1st-century-BC wreck found near Comacchio (Ferrara) (Fortuna Maris); the Corte Cavanella 1 and 2 wrecks found near Loreo (Rovigo) and dated to between the end of the 1st and beginning of the 2nd century AD (Beltrame, 1997: 139); and the remains of a wreck probably dating from the 1st century AD discovered near the island of Villanova in the Grado lagoon (Gaddi, 1999). More strictly relevant to the Veneto lagoon area are the remains of a clinker-built craft discovered near the beach at Alberoni, on the island of Lido di Venezia, and dating from between the 1st and the mid-2nd century AD; a fragment of wood from the north Venice lagoon carbon-dated to between the 6th and the early-5th century BC (although there are considerable doubts as to whether this is actually connected with a wrecked vessel); and part of a re-used hull from between the 1st and the beginning of the 2nd century AD in a probable river-wharf at Padua along the bank of the former course of the Brenta river (Beltrame, 1996; 1997: 138–9). All these wrecks have specific characteristics suggesting use on internal waterways or mixed routes with maritime sections. These characteristics include: the place where they were found, namely in canals (Corte Cavanella 1 and 2, Grado, Padua), along the coast near river-mouths, or in lagoon areas (Ravenna, Comacchio, Alberoni); the type of hull, flat-bottomed without keel (Corte Cavanella 1 and 2, Alberoni), almost-flat hull with very shallow keel (Comacchio), or V-shaped at the ends but flat in the middle, designed for mixed navigation (Ravenna).

The Po delta area has also yielded numerous dugout craft. Although difficult to date (most were discovered some time ago by chance and poorly documented, and few are preserved), these generally belong between the post-classical Roman period and the early Middle Ages (Berti, 1986: 19–24; Berti, 1990; Uggeri, 1990: 188–91) and their presence confirms the evidence listed above. Based on hull-type alone, and in the absence of precise stratigraphic references or scientific dating of the wood. dating of these dugouts is extremely difficult, given the continuity of use of such boats in the delta area, and the persistence of traditional constructional techniques. The dugouts found in the Bacchiglione river in the Padua area have been carbon-dated to the early Middle Ages (Bonino, 1983: 67-71). As regards the Venice lagoon, however, only one dugout craft has so far been discovered, in the late-19th century, near Lova, along the south-western edge of the lagoon, and recently analysed in the laboratory. Although dating from the early-11th century AD (Martinelli and Pignatelli, 1999), this small craft without doubt bears witness to an ancient tradition going back to the *lintres* described by Servius. Other apparent dugout elements in the lagoon, dating from the Roman period, are in fact associated with water-regulation structures and not boats (Rosso and Canal, 1985). These have now been joined by a dugout element discovered in the structure known as the Argine Passaora in the canal of the same name near the island of Sant' Erasmo, and not yet investigated.

Although there are few ancient wrecks directly attributable to inland navigation in the Veneto lagoon, historical and above all archaeological evidence enables the main navigational routes in the hinterland from the south end to the north end of the present lagoon area to be reconstructed, although with due caution. The profound geomorphological modifications occurring in the lagoon area over the last 2000 years (Bondesan and Meneghel, 2004: 284-367) also make it difficult to reconstruct well-defined waterways, although recent archaeological finds provide significant elements to confirm and develop the hypotheses. The *fossae* which cross the present Venice lagoon are the continuation of a complex system of inland waterways consisting of natural watercourses and artificial canals (fossae) which began in Ravenna and continued to Aquileia. At least partly pre-Roman in origin, this system of navigable canals was expanded in the early

Empire, with the opening of the Augusta, Flavia and Clodia *fossae*, and continued to develop until the 4th century AD (Uggeri, 1978; 1990).

Dorigo's proposed reconstruction of the possible route of the inland waterway between Chioggia and Jesolo in Roman times (1994: 49-55; 1995: 143, 147) is essentially based on historical evidence from the Middle Ages indicating the presence of place-names attributable to the Fossa Popilia (from Chioggia to Altino) and the Fossa Popilliola (between Altino and Jesolo and beyond). Historical records are backed up by archaeological evidence confirming the presence of Roman materials or settlements. The route began in Chioggia, the end of the Fossa Clodia, the last section of the inland waterway which started in Ravenna and continued through the Fossa Augusta and Fossa Flavia. It then continued more or less parallel to the island of Pellestrina as far as the island of Poveglia and the ancient Metamauco (Malamocco) and from there, towards the islands of San Clemente and San Servolo, the east end of Venice (San Pietro di Castello) and the islands of Murano, San Giacomo in Paludo and Torcello to Altino. Another branch continued from Torcello to Lio Piccolo. From Altino, it headed south/south east to join the Torcello branch and proceed towards Lio Piccolo and Lio Maggiore, then Jesolo. There were therefore two different but complementary and connected routes-one from Chioggia to Altino, the other continuing along the coast directly to Jesolo and from there to Aquileia. The two waterways must have merged somewhere between Torcello and Burano. Transverse canals must have connected this inland route with the sea through lagoon openings, or inlets between the barrier islands. Links with the sea were a fundamental prerequisite for the functionality of the inland waterway, acting as an interface through which maritime traffic could continue-directly or transferred to smaller shallow-draught craft-towards the hinterland, and, in reverse, internal traffic heading for the sea.

The lagoon inlets also served as ports and shelter for craft transiting along the coast, which otherwise offered no natural harbours or protection. Inside, there must have been safe and organised moorings where the transfer of goods could take place, just as was the case in the Middle Ages and modern times. The nautical, strategic and commercial importance of the ports in the lagoon inlets is confirmed by the new archaeological evidence we will examine below of an organised system of infrastructure at key points in the coastal and inland navigational network. This suggests the existence of an organisational structure covering inland waterways and ports throughout the lagoon area, the forerunner of that complex body which was to develop between the 6th and 7th centuries AD (Marchiori, 1990).

New discoveries on the 'Fossa Popilliola'

The north lagoon is well known for its high density of Roman archaeological sites. These discoveries are due

largely to the Honorary Inspector of the Veneto Superintendency for Archaeology, Ernesto Canal, and more recently to the research carried out by underwater archaeologists assisting in large-scale activities by the Ministry for Infrastructure and Transport/Venice Water Authority/concessionary Consorzio Venezia Nuova to safeguard the lagoon. These archaeological works have been directed by the Veneto Superintendency for Archaeology (NAUSICAA) and realised in the field by Idra s.n.c. The high incidence of Roman sites can be explained partly by proximity to the large city of Altino, but mainly by lower sedimentation rates than in the south lagoon.

Lio Piccolo-Ca'Ballarin

The Lio Piccolo area, between the San Felice and Rigà canals, is a further peculiarity, with the presence of a variety of settlements, probably including port areas. In the past, Canal identified the Scanello canal area with its complex plan and similarities with other finds from the classical Mediterranean world. Canal's research shows that the area was partly submerged during ancient times, and bordered by a canal which flowed out to sea near the present Treporti. On the opposite side, to the east, there were a number of canals and the rivers Dese, Sile and Piave, which probably connected this port with Altino about 8 km away. Alongside was a road which connected smaller settlements via *transversi tramites*.

In 1997 not far from Lio Piccolo, along the San Felice canal near Ca' Ballarin, a complex settlement was discovered, along a front of c.300 m (Fig. 2, site 1). Here investigations by the Consorzio Venezia Nuova, in support of Venice Water Authority work, led to the identification of three areas, probably forming part of a single group. Starting from the north, the structures identified are: Area 1, a strip of wall, still partly intact at foundation level, together with a large volume of collapsed material consisting of bricks bound with cement mortar; Area 2, next to the Ca' Ballarin 'moorings' and without doubt the most significant find (Fig. 3). This consists mainly of a quadrangular structure $(9 \times 10 \text{ m})$ raised around the edges to a height of, in one corner, more than 2.3 m. This structure was built in refined Roman long bricks and was not quite parallel to the canal, but rotated a few degrees so that its long side was lined up exactly north-south. Today, this structure is completely under water to a depth of between 0.5 and 5 m. When it was discovered, the area inside the walls was largely filled-in and covered with ancient debris, mostly concealed by silty sediment. Cleaning of a small section of the interior with an airlift exposed the floor consisting of three superimposed layers of the same long bricks as used for the raised part. Without pile foundations, this platform served as the base for the rest of the building.

Proceeding southwards, Area 3 consists essentially of a long thin strip of cement aggregate largely made



Figure 2. Venice lagoon from a satellite. The numbers indicate the archaeological sites mentioned in this article. (Consorzio Venezia Nuova/Venice Water Authority, with permission)

up of blocks of calcareous stone. This configuration is evident also in the raised quadrangular structure (Area 2) where erosion generated by the dynamic energy of the tides has exposed the foundation piles, producing a helpful cross-section. Towards the deeper levels, the slope of the side of the wedge-shaped canal and the greater hydrodynamics involved have broken up the structure into at least six collapsed elements. Close observation shows clearly that these blocks once belonged to a single structure which must have run parallel to the south side of the structure in Area 2. From the earliest surveys, a number of extremely interesting finds have been made, such as the fragmentary terracotta antefix portraying a Gorgon, dating from about the 1st to 2nd centuries, a number of broken amphoras, and a fragment of wood apparently belonging to the infrastructure of a building.

Between 1998 and 2003 surveys and work were carried out including the total underwater restoration of part of the structure in Area 2 (Figs 3 and 4). The surveys provided important evidence leading to a number of fairly certain identifications. A circular well was found inside the quadrangular enclosure in Area 2. Underwater excavation confirmed that the structure was probably no longer functional, and had been abandoned by the 3rd century AD. On the basis of the evidence, one element now appears certain: the enclosure in Area 2, still standing, would seem to correspond to a large raised cistern containing a well-a forerunner of the typical Venetian well. Through settling, the sand and gravel filling inside would have acted as a filter to drain the rainwater conveyed to the enclosure. The filtered purified water then re-emerged inside the well which rose up out of the floor of the enclosure. The water passed from the 'filter' to the well from where it was drawn by buckets through small fissures in the lower courses of the well-shaft where the bricks were deliberately laid without mortar to leave small spaces between the joints for the water to pass through. Such an interpretation in the context of Roman architecture seems unusual, and the writers are not aware of anything comparable.

A specific function having been attributed to Area 2, the local and regional contexts remain to be understood. An external cistern of such a size almost certainly served to support a settlement of a certain size, evidence of which can be found along the San Felice canal, but above all along the banks of the Rigao canal. The presence of such a structure is, in fact, more than justified by the water-supply problems in the Venice lagoon area, where it is impossible to draw on aquifer water, and by the fact that, precisely for this reason, the cistern was almost certainly constructed on a raised area on dry clay land to avoid infiltration of salty water.

Another problem still to be resolved concerns the structures surrounding this cistern-well, and in particular Area 3. Oriented in an east-west direction, this is about 8 m from the cistern and parallel to it on the south side, and is obviously associated with it. It is, however, not so simple to establish its functions and relationship with the rest of the group. Its narrow, elongated shape suggests it might be the edge of an ancient bank, a sort of wharf where craft could tie up. Alternatively, it might have been a jetty perpendicular to an ancient watercourse, although there is no stratigraphic evidence to support this theory. Unlike the cistern, it is built on piles, carbon-dated to more or less the same period as the rest of the group. The different building technique used, however, could suggest it was not constructed in the same phase as the brick structures. It also seems probable that the Ca' Ballarin cistern was situated near an ancient gap in the coast formed by the mouth of a former course of the Piave (Furlanetto, 2004). This would confirm the hypothesis that the group of structures served as a water-supply point for craft, and this interpretation should also be considered for the 'wharf' in Area 3. The plan of these structures dating from the 1st and 2nd centuries AD would also be in line with the process of restructuring and improving the waterways, which started during the early Empire.

The San Felice canal 'tower'

An extremely interesting site, in part because of the evident similarities with the Ca' Ballarin finds, is the



Figure 3. Lio Piccolo, Area 2 plan. (Venice Water Authority, Veneto Superintendency for Archaeology, with permission)



Figure 4. Lio Piccolo, underwater survey of the archaeological structures. (Venice Water Authority, Veneto Superintendency for Archaeology, with permission)

foundations of a large long structure (8 m along the side) discovered on the north side of the San Felice canal about 1 km from the Treporti 'Ricevitoria', site of one of the ancient gaps between the barrier islands (Fig. 2, site 2; Fig. 5). The remains of the building could be interpreted as a watchtower or lighthouse, in line with the hypothesis proposed for another two structures along the navigational *fossae* between Ravenna and Aquileia, near Comacchio (Baro Zavelea, Valle del Mezzano, where the Fossa Augusta flowed into the main branch of the Po) and near Jesolo (Turris de Plave, then Torre de Caligo, on the Piave Vecchia) respectively (Uggeri, 1978: 71; Dorigo

1994: 52–4). The site is still virtually unexplored. The prominent construction made entirely from long bricks bound with mortar, and perhaps *opus signinum*, was discovered during surveys and excavations carried out in 1988 by Delta Sub, Venice (A. Socal, E. Turchetto, and P. Zanetti). The relatively homogeneous finds recovered date from the 1st and 2nd centuries AD. According to Dorigo's reconstructions (1995: 147), both the Ca' Ballarin cistern and this hypothetical tower would seem to be located along the route of the ancient Fossa Popilliola, the semi-artificial waterway which once crossed almost the entire Venice lagoon.

Port structures at Scanello

The site at Scanello was identified by Ernesto Canal (1998: 55–66). It consists of a large archaeological area characterised by various types of structure, interpreted as an ancient port area which he suggests could represent the port of the City of Altino. The largest part, covering an area of c.40 hectares, was found along the Scanello canal near the present Treporti, a name which, as already mentioned, derives from the presence of an inlet here in ancient times. Almost certainly, a canal connected the sea with this impressive series of buildings, the most typical of which are two possible warehouses $(47 \times 42 \text{ m and } 50 \times 46 \text{ m})$ with columns (base 2 m), a theory supported by the existence of similar structures in other ancient port cities. The city of Altino was linked to this great port-system through the ends of the rivers Dese-Sile and Piave.



Figure 5. S. Felice canal 'tower' foundations. (Venice Water Authority, Veneto Superintendency for Archaeology, with permission)

Sant'Erasmo mudflats and saltmarshes

Between autumn 2003 and spring 2004, the Venice Water Authority, under the scientific direction of the Veneto Superintendency for Archaeology (NAUSI-CAA), undertook a vast underwater survey campaign in the area of mud-flats and salt-marshes along the lagoon side of the island of Sant'Erasmo near the Passaora canal (Fig. 2, site 3; Figs 6 and 7). At least six Roman 'embankment' structures were identified by metal probe for a considerable length (in some cases more than 100 m), consisting of pile-and-plank edging filled with bricks, tiles and amphoras. Of these six 'embankments', one was already known. This is the so-called 'Argine Passaora', the entire part or which, emerging from the bottom of the canal of the same name, was investigated and surveyed in autumn 2003, and samples of wood taken for laboratory analysis. The other five 'embankments' are new discoveries. The date of these structures lies between the 1st and 2nd centuries AD, and the type of amphora material is in every way comparable with that recorded at Altino, consistent with the topographic location of the lagoon side of Sant'Erasmo.

In the majority of cases, only the bottom of the structures is preserved, but in at least two cases, survey also identified the top part. The survey of Anomaly 8 in particular showed a structure consisting of upturned amphoras side by side, together with numerous amphora necks in the empty spaces in-between (Dressel 6A amphoras, the necks of Aegean-made amphoras, and one late-Rhodian amphora). Between and inside the amphoras were numerous brick and tile

fragments, largely flat or winged roof-tiles which seem to have been deliberately broken into small chunks. The sampling carried out in Anomaly 11, on the other hand, showed the presence of a number of piles above which there was apparently a floor made of pieces of long bricks.

The new evidence emerging from Sant'Erasmo confirms the correct interpretation of these Roman structures (well known in other areas of the lagoon) as 'embankments', in other words, partially-submerged structures with a path along the top. It is, however, certain that between the 1st and 2nd centuries AD, the island fronted on a part of the lagoon involved in major and extensive water-regulation activities, possibly in association with the presence of fish-farms or salt-works. However, as was the case from after the Roman period down to the present, the embankment structures must have been multi-purpose, serving as a means of communication within the lagoon, and as towpaths (Fozzati and Toniolo, 1998; Maramani and Toniolo, 2000).

The island of San Servolo

In 1998 a team of underwater archaeologists identified an area of archaeological interest dating from Roman times near the north-eastern side of the island of San Servolo, just a few hundred metres from Piazza San Marco (Fig. 2, site 4). The discovery was made in the course of archaeological monitoring which for a number of years has been accompanying major public works to safeguard Venice, covered by a programme agreement between the Veneto



Figure 6. S. Erasmo, survey of archaeological evidence of 'Saggio' A11. (Venice Water Authority, Veneto Superintendency for Archaeology, with permission)

Superintendency for Archaeology (Ministry of the Cultural Heritage) and the Venice Water Authority (Ministry of Infrastructure and Transport). The archaeological finds consist of at least two successive barriers (edge reinforcement?) consisting of wooden structures packed with amphora fragments, tiles, and other ceramics. This material dates from the 1st and 2nd centuries AD, although carbon-dating provides a more varied picture, with chronologies continuing towards the mid-Imperial age. Geomorphological examination of the deeper sediments provided an interesting picture, suggesting that the area was similar to a nearby lagoon channel heavily influenced by the sea, probably a channel near a lagoon inlet (Lezziero, 1999: 16).

The island of Poveglia

During 2002, as part of preliminary archaeological investigation of a Venice Water Authority work-site, Roman remains were found near the north side of the island of Poveglia (Fig. 2, site 5) by underwater archaeologist Claudia Pizzinato. At 2.63–2.93 m below mean sea-level at Punta della Salute, the site consists of a series of piles and wooden beams packed with various types of ceramic materials including *terra sigillata* Chiara A. In general, the material found can be dated from between the 1st and 5th centuries AD. The results from carbon-dating of wooden elements is extremely wide (4th century BC to 8th century AD, by Dendro-Data sas of Verona). If this dating is accepted as



Figure 7. S. Erasmo, survey of archaeological evidence of 'Saggio' A8. (Venice Water Authority, Veneto Superintendency for Archaeology, with permission)

reliable, it suggests that the site was used for a long period and can probably be interpreted as an embankment or edge-reinforcement structure. This is confirmed by its position along the north side of the island, notoriously exposed to erosion by wind and water.

This find is particularly important as it is the first archaeological confirmation that the island of Poveglia was frequented, probably as a statio along the route of the Fossa Popilliola. The name of this watercourse is not documented in classical sources, but deduced by Dorigo, together with that of the Fossa Popilia, on the basis of medieval sources (Dorigo, 1995: 151). The Fossa Popilia must have used existing sections of the Medoaci and sections of the Sile-Piave with stationes in Santa Maria della Cava (Portosecco, a typical placename), at Poveglia (Popilia?), perhaps near the present San Pietro di Castello, at Amiana or Constanciacum, at Equilum (Jesolo), Fine and Caorle. Recent archaeological finds suggest that the island of San Servolo could be added to this list. This ancient waterway, which survived into the early centuries of the Middle Ages, could have originated from, or been facilitated by, the birth of the so-called 'Venices before Venice', in other words, the settlements within the lagoon (Amiana, Constanciacum and Torcellum) which sprang up during the late-classical era and survived until the period of major eustatic phenomena in the Middle Ages and the definitive establishment of Venice. The fact that the Byzantine emperor Constantine VII Porphyrogenitus (*De Administrando Imperio*, ch. 27, probably quoting from an administrative source from the 8th century) defined Torcello as $\epsilon \mu \pi \delta \rho (\delta \nu \mu \epsilon \gamma \alpha \tau \sigma \tau \sigma \tau \zeta \epsilon \lambda \delta \nu'$ is an important indication of the presence of an inland waterway nearby, which continued to play an important function up to the 8th century AD.

The Sacca delle Case 'small towers'

The area identified by Ernesto Canal (1998: 66–70) lies on the western edge of the north Venice lagoon near the Tessera saltmarsh (Fig. 2, site 6; Fig. 8). The Consorzio Venezia Nuova carried out surveys and investigations there at the end of the 1990s. In this case, the dates vary between the 1st century BC and the 3rd-4th century AD. Finds from the 12th–15th century AD have also been discovered. The structures have a complex plan, but those relevant here consist of two rectangular towers measuring 3×2.5 m and 2.4×1.8 m respectively, and built of long bricks. Their condition deteriorated rapidly during the years following the discovery, due to both natural and human agencies. In the larger, the floor in opus spicatum is intact. Sedimentological surveys near the two small structures showed that a watercourse known as the 'Terzo' or 'Sarmacio' once



Figure 8. Tessera, 'Sacca delle Case' small tower. (Venice Water Authority, Veneto Superintendency for Archaeology, with permission)

ran between the two towers, as is also shown on Renaissance maps (Venice State Archive, misc. maps, dis. 912 of 1501). Larger buildings, probably serving as warehouses, have been found nearby, together with a road probably built in a period when subsidence and eustatism were already evident. Canal suggests that these two towers could be interpreted as barrier structures along the watercourse which allowed direct access to the Venice lagoon. In short, customs buildings. Setting aside for the moment what their actual function could have been, it is worth noting the presence of another two similar structures near a waterway flowing directly into the Venice lagoon.

Summary

While river-trade between Venice and other centres in the Padua area during the Middle Ages is widely documented, trade during the Roman period is known largely through archaeological sources. However, recent research into ancient lagoon place-names is providing an ever-clearer picture of an area characterised by scattered settlements with a largely rural and fishing economy.

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