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Amphora production and *salsamenta* trade: the case of Thamusida (Rabat, Morocco)

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Abstract

This paper aims at present the first results obtained in the study of *salsamenta* amphora production, integrating both archaeometric characterisation and archaeological study. Main objective was to verify the presence or the absence at Thamusida of a local production of amphorae, by means of optical microscopy, scanning electron microscopy, X-ray diffraction and X-ray fluorescence. The results obtained from the analysis of 76 samples proved the existence of an industrious local ceramic production, focused on the manufacturing of Beltran IIB and Dressel 7-11 types. As far as amphorae and *salsamenta* trade are concerned, these results are of particular significance because they establish a reciprocal (not anymore only univocal) exchange between *Baetica* and *Mauretania* roman provinces. Within the selected amphora context, Spanish, French, Tunisian, Algerian and Libyans products have been also analysed for comparison.

The archaeological site of Thamusida

The site of Thamusida (Fig. 1A-B) is situated on a plateau immediately to south of the Oued Sebou floodplain, near the modern town of Kenitra, about 45 km north of Rabat. The site has been subjected to several archaeological excavations, performed by French teams in the '30 and '60 (Callu *et al.*, 1965, Hallier *et al.*, 1970; Marion & Rebuffat, 1977), while five years ago, a team of Italian (The Siena University, directed by Prof. E. Papi) and Moroccan (Institut National des Sciences de l'Archéologie et du Patrimoine, directed by Prof. A. Akerraz) archaeologists started a joint archaeologi-

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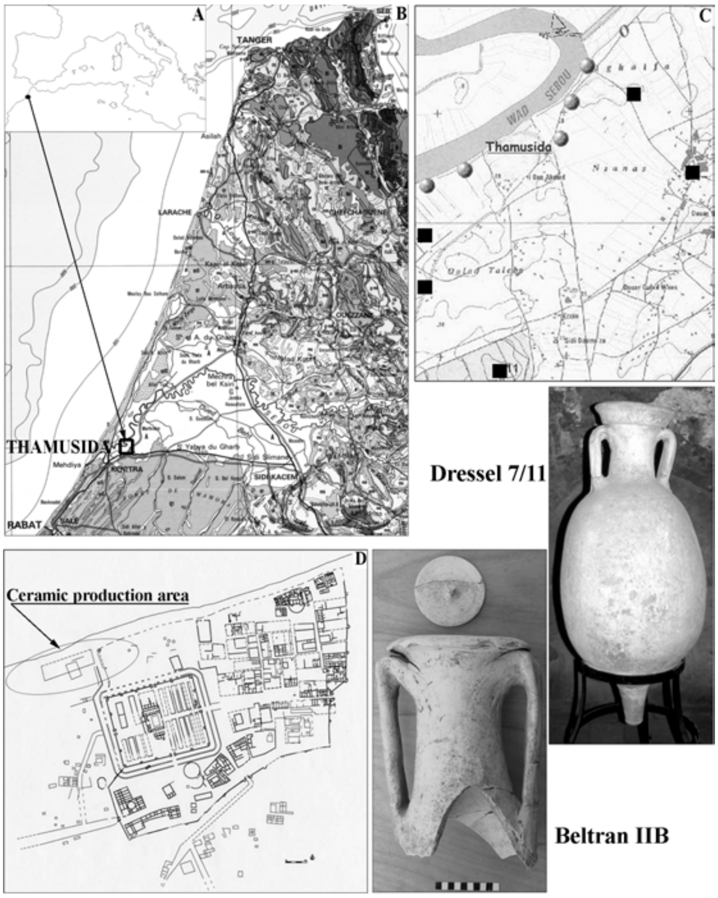

Fig. 1 – A) Geographical location and B) geological settings of the territory of Thamusida. C) Clay sediments sampling (grey circles indicate samples of grey clay, black squares indicate samples of black clays). D) Map of the town of Thamusida and its ceramic production area.

cal research project for the study of the town (Papi & Vismara, 2002; Papi *et al.*, 2003).

Geophysical prospections have been firstly performed, both inside the perimeter of the town and in the surrounding territory, in order to delimit the town extension and to direct the excavation activities. Beginning from 1999, the Italian-Moroccan intervention, both in the field of archaeological survey and stratigraphic excavation, provided new information and detailed reconstructions of numerous monuments inside the town walls and brought to light various and numerous materials, which have been object of a detailed archaeometric investigation.

The town of *Thamusida* was founded by the Romans in the 1^{st} century A.D. to serve as a garrison, a large river port and a control centre along the boundary of the Roman Empire. The city extended over nearly 13 hectares, including a military camp, three temples, a large thermal baths complex, several food stores, several private houses and a belt of watchtowers that ensured the security of the inhabitants and of the town buildings. The economic life was based on military activities but the favourable geographical position (along the Oued Sebou) and the availability of suitable raw materials, stimulated the development of numerous manufacture activities. Metal works, glass works, brick works are significantly testified onsite and an important ceramic production plant was brought to light during 2003 season.

The kiln resembles the well-known typology of Spanish amphora kilns but, up to now, no wastes have been found in those layers that we can connect with the activity of the production plant. However, the presence of a great number of amphorae destined to the *salsamenta* transport and the evidence of *salsamenta* factories in Thamusida may suggest a local amphora production, mainly destined to the commercialisation of fish sauces.

The state of the art in the field of *salsamenta* production and distribution is rather complex (see i.e. Ponsich, 1965; Lagostena Barrios, 2001), consequently it might be opportune to summarise some topics. The *salsamenta* (sauces prepared with fish entrails) was introduced in the Western countries by Phoenicians and was very appreciated during roman times. From the many *salsamenta* production centres grown along the coasts of Morocco, the sauce was carried through the countries of the Roman Empire by means of amphorae expressly produced, but the dynamics of this trade are still matter of debate. In Morocco, several amphora productions sites were known during the Phoenician period while, based on the archaeological evidences formerly available, the production of containers seemed to cease after the roman conquest. Subsequently, several archaeologists stated the import of *salsamenta* containers from southern Spain and Portugal but the discovery of the Thamusida kiln reopen the whole question. Moreover, the presence of a local amphora production would shed a new light on the dynamics of production and distribution of this good and to reconstruct the trade routes involved in its export.

The Materials

The excavations performed on the site of Thamusida brought to light numerous types of amphorae, dated back from the half of the 1^{st} century B.C. to the beginning of the V century A.D. The types Beltran IIB and

Dressel 7/11 constitute the greatest nucleus of findings, based on the total quantity of amphorae found onsite; however, numerous amphorae attributed to Dressel 16, Dressel 2/4, Dressel 30, Dressel 17, Dressel 20, Beltran 72, African I and II and Tripolitan I and II types are testified as well.

The *criteria* adopted for the selection of samples were the typology, the chronology, the content and, for a few specific types of localized amphorae, also the provenance.

The 76 selected specimens comprise, firstly, 61 samples ascribed to Beltran IIB (34 samples) and Dressel 7/11 types (27 samples), whose local production have been hypothesised (even though an exclusive Spanish provenance has been postulated by several authors). Further 15 samples were selected for comparison as they include amphorae produced in Spain, Portugal, Tunisia, Libya, Algeria, southern France, maybe central Italy. Among these last 15 samples, only 3 can not be ascribed to a precise type but they belong to stamped amphorae surely produced in Spain.

Besides investigating the ceramic finds, 7 samples representative of the clays outcropping in the territory of Thamusida (Fig. 1C) were collected and analysed.

The analytical techniques

The samples were taken from the rim of the vessel, in order to avoid eventual discrepancies due to different location of the sample (i.e. the handles are made separately from the vase and then attached). The samples were cut perpendicular to the surface of the artefact, so that both its inner and outer surfaces could be observed.

Optical microscopy (OM) and X-ray diffraction (XRD) were used for mineralogical analysis, and scanning electron microscopy (SEM-EDS) was employed for further textural and chemical investigation. Micropalaeontological analysis involved observation of thin sections under the optical microscope and SEM. Instrumentation consisted of a Philips PW 1710 diffractometer with a copper anode operating at 45kV accelerating voltage and 25μA sample current, and a Philips XL30 SEM equipped with a Philips EDAX DX4 energy dispersive spectrometer (EDS).

Chemical analysis involved the application X-ray fluorescence (XRF) using a Philips MagicX Pro. Loss on ignition was also determined by heating samples to 1050°C for two hours.

Statistical methods were used to process chemical data using major, minor and trace elements as variables (except P_2O_5, whose content is affected by post-depositional processes). Data were processed using principal component analysis (based on the covariance matrix with no rotation of the axes) and cluster analysis (Average Linkage, based on the quadratic Euclidean distance and values rescaled from 0 to 1). Discriminant analysis was further applied, mainly for grouping samples and calculating the relative Mahalanobis distances.

Bulk sediment samples were investigated through mineralogical (XRD) and chemical (XRF) analytical techniques. The separation of the clay fraction (<2μm) was obtained with gravity sedimentation. All the separated clay fraction samples were saturated with K and Mg ions. The Mg-saturated samples were heated to 550°C for 2 h, the K-saturated samples to 350°C for 2 h. The clay fraction composition and its semi-quantitative determination were estimated through the area of the peaks obtained by X-ray diffraction (Gjems, 1967; Moore & Reynolds, 1997).

Results

The amphoras. The presentation of the results follows a non-conventional order, as chemical analyses precede mineralogical and petrographical ones. This choice is motivated by the objective of this study, aimed at the individuation of a local production. The results obtained by chemical analyses of both amphorae and local bricks (object of a separate study) were used to identify a nucleus of Thamusida products to be further investigated by means of mineralogical and petrographical analyses.

X-ray fluorescence analysis have been performed on the entire sample set and the statistical treatment of the data allowed to discriminate 4 main groups of samples. The results provided by the chemical analysis and its statistical elaboration are given together in table 1, where the mean compositions and the standard deviations of each group of samples are shown. The values corresponding to the chemical composition of each sample are available on request, however, they have been used for the binary diagrams showed in figure 2. The binary diagrams SiO_2-Al_2O_3, CaO-Fe_2O_3 and MgO-TiO_2 (Figg. 2 A-C) have been selected on the basis of the results provided by the statistical treatments. Both Principal Component and discriminant analyses, infact, indicated these major elements as the principal discriminants for grouping. On the contrary, the binary diagram Na_2O-K_2O (Figg. 2 D) shows wide overlaps between samples included in different groups.

The first group is characterised by high CaO contents and medium-low SiO_2, Al_2O_3 and Fe_2O_3 contents with respect to the other groups, and includes 53 samples: 28 of Beltran IIB, 20 of Dressel 7/11, 1 of Beltran 72, 1 of Dressel 17 and 3 of Spanish stamped amphorae. The second group is characterised by lower CaO contents and higher SiO_2, Al_2O_3 and Fe_2O_3

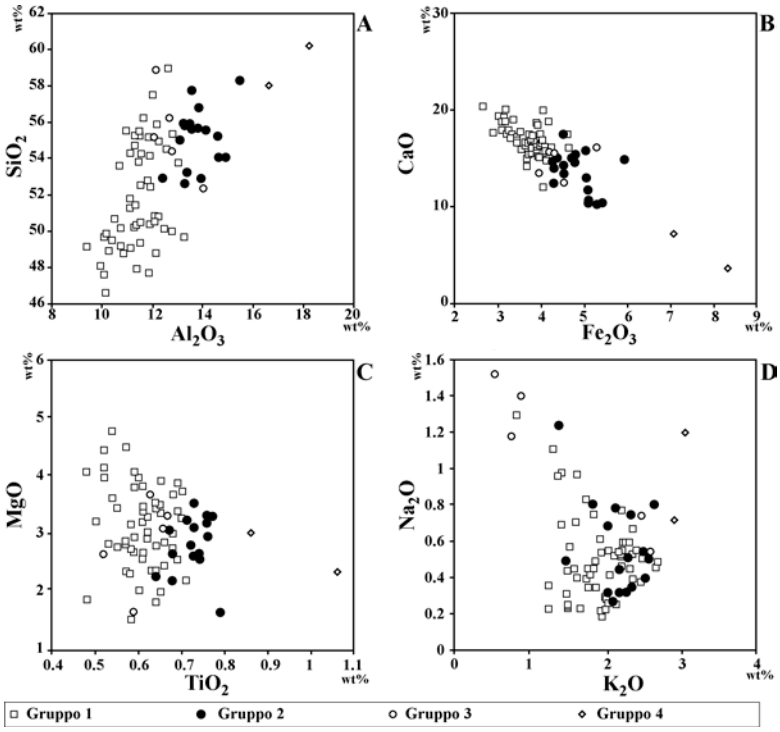

Fig. 2 – The chemical composition of the 76 samples: binary diagrams SiO_2-Al_2O_3 (A), CaO-Fe_2O_3 (B), MgO-TiO_2 (C) and Na_2O-K_2O (D).

contents with respect to the 1st group, and includes 17 samples: 6 of Beltran IIB, 4 of Dressel 7/11 and 2 of African I, 1 of African II, 1 of Tripolitan I, 1 of Tripolitan II and 2 of Dressel 20. The 3rd and the 4th groups can not be considered as proper groups, due to the long distance dividing samples (see standard deviation values reported in Tab. 1), that reflect the difference typology and provenance of the included specimens: 1 sample of Dressel 2/4 maybe from central-Italy, 1 sample of Dressel 16 from southern France, 1 sample of Dressel 30 from Algeria and 3 samples of unknown provenance ascribed to Dressel 7/11 and Beltran IIB types.

Comparing the mean content of each group with the mean composition of the local brick production (Tab. 1), it is possible to observe that the second group shows a similar composition. Anyway, several samples can be excluded from the 17, as they refer to Tunisian and Libyan productions, while a perfect correspondence relates to a subgroup of 6 samples only (subgroup in Tab. 1), that includes 4 samples of Beltran IIB and 2 samples of Dressel 7/11.

Tab. 1 – Mean chemical values obtained for the amphorae included in the 1° and the 2° groups and for a group of 10 bricks produced at Thamusida Oxides expressed in wt%, minor and trace elements expressed in ppm.

	1° group		2° group		3° group		4° group		"subgroup"		Bricks	
	n=53	s.d.	n=17	s.d.	n=4	s.d.	n=2	s.d.	n=6	s.d.	n=10	s.d.
Na_2O	0.5	0.3	0.6	0.3	1.1	0.4	1.0	0.3	0.8	0.3	0.7	0.3
MgO	2.4	0.7	2.8	0.5	2.9	0.8	2.7	0.5	2.2	0.4	1.9	0.5
Al_2O_3	11.5	0.9	13.8	0.8	12.8	0.8	17.4	1.1	13.6	0.7	13.4	2.1
SiO_2	52.5	3.1	54.8	2.1	55.4	2.4	59.1	1.5	55.6	2.3	54.2	1.6
P_2O_5	0.4	0.2	0.3	0.1	0.4	0.2	0.2	0.1	0.3	0.1	0.2	0.0
K_2O	1.8	0.4	2.1	0.3	1.4	1.0	2.9	0.1	1.7	0.3	1.6	0.5
CaO	16.6	1.9	13.7	2.1	15.1	1.3	5.4	2.5	14.6	1.1	14.2	3.2
TiO_2	0.6	0.1	0.7	0.0	0.6	0.1	1.0	0.1	0.7	0.0	0.7	0.1
MnO	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.0
Fe_2O_3	4.0	0.5	4.8	0.4	4.1	0.3	7.7	0.9	5.5	0.5	5.9	1.0
H_2O	9.3	2.3	6.1	2.0	6.1	0.7	2.3	1.0	4.8	2.4	6.9	2.5
V	69.2	12.0	116.2	15.5	92.8	21.6	131.0	0.0	98.9	9.3	96.5	16.4
Cr	69.4	10.8	115.8	12.2	97.6	6.5	93.0	38.2	89.1	8.4	88.4	8.4
Co	66.2	13.9	16.3	1.6	14.6	3.0	24.5	0.7	84.4	9.8	91.1	26.9
Ni	34.5	7.7	37.5	4.4	34.2	1.9	45.0	18.4	44.6	4.0	47.8	8.1
Zn	60.1	7.3	79.4	10.1	57.6	11.3	114.0	21.2	76.2	10.6	80.3	7.4
Rb	70.9	11.7	83.4	13.3	78.8	38.9	130.0	7.1	69.6	9.3	78.2	30.6
Sr	394.8	87.7	396.8	82.7	341.6	41.3	193.0	28.3	336.4	36.8	303.3	41.8
Y	22.9	1.4	24.8	1.8	25.0	3.7	37.0	5.7	24.0	1.2	23.3	1.7
Zr	199.5	24.7	180.0	20.4	198.6	26.1	234.5	26.2	177.8	21.8	177.0	22.6
Nb	11.7	1.1	16.1	2.2	15.0	1.2	18.0	1.4	12.9	1.1	12.2	1.2
Ba	417.6	97.2	421.4	141.7	362.2	141.8	497.0	222.0	353.0	61.4	398.9	89.9
La	21.9	2.9	27.8	4.2	24.8	3.0	60.0	26.9	24.4	3.4	21.4	2.7
Pb	30.4	7.9	27.8	4.5	34.0	27.9	38.5	2.1	26.7	4.2	26.7	4.2
Ce	47.5	10.3	47.7	10.0	46.6	9.4	107.5	48.8	51.6	9.8	51.7	9.5
Th	9.3	1.5	10.8	1.4	7.8	3.8	27.5	20.5	9.9	2.3	7.9	1.4
U	0.9	0.5	1.9	0.6	2.2	1.1	3.5	0.7	1.3	0.5	1.5	0.8

Given that the objective of this study is the individuation of local products, mineralogical and petrographical analyses (XRD, OM) have been performed on these 6 samples only, while the study of the other productions, local, regional or provincial or Mediterranean?, is in progress, as it needs a detailed research on imports and further Moroccan productions (not only amphorae).

The samples are characterised by serial texture, very fine granulometry, low sintering and high porosity. The ferric-carbonatic matrix represents about the 70-80% of the ceramic body and it is often characterised by the presence of a sandy component. The skeleton is characterised by the presence of numerous small crystals of mica, quartz, feldspars, calcite, oxides and opaque minerals. Lithic fragments (mainly limestone, sandstone and quarzites) and microfossils (mainly molluscs) have been also observed.

Scanning electron microscopy was further applied to this study in order to provide a detailed characterisation of both matrix and crystal textures and compositions. Quartz, the most abundant mineral, occurs as subrounded and rounded crystals of small size (maximum 200μm, mean 50 μm). Feldspars are mainly represented by angular to subrounded crystals of K-feldspars, sometimes highly fractured. Plagioclases crystals are also present. The abundant calcite is both primary and secondary: primary crystals of calcite shows reaction rims due to firing process while secondary microcrystalline calcite is present along the outer surface of the sherd and in the pores of the matrix. Mica crystals are rather frequent and show a composition ranging from clinochlore to chamosite. Numerous Fe- and Ti- oxides are present in the ceramic bodies together with rare apatite accessory crystals. Microfossils are mainly represented by molluscs but foraminifera have also been observed.

The local sediments. The 7 clay samples can be macroscopically divided into two groups, based on their colour. The sediments outcropping along the banks of the Sebou River shows a light grey colour, while, moving from the river to the inland, the sediments become black. The chemical analysis of the bulk sediments (Tab. 2) showed that the grey samples are characterised by a higher CaO content (mean 10.5 wt.%) and a lower SiO_2 e Fe_2O_3 contents, with respect to the black sediments whose CaO mean content is 3.6 wt.%. The chemical composition of the grey sediments shows a great compatibility with the composition of both the amphorae and the bricks ascribed to the local production, moreover, the analysis of the sandy and clay fractions seems to further sustain this observation. The sandy fraction of the grey sediments is constituted by quartz, feldspars, calcite, hematite and micas while black clays shows quartz and feldspars only. The clay fraction (Tab. 3) is characterised by the presence of illite, chlorite, kaolinite, smectite, vermiculite and mixed strata, however, grey sediments shows decidedly higher content of illite and a higher content of kaolinite with respect to the black sediments, where smectite is prevalent and a higher content of vermiculite can be observed.

Tab. 2 – Chemical analysis of the bulk sediments. Oxides expressed in wt%, minor and trace elements expressed in ppm.

	Black clays		Grey clays	
	mean (n=3)	s.d.	mean (n=4)	s.d.
Na_2O	0.5	0.0	0.3	0.1
MgO	2.0	0.2	6.4	9.6
Al_2O_3	13.7	0.5	14.9	0.3
SiO_2	53.1	4.2	64.0	1.2
P_2O_5	0.2	0.1	0.2	0.2
K_2O	1.7	0.1	1.0	0.1
CaO	10.5	1.3	2.9	1.0
TiO_2	0.7	0.0	0.9	0.0
MnO	0.1	0.0	0.1	0.0
Fe_2O_3	6.4	2.2	7.2	0.1
H_2O	12.0	2.6	6.9	0.5
V	127.0	9.5	154.0	5.9
Cr	111.7	8.0	122.3	3.9
Co	16.0	1.0	21.0	1.4
Ni	42.7	4.5	46.3	1.7
Zn	86.0	11.0	65.3	4.3
Rb	75.0	12.1	83.5	3.1
Sr	210.0	50.2	92.0	12.2
Y	22.7	1.5	29.5	1.0
Zr	189.0	44.3	236.3	8.4
Nb	12.7	1.5	16.0	0.0
Ba	282.0	29.6	317.5	42.9
La	26.0	4.6	38.5	3.7
Pb	24.7	3.8	32.3	1.9
Ce	55.0	5.3	76.0	11.1
Th	7.7	1.5	9.3	0.5
U	2.0	0.0	3.0	0.0

Table 3 – Clay fraction composition and its semi-quantitative determination.

Samples	colour	Illite	Chlorite	Kaolinite	Smectite	Vermiculite	Mixed Layers
					(%)		
THA 5	Grey	54	11	18	10	0	7
THA 12	Grey	61	7	15	4	1	12
THA 15	Grey	52	10	16	13	3	6
THA 3	Black	8	5	8	67	7	6
THA 13	Black	8	8	9	61	9	5
THA 14	Black	6	2	7	60	14	10
THA 16	Black	4	2	5	72	11	6

Discussion

As far as the technological cycle is concerned, it is possible to identify the grey sediments outcropping along the banks of the Sebou River as the raw materials used by the ceramists of Thamusida. Based on the mineralogical-petrographical analyses, the sediments show an identical composition with respect to the composition of the amphorae ceramic bodies, while chemical analyses show modest differences, mainly due to CaO contents. These differences may be easily explained considering the extreme compositional variability of fluvial sediments with respect to marine sediments. Fluvial meandering and erosional *phenomena* create a heterogeneous context which probably does not coincide with that of antiquity and the sandy component observed in the ceramic bodies may suggest to look for the sediments laying at the interface with the highly calcareous sands. Moreover, it is worth considering that secondary calcite is abundant in the ceramic bodies and, therefore, play an important role in the bulk chemical results.

All sediments outcropping in the territory of Thamusida are particularly fine grain-sized and the preparation of the paste must have been very simple and fast, while it is not possible to understand if the sand component is intentionally added or already present in the sediment.

Indeed, the firing temperature is rather low, as primary calcite is still present even if showing reactions rims.

Conclusions and future developments

Based on the comparison with the chemical and mineralogical composition of both local sediments and local bricks, it has been possible to identify a group of 6 samples (corresponding to Beltran IIB and Dressel 7/11 types) that can be ascribed to the local production.

In the field of amphorae production and distribution in the Mediterranean basin, the excavation of the Thamusida kiln and the individuation of a local production of Beltran IIB and Dressel 7/11 amphorae is of great interest as it allows to shed a new light upon the modalities of *salsamenta* trade. The trade of Moroccan *salsamenta* by means of Spanish containers needs to be partially reassessed, and the distribution model should now include also the trade of Moroccan fish-sauces by means of local amphorae expressly produced.

The small amount of samples does not allow the creation of a reference group but it is sufficient in order to outline some characteristics of the examined amphorae and to plan the future developments of this research. The data obtained so far show that the local production was focused on two types of amphorae only, characterised by a low-fired calcareous ceramic body, while the existence of further local amphorae still need to be verified. Obviously, a study of such a great importance will imply to take into consideration the amphora production centres, even if they can be dated back to an earlier period (i.e. Phoenician period). Further studies, will be equally needed in order to establish the provenance of the samples included in group 1, 3 and 4, while a detailed study of the local brick production is already in progress.

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