

# ANNALES



Piran 2012

**du 19<sup>e</sup> CONGRÈS**

de l'ASSOCIATION INTERNATIONALE  
pour l'HISTOIRE du VERRE

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du 19<sup>e</sup> CONGRÈS de l'ASSOCIATION INTERNATIONALE  
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(Piran, 17<sup>th</sup> – 21<sup>st</sup> September 2012)

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*Cover photo: Glass beads from prehistoric graves in Novo Mesto – Kapiteljska njiva;  
Dolenjski muzej Novo mesto, Slovenia (see Križ, Guštin in this volume, p. 48).*

## CONTENTS

PREFACE – Sylvia Fünfschilling	9
AVANT-PROPOS – Sylvia Fünfschilling	11
VORWORT – Sylvia Fünfschilling	13
<b>2<sup>nd</sup> – 1<sup>st</sup> millennium BCE / Bronze Age / Iron Age Glass</b>	
BELLINTANI Paolo	15
BRONZE AGE VITREOUS MATERIALS IN ITALY	
NICHOLSON Paul T., JACKSON Caroline M.	22
AN 18 <sup>TH</sup> DYNASTY GLASS CHALICE FROM GUROB, EGYPT	
NENNA Marie-Dominique	30
LE MOBILIER RELIGIEUX EN BOIS INCRUSTÉ DE VERRE DES TEMPLES ÉGYPTIENS: NOUVELLES DONNÉES (VII <sup>E</sup> AV. J.-C. – I <sup>ER</sup> SIÈCLE APR. J.-C.)	
BLEČIĆ KAVUR Martina, KAVUR Boris	39
THE GAME OF GLASS BEADS IN THE ATTIRE OF THE CULTURES OF CAPUT ADRIAE AND ITS HINTERLAND	
KRIŽ Borut, GUŠTIN Mitja	48
PREHISTORIC GLASS FROM NOVO MESTO / SLOVENIA	
ARLETTI Rossella, BELLESIA Sonia, NENNA Marie-Dominique	55
CORE-FORMED GLASS CONTAINERS FOUND ON RHODES (END OF THE 6 <sup>th</sup> – 5 <sup>th</sup> CENTURY BC). CHEMICAL ANALYSIS	
<b>Hellenistic Glass</b>	
READE Wendy J., JONES Janet, PRIVAT Karen	65
MEDITERRANEAN GROUPS I AND II CORE-FORMED VESSELS FROM THE FIRST MILLENNIUM BC GORDION. COMPOSITIONAL ANALYSES	
STAMPOLIDIS Nikolaos	75
A “HOMERIC” GLASS OBJECT FROM THE NECROPOLIS OF ELEUTHERNA, CRETE	

IGNATIADOU Despina EARLY GLASS IN METHONE	81
ARVEILLER DULONG Véronique UNE COUPE HELLÉNISTIQUE AU LOUVRE. UNE DECOUVERTE	89
<b>Roman Glass</b>	
ANTONARAS Anastassios, KERAMARIS Anastassios EVIDENCE ON THE SEALING OF GLASS GLOBES (ISINGS FORM 10) A SHORT NOTE	94
GANIO Monica, BOYEN Sara, BREMS Dieter, GIANNINI Rita, SHORTLAND Andrew, VANHAECKE Franck, DEGRYSE Patrick, 'TRUE' ROMAN GLASS. EVIDENCE FOR PRIMARY PRODUCTION IN ITALY	98
JACKSON Caroline M., COTTAM Sally, LAZAR Irena THE GREEN, GREEN GLASS OF ROME	109
FONTAINE HODIAMONT Chantal DANS L'ESPACE ET LE TEMPS, DIFFUSION D'UN PETIT DAMIER ANTIQUE EN VERRE MOSAÏQUÉ	118
PAYNTER Sarah, KEARNS Thérèse, COOL Hilary HOW GLASS WAS COLOURED IN THE ROMAN WORLD, BASED ON THE GLASS CAKES AND TESSERAE FROM ESSEX, ENGLAND	127
BARBERA Maria ROMAN GLASS FROM THE AREA OF NORA (CAGLIARI, SARDINIA)	134
COTTAM Sally GLASS FROM AN EARLY 2 <sup>ND</sup> CENTURY AD WELL DEPOSIT AT BARZAN, SOUTH WEST FRANCE	144
LIERKE Rosemarie MANUFACTURING MARKS AND THE PERSUASIVE POWER OF REPLICAS	151
ŠTEFANAC Berislav MANUFACTURERS' MARKS ON THE UNGUENT BOTTLES FROM THE ROMAN PROVINCE OF DALMATIA	159
BULJEVIĆ Zrinka THE SMALL GLASS BOAT FROM SALONA	167
DA CRUZ Mário, SÁNCHEZ DE PRADO Maria Dolores GLASS WORKING SITES IN HISPANIA: WHAT WE KNOW	178
DÉVAI Kata THE SECONDARY GLASS WORKSHOP IN THE CIVIL TOWN OF BRIGETIO	188

DEMIERRE PRIKHODKINE Brigitte LE VERRE DÉCOUVERT DANS LES THERMES ROMAINS D'ERÉTRIE (EUBÉE, GRÈCE)	198
ISRAELI Yael, KATSNELSON Natalya A FOREIGN FAMILY'S TOMB? RECONSIDERING THE GLASS FINDS FROM GEVA–ABU SHUSHA	207
STERN E. Marianne SENTIA SECUNDA AND SARAPODORA	215
AGOSTINO Angelo, BARELLO Federico, PANERO Elisa PRECIOUS GLASS FROM PIEDMONT: THE CASE OF THE PYXIS OF FORUM VIBII – CABURRUM	222
FUJII Yasuko A STUDY ON THE ROMAN ENGRAVED GLASS BOWL WITH A DIONYSIAC MOTIF IN THE MIDDLE EASTERN CULTURE CENTER IN JAPAN	228
ROFFIA Elisabetta VASES GRAVÉS À DÉCOR GÉOMETRIQUE À <i>BRIXIA</i> (ITALIE)	234
SILVANO Flora GLASS PRODUCTION IN ANTINOOPOLIS, EGYPT	244
KAISARLIS George, PAPAGEORGIU Metaxia, PROVATIDIS Christopher DIGITAL RECONSTRUCTION OF A ROMAN BIRD-SHAPED GLASS VESSEL FROM PATRAS IN 3D CAD ENVIRONMENT	250
UBOLDI Marina GLASS VESSELS AND OBJECTS FROM RECENT EXCAVATIONS IN MILAN. THE ROMAN BURIAL GROUND IN VIA MADRE CABRINI	257
VOMER GOJKOVIČ Mojca GLASS FINDS FROM POETOVIO GRAVE AT LJUDSKI VRT	264
<b>Late Roman Glass</b>	
SIMON Laure VERRES DU BAS-EMPIRE À VANNES (MORBIHAN, FRANCE) : LES DÉCOUVERTES DU IV <sup>e</sup> SIÈCLE DU SITE DE LA PLACE DES LICES	271
MILAVEC Tina LATE ANTIQUE GLASS IN SLOVENIA	277
LELJAK Mia GLASS VESSELS FROM THE LATE ROMAN CEMETERY AT ŠTRBINCI (CROATIA)	286
ANTONARAS Anastassios, CHRYSOSTOMOU Anastasia A SECONDARY GLASS WORKSHOP IN ANCIENT EDESSA	293

ERTEN Emel, GENÇLER GURAY Çiğdem GLASS FINDS FROM VILLA-A IN ZEUGMA, GAZIANTEP – TURKEY	304
DIANI Maria Grazia, INVERNIZZI Rosanina SÉPULTURE À INHUMATION AVEC DÉPOSITION DE VERRES DE LAUMELLUM DE L'ANTIQUITÉ TARDIVE (PAVIE – ITALIE DU NORD). FOUILLES 2008	314
PEROVIĆ Šime PRESENT STATE OF RESEARCH OF THE LATE ROMAN GLASS FINDS IN DALMATIA	320
UBOLDI Marina GLASS IN MILAN FROM ROMAN TIMES TO LATE ANTIQUITY	329
<b>Byzantine Glass</b>	
KRIŽANAC Milica 5 <sup>TH</sup> -6 <sup>TH</sup> CENTURY GLASS IN SERBIA AND TERRITORY OF KOSOVO	337
CANAV-ÖZGÜMÜŞ Üzlifat, KANYAK Serra RECENT GLASS FINDS FROM PANTOCRATOR CHURCH IN ISTANBUL	350
STRATIS A. John, NAZLIS Ioannis A. A STUDY OF PROTO-BYZANTINE GLASS FRAGMENTS FROM PHILIPPI, NORTHERN GREECE, USING ATOMIC SPECTROSCOPY	357
BELGIOVINE Elena THE GLASS OF TERME MILANO AT GORTYNA (CRETE)	361
CINGOLANI Sofia, PERNA Roberto LATE ROMAN AND BYZANTINE GLASS FROM HADRIANOPOLIS (SOUTHERN ALBANIA)	368
<b>Post Roman Glass</b>	
MEEK Andrew, MARZINZIK Sonja THE DISCOVERY OF COBALT COLOURANT RAW MATERIALS AS INCLUSIONS WITHIN ANGLO-SAXON GLASS BEADS	376
<b>Medieval Glass</b>	
LOUIS Aurore LES RÉCIPIENTS EN VERRE DES INHUMATIONS DE L'ANTIQUITÉ TARDIVE ET DU HAUT MOYEN AGE EN PICARDIE (FRANCE)	381
STAŠŠÍKOVÁ-ŠTUKOVSKÁ Danica, PLŠKO Alfonz DIFFERENCES BETWEEN THE FINDINGS OF SEGMENTED BEADS IN SKELETON GRAVES FROM THE REGION OF MIDDLE DANUBE DATED TO 7 <sup>TH</sup> -11 <sup>TH</sup> CENTURIES	389

SEDLÁČKOVÁ Hedvika, KOÓŠOVÁ Petra, LESÁK Branislav MEDIEVAL GLASS IN BRATISLAVA (ca 1200–1550)	400
VALIULINA Svetlana EARLY ISLAMIC GLASS OF THE VOLGA REGION IN BULGARIA	411
SILVESTRI Alberta, FIORETTI Anna Maria, MAURINA Barbara, ZANDONAI Fabiana GLASS FROM LOPPIO (TRENTO, NORTHERN ITALY): AN ARCHAEOLOGICAL AND ARCHAOMETRIC STUDY	420
<b>Islamic Glass</b>	
FOY Danièle VERRES ISLAMIQUES DE LA CITADELLE DE DAMAS (IX <sup>E</sup> -XIII <sup>E</sup> S.). UN APERÇU	429
GOMES Rosa Varela ISLAMIC GLASS FROM SILVES' CASTLE (PORTUGAL)	438
LAVYSH Krystsina NEW FINDS OF ORIENTAL GLASS IN THE TERRITORY OF BELARUS	446
SHINDO Yoko ISLAMIC GLASS WITH IMPRESSED DECORATION: THE PROBLEMS OF DATING AND PRODUCTION	455
<b>Venetian / Façon de Venise Glass</b>	
VERITÀ Marco, ZECCHIN Sandro THE TECHNOLOGY OF BLUE VENETIAN GLASS: FROM ITS ORIGINS TO THE 17 <sup>TH</sup> CENTURY. HISTORICAL SOURCES AND CHEMICAL ANALYSES	462
MORETTI Cesare (†), GRATUZE Bernard, HREGLICH Sandro LE VERRE AVENTURINE: SON HISTOIRE, LES RECETTES, LES ANALYSES, SA FABRICATION	471
MEDICI Teresa, RADIĆ ROSSI Irena GLASS FINDS FROM THE SHIPWRECK OF CAPE RATAČ (ISLAND OF KOLOČEP, CROATIA)	479
TOPIĆ Nikolina OCULI (CROWN GLASS) FROM ARCHAEOLOGICAL EXCAVATIONS IN THE DUBROVNIK REGION	490
FINN Claire DRINKING GLASSES AND THE CONSTRUCTION OF IDENTITY IN THE 17 <sup>TH</sup> -CENTURY DUTCH REPUBLIC	498
STOLYAROVA Ekaterina GLASS BEADS FROM THE BARROW GRAVE IN THE GREATER MOSCOW AREA DATED FROM 17 <sup>TH</sup> AND 18 <sup>TH</sup> CENTURY	505



**18<sup>TH</sup>–19<sup>TH</sup> Century Glass**

LIKHTER Julia A., VEXLER Alexander G., SUDAREV Nikolay I. TRACES OF GLASS BEAD PRODUCTION IN 18 <sup>TH</sup> CENTURY MOSCOW	512
GRATUZE Bernard LES PREMIERS VERRES «CRISTAL AU PLOMB» PRODUITS EN FRANCE PAR BERNARD PERROT: CONTEMPORAINS DE CEUX DE RAVENSCROFT?	519
MARTINHO Bruno A., VILARIGUES Márcia THE GLASS COLLECTION OF KING FERDINAND II OF PORTUGAL – ASSEMBLING THE PUZZLE	526
RATAJ Jože THE GLASS INDUSTRY IN THE REGIONS OF CELJE AND KOZJANSKO FROM THE MID-17 <sup>TH</sup> CENTURY TO PRESENT DAY	534
VAN GIFFEN N. Astrid R., KNOTHE Florian CHINESE PICTORIAL SCREENS. AN INVESTIGATION OF 19 <sup>TH</sup> CENTURY GLASS CANE PANELS	541

**Modern Glass**

BARDIN Christophe LE CIRVA UN OUTIL DE RECHERCHE ET D'EXPÉRIMENTATION AU SERVICE DE L'ART CONTEMPORAIN	548
STRATIS John A., MAKARONA Christina G., CHARALAMPOUS Eleftherios N., KALOGIOURI Natasa P. GLASS, A MATERIAL INDICATOR OF HUMAN ADVENTURE: A HOLISTIC VIEW	554
MAVROMICHALI Katerina THE HISTORY OF GLASS IN THE CZECH LANDS AND CONTEMPORARY DYNAMICS IN THE MANAGEMENT OF CULTURAL HERITAGE	562
INDEX OF AUTHORS	569

Sylvia FÜNFSCILLING

## **PREFACE**

Every third year our members and colleagues gladly await the newest annales of the AIHV congresses. Finally, we can yet again hold another volume, the annales of the 19<sup>th</sup> congress of our society. Our many thanks go to the authors, the scientific committee, the editors and the countless helping hands who took part in developing this publication. Special thanks go to Irena Lazar: her tireless efforts on all levels of the organisation could already be felt during the congress and the post-congress-tour.

The 19<sup>th</sup> congress of the AIHV took place from the 17<sup>th</sup> to 21<sup>st</sup> of September 2012 in Piran/Slovenia. The University of Primorska Science and Research Centre and Institute for Mediterranean Heritage was a wonderful host. Thank-you to the city of Piran for making it possible to hold our congress in such a lovely environment as the Trevisini Palace and for the cordial welcome by the city mayor. Countless institutions that supported the congress should be mentioned: the Slovenian Research Agency, the National Museum of Slovenia in Ljubljana, the Dolenjska Museum in Novo Mesto, from

Croatia the Archaeological Museum Zagreb and the Museum of Applied Arts and Crafts in Zagreb, the Archaeological Museum of Split, the Zavicajni Museum in Biograd, the Museum of Ancient Glass in Zadar and the National Archaeological Museum of Aquileia in Italy. We are also grateful to all sponsors and beneficiaries who supported the success of the congress both financially and with their expertise.

Seventy-eight papers were given in two parallel sessions, complemented by seventy-four posters. It was extremely interesting to discover the diversity of the excavations and the material of our colleagues on the Balkan Peninsula, made easily accessible due to the translations into English. The publications about materials from the Balkans are far too poorly known amongst the neighbouring countries in Europe and even less so on other continents due to various reasons, such as language, availability etc. It was therefore a particular pleasure to have the rich results of recent research projects “served on a plate”. Of course, the other regions brought new aspects in antique, Islamic and medieval/modern glass as well.

The interesting papers and posters were ideally complemented by the post-congress tour and the in-congress tours that took us from one highlight to another. The hosting city of Piran, with its winding alleyways, was shown to us in the most loveable way. Very interesting and comprehensive was the museum in Aquileia filled with its most special collection and the impressive basilica with its mosaics. The museums in Slovenia and Croatia presented amongst other things prehistoric pearls (Novo Mesto), glasses from antiquity to the modern age (Ljubljana, Zagreb), finds from shipwrecks (Biograd), as well as form-blown vessels with production signatures (Split), rich burial finds and square bottles with relief on the bottom (Zadar). The reception at each museum was very warm.

The time period of the glass discussed spans from the first millennium BC to the modern age, with the focus, as mentioned earlier, on the Balkans, Greece, Turkey and neighbouring regions. Some papers treated pearls and inlay; many new results were presented about glass- and vessel-production. In all the different periods, the analytical discussion included the subjects of the composition of the glass, its origins and colour. The variety of subjects and the number of given papers indicates the extremely lively discussion that is going on in current research on glass.

The volume at hand contains 69 contributions that span the complete chronological period from the beginning of glass production to the modern age. Starting with the glass in Bronze Age, the papers continue through the Hellenistic period and enlighten especially the Roman period. Several contributions are dedicated to the Byzantine and Islamic glass, although the

Middle Ages and the 17<sup>th</sup> to 20<sup>th</sup> century AD are well represented. Not only glass vessels are discussed but also pearls and window glass, special colours and decorations, as well as glass as a grave good and its production sites and, of course, the composition and origin of the raw material.

During the general assembly, the board was renewed. Anastasios Antonaras is the new general secretary; Maria Grazia Diani and Karol Wight have become new board members. Huib Tijssens, our merited treasurer was re-elected. Marie Dominique Nenna proposed myself as her successor as president of the society. The executive committee consists now of Erwin Baumgartner and Caroline Jackson, as well as the re-elected members Yoko Shindo, Marianne Stern and Lisa Pilosi. There were no changes among the presidents of the national committees, board members too. We would like to thank the whole board for their on-going commitment, especially Marie-Dominique Nenna, who still contributes the largest part of the newsletter after Daniel Keller had to announce his retirement from this assignment.

With great grief, we had to take notice of the deaths of Hubert Cabart, Birgit Klesse, David Whitehouse and Dunja Zobel-Klein.

The preparations for the 20<sup>th</sup> congress are in full swing. It will take place from the 7<sup>th</sup> to 11<sup>th</sup> September in Fribourg and Romont (Switzerland) ([www.aihv2015.ch](http://www.aihv2015.ch)). The focus will be laid on medieval and modern glass. The members of ICOM-Glass will meet at the same time in Fribourg, which hopefully will encourage collaboration between the two institutions.

*Translation Simone Mayer*

Sylvia FÜNFSCILLING

## AVANT-PROPOS

Tous les trois ans, nos membres et collègues ont le plaisir de recevoir les actes des congrès de l'AIHV: ça y est, nous tenons l'exemplaire du 19<sup>ème</sup> congrès entre nos mains. Nous adressons un grand merci aux auteur(e)s, au comité scientifique, aux éditeurs ainsi qu'aux nombreux auxiliaires, qui ont contribué à la publication. Il faut évoquer en particulier Irena Lazar : son engagement insatiable sur tous les plans de l'organisation se laissa déjà remarquer durant le congrès et pendant le tour post-congrès.

Le 19<sup>ème</sup> congrès de l'AIHV a eu lieu du 17 au 21 septembre 2012 à Piran, en Slovénie. L'université Primorska Science and Research Centre and Institute for Mediterranean Heritage s'est avéré être un hôte très accueillant. Il nous faut aussi remercier la ville de Piran : Nous avons pu organiser notre congrès dans un très bel endroit, le palais Trevisini, et avons été reçus chaleureusement par le maire. Il faut nommer également de nombreuses institutions, qui ont soutenu le congrès : la Slovenian Research Agency, le Musée National de Slowénie à Ljubljana, le Dolenjska Museum de Novo Mesto, en Croatie le Musée

Archeologique de Zagreb et le Musée des arts appliqués à Zagreb, le Musée archéologique de Split, le musée Zavicajni de Biograd, le Musée du Verre Antique à Zadar ainsi que le National Archaeological Museum de Aquileia en Italie. Nous remercions finalement tous nos mécènes et contributeurs, qui ont contribué financièrement ou par leur savoir-faire au succès du congrès.

En deux sections parallèles, nous avons écoutés 78 exposés. Ceux-ci ont été complétés par 74 contributions sur poster. Cela a été grandement intéressant de pouvoir découvrir les fouilles variées de nos collègues des Balkans ainsi que leur matériel, et ça avec un accès facilité grâce aux traductions en anglais! Les publications concernant les Balkans sont, de façon générale dans les pays voisins d'Europe ou sur d'autres continents, trop peu prises en compte – à cause de plusieurs facteurs, comme la langue, la disponibilité des publications, etc. C'était par conséquent un d'autant plus grand plaisir de recevoir des résultats complets « tout frais ». A côté de ça, les autres régions ont également permis de porter un nouveau regard

sur le verre antique, islamique et médiéval/d'époque moderne.

Les exposés et posters intéressants ont été complétés au mieux par l'excursion d'après le congrès ainsi que par les excursions durant la semaine, qui nous ont menés de point fort en point fort. La ville hôte de Piran avec ses petites rues tortueuses nous a été présentée avec un soin particulier. Aquilée, avec son musée comprenant une collection exceptionnelle ainsi que l'impressionnante basilique, s'est montrée une ville très intéressante et complète. Les musées en Slovénie et en Croatie présentèrent entre autres des perles préhistoriques (Novo Mesto) ainsi que des verres de l'Antiquité jusqu'à l'époque moderne (Ljubljana, Zagreb), des objets d'épaves de navires (Biograd) ainsi que des récipients formés par moule avec signatures des producteurs (Split) et de riches objets de tombes ainsi que des bouteilles carrées avec marques sur les fonds (Zadar). Les accueils dans les musées respectifs ont été très chaleureux.

La période du verre traité couvrait du premier millénaire av. J.-C. jusqu'à l'époque moderne. L'attention était portée, comme déjà évoqué, sur les Balkans, la Grèce, la Turquie et les régions limitrophes. Certaines contributions ont traité des perles ainsi que des travaux d'incrustation, de nombreuses découvertes concernant la production du verre et de récipients ont pu être mises en valeur. En complément, des questions sur la composition du verre, de son origine et de sa couleur ont pu être analysées à travers tous les âges. La thématique variée et le nombre des contributions montrent clairement que la recherche du verre est remarquablement foisonnante.

Le rapport ci-joint comprend 69 contributions, qui comportent l'entier de la chronologie, des débuts de production du verre jusqu'à l'époque moderne. Ils commencent au verre de l'âge du Bronze, touchent à l'époque hellénistique et

mettent l'accent particulièrement sur l'époque romaine. Plusieurs contributions sont consacrées au verre byzantin et islamique, mais l'époque médiévale ainsi que les 17<sup>e</sup> au 20<sup>e</sup> siècles sont bien représentés. Autant des récipients en verre que des perles et du verre de fenêtres sont thématiques, mais aussi du verre comme offrande de tombe, des ateliers et naturellement la composition et l'origine des matériaux bruts.

Durant l'assemblée générale, le conseil a été renouvelé. Anastasio Antonaras est nouvellement secrétaire général, Maria Grazia Diani et Karol Wight sont nouveaux membres du conseil. Huib Tijssens, notre méritant trésorier, a été à nouveau élu. Marie Dominique Nenna a proposé ma personne en tant que successeur de la présidence. Erwin Baumgartner et Caroline Jackson sont nouveaux membres du comité exécutif; les places des autres représentants, Yoko Shindo, Marianne Stern et Lisa Pilosi, ont été confirmées. Pour ce qui concerne le président des comités nationaux (eux aussi membres du conseil), aucun changement n'est à noter. Nous adressons nos remerciements à tous, en particulier à Marie-Dominique Nenna pour son engagement, qui se fait toujours sentir par sa gestion de la plus grande partie de la newsletter, après que Daniel Keller a annoncé son retrait de cette fonction.

Nous avons avec le plus grand chagrin pris connaissance des décès de Hubert Cabart, Birgit Klesse, David Whitehouse ainsi que de Dunja Zobel-Klein.

Les préparations pour le 20<sup>ème</sup> congrès battent leur plein. Celui-ci aura lieu du 7 au 11 septembre à Fribourg et à Romont (Suisse) ([www.aihv2015.ch](http://www.aihv2015.ch)). L'attention sera centrée sur le verre médiéval et moderne. Les membres de l'ICOM-glass se rencontreront parallèlement à Fribourg, afin de consolider le travail en commun entre les deux institutions.

*Traduction Johann Savary*

Sylvia FÜNFSCHILLING

## VORWORT

Alle drei Jahre freuen sich unsere Mitglieder sowie Kollegen auf die Akten der Kongresse der AIHV: nun ist es wieder soweit, wir halten den Band des 19. Kongresses unserer Gesellschaft in Händen. Den Autorinnen und Autoren, dem wissenschaftlichen Komitee, den Editoren sowie den zahlreichen helfenden Händen, die an der Entstehung der Publikation mitbeteiligt waren, ist höchster Dank auszusprechen. Besonderer Erwähnung bedarf Irena Lazar: ihr unermüdlicher Einsatz auf allen Ebenen der Organisation war bereits während des Kongresses und während der Post-Kongress-Tour spürbar.

Der 19. Kongress der AIHV fand vom 17.-21. September 2012 in Piran/Slowenien statt. Die Universität Primorska Science and Research Centre and Institute for Mediterranean Heritage war ein wundervoller Gastgeber. Dank auszusprechen ist der Stadt Piran, wir durften in einer sehr schönen Umgebung, im Trevisini Palace, unseren Kongress abhalten und wurden vom Bürgermeister herzlich empfangen. Zahlreichen Institutionen ist zu danken, die den Kongress unterstützt haben: der

Slovenian Research Agency, dem Slowenischen Nationalmuseum in Ljubljana, dem Dolenjska Museum in Novo Mesto, dem Archäologischen Museum Zagreb, dem Archäologischen Museum Split, dem Zavičajni Museum Biograd in Biograd na moru, dem Museum für antikes Glas in Zadar sowie dem Nationalen Archäologischen Museum in Aquileia/Italien. Zu Dank verpflichtet sind wir den Sponsoren und Gönnern, die finanziell und mit know-how das Gelingen des Kongresses unterstützt haben.

In zwei parallelen Sektionen hörten wir 78 Vorträge. Ergänzt wurden diese durch 74 Beiträge auf Postern. Es war ausserordentlich interessant, die vielfältigen Ausgrabungen und deren spannendes Material unserer Kollegen auf dem Balkan entdecken zu können, mit erleichtertem Zugang durch die Übersetzungen ins Englische! Die Publikationen den Balkan betreffend werden – aufgrund mehrerer Ursachen, wie Sprache, Verfügbarkeit usw. – in den benachbarten Ländern Europas oder gar auf anderen Kontinenten oft wenig zu Kenntnis genommen. Es war deshalb ein besonderes Vergnügen, die reichhaltigen und

spannenden Ergebnisse „frisch auf den Tisch“ zu bekommen. Aber auch die übrigen Regionen boten neue Einblicke in antikes, islamisches sowie mittelalterlich/neuzeitliches Glas.

Die interessanten Vorträge und Poster wurden auf's Beste ergänzt durch die Postcongress-Tour sowie Ausflüge während der Woche, die uns von Höhepunkt zu Höhepunkt führten. Die Gastgeberstadt Piran mit seinen verwinkelten Gassen wurde uns besonders liebevoll nahegebracht. Sehr interessant und reichhaltig zeigte sich Aquileia, das Museum mit seiner ausserordentlichen Sammlung wie auch die eindrückliche Basilika mit ihren Mosaiken. Die Museen präsentierten u.a. prähistorische Perlen (Novo Mesto) sowie Gläser von der Antike bis zur Neuzeit (Ljubljana, Zagreb), Funde aus gestrandeten Schiffen (Biograd) ebenso wie formgeblasene Gefässe mit Herstellersignaturen (Split) und reiche Grabfunde sowie vierkantige Flaschen mit Bodenmarken (Zadar). Die Empfänge in den jeweiligen Museen waren sehr herzlich.

Die zeitliche Spanne des behandelten Glases reichte vom ersten Jahrtausend vor Chr. bis zur Moderne. Der Fokus lag – wie bereits erwähnt – auf dem Balkan, auf Griechenland und der Türkei und angrenzenden Regionen. Einige Beiträge behandelten Perlen sowie Einlegearbeiten, zahlreiche neue Erkenntnisse konnten bei der Glas bzw. Gefässproduktion gewonnen werden. Ergänzend durch alle Zeiten wurden Fragen zur Komposition des Glases, dessen Herkunft, Farbe analytisch beleuchtet. Die unterschiedliche Thematik und die Vielzahl der Beiträge zeigen deutlich, dass die Glasforschung ausserordentlich lebendig ist.

Der vorliegende Band umfasst 69 Beiträge, die die gesamte chronologische Spanne von den Anfängen der Glasverarbeitung bis zur Moderne umfassen. Sie beginnen beim bronzezeitlichem

Glas, streifen die hellenistische Zeit und beleuchten besonders die römische Epoche. Mehrere Beiträge sind dem byzantinischen und islamischen Glas gewidmet, aber auch die mittelalterliche Epoche, sowie das 17.-20. Jahrhundert sind gut vertreten. Sowohl Glasgefässe kommen zur Sprache, wie auch Perlen und Fensterglas, spezielle Farben und Verzierungen, aber auch Glas als Grabbeigabe sowie Ateliers und natürlich Komposition und Herkunft des Rohmaterials.

Während der Generalversammlung wurde das board erneuert. Anastasios Antonaras ist neuer General Sekretär, Maria Grazia Diani und Karol Wight wurden neue board members. Huib Tijssens, unser verdienter treasurer wurde wiedergewählt. Marie Dominique Nenna schlug meine Person als ihre Nachfolgerin für die Präsidentschaft vor. Im Exekutive Komitee sitzen neu Erwin Baumgartner und Caroline Jackson, die übrigen Vertreter wie Yoko Shindo, Marianne Stern und Lisa Piloni wurden bestätigt, bei den Präsidenten der nationalen Komiteen gab es keine Änderungen. Wir danken allen, insbesondere Marie-Dominique Nenna, für ihr Engagement, das immer noch andauert: steuert sie doch den weitaus grössten Teil zum newsletter bei, nachdem Daniel Keller seinen Rücktritt von dieser Aufgabe bekannt geben musste.

In tiefer Trauer mussten wir den Tod von David Whitehouse, Hubert Cabart, Birgit Klesse sowie Dunja Zobel-Klein zur Kenntnis nehmen.

Die Vorbereitungen für den 20. Kongress laufen auf Hochtouren. Er wird vom 7. bis 11. September in Fribourg und Romont (Schweiz) stattfinden ([www.aihv2015.ch](http://www.aihv2015.ch)). Der Focus wird dabei auf dem mittelalterlichen und modernen Glas liegen. Die Mitglieder von ICOM-Glass werden sich ebenfalls in Fribourg treffen, auf dass die Zusammenarbeit zwischen den beiden Institutionen gestärkt werde.

SILVANO Flora

## GLASS PRODUCTION IN ANTINOOPOLIS, EGYPT

### INTRODUCTION

Located in Middle Egypt, 286 km south of Cairo, on the east bank of the Nile, the ancient city of Antinoopolis was founded by Hadrian in AD 130, in memory of his beloved Antinoos.<sup>1</sup> In the 2<sup>nd</sup> and 3<sup>rd</sup> century AD, the town, which enjoyed great favour from several Roman emperors, must have been one of the most beautiful towns in Upper Egypt. Parts of this splendor, such as the theatre, a triumphal arch and a hippodrome were still standing at the time of the Napoleonic Expedition to Egypt. The city survived until the 8<sup>th</sup> century AD.

The excavations carried out by the Istituto Papirologico “G. Vitelli” (University of Florence) since 2007 have uncovered several thousand glass fragments that represent important material for the study of Late Roman and Early Byzantine glass in Egypt.<sup>2</sup> Under the direction of Rosario Pintaudi, the archaeologists have been digging in two different parts of the town:

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1 Pintaudi 2008.

2 Silvano 2012, 272-276.

the northern necropolis and a vast area in the southeast quarter of the town, where a large basilica with five naves and another church were unearthed. Over 3000 glass fragments were found in these two areas. The amount of glass finds is not surprising considering that, under Diocletian (AD 286), the town became the capital of the Thebaid nome and flourished in the 4<sup>th</sup> and 5<sup>th</sup> century.

Local workshops must have produced at least part of such a large glass assemblage; these workshops, intended for the fashioning of glass vessels and objects, must have been located either inside the city or in the neighbourhood in order to supply the daily demand of tableware, lamps, cosmetic containers and window panes. This big city must have had an area used for craft and industrial activities with workshops for glass working as the numerous chunks of unworked or raw glass found all over the city seem to prove.

The archaeological evidence suggests the presence of a glass industry in different parts of Egypt where raw glass production was sepa-



rated from vessel manufacturing; raw glass production centres were usually located near raw materials, such as the natron of the Wadi Natrun, while workshops for the fashioning of glass vessels were usually situated in the industrial area of the city.<sup>3</sup> Three primary glass production sites of the 1<sup>st</sup>–2<sup>nd</sup> century AD were identified in the Wadi Natrun region (Beni Salama, Bir Hooker and Zakik).<sup>4</sup> These are the best-preserved raw glass furnaces discovered so far in Egypt and in the Near East, and are also the oldest furnaces of this kind, confirming Egypt's importance in the production and trade of glass between the East and the West during the Greek-Roman Period.<sup>5</sup> Two other primary workshops were found on the shores of Lake Mariout, near Alexandria (Tapisiris Magna and Marea-Philoxenité),<sup>6</sup> and another in North Sinai.<sup>7</sup>

Primary glass, made on big slabs, was then broken up into chunks and distributed to the secondary glass workshops where it was reheated and manufactured into various shapes. Many finds indicate glass vessel production at different Egyptian sites.<sup>8</sup>

Excavations have unearthed remains of glass workshops, including traces of furnaces, chunks of raw glass brought for melting, debris from glassblowing activities and a concentration of similar types of vessel in large quantities. Examples of such installations have been unearthed at Kom el-Dik in Alexandria<sup>9</sup> and Marea-Philoxenité along the southern bank of Lake Mariut, near Alexandria.<sup>10</sup>

#### SECONDARY GLASS WORKSHOP IN ANTINOOPOLIS

An area probably linked to glass working has been found in the southern part of Antinoopolis (sector III, zone XII); three small rounded kilns



*Fig. 1: Kilns 1 and 2 along the river bank.*

were discovered near the Nile bank. Two kilns were built next to each other (Fig. 1). The kilns have a roughly circular structure: the interior diameter of Kiln 1 is approximately 0.96 m; its preserved depth is 0.29 m ca.

At first we were reluctant to assume that these very small kilns were used to make glass; it is more likely that they were used to melt raw glass chunks and recycled glass shards to make glass objects. No trace of glass has been found on the walls of the kilns, which were covered by a thick lime coating. This particularity is not common, but it has been found, for instance, in three circular kilns in ancient Edessa, an important city of Macedon,<sup>11</sup> and in a furnace from the late 6<sup>th</sup> century<sup>12</sup> in Thessaloniki.

In 2007 and 2009 a survey near this area carried out by P. Ballet, M.C. Guidotti and myself, unearthed several chunks of unworked or raw glass;<sup>13</sup> the assemblage from zone XII (XII A, B, C, D) includes 47 examples with most of them derived from zone XII D (Fig. 2), which is nearest to the kilns. These are cube-like in shape and range in size from 0.9 to 4–4.5 cm on one side. The raw glass chunks come in three distinct colours: most of them are of bluish-green hues; some are light green; others are dark translucent green. A fine, clear fabric, lacking in bubbles characterizes the glass; some pieces display a lower quality fabric that are less clear with lime impurities. None of the

3 Nenna, Picon, Vichy 2000, 107-112.

4 Nenna, Picon, Thirion-Merle, Vichy 2005, 59-63.

5 Nenna 2008b, 61-66.

6 Nenna, Picon, Vichy 2000, 110.

7 Nenna 2014, 178-193.

8 Nenna 2012, 309-325, fig. 1.

9 Rodziewicz 1984, 239-243; Kucharczyk 2007, 45-46.

10 Nenna, Picon, Vichy 2000, 110; Nenna 2012, 310-312.

11 Antonaras, Chrysostomou 2015, 293.

12 Antonaras 2014, 95-113. I would like to thank my friend and colleague for a very stimulating discussion about this technical particularity.

13 Ballet, Guidotti 2014.



Fig. 2: Chunks of raw glass, furnace debris and melted green glass from zone XIID.



Fig. 3: Remains of the glass making furnace.

fragments bear direct evidence of the crucible or melting pot. The chemical analysis of a selection of chunks is in the process of being carried out.

Large quantities of raw glass are usually found around glass workshop locations: they represent primary glass probably made elsewhere and then brought to the site to be worked. Although this site, located near the river and areas of cultivation, has been severely damaged by local farmers over the centuries, its proximity to the water and the pottery workshops found further south in zone V<sup>14</sup> seems to confirm that this place was part of an industrial estate inside the city walls, located near the theatre. Raw glass chunks were usually traded and purchased to be melted again in furnaces.<sup>15</sup> The artisans probably melted the raw glass chunks in these

14 Ballet, Guidotti 2014.

15 Nenna 2008a, 125-147.

three small furnaces and worked the hot glass to make vessels and other objects.

Surface finds retrieved from the area surrounding the site also included 9 fragments of furnace debris; these are pieces of dismantled glass furnaces showing the conglomerate structure with some veins of partially-vitrified glass and opaque layers. The site also yielded fragments of the furnace floor with a glass layer on top. Fragments of Islamic glazed pottery were also recovered from this area as well as a 9<sup>th</sup> century coin found in zone XII A.<sup>16</sup>

Missing from the survey in zone XII are the most diagnostic remains of glass blowing, such as glass drops or deformed vessels, which would indicate the presence of a furnace; the only exception is one piece of melted green glass from zone XIID (Fig. 2).

#### PRIMARY GLASS WORKSHOP IN ANTINOOPOLIS

There is another area in Antinoopolis, in addition to the area along the riverbank, which is very closely connected to glass production. It is located in the middle of sector II of the town, between *decumanus* and Wadi Abada. Here, a glassmaking furnace (Fig. 3) was discovered, probably dated back to late antiquity, considering the numerous fragments of Islamic glazed pottery unearthed in the proximity during the survey.<sup>17</sup> It was a primary workshop for the manufacture of the material, built on the pieces of pottery scattered all over the site, which indicates a later construction.

The furnace remains were so badly damaged that it was impossible to determine its layout and appearance; only a part of the furnace survived and was built with bricks and stone blocks in different stages (approximate preserved length 2.50 m; preserved width 2.10 m; preserved height 2.40 m), whereas a big piece on the eastern side had collapsed. A layer of melted glass,

5-6 cm thick, covered part of the floor of the melting chamber (Fig. 4); the glass was green, transparent and with few bubbles or other impurities. The chemical analysis of the material,

16 Ballet, Guidotti 2014.

17 Ballet, Guidotti 2014.

carried out by Soprintendenza Archeologica della Toscana,<sup>18</sup> revealed that the glass failed to melt completely and the manufacturing process was not entirely complete. As a result, the glass was left there.

A tiny glass sample has been analysed to establish its chemical composition. For this purpose, energy dispersion microanalysis has been used (EDX: EDAX, DX-4), coupled with a microscopy electron scan (SEM: FEI, Quanta 200).

A sample was collected from the transparent part of a light green fragment, featuring sub-spherical white opaque areas of ~ 1 mm dimension.

The chemical analysis highlighted a Na-Ca composition with a different ratio for the two portions of glass: transparent and opaque. The transparent portion is highly similar to Roman glass, which usually has a SiO<sub>2</sub> content of around 60-70%, Na<sub>2</sub>O in the range of 14-22% and CaO between 4 and 10% (Table 1).<sup>19</sup> The different portions of the object vary in the ratio between Na<sub>2</sub>O and CaO, and the opacity is explained by calcium density. The material can therefore, be described as an intermediate phase of the vetrification process: a raw glass with non-completely homogenised fractions.

In October 2012, a large number of raw glass chunks and fragments of furnace debris were discovered a few hundred meters southwest of this furnace installation; the glass chunks are in three distinct colors. The first is bluish-greenish (29 ex.), the second light green (10 ex.) and the third black (4 ex.). Several pieces of dismantled glass furnaces were unearthed in the same area: they show a structure with transparent glass on top, a layer of partially vetrified glass and remains of furnace floor on the lower part (Fig. 5). The color is light blue, transparent in the upper part and opaque in the lower part that is closest to the floor of the furnace; a possibile explanation for this is that artisans removed the trans-

18 Analysis carried out by P. Pallecchi and G. Giachi from Soprintendenza Archeologica della Toscana, Lab. di analisi, L.go del Boschetto 3, 50100 Florence.

19 De Francesco, Ciarallo, Scarpelli, Vite, 2010.



Fig. 4: Detail of the furnace floor.



Fig. 5: Glass debris discovered in 2012.

parent glass of the upper part, where the temperature was higher, leaving the opaque layer on the furnace floor. Something similar can be seen on a fragment of furnace debris from Taposiris Magna.<sup>20</sup> Another possible explanation is that raw materials were added to the melting chamber in stages so that the raw glass was melted in layers rather than all at once.<sup>21</sup>

20 Nenna, Picon, Vichy 2000, 103, fig. 19.

21 Also one of the large glass chunks from Tyre showed two distinct layers (see Aldsworth, Haggarty, Jennings, Whitehouse 2002, 65, fig. 18).

	Percentage Composition				
	Transparent portion			Opaque portion	
Na <sub>2</sub> O	27,24	23,00	25,33	9,09	6,14
MgO	0,00	0,00	0,00	2,63	2,52
Al <sub>2</sub> O <sub>3</sub>	2,01	3,73	4,47	3,00	3,20
SiO <sub>2</sub>	68,60	66,63	65,69	41,10	60,74
Cl <sub>2</sub> O	1,20	1,30	1,02	4,96	1,91
K <sub>2</sub> O	0,21	0,25	0,10	2,06	1,62
CaO	4,98	4,77	3,23	35,96	23,09
Fe <sub>2</sub> O <sub>3</sub>	0,60	0,33	0,16	0,59	0,78

Table 1: The chemical composition of the glass sample from Antinoopolis. The components are given as weight percent.

Usually, a mixture of raw materials was placed on the floor of the melting chamber before the manufacturing process began. When all raw materials were melted, the glass was allowed to cool down in the melting chamber itself. After that, the large solidified glass tile was broken up into chunks; only the transparent part was removed and sent to secondary workshops.

For this reason, the debris found here from the glassmaking process confirms the use of this area for primary glass production.

Due to the high temperature at which they functioned, the furnaces probably had relatively short life spans. The furnaces were dismantled after each firing and could be reconstructed in the same place, as in Wadi Natrun, or moved to another place, as in Bet Eliezer. Further excavations will be needed to obtain a more accurate identification of the structure, to understand its importance and the nature of production in the town. Additionally, a comparison with other similar buildings, if there any are still remaining, would be useful.

#### CONCLUSIONS

The evidence gathered from the Antinoopolis site suggests that some glass vessels and objects were made in the southern industrial suburb along the river, near the pottery workshops. Further surveys and more careful excavations will be needed to fully understand the working

area located inside the town walls. At present, it is not certain when this area was used. However, it is surprising that there was just one characteristic of glass working waste. Some raw glass chunks found in zone XIID of the town will be analyzed to understand their origin.

The glass furnace, in the middle of sector II of the town, was certainly a structure used to make raw glass; the chemical analyses of the material revealed a failure in production and the glass found on the floor of the melting chamber was probably left there as a result of this unfinished process.

Continued excavations and documentation related to primary and secondary workshops in the city and its environs should help us gain a more complete picture about glass making and glass working in Antinoopolis and in Middle Egypt; the finds from Hermopolis Magna,<sup>22</sup> on the other side of the river Nile, could suggest a system of glass production and distribution which probably originated in a few locations.

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<sup>22</sup> Bimson, Freestone 1991, 64-65.

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