

STUDI MICENEI ED EGEO-ANATOLICI NUOVA SERIE

2, 2016

STUDI MICENEI
ED EGEO-ANATOLICI
NUOVA SERIE

è una rivista dell'Istituto di Studi sul Mediterraneo Antico
del Consiglio Nazionale delle Ricerche, Roma

ISSN 1126-6651
e-ISBN 978-88-7140-762-3

Direttore / Editor

Anna D'Agata (ISMA, CNR, Roma)

Comitato Editoriale / Editorial Board

Silvia Alaura (ISMA, CNR, Roma)
Marco Bettelli (ISMA, CNR, Roma)
Marco Bonechi (ISMA, CNR, Roma)
Maurizio Del Freo (ISMA, CNR, Roma)
Francesco Di Filippo (ISMA, CNR, Roma)
Andrea Di Renzoni (ISMA, CNR, Roma)
Yannis Galanakis (University of Cambridge)
Luca Girella (Università Telematica Internazionale Uninettuno, Roma)

Comitato Scientifico / Advisory Editorial Board

Mary Bachvarova (Willamette University, Salem, Oregon)
Marie-Louise Bech Nosch (University of Copenhagen)
Fritz Blakolmer (University of Vienna)
Harriet Blitzer (Buffalo State College, New York)
John Bintliff (Leiden University)
Eva von Dassow (University of Minnesota)
Birgitta Eder (Austrian Academy of Sciences, Vienna)
Fikri Kulakoğlu (University of Ankara)
Maurizio Giangiulio (Università di Trento)
Carl Knappett (University of Toronto)
Peter Pavúk (Charles University, Prague)
Jeremy B. Rutter (Dartmouth College)
Recai Tekoğlu (Dokuz Eylül University, Izmir)
Andreas Vlachopoulos (University of Ioannina)
Helène Whittaker (University of Gothenburg)

Stampa e distribuzione / Printing and distribution

Edizioni Quasar di Severino Tognon s.r.l.
Via Ajaccio 41-43 – 00198 Roma
tel. +39 0685358444, fax +39 0685833591
email: info@edizioniquasar.it
www.edizioniquasar.it

© CNR - Istituto di Studi sul Mediterraneo Antico (ISMA)
Area della Ricerca di Roma 1, Via Salaria Km 29,300, 00015 Monterotondo scalo (Roma)
Autorizzazione Tribunale di Roma nr. 288/2014 del 31.12.2014

SOMMARIO

<i>James M. Burgin</i> Graphical Origins of ‘Initial- <i>A</i> -Final’ in Hieroglyphic Luwian	7
<i>Mojca Cajnko</i> On Local Particles as Spatial Case Markers in Hittite	33
<i>Jarrett L. Farmer, Michael F. Lane</i> The Ins and Outs of the Great Megaron: Symbol, Performance, and Elite Identities around and between Mycenaean Palaces	41
<i>Silvia Ferrara, Judith Weingarten, Gerald Cadogan</i> Cretan Hieroglyphic at Myrtos-Pyrgos	81
<i>Francesco Iacono</i> Value, Power, and Encounter between the Eastern and Central Mediterranean during the Late Bronze Age	101
<i>Barbara Montecchi</i> <i>pu-ro, pa-ki-ja-na/ne</i> , and the Sanctuary of Poseidon at Pylos	119
<i>Massimo Maiocchi</i> Exploratory Analysis of Cuneiform Archives: A Network Approach to Ebla Texts	137

EXPLORATORY ANALYSIS OF CUNEIFORM ARCHIVES: A NETWORK APPROACH TO EBLA TEXTS*

Massimo Maiocchi

Summary

The article investigates the possibilities offered by network analysis applied to the field of cuneiform studies. Focusing on the archive of Ebla, dated to the middle of the third millennium BC, the author tries to examine the usability of this new technique in terms of establishing the relative chronology of the documents unearthed there, as well as finding joins via network connections of fragmentary texts. In doing so, the paper stresses the necessity of expanding current methodologies in Assyriological research, as to include scripting for processing large datasets – a technique rarely adopted in Ancient Near Eastern studies, but with a great potential for the future of this field of research.

1. INTRODUCTION

Network analysis has gained popularity among Assyriologists in very recent years. Surprisingly enough, two papers devoted to this topic were read at the 2012 Rencontre Assyriologique Internationale held in Leiden (Waerzeggers 2012; Still 2012). Pioneering research in this direction has been carried out especially by C. Waerzeggers (2014), whose article concerned with Neo-Babylonian texts inspired the remarkable work of Abraham *et al.* (2014). In the same direction goes the research of Anderson (forthcoming), exploring Old Assyrian archives from the point of view of social network analysis. A similar methodology has been used by Cline and Cline to study the Amarna archive (2015). However, most of the data regarding the application of network analysis to cuneiform texts are still unpublished. Nevertheless, it is noteworthy that this approach has already been adapted to very different scenarios, despite of the novelty of this methodology. As far as cuneiform studies are concerned, network analysis has been used in order to:

- achieve a better understanding of interactions between agents, be they either people attested in letters and administrative documents, or lexicographical variations of words in a text corpus;
- identify tablets as belonging to unprovenanced archives, based on prosopographical data from large text corpora;
- frame tablets within a relative chronology on the basis of the communities of people mentioned in the texts;
- establish a genealogy of literary documents.

This variety of approaches (many more will no doubt come in the forthcoming years) is no doubt motivated by the fact that network science was developed in the first place to handle very big data sets, which is exactly the situation scholars involved in cuneiform studies face today (large number of texts, of actors, of interactions). Network analysis

* The argumentation offered in the present article is meant to be complemented by a set of digital files, freely accessible through the SMEA NS website, <http://smea.isma.cnr.it>. More in detail, the digital package includes:

a. The network graph shown in Fig. 7, distributed as a Gephi file. This allows transparent access to the data discussed below. In addition, users can magnify the graph if need be, in order to achieve a better understanding of the relationships among graph entities, which are notably hard to capture on paper. Needless to say, this also allows for the possibility to perform further analytical research.

b. A Perl script for the generation of the complex networks described in this article. As the script can be easily adapted to operate on other scenarios, the author believes this may substantially promote similar studies based on other text corpora.

c. Sample input transliterations. The file is merely meant to provide a concrete example on how input data should be structured in order for the script to run correctly.

All files are distributed as open source software (GNU General Public license v. 3.0).

heavily relies on mathematics and computational methods, and is presently being applied in very disparate fields, such as particle physics, electrical engineering, biology, economics, marketing, sociology, anthropology, communication technology, etc.¹ All these fields share the fact that they deal with either complex or complicated systems. The distinction is crucial here: whereas complexity is the result of a bottom-up organization of elements, as one can observe for instance in a snow crystal, complicatedness takes the other way around, being the product of a top-to-bottom imposition of relationships (Érdi 2008). Complex systems can usually be described by few simple productive rules, whereas complicated systems are characterized by a larger amount of rules that have a more limited scope. Complex systems are inherently simple, complicated ones are difficult, and largely non-reducible to simple structures. When dealing with the products of human culture, conceived as both material and immaterial artefacts, the situation is clearly a mixed one. As it is true that society (both ancient and modern) may be regarded as a self-organizing structure subject to environmental pressure, it is equally clear that, once it gains a given set of infrastructural and cultural elements, it may behave as a top-bottom organization. This class of systems has been defined as “wicked”, stressing the fact that the methodologies that apply to either complex or complicated systems may only loosely apply to them (Andersson, Törnberg, Törnberg 2014, 146-148). Network analysis of cuneiform texts may thus be equally described as a “wicked” science, not only because of the nature of the systems it aims to study, but also because of the inherent limitations it suffers. Even in the best case scenario, such as the Ebla texts found *in situ* in their almost intact original spatial collocation, cuneiform archives don’t document every single aspect of ancient life. Instead, they record only information relevant to the institution that produced those very documents, invariably restricted in scope. Therefore, we certainly miss more than one node in any possible reconstruction of the ancient social network.² Homonymy adds a further element of difficulty, as it is often hard, if not impossible, to decide whether the documents mention two namesake individuals or one and the same person in different capacity. Hypochoristica and variations in spellings are equally problematic: do slightly different names refer to distinct individuals or not? Even with all this limitations in mind, I believe that is possible to successfully apply Social Network Analysis (SNA) to cuneiform archives to achieve statistically sound results, and most of all, to provide scholars with a powerful tool that enables exploratory data analysis.

2. SOCIAL NETWORK ANALYSIS: BASIC CONCEPTS

Social network analysis is a sub-field of network science that studies the connections between a set of related entities, such as for instance a group of individuals belonging to the early city administration. Visually, these entities may be represented as dots (nodes) in a graph, whereas their mutual interactions as edges connecting them. The terminology to these basic constituents of network theory in fact varies depending on authors and primary scope of application. Thus in mathematics one often speaks of vertexes instead of nodes. Similarly, edges are referred to also as arcs, links, ties, or simply connections. Once the information on these entities is properly structured, one may apply quantitative methods to measure network properties, and use dedicated software for visually render the data network in form of a graph. Scholars may be for instance interested to know how large, complex, or solid a network is, or how many sub-groups of actors (communities) one may spot, or again how much it relies on a central core, etc. The key concepts in network science have already been presented to Assyriological audience in the above mentioned articles by Waerzeggers (2012; 2014) and Abraham *et al.* (2014).³ Here, I may briefly summarize some of them, adding a few general comments that complement their observations, pinpointing at the same time what research techniques appear to me best suited for historical analysis. The complex mathematics that makes possible a quantitative evaluation of these concepts is beyond the scope of this article, as well as of the expertise of its author. Consequently it will only be hinted at in the following discussion.

1 For a detailed treatment of the development of network science see Freeman 2004.

2 As already recognized by Waerzeggers 2014, 225-226.

3 Waerzeggers 2014, 210-213; Abraham *et al.* 2014, 120-122.

Bridges: this term refers to those crucial nodes that link otherwise disconnected areas of the network. Bridges are interesting because they may refer to people having diverse access to human resources, like for instance high-status officials in charge of crucial administrative sectors.

Cliques: local groups of nodes that are well interconnected, but only loosely connected to the rest of the network. Guild workers, concubines in a harem, prisoners of war are all examples of cliques.

Clustering: also known as community or cliques detection. This technique is usually performed to automatically group nodes that are closely tied to one another (unsupervised clustering).⁴

Density: this is a measure of how well connected a network is. A network having every single node connected to any other (also known as a complete graph) has a density of 100%; a network of isolated nodes has density 0%. Cliques tend to have high local density (see above).

Centrality: it is an index that spots the most important nodes within a network. Depending on how one defines importance, different calculations in fact apply. Thus, *degree centrality* spots the nodes that are crucial points of passage; *closeness centrality* spots those nodes that are more deeply rooted within the network; *betweenness centrality* spots nodes that function as bridges (see above); etc.

In-degree: it is the measure of how many edges point to each node (in a network of individuals this is equivalent to their relative popularity).

Out-degree: it is the measure of how many connections a node has (equivalent to friendship or gregariousness).

Matrix: is a table containing all the necessary information to produce a network graph, in which nodes represent a given entity (persons, email addresses, molecules, etc.). A matrix can be thought of in terms of a contingency table, having the same variable on both axes. In case of a network of physical persons, the variable may be the personal name, or rather an identification number used to differentiate possible homonyms. The intersection between rows and columns contains a number equal to the frequency of interactions between two given individuals.⁵

A more prosaic description of topographic features, such as a broad evaluation of core and periphery may also shed light on the kind of administration performed at Ebla. Low-ranking individuals are expected to have fewer connections with the core, a clique in the periphery may indicate a peripheral office, etc.

3. THE EBLA DATASET

Obviously, the first step in the creation of a network graph is collecting data. In the case of Ebla, the EbDA project, of which I am associate editor, provides the digital edition of thousands of documents.⁶ Conforming to the EbDA database standards, transliterations have been enhanced as to include semantic information on discrete classes of 'objects', such as text reference, personal and divine names, toponyms, etc. Users can therefore restrict queries to any of these domains – a feature that, combined with the possibility of using regular expres-

⁴ Algorithms that perform this task are for instance Girvan Newman Clustering and Markov Cluster Algorithm. Clustering may be a computationally demanding process. Depending on the strategy put in place for spotting communities, and to the resolution to do so (recognizing for instance very small communities in very large network), the time necessary varies with the square of the number of nodes. For large networks, both algorithms may end up being impractical. Modularity clustering is instead a relatively fast process, but the speed in the result comes at a cost. It may in fact fail to recognize small communities within large networks. For the purpose of this paper – which is focused on macro-features of the main communities – this seems to be a reasonable approximation. For the mathematics of the modularity algorithm used here see Blondel *et al.* 2008.

⁵ For an example of a matrix see Waerzeggers 2014, 221-222.

⁶ <http://virgo.unive.it/ebdaonline/cgi-bin/home.cgi> EbDA is presently the largest on-line repository of Ebla texts (Charpin 2014, 344). Transliterations of Ebla documents are also available via CDLI. These are fewer in number, but they may be useful to those scholars that need data formatted according to the ORACC standards. EbDA uses an altogether different encoding, conceived to be simple but powerful in terms of research potential (see below). As far as on-line resources on the Ebla texts are concerned, I would like to mention here also The Prosopography of Ebla – a joint project of the University of Florence (P. Fronzaroli and A. Catagnoli), and Sapienza University of Rome (A. Archi and M.G. Biga), see *infra* n. 15.

sions in the search engine, provides scholars with maximum flexibility in data mining.⁷ The EbDA encoding makes possible to automatically extract, for instance, the complete list of personal names as recurring in the texts presently featuring in the database. This allows for a preliminary computer-based generation of matrixes for producing a network of cuneiform texts. In such a network, if two documents share one or more personal names, they are linked together. The strength of this tie is proportional to the number of people in common. After a spatialization algorithm operates on the raw data, in such a graph one expects to find tablets that share consistent prosopographical data visually grouped together. As the clusters thus formed are composed by tablets that mention people that lived at the same time, this process is also expected to partition tablets according to their relative chronology. This assumption can be tested against the chronological anchor points as discussed below. Manually producing matrixes for a network graph is a slow, tedious and energy consuming process, especially if one is working on large text corpora. Also, and perhaps more importantly from the methodological point of view, the manual production of matrixes does not produce linked data, inevitably ending up with two separate datasets: transliterations and matrixes. This is a big drawback for further research, as what modern Assyriologists and digital humanists alike actually need is a semantic data network to perform their researches.⁸ In fact, once loaded in a database, encoded transliterations can be queried in all sorts of ways, allowing scholars to cross linguistic, social, economic, and historical information. If need be, standard Assyriological transliterations can be easily produced from the encoded data, simply stripping the tags that conventionally mark individual words – this is in fact what is shown as results of any query in the EbDA database. The reverse process is of course impossible. Going back to the automatic creation of matrixes on the basis of encoded texts, this is done by a Perl script that extracts the relevant information from the transliterations and re-arranges it in form of a matrix.⁹ As scripting in Perl is in fact very simple, it is in fact possible to build a more powerful set of instructions, which outputs a file that can be readily open with the most recent pieces of software for network analysis, such as Gephi, thus entirely bypassing the matrix step.¹⁰ More in detail, the script generates a .gexf file, which offers the great advantage to store much more information when compared to traditional matrixes, allowing the definition of node and edge properties, such as size, label, colors, hierarchies, dynamics etc.¹¹ For instance, the actual personal names shared by any couple of tablets can appear as edge labels in the visualization software, for quick reference. In addition, this technique allows for embedding information on the content of a text represented as a node, flagging ‘administrative texts’, ‘letter’, ‘incantation’, etc. Sub-categories may be applied too, thus administrative texts can be further tagged as: ‘account of metal’, ‘delivery of textiles’, etc., which in turn can be sub-categorized as ‘annual’, ‘monthly’, etc. A brief description of the script workflow is in order. First, the script gathers all text references and the list of personal names attested in them. Second, the list of personal names is reduced as to discard duplicates or names too broken to be usable. Third, the list of nodes and edges composing the network is generated.

7 More in detail, PNs are marked by prefixing the element p_ to the actual personal name. Thus, one finds p_ib-rí-um, not ib-rí-um. Similarly, each text heading is marked by \$, which is a special character reserved for this function within the EbDA database. Thus one finds \$ARET 01 0001 as a label marking the first document published in the ARET series.

8 Linking data is in fact the ultimate goal of the ORACC project (Open Richly Annotated Cuneiform Corpus), reachable at oracc.museum.upenn.edu.

9 A Perl script is basically a text file containing a set of instructions that tells the computer what to do with strings of text. Perl is a scripting language widely used today in internet technology. More information on scripting in Perl can be found at <https://www.perl.org/>

10 Gephi (<http://gephi.github.io/>) is an open source, multi-platform, program. Contrary to other software devoted to network analysis, such as the old but popular Ucinet, Gephi has a stable 64 bit version, which is necessary for dealing with large networks requiring massive amount of memory to be displayed and analyzed.

11 .gexf files are XML based, this means that each node is declared and marked by special tags, such as <node> </node>. One may visit <http://gexf.net/format/> for more information on this file format, including examples and a useful .gexf primer. Basic knowledge of any mark-up language, such as HTML, is required to go through the details available on-line.

3. THE ARCHIVES OF EBLA AND THE RELATIVE CHRONOLOGY OF THE TEXTS

The Ebla archive provides us with invaluable data for the reconstruction of a third millennium capital city in modern days Syria.¹² The documents, covering a time span of roughly forty years, are datable to the first half of the 24th century BC, just before the rise of the Sargonic dynasty in Southern Mesopotamia. The texts unearthed so far stem from the royal palace area, stretching over a relatively large portion of the acropolis. There, ceremonial structures, including an audience-hall and a monumental staircase leading toward the center of the acropolis, are connected with residential units and storage quarters. Most of the texts were found in L. 2769, also known as the central archive. Smaller lots of tablets were found in several other spots, again all belonging to the palace area. The numerical consistency of each of these tablet groups is not easy to evaluate. Inventory numbers can in fact be misleading, listing both complete tablets and small fragments. In addition, the size of the tablets greatly varies from small to large. The following list table is therefore provisional:¹³

Locus	Conventional label	Estimated no. of inscribed items
L. 2769	Central archive	~ 3000 tablets
L. 2752	Audience court archive	18 tablets + 4 large fragments
L. 2875	Vestibule archive	~ 300 fragments = 30 large tablets?
L. 2764	Administrative quarter archive	~ 30 tablets
L. 2712	Provision archive	~ 250 tablets
L. 2586	Jar archive	32 tablets
L. 3143, L. 3462, L. 3474, L. 3654	Southern quarter archive	5 tablets

The content of the tablets has been analyzed from several points of view. The literature is vast, so I limit myself to general considerations and references, which may be useful to non-Ebla specialists.¹⁴ The texts are edited in the ARET and MEE series, partly overlapping. An in-depth study of the onomastics has produced remarkable advancements in our understanding of the local vernacular.¹⁵ Both the writing system and the Eblaite language has been objects of several studies,¹⁶ and are now treated in a grammar devoted to this subject.¹⁷ Political and social history, as well as religion¹⁸ and gender studies,¹⁹ were also the focus of several important contributions.²⁰ Administrative procedures and dossiers of text related to notable individuals have also been studied.²¹ A comprehensive treatment of the complex social relationships attested in the archive, as well as a sound archivistics-oriented study of the material, is still missing. As for testing the assumption that clustering algorithms should be able to produce a network diagram in which texts of the same period should be closely connected, we should now take a closer look to those texts that can be dated with confidence to a given sub-period of the archive. We therefore have an objective way to validate (or reject) the data produced applying network analysis to the documents under scrutiny. In the past decades, several important studies devoted to the relative chronology of the Ebla texts appeared on major Assyrio-

12 Milano 1995.

13 The data provided here are based on Archi 1986; 1996a; 2003.

14 For further (older) references see Baffi-Guardata, Baldacci, Pomponio 1997.

15 See most recently The Prosopography of Ebla project (<http://www.sagas.unifi.it/vp-359-prosopographyebbla.html>). Several volumes concerned with the onomastic study of hundreds of personal names attested in the tablets are already available on-line. As of January 2015, the volumes B, G, and K are freely accessible.

16 Buccellati 1982; 1990; Krebernik 1982; 1996; Rubio 2006; Sallaberger 2001.

17 Catagnoli 2012; see also Tonietti 2013.

18 Milano 1989; Pomponio, Xella 1997; Mander 2008.

19 Archi 1996d; 2002; Biga 1987; 2000.

20 Archi, Biga 2003, with previous references.

21 Milano 2003; Archi 2003.

logical journals.²² The problem of dating the tablets lies in the fact that at Ebla ‘year names’ are rare, and bear little chronological significance to us, for a twofold reason: a) there are almost no duplicates of a given year name, b) the event mentioned is often difficult to frame with certainties in a relative chronological grid (Biga 2003, 345-346). Establishing reliable criteria for dating the tablets is thus a fundamental step in the analysis of the important historical developments that occurred over the roughly 40 years covered by the archives. Placing documents in a relative temporal sequence allows in fact for a proper evaluation of political events, warfare, economic trends, and social developments that would otherwise remain opaque to us. Anchor points in the relative chronology are provided by prosopographical analysis. Through a detailed study of the content of the documents, scholars are in fact able to identify a small number of crucial texts that can be safely put in relative chronological sequence. These include (but are not limited to): lists of singers (nar) and of women belonging to the royal entourage (dam-en), mentioned within large resumptive tablets (annual accounts of metal, monthly accounts of textiles); deliveries of goods to various functionaries (most notably people belonging to the lugal-lugal class); texts bearing information on birth, wedding, and death of known individuals; miscellaneous tablets and fragments prosopographically connected to the ones just mentioned. Thanks to the progress in prosopographical research, it is now possible to establish the succession order of the Ebla kings, their ministers and concubines, and frame major events in their proper historical setting. The following table summarizes the data collected so far concerning kings and ministers.

King of Ebla	Minister
Irkab-Damu (7 years)	? (1-2) Arrukum (2-7)
Išar-Damu (35 years)	Ibrium (1-18) Ibbi-Zikir (19-35)

The Ebla archive is usually divided in sub-phases according to the mention in the texts of the relative ministers, and not the ruling kings. This conventional subdivision is followed in the present article. As for the scope of this inquiry, I would like to focus here on the lists of singers (nar), as a case study for testing the potential of network analysis in terms of reconstruction of a relative chronology. In two pioneering articles,²³ Tonietti was able to isolate a set of texts, mostly concerned with allotments of textiles to various individuals, among which appear a group of singers, sometimes classified as nar-mah and nar-tur, “chief” and “junior” singers respectively. Studying the variations in the composition of these groups, and combining this datum with the mention of the chief ministers in some of the texts (Ibrium and Ibbi-Zikir), she proposed to place the tablets in the following chronological order:²⁴

Ibrium	ARET 3 498; TM.75.G.1748 ~ TM.75.G.75.2455 ARET 3 260 ~ ARET 3 468 TM.75.G.1797 ~ ARET 3 127 ARET 3 320? TM.75.G.2456 TM.75.G.10079 ~ TM.75.G.1761 TM.75.G.2364 ~ TM.75.G.1731 ~ TM.75.G.2332
--------	--

22 Archi 1996b; 1996c; 2000; Archi, Biga 2003; Archi, Biga, Milano 1988; Biga 1996; 2003; 2010, 20-22; Biga, Pomponio 1990; 1993; Picchioni 1981; Pomponio 1987; Sallaberger 2001; Tonietti 1988; 1989a.

23 Tonietti 1988; 1989b. See also Archi 1988. Tonietti further discusses the social context and the historical implications of nar dossier in a series of contributions: Tonietti 1997a; 1997b; 1997c; 2010.

24 Tablets of uncertain periodization are marked by a question mark, ‘parallel’ tablets (*i.e.* tablets having almost parallel sections concerning the singers) by a tilde sign.

Ibbi-Zikir
 ARET 1 8 ~ ARET 3 458 ~ ARET 3 519
 TM.75.G.1224
 ARET 1 6
 TM.75.G.1775
 TM.75.G.1744?
 ARET 3 457
 ARET 4 14?
 TM.75.G.1833
 ARET 1 5 ~ ARET 8 531 ~ ARET 8 527

New fragmentary texts recently published can now be added to this dossier. These are: ARET 12 31, ARET 12 125, ARET 12 868, ARET 12 934, ARET 12 1294, ARET 12 1394.²⁵ For demonstrating the potential of network approach toward cuneiform texts, it is instructive at this point to momentarily exclude these new additions from our discussion, so we may check the results generated by the computer with those reached applying standard prosopographical criteria. After this preliminary evaluation, we may turn back to the whole picture, and consider how the new texts fit in the established scenario.

4. NETWORK ANALYSIS OF THE SINGERS' DOSSIER

The graph at Fig. 1 was produced using Gephi, running a modularity clustering algorithm with standard settings in order to color nodes according to their community structure, and the Force Atlas algorithm to spatialize them. The latter is an algorithm that applies physical models to the elements of the graph: each node attracts every other nodes connected to it with a force proportional to the edge weight, and repels the others. Thus, strongly connected nodes are close to each other, loosely connected nodes more distant, unconnected nodes far away.

The graph was also rotated as to align texts from left to right in rough chronological order (see below). On the basis of the connections alone (*i.e.* without any further information concerning the relative dating of the texts), the clustering algorithm identifies two groups of tablets (yellow and cyan nodes). This subdivision overlaps almost entirely with the historical phases of the tablets, except for those on the very border between the two groups (ARET 1 8 ~ ARET 3 458 ~ ARET 3 519, dated to the early Ibbi-Zikir). The clustering algorithm, trying to framing these documents in one of the two communities, includes them in the yellow one, which belongs to the tablets dated to Ibbrium. This fact suggests that there is a continuity in the composition of singers' groups that is not reflected in the political developments. This little historical datum is in fact very hard to evaluate without the help of digital tools such as network analysis software. As for the solidity of the network, the density measure reaches 0.946, suggesting a great continuity in the composition of the singers' group. The measure, being close to 1, implies that almost every node is connected to any other one. In turn, this means that, at any given moment, the composition of the singer's community does not vary too much. It is possible to get a better quantification of the degree of change through time filtering out edges. The problem of finding the minimal 'core' shared by all texts can be formulated in terms of finding what edge weight we can filter out before the network shows disconnected nodes. In this specific case, edge weight varies from 1 to 27 (this also means that there is at least one couple of texts sharing 27 individuals). The critical edge weight for our graph is 4. Assuming that each documents in our dossier belongs to a different yearly account (this seems in fact the case for many of the texts discussed here), this implies that, at maximum, only the 14.8% of the group can possibly vary from 'year' to 'year' (probably, not every year in our dossier is in fact represented). Nevertheless, one should bear in mind that this figure refers to an ideal situation, that is, it assumes that we have at our disposal the totality of information on this subject. As some of the lists contain brakes, it is possible that the critical weight is

25 ARET 12 27 mentions *En-na-NI* and *En-na-NI-2* – both fairly common within the singers' dossier – in broken context, within a list of personal names not otherwise connected with singers ([X]-NE-LUM, *Gú-ba*, and *A-wa-i-šar*). The text resumes in the next column, mentioning X+22 textiles and 1 belt delivered to the junior singers. It is therefore unclear if this text belongs to the dossier discussed here.

here overestimated. A detailed discussion of mortality rates at Ebla is beyond the scope of this article, but this datum – if based on more internal and comparative evidence, including archaeological records – may support future research on life expectancy in third millennium BC. Here, I may point out that the network graph also shows a much more connected area in the right side, corresponding to the last phase of the archive. This implies that the texts mention shared individuals more frequently than the earlier texts do (the presence of parallel texts affect both groups). In other words, the composition of the singers group tend to stabilize over time. As for the spatial arrangement of the tablets, it must be noted that the Force Atlas algorithm, albeit taking into consideration the relative weight of the edges, is not capable of placing the nodes in the same chronological sequence proposed by Toniatti (in the graph, time flows from left to right). Nevertheless, the order is not random: a clear pattern emerges when comparing the sequence proposed by Toniatti, the discrepancies being reasonably few. Actually, the chronological order of the text by Toniatti implies that some of the singers pass from the status of chief singer (*nar-mah*) to junior singer (*nar-tur*), which is a rather perplexing fact (Toniatti 1989b: 127 n. 76). This phenomenon affects precisely the ‘problematic’ texts ARET 1 8 ~ ARET 3 458 ~ ARET 3 519, discussed above. Interestingly enough, the clustering algorithm prefers to include these texts in the early phase, a fact that would remove the problematic *nar-mah* to *nar-tur* downgrade. In any case, the dating proposed by the algorithm must be considered as approximate, as a number of possible perturbation factors in the spatial arrangement of the nodes are to be taken in to account: breaks in the texts; omission of some personal names in lists for unclear reasons (possibly due to sickness, travels, etc.); presence of multiple parallel texts mentioning a given group versus only one mentioning another one, etc. Despite these uncertainties, I find this result encouraging: future implementation of the algorithm may produce a more precise output. Let us now examine the network of personal names that is subsumed by the graph at Fig. 2.

In this graph, nodes represent personal names. If two individuals are mentioned in the same tablet (*i.e.* they are part of the same group of singers), the nodes are connected by an edge. The thickness of the edges is in this case proportional to the relative frequency with which two personal names are mentioned together in different pairs of tablets. The size of the nodes is proportional to the relative frequency of the personal name it represents. Thus, one can get an idea at a glance of the individuals that are mentioned more often in the archives. It must be stressed that these are not necessarily the individuals that play a major role within the singer’s group. This is evident scaling nodes according to their centrality degree (*i.e.* the amounts of other nodes connected to them), as shown in Fig. 3. The new graph gives us a better visual idea of the most important nodes within the singers’ network.

Some peripheral nodes are now larger in size, and the same applies to some central ones, such as the one related to BE-É and BE-SUD-HI, which are now as large as *En-na-NI*’s node, which previously dominated the scene. Note that the texts provide very few details on the internal structure of the group, except for the macro-indication of ‘chief’ and ‘junior’ singers. We can therefore appreciate the main actors with a higher degree of confidence. As for the community detection, the algorithm again identifies two groups, corresponding to the two phases of the tablets where the individuals are mentioned. Considerations similar to those brought forward for the chronological subdivision of the texts apply: individuals are roughly spaced according to their relative chronology, even though the sequence from left to right may be not always precise.

5. NEW ADDITIONS TO THE DOSSIER

We can now proceed adding the transliterations of the new texts identified as belonging to the singers’ dossier and run again the Perl script that outputs the network file. The result is shown in Fig. 4.

The graph is substantially identical to the one produced before. It is slightly less connected (density 0.833), due to the fact that new documents, all fragmentary, provide only partial lists, the name of many singers being broken. Hence, the new texts share less connections with the remaining documents, which instead provide almost complete lists. This consideration also explains why the corresponding nodes are all positioned in the periphery of

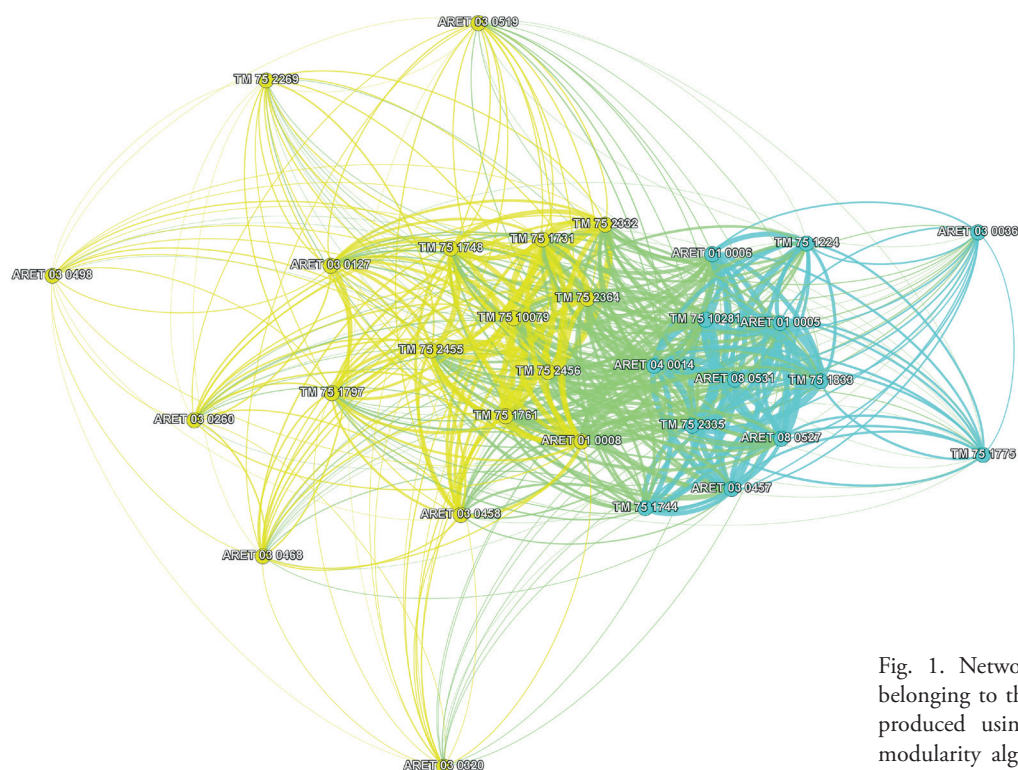


Fig. 1. Network distribution of texts belonging to the singers' dossier. Graph produced using Gephi, clustering by modularity algorithm, spatialization by Force Atlas.

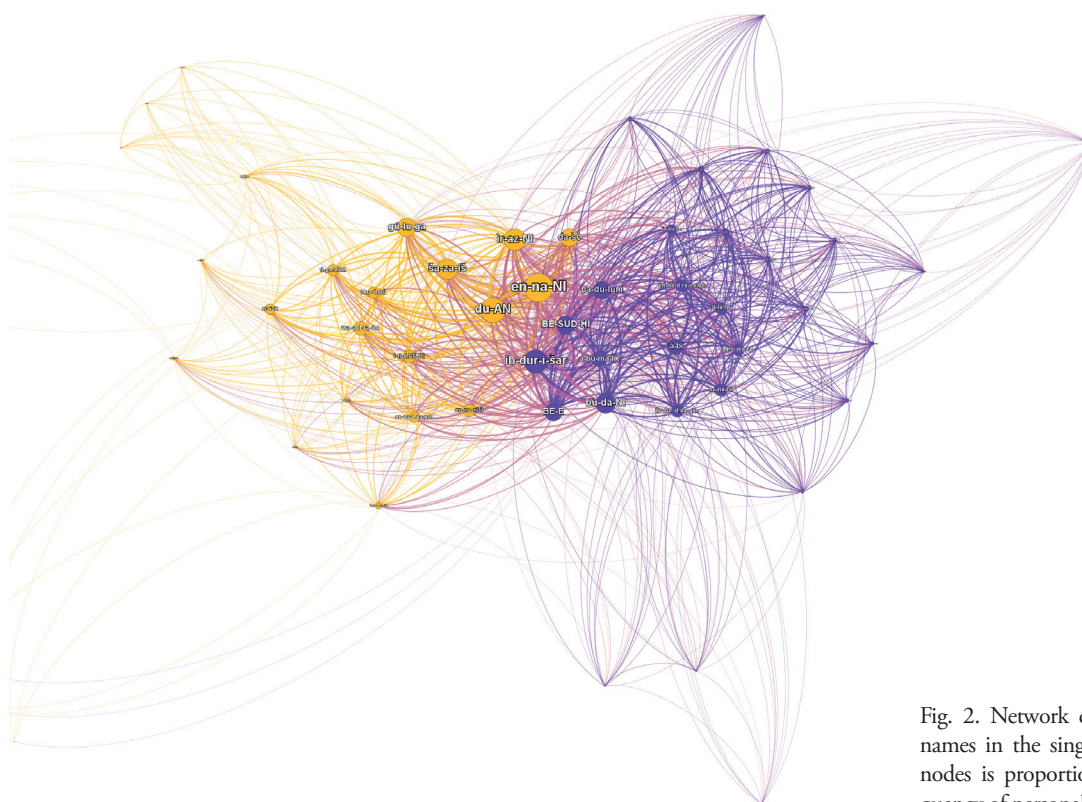


Fig. 2. Network distribution of personal names in the singers' dossier. Size of the nodes is proportional to the relative frequency of personal names.

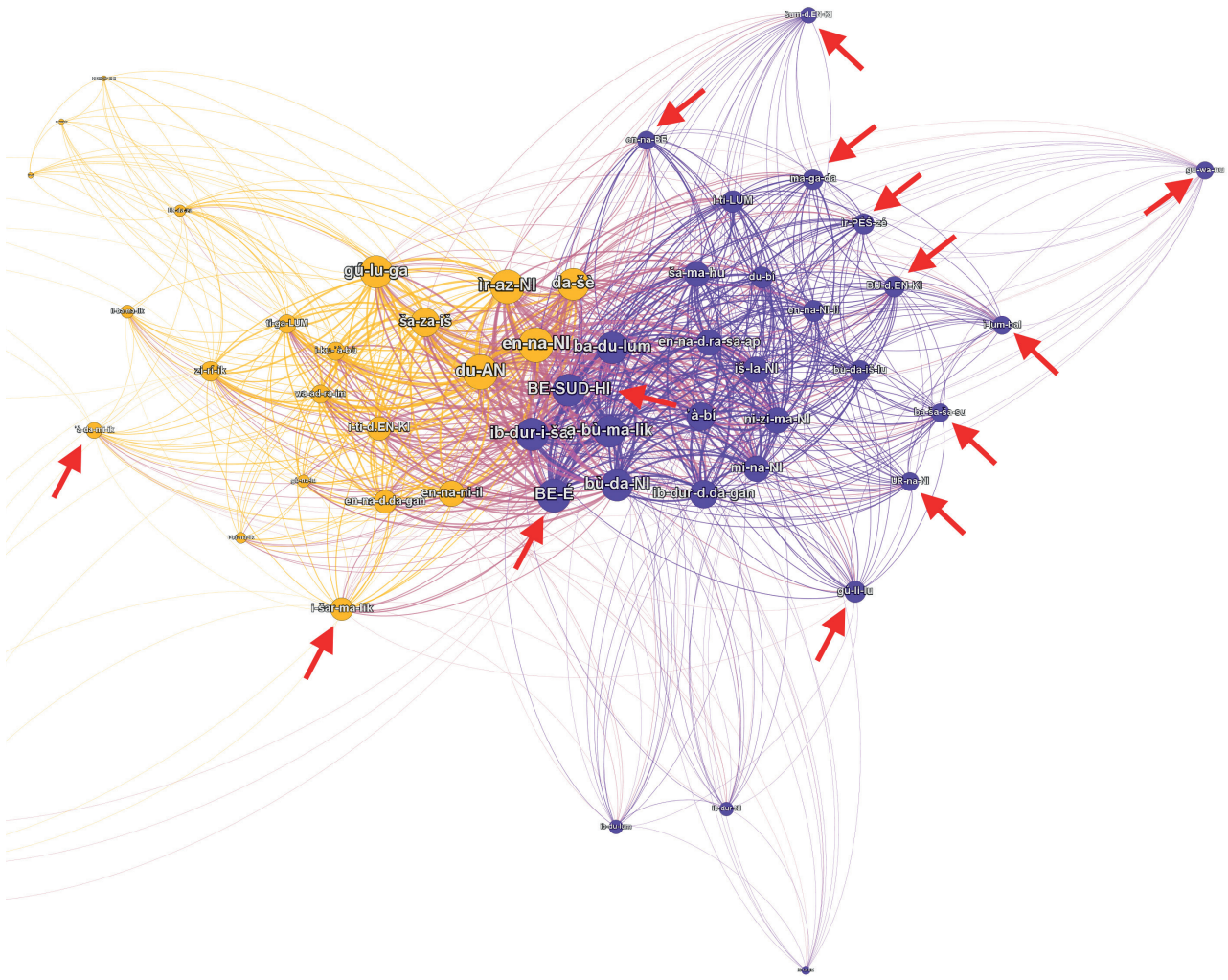


Fig. 3. Network distribution of personal names in the singers' dossier. Nodes are scaled according to their relative degree. Arrows have been added to the original graph to mark some of the most notable changes when compared to the graph in Fig. 2.

the graph. The modularity algorithm recognizes again two separate communities, which correspond to the ones seen above. Two of the new tablets are placed in the yellow cluster (ARET 12 31 and ARET 12 1294, the latter on the border with the cyan cluster), and four in the cyan one (ARET 12 1394, ARET 12 868, ARET 12 125, ARET 12 934). We can now briefly proceed to a check based on classic prosopographical analysis.

- ARET 12 31 only contains one personal name, namely *Wa-ad-ra-im*, which in fact disappears from later lists;
- ARET 12 1294 mentions three persons that belong to the core group, two individuals who disappears from later lists (*I-šar-ma-lik* and *En-na-da-gan*), as well as a certain *A-bū-ma-lik*, who is missing in the earliest lists, but always present otherwise. It is the mention of this individual that probably causes the node to be placed in the transition between the two phases;
- ARET 12 1394 only contains the personal name *Ba-du-lum*. As this is found in texts of both phases, it is impossible to assign with certainty the text to one group or another. However, since the documents from

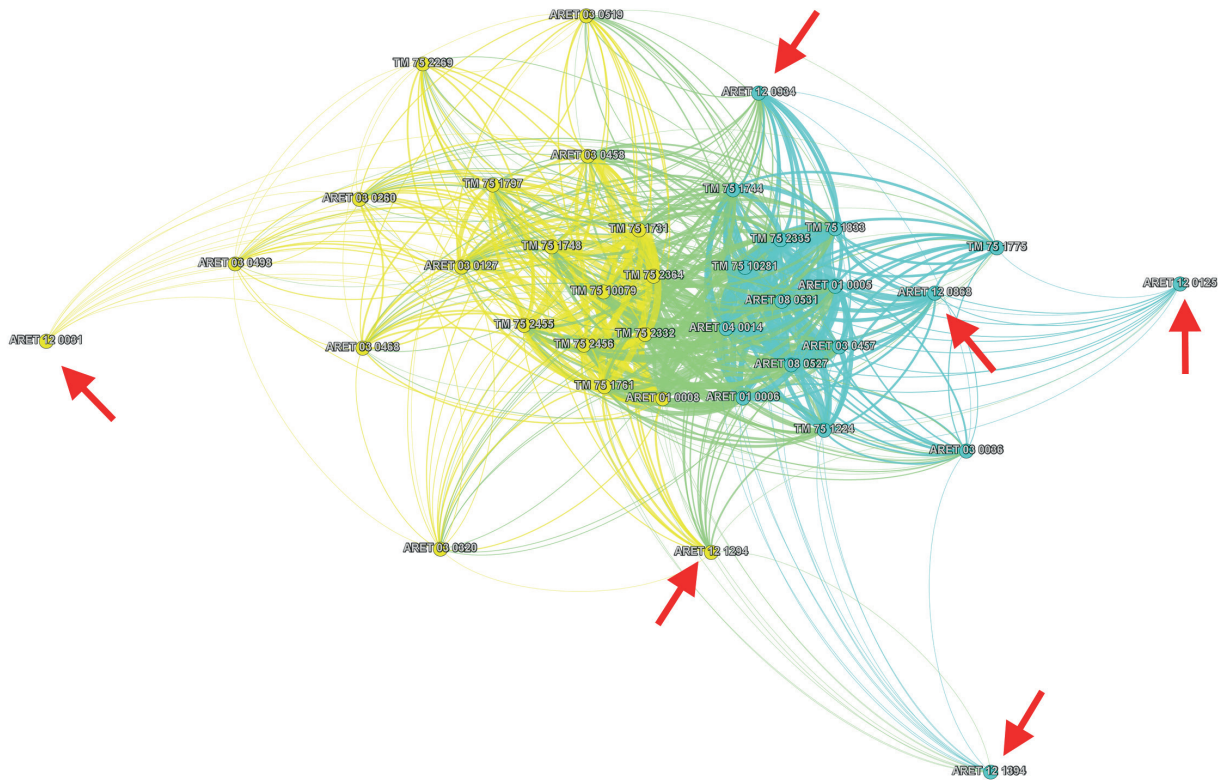


Fig. 4. Network distribution of the texts belonging to the singers' dossier, including recently published texts. Arrows have been added to the original graph to mark the new additions.

the second phase mention this individual more frequently, the node has more connections with the cyan group, and it is therefore assigned to it;

- ARET 12 868 mentions, besides individuals belonging to the core group, several individuals not present in the earliest lists (*En-na^d-ra-sa-ap*, *Ib-dur-da-gan*, *Iš-la-NI*, *Mi-na-NI*, *Ni-zi-ma-NI*, *Ša-ma-hu*). The document must in fact belong to the end of the second phase, as *Iš-la-NI* is mentioned here as *nar-mah*, as opposed to *nar-tur* in previous texts. In this regard, it is worth noticing that the node is in fact placed among the rightmost ones;
- ARET 12 125 contains two personal names (*Dub-bi* and *'À-bi*), who are again missing in the earliest texts. The fact that the node is placed on the rightmost end of the graph is due to the fact that, having few personal names, this text is only loosely connected to the core;
- ARET 12 934 mentions *Ba-ša-ša-šu*, missing in the early texts, as well as *Ma-ga-du*, attested only in the most recent documents of the dossier. This tablet also mentions *I-bi-zi-kir*, a fact that confirms the dating to the second phase.

In conclusion, all new additions discussed here have been correctly dated by the modularity algorithm, although the dating of one fragmentary document, mentioning only one individual, merely relies on statistical probability rather than on certain prosopographical connections. The old graph was only marginally affected by the newly attached nodes. This is no doubt due to the fact that the starting network was very solid (density close to 1).

6. THE NETWORK APPROACH: ADVANTAGES, LIMITATIONS, APPLICATIONS

When dealing with thousands of documents it is somehow difficult to appreciate at a glance the ‘sense’ of a given archive, besides general considerations about the amount of tablets belonging to various categories (administrative texts, letters, literary texts, etc.). The description of cuneiform archives is in fact usually limited to salient aspects of their content, such as linguistic features, people involved in the records, etc. This practice is dictated by the fact



Fig. 5. Network graph of all texts presently included in the EbDA database.

that in most cases the archaeological context of cuneiform archives is either lost or very roughly known. In addition, it is hard to evaluate the cohesiveness of the individual typologies: how many documents can be grouped together on the basis of internal evidence? How many dossiers can one build out of the available data? Network analysis allows scholars to deal with these complex and somehow complicated data, providing a key to spot trends that may otherwise pass unnoticed. It also greatly facilitates prosopographical studies, as it helps visualizing the relationships between individuals and social groups. The big limitation in this kind of studies lies in the fact that manually preparing the files to generate network graphs and relative statistics takes a huge amount of time. To bypass this issue, Assyriologists of the digital era need to think back at the way they transliterate texts. Adding semantic information may in fact allow for the creation of reliable scripts that generate network graphs without the need of manually producing matrixes. As administrative cuneiform texts are often formulaic, it is even conceivable to prepare a script that parses current transliterations and recognize patterns, such as sequences of personal names followed by their title. The author of these lines is presently testing such possibility, which may open up new ways of approaching cuneiform texts. For the time being, I would like to put forward some thoughts on how to use network analysis and scripting to achieve some preliminary results.

The graph at Fig. 5 is the result of processing EbDA transliterations with the Perl script discussed above. The size of the network, containing 3,012 nodes and 198,086 edges, makes the graph look like an almost impenetrable cloud. Its density is actually rather low (0.044), due to the fact that several nodes are disconnected from the network core. These are represented in the form of a large dim corona of orphan nodes surrounding the central area.

At present, the modularity algorithm recognizes four large clusters: red, composed by 27.32% of the total nodes; yellow, 18.53%; cyan, 17.03%; purple 6.94%. A fifth one (green) is too small to be visible in the photo, made of 1.13% of the total nodes. Interestingly, this clique is internally very well connected, and it is therefore discussed below. Before we proceed investigating the ‘identity’ of these communities (*i.e.* their possible subdivision in communities and textual typologies, as well as their possible chronological subdivision), some general remarks are in order. Clearly, the graph is provisional as the algorithm suffers the limitation described above, namely it is incapable of deciding whether two identical personal names belong to one and the same individual (this is in fact what the script assumes), or if two (or more) namesake individuals are involved instead. In addition, possible variant spellings in the name of a same individual are not considered. However, we can bypass to some extent both limitations via edge filtering. This is a technique we may use to remove from the network graph all edges that happen to have a weight below a given threshold level, defined by the user, as well as all nodes that become disconnected after the filter is applied. Filtering out loose connections is equivalent to discard from our analysis tablets that share few personal names. The remaining nodes in the network represent documents that mention the same consistent groups of persons. In other words, we shift our point of view from individuals to human groups. The price to pay is losing potential information on *bridges*, *i.e.* individuals that may connect otherwise disconnected areas of the network. This is however tolerable if we keep in mind that the focus is now on communities composed by more than one individual. The benefit of this approach lies also in the fact that we may spot possible joins of fragmentary tablets via network analysis, as described in the next paragraph. As setting the threshold level is an arbitrary process, it is advisable to proceed by small incremental steps. Thus, we may start excluding tablets that only have one personal name in common, then two, three, and so forth. As for the EbDA network graph, one notes that the first three steps in the progressive filtering by edge weight – corresponding to the exclusion of tablets sharing three personal names at most – produces substantial changes in the graph. On the contrary, there is little difference in filtering out documents that share four or five personal names. In this case, the graph remains almost unchanged, as illustrated in Fig. 6.

Hence, for the purpose of the present analysis it seems advisable to stop the process at threshold 4 (*i.e.* considering documents that share 4 or more individuals). At this point, one notes that cyan and yellow communities are still fairly represented, as opposed to purple and red communities, that are instead massively affected by the filtering process.

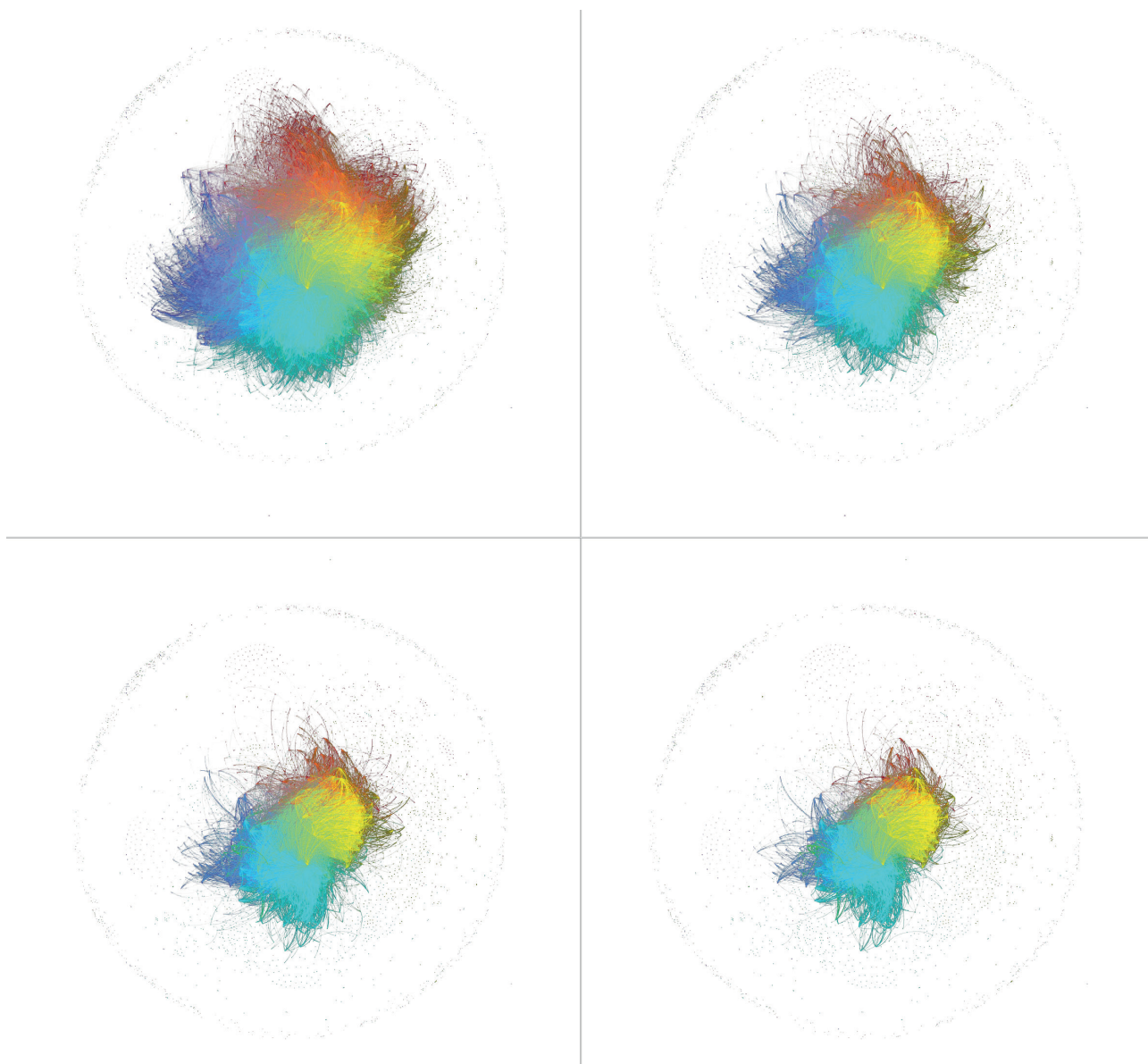


Fig. 6. Progressive filtering by edge weight of the EbDA network graph. Upper left corner: threshold 2 (only tablets sharing 2 or more individuals are visualized); upper right corner: threshold 3 (=3 or more individuals); bottom left corner: threshold 4; bottom right: threshold 5. Edges' weight has been rescaled in order to make the cloud less dense, and nodes more visible.

This implies that, on the average, the individuals mentioned in the documents belonging to the cyan and yellow clusters form more cohesive groups. This is equivalent to say that the purple and red groups are instead more varied in composition. For further details, we shall now proceed to a brief description of the tablets composing these communities. Let us therefore take a closer look at the resulting graph, shown in Fig. 7.

A cursory examination reveals that these communities do represent textual typologies. The yellow cluster is almost entirely composed by texts published in ARET 15, which are monthly account of textiles belonging to the period when Arrukum was minister.²⁶ The red cluster is composed again by allotments of textiles (or wool and textiles), mostly

²⁶ ARET 15 nos. 5, 7, 15, 40, 19, 29, 31, 34, 35, 42, 47 *et passim*.

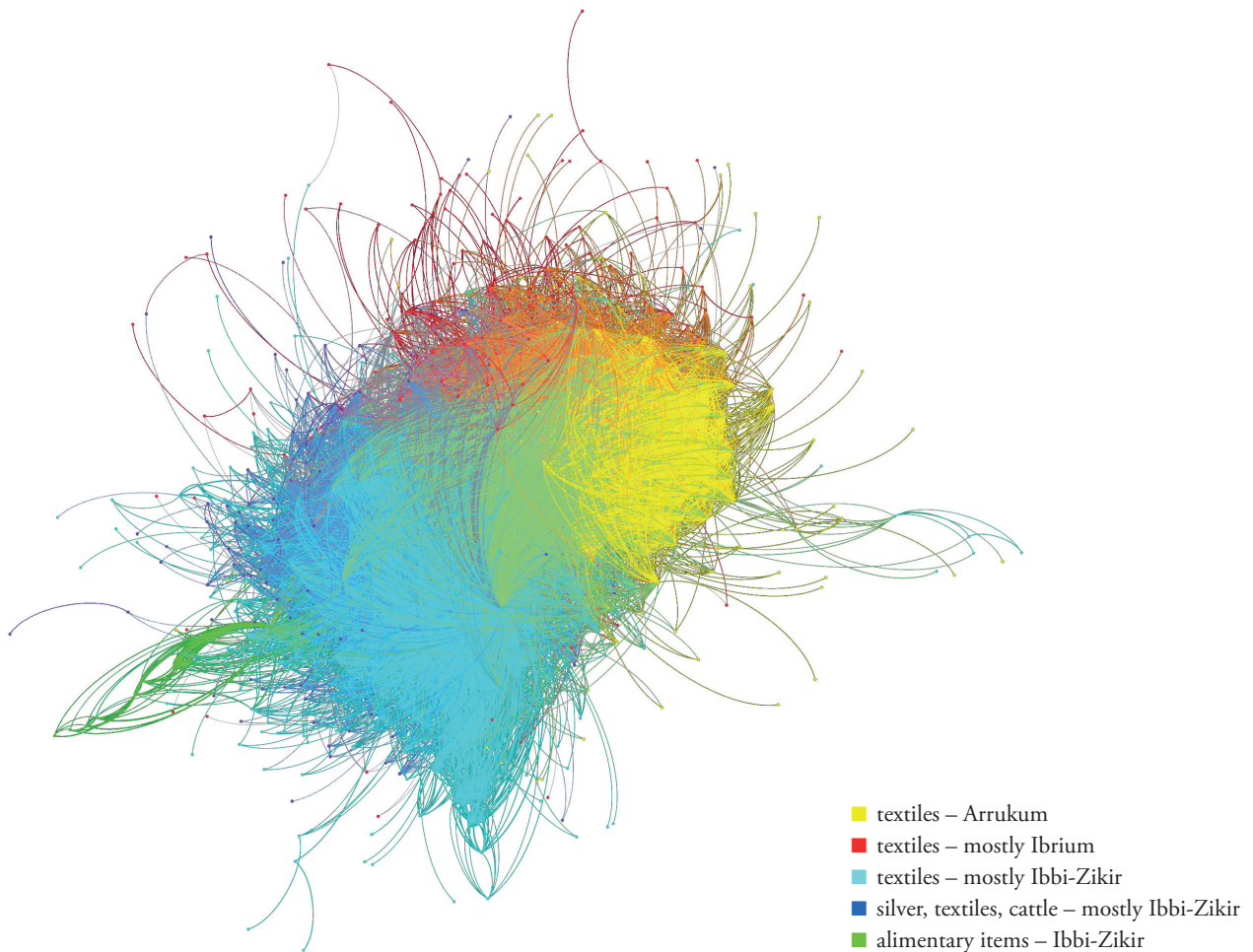


Fig. 7. The EbDA network filtered as in step 3 of the previous figure. Clusters can now be checked against the actual content of the tablets. In this graph, time flows from right to left. Note: the light green blob in the center of the graph is the result of superimposition of cyan and yellow edges. The actual green cluster is on the middle left part, protruding out of the cyan and purple intersection (see Fig. 8 for a magnified view).

datable to the period of Ibrium.²⁷ The cyan cluster is equally concerned with textiles, and is composed by texts mostly dating to Ibbi-Zikir.²⁸ The purple cluster is instead miscellaneous in content, including allotments of silver, textiles, and cattle, alimentary items, as well as some ‘chancellery’ texts, roughly datable to the period of Ibbi-Zikir.²⁹ Finally, the documents belonging to the green cluster are concerned with alimentary items, again roughly datable to the period of Ibbi-Zikir.³⁰ In the light of these facts, it appears that time in our refined network graph flows from right to left, and

27 ARET 3 nos. 215, 471, 588, 800; ARET 4 13; Mee 12 18, *et passim*.

28 Texts mostly published in ARET 8: cf. nos. 522-525, 529, 533 *et passim*.

29 ARET 16 nos. 16, 26; ARET 9 80; ARET 3 941; MEE 12 nos. 5, 28, 41 *et passim*.

30 All texts in this cluster have belong to archive L.2712, and have been published in ARET 9, cf. nos. 37-39, 41-43, 47, 48, 50-51 *et passim*. The preliminary chronological evaluation offered above is merely based on a cursory prosopographical analysis of other documents within this archive (cf. for instance the frequent mention of Ibbi-Zikir and of people related to him, also on the occasion of trips). According to Archi (1996, 64-65), the tablets cover a time span of roughly 3 years. A more precise dating of this archive will become possible once all tablets from L. 2712 are published.

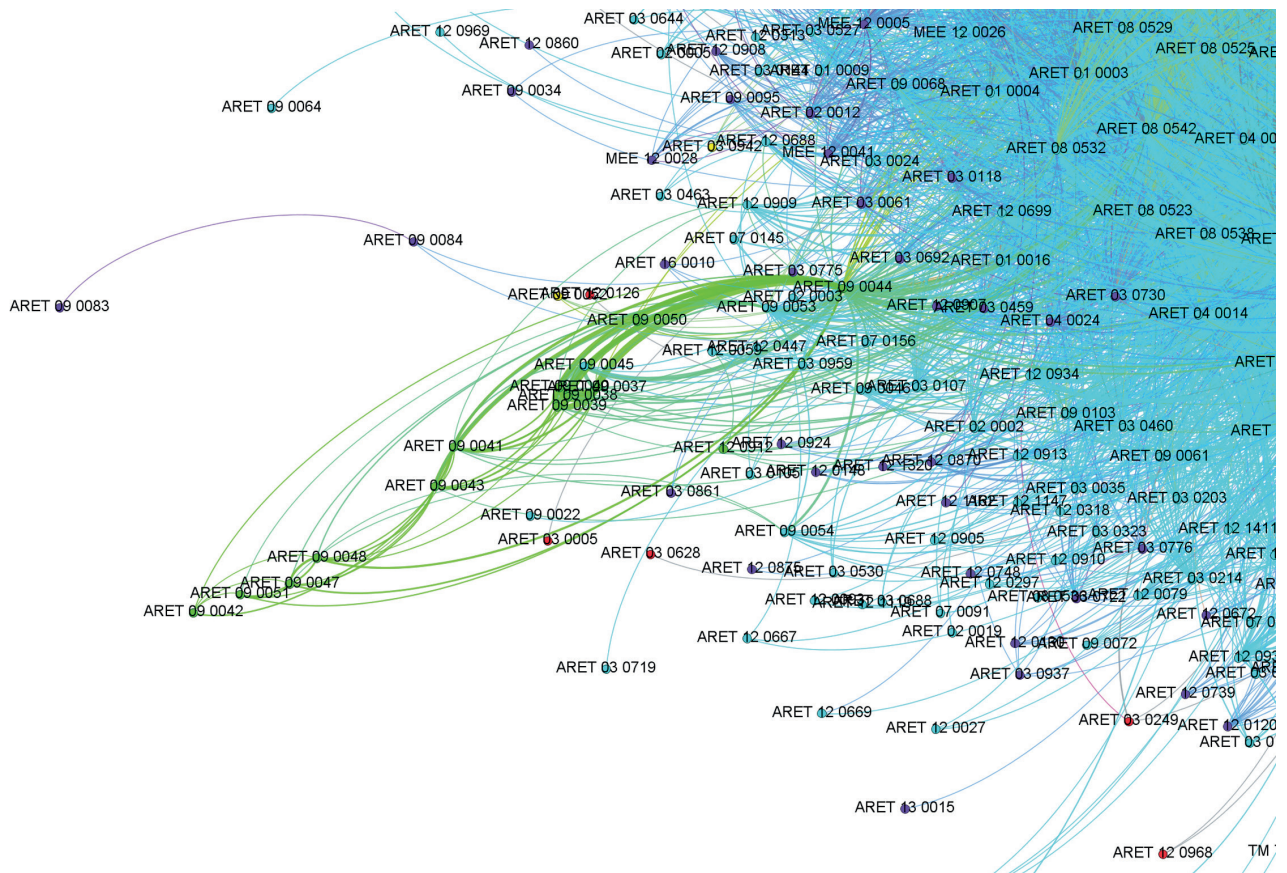


Fig. 8. Close up view of the green cluster protruding out of the network core. All texts concern food rations to the court personnel.

from top to bottom. The starting assumption that documents in the graph would be roughly spaced according to their chronology is therefore again confirmed. Going back to the small green cluster of texts, which was not visible in the all-inclusive graph shown in Fig. 5, one notes that it is still present, regardless of the filtering process. Its persistency is in fact remarkable, especially in the light of its small size. A magnified view of this little dossier is presented in Fig. 8.

The texts of this community belong to the so-called provision archive, found in L. 2712 (see above). The documents concern alimentary products, and are all published in the ARET 9 volume. The crucial *bridge* in our graph is ARET 9 44, connecting this group of texts to the cyan community. The document records an allotment of barley rations to the queen and other female personnel (*dam en*, *dam-en tur*, *dam ábba*), as well as a group of individuals referred to as *ib-ib*-officials. Their presence provides in fact the connection to the network's core. This crucial tablets is therefore important to us, as it clarifies the role of the *ib-ib*-officials in terms of supervisors of female personnel, as well as how groups of high-status women, which would otherwise belong to a completely different sphere of administration, fit in the general context of the Eblaite ration system.³¹ More tablets in our graph would deserve a better treatment that can possibly be provided here, as they seem to represent crucial points of passage in between various clusters, as for instance ARET 1 8, visible in Fig. 7 in the center of a cyan, yellow, and green vortex (the light green area surrounding it is the result of superimposition of yellow and cyan edges).

31 On these officials see also Milano 1987, 546-547.

7. JOINS PROPOSAL

As a corollary to the fact that the tablets are grouped according to the personal names attested in them, it is possible to easily spot parallel texts, or at least texts having parallel sections, when the edge weight is significantly high. Let us consider the following scenario: text A is complete, mentioning four individuals (PN_{1-4}), whereas texts B and C are both fragmentary, and mention respectively PN_{1-2} and PN_{3-4} . It is likely that B and C originally belonged to the same tablet, parallel to A. In network terminology, joins are expected to occur at the periphery of local cliques. The probability for two texts to join rises proportionally to the total number of personal names in common. In our network graph, these nodes will be relatively close to one another, the weight of their edges being proportional to the individuals shared by the texts. Note that for the purpose of establishing joins via prosopographical connections, it is better to keep variant spellings of the same personal name distinct. In fact, it seems unlikely (albeit not impossible) that the same scribe would spell the same name in two different ways on the same tablet. Unfortunately, I don't have access to photos of the fragmentary tablets, so the following joins remain hypothetical. Note that in this list the same text fragment may be mentioned more than once, depending on the fact that multiple parallels suggesting the joins may in fact exist.

Parallel text suggesting the joins	Groups of possible joins	PNs in common with parallel
MEE 12 19	ARET 12 232	11
	ARET 12 699	8
	ARET 12 1001	8
MEE 12 35	ARET 12 232	7
	ARET 12 699	12
	ARET 12 937	7
	ARET 12 977	7
MEE 12 36	ARET 12 232	7
	ARET 12 298	7
	ARET 12 343	7
	ARET 12 373	7
	ARET 12 699	13
MEE 12 37	ARET 12 699	11
	ARET 12 977	8
ARET 1 3	ARET 12 232	8
	ARET 12 699	8
	ARET 12 936	8
	ARET 12 1411	7
ARET 1 5	ARET 12 120	8
	ARET 12 232	7
	ARET 12 373	7
	ARET 12 699	11
	ARET 12 868	12
	ARET 12 934	18
	ARET 12 936	14
	ARET 12 937	8
	ARET 12 949	9
	ARET 12 1001	7
	ARET 12 1411	10

ARET 1 8	ARET 12 18	7
	ARET 12 232	9
	ARET 12 373	8
	ARET 12 699	9
	ARET 12 868	7
	ARET 12 934	11
	ARET 12 1411	7
ARET 1 11	ARET 12 232	7
	ARET 12 373	8
	ARET 12 1001	8
	ARET 12 1043	8
ARET 1 17	ARET 12 232	7
	ARET 12 1001	9
ARET 3 457	ARET 12 868	11
	ARET 12 936	7
ARET 3 458	ARET 12 699	7
	ARET 12 934	10
ARET 4 1	ARET 12 232	7
	ARET 12 298	7
	ARET 12 373	7
	ARET 12 699	12
	ARET 12 934	14
	ARET 12 936	10
	ARET 12 949	7
	ARET 12 1411	13
ARET 4 2	ARET 12 232	10
	ARET 12 373	7
	ARET 12 699	8
	ARET 12 934	8
	ARET 12 1001	7
ARET 4 3	ARET 12 232	7
	ARET 12 934	7
	ARET 12 937	7
	ARET 12 1001	7
ARET 4 5	ARET 12 232	7
	ARET 12 699	7
	ARET 12 977	7
ARET 4 6	ARET 12 373	8
	ARET 12 699	14
	ARET 12 934	9
	ARET 12 936	7
ARET 4 7	ARET 12 298	8
	ARET 12 699	13
ARET 4 11	ARET 12 232	13
	ARET 12 343	9
	ARET 12 1001	10
	ARET 12 1043	10
ARET 4 12	ARET 12 232	7
	ARET 12 1043	7

ARET 4 13	ARET 12 232	8
	ARET 12 298	9
	ARET 12 1043	9
ARET 4 14	ARET 12 699	12
	ARET 12 868	7
	ARET 12 934	10
	ARET 12 936	8
ARET 4 15	ARET 12 232	7
	ARET 12 1001	7
	ARET 12 1043	7
ARET 4 17	ARET 12 232	7
	ARET 12 298	9
ARET 4 22	ARET 12 232	7
	ARET 12 699	7
	ARET 12 909	9
ARET 8 521	ARET 12 232	9
	ARET 12 949	7
ARET 8 523	ARET 12 232	7
	ARET 12 699	9
	ARET 12 907	7
	ARET 12 934	12
	ARET 12 936	10
	ARET 12 937	7
	ARET 12 1411	7
ARET 8 525	ARET 12 232	9
	ARET 12 699	9
ARET 8 526	ARET 12 232	7
	ARET 12 373	8
	ARET 12 699	8
	ARET 12 934	8
	ARET 12 937	8
ARET 8 527	ARET 12 232	7
	ARET 12 298	7
	ARET 12 699	11
	ARET 12 868	9
	ARET 12 907	8
	ARET 12 909	9
	ARET 12 934	10
	ARET 12 936	9
ARET 8 531	ARET 12 18	7
	ARET 12 120	7
	ARET 12 232	8
	ARET 12 373	9
	ARET 12 699	10
	ARET 12 868	12
	ARET 12 934	18
	ARET 12 936	13
	ARET 12 937	7
	ARET 12 949	8
	ARET 12 1411	9

ARET 8 533	ARET 12 373	7
	ARET 12 937	7
ARET 8 540	ARET 12 232	8
	ARET 12 699	7
	ARET 12 907	7
ARET 8 542	ARET 12 232	8
	ARET 12 699	8
	ARET 12 909	11
	ARET 12 937	9
	ARET 12 1411	7

8. CONCLUSIONS AND FUTURE PERSPECTIVES

In this paper, I tried to demonstrate how a network approach combined with Perl scripting can be beneficial to our understanding of the complex (sometimes complicated) social relations attested in a large archive of cuneiform texts. At present, it is impossible to achieve results in terms of comparative quantitative analysis, due to the paucity of published material on this subject. I have little doubt that more studies centered on network analysis will appear in the next years. When a critical mass of data is available, it will be possible to look back at the Ebla evidence, and better appreciate the local administrative patterns in the light of contrastive data from other sites and time periods. Also, future research will hopefully provide new tools for speeding up the process of network creation via scripting. In this way, it will become more and more simple to adopt quantitative methods for the study of large data sets. The downside of network research lies in the fact that the time required to manually build the matrixes may be overwhelming. Scripting in Perl (or any other scripting language) may provide the solution to this problem. Scripting is unfortunately a poorly known technique among Assyriologists. However, its impact on the field of cuneiform studies can hardly be underrated. Compiling sets of instructions for dealing with thousands of formulaic texts may in fact provide the key for future studies on complex social systems. In the meanwhile, it is still possible to use network analysis to achieve several goals: producing virtual dossiers of texts; promote exploratory data analysis; frame texts within a relative chronological grid; find joins of fragmentary texts via network connections. It must be noted that the graphs I have built for this paper are texts networks, based on the Ebla tablets in digital format presently included in the EbDA database. Other choices can be made. For instance, one could easily adapt the script to work on toponyms. In this case, one could build dossiers of texts which may be informative of the developments in historical geography. To an extreme, one could also process standard Assyriological transliterations, *i.e.* with no special encoding, considering every single word as a separate unit. The resulting graph will show those texts that have more similarity in content in the network core. Pushing forward this analysis, one could even process material readings of signs instead of properly transliterated words. This may be useful for those scripts and/or textual corpora that are still poorly understood or simply undeciphered. As far as Ancient Near Eastern studies are concerned, the obvious candidates for such approach would be for instance Uruk texts, Old-Elamite texts, and UD.GAL.NUN texts. I am positive that approaching the documents according to these new methodologies will keep stimulating creative approaches toward ancient texts, facilitating the emergence of fresh ideas, and new ways to look at the past.

Abbreviations

ARET Archivi Reali di Ebla Testi
 EbDA project Ebla Digital Archives
 MEE Materiali Epigrafici di Ebla

References

- Abraham K., Wagner A., Levavi Y., Kedar S., Kohen Y., Zadok R. 2014, Quantitative Social Network Analysis (SNA) and the Study of Cuneiform Archives, *Akkadica* 134, 117-134.
- Anderson A. forthcoming, *The Old Assyrian Social Network: an Analysis Based on the 'Old Texts' from Kültepe (Kaneš)*, Ph.D. diss., Harvard.
- Andersson C., Törnberg A., Törnberg P. 2014, Societal Systems – Complex or Worse?, *Futures* 63, 145-157.
- Archi A. 1986, The Archives of Ebla, in Veenhof K.R. (ed.), *Cuneiform Archives and Libraries* (PIHANS 57 = XXX CRRAI), Istanbul, 73-86.
- Archi A. 1988, The musicians, nar, in Archi A. (ed.), *Eblaite Personal Names and Semitic Name-Giving* (ARES 1), Roma, 271-284.
- Archi A. 1993, Les archives royales d'Ebla, in Cluzan S., Delpont E., Mouliérac J. (eds), *Syrie. Mémoire et Civilisation*, Paris, 108-113.
- Archi A. 1994, Studies in the Pantheon of Ebla, *OrNS* 63, 249-256.
- Archi A. 1996a, Gli Archivi di Ebla (ca. 2400-2350 a.C.), *Archivi e cultura* 29, 59-85.
- Archi A. 1996b, Chronologie relative des archives d'Ebla, *Amurru* 1, 11-28.
- Archi A. 1996c, Les comptes rendus annuels de métaux (CAM), *Amurru* 1, 73-79.
- Archi A. 1996d, Les femmes du roi Irkab-damu, *Amurru* 1, 101-124.
- Archi A. 2000, The lords, lugal-lugal, of Ebla, *VO* 12, 19-58.
- Archi A. 2002, The Role of Women in the Society of Ebla, in Parpola S., Whiting R. (ed.), *Sex and Gender in the Ancient Near East: Proceedings of the 47th Rencontre Assyriologique Internationale, Helsinki, July 2-6, 2001*, Helsinki, 1-9.
- Archi A. 2003, Archival Record-Keeping at Ebla, in Brosius M. (ed.), *Ancient Archives and Archival Traditions: Concepts of Record-Keeping in the Ancient World*, Oxford, 17-36.
- Archi A., Biga M.G. 2003, A Victory over Mari and the Fall of Ebla, *JCS* 55, 1-44.
- Archi A., Biga, M.G., Milano L. 1988, Studies in Eblaite Prosopography, in Archi A. (ed.), *Eblaite Personal Names and Semitic Name-Giving* (ARES 1), Roma, 205-206.
- Baffi-Guardata F., Baldacci M., Pomponio F. 1997, Eblaite Bibliography IV, *SEL* 14, 109-124.
- Bamman D., Anderson A., Smith N. 2013, Inferring Social Rank in an Old Assyrian Trade Network, *Digital Humanities* 2013 (Lincoln, Nebraska), <http://arxiv.org/pdf/1303.2873v1.pdf>. Access date: 10 April 2016.
- Biga M.G. 1987, Femmes de la famille royale d'Ebla, in Durand J.-M. (ed.), *La femme dans le Proche-Orient antique* (XXXIII CRRAI; Paris 1986), Paris, 41-47.
- Biga M.G. 1996, Prosopographie et datation relative des textes d'Ebla, *Amurru* 1, 29-72.
- Biga M.G. 2000, Wet-nurses at Ebla: a Prosopographic Study, *VO* 12, 59-88.
- Biga M.G. 2003, The reconstruction of a relative chronology for the Ebla texts I, *Orientalia* 72, 345-367.
- Biga M.G., Pomponio F. 1990, Elements for a Chronological Division of the Administrative Documentation of Ebla, *JCS* 42, 179-201.
- Biga M.G., Pomponio F. 1993, Critères de rédaction comptable et chronologie relative des textes d'Ebla, *MARI* 7, 107-128.
- Blondel V., Guillaume J.-L., Lambiotte R., Lefebvre E. 2008, Fast Unfolding of Communities in Large Networks, *Journal of Statistical Mechanics: Theory and Experiment* 10, 1-12, <http://arxiv.org/abs/0803.0476>. Access date: 10 April 2016.
- Buccellati G. 1982, Studies in Ebla Graphemics, *SEb* 5, 39-74.
- Buccellati G. 1990, Ebla Electronic Corpus: Graphemic Analysis, *AAAS* 40, 8-26.
- Catagnoli A. 2012, *La grammatica della lingua di Ebla* (Quaderni di Semitistica 29), Firenze.
- Charpin D. 2014, Ressources assyriologiques sur Internet, *BiOr* 71, 331-357.
- Cline D.H., Cline E.H. 2014, Text Messages, Tablets, and Social Networks: The "Small World" of the Amarna Letters, in Mynářová J., Onderka P., Pavúk P. (eds), *There and Back Again – the Crossroads II. Proceedings of an International Conference Held in Prague, September 15–18, 2014*, Prague, 17-44.
- Érdi P. 2008, *Complexity Explained*, Berlin and Heidelberg.
- Krebernik M. 1982, Zu Syllabar und Orthographie der lexicalischen Texte aus Ebla. Teil 1, *ZA* 72, 178-236.
- Krebernik M. 1996, The Linguistic Classification of Eblaite, Methods, Problems, Results, in Cooper J., Schwartz G. (eds), *The Study of the Ancient Near East in the Twenty-First Century: The William Foxwell Albright Centennial Conference*, Winona Lake, 233-250.
- Freeman L.C. 2004, *The Development of Social Network Analysis: A Study in the Sociology of Science*, North Charleston.

- Mander P. 2008, Les Dieux et le culte a Ebla, in Del Olmo Lete G. (ed.), *Mythologie et religion des sémites occidentaux. Volume 1. Ébla, Mari* (Orientalia Lovaniensia Analecta 162), Leuven, 1-160.
- Matthiae P. 1986, The Archives of the Royal Palace G of Ebla: Distribution and Arrangement of the Tablets according to the Archaeological Evidence, in Veenhof K.R. (ed.), *Cuneiform Archives and Libraries* (PIHANS 57 = XXX CRRAI), Istanbul, 53-71.
- Milano L. 1987, Food rations at Ebla: A Preliminary Account on the Ration Lists Coming from the Ebla Palace Archive L.2712, *MARI* 5, 519-550.
- Milano L. 1989, Luoghi di culto ad Ebla: economia e sistema delle offerte, *ScAnt* 3-4, 155-73.
- Milano L. 1995, Ebla: A third Millennium City-State in Ancient Syria, in Sasson J.M. (ed.), *Civilizations of the Ancient Near East*, New York, 1219-1230.
- Milano L. 2003, Les affaires de monsieur Gida-Nai'im, in Marrassini P. (ed.), *Semitic and Assyriological Studies Presented to Pelio Fronzaroli by Pupils and Colleagues*, Wiesbaden, 411-429.
- Picchioni S. 1981, Osservazioni sulla paleografia e sulla cronologia dei testi di Ebla, in Cagni L. (ed.), *La lingua di Ebla: Atti del Convegno Internazionale (Napoli, 21-23 aprile 1980)*, Napoli, 109-120.
- Pomponio F. 1987, La datazione interna dei testi economico-amministrativi di Ebla, in Cagni L. (ed.), *La lingua di Ebla: Atti del Convegno Internazionale (Napoli, 21-23 aprile 1980)*, Napoli, 249-262.
- Pomponio F., Xella P. 1997, *Les dieux d'Ebla. Etude analytique des divinités eblaites à l'époque des archives royales du IIIe millénaire* (AOAT 245), Münster.
- Rubio G. 2006, Eblaites, Akkadian, and East Semitic, in Deutscher G., Kouwenberg N.J. (eds), *The Akkadian Language in its Semitic Context: Studies in the Akkadian of the Third and Second Millennium BC* (PIHANS 106), Istanbul, 110-139.
- Sallaberger W. 2001, Die Entwicklung der Keilschrift in Ebla, in Meyer W., Nowak M., Pruss A. (Hgg.), *Beiträge zur Vorderasiatischen Archäologie Winfried Orthmann gewidmet*, Frankfurt, 436-445.
- Still B. 2012, Wife-Givers and Wife-Takers: A Network Approach to Marriage and Hierarchy among Babylonian Priests, paper read at the *58th Rencontre Assyriologique Internationale*, Leiden.
- Tonietti M.V. 1988, La figura del nar nei testi di Ebla. Ipotesi per una cronologia delle liste di nomi presenti nei testi economici, *Miscellanea Eblaitica* 1 (= *QuSem* 15), 79-119.
- Tonietti M.V. 1989a, Le liste delle dam en: cronologia interna. Criteri ed elementi per una datazione relativa dei testi economici di Ebla, *Miscellanea Eblaitica* 2 (= *QuSem* 16), 79-115.
- Tonietti M.V. 1989b, Aggiornamento alla cronologia dei NAR, *Miscellanea Eblaitica* 2 (= *QuSem* 16), 117-129.
- Tonietti M.V. 1990, Le liste delle dam en: proposta di join, *NABU* 1990/55.
- Tonietti M.V. 1997a, Musik. A. II, in Ebla, *RLA* 8, 482-483.
- Tonietti M.V. 1997b, Nar directly connected to a temple in Ebla, *NABU* 1997/39.
- Tonietti M.V. 1997c, The Mobility of the NAR and the Sumerian Personal Names in Pre-Sargonic Mari Onomasticon, in Lebeau M. (ed.), *About Subartu* (Subartu 4/2), Turnhout, 83-101.
- Tonietti M.V. 2010, Singers in the Ebla Texts: A Third-Millennium Local Source for Northern Syria, in Pruzsinszky R., Shehata D. (Hgg.), *Musiker und Tradierung. Studien zur Rolle von Musikern bei der Verschiftlichung und Tradierung von literarischen Werken* (WOO 8), Wien, 67-93.
- Tonietti M.V. 2013, *Aspetti del sistema preposizionale dell'eblaita*, Venezia.
- Waerzeggers C. 2012, The Network of Resistance, paper read at the *58th Rencontre Assyriologique Internationale*, Leiden.
- Waerzeggers C. 2014, Social Network Analysis of Cuneiform Archives: A New Approach, in Baker H.D., Jursa M. (eds), *Documentary Sources in Ancient Near Eastern and Greco-Roman Economic History: Methodology and Practice*, Oxford, 207-233.

Massimo Maiocchi

Research Associate

Oriental Institute of the University of Chicago

1155 E 58th Street

Chicago, IL 60637

USA

massimo.maiocchi@gmail.com

