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A kinship network analysis of Palmyrene genealogies

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Abstract In this proof-of-concept study we investigate the potential and challenges of a formal network approach for the examination of 1st to 3rd century CE kinship networks in ancient Palmyra (in present-day Syria). The recent availability of a large, digitised archaeological dataset allows for a thorough reassessment of previously studied genealogies. By applying network and genealogical formal methods to these for the first time we can re-evaluate the genealogical completeness and gender bias in our sources, and scientifically explore the tendency for intermarriage within an extended Palmyrene family.

We combine archaeological information from funerary portraits in the exhaustive database created by the Palmyra Portrait Project with textual sources from funerary and public inscriptions, and critically evaluate the differences and limits of these sources for genealogical studies. Applying formal network and genealogical techniques to these datasets, as well as comparing five different case studies, allows us to draw attention to four key points: (1) our sources confirm a high degree of genealogical incompleteness and gender bias, which was already known from studies of Palmyrene society; (2) to evaluate whether the relinking index can enhance debates on endogamy and exogamy practices in Palmyra; (3) funerary and public inscriptions are highly complementary and reveal different genealogical structures; and (4) to assess the assumptions behind creating uncertain relationships in funerary cases and their effects on our results.

This paper demonstrates a number of quantitative and qualitative approaches for understanding the limits of fragmentary archaeological and historical sources in this process, and it lays the foundation for formulating highly specified hypotheses about the structure of ancient Palmyrene kinship networks in future work.

1. Introduction*

The public texts, funerary portraits and their inscriptions found in the desert city of Palmyra, famous for its tower tombs, hypogea (underground tombs) and temple tombs, document thousands of its ancient residents, as well as how they were related through kinship and other ties. But what was the structure of family networks in Palmyra, and how well do these diverse archaeological and written sources allow us to reconstruct them?

Previous studies have established genealogies for Palmyrene elite families, and combined insights drawn from inscriptions and portraits.¹ However, the recent creation of an exhaustive database by the Palmyra Portrait Project (PPP), directed by professor and Centre Director Rubina Raja, combined with the use of formal genealogical and network science techniques, allows for a thorough reassessment of our current knowledge of Palmyrene genealogies.

By applying, for the first time, a formal network analysis approach to genealogies derived from a combined corpus of Palmyrene portraits and inscriptions, we can highlight elements such as intermarriage in extended families, as well as generational and gender bias in our sources.²

To explore the diversity in which genealogical information might be represented in the data, we include five case studies, four based on funerary sources, and one based on public sources. We represent our datasets as genealogies, Ore graphs and p-graphs, and compare their structures using genealogical and network methods. We further propose two hypotheses to explore the impact of the missing parents in our sources and to increase the completeness of genealogies and generations. A discussion contextualising our quantitative results with Palmyrene history and data critique reveals the unique potential of this approach as well as the limits of our fragmentary sources for studying Palmyrene genealogies.

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1 Palmira Piersimoni, *The Palmyrene Prosopography* (London: University College London, 1995); Anna Sadurska and Adnan Bounni, *Les sculptures funéraires de Palmyre* (Rome: Giorgio Bretschneider Editore, 1994).

2 Here we use the term gender bias as it is used in the methodological literature to indicate the proportion of unknown men/women in sources. A more nuanced, contextualised discussion is provided in section 5.

2. Data collection

The data used in this study combined both archaeological and historical sources, in the form of funerary portraits and inscriptions, respectively. We drew on the genealogies presented in the studies by Anna Sadurska and Adnan Bounni (case studies 1 to 4) and by Palmira Piersimoni (case study 5), and expanded on these using the Palmyra Portrait Project (henceforth PPP) database.

The PPP aims to (1) compile a corpus of all known Palmyrene funerary portraits, (2) to digitalise the comprehensive photo archive of the Danish archaeologist Harald Ingholt, and (3) to produce text volumes to accompany the corpus, as well as a number of publications on various aspects of Palmyrene sculpture.³ The corpus, which will be made accessible in an online database, currently contains information on almost 3,500 objects with 4,000 portraits. Each of the objects in the database is assigned an individual number and each portrait is designated by a letter (for example, a stele with father and daughter at the Ny Carlsberg Glyptotek⁴ is assigned the object number NCG042, with the portrait of the daughter assigned the portrait letter A, and the portrait of the father assigned the portrait letter B). Information such as the current location of the object, its provenance, and context is recorded and compiled along with the full bibliography. Furthermore, the date of an object, and the age, attributes, and gender of a portrait is reassessed.

In spite of the high number of funerary inscriptions preserved from Palmyra, it is important to bear in mind that only a small fraction of the city's population, likely members of elite families, would have received the type of funeral that is reflected in our records. We have selected these case studies due to the fact that they were comparatively well-documented in existing literature and because they were in use over substantial periods of time. In sum, this entailed the risk that the family networks were not representative of the situation in Palmyra in general, but it nonetheless provided data that was well suited for the purpose of this article: to establish the potential usefulness of this methodological approach.

3 See for example Rubina Raja, "Compilation and digitisation of the Palmyrene corpus of funerary portraits," *Antiquity* 92, no. 365 (2018).

4 Ny Carlsberg Glyptotek (inv. no. I.N. 1029): Rubina Raja, *Catalogue: The Palmyra Collection, Ny Carlsberg Glyptotek* (Copenhagen: Ny Carlsberg Glyptotek, 2019a), 92–93, cat. II.

2.1 Selected genealogies

In 1994, Sadurska and Bounni published the sculptures from hypogea that were kept at the Palmyra Museum (e.g. Fig. 1). They intended this as a holistic study of the finds from fifteen hypogea, integrating sculptural and epigraphic data with the excavation records. Their observations about family structures, genealogies, sculptural workshops, and use of funerary complexes are essential for understanding Palmyrene society. As we studied Palmyrene sculpture within the framework of the PPP, however, we noticed that it was possible to expand their analysis, elaborate on their results, and gain an even more nuanced image of Palmyrene families and the relationships between them. For this reason, we selected four case studies based on the following criteria: (1) the richest sculptural representations, namely funerary portraits; (2) epigraphic evidence accompanying most of the sculptural representations found in the tomb; (3) a textual and material record spanning for more than three generations; and (4) good documentation of find locations.

Funerary inscriptions, however, only represented one aspect of Palmyrene society. These inscriptions gave information on onomastics, family relations and sometimes tribal affiliation, but revealed little about activities in the public sphere. The city also had a rich record of public inscriptions in Palmyrene Aramaic and Greek, and a few exceptional inscriptions in Latin. To explore the potential to combine this material with that of the funerary sphere, case study 5 was based on the Palmyrene prosopography published by Palmira Piersimoni in 1995 which included every Palmyrene individual attested in inscriptions known until then.⁵ From Piersimoni's work we selected the Firmôn family, which could be traced for eight generations between the early first century CE and the late second century CE.⁶ In addition to its longevity, the family was chosen because the varied epigraphic record attesting it indicated their participation in caravan trade, acts of euergetism, membership in the priestly profession, and the purchase of funerary space in an established tomb, perhaps indicating upward social mobility.⁷

5 Piersimoni, *The Palmyrene Prosopography*.

6 Piersimoni, *The Palmyrene Prosopography*, 563; also: Józef Tadeusz Milik, *Dedicaces faites par des dieux (Palmyre, Hatra, Tyr) et des thiasés Semiteques a l'epoque romaine* (Paris: Recherches d'epigraphie Proche-Orientale, 1972), 34–36.

7 In the case of the Firmôn family, we know that ID 9 in fig. 11 is known as the symposiarch of the priest of the temple of Bel: Harald Ingholt, "Inscription and Sculptures from Palmyra," *Berytus* 3 (1936): 89–91; Harald Ingholt, "Two unpublished tombs from the Southwest Necropolis of Palmyra, Syria, in *Near Eastern numismatics, iconography, epigraphy and history: studies in honor of George C. Miles*, ed. Dickran K. Kouymjian (Beirut: American University of Beirut, 1974), 45; Piersimoni, *The Palmyrene Prosopography*, 56. Moreover, ID 20 in fig. 11 is mentioned in an inscription on a tessera also depicting a priest, indicating that he was likely also a priest: Harald Ingholt, Henri Seyrig, and Jean Starcky, *Recueil des tessères de Palmyre* (Paris: Paul Geuthner, 1955), III, cat. 851, pl. 41.

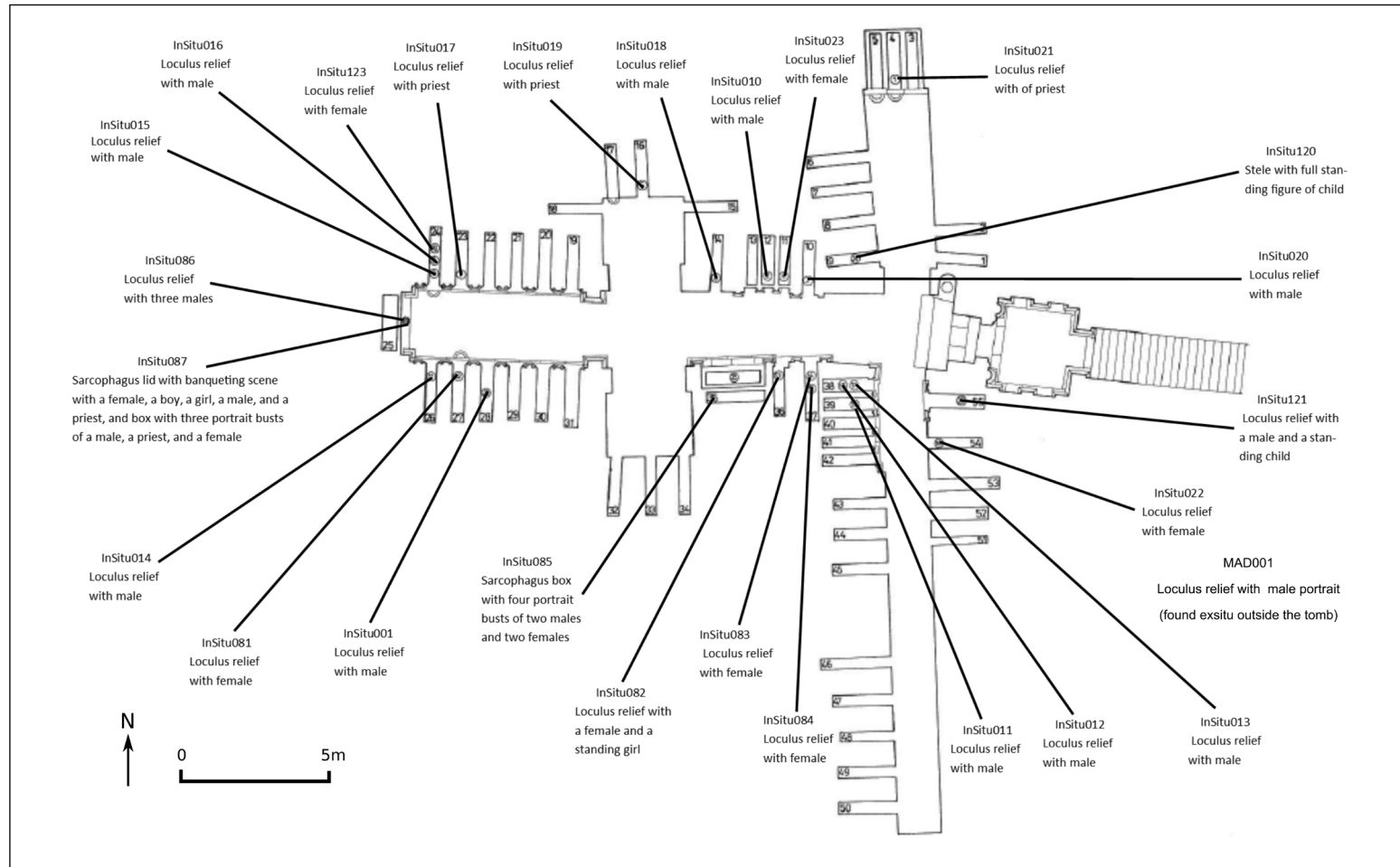


Fig. 1 The hypogeum of Artaban (case study 1). Note the corridor and location of the funerary portraits within them (ground plan adapted from Sadurska and Bounni 1994: plan IV).

The public inscriptions also provided the opportunity to extend the network to external individuals with whom the family interacted (a potential that will be explored in future work). Piersimoni's genealogy was checked with the epigraphic editions cited in her study, as well as with the later published corpora of Aramaic and Greek texts from Palmyra.⁸

The following five case studies were selected and studied for this paper:

- 1) The hypogeum of Artaban, son of 'Oggâ⁹
- 2) The hypogeum of Bôlhâ, son of Nebôšûri¹⁰
- 3) The hypogeum of Sassans and Mattai¹¹
- 4) The hypogeum of Zebîdâ, son of 'Ogeilû¹²
- 5) The Firmôn family¹³

2.2 Collected data and format

From our sources we derived information about as many individuals as possible, as well as about the existence and nature of relationships between them. We additionally made assessments of the reliability of the collected information, and included these in the dataset. The dataset was stored as three spreadsheets per case study in order to import them into the genealogical network analysis software Puck:¹⁴ (1) spreadsheet puck_relationships (genealogy information); (2) spreadsheet puck_individuals (additional information about all individuals); and (3) spreadsheet original_relationships (additional information about all collected relationships). The data was further prepared for genealogical and network analysis in the network analysis software Pajek¹⁵ by storing it using the GEDCOM standard, with all additional information we collected about the individuals from both archaeological and historical sources stored as supplementary information in the same file. All spreadsheets and GEDCOM files created are available as a supplement to this paper (see online supplementary material). The following data was collected for each case study:

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- 8 Delbert R. Hillers and Eleonora Cussini, *Palmyrene Aramaic Text* (Baltimore and London: The Johns Hopkins University Press, 1996); Jean-Baptiste Yon, *Inscriptions Grecques et Latines de la Syrie: Palmyre*, vol. 17.1 (Beyrouth: Institut Français du Proche-Orient, 2012).
 - 9 Sadurska and Bounni, *Les sculptures funéraires de Palmyre*, 23–40.
 - 10 Sadurska and Bounni, *Les sculptures funéraires de Palmyre*, 70–90.
 - 11 Sadurska and Bounni, *Les sculptures funéraires de Palmyre*, 41–69.
 - 12 Sadurska and Bounni, *Les sculptures funéraires de Palmyre*, 91–101.
 - 13 Piersimoni, *The Palmyrene Prosopography*, 563.
 - 14 All genealogical analyses were performed using the open access software Puck: Klaus Hamberger, Michael Houseman, and Cyril Grange, "La Parenté Radiographiée," *L'Homme* 191 (2009).
 - 15 Vladimir Batagelj and Andrej Mrvar, "Pajek, Program for Analysis and Visualization of Large Networks," accessed September 30 2019, <http://mrvar.fdv.uni-lj.si/pajek/>.

- Data collected about individuals (spreadsheet `puck_individuals`):
 - `Individual_ID`: unique ID for each individual.
 - `Object_number`: the object number in the PPP database.
 - `Portrait_number`: the portrait letter in the PPP database.
 - `Without_portrait?`: we had the choice of the values ‘YES’ and ‘NO’; we chose YES if the individual was known only from an inscription, and not known through a portrait.
 - `SB_number`: the catalogue number in Sadurska and Bounni’s publication.
 - `Name`: the name of the individual, when known.
 - `Name_analysis`: the name used in the analyses presented here, which included generically added and unknown names.
 - `Date_SB_from` and `Date_SB_to`: the proposed lower and upper date of the generation to which the individual belonged as published in the genealogies by Sadurska and Bounni.
 - `Date_inscription`: this was included when the portrait was dated by an inscription.
 - `Date_from` and `Date_to`: the date range proposed for this object in the PPP database.
 - `Date_to_analysis`: the upper date as known through any source, used for visualising networks.
 - `Age`: one of three hypothetical values: 0–15; 15–50; 50+. The Palmyrenes rarely indicated the age of the deceased in funerary inscriptions; therefore, the age of the depicted person was determined through iconographic features, such as specific attributes (for example grapes, birds, spindles) and facial features (receding hairlines and wrinkles).
 - `Represents_age_at_death`: we had the choice of the values ‘YES’ and ‘NO’; in the cases where we have a portrait of a child with a parent we assumed that only the parent was buried, therefore we chose ‘YES’ for the parent and ‘NO’ for the child (i.e. he/she was not represented at the age of death).
 - `Source_portrait` and `Source_inscription`: we had the choice of the values ‘YES’ and ‘NO’; we chose ‘YES’ if the individual was documented through a portrait/inscription.
 - `Gender`: male, female, unclear.
 - `Priest?`: we had the choice of the values ‘YES’ and ‘NO’; we chose ‘YES’ if the individual was a priest. We decided that it was important to record priests, because priesthood in Palmyra was a marker of particular social status; it was often hereditary, and the evidence shows that it was also associated particularly with the elite.¹⁶
 - `Profession_role`: this was recorded only when we had indications of the individual’s profession (for example, through attributes or an inscription).

16 See for example Rubina Raja, “Representations of priests in Palmyra: methodological considerations on the meaning of the representations of priesthood in Roman period Palmyra,” *Religion in the Roman Empire* 2, no. 1 (2016); Rubina Raja, “Between Fash-

- Relationships (spreadsheet original_relationships):
 - Relationship_ID: unique identifier for each relationship.
 - Source_individual_ID and target_individual_ID: the pair of individuals between whom the relationship existed (from child to parent).
 - Nature: is son of, is daughter of, is married to, ...
 - Source_inscription, source_portrait and source_proximity: these three were our sources for judging the reliability of a relationship. We had the choice of the values 'YES' and 'NO'. We chose YES if a relationship was documented through an inscription and/or portrait or theory of proximity (e.g. the relationship A father of B was documented through an inscription only; the relationship between a parent C and child D on the same portrait without inscription was documented through a portrait only; the marriage relationship between E and F was a hypothesis by Sadurska and Bounni based on the physical proximity of their portraits in the tomb; the relationship G grandson of H was assumed because of use of the same name).
 - Reliability: we had the choice of values 0–3: solid evidence that this relationship definitely did NOT exist (selection of value 0). We considered a relationship improbable when the only source for it was physical proximity in the tomb (selection of value 1). The relationship could still exist, but we did not have enough evidence to support it. When a relationship was suggested by onomastic practices, and the portraits were located close to each other in the tomb, then we considered a relationship probable and likely correct (selection of value 2). When a relationship was documented

ion Phenomena and Status Symbols: Contextualising the Dress of the So-Called 'Former Priests' of Palmyra," in *Textiles and Cult in the Mediterranean Area in the 1st millennium BC*, eds. Cecilie Brøns and Marie-Louise Nosch (Oxford: Oxbow, 2017a); Rubina Raja, "Networking beyond death: Priests and their family networks in Palmyra explored through the funerary sculpture," in *Sinews of Empire: Networks in the Roman Near East and Beyond*, eds. Eivind Heldaas Seland and Håkon Fiane Teigen (Oxford: Oxbow, 2017b); Rubina Raja, "Priesthood in Palmyra: Public Office or Social Status?," in *Palmyra: pearl of the desert*, ed. Rubina Raja (Aarhus: SUN-Tryk, Aarhus University, 2017c); Rubina Raja, "Præster i Palmyra: Et embede eller en social status?," in *Palmyra: ørknens perle*, ed. Rubina Raja (Aarhus: SUN-Tryk, Aarhus University, 2017d); Rubina Raja, "Representations of the So-Called 'Former Priests' in Palmyrene Funerary Art: A Methodological Contribution and Commentary," *Topoi* 21, no. 1 (2017e); Rubina Raja, "To be or not to be depicted as a priest in Palmyra: A matter of representational spheres and societal values," in *Positions and Professions in Palmyra*, eds. Annette Højen Sørensen and Tracy Long (Copenhagen: The Royal Danish Academy of Sciences and Letters, 2017f); Rubina Raja, "'You can leave your hat on': Priestly representations from Palmyra: between visual genre, religious importance and social status," in *Beyond Priesthood: Religious Entrepreneurs and Innovators in the Roman Empire*, eds. by Richard L. Gordon, Georgia Peitridou and Jörg Rüpke (Berlin: De Gruyter, 2017g); Rubina Raja, "It stays in the Family: Palmyrene Priestly representations and their Constellations," in *Women, children and the family in Palmyra*, eds. Signe Krag and Rubina Raja (Copenhagen: The Royal Danish Academy of Sciences and Letters, 2019b).

through an inscription, and/or a portrait (i.e. solid evidence), we considered it correct (selection of value 3).

2.3 Data collection challenges

Collecting the data also meant re-evaluating the information published by Sadowska and Bounni and Piersimoni. The information on the totality of the contexts of the tombs was checked against the previous bibliography, while the dates proposed by the excavators were reassessed. During this process, we encountered challenges in assessing the following criteria used by the scholars for establishing relationships: proximity, and onomastics.

Proximity was used as a criterion for establishing a relationship when two individuals, identified through portraits (since no skeletal remains were preserved in most cases), were placed in adjacent burial niches. ‘Adjacent’, according to Sadowska and Bounni, meant either that both niches were in a single dug-out section of the tomb, therefore, one niche located over the other, or niches in neighbouring dug-out sections, thus divided only by a thin pillar (see Fig. 1). Without any inscriptions on the portraits, though, we considered proximity to be an indication of a possible relationship between the buried individuals.

Another indicator used by scholars to establish a relationship between two individuals was onomastics. We know that *papponymy* (i.e. the grandson is named after the grandfather) was a common practice in Palmyra. This led scholars to propose genealogies based on the reuse of names, and to hypothesise maternal relationships especially when the name of a woman’s father was seen in the inscription of a man, where only his father is mentioned. Onomastics, however, were used in combination with other criteria, such as stylistic dating. So, for example, in a portrait dated between 150–170 CE, X was the daughter of Y, and in a portrait dated between 160–180 CE, Y was the son of Z, therefore X is the mother of Y, with grandfather and grandson sharing a name.¹⁷ Of course, there was a relatively small pool of names to choose from in Palmyra; however, by focusing on individuals buried in the same tomb complex, we considered that reuse of names did indicate likely relationships between the individuals.

The last challenge faced in the data collection, as well as in the network analysis, was that not every individual of a family was represented through an inscription and/or a portrait in the public and the funerary sphere. Women, especially, are underrepresented in our inscriptions, although thanks to the work done by the PPP on the database, we can now see that portraits of women constitute almost 40% of all recorded Palmyrene portraits.¹⁸ This gendered under-represen-

17 Piersimoni, *Palmyrene Prosopography*, 549–550.

18 Data taken from the PPP database (December 2019).

tation in inscriptions ('gender bias') means that in most cases we know the fathers but not the mothers of specific individuals; also, because women were usually recorded in the epigraphic record as daughters, we cannot be certain of their status as wives.

As we will show in the methodology section, we tried to address this issue by the creation of two networks, a primary and a secondary network.

3. Method

Summary: (1) to address some of the issues of missing or uncertain data, we focused on the largest connected component for each case study, creating a network with the collected genealogical data as is (referred to as **primary** network) and a *hypothesis* adding missing parents (referred to as **secondary** network); (2) the networks were represented as Ore graphs (using Puck) and p-graphs (using Pajek); (3) basic network statistics were derived (using Visone);¹⁹ (4) genealogical statistics were derived (using Puck and Pajek).

3.1 Missing information and boundary specification

The incompleteness of the dataset meant that some of the information needed to make correct representations and analyses was missing. One crucial issue was our lack of information about all parents of known children. There are a number of cases where we knew one parent (typically the father) with multiple children but not the other parent(s). For example, for creating p-graphs, this posed the issue that we did not know whether these children had the same pair of parents or only shared one parent (in the case of studying remarriage, which was our main reason for using p-graphs, as stated below). A second issue was the uncertain nature of certain documented relationships. In some inscriptions, relationships between pairs of individuals were referenced but it was not clear whether this referred to a parent, marriage, sibling, or other relationship. A third issue was the uncertainty of the existence of a relationship. For example, in a few cases a kinship relationship was neither documented in an inscription or a portrait, but rather only through the presence of both individuals' names in close proximity in the same hypogeum (see section 2.3).

The incompleteness of the record necessarily influenced the boundary specification of our network analyses, and determined what analytical techniques could be applied to what network representations. To address these issues, we excluded relationships whose nature was unknown, highlighted the relationships whose existence was uncertain, and explored their impact on the results. We focused

19 Visone Project Team, "Visone v.2.16," accessed September 30, 2019, <http://visone.info>.

our analyses on the largest connected component of the genealogy derived from each hypogeum (i.e. the largest set of individuals that can be connected to each other).

There were more people buried in the hypogea than the people represented in the networks' largest components, and these included the portrait representations of individuals without an accompanying inscription. Furthermore, there were also reliefs with inscriptions depicting people who could not be linked to those of the main or extended families represented by the largest components. All these additional individuals could be among those "missing" family members that our hypotheses aimed to reintroduce. Future studies should further scrutinise the evidence for these additional individuals in light of the network structure and missing individuals revealed in this study, to explore whether they can be included into the genealogies.

We also have inscribed reliefs testifying to small sets of connected individuals that cannot be otherwise linked to the largest component. These may have been connected to the people in our largest components, although onomastics points to them being separate family units. Their presence in the family tomb may have indicated the use of the tomb by relations of the wife, perhaps indicating a degree of exogamy, or that the women who entered the husband's household then became his primary heiresses and used the husband's family tomb as their own.²⁰ Another hypothesis for their presence may have been the cession of part of the family tomb to a different, possibly unrelated, family, although this cannot be proven without a cession text.

- 1) The issue of missing parents was more difficult to deal with and required us to perform our analyses on the sources as well as two *hypothetical* versions of each network:
- 2) Using the dataset as it was to explore the sources. See the Ore graph and genealogical information of the **primary** network.
- 3) Adding a single missing partner (unrelated to other individuals) for each single parent and assuming each child had the same pair of parents (the chil-

20 Signe Krag, "Palmyrene funerary buildings and family burial patterns," in *Women, children and the family in Palmyra*, eds. Signe Krag and Rubina Raja (Copenhagen: The Royal Danish Academy of Sciences and Letters, 2019), 50. We know of one woman, 'Alâ, who is represented on two different portraits; one was likely placed in the tomb of her father and the other in the tomb of her husband. Both portraits carry the same inscription, although differently arranged, and mention the same year of death. (1) One portrait is now in the Ny Carlsberg Glyptotek (inv. no. I.N. 1079) and (2) the other is in the British Museum (inv. no. BM25695): Signe Krag, *Funerary Representations of Palmyrene Women from the First Century BC to the Third Century AD* (Turnhout: Brepols, 2018), 189, cat. 88–89; Raja, *Catalogue*, 70–71, cat. 3.

dren being siblings). This hypothetical version was referred to as the **secondary** network and was studied in detail through genealogical, Ore graph and p-graph representations.

- 4) Making the hypothetical assumption that single parents with multiple children remarried such that each child had a different pair of parents (the children being stepsiblings). This hypothesis was **only represented in the p-graph of the primary network** (a p-graph of the sources themselves could not be made without either formulating this hypothesis or the secondary hypothesis).

These *hypothetical* scenarios were designed in light of the proof-of-concept nature of this study: we initially aimed to explore the structure of the available information, as well as the theoretical extremes. A study of the sources themselves allowed us to explore the missing information within and the structure of the dataset as we know it. The first hypothesis allowed us to explore the scenario with a maximum number of nuclear families. The second hypothesis allowed us to explore a conservative hypothesis assuming a minimum number of nuclear families, and the implications of making this assumption on the network structure. A comparison between the structure of the two hypotheses also gave us an idea of the degree of missing information about women in the historical and archaeological record of Palmyra.

3.2 Network representation

Genealogies are most commonly represented as trees, in which parents are the roots and children are the shoots (this representation format was used in the studies by Sadurska and Bounni as well as by Piersimoni). To allow for different network analytical techniques to be applied we used two different representations (Fig. 2). We represented the genealogies as Ore graphs, which included all individuals as separate nodes connected by edges for marriage and arcs from parents to children (i.e. following the flow of time), as well as p-graphs (or parentage-graph²¹) in which couples and unmarried individuals were the nodes and arcs that flowed from children to parents (i.e. against the flow of time). Arcs in p-graphs were dotted if the descendent was female and solid if the descendant was male, and the arc itself was labelled by the individual who embodied the relationship. Thanks to both father and mother being directly connected to each of their children, the Ore graph allowed for an easy calculation of the length and direction of kinship relationships (e.g. how far-removed ancestors were from an individual). The p-graph as a representation was arguably less intuitive than the

21 Douglas R. White, and Paul Jorion, "Representing and Computing Kinship: A New Approach," *Current Anthropology* 33 (1992).

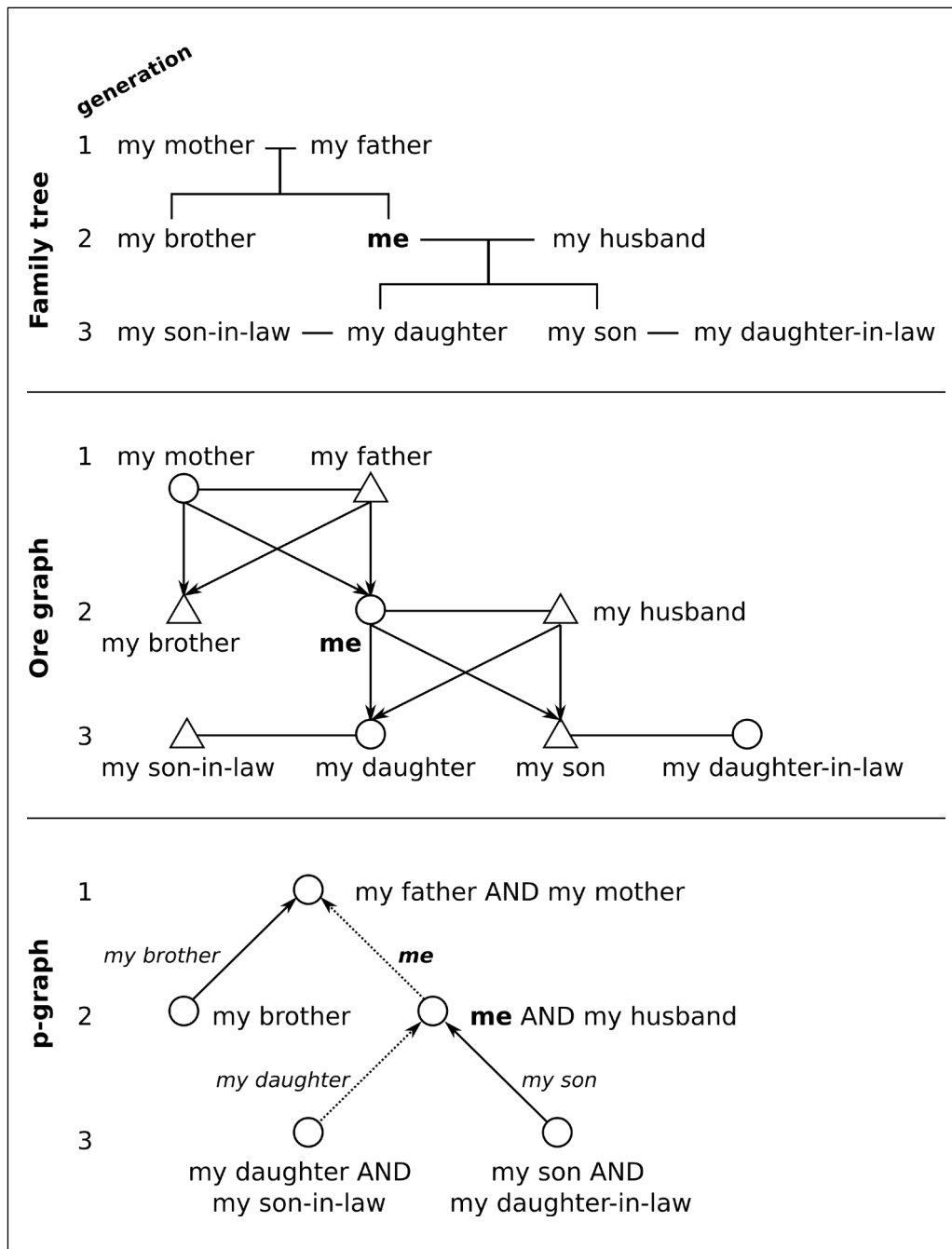


Fig. 2 Genealogical data are commonly represented as family trees (top), but here we use two network representations: Ore graphs (middle) represent women as circles, men as triangles, parent-to-child relationships as arrows and marriage relationships as edges; p-graphs (bottom) represent couples and single individuals as nodes, son-to-parents relationships as full arrows labelled by the son, and daughter-to-parents relationships as dotted arrows labelled by the daughter.

Ore graph, but it was more suitable for searching for relinking patterns in the kinship networks thanks to it being acyclic.²²

3.3 Network analysis

From the connected components of the primary and secondary networks, we derived a number of network statistics. These helped describe the differences between the structure of the case studies' genealogies and the alternative Ore graph and p-graph network representations.

For the Ore graph, we calculated the number of nodes (individuals), the number of arcs (children), the number of edges (marriages), the average degree, the average in/outdegree, and the density. For the p-graph, we calculated the number of nodes (unmarried individuals and couples), the number of arcs (parents), the sources (number of first nodes), the sinks (number of last nodes), the average degree, average in/outdegree, the maximum indegree (maximum number of children), and the density.

3.4 Genealogical analysis

We derived a number of descriptive genealogical statistics that serve a dual purpose: they allowed for biases in the historical and archaeological records to be identified and for the limits of using this data for genealogical studies to be ascertained; they also revealed glimpses of the structure of past kinship relationships in Palmyra.

The simplest genealogical statistics included: the number of individuals, men, women, those with unknown gender, marriages, non-single men, non-single women, parent-child ties, multiple marriages (the number of individuals who had more than one marriage relationship), and the number of relationships whose existence was uncertain. In addition to these, we calculated more complex descriptive statistics revealing data patterns and network structures that spanned multiple generations. We explored the gender bias in the data by identifying the number of individuals for whom only a male (agnatic) or a female (uterine) ancestor was known at several generations' distance. We also identified the completeness of our genealogy by calculating the percentage of known ancestors by generation, again distinguishing between male and female ancestors.

A key statistic was the relinking index, which measured the tendency for marriages between members of the same extended family, which therefore rel-

22 Vladimir Batagelj and Andrej Mrvar, "Analysis of Kinship Relations with Pajek," *Social Science Computer Review* 26, no. 2 (May 3, 2008), <https://doi.org/10.1177/0894439307299587>.

ink diverging branches within the extended family (i.e. branches with a common ancestor within the genealogy). A high relinking index can be expected for communities in isolated locations with limited opportunities to marry into completely unrelated families, whereas such opportunities are more common in large cities, where we can expect a low relinking index. This measure is calculated on p-graphs because every semicycle (every closed path over directed relationships) constituted a relinking.²³ We also identified the number of first cousin marriages.

4. Results

The network and genealogical statistics for all case studies are presented in table 1. This section provides a brief technical description of key results, which will be interpreted and compared in the discussion section. The Ore graphs for the five case studies are shown in figures 3, 5, 7, 9, and 11, while the p-graphs are shown in figures 4, 6, 8, 10, and 12 (sections a and b show the primary and secondary networks, respectively). The gender bias and genealogical completeness per case study are shown in figures 13 and 14, respectively.

The genealogies derived from the five case studies varied in size from about 20 individuals in the case of Firmôn, to 71 individuals in the case of Bôlhâ. Most included almost two centuries of kinship connections, covering a number of generations living in the first three centuries CE. The Hypogeum of Zebîdâ had the lowest, covering 5 generations over roughly 120 years. The Hypogeum of Artaban included 7 generations over roughly 180 years. The Hypogeum of Bôlhâ included 8 generations over roughly 210 years, and the Hypogeum of Sassans included 9 generations, the highest number in this study, over roughly 140 years. The network of the Firmôn family was rather different to the other four, in that its very low number of 20 individuals were spread over no less than 8 generations, covering c. 180 years.

Although most individuals' gender was known, there was one case of an individual of unknown gender in the Artaban network, and four cases in the Zebîdâ network (constituting a rather high proportion of the total of 26 individuals). Potentially more problematic for studying kinship networks was the uncertainty inherent in the reconstruction of some relationships. No less than 16 out of 37 relationships (43%) were not entirely certain for the Zebîdâ case study. For the other three funerary case studies, these proportions were slightly lower (13/52 (25%); 19/94 (20%); 18/68 (26%)) and for the Firmôn network all 19 relationships were considered certain.

23 Batagelj and Mrvar, "Analysis of Kinship Relations with Pajek."

The number of marriages documented in the sources was extremely low, and certainly much lower than in reality (ranging from 1 in the Firmôn network to 9 in the Bôlhâ network). Our hypothetical secondary network represented the minimum number of marriages that must have taken place in order to account for all known children (ranging from 12 in the Firmôn network to 35 in the Bôlhâ network). Moreover, there were only two known cases of individuals marrying multiple times. The primary network's p-graph represented an alternative theoretical scenario in which all children with unknown parents had a distinct parent pair, thus including the maximum number of marriages of known individuals with known children. Comparing the number of nodes of the primary and secondary p-graphs revealed that there was a significant difference between these maximum and minimum marriages hypotheses. The exception was the Hypogeum of Zebîdâ whose primary and secondary p-graphs had the same number of nodes: only for this case study do we know all the siblings' parents.

Intermarriage within the extended family was very limited in our sources, as revealed by the relinking index. It was zero for Zebîdâ and Sassans, and very low for all other case studies. The secondary network typically had a higher relinking index than the primary. First cousin marriages were rare across all case studies, with one case each documented for Artaban, Bôlhâ, and Firmôn.

The primary networks representing our sources revealed a very high degree of incompleteness: our sources lacked a high number of individuals from the studied genealogy (Fig. 14). The secondary hypothesis succeeded at increasing the completeness at the first generational level (i.e. the parents), but not at subsequent generational levels. Moreover, we saw that male ascendants were far more commonly represented at all generational levels than female ascendants (Fig. 13).

	Artaban		Bôlhâ		Sassans		Zebida		Firmon	
Genealogy										
Individuals	39	55	71	97	57	78	26	35	20	31
Men	27	29	56	58	41	43	13	13	18	18
Women	11	24	15	39	16	35	9	14	2	13
Gender unknown	1	2	0	0	0	0	4	8	0	0
Marriages	5	21	9	35	6	27	4	13	1	12
Non-single men	17	19	33	35	24	26	9	9	12	12
Non-single women	7	20	11	35	8	27	4	9	1	12
Parent-child ties	47	70	85	128	62	100	33	42	19	38
Multiple marriages	1	1	0	0	1	1	0	0	0	0
First cousin marriages	1	1	1	1	0	0	0	0	1	1
Uncertain relationships	13	13	19	19	18	18	16	16	0	0
Ore graph										
nodes (individuals)	39	55	71	97	57	78	26	35	20	31
arcs (children)	47	71	85	128	62	100	33	42	19	38
edges (marriages)	5	21	9	35	6	27	4	13	1	12
average degree	2,667	3,309	2,648	3,361	2,386	3,256	2,846	3,143	2	3,226
average in/out-degree	1,462	2,036	1,451	2,041	1,298	1,974	1,577	1,943	1,05	2
components	1	1	1	1	1	1	1	1	1	1
density	0,07	0,061	0,038	0,035	0,043	0,042	0,114	0,092	0,105	0,108

	Artaban	Bôlhâ	Sassans	Zebida	Firmon					
P-graph										
nodes (unmarried individuals and couples)	42	35	79	62	69	52	22	22	27	19
arcs (parents)	41	36	79	64	66	51	21	21	27	19
Sources (number of first nodes)	14	14	28	28	25	25	9	9	8	8
Sinks (number of last nodes)	6	4	7	5	8	6	5	5	1	1
average degree	1,952	2,057	2	2,065	1,913	1,962	1,909	1,909	2	2
average in/out-degree	0,976	1,029	1	1,032	0,957	0,981	0,955	0,955	1	1
Max. indegree (number of children)	5	4	6	6	6	6	6	6	3	3
components	1	1	2	1	3	1	1	1	1	1
density	0,048	0,061	0,026	0,034	0,028	0,038	0,091	0,091	0,077	0,111
Size of Largest Component	42 (100%)	35 (100%)	75 (94.9%)	62 (100%)	51 (73.9%)	52 (100%)	22 (100%)	22 (100%)	27 (100%)	19 (100%)
Relinking Index	0	0,0714	0,0299	0,0566	0	0	0	0	0,0385	0,0556

Tab. 1 Genealogical, Ore graph and p-graph statistics for the primary (white) and secondary (grey) versions of each case study's largest component. Note that for the primary p-graph, we assumed the hypothesis that siblings with a single unknown parent were stepsiblings with distinct parent pairs (hence the higher number of nodes as compared to the secondary p-graphs).

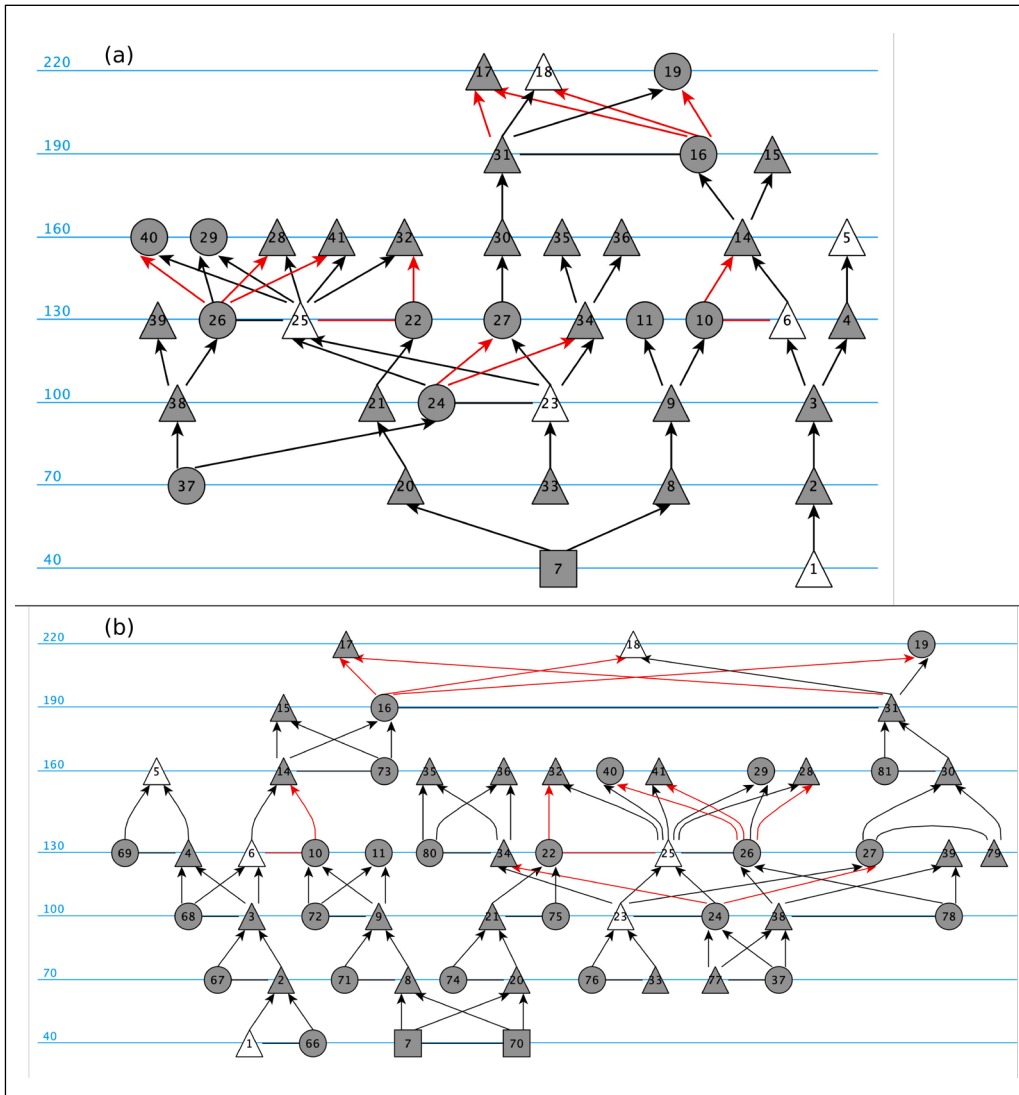


Fig. 3 Largest component of primary (a) and secondary (b) Ore graphs of the Hypogeum of Artaban. For this and all figures of Ore graphs below (Figs. 3, 5, 7, 9, 11): labels represent individual IDs, circles represent women, triangles represent men, squares represent individuals for whom the gender is unknown, white nodes represent priests, red lines represent relationships whose existence is uncertain, arrows represent parent-child relationships, undirected edges represent marriage. The y-axis represents years CE and individuals are placed according to the upper date known for them (this information is only used for representation and does not feature in the analysis).

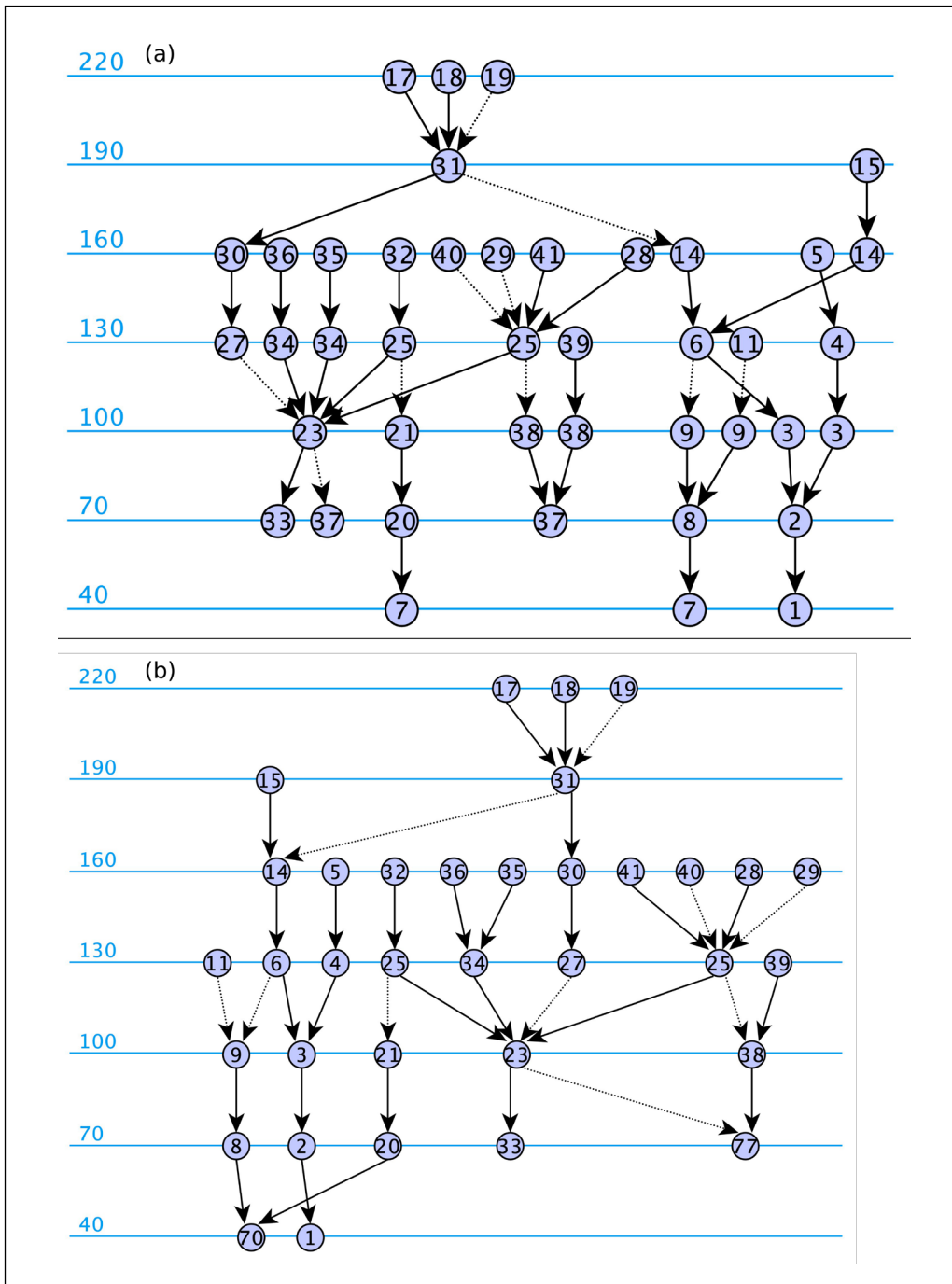


Fig. 4 Largest component of primary (a) and secondary (b) p-graphs of the Hypogeum of Artaban. In this and all p-graphs that follow (Figs. 4, 6, 8, 10, 12), “daughter of” relationships are represented by a dotted arrow and “son of” relationships by a solid arrow. Note how the secondary hypothesis reveals a degree of relinking, whereas the primary hypothesis does not.

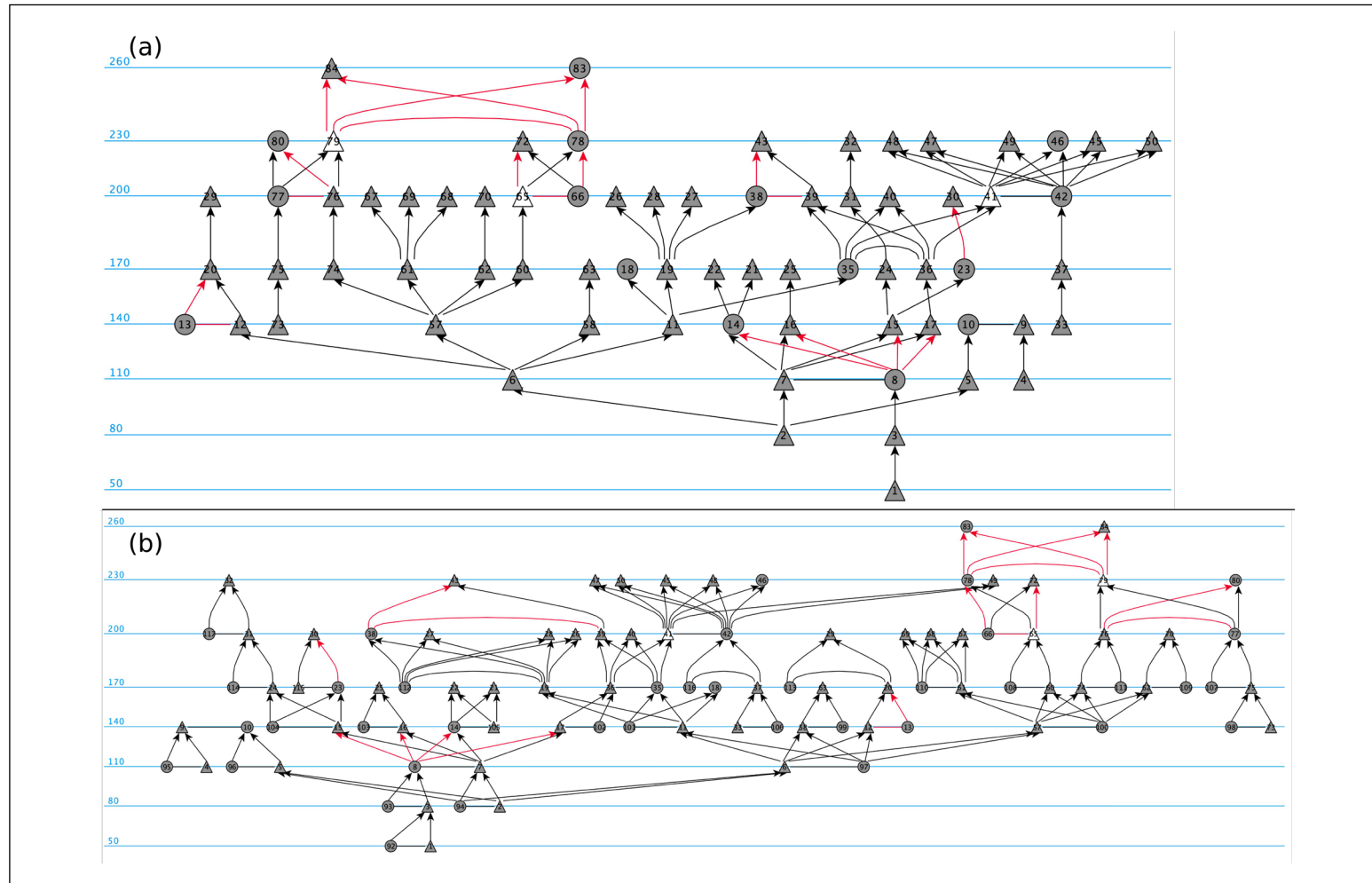


Fig. 5 Largest component of primary (a) and secondary (b) Ore graphs of the Hypogeum of Bôlhã.

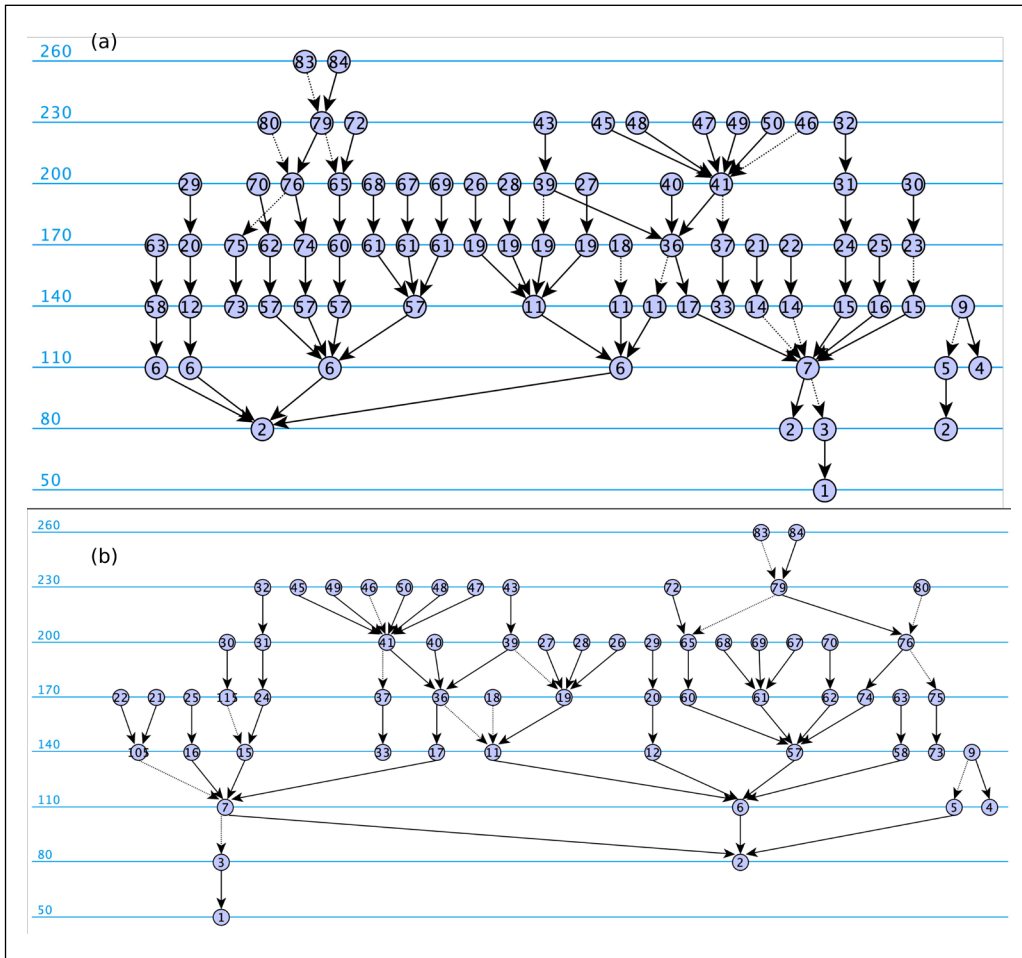


Fig. 6 Largest component of primary (a) and secondary (b) p-graphs of the Hypogeuum of Bôlhâ.

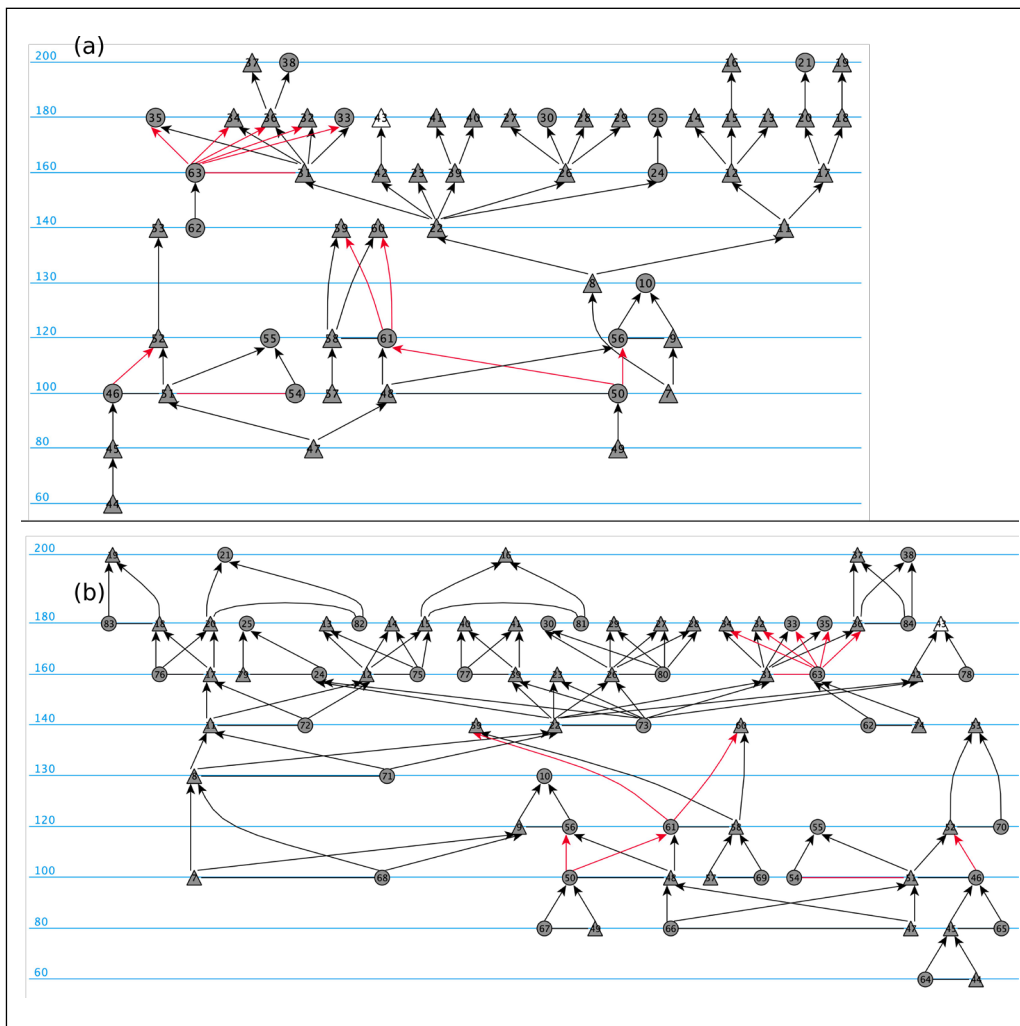


Fig. 7 Largest component of primary (a) and secondary (b) Ore graphs of the Hypogeum of Sassans.

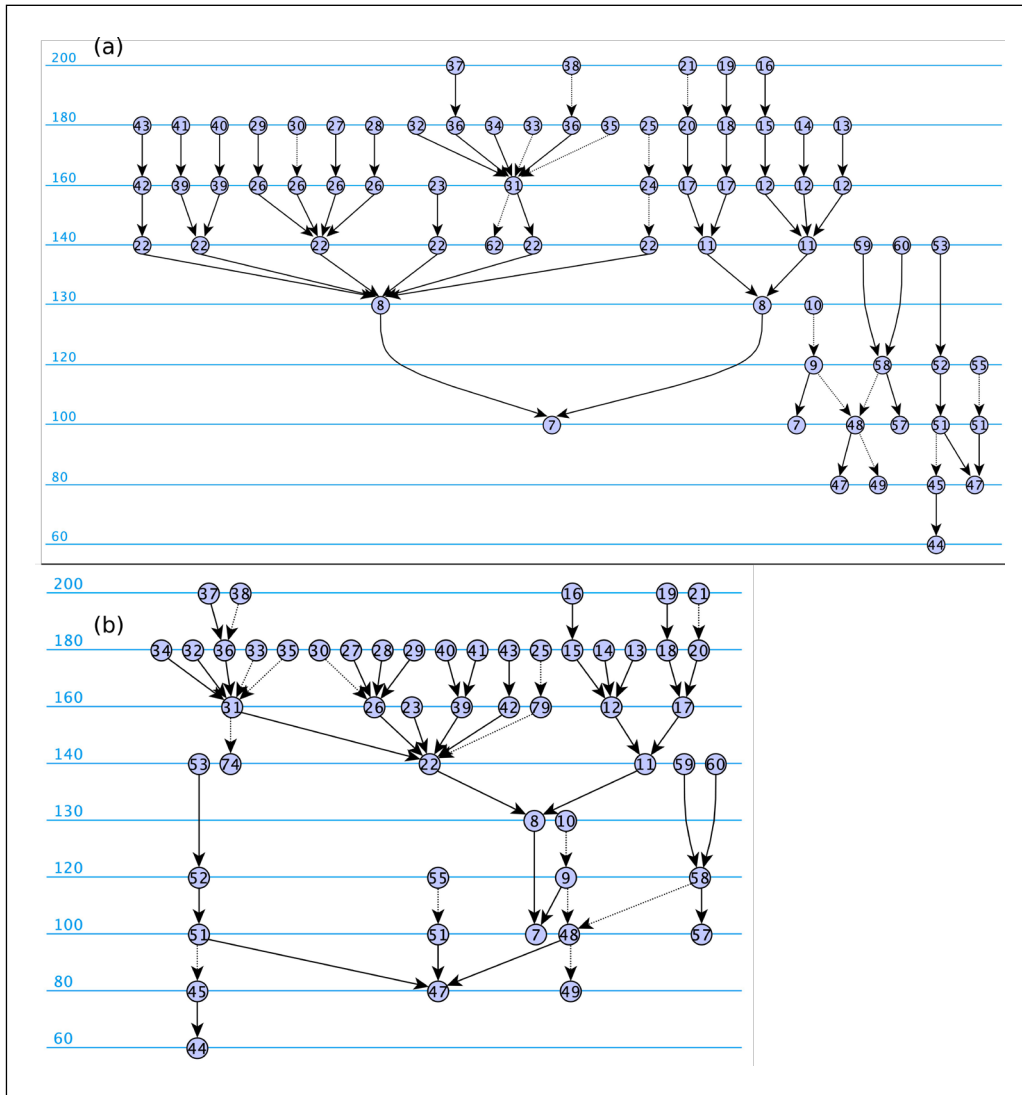


Fig. 8 Largest component of primary (a) and secondary (b) p-graphs of the Hypogeum of Sassans.

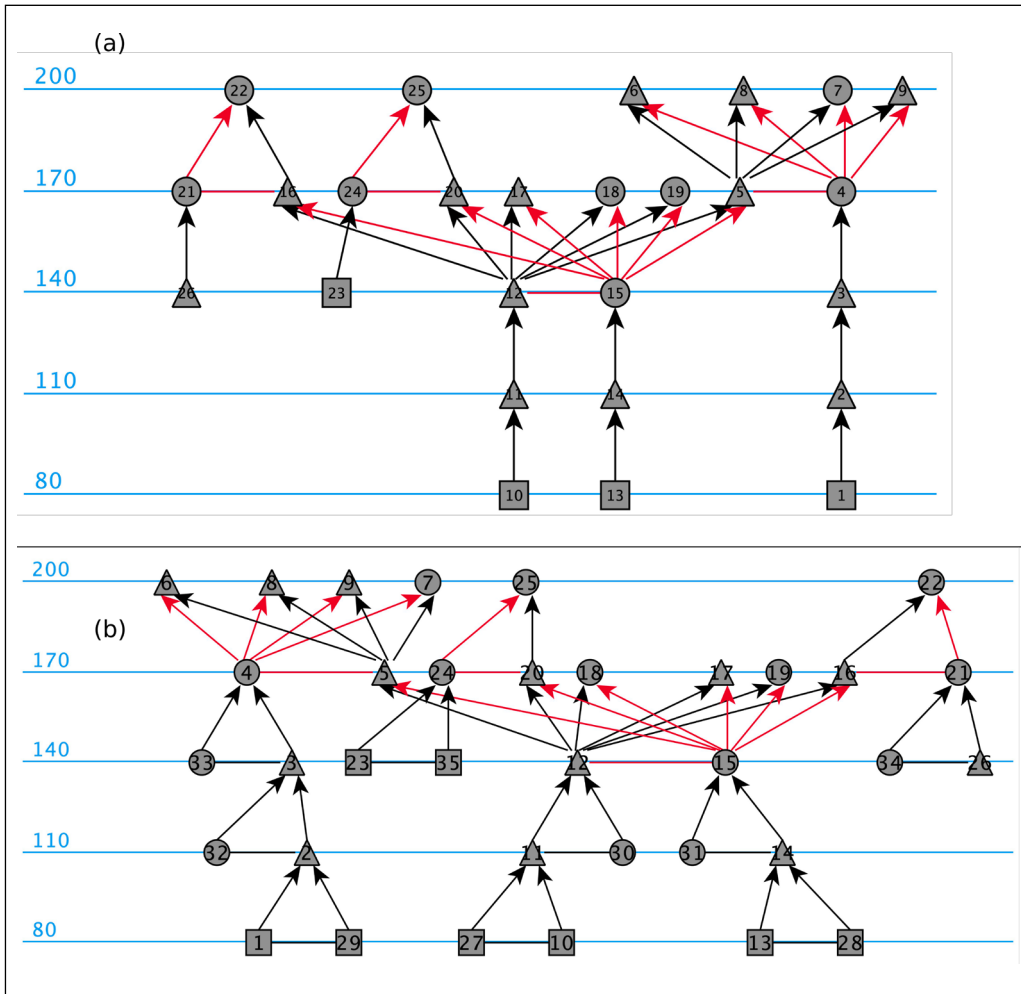


Fig. 9 Largest component of primary (a) and secondary (b) Ore graphs of the Hypogeum of Zebîdâ.

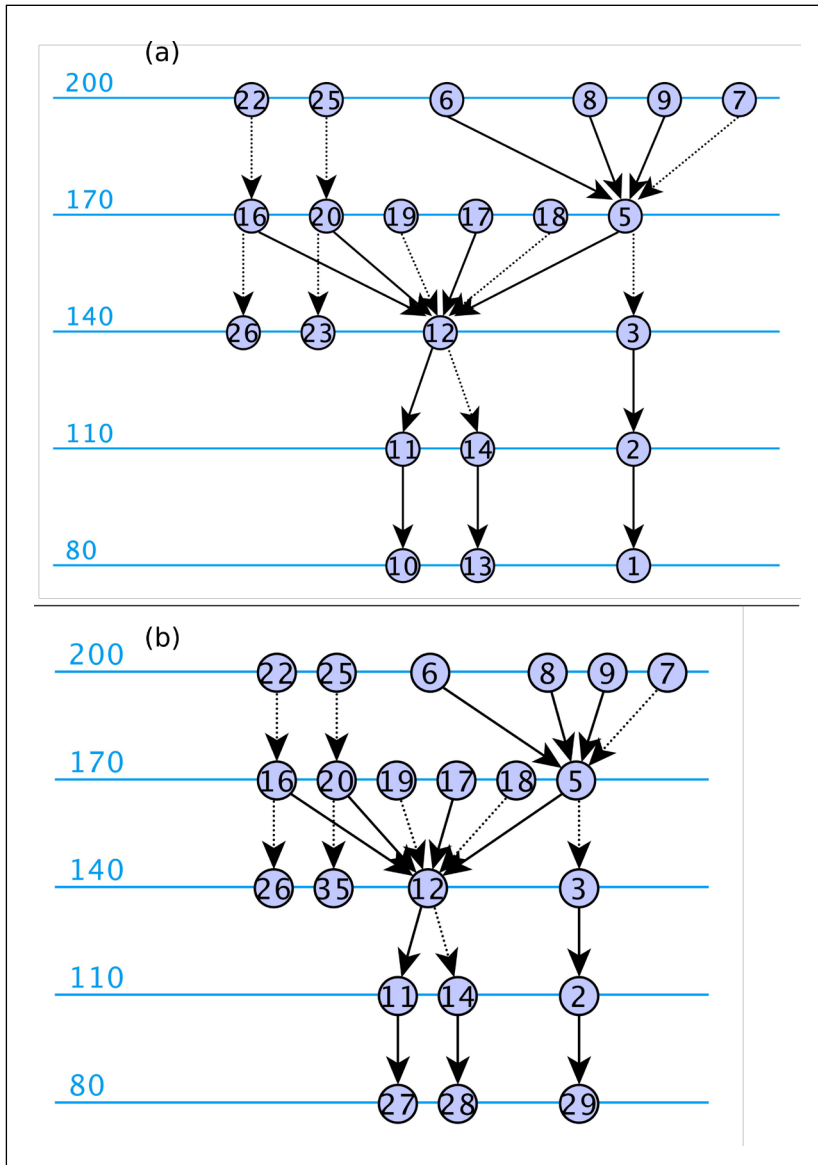


Fig. 10 Largest component of primary (a) and secondary (b) p-graphs of the Hypogaeum of Zebîdâ.

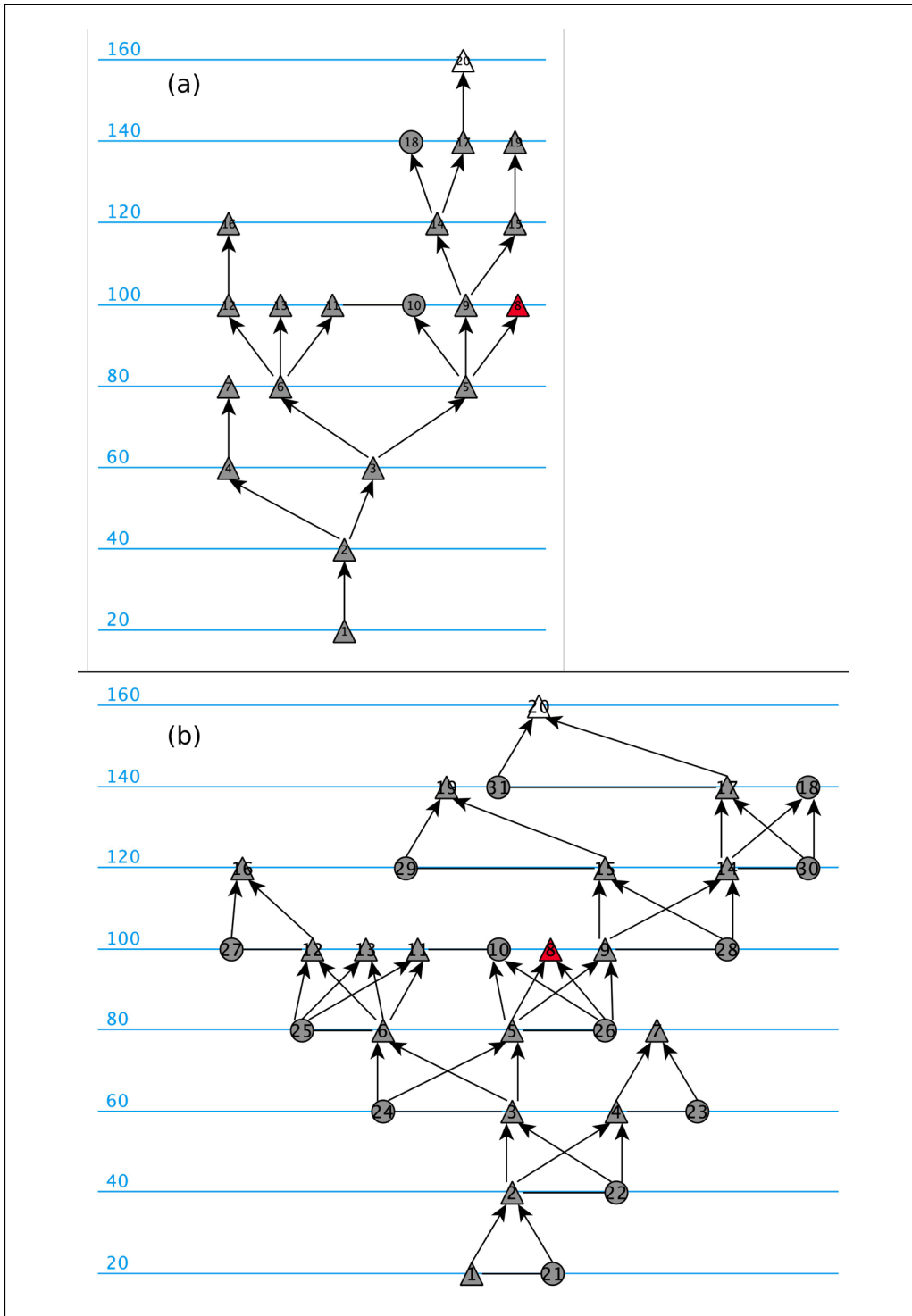


Fig. II Largest component of primary (a) and secondary (b) Ore graphs of the Firmôn network.

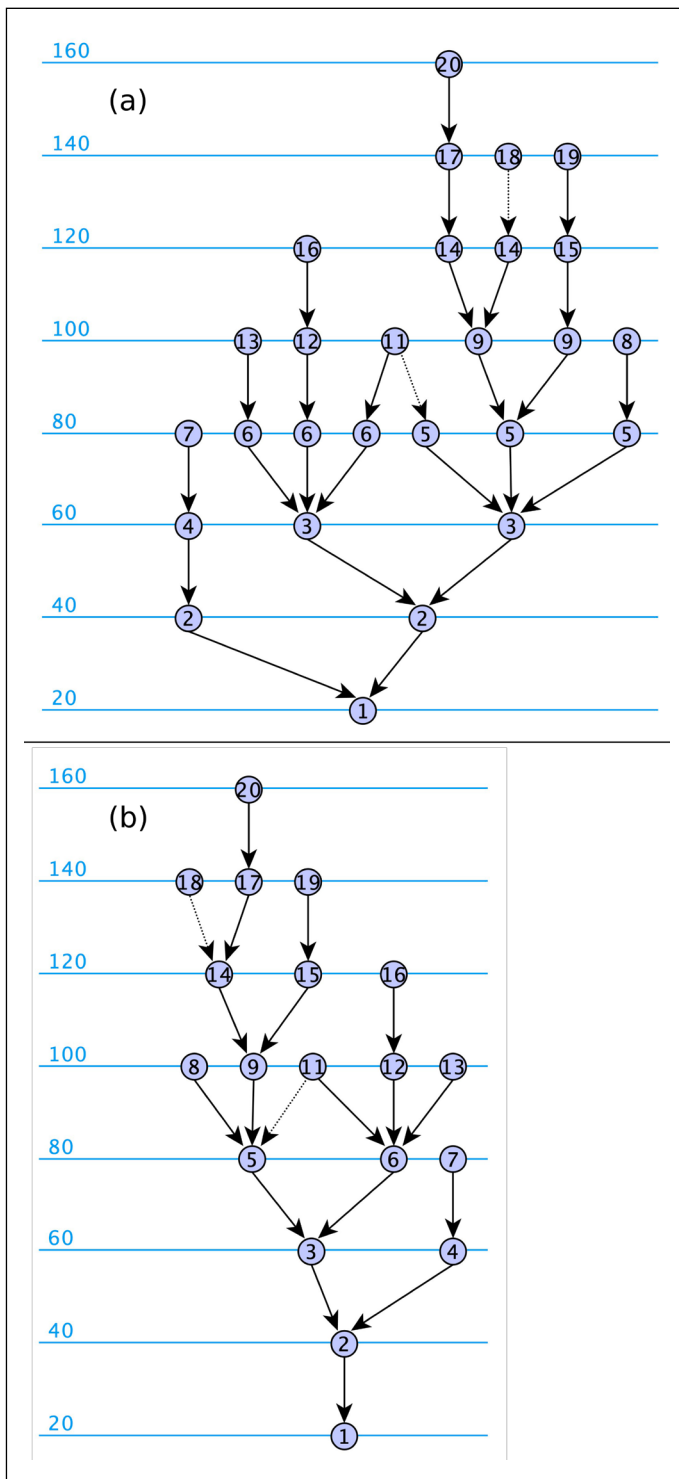


Fig. 12 Largest component of primary (a) and secondary (b) p-graphs of the Firmôn network.

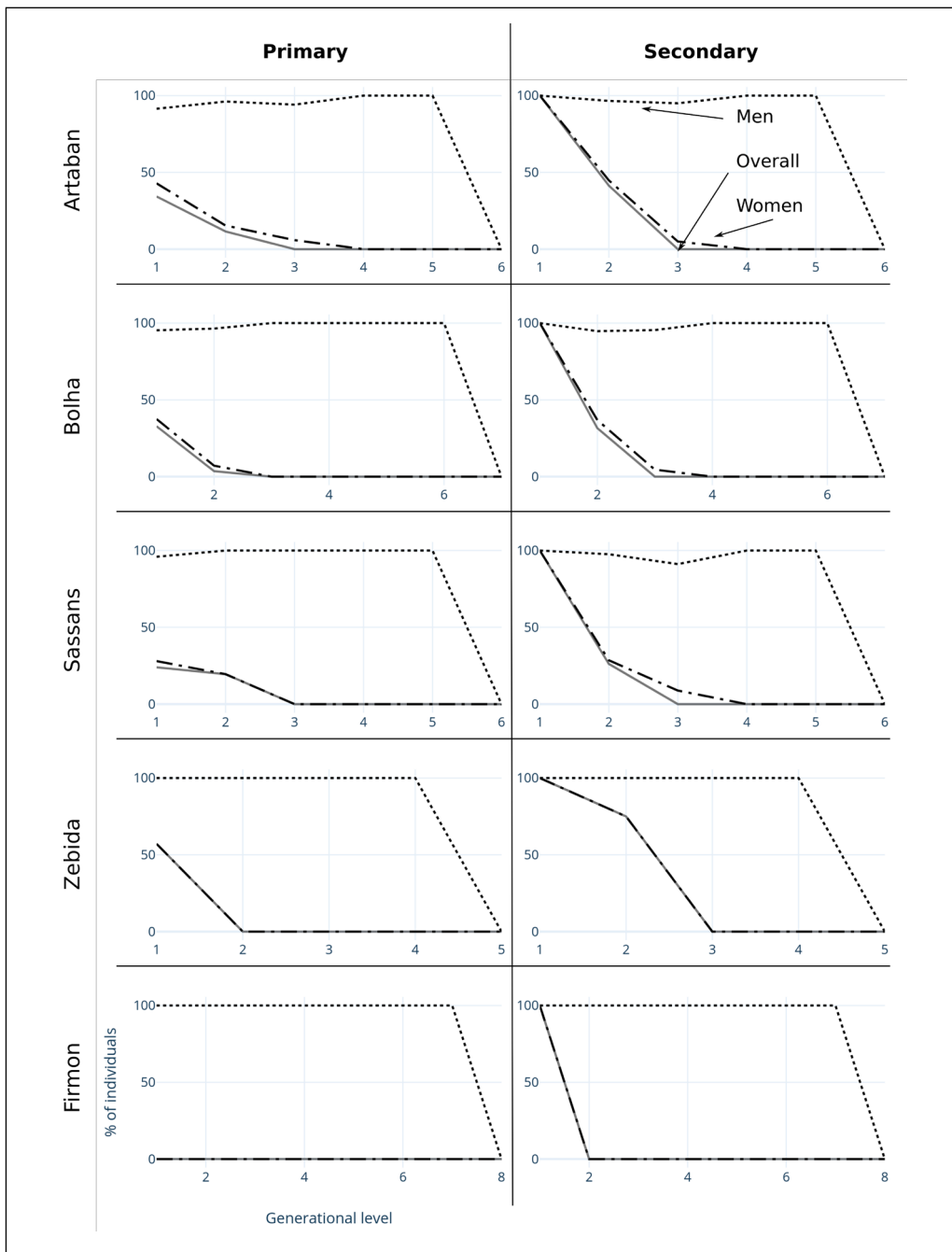


Fig. 13 The gender bias of all case studies' primary and secondary representations of the largest components. This represents the number of individuals for whom the male (dotted), female (dash-dot) and overall (solid line) linear ascendants of a given genealogical degree is known, as a percentage of individuals for whom the agnatic or uterine ascendant of that degree is known. Note the moderate decrease of gender bias in the secondary hypothesis.

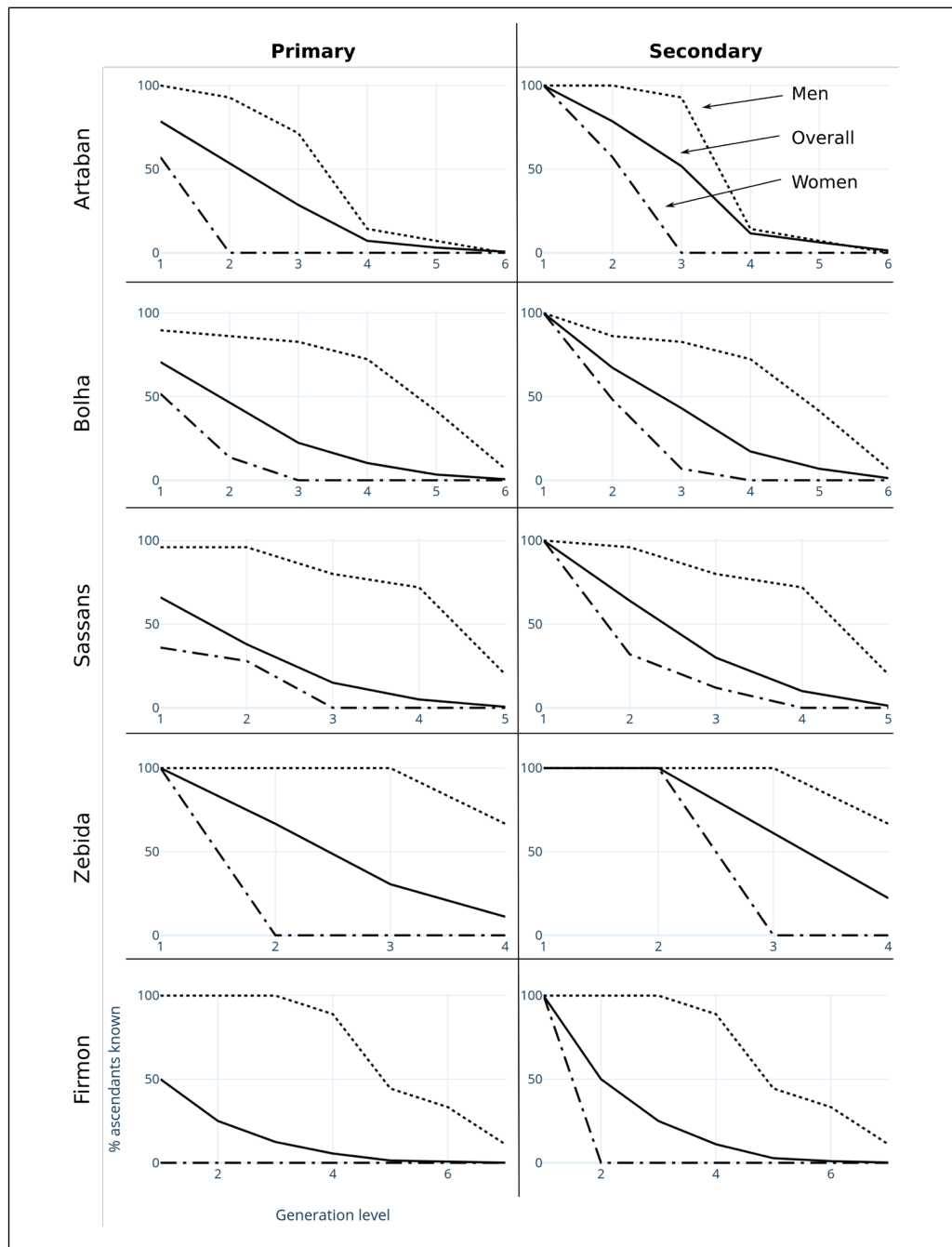


Fig. 14 The genealogical completeness of all case studies’ primary and secondary representations of the largest components. This represents the proportion of male (dotted), female (dash-dot) and overall (solid line) ascendants that are known at each generation level. Note the moderate increase in completeness in the case of the secondary hypothesis.

5. Discussion

In this section, we examine these four key issues in light of our technical results, correlated with a critical examination of the nature of our sources:

- 1) Our sources confirm a high degree of genealogical incompleteness and gender bias, previously known from studies of Palmyrene society.²⁴
- 2) Evaluating whether the relinking index can enhance debates on endogamy and exogamy practices in Palmyra.
- 3) Funerary and public inscriptions are highly complementary.
- 4) Assessing the assumptions behind creating uncertain relationships in funerary cases and their effects on our results.

5.1 Genealogical completeness and gender bias

A striking feature of the available sources and the resulting genealogical networks is the high number of missing individuals. It is very common for these sources not to mention one of the parents of each individual, and more often than not the unknown parent is the mother. Related to this absence of many individuals (mostly women) is the pattern, across all case studies, that very few of the marriages that must have taken place to produce the number of known descendants are actually documented. The number of documented marriages is very low, although it is much higher in the four funerary case studies than in the Firmôn network, for which just one marriage is known.

Our genealogical analysis allows us to display the extent of this missing information in a concrete manner, represented as the degree to which the genealogy is complete at different generational levels (Fig. 14), as well as identifying the proportion of individuals for whom we know the male and female ascendants (Fig. 13). For the primary networks representing our sources, these tables offer an unprecedentedly nuanced picture of the structure of the gender bias and of precisely what information is missing. For all case studies, we are highly informed about the male ascendants up to four or five generations removed (i.e. for a high proportion of individuals we know the father, grandfathers, great-grandfathers, and great-great-grandfathers). This is largely thanks to the onomastic practices and the listing of male ancestors (discussed below). The genealogies are far less complete in terms of the women: we know of the mothers for roughly 40–50% of

24 Jean-Baptiste Yon, *Les notables de Palmyre* (Beirut: Institut Français d'Archéologie du Proche-Orient, 2002); Maura K. Heyn, "Status and Stasis: Looking at Women in the Palmyrene Tomb," in *The World of Palmyra*, eds. Andreas Kropp and Rubina Raja (Copenhagen: The Royal Danish Academy of Sciences and Letters, 2016); Signe Krag and Rubina Raja (eds.), *Women, children and the family in Palmyra* (Copenhagen: The Royal Danish Academy of Sciences and Letters, 2019).

individuals in the four funerary case studies, but few women at subsequent generational distances. For the Firmôn network, we know of not a single woman one genealogical step removed from an individual: two women are documented for this case study, but neither of them has documented children.

We aim to partly address the incompleteness of our data through representing a hypothesis (which we refer to as the secondary networks): a new individual is added for all single individuals with children for whom the partner is not known. The secondary networks therefore have many more marriages than the primary networks representing the original data. However, when we compare the completeness and gender bias graphs of the primary and secondary networks (Figs. 13–14), we notice that the secondary hypothesis solves issues at one generational level (i.e. all parents are now known), but changes little for further generational levels.

It is crucial to realise that this secondary hypothetical network only includes a theoretical minimum number of marriages. Many of the documented single individuals for whom no children are known must have also been married. Moreover, some individuals might have remarried rather than only having ever had one partner. The number of documented multiple marriages is extremely low: 1 case for Artaban and Sassans, and 0 for all other case studies. If the practice of remarrying was common in Palmyra, then we would expect the real number of marriages to be much higher still than that represented in the secondary hypothesis. An extreme hypothetical version of this practice of remarrying is represented by the p-graph of the primary network, in which we theoretically assume that each child for whom both parents are not known had a unique parent pair (i.e. a very high frequency of remarriage). Comparing the primary and secondary networks' p-graphs allows us to grasp the potential extent of this issue. We notice that for almost all case studies, the number of nodes in the primary p-graph is much higher than those in the secondary p-graph: there are many cases where we do not know whether children with one common parent were siblings or step-siblings. One exception to this is the Zebîdâ network, for which both parents of all siblings are known.

These issues of completeness and gender bias underline what we know about Palmyrene social and family practices. The portraits reveal a higher representation of women in the funerary sphere than the inscriptions alone would allow us to think. This discrepancy between inscriptions and portraits is interesting and reveals the complementarity of these different sources for enhancing genealogical studies. In the public inscriptions, the ratio of women is again much lower than in the funerary sphere. Thomallachis, the female scion of the Firmôn family (ID 18) documented in an inscription as a major donor to a public building, is a rare exception.²⁵

25 Yon, *Inscriptions Grecques et Latines*, 264, cat. 312.

The Palmyrene *patrilineal* tradition, however, is very pronounced in the inscriptions, which tend to list male ancestors. From the onomastic practices of the Palmyrenes, we know that their society was patrilineal, and that children of both sexes belonged to the father's family.²⁶ For example, women still identified themselves as daughters of their fathers even after their marriage.²⁷ As Piersimoni notes, married women were frequently identified not only with their biological father's name, but also with the name of their paternal family.²⁸ We also see in the foundation inscriptions of the tower tombs, which were built expressly as family burial monuments, that only the male founders, their fathers, and male descendants are mentioned.²⁹ The emphasis on the male line in the epigraphic record could explain the low number of recorded marriages.³⁰

Moreover, from the available evidence it seems that Palmyra was a *patrilocal* society.³¹ Even though we have little evidence for the movement of women from their paternal to their husband's household,³² we see that women in most cases were buried in their husband's family tomb, indicating that they had already moved into his household during their lives.³³

Our primary and secondary hypotheses further explore alternative theories about the frequency of remarriage. Although two cases of remarriage are documented in our case studies, we do not know whether remarriage was common practice in Palmyra. The obvious reasons for remarriage would be either divorce or the death of a spouse. We have, however, no evidence concerning the practice of divorce in Palmyra.³⁴ Due to the nature of the documented cases of remarriage (that is, not having the marriage between two people recorded in the inscrip-

26 Piersimoni, *The Palmyrene Prosopography*, 550.

27 Eleonora Cussini, "Daughters and wives: Defining women in Palmyrene inscriptions," in *Women, children and the family in Palmyra*, eds. Signe Krag and Rubina Raja (Copenhagen: The Royal Danish Academy of Sciences and Letters, 2019), 70.

28 Piersimoni, *The Palmyrene Prosopography*, 550.

29 Agnes Henning, "The representation of matrimony in the tower tombs of Palmyra," in *Women, children and the family in Palmyra*, eds. Signe Krag and Rubina Raja (Copenhagen: The Royal Danish Academy of Sciences and Letters, 2019), 25.

30 See also Krag, "Palmyrene funerary buildings and family burial patterns," 49.

31 See, for example Nathanael Andrade, *Zenobia: Shooting Star of Palmyra* (Oxford: Oxford University Press, 2018), 59–88.

32 As, for example, we know occurred in other areas of the Roman world: Mona Tokarek LaFosse, "Age Hierarchy and Social Networks among Urban Women in the Roman East," in *Mediterranean Families in Antiquity: Households, Extended Families, and Domestic Space*, eds. Sabine R. Huebner and Geoffrey Nathan (Chichester: John Wiley and sons, 2017), 208.

33 Krag, *Funerary Representations of Palmyrene Women*, 48.

34 We have evidence of divorce in other areas of the Roman world. See Susan Treggiari, "Divorce Roman Style: How easy and how Frequent was it?" in *Marriage, Divorce, and Children in Ancient Rome*, ed. Beryl Rawson (Oxford: Oxford University Press, 1991).

tions of both partners), some scholars have supposed that the inscriptions were evidence of polygamy.³⁵ In one of the most likely candidates for documenting remarriage, we can see that the first wife died, after which the husband married for a second time and had several children with his second wife.³⁶

The above-mentioned example also hints at one of the known causes for female mortality in the ancient world: the death of the mother at childbirth. The opposite could also happen when the husband died before the wife, in which case the woman can remarry, but we have little evidence for women remarrying.³⁷ In other areas of the Roman world, we know that remarriage was possible for both husbands and wives, and for different reasons: financial, political, etc.³⁸ For Palmyra, we have to assume that remarriage was a possibility after the death of a spouse, but we cannot formulate any hypotheses as to the precise reasons why it happened.

5.2 Endogamous and exogamous marriage practices

The relinking index results are very low in comparison to other past and present-day genealogies of urban or nomadic communities.³⁹ This result requires a highly cautious and nuanced interpretation, given the fragmentary nature of our sources and our patchy knowledge of intermarriage practices in ancient Palmyra. Indeed, the epigraphic record is so sparse that it has allowed scholars to argue for either practices of endogamy⁴⁰ or exogamy⁴¹ in Palmyra: both are documented, but the extent to which one was dominant cannot be easily determined.

On the one hand, the low relinking index supports the argument that marriage outside the extended family was common. In her Palmyrene prosopography, Piersimoni argued that exogamy was common and that it was a way to forge and maintain alliances and peaceful relations between powerful families.⁴² This argument states that most Palmyrenes married outside their close or extended family. Tribal affiliation, however, seems to have been important for significant

35 Signe Krag and Rubina Raja, “Representations of Women and Children in Palmyrene Banqueting Reliefs and Sarcophagus Scenes,” *ZORA* 10 (2018); Krag, *Funerary Representations of Palmyrene Women*, 83; Krag, “Palmyrene funerary buildings and family burial patterns,” 50.

36 Krag, “Palmyrene funerary buildings and family burial patterns,” 50, 61, cat. 54.

37 Krag, *Funerary Representations of Palmyrene Women*, 83 n. 144.

38 See, for example April Pudsey, “Death and the Family: Widows and Divorcées in Roman Egypt,” in *Families in the Roman and Late Antique World*, eds. Lena Larsson Loven and Mary Harlow (London: Continuum, 2012).

39 Batagelj and Mrvar, “Analysis of Kinship Relations With Pajek,” table 3.

40 Krag, “Palmyrene funerary buildings and family burial patterns,” 50.

41 Piersimoni, *The Palmyrene Prosopography*, 552–553.

42 Piersimoni, *The Palmyrene Prosopography*, 552–553.

segments of Palmyrene society. The names of a significant number of tribes (*phd*) are known from the epigraphic record, and intermarriage between these groups took place.⁴³

On the other hand, it could be argued that marriage within the same family was common practice and that the relinking index is low due to the high degree of missing information in our sources. Indeed, we should perhaps expect a high degree of endogamy in Palmyra, given that this was a relatively small desert community that placed great emphasis on lineage: it was by no means entirely isolated,⁴⁴ but we cannot expect the diversity of marriage options to have been as high as for large coastal cities with less distinct local identities. Piersimoni identified examples of marriages between first cousins (also revealed in our Artaban, Bôlhâ, and Firmôn case studies) and of uncle/aunt-niece/nephew marriages.⁴⁵ Such endogamous relationships are generally considered to preserve property and status within the lineage,⁴⁶ which might explain Piersimoni's observation that they seem to be more common in priestly families, which were part of Palmyra's elite.⁴⁷ This argument suggests that an extremely low relinking index value is unlikely, and forces us to consider the impact of missing information on our relinking index results. Our low results are a reflection of missing individuals (was an unknown spouse a member of the extended family?) and missing information about known individuals (was a known marriage partner a member of

43 Piersimoni, *The Palmyrene Prosopography*, 530–543; Andrew M. Smith II, *Roman Palmyra: Identity, Community, and State Formation* (Oxford: Oxford University Press, 2013), 43; Yon, *Les Notables*, 251–252.

44 Two reliefs from Palmyra record the deaths of people originating from outside Palmyra: (1) one relief in Palmyra Museum (inv. no. A 133) commemorating Amata, daughter of Titus Iulius Babaeus, who was a native of Hierapolis: Yon, *Inscriptions Grecques et Latines*, 372, cat. 491; Krag and Raja, "Representations of Women and Children," 171, cat. 77, and (2) the relief of Marcus Iulius Maximus Aristides from Berytus, now in the Louvre Museum (inv. no. AO 1556): Jacqueline Dentzer-Feydy and Javier Teixidor, *Les antiquités de Palmyra au Musée du Louvre* (Paris: Éditions de la Réunion des musées nationaux, 1993), 162, cat. 166; Yon, *Inscriptions Grecques et Latines*, 413, cat. 551; Lukasz Sokolowski, "Portraying the Literacy of Palmyra: The Evidence of Funerary Sculpture and its Interpretation," *Études et Travaux* 27 (2014), 380, 386, fig. 8; Rubina Raja, "Palmyrene Funerary Portraits in Context: Portrait Habit between Local Traditions and Imperial Trends," in *Tradition: Transmission of Culture in the Ancient World*, eds. Jane. Fejfer, Mette Moltesen and Annette. Rathje (Copenhagen: Museum Tusulanum, 2015), 335–336, fig. 5. Greek and Latin names in Palmyrene inscriptions do not necessarily mean that the people were of Greek or Roman descent; Persian names, however, likely indicate Persian origin. For a list of non-Palmyrene names in Palmyrene inscriptions: Jürgen Kurt Stark, *Personal Names in Palmyrene Inscriptions* (Oxford: Clarendon Press, 1971), especially appendix 3.

45 Krag, "Palmyrene funerary buildings and family burial patterns," 50.

46 For a similar case, see Fred Strickert, *Philip's City: From Bethsaida to Julias* (Collegeville: Liturgical Press, 2011), chapter II.

47 Piersimoni, *The Palmyrene Prosopography*, 552.

the extended family?), as well as the relatively small size of these genealogies (are we informed about all members of the family?). Even in the case of the secondary networks, where we added many hypothetical (mostly female) spouses, the relinking index is necessarily low because we do not know whether these partners were part of the extended family. However, we do notice that the hypothetical secondary networks have a higher relinking index than when we hypothetically assume all siblings with one unknown parent were stepsiblings from distinct parent pairs (see p-graph primary networks). The differences in the relinking index between these two hypotheses suggests that a key piece of information for identifying the degree of endogamy is underreported in our sources: the missing marriage partners' relationships to the family. However, it also suggests that formulating a plausible hypothesis and studying its p-graph representation offers a promising approach for future critical studies of this issue.

5.3 Funerary and public inscriptions

These five case studies highlighted differences in how genealogies are represented between funerary and other inscriptions. The Firmôn network is mostly based on non-funerary inscriptions and appears more unilinear than the other four case studies: only a very few branches of the extended family are known, and it can be assumed that many siblings of the individuals included are not known. The other four case studies are based on funerary inscriptions: even though the formula 'X son of Y', or 'X daughter of Y' appears in both the public and the funerary sphere, simply by nature of the context (i.e. extensive family tombs), we have more inscriptions documenting more members of the extended family.

Most inscriptions, both public and funerary, emphasise the male line of descent. In the funerary sphere, because of the portraits of females that have survived, our genealogies can be more complete. In the public sphere, the female portraits have either been lost, or survive without accompanying inscriptions. This could explain the apparent unilinearity of the Firmôn network: on the one hand, we have public inscriptions that emphasise the male line, while on the other we have funerary cession texts that also exclude daughters, thus creating a case study where women are not visible in the extant sources (Fig. 13).⁴⁸

Other public inscriptions, however, show us that women can take on the same roles as men.⁴⁹ We have already mentioned Thomallachis sponsoring a public building, while in religious inscriptions referring either to benefactions or ded-

48 For example, Jean-Baptiste Yon's reconstruction of the genealogies of several elite families of Palmyra, based on evidence primarily from the public sphere, with additional information from the funerary record, underlines this tendency: Yon, *Les Notables*, 43–56, appendix 17.

49 Krag, *Funerary Representations of Palmyrene Women*, 116–123, 132.

ications, women are more prominent as agents. In particular, on the votives made to the god known as “He whose name is blessed forever” (the so-called “anonymous god”), women make offerings for their lives and those of their relatives, often giving both their patronymic name and the name of their husband, as well as those of their children.⁵⁰ Our present study contains none of these votary inscriptions, which represent an interesting basis for future work.

In general, though, we can say that both public and funerary inscriptions offer us complementary information: even though the formulae used to describe relationships are the same, funerary inscriptions emphasise family and tribal affiliations, while status and social and civic roles are transmitted through the medium of portraiture. Public inscriptions offer additional information about a person’s status, civic role, donations and benefactions, as well as their piety and religiosity.

The inscriptions documenting the Firmôn network show how public inscriptions can open up additional avenues of investigation. The name of the eponymous founder is believed to be Iranian, indicating geographical mobility in the early phase of Palmyrene urbanism.⁵¹ His great-great grandson Ḥaddûdan (8) is one of the very few Palmyrene individuals we can presume was a merchant based on the epigraphic corpus.⁵² His second cousin, also named Ḥaddûdan (12), purchased a funerary space for himself and his family in 160 CE,⁵³ indicating upward social mobility, and Thomallachis, the grand-niece of the merchant, is a rare example of a Palmyrene woman sponsoring a public building project (in 182 CE). In this way, family networks branch out into other spheres of Palmyrene society, highlighting the significant degree of complementarity of funerary and public inscriptions for the study of Palmyrene family networks. While the genealogical results of the Firmôn case might be unimpressive compared to the larger networks based on known funerary settings, the analysis indicates that Social Network Analysis may be a suitable tool for investigating other spheres of Palmyrene society.

50 Sanne Klaver, “The participation of Palmyrene women in the religious life of the city,” in *Women, children and the family in Palmyra*, eds. Signe Krag and Rubina Raja (Copenhagen: The Royal Danish Academy of Sciences and Letters, 2019), 157–167.

51 Piersimoni, *Palmyrene Prosopography*, 563; Yon, *Les Notables*, 260, 262.

52 He is named as the sponsor of a statue and inscription dedicated to the prominent caravan patron Marcus Ulpius Yarḥai in return for help offered in the Mesopotamian city of Spasinou Charax in 159 CE: Jean Cantineau, “Tadmorea,” *Syria* 19, no. 1 (1938).

53 Hillers and Cussini, *Palmyrene Aramaic Text*, 101, cat. 0523.

5.4 Uncertain relationships in funerary data

In our case-studies, we have used the following three criteria: inscriptions, together with the onomastic practices documented in them, portraits, and proximity. In order to have a more certain basis for establishing relationships and thereby extend this certainty to the wider network, we have often combined the criteria.

As stated above, most of the marriages and parental relationships in our case studies can be securely identified through either an inscription or a portrait and an inscription. Several of the relationships, however, are reconstructed with a degree of uncertainty (all relationships with a degree of uncertainty are red in figures 3, 5, 7, 9 and 11). For some of these relationships, we followed Sadurska and Bounni's assertion that the same name in inscriptions, when located very close to each other in the hypogeum, might refer to the same individual. This is a reasonable assumption given that it was likely that close family members occupied the same area in the family tomb; however, these relationships should be treated with caution.

A small number of relationships are reconstructed based on onomastics only (from 4 in Bôlhâ to 10 in Zebîdâ and Sassans). Because it was common practice in Palmyra to name children after their paternal and maternal grandfather, onomastics can be a reliable criterion for establishing both marital and parental relationships.⁵⁴ A section of the Zebîdâ family tree is a good example of how onomastics have been used as a criterion (Fig. 9a): four children (ID 6, 7, 8, 9) are linked to their father (ID 5) by inscription; however, the link to their mother (ID 4) is established because two of them are named after her father (their supposed grandfather). This then extends to the relation to the remaining two siblings and also alludes to the mother's marriage with their father.

In the case of funerary contexts in Palmyra, proximity seems to be the most unreliable of the four criteria (inscription, portrait, proximity, and onomastics) for establishing relationships. It is important to note that when an uncertain marriage is established based on a proximity argument, it affects the certainty of relations with their descendants. Nevertheless, other tomb contexts display family members in close proximity to each other with their relationships supported by inscriptions, hence making proximity a beneficial criterion for this study. Indeed, for all four funerary case studies, the removal of uncertain relationships would constitute a significant change in their structure. The Zebîdâ network would be by far the most impacted with 43% of uncertain relationships. Since the network of the Zebîdâ tomb is the smallest of the four funerary case studies, with very few portraits and family members that can be securely linked together by inscriptions and portraits, many of the family relationships are based on proximity or ono-

54 Piersimoni, *Palmyrene Prosopography*, 549–550.

mastics. Six different relations are formed on the basis of proximity of portraits; half of these are marriage relationships, while the other half are relationships between parent and child.

In contrast, the Firmôn network derived from public inscriptions does not have any relationships which are uncertain, likely a result of the nature of the inscriptions they were derived from. In these sources, only a limited number of relationships are recorded, and they therefore represent a problem of incompleteness. However, those few recorded relationships should be considered more certain compared to relationships derived from funerary inscriptions where the proximity or onomastics criteria were applied. Furthermore, the network underlines the Palmyrene preoccupation with patrilineal descent, the eponymous ancestor in this case being still remembered in the seventh generation.

6. Conclusions

A wealth of archaeological and historical information is available for studying the structure of Palmyra's family networks. In this paper, we have drawn on this data to explore how a formal network approach could enhance such studies, as well as the related methodological and data-related challenges. We have critically evaluated genealogies based on previous studies, using funerary portraits and funerary and public inscriptions. These were subsequently represented as Ore graphs to reveal family network structure, and as p-graphs to explore the degree of intermarriage within the extended family.

Our work underlines how material and written sources are highly complementary, and that their combined use enhances Palmyrene genealogical studies. The detailed study of funerary portraits allowed for a much richer picture of genealogies derived from funerary inscriptions. The inscriptions in particular omit many women, revealing a patrilineal tradition. Formal network and genealogical methods allow us to identify this incompleteness and gender bias in our sources to a high degree of detail. This has allowed us to formulate credible hypotheses to complete the genealogies. We have presented two extreme hypothetical scenarios to account for the missing individuals (most frequently women). These hypotheses significantly increase the completeness of the genealogies, but future work should specify more detailed hypothetical reconstructions, inspired by our knowledge of Palmyrene family and tribal structures.

A crucial advantage of using a formal network approach to these sources is the ability to identify the degree of intermarriage within the extended family, by calculating the relinking index based on the frequency of semicycles in the p-graph. Our results show the relinking index was very low for all case studies, which on the face of it seems to suggest exogamy as the dominant practice: marriage as a way to forge and maintain alliances between powerful families and across tribes.

However, the high degree of incompleteness in our genealogies and the few documented cases of intermarriage within the family suggest that possibly endogamy practices are underrepresented in our sources. As we have seen, both cases are documented for Palmyra, and our genealogical analysis cannot securely support one as the dominant practice, although we are able to present a methodology based on p-graphs and the relinking index to make important contributions to these debates. Moreover, the ability to formally identify the extent of endogamy using the relinking index allows for a formal comparison of the exceptional information we have about Palmyra with other ancient and present-day cases. This is a topic that a future extended analysis of Palmyrene genealogical networks should shed more light on.

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