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Social and Symbolic Boundaries in the Upper Egyptian Town of Pathyris (2nd to Early 1st Cent. BCE)

Limites sociais e simbólicos na cidade de Pathyris no Alto Egito (séculos II-I a.C.)

Lena Tambs[1]

Abstract
This paper asks and tests questions about ancient group boundaries against empirical data through a case study of the small-scale community of Pathyris in southern Egypt (186-88 BCE). By means of studying 382 documentary texts associated with 16 family archives from a distinct network perspective, the author jumps between scales, perspectives and methods to demonstrate the relevance of *Social Network Analysis* for boundary-work on ancient communities, yet with a critical eye. In doing so, she analyses a socio-economic network representing the community as well as male and female subnetworks in it, before exploring the intersection between these groups. A general lack of clear divisions observed between studied attributes like sex and legal ethnic status leads her to conclude that neither seem to have represented strict social boundaries that dictated with whom the inhabitants interacted.
Keywords: Ancient archives; Interpersonal relations; Social Network Analysis (SNA).

Resumo
Este artigo questiona e testa a delimitação de grupos na Antiguidade a partir de dados empíricos da pequena comunidade de Pathyris, ao sul do Egito (186-88 a.C.). Por meio do estudo de 382 textos associados a 16 arquivos familiares e a partir de uma perspectiva distinta da noção de rede, a autora salta entre escalas, perspectivas e métodos para demonstrar a relevância da Análise de Redes para o estudo de fronteiras em comunidades antigas, mas com um olhar crítico. Ao fazer isso, ela analisa uma rede socioeconômica que representa a comunidade, bem como as suas sub-redes masculinas e femininas antes de explorar a interseção entre esses grupos. A ausência de divisões claras observadas entre atributos estudados como sexo, etnia e status legal a leva a concluir que nenhum destes aspectos parece ter representado limites sociais estritos que ditavam as interações dos habitantes.
Palavras-chave: Arquivos antigos; Relações Interpessoais; Análise Social de Redes.

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Introduction

Recently, concepts such as "identities", "networks" and "boundaries" (or "borders") have been increasingly applied in historical as well as other social sciences.[2] By now, it has become evident that they greatly affect the lived realities and behavioural patterns of human beings, but also that they are interlinked, complex, fluid and often overlapping aspects of society. An individual will express different identities in different context, belong to several social groups at the same time and the lines drawn between them are often fuzzy. In addition, most social categories and boundaries are culturally dependent – our conceptions of the world can thus not be readily applied to an ancient (or contemporary) case, without considering the characteristics of the phenomena and subject under study. To increase our understanding of social life in the writing of ancient social history, we should thus aim to explore how identities, networks and boundaries were formed, felt, maintained and challenged.

In ancient history, sources allowing such aspects to be empirically tested are in most instances lacking, but a small-scale community in southern Egypt offers a rare opportunity to do so. With the help of *Social Network Analysis* (SNA),[3] this contribution will take the reader on a journey back to Ptolemaic Egypt, zooming in on the town and military camp known as Pathyris. By means of modelling and analysing information retrieved from 382 ancient texts belonging to 16 family archives found at this site from a network perspective, we shall meet some of the people that lived there between 186 and 88 BCE and explore the socio-economic networks they formed. In doing so, we shall question whether it makes sense to talk about men and women as separate social groups in this time and place, by studying networks of men and women separately, before considering what is gained from scaling up to the community formed by men *and* women.

My paper thus makes an attempt at a micro-historical exploration of the degree to which individual and collective identities based on biological sex are manifested in surviving family archives from Pathyris, and considers what observable patterns imply about the symbolic and social mechanisms at play in this small-scale community. For this purpose, the paper opens with specifications of the areas of boundary-work this study contributes to, and the peculiarities and relevance of SNA for such research. The larger part of the paper is, however, devoted to the case study of the Pathyris community, which is followed by a brief discussion on the

[2] For relevant review papers, see e.g. Lamont & Molnár (2002); Pachucki et al. (2007).
[3] For glossaries of network analytical terms, see e.g. Collar et al. (2015, p. 17-25); Fuhse (2018, p. 215-221); Tambs (2022b) App. A. For handbooks, e.g. Borgatti et al. (2013); Prell (2012); Wasserman & Faust (1994).

approach's relevance for studying social boundaries in antiquity, and concluding thoughts on particularly promising avenues for future research.

On the Relationality and Fuzzy Nature of Social Boundaries

Just as it has been pointed out that networks are everywhere,[4] it can be argued that boundaries are omnipresent. Human beings experience the world by means of classification, and in the process we draw conceptual boundaries that have the power to influence social boundaries.[5] Whereas some are manifested in physical walls or formally defined and enforced by operating legal systems, others become unwritten rules of society. Yet others remain vague or never make it past the drawing board or small group(s) of likeminded individuals. This poses difficulties for identifying and studying boundaries also in contemporary studies – a task that is further complicated by their often fuzzy nature. If we accept that boundaries exist and work in complex systems of overlapping and dynamic written and unwritten rules and concepts, they can seldom be meaningfully studied in isolation or understood on their own terms.

In this respect, social science studies into e.g. class boundaries imply that relationality plays a significant role in the definition and shaping of individual and collective identities, since both individuals and groups tend to identify themselves in relation to others.[6] To better understand this process, M. Lamont & V. Molnár propose that its binary versus multiplex character – or 'whether identities are defined in opposition to a privileged "other," or in juxtaposition to a number of possible "others"'[7] – is worthy of more scholarly attention. A key reason, they argue, is that so-called symbolic boundaries are more likely to evolve into social boundaries in the former than the latter situation.

Symbolic and Social Boundaries

Social scientists often make an (explicit or implicit) distinction between "symbolic" and "social" boundaries.[8] In the words of M. Lamont and V. Molnár,[9] 'symbolic boundaries are conceptual distinctions made by social actors to categorize objects, people, practices, and even time and space' whereas 'social boundaries are objectified forms of social differences manifested in unequal access to and unequal distribution of resources (material and non-

[4] (and nowhere), Brughmans et al. (2016, p. 3-6).
[5] Pachucki et al. (2007, p. 331).
[6] The significance of relational processes come up many times in the review paper by Lamont & Molnár (2002).
[7] Lamont & Molnár (2002, p. 174).
[8] E.g. Lamont & Molnár (2002); Pachucki et al. (2007).
[9] Lamont & Molnár (2002, p. 168-169).

material) and social opportunities.' In this framework, social boundaries can thus be conceived of as the more commonly accepted, durable, and institutional stage, that symbolic boundaries *may* translate into. As such, '[symbolic boundaries] exist at the intersubjective level whereas [social boundaries] manifest themselves as groupings of individuals.'

The relationship and interplay between the two concepts are complex: they coexist, the boundaries drawn between them are fuzzy, and one can translate into the other. Moreover, solid evidence of both, and especially of symbolic boundaries, is often not materialised or discernible – and this is especially true of ancient cases, where question of preservation, access to the material, etc. also comes into play. Thinking of them as aspects of social life can nevertheless also provide the ancient historian with a useful tool for reaching a better understanding of the variety of boundaries that shaped and impacted past community life. However, studying the complexity, multiplicity, and fluidity of social and symbolic boundary processes in a systematic manner can be challenging – and this is where SNA comes in.

Approaching Boundaries with Social Network Analysis (SNA)

As I hope to demonstrate in this contribution, SNA is a suitable methodological and conceptual ally to boundary-work, not least because it maps and highlights the relational aspect of social structures. Network analytical software such as *Gephi*[10] allows the researcher to explore the modelled system(s) in an interactive interface that facilitate multiscale analysis. In a richly attributed network of people, SNA thus enables the researcher to study not only ancient individuals, but also how they relate to one another, and which functions they serve in the structure that connects them, as well as to quickly shift perspective from individual agents to groups and study the interplay between recorded attributes or markers.

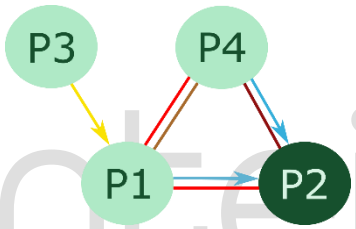
Network science originated and developed in other fields,[11] but in historical (and archaeological) network research, a common denominator is that past phenomena are abstracted and conceptualised as relational (and attribute) data that can be represented as networks graphs and formally analysed with (S)NA.[12] In network jargon, these models consist of nodes (which in *S*NA are the studied *social* entities) and edges (the relational links) drawn between pairs of nodes. These nodes and edges can be nearly anything, so what the building blocks of a given network represent must always be made explicit by the researcher. In the network graphs

[10] Bastian et al. (2009).
[11] For the history of network science and SNA, see e.g. Freeman (2004).
[12] For this process, see Collar et al. (2015, p. 4-5, Fig. 3).

discussed in this paper, nodes represent individuals attested in a selection of ancient texts from Pathyris, whereas the edges record the social and economic relationships and activities they were entangled in.[13]

To illustrate how I go about translating ancient documents into network graphs, we can imagine a letter that a man (Person 1) sent to his wife (Person 2) while on a military campaign. In the letter, which P1 dictated to a scribe (Person 3), he reported that all was fine and that his brother (Person 4) sends his greetings. Now, if we record this information we can represent the four persons as nodes (usually represented by dots) and their interpersonal connections as edges (lines or arrows), thereby modelling the content of this letter as a network graph (Figure 1) that can be formally analysed with SNA.[14]

Figure 1: Node-link visualisation of persons and relationships in an imagined letter. Node colours: male (light green); female (dark green). Edge colour: close kin (bright red); extended kin (dark red); colleague (brown); communication (blue); service (yellow).



Graph by author, created in *Inkscape*.

To create such models, data should be organised into one (or more) node and edge tables that must contain, but are not limited to, fields reserved for unique IDs assigned to the studied social entities. Both nodes and edges can also be attributed with qualitative and quantitative data to be explored in the network analysis. In the case of Pathyris, such empirically informed network models can be built and attributed with a range of information about the inhabitants and their relationships and activities, as reflected in preserved texts from the site.

In this respect, it is fortunate that many texts stem from archival contexts and that several of these are well studied, since that allows data to be collected in a bottom-up approach and aggregated into a complex model representing socio-economic life in this community. That this is possible is largely due to earlier studies having identified a significant number of individuals in more than one text,[15] but also that several such instances break archival boundaries since this

[13] The case study, source material and network models are described in more detail below.
[14] A concrete example of the transformation of a Demotic land sales document with a Greek tax receipt into 2-mode and 1-mode network models, see Tambs (2022a), but note that only the methodology described for the interpersonal (1-mode) dataset is here of relevance.
[15] Of particular importance to the studied dataset, is the effort of *TM People* (Broux & Depauw, 2015) to represent individuals and assigning unique ID numbers to them.

enables the text groups to be meaningfully studied together. Pathyris thus offers a rare opportunity to move past the archival level and gain more nuanced insight into aspects of daily life by modelling the material as inter-archival social networks.

Case Study: The Late Ptolemaic Community of Pathyris (186-88 BCE)

For the in-depth discussion of social group boundaries in an ancient community, we shall now turn our eye on Pathyris. As a disclaimer, the aim of this paper is not to study the Pathyris community in detail,[16] but to demonstrate the relevance of conceptual and computational methods of SNA for exploring the degree to which social boundaries are reflected in ancient documentary sources with concrete examples. Before going into more detail with the network model that represents this community, a few things should nevertheless be said about Pathyris and the people living there between 186 and 88 BCE.

The Ptolemaic town and military camp of Pathyris (*Pr-ḥwt-ḥr*, the House of Hathor) was located in the larger area of Gebelein (*Jnrtj*, two rocks), situated west of the river Nile some 28 km south of Thebes, or modern-day Luxor (Figure 2).[17] Topographically, the area is characterised by two small mountains consisting of a number of rocks, of which Pathyris (and its fields) was situated on and around the northernmost rock of the easternmost mount.[18]

[16] The most recent in-depth study of this Pathyris is my monograph (Tambs, 2022a-b), which also describes the data collection process in detail. For descriptions of the site and community formed by the inhabitants, see e.g. Tambs (2022a, p. 17-19 and 345-371), Vandorpe & Waebens (2009, p. 11-51).

[17] For the toponyms, see e.g. Fiore Marochetti (2010, p. 6-7). For the wider temporal and geographical scope of Gebelein, esp. Ejsmond (2020); Morenz (2010).

[18] I.e. Rock IIa, following the reference system established by *Gebelein Archaeological Project* (https://gebelein.wordpress.com/ [13.05.22]), Ejsmond et al. (2017, p. 241-243); Ejsmond et al. (2019, p. 217).

Figure 2: Location of Pathyris/Gebelein on modern map of Egypt.

Source: Google Earth, camera: 2,117 km.

Of particular interest here is the domestic area, which also contained a fortress and a temple of the goddess Hathor.[19] Although the area has been examined by a number of researchers, the archaeology of the site is poorly understood since few missions published their findings.[20] As such, an archaeological map was draw up as part of a systematic excavation of the town area in 1911, but only published in 2003.[21] Moreover, we know from the surviving texts that the mapped area only represents a section of what would have been the Ptolemaic

[19] For recent discussions of these institutions, see Ejsmond et al. (2018); Tambs (2022a, p. 350-356).
[20] An overview of the activities and potential of the site is given in Tambs (2022a, p. 78-84).
[21] The excavations were led by by the *Missione Archaeological Italiana* and *Museo Egizio* in Turin. For published versions of this plan, see Bergamini (2003, Figs. 5, 9); Ejsmond et al. (2019, Fig. 2); Tambs (2022a, Figs. 43-44, 51). For discussion of its accuracy, Ejsmond et al. (2019); Tambs (2022a, p. 359-370). For a topographical map of the area, also Fiore Marochetti (2010, Fig. 4).

town of Pathyris.[22] Combined with archival photos kept at the *Archivio Museo Egizio*, the map nevertheless gives valuable insight into the living conditions of the inhabitants.[23]

Documentary Papyri and Ancient Archives from the Site

That relatively much is known about life in late Ptolemaic Pathyris is, however, primarily thanks to the unusually rich body of textual sources that survived from the site. As devastating as it was, this is at least partially due to the town's unfortunate faith: combined with the content of a small archive of letters sent from Platon, *strategos* of the Thebaid, an abrupt end to the documentation suggests that the town was taken and abandoned in the fall of 88 BCE.[24] Although a small village is again situated in this area today, this led to the survival of several documents that are otherwise usually lost. They offer detailed glimpses into the lives and affairs of the last generations living there and, importantly, c. 428 of the roughly 1500 known texts from the site have been grouped into 21 ancient archives.[25]

This contribution concerns a selection of these, concentrating on the sixteen family archives while ignoring two institutional archives and three archives classified as correspondences. The network models discussed below thus only reflect information retrieved from the 382 texts that are listed under family archives in K. Vandorpe and S. Waebens' book[26] and/or the *Trismegistos* (TM) platform.[27]

The People and Community They Formed

Collectively, the archaeological and written sources draw a picture of a small and relatively uniform community, unlikely to have exceeded more than 1000 inhabitants in the

[22] Cf. the schematic plans based on textual evidence that were drawn up by Pestman (1965) and Vandorpe & Waebens (2009, Figs. 8, 10).
[23] For discussions on the settlement and its characteristics, see esp. Bergamini (2003); Ejsmond et al. (2019, p. 217- 225); Tambs (2022a, p. 356-371); Vandorpe & Waebens (2009, p. 18-36).
[24] For example, Vandorpe & Waebens (2009) noted that the latest text written by the local temple scribe is dated 4th October 88 BCE (TM_119). For this revolt, e.g. Fischer-Bovet (2014, p. 108-109); Ritner (2011, p. 101-103); Tambs (2022a, p. 23-24); Veïsse (2004, p. 64-73). The correspondence of Platon (TM_Arch_484) is excluded from the present study but treated elsewhere, e.g. Tambs (2022a, p. 212-216), Vandorpe & Waebens (2009, p. 95-97).
[25] The archives are presented in Vandorpe & Waebens (2009). For an overview and discussion of the material, see also Tambs (2022a, p. 89-94).
[26] Vandorpe & Waebens (2009, esp. p. 102-199).
[27] At the time of data collection, i.e. early spring of 2017. As explained in Tambs (2022a, p. 101ff.), *Trismegistos* (Depauw & Gheldof 2014) and especially the *TM People* and *TM Texts* databases were invaluable tools in the data collection process. For lists of texts considered under each archive, see Tambs (2022a, Tables 7-12, 15-16, 20-27). For the texts' sigla, cf. Tambs (2022b, App. C).

period of interest.[28] I say *relatively* uniform, because the community was bilingual and several of its members wore so-called legal ethnic designations that gave access to different fiscal and legal rights and obligations.[29]

In terms of who are modelled in the network graphs,[30] it should be stressed that only individuals explicitly mentioned in at least one of the 382 documents considered for this case study are represented by nodes. This means that only attribute and relational data concerning named persons were recorded, whereas unnamed individuals, groups and collective terms were ignored. This already excludes a large chunk of the community members, as children and people of lower social standing are unlikely to have ever been named in texts kept in such family archives.[31] The representativity of the network is further affected by the fact that even named persons are only known to us, if at least one text mentioning them (1) survived, (2) were assigned to one of the studied archives in modern time and (3) has been sufficiently studied and published to make it into my dataset.

Although the network extracted from the family archives is relatively large (see Figure 3 below), the chance that any person living in Pathyris in the century of interest made it into the sample is thus admittedly slim. Moreover, we must recognise that the dataset is skewed towards the higher echelons of society, the relatively active personalities (at least when it comes to producing and archiving written evidence of their affairs) and the people they were close to (or fought against). The sample is thus unlikely to be representative of the community as such, but still holds great value and has important stories to tell – so long as we are aware off, and explicitly address, such limitations.[32]

Attestable Social Categories and Grouping Criteria

Given the sense of community the inhabitants of a small settlement site are likely to have felt amongst themselves, it can perhaps be questioned whether distinguishing between in-group and out-group concepts constitutes a meaningful analytical tool in ancient community studies. For cases like Ptolemaic Pathyris, it is, however, possible to break the community network up into smaller and often overlapping groups that make it appropriate to talk about in-

[28] Tambs (2022a, p. 479-480).
[29] Tambs (2022a, p. 33-34); Vandorpe & Waebens (2009, p. 45). See also below.
[30] For conventions, see Tambs (2022a, p. 119-120).
[31] For a critical discussion of the representativeness of the material, based on data collected from the extended list of 21 archives, esp. Tambs (2022a, p. 267-271).
[32] For reflections on the limitations of the larger dataset analysed in my monograph, see Tambs (2022a, p. 494-499).

group and out-group distinction, and on different scales. If we conceptualise the entire community of Pathyris (as it is attested in the sources) as an interpersonal network and map the various social and economic relationships manifested in the family archives as described above, we arrive at a complex whole network encompassing multiple smaller groups. They could be classified according to categories such as age, ethnicity, biological sex, family units, archival affiliation(s), profession, legal status, etc.

In Pathyris, boundaries defined by age or ethnicity are particularly difficult to analyse, since the documentation does not allow much to be said about such characteristics. We already heard that children are rarely mentioned by name. Additionally, age was clearly a relative concept:[33] a person's age was often given as part of his or her descriptive characteristic in legal documents and many people reappear in several preserved texts. Since most of the studied texts are (tentatively) dated,[34] it is thus possible to study how specific individuals are described by different scribes and over time. Despite some consistency, esp. in terms of physical marks like scars, such comparison reveals that the descriptive identifications, including the age estimates, are largely subjective.

In the case of ethnic origin, the sources suggest that most people living in Pathyris were either local Egyptians or of foreign descent, but largely Egyptianised by the time we turn our eye on the community.[35] Although Pathyris hosted a Ptolemaic military camp in the larger part of the studied century (c. 165-88 BCE),[36] a clear Egyptian versus Greek (or other ethnic group) distinction is thus not reflected in the sources. For example, it is evident that the few people known to have had double-names were mostly locals from military or scribal families, who practiced their mixed identities interchangeably, depending on context, legal matter, opposing parties, availability of notaries, etc.[37] That Greek ethnic and cultural markers are not more prominent in the written evidence, is mirrored by a general lack of Greek buildings in the townscape.

Rather than denoting real ethnic origin, attributes like "Egyptian", "Persian" and "Greek" thus referred to a person's legal ethnic status. In the documentation, they are occasionally stressed in situations where they granted their holders access or privileges, but as

[33] For examples, see Tambs (2022a, p. 32).
[34] Tambs (2022a, p. 89 n. 55).
[35] Tambs (2022a, p. 30-31).
[36] For the camp, fortress and soldiers serving in it, e.g. Ejsmond et al. (2018); Tambs (2022a, p. 28-30, 352-356); Vandorpe & Waebens (2009, p. 43-46).
[37] Vandorpe & Waebens (2009, p. 47). An example of an Egyptian scribe retrained to serve as a Greek notary is Hermias, highlighted in Table 1, Table 3, Table 4 and App. A, and *ibid.* 47-48.

we shall see, people whose legal status is attested in writing did not only deal with people of similar social standing. This suggests that the labels confirm to state level systems more so than they do local systems. The lack of emphasis on age and (real) ethnic classification is itself interesting and revealing of the social boundaries at play in this community, but for this study, we shall concentrate on a classification criterion that is more easily retrieved from the ancient sources, namely biological sex.[38]

Extracting and Recording Information for Computational Modelling

As demonstrated by the transformation of an imagined letter into a network graph (see Figure 1), I built a 1-mode multi-layered network (in which all nodes represent ancient people, but both parallel and various types of edges are allowed to connect the same pair of nodes) from the sixteen family archives.[39] The graphs are unweighted (since I consider all ties to be of equal strength), but mixed (since they contain both undirected and directed edges). In the node-link visualisations, edges are thus represented by lines or arrows, with the former signalling undirected relationships (such as kinship) and the latter representing those economic activities that have an inherent direction (such as offering a service or sending a greeting). For these directed edges, arrowheads always point from the giver towards the receiver. Moreover, the nodes as well as the edges are richly annotated by attributes, e.g., providing information on the name, sex, legal status and profession of a person, or the language, date and document type of the source informing us about a specific relational link.[40]

The Network Model and its Structural Characteristics

Collectively, the studied texts enabled me to map 6436 relational ties involving 2467 individuals as an unweighted, multi-layered mixed network of people connected by socio-

[38] In the network models, nodes are classified as “male”, “female” or “unknown”, in an attempt not to impose assumptions on symbolic and performed gender identities that are not reflected in the source material. For the classification criteria of the tags, see Tambs (2022a, p. 63).

[39] The dataset discussed in this paper was queried from an updated version of the *MS Access* database described in Tambs (2022a, p. 106-108), and I used the latest version of *Gephi* (0.9.4), freely available at https://gephi.org/users/download/ (accessed 02.05.22), for the network analysis. The network boundaries of the larger dataset of which this forms an except are defined in Tambs (2022a, p. 95-96).

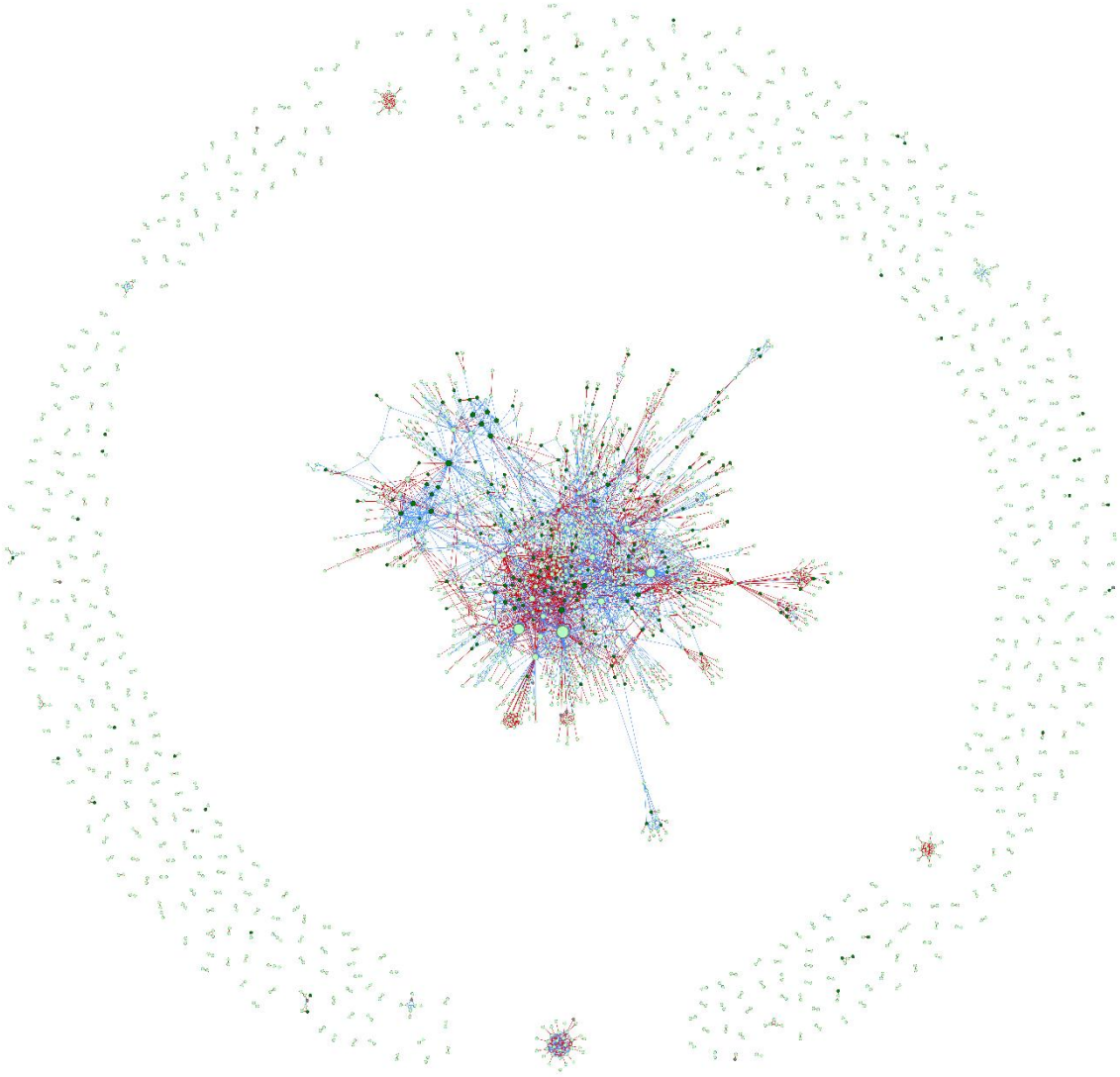
[40] In practice, this means that certain relationships linking individuals, such as child-parent relations revealed by naming practices, will be modelled many times. For computational reasons, it might have been more useful to merge these parallel edges, for example adding a weighting scheme that reflect the number of times a relationship is attested. Since the contextual information attached to each individual edge would have been lost in the process, a ‘don’t merge’ strategy was preferred during import to *Gephi*. For a full list of attributes and tags, see Tambs (2022b, App. H, p. 310-311 and 315-320).

economic relations (Figure 3).[41] They represent people that are both attested in at least one of the studied texts and revealed to have had at least one social or economic link to at least one other person mentioned in anyone of the incorporated texts.[42]

The whole network consists of 575 connected components and utilising the *ForceAtlas2*[43] layout algorithm to position the nodes made it clear that whereas most are dyads, triads, or relatively humble groups, one is significantly larger than the rest. The smaller components represent pairs or groups of people that were not connected to (or securely identified with) anyone in the main component.[44] Since this study aims to explore the workings of symbolic and social boundaries in a cohesive group, we will thus concentrate on the so-called giant component from this point onwards.

Figure 3*:* Whole network model of interpersonal relations revealed by 16 family archives from Ptolemaic Pathyris. Node size: degree centrality. Node colours: sex (light green = male, dark green = female, medium grey = unknown). Edge colour: type (bright red = social, light blue = economic).

[41] On the difficulties of identifying individuals, conventions on who to model and reflections on how representative the sample is of the community, see Tambs (2022a, p. 101-105, 119-120 and 267-271).
[42] Persons only mentioned alone or without any known relations were cut by means of removing isolates.
[43] Jacomy et al. (2014).
[44] Noteworthy is that possible cross-identifications were noted for 185 (or 7,50%) of the nodes in the whole network, and that 148 (or 80%) of them are excluded from the giant component. Some suggested duplicates are nodes only mentioned in the institutional archives and correspondences excluded from this study, but the point remains that many of the disconnected people are poorly connected because they are mentioned in fragmented sources or witness-lists, which make it difficult to establish their identity.



Graph by author, created in *Gephi*.

People and Ties in the Giant Component of the Community Network

In the giant component, which contains 48,36% of the nodes and 85,46% of the edges, 1193 persons are linked by 5500 edges, of which 3342 (or 60,73%) were classified as social (represented by red lines) and 2158 (or 39,24%) as economic relations (blue lines/arrows). The average degree of the nodes in the giant component is relatively high (9.22), but its density is only measured at 0.008. This tells us that, on average, nodes are involved in several relationships, but that very few of the potential pairs of nodes are nevertheless connected. Considering the long-tailed distribution pattern of calculated degree centrality scores and

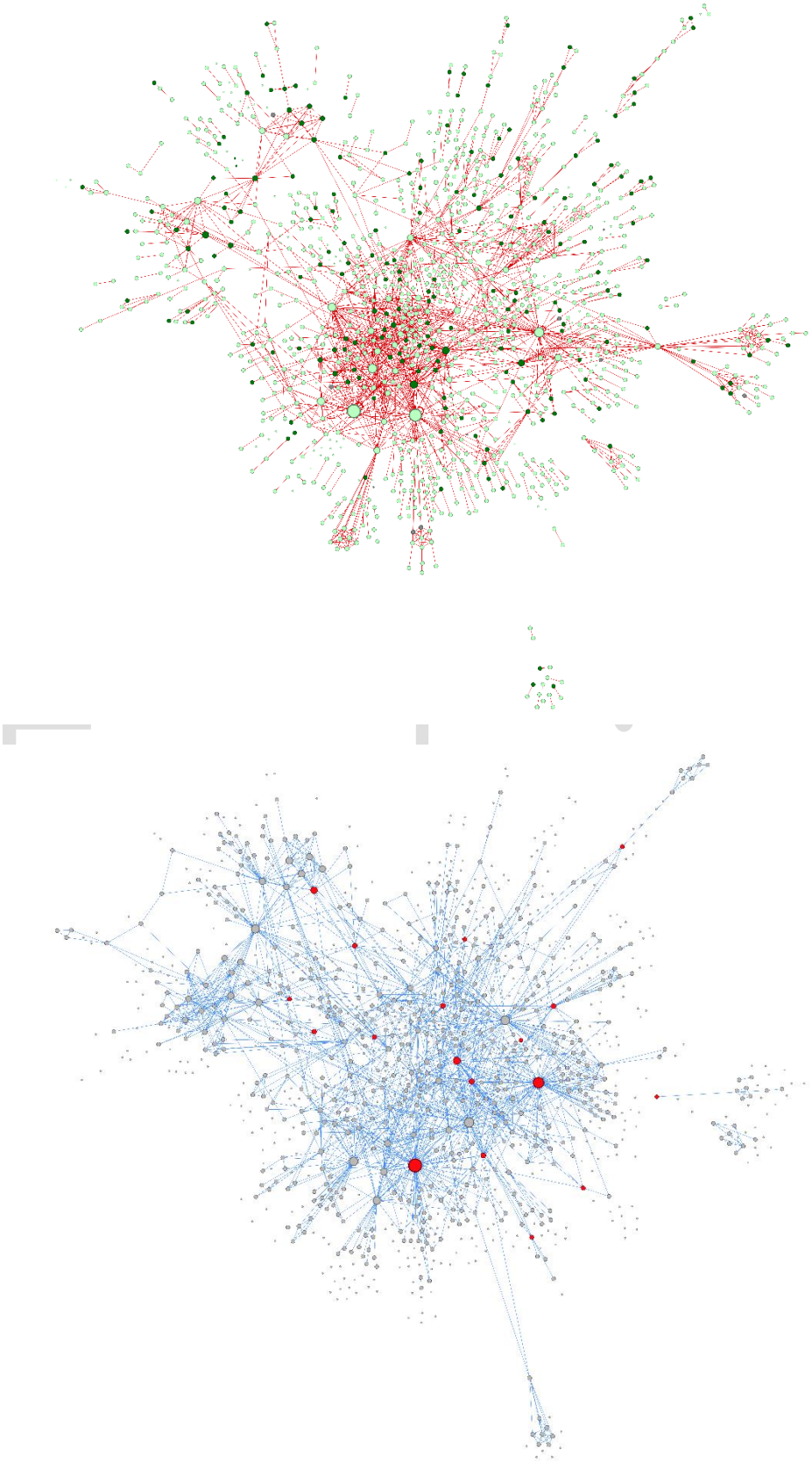
network position of the highest-ranking nodes by this metric,[45] it is evident that the main reason the average degree is high is that a few nodes are particularly active.

Remembering that we are looking at multi-layered graphs, this should warn us that we do not see the complete picture because *Gephi* places both multiplex and parallel edges on top of each other. To gain a slightly better impression of which parts of the model are activated by social, economic and both kinds of ties, it is thus also useful to filter and visualise them separately (Figure 4a-b).

These visualisations reflect that most peripheral nodes have relatively few relational ties and are only linked to others by edges of a social character. In most cases, these are persons who are indirectly mentioned in the documentation due to naming practices. Since many are exclusively attested as fathers (and a few as mothers), many peripheral social edges reach away from the centre of the graph. Once the social and economic spheres are separated, several of these form disconnected dyads, meaning that no continuous path of *social* relations connect the given pair to anyone else in the dataset. It follows that several parent-child dyads are only connected to the community core (or giant component) by means of the economic activities of the given acting party.

Figure 4a-b: Distribution of (a) social (red) and (b) economic (blue) relationships in the giant component, with nodes positioned as in Figure 3. Node size: degree centrality calculated for visible ties only. Node colours in social (top) model: biological sex (light green = male, dark green = female, medium grey = unknown). Node colours in economic (bottom) model: last archive owner (grey = false, red = true).

[45] For lists of high-ranking persons and their degree scores, see Table 1 and App. A.



Graphs by author, created in *Gephi*.

In addition to revealing structural characteristics of the giant component and the social and economic networks it encompasses, the colouring of the nodes represents selected characteristics of the community and its members. Colouring the nodes by sex in Figure 4a serves to show how female and male nodes are largely mixed across, as opposed to occupying distinct areas of, the community network. Noteworthy in this respect is also a relatively high number of female agents: of the 1193 nodes, 993 (or 83,24%) were classified as "male", 190 (or 15,93%) as "female" and 10 (or 0,84%) as having "unknown" biological sex.[46] As expected, the network is thus clearly male-dominant but, as we shall see, several women with relatively high degree centralities (as reflected by node size) are centrally positioned in the giant component, since they were also actively involved in economic activities.

Moreover, visual comparison of the distributional patterns of larger sized nodes in the whole network (Figure 3) and main component (Figure 4a-b) suggests that several individuals demand attention in all three versions of the dataset. Considering the sources that lay at the heart of the model and the fact that the number of preserved texts decline the longer back in time we go,[47] it may be assumed that the last archive owners will be relatively prominent. Since the size of a node reflects its degree centrality – which counts the number of edges a given node is involved in – we may thus expect that most high-ranking nodes represent last archive owners or people close to them. Highlighting the network positions of the last archive owners by means of colouring their nodes red does, however, reveal that they only make up some of the persons with high degree scores (Figure 4b).

To examine the intersection between the models closer, we can identify and list the twenty highest-ranking persons in table format (Table 1). Doing so confirms that several people do make an appearance in more than one list, and that relatively few of the 17 male and 1 female archive owners identified in Figure 4b are found among the highest-ranking persons (in red).[48]

Table 1: List of the twenty individuals with the highest degree centrality in Figure 3, Figure 4a and Figure 4b respectively. Cell colours indicate biological sex (light green = male, dark green = female) whereas red writing signals that a given person was the last owner of one of the studied archives. For personal IDs, see App. A.

[46] Despite certain variations between archival groups, this percentage align well with the general tendency observed in the Pathyris material, Tambs (2022a, p. 308-315, esp. Table 30).
[47] Tambs (2022a, p. 282-285, esp. Fig. 22).
[48] Here it should, however, be stressed that a few more people on the lists do represent earlier owners.

The whole network (Fig. 3)	The social network (Fig. 4a)	The economic network (Fig. 4b)
Peteharsomtous (391)	Panebchounis (235)	Peteharsomtous (180)
Panebchounis (325)	Peteharsomtous (211)	Horos (129)
Horos (271)	Horos (142)	Hermias (114)
Hermias (160)	Chesthotes (125)	Nechtminis (97)
Nechtminis (144)	Thrason alias Patous (108)	Panebchounis (90)
Petesouchos (136)	Totoes (94)	Apollonia alias Senmonthis (87)
Peteharsomtous (132)	Kobathesis alias Maithoytes (86)	Petesouchos (75)
Chesthotes (127)	Tathoytis (80)	Peteharsomtous (65)
Apollonia alias Senmonthis (126)	Ptolemaios alias Pamenos (73)	Aphrodisia alias Tachratis (61)
Totoes (120)	Nechoutes (70)	Pagonis (58)
Thrason alias Patous (116)	Peteharsomtous (67)	Apollonia alias Senmouthis (55)
Kobathesis alias Maithoytes (110)	Tamenos (67)	Apollonia junior alias Senpelaias (55)
Pagonis (103)	Asklepiades alias Patseous (65)	Nechoutes (55)
Dryton (101)	Petesouchos (61)	Senanoupis (54)
Tathoytis (98)	Patous (58)	Aristo alias Senmonthis (51)
Asklepiades alias Patseous (96)	Thibis (58)	Nikarion alias Thermouthis (51)
Paniskos (88)	Haes (56)	Dryton (49)
Apollonia alias Senmouthis (86)	Hermophilos alias Phibis (55)	Psenesis (47)
Senanoupis (86)	Areios alias Pelaias (54)	Ammonios alias Pakebkis (43)
Tamenos (85)	Panas alias Hermokrates (53)	Paniskos (43)

A few observations should however be made at this point. One is that several of the family archives reach across more than one generation and that some of the previous owners are also highlighted by this centrality measurement. An example is Dryton and Apollonia alias Senmonthis; the surviving part of their family archive was passed to their oldest daughter, Apollonia alias Senmouthis (represented in Table 1) and her husband Kaies (who has a degree of '36' in the whole network, '17' in the social graph and '19' in the economic network). Noteworthy is also, that Dryton and Apollonia alias Senmonthis' four other daughters are also found amongst the top twenty by degree score in the economic subset (Figure 4b). This is partly due to the archive in question being the second largest, but also the high number of links drawn between members of this family group and the active role several of these women played in

economic affairs.[49] Moreover, that Dryton's son from a previous marriage is not highlighted, might be explained by *his* archive not having survived.[50]

Another is that several people in the lists are mostly mentioned indirectly as part of a name. An extreme example is Nechoutes, the father of Horos, the last owner of the third largest archive. He has a degree of '70' in the social subset and '0' in the economic graph, since he is exclusively recorded in social relationships that tie him to his father, wife, and children. By contrast, Nechoutes' wife, and Horos' mother, Thibis, is also highly ranked in the whole network and economic models, although she only makes the cut in the social network. This reflects that she was another female agent actively involved in economic activities.[51]

Although degree centrality highlights several members of the families that left the largest archival groups – because *their* archives are the ones that happened to survive, or perhaps because they *were* the most active people of this community – it should also be stressed that these well-known persons do not fully dominate the giant component of this community network. Structurally, the graph is not alarmingly centralised,[52] and Figure 4b clearly shows that the last archive owners are dispersed across a large part of the graph. No single node thus sits comfortably at the centre, like a spider in a web. This is because we are looking at a community sample informed by several family archives from the site, which offer several viewpoints into the community and the activities of its members.[53]

Maintaining and Crossing Boundaries in Ptolemaic Pathyris

Now that we have learned some characteristics of the community, dataset and networks at hand, it is finally time to subdivide the giant component of the community network into social groups and explore each of them in isolation.

[49] For this family, see esp. Tambs (2022a, p. 132-145, 380-398); Tambs (2020); Vandorpe (2002b); Vandorpe & Waebens (2009, p. 102-113).
[50] It has been suggested that Esthlades inherited most of his father's personal documents (Vandorpe & Waebens, 2009, p. 104), which might explain the relatively insignificant role played by Dryton compared to his wife and daughters, but also other male archive owners.
[51] Thibis has a degree of '76' in the whole network and '18' in the economic model. For this family, see esp. Adler et al. (1974); Tambs (2022a, p. 164-174, 408-419, 427-433); Vandorpe & Waebens (2009, p. 127-141).
[52] For an example of a highly centralised historical network and the effect its structure has on selected centrality measures, see Bennett et al. (Forthcoming).
[53] For varying centralisation levels observed in the archive, cf. Tambs (2022a, esp. Ch 5), in which archive-restricted networks were also studied in isolation.

Splitting the Community Model by Biological Sex

In the dataset, nodes and edges are tagged with several attributes, one of which makes a distinction between "male", "female" and persons of "unknown" sex. The labels are emic in the sense that they represent biological sex as reflected in kinship terms and personal names, but makes no effort to mirror the more nuanced gender identity repertoire the inhabitants are likely to have practiced.[54] Albeit culturally considerate in the sense that the labels were applied on the basis of surviving texts, it follows that the boundaries defining the male and female networks reflect biological sex rather than socially constructed identities related to gender.[55] In asking whether such distinctions were felt and practiced by the inhabitants of Pathyris, we shall proceed to study and compare these subgroups separately, before considering the intersection between members of each group in the giant component of the community model.

Isolating an all-male and an all-female subnetwork from the community core reveals that 993 male nodes are linked by a total of 3400 male-to-male edges whereas 190 female nodes share 419 edges amongst each other. Although it can be argued that the proportion of ties over nodes is similar,[56] isolating each group and rerunning the *ForceAtlas2* layout algorithm serves to illustrate that the networks are quite differently structured (cf. Figure 5 and Figure 6).

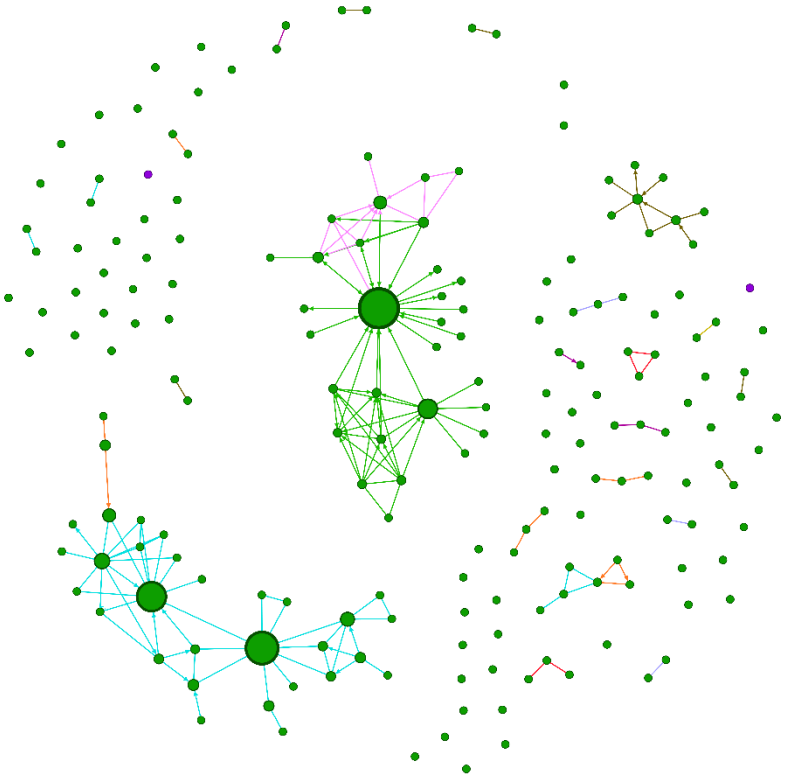
Figure 5: The male whole network. Node size: betweenness centrality. Node colours: light green = male person, dark purple = non-local male person. Edge colours: archival affiliation, as in Figure 6.

[54] Tambs (2022a, p. 63).
[55] For an overview of gender studies' three waves and issues regarding dichotomies like "sex" and "gender", e.g. Svärd (2016, p. 447-451).
[56] With an average degree of 6,848 in the male and 4,411 in the female network.

Graph by author, created in *Gephi*.

Figure 5 shows that the male network largely resembles the community whole network (cf. Figure 3). It consists of 90 connected components, including several isolates and some dyads and small groups. Still, one component is significantly larger than the rest, and this giant component makes up 88,52% (879) of the nodes and as much as 99,09% (3369) of the edges. This tells us that some men included in the giant component of the community network (Figure 3) are only tied to women or people of unknown sex, but also that the vast majority are linked to at least one other male node.

Figure 6: The female whole network. Node size: betweenness centrality. Node colours: dark green = female person, dark purple = non-local female person. Edge colours: archival affiliation, as in Figure 5.



Graph by author, created in *Gephi*.

A quick look at Figure 6 reveals that the female network is comparatively fragmented. This network is much smaller but consists of slightly more (92) connected components, most of which are isolates, dyads or small groups or strings. Rather than many nodes and edges being clustered together in one component, two larger groups are formed when only female-to-female relationships are modelled. The largest component, positioned in the centre of the graph, thus only represents 16,32% (31) of the nodes and 67,54% (283) of the edges.

Another noticeable difference between the male and female networks is the degree to which archival boundaries (represented by edge colour) are blurred in the main component(s). In the giant component of the male network (Figure 5), men are linked to other men by relational ties revealed by texts associated with all sixteen family archives. In comparison, only nine of the studied archives mention any female-to-female connection, and the two largest components of the female network (Figure 6) are each reconstructed from two archives. This is despite of the fact that both groupings are informed by a range of different documents.

Since the female network is relatively small, it might be argued that the two larger groups are likely to have been merged had it been larger or were more texts to be included in the study. However, diachronic analysis of the edges shows that the two main components are

largely contemporary, even if most of the largest group is attested slightly earlier.[57] The lack of links between these two groups can thus not be explained by chronology alone. It can thus be hypothesized that the female network is unlikely to reach a similar structure as that of the men, or community, even if it were to grow to a similar size – and that this might reflect differences in their socio-economic behaviours, in the agent's social and professional roles, in the ways in which men and women's relations and affairs were recorded, something else, or a complicated mix of the above. To various degrees, the case study allows us to test these hypotheses against the dataset.

Detectable Patterns of Male and Female In-group Ties

To enable more fine-grained quantitative and qualitative analyses of the socio-economic network, the edges in each main category were also classified according to kind and sub-kind.[58] In search of empirical evidence for the existence and practice of social boundaries, these are particularly relevant, because they enable us to explore the quality of the relationships that individuals and groups had with one another. In terms of the agent's detectable socio-economic behaviours, quantifying and comparing the types of relationships linking pairs of women and pairs of men will serve to highlight in-group similarities and differences across the male and female networks (Table 2).

Table 2: The quality of the edges that make up the female (Figure 6) and male (Figure 5) networks respectively, sorted by quantity. In the case of equal numbers, labels are sorted alphabetically. Cell colours indicate classification (light red = social, light blue = economic).

Edges Drawn between Women			Edges Drawn between Men		
Edge kind	#	%	Edge kind	#	%
Collaboration	127	30,31	Close kin	1101	32,38
Close kin	115	27,45	Neighbour	808	23,76
Neighbour	50	11,93	Service	620	18,24
Payment	37	8,83	Collaboration	269	7,91
Service	20	4,77	Colleague	180	5,29
Cession	16	3,82	Payment	93	2,74
Dispute	15	3,58	Land sale	70	2,06
Colleague	8	1,91	Loan	65	1,91
Land sale	7	1,67	Communication	36	1,06
Loan	6	1,43	Extended kin	27	0,79

[57] The largest component also includes some earlier text, but both groupings are primarily informed by texts from time slots 2 and 3 (ranging from 140-88 BCE). In the largest component, period 2 (140-116 BCE) is the better represented whereas in the second largest component, the majority of the edges are (tentatively) dated to period 3 (115-88 BCE). For definition of the time slots, Tambs (2022a, p. 121-122).

[58] For categories and tags used, see Tambs (2022b, p. 315, 317-318).

Agree to purchase	4	0,95	Cession	23	0,68
Exploitation	4	0,95	Dispute	23	0,68
Unknown	3	0,72	Return of loan	22	0,65
Gift or inheritance	2	0,48	Lease	15	0,44
Sale (Object)	2	0,48	Agreement	9	0,26
Cession (?)	1	0,24	Inheritance	9	0,26
Inheritance	1	0,24	Kinship	5	0,15
Loan security	1	0,24	Release from contract	5	0,15
-	-	-	Collaboration (?)	4	0,12
-	-	-	Agree to purchase	3	0,90
-	-	-	Conveyance	3	0,90
-	-	-	Loan promise	2	0,06
-	-	-	Appointment	1	0,03
-	-	-	Colleague (?)	1	0,03
-	-	-	Declaration	1	0,03
-	-	-	Inheritance (?)	1	0,03
-	-	-	Land sale (?)	1	0,03
-	-	-	Loan Security	1	0,03
-	-	-	Mortgage	1	0,03
-	-	-	Sale (Object)	1	0,03

Immediately, such tie analysis reveals that the male network (Figure 5) not only contains far more edges than the female model (Figure 6); it also consists of a wider range of recorded relationships. Several are tentative (listed as duplicates of existing tags followed by '(?)'), but these are insignificant here, as they make up a very low percentage of the total number of edges.[59]

The extent of this paper does not allow for an in-depth study of the socio-economic activities in the two models, but if we compare the five most frequently recorded edge kinds in each network, we find that social ties between close kin and neighbours and economic activities like collaborations and services are particularly common in both networks. The fourth highest ranking edge kind in the female network is "payment", which is ranked sixth highest in the male network. In the male network, the fifth highest is "colleague", which is ranked eight highest in the female model. Although the ranked order varies somewhat, there is thus a significant (80%) overlap in the top five edge types explicitly linking women to women and men to men, and the ones that did not make the cut nearly did.

It is a bit surprising that "colleague" is the eight most frequently attested female in-group tie, given that men occupied most of the professional positions that the inhabitants are

[59] Such cases represent 0,24% of the edges in the female and 0,21% in the male network.

known to have made use of – like scribes and bankers.[60] This notion is supported by the fact that the profession of very few women are explicitly mentioned in the family archives, and a closer look at the dataset reveals that the eight collegial ties found in the female subset of the community core were exclusively draw between three female slaves as revealed by the third will of the Cretan military officer Dryton, whose family they all worked for.[61] Speaking for the exceptionality of this example, they are the only slaves attested in the family archives from the site and no other woman's profession is explicitly mentioned in any of the archive's texts. In the male graph, the situation is quite different: 76 men are involved in at least one collegial tie of administrative, scribal, military and/or religious character.[62] The relative importance of collegial ties amongst women from Pathyris portrayed in Table 2 thus serves as an appropriate warning that the female subset is too small to generate statistically supported conclusions, and that the network analyst should always consider carefully what (s)he is looking at to spot such quirks.

Closer analysis of the data suggests a similar situation for "payments": in the male network, most such edges represent tax payments. In the female graph, several such ties were retrieved from accounts, but most payments linking pairs of female agents reflect that the named Dryton included instructions on payments to be made between close family members – most of which were women – in his wills. Again, it is thus clear that, whereas most male-to-male examples involved at least one person serving in his professional role, it is difficult to draw conclusions from the female case, since many records reflect the seeminlgy unusual case of this family, rather than a general characteristic of the community.

The Legal and Professional Status of the Modelled Individuals

In discussing the characteristics of the whole network representing the community we looked at the nodes' degree centrality scores, which are indicative of their overall level of activity. For the purpose of considering the significance of the agents' social and professional roles, we are more interested in locating persons that obtain particularly influential network position. Since betweenness centrality is designed to identify nodes serving as brokers, we shall here concentrate on the ten highest-ranking persons by this metric (Table 3).

[60] Tambs (2022a, p. 484-485).
[61] Tambs (2022a, p. 447-448, 451). The edges were informed by two copies of a will (TM_258/ P. Dryton 4 = P. bl 617 and TM_268/ P. Dryton 3 = P. bl 640 + 687 a + 687 e + P. Sorbonne Bouriant 46, published in Vandorpe, 2002b). For Dryton and his family, see also n. 49 above.
[62] Including one probable "unknown" edge between colleagues.

Table 3: List of the ten individuals with the highest normalised betweenness centrality scores in Figure 6 and Figure 5 respectively. Cell colours indicate biological sex (light green = male, dark green = female) whereas red writing signals that a given person was the last owner of one of the studied archives. For personal IDs, see App. A.

Women with high betweenness scores (in Fig. 6)	Men with high betweenness scores (in Fig. 5)
Apollonia alias Senmonthis (0.0187)	Peteharsomtous (0.2029)
Senpelaias (0.0147)	Horos (0.1736)
Kobathesis alias Maithoytes (0.0128)	Nechtminis (0.1407)
Apollonia alias Senmouthis (0.0068)	Panebchounis (0.1041)
Tathoytis (0.0045)	Hermias (0.1027)
Siepmous (0.0037)	Peteharsomtous (0.0897)
Thibis (0.0032)	Asklepiades alias Patseous (0.0828)
Senanoupis (0.0030)	Nechoutes (0.0579)
Takmeis (0.0019)	Thrason alias Patous (0.0549)
Takebkis (0.0016)	Petesouchos (0.0538)
Tareesis (0.0016)	-

As expected, the eleven women and ten men with the highest betweenness centrality scores are positioned in the two largest groups in Figure 6 and the giant component of Figure 5 respectively. This measure highlights these people, because they are the ones most frequently found on the shortest path that any pair of other nodes in the given networks can reach each other by. It thus finds people that serve to bridge otherwise weakly connected communities in a network structure, rather than people who are necessarily well connected themselves. That the highest-ranking individuals still form only one male and two female components when isolated from the rest of their networks might indicate that the community, at least as it is portrayed in the studied sources, was rather 'close' (Figure 7 and Figure 8).

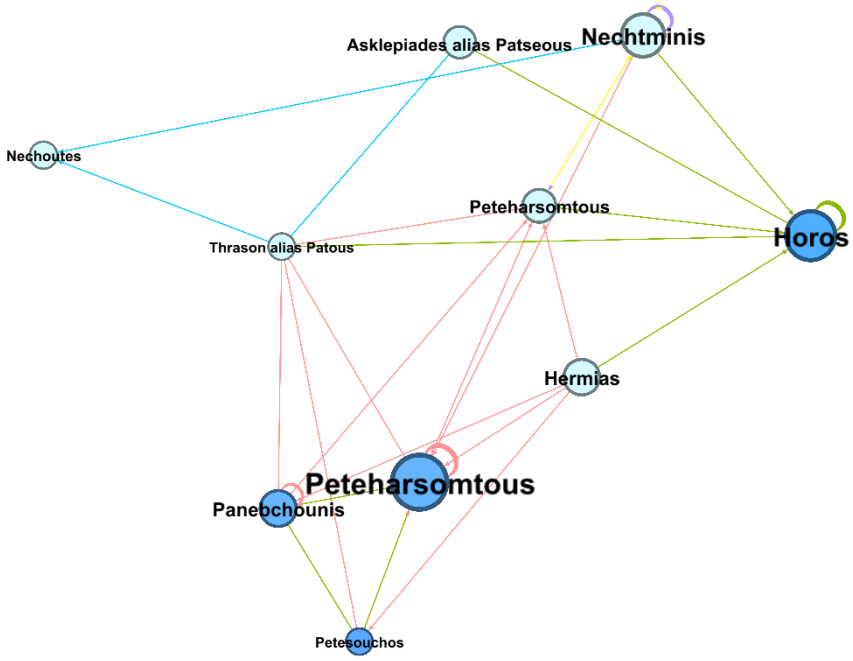
As before, we see that the male-to-male network is informed by more family archives than the discussed female-to-female groupings,[63] and that more archive owners are highlighted in the male than the female case (see Table 3). As far as the legal ethnic designations of these people are revealed by the documentation, we find that 40% of the highlighted men held Persian whereas 60% had unknown (Egyptian?) status (Figure 7). In comparison, 9,09% of the women are revealed to have enjoyed Greek, 54,55% Persian and 36,36% unknown (Egyptian?) status (Figure 8).

[63] A total of five archives (TM_Arch_081, TM_Arch_098, TM_Arch_106, TM_Arch_183, TM_Arch_488) link the ten highest-ranking men whereas the two female components are informed by one (TM_Arch_183) and two archives (TM_Arch_081, TM_Arch_074) respectively.

A couple of things are worth highlighting here. Firstly, only one of the twenty-one highlighted persons is said to have had Greek status. This is the wife of Dryton, who appear to have served a special function in the community as a creditor, offering loans to several different people, including non-kin women.[64]

Secondly, while her and her oldest daughter (i.e., the last owner of this archive), Apollonia alias Senmouthis, are highlighted in the female network, their respective husbands, Dryton and Kaies, are absent in the male top-raking list and no edge attested in this archive (TM_Arch_074) link top-ranking people in the all-male graph.[65] Given that their archive is the second largest surviving archive from the site, this stands in sharp contrast to the relatively large number of edges from the largest and third largest family archives (linking high-ranking men 161 and 29 times respectively).[66] This might well reflect the fact that several female members of this family were actively conducting business and got themselves involved in a multitude of activities, relationships, and disputes.

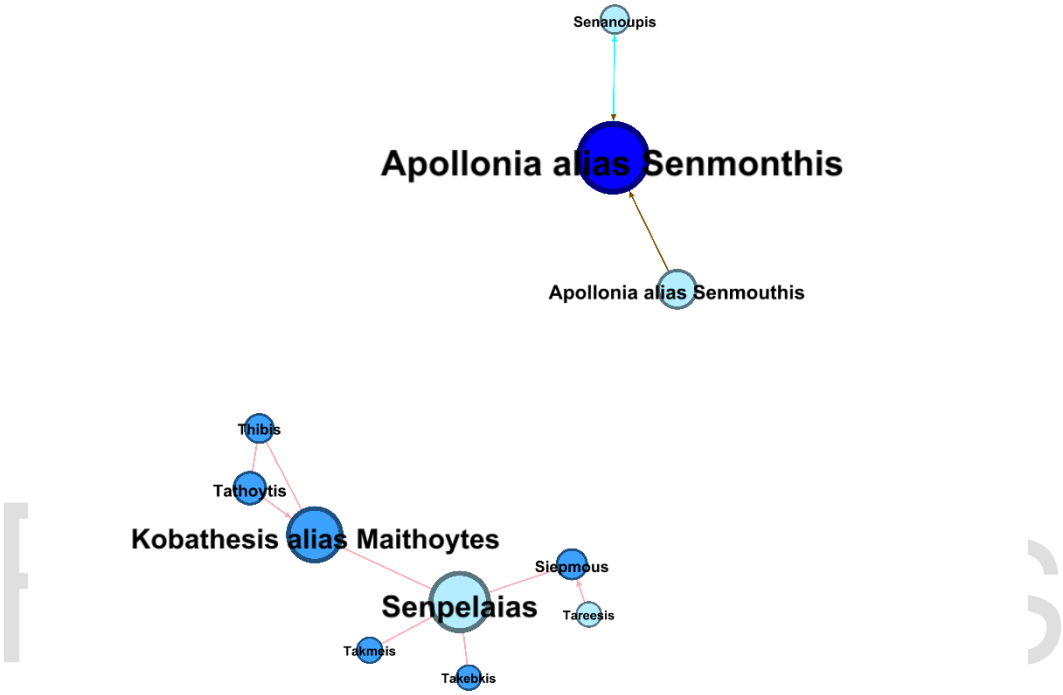
Figure 7: Detail of Figure 5, showing the in-group connections of the ten highest-ranking men by betweenness score, with nodes positioned as in Figure 5. Node size: betweenness centrality in the male network. Node colours: legal ethnic status (light blue = unknown/Egyptian, medium blue = Persian). Edge colours: archival affiliation, as in Figure 8.



Graph by author, created in *Gephi*.

[64] Tambs (2020, esp. 183-184); Tambs (2022a, p. 393, 466-473); Vandorpe (2002a).
[65] But see n. 50 above.
[66] I.e. the Archive of Peteharsomtous (TM_Arch_183) and the Archive of Horos (TM_Arch_106).

Figure 8: Detail of Figure 6, showing the in-group connections of the eleven highest-ranking women by betweenness score, with nodes positioned as in Figure 6. Node size: betweenness centrality in the female network. Node colours: legal ethnic status (light blue = unknown/Egyptian, medium blue = Persian, dark blue = Greek). Edge colours: archival affiliation, as in Figure 7.



Graph by author, created in *Gephi*.

Thirdly, isolating the highest-ranking women and their internal edges reveals that far more nodes and edges are preserved in the second largest than the largest component of this network. This can be explained by the networks structure of the female model (see Figure 6), in that more people form well-connected communities in the largest than the second largest component, which is also more long stretched.

Fourthly, whereas the women highlighted in both female components (mostly) form strings when only their internal relationships are considered, the ten men with the highest betweenness scores form a more densely connected component in which everyone are directly tied to a minimum of two other high-ranking men. This can at least be partially explained by the professional roles taken by several male characters in the all-male network (Figure 5). Whereas none of the highlighted women have an explicitly mentioned profession, several of

the highlighted men do.[67] As such, we do not only find some of the best-attested final archive owners (Table 3), but also some of the most prominent scribes among the men with the highest betweenness scores.

Fifthly, and perhaps most importantly, consideration of the (attested) legal ethnic status of the highlighted persons suggest that, albeit granting access to different legal and fiscal rights in the Ptolemaic system, in everyday life, social boundaries based on class distinction were not strictly defined. Again, this highly zoomed in scale represents a too small sample for any statistically supported conclusions to be drawn from it, but if we zoom back out to the meso-scale that is the female and male networks (Figure 5 and Figure 6), the same tendency is observed. It should, however, be warned that legal ethnic status was not a main concern in the data collection process and that several persons that now appear without any such tags in the models would surely also have enjoyed Persian or Greek status.[68]

Non-Locals and the Pathyris Community

On this meso-scale, distributional analysis of nodes tagged as non-local (i.e. the dark purple nodes in Figure 5 and Figure 6) further suggests that local men were more likely to deal with non-local men than local women were to interact with non-local women.[69] By closer inspection, it was established that of the non-local men in the giant component of the male graph (Figure 5), those positioned in the upper right corner are mentioned in some of the earliest documents, brought to Pathyris by Dryton (and his son), who settled in Pathyris late in his life.[70]

Zooming even further out, to the model of the community core (Figure 4a-b), it becomes evident that the two non-local women forming isolates in the female network (Figure 6) are positioned in the same area. This is because both are linked to men mentioned in texts that were found in Pathyris but written elsewhere. One is Senatymis, the mother of a man called Pachnoubis, who on the 1st of September 171 BCE identified himself by mother's as well as father's name, when he declared that he owed Dryton 261 *deben* of money and 5 *kite*, interests

[67] Of the ten men, six were recorded with an administrative, two with an agricultural, zero with a crafty, zero with a dependent, four with a military and seven with a religious profession, and most with a mix of the above.
[68] See also 'Concluding Remarks' below.
[69] For the roles and positions of non-locals in archives from Pathyris, also Tambs (2022a, p. 304-305, 484-487), but note that TM_Arch_481 was excluded from the current study. The ID refers to the stable identifiers assigned to the archives in *TM Archives*.
[70] See n. 75 below.

included.[71] The other is Serapias, who as the first wife and mother of Dryton's son Esthlades is mentioned in his wills, and linked to a total of seven men on the basis of them.[72]

In the female network, these women are nearly invisible because they are not directly linked to any of the 220 other women in the whole network representing the community (Figure 3), or 189 women in its giant component (Figure 4a-b). So long as all nodes and relationships are considered, several local women are in fact also linked to non-local nodes, but they represent men (or people of unknown sex). As is clear from this example, in exploring aspects of socio-economic life and boundary mechanisms in this time and place, we can thus gain some insight from studying the sexes separately but have more to learn by also considering the intersection between these groups, as there is clearly a significant number of boundary-crossers attested in the source material.

Exploring the Intersection between the Sexes

To study the number and quality of such cross-group relations, we shall finally zoom back out to the giant component of the community model (Figure 4a-b), thereby merging the male and female networks. Once the mixed-sex edges are reintroduced and the betweenness centrality metric rerun, a new list of highly ranked persons is generated (Table 4). It reveals that several of the people we met in the male and female subsets also serve brokering functions in this larger network, but some new personalities also step into the foreground. They are Portis alias Ouonsis, Eunous alias Nechoutes, Areios alias Pelaias and Dryton.

Table 4: List of the twenty individuals with the highest normalised betweenness centrality scores in Figure 4a-b. Cell colours indicate biological sex (light green = male, dark green = female) whereas red writing signals that a given person was the last owner of one of the studied archives. For personal IDs, see App. A.

[71] The document, TM_294/P. Dryton 12 = P. Louvre E 10440 (published in Vandorpe, 2002b), was written in Thebes and state that Dryton was a Greek citizen of Ptolemais at the time.

[72] TM_248/ P. Dryton 2 = P. Cairo cg 10349 + P. Heidelberg Gr. 1285 + P. bl 607, TM_258/ P. Dryton 4 = P. bl 617, TM_268/ P. Dryton 3 = P. bl 640 + 687 a + 687 e + P. Sorbonne Bouriant 46, TM_44872/ P. Dryton 1 = P. Laurenziana pl iii 155, published in Vandorpe (2002b).

Men and women with high betweenness scores in the community core (Fig. 4a-b)
Peteharsomtous (0.2360)
Horos (0.1914)
Nechtminis (0.17145
Asklepiades alias Patseous (0.1072)
Panebchounis (0.1031)
Peteharsomtous (0.0982)
Hermias (0.0955)
Thrason alias Patous (0.0745)
Portis alias Ouonsis (0.0646)
Apollonia alias Senmonthis (0.0605)
Petesouchos (0.0542)
Eunous alias Nechoutes (0.0519)
Tathoytis (0.0460)
Areios alias Pelaias (0.0456)
Nechoutes (0.0450)
Dryton (0.0410)
Kobathesis alias Maithoytes (0.0386)
Harsiesis (0.0371)
Nechoutes (0.0358)
Espnoutis (0.0344)

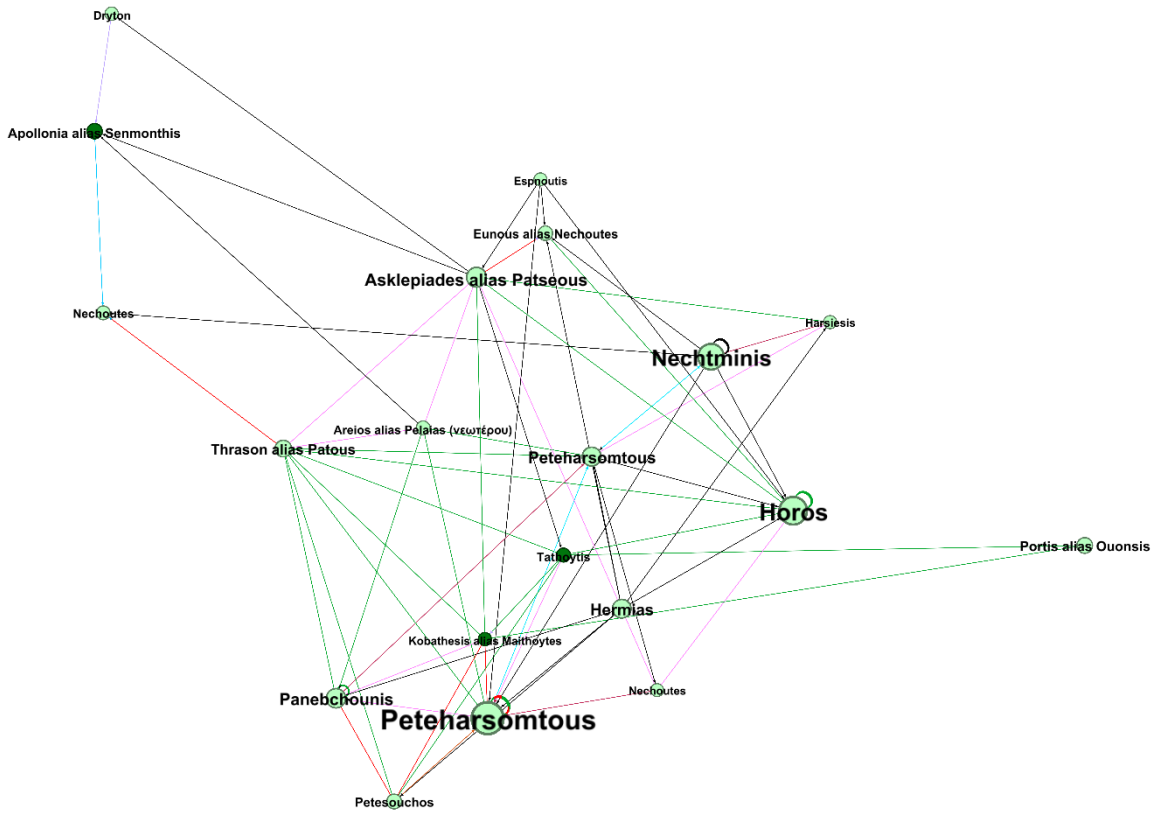
By means of placing the people that *now* have the highest betweenness centrality scores under the loop, we find the men and women that helped keep the (known segments of the) community together by linking various parts of the network graph. Neither the observation that most such nodes represent men, nor that they encompass several of the last (and previous) archive owners (and close family members), are surprising. Worth stressing is also that both Greek and Egyptian scribes are included in the list. This reflects the bilingual nature of the Pathyris community, since many of its inhabitants, families and professionals used and appear in documents written in both scripts.[73]

In terms of profession, it can be summarised that the only three nodes without a recorded occupation are the three women. In contrast, all men are tagged with at least one professional area: of the eighteen nodes representing them, ten are known to have held jobs of an administrative, two of an agricultural, zero of a crafty, zero of a dependent, six of a military and eleven of a religious character.[74] Moreover, all highlighted persons are believed to have lived in Pathyris[75] and, of the eleven agents with attested legal ethnic designations, one is attested as an Egyptian whereas eight had Persian and two enjoyed Greek status.

[73] On bilingualism in Ptolemaic Egypt and Pathyris, see Vierros (2008); Vierros (2012); Tambs (2022a, p. 34-36).
[74] Cf. the numbers of the male network, n. 67.
[75] The exception is Dryton, who only moved to Pathyris c. 150 BCE, Vandorpe & Waebens (2009, p. 106).

We already know that all highlighted persons are part of the giant component of the community whole network (Figure 3), but by isolating the twenty nodes with the highest betweenness scores, it becomes evident that they also form a single component amongst themselves (Figure 9).

Figure 9: Detail of Figure 4a, showing the in-group connections of the twenty highest-ranking individuals by betweenness score, with nodes positioned as in Figure 4a. Node size: betweenness centrality in the community core. Node colours: biological sex (light green = male, dark green = female, medium grey = unknown). Edge colours: edge kind.



Graph by author, created in *Gephi*.

In fact, they are interlinked by as many as 343 edges – corresponding to 6,24% of the 5500 edges that make up the giant component (Figure 4a-b) – as revealed by seven of the studied archives. In this subset, nodes thus have an average degree of '34,3' relationships and the filtered graph has a measured network density of '1,8'.[76] A closer look at the degree report does, however, reveal that the distribution of edges is again skewed, with a couple of nodes being far more active than the rest. They are Peteharsomtous and Panebchounis – the last owner of the

[76] Interpreted as undirected and exceeding '1' due to the many parallel edges in it.

largest archive and his father – who are particularly strongly connected to one another, since the latter is often attested through the patronym of the former.

Figure 9 also shows that the three female brokers – Apollonia alias Senmonthis (wife of Dryton, previous owner of the second largest archive), Tathoytis (mother or Kobathesis alias Maithoytes) and Kobathesis alias Meithoytes (wife of Panebchounis, previous owner of the largest archive) – are well integrated in it. This supports the notion that clear-cut social boundaries between male and female agents are not detectable in the network analysis of this material and dataset. This is further reflected in the (relative) myriad of edge kinds that these (and other) women are involved in (Table 5).

Table 5: The quality of the edges in which the three women with the highest betweenness scores were involved, sorted by quantity. In the case of equal numbers, labels are sorted alphabetically. Cell colours indicate classification (light red = social, light blue = economic). Degree centrality scores equal the total number of edges in which the given person is involved.

Apollonia alias Senmonthis (degree centrality: 126)		Tathoytis (degree centrality: 98)		Kobathesis alias Maithoytes (degree centrality: 110)	
Edge kind	#	Edge kind	#	Edge kind	#
Close kin	37	Neighbour	65	Neighbour	44
Extended kin	20	Close kin	14	Close kin	42
Collaboration	16	Service	9	Collaboration	9
Loan	16	Collaboration	3	Service	7
Service	14	Land sale	3	Land sale	4
Cession	6	Payment	2	Payment	3
Dispute	6	Extended kin	1	Inheritance	1
Exploitation	4	Inheritance	1	-	-
Inheritance	2	-	-	-	-
Payment	2	-	-	-	-
Sale (Object)	2	-	-	-	-
Communication	1	-	-	-	-

As in the case of the edges incorporated in the male and female subsets (cf. Table 2), there is a great deal of overlap amongst the edge kinds that these women were most frequently recorded in, although the ranked order varies. However, zooming in on the relational ties of selected individuals – here: women the network analytical software considers important from a structural perspective – suggests that people behaved differently.[77] The most telling example here is the absence of "neighbour" and "land sale" edges in Apollonia alias Senmonthis' lists, and of "loans" amongst the other women's relational ties.

[77] See also Tambs (2020); Tambs (2022a, esp. p. 433-438).

On a final note, the women's degree centrality scores reflect the total number of edges they are recorded in, but remembering that multiplex and parallel edges are both allowed in the model, these numbers reveal little about the (number of) people they were tied to. For this, we can take an ego network approach to isolate their respective personal networks. Doing so reveals that, in the community core (Figure 4a), Apollonia alias Senmonthis is directly tied to 19 women and 29 men, Tathoytis is linked to 11 women and 48 men, and Kobathesis alias Maithoytes to 12 women, 52 men and 1 node of unknown sex. That all form pairs with more male than female nodes suggest once again that more is gained, if we refrain from only studying men and women separately, but also consider the intersection between them.

Concluding Remarks on the Appropriateness of SNA for Studying Ancient Symbolic and Social Boundaries

The purpose of this paper was to utilise formal methods of SNA to explore the degree to which social and symbolic boundaries are detectable in the reconstructed family archives from the Ptolemaic town and military camp of Pathyris, spanning roughly a century from 186-88 BCE. In doing so, I have explored a relatively large and detailed dataset on different scales and from different angles, to outline some general trends and characteristics.

To bring the discussion back to the starting point, I find the social versus symbolic boundary division helpful for making sense of what we have seen in the discussed networks. In a nutshell, network analysis on the micro- and meso-scales of individuals and groups supported what was already suggested at the macro-scale of the community, namely that even institutionalised social markers, like language use and class, does not seem to have represented sharp social boundaries that were maintained in the everyday interaction of the community's members.

Social characteristics like sex and legal status surely made a difference in institutionalised settings such as Greek notarial offices – as is e.g. reflected in many women acting on their own terms in Egyptian but only with the consent of a male *kyrios* in Greek documents.[78] The inhabitants' private archives though indicate, that in more informal situations, it mattered less if you were male or female, Persian or Egyptian. It can thus be argued that, for the inhabitants of Pathyris, such boundaries looked different on the social and the symbolic level.

[78] Tambs (2022a, p. 270).

In advocating the appropriateness of networks science for asking boundary related questions of ancient written sources, I propose that a distinct network perspective can facilitate empirically informed exploration of the multiplex ways in which various types of boundaries impacted the lives of ancient subjects – but only if the source material allows it. Several issues regarding the dataset and sample size was highlighted above, so it should also be emphasised that the studied material *is* after all highly suitable for exploring ancient boundaries. In concluding this paper, I will thus hint at some promising avenues for further research.

An area worth closer inspection is the legal status of the inhabitants. In this paper, lack of a clear pattern suggests that people interacted regardless of their legal ethnic status, but several, like the Greek scribe Hermias and individuals with double-names (see Figure 7 and Figure 8), can also be assumed to have been privileged.

Moreover, focus was here placed on the structural characteristics of social groups, and the attributes that qualify their members, but much more could be said had the edge attributes been given more attention. Reorganising and adding information on legal ethnic status would e.g. make it possible to check whether status related boundaries are more clearly defined for certain types of relationships than others.

Another possibility is to take the perspective of other individuals or groups, and trace his/her/its life history through the storyline and relational perspective that the network models offer. Several persons are already attested across several texts, but far more have been recorded with *suggested* cross-identifications.[79] It would be interesting to check the robustness of the model(s) by merging such nodes and observing the effects of the manipulations.

Finally, a largely unexplored, yet relevant, aspect is SNA's ability to not only consider known (here: attested) relationships, but also to emphasise the connections that – for whichever reason – are *not* manifested or modelled.[80] For studying symbolic and social boundaries on the individual and group levels, the links that are *not* there might very well prove to be just as telling as the ones that are.

[79] See n. 44 above.
[80] For a case study stressing the significance of non-ties, see e.g. Morrissey (2015).

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Appendix A: Overview of 'Central' Individuals

The appendix presents lists of top-ranking persons by centrality measures discussed in the paper, including their unique IDs.[81] In the tables, name(s) and ID(s) of female agents are written in **bold** whereas the last (known) owners of the studied family archives are <u>underlined</u>.

Degree Centrality

Degree centrality is a local metric that counts the number of edges each node is involved in.[82] Here, this will highlight people with many attested relationships, but bear in mind that the networks under study are both multiplex (because various kinds of relations are recorded) and contain parallel edges (since more than one edge representing the same kind of relationship is allowed to be drawn between the same pair of nodes). Moreover, the measure does not consider

[81] For conventions, see Tambs (2022a, p. 11-12). For extended strings of persons with IDs followed by an asterisk, Tambs (2022b, p. 306-307).
[82] For a more technical description and algorithmic definition, see Borgatti et al. (2013, p. 165-168).

how many *different* persons an individual is connected to. In practice, it thus highlights (1) people whom the texts reveal to have been were particularly active and can thus be linked to (several) persons at various points in time and/or (2) people who are frequently paired with (one or more) person by the same relationship(s). The most prominent example of the latter are parents: if a person is frequently attested and is nearly always identified by patronym or metronym, the respective parent will also receive a high degree score (written in parenthesis in the table below).

The whole network (Fig. 3)	The social network (Fig. 4a)	The economic network (Fig. 4b)
Peteharsomtous / TM_PER_181_11975_53601* (391)	Panebchounis / PER_180_54203_54286* (235)	Peteharsomtous / TM_PER_181_11975_53601* (180)
Panebchounis / PER_180_54203_54286* (325)	Peteharsomtous / TM_PER_181_11975_53601* (211)	Horos / TM_PER_45_350884 (129)
Horos / TM_PER_45_350884 (271)	Horos / TM_PER_45_350884 (142)	Hermias / TM_PER_73_242437_351540 (114)
Hermias / TM_PER_73_242437_351540 (160)	Chesthotes / TM_PER_379_19628 (125)	Nechtminis / TM_PER_167_10657_75681 (97)
Nechtminis / TM_PER_167_10657_75681 (144)	Thrason alias Patous / TM_PER_9180_11647_242446 (108)	Panebchounis / PER_180_54203_54286* (90)
Petesouchos / TM_PER_12133_57376_336553 (136)	Totoes / TM_PER_339_70049_79394* (94)	**Apollonia alias Senmonthis / TM_PER_5259_187473** (87)
Peteharsomtous / TM_PER_222_64893_73113* (132)	**Kobathesis alias Maithoytes / TM_PER_531** (86)	Petesouchos / TM_PER_12133_57376_336553 (75)
Chesthotes / TM_PER_379_19628 (127)	**Tathoytis / TM_PER_13926_75615_303106** (80)	Peteharsomtous / TM_PER_222_64893_73113* (65)
Apollonia alias Senmonthis / TM_PER_5259_187473 (126)	Ptolemaios alias Pamenos / TM_PER_12830_241895_393396 (73)	**Aphrodisia alias Tachratis / TM_PER_6520** (61)
Totoes / TM_PER_339_70049_79394* (120)	Nechoutes / TM_PER_49 (70)	Pagonis / TM_PER_19279_58121_76458* (58)
Thrason alias Patous / TM_PER_9180_11647_242446 (116)	Peteharsomtous / TM_PER_222_64893_73113* (67)	**Apollonia alias Senmouthis / TM_PER_5256_161542_194778** (55)

Kobathesis alias Maithoytes / TM_PER_531 (110)	**Tamenos / TM_PER_13942** (67)	**Apollonia junior alias Senpelaias / TM_PER_5257** (55)
Pagonis / TM_PER_19279_58121_76458* (103)	Asklepiades alias Patseous / TM_PER_398_00398_73649* (65)	Nechoutes / TM_PER_10683 (55)
Dryton / TM_PER_7512_161891_189650* (101)	Petesouchos / TM_PER_12133_57376_336553 (61)	**Senanoupis / TM_PER_13398_241892** (54)
Tathoytis / TM_PER_13926_75615_303106 (98)	Patous / TM_PER_11650_117524 (58)	**Aristo alias Senmonthis / TM_PER_5862_160711_194781** (51)
Asklepiades alias Patseous / TM_PER_398_00398_73649* (96)	**Thibis / TM_PER_46_351543** (58)	**Nikarion alias Thermouthis / TM_PER_10784_160713_194780** (51)
Paniskos / TM_PER_70_242438_351541 (88)	Haes / TM_PER_68_337546 (56)	Dryton / TM_PER_7512_161891_189650* (49)
Apollonia alias Senmouthis / TM_PER_5256_161542_194778 (86)	Hermophilos alias Phibis / TM_PER_41_19094_79378* (55)	Psenesis / TM_PER_15078_351027 (47)
Senanoupis / TM_PER_13398_241892 (86)	Areios alias Pelaias / TM_PER_47_19305_54204* (54)	Ammonios alias Pakebkis / TM_PER_55 (43)
Tamenos / TM_PER_13942 (85)	Panas alias Hermokrates / TM_PER_7936_241893 (53)	Paniskos / TM_PER_70_242438_351541 (43)

Betweenness Centrality

Betweenness centrality is a global metric that calculates how often a node appears on the shortest path between any two other nodes in a network.[83] In our case, this measure is useful for identifying people with brokering positions, because they represent rare links between otherwise unconnected or poorly linked components or the texts present them as being particularly outward-looking in terms of economic activities.[84]

The female network (Fig. 6)	The male network (Fig. 5)	The community core (Fig. 4a-b)
Apollonia alias Senmonthis / TM_PER_5259_187473 (0.0187)	Peteharsomtous / TM_PER_181_11975_53601* (0.2029)	Peteharsomtous / TM_PER_181_11975_53601* (0.2360)

[83] For a more technical description and algorithmic definition, see Borgatti et al. (2013, p. 174-175).
[84] For an example of the latter, see the behavioural patterns of Apollonia alias Senmonthis described in Tambs (2020, esp. p. 183-184).

Senpelaias / TM_PER_364_13429 (0.0147)	Horos / TM_PER_45_350884 (0.1736)	Horos / TM_PER_45_350884 (0.1914)
Kobathesis alias Maithoytes / TM_PER_531 (0.0128)	Nechtminis / TM_PER_167_10657_75681 (0.1407)	Nechtminis / TM_PER_167_10657_75681 (0.17145)
Apollonia alias Senmouthis / TM_PER_5256_161542_194778 (0.0068)	Panebchounis / TM_PER_180_54203_54286* (0.1041)	Asklepiades alias Patseous / TM_PER_398_00398_73649 (0.1072)
Tathoytis / TM_PER_13926_75615_303106 (0.0045)	Hermias / TM_PER_73_242437_351540 (0.1027)	Panebchounis / TM_PER_180_54203_54286* (0.1031)
Siepmous / TM_PER_19292 (0.0037)	Peteharsomtous / TM_PER_222_64893_73113* (0.0897)	Peteharsomtous / TM_PER_222_64893_73113* (0.0982)
Thibis / TM_PER_46_351543 (0.0032)	Asklepiades alias Patseous / TM_PER_398_00398_73649 (0.0828)	Hermias / TM_PER_73_242437_351540 (0.0955)
Senanoupis / TM_PER_13398_241892 (0.0030)	Nechoutes / TM_PER_10683 (0.0579)	Thrason alias Patous / TM_PER_9180_11647_242446 (0.0745)
Takmeis / TM_PER_13936 (0.0019)	Thrason alias Patous / TM_PER_9180_11647_242446 (0.0549)	Portis alias Ouonsis / TM_PER_39_434932_434988 (0.0646)
Takebkis / TM_PER_19306 (0.0016)	Petesouchos / TM_PER_12133_57376_336553* (0.0538)	**Apollonia alias Senmonthis / TM_PER_5259_187473** (0.0605)
Tareesis / TM_PER_517_350892 (0.0016)	-	Petesouchos / TM_PER_12133_57376_336553* (0.0542)
-	-	Eunous alias Nechoutes / TM_PER_8170_78233_160275* (0.0519)
-	-	**Tathoytis / TM_PER_13926_75615_303106** (0.0460)
-	-	Areios alias Pelaias /TM_PER_47_19305_54204* (0.0456)
-	-	Nechoutes Nechoutes / TM_PER_10683 (0.0450)
-	-	Dryton / TM_PER_7512_161891_189650* (0.0410)
-	-	**Kobathesis alias Maithoytes / TM_PER_531** (0.0386)

-	-	Harsiesis / TM_PER_266 (0.0371)
-	-	Nechoutes / TM_PER_203_434 (0.0358)
-	-	Espnoutis / TM_PER_163_116635 (0.0344)

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