In Search of the Flocks: How to Perform Onomasiological Queries in an Ancient Greek Corpus?

Alek Keersmaekers, Toon Van Hal
University of Leuven
Blijde-Inkomststraat 21, 3000 Leuven, Belgium
{alek.keersmaekers; toon.vanhal}@kuleuven.be

Abstract

This paper explores the possibilities of onomasiologically querying corpus data of Ancient Greek. The significance of the onomasiological approach has been highlighted in recent studies, yet the possibilities of performing ‘word-finding’ investigations into corpus data have not been dealt with in depth. The case study chosen focuses on collective nouns denoting animate groups (such as flocks of people, herds of cattle). By relying on a large automatically annotated corpus of Ancient Greek and on token-based vector information, a longlist of collective nouns was compiled through morpho-syntactic extraction and successive clustering procedures. After reducing this longlist to a shortlist, the results obtained are evaluated. In general, we find that τίθωνος can be considered to be the default collective noun of both humans and animals, becoming especially prominent during the Hellenistic period. In addition, specific tendencies in the use of collective nouns are discerned for specific semantic classes (e.g. gods and insects) and over time. Throughout the paper, special attention is paid to methodological issues related to onomasiologically searching.

Keywords: onomasiology, data querying, collective nouns, Ancient Greek

1. Introduction

This paper explores the possibilities of onomasiologically querying corpus data of Ancient Greek. The significance of the onomasiological approach has been highlighted in recent studies, yet the possibilities of performing ‘word-finding’ investigations into corpus data have not been dealt with in depth. English has a wide range of words denoting groups of animals or people, such as a “pack of dogs”, “a school of fish” and “a gang of bandits”. This paper aims to explore how similar collective nouns can be detected in the Ancient Greek corpus by adopting an onomasiological approach to the data.

The paper is organized as follows. A survey of the state of the field (Section 2) precedes an outline of our strategies adopted to tracing collective nouns in Greek (Section 3). Section 4 analyzes various groups of animate entities in Ancient Greek by means of corpus data and discusses onomasiological change in Ancient Greek. In the concluding part (Section 5), alternative approaches and further avenues are discussed. The case studied in this paper has identifiable morpho-syntactic characteristics (see Section 3.2), but in the future it should be also made possible to find words expressing a certain concept for which the availability of syntactical and morphological annotation is not helpful.

2. State of the field

2.1 Onomasiological searching

Corpus-based research is usually based on a (set of) predefined term(s), of which the meaning is traced. In addition to this semasiological or ‘sense-finding’ approach, it is also conceivable to take a certain meaning (concept or notion) as a starting point, and examine which terms are used to shape this meaning in a corpus. In recent decades, linguists have strongly emphasized the importance and relevance of such an onomasiological or ‘word-finding’ approach (see e.g. Grzega, 2002; Geeraerts, 2009; Fernández-Dominguez, 2019), and more recently there have been increasing advocates of the onomasiological approach among conceptual historians too (see e.g. Müller & Schmieder, 2016; Cananu, 2019). For obvious reasons, querying corpora with a semasiological, word-based approach is much easier than meaning-based onomasiological queries, because unlike a meaning a term is a tangible starting point. In a methodological survey paper published against the backdrop of a corpus-based computational historical semantics project, Bernhard Jussen and Gregor Rohmann mention the onomasiological approach, yet the case-studies they present are semasiological in nature (Jussen & Rohmann, 2015). While there has been some research on querying onomasiological dictionaries (Kipfer, 1986; Sierra, 2008; Moerdijk et al., 2008 on the development of ‘semagrams’), the literature on how to onomasiologically querying corpora is limited (see McGillivray, 2020; see also Kutuzov, 2020). In general, onomasiological search strategies generally boil down to making use of annotations that approximate the concept under investigation as much as possible, the results of which are complemented through bottom-up approaches (see e.g. Goossens, 2013). Hence, this presupposes the presence of an annotated corpus, which is a demanding and time-consuming investment, if such a corpus is not yet available (see Mehl, 2016: 50; 92; Atallah et al., 2018). The type of annotations required depends on the onomasiological task at stake. For certain tasks, part-of-speech tags can be helpful, while for others tasks more detailed morphological, syntactic, semantic and/or pragmatic information is needed.

2.2 Collective nouns

Words as ‘flock’ and ‘herd’ are styled quantifying collectives and collective nouns by Biber et al. (2003: 61-62). The terms have been criticized for being too vague (see the references in Dedé, 2012). Some scholars have treated collective nouns as classifiers or (‘classifier constructions’, cf. Lehrer, 1986). Aikhenvald (2000: 115-116) however argues why such terms do not meet the criteria of genuine
Collective nouns have attracted much scholarly attention. Ancient Greek, even though the ‘oldest grammar of the language’ (West, 1991: 116) and the ‘oldest grammar of the world’ (Vitae, 1896: 103-116) are well-known corpora for Ancient Greek with the level of granularity that is necessary for the research described in this paper has been created. We therefore made use of a bottom-up approach that has become highly popular in recent years to represent semantics computationally, the so-called ‘distributional’ approach to semantics, where the meaning is represented by vectors of real numbers (with semantically similar words or constructions receiving mathematically similar vectors). These vectors are based on the context patterns of words in large text corpora (see Erk, 2012; Lenci, 2018 for more detail). Distributional semantic methods have been applied to Ancient Greek by Boschetti (2010), Rodda, Senaldi & Lenci (2017), Rodda, Probert & McGillivray (2019), Keersmaekers & Van Hal (2021), and Perrone et al. (2021). For this paper we use the implementation of Keersmaekers & Van Hal (2021), which calculates word vectors on the basis of PPMI-scaled syntactic dependency-based co-occurrence counts in the GLAUx corpus, with an SVD-based dimension reduction to 100 latent dimensions.

3. Identifying collective nouns in Ancient Greek

3.1 Starting points of the research

As pointed out in 2.1, onomasiological queries highly benefit from corpus annotations. This is especially true for Ancient Greek, a language with a highly flexible word order and complex inflectional morphology, which reduces the effectiveness of strictly form-based (as opposed to lemma-, morphology- and syntax-based) queries. For Ancient Greek, the most well-known corpora are the Greek treebanks (several annotators, consisting of dependency trees with syntactic, morphological and lemma annotation: see Celano and Keersmaekers et al., 2014), which are manually annotated but not extremely large (1.5M tokens), and the Diorisis corpus (a corpus that is annotated for lemmas and morphology, cf. Vatri and McGillivray, 2018), which is relatively sizable (10.2M tokens) but is automatically annotated and does not contain syntactic information. We therefore made use of the (so far unreleased) GLAUx corpus (Keersmaekers, 2021), a corpus containing literary (8th century BC-3th century AD) and documentary texts (3th century BC-8th century AD) automatically annotated for lemmas, morphology and syntax (28.8M tokens): see Keersmaekers (2021) for an evaluation of the quality of the annotation, which was high enough not to provide any substantial obstacles for the research described below.

Although some steps for semantic annotation of Greek have been taken (see Celano & Crane, 2015 and Keersmaekers, 2020 for semantic role annotation; Bizzoni et al., 2014 and Biagetti et al., 2021 for Ancient Greek WordNet), so far no large-scale semantically annotated corpus resource for Ancient Greek with the level of granularity that is necessary for the research described in this paper has been created. We therefore made use of a bottom-up approach that has become highly popular in recent years to represent semantics computationally, the so-called ‘distributional’ approach to semantics, where the meaning is represented by vectors of real numbers (with semantically similar words or constructions receiving mathematically similar vectors). These vectors are based on the context patterns of words in large text corpora (see Erk, 2012; Lenci, 2018 for more detail). Distributional semantic methods have been applied to Ancient Greek by Boschetti (2010), Rodda, Senaldi & Lenci (2017), Rodda, Probert & McGillivray (2019), Keersmaekers (2020), Keersmaekers & Van Hal (2021), and Perrone et al. (2021). For this paper we use the implementation of Keersmaekers & Van Hal (2021), which calculates word vectors on the basis of PPMI-scaled syntactic dependency-based co-occurrence counts in the GLAUx corpus, with an SVD-based dimension reduction to 100 latent dimensions.

3.2 Morpho-syntactic extraction

In Greek, collective nouns are syntactically well-defined, since they are usually accompanied by a so-called partitive genitive (Benvenuto, 2013). Based on the GLAUx corpus, we could extract all constructions of type ‘noun + animate entity in the genitive plural, having ‘attribute’ as its syntactic feature’. The animacy was determined via supervised machine learning techniques, training a deep learning model1 on data annotated for the animacy class of the lemma as the dependent variable and a 100-dimensional word vector of the lemma (as described in 3.1) as the independent variable(s) (see Keersmaekers, 2020: 103-116). Our training data was an animacy lexicon containing trained with stochastic gradient descent using back-propagation.

1 As implemented in R package h2o (LeDell et al., 2022), using a multi-layer feedforward artificial neural network 74 propagation.
486 animate and 2650 inanimate entities; animate entities yielded precision of 0.941 and recall of 0.914 – an estimation via 10-fold cross validation on the training data. On this basis, 1991 lemmas were labeled as animate, which allowed us to identify possible collective nouns.

Our approach is not infallible: in addition to possible errors in the automatically annotated data, we should note that there are a number of alternative constructions that can express collective nouns and that are not included in the extracted data. For example, the genitive can sometimes be replaced with an adjective (e.g. the LSJ dictionary of Ancient Greek, Jones et al., 1996, cites μελισσαῖον ‘swarm of bees’, with the adjective μελισσάς ‘consisting of bees’). Some collective nouns have no (need for) further attributive specification especially if the animal is already lexicalized in the collective noun itself (e.g. βοοκόλιον “a group of cows”, συβόσιον “a group of pigs”, αἰπόλιον “a group of goats”). Obviously, plural morphology might also be used to indicate a group of animate entities (e.g. simply αίγες ‘goats’ instead of αἰπόλιον αἰγών ‘a flock of goats’). Finally, constructions with a genitive in the singular are conceivable (e.g. ‘a swarm of vermin’ in English). Of the extracted lemmas (5488), only lemmas with a frequency of $\geq 5$ (frequency of the lemma accompanied by an animate genitive plural) were retained (1266 in total). These lemmas thus count as potential collective nouns, out of which we attempted to identify the real collective nouns using several computational techniques.

### 3.3 Visualization and clustering techniques

The query defined in section 3.2 likely has a high recall, since we expect most collective nouns to occur in the construction defined there, even though there are some other ways to express groups of animate entities as discussed above. However, its precision is rather low, since many nouns occurring in the noun + animate genitive plural construction are not collective nouns: this construction admits many more types of nouns such as body parts (e.g. ‘the legs of the horses’), possession relations (e.g. ‘the money of the men’) and so on. To retrieve collective nouns from this large set (1266 nouns), we used a variety of dimension reduction and clustering techniques to find structure in our dataset, as well as lexicographical data (the LSJ dictionary, Jones et al., 1996) and corpus examples from the GLAUs corpus (in case of doubt) to identify collective nouns in these structured datapoints. The dimension reduction and clustering techniques were applied to the cosine distances between the nouns in our dataset, which mathematically represent the ‘semantic distances’ between the nouns (see Erk, 2012: 636-637).

As a first step, we made use of t-SNE (t-distributed stochastic neighbor embedding, Van den Maaten and Hinton, 2008), a dimension reduction technique that allows us to represent high dimensional data (a 1266x1266 matrix representing the cosine distances between nouns) in a low-dimensional (in our case two-dimensional) space, with words that are similar in meaning occurring close to each other on the tsnemap.² This enables us to find structure in the data and identify which words are worth looking at to retrieve collective nouns. For instance, the cluster on the bottom right of Fig. 2 (in dark yellow) contains words that clearly refer to body parts (e.g. μύς ‘muscle’, γαστήρ ‘belly’, ὑρὶς ‘hair’). It is unlikely that a collective noun would occur in such a cluster, so these words can safely be discarded after identifying the thematic coherence of the cluster. Instead, on the bottom/center-left of the plot there are several clusters that clearly contain many collective nouns: military units (in red: e.g. ἔλιος, λόγχος, σώλαμος), words referring to herding (in dark blue, with several words that mean ‘a flock or herd’, such as αἰπόλιον, ἀγέλη, πῶς, but also some non-collective nouns such as γομάς ‘herdsman’) and a small cluster of words referring to groups in general (in yellow: πλῆθος, ὄχλος, πληθύς, ὀξύλος, ὀξυμός, σμῆνος); additionally, a little more doubtful are the clusters in pink (generally containing words related to transport such as ἄραμα ‘wagon’, φορτίον ‘load’ and ἰππος ‘horse’ but also some collective nouns such as σωφορίς ‘pair of horses’ and κτήνος ‘beast’, but also ‘flock’), dark green (mainly poetic words referring to family such as φόλον ‘tribe’, but maybe also ‘swarm’, γάτεβον ‘family’, but also unrelated poetic words such as σμάντορ ‘leader’) and light blue (two words referring to the action of collecting or coming together but maybe also to a collection or group, viz. ἄραμα and σναύραμ). After identifying these clusters, we used dictionaries and corpus data to check whether each word occurring in these clusters is actually a collective noun.

Next, we used two cluster techniques that are prevalent in corpus linguistics to identify additional nouns that we may have missed with the t-SNE analysis, viz. partitioning around medoids (PAM) and hierarchical agglomerative clustering (AGNES).³ The former technique divides the data into a predetermined number ($k$) of clusters. After experimenting with the values for $k$, in the end we settled for a small number of $k=20$ clusters. The latter technique hierarchically clusters all nouns into a tree, with similar words occurring in the same ‘branches’ of the tree – a subpart of the tree, containing many collective nouns, is shown in Fig. 3. As with the t-SNE analysis, we analyzed the thematic coherence of each cluster that was formed (in the case of PAM, simply each of the 20 clusters; in the case of AGNES, branches of the tree occurring roughly at the same height), and looked into more detail at the more ‘promising’ clusters containing many collective nouns. These techniques allowed us to identify some additional collective nouns that we had previously missed: these were especially words in the festive or public domain including θῦσος, χορός and σύλλογος, along with some words thematically related to the words we previously found such as σύστημα (a military unit, or also a group in general) and νύφος (literally ‘cloud’, but also a group of people or animals).

² We made use of the R package Rtse (Krijthe and Van der Maaten, 2018). We used a perplexity of 5, theta of 0.0 and 5 iterations.

³ As implemented in R package cluster (Maechler et al., 2022). We used out-of-the-box settings.
Figure 2: Visualization of the t-SNE embeddings

Figure 3: Subpart of the tree of hierarchical agglomerative clustering (AGNES)
4. Results and discussion

4.1 Discussion of shortlist in general

In total, we have traced 40 collective nouns (see Table 1). The dataset on which this paper is based is available through a csv-file.

5 collective nouns appeared more than 100 times in the data. At the top of the list, without a doubt, is the word θίασος (token frequency 998), which can be regarded as the default collective noun for animate referents. There is no semantic class in which this collective noun does not occur. In some cases, πλῆθος is used too, which is according to most dictionaries merely an Ionian variant (this, however, should be checked against the data). πλῆθος is followed by ἄγγελος (215), φίλον (129), τάξις (125) and χορός (109). Some words are exclusively used as collective nouns for animals, such as πῦ (10), αἰπόλιον (8), θίασος (7) and συβόσιον (5), while words that occur only with human referents are more numerous, viz. λόγος (37); τάγμα (34); σύνταγμα (22); συσσίτιον (12); θίασος (10); συλλογος (10); ἀθροισμα (6).

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Some words designating 'flock' or 'group', such as 'clouds of bees', II. 2.87-89) are not captured in the data. Some words designating 'lock' or 'group', such as βόσκημα, which is a club word (like many other words in this list) referring to a group of judges. Although we included several club words in our shortlist, we excluded those where people assemble for a highly specialized purpose, in this case making a judicial decision. It should be emphasized that by eliminating these words (as well as the δήμος and equivalents mentioned above) we have eliminated some clear examples of collective nouns. However, we felt that the inclusion of these words would give way to considerable noise in the data. Conversely, it should be noted that not all instances included in the shortlist unambiguously refer to a collective noun. This is certainly the case for a word like τάξις, which is very polysemous (e.g. also 'order', 'class', 'rank' etc.). Due to the scale of our undertaking, it was infeasible to inspect the data token-wise. We are however aware that our type-based approach is vulnerable to noise.

4.2 Classes of animals and humans

Next, we divided the lemmas of animals and people in a number of subgroups. These subgroups were semi-automatically created: through hierarchical clustering (AGNES) of the vectors of these lemmas, we first checked which of them were highly semantically related and created subgroups on this basis, but the final groups were created with a high degree of human control (e.g. if the cluster algorithm would cluster a specific fish with a bird together, we would put this fish in the group ‘water animals and fish’ rather than ‘birds’). Fig. 4 shows the frequency of collective nouns with the most frequent groups of animals,

Table 1: Collective nouns denoting animals and humans

| θίασος | 8 0% | 7 1% | 1 0% |
|--------|-----|-----|-----|
| αἰπόλιον | 7 0% | 7 1% | 0 0% |
| ἀθροισμα | 6 0% | 0 0% | 6 0% |
| συβόσιον | 5 0% | 5 1% | 0 0% |

4 The data in Johnston (2019) suggests that collective nouns are rare in Homeric similes.
Figure 4: Variation in the presence of animal collective nouns according to semantic subgroups

Figure 5: Variation in the presence of human collective nouns according to semantic subgroups
vist. animals in general, birds, water animals and fish, insects, livestock and wild mammals. The default word πλήθος is used in all categories, although remarkably less frequently in the case of livestock, insects and, to a lesser extent, birds. It is also notable that ἄγελη (often translated as ‘flock’) is used in every subgroup, and not exclusively for livestock. In the category of insects, the subgroup where ἄγελη is underrepresented, one can notice the use of a number of specific collective nouns that are almost exclusively used for insects, viz. ἵππος, σμῆνος and νέφος, the latter of which is also used for birds (see also 4.3). This specialization seems to be rather atypical: φῦλον, νομή and, to a lesser extent, ζεῦγος are animal collectives that can be used for almost any subgroup. One should also notice the high degree of ‘other’ with livestock: besides the ‘default’ options of ἄγελη and πλήθος, Ancient Greek has a large number of specialized words for livestock (e.g. βοικόλον ‘group of cows’).

The humans can also be divided into a number of subgroups. Fig. 5 makes a distinction between the most frequent subgroups, viz. gods, humans in general, men, professions and soldiers. The data shows that in case of the gods certain collective nouns, viz. χορός and φῦλον, outnumber the ‘default’ use of πλήθος. Among the military category one finds the most specialized collective nouns, such as τάξις, δῆλον, λόχος and φάλαγξ. Strikingly, στρατιά and στρατός (‘army’) are hardly represented in this category. In general, it is noticeable that there are plenty combinatory possibilities.

4.3 Degree of specialization

This leads us to the question of to what extent there are exclusive combinations in Greek, showing one-to-one correspondences between a specific collective noun and a specific animate type, like the English ‘mummer of crows’.

Table 2 shows the top results of a Pointwise Mutual Information (PMI) calculation, a measure of association showing whether two variables co-occur more frequently than expected based on their individual frequencies (see Gries 2010: 275-277 for more detail). We have only included collocational combinations that occur at least five times. The results show that in some cases there is a clear etymological connection between the collective noun and the species at stake (σμῆνος, αἰπόλιον, φυσικόλον), thus logically excluding alternative combinations (such as βουκόλον and αἰπέ). Excluding these words and the Homeric word πῶυ, which is exclusively used for δις ‘sheep’, it seems that especially specific insects (μέλισσα ‘bee’, ἀκρίς ‘grasshopper’, the same goes for less frequent insects such as κηφήν ‘drone’ and σφιξ ‘wasp’) are combined with specific collective nouns (νέφος: ἤπατος; σμῆνος), which are rarely used for animals other than insects (except νέφος which is also often combined with birds). A group of pigeons (τριγών or περιστρέφοι) is mostly referred to as κηφήν, likely indicating a duo.

Table 2: Strongest PMI associations between collective nouns and the genitives occurring with them

Closer inspection reveals that some of the exclusive correspondences in Table 2 might be somewhat deceptive, for example, because all the attestations come from one author. This is the case for the association between δῃς and ὅχλος, which seems to be a personal style characteristic of Origenes.

4.4 Diachronic developments

In the previous sections, we mapped the onomasiology of Ancient Greek collective nouns in a static way. However, this onomasiology is obviously prone to semantic change, i.e. the terms used to express groups of animate entities change over time. This section will consider how computational methods can shed light on this onomasiological change. To this aim, we have divided the data into archaic (8th-6th century BC), classical (5th-4th century BC), Hellenistic (3rd-1st century BC) and Roman eras (1st-4th century AD) (see Fig. 6 and Fig. 7). However, caution is advised here: for instance, we have almost exclusively epic texts from the archaic period, so that developments between the archaic and the classical period may be explained in terms of genre rather than in diachronic terms. In the archaic period, the number of data points is very limited. For the classical period the data for the animals are also rather limited, so that the transition between the Hellenistic and Roman period especially lends itself for a study of diachronic developments.

The main evolution that can be traced with respect to the animal collectives (cf. Fig. 6) is the prominence of πλήθος in the Hellenistic period, which clearly decreases in the Roman period. There is no clear challenger; rather, there seems to be a diversification in general, with, for example, a more frequent use of ἄγελη, φῦλον and ζεῦγος (even though πλήθος and ζεῦγος are likely not simply interchangeable). In a few cases we can also observe a tendency to specialization: it is especially in the Roman period that words for insects are associated with specific collective nouns, namely νέφος: ἤπατος; σμῆνος, whereas in the Hellenistic period πλήθος is still predominating here (see Table 3).

Table 3: Collective nouns used for insects in the Hellenistic and Roman period

| Collective | Hellenistic | Roman |
|------------|-------------|-------|
| πλήθος     | 9           | 8     |
| ἄγελη      | 0           | 1     |
| φῦλον      | 0           | 3     |
| νομή       | 0           | 1     |
| σμῆνος     | 3           | 15    |
| ἤπατος     | 1           | 10    |
| νέφος      | 3           | 4     |
| χορός      | 0           | 2     |
Figure 6: Evolution in the presence of animal collective nouns over time

Figure 7: Evolution in the presence of human collective nouns over time
For the human collective nouns the diachronic changes are less clear (cf. Fig. 7). A number of archaic collective nouns are used much less frequently in later periods. A clear example is ὄμηλος, which in later periods is mainly taken up by a few authors (especially Philo Judaeus). Another example is φῦλον. Here again we observe the prominence of πλῆθος in the Hellenistic period, but the decline in the Roman period is less pronounced. What is particularly striking is the diachronic increase of θύννος as a collective noun for soldiers in the Roman period (12 instances of θύννος and 58 instances of πλῆθος in the Hellenistic period versus 52 instances of θύννος and 53 instances of πλῆθος in the Roman period). In addition, there is a clear increase of χορός among certain ‘professions’ (2 instances of χορός and 19 instances of πλῆθος in the Hellenistic period versus 23 instances of χορός and 51 instances of πλῆθος in the Roman period). Inspecting the data, this is especially true when the profession has a ‘didactic’ or ‘heralding’ function, e.g. philosophers, teachers and prophets.

5. Conclusions and outlook
The syntactic/morphological-based extraction and clustering techniques have allowed us to detect a large number of collective nouns. Nevertheless, there are some important caveats. The quantitative methods used have enabled us to compile a longlist. A final manual selection, reducing the longlist to a shortlist, nevertheless remained necessary. This step involves a large degree of subjective decisions, many of which can be debated. In addition, we cannot evaluate which relevant words were not found (‘recall’). Furthermore, polysemy causes any clustering technique to be problematic. The multidimensional nature of semantics implies that Ancient Greek equivalents for polysemous and idiosyncratic collocations (such as e.g. English ‘murder of crows’) will be difficult to identify. Some ‘collective nouns’ can also be frequently combined with inanimate entities (e.g. πλῆθος χρημάτων “a group or amount of money”). While these examples were filtered out during the animacy detection described in section 3.2 (i.e. we only included words with a sufficient number of animate genitive attributes in the cluster analysis in section 3.3, and similarly only analyzed words with such attributes during the corpus analysis described in 4), these contexts with inanimate entities were still included in the word vectors, and therefore might distort the results of the cluster analysis. In the future, word vectors modelling the meaning of a word in context rather than the general meaning of a word might allow for a higher degree of precision. The results could also be improved by means of an objective set of criteria whether or not a word can be considered a collective noun. Another difficulty resides in the data scarcity, which makes it very difficult to make statements about the significance of the connection between certain collective nouns and specific animals. By way of example, we see that for θύννος (‘tuna’), attested thrice in the data, three different collective nouns are used: besides the generic πλῆθος, στρατός and θύννος occur. Table 1 shows that both στρατός and θύννος tend to be used as collective nouns of humans (especially in a military context; see 4.4). The question here is whether we are dealing with a fixed, conventional collective noun for tuna or a context-related metaphor. Obviously, close reading of the relevant passages may shed more light on the matter. For this particular case, it seems to be an occasional metaphor twice. However, if there would have been more data, it could be determined with more certainty to what extent the use of στρατός and θύννος is rooted in context or convention. The same applies to many other lemmas, so that it is very difficult to make firm statements about which combinations were idiomatically acceptable in Greek.

There are also alternative methods possible for onomasiological queries, including searching for English translations of the concept in question through lexica (e.g. the English-Greek dictionary by Woodhouse 1987, or reverse-searching the LSJ lexicon by Jones et al. 1996) or through parallel translations, as well as using Ancient Greek WordNets – a first Ancient Greek WordNet was created by Bizzoni et al. (2014), while recently a new attempt has been undertaken by Biagetti et al. (2021). Although we could not systematically compare these approaches to the one adopted in this paper due to time and space constraints, we will briefly address the advantages and disadvantages of both through a quick exploration. Searching the Woodhouse and LSJ lexica for words such as ‘lock’, ‘herd’, ‘crowd’ and ‘group’ returned many words listed in Table 1, but also missed some (e.g. neither lexicon included νέφος under an English lemma referring to a collective noun, for example, and Woodhouse expectedly does not contain Homeric words such as πῶον or post-classical words such as χρημάτων as it is limited to the Classical Attic dialect). On the other hand, they also include words missed by our computational approach, especially low-frequent ones that we filtered out in an initial step (see 3.2), e.g. κόμος (only 3 occurrences with an animate genitive noun). Additionally, they also reveal some alternative constructions to express a group of living beings rather than the noun + genitive construction, e.g. adjective + noun constructions such as μελισσαίος υλόματος (see section 3.2) or δρακονθόμιλος συνοικία “a swarm of dragons” (Woodhouse). However, a big limitation of this approach is that it simply shifts the burden of determining which on words or constructions can express a particular concept from one language (Ancient Greek) to another one (e.g. English). For instance, the word ἄθροισμα is defined, among other definitions, as ‘aggregate’ in the LSJ lexicon. While ‘aggregate’ is certainly a collective noun in English, one must take this English term into account as one of the many possibilities to express collective nouns in order to retrieve ἄθροισμα with a lexical-based method. While the Ancient Greek WordNets seem to be less vulnerable in this respect, as they encode semantic relations between words in the target language – in this case Greek – the WordNet designed by Bizzoni et al. (2014) was in fact based on automatic linking between Greek-English lexica and therefore prone to similar problems, while the Biagetti et al. (2021) WordNet is still in active development. All these human-curated resources are also highly dependent on human judgments and the data they have considered during their developments, while the automatic approach discussed in this paper can easily take the whole Greek corpus into account (although it is fair to say that the quality of the semantic methods is highly dependent on the frequency of specific genres in the input data, see also Perrone et al. 2019).

For this first exploration of onomasiologically searching, we have deliberately chosen a case with identifiable syntactic characteristics. The challenge for future research
consists in choosing less straightforward cases, where syntactic and morphological encoding is significantly less decisive. Without doubt, one of the greatest onomasiological challenges is to trace in the Ancient Greek corpus concepts that may be present but for which lexicalized words are missing (possible examples include modern concepts such as ‘queer’, ‘fashion’, etc.).

6. Acknowledgements

This research was made possible by FWO grant 3H200733: “Language and Ideas: Towards a New Computational and Corpus-Based Approach to Ancient Greek Semantics and the History of Ideas”. We would like to thank three anonymous reviewers for their stimulating criticisms.

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