UNIVERSIDADE FEDERAL DO PARANÁ

LORENA METZ ANTONIO

REDES DE INTERAÇÃO, PADRÕES ESPACIAIS E FILOGENÉTICOS NA DIETA DE MAMÍFEROS CARNÍVOROS DO NEOTRÓPICO

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Dissertação apresentada ao Programa de Pós Graduação em Ecologia e Conservação do Setor de Ciências Biológicas da Universidade Federal do Paraná, como requisito parcial para obtenção do título de Mestre em Ecologia e Conservação.

Orientador: Prof. Dr. André Andrian Padial

Co-orientador: Dr. Roberto Fusco Costa

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Aos colegas pesquisadores, em especial zoólogos e ecólogos, que se dedicam por completo diariamente para fazer o que amam, lutando pela preservação de espécies e ecossistemas.

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"In a world less hellbent on exhausting its natural resource capital, a prescription for the maintenance of diversity in tropical forest would be simple: leave them alone."

John Terborgh (1992)

APRESENTAÇÃO

O conhecimento básico sobre a dieta e uso de recursos são essenciais para compreender melhor as interações das espécies e suas funções no ecossistema. Da mesma forma, revisões são ferramentas importantes para identificar padrões em larga escala, além de funcionarem como diretrizes para lacunas de conhecimento. Assim, neste trabalho, focamos em compilar e analisar dados disponíveis sobre a dieta de mamíferos carnívoros ao longo da região Neotropical. Buscamos assim aperfeiçoar a compreensão de padrões e processos ligados à estruturação trófica e relações entre espécies, bem como ampliar o conhecimento básico sobre o uso de recursos pelas espécies e contribuir na orientação e melhoria de estratégias de conservação do grupo ao longo da distribuição destas espécies.

RESUMO

Mamíferos da Ordem Carnivora apresentam especializações estruturais e fisiológicas adaptadas para uma dieta com base em presas animais. Porém, estas espécies têm um espectro alimentar bastante variável. Algumas são consideradas estritamente carnívoras, enquanto outras se alimentam principalmente de materiais vegetais, desempenhando assim, diferentes papéis cruciais na ecologia trófica de comunidades e nas dinâmicas de ecossistemas. Assim, o conhecimento aprofundado sobre os hábitos alimentares dos mamíferos carnívoros e os padrões de uso de recursos por eles é necessário para conduzir estratégias de conservação e manejo.

Embora haja uma quantidade considerável de estudos sobre dieta de carnívoros, carecemos de abordagens gerais sobre a ecologia trófica destes. Nosso objetivo, além de identificar e descrever a estrutura das guildas de mamíferos carnívoros em diferentes escalas ao longo da região Neotropical, também consistiu em explorar os principais fatores por trás da estruturação. Para isso, coletamos e compilamos estudos, produzindo um amplo banco de dados sobre a dieta de carnívoros, e avaliamos a formação de guildas tróficas por meio de análises de rede, de dissimilaridade e de sobreposição na dieta. Também investigamos se há variação espacial em índices de amplitude e sobreposição da dieta entre as espécies e variação interespecífica entre locais. Além disso, avaliamos se a filogenia tem papel na estruturação de guildas tróficas.

Encontramos estudos para 32 espécies, de seis famílias na região Neotropical. Destacamos dois vieses importantes: primeiro, a maioria dos estudos concentra-se em felídeos e canídeos de grande porte; segundo, os trabalhos foram conduzidos predominantemente nas regiões Sul e Sudeste da América do Sul. Além disso, biomas ricos em biodiversidade, como Amazônia e Caatinga, têm um número muito baixo de estudos. A partir da análise de redes e módulos identificamos que a maioria dos recursos usados pelos carnívoros no Neotrópico são pequenos mamíferos, materiais vegetais, artrópodes e crustáceos. Ainda, a maioria das espécies oportunistas e generalistas são das famílias Canidae e Procyonidae, enquanto os felídeos são as espécies mais estritamente carnívoras. Quanto aos padrões de dieta, as análises revelam que os carnívoros tendem a manter a amplitude do nicho independentemente da ecorregião, possivelmente por substituição de itens na dieta, em função de características oportunistas e generalistas das espécies. Por fim, detectamos que a filogenia é um fator importante para os padrões alimentares dos carnívoros e na estruturação de guildas tróficas.

Palavras-Chave: Ordem Carnivora, Neotrópico, estrutura trófica, padrões de dieta.

ABSTRACT

Species from Carnivora order present specializations for carnivorous diet. However, their dietary spectrum is variable, some species are considered strictly carnivores, while some feed mostly on plants, playing different roles in structuring trophic webs. Accurate knowledge about mammalian carnivores' feeding habits and resource use patterns is necessary to lead up conservation and management strategies. Although there is considerable quantity of studies about carnivores' diet, we lack of general approaches on their trophic ecology. We aimed not only to identify and describe the trophic guild structure of carnivores at different scales throughout the Neotropics, but also to explore the main drivers behind structuring. For that, we compiled studies, producing a broad database about carnivora diet and evaluated trophic guild formation through network analysis, diet dissimilarity and overlapping. We also investigated whether there is spatial variation in diet parameters between species, and interspecific variation between sites. Further, we assessed the role of phylogeny in trophic guild structuring. We found dietary studies for 32 species, from six Carnivora families. We highlight two important biases: first, most studies focus on large-bodied felids and canids; second, they were predominantly conducted in South and South-eastern regions of South America. Further, biodiversity-rich biomes, such as Amazon and Caatinga, demand more dietary studies. Networks showed most common items in carnivorans diet are small mammals, plant materials, arthropods and crustaceans. Modularity suggests five modules, grouping generalists/opportunists, marine-based, plant-based and two mammal-based dietary patterns. Most opportunistic and generalist species are from Canidae and Procyonidae families, and felids are the most strictly carnivorous species. Dietary parameters reveal carnivores tend to maintain niche breadth regardless of ecoregion, possibly by substitution of items in diet. Finally, we detected phylogeny as an important driver to carnivorans dietary patterns. Basic knowledge about carnivores' diet and trophic ecology is essential to better comprehend species' interactions and function in the ecosystem. Equally, reviews are important tools to identify broad-scale patterns and guidelines to new studies.

Keywords: Carnivora Order, Neotropical, trophic structure, diet patterns, diet variation.

LISTA DE FIGURAS

Figure 1. Taxonomic distribution of studies...17

Figure 2. Geographical distribution of studies...18

Figure 3. Bipartite network representing predators and food resources using proportional to Frequency of Occurrence in diet..19

Figure 4. Bipartite network representing predators and food resources using Percentage of Occurrence in diet...20

Figure 5. Spatial variation on Levins' index considering conservation status of areas............21

SUMÁRIO

APRESENTAÇÃO....................VI

RESUMO....................VII

ABSTRACT....................VIII

Interaction networks, spatial and phylogenetic patterns in the Neotropical carnivorous mammals' diet....................11

INTRODUCTION....................13

METHODS....................14

Bibliographic search....................14

Dietary items categorization....................15

Diet patterns....................16

RESULTS....................17

Studies distribution....................17

Modules and bipartite network....................18

Spatial patterns....................20

Phylogenetic patterns....................21

DISCUSSION....................22

Patterns in studies: knowledge gaps in geography and taxonomy....................22

Bipartite network and modules....................23

Spatial patterns in diet variability....................24

Niche breadth....................24

Diet overlap....................26

Phylogenetic patterns....................26

CONCLUSIONS....................28

ACKNOWLEDGMENTS....................29

REFERENCES....................30

SUPPLEMENTARY INFORMATION....................38

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Interaction networks, spatial and phylogenetic patterns in the Neotropical carnivorous mammals' diet

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ABSTRACT

1. Species from Carnivora order present specializations for carnivorous diet. However, their dietary spectrum is variable, some species are considered strictly carnivores, while some feed mostly on plants, playing different roles in structuring trophic webs. Accurate knowledge about mammalian carnivores' feeding habits and resource use patterns is necessary to lead up conservation and management strategies.

2. Although there is considerable quantity of studies about carnivores' diet, we lack of general approaches on their trophic ecology. We aimed not only to identify and describe the trophic guild structure of carnivores at different scales throughout the Neotropics, but also to explore the main drivers behind structuring.

3. For that, we compiled studies, producing a broad database about carnivora diet and evaluated trophic guild formation through network analysis, diet dissimilarity and overlapping. We also investigated whether there is spatial variation in diet parameters between species, and interspecific variation between sites. Further, we assessed the role of phylogeny in trophic guild structuring.

4. We found dietary studies for 32 species, from six Carnivora families. We highlight two important biases: first, most studies focus on large-bodied felids and canids; second, they were predominantly conducted in South and South-eastern regions of South America. Further, biodiversity-rich biomes, such as Amazon and Caatinga, demand more dietary studies.

5. Networks showed most common items in carnivorans diet are small mammals, plant materials, arthropods and crustaceans. Modularity suggests five modules, grouping generalists/opportunists, marine-based, plant-based and two mammal-based dietary patterns. Most opportunistic and generalist species are from Canidae and Procyonidae families, and felids are the most strictly carnivorous species. Dietary parameters reveal carnivores tend to maintain niche breadth regardless of ecoregion, possibly by substitution of items in diet. Finally, we detected phylogeny as an important driver to carnivorans dietary patterns.

6. Basic knowledge about carnivores' diet and trophic ecology is essential to better comprehend species' interactions and function in the ecosystem. Equally, reviews are important tools to identify broad-scale patterns and guidelines to new studies.

Keywords: Carnivora Order, Neotropical, trophic structure, diet patterns, diet variation.

INTRODUCTION

Although the order Carnivora contains species with adapted characteristics to carnivorous eating habits, they present a broad diet range (Cabrera et al. 1940). Possessing morphological and physiological differentiations, carnivores' are efficient in locate, capture and kill animal prey. For that, skull, muscles and teeth are proper for perforation, crushing or cutting when biting (Emmons & Feer 1997), while distinctions in the digestive system enable food assimilation (Stevens & Hume 2004). However, despite all structural specialization, the dietary spectrum of these species is quite variable (Cabrera et al. 1940), such that some species are considered strictly carnivorous, while others feed mostly on plant materials (Emmons & Feer 1997). Thus, carnivores play crucial roles in structuring trophic webs as well as in ecosystems' dynamics by controlling prey populations at lower trophic levels (Terborgh & Estes 2013, Ripple et al. 2014), but also acting as secondary seed dispersers (Motta Junior & Martins 2009, Hämäläinen et al. 2017).

Accurate knowledge about carnivores' diet is essential for a better understanding of species' role in ecosystems (Scognamillo et al. 2003, Klare et al. 2011). Evaluating carnivores' dietary patterns as well as its variation through broad scale can gather information about relationships between predators and their prey or competitors, such as niche overlapping and segregation in resource use (Wilson 1975, Terborgh 1992, Rocha-Mendes et al. 2010). Besides, this information can provide foundation for understanding ecological processes, like competition and predation, or refine hypotheses involving competitive interference, intraguild predation and mesopredator release (Polis & Holt 1992, Holt & Polis 1997, Crooks & Soule 1999, Rocha-Mendes et al. 2010). Further, to verify the potential overlap with other carnivores, the generality or specificity of diets and its pressure on prey's and cooccurring species' populations is equally important to understand how species interfere in ecosystem functioning (Pereira et al. 2014). Consequently, basic knowledge about mammalian carnivores' feeding habits and resource use patterns is crucial to lead up conservation and management strategies (Klare et al. 2011).

There are considerable numbers of studies about carnivores' diet. However, few of these have a general approach on Neotropical mammalian carnivores' trophic ecology (Gainsbury et al. 2018). Here, we reviewed published articles and gray literature on carnivore diet in Neotropics. During the preparation of our literature review, another review on Neotropical carnivore diet was published (Cruz et al. 2021), where the authors reinforce the necessity of estimating available information and how the lack of it prevent investigation on broad dietary patterns for Neotropical carnivores (Heinen et al. 2020). Data obtained in the present study is similar to the abovementioned review. Even so, our manuscript adds to this knowledge by making new approaches, analyses and discussions on dietary patterns throughout the Neotropics.

We aimed not only to identify and describe the trophic guild structure of mammalian Neotropical carnivores at different scales throughout the Neotropics, but also to explore the main drivers behind the structuring processes. To do so, we collected and compiled available data in the literature producing a wide database about carnivora diet and evaluated guild formation through network analysis, diet dissimilarity and overlapping.

We also investigated whether there are diet niche breadth and overlap variation between species, and interspecific variation between sites. Finally, we assessed the role of phylogeny in trophic guild structuring, expecting that there was greater diet similarity between species with greater phylogenetic proximity (Davis et al. 2018).

We hope that such knowledge and database information may contribute to promote better understanding on the mechanisms involving carnivores' trophic ecology. We aim to improve further assessments, and boost carnivores' conservation by providing knowledge on species' interactions as well as trophic structuring drivers and on their role in the ecological systems.

METHODS

Bibliographic search

We reviewed the scientific literature in Web of Science and Google Scholar on the food habits of 46 Neotropical carnivore species. We used the following combination of keywords in the 'topic' search: "diet" OR "feeding habits" OR "food" AND the scientific names of species. We selected species based on the terrestrial carnivore species' list of Loyola et al. (Loyola et al. 2008) and complemented it using (Nagy-Reis et al. 2020) data set on carnivore distribution in the Neotropics. We considered variant scientific names of carnivore species (e.g., genus "*Lycalopex*" and "*Pseudalopex*" for the South American foxes). As we focused on terrestrial carnivores, species with mostly aquatic feeding habits (e.g., seals) were not included. This search occurred from September 2018 to August 2019, with an additional updating search in 2020 resulting in 263 published and unpublished documents in English, Portuguese, and Spanish (although we did make the search with English words only). We advocate that our search is a reliable sampling of quality data suitable for the proposed analyses, which complement information brought by Cruz et al. (2021).

To create a database of Neotropical carnivores' feeding habits, we filtered the studies selecting those containing tables with a full description of the carnivore diet. This data should be available as Frequency of Occurrence (FO, number of samples containing a particular food item, divided by the total number of samples, multiplied by 100) or Percentage of Occurrence (PO, number of occurrences of an item divided by the total occurrences of all prey types, multiplied by 100), and the sampling must have been conducted in the Neotropical region. After screening, the final database included approximately 140 studies, distributed in 160 sites (Appendix S1).

The database was separated in two main sets. The first one contains bibliographic information from each study, from which we recorded: document type, sampling year, country and coordinates of sampling site, name of study area, conservation status (inside or outside of any classification of conservative/preservation/protected area, or mixed samples from both types of area), cooccurrence information (yes or no, if there are two or more carnivora species studied at the same location), cooccurrence list (yes/no, list of carnivora species aside from the focal predators), seasonality (yes/no, if there were separation in diet according to seasons), sample type (scats or stomachs), predator identification method and sample size. The second data set contains diet information:

focal predator species, taxonomic level of prey identification, prey item class, order and family (if available), proportion in diet (all converted to FO), sample size and reference number (according to the first set). Metadata of all dataset is available (Appendix S2).

Dietary items categorization

In order to understand the intraspecific diet of carnivore species throughout the Neotropical region and compare it between species in different ecoregions, we grouped the prey items towards ecological equivalent prey. Considering the difficulty of prey identification at species level, many studies provided the prey description data by order, class or even upper taxonomic levels. Depending on the situation, grouping the predator diet into classes may not be adequate, due to the variety of prey characteristics within classes. However, some prey groups (e.g., birds and rodents) are harder to identify at lower taxon in scats and are often described only to class level (Magezi 2013). In contrast, using genus (or even species) can differentiate organisms, but they are worthless when comparing different prey that have similar natural histories and may be ecological equivalents. Therefore, we argue that it is possible to carry out analyses in order to effectively present patterns in the species' diet using intermediate categories (dividing large taxa or grouping biologically similar species), as they allow for cross-checking information and generating a closer picture of reality, particularly for species that live in different biomes.

Thus, we decided to use three prey categorizations in the analysis in order to identify possible differences caused by their usage. Firstly, items were grouped in Categories (Appendix S3): Mammals, Birds, Snakes, Lizards, Crocodilians, Chelonians, Amphibians, Fish, Invertebrates (all except Arthropoda), Arthropods (all except Crustacea), Crustaceans, Plant materials, Anthropic materials and Non-Identified Items. Furthermore, we separated prey mammals into five body mass categories (up to 1 kg, from 1 to 5 kg, 5 to 10 kg, 10 to 15 kg and above 15 kg), using mean species weight, based on (Paglia et al. 2012) and PanTHERIA database (Jones et al. 2009), thus, analysis using this division is more sensitive to variations in mammals' consumption. In the second classification, all items were divided according to the order identified in the studies, considering eggs within a separate category. In the last classification, all items were divided according to the identified class, also including eggs as a separate category.

Using categories, there is some loss of information for items identified only as order Rodentia. Despite being frequently found in the diet of many carnivores (Wang 2002, Abreu et al. 2008, Magezi 2013), prey identified only as Rodentia does not fit into any mammal body mass category due to the wide biomass variation. As for categorization of prey by Order, we may lose information for groups generally identified in the diet at class level, such as birds, amphibians and insects. Finally, for all categorizations, despite being found in the diet and added to the dataset, carrions was not included in the analysis, as it may not be identifiable and might compromise the interpretation of species dietary habits. We also did not include inedible anthropogenic materials (eg. plastic, nylon, aluminum foil), since they are often ingested involuntarily. Cattle and other farm animals were placed as a food item according to body mass or taxonomic classification and included in the analysis.

Diet patterns

For a better trophic ecology and guild interpretation, we used the data to analyze niche breadth and niche overlap spatial variation, and calculated dissimilarity indexes to use on cluster analysis. In order to evaluate possible dietary competitors, we used Pianka's index to estimate niche overlap between predator species; the index requires PO values, we calculated a mean PO value for each prey category, and the diet overlap between all possible pairs, using the three defined categorizations. Moreover, to identify an overall view of trophic guilds considering the wide range area of Neotropical region, and to understand interactions due to dietary habits, we did a network analysis, plotting exploratory bipartite webs and module matrices using the relative frequency (FR and PO) of the prey items in diet. These analyses were made using functions *niche.overlap* and *computeModule* from *spaa* and *bipartite* package respectively, in *R software 4.1.0* (Zhang 2004, Dormann & Strauß 2014).

To evaluate spatial patterns throughout the Neotropical region along different ecoregions and along different conservations scenarios, we calculated two diet parameters: species' dietary breath, using Levins' niche breadth index (Krebs 1999) and dietary overlap between paired species using Pianka's index (Krebs 1999). We used the WWF ecoregions classification (Olson et al. 2001) and coordinates from studies' sampling sites. Some studies did not provide the geographical coordinates, but we used the centroid of the municipality or locations described. We also used such coordinates to produce a map of studies distribution. The conservation status of the areas was based on available information from each study - if the sampling were located within or without legal protected areas.

To test whether there is spatial variation in those diet parameters, for each species we did General Linear Models (GLMs) correlations and Tukey tests checking the niche breadth's variation between sites, considering ecoregions and conservation status as factors, three analyzes were carried out each time, seeking to investigate whether items' categorization interferes in the index's variation. This assessment was carried out only for species that contained enough data to detect values variation, that is, those with three or more studies in at least two types of environments. Then, we built overlap matrices for each ecoregion with overlap values of their respective cooccurring paired species. These analyses were made using functions *niche.width* and *niche.overlap* from *spaa* package (Zhang 2004), *glm* function from *stats* and *glht* from *multcomp* package (Hsu 1996) in *R software 4.1.0*.

Ultimately, to test the phylogenetic influence in diet patterns, we used a dissimilarity index for ecological communities to build a dissimilarity matrix based on the mean PO of each prey in every predator diet and use it for a hierarchical cluster analysis. We accessed the Carnivora phylogeny from TimeTree database (Kumar et al. 2017) and used the data in a cophenetic distances for a hierarchical clustering to build a second dissimilarity matrix, based on phylogenetic distance. Lastly, we calculated the statistic correlation between the two dissimilarity matrices using Mantel test. These analyses were made using functions *vegdist*, *cophenetic*, *hclust* and *mantel*, from *vegan*, and *stats* packages in *R software 4.1.0* (Sneath & Sokal 1973, Murtagh 1985, Faith et al. 1987, Legendre & Legendre 2012).

RESULTS

Studies distribution

After the screening described above, from initially 263 dietary studies found, the diet dataset contained 259 records with diet description for 32 species, within six Carnivora families, from 140 dietary studies, distributed in 160 sites (Appendix S2). Two biases in studies distribution were highlighted. First, most studies focused on the Felidae and Canidae families, approximately 49% and 22%, respectively (Fig. 1). The second is a considerable geographical bias, as most studies were conducted in South and South-eastern regions of Brazil, Uruguay, Chile and Argentina. Large and biodiversity-rich biomes, such as Amazon and Caatinga, have very low number of dietary studies. Moreover, when considering the distribution of study sites among ecoregions, most studies were conducted in Cerrado, Uruguayan savanna and Alto Paraná Atlantic forests, 10%, 10% and 6%, respectively (Fig. 2). Biases are in line with those reported by Cruz et al. (2021), indicating that our dataset is a reliable sampling of the information on the diet of Neotropical carnivores.

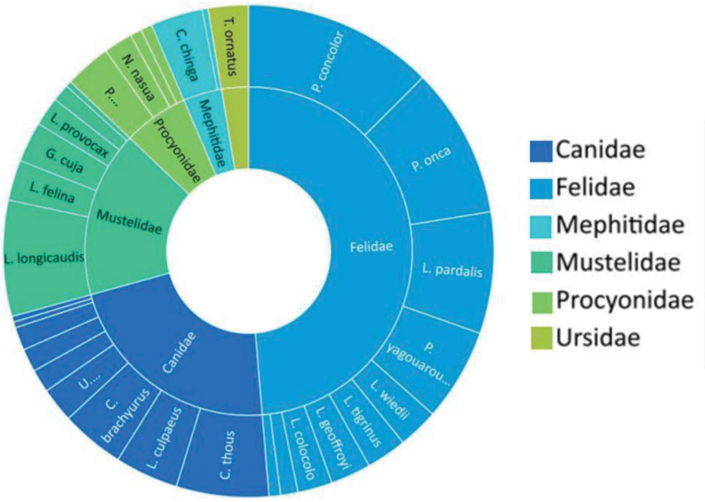

Figure 1. Taxonomic distribution of studies found describing carnivore's diet (n = 263). Detailed names of predators are available at Appendix S2.

Figure 2. Geographical distribution of studies describing carnivore's diet in the Neotropical region (n = 160).

Modules and bipartite network

The bipartite network allowed a clear visual representation of most common items in carnivores diet (Fig. 3). Using categories and items' frequency (FO), we identified Plant materials, Arthropods and Crustaceans as the most frequent items for most species. The predator's order of the left column in the plot suggests, from top to bottom, most generalist to most restrictive species, while the size of species' boxes represent the sum of total item's frequency. Thus, we can identify that most flexible and generalist species are *Cerdocyon thous* and *Lycalopex gymnocercus*, consuming a wider variety of items. Also, despite the fewer studies, we can still identify species with a more restrictive diet, such as *Potos flavus* and *Pteronura brasiliensis.* The right column provides a better quantitative view of common items considering all species, while the link width represents the items' frequency in each species' diet. We point out that, depending on its usage it is important to analyze considering biomass, once small items, such as seeds and insects are usually consumed in greater amounts.

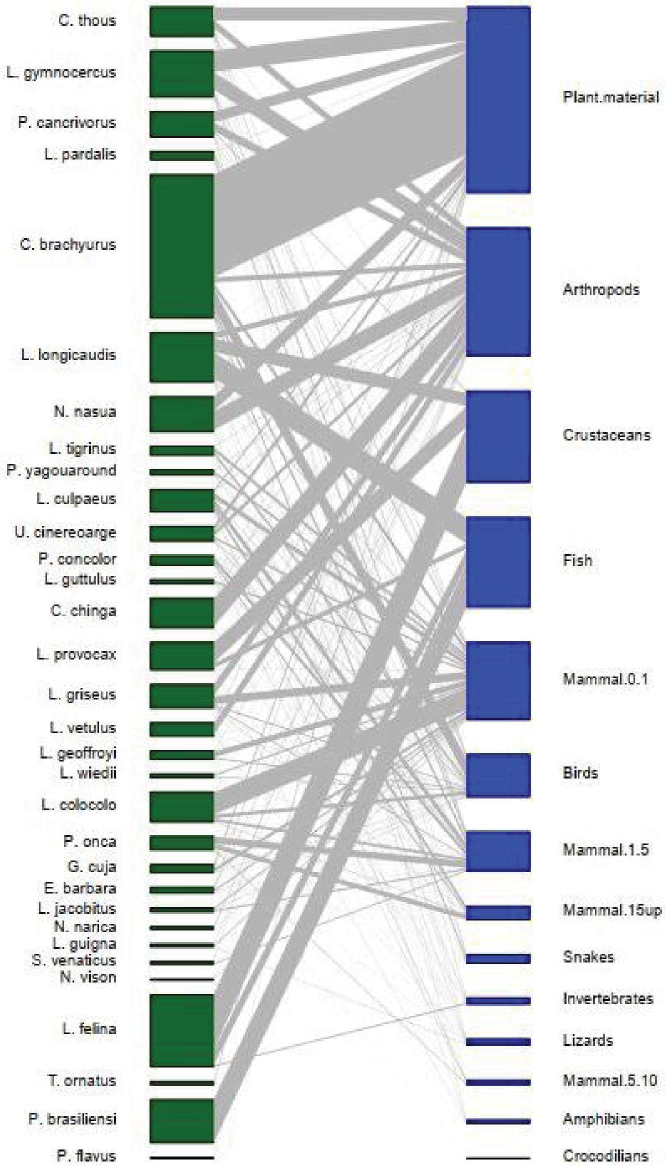

Figure 3. Bipartite network representing predators and food resources. Link width is proportional to Frequency of Occurrence in diet. Predators are ordered from most generalist to most restrictive diet (from top to bottom), while the sizes of species' boxes represent the sum of total item's frequency. Dietary items and boxes are ordered from most frequently to most rare item in total predators' consumption. Mammal preys are divided into five body mass categories (up to 1 kg, from 1 to 5 kg, 5 to 10 kg, 10 to 15 kg and above 15 kg). Detailed names of predators and meanings of food resources are available at Appendix S2.

Using the same categorization but with percentage of occurrence data, we can identify most common items for each carnivore (Fig. 4). Mammals up to 1 kg, Plant materials and Arthropods are the most consumed items by mammalian carnivores. In this case, all boxes in the left column represent the sum of percentage of occurrence, but the species' order is not informative. All link width represents the proportion of items in each species' diet, and the right column indicates the sum of these proportions. This plot enables a better qualitative view of common items, identifying most significant items in each species' diet. For example, we easily note that the diet of *Cerdocyon thous* is composed by lower proportions of many items, while the diet of *Lontra provocax* is based mostly on Crustaceans.

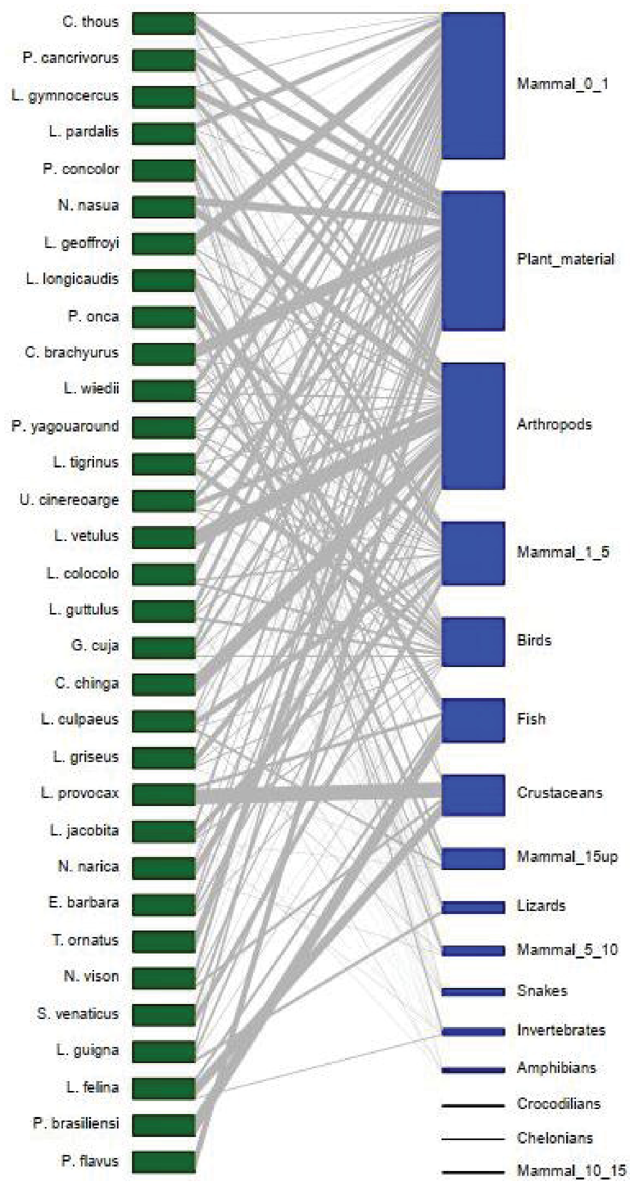

Figure 4. Bipartite network representing predators and food resources. Link width is proportional to Percentage of Occurrence in diet. Predators' boxes represent the sum of percentage of occurrence, but the species' order isn't informative. Link widths are proportional to items' PO in diet, and items' boxes indicate the sum of these proportions. Mammal prey are divided into five body mass categories (up to 1 kg, from 1 to 5 kg, 5 to 10 kg, 10 to 15 kg and above 15 kg). Detailed names of predators and meanings of food resources are available at Appendix S2.

Modularity analysis using different item categorizations were consistent, grouping species in to five modules (Appendix S4). Yet, there was some species turnover between the three categorization scenarios (Appendix S2). Likelihood values ranged between 0.455 and 0.581 for all six data arrangements, using percentage and items' frequency data for each categorization. The higher modularity value was obtained using orders categorization both using percentage of occurrence or frequency of items (0.496 and 0.581, respectively).

Spatial patterns

Levins' index did not variate between ecoregions for any of the species with enough data for the GLM analysis ($N_{categories}$=20, $N_{classes}$=21, N_{orders}=21). While considering conservation status ($N_{categories}$=19, $N_{classes}$=19, N_{orders}=16), two Canidae species had niche breadth variation, when using the orders diet categorization. Both *Cerdocyon thous* (P=0.01) and *Lycalopex gymnocercus* (P=0.001) had a larger niche breadth outside conservation unities (Fig. 5).

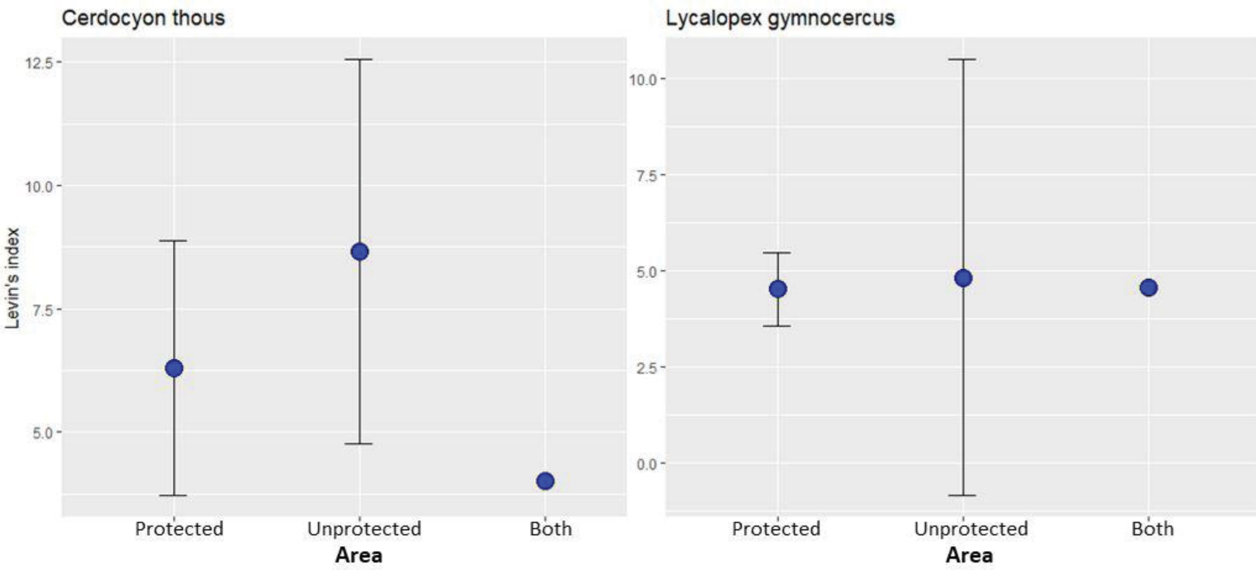

Figure 5. Spatial variation on niche breadth (Levins' index), considering conservation status of areas, for two Canidae species that presented significant variation.

As for Pianka's index, we did not have enough data to do GLM analysis using ecoregions due to the difficulty to locate the same pair of species enough times in the same two ecoregions. We then used the available data to build overlap matrices for each ecoregion with overlap values of their respective cooccurring species, and one general overlap matrix using the mean PO consumption values for each categorization, enabling to visualize how much each paired species has potential to overlap throughout the Neotropical regions (Appendix S2).

Phylogenetic patterns

The clustering plot shows similar aggrupation to network modules with a few species' turnover, with most species remaining together within the same modules and groups independently of categorization (cat., 87.5%; class, 93.75%; order, 87.5%). Furthermore, between categorizations, most species also remained within the same group (Appendix S2).

Using categories and classes, we identify four distinctive groups that may represent trophic guilds: First one, formed by all otter species; a second one, containing mostly procyonids and canids; and two formed mostly by felids. Besides that, the classes plot includes two more groups, one separating solely the maned wolf (*Chrysocyon brachyurus*) and the last one including two species, the spectacled bear (*Tremarctus ornatus*) and kinkajou (*Potos flavus*). The last plot, using orders categorization, formed five possible trophic guilds: one consisting on all otter species except one; one composed by three different species, from three different families, Procyonidae, Canidae and Ursidae; two formed by solely one species, *C. brachyurus* and *Lontra longicaudis*; the last and largest one composed by five different families, but mostly by felids and canids. Yet, this last one can be separated in to four subgroups: first one containing mostly procyonids and canids; second composed mainly by felids and mustelids, third one containing mostly felids; and the last one formed by two large felids and one canid.

The Mantel test for the phylogenetic and diet distance matrices correlation was significant for all three categorization scenarios (cat., P=0.001; class, P=0.026; order, P=0.049), indicating a positive (but weak) correlation between carnivores' phylogeny and dissimilarity in diet (cat., Mantel's $r = 0.334$; class, $r = 0.149$; order, $r = 0.101$).

DISCUSSION

Patterns in studies: knowledge gaps in geography and taxonomy

It was clear that the accessible information regarding Neotropical carnivores' diet is heterogeneous. Despite not so extensive, spatial patterns described in this review were in line with those described by Cruz et al. (2021). From the 46 carnivore species included in the research, we found dietary studies only for 32. Yet, most studies focus on Felidae family, especially on *Puma concolor, Panthera onca* and *Leopardus pardalis*, or Canidae and Mustelidae families, mostly on *Cerdocyon thous* and *Lontra longicaudis*. Other researchers also found a similar distribution of studies in carnivores' diet (Cruz et al. 2021). Oliveira and Pereira (2013) highlight that their findings on intraguild predation and interspecific killing could be biased due to the higher volume of data available for felids compared to other taxonomic groups (e.g., mustelids). Even so, there are under sampled species within all families, for Felidae, the most studied family, species such as *Leopardus jacobita* and *L. guigna* have respectively two and one dietary description studies. Moreover, for some Canidae species, the second most studied family, we found no results, such as *Lycalopex sechurae* and *L. fulvipes*.

The most studies included mainly large-bodied species. Large predators, such as *Puma concolor* and *Panthera onca*, have a wide distribution and usually occupy large territories (Soule & Terborgh 1862). Hence, scats from these species are more common and well known by researches, facilitating its location and identification. Also, they are considered charismatic and 'umbrella species', overlapping their home range with other predator and prey species (Miller et al. 2001, Roemer et al. 2009, Ripple et al. 2014), being commonly used as decoys in conservation studies and programs. As a consequence, researchers likely receive greater financial support to study large-bodied carnivores, and the amount of work focusing in large carnivores, or even with felids in general, is representatively higher.

Our results show similar proportions to the findings from (Cruz et al. 2021), where researchers also found significant distributions biases in dietary studies. Both reviews identified an important geographical gap, since most studies were conducted in South and Southeastern regions of South America and appear to neglect the Amazon biome. However, using the ecoregions distribution of our data, we found more studies in Cerrado, the opposite from Cruz et al (2021). This may be due to smaller total number of collected studies in this review. Even so, patterns on taxonomical and geographical distributions from our study and from Cruz et al (2021) were very similar, as expected given both followed the rules of systematic review. Despite the differences, we also suggest the heterogeneous funding availability and research centers distribution, combined to field work conditions to be the main reason for this pattern (Bini et al. 2006). Even so, our study explored other facets of diets in carnivores, describing the diet network and formally investigating differences in ecoregions, conservation areas and phylogenetic patterns.

Bipartite network and modules

The bipartite networks using items' frequency and percentage of occurrence allowed a clear visual representation of most common items for most species. And modularity plots are useful to identify possible trophic guild considering all species, and suggest possible competition between species based on common dietary items.

Most common items in carnivores' diet are Mammals up to 1 kg, Plant materials, Arthropods and Crustaceans. Furthermore, most generalist species belong to Canidae family and most canid species were allocated within modules consuming mainly plant materials and arthropods. Studying *Cerdocyon thous*, *Chrysocyon brachyurus* and *Lycalopex vetulus,* three sympatric canids, both Juarez and Marinho-Filho (2002) and Kotviski et al. (2019) describe the species as generalists. Although, their studies indicate that the trophic niche differences associated with the consumption of termites by foxes and fruits by maned wolves are fundamental for their coexistence (Kotviski et al. 2019) and that, besides greater diet overlap for *C. brachyurus* and *C. thous*, maned wolves fed mainly on larger prey than did foxes (Juarez & Marinho-Filho 2002). Thus, these canids' generalist and opportunistic habits are the main reason for their coexistence.

Species from Procyonidae family, especially *Procyon cancrivorus* and *Nasua nasua*, are allocated with most generalist species. Despite of lack of studies about the biology and diet habits of *P. cancrivorus* (Martinelli & Volpi 2010), many authors consider both species as generalist and opportunistic (Gatti et al. 2006b, Martinelli & Volpi 2010). Our data corroborates with those classifications, as both species included a variety of items on their diets, such as berries, invertebrates and small vertebrates, further, both tolerate anthropic areas, consuming garbage and exotic species as food resources (Gatti et al. 2006a, Martinelli & Volpi 2010, Pellanda et al. 2010, Aguiar et al. 2011).

We highlight species with a more restrictive diet coincide with species with fewer available studies. Still, considering the bipartite plot, species such as *Potos flavus* and *Pteronura brasiliensis* have lower items' diversity in diet. On the other hand, utilizing modularity plot we identified specialized species, like most felids. For the kinkajou (*P. flavus*), we found two dietary studies, but only one with applicable data. Yet, both studies emphasize the restrictive consumption of fruits by the species (Julien-Laferrière 1999, Kays 1999). Thus, placing the kinkajou with specialist species, and within a module containing species that mainly uses plant materials as food resource, like *C. thous, P. cancrivorus, C. brachyurus* and *Tremarctus ornatus*. For the giant otter (*P. brasiliensis*) we found three dietary studies, all describing fish as most consumed item, especially from Cichlidae, Characidae and Erythrinidae families (Rosas et al. 1999, Cabral et al. 2010, Silva et al. 2014). Because of that, we considered the giant otter a specialist species, and due to its diet based on fish, modularity placed it within other otters, that mainly consume fish, but also crustaceans (Mangel et al. 2011, Silva et al. 2014, Vezzosi et al. 2014).

Ultimately, although in bipartite plot some felids are considered as generalist, modularity plot places most species in two modules, one mainly based on small mammals' consumption, the other on mammals heavier than 1 kg and reptiles. As categories divide mammals by body mass, felids whose diet rely on different sized mammals presents a more generalist diet, although, basing on modularity, we can still reinforce the hyper carnivory of felids (Moreno et al. 2006, Rocha-Mendes et al. 2010, Giordano et al. 2018, Cruz et al. 2021).

The variation of modules sets and bipartite network highlights the importance of carefully choosing the way in which items are categorized when studying trophic relationships. Separate dietary items in categories were common for studies on feeding ecology, but grouping different classes or orders in one category may lead to different interpretations. Furthermore, many researchers were not able to identify prey species in lower levels, forcing to group items in broad categories. We argue that this limitation must be always considered when interpreting the results. In summary, modularity plots are useful to identify possible trophic guild considering all species, and suggest possible competition between species based on common dietary items as well as can be used as an indicator of focus prey communities in conservation strategies to maintain predators' communities.

Spatial patterns in diet variability

Niche breadth

Our data indicates that carnivores tend to maintain niche breadth regardless of ecoregion, possibly by substitution of items in diet and as a consequence of the opportunism characteristic from predators (Rocha-Mendes et al. 2010). In fact, the absence of spatial variation in Levins' niche breadth index for most species also indicate predators' diet flexibility as well as generalist and opportunistic habits (Moreno et al. 2006, de Azevedo & Murray 2007, Rinaldi et al. 2015), once they keep similar proportions in diet in different ecoregions and areas. For the most studied species, puma (*Puma concolor)* and jaguar (*Panthera onca)*, none presented niche breadth variation between areas with different conservation status. A similar result was found by Magioli and Ferraz (2021) studying effects of deforestation on the diet of puma in the Brazilian Atlantic Forest, they found niche breadth varied independently of the context or forest cover. Also, studying the influence of prey richness in carnivores' diet worldwide, Ferretti et al. (2020) points out that only the largest studied species, such as puma and jaguar, increase their dietary breadth with increasing prey richness, while other carnivores showed relatively stability. However, deforestation leads pumas to feed on smaller prey in Atlantic Forest (Magioli & Ferraz 2021), a consequence that may occur throughout the Neotropics. In this case, species can retain the same niche breadths values along different areas, but still shift their dietary composition.

We only detected index variation in dietary breadth between sites for two Canidae species, when utilizing orders items' categorization and evaluating conservation status (Fig. 5). Environmental changes and anthropogenic alterations of natural communities have profound ecological consequences, often influencing the richness and availability of resources (Walther et al. 2002). Thus, both species, *Cerdocyon thous* and *Lycalopex gymnocercus,* may be more sensitive to spatial variation and anthropic interference. Though, their increase of niche breadth outside protected areas indicates a possible dietary flexibility and adaptation for these species. Variation in richness and availability of food resources is expected to affect foraging habits, diet composition and consequently niche breadth (Hernández-SaintMartín et al. 2015, Ferretti et al. 2020), and protected areas contains higher prey diversity (Hernández-SaintMartín et al. 2015, Magioli & Ferraz 2021). According to optimal foraging theory, species consume most profitable food resources with increasing environmental productivity and food availability, narrowing their dietary breadth (MacArthur & Pianka 1966, Charnov 1976). Thus, the generalist habits of these species may allow selection of their resources inside preserved areas and utilization of a wider niche range to consume ecological substitutes outside. We support this idea considering that we identified Levins' index variation solely using orders categorization, suggesting that these species prey on different taxa that were grouped in the same category. For many species, we didn't have enough data to evaluate the niche breadth spatial variation, as well as some had a small number of studies sites. Thus, a future study with larger datasets could possibly have different results for those species. We strongly underline the importance of diet description studies and future diet measurements reviews based on bigger data size, once these shifts may be occurring for other species too.

To sum up, our data indicates Canidae and Procyonidae as most generalist species. All three categorization sets contain species from these families with higher niche breadth values. According to other dietary studies, many authors confirm the generalist nature of Canidae species, such as the *C. thous* and *L. gymnocercus* (Juarez & Marinho-Filho 2002, García & Kittlein 2005, Varela et al. 2008) and Procyonidae species, like the *P. cancrivorus* and *N. nasua* (Alves-Costa et al. 2004, Pellanda et al. 2010, Ferreira et al. 2013). On the other hand, Felidae species, present a more restrictive diet focused on mammal prey (Moreno et al. 2006, Giordano et al. 2018), but usually diverge consuming prey that differ in body mass (Moreno et al. 2006, de Azevedo & Murray 2007, Tirelli et al. 2019, Zanin et al. 2020). The strictly carnivorous diet is better represented using classes categorization, were felids show lower index values. While using order categorization allowed the identification of the most common mammal species in carnivores' diet, it is important to keep in mind that some predators are utilizing body mass equivalent mammal prey.

Lastly, in order to encourage studies on niche breadths variation, we provided a data set describing mean and variance of Levins' niche breadth's measurements for each species using all three categorizations (Appendix S2). It is essential to check the diet categorization carefully before use, once categories may result in loss of information on some orders, as also tend to group some taxa into one single category, while class and order categorizations may allocate separately prey species that could be considered ecological equivalents. For strictly carnivore species, like Felidae, using categories results in higher index values, once mammal prey are separated into five different types based on body mass. In this case, the index variation will be more sensitive to differences in mammal consumption. Using categories for more generalist species, like Procyonidae and Canidae, one would find lower index values, because different taxa from plant material and arthropods are grouped, in this case, order categorization may be a more suitable option. Therefore, the selection of categorization requires basic knowledge on species' dietary habits and biology.

Diet overlap

The general overlap matrices represent Pianka's index values considering all paired species throughout the Neotropics, providing an overview off all potential competitors. Moreover, we used the available data to build overlap matrices for each ecoregion with the index values of their respective paired cooccurring species (Appendix S2). Interspecific diet overlap is expected to increase probability of antagonistic interactions (Palomares & Caro 1999), like resource competition and interspecific killing, which may strongly affect carnivore guilds (Palomares & Caro 1999, Linnell & Strand 2000, Donadio & Buskirk 2006). Yet, how much sympatric carnivore species compete and the mechanisms contributing to their coexistence are still poorly understood (di Bitetti et al. 2010).

The different overlap between species often leads to different levels of competition and possibly exclusion of species from the community. Further, the resulting trophic niche also represents the functional status of species based on their relationships (Kotviski et al., 2019). Accurate knowledge on carnivores' diet is essential for a better understanding of the role of these species in the ecosystems, as well as to verify the potential overlap with other carnivores, the generality or specificity of the diet and its pressure on prey populations, being one of the first steps in understanding the ecological structure of communities (Zapata et al. 2007, Magezi 2013, Kasper et al. 2016). Therefore, our goal is to enable access to how much each paired species has potential to overlap throughout the Neotropical regions trough availability of our overlap matrices (Appendix S2).

Phylogenetic pattern

Phylogeny is an important driver to dietary patterns to most carnivore species. Over again, diet items' categorization influences species' clustering. Still, we found similar clustering utilizing Bray–Curtis' dissimilarity index to grouping using modularity for all categorizations. Like in network, most species remained within the same group, but here, we focus on taxonomy.

Firstly, we identify a guild based on fish and crustacean consumption. Otters were consistently clustered together using both categories and classes, thus, we suggest all four species form one trophic guild: *Lontra felina, Lontra provocax, Lontra longicaudis* and *Pteronura brasiliensis*. Otters are known to feed mainly on fish and crustaceans, items that are not very common in other carnivores' diet (Medina-Vogel et al. 2004, Sousa et al. 2013b, Silva et al. 2014). Yet, using orders, the Neotropical otter (*L. longicaudis*) is allocated alone, possibly by its wider diet variation, including arthropods and rodents as food resources (Vezzosi et al. 2014).

Secondly, another consistency in clustering was for generalist and opportunist species. Using classes and orders for prey, the maned wolf (*C. brachyurus*), spectacled bear (*T. ornatus*) and kinkajou (*P. flavus*) were separated from other carnivores due to plant use. Yet, considering food resources in categories, the three species were placed together with procyonids and canids species, that also presented high consumption of plant material, and also arthropods and small mammals (Juarez & Marinho-Filho 2002, Gatti et al. 2006b, Pellanda et al. 2010). We point out that, besides allocated within a plant-based group, the maned wolf uses a wide variety of food items, such as arthropods, small and medium mammals, even birds and snakes (Santos et al. 2003, de Arruda Bueno & Motta-Junior 2009). Thus, like many authors, we considered the species as generalist and opportunist omnivore (Aragona & Setz 2001, Juarez & Marinho-Filho 2002, Rodrigues et al. 2007). Therefore, there is a generalist guild formed by: *Procyon cancrivorus, Nasua nasua, Cerdocyon thous, Lycalopex gymnocercus, Urocyon cinereoaurgenteus, Nasua narica, Lycalopex vetulus, Conepatus chinga, Speothos venaticus, Chrysocyon brachyurus, Potos flavus and Tremarctos ornatus*. Yet, categories plot can still separate into three subgroups, a truly omnivorous guild, composed by two procyonids, *P. cancrivorus* and *N. nasua*, and three canids, *C. thous, L. gymnocercus* and *U. cinereoargenteus*; an omnivorous/insectivorous guild, containing N. *narica, L. vetulus* and *C. chinga*; and a frugivorous guild composed by *C. brachyurus, P. flavus* and *T. ornatus*. However, due to its mostly generalist diet, we suggest a better position to the maned wolf would be within the first guild.

Thirdly, we have species that feed almost exclusively on mammals. First thing we highlight is the reinforcement of hyper carnivory diet of Felidae family (Giordano et al. 2018, Tirelli et al. 2019, Nagy-Reis et al. 2019, Cruz et al. 2021). Considering the better usage of categories for mammal-based diets, we focus on this categorization. Most carnivorous species are felids, some mustelids (*Galictis cuja, Neovison vison, Eira barbara*) and two canids (*Lycalopex griseus* and *Lycalopex cupaeus*). Clustering presented a subgroup of mostly generalist species: *G. Cuja* described as both strictly carnivorous (Bisbal 1986, Migliorini et al. 2018) and opportunist (Zapata et al. 2005, Sade et al. 2012); *E. Barbara,* consuming fruits, arthropods, small mammals and birds (Bisbal 1986); *Leopardus guigna* and *Lycalopex griseus* using mainly small mammals, arthropods and lizards (Palacios et al. 2012, Figueroa et al. 2018). However, in modularity, the last two are placed in separated groups due to prevailing consumption of small mammals by *L. guigna* and greater use of arthropods by *L. griseus*.

There are guilds of more restrictively carnivore species consuming specially mammal prey. Yet, we still can separate small cats, mostly from *Leopardus* genera: *L. colocolo, L. geoffroyi, L. tigrinus, L. wiedii* and *Puma yagouaroundi*. It is clear that small cats remain together within the same trophic guild, especially due to rodents and small vertebrates' consumption (Silva Pereira et al. 2011, Kasper et al. 2016, Magioli & Ferraz 2018, Cruz et al. 2021). While American mink (*Neovison vison*) was placed within this same guild, due to high rodents and lagomorph consuming, yet, its diet is not that similar to small cats due consumption of crustaceans and marine prey (Fasola et al., 2009; Gomez et al., 2010).

Last guild is based on medium-large mammals, especially between 1 to 5 kg, 5 to 10 kg and upper than 15 kg. Again, felids are majority of cluster's species: *Panthera onca, Puma concolor, Leopardus pardalis, Leopardus jacobita* and *Lycalopex culpaeus*. Firstly, we underline large cats placing together, *P. concolor* and *P. onca*. The especially high consumption of larger mammal prey and even other carnivores by these species are well known (Rueda et al. 2013, Magioli & Ferraz 2018, 2021, Llanos & Travaini 2020), and some researches relate it to the morphological capability of larger predators to feed on larger prey (Carbone et al. 2007, Rueda et al. 2013, Santos et al. 2014, Perilli et al. 2016). Yet, *P. concolor* is widely considered a flexible eater, whereas the species can shift its diet according to prey availability (Foster et al. 2010, Magioli & Ferraz 2021). Finally, the three last species are included in this guild by medium mammal prey, between

1 to 10 kg. Although, it is noteworthy to focus on ocelot (*L. Pardalis)* group shifting considering category and order clustering. This species' diet is especially composed by rodents (Silva Pereira 2009, Taylor & Wang 2010, Santos et al. 2014). Yet, due to harder identification of prey item to genus or species (Magezi 2013), most data were not included in categories clustering. Thus, in order clustering, that includes Rodentia data, ocelot occupies a more plausible place within small felids and rodent-based species, as *L. wiedii, L. tigrinus and P. yagouaroundi* (Silva Pereira 2009, Magioli & Ferraz 2018).

We conclude that phylogenetic distance is an important driver to dietary guilds in carnivore assemblage. To sustain this idea, Mantel test shows positive, yet weak, correlation between dissimilarity matrices, indicating that phylogenetic relationships explain part of the structure of carnivores' trophic guilds (Prevosti & Pereira 2014). Further, body size determines energetic requirements of organisms as well as species' abundances (Robinson & Redford 1986, White et al. 2007). Therefore, differences in size, habits and morphophysiology may explain, among other factors, the coexistence and dietary patters in neotropical carnivores' assemblage. Thereby, basic knowledge on trophic guilds allows better conservations strategies focusing on predator and prey communities as it can help to predict possible predators' competitions based on prey populations and helps understand ecological holes and functional diversity of different carnivores (Korschgen 1987, Magezi 2013, Sousa et al. 2013a).

CONCLUSIONS

This review reinforces the heterogeneous distribution of studies regarding the feeding habits of Neotropical carnivorans. Our work, congruous to Cruz et al. (2021), points out the accessible information and consequent knowledge about these predators' diet has important taxonomic and geographical gaps.

The Neotropical region holds a highly diverse fauna, but mammal populations are declining, while rates of extinction are elevated (Ceballos et al. 2005). Basic knowledge about carnivores' diet and trophic ecology are crucial to better comprehend their function in the ecosystem (Klare et al. 2011). Thus, studies supplying data on feeding behavior and dietary patterns are essential for conservation and population management (Peters et al. 2011). This review and analysis reveal common dietary items throughout the distribution of carnivore species, as well as trophic guilds organizations, network and modularity patters and variation of diet parameters in a broad-scale. The similarities can be interpreted as potential for competition, but not as a synonym, as many other factors are involved in competition theories (Kasper et al., 2016). Further, we detected the phylogenetic influence on trophic structuration and the importance of carefully determine the categorization of items in dietary studies. We provided datasets describing resource usage by species throughout the Neotropics, studies distribution and values of trophic niche parameters using Levins' and Pianka's indexes. Finally, this work is expected to be helpful to future studies regarding all involved species, as well as for taking decisions about conservation.

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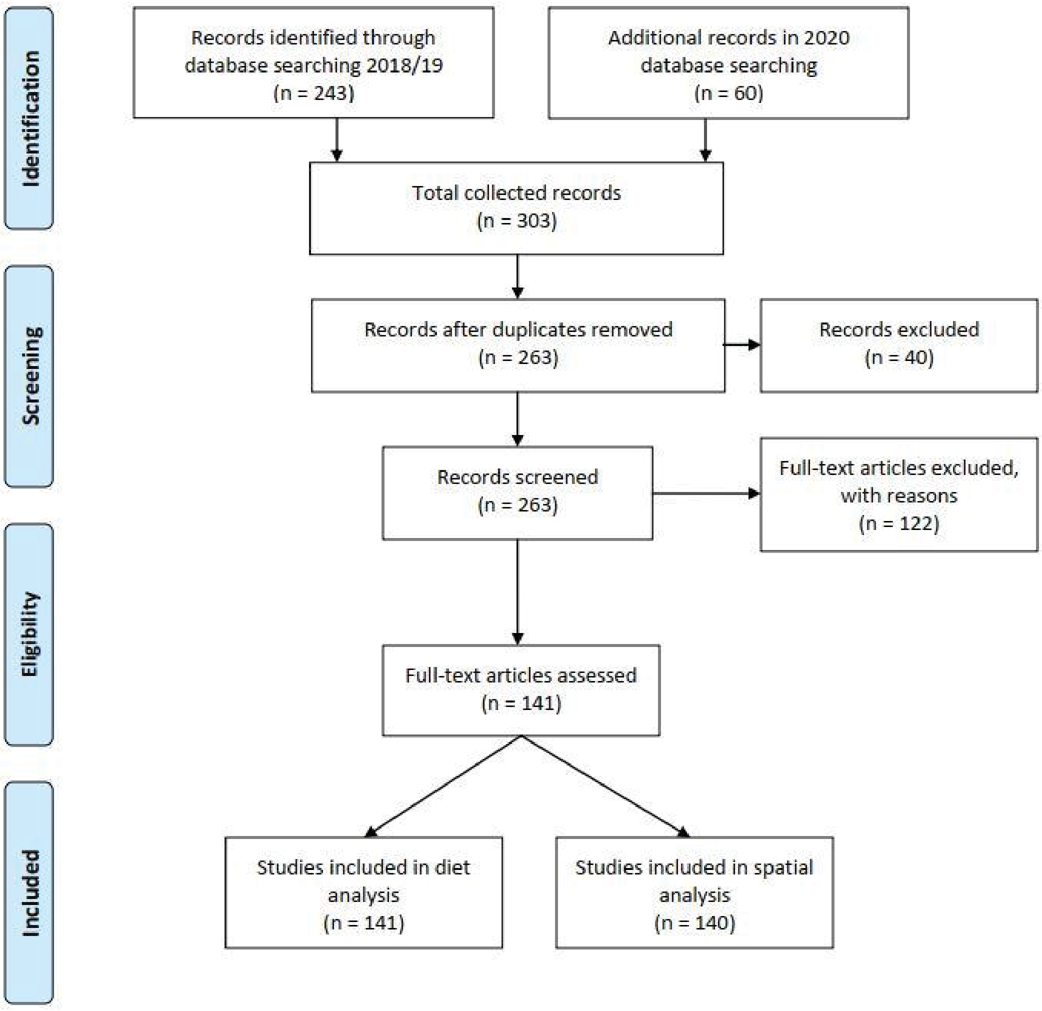
Supporting Information – Appendix S1



Appendix S1. Prisma Flow Diagram reporting the sequence of data collection and interventions. Published papers and gray literature citing Neotropical carnivore's species' diet were gathered and screened.

Supporting Information – Appendix S2 (Metadata)

Metadata of interaction network, niche breadth and diet overlap analysis based on compiled studies on mammalian carnivorans' diet.

Owners:

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Abstract: The dataset, from a review on Neotropical carnivores' diet, describe species included in the study, used references' information, dietary description assessed from those references, network and modularity plots, and matrices with niche breadth and niche overlap values throughout the Neotropics from approximately 140 studies gathered in 2019 and 2020.

Keywords: Carnivora Order, mammalian carnivores, Neotropical, trophic structure, diet patterns, diet variation, ecoregions.

License and Usage Rights: All data will be available for using, but pending on contacting owners. Collaboration in future scientific papers are encouraged.

Data extension: Data contains information from studies collected between 2019 and 2020, gathering published data and gray literature from 1977 to 2019 sampled in all

Neotropical Ecoregions. Matrices describe items' consumption from 32 species, from 6 families as well as values of dietary parameters (Levins' niche breadth and Pianka's niche overlap). Documents contain bipartite networks and modularity plots based on those studies' diet information.

Definition of document information and contents from matrices: Full methods are available in Lorena Metz Dissertation, it will be added to UFPR collection's website at www.portal.ufpr.br

Species information: list of species with data on diet description.

List of species: family, scientific and common names of species mentioned in the review, species' describing author and number of studies included in the analysis.

Family	Species	Common name	Author	Diet studies
Canidae	*Cerdocyon thous*	Crab-eating fox	Linnaeus, 1766	16
Canidae	*Chrysocyon brachyurus*	Maned wolf	Illiger, 1815	11
Canidae	*Lycalopex culpaeus*	Culpeo	Molina, 1782	11
Canidae	*Lycalopex griseus*	South American Gray fox	Gray, 1837	4
Canidae	*Lycalopex gymnocercus*	Pampas fox	Fischer, 1814	4
Canidae	*Lycalopex vetulus*	Hoary fox	Lund, 1842	4
Canidae	*Speothos venaticus*	Bush dog	Lund, 1872	1
Canidae	*Atelocynus microtis*	Short-eared dog	Sclater, 1882	1
Canidae	*Urocyon cinereoargenteus*	Gray fox	Schreber, 1775	6
Felidae	*Leopardus colocolo*	Colocolo	Molina, 1782	6
Felidae	*Leopardus geoffroyi*	Geoffroyi's cat	D'Orbigny & Gervais, 1844	7
Felidae	*Leopardus guttulus**	Oncilla*	Hensel, 1872	3
Felidae	*Leopardus jabobita*	Andean mountain cat	Cornalia, 1865	2
Felidae	*Leopardus pardalis*	Ocelot	Linnaeus, 1758	21
Felidae	*Leopardus tigrinus**	Oncilla*	Schreber, 1775	7

Felidae	*Leopardus wiedii*	Margay	Schinz, 1821	7
Felidae	*Panthera onca*	Jaguar	Linnaeus, 1758	26
Felidae	*Puma concolor*	Cougar	Linnaeus, 1771	33
Felidae	*Puma yagouaroundi*	Jaguarundi	Saint-Hilaire, 1803	16
Mephitidae	*Conepatus chinga*	Molina's Hog-nosed skunk	Molina, 1782	9
Mephitidae	*Conepatus humboldtii*	Humboldt's Hog-nosed skunk	Gray, 1837	1
Mustelidae	*Eira barbara*	Tayra	Linnaues, 1758	1
Mustelidae	*Galictis cuja*	Lesser grison	Molina, 1782	7
Mustelidae	*Lontra felina*	Marine otter	Molina, 1782	7
Mustelidae	*Lontra longicaudis*	Neotropical otter	Olfers, 1818	20
Mustelidae	*Lontra provocax*	Southern river otter	Thomas, 1908	5
Mustelidae	*Pteronura brasiliensis*	Giant otter	1788	3
Procyonidae	*Nasua narica*	White-nosed coati	Linnaeus, 1766	2
Procyonidae	*Nasua nasua*	South American coati	Linnaeus, 1766	5
Procyonidae	*Potos flavus*	Kinkajou	Schreber, 1774	2
Procyonidae	*Procyon cancrivorus*	Crab-eating raccoon	Cuvier, 1798	8
Ursidae	*Tremarctos ornatus*	Spectacled bear	Cuvier, 1825	7
Total				263

*Some authors consider *L. guttulus* as a subspecies of *L. tigrinus*.

Bibliographic information: bibliography.csv

Table describing all information gathered from 141 studies included in the review.

Data: Reference number, type of reference, sampling years, sampling country, coordinates, name of sampling area, conservation status, co-occurrence information, seasonality information, sample type, predator's identification method, sample size.

Diet information: diet.xlsx

Table describing item's consumption for all 32 species from the screened studies.

Data: predator species, prey taxonomy information, item's categorization, quantitative values of item's frequency in diet, sample size, number of studies' reference

Ecoregions information: Ecoregions.csv

Table describing identified ecoregion from studies coordinates.

Data: number of studies' local reference, coordinates, identified ecoregion

Levins' niche breadth index: mean_Levins_XX.csv

Tables with calculated values of Levins' niche breadth index, using mean of Proportion of Occurrence of diet items, divided in categories, classes and orders (XX), for each species throughout the Neotropical area.

Data: species, mean, variance, minimum and maximal values of Levins' index

Pianka's niche overlap index: matriz_geral_pianka_XX.txt;

matriz_pianka_XX_YY.txt

Matrices with calculated values of Pianka's niche overlap index, using mean of Proportion of Occurrence of diet items, divided in categories, classes and orders (XX) and by ecoregion site (YY), for each species throughout the Neotropical area.

Data: similarity matrices for paired species accordingly from Pianka's index

Network information: mod_XX.JPG; bip_XX_ZZ.JPG

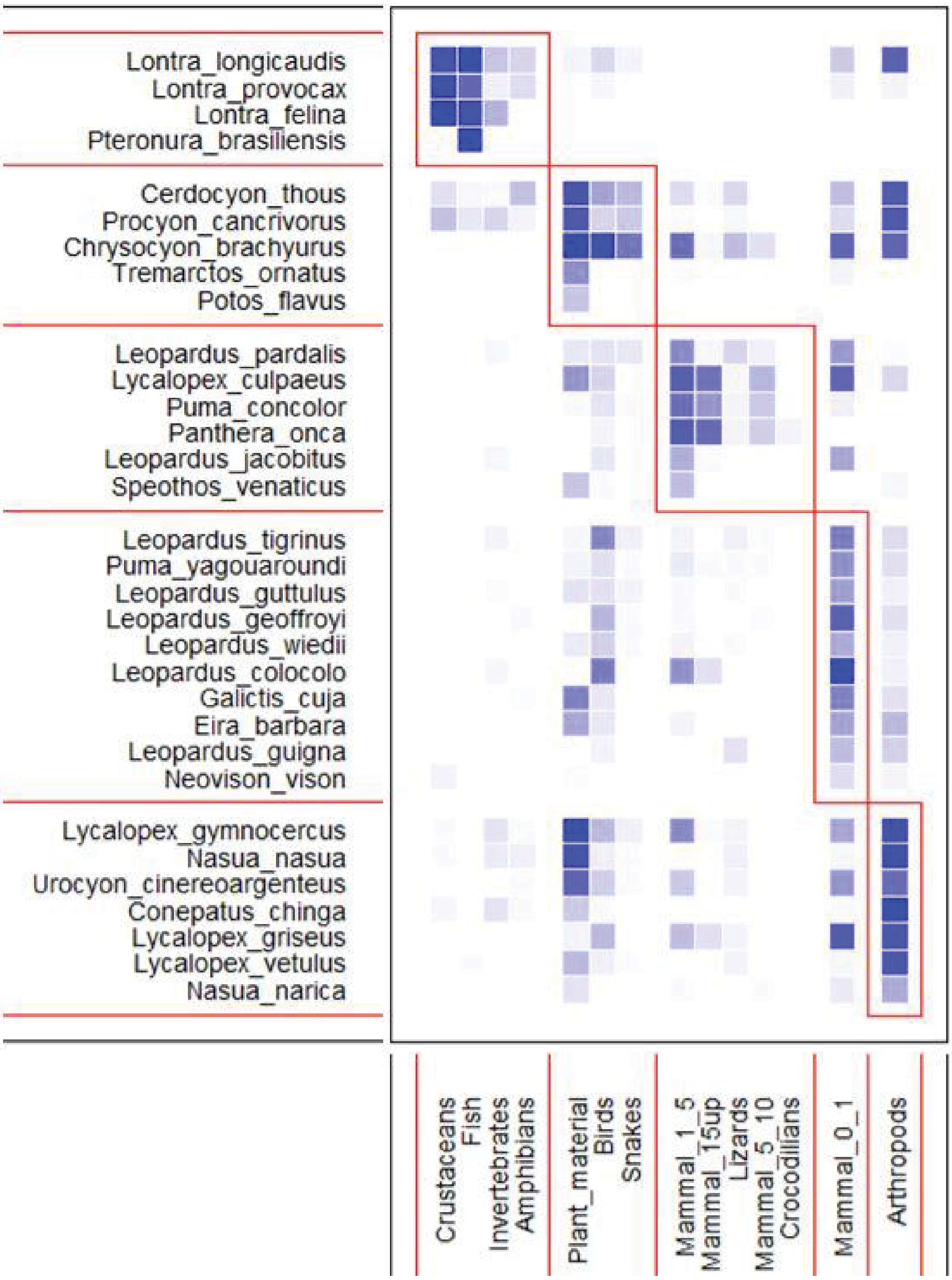
Modularity and bipartite networks plots, using items in categories, classes and orders (XX), based on Proportion and Frequency of occurrence (ZZ).

Supporting Information – Appendix S3

Appendix S3 Description of prey items' criteria to use in categories categorization.

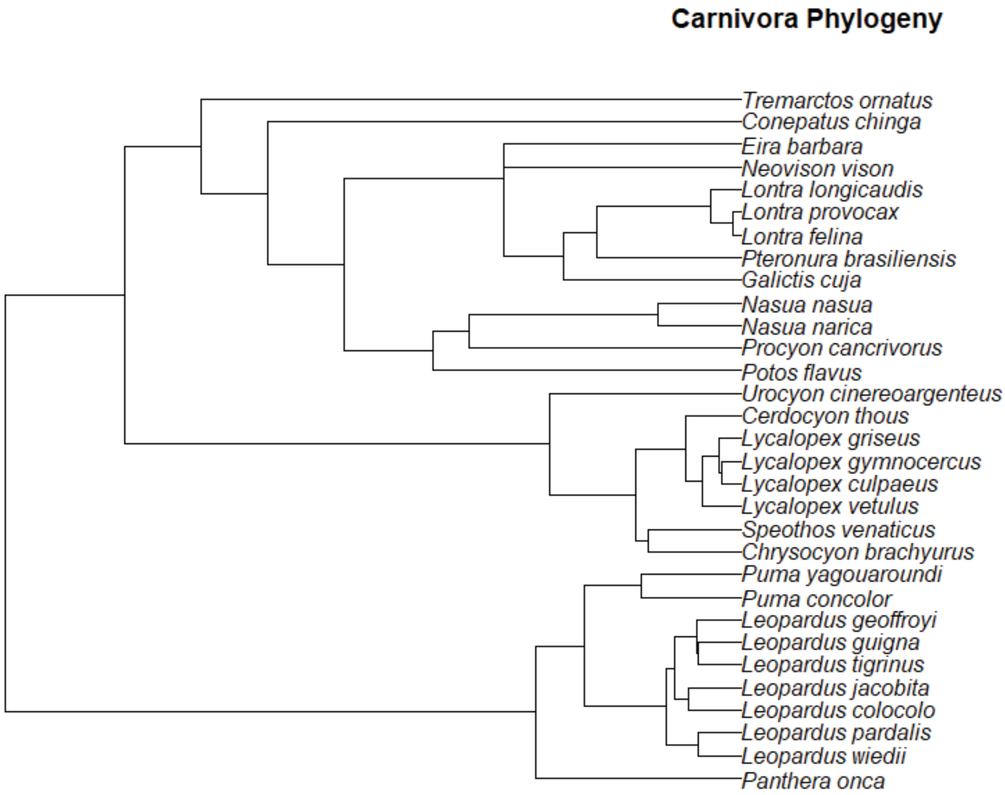
Category	Description
Mammal 0 to 1	Mammalian prey between 0 and 1 kg
Mammal 1 to 5	Mammalian prey between 1 and 5 kg
Mammal 5 to 10	Mammalian prey between 5 and 10 kg
Mammal 10 to 15	Mammalian prey between 10 and 15 kg
Mammal 15 up	Mammalian above 15 kg
Fish	Fishes
Amphibians	Amphibians
Chelonians	Chelonians (or Testudines), including identified eggs
Crocodilians	Crocodilians, including identified eggs
Lizards	Lacertilia, including identified eggs
Snakes	Ophidia, including identified eggs
Aves	Birds, including identified eggs
Plant materials	Plant-based items
Anthropic material	Inedible anthropic material
Invertebrates	Invertebrates, all except Arthropoda
Arthropods	Arthropods, all except Crustacea
Crustaceans	Crustacea
Item n. i.	Non identified items

Supporting Information – Appendix S4

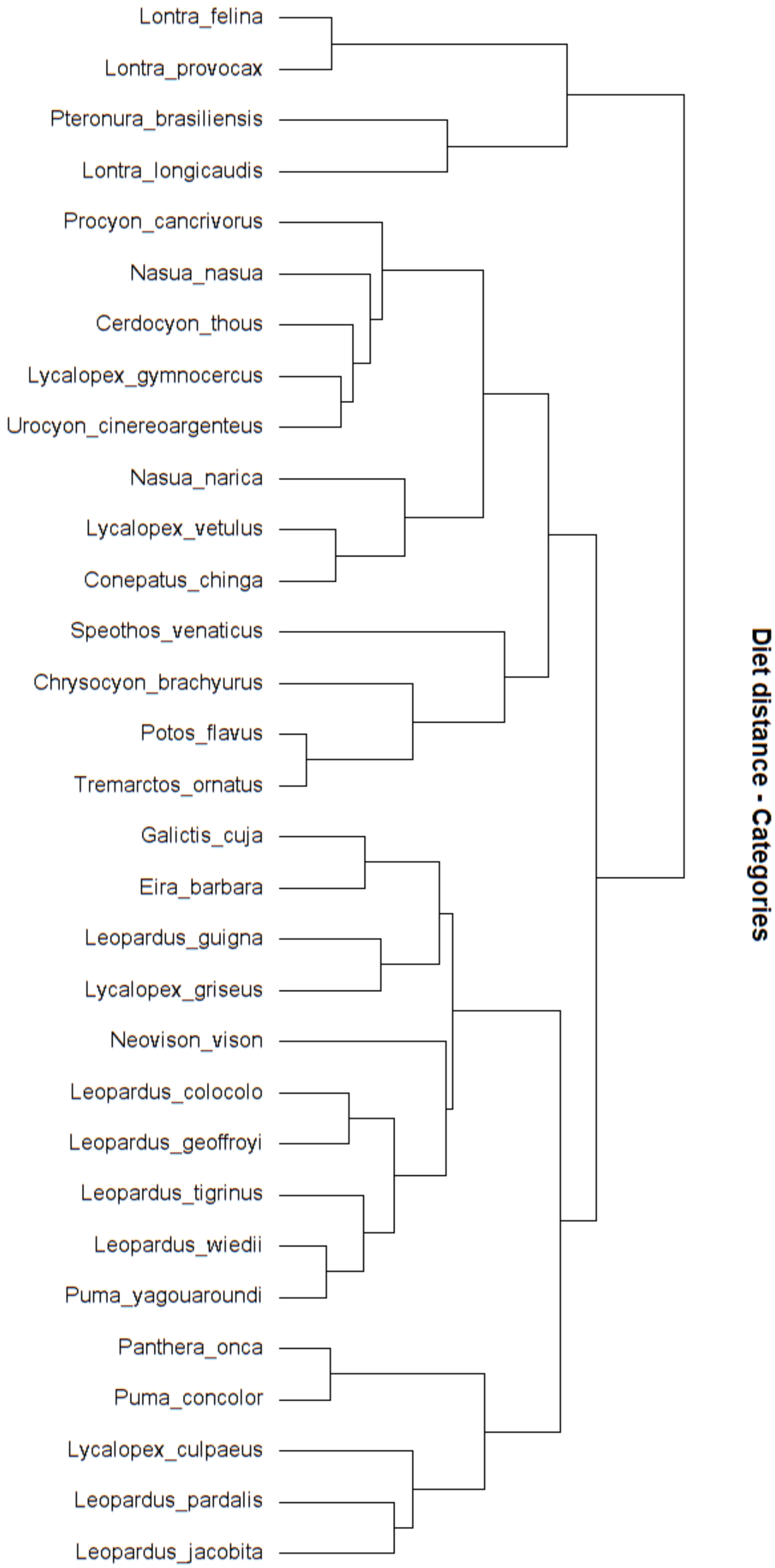


Appendix S4 Modules identified using items' frequency, divided in categories, from network analysis.

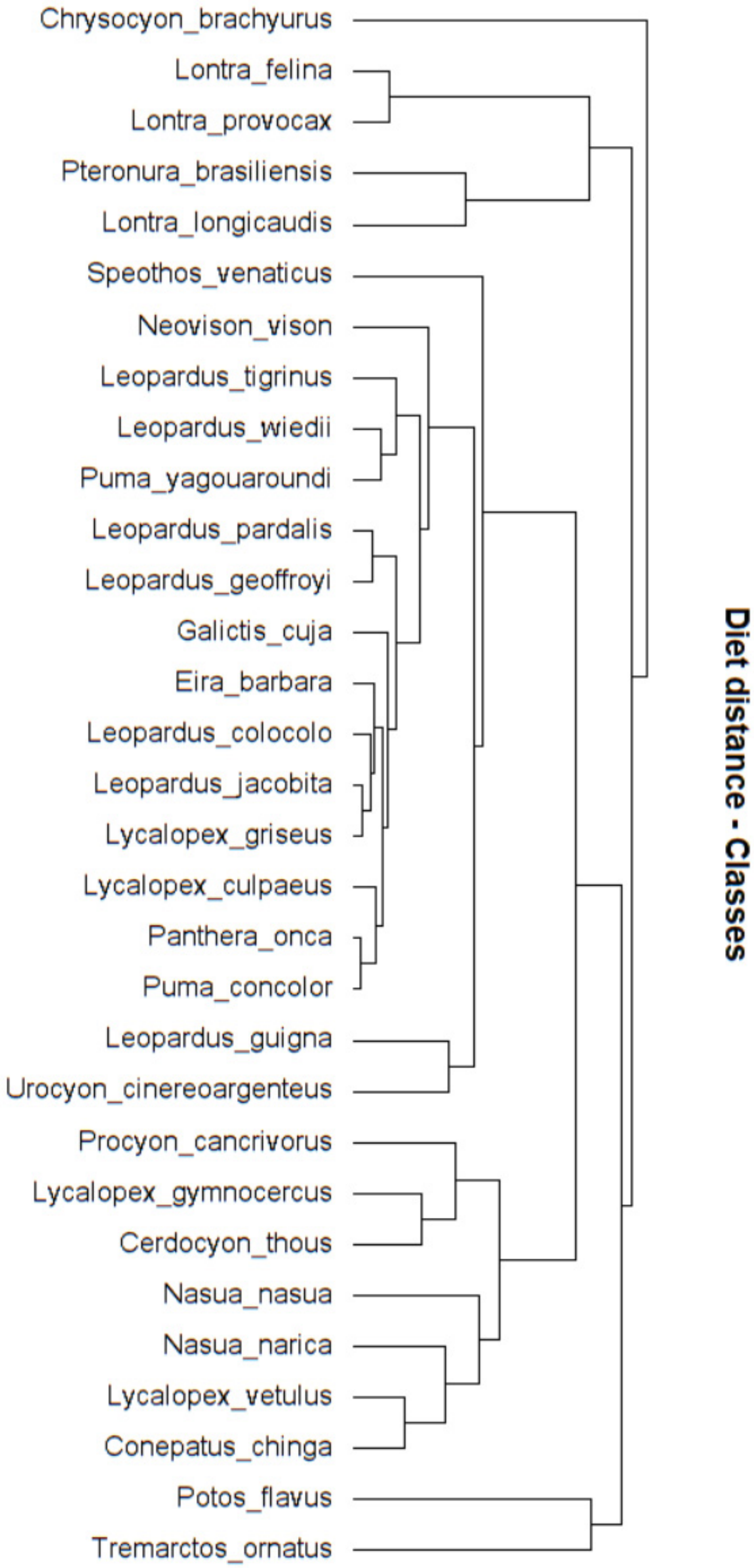
Supporting Information – Appendix S5 – S8



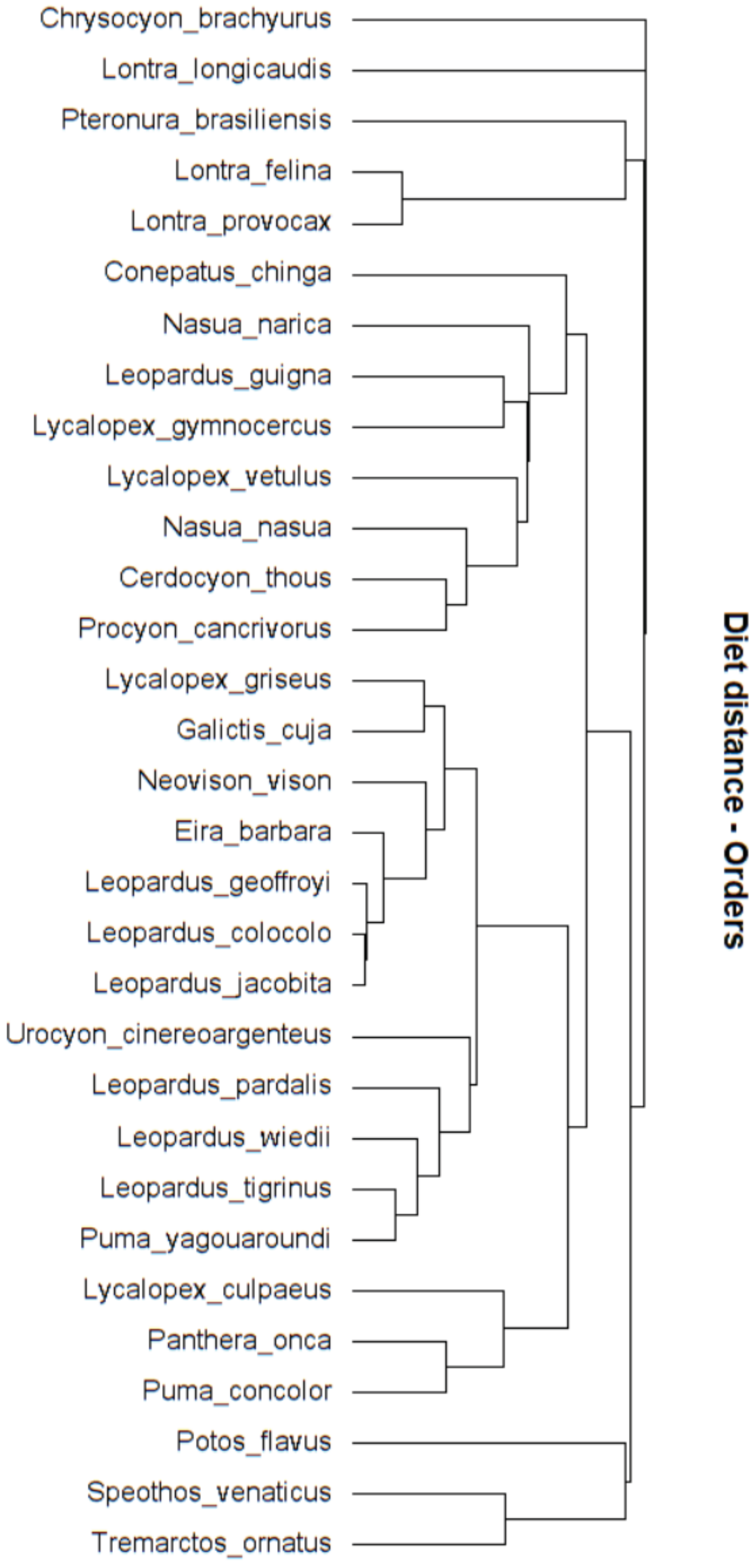
Appendix S5 Phylogeny of species from Carnivora order constructed using TimeTree database.



Appendix S6 Clustering of diet dissimilarity, using items in Categories.



Appendix S7 Clustering of diet dissimilarity, using items in Classes categorization.



Appendix S8 Clustering of diet dissimilarity, using items in Orders categorization.