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Diet composition of the gecko species, *Cyrtodactylus leegrismeri*, on Hon Khoai Island, southern Vietnam

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Abstract. The study investigated the diet composition of *Cyrtodactylus leegrismeri* on Hon Khoai Island, southern Vietnam. A total of 852 prey items representing 25 prey categories were identified from the stomach contents of 128 individuals. The diet of *C. leegrismer* included small invertebrates, with Isoptera (termites) being the primary prey category, followed by Orthoptera, Blattodea, Lepidoptera, Araneae and other prey groups. The species is characterized with a high degree of dietary specialization, consuming a narrow spectrum of prey. There are no significant differences in the overall diet composition of *C. leegrismeri* between seasons (rainy vs. dry) and between habitats (forest vs. road). However, the results documented a lower prey richness in disturbed habitats, with an increased reliance on termites, compared to the prey in forest habitats. Regarding conservation, we highlight the importance of forest protection for safeguarding fauna diversity on Hon Khoai Island.

Keywords. Dietary specialization, Disturbed habitats, Forest, Important index, Seasons, Termites.

INTRODUCTION

Understanding dietary composition is essential in ecological research, as it reveals how organisms adapt to their natural habitats (Lihoreau et al., 2015). As a key element of life history, the diet shapes patterns of energy allocation, survival, reproduction and long-term evolutionary adaptation (Sibly et al., 2012; Barnagaud et al., 2019). Thus, the spatial variation in diet composition can be particularly informative in explaining the local adaption of an endemic species in restricted areas, including islands (Heaney, 2007; Whittaker et al., 2008; Lomolino et al., 2010; Ngo et al., 2024).

With a high level of endemism, the third-largest vertebrate genus – *Cyrtodactylus,* comprising nearly 400 recognized species worldwide, represents an exceptionally complex taxonomic group (Grismer et al. 2021b; Uetz et al., 2026). The diversification of *Cyrtodactylus* species can be better understood through integrative taxonomic approaches, in combination with ecological niche studies, including dietary niche research (Sibly et al., 2012; Barnagaud et al., 2019; Grismer et al., 2021a, 2021b; Ngo et al., 2022; 2025). *Cyrtodactylus leegrismeri* Chan and Norhayati, 2010, was first discovered from a small Malaysian island and reported afterwards from several islands of southern Vietnam, including Hon Khoai Island, Ca Mau Province (Chan and Norhayati, 2010; Grismer and Grismer, 2017; Ngo et al., 2022). The oceanic barrier together with adaptation of populations to distinct niches, including diet composition, might shape the distribution of *C. leegrismeri* on the islands (Hutchinson, 1957; Heaney, 2007; Soberón, 2007). Recently, surveys on Hon Khoai Island by Ngo et al. (2024) documented the diet composition of *Cnemaspis psychedelica,* occuring in syntopy with *Cyrtodactylus leegrismeri*.

The natural forest on Hon Khoai Island has been recently degraded by human activities, leading to a decline in reptile populations (Ngo et al., 2016b, 2018, 2022). The species of *C.*

leegrismeri and other reptiles were even soaked together in rice wine and used for traditional medicine by road workers on Hon Khoai Island (Ngo et al., 2018). Such impacts are thought to further influence both their populations and abundance of prey on the island (Ngo et al., 2024). In the present study, we conducted field surveys on the island, and collected stomach contents of *C. leegrismeri* in both forest and road habitats. Prey items were identified and compared between the rainy season (November 2015) and the dry season (January 2016 and March 2025), and between forest and disturbed habitats. Based on the findings, we examined whether seasonal conditions and human disturbance impact on the species in terms of food selection.

MATERIAL AND METHODS

Study site

Hon Khoai Island is located in Rach Gia Bay, approximately 14.6 km from the mainland of Ca Mau Province in southern Vietnam. It is the largest of 92 islands in the Bay, with the highest peak of 318 m above sea level and a total area of approximately 4 km² (Ngo et al. 2022). The terrestrial ecosystem is primarily characterized by granitic formation and dense forest with small to medium-sized trees (Ngo et al., 2018, 2022). Ngo et al. (2022) recorded a checklist of 19 herpetofaunal species on Hon Khoai Island, including the focal species of *Cyrtodactylus leegrismeri*. The species was observed nocturnally across a range of microhabitats, including granite boulders, branches, leaves on vegetation 0.1–2 m above ground, and the forest floor (Ngo et al. 2022).

Field surveys

Field surveys were conducted in forest habitats and along road trails on Hon Khoai Island, Ca Mau Province, southern Vietnam, during the rainy season in November 2015 (forest), and the dry season in January 2016 (forest) and March 2025 (road) (Fig. 1). Nocturnal excursions were carried out after sunset between 19:00 and 24:00. Individuals were captured by hand and released at the same spot after morphometric measurements and obtaining stomach contents. We identified *C. leegrismer,* based on the following combination of characters: maximum snout-vent length (SVL) up to 92 mm; conical, keeled tubercles on the occiput, body, hind limbs, and tail base (absent on forelimbs); 18–19 longitudinal tubercle rows and 27–35 ventrals at midbody; a single row of enlarged median subcaudals; transversely expanded subdigital lamellae (18–20 under fourth toe); four precloacal pores in an arch, separated from a single row of enlarged, poreless femoral scales; absence of a precloacal groove but presence of a depression; and a dorsal pattern of brown coloration with a dark-brown stripe forming a “V” on the nape, dark head reticulations, irregular dark-brown bands on body and tail, and mottled dark-brown limbs (Chan and Norhayati, 2010; Ngo et al. 2022).

Stomach content analysis

A stomach-flushing technique was used to obtain stomach contents without sacrificing animals (Griffiths, 1986; Norval et al., 2012; Nguyen et al., 2018; Ngo et al. 2024; 2025). Prey items were collected by stomach-flushing with fresh water, using spatula, forceps, two syringes with thread (60 ml), and an infusion tube of soft material (silicon). All collected items were preserved in 70% ethanol and deposited in a refrigerator at a temperature of −4°C at the Institute of Biology (IB), Hanoi, and Hong Duc University, Thanh Hoa Province, Vietnam.

In the laboratory, prey items were identified to the lowest possible taxonomic level, using a stereomicroscope, following CSIRO (1991), Thai (2003) and Triplehorn et al. (2005). The maximum length (L) and width (W) of each prey item were measured to the nearest 0.01 mm using either a digital caliper for large prey or the stereomicroscope with a camera for small prey (Hirai and Matsui, 2001). The prey volume (V, mm^3) was calculated using the formula for a prolate spheroid ($\pi = 3.14$; Magnusson et al., 2003): $V = 4\pi/3 \times (L/2) \times (W/2)^2$.The index of relative importance (Ix), was used to determine the importance of each food category (except for unidentified categories) and was calculated following the formula: $Ix = (\%F + \%N + \%V)/3$ (Caldart et al., 2012), where $\%F = (S_i/St) \times 100$ (F: frequency of occurrence; S_i: number of stomachs with the prey category; S_t: total number non-empty stomachs), $\%N = (N_i/N_t) \times 100$ (N: number; N_i: number of items of a prey category; N_t: total number of of all prey items); $\%V = (V_i/V_t) \times 100$ (V_i: volume per prey category per stomach; V_t: total volume of prey in all stomachs).

Furthermore, we applied the "Dominance" index: $D = \sum[n_i(n_i - 1)]/[N(N - 1)]$, where n_i is the number of food items in the i th taxon category and N is the total number of prey items (Krebs, 1999), ranging from 0 (all prey categories are equally present) to 1 (one category dominates the community), the "Simpson" index $1 - D$ to estimate the dietary heterogeneity (from 0 to 1 as complete evenness among prey categories), and the Shannon index: $H = \sum[(n_i/N) \times ln(n_i/N)]$ to calculate the diversity from 0 with only a single prey category to high values with many prey categories (Magurran, 2004). All these indices were determined using PAST (PAleontological STatistics software, version 4.12; Hammer et al., 2001).

We created a Month × Prey interaction matrix by grouping feeding records by month and summing the number of each prey category. This matrix represents the total prey composition for each survey month. The matrix was then converted into bipartite format and visualized using the "bipartite" package in the R v3.5.2 (RStudio Team, 2018) to compare how prey contributions varied among months (Dormann et al., 2009). Distinct colors were assigned to each month to aid interpretation.

Dietary data on numbers of prey was employed for the Principal Coordinates Analysis (PCoA). All prey items were extracted as numeric columns. A Bray–Curtis distance matrix was computed in the "vegan" package in the PcoA (Oksanen et al., 2016). To visualize group structure, we calculated group centroids and constructed convex hulls for each month. The relationships between prey categories and diet months ordination were assessed, and only the strongest vector loadings (top four) were projected onto the biplot. To test for differences in diet composition among months, we conducted a permutational multivariate analysis of variance (PERMANOVA) with 4,999 permutations. Pairwise differences between months were assessed using pairwise PERMANOVA on all month combinations. A significance level of different comparisons was applied with P-value < 0.05.

Pianka's index of niche overlap (Pianka, 1973) was used to calculate the trophic similarity or segregation among surveyed months of the two seasons, by using the package "EcoSimR" set up with 5000 replications and the "ra3" algorithm (Gotelli and Ellison, 2013), in the Rstudio:

$$O_{ij} = \sum_{n=1}^{0} P_{ij} \times P_{ik} / \sqrt{\sum_{n=1}^{0} P_{ij}^2 \times P_{ik}^2}$$

in which P_{ij} and P_{ik} are the proportions of number of food item i for the species categories j and k, respectively.

RESULTS

Diet Composition

A total of 852 food items representing 25 prey categories were identified from the stomachs of 128 individuals of *Cyrtodactylus leegrismeri* on Hon Khoai Island (Table 1). The diet primarily consisted of small-sized invertebrates, encompassing 15 orders of the class Insecta and other taxa belonging to Arachnida, Crustacea, and Annelida. It is noteworthy that we found attached plant parts (including leaves) together with invertebrate prey, and shed skin of *C. leegrismeri* in the stomach contents (Table 1).

Isoptera was identified as the primary prey category of *C. leegrismeri*, accounting for the highest frequency of occurrence (F = 0.41, 27%), the largest number of prey items (N = 670, 78.6%), and the highest importance index (Ix = 48.28%) (Table 1). Some prey groups also played a vital role in the species' diet, including Orthoptera (Ix = 16.62%), Lepidoptera (7.02%), Blattodea (11.55%), and Araneae (7.68%). Remaining prey categories only occurred with small frequencies, limited numbers, and low importance values (Table 1).

Seasonal Variation

The stomach contents of *C. leegrismeri* were collected in three different months and we identified 298 prey items of 57 individuals in November 2015 of the rainy season, and 205 items of 44 individuals in January 2016 and 349 items of 27 individuals in March 2025 of the dry season, corresponding to the number of prey categories with 19, 18 and 11, respectively (Table 1; Fig. 2). Isoptera consistently presented as the dominant prey group of *Cyrtodactylus leegrismeri* on the island in all three months, exhibiting the highest frequency and abundance values (Fig. 3). The importance index (Ix) score of Isoptera exceeded 35% in all periods, and even reached over 80%

in March 2025. During the rainy season (November 2015), Orthoptera, Lepidoptera, and Blattodea were the following important prey groups (Ix values > 10%) (Table 1; Figs 2-3). During the dry season, Orthoptera (Ix = 21.91%) and Blattodea (Ix = 17.28%) also represented key components of the diet in January 2016, and Orthoptera (Ix = 18.27%) and Araneae (Ix = 12.93%) were identified as major prey categories in March 2025 (Table 1; Figs 2-3).

In November 2015 (rainy season) and January 2016 (dry season), the estimated values of Dominance_D and Simpson_1–D were approximately 0.5, indicating a moderate level of dietary diversity and prey dominance. Similarly, the Shannon diversity index (Shannon_H) reflected a medium level of prey richness, ranging from 1.28 to 1.33. However, these values were significantly different from those recorded in March 2025 (dry season). In particular, the value of Dominance_D, increased to a higher level, averaging 0.8 (95% CI: 0.74–0.84), while Simpson_1–D decreased to less than half, averaging 0.199 (95% CI: 0.15–0.26) in March 2025. The Shannon_H index likewise presented a threefold decline, averaging 0.55 (95% CI: 0.45–0.70), suggesting a reduction in the prey richness, during this month (Table 2). The species exhibited a consistently narrow trophic niche across the surveyed months, with low estimated niche breadth (B = 1.6–1.95) and standardized values (< 0.06), indicating a highly selective feeding strategy (Table 2). Notably, the standardized niche breadth in March 2025 was extremely lower than in the two remaining months (Table 2).

Pianka's index revealed a relatively high degree of dietary overlap (P-value > 0.65) among the survey months of the two seasons on Hon Khoai Island, indicating a similarity in the prey use by *C. leegrismeri* (Fig. 4). The PCoA analysis showed that the first two axes accounted for 19.2% (PCo1) and 14.9% (PCo2) of the variance in dietary composition of *C. leegrismeri* among the three months. The PCoA ordination indicated a considerable overlap in the dietary variance space among months and between the two seasons, with no significant differences (PERMANOVA, P-values > 0.05; Fig. 5). Based on the ordination of dietary space, Blattodea primarily contributed to the central position observed in January 2016, Orthoptera predominantly to March 2025, and Isoptera to both November 2015 and March 2025 (Fig. 5).

Habitat Comparison

We documented somewhat different patterns in the diet composition of *C. leegrismeri* between forest and disturbed habitats. Specifically, two surveys in the sites of undisturbed forest, recorded 19 (November 2015) and 18 prey categories (January 2016) (Fig. 1C), whereas the survey conducted along road transects (March 2025; Fig. 1D), yielded only 11 prey categories. In disturbed habitats, several prey groups, such as Diptera, Oniscomorpha, Cestoda, Opiliones, Gastropoda and Insecta others, were not found in the stomach contents of *C. leegrismeri*. The Shannon diversity index (Shannon_H) and the standardized dietary niche breadth declined by more than twice in the disturbed habitats, but the dominance index (Dominance_D) increased (from 0.5 to 0.8) (Table 2).

DISCUSSION

Stomach contents were obtained from 128 individuals of *C. leegrismeri* during both the rainy season (November 2015) and dry season (January 2016 and March 2025), identified with a total of 25 prey categories. The species presented a high degree of dietary specialization, with a high dependence on Isoptera. The standardized niche breadth values were extremely narrow (< 0.06) and the Shannon_H diversity values were also small (0.55–1.33), indicating that the species has a narrow dietary range and exhibits selective feeding on specific prey categories. The results confirm the central role of Isoptera in the trophic composition of *C. leegrismeri* on Hon Khoai Island. In addition, the study identified other prey groups such as Orthoptera, Blattodea, Lepidoptera, and Araneae as important dietary components for *Cyrtodactylus leegrismeri* on the Island. In natural habitats, geckos have often been reported feeding on termites, spiders, grasshoppers, and ants (Vitt and Zani, 1997; Vitt et al., 1997; Zamprogno and Teixeira, 1998; Colli et al., 2003; Bonfiglio et al., 2006; Rocha and Anjos, 2007; Iturriaga and Marrero, 2013; Ngo et al., 2016a, 2024, 2025; Amadi et al., 2020; Le et al., 2025).

Regarding the seasonal variation in the dietary composition, Isoptera was the most dominant prey, and Pianka's index values indicating high dietary overlap among survey months and between the two seasons. This pattern suggests that termites serve as a key food resource for *C. leegrismeri,* due to their availability on Hon Khoai Island throughout both the rainy and dry seasons. The reliance on ground-dwelling Isoptera may relate to the species' ground-foraging habit, as *C. leegrismeri* was normally observed on the forest floor of soil substrate type or on trees at a low height above the ground (Ngo, pers. obs.; Fig. 1). Another syntopic species, the Psychedelic rock gecko *Cnemaspis psychedelica,* mainly occurring on rocky outcrops of the island (Ngo et al., 2018), exhibited a higher consumption of Hymenoptera and Araneae (Ngo et al., 2024). For other tree or ground-foraging lizard species, such as *Eutropis multifasciatus* (Ngo et al., 2014) and *Physignathus cocincinus* (Nguyen et al., 2018), their food contents were dominated by Isoptera and Formicidae. Meanwhile, rock-dwelling species, such as *Goniurosaurus catbaensis* and *G. huuliensis* were found to feed predominantly on Arachnida and Orthoptera (Gryllidae), respectively (Ngo et al., 2016a; Le et al., 2025). Ngo et al. (2025) also identified Araneae as the most important prey in the diet composition of the rock-dwelling *Cyrtodactylus nigriocularis* in the southern mainland of Vietnam. The differences suggest that the dietary partitioning between the ground+tree species group (including, *C. leegrismeri*) and the rocky species group (*C. psychedelica*) might be associated with preferred microhabitat use and foraging behavior. In particular, *C. psychedelica,* a fast-moving and rock-dwelling species, prefers winged prey of Hymenoptera and Araneae, whereas *C. leegrismeri,* a slower-moving and ground+tree-dwelling species, tends to exploit the abundant termite colonies on the forest floor (Ngo et al., 2018, 2024; Ngo per. obs). Such niche partitioning likely reduces interspecific competition for food resources, facilitating the coexistence and abundance of both syntopic gecko species on the resticted area of Hon Khoai Island (Capitán et al., 2015; Ngo et al., 2018, 2022).

The results revealed that human activities degrading the forest on Hon Khoai Island (Ngo et al. 2018, 2022), are associated with the biased diet composition of *C. leegrismeri*. Although termites (Isoptera) remained the dominant prey across all habitats, *C. leegrismeri* increasingly relied on this prey group in disturbed habitats where overall prey richness was reduced. Unlike groups absent from the diet contents of *C. leegrismeri* in the disturbed-open roads on Hon Khoai Island (such as, Diptera, Oniscomorpha, Cestoda, Opiliones, and Gastropoda), termites characteize a physiological thermal tolerance with complex nest-building behavior that buffers environmental extremes, allowing them to persist across both thermally stable forest habitats and more variable disturbed-open environments (Korb, 2003; Jones and Oldroyd, 2006; Woon et al., 2022). In contrast, the groups rely more on intrinsic physiological flexibility (e.g., Diptera) or moisture-dependent microhabitats (Cestoda, Oniscomorpha, Opiliones, Gastropoda), which generally restricts them to more buffered forest conditions or limits their activity in disturbed, open habitats with greater thermal and hydric stress (Edney, 1977; Willmer, 1982; Huey and Kingsolver, 2008).

In conclusion, there are no significant differences in the overall diet composition of *C. leegrismeri* between seasons (rainy vs. dry) and between habitats (forest vs. road). However, our findings recorded an increased reliance on termites and less prey richness in the disturbed habitats.

The shifts may result in the nutritional imbalance, and even pose a threat to the species if termite availability declines. Together with the study of Ngo et al. (2024) on *Cnemaspis psychedelica* (Endangered, IUCN Red List), we recommend protecting forest habitats. The protection is therefore essential for the long-term persistence of *C. leegrismeri, C. psychedelica* and other herpetofauna on Hon Khoai Island.

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Tables.

Table 1. Dietary composition of *Cyrtodactylus leegrismeri* between rainy and dry seasons, in forest and road habitats, on Hon Khoai Island, Ca Mau Province (F – Frequency ; N – Number ; V – Volume ; Ix – Index of relative importance)

	Rainy season				**Dry season**								**Total**			
	November – 2015 (Forest)				January – 2016 (Forest)				March – 2025 (Road)							
	F	N	V	Ix	F	N	V	Ix	F	N	V	Ix	F	N	V	Ix
Araneae	0.11	6	2292.37	8.16	0.07	3	273.42	3.43	0.33	9	226.39	12.93	0.14	18	2792.18	7.68
Amblypygi	0.02	1	183.34	1.02									0.01	1	183.34	0.45
Opillions	0.09	5	306.70	4.02	0.02	1	10.09	0.95					0.05	6	316.79	2.06
Blattodea	0.14	10	2433.47	10.02	0.32	16	1691.42	17.38	0.15	4	268.32	6.45	0.20	30	4393.21	11.55
Coleoptera	0.02	1	8.94	0.71	0.02	1	100.93	1.17	0.07	2	6.57	2.69	0.03	4	116.44	1.29
Diptera	0.02	1	4.35	0.70	0.02	1	2.28	0.93					0.02	2	6.63	0.60
Ephemeroptera									0.04	1	13.65	1.39	0.01	1	13.65	0.31
Hemiptera	0.04	2	58.91	1.50	0.02	1	25.61	0.98	0.04	1	257.57	2.42	0.03	4	342.09	1.48
Hymenoptera	0.02	2	20.58	0.84									0.01	2	20.58	0.36
Hymenoptera-Formicidae	0.09	26	78.48	5.97	0.02	1	0.64	0.92	0.04	1	0.24	1.33	0.05	28	79.35	2.98
Isoptera	0.32	211	1974.41	37.56	0.30	147	2233.43	39.26	0.81	312	5861.95	81.73	0.41	670	10069.8	48.28
Lepidoptera	0.02	2	5331.96	10.07	0.02	1	684.49	2.61	0.15	4	292.79	6.56	0.05	7	6309.23	7.02
Orthoptera	0.09	5	4692.43	11.63	0.11	6	6953.94	21.91	0.41	12	839.44	18.27	0.16	23	12485.8	16.62
Thysanoptera					0.05	2	262.18	2.49					0.02	2	262.18	0.81
Thysanura					0.07	13	32.88	4.47					0.02	13	32.88	1.32
Insect - others	0.05	3	219.21	2.47	0.07	3	16.87	2.80					0.05	6	236.08	1.99
Insect larva	0.02	1	26.70	0.74									0.01	1	26.70	0.32
Isopoda					0.05	4	43.24	2.27	0.07	2	110.91	3.13	0.03	6	154.14	1.40

Oniscomorpha	0.11	6	46.47	4.26	0.02	1	26.13	0.98					0.05	7	72.61	2.16
Polydesmoidea	0.02	1	82.38	0.84									0.01	1	82.38	0.37
Lumbricina					0.02	1	601.52	2.40					0.01	1	601.52	0.79
Polydesmida									0.04	1	11.48	1.38	0.01	1	11.48	0.31
Scolopendromorpha	0.02	1	42.90	0.77									0.01	1	42.90	0.33
Cestoda	0.16	9	1159.92	8.28	0.05	2	526.61	3.14					0.09	11	1686.53	4.68
Gastropoda	0.07	5	229.02	3.30	0.02	1	32.38	1.00					0.04	6	261.40	1.75
Plant parts	0.01	1											0.01	1		
Shed skin									0.01	1			0.01	1		
Total	**57**	**298**	**19193**	**112.87**	**44.00**	**205**	**13518**	**109.09**	**27.00**	**349**	**7889.30**		**128.00**	**852**	40599.9	

Table 2. Dominance (D), Simpson (1−D), Shannon indices (H) and Niche breadth of *Cyrtodactylus leegrismeri,* among three survey months, in forest and road habitats on Hon Khoai Island.

	November (Forest)			**January (Forest)**			**March (Road)**		
		95% Lower	95% Upper		95% Lower	95% Upper		95% Lower	95% Upper
Taxa_S	19			18			11		
Individuals	298			205			349		
Dominance_D	0.51	0.44	0.57	0.52	0.43	0.59	0.80	0.74	0.84
Simpson_1-D	0.49	0.43	0.56	0.48	0.41	0.57	0.19	0.16	0.26
Shannon_H	1.33	1.18	1.52	1.28	1.11	1.51	0.55	0.45	0.70
Niche breadth	1.95			1.89			1.61		
Standardized Niche breadth	0.05			0.05			0.02		

Legends of figures

Fig. 1. *Cyrtodactylus leegrismeri* on a tree (A), on the ground (B), and habitat types of (C) forest (D) road on Hon Khoai Island

Fig. 2. Frequency; Number; and Importance index of prey categories consumed by *Cyrtodactylus leegrismeri* during survey months, on Hon Khoai Island

Fig. 3. The Bipartite network for prey contributions of *Cyrtodactylus leegrismeri* varied among months

Fig. 4. The simulated Pianka's index of trophic niche overlap among survey months of *Cyrtodactylus leegrismeri* on Hon Khoai Island (The red line indicates the observed overlap).

Fig. 5. The PcoA comparison of diet niches of *Cyrtodactylus leegrismeri* among three month surveys, with contribution of strongest prey categories, explained by axes of principal components (PCo1 and PCo2).

Fig. 1.

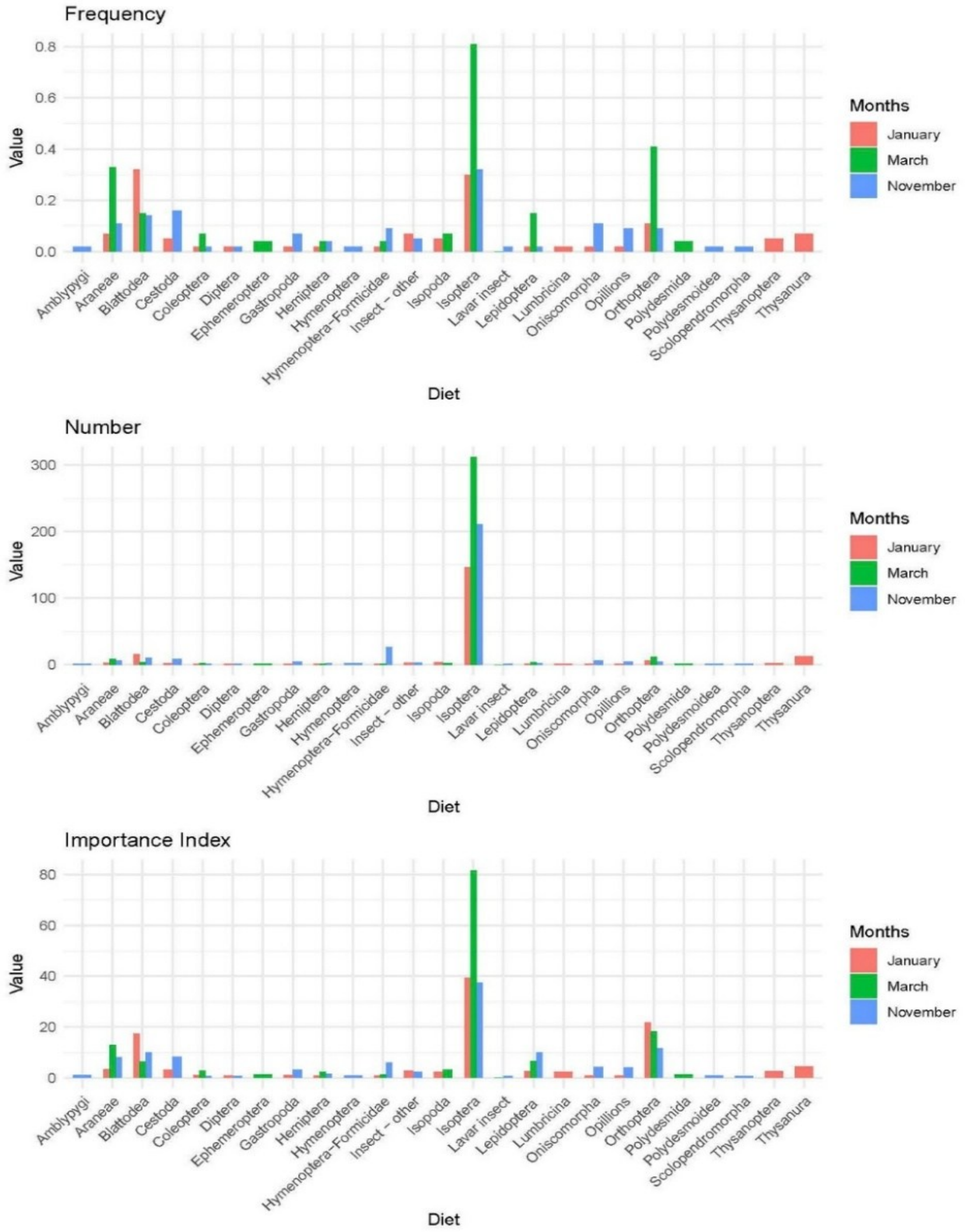
Frequency
Value
0.8
0.6
0.4
0.2
0.0
Diet
Number
Value
300
200
100
0
Diet
Importance Index
Value
80
60
40
20
0
Diet
Amblypygi
Araneae
Blattodea
Cestoda
Coleoptera
Diptera
Ephemeroptera
Gastropoda
Hemiptera
Hymenoptera
Hymenoptera-Formicidae
Insect - other
Isopoda
Isoptera
Lavar insect
Lepidoptera
Lumbricina
Oniscomorpha
Opillions
Orthoptera
Polydesmida
Polydesmoidea
Scolopendromorpha
Thysanoptera
Thysanura
Months
January
March
November

Fig. 2.

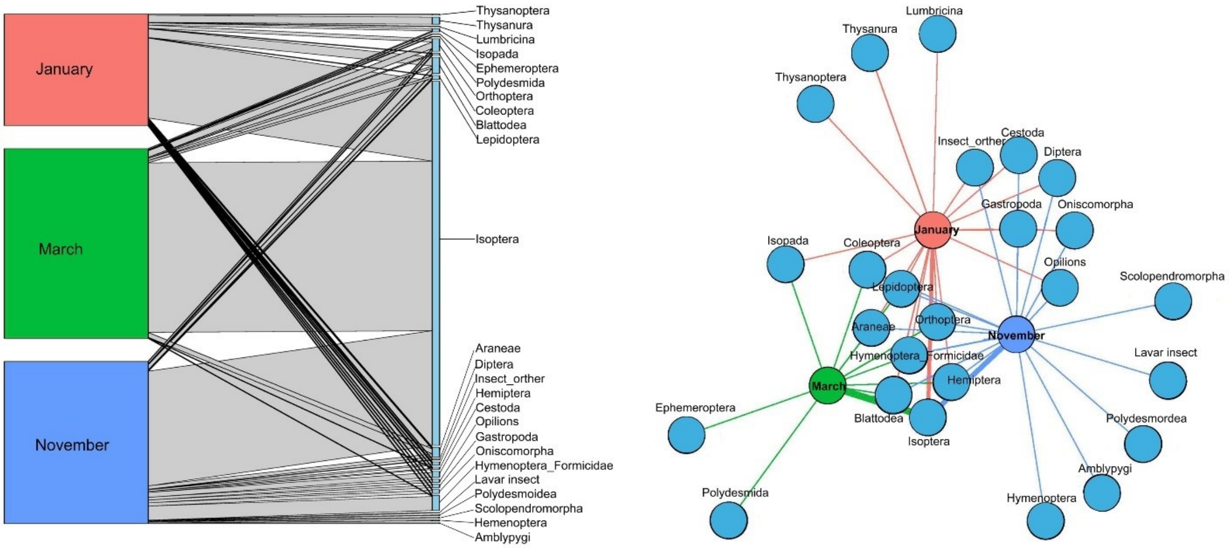
January
March
November
Thysanoptera
Thysanura
Lumbricina
Isopada
Ephemeroptera
Polydesmida
Orthoptera
Coleoptera
Blattodea
Lepidoptera
Isoptera
Araneae
Diptera
Insect_orther
Hemiptera
Cestoda
Opilions
Gastropoda
Oniscomorpha
Hymenoptera_Formicidae
Lavar insect
Polydesmoidea
Scolopendromorpha
Hemenoptera
Amblypygi
Lumbricina
Thysanura
Thysanoptera
Insect_orther
Cestoda
Diptera
Gastropoda
Oniscomorpha
January
Isopada
Coleoptera
Opilions
Scolopendromorpha
Lepidoptera
Orthoptera
Araneae
November
Hymenoptera_Formicidae
Lavar insect
Hemiptera
March
Ephemeroptera
Blattodea
Isoptera
Polydesmordea
Amblypygi
Polydesmida
Hymenoptera

Fig. 3.

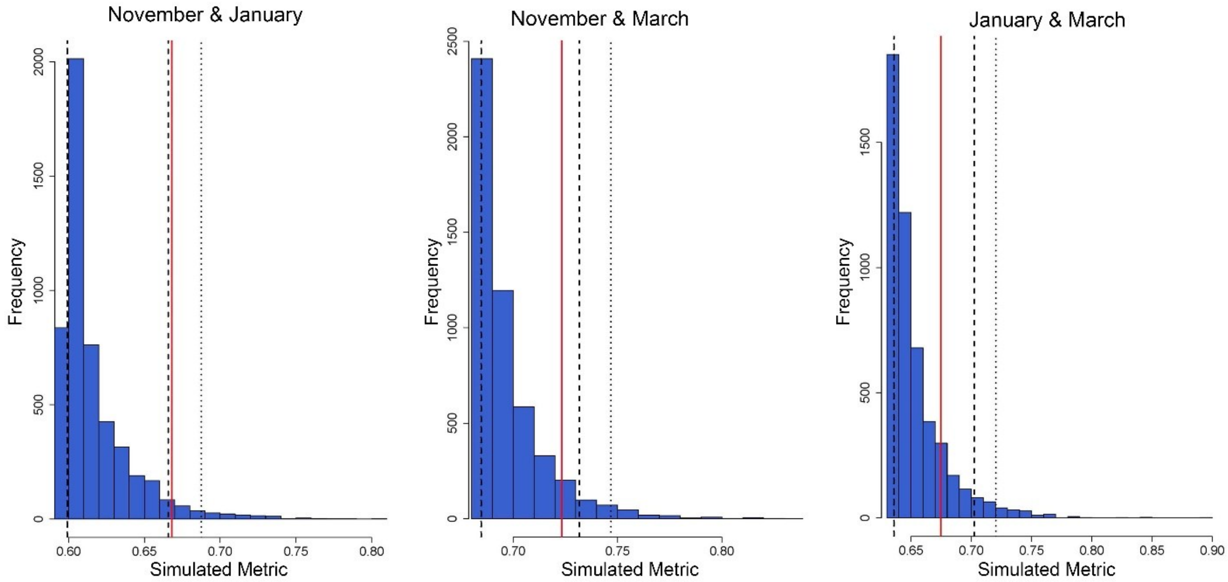
November & January
Frequency
0
500
1000
1500
2000
0.60
0.65
0.70
0.75
0.80
Simulated Metric
November & March
Frequency
0
500
1000
1500
2000
2500
0.70
0.75
0.80
Simulated Metric
January & March
Frequency
0
500
1000
1500
0.65
0.70
0.75
0.80
0.85
0.90
Simulated Metric

Fig. 4.

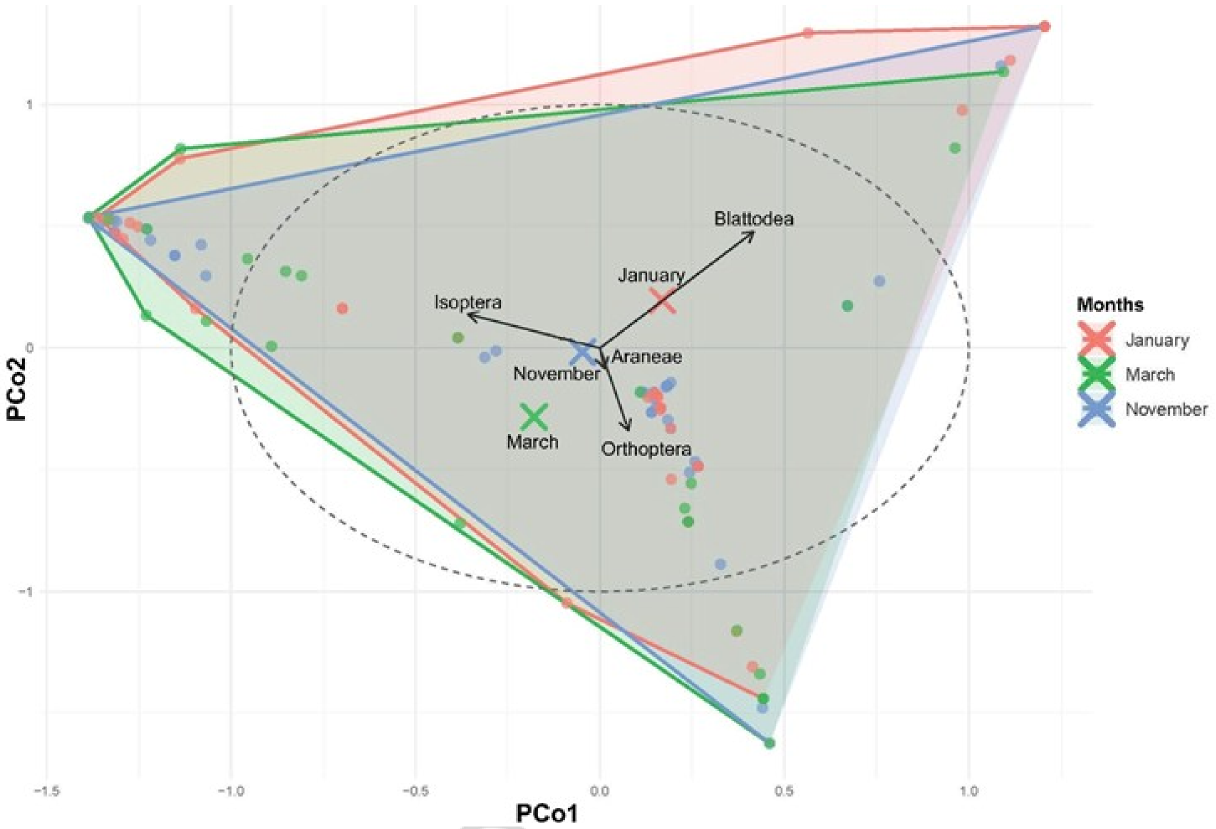
Blattodea
January
Isoptera
Araneae
November
March
Orthoptera
Months
January
March
November
PCo2
1
0
-1
PCo1
-1.5
-1.0
-0.5
0.0
0.5
1.0

Fig. 5.