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Morphological Similarity and Taxonomic Confusion Between Neoscona (Araneidae) Species: Neoscona adianta (Walckenaer, 1802) and Neoscona byzanthina (Pavesi, 1876)

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Abstract

This study presents a comparative morphological analysis of the closely related species *Neoscona adianta* (Walckenaer, 1802) and *Neoscona byzanthina* (Pavesi, 1876) (Araneidae). A total of 100 specimens representing these two species were examined, and 83 morphological characters were identified. A dataset was constructed and scored based on these characters, including morphological features of the prosoma, opisthosoma, spinnerets, as well as male and female genital structures. Principal Coordinate Analysis (PCoA) and the Unweighted Pair Group Method with Arithmetic Mean (UPGMA) were applied to the dataset to generate scatter plots and dendrograms illustrating morphological relationships among the specimens. The results indicated that specimens of *N. adianta* and *N. byzanthina* could not be reliably distinguished based on habitus-related morphological characters or genital morphology. Analyses based solely on female genital characters allowed partial separation of the species, whereas male genital characters exhibited limited discriminatory power. Overall, the findings suggest that these taxa are not fully differentiated and that *N. byzanthina* may represent a subspecies of *N. adianta*. However, further integrative and comprehensive comparative studies are required to clarify the taxonomic relationship between these taxa.

Introduction

Neoscona Simon, 1864, belongs to the family Araneidae and can be readily distinguished from other genera by the characteristic oval shape of the opisthosoma and its distinctive zigzag pattern (Nentwig et al., 2026). The genus comprises 124 species worldwide, ranking fifth in species richness within the family (World Spider Catalog, 2026). *Neoscona adianta* (Walckenaer, 1802) and *Neoscona byzanthina* (Pavesi, 1876) are among the most taxonomically controversial species within the genus (Geci and Naumova, 2021). The species identified as *N. byzanthina* is a poorly studied orb-weaving spider and was only relatively recently recognized as a valid species by Ledoux (2008). This species was originally described by Pavesi (1876) as *Epeira byzanthina* and was later described by Simon (1879) as *Epeira turcica*, based on specimens collected from Istanbul, Turkey. Simon (1884) subsequently acknowledged the priority of *E. byzanthina* when he reported this species for the first time from Greece (Euboea Island). Subsequently, both names were treated as synonyms of the widespread European species Neoscona adianta (Walckenaer, 1802) by Simon (1929). However, Ledoux (2008) re-established *Neoscona byzanthina* as a distinct species from the closely related *N. adianta*, based on a series of morphological characters, including genital structures. These two species have been primarily evaluated based on their external morphology, with *N. byzanthina* generally distinguished from *N. adianta* by its larger body size, opisthosomal pattern (in which the first lateral extensions of the opisthosomal bands are slightly smaller and the overall opisthosomal pattern is more variable than in *N. adianta*), and femora that are typically darker apically (Mora-Rubio et al., 2019). To date, studies addressing these two species have been presented mainly as new records or checklist contributions rather than detailed morphological descriptions and comparative analyses (Danısman et al, 2025; Demircan Aksan N, Topçu A (2022c), Pintilioaie A-M, Urák I, (2022a); Bolognin et al, 2021; Maro Rubio et al, 2019; Blick 2018; Bosman et al,

2013; Ivanov,2013; Rozwałka R, Stanska M (2008); Bosman and Chatzaki, 2005; Kronestedt 2001; Gajdoš et al, 1999).

The aim of this study was to compare *N. adianta* and N. *byzanthina* based on 83 morphological characters identified from their specimens in order to elucidate their similarities and differences.

Materials and Methods

Specimens were collected from the provinces of Çorum, Samsun, Sinop, and Amasya, located in the Black Sea Region of Türkiye, using an aspirator, hand collecting, and sweep-netting from vegetation. A total of 100 specimens belonging to *N. adianta* and *N. byzanthina* were examined, and 83 morphological characters were identified. Morphological characters were determined through direct examination using an Olympus SZX12E trinocular stereomicroscope. For specimens of both species, the following morphological features were examined: eye shapes; dorsal and lateral patterning of the prosoma; sternum shape; dorsal, lateral, and ventral patterning of the opisthosoma; structure and positioning of the spinnerets; and the morphology of male and female genital structures. The identified characters were scored as present (1) or absent (0) through manual entry in Microsoft Excel, and a data matrix was subsequently constructed (Appendix1 and Supplementary Table 1). The resulting data matrix was analyzed using the Dice similarity coefficient in PAST version 4.05, and an UPGMA dendrogram and PCoA scatter plots were generated. The collected specimens are preserved in 96% ethanol at – 20°C in the Zoology Laboratory of the Department of Biology, Faculty of Arts and Sciences, Gaziantep University.

Results

UPGMA and PCoA analyses were performed based on the morphological characters identified for *N. adianta* and *N. byzanthina* (excluding characters related to genital structures). According to the results of these analyses, no clear separation between the species was observed, and the dendrograms revealed mixed clustering of the two species (Figs. 1 and 2).

UPGMA and PCoA analyses were performed based solely on the morphological characters of male sexual structures (Figs. 3 and 4). Examination of the results indicated that no clear separation could be observed among the male specimens (n = 20) of *N. adianta* and *N. byzanthina*. This suggests that the male sexual characters of both species are insufficient for reliably distinguishing between them.

Data for UPGMA and PCoA analyses were obtained using only the morphological characters of female sexual organs based on the Dice coefficient (Figs. 5 and 6). The results indicated that partial separation could be observed among the female specimens (n = 80) of *N. adianta* and *N. byzanthina*.

Discussion

The main focus of this study was the morphological similarity between Neoscona adianta and *Neoscona byzanthina*. Previous studies have also highlighted their close resemblance. Simon (1929) treated *N.*

byzanthina as a synonym of *N. adianta*, a species widely distributed in Europe. Later, Ledoux (2008) revalidated *N. byzanthina* as a distinct species, separate from the morphologically similar *N. adianta*. Comparative analyses of external morphology by Mora-Rubio et al. (2019) indicated that *N. byzanthina* differs *from N. adianta* by its larger overall size, the pattern of the opisthosoma (with the initial extensions of the opisthosomal bands being slightly smaller and the pattern more variable than in *N. adianta*), and generally darker apical femora. Geci and Naumava (2021) further reported that males of *N. byzanthina* are notably larger and more robust, whereas no significant morphological differences were observed among females. These findings are further supported by the UPGMA and PCoA analyses presented in Figs. 3–6. While sexual characters of male specimens were found to be insufficient for reliably distinguishing the species, partial separation could be achieved among female specimens.

Ledoux (2008) reported that *N. byzanthina* is generally larger than *N. adianta* and does not typically occur in highly humid habitats. He also observed that adult *N. adianta* are usually active in June and July, whereas adult *N. byzanthina* are primarily observed in August and September. In contrast, in the present study, specimens of both species were collected in June and July, including adult individuals of both species. Contrary to Ledoux (2008), no consistent size differences were detected between *N. byzanthina* and *N. adianta*. Although Ledoux (2008) was the first to revalidate *N. byzanthina*, the morphological distinctions reported in his study were insufficient to provide clear diagnostic criteria for differentiating the two species.

In this study, morphological differences reported in the literature were taken as references, and examinations were conducted using characters determined excluding genital structures to distinguish between *N. adianta* and *N. byzanthina*. In female specimens, distinct differences were observed particularly in the opisthosomal patterning, whereas such differences were not detected in male individuals. These variations observed in females, which were considered to be associated with geographic location, were found to be insufficient for reliable species discrimination. Based on this outcome, both male and female specimens were re-examined with genital structures included in the analyses. According to the evaluated characters, female specimens exhibited a partial clustering pattern distinguishing the two species; however, similarities in the epigynal structures created difficulties in species separation. Similarly, analyses conducted by including the pedipalp structures of male individuals did not reveal a species-level separation comparable to that observed in females. The overall morphological similarities observed in male specimens, together with the resemblance in pedipalp structures, were found to be inadequate for distinguishing the two species. Indeed, analyses based solely on habitus characteristics are generally considered insufficient for clear species-level discrimination in spiders, particularly within diverse groups such as Araneae, where morphological variation is often high. Furthermore, examinations performed at the genital level may also present relative challenges in morphologically similar species such as *N. adianta* and *N. byzanthina*, and the findings obtained from such analyses may vary among researchers.

According to the PCoA and UPGMA analyses performed based on all morphological data obtained in this study, a clear species-level separation could not be achieved due to the high morphological similarity

between the two species; however, location-dependent variations were observed. In conclusion, no morphological characters capable of reliably distinguishing the two species were identified. Although the opisthosomal characteristics of both taxa exhibited variation depending on seasonal conditions and sampling localities, these variations were not sufficient to permit clear species-level discrimination. The high degree of morphological similarity observed between the two taxa, supported by multivariate analyses such as PCoA and UPGMA, further indicates the absence of consistent diagnostic differences.

In light of these findings, *Neoscona byzanthina* does not appear to be fully distinct from *Neoscona adianta*, and it may represent a subspecies of *N. adianta*. However, additional integrative studies incorporating molecular, ecological, and broader geographic sampling are recommended to clarify the taxonomic status of these taxa and to confirm the extent of their differentiation.

Declarations

Author Contribution

AA: Identifying examples, interpreting analyses, and writing the manuscript textSA:Identifying examples,writing the manuscript textAS:conducting and interpreting analysesDAT: conducting and interpreting analyses,writing the manuscript text

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Figures

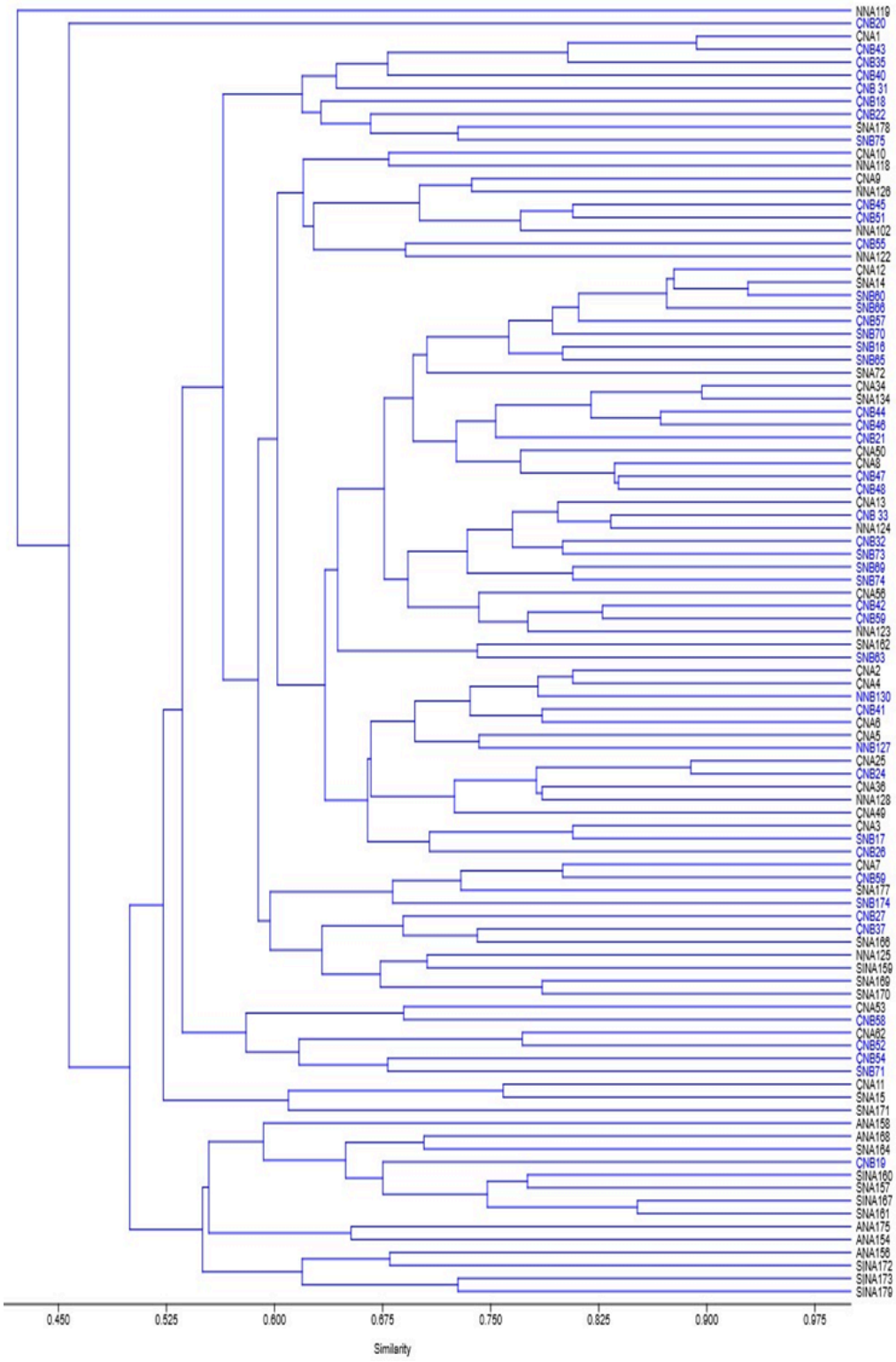


Figure 1

UPGMA dendrogram of 100 Neoscona specimens based on the Dice coefficient of morphological characters, excluding sexual organs. Black symbols represent *N. adianta*, and blue symbols represent *N. byzanthina*.

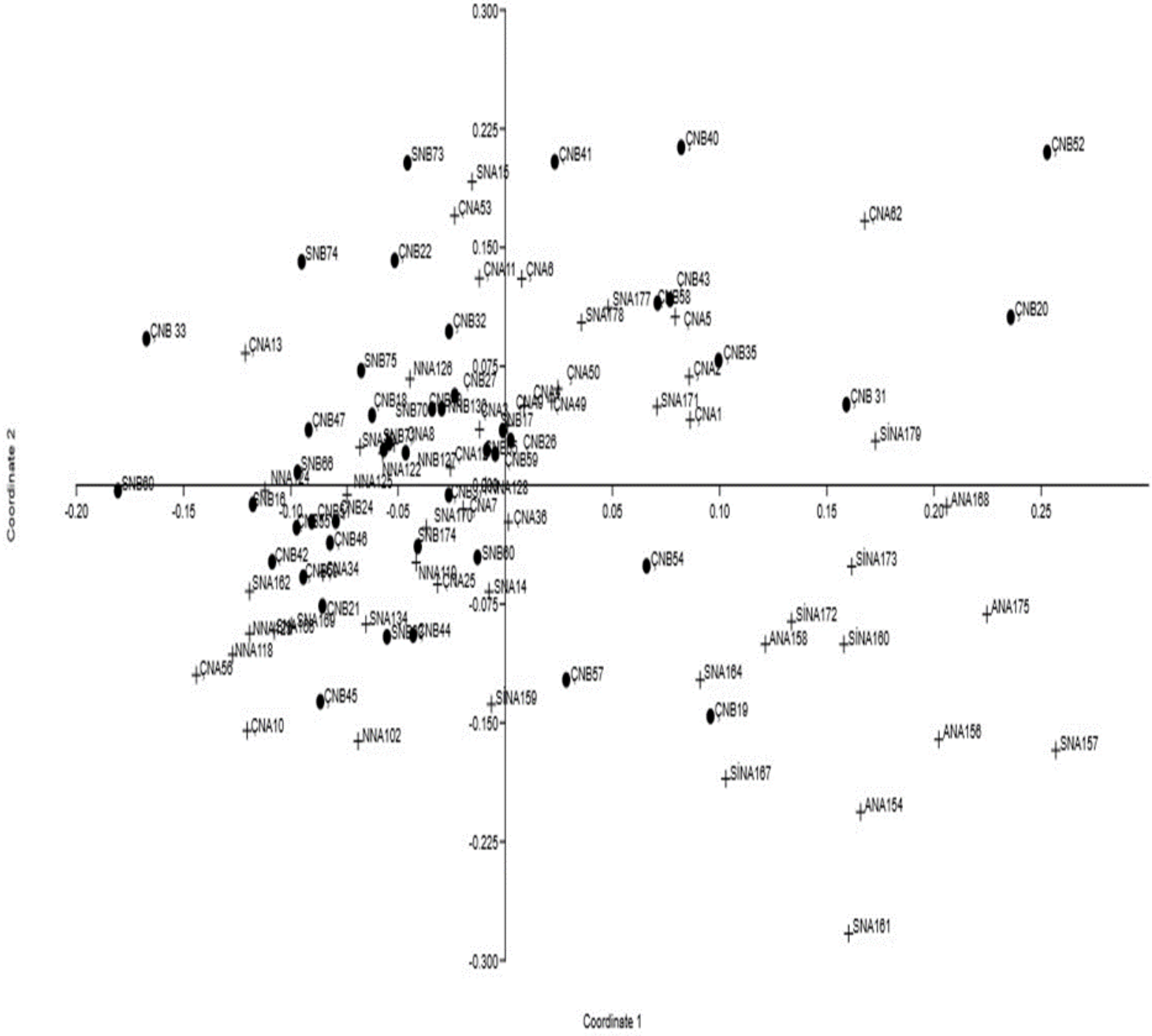


Figure 2

PCoA plot of 100 Neoscona specimens based on the Dice coefficient of morphological characters (excluding sexual organs), with "+" *N. adianta* and "●"*N. byzanthina*.

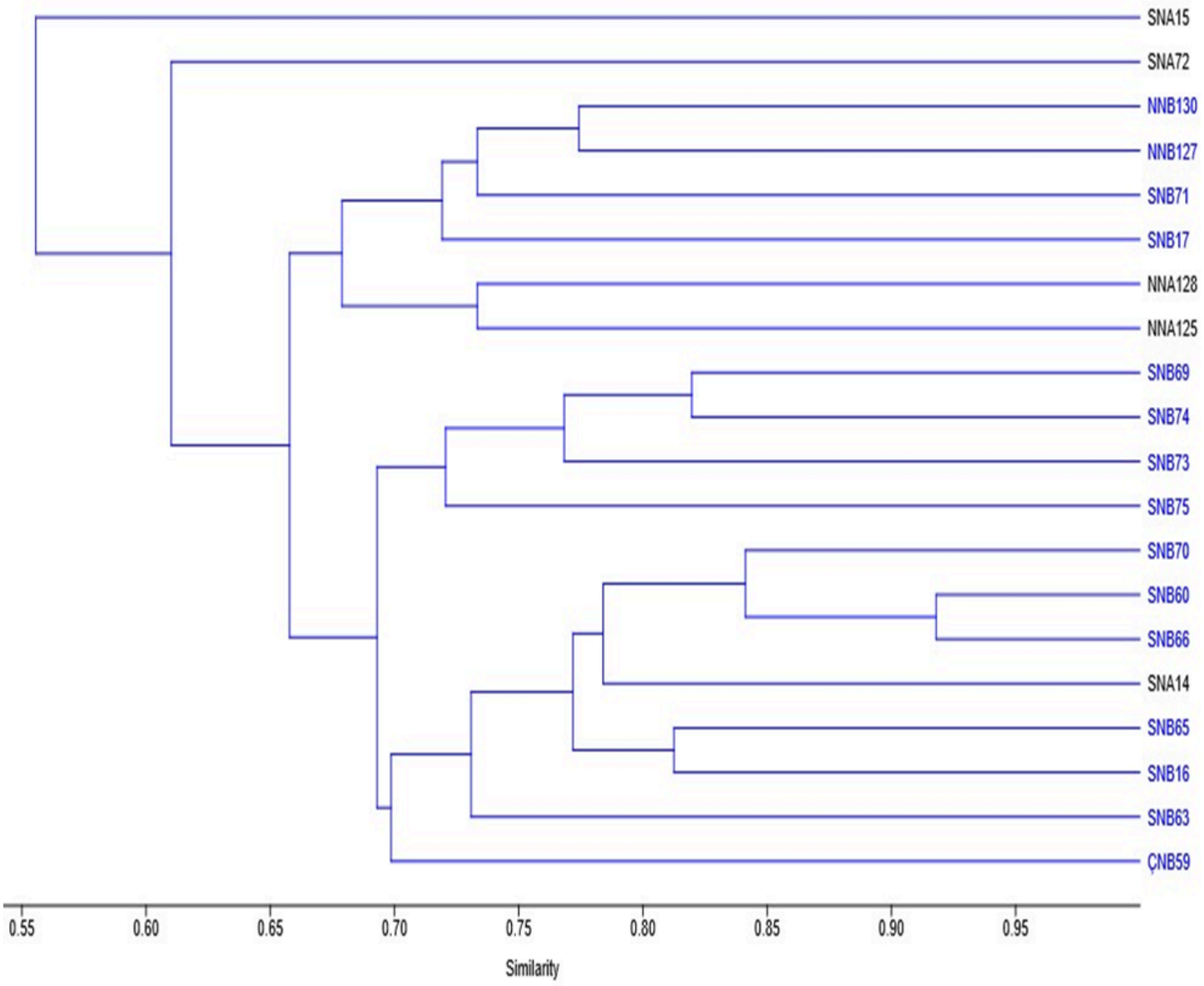


Figure 3

UPGMA dendrogram of 20 male Neoscona specimens based on the Dice coefficient of morphological characters, including male sexual organs. Black symbols indicate *N. adianta*, and blue symbols indicate *N. byzanthina*.

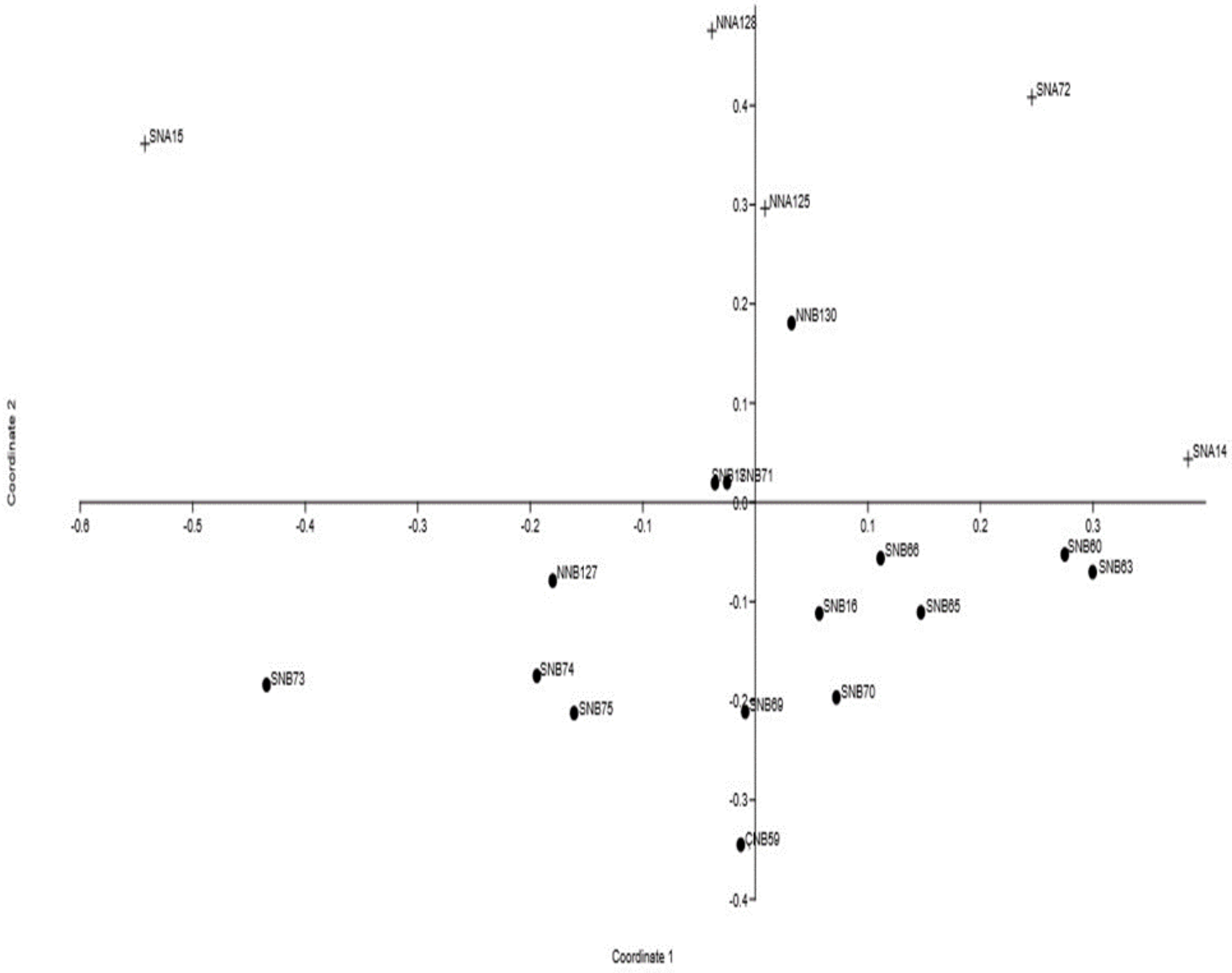


Figure 4

PCoA plot of 20 male Neoscona specimens based on the Dice coefficient of morphological characters, including male sexual organs. *N. adianta* are indicated by "+" symbols, and *N. byzanthina* are indicated by "●" symbols.

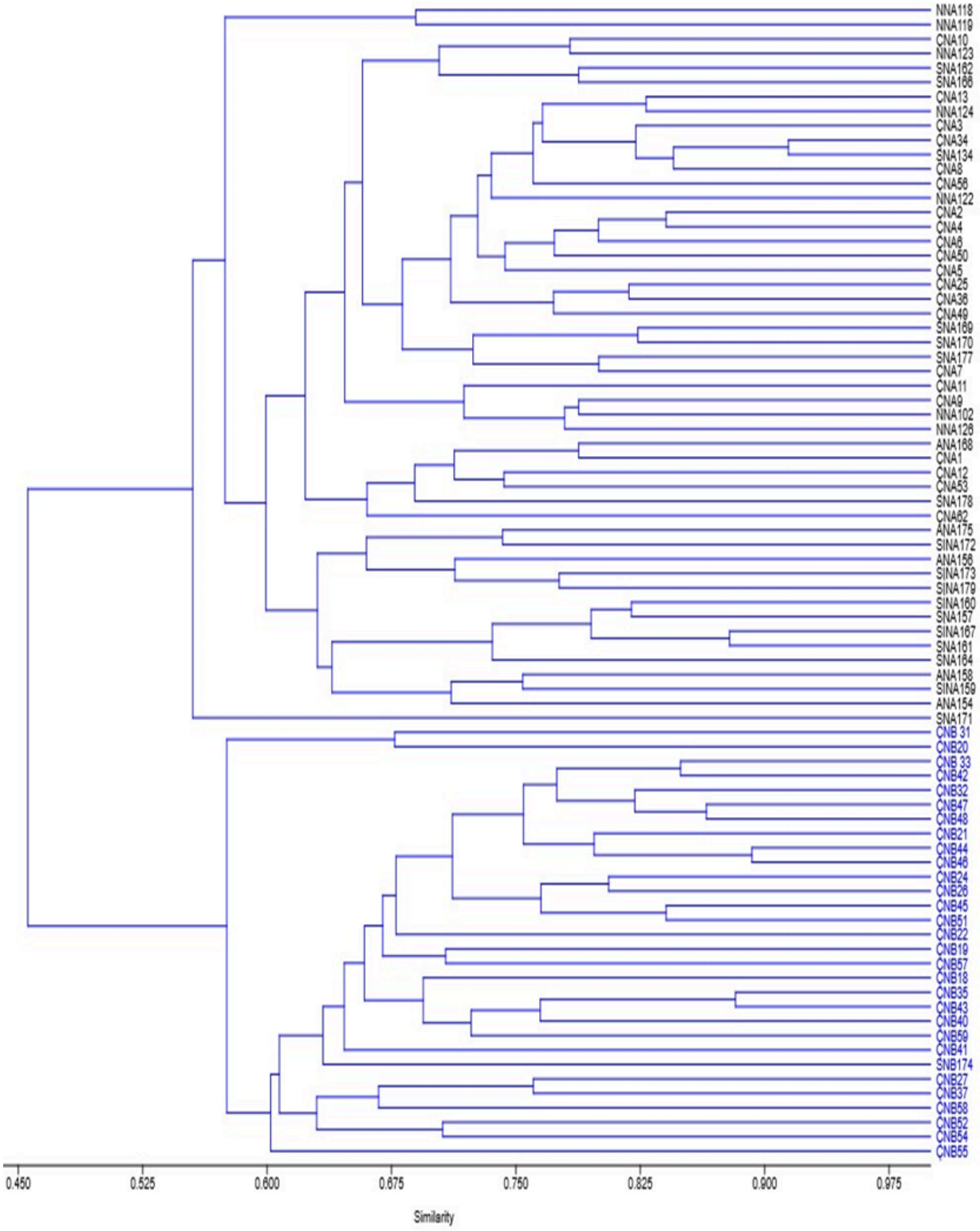


Figure 5

UPGMA dendrogram of 80 female Neoscona specimens based on the Dice coefficient of morphological characters, including female sexual organs. Black symbols represent *N. adianta*, and blue symbols represent *N. byzanthina*.

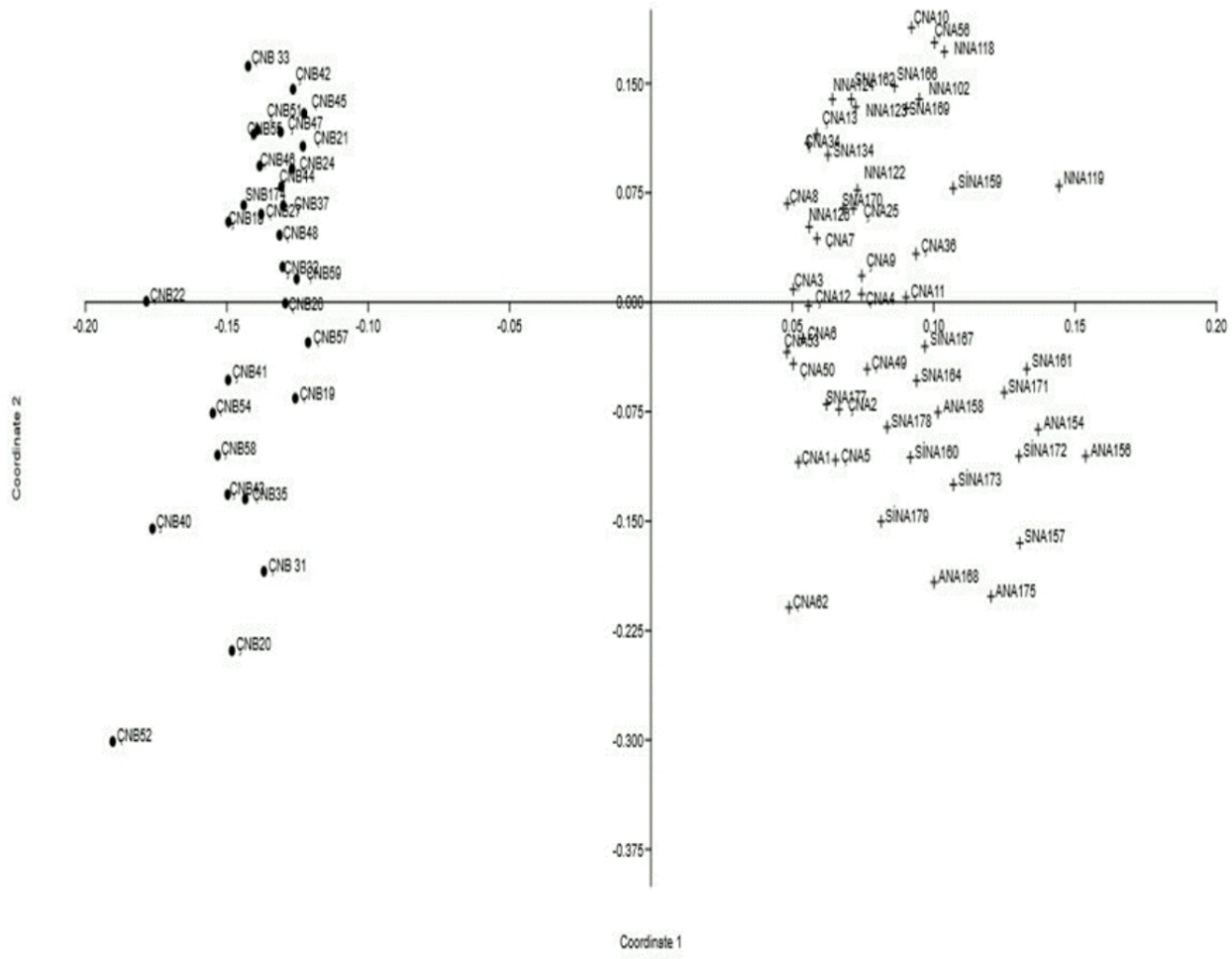


Figure 6

PCoA plot of 80 female Neoscona specimens based on the Dice coefficient of morphological characters, including female sexual organs. Specimens of *N. adianta* are indicated by “+” symbols, and specimens of *N. byzanthina* are indicated by “●” symbols.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryTable1.xlsx
- Appendix1.docx