Zootaxa 5856 (1): 107–118
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Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.5856.1.18
http://zoobank.org/urn:lsid:zoobank.org:pub:344D35EA-D994-494A-8F4D-186617D0BF63

Leafhoppers (Hemiptera: Cicadellidae) of the Shaanxi Hanzhong Crested Ibis National Nature Reserve, China, with descriptions of a new typhlocybine genus and a new species

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Abstract

A systematic survey of the leafhoppers of Shaanxi Hanzhong Crested Ibis National Nature Reserve was conducted from March to September 2021 across three sampling sites: Longting, Huayuan, and Yaoping, yielding 3,033 specimens representing 76 species, 47 genera, 14 tribes, and 10 subfamilies. The assemblage was numerically dominated by *Kolla paulula* (Walker, 1858) and *Kolla nigrifascia* Yang & Li, 2000. Diversity and evenness reached their highest values in June, whereas specimen abundance peaked in July. Community similarity analyses indicated clear differences among sampling sites and months, with particularly low similarity between the Longting agro-ecosystem and the two forest sites. This study provides the first systematic taxonomic inventory of Cicadellidae in the reserve and provides baseline data for future taxonomic and diversity studies of leafhoppers in the Qinling Mountains region of China. The survey revealed one new genus and a new species of Empoascini described and illustrated here: *Neoempoasca* Dai, Yu & Li **gen. nov.** with type species *Neoempoasca lizizhongi* Dai, Yu & Li **sp. nov.**

Key words: Empoascini, diversity, Qinling Mountains, taxonomy

1 Introduction

Leafhoppers (Hemiptera: Cicadellidae) represent one of the largest groups within Membracoidea, with more than 23,000 described species worldwide (Dietrich 2005; Liang *et al.* 2024). Within Cicadellidae, Typhlocybinae is one of the most species-rich and taxonomically complex subfamilies (Xu *et al.* 2021; Zhou *et al.* 2023). The tribe Empoascini is among the largest groups within Typhlocybinae, currently comprising approximately 107 genera and 1,396 species worldwide, of which 50 genera and more than 260 species have been recorded from China (Xu *et al.* 2021; Ding *et al.* 2024). Members of this tribe are widely distributed in the Palaearctic and Oriental regions. Because many empoascine taxa are externally similar in general appearance, generic delimitation and species identification rely heavily on characters of the male genitalia (Xu *et al.* 2021; Ding *et al.* 2024).

In China, the taxonomy of Typhlocybinae, including Empoascini, has been studied extensively for decades. In particular, Prof. Zizhong Li has made outstanding and lasting contributions to the taxonomy of Chinese typhlocybine leafhoppers, and his work has provided an essential foundation for subsequent systematic studies on this group (Song & Li 2014). Recent studies on Chinese Empoascini have continued to reveal undescribed genera and species, indicating that the diversity and generic limits of this tribe remain incompletely documented, especially in geographically complex montane regions (Xu *et al.* 2021; Ding *et al.* 2024; Yao *et al.* 2025).

Accepted by C. Dietrich: 15 Jun. 2026; published: 27 Jul. 2026

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The Qinling Mountains constitute an important biogeographical boundary between the Palaearctic and Oriental regions in China (Chen 1996). The southern slopes of the Qinling Mountains include a mosaic of habitats ranging from low-elevation wetlands and agricultural landscapes to mid-elevation mixed forests, providing diverse environments for insect assemblages (Yang 2017). Although the biodiversity of the Qinling region has attracted considerable attention (Ren *et al.* 2022), records of Cicadellidae from protected areas in this region remain fragmentary, and no focused survey has been conducted for the Shaanxi Hanzhong Crested Ibis National Nature Reserve.

In the present study, we conducted a systematic survey of Cicadellidae in the Shaanxi Hanzhong Crested Ibis National Nature Reserve. The objectives were to: (1) document the taxonomic composition of the leafhopper community in the reserve; (2) describe and illustrate one new genus and one new species discovered during the survey; (3) compare species diversity among sampling months and sampling sites; and (4) evaluate community similarity across spatial and temporal gradients using the Jaccard coefficient.

2 Materials and Methods

2.1 Study Sites

The study was conducted in the Shaanxi Hanzhong Crested Ibis National Nature Reserve, which spans an area of 37,549 ha at the junction of Yangxian and Chenggu counties in Shaanxi Province, China (Fig. 1). The reserve is geographically situated between 33°08′–33°35′ N and 107°21′–107°44′ E (Zhang *et al.* 2016; Wang *et al.* 2019). The region features a transitional climate ranging from warm temperate to northern subtropical, characterized by an average annual temperature of 12–14°C and an annual precipitation of 900–1,000 mm. The vegetation is diverse, primarily composed of coniferous forests, deciduous broad-leaved forests, and mixed evergreen-deciduous broad-leaved forests (Wang *et al.* 2019). Under local conservation management, agricultural areas within the reserve are subject to reduced chemical disturbance, including restrictions on the use of fertilizers and pesticides.

2.2 Sample Setup and Sampling

To investigate patterns of leafhopper diversity along an elevational gradient within the reserve, three sampling sites were established. The first site, Longting (479–488 m; 33.272°–33.294° N, 107.530°–107.576° E), is located in the experimental zone and is characterized by an agro-ecosystem consisting primarily of wetlands and organic paddy fields, representing a habitat with moderate human activity and reduced chemical disturbance under reserve management. The second site, Huayuan (606–632 m; 33.348°–33.351° N, 107.467°–107.468° E), is situated in the core zone, while the third site, Yaoping (794–811 m; 33.404°–33.409° N, 107.351°–107.352° E), is located at the intersection of the core and buffer zones. Both Huayuan and Yaoping represent typical forest habitats with minimal disturbance, dominated by mixed coniferous and deciduous broad-leaved forests, which provide a complex vertical structure for insect communities (Fig. 1).

2.3 Sample Collection

Field surveys were conducted from March to September 2021, encompassing the peak activity period of leafhoppers in the region. Specimens were collected using three complementary methods: sweep netting, light trapping, and Malaise trapping. Sweep netting was performed diurnally (08:00–18:00) on shrubs and herbaceous vegetation using a standard insect net. Light trapping was conducted nocturnally (20:00–22:00) utilizing a 450 W high-pressure mercury lamp combined with a trapping tent to capture phototactic species. Light trapping is widely considered a highly effective sampling method for collecting active leafhoppers and evaluating their population dynamics (Shimoda & Honda 2013; El-Hady *et al.* 2021). Additionally, Malaise traps were deployed in open areas within the sampling sites, and collection bottles (containing absolute ethanol) were retrieved and replaced on a monthly basis. All collected specimens were preserved in 100% ethanol and stored at −20°C in the laboratory prior to identification. Differences in vegetation structure among sampling sites may influence trap efficiency and should therefore be taken into account when interpreting abundance data.

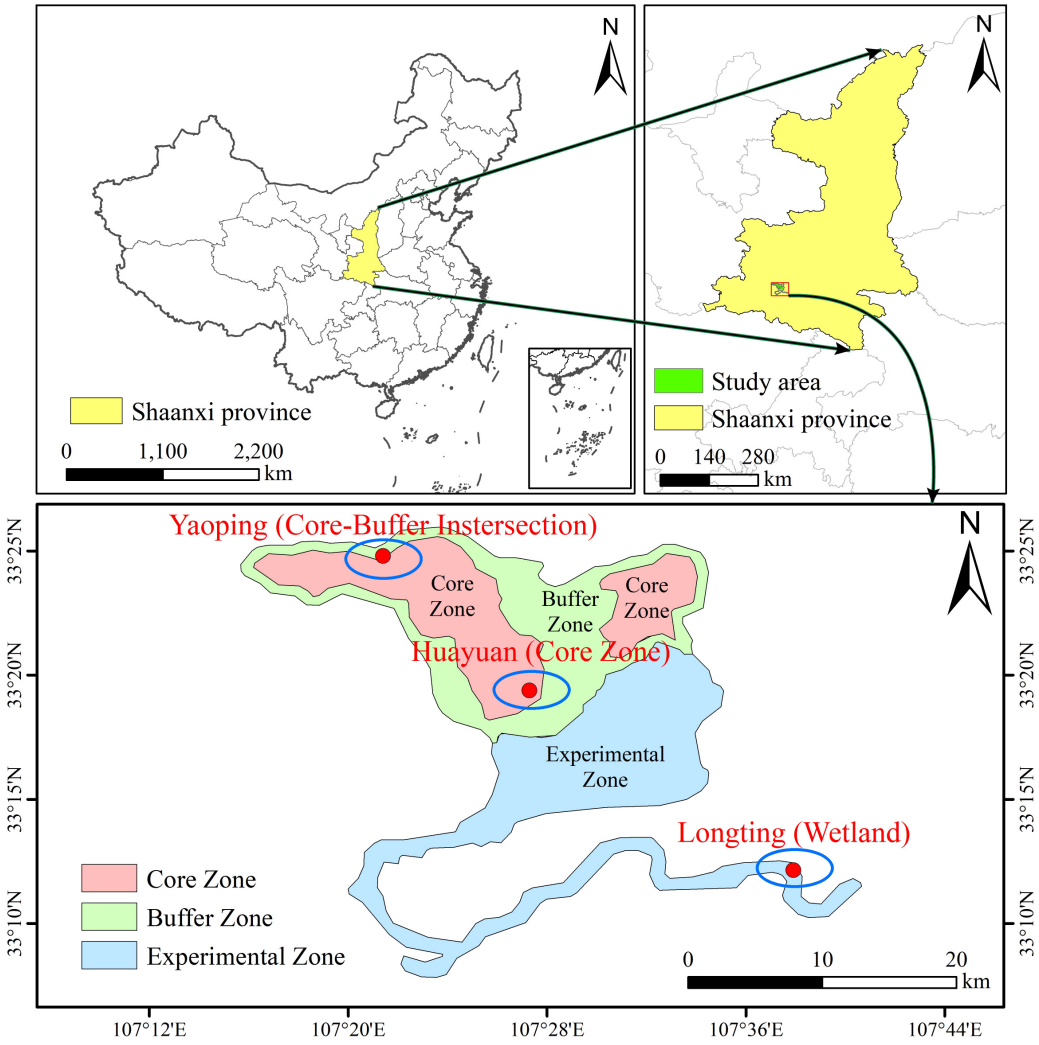

FIGURE 1. Geographic location, functional zoning, and sampling sites of the Shaanxi Hanzhong Crested Ibis National Nature Reserve. The blue circles indicate the approximate positions of the three sampling transects along the elevational gradient at Longting (Hilly Area, agro-ecosystem), Huayuan (Low Mountain Area, forest), and Yaoping (Middle Mountain Area, forest).

2.4 Specimen Identification and Deposition

Specimen identification was primarily based on external morphology and male genitalic characteristics. For genitalic examination, the apical portion of the male abdomen was excised, immersed in a boiling 8% NaOH solution for 3–5 minutes to dissolve soft tissues, subsequently rinsed in distilled water, and finally transferred to glycerin for dissection (Oman 1949; Knight 1965). Morphological terminology mainly follows Southern (1982), Zhang (1990) and Dietrich (2005). Gross morphological examinations were performed using an Olympus SZX7 stereomicroscope, while detailed structures of the male genitalia were observed and illustrated under an Olympus BX43 compound microscope. High-resolution images of the adult habitus were captured using a Keyence VHX-7000 digital microscope system, and all plates and line drawings were subsequently processed using Adobe Photoshop CS6 and Adobe Illustrator CS6. Following identification, the dissected genitalia were preserved in microvials containing glycerin and pinned beneath the respective specimens.

Type specimens of the new species and other examined material are deposited in the Museum of Zoology and Botany, Shaanxi University of Technology, Hanzhong, China (SUHC).

2.5 Data Analysis

To evaluate the alpha diversity of the leafhopper communities across different sampling sites and months, three standard ecological indices were employed: the Shannon-Wiener diversity index (*H'*), Simpson's diversity index (*D*), Pielou's evenness index (*J*). These metrics were computed according to the following equations (Shannon 1948; Simpson 1949; Pielou 1966):

$$H' = -\sum_{i=1}^{S} \frac{P_i}{lnP_i}$$

$$D=1-\sum_{i=1}^{S} P_i^2$$

$$J=\frac{H^{'}}{\ln S}$$

where *S* is the total number of leafhopper species, and *Pi* denotes the relative proportion of the i^{th} species within a given sample.

Additionally, the Jaccard similarity coefficient (*Cj*) was employed to evaluate the compositional similarity of leafhopper assemblages among different sampling sites and months (Jaccard 1901). It was calculated based on species presence/absence data using the following equation:

$$C_j=\frac{c}{(a+b-c)}$$

where *c* is the number of shared species, and *a* and *b* are the total numbers of species in the respective compared communities. The resulting similarity coefficients were interpreted using the following thresholds: very dissimilar (0.00–0.25), moderately dissimilar (0.25–0.50), moderately similar (0.50–0.75), and very similar (0.75–1.00).

All basic statistics and index calculations were performed in Microsoft Excel 2024. Data organization and supplementary analyses were conducted using the 'vegan' package (Oksanen *et al.* 2024) in the R statistical computing environment (R Core Team 2024).

3 Results

3.1 Species Composition

A total of 3,033 leafhopper specimens were collected from the Shaanxi Hanzhong Crested Ibis National Nature Reserve. Morphological identification revealed 76 species belonging to 47 genera, 14 tribes, and 10 subfamilies (detailed seasonal abundance matrices and species collection records are provided in Supplementary Table S1). The hierarchical composition of the community is visualized in the sunburst chart (Fig. 2). Based on specimen abundance data summarized in Supplementary Table S1, Typhlocybinae exhibited the highest species richness with 24 species (31.58%), followed by Deltocephalinae (17 species, 22.37%) and Cicadellinae (11 species, 14.47%). However, in terms of numerical abundance, Cicadellinae was the dominant subfamily, comprising 1,315 individuals (43.36% of the total collection), followed by Typhlocybinae (1,079 individuals, 35.58%) and Deltocephalinae (474 individuals, 15.63%). At the species level, the community was heavily dominated by *Kolla paulula* (Walker, 1858) (657 individuals, 21.66%) and *Kolla nigrifascia* Yang & Li, 2000 (554 individuals, 18.26%). Although the survey material included several unassigned or potentially undescribed morphospecies, the present study formally describes only one new genus and one new species of Empoascini, *Neoempoasca* Dai, Yu & Li **gen. nov.** and *Neoempoasca lizizhongi* Dai, Yu & Li **sp. nov.** (9 individuals). The morphological descriptions of these taxa are provided below.

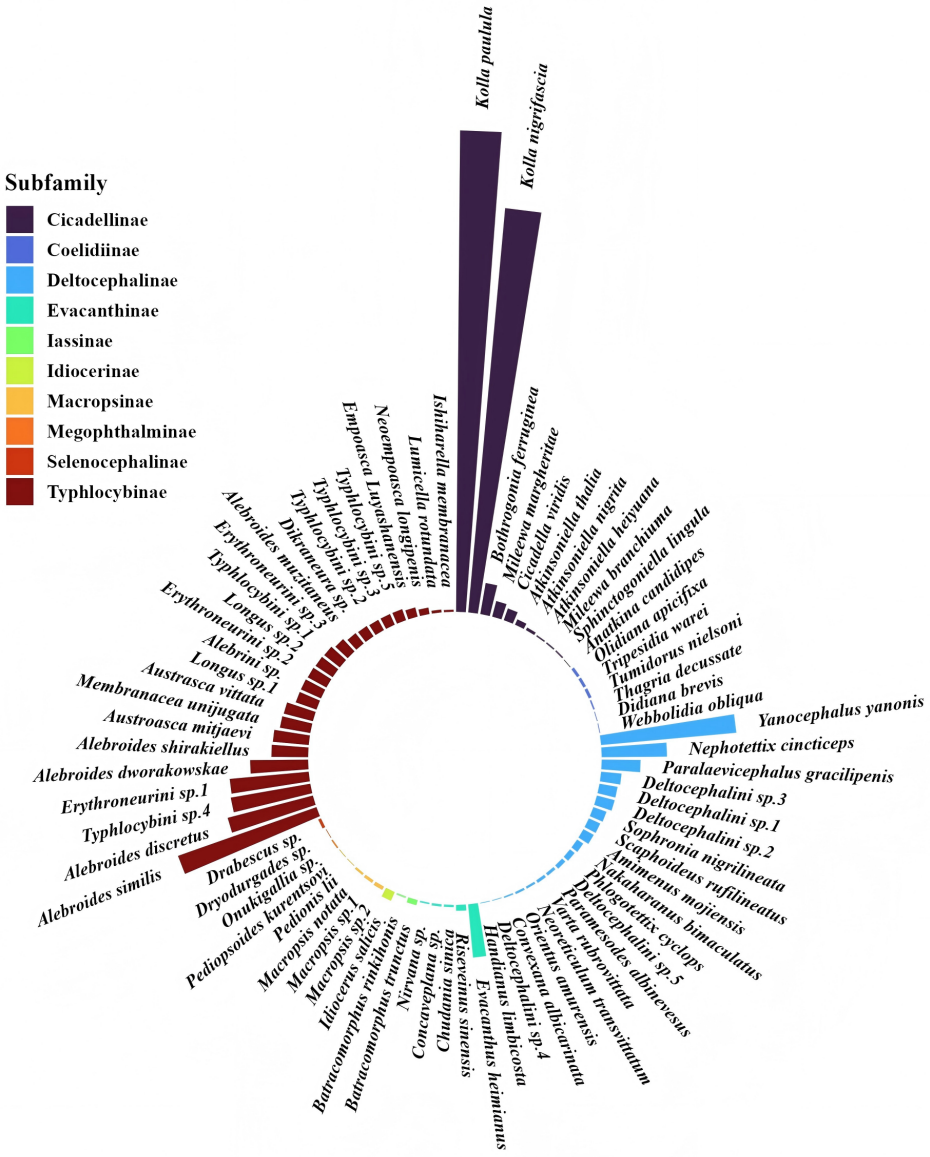

FIGURE 2. Sunburst chart illustrating the taxonomic composition and relative abundance of the leafhopper community at the subfamily level.

3.2 Descriptions of New Taxa

3.2.1 Genus *Neoempoasca* Dai, Yu & Li, gen. nov.

Type species: *Neoempoasca lizizhongi* Dai, Yu & Li, **sp. nov.**, here designated.

Description. Body cylindrical, fragile; dorsal coloration brown, ventral surface pale yellow. Head including eyes as wide as or slightly wider than pronotum. Vertex produced; coronal suture distinct but not reaching anterior margin. Ocelli situated on transition between vertex and face, or near imaginary line connecting antennal ledges. Face elongate; anteclypeus of male inflated, fused with frontoclypeus. Pronotum median length exceeding that of vertex. Forewing narrow and elongate, appendix absent; vein MP arising from cell r. Hind wing with submarginal vein well developed, extending to apex of vein R+M; vein CuA unbranched.

Male genitalia. Pygofer lobe broad, with anterior margin rounded and posterior margin slightly concave; apical and basolateral groups of setae absent; ventral pygofer appendage absent. Subgenital plates separated basally, elongate; basolateral angulate projection absent; basal dorsolateral row of setae absent; distal half with a row of short,

stout setae along dorsolateral margin; macrosetae arranged in a single row near apex along ventromesal margin; lateral fine setae present. Style slender and elongate, apophysis bearing several fine setae subapically. Connective robust, approximately U-shaped, completely separated from aedeagus. Aedeagus with preatrium well developed, elongate, directed posteroventrally and forming a distinct angle with the gonopore-bearing shaft; gonopore-bearing shaft moderately long, slender and slightly curved, extending beyond posterior margin of pygofer lobe. Anal tube appendage well developed, simple, unbranched.

Diagnosis. *Neoempoasca* Dai, Yu & Li, **gen. nov.** is placed in Empoascini based on the combination of the forewing lacking an appendix, the hind wing with the submarginal vein developed apically, the male subgenital plate bearing a longitudinal row of macrosetae, and the style lacking a distinct preapical lobe. In general habitus and wing venation, the new genus resembles members of the *Empoasca* generic complex, especially *Empoasca* Walsh and related Oriental genera. However, it can be distinguished from *Empoasca* and other allied genera by the following combination of male genitalic characters: ventral pygofer appendage entirely absent; subgenital plates separated basally and elongate; basolateral margin without distinct angulate projection; basal dorsolateral row of setae not evident; distal half with a row of short, stout setae along dorsolateral margin; macrosetae arranged in a single row near apex along ventromesal margin; connective robust, U-shaped, articulated to aedeagus with preatrium well developed, elongate, directed posteroventrally and forming a distinct angle with the gonopore-bearing shaft; gonopore-bearing shaft moderately long, slender and slightly curved, extending beyond posterior margin of pygofer lobe; anal tube appendage simple, well developed, and unbranched. The new genus differs from genera such as *Distantasca*, *Kybos*, and *Asymmetrasca* in lacking their respective diagnostic modifications of the subgenital plate, style, or aedeagus, and is therefore recognized here as a distinct new genus.

Etymology. The generic name is a combination of the Latin prefix "*neo*-" (new) and the generic name "*Empoasca*", indicating its close morphological resemblance to the genus *Empoasca*. The gender is feminine.

3.2.2 *Neoempoasca lizizhongi* Dai, Yu & Li, sp. nov.

(Figs 3a–3i)

Description. Length: Male 1.86–1.88 mm.

Body pale brown to yellowish. Head including eyes wider than pronotum. Vertex arc-shaped, produced anteriorly; median length subequal to that of pronotum; mid-region with distinct black coronal suture extending from base anterad (not reaching anterior margin). Face slightly convex in profile; in male, anteclypeus fused with frontoclypeus and not distinctly inflated; female condition unknown. Pronotum pale brown, concolorous with vertex. Scutellum transitioning from pale brown to yellow; posterior half distinctly concave, with a short transverse black stripe within depression. Forewing pale yellow, with irregular transparent maculae; appendix absent.

Male genitalia. Pygofer lobe (Fig. 3h) broad, posterior margin rounded; ventral appendage absent. Anal tube appendage simple, unbranched. Subgenital plate elongate, gradually narrowed from base to apex (apex blunt), provided with row of 5 macrosetae and 5 small setae. Style (Fig. 3g) slender, elongate; apophysis slightly curved and tapered to an acute point, bearing fine setae subapically. Connective (Fig. 3i) U-shaped, with a transverse bar connecting lateral arms at basal 1/3. Aedeagus (Figs. 3e, 3f) robust, well-developed; preatrium moderately long, forming a ventral extension of aedeagal base; shaft moderately long, tapered, extended beyond posterior margin of pygofer lobe; gonopore subapical; a single large process arising ventrally from base of shaft.

Material examined. Holotype: ♂, CHINA: Shaanxi Prov., Hanzhong City, Crested Ibis National Nature Reserve, Yaoping, 15.VII.2021, coll. Zi-Wei Dai (SUHC). **Paratypes:** 3♂, 4♀, same data as holotype; 1♀, CHINA: Shaanxi Prov., Hanzhong City, Crested Ibis National Nature Reserve, Huayuan, 15.VII.2021, coll. Zi-Wei Dai (SUHC).

Etymology. The specific epithet is named in honor of Prof. Zizhong Li on the occasion of his 90th birthday, in recognition of his outstanding contributions to the taxonomy of Chinese Auchenorrhyncha.

Remarks. *Neoempoasca lizizhongi* Dai, Yu & Li, **sp. nov.** is the type and only known species of *Neoempoasca* **gen. nov.** It can be recognized within the new genus, and readily separated from externally similar empoascine taxa, by the following combination of characters: posterior half of scutellum distinctly concave and bearing a short transverse dark stripe; pygofer without ventral appendage; style apophysis slender, slightly curved and tapered to acute point apically; aedeagal shaft extended beyond posterior margin of pygofer lobe; and aedeagus bearing

unpaired basal process arising below shaft. This unique combination of external and male genitalic features supports the recognition of the species as distinct.

Distribution and habitat. Specimens of this new taxon were exclusively collected from the mid-elevation mixed forests (Huayuan and Yaoping sites, 606–811 m), and were entirely absent from the low-elevation agro-ecosystem.

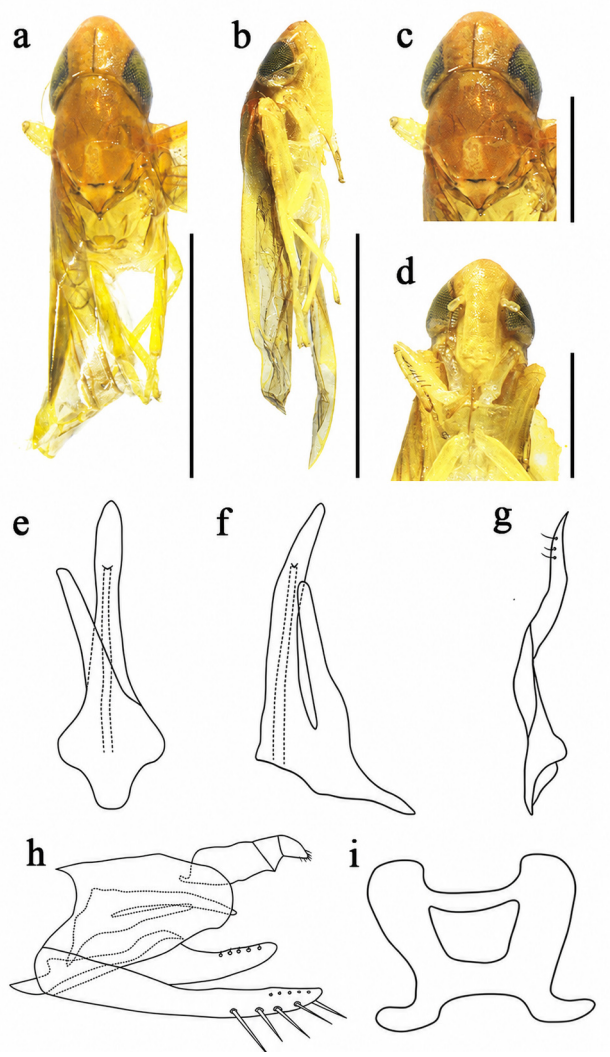

FIGURE 3. Adult and male genitalia of *Neoempoasca lizizhongi* Dai, Yu & Li **sp. nov.**, **a.** Habitus, dorsal view (scale bar = 1.0 mm); **b.** Habitus, lateral view (scale bar = 1.0 mm); **c.** Head and thorax, dorsal view (scale bar = 0.5 mm); **d.** Face (scale bar = 0.5 mm); **e.** Aedeagus, ventral view; **f.** Aedeagus, lateral view; **g.** Style; **h.** Pygofer lobe, lateral view; **i.** Connective, dorsal view.

3.2.3 Key to *Neoempoasca* gen. nov. and selected related genera of Empoascini (males)

(Modified from Xu *et al.* (2021), Liu *et al.* (2014), and Wang *et al.* (2025))

The genera included in this key are selected related Empoascini taxa for comparison with Neoempoasca **gen. nov.**, mainly based on their general habitus, wing venation, and previous placement in comparative treatments of the Empoasca generic complex; they differ markedly in several male genitalic characters.

1. Style with a thickened preapical section bearing a conspicuous dense tuft of elongate setae . . . . . *Kybos* Fieber
   Style without such a thickened preapical tuft of elongate setae 2
2. Subgenital plate with two distinct groups of elongate, slender fine setae; connective strongly constricted posteriorly . . . . . .*Distantasca* Dworakowska
   Subgenital plate without two such distinct groups of elongate, slender fine setae; connective not strongly constricted posteriorly in this manner 3

3. Ventral pygofer appendage absent; subgenital plates separated basally; connective robust, U-shaped and completely free from the aedeagus; aedeagal shaft moderately long, extending beyond posterior margin of pygofer lobe; anal tube appendage simple, unbranched . . . . . *Neoempoasca* **gen. nov.**
Ventral pygofer appendage present 4
4. Subgenital plate with group A setae situated near middle of plate; aedeagal shaft with a long unpaired asymmetric distal process . . . . . *Asymmetrasca* Dlabola
Subgenital plate with basal group comprising 2-4 well-differentiated setae; aedeagus simple, without processes or teeth . . . . . *Empoasca* Walsh

3.3 Diversity Patterns and Community Similarity

The survey data showed temporal and spatial variation in leafhopper diversity and community composition.

3.3.1 Temporal Variation in Species Diversity

Leafhopper diversity exhibited distinct seasonal dynamics throughout the survey period from March to September 2021 (Table 1). Monthly species richness increased progressively from 9 species in March to a peak of 36 species in July, before declining to 24 species in August and 25 species in September. Specimen abundance followed a similar trajectory, peaking abruptly in July (1,011 individuals, 33.33% of total). Regarding the diversity metrics, the Shannon-Wiener diversity index (*H*) and Pielou's evenness index (*J*) both reached their maximum values in June (2.78 and 0.81, respectively), indicating the most uniform species distribution prior to the absolute abundance peak in July.

3.3.2 Spatial Variation in Species Diversity

Significant differences in leafhopper diversity and abundance were observed among the three sampling sites (Table 2). The Longting site (agricultural wetland ecosystem) had the lowest species richness (10 species) and abundance (57 specimens, 1.88%), resulting in the lowest diversity indices (H = 1.45; D = 0.68; J = 0.63). In contrast, the mid-elevation forest habitats supported substantially greater diversity. The Huayuan site (mixed forest, core zone) yielded the highest absolute species richness with 73 species from 1,476 specimens (H = 2.92; D = 0.88; J = 0.68). The Yaoping site (mixed forest, core/buffer intersection) recorded 58 species from 1,495 specimens, maintaining high diversity and evenness scores (H = 2.87; D = 0.93; J = 0.71). As indicated by the taxonomic collection data, the newly described species *N. lizizhongi* was exclusively recorded at the Huayuan and Yaoping sites. Concurrently, these two forest sites exhibited the highest species diversity indices across the sampled gradient (Table 2).

3.3.3 Community Similarity

Comparisons among the three sampling sites revealed clear differences in community composition (Table 3). The community similarity between the low-elevation Longting agro-ecosystem and the two forest sites was low, with C_j values of 0.14 and 0.17 for comparisons with Huayuan and Yaoping, respectively. The similarity coefficient between the two forest sites (Huayuan and Yaoping) reached 0.72.

Temporal variations in community composition were assessed by comparing monthly occurrence matrices from March to September (Table 4). The monthly comparisons showed continuous variation in community composition throughout the sampling period. The highest temporal similarity occurred during the late-season transition between August and September (C_j = 0.48), approaching the threshold for moderate similarity. Other relatively close sequential pairings included March and May (C_j = 0.33), as well as June and July (C_j = 0.28). In contrast, pairwise comparisons between temporally distant months or across major seasonal shifts exhibited profound dissimilarity. The lowest community overlap was recorded between April and August (C_j = 0.09), followed by comparisons between the spring emergence period and the summer peak (e.g., April and June, C_j = 0.11; June and August, C_j = 0.11).

TABLE 1. Temporal dynamics of Cicadellidae diversityin the Shaanxi Hanzhong Crested Ibis National Nature Reserve.

Month	Shannon-wiener(*H*)	Simpson(*D*)	Pielou(*J*)
March	1.25	0.58	0.57
April	2.15	0.82	0.72
May	2.45	0.85	0.74
June	2.78	0.91	0.81
July	2.65	0.89	0.74
August	2.30	0.86	0.72
September	2.52	0.90	0.78

TABLE 2. Spatial dynamics of Cicadellidae diversity across sampling sites in the Shaanxi Hanzhong Crested Ibis National Nature Reserve.

Sampling site	Shannon-wiener(*H*)	Simpson(*D*)	Pielou(*J*)
Longting site	1.45	0.68	0.63
Huayuan site	2.92	0.88	0.68
Yaoping site	2.87	0.93	0.71

TABLE 3. Jaccard similarity coefficients (*Cj*) of Cicadellidae communities across sampling sites in the Shaanxi Hanzhong Crested Ibis National Nature Reserve.

Study sites	Longting	Huayuan	Yaoping
Longting	1.00		
Huayuan	0.14	1.00	
Yaoping	0.17	0.72	1.00

TABLE 4. Jaccard similarity coefficients (C_j) of Cicadellidae communities across sampling months in the Shaanxi Hanzhong Crested Ibis National Nature Reserve.

Months	March	April	May	June	July	August	September
March	1						
April	0.25	1					
May	0.33	0.20	1				
June	0.19	0.11	0.24	1			
July	0.15	0.18	0.17	0.28	1		
August	0.18	0.09	0.23	0.11	0.28	1	
September	0.18	0.16	0.22	0.13	0.22	0.48	1

4 Discussion

Leafhopper communities in the Shaanxi Hanzhong Crested Ibis National Nature Reserve showed clear temporal and spatial variation during the sampling period. Temporally, the Shannon-Wiener diversity index and Pielou's evenness index reached their highest values in June, indicating that the assemblage was most even at that time, whereas specimen abundance peaked in July and was dominated by the widespread species *Kolla paulula* and *K. nigrifascia*. This pattern suggests that midsummer conditions favored a rapid increase in overall abundance, while the lower diversity values in July reflect the numerical dominance of a few common species, a pattern also reported in other leafhopper assemblages with strong seasonal turnover (El-Hady *et al.* 2021). The subsequent decline in abundance in August and September may be associated with seasonal climatic conditions in the region, including increased

precipitation and humidity during late summer and early autumn, which are known to influence the population dynamics of leafhoppers and planthoppers (Hafizal & Idris 2014).

Spatially, the three sampling sites differed markedly in community composition. The Longting agro-ecosystem had the lowest species richness and abundance, and its Jaccard similarity with the two forest sites was very low. In contrast, the two mid-elevation forest sites, Huayuan and Yaoping, supported much higher species richness and showed relatively high similarity to each other. These results indicate that leafhopper assemblages differed substantially between the low-elevation agricultural habitat and the forest habitats. The observed pattern is likely associated with differences in habitat structure, vegetation complexity, and elevational setting among sampling sites, all of which are known to shape insect community composition along mountain gradients (Hodkinson 2005).

Comparable surveys have been conducted in other nature reserves and protected areas in China, although they differ in taxonomic scope, sampling design and analytical level. Chen *et al.* (2021) investigated leafhopper communities in Fanjingshan National Nature Reserve and recorded 4,279 specimens belonging to 15 subfamilies and 127 genera. Their study showed that genus-level richness was highest in shrub and forest-margin habitats, and that community similarity was highest between habitats with similar vegetation structure, especially shrub and forest-margin habitats. This pattern is broadly consistent with the present study, in which the two structurally complex forest sites, Huayuan and Yaoping, supported much higher species richness and showed relatively high similarity to each other, whereas the Longting agro-wetland site was clearly separated from the two forest sites. However, the habitat with the highest diversity differed between the two studies: in Fanjingshan, shrub habitats supported the richest leafhopper assemblage, whereas in the present reserve the highest richness and diversity occurred in mid-elevation mixed forests. This difference may reflect regional differences in vegetation type, elevational range, sampling methods and the taxonomic level used for analysis, because the Fanjingshan study mainly compared genus-level assemblages, whereas the present study provides a species-level inventory of Cicadellidae.

Other studies from protected or ecologically sensitive areas in China also support the importance of habitat quality and vegetation complexity in shaping leafhopper or hemipteran assemblages. Wang *et al.* (2023) surveyed Typhlocybinae in three karst areas of Guizhou, including Shibing Yuntai Mountain Nature Reserve, and recorded 4,078 specimens representing 121 species in 40 genera; their results showed that leafhopper abundance and diversity increased with vegetation coverage. Chen *et al.* (2022) further studied Erythroneurini in the same karst region and found that the Shibing Yuntai Mountain Nature Reserve, which had the lowest degree of habitat fragmentation, supported the richest and most diverse assemblage. A broader Hemiptera survey in Ningxia Lingwu Baijitan National Nature Reserve also showed that species composition differed among habitat types and that habitat quality was a major factor influencing hemipteran diversity (Wang & Zhang 2015). Taken together, these studies indicate that habitat heterogeneity, vegetation structure and habitat continuity are key drivers of leafhopper and hemipteran community composition in Chinese protected areas. The present results conform to this general pattern, but also extend previous surveys by documenting 76 species in 47 genera of Cicadellidae from the Qinling region and by combining community-level diversity analysis with the description of one new typhlocybine genus and one new species.

The pronounced spatial heterogeneity and structural complexity of these mid-elevation forests may help explain the occurrence of previously undocumented taxa in these sites. These observations provide a faunistic context for the taxonomic discoveries reported here. One new genus, *Neoempoasca* **gen. nov.**, and a new species, *Neoempoasca lizizhongi* **sp. nov.** were recognized from the collected material. Notably, these taxa were found in the forest sites rather than in the low-elevation agro-ecosystem, which is consistent with the higher taxonomic diversity recorded in the mid-elevation habitats. Although the present study did not directly test habitat specialization, the occurrence of these newly recognized taxa in forested sites suggests that such habitats retain incompletely documented leafhopper diversity in the Qinling region, a biogeographically complex transitional area between the Palaearctic and Oriental regions (Chen 1996; Zhang *et al.* 2016; Wang *et al.* 2019).

Morphologically, *Neoempoasca* **gen. nov.** is readily distinguished from related genera of Empoascini by the absence of a ventral pygofer appendage and the moderately long aedeagal shaft. In *N. lizizhongi* **sp. nov.**, the shaft extends beyond the posterior margin of the pygofer lobe, forming a combination of characters not observed in closely similar genera treated in the present key. These characters support the establishment of the new genus based on morphology. However, because generic delimitation in Empoascini relies heavily on male genitalic morphology and some of these characters may be evolutionarily labile, the phylogenetic position and monophyly of *Neoempoasca* should be further tested using integrative approaches, especially molecular data (Xu *et al.* 2021; Ding *et al.* 2024; Yao *et al.* 2025).

Together, these findings indicate that the leafhopper fauna of the Qinling Mountains, particularly within protected montane habitats, remains insufficiently documented and still contains noteworthy taxonomic diversity.

5 Conclusions

This study provides the first comprehensive survey of leafhopper diversity in the Shaanxi Hanzhong Crested Ibis National Nature Reserve. A total of 3,033 specimens representing 76 species, 47 genera, 14 tribes, and 10 subfamilies were recorded during the sampling period. Diversity analyses revealed clear temporal and spatial variation in leafhopper communities, with higher diversity occurring in forest habitats than in the agricultural wetland site.

Taxonomically, the survey resulted in the discovery of one new genus and a new species of Empoascini: *Neoempoasca* Dai, Yu & Li **gen. nov.**, *Neoempoasca lizizhongi* Dai, Yu & Li **sp. nov.** These findings further demonstrate that the leafhopper fauna of the southern Qinling Mountains remains incompletely documented. The present study therefore provides important baseline data for future taxonomic and faunistic studies of Cicadellidae in the Qinling region.

Acknowledgements

The authors are grateful to the Shaanxi Hanzhong Crested Ibis National Nature Reserve Administration for their kind permission and support during our field surveys, and to the reserve staff members for their assistance in sample collection. We sincerely thank the anonymous reviewers for their valuable comments and suggestions that improved an earlier version of this manuscript. The study was funded by the Graduate Innovation Fund of Shaanxi University of Technology (Grant No. SLGYCX2652).

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