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Research Article

Biodiversity and Host Plant Associations of Cryptocephalinae Leaf Beetles (Coleoptera: Chrysomelidae) Across Agroecological and Natural Habitats of Sindh, Pakistan

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ABSTRACT

The present study was designed to document the species diversity of the subfamily Cryptocephalinae in Sindh, Pakistan, and to elucidate the host plant associations of each recorded species. A total of 21 species of case-bearing leaf beetles (Cryptocephalinae) were recorded, representing two tribes: Clytrini and Cryptocephalini. These species were associated with a wide range of host plants. The genus *Cryptocephalus* was represented by several species, including *Cryptocephalus lacosus*, *C. obliteratus*, *C. triangularis triangularis*, *C. vittipennis*, *C. oppositus*, *C. sexsignatus*, and *C. guttifer*. Other genera examined included *Aetheodactyla*, *Ceratobasis*, *Clytra*, *Coptocephala*, *Diapromorpha*, *Epimela*, *Miochira*, *Physosmaragdina*, *Smaragdina*, and *Tituboea*. Notable species among these were *Aetheodactyla dimidiatipennis*, *Ceratobasis koenigii*, *Clytra subfasciata*, *C. afghanica*, *Coptocephala crassipes iranica*, *C. crassipes vavilovi*, *Diapromorpha pallens*, *D. turcica*, *Physosmaragdina tonkinensis*, *Smaragdina pakistanica*, *S. minutissima*, *Tituboea daccordii*, *Epimela trimaculata*, and *Miochira signaticollis*. Host plant association analysis revealed that the 21 recorded species were linked to diverse plant families, predominantly Fabaceae, Poaceae, and Myrtaceae. Particularly important host species included *Cynodon dactylon* (Poaceae) and *Eucalyptus citriodora* (Myrtaceae). Some beetle species, such as *Cryptocephalus vittipennis* and *C. triangularis triangularis*, exhibited a broad host range, whereas others showed a higher degree of host specificity. Species of the tribe Clytrini were primarily associated with trees and shrubs, while members of Cryptocephalini were more frequently associated with grasses. These findings enrich the taxonomic and ecological knowledge of Cryptocephalinae in Sindh and provide baseline data relevant to biodiversity conservation and pest management strategies, particularly in relation to economically important crops such as *Sorghum bicolor* and *Zea mays*.

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Introduction

The subfamilies Cryptocephalinae and Lamprosomatinae within the family Chrysomelidae are collectively referred to as Camptosomata, or "case-bearers," due to their distinctive life history in which the larvae, pupae, and eggs develop within a fecal case (Erber, 1988; Jolivet, 1995;

Brown and Funk, 2005; Chaboo et al., 2016). One of the most diagnostic morphological characters distinguishing these beetles is the head, which is often wholly or partially concealed beneath the pronotum.

Beetles of the subfamily Cryptocephalinae are considered excellent model organisms for ecological and evolutionary studies owing to their remarkable diversity in body size, vivid coloration, and broad host-plant associations.

Members of the family Chrysomelidae, commonly known as leaf beetles, are small to medium-sized insects, ranging from approximately 1 to 20 mm in length. Their body forms vary from flattened and rounded to elongated and cylindrical, and many species are conspicuously brightly colored. This family presents considerable challenges for systematists, is of great interest to insect collectors, and includes numerous agriculturally destructive species. Both adults and larvae are primarily phytophagous, feeding on roots, stems, and leaves of herbaceous plants as well as on the foliage of woody plants (Basu et al., 1981).

Adult case-bearing chrysomelids typically feed on the leaves of various eudicotyledonous plants; however, their larvae often depart from strict phytophagy (Erber, 1988). In several species of the tribes Clytrini and Cryptocephalini, larvae develop within ant nests, where they feed on ant feces and pellets, organic debris, leaf litter, and occasionally dead insects collected by ants (Agrain et al., 2015). These beetles become strictly phytophagous at the adult stage, primarily feeding on leaves and flowers. Species belonging to all three tribes of the subfamily Cryptocephalinae have been recorded from Argentina (Reid, 2017).

Most leaf beetles are phytophagous and closely associated with plant hosts, although a few exceptions exist. Several species are important agricultural pests, including *Leptinotarsa decemlineata* Say, 1824, and *Diabrotica virgifera* Le Conte, 1868. The strong association between leaf beetles and their host plants makes this group particularly valuable for studies of insect-plant coevolution (Futuyma and McCafferty, 1990). At the same time, their dual role as crop pests and as biological control agents against invasive plant species has attracted significant scientific attention (Grevstad, 2006; Szűcs et al., 2012).

Beetles of the subfamily Cryptocephalinae play an important role in natural ecosystems as herbivores and occasional pollinators. In addition, some species have been employed as biological control agents. For example, *Cryptocephalus parasimilis* has been successfully used to suppress the invasive weed *Chromolaena odorata* in Indonesia (Syamsuwida et al., 2018).

The subfamily Cryptocephalinae comprises more than 5,300 species worldwide, as independently estimated by Chamorro (2014) and Reid (2017), and is divided into three tribes: Cryptocephalini, Clytrini, and Fulcidacini. Although members of this subfamily have a global distribution, most tribes exhibit relatively restricted geographic ranges (Erber, 1988). Among them, Clytrini is one of the most intensively studied tribes within Chrysomelidae at the species level and is particularly favored by entomologists. Nevertheless, the taxonomy of many cryptocephaline genera remains challenging due to extensive variation in coloration, a wide range of body sizes, and sexually dimorphic traits that are well developed in large males but weakly expressed in smaller individuals (Bezděk and Regalin, 2015).

Considering the ecological and agricultural importance of leaf beetles, and the scarcity of studies on host-plant associations of Cryptocephalinae in Pakistan, the present study aims to contribute to a better understanding of host-plant preferences in this subfamily. By providing locally generated data based on morphological identification, this research seeks to support farmers, researchers, and the local community with reliable host-plant information on case-bearing leaf beetles of the subfamily Cryptocephalinae.

Materials and Methods

Specimen collection sites

Case-bearing leaf beetles belonging to the subfamily *Cryptocephalinae* (Coleoptera: Chrysomelidae) were collected from diverse zoo-geographical regions of Sindh Province, Pakistan. The sampling localities included transitional zones influenced by the Palearctic, Ethiopian, and Oriental biogeographic regions, thereby reflecting the ecological heterogeneity of the province (Cox, 1994a, b, c, d; Löbl and Smetana, 2010). Specimens were obtained from a wide range of habitats and host plants, including agricultural crops, vegetable fields, orchards, ornamental plants, fodder crops, wild shrubs, forest trees, storage facilities (godowns), desert ecosystems, mountainous areas, and riparian zones. Sampling across multiple habitat types was conducted to maximize species representation and to capture ecological variability, as host plant association plays a critical role in determining the diversity and distribution of cryptocephaline beetles (Schmitt, 1996; Jolivet and Verma, 2002).

Methods of collection

Specimens were collected using standard entomological techniques appropriate for Chrysomelidae (Borror and DeLong, 2005; Triplehorn and Johnson, 2005). Collection methods included sweep netting with a standard entomological hand net in vegetation-rich habitats, aspirator (pooter) collection for small and delicate specimens, and light traps operated during evening hours to capture nocturnally active individuals. These techniques are widely recognized as effective for sampling phytophagous beetles, including members of Cryptocephalinae, across different vegetation strata and habitat types (Southwood and Henderson, 2000).

Specimen preservation and labeling

All collected specimens were transferred into labeled killing jars charged with ethyl acetate and subsequently preserved either by dry mounting on entomological pins (for medium to large specimens) or by storage in 70-95% ethanol (for small or soft-bodied individuals), following standard curatorial procedures (Triplehorn and Johnson, 2005). Each specimen was assigned a unique identifier and accompanied by comprehensive metadata, including country, province, and region; exact locality name; geographic coordinates (latitude and longitude); elevation (m above sea level); date of collection; collector's name; host plant association; and relevant ecological notes. Proper labeling and preservation were carried out in accordance with internationally accepted taxonomic standards to ensure long-term curation, traceability, and reproducibility of scientific data (Evenhuis, 2007).

Place of work

Laboratory-based processing, mounting, identification, and documentation of specimens were conducted at the Insect Systematics Laboratory, Department of Entomology, Sindh Agriculture University, Tandojam, Pakistan.

Methods of identification

Specimens were examined under a stereomicroscope (Leica or equivalent) for detailed morphological study. Identification to species level was performed using available regional and global taxonomic keys, original species descriptions, and catalogues of Chrysomelidae (Lopatin, 1984; Baly, 1861, 1862, 1864, 1865, 1874, 1876a, b, c, 1877, 1888; Medvedev, 1992; Löbl and Smetana, 2010). Diagnostic morphological characters, including body shape, coloration, punctation, antennal segmentation, pronotal structure, elytral sculpturing, and male genitalia, were carefully examined, as genital morphology provides essential characters for reliable species-level identification in Cryptocephalinae (Reid, 1995; Chamorro, 2014). When necessary, male genitalia were dissected, cleared in 10% potassium hydroxide (KOH), rinsed in distilled water, and preserved in glycerin-filled microvials pinned beneath the respective specimen, following established taxonomic procedures (Robinson, 1976).

Keys to species of Cryptocephalinae of Sindh, Pakistan

1. Body large; pronotum wider than long; elytra strongly dilated in male; scutellum triangular 2

-Body small to medium; pronotum not wider than long; elytra not strongly dilated in male; scutellum weakly triangular............9

2. Body color reddish brown; eyes convex; pronotum shiny, posterior angles distinctly angulated; aedeagus dorsally straight.............3

-Body color black or dark brown; eyes oval; pronotum dull, posterior angles not angulated; aedeagus dorsally concave...............6

3. Antennae serrate; scutellum sharply triangular; elytra with black patches; vertex smooth..................*Aetheodactyla dimidiatipennis*

-Antennae pectinate; scutellum weakly triangular; elytra without black patches; vertex punctuated 4

4. Pronotum medially humped; scutellum convex; body broader at mid; hairs present on clypeus...............*Ceratobasis koenigii*

-Pronotum not medially humped; scutellum concave; body not broader at mid; hairs absent on clypeus...........5

5. Pronotum black; elytra with two black strips; tarsal claw bifid; antennal first segment club-shaped............ *Clytra subfasciata*

-Pronotum brown; elytra without black strips; tarsal claw not bifid; antennal first segment elongated.............. *Clytra afghanica*

6. Scutellum dark brown; vertex rough; elytral spots present; pronotum finely punctuated 7

-Scutellum black; vertex smooth; elytral spots absent; pronotum coarsely punctuated 8

7. Body with fine punctures; pronotum longer than broad; femur with fine hairs; pronotum margin bordered anteriorly............. *Coptocephala crassipes iranica*

-Body with coarse punctures; pronotum broader than long; femur without fine hairs; pronotum margin not bordered..............*Coptocephala crassipes vavilovi*

8. Elytra orange brown; pronotum without black patches; aedeagus dorsally straight; tarsi robust................ *Diapromorpha pallens*

-Elytra black; pronotum with black patches; aedeagus dorsally concave; tarsi moderately emarginate.............*Diapromorpha turcica*

9. Body oval; pronotum with two spots; elytral spots present; vertex fine punctuated 10

-Body elongate; pronotum without spots; elytral spots absent; vertex rough 15

10. Antennal first segment club-shaped; scutellum black; pronotum orange; elytra with large irregular patches 11

-Antennal first segment enlarged; scutellum brown; pronotum yellowish brown; elytra without irregular patches 13

11. Body brown; pronotum bordered posteriorly; tarsi short and broad; aedeagus apex dorsally acute.............. *Smaragdina minutissima*

-Body reddish brown; pronotum not bordered posteriorly; tarsi robust; aedeagus apex semi--mucronate 12

12. Elytra yellowish brown with five spots; pronotum with brown patches; eyes dark brown..................... *Smaragdina pakistanica*

-Elytra orange with three spots; pronotum without patches; eyes light brown.............*Physosmaragdina tonkinensis*

13. Pronotum slightly equal to elytron; aedeagus apex dorsally acute; vertex smooth.................*Cryptocephalus lacosus*

-Pronotum broader than elytron; aedeagus laterally curved; vertex punctuated 14

14. Elytra reddish brown; spots present; gonopore round and below the apex; tarsal claw bifid................ *Cryptocephalus obliteratus*

-Elytra black; spots absent; gonopore truncate; tarsal claw not bifid……………*Cryptocephalus oppositus*

15. Elytra black with smooth texture; pronotum side margins thickened……………*Cryptocephalus triangularis triangularis*

-Elytra dark brown, pronotum smooth, lateral margins weakly thickened....................*Cryptocephalus vittipennis*

16. Elytra black; pronotum smooth; aedeagus laterally curved............*Cryptocephalus guttifer*

-Elytra dark brown; pronotum punctated; aedeagus dorsally straight............. *Cryptocephalus sexsignatus*

17. Pronotum side margined; elytra strongly dilated in male; aedeagus dorsally straight; scutellum concave 18

-Pronotum not side margined; elytra not dilated in male; aedeagus dorsally concave; scutellum convex 20

18. Elytra yellowish; spots irregular; head broader than long; pronotum posterior angles distinctly angulated............*Tituboea daccordii*

-Antennae closely inserted; scutellum convex; pronotum coarsely punctate; tarsal claw not bifid.................*Miochira signaticollis*

20. Elytral texture smooth; scutellum broader; aedeagus dorsally truncate................*Epimela trimaculata*

Preparation of distributional map

Geographic coordinates recorded during field collection were used to generate a distributional map. Spatial data were first organized in Microsoft Excel and subsequently imported into QGIS (Quantum Geographic Information System) software (QGIS Development Team, 2019, 2023). Locality points were plotted using the WGS 84 coordinate reference system, and the final distribution map was produced to illustrate the spatial occurrence and distribution patterns of *Cryptocephalinae* species across Sindh Province (Figure 1).

Results

In the present study, a total of 135 specimens of case-bearing leaf beetles were collected from various localities in Sindh Province, Pakistan. The investigation revealed the occurrence of 21 species belonging to two tribes, Clytrini and Cryptocephalini, of the subfamily Cryptocephalinae. The recorded species include *Cryptocephalus* (*lacosus*) *lacosus* (Pic, 1922), *C. obliteratus* (Suffrian, 1854), C. triangularis triangularis (Hope, 1831), *C. vittipennis* (Suffrian, 1854), *C. oppositus* (Jacoby, 1908), *C. sexsignatus* (Fabricius, 1801), *C. guttifer* (Suffrian, 1854), *Aetheodactyla dimidiatipennis* (Baly, 1878), *Clytra* (*Clytraria*) *afghanica* (Reineck, 1937), *C. subfasciata* (Lacordaire, 1848), *Coptocephala* (*crassipes*) *iranica* (Medvedev, 1971), *C.* (*crassipes*) *vavilovi* (Lopatin, 1966), *Ceratobasis koenigii* (Fabricius, 1775), *Diapromorpha pallens* (Fabricius, 1787), *D. turcica* (Fabricius, 1801), *Epimela trimaculata* (Fabricius, 1798), Physosmaragdina tonkinensis (Lefèvre, 1861), *Smaragdina minutissima* (Lopatin, 1967), S. *pakistanica* (Medvedev, 2010), *Tituboea daccordii* (Lopatin, 1981), and *Miochira signaticollis* (Kollar and Redtenbacher, 1844).

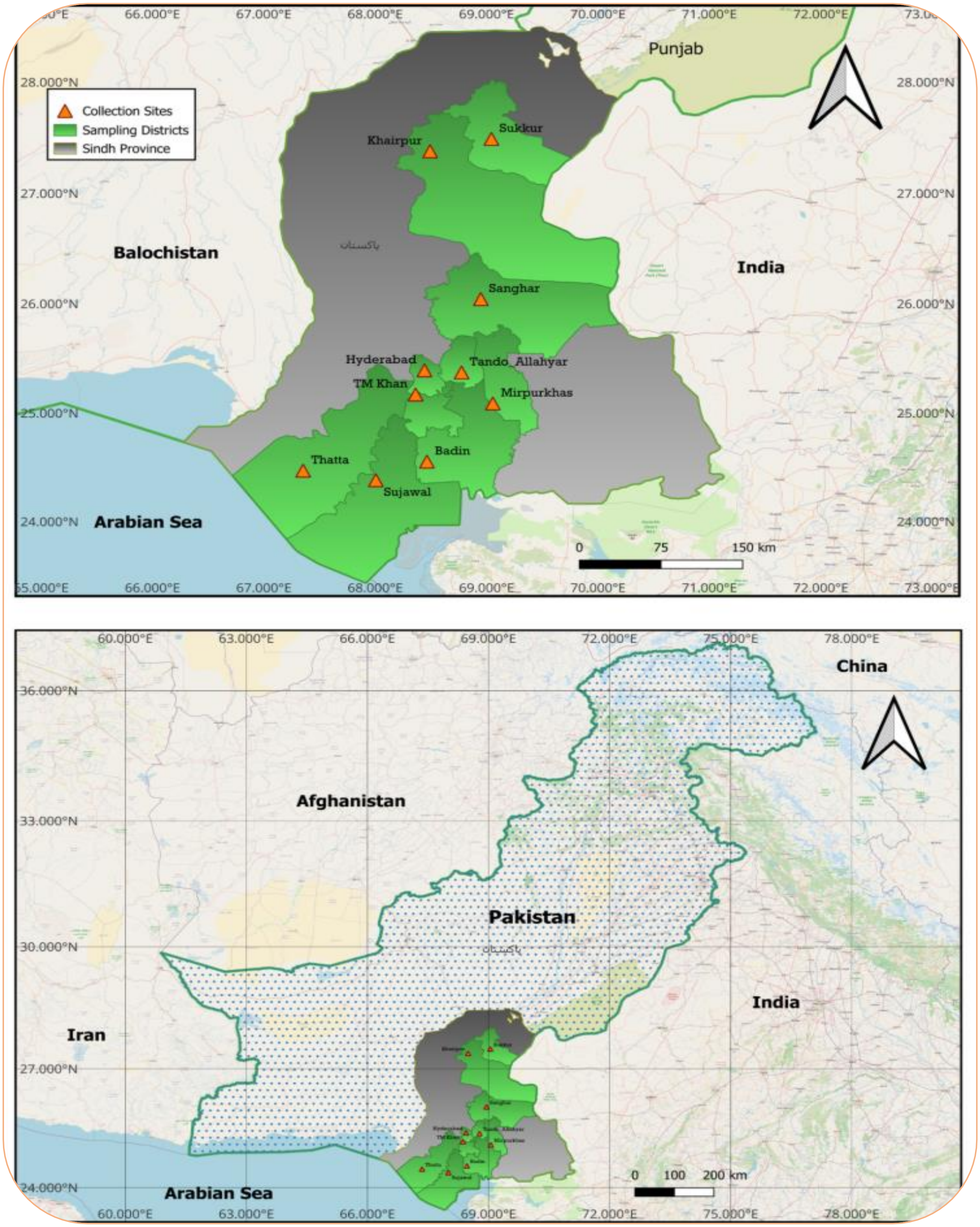

Figure 1. Distribution map of Cryptocephalinae in Sindh, Pakistan.

Host plant investigations indicated that members of Cryptocephalinae were associated with a wide range of plant species, including Broussonetia papyrifera (Moraceae), *Eucalyptus citriodora* and *Psidium guajava* (Myrtaceae), *Prosopis juliflora*, Acacia nilotica, *Moringa oleifera*, *Glycyrrhiza glabra*, and *Dalbergia sissoo* (Fabaceae), *Cynodon dactylon* (Poaceae), *Plantago* sp. (Plantaginaceae), *Eleusine indica*, *Sorghum bicolor*, and *Zea mays* (Poaceae), *Rosa canina* and *Rosa multiflora* (Rosaceae), and *Salix alba* (Salicaceae).

The results further demonstrated that *E. citriodora* (Myrtaceae) and *C. dactylon* (Poaceae) were the most preferred host plants. Of the 21 recorded species, 10 species of the tribe Clytrini and 5 species of the tribe Cryptocephalini were found feeding on *Eucalyptus* spp. and *C. dactylon* (Figure 2).

Overall, the host plant records of Cryptocephalinae in Sindh reveal considerable species diversity and varied plant associations. The dataset highlights differences in host specificity and feeding behavior, indicating that some species are polyphagous, whereas others exhibit oligophagous tendencies. Understanding these host associations is essential for ecological assessments, pest management strategies, and biodiversity conservation programs.

Among the recorded plant families, Fabaceae, Poaceae (Gramineae), and Myrtaceae were the most frequently utilized by Cryptocephalinae beetles. Fabaceae supported the highest number of species, including associations with *Prosopis juliflora*, *Acacia nilotica*, *M. oleifera*, *Dalbergia sissoo*, and *Glycyrrhiza glabra*. The predominance of Fabaceae as a host family suggests that its members may provide suitable nutritional resources or structural characteristics necessary for larval development. Similarly, Poaceae, particularly grasses such as *C. dactylon*, *Eleusine indica*, *Sorghum bicolor*, and *Zea mays,* harbored numerous beetle species, highlighting the ecological importance of grasses in the life cycle of these insects. Within Myrtaceae, *E. citriodora* and *P. guajava* served as important host plants for several Cryptocephalinae species. Additional host families included Moraceae (*Broussonetia papyrifera*), Salicaceae (*Salix alba*), Rosaceae (*Rosa canina*, *R. multiflora*), and Plantaginaceae (*Plantago* sp.).

The ecological significance of these plant species is reflected in the number of beetle species associated with them. *C. dactylon*, a widely distributed grass, was the most frequently recorded host, supporting 13 Cryptocephalinae species and serving as both a feeding and breeding site. *E. citriodora* ranked second, hosting 12 species, underscoring its importance in sustaining Cryptocephalinae populations in Sindh. Other commonly associated host plants included *Broussonetia papyrifera* (9 species), *S. bicolor* (6 species), *S. alba* (6 species), *Rosa canina* (6 species), *Eleusine indica* (5 species), *P. juliflora* (4 species), and *Plantago* sp. (4 species). These plants provide not only food resources but also microhabitats that facilitate survival, reproduction, and population persistence.

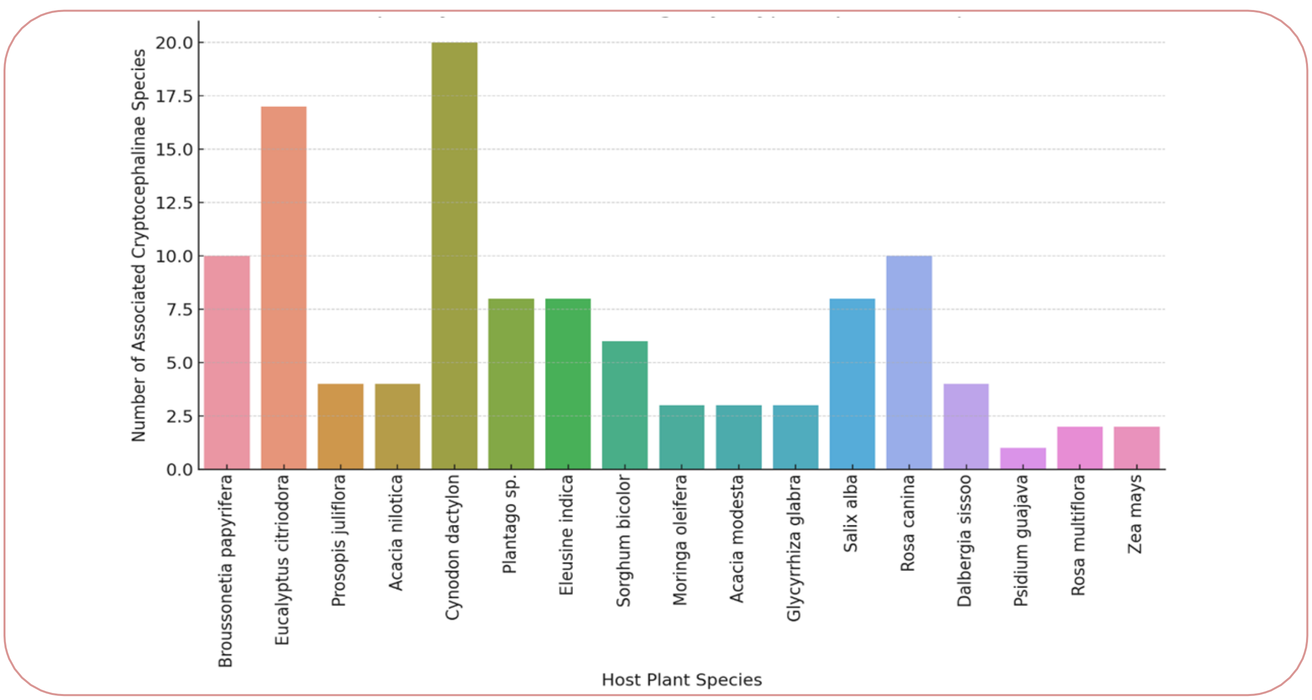

Figure 2. Frequency of host plant utilization by Cryptocephalinae species.

An important observation from the dataset is the repeated association of certain beetle species with multiple host plants. For example, *Cryptocephalus vittipennis* was recorded several times on different host species, suggesting ecological flexibility or geographic variation in feeding behavior. Likewise, *C. triangularis triangularis* was associated with multiple plant species, indicating potential host plasticity and adaptive capacity to local environmental conditions.

A distinction can also be drawn between species preferring woody hosts and those associated primarily with grasses or herbaceous plants. Within the tribe Clytrini, species such as *Clytra subfasciata*, *Coptocephala crassipes*, *Diapromorpha pallens*, and *Tituboea daccordii* were predominantly associated with woody plants, including *E. citriodora*, *S. alba*, *R. canina*, and *Broussonetia papyrifera*. In contrast, members of the tribe Cryptocephalini, such as *C. vittipennis*, *C. triangularis triangularis*, and *C. obliterates,* were more frequently recorded on grasses and herbaceous plants, including *C. dactylon*, *E. indica*, *S. bicolor*, and *Plantago* sp. Differences in host breadth among genera may reflect evolutionary divergence and ecological specialization between the two tribes.

These host records have important ecological implications. The wide diversity of host plants indicates that Cryptocephalinae beetles occupy multiple ecological niches across forested areas, agricultural fields, grasslands, and riparian habitats in Sindh. Certain plant species, particularly *C. dactylon* and *E. citriodora*, function as key host plants supporting a high diversity of Cryptocephalinae. Their conservation may therefore be essential for maintaining local beetle biodiversity. Moreover, the association of some Cryptocephalinae species with economically important crops such as *S. bicolor* and *Z. mays* suggests potential agricultural significance, warranting further investigation into their pest status and economic impact.

In summary, the host plant records of Cryptocephalinae in Sindh reveal complex and diverse beetle-plant interactions. The predominance of Fabaceae, Poaceae, and Myrtaceae, the host plasticity exhibited by species such as *C. vittipennis* and *C. triangularis triangularis*, and the reliance of certain taxa on specific host plants collectively enhance our understanding of the ecology and adaptive strategies of these beetles. These findings provide a foundation for future research in taxonomy, conservation biology, and integrated pest management of Cryptocephalinae in Pakistan and beyond.

Discussion

The present study revealed distinct patterns of host plant association among tribes of Cryptocephalinae in Sindh Province. Within the tribe Clytrini, species such as *Clytra subfasciata*, *C. crassipes*, *C. palliatum*, and *Tituboea daccordi* were predominantly associated with woody plant species, including *E. citriodora*, *S. alba*, *R. canina*, and *B. papyrifera*. In contrast, members of the tribe Cryptocephalini, such as *Cryptocephalus vittipennis*, *C. triangularis triangularis*, and *C. obliterates*, were more frequently recorded on grasses and herbaceous plants, including *C. dactylon*, *Eleusine indica*, *S. bicolor*, and *Plantago* spp. The comparatively narrower host range observed in certain genera may reflect evolutionary specialization within each tribe, possibly driven by plant chemistry, structural traits, and habitat preferences. These findings are consistent with Basu et al. (1981), who reported that leaf beetles generally feed on various parts of both woody and herbaceous plants, with both larvae and adults exhibiting phytophagous behavior.

Despite their predominantly phytophagous nature, deviations from strict plant feeding have been documented in Cryptocephalinae. Erber (1988) noted that although adult case-bearing chrysomelids typically consume foliage of numerous eudicot species, the larvae often display more diverse ecological strategies. In particular, certain species within Clytrini and Cryptocephalini exhibit myrmecophilous associations, with larvae inhabiting ant nests and feeding on organic debris, ant droppings, leaf litter, and occasionally dead insects collected by ants (Agrain et al., 2015). This facultative or obligate association with ants represents a significant ecological divergence within an otherwise herbivorous lineage and highlights the adaptive versatility of the group.

Among the host plant families recorded in the present study, Fabaceae, Poaceae (Gramineae), and Myrtaceae were the most frequently utilized. Fabaceae, in particular, supported a high diversity of Cryptocephalinae species, including associations with *P. juliflora*, *A. nilotica*, *M. oleifera*, *D. sissoo*, and *Glycyrrhiza glabra*. The frequent utilization of Fabaceae may be attributed to its widespread distribution, nitrogen-rich tissues, and structural suitability for feeding and oviposition. Similarly, grasses within Poaceae, such as *C. dactylon*, *Eleusine indica*, *S. bicolor*, and *Z. mays*, harbored multiple species, emphasizing the ecological importance of grass-dominated habitats in sustaining cryptocephaline populations.

From an evolutionary perspective, leaf beetles are widely recognized as predominantly phytophagous insects. Reid (2017) emphasized that adults are primarily folivorous and florivorous, feeding mainly on leaves and flowers. Futuyma and McCafferty (1990) further highlighted that host specialization and diversification in Chrysomelidae have been closely linked to plant evolution, with several species attaining pest status in agroecosystems. Notable examples include *Leptinotarsa decemlineata* (Say, 1824) and *Diabrotica virgifera* LeConte, 1868, both of which have become economically significant pests due to their close association with cultivated crops. Such host-specific interactions underscore the importance of leaf beetles as model organisms for studying insect-plant coevolution and ecological specialization.

Beyond their ecological and evolutionary relevance, Cryptocephalinae also possess applied importance in agriculture and weed management. Although some species may cause localized damage to crops and woody plants, others have demonstrated potential as biological control agents. For instance, *Cryptocephalus parasimilis* has been utilized in Indonesia for the management of the invasive weed *Chromolaena odorata* (Syamsuwida et al., 2018). The dual ecological role of leaf beetles, as both pests and beneficial biocontrol agents, makes them particularly significant in the context of integrated pest management (IPM) and conservation biological control (Grevstad, 2006; Szűcs et al., 2012).

Overall, the findings from Sindh Province highlight the complex and dynamic relationships between Cryptocephalinae beetles and their host plants. The predominance of Fabaceae, Poaceae, and Myrtaceae as host families, coupled with the ecological plasticity observed in species such as *C. vittipennis* and *C. triangularis triangularis*, enhances our understanding of their adaptive strategies. The selective yet flexible feeding behavior exhibited by these species likely contributes to their evolutionary success and ecological resilience. These understandings not only broaden the regional knowledge of cryptocephaline diversity but also provide a foundation for future studies on host specificity, ecosystem functioning, and potential applications in biological control programs.

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Authors' Contribution

MUB and IK conceptualized and designed the study. MUB conducted field surveys, collected specimens, compiled the dataset, and prepared the initial draft of the manuscript. IK carried out the morphological identification and taxonomic verification of the collected species. AAG contributed to data organization, critical revision, and improvement of the manuscript structure and presentation. RS assisted in the identification and confirmation of host plant species. All authors reviewed, revised, and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

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Conflict of Interest

The authors declare no conflict of interest.

Sustainable Development Goals Targeted

SDG 2: Zero Hunger

SDG 12: Responsible Consumption and Production

SDG 15: Life on Land

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