

Adaptive strategies for survival and reproduction in two Monarch butterflies and their associated insects on milkweed plants in Northern India and Chicago, USA

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DOI: <https://doi.org/10.66856/ijer.2026.11.3.11356>

Abstract

The present study compares the host association, feeding behaviour, seasonal occurrence, reproductive behaviour, survival strategies, and associated insect fauna of two monarch butterflies, *Danaus chrysippus* Linnaeus in Northern India and *Danaus plexippus* (Linnaeus) in Chicago, USA. Weekly observations on *D. chrysippus* were conducted from April 2021 to October 2025 in 16 villages of South-West Delhi and Gurugram, India, with particular emphasis on its principal larval host plant, *Calotropis procera*. Observations on *D. plexippus* were conducted in Chicago during August–October 2023, July–August 2024, and August 2026, with additional observations along the Pacific Coast of California during the fall-migration period in 2026. *Danaus chrysippus* larvae were recorded feeding on *C. procera* throughout the year, despite temperatures ranging from approximately 10–13°C during winter to about 41°C during May–June. Adults utilized a wide range of flowering plants for nectar feeding, including *Lantana camara*, *Jatropha integerrima*, *Calotropis procera*, *Tamarix aphylla*, *Heliotropium curassavicum*, and *Oxystelma esculentum*. Courtship behaviour, roosting, and seasonal congregation were also documented. Associated insects on *C. procera* included *Spilostethus pandurus*, *S. hospes*, and *Aphis nerii*, the latter frequently associated with the ladybird predator *Coccinella septempunctata*. In Chicago, *D. plexippus* larvae were primarily associated with *Asclepias syriaca*, although *Gomphocarpus physocarpus* supported substantial larval feeding during late August 2026 when the former host was undergoing senescence. Adults extensively utilized flowering plants for nectar, particularly *Silphium perfoliatum* and *Phlox paniculata*. The late-summer generation exhibited the characteristic reproductive delay associated with autumn migration and overwintering. *Oncopeltus fasciatus* was recorded feeding on *A. syriaca*, while *A. nerii* and *C. septempunctata* showed associations comparable to those observed in Northern India.

Keywords: *Danaus chrysippus*, *Danaus plexippus*, monarch butterflies, milkweed, *Calotropis procera*, *Asclepias syriaca*, *Gomphocarpus physocarpus*, host plant, migration, survival strategies, associated insects

Introduction

Danaus chrysippus Linnaeus, commonly known as the Golden Monarch or Plain Tiger in Asia and the African Monarch in Africa, is a widely distributed milkweed butterfly (Smith *et al.*, 2019) ^[16]. In the American continent, *Danaus plexippus* (Linnaeus) is commonly known as the Monarch butterfly (Brower and Moffit, 1974) ^[2]. Poulton (1908) ^[12] regarded *D. chrysippus* as one of the most widely distributed butterflies in the world because of its extensive occurrence throughout the Old-World tropical and subtropical regions, extending into warm temperate areas during summer. Human activities have historically increased the availability of suitable habitats for *D. chrysippus* through deforestation, desertification, expansion of agricultural areas, and the proliferation of weedy habitats and flower-rich gardens. The species also has a long association with human culture; it was depicted approximately 3500 years ago in a Bronze Age fresco in the tomb of Nebamun in the Valley of the Kings, Egypt (Larsen, 1977) ^[10]. Since its description by Linnaeus in 1758, *D. chrysippus* has remained an important subject of biological and ecological research. The species is widespread in Africa and parts of Europe (Smith *et al.*, 2019; Kheloufi *et al.*, 2019) ^[16,9], while its biology and migration have also been investigated in India (Rao *et al.*, 2016; Dalui *et al.*, 2022; Singh and Mboma, 2026) ^[13,3,15], Bangladesh (Alam *et al.*, 2019) ^[1], Iran (Golestaneh *et al.*, 2009) ^[7], and other parts of Asia (Liu *et al.*, 2022) ^[11]. In Northern India, *D. chrysippus* is popularly known as the AK butterfly because of its close association with AK or

milkweed plants, particularly *Calotropis procera*, which is abundant in neglected and disturbed habitats. Its occurrence across India, from Punjab in the north to Kerala and Tamil Nadu in the south, together with its dependence on milkweed hosts, indicates a highly specialized larval feeding relationship (Vattakaven *et al.*, 2016) ^[18].

The second species considered in the present study, *Danaus plexippus*, is native to North and South America. During the nineteenth century, it expanded its distribution to other regions, including Australia and New Zealand (Gibbs, 1994) ^[5]. Unlike most butterflies, the North American Monarch is renowned for its long-distance seasonal migration. During autumn, generally in September and October, large numbers migrate from northern regions, including Canada, to overwintering sites in central Mexico, covering distances of approximately 4830 km (Urquhart and Urquhart, 1977) ^[17]. The migration is associated with the inability of the northern populations to survive prolonged freezing winter conditions. Monarch butterflies generally require temperatures of approximately 21–27°C for active growth and reproduction. As autumn approaches, environmental cues such as decreasing day length, fluctuating temperatures, and deterioration of host plants induce reproductive diapause in the late-summer generation (Goehring and Oberhauser, 2002) ^[6]. These butterflies postpone reproductive development and undertake migration to overwintering sites. In spring, the overwintering population begins its northward movement toward breeding areas. Monarchs occurring east of the Rocky Mountains generally overwinter in the mountains of central Mexico, whereas populations

west of the Rocky Mountains commonly overwinter along the California coast. Both *Danaus* species have evolved specialized adaptations that enable them to utilize milkweed plants containing cardiac cardenolides in their latex. These compounds can provide chemical protection against potential predators (Brower and Moffit, 1974) [2]. In view of their close association with milkweed plants but contrasting geographical and climatic environments, the present study was undertaken to compare the natural incidence, host-plant utilization, feeding and reproductive behaviour, and survival-related adaptations of *D. chrysippus* in Northern India and *D. plexippus* in the USA. Observations were also made on other insects associated with and adapted to milkweed plants in the two regions.

Materials and Methods

Study area and observations on Golden Monarch

Weekly field surveys were conducted to document the occurrence and feeding activity of the Plain Tiger or Golden Monarch, *Danaus chrysippus* Linnaeus (Nymphalidae: Lepidoptera), on milkweed plants and other vegetation from the first week of April 2021 through the last week of October 2025. Surveys covered 16 villages in the south-western National Capital Region of India, comprising eight villages in South-West Delhi—Raghopur, Nanak Heri, Badu Sarai, Kangan Heri, Jhatikara, Shikarpur, Rawta, and Daurala—and eight villages in Gurugram—Dharampur, Daulatabad, Kharki Majra, Mankrola, Mohammad Heri, Babupur, Badhera, and Harsaru. The surveyed region was centred approximately at 28.4972°N, 76.9867°E. Observations concentrated on the major larval host plants of *D. chrysippus* in Northern India, particularly species of *Calotropis*, locally known as Ak. *Calotropis procera* is widespread in dry and arid habitats, wastelands, fallow fields, scrub vegetation, roadsides, semi-urban areas, agricultural landscapes, pastures, and drainage areas. Its leaves constitute an important food source for larvae of *D. chrysippus* (Dhaliwal *et al.*, 2006) [4]. In contrast, *C. gigantea* was relatively scarce in the surveyed region. *Asclepias curassavica*, another potential larval host of *D. chrysippus*, is generally cultivated as an ornamental plant in gardens and parks in Indian cities (Rao *et al.*, 2016) [13], but it was not recorded during the present field surveys. Adult butterflies were observed feeding on flowers of a range of plant families. Larval occurrence and feeding activity were recorded primarily on *C. procera*, whereas adult nectar-feeding activity was documented on flowering plants encountered within the study areas. Observations were also made on other insects regularly associated with *C. procera* and other milkweed plants.

Study area and observations on American Monarch

Field surveys for the Monarch butterfly, *Danaus plexippus* (L.) (Nymphalidae: Lepidoptera), were conducted in Chicago, Illinois, USA, from 25 August to 17 October 2023, 20 July to 16 August 2024, and 10 to 30 August 2026. The study area was centred approximately at 41.8818°N, 87.6232°W. Major survey locations included Lincoln Park, Millennium Park, Field Museum Campus, the Lake Michigan shoreline, River Walk and River Front, Old Town, Lurie Park, Lincoln Park Zoo and Broad Walk, as well as roadside vegetation within the city. Records included larval feeding and damage on milkweed plants, adult feeding on flowers belonging to different plant families, and the occurrence of other insects associated with milkweed. Particular attention was given to *Asclepias syriaca* and

Gomphocarpus physocarpus, which are important milkweed plants in the Chicago region. Because the onset of autumn or southward migration occurs during September and October and is associated with reproductive diapause, additional observations were planned along the Pacific Coast of the USA. Southern California locations, including San Diego, Temecula, and San Bernardino, approximately 3264 km from Chicago, were visited from 31 August to 6 September 2026. The route continued toward Los Angeles along the Pacific Coast to document the presence of Monarch butterflies during the fall-migration period.

Results and Discussions

Golden Monarch

Larval feeding and survival: The Plain Tiger or Golden Monarch, *Danaus chrysippus* Linnaeus, commonly known as the AK butterfly in Northern India, was surveyed extensively in South-West Delhi and Gurugram. Larvae were found predominantly feeding on the leaves and, occasionally, on mature unopened flower buds of *Calotropis procera*. The host plant was widely distributed in rural and semi-urban habitats and supported larval feeding throughout the year. Observations summarized in Table 1 indicate that larvae and feeding damage occurred during all 12 months. During the five-year observation period, the mean minimum temperatures during January, February, and December were approximately 10–13°C, whereas temperatures reached approximately 41°C during May and June. Despite this substantial seasonal variation, larvae continued to feed on leaves and flower buds throughout the year (Fig. 1), indicating considerable tolerance to seasonal temperature fluctuations. Larval abundance and feeding damage were comparatively greater in 2021, 2023, and 2025 than in 2022 and 2024. The larvae illustrated in Fig. 1 were predominantly in the fourth or fifth instars. Mature larvae were characterized by three pairs of elongated, black, tentacle-like filaments situated on the third, sixth, and twelfth body segments. The body showed alternating black and white/grey bands with prominent yellow dorso-lateral spots. The filaments often had reddish bases, and fully developed fifth-instar larvae reached approximately 36–41 mm in length, consistent with earlier observations (Golestaneh *et al.*, 2009; Dalui *et al.*, 2022) [7,3].

Table1: Prevailing monthly temperatures and presence of *D. chrysippus* larva on *Calotropis procera* plants in Gurugram and South-west Delhi from April 2021 to October 2025

Period	Av. Temp. (°C)		Larval presence with feeding activity on <i>Calotropis procera</i> leaves/flowers				
	Jan. 2021 to Dec. 2025						
	Low	High	2021	2022	2023	2024	2025
January	10	21			☑		☑
February	13	25		☑	☑	☑	
March	19	32			☑		☑
April	25	38	☑	☑	☑	☑	☑
May	29	41	☑				☑
June	31	41	☑		☑		
July	29	36	☑		☑		
August	28	34	☑	☑	☑	☑	☑
September	27	34	☑		☑	☑	☑
October	24	34	☑	☑	☑		☑
November	18	29	☑	☑		☑	
December	13	23		☑	☑		

Indicates presence and feeding damage of larva on *C. procera* plants.

Adult feeding, courtship and roosting: Adult *D. chrysippus* butterflies were observed feeding on flowers of several plant species. Frequently utilized plants included *Lantana camara* (Verbenaceae), *Jatropha integerrima* (Euphorbiaceae), *Calotropis procera* (Apocynaceae), *Tamarix aphylla* (Tamaricaceae), *Heliotropium curassavicum* (Heliotropiaceae), and *Oxystelma esculentum* (Apocynaceae) (Fig. 2, 1–6). *Lantana* and *Heliotropium* have previously been reported as preferred nectar sources of the Plain Tiger (Rao *et al.*, 2016; Alam *et al.*, 2019) [13,1]. A notable observation was the congregation of several Plain Tiger butterflies on flowers of the rosy milkweed vine, *O. esculentum*, during August–September 2024 and 2025. Similarly, groups of butterflies were observed feeding on *H. curassavicum* during October–November 2024, although larval activity was not recorded on these plants. Courtship behaviour was also documented on 10 occasions at different

locations. During courtship, males were observed attached above females, with the female hanging below. Males could readily be distinguished by an additional black spot with a white centre on the hindwing, representing a pheromone pouch or scent structure. Thus, males generally showed four black markings on the hindwing, including the scent-marking structure, whereas females showed three. Resting or roosting behaviour was observed on non-flowering plant parts and other substrates, including barbed wire, dry twigs, and foliage. Butterflies were particularly observed resting on stems and branches of *Chenopodium album*, *Hibiscus rosa-sinensis*, and *Clerodendrum inerme*. An unusual congregation was observed during morning hours in September and October, when several butterflies rested together on individual stems of *Parthenium* weeds (Fig. 3, 1–4). The occurrence of other *Danaus* species was also recorded.

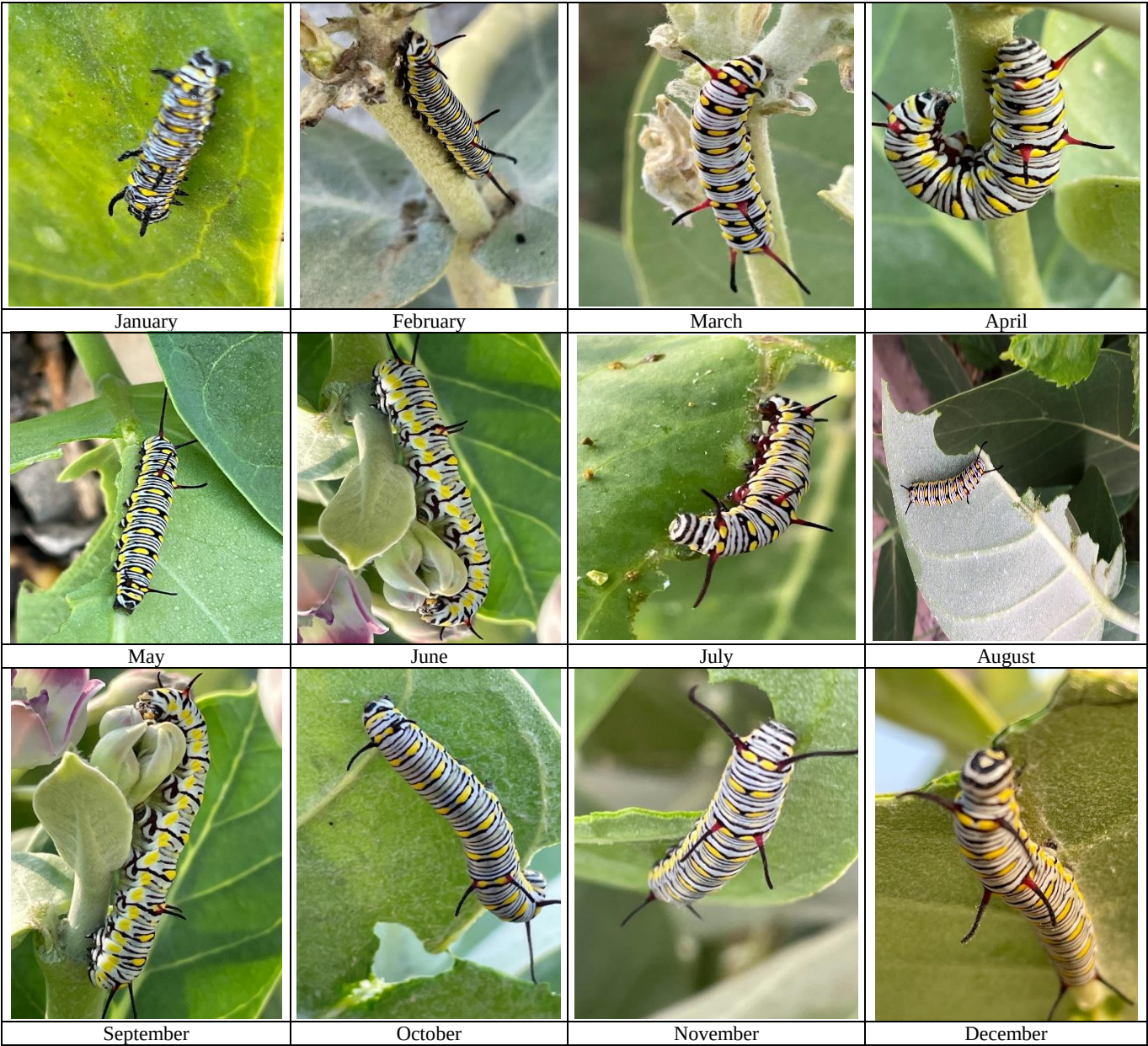


Fig 1: Pics of field incidence of *D. chrysippus* larvae on *Calotropis procera* leaves year-round.

As is common in areas where milkweed butterflies coexist, a second species with a similar appearance was occasionally observed feeding on flowers of *Oxystelma esculentum*. It was identified as the Striped Tiger, *Danaus genutia*

(Cramer). The two species could be distinguished by their wing patterns (Fig. 3, 5–8). *Danaus genutia* exhibited broad and conspicuous black bands along the wing veins, producing a pronounced striped pattern over



Fig 2: Preferred hosts for *D. chrysippus* butterflies feeding and mating in Gurugram and Delhi region.

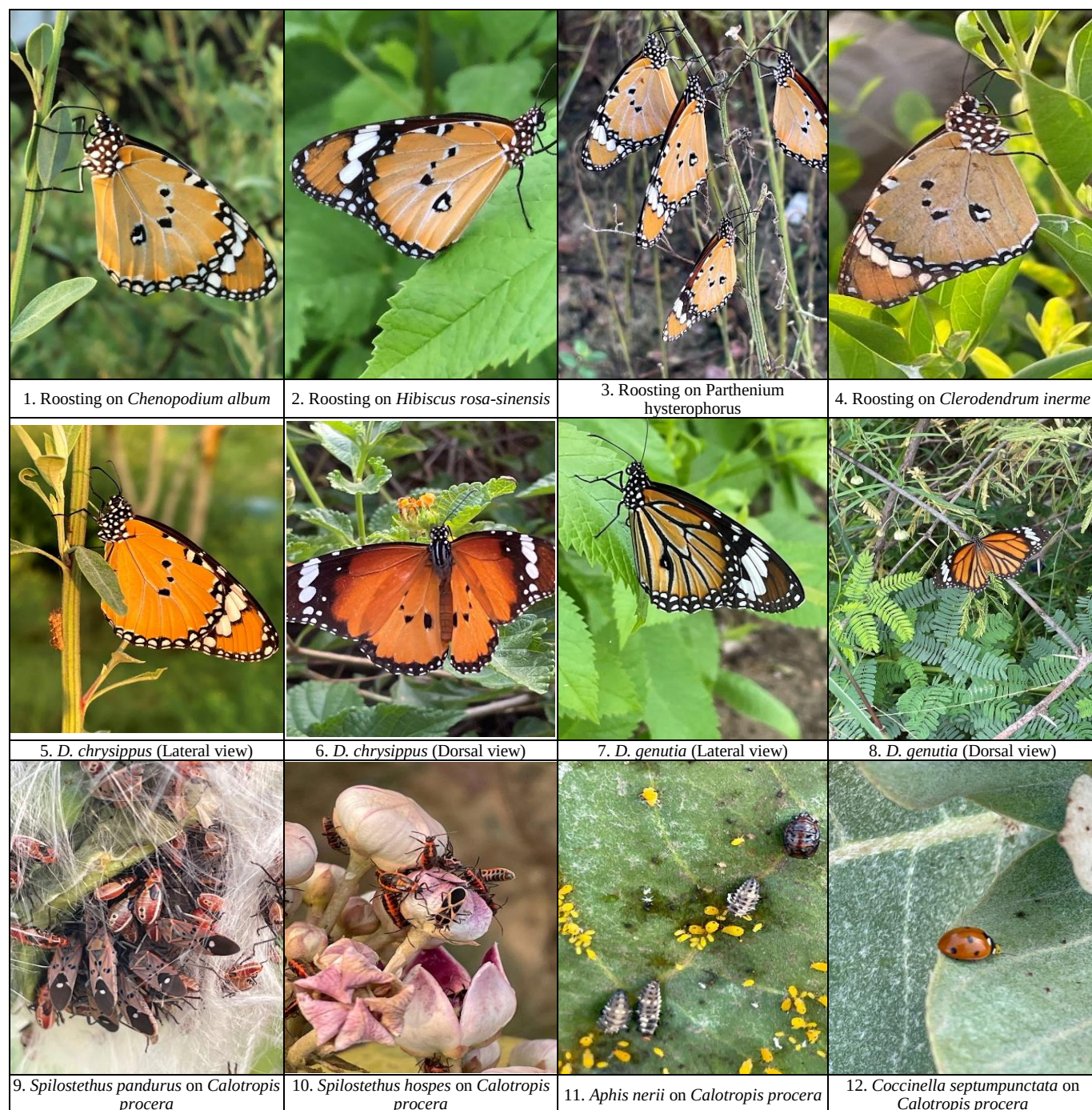


Fig 3: Preferred hosts of *D. chrysippus* for roosting (1-4) and comparison of its lateral and dorsal views (5-6) with *Danaus genutia* (7-8); other associated insects of *C. procera* (9-12)

The orange wing areas. In contrast, *D. chrysippus* possessed relatively thin and less conspicuous black veins, leaving the orange areas comparatively uninterrupted. The hindwing of *D. genutia* was characterized by a prominent black framework, whereas *D. chrysippus* generally displayed three or four discrete black spots on the orange hindwing. The wingspan of *D. genutia* was approximately 75–95 mm compared with 70–80 mm in *D. chrysippus*.

Associated Insects: Several other insects were closely associated with *C. procera*. The lygaeid bugs *Spilostethus pandurus* (Scopoli) and *S. hospes* (Lygaeidae: Hemiptera) were commonly observed feeding on leaves and pods (Fig. 3, 9–10). *Spilostethus pandurus* was more abundant and was primarily observed feeding on seeds within pods, whereas *S. hospes* was associated more frequently with tender leaves and flowers. Their association with *C. procera* suggests

adaptation to the milkweed host. The oleander aphid, *Aphis nerii* Boyer de Fonscolombe, was also closely associated with *C. procera*, particularly during the cooler period from October to April. Colonies of the aphid were frequently attacked by the seven-spotted ladybird, *Coccinella septempunctata* Linnaeus (Fig. 3, 11–12). The association of *A. nerii* with milkweed plants has also been reported from other regions (Dhaliwal *et al.*, 2006)^[4].

American Monarch

Observations in Chicago documented the seasonal activity of the American Monarch, *Danaus plexippus*, a species renowned for its long-distance migration in North America. Although several sites were surveyed, particular attention was given to three major areas—Broad Walk, Lincoln Park Zoo, and the Field Museum Campus (Fig. 4, 1–3).



Fig 4: Major three Flower Parks in Chicago for Monarch Conservation (1-3) and three major plants in full bloom (4-6) in August-September 2026.

During August–October, several flowering plants in these locations provided important nectar resources for adult butterflies, including individuals of the late-summer generation undergoing reproductive diapause.

Table 2: Prevailing monthly temperatures and presence of *D. plexippus* larva on *Asclepias syriaca* plants in Chicago (Illinois) from October 2023 to September 2026.

Period	Av. Temp. (°C) Oct.2023 to Sept. 2026		Larval presence with feeding activity on <i>Asclepias syriaca</i> leaves/flowers		
	Low	High	25 August to 17 October 2023	20 July to 16 August 2024	10 August to 6 September2026
January	-7.3	-0.2			
February	-5.7	2.1			
March	-0.6	8.3			
April	4.6	15.0			
May	10.3	21.4			
June	16.0	26.9			
July	19.1	29.2			
August	18.4	28.1	☑(1 survey)	☑(2 survey)	☑(7 surveys)
September	13.9	24.2	☑(5surveys)	☑(2 survey)	☑(1 survey)
October	7.4	17.1	(2 surveys)		
November	1.2	9.1			
December	-4.2	2.6			

Indicates presence and feeding damage of larva on *Asclepias syriaca* plants.

Larvial survival: The larvae of *D. plexippus* were readily distinguished from those of *D. chrysippus*. Monarch larvae possess two pairs of tentacle-like filaments, one pair toward

the anterior region and another near the posterior end, whereas *D. chrysippus* has three pairs. The larvae of *D. plexippus* also exhibit conspicuous, regular bands of black,

white, and yellow across the body, without the additional irregular yellow lateral spotting characteristic of *D. chrysippus*. Fifth-instar larvae generally reached approximately 25–55 mm in length. Larvae were readily observed feeding on the traditional milkweed host, *Asclepias syriaca*, during July and August (Table 2). With the decline in temperature to approximately 7.4–13.9°C during September and October, the leaves of *A. syriaca* showed progressive senescence and yellowing (Fig. 5, 3). By the last week of August 2026, only a small number of larvae were observed on *A. syriaca*. At the same time, relatively large numbers of larvae, approximately 2–3 per plant, were found feeding on the alternative milkweed, *Gomphocarpus physocarpus* (Fig. 5, 4–5). This plant, cultivated near the Lincoln Park Zoo area for ornamental

purposes, appeared to provide a suitable food source for newly emerging Monarch larvae.

Adult feeding and host range: Adult Monarchs were abundant in the surveyed areas and actively visited a wide variety of flowering plants. During August and September, these butterflies represented the late-summer generation associated with reproductive diapause and preparation for southward migration before the onset of increasingly low temperatures during October and November, when temperatures may decline to approximately 1.2–7.4°C (Table 2). *D. plexippus* butterflies have a wingspan of approximately 8.9–10.2 cm. The dorsal wing surface was predominantly deep orange with conspicuous black veins. A broad black marginal border contained two rows of small white spots (Fig. 5, 7).



Fig 5: *Danaus plexippus* (L.) larval host (1-5), butterfly (lateral) and dorsal (7) views, major adult hosts (8-9); associated evolved insects on *A. syriaca* plant in Chicago (USA).

The contrasting coloration is associated with aposematic signalling and the chemical protection acquired through feeding on milkweed. The ventral wing surface was paler and more subdued, ranging from orange to yellowish brown (Fig. 5, 6). The head, thorax, and abdomen were black with small white markings. Males possessed a characteristic black spot on a hindwing vein on the dorsal surface. These structures contain specialized androconial scales involved in pheromone release during courtship. Females lacked these spots and generally had broader black wing veins than males. Whereas non-migratory generations generally survive for approximately 2–6 weeks, the late-summer generation associated with the present observations undergoes delayed reproductive development and survives for several months while completing long-distance migration to overwintering sites (James and Kappen, 2021)^[18]. Butterflies were observed feeding on numerous flowering plants, including *Asclepias syriaca*, *Rudbeckia fulgida*, *Zinnia elegans*, *Echinacea paradoxa*, and *Oenothera biennis* (Fig. 4, 5–6). Particularly frequent visits were observed on *Silphium perfoliatum* (Fig. 5, 8) and *Phlox paniculata* (Fig. 5, 9). The southern parts of California including San Diego, Temecula, San Bernardino and Pacific Coast up to Los Angeles are in the path of fall migration of Monarch butterflies but surveys in these areas from 1 to 6 September did not reveal the prevalence of Monarch butterflies, indicating event is yet to be initiated.

Associated insects: The Large Milkweed Bug, *Oncopeltus fasciatus* (Dallas) (Lygaeidae: Hemiptera), was recorded feeding on the leaves and pods of *A. syriaca* (Fig. 5, 10). This association represents a functional parallel with the lygaeid bugs recorded on *C. procera* in India. Similarly, *Aphis nerii* was found on the leaves of *A. syriaca* and *G. physocarpus*, accompanied by the predatory ladybird *Coccinella septempunctata* (Fig. 5, 11–12). The occurrence of these aphid–predator associations in both study regions provides an additional ecological parallel between the milkweed-associated insect communities of Northern India and Chicago.

Conclusion

The observations demonstrate contrasting but functionally comparable strategies of host utilization, seasonal survival, reproduction, and resource exploitation in the two *Danaus* species under markedly different climatic conditions. Their close association with milkweed plants and the occurrence of specialized herbivorous and predatory insects further illustrate the ecological complexity of milkweed-based insect communities.

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