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Chromolaena odorata (L.) King & H.E. Robins (Asteraceae), an important nectar source for adult butterflies

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Abstract: *Chromolaena odorata* is a seasonal weed and grows like a cultivated crop. It flowers during October-December. The floral characteristics such as white to purple colour of florets, short-tubed narrow corolla with deep seated nectar, the morning anthesis and the flat-topped head inflorescence providing a standing platform are important attractants for visitation by butterflies. The florets attract butterflies of five families and sphingid hawk moths. Among the butterflies, nymphalids are diverse and visit the florets consistently; their visits effect pollination. The diurnal hawk moths, *Macroglossum gyrans* and *Cephonodes hylas* also visit the florets during dawn and dusk hours for nectar, and effect pollination. Therefore, *C. odorata*, being an exotic is an important nectar source for adult butterflies.

Keywords: Butterflies, *Chromolaena odorata*, nectar, psychophily.

Chromolaena odorata is a perennial weed in many parts of the world from sea level to over 1,000m in elevation (Binggeli 1999). It was introduced into India from tropical America during the Second World War and since then it has spread widely and has become a dominant weed of wastelands, roadsides and other exposed areas (Kushwaha et al. 1981). Disturbance is a pre-requisite for the colonization of an area by this plant and once colonized, it competes aggressively with herbs, grasses, and shrubs in open areas. It is not shade-tolerant and does not grow under a closed forest stand (Francis 2001). It possesses an underground organ which ensures its survival in case of fire, drought or mechanical damage through coppicing (Schmidt & Schilling 2000). Its reproduction is exclusively by seeds (Coleman 1989). Sexual reproduction starts when the plant is one-year old and this observation agrees with Schmidt & Schilling (2000) who reported similarly. In the present study sites, this weed occurs in open, sunny areas of forest margins and open gaps in the forest at an elevation of over 700m. The regular disturbance in the forest due to various human activities facilitates colonization of exposed areas by this plant. *C. odorata* grows like a crop during the active growth period and suppresses the growth of native low ground herbaceous flora. This paper describes the importance of *C. odorata* as a nectar source for adult butterflies.

Materials and Methods

Chromolaena odorata occurring at the Seshachalam Hills of southern Eastern Ghats of Andhra Pradesh was used for the study during the summer season of 2009. Twenty-five tagged mature buds were followed for recording the time of anthesis and anther dehiscence. The details of flower morphology such as flower sex, shape, size, colour, odour, sepals, petals, stamens and

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ovary were described. Regular observations were made on the butterflies visiting the flowers for forage. They were observed for their foraging behaviour such as mode of approach, landing, probing behaviour for nectar collection, contact with essential organs to result in pollination, inter-plant foraging activity in terms of cross-pollination, etc. The foraging visits of each butterfly species for the entire day on the selected number of flowering heads were recorded to know the relative percentage of visits of each butterfly family. Three to five specimens of each butterfly species collected at different times of the day were brought to the laboratory for examining their proboscis under a microscope for the presence of pollen grains in order to assess their role in pollen transfer and pollination.

Results

Floral biology: The plant is a free standing shrub and grows up to 1m. It is maintained by a system of abundant, yellowish, fine lateral roots. The opposite, three-nerved leaves are ovate-lanceolate, usually with a dentate margin and a long pointed tip. Seed germination starts in May-June and active growth occurs during June-October. The plant possesses underground organs which ensure its survival during drought or mechanical damage or in case of fire. Flowering does not occur in the first year but it occurs in the consecutive years during October-December. The inflorescences consist of corymbs of cylindrical heads; they arise at the terminal part of the branches (Image 1a). A cylindrical head consists of 21 to 28 tubular florets per head (Image 1b,c). The florets open during 0600-0800 hr (Image 1d-g). They are very small, white to light purple, bisexual, and zygomorphic. The calyx is reduced to pappus and represented by hairs. The corolla is tubular with five teeth at the tip. The stamens are five, epipetalous, arise from the base of the corolla, filaments are free but anthers are united representing syngenesious condition. The anthers are dithecous, have their connective prolonged into hood and their bases produce hairy outgrowths, which in turn form a protective envelope for the nectary. The pollen grains are very small, round, ornamented, 196 ± 14.6 per anther and the total pollen output per floret is 980 (Image 1h). The narrow anthers form a hollow space and pollen is liberated into this space. The ovary is bicarpellary and syncarpous, unilocular with a single basal ovule (Image 1i,j). The style is surrounded by the nectary at the base and it is forked into two parts. The receptive surfaces of the stylar branches stay in the closed state and as they grow through the hollow space brush out the pollen liberated in the hollow space. Further, the style stretches out beyond the anthers, spreads out its branches to receive pollen. The nectar is secreted in traces only; for this reason nectar analysis was not carried out. The florets remain in place for about 3-4 days. The fruits are small and one-seeded. The seeds are dry, light and 4mm long brownish gray to black achene with a small hook and tipped with pale brown 5-6 mm long pappus (Image 1k).

Foraging activity of butterflies and hawkmoths: The florets were visited during day time by butterflies and hawkmoths for nectar collection. The butterflies included 23 species representing the families: Papilionidae, Pieridae, Nymphalidae, Lycaenidae and

Table 1. List of butterflies on *Chromolaena odorata*

Family	Scientific Name	Common Name
Lepidoptera		
Papilionidae	*Pachliopta hector*	Crimson Rose
	Papilio polytes	Common Mormon
	Papilio demoleus	Lime Butterfly
Pieridae	*Catopsilia pyranthe*	Mottled Emigrant
	Anaphaeis aurota	Pioneer
	Delias eucharis	Common Jezebel
Nymphalidae	*Ariadne ariadne*	Angled Castor
	Junonia lemonias	Lemon Pansy
	Junonia hierta	Yellow Pansy
	Precis iphita	Chocolate Pansy
	Acraea violae	Tawny Coster
	Euploea core	Common Indian Crow
	Phalanta phalantha	Common Leopard
	Danaus genutia	Striped Tiger
	Danaus chrysippus	Plain Tiger
	Ypthima asterope	Common Three- Ring
	Melanitis leda	Common Evening Brown
	Tirumala limniace	Blue Tiger
	Parantica aglea	Glassy Tiger
	Neptis hylas	Common Sailer
Lycaenidae	*Everes lacturnus*	Indian Cupid
	Tarucus nara	Rounded Pierrot
Hesperiidae	*Borbo cinnara*	Rice Swift
Sphingidae	*Cephonodes hylas*	Coffee Hawk-Moth

Image 1. ***Chromolaena odorata***
a - flowering inflorescences; b - individual cylindrical head; c - mature head; d & e - mature florets; f - open floret; g - l.s. floret; h - pollen grain; i - ovary; j - ovule; k - mature seeds ready for dispersal; l - ***Pachliopta hector*****; m -** ***Papilio polytes*****; n -** ***Acraea violae*****; o -** ***Ariadne ariadne*****; p -** ***Junonia lemonias***

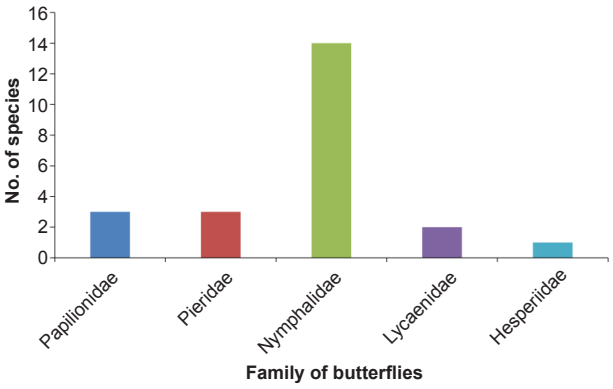

Figure 1. Family-wise number of butterfly species foraging for nectar on *Chromolaena odorata*

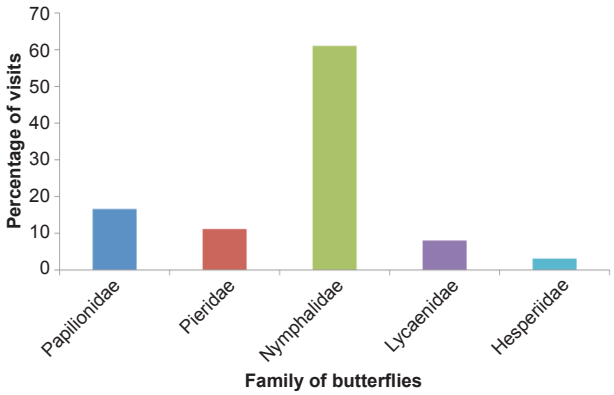

Figure 2. Family-wise percentage of foraging visits of butterflies on *Chromolaena odorata*

Hesperiidae (Table 1). The Papilionidae and Pieridae each was represented by three species, Nymphalidae by 14 species, Lycaenidae by two species and Hesperiidae by one species (Fig. 1). The papilionids were *Pachliopta hector* (Image 1l), *Papilio polytes* (Image 1m) and *P. demoleus*. The pierids were *Catopsilia pyranthe* (Image 2g), *Anaphaeis aurota* and *Delias eucharis* (Image 2f). The nymphalids were *Danaus genutia* (Image 2c), *D. chrysippus* (Image 2d), *Junonia lemonias* (Image 1p), *Precis iphita, Junonia hierta, Euploea core* (Image 2a), *Ariadne ariadne* (Image 1o), *Acraea violae* (Image 1n), *Phalanta phalantha* (Image 2b), *Ypthima asterope* (Image 2i), *Melanitis leda, Tirumala limniace* (Image 2e), *Parantica aglea* and *Neptis hylas*. The lycaenids were *Everes lacturnus* and *Tarucus nara* (Image 2h). The hesperid was *Borbo cinnara* of these, the individuals of nymphalid butterflies foraging at the florets were found to be more than those of other families throughout the flowering season (Fig. 1). The data collected on the foraging visits of butterflies of each family showed that nymphalids made 61%, papilionids 17%, pierids 11%, lycaenids 8% and hesperiids 3% of the total visits (Fig. 2). The cylindrical heads equipped with a cluster of florets provide a convenient landing place for butterflies and also this arrangement enables them to probe several flowers in each visit in succession for nectar before their departure. The flowering heads borne terminally stand out prominently and the butterflies were found to be attracted to them even from a long distance. A sample of 3-5 specimens of all butterfly species was used to examine the pollen carrying capacity of their proboscises. The results indicated that the proboscises invariably contained pollen grains ranging from 15-35 in papilionids, 14-23 in pierids, 29-189 in nymphalids, 8-17 in lycaenids and 9-21 in hesperiids. All these butterflies stretched out their proboscises to reach the floret base to access nectar; while doing so the proboscis invariably contacts the stylar surfaces and hence effects pollination. They frequently moved between individual plants of *C. odorata* which has patchy distribution along the forest margins and in the open gaps of the forest interior; this inter-plant foraging activity within the patch and between patches situated nearby and far away promotes cross pollination. The study showed that nymphalids play an important role in the pollination of *C. odorata*. The diurnal hawk moths included *Macroglossum gyrans* (Image 2j) and *Cephonodes hylas* (Image 2k). These hawk moths showed intense foraging activity during dawn hours when the florets offer fresh nectar and reduced activity during dusk hours when the florets offer only the leftover nectar which is not fresh; they rarely foraged during daytime. They hovered at the floret heads, inserted the proboscis, and collected nectar quickly from as many florets from several flowering heads in quick succession. Their proboscis gained contact with the stylar surfaces of each floret they visited and this contact results in pollination.

Discussion

The floral characteristics of *C. odorata* such as white to purple colour of florets, short-tubed narrow corolla with deep seated nectar, the flat-topped head inflorescence providing a landing platform and morning anthesis suggest that the plant is psychophilous (Faegri & van der Pijl 1979). Galetto & Bernardello (2003) reported that hexose nectars are characteristic

Image 2. *Chromolaena odorata* visited by
a - *Euploea core*; b - *Phalanta phalantha*; c - *Danaus genutia*; d - *Danaus chrysippus;* e - *Tirumala limniace*; f - *Delias eucharis* ; g - *Catopsilia pyranthe*; h - *Tarucus nara* ; i - *Ypthima asterope*; j - *Macroglossum gyrans*; k - *Cephonodes hylas*

of Asteraceae. Baker & Baker (1983) also stated that hexose sugars dominate in the nectars of Asteraceae and the nectars are also relatively strong in amino acids to compensate for the low sucrose-hexose ratio in the members of this family which attract butterflies. Since *C. odorata* is a member of Asteraceae, hexose-rich sugars and high amino acid concentration could be expected in the nectar. The retention of florets for extended periods may enhance the attractiveness of flowering heads to visiting butterflies. *C. odorata* with these floral structural and functional characteristics attract butterflies and hawk moths. The butterflies of all families collect nectar from the flowering heads as soon as the florets are open and in doing so effect both self- and cross-pollination. Since the florets secrete traces of nectar, the butterflies in quest of nectar visit

as many florets and flowering heads as possible in a single foraging visit, this foraging behaviour promotes cross-pollination. The patchy distribution of the plant with numerous flowering heads facilitates frequent movement of butterflies between different individuals and such movements promote cross-pollination. Since the florets are short-tubed, the butterflies with any length of proboscis collect nectar without any difficulty. The florets borne in cylindrical heads collectively offer considerable quantities of nectar and are energetically profitable for butterflies and such an arrangement reduces search and flight time. The proboscises of butterflies carry pollen and the quantity recorded may be related to the length of the proboscis and the contact extent between the proboscis and the dehisced anthers. Among the butterflies, Nymphalids frequent the flowers consistently throughout the season in individual numbers and species, and hence play a prime role in the pollination, more than other butterflies. In another exotic species, *Tridax procumbens*, an Asteraceae member, danaid and pierid butterflies have been shown to be the main pollinators by Balasubramanian (1989). Therefore, psychophily is adaptive and advantageous for the plant to maximize pollination with specialized florets and nectarivory of butterflies.

The diurnal hawk moths, *Macroglossum gyrans* and *Cephonodes hyla*s also visit *C. odorata* flowering heads during dawn and dusk hours. The dawn foraging activity is energetically profitable for them while the foraging at dusk period may not be as profitable as the florets by that time are likely to be emptied of nectar by butterflies and other insects during the day. They collect nectar on clear sunny and rainy days and utilize this floral source until exhausted. Balasubramanian (1989) reported that hawk moths visit the florets of *Tridax procumbens* during rainy weather when most butterflies take shelter among foliage in nearby bushes. In the present study, it is found that the butterflies do not visit *C. odorata* on rainy days and hence they effect pollination only on clear sunny days. The study shows that *C. odorata* being an exotic weed is psychophilous and its prevalence in the forest areas is a potential source of nectar for butterflies for a period of three months. Although it is a menace due to its prevalence and suppressive activity on the growth of certain native low ground herbs, its flowers are most attractive to butterflies throughout its distribution range and act as a provisioning post for the butterflies. Its abundant growth everywhere in the tropics might also be depriving the pollination services to native flora, which are butterfly pollinated.

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