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Study on adaptive strategies found in family asteraceae for better survival

Rajbala
Associate Professor, Department of Botany SRRM Govt. P.G. College, Jhunjhunu, Rajasthan, India

Abstract
Asteraceae is the most diverse family primarily found in semi-arid areas and species from the same botanical family have comparable phenotypes, occupy semi-arid habitats, and have adaptive convergences to environmental stress. Such characteristics aid in understanding adaptive radiations of recent groups on a regional scale and their successful establishment in habitats with challenging climate. We investigated the adaptive convergence of the family as well as the fragile balance between fine-scale variation in adaptive traits and general convergence towards stresstolerance and adaptation to aridity, using thorough field surveys and trait-based ecological features. The findings underscore the intricate interplay between environmental variables and Asteraceae morphological and reproductive diversity, this research contributes valuable insights into the ecological dynamics of Asteraceae, troughing light on their responses to diverse environmental conditions and providing a better understanding of the factors influencing their spatial distribution. This research paper exploring morphological, ecological, and anatomical adaptations in the Asteraceae family that would delve into the diverse ways so these plants are structured to thrive in various environments. Morphological adaptations encompass their unique flower structures, leaf shapes, and growth forms, while ecological adaptations focus on their ability to survive in different climates and habitats.

Keywords: Asteraceae adaptive, strategies, environmental stress, morphological adaptations, ecological traits

Introduction

As one of the most rapidly diversifying angiosperm families, it boasts a broad spectrum of ecological and morphological variations. Its members are found in open grasslands, forests, and across all climate zones, exhibiting various habits such as herbs, shrubs, vines, and trees. The Asteraceae family, a relative to dicotyledons, is comparatively evolved, is mostly comprised of herbaceous species. Asteraceae, also known as Compositae or sunflower plant family, with an estimated number of 25 000–35 000 species account for 10% of all flowering plants (Funk *et al*., 2009 [16]; Mandel *et al*., 2019) [19]. Together with orchids (Orchidaceae) and legumes (Fabaceae), Asteraceae represents the most species-rich family with 16 subfamilies and 50 tribes (Panero & Crozier, 2016 [21]; Mandel *et al*., 2019 [19]; Susanna *et al*., 2020). Asteraceae, commonly known as the daisy or sunflower family, is renowned for its vast diversity among species of angiosperms (Funk *et al*., 2009) [16]. With an estimated range of 22,500 to 30,000 species, it represents approximately 10 % of all flowering plants and is only rivaled in size by the orchid family (Barreda *et al*., 2012) [5]. It extends all over the world to distinct habitats from the arctic to tropics, in a wide range of altitudes, and shows enormous variation in developmental traits, secondary metabolites, life histories and growth forms spanning from large trees to shrubs and herbs and even aquatic species (Palazzesi *et al*., 2022) [20]. The family includes economically important crops, ornamentals, medicinal plants as well as weeds and invasive species. Moreover, a handful of these species are also used as models to achieve a fundamental understanding of the genetic mechanisms that drive the enormous developmental variation in the family. In this review, we aim to summarize the most recent work, in the light of key on morphological and reproductive traits in Asteraceae.

The proposed key innovation is the capitulum (Cronquist, 1977 [9]**;** Jeffrey, 2009) [17], a highly compressed head-like inflorescence that may consist of a single flower but is generally formed of multiple (tens or even hundreds) florets that emerge on an enlarged receptacle. By layman, this aggregated structure is commonly considered as a single flower and is thus called a pseudanthium or a false flower. The showy capitulum contributes to the economic value of many commercially cultivated ornamentals such as gerbera (Gerbera hybrida) and chrysanthemum (Chrysanthemum morifolium) while it also provides an efficient pollinator target with a selective advantage in promoting reproductive fitness (Stuessy *et al*., 1986 [24]; Sun & Ganders, 1990 [25]; Andersson, 2008 [2]; Cerca *et al*., 2019) [7]. The adaptive radiations of Asteraceae have also been associated with highly specialized floral structures. The capitulum in all Asteraceae species is surrounded by involucral bracts that perform a protective function for the whole structure) Panero & Crozier, 2016 [21]; Fu *et al*., 2023) [15]. Another evolutionary advancement are the propagules, the dispersal units, as the transformed calyx(pappus) persists in the fruit as an effective seed dispersal strategy and also acting as a deterrent against herbivory. (Mandel *et al* 2019) [19]. Additionally, specific organs such as the protective involucre bracts around the entire head as well as the pappus bristles surrounding and protecting each of the florets are considered to have contributed to the evolutionary success of the family (Panero & Crozier, 2016) [21].). Pappus bristles offer a unique advantage for long-distance seed dispersal and have even been proposed to have contributed to the transoceanic dispersal of seeds during the radiation of Asteraceae (Panero & Crozier, 2016) [21]. Due to the efficiency of their dispersal mechanisms, many Asteraceae species are capable of traveling long distances, resulting in their wide distribution across different continents around the globe. However, several species in this family have relatively constrain geographical ranges (Bhellum, 2020) [6]. Efficient propagule (diaspores) dispersal holds extreme significance from an ecological and evolutionary prospective by facilitating broad distribution ranges, leading to increased genetic variability (Colautti *et al*., 2017) [8]. The fundamental focus of ecology is to recognize and document the spatial patterns of species distributions, as well as the structure and makeup of different species groups, as well as the diversity patterns associated with them (Dray *et al*., 2012) [11]. Plant biodiversity's physical distribution is non-random, which indicates that the occurrence of a specific species in a specific location or region is dependent on the availability of a particular collection of environmental factors (Socolar *et al*., 2016) [23]. Hence, species composition, diversity, and range are not random properties but demonstrate a range of geographic patterns reflecting differences between ecological scenarios (Eiserhardt *et al*.2011) [12]. The foliar morphology and anatomy of the species studied show the predominant occurrence of characteristics adaptive to xeric environments, such as reduced and coriaceous leaves, tomentose indumentum, thickened cuticle and epidermal cells, epicuticular wax, amphi-stomatic leaves and investment in photosynthetic and support tissues. Asteraceae is remarkable in many respects; it has the maximum number of species, its worldwide distribution, its variety of forms and its very effective mechanism for cross-pollination (Dutta, 1974) [10]. This type of a widespread successful ecological distribution of Asteraceae possibly be attributed to the evolvement a very efficient compact structural organization of the distinct flowers with exclusive functions, in the form of a pseudo-flower called capitulum also called pseud-anthium which has an added advantage for efficient pollination (Elomaa *et al*., 2018) [13]

Changes to herbaceous-ness and capitula-scence with multiple flower-like capitula, often with distinct florets and scaly pappus/receptacular bracts, are associated with multiple upshifts in diversification rate. The resulting competitive advantage for adapting to different niches would have increased biodiversity in Asteraceae.

Several botanical families have phenotypically similar species that inhabit arid and semi-arid environments and share adaptive convergences to seasonal water stress (Fahn & Cutler 1992) [14]. Species of the family Asteraceae, especially herbaceous and subshrub species, possess features related to water stress. Such features include the development of bud-bearing underground storage systems, which are related to the occurrence of secretory tissues that are efficient in maintaining individuals during seasonal water stress, and vegetative propagation, which provides resistance to extreme climatic variation (Anderberg *et al*. 2007 [1]; Appezzato-da-Glória 2015) [3].

The success and wide distribution of the Asteraceae family in the most diverse habitats have been attributed to the diversity of secretory structures, the ease of wind dispersal and the phenotypic plasticity of their representatives (Funk *et al*., 2005; Smiljanic, 2005).

Study Area

Chirawa is a town in Chirawa Tehsil in Jhunjhunu District of Rajasthan State, India. It belongs to Jaipur Division. It is located 32 km towards East from district headquarters Jhunjhunu. It is a Tehsil head quarter. Adooka (2 km), Sehi Kalan (3 km), Gadakhera (4 km), Shyopura (4 km), Ojtoo (5 km) are the nearby villages to Chirawa. Chirawa is surrounded by Surajgarh Tehsil towards North, Buhana Tehsil towards East, Jhunjhunu Tehsil towards west. Pilani, Jhunjhunu, Rajgarh, Mahendragarh are the nearby cities to Chirawa.

Material and Methods

The species belonging to Asteraceae family were collected from Chirawa region. Field notes were made of precise location and plants type. They were record and take photographs in the field. After the collection, the vegetative and floral parts of fresh specimens were studied for taxonomic characters; some of collected specimens were dried pressed to prepared herbarium sheet.

Results

Table shows that total 22 genera of Asteraceae have been studied during different seasons showing their presence in different climatic conditions showing various adaptive structure for their survival. The adaptive features are inflorescence, ray and disc florets, attractive flower coloration or cypsela fruits etc.

Table 1

S. No	Scientific Name	Common Name	Flowering Season
1.	*Artemisia scoparia* Waldst. et Kit	Bano	Aug-Oct
2.	*Acanthospermum hispidum* DC.	Kanti	July-Oct
3.	*Bidens biternata* (Lour.) Merr. &Sherff	Katlo	Aug-Jan
4.	*Blainvillea acmella* (L.) Phil.	Kanghi	Aug-Nov
5.	*Cirsium arvense* (L.) Scop	Kateli	Jan-May
6.	*Conyza aegyptiaca* L	Kaliziri	June-Oct
7.	*Cotula australis* L.	Buttonweed	Jan-Mar
8.	*Cyanthillium cinereum*	Little Ironwood	Nov-Mar
9.	*Dicoma tomentosa* Cass.	Hiran charo	Oct-Dec
10.	*Echinops echinatus* Roxb	Unt katelo	Nov - Jan
11.	*Eclipta alba (L.) Hassk.*	Bhringraj	Jan-Dec
12.	*Erigeron bonariensis* L.	Fleabane	Feb -Nov
13.	*Grangea maderaspatana* (L.) Poir.	Mutkhari,	Jan-Dec
14.	*Launaea resedifolia* (L.) Kuntze	Fulwalo kantelo	Jan-Dec
15.	*Oligochaeta ramosa* (Roxb.) Wagenitz	Brahm buti	Oct-Mar
16.	*Parthenium hysterophorus* L.	Congress weed	July-Nov
17.	*Pulicaria wightiana* (DC.) Clarke	Sonfuladi	Aug-Dec
18.	*Sonchus asper* (L.) Hill.	Kalijibi	Nov-Jan
19.	*Sonchus oleraceus* L	Ankhali	Dec-Mar
20.	*Tridax procumbens* L.	Ghavpatta	Oct-Nov
21.	*Verbesina enceliodes* (Cav.)	Jagli surajmukhi	Oct-Feb
22.	*Xanthium strumarium*	Cocklebour	May-oct

Discussion

The primary goal of the research work was to better understand the ecological dynamics of Asteraceae in a dry setting by integrating trait-based ecology techniques to microenvironmental changes. Functional features link plants to their surroundings and help to explain how ecological strategies emerge (Westoby *et al*., 2002) [27]. Plant functional features reflect a species' ability to adapt to environmental changes through physiological and morphological evolution throughout time (Wang, *et al*.,2021) [26].

From the results of the study it is concluded that Asteraceae is an important family of the unique flora of semi-arid land of Chirawa, and this family is highly adaptable to the harsh prevailing climate and dominance of life-forms defines a semi-arid climate for the region. Changing environmental conditions may affect the adaptive capacities of these biological forms and may endure shifts in spectrum or even range contractions.



Verbesina enceloides *Erigeron bonariensis* *Cyanthillium cinereum*



Xanthium strumarium *Echinops echinatus* *Parthenium hysterophorus*



Sonchus oleraceus Art*emisia scoparia* *Dicoma tomentosa*

Conclusion

The result explores key reproductive and morphological features of plants. This study offers an exploration of the ecological dynamics of Asteraceae in the semi-arid region of Rajasthan. Asteraceae members had adaptability with dry hot, humid climatic conditions prevailing throughout majority of the geographical extent of Chirawa high adaptableness of the family to adverse environmental conditions and reflecting on efficient dispersal mechanism of their reproductive structures. Asteraceae chamaetherophytic spectrum of life-forms exemplifies an arid Phyto climate for the overall region as Asteraceae is in most dominant families. Angiosperms in the region and contributes to a great abundance in local floral records. The study provides a foundation for further research on floral adaptation and plant–pollinator relationships in the area. The floral morphology indicates the attractive flowers and floral traits. The comprehensive field surveys conducted over two years revealed a diverse floral composition, with frequent genera such as *Erigeron bonariensis L, Verbesina enceloides Sonchus oleraceus L,* exhibiting adaptability to varied ecological conditions in urban, forest, waste land habitats. The dominance presence of these plants particularly in disturbed habitats, suggested a response of adaptability to the biological flora, reflecting the adaptive functions as phenotypic variations at ecological, morphological and evolutionary levels.

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