

A REVIEW OF NYCTAGINACEAE PLANTS FAMILY OF SIGNIFICANCE

Arman Ansari, Mosharraf Hussain, Nurulalam Siddique, Shaik Tharveen Jaha,
Averineni Ravi Kumar

Department of Pharmacognosy and Phytochemistry, Nimra College of Pharmacy Vijayawada 521456 AP INDIA
karavi315@gmail.com

ABSTRACT

Nyctaginaceae family, also known as the four o'clock family, includes a variety of flowering plants found predominantly in tropical and subtropical areas, including India. Several members of this family, like *Boerhavia diffusa* (Punarnava) and *Mirabilis jalapa*, are valued for their medicinal properties, especially within traditional practices such as Ayurveda. These plants possess notable therapeutic effects such as reducing inflammation, promoting urine flow, protecting the liver, and aiding wound healing, making them important natural remedies for many health conditions. While some species have been extensively researched and incorporated into established medicine, others remain less studied and hold potential for future exploration. Nyctaginaceae plays a vital role both ecologically and medicinally, emphasizing the need for conservation and further scientific study.

Keywords: Nyctaginaceae , Description of Plants, Genus, Species, Ayurvedic Importance

INTRODUCTION

Nyctaginaceae, commonly referred to as the **four o'clock family**, is a group of flowering plants comprising roughly **30 genera** and more than **400 species**. These plants are predominantly found in **tropical and subtropical** regions, with a strong presence in the **Americas**, although some species extend into **temperate climates**.

Distinctive Features

- **Growth Habit:** Includes **herbs, shrubs**, and occasionally **small trees** or **climbing plants** (lianas).
- **Leaves:** Typically **simple, oppositely arranged**, and lack **stipules**.
- **Flowers:**
 - Known for being **brightly colored** and **visually striking**.
 - **True petals are absent**; instead, **bracts** or **colorful sepals** mimic petal-like structures.
 - Flowers are generally **hypogynous** and have a **single whorl of sepals**, forming the perianth.
- **Fruits:** Usually produce a **one-seeded achene**, often surrounded by a **persistent floral tube** or **bract**, which may also be showy.
- **Pollination:** Most species are pollinated by **insects** or **birds**, attracted by the vibrant floral structures.

Prominent Genera and Species

- **Bougainvillea:** A popular **ornamental plant** from South America, recognized for its **bright bracts**.
- **Mirabilis** (e.g., *Mirabilis jalapa*, the **four o'clock flower**): Known for blooming in the evening; used in **traditional medicine** and gardening.
- **Abronia:** Often called **sand verbenas**; these are native to **arid** areas of North America.

Uses and Ecological Roles

- **Ornamental Value:** Widely cultivated for their **aesthetic appeal**, especially species like *Bougainvillea*.
- **Medicinal Uses:** Certain plants, particularly *Mirabilis jalapa*, have applications in **folk medicine**.

- **Ecological Importance:** Play a role in supporting **pollinators** such as **bees**, **butterflies**, and **hummingbirds**.

Fascinating Facts

- Flowers of *Mirabilis jalapa* can display **multiple colors on the same plant** and even change color over time.
- Despite their colorful appearance, the family's flowers **lack petals**—the showiness comes from **modified sepals** or **bracts**.

- **Medicinal Plants of Nyctaginaceae Family**

Plant Name	Genus	Traditional or Reported Uses
<i>Mirabilis jalapa</i>	<i>Mirabilis</i>	Known for its use as an anti-inflammatory, diuretic, laxative, and wound healer; also reported to have antiviral effects.
<i>Boerhavia diffusa</i>	<i>Boerhavia</i>	Widely used in traditional medicine, especially Ayurveda (where it's called <i>Punarnava</i>), for supporting liver function, reducing inflammation, and acting as a diuretic and antioxidant.
<i>Bougainvillea glabra</i>	<i>Bougainvillea</i>	Used in folk remedies for managing coughs, blood sugar levels, and bacterial infections.
<i>Commicarpus chinensis</i>	<i>Commicarpus</i>	Employed in traditional healing practices for treating skin problems and rheumatic conditions.
<i>Abronia fragrans</i>	<i>Abronia</i>	Utilized by Native American communities for digestive issues and throat ailments.
<i>Anulocaulis leiosolenus</i>	<i>Anulocaulis</i>	Indigenous groups have used it for managing symptoms of colds and for gastrointestinal discomfort.

1. *Boerhavia diffusa* (Punarnava / Red Spiderling)

Botanical Features

- **Growth Form:** A low-growing, perennial herb characterized by reddish, branching stems and thick, tapering roots that may extend up to 1.5 meters.
- **Leaves:** Arranged oppositely, with uneven sizes; broadly ovate to round, with wavy edges and a whitish sheen on the underside.
- **Flowers:** Small, reddish-pink, tube-shaped flowers forming in loose clusters at leaf axils or stem tips; commonly bear 2–3 stamens.
- **Fruits:** Dry, ribbed, single-seeded structures encased in a sticky floral tube that aids in seed dispersal via animals.

Habitat & Life Cycle

- Found widely across India, thriving in open grasslands, roadsides, and forest clearings.
- Flowering and fruiting occur mainly between **August and December**.

Therapeutic Importance

- Traditionally valued for its **diuretic**, **liver-protective**, and **anti-inflammatory** actions.
- The **roots** are often used in decoctions for treating **kidney and liver ailments**, **rheumatism**, **jaundice**, **edema**, **asthma**, **digestive issues**, and **skin disorders**.
- Contains active compounds like **boeravinones**, **punarnavine**, **liriodendrin**, **ursolic acid**, and **β-sitosterol**, which offer a range of **pharmacological benefits** including **antioxidant**, **immunomodulatory**, **antidiabetic**, and **analgesic** effects.

2. *Boerhavia crispa*

Botanical Features

- Morphologically similar to *B. diffusa*, but identifiable by its **wavy or crisped leaf margins**.
- Recently reported in parts of **central and peninsular India**, including **Madhya Pradesh**.

Medicinal Notes

- Though it appears in local traditional medicine, scientific documentation of its medicinal use is **limited**.
- Requires further **phytochemical and pharmacological investigation**.

3. *Pisonia grandis* (Sticky-Seed Tree)

Botanical Features

- A small to medium-sized tree or shrub often found in **southern India**.
- Has **glossy green foliage** and compact flower clusters; its sticky fruits readily attach to animal fur, facilitating natural seed dispersal.

Ethnomedicinal Relevance

- Utilized by **tribal communities** for a range of traditional remedies, particularly involving the **leaves and roots**.
- Scientific studies have identified several **bioactive compounds** through analytical methods like **HPTLC**, though **detailed medicinal uses** are still under evaluation.

Table: Medicinal Nyctaginaceae Plants of India

Species	Growth Habit	Key Traditional & Medicinal Uses
<i>Boerhavia diffusa</i>	Spreading herb	Diuretic, liver/kidney tonic, antioxidant, anti-inflammatory; Ayurvedic use
<i>Boerhavia crispa</i>	Spreading herb	Related to <i>B. diffusa</i> ; needs further research for medicinal validation
<i>Pisonia grandis</i>	Shrub or small tree	Tribal medicine; sticky seeds, bioactive compounds under study

1. *Mirabilis jalapa* (Four O'clock Flower)

Botanical

- A **perennial herb** reaching about 1 meter in height.
- Notable for its **bushy growth, tubular trumpet-shaped flowers**, and **diverse floral colors**—a single plant may bear flowers of multiple hues.
- Flowers usually **open in the late afternoon (4–8 PM)** and emit a **pleasant scent**.
- Produces **dark, single-seeded fruits**.

Medicinal Applications

- **Anti-inflammatory**: Leaf extracts have shown effectiveness in reducing inflammation in lab models.
- **Liver protective**: Ethanol-based extracts support liver health, especially in drug-induced toxicity.
- **Antidiabetic & Hypolipidemic**: Roots are used to lower blood sugar and cholesterol levels.
- **Traditional Uses**: Acts as a **diuretic, purgative**, and **wound healer**; root considered an **aphrodisiac**; also applied for **abscesses, inflammation**, and **dropsy**.

Key Compounds

- Contains **rotenoids** (e.g., mirabijalone), **betaxanthins**, **phenolics**, and **proteins** with **antimicrobial, antiviral**, and **anticancer** potential.

Safety Consideration

- Seeds and roots have **mild toxicity** due to **alkaloids like trigonelline**; ingestion in large amounts may lead to **gastrointestinal distress**.

2. *Boerhavia diffusa* (Punarnava / Red Spiderling)

Botanical Features

- A low-growing **perennial herb** with spreading reddish stems and thickened roots.
- Leaves are **unequal in size**, with a **silvery underside**.
- Produces small, **funnel-shaped pink flowers**.
- Fruits are **ribbed** and enclosed in a **sticky floral tube** for animal-assisted dispersal.

Medicinal Significance

- Highly regarded in **Ayurveda** for managing **liver and kidney ailments, jaundice, asthma, edema, and joint pains**.
- Known for **diuretic, antioxidant, anti-inflammatory, and immunomodulatory** properties.

Active Constituents

- Includes **boeravinones, punarnavine, liriodendrin, ursolic acid, and β -sitosterol**.

3. Boerhavia crispa

Botanical Notes

- A **close relative** of *B. diffusa*, distinguished by its **curled or crisped leaf margins**.
- Occurs in **central and southern India**, recently reported in **Madhya Pradesh**.

Medicinal Relevance

- Used traditionally in local remedies, but lacks detailed scientific or pharmacological study.
- Further **ethnobotanical research** is warranted.

4. Bougainvillea glabra

Botanical Description

- A **woody climbing plant** commonly grown as an **ornamental** for its **colorful bracts** (often mistaken for petals).
- The true flowers are small and white, encased within bright, papery bracts.

Ethnomedicinal Uses

- Used in traditional practices for **relieving coughs and throat irritation**.
- Shows **antimicrobial and antidiabetic** potential in preliminary studies.

5. Commicarpus chinensis (Diffuse Hogweed)

Botanical Features

- A **creeping perennial herb** with fleshy stems and **velvety triangular leaves**.
- Bears **small pink funnel-shaped flowers** in axillary umbels and **ribbed, sticky fruits**.

Medicinal Use

- The **tuberous roots** are used in folk medicine, particularly in treating **skin conditions and rheumatism**, though documentation in India is limited.

6. Abronia fragrans (Fragrant Sand Verbena)

Botanical

- Native to **North America**, particularly **dry, sandy regions**.
- Noted for its **pleasant-smelling white to pale pink flowers** and low-growing habit.

Traditional Applications

- Indigenous peoples use it to treat **stomachaches, sore throats, and digestive issues**.
- Its use in India is limited and likely **restricted to ornamental cultivation**.

7. Anulocaulis leiosolenus

Botanical Description

- Found in **arid parts of southwestern USA**.
- Features **glandular ringed stems, large basal leaves, and pale pink to white trumpet-shaped flowers**.
- Produces capsule-type fruits.

Table

Species	Growth Form	Primary Uses & Research Status
<i>Mirabilis jalapa</i>	Perennial herb	Well-studied for anti-inflammatory, hepatoprotective, and antidiabetic effects.
<i>Boerhavia diffusa</i>	Spreading herb	Ayurvedic staple for kidney, liver, and inflammatory disorders.
<i>Boerhavia crista</i>	Spreading herb	Under-studied; resembles <i>B. diffusa</i> .
<i>Bougainvillea glabra</i>	Climber/vine	Used for cough; shows antimicrobial potential.
<i>Commicarpus chinensis</i>	Creeping herb	Roots used in traditional skin and joint treatments.
<i>Abronia fragrans</i>	Groundcover herb	Native use for digestive health; limited Indian relevance.
<i>Anulocaulis leiosolenus</i>	Erect herb/shrub	Botanical interest; no known medicinal use in India.

Nyctaginaceae Plants Used in Ayurveda

1. *Boerhavia diffusa* (*Punarnava*)

- **Sanskrit Name:** Punarnava, meaning "that which rejuvenates."
- **Ayurvedic Properties:**
 - *Rasa* (Taste): Bitter (Tikta), Astringent (Kashaya)
 - *Guna* (Quality): Light (Laghu), Dry (Ruksha)
 - *Virya* (Potency): Hot (Ushna)
 - *Vipaka* (Post-digestive effect): Pungent (Katu)
 - *Dosha Effects:* Balances Kapha and Vata
- **Medicinal Actions:**
 - Diuretic (Mutrala)
 - Anti-inflammatory (Shothahara)
 - Liver stimulant (Yakrit-Uttejaka)
 - Rejuvenator (Rasayana)
 - Cardiotonic (Hridya)
 - Relieves respiratory issues like asthma (Shwasahara)
- **Therapeutic Uses:**
 - Treats liver conditions such as jaundice and hepatitis
 - Addresses kidney disorders including nephrotic syndrome
 - Helps reduce generalized edema (dropsy)
 - Alleviates rheumatism and arthritis
 - Used for anemia and urinary tract infections
- **Common Ayurvedic Preparations:**
 - *Punarnavadi Kashayam*
 - *Punarnava Mandur*
 - *Gokshuradi Guggulu*

2. *Mirabilis jalapa* (*Four O'clock Flower*)

- Although not cited in classical Ayurvedic texts, it is commonly used in traditional and folk Ayurvedic medicine.
- **Uses:**
 - Anti-inflammatory (Shothahara)
 - Antiparasitic (Krimighna)
 - Wound healing (Vranaropaka)

- Balances excess Pitta due to its cooling effect (Pittahara)
- **Traditional Preparations:**
 - Leaf paste for treating swelling and skin ailments
 - Root decoction used for liver disorders, constipation, and dropsy

Ayurvedic Formulations of Nyctaginaceae Plants

Formulation Name	Primary Ingredient	Therapeutic Use
Punarnavadi Kashayam	Boerhavia diffusa	Edema, liver, and kidney ailments
Punarnava Mandur	Boerhavia diffusa + iron	Anemia, edema, liver protection
Gokshuradi Guggulu	Includes Punarnava	Urinary tract infections, kidney support

Other Nyctaginaceae in Folk or Regional Practices

- **Bougainvillea glabra:** Used mainly in traditional remedies for respiratory issues such as coughs and sore throats, as well as in managing diabetes. Though not prominent in classical Ayurveda, it is common in tribal and home remedies.
- **Commicarpus chinensis & Boerhavia crispa:** Utilized in regional folk medicine for skin ailments and joint pain. These are not widely recognized in classical Ayurveda but sometimes act as substitutes for *Punarnava* in local traditions.

Nyctaginaceae Role in Ayurveda

Plant	Ayurvedic Role
Boerhavia diffusa	A fundamental herb for liver, kidney, and fluid balance conditions
Mirabilis jalapa	Folk Ayurvedic uses; known for anti-inflammatory and healing effects
Boerhavia crispa	Minor role; used occasionally when <i>B. diffusa</i> is unavailable
Bougainvillea glabra	Limited to folk use, especially for respiratory and blood sugar support
Commicarpus chinensis	Used in tribal medicine; not part of classical Ayurveda

Genera and Species in Nyctaginaceae

1. Mirabilis

Mirabilis jalapa (commonly called the Four o'clock flower) is recognized for its distinctive blooms that typically open late in the day or during the evening. This plant is notable for producing flowers in a variety of colors, often displaying multiple hues on a single specimen. It is widely cultivated as an ornamental garden plant.

2. Bougainvillea

Species like *Bougainvillea glabra* and *Bougainvillea spectabilis* belong to this genus. These plants are woody climbers or shrubs, admired for their vivid, papery bracts that come in colors such as pink, purple, red, orange, and white. Bougainvilleas are popular choices for decorative landscaping and garden use.

3. Pisonia

This genus consists of tropical trees that produce sticky fruits capable of trapping birds. They are generally found in coastal areas and on islands.

4. Abronia

Known as sand-verbenas, *Abronia* species typically thrive in sandy soils, especially across western North America. These plants bear small, fragrant flowers and are adapted to their dry, sandy habitats.

Mirabilis Species

Mirabilis jalapa

Commonly called the Four o'clock flower, this species is a popular ornamental plant widely grown around the

world. Its distinctive blooms typically open in the late afternoon or evening and can appear in several colors, often showing multiple hues on a single plant. It originates from tropical regions of the Americas.

Mirabilis longiflora

Also known as the sweet four o'clock, this species features long, tubular white flowers that emit a pleasant fragrance. It attracts night-active pollinators such as moths and is native to areas of the southwestern United States and Mexico.

Mirabilis multiflora

Known as the Colorado four o'clock, this species produces numerous small flowers grouped closely together. It is native to the southwestern United States and northern Mexico.

Mirabilis oxybaphoides

Referred to as the Colorado desert four o'clock, this plant has yellow or cream-colored flowers and is well adapted to thrive in desert habitats.

Mirabilis nyctaginea

Commonly called the wild four o'clock, this species is found in central and western parts of North America. Its flowers are typically purple or magenta in color.

Bougainvillea Species

1. Bougainvillea glabra

Commonly referred to as the paperflower or lesser bougainvillea, this plant is a woody vine or shrub known for its vibrant, papery bracts that come in shades of pink, magenta, and purple. It is widely cultivated in gardens and used as ornamental hedging. The stems are notable for their thorns.

2. Bougainvillea spectabilis

Often called the great bougainvillea or bugambilia, this species produces large and brightly colored bracts that may appear in pink, purple, red, orange, or white. It is a vigorous climber frequently trained over trellises and walls. It is native to regions of South America, particularly Brazil and Peru.

3. Bougainvillea peruviana

Originating from Peru, this species displays colorful bracts similar to those of other Bougainvillea plants but typically has smaller leaves. It is commonly planted in warmer climates for landscaping purposes.

4. Bougainvillea praecox

This species is recognized for its bright orange or reddish bracts. It grows as either a vine or shrub in tropical and subtropical environments but is less commonly cultivated than *B. glabra* or *B. spectabilis*.

Pisonia Species

1. Pisonia grandis

This is a rapidly growing tree native to coastal islands throughout the Indo-Pacific region. It commonly forms thick groves in island forests and plays a crucial role in seabird nesting ecosystems. Its broad, soft green leaves and sticky seeds are distinctive, although the seeds can sometimes entangle birds unintentionally.

2. Pisonia umbellifera

Also known as the umbrella tree, this species has large, glossy leaves that may be variegated in some varieties. It is occasionally grown as an ornamental plant in warm climates. Like others in the genus, it produces adhesive fruits that stick to animals for dispersal.

3. Pisonia brunoniana

Often referred to as the birdcatcher tree or Maori hen tree, this species is native to various Pacific Islands, including parts of New Zealand. It is a small tree with simple green leaves and sticky seeds that readily attach to birds, helping spread the seeds across habitats.

4. Pisonia aculeata

This species grows as a thorny shrub or small climbing tree. It is found across the Americas, especially in the

Caribbean and Central America. Characterized by tangled, spiny branches and small greenish flowers, it also produces sticky fruits that adhere to animals for seed dispersal.

Abronia Species

1. Abronia fragrans

Known as the *fragrant sand-verbena*, this species is native to central and southwestern regions of the United States. It produces white to pale pink blossoms with a strong, sweet fragrance and commonly grows in open woodlands, grasslands, and prairies. It is especially attractive to nocturnal pollinators like moths.

2. Abronia villosa

The *desert sand-verbena* thrives in dry desert environments such as the Mojave and Sonoran deserts. It is a low, spreading plant with sticky, hairy leaves and bright pink to magenta flowers. Its blooms typically appear following seasonal rains, bringing color to desert landscapes.

3. Abronia latifolia

Often called the *yellow sand-verbena*, this coastal species is found along beaches and sand dunes of the Pacific Northwest and California. It grows in a sprawling form and features thick, fleshy leaves with clusters of golden-yellow flowers, adapted to withstand sandy and saline conditions.

4. Abronia maritima

This rare plant, known as the *red sand-verbena*, inhabits the coastal dunes of southern California and northern Baja California. Its rich reddish or magenta flowers contribute to the biodiversity of fragile dune ecosystems. It is considered regionally uncommon and ecologically important.

5. Abronia ameliae

Commonly referred to as *Amelia's sand-verbena*, this species is native to southern Texas. It has attractive lavender to pink blossoms and typically grows in sandy grasslands and open areas. It is named in honor of Amelia Anderson Lundell, a Texas botanist.

CONCLUSION

Nyctaginaceae Family: Diversity, Importance

Diversity & Distribution:

The Nyctaginaceae family, commonly called the four o'clock family, comprises about 30 genera and more than 400 species. These plants predominantly thrive in tropical and subtropical regions worldwide, with a notable presence in India.

Ecological Role:

Species in this family play an important role in ecosystems by attracting pollinators such as insects and birds. They are well adapted to a range of environments, from dry arid areas to dense forests.

Medicinal Importance:

Certain species, notably *Boerhavia diffusa* (Punarnava) and *Mirabilis jalapa*, are highly valued in traditional medicine, especially Ayurveda. They are recognized for their anti-inflammatory, diuretic, liver-protective, and wound-healing properties.

Economic and Ornamental Value:

Genera like *Bougainvillea* are widely grown for their showy, colorful bracts, making them popular ornamental plants worldwide.

Research Status:

Although some species have been extensively studied and incorporated into herbal medicine, many members of the family remain insufficiently researched, offering opportunities for scientific exploration.

Future Prospects:

- **Phytochemical Research:** Exploring lesser-known species may reveal new bioactive compounds with therapeutic benefits.

- **Conservation:** Preserving natural habitats and genetic diversity is crucial, especially in the face of habitat loss and climate change.
- **Modern Medicine Integration:** Continued pharmacological studies and clinical trials are needed to develop plant-based medicines from Nyctaginaceae species.
- **Sustainable Use:** Encouraging responsible harvesting and cultivation will support both medicinal and ornamental applications in the long term.

ACKNOWLEDGEMENTS : The Authors are Thankful to Guide Prof Averineni Ravi Kumar Post Graduate Head Nimra College of Pharmacy Vijayawada Andhra Pradesh India for Initiation of Project Proposals for we IV B Pharmacy Project Students his planning proposed works protocols of selection of plants for different studies we immensively thankful for his Guideship for encouragemet in project works and publication of papers.

REFERENCES

1. Chetty K, Sivaji K, Rao K. Flowering Plants of Chittoor District, Andhra Pradesh, India. Stud Offset Print Tirupati India, 2008.
2. Kamagaju L, Bizuru E, Minani V, Morandini R, Stévigny C, Ghanem G et al. An ethnobotanical survey of medicinal plants used in Rwanda for voluntary depigmentation. *Journal of Ethnopharmacology*. 2013; 150(2):708-717.
3. Levin, 2000, Phylogenetic relationships within Nyctaginaceae tribe Nyctagineae: Evidence from nuclear and chloroplast genomes. *Systematic Botany* 24(4) 738-750
4. Douglas, NA and Manos, PS. 2007. Molecular phylogeny of Nyctaginaceae: taxonomy, biogeography, and characters associated with a radiation of xerophytic genera in North America. *American Journal of Botany* 94(5) 856-872.
5. Gillis, W.T., 1976. Bougainvilleas of cultivation (Nyctaginaceae). *Baileya* 20, 34–41.
6. Heimerl, A., 1934. Nyctaginaceae, In Engler & Prantl, *Naturl. Pflanzenfam.* Ed. 2, IV 16, 86–134.-Wilhelm Engelmann, Leipzig
7. Nowicke, J.W., 1970. Pollen morphology in the Nyctaginaceae. *Grana* 10, 79–88.
8. Cowan DV, Flowering trees and shrub in India, 6Th ed., Messrs Thacker & Co., 1952; 75.
9. Al-Hawshabi, O.S.S. (2015). *Boerhavia erecta* L. (Nyctaginaceae): A new record to the flora of the Arabian Peninsula from Yemen. *International Journal of Advanced Research* (2015), Volume 3, Issue 11, 813 – 817
10. Bittrich, V., Kühn, U. (1993). Nyctaginaceae. In: Kubitzki, K., Rohwer, J.G. and Bittrich, V. (eds.) *The Families and Genera of Vascular Plants. Vol. 2, Flowering Plants, Dicotyledons.* Springer-Verlag, Berlin, pp. 473-481.
11. Ch Bogle, A. L. (1974). The genera of Nyctaginaceae in the southeastern United States. *Journal of the Arnold Arboretum*, 55(1), 1-37.
12. Chopra, R. N., Nayar, S. L., Chopra, I. C., Asolkar, L. V., Kakkar, K. K., Chakre O. J., Varma, B. S., Council of Scientific & Industrial Research (India) (1956). *Glossary of Indian medicinal plants.*
13. Debasmita, D. P., Maiti, G. G., Mondal, M. S. (2015). A taxonomic revision of the genus *Boerhavia* L. (Nyctaginaceae) in India. *Journal of Global Biosciences*, 4(3), 1704-1717.
14. A Textbook of Botany, Volume 2: Angiosperms by B.P. Pandey, S. Nath, and K.N. Rana
15. Plant Taxonomy by R.R. Rao and B.S. Mehrotra
16. Flora of the Indian Desert by S.K. Jain and S.P. Singh