BOTANY IN FORENSIC SCIENCE

GULMOHAR NEWSLETTER

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FROM THE EDITORS DESK

Dear Readers,

Welcome to the third edition of GULMOHAR 2023-24 dedicated to the fascinating world of forensic botany! In this edition we are thrilled to explore the intersection of plant science and criminal investigations. In this newsletter, we dive deep into the innovative techniques and methodologies utilized by forensic botanists to solve crimes, unravel mysteries, and uncover crucial evidence. From the analysis of pollen grains to the examination of wood sections, we will unravel the intricate role that plants play in forensic investigation. Looking ahead, we invite you to immerse yourself in an intriguing movie review that highlights the role of botany in criminal investigations. Additionally, we present a visually stunning photo gallery, showcasing the exquisite beauty of botanical specimens. We extend our heartfelt gratitude to you, our cherished readers, for joining us on this captivating journey. We hope you find this edition of GULMOHAR to be both enlightening and enriching.

HAPPY READING!

Editor,

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DEPARTMENT OF BOTANY

GULMOHAR

INDEX

1 UNEARTHING TRUTHS: THE ROLE OF FORENSIC BOTANY IN MODERN INVESTIGATIONS | PAGE NO. 01-05

2 POISONOUS PLANT IDENTIFICATION IN CRIMINAL INVESTIGATION | PAGE NO. 06-07

3 FORENSIC MYCOLOGY AND BOTANY IN RAPE INVESTIGATION | PAGE NO. 08-10

4 MOVIE REVIEW: THE LINDBERGH KIDNAPPING CASE | PAGE NO. 11-12

5 EXAM ALERTS | PAGE NO. 13

6 PHOTO GALLERY | PAGE NO. 14

THE ROLE OF FORENSIC BOTANY IN MODERN INVESTIGATIONS

BY KAHEKASHA

WHAT IS FORENSIC BOTANY?

Forensic botany is the application of plant sciences to criminal investigations. A relatively new discipline, forensic botany incorporates several sub disciplines: palynology (the study of pollens), dendrochronology (the study of tree rings), limnology (the study of aquatic environments), systematics (the classification of plants), ecology (the study of ecosystems), and molecular biology.

INTRODUCTION

The law of circumstances states that “Facts do not lie, but man can do.” This law proves that every piece of evidence is important and useful while investigating a sequence of events. It also indicates that oral testimony can be influenced or changed, but the result of physical evidence along with other corroborative cannot be changed, which makes a sequence of the event clear. Therefore, it is necessary to carefully collect every piece of evidence and preserve it properly. Similarly, the omnipresence of botanical evidence on the crime scene enhances its usefulness in solving criminal cases. Therefore, forensic botany is the field of science that applies the knowledge, techniques, and study of plant science to legal matters .Botanical trace evidence can be used for different purposes, such as establishing links between suspects, victims, crime scenes, and objects.

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This link is established by comparing those botanical pieces of evidence obtained from suspects with botanical evidence found at the crime scene . However, using forensic botany is limited in criminal or civil cases because a diminutive number of forensic scientists are trained for this field through academic learning . A Although most forensic scientists are familiar with methods for human identity testing, the evidence from plants, animals, and insects remains unknown. This scarcity in knowledge is due to the lack of awareness by evidence collection teams, who are unaware of the value of collecting botanical trace evidence. Scientists who studied in academic institutions have received training in one or more special aspects of plant science, such as anatomy, genetics, morphology, systematics, taxonomy, plant ecology, palynology, algology, diatomology, and so on, nonetheless, they frequently are untrained in forensic science. Hence, it becomes the task of the investigator to inform the plant scientist of standard forensic procedures, including how to handle evidence, how to handle the crime scene, and related matters until they are familiar with the routine . Still, this field remains an underutilized field of investigation, with its most common application being limited to identifying plant species, including suspected illegal plants.

PLANTS AS BOTANICAL EVIDENCE

Plants can provide forensic evidence because of their body's components and structural make-up, including its ecological requirements, which are particular to specific species. Botanical materials can therefore be useful in forensic analyses of rape cases, burglaries, kidnapping, and plant poisoning cases. Plants can also be useful for determining whether the death was due to an accident, suicide, or homicide, as well as what time of the year burial was proposed to have taken place. Additionally, it helps determine primary or secondary scenes, locate missing bodies, determine time and cause of death through the analysis of gastrointestinal contents, and track drug distribution networks in which plant species were involved. Alternatively, wood identification and comparisons can help identify a suspect involved in illegal logging, whereas fungi may help in locating buried corpses. Plant fragments lodged in a shoe associated with the cloth of a victim can also provide clues to a specific location. Likewise, pollen grains of different species can help determine the time and location of a crime, thereby linking suspects to crime scenes. Botanical evidence is also encountered in wildlife cases where endangered or forbidden plants, or products derived from these plants, were collected or traded.

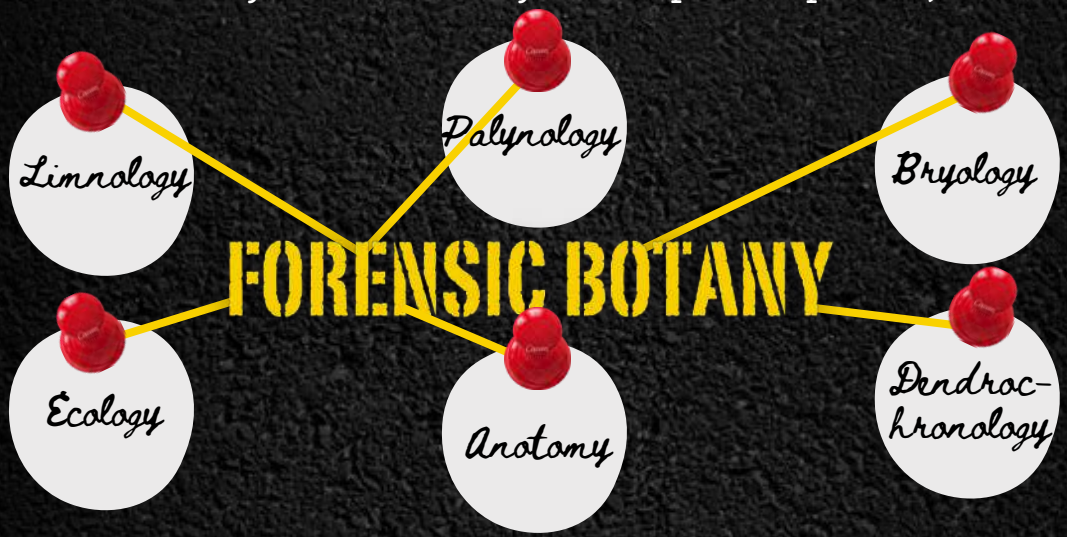
COLLECTION, HANDLING, AND PRESERVATION OF BOTANICAL EVIDENCE

Management of a crime is the process of performing accurate and effective collection and preservation of evidence . The whole plant itself is not the transgressor, but is used as an evidence against the perpetrator of a crime. Various types of botanical evidence are present on the crime scene. For example, pollen grains and spores, seeds, leaves, flowers, wood, and the stem of a plant or tree, the root of a plant or tree, bryophytes or mosses, lichens, different fungi, diatoms in underwater crime scenes, fruit, the bark of a stem or wood, etc., all serve as evidence. Likewise, botanical evidence can microscopically be present in the crime scene, in which careful collection, documentation, and preservation of these critically influence the evaluation of botanical evidence. The correct and proper identification of botanical evidence also depends on the training of botanists, including their abilities to gain access to recorded information on the characteristics of the species to which the sample belongs. Unfortunately, sometimes samples are collected by untrained personnel or police officers. Therefore, guidelines should state that plant materials need to be collected along with a control sample. Also, before collecting botanical evidence, the color and shape of plants and leaves, along with physical attributes of the botanical material should be noted and photographed. Botanical evidence can be preserved by pressing the plant material between a newspaper or catalog and allowing it to dry naturally. This method retains all the morphological characteristics of the plant. Additionally, for collection and handling of botanical materials, paper or plastic bags in addition to cardboard boxes or airtight containers are used, as they help in storing and drying botanical evidence. The storage bags or containers that would be used depends on the type and nature of the botanical evidence. Moreover, while preserving evidence, forensic scientists should ensure optimal temperature because many botanical pieces of evidence can be degraded due to high temperature, humidity, or moisture. Botanical samples exposed to heat and higher temperatures, including other adverse climatic conditions, also decompose or degrade within two to three days due to fungal or bacterial action. Alternatively, before collecting fungi, it should be photographed from different angles such that it includes its physical properties like its shape, color, and size. Then, the evidence is collected in paper bags or packed into pasteboard boxes. Other evidence, such as pollen grains, can be recovered from various sources, including victims' and offenders' clothes, as well as from their hair, respiratory tracts, vehicle tires, air filters in cars, surrounding objects, and muds .

Therefore, when pollen grain evidence is suspected to be present in the crime scene, palynologists should be given access to the area first before pollen information is unintentionally altered, removed, or contaminated by the action of other forensic and crime scene investigators. Control samples are samples of surface dirt containing this pollen evidence and spores, including dust, fibers, soot, minerals, or other materials at, near, or directly associated with a crime scene. Thus, a pinch of the control sample should be collected and placed into a sterile container, and the location of the sampled area noted along with the time of sample collection. The collected samples can then be stored in contamination-proof containers that are marked, and later placed in cold storage at approximately 0°C to prevent microbial damage of pollen grains in the sample. Subsequently, the botanical evidence is separated using techniques, such as hot surfactant solution, sieving, and centrifugation for further analysis. Likewise, pollen samples from paving materials (for example artificial stone, tiles, bricks, wood, concrete slab, etc.) can be collected using various methods. Tape lifting methods include Transparent taping, Lint rollers and Electrical tapes; swabbing methods include sterile water-soaked cotton swabbing and dust remover-soaked cotton swabbing. If required, these samples can then be preserved in paper or plastic bags as well, in addition to cardboard boxes or airtight containers after proper drying.

DISCIPLINES OF FORENSIC BOTANY

Different sub-disciplines exist, which come under forensic botany. They include; palynology (the study of pollen and spores), plant anatomy, which includes leaf morphology (the study of leaf), dendrochronology (the study of growth rings of tree stems, wood, and roots), bryology (the study of bryophytes), plant ecology (the study of the growth pattern of vegetation), limnology (the study of freshwater plants), and plant systematics (the study of evolutionary relationships between plant species and taxonomy for the analysis of plant species) .



ANOTHER IMPORTANT BIOLOGICAL EVIDENCE- MYCOLOGY

Mycology is excluded from the Plantae kingdom. However, it is one of the important biological evidences, as many crimes have been investigated using fungal pieces of evidence. Mycology includes the study of all kinds of fungi, such as molds, mushrooms and yeasts. Forensic mycology is the field of biological science that applies the study, analysis, and identification of fungi obtained from the crime scene to solve legal matters. Forensic mycology can provide various applications. It can provide trace evidence in estimating postmortem intervals, detecting the time of deposition, and finding the cause of death. Applications also involve finding the cause of hallucinations or poisoning, locating buried corpses, detecting biological warfare, and linking a suspect with the crime scene . Few fungi cause diseases. But, in contrast, they are also beneficial to their hosts and live on dead and decaying remains. Mostly, fungal polymorphs are found on stones, bricks, tiles, wooden objects, foodstuffs, leathers, plastics, rubbers, etc. During criminal investigations, the main sources where fungi can be found are soil, sediments, vegetation, plant litter, dead bodies, blood, and so on. Fungi are dispersed through spores, which are produced either sexually, asexually, or both. Millions of fungal species are present on Earth. Healthy humans are proposed to also have fungal infections, thus, fungi that infect humans are those species tolerant to human body temperature and the body's natural defenses. These species can infect the skin's surface (such as ringworm fungi), some can cause invasive infections, such as candidiasis (thrush), whereas others form more deep-seated infections in the lungs (such as aspergillosis) and other tissues (mycetomas, mycoses) . Alternatively, some species of fungi, like the species of *Penicillium*, *Mucor*, *Aspergillus*, *Fusarium*, and *Geotrichum*, which are present on foodstuffs, are proven as useful tools for estimating postmortem intervals. Hence, mycology has now proved to be one of the most important fields of forensic science. However, to date, its potential and application in actual cases have so far been limited.

Poisonous Plant Identification in Criminal Investigation

BY FATEMA

Forensic botany is the study of plant identification, which can include identifying a plant-based toxin or leaf hairs found on a suspect's clothing. Plants can be witnesses that offer evidence of suicide, theft, and other criminal offenses . Parts of plants may have lodged in the clothing or properties of the perpetrator of a crime. They may later serve as evidence in a court of law when those trained in taxonomy, molecular taxonomy, anatomy, and ecology perceive their significance. The first incident happened in 1935 when Bruno Hauptmann was tried for kidnapping. The son of Charles and Anne Lindbergh, and Arthur Koehler, a wood technologist (scientist), used his knowledge of wood anatomy to detect the origin of one of the parts of a wooden ladder used in the crime to reach the baby son. Later, Koehler's work and testimony served as a precedent for the addition of botanical evidence in subsequent court cases. Plants that produce toxic substances in the form of secondary metabolites for self-defence can also be used as forensic investigation indicators. Plants are used as tools and weapons for killing and various crimes in recent times. Poisons, those silent weapons capable of destroying life mysteriously, secretly and without violence, have ever had a peculiar fascination for mankind. The plant originated weapons or "BOTANICAL WEAPONS (BW)" were also used by criminals in murder cases. Poisonous plants are those biological weapons which cause serious problems or even death occur. These weapons are first choice of professional poisoners in toxic crime because they are easily available and involves no cost. India has the highest incidence of the use of medicinal plants as a killer substance, in war as a war tactic (poisoned weapons), as well as for murder and suicide, using substantial doses in a singular instance or small doses for an extended period.

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Some poisonous plant species, such as *Conium, Cicuta, Nerium, Aconitum, Datura, and Ricinus* are particularly useful in forensics for the apprehension of criminals. It was revealed that the *Nerium oleander* is a medicinal plant that is grown in two attractive colors, pink and white. It is grown in gardens, schools, and all over India, and has been used as medicine to treat skin problems. However, it also appears to have some toxic effects attributable to its roots, leaves, seeds, and stems. *Oleander* plants contain cardiac glycosides, which predominantly cause cardiotoxicity, and in some cases, may lead to death. In contrast, some plants do not contain cardiac glycosides but still harm the human heart and oesophagus. Molecular and biotechnological tools are used in detecting specific toxins associated with particular organs of animals or humans' effects when imbibed via inhalation, which causes some breathing difficulties that can turn the skin blue. In contrast, oral ingestion can cause digestion difficulties such as vomiting, liver spleen, low blood pressure, and blood in urine, diarrhoea, hallucination, and the kidneys may stop working. It also causes death. Forensic experts can collect traces and residual materials from these toxic medicinal plants at a crime scene and use them as forensic evidence to decipher the mysteries behind the crime and resolve the cases through several molecular analyses and applications used in the field of forensics.

Oleander (*Nerium oleander*)

Thornapples (*Datura* genus)

FORENSIC MYCOLOGY AND BOTANY IN RAPE INVESTIGATION

BY PRIYA VISHWKARMA

Forensic palynology and mycology are sub-disciplines of Forensic botany and mycology. Botany is the study of every aspect of all plant groups, and mycology is the study of all fungi which includes lichens, mushrooms, Molds, mildews, slime Molds, and Yeasts. Pollen grains are produced by conifers and flowering plants. The various groups of fungi produce different kinds of spore in a wide variety of microscopic and macroscopic structures; and these structures form a part of the palynological profile. The following is an instance where both botanical and mycological trace evidence has been obtained from the same samples, and an extensive knowledge of the ecology and geographical distribution of the plants and fungi helped in the data interpretation. This article involves the rape case of a young woman in the county of Wiltshire, Southern England. The results obtained after the mycological and botanical study forced a confession of the crime.

A young woman claimed that she had been raped by her boyfriend after they had spent the evening together. According to the woman her boyfriend walked her home and instead of stopping outside her house, he forced her to walk another 50 m to a wooded strip of land running between two quiet roads and raped her. Whereas the suspect (the boyfriend) said that they had consensual sexual relations on the turf in the middle of an Open Park approximately 200 m to the southwest of the putative Crime scene. The couple admitted to sexual activity on the day of the alleged offence, so DNA analysis would not have been useful in testing the truth of the testimony of either party. The suspect claimed that he had never been in the wooded area any time, while the woman claimed that he had forced her to lie on the ground there. Thus, the only way to find the truth was to find if trace evidence showed similarities with the woodland or with the park. This would provide support for one of the testimonies over the other.

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TWO ALTERNATIVE HYPOTHESES WERE CONSTRUCTED BY THE INVESTIGATORS:

THE PARTIES HAD LAIN ON THE GROUND IN THE WOODLAND.

THE PARTIES HAD LAIN ON THE GROUND IN THE PARK.

The results of palynological analysis of clothing and footwear, from the male, female, and both the sites i.e., the wooded area and the park, were used to test these two hypotheses. As the woman claimed that she had been forced to the ground and raped in the wooded area it was important to confirm from her clothing and footwear that she could have been on the ground in that place while wearing those garments. If the accused had also lain in the same place, his clothing would also yield a similar profile of palynomorphs to that of the Woman. Thus, it was necessary to assess the palynological profiles from the clothing and footwear of each party before. Once the nature of each palynological profile was established, the species lists from all survey places were compared, and locations (including that of the park where the Man asserted that the parties had had consensual sex) could be differentiated by virtue of the vegetation alone. Analysis of comparator samples and exhibits showed that the Palynological profiles, obtained from the clothing and shoes of both parties, resembled the profiles of the woodland more than those from the park. Hence the palynological evidence strongly Supports Hypothesis 1 over Hypothesis 2. Thus, it was deemed more likely that the girl's testimony was true rather than that of the defendant's. When presented with the evidence, the defendant confessed that he had lain with the girl in the wooded area, as she had claimed. Thus, the suspect was forced to confess his crime on the basis of palynological studies.

Palynological analysis was thus instrumental for obtaining a conviction without the need for lengthy and costly Court proceedings.

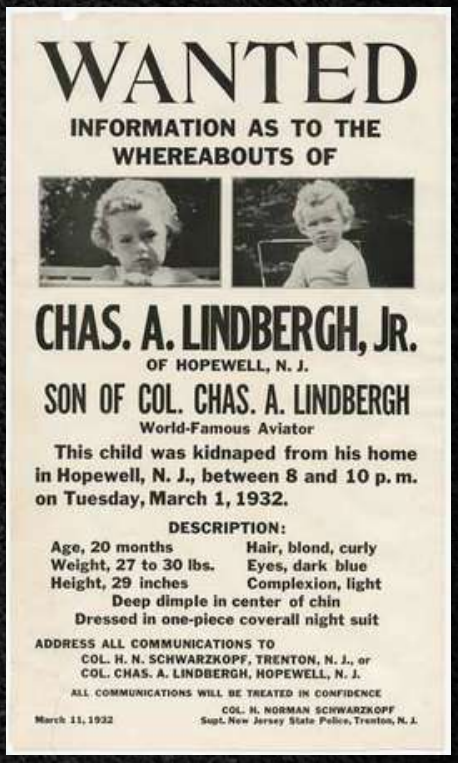
PRESENCE/ABSENCE OF FUNGAL SPORES ON THE CLOTHING OF VICTIM AND SUSPECT IN A RAPE CASE WITH THOSE IN THE TWO POSSIBLE LOCATIONS, INVESTIGATED FOR WILTSHIRE CONSTABULARY IN 2009. "PALYNOMORPHS COUNTED" = POLLEN AND PLANT SPORES AS WELL AS FUNGAL SPORES.

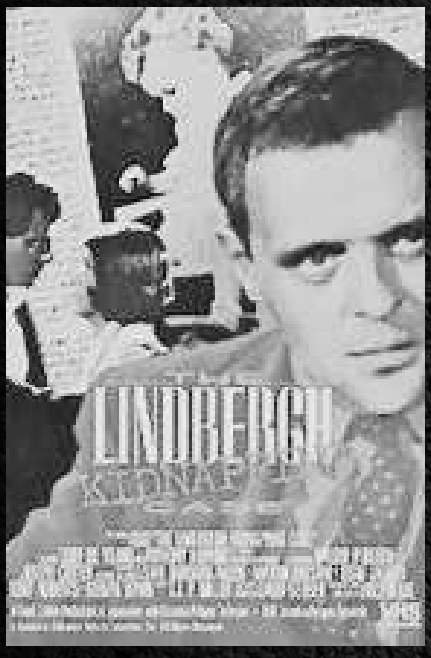
Fungi	Suspect	Victim	Wood	Park
Clasterosporium flexum	+	+	+	
Pseudovalsella-like	+	+	+	
Pestalotiopsis funerea	+	+	+	+
Brachysporium britannicum	+	+	+	
Camposporium cambrense		+	+	
Diplocladiella scalaroides	+		+	
Glomus-type	+		+	
Didymosphaeria sp.		+	+	
Melanospora sp.		+	+	+
Bactrodesmium obovatum	+		+	
Dictyosporium toruloides	+		+	
Bactrodesmium betulicola	+		+	
Periconia byssoides	+	+	+	+
Epicoccum nigrum	+	+	+	
Endophragmiella fagicola	+			
Asterosporium hoffmannii	+			
Cymadothea trifolii				+
cf. Diporotheca sp.	+			
Phaeotrichosphaeria brittanica	+			
Niesslia exosporioides	+			
Ball of straw coloured cells		+	+	
Palynomorphs counted	3236	1680	3294	30,129

THE LINDBERGH KIDNAPPING CASE

-Shraddha Nandepalli

"Crime of the Century: The Lindbergh Kidnapping Case" delves into one of the most notorious crimes in American history. Directed by John Smith, the film meticulously reconstructs the events surrounding the abduction of Charles Lindbergh Jr., son of the famous aviator. What sets this movie apart is its focus on botanical evidence, a groundbreaking aspect often overlooked in other retellings of the case.





The film masterfully incorporates the role of plants and soil analysis in the investigation, showcasing how forensic botany played a crucial role in identifying the perpetrator. Through detailed examination of plant material found at the crime scene and on the ladder used in the kidnapping, the investigators were able to narrow down the search, ultimately leading to the arrest of Bruno Hauptmann.

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Smith's direction brings the tension of the investigation to life, capturing the meticulous work of the forensic botanists and the relentless pursuit of justice by law enforcement. The audience is kept on the edge of their seats as each piece of botanical evidence unravels more of the mystery.

Moreover, the film highlights the significance of interdisciplinary collaboration between botanists, law enforcement, and forensic experts—a collaboration that was groundbreaking for its time and paved the way for modern forensic techniques.

The botanical evidence presented in the film not only adds depth to the narrative but also underscores the importance of attention to detail in criminal investigations. It serves as a reminder of the power of science in solving even the most baffling crimes.

Overall, "Crime of the Century: The Lindbergh Kidnapping Case" is a riveting historical thriller that sheds new light on a well-known case, thanks to its unique focus on botanical evidence. It's a must-watch for true crime enthusiasts and anyone fascinated by the intersection of science and justice.

EXAM NAME	DATE	CONDUCTING BODY	LINK
NEET UP	5TH MAY 2024	National; testing agency (nta)	CLICK HERE
CUET [PG]	b/w 15th MAY and 31st MAY 2024	nta	CLICK HERE
UGC NET SESSION 1	b/w 11th MARCH and 28TH MARCH 2024	The national testing agency (nta)	CLICK HERE
MAH-CET	b/w 10th JUNE and 21st JUNE	State common entrance test cell-maha state	CLICK HERE

ANJALI YADAV
Botanical name: *Caladium bicolor f.macrophyllum*
Location : Suryamal

SELVAMATHI KAMARAJ NADAR
Botanical name- *Hemerocallis fulva*
Location: Mahabaleshwar

ASWATHY NAIR
Botanical name: *Saraca indica*
Location: Coastal Biodiversity Centre, Airoli

PHOTO GALLERY

ASWATHY NAIR
Botanical name: *Cyathocline purpurea*
Location: Khopoli

ASWATHY NAIR
Botanical name: *Kigelia pinnata*
Location: Coastal Biodiversity Centre, Airoli

SELVAMATHI KAMARAJ NADAR
Botanical name- *Passiflora vitifolia*
Location: Mahabaleshwar

SELVAMATHI KAMARAJ NADAR
Botanical name- *Thunbergia grandiflora*
Location: Mahabaleshwar

ARSHI KHAN
Botany name:*Solanum virginianum*
Location : Khopoli

KANAK SONI
Botanical name- Gaillardia aristata
Location: Mapro garden, Mahabaleshwar

KANAK SONI
Botanical name: Jacobaea maritima
Location: Krishnabai Devi Temple, Mahabaleshwar

PHOTO GALLERY

KANAK SONI
Botanical name: Petunia x atkinsiana (hybrid)
Location: Mapro Garden, Mahabaleshwar

SHRADDHA NANDEPALLI
Botanical name- Leucospermum cordifolium
Location: Rani Baugh

KANAK SONI
Botanical name: Chrysanthemum coronarium
Location: Wheat Rust Research Center, Mahabaleshwar

ARSHI KHAN
Botanical name- Celosia argentea cristata
Location: Rani Baugh

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