TAXONOMIC STUDIES ON THE GENUS *IMPATIENS* L. (BALSAMINACEAE) OF NORTHERN AND CENTRAL WESTERN GHATS WITH SPECIAL REFERENCE TO ENDEMIC SPECIES

THESIS SUBMITTED TO GOA UNIVERSITY
FOR THE AWARD OF DEGREE OF

DOCTOR OF PHILOSOPHY
IN
BOTANY

BY

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Referees have not suggested any corrections.
graduate incorporated a small correction on her own.
) Thesis certified.

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STATEMENT

As required by the University Ordinance 0.19.8 (ii), I state that the present thesis "Taxonomic studies on the genus *Impatiens* L. (Balsaminaceae) of Northern and Central Western Ghats with special reference to endemic species" is my original contribution and the same has not been submitted on any occasion for any degree or diploma of this University or any other University / Institute. To the best of my knowledge, the present study is the first comprehensive work of its kind from the area mentioned. The literature related to the problem investigated has been cited. Due acknowledgments have been made wherever facilities and suggestions have been availed off.

Place: Goa University

Date: 21|08|2009

(Jyosna R. Naik Dessai)

Candidate

CERTIFICATE

As required by the University Ordinance 0.19.8 (IV), this is to certify that the thesis entitled "Taxonomic studies on the genus *Impatiens* L. (Balsaminaceae) of Northern and Central Western Ghats with special reference to endemic species", submitted by Miss Jyosna R. Naik Dessai for the award of the degree of Doctor of Philosophy in Botany, is based on her original and independent work carried out by her during the period of study, under my supervision.

The thesis or any part thereof has not been previously submitted for any other degree or diploma in any University or institute.

Place: Goa University
Date: 21.08.2009

(M. K. Janarthanam)
Research Guide

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INTRODUCTION

The richness of flowering plants makes India one of the megadiversity country in the World with four biodiversity hotspots and three megacentres of endemism. The flora of India shows high diversity in terms of families, genera and species of Angiosperms. Many plant genera and families are known to be represented by high number of endemic species. One amongst them is *Impatiens* L. belonging to the family Balsaminaceae.

The family Balsaminaceae comprises of annual as well as perennial herbs that evince conspicuous and striking floral morphology. It comprises of two wide spread genera, viz. *Hydrocera,* a monotypic genus and *Impatiens,* a genus with large number of species. *Hydrocera* can be easily distinguished by its five free petals and the berry like capsule, while *Impatiens* has four petals that are fused to form two lateral petals and a 5-valved capsule. *Hydrocera triflora* (L.) Wight & Arn. is a semi-aquatic herb distributed in the Indo-Malesian countries.

Impatiens with more than 1,000 species (Janssens *et al.*, 2006, 2009a, 2009b; Morgan, 2007) is distributed in the tropical and sub-tropical regions of the Old World (Grey-Wilson, 1980a) while a few species are recorded from the temperate regions of Asia, Europe and America (Vivekananthan *et al.*, 1997). The genus is known to have five distinct diversity hotspots – tropical Africa, Madagascar, South India and Sri Lanka, the Eastern Himalayas and South East Asia (Yuan *et al.*, 2004). Many species of this genus are cultivated as ornamentals and some are used in medicine and cosmetics. The genus derives its name '*Impatiens*', meaning 'impatient', due to its mature fruits curling up inwards and bursting suddenly when touched, thus ejecting its seeds out. Species belonging to this genus are commonly referred to as 'balsams' or 'jewel weeds'.

***Impatiens* in India:**

In India, the genus is represented by about 209 species with two centres of diversity – the eastern Himalayas in the north and the Western Ghats in the south. Both these regions show high degree of endemism and hence recognised as two amongst the 34 biodiversity hotspot regions of the World (Mittermeier *et al.* 2005). Species occurring in India can be differentiated into two main groups: species that have short, swollen spindle shaped pods occurring in the Western Ghats and the other group of species that have long and narrow pods occurring in the north East Himalayas.

Problems associated with *Impatiens*:

The main problem associated with the study of *Impatiens* is the delicate nature of its flowers which are difficult to work once processed for herbarium. Profuse variation within the species of this actively evolving group led to taxonomic and nomenclatural confusions. Though closely related species can be grouped into different sections it is very difficult to resolve the phylogenetic relationships among the species in each group based on the overall morphology. Studies on their phylogenetic relationships were never attempted in India.

In spite of having a wide range of diversity in its floral structures, systematic studies on *Impatiens* have encountered problems in clarifying the relationship amongst species. Till date, only few sporadic studies have been carried out on Balsaminaceae and none of them assessed the usefulness of existing century old infrageneric classifications.

The collections available in herbaria are few and some species are not collected after type. Species like *I. anaimudica, I. johnii, I. macrocarpa, I.*

munnarensis, I. neo-barnesii, I. nilgirica, I. pandata, I. talbotii have already entered into the Red Data Book (Ramamurthi, 1988; Singh and Kulkarni, 1990; Vivekananthan, 1990; Vivekananthan and Malathi, 1990). Due to the lack of comprehensive and group specific studies, their distribution, taxonomy and phylogeny are not understood properly. Therefore there is an urgent need to study them based on fresh specimens and reinterpret their taxonomy, threat status and phylogeny. Hence, the present study was taken up with the following **objective**:

To carry out systematic and phytogeographic studies of the genus *Impatiens* L. in the Northern and parts of Central Western Ghats covering the states of Gujarat, Maharashtra, Goa and Karnataka with special reference to endemic species.

REVIEW OF LITERATURE

Floristic works:

The history of the genus *Impatiens* in India starts with the publication of *Species Plantarum*. However, the species of *Impatiens* first appeared in print in Rheede's *Hortus Malabaricus* (Rheede, 1689). This monumental pre-Linnean work of Rheede includes six plates of balsams along with a brief description of plants in Latin. These six plates are now recognised as four distinct species.

Linneaus (1753) described seven species of *Impatiens* including the present day *Hydrocera triflora* which was treated as a species under the genus, but was later segregated as a distinct genus. Of the six species of *Impatiens* described by Linneaus, three species occur in India that include 'Valli onapu' (*I. latifolia*) and 'Kondam pallu' (*I. oppositifolia*) of Rheede.

Lamarck (1785) enumerated eight species of *Impatiens* in his *Encyclopedie methodique*: *botanique* which include all the seven species described by Linneaus (1753) and one new species i. e. *I. fasciculata*. Roth (1821) described *I. mysorensis* based on Heyne's collection from Mysore. Roxburg (1824) in his *Flora Indica*, listed 16 species of *Impatiens* from India. De Candolle (1824) in his *Prodromus* listed 31 species of *Impatiens* from Nepal, India and Sri Lanka (Ceylon) of which 24 occur in India. Based on inflorescence, anther, stigma and capsule character, he divided *Balsamineae* into two genera: *Impatiens* (anthers 5, bilocular, stigma 5, distinct, pedicel 1-flowered, solitary or aggregated, capsule puberulous) and *Balsamina* (anthers 5, parted, 3 bilocular, stigma 5, united, peduncles axillary, many flowered, capsule glabrous).

Wight and Arnott (1834) enumerated 21 species of *Impatiens* for Peninsular

India of which nine species occur in the study area. They divided the species occurring in Peninsular India into three groups. One group comprised of species with alternate leaves, axillary, solitary or several flowered inflorescence. The second group comprised of species having alternate leaves and peduncled inflorescence with many flowers. The third group comprised of species with opposite leaves and axillary, solitary or aggregated inflorescence. Arnott (1835) described 14 new species of *Impatiens* from (Ceylon) Sri Lanka and India. Of these, *I. cuspidata*, *I. henslowiana*, *I. grandis* and *I. acaulis* are common to Sri Lanka and Peninsular India. Wight (1837) described 11 new species of balsams collected from Courtallum (Kutrallam) and Shevagerry hills of southern Western Ghats. Lindley (1841) described *I. rosea* from Himalayas which was later reduced to a variety under *I. balsamina* by Hooker (1874). Wight (1844, 1845, 1846) illustrated 22 species of *Impatiens* from the Western Ghats region.

Beddome (1858) brought out synopsis of Peninsular *Impatiens* species wherein he described several new species of *Impatiens* from the Anamalai hills. Beddome (1868-1874) illustrated 14 species of *Impatiens* with brief description of the species and provided a list of species occurring in the Southern Western Ghats.

Hooker's contribution to Indian species of *Impatiens* was considerably more than that of any others. The present day understanding of the genus *Impatiens* in India can be attributed to Hooker. Hooker along with Thomson made an attempt to study the genus from India. Hooker and Thomson (1859) in their "*Praecursores ad Floram indicum – Balsamineae*" described 111 species including 15 new species from the region. Although they are of the opinion that the genus could be divided into two broad groups, viz. *scapigerae* and *caulescentes,* based on thei habit, recognised seven sections in their classical work. Phyllotaxy was the main character for section

delimitation in their classification. Besides this key character, inflorescence type and seed characters were also used to delimit the sections to certain extent. Their work also provides a valuable discussion on the morphological variations, floral morphology and explanation to the terminology coined and used in their study, species common to India and other countries. Dalzell and Gibson (1861) listed 14 species for Bombay of which 8 species occur in the study area.

Hooker (1874) refined the classification provided by Hooker and Thomson (1859). He divided the genus into two principle groups on the basis of capsule shape - the Himalayan group comprising of species with slender, terete or obovate capsule and the Peninsular group comprising of species with short capsules which are swollen in the middle. Though he divided the species into two series, sections were retained as proposed earlier by Hooker and Thomson (1859). Section *Oppositifoliae*, *Uniflorae* and *Racemosae* were common to both the groups.

Warburg and Reiche (1895) were the pioneering authorities to classify *Impatiens* at global level. They produced a new classification without taking into consideration the classification provided by Hooker and Thomson (1859). They divided the genus into two broad groups: *Acaulimpatiens* with two sections and *Caulimpatiens* with twelve sections. However, this classification was considered artificial by Grey-Wilson (1980a).

Hooker (1904, 1905,1906) in his conspectus on the genus *Impatiens* dealt the species based on phytogeographic range/zones. Here section *Uniflorae* is treated as *Microsepalae*. Many new species were described from different regions. In his later works Hooker (1910a, 1911) described several new species of *Impatiens* from Western Peninsular India based on Meebold's collections.

Since these pioneering works, no major work involving the study of entire

genus has been taken up in India but for the latest taxonomic study on Indian *Impatiens* by Vivekananthan *et al.* (1997). This is primarily based on literature and herbarium specimens and records 204 species for India. Critical taxonomic account, nomenclature, relationship between species and infrageneric classification are missing in this treatment.

Regional floristic studies and inventories published in the early and mid 20th century have also contributed significantly. Cooke (1901) described 16 species and 5 varieties of *Impatiens* and a new variety under *Impatiens balsamina*, i. e. *I. balsamina* var. *brevicalcarata* for the Bombay Presidency. Most of his descriptions were based on collections of Law, Stocks, Dalzell, Graham, Gibson, Talbot and Woodrow. Gamble (1915) listed 70 species for the Presidency of Madras, though many species were synonymised in later works. He classified the species into sections proposed by Hooker (1906). Sedgwick (1919) described *Impatiens kleiniformis* from Castle rock, Karnataka. Later, Fisher (1936) added 11 species to Gamble's list. He published several new species of *Impatiens* from the Western Ghats region (Fischer 1930, 1931, 1934, 1935a, 1935b, 1938). Fyson (1932) included 31 taxa from the south Indian hill stations. Blatter (1933) revised Balsaminaceae for the flora of Presidency of Bombay and added *I. kleiniformis*, *I. talbotii*, *I. rupicola*, *I. diversifolia* and *I. pusilla* thus increasing the number from 15 to 20 for the region. Barnes (1939) collected 37 species of balsams including one new species and one new variety from the High Ranges of Travancore. He found that more than 30 species of *Impatiens* occur within a radius of 16 km in Munnar. Thus he concluded that the High Ranges are richest areas of the Western Ghats and consequently of the World with regard to *Impatiens*. Santapau (1948) described a new variety under *I. balsamina,* i. e. *I. balsamina* var. *corymbosa* from Khandala, Maharashtra. Santapau (1967) included five taxa of

Impatiens for flora of Khandala.

Bhaskar (1975) worked extensively on the genus *Impatiens* in South India. His study included taxonomy, cytology, palynology, anatomy and reproductive biology. The results obtained from this study were published as a series of articles.

Bhaskar *et al.* (1975) described a new variety of *I. acaulis*, i. e. *I. acaulis* var. *granulata* based on the granutate exine of pollen as opposed to the reticulate exine in the typical variety. Bhaskar and Razi (1978a) gave a brief historical account of the genus *Impatiens.* They listed the characters used in classification; difficulties encountered by Hooker while working with *Impatiens* and provided notes on ecology, habitat and taxonomy for some south Indian species. Bhaskar and Razi (1978b) followed infrageneric classification proposed by Hooker (1906) but further sub-divided section *Oppositifoliae* (treated as *Annuae*) into two subsections – *Oppositifoliae* and *Verticillatae.*

Shah (1978) listed only three taxa for Gujarat. This includes two varieties of *I. balsamina* and *I. minor* which are widely distributed species. Vajravelu (1983) included 61 species and one variety for Tamil Nadu state. Sharma *et al.* (1984) listed 35 species and two varieties for flora of Karnataka. Rao (1985) listed nine species and one variety for Goa. Saldanha (1996) described 32 species and 3 varieties of *Impatiens* in his Flora. His descriptions were based on his personal collections and also based on earlier collections by different collectors and literature. Sasidharan (2004) and Nayar *et al.* (2006) in their checklist included 79 species of *Impatiens* for Kerala state.

Several district floras and floristic works were published during the later part of 20th century by various authors (Ramamoorthy, 1978; Rao and Razi, 1981; Yaganarasimhan *et al.*, 1982; Manilal, 1988; Ramachandran and Nair, 1988; Almeida,

1990; Keshava Murthy and Yoganarasimhan, 1990; Vajravelu, 1990; Lakshminarasimhan and Sharma, 1991; Deshpande *et al.*, 1993; Kothari and Moorthy, 1993; Mohanan and Henry, 1994; Augustine *et al.*, 1999; Ramaswamy *et al.*, 2001; Yadav and Sardesai, 2002; Bhat, 2003). All these taxonomic endeavours resulted in accumulation of large number of collections which are deposited in various herbaria.

Several new species and extended distributional reports from various parts of the Western Ghats have been published from time to time (Chandrabose, 1978; Bhaskar and Razi, 1982; Chandrabose *et al.*, 1979; Pandurangan and Nair, 1995; Kumar and Sequiera, 1996, 2001; Pandurangan and Nair, 1996; Ravikumar *et al.*, 2000; Viswanathan and Manikandan, 2003; Bhaskar, 2006). These publications imply that our knowledge on *Impatiens* is incomplete and there are species to be discovered and described.

Grey-Wilson (1980a) revised and compiled a book on *Impatiens* of Africa. The treatise contains a detailed account of 110 species of *Impatiens* occurring in Africa, a brief history of the genus along with a discussion on its floral morphology, biology, phytogeography, detailed descriptions, illustrations and distribution maps. For the first time illustrations are used in key construction which aid in easy identification of the species. He also provided notes on how to collect and prepare *Impatiens* for herbaria and how to cultivate African *Impatiens*.

Grey-Wilson (1985) compiled Balsaminaceae for Flora of Ceylon (Sri Lanka). Of the 25 species dealt in the work *I. acaulis*, *I. balsamina*, *I. grandis*, *I. henslowiana*, *I. oppositifolia* and *I. verticillata* are common to Sri Lanka and Western Ghats. Akiyama and Ohba (2000) studied the shape of inflorescence of Himalayan *Impatiens*. Yi-ling *et al.* (2007) compiled Balsaminaceae for flora of China.

Several new species have been published during the last few decades (Grey-

Wilson, 1979; Shimizu and Utami, 1997; Cheek and Fischer, 1999; Frimodt-Moller and Grey-Wilson, 1999; Cheek and Csiba, 2002; Fischer *et al.*, 2003; Fischer and Rahelivololona, 2002, 2004a, 2004b; Janssens *et al.*, 2009a). Though these publications are for the areas outside the present study area, they prove that the situation is more or less similar elsewhere.

Endemism:

A brief account on the evolution and endemism of the genus in south India, affinities of the south Indian species with Sri Lankan species and the pattern of distribution of herbaceous and shrubby balsams in south India were discussed by Bhaskar (1981). Nair (1991) discussed about the endemism and the pattern of distribution of the genus *Impatiens* in the Western Ghats. He considered Western Ghats as one of the centres of origin of the genus. He is of the opinion that *Impatiens* is one of the largest genera among angiosperms in India with maximum number of endemic species. Ahmedullah and Nayar (1986) listed 71 endemic species to the Western Ghats region of India. Nayar (1996) listed 81 taxa of *Impatiens* as endemic to Peninsular India.

Cytology:

Khoshoo (1956) developed a unique technique to study chromosomes from the herbarium specimens of *Impatiens*. All the three species in his study are from the Himalayas and they do not occur in the study area. Krishnaswamy *et al.* (1969), Rao (1972, 1973a, b, 1975, 1978), Bhaskar and Razi (1972 – 73) and Bhaskar (1976, 1980) carried cytological and palynological studies on the South Indian Balsaminaceae with major contributions from Bhaskar and Razi (1972 – 73) and

Bhaskar (1976, 1980).

Bhaskar and Razi (1972-73) reported chromosome numbers in 20 species of *Impatiens* found in south India. Based on their work and literature they concluded that chromosome number supports the taxonomic grouping of species into sections as proposed by Hooker for the south Indian species of *Impatiens*. Bhaskar (1976) reported chromosome number in 26 taxa of *Impatiens*. Based on the cytological studies he found that the chromosome numbers in section *Scapigerae* are highly variable. Hence, Bhaskar (1980) carried out cytological studies on *I. scapiflora* and *I. modesta* taking into consideration the ecological parameters. He observed chromosomal drift in both the species and pointed out that the severe climatic conditions found at higher altitudes could be the probable reason for the variations in chromosome numbers in these species.

Song *et al.* (2003) studied chromosomal evolution in family Balsaminaceae. Their study was based on 45 species of *Impatiens* found growing in SE Asia. They found that x = 7, 8, 9, 10 are the basic chromosome numbers occurring frequently among the species in the family. They concluded that x= 8, 9 and 10 could be the ancestral basic chromosome numbers in *Impatiens*. They found that basic chromosome numbers x = 7, 8 are shared by species from Africa, Sri Lanka, South India and SE Asia while x = 10 are distributed in northern hemisphere and x = 9 is shared by species from Himalayas and SE Asia.

Palynology:

Bhaskar and Razi (1973) discovered a new kind of exine sculpturing in *I. acaulis* and *I. goughii*. Bhaskar and Razi (1974) studied pollen germination in *Impatiens* species. They found that pollen grains of different species have different

germination timings. Among the 22 taxa, maximum species showed nocturnal pollen germination. In *I. barberi, I. dasysperma* and *I. fruticosa* the pollens germinated in the morning hours while *I. leschenaultii* showed both nocturnal as well as diurnal pollen germination.

Perveen and Qaiser (2001) studied pollens of eight species of *Impatiens* using light and Scanning Electron Microscope (SEM). Janssens *et al.* (2005) studied palynological diversity of Balsaminaceae, Tetrameristaceae and Pellicieraceae to find out the interfamilial relationships within the balsaminoid clade. They found that Balsaminaceae are completely different from the other balsaminoid families due to the occurrence of colpate or porate with an oblate to peroblate shape, very thin foot layer and a lamellated endexine.

Seed morphology:

Studies on seed coat morphology of 38 species from China have been carried out by Song *et al.* (2005). Utami and Shimizu (2005) carried out Scanning Electron Microscope (SEM) studies of 65 species of *Impatiens* representing two subgenera: *Acaulimpatiens* and *Impatiens* and 10 sections (2 sections of subg. *Acaulimpatiens* and 8 sections of subg. *Impatiens*) of Warburg and Reiche (1895).

Molecular studies:

Till date, only few molecular studies have been carried out to study the phylogenetic relationship in Balsaminaceae. Fujihashi *et al.* (2002) studied origin and relationships of the Sino-Himalayan *Impatiens* (Balsaminaceae) based on molecular phylogenetic analysis, chromosome numbers and gross morphology. They used the combined sequence of *rbcL* and the spacer between *trnL* and *trnF* to generate the first

molecular phylogeny of *Impatiens* (Balsaminaceae) based on twenty five species of *Impatiens* and using *Tropaeolum major* L. (Tropaeolaceae) as the outgroup. Their studies revealed the presence of two large monophyletic clades: one comprising only of Himalayan species and the other consisted of species distributed in various areas of the world. The phylogenetic tree was correlated with chromosome numbers. The Himalayan clade has x = 7 or 9; the other clade has x = 8 or 10. Morphological diversification of the lower sepal, a significant character which is used in the classification of the species, does not clearly correlate with the tree.

Yuan *et al.* (2004) carried out phylogenetic study on family Balsaminaceae using nucleotide sequence data of ITS of nuclear ribosomal DNA and also taking into consideration the morphological, karyological and biogeographical data. Phylogenetic analysis confirmed monophyly of *Impatiens*. However inspite of recognition of strongly supported clades their molecular phylogenies do not resolve relationships among the lineages and thus offer limited taxonomic implications.

Janssens *et al.* (2006) carried out phylogenetic studies to study the relationship between *Hydrocera* and *Impatiens* species using chloroplast *atpB-rbcL* spacer sequences. They found sister group relationship between *Hydrocera* and *Impatiens*. The grouping of *Impatiens* species is based on the geographical distribution. They concluded that *Impatiens* originated in south China and colonized neighbouring areas and later spread into North America, Africa, India, southeast Asian peninsula and the Himalayan region.

Janssens *et al.* (2009b) investigated the origin and evolution of the family Balsaminaceae with special emphasis on the genus *Impatiens* based on the species distributed worldwide. They estimated the age of the recently diversified lineages in *Impatiens* using molecular tools. Their study revealed that *Impatiens* originated in

Southwest China and started to diversify in the early Miocene. Biogeographic reconstruction clearly illustrates that the south Indian species originated from two independent dispersal events. One clade comprises of species belonging to section *Uniflorae* and the other clade comprises of species belonging to section *Subumbellatae*, *Epiphyticae* and *Scapigerae*.

This study indicates that diversification in *Impatiens* increased since the last 4.6 – 5 million years. However until the early Pilocene, the diversification rate within the genus was quite slow. It was found that the species richness in the genus is the result of sudden diversification boost and they did not originate via gradual accumulation of species over a long geological period.

STUDY AREA

Western Ghats is a chain of mountains running parallel to the West coast of Peninsular India. The range starts from the mouth of river Tapti and extends southwards up to Kanniyakumari (Cape Camorin) through the states of Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu. The continuous chain of mountains has a major discontinuity in the Palghat gap thus separating the Nilgiris from the Anamalais. Western Ghats lie between 8° 20′ – 20° 40′ N and 73° – 77° E and is approximately 1,600 km long (Nair and Daniel, 1986) and covers an area of 1,60,000 km^2. The average elevation is around 900 m and the highest mountain peak is Anaimudi (2695m). Western Ghats lies towards the western edge of Deccan plateau and separates the plateau from the narrow coastal zone of the Arabian Sea. It is surrounded by the Arabian Sea towards the west, the arid Deccan plateau towards the east and the Vindhya-Satpura ranges in the north.

Western Ghats are characterised by conical as well as flat topped hills interspersed with valleys and spurs (Vajravelu and Vivekananthan, 1996). Along the Western side there are steep ravines and canyons and towards the eastern side there are the flat topped spurs intersected by valleys (Subramanyam and Nair, 1974). The mountain chains of Western Ghats are steep on the windward side and sloping towards the Deccan plateau on the leeward side in the state of Maharashtra whereas the range south of Palghat is sloping towards the windward side in Kerala and steep towards the leeward side in Tamil Nadu (Nayar, 1996).

The hills north of the Krishna basin (largely Maharashtra and Gujarat) are with fragile basaltic rocks. South of the Krishna basin is the region of precambrian archean crystalline hard rock's (nearly 2000 million years old granites, schists, gneisses,

PLATE 1

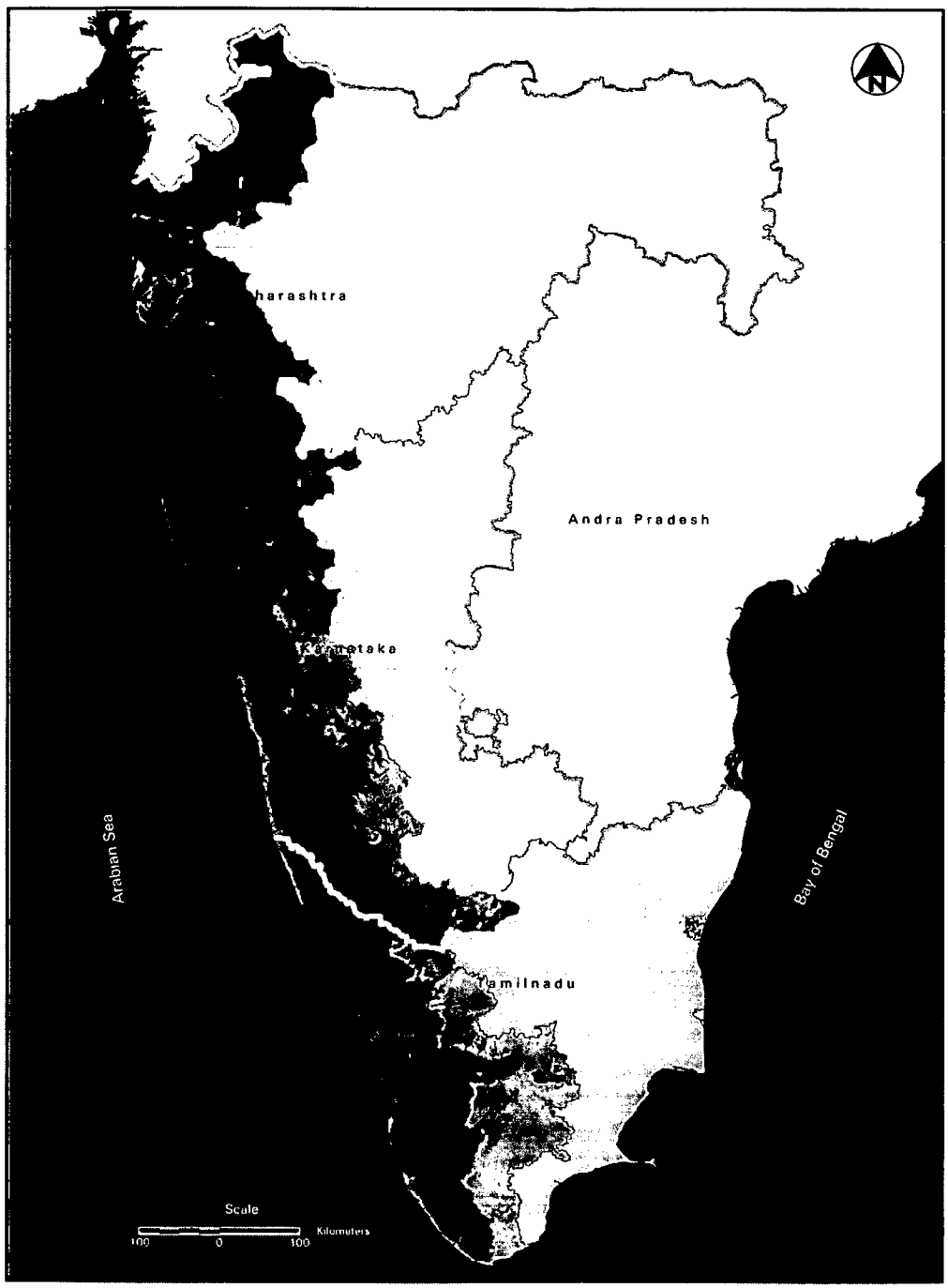


PLATE 1: Map of Western Ghats showing study area (Source: IIRS Publication, June 2002).

quartzites, etc). Soils vary from humus rich peat in the montane areas to laterite in the lower elevation and high rainfall belts. Soils are generally acidic.

The Western Ghats sector receives rains from the southwest monsoon. It rains all the year round in southern parts while in the areas in the north remain dry for 8 – 9 months. The average annual rainfall in the Western Ghats region is 2500 mm. Rainfall is as high as 7600 mm in localities such as Agumbe (Daniels and Vencatesan, 2008). The climate is generally warm and humid but becomes hot in summer and cold in winter months. Mean temperature ranges from 18° to 24° C, rises beyond 30° C in summer season and sometimes down up to 0° C in winter season in places of high altitudes. There are 38 east flowing and 27 west flowing major rivers in the Western Ghats. The rivers which originate in the west in the Western Ghats drain into the Arabian Sea while the three major rivers in the Western Ghats – Kaveri (Cauvery), Krishna and Godavari flows eastwards into the Bay of Bengal (Murthy *et al.*, 1996).

Champion and Seth (1968) classified the vegetation of Western Ghats into four major types:

1. Moist tropical forests (Tropical evergreen forest, tropical semi evergreen forest, tropical moist deciduous forest, and littoral and swamp forests).
2. Dry tropical forests (tropical dry deciduous forests, tropical thorn forests)
3. Montane subtropical forests (subtropical broad leaved hill forests)
4. Montane temperate forests (montane wet temperate forests)

Apart from the above mentioned vegetation types different types of vegetation occurs along the Western Ghats. This includes scrubs, sholas, montane grasslands, tropical moist deciduous forest, tropical dry deciduous forest, peat blogs, *Myristica* swamps, tropical evergreen forests, semi-evergreen forest and lateritic rocky plateaus.

Evergreen forests: These forests occur along the windward side at an altitude of 200

- 1,500 m with 2,500 - 5,000 mm rainfall. The canopy is dense with trees which are up to 60 m high. Evergreen forests are found in the western slopes of the Western Ghats in Kerala and Karnataka (Nair and Daniel, 1986; Daniels and Vencatesan, 2008).

Semi-evergreen forests: Semi-evergreen forests occur in the Western Ghats of Maharashtra, Goa, Karnataka and Kerala within an elevation range of about 300-900 m.

Moist Deciduous forests: Moist deciduous forests occur between 500 – 900 m altitudes where the rainfall is 2,500 mm to 3,500 mm. Trees are as high as 60 m but the canopies of the trees in these forests are not as dense as the ones in the evergreen forests (Nair and Daniel, 1986; Daniels and Vencatesan, 2008).

Dry Deciduous forests: Dry Deciduous forests are confined to areas with an elevational range of 300 – 900 m with 1000 – 2000 mm mean annual rainfall (Nair and Daniel, 1986; Daniels and Vencatesan, 2008).

The Sholas (Grasslands): In the Western Ghats natural grasslands are found above 1,500 m with 2500 – 5000 mm rainfall in Bababudangiris, Kudremukh, Nilgiris, Anaimalais, Palnis and Cardamom hill ranges. The grasslands which are also called as shrub savannas or the sholas are characterized by number of herbaceous and shrubby species mixed with grasses (Nair and Daniel, 1986; Daniels and Vencatesan, 2008).

Rocky lateritic plateaus: Undulating lateritic plateaus occur along the west coast of the Western Ghats. These harbour herbaceous vegetation. These are commonly found in the Northern and Central Western Ghats (Nair and Daniel, 1986).

***Myristica* swamps**: These are located at the bottom of valleys which are covered with water during the greater part of the year. These are found in southernmost part of Kerala, Tamil Nadu, Karnataka and Goa. These occur up to 600 m altitude in areas

with medium to high rainfall (Nair and Daniel, 1986).

Scrub forest: Scrub jungles are located in areas between 200-500 m elevation with 300-600 mm of annual rainfall. This vegetation type is dominated by short trees which are 15-20 m high (Nair and Daniel, 1986; Daniels and Vencatesan, 2008).

Savannas: Savannas are seen in areas between 1,700-1,900 m in elevation with 2500 – 3500 mm rainfall (Nair and Daniel, 1986; Daniels and Vencatesan, 2008).

Pascal (1988) categorized Western Ghats into three regions: the Northern Western Ghats, the Central Western Ghats and the Southern Western Ghats. The geographical area of present study is restricted to the Northern Western Ghats and the Central Western Ghats (up to the political boundary of Karnataka).

1) Northern Western Ghats (Tapti to Goa): The northern Western Ghats are popularly known as *Sahyadris*. It starts from the mouth of river Tapti and extends 750 km in length up to Goa. The altitudinal range is between 300-1500 m msl excluding high crests (Karthikeyan, 1996). Along the Northern Western Ghats isolated, conical, flat-topped hills occur with steep sides which are marked with distinct striations. The major peaks in Northern Western Ghats (*Sahyadris*) are Kalsubai (1645m), Mahableshwar (1438m) and Harishchandragad (1424m).

The main groups of soils found along the Northern Western Ghats are high and low level laterites, red loam, medium black soil, red gravelly soils and mixed red and black soil. Medium black soils are found on flat hill tops while the valleys have deep red gravelly soils with good humus content (Karthikeyan, 1996).

The South west monsoons bring heavy rains in the Northern Western Ghats. The rainy season begins in early June and ceases off during September. The mean

annual rainfall varies from 2000 - 7000 mm. The humidity is 70 - 90% during the monsoons and 10 - 30% during dry periods. The mean annual temperature varies from 20° - 24°C. Mean daily temperature in the coldest months (December - January) ranges between 18° - 24°C while the absolute minimum temperature is 6° - 15°C in different places of Northern Western Ghats (Karthikeyan, 1996).

The vegetation occurring along the Northern Western Ghats can be classified as: scrub forest, dry deciduous forest, moist deciduous forest, montane subtropical evergreen forest (Karthikeyan, 1996).

2) Central Western Ghats (South of Goa up to Palghat gap): Central Western Ghats starts from south of Goa up to the Palghat gap. However, due to logistic reasons, in the present study the area is restricted up to the political boundary of Karnataka. This region is approximately 320 km long (Kamath, 1982). The ghats in this section rise sharply to form unbroken and uneven rampart averaging an altitude of 900 m. In the study area of Central Western Ghats, Kudremukh (1892 m) is the highest peak followed by Thadiandamol (1745 m) and Pushpagiri (1713 m). The Western Ghats in this section are very close to the coast and at several places touches the shore.

The main groups of soils found along the Central Western Ghats are lateritic soil, red soil, mixed red and black soil, red loam and brown clay. Lateritic soils occur in the coastal regions of Uttara Kannada, Dakshina Kannada, Shimoga and Hassan districts. Red soils occur in Shimoga, Hassan and Chikmagalur districts.

Western Ghats in Karnataka though receive rainfall from the south west monsoons also receive rains from the north east monsoons during October to January. Annual rainfall varies from 4000 mm to 8000 mm. Annual rainfall is highest in the

Western Ghats section and lowest in the eastern parts of Chitradurga towards the leeward side. Agumbe receives highest rainfall (8270 mm) in this sector followed by Bhagamandala (6032 mm).The mean annual temperature varies from 18° - 20°C. Mean daily temperature ranges between 20° - 24°C. The humidity is 90% during the monsoons in the month of July and August.

The vegetation occurring along the Central Western Ghats can be classified as: tropical evergreen forest, semi-evergreen forest, moist deciduous forest and the *sholas*.

MATERIALS AND METHODS

The taxonomic study on *Impatiens* was taken up in July 2004. A checklist of all the published names for the species of *Impatiens* found to be occurring in the study area as well as from the adjacent areas was prepared using local and regional floras such as Cooke (1901), Gamble (1915), Hooker (1874), Saldanha (1996), Almeida (1996), Vivekananthan *et al.* (1997) and Mudaliar and Prasad (2000). For all the species occurring in this region, place of original publication was gathered using International Plant Name Index (IPNI – www.ipni.org). Floras, old literature pertaining to the genus and various herbaria were consulted to find out the location details along with their flowering and fruiting period.

Herbarium specimens from the following herbaria were studied. Variations were noted down along with the details on the herbarium label for incorporation into the descriptions, notes and for further analysis.

- BSI - Botanical Survey of India, Western Circle, Pune;
- BLAT – St. Xavier's College, Mumbai;
- CAL – Central National Herbarium, Kolkata;
- JCB – St. Joseph's College, Bangalore (Presently shifted at IISc., Bangalore);
- MH – Madras herbarium, Botanical Survey of India, Southern Circle, Coimbatore;
- MGM* – Mysore University Herbarium, Manasagangotri, Mysore and
- SUK – Shivaji University Herbarium, Kolhapur.

Photographs of herbarium sheets including that of type specimens were also obtained (or downloaded) from various herbaria abroad. They are:

- E - Royal Botanic Garden Edinburgh.

- G – Conservatoire et Jardin botaniques de la Ville de Genève, Switzerland.
- K – Royal Botanical Garden, Kew.
- LINN – Linnean Herbarium, London.
- NY – New York Botanical Garden, U. S. A.
- W – Naturhistorisches Museum Wien, Austria.

***Note:** MGM and GUH are not standard acronyms but are used for convenience.

The flowers of *Impatiens* are delicate and succulent in nature and they don't preserve well in herbaria to show the details. This makes it difficult to study them based on herbarium specimens. Hence, fresh specimens were collected from various part of the study area.

Collection and preservation:

The specimens collected were given collection numbers and were initially pressed in folds of newspapers. These were later processed for herbarium using standard herbarium techniques. Ethyl alcohol saturated with mercuric chloride ($HgCl_2$) was used to poison specimens (Jain and Rao, 1976). The field data such as habitat, habit, flower colour, flower and fruit dimensions, phenology, etc. were recorded in the field. For microscopic observations specimens were preserved in FAA (5ml 40% Formaldehyde + 5 ml glacial acetic acid + 90 ml 50% ethanol) solution (Krishnamurthy, 1988) or 50% ethanol with few (4 – 5) drops of glycerol. Photographs were taken with Nikon Coolpix 4500 camera.

Floral parts were preserved using the method described by Hooker (1904) and Grey-Wilson (1980a) wherein fully open flowers were collected and the floral parts were separated. These were then placed in-between butter paper and kept for pressing.

These were then pasted on small portfolios of chart paper using fevicol. These portfolios were then pasted on the herbarium sheet along with the specimen.

The processed dried specimens were mounted on standard herbarium sheets; labelled and identified sheets are deposited in the Herbarium of Botany Department, Goa University, Goa (GUH).

Microscopic studies:

The morphological details were studied using specimens preserved in FAA/fresh material. Specimens were dissected under WILD M3Z Leica stereo microscope. Detailed descriptions were written by observing dissected floral parts under stereo microscope and illustrations of the floral parts were made using drawing tube attached to WILD M3Z Leica stereo microscope. Ornamentation on seed hair and pollen of *Impatiens acaulis* were observed under OLYMPUS CH30 compound microscope. Free hand sketches were made for habit.

Identification:

All the collections were critically studied and later segregated into groups consisting of entities with distinct similar morphological characters. Characters observed were matched with the characters mentioned in the protologue and the type specimens procured from various herbaria. Names have been applied to the species after comparing them with the type specimens and protologues. If a species consists of more than one name than the principle of priority has been applied for the correct application of names. Application of names has been done independently without any bias of earlier treatments by various workers. Provisions of the latest International

Code of Botanical Nomenclature (McNeil *et al.*, 2006) have been applied for resolving various nomenclatural issues and typification.

Entities that remained without any name were critically studied, and if confirmed as novelties they have been recognised as new species.

After thorough search in the study area, species that were not found in the study area and are not represented by any collection from the study area in any of the herbaria are treated as excluded species.

Author names have been abbreviated following Brummitt and Powell (1992) and International Plant Name Index (IPNI – www.ipni.org). Author names of the Floras are cited in full without any initials (personal communication with John McNeil) irrespective their abbreviations as authors of taxa. Old Floras have been abbreviated using the online edition of Taxonomic Literature, 2nd edition (TL-2). Journal names have been abbreviated using Botanico Periodicum Huntianum – BPH (Lawrence *et al.*, 1968).

Systematic treatment:

The treatment of the genus includes its correct name with original citation including important references, a detailed description, followed by number of species and geographical distribution. A key to the species available in the study area has been provided. Species of study area fall under three different sections recognised by Hooker and Thomson (1859) and they are dealt section wise. In each section species are arranged alphabetically. Excluded species for the study area are also given at the end.

For each species the correct name has been given. All the synonyms are

arranged in chronological order. For all the names reference to its original publication, important floras in the region, revisions and important floristic publications are given. Wherever types are available they have been cited. In cases where it could not be traced types are not quoted. Lectotypes were designated wherever holotypes were not designated but original materials were existing as syntypes. Neotypes have been designated if it was confirmed beyond doubt that the original material was not existing. A detailed description has been provided including all the variations. Terminology used to describe the floral parts is as per Hooker and Thomson (1859) and Hooker (1906). Reference to illustration and photos has been provided at the end of the description. This is followed by flowering and fruiting period, habitat, distribution, specimen examined (comprising specimens examined from various herbaria as well as the specimens collected during the study), note (diagnostic characters of the species, the closely related species, morphological variations, nomenclatural problems, etc.), chromosome number and IUCN threat status.

Maps:

Distributional maps for each species are prepared (only for Western Ghats region) based on the present collections, herbarium and literature. References to the maps are given under distributional data.

Phylogeny:

Phylogenetic analysis of *Impatiens* using morphological data was conducted using PAUP version 4.0b10 (Swofford, 2003). Characters used in the analysis are as follows:

Character and character states for phylogenetic analysis:

1. Plants: caulescent (0), acaulescent (1)

2. Habitat: aquatic (0), terrestrial (1), epiphytic (2), epiphytic and terrestrial (3)

3. Hair on stem: absent (0), present (1)

4. Stem: 5-angled (0), terete (1), quadrangular (2), absent (3)

5. Plants: rooted (0), tuberous (1)

6. Phyllotaxy: alternate (0), opposite (1), ternate (2), radicle (3)

7. Leaf shape: linear-elliptic (0), ovate-lanceolate (1), linear-lanceolate (2)

8. Adaxial leaf surface: glabrous (0), hairy (1)

9. Abaxial leaf surface: glabrous (0), hairy (1), hairy only on nerves (2)

10. Hair on petiole: absent (0), present (1)

11. Petiolar glands: absent (0), present (1)

12. Petiole: not decurrent (0), decurrent on the stem (1)

13. Glands at the base of lamina: present (0), absent (1)

14. Inflorescence: axillary raceme (0), axillary fascicle (1), scapose (2), solitary or binate (3)

15. Flower colour: pink (0), white (1), orange (2), yellow (3)

16. Shape of bracts: ovate (0), linear-lanceolate (1)

17. Sepals: 4+1 (0), 2+1 (1)

18. Shape of sepals: elliptic-oblong (0), ovate (1), linear-lanceolate (2)

19. Fusion of petals: free (0), fused (1)

20. Number of petals: five (0), three (1)

21. Petals: entire (0), lobed (1)

22. Stipe of petals: absent (0), present (1)

23. Wing petals: entire (0), bilobed (1), trilobed (2)

24. Petal lobes: not lobed (0), not equal (1), sub-equal (2)

25. Pedicel: glabrous (0), hairy (1)

26. Pedicel: glabrous (0), hairy throughout (1), with two longitudinal rows of hair (2), with one longitudinal row of hair (3)

27. Tuft of hairs on wing petals: absent (0), present (1)

28. Auricle: absent (0), present (1)

29. Auricle: absent (0), rounded (1), spiniform (2)

30. Lip: spurred (0), saccate (1)

31. Lip surface: glabrous (0), hairy (1)

32. Spur surface: glabrous (0), hairy (1)

33. Spur length: 1 – 2 cm (0), >2.1 cm (1), 2 – 8 mm (2), absent (3)

34. Spur: tapering from the base to apex (0), clavate (1), broad in the middle (2), absent (3), uniform (4)

35. Spur: curved (0), hooked (1), bent (2), straight (3), absent (4)

36. Spur: cylindrical (0), flat (1), absent (2)

37. Spur tip: rounded (0), notched (1), absent (2), rounded and notched (3)

38. Fruit: berry (0), capsule (1)

39. Fruit: ellipsoid-lanceoloid (0), oblongoid (1)

40. Fruit wall: glabrous (0), hairy (1)

41. Seed surface: rugose (0), hairy (1), papilate (2), granulate (3), glabrous (4)

42. Seed hair: absent (0), comose (1), hairy throughout (2)

Character scores in the form of matrix are given in table 1. A parsimony analysis was began wherein *Hydrocera triflora* was designated as the outgroup. All characters were weighed equally and character state transition was treated as

unordered. Bootstrap analysis was performed with 100 replicates. The starting tree was obtained using random additions with 10 random addition replicates along with TBR (tree bisection-reconnection) branch swapping option and the MULTREE option in effect. MAXTREES was set to 100. UPGMA analysis was performed to obtain the parsimonious tree.

Phytogeographic analysis:

Phytogeographic analysis was carried out based on their endemism and distributional data. Based on the presence (1) or absence (0) of a species in a district, a cluster analysis was carried out using UPGMA method in MVSP (Multi Variate Statistical Package).

Threat status:

All the species have been evaluated for threat status using IUCN Red List Categories and Criteria: Version 3.1 (IUCN, 2001) based on the present collections, herbarium data as well as data from the published literature.

Table 2: Data matrix for phylogenetic analysis.

Taxa	Character scores																																									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Hydrocera triflora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	?	?	0	0	0	0	0	0	0	0	0	0	0	0	0
Impatiens acaulis	1	3	2	3	1	3	1	1	0	0	0	0	1	2	0	0	1	1	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	2
I. balsamina var. *balsamina*	0	1	1	1	0	0	0	1	2	1	1	0	1	3	0	1	1	1	1	1	1	0	1	1	1	1	0	1	1	0	1	1	1	0	0	0	0	1	0	1	3	0
I. balsamina var. *micrantha*	0	1	1	0	0	0	0	1	2	1	1	0	1	1	0	1	1	1	1	1	1	0	1	1	1	1	0	1	1	0	1	1	1	0	0	0	0	1	0	?	3	0
I. barberi	1	2	2	3	1	3	1	1	0	0	0	0	1	2	0	0	1	1	1	1	1	0	2	1	0	0	1	1	2	0	0	0	0	1	0	1	1	1	0	0	1	2
I. bhaskarii	1	2	2	3	1	3	1	1	0	0	0	0	1	2	0	0	1	1	1	1	1	0	2	1	0	0	1	1	2	1	0	2	3	3	4	2	2	1	0	0	1	2
I. chinensis	0	1	0	2	0	1	2	1	0	0	0	1	1	1	0	1	1	2	1	1	1	0	1	1	1	2	0	1	1	0	2	0	1	2	0	1	3	1	0	0	4	0
I. clavata	1	2	2	3	1	3	1	1	0	0	0	0	1	2	0	0	1	1	1	1	1	0	2	1	0	0	1	1	2	0	0	0	0	1	0	1	0	1	0	0	1	2
I. dalzellii	0	1	0	1	0	1	2	0	0	0	0	0	1	1	3	1	1	2	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	2	4	2	0	0	1	0	0	4	0
I. dasysperma	0	1	0	2	0	0	1	1	2	0	1	0	1	3	0	1	1	1	1	1	1	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	2	0
I. dendricola	1	2	2	3	1	3	1	1	0	0	0	0	1	2	1	0	1	1	1	1	1	0	2	1	0	0	1	1	1	0	0	0	0	1	0	1	0	1	0	0	1	1
I. diversifolia	0	1	0	2	0	1	2	1	0	0	0	1	1	1	0	1	1	1	1	1	1	0	1	1	1	2	0	1	1	0	0	0	0	0	0	0	3	1	0	0	4	0
I. gardneriana	0	1	0	2	0	2	1	1	2	0	0	0	1	3	0	1	1	1	1	1	1	0	1	1	1	1	0	0	0	0	1	1	1	0	0	0	3	1	1	0	1	2
I. kleiniformis	0	1	0	1	0	1	2	1	0	0	0	0	1	1	0	1	1	2	1	1	0	1	1	?	1	2	0	0	0	0	0	0	0	2	0	1	3	1	0	0	4	0
I. lawii	0	1	0	2	0	1	1	1	0	0	0	1	1	3	0	1	1	2	1	1	1	0	2	1	1	3	0	1	1	0	0	0	2	4	2	0	1	1	0	0	4	0
I. minor	0	1	0	1	0	1	2	1	0	0	0	0	0	1	0	0	1	2	1	1	0	1	1	?	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4	0
I. mysorensis	0	1	1	1	0	0	0	0	1	1	1	0	1	1	0	1	1	1	1	1	1	0	1	1	1	3	0	0	0	0	1	1	2	4	3	0	0	1	0	1	3	0
I. oppositifolia	0	1	0	2	0	1	2	1	0	0	0	1	1	1	0	1	1	2	1	1	1	0	1	1	1	2	0	1	1	0	0	0	2	4	1	0	3	1	0	0	4	0
I. pulcherrima	0	1	0	1	0	0	1	1	0	0	1	0	1	3	0	0	1	1	1	1	1	0	1	2	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0
I. raziana	0	1	0	2	0	0	2	1	0	0	0	1	1	1	2	1	1	2	1	1	1	0	1	1	1	2	0	1	1	0	0	0	2	4	1	0	3	1	0	0	4	0

I. rosea	0	1	1	1	0	1	0	1	0	1	1	0	1	1	0	0	1	1	1	1	1	0	1	1	1	1	0	1	1	0	1	1	2	4	1	0	0	1	0	1	3	0
I. scabriuscula	0	1	1	1	0	0	0	1	1	1	0	0	1	1	0	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	2	3	3	4	2	2	1	0	1	3	0
I. scapiflora	1	3	2	3	1	3	1	1	0	0	0	0	1	2	0	0	1	1	1	1	1	0	2	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	2
I. stocksii	1	2	2	3	1	3	1	1	0	0	0	0	1	2	1	0	1	1	1	1	1	0	2	1	0	0	1	0	0	1	0	2	3	3	4	2	2	1	0	0	1	1
I. talbotii	0	1	0	1	0	0	1	1	3	1	1	0	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	2	0
I. tenella	0	1	0	1	0	1	2	1	0	0	0	1	1	3	0	1	1	2	1	1	1	0	1	1	1	2	0	1	1	0	0	0	0	0	0	0	0	1	0	0	4	0
I. tomentosa	0	1	1	2	0	1	2	1	2	1	0	1	1	1	0	1	1	2	1	1	1	0	1	1	1	2	0	1	1	0	1	1	2	4	0	0	1	1	0	0	4	0
I. vivekananthanii	0	1	0	2	0	1	2	1	0	0	0	1	1	1	0	1	1	2	1	1	1	0	1	1	1	3	0	1	1	0	0	0	1	0	0	0	1	1	0	0	4	0

RESULTS AND DISCUSSION

i) Morphology of *Impatiens*

Impatiens species grow in moist conditions usually in large patches. They are mostly terrestrial, but epiphytic forms also occur. They show splendid morphological variations, bringing various forms in vegetative and floral parts.

Habit: All the species occurring in the study area are annuals growing in monsoons, though *I. balsamina* is raised from the seeds throughout the year. They usually have a thin, flaccid, often pigmented stem which is either branched or unbranched, often rooting at the basal nodes. True stem is absent in section *Scapigerae*.

Roots/tubers: Based on the underground organ balsams can be grouped into two types:

a.) **Tuberous:** All the species in section *Scapigerae* bear tubers, however some specimens of *I. acaulis* show the presence of rhizomes.

b.) **Rooted:** All the species belonging to section *Uniflorae* (*Microsepalae*) and *Oppositifoliae* bear true roots.

Leaves: Two types of leaf forms occur in *Impatiens*

a.) **Acaulescent:** This is a characteristic of section *Scapigerae* where the species lack a true stem and the leaves arise directly from the tuber.

b.) **Caulescent:** Species belonging to section *Uniflorae* (*Microsepalae*) and *Oppositifoliae* belong to this category. Leaves are opposite-decussate in section *Oppositifoliae* and alternate in section *Uniflorae* (*Microsepalae*). *I. gardneriana*

bears opposite leaves at the base and the leaves are ternate at the apex.

Leaf shape varies from linear to ovate, lanceolate, elliptic, oblong and oblanceolate. Petiole is long and petiolar glands are scattered in section *Uniflorae* (*Microsepalae*), absent in section *Scapigerae*. In section *Oppositifoliae* the petiole is short, decurrent on the stem and ends as petiolar glands except in *I. minor* and *I. kleiniformis*. Glands at the base of the lamina are present in *I. minor*.

Leaf margin ranges from crenate to serrate. In *I. lawii* and *I. gardneriana*, the lowermost crenations are modified into tentacle like structures. Leaf apex is either acute or acuminate. Leaf surface is sparsely to densely hairy adaxially and abaxially hairy on the midrib and nerves in *I. balsamina* var. *balsamina*, *I. balsamina* var. *micrantha*, *I. dasysperma*, *I. gardneriana*, *I. mysorensis*, *I. scabriuscula* and *I. talbotii*.

Inflorescence: Flowers in *Impatiens* are axillary, either binate, fascicled or in clusters of 2 – 4 on a short or vestigial peduncle. In *I. dalzellii* the flowers are fascicled on a 5 – 8 mm long peduncle forming an umbel. Solitary flowers also occur in some specimens as in *I. chinensis*. In section *Scapigerae* flowers are borne on long scapes.

Bracts: Bracts are ovate in section *Scapigerae* and linear to triangular in section *Uniflorae* (*Microsepalae*) and *Oppositifoliae*. They are thick and fleshy in scapigerous forms whereas scaly in the alternate leaved species.

Pedicel: Pedicel is either glabrous as in *I. minor*, *I. talbotii*, *I. pulcherrima*, completely hairy as in *I balsamina*, *I. gardneriana*, with two longitudinal rows of hairs as in *I. diversifolia*, *I. kleiniformis*, *I. raziana* or with a single row of hair as in *I. mysorensis*.

Sepals: Three in number; two small and lateral in position referred to as *lateral sepals*

and one lower sepal referred to as *lip*.

Lateral sepals are ovate in section *Uniflorae* (*Microsepalae*) and *Scapigerae*. Lateral sepals in section *Uniflorae* (*Microsepalae*) are minute whereas in *I. gardneriana* they are 5 – 6 mm long. Linear-lanceolate lateral sepal is a characteristic feature of species with opposite leaves.

Lip is saccate or conical abruptly emerging into a slender spur at the base. In *I. scapiflora* the spur is up to 8.5 cm long. In *I. dalzellii*, *I. lawii*, *I. mysorensis*, *I. oppositifolia*, *I. raziana*, *I. rosea* and *I. tomentosa* spur is short, 3 - 6 mm long whereas in *I. bhaskarii*, *I. scabriuscula* and *I. stocksii* spur is absent. Usually the spur is tubular, tapering from the base to the apex. Spur is broad in the middle in *I. chinensis*. Clavate spur is found in *I. barberi*, *I. clavata* and *I. dendricola*. Tip of the spur is round but forked tips occur in *I. chinensis, I. raziana*.

Corolla: Comprises of 5 petals; the upper free petal is referred to as *standard* and the remaining four petals fused in twos to form two lateral petals referred to as *wing petals*. Colour varies from lilac to pink in most of the species, white in *I. dendricola* and *I. stocksii*, scarlet in *I. raziana* and yellow in *I. dalzellii*.

Standard petal is flat or concave, rounded, orbicular to ovate often keeled dorsally. Keel mucronate at apex as in *I. balsamina*, *I. rosea*.

Wing petals are either bilobed or trilobed or entire as in *I. minor* and *I. kleiniformis*. Species belonging to section *Oppositifoliae* and some species such as *I. balsamina*, *I. mysorensis*, *I. scabriuscula* and *I. rosea* from section *Uniflorae* (*Microsepalae*) have a small basal lobe and a larger distal lobe. In *I. dasysperma*, *I. pulcherrima* and *I. talbotii* the lobes are subequal. Wing petals are trilobed in scapigerous forms except in *I. acaulis*. Tuft of hairs are present at the base of the middle lobe in *I. barberi*, *I. bhaskarii*, *I. clavata*, *I. dendricola* and *I. stocksii* whereas

hairs are scattered in *I. scabriuscula*. A characteristic feature of balsam is the presence of dorsal auricle. It is small ear shaped as in most of the species belonging to section *Oppositifoliae* and *Uniflorae* (*Microsepalae*), long and tapering as in *I. barberi* and *I. clavata*, short outgrowth as in *I. tenella*, *I. bhaskarii* and *I. dendricola* and absent in *I. acaulis*, *I. scapiflora*, *I. dalzellii*, *I. minor*, *I. kleiniformis* and *I. gardneriana*. The wing petals in *I. talbotii*, *I. dasysperma* and *I. pulcherrima* is produced into the spur thus giving an auricle like appearance.

Androecium: Androecium is uniform for all the species of *Impatiens* in this region comprising of 5 anthers which are connate, forming a hood above the pistil. They are protrandous. Filaments are narrow and free at the base and broad and fused at the apex. The colour varies with the colour of the flower.

Gynoecium: Uniform for all the species of *Impatiens* in this region although the ovary may be glabrous e. g. *I. oppositifolia*, *I. pulcherrima*, etc. or hairy e. g. *I. balsamina*, *I. rosea*, *and I. scabriuscula.*

Capsule: The genus derives its name because the mature fruit curls up inwards and bursts suddenly when touched, thus ejecting out its seeds. Capsule shape varies from lanceoloid to ellipsoid-lanceoloid. Glabrous in most species whereas hairy in *I. mysorensis* and *I. talbotii* and villous in *I. balsamina*, *I. rosea*, *I. scabriuscula*. Capsule of *I. dalzellii* shows distinct ridges and furrows.

Seeds: Seeds vary in shape. They are globular, ovoid or oblongoid. Usually in shades of brown, but black coloured seed occur in *I. dalzellii*. Seeds of *Impatiens* in the study

area can be categorised into the following three types:

1) Glabrous and shining as in all the species of section *Oppositifoliae*.

2) With hairy appendages: This type of seeds occurs in section *Scapigerae* and in *I. dasysperma* and *I. gardneriana* (*Uniflorae*). These hairs help in attachment of the seed to the substratum and dispersal. Hairs are spirally coiled. These can be further grouped into two types:

i) Comose as in *I. dendricola* and *I. stocksii.*

ii) Hairy throughout: Hairs are uniformly distributed in case of *I. acaulis I. dasysperma* and *I. scapiflora* but are spirally coiled forming a cone-like structure in *I. acaulis* and *I. scapiflora*. Seeds in *I. barberii*, *I. bhaskarii*, *I. clavata* are hairy throughout but hairs are long and tufted at the lateral ends. Hairs are of two types in *I. gardneriana*: apical ones are spirally coiled; basal ones are with reticulate thickening.

3) With protruberances: These types of seeds are found in section *Uniflorae* (*Microsepalae*). They are either

i) rugose as in *I. pulcherrima*.

ii) papillate: this type of seed surface is found in *I. talbotii.*

iii) granulate: this type of seed surface is found in *I. balsamina* var. *balsamina*, *I. balsamina* var. *micrantha*, *I. mysorensis*, *I. rosea* and *I. scabriuscula.*

ii) a. Systematic treatment

The genus *Impatiens* is represented by 26 species and 2 varieties in the study area (Table 2). They belong to three sections out of the total eight sections proposed by Hooker and Thomson (1859).

Table 2: List of species along with the respective section to which they belong.

Section	Sr. No.	Binomial
Scapigerae	1	*Impatiens acaulis* Arn.var. *acaulis*
	2	*I. acaulis* Arn.var. *granulata* Bhaskar, Razi & Yogan.
	3	*I. barberi* Hook. f.
	4	*I. bhaskarii* sp. nov.
	5	*I. clavata* Bhaskar
	6	*I. dendricola* C. E. C. Fisch.
	7	*I. scapiflora* Heyne ex Roxb.
	8	*I. stocksii* Hook. f. & Thomson
Oppositifoliae	9	*I. chinensis* L.
	10	*I. dalzellii* Hook. f. & Thomson
	11	*I. diversifolia* Wall. ex Wight & Arn.
	12	*I. kleiniformis* Sedgw.
	13	*I. lawii* Hook. f. & Thomson
	14	*I. minor* (DC.) Bennet
	15	*I. oppositifolia* L.
	16	*I. raziana* Bhaskar & Razi
	17	*I. tenella* Heyne ex Wight & Arn.
	18	*I. tomentosa* Heyne ex Wight & Arn.
	19	*I. vivekananthanii* sp. nov.
Uniflorae (*Microsepalae*)	20	*I. balsamina* L. var. *balsamina*
	21	*I. balsamina* var. *micrantha* Hook. f.
	22	*I. dasysperma* Wight
	23	*I. gardneriana* Wight
	24	*I. mysorensis* Heyne ex Roth
	25	*I. pulcherrima* Dalzell
	26	*I. rosea* Lindl.
	27	*I. scabriuscula* Heyne ex Roxb.
	28	*I. talbotii* Hook. f.

Impatiens L.

Sp. Pl. 2: 937. 1753; DC. Prodr. 1: 687. 1824; Roxb., Fl. Indica 2: 452. 1824; Wight & Arnott, Prodr. Fl. Ind. Orient. 135. 1834; Dalzell & Gibson, Bombay Fl. 42. 1861; Hooker & Thomson in J. Proc. Linn. Soc. Bot. 4: 118. 1859; Hooker, Fl. Brit. India 1: 440. 1874; Cooke, Fl. Bombay 1: 168. 1901; Gamble, Fl. Madras 1: 134. 1915; Grey-Wilson in Dassanayake & Fosberg, Fl. Ceylon 5: 80. 1985; Saldanha in Saldanha, Fl. Karnataka 2: 247. 1996; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 99. 1997; Yi-ling *et al.*, Fl. China 12: 42. 2007.

Annual or perennial caulescent or acaulescent herbs, rarely shrubs, terrestrial or epiphytic, sometimes with tuberous or rhizomatous rootstock. Stem flaccid, succulent, rarely woody at base, often rooting at lower nodes, quadrangular to terete, glabrous to tomentose; rarely acaulous. Leaves simple, alternate to opposite, alternate-opposite, whorled, or all radical, rarely palmately lobed, exstipulate, petiolate to sessile, petiole short or long, glabrous to hairy, with glands at base or on petiole, lamina attenuate to cordate at base, crenate to serrate along margins; crenations apiculate, acute, acute-apiculate to emarginate at apex, pinnately veined, glabrous or hairy. Flowers bisexual, zygomorphic, resupinate through 180° in axillary raceme, fascicle, umbels or solitary, sometimes scapose. Bracts present, entire. Pedicel glabrous or with one or two longitudinal rows of hairs or hairy throughout. Sepals 3, rarely 5, free, entire. Lateral sepals small, linear to ovate. Lip (posterior sepal) small to large, navicular, funnel shaped or saccate, spurred; spur long or short, rarely absent, straight, curved, incurved or coiled, clavate, cylindrical or inflatted, with swollen, bulged, forked, pointed at the tip, rarely bilobed or digitately lobed, coloured. Petals 3 or 5. Standard (anterior) small or large, petalloid, flat or concave, crested or keeled dorsally, lower 4 petals free or fused (wing petals), single or bilobed

or trilobed, sometimes with a short or long and slender dorsal auricle near the base. Stamens 5, cohering above the pistil. Filaments 5, narrow and free at base, broad and fused at apex. Ovary superior, 5-locular with axile placentation, ovules 2 – many; style 1, absent or rudimentary; stigma 5-toothed. Fruit a loculicidal explosive capsule, the valves open and coil elastically expelling the seeds out. Seeds without endosperm, testa smooth, warted or hairy.

About 1,000 species distributed mainly in the tropical and subtropical regions of Asia and Africa with a few species in temperate regions of Asia, Europe and North America with five centres of diversity, *viz*. Africa, Madagascar, Western Ghats, Eastern Himalayas and Southeast Asia.

In India the genus is represented by more than 209 species of which about 90 species occur in the Western Ghats region (Dessai and Janarthanam, 2008).

Key to the sections of *Impatiens*

1. Plants acaulescent, with tubers; leaves radical;
   flowers in scapes.....*Scapigerae*
1. Plants caulescent, without tubers; leaves cauline; flowers axillary.....(2)

2. Leaves all opposite; seeds glabrous.....*Oppositifoliae*
2. Leaves alternate or ternate; seeds hairy
   or with appendages.....*Uniflorae* (*Microsepalae*)

Key to the species of *Impatiens*

1. Plants acaulescent, with tubers; leaves radical;
   flowers in scapes.....(2)
1. Plants caulescent, without tubers; leaves cauline; flowers axillary.....(8)

2. Wings 2-lobed.....*I. acaulis*
2. Wings 3-lobed.....(3)

3. Wing petals without tuft of hairs at the base;
   spur 3 – 5 cm long, cylindrical.....*I. scapiflora*
3. Wing petals with a tuft of hairs at the base;
   spur < 2 cm long or absent, flat.....(4)

4. Flowers white; seeds comose.....(5)
4. Flowers pink to lilac; seeds hairy throughout.....(6)

5. Spur saccate or absent; dorsal auricle absent.....*I. stocksii*
5. Spur club shaped; dorsal auricle present.....*I. dendricola*

6. Dorsal auricle long and spiniform.....(7)
6. Dorsal auricle short and rounded.....*I. bhaskarii* sp. nov.

7. Spur clavate; standard orbicular.....*I. clavata*
7. Spur oblong; standard ovate.....*I. barberi*

8. Leaves at least few opposite.....(9)
8. Leaves all alternate.....(20)

9. Leaves all opposite; lobes of wing petals not equal;
   seeds glabrous.....(10)
9. Leaves opposite at base, ternate at apex;
   lobes of wing petals subequal; seeds hairy.....*I. gardneriana*

10. Plants tomentose.....*I. tomentosa*
10. Plants glabrous.....(11)

11. Wing petals with a single lobe.....(12)
11. Wing petals bilobed.....(13)

12. Leaf glands present at the base of lamina; pedicel glabrous.....*I. minor*
12. Leaf glands absent at the base of lamina; pedicel with two longitudinal rows of hair.....*I. kleiniformis*

13. Spur < 0.8 cm long, hooked.....(14)
13. Spur > 1 cm long, straight or curved.....(17)

14. Dorsal auricle present.....(15)
14. Dorsal auricle absent.....*I. dalzellii*

15. Flowers pink in colour.....(16)
15. Flowers orange in colour.....*I. raziana*

16. Leaves linear to linear lanceolate, serrations acute; spur curved, straight or hooked.....*I. oppositifolia*
16. Leaves ovate, serrations cuspidate; spur bent, parallel to the lip.....*I. lawii*

17. Spur strongly curved, flat, broad in the middle, thick.....*I. chinensis*
17. Spur not curved, cylindrical, thin.....(18)

18. Distal lobe of wing petals stipitate, basal lobe triangular with acute apex.....*I. diversifolia*
18. Distal lobe of wing petals sessile, basal lobe ovate with obtuse apex.....(19)

19. Flowers > 2 cm across; spur as long as the pedicel.....*I. vivekananthanii* sp. nov.
19. Flowers < 1 cm across; spur shorter than the pedicel.....*I. tenella*

20. Plants glabrous; leaves broadly elliptic to lanceolate; lobes of wing petals subequal.....(21)
20. Plants pubescent; leaves linear-elliptic to linear-lanceolate; lobes of wing petals unequal.....(23)

21. Fruit wall tomentose.....*I. talbotii*
21. Fruit wall glabrous.....(22)

22. Stem quadrangular; seeds hairy.....*I. dasysperma*
22. Stem circular; seeds rugose.....*I. pulcherrima*

23. Spur present.....(24)
23. Spur absent.....*I. scabriuscula*

24. Spur short, <1 cm, straight or hooked.....(25)
24. Spur long, > 2 cm, curved.....*I. balsamina*

25. Spur straight; capsule minutely hairy.....*I. mysorensis*
25. Spur curved or hooked; capsule villous.....*I. rosea*

Systematic treatment of species in sections as proposed by Hooker and Thomson (1859)

Section: *Scapigerae* Hook. f. & Thomson

Rootstock tuberous; leaves all radical; flowers racemose; seeds very minute, clothed with spiral hairs (Hooker, 1906).

Key to the species (section *Scapigerae*)

1. Wings 2-lobed.....*I. acaulis*
1. Wings 3-lobed.....(2)

2. Wing petals without tuft of hairs at the base; spur 3 – 5 cm long, cylindrical.....*I. scapiflora*
2. Wing petals with a tuft of hairs at the base; spur < 2 cm long or absent, flat.....(3)

3. Flowers white; seeds comose.....(4)
3. Flowers pink to lilac; seeds hairy throughout.....(5)

4. Spur saccate or absent; dorsal auricle absent.....*I. stocksii*
4. Spur club shaped; dorsal auricle present.....*I. dendricola*

5. Dorsal auricle long and spiniform.....(6)
5. Dorsal auricle short and rounded.....*I. bhaskarii* sp. nov.

6. Spur clavate; standard orbicular.....*I. clavata*
6. Spur oblong; standard ovate.....*I. barberi*

Impatiens acaulis Arn. in Hook. Comp. Bot. Mag. 1: 325. 1835.

Terrestrial or epiphytic, tuberous or rhizomatous herb, 8 – 27 cm high; tubers oblongoid, 0.5 – 0.8 × 0.5 –1.5 cm. Leaves radical, 3-6 per tuber, petiolate; petiole 2.5 – 9 cm long, glabrous; lamina ovate, oblong to orbicular, (1.1) 2.5 – 16 × (0.8) 2 – 9 cm, obtuse, cordate to truncate at base, distantly crenate along margin; crenae apiculate, acute to acute-apiculate at apex hairy mainly on nerves adaxially, glabrous abaxially. Inflorescence a 4 – 10-flowered racemose scape, 7 – 27 cm long. Flowers

pink to lilac with white throat, 1.5 – 5 cm across, bracteate, pedicellate; bracts ovate, 2 – 3.5 × 1 – 3 mm, green in colour; pedicel 0.7 – 3 cm long, glabrous, deflexed in fruits. Lateral sepals asymmetrically ovate, 2 – 5 × 1.5 – 4 mm, acute at apex, pale green in colour, glabrous. Standard broadly obovate, 0.5 – 1 × 0.6 – 1.6 cm, concave, humped at base, forming a hood above column, obcordate to emarginate at apex, pink outside, white within, glabrous. Wing petals 1.6 – 3.2 × 1 – 2.5 cm, bilobed, lobes unequal; basal lobe oblong, 0.9 – 2.5 × 0.3 – 0.8 cm, rounded to obtuse at apex; distal lobe asymmetrically obovate, 1.1 – 2.6 × 0.6 – 1.5 cm, rounded at apex. Lip boat shaped, 0.6 – 1.2 cm long, 0.2 – 6 mm deep, 4 – 6 mm wide, acute at apex, pinkish white in colour, glabrous, spurred; spur basal, 3 – 5. 8 cm long, tubular, tip rounded, pink to white in colour, glabrous. Column 3 – 6 × 1 – 3 mm, curved. Anthers c. 1 × 1 mm, white in colour; filaments 3 – 5 × 0.5 – 1 mm, pink in colour. Pistil 2.5 – 5 × 1 – 3 mm; ovary ellipsoid to broadly lanceoloid, glabrous. Capsule asymmetrically ellipsoid to lanceoloid, 1 – 1.3 × 0.4 – 0.7 cm, glabrous, pedicel 1 – 3.5 cm long. Seeds minute, oblongoid to lanceoloid, c. 1 × 0.5 mm, brown in colour, hairy; hairs coiled forming a cone-like structure (Fig. 1; Plate - 2 a).

Note: Two varieties have been recognized under this species that differ only in their pollen characters.

Key to the the varieties:

Pollens 4-colpate, exine reticulate.....*acaulis*

Pollens 3-colpate, exine granulate.....*granulata*

Impatiens acaulis Arn. in Hook. Comp. Bot. Mag. 1: 325. 1835; var. **acaulis**; Hooker & Thomson in J. Proc. Linn. Soc. Bot. 4: 119. 1859; Dalzell & Gibson, Bombay Fl., 42. 1861; Hooker, Fl. Brit. India 1: 443. 1874 & in Rec. Bot. Surv. India 4: 44. 1906;

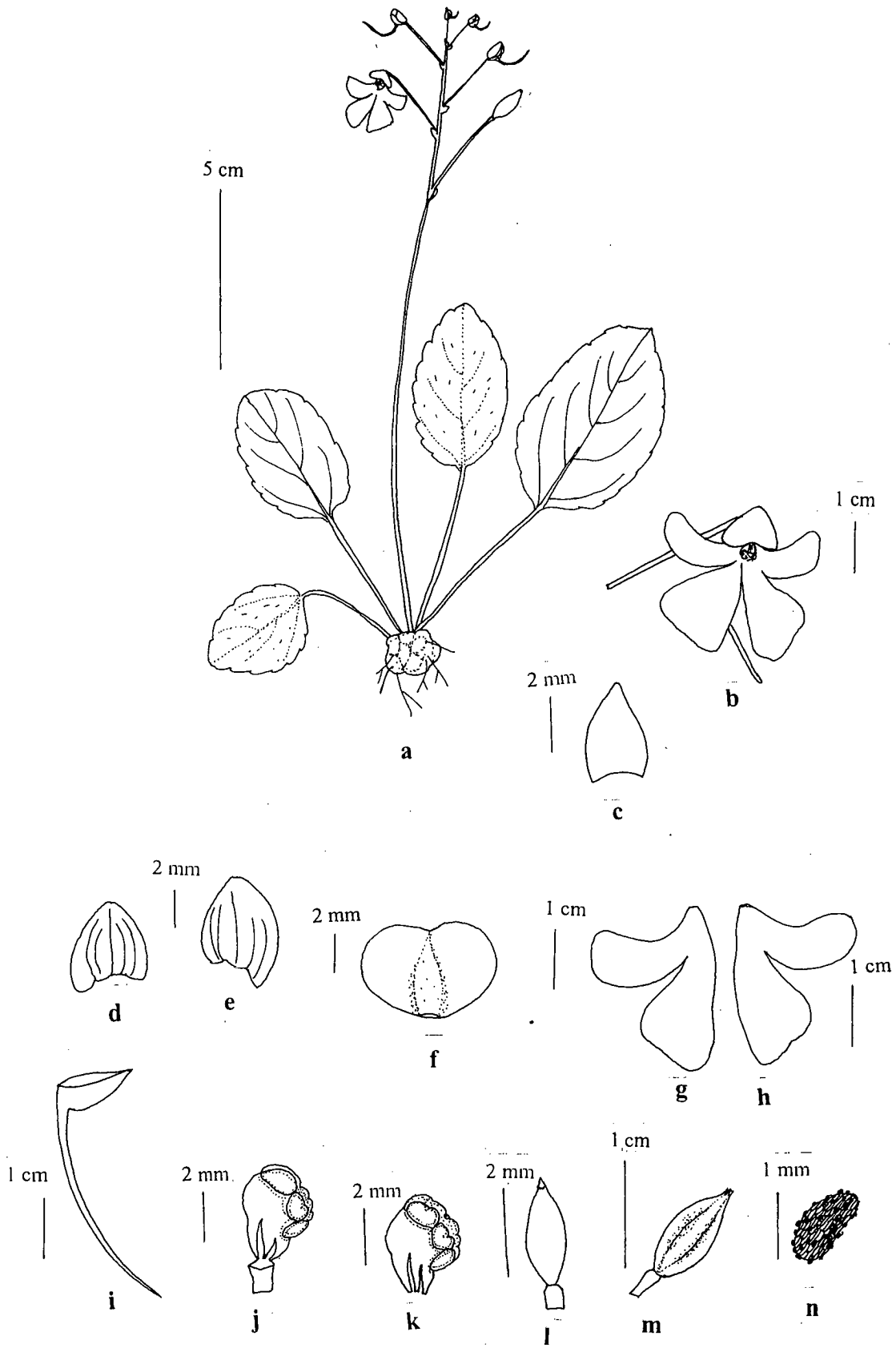


Fig. 1: *Impatiens acaulis* Arn. var. *acaulis*. a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard, g, h) wing petals, i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

Cooke, Fl. Bombay 1: 170. 1901; Gamble, Fl. Madras 1: 138. 1915; Blatter in J. Bombay Nat. Hist. Soc. 33: 309, t. 1. 1933; Santapau, Fl. Khandala, 30. 1967; Vajravelu in Nair & Henry, Fl. Tamil Nadu 1: 52. 1983; Sharma *et al.*, Fl. Karnataka Analysis, 36. 1984; Rao, Fl. Goa 1: 56. 1985; Grey-Wilson, in Dassanayake & Fosberg, Fl. Ceylon 5: 82, f. 2 A-C. 1985; Nair & Nayar, Fl. Courtallum (Kutrallam) 2: 207. 1987; Kulkarni, Fl. Sindhudurg District, 58. 1988; Ramachandran & Nair, Fl. Cannanore, 78. 1988; Almeida, Fl. Savantwadi 1: 76. 1990; Vajravelu, Fl. Palghat District, 99. 1990; Lakshminarasimhan & Sharma, Fl. Nasik District, 113. 1991; Deshpande *et al.*, Fl. Mahabaleshwar 1: 113. 1993; Kothari & Moorthy, Fl. Raigad District, 46. 1993; Saldanha in Saldanha, Fl. Karnataka 2: 257. 1996; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 111. 1997; Mudaliar & Prasad in Singh & Karthikeyan, Fl. Maharashtra Dicots 1: 445. 2000; Yadav & Sardesai, Fl. Kolhapur District, 93, t. 3, f. 19. 2001; Bhat, Fl. Udupi, 87, t. 21. 2003; Nayar *et al.*, Fl. Pl. Kerala, 131. 2006. **NEOTYPE**: INDIA, Maharashtra, Sindhudurg district, Amboli ghat, 17. 07. 2004, Jyosna R. N. Dessai & M. K. Janarthanam 04 (GUH).

Fl. & Fr.: June – December (April).

Habitat: Grows on damp rocks, inbetween rock crevices and on vertical black boulders dripping with water, amidst grasses in loose soil; in spray zones of waterfalls and on cemented walls; also grows as an epiphyte on tree trunks.

Distribution: Western Ghats (Map - 1a) and Sri Lanka.

Specimens examined:

Goa: Mollem-Belgaum road, 17. 09. 1970, N. P. Singh 124261 (BSI); Dudhsagar, 17. 09. 1970, M. Y. Ansari 124017 (BSI); Chorla ghat, North Goa District, 27. 08. 2005, Jyosna R. N. Dessai 69 (GUH); Savar falls, Tudav, Netravali, South Goa district, 26. 04. 2006, Ashish Prabhugaonkar 102 (GUH).

Maharashtra: Khandala, Satara district, 09. 06. 1941, H. Santapau HS 715 (BLAT); Fitzgerald ghat, Mahableshwar, Satara district, 09. 06. 1954, P. V. Bole BOLE 1150 (BLAT); Fitzgerald ghat, Mahableshwar, Satara district, 22. 12. 1954, P. V. Bole BOLE 1270 (BLAT); Fitzgerald ghat, Mahableshwar, Satara district, 22. 10. 1957, P. V. Bole BOLE 1452 (BLAT); Fitzgerald ghat, Mahableshwar, Satara district, 31. 08. 1958, B. Balaman BB 349 (BLAT); Fitzgerald ghat, Mahableshwar, Satara district, 16. 09. 1958, H. Santapau HS 22827 (BLAT); Fitzgerald ghat, Mahableshwar, Satara district, 30. 10. 1958, H. Santapau HS 22905, 22907 (BLAT); Waterpipe, Junnapatti (Matheran), Raigad district, 26. 08. 1959, N. A. Irani NI 4425, 4426 (BLAT); Amba ghat, Ratnagiri district, 17. 09. 1961, C. J. Saldanha CS 7195 (JCB); Phonda ghat, Sindhudurg district, 18. 08. 1965, B. G. Kulkarni 105574 (BSI); Ambha, Kolhapur district, 17. 09. 1996, Milind Sardesai MMS 227 (SUK); Amboli ghat, Sindhudurg district, 17. 07. 2004, Jyosna R. N. Dessai & M. K. Janarthanam 04 (GUH); Amboli ghat, Sindhudurg district, 09. 08. 2005, Jyosna R. N. Dessai 41 (GUH); Amboli ghat, Sindhudurg district, 12. 08. 2006, Jyosna R. N. Dessai 107 (GUH); On the way to Chaukul, Amboli, Sindhudurg district, 12. 08. 2006, Jyosna R. N. Dessai 112 (GUH); Phonda ghat, Sindhudurg district, 30. 09. 2007, Jyosna R. N. Dessai & M. K. Janarthanam 167 (GUH).

Kerala: Way to Kattuppana, Idukki district, 05. 10. 1983, A. G. Pandurangan 79262 (MH).

Sri Lanka: Madulkelle, *s. d., s. c., s. n.* (MH-60643)

Chromosome number: 2n = 20 (Bhaskar, 1976; 1980).

Note: *Impatiens acaulis* finds its closest ally in *I. scapiflora*. However *I. acaulis* differs from *I. scapiflora* in having two lobed wing petals rather than three lobed wing petals. In the herbarium *I. acaulis* can be confused with *I. scapiflora* and are difficult

to recognize unless the flowers are properly spread. This species has the widest latitudinal distribution from Maharashtra to Tamil Nadu in the Western Ghats and Sri Lanka with major concentration in the Northern Western Ghats of Maharashtra.

Grey-Wilson (1985) quotes that the type (Ceylon, *s. d.*, Walker, *s. n.*) specimen of *I. acaulis* is deposited in Kew herbarium. However the authorities at Kew could not locate this specimen in their herbarium (personal communication) hence a neotype is selected for this species.

Bhaskar *et al.* (1975) based on the pollen morphology described a new variety *Impatiens acaulis* var. *granulata.*

IUCN threat status: LC

Etymology: Latin: *acaulis* = lacking an obvious stem.

Impatiens acaulis Arn. var. **granulata** Bhaskar, Razi & Yogan. in Curr. Sci. 44: 622 – 623, t. 2. 1975; Yoganarasimhan *et al.*, Fl. Chikmagalur District, 60, f. 1. 1982; Sharma *et al.*, Fl. Karnataka Analysis, 36. 1984; Nayar, Hot spots of endemic plants of India, Nepal and Bhutan, 214. 1996. **TYPE** – INDIA, Karnataka, Charmadi ghat, Chikmagalur district, 29. 08. 1972, V. Bhaskar 312 (MGM!). **Fl. & Fr.:** August – September.

Distribution: Endemic to the Western Ghat region of Karnataka (Map - 1b).

Specimens examined:

Karnataka: Karwar, North Kanara district, W. A. Talbot *s. n.* (BSI - 9217); Charmadi ghat, Chikmagalur district, 15. 08. 2005, Jyosna R. N. Dessai & M. K. Janarthanam 59, 63 (GUH); Agumbe ghat, Shimoga district, 04. 09. 2005, Jyosna R. N. Dessai 72 (GUH); Agumbe ghat, Shimoga district, 27. 08. 2006, M. K. Janarthanam 161 (GUH).

Chromosome number: 2n = 16, 18 (Bhaskar, 1980), 2n = 18, 20 (Bhaskar and Razi, 1972–73).

IUCN threat status: EN [B2ac(iii)].

Etymology: Latin: *granulata* = covered with granules, in reference to the granulate pollen surface.

Impatiens barberi Hook. f. in Rec. Bot. Surv. India 4: 39, 45. 1906; Gamble, Fl. Madras 1: 139. 1915; Ramamoorthy in Saldanha & Nicolson, Fl. Hassan District, 400, f. 78 A. 1978; Sharma *et al.*, Fl. Karnataka Analysis, 37. 1984; Ahmedullah & Nayar, Endemic plants of the Indian region 1: 190. 1986; Nayar, Hot spots of endemic plants of India, Nepal and Bhutan, 214. 1996; Saldanha in Saldanha, Fl. Karnataka 2: 250, f. 100 A. 1996; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 124. 1997. **TYPE** - INDIA, Cadamany, Mysore state, 08. 09. 1903, C. A. Barber *s. n.* (MH – 6082!).

Impatiens agumbeana Bhaskar & Razi in Curr. Sci. 79: 382. 1982 **syn. nov.**; Ahmedullah & Nayar, Endemic plants of the Indian region 1: 190. 1986; Saldanha in Saldanha, Fl. Karnataka 2: 249. 1996; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 124. 1997; Ramaswamy *et al.*, Fl. Shimoga District, 107. 2001. **TYPE** – Agumbe, Shimoga district, 29. 09. 1973, V. Bhaskar 386 (MGM!)

An epiphytic, scapigerous, tuberous herb, 7 – 15 cm long; tubers oblongoid to globular, 0.4 – 0.7 cm across, creamish-brown in colour. Leaves radical, 3 – 4 per tuber, petiolate; petiole 1 – 3 cm long, glabrous, light green with reddish tinge, lamina elliptic to ovate, 1.1 – 3.7 × 1 – 1.8 cm, attenuate at base, crenate along margin, retuse to apiculate at apex; crenae apiculate; adaxial surface hairy only on the nerves, abaxial surface glabrous, nerves 3 – 5 pairs, alternate. Inflorescence a 3 – 7-flowered racemose scape, 6 – 9 cm long. Flowers lilac to pink in colour, 1.2 – 2.4 cm across,

bracteate, pedicellate; bracts ovate, 1.5 – 2.5 × 1 – 1.5 mm, concave, entire, acute at apex, glabrous; pedicel 1.3 – 1.8 cm long. Lateral sepals asymmetrically ovate, c. 2 × 1 mm, glabrous, entire, acute to obtuse at apex. Standard ovate, 2.5 – 4 × 2 – 3 mm, concave, forming a pouch like structure at the base, cordate at apex, glabrous, veins 3. Wing petals 1 – 1.5 × 0.6 – 0.8 cm, 3-lobed, auricled near the base, lobes unequal; basal lobe oblong, 2 – 4 × 1 – 2 mm, apically rounded; middle lobe larger than the other two, ovate, 5 – 7 × 4 – 6 mm, obtuse at apex; distal lobe oblong, 4 – 6 × 1.5 – 2.5 mm, rounded at apex; dorsal auricle slightly above the base of the wing petal, modified into a tapering needle-like structure, 5 – 7 mm long, yellow at the base and the tip. Lip boat shaped, glabrous, 3 – 6 mm long, 1 – 2 mm deep, acute at apex, spurred; spur basal, 3 – 6 mm long, glabrous, laterally flattened, broad at base, tip notched. Column c. 2.5 mm long, bent forward. Anthers c. 0.5 × 0.5 mm; filaments c. 2 × 0.5 mm. Pistil c. 1.5 × 1 mm; ovary ellipsoid to oblanceoloid, glabrous. Capsule asymmetrically ellipsoid, 6 – 8 × 3 – 4 mm, glabrous, pedicel 1.7 – 2 cm long. Seeds oblongoid, minute, c. 1 × 0.25 mm, reticulate, hairy throughout; hairs long and dense at the ends, lateral ones short and uniformly distributed, spirally coiled (Fig. 2; Plate - 2 b - d).

Fl. & Fr.: July – October.

Habitat: Epiphytic; found on wet moss covered tree trunks. Also grows as a lithophyte

Distribution: Endemic to the Western Ghats of Karnataka (Map - 1c).

Specimen examined: Karnataka, Malabar, Concan, *s. d.*, Stocks and Law, *s. n.* (MH-7870); Gubbiaga, Shimoga district, 22. 08. 1963, R. Sundara Raghavan 90159 (BSI, CAL); Hulical, Shimoga district, 25. 08. 1963, R. Sundara Raghavan 90206 (CAL); Agumbe ghat, Shimoga district, 30. 08. 1963, R. Sundara Raghavan 90304

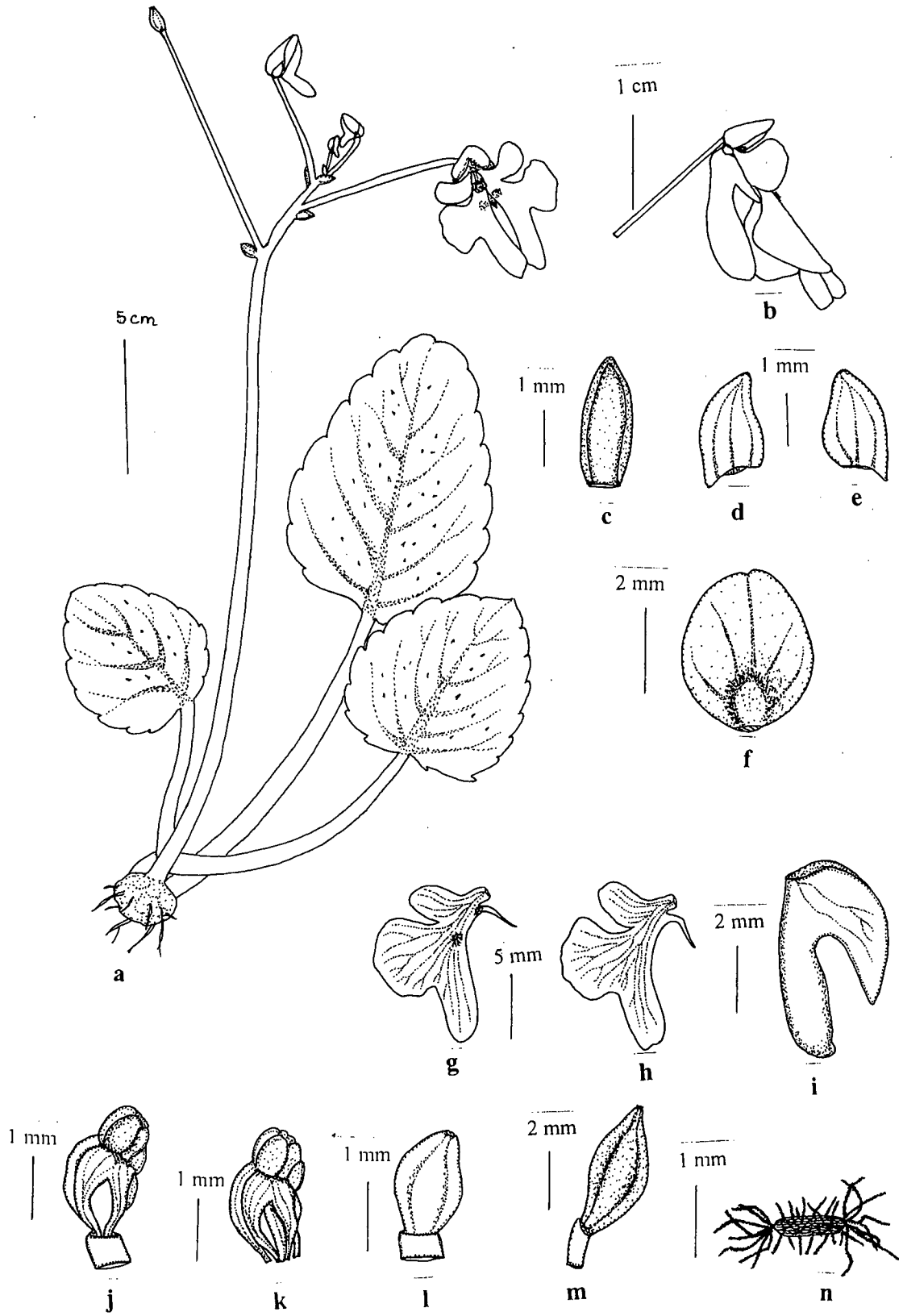


Fig 2: *Impatiens barberi* Hook. f. a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g) wing petal (dorsal view), h) wing petal (ventral view), i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

(BSI, CAL); Kenchankumri State Forest, Hassan district, 15. 08. 1971, T. P. Ramamoorthy 2042 (JCB); Hulical ghat, Shimoga district, 05. 08. 1979, C. J. Saldanha, S. R. Ramesh, K. P. Sreenath KFP 8933 (JCB); Jog falls, North Kanara district, 06. 08. 2005, Jyosna R. N. Dessai 39 (GUH); Agumbe, Shimoga district, 04. 09. 2005, Jyosna R. N. Dessai 74, 75 (GUH); Agumbe ghat, Shimoga district, 27. 08. 2006, M. K. Janarthanam 162 (GUH).

Note: *Impatiens barberi* was described by Hooker (1906) in his conspectus on Peninsular Indian *Impatiens*. However, he did not provide any illustration or any detailed description while publishing this species. The characters available in the key and the type specimen formed the basis for identification of this species.

Later, Bhaskar and Razi (1982) described a new species *I. agumbeana* from Agumbe. They compared the species with *I. lawsonii* and *I. stocksii* and distinguished the species based on a distinct cylindrical spur which is up to 4 mm long which encloses a dorsal auricle that is 3–4 mm long, a slightly lobed distal lobe of wing petal that is with open dichotomous venation.

The type sheet of *I. barberi* is available at MH. Though the specimens are not properly spread on the sheet, Hooker illustrated the floral parts on the type sheet. The illustration clearly show trilobed wing petal with a tapering spiniform dorsal auricle and slightly broader spur.

The type of *I. agumbeana* (*Bhaskar 386*) is deposited at MGM (Mysore University Herbarium) is very inadequate and neither with well preserved flowers nor any dissected floral parts. There are two specimens pasted on the sheet but the flowers are not properly pressed and hence the details are not clear. However the author has provided illustrations of floral parts on the type sheet that throw light on morphology. Interestingly there are no collections of *I. barberi* in Bhaskar's collection at MGM,

though it is one of the common species in the locality of *I. agumbeana*. The specimens identified as *I. barberi* by Bhaskar (1975) were later described by him as a new species, i.e *I. clavata* (Bhaskar, 2006).

Further, thorough search in the type locality of *I. agumbeana* did not result in locating even a single specimen of the species, whereas *I. barberi* is found growing abundantly on tree trunks.

Critical observations of the type specimens of *I. agumbeana* and *I. barberi* including the illustration therein revealed that both the species are morphologically similar with minor variations such as height, spur length, length of the dorsal auricle. My other collections show all these characters as continuous variations. Hence, I see no justification for maintaining this as a distinct species and therefore in the present work, I treat *I. agumbeana* as conspecific to *I. barberi*.

Impatiens barberi is similar to the newly described species *I. clavata* but differs in having oblong spur rather than clavate spur.

The species is also found growing along with *Utricularia striatula*. Plants grow on tree trunks from base to heights of more than 20 m. Individuals growing in shade are with dark pink flowers having deep yellow coloured tuft of hairs while the ones growing in light have lilac coloured flowers with light yellow coloured tuft of hairs. The plants growing amidst mosses are more luxuriant than the ones which are not growing along with moss.

IUCN threat status: EN [B2ab(iii)].

Etymology: Latin: *barberi* = after C. A. Barber. The species was named by J. D. Hooker in honour of C. A. Barber, collector of the species, who helped him in forwarding the specimens from the herbarium of Madras Museum whilst he was working on *Impatiens*.

Impatiens bhaskarii sp. nov.

Impatienti stocksii et I. dendricola similis, ab ambobus floribus lilacinis ad roseis, seminibus omnino pubescentibus, a prima auricula dorsali brevi, a secunda calcare saccato differt.

HOLOTYPE – INDIA, Karnataka, Chikmagalur district, Charmadi ghat, 15. 08. 2005, Jyosna R. N. Dessai & M. K. Janarthanam 62 (CAL!).

Epiphytic, scapigerous, tuberous herb, 10 – 15 cm high; tubers creamish brown, rounded to oblongoid, 0.5 – 0.8 cm across. Leaves radical, 3 – 7 per tuber, petiolate; petiole 1.5 – 4 cm long, glabrous; lamina broadly ovate to orbicular, 0.6 – 4 × 0.5 – 3.6 cm, obtuse to truncate at base, crenate along margin, acute, retuse to apiculate at apex; crenae apiculate, adaxially hairy, abaxially glabrous. Inflorescence a 6 – 10-flowered raceme; 1 – 4 per tuber, scape 5 – 14 cm long, slender, glabrous. Flowers lilac to pink with a tuft of yellow hairs at the base of the middle lobe, 0.8 – 2 cm across, bracteate, pedicellate; bracts ovate, 1.5 – 2 × 1 – 1.3 mm, acute at apex; pedicels 0.6 – 2 cm long, slender, glabrous, deflexed in fruits. Lateral sepals asymmetrically ovate, 1.5 – 2 × 0.5 – 1 mm, slightly concave, acute at apex, distinctly 3-nerved, light green in colour, glabrous. Standard orbicular to obovate, 2.5 – 4 × 3 – 4.5 mm, white without, lilac to pink within, glabrous, concave, humped at base dorsally, obcordate at apex. Wing petals 0.8 – 1.5 × 0.6 – 1 cm, 3-lobed, auricled near base, dorsal auricle short, yellow in colour, lobes unequal; basal lobe smaller than the distal and middle lobe, asymmetrically ovate, 3 – 5 × 1.5 – 3 mm, obtuse to rounded at apex; middle lobe broadly ovate, 2.5 – 5 × 2 – 5 mm, obtuse at apex; distal lobe oblong, 2.5 – 6 × 1 – 3 mm, rounded at apex. Lip ovate, 4 – 5 mm long, 1.5 – 3 mm deep, acute at apex, spur saccate. Column c. 2 mm long, curved. Anthers c. 1 × 0.5 mm, white in colour; filaments c. 1.5 mm long, light pink to white in colour. Pistil c.

1.5 × 0.5 mm; ovary lanceoloid to ellipsoid, glabrous. Fruit a capsule, 0.6 – 1 × 0.2 – 0.4 cm, asymmetrically ellipsoid, glabrous, pedicels 1.5 – 2.2 cm long. Seeds numerous, minute, oblongoid, c. 1 × 0.5 mm; testa reticulate, brown, hairy; hairs sparse throughout but long and tufted at both the ends, spirally coiled (Fig. 3; Plate - 2 e, f).

Fl. & Fr.: August.

Habitat: Epiphyte. Growing on tree trunks amidst moss.

Distribution: Endemic to Karnataka. Known only from the type locality (Map - 1d).

Specimen examined: Karnataka, Charmadi ghat, Chikmagalur district, 13° 07' 15.0" N, 75° 29' 38.3" E, 15. 08. 2005, Jyosna R. N. Dessai & M. K. Janarthanam 62 (Holotype – CAL; Isotypes – BSI, MH,).

Note: The species is related to *I. stocksii* Hook. f. & Thomson and *I. dendricola* C. E. C. Fisch. but differs in possessing lilac to pink coloured flowers, short dorsal auricle, and seeds with hairs all over from the former, and in having lilac to pink coloured flowers, saccate spur and seeds with hairs all over from the latter.

Characters	***Impatiens dendricola***	***I. stocksii***	***I. bhaskarii* sp. nov.**
Flower colour	white	white	pink to lilac
Dorsal auricle of wing petal	short	absent	short
Spur	club-shaped	saccate	saccate
Seed	comose	comose	hairy throughout, but hairs long at both the ends

Bhaskar (1975) identified this species as *I. lawsonii* and voucher specimens are available at MGM. He considered the auricle as spiniform as described by Hooker (1906) in the protologue, neglecting the fact that the species is placed under the short spurred group. However *I. bhaskarii* can be distinguished from *I. lawsonii* based on

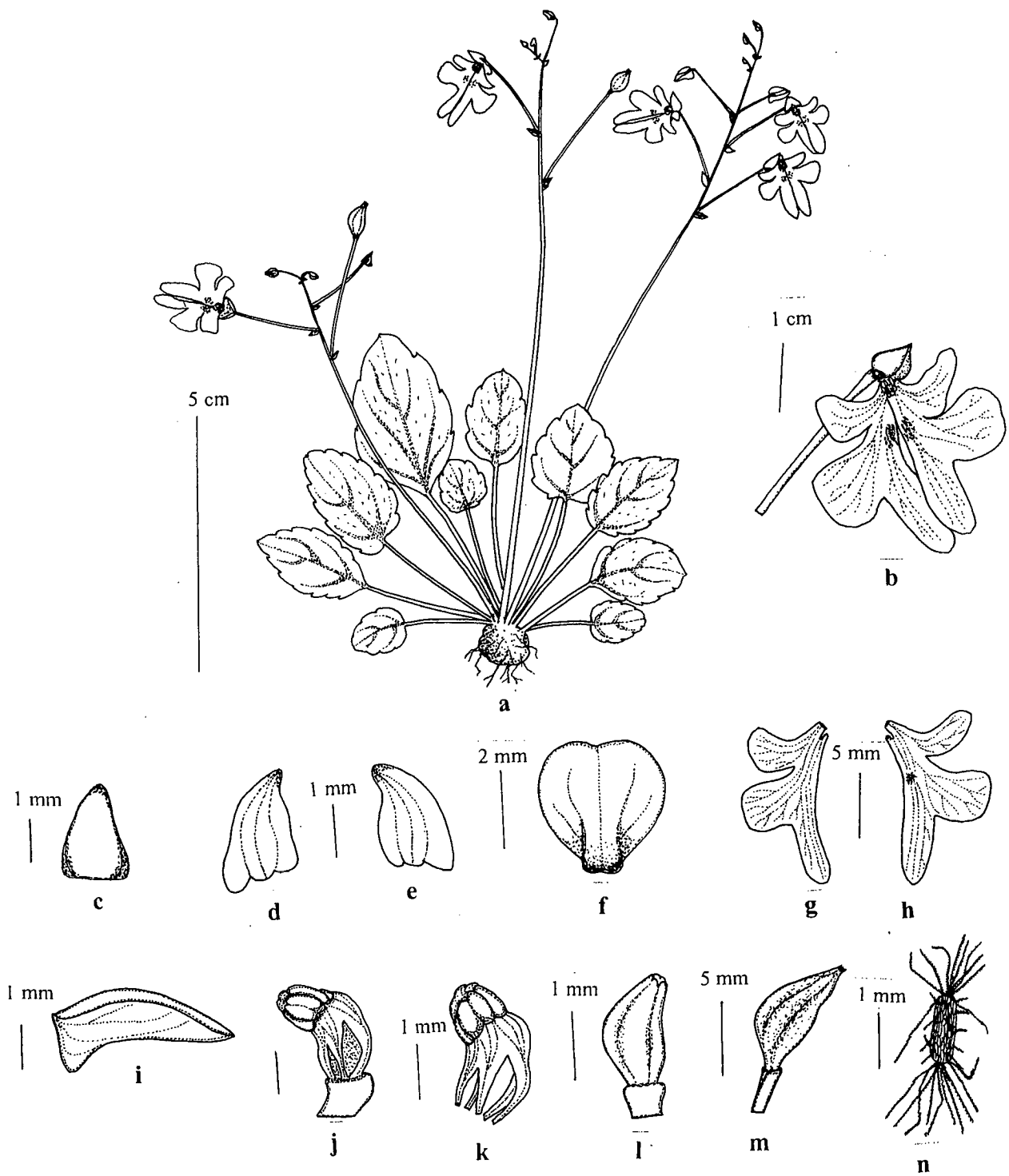
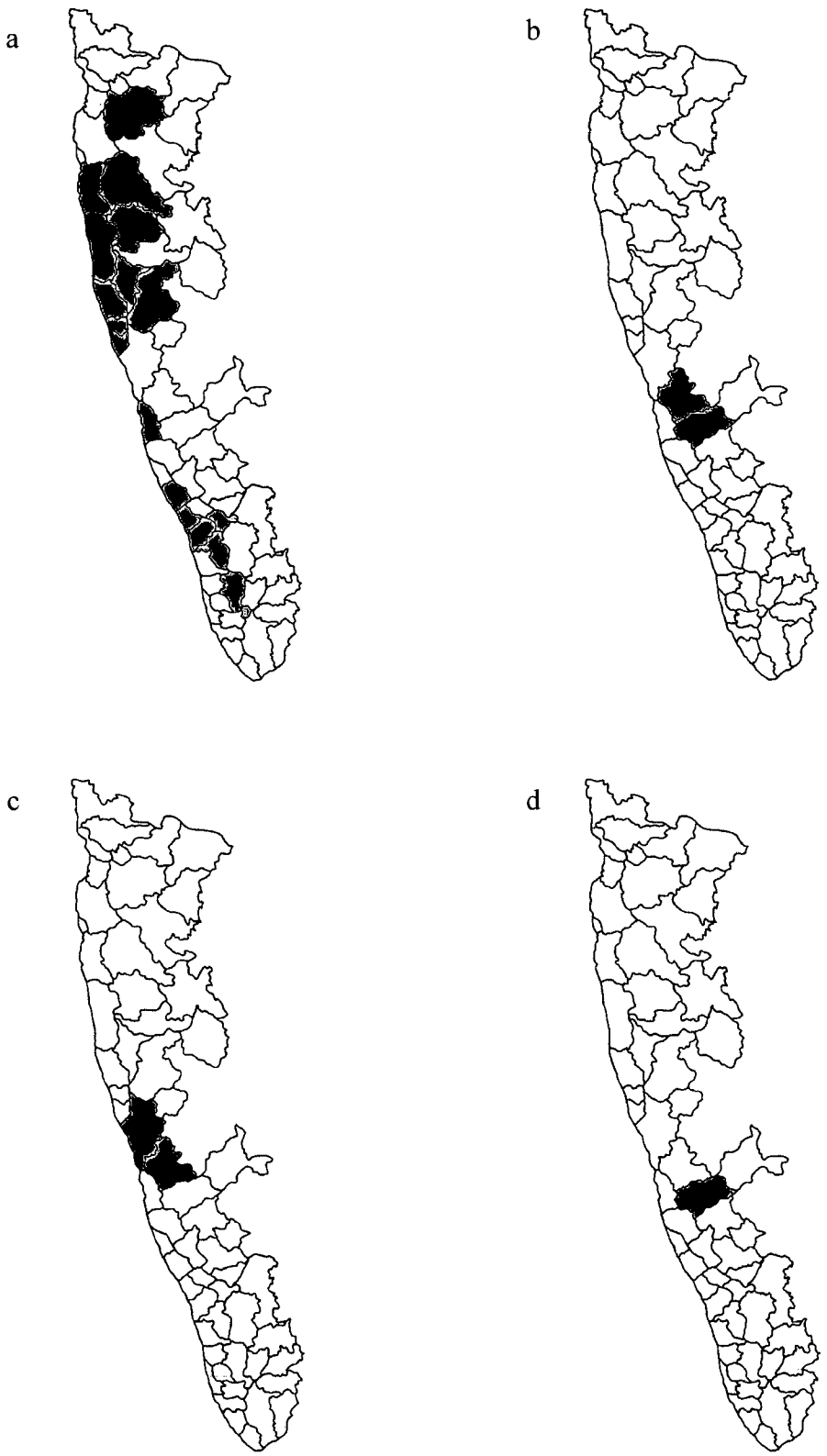


Fig. 3: *Impatiens bhaskarii* sp. nov. a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g) wing petal (ventral view), h) wing petal (dorsal view), i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

Map 1: Distribution of a) *Impatiens acaulis* var. *acaulis*; b) *I. acaulis* var. *granulata*; c) *I. barberi*; d) *I. bhaskarii.*



its saccate spur and rounded dorsal auricle rather than short spur that is c. 5 mm long and short spiniform dorsal auricle. The specimen of *I. lawsonii* collected by Barnes that is deposited at K matches with the key characters provided by Hooker thus indicating that *I. lawsonii* as identified by Bhaskar is actually an undescribed species.

Impatiens bhaskarii is restricted to the type locality and *I. dendricola* is reported from only two localities in Coorg District further south of the type locality of *I. bhaskarii* whereas *I. stocksii* is found growing in the areas occupied by both these species. *Impatiens stocksii* and *I. dendricola* are found growing on moss covered tree trunks while *I. bhaskarii* grows on horizontal lateral branches.

Chromosome number: 2n = 20 [as *Impatiens lawsonii* Hook. f. (Bhaskar, 1976; 1980)].

IUCN threat status: CR [B2ab(iii)].

Etymology: Latin: *bhaskarii* = after Prof. V. Bhaskar, for his immense contribution towards the understanding of *Impatiens* of south India.

Impatiens clavata Bhaskar in Curr. Sci. 91(9): 1138 – 1140, f. 2. 2006. **TYPE** – INDIA, Karnataka, Hassan District, Pushpagiri, Bisle ghat, 24. 09. 1972, V. Bhaskar 328 (MGM!).

An epiphytic, scapigerous, tuberous herb, 8 – 10 cm long; tubers whitish-brown in colour, globose, 0.5 – 0.7 cm in radius. Leaves radical, 1 – 3 per tuber, petiolate; petiole 1.3 – 2.5 cm long, glabrous, lamina asymmetrically ovate, orbicular to obovate, 0.8 – 3.6 × 0.7 – 2.5 cm, attenuate at base, crenate along margin, apiculate at apex; crenae apiculate, adaxially hairy; hairs mostly on nerves, abaxially glabrous, veins 2 – 3 pairs, alternate. Inflorescence a 2 – 4-flowered racemose scape, 4.5 – 9 cm long, slender, pale green to white with reddish tinge, glabrous. Flowers pink to lilac-

pink in colour, 1 – 2.2 cm across, bracteate, pedicellate; bracts ovate, concave, c. 1.5 × 1 mm, green in colour, glabrous, acute to rounded at apex, tip thick, fleshy; pedicel 0.7 – 1.2 cm long, slender, glabrous, pale green in colour, deflexed in fruits. Lateral sepals pale green with reddish tinge, asymmetrically broadly ovate, c. 1.5 × 1 mm, glabrous, acute at apex, thick, fleshy, veins 3, distinct. Standard broadly ovate, 4 – 6 × 2 – 4 mm, light pink in colour, concave, glabrous, forming a hood above the column, obcordate at apex. Wing petals 1.5 – 1.9 × 0.6 – 1 cm, 3-lobed, auricled near the base, lobes unequal, with tuft of yellow hairs at the base of the middle lobe and at the base of the dorsal auricle; basal lobe asymmetrically ovate to oblong, 4 – 7 × 2 – 4 mm, apically rounded to obtuse; middle lobe broadly ovate to oblong, 3 – 7 × 4 – 8 mm, apically rounded; distal lobe 3 – 6 × 2 – 3 mm, oblong, apically rounded; auricle spiniform, produced in the spur, 0.8 – 1 cm long, yellow at base, tip rounded with yellow tinge. Lip ovate, 5 – 7 mm long, 2 – 5 mm deep, 5 – 6 mm wide, acute at apex, pinkish-white in colour, spurred; spur clavate, 0.7 – 1.3 × 0.3 – 7 mm. Column c. 3.5 × 1.5 mm, curved. Anthers c. 1 × 1 mm, white in colour; filaments c. 2 mm long, light pink to white in colour. Pistil c. 2.5 × 1 mm; ovary ellipsoid to oblongoid, glabrous. Capsules asymmetrically ovoid to ellipsoid, 5 – 7 × 2.5 – 4 mm, glabrous; pedicels 1.3 – 1.5 cm long. Seeds numerous, minute, oblongoid, c. 1 × 0.5 mm, brown, hairy throughout; hairs long and dense at the ends, lateral ones short and uniformly distributed; spirally coiled (Fig. 4; Plate - 2 g, h).

Fl. & Fr.: September.

Habitat: Epiphyte. Growing on wet tree trunks amidst moss.

Distribution: Endemic to the Western Ghats of Karnataka. Not known elsewhere other than the type locality (Map – 2a).

Specimen examined: Karnataka, Hassan district, Panoroma point, Bisle ghat, 16.

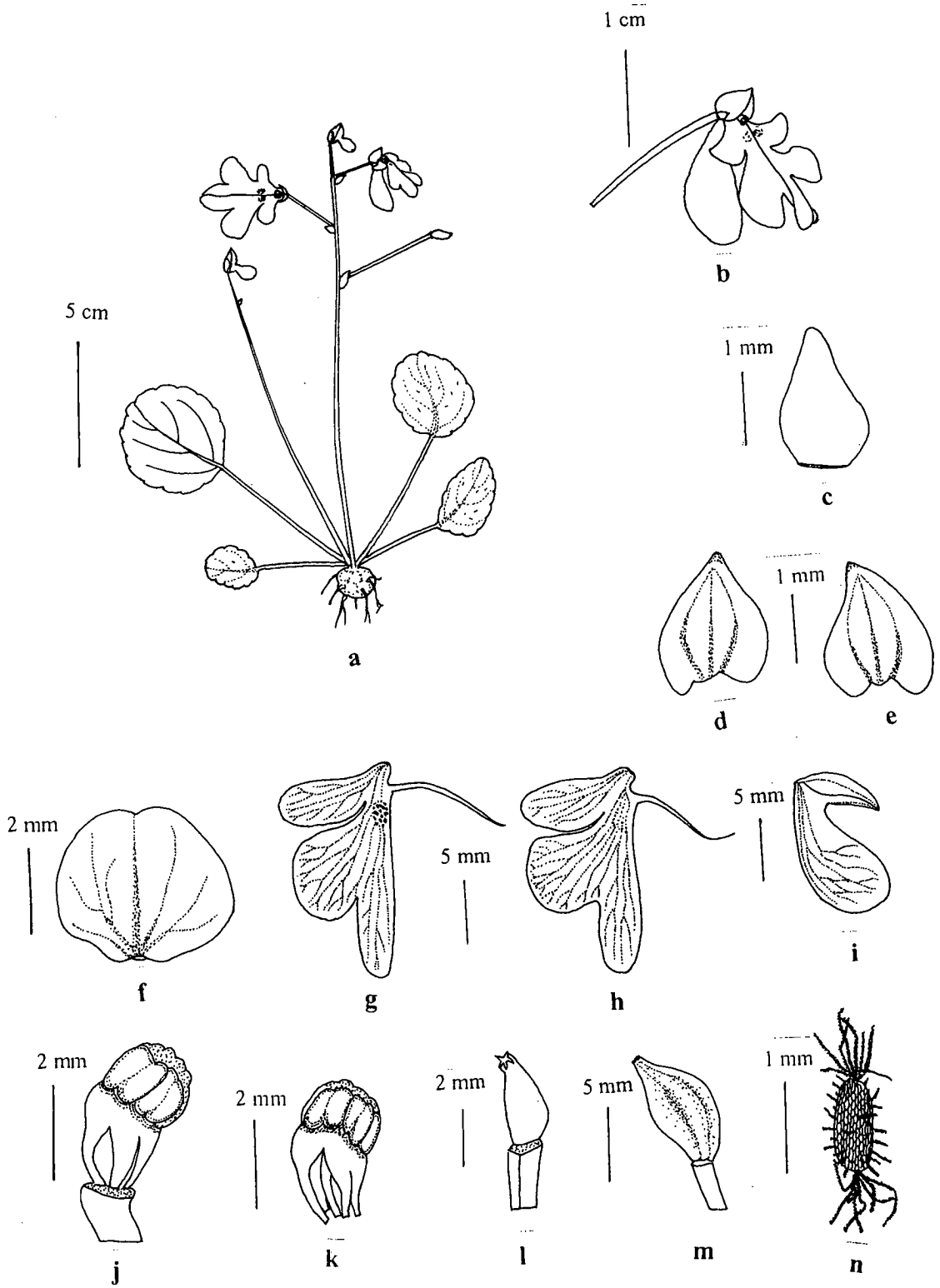


Fig. 4: *Impatiens clavata* Bhaskar. a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g) wing petal (dorsal view), h) wing petal (ventral view), i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

09. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 138 (GUH).

Note: *Impatiens clavata* is morphologically similar to *I. barberi* Hook. f. with respect to flower colour, tuft of hairs near the base of the wing petal and the long tapering spiniform dorsal auricle. However the species differs from *I. barberi* in having a long, broadly clavate and inflated spur rather than slightly club shaped and somewhat cylindrical spur. Since this is the only difference between the two species and both the species show morphological variations study of more populations along with molecular data will be of great significance in throwing light on their individual status. However I could not locate even second population inspite of my repeated attempts.

IUCN threat status: CR [B2ab(iii)].

Chromosome number: 2n = 16 [as *I. barberi* (Bhaskar, 1976; 1980)].

Etymology: Latin: *clavata* = club-shaped referring to its prominent clavate nature of the spur.

Impatiens dendricola C. E. C. Fisch. in Bull. Misc. Inform. Kew. 1935: 157. 1935; Fischer in Gamble, Fl. Madras, 3: 1870. 1936; Henry *et al.*, in J. Bombay Nat. Hist. Soc. 75: 686. 1979; Sharma *et al.*, Fl. Karnataka Analysis, 37. 1984; Ahmedullah & Nayar, Endemic plants of the Indian region, 1: 191. 1986; Nayar, Hot spots of endemic plants of India, Nepal and Bhutan, 214. 1996; Saldanha in Saldanha, Fl. Karnataka, 2: 251. 1996; Keshava Murthy & Yoganarasimhan, Fl. Coorg 'Kodagu', 86. 1990; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 139. 1997; Ravikumar *et al.*, in J. Econ. Taxon. Bot. 24(2): 335. 2000. **TYPE** – INDIA, Karnataka, in Shola, at foot of Thadiandamolu, Coorg 'Kodagu' district, Karnataka, 17. 09. 1934, E. Barnes 887 (K; Photo!).

Epiphytic, scapigerous, tuberous herb, 10 – 19 cm high; tubers brownish-white

in colour, oblongoid to globular, 1 – 1.5 × 0.5 – 0.9 cm. Leaves radical, 4 – 5 per tuber, petiolate; petiole 1.5 – 7 cm long, glabrous, lamina ovate, elliptic, lanceolate to oblong-lanceolate, 1.2 – 6 × 1 – 4 cm, cuneate, oblique to obtuse at base, crenate along margins, obtuse, apiculate to retuse at apex; crenae apiculate; adaxial surface hairy, abaxially glabrous, veins obscure, midrib distinct. Inflorescence 2 – 10-flowered racemose scape, 5 – 18 cm long. Flowers white in colour, 1.3 – 1.8 cm across, bracteate, pedicellate; bracts ovate, 3 – 5 × 1.5 – 3 mm, flaccid, green in colour, concave, acute to obtuse at apex, pedicel 1 – 2 cm long, filiform, glabrous, deflexed in fruits. Lateral sepals asymmetrically ovate, acute to obtuse at apex, glabrous, veins 3 – 5. Standard orbicular to reniform, 4 – 5 × 7 – 9 mm, concave, glabrous, retuse at apex, bulged at the base. Wing petals 1.6 – 2 × 0.8 – 1 cm, 3-lobed, auricled at base; lobes unequal, distal and basal lobes narrow, median broader; basal lobe linear-oblanceolate, 6 – 7 × 1.5 – 2.5 mm, median lobe orbicular, 5 – 6 × 5 – 6 mm, with a tuft of hairs at the base, hairs yellow, yellowish brown to orange in colour (only at the tips), c. 1.5 mm long, bulged at apex; distal lobe linear-oblong, 9 – 11 × 3 – 5 mm, rounded at apex; auricle small, c. 1 × 1 mm, yellow in colour. Lip broadly ovate, 7 – 8 mm long, 3 – 4 mm deep, 4 – 6 mm wide acute to acuminate at apex, spurred; spur basal, clavate, flat, 1.3 - 1.8 × 0.4 – 0.7 cm, white in colour, rounded at apex, glabrous. Column c. 4 × 2 mm, bent forward. Anthers c. 0.5 × 0.5 mm, white in colour; filaments c. 3 × 1 mm, white in colour. Pistil c. 3 × 1.5 mm, ovary lanceoloid, ellipsoid to ellipsoid-lanceoloid, glabrous. Fruit a capsule, 6 – 8 × 3 – 5 mm, ellipsoid, oblanceoloid to lanceoloid, glabrous, many seeded; pedicel 1.9 – 2.5 cm long. Seeds oblongoid, c. 1 × 0.5 mm, reticulately veined, comose; hairs spirally coiled (Fig. 5; Plate - 2 i, l).

Fl. & Fr.: August – September.

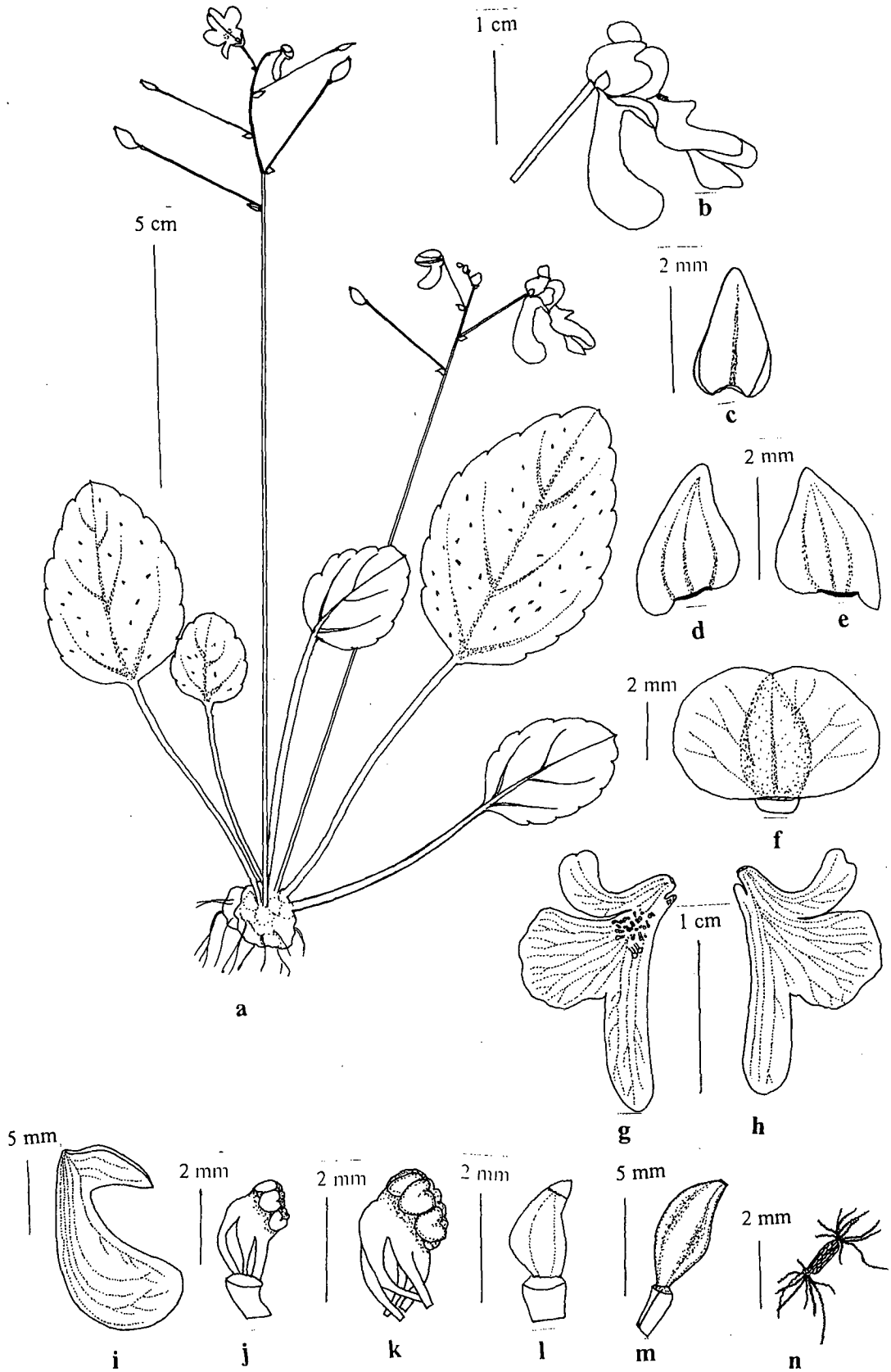


Fig. 5: *Impatiens dendricola* C. E. C. Fisch. a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g) wing petal (dorsal view), h) wing petal (ventral view), i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

Habitat: Epiphytic on tree trunks amidst moss.

Distribution: Endemic to the Western Ghat region of Kodagu (Coorg) district, Karnataka. Till date the species is known only from two localities *viz.* Talacauvery and Thadiandamol (Kodagu district) (Map - 2b).

Specimens examined: Karnataka, on tree trunks in shola on the side of Thadiandamolu, Coorg (Kodagu) district, Karnataka, 17. 09. 1934, E. Barnes 886 (K; photo!); Thadiandamolu, Coorg (Kodagu) district, 25. 08. 1975, V. Bhaskar 473 (MGM); Talacauvery, Coorg (Kodagu) district, 10. 08. 1998, K. Ravikumar, P. S. Udayan, S. P. Subramani & Mohan Karnat 06418 (FRLH); Foot of Thadiandamolu peak, Kodagu district, 18. 09. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 153 (GUH); 18. 08. 2007, Jyosna R. N. Dessai & M. K. Janarthanam 166 (GUH).

Note: The species was described by C. E. C. Fischer in 1935 based on two specimens collected by Barnes [886, 887 (K)] from Thadiandamolu. Nair (1991) quotes that the species is known only from type collection. Bhaskar collected the species from the type locality in 1975 after a lapse of 40 years (473–MGM!). Saldanha (1996) also cites Barnes collections available at Kew. Keshava Murthy and Yoganarasimhan (1990) included the species in their flora based on the authority of Fischer (1936). As there were no other collections, Nayar (1996) included the species under endangered category. Vivekananthan *et al.* (1997) however overlooked Bhaskar's collection and mentioned that the species was not collected after type. Ravikumar *et al.* (2000) reported the species from Talacauvery, which is almost 10 km south of type locality thus indicating its extended distribution. The present collection from the type locality confirms its existence in the type locality.

Impatiens dendricola is similar to *I. stocksii* Hook. f. & Thomson in having white coloured flowers, but differs in the following key characters.

Character	*I. dendricola*	*I. stocksii*
Dorsal auricle	present	absent
Spur	clavate	saccate

The species is found growing on trunks and lateral branches of huge trees along the periphery of coffee and cardamom plantations in evergreen forest at an altitude of 1250 m. Plants are found growing on tree trunks from 1 m above the ground level up to a height of 20 m. The peak flowering period is mid August and ceases thereafter. The existence of this species mostly on the trees along cardamom and coffee plantations may be a major threat to the species in the near future.

Chromosome number: 2n = 14 (Bhaskar, 1976; 1980).

IUCN threat status: CR [B1ab(iii)].

Etymology: Latin: *dendricola* = tree-dwelling.

Impatiens scapiflora Heyne ex Roxb., Fl. Indica 2: 464. 1824; Wight & Arnott, Prodr. Fl. Ind. Orient. 137. 1834; Hooker & Thomson in J. Proc. Linn. Soc. Bot. 4: 118. 1859; Hooker, Fl. Brit. India 1: 443. 1874 & in Rec. Bot. Surv. India 4: 44. 1906; Gamble, Fl. Madras 1: 138. 1915; Blatter in J. Bombay Nat. Hist. Soc. 33: 310. 1933; Ramamoorthy in Saldanha & Nicolson, Fl. Hassan District, 403. 1978; Yoganarasimhan *et al.*, Fl. Chikmagalur District, 60. 1982; Vajravelu in Nair & Henry, Fl. Tamil Nadu 1: 56. 1983; Sharma *et al.*, Fl. Karnataka Analysis, 39. 1984; Ramchandran & Nair, Fl. Cannanore, 80. 1988; Almeida, Fl. Savantwadi 78. 1990; Keshava Murthy & Yoganarasimhan, Fl. Coorg 'Kodagu', 87. 1990; Nayar, Hot spots of endemic plants of India, Nepal and Bhutan, 215. 1996; Saldanha in Saldanha, Fl. Karnataka 2: 257. 1996; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 208. 1997; Mudaliar & Prasad in Singh & Karthikeyan, Fl. Maharashtra Dicotyledons 1: 461.

2000; Ramaswamy *et al.*, Fl. Shimoga District, 109. 2001; Nayar *et al.*, Fl. Pl. Kerala, 138. 2006.

Impatiens rivalis Wight in Madras J. Lit. Sci. ser. 1, 5: 13, t. 8. 1837; Wight, Icon. Pl. Ind. Orient. t. 751. 1844; Hooker, Fl. Brit. India 1. 444. 1874; Cooke, Fl. Bombay 1: 170. 1901.

A scapigerous herb with tuberous rootstock, 9 – 45 cm high, tuberous or rhizomatous; tubers oblongoid, 1 – 1.5 cm across. Leaves radical, 2 – 5 per tuber, petiolate; petiole 2.5 – 12 cm long, glabrous, lamina reniform, ovate to obovate, 2.5 – 20 × 2 – 15 cm, acute to acuminate at apex, crenate to distantly serrate along margin, cordate to rounded at base, adaxially pubescent, abaxially glabrous. Inflorescence a 4–16 flowered raceme, scape 8 – 45 cm long. Flowers pink in colour, 2.5 – 5 cm across, bracteate; pedicellate, bracts ovate, 2 – 8 × 1 – 5, acute to rounded at apex, pink to green in colour, thick, fleshy, slightly concave, glabrous, pedicel 1.8 – 5 cm long, glabrous, deflexed in fruits. Lateral sepals asymmetrically ovate, 3 –5 × 1 – 3 mm, acute at apex, glabrous, pale green in colour, veins 5 –7. Standard broadly reniform, 0.6 – 1 × 1 – 1.5 cm, forming a hood above the column, humped at the base dorsally, pink dorsally, white within, glabrous, emarginate to obcordate at apex. Wing petals 2.3 – 3.5 × 1.7 – 2.6 cm, 3-lobed, basal lobe oblong, 1.6 – 2.4 × 0.5 – 0.8 cm, apically rounded, middle lobe ovate to oblong, 1 – 2 × 0.6 – 1.2 cm, obtuse at apex, distal lobe oblong, 1.1 – 1.8 × 0.3 – 0.6 cm, rounded at apex, dorsal auricle absent. Lip saccate, 0.8 – 1.2 cm long, 0.5 – 0.9 cm deep, 4 – 7 mm wide, acute at apex, glabrous; spurred, spur tubular, 4 – 8.5 cm long, curved, straight or coiled, glabrous, tip rounded. Column c. 5 × 3 mm, bent forward. Anthers c. 2 × 1 mm; filaments c. 5 × 1 mm; pistil c. 5 × 2 mm; ovary lanceolate to ovate lanceolate, glabrous. Capsule 1 – 1.5 × 0.5 – 0.8 cm, lanceoloid, glabrous; pedicel 4 – 6 cm long; seeds oblongoid to ovoid-

oblongoid, c. 1.5 × 0.5 mm, reticulate venation, hairy all over; hairs spirally coiled, forming a cone like structure (Fig. 6; Plate - 2j, m).

Fl. & Fr.: June – November.

Habitat: Epiphytic or terrestrial. Grows on trees trunks, amidst grass and moss. Also grows on rocks as lithophyte.

Distribution: Endemic to Western Ghats, from Karnataka to Tamil Nadu (Map - 2c).

Specimens examined:

Karnataka: Karwar, North Kanara district, 28. 08. 1883, W. A. Talbot 599 (CAL); Gersoppa falls, North Kanara district, October 1908, A. Meebold 10721 (CAL); Bisle ghat, Hassan district, 16. 07. 1967, C. J. Saldanha 10745 (JCB); Bisle ghat, Hassan district, 14. 08. 1967, C. J. Saldanha 10927 (JCB); Shiradi, South Kanara district, 15. 08. 1967, *s. c.* 10957 (JCB); Shiradi ghat, South Kanara district, 07. 08. 1969, C. J. Saldanha 14427 (JCB); Vanagur, Hassan district, 08. 07. 1970, T. P. Ramamoorthy HFP 292 (JCB); Peak above Vanagur, Hassan district, 10. 09. 1970, F. M. Jarrett & C. J. Saldanha, *s. n.* (JCB); Bisle ghat, Hassan district, 07. 07. 1971, T. P. Ramamoorthy HFP 1885 (JCB); Peak overlooking Vanagur, Hassan district, 14. 08. 1971, T. P. Ramamoorthy HFP 1992 (JCB); Hulical ghat, Shimoga district, 08. 11. 1972, V. Bhaskar 345 (MGM); Peetha, Bababudan, Chikmagalur district, 23. 07. 1973, V. Bhaskar 360 (MGM); Bababudan, on the way to Abbe falls, Chikmagalur district, 26. 07. 1973, V. Bhaskar 368 (MGM); Sampaji ghat, Coorg 'Kodagu', district, 06. 08. 1973, V. Bhaskar 374 (MGM); Jodpala, Coorg 'Kodagu' district, 04. 08. 1974, V. Bhaskar 411 (MGM); Talacauvery, Coorg (Kodagu) district, 914 m, 24. 06. 1977, T. A. Rao & B. C. Banerjee 18227 (CAL); 10 kms from Mercara, Mercara to Mangalore road, Coorg (Kodagu) district, 20. 07. 1978, S. R. Ramesh KFP 1851 (CAL); Chikmagalur district, 1500 – 1600 m, 27. 07. 1979, C. J. Saldanha & K. P. Sreenath

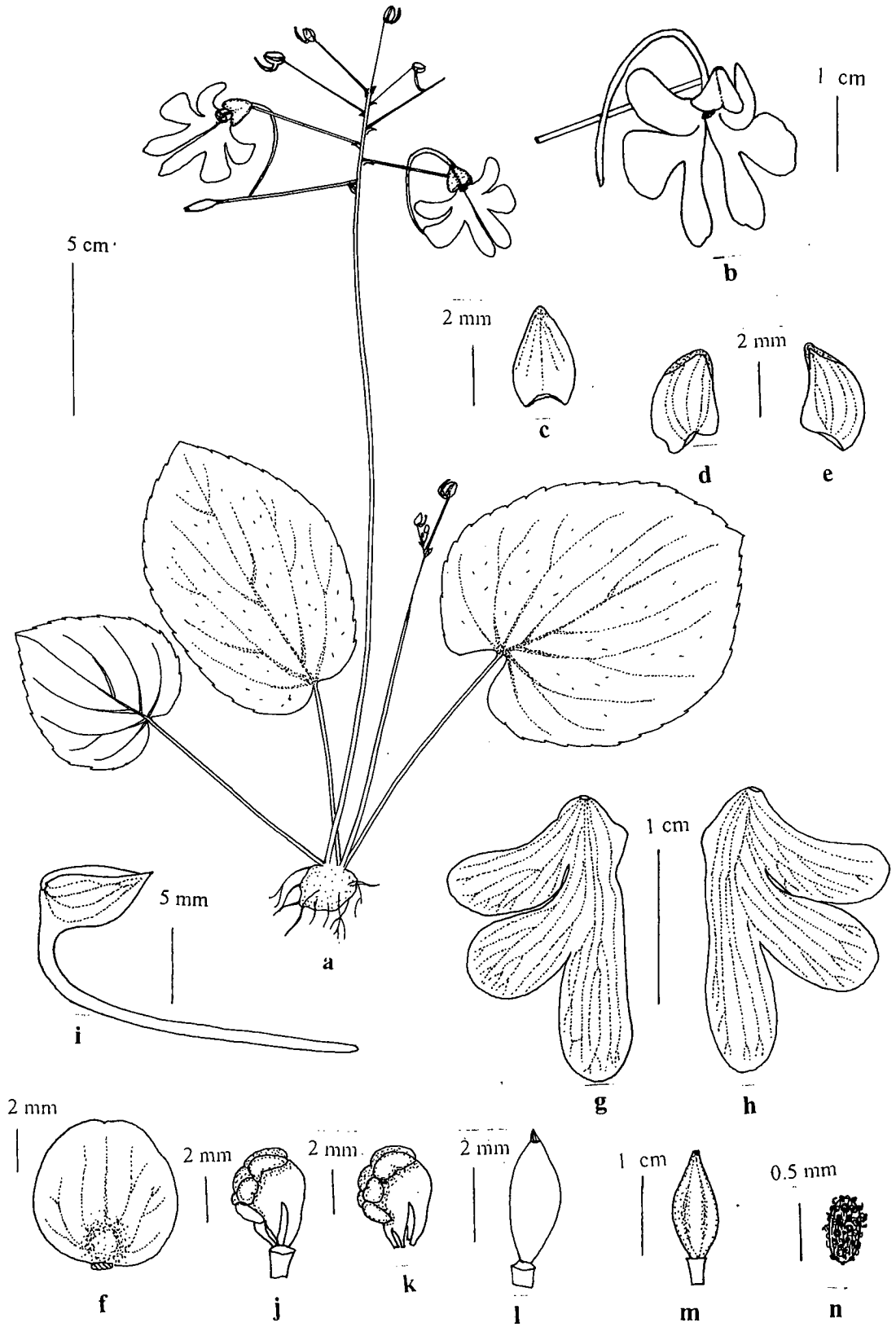


Fig. 6: *Impatiens scapiflora* Heyne ex Roxb. a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g, h) wing petal, i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

KFP 8521 (CAL); Bababudan hills, Chikmagalur district, 27. 07. 1979, C. J. Saldanha & K. P. Sreenath KFP 8521 (JCB); *s. l.*, 27. 07. 1979, C. J. Saldanha & K. P. Sreenath KFP 8521 (JCB); Kemmangundi, Bababudan hills, Chikmagalur district, 05. 09. 1980, C. J. Saldanha KFP 12189 (JCB); Kemmangundi, on the way to Z-point, Chikmagalur district, 17. 11. 2004, Jyosna R. N. Dessai & M. K. Janarthanam 25 (GUH); Jog falls, North Kanara district, 06. 08. 2005, Jyosna R. N. Dessai 38 (GUH); Jodpalla, on the way to Madikeri from Mangalore, Coorg 'Kodagu' district, 13. 08. 2005, Jyosna R. N. Dessai 46 (GUH); 2 km from Bagmandala, on the way to Talacauvery, Coorg 'Kodagu' district, 13. 08. 2005, Jyosna R. N. Dessai 50 (GUH); Kemmangundi, 05. 09. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 78 (GUH); Bisle ghat, Hassan district, 16. 09. 2006, Jyosna R. N. Dessai 136 (GUH); Talacauvery, Coorg 'Kodagu' district, 17. 09. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 149 (GUH); Foot of Thadiandamol peak, Coorg (Kodagu) district, 18. 09. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 151 (GUH); Thadiandamol peak, Coorg 'Kodagu' district, 18. 09. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 152 (GUH); Foot of Thadiandamol peak, Coorg 'Kodagu' district, 18. 09. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 165 (GUH).

Tamil Nadu: Courtallum 'Kutrallam', Tirunelveli district, August 1835, R. Wight 174 (E; Photo!); Konalar, Anamalai hills, Coimbatore district, 1950 m, 18. 11. 1980, M. Chandrabose 69004 (CAL); Akkamalai R. F., Coimbatore district, 1650 m, 19. 11. 1980, M. Chandrabose 69033 (CAL); Kallar river forest, Tirunelveli district, 16. 10.1989, R. Gopalan 90691 (MH).

Kerala: Silent valley, 10. 10. 1965, E. Vajravelu 26068 (MH); Murinnavizha, Idukki district, 17. 06. 1972, V. Bhaskar 288 (MGM); Peermade, Idukki district, 18. 06. 1972, V. Bhaskar 291 (MGM); Palghat district, 10. 08. 1972, V. Bhaskar 308 (MGM);

Devicolam, Kottayam district, 31. 10. 1973, V. Bhaskar 401 (MGM); Way to Ayyappan temple, 02. 09. 1977, N. C. Nair 50787 (CAL); Idukki to Kattappana, Idukki district, 900 m, 26. 09. 1981, C. N. Mohanan & B. Ramarajan 72018 (CAL).

Note: *Impatiens scapiflora* is similar to *I. acaulis* in its general habit and spur characteristics but differs from it in having 3-lobed wing petals rather than bilobed wing petals. Though both the species are closely allied, it was observed that *I. acaulis* and *I. scapiflora* are mutually exclusive in the study area.

Impatiens scapiflora was described by Roxburgh based on Heyne's collection (Roxburg, 1824). However, neither he provided detailed description of the flower especially the wing petal nor any illustration of the flowers or its dissected parts. But in the description he mentioned that the spur is several inches in length that provides the only clue. Unknowingly or may be due to the want of description of the species, Wight (1837) described a new species, *I. rivalis* which is actually *I. scapiflora.* Wight (1844) illustrated both i. e. *I. scapiflora* (t. 967) and *I. rivalis* (t. 751) in his icones. As per his illustrations, *I. rivalis* is having a long tubular spur and *I. scapiflora* is with a short clavate spur which is actually *I. beddomei* (synonym of *I. clavicornu*) described by Hooker (Hooker, 1874). Hooker and Thomson (1859) and Hooker (1874) were unaware of the fact and dealt both the species independently, though in Hooker's later work he considered *I. rivalis* as a synonym under *I. scapiflora.*

Specimens growing at an altitude of above 1250 m around shola vegetation show white flowers.

Based on the herbarium and the present collections it is concluded that species is well distributed with large populations in the Western Ghats of Karnataka.

When Blatter (1933) revised Balsaminaceae for the Flora of Bombay Presidency North Kanara was also a part of Bombay presidency. It is likely that on the

basis of this Almeida (1990) and Mudaliar and Prasad (2000) must have included the species for Maharashtra. Moreover there are no specimens from Maharashtra in any of the herbaria to prove its distribution in the state.

Chromosome number: 2n = 20 (Krishnaswamy *et al.*, 1969); 2n = 12 (Bhaskar, 1976); 2n = 14, 16, 20 (Bhaskar, 1980).

IUCN threat status: LC.

Etymology: Latin: *scapi* = clear-stemmed, *flora* = flower, in reference to the flowers borne on scapes.

Impatiens stocksii Hook. f. & Thoms. in J. Proc. Linn. Soc. Bot. 4: 119. 1859; Hooker, Fl. Brit. India 1: 442. 1874 & in Rec. Bot. Surv. India 4: 45. 1906; Cooke, Fl. Bombay 1: 170. 1901; Fischer in Gamble, Fl. Madras 3: 1870. 1936; Blatter in J. Bombay Nat. Hist. Soc. 33: 310. 1933; Ramamoorthy in Saldanha & Nicolson, Fl. Hassan District, 404, f. 78 B. 1978; Henry *et al.*, in J. Bombay Nat. Hist. Soc. 75: 686. 1979; Yoganarasimhan *et al.*, Fl. Chikmagalur District, 59. 1982; Sharma *et al.*, Fl. Karnataka Analysis, 39. 1984; Ahmedullah & Nayar, Endemic plants of the Indian region 1: 194. 1986; Keshava Murthy & Yoganarasimhan, Fl. Coorg 'Kodagu', 88. 1990; Saldanha in Saldanha, Fl. Karnataka 2: 257, t. 100 B. 1996. **TYPE** - INDIA, Karnataka, Malabar, Concan and regio trop., *s. d.*, Stocks and Law *s. n.* (CAL!).

Epiphytic, scapigerous, tuberous herbs, 5 – 10 cm; tubers c. 0.6 cm rounded, creamish brown. Leaves radical, 2–5 per tuber, petiolate; petiole glabrous, slender, 1 – 4.5 cm long; lamina broadly ovate, broadly elliptic to orbicular, 1 – 5 × 0.8 – 2.5 cm, obtuse to truncate at base, distantly crenate along margins, notched to emarginate at apex; crenae apiculate; membranous, pubescent above (more hairy on the nerves), glabrous beneath. Inflorescence 2 – 7-flowered racemose scape, glabrous, slender, 3 –

8.5 cm long. Flowers white, 1 – 1.5 cm across, bracteate, pedicellate; bracts ovate, c. 2.5 × 1 mm, light green, glabrous; pedicel 0.9 – 1.3 cm long, glabrous, deflexed in fruits. Lateral sepals minute, ovate, c. 2.5 × 1.5 mm, acute at apex, light green, glabrous. Standard orbicular, c. 3.5 × 4 mm, white in colour, forming a small sac-like structure at the base, glabrous. Wing petals 1.3 – 1.6 × 0.5 – 0.8 cm, 3-lobed, white with a tuft of yellow hairs at the base of the middle lobe, middle lobe broader than the distal and basal lobe, basal and distal lobes subequal; basal lobe oblong, c. 5 × 3 mm, apically acute to obtuse; middle lobe c. 5 × 4 mm, apically obtuse; distal lobe oblong oblanceolate, c. 7 × 3 mm, apically rounded to obtuse. Lip saccate, c. 6 mm long, c. 3 mm deep, c. 3 mm wide, white with a yellow spot, tip acute, spur absent. Column c. 2 mm, curved. Anthers c. 0.5 × 0.25 mm, white in colour; filaments c. 1.5 × 0.5 mm translucent. Pistil c. 1 × 0.75 mm; ovary broadly lanceoloid to ellipsoid, glabrous. Capsule broadly asymmetrically ellipsoid, 5 – 7 × 2 – 4 mm, glabrous; pedicel 1 – 1.6 cm long. Seeds oblongoid, c. 1 × 0.25 mm, comose; hairs spirally coiled (Fig. 7; Plate - 2 k, n).

Fl. & Fr.: July – September.

Habitat: Epiphyte. Growing on tree trunks along with moss at an altitude between 700 - 1600 m.

Distribution: Endemic to the Western Ghats of Karnataka (Map - 2d).

Specimen examined: Karnataka, Near Vanagur, Hassan district, 14. 08. 1967, C. J. Saldanha 10876 (JCB); Bisle ghat, Hassan district, 21. 08. 1969, C. J. Saldanha 14595 (JCB); Vanagur, Hassan district, 04. 09. 1969, C. J. Saldanha 17815 (JCB); Mankanahalli, Hassan district, 19. 09. 1969, C. J. Saldanha 15075 (JCB); Shiradi ghat, South Kanara district, 700 m, 03. 08. 1979, Saldanha, Ramesh & Sreenath KFP 8801 (CAL, JCB); Peak above Vanagur, Hassan district, 14. 08. 1971, T. P.

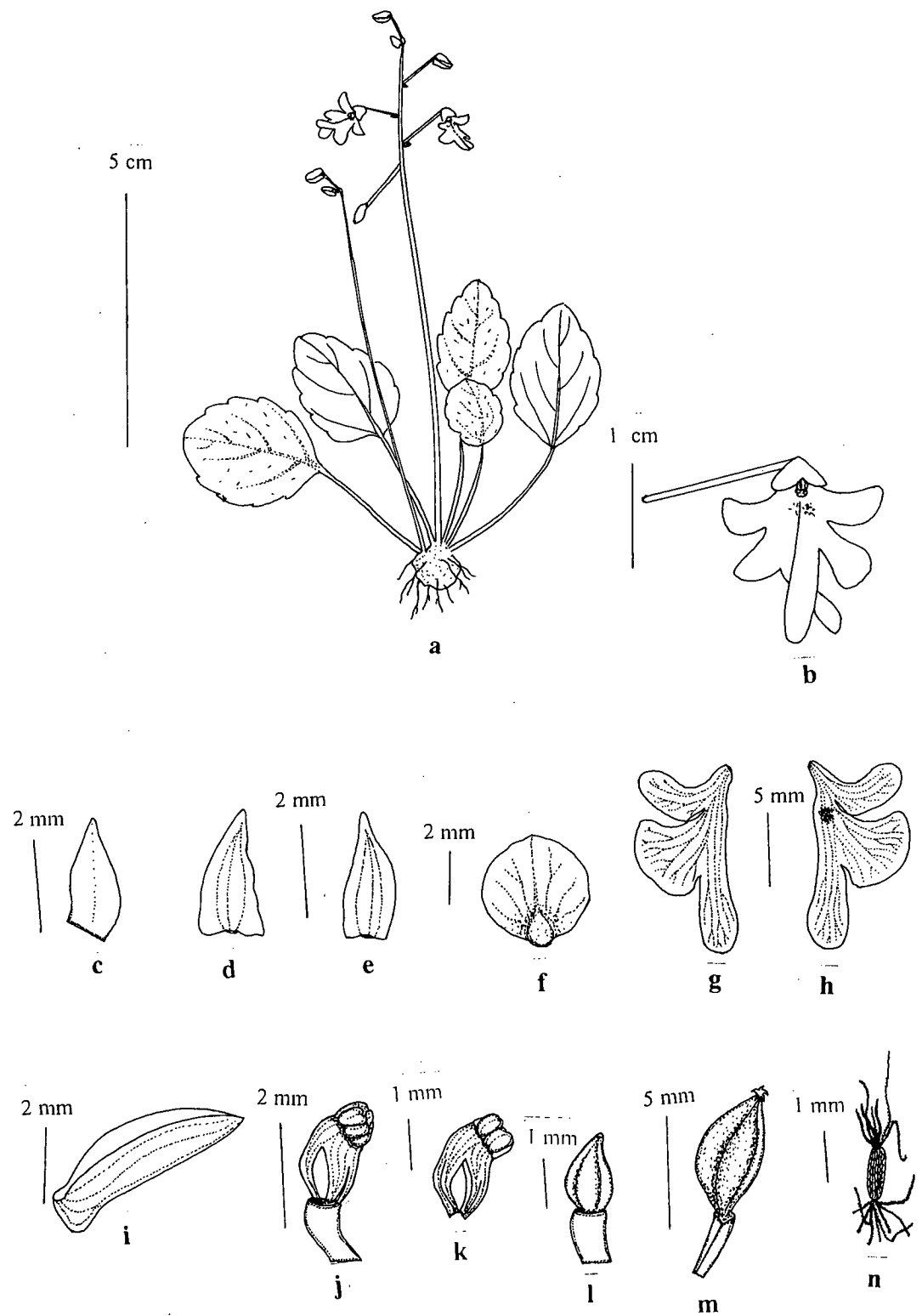
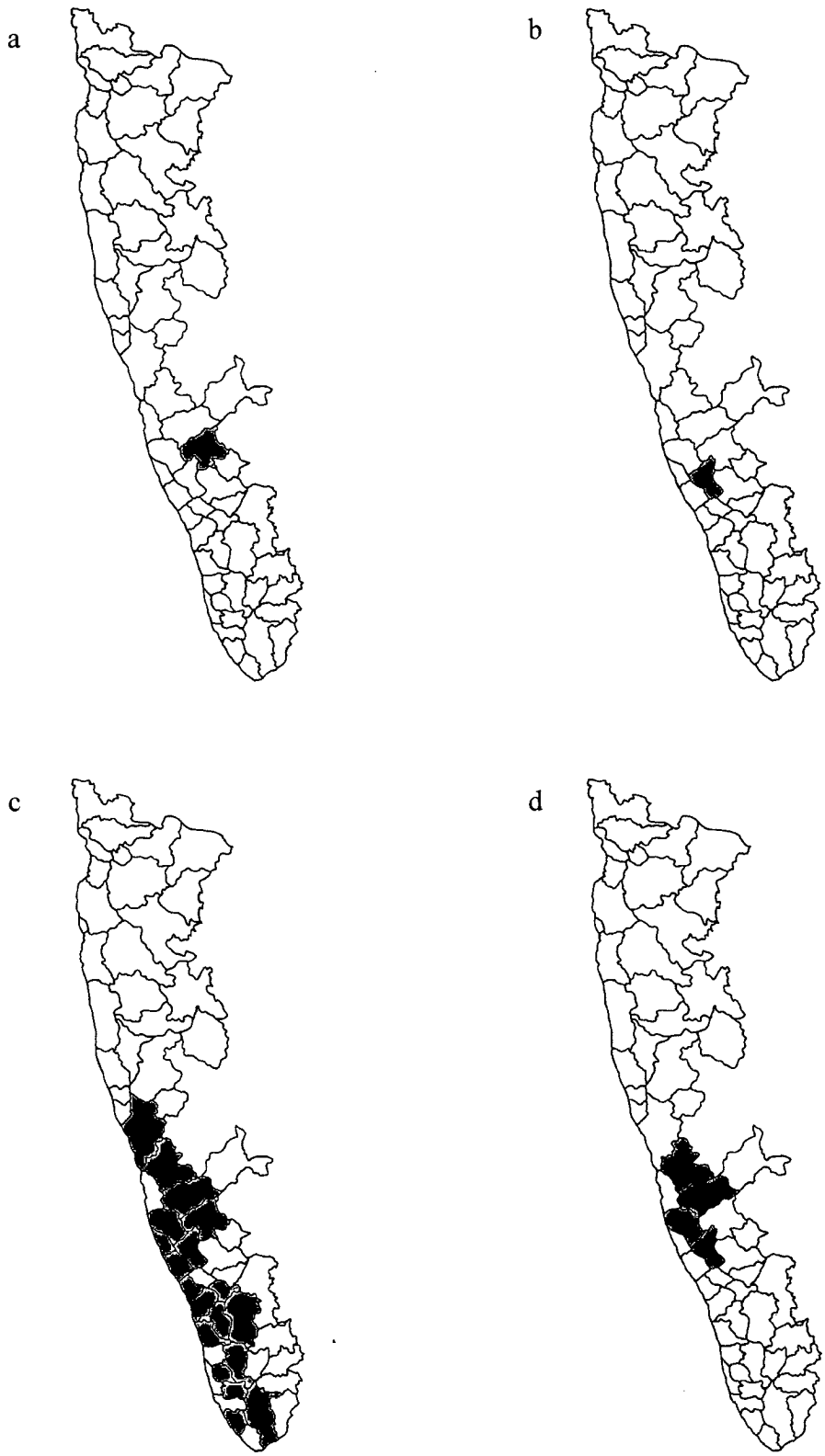


Fig. 7: *Impatiens stocksii* Hook. f. & Thomson a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g)wind petal (ventral view), h) wing petal (dorsal view), i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

Map 2: Distribution of a) *Impatiens clavata*; b) *I. dendricola*; d) *I. stocksii*; c) *I. scapiflora.*



Ramamoorthy HFP 2003 (JCB); Peetha, Bababudan, Chikmagalur district, 24. 07. 1973, V. Bhaskar 363 (MGM); Shiradi ghat, South Kanara district, 22. 08. 1980, C. J. Saldanha KFP 12080 (MGM); Indu Poovaia Estate (Madhe), 13. 08. 2005, Jyosna R. N. Dessai 49 (GUH); Talacauvery, Kodagu district, 13. 08. 2005, Jyosna R. N. Dessai 51 (GUH); Bisle ghat, Hassan district, 14. 08. 2005, Jyosna R. N. Dessai 56 (GUH); Kemmanagundi, Chikmagalur district, 05. 09. 2005, Jyosna R. N. Dessai 82 (GUH); Mankanahalli, Bisle Ghat, Hassan district, 16. 09. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 142 (GUH).

Note: The species is distinguished from others in section *Scapigerae* based on its white coloured flowers wherein the lip is saccate. The species is similar to *I. dendricola* in having white coloured flowers but differ in lacking distinct clavate spur and dorsal auricle.

Character	***I. stocksii***	***I. dendricola***
Spur	saccate	clavate
Dorsal auricle	absent	present

Ramachandran and Nair (1988), Mudaliar and Prasad (2000), Sasidharan (2004) and Nayar *et al.* (2006) consider *I. stocksii* as a synonym of *I. crenata*. However both the species differ in the following characters:

Character	***I. stocksii***	***I. crenata***
Margin of standard petal	entire	crenate
Wing petals	with tuft of yellow hairs	without tuft of yellow hairs
Lip	saccate	with a short obtuse spur

Hence *I. stocksii* is treated as a distinct species in this work.

Fischer (1936) describes the wing petal as two lobed and the lobes as filamentous thus introducing an element of doubt about the collection. However,

Hooker and Thomson (1859) in the protologue describe the wing petals as three lobed. The present collections from the Western Ghat regions of Karnataka match with this character.

Dalzell and Gibson (1861) and Blatter (1933) did not mention any specific locality for the species whereas Cooke (1901) quotes collections (by Stocks, Law and Woodrow) from mountains of Konkan and Kanara without any details. However in the present study the species could not be collected from outside Karnataka in the study area. Hence its existence in the above localities is doubtful.

The species was considered endemic to Karnataka untill Pandurangan and Nair (1996) reported it from Meenmutty, Idukki district of Kerala. In the description provided, the authors mention that the lip is saccate with 3–4 mm curved spur. The specimen cited by them is deposited at MH. The specimen is with a short spur (c. 3 mm long) in buds. Hence this cannot be *I. stocksii*. The flowers are not spread properly and hence the identity of the species could not be ascertained.

IUCN threat status: VU [D1].

Chromosome number: 2n = 14 (Bhaskar, 1976; 1980), 2n = 20 (Bhaskar and Razi, 1972–73).

Etymology: Latin: *stocksii* = in honour of John Ellerton Stocks.

PLATE 2

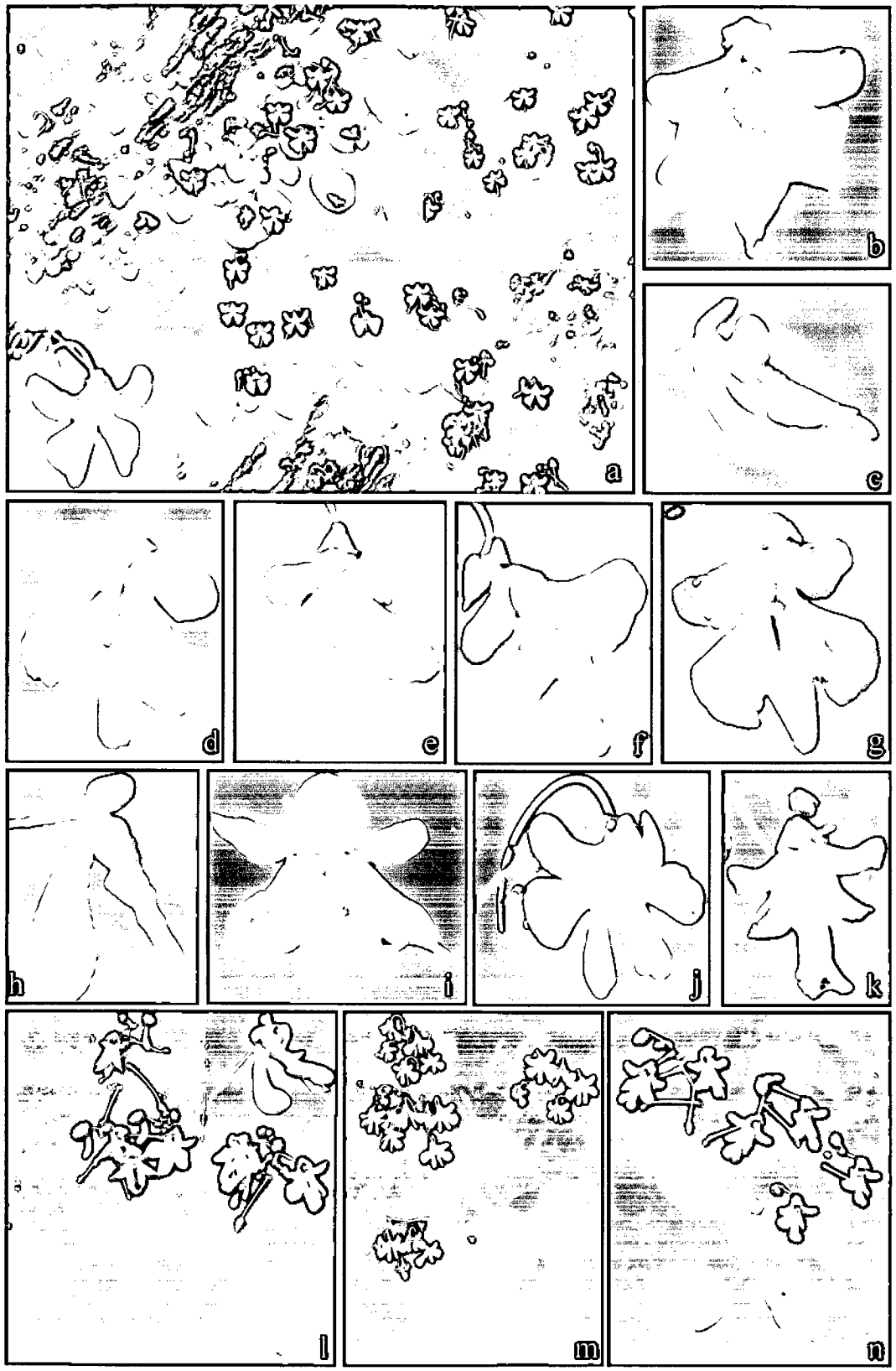


PLATE 2: a. *Impatiens acaulis* Arn.; b - d. *I. barberi* Hook. f.; e, f. *I. bhaskarii* sp. nov.; g, h. *I. clavata* Bhaskar; i, l. *I. dendricola* C. E. C. Fisch.; j, m. *I. scapiflora* Heyne ex Roxb.; k, n. *I. stocksii* Hook. f. & Thomson.

Section: Oppositifoliae Hook. f. & Thomson

Annual herbs; leaves opposite; flowers pedicelled, solitary, binate or fascicled in the axils of the leaves, ebracteate or minutely bracteate at the base; sepals elongate, linear, rarely ovate or lanceolate; seeds glabrous, usually globose, black, polished, glabrous (Hooker, 1906).

Key to the species (section *Oppositifoliae*)

1. Plants tomentose.....*I. tomentosa*
1. Plants glabrous.....(2)

2. Wing petals with a single lobe.....(3)
2. Wing petals bilobed.....(4)

3. Leaf glands present at the base of lamina; pedicel glabrous.....*I. minor*
3. Leaf glands absent at the base of lamina; pedicel with two longitudinal rows of hair.....*I. kleiniformis*

4. Spur < 0.8 cm long, hooked.....(5)
4. Spur > 1 cm long, straight or curved.....(8)

5. Dorsal auricle present.....(6)
5. Dorsal auricle absent.....*I. dalzellii*

6. Flowers pink in colour.....(7)
6. Flowers orange in colour.....*I. raziana*

7. Leaves linear to linear lanceolate, serrations acute; spur curved, straight or hooked.....*I. oppositifolia*
7. Leaves ovate, serrations cuspidate; spur bent, parallel to the lip.....*I. lawii*

8. Spur strongly curved, flat, broad in the middle, thick.....*I. chinensis*
8. Spur not curved, cylindrical, thin.....(9)

9. Distal lobe of wing petals stipitate, basal lobe triangular with acute apex.....*I. diversifolia*
9. Distal lobe of wing petals sessile, basal lobe ovate with obtuse apex.....(10)

10. Flowers > 2 cm across; spur as long as the pedicel.....*I. vivekananthanii* sp. nov.
10. Flowers < 1 cm across; spur shorter than the pedicel.....*I. tenella*

Impatiens chinensis L. Sp. Pl. 937. 1753; Hooker & Thomson in J. Proc. Linn. Soc. Bot. 4: 119. 1859; Dalzell & Gibson, Bombay Fl. 42. 1861; Hooker, Fl. Brit. India 1: 444. 1874 & in Rec. Bot. Surv. India 4: 46. 1906; Cooke, Fl. Bombay 1: 171. 1901; Gamble, Fl. Madras 1: 141. 1915; Ramamoorthy in Saldanha & Nicolson, Fl. Hassan District, 402. 1978; Sharma *et al.*, Fl. Karnataka Analysis, 37. 1984; Ramachandran & Nair, Fl. Cannanore, 78. 1988; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 131. 1997; Mudaliar & Prasad in Singh & Karthikeyan, Fl. Maharashtra Dicots. 1: 449. 2000. **TYPE** - CHINA. Linn. Herb. No. 1053.1 (LINN; Photo!).

Balsamina chinensis (L.) DC. Prodr. 1: 686. 1824.

Impatiens heterophylla Wall. ex Roxb. Fl. Ind. 2: 458. 1824. **TYPE** - Wall. Cat. 4748 (CAL!)

Impatiens cosmia Hook. f., Hook. Ic. Pl. t. 2915. 1910. **LECTOTYPE** - CHINA. Jungkun (Tungkun), *s. d.*, E. Faber, *s. n.* (W 0016508; Photo!). **Lectotype selected herein.**

Impatiens chinensis var. *brevicornis* Barnes in J. Indian Bot. Soc. 18(3): 99. 1939; Yoganarasimhan *et al.*, Fl. Chikmagalur District, 62. 1982; Sharma *et al.*, Fl. Karnataka Analysis, 37. 1984; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 131. 1997. **syn. nov. LECTOTYPE** – INDIA, Kerala, Travancore, Munnar, 20. 10. 1932, E. Barnes 558 (K; Photo!). **Lectotype selected herein.**

Annual herbs, 15 - 40 cm high. Stem quadrangular, glabrous, pinkish red in colour, rooting at lower nodes, branched; branches alternate. Leaves opposite, linear-lanceolate to linear oblong, sessile to shortly petiolate; petiole c. 5 mm long, decurrent on stem and ends as petiolar glands (sometimes glands are absent), lamina 3 – 8.5 × 0.8 – 1.5 cm, truncate to cuneate at base, serrate along margins, acuminate at apex, adaxial surface hairy, midrib distinct, lateral veins obscure, abaxial surface glabrous.

Flowers axillary, 2 - 4 per axil, dark pink with violet throat, 2 – 2.5 cm across, bracteate, pedicellate; bracts minute, linear, pink in colour, c. 3 × 1 mm, acuminate to aristate at apex, minutely hairy on costa dorsally; pedicel 3 – 3.8 cm long, pinkish red in colour, dialated, glabrous to pubescent with two (rarely one) longitudinal rows of hairs, deflexed in fruits. Lateral sepals linear-lanceolate to oblanceolate, 7 – 10 × 1 – 1.5 mm, acuminate at apex, minutely hairy on keel dorsally. Standard orbicular to reniform, 8.8 – 1 × 0.6 – 0.8 cm, glabrous, apically semi-obcordate, dorsally keeled, keel mucronate; mucro c. 1 mm long. Wing petals 1.8 – 2.4 × 1 – 1.4 cm, bilobed, basal lobe small, ovate, 5 – 7 × 4 – 5 mm, apically acute, distal lobe assymmetrically obovate, 1.3 – 1.6 × 1 – 1.4 cm, shortly stipitate, elevated at base, apically obtuse, auricled at base. Lip conical, 0.9 – 1.2 cm long, 6 – 7 mm deep, 4 – 6 mm wide, glabrous to minutely hairy (specially on veins), acuminate at apex, spurred; spur 1.8 – 2.5 cm long, inflated, broad in middle, strongly curved, thick, glabrous to minutely hairy, tip acute to notched. Column c. 5 × 3 mm, curved. Anthers c. 1 × 1 mm, pink in colour; filaments 5, c. 3.5 × 1 mm. Pistil c. 3 × 1.5 mm; ovary oblongoid-lanceoloid, glabrous. Fruit assymmetrically ellipsoid to lanceoloid, 1.5 – 2 × 0.5 – 0.7 cm, glabrous, stigma persistent; pedicel 3.3 – 3.8 cm long. Seeds globular, c. 3 × 3 mm, black, shining, glabrous, funiculus prominent (Fig. 8; Plate - 3a, b).

Fl. & Fr.: August – November.

Habitat: Growing along roadsides in evergreen forests, open plains, foot hill and on rock faces along with grasses.

Distribution: India to Southeast Asia. Widely distributed in Western Ghats (Map - 3a).

Specimen examined: Karnataka: Maranahalli, Bisle ghat, Hassan district, 22. 08. 1969, C. J. Saldanha 14611 (JCB); Maranahalli, Bisle ghat, Hassan district, 03. 09.

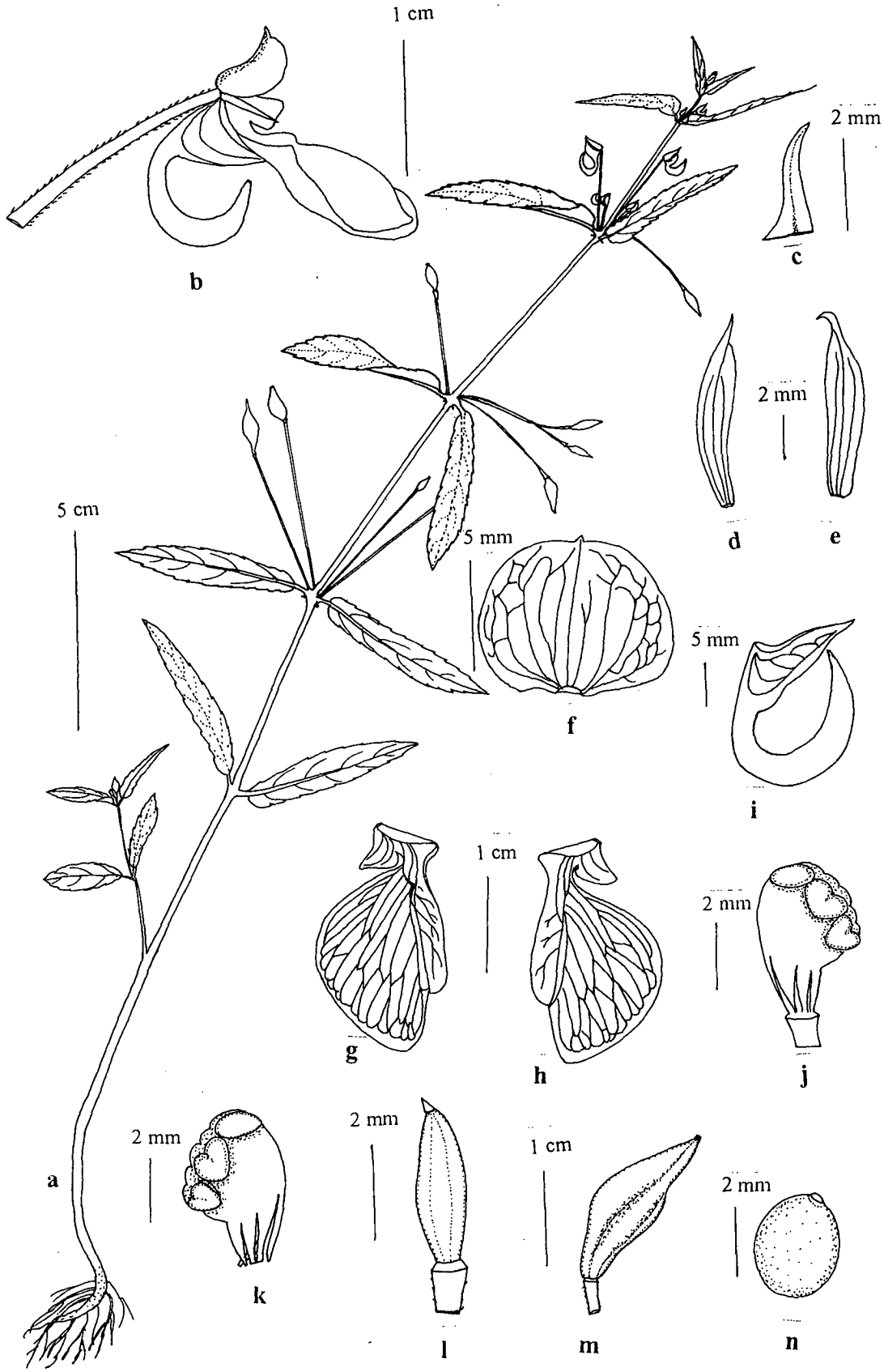


Fig. 8: *Impatiens chinensis* L. a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g) lip, g, h) wing petals, i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

1969, C. J. Saldanha 14725 (JCB); Vanagur, Bisle ghat, Hassan district, 14. 08. 1971, T. P. Ramamoorthy HFP 2054 (JCB); Charmadi ghat, Chikmagalur district, 13. 08. 1981, C. J. Saldanha KFP 13459 (JCB); Kudremukh, Chikmagalur district, 18. 11. 2004, Jyosna R. N. Dessai & M. K. Janarthanam 27 (GUH); Charmadi ghat, Chikmagalur district, 15. 08. 2005, Jyosna R. N. Dessai M. K. Janarthanam 61 (GUH); Bisle ghat, from Subramanya to Vanagur, Hassan district, 16. 09. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 137, 139 (GUH); Mankanhalli, Bisle ghat, Hassan district, 16. 09. 2006, Jyosna R. N. Dessai M. K. Janarthanam 140 (GUH); Talacauvery, Kodagu district, 17. 09. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 148 (GUH).

Kerala: Munnar, Travancore, 20. 10. 1932, E. Barnes 556, 557 (K, Photo!); Kanan Devan hills, Munnar, Travancore, September 1933, E. Barnes 553 (K, Photo!); Munnar, Travancore, September 1933, E. Barnes 554,606 (K, Photo!); Below Kandalur, Travancore High Range, September 1937, E. Barnes 1729 (K, Photo!).

Note: *Impatiens chinensis* is similar to *I. diversifolia* Wall ex Wight & Arn. but differs in having strongly curved and thick spur that is broad in the middle. The strongly curved, thick spur is the key character for identification of this species in section *Oppositifoliae*.

Plants growing in open plains are short, leaves are small and the plants bear white to light pink flowers.

Impatiens chinensis is a widely distributed species and shows a high degree of variation in characters like the shape of leaves, presence or absence of stipular glands, hairy nature of pedicel with one or two longitudinal rows of hairs or absent. Hence several species have been described that are referable to this single variable entity.

During the present study of *Impatiens* in the northern and central Western

Ghats two distinct entities that were referred to as varieties of *I. chinensis* in a local Flora (Saldanha 1996) were collected. Outside the study area no other variety has been recognised under this species, though *I. cosmia* Hook. f., *I. crassicornu* Hook. f., *I. ecalcarata* Collet & Hemsl., *Impatiens fasciculata* Lam., *I. heterophylla* Wall. ex Roxb., *I. setacea* Colebr. are treated as synonyms of *I. chinensis*. Hence to properly understand the taxonomy and correct application of names, protologues of *I. chinensis* and all its synonyms including those at variety level were critically examined along with their types.

Linnaeus (1753) described *Impatiens chinensis* based on a specimen collected from China. He described its spur as, "*Nectarium valde arcuatum crassum*". Though the type of *I. chinensis* has not been mentioned in the Linnean typification project, a specimen labelled as *I. chinensis* bearing number 1053.1 (http://www.linnean-online.org/11124) in the Linnean herbarium clearly depicts the spur character described by Linneaus in *Species Plantarum*. Later, Lamarck (1785) published *I. fasciculata* based on Van Rheede's (1689) illustration from *Hortus Malabaricus*. The illustration (Vol. IX t. 47) in Hortus Malabaricus, that formed the basis for *I. fasciculata* shows that spur is filiform and neither arcuate nor thick as described by Linneaus for *I. chinensis*. Further observations show that the wing petal of latter is with a distinct basal lobe that is absent in Rheede's illustration. Hence, *I. fasciculata* Lam. is being reinstated as a distinct species.

Wight and Arnott (1834) treated *I. fasciculata* as distinct species, but described the wing petal as bilobed that has been well depicted by Wight (1844) in the Icones (t. 748). Hooker (1852) too illustrated *I. fasciculata* in colour but the plants were grown from the seeds obtained from Thwaites from Ceylon. He observed that the name "*fasciculata*" was not appropriate, as the flowers were solitary in axils. He also

noticed through Wight's illustration a conspicuous 'spur' at the base of decurrent leaf on stem that he called as stipules. These characters are conspicuously absent in Van Rheede's illustration thus showing that what had been considered by these authors as *I. fasciculata* was distinct from that of Lamark's thus paving way for confusion.

I. setacea was described as *Balsamina setacea* by Hooker (1824) in his Exotic flora. An excellent coloured illustration therein shows the spur of the lip as long and thin one but projecting backwards. This is seen in all the three flowers shown in colour illustration and also in the line drawing of dissected flower. This character is entirely different from the spur of *I. chinensis* and *I. fasciculata.* The distal lobe of the wing petal is also without a notch at the apex. Hence this species is reinstated as a distinct entity here. Incidentally, while publishing *Balsamina setacea* Hooker also quoted "*Impatiens setacea* Colebr. MSS. ined." under the name. Thus *I. setacea* Colebr. has been published as pro. syn. and later authors directly quoted *I. setacea* Colebr. as synonym of *I. chinensis*. Hence, a new combination is proposed here.

Since *I. fasciculata,* as illustrated by Wight (1844) and Hooker (1852) has been synomised under *I. chinensis* by Hooker and Thomson (1859), later authors mistook it for true *I. chinensis.* This is evident as subsequent collection of actual *I. chinensis* with thick and strongly curved spur led Barnes (1939) to describe a new variety. The description of *I. chinensis* var. *brevicornis* Barnes exactly matches with *I. chinensis* especially in its spur character and paradoxically the spur character formed the basis for this new variety. Hence, *I. chinensis* var. *brevicornis* is herein merged under *I. chinensis*. Since Barnes did not designate any type for this taxon, a lectotype has been designated herein.

Hooker (1852, 1874) also quotes *I. heterophylla* Wall. ex Roxb. as a synonym of *I. fasciculata.* The type of *I. heterophylla* in Wallich herbarium (Cat. no. 4748!) has

been examined and found that it is conspecific to *I. chinensis*.

Hooker (1910b, 1910c) described two more species of *Impatiens* from China. Both these species are treated as conspecific to *I. chinensis* in Flora of China (Yi-ling *et al.*, 2007). *Impatiens cosmia* has been described based on the specimens collected from Jungkun, China by Fr. Faber (Herb. Mus. Palat. Vindobon) and from Chekiang by Capt. Jacobs ("Herb. Kew"). The former specimen could be traced at W and the photograph has been studied (http://herbarium.univie.ac.at/database/detail.php?ID=99735). The spur of the flower in Faber's specimen and in the illustration is though slightly different from the typical *I. chinensis*, it can be considered as a permissible variation. Hooker also considered it a form of *I. chinensis*. However, there is a separate flower that is not organically connected to the plant on herbarium sheet and also an additional illustration of spur on herbarium sheet and in protologue that is entirely different from that of the flower attached to the plant, possible a mix up. As there is more than one original specimens designation of lectotype becomes necessary. Because the herbarium sheet at W has been used for illustration in protologue I herein select it as lectotype of *I. cosmia* (excluding the unattached flower).

Impatiens crassicornu is characterised by its spur that is forked a little below the apex. This is very well depicted in one of the dissected flower, a bud present on the habit and the illustration made by Hooker on the sheet (http://herbarium.univie.ac.at/database/detail.php?ID=100804). However, the spur on the other dissected flower is without the forked nature. Apart from the above character the species bears ovate-lanceolate lateral sepal, dorsally crested standard petal and oblong basal lobe thus distinguishing it from *I. chinensis*. These characters support independent specific status for *I. crassicornu* and hence the species is being reinstated.

Impatiens ecalcarata Collet & Hemsl. has been reduced to a variety under *I. chinensis* by Hooker (1906). However, this is distinct from the latter in complete absense of spur that has been critically illustrated by Collet and Hemsley in their protologue (Collet and Hemsley 1890). They also mention that they have observed copious healthy specimens all exhibiting the same character. Hence, its status as a distinct species is being reinstated herein.

Chromosome number: n = 8 (Song *et al.*, 2003).

IUCN threat status: LC.

Etymology: Latin: *chinensis* = referring to China.

Impatiens dalzellii Hook. f. & Thomson in J. Proc. Linn. Soc. Bot. 4: 123. 1859; Dalzell & Gibson, Bombay Fl. 43. 1861; Hooker, Fl. Brit. India 1: 449. 1874 & in Rec. Bot. Surv. India 4: 46. 1906; Cooke, Fl. Bombay 1: 173. 1901; Blatter in J. Bombay Nat. Hist. Soc. 33: 312. 1933; Lakshminarasimhan & Sharma, Fl. Nasik District, 114. 1991; Deshpande *et al.*, Fl. Mahableshwar 1: 114. 1993; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 138. 1997; Mudaliar & Prasad in Singh & Karthikeyan, Fl. Maharashtra Dicots. 1: 443. 2000.

Annual herbs, 30 – 50 cm high. Stem terete, swollen at nodes, light green in colour, glabrous, branched; branches opposite. Leaves opposite, broadly lanceolate to oblong-lanceolate, 5 – 8 × 2 – 3 cm, truncate at base, serrate along margin, acute at apex, glabrous on both surfaces, membranous, dark green above, pale green beneath, lateral veins 4 – 6 pairs, petiolate; petiole short, c. 3 mm, glabrous, light green. Flowers axillary, fascicled, 3 – 6 in each axil, 0.8 – 1 cm across, yellow in colour, bracteate, pedicellate; bracts lanceolate, light green in colour, c. 1.8 × 0.8 mm, acuminate at apex, margin entire, pedicel slender, 2 – 2.5 cm long, terete, glabrous,

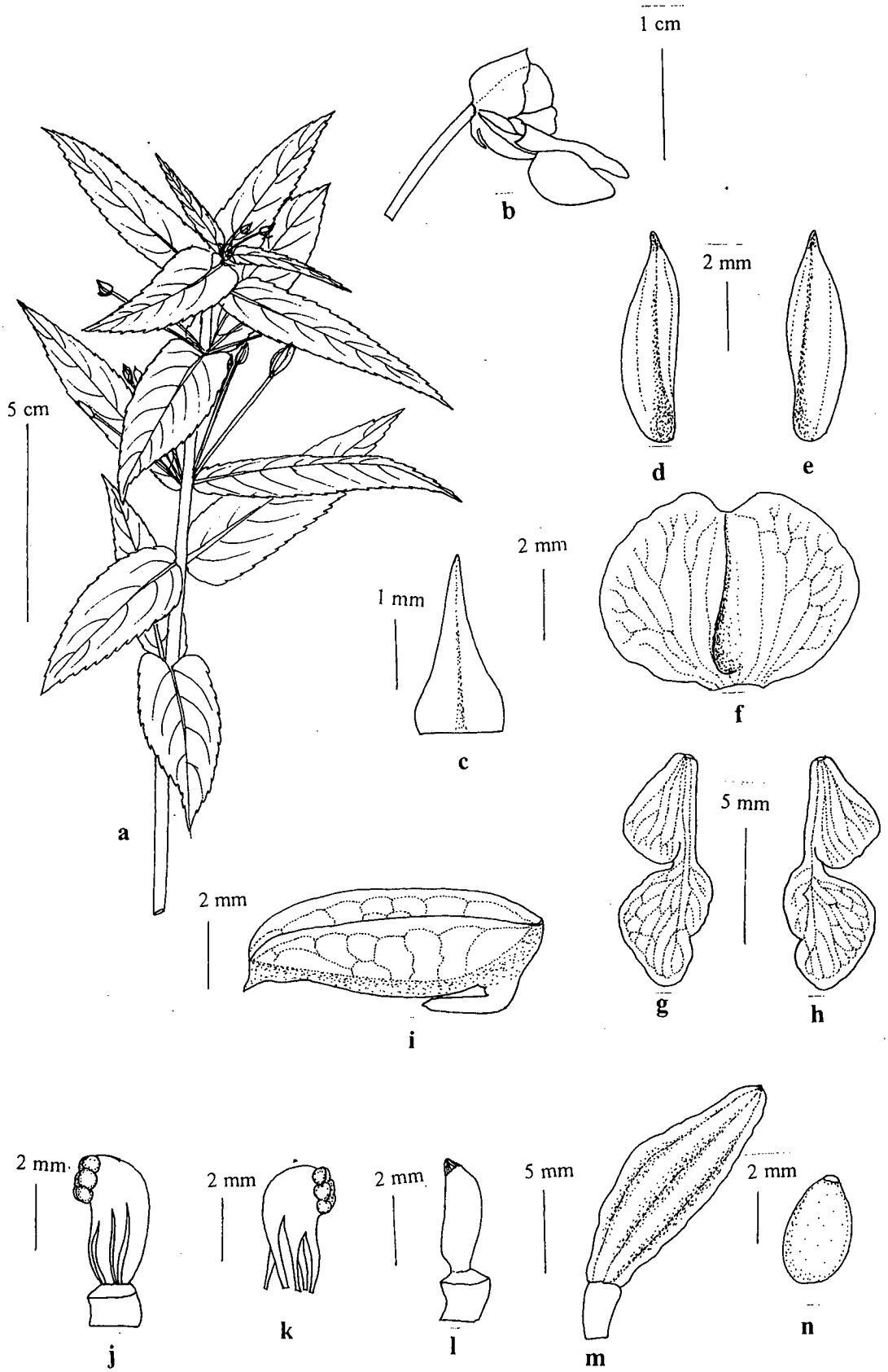


Fig. 9: *Impatiens dalzellii* Hook. f. & Thomson a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g, h) wing petals, i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

deflexed in fruits. Lateral sepals 4 – 6 × 1 – 1.5 mm, oblanceolate, greenish yellow in colour, glabrous, acute to acuminate at apex, veins 3, middle more distinct, slightly keeled dorsally. Standard broadly orbicular, 5 – 7 × 6 – 8 mm, yellow in colour, concave, obcordate at apex, dorsally keeled (keeled surface green in colour and with teeth-like outgrowth), glabrous. Wing petals 1.1 – 1.4 × 0.5 – 0.6 cm, bilobed, yellow in colour with orange to brown streaks at base, lobes subequal, basal lobe broadly ovate, 5 – 6 × 4 – 5 mm, rounded at apex, distal lobe ovate, 6 – 8 × 4 – 5 mm, acute at apex, slightly notched in upper half towards inner side. Lip boat shaped, 7 – 9 × 3 – 4 mm long, 3 – 4 mm deep, 3 – 4 mm wide, yellow in colour with reddish brown streaks within, glabrous, spurred; spur short, c. 2 mm long, tubular, glabrous, yellow in colour, tip green in colour, rounded. Column c. 4.5 × 2 mm, slightly curved; anthers c. 1 × 1 mm, yellow in colour; filaments 3 – 4 mm long, c. 1 mm wide, yellow in colour. Pistil c. 3.5 × 1 mm; ovary ellipsoid, lanceoloid to oblongoid, glabrous. Capsule 1 – 1.9 × 0.4 – 0.5 cm, ellipsoid, with distinct ridges and furrows, dark green in colour, glabrous; pedicel 3.5 – 4.1 cm long. Seeds oblongoid, c. 4 × 2 mm, black, smooth, shining, laterally compressed (Fig. 9; Plate- 3c, d, e).

Fl. & Fr.: July – October.

Habitat: Found growing in open areas, on grassy hill slopes, along the periphery of semievergreen forests and lateritic plateaus.

Distribution: Endemic to Western Ghats of Maharashtra (Map - 3b).

Specimens examined: Maharashtra: Concan, *s. d.*, Stocks *s. n.* (MH- 86777); Purandhar fort, Pune district, 22. 09. 1902, R. K. Bhide 1025 (BLAT); Purandhar hill fort, Pune district, 25. 10. 1944, H. Santapau 5304 (BLAT); Purandhar, Pune district, July end 1945, Lesze 7277 (BLAT); Purandhar hill, behind RC church, Pune district, 29. 08. 1945, H. Santapau 7084 (BLAT); Purandhar, level path above camp, Pune

district, 31. 08. 1945, H. Santapau 7144, 7145, 7146, 7147, 7148 (BLAT); Purandhar camp, Pune district, 10. 07. 1950, H. Santapau 11332 (BLAT); Lodwick point, Mahableshwar, Satara district, 17. 08. 1951, H. Santapau 13111, 13112 (BLAT); Lingmala, Mahableshwar, Satara district, 18. 08. 1951, H. Santapau 13182, 13183 (BLAT); Mahableshwar, Satara district, 09. 07. 1954, P. V. Bole Bole-1168 (BLAT); Purandhar, Pune district, 12. 08. 1955, N. A. Irani, NI 1052 (BLAT); Sinhagad, Pune district, 25. 08. 1956, V. D. Vartak 5592 (MGM); Mahabaleshwar, Satara district, 10. 09. 1956, S. D. Mahajan 6847 (CAL); Wilson point road, Mahableshwar, Satara district, 12. 10. 1957, S. D. Mahajan 27172 (CAL); Hotel Lake, Mahableshwar, Satara district, 14. 09. 1958, H. Santapau 22706 (BLAT); Mahableshwar, Satara district, 13. 09. 1959, H. Santapau 23263 (BLAT); Mahableshwar (along Petit road), Satara district, 13. 09. 1959, Y. A. Merchant 1280 (BLAT); Mahableshwar, Satara district, 13. 09. 1959, Y. A. Merchant 1273 (BLAT); Sinhagad, Pune district, 03. 07. 1961, U. R. Puram *s. n.* (MGM); Khandala, Satara district, 21. 08. 1992, Bhiva (MH); Kas, Satara district, October 1993, M. P. Bachulkar-Cholekar 5419 (SUK); Wilson point, Mahableshwar, Satara district, *s. d.*, B. Balaman BB 305 (BLAT); Ambenini ghat, Mahableshwar, Satara district, 17. 09. 2005, Jyosna R. N. Dessai 95 (GUH); Lingmala fall, Mahableshwar, Satara district, 17. 09. 2005, Jyosna R. N. Dessai 97 (GUH); 1 km before Kas plateau from Satara, Satara district, 18. 08. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 114 (GUH); Panchgani, Satara district, 19. 08. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 121 (GUH).

Note: Endemic to Maharashtra. But, Rao (1986) included the species in his Flora of Goa. He mentions the locality as Amdiga near Bhutpal in Canacona taluka. However, the species could not be collected from the locality mentioned in his Flora or any other place in Goa. There are no collections of this species from this locality in BSI or

any other herbaria. Hence the species is excluded for this region.

The yellow colour of the flowers easily distinguishes this species from other species in the section *oppositifoliae* and also this is the only yellow coloured *Impatiens* species in study area. However, *Impatiens dalzellii* Hook. f. & Thomson is similar to *I. oppositifolia* L., but differs in having broadly lanceolate to oblanceolate leaves, yellow coloured flowers with glabrous pedicel, straight spur that is bent and black coloured oblongoid seeds rather than linear-lanceolate leaves, pink flowers with glabrous to pubescent pedicel, hooked spur and brown coloured globular seeds.

The flowers are either solitary or in fascicle forming an umbel. This made Santapau to assign a new variety for the species. This collection is deposited at BLAT bearing collection number 7144. However, the present collections show solitary as well as fascicled forms of inflorescence on the same plant and hence should not be treated as a variety under this species. Bhaskar and Razi (1979) found that the pollen character of var. *umbellata* is similar to proper *I. dalzellii.* Thus, Bhaskar (1986) considers the presence of umbellate inflorescence as atavism (the reappearance in an individual of characteristics of some remote ancestor that have been absent in intervening generations) and opines that it should not be treated as a separate taxonomic entity.

Chromosome number: n = 8 (Zinov'eva-Stahevitch and Grant, 1982, 1984).

IUCN threat status: EN [B1ab(iii)].

Etymology: Latin: *dalzellii* = in honour of Nicol [Nicholas] Alexander Dalzell, Scottish botanist and forester.

Impatiens diversifolia Heyne ex Wight & Arn., Prodr. Fl. Ind. Orient. 139. 1834; Hooker & Thomson in J. Proc. Linn. Soc. Bot. 4: 121. 1859; Hooker, Fl. Brit. India 1.

446. 1874 & in Rec. Bot. Surv. India 4: 46. 1906; Gamble, Fl. Madras 1: 140. 1915; Blatter in J. Bombay Nat. Hist. Soc. 33: 310. 1933; Ramamoorthy in Saldanha & Nicolson, Fl. Hassan District, 402. 1978; Vajravelu in Nair & Henry, Fl. Tamil Nadu 1: 53. 1983; Sharma *et al.*, Fl. Karnataka Analysis, 37. 1984; Ahmedullah & Nayar, Endemic plants of the Indian region 1: 192. 1986; Ramachandran & Nair, Fl. Cannanore, 79. 1988; Mohanan & Henry, Fl. Thiruvananthapuram, 97. 1994; Saldanha in Saldanha, Fl. Karnataka 2: 252, t. 33. 1996; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 141. 1997; Mudaliar & Prasad in Singh & Karthikeyan, Fl. Maharashtra Dicots. 1: 463. 2000; Bhat, Fl. Udupi, 88, t. 22. 2003. **TYPE** - Wall. Cat. 4749 (CAL!)

Annual erect herbs rooting at lower nodes, 20 – 40 cm high. Stem quadrangular, glabrous, red in colour. Leaves opposite-decussate, 3 – 4.5 × 0.9 – 1.5 cm, petiolate; petiole short, c. 2 mm long, glabrous, decurrent on stem and ending as petiolar glands, lamina linear-lanceolate, rounded to truncate at base, distantly crenate along margin, acute to acuminate at apex, pubescent above, glabrous beneath, midrib distinct, lateral veins obscure. Flowers axillary, 3 in each axil, pink in colour, c. 2.1 cm across, bracteate, pedicellate; bracts minute, c. 1.5 × 0.5 mm, acute at apex, glabrous, pedicel 2.5 – 3 cm long, with 2 lines of longitudinal hairs, deflexed in fruits. Lateral sepals 2, linear to linear-oblanceolate, c. 6 × 1 mm, acuminate at apex, glabrous, veins 3, parallel. Standard orbicular, c. 6.5 × 5 mm, glabrous, apically mucronate, deeply concave. Wing petals 1.2 – 1.5 × 0.7 – 1 cm, bilobed, basal lobe much smaller than distal lobe, c. 3 × 1 mm, linear to lanceolate, apically acute to mucronate, distal lobe broadly obovate, apically obtuse, c. 1.2 × 1 cm, elevated at base, shortly stipitate, dorsal auricle small, rounded. Lip saccate, 0. 9 – 1.3 cm long, 3 – 4 mm deep, 3 – 4 mm wide, glabrous, tip acuminate, spurred; spur 1.5 – 2.2 cm

long, tubular, coiled into a semicircular ring, straight to curved upwards, tapering from base to tip, tip notched or rounded. Column c. 4 × 2 mm, slightly curved. Anthers c. 1 × 1 mm, cohering above pistil; filaments 5, c. 3 × 1 mm, light pink in colour; pistil c. 3.5 mm long; ovary ellipsoid, c. 3 × 1 mm long, glabrous. Capsule assymmetrically ellipsoid, 1 – 1.3 × 0.4 – 0.6 cm long, glabrous, pedicel 3 – 3.4 cm long. Seeds ovoid c. 1.5 × 1 mm, black to brown in colour, shining, glabrous (Fig. 10; Plate - 3f, g, h).

Fl. & Fr.: July – October.

Habitat: Along field bunds, grassy meadows and near streams, up to 850 m.

Distribution: Endemic to the Western Ghats of Karnataka and Kerala (Map - 3c).

Specimens examined:

Karnataka: Sullia, 25. 10. 1900, C. A. Barber, *s. n.* (MH-2062); Hulical, Shimoga district, 25. 08. 1965, R. Sundara Raghavan 90212 (CAL); Vanagur, 23. 09. 1971, C. J. Saldanha & K. N. Gandhi HFP 2132, 2164 (JCB); Yernal, South Kanara district, 29. 07. 1978, C. J. Saldanha, Ramesh & Ravindra KFP 2022 (CAL); Mavinmanay, Baindur-Kollur road, 04. 09. 2005, Jyosna R. N. Dessai & M. K. Janarthanam 71 (GUH).

Kerala: Tirunelli, Wayanad district, 850 m, V. S. Ramachandran *s. n.* (CAL).

IUCN threat status: EN [B1ab(iii)].

Etymology: Latin: *diversi-* = diversely; *folia* = leaved.

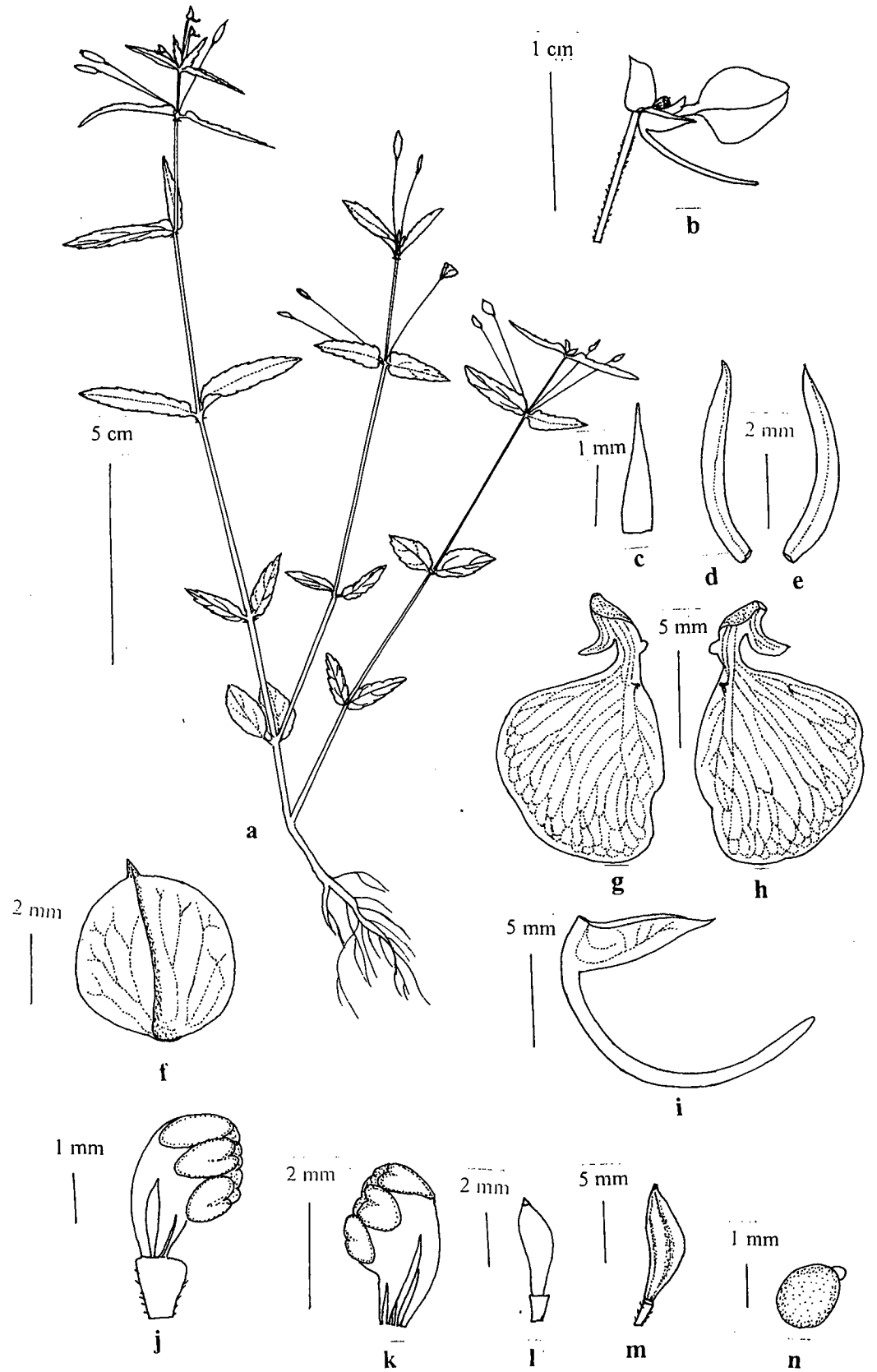


Fig. 10: *Impatiens diversifolia* Wall. ex Wight & Arn. a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g, h) wing petals, i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

PLATE 3

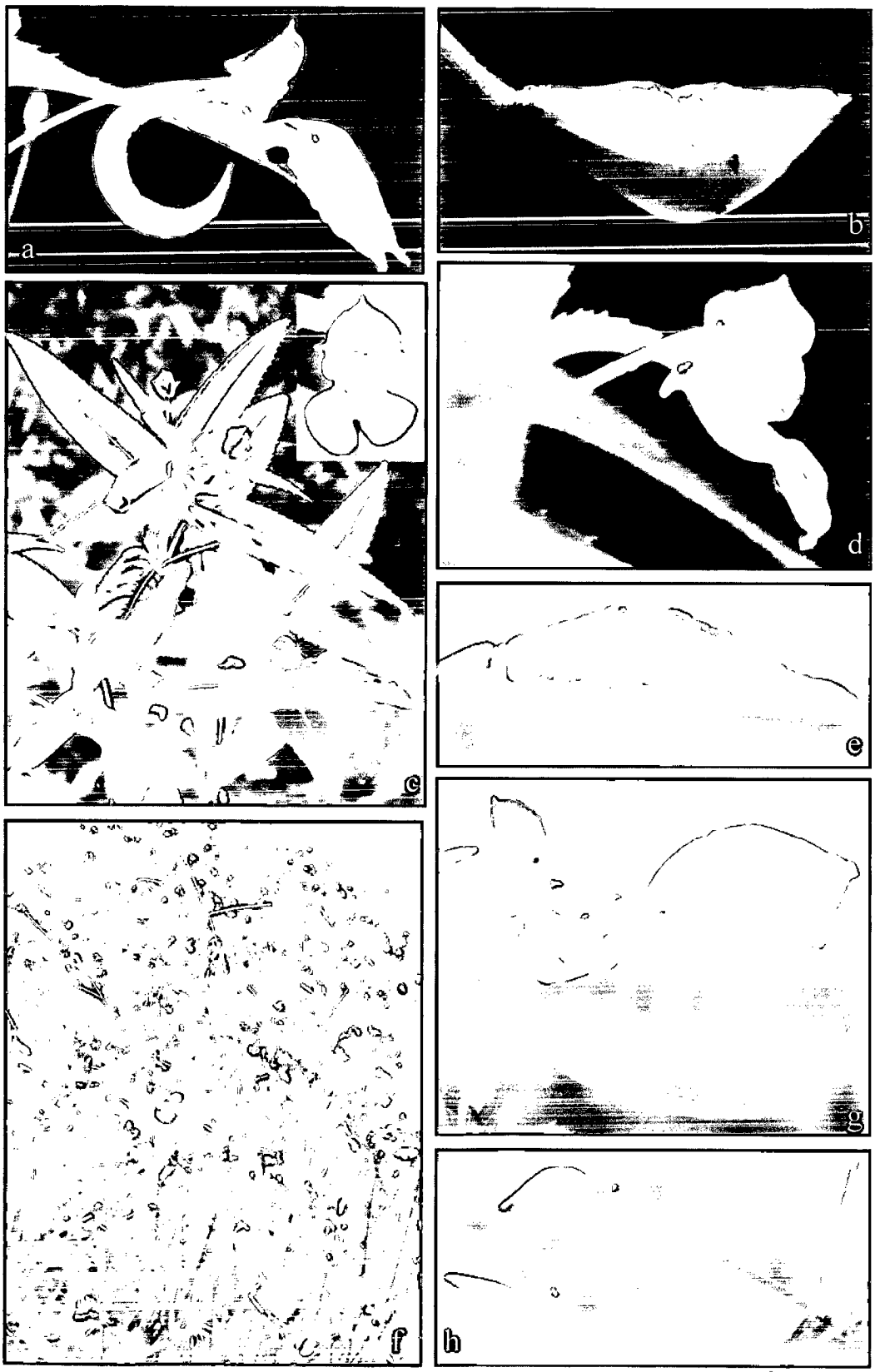


PLATE 3: a, b. *Impatiens chinensis* L.; c - e. *I. dalzellii* Hook. f. & Thomson; f - h. *I. diversifolia* Heyne ex Wight & Arn.

Impatiens kleiniformis Sedgw. in Rec. Bot. Surv. India 6: 351. 1919; Blatter in J. Bombay Nat. Hist. Soc. 33: 311. 1933; Fl. Karnataka Analysis, 38. 1984; Rao, Fl. Goa 1: 59. 1985; Kulkarni, Fl. Sindhudurg, 60. 1988; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 164. 1997; Mudaliar & Prasad in Singh & Karthikeyan, Fl. Maharashtra Dicots. 1: 455. 2000; Yadav & Sardesai, Fl. Kolhapur District, 95. 2001. **NEOTYPE** – INDIA, Goa, South Goa district, Anmod ghat, 25. 07. 2004, M. K. Janarthanam 08 (GUH). **Selected herein**.

Annual herbs, 15 – 40 cm high, stem branched or unbranched, semiterete, glabrous, green in colour. Leaves opposite-decussate, sessile to shortly petiolate; petiole 3 – 6 mm long, glabrous; lamina lanceolate, linear-lanceolate, oblong to elliptic, 5 – 14 × 2 – 3.8 cm, obtuse at base, crenate to serrate along margins, acuminate at apex; crenae apiculate; adaxial surface hairy, abaxial surface glabrous, veins 5 – 7 pairs. Flowers axillary, 2 – 3 per axil, pink with violet throat, 0.8 – 1.2 cm across, bracteate, pedicellate; bracts minute, triangular to ovate, c. 1 × 0.75 mm, acute to acuminate at apex, glabrous; pedicel 2.5 – 3 cm long, pubescent with two longitudinal rows of hairs, deflexed in fruits. Lateral sepals 2, linear-lanceolate, c. 5 × 1 mm, acuminate at apex, dorsally hairy on costa and side facing downwards, pale green in colour. Standard ovate, c. 4 × 3 mm, acute at apex, pinkish white in colour, dorsally keeled; keel hairy, green in colour. Wing petals 8 – 10 × 5 – 6 mm; basal lobe rudimentary or absent, c. 0.5 × 0.5 mm, assymmetrically ovate, acute to obtuse at apex; distal lobe c. 7 × c. 6 mm, assymmetrically ovate, clawed at base, claw c. 2.5 × 0.5 mm. Lip saccate to conical, c. 6 mm long, c 2 mm deep, c. 3 mm wide, acuminate at apex, glabrous, spurred; spur 1 – 1.3 cm long, compressed, straight or curved, broad in centre, pale green in colour, notched to rounded at apex, glabrous. Column c. 3 × 1 mm, curved. Anthers c. 0.5 × 0.5 mm, pink in colour. Pistil c. 2.5 × 0.5 mm; ovary

lanceoloid, c. 2 × 0.5 mm, glabrous. Capsule linear-ellipsoid to fusiform, 1.2 – 1.7 × 3 – 4 mm, glabrous; pedicel 3 – 3.5 cm long. Seeds globular, compressed, c. 1.5 mm in diameter, black to brown in colour, glabrous, shining, funiculus present (Fig. 11; Plate - 4a, b, c).

Fl. & Fr.: June – October.

Habitat: Grows along roadsides, in rock crevices, sometimes also occurs as an epiphyte.

Distribution: Endemic to the Western Ghats of Goa, Karnataka and Maharashtra (Map – 3d).

Specimens examined:

Goa: Anmod ghat, South Goa district, 25. 07. 2004, M. K. Janarthanam 08 (GUH); Surla, North Goa district, 01. 08. 2004, M. K. Janarthanam 14 (GUH); Chorla ghat, North Goa district, 27. 08. 2005, Jyosna R. N. Dessai 67 (GUH); Chorla, North Goa district, 27. 08. 2005, Jyosna R. N. Dessai 68 (GUH).

Karnataka: Castle rock, Belgaum district, August 1919, L. J. Sedgwick 2841 (CAL); Karwar, North Kanara district, October 1919, Hall & Mc Cann 34258 (BLAT); Guddshali, Karwar, North Kanara district, *s. d.*, L. J. Sedgwick 6629 (CAL).

Maharashtra: Amboli, near water fall, Sindhudurg district, 17. 07. 2004, Jyosna R. N. Dessai & M. K. Janarthanam 03 (GUH); Amboli ghat, Sindhudurg district, 16. 07. 2005, Jyosna R. N. Dessai 31 (GUH); Amboli ghat, Sindhudurg district, 09. 08. 2005, Jyosna R. N. Dessai 42 (GUH); Amboli ghat, Sindhudurg district, 06. 10. 2007, Jyosna R. N. Dessai 171 (GUH).

Notes: *Impatiens kleiniformis* is morphologically similar to *Impatiens minor* but differs in lacking glands at the base of the lamina, and in having pedicel with two longitudinal rows of hairs.

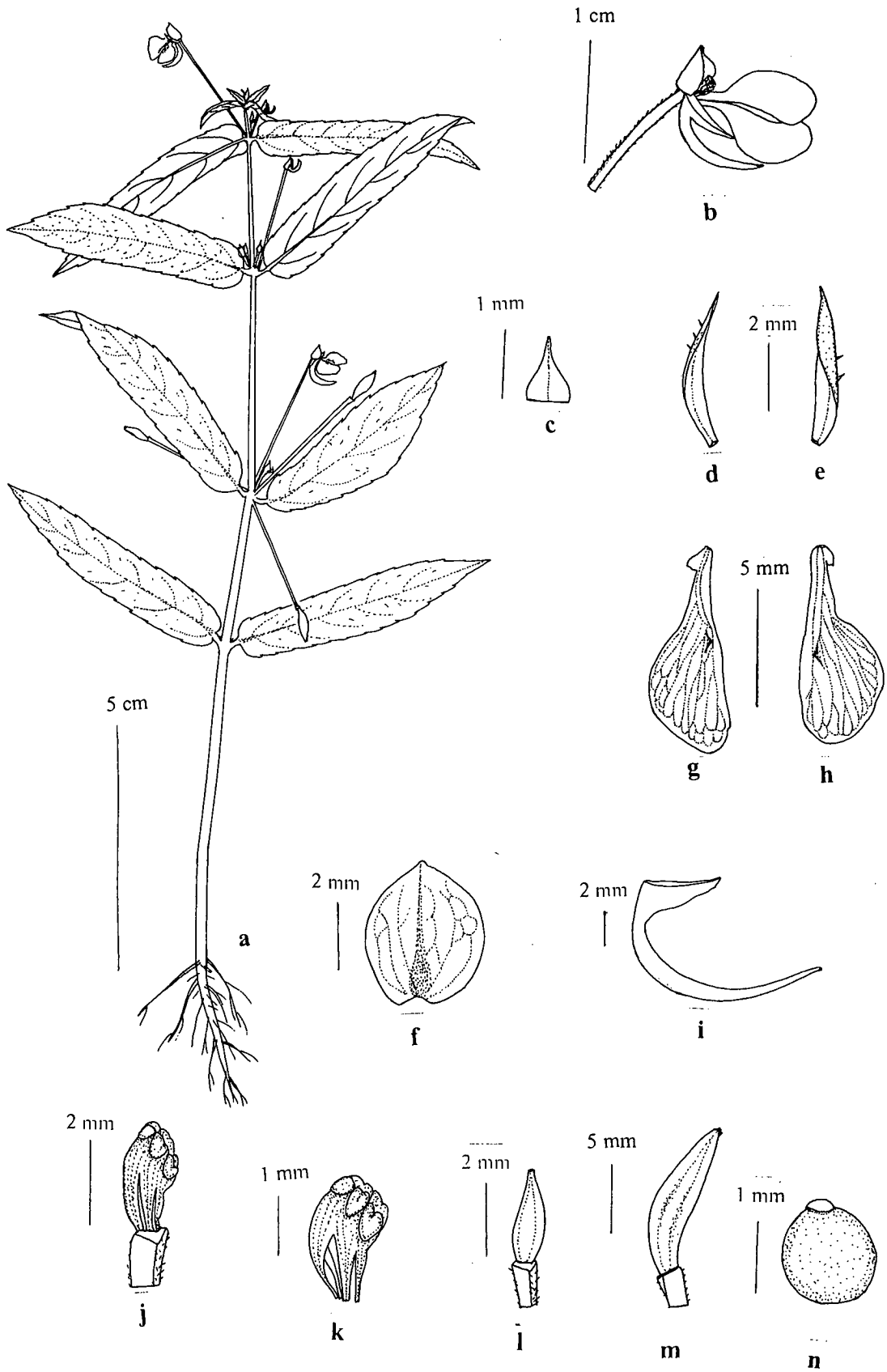
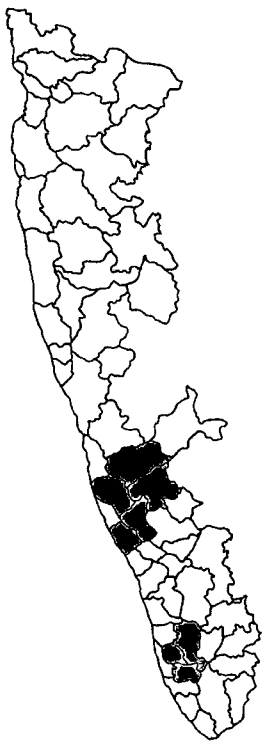


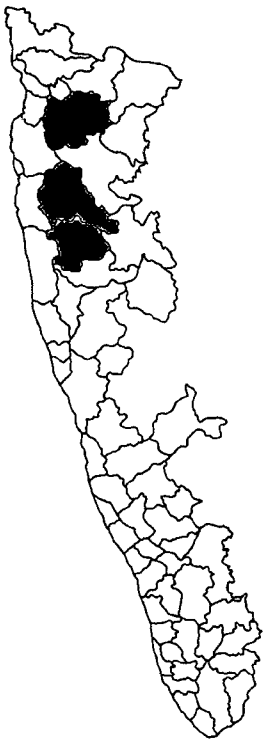
Fig. 11: *Impatiens kleiniformis* Sedgw. a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g, h) wing petals, i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

Map 3: Distribution of a) *Impatiens chinensis*; b) *I. dalzellii*; c) *I. diversifolia*; d) *I. kleiniformis.*

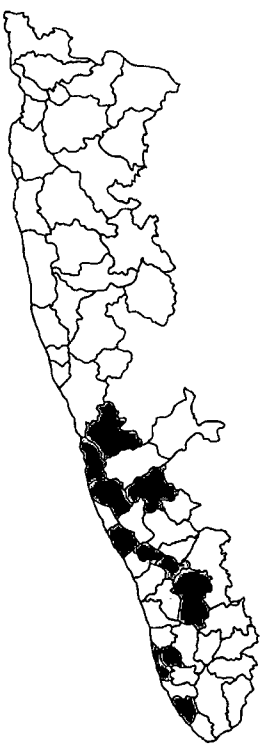
a



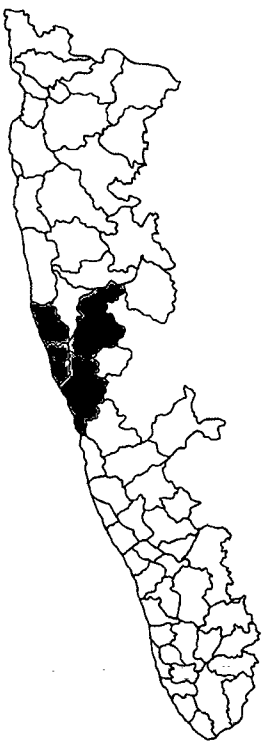
b



c



d



Sedgwick (1919) mentions that the type is from Castle rock, North Kanara district (Karnataka) collected in August 1917. But did not cite the place where it is deposited. However the type of this species could not be traced in any of the major herbaria in India or abroad. Hence a neotype is being designated.

IUCN threat status: EN [B1ab(iii)].

Etymology: Latin: *kleini-* = *Impatiens minor* (=*I. kleinii*), *formis* = similar. Similar to *I. kleinii* (=*I. minor*).

Impatiens lawii Hook. f. & Thomson in J. Proc. Linn. Soc. Bot. 4: 122. 1859; Dalzell & Gibson, Bombay Fl., 43. 1861; Hooker, Fl. Brit. India 1: 448. 1874 & in Rec. Bot. Surv. India 4: 46. 1906; Cooke, Fl. Bombay 1: 172. 1901; Gamble, Fl. Madras 1: 141. 1915; Blatter in J. Bombay Nat. Hist. Soc. 33: 312. 1933; Vartak, Enum. Plant. Gomantak, India, 32. 1966; Ahmedullah & Nayar, Endemic plants of the Indian region 1: 192. 1986; Kulkarni, Fl. Sindhudurg, 60. 1988; Almeida, Fl. Savantwadi 1: 77. 1990; Deshpande *et al.*, Fl. Mahableshwar 1: 116. 1993; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 169. 1997; Mudaliar & Prasad in Singh & Karthikeyan, Fl. Maharashtra Dicots. 1: 457. 2000; Yadav & Sardesai, Fl. Kolhapur District, 95. 2001.

TYPE – INDIA, Malabar, Concan, *s. d.*, Stocks & Law, *s. n.* (CAL!).

Annual herbs, 20 – 30 cm high. Stem diffusely branched, semi-quadrangular, grooved on two sides, glabrous, reddish pink in colour; branches alternate. Leaves opposite-decussate, subsessile; petiole glabrous, decurrent on stem; lamina 1 – 2 × 1 – 1.5 cm, ovate, truncate at base, serrately toothed along margin, acuminate at apex, adaxial surface hairy; hairs present in upper half region of leaf; abaxial surface glabrous, midrib distinct, lateral veins 3 – 4 pairs. Flowers axillary, solitary, 1.7 – 2.2 cm across, pink to purple with violet throat, bracteate, pedicellate; bracts c. 1.5 × 0.5

mm, linear, light green in colour, acuminate at apex, glabrous to sparsely hairy dorsally, pedicel 1.5 – 1.9 cm long, pubescent with one longitudinal row of hairs, pinkish red in colour, deflexed in fruits. Lateral sepals linear, 8 – 10 × 1 mm, pink in colour, glabrous, slightly keeled on midvein dorsally, acuminate at apex. Standard orbicular, 0.8 – 1.1 × 0.8 – 0.9 cm, pink in colour, slightly concave, hairy in central region on dorsal surface, dorsally keeled; keel mucronate, lacerated. Wing petals 1.7 – 2.2 cm long, bilobed, auricled near base; auricle small; basal lobe much smaller than distal lobe, triangular, ovate to fin shaped, 4 – 6 × 2 – 2.5 mm, apically acute; distal lobe assymmetrically obovate, 1 – 1.5 × 0.8 – 1 cm, shortly stipitate, elevated at base, apically obtuse. Lip saccate, purple with violet veins, 1 – 1.2 cm long, 4 – 5 mm deep, 4 – 5 mm wide, glabrous; spur short, c. 1.5 mm long, straight, bent inwards, very close and parallel to lip surface and hence appears spurless when viewed from sides, greenish yellow in colour, tip notched. Column c. 5 × 3 mm, incurved. Anthers c. 0.5 × 0.5 mm, yellow in colour; filaments c. 4.5 × 1 mm, pink in colour. Pistil c. 2.5 × 1 mm; ovary ellipsoid, oblongoid to oblongoid-lanceoloid, glabrous. Capsule assymetrically ellipsoid to ellipsoid-lanceoloid, glabrous; pedicel 2 – 2.5 cm long. Seeds spherical to oblongoid, c. 2.5 × 1.5 mm, brown to brownish-black in colour, glabrous, shining, funiculus prominent (Fig. 12; Plate - 4d, e, f).

Habitat: The species is found growing on open lateritic plateaus and table lands where there is high velocity of wind and mist. Grows in association with grasses, *Impatiens tomentosa* Heyne ex Wight & Arn., *I. oppositifolia* L., *Strobilanthes* spp. and *Utricularia* spp.

Fl. & Fr.: August – October.

Distribution: Endemic to the Western Ghats of Karnataka and Maharashtra (Map - 4a).

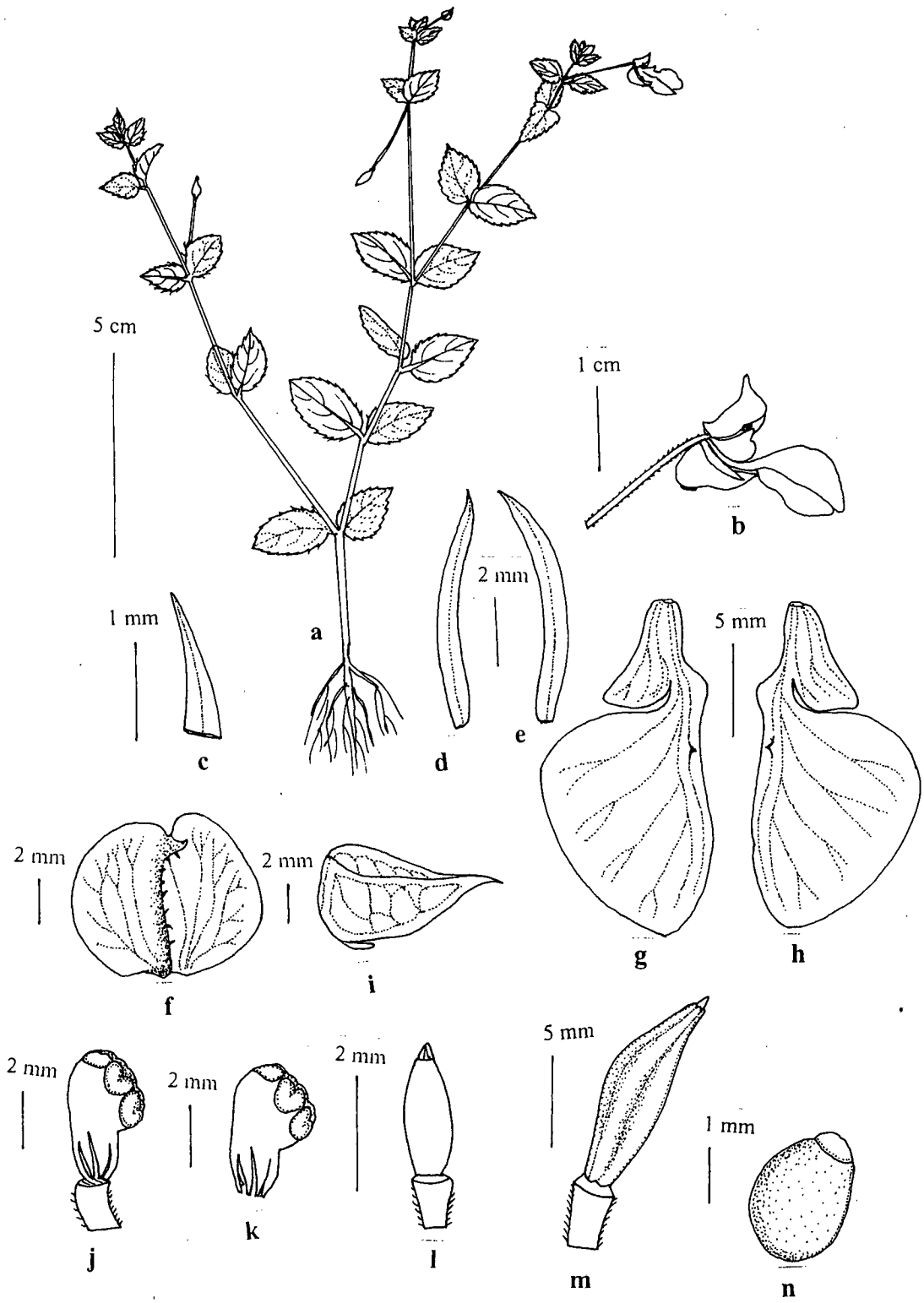


Fig. 12: *Impatiens lawii* Hook. f. & Thomson. a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g, h) wing petals, i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

Specimens examined:

Karnataka: Malabar, concan region, *s. d.*, Stocks, Law *s. n.* (MH); Sada, near Goa Karnataka border, Belgaum district, 24. 09. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 158 (GUH).

Mahatashtra: Mahableshwar, Satara district, 19. 09. 1958, V. D. Vartak 13907 (MGM); Kas, Satara district, September 1992, M. P. Bachulkar-Cholekar 5337 (SUK); Kas plateau, Satara district, 18. 09. 2006, Jyosna R. N. Dessai 98 (GUH), Kas plateau, Satara district, 18. 08. 2006, Jyosna R. N. Dessai 115 (GUH).

Note: *Impatiens lawii* is similar to *I. oppositifolia* but differs in having diffusely branched habit, ovate leaves which are crowded at the apex, short lip and straight spur that is very close to the lip. *I. oppositifolia* has branched habit, linear-lanceolate leaves and lip with a short, hooked spur. From a distance the species appears to be spurless but it has a small spur that lies very close to the lip.

While describing the species, Hooker and Thomson (1859) compared it with *I. inconspicua* and *I. diversifolia* and differentiated it from these two based on its stature, branched nature, smaller leaves at the apex and size of the flower. Gamble (1915) in his key mention's that the flowers are yellow but in the text he describes them as purple or rose. Blatter (1933) also mentions that the flowers are yellow. Saldanha (1996) quotes that the type collected by Law from Bababudan hills that is available at K resembles *I. scabriuscula* Heyne ex Roxb. except for the linear lateral sepals. However the later species is with alternate leaves. Moreover the material Saldanha quoted is not available in Kew (pers. comm.) for checking its identity.

IUCN threat status: EN [B1ab(iii)].

Impatiens minor (DC.) Bennet in Indian J. Forest. 2(3): 283. 1979; Ramachandran & Nair, Fl. Cannanore, 80. 1988; Almeida, Fl. Savantwadi 1: 78. 1990; Lakshminarasimhan & Sharma, Fl. Nasik District 144. 1991; Deshpande *et al.*, Fl. Mahabaleshwar 1: 116. 1993; Saldanha in Saldanha, Fl. Karnataka 2: 255, t. 36. 1996; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 181. 1997; Mudaliar & Prasad in Singh & Karthikeyan, Fl. Maharashtra Dicots. 1: 457. 2000; Yadav & Sardesai, Fl. Kolhapur District, 95. 2002; Bhat, Fl. Udupi, 88. 2003.

Balsamina minor DC., Prodr. 1: 686. 1824.

Impatiens kleinii Wight & Arn., Prodr. Fl. Ind. Orient. 1: 140. 1834; Wight, Icon. Pl. Ind. Orient. t. 884. 1844 – 45; Hooker & Thomson in J. Proc. Linn. Soc., Bot. 4: 122. 1859; Dalzell & Gibson, Bombay Fl., 43. 1861; Hooker, Fl. Brit. India 1. 445. 1874 & in Rec. Bot. Surv. India 4: 46. 1906; Cooke, Fl. Bombay 1: 171. 1901; Gamble, Fl. Madras 1: 140. 1915; Blatter in J. Bombay Nat. Hist. Soc. 33: 311. 1933; Vartak, Enum. Plant. Gomantak, India, 31. 1966; Santapau, Fl. Khandala, 30. 1967; Ramamoorthy in Saldanha & Nicolson, Fl. Hassan District, 403. 1978; Shah, Fl. Gujarat 1: 143. 1978; Yoganarasimhan *et al.*, Fl. Chikmagalur District, 62. 1982; Vajravelu in Nair & Henry, Fl. Tamil Nadu 1: 54. 1983; Sharma *et al.*, Fl. Karnataka Analysis, 38. 1984; Rao, Fl. Goa 1: 60. 1985; Ahmedullah & Nayar, Endemic plants of the Indian region 1: 192. 1986; Kulkarni, Fl. Sindhudurg, 59. 1988; Keshava Murthy & Yoganarasimhan, Fl. Coorg District, 87. 1990; Vajravelu, Fl. Palghat District, 100. 1990; Kothari & Moorthy, Fl. Raigad district, 46. 1993; Ramaswamy *et al.*, Fl. Shimoga District, 109. 2001. **TYPE:** Not traceable so far.

Annual herbs, 8 – 50 cm high. Stem branched or unbranched, semiterete, glabrous, green in colour. Leaves opposite-decussate, sessile to shortly petiolate; petiole 4 – 6 mm long, glabrous; lamina 3 – 14 × 1 – 3.8 cm, lanceolate, linear-

lanceolate, oblong, ovate to elliptic, glands present at the base of lamina, obtuse to semicordate at base, crenate to serrate along margins, acute to acuminate at apex; crenae apiculate; adaxial surface hairy, abaxial surface glabrous, veins 3 – 7 pairs. Flowers axillary, 1 – 3 per axil, 0.8 – 1.5 cm across, pink with violet throat, bracteate, pedicellate; bracts minute, triangular to ovate, c. 0.5 × 0.3 mm, acute at apex, glabrous; pedicel 1 – 2.5 cm long, glabrous, deflexed in fruits. Lateral sepals linear-lanceolate, 3 – 6 × 0.7 – 1 mm, acute at apex, dorsally hairy on the costa, pale green in colour, veins 3. Standard ovate to orbicular, 3 – 4 × 3 – 5 mm, acute at apex, pinkish white in colour, dorsally keeled; keel glabrous to hairy, green in colour. Wing petals entire, 0.8 – 1 × 0.5 – 0.7 cm, lobe 4 – 7 × 5 – 7 mm, assymmetrically obovate, apically obtuse, stipitate; stipe 2 – 3 mm long, c. 0.5 mm wide. Lip boat shaped, 3 – 6 mm long, 1 – 2 mm deep, c. 2 mm wide, acute at apex, glabrous, spurred; spur 1 – 1.3 cm long, straight or curved, tubular to compressed, pale green in colour, rounded at apex, glabrous. Column c. 2 × 1 mm, curved. Anthers c. 0.25 × 0.25 mm; filaments c. 1.5 × 0.5 mm, pink in colour. Pistil c. 1.5 × 0.5 mm; ovary lanceoloid, glabrous. Capsule linear-ellipsoid to fusiform, 1 – 1.5 × 2 – 4 mm, glabrous; pedicel 1.8 – 2.3 cm long. Seeds globular, compressed, c. 0.5 × 0.5 mm, black to brown in colour, glabrous, shinning, funiculus present (Fig. 13; Plate - 4g, h).

Fl. & Fr.: June – December (May).

Habitat: Grows in moist places, in open plains amidst grasses, in rock crevices, roofs, cemented walls, under tree canopy and also as an epiphyte on tree trunks.

Distribution: Endemic to Peninsular India. Widely distributed in Western Ghats (Map - 4b).

Specimens examined

Goa: Anmod ghat, North Goa district, 18. 07. 2004, Jyosna R. N. Dessai 06 (GUH);

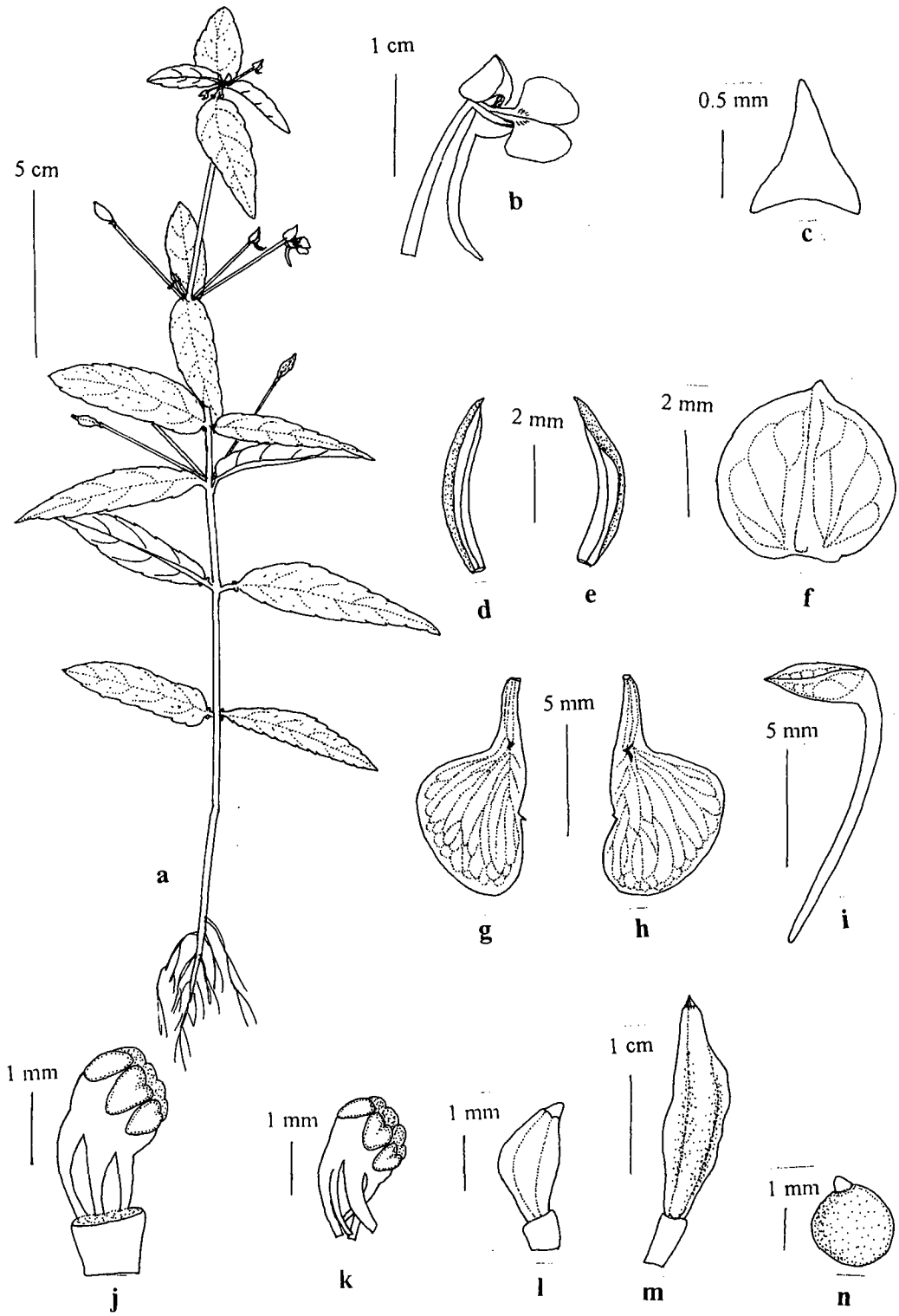


Fig. 13: *Impatiens minor* (DC.) Bennet a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g, h) wing petals, i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

Goa University campus, Taleigao plateau, North Goa district, 21. 07. 2005, Jyosna R. N. Dessai 33 (GUH); Bondir, Sattari, North Goa district, 27. 07. 2006, Jyosna R. N. Dessai 103 (GUH).

Karnataka: Karwar, North Kanara district, July 1882, W. A. Talbot 28 (CAL); Shiradi, South Kanara district, 15. 12. 1918, *s. c., s. n.* (MH-7422); Karwar, North Kanara district, 01. 10. 1919, Hall & McCann 34254 (BLAT); Heggargudda, Tirthahalli, 30. 08. 1963, S. Sundara Raghavan 90097 (CAL); Balehonnur, Coffee research station estate, 19. 10. 1971, V. Bhaskar (MGM); Baserukatte, Chikmagalur district, 28. 07. 1972, V. Bhaskar 300 (MGM); Charmadi ghat, Chikmagalur district, 26. 08. 1972, V. Bhaskar 317 (MGM); Jog falls, North Kanara district, 05. 11. 1972, V. Bhaskar 341 (MGM); Bababudan, Abbe, Chikmagalur district, 26. 07. 1973, V. Bhaskar 368 (MGM); Sukalahatti, Chikmagalur district, 28. 07. 1973, V. Bhaskar 369 (MGM); Subramanya, South Kanara district, 05. 08. 1973, V. Bhaskar 373 (MGM); Udupi, South Kanara district, 04. 09. 1974 V. Bhaskar 413 (MGM); Jog falls, North Kanara district, 06. 08. 2005, Jyosna R. N. Dessai 36 (GUH); Managunddi, on the way to Madikeri from Mangalore, 13. 08. 2005, Jyosna R. N. Dessai 45 (GUH); Madyanadu, Jodpalla, 14 km before Madikeri from Mangalore, 13. 08. 2005, Jyosna R. N. Dessai 48 (GUH); Bisle ghat, Hassan district, 16. 09. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 134 (GUH).

Kerala: Pulluparai, Kottayam district, 24. 09. 1964, K. Vivekananthan 21342 (MH); Marinjapuzha, Idukki district, 17. 06. 1972, V. Bhaskar 293 (MGM); Marinjapuzha, Idukki district, 17. 06. 1972 V. Bhaskar 294 (MGM); Near Kalpetta, Wyanad district, 04. 07. 1972, V. Bhaskar 293 (MGM); Tambracheri ghat, Wyanad district, 05. 08. 1972, V. Bhaskar 303 (MGM); Vazhani, Trissur district, 05. 09. 1976, K. Ramamurthy 47637 (MH); Karivara, Palghat district, 20. 09. 1977, J. Joseph 51401 (MH).

Andhra Pradesh: Maredumilli, East Godavari district, 18. 08. 1995, M. Mohanan 105044 (MH).

Maharashtra: Lonavala, Pune district, 01. 09. 1919, H. Santapau 18684 (BLAT); Khandala, Satara district, 09. 06. 1941, H. Santapau 714 (BLAT); Andheri, Makal caves, 08. 09. 1942, H. Santapau 685 (BLAT); Khandala, St Xavier's ravine, Satara district, 10. 03. 1943, H. Santapau 2867 (BLAT); Khandala, Satara district, 24. 07. 1943, H. Santapau 2232 (BLAT); Khandala, Saddle, Satara district, 08. 04. 1945, H. Santapau 6870 (BLAT); Khandala, Monkey hill, Satara district, 13. 07. 1946, H. Santapau 9242 (BLAT); Khandala, Bhoma hills, Satara district, 23. 07. 1949, H. Santapau 10135 (BLAT); Khandala, Battery hill plateau, Satara district, 21. 07. 1950, H. Santapau 6794 (BLAT); Lonavala, Pune district, 18. 07. 1951, B. A. Razi Razi 5229 (BLAT); National park, Borivili, 17. 08. 1952, G. Kalianiwalla GK 1072 (BLAT); National park, Borivili 08. 09. 1952 G. Kalianiwalla GK 338 (BLAT); Mumbra, 08. 04. 1953, K. V. Shenoy KVS319 (BLAT); National park, Borivili, 26. 09. 1953, H. Santapau 16112 (BLAT); National park, Borivili, 29. 09. 1954, P. S. Herbert SH 109 (BLAT); Fitzgerald ghat Mahableshwar, 20. 08. 1957, H. Santapau 13230 (BLAT); Borivili, Kaneri caves, 31. 08. 1957, Y. A. Merchant 41 (BLAT); National park, Borivili, 08. 10. 1957, P. S. Herbert SH 2800 (BLAT); Dhobi's waterfall, Mahabaleshwar, Satara district, 26. 12. 1957, Balamani B. Bole 281 (BLAT); Chandip, Tungar, 08. 02. 1959, N. Y. Das NYD 39 (BLAT); Dasturi garbut, 13. 7. 1959, N. A. Irani NI 4186 (BLAT); Shivasorai, Tungar, 16. 08. 1959, N. Y. Das NYD 358 (BLAT); Neral-Thahurwadi, 26. 08. 1959, N. A. Irani NI 4432 (BLAT); Bannuhalla, 21. 08. 1969, C. J. Saldanha 14564 (JCB); Tansa lake along dam, 25. 09. 1959, B. Balaman BB 467 (BLAT); Usgaone, Tungar, 21. 08. 1960, N. Y. Das NYD 1953 (BLAT); Matheran waterpipe, Raigad district, 17. 09. 1960, N. A. Irani NI 5410

(BLAT); Mazgaon, Savantwadi, Sindhudurg district, 13. 09. 1980, S. M. Almeida SMA 2950 (BLAT); Zanowli, 26. 06. 1986, Dr. D. K. Patel (BLAT); Chaukul road, Amboli, Sindhudurg district, 07. 10. 2007, Jyosna R. N. Dessai 174 (GUH).

Note: *Impatiens minor* is similar to *I. kleiniformis* Sedgw. but differs in having glands at the base of lamina (glands absent in *I. kleiniformis*) and in having glabrous pedicel (pedicel with two longitudinal rows of hairs in *I. kleiniformis*). However in certain cases the leaves are devoid of glands and the species could be mistaken for *I. kleiniformis* and vice versa. Hence this character does not form the main basis for segregating this species with *I. kleiniformis*.

Impatiens minor is endemic to Peninsular India. It is the only endemic species that is distributed from Gujarat to Kanyakumari.

Impatiens minor was first described by De Candolle (1824) in his Prodromus as *Balsamina minor.* Later, Wight and Arnott (1834) described *I. kleinii* and considered *B. minor* as a synonym under *I. kleinii.* Since '*minor*' was the earlier proposed epithet for this taxon and *I. kleinii* is 'superfluous name, Bennet (1979) proposed a new combination for the species, i.e. *I. minor* (DC.) Bennet.

Chromosome number: n = 8 (Zinovéva-Stahevitch and Grant, 1982; 1984 as *I. kleinii* Wight & Arn.).

IUCN threat status: LC.

Etymology: Latin: *minor* = smaller, referring to its small flowers.

Impatiens oppositifolia L. Sp. Pl. 937. 1753; Lamark, Encycl. 1: 363. 1785; Wight & Arnott, Prodr. Fl. Ind. Orient. 1: 139. 1834; Wight, Icon. Pl. Ind. Orient. t. 883. 1844 -

45; Hooker & Thomson in J. Proc. Linn. Soc., Bot. 4: 120. 1859; Dalzell & Gibson, Bombay Fl. 43. 1861; Hooker, Fl. Brit. India 1: 448. 1874 & in Rec. Bot. Surv. India 4: 46. 1906; Cooke, Fl. Bombay 1: 172. 1901; Gamble, Fl. Madras 1: 141. 1915; Blatter in J. Bombay Nat. Hist. Soc. 33: 312. 1933; Vartak, Enum. Plant. Gomantak, India, 32. 1966; Santapau, Fl. Khandala, 30. 1967; Ramamoorthy in Saldanha & Nicolson, Fl. Hassan district, 403. 1978; Vajravelu in Nair & Henry, Fl. Tamil Nadu 1: 55. 1983; Sharma *et al.*, Fl. Karnataka Analysis, 38. 1984; Grey-Wilson in Dassanayake & Foseberg, Fl. Ceylon 5: 110, f. 2(X-Z); Rao, Fl. Goa 1: 60. 1985; Kulkarni, Fl. Sindhudurg, 60. 1988; Kothari & Moorthy, Fl. Raigad district, 47. 1993; Almeida, Fl. Savantwadi 1: 78. 1990; Deshpande *et al.*, Fl. Mahableshwar 1: 117. 1993; Saldanha in Saldanha, Fl. Karnataka 2: 256. 1996; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 187. 1997; Mudaliar & Prasad in Singh & Karthikeyan, Fl. Maharashtra Dicots. 1: 459. 2000; Ramaswamy *et al.*, Fl. Shimoga District, 109. 2001; Yadav & Sardesai, Fl. Kolhapur District, 95. 2002; Bhat, Fl. Udupi, 88. 2003. **TYPE** - CEYLON, Hermann Herb. 314 (BM; Photo!).

Balsamina oppositifolia (L.) DC., Prodr. 1: 686. 1824.

Impatiens rosmarinifolia Retz. Observ. Bot. 5: 29. 1788; Wight, Icon. Pl. Ind. Orient. t. 750. 1844.

Impatiens rupicola Hook. f. in Bull. Misc. Inform. 1910: 292. 1910; Gamble, Fl. Madras 1: 140. 1915; Blatter in J. Bombay Nat. Hist. Soc. 33: 312. 1933; Sharma *et al.*, Fl. Karnataka Analysis, 39. 1984; Ahmedullah & Nayar, Endemic plants of the Indian region 1: 193. 1986; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 206. 1997.

Impatiens nataliae Hook. f. in Bull. Misc. Inform. 1910: 294. 1910; Gamble, Fl. Madras 1: 141. 1915; Sharma *et al.*, Fl. Karnataka Analysis, 39. 1984; Ahmedullah & Nayar, Endemic plants of the Indian region 1: 193. 1986; Saldanha in Saldanha, Fl.

Karnataka 2: 225. 1996; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 184. 1997. **syn. nov. TYPE** - INDIA, Karnataka, Shimoga district, Kumsi, October 1908, A. Meebold 10718 (K; Photo!)

Impatiens chinensis L.var. *rupicola* (Hook. f.) Bhaskar in Indian J. Forest. 1: 172. 1978.

Annual herbs, 15 – 50 cm high. Stem often branched, semicircular at base, quadrangular above, glabrous, red in colour, rarely green in colour above. Leaves opposite-decussate, sessile to shortly petiolate; petiole 1 – 4 mm long, glabrous, decurrent on the stem and ending as two petiolar glands; lamina elliptic-lanceolate, linear-lanceolate, linear-oblanceolate, oblong to spathulate, 3.5 – 7 × 0.8 – 1.9 cm, cuneate, truncate to subcordate at base, crenate along margins, acute to acute-apiculate at apex; crenae apiculate; adaxial surface hairy; hairs mostly on nerves; abaxial surface glabrous, veins 4 – 5 pairs. Flowers axillary, 2 – 3 per axil, 1 – 1.6 cm across, lilac to pink with violet throat, bracteate, pedicellate; bracts linear, c. 1.5 × 0.5 mm, acuminate at apex, glabrous; pedicel 1 – 2.6 cm long, with two longitudinal rows of hairs, rarely glabrous, deflexed in fruits. Lateral sepals linear, 4 – 5 mm long, c.1 mm wide, acute at apex, glabrous, translucent. Standard broadly ovate, 3 – 6 × 4 – 6 mm, emarginate to obcordate at apex, concave, pink in colour, dorsally keeled; keel mucronate; mucro c. 0.5 mm long. Wing petals 0.9 – 1.3 × 0.4 – 0.7 cm, bilobed; basal lobe ovate, 3 – 5 × 2 – 3 mm, distal lobe 7 – 9 × 4 – 6 mm, assymmetrically obovate, elevated at base, apically obtuse. Lip conical to saccate, 5 – 6 mm long, 1 – 3 mm deep, c. 3 mm wide, acuminate at apex, glabrous, spurred; spur 2 – 3 mm long, straight or hooked, pink in colour, rounded, notched to bulged at apex, green in colour, glabrous. Column c. 3 × 1.5 mm, curved. Anthers c. 0.5 × 0.5 mm, white to pink in colour, filaments c. 2.5 × 0.5 mm, pink in colour. Pistil c. 2 × 0.5 mm; ovary

oblongoid-lanceoloid, curved at apex, glabrous. Capsule assymmetrically ellipsoid, lanceoloid to oblanceoloid, 0.8 – 1.5 × 0.4 – 0.5 cm, glabrous; pedicel 2 – 3 cm long. Seeds globular, compressed, c. 0.5 × 0.5 mm, black to brown in colour, glabrous, shining, funiculus present (Fig. 14; Plate - 4i, j. k).

Fl. &. Fr.: July – October.

Habitat: Generally grows in grassy places, often forming large scattered colonies.

Distribution: Burma, Sri Lanka and India (Western Ghats) (Map - 4c).

Specimens examined:

Goa: Nagzar, Pernem, North Goa District, 17. 07. 2004, Jyosna R. N. Dessai & M. K. Janarthanam 05 (GUH); Surla, 01. 08. 2004, M. K. Janarthanam 12 (GUH); Cotigao WLS, South Goa District, 22. 08. 2004, Jyosna R. N. Dessai 20 (GUH); Goa-Karnataka border, North Goa District, 27. 08. 2005, Jyosna R. N. Dessai & M. K. Janarthanam 70 (GUH); Bondir, Sattari, North Goa District, 27. 07. 2006, Jyosna R. N. Dessai 104 (GUH); Cotigao, South Goa District, 05. 08. 2006, Jyosna R. N. Dessai 105 (GUH); Cotigao, South Goa District, 05. 08. 2006, Jyosna R. N. Dessai 106 (GUH); Surla, North Goa District, 24. 08. 2006, Jyosna R. N. Dessai 125 (GUH).

Karnataka: North Kanara district, 15. 09. 1891, W. A. Talbot 2514 (K; Photo!); Khandala, Satara district, September 1907, A. Meebold 8813 (K; Photo!); Castle rock, Belgaum district, October 1908, A. Meebold 10719 (K; Photo!); Nagavelly, on the way to Bhatkal from Jog falls, North Kanara district, 06. 08. 2005, Jyosna R. N. Dessai 40 (GUH); Talaguppa, Shimoga district, 06. 09. 2005, Jyosna R. N. Dessai & M. K. Janarthanam 91 (GUH); Sada, Belgaum district, 24. 09. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 155, 156 (GUH).

Maharashtra: Amboli, beyond the ghats, Sindhudurg district, 17. 07. 2004, Jyosna R. N. Dessai & M. K. Janarthanam 01 (GUH); Tilari ghat, Sindhudurg district, *s. d.*

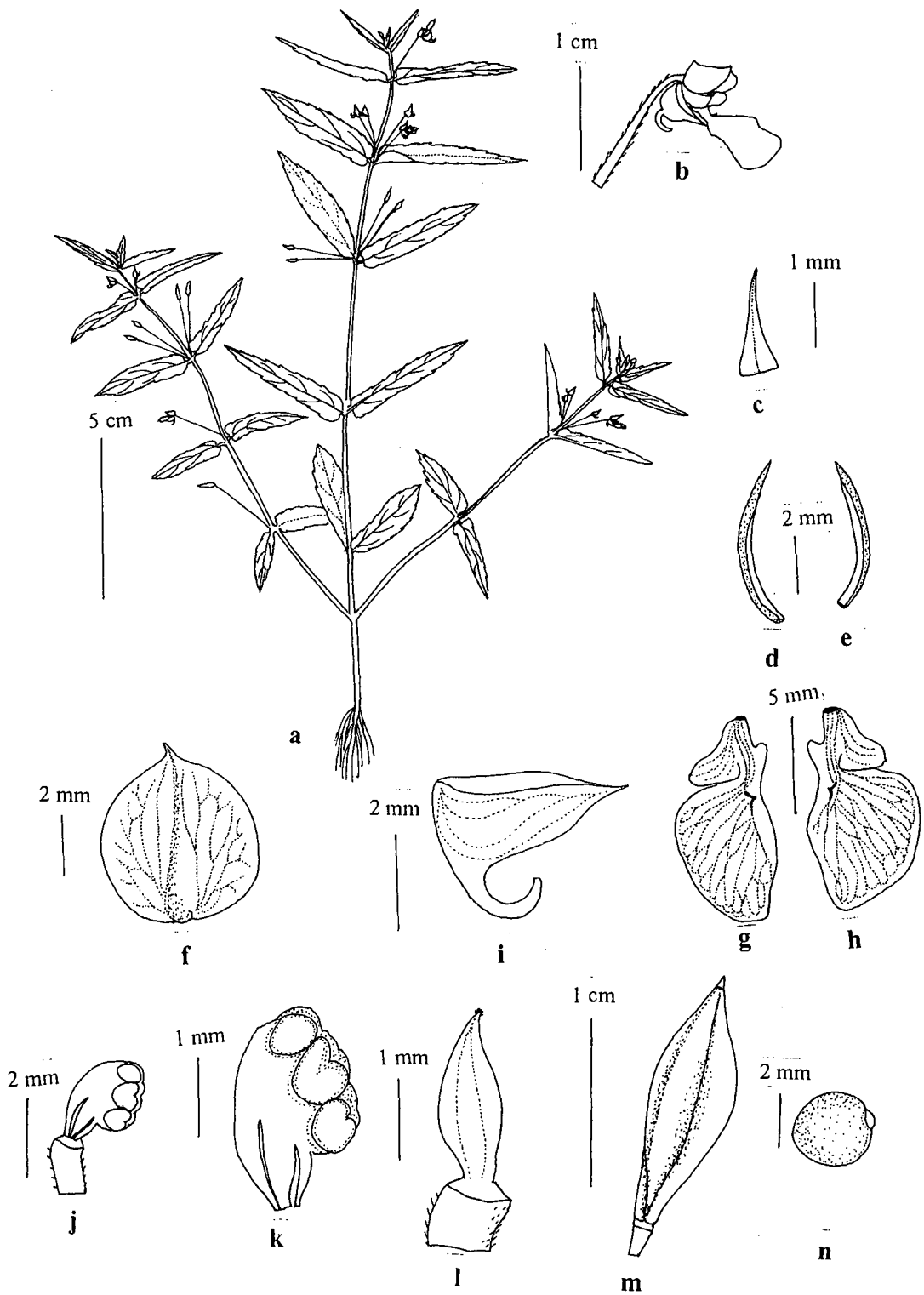


Fig. 14: *Impatiens oppositifolia* L. a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard, g, h) wing petals, i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

PLATE 4

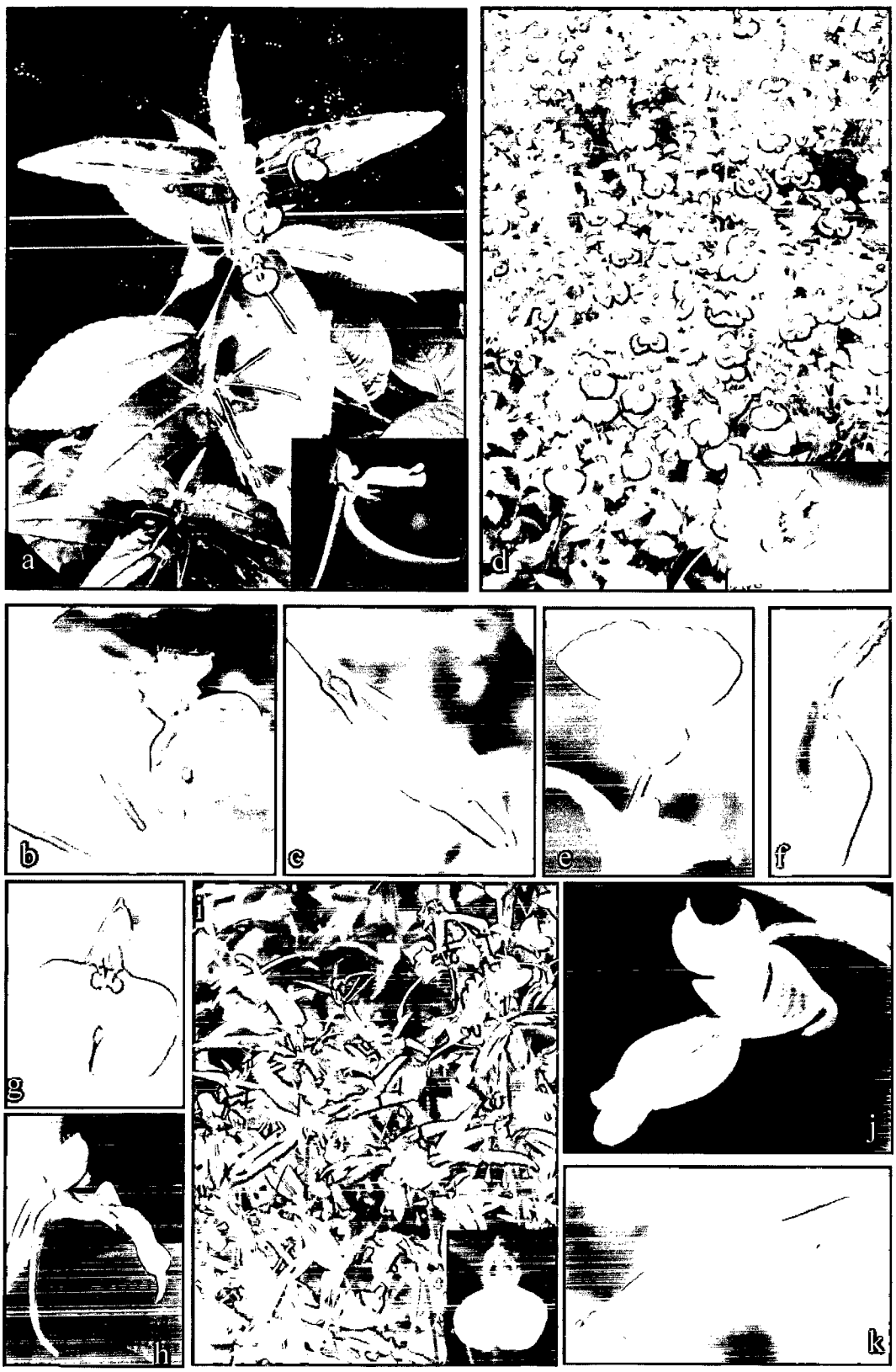


PLATE 4: a - c. *Impatiens kleiniformis* Sedgw.; d - f. *I. lawii* Hook. f. & Thomson; g, h. *I. minor* (DC.) Bennet; i - k. *I. oppositifolia* L.

M. K. Janarthanam 17 (GUH); Gaganbawda, Kolhapur district, 18. 09. 2004, M. K. Janarthanam 21 (GUH); Barrington point, Mahabaleshwar, Satara district, 17. 09. 2005, Jyosna R. N. Dessai 94 (GUH); Needle point, Mahabaleshwar, Satara district, 17. 09. 2005, Jyosna R. N. Dessai 96 (GUH); Kas plateau, Satara district, 18. 09. 2005, Jyosna R. N. Dessai 99 (GUH); Amboli ghat, Sindhudurg district, 12. 08. 2006, Jyosna R. Dessai 108 (GUH); Chaukul road, Amboli, Sindhudurg district, 12. 08. 2006, Jyosna R. Dessai 110 (GUH); Panchgani, Satara district, 19. 08. 2006, Jyosna R. N. Dessai 120 (GUH); Tilari, Sindhudurg district, 03. 09. 2006, M. K. Janarthanam 126 (GUH); Amboli ghat, Sindhudurg district, 09. 09. 2006, Harshala Gad 131, 133 (GUH); Phonda ghat, Sindhudurg district, 30. 09. 2007, Jyosna R. N. Dessai & M. K. Janarthanam 170 (GUH); Chaukul, Amboli, Sindhudurg district, 07. 10. 2007, Jyosna R. N. Dessai 173 (GUH).

Note: *Impatiens oppositifolia* is allied to *I. tomentosa* Heyne ex Wight & Arn. but differs in having glabrous stem, lateral sepals, lip and spur. It is also similar to *I. raziana* Bhaskar and Razi but differs in having lilac to pink coloured flowers rather than orange coloured flowers.

This is one of the non endemic species in the study area. It is a very variable species of balsam, especially with regard to the shape of leaves and hairy nature of the pedicel (glabrous or with 1-2 longitudinal rows of hairs). Plants exposed to sunlight and growing in humus rich soil are tall, have semicircular stem with broad leaves whereas those growing under forest floors are stunted with quadrangular stem, linear and smaller leaves. Variations were also seen in the spur. The spur in plants collected from Amboli region was straight, hooked or straight and curved inwards at the tip. Grey-Wilson (1985) mentions that the Ceylon specimens vary in their leaf shapes and size however did not see any variation in the flower.

Impatiens oppositifolia was described by Linneaus (1753) based on the specimen collected from Ceylon (Sri Lanka). The following is the brief description provided by Linneaus for the species "*pedunculis unifloris aggregatis, foliis oppofitis linearibus*". Later, Hooker (1910a) described *I. rupicola.* He compared the species with *I. chinensis* and differentiated the species from the later in having entire leaves, much smaller flowers and capsules and a small and distinct spur. He also quotes that *I. rupicola* may prove to be a small flowered and fruited, almost spurless state of *I. chinensis* which seems to represent in the Western Ghats from the latitude of Goa up to Pune.

Santapau (1967) studied the specimens of *I. rupicola* and *I. oppositifolia* available at Kew and treated *I. rupicola* as a synonym under *I. oppositifolia.* He also mentions that none of the specimens are with entire leaves as quoted by Hooker (1910a). Gamble (1915), Blatter (1933), Sharma *et al.* (1984), Ahmadulla and Nayar (1986) and Vivekananthan *et al.* (1997) treated them as independent species. However Saldanha (1996) treated *I. rupicola* conspecific to *I. oppositifolia.* Bhaskar (1978) considered it as a variety under *I. chinensis* i. e. *I. chinensis* variety *rupicola* (Hook. f.) Bhaskar.

Detailed study of the specimens collected from the study area and some of the collections available at Kew cited by Hooker (1910a) for *I. rupicola,* are morphologically similar to I. oppositifolia with acceptable minor variations. Therefore *I. rupicola* is considered as a synonym under *I. oppositifolia.*

Hooker (1910a) described *I. nataliae* along with *I. rupicola.* Detailed study of the type material (photo) also revealed that *I. nataliae* is a morphological variation of *I. oppositifolia* and hence synonymised under *I. oppositifolia.*

IUCN threat status: LC.

Etymology: Latin: *oppositi* = opposite; *folia* = leaved, referring to its opposite leaves.

Impatiens raziana Bhaskar & Razi in J. Bombay Nat. Hist. Soc. 79: 383. 1982; Sharma *et al.*, Fl. Karnataka Analysis, 39. 1984; Saldanha in Saldanha, Fl. Karnataka 2: 257, t. 38. 1996; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 204. 1997. **HOLOTYPE** – INDIA, Karnataka, Chikmagalur district, Charmadi ghat, 26. 08. 1972, V. Bhaskar 311(MGM!).

Annual herbs, 10 – 40 cm high. Stem erect, prostrate to procumbent, flaccid, quadrangular, glabrous, red in colour, branched; branches arising from basal nodes. Leaves opposite-decussate, petiolate, apical ones subsessile; petiole short, 2 – 4 mm long, glabrous, decurrent on stem and ending as petiolar glands; lamina oblong, elliptic, oblanceolate to obovate-spathulate, 2 – 6.5 × 1 – 1.8 cm, membranous, cuneate to truncate at base, crenate along margins, acute at apex; crenae apiculate; hairy adaxially, glabrous abaxially, veins distinct abaxially. Flowers axillary, 1 – 4 in each axil, 1.4 – 1.9 cm across, bright saffron coloured, bracteate, pedicellate; bracts linear- lanceolate, glabrous, c. 1.5 × 0.75 mm, acute at apex; pedicels 2 – 3 cm long, pubescent with two longitudinal rows of hairs, deflexed in fruits. Lateral sepals 8 – 10 × 1 – 1.5 mm, linear to linear-lanceolate, glabrous, light orange in colour, acute to acuminate at apex, veins 3, middle vein distinct, keeled dorsally, other 2 faintly visible. Standard orbicular to broadly ovate, 5 – 7.5 × 7 – 9 mm, concave, orange in colour, apically rounded to subcordate, dorsally keeled, costa mucronate, glabrous to hairy dorsally. Wing petals 1 7 – 2 × 0.8 – 1.1 cm, auricled at base, bilobed, lobes unequal; basal lobes triangular, c. 5 × 4 mm, lighter than distal lobe; distal lobe 1 – 1.3 × 0.8 –1.1 cm, obliquely ovate, elevated in basal region, shortly stipitate; stipe lighter than lobe and bears 4 – 5 dark orange spots. Lip funnel shaped, 10 – 12 × 5 – 6

mm, 6 – 8 mm deep, 4 – 6 mm wide, light orange with darker veins, acuminate at apex, spurred; spur short, 3 – 5 mm long, curved, glabrous to hairy, tip rounded to notched, yellow to green in colour. Column c. 5 mm long, curved. Anthers c. 1 × 1 mm; filaments c. 3 × 1 mm, yellowish orange in colour. Pistil c. 4 × 2 mm long; ovary linear-oblongoid, curved at tip, glabrous. Capsule ellipsoid, oblongoid to oblanceoloid, 1 – 1.2 × 0.4 – 0.5 cm, glabrous; pedicel 3.5 – 4 cm long. Seeds globular, c. 2.5 × 2 mm, dark brown to black in colour, glabrous, shining, laterally compressed, funiculus prominent (Fig. 15; Plate - 5a, b).

Fl. & Fr.: July – September.

Habitat: *Impatiens raziana* is found growing along the periphery of the moist deciduous forest beneath *Terminalia bellirica* and *T. paniculata* amidst grasses and on the field bunds at Tinaighat (Belgaum district) at an altitude of 647 m and in cultivated areas beneath *Acacia auriculiformis* plantation in sandy soil at Bidargad (Shimoga district). Altitude: up to 800 m.

Distribution: Endemic to the Western Ghats of Karnataka (Map - 4d).

Specimen examined: Karnataka, Kotigehar, Chikmagalur district, 850 m, 25. 09. 1979, C. J. Saldanha KFP 9756 (JCB); Chikmagalur, 800 m, 03. 11. 1981, C. J. Saldanha KFP 13494 (JCB); Tinaighat, Rajval, Belgaum district, 15° 26' 13.8" N and 74° 26' 19.2" E, 646 m, 01. 08. 2004, M. K. Janarthanam 11 (GUH); 21. 08. 2005, Jyosna R. N. Dessai & M. K. Janarthanam 64 (GUH); Bidargad, Agumbe-Sringeri road, Shimoga district, 04. 09. 2005, Jyosna R. N. Dessai & M. K. Janarthanam 76 (GUH).

Note: *Impatiens raziana* is the only species with scarlet-orange coloured flowers in the section *oppositifoliae*. The flower colour is a key character for identifying the species in the field though it is similar to *I. oppositifolia* L. in most of the characters.

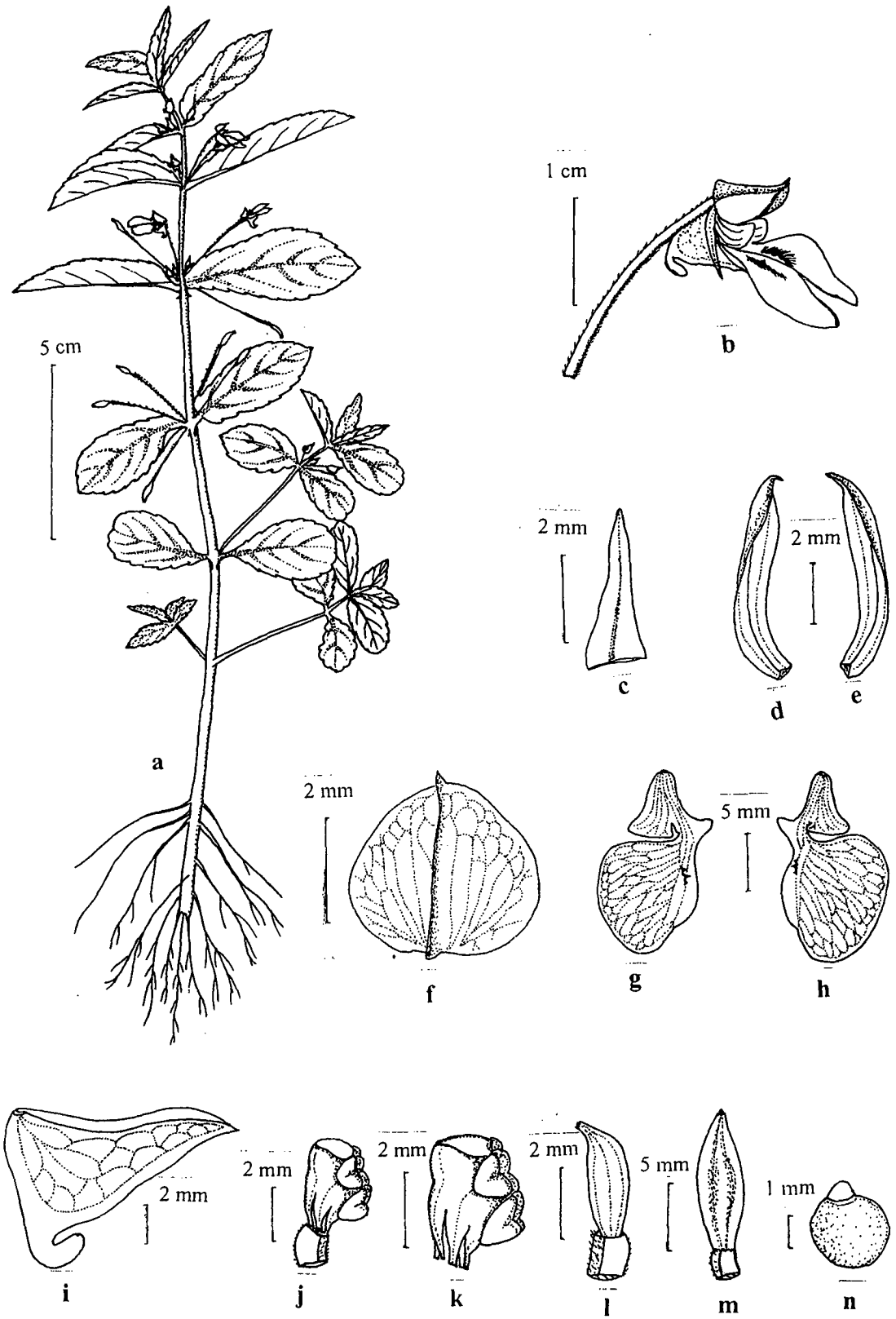
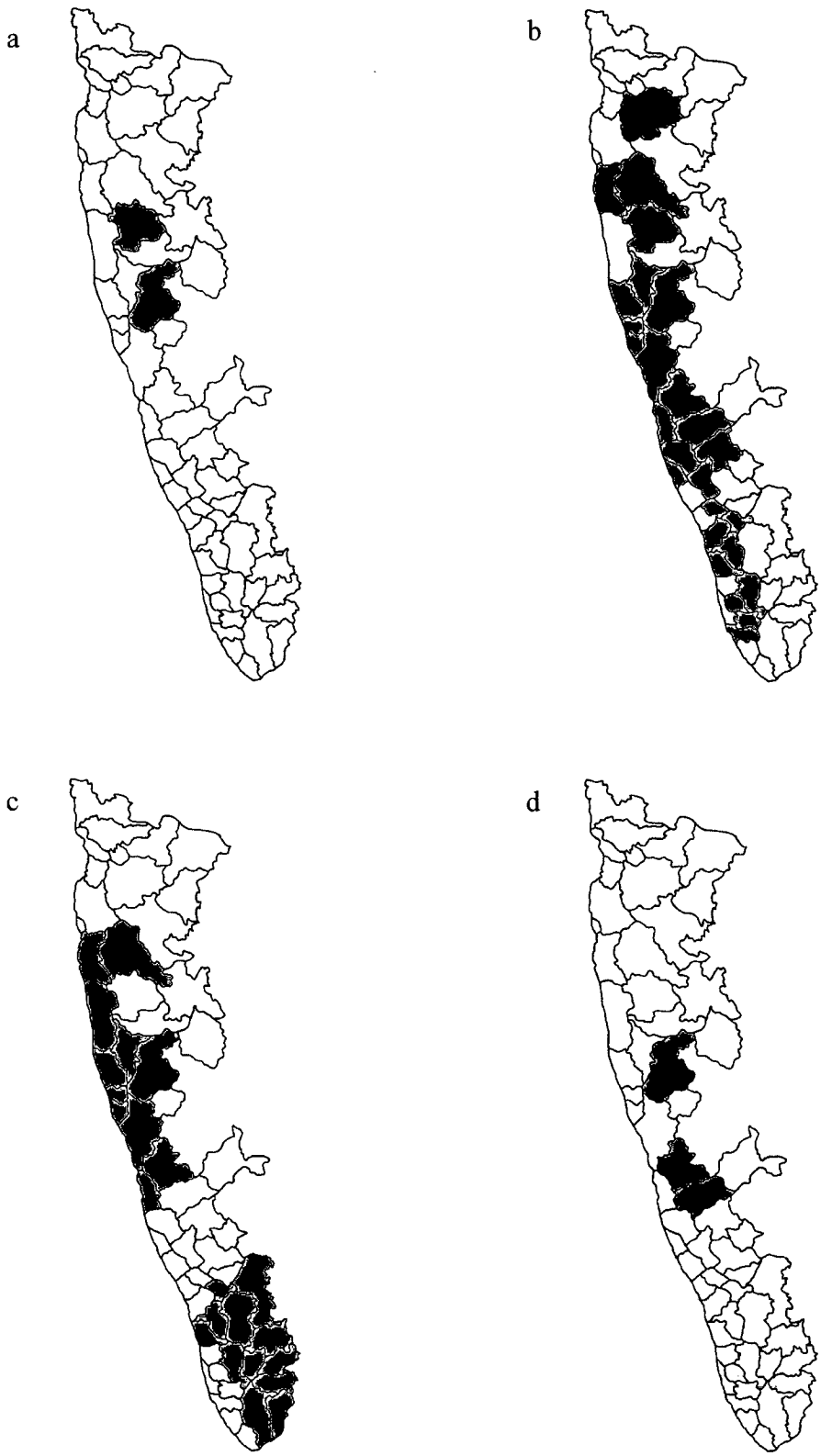


Fig. 15: *Impatiens raziana* Bhaskar & Razi a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g, h) wing petals, i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

Map 4: Distribution of a) *Impatiens lawii*; b) *I. minor*; c) *I. oppositifolia*; d) *I. raziana.*



The species is seen growing in plain areas on the eastern side of the Western Ghats with relatively low rainfall. Flowers are visited by bees, butterflies and moths.

In the present study this species is collected from outside the type locality, after they were reportedly missing from their original habitat thus showing extended distribution.

Impatiens raziana, an endemic species, was described based on a single collection made in 1972 from Kotigehar, Chikmagalur district, Karnataka (Bhaskar and Razi, 1982). Saldanha made further collection from type locality that is deposited at JCB, Bangalore. The major herbaria such as BLAT, BSI, CAL and MH do not have any collection of the species. Hence, Nayar (1996) refers this species as rare. Saldanha (1996), during his subsequent visits to the type locality, could not trace the species and reported the conversion of locality into a residential colony. Attempts to collect this species from th type locality during the present study also failed.

During the present study, *I. raziana* is collected from two more localities from the Western Ghats. These are very important, as they are the only collections from outside the type locality, collected after they were reportedly missing from their original habitat. The present collections from Shimoga and Belgaum districts show its presence outside the type locality and show a wide range of variation as compared to the type specimen. The variations in the species are seen with respect to its habit, leaves (shape, base and apex), number of flowers per axil, pubescent nature of pedicel, shape and margin of lateral sepals, tip of spur and colour of seeds.

Chromosome number: 2n = 16 (Bhaskar, 1975).

IUCN threat status: CR [B1ab(iii)].

Etymology: Latin: *raziana* = in honour of Prof. B. A. Razi.

Impatiens tenella Heyne ex Wight & Arn., Prodr. Fl. Ind. Orient. 1: 140. 1834; Hooker & Thomson in J. Proc. Linn. Soc., Bot. 4: 123. 1859; Hooker, Fl. Brit. India 1: 447. 1874 & in Rec. Bot. Surv. India 4: 46. 1906; Gamble, Fl. Madras 1: 141. 1915; Vajravelu in Nair & Henry, Fl. Tamil Nadu 1: 56. 1983; Sharma *et al.*, Fl. Karnataka Analysis, 39. 1984; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 215. 1997. **TYPE** – INDIA, Wall. Cat. 4746 (CAL!).

Annual herbs, 20 – 60 cm high. Stem semiterete, glabrous, reddish pink, swollen at the nodes, branched; branches opposite. Leaves opposite, lanceolate, 4 – 5.5 × 1.5 – 1.9 cm, cuneate at base, margin serrate; serrations apiculate, acute to acuminate at apex, membraneous, adaxially dark green and pubescent, abaxially pale green and glabrous, shortly petiolate or subsessile, petiole c. 2 mm, decurrent on the stem and ending as two petiolar glands, nerves obscure above, prominent below, alternate. Flowers axillary, binate, c. 9 mm across, dark pink, lilac to white in colour, pedicellate; pedicel slender, pubescent with two longitudinal rows of hairs, 2.3 – 2.7 cm long, deflexed in fruits, bracteate; bracts linear, c. 2 × 0.5 mm, linear, acute to acuminate at apex, glabrous. Lateral sepals linear lanceolate to oblanceolate, c. 5 × 0.75 mm, acute to acuminate at apex, glabrous, vein single, distinct. Standard broadly ovate, c. 4 × 3.5 mm, white to pink in colour, concave, mucronate at apex. Wing petals bilobed, c. 1 × 0. 4 cm, auricled near base; basal lobe ovate to subulate, c. 3 × 1 mm, obtuse at apex; distal lobe asymmetrically obovate, c. 6 × 4 mm, apically rounded to obtuse; auricle c. 1 mm, rounded at apex. Lip saccate, c. 8 mm long, c. 3 mm deep, c. 3 mm wide, tip acute, spurred; spur basal, c. 7 mm long, tubular, cylindrical, slightly curved, glabrous, tip rounded. Column c. 3 × 1.5 mm, curved. Anthers c. 0.75 × 0.5 mm; filaments 5, c. 2 × 0.5mm, pink in colour. Pistil c. 2 × 0.5 mm; ovary linear-oblongoid, curved at the tip, glabrous. Capsule ellipsoid, oblongoid

to oblanceoloid, c. 1.2 × 0.5 cm, glabrous; pedicel 3 – 4 cm long. Seeds globular, c. 2.5 × 2 mm, dark brown to black in colour, glabrous, shining, laterally compressed, funiculus prominent (Fig. 16; Plate - 5c, d).

Fl. & Fr.: September – November.

Habitat: Growing on vertical cut surfaces along the roadsides and in open plains amidst grasses.

Distribution: Endemic to Western Ghats of Karnataka, Tamil Nadu (Map - 5a).

Specimens examined:

Karnataka: Bababudan, Chikmagalur district, 1400 m. 06. 11. 1979, C. J. Saldanha KFP9644 (CAL); Kavikal Gandhi forest check post, Kemmangundi, Chikmagalur district, 05. 09. 2005, Jyosna R. N. Dessai & M. K. Janarthanam 77 (GUH); Kemmangundi, Chikmagalur district, 05. 09. 2005, Jyosna R. N. Dessai & M. K. Janarthanam 89 (GUH).

Tamil Nadu: Nilgiri, 26. 11. 1971, N. C. Rathakrishnan 39017 (MH); Pykara range, Coimbatore district, 07. 10. 1972, V. Bhaskar 331 (MGM); Naduvattam, Nilgiris, 16. 09. 1973, V. Bhaskar 384 (MGM).

Note: *Impatiens tenella* is closely related to *I. diversifolia* but differs in the following characters:

Character	*Impatiens tenella*	*Impatiens diversifolia*
Standard	broadly ovate	orbicular
Basal lobe of wing petal	ovate to subulate	linear to lanceolate
Dorsal auricle	rounded	ovate
Spur	0.5 – 0.7 cm long	1.5 – 2 cm long

Chromosome number: n = 7 (Rao *et al.*, 1986), n = 8 (Bhaskar and Razi, 1972-73).

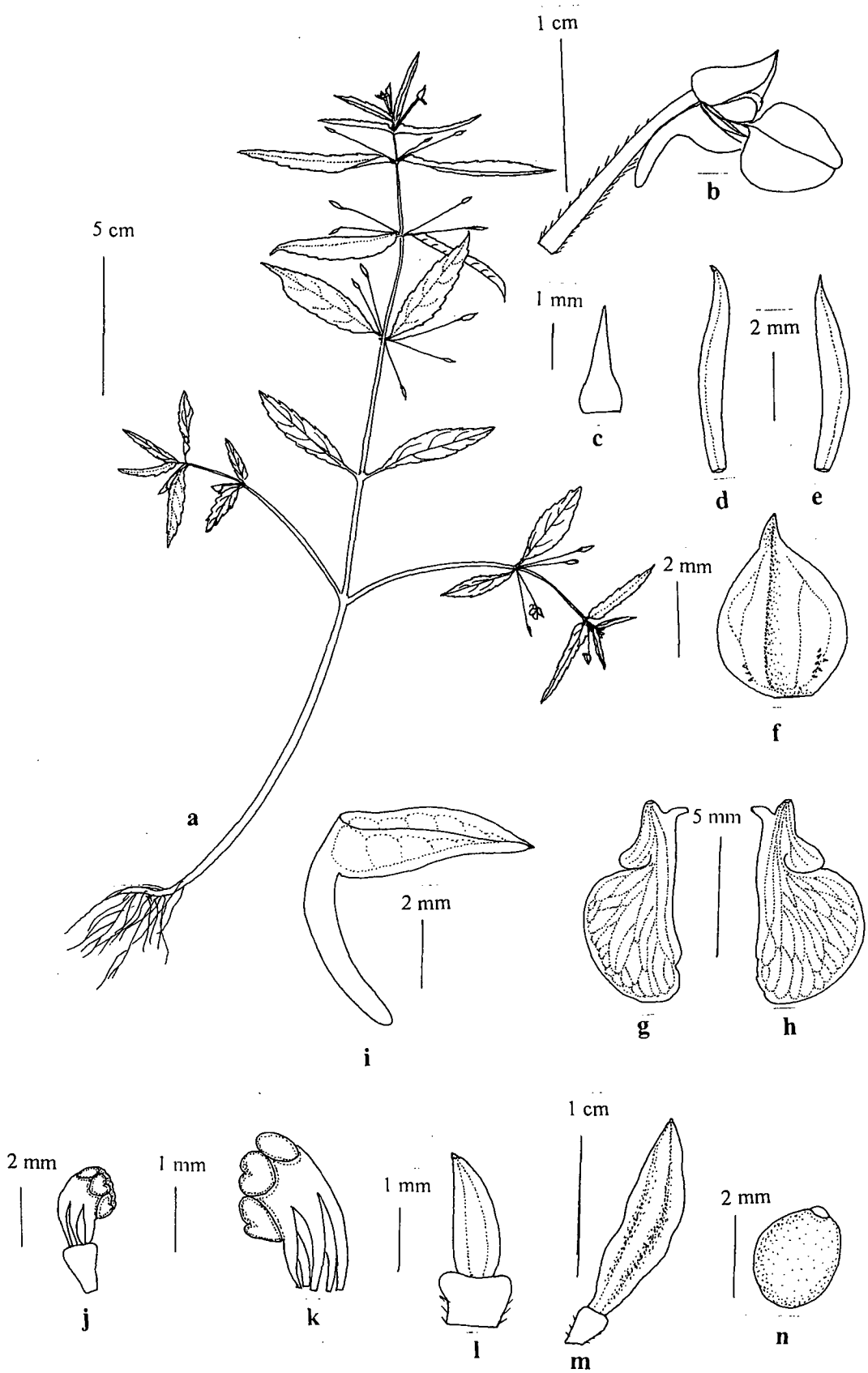


Fig. 16: *Impatiens tenella* Heyne ex Wight & Arn.a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g, h) wing petals, i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

IUCN threat status: EN [B1ab(iii)].

Etymology: Latin: *tenella* = delicate.

Impatiens tomentosa Heyne ex Wight & Arn., Prodr. Fl. Ind. Orient. 2: 139. 1834; Wight, Icon. Pl. Ind. Orient. t. 749. 1844; Hooker & Thomson in J. Proc. Linn. Soc., Bot. 4: 121. 1859; Dalzell & Gibson, Bombay Fl., 43. 1861; Hooker, Fl. Brit. India 1: 449. 1874 & in Rec. Bot. Surv. India 4: 46. 1906; Cooke, Fl. Bombay 1: 173. 1901; Gamble, Fl. Madras 1: 141. 1915; Blatter in J. Bombay Nat. Hist. Soc. 33: 312. 1933; Vajravelu in Nair & Henry, Fl. Tamil Nadu 1: 56. 1983; Ahmedullah & Nayar, Endemic plants of the Indian region 1: 194. 1986; Kulkarni, Fl. Sindhudurg, 61. 1988; Deshpande *et al.*, Fl. Mahabaleshwar 1: 119. 1993; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 217. 1997; Mudaliar & Prasad in Singh & Karthikeyan, Fl. Maharashtra Dicots. 1: 443. 2000; Yadav & Sardesai, Fl. Kolhapur District, 95. 2001.

Herb, 25 – 30 cm high. Stem branched; branches semi-quadrangular, pinkish red in colour, glabrous below, densely hairy above. Leaves opposite decussate, oblong to oblanceolate, lower leaves shortly petiolate, upper subsessile; petiole c. 2 mm long, decurrent and ending as glands; lamina 3 – 4.5 × 1. 5 – 2 cm, truncate to obcordate at base, serrate along margin, acute to acuminate at apex, adaxial surface pubescent, abaxial suface pale green in colour, hairy on the midrib and veins. Flowers axillary, 4 – 5 per axil, dark pink with purple throat, c. 1.5 cm across, bracteate, pedicellate; bracts linear, c. 2 mm long, hairy on the vein in the middle dorsally, pedicel 2 – 3 cm long, hairy with two longitudinal rows of hairs. Lateral sepals 2, linear, c. 9 × 1 mm, pink in colour, dorsally slightly keeled, hairy on the keel and on the side facing downwards, acute to acuminate at apex, green in colour. Standard orbicular to

rounded, pink in colour, c. 9 × 8 mm, dorsally keeled, hairy on the keeled surface, keel mucronate, green in colour. Wing petals c. 2.2 × 0.8 cm, bilobed, auricled at the base, basal lobe small, triangular, c. 6 × 4 mm, apically acute to obtuse, distal lobe assymmetrically obovate, c. 1.3 × 0.8 cm, elevated at the base towards the inner side, apically obtuse; lip conical, pink in colour, c. 1.1 cm long, c. 6 mm deep, c. 4 mm wide, acuminate at apex, green in colour, hairy all over, spurred; spur hooked, c. 3 mm long, cylindrical, hairy, tip notched, green in colour. Column c. 5 × 3 mm, bent on one side. Anthers c. 0.5 × 1 mm, pink in colour, coherent above the pistil; filaments 5, c. 4.5 × 1 mm, pink in colour. Pistil c. 3.5 × 1 mm; ovary oblongoid-lanceoloid, glabrous. Fruit assymmetrically ellipsoid to ellipsoid-lanceoloid, glabrous. Seeds oblongoid, c. 2.5 × 1.5 mm, brown to brownish-black in colour, glabrous, shining, funiculus prominent (Fig. 17; Plate - 5e).

Fl. & Fr.: (May) July – October.

Habitat: Grows on open table lands. Grows in association with grasses, *Impatiens lawii* Hook. f. & Thomson and *I. oppositifolia* L.

Distribution: Endemic to the Western Ghats of Maharashtra, Kerala and Tamil Nadu (Map - 5b).

Specimens examined:

Tamil Nadu: Pulney hills, 1804, R. H. Beddome *s. n.* (MH-7490); Pambar river, Kodaikanal, 12. 09. 1905, C. A. Barber 7265 (MH) Agasthiyamalai, Tirunelveli district, 22. 05. 1901, *s. c.* 2923 (CAL); Agastyamalai, Tirunelveli district, 01. 07. 1964, A. N. Henry & M. Chandrabose 19182 (MH); Mudimund, in swamps, 22. 06. 1986, M. K. Janarthanam 83000 (MH); Pykara river, Nilgiris, 15. 07. 1970, J. L. Ellis *s. n.* (MH); Kollimund, Nilgiris, 12. 10. 1972, K. Vivekananthan 43034 (MH); Sangamithirai, Tirunelveli district, 23. 02. 1990, R. Gopalan 91656 (MH).

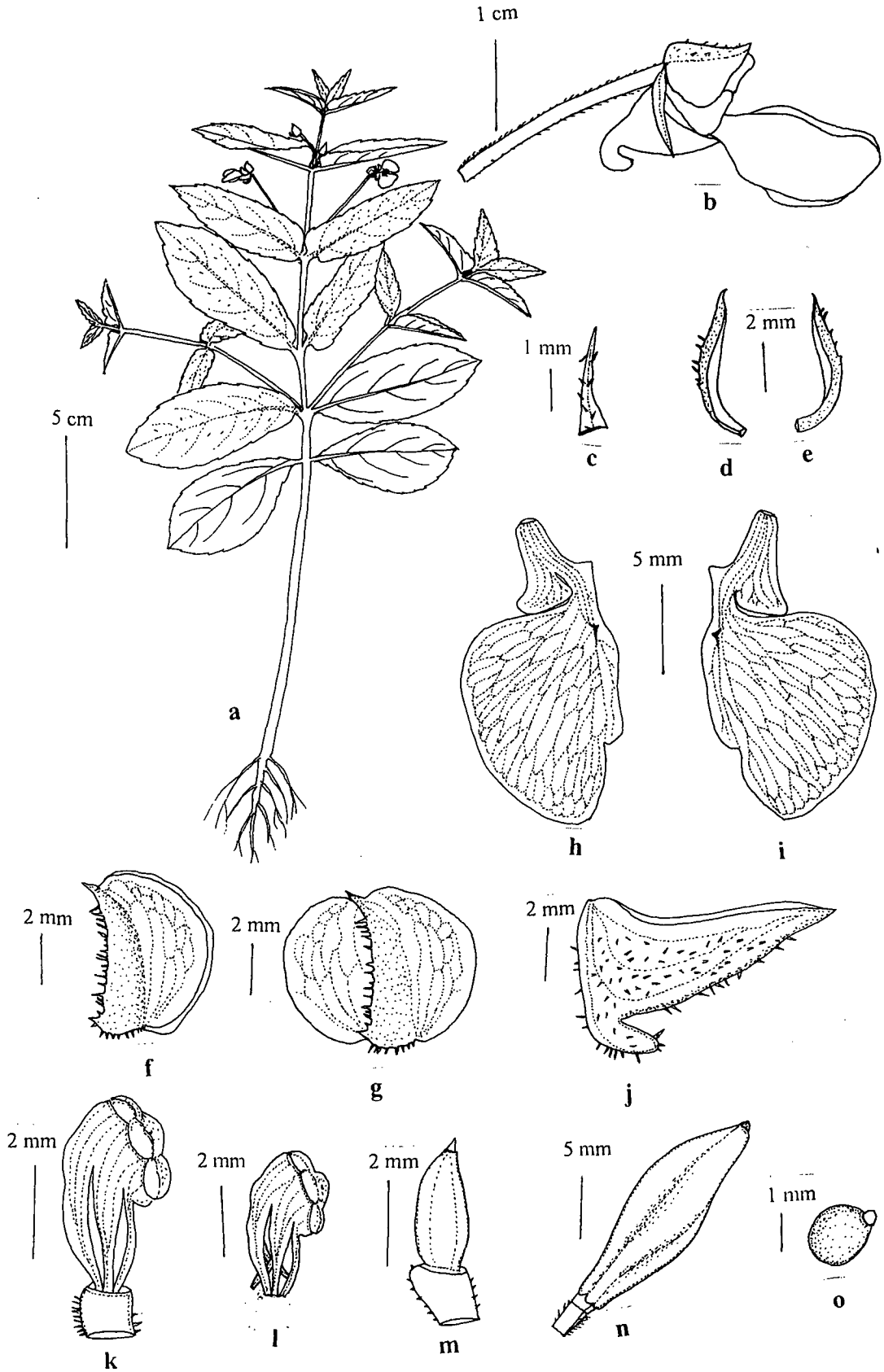


Fig. 17: *Impatiens tomentosa* Heyne ex Wight & Arn. a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard, g) standard petal (side view), h, i) wing petals, j) lip, k) column, l) androecium, m) pistil, n) capsule, o) seed.

Maharashtra: Kas plateau, 18. 09. 2006, Jyosna R. N. Dessai 101 (GUH), Kas plateau, 18. 08. 2006, Jyosna R. N. Dessai 116 (GUH).

Notes: *Impatiens tomentosa* is similar to *I. rufescens* Benth. ex Wight & Arn. but differs in the following characters

Character	***Impatiens tomentosa***	***Impatiens rufescens***
Stem	hairy only in the upper half of the plant; hairs soft	hairy throughout, hairs stiff
Spur	present	absent

Hooker (1874) due to morphological similarities between *I. tomentosa* and *I. rufescens* reduced *I. rufescens* as a variety under the former. However both the species can be distinguished from each other based on the presence and absence of spur. Hence these have been treated as distinct species in the present study.

Chromosome number: n = 8 (Rao *et al.*, 1986).

IUCN threat status: EN [B1ab(iii)].

Etymology: Latin: *tomentosa* = thickly matted with hairs, with reference to the hairy nature of the plant.

Impatiens vivekananthanii sp. nov.

Impatienti chinensi similis, calcare gracili curvato e basi ad apice angustato (versus crasso valde incurvato compresso in medio latissimo), foliis scabridis (versus sparse pubescentibus) differt.

HOLOTYPE – INDIA, Karnataka, Kodagu district, Talacauvery, 17. 09 2006, Jyosna R. N. Dessai & M. K. Janarthanam 146 (CAL!).

Erect annual herbs, 60 – 70 cm high. Stem quadrangular, succulent, base subsucculent, glabrous, pale green, nodes slightly swollen, internodes smaller at base, longer at apex. Leaves opposite-decussate, sessile or subsessile; petiole decurrent on

stem and ending as two petiolar glands, lamina linear-oblanceolate to spathulate, 3.5 – 7 × 0.5 – 1.2 cm, truncate at base, margin distantly serrate, acute to apiculate at apex, coriaceous, adaxial surface dark green in colour, scabrid, veins obscure, abaxial surface glaucous, glabrous. Flowers axillary, 2 – 3 (4) per axil, 2 – 3 cm across, pink with marron throat, bracteate, pedicellate; bract minute, triangular, c. 1.5 × 1 mm; pedicel 3 - 4.5 cm long, subterete, glabrous to hairy with a row of pubescence. Lateral sepals linear to linear-oblanceolate, 0.7 – 1.2 × 0.1 – 0.2 cm, pinkish white in colour, nerves 3, middle ridged dorsally, minutely hairy, acuminate at apex, pinkish red in colour. Standard reniform, 0.7 – 0.8 × 0.9 – 1.3 cm, pink to pinkish white in colour, glabrous, concave, dorsally keeled, keel mucronate; mucro c. 1 mm long. Wing petals 1.7 – 2.5 × 1 – 1.7 cm, bilobed, pink with purple throat; basal lobe small, ovate, 4 – 7 × 2 – 3 mm, apically acute to rounded; distal lobe much larger than basal lobe, 1.1 – 1.9 × 0.9 – 1.8 cm, apically obtuse, notched towards inner side much below apex. Lip conical, 0.9 – 1.4 cm long, 5 – 7 mm deep, 5 – 6 mm wide, pink with dark pink veins, glabrous to sparsely minutely hairy, spurred; spur tubular, 2 – 4 cm long, pinkish white, glabrous to sparsely minutely hairy, tip thick, notched. Column 5 – 6 × 2 – 3 mm. Anthers c. 1 × 0.75 mm, yellow in colour; filaments 4 – 5 × 1 – 1.5 mm, pink to white in colour. Pistil c. 5 mm long; ovary asymmetrically oblongoid, c. 4.5 × 1 mm, glabrous (Fig. 18; Plate - 5f, g).

Fl. & Fr.: July - November.

Habitat: On grass slopes and vertical cut surfaces along roadsides.

Distribution: Karnataka, Tamil Nadu, Ceylon (Map - 5c).

Specimen examined:

Karnataka: Talacauvery, Coorg district, 17. 09 2006, Jyosna R. N. Dessai & M. K. Janarthanam 146 (Holotype – CAL; Isotypes – BSI, MH).

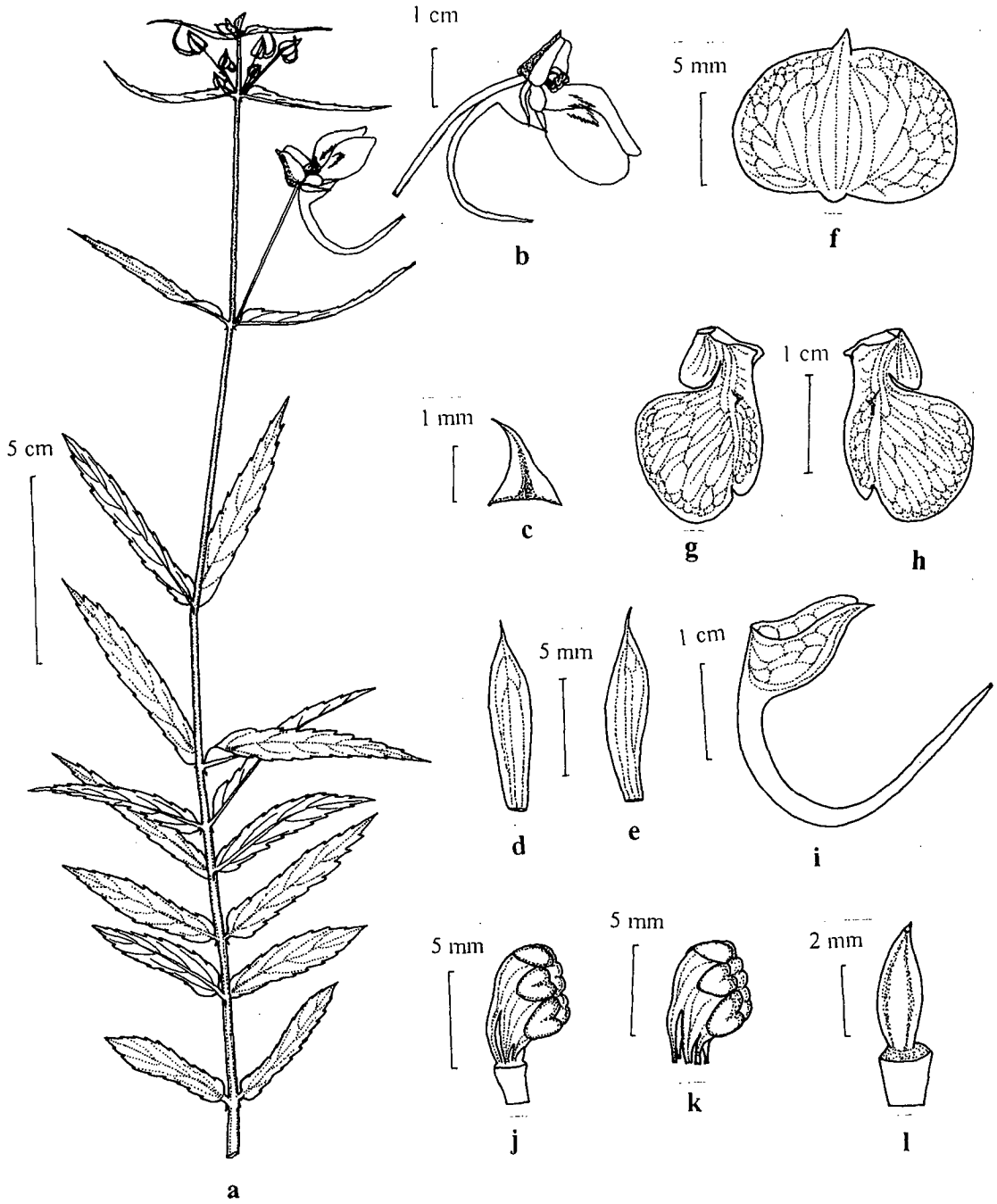


Fig. 18: *Impatiens vivekananthanii* sp. nov. a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g, h) wing petals, i) lip, j) column, k) androecium, l) pistil.

PLATE 5

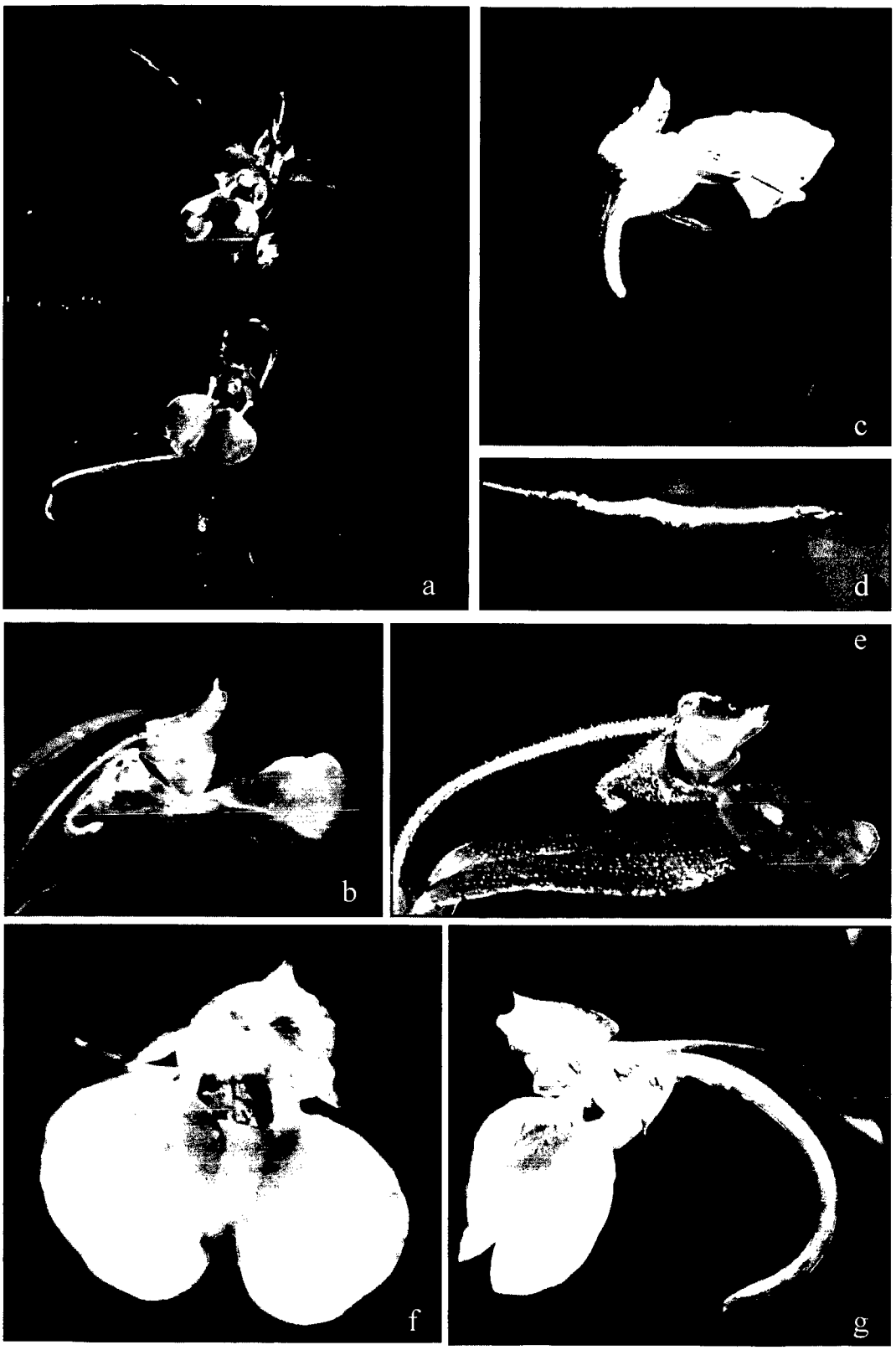


PLATE 5: a, b. *Impatiens raziana* Bhaskar & Razi; c, d. *I. tenella* Heyne ex Wight & Arn.; e. *I. tomentosa* Heyne ex Wight & Arn.; f, g. *I. vivekananthanii* sp. nov.

Tamil Nadu: Nilgiri, *s. d.*, R. Wight 35 (G; Photo!); Chinchona plantation, Naduvattam, Nilgiri district, 11. 11. 1959, N. P. Balakrishnan 9693 (MH); Benne forest, Nilgiri, 19. 07. 1960, K. Subramanyam 10477 (MH); Mukruti, Nilgiri district, 14. 07. 1970, J. L. Ellis 34668 (MH); Thala kunda, Nilgiri district, 27. 08. 1970, B. D. Sharma 35835 (MH); Pykara, Nilgiri district, 30. 08. 1970, B. D. Sharma 35951 (MH); Avalanche, Nilgiri district, 14. 10. 1972, K. Vivekananthan 42964 (MH);

Note: *Impatiens vivekananthanii* is similar to *Impatiens chinensis* L. but differs in its slender, curved spur that tapers from the base to the apex (against thick, strongly incurved, compressed spur that is broad in the centre) and in having scabrid leaves (against sparsely hairy leaves).

In most of the Indian Floras this species was referred as *I. chinensis* var. *chinensis*. But the species described by Linnaeus (1753) as *I. chinensis* is with a strongly curved spur. Lamark (1785) published *I. fasciculata* based on Van Rheede's (1689) illustration from *Hortus Malabaricus*. Subsequently this has been reduced to a synonym under *I. chinensis* (Hooker and Thomson, 1859).

Hooker and Thomson (1859) and Hooker (1874) consider *I. fasciculata* to be conspecific to *I. chinensis*. Wight and Arnott (1834) treated *I. fasciculata* as distinct species, but described the wing petal as bilobed (not lobed in Van Rheede's illustration) that has been well depicted by Wight (1844) in the Icones (t. 748). The collections of Wight identified as *I. fasciculata* are deposited at G.

Hooker (1852) too illustrated *I. fasciculata* based on the plants that were grown from the seeds obtained from Thwaites from Ceylon. He observed that the name "*fasciculata*" was not appropriate, as the flowers were solitary in axils. He also noticed through Wight's illustration a conspicuous 'spur' at the base of decurrent leaf

on stem that he called as stipules. These characters are conspicuously absent in Van Rheede's illustration thus showing that what had been considered by these authors as *I. fasciculata* was distinct from that of Lamark's thus paving way for confusion. Since *I. fasciculata,* as illustrated by Wight (1844) and Hooker (1852) has been synomised under *I. chinensis* by Hooker and Thomson (1859), later authors mistook it for true *I. chinensis*. The subsequent collection of actual *I. chinensis* with thick and strongly curved spur led Barnes (1939) to describe a new variety *I. chinensis* var *brevicornis*. However the entity treated as *I. fasciculata* by Wight (1844) and Hooker (1852) remained undescribed. The description and illustration provided by Wight (1844) and Hooker (1852) for *I. fasciculata* are based on wrong identifications. Thus their illustrations and descriptions were that of yet to be undescribed species. Hence this species is described here as a new species.

IUCN threat status: LC.

Etymology: Latin: *vivekananthanii* = in honour of Mr. K. Vivekananthan, who contributed extensively to the understanding of flora of Western Ghats and who is also the senior author of family Balsaminaceae in Flora of India.

Section: *Uniflorae* (*Microsepalae*) Hook. f. & Thomson

Shrubs and herbs; leaves opposite, alternate and rarely whorled; flowers pedicelled; pedicel solitary, binate or fascicled in the axils of the leaves (peduncle 0); sepals small or minute; seeds smooth, rugose or papillose (Hooker, 1906).

Key to the species (section *Uniflorae*)

1. Leaves opposite at base, ternate at apex.....*I. gardneriana*
1. Leaves all alternate.....(2)

2. Plants glabrous; leaves broadly elliptic to lanceolate; lobes of wing petals subequal.....(3)
2. Plants pubescent; leaves linear elliptic to linear lanceolate; lobes of wing petals unequal.....(5)

3. Fruit wall tomentose.....*I. talbotii*
3. Fruit wall glabrous.....(4)

4. Stem quadrangular; seeds hairy.....*I. dasysperma*
4. Stem circular; seeds rugose.....*I. pulcherrima*

5. Spur present.....(6)
5. Spur absent.....*I. scabriuscula*

6. Spur short, < 1 cm, straight or hooked.....(7)
6. Spur long, > 2 cm, curved.....*I. balsamina*

7. Spur straight; capsule minutely hairy.....*I. mysorensis*
7. Spur curved or hooked; capsule villous.....*I. rosea*

Impatiens balsamina L. Sp. Pl. 938. 1753.

Hooker (1906) lists 10 varieties under this species for Peninsular India of which the following two were found in the study area.

Key to the varieties

1. Flowers binate; distal lobe of wing petal broadly obovate; lateral sepals ovate.....*balsamina*
1. Flowers 3-4 per axil; distal lobe of wing petal obovate; lateral sepals lanceolate.....*micrantha*

Impatiens balsamina L. Sp. Pl. 938. 1753; var. **balsamina**; Wight & Arnnott, Prodr. Fl. Ind. Orient. 135. 1834; Hooker & Thomson in J. Proc. Linn. Soc. Bot. 4: 130. 1859; Hooker, Fl. Brit. India 1: 453. 1874 & in Rec. Bot. Surv. India 4: 47. 1906; Cooke, Fl. Bombay 1: 174. 1901; Gamble, Fl. Madras 1: 142. 1915; Ramamoorthy in Saldanha & Nicolson, Fl. Hassan District, 400. 1978; Vajravelu in Nair & Henry, Fl. Tamil Nadu 1: 52. 1983; Almeida, Fl. Savantwadi 1: 77. 1990; Keshava Murthy & Yoganarasimhan, Fl. Coorg, 86. 1990; Saldanha in Saldanha, Fl. Karnataka 2: 249. 1996; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 123. 1997; Mudaliar & Prasad in Singh & Karthikeyan, Fl. Maharashtra Dicots. 1: 445. 2000; Bhat, Fl. Udupi, 87. 2003; Nayar *et al.*, Fl. Pl. Kerala, 141. 2006. **TYPE** - INDIA. Linnean Herb. No. 1053.3 (LINN; Photo!).

Impatiens cornuta L. Sp. Pl. 937. 1753. **TYPE** – CEYLON, Linnean Herb. 316 (LINN; Photo!).

Impatiens coccinea Sims, Bot. Mag. t. 1250. 1810. **TYPE** – Sims, Bot. Mag. t. 1250.

Erect, much branched herbs, 0.40 – 1.5 m high. Stem circular, swollen at nodes, pubescent, pinkish-red in colour. Leaves alternate, petiolate; petiole 1 – 1.5 cm long, hairy, glandular; glands 3 – 5 pairs; lamina lanceolate, oblanceolate, elliptic to linear-oblanceolate, 3 – 15 × 0.7 – 2 cm, cuneate to attenuate at base, crenate to serrate along margins, acuminate at apex, sparsely hairy adaxially, hairy only on nerves abaxially, venation reticulate; nerves 6 – 9 pairs. Flowers axillary, solitary to binate, c. 2.5 cm across, pink in colour, bracteate, pedicellate; bracts linear-lanceolate, c 1 × 0.5 mm, acute at apex, hairy on dorsal surface, dark pink in colour; pedicel 1 – 1.5 cm long, hairy all over, deflexed in fruits. Lateral sepals 2, ovate, c. 2.5 × 1.5 mm, acute to acuminate at apex, slightly concave, hairy dorsally. Standard broadly ovate to orbicular, c. 8 × 7 mm, concave, dorsally keeled; keel hairy, mucronate at apex; mucro

c. 2 mm long. Wing petals c. 2 × 1.6 cm, bilobed, auricled near base, curved outwards; basal lobe oblong-ovate, c. 6 × 3 mm, obtuse to apiculate at apex; distal lobe asymmetrically obovate, c. 1.6 × 1.5 cm, deeply notched at apex. Lip conical, c. 1.3 cm long, c. 8 mm deep, c. 6 mm wide, acuminate to cuspidate at apex, hairy, spurred; spur basal, 3 – 3.5 cm long, tubular, sparsely hairy, tip bulged. Column c. 4 × 3 mm, curved. Anthers c. 1 × 1 mm; filaments c. 3 × 1 mm. Pistil c. 3 × 1 mm; ovary ellipsoid to lanceoloid, villous. Capsules broadly ellipsoid, 1 – 1.5 × 0.6 – 0.9 cm, wooly; pedicel c. 2 cm long. Seeds globular, c. 2.5 × 2.5 mm, dark brown in colour, granulate (Fig. 19; Plate - 6a, b, c).

Fl. & Fr.: August – November.

Habitat: Found growing along roadsides in damp loose soil and in and around habitations. Grows up to an altitude of 1600 m.

Distribution: China, India, Malesia, Sri-Lanka (Map - 5d).

Specimens examined: Karnataka: Shivlinga estates, Kemmangundi, Chikmagalur district, 17. 11. 2004, Jyosna R. N. Dessai & M. K. Janarthanam 30 (GUH); Kemmangundi, Chikmagalur district, 05. 09. 2005, Jyosna R. N. Dessai 81 (GUH); Near Kuvempu University, Shimoga district, 05. 09. 2005, Jyosna R. N. Dessai 88 (GUH); Jog falls, North Kanara district, 06. 09. 2005, Jyosna R. N. Dessai 92 (GUH).

Madhya Pradesh: Jeeram hills, Bantar district, 27. 08. 1959, K. Subramanyam 8669 (MH).

Tamil Nadu: Thandikudi hills, Dindigul district, 05. 12. 1989, K. Ravikumar 92361 (MH).

Note: The species is widely cultivated in gardens as an ornamental; grows invasively under all climatic conditions.

The plant possesses medicinal properties. Seeds of *Impatiens balsamina*

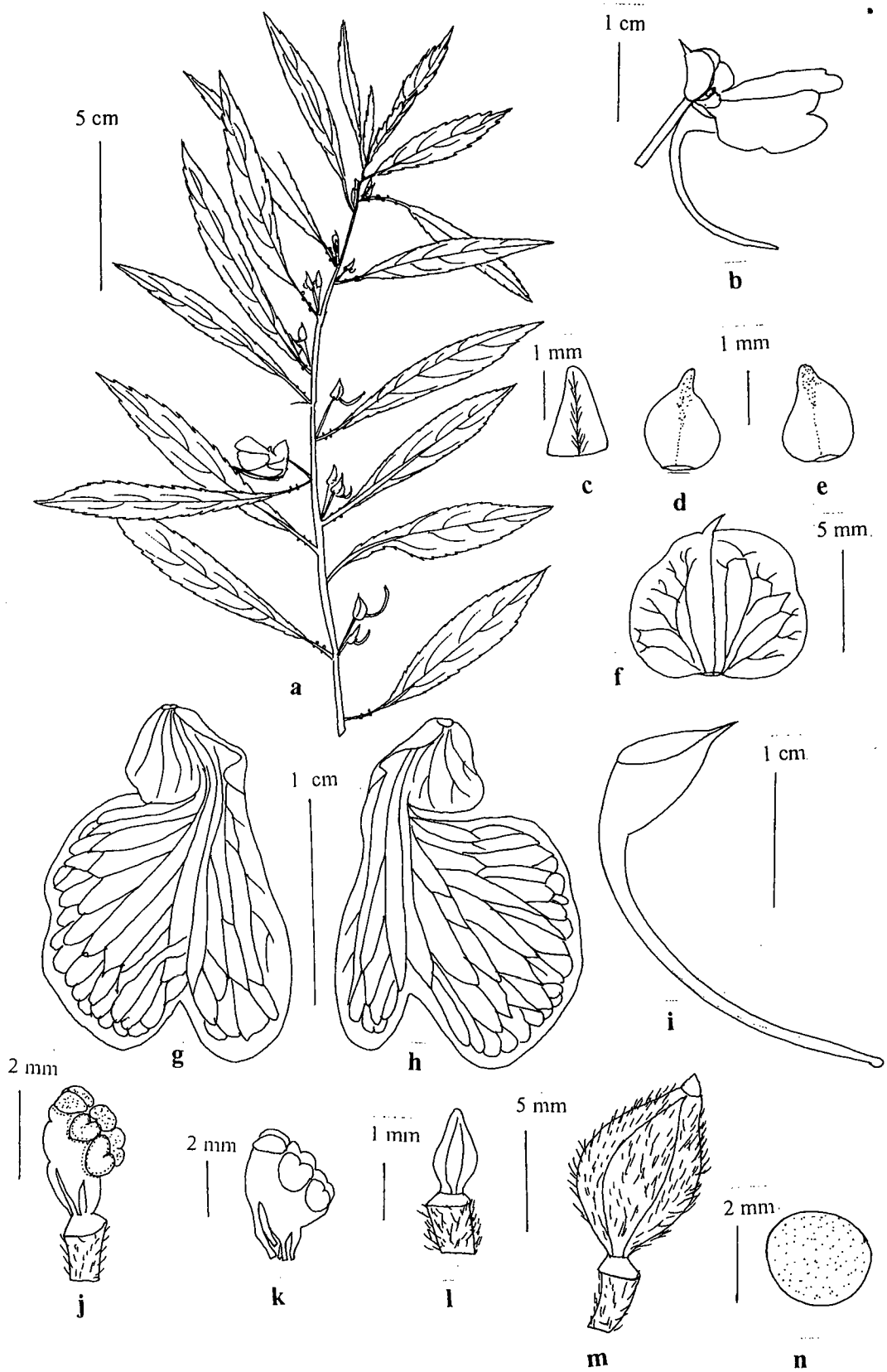
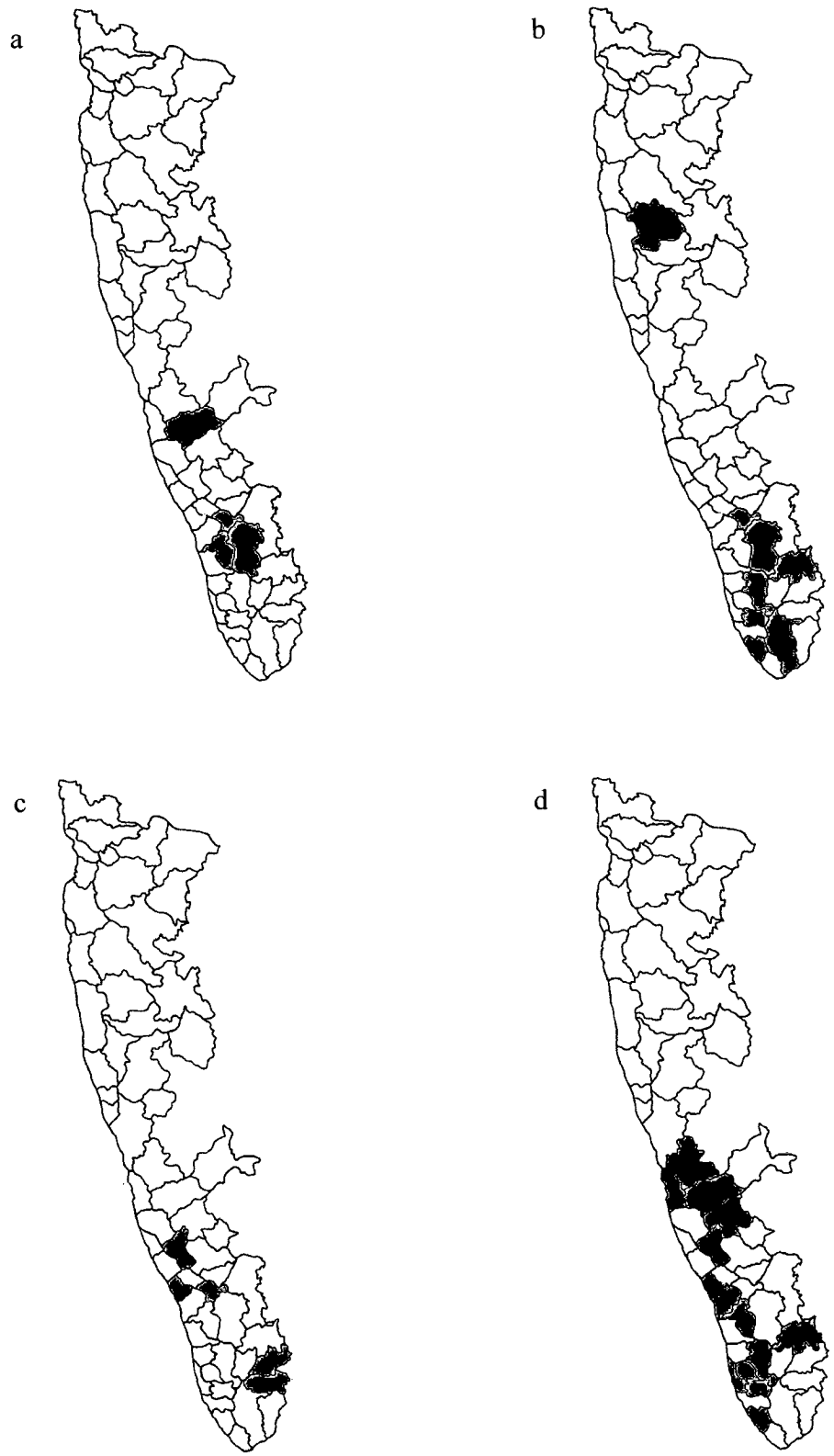


Fig. 19: *Impatiens balsamina* L. var. *balsamina*. a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g, h) wing petals, i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

Map 5: Distribution of a) *Impatiens tenella*; b) *I. tomentosa*; c) *I. vivekananthanii*; d) *I. balsamina* var. *balsamina.*



contain cysteine-rich peptides with marked antimicrobial activity. These proteins inhibit the growth of fungi and bacteria without harming human cells (Tailor *et al.*, 1997). Dye obtained from the flowers and leaves is used for dyeing nails red (Polunin and Stainton, 1984; Yi-ling *et al.*, 2007).

IUCN threat status: LC.

Impatiens balsamina L. var. **micrantha** Hook. f., Fl. Brit. India 1: 454. 1874 & in Rec. Bot. Surv. India 4: 50. 1906.

Erect herbs, 10 – 50 cm high. Stem branched or unbranched; branches alternate, circular, light green with reddish tinge, succulent, sparsely minutely hairy at the base, densely minutely hairy above, nodes swollen. Leaves alternate, linear lanceolate, elliptic, linear-oblong, 2.3 – 7.5 × 0.5 – 1.8 cm, petiolate; petiole 1 – 2 cm long, densely hairy beneath, minutely sparsely hairy above, glandular; glands one pair at base of lamina, adaxially hairy, abaxially hairy only on the nerves, cuneate to attenuate at base, closely serrate and ciliate along margins, acuminate at apex; serrations apiculate, basal 1 – 2 serrations glandular, lateral veins distinct on both surfaces, 4 – 12 pairs, alternate. Flowers axillary, 3-4 per axil, 2 – 2.5 cm across, pink with light purple throat, bracteate, pedicellate; bracts linear-subulate, c. 3 × 1 mm, light green in colour, scaly, costa dorsally keeled, hairy, margins hairy, tip acuminate; pedicel 1 – 1.5 cm long, densely hairy all over, deflexed in fruits. Lateral sepals minute, ovate-lanceolate, c. 2.5 × 1 mm, light green in colour, hairy along margins, acute to acuminate at apex, veins 3, median dorsally keeled; keel hairy. Standard broadly ovate, 0.6 – 0.8 × 0.8 – 1 cm, pink with white centre, deeply concave, apically semicordate, dorsally keeled, hairy on costa and central basal region, mucronate; mucro 2 – 3 mm long, green in colour. Wing petals 1.6 – 2 × 1.2 – 1.6 cm, bilobed,

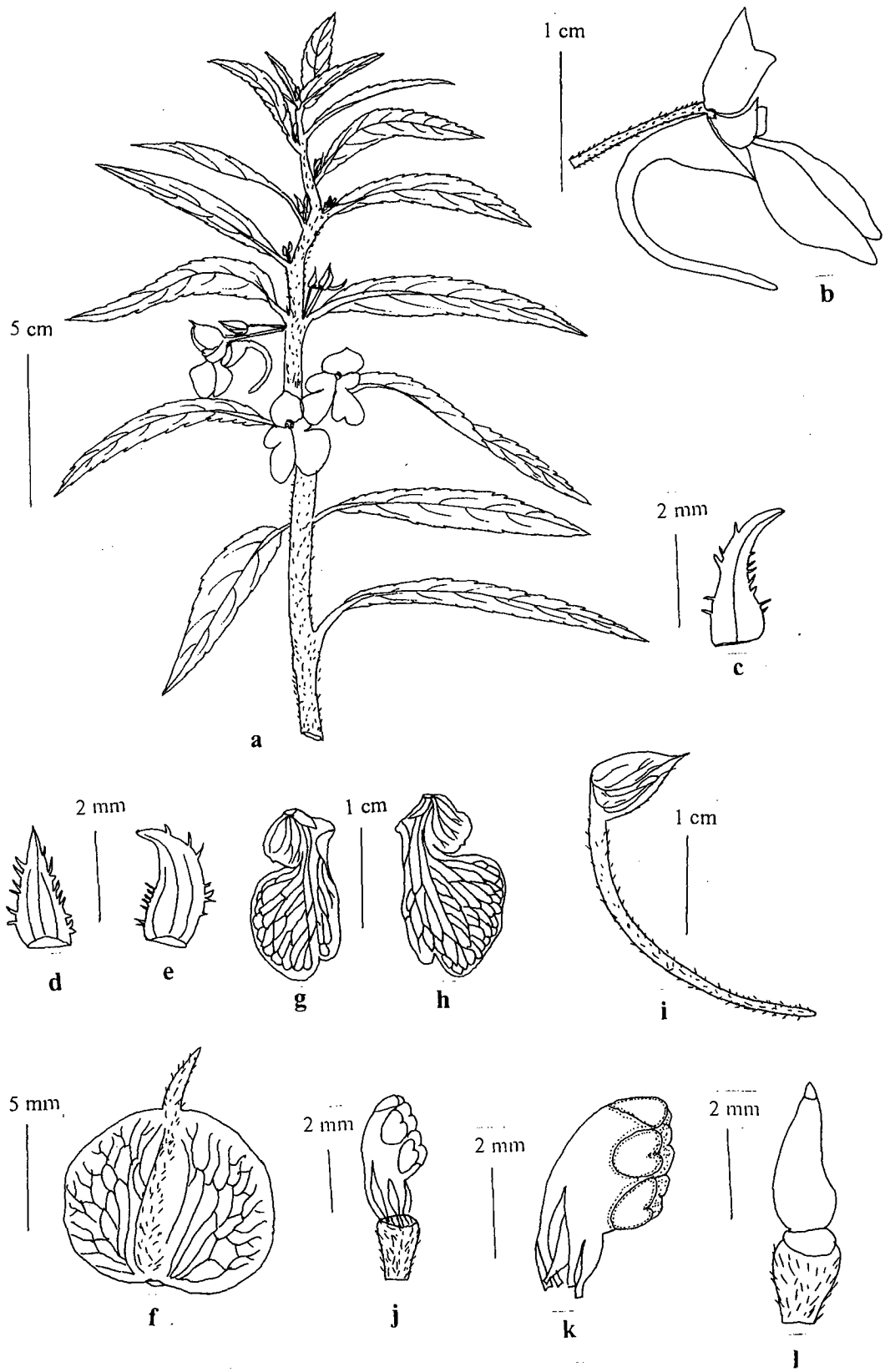


Fig. 20: *Impatiens balsamina* L. var. *micrantha* Hook. f. a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g, h) wing petals, i) lip, j) column, k) androecium, l) pistil.

lobes unequal, auricled near base; auricle small; basal lobe small, 5 – 6 × 4 – 5 mm, oblong, apically obtuse; distal lobe asymmetrically ovate, 1.2 – 1.6 × 1 – 1.1 cm, bilobulate, apically rounded. Lip conical, 0.8 – 1 cm long, c. 5 mm deep, c. 5 mm wide, pink to white with greenish tinge, densely hairy, tip acuminate, green in colour, spurred; spur 3 – 3.5 cm long, tubular, light pink in colour, hairy, tip bulged, rounded, green in colour. Column c. 6 × 2 mm. Anthers c. 1 × 1 mm, white to pink in colour; filaments c. 4.5 × 1.5 mm, pink in colour. Pistil c. 4.5 × 2 mm; ovary ellipsoid, c. 4 × 1.5 mm, minutely hairy (Fig. 20; Plate - 6d, e, f).

Fl.: September – December (not collected in fruiting).

Habitat: Grows on grassy slopes, cut hills.

Distribution: Karnataka at + 1480 m above msl (Map - 6a).

Specimens examined: Karnataka: Talacauvery, Kodagu district, 13. 08. 2005, Jyosna R. N. Dessai 52 (GUH), Mankanahalli, Bisle ghat, Hassan district, 16. 09. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 144 (GUH); Talacauvery, Kodagu district, 17. 09. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 147 (GUH).

Notes: Similar to *Impatiens balsamina* var. *balsamina* but differs in having 3 – 4-flowered inflorescence, obovate distal lobe of wing petal and pink coloured lip and spur rather than binate flowers, broadly obovate distal lobe of wing petal and white coloured lip and spur.

IUCN threat status: EN [B2ab(iii)].

Impatiens dasysperma Wight in Madras J. Lit. Sci. 5: 7, t. 2. 1837; Wight, Icon. Pl. Ind. Orient. t. 742. 1844; Hooker & Thomson in J. Proc. Linn Soc., Bot. 4: 134. 1859; Hooker, Fl. Brit. India 1: 457. 1874 & in Rec. Bot. Surv. India 4: 47. 1906; Gamble, Fl. Madras 1: 148. 1915; Vajravelu in Nair & Henry, Fl. Tamil Nadu 1: 53. 1983;

Sharma et. al., Fl. Karnataka Analysis, 37. 1984; Ahmedullah & Nayar, Endemic plants of the Indian region 1: 191. 1986; Nair & Nayar, Fl. Courtallum (Kutrallam) 2: 207. 1987; Ramachandran & Nair, Fl. Cannanore, 79. 1988; Nayar, Hot spots of endemic plants of India, Nepal and Bhutan, 214. 1996; Saldanha in Saldanha, Fl. Karnataka 2: 251. 1996; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 139. 1997. **TYPE** – INDIA, Tamil Nadu, Courtallum (Kutrallam), August 1835, R. Wight 334 (CAL!)

Herbs, 15 – 50 cm high. Stem quadrangular, glabrous to hairy at base, glabrous above, light green in colour. Leaves simple, alternate, petiolate; petiole 2 – 3.5 cm long, glabrous, with 2 pairs of glands (rarely absent); lamina broadly lanceolate to ovate-lanceolate, 1.8 – 6.5 × 1.1 – 3.5 cm, attenuate at base, crenate along margin, acute to apiculate at apex; crenae apiculate, adaxial surface dark green in colour, hairy throughout, abaxial surface pale green in colour, hairy only on the midrib and nerves. Flowers axillary, 2 in each axil, pink in colour, 1.5 – 2 cm across, bracteate, pedicellate; bracts concave, linear, c 1.5 mm long, acute at apex; pedicel 2.5 – 4 cm long, glabrous, light green in colour, deflexed in fruits. Lateral sepals ovate, light green in colour, glabrous, c. 2.5 × 1.5 mm, acute at apex, veins 3, 2 distinct, 1 obscure. Standard heart shaped, 0.8 – 10 × 6 – 8 mm, hairy on dorsal surface, costa mucronate, mucro c 1mm long, apically obcordate. Wing petals 1 – 1.5 × 0.8 – 1 cm, bilobed, lobes unequal, basal lobe obovate, bilobulate, 6 – 8 × 4 – 6 mm, distal lobe broadly oblanceolate, 0.8 – 1 × 4 – 6 mm, rounded apically, base of wing petals slightly protrudes into the spur thus giving the appearance of dorsal auricle. Lip conical, light pink in colour, sparsely hairy, c. 7 mm long, c. 4 mm deep, 4 – 5 mm wide, apex acuminate, spurred; spur tubular, 2 – 2.5 cm long, glabrous to sparsely hairy, tip rounded. Column c. 4 × 1.5 mm. Anthers c. 1 × 1 mm; filaments c. 2.5 × 1

mm; ovary ellipsoid, glabrous. Capsules assymmetrically ellipsoid, 1 – 1.3 × 0.3 – 0.6 cm, glabrous; pedicel 2 – 4.3 cm long. Seeds ovoid to globular, c. 1.5 × 1.5 mm, papillate-hairy, dark brown, compressed (Fig. 21; Plate - 6g, h).

Fl. & Fr.: August – September.

Habitat: Along the forest edges, in and along coffee estates, at the base of cut hills, on black boulders/rocks along with *I. gardneriana*. Altitudinal range 650 – 1650 m above msl.

Distribution: Endemic to the Western Ghats of Karnataka, Kerala and Tamil Nadu (Map - 6b).

Specimen examined:

Karnataka: Bababudan hills, Chikmagalur district, 4000 ft, 07. 09. 1893, W. A. Talbot 3099 (K; Photo!); Santaveri, Bababudan, Chikmagalur district, 4000 ft, October 1908, A. Meebold 10701 (K; Photo!); Agumbe, Shimoga district, 02. 10. 1960, R. Sundara Raghavan 69064 (BSI); Vanagunda, Bisle ghat, Hassan district, 14. 08. 2005, Jyosna R. N. Dessai 54 (GUH); Agumbe, Shimoga district, 04. 09. 2005, Jyosna R. N. Dessai 73 (GUH); Near Gaurishankar estates, Kemmangundi, Chikmagalur district, 05. 09. 2005, Jyosna R. N. Dessai 83 (GUH); Kalhati coffee estates, Kemmangundi, Chikmagalur district, 05. 09. 2005, Jyosna R. N. Dessai 87 (GUH); Talaguppa, Shimoga – Sagar road, 06. 09. 2005, Jyosna R. N. Dessai 90 (GUH); Mankanahalli, Bisle Ghat, Hassan district, 16. 09. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 141 (GUH); Thadiandamol, Kodagu district, 18. 09. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 150 (GUH); Palace estate, Thadiandamol, Kodagu district, 18. 09. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 154 (GUH); Thadiandamol, Kodagu district, 18. 08. 2007, Jyosna R. N. Dessai & M. K. Janarthanam 164 (GUH).

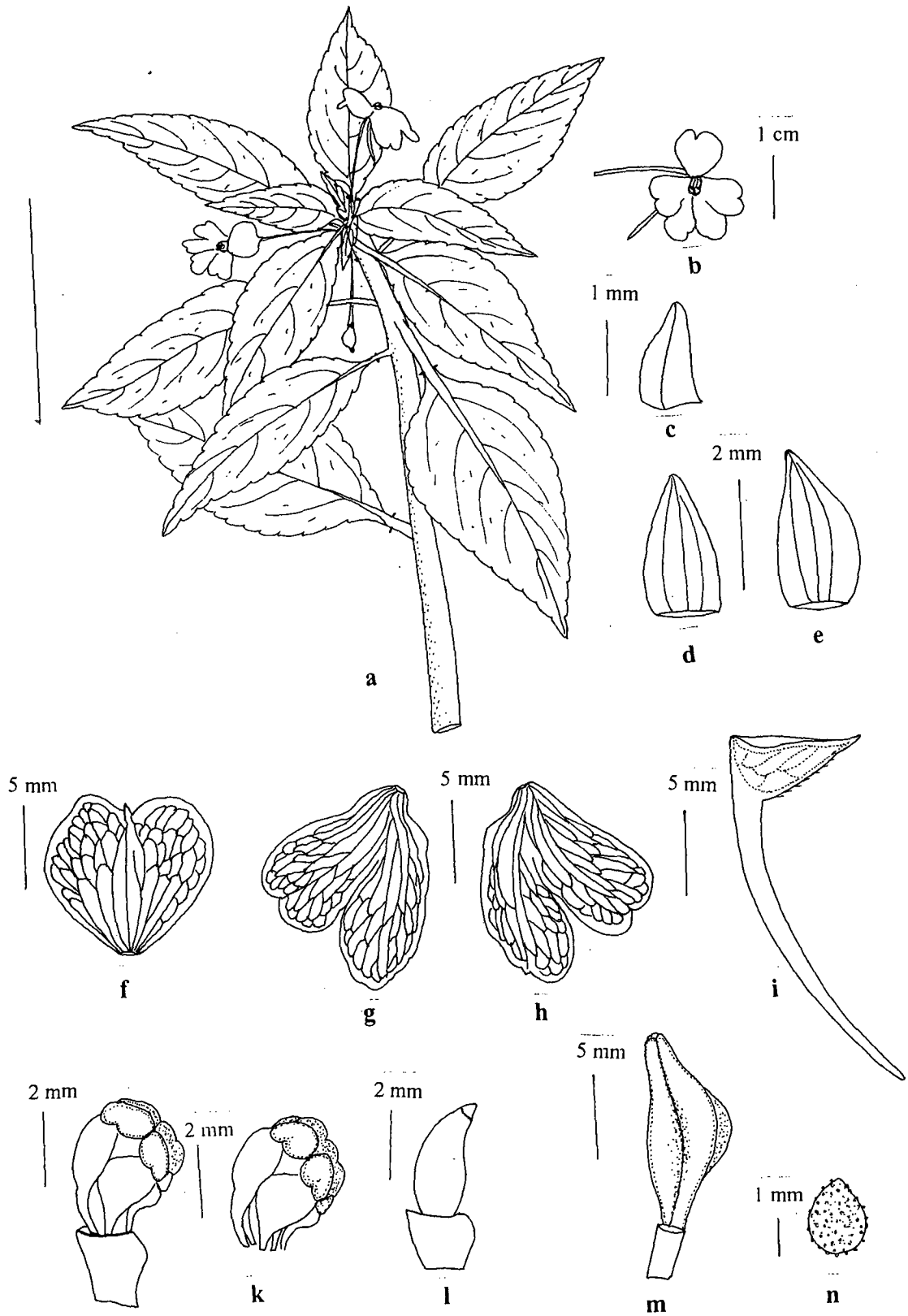


Fig. 21: *Impatiens dasysperma* Wight. a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g, h) wing petals, i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

PLATE 6

PLATE 6: a - c. *Impatiens balsamina* L. var. *balsamina*; d - f. *I. balsamina* L. var. *micrantha* Hook. f.; g, h. *I. dasysperma* Wight.

Kerala: Makora, Travancore, 05. 09. 1913, M. Rama Rao 1591 (CAL).

Tamil Nadu: Courtallum (Kutrallam), 1835, R. Wight 163, 164, 166 (E; Photo!);

Notes: *Impatiens dasysperma* is similar to *I. talbotii* Hook. f. but differs in having quadrangular stem, obovate standard petal and glabrous fruit wall as compared to circular stem, orbicular standard petal and tomentose capsule of the latter.

The identity of *Impatiens dasysperma* is confused with *I. flaccida* Arn. in India. The collections of *I. dasysperma* available in the Indian herbaria are identified as *I. flaccida* which is found only in Sri Lanka. However, the illustration of *I. dasysperma* provided by Wight (1837) in the protologue shows hairy spur, but none of the present collections are with hairy spur.

IUCN threat status: VU [B1ab(iii)].

Etymology: Latin: *dasy* = thickly-hairy; *sperma* = seed, refering to its hairy seeds.

Impatiens gardneriana Wight, Icon. Pl. Ind. Orient. t. 1050. 1846; Hooker & Thomson in J. Proc. Linn. Soc. Bot. 4: 121. 1859; Hooker, Fl. Brit. India 1. 445. 1874 & in Rec. Bot. Surv. India 4: 46. 1906; Gamble, Fl. Madras 1: 141. 1915; Ramamoorthy in Saldanha & Nicolson, Fl. Hassan district, 402, f. 78 C. 1978; Yoganarasimhan *et al.*, Fl. Chikmagalur District, 61. 1982; Vajravelu in Nair & Henry, Fl. Tamil Nadu 1: 53. 1983; Sharma *et al.*, Fl. Karnataka Analysis, 38. 1984; Ahmedullah & Nayar, Endemic plants of the Indian region 1: 192. 1986; Ramachandran & Nair, Fl. Cannanore, 79. 1988; Keshava Murthy & Yoganarasimhan, Fl. Coorg (Kodagu), 87. 1990; Saldanha in Saldanha, Fl. Karnataka 2: 257. 1996; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 150. 1997; Ramaswamy *et al.*, Fl. Shimoga District, 107. 2001. **TYPE**: Wight, Icon. Pl. Ind. Orient. t. 1050.

Impatiens setosa Hook. f. & Thomson in J. Proc. Linn. Soc. Bot. 4: 123. 1859.

Herb, 25 – 60 cm high; stem quadrangular. Leaves opposite at base, ternate at apex, basal leaves petiolate; petiole 1 – 3 cm long, glabrous, upper leaves subsessile, petiole c 3 mm long, hairy, lamina 3 – 8 × 2 – 4 cm, ovate, elliptic to lanceolate, cuneate to attenuate at base, serrate along margins, serrations apiculate, acuminate at apex, adaxial surface hairy, abaxial surface hairy on the midrib and lateral nerves. Flowers axillary, solitary to binate, c. 2 cm across, dark pink in colour, bracteate, pedicellate; bracts minute, scaly, triangular, c. 0.5 × 0.5 mm, apex acuminate; pedicel 2.5 – 4 cm long, hairy. Lateral sepals ovate, concave, c. 6 × 2 mm, caudate at apex, pale green in colour, hairy dorsally, veins 5. Standard broadly obovate, c. 8 × 8 mm, pink in colour, apiculate at apex, keeled and hairy dorsally. Wing petals c. 1. 2 × 0.9 cm, bilobed, basal lobe c. 8 × 4.5 mm, oblong-lanceolate to obovate, obcordate at apex, distal lobe c. 8 × 5 mm, oblong-oblanceolate to oblanceolate, obcordate at apex. Lip boat shaped, c. 8 mm long, c. 2.5 mm deep, caudate at apex, hairy only in the middle, spurred; spur 2 – 3 cm long, sparsely hairy, tip notched to rounded. Column c. 3 × 2 mm. Anthers c. 0.75 × 0.5 mm, pink in colour; filaments c. 3 × 0.75 mm, pink in colour. Pistil c. 2.5 × 0.75 mm; ovary oblongoid-lanceoloid glabrous. Capsule, oblongoid, c. 1.3 × 0.3 cm, glabrous, curved, pedicel 3 – 4.5 cm long. Seeds ovoid, c. 2.5 × 1.5 mm, densely hairy; apical hair spirally coiled and without thickening, basal ones not coiled but with reticulate thickenings (Fig. 22; Plate - 7a, b, c).

Fl. & Fr.: July – November.

Habitat: The species is often found growing in association with *I. dasysperma* at 500 – 1000 m., usually grows under the canopy of huge trees but also occurs in open plains.

Distribution: Endemic to the Western Ghats of Karnataka, Kerala and Tamil Nadu

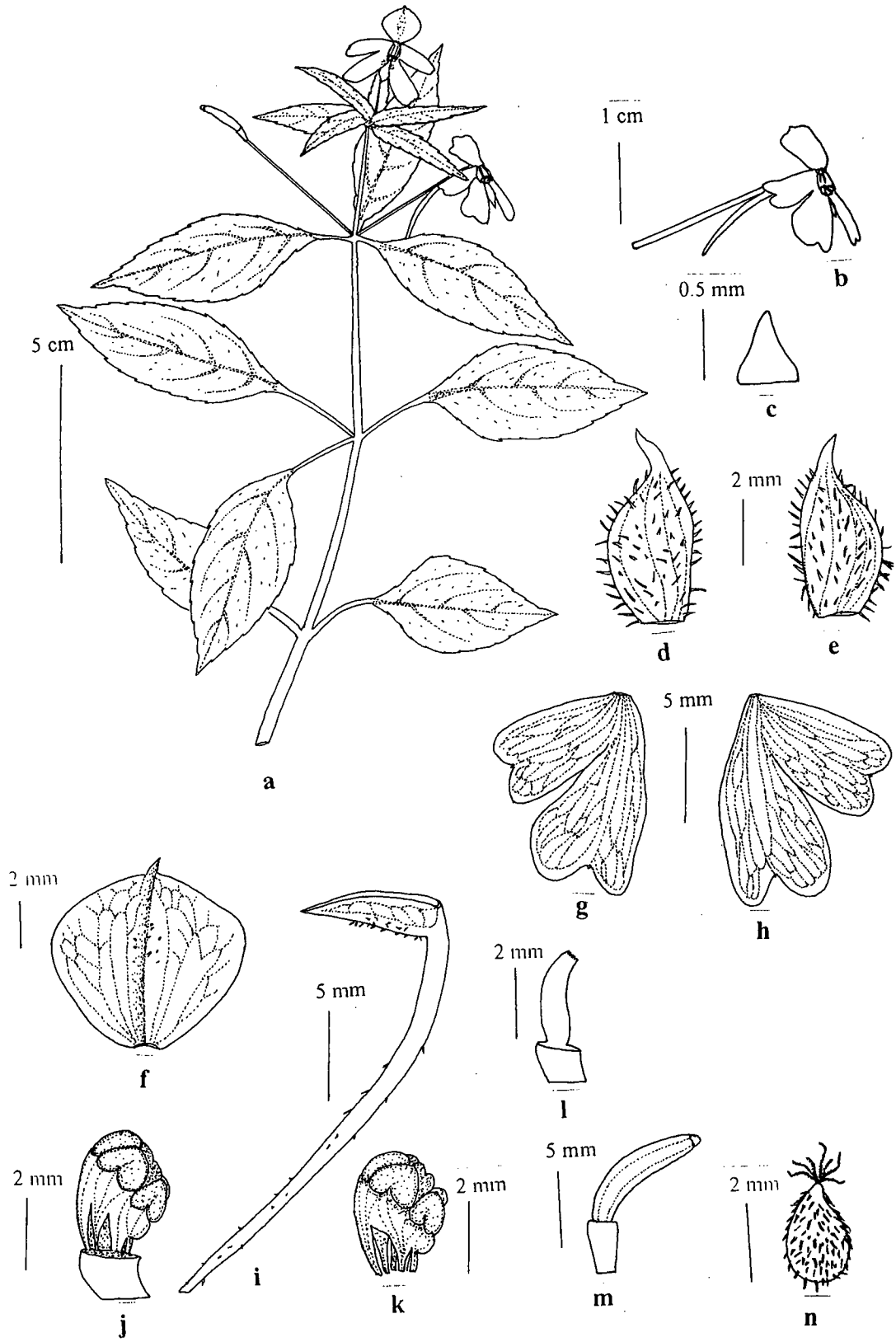


Fig. 22: *Impatiens gardneriana* Wight. a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g, h) wing petals, i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

(Map - 6c).

Specimens examined:

Karnataka: Charmadi, Chikmagalur district, 24. 11. 1927, S. R. Raju 18192 (MH); Hulical ghat, Shimoga district, 16. 10. 1964, R. Sundara Raghavan 90449 (BSI); Charmadi ghat, Chikmagalur district 25. 08. 1972, V. Bhaskar 318 (MGM); Pushpagiri, Bisle ghat, Hassan district, 24. 09. 1972, V. Bhaskar 329 (MGM); Hulical ghat, Shimoga district, 07. 11. 1972, V. Bhaskar 344 (MGM); Yelneerukad, Chikmagalur district, 21. 11. 1972, V. Bhaskar 351 (MGM); Kudremukh, Chikmagalur district, 18. 11. 2004, Jyosna R. N. Dessai & M. K. Janarthanam 28 (GUH); Vanagur, Bisle ghat, Hassan district, 14. 08. 2005, Jyosna R. N. Dessai & M. K. Janarthanam 55 (GUH); Maranahally, Shiradi ghat, South Kanara district, 15. 08. 2005, Jyosna R. N. Dessai & M. K. Janarthanam 57 (GUH); Charmadi ghat, Chikmagalur district, 15. 08. 2005, Jyosna R. N. Dessai & M. K. Janarthanam 60 (GUH); Bisle ghat, Hassan district, 16. 09. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 135 (GUH); Vanagur, Bisle ghat, Hassan district, 16. 09. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 143 (GUH).

Kerala: Tambrachari ghat, Wayanad district, 23. 07. 1905, *s. c.*, *s. n.* (MH-7533, 7534, 7535); Dhoni reserve forest, Palghat district, 18. 07. 1963, J. Joseph 17196 (MH); Near Kalpetta, Wayanad district, 03. 07. 1972, V. Bhaskar 296 (MGM); Wayanad district, 03. 08. 1972, V. Bhaskar 305 (MGM); Dhoni hills, Palghat district, 04. 08. 1972, V. Bhaskar 305 (MGM); Dhoni hills, Palghat district, 09. 08. 1972, V. Bhaskar 310 (MGM); Kariapalakad, Idukki district, 21. 08. 1977, K. Vivekananthan 50458 (MH); Karivara, Palghat district, 20. 09. 1977, J. Joseph 51403 (CAL); Mukkali slopes, Palghat district, 15. 10. 1979, N. C. Nair 64658 (CAL); Way to

Ponamukutty, Idukki district, 07. 10. 1983, A. G. Pandurangan 79280 (MH).

Notes: Phyllotaxy of *Impatiens gardneriana* is distinct among the species of the study area as both ternate (at apex) and opposite (at base) leaves are seen. Another characteristic feature is lateral sepals that are dorsally hairy. It is closely allied to *I. dasysperma* in its floral structure but differs principally by the following characters.

Character	***I. gardneriana***	***I. dasysperma***
Leaves	ternate at apex, oppsite at base	all alternate
Lateral sepals	c. 6 mm long, lanceolate	c. 3 mm long, ovate
Capsule	oblongoid	lanceoloid
Seed hair	two types	all uniform

Hooker and Thomson (1859) while classifying the south Indian *Impatiens* placed the species in section *Oppositifoliae* inspite of its ternate leaves and hairy seeds rather than opposite leaves and glabrous seeds that are characteristics of the section *Oppositifoliae.* In the present study the species is grouped under section *uniflorae* due to its hairy nature of the seeds and subequal lobes of the wing petals.

Chromosome number: 2n = 16 (Bhaskar and Razi, 1972-73; Zinovéva -Stahevitch and Grant, 1982, 1984).

IUCN threat status: EN [B1ab(iii)].

Etymology: Latin: *gardneriana* = in honour of George Gardner, British botanist and explorer.

Impatiens mysorensis Heyne ex Roth, Nov. Pl. Sp. 164. 1821; Wight & Arnott,

Prodr. Fl. Ind. Orient. 137. 1834; Hooker & Thomson in J. Proc. Linn. Soc. Bot. 4: 133. 1859; Hooker, Fl. Brit. India 1. 456. 1874 & in Rec. Bot. Surv. India 4: 47. 1906; Gamble, Fl. Madras 1: 142. 1915; Ahmedullah & Nair, Endemic plants of the Indian region 1: 193. 1986; Nayar, Hot spots of endemic plants of India, Nepal and Bhutan, 214. 1996; Saldanha in Saldanha, Fl. Karnataka 2: 255. 1996; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 184. 1997; Ganeshbabu *et al.*, in Phytotaxonomy 7: 83 – 88. 2007. **TYPE** – INDIA, Karnataka, Mysore, 1801, Heyne, *s. n.* (K; Photo!).

Balsamina mysorensis (Heyne ex Roth) DC., Prodr. 1: 686. 1824.

Annual herbs, 20 – 75 cm high. Stem erect, diffusely branched or unbranched; branches alternate to pseudo-dichotomous, obtusely 4-angled, 0.8 – 2 cm thick at the base, sub-succulent, green to pinkish red, sparsely minutely hairy at the base, densely minutely hairy above, swollen at nodes, internodes longer at base, shorter at apex. Leaves alternate, basal leaves petiolate, upper leaves sessile to petiolate, petiole 0.6 – 1 cm long, hairy beneath, with or without a pair of glands at base; lamina elliptic, linear-oblong to ovate, 1 – 6 × 0.6 – 1.8 cm, acute to attenuate at base, distantly serrate along margins, acute to acuminate at apex; dark green adaxially, pale green abaxially, subcoriaceous, glabrous, lateral veins 3 – 5 pairs, alternate, obscure/indistinct above, distinct and hairy beneath; serrations apiculate. Flowers axillary, solitary to six per axil, c. 1 cm across, pink, lilac or white with reddish tinge, bracteate, pedicellate; bracts minute, scaly, linear to subulate, c. 1 × 0.5 mm, light green, sparsely minutely hairy at the base dorsally; pedicel 0.7 – 1 cm long, dilated, pink to green, with a longitudinal row of hairs on the lower surface, deflexed in fruits. Lateral sepals minute, ovate, slightly concave, c. 0.75 × 0.5 mm, acute at apex, dorsally sparsely minutely hairy, veins obscure. Standard broadly ovate, c. 5 × 4 mm, glabrous, deeply concave, white within, pink outside, apically cordate, dorsally

keeled; keel lacerated, apically mucronate; mucro c. 1 mm long, tip curved, green in colour. Wing petals stipitate, bilobed; stipe c. 4 mm long with pinkish red veins, c. 9 × 4 mm, pink to white with white throat; throat elevated above, elevation with yellow or red streaks; basal lobe small, ovate, c. 1.5 × 1 mm, acute, apiculate or obtuse; distal lobe bigger than basal lobe, assymmetrically ovate, c. 5 × 4 mm, obtuse. Lip saccate, c. 6 mm long, c. 2 mm deep, c. 2 mm wide, pink with red veins, veins minutely hairy, spurred; spur slightly above the base of lip, 2 - 3 mm long, cylindrical, c. 0.5 mm wide, hairy, rarely glabrous, tip rounded or bulged, densely hairy, green or yellow in colour. Column c. 3 × 1 mm. Anthers c. 1 × 1 mm, light pink in colour; filaments 5, c. 2.5 × 1 mm, light pink in colour. Pistil c. 1.5 × 0.5 mm; ovary ellipsoid-oblongoid, glabrous. Capsules assymmetrically lanceoloid to oblanceoloid, rarely ellipsoid, 8 – 1.1 × 0.3 – 0.5 cm, ridged, densely puberulous, beaked, pedicel 1.5 – 2 cm long. Seeds 3 – 7 per capsule, brown, globular, c. 1.5 mm wide, muricate (Fig. 23; Plate - 7d, e, f).

Fl. & Fr.: August – October.

Habitat: Grows in between rock crevices, on boulders with thin layer of soil at an altitude of 700 – 1020 m above msl.

Distribution: Endemic to Karnataka (Map - 6d).

Specimens examined: Karnataka, Chitradurga, Chitradurga district, 08. 10. 1974, K. R. Prasantha Kumar 102 (MGM); Chitradurga fort, Chitradurga district, 12. 10. 1974, V. Bhaskar 419 (MGM); Janakal, Chitradurga district, 09. 09. 2006, Jyosna R. N. Dessai 128 (GUH); near Chitradurga fort, Chitradurga District, 10. 09. 2006, Jyosna R. N. Dessai 129, 130 (GUH).

Note: Hooker (1874) compared *I. mysorensis* with *I. inconspicua*, but distinguished the former from the later by its alternate leaves and tomentose capsule. Wight and

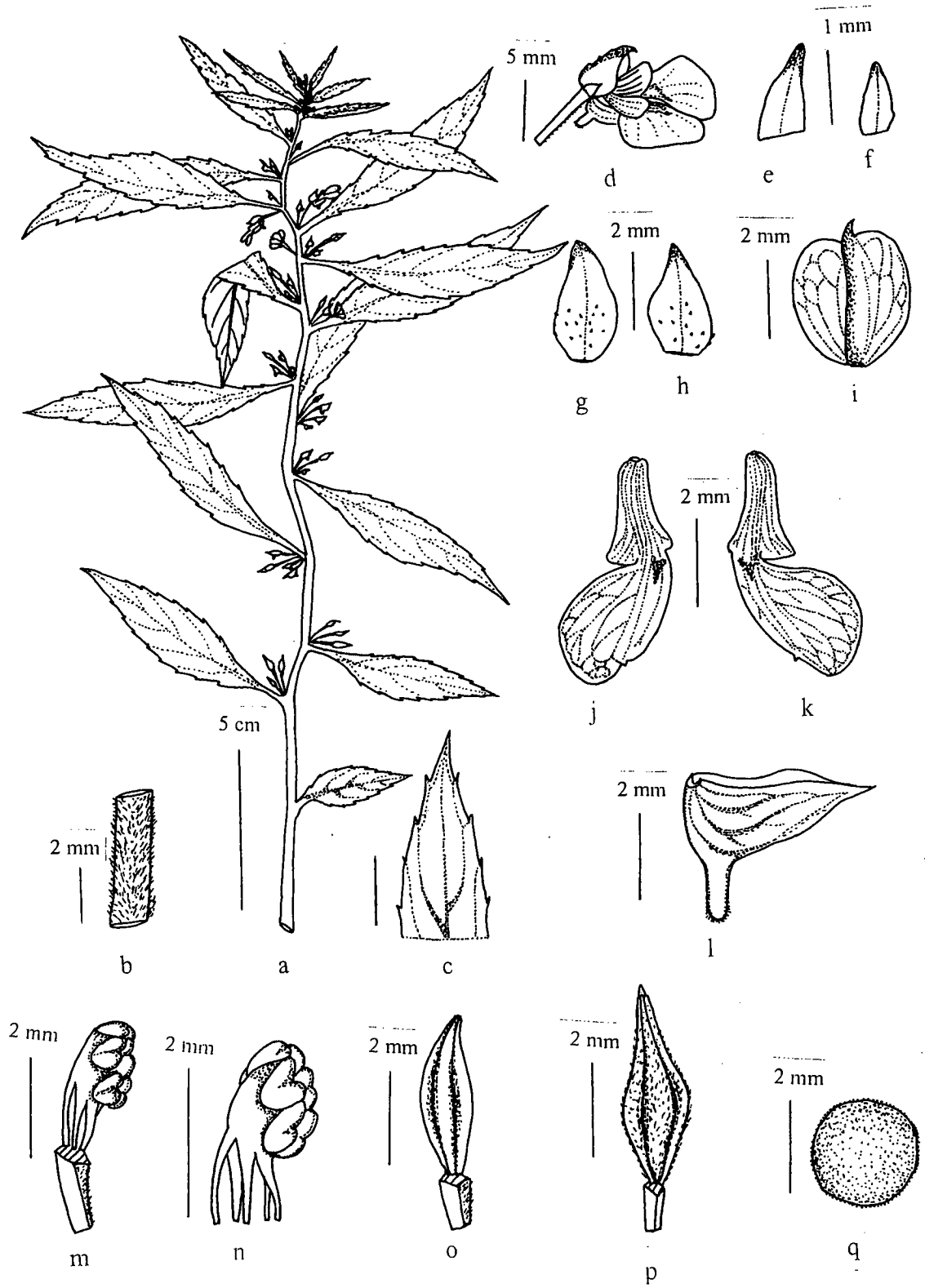
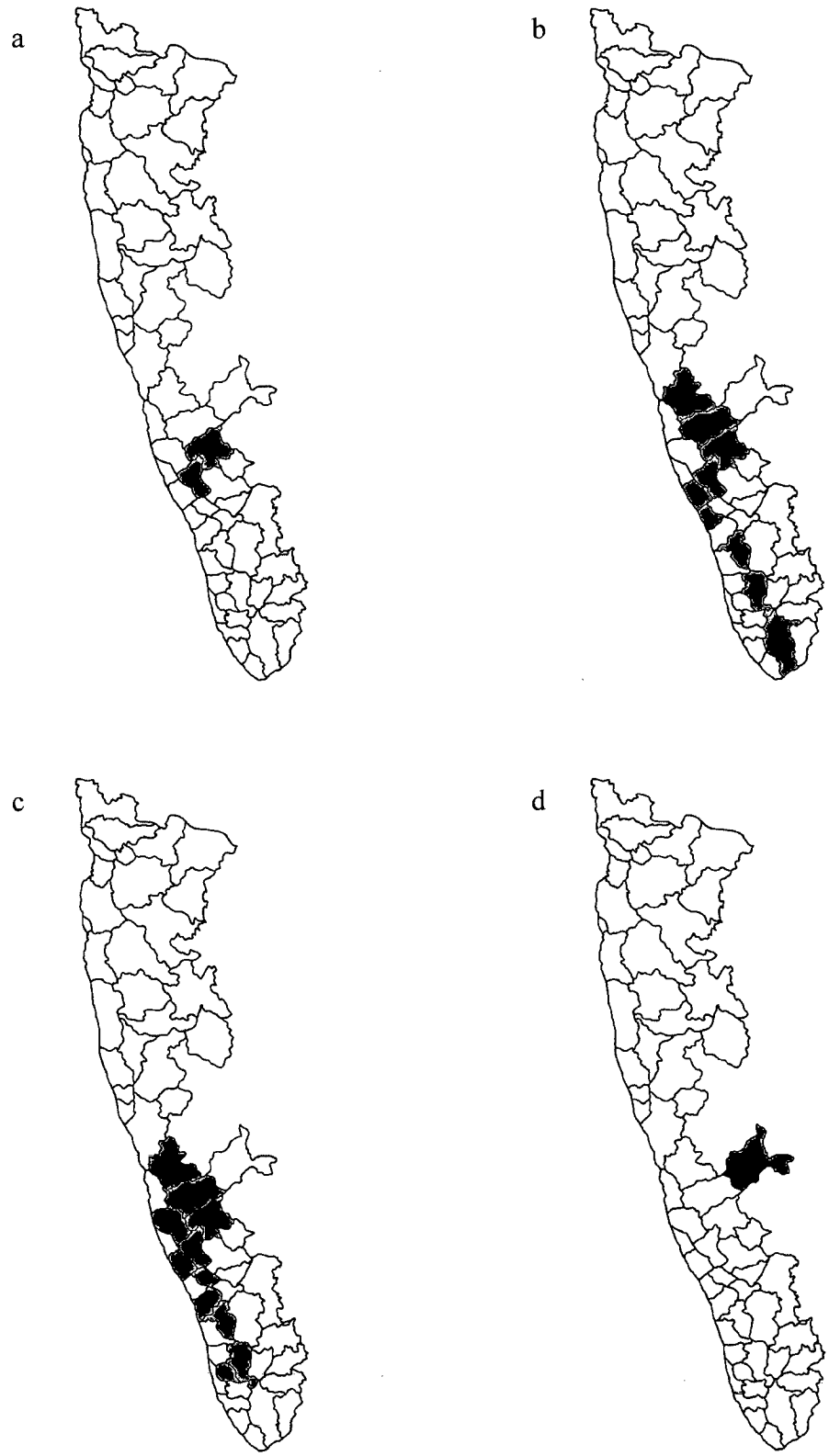


Fig. 23: *Impatiens mysorensis* Heyne ex Roth a) habit, b) portion of stem, c) leaf portion enlarged d) flower, e, f) bract, g, h) standard petal, i) standard petal, j,k) wing petals, l) lip, m) column, n) androecium, o) pistil, p) capsule, q) seed.

Map 6: Distribution of a) *Impatiens balsamina* var. *micrantha*; b) *I. dasysperma*; c) *I. gardneriana*; d) *I. mysorensis.*



Arnott (1834) found the species to closely resemble *I. minor* and *I. oppositifolia* but differentiated it based on alternate leaves. However, *I. mysorensis* figures under section *Uniflorae* (*Microsepalae*) and the species with which it has been compared fall under section *Oppositifoliae*. The present study shows that *I. mysorensis* is allied to *I. scabriuscula* but differs in its lip with a short, straight spur (rather than spurless lip), puberulous capsule (rather than villous) and in lacking a distinct dorsal auricle.

Roth (1821) described the species based on Heyne's collection from Mysore in his *Novae Plantarum Species Praesertim Indiae Orientalis*. The type of the species could be located at Kew. Saldanha (1996) in his flora of Karnataka included this species based on literature. He also mention's the location as southern Western Ghats based on the two herbarium sheets available at Kew. However these specimens, one from Chitradurga Fort and the other from Nandi Hills of Kolar district, do not fall under Western Ghats.

Prasantha Kumar (102-MGM) and Bhaskar (419-MGM) collected the species from Chitradurga and the collections are available at Mysore University herbarium (MGM). These are the only two collections available for the species in Indian herbaria and untill now this was the only locality from where the species was reported since Roth's collection. As a part of maintenance, fort walls have been cleared off from all vegetation without leaving any traces of the plants. Hence, Nayar (1996) quotes the species to be 'endangered'. The recent publication by Vivekananthan *et al.* (1997) also mentions "Mysore" as its place of occurrence without assigning any specific locality.

During the present study the species was collected from Ghatti Hosahalli of Hosadurga Taluk, Janakal and Gopalswamy Honda of Chitradurga Fort. At all these localities the species was found growing in a thin layer of soil between rock crevices.

Plants growing in all these localities were exposed to bright light and showed stunted growth. At a height of about 965 m, plants that were growing on a thin layer of soil deposits were 50 cm high with diffusely branched stem, leaves were dark green and fleshy and flowers were mostly white along with some pink coloured flowers. Plants, which were found growing in shade, were healthier. Flowers are visited by bees and ants.

Excessive grazing by goats was observed at Janakal. Quarrying at Ghatti Hosahalli is also a major threat to the species which may result in decreasing or diminishing the population.

Though the species occurs outside the Western Ghats (beyond study area) the species has been included in this work based on its narrow endemic nature.

Chromosome number: 2n = 14 (Bhaskar, 1976).

IUCN threat status: CR [B1ab(iii)].

Etymology: Latin: *mysorensis* = from Mysore.

Impatiens pulcherrima Dalzell in J. Bot. Kew gard. Misc. 2: 37 - 38. 1850; Hooker & Thomson in Proc. J. Linn. Soc. 4: 134. 1859; Hooker, Fl. Brit. India 1: 458. 1874 & in Rec. Bot. Surv. India 4: 47. 1906; Cooke, Fl. Bombay 1: 175. 1901; Gamble, Fl. Madras 1: 143. 1915; Blatter in J. Bombay Nat. Hist. Soc. 33: 314, t. 2. 1933; Vartak, Enum. Plant. Gomantak, India, 32. 1966; Kulkarni, Fl. Sindhudurg, 60. 1988; Sharma *et al.*, Fl. Karnataka Analysis, 39. 1984; Rao, Fl. Goa 1: 60. 1985; Ahmedullah & Nayar, Endemic plants of the Indian region 1: 193. 1986; Almeida, Fl. Savantwadi 1: 78. 1990; Deshpande *et al.*, Fl. Mahabaleshwar 1: 117, t. 6. 1993; Kothari & Moorthy, Fl. Raigad District, 48. 1993; Nayar, Hot spots of endemic plants of India, Nepal and

Bhutan, 215. 1996; Saldanha in Saldanha, Fl. Karnataka 2: 256. t. 37. 1996; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 198. 1997; Mudaliar & Prasad in Singh & Karthikeyan, Fl. Maharashtra Dicots. 1: 459. 2000; Yadav & Sardesai, Fl. Kolhapur District, 95, t. 11. 2001.

Annual herbs, growing 0.3 – 1.5 m high. Stem swollen at nodes, branched or unbranched, four sided, two flat and two curved. Leaves alternate, petiolate; petiole 1 – 4 cm long, with 3-5 pairs of glands, glabrous; lamina ovate, elliptic to lanceolate, 4 – 12 × 1.8 – 6 cm, obtuse to attenuate at base, crenate and ciliate along margins, acute at apex, hairy above, glabrous abaxially; crenae apiculate. Flowers axillary, binate, 2.5 – 5 cm across, pink in colour with violet to red in the centre below the column, bracteate, pedicellate; bracts minute, scaly, ovate, c 0.5 mm long, glabrous, acute at apex; pedicel 3 – 5 cm long, terete, green in colour, glabrous. Lateral sepals 2, asymmetrically ovate, c. 4 × 1 mm, acute at apex, green in colour, glabrous. Standard orbicular to reniform, 1.5 – 2 × 1.9 – 2.2 cm, pink in colour, emarginate at apex, glabrous, dorsally keeled; keel mucronate, green in colour; mucro 5 – 7 mm long. Wing petals 3 – 3.6 × 2 – 2.5 cm, base of wing petals is bent at the spur region thus giving the appearance of an auricle, bilobed, lobes unequal; basal lobe broadly ovate, 1 – 1.4 × 1.2 – 1.6 cm, obcordate at apex; distal lobe ovate, 2 – 2.5 × 1.6 – 2 cm, obcordate much below apex. Lip conical, 1 – 1.5 cm long, 0.7 – 1 cm deep, 6 – 9 mm wide, pink in colour, mucronate at apex, glabrous, spurred; spur 3.5 – 4.5 cm long, cylindrical, light pink in colour, glabrous, tip rounded. Column c. 8 × 5 mm. Anthers c. 1 × 2 mm, cohering above the pistil; filaments c. 7 × 1.5 mm, pink in colour. Pistil c. 5 × 2 mm; ovary oblongoid-lanceoloid, glabrous. Capsules asymmetrically ellipsoid, 1.2 – 2 × 0.5 – 1 cm, glabrous to minutely hairy; pedicel 5 – 7 cm long, curved at apex. Seeds globular to ovoid, compressed, c. 4 × 3.5 mm, brown in colour,

rugose (Fig. 24; Plate - 7g, h, i).

Fl. & Fr.: July – December.

Habitat: Grows on grass slopes and vertical cut surfaces along roadsides.

Distribution: Endemic to Western Ghats region of Maharashtra, Goa and Karnataka (Map - 7a).

Specimen examined:

Goa: Kumbhari, Sanguem, South Goa district, 02. 08. 2005, Jyosna R. N. Dessai 32 (GUH); Keri, North Goa district, 27. 08. 2005, Jyosna R. N. Dessai & M. K. Janarthanam 65 (GUH); Khorjuvem, North Goa district, 24. 08. 2006, Emilia Mascarenhas 124 (GUH).

Karnataka: Londa, Belgaum district, 01. 08. 1928, R. D. Acland ACK 128 (BLAT); On the way to Dandheli, North Kanara district, 04. 11. 1969, H. S. Shantha Kumari 11 (MGM).

Maharashtra: Fitzgerald ghat, Mahableshwar, Satara district, 01. 10. 1924, R. D. Acland ACK 134 (BLAT); Fitzgerald ghat, Mahableshwar, Satara district, 24. 09. 1930, e McCann 3319 (BLAT); Fitzgerald ghat, Mahableshwar, Satara district, 29.12.1950, P. V. Bole PVB 178 (CAL); Fitzgerald ghat, Mahableshwar, Satara district, 20. 08. 1951, H. Santapau 13231, 13232, 13233, 13234 (BLAT); Fitzgerald ghat, Mahableshwar, Satara district, 22. 10. 1951, P. V. Bole BOLE 444, 445 (BLAT); Fitzgerald ghat, Mahableshwar, Satara district, 09. 06. 1954, P. V. Bole Bole 1147 (BLAT); Fitzgerald ghat, Mahableshwar, Satara district, 16. 09. 1958, H. Santapau 22815, 22816 (BLAT); Fitzgerald ghat, Mahableshwar, Satara district, 30. 10. 1958, H. Santapau 22904, 22908, 22909 (BLAT); Fitzgerald ghat, Mahableshwar, Satara district, 31. 08. 1959, P. V. Bole 2079 (BLAT); Phonda ghat, Sindhudurg district, 04. 10. 1970, *s. c.*, 121449 (BSI); Malgaon, Savantwadi, Sindhudurg district, 04. 09. 1977

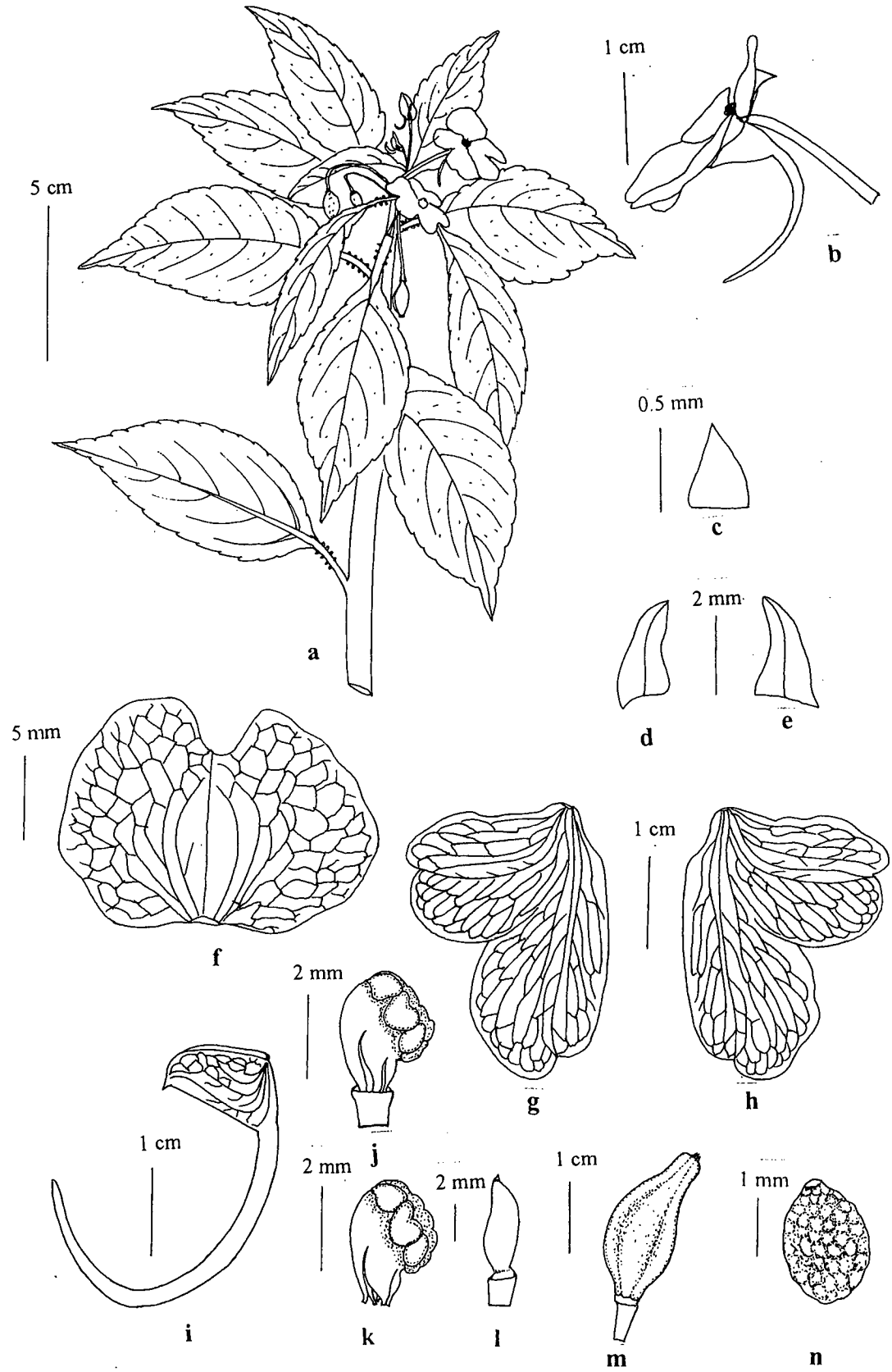


Fig. 24: *Impatiens pulcherrima* Dalzell a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g, h) wing petals, i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

PLATE 7

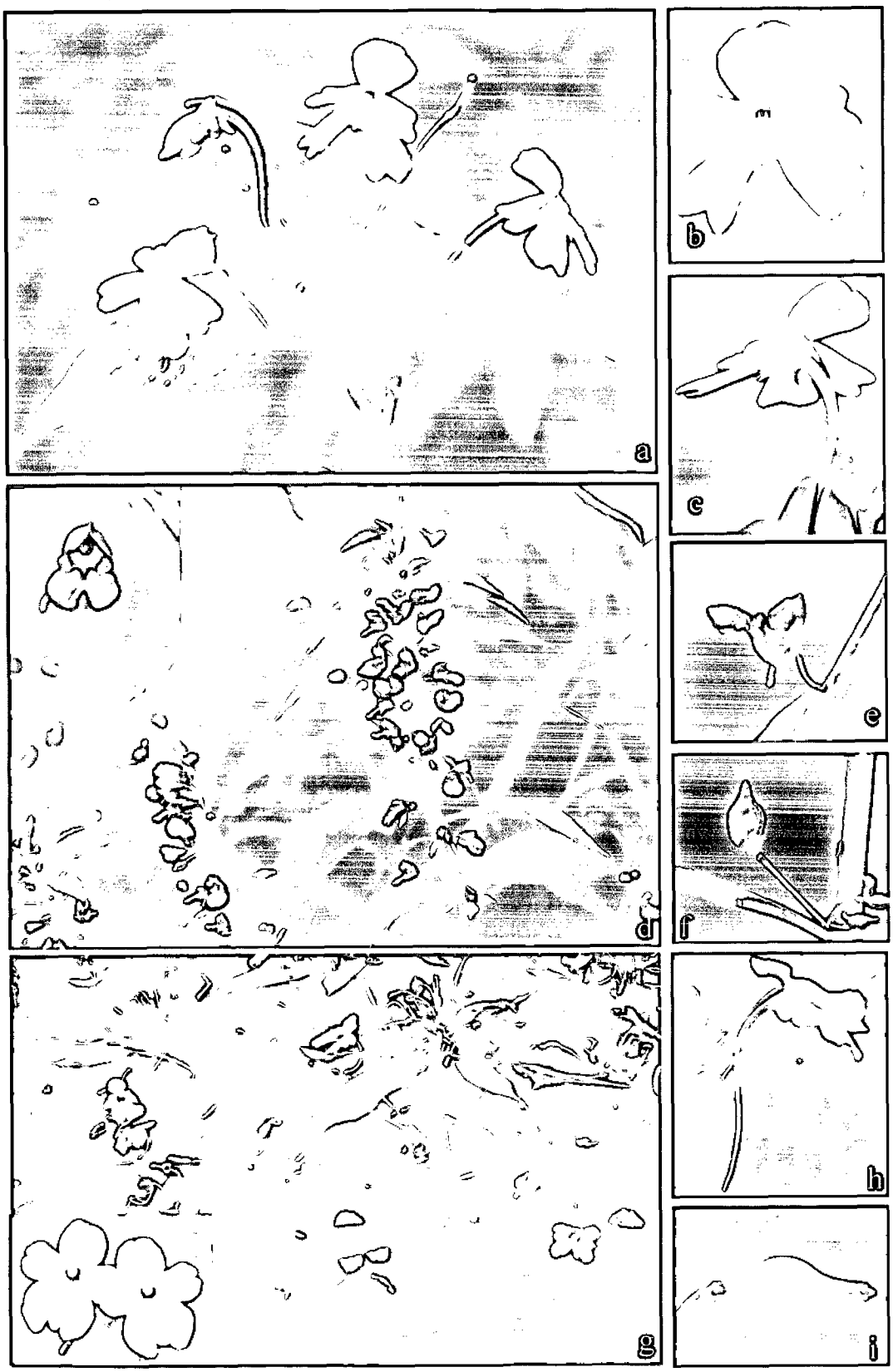


PLATE 7: a - c. *Impatiens gardneriana* Wight; d - f. *I. mysorensis* Heyne ex Roth; g - i. *I. pulcherrima* Dalzell.

S.M. Almeida SMA 764 (BLAT); Amba ghat, Ratnagiri district, *s. d.*, C. J. Saldanha CS 7197 (JCB); Vasota, Satara district, September 1992, M. P. Bachulkar-Cholekar 5999 (SUK); Amboli ghat, Sindhudurg district, 17. 07. 2004, Jyosna R. N. Dessai & M. K. Janarthanam 02 (GUH); Amboli, Sindhudurg district, 12. 08. 2006, Jyosna R. N. Dessai 111 (GUH); Amboli ghat, Sindhudurg district, 09. 09. 2006, Harshala Gad & Emilia Mascarenhas 132 (GUH); Phonda ghat, Sindhudurg district, 30. 09. 2007, Jyosna R. N. Dessai & M. K. Janarthanam 168 (GUH); Amboli, Sindhudurg district, 06. 10. 2007, Jyosna R. N. Dessai 172 (GUH).

Note: *Impatiens pulcherrima* is a beautiful species that is allied to *I. flaccida* in its overall morphology. However both the species differ in the following characters.

Comparative account of *I. pulcherrima* and *I. flaccida.*

Character	***I. pulcherrima***	***I. flaccida***
Habit	annual	perennial
Standard	orbicular	obovate
Standard (apex)	obcordate	emarginate
Distal lobe of wing petals	not equal	nearly equal

Impatiens pulcherrima is also allied *I. talbotii*, however though the former is a larger plant in all its parts. The former also differs from the latter in its standard, wing petals, capsule and seeds. This species prefers shady places and is found growing under the canopy of trees with adequate light penetration. However plants growing in complete shade bear white flowers with red markings in the centre. This is a vigorous species and often makes patches of large populations. The species is very valuable to receive into cultivation because of its large showy flowers.

Chromosome number: 2n = 12 (Zinov'eva-Stahevitch and Grant, 1982, 84, 85).

IUCN threat status: VU [B1ab(iii)].

Etymology: Latin: *pulcherrima* = most beautiful, referring to its large showy flowers.

Impatiens rosea Lindl. Edwards's Bot. Reg. 27(Misc.): 6, t. 27. 1841. **TYPE** - Lindley Edwards's Bot. Reg. 27(Misc.): 6, t. 27.

Impatiens trichocarpa Hook. f., Hooker's Icon. Pl. 30: t. 2914. 1910 **syn. nov. TYPE** – INDIA, Nilgiri hills, s. d., Perrottet 176 (Herb. Mus. Palat. Vindobon).

Impatiens balsamina L. var. *rosea* (Lindl.) Hook. f., Fl. Brit. India 1: 454. 1874 & in Rec. Bot. Surv. India 4: 49. 1906; Blatter in J. Bombay Nat. Hist. Soc. 33: 314. 1933; Santapau, Fl. Khandala, 30. 1967; Shah, Fl. Gujarat 1: 143. 1978; Rao, Fl. Goa 1: 59. 1986; Lakshminarasimhan & Sharma, Fl. Nasik District, 113. 1991; Deshpande *et al.*, Fl. Mahableshwar 1: 114, t. 5. 1993; Kothari & Moorthy, Fl. Raigad District, 47. 1993; Mudaliar & Prasad in Singh & Karthikeyan, Fl. Maharashtra Dicots. 1: 449. 2000.

I. balsamina var *brevicalcarata* Cooke, Fl. Bombay 1: 185. 1901.

. Annual herbs, 0.5 – 1.5 m high; stem terete or slightly grooved, branched or unbranched, green to pinkish red in colour, minutely puberulous. Leaves alternate, petiolate; petiole 0.5 – 1.5 cm long, with 2 – 4 pairs of glands, reddish in colour, minutely puberulous; lamina linear-lanceolate, elliptic, lanceolate to linear-oblanceolate, 6 – 14 × 0.6 – 2 cm, attenuate at base, serrate along margins, acuminate at apex, hairy adaxially, glabrous abaxially, nerves 5 – 10 pairs, alternate. Flowers axillary, 2 – 3 per axil, rarely solitary, 1.8 – 2.5 cm across, pink with white throat having a yellow patch on the elevation, bracteate, pedicellate; bracts minute, triangular, c. 1.5 × 1 mm, hairy along margins, acute to acuminate at apex, hairy on the costa dorsally, pedicel 1 – 1.2 cm long, pinkish red in colour, puberulous, dilated, deflexed in fruits. Lateral sepals ovate to ovate-lanceolate, c. 2.5 × 1.25 mm, concave, hairy along margins and on the costa dorsally, acute to rounded at apex. Standard orbicular, 0.7 – 1 × 0.7 – 1.1 cm, pink in colour, concave, glabrous to sparsely hairy

on the dorsal surface, horned at apex; mucro c. 3 mm long. Wing petals 1.7 – 2 × 0.9 – 1.1 cm, bilobed, auricled near the base; auricle small, rounded, curved above; basal lobe obovate, 6 – 8 × 4 – 5 mm, obtuse at apex; distal lobe broadly assymmetrically obovate, 1 – 1.2 × 0.8 – 1.1 cm, elevated near base towards inner side, obcordate much below the apex. Lip boat shaped, 1 – 1.4 cm long, 5 – 6 mm deep, pink in colour, acuminate at apex, hairy, spurred; spur slightly above the base, short, 5 – 8 mm long, hooked, cylindrical, puberulous, pale green in colour, tip rounded. Column c. 7 × 3 mm. Anther c. 1 × 1.5 mm, pink to white in colour; filaments c. 6 × 1.5 mm, pink to white in colour. Pistil c. 5 × 1.5 mm, curved at apex; ovary lanceoloid to ellipsoid-lanceoloid. Capsules broadly ellipsoid, 1 – 1.5 × 0.5 – 0.8 cm, puberulous, beaked at apex, pedicel 1 – 1.5 cm long. Seeds globular, c. 2.5 × 2.5 mm, brown in colour, granulate (Fig. 25; Plate - 8a, b, c, d).

Fl. & Fr.: July – December.

Habitat: Cosmopolitian. Commonly found growing around or near human settlements. It is also found growing along roadsides, near cultivated lands/fields, and foot paths. Rarely found growing in and around forests.

Distribution: Himalayas in the north, Gujarat, Maharashtra, Goa and Belgaum district of Karnataka state in the south (Map - 7b).

Specimens examined:

Goa: Mollem, South Goa district, 26. 09. 2004, Jyosna R. N. Dessai 24 (GUH).

Karnataka: Sada, Belgaum district, 24. 09. 2006, Jyosna R. N. Dessai & M. K. Janarthanam 157 (GUH).

Maharashtra: Khanadala, Sousages top, Satara district, 09. 02. 1943, *s. c.*, 2480 (BLAT); Khandala, near St. Xavier's villa, Satara district, 30. 09. 1943, H. S. Santapau 2754 (BLAT); Purandhar hill, Poona district, 30. 12. 1944, H. S. Santapau 5780

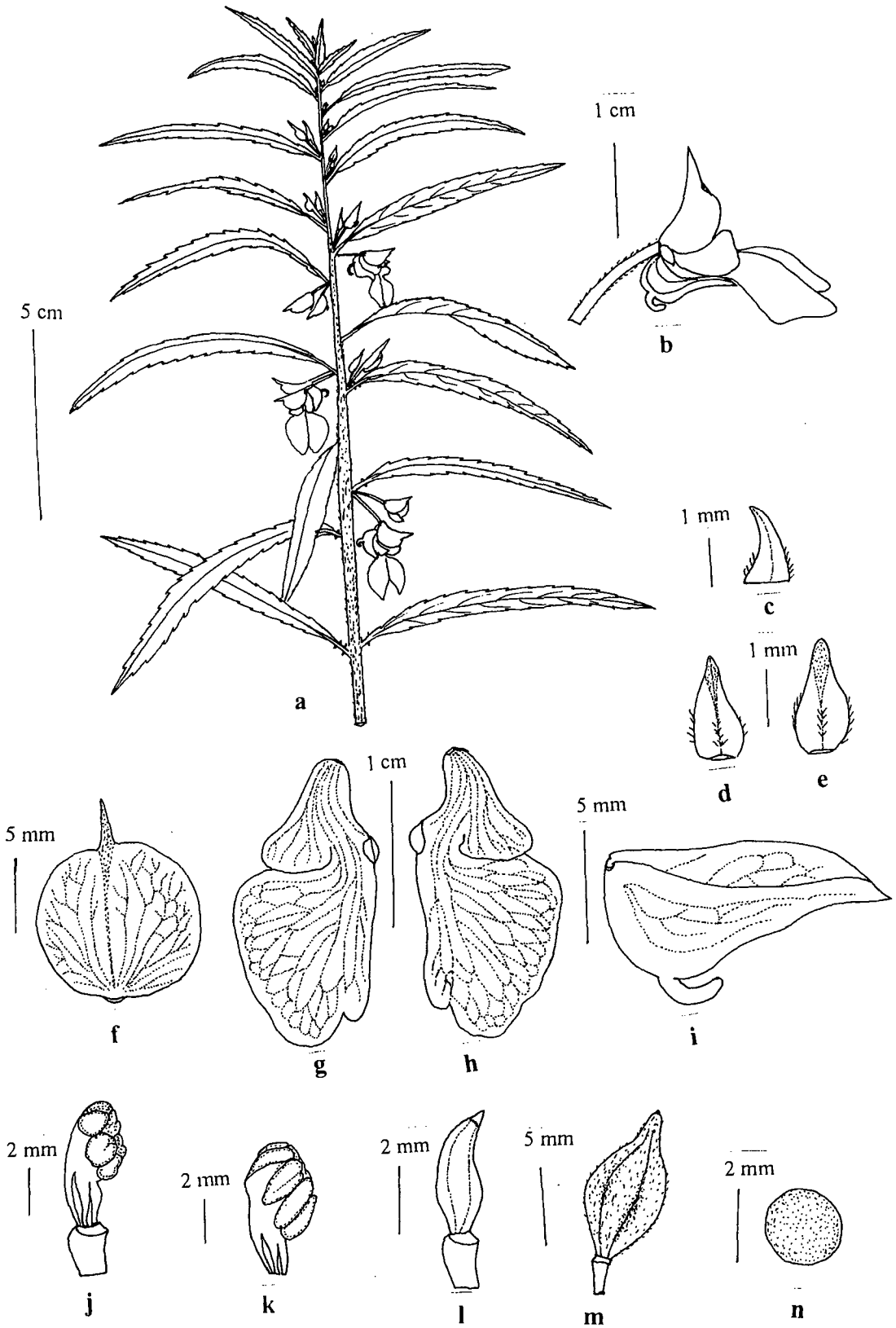


Fig. 25: *Impatiens rosea* Lindl. a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g, h) wing petals, i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

(BLAT); Top of Purandhar fort, Poona district, 31. 12. 1945, H. S. Santapau 8345 (BLAT); Khandala, Canval home, Satara district, 04. 09. 1950, H. S. Santapau 11200, 11198, 11199 (BLAT); Matheran, Raigad district, 22. 11. 1958, N. A. Irani 2475 (BLAT); Kas, Satara district, September 1991, M. P. Bachulkar-Cholekar 5149 (SUK); 6 km before Kas plateau from Satara, Satara district, 18. 09. 2005, Jyosna R. N. Dessai 100 (GUH); Yuvateshwary, Satara to Kas road, Satara district, 18. 08. 2006, Jyosna R. N. Dessai 113 (GUH); Meda, Satara to Mahabaleshwar road, Satara district, 19. 08. 2006, Jyosna R. N. Dessai 117 (GUH); Ambeghar, Satara to Mahabaleshwar road, Satara district, 19. 08. 2006, Jyosna R. N. Dessai 118 (GUH); Wai, Panchgani to Satara road, Satara district, 19. 08. 2006, Jyosna R. N. Dessai 122, 123 (GUH); Tilari ghat, Sindhudurg district, 03. 09. 2006. M. K. Janarthanam 127 (GUH); Phonda ghat, Sindhudurg district, 30. 09. 2007, Jyosna R. N. Dessai & M. K. Janarthanam 169 (GUH).

Note: Standard persistent on capsule. Widespread species in the northern Western Ghats. *Impatiens rosea* is similar to *I. scabriuscula* in its overall morphology but differs in its robust habit and short incurved spur (spur absent in *I. scabriuscula*).

Impatiens rosea was described by Lindley in Edwards's Botanical Register in 1841. He also provided a beautiful painting along with the description. In the note Lindley (1841) mentions that species is closely allied to several species and one amongst them is *I. balsamina* but this species possesses large flowers and the lip is with a long spur. Later, Hooker (1874) reduced the species as a variety under *I. balsamina* (*I. balsamina* var. *rosea*).

The species of balsams belonging to section *Uniflorae* in the study area can be divided into two groups:

- Lip with a long spur + lobes of wing petal subequal, and
- Lip with a short spur or spur absent + basal lobe of wing petal much smaller

then the distal lobe.

Impatiens balsamina shares characters from both the groups i. e. it possessess wing petals with a small basal lobe and the lip is with a long spur. Whereas *I. balsamina* var. *rosea* has characters from the second group i. e. a short spur and the basal lobe of the wing petal that is much smaller than the distal lobe. Hence *I. balsamina* var. *rosea* has been elevated back to the rank of species, i. e. *I. rosea* as described by Lindley.

Hooker (1910d) described *I. trichocarpa* Hook. f. from Nilgiri hills. In the present study it is found that this species is no different from *I. rosea* Lindl. and hence treated conspecific.

IUCN threat status: LC.

Etymology: Latin: *rosea* = rose coloured, referring to its flower colours.

Impatiens scabriuscula Heyne ex Roxb., Fl. Indica 2: 464, 1824; Wight & Arnott, Prodr. Fl. Ind. Orient. 2: 136. 1834; Hooker & Thomson in J. Proc. Linn. Soc. Bot. 4: 131. 1859; Hooker, Fl. Brit. India 1: 454. 1874 & in Rec. Bot. Surv. India 4: 46. 1906; Dalzell & Gibson, Bombay Fl., 44. 1861; Beddome, Icon. Pl. Ind. Or. T. 144. 1868-1874; Cooke, Fl. Bombay 1: 174. 1901; Gamble, Fl. Madras 1: 142. 1915; Blatter in J. Bombay Nat. Hist. Soc. 33: 314. 1933; Yoganarasimhan *et al.*, Fl. Chikmagalur District, 60. 1982; Vajravelu in Nair & Henry, Fl. Tamil Nadu 1: 55. 1983; Sharma *et al.*, Fl. Karnataka Analysis, 39. 1984; Ahmedullah & Nayar, Endemic plants of the Indian region 1: 193. 1986; Ramachandran & Nair, Fl. Cannanore, 80. 1988; Nayar, Hot spots of endemic plants of India, Nepal and Bhutan, 215. 1996; Saldanha in Saldanha, Fl. Karnataka 2: 257. 1996; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4:

207. 1997; Mudaliar & Prasad in Singh & Karthikeyan, Fl. Maharashtra Dicots. 1: 462. 2000. **TYPE** –Wall. Cat. 4736 (CAL!)

Erect herb, 20 – 60 cm high; stem unbranched or branched, subterete to terete, sparsely minutely hairy at the base, densely hairy above; branches alternate. Leaves alternate, petiolate; petiole 0.5 – 2 cm long, hairy; lamina linear-elliptic to oblanceolate, 1 – 10.5 × 0.4 – 1.5 cm, hairy throughout adaxially, only on the midrib and veins abaxially, attenuate or rarely obtuse and oblique at base, crenate to serrate along margin, acuminate at apex; crenae apiculate. Flowers axillary, 2 – 4 per axil; pink in colour, 0.9 – 1.2 cm across, bracteate, pedicellate; bracts ovate, c. 0.75 × 0.5 mm, hairy dorsally, acute at apex; pedicel 0.6 – 1 cm long, hairy, deflexed in fruits. Lateral sepals minute, c. 1.25 mm long, hairy dorsally, light green in colour, acute to acuminate at apex. Standard broadly obovate, c. 8 × 6 mm, concave, hairy adaxially, retuse at apex, mucro horned, c. 2 mm long, hairy. Wing petals 1 – 1.4 × 0.4 – 0.6 cm, bilobed, lobes unequal; basal lobe triangular, 4 – 5 × 2 – 4 mm; distal lobe asymmetrically obovate, 6 – 8 × 4 – 5 mm, obtuse at apex, papillate at base towards inner side, acute at apex, notched slightly at the base of apex, auricled at base; auricle rounded, c. 1.5 × 1.5 mm. Lip saccate, 5 – 9 mm long, 2 – 4 mm deep, 4 – 5 mm wide, hairy, light pink in colour, spur absent. Column c. 4 × 1.5 mm. Anthers c. 0.5 × 0.5 mm; filaments c. 3 × 0.5 mm. Pistil c. 3 × 0.5 mm; ovary lanceoloid to ellipsoid-lanceoloid, sparsely minutely hairy. Capsules broadly ellipsoid, 0.8 – 1 × 0.5 – 0.7 cm, villous, pedicel 1 – 1.3 cm long. Seeds circular, c. 1 mm in diameter, brown, shortly papillate; papillae dark brown (Fig. 26; Plate - 8e, f, g, h).

Fl. & Fr.: August – November.

Habitat: Grows on lateritic rocks, along the periphery of semi evergreen forests.

Distribution: Western Ghats of Karnataka, Kerala and Tamil Nadu. 1800 m (Map -

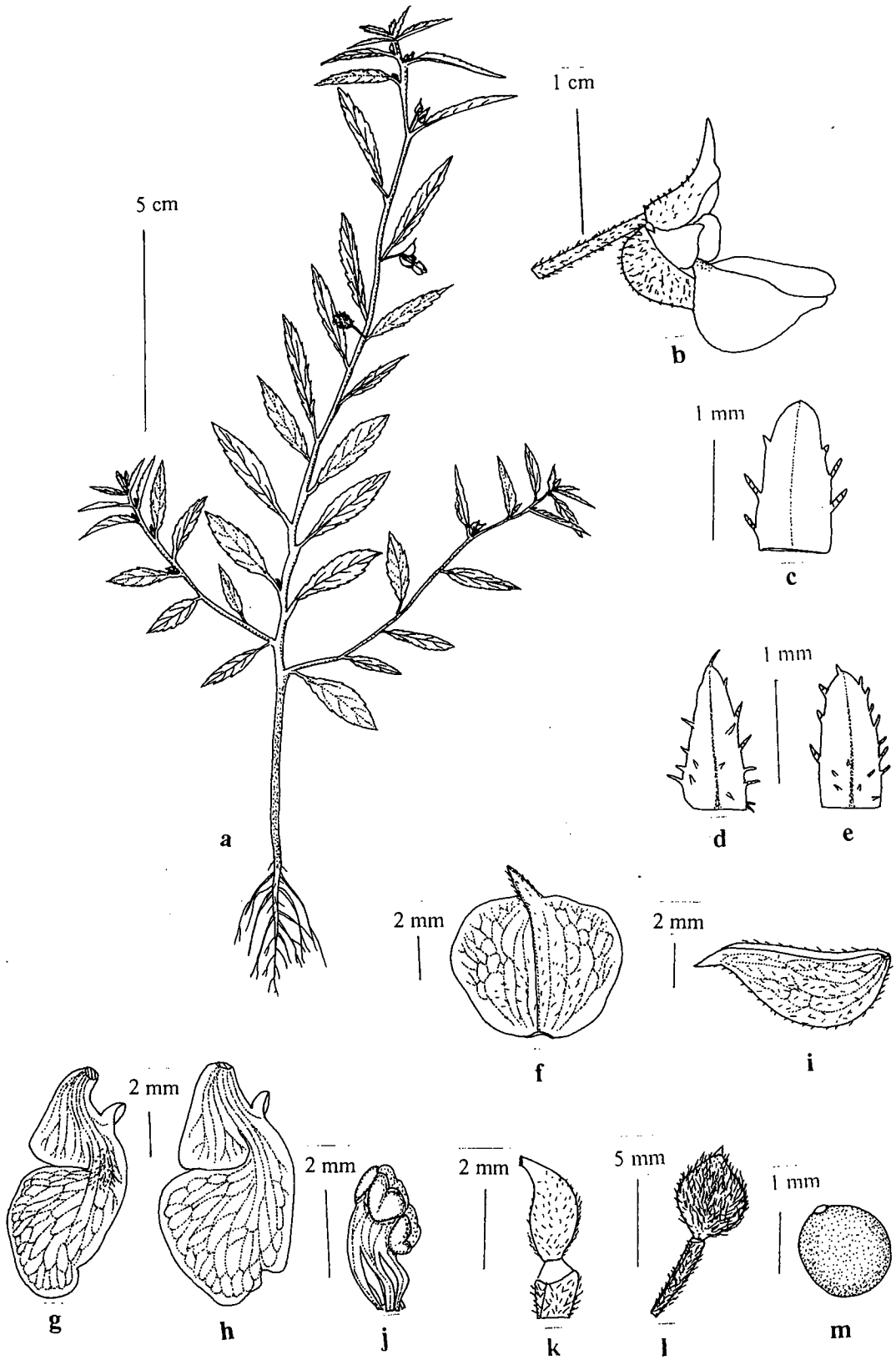


Fig. 26: *Impatiens scabriuscula* Heyne ex Roxb. a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g) wing petal (dorsal view), h) wing petal (ventral view), i) lip, j) androecium, k) pistil, l) capsule, m) seed.

7c).

Specimen examined:

Karnataka: Kulhathy, Bababudan, Chikmagalur district, 5000', October 1908, A. Meebold 10702 (CAL); Near Shankar falls, Bababudan, Chikmagalur district, 24. 07. 1973, V. Bhaskar 362 (MGM); Way to Kalhattigiri, Bababudan, Chikmagalur district, 25. 07. 1973, V. Bhaskar 367 (MGM); Bababudan hills, Chikmagalur district, 27. 09. 1979, C. J. Saldanha KFP 9560 (JCB); Charmadi ghat, Chikmagalur district, 26. 08. 1972, V. Bhaskar 314 (MGM); Road to Kemmangundi, Chikmagalur district, 05. 09. 1980, C. J. Saldanha KFP 12191 (JCB); Z-point, Kemmangundi, Chikmagalur district, 17. 11. 2004, Jyosna R. N. Dessai & M. K. Janarthanam 26 (GUH); Kemmangundi, Chikmagalur district, 05. 09. 2005, Jyosna R. N. Dessai & M. K. Janarthanam 80 (GUH), 2 km before Kemmangundi from Chikmagalur, Chikmagalur district, 05. 09. 2005, Jyosna R. N. Dessai & M. K. Janarthanam 84 (GUH); Kemmangundi to Kalhatti road, Chikmagalur district, 05. 09. 2005, Jyosna R. N. Dessai & M. K. Janarthanam 86 (GUH).

Kerala: Panthanthode, Palghat district, 12. 10. 1965, E. Vajravelu 26173 (MH); Aruvampara, Palghat district, 725 m, 10. 10. 1979, N. C. Nair 64463 (CAL).

Tamil Nadu: Sholur, Nilgiri district, 26. 08. 1970, B. D. Sharma 35777 (MH); Pykara range, Coimbatore district, 07. 10. 1972, V. Bhaskar 332 (MGM).

'Concan', *s. d.*, Stocks *s. n.* (CAL) (most of the species collected from Karnataka are also quoted under 'Concan".

Notes: *Impatiens scabriuscula* is similar to *I. mysorensis* but differs in its villous capsule (capsule minutely hairy in *I. mysorensis*), absence of spur (spurred in *I. mysorensis*) and presence of distinct red coloured stiff hairs on the plant. Individuals growing on lateritic rocks and plains show stunted growth whereas the ones growing

along the periphery of semi evergreen forest show luxuriant growth. Plants exposed to bright sunlight bears white flowers.

When Blatter (1933) revised Balsaminaceae for the Flora of Bombay presidency North Kanara was also a part of Bombay presidency and hence Almeida (1990) and Mudaliar and Prasad (2000) must have included the species based on the authority of Blatter.

Chromosome number: 2n = 14 (Bhaskar and Razi, 1972-73).

IUCN threat status: VU [B1ab(iii)].

Etymology: Latin: *scabriuscula* = scabrid, referring to the scabrid nature of the plant.

Impatiens talbotii Hook. f. in Rec. Bot. Surv. India 4: 42, 47. 1906; Blatter in J. Bombay Nat. Hist. Soc. 33: 314. 1933; Sharma *et al.*, Fl. Karnataka, 39. 1984; Ahmedullah & Nayar, Endemic plants of the Indian region, 1: 194. 1986; Singh & Kulkarni in Nayar & Sastry, Red Data Book 3: 63, t. 64. 1990; Nayar, Hot spots of endemic plants of India, Nepal and Bhutan, 215. 1996; Saldanha in Saldanha, Fl. Karnataka 2: 259. 1996; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 214. 1997; Dessai & Janarthanam in J. Econ. Taxon. Bot. (3): 624-627. 2008. **TYPE**: INDIA, Karnataka, Devimane, 24. 10. 1905, W. A. Talbot 3732 (K; Photo!)

Herbs, 25 – 60 cm high. Stem terete, flaccid, glabrous, swollen at nodes, branched. Leaves alternate, crowded at apex, petiolate; petiole 2 – 3.5 cm long, with 3 – 5 pairs of petiolar glands, hairy on either side; lamina lanceolate, 5.5 – 14 × 1.5 – 5.3 cm, cuneate at base, crenate and ciliate along margin, acute to acuminate at apex; crenae apiculate; adaxial surface hairy, abaxial surface glabrous to sparsely hairy, densely hairy on nerves. Flowers axillary, 2 – 4 in each axil, pink with purple centre,

2.2 – 2.5 cm across, bracts linear-lanceolate, c. 3 × 1 mm, acute at apex, glabrous, hairy along margin in the upper half; pedicel 1.8 – 2.5 cm long, slender, glabrous to hairy, deflexed in fruits. Lateral sepals c. 2 × 0.7 mm, ovate to linear-lanceolate, green in colour, sparsely hairy on the dorsal surface, mid vein distinct, entire along margin, acute at apex. Standard orbicular, 7 – 9 × 8 – 11 mm, pink within, white outside, dorsally keeled, keeled portion green in colour, apically cordate, costa mucronate, hairy, mucro green in colour, c 2 mm long. Wing petals 1.3 – 1.7 × 0.8 – 1 cm, bilobed, lobes unequal, basal lobe 0.8 – 1 × 6 – 8 mm, oblong to oblong-lanceolate, bilobulate, apically apiculate; distal lobe larger than the basal lobe, 1 – 1.3 × 0.5 – 0.7 cm, assymmetrically obovate, bilobulate, dorsal auricle absent, base of the wing petals is bent at the spur region thus giving the appearance of an auricle. Lip conical, 6 – 9 mm long, 3 – 5 mm deep, 3 – 4 mm wide, light pink in colour, glabrous to hairy, spurred; spur tubular, curved, white to light pink in colour, 2.5 – 3.5 cm long, glabrous to hairy, tip rounded. Column c. 3.5 × 2 mm. Anthers c. 1 × 1.5 mm, white to light pink in colour; filaments, c. 2.5 mm long, pink in colour. Pistil c. 3 × 1.mm; ovary ellipsoid-lanceoloid, c. 2 × 1 mm, glabrous; stigma 5-toothed, each tooth c. 1 mm long. Capsules assymmetrically lanceoloid, 1 – 1.5 × 0.5 – 0.7 cm, tomentose, stigma persistent, pedicel 2.6 – 3 cm long. Seeds ovoid, 4 × 2.5 mm, papillate to hairy, brown, flattened (Fig. 27; Plate - 8i, j. k, l).

Fl. & Fr.: August – November.

Habitat: Grows on either side of the narrow steep path/footsteps leading to the base of the Jog falls (Karnataka) and along the road side near waterfalls at Gaondongri (Goa).

Distribution: Goa (South Goa), Karnataka (North Kanara and Shimoga dictrict)

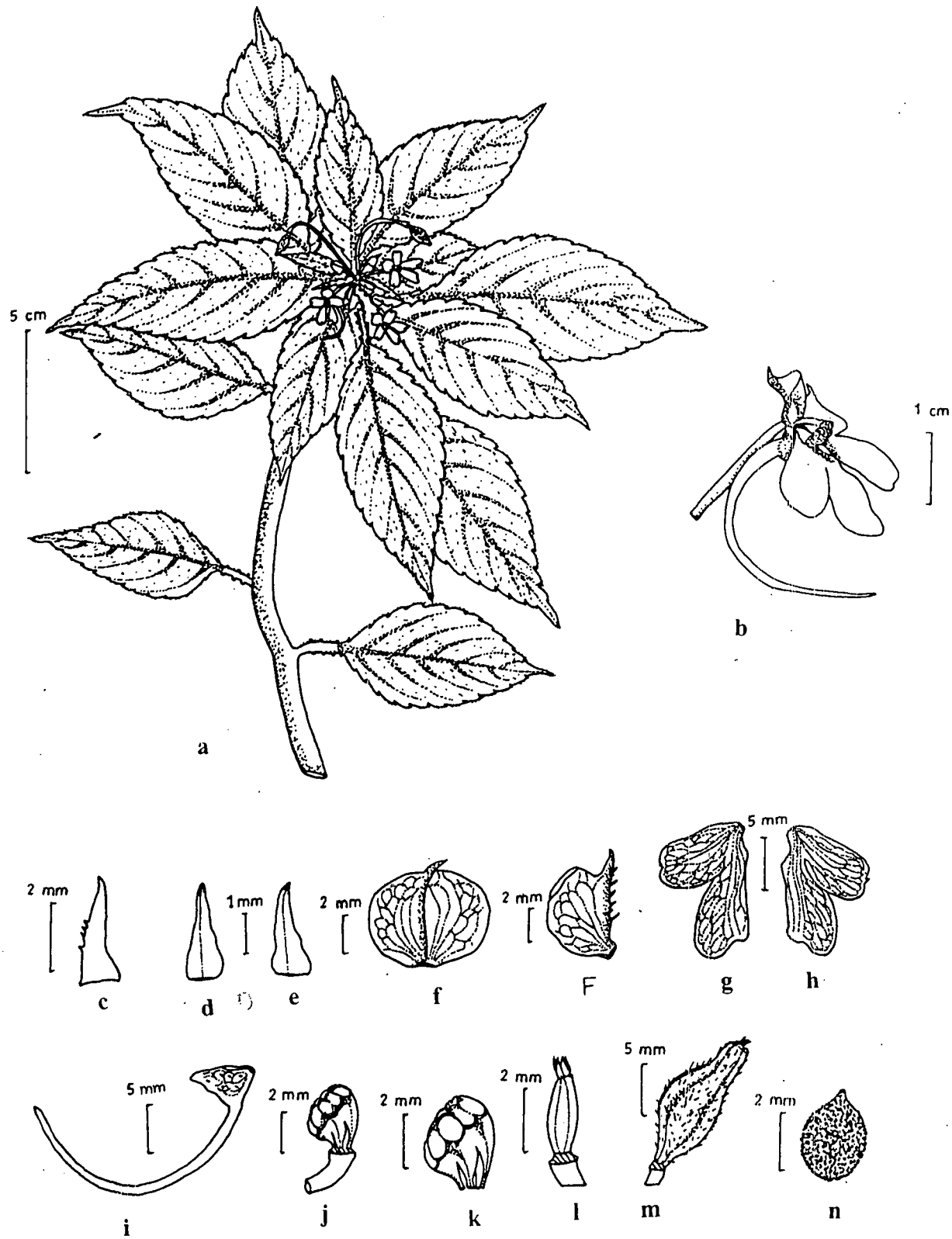


Fig. 27: *Impatiens talbotii* Hook. f. a) habit, b) flower, c) bract, d, e) lateral sepals, f) standard petal, g, h) wing petals, i) lip, j) column, k) androecium, l) pistil, m) capsule, n) seed.

PLATE 8

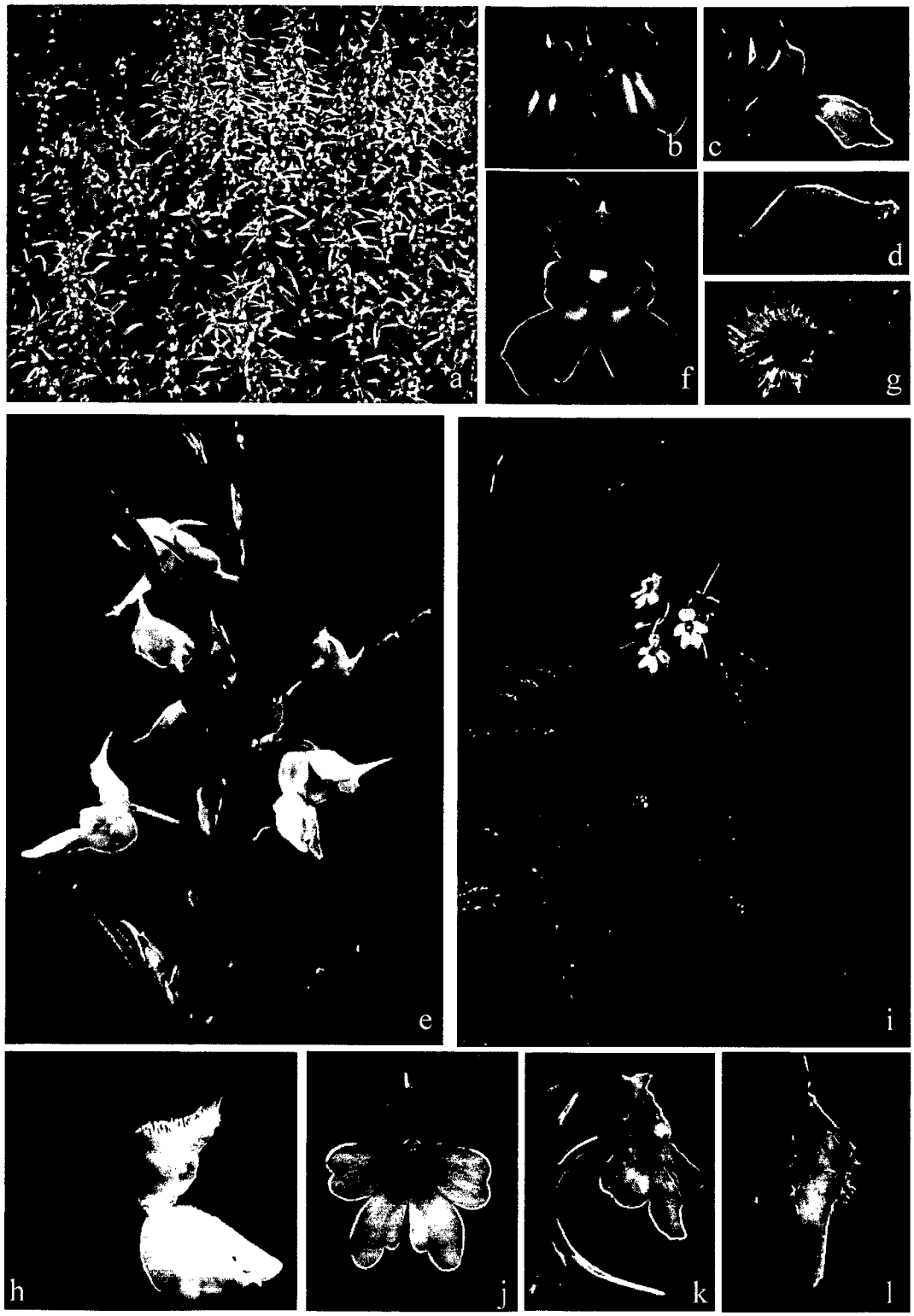
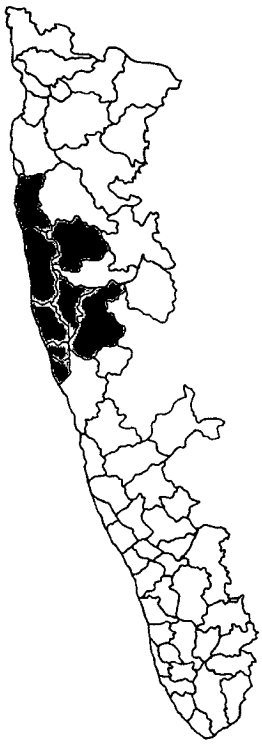


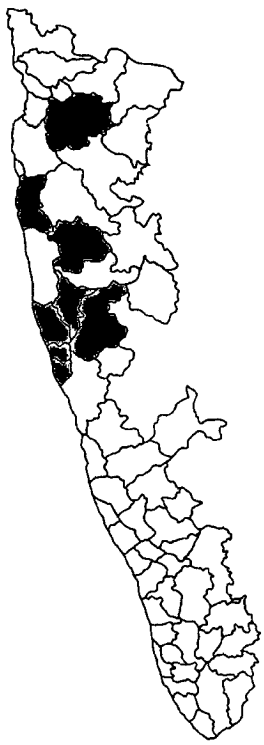
PLATE 8: a - d. *Impatiens rosea* Lindl.; d - h. *I. scabriuscula* Heyne ex Roxb.; i – l. *I. talbotii* Hook. f.

Map 7: Distribution of a) *Impatiens pulcherrima*; b) *I. rosea*; c) *I. scabriuscula*; d) *I. talbotii.*

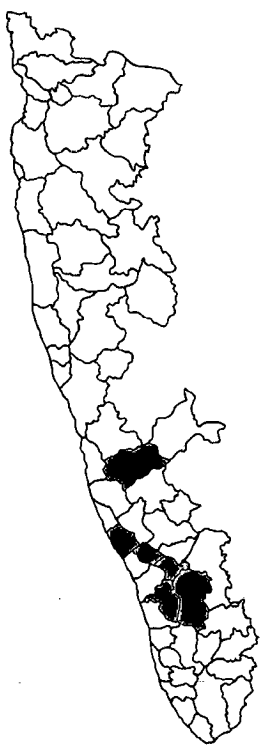
a



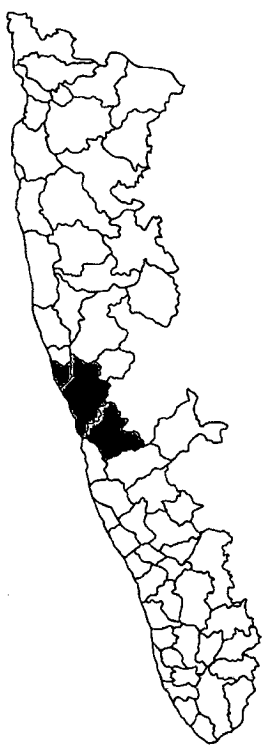
b



c



d



(Map - 7d).

Specimens examined:

Goa: Gaodongri, Bharsa, near Baman buda waterfalls, South Goa district, 12. 08. 2007, M. K. Janarthanam 163 (GUH); 28. 11. 2007, Emilia Mascarenhas 175 (GUH).

Karnataka: Devimane ghat, North Kanara district, 02. 11. 1903, W. A. Talbot *s. n.* (BSI); Castle rock, Belgaum district, *s. d.*, A. Meebold *s. n.* (CAL); Jog falls, 05. 11. 1972, V. Bhaskar 341 (MGM); Agumbe ghat, Shimoga district, 06. 11. 1972, V. Bhaskar 342 (MGM); Jog falls, North Kanara district, 06. 08. 2005, Jyosna R. N. Dessai 37 (GUH); 06. 09. 2005, Jyosna R. N. Dessai 93 (GUH).

Note: *Impatiens talbotii* is similar to *I. dasysperma* but differs in having circular stem, orbicular standard petal and tomentose capsule rather than quadrangular stem, obovate standard petal and glabrous fruit wall (vide note under *I. dasysperma*).

Impatiens talbotii Hook. f., a narrow endemic is so far reported only from North Kanara and Shimoga districts of Karnataka along the Central Western Ghats. It appears in Red Data Book of Indian plants as a rare endemic species that is represented by few old collections (Singh and Kulkarni, 1990). *I. talbotii* was described by Hooker in 1906 based on Talbot's collection from Devimane ghat in North Kanara district. However he did not provide any description and illustration while publishing this species. Later, during the revision of Balsaminaceae for the Presidency of Bombay, Blatter (1933) accessed Law's (*s. n.* – N. Kanara), Talbot's (3722 – Devimane Ghat) and Meebold's (6960 – Castle Rock) collections and included the description from Hooker's manuscript supplied by C. E. C. Fischer of the Kew Herbarium. Subsequently this species was collected from Jog falls (North

Kanara) and Agumbe (Shimoga) by Bhaskar (Bhaskar and Razi, 1978b). In Indian herbaria the species is known only by four collections. Due to its narrow distribution and representation by few collections in herbaria it has been designated as rare (Singh and Kulkarni, 1990; Nayar, 1996).

The present collection of this species from Goa shows its extended distribution from the central Western Ghats to the northern Western Ghats.

The species occurs in vulnerable habitat as thousands of tourist's visit Jog falls during the monsoons. As the flowers are attractive people are seen plucking the flowers and breaking the twigs thus putting the plant in a precarious position. Hence measures should be taken for its conservation.

Chromosome number: 2n = 12 (Bhaskar, 1976).

IUCN threat status: EN [B2ab(iii)].

Etymology: Latin: *talbotii* = in honour of William Alexander Talbot.

List of excluded taxa from the study area:

Impatiens aliciae C. E. C. Fisch.

I. balsamina var. *corymbosa* Santapau

I. clavicornu Turcz.

I. fruticosa DC.

I. goughii Wight

I. henslowiana Arn.

I. herbicola Hook. f.

I. inconspicua Benth. ex Wight & Arn.

I. jerdoniae Wight

I. crenata Bedd.

I. cuspidata Wight

I. flaccida Arn.

I. latifolia L.

I. lawsonii Hook. f.

I. leschenaultii DC.

I. lucida Heyne ex Hook. f.

I. pendula Heyne ex Wight & Arn.

I. trichocarpa Hook. f.

All the above species were earlier reported by various authors including Cooke (1901), Almeida (1996), Saldanha (1996), Vivekananthan *et al.* (1997) and Mudaliar and Prasad (2000). However, there are no specimens in any of the herbaria cited by them. I could not locate and collect them in the study area in spite of my best efforts. Wrong identification was one of the major causes for their inclusion in the study area. Moreover specimens collected by Stocks and Law were labeled as 'Concan' but also consist of specimens collected from Malabar that made later authors to include them for Karnataka and Maharashtra.

ii) b. Taxonomic discussion:

Literature survey for the genus *Impatiens* resulted in listing 50 taxa to be occurring in the study area. However the present study resulted in the collection of 175 field numbers belonging to 26 species and two varieties (28 taxa). Remaining species have been excluded from the study area as there are no evidences to support their distribution. This includes two new species *viz. I. bhaskarii* sp. nov. and *I. vivekananthanii* sp. nov. After thorough examination of the type specimens along with the scrutinization of the protologues it was found that *I. agumbeana* and *I. barberi* are conspecific. *I. rupicola* and *I. nataliae* are synonymized under *I. oppositifolia. I. chinensis* var. *brevicornis* has been proved to be *I. chinensis. I. fasciculata* Lam. and *I. crassicornu* which were synonymised under *I. chinensis* are reinstated as distinct species, while *I. fasciculata* auct. non Lam. as illustrated by Wight (1844) and Hooker (1852) is described as a new species. Based on the morphological characters and the phylogenetic data *I. rosea* has been reinstated to species level. It was earlier reduced as a variety under *I. balsamina* by Hooker (1874). *I. gardneriana*, a species wherein the leaves are ternate at the apex and the seeds are hairy, which was earlier placed in section *Oppositifoliae* by Hooker and Thomson (1859) and subsection *Verticillatae* by Bhaskar and Razi (1978b) is transferred to section *Uniflorae* (*Microsepalae*) due to its close affinities with this group of *Impatiens* species.

All the taxa reported in the study area belong to three sections out of the eight proposed by Hooker and Thomson (1859). Warburg and Reiche (1895) classified the genus into two subgenera – *Acaulimpatiens* and *Impatiens*. Subgenus *Acaulimpatiens* consists of two sections and subgenus *Impatiens* consists of 12 sections. Of the total 14 sections, species in the study area fall into six sections. These are *Scapimpatiens*,

Orchimpatiens, *Entantiophyllon*, *Kethetophyllon*, *Microcentron* and *Macrocentron*.

Hooker and Thomson (1859) placed all the scapigerous balsams under *Scapigerae*, alternate leaved species under *Uniflorae* (*Microsepalae*), and the opposite leaved species under *Oppositifoliae*. Warburg and Reich (1895) placed all the scapigerous balsams under two sections – *Orchimpatiens* and *Scapimpatiens*, opposite leaved species under *Entantiophyllon* and *Kethetophyllon* and alternate leaved species under *Microcentron* and *Macrocentron*.

Species grouped under *Uniflorae/Microsepalae* by Hooker and Thomson based on the morphological characters can be grouped into two groups. One group consists of species with ovate-lanceolate leaves and subequal lobes of the wing petals and the other with linear-lanceolate to linear-elliptic leaves and much smaller basal lobes (as compared to distal lobes) of the wing petals. Both these groups are represented in two sections: *Microcentron* and *Macrocentron* of Warburg and Reiche (1895).

Based on the spur length species with opposite leaves can be divided into two groups – the long spurred species and the short spurred species. Warburg and Reich (1895) placed the opposite leaved species into two sections though their spur character (length) overlaps.

In the present study even with limited number of species, it was found that grouping of the species supports the classification of *Impatiens* into sections as provided by Hooker and Thomson (1859) and Warburg and Reiche (1895) to major extent. However combination of both the classifications would result in a better system for classifying *Impatiens* species at global level.

iii) Phylogeny

Of the 42 characters used in phylogenetic analysis, 36 were parsimony informative while 6 characters were parsimony uninformative. A majority rule consensus tree was computed wherein tree length (L) = 188, consistency index (CI) = 0.4202, homoplasy index (HI) = 0.5798, retention index (RI) = 0.6065 and rescaled consistency (RC) = 0.2549.

The phylogeny of *Impatiens* is very well resolved separating the taxa into distinct groups with similar morphological characters (Fig. 28). Most of the groups are well supported with significant bootstrap values.

All the ingroup taxa formed a monophyletic group with respect to the outgroup i. e. *Hydrocera triflora*. The ingroup taxa formed two major clades A and B. These clades correspond to the broad division of all the species into two broad groups that have been recognised previously. Clade A includes all the *acaulescent* species while clade B includes all the *caulescent* species. This supports the broad classification adopted by Hooker and Thomson (1859). As per Warburg and Reiche's (1895) clade A includes all the species which he included in subgenus *Acaulimpatiens* and clade B included species belonging to subgenus *Impatiens*.

Clade A is further divided into two subclades C and D. Subclade C includes all the spurred species while subclade D includes species in which spur is absent. Within subclade C, *I. acaulis* is sister to *I. scapiflora* forming a separate cluster within the spurred group. Absence of dorsal auricle and the spur length (> 2.5 cm long) supports this clade. *I. acaulis* and *I. scapiflora* are differentiated from each other based on the number of lobes of the wing petal. The wing petals are bilobed in the former and trilobed in the latter.

Impatiens barberi, *I. clavata* and *I. dendricola* form a clade. All these species

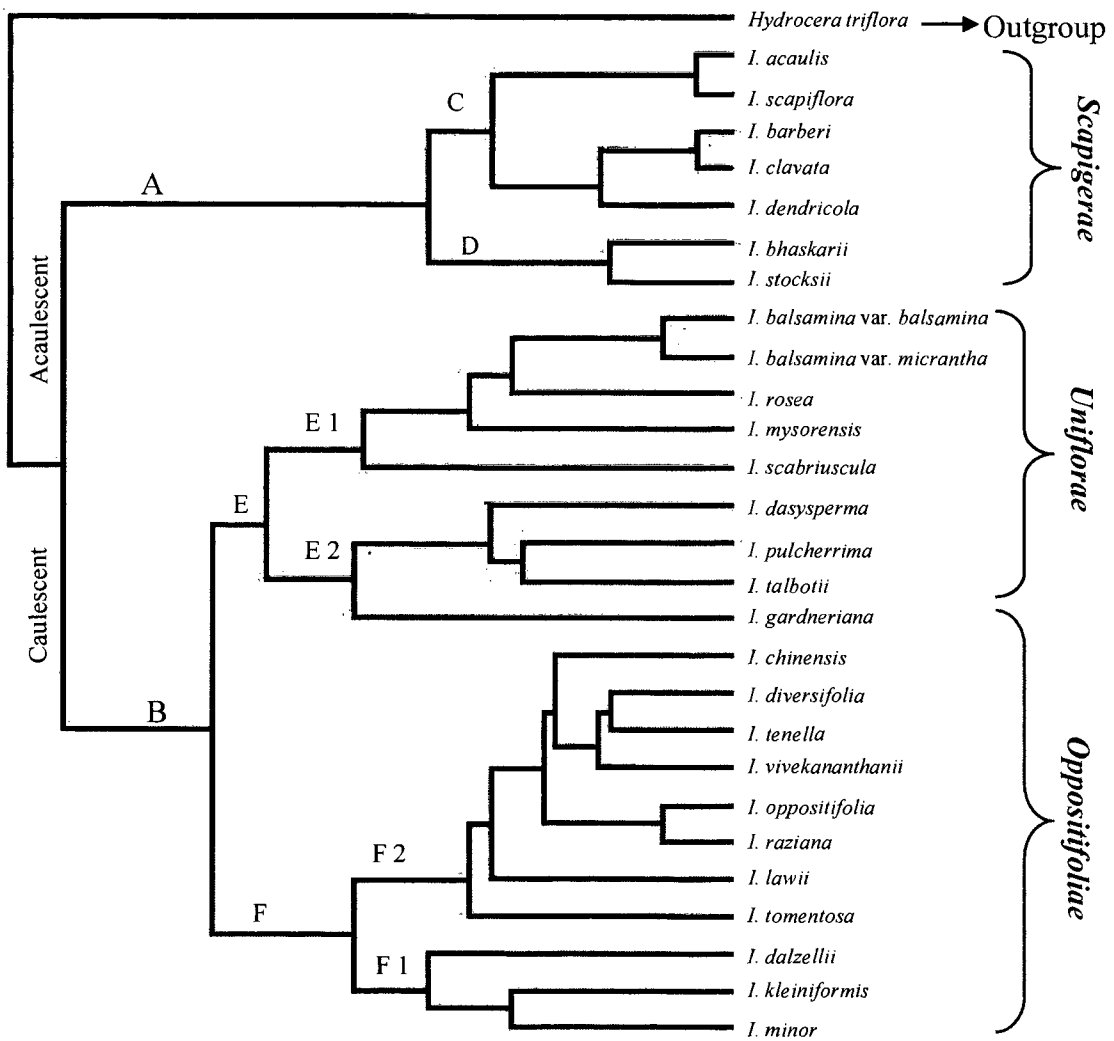


Fig. 28: Phylogenetic tree constructed using UPGMA method of PAUP based on morphological characters.

possess a distinct dorsal auricle and the spur is < 2 cm long. *I. dendricola* is a white flowered species wherein the dorsal auricle is short and rounded appears at the base and shows phylogenetic relationship with *I. barberi* and *I. clavata*. In both these species flowers are pink coloured and the dorsal auricle is long and spiniform. Both these species are morphologically similar but differ in their spur structure. The spur is hollow and notched at the base in the former while flat and rounded at the base in the latter species. Further molecular studies from different populations will throw light on the distinct status of both these species.

Clade B is further divided into two groups E and F. Clade E includes all the alternate leaved species belonging to section *Uniflorae* (*Microsepalae*) of Hooker and Thomson (1859) and section *Microcentron* and *Macrocentron* of Warburg and Reich (1895). Clade F includes all the opposite leaved species belonging to section *Oppositifoliae* of Hooker and Thomson (1859) and section *Entantiophyllon* and *Kethetophyllon* of Warburg and Reiche (1895).

Clade E is further divided into two suclades E1 and E2. Subclade E1 includes five taxa which are naturally related to each other. This includes *I. scabriuscula, I. mysorensis, I. rosea, I. balsamina* var. *balsamina and I. balsamina* var. *micrantha.* They are with linear-lanceolate to linear-elliptic leaves and the basal lobe is much smaller than the distal lobe. Of these five taxa *I. scabriuscula* is without spur, *I. mysorensis* and *I. rosea* are short spurred species and *I. balsamina* var. *balsamina and I. balsamina* var. *micrantha* are long spurred taxa. Within this subclade *I. scabriuscula* appears at the basal position and groups with the spurred species. *I. mysorensis* is allied to *I. scabriuscula* but differs in its lip with a short, straight spur (rather than spurless lip), puberulous capsule (rather than villous) and in lacking a distinct dorsal auricle. Both these species show affinity with *I. rosea. I. rosea* is a

short spurred species and hence elevated to species level. *I. balsamina* var. *balsamina* and *I. balsamina* var. *micrantha* are long spurred taxa and cluster together.

Subclade E2 comprises of *I. gardneriana, I. talbotii. I dasysperma* and *I. pulcherrima*. Hooker and Thomson (1859) and Warburg and Reiche (1895) placed *I. gardneriana* along with the opposite leaved species due to its opposite leaves at the base without taking into consideration the apical leaves and the hairs on the seeds, while Bhaskar and Razi (1978b) proposed a new subsection - *Verticillatae* under section *Oppositifoliae* to accommodate this species. However in the present study the species clusters along with the alternate leaved species in the phylogenetic tree. This is due to its ternate phyllotaxy of the leaves at the apex and the hairy seeds. Thus it joins its closely related species, i. e. *I. talbotii, I. dasysperma* and *I. pulcherrima*. Hence the species has been transferred to section *Uniflorae* (*Microsepalae*).

Warburg and Reiche's placed species belonging to section *Uniflorae* (*Microsepalae*) of Hooker and Thomson (1859) under two sections, *viz. Macrocentron* and *Microcentron*. Section *Macrocentron* includes species like *I. pulcherrima*, *I. dasysperma* and section *Microcentron* includes species like *I. scabriuscla*. The phylogenetic tree obtained strongly supports the classification of all these alternate leaved species into sections as proposed by Warburg and Reich (1895).

Clade F includes all the opposite leaved species and splits into two subclades F1 and F2. Subclade F1 includes *I. minor*, *I. kleiniformis* and *I. dalzellii*. *I. minor* is sister to *I. kleiniformis*. Both these species do not possess the basal lobe of the wing petal. Both the species are morphologically similar. *I. minor* differs from *I. kleiniformis* in having glabrous pedicel and in having glands at the base of the lamina (in the latter pedicel is with two rows of hairs and glands are absent at the base of lamina). These two species cluster with *I. dalzellii*, which is a yellow flowered

species. Though the species is with bilobed wing petal does not cluster along with the subclade F2 due to its glabrous pedicel.

Impatiens tomentosa and *I. lawii* are the basalmost species in subclade F2. In the former species stem is hairy all over and leaves are linear-lanceolate whereas in latter stem is glabrous and the leaves are ovate. Both these species are basal to both long spurred as well as short spurred species. *I. raziana* and *I. oppositifolia*, short spurred species form a sister clade. However both the species are differentiated from each other based on their flower colour. The flowers are orange-coloured in the former and pink-coloured in the latter species.

Within the long spurred species, *I. chinensis* is the basal taxon. This is a widespread species and bears strongly curved thick spur which is broad in the middle. *I. vivekananthanii*, another non endemic species of the clade occurs in Peninsular India and Sri Lanka. *I. diversifolia* is sister to *I. tenella*. Both these species differ in having a distinct dorsal auricle. In all these three species the spur is thin and tapers from the base to apex.

Though, the phylogenetic tree shows overall low Consistency Index and high Homoplasy Index due to varied morphological lineages, within the clades of the tree phylogenetic relationship is resolved very well. It also shows more than a century old infrageneric classification still holds good though needs to be fine tuned with minor reshuffling of taxa.

iv) Phytogeography

An important feature of the genus *Impatiens* is high degree of endemism of its species. In India, the genus is represented by 209 (20.9 % of total species worldwide) species in two diversity centres: Eastern Himalayas and the Western Ghats. Only *Impatiens balsamina* var. *balsamina*, *I. chinensis* and *I. rosea* are common to the Western Ghats and the eastern Himalayas. Of the total number, 144 species (68.89 %) are endemic to the political boundary of India, though most of the remaining are endemic to phytogeographical zone.

The Western Ghats region harbours c. 90 species of *Impatiens*, of which c. 80 species are endemic. This constitutes about 5.3 % of the total endemic species in the Western Ghats. The genus is represented by maximum number of endemic species and most of them are restricted to small geographic areas (Nair, 1991) while a few are widely distributed throughout the mountain range. Bhaskar (1981) considered Western Ghats as a region of speciation for the genus *Impatiens*. Similar trend in endemism was observed in Africa by Grey-Wilson (1980a, 1980b) wherein the species of *Impatiens* are often restricted to a very limited area and Yuan *et al.*, (2004) mention that all the native species of *Impatiens* in Madagascar are endemic.

Subramanyam and Nayar (1974) referred India to oceanic islands due to high percentage of endemic species. They also considered Western Ghats equivalent to oceanic island in the development of endemic species because the hill range is protected by the Arabian Sea along the western side, the Vindhya-Satpura ranges on to the north and the semi-arid Deccan plateau towards its east. Turill (1964) is of the opinion that the peninsular regions provide favourable conditions for endemism after islands. Peninsular Indian region is no exception and hence has a high degree of endemism.

Western Ghats is the second richest endemic centre in India after the Himalayas. It presides over the biogeography of Peninsular India like the Himalayas presiding over the biogeography of India (Nayar, 1996). The complex hill system with several peaks occurring in the Western Ghats provides various habitats and niches suitable for the growth of endemic species (Vajravelu and Vivekananthan, 1996). The latitudinal position along with the altitudinal gradients, the rainfall pattern of the SW and SE monsoons, climatic shifts due to dry period on the leeward side of the mountains range, the semi-arid Deccan plateau, different soil types and their nutrients have resulted in different ecological island niches favouring high degree of endemism, vicariants and relict species (Nayar, 1996).

The high rate of endemism of the genus *Impatiens* depicts the importance of the genus with regard to phytogeography for understanding the mechanism of speciation and adaptations to the environmental conditions.

During the present study on the genus *Impatiens*, 28 taxa were collected from the study area although literature search reveals the total number of taxa to be 50 for this region. *I. agumbeana*, *I. rupicola*, *I. nataliae*, *I. trichocarpa* and *I. chinensis* var. *brevicornis* are are synonymised and for the others material is not available in any herbaria to prove their existence or distribution in the study area. Of the 28 taxa, *I. balsamina* var. *balsamina* and *I. chinensis* are widely distributed in south east Asian countries, *I. acaulis* var. *acaulis*, *I. oppositifolia* and *I. vivekananthanii* are widely distributed in the Western Ghats and Sri Lanka biodiversity hotspot, *I. minor* occurs throughout the Peninsular India, *I. mysorensis* is found growing towards the leeward side of the Western Ghats towards the western edge of the Deccan plateau. Most of the species occupy a particular geographical or hill range while others are narrow endemics restricted to specific habitats. Due to their restricted distribution and habitat

specificity, several species have been ranked as critically endangered (CR), endangered (EN) and vulnerable (VU) in their conservation status.

Of the 28 taxa occurring in the study, 20 taxa (Table 4) are endemic to the Western Ghats region. Of these endemic taxa, 14 taxa are exclusively endemic to the study area of which (Table 3), one species is endemic to the Western Ghats of Maharashtra while 9 species are endemic to the Western Ghats of Karnataka. Five species viz. *I. bhaskarii* (Charmadi ghat, Chikmagalur district), *I. clavata* (Bisle ghat, Hassan district), *I. dalzellii* (Satara district), *I. dendricola* (Coorg district) and *I. mysorensis* (Chikmagalur district) are narrow endemics restricting their distribution either to the type localities or to the particular district in which they occur. Thirteen taxa extend their distribution from the study area to the southern Western Ghats inspite of the major discontinuity in the mountain range in the form of Palghat gap (Table 5).

Table 3: List of species endemic to the study area.

Taxa	**Distribution (districts)**
Impatiens acaulis var. *granulata*	Kodagu, Hassan
I. balsamina var. *micrantha*	Kodagu
I. barberi	North Kanara, Shimoga
I. bhaskarii	Chikmagalur
I. clavata	Hassan
I. dalzellii	Satara
I. dendricola	Kodagu
I. kleiniformis	North Goa, South Goa, Sindhudurg, North Kanara
I. lawii	Satara, Belgaum
I. mysorensis	Chitradurga
I. pulcherrima	North Goa, South Goa, Sindhudurg, Kolhapur, Raigad, Satara, North Kanara
I. raziana	Belgaum, Shimoga
I. stocksii	Hassan, South Kanara, Chikmagalur, Kodagu
I. talbotii	South Goa, Shimoga, North Kanara

Table 4: List of species endemic to Western Ghats.

Sr. No	Taxa	State-wise distribution
1	*Impatiens acaulis* var. *granulata*	Karnataka
2	*I. balsamina* var. *micrantha*	Karnataka
3	*I. barberi*	Karnataka
4	*I. bhaskarii*	Karnataka
5	*I. clavata*	Karnataka
6	*I. dalzellii*	Maharashtra
7	*I. dasysperma*	Karnataka, Kerala, Tamil Nadu
8	*I. dendricola*	Karnataka
9	*I. diversifolia*	Karnataka, Kerala, Tamil Nadu
10	*I. gardneriana*	Karnataka, Kerala, Tamil Nadu
11	*I. kleiniformis*	Goa, Karnataka, Maharashtra
12	*I. lawii*	Karnataka, Maharashtra
13	*I. pulcherrima*	Goa, Karnataka, Maharashtra
14	*I. raziana*	Karnataka
15	*I. scabriuscula*	Karnataka, Kerala, Tamil Nadu
16	*I. scapiflora*	Karnataka, Kerala, Tamil Nadu
17	*I. stocksii*	Karnataka
18	*I. talbotii*	Karnataka, Goa
19	*I. tenella*	Karnataka, Tamil Nadu
20	*I. tomentosa*	Maharashtra, Tamil Nadu

Table 5: List of species showing extended distribution from the study area to the southern Western Ghats

Sr. No.	Taxa
1	*I. acaulis* var. *acaulis*
2	*I. balsamina* var. *balsamina*
3	*I. chinensis*
4	*I. dasysperma*
5	*I. diversifolia*
6	*I. gardneriana*
7	*I. minor*
8	*I. oppositifolia*
9	*I. scabriuscula*
10	*I. scapiflora*
11	*I. tenella*
12	*I. tomentosa*
13	*I. vivekananthanii*

The number of endemic species increases with the decreasing latitude or *vice*

versa. The species of *Impatiens* are concentrated in the Western Ghats region of Karnataka state in the study area.

According to Nayar (1996), the southern section of the Western Ghats is the richest area as far as floristic composition and endemic species is concerned. Similar trend is seen in case of *Impatiens* species. Maximum number of species occurs in the southern Western Ghats representing all the sections proposed by Hooker (1906) for Peninsular India.

Augustine *et al.*, (1999) recognized 5 endemic centres for the genus *Impatiens* in the Western Ghats and one amongst them is Shimoga. However based on the present study it is found that maximum number of species occurs in the Chikmagalur district and hence could be one of the endemic centre for the genus rather than Shimoga.

Nayar (1996) on the basis of distribution of endemic plants recognised two megacentres of endemism *viz*. the northern Western Ghats and the southern Western Ghats, in Peninsular India. Similarly based on the concentration of *Impatiens* species, the Western Ghats can be broadly divided into two as proposed by Nayar (1996).

Species of *Impatiens* occurring in the study area belong to three sections of the total eight sections as proposed by Hooker and Thomson (1859) for Peninsular India. They are *Scapigerae*, *Uniflorae* and *Oppositifoliae*. All the sections overlap each other in their distribution.

Section *Scapigerae*: Species belonging to section *scapigerae* occurring in the study area have tubers and seeds are with hairy appendages which aid in dispersal and attachment with the substratum.

Impatiens acaulis and *I. scapiflora* are lithophytic but also occur as epiphytes.

Occasionally these are also found growing in soil. *I. acaulis* is a widely distributed species occurring throughout the Western Ghats and Sri Lanka (Map - 1a). The widespread occurrence and different habitats (grows as a lithophytes, epiphyte and also in soil) suggests that this species could be a probable root from which all other forms must have evolved. *I. scapiflora* extends its distribution from the Central Western Ghats up to the southern Western Ghats (Map - 2c). *I. acaulis* var. *granulata* which is differentiated from the typical variety based on the pollen characters occurs in the Central Western Ghats of Karnataka (Map - 1b). *I. acaulis* is closely related to *I. scapiflora*. They differ in the number of lobes of the wing petal, bilobed wing petals in the former in contrast to trilobed wing petals in the latter. Both these species produce large flowers with a long spur and are found growing in and along the spray zones of waterfalls. At higher altitudes with high rainfall, these species are found growing as epiphytes on tree trunks up to a height of 15 m. Although both the species are morphologically similar they are isolated from each other in their distribution.

The true epiphytic species belonging to this section occupy a special niche in the environment and do not regenerate outside their habitats. These species are also shade tolerant. They grow on wet tree trunks which are covered with moss (sometimes in areas with heavy rainfall the species grow on tree trunks even without moss). All the true epiphytic balsams in the study area are endemic to the Western Ghats of Karnataka.

Impatiens barberi, I. bhaskarii and *I. clavata* are allopatric in their distribution, *I. stocksii* and *I. dendricola* show overlapping distribution. *I. barberi* occurs in the northern parts of the central Western Ghats. It extends its distribution from Jog falls (North Kanara) down south to Agumbe ghat in Shimoga district (Map - 1c). Both these regions receive high rainfall. *I. clavata*, a close relative of *I. barberi*

occurs along the periphery of semievergreen forest at higher elevations under dense canopy cover. This species is a narrow endemic so far reported only from the type locality (Map - 2a). *I. dendricola* is so far reported only from two localities of Kodagu district (Map - 2b). These are high altitude areas receiving heavy rainfall. *I. stocksii* is distributed from Chikmagalur to Kodagu district through Hassan district (Map - 2d). *I. bhaskarii* an allied species of *I. stocksii* is a narrow endemic not reported elsewhere outside the type locality (Map - 1d). It grows at an altitude of + 800 m on the lateral branches of trees.

Section *Uniflorae* (*Microsepalae*): This group has a centre of distribution in the Central and Southern Western Ghats. Species belonging to this section can be grouped into two subgroups based on the morphology of the wing petals. **Subgroup I** comprises of *I. pulcherrima*, *I. talbotii*, *I. dasysperma* and *I. gardneriana* with ovate-lanceolate leaves and equal to subequal lobes of the wing petals and **subgroup II** comprises of *I. balsamina*, *I. mysorensis*, *I. rosea* and *I. scabriuscula* with linear-lanceolate leaves and much smaller basal lobes of the wing petal as compared to distal lobes.

Subgroup I: *Impatiens pulcherrima* is widely distributed from the Northern Western Ghats to the northern parts of Central Western Ghats (Map - 7a). The species has a distinctive appearance. It has large showy flowers with a long spur and also its seeds are big with rugose surface. *I. talbotii* occurs in the peripheral regions of the northern and central Western Ghats (Map - 7d). *I. dasysperma* and *I. gardneriana* show sympatric distribution patterns, though they also grow in isolation. They are found growing in the central and southern Western Ghats (Map - 6b, c). Both these species are closely related to each other in having similar floral structure and has seed which

bears hair.

Subgroup II: Species belonging to this subgroup of section *Uniflorae* (*Microsepalae*) show more affinities with the species belonging to section *Oppositifoliae* with regard to their floral morphology specially the bilobed wing petals wherein the basal lobe is much smaller than the distal lobe and the seeds without any appendages. However, the group mainly differs from section *Oppositifoliae* in its alternate arrangement of leaves, minute scaly lateral sepals and in having granulated seed surface. *I. balsamina* is a widely distributed species in India and the neighbouring countries (Map - 5d). It occurs along the human inhabitated regions. *I. rosea* occurs in the Eastern Himalayas and in Western Ghats with a discontinuous range of distribution (Map - 7b). In the Western Ghats this species mainly occurs in and around human settlements and thus appears to be an introduced species. However it is not known whether the species is native or introduced in the eastern Himalayas.

Impatiens mysorensis and *I. scabriuscula* though closely related to each other show allopatric distribution. *I. mysorensis* is a geographyically isolated species from the rest of the species in the group. It occurs on the leeward side of the Western Ghats towards the Western edge of the Deccan plateau (Map - 6d), where the area receives less rainfall. *I. scabriuscula* occurs on lateritic rocks, at higher altitudes along the semi-evergreen forest (Map - 7c).

Section *Oppositifoliae*: Two major groups can be recognised in this section based on the morphology of the wing petals. **Group I** includes species in which the wing petal is not lobed (*I. minor* and *I. kleiniformis*) and **group II** includes all the species with bilobed wing petals (remaining species of this section). The latter group can be further divided into two sub groups: subgroup I includes species with long spur (*I. tenella, I.*

diversifolia and *I. vivekananthanii*) and subgroup II includes species with short spur (*I. dalzellii*, *I. lawii*, *I. oppositifolia*, *I. tomentosa* and *I. raziana*).

Impatiens minor is a widely distributed species in Peninsular India (Map - 4b). It occurs in almost all types of habitats. It is also found growing as an epiphyte on tree trunks and also on cemented walls. *I. kleiniformis*, closely allied to *I. minor*, occurs along the ghats in between 12.5° - 16° N latitudes (Map - 3d). Though the latitudinal range is between 12.5° - 16° N, the species occurs in areas like Amboli, Chorla Ghat, Anmod Ghat with relatively high altitude.

Impatiens dalzellii is the only yellow coloured species in the study area and also in the Western Ghats. It is endemic to Western Ghats of Maharashtra (Map - 3b). It occurs in between 17° – 18° N latitudes. *I. oppositifolia* is a widely distributed species extending its distribution from Maharashtra up to Sri Lanka (Map - 4c). This species shows wide range of variations with respect to its overall morphology particularly leaf shape, flower colour and spur shape under different climatic conditions. *I. lawii* and *I. tomentosa* show discontinuous distribution (Map - 4a, 5b). Both these species occur in open table lands where there is high velocity of wind, though the latter has been recorded to occur in marshy areas in south. *I. raziana* occurs on the leeward side of the Western Ghat region of Karnataka (Map - 4d) which receives relatively less amount of rainfall. It occurs in cultivated areas. The distribution of this species in cultivated areas is a major threat to its existence

Impatiens tenella and *I. vivekananthanii* grows from 1000m – 1600 m altitude (Map - 5a, c). *I. diversifolia* occurs at low elevation areas (Map - 3c). *I. chinensis* is a widely distributed species, occurring in China, Eastern Himalayas and Western Ghats (Map - 3a).

The distributional data analysed using MVSP showed that districts having

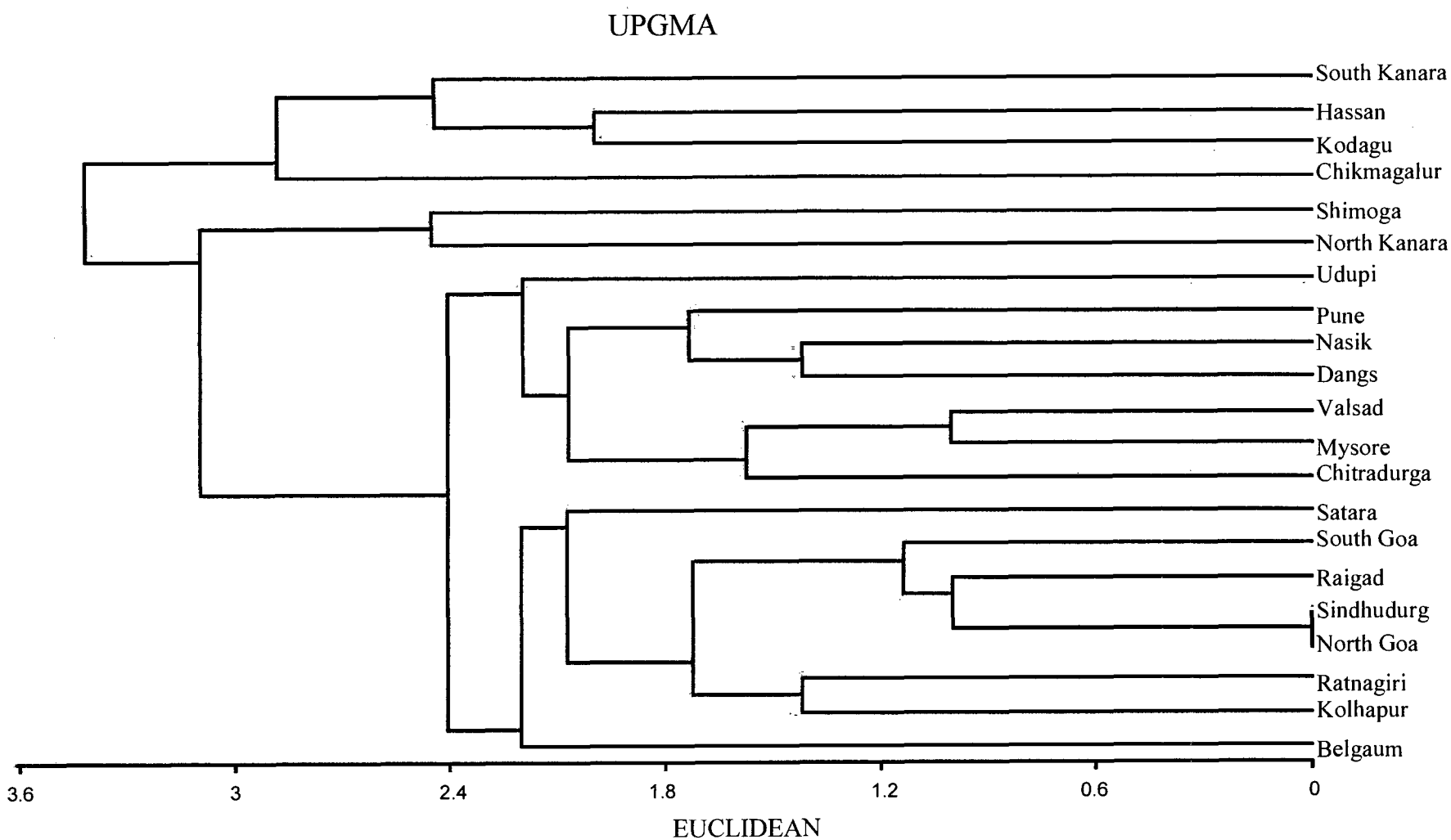


Fig. 29: Dendrogram constructed based on the distribution of *Impatiens* species in the study area.

similar topology, geology, altitudinal range, environmental conditions and to a great extent the number of endemic species they harbour cluster together. The clusters on the dendrogram show the division of the study area into three zones (Fig. 29). The first zone comprises of the districts of Central Western Ghats of Karnataka state except Mysore, Chitradurga which are towards the western edge of the dry Deccan Plateau. Udupi district is characterized by laterites and coastal soils and there are no high altitude hill ranges in the area. Hence, though the district is very close to districts of Central Western Ghats it clustered with the northernmost laterite rich districts ts. All the districts in this zone are characterized by evergreen forests, semi-evergreen forests, sholas, high altitudinal range and rainfall. All these conditions provide ideal habitat for the growth of *Impatiens*. Maximum number of endemic species, especially the narrow endemic scapigerous forms are restricted to these districts of the study area.

The second zone comprises of most of the districts which are included in the Northern Western Ghats. These are characterized by open table lands and semi-evergreen forests. These are comparatively areas with medium elevation. This group includes species which occupy a wider range of distribution.

The third zone comprises of districts from either side of the Central Western Ghats as well as the Northern Western Ghats. These are areas with low altitude and either with open lateritic plateaus or dry areas with less rainfall. These regions are poor in *Impatiens*.

v) Threat status

An important aspect of the genus *Impatiens* is the high degree of endemism of its species. Most of the species are narrow endemics, though some occupy wider areas. Some species are represented by one or two collections in the herbaria. Several species have entered into the Red Data Book. Hence all the species in the study area were evaluated to understand their threat status using IUCN version 3.1.

Table 6: Threat categories along with the number of taxa.

Threat category	**No. of taxa**
Critically endangered (CR)	5
Endangered (EN)	12
Vulnerable (VU)	4
Least concern (LC)	7

Critically endangered (CR): Species belonging to this category are narrow endemics and are known only from the type localities or 2 – 3 collections. Five species fall into this category (Table 7). *I. bhaskarii* and *I. clavata* are known only by the collections from the type localities. These are represented by single population comprising of few individuals. *I. dendricola* occurs on huge trees along the periphery of coffee plantation and also at Talacauvery where the species is represented by few individuals. The clearance of these huge trees for the extension of the plantation area would leave no traces of the plant in the type locality. This is a major threat to the species in the near future.

Impatiens raziana inhabits the cultivated areas. There are no traces of the species in the type locality. The existence of the species in and along the cultivated

areas is a major threat for the species and hence falls into this category. *I. mysorensis* is known only from Chitradurga district of Karnataka. Excessive grazing of the species by goats, quarrying in the locality and in the area where the species occur are the major threats to the species.

Endangered (EN): Twelve species fall into endangered category (Table 8). Species like *I, dalzellii, I. diversifolia, I. gardneriana, I. kleiniformis, I. lawii, I. tenella* and *tomentosa* fall under this category. The extent of occurrence is estimated to be less than 5000 km^2 and continuing decline is predicted in area of occupancy, extent of occurence and quality of habitat. For *I. balsamina* var. *micrantha*, *I. barberi* and *I. talbotii* area of occupancy is estimated to be less than 500 km^2, species not known from more than five locations and continuing decline is predicted in area of occupancy, extent of occurence and quality of habitat. *I. acaulis* var. *granulata* occupy an area of occupancy which is estimated to be less than 500 km^2 and extreme fluctuations are observed in the number of subpopulations. *I. stocksii* is an endemic where in the population comprises of less than 250 mature individuals.

Vulnerable (VU): The species under this category are endemics that occur throughout the Western Ghats or are represented by a large number of populations. Four species are categorized under this category (Table 9). *I. dasysperma*, *I. scabriuscula* and *I. scapiflora* and *I. pulcherrima* are known to exist in atleast 10 locations and continuing decline is predicted in area of occupancy, extent of occurence and quality of habitat.

Least concern (LC): These are non endemic species which are widely distributed in

the study area as well as in neighbouring countries except *I. minor*. Six species are categorized under this category (Table 10).

Table 7: List of critically endangered taxa.

Taxa	**Threat status [Criteria]**
Impatiens bhaskarii	CR [B2ab(iii)]
I. clavata	CR [B2ab(iii)]
I. dendricola	CR [B1ab(iii)]
I. mysorensis	CR [B1ab(iii)]
I. raziana	CR [B1ab(iii)]

Table 8: List of endangered taxa.

Taxa	**Threat status [Criteria]**
I. acaulis var. *granulata*	EN [B2ac(iii)]
I. balsamina var. *micrantha*	EN [B2ab(iii)]
I. barberi	EN [B2ab(iii)]
I. dalzellii	EN [B1ab(iii)]
I. diversifolia	EN [B1ab(iii)]
I. gardneriana	EN [B1ab(iii)]
I. kleiniformis	EN [B1ab(iii)]
I. lawii	EN [B1ab(iii)]
I. stocksii	EN [D]
I. talbotii	EN [B2ab(iii)]
I. tenella	EN [B1ab(iii)]
I. tomentosa	EN [B1ab(iii)]

Table 9: List of vulnerable taxa.

Taxa	**Threat status [Criteria]**
I. dasysperma	VU [B1ab(iii)]
I. pulcherrima	VU [B1ab(iii)]
I. scabriuscula	VU [B1ab(iii)]
I. scapiflora	VU [B1ab(iii)]

Table 10: Least concern taxa.

Taxa	**Threat status**
I. acaulis var. *acaulis*	LC
I. balsamina var. *balsamina*	LC
I. chinensis	LC
I. minor	LC
I. oppositifolia	LC
I. rosea	LC
I. vivekananthanii	LC

CONCLUSION

The taxonomic studies of the genus *Impatiens* in the Northern and parts of Central Western Ghats resulted in the collection of 28 taxa as against 50 mentioned in the literature. Eighteen taxa have been excluded from the study area as these species are neither represented by any collections from the study area in any of the major herbaria of the country nor could be collected during the course of present study. After careful examination of the type material and protologues *I. balsamina* L. var. *rosea* Hook. f. has been elevated to species level and five taxa have been synonymised (*I. agumbeana* under *I. barberi*, *I. chinensis* L. var. *brevicornis* Barnes under *I. chinensis*, *I. nataliae* Hook. f. and *I. rupicola* Hook. f. under *I. oppositifolia* L., *I. trichocarpa* Hook. f. under *I. rosea* Lindl.). Phytogeographic studies revealed that most of the species are narrow endemics and in the present study categorized under critically endangered, endangered and vulnerable threat categories of IUCN version 3.1. The phylogenetic tree obtained strongly supports the infrageneric classifications proposed by Hooker and Thomson (1859) and Warburg and Reiche (1895). Based on the morphological characters and phylogenetis studies *I. gardneriana* Wight has been shifted to section *Uniflorae* (*Microsepalae*) of Hooker and Thomson (1859) from section *Oppositifoliae*. The present study forms a comprehensive taxonomic account of balsams of Northern and parts of Central Western Ghats thus fulfilling the objectives of the study. Similar studies on the genus *Impatiens* for the whole of Western Ghats, though time consuming, will help in understanding the process of speciation and their threat status.

SUMMARY

The genus *Impatiens* comprises of over 1,000 species Worldwide. In India the genus is represented by 209 species in two centres of diversity: the Eastern Himalayas and the Western Ghats. The Western Ghats region harbours c. 90 species of *Impatiens* of which 80 are endemic. Inspite of being the only genus with highest number of endemic species, collections available in herbaria are few and some species are not collected after type. Some species have already entered into RET category. No comprehensive and group specific studies have been carried out on the genus. Specimens in herbaria posed problems as the flowers do not preserve well to show the details. Hence the present study was taken up to study taxonomy based on fresh specimens, understand their phytogeography and phylogeny and reinterpret threat status for the species occurring in the Northern and parts of Central Western Ghats.

Standard revisionary method was followed during the study. A checklist of all the published names for the species of *Impatiens* was prepared using local and regional floras. For all the species, place of original publication was obtained. Herbarium specimens including type specimens from BSI, BLAT, CAL, JCB, MH, MGM, and SUK were studied. Photographs of herbarium sheets (type specimens) were obtained from E, G, K, LINN, NY and W. Specimens were collected from various localities of the study area. They were processed for herbarium using standard herbarium techniques. Dissected floral parts were processed using special methods. Names have been applied to the species based on the type specimens and protologues. If more than one name is available for an entity then the principles of priority has been applied. Entities that remained without any name were critically studied, and when confirmed as novelties, have been recognised as new species. Species that were not found in the study area and not represented by any collection from the study area

in any of the herbaria were excluded. Provisions of the latest International Code of Botanical Nomenclature have been applied for resolving various nomenclatural issues and typification problems. Distributional map was prepared for each species. Phylogeny has been worked out using morphological data. All the species have been evaluated for their threat status.

The present study resulted in collecting 26 species and 2 varieties of balsam in the study area. Section *Oppositifoliae* is represented by the highest number of species, followed by *Uniflorae* and *Scapigerae*.

Two taxa have been confirmed as novelties and are described as new species viz. *I. bhaskarii* sp. nov. and *I. vivekananthanii* sp. nov. *I. balsamina* L. var. *rosea* (Lindl.) Hook. f. has been reinstated as species. *I. gardneriana* Wight which was earlier placed under section *Oppositifoliae* has been transferred to section *Uniflorae*. Lectotype has been selected for *I. chinensis* L. var. *brevicornis* Barnes and *I. cosmia* Hook. f. Neotype has been designated for *I. acaulis* Arn. var. *acaulis* and *I. kleiniformis*. *Impatiens chinensis* L. var. *brevicornis* Barnes is reduced to a synonym under *I. chinensis*. *I. agumbeana* Bhaskar & Razi is synonymised under *I. barberi* Hook. f.

Widely distributed species show a wide range of morphological variations. Hence several entities have been described by different authors. After careful studies of the type specimens, *I. rupicola* Hook. f. and *I. nataliae* Hook. f. are synonymised under *I. oppositifolia* L. *I. trichocarpa* Hook. f. is synonymised under *I. rosea* Lindl.

Impatiens talbotii Hook. f. and *I. raziana* Bhaskar & Razi are reported from new localities other than the earlier reported areas thus expanding their geographical distribution. *Impatiens dendricola* C. E. C. Fisch., has been collected from the type locality after a lapse of three decades.

Most of the species overlap each other in their distribution while few are geographically isolated from each other. Of the 28 taxa occurring in the study area, 20 taxa are endemic to the Western Ghats, *Impatiens minor* (DC.) Bennet is endemic to Peninsular India, *I. acaulis* Arn. var. *acaulis, I. oppositifolia* L. and *I. vivekananthanii* sp. nov. are common to Western Ghats and Sri Lanka, *I. balsamina* L. var. *balsamina*, *I. chinensis* L. and *I. rosea* Lindl. are widely distributed species in India and neighbouring countries. *I. mysorensis* Heyne ex Roth occurs towards the western edge of the Deccan plateau. Fourteen taxa are exclusively endemic to the study area. Thirteen taxa extend its distribution from the study area to the southern Western Ghats. The phylogenetic tree constructed using *Hydrocera* as an outgroup shows distinct clades representing individual sections recognised by Hooker and Thomson (1859) and Warburg and Reiche (1895) with minor realignments.

The threat categories have been assigned following IUCN version 3.1. It was found that, 5 taxa are critically endangered, 12 are endangered, 4 are vulnerable and 7 taxa which are widely distributed are least concerned.

The present study forms a comprehensive taxonomic account of balsams of Northern and parts of Central Western Ghats.

REFERENCES

Ahmedullah, M. & M. P. Nayar. 1986. *Endemic plants of the Indian region.* Vol. 1. Botanical Survey of India, Howrah. pp. 190 – 194.

Akiyama, S. & H. Ohba. 2000. Inflorescences of the Himalayan species of *Impatiens* (Balsaminaceae). *J. Japanese Bot.* 75(4): 226 – 260.

Almeida, M. R. 1996. *Flora of Maharashtra.* Vol. 1. Orient Press, Mumbai. pp. 187 – 196.

Almeida, S. M. 1990. *Flora of Savantwadi.* Vol. 1. Scientific Publisher's, Jodhpur. pp. 76 – 78.

Arnott, G. A. W. 1835. New species of Indian Balsamineae. *Hook. Comp. Bot. Mag.* 1: 320 – 325.

Augustine, N., N. Sasidharan & M. Sivadasan. 1999. Balsams of Periyar Tiger Reserve. In: M. Sivadasan & P. Mathew (Eds) *Biodiversity, taxonomy and conservation of flowering plants.* Mentor books, Calicut, Kerala. pp. 275 – 292.

Barnes, E. 1939. The species of Geraniaceae occurring on the Travancore high range including the description of a new balsam. *J. Indian Bot. Soc.* 18(3): 95 – 105.

Beddome, R. H. 1868 - 1874. *Icones Plantarum Indiae Orientalis.* Grantz Brothers, Madras.

Beddome, R. H. 1858. The genus *Impatiens.* Description of new species from the Anamalai hills. *Madras J. Lit. Sci.* 4: 66-70.

Bennet, S. S. R. 1979. Nomenclature of two taxa of flowering plants. *Indian J. Forest.* 2(3): 283.

Bhaskar, V. & B. A. Razi. 1972-73. Studies on South Indian Balsaminaceae: 1. Chromosome numbers in some species of *Impatiens* L. *J. Mysore Uni.* Sec.- B. 25: 115 – 122.

Bhaskar, V. & B. A. Razi. 1973. A new kind of exine sculpturing in *Impatiens* L. (Balsaminaceae) from South India. *Curr. Sci.* 43(19): 626 – 628.

Bhaskar, V. & B. A. Razi. 1974. Nocturnal pollen germination in *Impatiens* (Balsaminaceae). *Curr. Sci.* 42(14): 510 – 512.

Bhaskar, V. & B. A. Razi. 1978a. Studies in South Indian *Impatiens* L. - General. *Indian J. Forest.* 1(1): 191 – 198.

Bhaskar, V. & B. A. Razi. 1978b. Studies on South Indian *Impatiens* L. - III Further notes. *Indian J. Forest.* 1(1): 68 – 78.

Bhaskar, V. & B. A. Razi. 1979. Studies on South Indian *Impatiens* L. - Palynology. *J. Palynol.* 15(1): 12 – 23.

Bhaskar, V. & B. A. Razi. 1982. Two more new species of *Impatiens* L. from South India. *J. Bombay Nat. Hist. Soc.* 79(2): 382 – 384.

Bhaskar, V. 1975. *Studies in Balsaminaceae.* Vol. 1 & 2. Thesis submitted to Post graduate Department of Botany, University of Mysore, Manasagangotri.

Bhaskar, V. 1976. Balsaminaceae in IOPB chromosome number reports LI. *Taxon* 25 (1): 155 – 156.

Bhaskar, V. 1980. Chromosomal drift in *Impatiens* L. (Balsaminaceae). *Cytologia* 45: 233 – 239.

Bhaskar, V. 1981. The genus *Impatiens* L. in south India: endemism and affinities. *Indian Forester* 107: 368-376.

Bhaskar, V. 1986. Floral freaks in *Impatiens* L. (Balsaminaceae). *Indian J. Forest.* 9(3): 276 – 278.

Bhaskar, V. 2006. *Impatiens clavata* Bhaskar sp. nov. - a new scapigerous balsam (Balsaminaceae)from Bisle ghat, Western Ghats, South India. *Curr. Sci.* 91(9): 1138 – 1140.

Bhaskar, V., B. A. Razi & S. N. Yoganarasimhan. 1975. A pollen variety of *Impatiens acaulis* Arn. (Balsaminaceae). *Curr. Sci.* 44(17): 622 – 623.

Bhat, K. G. 2003. *Flora of Udupi.* Indian Naturalist, Udupi, Karnataka. pp. 87 – 88.

Blatter, E. 1933. Revision of the Flora of the Bombay Presidency – Balsaminaceae. *J. Bombay Nat. Hist. Soc.* 36: 307 – 315.

Brummitt, R. K. & C. E. Powell. 1992. *Authors of plant names.* Royal Botanical Garden, Kew.

Candolle, A. P. D. 1824. *Prodromus systematis naturalis regni vegetabilis.* Vol. 1. Paris. pp. 685 – 688.

Champion, H. G. & S. K. Seth. 1968. A *revised survey of the forest types of India.* Delhi.

Chandrabose, M. 1978. A new species of *Impatiens* L., (Balsaminaceae) from South India. *J. Bombay Nat. Hist. Soc.* 75: 901-902.

Chandrabose, V., V. Chandrasekharan & N. C. Nair. 1979. A new species of *Impatiens* L., (Balsaminaceae) from South India. *J. Bombay Nat. Hist. Soc.* 81: 676-677.

Cheek, M. & E. Fischer. 1999. A tuberous and epiphytic new species of *Impatiens* (Balsaminaceae) from southwest Cameroon. *Kew Bull.* 54(2): 471 – 475.

Cheek, M. & L. Csiba. 2002. A new epiphytic species of *Impatiens* (Balsaminaceae) from Western Cameroon. *Kew Bull.* 57(3): 669 – 674.

Collet, H. & W. B. Hemsley. 1890. On a collection of plants from upper Burma and the Shan estates. *J. Linn. Soc. Bot.* 28: 40, t. 4.

Cooke, T. 1901. *The Flora of the Presidency of Bombay.* Vol 1. Tailor and Francis. London. pp. 169 – 175.

Dalzell, N. A. & A. Gibson. 1861. *The Bombay Flora.* Education Society's Press, Byculla, Maharashtra. pp. 42 – 44.

Daniels, R. J. R. & J. Vencatesan. 2008. *Western Ghats: Biodiversity, people , conservation.* Rupa Co. New Delhi.

Deshpande, S., B. D. Sharma & M. P. Nayar. 1993. *Flora of Mahabaleshwar and adjoinings, Maharashtra.* Vol. 1. Botanical Survey of India, Howrah. pp. 113 – 119.

Dessai, J. R. N. & M. K. Janarthanam. 2008. Taxonomy and distribution of *Impatiens talbotii* – a rare endemic balsam from Western Ghats. *J. Econ. Taxon. Bot.* 32(3): 624 – 627.

Fischer E. 2004. Balsaminaceae. In: K. Kubitzki (Ed.) *Families and genera of vascular plants.* Vol. 6. Berlin: Springer-Verlag. pp. 20–25.

Fischer, C. E. C. 1930. Decades Kewenses. Plantarum Novarum in Herbario Horti Regii Conservatarum. Decas CXXIV. Bull. *Misc. Inform. Kew.* 1930(4): 153 - 154.

Fischer, C. E. C. 1931. Decades Kewenses. Plantarum Novarum in Herbario Horti Regii Conservatarum. Decas CXXV. *Bull. Misc. Inform. Kew.* 1931 (1): 41 - 42.

Fischer, C. E. C. 1934. New or Little-Known Plants from South India: IV. *Bull. Misc. Inform. Kew.* 1934(9): 389 - 394.

Fischer, C. E. C. 1935. New or little known plants from South India: VI. *Bull. Misc. Inform. Kew.* 1935(3): 157.

Fischer, C. E. C. 1936. *Flora of the presidency of Madras.* Vol. 3. West Newman & Co., Adlard & Son, London. pp. 1868 – 1871.

Fischer, C. E. C. 1938. New or little known plants from South India: VIII. *Bull. Misc. Inform. Kew.* 1938(1): 32 - 34.

Fischer, E. & M. E. Rahelivololona. 2002. New taxa of *Impatiens* (Balsaminaceae) from Madagascar. I. *Adansonia* 24(2): 271 – 294.

Fischer, E. & M. E. Rahelivololona. 2004a. New taxa of *Impatiens* (Balsaminaceae) from Madagascar. III. *Adansonia* 26(1): 37 – 52.

Fischer, E. & M. E. Rahelivololona. 2004b. A new epiphytic species of *Impatiens* (Balsaminaceae) from Comoro Islands. *Adansonia* 26(1): 93 – 95.

Fischer, E., S. Wohlhauser & M. E. Rahelivololona. 2003. New taxa of *Impatiens* (Balsaminaceae) from Madagascar. II. A collection from Masoala Peninsula. *Adansonia* 25(1): 17 – 31.

Frimodt-Moller, C. & C. Grey-Wilson.1999. Two new taxa of *Impatiens* Balsaminaceae) from the Udzungwa mountains, Tanzania. *Kew Bull.* 54(1): 179 – 184.

Fujihashi, H., S. Akiyama & H. Ohba. 2002. Origin and relationships of the Sino-Himalayan *Impatiens* (Balsaminaceae) based on molecular phylogenetic analysis, chromosome numbers and gross morphology. *J. Japanese Bot.*77: 284 – 295.

Fyson, F. Y. 1932. *The Flora of South Indian hill stations.* Vol. 1 & 2. Today and Tommorrow Printers Publication, New Delhi. pp. 78 – 97 (Vol. 1), 54 – 76 (Vol. 2).

Gamble, J. S. 1915. *Flora of the presidency of Madras.* Vol. 1. West Newman & Co., Adlard & Son, London. pp. 134 – 145.

Grey-Wilson, C. 1979. A new species of Impatiens (Balsaminaceae) from Hong Kong. *Kew Bull.* 33(4): 551 – 553.

Grey-Wilson, C. 1980a. *Impatiens of Africa.* A. A. Balkema, Rotterdam.

Grey-Wilson, C. 1980b. *Impatiens* in Papuasia: Studies in Balsaminaceae: I. *Kew Bull.* 34(4): 661 – 688.

Grey-Wilson, C. 1985. *Balsaminaceae.* In: Dassanayake, M. D. and F. R. Fosberg (Eds), *A revised handbook to the flora of Ceylon.* Vol. 5. Oxford & IBH Publishing Co., New Delhi, India. pp. 76-120

Hooker, J. D. 1874. *Balsamineae.* In *Flora of British India*, Vol. 1. London. pp. 440 – 483.

Hooker, J. D. 1904. An epitome of the British Indian species of *Impatiens*. *Rec. Bot. Surv. India* 4(1): 1 – 10.

Hooker, J. D. 1905. An epitome of the British Indian species of *Impatiens*. *Rec. Bot. Surv. India* 4(2): 11 – 35.

Hooker, J. D. 1906. An epitome of the British Indian species of *Impatiens*. *Rec. Bot. Surv. India* 4(3): 37 – 58.

Hooker, J. D. 1910a. Indian species of *Impatiens*. *Generis Impatiens species Indicae novae et minus rite cognitae a cl. A. Meebold detectae. Bull. Misc. Inform. Kew.* 1910: 291 – 300.

Hooker, J. D. 1910b. *Impatiens cosmia*. In: Hooker's *Icones Plantarum*, t. 2915. 4th series 10(1). London.

Hooker, J. D. 1910c. *Impatiens crassicornu*. In: Hooker's I*cones Plantarum*, t. 2916. 4th series 10(1). London.

Hooker, J. D. 1910d. *Impatiens trichocarpa*. In: Hooker's I*cones Plantarum*, t. 2914. 4th series 10(1). London.

Hooker, J. D. 1911. Indian species of *Impatiens*. On some Western Peninsular Indian Balsamineae collected by Mr. A. Meebold. *Bull. Misc. Inform. Kew.* 1911(9): 353 – 356.

Hooker, W. J. 1824. *Impatiens setacea*. In: Hooker's *Exotic Flora*, 2, t. 137.

Hooker, W. J. 1852. *Impatiens fasciculata*. In: *Curtis Botanical Magazine*, 8, t. 4631. London.

Hooker. J. D. & T. Thomson. 1859. Praecursores ad Floram Indicam – Balsamineae. *J. Proc. Linn. Soc. Bot.* 4: 106 – 157.

IUCN. 2001. *IUCN Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge.

Jain, S. K. & R. R. Rao. 1976. *A handbook of field and herbarium methods*. Today & Tomorrow's Printers and Publishers, New Delhi.

Janssens, S. B., E. B. Knox, S. Dessein & E. Smets. 2009a. *Impatiens msisimwanensis* (Balsaminaceae): description, pollen morphology and phylogenetic position of a new east African species. *S. African J. Bot.* 75: 104 – 109.

Janssens, S. B., E. B. Knox, S. Huysmans. E. F. Smets & V. S. F. T. Merkx. 2009b. Rapid radiation of *Impatiens* (Balsaminaceae) during Pliocene and Pleistocene: result of a global climate change. *Molec. Phylogen. Evol.* 52: 806 – 824.

Janssens, S., F. Lens, S. Dressler, K. Geuten, E. Smets & S. Vinckier. 2005. Palynological variation in Balsaminoid Ericales. II. Balsaminaceae, Tetramerstaceae, Pellicieraceae and general conclusions. *Ann. Bot.* 96: 1061 – 1073.

Janssens, S., K. Geuten, Y. M. Yuan, Y. Song, P. Küpfer and E. Smets. 2006. Phylogenetics of *Impatiens* and *Hydrocera* (Balsaminaceae) using Chloroplast *atpB-rbcL* spacer sequences. *Syst. Bot.* 31: 171-180.

Kamath, S. U. 1982. *Karnataka State Gazetteer*. Part 1. Bangalore.

Karthikeyan, S. 1996. Northern Western Ghats and Northern West coast. In: P. K. Hajra, B. D. Sharma, M. Sanjappa & A. R. K. Sastry (Eds) *Flora of India – Introductory volume* (Part 1). Botanical Survey of India, Howrah. pp. 375 – 391.

Keshava Murthy, K. R. & S. N. Yoganarsimhan. 1990. *Flora of Coorg (Kodagu), Karnataka – India.* Vimsat Publishers, Bangalore. pp. 86 – 88.

Khoshoo, T. N. 1956. Chromosomes from herbarium sheets of *Impatiens*. *Stain Technol.* 31(1): 31 – 33.

Kothari, M. J. & S. Moorthy. 1993. *Flora of Raigad district.* Botanical Survey of India, Howrah. pp. 45 – 48.

Krishnamurthy, K. V. 1988. *Methods in plant histochemistry.* S. Viswanathan (Printers & Publishers) Private Limited.

Krishnaswamy, S., S. Muthulingam and V. S. Raman. 1969. Cyto-morphological studies in the genera *Impatiens*, *Lupinus*, *Viola* and *Antirrhinum*. *South Indian Hort.* 17(1 & 2): 28 – 33.

Kumar, M. & S. Sequeira. 1996. *Impatiens sivarajanii* – A new species from Silent Valley National Park, Kerala, India. *Rheedea* 6(2): 51-54.

Kumar, M. & S. Sequeira. 2001. Two new species of *Impatiens* (Balsaminaceae) from India. *Sida* 19(4): 795 – 801.

Lakshminarasimhan, P. & B. D. Sharma. 1991. *Flora of Nasik district.* Botanical Survey of India, Howrah. pp. 112 – 114.

Lamarck, J.B.A.P.de M. 1785. *Encyclopedie methodique: botanique.* Vol. 1. Paris. pp. 363.

Lawrence, G. H. M., A. F. G. Buchheim, G. S. Daniels & H. Dolezal. 1968. *Botanico Periodicum Huntianum*. Hunt Botanical Library.

Lindley, J. 1841. *Impatiens rosea*. In Edward's *Botanical Register*. Vol. 4. t. 27.

Linnaeus, C. 1753. *Species Plantarum*. Vol. 2. Stockholm. pp. 937 – 938.

Manilal, K. S. 1988. *Flora of Silent Valley tropical rain forests of India.* The Mathrubhumi Press, Calicut, Kerala. pp. 39 – 42.

McNeill, J., F. R. Barrie, H. M. Burdet, V. Demoulin, D. L. Hawksworth, K. Marhold, D. H. Nicolson, J. Prado, P. C. Silva, J. E. Skog, J. H. Wiersema, N. J. Turland. 2006. *Internatinal Code of Botanical Nomenclature* (Vienna Code) – Electronic version.

Mittermeier, R. A., P. R. Gil, J. Pilgrim, T. Brooks, C. G. Mittermeier, J. Lamoreux & G. A. B. D. Fonseca. 2005. *Hotspots revisited: Earth's biologically richest and most threatened terrestrial ecoregions*. Conservation International, USA.

Mohanan, M. & A. N. Henry. 1994. *Flora of Thiruvananthapuram Kerala.* Botanical Survey of India, Howrah. pp. 96 – 100.

Morgan, R. J. 2007. *Impatiens – the vibrant World of busy lizzies, balsams and touch-me-nots*. Timber Press, Portland, USA.

Mudaliar, S. K. & V. P. Prasad. 2000. Balsaminaceae. In: N. P. Singh & S. Karthikeyan (Eds) *Flora of Maharashtra state – Dicotyledones*. Vol. 1. Botanical Survey of India, Howrah. pp. 444 – 463.

Murthy, G. V. S., P. Venu & M. Sanjappa. 1996. Physiography. In: P. K. Hajra, B. D. Sharma, M. Sanjappa & A. R. K. Sastry (Eds) *Flora of India – Introductory volume* (Part 1). Botanical Survey of India, Howrah. pp. 1 – 15.

Nair, N. C. & P. Daniel. 1986. The floristic diversity of the Western Ghats and its conservation: a review. *Proc. Indian Acad. Sci. (Animal/Plant Sci.) Suppl.* 127 – 163.

Nair, N. C. 1991. Endemism on the Western Ghats with special reference to *Impatiens* L. Proc. of the symposium on rare, endangered and endemic plants of the Western Ghats, Kerala Forest Dept. (Wildlife wing) Publ. No: III. 93 – 102.

Nayar, M. P. 1996. *Hot spots of endemic plants of India, Nepal and Bhutan*. Tropical Botanical Garden and Research Institute, Thiruvananthapuram.

Nayar, T. S., A. Rasiya Beegam, N. Mohanan & G. Rajkumar. 2006. *Flowering plants of Kerala*. Tropical Botanic Garden and Research Institute, Thiruvananthapuram. pp. 131 – 141.

Pandurangan, A. G. & V. J. Nair. 1995. *Impatiens kulamavuensis*, a new species of Balsaminaceae from India. *Novon* 5(1): 57 – 58.

Pandurangan, A. G. & V. J. Nair. 1996. Three rare and threatened *Impatiens* L. (Balsaminaceae) of Kerala, India. *J. Econ. Taxon. Bot.* 20(3): 699 – 702.

Pascal, J. P. 1988. Wet *evergreen forests of the Western Ghats of India*. Institut Francais de Pondicherry.

Perveen A. & M. Qaiser. 2001. Pollen Flora of Pakistan - XXVI. Balsaminaceae. *Turk. J. Bot.* 25: 35 – 38.

Polunin, O. & A. Stainton. 1984. *Flowers of the Himalayas*. Oxford Universtiy Press.

Ramachandran, V. S. & V. J. Nair. 1988. *Flora of Cannanore*. Botanical Survey of India, Howrah. pp. 77 – 80.

Ramamoorthy, T. P. 1978. Balsaminaceae. In: C. J. Saldanha & D. H. Nicolson (Eds) *Flora of Hassan District, Karnataka*. Amerind Publishers, New Delhi. pp. 399 – 404.

Ramamurthy, K. 1988. *Impatiens neo-barnesii* Fisch. and *Impatiens nilgirica* Fisch. In: M. P. Nayar & A. R. K. Sastry (Eds) *Red Data Book of Indian Plants*. Vol. 2. Botanical Survey of India, Howrah.

Ramaswamy, S. N., M. R. Rao & D. A. Givindappa. 2001. *Flora of Shimoga District.* University Printing Press, Manasagangothri, Mysore, Karnataka. pp. 106 – 110.

Rao, R. V. S. 1972. Cytological studies in South Indian Balsaminaceae. *Proceedings of 59th Indian Science Congress*, Part 3: 356-357.

Rao, R. V. S. 1973a. Karyotype analysis in the varieties of *Impatiens balsamina* L. *Proceedings of 60th Indian Science Congress*, Part 3: 316.

Rao, R. V. S. 1973b. Further studies on the cytology of the South Indian Balsaminaceae. *Proceedings of 60th Indian Science Congress*, Part 3: 317.

Rao, R. V. S. 1975. On the chromosome counts from the pollen grains of *Impatiens. Proceedings of 62nd Indian Science Congress*, Part 3: 120.

Rao, R. V. S. 1978. New basic chromosome number of three in the genus *Impatiens. Journal of Indian Botanical Society,* 1st Botanical Conference, 57, Supplement: 77-78.

Rao, R. V. S., K. R. Ayyangar & R. Sampathkumar. 1986. On the karyological characteristics of some members of Balsaminaceae. *Cytologia* 51: 251 – 260.

Rao, R. R. and B. A. Razi, 1981. *A synoptic Flora of Mysore district.* Today and Tomarrow's Printers & Publisher's, New Delhi. pp. 484 – 485.

Rao, R. S. 1985. *Flora of Goa, Diu, Dadra and Nagarhaveli.* Vol. 1. Botanical Survey of India, Howrah. pp. 58 – 60.

Ravikumar, K., S. B. Subramani, P. S. Udayan & M. Karnat. 2000. Notes on a few rare and endemic plants from the Western ghats of Coorg district, Karnataka, India. *J. Econ. Taxon. Bot.* 24(2): 334 – 338.

Roth, A. G. 1821. *Novae Plantarum Species Praesertim Indiae Orientalis.* Halberstadii. pp. 164.

Roxburg, W. 1824. *Flora Indica.* Vol. 2. William Carey Ed. Serampore. pp. 452 – 465.

Saldanha, C. J. 1996. *Flora of Karnataka.* Vol. 2. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi. pp. 247 – 259.

Santapau, H. 1948. Novitates Bombayenses. *Kew Bull.* 3(3): 489.

Santapau, H. 1967. The flora of Khandala on the Western Ghats of India. 3rd Ed. *Rec. Bot. Surv. India* 16(1): 30 – 31.

Sasidharan, N. 2004. *Biodiversity Documentation for Kerala, Part VI : Flowering Plants.* Kerala Forest Research Institute, Peechi.

Sedgwick, L. J. 1919. A new Indian *Impatiens. Rec. Bot. Surv. India* 6: 351.

Shah, G. L. 1978. *Flora of Gujarat state*. Vol. 1. Sardar Patel University Press, Vallabh Vidhyanagar. pp. 142 – 143.

Sharma, B. D., N. P. Singh & R. S. Raghavan. 1984. Flora of Karnataka analysis. Botanical Survey of India, Howrah. pp. 36 – 39.

Shimizu, T. & N. Utami. 1997. Three new species of *Impatiens* (Balsaminaceae) added to Flora Malesiana. *Kew Bull.* 52(2): 435 – 442.

Singh, N. P. & B. G. Kulkarni. 1990. *Impatiens talbotii* Hook. f. In: M. P. Nayar & A. R. K. Sastry (Eds) *Red Data Book of Indian Plants*. Vol. 3. Botanical Survey of India, Howrah.

Song, Y., Y-M. Yuan & P. Küpfer. 2003. Chromosomal evolution in Balsaminaceae, with cytological observations on 45 species from Southeast Asia. *Caryologia* 56(4): 463 – 481.

Song, Y., Y-M. Yuan & P. Küpfer. 2005. Seedcoat micromorphology of Impatiens (Balsaminaceae) from China. *Bot. J. Linn. Soc.* 149(2): 195 – 208.

Subramanyam, K. & M. P. Nair, 1974. Vegetation and phytogeography of the Western Ghats. In M. S. Mani (Ed.) *Ecology and Biogeography of India*. pp. 178 – 196.

Swofford, D. L. 2003. *PAUP* Phylogenetic Analysis Using Parsimony (*and other methods), version 4.0 b10*. Sinauer Associates, Sunderland, Massachusetts.

Tailor, R. H., D. P. Acland, S. Attenborough, B. P. A. Cammue, I. J. Evans, R. W. Osborn, J. A. Ray, S. B. Rees & W. F. Broekaert. 1997. A novel family of small cysteine-rich antimicrobial peptides from seed of *Impatiens balsamina* is derived from a single precursor protein. *J. Biol. Chem.* 272(39): 24480 – 24487.

Turill, W. D. 1964. Plant *taxonomy, phytogeography and plant ecology*. In Vistas in Botany. Vol. 4. Pergamon Press, London.

Utami, N. & T. Shimizu. 2005. Seed morphology and classification of *Impatiens* (Balsaminaceae). *Blumea* 50: 447–456.

Vajravelu, E. & K. Vivekananthan. 1996. Southern Western Ghats – South of Goa. In: P. K. Hajra, B. D. Sharma, M. Sanjappa & A. R. K. Sastry (Eds) *Flora of India – Introductory volume* (Part 1). Botanical Survey of India, Howrah. pp. 391 – 450.

Vajravelu, E. 1983. Balsaminaceae. In: N. C. Nair & A. N. Henry (Eds) *Flora of Tamil Nadu, India*. Vol. 1. Botanical Survey of India, Coimbatore. pp. 53 – 57.

Vajravelu, E. 1990. *Flora of Palghat district*. Botanical Survey of India, Howrah. pp. 99 – 101.

Van Rheede, H. A. 1689. *Hortus Malabaricus*. Vol. 9. Amsterdam.

Viswanathan, M. B. & U. Manikandan. 2003. A new species of Balsaminaceae, *Impatiens tirunelvelica*, from Peninsular India. *Bull. Bot. Surv. India* 45(1-4): 189-194.

Vivekananthan, K. & C. P. Malathi. 1990. *Impatiens johnii* Barnes. In: M. P. Nayar & A. R. K. Sastry (Eds) *Red Data Book of Indian Plants*. Vol. 3. Botanical Survey of India, Howrah.

Vivekananthan, K. 1990. *Impatiens anaimudica* Fisch., *Impatiens macrocarpa* Barnes and *Impatiens pandata* Barnes. In: M. P. Nayar & A. R. K. Sastry (Eds) *Red Data Book of Indian Plants*. Vol. 3. Botanical Survey of India, Howrah.

Vivekananthan, K., N. C. Rathakrishnan, M. S. Swaminathan & L. K. Ghara.1997. *Balsaminaceae*. In: P. K. Hajra, V. J. Nair & P. Daniel (Eds) *Flora of India*. Vol. 4. Botanical Survey of India, Howrah. pp. 95 – 229.

Warburg, O. & K. Reiche. 1895. Balsaminaceae. In: A. Engler & K. Prantl (Eds) *Die natürlichen Pflanzenfamilien* 3, 5: 383 - 392. Engelmann, Leipzig.

Wight, R. 1837. On the genus *Impatiens*. *Madras J. Lit. Sci.* 1, 5: 1 – 15.

Wight, R. 1844. *Icones plantarum Indiae Orientalis*. Madras.

Wight, R. 1845. *Icones plantarum Indiae Orientalis*. Madras.

Wight, R. 1846. *Icones plantarum Indiae Orientalis*. Madras.

Wight, R. & G. A. Walker-Arnott. 1834. *Prodromus florae Peninsulae Indiae Orientalis*. Parbury Allen & Co. London. pp. 134 – 140.

Yadav, S. R. & M. M. Sardesai. *Flora of Kolhapur District*. Shivaji University, Kolhapur, Maharashtra. pp. 93 – 96.

Yi-ling, C., S. Akiyama & H. Ohba. 2007. Balsaminaceae. In: W. Zhengyi, P. H. Raven & H. Deyuan (Eds), *Flora of China*. Vol. 12. Missouri Botanical Garden Press. pp. 43 – 114.

Yoganarasimhan, S. N., K. Subramanyam & B. A. Razi. 1982. *Flora of Chikmagalur District, Karnataka, India*. International Book Distributor, Dehra Dun. pp. 58 – 63.

Yuan Y-M., Y. Song, K. Geuten, E. Rahelivololona, S. Wohlhauser, E. Fischer, E. Smets & P. Küpfer. 2004. Phylogeny and biogeography of Balsaminaceae inferred from ITS sequences. *Taxon* 53(2): 391 – 403.

Zinov'eva-Stahevitch, A. E. & W. F. Grant. 1982. In IOPB chromosome number reports LXXIV. *Taxon* 31: 365 – 366.

Zinov'eva-Stahevitch, A. E. & W. F. Grant. 1984. Chromosome numbers in *Impatiens* L. (Balsaminaceae). *Canad. J. Bot.* 6: 2630 – 2635.

Zinov'eva-Stahevitch, A. E. & W. F. Grant. 1985. Aberrant microsporogenesis in *Impatiens* L. (Balsaminaceae) and its bearing on the taxonomy of the genus. *Cytologia* 50: 825 – 826.

PUBLICATIONS

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Dessai, J. R. N. & M. K. Janarthanam. 2008. Taxonomy and distribution of *Impatiens talbotii* – a rare endemic balsam from Western Ghats. *J. Econ. Taxon. Bot.* 32(3): 624 – 627.

Dessai, J. R. N., L. Joseph & M. K. Janarthanam. 2009. A new species of epiphytic *Impatiens* (Balsaminaceae) from the Western Ghats, India. *Taiwania* 54(2): 149 – 151.

Dessai, J. R. N. & M. K. Janarthanam. 2009. *Impatiens raziana* (Balsaminaceae): a poorly known endemic species of Western Ghats and its extended distribution. *Indian J. Forest.* 32(2): 313 – 315.

PHYTOTAXONOMY
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Impatiens mysorensis Heyne *ex* Roth (Balsaminaceae), a little known endemic from Karnataka

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Intensive systematic studies conducted in Chitradurga district, Karnataka since 2004 recorded occurrence of many endemic and noteworthy species in these dry hills. The paper deals with one such narrow endemic, *Impatiens mysorensis* Heyne *ex* Roth. A detailed description, illustration, population, ecology and threats are elucidated.

Keywords: *Impatiens mysorensis*, narrow endemic, population, conservation

Introduction

Impatiens L. is represented by about 900 species distributed throughout the wet and subtropical regions of Asia, Africa and a few in temperate regions of Asia, Europe and North America; 204 species occur in India, of which 148 are endemic to Indian region (Vivekananthan *et al.* 1997). *Impatiens mysorensis* Heyne *ex* Roth is one such narrow endemic species known to occur only in Karnataka state. There are no specimens of this species in any of the major herbaria of the country; it is represented by only two collections made in 1974 from Chitradurga fort. Hence, special efforts were made in relocating the species and study its population.

Impatiens mysorensis was first collected by Heyne in 1801 from "Mysore" without mentioning specific locality. These specimens remained unpublished till Roth validated it in *Novae Plantarum Species Praesertim Indiae Orientalis*, in 1821. Saldanha (1996) in flora of Karnataka, has mentioned the location as southern Western Ghats based on the two herbarium sheets available at Kew: one from Chitradurga fort and the other from Nandi Hills, Kolar district. Rao (1981) did not mention this species in flora of Mysore district, whereas Vivekananthan *et al.* (1997) included it based on earlier literature. Later, Bhaskar (1978) reported it from Chitradurga and these collections are available at Mysore University herbarium (MGM). These are the only collections available in Indian herbaria, until it was relocated by us. It was presumed that the species was lost in Chitradurga district due to regular weeding out process given to the fort walls by the fort authority in order to keep the walls clean. Hence, the species has been assigned 'endangered' status by Nayar (1996) and the locality Chitradurga was missed out in the distribution data published by him. Further, a thorough literature screening revealed the fact that for this species, neither a detailed description nor a complete illustration is available till date. Therefore, a detailed description, illustration, population, ecology and threats are elucidated in this article.

Impatiens mysorensis Heyne *ex* Roth, Nov. Plant. Sp. 164. 1821; Wight & Arn. Prodr. 137. 1834; Hook.f., Fl. Brit. India 1. 456. 1874 & in Rec. Bot. Surv. India 4: 42 & 47. 1906; Gamble, Fl. Pres. Madras 142. 1915; Saldanha in Saldanha, Fl. Karnataka 2: 255. 1996; Vivekananthan *et al.* in Hajra *et al.* (eds.) Fl. India. 4: 184. 1997. *Balsamina mysorensis* DC., Prodr. 1: 686. 1824.

Erect herbs, up to 75 cm high with fibrous roots. Stems diffusely branched; branches alternate, obtusely 4-angled, up to 2 cm thick, sub-succulent, sparsely minutely hairy below, densely minutely hairy above; nodes swollen. Leaves (0.7) 2.8-6 x 0.4-2.8 cm, alternate, elliptic or linear-oblong to ovate, subcoriaceous, base acute to attenuate, apex acute to acuminate, margins distantly serrate; serrations apiculate, basal leaves sessile, upper leaves petiolate; petioles up to 1 cm long, hairy beneath; glands one pair or 0; lateral veins distinct and hairy beneath, up to 5 pairs. Flowers axillary, solitary to a cluster of 6, up to 7 mm across, pink, lilac or white with reddish tinge; bracts minute, scaly, linear to subulate, *c.* 1 x 0.5 mm, light green, sparsely minutely hairy at base dorsally; pedicels up to 1 cm long, deflexed in fruits, dilated, pink to green, dorsally with a longitudinal row of hairs. Lateral sepals 2, ovate, slightly concave, *c.* 0.75 x 0.5 mm, acute at apex, minutely hairy above. Standard broadly ovate, *c.* 5 x 4 mm, glabrous, deeply concave, white within, pink without, apex cordate, dorsally keeled; keel lacerated, apex mucronate; mucro *c.* 1 mm long, curved, green. Wing petals 2, bilobed, *c.* 9 x 4 mm, pink to white with white throat, elevated above, elevation with yellow or red streaks, stipitate; stipe up to 4 mm long with pinkish red veins; basal lobes ovate, up to 1.5 x 1 mm, acute, apex apiculate or obtuse; distal lobes asymmetrically ovate, *c.* 5 x 4 mm, apex obtuse. Lip saccate, up to 6 x 3 mm, pink, veins minutely hairy, spurred; spur *c.* 2.5 x 0.5 mm, cylindrical, hairy, rarely glabrous, tip rounded or bulged, densely hairy, green or yellow. Column *c.* 3 mm long, bent on one side; anthers 5, *c.* 1 x 1 mm, light pink, connate above ovary; filaments 5, up to 2.5 mm long, light pink, base free and narrow, apex connate and broad. Ovary elliptic-oblong, *c.* 1.5 x 0.5 mm, glabrous to minutely hairy; stigma 5-toothed; style absent. Capsules asymmetric, lanceolate, rarely elliptic, 8-11 x 3-5 mm, ridged, puberulous, beaked; pedicels up to 2 cm long. Seeds 3-7, *c.* 1.5 mm across, brown, globose, muricate.

Specimens examined: Karnataka: Chitradurga District: Chitradurga fort, Chitradurga Taluk, *Prasantha Kumar 102*, 08.10.1974, (MGM); *l. c.*, *Bhaskar 419*, 12.10.1974, (MGM); Devaragudda State Forest, Hosadurga Taluk, *Ravikumar & Ganesh Babu 101104*, 25.10.2005, 1100 m, (FRLH); Chitradurga Fort, Chitradurga Taluk, *Ganesh Babu 103669*, 12.08.2006, 1015 m, (FRLH); *l. c.*, *Ganesh Babu 103670*, 12.08.2006, 980 m, (FRLH); *l. c.*, *Ganesh Babu 103671*, 13.08.2006, 908 m, (FRLH); *l. c.*, *Ganesh Babu 103676*, 13.08.2006, 870 m, (FRLH); Janakal Sate Forest, Hosadurga Taluk, *Ganesh Babu 103660*, 15.08.2006, 748 m (FRLH); *l. c Ganesh Babu 103694*, 15.08.2006, 838 m, (FRLH); Devaragudda State Forest, Hosadurga Taluk, *Ganesh Babu 103748*, 19.08.2006, 800 m, (FRLH).

Flowers & Fruits: August - October

Vernacular name: *Chikka Basavanapatha* (Kannada).

Local use: The local people around Chitradurga Fort, apply the plant juice on fresh cuts and wounds.

Population & Ecology

During the explorations, *I. mysorensis* was collected from four different localities in Chitradurga district, namely, Devaragudda, Janakal and Ghatti Hosahalli of Hosadurga Taluk and Chitradurga Fort in Chitradurga Taluk. Population status, ecology and threats observed in these localities are discussed below.

Impatiens mysorensis was collected near Rangaswamy temple at Devaragudda State Forest on 25.10.2005 at an altitude of 1100 m. About 250 individuals represented the population size. These plants were growing only in the crevices of man made wall around the temple premises. These plants were stout, profusely branched, up to 60 cm tall. The individuals were found growing in association with *Crotalaria fulva* Roxb., *C. hirta* Willd., *C. mysorensis* Roth, *Hemigraphis latebrosa* (Heyne *ex* Roth) Nees, *Indigofera colutea* (N. Burm.) Merrill., *Oldenlandia herbacea* (L.) Roxb. and *Rhynchosia hirta* (Andrews) Meikle & Verdc. A thorough

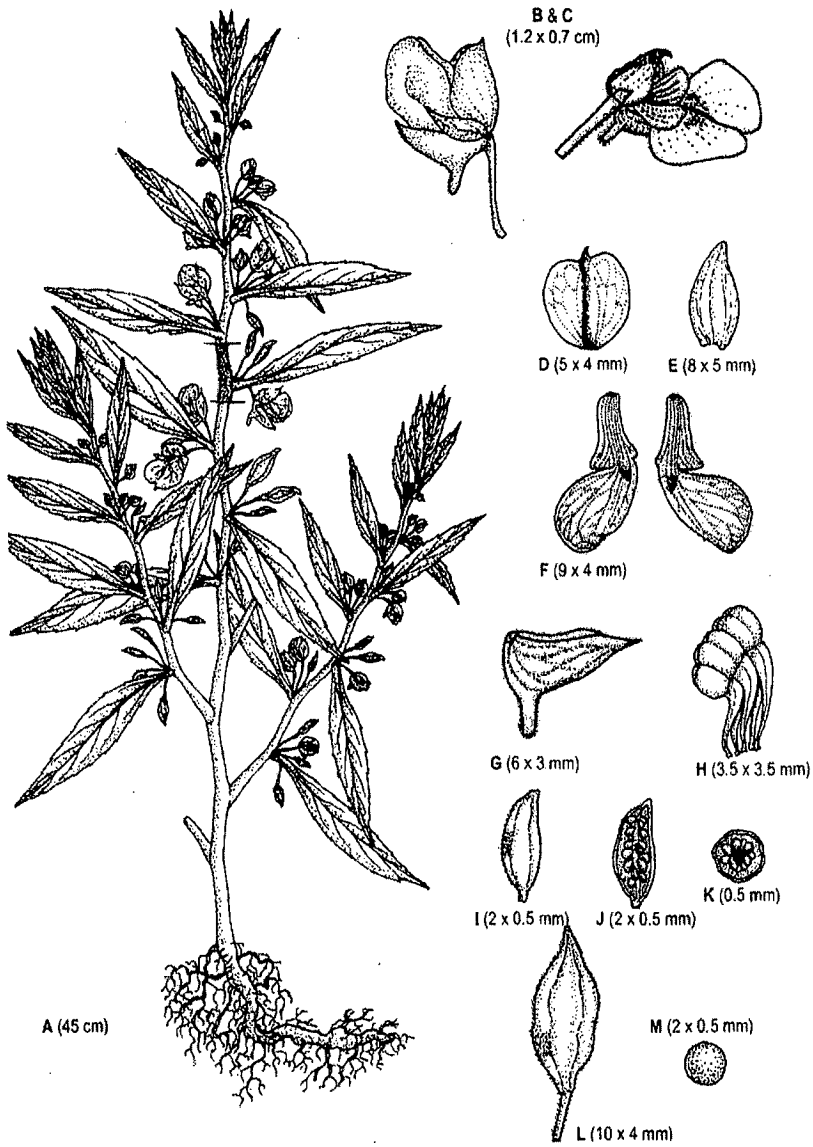

Fig.1. **A** – habit, **B** & **C** - flower, **D** – standard, **E**- lateral sepal, **F** – wing petals, **G** – lip, **H** - androecium, **I** – pistil, **J** - L. S. of the capsule, **K** – C. S. of the capsule, **L** - capsule, **M**- seed,

Plate.1 : a – habit, b-d- flower & fruit, e- habitat, f- grazing, g-quarrying

perambulation to the same area undertaken again on 19.08.2006, resulted in location of another population of around 200 individuals at 800 m, growing under the shade of tree species such as *Boswellia serrata* Roxb. *ex* Colebr., *Cochlospermum religiosum* (L.) Alston, and *Ixora pavetta* Andrews. Other herbaceous species associated were *Buchnera hispida* Buch.-Ham., *Zingiber montanum* (Koen.) Link *ex* Dietr., *Chlorophytum* sp., *Crinum asiaticum* L., *Cymbopogon flexuosus* (Nees *ex* Steud.) Wats., *Habenaria longicorniculata* Grah., and *Rothia indica* (L.) Druce.

At Chitradurga fort, all the fort walls have been cleared off vegetation by the Archeological Survey of India as part of maintenance. However, careful and keen observation has resulted in locating a total of around 990 individuals just above the Gopalswamy Honda to Rana Battery (14° 12' 29.40"-14° 12' 36.36" N; 76° 23' 36.00"- 76° 23'36.06" E; 870 - 1015 m). A population of 163 individuals of slender habit with light pink to deep pink flowers and light green pedicels was observed at 870 m. Floral visitors such as ants, flies, bees have also been recorded. At 904 m, nearly 100 plants were observed. These plants were found growing in complete shade and showed a wide range of variations with regard to stem, leaves and flower. At an altitude of 965 m, 30 individuals were growing on a thin layer of soil deposits over a huge open barren rock. Here the plants were *c.* 50 cm high, diffusely branched; flowers were white along with a few pale pink flowers. The plant associates in this area were: *Ageratum conyzoides* L., *Anisochilus carnosus* (L.f.) Wall., *Bidens pilosa* L., *Brachiaria* spp., *Kalanchoe* sp., *Chamaecrista kleinii* (Wight & Arn.) Singh, *Ceratopteris thalictroides* (L.) Brong., *Cleome monophylla* L., *Commelina* sp., *Corchorus* sp. *Cyanotis* sp., *Cyanotis tuberosa* (Roxb.) Schultes & Schultes f., *Cyperus* sp., *Henckelia incana* (Vahl.) Spreng., *Eragrostiella* sp., *Habenaria longicorniculata* Grah., *Oldenlandia corymbosa* L., *Indigofera colutea* (N. Burm.) Merrill., *Leucas indica* (L.) R. Br. *ex* Vatke, *Panicum* sp., *Phyllanthus reticulatus* Poir., *Polygala elongata* Klein. *ex* Willd., *Persicaria glabra* (Willd.) M. Gomez , *Vernonia albicans* DC., *Vernonia cinerea* (L.) Less. and *Vigna* sp.

Janakal is a pilgrim site situated in Hosadurga Taluk where the main deity is Haalu Rameshwara. At the backdrop of this temple, Janakal State forests range-boundary starts by huge barren hillock with seasonal streamlet at the base. During a botanical exploration on 15.08.2006, a population of more than 700 individuals was noted just a hundred metres above the streamlet (13° 52' 24.36"N; 76° 17' 18.48" E, 748 m). Individual plants were fresh and healthy. Another exploration was made on 09.09.2006 to study the population and ecological changes. During this time, only 356 individuals were counted. Associated plants noted in this locality were *Anisochilus eriocephalus* Benth., *Cleome aspera* Koen. *ex* DC., *Dioscorea oppositifolia* L., *Drosera burmannii* Vahl, *Eragrostiella bifaria* (Vahl) Bor, *Hemionitis arifolia* (Burm.) T. Moore, *Kalanchoe floribunda* Wight & Arn., *Leucas indica* (L.) R. Br. *ex* Vatke, *Murdannia nudiflora* (L.) Brenan and *Oldenlandia* sp.

Another healthy population was noted on the isolated, low-level hilllock near Ghatti Hosahalli village (13° 57' 43.08" N; 76° 17'41.58" E; 838 m ASL). A total of 364 individuals were found growing in between the rock crevices along with *Anisochilus carnosus* (L.f.) Wall., *Commelina benghalensis* L., *Crotalaria linifolia* L.f., *Cymbopogon felxuosus* (Nees *ex* Steud.) Wats., *Cynotis* sp., *Oldenlandia herbacea* (L.) Roxb., *Phyllanthus kozhikodianus* Manilal & Sivadasan and *Vernonia albicans* DC.

Threats

Human interference was more near Gopalswamy Honda of Chitradurga fort at an altitude of 870 m. Major threats at this altitude were grazing, weeding, cutting fodder grass and intentional fire. There was no external threat observed and human interference was also less above 982 m but the conditions were inhospitable for the growth of this species. Excessive grazing observed at Janakal State forest poses a major threat.

Progressive quarrying was noticed at Ghatti Hosahalli of Hosadurga Taluk. As these plants were growing very close to the quarry area, it would be highly impossible for the species to escape from this major threat in near future. Devaragudda, another locality, is a popular pilgrim centre where hundreds of devotees visit everyday. It was witnessed that in order to keep this area clean, devotees set fire periodically. Grazing was another common threat in this locality.

Conservation

Seeds and a few seedlings were carefully collected and are grown in Ethno-Medicinal Garden, Foundation for Revitalisation of Local Health Traditions (FRLHT); Gandhi Krishi Vignyan Kendra, Bangalore, Karnataka and Gurukula Botanical Sanctuary, Wyanad, Kerala for developing germination protocol and multiplication strategy towards conserving this narrow endemic species. In Chitradurga, the areas wherever this species was cited, local people have been sensitized to save this from the existing threats.

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References

Bhaskar, V. 1978. Studies on South Indian *Impatiens* L. - III, Further notes. *Indian J. For.* **1**(1), 74, 75.

Bhaskar, V. 1978. Studies on South Indian *Impatiens* L. - Palynology. *J. Palynol.* **15**(1), 118.

Nayar, M. P. 1996. *Hot spots of endemic plants of India, Nepal and Bhutan.* Tropical Botanical Garden and Research institute, Thiruvananthapuram, p. 214.

Rao, R. R. 1981. *A Synoptic Flora of Mysore District.* Today & Tomorrow's Printers and Publishers, New Delhi.

Saldanha, C. J. 1996. *Flora of Karnataka (Vol. 2).* Oxford & IBH publishing Co., New Delhi, Vol. 2, p. 255.

Vivekananthan, K. *et al.* 1997. In Hajra, P. K. *et al.* (eds.) *Flora of India* Vol. 4. Botanical Survey of India, Kolkata, p. 184.

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TAXONOMY AND DISTRIBUTION OF *IMPATIENS TALBOTII* - A RARE ENDEMIC BALSAM FROM WESTERN GHATS

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ABSTRACT

The paper deals with a rare and poorly known species of balsam, viz. *Impatiens talbotii* Hook. f. from the Western Ghats. The historical account, a detailed description, distribution and illustrations based on fresh specimens are provided.

INTRODUCTION

The genus *Impatiens* L. (Balsaminaceae), a highly diversified genus is represented in India by around 209 species. Western Ghats, one of the 34 biodiversity hotspots of the World harbours about 90 species of *Impatiens*, most of which are narrow endemics. *I. talbotii* Hook. f. is one such narrow endemic so far reported only from North Kanara and Shimoga districts of Karnataka along the Central Western Ghats. It appears in Red Data Book of Indian plants as a rare endemic species that is represented by few old collections (Singh & Kulkarni, 1990). The description available in literature is very meagre and floral details were never illustrated. Hence, an attempt has been made in this paper to bring historical account, elaborate description and illustation of the little known endemic species.

Impatiens talbotii was described by Hooker in 1906 based on Talbot's collection from Devimane ghat in North Kanara district. However, he did not provide any description and illustration while publishing this species. Later, during the revision of Balsaminaceae for the Presidency of Bombay, Blatter (1933) accessed Law's (*s. n.* - N. Kanara), Talbot's (3722 – Devimane Ghat) and Meebold's (6960 – Castle Rock) collections and included the description from Hooker's manuscript supplied by C. E. C. Fischer of the Kew Herbarium. Subsequently this species was collected from Jog falls (North Kanara) and Agumbe (Shimoga) by Bhaskar (Bhaskar & Razi,

1978). In Indian herbaria the species is known only by four collections. Due to its narrow distribution and representation by few collections in herbaria it has been designated as rare (Singh & Kulkarni, 1990; Nayar, 1996).

During the course of studies the present authors have collected the species from Jog falls after a lapse of 33 years since Bhaskar's collection from the same locality in 1972. Recent collection of this species from Goa by authors shows its extended distribution from Karnataka. Hooker did not provide any description or illustration while publishing *I. talbotii* as new species and the description available in Floras is scanty and inadequate. Hence, a detailed description and illustrations of the species based on fresh specimens is provided.

Impatiens talbotii Hook. f. in Rec. Bot. Surv. India 4: 42, 47. 1906 ex Blatter in J. Bombay Nat. Hist. Soc. 33: 314. 1933; Sharma *et al.* Fl. Karnataka 39. 1984; Ahmedullah & Nayar, Endemic plants of the Indian region 1: 194. 1986; Singh & Kulkarni in Nayar & Sastry, Red Data Book 3: 63 t. 64. 1990; Saldanha, Fl. Karnataka 2: 259. 1996; Vivekananthan *et al.* in Hajra *et al.* Fl. India 4: 214. 1997.

Herb, up to 60 cm high. Stem terete, flaccid, glabrous, swollen at the nodes, branched. Leaves alternate, crowded at the apex, petiolate; petiole 2 – 2.5 cm long, with 3 - 5 pairs of petiolar glands, hairy on either side. Lamina lanceolate, up to 14 x 5.3 cm, cuneate at base, crenate and ciliate along margins, acute to acuminate at apex, crenae apiculate, adaxial surface hairy, abaxial surface densely hairy on the nerves and glabrous to sparsely hairy on the rest surface. Flowers axillary, 2-4 in each axil, pink with purple centre, up to 2.5 cm across, up to 3 cm long; bracts linear-lanceolate, *ca* 3 x 1 mm, glabrous, hairy along the margins in the upper half, apically acute; pedicels up to 2 cm long, slender, glabrous to hairy, deflexed in fruits. Lateral sepals 2, ovate to linear-lanceolate, up to 2.5 x 1 mm, green in colour, sparsely hairy on the dorsal surface, mid vein distinct, entire along margins, acute at apex; standard orbicular, up to 7 x 8 mm, pink within, white outside, dorsally keeled, keeled portion green in colour, apically cordate, costa mucronate, hairy, mucro green; wing petals 2, bilobed, up to 1.5 x 1 cm, lobes unequal; basal lobe *ca* 9 x 5 mm, oblong to oblong-lanceolate, bilobulate, apically apiculate; distal lobe larger than the basal lobe, up to 1.3 x 0:5 cm, assymmetrically obovate, bilobulate, dorsal auricle absent, base of the wing petal is bent at the spur region thus giving the appearance of an auricle; lip conical, light pink in colour, glabrous to sparsely hairy, spurred; spur tubular, curved, white to light pink in colour, up to 3 cm long, glabrous to hairy, tip rounded. Column up to 3.5 x 2 mm, bent on one side. Filaments 5, up to 2.5 mm long, free and narrow at the base, fused and broad at the apex, pink in colour; anthers 5, fused, *ca* 1.5 mm wide, white to light pink in colour, forming a hood above the ovary. Pistil *ca* 3 mm long; ovary elliptic-lanceolate, *ca* 2 mm long, glabrous; style absent; stigma 5-toothed, each tooth *ca* 1 mm long. Fruit assymmetrically lanceolate, up to 1.5 x 0.7 cm, tomentose, stigma persistent, pedicel up to 3 cm long. Seeds ovate, papillate, up to 4 x 2.5 mm, brown, flattened. **(Fig. 1)**

Flowering and fruiting: August – November.

Habitat: Grows on either side of the narrow steep path/footsteps leading to the base of the Jog falls (Karnataka) and along the road side near water falls at Gaondongri (Goa).

Note: The species occurs in vulnerable habitat as thousands of tourists flock Jog falls during the monsoons. As the flowers are attractive people are seen plucking the flowers and breaking the twigs thus putting the plant in a precarious position. Hence, measures should be taken for its conservation.

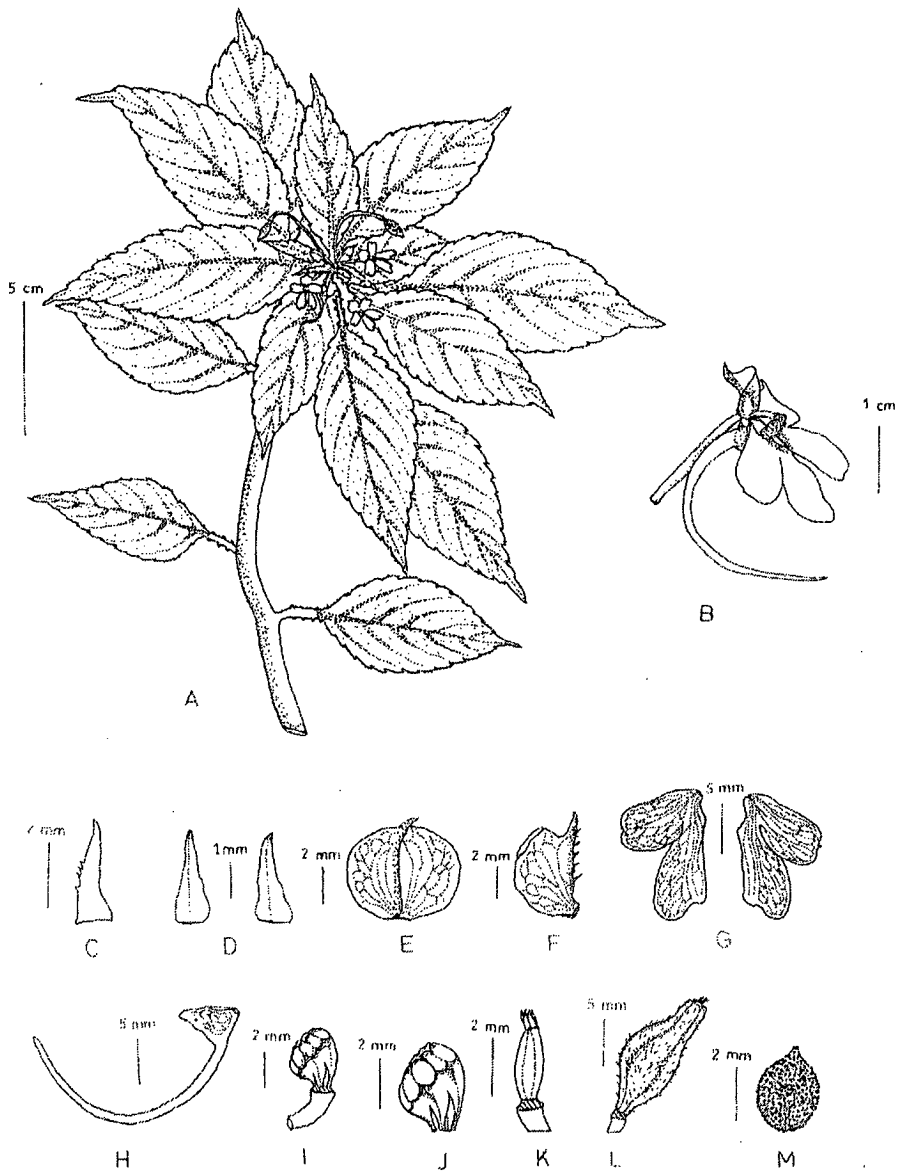

Fig. 1. *Impatiens talbotii* Hook. f.: A. Twig, B. Flower, C. Bract, D. Lateral sepals, E & F. Standard, G. Wing petals, H. Lip, I. Column, J. Androecium, K. Pistil, L. Capsule, M. Seed.

Potential value: The plant is worth introducing in gardens as an ornamental for its beautiful flowers.

Specimens examined: Karnataka : Devimane ghat, 02.11.1903, *W.A. Talbot s.n.* (BSI); Castle rock, *s.d. A. Meebold s.n.* (CAL); Jog falls, 05.11.1972, *V. Bhaskar* 341 (MGM); Agumbe ghat, 06.11.1972, *V. Bhaskar* 342 (MGM); Jog falls, 06.08.2005, *Jyosna R.N. Dessai* 37 (Goa University Herbarium); 06.09.2005, *Jyosna R. N. Dessai & M.K. Janarthanam* 93 (Goa University Herbarium); Goa: Gaodongri, Bharsa, along roadside near Baman buda waterfalls, 12. 08. 2007, *M.K. Janarthanam* 163 (Goa University Herbarium).

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REFERENCES

BHASKAR, V. & B.A. RAZI 1978. Studies on South Indian *Impatiens* L. - III. Further notes. *Indian J. For.* 1(1): 68-78.

———— 1990. Species complexes in South Indian *Impatiens* L. (Balsaminaceae) – I. Taxonomy of *I. talbotii* Hook. f. ex Blatt. and *I. pulcherrima*. In S.K. Gupta (Ed.) *Higher plants of Indian subcontinent* 1: 25-30.

BLATTER, E. 1933. Revision of the flora of the Bombay Presidency. *J. Bombay Nat. Hist. Soc.* 36: 307-315.

HOOKER, J.D. 1906. An epitome of the British Indian species of *Impatiens*. *Rec. Bot. Surv. India* 4: 42, 47.

NAYAR, M.P. 1996. *Hot spots of Endemic plants of India, Nepal and Bhutan.* Tropical Botanical Garden and Research Institute, Thiruvananthapuram.

SINGH, N.P. & B.G. KULKARNI 1990. *Impatiens talbotii* Hook. f. In Nayar, M.P. & A.R.K. Sastry (Eds.) *Red Data Book of Indian Plants*, Vol. 3. Botanical Survey of India, Calcutta.

Taiwania, 54(2): 149-151, 2009

A New Species of Epiphytic *Impatiens* (Balsaminaceae) from the Western Ghats, India

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ABSTRACT: *Impatiens bhaskarii*, a new species is described and illustrated from the Western Ghats, India. It is endemic and confined to the Western Ghats of Karnataka (India). This species is closely allied to *I. stocksii* Hook. f. & Thomson and *I. dendricola* C. E. C. Fisch., but differs in possessing lilac to pink-coloured flowers, a short dorsal auricle, and seeds with hairs all over from the former, and in having lilac to pink-coloured flowers, saccate spur and seeds with hairs all over from the latter.

KEY WORDS: Endemic, *Impatiens bhaskarii*, new species, Western Ghats, India.

INTRODUCTION

The genus *Impatiens* L. is a highly diversified genus and is represented by over 1,000 species (Janssens et al., 2006; Morgan, 2007). The species of the genus are primarily distributed in the tropical and subtropical regions of the Old World while few are distributed in the northern temperate regions (Grey-Wilson, 1980, 1985). About 203 species are found in India (Vivekananthan et al., 1997) to which few more species have been added subsequently.

Western Ghats, one of the 34 biodiversity hotspots of the world, harbours about 90 species of *Impatiens*. It is a region of speciation for the genus *Impatiens* (Bhaskar, 1981; Kumar and Sequiera, 1996) with maximum number of endemic species (Nair, 1991).

During the course of taxonomic studies of the genus *Impatiens* in the Western Ghats, the authors collected specimens of an epiphytic balsam belonging to section *Scapigerae* Hook. f. & Thomson. Section *Scapigerae* is confined to Peninsular India with an exception of one species in Sri Lanka. In the Western Ghats region, scapigerous balsams are either with a saccate lip wherein the wing petals are lacking a distinct dorsal auricle or possess spurred lip wherein the wing petals may or may not be with a distinct dorsal auricle. Detailed studies show that the collected specimens are similar to *I. stocksii* Hook. f. & Thomson in their saccate spur and *I. dendricola* C. E. C. Fisch. with respect to their dorsal auricle thus representing the characters of both groups in *Scapigerae*. Several live specimens of the same entity collected from the type locality are being grown at Gurukula Botanical Sanctuary, Wayanad. Our study of these specimens for variations also reveals that this is a distinct novel taxon. Hence it is being described here as a new species.

TAXONOMIC TREATMENT

Impatiens bhaskarii J. Dessai, L. Joseph & Janarth., *sp. nov.* Fig. 1

Type: INDIA, Karnataka, Chikmagalur District, Charmadi ghat, 15 August 2005, *Jyosna R. N. Dessai & M. K. Janarthanam 62* (holotype: CAL; isotypes: BSI, MH).

Impatienti stocksii et *I. dendricola* similis, ab ambobus floribus lilacinis ad roseis, seminibus omnino pubescentibus, a prima auricula dorsali brevi, a secunda calcare saccato differt.

Epiphytic, scapigerous, tuberous herb, 10-15 cm high; tubers creamish brown, spherical to oblongoid, 0.5-0.7 × 0.5-0.8 cm. Leaves radical, 3-7 per tuber, petiolate; petiole 1.5-4 cm long, glabrous; lamina broadly ovate to orbicular, 0.6-4 × 0.5-3.6 cm, base obtuse to truncate, margin crenate, apex acute, retuse to apiculate; crenae apiculate, adaxially hairy, abaxially glabrous. Inflorescence a 6-10-flowered raceme; 1-4 per tuber, scape 5-14 cm long, slender, glabrous. Flowers lilac to pink with a tuft of yellow hairs at the base of the middle lobe, 8-20 mm across, bracteate, pedicellate; bracts ovate, 1.5-2 × 1-1.3 mm, apex acute; pedicel 6-20 mm long, slender, glabrous, deflexed in fruits; lateral sepals 2, asymmetrically ovate, 1.5-2 × 0.5-1 mm, slightly concave, apex acute, distinctly 3-nerved, light green, glabrous; standard orbicular to obovate, 2.5-4 × 3-4.5 mm, white externally, lilac to pink internally, glabrous, apex obcordate; wing petals 2, 8-15 × 6-10 mm, 3-lobed, lobes unequal, basal lobe smaller than the distal and middle lobe, asymmetrically ovate, 3-5 × 1.5-3 mm, middle lobe broadly ovate, 2.5-5 × 2-5 mm, distal lobe oblong, 2.5-6 × 1-3 mm; dorsal auricle short, yellow; lip ovate, 4-5 × 1-3 mm, apex acute, spur saccate. Column ca. 2 × 1 mm, curved; anthers 5, cohering above the pistil, ca. 1 × 0.5 mm, white; filaments 5, ca. 1.5 × 0.5

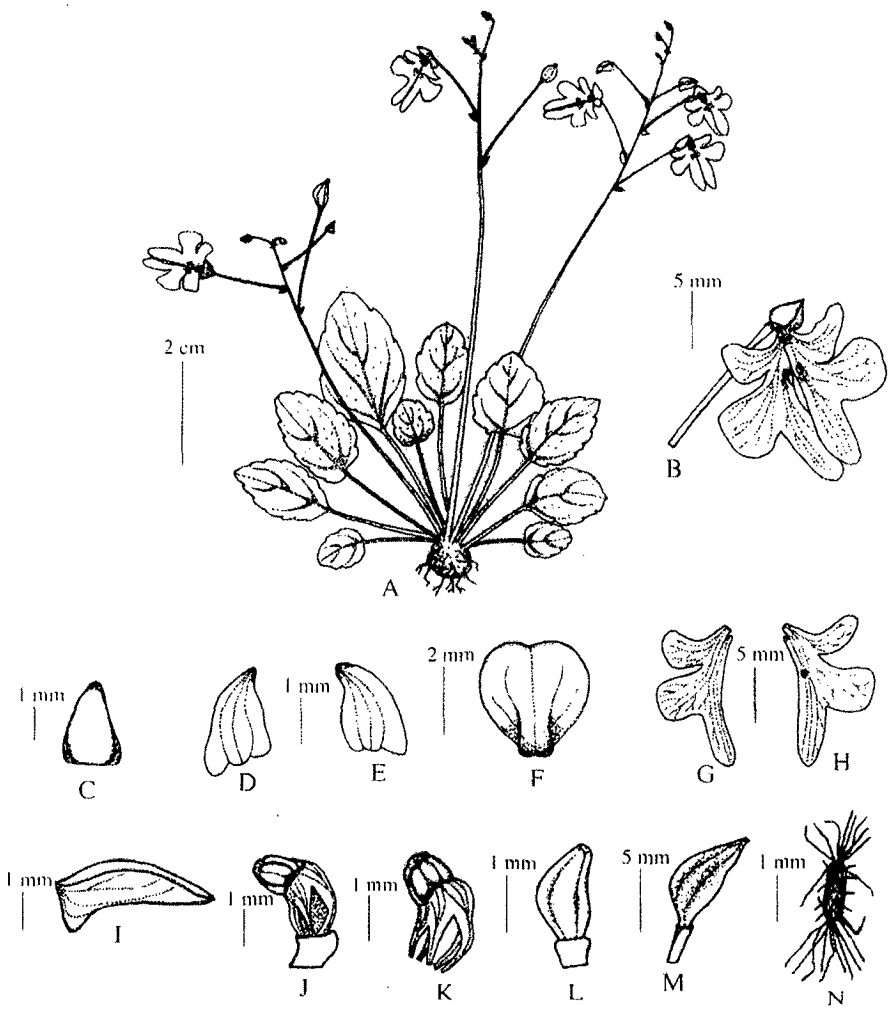

Fig. 1. A: Habit. B: Flower. C: Bract. D, E: Lateral sepals. F: Standard. G: Wing petal (dorsal view). H: Wing petal (ventral view). I: Lip. J: Column. K: Androecium. L: Pistil. M: Capsule. N: Seed. (line drawing by *Jyosna Dessai* from *Jyosna R. N. Dessai & M. K. Janarthanam* 62)

mm, narrow and free at base, fused and broad at apex, light pink to white. Pistil ca. 1.5 × 0.5 mm; ovary lanceoloid to ellipsoid, glabrous; style absent; stigma 5-toothed. Fruit a capsule, 0.6-1 × 0.2-0.4 cm, asymmetrically ellipsoid, glabrous, pedicel 1.5-2.2 cm long. Seeds numerous, minute, oblongoid, ca. 1 × 0.5 mm; testa reticulate, brown, hairy; hairs sparse throughout but long and tufted at both the ends, spirally coiled.

Distribution: Charmadi ghat (type locality) of Karnataka, Western Ghats, India.

Flowering and fruiting: July – August.

Habitat: Epiphyte. Growing on tree branches within moss.

Conservation status: Data deficient; not collected from outside type locality. Specimens collected from type locality are being grown at Gurukula Botanical Sanctuary, Wayanad.

Etymology: The species is named in honour of Prof. V. Bhaskar for his immense contribution towards the understanding of *Impatiens* of south India.

Table 1. Comparative account of *Impatiens bhaskarii*, *I. dendricola* and *I. stocksii*.

Characters	*Impatiens bhaskarii* sp. nov.	*I. dendricola*	*I. stocksii*
Flower colour	Lilac pink	White	White
Dorsal auricle	Present	Present	Absent
Spur	Saccate	Clavate	Saccate
Seeds	Hairy throughout, hairs long and tufted at both the ends	Comose	Comose

Note: The species is related to *I. stocksii* and *I. dendricola* but differs in possessing lilac to pink-coloured flowers, short dorsal auricle, and seeds with hairs all over from the former and in having lilac to pink-coloured flowers, saccate spur and seeds with hairs all over from the latter (Table 1).

Impatiens bhaskarii is restricted to the type locality and *I. dendricola* till date is reported from only two localities in Coorg District further south of the type locality of *I. bhaskarii* whereas *I. stocksii* is found growing in the areas occupied by both these species. *Impatiens stocksii* and *I. dendricola* are found growing on moss covered tree trunks while *I. bhaskarii* grows on horizontal lateral branches.

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LITERATURE CITED

Bhaskar, V. 1981. The genus *Impatiens* L. in south India: endemism and affinities. Indian Forester **107**: 368-376.

Grey-Wilson, C. 1980. *Impatiens* of Africa. A. A. Balkema, Rotterdam, The Netherlands. 235pp.

Grey-Wilson, C. 1985. *Balsaminaceae*. In: Dassanayake, M. D. and F. R. Fosberg (eds.), A revised handbook to the flora of Ceylon **5**: 76-120. Oxford & IBH Publishing Co., New Delhi, India.

Janssens, S., K. Geuten, Y. M. Yuan, Y. Song, P. Küpfer and E. Smets. 2006. Phylogenetics of *Impatiens* and *Hydrocera* (Balsaminaceae) using Chloroplast *atpB-rbcL* spacer sequences. Syst. Bot. **31**: 171-180.

Kumar, M. and S. Sequiera. 1996. *Impatiens sivarajanii* – a new species of Balsaminaceae from Silent Valley National Park, Kerala, India. Rheedea **6**: 51-54.

Morgan, R. J. 2007. *Impatiens* – the vibrant World of busy lizzies, balsams and touch-me-nots. Timber Press, Portland, USA. 219pp.

Nair, N. C. 1991. Endemism on the Western Ghats with special reference to *Impatiens* L. *Proceedings of the Symposium on rare, endangered and endemic plants of Western Ghats*, Kerala Forest Dept. (Wildlife wing), Thiruvananthapuram, Spl. Publ. No: **III**: 93-102.

Vivekananthan, K., N. C. Rathakrishnan, M. S. Swaminathan and L. K. Ghara. 1997. *Balsaminaceae*. In: Hajra, P. K. et al. (eds.), Flora of India **4**: 95-229. Botanical Survey of India, Howrah, India.

印度西高止山脈新種附生型鳳仙花

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摘要：本文描述並繪圖介紹特產於印度西高止山脈的鳳仙花一新種：巴斯卡鳳仙 (*Impatiens bhaskarii*)。本種除了是印度特有種外，更侷限分布於西高止山脈。文中提及本種與幹生鳳仙 (*I. stocksii* Hook. f. & Thomson) 及樹生鳳仙 (*I. dendricola* C.E.C. Fisch.) 雖為相近種，然淡紫色到粉紅色的花、囊形的距及全被毛的種子等特徵，是很容易與後二者區別。

關鍵詞：特有種、巴斯卡鳳仙、新種、西高止山、印度。

EXTENDED DISTRIBUTION OF *IMPATIENS RAZIANA* (BALSAMINACEAE): A POORLY KNOWN ENDEMIC SPECIES OF WESTERN GHATS

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Abstract: *Impatiens raziana* Bhaskar & Razi, a rare endemic balsam of Western Ghats, so far known only from the type locality has been collected from two more localities. A detailed description and illustration based on fresh specimens is provided for easy identification of the species.

INTRODUCTION

The species of *Impatiens* are found distributed throughout the wet tropical and sub-tropical regions of Asia and Africa, while a few species are recorded from the temperate regions of Asia, Europe and North America, with major centres in India, Sri Lanka and Madagascar (Vivekananthan *et al.*, 1997). The genus is represented by over 1000 species (Janssens *et al.*, 2006), of these about 203 species are found in India (Vivekananthan *et al.*, 1997). Subsequently, few more new species have been added to this list. In India Eastern Himalayas and Western Ghats are rich in *Impatiens* and the latter harbours about 90 species.

Impatiens raziana Bhaskar & Razi, an endemic species, was described based on a single collection made in 1972 from Kotigehar, Chikmagalur district, Karnataka (Bhaskar and Razi, 1982). Saldanha made further collections from the type locality that are deposited at JCB, Bangalore. Though locality of collection is mentioned as Chikmagalur on herbarium label, it is clearly mentioned as type locality in Flora of Karnataka (Saldanha, 1996). These two publications are the major source of information on its morphology and geographical distribution. Vivekananthan *et al.* (1997), while dealing the family for Flora of India have not added much to the existing information on the species. The major herbaria such as BLAT, BSI, CAL and MH do not have any collection of the species. Hence, Nayar (1996) considered this species as rare. Saldanha (1996), during his subsequent visits to the type locality, could not trace the species and reported the conversion of locality into a residential colony. The present authors' attempts to collect it from type locality also failed.

However, during the taxonomic studies of the genus *Impatiens*, the authors collected *I. raziana* from two more localities other than the type locality in Western Ghats. These collections from Shimoga and Belgaum districts show the extended distribution and also considerable variations. Hence a detailed description and illustrations are provided here.

Impatiens raziana Bhaskar & Razi in J. Bombay Nat. Hist. Soc. 79: 383. 1982; Sharma *et al.*, Fl. Karnataka 39. 1984; Saldanha, Fl. Karnataka 2: 257, t. 38. 1996; Vivekananthan *et al.* in Hajra *et al.*, Fl. India 4: 204. 1997.

Annual herbs up to 40 cm high. Stem erect, prostrate or procumbent, flaccid, quadrangular, glabrous, pigmented, branched; branches arising from basal nodes. Leaves opposite-decussate, petiolate, apical ones subsessile; petiole short, up to 4 mm long, glabrous, decurrent on the stem and ending as petiolar glands; lamina oblong, elliptic, oblanceolate, obovate to spathulate, up to 6.5 x 1.8 cm, membranous, cuneate to truncate at base, crenate along margins, acute at apex; crenae apiculate; hairy adaxially, veins distinct abaxially. Flowers axillary, 1-4 in each axil, up to 1.9 cm across, bright saffron coloured; bracts linear-lanceolate, glabrous, up to 1.5 x 0.75 mm, acute at apex; pedicels up to 3 cm long, pubescent, with two longitudinal rows of hairs, deflexed in fruit; lateral sepals 2, linear

to linear-lanceolate, up to 10 x 1.5 mm, glabrous, light orange in colour, acute to acuminate at apex; veins 3, middle vein distinct, ridged dorsally, other two faintly visible; standard orbicular to broadly ovate, up to 7.5 x 9 mm, concave, orange in colour, rounded to retuse at apex, dorsally keeled; costa mucronate, glabrous to hairy dorsally; lip funnel shaped, light orange with darker veins, 10-12 x 5-6 mm, acuminate at apex, with a yellow spot within below the apex; spur short, 3-5 mm long, curved, glabrous to hairy, tip rounded to notched, yellow to green in colour; wing petals 2, up to 2 x 1.1 cm, bilobed, lobes unequal, basal lobes triangular, *ca.* 5 x 4 mm, lighter than the distal lobe, distal lobe up to 1.3 x 1 cm, obliquely ovate, lacerated in the basal region, shortly stipitate; stipe lighter than the lobe bearing 4-5 dark orange spots, auricled at base. Column 4-5 mm long, curved; filaments up to 3 mm long, free at base, connate at apex, yellowish orange in colour; anthers 5, *ca.* 1 x 1 mm, cohering; pistil up to 4 mm long; ovary linear-oblongoid, curved at apex, glabrous; style absent; stigma 5-toothed. Capsules ellipsoid to oblongoid, up to 1.2 x 0.5 cm, glabrous; pedicels up to 4 cm long. Seeds laterally compressed, circular in outline, *ca.* 2.5 x 2 mm, dark brown to black in colour, glabrous, shining. (Fig. 1).

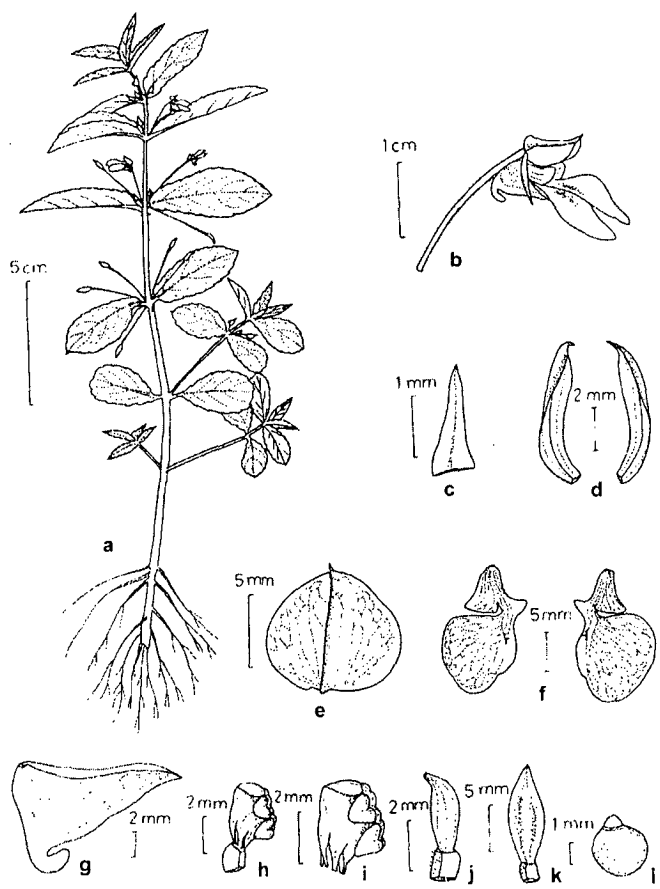

Fig. 1: a. Habit, b. Flower, c. Bract, d. Lateral sepals, e. Standard, f. Wing petals, g. Lip, h. Column, i. Androecium j. Pistil, k. Capsule, l. Seed.

Flowering & Fruiting: July – September.

Habitat: Amidst grasses beneath *Terminalia bellirica* and *T. paniculata* and field bunds along the periphery of moist deciduous forest at Tinaighat (Belgaum district) and in *Acacia* plantation with sandy soil at Bidargad (Shimoga district).

Specimens examined: Karnataka, Chikmagalur, Charmadi ghat, 26.08.1972, *V. Bhaskar* 311 (*Type* - MGM); Kotigehar, 850 m, 25.09.1979; *C. J. Saldanha* KFP 9756 (JCB); Chikmagalur, 800 m, 03.11.1981, *C. J. Saldanha* KFP 13494 (JCB); Belgaum, Tinaighat, Rajval, 15° 26' 13.8" N and 74° 26' 19.2" E, ± 647 m, 01.08.2004, *M. K. Janarthanam* 11 (GUH), 21.08.2005, *Jyosna R. N. Dessai & M. K. Janarthanam* 64 (GUH); Shimoga, Bidargad, Agumbe-Sringeri road, 04.09.2005, *Jyosna R. N. Dessai & M. K. Janarthanam* 76 (GUH). (GUH - Goa University Herbarium, MGM – Mysore University Herbarium are not acronyms but used for convenience).

Note: The species was seen growing in plain areas on the eastern side of the Western Ghats with relatively low rainfall. Flowers are visited by bees, butterflies and moths. The variations in the species are seen with respect to its habit, leaves (shape, base and apex), number of flowers per axil, pubescent nature of pedicel, shape and margin of lateral sepals, tip of spur and colour of seeds.

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The authors are thankful to the Directors/ Officers in-charge of BLAT, BSI, CAL, JCB, MH and Mysore University Herbarium for permission to consult their specimens and Prof. V. Bhaskar, GKVK, Bangalore for confirming the identity of the species. The first author is thankful to the International Association for Plant Taxonomy for research grant.

REFERENCES

Bhaskar, V. and Razi, B.A. (1982). Two more new species of *Impatiens* L. from South India. *J. Bombay Nat. Hist. Soc.* **79**: 382-384.

Janssens, S., Geuten, K., Yuan, Y.M., Song, Y., Küpfer, P. and Smets, E. (2006). Phylogenetics of *Impatiens* and *Hydrocera* (Balsaminaceae) using Chloroplast *atpB-rbcL* spacer sequences. *Syst. Bot.* **31**: 171-180.

Nayar, M. P. (1996). *Hot spots of Endemic plants of India, Nepal and Bhutan.* Tropical Botanical Garden and Research Institute, Thiruvananthapuram.

Saldanha, C.J. (1996). *Flora of Karnataka*, Vol. 2, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Vivekananthan, K., Rathakrishnan, N.C., Swaminathan, M.S. and Ghara, L.K. (1997). Balsaminaceae. In *Flora of India*, Vol. 4 (Edited by P.K. Hajra, V.J. Nair & P. Daniel), BSI, Calcutta, p. 95-229.