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DISTRIBUTION, MORPHOLOGY AND ECOLOGY OF *PIPER* SPECIES IN KARNATAKA, INDIA×

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ABSTRACT

Collections of the genus *Piper* occurring widely in the forests of Karnataka, India were made. These consisted of eight species, *P. nigrum* Linn., *P. longum* Linn., *P. attenuatum* Buch.-Ham., *P. galeatum* C. DC., *P. trichostachyon* C. DC., *P. argyrophyllum* Miq., *P. hymenophyllum* Miq., and *P. brachystachyum* Wall. The various species showed considerable variation in distribution habitat preference, ecology, and morphology. All these *Piper* species were unisexual and dioecious, though the cultivated varieties of *P. nigrum* are bisexual. The two morphologically similar taxa, *P. galeatum* and *P. trichostachyon*, showed adjacent distribution. The genus showed senescence in distribution.

INTRODUCTION

The genus *Piper* is a large one consisting of about 2000 species (Usher, 1974; Heywood, 1978). From the Indian subcontinent alone, 87 species have been recorded (cf., Index Kewensis, 1895-1970). The genus includes two important cultivated cash crops, *P. nigrum*, black pepper, and *P. betle*, betel leaf. A number of wild species possess medicinal properties.

Several species of this genus occur wild in the forests of Western and Eastern Ghats of India. The submountainous tracts of Western Ghats are believed to be the centre of origin of black pepper, *P. nigrum*. We surveyed the forest areas of Karnataka during December 1973 to August 1979 to collect and evaluate the natural variability available in the genus *Piper*. The results are presented here.

OBSERVATIONS

1. COLLECTION

During this survey, we collected about 300 specimens and prepared over 1000 herbarium sheets. In addition, we planted about 850 live specimens (runner and stem cuttings) in the Station farm. The different species were identified using the descriptions given in the Flora of the Presidency of Madras (Gamble, 1925) and the plates in Icone Plantarum Indiae Orientalis (Wight, 1853). The herbarium specimens were compared with those maintained at the Centre for Taxonomic Studies, St. Joseph's College,

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The study of the herbarium and live specimens revealed the presence of the following eight species in Karnataka: 1. *P. nigrum* Linn., 2. *P. longum* Linn., 3. *P. attenuatum* Buch-Ham., 4. *P. galeatum* C. DC., 5. *P. trichostachyon* C. DC., 6. *P. argyrophyllum* Miq., 7. *P. hymenophyllum* Miq., and 8. *P. brachystachyum* Wall.

2. ECOLOGY

Plants belonging to the genus *Piper* were found to occur in evergreen and semievergreen forests, and also in pockets of moist deciduous forests. A damp location with rich organic matter content in the soil and large trees which provide shade and support for the climbing vines, were very congenial for the luxuriant growth of these species. Wild *Piper* species were mostly seen in localities where adequate moisture was available throughout the year. The tender vines were very sensitive to heat and died due to withering and scorching whenever they were exposed to direct sunlight for any extended period.

Of the eight species, *P. nigrum* was the most widely distributed. It was found from sea level to a height of 2000 m above MSL. *P. attenuatum* was found to grow in the lowest elevation forests (50 m above MSL). *P. brachystachyum* occured only in higher altitude localities such as Kemmanagundi (1325 m) and Mercara (1200 m). Other species occurred mostly in middle elevation forests.

3. DISTRIBUTION

Karnataka State can be divided into three distinct natural regions, namely, *Karavali*, *Malnad*, and *Maidan*. *Karavali* is the coastal strip of land lying between the Arabian Sea and the foot hills of Western Ghats. *Malnad*, literally meaning 'rain country', lies to east of it. It is dissected into steep hills and valleys and covered with dense forests. Both these regions, *Karavali* and *Malnad*, receive high rainfall, 3,000-4,000 mm annually. *Maidan*, literally meaning 'flat lands', is the Deccan peninsular region. It is more or less flat with an average elevation of 600 m and receives 500-800 mm rainfall annually.

All the eight *Piper* species were found in *Malnad* region. Three species, viz., *P. nigrum*, *P. attenuatum*, and *P. galeatum* were collected from the forests of *Karavali* region. *Maidan*, the rain-shaded region, harboured only two species *P. nigrum* and *P. trichostachyon*, and even these were confined to the western part, which receives comparatively more rainfall than the rest. *Piper* species were not observed to the east of B. R. Hills (Biligiri Rangana Betta) of Mysore District (Table 1).

The *Piper* species were well distributed throughout Chikmagalur, Coorg, and North Kanara districts. In Dakshina Kannada district, *Piper* species showed continuous distribution, but were mostly confined to the hilly regions. But, this appeared to be primarily because all the natural forest stands had been removed from the rest of the area, for in pockets where such stands occurred, wild *P. nigrum* and *P. attenuatum* were most often present. In Shimoga district, these species were noticed in only isolated patches. In Hassan and Mysore districts, *Piper* vines were seen only rarely. There is no record of the occurrence of wild *Piper* in any of the other districts of Karnataka.

Wild forms of *P. nigrum* was the most widely distributed species, followed by *P. trichostachyon*, *P. hymenophyllum*, *P. attenuatum*, *P. argyrophyllum*, *P. longum*, *P. brachystachyum*, and *P. galeatum*, in that order. *P. galeatum* was confined to Karwar, Yellapur, and Haliyal Forest Divisions of North Kanara district (Table 1 and Fig. 1).

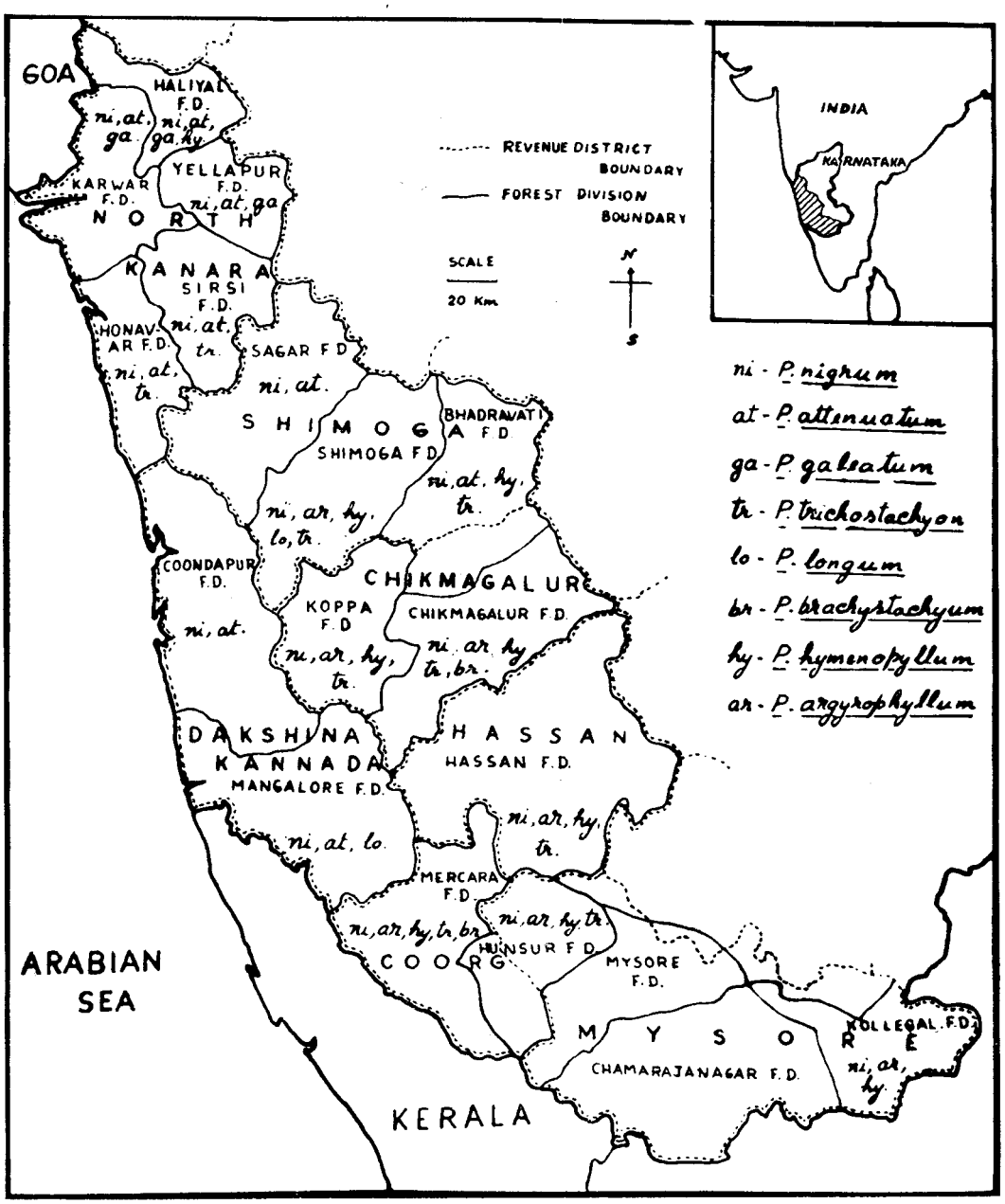

Fig. 1. Forest Division-wise Distribution of Wild *Piper* in Karnataka.

Table I. *Distribution of* Piper *Species in Karnataka*

Species	Localities	Forest Division	District
1. *P. argyrophyllum*	Mudigere, Kottigehar, Bababudangiri	Chikmagalur	Chikmagalur
	Chikkagrahara, Balur, Kudremuk	Koppa	Chikmagalur
	Agumbe, Yedur, Hanegere	Shimoga	Shimoga
	Abbe falls, Bagamandala, Makut	Mercara	Coorg
	Kalhalla, Thithimathi	Hunsur	Coorg
	Sakeleshpur, Bisle	Hassan	Hassan
2. *P. attenuatum*	Subrahmanya, Puttur, Charmadi, Sampaje, Shiradi	Mangalore	D. Kannada
	Karkal, Someshwar, Coondapur Hulikal, Shankaranarayana	Coondapur	D. Kannada
	Batkal, Kumta, Devimane	Honavar	N. Kanara
	Sirsi, Siddapur	Sirsi	N. Kanara
	Ramanguli, Kadra, Supa, Kumbarwada	Karwar	N. Kanara
	Haliyal, Ulvi	Haliyal	N. Kanara
	Yellapur, Manchikeri	Yellapur	N. Kanara
3. *P. brachystachyum*	Bababudangiri	Chikmagalur	Chikmagalur
	Kemmanagundi	Bhadravati	Chikmagalur
	Bagamandala, Abbe falls	Mercara	Coorg
4. *P. galeatum*	Kumbarwada, Supa	Karwar	N. Kanara
	Ulvi	Haliyal	N. Kanara
	Yellapur, Manchikeri	Yellapur	N. Kanara
5. *P. hymenophyllum*	Chikmagalur, Muttodi, Bababudangiri	Chikmagalur	Chikmagalur
	Balur, Chikkagrahara	Koppa	Chikmagalur
	Agumbe, Settihalli, Hulikal, Hanegere, Tirthahalli	Shimoga	Shimoga
	Kemmanagundi	Bhadravati	Shimoga
	Bagamandala, Abbe falls, Makut	Mercara	Coorg
	Thirthimathi, Kalhalla	Hunsur	Coorg
	Ulvi	Haliyal	N. Kanara
6. *P. longum*	Subrahmanya, Perla, Bantwal	Mangalore	D. Kannada
7. *P. trichostachyon*	Mudigere, Kottigehar, Bababudangiri	Chikmagalur	Chikmagalur
	Chikkagrahara, Balur, Kuduremuk	Koppa	Chikmagalur
	Settihalli, Agumbe, Hanegere	Shimoga	Shimoga
	Kemmanagundi	Bhadravati	Shimoga
	Bagamandala, Abbe falls	Mercara	Coorg
	Kalhalla, Thirthimathi	Hunsur	Coorg
	Kumta, Honavar	Honavar	N. Kanara
	Sirsi, Siddapur	Sirsi	N. Kanara
8. *P. nigrum*	Throughout the area.		

4. MORPHOLOGY

Species belonging to this genus exhibited considerable variation in their morphology (Tables II, III). All the species, except *P. nigrum* were dioecious. All except *P. longum*, were woody climbers, with the vines climbing on the tree trunks with the help of adventitious roots put forth from the nodes. Among these, *P. nigrum* showed more of twining habit. *P. longum* was a creeper. Its runners struk roots and branches at every node. The branches were erect or scandent.

The stem of *P. longum* is smooth, green and comparatively very thin (ca. 1.5 cm in diameter). In *P. nigrum*, the main stem is comparatively thicker (ca. 3.0 cm) and show a rough blistered surface. In old vines, the surface appears very rough due to the formation of bark. The stems of *P. attenuatum*, *P. argyrophyllum*, and *P. hymenophyllum* are intermediate in thickness between those of *P. nigrum* and *P. longum*. Their young stems are green and smooth, and the mature ones grey and rough. The stems of *P. trichostachyon* and *P. galeatum* also are very thick, sometimes, the diameter exceeding 7.0 cm. The stem is covered with a thick greyish bark which often shows longitudinal furrows.

The leaves also showed much variability. They were membraneous in *P. longum* and *P. attenuatum*, somewhat thick in *P. argyrophyllum*, *P. hymenophyllum*, and *P. brachystachyum*, and coreaceous in *P. nigrum*, *P. galeatum*, and *P. trichostachyon*. The leaves were glabrous in *P. nigrum*, *P. attenuatum*, *P. brachystachyum* and *P. galeatum*, densely pubescent in *P. hymenophyllum* and covered with silvery scales in *P. argyrophyllum*.

Inflorescences were globose in *P. brachystachyum*, cylindrical in *P. longum*, and filiform in the other six species. The inflorescences were erect in *P. longum* and *P. brachstachyum*, and in all the other species drooping. Male inflorescences varied in length from 5.0 cm in *P. brachystachyum* to 25.0 cm. in *P. attenuatum*. Fruiting spikes also showed wide variations in length, with 1.0 cm length in *P. brachystachyum* and 30.0 cm in *P. hymenophyllum*.

But the developing berries were oblong in *P. attenuatum*, oval in *P. argyrophyllum* and *P. hymenophyllum*, and spherical in *P. nigrum*. However, when mature, they were spherical in shape. The size of the berries varied from 0.2 cm in *P. brachystachyum* to 0.8 cm in *P. trichostachyon* and *P. galeatum*. Berries of wild *P. nigrum* showed considerable variations in pungency. The berries of *P. galeatum* and *P. trichostachyon* were also pungent, but to a lesser extent. Berries of *P. attenuatum*, *P. argyrophyllum*, and *P. hymenophyllum* were slightly bitter in taste. Berries of *P. brachystachyum* were highly pungent and gave a burning sensation when chewed.

Flowers of almost all the cultivars of black pepper, except probably *Uthirankotta* (whose spikes possess mostly female flowers) studied so far have been bisexual. Interestingly, all the wild species collected so far from Karnataka have been dioecious. The vines of all the species were either male or female.

All the wild species flowered profusely in May-July. Male vines sometimes showed off-season flowering. Cuttings of *P. nigrum*, *P. galeatum*, and *P. trichostachyon* took three years for the initiation of flowering. Those of *P. attenuatum* and *P. argyrophyllum* flowered in the very next season of planting. The main variations within the genus are presented in Tables II and III.

DISCUSSION

Like most of the forest flora, the genus *Piper* also showed senescence in distribution. Help of local inhabitants were utilized for locating wild *Piper* in the forests. They would often take the survey team to areas from where they had collected large quanti-

Table II. *Morphology of* Piper *Species Occurring in Karnataka: Vegetative Characters*

Species	Habit	Leaf						Remarks
		Size in cm	Shape	Thickness	Texture	Leaf base	Anterior-most pair of veins	
1. *P. argyro-phyllum*	Climber	Upto 21.0× 7.5	Variable: Elliptic to lanceolate	Thin	Silvery scales present	Acute or rounded	Deviates Slightly above the base	Sometimes minute hairs are present on leaves
2. *P. attenuatum*	Climber	Upto 18.0× 8.5	Ovate	Membraneous	Glabrous	Rounded or truncate	Deviates slightly above the base	
3. *P. brachystach-yum*	Climber	Upto 14.5× 5.5	Elliptic or elliptic-ovate	Thinly coreaceous	Glabrous	Acute	Deviates more than 2 cm above the leaf base from the main rib	
4. *P. galeatum*	Climber	Upto 19.0× 6.0	Elliptic lanceolate to ovate	Coreaceous	Glabrous	Rounded or acute	Deviates more than 2 cm above the leaf base from the main rib	Leaves on the main stem are much larger and more coreaceous
5. *P. hymeno-phyllum*	Climber	Upto 17.0× 7.5	Variable: Elliptic to ovate	Thin	Puberous	Acute or rounded	Deviates slightly above the leaf base	Sometimes white scales are present on leaves
6. *P. longum*	Creeper	Upto 13.0× 6.5	Ovate or ovate oblong	Membraneous	Young leaves downy	Asymmetrically cordate	Diviates from the leaf base	One of the two lobes of leaf base is large cover the petiole. Leaves on the creeping stems are cordate with equal lobes
7. *P. nigrum*	Climber	Upto 21.0×13.0	Broadly ovate in ♂ and elliptic in ♀	Coreaceous	Glabrous	Obtuse, acute or cordate	Deviates more than 2 cm above the leaf base from the main rib	Leaves on the ♂ plants are usually smaller
8. *P. trichosta-chyon*	Climber	Upto 20.0×10.0	Elliptic, lanceolate to ovate	Coreaceous	Glabrous	Rounded or acute	Deviates more than 2 cm above the leaf base from the main rib	Leaves on the main stem are much larger and more coreaceous

Table III. *Morphology of* Piper *Species Occurring in Karnataka: Floral Characters*

Species	Average spike length in cm		Spike shape	Spike surface	Bract	No of stamens	Berry		Remarks
	Male	Female					Shape of developing berries	Pungency	
1. *P. argyrophyllum*	19.0	16.0	Filiform	Glabrous	Adnate, decurrent	3	Ovate	Bitter	The green berries on ripening directly turn to black
2. *P. attenuatum*	26.0	21.0	Filiform	Glabrous	Adnate, decurrent	3	Oblong	Bitter	The green berries on ripening directly turn to black
3. *P. brachystachyum*	4.5	1.5	♂ filiform ♀ ovate or globose	Glabrous	Peltate, orbicular	2	Almost spherical	Very pungent	
4. *P. galeatum*	7.0	7.0	Filiform	Glabrous	Transformed into a fleshy cup like structure	2	Spherical or oval	Pungent	
5. *P. hymenophyllum*	14.0	28.0	Filiform	Peduncle pubescent	Adnate, decurrent	3	Ovate	Bitter	The green berries on ripening directly turn to black
6. *P. longum*	9.5	3.5	Cylindrical	Glabrous	Peltate, orbicular	3	More or less ob-conical	Pungent	The berry shape is conical possibly because the berries are closely packed on the spike
7. *P. nigrum*	16.5	12.5	Filiform	Glabrous	Adnate, upper portion forms a cup	2	Spherical	Pungent	Berries green when young, turning yellow, then orange and finally red
8. *P. trichostachyon*	9.5	10.0	Filiform	Bract surface pubescent	Transformed into a fleshy cup like structure	2	Spherical or oval	Pungent	

ties of wild black pepper in earlier years, but only a few such places showed any significant stands. The disappearance of these large stands could be attributed to large scale deforestation. A comparision of the present distribution of *P. trichostachyon* in Karnataka with that as given in earlier reports provide convincing evidence for its senescent distribution. De Candolle (1869) had made the following remark in the description of this species in his *Prodromus*- "Prope Urbem Mangalor in compis aridis et hortis terrae Canarae", meaning (*P. trichostachyon*) was found near the town of Mangalore in dry fields and gardens of Canara (South and North Kanara). But in the present survey, the nearest location to Mangalore where this species could be located was Sampaje Ghat, which is 80 km away from Mangalore.

The present survey showed an interesting feature on the distribution of two closely resembling taxa. *P. galeatum* and *P. trichostachyon* are morphologically similar in all characters except for the presence of minute hairs on the outer surface of the bracts of the flower. While most of the species, including those which are distinct from each other showed sympatric distribution these two taxa showed adjacent distribution. However, while *P. trichostachyon* had a wide distribution in south-west Karnataka, *P. galeatum* showed only a limited distribution in north-west Karnataka. The demarcation line was the Gangavali river of North Kanara District. Whether these two represent two different species or only two races which are adapted differently to two different localities is worth studying.

The rich variability in these wild species, especially in the economic characters like the length of the spike, pungency and size of the berries, could be exploited with advantage in black pepper improvement programmes.

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