THE IDENTIFICATION OF *ZINGIBER PURPUREUM* ROSC.

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ABSTRACT

Two plants were previously studied pharmacognostically (Oliveros and Cantoria, 1982) and one was identified as *Zingiber zerumbet* (L.) Smith while the other could not be identified with certainty at the National Museum. At the suggestion of the botanists at the Museum, the plant was referred to as a proposed variety of *Z. zerumbet* which it closely resembles. This paper describes the botanical studies which led to the identification of the plant. Based on an examination of the inflorescence, floral parts, and leaf sheath with its ligule, supported by confirmation at the Royal Botanic Garden at Edinburgh, the plant is identified as *Zingiber purpureum* Rosc. Steiner (1959) includes this species in her account of the Zingiberaceae of Manila under *Z. cassumunar* Roxb. The composition of the volatile oil of *Z. cassumunar* reported in literature is very similar to that of the plant identified as *Z. purpureum* Rosc.

Introduction

The first major event indicating a rising interest in the taxonomy of the Family Zingiberaceae was in 1950 when Holttum revised the family as it occurred in the Malay Peninsula (Burtt, 1972). According to Burtt, Holttum emphasized the importance of inflorescence structure in the classification of the whole family. Holttum laid much importance on the presence and form of the bracteoles (tubular versus nontubular) which, in many instances, are of help in identification (Smith, 1981). It is rarely practical to make use of fruit characters, as the form of the capsule is seldom known throughout a genus. Holttum's studies were based on the living plants or on adequate material preserved in alcohol, showing up the inevitable deficiencies of an investigation based on herbarium specimens (Burtt, 1972). Workers on the family appreciate the fact that the plants can only be studied satisfactorily when alive (Burtt and Smith, 1972).

Work at the Royal Botanic Garden at Edinburgh started in 1962 in an attempt to extend Holttum's classification geographically (Burtt, 1972). Much of this work has been concerned with the enormous difficulties of nomenclature and typification with which the family abounds. The problems encountered in this work dictated its expansion into a more general survey and encouraged the building-up

at Edinburgh of a collection of living plants and of flowers and inflorescences preserved in alcohol.

On a visit to the Jodrell Laboratory in the Royal Botanic Gardens at Kew, the author was referred to Miss Rosemary M. Smith at Edinburgh. That visit led to the work reported in this paper.

Botanical Studies

Guided by reprints of works of Miss Smith and her coworkers, the floral structure of the plant was studied in detail. At the same time, planting materials were sent to Miss Smith for confirmation of the identification of the plant.

The Family Zingiberaceae consists of over 40 genera and about 1,000 species and is divided into two subfamilies: Costoideae and Zingiberoideae (Burtt and Smith, 1983). The Zingiberoideae occur mainly in the tropics of the Old World with some representatives in the New World tropics and subtropical Asia. The Costoideae is poorly represented in the Old World. In Sri Lanka, the Zingiberaceae are most abundant in lowland and midmontane primary forests, less so in secondary forests. They are rarely encountered in dry zones. The family is of considerable importance as a spice family and includes ginger (*Zingiber officinale* Rosc.), turmeric (*Curcuma longa* L.), and cardamom [*Elettaria cardamomum* (L.) Maton]. Several species, notably *Zingiber zerumbet* (L.) Smith, *Costus speciosus* (Koenig) Smith, *Curcuma zedoaria* (Christm.) Rosc., and *C. aromatica* Salisb. are used medicinally.

Some illustrations of diagnostic floral features of the Zingiberaceae by Smith (1981) are reproduced (Figs. 1-5). These are characters which are important in the

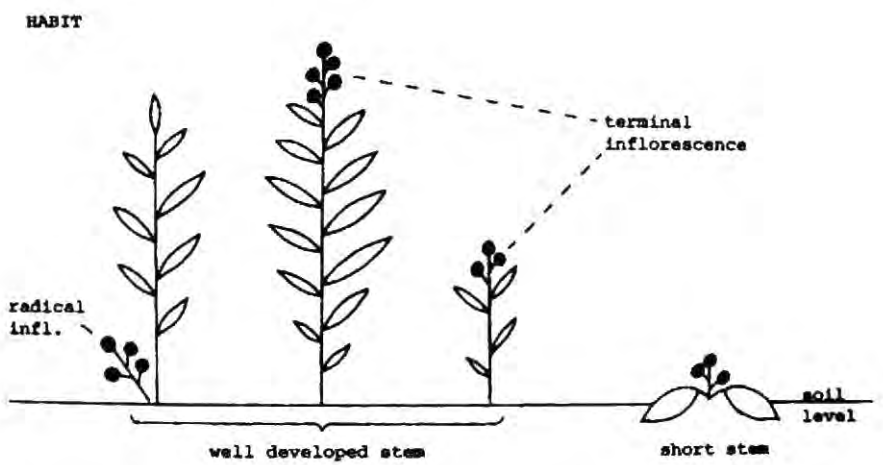

Fig. 1. Habit of members of the tribes Zingibereae, Globbeae, and Hedychieae, and those members of the tribe Alpineae in which the inflorescence is borne separately from the leaves in a leafless scape (Smith, 1981).

identification of members of the tribes Zingibereae, Globbeae, and Hedychieae and those members of the tribe Alpineae in which the inflorescence is borne separately from the leaves on a leafless scape. Fig. 1 shows the habit; Fig. 2, the arrangement of bracts; Fig. 3, the form of the bracts and bracteoles; Fig. 4, the flowers and floral parts of *Globba* and *Zingiber*; Fig. 5, the flowers and floral parts of *Hedychium*, *Amomum*, and some other members of the tribe Hedychieae.

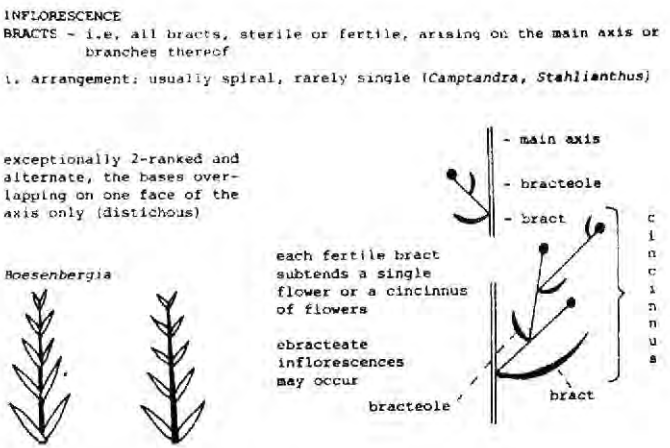

Fig. 2. Arrangement of bracts (Smith, 1981).

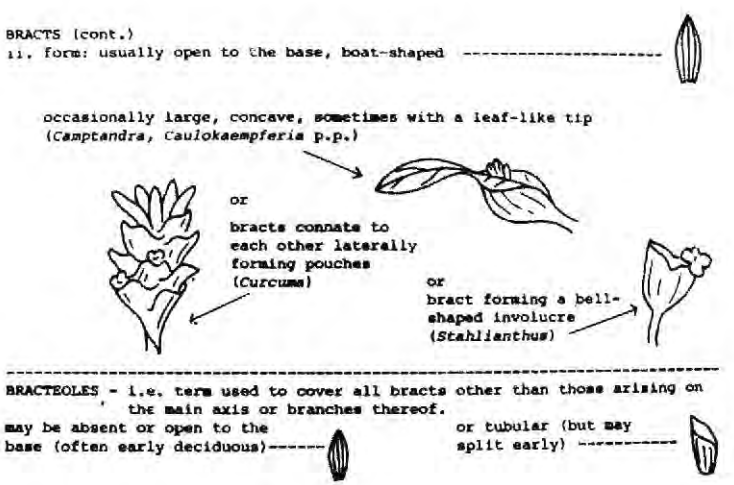

Fig. 3. Form of bracts and bracteoles (Smith, 1981).

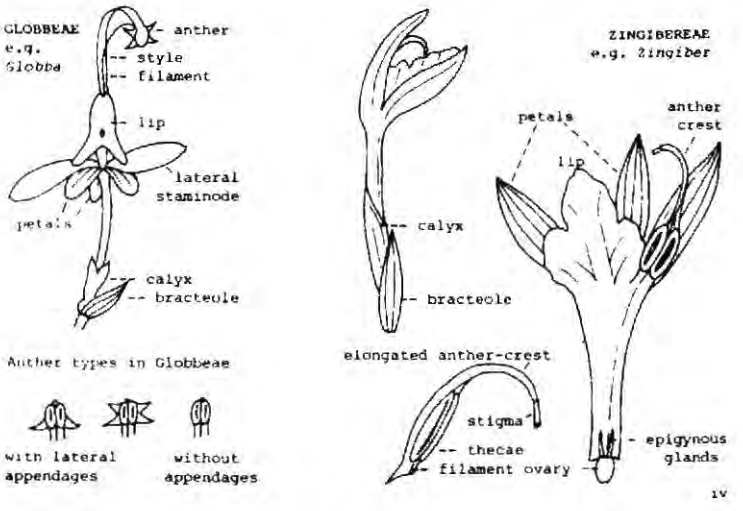

Fig. 4. Flowers and floral parts of *Globba* and *Zingiber* (Smith, 1981).

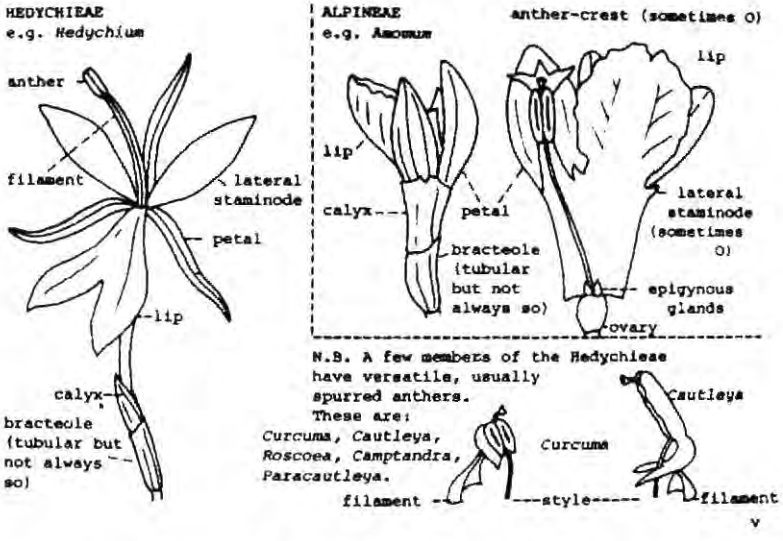

Fig. 5. Flowers and floral parts of *Hedychium*, *Amomum*, and some members of the tribe Hedychieae (Smith, 1981).

The subfamily Zingiberoideae shows the following characteristics: leaves distichously arranged (rarely indistinctly so), leaf shoots occasionally single-leaved; leaf sheaths almost always open on side opposite lamina; lateral staminodes mostly

present; and aromatic oil cells present (Smith, 1981; Burtt and Smith, 1983). In the tribe Zingibereae, the distichy of the leaves is parallel to the rhizome) the lateral staminodes are petaloid, adnate to the lip; the style is exserted well beyond the anther tip, the elongated anther-crest is wrapped around the style; and the ovary is trilocular with axile placentation. The genus *Zingiber* Boehm is a large Asiatic genus, readily distinguished from all other Zingiberaceae by the manner in which the elongated anther-crest enfolds the exserted style, thus giving the stamen a beaked appearance.

The Philippine plant is over a meter tall with distichous leaves, the plane of distichy being parallel to the rhizome (Fig. 6). The inflorescence arises from the rhizome. The leaf sheath is open on the side opposite the leaf blade and the ligule is inconspicuous, about 1 mm long, pubescent (Fig. 7). The inflorescence is an ovoid to elliptic spike borne on the rhizome separately from the leaves (Fig. 8). The peduncle is enclosed by bladeless sheaths. The cream-colored flowers are solitary in the axils of bracts. The bracts are all similar, ovate with an acute tip, pubescent, purplish-brown, green near the edge, with a membranaceous margin.

Fig. 6. Habit of *Zingiber purpureum* Rosc. The leaves are distichous, the plane of distichy being parallel to the rhizome. The inflorescence is an ellipsoid spike arising from the rhizomes.

Fig. 7. The ligule of each leaf is inconspicuous, about 1 mm long, pubescent.

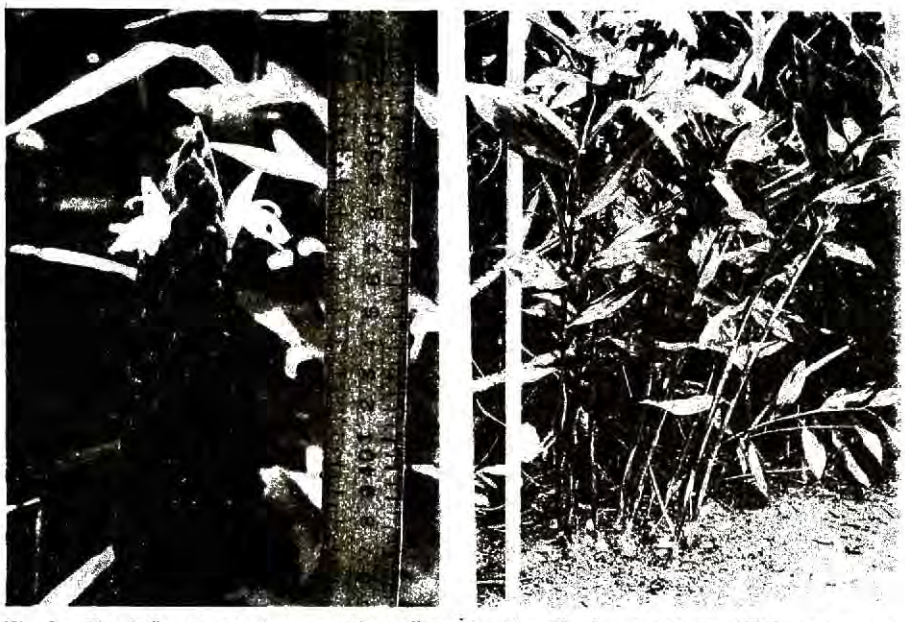

Fig. 8. The inflorescence is an ovoid to ellipsoid spike. The bracts are purplish-brown, green near the edge, with a membranaceous margin. The cream-colored flowers are borne singly in the axils of the bracts of *Z. purpureum*.

Fig. 9. Habit of *Zingiber zerumbet* (L.) Smith. The plant is shorter than *Z. purpureum* with the same leaf arrangement.

Zingiber zerumbet (L.) Smith is a shorter plant with the same leaf arrangement (Fig. 9). The ligule is large, about 1.5 to 3.5 cm long, and papery (Fig. 10). The inflorescence is an ovate spike; the bracts are ovate with an obtuse apex, green in color, turning red after flowering (Fig. 11).

The habit of *Z. purpureum* is illustrated in Fig. 12a. Fig. 12b shows the rhizome and the inflorescence. Figs. 12c and 12d show a portion of the leaf blade and the leaf sheath with a minute, pubescent ligule.

The inflorescence is illustrated in Fig. 13a. The anterior view of the flower is shown in Fig. 13c, the dorsal view in Fig. 13d, and the lateral view in Fig. 13a. Fig. 13b shows a single bract which is about 4.3 cm long and about 3 cm wide, with a characteristic odor when detached. The bracteole or secondary bract is about 2.8 cm long, 1.8 cm wide when spread out, ovate (Figs. 13g, 13h), pubescent, pale green with a faintly purplish margin. The calyx is white, membranaceous, tubular, about 1.7 cm long, 3-toothed at the tip, thinly pubescent, split lengthwise downward to about 1 cm (Fig. 13i). The corolla is cream-colored, tubular, 3-lobed, translucent, about 5.2 cm long; the middle lobe is 2.5 cm long, 1.1 cm wide, upright, concave, with an acute apex (Figs. 13c, 13d, 13e); the lateral lobes, 2.5 cm long, 7 mm wide, curved downward. The labellum or anterior staminode is the conspicuous part of the flower. It is cream-colored and is adnate at the base to the

corolla tube and the filaments. The middle lobe is suborbicular, 2.2 cm broad, with a slightly undulate margin. The apex is shallowly bifid in newly opened flowers, the indention later becoming split toward the base. The lateral lobes (staminodes) are about 6 mm wide, oblong, obtuse (Fig. 13f). The anther-crest, anthers, stigma, style, epigynous glands, and ovary are shown in Fig. 13j. The connective extends about 7 mm beyond the anthers, developing into an anther-crest. The style is slender, the stigma expanded, the aperture lined with short stiff hairs visible with a hand lens. Two epigynous glands or "styloids", about 5 mm long, linear, yellow in color, are outgrowths of the upper surface of the ovary in an antero-lateral position. The inferior ovary is about 1 cm long, 3 mm in diameter, with a trilocular axile placenta (Fig. 13k). The rhizome is creeping, fleshy, aromatic, yellow-orange inside.

Before the plant was identified, its characteristics seemed to be so close to available descriptions of *Z. zerumbet*, that it was thought to be a variety. They are distinguished mainly by the size of the ligule; *Z. zerumbet* has a prominent ligule about 1.5 to 3.5 cm long while *Z. purpureum* has an inconspicuous ligule about 1 mm long.

Fig. 10. The papery ligule is prominent, 1.5 to 3.5 cm long.
Fig. 11. The inflorescence is an ovate spike and the bracts are ovate with an obtuse apex, green in color, turning red after flowering.

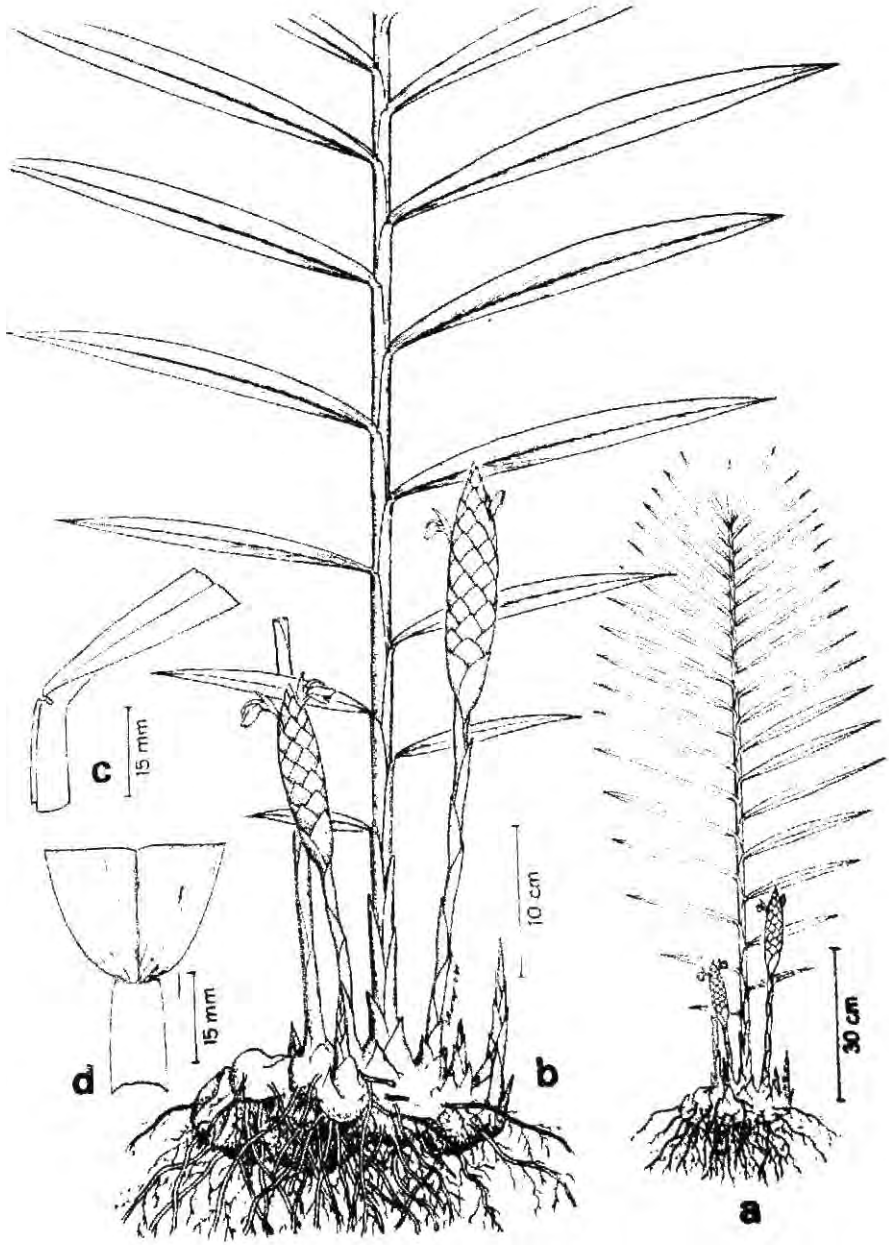

Fig. 12. *Zingiber purpureum* Rosc. a, b, Habit; c, d, Leaf sheath with a small ligule.

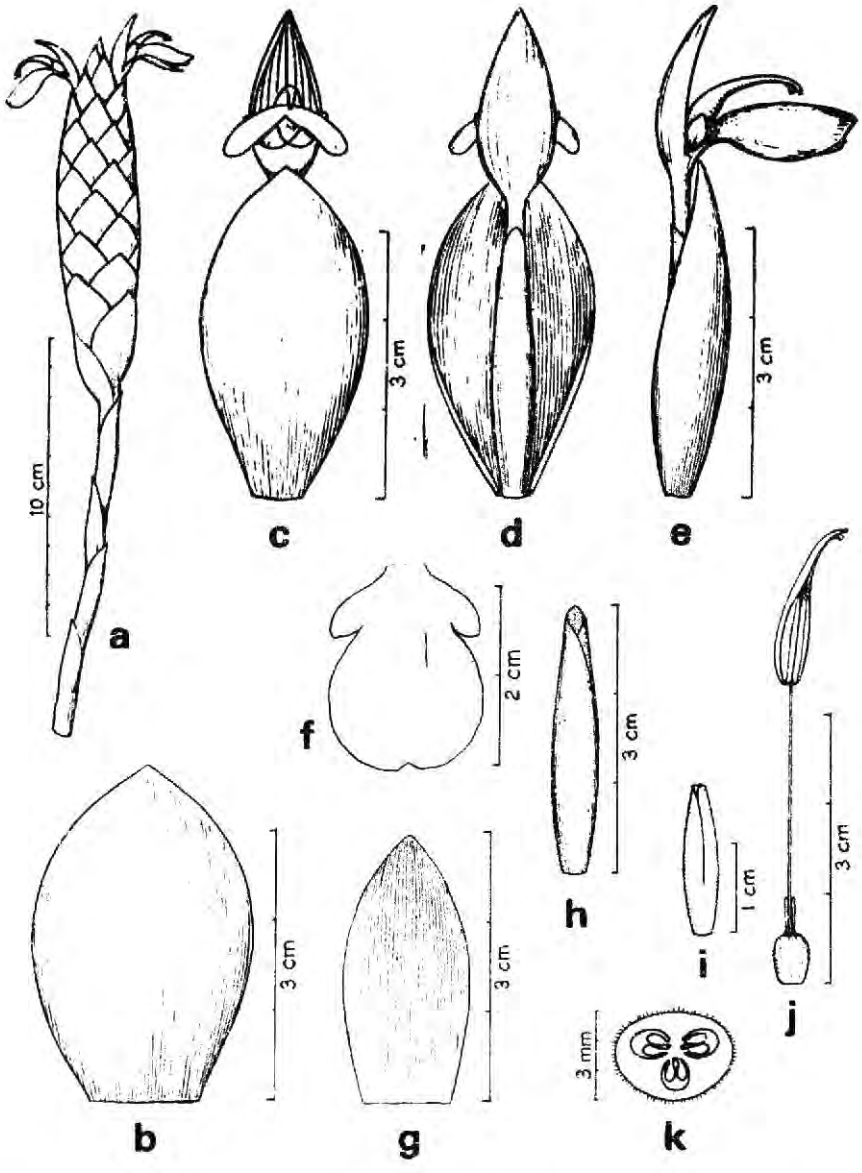

Fig. 13. Inflorescence and floral parts of *Zingiber purpureum* a, Inflorescence with bracts all similar; b, Bract; c, Anterior view of the flower; d, Posterior view of the flower; e, Lateral view of the flower; f, Labellum, cream-colored; g, h, Bracteole; i, White, thin, membraneceous calyx; j, Anther-crest, anthers, stigma, style, epigynous glands, and ovary; k, Transverse section of the ovary with three locules.

The rhizomes sent to Miss Smith at the Royal Botanic Garden at Edinburgh in 1984 grew well and flowered in 1985. She noted that the flowers produced are aberrant in that they are composed of three petals, three petaloid staminodes, and three anthers, the central one clasping the single style. She identified the plant as *Z. purpureum* Rosc. (syn. *Z. cassumunar* Roxb.) which is widely cultivated pantropically for its medicinal properties and is probably native in India.

The original description of *Z. purpureum* by Roscoe (1807) is very brief. The species is listed and described in detail in the Flora of Java (Backer and Bakhuizen, 1968) and in a Revised Handbook to the Flora of Ceylon (Burtt and Smith, 1983). The first person to use the epithet, *Z. purpureum* Rosc., is Alston (In Trimen, Handb. Fl. Ceylon 6:283, 1931). The type species is cultivated in the Liverpool Botanic Garden (Burtt and Smith, 1983). Burtt and Smith give the following as synonyms of *Z. purpureum* Rosc.: *Z. cassumunar* Roxb., *Z. cassumunar* var. *subglabrum* Thw., and *Z. montanum* auct. non (Koenig) Dietr. Steiner (1959) includes *Z. purpureum* Rosc. in her account of the Zingiberaceae of Manila under *Z. cassumunar* Roxb.

Properties of the Volatile Oil

After the identification of the plant was confirmed, the properties of the volatile oil (Oliveros and Cantoria, 1982) were compared (Tables 1 and 2) with those of cassumunar oil as reported in literature (Lawrence, *et al.*, 1970; Casey, *et al.*, 1971). The physical constants are somewhat similar and the principal constituent of both oils is terpinen-4-ol.

Table 1. Physical constants of the volatile oil of *Zingiber purpureum* Rosc. and those of the oil of *Z. cassumunar* Roxb.

Physical Constant	*Oil of Z. purpureum (Oliveros and Cantoria, 1982)*	*Oil of Z. cassumunar (Lawrence, et al., 1970)*	*Oil of Z. cassumunar* (Casey, et al., 1971)*
Refractive index	n_D^{26} 1.4800	n_D^{20} 1.489	1.489
Optical activity	$[\alpha]_D^{26}$ -19.78°	[α]-33°36'	-33.2°
Specific gravity	d^{24} 0.9008	a^{20} 0.894	0.895

*Determined by the methods of British Standard 2073, 1962.

Table 2. Constituents found in both the volatile oil of *Z. purpureum* Rosc. and that of *Z. cassumunar* Roxb.

Oil of Z. purpureum (Oliveros and Cantoria, 1982).	*Oil of Z. cassumunar (Casey, et al., 1971)*
Myrcene (22.29%)	Myrcene
Limonene (0.49%)	Limonene
γ-Terpinene (9.45%)	γ-Terpinene
p-Cymene (2.51%)	*p*-Cymene
α-Terpinene (1.73%)	α-Terpinene
Terpinen-4-ol (45.44%)	Terpinen-4-ol (35%)

Concluding Remarks

This investigation reveals one of the difficulties encountered by plant chemists, namely, the identification of the plant being analyzed for its chemical constituents. Plant taxonomists generally concentrate on one group of plants. It is not unusual for them not to have specific references to help them identify plants belonging to other groups which are brought to them by plant chemists. Furthermore, the use of herbarium specimens is not always adequate and living materials have to be used. Unless one knows who is specializing in the particular plant taxon, it may take time for the plant to be correctly identified. The use of incorrect botanical names has led to some confusion in literature dealing with natural products. It was fortunate that the search by the author led her to Miss Rosemary M. Smith, who was able to identify the Philippine plant, previously thought to be a variety of *Z. zerumbet*, as *Z. purpureum* Rosc. (syn. *Z. cassumunar* Roxb.) Family Zingiberaceae.

Acknowledgments

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