

Review

Plectranthus: A review of ethnobotanical uses

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Abstract

Plectranthus is a large and widespread genus with a diversity of ethnobotanical uses. The genus is plagued with numerous nomenclatural disharmonies that make it difficult to collate accurate data on the uses. The aim of this review is to gather together all ethnobotanical information on *Plectranthus* and to map the data onto the most up-to-date phylogenetic classification in order to see if there are similar uses among related species and hence provide a framework for the prediction and exploration of new uses of species.

The uses of 62 species of *Plectranthus* were mapped onto a current phylogeny based on DNA sequence data. The phylogeny reveals two major Clades, 1 and 2. The members of Clade 1 (corresponding to the formally recognized genus *Coleus*) were richer in number and diversity of uses than members of Clade 2 (comprising the remaining species of *Plectranthus*). The high incidence of synonymy can lead to problems in uncovering a species' ethnobotanical profile. About 30% of all citations of *Plectranthus* use a synonym and most of the synonyms are attributed to 10 of the most used species, 9 of which are in Clade 1.

Members of the 'Coleus' Clade are the most studied group both taxonomically and economically. The higher incidence of study may be as a result of the higher diversity of uses and the fact that species in Clade 1, such as *Plectranthus barbatus*, *Plectranthus amboinicus* and *Plectranthus mollis*, are geographically more widespread than those in Clade 2.

Plectranthus species in Clade 1 are frequently used as medicines and are used to treat a range of ailments, particularly digestive, skin, infective and respiratory problems. *Plectranthus* used as foods, flavours, fodder and materials are also mostly found in Clade 1.

Monoterpenoids, sesquiterpenoids, diterpenoids and phenolics have been reported in species of *Plectranthus*. The abietane diterpenoids are the most diverse of the diterpenoids isolated from species of *Plectranthus*. The labdane diterpenoid, forskolin, occurs in *Plectranthus barbatus* and could explain some of the traditional uses of this species. This review highlights the fact that not enough is known about the chemistry of other species of *Plectranthus* to explain their traditional uses.

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Keywords: *Plectranthus*; Ethnobotanical uses; *Coleus*

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1. Introduction

The family Lamiaceae contains several genera, such as sage (*Salvia*), basil (*Ocimum*) and mint (*Mentha*), with a rich diversity of ethnobotanical uses. Another important genus is *Plectranthus*, a large genus containing about 300 species found in Tropical Africa, Asia and Australia. Some species of *Plectranthus* are difficult to identify because of a lack of clear-cut morphological criteria to discriminate not only among species within the genus but also among the closely related genera. This has resulted in numerous taxonomic problems in the naming of species with the result that species have often been placed in several closely related genera like *Coleus*, *Solenostemon* and *Englerastrum*. In addition, some species formally placed in *Plectranthus*, are now recognized as the more distantly related *Isodon* (Paton et al., 2004).

Because of these taxonomic issues, different names have been used for the same species of *Plectranthus* and thus it has been difficult to collate information about the ethnobotanical uses of this genus. Furthermore, the most commonly used medicinal species of *Plectranthus* have a high degree of synonymy. This review aims to collate data about the different uses of species of *Plectranthus*, held in disparate sources and frequently under several synonymous Latin names. Information about the uses of the different species was gathered from searching the published literature using the databases NAPRALERT (Pharmacological Sciences (PCRPS), College of Pharmacy, University of Illinois), Web of Science (<http://isiknowledge.com>), CAB-direct (<http://www.cabdirect.org>), SEPASAL (<http://www.kew.org/ceb/sepasal>), Ingenta connect (<http://www.ingentaconnect.com/?jsessionid=fq5k5kaeOrgi9.victoria>), Medline (<http://medline.cos.com>), Kew Library Catalogue, Elsevier ScienceDirect (www.sciencedirect.com), Dr. Duke's database (<http://www.ars-grin.gov/duke/ethnobot.html>) as well as looking through the Floras of countries in Africa, South America, Asia and Australia. Terms used in the searches included 'ethnobotany, traditional uses, chemicals, phytochemistry, of *Plectranthus*, *Coleus*, *Solenostemon*, *Anisochilus* and *Tetradenia*'. All voucher specimens of *Plectranthus* and *Coleus* as well as relevant ones of in *Solenostemon* in herbaria at Kew (K), British Museum (BR), East Africa (EA) and Nairobi (NAI) were also

examined to verify the different synonyms used to describe the species and to examine them for notes about their uses. Collectors often made notes either on their vouchers or in their field notebooks about the local use made of species they collect. (Herbarium vouchers cited in the text and/or tables are given at the end of the reference section.) Finally, the ethnobotanical data were mapped onto the most recent phylogeny of the genera (Paton et al., 2004) to see if there is any relationship among species of *Plectranthus* with similar ethnobotanical uses.

2. Synonymy

This review covers the ethnobotanical uses of 62 species of *Plectranthus* and about 30% of the literature citations covered by this review use synonyms to describe these species. The 10 species with the most uses also have the greatest number of synonyms. For example, *Plectranthus barbatus* Andr. has commonly been referred to as *Plectranthus forskohlii* Briq., *Plectranthus forskalaei* Willd., *Plectranthus kilimandschari* (Gürke) H.L. Maass., *Plectranthus grandis* (Cramer) R.H. Willemse, *Coleus forskohlii* Briq., *Coleus kilimandschari* Gürke ex Engl., *Coleus coerulescens* Gürke and *Coleus barbatus* (Andr.) Benth. *Plectranthus amboinicus* synonyms include *Plectranthus aromaticus* Roxb., *Coleus aromaticus* Benth. and *Coleus amboinicus* Lour. Those of *Plectranthus esculentus* N.E.Br are *Coleus esculentus* (N.E.Br.) G. Tayl., *Coleus dazo* A. Chev. and *Coleus floribundus* N.E.Br. and that of *Plectranthus vettiveroides* (K.C. Jacob) H.I. Maass is *Coleus vettiveroides* K.C. Jacob. Those of *Plectranthus laxiflorus* Benth. and *Plectranthus mollis* (Aiton) Spreng. are *Plectranthus albus* Gürke and *Plectranthus incanus* Link, respectively. Synonyms of *Plectranthus rotundifolius* (Poir.) Spreng. are *Coleus rotundifolius* (Poir.) A. Chev. & E. Perrot, *Coleus dysentericus* Bak., *Solenostemon rotundifolius* (Poir.) J.K. Morton and *Plectranthus tuberosus* Blume. *Plectranthus alpinus* (Vatke) O. Ryding has been called *Coleus assurgens* Bak. and *Plectranthus assurgens* (Bak.) J.K. Morton. *Plectranthus aegyptiacus* (Forssk.) C. Chr. is called *Plectranthus tenuiflorus* (Vatke) Agnew, whereas *Plectranthus hadiensis* (Forssk.) Schweinf. ex Spreng. is referred to as *Plectranthus zeylanicus* Benth., *Plectranthus cyaneus* Gürke ex Engler and *Plectranthus zatarhendi* (Benth.) E.A. Bruce. The percentage of synonymy would rise if the species *Plectranthus vettiveroides* (K.C. Jacob)

H.I. Maass, which is thought to be conspecific with *Plectranthus rotundifolius* (Poir.) Spreng., is reduced to synonymy under the latter name, as it is the earliest name.

The lack of an up-to-date, authoritative synonymised checklist is a significant barrier to synthesizing knowledge on plant-use from the diverse and fragmented data sources available. The need for such checklists has been identified in other disciplines: for example, in the Global Strategy for Plant Conservation (UNEP, 2004). The fact that most taxonomic revisions of *Plectranthus* have tended to be regional rather than global could have contributed to the confusion that has ensured the use of multiple taxonomic names to describe the same species. Another issue is the range of common names that can be used for different species of *Plectranthus*, but collating this information is beyond the remit of this review.

3. Ethnobotanical uses

The ethnobotanical data collated for this review have been grouped using the categories in Economic Botany Data Collection Standard (Cook, 1995). A summary of the different ethnobotanical uses of the 62 best documented species of *Plectranthus* is presented in Tables 1 and 2.

3.1. Medicine

The most frequently cited use of species of *Plectranthus* is for their medicinal properties, which accounts for over 85% of all uses. *Plectranthus amboinicus* and *Plectranthus barbatus* are used to treat a wide range of diseases (13 categories) and accounts for about 68% of all traditional uses of the genus (Tables 1 and 2). *Plectranthus laxiflorus* is used in 10 categories, *Plectranthus mollis* in 8 categories, both *Plectranthus vettiveroides* and *Plectranthus aegyptiacus* in 6, *Plectranthus montanus* (syn. *Plectranthus cylindraceus*) in 5 and both *Plectranthus sylvestris* and *Plectranthus bojeri* in 4. The rest of the species are used in one to three categories (Table 1).

3.1.1. Digestive conditions

Disorders of the digestive system are treated using 21 species of *Plectranthus* (Table 1). Species are used to treat stomach pain, nausea, vomiting, diarrhoea, mouth and throat infections and are used as purgatives, carminatives and as anthelmintics. *Plectranthus barbatus*, *Plectranthus amboinicus*, *Plectranthus laxiflorus*, *Plectranthus esculentus* and *Plectranthus vettiveroides* are the most frequently used species and *Plectranthus barbatus* and *Plectranthus amboinicus* are used to treat a wide variety of digestive problems. For instance, *Plectranthus barbatus* is used for the treatment of stomachache and as a purgative (Rounce, 1933; Jarrett, 1950; Johns et al., 1990; Kokwaro, 1993; Simon and Mollel, 1999), for nausea (Hamill et al., 2003) and for gastritis and intestinal spasms in Brazil (Camara et al., 2003). *Plectranthus amboinicus* is popular in the treatment of dyspepsia, indigestion, diarrhoea and as a carminative in India and Africa (Morton, 1992; Gurib-Fakim et al., 1996; Jain and Lata, 1996; Ong and Nordiana, 1999). *Plectranthus caninus*, *Plectranthus laxiflorus* and *Plectranthus barbatus* are used in the treatment of teeth and gum disorders (Hulme,

1954; Kokwaro, 1993; Meyerhoff, 1978b). *Plectranthus laxiflorus* is also used as a purgative (Kokwaro, 1993), while *Plectranthus defoliatus* is used to treat diarrhoea (Schlage et al., 2000). *Plectranthus vettiveroides* is used in India to treat stomachaches, dyspepsia, nausea and vomiting (Dash and Kashyap, 1987; Yoganarasimhan, 2000). *Plectranthus esculentus* and the leaves of *Plectranthus aegyptiacus* are also used to treat stomachache (Morris, 1996; Parkia and Cooke, 2003). In Eastern and Southern Africa, both *Plectranthus elegans* and *Plectranthus esculentus* are reported to be used as anthelmintics (Kokwaro, 1993; Burkill, 1995; Allemann et al., 2004).

3.1.2. Skin conditions

A total of 20 species are recorded as being used for skin conditions (Table 1). *Plectranthus barbatus* and *Plectranthus amboinicus* are the most frequently cited species for the treatment of burns, wounds, sores, insect bites and allergies. In Kenya and the Democratic Republic of Congo, *Plectranthus barbatus* is used in the treatment of wounds and ringworms (Githinji and Kokwaro, 1993; Chifundera, 2001), to reduce swelling on bruises (Gentry, 1970) and for bathing babies suffering from measles (Kokwaro, 1993). This species has anti-ageing effects in combination with tocotrienol (Adachi et al., 1996). The whole plant contains a forskolin-like compound that is used in hair dyeing (Sugiyama et al., 1988). In addition, *Plectranthus barbatus* contains an essential oil that exhibits anti-allergic activities through passive cutaneous anaphylaxis inhibition (Gupta et al., 1993a). *Plectranthus amboinicus* is used in Brazil for the treatment of skin ulcerations caused by *Leishmania braziliensis* (França et al., 1996). It is also used to treat burns and as a poultice for centipedes and scorpion bites in Malay (Morton, 1992). In India, the juice of the leaves is used to treat skin allergies (Harsha et al., 2003). Other species used to treat skin allergies include *Plectranthus amboinicus* (Harsha et al., 2003) and *Plectranthus asirensis* which is used in Saudi Arabia for diaper rash and itching, as well as an antiseptic dressing (Abulfatih, 1987a,b). The leaves of *Plectranthus congestus* are used in Papua New Guinea as an antiseptic dressing for wounds (Holdsworth, 1977; Woodley, 1991) and in the treatment of scabies (Holdsworth and Rali, 1989). *Plectranthus madagascariensis* is also used in the treatment of scabies and small wounds (Watt and Breyer-Brandwijk, 1962; Roberts, 1990; Rabe and van Staden, 1998; Neuwinger, 2000), the finely ground leaves of *Plectranthus bojeri* are applied as dressing on wounds and abscesses (Neuwinger, 2000), *Plectranthus laxiflorus* is rubbed onto the skin to treat leprosy (Chifundera, 2001), *Plectranthus vettiveroides* is a hair tonic (Yoganarasimhan, 2000) and *Plectranthus fruticosus* was used in traditional Romanian medicine for its healing properties, especially for treating burns (Pages et al., 1991). *Plectranthus ecklonii* is used in Zimbabwe to treat skin infections (Nyanyiwa and Gundidza, 1999) while in Rwanda, the essential oil of *Plectranthus sylvestris* is used to treat skin diseases (Chalchat et al., 1996).

3.1.3. Respiratory conditions

A total of 15 species are recorded for the treatment of respiratory conditions. *Plectranthus barbatus* is the most fre-

Table 1
Medicinal uses of species of *Plectranthus* categories are defined in Cook (1995)

Species	Synonyms encountered in the study	Geographical distribution	Medicinal categories						
			Digestive	Skin	Respiratory	Infections/fevers	Genito-urinary	Pain	Muscular–skeletal
<i>Plectranthus aegypticus</i> (Forssk.) C. Chr.	<i>Plectranthus tenuiflorus</i> (Vatke) Agnew	Arabia, East and Northeast Tropical Africa	Parkia and Cooke (2003)		Al-Yahya et al. (1985)	Abulfatih (1987b), Othman and Shoman (2004)	Parkia and Cooke (2003)		
<i>Plectranthus alpinus</i> (Vatke) O. Ryding	<i>Plectranthus assurgens</i> (Baker) J.K. Morton	East and Central Africa		Burkill (1995)				Hedberg et al. (1983), Neuwinger (2000)	
<i>Plectranthus ambiguus</i> (Bolus) Codd		South Africa			Hulme (1954), Hutchings et al. (1996), Rabe and van Staden (1998), Neuwinger (2000)				
<i>Plectranthus amboinicus</i> (Lour.) Spreng.	<i>Coleus amboinicus</i> Lour., <i>Coleus aromaticus</i> Benth., <i>Plectranthus aromaticus</i> Roxb.	North, East, Central Africa, Asia, South America, Caribbean, Pacific	Meyerhoff (1978c), Bos et al. (1983), de Padua (1988), Morton et al. (1996), Neuwinger (2000), Harsha et al. (2003)	de Padua (1988), Morton (1992), Franca et al. (1996), Harsha et al. (2003)	Ayensu (1978), de Padua (1988), Morton (1992), Jain and Lata (1996), Castillo and González (1999), Yoganarasimhan (2000), Cano and Volpato (2004)	Morton (1992), Gurib-Fakim et al. (1996), Jain and Lata (1996), Harsha et al. (2002)	Morton (1992), Jain and Lata (1996), Ayensu (1998), Neuwinger (2000), Yoganarasimhan (2000)	Meyerhoff (1978c), de Padua (1988)	Meyerhoff (1978c)
<i>Plectranthus asirensis</i> J.R.I. Wood		Arabia		Abulfatih (1987a,b)					
<i>Plectranthus barbatus</i> Andr.	<i>Coleus kilimandschari</i> Gurke ex Engl., <i>Coleus barbatus</i> (Andr.) Benth., <i>Coleus forskohlii</i> Briq., <i>Coleus comosus</i> A. Rich., <i>Plectranthus kilimandschari</i> (Gürke) H.L. Maas, <i>Plectranthus forskohlii</i> auct Briq.	North, East, Central Africa, Asia, South America	Bally (1934, 1937), Jarrett (1950), Hulme (1954), Meyerhoff (1978a,b,c), Baerts and Lehmann (1989), Johns et al. (1990), Githinji and Kokwaro (1993), Gupta et al. (1993a,b), Kokwaro (1993), Rwangabo (1993), Johns et al. (1995), Rounce (1933), Rodríguez et al. (1995), Simon and Mollel (1999), Neuwinger (2000), Yoganarasimhan (2000), Chifundera (2001), Geissler et al. (2002), Camara et al. (2003), Costa and Nascimento (2003), Hamill et al. (2003)	Baerts and Lehmann (1989), Gachathi (1989), Kokwaro (1993), Rwangabo (1993), Neuwinger (2000), Chifundera (2001)	Bouquet (1969), Boily and van Puyvelde (1986), Baerts and Lehmann (1989), van Puyvelde et al. (1994), Rajendran et al. (1999), Yoganarasimhan (2000), Chifundera (2001), Cos et al. (2002), Benerjee (2003), Schanberg and Ikan (2003)	Williams (1975), Holdsworth (1977), Milliken (1977), Meyerhoff (1978b), Baerts and Lehmann (1989), Githinji and Kokwaro (1993), Gupta et al. (1993a,b), Rwangabo (1993), Rajendran et al. (1999), Neuwinger (2000), Matu and van Staden (2003), Vigneron et al. (2005)	Watt and Breyer-Brandwijk (1962), Innamorati (1973), Boily and van Puyvelde (1986), Rwangabo (1993), Neuwinger (2000), Chifundera (2001), Cos et al. (2002)	Newwinger (2000), Yoganarasimhan (2000), Chifundera (2001)	Baerts and Lehmann (1989), Githinji and Mwangangi (1989), Githinji and Kokwaro (1993), Kokwaro (1993), Rwangabo (1993), Neuwinger (2000)
<i>Plectranthus beddomei</i> Raiz.		India		Rajendran et al. (1999)					
<i>Plectranthus bojeri</i> (Benth.) Hedge		Madagascar		Newwinger (2000)	Newwinger (2000)				
<i>Plectranthus caninus</i> Roth		East Tropical Africa	Kokwaro (1993), Neuwinger (2000)		Githinji (1990), Githinji and Kokwaro (1993)				

<i>Plectranthus coeruleus</i> (Gürke) Agnew		East Tropical Africa							Neuwinger (2000)
<i>Plectranthus congestus</i> R.Br.		Australia		Holdsworth (1977), Holdsworth and Rali (1989), Woodley (1991)					Woodley (1991)
<i>Plectranthus decurrens</i> (Gürke) J.K. Morton	<i>Plectranthus varitifolius</i> De Wild	Africa-DRC		Neuwinger (2000)					
<i>Plectranthus defoliatus</i> Hochst. ex Benth.		Asia Tropical		Schlage et al. (2000)					
<i>Plectranthus ecklonii</i> Benth.		South Africa		Nyanyiwa and Gundidza (1999)					
<i>Plectranthus edulis</i> (Vatke) Agnew		East Tropical Africa		Githinji and Kokwaro (1993)				Neuwinger (2000)	
<i>Plectranthus elegans</i> Britten		East and Southern Africa		Kokwaro (1993), Neuwinger (2000)				Bally (1937), Githens (1949), Neuwinger (2000)	Morris (1996)
<i>Plectranthus esculentus</i> N.E.Br.	<i>Coleus dazo</i> A. Chiev., <i>Coleus esculentus</i> G. Tayl., <i>Plectranthus floribundus</i> N.E.Br.	Southern Africa, West-Central Africa, Asia Tropical		Burkill (1995), Neuwinger (2000)					Morris (1996), Neuwinger (2000)
<i>Plectranthus fruticosus</i> L'Her.		South Africa		Pages et al. (1991)					
<i>Plectranthus glandulosus</i> Hook.f.	<i>Plectranthus urticoides</i> Baker	West-Central Africa-Cameroon						Ngassoum (2001)	
<i>Plectranthus grallatus</i> Briq.		South Africa							
<i>Plectranthus hadiensis</i> (Forssk.) Schweinf. ex Spreng.	<i>Plectranthus zeylanicus</i> Benth., <i>Plectranthus cyaneus</i> Gürke ex Engler, <i>Plectranthus zatarhendi</i> (Benth.) E.A. Bruce	Northeast and East Tropical Africa to India		Mehrotra et al. (1989)	Tanner (1959)			Hutchings et al. (1996)	
<i>Plectranthus hereoensis</i> Engl.	<i>Plectranthus myrianthus</i> Briq.	Sothorn Africa		Batista et al. (1995), Ferraeira et al. (1997)					
<i>Plectranthus igniarius</i> (Schweinf.) Agnew		East Tropical Africa			Timberlake (1987)				Lusigi et al. (1984)
<i>Plectranthus insignis</i> Hook.f.		West-Central Africa-Cameroon		Cheek et al. (2000)					
<i>Plectranthus kamerunensis</i> (Gürke)		West and East Tropical Africa		Githinji and Kokwaro (1993)	Githinji and Kokwaro (1993)				
<i>Plectranthus lactiflorus</i> (Vatke) Agnew.		East Tropical Africa-Tanzania		Tanner (1961b)					
<i>Plectranthus lanceolatus</i> Bojer ex Benth.		Africa-Malgaches						Neuwinger (2000)	Neuwinger (2000)
<i>Plectranthus lanuginosus</i> (Benth.) Agnew.		East Tropical Africa		Kokwaro (1993), Wirtu et al. (1997), Neuwinger (2000)					
<i>Plectranthus laxiflorus</i> Benth.	<i>Plectranthus albus</i> Gürke	West-Central Africa, East and Southern Africa		Roberts (1990), Kokwaro (1993), Hutchings et al. (1996), Rabe and van Staden (1998), Neuwinger (2000)	Kakudidi et al. (1996), Neuwinger (2000), Chifundera (2001)	Hutchings et al. (1996), Rabe and van Staden (1998), Neuwinger (2000)	Watt and Breyer-Brandwijk (1962), Roberts (1990), Hutchings et al. (1996), Rabe and van Staden (1998)	Lindsay and Hepper (1978), Kokwaro (1985), Neuwinger (2000)	Kokwaro (1993), Neuwinger (2000)
<i>Plectranthus longipes</i> Baker	<i>Plectranthus amaniensis</i> Gürke	East Tropical Africa-Kenya		Neuwinger (2000)					

Table 1 (Continued)

Species	Synonyms encountered in the study	Geographical distribution	Medicinal categories						
			Digestive	Skin	Respiratory	Infections/fevers	Genito-urinary	Pain	Muscular–skeletal
<i>Plectranthus madagascarensis</i> Benth.	<i>Plectranthus hirtus</i> Benth.	Southern Africa		Holdsworth (1977), Roberts (1990), Rabe and van Staden (1998), Neuwinger (2000)	Githens (1949), Roberts (1990), Rabe and van Staden (1998), Neuwinger (2000)				
<i>Plectranthus mandalensis</i> Baker		Africa–Malawi							Morris (1996)
<i>Plectranthus melleri</i> Baker	<i>Plectranthus luteus</i> Gürke	East Africa Madagascar					Yamada (1999)		
<i>Plectranthus mollis</i> (Aiton) Spreng.	<i>Plectranthus incanus</i> Link	India		Jain et al. (1994)	Yoganarasimhan (2000)	Yoganarasimhan (2000)			Sebastian and Bhandari (1984), Yoganarasimhan (2000)
<i>Plectranthus montanus</i> Benth.	<i>Plectranthus cylindraceus</i> Hochst. ex Benth.	East Tropical Africa	Timberlake (1987), Githinji and Kokwaro (1993), Kokwaro (1993)		Rahman et al. (2004)	Kokwaro (1993)		Kokwaro (1993)	
<i>Plectranthus parviflorus</i> (Poir.) Henckel	<i>Plectranthus australis</i> R.Br., <i>Coleus parviflorus</i> Benth.	Australia, Pacific					Tewtrakul et al. (2003)		
<i>Plectranthus prostratus</i> Gürke		East Tropical Africa, Uganda						Mugisha (2002)	
<i>Plectranthus pseudomarrubioides</i> Willemse		East Tropical Africa, Asia temperate		Luke (2004)					
<i>Plectranthus pubescens</i> Baker		Malawi							Morris (1996)
<i>Plectranthus punctatus</i> L'Her.		Northeast and East Tropical Africa–Ethiopia					Hedberg (1979)		
<i>Plectranthus stachyoides</i> Oliv.		East Tropical Africa–Tanzania		Tanner (1961a)					
<i>Plectranthus stolzii</i> Gilli		East Tropical Africa–Tanzania			Gaetan (1952)				
<i>Plectranthus sylvestris</i> Gürke		East and Central Africa	Githinji and Kokwaro (1993)	Chalchat et al. (1996), Neuwinger (2000)		Kokwaro (1993), Neuwinger (2000), Meyerhoff (1978a)		Kokwaro (1993), Neuwinger (2000)	
<i>Plectranthus tetensis</i> (Bak.) Agnew		East Tropical Africa							
<i>Plectranthus vettiveroides</i> (K.C. Jacob) H.I. Maass	<i>Coleus vettiveroides</i> K.C. Jacob	Asia Tropical–India	Dash and Kashyap (1987), Yoganarasimhan (2000)	Yoganarasimhan (2000)		Yoganarasimhan (2000)	Yoganarasimhan (2000)		
<i>Plectranthus</i> sp.		Asia Tropical–Papua New Guinea						Holdsworth (1977)	
<i>Plectranthus</i> sp.		East Tropical Africa–Tanzania	Tanner (1961c)	Kokwaro (1993)					

Species	Synonyms encountered in the study	Geographical distribution	Medicinal categories					
			Circulatory and blood	Nervous	Sensory	Poisons treatment	Unspecific	Inflammation
<i>Plectranthus aegypticus</i> (Forssk.) C. Chr.	<i>Plectranthus tenuiflorus</i> (Vatke) Agnew	Arabia, East and Northeast Tropical Africa			Abulfatih (1987b)			Othman and Shoman (2004)
<i>Plectranthus alpinus</i> (Vatke) O. Ryding	<i>Plectranthus assurgens</i> (Baker) J.K. Morton	East and Central Africa		Hedberg et al. (1983)				
<i>Plectranthus amboinicus</i> (Lour.) Spreng.	<i>Coleus amboinicus</i> Lour., <i>Coleus aromaticus</i> Benth., <i>Plectranthus aromaticus</i> Roxb.	North, East, Central Africa, Asia, South America, Caribbean, Pacific	Morton (1992), Neuwinger (2000)	Ayensu (1978), Morton (1992), Jain and Lata (1996), Ruiz et al. (1996), Salmán et al. (1996), Neuwinger (2000), Camara et al. (2003)	Zepernick (1972), Morton (1992)	Yoganarasimhan (2000)	Kuebel and Tucker (1988), Prudent et al. (1995), França et al. (1996), Hutchings et al. (1996), Bennett and Prance (2000)	Morton (1992)

<i>Plectranthus barbatus</i> Andr.	<i>Coleus kilimandschari</i> Gurke ex Engl., <i>Coleus barbatus</i> (Andr.) Benth., <i>Coleus forskohlii</i> Briq., <i>Coleus comosus</i> A. Rich., <i>Plectranthus kilimandschari</i> (Gürke) H.L. Maass, <i>Plectranthus forskohlii</i> auct Briq.	North, East, Central Africa, Asia, South America	Neuwinger (2000), Yoganarasimhan (2000), Chifundera (2001)	Neuwinger (2000), Chifundera (2001)	Baerts and Lehmann (1989), Neuwinger (2000), Geissler et al. (2002), Benerjee (2003)	Greenway (1946), Tanner (1946), Akendenué and Louis (1994)	Fratkin (1975), Caufield (1978), Githinji and Kokwaro (1993), Svoboda (1996), Barnett (2000), Bennett and Prance (2000), Byavu et al. (2000)	Yoganarasimhan (2000), Chifundera (2001)
<i>Plectranthus bojeri</i> (Benth.) Hedge		Madagascar			Neuwinger (2000)	Neuwinger (2000)		
<i>Plectranthus congestus</i> R.Br.		Australia					Maiden (1899)	
<i>Plectranthus edulis</i> (Vatke) Agnew		East Tropical Africa					Githinji (1990), Lukhoba and Mathenge (1993) Pages et al. (1991)	
<i>Plectranthus fruticosus</i> L'Her.		South Africa						
<i>Plectranthus glandulosus</i> Hook.f.	<i>Plectranthus urticoides</i> Baker	West-Central Africa–Cameroon					Cheek et al. (2000)	
<i>Plectranthus grallatus</i> Briq.		South Africa					Hutchings et al. (1996)	
<i>Plectranthus grandidentatus</i> Gürke			Cerqueira et al. (2004)					
<i>Plectranthus hadiensis</i> (Forssk.) Schweinf. ex Spreng.	<i>Plectranthus zeylanicus</i> Benth., <i>Plectranthus cyaneus</i> Gürke ex Engler, <i>Plectranthus zatarhendi</i> (Benth.) E.A. Bruce	Northeast and East Tropical Africa to India						Neuwinger (2000)
<i>Plectranthus igniarius</i> (Schweinf.) Agnew		East Tropical Africa			Timberlake (1987)			
<i>Plectranthus kivuensis</i> (Lebrun & Touss.) R.H. Willems		East Tropical Africa					Napier (1933)	
<i>Plectranthus lanceolatus</i> Bojer ex Benth.		Africa–Malgaches						
<i>Plectranthus lanuginosus</i> (Benth.) Agnew.		East Tropical Africa						
<i>Plectranthus laxiflorus</i> Benth.	<i>Plectranthus albus</i> Gürke	West-Central Africa, East and Southern Africa		Kakudidi et al. (1996)	Lindsay and Hepper (1978), Neuwinger (2000)			Kokwaro (1993), Neuwinger (2000)
<i>Plectranthus longipes</i> Baker	<i>Plectranthus amaniensis</i> Gürke	East Tropical Africa–Kenya					Neuwinger (2000)	
<i>Plectranthus madagascarensis</i> Benth.	<i>Plectranthus hirtus</i> Benth.	Southern Africa					Fleurentin et al. (1983)	
<i>Plectranthus mandalensis</i> Baker		Africa–Malawi		Morris (1996)				
<i>Plectranthus mollis</i> (Aiton) Spreng.	<i>Plectranthus incanus</i> Link	India	Yoganarasimhan (2000)	Singh and Ali (1992)		Jain et al. (1994)	Sebastian and Bhandari (1984) Fleurentin et al. (1983), Barnett (2000) Harvey et al. (2004)	
<i>Plectranthus montanus</i> Benth.	<i>Plectranthus cylindraceus</i> Hochst. ex Benth.	East Tropical Africa						
<i>Plectranthus occidentalis</i> B.J. Pollard	<i>Solenostemon mannii</i> (Hook. f.) Baker	West Africa						

Table 1 (Continued)

Species	Synonyms encountered in the study	Geographical distribution	Medicinal categories		Sensory	Poisons treatment	Unspecific	Inflammation
			Circulatory and blood	Nervous				
<i>Plectranthus pubescens</i> Baker		Maliawi		Morris (1996)				
<i>Plectranthus punctatus</i> L'Her.		Northeast and East Tropical Africa-Ethiopia			Hedberg (1979)			
<i>Plectranthus</i> sp. aff. <i>occidentalis</i> Gilli		West Tropical Africa					Leeuwenberg (1972)	
<i>Plectranthus stolzii</i>		East Tropical Africa-Tanzania					Gaetan (1952), Cunningham and Bangyira (1992) Shankar and Majumdar (1995), Tandon (1996) Lovett and Kayombo (1989a,b)	
<i>Plectranthus vetiveroides</i> (K.C. Jacob) H.I. Maass <i>Plectranthus viphysensis</i> Brunnmitt & J.H. Seyani	<i>Coleus vetiveroides</i> K.C. Jacob	Asia Tropical-India East Tropical Africa-Tanzania		Yoganarasimhan (2000)				

quently cited species used to relieve colds (Rajendran et al., 1999), cough (Baerts and Lehmann, 1989; Neuwinger, 2000; Yoganarasimhan, 2000; Chifundera, 2001), bronchitis (Boily and van Puyvelde, 1986; Cos et al., 2002), pneumonia (Bouquet, 1969) and for general respiratory ailments (van Puyvelde et al., 1994). Studies have shown that it reverses allergic bronchospasm (Kreutner et al., 1985). *Plectranthus amboinicus* is also frequently cited in the treatment of chronic coughs, asthma, bronchitis and sore throat in India and the Caribbean (Morton, 1992; Jain and Lata, 1996; Ruiz et al., 1996), and in Cuba it is used to treat catarrhal infections and asthma (Castillo and González, 1999; Cano and Volpato, 2004). The leaves of *Plectranthus amboinicus* have been found to have bronchodilator activity in guinea pig and anti-*Mycobacterium tuberculosis* activity (Carbajal et al., 1991; Frame et al., 1998). *Plectranthus madagascariensis* is used for colds (Githens, 1949), cough and chest complaints (Watt and Breyer-Brandwijk, 1962; Rabe and van Staden, 1998; Neuwinger, 2000) and asthma (Roberts, 1990). A decoction of the whole plant of *Plectranthus bojeri*, together with *Ocimum gratissimum*, is drunk to treat pneumonia (Neuwinger, 2000). *Plectranthus aegyptiacus* is used in Saudi Arabia, for the treatment of sore throats and laryngitis (Al-Yahya et al., 1985) and in Kenya, *Plectranthus elegans* is used to alleviate sore throats (Bally, 1937). *Plectranthus montanus* (Rahman et al., 2004) and *Plectranthus tetensis* (Meyerhoff, 1978a) are used to treat sore throats. *Plectranthus mollis* is used in India as a respiratory stimulant and vasoconstrictor (Yoganarasimhan, 2000), while extracts from the roots of *Plectranthus caninus* are used in Kenya for the treatment of coughs (Githinji, 1990). In South Africa, tea made from the leaves of *Plectranthus laxiflorus* is taken for coughs and colds (Hutchings et al., 1996; Rabe and van Staden, 1998) and an infusion of the crushed leaves of *Plectranthus ambiguus* is mixed with a little hot water and sipped for coughs (Hulme, 1954; Hutchings et al., 1996). The roots of *Plectranthus stolzii* are eaten in Tanzania for coughs (Gaetan, 1959).

3.1.4. Infections and fever

Fifteen species have been recorded for the treatment of infections and fever. *Plectranthus barbatus* is used to treat a range of infections including throat and mouth infections (Meyerhoff, 1978b), tonsillitis (Neuwinger, 2000), gastro-intestinal infections (Baerts and Lehmann, 1989; Gupta et al., 1993b), genitourinary infections (Rwangabo, 1993; Neuwinger, 2000) as well as ear and eye infections (Baerts and Lehmann, 1989). It is used to treat malaria in Brazil and to break fevers in East Africa and India (Holdsworth, 1977; Rwangabo, 1993; Githinji and Kokwaro, 1993; Milliken, 1977; Rajendran et al., 1999; Neuwinger, 2000; Schlage et al., 2000; Steele et al., 2002), whereas in Kenya it is used for the treatment of East Coast Fever in cattle (Ole-Marion, 2003). The whole plant is said to have antibacterial, antiviral and antifungal activity (Boily and van Puyvelde, 1986; van Puyvelde et al., 1994; Vlietinck et al., 1995; Alasbahi et al., 1999; Cos et al., 2002; Matu and van Staden, 2003) and against protozoa, such as *Giardia* (Johns et al., 1995). *Plectranthus amboinicus* is important in Asia and South America for the treatment of fevers (Morton, 1992; Harsha et

Table 2
Non-medicinal uses of species of *Plectranthus*

Species	Synonyms encountered in the study	Geographical distribution	Non-medicinal uses													
			Poisons	Ornamentals	Hedges	Soil improvers	Food	Food additives	Animal feeds	Materials	Social uses	Bees				
<i>Plectranthus aegypticus</i> (Forssk.) C. Chr.	<i>Plectranthus tenuiflorus</i> (Vatke) Agnew	Arabia, East and Northeast Tropical Africa														Rahman et al. (2004)
<i>Plectranthus alpinus</i> (Vatke) O. Ryding	<i>Plectranthus assurgens</i> (Baker) J.K.Morton	East and Central Africa		Cheek et al. (2000)												
<i>Plectranthus amboinicus</i> (Lour.) Spreng.	<i>Coleus amboinicus</i> Lour., <i>Coleus aromaticus</i> Benth., <i>Plectranthus aromaticus</i> Roxb.	North, East, Central Africa, Asia, South America, Caribbean, Pacific		Schoelhorn (2002)				Dymoc (1885)	Epling (1981), Purselove (1987), Craig and Mayenda (1990), Mayenda (1991), Morton (1992), Prudent et al. (1995), Brown (1997)		Yuncker (1953), Morton (1992), Prudent et al. (1995)	Morton (1992), Prudent et al. (1995)				
<i>Plectranthus argentatus</i> S.T. Blake		Australia		Schoelhorn (2002)												
<i>Plectranthus barbatus</i> Andr.	<i>Coleus kilim & schari</i> Gurke ex Engl., <i>Coleus barbatus</i> (&f) Benth., <i>Coleus forskohlii</i> Briq., <i>Coleus comosus</i> A. Rich., <i>Plectranthus kilim & schari</i> (Gürke) H.L. Maass., <i>Plectranthus forskohlii</i> auct Briq.	North, East, Central Africa, Asia, South America	Owili (1977), Mitchell and Rook (1979)	Grimshaw (1993), Bennett and Prance (2000)	Battiscombe (1912), Rounce (1933), Bush (1943), Templer (1960), Rwaburindore (1969), Mathew (1970), Mwangangi (1982), Riley and Brokensha (1988), Gachathi (1989)	Drummond and Hemsley (1953), Mwangangi (1982)	Fleurentin et al. (1983), Wiersema and Leon (1999)		Maher (1935), Henty (1977), Caulfield (1978)		Bally (1934), Gentry (1969, 1970), Mwangangi (1971, 1982), Brokensha and Riley (1978), Githinji (1988)	Tabuti et al. (2003)	Napier (1933)			
<i>Plectranthus caninus</i> Roth		East Tropical Africa	Githinji (1990)								Githinji (1990)	Githinji (1990)				
<i>Plectranthus ciliatus</i> E. Mey.	<i>Plectranthus natalensis</i> Bak.	South Africa									Roberts (1990), Rabe and van Staden (1998)					
<i>Plectranthus crassus</i> N.E.Br.		Malawi								Spicy hu (2004)						
<i>Plectranthus decurrens</i> (Gürke) J.K. Morton		East-Central Africa-DRC														Yamada (1999)
<i>Plectranthus ecklonii</i> Benth.		South Africa		Auchland Regional Council (2002), Schoelhorn (2002)												
<i>Plectranthus edulis</i> (Vatke) Agnew		East Tropical Africa						Fleurentin et al. (1983), Lukhoba and Mathenge (1993)		Githinji (1990)						
<i>Plectranthus elegans</i> Britten		East and Southern Africa		Jaarsveld (1991)												
<i>Plectranthus esculentus</i> N.E.Br.	<i>Coleus dazo</i> A. Chiev., <i>Coleus esculentus</i> G. Tayl., <i>Plectranthus floribundus</i> N.E.Br.	Southern Africa, West-Central Africa, Asia Tropical						Ward (1935), Msyla (1944), Semsei (1956a,b), Fleurentin et al. (1983), Purselove (1987), Burkill (1995), Morris (1996), Mooi et al. (1999), Cheek et al. (2000), Reinten and Cootzee (2002), Allemann and Hammes (2003), Allemann et al. (2004)		Allemann and Hammes (1998)						

Table 2 (Continued)

Species	Synonyms encountered in the study	Geographical distribution	Non-medicinal uses													
			Poisons	Ornamentals	Hedges	Soil improvers	Food	Food additives	Animal feeds	Materials	Social uses	Bees				
<i>Plectranthus fruticosus</i> L'Her.		South Africa		Schoelhorn (2002)												Roberts (1990)
<i>Plectranthus glandulosus</i> Hook.f.	<i>Plectranthus urticoides</i> Baker	West-Central Africa–Cameroon	Harvey et al. (2004)					Roberts (1990)								
<i>Plectranthus graveolens</i> R.Br.		Australia										Anon. (1874)				
<i>Plectranthus hadiensis</i> (Forsk.) Schweinf. Ex Spreng.	<i>Plectranthus zeylanicus</i> Benth., <i>Plectranthus cyaneus</i> Gürke ex Engler, <i>Plectranthus zatarhendi</i> Benth.) E.A. Bruce	Northeast and East Tropical Africa to India									Tanner (1952a)				Hutchings et al. (1996)	NMK Expt. (1974), Timberlake (1987)
<i>Plectranthus igniarius</i> (Schweinf.) Agnew		East Tropical Africa									Sato (1976), Timberlake (1987)					
<i>Plectranthus insignis</i> Hook.f.		West-Central Africa–Cameroon										Cheek et al. (2000)				Cheek et al. (2000)
<i>Plectranthus kamerunensis</i> (Gürke)		West and East Tropical Africa	Glover et al. (1961a)								Glover et al. (1961a)				Githinji and Kokwaro (1993)	Parkia and Cooke (2003)
<i>Plectranthus lactiflorus</i> (Vatke) Agnew.		East Tropical Africa–Tanzania														
<i>Plectranthus lanuginosus</i> (Benth.) Agnew.		East Tropical Africa		Hepper and Jaeger (1978)												
<i>Plectranthus laxiflorus</i> Benth.	<i>Plectranthus albus</i> Gürke	West-Central Africa, East and Southern Africa	Neuwinger (2000)													Koritschoner (1935a,b), Kakudidi et al. (1996)
<i>Plectranthus longipes</i> Baker	<i>Plectranthus amaniensis</i> Gürke	East Tropical Africa–Kenya	Glover et al. (1961b), Glover and Samuel (1962)													
<i>Plectranthus madagascarensis</i> Benth.	<i>Plectranthus hirtus</i> Benth.	Southern Africa		Schoelhorn (2002)												
<i>Plectranthus melleri</i> Baker	<i>Plectranthus luteus</i> Gürke	East Africa Madagascar														Yamada (1999)
<i>Plectranthus mollis</i> (Aiton) Spreng.	<i>Plectranthus incanus</i> Link	India	Jain et al. (1994), Yoganarasimhan (2000)					Maikhuri and Gangwar (1993)								Jain et al. (1994)
<i>Plectranthus montanus</i> Benth.	<i>Plectranthus cylindraceus</i> Hochst. ex Benth.	East Tropical Africa														Tanner (1952b)
<i>Plectranthus oertendahlii</i> T.C.E.Fr.		Brazil, South Africa		Wiersema and Leon (1999), Welsh and Cotner (2000)												
<i>Plectranthus parviflorus</i> (Poir.) Henckel	<i>Plectranthus austalis</i> R.Br., <i>Coleus parviflorus</i> Benth.	Australia, Pacific		Tourle (2003), Schmidt (2005)				Ramachandran and Nair (1981), Purseglove (1987)								
<i>Plectranthus prostratus</i> Gürke		East Tropical Africa, Uganda		McNew (2002)												
<i>Plectranthus pseudomarrubiooides</i> Willemsse	<i>Plectranthus marrubiooides</i> Hochst.	East Tropical Africa, Asia temperate	Omolo et al. (2004)	Meyer (1964)							Zaroug (1981)					
<i>Plectranthus radiatus</i> A.J. Paton in ed.		Tanzania														Singh et al. (2003)

<i>Plectranthus punctatus</i> L'Her.	Northeast and East Tropical Africa–Ethiopia Tropical Asia, Southern Africa	Mooney (1954), Tadesse (1967), Scott (1979) Flourentin et al. (1983)	
<i>Plectranthus rotundifolius</i> (Poir.) Spreng.	<i>Coleus rotundifolius</i> (Poir.) A. Chev. & E. Perrot.; <i>Solenostemon rotundifolius</i> (Poir.) J.K. Morton		
<i>Plectranthus saccatus</i> Benth.	South Africa		
<i>Plectranthus</i> sp. aff. <i>occidentalis</i>	West Tropical Africa	Joffe (1993, 2001), Kahurananga and Kiliu (1976)	
<i>Plectranthus sylvestris</i> Gürke	East and Central Africa	Leeuwenberg (1972)	Riley and Brokensha (1988)
<i>Plectranthus ungentarius</i> Codd	Southern Africa		
<i>Plectranthus verticillatus</i> Druce T. Cooke	Southern Africa	Buitendag (1971)	
<i>Plectranthus zuluensis</i> T. Cooke	South Africa	Coe (2001)	
<i>Plectranthus</i> sp.	Europe–Belgium		Motolese et al. (1991)
			Lusigi et al. (1984) Riley and Brokensha (1988) Winter and Leistner (1957) Githinji and Kokwaro (1993)

al., 2002) and as a cure of cholera in Rodrigues (Gurib-Fakim et al., 1996). It also has antimicrobial activity (Bos et al., 1983; Castillo and González, 1999) and is reported to have antiviral activity against *Herpes simplex virus-1* (Hattori et al., 1995) and anti-HIV inhibition activity (Kusumoto et al., 1995). *Plectranthus aegyptiacus* and *Plectranthus punctatus* are used to treat ear infections in Ethiopia (Hedberg, 1979) and Saudia Arabia (Abulfatih, 1987b), respectively. *Plectranthus glandulosus* is used to treat influenza in Cameroon (Ngassoum, 2001) and *Plectranthus sylvestris* is given to patients with malaria in East Africa (Kokwaro, 1993). A decoction of the whole plant of *Plectranthus bojeri* is used in Madagascar, to bathe children in order to reduce fever (Neuwinger, 2000). *Plectranthus mollis* is a recognized febrifuge (Varma and Sharma, 1963; Yoganarasimhan, 2000), whereas *Plectranthus laxiflorus* is used by the Pokot in Kenya as an enema for the treatment of influenza (Watt and Breyer-Brandwijk, 1962). *Plectranthus fruticosus* is also antimicrobial and this activity may be attributed, in part, to the presence of kaurane diterpenoids (Gaspar-Marques et al., 2003). Both *Plectranthus ecklonii* and *Plectranthus montanus* have antibacterial and antifungal activity (Chadya and Gundidza, 1999; Nyanyiwa and Gundidza, 1999). Recently, *Plectranthus parvifolius* was shown to contain compounds that inhibit HIV-1 integrase (Tewtrakul et al., 2003).

3.1.5. Genito-urinary conditions

Eight species are used to treat genito-urinary conditions. This includes *Plectranthus barbatus* that is used in the treatment of syphilis in Central Africa (Boily and van Puyvelde, 1986; Cos et al., 2002), as an emmenagogue and oral abortifacient or contraceptive (Watt and Breyer-Brandwijk, 1962; Almeida and Lemonica, 2000) and as an aphrodisiac in Somalia (Innamorati, 1973). The contraceptive property of this species is corroborated by the fact that the leaves were found to have an anti-implantation effect in rats (Almeida and Lemonica, 2000). The leaves of *Plectranthus amboinicus* are frequently utilized in the treatment of urinary diseases in the Amazon and India (Jain and Lata, 1996; Yoganarasimhan, 2000). This species is also reported to relieve kidney troubles, treat vaginal discharges and is drunk after childbirth (Morton, 1992). The Giriama of Kenya use *Plectranthus aegyptiacus* as a medicine to treat ailments associated with sexual misconduct (Parkia and Cooke, 2003), while in Marakwet, Kenya, *Plectranthus laxiflorus* is used as an abortifacient (Lindsay and Hepper, 1978; Kokwaro, 1985). *Plectranthus vetiveroides* is used as an emmenagogue in India (Yoganarasimhan, 2000). *Plectranthus prostratus* is used by women in Uganda to increase sexual stimulation and vaginal fluids (Mugisha, 2002), while *Plectranthus elegans* is a potency medicine in Malawi (Morris, 1996). In laboratory experiments, *Plectranthus caninus* has been found to have diuretic activity (Painuly and Tandon, 1983; Aswal et al., 1984), although we could not find any ethnobotanical information to support this activity.

3.1.6. Pain

Plectranthus barbatus is used for the treatment of gastric and spasmodic pain in Africa and Asia (Dubey et al., 1981;

Yoganarasimhan, 2000; Chifundera, 2001), abdominal pain (Baerts and Lehmann, 1989; Neuwinger, 2000), painful micturition (Dubey et al., 1981), muscular pains (Githinji and Kokwaro, 1993) and for generalized pain (Elisabetsky and Castilhos, 1990; Woodley, 1991). In Kenya, an extract of *Plectranthus sylvestris* is inserted into two holes cut in the chest to relieve chest pain. When the leaf sap of *Plectranthus sylvestris* is mixed with decoctions of *Senna didymotrya* and *Clerodendron johnsonii* it is drunk for headache and abdominal pain and *Plectranthus montanus* mixed with *Microglossa oblongifolia* is a remedy for fever and severe headache (Kokwaro, 1993). In Africa, *Plectranthus amboinicus* is a remedy for headaches (Meyerhoff, 1978c; de Padua, 1988) as is *Plectranthus esculentus* (Morris, 1996) and *Plectranthus laxiflorus* is a treatment for abdominal pain (Kokwaro, 1993; Neuwinger, 2000).

3.1.7. Muscular–skeletal conditions

Six species of *Plectranthus* are used to treat musculo-skeletal conditions. *Plectranthus amboinicus* and *Plectranthus barbatus* are used for treating stiff neck and backache (Meyerhoff, 1978b; Githinji, 1990; Githinji and Kokwaro, 1993). The leaves of *Plectranthus barbatus* when burned a little and placed on the skin of the neck relieve stiffness (Githinji and Mwangangi, 1989). *Plectranthus barbatus* is also used in the treatment of bone dislocations (Baerts and Lehmann, 1989). In Africa, *Plectranthus barbatus* (Rwangabo, 1993), *Plectranthus laxiflorus* (Koritschoner, 1935b; Kokwaro, 1993; Neuwinger, 2000), *Plectranthus mandalensis* and *Plectranthus pubescens* (Morris, 1996) are used to treat rheumatism, whereas in India the species used is *Plectranthus mollis* (Sharma and Sharma, 1981; Sebastian and Bhandari, 1984). *Plectranthus mollis* is reported to exhibit relaxant activity on smooth and skeletal muscles (Yoganarasimhan, 2000).

3.1.8. Other medical conditions

Plectranthus barbatus is used to treat heart, blood and circulation conditions, such as myalgia, angina, haemorrhage and hypertension in Africa and Asia (Dubey et al., 1981; Valdes et al., 1987; Yoganarasimhan, 2000; Chifundera, 2001). *Plectranthus amboinicus* is used in the Caribbean, to treat congestive heart failure (Morton, 1992) and *Plectranthus mollis* is used in India as a cardiac depressant (Yoganarasimhan, 2000). Species of *Plectranthus* used to treat various blood conditions include *Plectranthus mollis* as a cure for haemorrhage (Yoganarasimhan, 2000) and *Plectranthus grandidentatus* which has antiproliferation activity on human lymphocytes (Cerqueira et al., 2004).

Species of *Plectranthus* used in the treatment of nervous disorders include *Plectranthus amboinicus*. It is prescribed in cases of epilepsy and convulsions (Morton, 1992; Ruiz et al., 1996; Castillo and González, 1999) and meningitis (Neuwinger, 2000). *Plectranthus barbatus* is used to treat psychiatric problems in Tanzania (Chhabra et al., 1993; Neuwinger, 2000) as well as treatment of insomnia and convulsions in Asia (Schanberg and Ikan, 2003). *Plectranthus alpinus* is used in Tanzania as an anti-convulsant (Hedberg et al., 1983). *Plectranthus pubescens* is used in Malawi for depression (Morris, 1996) and in Asia *Plec-*

tranthus mollis is used for the treatment of mental retardation (Singh and Ali, 1992). In Uganda, *Plectranthus laxiflorus* is used to treat psychological problems including madness (Kakudidi et al., 1996). *Plectranthus mandalensis* is used in Malawi to treat depression (Morris, 1996) and in India *Plectranthus vetiveroides* is used as a stimulant (Yoganarasimhan, 2000).

Species of *Plectranthus* are also used to treat sensory disorders associated with ear and eye problems. For example, *Plectranthus amboinicus* seed oil is a treatment for acute edematous otitis acuta in Polynesia (Zepernick, 1972), whereas in India its leaves are rubbed onto the eyes to alleviate conjunctivitis (Morton, 1992). *Plectranthus barbatus* is a recognized source of useful antiglaucoma agents (Caprioli et al., 1984; Svoboda, 1996; Schanberg and Ikan, 2003). The leaves are used to treat conjunctivitis in the Democratic Republic of Congo (Baerts and Lehmann, 1989; Neuwinger, 2000) and earache in Kenya (Geissler et al., 2002). In Malgaches, the finely ground leaves of *Plectranthus bojeri* are used for the treatment of conjunctivitis (Neuwinger, 2000). In Kenya, the leaves of *Plectranthus igniarius* and *Plectranthus laxiflorus* are used to treat inflamed eyes and ophthalmia, respectively (Lindsay and Hepper, 1978).

A number of species including *Plectranthus amboinicus* (Bhakuni et al., 1969), *Plectranthus barbatus* (Zelnik et al., 1977; Schanberg and Ikan, 2003), *Plectranthus caninus* (Painuly and Tandon, 1983), *Plectranthus esculentus* (Mooi et al., 1999; Ali et al., 2000), *Plectranthus mollis* (Bhakuni et al., 1971) and *Plectranthus ternifolius* (Aswal et al., 1984) have cytotoxic and anti-tumour promoting activity and can be used in the treatment of cancer. *Plectranthus barbatus* is reported to stimulate the immune system (Lasure et al., 1995). *Plectranthus amboinicus* (Yoganarasimhan, 2000), *Plectranthus barbatus* (Greenway, 1946), *Plectranthus bojeri* (Neuwinger, 2000) and *Plectranthus mollis* (Jain et al., 1994) have been used against snakebites in India, Gabon and Kenya. In Uganda and Kenya, *Plectranthus barbatus* and *Plectranthus aegyptiacus*, respectively, are used to treat spiritual ailments (Parkia and Cooke, 2003; Tabuti et al., 2003). *Plectranthus barbatus* and *Plectranthus amboinicus* are used to prevent or alleviate inflammation (Morton, 1992; Chifundera, 2001). *Plectranthus barbatus* is also used in ethnoveterinary medicine in Africa (Holdsworth, 1977; Byavu et al., 2000; Ole-Marion, 2003).

A number of *Plectranthus* species were recorded as being used in medicine but no specific condition was stated. For example, *Plectranthus barbatus* was cited as being used as a traditional medicine in Machakos (Barnett, 2000), a children's tonic (Caufield, 1978), an emetic used by Samburu of Kenya for strength (Fratkin, 1975) and as an Ayurvedic medicinal plant (Svoboda, 1996). *Plectranthus amboinicus* is used medicinally in South East Asia and Martinique (Kuebel and Tucker, 1988; Prudent et al., 1995). Others include *Plectranthus aegyptiacus* used medicinally in Egypt (Othman and Shoman, 2004), *Plectranthus congestus* used in Australia for internal complaints (Maiden, 1899; Lassak and McCarthy, 1983), *Plectranthus edulis* is medicinal in Kenya (Likhoba and Mathenge, 1993), *Plectranthus gradulosus* and *Plectranthus occidentalis* in Cameroon (Cheek et al., 2000; Harvey et al., 2004) and *Plectranthus gallatus* in South Africa (Cunningham, 1995).

Plectranthus vettiveroides is medicinal (Shankar and Majumdar, 1995) and *Plectranthus mollis* is a tonic in India (Sebastian and Bhandari, 1984).

Some species of *Plectranthus* are reported to have caused some adverse responses to people and domestic animals. *Plectranthus barbatus* causes perianal dermatitis (Owili, 1977) and contact with unnamed species of *Plectranthus* has been reported to cause skin irritations and dermatitis in susceptible persons (Mitchell and Rook, 1979; Motolese et al., 1991). *Plectranthus caninus* and *Plectranthus longipes* are poisonous to livestock (Glover and Samuel, 1962; Githinji, 1990). *Plectranthus barbatus* (Kemtoff et al., 2002) and *Plectranthus fruticosus* (Chamorro et al., 1991; Pages et al., 1998) have embryo- and fetotoxic activities on rodents.

3.2. Horticultural uses

Twenty species were reported as having horticultural uses. The majority are ornamentals either planted for their coloured and attractive foliage or for their beautiful flowers. Many species of *Plectranthus* grown as ornaments are resistant to diseases, they are usually succulent and can survive in dry conditions. Some species of *Plectranthus* planted as ornamentals in Africa, Asia, Northern and Southern America and Australia include *Plectranthus oertendahlii*, *Plectranthus parvifolius* (syn *Plectranthus australis*) (Wiersema and Leon, 1999; Tourle, 2003; Schmidt, 2005), *Plectranthus argentatus*, *Plectranthus amboinicus*, *Plectranthus fruticosus*, *Plectranthus madagascariensis*, *Plectranthus ciliatus* (Garden Plants List, 2004), *Plectranthus barbatus*, (Grimshaw, 1993; Bennett and Prance, 2000), *Plectranthus ecklonii* (Auchland Regional Council, 2002), *Plectranthus zuluensis* (Coe, 2001) and *Plectranthus saccatus* (Kahurananga and Kiilu, 1976; Joffe, 1993, 2001). *Plectranthus lanuginosus* makes a splendid rock garden plant (Hepper and Jaeger, 1978), *Plectranthus elegans* (Jaarsveld, 1991) and *Plectranthus verticillatus* (Buitendag, 1971; Garden Plants List, 2004) are planted in gardens in South Africa while *Plectranthus parvifolius* is grown as a house plant (Schmidt, 2005). *Plectranthus prostratus* has decorative, fuzzy leaves that develop red markings in high light and is ideal for hanging baskets (McNew, 2002) and likewise for *Plectranthus purpatus* and *Plectranthus oertendahlii* (Welsh and Cotner, 2000). In East Africa, *Plectranthus barbatus* (Rounce, 1933; Greenway, 1946; Battiscombe, 1956; Templer, 1960; Mathew, 1970; Gachathi, 1989; Grimshaw, 1993) and *Plectranthus sylvestris* are planted as a hedge, fence or boundary marker. Cowpeas, green grams and maize are cultivated in areas where *Plectranthus barbatus* has been cleared as the plant is said to be a good indicator of fertile soil (Riley and Brokensha, 1988). The plant is used for making manure (Mwangangi, 1982) and is planted on the hillsides to prevent soil erosion (Drummond and Hemsley, 1953).

3.3. Food

Nine species of *Plectranthus* are reported to be edible. For example, the tubers of *Plectranthus esculentus* are rich in

carbohydrates, Vitamin A and minerals and are usually boiled or roasted and eaten as a substitute for sweet potato in most parts of Africa (Dudgeon, 1909; Holland, 1915; Perrot, 1944; Purseglove, 1944; Semsei, 1956a,b; Roberts, 1990; Morris, 1996; Blench, 1997; Allemann and Hammes, 2003; Allemann et al., 2003). In Malaysia, the tuber is eaten as a vegetable (Mooi et al., 1999). Those of *Plectranthus punctatus* (Mooney, 1954; Tadesse, 1967; Scott, 1979) and *Plectranthus edulis* (Lukhoba and Mathenge, 1993) are eaten in Ethiopia and Kenya, respectively. Tubers of *Plectranthus rotundifolius* are a popular food in South Africa and research is currently underway to see if they can be cultivated for use as a domestic crop (Venter et al., 2000), whereas in Tropical Asia, the tubers of *Plectranthus parviflorus* are popular (Ramachandran and Nair, 1981; Purseglove, 1987). In India, the fruits of *Plectranthus parvifolius* are also eaten (Ramachandran and Nair, 1981). The leaves of *Plectranthus mollis* (Maikhuri and Gangwar, 1993) and *Plectranthus barbatus* (Fleurentin et al., 1983; Wiersema and Leon, 1999) are cooked as a vegetable. Leaves of *Plectranthus amboinicus* are chopped, made into flour balls and fried in oil or butter (Dymoc, 1885).

3.4. Food additives

The three species of *Plectranthus* reported as food additives are *Plectranthus amboinicus*, *Plectranthus esculentus* and *Plectranthus crassus* (Table 2). The leaves of *Plectranthus amboinicus* are used in food stuffings (Purseglove, 1987), for flavouring and marinating beef and chicken (Epling, 1981; Kuebel and Tucker, 1988; Bodner and Gereau, 1988; Craig and Mayenda, 1990; Brown, 1997), to mask odor of strong smells associated with goat, fish and shellfish (Morton, 1992) and to spice dishes containing tomato sauces (Mayenda, 1991). The leaves are sometimes eaten raw with bread and butter and in India, they may be added to beer and wine (Morton, 1992). The stems of *Plectranthus esculentus* are used in Embu, Kenya, to sweeten gruel (porridge) (Allemann and Hammes, 1998) and in Hungary, the leaves of *Plectranthus crassus* are used for culinary purposes (Spicy hu, 2004).

3.5. Fodder

Plectranthus spp. are mostly used as dry season fodder. *Plectranthus barbatus* is the most frequently cited of the five species used (Table 2). In Kenya and Yemen, it is fed to sheep, goats and cattle (Maher, 1935; Hendy, 1977; Caufield, 1978). *Plectranthus igniarius* is an important succulent fodder for camels, goats and cattle (Sato, 1976; Lusigi et al., 1984), *Plectranthus sylvestris* is recognized as fodder for domestic animals (Lusigi et al., 1984) and in Oman, *Plectranthus pseudomarruboides* is sometimes given to cattle (Zaroug, 1981) while wild growing *Plectranthus kamerunensis* is reported to be eaten by domestic animals in the Rift Valley of Kenya (Glover et al., 1961a). *Plectranthus hadiensis* is eaten by rock rabbits in Tanzania (Tanner, 1952a) and *Plectranthus edulis* is eaten by elephants in the Aberdare National Park of Kenya (Githinji, 1990).

3.6. Materials

Plectranthus insignis is the only species whose wood is used to build huts and temporary houses and for firewood (Cheek et al., 2000; Table 2). In Kenya, the soft velvety leaves of *Plectranthus barbatus* are used as sanitary tissue (Githinji, 1988) to clean milk guards (Brokensha and Riley, 1978) and both the leaves and stems are used to hasten the ripening of bananas (Mwangangi, 1971, 1982). *Plectranthus amboinicus* has scented leaves and these are often rubbed into the hair and body after bathing (Morton, 1992). In the Amazon, the leaves are mixed with sugar and used as an intoxicant (Jain and Lata, 1996), while in Tonga and Martinique the leaves are used in the cleaning of textiles to perfume them (Yuncker, 1953; Prudent et al., 1995). A decoction of *Plectranthus kamerunensis* is used in bathing newborn babies in Kenya (Githinji and Kokwaro, 1993). *Plectranthus ciliatus* and *Plectranthus montanus* are used in personal hygiene and to wash clothes and animal skins (Tanner, 1952b; Watt and Breyer-Brandwijk, 1962). In Namibia, the roots of *Plectranthus unguentarius* are used as an ingredient of aromatic pomade for use by ladies (Winter and Leistner, 1957). In Kenya, old men use the leaves of *Plectranthus caninus* as snuff, a habit that can become addictive (Gentry, 1969). The mothers in Marakwet are reported to use the succulent leaves of this species to clean their breasts before suckling a baby after arriving from a journey (Githinji, 1990).

A number of species are used for spiritual or religious purposes (see social use in Table 2). For instance, *Plectranthus amboinicus* is offered to the spirits when a house is being built (Morton, 1992). *Plectranthus mollis*, *Plectranthus sylvestris* and the roots of *Plectranthus laxiflorus* are used to drive away evil spirits in India, Kenya and Tanzania (Koritschoner, 1935a; Githinji and Kokwaro, 1993; Jain et al., 1994). The tubers of *Plectranthus viphyensis* are given to children in Tanzania to stop them grinding their teeth in their sleep (Lovett and Kayombo, 1989a,b).

The seeds of *Plectranthus mollis* are fried in mustard oil and then massaged all over the body as an insect repellent (Jain et al., 1994). *Plectranthus fruticosus*, *Plectranthus amboinicus* and *Plectranthus pseudomarruboides* are also used as insect repellents (Roberts, 1990; Prudent et al., 1995; Omolo et al., 2004).

4. Geographical distribution

A survey of the ethnobotanical information by geographical areas shows that 45 species are used in the African continent (Watt and Breyer-Brandwijk, 1962; Roberts, 1990; Kokwaro, 1993; Githinji and Kokwaro, 1993; Morris, 1996; Neuwinger, 2000), 14 species in Asia (Morton, 1992; Yoganarasimhan, 2000), 10 species in America (Prudent et al., 1995; Ruiz et al., 1996), five species in Australasia (Morton, 1992) and one species in the Pacific (Mayenda, 1991) (Tables 1 and 2). In Africa, the most frequently used species are *Plectranthus barbatus* and *Plectranthus laxiflorus*, whereas in Asia *Plectranthus amboinicus* and *Plectranthus mollis* are the most frequently cited species. Overall, *Plectranthus amboinicus* and *Plectranthus barbatus*

have the widest geographical range occurring beyond Africa and Asia continents into the Americas, whereas *Plectranthus laxiflorus* is typically African in distribution occurring in Ethiopia through Eastern Africa to Southern Africa and *Plectranthus mollis* is mainly Asiatic. Most of the species in Africa and Asia are wild harvested, although some, such as *Plectranthus esculentus*, are now being commercially cultivated for use as a food source (Reinten and Cootzee, 2002). Overall, there is very little information about the harvesting methods used to supply these species and whether these methods are sustainable.

5. Chemistry of *Plectranthus* species

To date, the majority of phytochemical studies on species of *Plectranthus* have focused on the isolation of a range of diterpenoids. Although, some of these studies report the biological activity of the diterpenoids isolated (Abdel-Mogib et al., 2002), very few have used activity-guided fractionation to isolate the compounds associated with a specific ethnobotanical use. Of the different types of diterpenoids found in the genus, the abietane diterpenoids are the most diverse group. Some of the abietane diterpenoids isolated include 6 β -formyloxy-7 α -hydroxyroyleanone, coleon U and V in *Plectranthus argentatus* (Adler et al., 1984), coleon F, C, coleonol C, cariocol and plectrin in *Plectranthus barbatus* (Rüedi and Eugster, 1973; Grob et al., 1978; Tandon et al., 1978; Kelecom and Dos Santos, 1985; Kreutner et al., 1985; Jin et al., 1990), coleon M, N, O, P, Q and R in *Plectranthus caninus* (Arihara et al., 1975; Grob et al., 1978), edulone A and 16-*O*-acetylcoleon D in *Plectranthus edulis* (Buchbauer et al., 1978; Kunzle et al., 1987), 7 α ,11-dihydroxy-12-methoxy-8,11,13-abietatriene in *Plectranthus elegans* (Dellar et al., 1996), grandidone A and grandidone B in *Plectranthus grandidentatus* (Uchida et al., 1981), 6 β ,7 β -dihydroxyroyleanone in *Plectranthus hadiensis* (syn *Plectranthus zeylanicus*) (Mehrotra et al., 1989), horminone and 7 α ,12-dihydroxy-17(15 \rightarrow 16)-abeo-abieta-8,12,16-triene-11,14-dione in *Plectranthus hereroensis* (Batista et al., 1994, 1995, 1996; Ferraeira et al., 1997) and lanugon M, N, S, 15-epilanugin F, coleon J and H in *Plectranthus lanuginosus* (Moir et al., 1973a,b; Schmid et al., 1982; Matloubi-Moghadam et al., 1984). A few of these compounds have been tested for antimicrobial activity and this could explain some of medicinal uses, especially for the treatment of infections, fever and inflammation (Table 1). For example, the abietane diterpenes 7-epigrandidone D and grandidone D isolated from *Plectranthus grandidentatus* have antimicrobial activity (Teixeira et al., 1997). 11-Hydroxy-12-oxo-7,9(11),13-abietatriene, isolated from *Plectranthus elegans* inhibited spore germination of the fungus *Cladosporium cucumerinum* and growth of Gram-positive bacteria, particularly *Bacillus subtilis* (Dellar et al., 1996; Gibbons, 2004). Similarly, *Plectranthus hereroensis* produces an acetylated abietane quinone related to horminone that has potent antimicrobial activity, especially against *Staphylococcus* (Batista et al., 1994, 1995; Htwe et al., 2001; Gibbons, 2004). Horminone isolated from the roots of *Plectranthus hereroensis* can cause liver damage, an adverse response that justifies further investigation as extracts of *Plectranthus hereroensis* are used to treat digestive

disorders (Ferreira et al., 1997). Other diterpenoids including derivatives of barbatusol, carioical and coleonol derivatives have hypotensive activity (Kelecom, 1983; Tandon et al., 1984, 1992; Kelecom and Dos Santos, 1985).

Labdane diterpenoids found in *Plectranthus barbatus*, include forskolin, forskolin E and F (Valdes et al., 1987; Gabetta et al., 1989; Jin and He, 1998), ent-labda-8(17),12Z,14-trien-2 α -ol and ent-3 β -acetoxylabda-8(17),12Z,14-trien-2 α -ol in *Plectranthus fruticosus* (Gaspar-Marques et al., 2003) and plectranatin C and D in *Plectranthus ornatus* (Rijo et al., 2002). The fact that forskolin directly activates adenylyl cyclase and thus the modulation of cAMP could underlie the diversity of different traditional uses of forskolin-containing species of *Plectranthus*, such as *Plectranthus barbatus*. For example, activation of adenylyl cyclase can stimulate gastric secretions and the presence of forskolin in *Plectranthus barbatus* could explain why extracts from the plant are used for the treatment of digestive disorders (Bhat et al., 1979, 1980; Hersey et al., 1983; Mukherjee et al., 2000). Forskolin is known to directly activate the catalytic subunit of adenylyl cyclases in smooth muscle cells, an action that is made possible by enhanced calcium intake (Metzger and Lindner, 1981; Lindner and Metzger, 1983). Forskolin is a known cardiostimulant agent that mediates contractility by increasing levels of intracellular cAMP or by inhibiting its metabolism (Ghisalberti, 1977). It is also effective in the treatment of hypertension (Lindner et al., 1978; Valdes et al., 1987). Thus, forskolin could explain why extracts of *Plectranthus barbatus* are reported to lower blood pressure of anaesthetized rat due to relaxation of vascular smooth muscle (Dubey et al., 1981). The fact that forskolin can activate the cAMP-dependent protein kinase A signalling pathway (Huang et al., 2005) indicates that it could have beneficial anti-cancer properties. In fact, early studies showed that forskolin strongly inhibits melanoma cell-induced human platelet aggregation (Agarwal and Parks, 1983). Forskolin could also contribute to the therapeutic antidepressant potential of *Plectranthus barbatus* (Ozawa et al., 1997). Recently, products containing forskolin have been sold in the United States of America as slimming treatments as extracts of *Plectranthus barbatus* are reported to stimulate the breakdown of fat. However, there are concerns about the use of these products by patients taking medicinal drugs as forskolin can influence the drug-metabolizing enzymes in the liver and thus could be implicated in adverse herb–drug interactions (Ding and Staudinger, 2005).

As yet there are little data on the biological properties of kaurane diterpenoids found in *Plectranthus fruticosus* (Gaspar-Marques et al., 2003) and *Plectranthus purpuratus* (Katti et al., 1985), the rare phyllocladane diterpenoids from *Plectranthus ambiguus* (Liu and Rüedi, 1996; Liu et al., 2003), the neoclerodanes from *Plectranthus ornatus* (Rijo et al., 2002) and the methylenequinones from *Plectranthus barbatus* (Rüedi, 1986; Yoganarasimhan, 2000).

Biologically active mono- and sesquiterpenoids are frequently found in many species of *Plectranthus* but there are little published data that directly link the presence of specific compounds in a species with the traditional uses of that species. For example, *Plectranthus barbatus* contains a

wide range of mono- and sesquiterpenoids including humulene and β -caryophyllene that are known for their antimicrobial properties (Ascensão et al., 1998). *Plectranthus sylvestris* also contains β -caryophyllene that could explain its use in treating infections (Chalchat et al., 1996). *Plectranthus mollis* contains fenchone, limonene, piperitenone, β -bisabolene, β -cubebene and α -humulene (Chalchat et al., 1996). These compounds have antimicrobial activity and could explain the use of *Plectranthus mollis* as a febrifuge (Varma and Sharma, 1963; Yoganarasimhan, 2000). The use of extracts of leaves of *Plectranthus barbatus* in birth control could be associated with the presence of sabinyl acetate as this compound has been found to be embryotoxic in rodents (Chamorro et al., 1991; Pages et al., 1991, 1998; Kemtoff et al., 2002). Sabinyl acetate has also been reported from *Plectranthus fruticosus* (Pages et al., 1998).

Other monoterpenes and sesquiterpenes have been reported from different species and many have antimicrobial activity including β -caryophyllene, *p*-cymene and thymol from *Plectranthus aegyptiacus* (Smith et al., 1996), limonene, linalool, myrcene and thymol from *Plectranthus amboinicus* (Baslas and Kumar, 1981; Prudent et al., 1995), borneol, camphene, β -phellandrene and α -thujene from *Plectranthus barbatus* (Mathela et al., 1986; Maia et al., 1988), fenchone, nerol and terpinolene from *Plectranthus glandulosus* (Ngassoum, 2001), β -caryophyllene, fenchone and α -fenchyl acetate from *Plectranthus madagascariensis* (Ascensão et al., 1998), menthone and thymol from *Plectranthus montanus* (Chadya and Gundidza, 1999). α -Amorphene and β -cubebene occur in *Plectranthus amboinicus* (Prudent et al., 1995; Pino et al., 1996), δ -selinene, α -ionone and humulene are found in *Plectranthus barbatus* (Mathela et al., 1986; Maia et al., 1988; Camara et al., 2003), caryophyllene oxide and 15-hydroxyspathulenol in *Plectranthus fruticosus* (Gaspar-Marques et al., 2003) and germacrene D occurs in *Plectranthus sylvestris* (Chalchat et al., 1996).

The role of phenolic compounds in the medicinal properties of species of *Plectranthus* has not been well studied. An antioxidant activity-guided fractionation of *Plectranthus ambiguus* resulted in the isolation of 5,6-dihydroxy-7,4'-dimethoxyflavone (ladanein) (Liu and Rüedi, 1996). Phenolics have also been reported from *Plectranthus amboinicus* (Brieskorn and Riedel, 1977), *Plectranthus caninus* (Painuly and Tandon, 1983) and *Plectranthus sylvestris* (Juch and Rüedi, 1997). As part of a chemotaxonomic study, the flavonoids of 42 species of *Plectranthus* were studied and found to contain two non-flavonoid phenolics, the caffeic acid derivatives, nepetoidin A and B (Grayer et al., 2003). Grayer et al. (2003) showed that nepetoidin B had potent free radical scavenging activity and was more active than rosmarinic acid and gallic acid. Nepetoidin A was not tested due to lack of material. Both compounds had antifungal activity. Nepetoidin A and B were found in the water extracts of leaves from 13 of the species of *Plectranthus* reported in this review to have medicinal activity: *Plectranthus ambiguus*, *Plectranthus asirensis*, *Plectranthus barbatus*, *Plectranthus coeruleus*, *Plectranthus ecklonii*, *Plectranthus elegans*, *Plectranthus hadiensis*, *Plectranthus igniarius*, *Plectranthus kivuensis*, *Plectranthus lanuginosus*, *Plectranthus madagascariensis*, *Plectranthus parviflorus* and *Plectranthus pseudomarruboid*. Whether these

two compounds contribute to the medicinal properties of these species has not been studied. In addition, lipids have been reported from *Plectranthus mollis* (Yoganarasimhan, 2000). Lipids, resinous gum and compounds of nutritional value like calcium, iron, proteins and carbohydrates have been recorded from *Plectranthus esculentus* (Allemann and Hammes, 2003; Allemann et al., 2003). Alcohols occur in *Plectranthus aegyptiacus* (Smith et al., 1996), *Plectranthus amboinicus* (Prudent et al., 1995) and *Plectranthus glandulosus* (Ngassoum, 2001).

6. Ethnobotanical uses and phylogeny

In order to see if there are any relationships among the species of *Plectranthus* with ethnobotanical uses, the ethnobotanical data were mapped onto a phylogeny of the genus. The most recent traditional classification of the genus proposed by Codd (1975) is problematic because it does not include all species encountered in the literature and it groups species by superficial morphological similarity based on one or two characters leading to groupings which are incongruent with the phylogeny proposed by Paton et al. (2004). The phylogeny by Paton et al.

(2004), based on DNA sequence data and augmented by morphological data, provides an informal classification that divides the species into two main groups or clades (Fig. 1). Clade 1, the ‘*Coleus*’ Clade of Paton et al. (2004), broadly corresponding to the formally recognized genus *Coleus*, is divided into two subclades, Clades 1a and b. Clade 2 is recognized as the ‘*Plectranthus*’ Clade (Fig. 1). Not all species encountered in this ethnobotanical survey are covered in the phylogeny. Species not covered are grouped together with those included in the phylogeny that are morphologically similar. In this way it is possible to assign most species to groups within one of the Clades 1a, b or 2 (Fig. 1). Species that form one of these groups were given numbers within the clade, for example, Clade 1a group 8 contains species morphologically similar to *Plectranthus amboinicus*. Occasionally, it was not possible to assign a species cited in the literature to numbered groups in Clade 1 or 2 because they did not share morphological characters with species in those clades. Such species were placed in groups annotated by letters. For example, *Plectranthus edulis* belongs in Clade 1 as its corolla, calyx and nutlet morphology are similar to species in that Clade. However, *Plectranthus edulis* is not very similar to

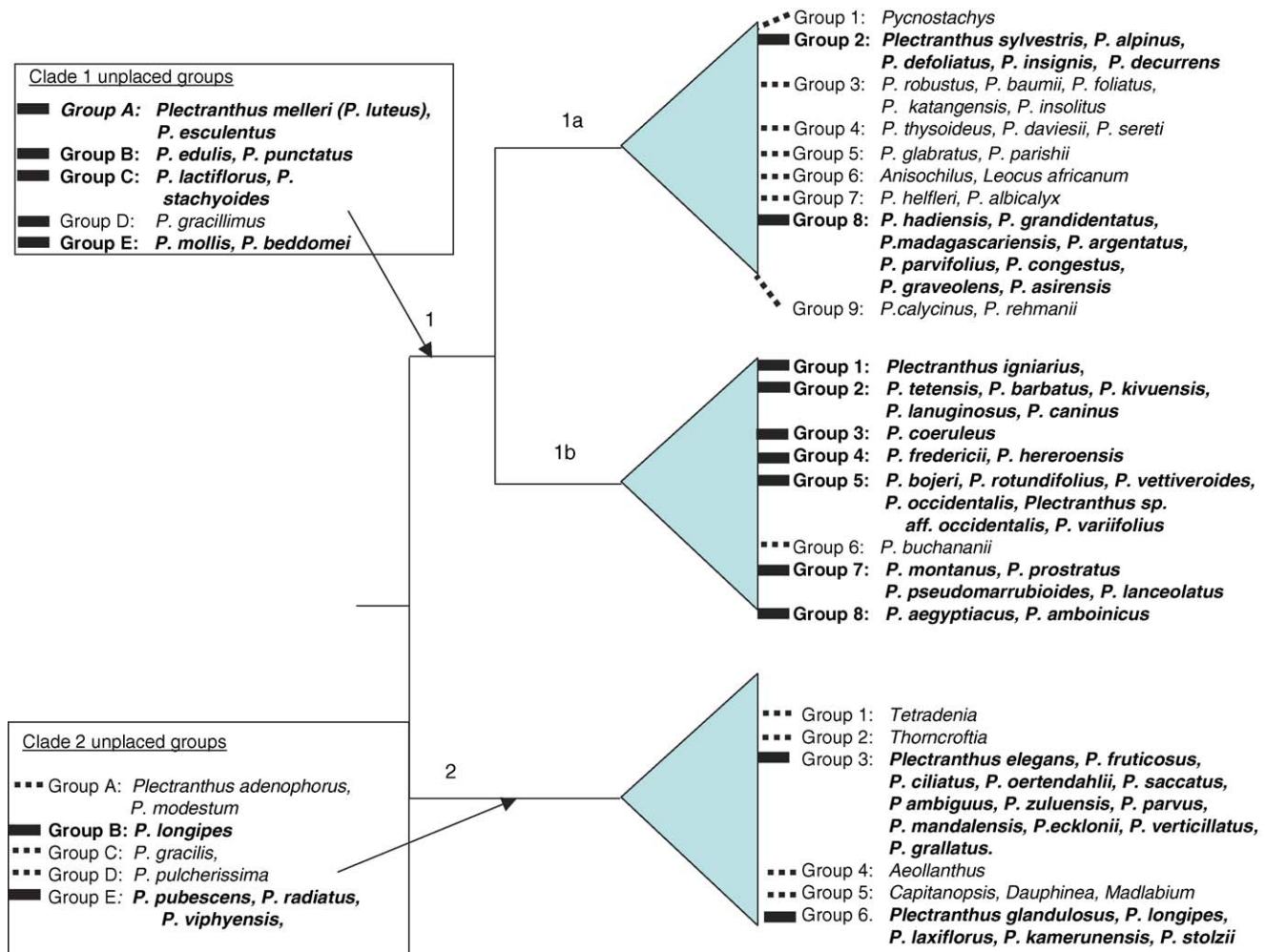


Fig. 1. Figure illustrating the placement of utilized *Plectranthus* species on the phylogeny following Paton et al. (2004). The thick unbroken lines represent groups with species cited as useful; the broken lines indicate groups with no/or few cited uses; groups shown in bold have recorded medicinal uses.

any of the numbered groups represented in the phylogeny. Thus, *Plectranthus edulis* is placed in Clade 1, group B along with another species, *Plectranthus punctatus* that is morphologically similar.

When the ethnobotanic data were mapped onto the phylogenetic cladogram for *Plectranthus* it shows that 70% of all species of *Plectranthus* with medicinal uses are found in Clade 1 (Fig. 1). In fact, the majority is found in groups in Subclade 1b, except those in group 6. It is of interest that species in group 6 have no recorded medical uses. Subclade 1a has two medically important groups, groups 2 and 8. The unplaced groups of species in Clade 1 are all used medicinally except group D (Fig. 1). In Clade 2, the only medicinally used species fall into groups 3, 6, B and E.

All species used as food or in flavouring food are found in Clade 1 with the exception of *Plectranthus glandulosus* that belongs to Clade 2. Within Clade 1, species used as food occur within groups A, B and E and in Subclade 1b group 5. The majority of species utilized as fodders also occur within Clade 1 (particularly Subclade 1a groups 2 and 7 and Subclade 1b groups 2 and 8), except *Plectranthus kamerunensis* that belongs to Clade 2 group 6. All species used in apiculture are also found in Clade 1. The majority of species used in the materials and social use categories are also from Clade 1 (Table 2; Fig. 1) as are the species used for magic-religious activities. The same trend is seen in the horticultural category, where Clade 1 has a greater number of species than in Clade 2. In addition, species of Clade 1 are used in a wide range of agricultural and horticultural procedures, such as preparing manure, preventing erosion and as hedges (Bush, 1943; Drummond and Hemsley, 1953; Mwangangi, 1982). The species recorded as having horticultural uses that are placed in Clade 2 all occur in group 3 and are ornamentals.

7. Conclusion

Of the 300 species of *Plectranthus*, 62 species are reported to be used as medicines, ornamentals, foods, flavours, fodder and/or material. It could be that the number of species used is greater as there were citations to unconfirmed species that were only cited at the level of genus, but because it was unclear as to the species used very few of these references have been cited in this review. There are some interesting trends that emerge from this review. Species with ethnobotanical uses are not randomly distributed throughout the genus but are related. The majority of species with ethnobotanical uses belong to Clade 1, a group of *Plectranthus* formally known as *Coleus*. Most species with medicinal uses occur in Clade 1 Subclade 1b and Subclade 1a groups 2 and 8. Whether other species in the other groups within Clade 1 or those in Clade 2 have potential to be used as medicinal plants justifies further study as the compounds, especially the diterpenoids, occur in species from both clades. To date the majority of the phytochemical studies have concentrated on the isolation of diterpenoids and although these compounds have been shown to have potent antimicrobial activity few have been tested in bioassays that are directly related to the traditional uses of the species the compounds were isolated from. Further

research is needed to identify the active compounds, especially in those species that are most frequently cited.

One of the most studied *Plectranthus*-derived compounds is the labdane forskolin isolated from *Plectranthus barbatus*. It has a range of pharmacological properties and could explain many of the diverse medicinal uses of *Plectranthus barbatus*. Despite the interest in the activity of this compound our knowledge about its distribution in the genus is poor. Natural product chemists have mostly reported on novel diterpenoids in species of *Plectranthus* and maybe not always reported on the occurrence of known compounds. Thus, there is a scientific case for more research to be undertaken on the activity and distribution of diterpenoids in this genus.

The majority of the 300 species of *Plectranthus* occur in Africa and around half are distributed within sub-Saharan Africa of these most, about 110, species belong to Clade 1 and 40 species belong to Clade 2 (Paton et al., 2004). Madagascar and Southern Africa both have around 50 species, although in these areas around 75% of species belong in Clade 2. There are around 70 species in Asia and Australia together and these species can be placed in Clade 1 (Paton et al., 2004). The genus is not native in the New World, the species which have been introduced there largely belong to Clade 1. In this review, we have collected information about the uses of 21% of the 300 species. The lack of documentation for the other species could reflect the fact that it is not easy to differentiate among some of the species and species with a limited distributed could have been confused with the more common widespread distributed species.

In this study, we have made use of the notes on herbarium sheets and on collector notes for herbarium vouchers lodged in herbaria in parts of Africa and the United Kingdom. If this review was expanded to cover samples of *Plectranthus* from herbaria in other countries as well as unpublished literature, such as locally produced ethnobotanical reports from African and Asian universities or research institute, our knowledge about the diversity of species used and how they are used would most likely increase.

Whatever the source of information, it is important that the authors refer to voucher samples lodged in a herbarium. These vouchers can be used to support the identification of the species. The value and importance of vouchers and the notes associated with the vouchers can be illustrated by reference to *Plectranthus stolzii*. *Plectranthus stolzii* is restricted in its natural distribution to parts of Southern Tanzania and Northern Malawi, and there is very little information about its uses in the published literature. A survey of different herbaria found vouchers deposited at Kew that had been made during general collecting trips (Gaetan, 1952) and projects aimed to record the importance of medicinal plants to the people of Africa to support their conservation (Cunningham and Barigyira, 1992). The vouchers of *P. stolzii* record the occurrence of the species and its ethnobotanical uses (Table 1). These data have not yet been documented in published papers. The species is reported to treat a range of medicinal conditions including respiratory conditions (Table 1). This species is very similar in appearance to the more widespread *Plectranthus laxiflorus* that occurs in the same areas as *Plectranthus stolzii*

and is used to treat some of the sample medicinal conditions (Table 1). However, because voucher specimens of *Plectranthus stolzii* were lodged in the herbarium at Kew, along with notes about its traditional uses, the identification of the species can be confirmed.

Species that have the greatest number of different medicinal uses, such as *Plectranthus barbatus* and *Plectranthus amboinicus*, appear to be distributed widely in both the Old and New World. The wide distribution of these frequently used species reflects the fact that they have been semi-cultivated as “herbs” and taken by people from one place to another as they have migrated across the world. Generally, the uses in the New World are similar to those in the Old World, although there are some differences. In Africa and Asia, *Plectranthus* species were mostly used to treat digestive, skin and infections, whereas *Plectranthus amboinicus* is used in the treatment of epilepsy and convulsions in the Caribbean (Morton, 1992; Ruiz et al., 1996) and as an intoxicant in the Amazon (Jain and Lata, 1996). These species are also used in the treatment of pain in Africa but not so frequently in Asia. This could reflect the fact that in Asia other more active species were available, whereas this was not the case in Africa.

Plectranthus includes a few species that are often found in dry open cleared areas near villages and could be classed as a “weed” using the definition proposed by Baker (1965). Baker (1965) defines a weed as a species that can successfully grow in “any specified geographical area, its population grow entirely or predominantly in situations markedly disturbed by man, without, of course, being deliberately cultivated”. Species classed as weeds are often medicinal plants (Stepp, 2004). The natural habitat of species, such as *Plectranthus laxiflorus*, can be associated with the behaviour of village people as it is found at the margin of forests and near paths. Nevertheless, there are many other species of *Plectranthus* found in similar habitats but they are not recorded as having medicinal or other economic uses. This could be because some are rare and thus not frequently used or their economic uses have not been documented. Nevertheless, within *Plectranthus* the link between being classed as a weed and having medicinal properties is at the moment weak, as it is only supported by a few species.

The phenomenon of synonymy within the genera has also made it difficult to collate together the uses of specific species. Synonymy is most prevalent for species in Clade 1 and particularly in Subclade 1b, which contains both of the popularly used species, *Plectranthus barbatus* and *Plectranthus amboinicus*. The diversity of names used to describe the same species could in part reflect the widespread use of these species along with the difficulties in differentiating among closely related species. In this review, we have shown how a cladogram produced from the new molecular phylogeny of the genus (Paton et al., 2004) has provided a framework to superimpose our knowledge about the uses of *Plectranthus*. Furthermore, the cladogram can also serve as a guide to direct the search for information on the uses of other species, especially those in Clade 2. Within Clade 1b it is highly likely that those species closely related to those with traditional uses could also share these uses.

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- Kahurananga, Kiilu, 1976. *P. saccatus* Benth. Herbarium specimen held at EA collected from Kenya (Kahurananga & Kiilu 2953).
- Koritschoner, 1935a. *P. laxiflorus* Benth. Herbarium specimen held at K collected from Tanzania (Koritschoner 880).
- Koritschoner, 1935b. *P. laxiflorus* Benth. Herbarium specimen held at K collected from Tanzania (Koritschoner 1365).
- Leeuwenberg, 1972. *Plectranthus* aff. *occidentalis*. Herbarium specimen held at K collected from Cameroon (Leeuwenberg 10289).
- Lovett, Kayombo, 1989a. *P. viphyensis* Brummit & J.H. Seyani. Herbarium specimen held at K collected from Tanzania (Lovett & Kayombo 3317).
- Lovett, Kayombo, 1989b. *P. viphyensis* Brummit & J.H. Seyani. Herbarium specimen held at K collected from Tanzania (Lovett & Kayombo 3508).
- Likhoba, Mathenge, 1993. *P. edulis* (Vatke) Agnew. Herbarium specimen held at NAI collected from Kenya (Likhoba & Mathenge 220).
- Maher, 1935. *P. barbatus* Andr. Herbarium specimen held at K collected from Kenya (Maher 3229).
- Mathew, 1970. *P. barbatus* Andr. Herbarium specimen held at K collected from Kenya (Mathew 6163).
- Mayenda, 1991. *P. amboinicus* (Lour.) Spreng. Herbarium specimen held at K collected from the Pacific (Mayenda 43).
- Meyer, 1964. *P. pseudomarrubioides* Willemse. Herbarium specimen at EA collected from Ethiopia (Meyer 8590).
- Meyerhoff, 1978a. *P. tetensis* (Bak.) Agnew. Herbarium specimen held at K collected from Kenya (Meyerhoff 14M).
- Meyerhoff, 1978b. *P. barbatus* Andr. Herbarium specimen held at K collected from Kenya (Meyerhoff 28M).
- Meyerhoff, 1978c. *P. amboinicus* (Lour.) Spreng. Herbarium specimen held at K collected from Kenya (Meyerhoff 94M).
- Mooney, 1954. *P. punctatus* L'Her. Herbarium specimen held at K collected from Ethiopia (Mooney 6225).
- Msyla, 1944. *P. esculentus* N.E.Br. Herbarium specimen held at EA collected from Uganda (Msyla 1600).
- Mwangangi, 1971. *P. barbatus* Andr. Herbarium specimen held at K collected from Kenya (Mwangangi 1648).
- Mwangangi, 1982. *P. barbatus* Andr. Herbarium specimen held at K collected from Kenya (Mwangangi 2241).
- Napier, 1933. *P. kivuensis* (Lebrun & Touss.) R.H. Willemse. Herbarium specimen held at K collected from Kenya (Napier 5409).
- NMK Expd., 1974. *P. hadiensis* (Forssk.) Schweinf. ex Spreng. Herbarium specimen held at EA collected from Kenya (NMK Expd. 171).
- Purseglove, 1944. *P. esculentus* N.E.Br. Herbarium specimen held at K collected from Uganda (Purseglove P1600).
- Rounce, 1933. *P. barbatus* Andr. Herbarium specimen held at K collected from Tanzania (Rounce 253).
- Rwaburindore, 1969. *P. barbatus* Andr. Herbarium specimen held at K collected from Uganda (Rwaburindore Rwab. 32).
- Sato, 1976. *P. igniarius* (Schweinf.) Agnew. Herbarium specimen held at EA collected from Kenya (Sato 22).

- Scott, 1979. *P. punctatus* L'Her. Herbarium specimen held at K collected from Ethiopia (Scott 63).
- Semsei, 1956a. *P. esculentus* N.E.Br. Herbarium specimen held at EA collected from Tanzania (Semsei 2464).
- Semsei, 1956b. *P. esculentus* N.E.Br. Herbarium specimen held at K collected from Tanzania (Semsei 2498).
- Simon, Mollel, 1999. *P. barbatus* Andr. Herbarium specimen held at K collected from Tanzania (Simon & Mollel 94).
- Tadesse, 1967. *P. punctatus* L'Her. Herbarium specimen held at K collected from Ethiopia (Tadesse 638).
- Tanner, 1946. *P. barbatus* Andr. Herbarium specimen held at K collected from Tanzania (Tanner 4877A).
- Tanner, 1952a. *P. hadiensis* (Forssk.) Schweinf. ex Spreng. Herbarium specimen held at K collected from Tanzania (Tanner 629).
- Tanner, 1952b. *P. montanus* Benth. (*P. cylindraceus*). Herbarium specimen held at K collected from Tanzania (Tanner 728).
- Tanner, 1959. *P. hadiensis* (Forssk.) Schweinf. ex Spreng. Herbarium specimen held at K collected from Tanzania (Tanner 4221).
- Tanner, 1961a. *P. stachyoides* Oliv. Herbarium specimen held at K collected from Tanzania (Tanner 5742).
- Tanner, 1961b. *P. lactiflorus* (Vatke) Agnew. Herbarium specimen held at K & EA collected from Tanzania (Tanner 5911).
- Tanner, 1961c. *Plectranthus* sp. Herbarium specimen held at K collected from Tanzania (Tanner 5907).
- Templer, 1960. *P. barbatus* Andr. Herbarium specimen held at K collected from Tanzania (Templer T11).
- Ward, 1935. *P. esculentus* N.E.Br. Herbarium specimen held at K & EA collected from Tanzania (Ward H39/35).
- Williams, 1975. *P. barbatus* Andr. Herbarium specimen held at EA collected from Tanzania (Williams 60).
- Winter, Leistner, 1957. Herbarium specimen held at K collected from Namibia (Winter & Leistner 5595).
- Yuncker, 1953. *P. amboinicus* (Lour.) Spreng. Herbarium specimen held at BM collected from Tonga (Yuncker 15232).
- Zaroug, 1981. *P. pseudomarrubioides* Willemsse. Herbarium specimen held at K collected from Oman (Zaroug RMD 23).