1. Introduction

1.1. General overview of the family and genera used for the present study

1.1.1. Species Abundance and Botanic Descriptions

Lamiaceae (Labiatae) is a family of flowering plants comprising about 236 genera and 7, 200 species, cosmopolitan in temperate parts of the world (Ryding *et al.*, 2006). Members of the family, on the whole, inhabit open spaces and forest edges. Usually, their height does not exceed a few meters (Meeuse, 1992). The plants are herbs, shrubs, subshrubs or rarely trees with quadrangular stems and usually aromatic (Ryding *et al.*, 2006).

Lamiaceae is one of the readily recognized families of flowering plants, even by the layman. Herbs or shrubs having square stems, opposite leaves, and emitting a minty smell when crushed are likely to belong to the Lamiaceae (Elder and Turner, 2005). The Lamiaceae is generally regarded as one of the most highly evolved of plant families at least from the viewpoint of flora structure (Hedge, 1992).

According to Ryding *et al.* (2006), their young stems are mostly 4-angled; and older stems are mostly terete. Their leaves are decussate, sometimes whorled, or scattered; blade mostly simple and toothed, sometimes pinnately lobed or palmately compound. Their inflorescence is thyrsoid with 1-2 or 2-3 cymes per node or racemoid, unbranched or branched, lax to dense and sometimes head-like; bracts are similar to or distinct from the ordinary leaves; cymes are one to many flowered, pedunculate or more often sessile; bracteoles are usually small or

absent. Their flowers are pedunculate or sessile, bisexual or rarely unisexual; calyx is with united sepals, persistent in the fruit, regular or bilaterally symmetrical, often distinctly 2-lipped and 2-11 lobed. Their corolla is with the petals united into a tube, 3-5 lobed, slightly to strongly bilaterally symmetrical and mostly distinctly 2-lipped or sometimes apparently 1-lipped. Stamens are 4 in number, didynamous (of two different lengths), or rarely 2; posterior pair sometimes sterile, dwarfed or absent, attached to the corolla-tube, anterior pair longer or sometimes shorter; filaments are free or sometimes united, often hairy near the base; anther with 2 thecae or sometimes only one theca, thecae distinct or joined to form one chamber. The flowers possess one pistil; their style is bifid, or sometimes clavate and entire at the apex; ovary is superior and 4-lobed down the base with 4-locules with one ovule in each locule, or sometimes with fewer locules and/or ovules. The fruit is dry or sometimes fleshy, separating into 4 nutlets, or not separating; nutlets usually glabrous or sometime hairy, winged or scaly, often becoming mucilaginous upon wetting.

The family Lamiaceae is represented in Ethiopia by 44 genera, (of which 5 are cultivated), and by about 170 species, (of which 14 are cultivated), (Ryding *et al.*, 2006). The genera *Ajuga, Ocimum, Plectranthus, Salvia, Satureja* and *Thymus* are some of the genera which are found in Ethiopia.

1.1.1.1. The genus *Ajuga* L.

Ajuga is a genus with about 50 species found mainly in temperate and subtropical regions of the Old World. It includes species that are perennial or annual herbs. Their inflorescence is thyrsoid; bracts are more or less leaf-like; cymes are 3-10 flowered, bracteoles are small or

absent; calyx is subequally 5-lobed or with the upper lobe slightly narrower; and corolla is 2-lipped (or apparently 1-lipped), often persistent after anthesis. They possess 4 stamens, directed to the upper lip of the corolla and anthers are 1-chambered. Their style is equally or subequally 2-lobed at the apex; nutlets are reticulate, pitted or rugose, with a large scar, extending beyond the middle of the nutlet (Ryding *et al.*, 2006).

According to Ryding *et al.* (2006), two species of the genus, *A. integrifolia* and *A. alba*, are found in Ethiopia.

1.1.1.1.1. *A. integrifolia* Buch. Ham.

Ajuga integrifolia (locally known as "Armagusa" in Amharic) is a decumbent herb, rooting at the nodes (Fig.1-A). Its young stems and leaves are more or less densely canescent. Its leaves are subsessile or shortly petiolate, oblanceolate, or narrowly obovate, 3-10 x 1-3 cm, apex obtuse or subacute and base attenuate. Its fruiting calyx is widely copular, often slightly constricted at the mouth, thin, often bursting, and 3-6 mm long. Its corolla is 6-13 mm long, pale violet, light blue or white; and stamens are exserted well beyond the tube. Its nutlets are strongly reticulate (Ryding *et al.*, 2006).

Ajuga integrifolia grows in moist or shaded grassland, often in ditches at 1700-2700 m altitude. It is distributed in East Africa. In Ethiopia it is found in Tigray, Gondar, Welo, Shewa, Gojam, Kefa, Sidamo, Bale and Harerge floristic regions (Ryding *et al.*, 2006).

Fig. 1. Pictures of specimens of *Ajuga, Ocimum and Plectranthus*: (A) *Ajuga integrifolia*, (B) *Ocimum basilicum* var. *basilicum* (C) *O. lamiifolium,* (D) *Plectranthus caninus, (E) P. ornatus*, (F) *P. pseudomarrubioides.*

1.1.1.2. The genus *Ocimum* L.

The genius *Ocimum* includes 64 species (McCallum and Balkwill, 2004). It is widely distributed in the warm regions of the world. The species are aromatic, annual or perennial, herbs or shrubs with indumentum of simple to dendroid hairs. They are with inflorescence of several verticillasters, bracts are persistent and clearly differentiated from the leaves, without glands at the base; cymes are 3-flowered, with out peduncle, and bracteoles are absent. They posses 5-lobed calyx with a much larger upper lobe and 2-lipped corolla. Their stamens are 4 in number; anthers are sagittate to kidney-shape; style is bifid and nutlets are ellipsoid, ovoid or subglobose (Paton, 1992).

12 species are found in Ethiopia and *O. bacilicum,* and *O. lamiifolium* are two of the species found in Ethiopia (Sebald, 2006).

1.1.1.2.1. *O. basilicum* L.

Ocimum basilicum (locally known as "Besobela" in Amharic) is aromatic, 20-60 cm tall, annual or short-lived perennial herb (Fig.1-B). Its stems are round quadrangular, erect or ascending, often woody at base, branching above; its leaf blade is glandular-punctate, narrowly ovate to elliptic, 15-50 x 5-20 mm, entire to shallowly serrate, and with 2-40 mm long petiole. Its Inflorescence is lax, verticils 8-20 mm apart; bracts are deciduous or not, narrowly ovate to elliptical, 3-8 x 1-3 mm; pedicels are 3-4 mm erect and slightly curved; calyx is downward pointing and 2-3 mm at anthesis; fruiting calyx is 6 mm long with open throat; corolla is pink, white or creamy yellow and 5-8 mm. Its stamens are exceeding corolla by 2-4 mm. Ovaries are glabrous. Nutlets are black, ovoid, 1.5-2 mm long and mucilaginous when wet (Paton, 1992).

Paton (1992) stated that the species was introduced from Asia, and locally naturalized throughout Africa, Asia and America. It is also cultivated in North Africa, Europe and America. It grows on disturbed grounds, grounds prone to flooding, and grasslands, from sea level to 2350 m altitudes.

Ocimum basilicum var. *basilicum* is one of the two varieties found in Ethiopia. It is an annual herb up to 40 cm tall and moderately pubescent. Its leaves are usually prominently, but remotely crenate-serrate; its inflorescence is relatively lax, up to 25 cm long but usually shorter, with up to 25 verticillasters (Sebald, 2006).

It is widely cultivated in tropical to temperate regions at an altitude of 1000-2600 m (Sebald, 2006). It is widely cultivated as a spice in many parts of Ethiopia.

1.1.1.2.2. *O. lamiifolium* Hochst. ex Benth.

Ocimum lamiifolium (locally known as "Demakese" in Amharic) is subshrub or shrub, which is 0.7-3 m tall (Fig.1-C). Its leaves are petiolate with petiole 0.1-0.5 times as long as the blade and up to 40 mm long; blade is ovate, 20-100 x 12-60 mm, dark green above and grey green to whitish below, apex acute to acuminate, and margin shapely serrate. Its inflorescence is lax, with 5-20 verticillasters and 8-25 cm long; its bracts are ovate-acuminate, up to 12 mm long and later deciduous; its pedicels are 3-7 mm long, its calyx is 5-8 mm long in the flower, 10-13 mm in the fruit and often dull purple. Its corolla is 10-15 mm long with white, pink or blue and with cylindrical and slightly curved tubes, which are 7-10 mm long. Its posterior stamens are attached 2 mm above the tube base; anterior pair of stamens is 2-4 mm

longer than the lower lip of corolla. Its style is with 0.5 mm long equal branches and nutlets are obovoid, 2.5 mm long and glabrous (Sebald, 2006)

Sebald (2006) explains that the species grows at clearings and edges of primary and secondary mountain forests, bushlands, tall grasslands and abandoned fields at about 1200-2900 m altitudes. It is with some tolerance for shadow and it is also rarely cultivated as an ornamental.

It is distributed in Ethiopia, Kenya, Uganda, Tanzania, Cameroon, Dem. Rep. Congo, Rwanda, Zambia and Malawi (Paton, 1992) at an altitude of 1200-2900 m. In Ethiopia it is commonly found in Tigray, Gondar, Gojam, Shewa, Arsi, Welega, Ilubabor, Kefa, Gamo Gofa, Sidmo and Harerge floristic regions (Sebald, 2006).

1.1.1.3. The genus *Plectranthus* L' Her.

Plectranthus is a large genus in the Lamiaceae family comprising about 300 species of evergreen perennials and subshrubs widely distributed in tropical regions of Africa, Asia, and Australia (Ascensao *et al.*, 1999).

The plants are erect or trailing shrubs or herbs with terminal, rarely axilary spikes, racemes or panicles of whorled flowers; their flowers are usually more than two in each whorl; bracts usually small and deciduous or absent; bracteoles are usually absent; calyx is bilaterally symmetrical; their corolla tube is bent. They posses 4 declinate stamens, with filament attached near the mouth of the corolla tube, either free or fused around the style for part of their length. Their style is bifid at the apex; their nutlets are orbicular to elliptic, flattened, smooth and glabrous (Ryding, 1999).

There are 32 species of the genus found in Ethiopia. *P. caninus, P. ornatus, P. pseudomarrubioides* and *P. punctatus, are* few of these species (Morton and Ryding, 2006).

1.1.1.3.1. *P. caninus* Roth

Plectranthus caninus is a branched, succulent, pubescent annual herb 15-40 cm high, rarely more, with strong unpleasant aroma (Fig.1-D). Its leaves are broadly oblanceolate to elliptic or lanceolate, gradually tapered to a narrower pseudo-petiolate base, 3-6 x 1-3 cm (including the petiole) and fleshy. Its inflorescences are dense cylindrical pseudo-spikes, 3-8 cm long x 10-14 mm (without the corolla), continuous even in fruit; bracts up to 10 mm, ovate-lanceolate with a thickened tip, usually deciduous when the flowers open. Cymes sessile, pedicels erect and 2-3 mm long. Mature calyx glandular pubescent, 4-6 mm long; Corolla blue to purple, 5-10 mm long, tube slender and almost straight; stamens longer than the lip, filaments fused for about ½ of their length and upcurved (Morton and Ryding, 2006).

It grows on dry stony grounds, rocky areas, cultivated lands and roadsides at an altitude of 1000-2000 m. It is widespread through eastern and southern Africa; and also found in India. In Ethiopia it is distributed in Gamo Gofa, Bale, Sidamo, and Harerge floristic regions (Morton and Ryding, 2006).

1.1.1.3.2. *P. ornatus* Codd.

Plectranthus ornatus (locally known as “Ndefdef” in Amharic) is a coarse, perennial, pubescent, succulent herb with unpleasant aroma (Fig.1-E). Its stems are decumbent, branched, and woody at the base and up to

0.5 m high. Its leaves are obovate, up to 5 cm long and 3.5 cm broad, round at the tip, thick and fleshy. Its inflorescences are terminal, dense, with cylindrical spikes, 12-15 mm diameter, and with large, ovate bracts, which persist until the flowers fade. Its cymes are sessile; pedicels are short; corolla is blue to rich purple, 15-20 mm long, with tube sharply bent and funnel shaped. Its stamens are fused for over one fourth of their length (Morton and Ryding, 2006).

It grows over rocky and stony ground in semi-shade from Ethiopia to Tanzania, being nowadays cultivated and semi-naturalized in southern Africa (Ascensao, *et al.*, 1999). It grows at an altitude of 1300-3500 m. In Ethiopia it is found in Tigray, Gondar, Welo, Shewa, Sidamo and Harerge floristic regions (Morton and Ryding, 2006).

1.1.1.3.3. *P. pseudomarrubioides* Willemse

Plectranthus pseudomarrubioides (locally known as "Yemaryam Wuha" in Amharic) is softly villose fleshy aromatic herb, somewhat woody at the base (Fig. 1-F). Its flowering shoots are ascending about 10-30 cm high; its leaves are lanceolate to ovate, 1-3.5(-6) x 0.75-3(-5) cm broad, thick and fleshy, coarsely and shallowly crenate. Its inflorescence is densely villose, with verticillasters interrupted in flower, crowded in bud, 1 cm in diam. and 5-20 cm long; cymes are sessile; pedicels are shorter than the mature calyx. Its corolla is sky blue to violet, 6-10 mm long, with bent tube, broadly funnel-shaped, upper lip well developed and upcurved, lower concave, both lips with long wooly hairs. Its stamens are free and exserted at anthers; mature calyx is 4 mm long, villose, tube campanulate, lip lanceolate, not recurved, median and lower lobes lanceolate acute, of equal length and shorter than the lip (Willemse, 1985).

It grows at dry rocky grasslands, open rocky places and partial shady areas at 1370- 2400 m altitudes in central and southern Ethiopia, Northeast Uganda, North and West Kenya and North Tanzania (Willemse, 1985).

1.1.1.3.4. *P. punctatus* (L. f.) L' Her.

Plectranthus punctatus (locally known as "Dembo" in Amharic) is a pubescent, branched herb, 15-75 cm high, and villose with long, purple, simple hairs (Fig. 2-A). Its leaves are ovate, elliptic, obtuse, cuneate, upper leaves sessile, lower leaves shortly petiolate, shallowly and rather finely crenate-dentate, pubescent below on the veins, heavily punctuate with golden-brown glands. Its inflorescences are terminal and axillary, its cymes are sessile; pedicels are erect, shorter than to equaling the calyx. Its corolla is blue, 4-10 mm long, tube funnel- shaped and not sharply bent. Its filaments are free or slightly fused at the base and its mature calyx is 5-7 mm long (Morton and Ryding, 2006).

It is a roadside weed found in open ground and by streams and in marshes and forest edges at 1350-3200 m altitudes. It is widespread in East Africa and also on mountains of West Africa. In Ethiopia it is found in Gondar, Gojam, Welo, Shewa, Arsi, Ilubabor, Welega, Kefa, Gamo Gofa, Sidamo and Harerge floristic regions (Morton and Ryding, 2006).

Fig. 2. Pictures of specimens of *Plectranthus*, *Salvia, Satureja* and *Thymus*: (A) *Plectranthus punctatus*, (B) *Salvia nilotica*, (C) *Satureja paradoxa, (D) S. simensis,* and (E) *Thymus schimperi.*

1.1.1.4. The genus *Salvia* L.

Salvia, with over 900 species from both the Old and New Worlds, is the largest genus of the Lamiaceae (Walker *et al.*, 2004). It is a worldwide-distributed genus comprising woody shrubs, perennial, and annual plants (Claben-Bockhoff and Speck, 2000).

The genus consists of perennial or annual herbs, subshrubs or shrubs. Their inflorescences are thyrsoid or sometimes racemoid; their bracts are usually distinctly smaller than the leaves, their cymes are one-to many flowered; bracteoles are present or absent. Their calyx is more or less distinctly 2-lipped; their corolla is 2-lipped; they possess 2-4 stamens; upper theca always large, fertile; lower theca smaller, fertile or sterile. Their style is 2-lobed, usually with lower lobe much longer; their nutlets are smooth, with scar at the base or at the proximal side near the base (Ryding, 2006).

The genus is widely distributed from temperate to tropical parts of the world; and there are 4 species indigenous to Ethiopia, and 6 species are cultivated and/or introduced. *S. nilotica* is one of the species found in Ethiopia (Ryding, 2006).

1.1.1.4.1. *Salvia nilotica* Jacq.

Salvia nilotica (locally known as "Hulegeb" in Amharic) is a perennial rhizomatous herb, up to 1 m tall (Fig. 2-B). Its leaves are in a basal rosette and along the stems, usually petiolate at the base, shortly petiolate to sessile along the stems; their blade is obovate to elliptic, irregularly crenate to pinnately lobed. Its bracts are ovate; cymes are 3-4 flowered; and bracteoles are present. Their fruiting calyx is 8-10 cm

long; the corolla is blue, violet, pink, or sometimes white, 8-12 mm long. Its nutlets are elliptic, 1.5-2 x 1.2-1.5 mm long and mucilaginous on wetting (Ryding, 2006).

It is a very common species in a rather moist to semiarid places; in grassland or bushland, often on somewhat moist or shaded places, usually on disturbed grounds; and growing at 1300-3800 m altitudes. It is wide spread in East and Central Africa, Malawi, Zambia and Zimbabwe. Except the Afar region, it is found in all floristic regions in Ethiopia (Ryding, 2006).

1.1.1.5. The genus *Satureja* L.

The genus *Satureja* includes about 200 species of herbs and shrubs, often aromatic, widely diffused in Europe, Africa, Asia and America (Abdolhossein *et al.*, 2004).

The species of *Satureja* are small shrubs, subshrubs, perennials, or annuals. They are with stems often branched, often hairy, especially in the upper part. Their flowers are in cymes found in the axial of bracts; bracts leaf-like; bracteoles are small and often subulate; calyx is tubular to campanulate, 10-13 veined, 2-lipped and hairy at the mouth. Their corolla is 2-lipped; with upper lip bifid or emarginated and lower lip 3-4 lobed. Their stamens are 4 or rarely 2 in number and posses 2 staminoids, shorter than the corolla; and style-branches are subequal or lower branch is longer (Seybold, 2006).

The genus includes 8 species in Ethiopia including *S. simensis* and *S. paradoxa* (Seybold, 2006).

1.1.1.5.1. *S. paradoxa* Engl. ex Seybold

Satureja paradoxa (locally known as "Nado" or "Zenadan" in Amharic) *is* a perennial herb with a strong fragrance of mint (Fig. 2-C). Its stems are creeping with runners and 20-40 cm high. Its leaves are shortly petiolate; blade is elliptic, 10-50 x 8-40 mm and margin is undulate-crenate. Its inflorescence is head like, with confluent vertticillasters; bractes are subulate and 1-2 mm long, calyx is 5-6 mm long, only with a few hairs at the mouth; lobes are triangular, ciliate, up to 2 mm long and straight. Its corolla is red to dark violet and lower lip is with broad middle-lobe. Its stamens are 4 in number, longer than the tube but shorter than the upper lip. Its mature nutlets are not seen (Seybold, 2006).

It is endemic to Ethiopia and found in Gondar, Gojam, Shewa, Arsi, Welega, Ilubabor, Kefa, Gamo Gofa, Sidamo, Bale, and Harerge floristic regions. It grows in moist soil in open shady grasslands, forests with *Podocarpus* and rarely as a weed in tea plantations at 1300-3500 m altitudes (Seybold, 2006).

1.1.1.5.2. *S. simensis* (Benth.) Briq.

Satureja simensis is a perennial herb, 5-40 cm high, prostrate or ascending to erect and with branches like runners (Fig. 2-D). Its leaves are ovate, acute, cuneate at the base and with 2-10 cm long petiole; blade is broadly ovate, 4-13 x 3-10 mm and margin with 4-6 crenations on both sides. Its cymes are 1-10 flowered, the flowers are shorter than the bracts; bracteoles are short and subulate; and calyx green, gibbous, 2.5-6 mm long and with 1-2 mm long lobes curved upwards; corolla is 4-11 mm long, white, rose or lilac, with upper lip bifid and lower lip

with trifid middle-lobe and 2 side–lobes. It possesses 2 stamens and 2 staminoids. Its nutlets are ellipsoid and 1 mm long (Seybold, 2006).

It grows on slightly moist ground in grassland, near bushes and in forests at 1900-4100 m altitudes. In Ethiopia it is found in Tigray, Gondar, Welo, Gojam, Shewa, Arsi, Welega, Kefa, Sidamo, Bale and Harerge floristic regions. It is also found in Uganda and Demo. Rep. of Congo (Seybold, 2006).

1.1.1.6. The genus *Thymus* L.

The genus includes about 350 species worldwide, and is mainly distributed in temperate Eurasia (Sebesbe Demissew, 1993). It consists of perennial and aromatic herbs and small shrubs. *Thymus* are with quadrangular branches; sessile or petiolate leaves; their infilorecences are axillary in the axial of leaf-like bracts or often crowded into terminal heads; bracteoles are present but often minute; their flowers are white, pink, blue, or purple; their calyx is tubular; corolla is 2-lipped, upper lip is unlobed oblong, emarginated, lower lip 3-lobed; their stamens are 4 in number, and exserted more or less equal to slightly didynamous with 2-thecous anthers; and their style is exserted and shortly bifid (Sebsebe Demissew, 1993).
According to Sebsebe Demissew (2006), there are 3 species of the genus represented in Ethiopia. *Thymus schimperi* Roninger is one of the endemic species.

1.1.1.6.1. *T. schimperi* Roninger

Thymus schimperi (locally known as ("Tosegn" in Amharic) is a perennial herb, which is woody at the base and up to 5-40 cm long (Fig.

2-E). Its stems are prostrate, sometimes erect in younger parts, quadrangular and green to purplish. Its leaf-blade is blue-green or pale-green, glandular on both sides, ovate to suborbiccular, elliptic or lanceolate, 3.5-15 x 2.6-6 mm, entire, obtuse to subacute at the apex and crowded into globose or oblong to lax terminal heads. It is with 2-8 flowered verticillasters in the axils of leaf-like bracts; bracts are more or less similar to leaves and they are ciliate at the margins; bracteoles are linear 1-3 mm long and ciliate; peduncle is absent; pedicel is 2-4 cm long. Its calyx is green with purple tinge, 4-5 mm long pubescent, tubular and companulate. Its corolla is white purple, 6-8 mm long and 2-lipped, and style is 7-8 mm long, with slightly unequal branches (Sebsebe Demissew, 1993, 2006).

It grows on open grassland, on bare exposed rocks, on slopes and tops of mountains, sometimes growing near ditches in afromontane and afroalpine vegetation zones at altitudes of 2250-4000 m. Being endemic to Ethiopia, it is found in Gondar, Tigray, Welo, Shewa, Arsi, Sidamo, Bale and Harerge floristic regions (Sebsebe Demissew, 2006).

1.1.2. Significance of the Lamiaceae

Lamiaceae is a family with a set of chemical compounds, which give distinctive odours and flavours to the foliage of many well-known species. Considerable economic importance of many species in the family is due to their essential oils (Harley and Reynolds, 1992), produced mainly by glandular trichomes (Ascensao *et al.*, 1995). The characteristic multicellular glandular trichomes are present primarily on the leaves and calyces (Lawrence, 1992). The structure and function of glandular trichomes is well documented and they are recognized as the site of essential oil biosynthesis, secretion and accumulation

(Gersbach, 2002). Some 40% of Lamiaceae produce aromatic oils (Oxenham, *et al.*, 2005).

With increasing interest in the natural products, especially as foods, flavorings, perfumes, and colourants, and also in the sustainable utilization of wild species, it is hardly surprising that the Lamiaceae should attract much attention from chemists, ethnobotanists and those interested in their commercial exploitation (Harley and Reynolds, 1992).

Many species in the family have been investigated because of their high content of essential oils, which are widely used in pharmaceutical preparation, perfumery and cosmetics (Ascensao, *et al.*, 1999). Most of the species have been taken into cultivation as ornamentals. Some are highly widely cultivated as commercial crop plants (Elder and Turner, 2005). Far more important, however, especially in rural communities, is the use of Lamiaceae as medicines. The family is of outstanding importance in its use in indigenous medicinal systems in rural and primitive societies all over the world (Harley and Reynolds, 1992).

The family has held a place of importance for hundreds of years because tinctures of numerous aromatic species have been, and are still, used as compounds of herbal treatments for variety of ailments (Lawrence, 1992). This is to be expected, given that the strongly aromatic nature of the plants has probably attracted man since ancient times (Gonzalez-Tejero *et al.*, 1992).

The Lamiaceae are also employed for other valuable properties. Many are extremely important as "bee plants" in the honey industry. Some species of *Stachys, Plectranthus* (e.g. *P. edulis*) and *Solenostemon* provide edible tubers or a few may have mucilaginous nutlets, which

are used in drinks (*Salvia hispanica* and others) and some have oils that are used in the production of paints (Harley and Reynolds, 1992).

Thymus species are used for medicinal purposes because of their antiseptic, antispasmodic and antitussive properties (Pina-Vaz, *et al.*, 2004). Some *Satureja* species are used as flavoring agents and for medicinal purposes (Abdolhossein, *et al.*, 2004). Several species of *Salvia* are cultivated because of their aromatic nature and are used as a flavor and food condiments, in cosmetics, perfumes and in folk medicine (Felice, *et al.*, 2005). On the other hand, several *Plectranthus* species are cultivated as ornamentals or as sources of essential oils, whereas others are used for their edible tubers or as food flavouring. In folk medicine, *Plectranthus* are employed for headaches, sores, burns, dermatitis and against nausea and scorpion stings (Ascensao, *et al.*, 1999).

1.1.2.1. Some useful species of the Lamiaceae in Ethiopia

1.1.2.1.1. *Ocimum basilicum*

Ocimum basilicum is found in cultivation as well as in the wild in most regions of Ethiopia. Fresh or dried plant parts are for sale on almost every Ethiopian market and small-scale cultivation near houses is wide spread.

Ocimum basilicum has culinary and medicinal uses. Both the dried and fresh inflorescences and leaves of basil are used almost daily as a flavoring agent in the preparation of all kinds of 'wot' and usually their leaves, flowers, fruits and tender stems are added to sauces, together

with other spices. Dried, ground basil is also used to flavor butter and is sometimes sprinkled in tea or coffee to add flavor (Jansen, 1981)

In Ethiopia, basil is used as a medicine against malaria (also as an insect repellant) and as a medicine against headache (Jansen, 1981) Infusion of its fresh leaves is used as a remedy against amoebiasis (Dawit Abebe *et al.*, 2003).

1.1.2.1.2. *Ocimum lamiifolium*

Ocimum lamiifolium is another medicinally important species in Ethiopia. Its leaves are used to treat eye diseases, headache and stop nose bleeding (Jansen, 1981). Infusion of its leaves is employed for treatment of colds and used as snuff for headache, for stomach distension and as antipyretic. Its leaf juice is also employed to treat eye disease and cough (Dawit Abebe *et al.*, 2003).

1.1.2.1.3. *Thymus schimperi*

Thymus schimperi is a useful condiment. It is used as a spice, medicinal herb and forage for the sheep and goats (Zemede Asfaw *et al.*, 2007). As a spice, it is dried, ground and mixed with other spices that are used in the preparation of “berbere” and “shiro”. It is also used to flavor tea or drunk alone as tea. It is also reportedly used in the control of gonorrhea. When it is added to boiling water and drunk, it is used against cough and liver disease (Amare Getahun, 1976). In some parts of the country, it is believed to have disease preventive value for heart diseases, hypertension and diabetics (Zemede Asfaw *et al.*, 2007).

1.1.2.1.4. *Salvia nilotica*

Salvia nilotica is an erect rough herb, which is used as painkiller and to treat sunburns (Jansen, 1981). It is employed in treatment of wounds; diarrhea, sore throat and cough. The whole plant is also used for treatment of rheumatism (Dawit *et al.*, 2003).

1.2. Cytogenetics and Plant Systematics

Cytological approaches to the systematics of higher plants are largely confined to the cell nucleus, especially the chromosomes. There are several reasons that chromosomes are important in taxonomy. They occur in sets of defined number and can be counted during mitotic and meiotic divisions, they have defined shapes that can be expressed in absolute and relative length units, they show landmarks (spindle attachment sites, nucleolar organizing regions, heterochromtic bands) for individual identification, and their content of DNA can be measured (Grellhuber and Ehrendorfer, 1988).

There are various ways that karyotypes, the phenotypic appearances of the somatic chromosomes in contrast to their genetic content, may differ from one group of plant to the other. According to Jackson (1971), the following are among some of the distinguishing characteristics of the karyotypes: 1. chromosome number, 2. absolute size of chromosomes, 3. size differences within a complement, 4. position of centromers and the number of microtubule attachment sites, 5. arm ratios, 6. number, size, and position of secondary constrictions and satellites, 7. position, number, size and distribution of differentially staining heterochromatic segments, and 8. total amount of DNA.

1.2.1. Variations in chromosome morphology

Chromosome morphology is usually studied at the metaphase of mitosis, when chromosomes become contracted to the maximum or nearly so (Stebbins, 1971). Chromosomes are arrested at metaphase by treating them with spindle disrupting or inhibiting chemicals such as colchicine, colcemid, vinblastine, bromonapthalene, 8-hydroxyquinloline or griseofulvin (Jakson, 1971). Cold treatment can also be used. The morphology of somatic chromosomes at this stage is a constant feature. From cell to cell, and among individuals of the same species, little variation is encountered (Swanson, *et al.*, 1973). A species may, therefore, be characterized by the number and morphology of its metaphase chromosomes.

The most obvious feature defining morphological variations is the position of the centromere or primary constriction, to which spindle fibers are attached, and in many chromosomes one or more secondary constrictions, which are the sites of origin of the nucleoli (Stebbins, 1971). The centromere is the localized region responsible for chromosome movement and which divides each chromosome into two arms (Jackson, 1971). Secondary constrictions are non-staining gaps in chromosomes caused by the presence of a nucleolus at this site during prophase, preventing the coiling of the chromosomes (Swanson, *et al.*, 1973). In addition, one, two or (rarely) a large number of chromosome pairs may bear at one end a satellite, which usually appears as a single small spherical body or a pair of such bodies, attached to the remainder of the chromosome by a slender thread (Stebbins, 1971). Differences in the number of satellites indicate differences in the number of nucleolar organizer regions.

According to Stace (2000), chromosomes can loosely be described as metacenteric, with the centromere nearer the mid point than the end, and acrocentric in the opposite case. However, strict numerical ratios can be used, for detailed comparative work (Levan *et al.*, 1964).

The other most important morphological variable in chromosomes is the variation in size between the chromosomes of a genome. The chromosomes in a genome can vary from being virtually all identical in size to exhibiting a size difference ratio of five or more (Stace, 2000).
Variation in the above parameters has provided a powerful means of characterizing genomes by means of their relative sizes and shapes, giving rise to the concept of karyotype, representing the appearance of the chromosomes at mitotic metaphase stage. Differences in karyotypes have aided many cytotaxonomic decisions (Stace, 2000).

1.2.2. Variation in chromosome number

Chromosome number and type are characteristic of species. The chromosome number is as important a datum for a species as any other characteristic deemed significantly stable to merit taxonomic significance (Garber, 1972). Chromosome number is constant in somatic cells of all normal individuals of a given species. Nearly all floras include a chromosome number for each species given as just one or more characters to confirm the identification (Shaw, 1973).

Chromosome number is the product of the two variables, basic chromosome number (x) and ploidy level (Stace, 2000).

Basic chromosome number

Basic chromosome number is defined as the number of chromosome in a set (Snustad *et al.*, 1997). Basic-number is one of the most widely used characters in biosystematic studies and there has been a vast amount of phylogenetic speculation using this value as a guide (Jones, 1970).

Polyploidy

Polyploidy is the case where chromosome complements are consisting of three or more basic sets (De Wet, 1971). It is the most widespread and distinctive cytogenetic process which has affected the evolution of higher plants (Stace, 2000). It played a significant role in the origin and evolution of many plant species (Avers, 1980). It is one of the most common changes found within and between species of angiosperms (John, 1976).

Polyploidy may arise from chromosome doubling in somatic cells, or through the functioning of cytologically unreduced gametes (De Wet, 1971). Polyploid cells are often encountered among diploid cells in vegetative tissues of most plants. These polyploid cells occasionally lead to the development of polyploid branches, the production of diploid gametes, and eventually lead to the development of polyploid individuals. Such type of polyploidy is referred to as autopolyploidy because the same chromosome set is present three or more times. At meiosis chromosomes are associated into univalents, trivalents and quadrivalents instead of the usual bivalent association. According to De Wet (1971), most polyploids may originate as a result of hybridization between either well differentiated ecotypes within a species or between

closely related species which is followed by chromosome doubling. Such type of polyploidy is known as allopolyploidy where the normal bivalent association of meiotic chromosomes is observed.

Sometimes decrease or increase in chromosome number by less than a complete set may occur in individual plants (Jackson, 1971). This is referred to as aneuploidy and unlike polyploidy it may imply genetic imbalance.

Level of Polyploidy

The extent of polyploidy can be revealed only in conjunction with a decision on base-number. The ploidy level of a species can be easily determined if the genus exhibits a single base-number. But, it is more difficult where more than one base-number occurs, where different interpretations of the base-number can be made (Stace, 2000). In many plant genera all of the species have chromosome numbers that are multiples of the basic chromosome number of the genus (Stebbins, 1971).

Differences in ploidy level that diagnose each of a pair or group of species have been utilized as standard taxonomic information for many decades (Stace, 2000). The overwhelming body of evidence in the case of polyploidy series is that the lower levels are primitive and the higher ones are derived, but occasional reductions from higher to lower levels are not impossible (Stebbins, 1971). Information on change in chromosome number is used to trace possible evolutionary patterns at generic and family levels (De Wet, 1971). Therefore, studying chromosome number and karyotype has generally been useful for

taxonomic purposes and for possible clues to the evolution of related groups of species (Garber, 1972).

1.3. Chromosome Cytology of the Lamiaceae

Although the small chromosome size found in most taxa of the Lamiaceae often makes meaningful karyotypic analysis impracticable, chromosome number has proven to be of importance to systematics in many groups of the Family (Harley and Heywood, 1992). However, reports on chromosome numbers and karyotypes of the Lamiaceae species are relatively rare. Only some genera of Lamiaceae have been investigated from the standpoint of chromosome number and chromosome morphology.

Chromosome numbers of the Lamiaceae species reported from different sources indicate variable basic chromosome numbers for species found within the same genus. El-Gazzar and Watson (1970) in their report of chromosome counts for species of Lamiaceae list numbers that are multiples of 6, 7, 8, 9, 10, 11, 13, 17, 19 and 23, but mostly multiples of 7, 8 and 10.

2. The Present Study

Although molecular methods have become more and more popular and easy to use in studies of systematics and evolution of plants, it is often necessary to know the chromosome number and karyotype of species (Stedje, 1996). Cytological studies, including chromosome number and Karyotype analysis have been considered as reliable guides in studies of taxonomic and evolutionary relationships of plant species (Soliman, 2000). The data on chromosome numbers and comparative karyology

are fundamental to overall understanding of genome in different species or in morphologically diverse populations within a species (Kumar and Raol, 2002). In addition to this, knowledge of chromosome number and behavior might suggest something of potential interspecific crossability among related species (Chambers, 1961).

In flowering plants, chromosome numbers are known to range from n=2 to around n=263 (De Wet, 1971). According to Bennett (1998), chromosome counts exist for only about 25% of angiosperm species. In view of the fundamental significance of chromosome number in systematics and evolution, chromosome number data of angiosperms is thus quite incomplete.

Reports on chromosome numbers and karyotypes of the Lamiaceae species are relatively rare. Most importantly, the chromosome numbers of the species of the Lamiaceae found in Ethiopia have not been reported. Thus, the present study was conducted with the following objectives.

2.1. General objective of the study

The main objective of this study is to generate chromosomal information for some species of the Lamiaceae occurring in Ethiopia.

2.2. Specific objectives of the study

The specific objectives of this study are:

- To determine chromosome numbers of some species in the genera *Ajuga, Ocimum, Plectranthus, Salvia, Satureja* and *Thymus* in the Lamiaceae family.

- To describe the karyotype of these species, where possible.
- To determine the ploidy levels for these species.

3. Materials and Methods

3.1. Sample collection

In the present study, which involved 6 genera of the Lamiaceae, chromosome counts of 11 species, of which two are endemic to Ethiopia, were made. Sample specimens of the plant species (Table 1) for the study were collected from their natural localities and home gardens in Addis Ababa and other parts of the country and transplanted into pots and grown in the greenhouse (Figs. 1, 2 and 3) at the Science Faculty, Addis Ababa University. Fresh root tips of the specimens were used for chromosome study.

Fig. 3. Some species of the Lamiaceae collected and grown in the greenhouse.

Table 1. List of specimens studied and their sites of collection.

Taxon		Site of specimen collection	Collection number
Genus	Species		
Ajuga	*A. integrifolia*	Addis Ababa	Em/aa/05/01
Ocimum	*O. basilicum* var. *basilicum*	Addis Ababa	Em/aa/05/02
	O. lamiifolium	Addis Ababa	Em/aa/05/03
Plectranthus	*P. caninus*	Arba Minch	Em/am/05/04
	P. ornatus	Gojam	Em/gj/05/05
	P. pseudomarrubioides	Addis Ababa	Em/aa/05/06
	P. punctatus	Addis Ababa	Em/aa/05/07
Satureja	*S. paradoxa*	Entoto	Em/en/05/08
	S. simensis	Entoto	Em/en/05/09
Salvia	*S. nilotica*	Addis Ababa	Em/aa/05/10
Thymus	*T. schimperi*	Entoto	Em/en/05/11

3.2. Somatic chromosome study

3.2.1. Pretreatment

For somatic chromosome studies, actively growing roots (3-4 cm) were harvested from specimens growing in the greenhouse and collected in vials. The roots were then either cold treated by keeping the vials in ice water in the refrigerator for about 24 hours or treated with colchicine (0.05%) or 8-hydroxyquinoline (0.002 M) for 2-4 hours at room temperature. These treatments result in inhibition of spindle formation and bring about accumulation of metaphase stages, and contraction and separation of the chromatid arms, thus facilitating chromosome spreading (Walker, 1973). The roots were then fixed in ethanol and

acetic acid (3:1 by V/V) for 1 hour or more at 4^0C. The prime purpose of fixation is to coagulate the cell contents in such a way as to retain their shape, structure and position. It also prepares the surface of the chromosomes so that they readily take up suitable stains (Walker, 1973). The roots were stored in 70% ethanol at 4^0C until used. After brief rinsing of the roots in distilled water, enzyme maceration was performed in 4% cellulase + 4% pectinase solution for about 1 hour at 36-37^0C (Kifle Dagne and Heneen, 1992). The roots were rinsed in several changes of distilled water after decanting the enzyme.

3.2.2. Slide preparations

In well macerated roots, the lower tips (1-2 mm) detach from the roots by themselves or upon slight agitation. The detached root tips were pipetted onto glass slides. The water was carefully blotted off using absorbent paper and the root tips were mashed in a few drops of fresh fixative (3:1, ethanol: acetic acid). Then, cells were spread by strong air blowing on the slide. The slides were then allowed to air dry under room temperature.

The air-dried slides were stained with Giemsa in Sorensen's phosphate buffer (pH 6.8) for about 30 minutes or more. Then, the slides were rinsed in distilled water, air-dried and permanently mounted with cover slips using DPX, which is a mixture of Distyrene, Plactcister and Xylene (Gustashaw, 1991).

The prepared slides were analyzed for chromosome spreads under light microscope and photographs of cells with well-spread chromosomes were taken. Then, analysis was made by direct observation under the microscope as well as using the photomicrographs.

4. Results and Discussion

Chromosome numbers of the species *Ajuga. integrifolia, Ocimum basilicum* var. *basilicum, O. lamiifolium, Plectranthus caninus, P. ornatus, P. pseudomarrubioides, P. punctatus, Satureja paradoxa, S. simensis, Salvia nilotica and Thymus schimperi,* are presented. The chromosome counts were based on maximum counts from more than one intact cell. Table 2 shows the summary of the chromosome counts obtained for the species studied. These chromosome numbers, except that of *Ocimum basilicum* var. *basilicum*, are believed to be first for the species. However, we cannot confirm that this is so because not all possible reports are accessible.

Because of the limitations rendered by the small chromosome size and lack of significant morphological differentiation between the chromosomes, it has not been possible to give detailed cytogenetical characterization of most of the species including karyotype and number of satellite chromosomes. Thus, this made further cytological analysis difficult. It has to be noted that some chromosomal morphological features are better observed under the microscope than using their photomicrographs.

4.1. Genus *Ajuga*

Ajuga integrifolia: Chromosome number 2n=64 was consistently found (Fig. 4-A). The chromosomes are small, with homogeneous appearance. The chromosome length within a complement is fairly uniform. One satellited chromosome was observed (Fig. 4-A). UTH (2007), reported basic chromosome numbers x=14, 15, 16 for the genus. Previously reported chromosome numbers of several species belonging

to the genus, 2n=32 for *A. macrosperma* Wall (Vij and Kashyap, 1975), 2n=32 for *A. genevensis* L. (Markova and Thitun, 1974), 2n= 32 for *A. pyramidalis* L. (Murin and Majovsky, 1976), indicate basic chromosome number x=16. Thus the chromosome number 2n=64 reported here for *A. integrifolia* probably indicates tetraploidy, with possible basic chromosome number x=16.

Table 2. Summary of chromosome number counts of the studied species of the Lamiaceae.

Taxon	Number of potted plants analyzed	Number of metaphase plates analyzed for each plant	*2n* Chromosome number
Ajuga integrifolia	4	6-7	64
Ocimum basilicum var. *basilicum*	5	4-6	50
Ocimum lamiifolium	2	5-6	42
Plectranthus caninus	4	4-7	30
Plectranthus ornatus	4	4-6	30
Plectranthus punctatus	4	3-6	56
Plectranthus pseudomarrubioides	3	3-5	64
Satureja paradoxa	3	5-7	32
Satureja simensis	2	4-6	22
Salvia nilotica	3	4-5	32
Thymus schimperi	2	6-8	30

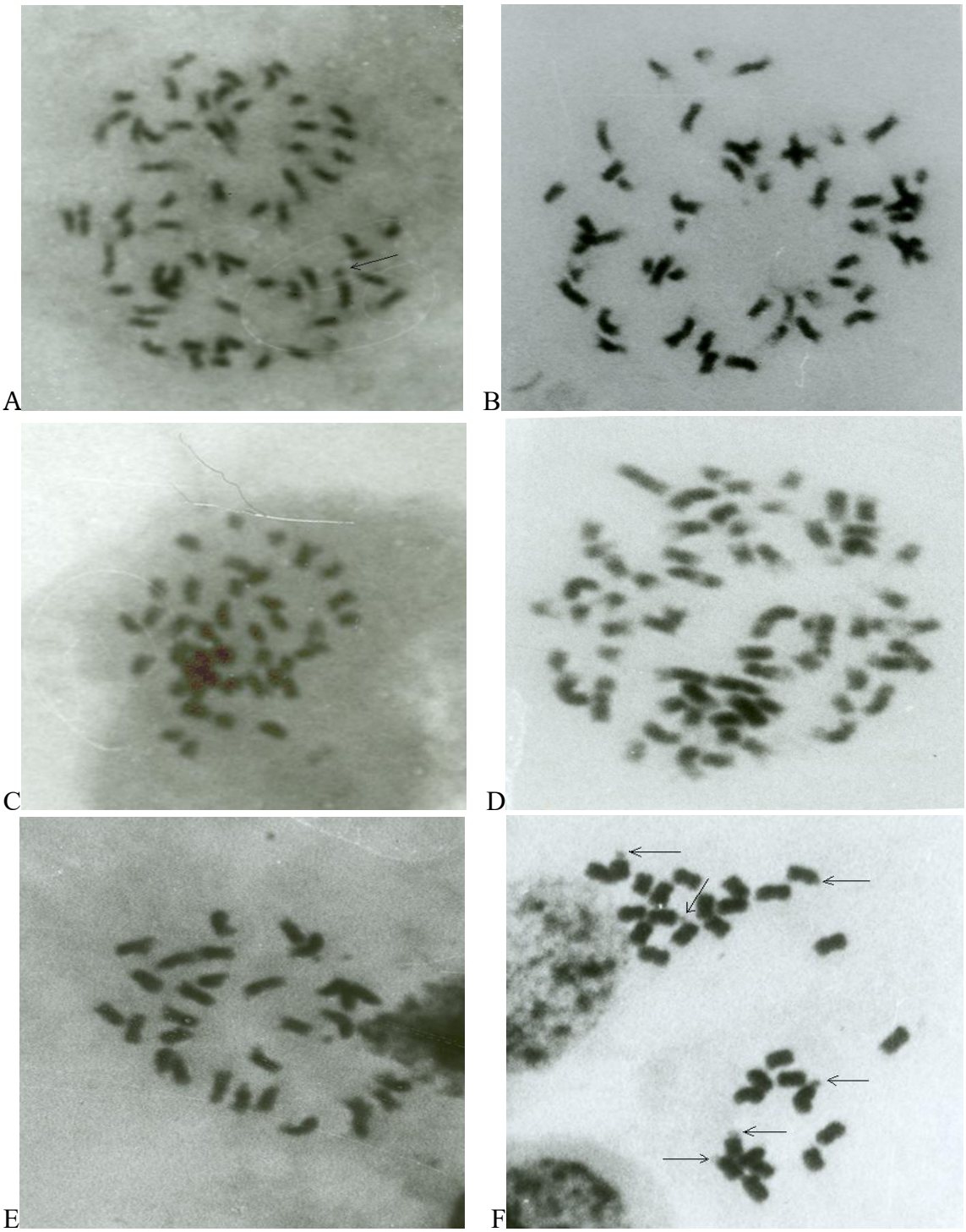

Fig. 4. Photomicrographs of mitotic chromosomes: (A) *Ajuga integrifolia* (2n=64), (B) *Ocimum basilicum* var. *basilicum* (2n=50), (C) *O. lamiifolium* (2n=42), (D) *Plectranthus pseudomarrubioides* (2n=64), (E-F) *P. caninus* (2n=30) (E-prometaphase and F-metaphase). Arrows indicate satellite and/or satellited chromosomes. Magnification: 50, 000 x

4.2. Genus *Ocimum*

Ocimum basilicum* var. *basilicum: Somatic chromosome number 2n=50 was found in many counts (Fig. 4-B). Unlike most of the other species in this study, distinctly large and small chromosomes were observed in a complement (Fig. 4-B). Paton and Putievsky (1996), reported chromosome numbers 2n=50, 52, 56, 72, and 74 for different accessions of *O. basilicum* var. *basilicum*. Moumita *et al.* (2005), reported 2n=72 for *O. basilicum* var. *citriodorum* and 2n=52 for *O. basilicum* var. *crispum*. Other reports also indicated 2n=52 for *O. basilicum* var. *thyrsiflorum* (Krishnappa and Basavaraj, 1982). 2n=48 was also reported for *O. basilicum* var. *purpurascens* (Paton and Putievsky, 1996). According to Moumita *et al.* (2005), statistical analysis of cytological data revealed x=12 as basic chromosome number for the varieties of *O. basilicum* and polyploidy as well as aneuploidy might have been operative at different levels to give variable chromosome numbers. Thus the chromosome number 2n=50 reported here for *O. basilicum* var. *basilicum* probably indicates tetraploidy, with basic chromosome number x=12, and aneuploidy increment.

Ocimum lamiifolium: Somatic chromosome number 2n=42 was obtained from many counts (Fig. 4-C). There is homogeneous appearance of chromosomes within a complement, with fairly uniform length. Previous chromosome number reports of species in the genus, 2n=36 for *O. tenuiflorum* (Datta and Moumita, 2005), 2n=40 for *O. grassimum*, 2n=26 for *O. americanum* L (Harley and Heywood, 1992), 2n=64 for *O. citriodorum*, 2n=56 for *O. minimum*, and 2n=76 for *O. tenuiflorum* (Paton and Putievsky, 1996), probably indicate polyploidy with possible basic chromosome numbers of x= 6, 7, 8, 9, 10, 12, 13, 16 or 19, with a possibility of aneuploid series. Thus, 2n=42 reported

here for *O. lamiifoium,* might indicate plolyploidy with possible basic chromosome numbers x=6 or 7.

4.3. Genus *Plectranthus*

P. caninus: Chromosome number 2n=30 was found (Fig. 4, E-F). Chromosomes are relatively larger and some morphological features are visible. Most of the chromosomes appeared to have median centromeric position and six satellited chromosomes were observed (Fig.4-F).

P. ornatus: The chromosome number 2n=30 was obtained for this species (Fig.5, A-B). Five satellited chromosomes were observed (Fig. 5-B). From observation of the photomicrographs, it can be seen that the chromosomes are relatively larger (Fig. 5, A-B). Most chromosomes in the complement seem to be metacentric or submetacentric and some acrocentric (Fig. 5-A, B).

P. pseudomarrubioides: Chromosome number 2n=64 was found (Fig.4-D). It has relatively larger chromosomes and size variation within a complement is evident (Fig. 4-D).

P. punctatus: Chromosome number 2n=56 was found (Fig.5, C-D). Compared to the other species in the genus, chromosomes are too small to observe any morphological features.

Chromosome number 2n=24 was previously reported for four species in the genus, *P. coesta, P. striatus,* and *P. wightii* (Krishnappa and Basavaraj, 1982) and *P. rogosus* (Mehra and Gill, 1968). This may probably suggest possible basic chromosome numbers x=6, 8, 12 or

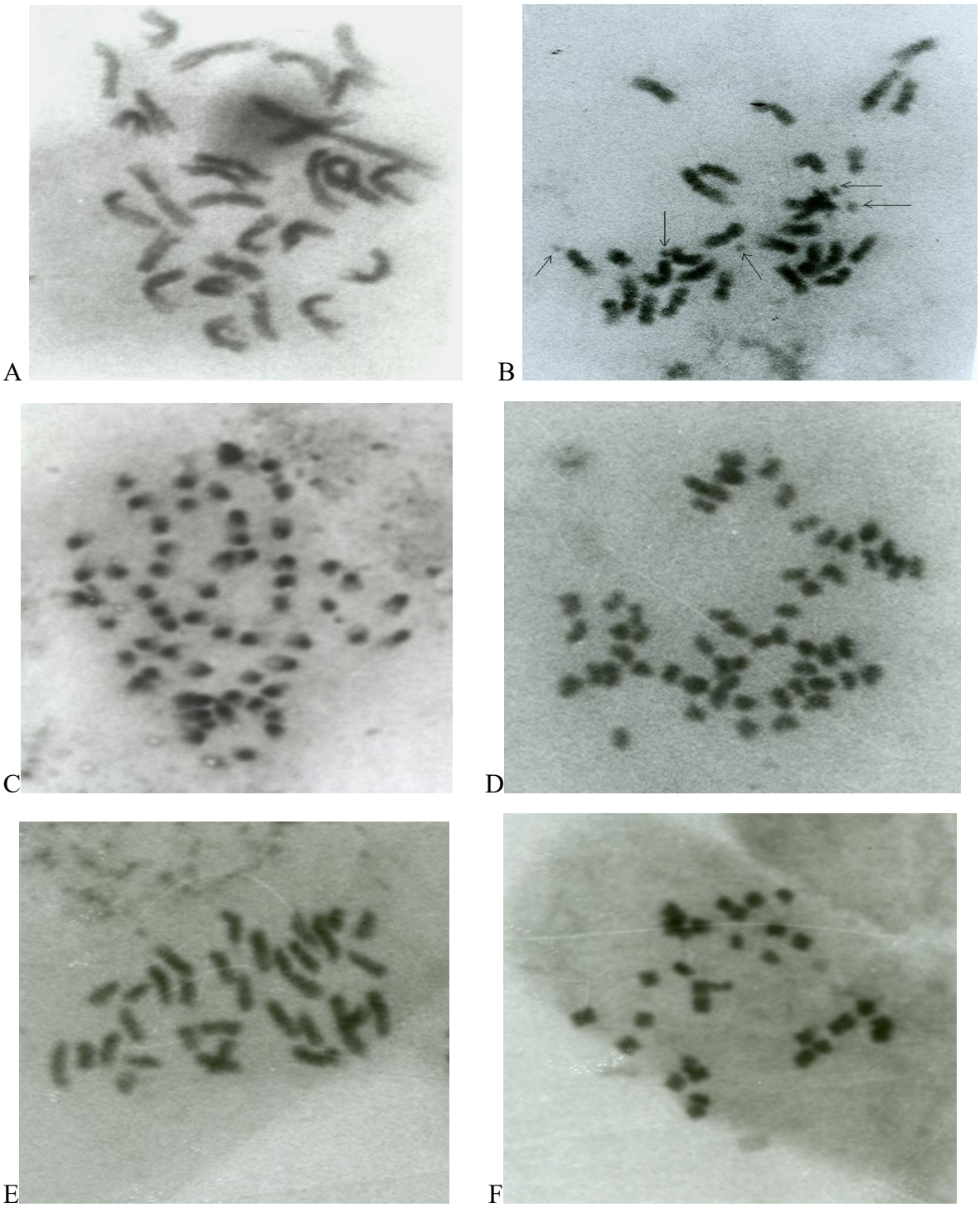

Fig. 5. Photomicrographs of mitotic chromosomes: (A-B) *Plectranthus ornatus* (2n=30) (A-lateprophase, B-prometaphase), (C-D) *P. puctatus* (2n=56) (C-prophase, D-metaphase), (E-F) *Salvia nilotica* (2n=32) (E-prometaphase and F-metaphase). Arrows indicate satellite and/or satellited chromosomes. Magnification: 50, 000 x

16 for the genus. Chromosome number, 2n=30 reported here for two of the species, *P. caninus* and, *P. ornatus*, probably indicate polyploidy with possible chromosome numbers x=6 or 10. On the other hand, numbers reported here, 2n=64 for *P. pseudomarrubioides* and 2n=56 for *P. punctatus*, probably indicate polyploidy with possible basic chromosome numbers x=8 or 16 and x=7 or 8, respectively.

4.4. Genus *Salvia*

S. nilotica: Chromosome number 2n=32 was obtained for this species (Fig. 5, E-F). Two distinctly large chromosomes are observed in a complement (Fig. 5-E). Fedrove (1974) (cited in Yildiz and Gucel, 2006), reported basic chromosome numbers x=6, 7, 8,9,11,15,17,19 for the genus *Salvia.* Xun *et al.* (2005), also reported basic chromosome number x=8 for the species of *Salvia* they studied in China. Vij and Kashyap (1975), reported 2n=16 for *S. plebia* and Markova and Thithu (1974) also reported 2n=16 for *S. viridis*. Thus, it is plausible to say that *S. nilotica,* with 2n=32, is a tetraploid with basic chromosome number x=8.

4.5. Genus *Satureja*

S. paradoxa: Somatic chromosome number of 2n=32 was consistently found in many counts for this endemic species (Fig. 6, A-C). The chromosomes are too small that morphological features are not evident. The chromosomes seem to be homogeneous in a complement.

S. simensis: Diploid chromosome number 2n=22 was found (Fig. 6-D). This species is with the smallest chromosome number reported in

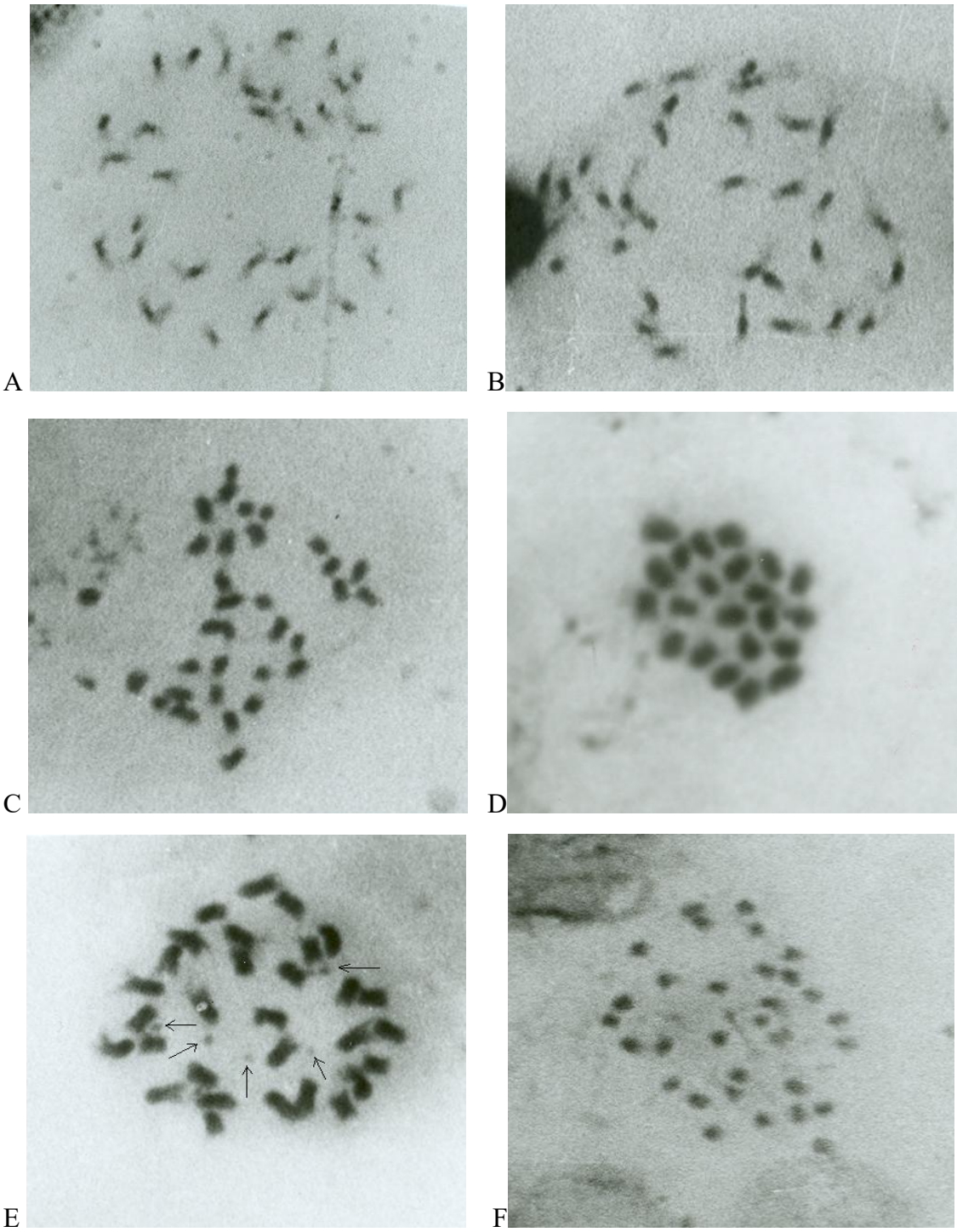

Fig. 6. Photomicrographs of mitotic chromosomes: (A-C) *Satureja paradoxa* (2n=32) (A-earlyprophase, B-lateprophase and C-metaphase), (D) *S. simensis,* (2n=22), (E-F) *Thymus schimperi* (2n=30) (E-prometaphase and F-metaphase). Arrows indicate satellite and/ or satellited chromosomes. Magnification: 50, 000 x

this study. It can be observed that the chromosomes are uniform in size.

Previously, chromosome numbers for species in the genus, such as 2n=30 for *S. montana* (Murín, 1997) and 2n=46 for *S. stachyodes* (Harley and Heywood, 1992), 2n=46 for *Satureja ascendens*, 2n=18 for *Satureja acinos*, 2n=48, 72 for *Satureja calamintha*, 2n=24 for *Satureja menthifolia* and 2n=20 for *Satureja vulgaris* (Stace *et al.*, 2007), were reported. BC Flora (2007), reported basic chromosome number x=6 for species of *Satureja*. However, chromosome numbers 2n=32 for *S. paradoxa* and 2n=22 for *S. simensis*, reported here, do not indicate similar basic chromosome number. Probably, *S. simensis* and *S. paradoxa*, are with basic chromosome numbers x=11 and x=8 (which were reported as the basic chromosome numbers in the family by El-Gazzar and Watson (1970)), respectively. Hence, *S. simensis* is probably a diploid with x=11 and S. *paradoxa* is probably a tetraploid with x=8.

4.6. Genus *Thymus*

***Thymus schimperi*:** Chromosome number 2n=30 was found (Fig. 6-E & F). Five satellites were observed within the complement. There is fairly uniform size of chromosomes within the complement. Similar chromosome number, 2n=30, have been reported previously for other species of the genus such as *T. vulgaris*, by Elena-Rosello (1981) and Murín (1997). Known chromosome numbers for the genus *Thymus* are 2*n*=24, 26, 28, 30, 32, 42, 48, 50, 52, 54, 56, 58, 60, 84 and 90, which correspond to the diploid, tetraploid and hexaploid levels (Morales, 1996). The most frequent numbers are 2*n*= 28, 30, 56 and 60. According to Morales (1996) the basic chromosome number in the

genus is x=7 with probable secondary basic chromosome numbers x=14 and x=15. Hence the species in this study is a diploid with x=15.

In summary, as seen from the microscopic as well as the photomicrographic observations, the chromosomes of most of the species in the genus *Plecrctrantus* are relatively larger than those of the other genera. Chromosome number 2n=30 was established for three species, and both 2n=64 and 2n=32 were established for two species each (Table 2). Chromosome number count, 2n=64, for *A. integrifolia and P. pseudomarrubioides, is* the maximum and 2n=22 for *S. simensis* is the minimum obtained in the study. In most of the species, chromosome size variation within a complement is not evident. A clear-cut separation into larger and smaller chromosomes within a complement can be seen only in *O. basilicum* var. *basilicum*, and *P. pseudomarrubioides*. Satellited chromosomes were observed in *P. caninus*, *P. ornatus, A. integrifolia, and T. schimperi*. In all the other species no visible satellites could be detected. This may be due to the relatively small size of the chromosomes, and so their satellites.

5. Conclusions and Recommendations

Conclusions

In the present study, which attempted to determine the chromosome numbers, karyotype and ploidy levels of some species of the Lamiaceae, the small chromosome size and undifferentiation between chromosomes within the same complement, made detailed cytological analysis difficult. Thus, this work could not go far beyond determining chromosome numbers and depicting some observable morphological features such as satellites.

Polyploidy is evident in most of the species. The observed chromosome numbers reveal that there are variable basic chromosomes for the various genera and even for species of the same genus. Uniform chromosome size within a complement is observed in most of the species. This apparent uniformity in chromosome size would partly be due to the difficulty to study detailed structure of the chromosomes as they are small in size.

Since the cytogenetics of members of the family Lamiaceae in Ethiopia had not been studied prior to this study, as far as our literature search goes, this work may lay the foundation for more studies in the family in the future. However, compared to the number of species in the family found in Ethiopia, this work is far from complete in providing any clues about the evolution and phylogenetic relationships of the species in the family.

Recommendations

More investigations have to be done on the various species of the Lamiaceae from different localities in the country so as to make plausible inferences regarding the phylogenetic and evolutionary relationships among the various genera and species. Even if their small chromosome size may be a barrier, further cytological study of many other species may give better understanding of the cytogenetics of the family, and thus extensive chromosomal study of the family is recommended.

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