

**PHYSALIS (SOLANACEAE) IN NIGERIA****Olorode, O.\*, Olayanju, S. and Garba, A.**Department of Biological Sciences,  
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**ABSTRACT**

A detailed description of seven collections of *Physalis* Linn., in Nigeria, is presented using morphometric and some hitherto un-utilised characters such as colour of corolla tube throat, and number of ribs on fruiting calyx. Five of the collections fall distinctly in three of the species recognised in West Africa (*Physalis micrantha*, *P. angulata* and *P. peruviana*) while two relatively uncommon collections do not fit into any recognised species. Preliminary distributional and cytological observations in conjunction with recent pollen grain studies suggest that *P. angulata* is a tetraploid ( $2n=48$ ) of hybrid origin probably involving *P. micrantha* ( $2n=24$ ) and *P. peruviana* ( $2n=24$ ). The two less common collections OGB(P) and UAPS are probably conspecific, representing an undescribed species of *Physalis* in West Africa.

**Key Words:** *Physalis*, Populational, Morphometric Characters, Taxonomic Description.

**INTRODUCTION**

Four species of *Physalis* Linn. are known to occur in West Tropical Africa (Hutchinson and Dalziel, 1963; Burkill, 2000). Only three of the said species--*Physalis angulata* Linn., *P. peruviana* Linn. and *P. micrantha* Linn.-- are reported in Nigeria. A fourth species (*P. pubescens* Linn.) a native of America is, according to Burkill (2000), "known in West Africa only in Ghana". The three species reported in Nigeria especially *P. angulata* and *P. peruviana* are widely distributed in Nigeria as weeds of farmlands and waste places.

Considerable information exists on the West African species of *Physalis* as food items (leaves and fruits), as medicinal plants and as sources of various secondary plant products (Burkill, 2000). The three species of *Physalis* in Nigeria had been delimited on the basis of vegetative, floral and cytological characteristics as shown in Table 1. Generally, although the vegetative and reproductive, morphological, and morphometric characteristics used hitherto to delimit the three species are diagnostic, they are not exhaustive. As for the cytological characteristics used hitherto, no insight is afforded, so far, of the genomic relationships among the three species beyond their definition as being diploid or tetraploid on the basic number of  $x=12$  which is characteristic for Solanaceae (Allard, 1960; Burkill, 2000).

In the last few years, exhaustive collections of

*Physalis* have been carried out for the Biological Sciences Garden at the University of Abuja and the University of Abuja Herbarium in Nigeria. This paper reports the results of morphological and morphometric observations from field and garden populations of *Physalis*. Exhaustive descriptions of the different collections were carried out employing important characteristics that have not, or have hardly, featured in previous taxonomic descriptions in the floras. Based on preliminary observations from mitotic and meiotic studies, some speculation on the genomic structure of *Physalis* in Nigeria is also attempted.

**MATERIALS AND METHODS**

The sources of materials used in this study are presented in Table 2. Specimens of whole plants, fruiting and flowering; flowering parts and mature fruiting-calyx were collected from different locations as indicated in Table 2. Whole plants and plant parts were processed in plant presses and prepared for deposit at the University of Abuja Herbarium. Some whole live plants were transplanted from the field while seeds from field collections were germinated as parts of garden populations at the University of Abuja Biological Gardens.

Observations on qualitative characters were made from both field and garden populations. Morphometric observations were also made from field and garden populations. The limits of

morphometric characters were augmented from previous studies carried out by Garba (2009). Preliminary chromosome studies were carried out from young flower buds and root-tips at appropriate stages using routine fixation, staining and squash techniques as described previously (Olorode, 1973; 1974, Olorode, Hassan, Labinjo and Raimi, 2011).

## RESULTS

### Qualitative and Morphometric Observations

The six collections of *Physalis* studied in this investigation are described below with respect to their general habit, measurements of other quantitative attributes, their qualitative characters, and their usual population densities. Table 3, Figure 1 and Figure 2 and Plates 1, 2 and 3 illustrate and summarize the observations.

**Table 1:** Characteristics of West African Taxa of *Physalis* (Hutchinson & Dalziel, 1963: p.329; Burkill, 2000: pp.115-118)

Character	<i>P. angulata</i>	<i>P. micrantha</i>	<i>P. peruviana</i>	<i>P. pubescens</i>
<b>Habit</b>	Erect, branched, glabrous annual; up to 3 ft high; markedly more robust than <i>P. micrantha</i>	Very variable annual herbs; prostrate or erect, up to 3 feet high in disturbed places diploid: 2n = 24	Erect perennial, up to 1m high from a creeping rootstock; densely villous tetraploid: 2n=48.	Annual herb, up to 60cm high; lower parts glabrous; upper parts and pedicels appressed-strigose
<b>Leaves</b>	Coarsely dentate; 5-10cm long; cuneate to rounded at base	Sub-entire, ovate; 1.5-3(-5) cm long; apex acuminate; base cuneate.	Entire or with a few large teeth, 8-10cm long, 6-7.5cm broad; apex acuminate, rhomboid to deltoid; base broadly-rounded, truncate or cordate.	Coarsely and irregularly dentate; 3-5cm long; apex acuminate, base broadly-rounded to cordate.
<b>Flower</b>	Cream; corolla tube, up to 8.5mm long; corolla tube centre, light brown	Cream; corolla tube, very small, up to 4mm long corolla tube centre, deep brown	Corolla tube 15mm long, corolla tube centre colourless	Yellow with brown centre, corolla 8-10mm long.
<b>Fruit</b>	Edible; fruiting calyx ovoid up to 3cm long and 2cm broad; glabrous or finely puberulous; pedicels glabrous, up to 1cm long.	Fruiting calyx sub-globular; up to 15(20)mm long, 12mm broad, finely puberulous; pedicels up to 3cm long	Fruiting calyx ovoid, ca 4cm long & 3cm broad, villous; pedicels up to 5-8mm long, not longer in fruit	Fruiting calyx turbinate i.e. ovoid, abruptly acute; 3cm long, ca 2.2cm in diameter, nearly glabrous.
<b>Distribution</b>	Native of tropical America, widely distributed in the tropics	Pan-tropical(?); neither distribution nor taxonomic position properly known owing to complexity of the genus.	Nigeria (Jos), Br. Cameroon, Ghana, S. Leone; occasionally cultivated and naturalised.	Introduced from America, only known in Ghana (Achimota).

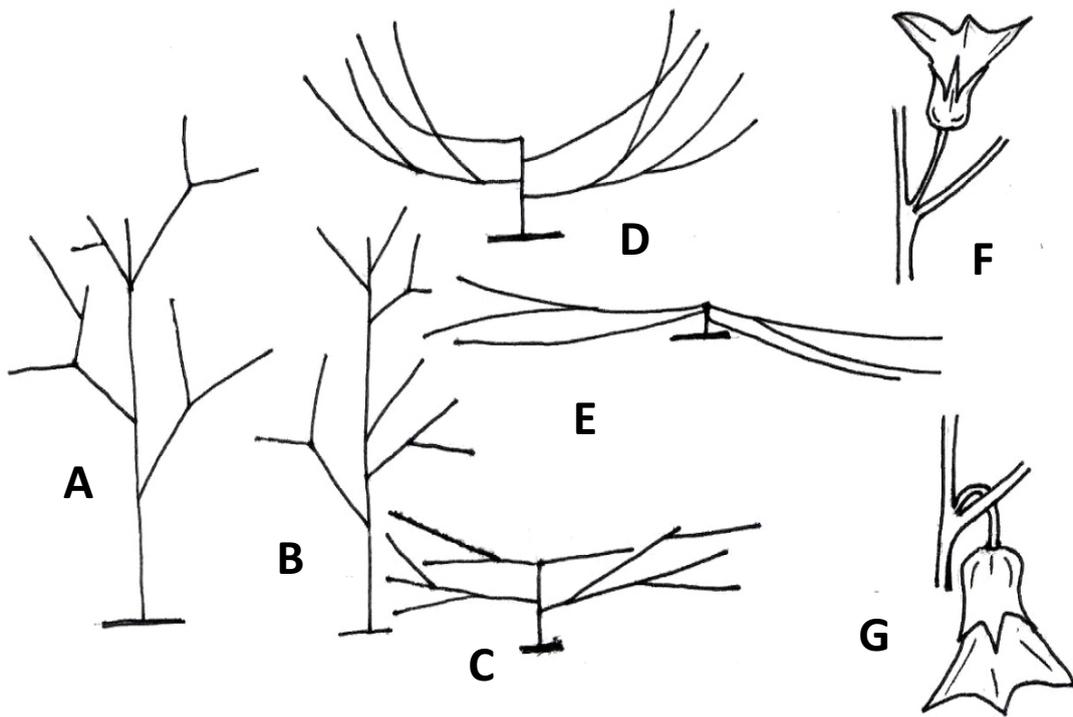
**Table 2:** Sources of Accessions of *Physalis* spp. Studied

Plant	Collection No.*	Collectors observation
<i>Physalis peruviana</i> Linn.	497	Coded GW <sub>1</sub> ; large populations in waste places at Gwagwalada (Federal Capital Territory); robust with greyish leaves; common plant of early rainy season; seedlings throughout rainy season.
<i>P. angulata</i> Linn.	498	Coded GW <sub>2</sub> ; robust plant in large populations especially in drainages and waste places around Gwagwalada (FCT).
<i>P. micrantha</i> Link	499	Coded GW <sub>3</sub> ; variable erect to spreading plant of waste places occurring largely as isolated individuals around Gwagwalada (FCT).
<i>P. angulata</i> Linn.	500	Coded OGB (ER); Robust annual much like 498; isolated individuals in waste places at Odoje Ojubo on Ogbomoso-Ajawa Road, Ogbomoso, Oyo State.
<i>Physalis</i> sp.	501	Coded OGB (P); prostrate, fragile and hairy herb; isolated in waste places flowering around June/July and in same location as 500.
<i>Physalis</i> sp.	495	Coded UAPS; fragile erect/ascending hairy herb in open sun isolated in fallowed farmland at the University of Abuja Permanent Site. FCT.
<i>P. angulata</i> Linn.	496	Coded IFE; isolated robust herb in waste places near CTCS building on OAU Campus Ile-Ife Osun State; much like 498.

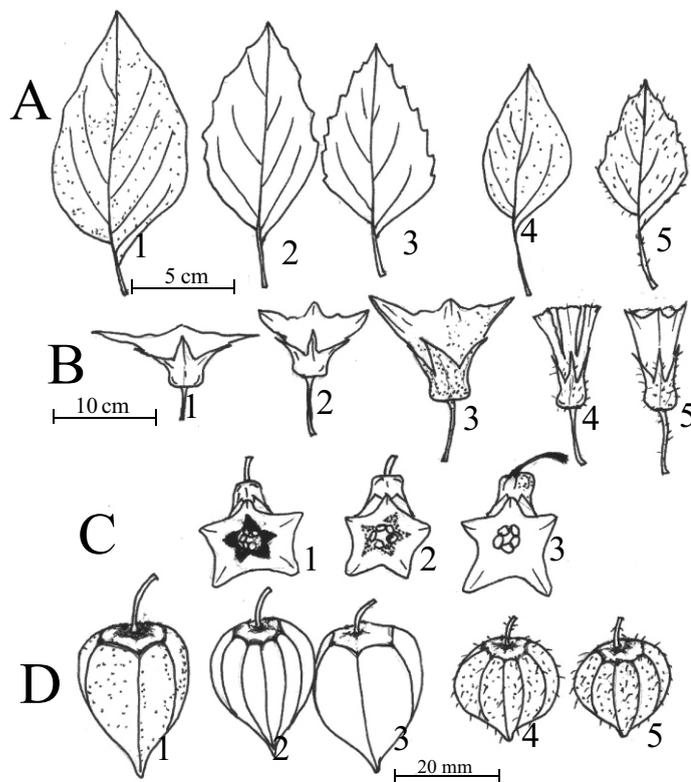
\* Olorode's accession number.

**Table 3:** Characterisation of Collections in the Current Investigation: GW = Gwagwalada; OAU = Obafemi Awolowo University, Ile-Ife; OGB (ER) = Ogbomoso (Erect); OGB(P) = Ogbomoso (Prostrate); UAPS (University of Abuja Permanent Site).

Character	GW1	GW2	GW3	OAU/OGB(ER)	OGB(P)	UAPS
<b>Habit</b>	Erect robust annual in waste places to 3ft tall; appressed villous.	Robust, erect, glabrous, annual herb; widespread in waste places and drainages up to 3ft tall; stems, veins may be purplish	Variable annual, erect or ascending herb in waste places; ca 2.5 feet high; stems, midribs may be purplish	Robust, erect annual herb; glabrous, branched, stems, vein may be purplish; similar to GW2.	Prostrate/trailing, annual herb of open ground; hairy (hairs not appressed); isolated individuals.	Erect/scandent annual herb of farmland; hairy (hairs not appressed); isolated individuals.
<b>Leaves</b>	Entire, margins sub-undulate or with coarse teeth; grey-green, puberulous; 6-10cm long; 5-7cm wide; base unequal cordate; apex Acuminate.	Entire to coarsely toothed or undulate margin; glabrous; base unequal; 6-10cm long, 5-7cm wide; apex acuminate, glabrous.	Ovate; coarsely-dentate; to 5cm long & 3cm wide; glabrous or sparsely hairy with acuminate apex; base Unequal.	Coarsely dentate; 6-10cm long, 3-6cm broad; cordate/cuneate, unequal base.	Sub-entire; ovate; to 3cm long by 2cm wide; base cuneate to sub-cordate unequal; hairy.	Sub-entire ovate; to 3.5cm long by 2.5cm broad; base cuneate unequal; hairy
<b>Flowers</b>	Corolla tubular; flower 15mm long, 10mm at top; villous; cream; flower Erect..	Corolla tubular; tube ca. 8mm long & 6mm wide at top; calyx ca. 5mm long; corolla tube yellow with light brown centre; flower Erect.	Corolla tube ca. 5mm long, unlobed with 5 points; corolla tube deep brown inside; flower Reflexed.	9-10 mm long, 8mm wide; petals joined to the top; calyx ca. 5mm long, glabrous; flower erect; corolla tube with brown centre;	Up to 8mm long; hardly opening; calyx ca. 4 mm long; petals joined almost to the top; white; petals and sepals appressed hairy	Up to 10mm long, opens fully at anthesis; calyx 0.3 the length of flower; petal lobes free for ca. 5mm; petals and sepals appressed hairy; petals white.
<b>Fruits</b>	Fruiting calyx ovoid, tapering reflexed; to 25mm long and 15mm wide; light green with 5 ribs; pedicels to 10mm long	Fruiting calyx ovoid; 10-ribbed with purple ribs and veins; pedicels ca. 5mm long	Fruiting calyx ovoid reflexed; pointed with 5 ribs; to 20mm long, 15mm wide; pedicels ca. 12mm long; veins not purple; fruiting may be with purplish striations.	Fruiting calyx ca. 25mm long, 15mm wide reflexed; with 10 purple ribs and with purple veins.	Fruiting calyx spheroidal; up to 12mm long & 12mm broad; with ten ribs; green; appressed Hairy.	Fruiting calyx ovoid, green; ca. 12 mm long & ca. 10mm broad; appressed hairy.
<b>Distribution</b>	Widespread: Gwagwalada; most of FCT; Jos.	Widespread in Nigeria. cf. OAU (Ife) & OGB(ER)	Not widespread in Nigeria; common around Gwagwalada	Ile-Ife; Ogbomoso;	Ogbomoso	University of Abuja Permanent site.

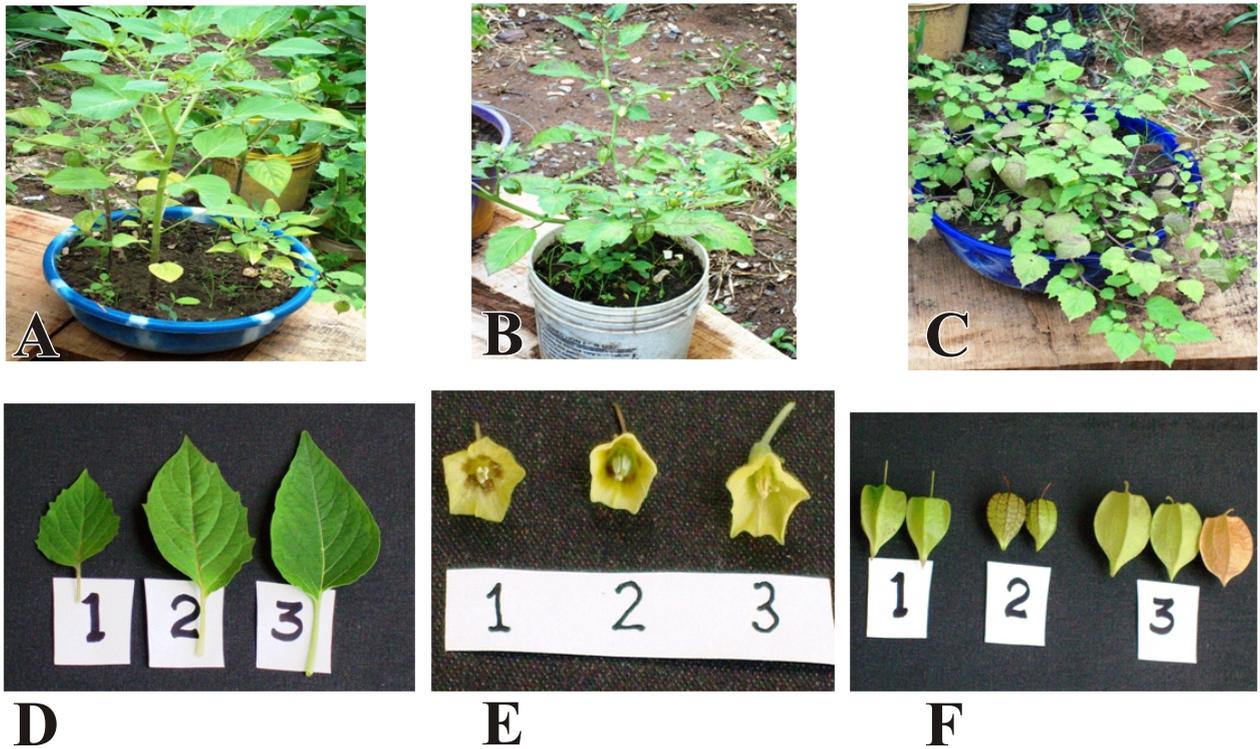


**Figure 1:** General Habit and Branching Patterns and Carriage of Flowers Nigerian Collections of *Physalis*. **A:** *Physalis peruviana* (GW1); **B:** *P. angulata* (GW2); **C:** *P. micrantha* (GW3); **D:** *Physalis* sp (UAPS); **E:** *Physalis* sp. [OGB (P)]; **F:** Erect flower carriage in *P. peruviana* and *P. angulata*; **G:** Reflexed flower carriage in *P. angulata*, *P. micrantha*, UAPS and OGB (P)

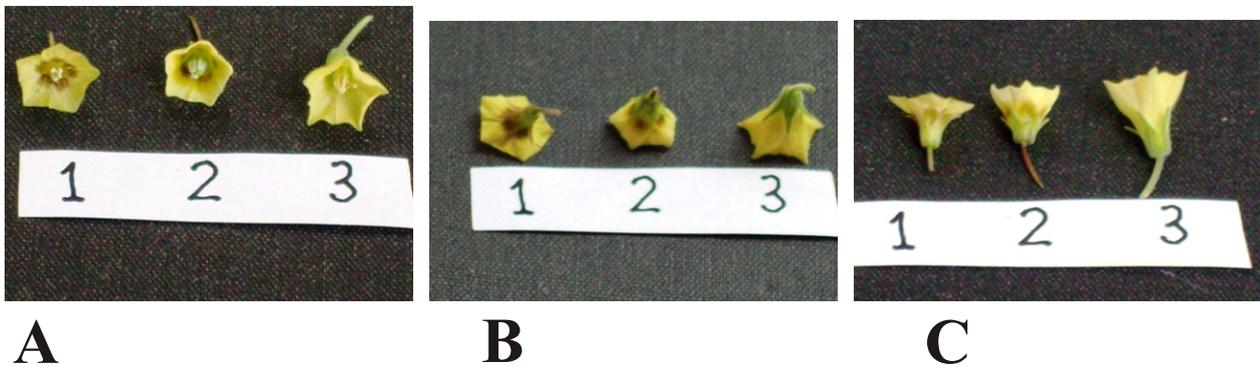


**Figure 2:** Leaf, Flower and Fruiting Calyx Characteristics in Nigerian Accessions of *Physalis*.

**A:** Leaves of *Physalis peruviana* (GW1), *P. angulata* (GW2), *P. micrantha* (GW3), *Physalis* sp. (UAPS) and *Physalis* spp. [OGB (P)] respectively; **B:** Flowers of the accessions in the same order as in A; **C:** Corolla tube throat colouration in GW3 (C1), GW2 (C2) and GW1 (C3); **D:** Fruiting calyces in GW1, GW2, GW3, UAPS and OGB (P) respectively.



**Plate 1.** **A,B,C:** Habits of Gwagwalada collections: (X 0.2). **A:** GW1 (*Physalis peruviana*); **B:** GW2 (*P. angulata*). **C:** GW3 (*Physalis micrantha*). **D, E, F:** Leaves (X 0.5), flowers (X 1.5) and fruits (X 0.5) of *Physalis micrantha* (1), *Physalis angulata* (2), and *Physalis peruviana* (3) respectively.



**Plate 2:** *Physalis* flowers (X 1.5). **A, B, C:** View of interior of corolla tubes, corolla tubes facing down and side view of corolla tubes of *P. micrantha* (1), *P. angulata* (2), and *P. peruviana* (3)



A



B



C



D

**Plate 3:** A, B, Early Flowering and Late Flowering respectively in UAPS and *P. angulata* (Ile-Ife) Collections: both are at 8-leaves seedling stage (X 0.5). C, D, Fruiting stems of OGB(P) and UAPS respectively; (X0.5) and (0.8) respectively.

**GW1 (*Physalis peruviana*):** Erect robust annual in waste places to 1 m tall; leaves appressed-villous; entire, margins sub-undulate or with coarse teeth; grey-green; stems puberulous; leaves 6-10cm long; 5-7 cm wide; base unequal, cuniate; leaf apex acuminate; corolla tubular; flower 15 mm long, 10 mm at top; villous; cream; flower erect; fruiting calyx ovoid, tapering; to 25 mm long and 15 mm wide; light green with 5 ribs; pedicels to 10 mm long.

**GW2 (*Physalis angulata*):** Robust, variable, erect, glabrous, annual herb; widespread in waste places and drainages up to 3ft tall; stems, veins may be purplish, entire to coarsely toothed or undulate margin, glabrous, base un-equal, 6-10 cm long, 5-7 cm wide, apex acuminate, glabrous; corolla tubular, tube ca. 8 mm long and 6 mm wide at top, corolla tube yellow with light brown throat; calyx ca. 5 mm long; flower erect; fruiting calyx ovoid; 10-ribbed with purple ribs and veins;

pedicels ca. 5 mm long.

**GW3 (*Physalis micrantha*):** Variable annual, generally spreading, but may be an erect or ascending herb of waste places; up to 0.8 m high; stems, midribs may be purplish; leaf ovate, coarsely-dentate, to 5 cm long & 3 cm wide, glabrous or sparsely hairy with acuminate apex, base unequal; corolla tube ca. 5mm long, un-lobed with 5 points; corolla tube throat deep brown; flower reflexed, fruiting calyx ovoid, reflexed, pointed with 5 ribs, to 20 mm long, 15mm wide; pedicels ca. 12 mm long; veins not purple; fruiting calyx may be with purple tinge.

**OAU (Ife), OGB(ER) (*Physalis angulata*):** Robust, erect annual herb; glabrous, branches, stems, and veins may be purplish, similar to GW2; leaves coarsely dentate; 6-10 cm long, 3-6 cm broad; cordate/cuneate, unequal base, 9-10 mm long, 8mm wide; petals joined up to the top; calyx ca. 5 mm long, glabrous; flower erect; corolla tube with light brown throat; fruiting calyx ca. 25 mm long, 15mm wide with 10 purple ribs and with purple veins.

**OGB(P) (*Physalis* sp.):** Prostrate/trailing, annual herb of open ground; hairy (hairs not appressed); isolated individuals; leaves sub-entire, ovate, to 3 cm long by 2 cm wide, base cuneate to sub-cordate, hairy; flowers up to 8mm long; hardly opening; calyx ca. 4 mm long; petals joined almost to the top, white, petals and sepals appressed hairy; fruiting calyx spheroidal, green; up to 12 mm long and 12 mm broad, with ten or more ribs, green, hairy.

**UAPS (*Physalis* sp.):** Erect/scandent annual herb of farmland; hairy (hairs not appressed); isolated individuals; leaves entire to sub-entire, ovate, to 3.5 cm long by 2.5 cm broad, base cuneate; flower hairy, up to 10 mm long, opens fully at anthesis; calyx 0.3 the length of flower, petal lobes free for ca. 5mm, petals and sepals appressed hairy; petals white; fruiting calyx ovoid, green, ca. 12 mm long and ca. 10 mm broad, hairy, with ten ribs.

#### Mitotic and Meiotic Studies

Examination of mitotic root-tip squashes suggest that the collections of *P. peruviana* in this study are

diploid with  $2n=24$  chromosomes. Diakinesis in pollen mothercells of *P. Angulata* shows that it is tetraploid with  $2n=48$  chromosomes.

The chromosome number and cytogenetic characteristics of collections OGB(P) and UAPS have not been ascertained although ample seed production in both suggests that they are fertile.

#### DISCUSSION AND CONCLUSIONS

Data from various collections and garden populations of *Physalis* show that *P. angulata*, *P. peruviana* and *P. micrantha* are distinct species. Even though they are found to be sympatric, there is no evidence that they exchange genes naturally.

Although Burkill (2000) provided information that *P. angulata* and *P. peruviana* are tetraploid ( $2n=48$ ) while *P. micrantha* is diploid ( $2n=24$ ), both cytological observations in this study and pollen grain size studies by Faransa (2011), suggest that our collections of *P. micrantha* and *P. peruviana* are diploid while only *P. angulata* is tetraploid. All the available evidence from cytological and pollen grain studies along with morphological observations (habit, fruit characters and flower colour) suggest that *P. angulata* may be of hybrid origin from a cross between *P. peruviana* and *P. micrantha* (Figure 1, Figure 2, Plate 1, Plate 2). The much wider latitudinal range of distribution of *P. angulata* with its usually large populations is also characteristic of the distribution of successful hybrid genomes such as *Andropogon gayanus* Kunth. (Okoli and Olorode, 1983) and *Emilia praetermissa* Milne-Redhead (Olorode, 1973; Olorode and Olorunfemi, 1973).

The two collections of *Physalis*, OGB(P) and UAPS, do not fit into any of the three specific categories that were reported in FWTA (Hutchinson and Dalziel, 1963; Burkill, 2000) although, as we discussed above, they share certain morphological and ecological identities. More detailed collections, hybridisation studies and cytological studies are required to establish the evolutionary and cytogenetic relationships among the three identified species and the two unidentified collections encountered in this study.

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