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Pupalia micrantha Hauman (Amaranthaceae), a Newly Naturalized Species in Taiwan

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ABSTRACT: The specimens of *Pupalia micrantha* Hauman collected from southern Taiwan have been misidentified as *Cyathula prostrata* (L.) Blume for many years. This is because little attention was given to the diagnostic characteristics of pseudostaminodes and the hooked spines fascicled on a short stalk. The distinction between these two species is that *Pupalia micrantha* is without pseudostaminodes and the hooks are fascicled on a short stalk, and *Cyathula prostrata* has pseudostaminodes and the hooks are fascicled without peduncles. Therefore, *Pupalia micrantha* is a newly naturalized species of Amaranthaceae in Taiwan and represents the first generic record of *Pupalia*. This species was sparsely distributed for the past 20 years and is not recorded in the Flora of China. The taxonomic treatment, descriptions, photographs, line drawing, two keys about the subfamilies and genera of Amaranthaceae are provided here.

KEY WORDS: Amaranthaceae, Newly recorded genus, *Pupalia micrantha*, Taiwan.

INTRODUCTION

Amaranthaceae is a pantropical family with 69 genera and over 1000 species that is mainly distributed in tropical regions, with some genera or species reaching the warmer temperate regions (Townsend, 1979). This family includes many xerophytic species and cosmopolitan weeds whose sterile flower parts are always modified into hooked spines, scales, and hairs. The hooked spines, as in the genera *Cyathula* and *Pupalia*, usually fall with the ripe fruits or are carried off by animals to colonize disturbed ground. The filaments commonly fused into a cup at base and alternate with pseudostaminodes are usually recognized as diagnostic characteristics between the genera of Amaranthaceae. In Taiwan, there are nine genera with 19 species, including some introduced ones (Liu and Kao, 1996).

The specimen *S.-Z. Yang* 42561 was collected from the Paoli experimental forest station, Pingtung County in 1984 and was identified as the genus *Cyathula*. Recently, we collected more specimens from other places, such as the Chachayaliashan forest trail and Xiaoliuchqiu (excluding Paoli village).

The habits and characteristics of the genus *Cyathula* are similar to those of the genus *Pupalia*. Both genera belong to the subfamily Amaranthoideae, tribe Amarantheae, subtribe Aervinae (Townsend, 1993). Both of them bear modified sterile flowers forming hooked spines alongside the fertile flowers. But while *Cyathula* has pseudostaminodes alternating with stamens and one or more fascicled hooks without a peduncle, *Pupalia* lacks pseudostaminodes and has hooks grouped in clusters of mostly 5-10 on short stalks on a common peduncle. Carefully dissecting the parts of flowers we had collected from Chachayaliashan forest trail and Xiaoliuchqia, we found that they were all without pseudostaminodes. Hence, due to ignoring the characteristics of pseudostaminodes and peduncles and consulting insufficient references, we had misidentified *S.-Z. Yang* 42561 as *Cyathula prostrata* for 20 years. By referring to the key of the genus *Pupalia* from Townsend (1993), those specimens are in accordance with *Pupalia micrantha* Hauman. So, we here propose that *P. micrantha* is a newly naturalized species. This represents the first generic record of *Pupalia* in Taiwan. All the collections are preserved in the herbarium of PPI.

The follows are the taxonomic treatment, the descriptions of genus and species, photographs of habitat and morphology, and a line drawing of *Pupalia micrantha*. We also provide two keys to the subfamilies and tribes and 10 genera of Amaranthaceae in Taiwan.

TAXONOMIC TREATMENTS

Pupalia A. Jussieu. Ann. Mus. Hist. Nat. Paris 2: 132 (1803), nom. cons. Pupal Adans., Fam. Pl. 2: 268, 596 (1763).

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Annual or perennial herbs, sometimes woody at the base. Leaves opposite, entire. Inflorescence terminal or axillary, spiciform; bracteate, sustending lateral clusters of one or more central fertile hermaphrodite flowers and a pair of modified lateral flowers formed of 3 or more hooked spines; spines rapidly accrescent and grouped in clusters of mostly 5-10 on short stalks on a common peduncle, exceed perianth; bracts persistent, deflexed; perianth segments 5, free, pilose; stamens 5, filaments rather solid and fused at the base into a fleshy, disk-like cup; pseudostaminodes absent; ovary uniovulate, narrow; style slender, stigma capitate. Fruit an irregularly rupturing thin-walled utricle, oblong-obovoid, subcompressed.

Key to the subfamilies and tribes of Amaranthaceae in Taiwan

1. Anthers unilocucular (2-locellate). Subfamily Gomphrenoides, Tribe Gomphreneae
2. Stigma capitate, penicillate or depressed or obscurely 2-lipped, never distinctly 2-lobed or filiform, flowers never compressed …… Subtribe Froelichiinae, *Alternanthera*
2. Stigma distinctly bilobed or branches subulate, if capitate then the flowers distinctly compressed …….. ……. Subtribe Gomphreninae, *Gomphrena*, *Blutaparon*
1. Anthers bilocucular (4-locellate) …. Subfamily Amaranthoides
3. Ovary with numerous or several ovules; leaves alternate …….. ……..……. Tribe Celosieae, *Celosia*, *Deeringia*
3. Ovary uniovulate …… Tribe Amarantheae
4. Seed erect, the radicle downwardly directed; leaves always alternate ……. Subtribe Amaranthinae, *Amaranthus*
4. Seed pendulous, the radicle upwardly directed; leaves more commonly opposite, in a few genera alternate or variable …..... ….. Subtribe Aervinae, *Achyranthes*, *Aerva*, *Cyathula*, *Pupalia*

Key to the ten genera of Amaranthaceae in Taiwan

1. Tall scandent or climbing shrub; leaves alternate; fruit red berry …….. *Derringia*
1. Erect or ascending annual or perennial herb, rarely undershrubs; leaves alternate or opposite; fruit utricle or capsule, circumscissile or indehiscent.
2. Leaves alternate.
3. Flowers bisexual; filaments connate at base; seeds 2-many ….. ……..……...…… *Celosia*
3. Flowers unisexual or polygamous; filaments free at base; seed solitary ……..….. *Amaranthus*
2. Leaves opposite.
4. Anthers 1-celled; flowers in sessile or peduncle heads.
5. Stigma simple, capitate ……..…….. *Alternanthera*
5. Stigma 2-fid.
6. Bracts 2; perianth segments with long wools at base outside …. ……..…… *Gomphrena*
6. Bracts 1; perianth segments not as above ...……. *Blutaparon*
4. Anthers 2 celled; flowers in racemes or spikes.
7. Modified sterile flowers alongside the fertile flower.
8. Pseudostaminodes absent; hooks grouped on a common peduncle ……... *Pupalia*
8. Pseudostaminodes present between stamens; hooks fascicle without peduncle ……...…….. *Cyathula*
7. Modified sterile flowers absent.
9. Bract spinescent, perianth glabrous; pedicel reflexed in fruit … ……...……..... *Achyranthes*
9. Bract not spinescent, perianth with silky hair at base; pedicel not reflexed in fruit …….. *Aerva*

Pupalia micrantha Hauman in Bull. Jard. Bot. Brux. 18: 109 (1946).

小花鉤牛膝(新擬) Figs. 1 & 2

Perennial herb. Stem obtuse or subterete, pubescent, swollen above the nodes, erect or ascendent, 30-80 cm high. Leaves simple, opposite, entire or ciliate, ovate, acuminate or acute at base, acuminate and apiculate at apex, 2.5-7 cm long, 1.5-4 cm wide, punctuate, pilose or glabrescent on both surfaces; petiole 2-13 mm, pilose; vein reticulate, raised on both surface, pilose; hair transparent, with 2-3 nodes, 0.25-0.5 mm long. Inflorescence spikes, terminal, 4-15 cm long, pilose, lower flower-clusters remote, highest one crowded; flower-clusters sessile or short stalked with 1 bisexual flower and 2 sterile flowers; bract 1, lanceolate, reflexed, 1-1.5 mm long, pilose on the upper surface and glabrous on the lower, scarious at the margin; each sterile flower containing 1 bracteoles and 3-4 (5) stipitate clusters of hooks on a common peduncle, 4.5 mm long; bracteoles ovate-lanceolate, 2 mm by 1 mm, villous, scarious at the margin; each stipitate of hooks containing 5-7 hooks, glabrous at apex and villous at base; perianth segments 5, free, lanceolate, 3.5 mm by 1 mm, 3-5 veins, villous outside and glabrous inside; stamen without pseudo-staminodes, staminal cup very shallow, ca. 0.2-0.4 mm; free parts of filaments 1.5-2 mm long; anther 2 celled, ca. 0.25 mm, longitudinal; pistil 1.5 mm long, ovary with a narrow base and a clearly delimitated broadly rounded apex; style 0.8 mm; stigma capitate. Fruit a utricle, 1.5-1.7 mm long, membrane at base, and thicker toward apex. Seed 1, ca. 1.3-1.5 mm, shining black.

Species examined: *S.-Z. Yang* 42561 (18 August, 1984); *C.-F. Chen* 1824 (September 7, 2005), Experimental forest station of NPUST, Paoli village, Checheng Hsiang, Pingtung Co. *C.-F. Chen* 753 (October 31, 2004), Chachayaliashan forest trail, Shizi Hsiang, Pingtung Co. *C.-F. Chen* 876 (August 31, 2004), Xiaoliuchqiu, Pingtung co.

DISCUSSION

Philoxerus wrightii Hooker f. has been reported in the Flora of Taiwan and generally occurs on the seashore of southern Taiwan (Liu and Kao, 1996). According to previous records of the characteristics about the expanded, spongy disc-like petiole that appears to keep the fruiting flower associated with the axis of the inflorescence, Mears (1982) made a

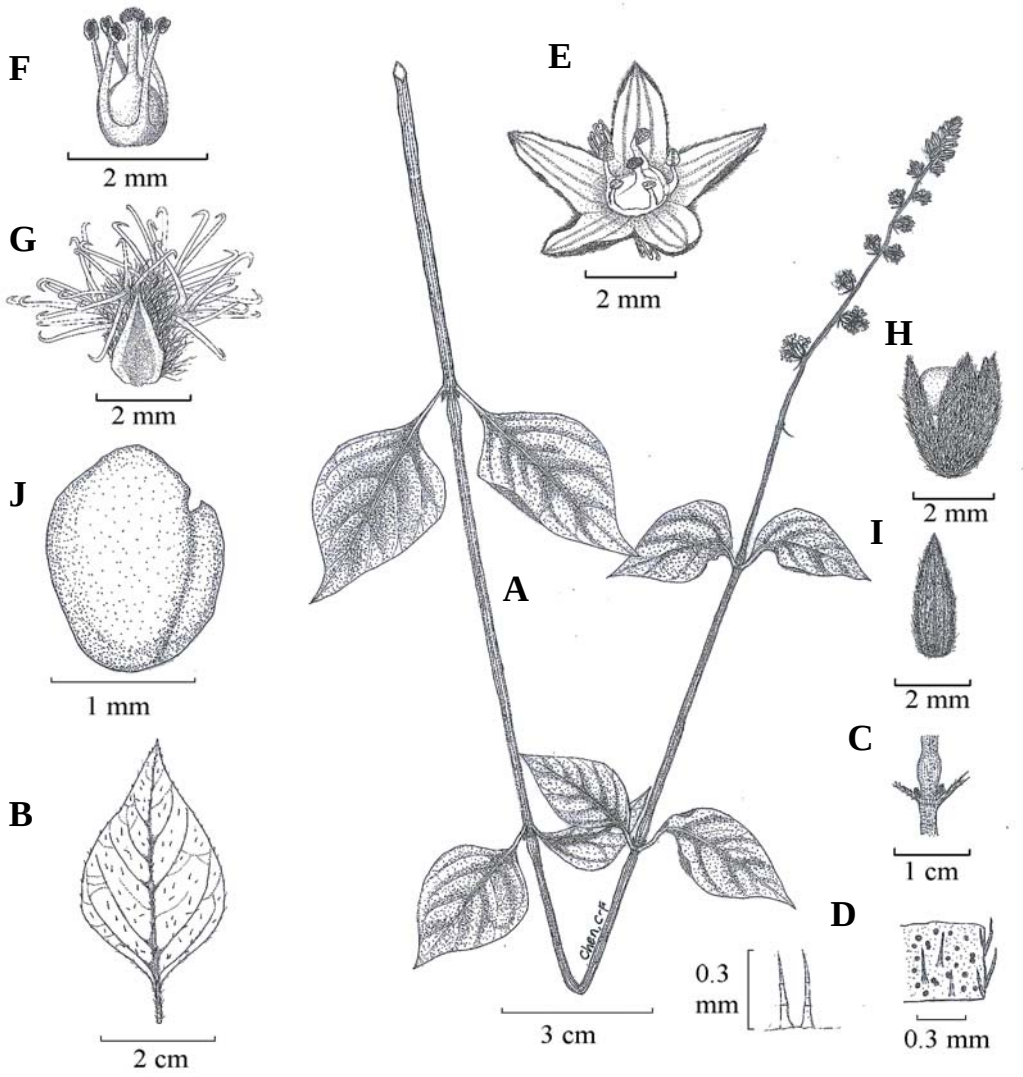

Fig. 1. *Pupalia micrantha* Hauman. A: Habit. B: Leaf. C: Stem swollen above the nodes. D: Leaf surface punctuate and hairs with 2-3 nodes. E: Fertile flower. F: Pistil and stamens with fused filaments. G: Sterile flowers modified into hooked spines. H: Upper surface of perianth villous. I: Perianth segment with 3-veins. J: Seed.

new combination that *Philoxerus wrightii* Hooker f. was treated as *Blutaparon wrightii* (Hooker f.) Mears., and described that *B. wrightii* is not intermediate to *Blutaparon* and any other genus (especially the Australiasian *Philoxerus*). Thus we recognize that the family of Taiwan Amaranthaceae should be closely related to the genus *Blutaparon* Rafinesque.

Pupalia micrantha is primarily distributed in Tropical Africa, the Philippines, and Luzon, while Taiwan is another new distribution record (Fig. 3). In Taiwan, *P. micrantha* grows along woodland paths or roadsides, and on dry, sunny or slightly shaded places. The species has an elevation range from 50-250 m, and is usually associated with *Acacia confusa* Merr., *Ipomoea obscura* (L.) Ker-Gawl., *Leucaena glauca* (L.) Benth., *Litsea hypophaea* Hayata, *Phyllanthus multiflorus* Willd., and *Vitex negundo* L.

Four species are recognized in *Pupalia*, mainly distributed in the old world from West Africa to Malaysia and the Philippines (Heemstede, 1949; Townsend, 1979, 1980). Merrill (1923) stated that only *Pupalia atropurpurea* was found in the Philippines. Townsend (1979) treated this name as a synonym of *Pupalia lappacea* (L.) Juss., which included five varieties, and indicated that *P. micrantha* was also distributed in the Philippines. The difference between *P. lappacea* and *P. micrantha* is that the bract of *P. lappacea* subtends more than one fertile flowers and the perianth segments are 4.3-6 mm long, and the bract of *P. micrantha* sustends only one fertile flower, and the perianth segments are 2.8-3.5 mm long. We

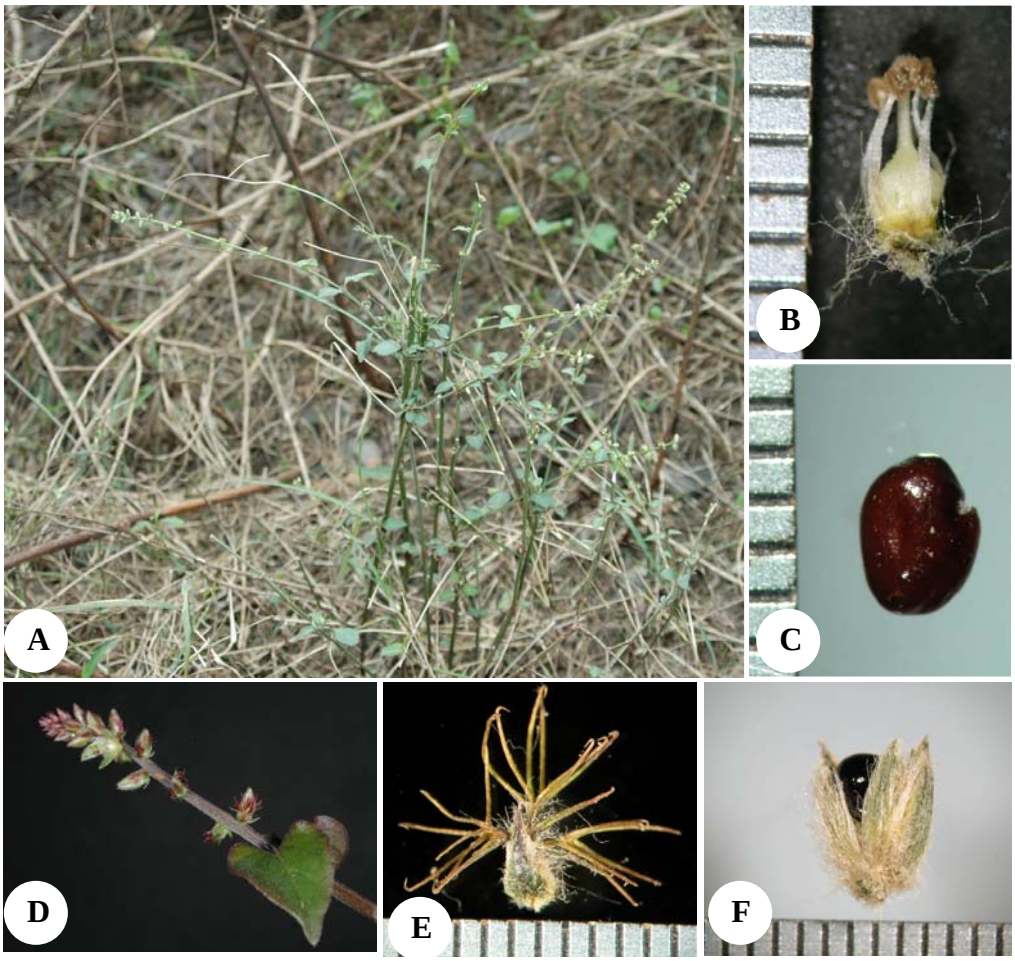

Fig. 2. *Pupalia micrantha* Hauman. A: Habit. B: Fertile flower (perianth segments removed). C: Seed. D: Inflorescence. E: Sterile flower. F: Perianth and seed. (Scale = 0.5 mm; photo by Nikon Coolpix 5000 and Zeiss Stemi SV 11)

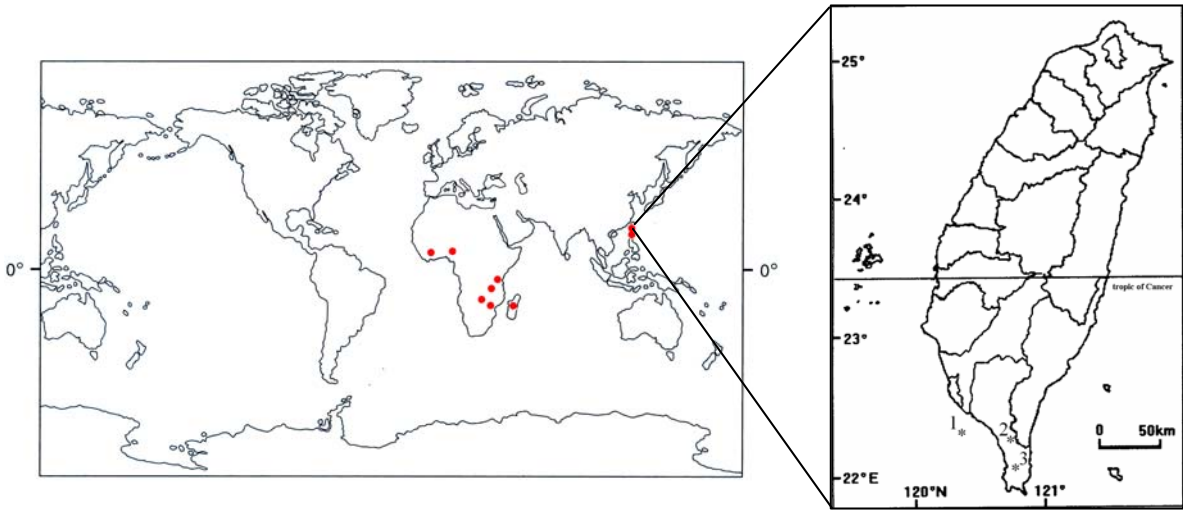

Fig. 3. The distribution of *Pupalia micrantha* Hauman in the world and in southern Taiwan. 1: Xiaoliuchqiu. 2: Chachayaliashan. 3: Paoli experimental forest station.

suggested that the distribution center of *P. micrantha* could be located in Africa because its distribution was mainly recorded in Ivory Coast, Nigeria, Zambia, Zaire, Malawi, Mozambique, Tanzania and Madagasgar (Townsend, 1979).

Townsend (1979) indicated that materials from Luzon were different from those from Africa because of the length of perianth segments and style, so the correct name of specimens from Luzon should be *Pupalia micrantha*. In the materials from Taiwan, the length of perianth segments and style are 3.5 mm and 0.8 mm, respectively; they are very similar to materials from Luzon. It is clear that *P. micrantha* has been established in southern Taiwan for quite a long time and Taiwan is a newly recorded area for this population in Asia, although how this population was colonized here remains unknown. We are also not sure why this population was not recorded in the Flora of China, especially the province near Taiwan. *Pupalia micrantha* has grown in southern Taiwan for over 20 years, but is still not abundant, demonstrating that only a few drier microhabitats are suitable for this population's growth and dispersal. It is necessary to study its population dynamics in the near future.

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臺灣莧科新歸化種－小花鉤牛膝

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摘　　要

採於臺灣南部的小花鉤牛膝 (*Pupalia micrantha* Hauman）過去被鑑定為假川牛膝 (*Cyathula prostrata* (L.) Blume)，主要是沒注意到假雄蕊與鉤刺狀物叢生於短柄上等兩種特徵。兩種植物主要區別於鉤牛膝屬（*Pupalia*）不具有假雄蕊且鉤刺狀物叢生於短柄上，假川牛膝具有假雄蕊、鉤刺狀物叢生但不具有短柄。因此小花鉤牛膝為臺灣莧科新歸化種，鉤牛膝屬為臺灣莧科新記錄屬。小花鉤牛膝在過去 20 年間分佈數量不多，亦未見於中國植物誌。本文提供分類處理、形態描述、植物繪圖、照片及莧科植物亞科與屬的檢索表。

關鍵詞：莧科、新記錄屬、小花鉤牛膝、臺灣。

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