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Pigeonpea

Breeding

Characterization of *Cajanus scarabaeoides* Growing in Yuanjiang County of Yunnan Province in China

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The known and unknown traits available in the wild relatives of the cultivated types are useful for dynamic crop improvement programs and therefore conservation and evaluation of secondary and tertiary gene pools assume great importance. At present the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India maintains a total of 213 accessions of 20 *Cajanus* species which can be used by breeders. In China limited attention has been paid to the collection, maintenance, and evaluation of pigeonpea (*Cajanus cajan* (L.) Millsp.) germplasm and its wild relatives. van der Maesen (1986) reviewed the taxa closely related to pigeonpea and listed six species from China; the same species are also recorded in "Reipublicae Popularis Sinicae" by Lee (1995). According to these records, *Cajanus crassus* (Prain ex King) van der Maesen is distributed in southern Yunnan, southwestern and southern Guangxi; *C. goensis* Dalz. in southern and northwestern Yunnan; *C. grandiflorus* (Benth. ex Bak) van der Maesen comb. nov. in Yunnan and Zhejiang; *C. mollis* (Benth.) van der Maesen comb. nov. in western and southern Yunnan; *C. niveus* (Benth.) van der Maesen comb. nov. in Yunnan; and *C. scarabaeoides* (L.) Thouars in Yunnan, Guizhou, Guangxi, Guangdong, Hainan, Fujian, and Taiwan (Lee 1995). In addition, Saxena (2000) found another wild species in Fengshan county of Guangxi province and based on its perennial habit, general morphology, leaf shape, and branching habit it was suspected to be *C. cajanifolius* (Haines) van der Maesen.

Cajanus scarabaeoides is the most widely spread wild species in Asia. In China it has two botanical varieties, i.e., var. *scarabaeoides* and var. *argyrophyllus* (W.T. Wei & Lee) Y.T. Wei & S. Lee. comb. nov. *Cajanus scarabaeoides* is called "Man Cao Chong Dou" in Mandarin Chinese, "Shui Kom Ts'o" in Guangdong dialect, and "Jia Yan Pi Guo" in Yunnan dialect. In Yunnan province it is endemic in Yang Tse Ferry near La Ka Triang between Yunnan and Huili of Shichuan while in Hainan province it has been found growing in Wanning. The species is widely distributed in Mojiang, Yongde, Jingdong, Gengma, Shuangjiang, and Changyuan counties in Yunnan (Lu Fuji, Chinese Academy of Agricultural Sciences, China, personal communication). Saxena (2000) found this species growing in the wastelands at 180 m elevation in Tiandong county of Guangxi province. In June 2000, we found a large population of *C. scarabaeoides* growing wildly in the dry slope hills of Yi Qun Yang mountain (23°36' N, 101°59' E, 450 m elevation) near Yuanjiang county town, located beside the Yuanjiang river.

To characterize this species, four sites with good plant population were identified and at each site 10 random plants were selected to record observations on various traits. The measurements were recorded according to the methodology suggested by Remanandan et al. (1988). The protein estimation in matured whole seed and fresh leaves was done using 751-GW spectrophotometer for colorimetric estimation.

Cajanus scarabaeoides was found in abundance in open grasslands and dry scrub vegetation on hill slopes and ridges between cultivated fields. It was also located along roadside, footpath, or convex ridges where reasonable amount of sunlight was available (Fig. 1). However, its population was low in the deep inland bushes and dark forests.

Cajanus scarabaeoides is a creeper-climber, supported by grass and small shrubs. Branches are straight or winding, quite woody at the base, up to 135 cm long; stem is white-pubescent with hair. Leaves are pinnately trifoliate, lower surface densely white-pubescent, upper surface white-pubescent; end leaflet obovate, 21–47 mm long, 10–30 mm wide, tip acute or obtuse, base cuneate; side leaflets obliquely obovate, 15–38 mm long, 7–24 mm wide. Flowering habit is indeterminate and sporadic and its duration ranged from early June to late November. Racemes are short with 1–4 flowers, peduncles 3–9 mm long, pedicels 3–5 mm long. The flowers are yellow or creamish yellow with dense sun-red veins. Calyx is densely pubescent with white hairs, tube 2–3 mm, 4 teeth, 4–8 mm long. Vexillum is obovate, 5–6 mm long, 2 mm wide, base clawed. Alae is elongate-obovate, 7–10 mm long, 2–5 mm wide, base auriculate. Keel petals are oblique, 8–11 mm long, ventrally adnate. Ovary is densely white-pubescent with hair, 5–6 mm long, 2 mm wide, ovules 4–6. Styles are 5–8 mm long, glabrous, the top 2–4 mm upcurved. Stamens are 9–13 mm long, with top 2–5 mm free and curved upwards; anthers mostly 9+1, but sometimes 8+1. Pods are oblong, 11–34 mm long, 6–10 mm wide, densely covered with golden brown long and short hairs (2–4 mm long), pods purple or dark purple with 1–7 seeds per pod (mostly 4–6). Seeds are rectangular-rounded, 2.4–4 mm long, 1.8–3 mm wide, 1–2 mm thick, black, and plain or speckled. Strophiole is divided, 1.9 × 0.7 mm, greenish or black. The 100-seed mass is 1.94 g. The mean protein content is 21.88% in the seed and 13.23% in the dried leaves.

Cajanus scarabaeoides is reportedly a useful but unimpressive species in grasslands for fodder (Dabadghao and Shankarnarayan 1973). Kirtikar and Basu (1933) reported that *C. scarabaeoides* is effective against diarrhea in cattle. Leaves are used in traditional Chinese medicine to improve indigestion and diuresis (Lee 1995). Insects such as podborers (*Helicoverpa armigera*) and podfly (*Melanagromyza obtusa*) also attack wild *Cajanus* spp, but in a few species including *C. scarabaeoides* some degree of antibiosis is observed (van der Maesen 1986). In lac production areas such as Jingdong county in Yunnan province of China, the lac insect *Kerria lacca* was found occasionally growing on branches of *C. scarabaeoides* and lac secretion was observed (Lu Fuji, Chinese Academy of Agricultural Sciences, China, personal communication).

According to Lee (1995), stem and leaf traits such as white hairs, broad elliptical, obovate, or near round leaflet, and veins on upper side prominently concave make var. *argyrophyllus* distinct from var. *scarabaeoides*. Thus, based on the available information, we suspect the species found in Yuanjiang county to be var. *argyrophyllus*. This variety is widely distributed in Guangxi, Yunnan, and Sichuan provinces. Since only *C. scarabaeoides* and *C. cajanifolius* among the wild species so far reported in China can be crossed easily with pigeonpea, it is necessary that the economic traits of these two species should be further evaluated in China for their use in breeding programs.

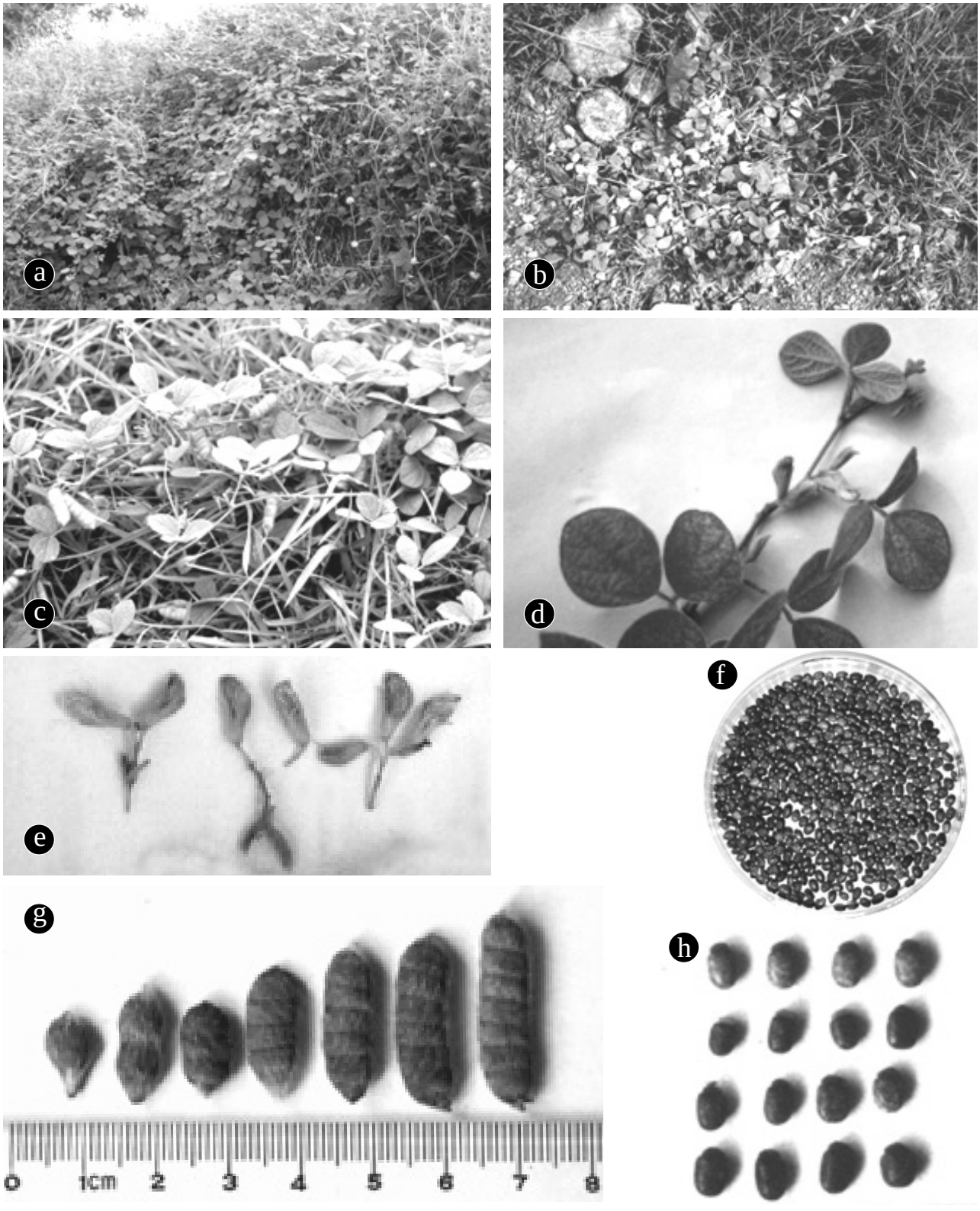

Figure 1. ***Cajanus scarabaeoides*** **in Yunnan, China: (a) Growing in a ridge; (b) Growing in barren soil; (c) Mature plants; (d) Racemes; (e) Flowers; (f) Seeds showing color diversity; (g) Pods with 1–7 seeds; and (h) Seeds with strophioles.**

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First Report of Natural Outcrossing in Pigeonpea from China

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Natural outcrossing in pigeonpea (*Cajanus cajan*) is primarily responsible for the deterioration of purity of cultivars and genetic stocks. Several insects are responsible for transferring pollen from one plant to another within and across the fields. The major pollinating insects identified are *Apis mellifera*, *A. dorsata*, *Megachile lanata*, *Ceratina binghami*, and *Xylocop* spp. The populations of these pollinating insects and local environmental factors that assist in their movement determine the extent of natural outcrossing at a particular location. Natural outcrossing in pigeonpea has been reported from India, Kenya, Australia, Hawaii (USA), and Sri Lanka (Saxena et al. 1990, 1994).

Pigeonpea was introduced into China in the 6th century from India and since then it was cultivated sporadically in the southern provinces. In the 1950s, Chinese scientists in Yunnan province identified pigeonpea as a favorable host for lac insect (*Kerria lacca*) because it was found to have useful traits such as easy establishment, fast growth, and high yield of quality lac. Recently, under the crop diversification program in China several other uses of pigeonpea have emerged, e.g., for soil conservation; and as fodder, feed, and fresh vegetable (Saxena 2000). Specific cultivars for precise purposes have been developed from breeding materials received from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India. To sustain pigeonpea productivity it has now become mandatory to maintain the genetic purity of these cultivars. Therefore, an experiment was conducted to determine the extent of natural outcrossing in China.

Pigeonpea variety ICPL 87091 with a distinct recessive trait of 'determinate growth habit' was selected for this study. The experiment was conducted in 1999 at Nanning in Guangxi province in China. Due to lack of experimental facilities 20 single-row plots of ICPL 87091 were sown in a field planted with breeding materials having dominant genetic marker of indeterminate growth habit and matching flowering time. These plots, measuring 5 m in length, were scattered at different places in the field. At least 10 pollinator rows on either side of each ICPL 87091 plot were ensured. The inter- and intra-row spacing was 100 cm and 50 cm respectively. Only two insecticide sprays were done at early flowering stage to control the pod borer *Maruca vitrata*. From each plot five individual plants were randomly harvested. The progenies of 66 selections with sufficient quantity of open-pollinated seed were sown in the subsequent rainy season. Since indeterminate growth habit is dominant over determinate growth habit, counts were recorded in each plant-progeny row for the self (determinate) and hybrid (indeterminate) plants. The frequency of natural outcrossing in each row was estimated as percentage of the observed number of hybrid plants.

In spite of two insecticide sprays a lot of insect activity was observed during flowering stage in the entire field. Also, several insect species were active but their identification was not feasible. However, among these, honeybees (*Apis* spp) were predominant. The data from the single plant progenies of ICPL 87091 revealed a large plant-to-plant variation (Fig. 1) for natural outcrossing in the preceding generation with a mean of 24.6%. In two progenies no outcrossed hybrid plant was recorded while in four progenies more than 40% hybrid plants were observed. In one progeny 60% natural outcrossing was