Phaseolus talamancensis, a New Wild Bean Species (Leguminosae, Phaseolinae) from Montane Forests of Eastern Costa Rica

Alba Marina Torres González, Orlando Toro Chica, and Daniel G. Debouck
Genetic Resources Unit, Centro Internacional de Agricultura Tropical, Apartado Aéreo 6713, Cali, Colombia

98425

ABSTRACT. A new species of Phaseolus (Leguminosae, Phaseolinae) has been found in the montane forests of the Sierra de Talamanca in eastern Costa Rica, where it appears endemic. Distinctive traits include: radican roots, purplish red internodes, veins of leaflets, primary bracts, inner face of standard, and wings. Differences with related taxa of Costa Rica and other parts of Central America are discussed, namely the smaller and rounded primary bracts as compared to *P. macrolepis*, and the radican fibrous root system as compared to *P. xanthotrichus*.

Key words: Costa Rica, Leguminosae, Phaseolinae, Phaseolus.

With a view to enrich germplasm collections for bean breeding and future genetic engineering, one of us (DGD) has collected and studied Phaseolus beans in Latin America since the late 1970s. During the 1987 preparation of a germplasm exploration in Costa Rica, a specimen of *G. Davidiae* & *G. Herrera 29127* (CR) collected in 1984 from Limón appeared to be a new *Phaseolus* species for Costa Rica since it did not match with any species reported so far for that country (Debouck et al., 1989; Delgado Salinas, 1985; Piper, 1926; Standley, 1937). In the subsequent germplasm exploration, corresponding plants were found in the buffer zone of Parque Nacional Chirripó.


Hace species *Phaseolus macrolepidii* similis, sed ab eo inflorescentiae bractis primaris rotundatis vel late ovatis minoribus, ab aliis congeneribus costaricenibus caulisibus petiolis foliorum nervis principalibus pedunculisque purpureis vel rubrumpurpureis distinguitur; cum leguminibus *Phaseolus xanthotrichus* primo aspectu similibus.

Seedlings small, delicate, from hypogeal germination; epicotyl terete, green to slightly reddish, 28–32 mm long, glabrous (Fig. 1c). Primary leaves opposite, simple; lamina deltoid, acuminate, petiolate, margin puberulent with minute whitish uncinate hairs; petioles canaliculate, 4–5 mm long, green; central and two lateral main veins prominent. Stipules erect, basifixed, 1–2 mm long, orbongo, slightly bifid, green; no stipels or stipels reduced to minute triangular scales, pulvini green glabrous. First true leaf trifoliate, stipels reduced to minute triangular scales. Roots fibrous, often radican with adventitious roots arising from nodes of lower stems, superficial not penetrating deep into the soil, gray brown (199A on 1966 RHS colour chart; Anonymous, 1966), with numerous nodules sphaeroidal, 1–3 mm, finely ridged, light to dark brown (Fig. 1a). Plant a short-lived herbaceous perennial with reduced branching from lower and middle stem nodes (Fig. 3a). Stem vine sprawling 1–3 m (Fig. 1b). Internodes 12 (4–17) cm, 0.7–2.5 mm diam. (up to 4.8 mm at base of main stem), terete, slightly grooved, red purplish (59A) fading green straw on drying, sparingly covered with yellow medium and short retrorse hairs, with minute uncinate hooked hairs abundant around nodes. Nodes red purplish that fade straw or light tan on drying. Stipules membranaceous, thin, basifixed, deltoid to ovate, 5–7 × 4–5 mm, reflexed or spreading, strongly 6–12-nerved, red purplish (59A), sparsely puberulent, margin sparsely ciliate toward the acute to obtuse apex. Leaves trifoliolate, medium green (137B), slightly lustrous, sparsely puberulent with small to minute almost translucid uncinate hairs on veins, the main veins conspicuous and purplish on the upper surface, the main and secondary veins strongly conspicuous and purplish beneath with few grouped yellowish brownish long hairs, lamina finely reticulate. Petioles stout, canaliculate, 3.8–7.3 cm, purplish, sparsely puberu-

Figure 2. Close-ups of seeds in lateral views and views from hilum of: —a. *P. talamancaensis* (Debouch et al. 2130) from type collection site. —b. *P. vulgaris* (Debouch, Araya Villalobos & Sánchez Trejos 3131) (wild form) from Jérico, San José, Costa Rica. —c. *P. xanthotrichus* (Debouch, Araya Villalobos, González Ugalde, Sánchez Trejos & Camacho Chacón 3104) from San José de la Montaña, Heredia, Costa Rica. —d. *P. macrolepis* (Debouch & Soto 1634) from Nahuala, Sololá, Guatemala. Same scale in mm and half mm, used for all four photographs.

Figure 3. —a. Living plant in seed production plot in Tenerife, Valle del Cauca, Colombia; four pointing arrows indicate the location of racemes at blooming. —b. SEM micrograph of the distal portion of style and stigma. Scale bar: 1 mm.
lent; basal pulvinus 6–7 mm, hairy, green turning yellowish green on drying; distal pulvinus 3–4 mm, hispid above. Rachis canaliculate, 9–11 mm, purplish, glabrescent. Lateral stipels lanceolate, acute, 2- or 3-nerved, 2–3 × 1 mm, glabrescent, margin sparsely ciliate. Distal stipels 1-nerved, 1 × 0.8–0.9 mm, margin puberulent. Lateral leaflets with pulvini 2–4 mm, green, ventrally tawny-hispid. Terminal leaflet deltoid to ovate, acuminate, occasionally curvilinearly caduate, 7.5 (4–8.9) × 5 (2.8–6.3) mm. Lateral leaflet inequilateral, ovate acuminate to curvilinearly caduate, 6.5 (3.3–7.7) × 4.4 (2.3–5.2) mm, main vein dividing lamina 1/3 distally and 2/3 proximally. Inflorescence a raceme of racemes, 26.5 (14.8–34) cm long, ascending, twice exceeding the leaves. Peduncle 14.8 (5.9–17.5) cm, terete, purplish green turning yellowish green upon drying, glabrous. Rachis stout, with 14 to 24 flowering secondary racemes; secondary racemes proximally 2.7 (3.1–1.4) cm distally 0.5 (0.8–0.2) cm spaced, purplish green turning yellowish green upon drying, sparsely puberulent with small whitish uncinate hairs. Secondary racemes extremely reduced. Primary bracts rounded to broadly ovate, 8–10 × 6–7 mm, with a short acumen seldom 2- or 3-toothed, ciliate, 6- to 9-nerved, purplish red (59A) fading purplish tan upon drying, persistent until anthesis, often caducous once pods fully develop (Fig. 1f). Pedicellar bracts triangular, hyaline, 0-nerved, 1 mm long or less, early caducous. Pedicels terete, 9 (7–11) mm long, ascending, purplish red fading yellow or tan, with sparsely minute uncinate hairs. Bracteoles lanceolate, hyaline, 0- to 1-nerved, 1 mm long or less, caducous shortly after anthesis. Flowers purplish red fading purplish violet, 2 for each secondary raceme. Calyx campanulate, 5 (4–6) mm long, lobes subequal, the upper lobes wider than the lower ones, triangular, short, margin shortly ciliolate, glabrous with minute whitish uncinate hairs, purplish (Fig. 1g). Standard purplish red (74A) fading purple (77A), outer face shiny purple violet (83A), 12 × 12 mm, with claw forward and limb erect above a deep sinus, rounded, emarginate, glabrous, auricles reflexed (the right auricle more reflexed than the left one), thickened at flexure; claw 2 mm long, channel-shaped, with two subequal longitudinal triangular calliosties (Fig. 1i). Wings purplish red (74A) fading purple (77A), spreading obliquely forward, subequal, rounded, cupped, 17–19 mm long, blade 14 × 10 mm, channel-shaped above the claw, claw 5 × 1 mm, spur squarish, adherent to the keel (Fig. 1h). Keel tubular, spirally incurved, ca. 10 mm long, 1/4 coil, claws divided 3–4 mm long, 2 mm to flexure and 3.7–4.6 mm from flexure to terminal coil, convex "pockets" 2 mm long at the flexure adhering to the wings, glabrous, whitish at base (Fig. 1k). Stamens diadelphous (9 + 1). Vexillar stamen free, ca. 8.7 mm long, curved claw 1 mm long to cupulate knob 0.8 mm long, 1.3 mm wide (Fig. 1j). Stamina tube 10 mm long, smoothly veined, circular opening for the vexillar stamen with small appendages when closing (Fig. 1m). Anthers ellipsoid, dorsifixed, dithecous, yellow. Pollen spheroidal, tricolporate, and finely reticulate; both axes subequal, diameter 30–32 μm.
margin bordering the colpi well developed 3–4 μm wide, endoaerture circular diameter 7–8 μm; endoaerture membrane smooth, ectoaerture membrane finely granular, tectum finely corrugated (Fig. 4a, b). Gynoecium with a basal disk diameter 1 mm, 0.5 mm high, denticulate. Ovary ca. 5 mm long, straight, laterally compressed, finely velvety with minute uncinate hairs, 6 or 7 ovules (Fig. 11). Style upturned and spiraled, ca. 10 mm long with long fine hairs below the stigma, not pronounced beyond the stigma. Stigma triangular, adaxially oriented, orange yellow (Fig. 3b). Pod straight, slightly falcate, 43–67 × 4–9 mm, chartaceous, obliquely finely veined, sutures pronounced, 4 to 7 seeds, strongly dehiscent, beak small, delicately recurved, sparsely puberulent with few uncinate hairs, purplish green when young, green once fully developed drying tan brown (165A) (Fig. 1d). Seed suborbicular convex, 3–5 × 3–4 mm, black speckled on tan brown background, hilum elliptic white, a black ring around the hilum, lens slightly raised (Fig. 1e, 2a).

The above description has been made on holotype and isotype vouchers obtained from and on living plants grown at CIAT, in the substations of Palmira, Popayán, and Tenerife, Colombia, which allow the description of all parts, including seed-
lings. Color codes mentioned in the description refer to the RHS chart (Anonymous, 1966). Small amounts of seed are available from the Genetic Resources Unit of CIAT.

Geographic distribution. This species seems to be distributed only in the eastern part of Costa Rica, on both slopes of Sierra de Talamanca (Fig. 1). While the material G. Davids & G. Herrera 29127 (CR) was found on the Atlantic slope of the Cordillera de Talamanca in the southeastern corner of the Limón province, the type population of Debouck et al. 2130 was found on its Pacific slope in the eastern part of San José province. It is premature to conclude about its rarity or level of endemicism, given the incomplete botanical survey of eastern Costa Rica. Only two specimens have been found so far in herbaria. A possible explanation for this may lie in the fractionating and small acreage of the habitats in which P. talamanicensis has been found so far (see below). On the other hand, part of its range could be in the Parque Internacional La Amistad, an important protected area between Costa Rica and Panama (Herlihy, 1997; Robison et al., 1999).

Ecology. This species is found in humid montane forests at elevations around 1800–1900 m. These habitats correspond to mixed forests described by Gómez Pignataro (1966) or the lower montane wet forest reported by Bolaños and Watson (1993), Hartschof (1983), Sawyer and Lydsey (1971), and Tosi (1969). They occupy only a small acreage in Costa Rica (767 km² or 1.5% of land; Hartschof, 1983). There the short dry season would be from December to March (Herrera, 1985). As compared to other Phaseolus species thriving in Costa Rica, e.g., P. lunatus L., P. oligospermus Pipt, P. tuerckheimii Donnell-Smith, and P. vulgaris L. (Araya Villalobos et al., 2001), P. talamanicensis seems to be an early plant blooming around October and setting seeds in December. As searches for common bean germplasm are often carried late in the year in Central America, early species such as this one may have escaped the attention of plant collectors. Developing seeds of the type collection were heavily infested by bean pod weevils (Coleoptera, Curculionidae, Apion sp.). The presence of spider mites was noted at the type locality. While under cultivation in the field in Colombia, P. talamanicensis was found susceptible to nematode attacks.

Etymology. The species is named in honor of the Talamanca Amerindians who first inhabited the mountainous range that is today called Sierra de Talamanca, where the species is distributed (Fig. 1).

Discussion. The intense purplish red color of the corolla is a distinctive trait of this new species. The large ovate red purple sometimes caducous primary bracts are also noteworthy. It is generally accepted (Lackey, 1983; Maréchal et al., 1978) that primary bracts are persistent up to anthesis in Phaseolus, in contrast with Vigna and Macroptilium species. As compared to other Phaseolus species present in Costa Rica, e.g., P. lunatus, P. oligospermus, P. tuerckheimii, and P. vulgaris (Debouck et al., 1989), floral bracts (primary and pedicellar bracts, and bracteoles) usually fall early in the course of floral ontogenesis and pod development in P. talamanicensis. Pods and seeds (Figs. 1 and 2a–c, respectively) are similar to those of P. xanthotrichus Piper, although larger. In contrast with P. xanthotrichus, P. talamanicensis has the distal part of the keel 1/4 coiled, with the terminal part of the coil coming from the right, vertically located in the front, and counterclockwise. It thus belongs to the section Phaseolus of the genus as currently understood (Delgado Salinas, 1985; Maréchal et al., 1978). The pollen (Fig. 4) is tricolporate with a finely reticulate exine: both traits are relatively common in Phaseolus (Delgado Salinas, 1985). Another distinctive trait of P. talamanicensis is the radicant and fibrous non-tuberous root system associated with hypogeal germination. This contrasts with the very frequent association of tuberous (conical, cylindrical, spherical) root systems with hypogeal germination in section Phaseolus (Caicedo et al., 1999). Lateral leaflets are often inverted once the plant is put in the plant press because of a peculiar phototropism on living plants (Fig. 3a).

The type collection has been elsewhere (Delgado et al., 1999) considered as P. macrolepis Piper, from which it clearly separates by several traits. In P. macrolepis inflorescence primary bracts are longer (10–25 mm long), foliaceous, and “elliptical, long-acuminate” (Piper, 1926: 698). Its leaflets are narrower and “long-acuminate and apiculate” (Piper, 1926: 698). Pods are broader (10–12 mm wide) and flattened in P. macrolepis as compared to P. talamanicensis. Seeds are larger and roundish in P. macrolepis as compared to P. talamanicensis (Fig. 2d and 2a, respectively). So far, P. macrolepis has not been found outside central and western Guatemala, where it seems to be endemic (Debouck, 1991, 1999; Delgado Salinas, 1985). According to Delgado Salinas and co-workers (1999), on the basis of ITS/5.8S DNA sequence, the material Debouck et al. 2130 would be remotely related to P. oligospermus, P. tuerckheimii, and P. xanthotrichus.

Paratype. COSTA RICA. Limón: Cordillera de Tal-
Acknowledgments. The senior author expresses gratitude to Rodolfo Araya Villalobos, Rafael Ocampa Sánchez, and William González Ugalde for enthusiastic and continuing support during fieldwork in 1987. The help of G. Davidec (MO) and W. Burger (F) in locating the paratype has been much appreciated. The financial support of the International Board for Plant Genetic Resources for the fieldwork is deeply acknowledged. The help of José Alejandro Arroyave and the Virology Unit of CIAT for the SEM micrographs of pollen and stigma has been most appreciated. The help of Oscar Íñárraga and Fernando Pino, both at the Graphic Arts Unit of CIAT, for the preparation of the map and the photographs of seeds, respectively, is acknowledged. The authors thank the curators of CR, F, K, MO, US, and USI for the loan of specimens.

Literature Cited