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POLLEN MORPHOLOGY OF PERUVIAN *PROSOPIS* (FABACEAE)

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Abstract

Pollen morphology from ten Peruvian species of *Prosopis* genus (*P. alba*, *P. chilensis*, *P. limensis*, *P. mantaroensis*, *P. pallida*, *P. peruviana*, *P. piurensis*, *P. purpurea*, *P. reptans* and *P. tupayachensis*) was examined using light microscopy (LM), looking for new features that might contribute to clarify classification of the genus in Peru. The *Prosopis* species are stenopalynous, which is an agreement with observations in previous studies of other species. Pollen is shed in monads and characterized by being isopolar, radially symmetric, generally prolate, and psilate. Pollen is medium size (31.41 – 23.89 µm in *P. alba* and 40.65 – 22.04 µm in *P. reptans*), tricolporate, with long and narrow colpi, a circular endoaperture and a reduced polar area. The exine has a range between 1.72 to 2.37 µm thick.

Key words: *Prosopis*, Peruvian species, pollen morphology.

INTRODUCTION

The order Fabales consists of 3 families and about 18 000 species widely distributed throughout the world; the Fabaceae (Papilionaceae) comprises more than 12 000 species, the Mimosaceae about 3 000, and the Caesalpinaceae more than 2 000 [1]. In the APG classification, Fabaceae comprises the three families in the order Fabales (Eurosids I) [2]. The genus *Prosopis* L. comprises some 44 species, distributed throughout Western Asia, Africa and arid and semi-arid regions in the Americas, from the Southwestern United States to central Chile and Argentina [3, 4]. The circumscription and taxonomic relationships between the *Prosopis* species have been controversial.

The name *Prosopis* was assigned by Linnaeus in 1767 to the single species of which he was aware. This was *P. spicigera*, now synonymous with *P. cineraria* [5], one of the three Old World species of the genus with a range from India to the Middle East [6], and the type species for the genus. The taxonomy of the genus *Prosopis* is extremely complex and many aspects remain unclear and subject to ongoing revisions. This has already been the subject of several reviews by different authors [3, 5-8], and it still needs further revisions to facilitate comprehension. The genus is easy to recognize, but its species are difficult to identify. This problem with identification results from the extreme variability among individual plants or among individuals of the same species. Another problem which makes recognition difficult is related to the species facility for hybridization, for instance, *P. abbreviata* individuals exhibited intermediate characters from the both species, *P. torquata* and *P. strombulifera*; in order to corroborate this hypothesis, morphological studies and studies of pollination viability were done in the individuals of the three species growing in sympatry, and the obtained results indicate that *P. abbreviata* because of its very low viability, bad exine structure and addition of the exine sculpture could be a hybrid or perhaps an (introgresante) originated by cross pollination between *P. torquata* and *P. strombulifera* [9], thus corroborating prior observations referred to *P. burkartii* [10].

The classification according to Burkart (1976) [3] in five sections (*Prosopis*, *Anonychium*, *Strombocarpa*, *Monilicarpa* and *Algarobia*) and eight series (*Strombocarpae*, *Cavenicarpae*, *Sericanthae*, *Ruscifoliae*, *Denudanthes*, *Humilis*, *Pallidae* and *Chilensis*) facilitated enormously the

taxonomy of this genus. Within these five sections, species can be very similar and frequently hybridize. By far, the largest of the Burkart Section is *Algarobia*, and comprises around 30 New World species [3, 11].

In Peru, the study of the systematics of the genus *Prosopis* has been subject to the taxonomic complications that characterize the whole section *Algarobia*. Bentham (1875) [12] originally recognized the single species, *P. limensis*, from the coast of Peru; Fortunato Herrera identified trees in the dry inter-Andean valley as *P. chilensis*; in Flora of Peru were lists *P. chilensis* and *P. limensis* as the two species that occurring, both on the coast and in the high, dry intermontane valleys [13]; in El Mundo Vegetal de los Andes Peruanos was named only one species, *Prosopis juliflora*, as occurring throughout the Peruvian coast [14] and Ferreyra (1987*)* [15] reported, in addition to *P. chilensis* and *P. juliflora*, *P. affinis*; however, the presence of the latter species in the study area proposed some doubts, since its distribution in the La Plata River basin (Uruguay, Argentina, Paraguay and Brazil), is associated with a much wetter climate, therefore Diaz-Celis (1995) [16] and Pasiecznick et al. (2001) [5] considered an incorrect identification. Mom et al. (2002) [17] in recent years have noted the presence of *P. pallida* and *P. limensis* in Grau Region (Piura) and as results of quantitative analysis of leaf characters of specimens of the genus *Prosopis*, collected along the coast from Arequipa (Peru) to Manta (Ecuador), point out three well defined groups that are: *P. pallida*, *P. limensis* (both with a wide distribution) and *P. chilensis* restricted to the Camaná river valley [18]. Recently five new Peruvian species from *Prosopis* genus (*P. mantaroensis*, *P. peruviana*, *P. piurensis*, *P. purpurea* and *P. tupayachensis*) were described [8].

Prosopis species are trees or shrubs of variable size, rarely sub-shrubs, predominantly xerophytic, aculeate or spinescent, rarely thornless. Leaves are bipinnate with pinnae opposed in pairs, with an interpetiolate or cupuliform gland, sessile with apical pore. Folioles small and numerous, whole, elliptic, linear, oblong or fusiform, rarely large as in the case of *Prosopis ruscifolia*, downy, rarely glabrous. Inflorescence in spicate or clustered bunches, or ementiform, axillary and thick-flowered, short or long, yellow. Flowers are small, actinomorphous, pentamerous, and hermaphrodite. Calyx is campanulate; corolla with linear petals, free or slightly fused at the base, glabrous or finely pubescent. Androecium formed by 10 free stamens; anthers are elliptical, dorsifixed, with globous connectival gland at the apex, pedicellate apical. Pollen grain more or less spherical. Gynaeceum with stipitate ovary, glabrous or pilous, the filiform style emerging from the flower bud before the stamens appear. Anthesis protoginous. Flowers greenish and then yellowish. Fruit of leguminous type, straight, linear, falcate or annular, with coriaceous mesorcarp divided into one or various segments; seeds compressed, ovoid, hard, dark brown with mucilaginous endosperm surrounding the embryo; cotyledons flat, rounded, epigeous when germinating [3].

Studies on pollen morphology from *Prosopis* genus have been published by Erdtman (1952) [19]. This and posterior studies of pollen morphology of *Prosopis* were mainly based on light microscopy (LM) and/or scanning electron microscopy (SEM) studies of selected taxa, or incorporated into regional pollen floras [20, 21]. The pollen morphology from some taxa, namely *P. chilensis* [20] and *P. juliflora* [22], has been described more than once, but little is known about palynological features over the whole genus and their systematic/taxonomic implications, except palynological studies comparing *P. chilensis*, *P. juliflora* and *P. pallida* [23] and *P. abbreviata*, *P. strombulifera* and *P. torquata* [9].

The present study is focused on pollen morphology of the Peruvian representatives of the genus *Prosopis* in order to contribute to the palynological knowledge of the Fabaceae. It comprises preliminary results of a broad taxonomic revision of the basal mimosoidaceous lineages in Peru.

MATERIALS AND METHODS

Pollen samples of ten taxa of *Prosopis* (*P. alba*, *P. chilensis*, *P. limensis*, *P. mantaroensis*, *P. pallida*, *P. peruviana*, *P. piurensis*, *P. purpurea*, *P. reptans* and *P. tupayachensis*) were obtained from herbarium specimens deposited in the Peruvian herbaria PRG (Universidad Nacional Pedro Ruiz Gallo, Lambayeque). To document total morphological variability for each species, all the fertile species were analyzed.

Pollen samples were processed following the acetolysis method described by Erdtman (1952, 1960) [19, 24]. Permanent slides were mounted in glycerine jelly and stored at the Palynotheca of the Laboratory of Palinology from the Universidad Nacional Pedro Ruiz Gallo (UNPRG), Lambayeque,

Peru. Ten slides of each herbarium specimen were prepared. General observations were made using a Labomed optical microscope. Dimensions of grains were measured one week after acetolysis. Twenty-five pollen grains per species were measured in equatorial and polar view for determination of the polar diameter (P), the equatorial diameter (E), the polar length (PL), the exine thickness and grain shape (P/E ratio). Terminology follows Punt et al. (1994, 2007) [25, 26]. Statistical analysis was conducted to obtain the means and standard deviations, and coefficient of variation was calculated and compared using the confidence interval (95%).
In developing the similarity analysis took into account the most significant, such as polar diameter, exine thickness, length and wide of colpi, polar length and equatorial diameter. Was used the program NTSYS pc 2.2, in order to structure the dendrogram to show the relationships between species based on pollen data studied.

RESULTS

Based on LM observations, pollen grains from Peruvian species of *Prosopis* genus are stenopalynous and can be characterized by the following general description: monads; isopolar, radially symmetric, prolate (subprolate in *P. alba*); medium size; psilate and a reduced polar area; tricolporate with long and narrow colpi; circular endoaperture, exine up to 1.7 µm thick (Figure 1) (Table 1).
Prosopis peruviana had the smallest equatorial diameter (20.72 µm), while *P. limensis* had the largest pollen with an equatorial diameter of 24.68 µm. The smallest mean polar length was identified *in P. alba* (31.41 µm); the largest was in *P. reptans* (40.65 µm) (Tables 2 and 3).
The similarity dendrogram based on the coefficient of variation of six characters pollen grains show three different clusters (Figure 2): Cluster 1, with *P. alba*, Cluster 2, the largest cluster in terms of species number (*P. chilensis*, *P. mantaroensis*, *P. pallida*, *P. limensis*, *P. piurensis*, *P. purpurea* and *P. peruviana*), and Cluster 3, with *P. reptans* and *P. tupayachensis*). *P. alba*, the only member of Cluster 1, is the only subprolate shape and had the smallest pollen with 1.33 P/E ratio, while *P. reptans*, one of two members of the Cluster 2, had the largest pollen with 1.86 P/E ratio. The others species of Peruvian *Prosopis*, that conforman the Cluster 3, tienen un rango de P/E entre 1.43 - 1.70.
The figure 3 shows the geographical distribution of *Prosopis* species in Peru.

DISCUSSSION

Fabaceae is a family with europalynous pollen characterized by rather great variation in pollen morphology; however, at the level of genera, pollen morphology tends to be more consistent. According to our study, pollen in the genus *Prosopis* is stenopalynous, consequently, the pollen morphology of the Peruvian *Prosopis* is in full agreement with the reported profile for the other taxa traditionally included in the subfamily Mimosoideae [3, 27]. All the *Prosopis* species examined are characterized by monad, isopolar, radiosymmetric, tricolporate and psilate [20, 21, 23, 27]; however, there are significant differences in the value of quantitative palynological characters that may to some extent be related to differences in the preparation of pollen grains [28] as well as the mounting medium [29]. Although the majority of palynologists use the acetolysis method of Erdtman (1960) [24] for the preparation of pollen grains for LM observations, these methods themselves also affect the size of pollen grains. The increase of pollen size after acetolysis varies among genera, sometimes even among species [30]. In this study, all samples pollen *Prosopis* species were prepared using the method of acetolysis of Erdtman.
The pollen morphological characters of 36 taxa of the Mimosoideae representing 30 species, four subspecies and two varieties were investigated by the aid of LM and SEM [27]. In this research the pollen samples were prepared according to customary method of Erdtman (1960) [24]. *Prosopis* species, *P. chilensis*, *P. farcta* and *P. juliflora*, were described as monad, isopolar and radially symmetric. Only, for *P. chilensis* and *P. juliflora* the shape in polar view was elliptic and in equatorial view semi circular; however, the P/E ratio for *P. chilensis* and *P. juliflora* was 1.33 (subprolate) and 1.0 (prolate-spheroidal), respectively [27]. In our study the P/E ratio of *P. chilensis* was 1.55 (prolate), and in the study of Heusser (1971) [20] the P/E ratio of the same species was 0.94 (spheroidal); in both studies the pollen samples were prepared with the method of Erdtman (1960) [24]. In addition, in the study of Kapp (1969) [21], the P/E ratio of *P. juliflora* was 1.75 (prolate), in the study of Alves et al. (1988) [22], the P/E ratio was 1.28 (subprolate), and the study of Perveen & Qaiser (1998) [31],

the P/E ratio was 0.87 (sub-oblate); in these three works the pollen grains were prepared by the standard methods described by Erdtman (1960) [24].

A review of the relevant literature and the data provided in the present study suggest that pollen morphology alone cannot be used for distinction at the specific level in the *Prosopis* section and series established by Burkart (1976) [3] [Section *Prosopis* (Syn. *Adenopis*), *Anonychium*, *Strombocarpa* (Syn. *Spirolobium*), *Monilicarpa* and *Algarobia* (Syn. *Neltuma*)]. Consequently, additional studies focusing on the search of morphological micro-characters using transmission electron microscopy (TEM) and exine stratification in this genera are necessary for a better understanding of intrageneric and intrafamilial relationships in the basal lineages of Fabaceae – Mimosoideae; however, in a study on pollen morphology of the subfamily Mimosoideae from Pakistan, four species of *Prosopis* were included in the *Prosopis juliflora*-type, i.e. *P. cineraria*, *P. farcta*, *P. juliflora* and *P. glandulosa*; these species have considerable variation in their pollen characters, and can easily be separated from each other on the basis of shape, exine thickness and apocolpium [31].

Others genera of Mimosoideae: *Calliandra*, *Acacia* and *Albizia* are polyad and inaperturate [20], *Mimosa* and *Schrankia* are tetrad quadrate with exine apparently intectate [21], *Acacia*, *Adenanthera*, *Albizia*, *Anadenanthera*, *Calliandra*, *Dichrostachys*, *Enterolobium*, *Faidherbia*, *Mimosa* and *Pithecellobium* are polyad (4, 8, 16 and 32-monad) and heteropolar; only *Leucaena* and *Prosopis* species present single grains [27] or *Acacia* and *Mimosa* are polyads [31]. The present data revealed that the pollen morphology of Mimosoideae subfamily is significant at the generic and tribal level; these five or six tribes are *Ingeae*, *Acacieae*, *Mimosieae*, *Adenantheraeae*, *Piptadenieae* and *Parkieae*), recognized by Polhill & Raven (1981) [32] and Bentham & Hooker (1862-1883) [33], respectively.

Dendrogram analysis based similarity coefficient variation of pollen six characteristics show that Group 1 consists of only *P. alba* (P/E 1.33, subprolate). This species is distributed in the Andean regions of Apurimac and Cuzco, at 2 000 m, sharing the same ecological environment with *P. peruviana* (P/E 1.70, prolate) and *P. tupayacensis* (P/E 1.46, prolate); however, these species are grouped into different clusters. The Cluster 2, is constituted by *P. reptans* (P/E 1.86), collected in the Andean region of Huancavelica at 2500 m, sharing the same ecological environment with *P. mantaroensis* (P/E 1.48, prolate), collected in the Andean región of Ayacucho at 2 200 m and *P. tupayacensis*; between *P. reptans* and *P. tupayachensis* slight differences were observed in pollen characteristics. The Cluster 3, the largest cluster in terms of species number, comprises mainly taxa from different ecological environments: *P. chilensis* (P/E 1.55, prolate), *P. mantaroensis*, *P. pallida* (P/E 1.55, prolate), *P. limensis* (P/E 1.43, prolate), *P. piurensis* (P/E 1.55, prolate), *P. purpurea* (P/E 1.51, prolate) and *P. peruviana*. Among these species, the most closely related were *P. mantaroensis* with *P. pallida* and *P. limensis* with *P. piurensis*, well as *P. chilensis* with *P. limensis* and *P. piurensis*. *P. purpurea*, *P. piurensis* and *P. limensis*, distributed species in the seasonally dry forest (BES) of Tumbes, Piura and Lambayeque, respectively. These species, together with *P. pallida*, collected in the BES of Cajamarca, their pollen grains have similar characteristics especially the P/E around 1.50.

CONCLUSIONS

Until now, all attempts to establish a classification at level of species of *Prosopis* from Peru have been controversial [8, 13, 16, 15]. Here, we have demonstrated that pollen morphological features do no not support the distinction at the specific level in the *Prosopis* genera. Additional studies using transmission electron microscopy (TEM) and exine stratification are necessary; however, analysis of the similarity dendrogram may be useful to identify relationships among the species as well as in the basal lineages of Mimosoideae.

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Specimens investigated

Prosopis alba Grisebach. Perú, Dpto. Apurimac, prov. Andahuaylas, Sapichaca, Pampas River, 13º26.202' S, 73º49.622' W, 1972 m, 27-X-2007, *L. Vásquez, J. Escurra, A. Huamán, G. Vásquez & J. Zamora, 12843* (PRG); prov. Abancay, distrito de Curahuasi 13º32.641'S, 72º40.181' W, 28-X-2007, *L. Vásquez, J. Escurra, A. Huamán, G. Vásquez & J. Zamora, 12848* (PRG); Dpto. Cusco, prov. Cunyac-Carahuasi, distrito de Limatambo-Mollepata, 13º32' S, 72º31' WIV-2004, *W. Galiano*, 5748 (CUZ). *P. chilensis* (Molina) Stuntz. Perú, Dpto. Arequipa, prov. Camaná, Hawaii bridge 16º32.169' S, 72º51.607' W, 24 m, 03-XI-2007, *L. Vásquez, J. Escurra, A. Huamán, G. Vásquez & J. Zamora, 12847* (PRG); prov. Castilla, Aplao – Huancarqui, 1200 m, XIV-VI-2000, *José Carlos Córdova y colaborador* (HUSA); 1268 m, XXIV-I-1996, *Percy Zeballos 1254* (MOL).

P. limensis Benth. in Hook. Perú. Dpto. Lambayeque (Mórrope, Cayaltí, Bosque de Pomac, Lambayeque); dpto. La Libertad (San Pedro de Lloc, San José del Moro, Pacanguilla); dpto. Ica (Ica, Camaná, Ocucaje, Nasca); dpto. Arequipa (Lomas de Atiquipa, Islay); Herbarios: Universidad Nacional Agraria La Molina, Universidad Nacional Mayor de San Marcos, Universidad Nacional de Trujillo, Universidad Particular Antenor Orrego, Universidad Nacional de Cajamarca y Universidad Nacional Pedro Ruiz Gallo.

P. mantaroensis L. Vásquez, Escurra & A. Huamán. Perú. Dpto. Ayacucho, prov. Huanta, distrito Huanta (field near the Huanta city), 2204 m, 26-X-2007, *L. Vásquez, J. Escurra, A. Huamán, G. Vásquez & J. Zamora, 12845* (PRG).

P. pallida (Humboldt & Bonplant ex Wildenow) H.B.K. Perú. Dpto. Cajamarca, prov. Jaén, distrito de Jaén, Palo Blanco locality, 5º50.330' S, 78º45.389' W, 485 m, III-VIII-2007, *L. Vásquez, J. Escurra & A. Huamán, 13388* (PRG). Dpto. Amazonas, prov. Bagua, Pongo de Rentema locality, 480 m, XVI-XII-1992, *I. Sánchez Vega & J. Tanta 6465* (CPUN).

P. peruviana L. Vásquez, Escurra & A. Huamán. Perú. Dpto. Apurimac, prov. De Andahuaylas, distrito de Sapichaca (field near the Pampas River bridge) 2077 m, 27-X-2007, *L. Vásquez, J. Escurra, A. Huamán, G. Vásquez & J. Zamora, 12849* (PRG).

P. piurensis L. Vásquez, Escurra & A. Huamán. Perú. Dpto. Piura, prov. Sullana. Panamericana roadside near the Chira River bridge, 300 msnm, 15-IX-2008, *L. Vásquez, J. Escurra & A. Huamán, 13258* (Holotipo: PRG), Ecuador. Prov. Macaví – Machala, *R. Palacios*, 15-11-2002 USM. Perú. Dpto. Piura, Prov. Sullana, 13-03-1979, *R. Ferreira*, USM. Perú. Dpto. Lima (cultivated plant) 27-04-1971. *F. Encarnación*.

P. purpurea L. Vásquez, Escurra & A. Huamán. Perú. Dpto. Tumbes, prov. Tumbes, distrito Puerto Pizarro (forest surrounding the city cemetery) 3º29.956' S, 80º23.300' W, 3 m, 20-XI-2007, *L. Vásquez, J. Escurra & A. Huamán, 12941* (PRG); 50 m, 31-XII-1993, *S. Llatas* 3383.

P. reptans Bentham. Perú. Dpto. Huancavelica, prov. Acobamba, distrito San Miguel de Mayocc, 2530 m, XXII-VIII-1968, *César Vargas* 15852 (Cuz).

P. tupayachensis L. Vásquez, Escurra & A. Huamán. Perú. Dpto. Cusco, prov. Cusco, distrito Lucre (in the archaeological ruins of Pikillacta-Huacarpay) 13º36'30.5" S, 71º44'0.41" W, 3120 m, 30-X-2007, *L. Vásquez, A. Huamán, G. Vásquez & J. Zamora, 12846* (PRG); 3120 m, 30-X-2007, *L. Vásquez, J. Escurra & A. Huamán, 12846* (PRG); 2200 m, 9-VIII-2000, *J. Córdova y colaboradores* (HUSA); 3200 m, I-IX-1948, *C. Vargas* (Cuz); 2900 m, 30-VIII-1990, *A. Tupayachi* 28007 (Cuz).

Table 1. Exine, colpus and ornamentation of pollen grains on the Peruvian species of *Prosopis*.

Species	Exine (variation/χ/SD)	Colpus (L) (variation/χ/SD)	Colpus (W) (variation/χ/SD)	Ornamentation
Prosopis alba	1.22 - 2.12 1.72 ± 0.50	28.28 - 32.76 30.52 ± 2.24	0.89 - 2.69 1.79 ± 0.90	Psilate
P. chilensis	1.52 - 2.48 2.08 ± 0.48	31.81 - 36.17 33.49 ± 2.68	0.81 - 2.89 1.85 ± 1.04	Psilate
P. limensis	2.18 - 2.60 2.37 ± 0.21	32.29 - 36.29 34.23 ± 2.06	0.92 - 2.10 1.51 ± 0.59	Psilate
P. mantaroensis	1.37 - 2.33 1.88 ± 0.48	28.46 - 32.92 30.69 ± 2.23	0.89 - 1.89 1.39 ± 0.50	Psilate
P. pallida	1.58 - 2.36 1.94 ± 0.39	30.33 - 36.33 33.33 ± 3.00	1.13 - 2.29 1.71 ± 0.58	Psilate
P. peruviana	1.97 - 2.77 2.31 ± 0.40	32-11 - 35.87 33.99 ± 1.88	0.56 - 1.90 1.23 ± 0.67	Psilate
P. piurensis	1.74 - 2.16 1.82 ± 0.21	31.61 - 31.91 31.76 ± 1.50	0.79 - 2.16 1.48 ± 0.69	Psilate
P. purpurea	1.52 - 2.46 2.20 ± 0.47	30.11 - 35.71 32.91 ± 2.80	0.55 - 1.95 1.25 ± 0.70	Psilate
P. reptans	1.70 - 2.88 2.23 ± 0.59	35.00 - 42-88 38.94 ± 3.94	1.43 - 2.50 1.98 ± 0.55	Psilate – fossulate
P. tupayachensis	2.01 - 2.61 2.05 ± 0.30	32.20 - 36.92 34.56 ± 2.36	0.69 - 2.27 1.48 ± 0.79	Psilate

Arithmetic average (χ) and standard deviation (SD), (*n* = 25); (L), length; (W), wide.

Table 2. Polar length (PL) measurements (in µm) of pollen grains on the Peruvian species of *Prosopis*.

Species	Variation	χ ± SD	CV (%)	IC 95 (%)	P/E
Prosopis alba	28.58-34.24	31.41 ± 2.83	9.03	30.24 - 32.58	1.33
P. chilensis	31.17-37.47	34.32 ± 3.15	9.20	33.02 - 35.62	1.55
P. limensis	32.36-37.32	34.84 ± 2.48	7.14	33.82 - 35.86	1.43
P. mantaroensis	28.75-34.21	31.48 ± 2.73	8.68	30.35 - 32.61	1.48
P. pallida	30.36-38.50	35.50 ± 4.07	11.47	33.82 - 37.18	1.55
P. peruviana	32.78-36.64	34.71 ± 1.93	5.56	33.91 - 35.51	1.70
P. piurensis	30.60-34.74	32.67 ± 2.07	6.35	31.82 - 33.52	1.55
P. purpurea	30.78-36.80	33.79 ± 3.01	8.92	32.55 - 35.03	1.51
P. reptans	37.00-44.30	40.65 ± 3.65	8.98	39.14 - 42.16	1.86
P. tupayachensis	32.64-38.50	35.57 ± 2.93	8.26	34.36 - 36.78	1.46

Arithmetic average (χ), standard deviation (SD), variability coefficient (CV) and confidence interval (IC), (*n* = 25).

Table 3. Equatorial lenght or equatorial diameter (E) measurements (in µm) of pollen grains on the Peruvian species of *Prosopis*.

Species	Variation	χ ± SD	CV (%)	IC 95 (%)	Shape
Prosopis alba	21.07-26.71	23.89 ± 2.82	11.83	22.73 - 25.05	Subprolate
P. chilensis	19.73-24.87	22.30 ± 2.57	11.52	21.24 - 23.36	Prolate
P. limensis	21.47-27.89	24.68 ± 3.21	13.01	23.35 - 26.01	Prolate
P. mantaroensis	18.98-23.78	21.38 ± 2.40	11.24	20.39 - 22.37	Prolate
P. pallida	19.92-24.96	22.44 ± 2.52	11.23	21.40 - 23.48	Prolate
P. peruviana	18.11-23.33	20.72 ± 2.61	12.60	19.64 - 21.80	Prolate
P. piurensis	18.68-23.82	21.25 ± 2.57	12.13	20.19 - 22.31	Prolate
P. purpurea	20.21-24.93	22.57 ± 3.36	10.49	21.18 - 23.96	Prolate
P. reptans	19.40-24.68	22.04 ± 2.64	12.00	20.95 - 23.13	Prolate
P. tupayachensis	21.40-27.74	24.57 ± 3.17	12.91	23.26 - 25.88	Prolate

Arithmetic average (χ), standard deviation (SD), variability coefficient (CV), confidence interval (IC) and shape, (n = 25).

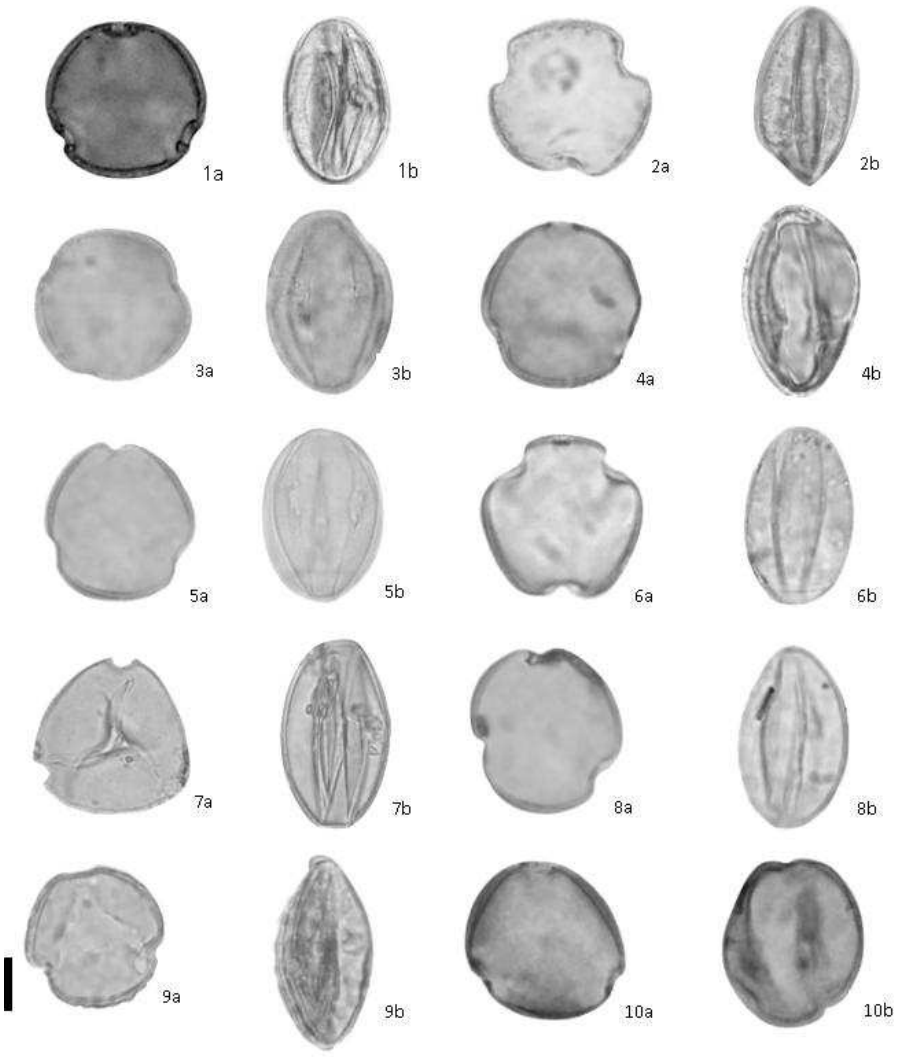

Figure 1. Mature pollen of *Prosopis* (light microscopy). 1. *Prosopis alba*: 1a. Polar view; b. Equatorial view. 2. *P. chilensis*: 2a. Polar view; 2b. Equatorial view. 3. *P. limensis*: 3a. Polar view; 3b. Equatorial view. 4. *P. mantaroensis*: 4a. Polar view; 4b. Equatorial view. 5. *P. pallida*: 5a. Polar view; 5b. Equatorial view. 6. *P. peruviana*: 6a. Polar view; 6b. Equatorial view. 7. *P. piurensis*: 7a. Polar view; 7b. Equatorial view. 8. *P. purpurea*: 8a. Polar view; 8b. Equatorial view. 9. *P. reptans*: 9a. Polar view; 9b. Equatorial view. 10. *P. tupayachensis*: 10a. Polar view; 10b. Equatorial view. Scale bar - 12.5 µm.

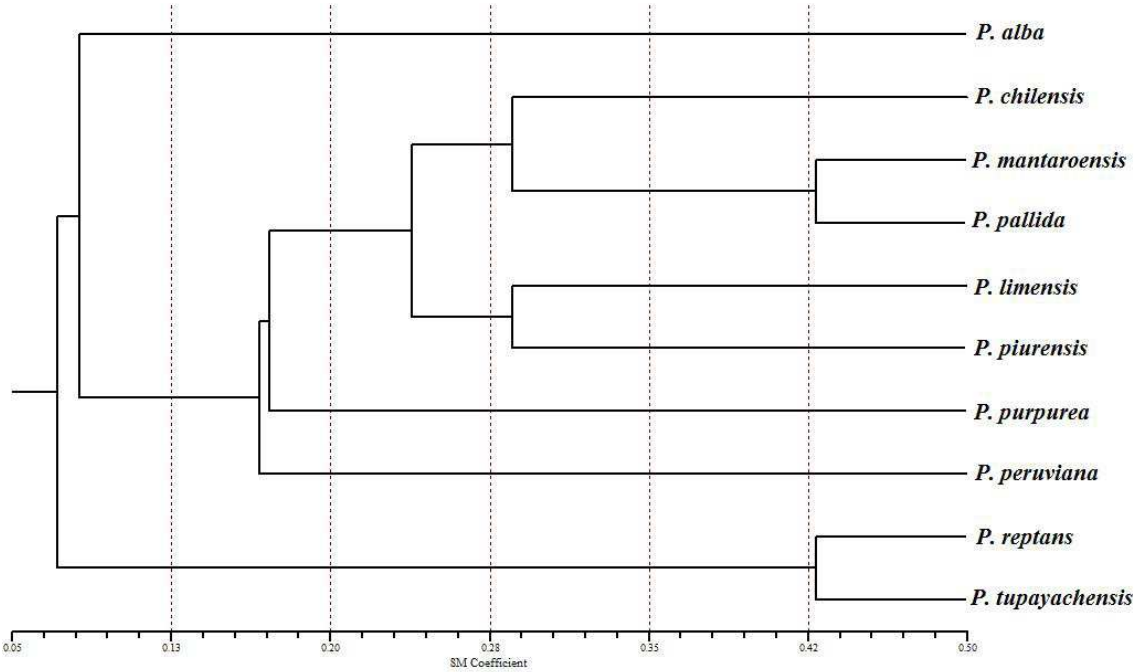

Figure 2. Dendrogram based on the coefficient of variation of characters illustrating the similarity between *Prosopis* species in Peru.

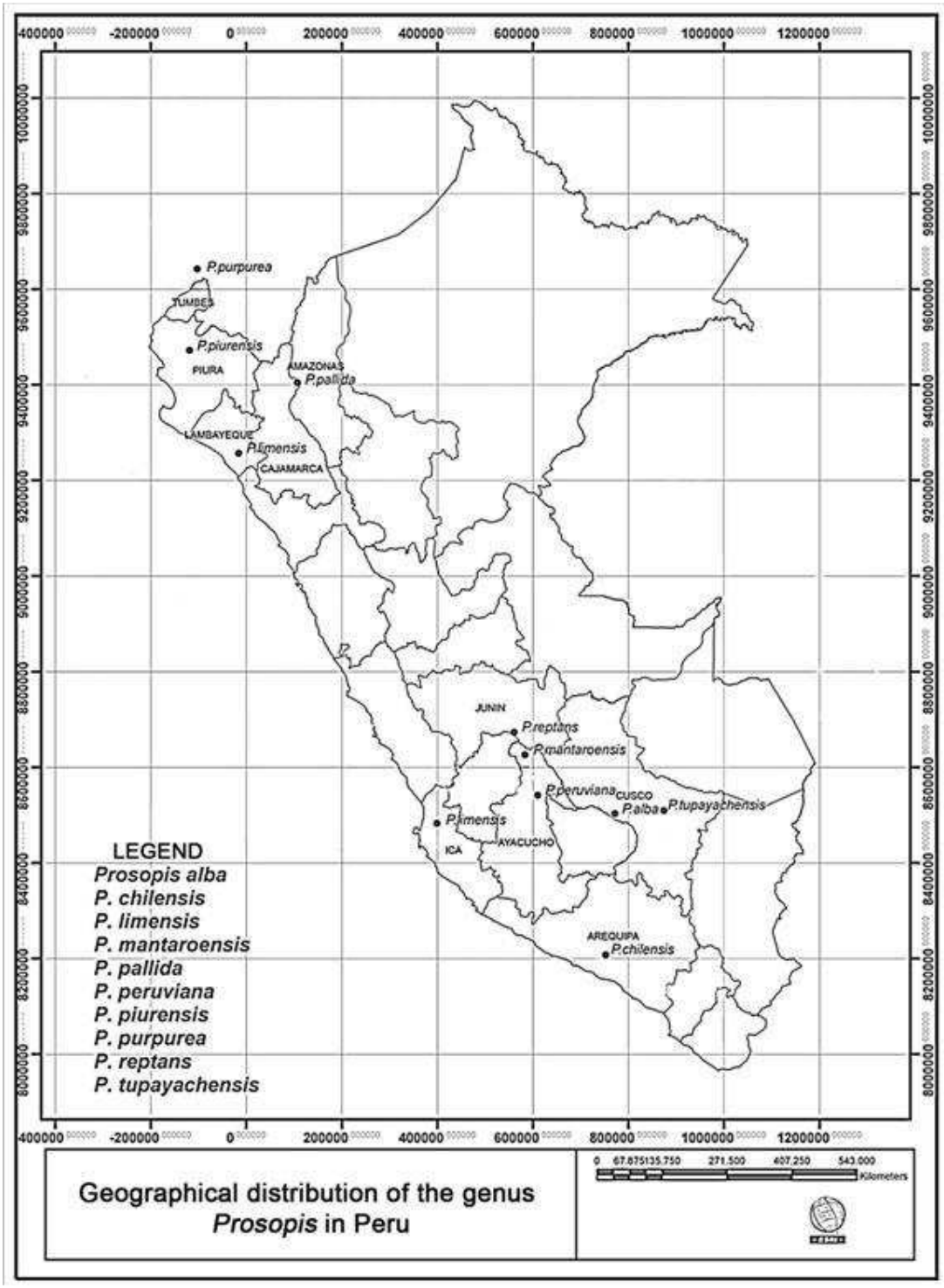

Figure 3. Geographical distribution of the genus *Prosopis* in Peru.

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