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THE SMALL-SPORED SPECIES OF *PODAXIS*

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ABSTRACT

A new section, *Parvispora*, is described in the genus *Podaxis* to accommodate *Podaxis argentinus* Speg. and two additional species, *Podaxis longii* sp. nov. and *Podaxis microporus* sp. nov. A key for identification, detailed descriptions, and known distributions are given for the three species of Section *Parvispora*.

Key Words: Gasteromycetes, new species, new Section, *Podaxis*, taxonomy, SEM.

The presence in South America of small-spored species of *Podaxis* Desv. was established by Spegazzini (1898) and confirmed by Martinez (1971). He united Spegazzini's two small-spored species under the name *Podaxis argentinum* (sic) Speg. and reduced *Podaxis macrosporus* Speg. to synonymy under *Podaxis pistillaris* (Pers.) Fr. Using light microscopy, Martinez demonstrated the value of critical study of spore characteristics in delineating species of *Podaxis*.

The taxonomy and distribution of *P. argentinus* (as *argentinum*) from southwestern U.S.A. through Patagonia was reviewed recently (McKnight and Stransky, 1980). That report demonstrated the value of scanning electron microscopy in revealing structural details of germ pores and apiculi. (Although most authors have correctly treated *Podaxis* as a masculine noun, we erred in following Spegazzini and Martinez in using an incorrect form of the specific epithet: *argentinum*.) Further study of type specimens from the collections at the Spegazzini Herbarium (LPS) and the extensive collections of *Podaxis* at BPI, especially those of the W. H. Long herbarium, reveal two additional species included here along with *P. argentinus* in a new section, *Parvispora*, of the genus *Podaxis*.

MATERIALS AND METHODS

For study under the light microscope, a small amount of gleba from a dried herbarium specimen was mounted directly in lactophenol. Spores were prepared for SEM by one of the following three methods: (1) spores coated and scanned with no additional preparation; (2) spores affixed to SEM stub stored for 48 h in the saturated atmosphere of a moist chamber, then dried by exposure to the open atmosphere of the laboratory for 24 h; (3) spores from herbarium specimens revived in H₂O, dehydrated in a graded ethanol series and critical-point-dried before coating. Prior to coating with gold-palladium in a sputter-coater spores were affixed to the SEM stub with a glue spot from an Avery¹ SelfAdhesive Paper Tack.

PODAXIS DESV.

Parvispora sect. nov.

Basidiosporae subglobosae vel late ellipsoideae vel intermediae, longitudo mediana minus quam 8 μ m; apiculus per porum germinationis procurrit. Typus sectionis *Podaxis argentinus* Speg.

¹ Mention of a trademark or a proprietary product does not constitute a guarantee or warranty of the product by the U.S.D.A., and does not imply its approval to the exclusion of other products that may also be available.

Basidiospores subglobose to broadly ellipsoidal, mean length less than 8 μm ; apiculus may project through germ pore.

KEY

1. Spores with broad, distal germ pore and proximal apiculus; mean spore length $>9.5 \mu\text{m}$ *Podaxis* Sect. *Podaxis* (not included)
1. Mean spore length $<7.5 \mu\text{m}$ or apiculus collapsed in shallow germ pore
 2. Gastrocarp very large and robust, up to 40 cm tall; stipe $>1 \text{ cm}$ thick at apex *Podaxis* Sect. *Parvispora*
 2. Gastrocarp not over 20 cm tall; stipe slender, $<1 \text{ cm}$ thick at apex 3
3. Gleba olive brown to yellowish brown, spores broadly ellipsoid, mean length $<7 \mu\text{m}$ *Podaxis* *argentinus* Speg.
3. Gleba strong reddish brown, spore subglobose, mean length $>7 \mu\text{m}$ *Podaxis* *microporus*

PODAXIS ARGENTINUS Speg. Anales Mus. Nac. Buenos Aires 6: 186. 1898.

FIGS. 1–7

Syn: *Podaxis patagonicum* Speg. Anales Mus. Nac. Buenos Aires 6: 186. 1898.

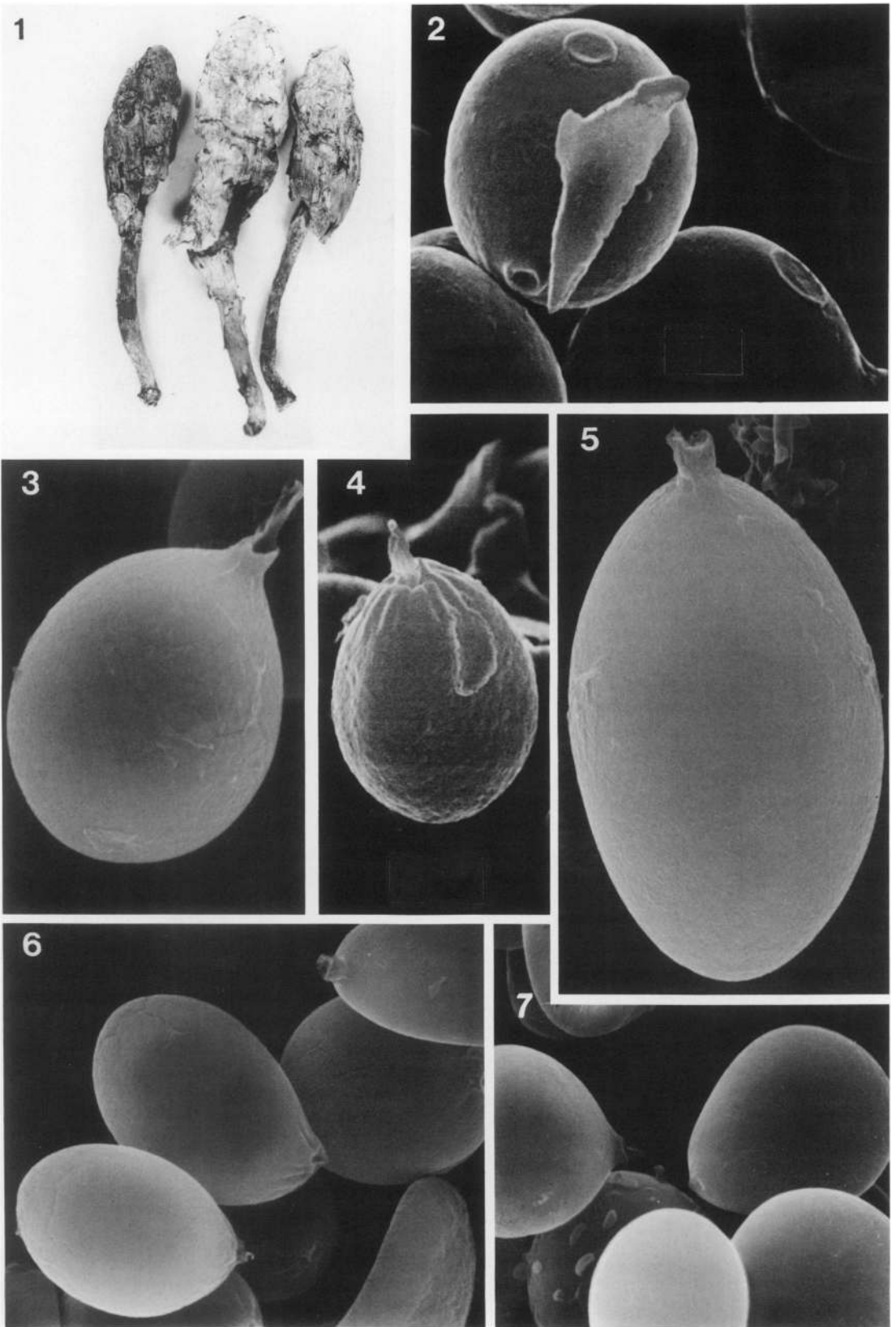
Gastrocarp stipitate, 9–17 cm tall, dry, indehiscent at maturity. Peridium ellipsoidal to subcylindric or broadly fusiform with rounded apex, occasionally broadly campanulate at maturity, 4–8 \times 2.5–4 cm, lower margin incurved and sheathing stipe when young and remaining so at maturity or separating, sometimes flattened, bent, or contorted, often slit longitudinally at maturity, 2-layered, surface **yellowish white**² (Centr. 92) or brownish, irregularly rugulose to longitudinally fibrillose streaked; outer layer of peridium sheathing margin of inner peridium and stipe, elsewhere on inner peridium and stipe forming superficial scales or patches. Stipe cylindric and sometimes tapered downward or fusiform, most often with a small, rounded bulb and white rhizomorphs in adherent ball of soil, often bent near base, 5–15 \times 0.4–1.7 cm, hollow, woody, surface longitudinally striate, rivulose, or fibrillose-scaly, sparsely ornamented with superficial, irregular, coriaceous scales.

Gleba powdery with few capillitial filaments attached to stipe columella; **moderate brown** (Centr. 58) to **dark brown** (Centr. 59) at maturity, some shade of **grayish yellow** to **olive brown** or yellowish brown in dried, but not fully mature specimens. Spores 5.3–7.7(–8.8) \times 4.4–6.6(–7.7) μm [means 5.9–7.7 \times 4.6–6.2 μm , l/w ratio 1.1–1.3(–1.4)], subglobose to broadly ellipsoid, smooth, thick-walled with apiculus short and often seen under high magnification light microscopy or sometimes lacking and no apparent germ pore, **pale orange yellow** (Centr. 73) to **light orange** (Centr. 52) in lactophenol. (Thick-walled but probably immature spores may be **grayish yellow**: Centr. 90.)

HABIT, HABITAT, AND DISTRIBUTION: Solitary or scattered, in clayey or sandy, often strongly alkaline soil: southwestern U.S.A. to the Bahamas and southward to Patagonia, Argentina.

COLLECTIONS STUDIED: ARGENTINA: A. R. Leal 23599, Mendoza, Ramblon, 15.II.1963. A. Maranta #28, ca. 15 km from Morillo, road to Mision Dos Baldes, Salta, Dept. Rivadavia. A. Maranta #55, Alto de la Sierra, Salta, Dept. Rivadavia (BAFC). Spegazzini II.1898, LPS 19244 (lectotype of *P. argentinus*), Carmen de Patagones, Salitral de Luro. Spegazzini II.1898, LPS 19246 (lectotype of *P. patagonicum*), Rio Negro, La Pantanosa (LPS). BAHAMA IS.: Grand Turk, North edge of town, 29.XI.1977, Correll 49229 (BPI). UNITED STATES: ARIZONA: W. H. Long 8236, 1 mi from Toltec, 9.XI.1938; TEXAS: W. H. Long 6195, Brownsville, XI.1916. W. H. Long 7738, Brownsville, VII.1918. W. H. Long s.n., Eagle Pass, 20.I.1933 (BPI).

² Names of colors in boldface type are from Kelly and Judd (1955). Color references in parentheses following these names consist of the Centroid designation (Kelly, 1965).



Podaxis longii McKnight, sp. nov.

FIGS. 8–12

Gastrocarpium stipitatum, 17–40(–45) cm altum. Pileus subglobosus vel ellipsoideus vel subcylindricus apice rotundato, (5–)12–16 × 5–8 cm. Peridium e stratis duobus formatum, interius teniter membranaceus, exterius fere albus initio viscidus demum in squamas findens. Columella percurrrens, durissima. Capillitium magis subrubro-brunneum. Stipes clavatus, 8–20(–25) × 1.5–3.5(–4) cm, pars subterraneus usque ad 8 cm longum; in longitudinem costatus vel sulcatus interdum grosse laceratus vel squarrosus, squamis tenicibus crassibus in parte inferiore; pagina gelatinosa ubi nova, dura ubi sicca. Sporae satis subrubro-brunneae, subglobosae vel ellipsoideae vel intermediae, parietibus crassis, (5.5–)6.1–8.8 × (4.4–)5–7.7 μm; poro germinationis non profundo, lato, ca. 1 μm diam, sterigmate in porum germinationis collapse. Gastrocarpia solitaria vel dispersa, in solo arenario.

Gastrocarp stipitate, 17–40(–45) cm tall, dry, indehiscent at maturity. Peridium 2-layered, subglobose to ellipsoid to subcylindric with rounded apex, (5–)12–16 × 5–8 cm; inner layer tough membranous, separating from stipe-columella only at maturity and then often splitting longitudinally, more or less fragile when fully dry; outer layer white or nearly so, viscid at first, eventually breaking into eggshell-like or coriaceous scales. Columella percurrent, tapering gradually from stipe apex to distal tip of peridium, very hard, covered with sparse to dense, **dark reddish brown** (Centr. 44) capillitium, spores, and glebal remnants.

Stipe clavate, sometimes tapering at base below ground to a stubby, rounded tip; 8–20(–25) × 1.5–3.5(–4) cm, subterranean portion up to 8 cm long; hard and more or less woody at maturity, longitudinally ribbed or grooved, sometimes coarsely lacerate or squarrose with tough, thick scales in lower part; surface gelatinous fresh, drying hard, corneous and shiny, **yellowish white** (Centr. 92), discoloring gray or brown; outer cortical region a thin zone of **dark reddish brown** (Centr. 44) to **grayish reddish brown** (Centr. 46), brittle tissue, inner cortex a broad zone of softer, more or less punky, **light grayish reddish brown** (Centr. 45) tissue surrounding a narrow, central hollow.

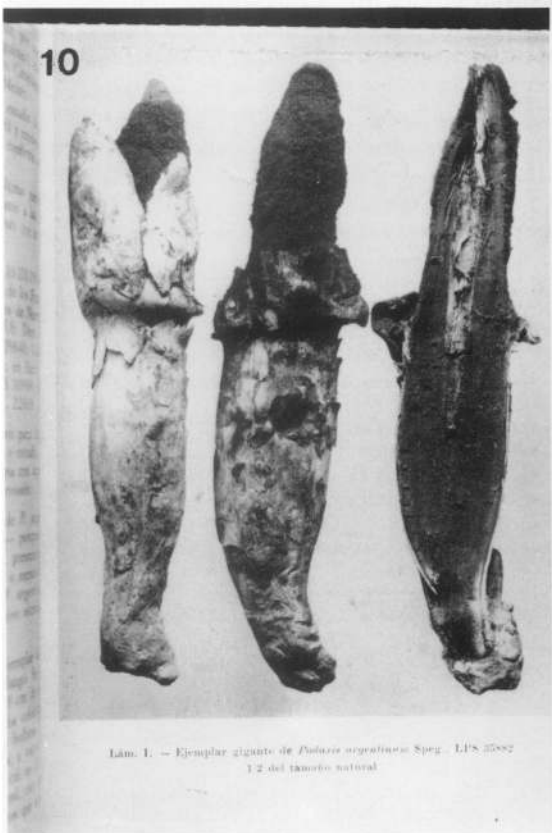
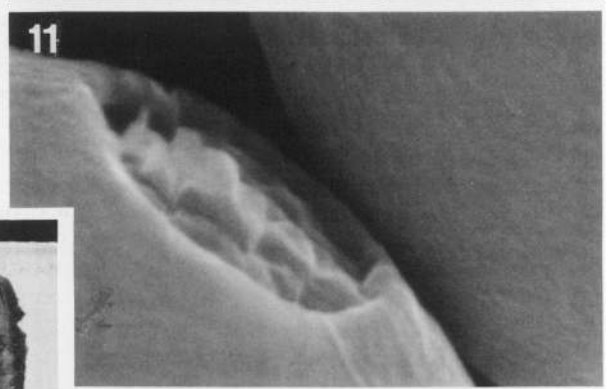
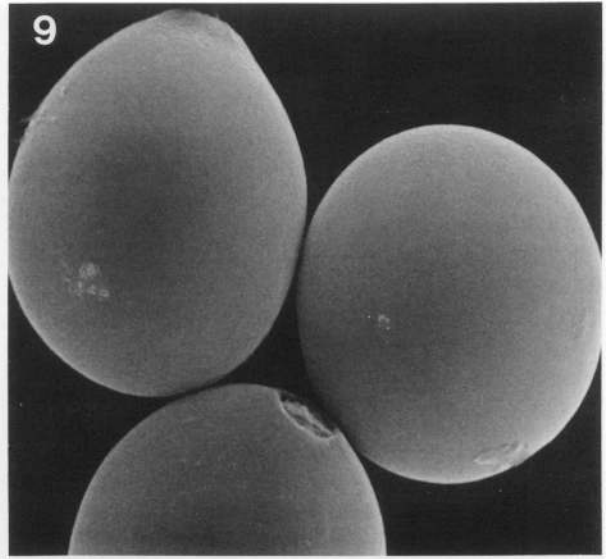
Gleba **dark brown** (Centr. 59). Spores (5.5–)6.1–8.8 × (4.4–)5–7.2(–7.7) μm, means 7.3 (s = 0.67) × 6.1 μm (s = 0.77), l/w 0.92–1.44, mean 1.20 (s = 0.12), germ pore shallow, broad, 0.9–1.1 μm across, sterigma collapsed in germ pore, rarely seen with highest magnification light microscopy; subglobose to broadly ellipsoid, thick-walled. Capillitium thick-walled, sparingly branched; **light orange** (Centr. 52) in lactophenol. Spores **moderate reddish brown** (Centr. 43) in lactophenol.

HABIT, HABITAT, AND DISTRIBUTION: Solitary or scattered on sandy soil, along roadsides or under "mesquite" and "giant cacti." Known only from southern Arizona and California, U.S.A., and Santiago del Estero, Argentina.

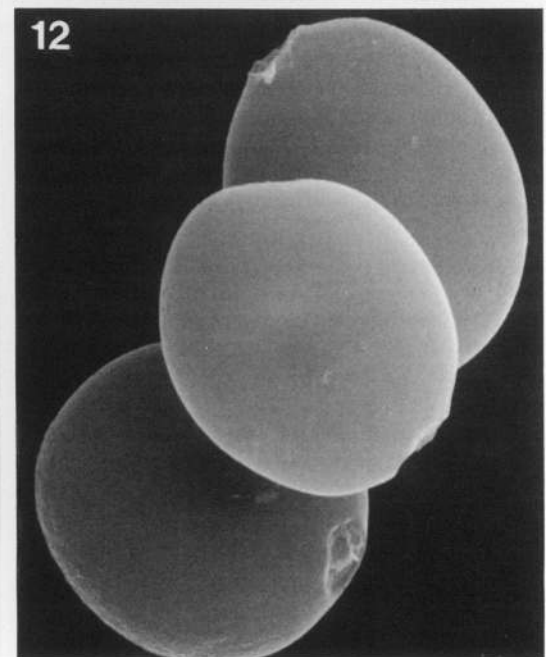
COLLECTIONS STUDIED: ARGENTINA: Roig, Diaz & Fischer, s.n., Santiago del Estero, 14.X.1968, Ex LPS 35882, LPS. UNITED STATES: ARIZONA: Gooding 11086, ca. 15 mi south of Ajo, 7.XII.1945. Griffiths s.n., near Tucson, 1900. W. H. Long 7622, 1 mi from Sabino Canyon, near Tucson, 20.II.1934. W. H. Long 7750, near Oracle, 9.XII.1919. W. H. Long 7860, 7 mi from Tucson, 24.XI.1933. W. H. Long 8068, Sabino Canyon Rd., near Tucson, 11.XI.1936. W. H. Long 8235, near Toltec, along Highway 84, 9.XI.1938, TYPE. P. Lightle 10052, Saguaro Nat. Monument, 22.XI.1941. W. H. Long, s.n., 4 mi from Sabino Canyon, near Tucson, 29.IX.1939. Lightle 11136, Saguaro Nat. Monument, V.1946. Lightle 11415, Saguaro Nat. Monument, 4 mi from Sabino Canyon; CALIFORNIA: O. F. Cook, Laguna Dam, 29.X.1911, BPI.

Most of the 11 collections of *P. longii* from the William H. Long herbarium (now at BPI) are annotated in Long's handwriting. From his notes it is obvious that he recognized them as different from *Podaxis pistillaris* (Pers.) Fr. The species

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FIGS. 1–7. *Podaxis argentinus*. 1. Dried herbarium specimen, ×½. 2–7. SEM of basidiospores. FIGS. 3, 5 × 15,000, 6 × 10,000, 7 × 8000.



Lám. 1. — Ejemplar gigante de *Polyporus argentinus* Speg., LPS 2582
12 del tamaño natural



is named for Long in recognition of his contribution. The label of his collection #7750 has the notation, "n. sp.?" Annotations by E. E. Morse and L. Bonar also in the specimen box bear the notes: "A very interesting variation of our plant to be noted here—," by Bonar, and "This is a 'small-spored race,' I think, as per C. Rea—," by Morse. Long's spore measurements are recorded on annotation slips for several collections and his notes refer repeatedly to the small spore size. He also described the large, white gastrocarp having thick stalk and gelatinous stalk surface with coarse scales. This combination of characters recorded by Long distinguishes the species, in combination with the comparatively broad germ pore in the outer spore wall traversed by the apiculus and the reddish brown color of spores in lactophenol.

***Podaxis microporus* McKnight, sp. nov.**

FIGS. 13–16

Gastrocarpium stipitatum, circa 18 cm altum. Peridium e stratis duobus formatum, teniter coriaceum, subflavo album, subcylindricum, apice rotundato, 6×1.8 – 2.3 cm, strato interiore longitudinaliter in maturitate findens, strato externo squamis irregularibus adhaerentibus formans. Columella conica, ex apice expanso stipitatis superne acute angustata.

Stipes subcylindricus, cavus, superne parum angustatus apicem versus acute expansus, mycelio basali cum arena et calculis parvis implicito itaque plus minusve pseudostipe radicans formans; pagina subflavo alba, irregulariter longitudinaliter costata et cum squamis dispersis similis certoni obsita. Gleba valide brunnea. Sporis 6.6 – 8.8×5.5 – $7.7 \mu\text{m}$, late ellipsoideis, laevibus, parietibus crassis, apiculo breve et poro germinationis angustissimo.

In terra sicca petrosa inter Larream sp.

Gastrocarp stipitate, about 18 cm tall, dry. Peridium 6×1.8 – 2.3 cm, tough coriaceous, subcylindric with rounded apex, **yellowish white** (Centr. 92); 2-layered; inner layer splitting longitudinally at maturity, outer layer forming irregular, adherent scales. Columella conical, tapered sharply upward from expanded stipe apex; sparsely clothed with capillitium remnants.

Stipe subcylindric, tapering slightly upward to sharply expanded apex, basal mycelium matted with sand and small pebbles to form a more or less rooting pseudostipe below, hollow; surface irregularly longitudinally ribbed and overlain with scattered, irregular, patch-like scales, **yellowish white** (Centr. 92); cortex thin, 1–2 mm under a very hard outer layer less than 1 mm thick, both yellowish white separated by a grayish brown line.

Gleba **strong brown** (Centr. 55). Spores 6.6 – 8.8×5.5 – $7.7 \mu\text{m}$, means 7.3 ($s = 0.57$) $\times 6.8$ ($s = 0.58$), $l/w = 1.08$, broadly ellipsoid, smooth, thick-walled with short apiculus seldom seen under highest magnification light microscopy and very narrow germ pore, **light orange yellow** (Centr. 70) to **light orange** (Centr. 52) in lactophenol. Capillitium thick-walled with rough surface, 3.5 – $4.5 \mu\text{m}$ in diam, **pale yellow** (Centr. 89) to **light orange** (Centr. 52) in lactophenol.

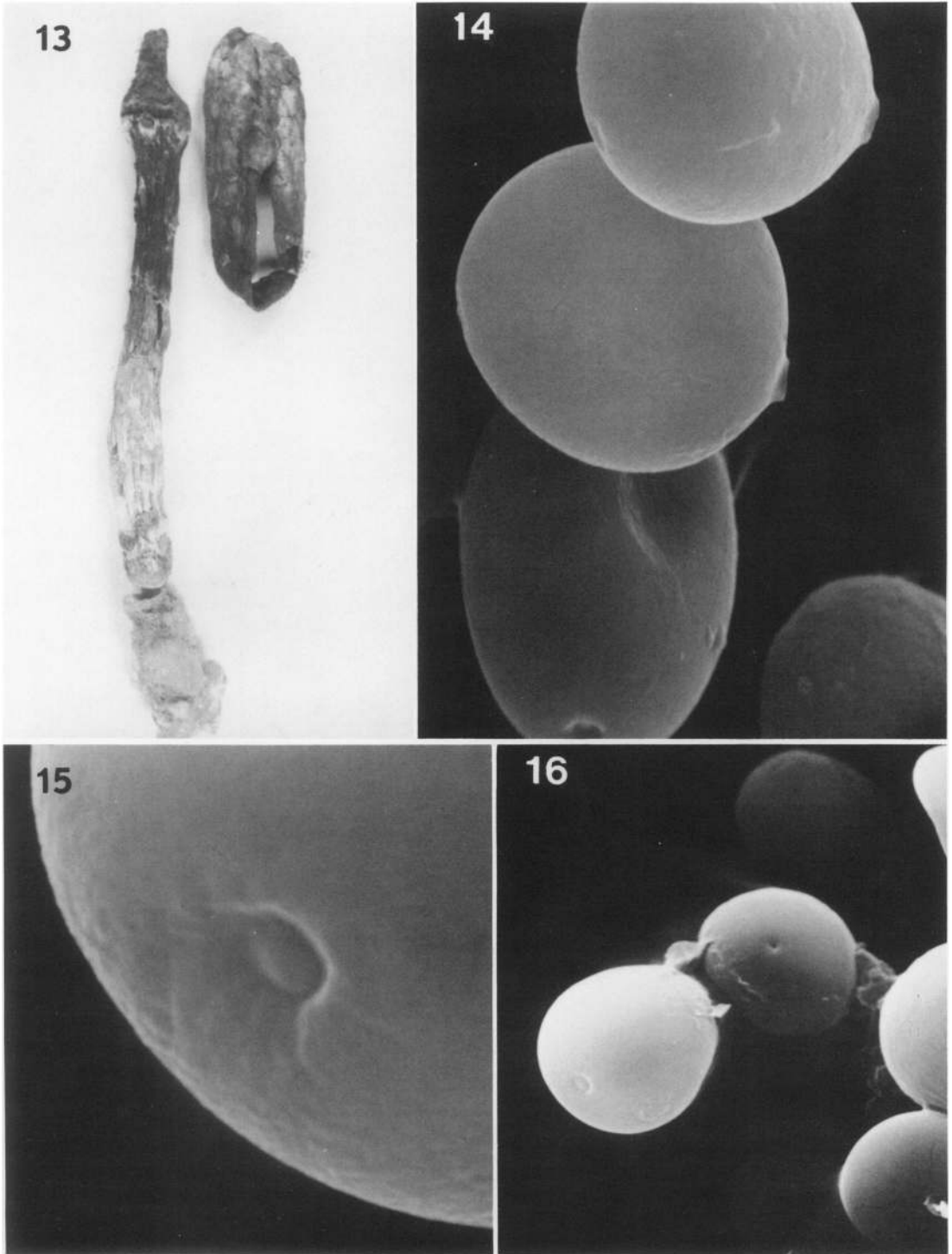
HABIT, HABITAT, AND DISTRIBUTION: U.S.A.: CALIFORNIA: on dry, rocky ground with scattered "creosote bushes (*Larrea* sp.)." Known only from a single collection at Mesquite Springs, Death Valley, Inyo Co.

COLLECTION STUDIED: A. E. Borell 12.V.1935, TYPE, BPI.

This specimen has the comparatively slender stature of *Podaxis argentinus* or *Podaxis pistillaris* (Pers.) Fr. but the orange-brown glebal color gives an immediate clue to its identity, and may be unique in *Podaxis*. It is important, however, to study its gleba in different stages of maturity. This was not possible with the single

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FIGS. 8–12. *Podaxis longii*. FIGS. 8 and 10 dried herbarium specimens. 8. Holotype. 10. LPS 35882 reproduced from Martinez (1971). 9, 11, 12. SEM of basidiospores. FIGS. 9, 12 *ca.* $\times 10,000$, 11 $\times 55,000$.



FIGS. 13–16. *Podaxis microporus*. 13. Dried herbarium specimen, holotype. 14–16. SEM of basidiospores. FIGS. 14 $\times 8000$, 15 $\times 25,000$, 16 $\times 5000$.

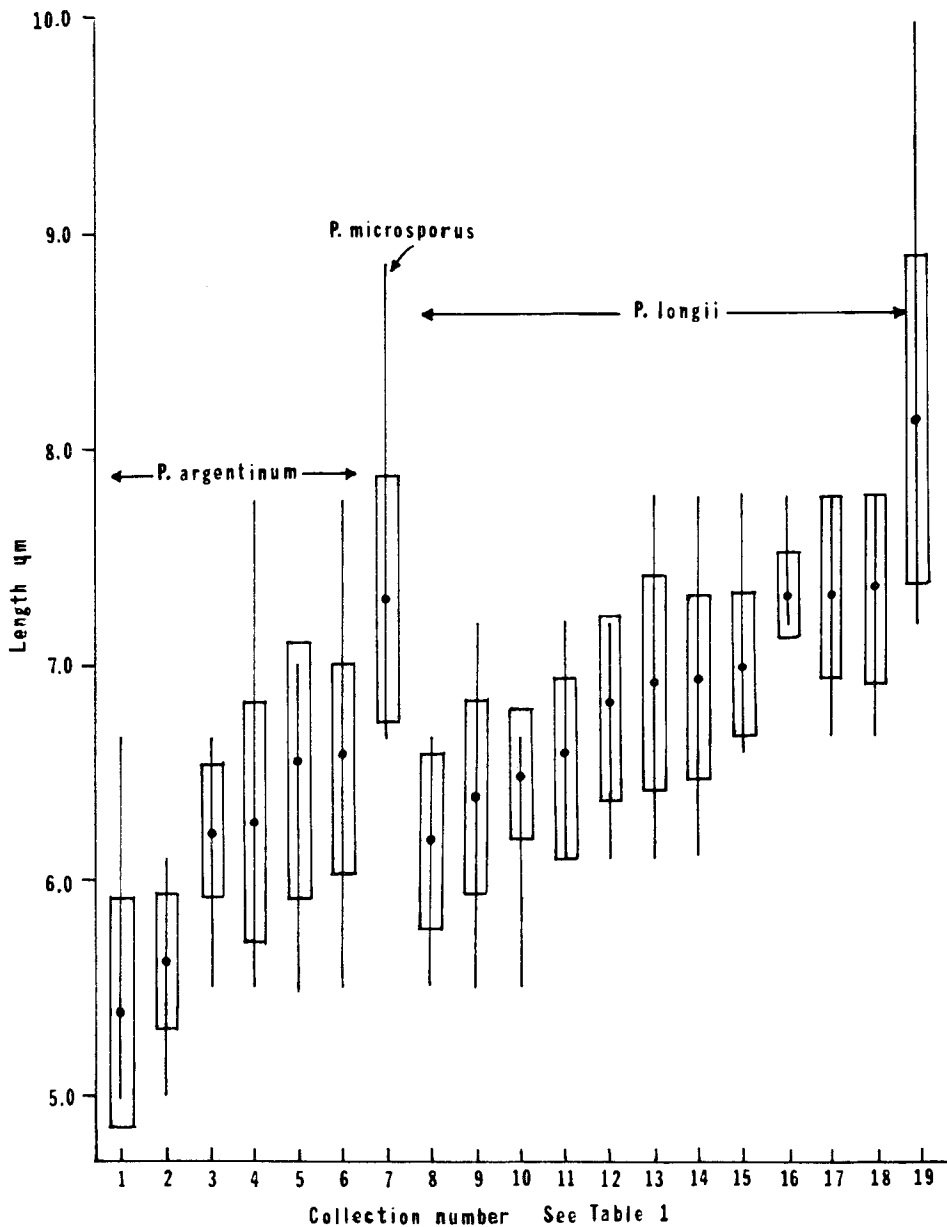


FIG. 17. Spore lengths of three species of *Podaxis*.

dried specimen available for study. [Another *Podaxis* collection from the same locality, made by J. VanCott in 1963 (F6343 BRY), has the large spores typical of *P. pistillaris*.] Small spore size places *P. microsporus* among the species of Sect. *Parvispora* where it was originally thought to be a form of *P. argentinum*. The scanning electron microscope revealed a very narrow germ pore opposite the apiculus on most of the spores, in contrast to the wider germ pore traversed by the apiculus in some spores of *P. argentinum* and in *P. longii*. Spores are shorter in relation to width ($l/w = 1.08$) than in the other two species.

DISCUSSION

Previous workers, and for a time Long, himself, regarded small spore size and unusual macromorphological characteristics as extremes in the natural range of variations to be found in *P. pistillaris*. Morse (1933, 1941) commented that Spegazzini's two small-spored species, *Podaxis argentinus* and *Podaxis patagonicus*, should probably be synonymized with *P. pistillaris*, but did not distinguish them from her invalidly published variety *paurospora* of *P. pistillaris*, although she used this name in citing Long's collection (Long 6884, BPI) from Texas. Martinez (1971) clearly established the validity of *Podaxis argentinus* Speg. as distinct from the collective species *P. pistillaris* sensu Morse on the basis of distinctive spore morphology including spore size. The distribution of *P. argentinus* indicated by the BPI collections was reviewed by McKnight and Stransky (1980).

Martinez (1971) concluded that the apiculus projects through the germ pore in *P. argentinus* in contrast to *P. pistillaris* which has a distal germ pore. He illustrated both conditions using spores from the type of *Podaxis macrosporus* Speg. as an example of the condition found in *P. pistillaris*. He described and illustrated a giant form (LPS 35882) whose slightly larger spores have the broad germ pore like that described here for *P. longii* but did not distinguish it as a separate taxon, regarding it as merely a robust form of *P. argentinus*. Martinez noted that similar robust variants had been described for *P. pistillaris* and that Spegazzini had described *P. patagonicus* as more robust than *P. argentinus*.

With *P. argentinus* so delimited, my attention was drawn to the large, shallow germ pore revealed by SEM in some small-spored specimens of *Podaxis*. A critical study of the available collections shows a definite correlation of the characters referred to in Long's notes cited above with the broad germ pore and reddish glebal colors in lactophenol. These collections are placed in the new species, *P. longii*. Martinez (1971) reported an "ejemplar gigante de S. del Estero" (FIG. 10), as a robust form of *P. argentinus*. Although his photograph does not show the characteristic coarse longitudinal ribs on the stipe, other characters indicate that it also belongs in *P. longii*, establishing a distribution for the species from Arizona and southeastern California to Argentina. No doubt a critical examination of collections from localities intermediate or peripheral to those now known will fill gaps in this disjunct distribution.

Spores of all collections studied appeared smooth under SEM at magnifications below $\times 10,000$. A very slight rugulosity was seen only at magnifications two or more times this (FIGS. 11, 15). No spores were seen with a rodlet structure as reported by Bronchart and Demoulin (1971) for *Podaxis pistillaris* on spores prepared by a freeze-etch technique.

In the small-spored species the apiculus and germ pore of *P. microporus* as seen by SEM is most like that of *P. pistillaris*. Typically, the apiculus appears as a thick, tubular collar which may be quite long in occasional spores. On other spores the tubular collar which is continuous with the outer spore wall is very short or not evident (FIG. 14). Presumably this represents the gastromycetous pedicel derived from or contiguous with the sterigma (Perreau, 1977). A narrow, cicatrate germ pore is seen at the distal end of the spore. It may be eccentric and, depending on orientation of the spore, both apiculus and germ pore are sometimes seen simultaneously on the same spore under SEM. The depressed pore with central, rounded surface bowing slightly outward conforms to the expected shape on spores subjected to high vacuum during preparation (Meléndez-Howell, 1967). Some spores of *P. microspora* have an even narrower distal "pin prick" pore structure (FIG. 16). These are possibly non-functional, in which case germination could be through the pedicel as suggested by Martinez (1971) for *P. argentinus*.

TABLE I
SPORE MEASUREMENT DATA FOR THREE SPECIES OF *Podaxis* SECT. *Parvispora*

| Collection | Length μm | \bar{x} | s | $\bar{x} - s$ | $\bar{x} + s$ | Width μm | \bar{x} | s | l/w |
|---------------------------|----------------------|----------------|-----|---------------|---------------|---------------------|----------------|-----|------|
| <i>Podaxis argentinus</i> | | | | | | | | | |
| 1 Correll 49229 | 5.0-6.6 | 5.38 | .53 | 4.85 | 5.91 | 3.98-5.50 | 4.23 | .41 | 1.27 |
| 2 LPS 19244 TYPE | 5.0-6.1 | 5.63 | .32 | 5.31 | 5.95 | 4.40-5.50 | 4.93 | .44 | 1.15 |
| 3 Long 7738 | 5.5-6.6 | 6.23 | .31 | 5.92 | 6.54 | 4.40-5.50 | 5.06 | .27 | 1.23 |
| 4 Long, 20.I.1933 | 5.5-7.7 | 6.29 | .57 | 5.72 | 6.82 | 4.40-6.10 | 4.88 | .48 | 1.29 |
| 5 LPS 19246 | 5.5-7.0 | 6.51 | .60 | 5.91 | 7.11 | 5.00-5.50 | 5.30 | .25 | 1.23 |
| 6 Long 6195 | 5.5-7.7 | 6.54 | .51 | 6.03 | 7.05 | 4.40-6.60 | 5.28 | .63 | 1.25 |
| | ave. \bar{x} : | 6.10 \pm .48 | | | | ave. \bar{x} : | 4.95 \pm .39 | | |
| <i>Podaxis microporus</i> | | | | | | | | | |
| 7 Borell 12.V.1935 | 6.6-8.8 | 7.30 | .57 | 6.73 | 7.87 | 5.5-7.7 | 6.38 | .58 | 1.19 |
| <i>Podaxis longii</i> | | | | | | | | | |
| 8 Long 7622 | 5.5-6.6 | 6.18 | .41 | 5.77 | 6.59 | 4.4-5.5 | 5.05 | .33 | 1.22 |
| 9 Lightle 11136 | 5.5-7.2 | 6.39 | .45 | 5.94 | 6.84 | 4.4-5.5 | 5.13 | .31 | 1.25 |
| 10 Long 29.IX.1939 | 5.5-6.6 | 6.49 | .30 | 6.19 | 6.79 | 5.0-6.1 | 5.51 | .21 | 1.18 |
| 11 Long 7750 | 6.1-7.2 | 6.52 | .42 | 6.10 | 6.94 | 5.0-5.5 | 5.43 | .18 | 1.20 |
| 12 Gooding 11086 | 6.1-7.2 | 6.82 | .46 | 6.36 | 7.28 | 5.5-7.2 | 6.00 | .52 | 1.14 |
| 13 LPS 35882 | 6.1-7.7 | 6.91 | .50 | 6.41 | 7.41 | 5.5-6.1 | 5.62 | .25 | 1.23 |
| 14 Griffiths 1900 | 6.1-7.7 | 6.94 | .38 | 6.56 | 7.32 | 5.0-5.5 | 5.31 | .25 | 1.31 |
| 15 Lightle 10052 | 6.6-7.7 | 6.99 | .36 | 6.63 | 7.35 | 6.1-8.3 | 6.92 | .36 | 1.18 |
| 16 Long 8068 | 7.2-7.7 | 7.30 | .22 | 7.11 | 7.52 | 5.5-7.2 | 6.20 | .62 | 1.18 |
| 17 Long 7860 | 6.6-7.7 | 7.32 | .38 | 6.94 | 7.70 | 5.0-6.1 | 5.47 | .25 | 1.34 |
| 18 Lightle 11415 | 6.6-7.7 | 7.35 | .44 | 6.91 | 7.79 | 5.5-6.6 | 6.00 | .41 | 1.23 |
| 19 Long 8235 | 7.2-9.9 | 8.13 | .75 | 7.38 | 8.88 | 6.1-8.3 | 6.92 | .65 | 1.18 |
| | ave. \bar{x} : | 6.95 \pm .53 | | | | ave. \bar{x} : | 5.82 \pm .62 | | |

Spores of *P. longii* have a very broad, shallow, rimless germ pore and lack any sign of sterigmal appendage or apiculus at the opposite end (FIGS. 9, 11, 12), which contrasts with the narrow germ pore and generally well-developed apiculus on spores of *P. microporus*. The central surface of the germ pore on spores of *P. longii* is folded, wrinkled, or lobed in a manner suggesting a collapsed thinner layer of the wall in contrast with the convex central "plug" seen on spores of *P. microporus* (FIG. 15) and sometimes on the larger spores of such species as *P. pistillaris*. Contrary to the conclusion of Martinez (1971), who studied spores from the same collection from S. del Estero in Argentina (LPS 35882) without the benefit of SEM, there are differences in spores of the very robust specimens described here as *P. longii* and those of *P. argentinus*. Spores of *P. argentinus* almost always have some form of apicular structure evident under SEM but not always seen with light microscopy. The apiculus may be a very low, slightly upturned rim (FIG. 2) or a longer, thick-walled tubular projection contiguous with at least the outer spore wall (FIGS. 3, 5). In some spores it appears that a partially collapsed or folded thinner wall projects from the interior of the apiculus (FIG. 7). In other spores there may be a depression around the apiculus which could represent the germ pore described by Martinez (1971). The margin of the depression may be smooth as previously shown (McKnight and Stransky, 1980) or it may have an irregularly lobed margin (FIG. 4). Some preparations of critical-point-dried spores from the type collection show a broad, round, central or eccentric distal structure which may represent at least a rudimentary germ pore similar in diameter to the germ pore of *P. longii* spores (FIG. 2). This has not been seen on any of the spores from North American collections referred to *P. argentinus* and was missed on spores of the type collection not critical-point-dried in preparation for SEM reported earlier (McKnight and Stransky, 1980).



FIG. 18. Distribution of three American species of *Podaxis*.

Scanning electron micrographs and analysis of spore measurement data confirm the impressive range of variation in spore size and shape noted earlier for *P. argentinus* by Martinez (1971) and seen readily with high power light microscopy. FIGURE 17 and TABLE I present information from an analysis of spore measurement data for the 22 collections of *Podaxis* studied. Spore length ranges are plotted with means and ± 1 standard deviation. Although the single collection of *P. microporus* is less than desired for a most meaningful comparison, it can be seen that the spores of *P. argentinus* are on the average significantly shorter than those of the other two species.

The collections of *Podaxis argentinus* studied show a wide distribution from southern U.S.A. through South America (FIG. 18). *Podaxis longii* is known from one locality in Argentina and several localities from south central Arizona and southeastern California in the U.S.A. These range from the Saguaro National Monument near Tucson, north to Oracle and Toltec and west to Ajo, Arizona, and the California side of the Colorado River at Laguna Dam, near the Mexican border in California. It should be expected more widely in tropical or subtropical desert regions. The single collection of *P. microporus* from the vicinity of Mesquite

Springs in Death Valley, California, could lead to some erroneous conjecture unless one realizes that this locality in the Cottonwood Hills of the Panamint Range has an elevation of 2000 ft. There is no reason to assume that the species is necessarily endemic to Death Valley. It is noteworthy, however, that none of the small-spored species has been reported from localities outside the two American continents and the Caribbean Archipelago.

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LITERATURE CITED

- Bronchart, R., and V. Demoulin.** 1971. Ultrastructure de la paroi des basidiospores de *Lycoperdon* et le *Scleroderma* (Gastéromycètes) comparée à celle de quelques autres spores de champignons. *Protoplasma* **72**: 179–189.
- Kelly, K. L.** 1965. *ISCC-NBS color name charts illustrated with centroid colors*. Standard Sample #2106 Suppl. to Nat. Bur. Standards Circ. 553. U.S. Government Printing Office, Washington, D.C.
- , and **D. B. Judd.** 1955. *The ISCC-NBS method of designating colors and a dictionary of color names*. Nat. Bur. Standards Circ. 553. U.S. Government Printing Office, Washington, D.C. 158 p.
- Martinez, A.** 1971. Notas sobre el género *Podaxis* (Gasteromycetes) en Argentina. *Bol. Soc. Argent. Bot.* **15**: 73–87.
- McKnight, K. H., and M. Stransky.** 1980. Notes on *Podaxis argentinum* from North America. *Mycologia* **72**: 195–199.
- Meléndez-Howell, L. M.** 1967. Recherches sur le pore germanitif des basidiospores. *Ann. Sci. Nat. Bot.* (Sér. 12) **8**: 487–638.
- Morse, E.** 1933. A study of the genus *Podaxis*. *Mycologia* **25**: 1–33.
- . 1941. *Podaxis pistillaris*. II. *Mycologia* **33**: 609–610.
- Perreau, J.** 1977. A propos de l'appendice hilare des basidiospores: organisation de la partie proximale sporique chez quelques Gastéromycètes. *Rev. Mycol.* **41**: 363–379.
- Spegazzini, C.** 1898. Fungi Argentini novi vel critici. *Anales Mus. Nac. Hist. Nat. Buenos Aires* **6**: 6–365.

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