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MICROMORPHOLOGICAL CHARACTERS SUPPORTING THE REMOVAL OF *SENECIO* SERIES OTOPTERI FROM *SENECIO* (ASTERACEAE, SENECIONEAE)

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Abstract. Riva, A.; R. Pozner & S. E. Freire. 2009. Micromorphological characters supporting the removal of *Senecio* series Otopteri from *Senecio* (Asteraceae, Senecioneae). *Darwiniana* 47(2): 327-334.

Recent molecular studies suggest that *Senecio otites* belonging to *Senecio* sect. Senecio ser. Otopteri should be removed from *Senecio* so that this large and taxonomically complicated genus would be monophyletic. In order to evaluate the taxonomic position of *Senecio otites* and the placement of series Otopteri, 13 species belonging to Senecio sect. *Senecio* ser. Otopteri, including *S. otites*, were examined for micro-morphological characters of the style branches (stigmatic surface, style-arm apices) and anthers (filament collar, anther bases, anther appendages). Three states of these micromorphological characters were present in nearly all species of Senecio sect. *Senecio* ser. Otopteri: 1) the style-arms are apically convex or subconvex, papillate, and surrounded by a crown of hairs of different lengths; 2) the stigmatic surfaces have a cleft configuration (banded to cleft in *S. attenuatus*); and 3) the anthers are auriculate. These results provide new morphological support for the placement of *Senecio otites* in *Senecio* sect. Senecio ser. Otopteri and the future removal of that series from *Senecio* proper.

Keywords. Asteraceae, Compositae, micro-morphology, section Otites, *Senecio*, series *Otopteri*, South America.

Resumen. Riva, A.; R. Pozner & S. E. Freire. 2009. Caracteres micromorfológicos que apoyan la segregación de *Senecio* serie Otopteri de *Senecio* (Asteraceae, Senecioneae). *Darwiniana* 47(2): 327-334.

Estudios moleculares recientes sugieren que *Senecio* sect. Senecio ser. Otopteri debería ser removido de *Senecio* para que este género extenso y taxonómicamente complicado sea monofilético. Con el propósito de evaluar la posición taxonómica de *Senecio otites* y la ubicación de la serie Otopteri, 13 especies, incluyendo *S. otites*, fueron examinadas en cuanto a los caracteres micromorfológicos de las ramas estigmáticas (superficie estigmática, ápice de las ramas estigmáticas) y de las anteras (collar del filamento, base de las anteras, apéndice de las anteras). Tres estados de estos caracteres micromorfológicos están presentes en todas las especies estudiadas de Senecio sect. *Senecio* ser. Otopteri: 1) ramas estilares apicalmente convexas o subconvexas, papilosas, rodeadas por una corona de pelos de distinta longitud; 2) superficies estigmáticas de configuración hendida (bandeada a hendida en *S. attenuatus*); y 3) anteras auriculadas. Estos resultados proveen apoyo morfológico nuevo para la ubicación de *Senecio otites* en *Senecio* sect. Senecio ser. Otopteri y la futura remoción de esta serie de *Senecio* L.

Palabras clave. Asteraceae, Compositae, micro-morfología, sección Otites, *Senecio*, serie *Otopteri*, Sudamérica.

INTRODUCTION

Senecio L. s.l. is one of the largest genera of Asteraceae (Compositae) with ca. 3000 species. It is highly diverse in the mountainous areas and deserts of the Americas, Africa, and Asia, whereas it is poorly represented in the wet tropics (Cabrera, 1949, 1957; Jeffrey et al., 1977). The

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variable generic and sectional concepts applied by different authors to *Senecio* have long been recognized as a major taxonomic problem in the genus. In the past, some authors (e.g. Bentham & Hooker, 1873; Hoffmann, 1894) tried to give the genus an expanded concept, even including within it the genera *Gynoxys* Cass. and *Emilia* (Cass.) Cass., respectively. More recently, several authors removed numerous species from *Senecio*, and placed them in new genera, or raised to generic rank taxa previously recognized at the sectional level within *Senecio* (Robinson & Brettell, 1973a, 1973b, 1973c; Robinson, 1974; Nordenstam, 1978; Jeffrey & Chen, 1984; Jeffrey, 1986, 1992). Most of the new taxa were established based on micromorphological characters, such as the configuration of the endothecial cells in the filament collar of the anther, the distribution of the stigmatic area on the style branches, the presence of calcium oxalate crystals in the ovary, and the cellular structure of the carpopodium (Wetter, 1983; Vincent, 1996). As circumscribed by Nordenstam (2007) the genus *Senecio* s.str. includes about 1250 species of cosmopolitan distribution; it was distinguished principally by its truncate, penicillate stylar tips, separated stigmatic lines, and the obtuse or rounded anther base with a balusterform filament collar.

On the basis of molecular studies, Pelser et al. (2007) proposed a new monophyletic delimitation of *Senecio* containing ca. 1000 species. In this new delimitation, six genera previously excluded from *Senecio* are now included in the generic concept of *Senecio*, and eight species assemblages formerly placed in *Senecio* s.l. are removed from *Senecio*. There is a need to examine the morphology of each of the taxa involved in these changes to determine if they can be supported by data other than those generated by the molecular studies. One of these groups is the South American Senecio section *Senecio* series Otopteri (including Senecio section *Otites* Cabrera (Cabrera, 1949; Jeffrey, 1992). When Cabrera originally described this section he recognized only one species, *Senecio otites* Kuntze ex DC., which was restricted to Chile (Cabrera 1949). Later, Cabrera (1985) submerged his section *Otites* into Senecio section Otopteri (Cabrera) Cabrera (1939), because of its petiolate leaves and auriculate petiole, and placed the group at serial rank, i.e. Senecio sect. *Senecio* ser. *Otopteri* (Cabrera) Cabrera (1985). It then contained 14 South American species: *Senecio attenuatus* Sch. Bip. ex Rusby, *S. bangii* Rusby, *S. belenensis* Griseb., *S. deferens* Griseb., *S. herrerae* Cabrera, *S. kosterae* Cabrera, *S. lorentzii* Griseb., *S. otites* Kuntze ex DC., *S. otopterus* Griseb., *S. pensilis* Greenm., *S. pseudotites* Griseb., *S. sepium* Sch. Bip. ex Rusby, *S. sinapoides* Rusby, and *S. tucumanensis* Cabrera (Cabrera et al., 1999). This group was defined as being perennial and leafy stemmed plants, leaves petiolate with petiole basally auriculate or decurrent and limb ovate-lanceolate or deltoid, usually 2-9 cm long, capitula usually radiate and several, arranged in corymbose synflorescence, anthers basally obtuse, and style branches apically truncate with short sweeping hairs (Cabrera 1985, Cabrera et al. 1999).

The objective of this study was to test the results of the Pelser et al. molecular phylogenetic study of tribe *Senecio*neae (2007) in which they suggested that *Senecio otites* and its closest relatives are too distantly related to *Senecio* s. str. to remain included in this genus. By examining in detail some micro-morphological characters of the style branches (stigmatic surface, style-arm apices) and anthers (filament collar, anther bases, anther appendages) we wanted to determine whether or not *Senecio* series *Otopteri* could be supported as a distinct genus based on morphology.

MATERIALS AND METHODS

Taxa

The study was based on herbarium material from SI and LP. All species of series Otopteri were included in the analysis, except *S. tucumanensis*; no herbarium material was located for this taxon. In order to examine the taxonomic value of the characters, specimens of the type species of *Senecio*, *S. vulgaris* L., were included in the present study. A list of examined specimens is provided in Appendix 1.

Light Microscopy

Mature, fully developed disc florets (al least 3 florets per specimen) were selected for analy-

sis. Herbarium samples were rehydrated in warm soapy water and fixed in FAA. Anthers and styles were dissected, clarified with diluted chlorine, and stained with basic fucsin. Observations were done with LM (Light Microscope) Nikon Microphot-FXA, equipped with a photographic camera.

Scanning Electron Microscopy

Observations with SEM (scanning electron microscopy) were done on herbarium material. Samples were rehydrated with warm soapy water and fixed with FAA. Disc florets were dehydrated in a graded series of ethanol and critical-point-dried (BAL-TEC CPD 030) with liquid CO_2. Dried samples were partially dissected, mounted on stubs, sputter-coated with gold/palladium (Termo VG Scientific SC 7620) and observed with SEM (PHILIPS XL30 TMP New Look).

RESULTS AND DISCUSSION

Style-Arm Apices

In all species of ser. Otopteri the style-arms are apically convex or subconvex, papillate, surrounded by a crown of hairs that differ in length. The hairs can be rather short and few as in *Senecio bangii* (Fig. 1A) or more commonly long and many in the remaining species (Fig. 1B-E). The outer surfaces of the style-arms may be minutely papillate to papillate in the distal half (Fig. 1A). *Senecio vulgaris*, the type species of *Senecio*, has typically truncate stylar tips with only a few hairs that are different in length, and outer surfaces glabrous (Fig. 1F). The fundamental importance of the shape of the style branches in the taxonomy of *Senecio* has long been recognized. For instance, many species with aberrant stylar branches, were removed from *Senecio* [e.g. *Pseudogynoxys* (Greenm.) Cabrera, *Paragynoxys* (Cuatrec.) Cuatrec.]. However, molecular studies of Pelser et al. (2007), indicate that taxa without precisely penicillate style tips, should be transferred to *Senecio* (e.g. *Aetheolaena* Cass., *Iocenes* B. Nord.).

Stigmatic Surface of the Style Branches

Some authors (e.g. Robinson & Brettell, 1973c; Nordenstam, 1977; Jeffrey et al., 1977) have found the extension of the stigmatic area on the style branch to be a useful diagnostic character, e.g., the bands are fused in “Cacalioid” Senecioneae and discrete or separate in non “Cacalioid” Senecioneae. In all except one species of series Otopteri examined in this study the stigmatic surface has a narrow, longitudinal, medial cleft running the length of the style branches, without any apparent morphological distinction between the cells of the ridges and those in the cleft (Fig. 1A-C). Wetter (1983) used the term “cleft” for this configuration. The exception is *Senecio attenuatus* as its stigmatic surface presents a noticeable morphological distinction between the cells of the groove and those of the bands at the terminal half of the style branch (Fig. E). This type of stigmatic surface represents an intermediate state between the cleft configuration and the one referred as “banded” by Wetter (1983). In the banded configuration the different morphology of the groove cells is appreciable all the long of the style branch since the bands look more separated. The typical banded form is present in *S. vulgaris* (Wetter, 1983). Consequently, the absence of clearly banded stigmatic surface supports the removal of species of series Otopteri from Senecio.

Filament Collar

The filament collars (Koyama, 1967; Drury, 1973; Nordenstam, 1978) or anther collars (Robinson & Brettell, 1973d; Jeffrey et al., 1977) have also been used to separate "Cacalioid" Senecioneae from "non Cacalioid" Senecioneae, having a "balusterfom" collar and "cylindrical" collar, respectively. All but two members of series Otopteri and *Senecio vulgaris* have an elongated filament collar that is dilated or somewhat dilated towards the base, and broader than the filament (Fig. 2C-F). This type of filament collar was called "balusterform" by Drury (1973) and its occurance supports a relationship with *Senecio*. Only *Senecio kosterae* and *S. bangii*, have filament collars that are very elongated and uniformly thick with some cells slightly thicker than the filament (Fig. 2A, B); this condition is similar to the "cylindrical" filament collar described by Drury

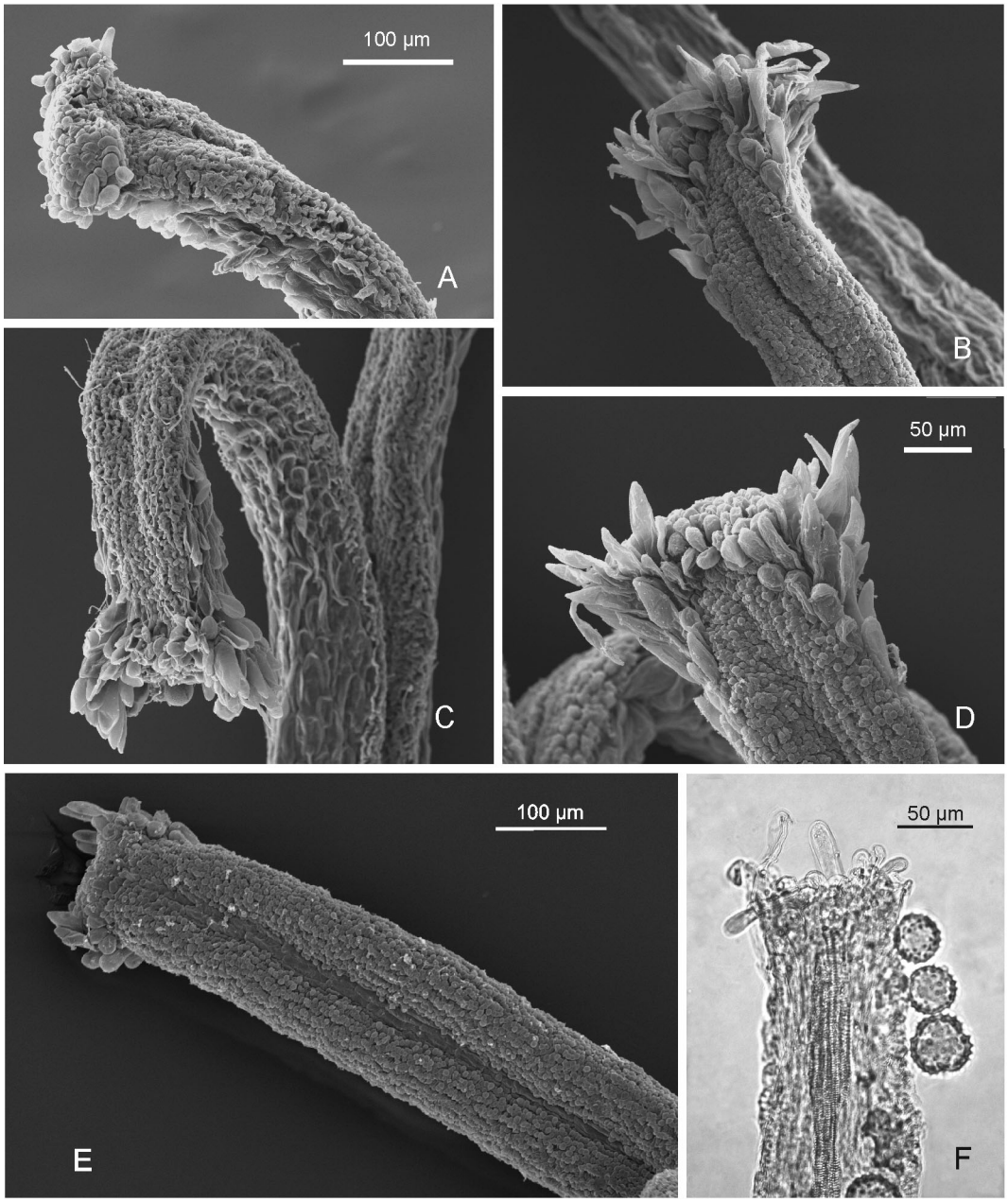

Fig. 1. Style branches (**A-D,** SEM; **E-G,** LM): **A-D,** Cleft stigmatic configuration. **A,** *S. bangii*. Style-arm showing subconvex apex surrounded by a crown of short and few hairs and outer surface papillate. **B-D,** Style-arm apex subconvex surrounded by a crown of many and differently long hairs. **B, D,** *S. otites*. **C,** *S. otopterus*. **E,** *S. attenuatus*, banded stigmatic configuration at the tip with basal cleft, style-arm apex subconvex, surrounded by a crown of many and differently long hairs. **F,** *S. vulgaris*. Style-arm showing truncate apex with few hairs, and outer surface glabrous.

(l.c.). Therefore, "cylindrical" filament collars distinguish *Senecio bangii* and *S. kosterae* from the remaining species of ser. Otopteri and *S. vulgaris*.

Recently, Nordenstam et al. (2009) included *Senecio bangii* in a new genus segregated from *Senecio*, *Lomanthus* B. Nord. & Pelser. According

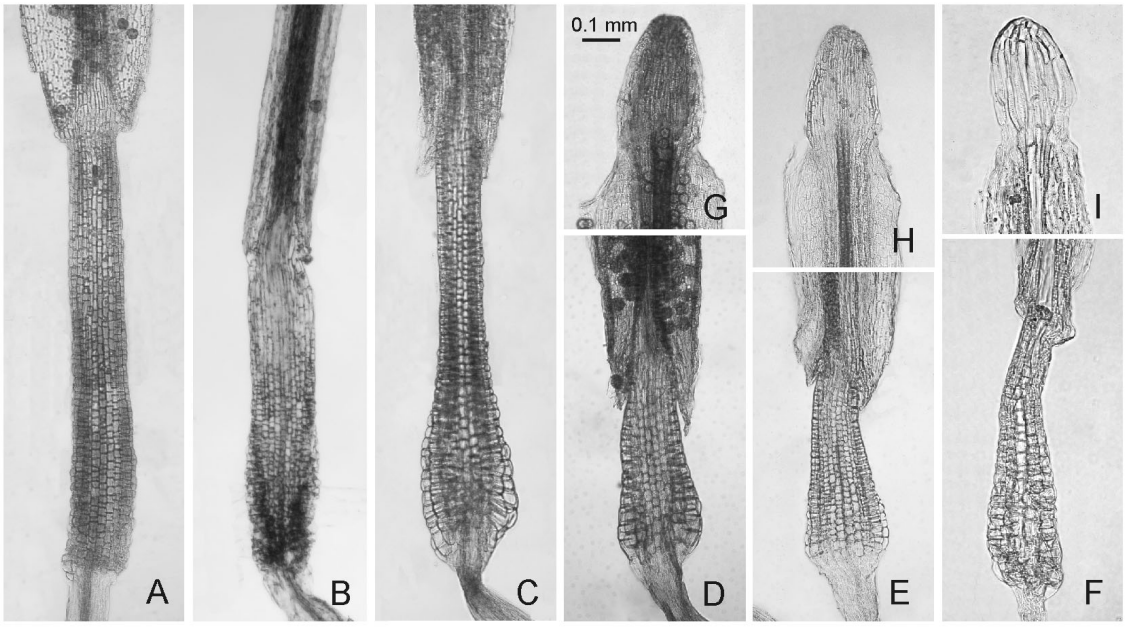

Fig. 2. Anthers (LM): **A-F,** Anther collars and anther bases. **A, B,** Cylindrical collar. **C-F,** Balusterform collar. **A-E,** Auriculate bases. **F,** Obtuse or rounded bases. **A,** *S. kosterae* **B,** *S. bangii*. **C,** *S. attenuatus*. **D,** *S. otites*. **E,** *S. deferens*. **F,** *S. vulgaris*. **G-I,** Anther appendages narrower than the anther apex.**G,** *S. otopterus*. **H,** *S. deferens*. **I,** *S. vulgaris*.

to these authors, *Lomanthus* has filament collars that are elongate-balusterform with larger basal cells. Our study shows that *Senecio bangii* has an elongate-cylindrical and uniformly thick (not balusterform) filament collar.

Anther Bases

Obtuse or rounded anther bases (ecaudate anthers), are features of *Senecio* s.str. that occasionally occur in other Senecioid genera (e.g., *Dendrophorbium* Cuatrec.). Our results confirm that ecaudate anthers are present in *S. vulgaris* (Fig. 2F). However, all species of series Otopteri examined in this study have auriculate anthers (Fig. 2A-E), which separate them from *Senecio*. *Graphystilis* B. Nord., one of the sister genera of *S. otites* in the molecular cladogram (Pelser et al., 2007), also has auriculate anthers showing a close relationship to series *Otopteri*. However, there are exceptions, for instance *S. deferens* Griseb. (Fig.2 E) appears within *Senecio* s.str. in Pelser et al. (2007), even having auriculate anthers (vs. obtuse or rounded anthers in *Senecio* s. str.).

Anther Appendages

Jeffrey (1980) mentioned the taxonomic value of the shape of the anther apical appendages but it has not been emphasized by many other authors. All species of series Otopteri examined in this study and *Senecio vulgaris* have anther appendages that are more narrow than the anther apex (Fig. 2G-I) linking this series with Senecio.

CONCLUSIONS

According to the present study, the segregation of series Otopteri from *Senecio* seems justified by the concurrence of the following micromorphological characters: (1) style-arms that are apically convex or subconvex, papillate or minutely papillate, surrounded by a crown of hairs that are different in length; (2) members of the group usually with a cleft configuration of the stigmatic surface; and (3) auriculate anthers present in all of the group. These results suggest two possible future taxonomic and nomenclatural changes: 1) removal of series Otopteri from *Senecio* s. str., and 2), its recognition as a

distinct genus. However, neither of these changes are presently advisable until more morphological and molecular data are available for more species of *Senecio* s. lat. and those already analized.

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Appendix I. Studied specimens of *Senecio* sect. Senecio ser. Otopteri (Cabrera) Cabrera.

Species	Locality	Collector	Herbarium
S. attenuatus	BOLIVIA: Dept. La Paz, Prov. Murillo, La Paz 5 km NNE, Quebrada Minasa	Beck 4340	SI
	BOLIVIA: Dept. La Paz, Prov. Murillo, La Paz, Calacoto	Beck 8405	SI
	BOLIVIA: Dept. La Paz, Prov. Murillo, Pie de la Muela del Diablo (ca. La Paz)	Liberman 25	SI

Appendix I. (Continuation).

Species	Locality	Collector	Herbarium
S. bangii	BOLIVIA: Dept. La Paz, Prov. Murillo, La Paz 22 km down the river, Mecapaca	Beck 3627	SI
	BOLIVIA: Dept. La Paz, Prov. Murillo, La Paz 2 km E (below) Mecapaca. 16º 40' S, 68º 01' W	Solomón 7403	SI
S. belenensis	ARGENTINA: Prov. Catamarca, Vayas altas near Belén (type)	Lorentz 612	LP
S. deferens	ARGENTINA: Dept. Paclin, Cuesta de la Viña	Cabrera et al. 34074	SI
	ARGENTINA: Prov. Catamarca, Dept. Andalgalá, 4 km N of Andalgalá, along the river	Cantino 442	SI
	ARGENTINA: Prov. Tucumán, Dept. Trancas, 5 km E of San Pedro de Colalao	Xifreda 1051	SI
S. herrerae	PERÚ: Dept. Puno, Prov. Azángaro, Salinas, between Arapa and Azángaro	Aguilar 138	SI
	PERÚ: Cuzco	Herrera 25	SI
	BOLIVIA: Dept. La Paz, Prov. Manco Kapac, Lago Titicaca, Isla Jochihuata	Liberman 1250	SI
S. kosterae	BOLIVIA: Dept. Cochabamba, between Uyati and Totora (type)	Herzog 2040	LP
S. lorenzii	ARGENTINA: Prov. Catamarca, Dept. Andalgalá, La Ollada	Jörgensen 1373	SI
	ARGENTINA: Prov. Jujuy, Valle Grande, between Alto Calilegua and Cerro Amarillo	Kiesling 1492	SI
	ARGENTINA: Prov. Tucumán, Tafí, Río Blanco	Lillo 7567	SI
S. otites	ARGENTINA: Prov. Neuquén, Parque Nacional Lanín, L. Verde (L. Curruhé)	Eskuche 0196	SI
	ARGENTINA: Prov. Neuquén, Lago Correntoso	Gentili 435	SI
	CHILE: Reg. Los Lagos, Prov. Llanquihue, Puerto Varas	Hicken 181	SI
S. otopterus	ARGENTINA: Prov. Jujuy, Dept. Santa Bárbara, S of El Fuerte, Finca Confines	Kiesling 8334	SI
	ARGENTINA: Prov. Tucumán, Chicligasta, Estancia Las Pavas	Venturi 2972	SI
	ARGENTINA: Prov. Jujuy, Caspalá	Burkart 11727	SI
S. pensilis	BOLIVIA: Dept. La Paz, Prov. Murillo, Zongo, Laguna Viscachani	Feuerer 4539	SI
	BOLIVIA: Dept. La Paz, Prov. Murillo, Zongo	Krach 8800	SI
	BOLIVIA: Dept. La Paz, Prov. Murillo, upper Valle de Zongo, 32.4 km NE off the junction of road to Chacaltaya. 16º 12' S, 68º 09'W	Solomón 5864	SI

Appendix I. (Continuation).

Species	Locality	Collector	Herbarium
S. pseudotites	ARGENTINA: Prov. Catamarca, Sierra de Famatina, Rodeo de las Vacas	Flossdorf 9797	SI
	ARGENTINA: Prov. La Rioja, Velazco	Soriano 1005 dupl.	SI
	ARGENTINA: Prov. Tucumán, Dept. Chieligasta, Estancia Santa Rosa	Venturi 4801	SI
S. sepium	BOLIVIA: Dept. La Paz, Prov. Bautista Saavedra, Charazani	Beck 11369	SI
	BOLIVIA: Dept. La Paz, Prov. Bautista Saavedra, Charazani	Feuerer 5632	SI
	BOLIVIA: Dept. La Paz, Prov. Bautista Saavedra, Charazani	Feuerer 6376	SI
S. sinapoides	BOLIVIA: Dept. La Paz, Prov. Bautista Saavedra, Amarete	Krach 8345	SI
S. vulgaris	ARGENTINA: Ciudad de Buenos Aires	Burkart 10649	SI
	ARGENTINA: Prov. Buenos Aires, La Plata	Cabrera 9163	SI
	Falkland Islands, Port Standley	Dimitri 200	SI
	Falkland Islands, Port Standley	Ulibarri 1209	SI