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On Pollen Morphology and Floral Micromorphology of South American *Hypochoeris* L.

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ABSTRACT. Pollen morphology and floral microcharacteristics as achene surface, filament collar and style form were investigated in 41 South American *Hypochoeris* species by LM and, in certain cases, by SEM.

The studied species are divided into three well defined groups. It is proposed that one group, *viz. H. sessiliflora* be separated from *Hypochoeris* as a distinct genus *Oreophila* D. Don. Typified by *D. sessiliflora* (Kunth) D. Don.

Hypochoeris has a characteristic geographic distribution compared with other genera in Lactuceae. It has different major centers of distribution, Mediterranean Basin, western Eurasia, eastern Asia and south America (Stebbins *et al.* 1953). Besides, it displays great morphological variations. Some species are scapose, others have cauline leaves and some have one row of pappus hairs, others two (Sell 1975). Bentham (1873) divided *Hypochoeris* into 10 sections, some of which had been described earlier as separate genera. Hoffmann (1894) reduced the sections to five, and included in sect. *Achyrophorus* (Scop.) *Benth.* S. American species, plus *H. grandiflora, H. maculata*, and *H. uniflora*. El-Ghazaly (1980) divided the genus into three groups, based on pollen characteristics and such other microcharacteristics as achene morphology, anther tissue, filament collar, basal anther appendages, style form and corolla pubescence. The present study is concerned with the South American *Hypochoeris* species. Some of the above mentioned characteristics were reinvestigated in other collections of the previously

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studied species and in South American species which were examined for the first time. The aim of this study is to consider the importance of pollen morphology and certain micromorphological features in the re-evaluation of the South American *Hypochoeris*.

Material and Methods

Pollen samples were taken from specimens in the herbaria of the Swedish Museum of Natural History, Stockholm (S) and the University of California – Berkeley (UC).

The pollen samples were acetolyzed (Erdtman 1960) and mounted in glycerol jelly for light microscopy observations. On the basis of the light microscopy study, some species representing different pollen types were prepared for scanning electron microscopy (SEM) study. The acetolyzed pollen grains were dehydrated in acetone series and mounted on the surface of a metal holder in a few drops of 100% acetone. The specimens were then coated with gold/palladium, using the evaporation technique. The specimens were examined and photographed with a Jeol JSM 35.

For the micromorphological observations, florets from herbarium material were softened in boiling water, dissected under a stereomicroscope, mounted in Hoyer's Solution (Anderson 1954), examined, and photographed with light microscopy (LM).

Dry achenes were mounted on an adhesive surface on the metal holder and prepared for SEM study.

Results and Discussion

The floral micromorphological and palynological findings in the present study on the South American species of *Hypochoeris*, suggest the possibility of division of the genus into three groups: *i.e.*, the *H. gardneri*, *H. andina*, and *H. sessiliflora* groups, respectively.

I. The H. gardneri group

*This group includes H. alba**, *H. apargioides*, *H. atrocephala*, *H. brasiliensis*, *H. chondrilloides**, *H. chrysantha**, *H. gardneri*, *H. lessingii*, *H. lutea**, *H. rosengurttii** and *H. variegata**, (* = examined for the first time).

This group is characterized by having subechinolophate pollen grains with developed ridges and depressions (Fig. 1B, 2B), similar to the echinolophate pollen grains of the European-Mediterranean species, *e.g. H. maculata* and *H. laevigate* (Fig. 1A, 2A), but differ in having larger polar areas (cf. Fig. 1A, B) and elon-

gated, irregular depressions (*cf.* Fig. 2A, B). These features indicate that the lophate pattern of the *H. gardneri* group is not as well developed as in the European-Mediterranean species. The filament collar is the uppermost part of the filament. In the taxa investigated, the collar is a more or less cylindrical structure that varies in length and width. In *H. gardneri* group, the filament collar is longer than in the *H. andina* and *H. sessiliflora* groups (Fig. 3A). The style is thin and bears long hairs (Fig. 3D), and its branches are generally shorter than in the other groups. The achene is covered with ribs of fimbriated, superposed scales that vary

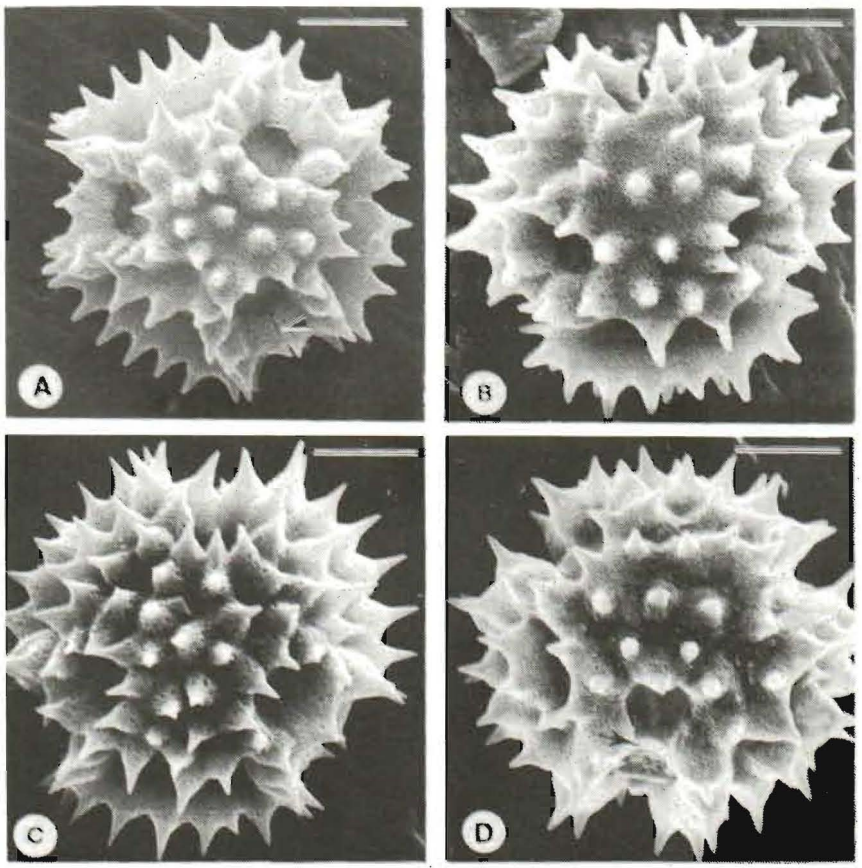

Fig. 1. SEM micrographs. Different types of *Hypochoeris* pollen in polar view. **A.** *H. maculata*. The polar area is large and the interlacunar gap is narrow (arrow head). **B.** *H. gardneri*. The polar area is larger than in the previous one and the interlacunar gap rather broad. **C.** *H. chillensis*. The polar area is the largest among the previous types. Note echinae are long with swollen bases, and perforations are comparatively wide. **D.** *H. lanata*. The polar area is similar to the preceding one and the interlacunar gap is very broad (arrow head). Scale line equals 10 μm.

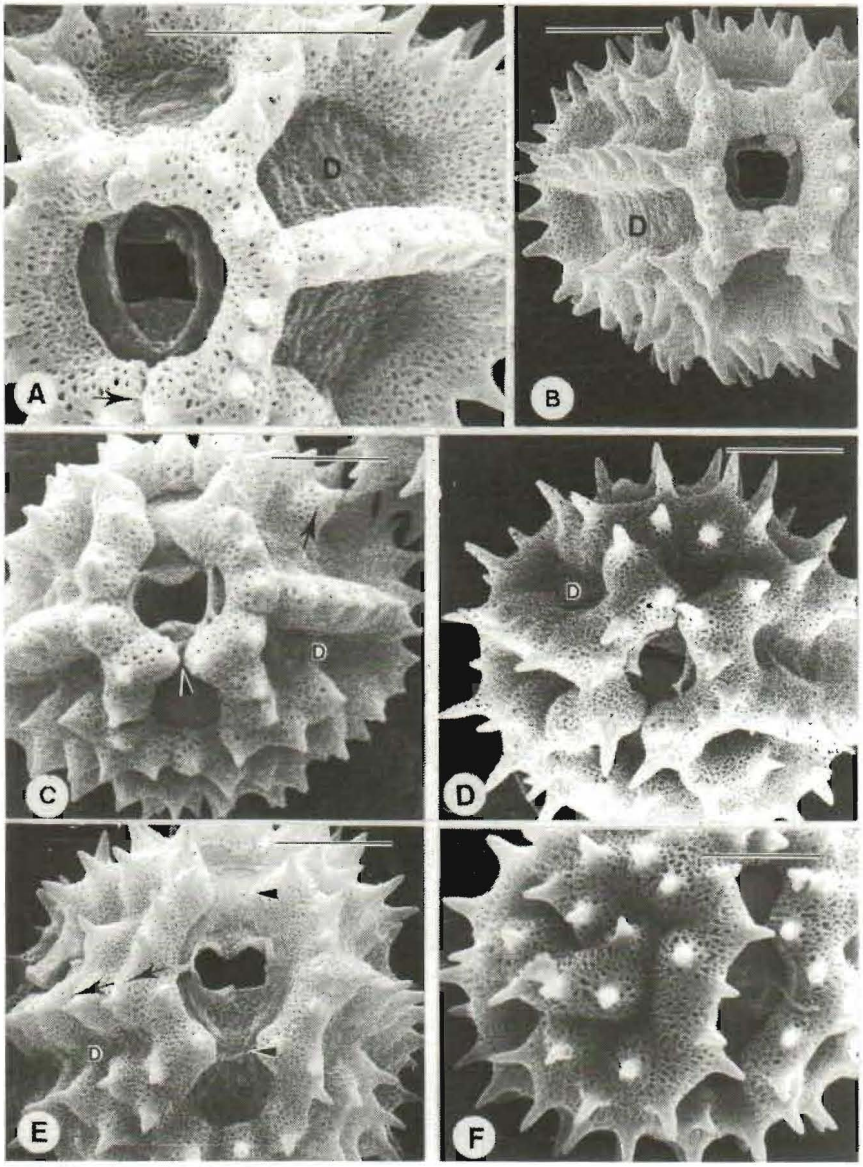

Fig. 2. SEM micrographs. Different types of *Hypochoeris* pollen in equatorial view. **A.** *H. maculata*. Note well defined pentagonal depressions (D) and very narrow interlacunar gaps (arrow). **B.** *H. atrocephala*. Note the depressions (D) are elongated and are not as well defined as in the preceding type. **C.** *H. meyeniana*. The depressions (D) are comparatively narrow with echinae (arrow) at their bottoms. **D.** *H. odorata*. It belongs to the preceding pollen type. They have similar undeveloped subechinolophate pollen. The *H. odorata* differs by presence of long echinae with narrow bases. **E.** *H. coronopifolia*. The equatorial ridges (arrows) and the depressions (D) are poorly defined. The interlacunar gaps are very broad (arrow heads). **F.** *H. lanata*. Note the equatorial ridges and the depressions are absent. Scale line equals 10 μm.

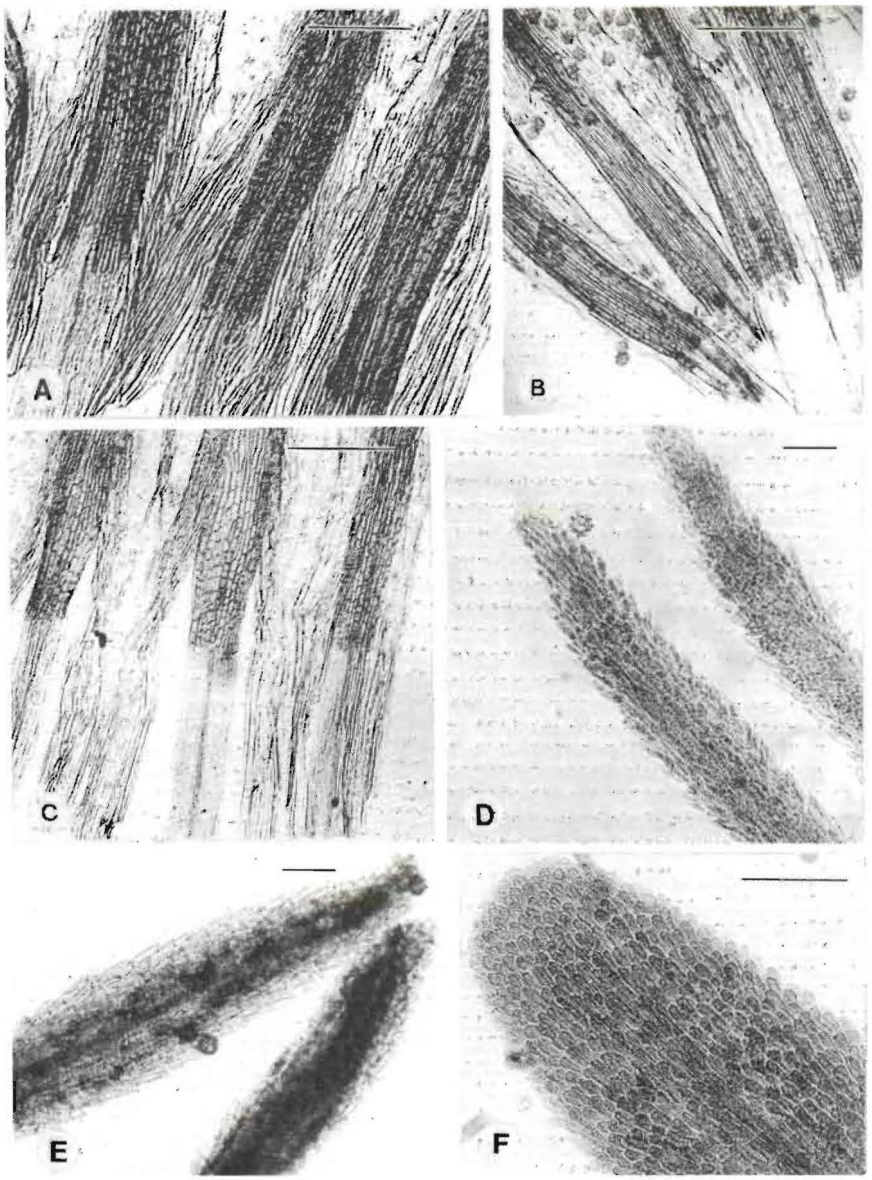

Fig. 3. LM photographs. **A-C.** Different types of *Hypochoeris* filament collar. **A.** *H. gardneri*. Note the filament collar is longer than in the other types. **B.** *H. andina*. Note the filament collar is shorter and thinner than the preceding one. **C.** *H. lanata*. It is the shortest filament collar among the previously mentioned types. **D-F**: different types of *Hypochoeris* style forms. **D.** *H. gardneri*. The stigmas are comparatively thin and bear long hairs. **E.** *H. meyeniana*. The stigmas are slightly thicker than the preceding one. **F.** *H. lanata* belongs to *H. sessiliflora* group. It is strikingly differs from the others. Note thick stigma that bears long papillae. Scale line equals 100 μm.

from short with slightly dissected margines, to elongate with deeply dissected margines (Figs 4 A-C).

II. The H. andina group

This group includes *H. andina, H. chillensis**, *H. elata**, *H. foliosa**, *H. graminea**, *H. grandidentata**, *H. hookeri, H. humilis, H. megapotamica, H. meyeniana, H. microcephala, H. odorata, H. parodii**, *H. petiolaris**, *H. scorzonerae**, *H. spathulata** and *H. stenocephala**.

This group is characterized by having subechinolophate pollen grains with large polar areas and long echinae (Fig. 1C). The aperture is distinguished by large and meridionally oriented oral lacuna (Fig. 2C, D). The interlacunar gaps are comparatively broader than in the previous group (Fig. 2C). The depressions are comparatively narrower and irregular in shape with echinae at their centres (Fig. 2C, D). The pollen grains of this type appear to be intermediate in development between the primitive echinolacunate pollen of the *H. sessiliflora* group and the derived one of the *H. gardneri* group and the European-Mediterranean species of *Hypochoeris*. The filament collar is generally shorter and thinner than the previous type (*cf.* Fig. 3A & B). The style is thicker than in the *H. gardneri* type, its branches are long and the style is covered with hairs that vary from long with narrow base and sharp tip to short with swollen base and rounded tip (Fig. 3E). The achene is covered with broad ribs of superposed scales that have dissected margins (Fig. 4D-F).

III. The H. sessiliflora group

This group includes *H. acaulis, H. barbata**, *H. clarionoides**, *H. coronopifolia**, *H. eriolaena**, *H. incana**, *H. lanata**, *H. pampasica**, *H. sessiliflora**, *H. setosa**, *H. sonchoides**, *H. taraxacoides**, *tenuifolia**.

This group differs from the other two in having echinolacunate pollen grains rather than subechinolophate or echinolophate grains. The echinolacunate pollen grains of this group are distinguished by large polar areas and long echinae (Fig. 1D). The equatorial ridges and the depressions are poorly developed (Fig. 2E) or absent (Fig. 2F). The aperture is characterized by larger oral lacuna (Fig. 2E) and broader interlacunar gaps (Fig. 2E) than in the previous types. The filament collar is usually shorter than the previous types (Fig. 3C). The style branches are comparatively thick and covered by long papillae (Fig. 3F). The achene is covered by broad glabrous ribs (Fig. 4G-I). In few cases, the ribs are covered by rudimentary scales, as in *H. eriolaena* and *H. setosa*.

The echinolacunate pollen grains are usually accompanied by characters such as long echinae and large size, which are considered primitive by Wagenitz (1976) and Tomb (1975). The apertural lacunae of these pollen grains are not well delimited. It seems possible that the echinolacunate pollen grains could be derived

from an echinate pollen similar to the *Glyptopleura* type described by Tomb *et al.* (1974). This type has colpal regions undivided into lacunae and is generally considered primitive. On the other hand, the derived echinolophate pollen grains are usually smaller and have shorter echinae than in the echinolacunate pollen grains. Beside the apertural lacunae are well delimited in the echinolophate pollen. From

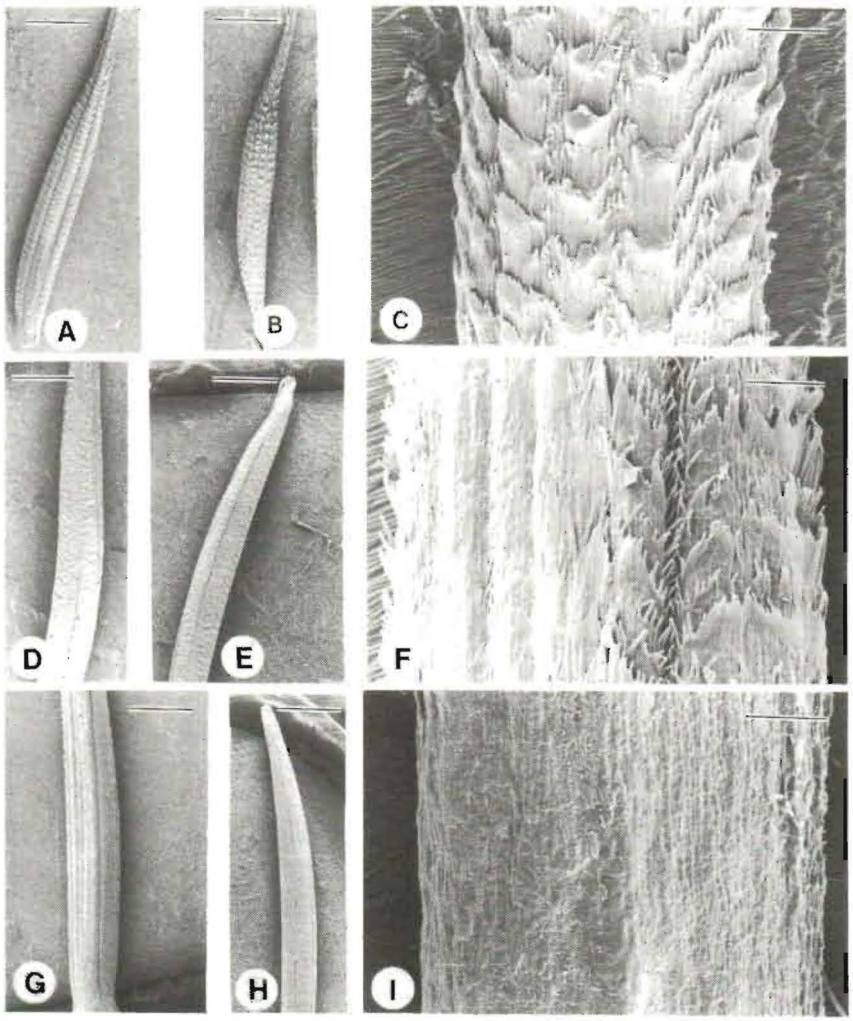

Fig. 4. SEM micrographs. Different types of *Hypochoeris* achene morphology. **A-C**: *H. gardneri* group. **A.** *H. brasiliensis*. **B.** *H. atrocephala*. Note the achene is covered with narrow ribs of fimbriated, superposed scales. **D-F**: *H. andina* group. **D.** *H. stenocephala*, **E-F.** *H. spathulata*. Note the achene is covered with broad ribs of superposed scales that have dissected margins. **G-I**: *H. sessiliflora* group. **G.** *H. eriolaena*. **H, I**. *H. lanata*. Note the achene is not covered with superposed scales *cf.* Fig. C, F. Fig. C, F, I Scale line equals 100 μm, and in the others scale line equals 0.5 μm.

these considerations, it seems likely that the South American species of the *Hypochoeris sessiliflora* group are primitive. Studies on the external morphology and cytology of some of the concerned species have shown a similar trend (Stebbins *et al.* 1953). It seems probably that the European-Mediterranean species are derived from the South American species (El-Ghazaly 1980). The pollen grains of the *H. sessiliflora* group are similar to some of those of the Stephanomeriinae studied by Tomb *et al.* (1974) and Tomb (1975). Another similarity has been found with *Apargidium boreale* and *Picrosia longifolia* of the primarily North American Microseridinae, which were described by Feuer and Tomb (1977) as having echinate pollen grains. The pollen grains of other groups of *Hypochoeris* are subechinolophate and echinophate and show some similarities to those of the genera *Leontodon* and *Picris* (El-Ghazaly 1980).

The palynological and micromorphological investigations in the present study as well as those of Stebbins *et al.* (1953) on morphology and cytology indicate that the composition of the genus *Hypochoeris* is polymorphic and heterogenous. The species of the *H. sessiliflora* group show striking differences from those of the other groups mentioned, and they can better be separated in a genus by themselves.

The genus *Oreophila* D. Don, typified by *O. sessiliflora* (Kunth) D. Don, holds priority and is retained here and proposed to include the species of the *Hypochoeris sessiliflora* group mentioned in this study.

Acknowledgement

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APPENDIX. Specimens of South American *Hypochoeris* Examined in this study

***H. acaulis* (Remy) Britton**
Chile, Nuble, Mar 1927, *Werdermann 1284* (UC 323184).
Chile, Talca, 27 Jan 1975, *Aravena 1045* (UC 1414365).

***H. alba* Cabrera**
Argentina. Corrientes, 29 Feb 1977, *Pedersen 12.007* (UC 1442279).

***H. andina* (DC.) Griseb.**
Argentina. Santa Cruz, 12 Jan 1939, *Eyerdam et al. 24.308* (UC 623846).
Chile, Llanquihue, Mar 1925, *Werdermann 664* (UC 278657).

***H. apargioides* Hook. & Arn.**
Peru. Andahualylas, 1914 Weberbauer (S).

***H. atrocephala* (A. Gray) Kuntze**
Peru. Small Canyon, 1925 White (S).

***H. barbata* (Sch. Bip.) Reiche**
Peru. Cuzco, 6 May 1939, *Balls 6725* (UC 683090).
Peru. Cuzco, 27 Feb 1939, *Vargas 11.003* (UC 672678).

***H. brasiliensis* (Less.) Griseb.**
Argentina. Buenos Aires, 24 Nov 1945, *Krapovickas 2686* (UC 716870).
Brazil. Rio Grande do Sul, *Sacco 408* (UC 167833).

***H. chillensis* (kunth in HBK) Hieron.**
Argentina. Entre Rios, 21 Nov 1964, *Pedersen 7246* (UC 1442318).

***H. chondrilloides* (A. Gray) Cabrera**
Argentina. Jujuy, 23 Feb 1929, *Venturi 8321* (UC 397885).

***H. chrysantha* Poepp. ex DC.**
Chile. Santiago, 17 Nov 1973, *Stebbins & Zeiger 8897* (UC 1423596).

***H. clarionoides* (Remy) Reiche**
Chile. Aconcagua, 11 Feb 1939, *Morrison 17.279* (UC 630200).

H. coronopifolia* (Commers.) Franch. *[= H. incana?]
Argentina. Santa Cruz. 10 Jan 1939, *Eyerdam et al. 24.263* (UC 623880).

***H. elata* (Wedd.) Griseb.**
Bolivia. Cochabamba, 9 Mar 1939, *Eyerdam 24.728* (UC 671191).

***H. eriolaena* (Sch. Bip.) Reiche**
Peru. La Libertad, 10 Aug 1964, *Hutchison et al. 6267* (UC 1337451).

***H. foliosa* (Phil.) Reiche**
Chile. Antofagasta, 12 Oct 1938, *Worth & Morrison 15.778* (UC 636248).

***H. gardneri* Baker**
Brazil. Serrinha, 1908 Dusen (S).

***H. graminea* Hieron.**
Peru. Cajamarca, 16 May 1964, *Hutchison & Wright 5111* (UC 1335086).

***H. grandidentata* (Phil.) Reiche**
Chile. Coquimbo, 14 Oct 1940, *Wagenknecht 18,584* (UC 701001).

***H. hookeri* Phil.**
Argentina. Chubut, 24 Dec 1938, *Eyerdam et al. 23.801* (UC 623916).
Argentina. Santa Cruz, 10 Jan 1939, *Eyerdam et al. 24.276* (UC 623869).

***H. humilis* Phil.**
Chile. Valdivia, 12 Jan 1939, *Hollermeyer 795* (UC 657916).

***H. incana* (Hook. & Arn.) Macl.**
Argentina. Tierra del Fuego, 18 Dec 1966, *Goodall 400* (UC 1356110).

***H. Lanata* Dusén**
Chile. Territorio de Magellanes, 1921 Valentin (S).

***H. lessingii* (Sch. Bip.) Reiche**
Chile. Talca, 2 Nov 1973, *Stebbins 8816* (UC 1423555).

***H. lutea* (Velloso) Britton**
Brazil. Paraná, Nov 1970, *Hatschbach 23.002* (UC 1426123).

***H. megapotamica* Cabrera**
Argentina. Corrientes, 6 Nov 1976, *Pedersen 11.377* (UC 1442277).

***H. meyeniana* (Walp.) Griseb.**
Argentina. Catamarca, 29 Jan 1952, *Sleumer & Vervoorst 2589* (UC 1049076).

***H. microcephala* (Sch. Bip.) Cabrera**
Argentina. Corrientes, 31 Oct 1970, *Krapovickas & Cristóbal 16.427* (UC 1380785).

H. odorata* (Walp.) Benth. & Hook. *[= H. tenuifolia?]
Chile. Cautín, Feb 1927, *Werdermann 1235* (UC 323140).

***H. pampasica* Cabrera**
Argentina. La Pampa, 5 Nov 1944, *Fortuna s. n.* (UC 1237763).

***H. parodii* Cabrera**
Argentina. Tucumán, 8 Jan 1945, *Olea 191* (UC 1237760).

***H. petiolaris* (Hook. & Arn.) Griseb.**
Argentina. Buenos Aires, 13 Dec 1938, *Eyerdam et al. 23.734* (UC 623592).

***H. rosengurttii* Cabrera**
Argentina. Buenos Aires, 4 Nov 1939, *Cabrera 5512* (UC 926401).

***H. scorzonerae* Muell.**
Chile. Coquimbo, 20 Nov 1938, *Worth & Morrison 16.611* (UC 633171).

***H. sessiliflora* Kunth in HBK**
Colombia. Cundinamarca, 15 Dec 1938, *Balls 5695* (UC 682883).
Peru. Amazonas, 23 Mar 1964, *Hutchison & Wright 4500* (UC 1200022).

***H. setosa* (Wedd.) Rusby**
Ecuador. Imbabura, 30 Nov 1961, *Cazalet & Pennington 5424* (UC 218316).

***H. sonchoides* Kunth in HBK**
Ecuador. Pichincha, 30 Jan 1955, *Asplund 17.502* (UC 1450090).

***H. spathulata* (Remy) Reiche**
Argentina. Chubut, 20 Jan 1901, *Illin 153* (UC 50372).

H. stenocephala* (A. Gray) Kuntze *[= H. taraxacoides?]
Peru. Ayacucho, 28 Oct 1935, *West 3663* (UC 561097).

***H. taraxacoides* Walp.**
Peru. Junin, 14 Jul 1964, *Hutchison et al. 5892* (UC 1200014).

***H. tenuifolia* (Hook. & Arn.) Griseb.**
Argentina. Neuquén, 17 Feb 1940, *Cabrera 6162* (UC 898076, UC 926402).

***H. variegata* (Lam.) Baker**
Argentina. Buenos Aires, 7 Nov 1940, *Cabrera 6721* (UC 926424).

الشكل الخارجى لحبوب اللقاح والصفات الزهرية الدقيقة لأنواع من الجنس هيبوشيريس بأمريكا الجنوبية

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دُرست صفات الشكل الخارجى لحبوب اللقاح والخصائص الزهرية الدقيقية فى مجموعة من أنواع الجنس هيبوشيريس التى تنمو فى أمريكا الجنوبية، وقد تناولت الدراسة خصائص كل من سطح الثمار، وقاعدة خيط الطلح وزوائده والميسم إلى جانب حبوب اللقاح فى واحد وأربعين نوعاً باستخدام كل من الميكروسكوب الضوئى والميكروسكوب الالكترونى المجسم.

أمكن تقسيم هذه الأنواع إلى ثلاث مجموعات واضحة بناء على التباينات فى الخصائص المذكورة؛ واقترح أن تفصل إحدى هذه المجموعات، وهى مجموعة *سيسيليفلورا*، من الجنس هيبوشيريس وتُميّز كجنس محدد هو الجنس *أوريوفيلا*، والذى سبق أن وصفت خصائصه بالنوع *أوريوفيلا سيسيليفلورا*.

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