COMPOSITAE NEWSLETTER

Number 29 **November 1996**

Scientific Editor: Bertil Nordenstam
Technical Editor: Gunnel Wirénius Nohlin
Published and distributed by The Swedish Museum of Natural History,
Department of Phanerogamic Botany,
P.O. Box 50007,
S-104 05 Stockholm, Sweden
(Director: Professor Bertil Nordenstam)
ISSN 0284-8422

CONTENTS

JOSÉ CUATRECASAS ARUMÍ (1903-1996)

H. E. Robinson, V. A. Funk, J. F. Pruski & R. M. King
Division of Synantherology, Department of Botany, MRC 166
Smithsonian Institution
Washington D.C. 20560, U.S.A.
mnhbo003@sivm.si.edu (VAF)

José Cuatrecasas died on May 23 1996, only about ten days after his last working visit to the U.S. National Herbarium. In his passing we at the Smithsonian have lost a fellow synantherologist, friend, and colleague. Don José worked right up until the end of his life, even in the hospital he continued to ask about preparations for the publication of his submitted manuscript on the Espeletiinae. In spite of his 93 years, Dr. Cuatrecasas' health had been such that it did not seem unrealistic that he would be able to return to his studies and we all expected to see him back at work. This was clearly his intention as is evidenced by his publication this year of the "preliminary" key to *Espeletiopsis*.

Don José, sometimes affectionately called Pepe, loved Botany and his warm nature was immediately apparent to all who knew him. He truly was a sweet, kind, and gentle man who was simultaneously proud of his accomplishments although very modest and humble. Staff and visitors in Botany, as well as in other departments, frequently visited him in his office. In fact, a stop in his office was very nearly part of the ritual of visiting the Smithsonian. He took obvious pleasure in showing them (and us) the wonderful plates of his Espeletiinae treatment and in ending such visits with a round of Guava paste for all. He humorously founded the "School for Style Branches" graduating his only two "students" (R. M. King and the late Kittie Parker) "Magna Cum Laude." He was genuinely interested in our work and was always a source of encouragement. He surprised one of us with the remark "I hear you are sinking one of my genera.... Bueno!", showing an attitude that was infectious to all. He had nothing but warm words for all. Atypically, however, upon learning that Generalissimo Franco would not live out the day simply and slyly said to one of us "I'll have to call home and ask Martha to put the Champagne on ice." His life was much influenced by politics, but this was a side of him that in later years would only occasionally surface.

The career of José Cuatrecasas extends from his birth, March 19, 1903, in Campodrón (Gerona), Spain, in the foothills of the Pyrenees, through his studies in Barcelona and Madrid (1924-1931) partly under the direction of P. Font Quer, graduate work in Berlin (1930-31) where he knew Adolph Engler, Directorship of the Sección de Flora Tropical del Jardin Botánico de Madrid (1933-39), the years in Colombia (1939-47), in Chicago (1947-1955) to his years in Washington (1955-1996). His early work included studies in Andalusia, early efforts at chemotaxonomy, and cooperation with the efforts of Macbride to photograph classical type specimens in the herbarium in Madrid. In 1985 a story was told of the manner in which he left Spain which Dr. Cuatrecasas later told the senior author was incorrect. Actually, he had been on a trip to South America as part of the Loyalist government mission honoring a historical event in Colombia. His intentions had been purely botanical, but they were not seen that way by the Franco government that gained power in his absence. If he had not been warned before returning to Spain on his way through France, his botanical career might have ended almost 60 years ago. It was a time when his professor, P. Font Quer, was imprisoned and his colleagues, Faustino Miranda and Manuel López-Figueiras, were arrested and driven from Spain. Return to Spain might have been possible during later decades of the Franco government, but Dr. Cuatrecasas did not choose revisit until after the government had changed.

Dr. Cuatrecasas' first publication was in 1924 and his last one is still in press. Over the years he published 262 papers (by our count), most of them single authored. For 73 years he published something nearly every year, missing only 1939, 1974, and 1983; an incredible accomplishment.

All synantherologists should be aware of some of his non-asteraceous accomplishments. These include the founding of Organization for Flora Neotropica; studies on the flora of Magina, Spain, published in the 1920's; monographs of Humiriaceae, Brunelliaceae, and *Theobroma*; and his Prima Flora Colombiana, which includes important revisionary studies in Burseraceae and Malpighiaceae.

Interest in Andean botany, that began while still in Spain, became the main thrust of the Cuatrecasas' research. Earlier studies included *Cecropia*, *Theobroma*, and genera of the Bombacaceae, Brunelliaceae, Burseraceae, Rubiaceae, Sabaceae, Simaroubaceae, Solanaceae, Violaceae, and studies of Cunoniaceae, Humiriaceae, Malpighiaceae continued through the period when Dr. Cuatrecasas was concentrating on the Asteraceae. The efforts in the Heliantheae subtribe Espeletiinae led to a completed manuscript that will be published on all the genera except *Espeletiopsis*. Work in the Senecioneae includes papers with Robinson and continued with a paper still to be published with S. Diáz-Piedrahita on Colombian

Pentacalia. Studies in the Astereae on *Diplostephium* and *Oritrophium* were also continuing at the time of Cuatrecasas' death.

Don José was an excellent photographer and his research files contain numerous photos, some on glass negatives, dating from his field work in Colombia in the 1930's and 40's. A selection of them with legends that he prepared were on display at the Montane Forest Symposium at the New York Botanical Garden, 1993. One of these is a cabin in the mountains made out of *Espeletia* (Figure 1). Currently the photos are on display in the Department of Botany, Smithsonian Institution.

Dr. Cuatrecasas received many honors in his long career, including festschrifts in Lazaroa, volume 5, 1983; in Flora Neotropica, Monograph, number 2, supplement, 1985; in Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales, volume 17, 1989; the Cruz de Boyacá awarded by the Colombian government, and the Gran Cruz de Alfonso X el Sabio by the Spanish government. Three additional tributes are found in Quercus 85: 16-18, 1993; Revista Academia Colombiana de Ciencias Exactas, Físicas y Naturales 20: 167-170, 1996; and Lazaroa 16: 7-8, 1996.

Dr. Cuatrecasas is an author or coauthor of two subtribes, Espeletiinae and Hinterhuberinae, and many genera of the Asteraceae: *Blakiella, Floscaldasia, Flosmutisia, Piofontia* (= *Diplostephium), Westoniella* of the **Astereae**; *Ascidiogyne, Ellenbergia* of the **Eupatorieae**; *Carramboa, Coespeletia, Espeletiopsis, Paramiflos, Ruilopezia, Tamania, Thelechitonia (= Sphagneticola)* of the **Heliantheae**; *Neocaldasia (= Gongylolepis)* of the **Mutisieae**; and *Arbelaezaster, Cabreriella, Dendrophorbium* as section, *Garcibarrigoa, Jessea, Paracalia, Paragynoxys, Talamancalia* of the **Senecioneae**. Also, he did important studies of other Asteraceous genera, *Baccharis, Hinterhubera, Llerasia, Loricaria, Mnioides, Philoglossa*, and *Vernonia* sect. *Critoniopsis*. A quick check of the Index Kewensis gives a list of 2391 records (novelties, his transfers, transfers by others based on his names, nomina novae) with Cuatrecasas in the author field of which an astounding 1307 are Compositae records. Few taxonomists can work in the family Compositae without making use of his work. At the time of the 1985 festschrift, Dr. Cuatrecasas was listed with B. L. Robinson, S. F. Blake, A. L. Cabrera, and H. Merxmüller, as individuals who had made truly constructive and insightful contributions to the study of the Asteraceae in the first three quarters of this Century.

Dr. Cuatrecasas collected extensively and in areas that were difficult to reach. Over the years many new taxa have been described based on his collections. Eight genera have been named in honor of Don José in five families, *Cuatresia* A. T. Hunziker, Solanacaeae; *Cuatrecasea* Dugand, Palmae; *Cuatrecasasiella* H. Robinson, *Cuatrecasanthus* H. Robinson, *Joseanthus* H. Robinson, and *Neocuatrecasia* R. M. King & H. Robinson, all in the Asteraceae; *Cuatrecasasiodendron* Standley & Steyermark, Rubiaceae; and *Quadricasaea* Woodson, Apocynaceae. At the time of the festschrift in 1985, a list was produced of species honoring Don José in Musci, Hepaticae, Pteridophyta, Asteraceae, Begoniaceae, Berberidaceae, Bromeliaceae, Caryophyllaceae, Chrysobalanaceae, Cunoniaceae, Cyclanthaceae, Cyperaceae, Ericaceae, Gramineae, Guttiferae, Lauraceae, Leguminosae, Melastomataceae, Myristicaceae, Palmae, Piperaceae, Rosaceae, Rubiaceae, Sapotaceae, Sterculiaceae, Umbelliferae and Xyridaceae. Additonally, there are now species named for him in the following families: Acanthaceae, Actinidiaceae, Amaryllidaceae, Anacardiaceae, Annonaceae, Apocynaceae, Araliaceae, Asclepiadaceae, Brunelliaceae, Brassicaceae, Campanulaceae, Capparaceae, Chloranthaceae, Cistaceae, Convolvulaceae, Erythroxylaceae, Euphorbiaceae, Gentianaceae, Gunneraceae, Iridaceae, Lamiaceae, Malpighiaceae, Malvaceae, Menispermaceae, Moraceae, Onagraceae, Passifloraceae, Polygalaceae, Salicaceae, Saxifragaceae, Scrophulariaceae, Solanaceae, Theaceae, Valerianaceae, Verbenaceae, Violaceae, Zingiberaceae. We have found over 150 epithets honoring Cuatrecasas and they take a variety of forms: *cuatrecasae, cuatrecasana, cuatrecasasana, cuatrecasasanum, cuatrecasasi, cuatrecasasiana, cuatrecasasii, cuatrecasatis, cuatrecasii, cuatrecazanum, josei, pepei, quadridomius, tetroici,* and *tetroicia.* Tributes of this type will inevitably continue as the many collections by Cuatrecasas continue to be studied. The destruction of many localities since they were visited by him means that many of the Cuatrecasas collections will never be duplicated.

Cuatrecasas' extensive library has been given to the Botanical Garden in Barcelona and his files and travel descriptions to the Botanical Garden in Madrid. His research materials and photographs remain at the Smithsonian Institution.

His wife Martha died in 1986. He is survived by two sons, Pedro, a medical researcher in Ann Arbor, Michigan, and Gil, an artist residing in Barcelona, Spain; a daughter, Teresa Rivera, a teacher living in San Francisco, California; seven grandchildren and three great grandchildren. His ashes are to be returned to Spain. His memorial service, held in Washington shortly after his death, ended with the words "Farewell Don José, Farewell!"

Endowment Fund - The Smithsonian Institution is in the process of establishing an endowment fund to be named the "José Cuatrecasas Botanical Fund" that will honor Cuatrecasas' lifelong work in botany. His research was devoted to systematics and taxonomy, plant ecology, biogeography, and exploration and collecting, especially the family Asteraceae, in páramo and subpáramo regions of Andean South America, therefore, the fund will sponsor competitive botanical research in these areas through a biannual call for proposals. The proposals will be reviewed by a panel of scientists. The results of the funded projects will be dispersed widely in the botanical and related communities. Those wishing to contribute to the fund or request additional information should contact the Chairman, Department of Botany, at the address listed above.

Degrees

Pharm. Lic., Barcelona, 1923

Dr. Pharm., Madrid, 1928 (Thesis: Flora and vegetation of the Magina Mountains, published 1929)

Postgraduate studies: University of Geneva, 1927; and Berlin-Dahlem, 1930-1934

Positions

1924-1931	Assistant Professor of Botany, University of Barcelona
1932-1939	Full Professor of Systematic Botany, University of Madrid
1933-1939	Curator of Tropical Flora, Madrid Botanical Garden
1937-1939	Director, Madrid Botanical Garden
1939-1942	Professor of the Instituto Botanico (Universidad Nacional), Bogotá, Colombia
1942-1943	Director of the School of Tropical Agriculture, Cali, Colombia
1943-1947	Director of the Comisión Botánica del Valle and Professor at the Facultad de Agronomia del Valle, Cali
1947-1950	Curator of Colombian Botany, Chicago Natural History Museum
1951-1952	Guggenheim Fellow

1952-1955	Investigator, National Science Foundation grant, Chicago Natural History Museum
1955-1977	Investigator, National Science Foundation grants
1955-1996	Research Associate, Smithsonian Institution

HONORS AND AWARDS

Honorary Member, Sociedad Geográfica de Colombia, Bogotá (1936)

Honorary Member, Academia Colombiana de Ciencias, Bogotá (1937)

Honorary Member, Instituto Ecuatoriano de Ciencias Naturales (1968)

Honorary Member, Institució Catalana d'Historia Natural (1974)

Member of the "Ateneo Nacional de Altos Estudios", Republica de Colombia (1941)

Guggenheim Fellow (1951-1952)

Honorary President, Sect. Phytogeographie, 8th Congrès International de Botanique, Paris (1954)

Research Associate, Department of Botany, Smithsonian Institution (1955)

Associate, Muséum National d'Histoire Naturelle, Paris (1959)

Cruz de Boyacá, from the government of Colombia for scientific achievement for the benefit of Colombia (1959)

Fellow, American Association for the Advancement of Science (1960)

Henry Allan Gleason Award, from the New York Botanical Garden for the 1961 publication of "A taxonomic revision of the Humiriaceae" (1963)

Member, Society of the Sigma Xi (1963)

Scientific Director of Flora Neotropica (for Cormophyta) (1964-1971)

Honorary Vice President, First Latin-American Congress of Botany, Mexico (1972)

President of the Organization for Flora Neotropica (1972-1975)

"Curador Asociado, ad honorem", Museo Nacional de Costa Rica (1978)

"Profesor Honorario", Universidad Nacional de Colombia, Bogotá (1983)

Corresponding Member: Institut d'Estudis Catalans; Academia de Ciencias de Barcelona; Sociedad Cubana de Botánica; Academia de Farmacia de Cuba; Societat Catalana de Biología

Director honorario del Real Jardín Botánico (CSIC)

Gran Cruz de Alfonso X el Sabio

Gran Cruz de la Orden del Mérito Civil (1995)

Expeditions and Collections

Europe

Collections and botanical trips from 1920 to 1939 in several countries, especially in Spain.

Africa

Canary Islands (Gomera, Gran Canaria, Tenerife, 1935)

South America

1932 - FIRST PERIOD, Colombia

Sponsored by the University and the Madrid Botanical Garden. Devoted to observations in plant ecology and plant collecting. Magdalena river; Cundinamarca, chiefly páramos; Ibagué, Nevado del Tolima and Valle de Cauca. Collection Numbers: 2000-3499.

1938 - SECOND PERIOD, Colombia

Partially sponsored by the University and the Madrid Botanical Garden. Devoted to observations in plant ecology and plant collecting. Cundinamarca, chiefly Macizo de Bogotá; Boyacá, Soatá-Cocuy, páramos of Nevado del Cocuy; Meta, Llanos del Meta and Orinoco (savannas) between Puerto López and Puerto Carreño, Llanos de Villavicencio. Collection Numbers: 1-1999 and 3500-4999.

1939-1942 - THIRD PERIOD, Colombia

Base for the explorations was Bogotá, being resident there as professor of the Universidad Nacional at the Instituto de Ciencias Naturales.

The regions explored during this period were chiefly the savannas of the Llanos of Meta-Vichada-Guaviare; rainforests of Caquetá river in Tres Esquinas, of Vaupés river from Cuduyarí to Calamar (Mitú, Cuduyarí, Tuí-igarapé, Cananarí, Circasia,

Cubiyú, Yacayacá, Parana-midi, Mirití, Yuruparí, Pucarón, Carurú); of Apaporis (Río Popore); of Guaviare and Guayabero rivers; rainforests of Putumayo rivers from Concepción to Puerto Asís and its tributaries Sucumbios (San Miguel) and Guamués, and the lowlands to Mocoa; the Eastern Cordillera from Páramo de Tamá, through páramos of Pamplona, Santurbán, Almorzadero, Rusia, Arcabuco, Hüina, Bogotá, to Huila and Pasto region, exploring middle and high altitudes; Central Cordillera, chiefly the region of Nevado del Ruíz and Volcan Puracé; Western Cordillera near Popayán (Carpinterías) and Antioquia; part of the lower Magdalena valley and of Cauca valley. Collection Numbers: 5000-13,661.

1942-1947 - FOURTH PERIOD, Colombia

Base for explorations was Cali, where a professor of the Agronomy Faculty of El Valle, and the director of the "Comisíon Botánica del Valle" (Government agency).

The following regions were especially explored and collected: Western Cordillera on both slopes and their highest peaks (Los Farallones), in several localities; rainforest of The Pacific Coast, along the low part of the rivers Micay, Naya, Yurumanguí, Cajambre, Anchicayá, Dagua, Calima, San Juan, and Togoromá; mangroves of the west coastal range; Central Cordillera around middle altitude and páramos of Barragán; the high valleys of the Tuluá and Bugalagrande rivers; páramos de Las Vegas; Río López (west slopes of Nevado del Huila): páramos of Puracé; mountain forests of Tacueyó and Moscopán; plains of Cauca Valley from Sevilla and Cartago to Cali and Popayán (from 900 to 2000 m). Collection Numbers: Cuatr. 13,662-24,016, also Killip & Cuatr. 38,613-39,212.

During most of these explorations, much ecological and plant distribution data were collected. Special emphasis was given to collecting trees and palms, as Colombia was extensively covered with primary forests. This fact made traveling and collecting more arduous and the collections consequently more valuable.

1958-1973 - FIFTH PERIOD

Base was Washington, DC., Smithsonian Institution, under NSF grant as principal investigator.

March-April 1958: Colombia

Chocó, collections near Quibdó; along Río Atrato and tributaries; and Antioquia, near Medellín and Páramo de los Baldíos; trip financed by UNESCO; expenses in part by NSF. Collection Numbers: 24,025-24,283, also Idrobo & Cuatr. 2664-2711.

September-December 1959: Colombia

Sierra Nevada de Santa Marta, SE range, on its highest páramos, between lakes Mamo, Mamito, and Naboba, between peaks Reina and Guardían, and upper part of Donachiú valley; Valley of Valledupar; Eastern Cordillera, northern end, Sierra de Perijá above Manaure (páramos of Floridablanca, Sabana Rubia, Cerro Venado, Cerro Avión); Macizo de Bogotá; Western Cordillera, near Cali (Cerro de los Cristales); Atlantic region, near Barranquilla and Guajira. Sponsored by the National Science Foundation and Smithsonian Institution, with assistance for inland transportation by the Ministerio de Agricultura de Colombia. Collection Numbers: 24,284-25,787.

August-November 1961

Trinidad

Imperial College of Tropical Agriculture, for study of cacao.

Venezuela

Region of Barlovento, for cacao.

Colombia

The following departments:

(1) Cundinamarca: Several sections of the savanna and páramos around Bogotá up to 3700 m.

(2) Valle del Cauca: Visiting plantations of old cocoa varieties near Palmira and Puerto Tejada, and the heavily forested lowlands of the Pacific coast in the Río Calima region.

(3) Antioquia: Northern region (Chocó) around Villa Arteaga, looking especially for *Theobroma* and *Cecropia*, and collecting Andean cecropias in the Central Cordillera near the Boquerón.

(4) Cauca: Páramos of Puracé and Guanacas, the latter a Hartweg type-locality.

Costa Rica

Turrialba and Puerto Limón, visiting cocoa plantations, páramos of Volcán Irazú and Maciso de Bellavista.

Nicaragua

Chinandega, looking for types of cacao. Collection Numbers: 25,750T-26,565.

October-November 1962

Colombia

Valle del Cauca.

Brazil

Estado São Paulo: Cerrado de Cachoeira Emas; Estado Guanabara: Rio de Janeiro; Pará: Belém; research financed by NSF grant; trip paid by UNESCO. Collection Numbers: 26,567-26,668.

January-February 1965: Colombia

Cundinamarca: subarid region of muncipio Mosquera, verada de La Punta and San Francisco, and Páramo de Guerrero; Valle: Cordillera Central (Río Amayme) and Occidental (Villa Colombia); Cauca: Quilichao-Piendamó; Nariño: Volcán Galeras. Research financed by NSF Grant; trip paid by UNESCO. Collection Numbers: 26,669-26,952.

December 14, 1968-March 15, 1969: Colombia

The regions explored were: the highlands, or páramos, of the Eastern Cordillera around the Massif of Bogotá-Sumapaz, mainly between 3000 and 3800 m; the highlands (2800-3800 m) of the Central Cordillera in the dept. of Cauca (Páramo de las Moras, Páramos de Paletera), the dept. Valle (Páramo de Pan de Azúcar), and the dept. Tolima (Subpáramo El Campanario, forest of Combeima valley); and the plain of the Valle del Cauca at middle altitude (900-1000 m) and slopes of the Cordillera above El Valle (1500-2500 m); the lowlands of the Pacific coast at Buenaventura and Calima river, mainly in search of wild *Theobroma* species; lowlands of the Caquetá region from Florencia, along the Río Orteguaza, to the Río Caquetá, mainly in search of species of *Theobroma*, *Cecropia* and *Compositae*. Trip sponsored by NSF grant. Collection Numbers: 26,953-27,719.

September 1969: Colombia

From Bogotá to the Venezuelan border along the Eastern Cordillera, to collect Compositae, especially *Espeletia*, at classical localities. The páramos visited were those of La Rusia, Alto de Canutos, Caracoles, Las Gaitas, Hüina, Guantiva, de Chita, de Sácama, La Uvita, Cocuy and Güican in dept. Boyacá, Páramos de Perlaonso, Almorzadero and Santurbán in dept. Santander and Norte de Santander. Also the region of Ocaña (Norte de Santander and Cesar) was explored. Trip sponsored by NSF grant. The Universidad Nacional of Colombia contributed a vehicle for 20 days from Bogotá to Cúcuta with a driver and an assistant (Laureano Rodriguez). Collection Numbers: 27,720-27,991.

October-November 1969: Venezuela

The headquarters were the Universidad de los Andes in Mérida. With the vehicle which always was provided by the University, the following páramos were visited mainly in search of topo-types of *Espeletia* species. Páramos del Colorado, del Zumbador, del Batallón and Paramo de Tamá (Táchira); Páramo de La Negra, Páramo de Mucuchíes, de Piñango, de Los Granates, del Pico Espejo, de Loma Redonda, de La Aguada, Apartaderos, Mucubají, Mucuñuque, Laguna Negra, Laguna de Los Patos, de Mifafí, de Mucurubá, de La Carbonera-La Piñuela, de Pueblo Llano and Llano Corredor (Mérida). Páramos de Guirigay, de Jajó, La Cristalina, de Niquitao, de El Jabón, de Santa Rosa and de El Turma (Trujillo). Cerro Avila-Silla de Caracas (Federal District). Páramo de Tamá, state of Táchira, near the border with Colombia. Trip sponsored by NSF grant and helped by the Universidad de Los Andes, Mérida, which provided private and free transportation and assistance by professors L. Ruiz-Terán, M. López-Figueiras and/or L. Marcano-Berti. Collection Numbers: 27,992-28,250.

January-February-March 1973: Venezuela

The headquarters were again the Universidad de Los Andes in Mérida. Páramos de Tamá at the headwaters of Río Táchira, Páramo del Zumbador, Páramo del Colorado, Sub-páramo de La Grita, Páramo del Batallón, and Páramo de La Negra (Táchira). Páramos de San José, Zanjón de Cupís and Pozo Negro, de Quirorá, de Las Coloradas, El Morro, Sierra Nevada in Cañada Espejo, Loma Redonda and Aguada, Páramo de Mucuchíes, Sierra de Santo Domingo in Mucuñuque and Laguna Valencia (El Baho), Páramo de Piñango (Mérida). Páramos del Turmal, de Boconó and La Cristalina (Trujillo). Collection Numbers: 28,300-28,627.

March-April 1973: Colombia

The headquarters were at the Instituto de Ciencias Naturales, Bogotá. Páramo de Las Moras (Cauca) in the Central Cordillera, Páramos de Quilinsayaco and La Cocha (Nariño-Putumayo) at the southern massif. Eastern Cordillera, from Bogotá to the northern cities Pamplona and Bucaramanga at the following main spots (with Roberto Jaramillo): Páramos and subpáramos of Combita, Tunja, Río Pómeca, Arcabuco, La Palma, Laguna de Tota, Páramos de La Sarna, Río Cusiana, Santa Rosa de Viterbo-Floresta, Portachuelo, Alto de Las Cruces (Belen-Encino), Páramo de la Rusia, Páramo de Socotá, de Socha or Pisba, and Chita on

both sides, east and west, of the cordillera. Páramos de Grantiva, de Hüina and de Santa Rosita towards Gonzaga and Soatá, all in Boyacá. Further north, the departments of Santander and Norte de Santander from Bucaramanga and from Pamplona. The steep upper valley of Río Suratá was followed above La Baja ascending to the top of Páramo del Romeral and to the headwaters of Río Cucutilla (3600-3800 m). Other Páramos visited were those of Fontibón, Berlín, Santurbán and Vetas. In Cundinamarca, the subpáramo between Chocontá and Sesquilé. All explorations were limited to páramos and subpáramos, at altitudes between 2500 and 4200 m. Collection Numbers: 28,630-28,763A.

February 1978 and May 1979: Colombia

The last collecting trips made to Colombia. Collection Numbers: 28,770-28,798 and 28,819-28,967.

November 1978 and May 1980: Venezuela

The last collecting trips made to the Venezuelan Andes. Collection Numbers: 28,799-28,816 and 28,968-29,015.

Publications

(*Papers that involve members of the family Compositae or discuss the family in general)

1924

*Notes Botaniques. *Butl. Inst. Catalana Hist. Nat.*, Ser. 2, 4: 46-47.

1925

Algunos datos para la flora mixomicética de Cataluña. *Butl. Inst. Catalana Hist. Nat.* 5: 92-94.

1926

Excursion Botánica a Alcaraz y Riópar. *Trab. Mus. Ci. Nat. Barcelona* 5: 1-49.

**Montagnites radiosus* (Pall.) Holl. *Butl. Inst. Catalana Hist. Nat.* 6: 152-154.

Una nueva especie de *Rosa*. *Butl. Inst. Catalana Hist. Nat.* 6: 164-166.

1927

*Hallazgo de una especia desconocida de *Jurinea*. *Bol. Soc. Esp. Hist. Nat.* 27: 221-224.

Ascomicet nou per a Espanya. *Butl. Inst. Catalana Hist. Nat.* 7: 24.

Una forma de *Conium maculatum* var. *inmaculatum*, àdhuc en el jardí de la Universitat de Barcelona. *Butl. Inst. Catalana Hist. Nat.* 7: 132-133.

Kirchneriella lunaris (Kirch) Moeb. àdhuc a Catalunya. *Butl. Inst. Catalana Hist. Nat.* 7: 133.

Campanula Scheuchzeri var. nov. *zygomorpha* Cuatr. *Bull. Soc. Bot. Genève* 1927: 280-281.

1928

*Nota sobre et *Leucanthemum arundanum* (Bss.) Cuatr. *Cavanillesia* 1: 41-44 + 1 fig.

Leon Guignard. *Cavanillesia* 3: 118-119.

1929

*Estudios sobre to flora y to vegetación del macizo de Mágina. *Trab. Mus. Ci. Nat. Barcelona* 12: 1-510.

Notas micológicas. *Mem. Real Soc. Esp. Hist. Nat.* 15: 23-30.

En Romuald González Fragoso. *Butl. Inst. Catalana Hist. Nat.* 9: 49-51.

1930

*Adiciones y correcciones a mis estudios sobre Mágina. *Cavanillesia* 3: 8-19.

*Una visita al pinsapar de Sierra de la Nieve. *Butl. Inst. Catalana Hist. Nat.* 10: 65-67.

Una familia nova per a la flora micológica peninsular. *Butl. Inst. Catalana Hist. Nat.* 10: 79-80.

Adolf Engler. *Cavanillesia* 3: 196-198.

1931

*De flora pyrenaica. I. Ojeada a la cliserie del Valle de Ordesa. *Cavanillesia* 4: 113-127.

La fitosociología en las costas de Garraf. Barcelona.

Richard Wettstein. *Cavanillesia* 4: 161-162.

1932

Die Verbreitung von *Fagus silvatica* auf der Iberischen Halbinsel. *Veröff. Geobot. Rübel Zürich,* Heft 8, 1-21.

El bicentenario de Mutis en Colombia. *Res. Cient. Soc. Esp. Hist. Nat.* 7: 49-63.

Programa de la Enseñanza de botánica descriptiva en la Facultad de Farmacia, curso de 1932. 1933: 1-16. Madrid.

Discurso de don José Cuatrecasas en el homenaje del Colegio Mayor del Rosario. *Lecturas Dominicales* 436: 12.

1933

*Plantae Colombianae novae. *Trab. Mus. Nac. Ci. Nat., Ser. Bot.* 26: 1-31 + 2 plates.

1934

La composicion química en sistemática vegetal. *Ciencias* (*Madrid*) I, 1: 1-6.

Observaciones geobotánicas en Colombia. *Trab. Mus. Nac. Ci. Nat., Ser. Bot.* 27: 1-144.

Charles C. Lacaita. *Cavanillesia* 6: 137-139.

Robert Chodat. *Cavanillesia* 6: 139-141.

1935

*Plantae novae Colombianae. Series altera. *Trab. Mus. Nac. Ci. Nat., Ser. Bot.* 29: 1-48.

*Impresiones sobre la vegetación de los Andes en Colombia. *Revista Acad. Ci. Exact. Zaragoza* 18: 29-41. [1934]

*Programa de la enseñanza de botánica descriptiva en la Facultad de Farmacia, Madrid.

La *Viola cazorlensis*, su distribución, sistemática y biología (with H. Melchior). *Cavanillesia* 7: 135-148.

*Plantae Isernianae I. *Bol. Univ. Madrid.* 4: 206-265.

1936

Datos geobotánicos de una visita a Torremolinos (with M. Laza). *Bol. Soc. Esp. Hist. Nat.* 63: 287-290.

*Resumen de mi actuación en Colombia con motivo del II Centenario del nacimento de Mutis. *Trab. Mus. Nac. Ci. Nat., Ser. Bot.* 33: 1-158.

1937

Don Carlos Pau. *Rev. Madrid. Cuaderm. Casa Cultura* 3: 1.

1938

La República reanuda la mejor tradición cultural española: La gran obra del botánico Mutis. *Bol. Inform. Inst. Cult. Minist. Instr. Publ. Barcelona* 2: 1-2.

1940

*Notas a la Flora de Colombia, I. *Revista Acad. Colomb. Ci. Exact.* 3: 247-250.

*Notas a la Flora de Colombia, II. *Revista Acad. Colomb. Ci. Exact.* 3: 425-438.

Nuevos encenillos de Colombia. *Ciencia (México)* 1: 253-254.

**Mutisia Caldasiana*, especia nueva de Colombia. *Ciencia (México)* 1: 308-309.

Una especie nueva de Bombacáceas en Colombia. *Ciencia (México)* 1: 401-402.

*Estudios sobre plantas andinas, I. *Caldasia* 1(1): 5-9 + 1 plate.

Palabras preliminares. *Caldasia* 1(1): 3-4.

1941

*Notas a la Flora de Colombia, III. *Revista Acad. Colomb. Ci. Exact.* 4: 158-169.

*Notas a la Flora de Colombia, IV. *Revista Acad. Colomb. Ci. Exact.* 4: 337-348.

Estudios sobre plantas andinas, II. *Caldasia* 1(2): 13-27.

*Impresiones sobre la vegetación de los Andes en Colombia. *España* 1: 14-16.

1942

*Notas a la Flora de Colombia, V. *Revista Acad. Colomb. Ci. Exact.* 5: 16-39.

Estudios sobre plantas andinas, III. *Caldasia* 1(5): 17-19.

Cucurbitaceae novae colombianae. -I. *Caldasia* 1(5): 21-28.

1943

*Estudios sobre plantas andinas. -IV. *Caldasia* 2: 5-9.

*Estudios sobre plantas andinas. -V. *Caldasia* 2: 209-240.

Algunos chites nuevos colombianos. *Ciencia (Mexico)* 4: 63-65.

Cucurbitaceae novae colombianae. -II. *Caldasia* 2: 141-148.

Resumen de unas observaciones geobotánicas en Colombia. *Revista Acad. Colomb. Ci. Exact.* 5: 289-294.

1944

*Notas a la Flora de Colombia, VI. *Trab. Com. Bot. Secr. Agric. Cali.* 43 pp. [Reproduced in *Revista Acad. Colomb. Ci. Exact.* 6: 32-67.]

1945

Notas a la Flora de Colombia, VII. *Revista Acad. Colomb. Ci. Exact.* 6: 274-299.

*Estudios sobre plantas andinas, VI. *Caldasia* 3: 421-437.

Frailejones nuevos de Venezuela. *Ciencia (México)* 6: 261-267.

1946

Notas a la Flora de Colombia, VIII. *Revista Acad. Colomb. Ci. Exact.* 6: 533-551.

Notas a la Flora de Colombia, IX. *Revista Acad. Colomb. Ci. Exact.* 7: 47-52.

Vistazo a la vegetacion del bajo Calima. *Publ. Secr. Agric. Fom. Valle (Colomb.):* 42-60.

1947

Vistazo a la vegetación del bajo Calima (2nd edition). *Revista Acad. Colomb. Ci. Exact.* 7: 306-312.

1948

New mural shows plant life of Colombia's high Andes. *Bull. Chicago Nat. Hist. Mus.* 19(1): 1-3.

Studies in South American plants, I. *Lloydia* 11: 185-225.

1949

*Les espècies del gènere *Espeletia*. *Butl. Inst. Catalana Hist. Nat.* 37: 3-14.

*Rosette trees, a tropical growth form that defies mountain climate. *Bull. Chicago Nat. Hist. Mus.* 20(10): 6-7.

Gutíferas nuevas o poco conocidas de Colombia. *Anales Inst. Biol. Univ. Nac. México* 20: 91-112.

Cecropia mocoana, Cecropia Porvenirensis and *Quararibea Schultesii*. *In* R.E. Schultes, Plantae Colombianae XII. *Bot. Mus. Leafl.* 14(2): 24-27, 31-32.

Borojoa, un nuevo género de Rubiáceas. *Publ. Sec. Agric. Ganad., Cali (Colombia)*, Agosto 1949. 4 pp.

1950

*Frailejonal, típico cuadro de la vida vegetal en los páramos andinos. *Revista Acad. Colómb. Ci. Exact.* 7: 457-461.

Borojoa, un nuevo género de Rubiáceas. *Revista Acad. Colomb. Ci. Exact.* 7: 478-481. (re-publication of 1949 article)

Notas a la Flora de Colombia, X. Guttiferae. *Revista Acad. Colomb. Ci. Exact.* 8: 33-64.

*Studies on Andean Compositae-I. *Fieldiana, Bot.* 27(1): 1-53.

Studies in South American plants-II. *Fieldiana, Bot.* 27(1): 55-113.

New and noteworthy Colombian trees. *Trop. Woods* 96: 37-47.

1951

New Proteaceae from Colombia. *Lloydia* 13: 198-204.

Notas a la Flora de Colombia, XI. *Revista Acad. Colomb. Ci. Exact.* 8: 297-328.

*Studies on Andean Compositae-II. *Fieldiana, Bot.* 27(2): 1-74.

Studies in South American plants-III. *Fieldiana, Bot.* 27(2): 75-113.

Luehopsis Schultesii and *Quararibea muricata*. *In* R. E. Schultes, Plantae Austro-Americanae VII. *Bot. Mus. Leafl.* 15(2): 49-52, 53-54.

Moraceae. *In* J. A. Steyermark, Contribution to the Flora of Venezuela. *Fieldiana, Bot.* 28: 210-216.

1952

Notas a la Flora de Colombia, XII. *Revista Acad. Colomb. Ci. Exact.* 8: 464-488.

Cunoniaceae. *In* J. A. Steyermark, Contribution to the Flora of Venezuela. *Fieldiana, Bot.* 28: 246-251.

Bombacaceae. *In* J. A. Steyermark, Contribution to the Flora of Venezuela. *Fieldiana, Bot.* 28: 363-366.

1953

*Estudios sobre plantas andinas, VII. *Mutisia* 16: 1-8.

*Estudios sobre plantas andinas, VIII. *Mutisia* 17: 1-12.

Caracterización del género *Borojoa*. *Acta Agron.* 3: 89-98.

*Senecioneae andinae novae. *Collect. Bot. (Barcelona)* 3: 261-307.

*Neue und bemerkenswerte andine Compositen. *Feddes Repert. Spec. Nov. Regni Veg.* 55: 120-153.

Un nouveau genre de Bombacées, *Patinoa*. *Rev. Int. Bot. Appl. Agric. Trop.* 33: 306-313.

Huertea, un genre nouveau pour la flore de Colombie. *Bull. Soc. Bot. France* 100: 159-163.

Une nouvelle espèce de *Theobroma*. *Rev. Int. Bot. Appl. Agric. Trop.* 33. 562-565.

*New taxa in the genus *Diplostephium*. *Bull. Torrey Bot. Club* 80: 401-408.

Notes on the cultivated Lulo *(Solanum quitoense)*. *Bot. Mus. Leafl.* 16: 97-105 (with R.E. Schultes).

1954

Novelties in Bombacaceae. *Phytologia* 4: 465-480.

Five new species of *Brunellia*. *Phytologia* 4: 481-485.

*Dos moráceas y dos compuestas nuevas de Venezuela. *Bol. Soc. Venez. Ci. Nat.* 15: 107-111.

*New species of Compositae from Ecuador, collected by W.H. Camp. *Brittonia* 8: 39-49.

*Estudios sobre plantas andinas, IX. *Mutisia* 19: 1-9.

Disertaciones sobre Bombacáceas. *Revista Acad. Colomb. Ci. Exact.* 9: 164-177.

*Notas a la flora de Colombia, XIII. *Revista Acad. Colomb. Ci. Exact.* 9: 233-249.

*Synopsis der Gattung *Loricaria* Wedd. *Feddes Repert. Spec. Nov. Regni Veg.* 56: 149-172.

*Nouvelles Composées de l'Amérique de Sud. *Bull. Soc. Bot. France* 101: 242-246.

*Distribution of the genus *Espeletia*. *Rapports et Communications, Huitième Congrès International de Botanique, Paris*, sect. 4, pp. 131-132.

Outline of vegetation types in Colombia. *Rapports et Communications, Huitième Congrès International de Botanique, Paris*, sect. 7, pp. 77-78.

*El género *Mniodes*. *Folia Biol. Andina (Puno)* 1: 1-7.

Review of the Proceedings of the 7th International Botanical Congress (Stockholm, 1950). *Ciencia y Tecnología, Pan American Union* 4: 182-184.

1955

*A new genus and other novelties in Compositae. *Brittonia* 8: 151-163.

Taxonomic notes on neotropical trees. *Trop. Woods* 101: 10-28.

**Matisia apaporiensis* Cuatr. and *Stenopadus colombianus* Cuatr. & Steyer. *Bot. Mus. Leafl.* 17: 82-84, 99-100.

El genero *Meliosma* en Colombia. *Caldasia* 7: 187-211 (with J. M. Idrobo).

Establishment of a permanent Commission for the publications of a Tropical American Flora. *UNESCO/NA/HT/75*.

1956

*Neue *Vernonia*-Arten und Synopsis der Andinen Arten der Sektion *Critoniopsis*. *Bot. Jahrb. Syst.* 77: 52-84.

Notas a la Flora de Colombia, XIV. *Revista Acad. Colomb. Ci. Exact.* 9: 325-341.

*Nouvelles espèces de l'Amérique du Sud récoltées par Le Professeur Henri Humbert. *Notul. Syst. (Paris)* 15: 233-240.

*Studies on Andean Compositae-III. *Brittonia* 8: 179-193.

Studies in South American plants-IV. *Brittonia* 8: 195-200.

Moráceas nuevas de Colombia. *Caldasia* 7: 287-304.

*Notas a la flora de Venezuela. *Bol. Soc. Venez. Ci. Nat.* 17: 80-97.

*El género *Hinterhubera* Weddell. *Bol. Soc. Venez. Ci. Nat.* 17: 98-104 (with L. Aristeguieta).

Theobroma. *In* J.F. Macbride, Flora of Peru. *Field Mus. Nat. Hist., Bot. Ser.* 13: 650-660.

*Esquema sumariado de la vegetación de la Provincia Norteandina. *Suelos Tropicales, Medellín* 1: 13-30.

1957

Prima Flora Colombiana. 1. Burseraceae. *Webbia* 12: 375-441.

The American species of *Dacryodes*. *Trop. Woods* 106: 46-65.

Fanerógamas colombianas recientemente descritas de posible interés farmacológico. *Memoria del 3er Symposio de Farmacobotánica Americana.Habana*, pp. 103-109.

The Colombian species of *Tetrorchidium*. *Brittonia* 9: 76-82.

*A sketch of the vegetation of the North-Andean province. *Proc. 8th Pac. Sci. Congr. Bot.* (Manila, 1953) 4: 167-173.

1958

Notes on American Solanaceae. *Feddes Repert. Spec. Nov. Regni Veg.* 61: 74-86.

The Colombian species *Juanulloa*. *Brittonia* 10: 146-150.

Burseraceae *(Paraprotium amazonicum)*. *In* R. E. Schultes, Plantae Austro-Americanae X. *Bot. Mus. Leafl.* 18: 156-158.

Prima Flora Colombiana. 2. Malpighiaceae. *Webbia* 13: 343-664.

*Aspectos de la vegetación natural de Colombia. *Revista Acad. Colomb. Ci. Exact.* 10: 221-268.

Introducción al estudio de los manglares. *Bol. Soc. Bot. México* 23: 84-98.

Report on the Tropical American Flora project. *UNESCO/NS/HT/78*, Paris. [Original in English, also translated into French and Spanish.]

1959

A critical new *Bursera* from Costa Rica. *Trop. Woods* 110: 30-32 (with L. 0. Williams).

Studies on South American Plants-V. *Brittonia* 11: 163-172.

Burseraceae. *In* L.B. Smith, The Machris Brazilian Expedition, Botany. *Los Angeles County Mus. Contr. Sci.* 30: 4-6.

New chiropterophilous Solanaceae from Colombia. *J. Wash. Acad. Sci.* 49: 269-272.

1960

*Studies on Andean Compositae-IV. *Brittonia* 12: 182-195.

Supplemental notes on the American species of Passifloraccae with descriptions of new species [by J. Cuatrecasas]. By E. P. Killip. *Contr. U.S. Natl. Herb.* 35: 1-23.

*Dos Compuestas nuevas de Venezuela. *Bol. Soc. Venez. Ci. Nat.* 21: 302-306.

Prima Flora Colombiana. 2A. Malpighiaceae, Apéndice 1. *Webbia* 15: 393-398.

1961

A taxonomic revision of the Humiriaceae. *Contr. U.S. Natl. Herb.* 35: 21-214.

Burseraceae Brasiliae Novae. *Bol. Mus. Paraense Emílio Goeldi, n. s., Bot.*, 11: 1-10.

*Notas sobre Astereas Andinas. *Ciencia (México)* 21: 21-32.

*Studies on Andean Compositae V. *Proc. Biol. Soc. Wash.* 74: 7-28.

*Una nueva especie de *Erigeron* de Venezuela y Colombia. *Bol. Soc. Venez. Ci. Nat.* 22: 5-7.

A new Burseraceae from Santa Catarina. *Sellowia* 13: 261-263.

Humiriaceae. *In* Catalogo e Estadística dos Gêneros Botânicos Fanerogâmicos. *Inst. Paranaensis, Bot.* 54: 2.

Importancia de la ciencia en la educación. *Revista Acad. Colomb. Ci. Exact.* 11(43): IX-XIII.

1962

Studies in South American Plants-VI. *Brittonia* 14: 50-57.

Summary report of the Flora Neotropica project, at the São Paulo meeting.

1963

*Notes on Neotropical Compositae, I. *Phytologia* 9: 1-7.

El género *Theobroma* en la "Flora Peruviana et Chilensis" de Ruíz y Pavón. *Ciencia (México)* 22(4): 85-92 (with E. Alvarez López).

Una impresión personal de Paul Standley. *In* L. 0. Williams (editor), *Homage to Standley*, pp. 88-89. Chicago Natural History Museum.

1964

Cacao and its allies; a taxonomic revision of the genus *Theobroma. Contr. U.S. Natl. Herb.* 35: 379-614.

*Miscelánea sobre Flora Neotrópica, I. *Ciencia (México)* 23: 137-151.

*Studies on Andean Compositae: VI. *Proc. Biol. Soc. Wash.* 77: 127-156.

Theobroma. Flora of Panama. *Ann. Missouri Bot. Gard.* 51: 89-97.

1965

*Some new Compositae from Peru. *Ann. Missouri Bot. Gard.* 52: 304-313.

Una Bombacácea nueva de Venezuela. *Bol. Soc. Venez. Ci. Nat.* 24: 153-155.

*Miscelánea sobre Flora Neotrópica, II. *Ciencia (México)* 24: 121-124.

1966

El genero *Sorocea* (Moraceae) en la costa occidental de Colombia. *Ciencia (México)* 24: 185-188.

Establecimiento de la "Organización pro Flora Neotrópica." *Ciencia (México)* 24: 267-270.

1967

*Estudios sobre plantas Andinas, X. *Caldasia* 10: 3-26.

Moraceae. *In* J. A. Steyermark. Flora del Auyan-tepui. *Acta Bot. Venez.* 2: 202-205.

*Revisión de las especies colombianas del género *Baccharis*. *Revista Acad. Colomb. Ci. Exact.* 13: 5-102.

Plant introduction with *Theobroma cacao*. *Proc. Int. Symp. Plant Introd. (Tegucigalpa)*, pp. 137-145 (with E. P. Imle).

*Chromosome numbers in Compositae, XI, Peruvian species. *Ann. Missouri Bot. Gard.* 54: 172-177 (with B. L. Turner and A. M. Powell).

1968

Dos araliáceas nuevas de Colombia. *Collect. Bot. (Barcelona)* 7: 221-226.

*Páramo vegetation and its life forms. *Colloq. Geogr.* 9: 163-186.

1969

*Prima Flora Colombiana. 3. Compositae-Astereae. *Webbia* 24: 1-335.

*Notas adicionales, taxonómicas y corológicas, sobre *Baccharis*. *Revista Acad. Colomb. Ci. Exact.* 13: 201-226.

1970

Brunelliaceae. *Fl. Neotrop. Monogr.* 2: 1-189.

*Reinstatement of genus *Llerasia* (Compositae). *Biotropica* 2: 39-45.

Una nueva mirtácea frutal de la costa del Pacífico. *Mutisia* 32: 6-8.

La Organización pro Flora Neotrópica. *II Simposio y foro de biología tropical amazónica. Bogotá, Colombia*, pp. 284-286.

*Chromosome number in Compositae: Colombian and Venezuelan species. *Ann. Missouri Bot. Gard.* 57: 374-379 (with A. M. Powell).

*Observaciones sobre Compositae. *Anales Esc. Nac. Ci. Biol.* 18: 9-15. [dated 1969 and 1970, possibly printed and distributed in 1971]

1971

*Miscellaneous notes on neotropical flora. *Phytologia* 20: 465-481.

Cunoniáceas. *In* P. R. Reitz, *Flora Illustrada Catarinense*, pp. 1-22 (with L. B. Smith).

1972

*Miscellaneous notes on neotropical flora, II. *Phytologia* 23: 350-365.

A new species of ichthyotoxic plant from the Amazon. *Bot. Mus. Leafl.* 23: 129-136 (with R.E. Schultes).

*Miscelánea sobre flora Neotropica, III. *Ciencia (México)* 27: 171-184.

*Algo sobre Compositae en la Flora de Colombia. *Mem. Symp. I Congr. Latin-Amer. Mexico Bot.*, pp. 157-166.

Armando Dugand. *Taxon* 21: 377-378.

1973

*Miscellaneous notes on neotropical flora, III. *Phytologia* 25: 249-256.

*Synopsis of the genus *Philoglossa* (Liabeae, Asteraceae). *Phytologia* 26: 381-388 (with H. Robinson).

*Supplemental characterization of the genus *Pseudoconyza* (Compositae, Inuleae-Plucheinae). *Phytologia* 26: 410-412.

A new species of *Brunellia* from Panama. *Phytologia* 26: 485-486 (with D. M. Porter).

*Miscellaneous notes on neotropical flora, IV. *Phytologia* 27: 41-51.

*Miscellaneous notes on neotropical flora, V. *Phytologia* 27: 169-179.

*The generic limits of *Pluchea* and *Tessaria* (Inuleae, Asteraceae). *Phytologia* 27: 277-285 (with H. Robinson).

1975

*Miscellaneous notes on neotropical flora, VI. *Phytologia* 29: 369-385.

Brunelliaceae. Flora of Panama. *Ann. Missouri Bot. Gard.* 62: 11-14 (with D.M. Porter).

*Miscellaneous notes on neotropical flora, VII. *Phytologia* 31: 317-333.

*Chromosome numbers in Compositae, Colombian and Venezuelan species. *Taxon* 24: 675-676 (with A.M. Powell).

*Miscellaneous notes on neotropical flora, VIII. *Phytologia* 32: 312-326.

1976

*A new subtribe in the Heliantheae (Compositae): Espeletiinae. *Phytologia* 35: 43-61.

Cecropia steyermarkii Cuatr., sp. nov. (Moraceae). *Bol. Soc. Venez. Ci. Nat.* 32(132-133): 231.

1977

**Westoniella*, a new genus of the Astereae from the Costa Rican páramos. *Phytologia* 35: 471-487.

*Notes on the genus and species limits of *Pseudogynoxys* (Greenm.) Cabrera. *Phytologia* 36: 177-192 (with H. Robinson).

*Miscellaneous notes on neotropical flora, IX. *Phytologia* 38: 7-22.

1978

Una nueva crucífera de la Sierra Nevada del Cocuy (Colombia). *Caldasia* 12: 145-158 (with A.M. Cleef).

*Miscellaneous notes on neotropical flora, X. *Phytologia* 40: 25-36.

*A review of the Central American species of *Pentacalia* (Asteraceae: Senecioneae). *Phytologia* 40: 37-50 (with H. Robinson).

*Studies in neotropical Senecioneae, Compositae I. Reinstatement of genus *Lasiocephalus*. *Phytologia* 40: 307-312.

1979

*Growth forms of the Espeletiinae and their correlation to vegetation types of the high tropical Andes. *In* K. Larsen and L. B. Holm-Nielsen, eds., *Tropical botany*, pp. 397-410. Academic Press, London.

*Comparación fitogeográfica de Páramos entre varias Cordilleras. *In* M. L. Salgado-Labouriau, ed., El medio ambiente páramo, *Actas del seminario de Mérida, Venezuela*, pp. 89-99. Caracas, Centro Estudios Avanzados.

1980

Malpighiaceae. Flora of Panama. *Ann. Missouri Bot. Gard.* 67: 851-945 (with T. Croat).

*La inflorescencia en la taxonomía de las Espeletiinae (Heliantheae, Compositae). *Memorias, VI congreso venezolano de botánica, U.C.A., Maracay*, pp. 191-194. Facultad de Agronomía.

*Miscellaneous notes on neotropical flora, XI. *Phytologia* 45: 17-29.

*Neue Diterpene aus der Subtribus Espeletiinae. *Phytochemistry* 19: 267-271 (with R. Bohlmann, H. Wuding, R. M. King and H. Robinson).

*Neue Sesquiterpene und Norditerpene aus Vertretern der Gattung *Libanothamnus*. *Phytochemistry* 19: 1145-1148 (with F. Bohlmann, C. Zdero, R. M. King and H. Robinson).

*Tricyclic sesquiterpenes and further diterpenes from *Espeletiopsis* species. *Phytochemistry* 19: 2399-2403 (with F. Bohlmann, H. Suding, H. Robinson and R. M. King).

*Un nuevo género Colombiano de Senecioneae (Compositae). *Bol. Soc. Argent. Bot.* 19: 13-17.

*Miscellaneous notes on neotropical flora, XII. *Phytologia* 47: 1-13.

1981

*Miscellaneous notes on neotropical flora, XIII. *Phytologia* 49: 69-75.

*Studies in neotropical Senecioneae II. Transfers to genus *Pentacalia* of North Andean species. *Phytologia* 49: 241-260.

1982

*Miscellaneous notes on neotropical flora, XIV. *Phytologia* 52: 157-159.

*Studies in neotropical Senecioneae III. New taxa in *Senecio, Pentacalia* and *Gynoxys*. *Phytologia* 52: 159-166.

*Miscellaneous notes on neotropical flora, XV. New taxa in the Astereae. *Phytologia* 52: 166-177.

1984

*Observations of the genus *Gynoxys* in Ecuador (Senecioneae, Asteraceae) (with H. Robinson). *Phytologia* 56: 368-375.

1985

Brunelliaceae, Supplement. *In Fl. Neotrop. Mongr.* 2(Suppl.): 28-103.

*Miscelánea sobre flora neotrópica, IV. *Fontqueria* 8: 9-18.

*Studies in neotropical Senecioneae IV. New taxa in *Senecio* and *Cabreriella*. *Proc. Biol. Soc. Wash.* 98: 623-626.

*Studies in neotropical Senecioneae V. Two new species of *Pentacalia* from Colombia. *Phytologia* 57: 169-174.

*Nomenclatura plantarum Americanarum III. Compositae. *Phytologia* 58: 475-476 (with A. Lourteig).

1986

*Miscelánea sobre flora neotrópica, IV. Addenda. *Fontqueria* 9: 5-7.

*Un género nuevo de Astereae, Compositae, de Colombia. *Anal. Jard. Bot. Madrid* 42: 415-426.

*Miscellaneous notes on neotropical flora, XVI. New taxa in the Espeletiinae. *Phytologia* 61: 51-61.

*Dos géneros nuevos de Compositae de Colombia. *Caldasia* 15(71-75): 1-14.

*Speciation and radiation of the Espeletiinae in the Andes. *In* Vuillemier & Monasterio (editors), *"High Altitude Tropical Biogeography"* pp. 267-303. Oxford University Press.

1987

*Clave diagnóstica de las especies de *Ruilopezia* (Espeletiinae, Heliantheae, Compositae). *Anal. Jard. Bot. Madrid* 44: 401-419.

1988

Miscellaneous notes on neotropical flora, XVII. New species of *Meliosma*. *Phytologia* 64: 489-494.

Pius Font Quer, 1888-1964. *In Miscellania Botanica.* Llibre d'homenatje a P. Font Quer, pp. 59-63. Edicions Institut d'estudis Illerdencs.

Tres nuevas especies de *Meliosma* Blume (Sabiaceae) de Colombia (with J. Idrobo). *Ernstia* 49: 8-14.

1989

*Compuestas - Asteréas. *In* J.C. Mutis, *Flora de la Real Expedición Botánica del Nuevo Reyno de Granada* XLVII. Ediciones de Cultura Hispánica Madrid (with S. Díaz-Piedrahita).

1990

Miscelanea sobra flora neotrópica V. Algunas novedades en *Ilex*. *Revista Acad. Colomb. Ci. Exact.* 17: 631-635.

*El género *Aequatorium* Nordenstam (Senecioneae, Asteraceae) en Colombia. *Revista Acad. Colomb. Ci. Exact.* 17: 659-666 (with S. Díaz-Piedrahita).

Miscellaneous notes on neotropical flora, XVIII. New species in the Humiriaceae. *Phytologia* 68: 260-266.

*Miscellaneous notes on neotropical flora, XIX. Combinations in Senecioneae, Compositae. *Phytologia* 69: 313-315.

*Nuevas especies de *Pentacalia*. *Revista Acad. Colomb. Ci. Exact.* 17: 687-690 (with S. Díaz-Piedrahita).

1991

*Especie nueva de *Diplostephium* de Colombia y sinonimos de *D. ericoides* del Ecuador. *Revista Acad. Colomb. Ci. Exact.* 18: 123-125.

*Expediciones y colecciones entre 1942-1947, VALLE. *Cespedesia* 15-16(57-58): 17-38.

Miscellaneous notes on neotropical flora, XX. A new species of *Humiriastrum*. *Phytologia* 71: 165-166.

*Nueva especie de *Baccharis* (Asteraceae) de Colombia. *Revista Acad. Colomb. Ci. Exact.* 18: 127-129 (with S. Díaz-Piedrahita).

1992

**Thelechitonia* Cuatrecasas, an older name for *Complaya* Strother (Ecliptinae-Heliantheae-Asteraceae). *Phytologia* 72: 141-143 (with H. Robinson).

*Additions to *Aequatorium* and *Gynoxys* (Senecioneae: Asteraceae) in Bolivia, Ecuador, and Peru. *Novon* 2: 411-416 (with H. Robinson).

1993

*Miscelanea sobre flora neotrópica VI. Dos especies nuevas de *Diplostephium* del Perú. *Revista Acad. Colomb. Ci. Exact.* 18: 475-477.

Miscellaneous notes on Neotropical flora XXI. A new species of *Humiriastrum* from Brazil. *Phytologia* 75: 235-238.

*New species of *Pentacalia* (Senecioneae: Asteraceae) from Ecuador, Peru, and Bolivia. *Novon* 3: 284-301 (with H. Robinson).

1994

*Miscellaneous notes on Neotropical flora XXII. Identification of the genus *Phyllostelidium* and a few new combinations in the Compositae.*Phytologia* 76: 402-405.

**Jessea* and *Talamancalia*, two new genera of the Senecioneae (Asteraceae) from Costa Rica and Panama. *Novon* 4: 48-52 (with H. Robinson).

*Adiciones al genero *Pentacalia* (Asteraceae, Senecioneae) en Colombia. *Revista Acad. Colomb. Ci. Exact.* 19: 21-23 (with S. Díaz-Piedrahita)

1995

*A new genus of the Compositae: *Paramiflos* (Espeletiinae) from Colombia. *Proc. Biol. Soc. Wash.* 108: 748-750.

1996

*Clave provisional de las especies del género *Espeletiopsis* Cuatrec. (Espeletiinae, Compositae). *Anales Jard. Bot. Madrid* 54: 370-377.

In Press

*Key to the species of *Oritrophium* (Asteraceae: Astereae). *BioLlania*, edición especial no.6: 000-000.

In 1993 Dr. Cuatrecasas wrote a short article for a volume to honor Dr. Richard Schultes. Although we have a copy of the manuscript we have no record of it having been published.

Fig. 1.

Paramo of Nevado del Cocuy, Boyaca, Colombia: Pozo Azul ± 4200 m alt. Cabin made with stems of *Espeletia lopezii* and (the roof) of *Calamagrostis effusa*. It is a good shelter, a free "hotel" for every temporary worker coming to this paramo. A big amount of *Espeletia* leaves on the ground inside served as a mattress for all "guests". The small tree at left: *Gynoxys paramuna*. The white Compositae herbs in front are *Senecio (Culcitium) canescens*. Bushes on the slope: *Pentacalia flos-fragrans* v. *frigidophila, Vaccinium floribundum, Diplostephium colombianum, D. rhomboidale, Valeriana arborea, Pentacalia guicanensis, P. andicola, Loricaria complanata, Miconia chionophila, Hypericum bryoides, Baccharis tricuneata*, etc.

Photo: J. Cuatrecasas, 12 Sept. 1938.

FLORAL MICROCHARACTERS AND TAXONOMY OF THE GENUS *TITHONIA* (HELIANTHEAE: ASTERACEAE) IN NIGERIA

M.A. Isawumi
Natural History Museum
Obafemi Awolowo University
Ile-Ife, Nigeria

Abstract

The present treatment reports the occurrence of two taxa for Nigeria of the 13 *Tithonia* taxa reported for the whole world. Morphologically, the two species have some distinctness. The floral microcharacters of the species are described.

Introduction

Tithonia Desf. ex Juss. was first described by Jussieu (1789). Blake (1918) moved a number of taxa of *Gymnolomia* H.B.K. into *Tithonia* and made the first major revision of the genus in 1921, recognizing ten species and two subspecies (twelve taxa in all). In the recent revision of the genus, La Duke (1982) recognized eleven species and two subspecies (thirteen taxa) in two sections. The taxa are distributed primarily in southern Mexico and central America. They are also introduced worldwide and escaped.

Two taxa, *T. diversifolia* (Hemsl.) A. Gray and *T. rotundifolia* (Miller) S. F. Blake have been reported to be quite similar in a number of features and they have been misidentified in a number of recent publications (Pal et al. 1976, Herz & Sharma 1975, and others). In spite of the similarities between them, La Duke (1982) found that they could be consistently differentiated from one another and should be retained at the rank of species. These two taxa have been consistently misidentified in Nigeria and West Africa as one species, *T. diversifolia*. The main thrust of this work therefore is to give the distinguishing features for the proper identification of the two taxa in Nigeria.

Materials and Methods

The plant specimens for the work were collected from different locations in Nigeria and the voucher specimens were lodged in the herbarium of the Natural History Museum, Obafemi Awolowo University, Ile-Ife (UNIFEM). For the micromorphological observations, florets were softened in boiling water to which a drop of detergent was added, dissected under a stereo microscope, mounted in Hoyer's solution (Anderson 1954, King & Robinson 1970) and studied with LM.

Results and Discussion

Macromorphology

Morphologically, *T. rotundifolia* has been often confused with *T. diversifolia*, from which it differs in many features. *T. rotundifolia* is an annual, with broad-lanceolate phyllaries in 2 series, 13—16 in number (Table 1), and ray ligules orange, about 33 mm long, whereas *T. diversifolia* is a herbaceous perennial, with broadly ovate phyllaries in 3 series, 16—19 in number (Table 1), and ray ligules yellow, 48—69 mm long, and with an unusual auricle at the base of the petiole. Peduncles are stout and swollen just below the capitula in *T. diversifolia*, but rather slender in *T. rotundifolia*. In the material studied *T. diversifolia* has ray-florets about 10—13, disc-florets 107—170, while *T. rotundifolia* has ray-florets about 9—10 and disc-florets 74—91 (Table 1). The two taxa often are confused everywhere including Nigeria due to the similarity of 3—5-lobed leaves.

Corolla pubescence

Disc corolla with 5 lobes at apex, throat cylindrical with bulging minutely pubescent base, cylindrical portion 3—5 mm long (Figs. 1A, 2F). Corolla throat in *T. diversifolia* with trichomes about 1—3 cells long, while those in *T. rotundifolia* are up to 5 cells long. Corolla lobe of *T. rotundifolia* has papillae and short trichomes about 3 cells long while the lobes of *T. diversifolia* are with short papillae only.

Ducts (coloured yellow) single or paired along veins of disc corolla throats and tubes, extending a bit into the lobes (Fig. 1B). There are about 2—3 bundles of veins with ducts in a lobe, beside those on the margins, in *T. diversifolia* whereas there is only one bundle in each lobe in *T. rotundifolia*.

Style

Disc styles bifid with hispidulous hairs at the tip of the branches, with single narrow stigmatic surface, at base usually swollen with distinct small cells regularly shaped in *T. diversifolia* (Fig. 1C), whereas such cells are lacking in *T. rotundifolia* (Fig. 2G); style ducts outside veins in shaft (Figs. 1C, 2G).

Anther apical appendage

The anther apical appendages are not significantly different in the two species. The anther appendages are glandular and ovate with a constricted base (Figs. 1D; 2H, J). The presence of glands on the appendages is an indication of the exotic nature of the taxa because glands have not been reported present on the appendages of the indigenous plants in Africa.

Endothecial tissue

The endothecial tissue in the two species is polarized with the cells having 1—2 thickenings on the transverse walls. In this way, the taxa exhibit one of the characteristics of the subtribe Helianthinae as pointed out by Robinson (1981).

Filament

The filament collars are more or less widened towards the base in the two species. Pubescence on the filaments occurs sporadically in the Heliantheae (Robinson 1981). Of the two species studied only *T. rotundifolia* has hispidulous hairs on the filament (Fig. 2H). The hairs are very short or absent immediately below the point of insertion of the filament to the collar, but become more conspicuous distally

Anther thecae

Many genera of the Heliantheae have anthers that blacken at maturity due to pigments in the outer layer of the thecial wall (Robinson 1981). This blackening occurs on the anthers of the two taxa studied. On the other hand their anthers are shortly calcarate because the thecae are not distinctly prolonged below the point of filament insertion (Figs. 1D, 2H).

Cypsela

The main feature of the cypsela in the tribes Eupatorieae and Heliantheae is the presence of the carbonization or black layer formed by the materials known as phytomelanins (Robinson 1981). The two taxa have their cypsela walls carbonized with distinct striations and without ovary wall crystals.

The disc cypselas in the two taxa are black or mottled, pubescent, quadrangular and at base smooth without elaiosome (Figs. 1E, 2K). The cypselas are completely covered with aristate-tipped scales. The cells of the twin hairs (Hess 1938) covering the cypselas are almost of the same length; the pappus is of fused squamellae basally and laterally with 2 subequal awns; the awns in *T. rotundifolia* are about 5 mm long, while those in *T. diversifolia* are about 4 mm long.

The carpopodium has two short, rounded, opposing lobes in both taxa (Figs. 1E, 2K). The cells of the seed coat in both taxa are weakly ornamented.

Key to the species of *Tithonia* in Nigeria

1. Phyllaries broad-lanceolate, 13—16, in 2 series; ray-florets orange, 9—10; ligules c. 33 mm long; disc-florets 74—91; filaments pubescent .... 1. *T. rotundifolia*

2. Phyllaries broadly ovate, 16—19, in 3 series; ray-florets yellow, 10—14; ligules 48—69 mm long; disc-florets 107—170; filaments glabrous..... 2. *T. diversifolia*

1. *Tithonia rotundifolia* (Miller) S.F. Blake, Contr. Gray Herb. ser. 52:41 (1917); La Duke, Rhodora 84: 453—522 (1982).

Tagetes rotundifolia Miller, Gard. Dict. ed. 8 *Tagetes* # 4 (1768). — Type: Mexico, Veracruz, grown from seed, probably at the Chelsea garden, W. Houstoun s.n. (Holotype, BM! [Photo, GH!, NY!, OS!, UC!]). — For complete synonymy see La Duke (1982).

2. *Tithonia diversifolia* (Hemsl.) A. Gray, Proc. Amer. Acad. Arts 19:5 (1983); La Duke, Rhodora 84: 453—522 (1982).

Mirasolia diversifolia Hemsl. in Godman & Salvin, Biol. Contr. Amer. Bot. 2: 168 t. 47 (1881). — Type: Mexico, Veracruz, Valley of Orizaba, 12 May 1866, E. Bourgeau 2319 (Lectotype, K!, [Photo, OS!]; Isolectotypes, BR!, FI!, GH!, S!, US!).

Tithonia diversifolia var. *glabriuscula* S.F. Blake, Contr. U.S. Nat. Herb. 20: 435 (1921). — Type: Mexico, Oaxaca, N of Tuxtepec, 90 m, 9 Apr. 1894, E. W. Nelson 346 (Holotype, US!) — For complete synonymy see La Duke (1982).

Conclusion

The two taxa are very distinct and could be easily separated. The confusion often experienced in their identification is due to their similar 3—5-lobed leaves and hearty habit.

Their distinctness was further established by La Duke (1982), when he placed *T. rotundifolia* in section *Tithonia* series *Tithonia* and *T. diversifolia* in section *Tithonia* series *Grandiflorae*.

T. diversifolia is the most widespread taxon of *Tithonia* (La Duke 1982). According to him it has been successfully cultivated in Africa, Australia, Asia, and North America, where it has escaped. In Nigeria it is found blooming with show of conspicuous brilliantly coloured flowers along roads or any open place in the country. *T. rotundifolia* grows sometimes along with it. Both taxa flower from October to January and reach a bushy stature.

T. rotundifolia is a new record for Nigeria and West Africa as a whole. However, *T. diversifolia* has been reported present in Nigeria by Akobundu & Agyakwa (1987) as an introduced plant.

Acknowledgement

I thank Messrs A. A. Elufisan and J. O. Olaleye, both of the Natural History Museum, Obafemi Awolowo University, Ile-Ife, Nigeria, for their assistance during the preparation of this work.

References

Akobundu, I. O. & C. W. Agyakwa 1987. *A handbook of West African Weeds.* International Institute of Tropical Agriculture, Ibadan, Nigeria.

Anderson, L. E. 1954. Hoyer's solution as a rapid mounting medium for bryophytes. *Bryologist* 57: 242–247.

Blake, S. F. 1918. A revision of the genus *Viguiera. Contr. Gray. Herb.* 54: 1–205.

Blake, S. F. 1921. Revision of the genus *Tithonia. Contr. U.S. Natl. Herb.* 20: 423–436.

Herz, W. & R. P. Sharma 1975. A trans-1, 2-cis-4,5-germacradienolide and other new germacranolides from *Tithonia* species. *J. Org. Chem.* 40: 3118–3123.

Hess, R. 1938. Vergleichende Untersuchungen über die Zwillinghaare der Compositen. *Bot. Jarb. Syst.* 68: 435—496.

Jussieu, A. L. de 1789. *Genera Plantarum.* Facsimile edition 1964, J. Cramer, Weinheim.

King, R. M. & H. Robinson 1970. The new synantherology. *Taxon* 19: 6–10.

La Duke, J. C. 1982. Revision of *Tithonia. Rhodora* 84: 453–521.

Pal, R., Kulshreshtla, D. K. & R. P. Rastogi 1976. Antileukemic and other constituents of *Tithonia tagetiflora* Desf. *J. Pharm. Sci.* 65: 918–920.

Robinson, H. 1981. A revision of the tribal och subtribal limits of the Heliantheae (Asteraceae). *Smithsonian Contr. Bot.* 51: 1–102.

Table 1. **Number of florets and phyllaries per capitulum of *Tithonia* specimens from different locations**

Species	No of. ray-florets	No. of disc-florets	Total	No. of phyllaries
T. diversifolia	13	170	183	17
	13	121	134	18
	13	157	170	19
	10	107	117	16
T. rotundifolia	9	89	98	13
	9	74	83	16
	10	91	101	15

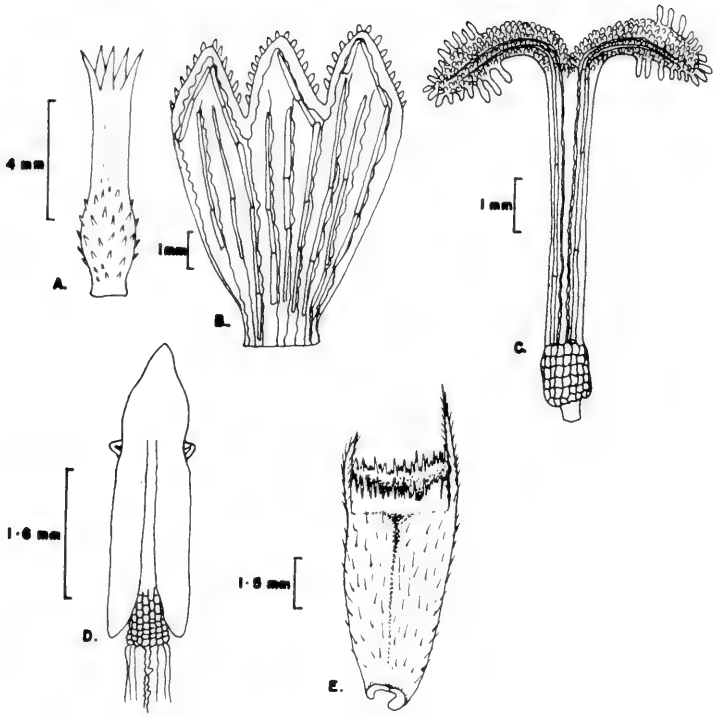

Fig. 1. ***T. diversifolia***

A: Disc corolla 5-lobed with bulging, cylindrical and minutely pubescent throat. **B:** Disc corolla with resin ducts along veins in the throats, tubes and lobes. **C:** Disc style bifid with hispidulous hairs at the tip of the branches, with single narrow stigmatic surface, at base swollen with small regular cells. **D:** Anther with ovate apical appendage and glabrous filament. **E:** Cypsela hairy with bilobed carpopodium, pappus of fused squamellae basally and laterally with 2 subequal awns. - A—E: Isawumi & Elufisan 1793 (UNIFEM).

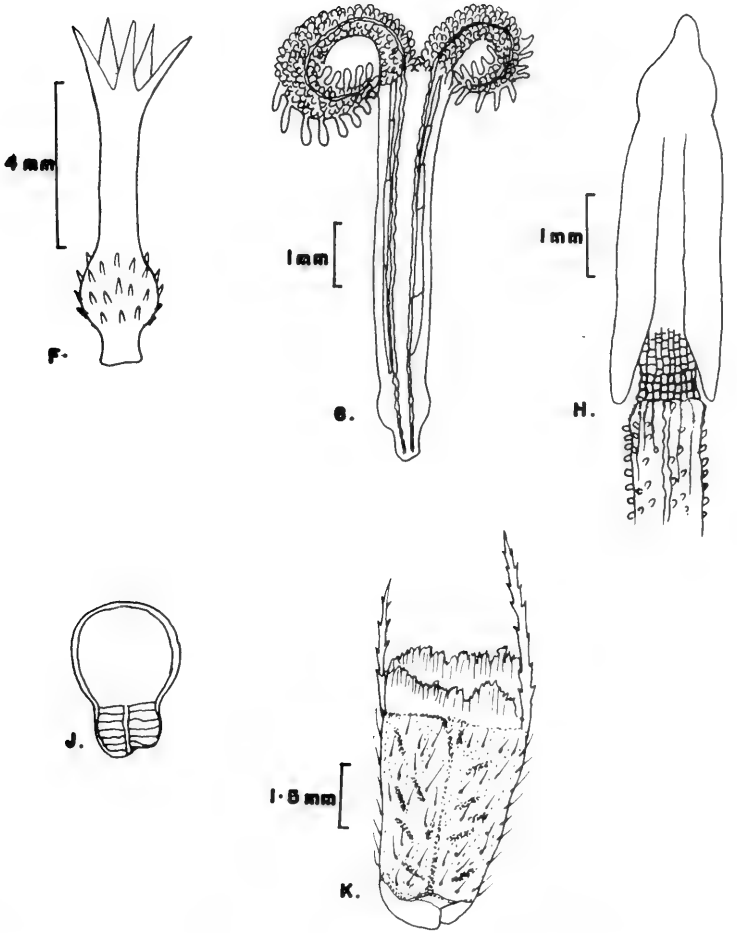

Fig. 2. *T. rotundifolia*

F: Disc corolla minutely pubescent on the bulging, cylindrical throat. **G:** Disc style bifid with resin ducts along the veins in shaft, and single stigmatic surface on the branches. **H:** Anther with ovate apical appendage and pubescent filament. **J:** Glandular trichome on the apical appendage. **K:** Cypsela hairy with bilobed carpopodium, fused squamellae and 2 subequal awns. - F—K: Isawumi & Elufisan 1801 (UNIFEM).

VESICULAR ARBUSCULAR MYCORRHIZAE IN PLANTS OF COMPOSITAE: OCCURRENCE, IDENTITY AND SIGNIFICANCE

Rajni Gupta and K.G. Mukerji
Applied Mycology Laboratory
Department of Botany
University of Delhi
Delhi - 110007, India

Abstract

The VAM (Vesicular Arbuscular Mycorrhizae) fungi are extensively present in soils of Delhi including University campus. Association of VAM fungi amongst the roots of various plants belonging to family Compositae, namely *Ageratum, Bidens, Blumea, Eclipta, Galinsoga, Gnaphalium, Launaea, Sonchus, Tridax* and *Vernonia,* were studied. Except for *Blumea bifoliata* and *Gnaphalium purpureum,* in all plants studied VAM colonization was about 40-100%.

Introduction

The vesicular arbuscular mycorrhizae (VAM) are wide-spread in occurrence and because of their potential for crop improvement have been investigated extensively (Mukerji 1995, Powell & Bagayraj 1984). All soils contain either spores of VA mycorrhizal fungi or mycorrhizae formed by them (Mosse 1973). Most of the plants are VA mycorrhizal, but little work has been done in the Compositae. Since VAM influence soil fertility and thus the growth and developments of plants, their study is essential. Such investigations are not only of great botanical interest, but also important in social forestry and land reclamation (Mukerji & Dixon 1992). The present investigation was undertaken in order to characterize and quantify the VAM associations in roots of Compositae weeds growing in Delhi.

Material and Methods

A survey was made to examine VAM formation in natural dense populations of composites growing in and around Delhi University. In all 10 genera were investigated; their roots were carefully dug out at the time of seed setting, selecting 10 plants at random for each species. Roots were gently washed with fresh water and kept in 10% KOH solution for 48 hours. After that KOH was drained out and roots were carefully washed with fresh water and stained with 0.1% Trypan blue stain (Philips & Hayman 1970). Percent VAM colonization was calculated using Nicolson's simple formula (1995):

$$\% \text{ colonization} = \frac{\text{No. of segments colonized with VAM}}{\text{Total no. of segments observed}} \times 100$$

The spores from the rhizosphere soil of each plant were isolated by Gerdemann & Nicolson's (1963) wet sieving and decanting technique. Spores were mounted in lactophenol and identified using standard key (Hall 1983, Schenck & Perez 1990).

Observations and Discussion

The results of this investigation clearly indicate that many, perhaps most of the plants belonging to the family Compositae are vesicular arbuscular mycorrhizal. The amount of vesicles and arbuscules formed in roots varied in all plants (Table 1, 2). The shape of vesicles may be oval or rounded.

In *Ageratum conyzoides* external hyphae were absent. Internal hyphae were distinguished as arbuscules or vesicles. Vesicles were oval in shape, and the number of vesicles was very low. Y-shape hyphae were also present. See Table 2 and Fig. 1 (A-H) for presence of arbuscules, external hyphae, number of vesicles and shape.

Further, in the plants of *Galinsoga parviflora* arbuscules were densely present. They were dichotomously branched and were of dominant type. Percent infection of arbuscules is 40%, number of vesicles per one cm root bits is 5, and number of spores per 100 gm rhizosphere soil is 11. The dominant VAM fungal spores in the rhizosphere soil consisted of *Glomus macrocarpum* and *Glomus fasciculatum.*

A comparative study of diseased and healthy plants of *Sonchus arvensis* was made. Diseased *Sonchus arvensis* was severely infected by *Bremia lactuca,* in its roots external hyphae were densely present, and with this appresoria formation was alsopresent, while in the healthy plants number of vesicles and arbuscules per one cm was also high. So it can be concluded that VAM increased the foliar infection in this plant (Zaidi & Mukerji 1983).

Out of ten Compositae species only two did not show any association. The other eight species were highly colonized by the VAM fungi (Table 1, 2). In diseased *Sonchus arvensis* VAM colonization was found to be very high, i.e. 90% of the root segments were colonized, and about 20 vesicles per one cm root bits were found. In *Vernonia cinerea* 80% of the root segments were colonized, and 8 vesicles were present per one cm root bits. In the roots of *Ageratum conyzoides* only 40 % of the root segments were colonized, and the number of vesicles present in one cm root bits was only 2. In the roots of *Vernonia cinerea* the number of vesicles per one cm is low, but the number of spores per 100 gm rhizosphere soil is high, i.e. 20. Ammani et al. (1994) also reported a high percentage of mycorrhization but low number of spores from various habitats.

VAM fungi provide the plant with minerals especially phosphorus, while the plant supplies the fungus with photosynthetic sugars. The bidirectional transport leads to enhanced plant growth and the completion of the fungal life cycle. For these reasons, mycorrhizal symbiosis is an attractive system in agriculture and forest management to enhance crop and wood production in the sense of a sustainable agriculture and restoring soil fertility (Bansal & Mukerji 1994 a, b, Varma 1995). Since roots of some plants are heavily VA mycorrhizal, they are indirectly fertilizing the soil (Mukerji & Dixon 1992).

References

Ammani, K., Venkateswarlu, K. & A. S. Rao 1994. Vesicular-arbuscular mycorrhizae in grasses: their occurrence, identity and development. *Phytomorphology* 44: 159–168.

Bansal, M. & K. G. Mukerji 1994a. Efficacy of root litter as a biofertiliser. *Biol. Fertil. Soils* 18: 228–230.

Bansal, M. & K. G. Mukerji 1994b. Positive correlation between VAM induced charges in root exudation and mycorrhizosphere mycoflora. *Mycorrhiza* 5: 39–44.

Gerdemann, J.W. & T.H. Nicolson 1963. Spores of mycorrhizal endogone species extracted from soil by wet sieving and decanting. *Trans. Br. Mycol. Soc.* 46: 235–244.

Hall, I.R. 1983. *A summary of the features of endogonaceous taxa. Tech. Rep. No.* 8. Agricultural Research Centre, Mosigel, New Zealand.

Mosse, B. 1973. Advances in the study of vesicular arbuscular mycorrhizae. *A. Rev. Phytopath.*II: 171–196.

Mukerji, K.G. 1995. Taxonomy of endomycorrhizal fungi. *In: Advances in Botany* (eds. K.G. Mukerji, Binny Mathur, B.P. Chamola & P. Chitralekha), pp. 212–218. APH Publishing Corporation, New Delhi.

Mukerji, K.G. & R.K. Dixon 1992. Mycorrhizae in Reforestation. *In: Rehabilitation of Tropical Rain-Forest Ecosystem - Research and Development Priorities* (eds. N.M. Majid, A.A. Ab. Malik, Z. Md. Hamzdu & K. Jusoff), pp. 62–82. University Pertanian Malaysia Salangar Malaysia.

Nicolson, T.H. 1995. *The mycotrophic habit in grass.* Thesis, University of Nottingham, Nottingham, pp. 66–82.

Philips, J.M. & D.S. Hayman 1970. Improved procedures for clearing roots and staining parasitic and vesicular arbuscular mycorrhizal fungi for rapid assessment of infection. *Trans. Br. Mycol. Soc.* 55: 158–161.

Powell, C.L.J. & D.J. Bagayraj 1984. Why all the interest. *In: VA mycorrhizae*; pp. 1–3 (eds. C.L.I. Powell & J. Bagayraj). Florida, CRC Press.

Schenck, N.C. & Y. Perez 1990. *Manual for the identification of VA mycorrhizal fungi.* VAM 3rd. edn., Gainsville, Florida; University of Florida.

Varma, A. 1995. Arbuscular mycorrhizal fungi: The state of Art. *Crit. Rev. Biotech.* 15: 179–199.

Zaidi, R. & K.G. Mukerji 1983. Incidence of vesicular-arbuscular mycorrhiza (VAM) in diseased and healthy plants. *Indian J. Plant Pathol.* 1: 24–26.

Table 1. VA mycorrhizal colonization in Compositae

Host	Percentage of root segments colonized	No. of vesicles per one cm in root bits	No. of spores per 100 gm. rhizosphere soil
Ageratum conyzoides	40	2	4
Bidens pilosa	70	20	20
Blumea bifoliata	-	-	-
Eclipta alba	70	10	12
Galinsoga parviflora	40	5	11
Gnaphalium purpureum	-	-	-
Launaea nudicaulis	60	2	6
Sonchus arvensis (Diseased)	80	20	28
Sonchus arvensis (Healthy)	70	14	24
Tridax procumbens	50	12	12
Vernonia cinerea	80	8	20

Table 2. **Presence of different structures of VAM fungi in various Compositae**

Test Plant	External hyphae	Y-shape connection	Appresoria formation	Arbuscules	Vesicles	
					Shape	Number /cm^2
Ageratum conyzoides	A	LP	A	LD	O	2
Bidens pilosa	P	P	A	DP	O	20
Blumea bifoliata	A	A	A	A	A	A
Eclipta alba	A	P	P	LD	R	12
Galinsoga parviflora	A	P	P	DP	O	11
Gnaphalium purpureum	A	A	A	A	A	A
Launaea nudicaulis	LP	A	A	DP	O	2
Sonchus arvensis (Diseased)	DP	DP	P	DP	R	20
Sonchus arvensis (Healthy)	LP	P	A	DP	O	14
Tridax procumbens	DP	P	P	DP	R	12
Vernonia cinerea	A	A	A	DP	O	8

Designation

A – Absent; P – Present; LP – Less Present; DP – Densely Present; O – Oval; R – Rounded.

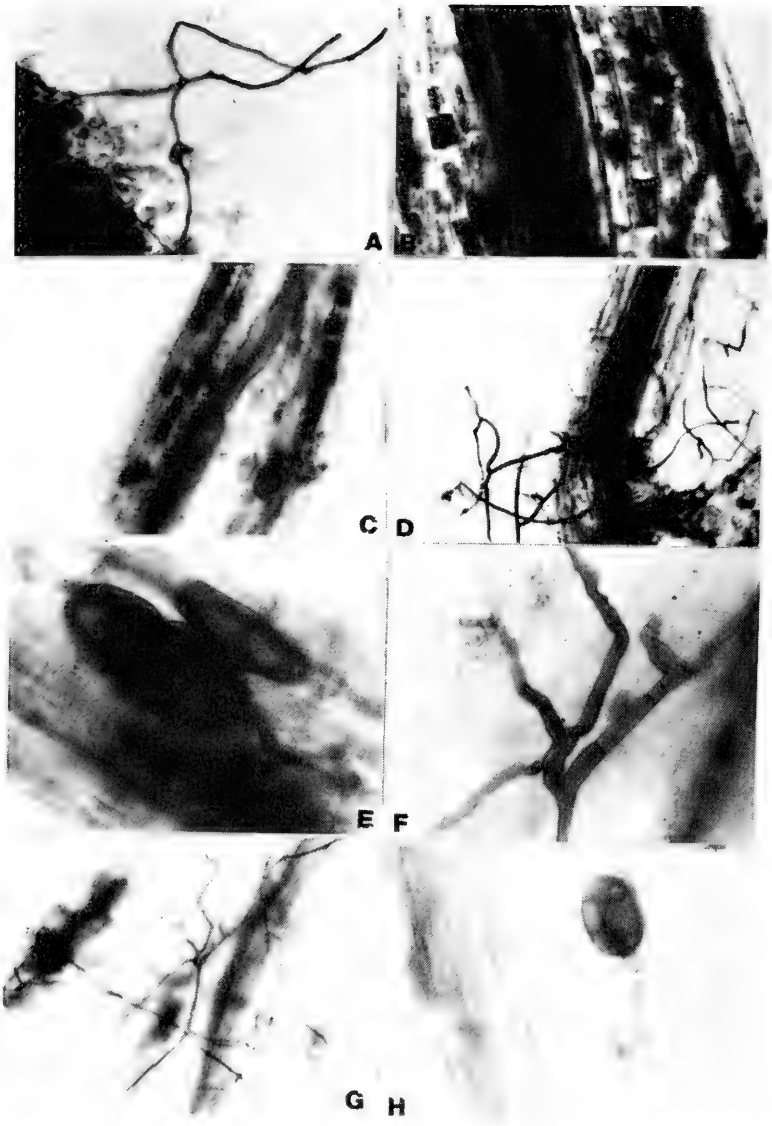

Fig. 1. VAM structures.

A: External hyphae with appresoria of *Bidens pilosa*. **B:** Appresoria of *Bidens pilosa*. **C, D:** Vesicles and external hyphae of *Galinsoga parviflora*. **E, F:** Vesicles and external hyphae of *Vernonia cinerea*. **G, H:** Internal hyphae and vesicle of *Tridax procumbens*.

NEW COMBINATIONS IN ECUADOREAN SENECIONEAE

Bertil Nordenstam
Department of Phanerogamic Botany
Swedish Museum of Natural History
P.O. Box 50007, S-104 05 Stockholm, Sweden
fbo-bertil@nrm.se

Abstract

Fifteen new combinations of Ecuadorean taxa in the genera *Dendrophorbium*, *Monticalia*, and *Talamancalia* are published.

Introduction

Ongoing studies on Ecuadorean Senecioneae for the 'Catalogue of Vascular Plants of Ecuador' and the 'Flora of Ecuador' necessitate a number of new combinations, some of which are published here. Others will follow in due course, as well as descriptions of some new taxa.

New combinations

Dendrophorbium amplexicaule **(Kunth) B. Nord., comb. nov.**

Basionym: *Senecio amplexicaulis* Kunth in H.B.K., Nov. Gen. Sp. Pl. 4: 181(folio ed.), 142 (quarto ed.) (1820, text available in 1818). - Syn.: *Pentacalia amplexicaulis* (Kunth) Cuatrec., Phytologia 49: 252 (1981). - Orig. coll.: Humboldt & Bonpland s.n., Ecuador, "prope Alausi et Tambo de Guamote Quitensium, alt. 1300-1500 hex." (P holotype).

Dendrophorbium angelense **(Domke) B. Nord., comb. nov.**

Basionym: *Senecio angelensis* Domke in Diels, Biblioth. Bot. 116: 171 (1937). - Orig. coll.: Diels 785, Ecuador, Carchi: Above El Angel, upper forest limit, ca. 3200 m, 2.IX.1933 (B holotype †).

***Dendrophorbium balsapampae* (Cuatrec.) B. Nord., comb. nov.**

Basionym: *Senecio balsapampae* Cuatrec., Fieldiana 27: 18 (1950). - Orig. coll.: A. Rimbach 240, Ecuador, W cordillera above Balsapampa, 2600 m, X.1934 (F holotype!).

***Dendrophorbium dodsonii* (H. Robinson & Cuatrec.) B. Nord., comb. nov.**

Basionym: *Pentacalia dodsonii* H. Robinson & Cuatrec., Novon 3: 285 (1993). - Orig. coll.: Dodson & Thien 676, Ecuador, Zamora: Road from Loja to Zamora, 2800 m, 18.IX.1961 (SEL holotype).

***Dendrophorbium gesnerifolium* (Cuatrec.) B. Nord., comb. nov.**

Basionym: *Senecio gesnerifolius* Cuatrec., Fieldiana Bot. 27: 33 (1950). - Orig. coll.: J. A. Steyermark 54743, Ecuador, Santiago-Zamora: Trail between Achupallas and Nudo de Sabanillas, 3000-3500 m, 17.X.1943 (F holotype!).

***Dendrophorbium ingens* (Benoist) B. Nord., comb. nov.**

Basionym: *Senecio ingens* Benoist, Bull. Soc. Bot. Fr. 83: 808 (1936). - Orig. coll.: Benoist 4467, Ecuador: "Chemin de Aloag à Santo Domingo de los Colorados, au km 18", 4.VII.1931 (P holotype).

***Dendrophorbium onae* (Cuatrec.) C. Jeffrey var. *leonis* (Cuatrec.) B. Nord., comb. nov.**

Basionym: *Senecio onae* Cuatrec. var. *leonis* Cuatrec.; Fieldiana Bot. 27: 33 (1950). - Orig. coll.: J. A. Steyermark 53697, Ecuador, Azuay: Dry rocky slopes bordering Río León towards Ona, on N side of Río León, 1970 m, 3.VIII.1943 (F holotype).

***Dendrophorbium solisii* (Cuatrec.) B. Nord., comb. nov.**

Basionym: *Senecio solisii* Cuatrec., Fedde Repert. 55: 146 (1953). - Orig. coll.: M. Acosta Solís 10504, Ecuador, Carchi: Between Paja Blanca and El Cucho, 2900-3200 m, 18.VII.1945 (F holotype!, F isotype!)

***Dendrophorbium tipocochense* (Domke) B. Nord., comb. nov.**

Basionym: *Senecio tipocochensis* Domke in Diels, Biblioth. Bot. 116: 173 (1937). - Orig. coll.: Diels 594, Ecuador, Chimborazo: Oberer Bergwald, 3200 m, 17.VIII.1933 (B holotype †).

***Dendrophorbium toreadoris* (Cuatrec.) B. Nord., comb. nov.**

Basionym: *Senecio toreadoris* Cuatrec., Fieldiana Bot. 27: 34 (1950). - Orig. coll.: J. A. Steyermark 53021, Ecuador, Azuay: Between Molleturo and Toreador, 2590-3900 m, 14.VI.1943 (F holotype!).

***Monticalia andicola* (Turcz.) C. Jeffrey var. *pseudonitida* (Cuatrec.) B. Nord., comb. nov.**

Basionym: *Senecio andicola* Turcz. var. *pseudonitidus* Cuatrec., Brittonia 12: 194 (1960). - Orig. coll.: Mille 725, Ecuador: Declivibus Antisana, 3600 m, I. 1917 (GH holotype).

***Monticalia befarioides* (Cuatrec.) B. Nord., comb. nov.**

Basionym: *Senecio befarioides* Cuatrec., Fedde Repert. 55: 134 (1953). - Syn.: *Pentacalia befarioides* (Cuatrec.) Cuatrec., Phytologia 49: 253 (1981). - Orig. coll.: A. S. Hitchcock 21940, Ecuador, Chimborazo: Between Urbina and Mt. Chimborazo, 3600-4500 m, 4.X.1923, (US holotype).

***Monticalia microdon* (Wedd.) B. Nord., comb. nov.**

Basionym: *Senecio microdon* Wedd., Chlor. And. 1: 102 (1856). - Syn.: *Pentacalia microdon* (Wedd.) Cuatrec., Phytologia 49: 256 (1981). - Orig. coll.: Jameson 118, Ecuador: "Sur le mont Cotopaxi", 1845 (P type).

***Monticalia teretifolia* (Kunth) B. Nord., comb. nov.**

Basionym: *Cacalia teretifolia* Kunth in H.B.K., Nov. Gen. Sp. Pl. 4: 124 (folio ed.), 159 (quarto ed.) (1820, text available in 1818). - Syn.: *Senecio teretifolius* (Kunth) DC., Prodr. 6: 420 (1837); *Microchaete teretifolia* (Kunth) Benth., Pl. Hartw. 209 (1845); *Pentacalia teretifolia* (Kunth) Cuatrec., Phytologia 49: 259 (1981). - Orig. coll.: Humboldt & Bonpland s.n., Ecuador: "In arenosis juxta pagum Mulalo Quitensium ignivomos Cotopaxi et Ilinissa, alt. 1600 hex." (P holotype).

***Talamancalia fosbergii* (Cuatrec.) B. Nord., comb. nov.**

Basionym: *Senecio fosbergii* Cuatrec., Fedde Repert. 55: 138 (1953). - Orig. coll.: F. R. Fosberg & M. A. Giler 22946, Ecuador, Loja: NE slope of Cerro Mataperro 3 km SW San Pedro, 10 km WNW of Catamayo, 1815 m, 10.II.1945 (US holotype!).

The genus *Talamancalia* was recently reported as a new generic record for South America (Nordenstam & Pruski 1995), by transfer of the Ecuadorean *Senecio putcalensis* Hieron. to this genus. The available material of this species was collected more than a century ago in the Loja area. A related species was discovered in unnamed material on loan from the Aarhus University (AAU). Upon further study it turned out to be identical to *Senecio fosbergii* Cuatrec. This is obviously related to *Talamancalia putcalensis*, but sufficiently distinct to be maintained as a different species. It shares with *T. putcalensis* the pinnatilobate leaf-shape, but the leaves are larger and less dissected, white-tomentose on the lower side (thereby resembling *T. westonii* H. Robinson & Cuatrec. from Costa Rica), and provided with distinctly winged petioles with conspicuously enlarged auricles at the base. The leaves of *T. putcalensis* are only scabrous-hirsute below and the petioles are narrowly winged. All three previously known species of *Talamancalia* are said to possess orange-coloured rays, but *T. fosbergii* has pure yellow ray-florets. This is not a very important difference, however, as can be seen from the variation within the related genus *Dorobaea*, where orange and yellow rays may occur within a species (Nordenstam & Pruski 1995).

Talamancalia fosbergii has a restricted range in the Catamayo valley near Loja in southern Ecuador, where it grows on dry slopes at 1800-2000 m altitude. Apart from the type, the following two collections are known to me: Ecuador, Loja: Road Loja-Catamayo, in the Catamayo valley, 79°18'W, 3°57'S, 2000 m, 25.II.1989, Øllgaard et al. 90697 (AAU); Road San Pedro de la Bendita (W of Catamayo)-El Cisne, c. km 8 (N extension of the Catamayo valley), 1900 m, 79°25'W,3°55'S, 25.II.1989, Øllgaard et al. 90706 (AAU).

Reference

Nordenstam, B. & J. F. Pruski 1995. Additions to *Dorobaea* and *Talamancalia* (Compositae-Senecioneae). *Comp. Newsl.* 27: 31-42.

gotab 17748, Stockholm 1996