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COMPOSITAE

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CONTRIBUTIONS TO THE EMBRYOLOGY OF ARCTOTIDEAE (COMPOSITAE)

The Genera *Dymondia* Compton, *Cullumia* R. Br., *Didelta* L'Hérit. and *Heterolepis* Cass.

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Abstract

Embryology of the monotypic genus *Dymondia* Compton, one species of *Cullumia* R. Br., one species of *Didelta* L'Hérit., and two species of *Heterolepis* Cass. was studied. Except for the species of *Heterolepis* with bisporic embryo sacs the investigation shows the usual Polygonum type of embryo sac development in the genera *Dymondia*, *Cullumia* and *Didelta*. The microspores of *Dymondia margaretae* Compton form tetrahedral tetrads and the tapetum develops into a periplasmodium. The deviating embryology in *Heterolepis* strengthens the suspicion that this genus is incorrectly placed in Arctotideae-Gorteriinae.

Material and Methods

The investigated material was collected by the author in southern South Africa in September 1982 as follows:

Dymondia margaretae Compton in Kirstenbosch Botanic Garden, Cape Town.
Cullumia squarrosa (L.) R.Br. at a roadside not far from Cape Point.
Didelta carnosae (L.f.) Ait. on the beach of Blouberg, Cape Town.
Heterolepis aliena (L.f.) Druce in Karroo Botanic Garden, Worcester.
Heterolepis peduncularis DC. at the airfield of Worcester.

The cytological technique used is that described by Ahlstrand (1978). The voucher specimens have been identified by Professor Tycho Norlindh, Stockholm. These documents and the slides studied are kept at GB.

Introduction

The genus *Dymondia* Compton is solely represented by the yellow-flowering, prostrate growing and ground covering species *Dymondia margaretae* Compton. Specimens of it were for the first time gathered by Margaret Dryden-Dymond in 1933. The species got its description by Compton (1953). It spontaneously and sparsely occurs in a few localities along the southern Cape coast of South Africa between Agulhas and the Breede River mouth (Rourke 1974).

Following the scheme by Hoffmann (1894), Compton (1953) thinks *D. margaretae* to have its nearest affinities with the sections *Landtia* Less. and *Arctotheca* Wendl. of genus *Arctotis* L. in the Arctotideae-Arctotidinae. Norlindh (1977) also includes both *Dymondia* and *Arctotheca* in subtribe "Arctotinae" (Arctotidinae). *Landtia* is there obliterated as a taxon.

After revisions of *Cullumia* R. Br. and *Didelta* L'Hérit. by Roessler (1959) and Merxmüller (1967), Norlindh (1977) arranges these genera in the subtribe Arctotideae-Gorteriinae. Owing to, i. a., style characters Robinson and Brettell (1973) think *Heterolepis* Cass. to be related to *Didelta*. Norlindh (1977) accepts the genus *Heterolepis* in the Gorteriinae. However, its position there is precarious. Bremer (1987) finds the three-lobed ray florets of *Heterolepis* to differ so much from those in other species of the Gorteriinae that he denies *Heterolepis* to be a member of this subtribe. He is also unwilling to place it in subtribe Arctotidinae, so he leaves it unclassified. He thinks, however, that *Heterolepis* belongs to the tribe Arctotideae. On the whole the placement of *Heterolepis* as regards tribe is much debated. For instance Merxmüller et al. (1977) exclude it from the Inuleae but they question a place for it in Mutisieae.

Representatives of *Cullumia* (15 species), *Didelta* (2 species) and *Heterolepis* (3 species) grow spontaneously in southwestern South Africa (Cape region, Karroo) and Namibia.

Observations

Dymondia margaretae. The microsporangial wall has four cell-layers: epidermis, endothecium, middle layer and tapetum (Fig. 1A). The middle layer looks degenerated when the tetrahedral microspore tetrads appear (Fig. 1B). The tapetal cells become many-nucleate and they successively lose their cell membranes (Fig. 1B, C). Their cell-plasmas, however, mostly remain in situ for a long time (Fig. 1B) and they very gradually leave their cell lumens to make faintly conspicuous periplasmodia (Fig. 1C). When the pollen grains are ready to be shed

no remnants of the tapetal cells are left (Fig. 1D). The cells of the epidermis and the endothecium have now increased in size (Fig. 1D).

The female archesporium consists of one cell (Fig. 1E). The meiotic divisions give rise to a dyad (Fig. 1F) and a linear tetrad of macrospores (Fig. 1G). The chalazal macrospore develops into the embryo sac (Fig. 1H). The embryo sac development is of the Polygonum type (Fig. 1H - N). The antipodes are three and 1-nucleate (Fig. 1M, N).

Cullumia squarrosa. The archesporium is 1-celled (Fig. 2A). Beneath the single embryo sac mother cell a few potential archesporial cells are observed (Fig. 2A, B). The macrosporogenesis (Fig. 2A - C) results in the formation of a linear tetrad (Fig. 2C). The basal macrospore germinates to produce an embryo sac (Fig. 2C). My material has given no stages showing the embryo sac development. I think, however, there should be no deviations from the usual Polygonum type of embryo sac development in the Arctotideae. The old embryo sac stage (Fig. 2D) shows a degenerating egg apparatus. The micropylar canal is widened and mucilaginous. There are no remnants of antipodal cells. The integumentary tapetum consists of two rows of cells around the chalazal part of the embryo sac.

Didelta carnosa. The archesporium is 1-celled (Fig. 3A). The meiotic divisions end via a dyad stage (Fig. 3B) in a linear tetrad (Fig. 3C) where the chalazal cell develops into an embryo sac. The other tetrad cells degenerate (Fig. 3D). The macro-gametogenesis produces an 8-nucleate embryo sac of the Polygonum type (Fig. 3E). The old embryo sac stage (Fig. 3F) shows elongated cells rich in plasma at one side of the micropylar canal. The integumentary tapetum consists of one layer of cells.

Heterolepis aliena and *H. peduncularis*. The archesporium is 1-celled (Fig. 4A, F). The heterotypic meiotic division results in a dyad stage (Fig. 4G). The succeeding homotypic division of the dyad cell nucleus is not accompanied by cell wall formation so each one of the dyad cells becomes 2-nucleate (Fig. 4C, H). The apical dyad cell degenerates (Fig. 4E, I). The basal one develops into an embryo sac (Fig. 4D, E, I) during increasing cell growth and plasma vacuolization (Fig. 4J, K). After new nuclear divisions there is a 4-nucleate embryo sac stage (Fig. 4L). The material shows all the accounted stages very richly. However, there are no older embryo sac stages.

Discussion

Owing to a monosporic Polygonum type of embryo sac development *Dymondia margaretae* from embryological aspects justifies a place in Arctotideae-Arctotidiinae. The author (Ahlstrand 1979a) has found the same embryology in species of all the other genera of this subtribe.

The embryology of *Cullumia squarrosa* and *Didelta carnosia* is very similar to that of members of other investigated genera in Arctotideae-Gorteriinae (Ahlstrand 1979b). There is an archesporium of one cell only and the 8-nucleate Polygonum type of embryo sac development. There are no synergid or antipode haustoria. As in *Gazania* Gaertn. and *Berkheya* Ehrh. slender mucilaginous hair-cells are observed at one side of the micropylar canal in *Didelta carnosia*. In *Cullumia squarrosa* the integumentary tapetum tends to be thickened around the chalazal part of old embryo sacs as is the case in *Gazania* and *Berkheya* species.

The circumstance that *Heterolepis* has a bisporic embryo sac development makes this genus embryologically quite different from all the other investigated genera of Arctotideae. Nota bene such a development is very rare in Compositae. Asplund (1978) makes a short survey of Compositae species with bisporic embryo sac development. They are very few in number and they occur in the tribes Astereae, Anthemideae, Helenieae, Heliantheae and Inuleae. However, I have never before met bisporic embryo sacs in my embryological investigations of tribe Arctotideae (Ahlstrand a, b, c). My *Heterolepis* material was richly represented by stages where I could study the bisporic conditions carefully. However, there were no mature embryo sac stages. Yet my observations show that *Heterolepis* embryologically is a very dubious genus in subtribe Arctotideae-Gorteriinae and in tribe Arctotideae on the whole.

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Fig. 1. *Dymondia margaretae*. - Microsporangial conditions (A - D), macrosporogenesis (E - G), embryo sac development (H - N).

A. Four wall-layers; sporogenous tissue. - B: Middle layer is degenerating; many-nucleate tapetal cells gradually losing their cell-membranes; microspore tetrads. - C: Developing periplasmodium among young pollen grains. - D: Epidermis, endothecium; pollen grains with spines; no periplasmodium left. - E: Macrospore mother cell. - F: Dyad stage. - G: Tetrad stage. - H: 1-nucleate embryo sac; degenerating macrospores; nucellar epidermis. - J, K: 4-nucleate embryo sac stage. - L: 4-nucleate embryo sac with nuclei in division. - M: 8-nucleate embryo sac; three 1-nucleate antipodes. - N: Embryo sac with integumentary tapetum; polar nuclei fused; antipodes 1-nucleate.

Fig. 2. *Cullumia squarrosa*. - A: Macrospore mother cell. - B: Macrospore mother cell; heterotypic division, metaphase; potential macrospore mother cells. - C: Functioning macrospore mother cell of a degenerating linear tetrad. - D: Old embryo sac stage with decomposing synergids; the integumentary tapetum with two cell-layers chalazally.

Fig. 3. *Didelta carnososa*. - A: Macrospore mother cell. - B: Dyad stage. - C: Linear tetrad. - D: Tetrad stage; the basal macrospore functioning. - E: Organized embryo sac; polar nuclei fused. - F: Old embryo sac stage; antipode cells degenerating; slender mucilaginous cells of one side of the micropylar canal.

Fig. 4. *Heterolepis aliena* (A - E) and *H. peduncularis* (F - L).

- A, F: Macrospore mother cell. - B: Metaphase of the heterotypic division of the macrospore mother cell. - G: Dyad stage. - C, H: 2-nucleate dyad cells; no cell-wall formation after the homotypic division of the meiosis. - D, E, I: 2-nucleate embryo sac formed from the basal dyad cell; the upper dyad cell degenerating. - J, K: 2-nucleate embryo sac enlarging with vacuolization. - L: 4-nucleate embryo sac stage.

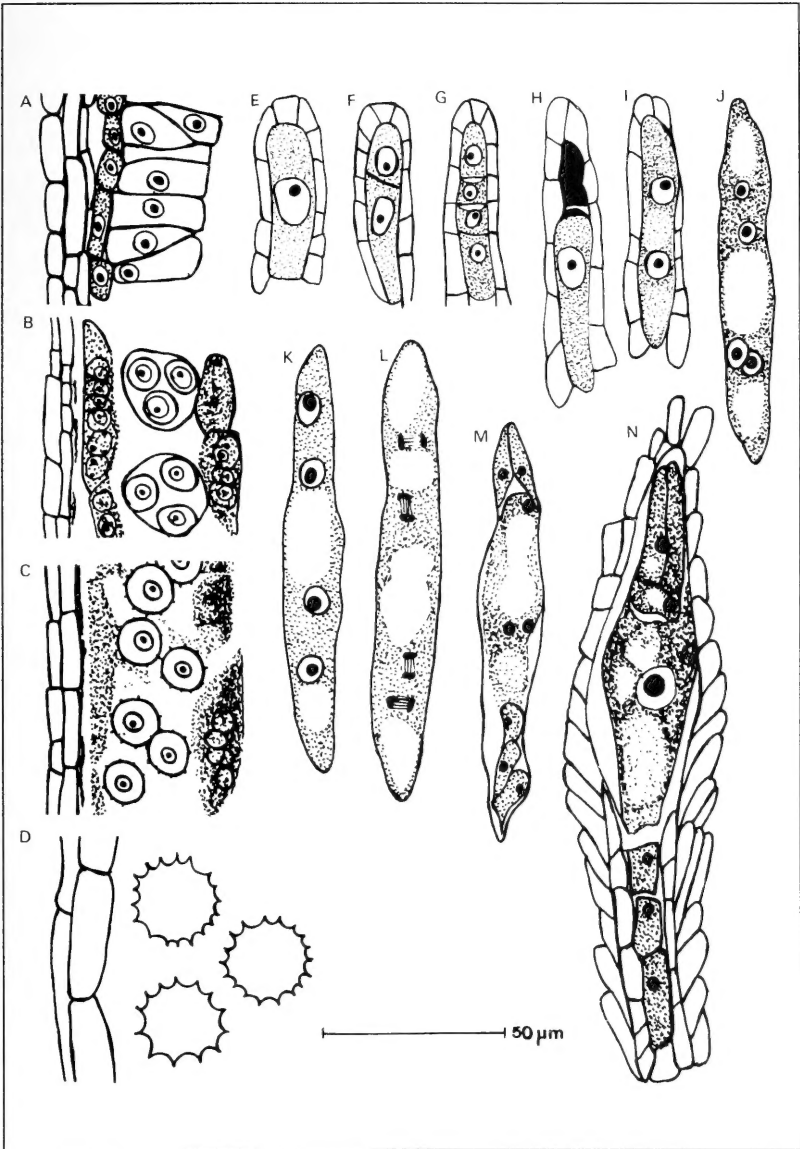


Fig. 1

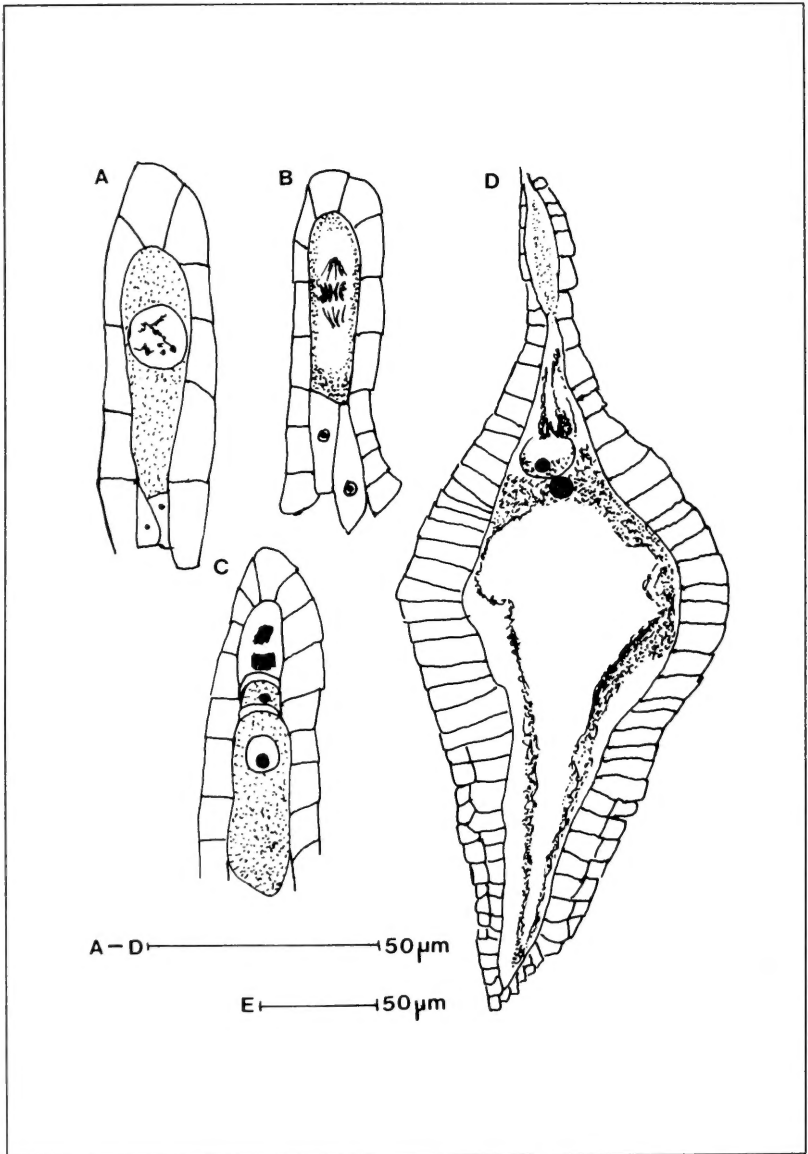


Fig. 2

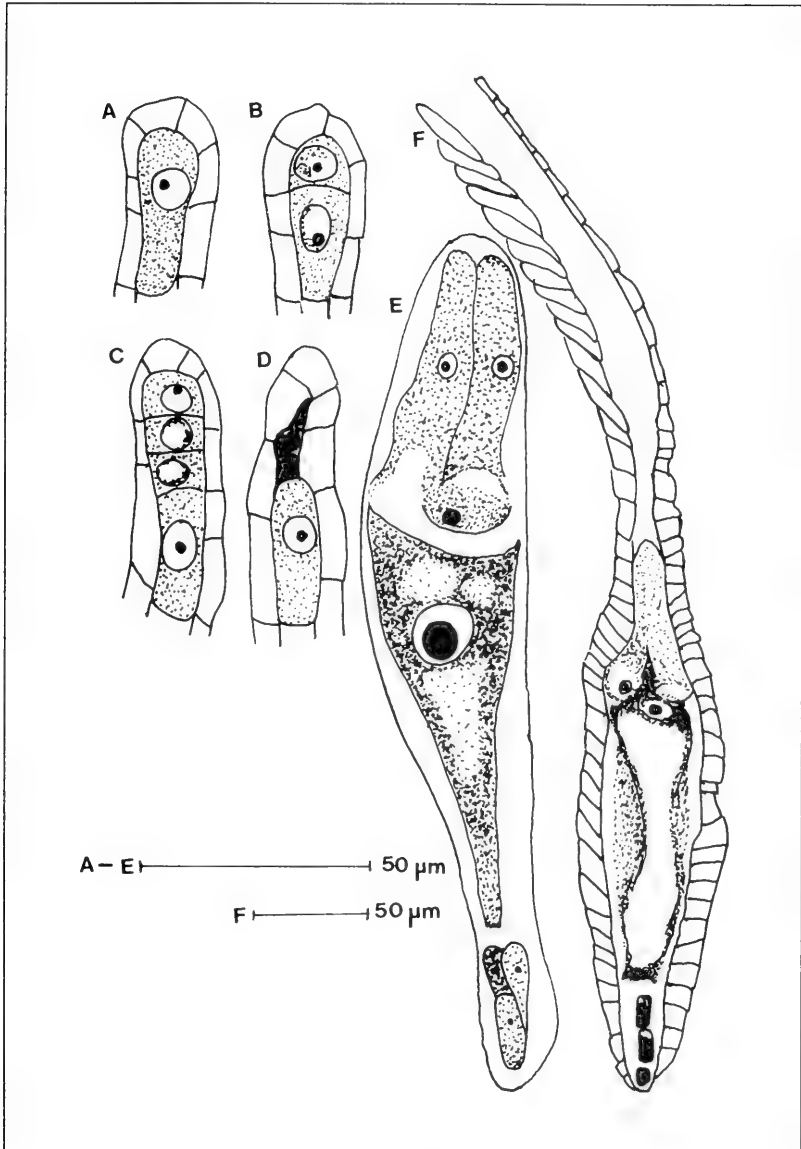


Fig. 3

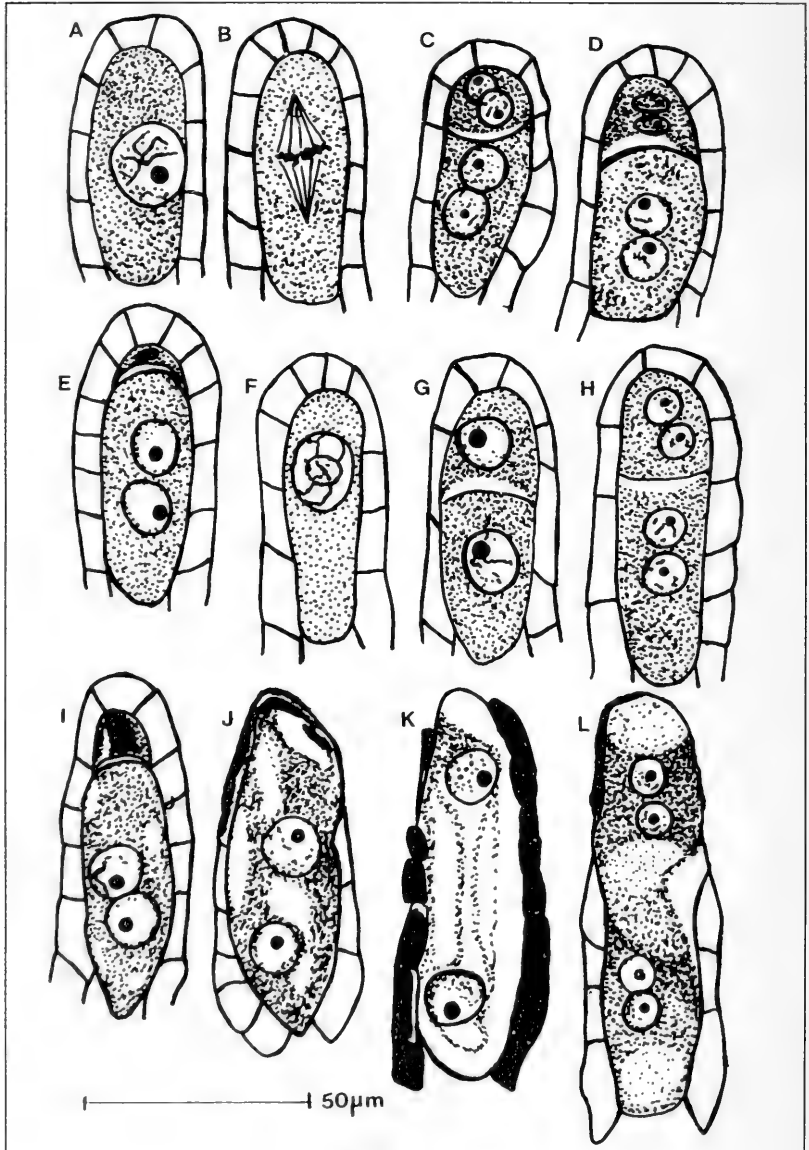


Fig. 4

NEW COMBINATIONS AND NOTES IN COMPOSITAE (VERNONIEAE, INULEAE S.L. AND HELIANTHEAE)

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Abstract

The following new combinations are proposed: *Distephanus plumosus* (O. Hoffm.) Mesfin, **comb. nov.** (Vernonieae), *Pseudognaphalium petitianum* (A. Rich.) Mesfin, **comb. nov.**, *Helichrysum forskahlii* (J.F. Gmel.) Hilliard & Burt var. *compactum* (Vatke) Mesfin, **comb. nov.** and *Helichrysum formosissimum* (Sch.Bip.) A. Rich. var. *guilelmii* (Engl.) Mesfin, **comb. et stat.nov.** (Inuleae s.l.). New synonymies are provided in *Pulicaria* Gaertn. (Inuleae) and *Guizotia* (Heliantheae). A few selected specimens are also cited for some of the taxa mentioned.

Distephanus Cass. (Vernonieae)

The genus *Distephanus* was resurrected by Robinson and Kahn (1986) to accommodate those species from the islands in the western Indian Ocean and from East & Central Africa with yellow flowers and trinervate leaves that were, earlier on, kept in *Vernonia*. *Gongrothamnus* Steetz ex Peters which was reduced to synonymy under *Vernonia* (Brown 1909) was transferred and made a synonym under *Distephanus*. The following taxon was not studied by Robinson and Kahn (1986) and, as it was found to possess many of the characters of *Distephanus*, the transfer from *Gongrothamnus* is duly made here.

Distephanus plumosus (O. Hoffm.) Mesfin, **comb.nov.**

Basionym: *Gongrothamnus plumosus* O. Hoffm. in Engl. Bot. Jahrb. 38: 206 (1906), Fig. 4. Type: Ethiopia, Boran, Koron, May 1901, Ellenbeck 2244 (B†, syntype), Tarro Gumbi, April 1901, Ellenbeck 2070 (B†, syntype), 1350-1500m, Arussi-Galla, Webi Maua, March 1901, Ellenbeck 1989^a (B†, syntype).

This is a woody shrub to 1.5 m high with brittle stems and branches. The leaves are slightly fleshy and distinctly 3-nerved from near the base. The flowers are

bright orange to yellow. The pollen grains (Fig.1) are 33.9-38.8 μm in diameter and are \pm similar to those described as 'type A' by Keeley and Jones (1979) and those given as Figures 3 and 4 by Robinson and Kahn (1986).

Distribution: Ethiopia, Somalia, Kenya.

Specimens: **Somalia**, 21 km N of Bardera on Garba Harre road, 14 June 1983, Gillett & Hemming 24744 (EA). **Ethiopia**, Sidamo, 67 km E of Filtu, 10 June 1986, Gilbert, Sebsebe & Vollesen 8116 (ETH, K), Petelin s.n. (ETH); on Filtu-Bokol Mayo road, 7 May 1987, Puff, Igersheim, Sebsebe & Ensermu 870507-2/9 (ETH). **Kenya**, Lag Ola, 23 May 1952, Gillett 13277 (K); Musi, 30 June 1951, Kirika 119 (K).

Pseudognaphalium Kirpichnikov (Inuleae)

A. Richard (1848) listed five names and Cufodontis (1966) seven under *Gnaphalium* L. In a revision of generic concepts in Gnaphaliinae, Hilliard & Burt (1981: 202) provided the characters that differentiate *Pseudognaphalium* from *Gnaphalium* L. and *Helichrysum* Mill. and transferred four of the names in *Gnaphalium* to *Pseudognaphalium*. Two of the names in *Gnaphalium* were also transferred to *Helichrysum*. One name, *G. petitianum* A. Rich., remained, however, probably owing to the paucity of the available specimens. A. Richard (1848: 430) wrote that this taxon is different from the other species in having lanceolate and decurrent leaves and more numerous female florets. Recent collections (Sue et al. 70, and Mesfin 8436) confirmed the existence of this species in montane woodlands in Central and Northern Ethiopia. The female florets are 18-22 and the hermaphrodite florets 2-3.

Pseudognaphalium petitianum (A. Rich.) Mesfin, **comb.nov.**

Basionym: *Gnaphalium petitianum* A. Rich., Tent. Fl. Abyss. 1:429 (1848). Types: Ethiopia, Ouodgerate, Petit s.n. (P, syntype), between Mayegouagua and Debre Sina, Petit s.n. (P, syntype).

This species was listed as a synonym of *Helichrysum odoratissimum* by Cufodontis (1966), but has a different floret ratio.

Distribution: Known only from Ethiopia.

Specimens: **Ethiopia**, Choa, [= Shewa], 1862, Petit s.n. (K); Shewa, Gorobela, 5 June 1982, Sue, Edwards & Class 70 (ETH); Tigray, 14 km on Maychew-Mekelle road, 20 Oct. 1991, Mesfin 8436 (ETH, K).

Helichrysum Mill. (Inuleae)

Hilliard & Burt (1980) provided the correct name and the taxonomic position of *H. fruticosum* Vatke (1875). A variety recognized under this illegitimate name by Vatke (loc. cit.) is here transferred to its correct position.

H. forskahlii (J.F. Gmel.) Hilliard & Burt (1980) var. *compactum* (Vatke) Mes-fin, **comb. nov.**

Basionym: *H. fruticosum* Vatke var. *compactum* Vatke (1875). Type: Ethiopia, Mt. Gunna, 1863-8, Schimper 1426 (B† holo.; K! W! isotypes).

Distribution: Ethiopia, Kenya, Tanzania.

Selected specimens from **Ethiopia**: Gonder, Semien, Chenek, 25 Nov. 1952, Scott 284 (K); above Lori, 28 Nov. 1952, Scott 279 (K); Mt. Jesus Tabor, 22 March 1937, Pichi-Sermolli 981 (K); Gojam, Mt. Birhan, 21 August 1957, Evans & Hillier 579 (ETH, K); Shewa, Wechecha, 20 Nov. 1954, Mooney 6363 (K); nr. Addis Abeba, 1965, Wright in Mooney 6710 (K); Arsi, Mt. Borulucco, 2 Dec. 1965, W. de Wilde 9063 (ETH, K), 27 Nov. 1966, Gilbert 127 (ETH, K); Mt. Chilalo, 21 Dec. 1953, Mooney 5210 (ETH, K); Nov. 1926, Scott s.n. (K); 35 km E of Assela, 12 Jan. 1974, Ash 2338 (K); Bale, Tullu Deemtu, 13 Oct. 1988, Friis, Michelsen & Sebsebe 5500 (ETH, K); Nov. 1973, Hedberg 5614 (ETH, K); Rira, 20 Dec. 1959, Mooney 8347 (ETH, K); 5 Nov. 1971, Sue Gilbert 68 (ETH, K); 24 km on Goba-Dello Menna road, 6 Nov. 1988, Friis, Michelsen & Sebsebe 5745 (ETH, K); 31 km on Goba-Masslo road, 24 Oct. 1984, Friis, Gilbert & Vollesen 3402 (ETH, K); Harerge, Gara Mulletta, 24 Nov. 1962, Burger 2387 (K); Sidamo, Mt. Dello, 27 Jan. 1953, Gillett 14955 (K); 8 km SE of Wondo, 21 Oct. 1965, W.de Wilde 8366 (K); Mt. Damota, Nov. 1948, Scott 78 (K); Gamo Gofa, Doko valley, 1968, Mulvany 13 (K); Gughe Highlands, Mt. Tola, 15 Dec. 1948, Scott 143 (K).

Helichrysum formosissimum (Sch. Bip.) A. Rich.

In a note on the "*Helichrysum formosissimum* group" in the Afroalpine flora of tropical Africa, Hedberg (1957:347-348) wrote that "... the 10 species described in this group have been reduced to 2 taxa, *Helichrysum formosissimum* and *H. guilelmii*" and also stated that "... although they are treated here as distinct species it might perhaps be equally justifiable to reduce them to subspecies."

While studying the Ethiopian material of *H. formosissimum*, a few specimens that shared the stem and foliar features of those in East Africa and known as *H. guilelmii* Engl. were encountered. All available material from the entire range of distribution of the "group" was later studied. Particular attention was paid to leaf size, shape, pubescence and stem height and pubescence. The variation in these features was found to be continuous both along altitudinal and latitudinal gradients. A few specimens with the characteristic features of *H. guilelmii* (e.g., Mooney 8346,

Bale, above Rira, 3800 m, on steep much burnt and grazed slope in *Erica* scrub, c. 20-30 cm high; Friis, Michelsen & Sebsebe 5698, Bale, 3-4 km N of Rira, 3300 m, to 1.5 m high) in the same general area as those with the characters of *H. formosissimum* (e.g., Mooney 8363, Bale, Rira, 3260 m, in marshy ground, 1.5 m high; Friis, Gilbert & Vollesen 3625, Bale, 58 km on Dello Menna-Goba road, 3300 m; Hedberg 5573, Bale, nr. Garba Guracha, 3950 m) were encountered.

The distinguishing features between *H. formosissimum* (leaves scabrid with numerous stiff and glandular hairs, sometimes also thinly arachnoid) and *H. guilelmii* (leaves thinly arachnoid sometimes with few glandular hairs above, densely woolly tomentose beneath) are too few and trivial to warrant their recognition as separate species. Hence, *H. guilelmii* is reduced to a variety of *H. formosissimum*.

H. formosissimum (Sch. Bip.) A. Rich. var. ***guilelmii*** (Engl.) Mesfin, **comb. et stat. nov.**

Basionym: *H. guilelmii* Engl. (1892). Type: Tanzania, Kilimanjaro, above Kilosho, Volkens 1556 (K, lectotype, selected by Hedberg 1957: 215).

Distribution: Ethiopia, Uganda, Kenya, Tanzania.

Selected specimens. **Ethiopia**: Bale, 4 Nov. 1988, Friis, Michelsen & Sebsebe Demissew 5689 (ETH, K); 19 Dec. 1959, Mooney 8346 (K), 30 Oct. 1973, Hedberg 5573 (ETH, K); 29 Dec. 1989, Mesfin Tadesse 7782 (ETH), 26-28 Dec. 1990, Mesfin T., Lisanweork & Berhanu 8128 and 8149 (ETH); Arsi, 1975, Thomerson 551 (ETH); Gamo Gofa, 23 Dec. 1948, Scott 162 and 148 (K). **Tanzania**, 9 Nov. 1968, Bigger 2302 (ETH, K). **Uganda**, 14 Nov. 1961, Kerfoot 1172 (K). **Kenya**, 23 Dec. 1970, Tweedie 2346 (K).

***Pulicaria* Gaertn. (Inuleae)**

In a review of the Inuleae for the Flora of China, Ling (1965) placed *Vicoa* Cass. (1829) in the synonymy of *Pentanema* Cass. (1818) and gave *V. auriculata* Cass. as a synonym of *Pentanema indicum* (L.) Ling. Oliver and Hiern (1877) described *V. divaricata* Oliv. & Hiern from specimens collected in northern Ethiopia. Examination of the holotype of *V. divaricata* revealed that it rather belongs to *Pulicaria* Gaertn. In the revision of the genus *Pulicaria* by E. Gamal-Eldin (1981) its correct systematic position was not pointed out, although the isotype of *V. divaricata* (from W) is cited under *P. petiolaris* Jaub. & Sp. (Gamal-Eldin 1981: 186) in the list of specimens studied from Ethiopia.

P. petiolaris Jaub. & Sp., Ill. Pl. Orient. 4: 69, tab. 344 (1852). Type: Arabia, Yemen, Botta s.n. (P, hol.)

Syn.: *Vicoa divaricata* Oliv. & Hiern, Fl. Trop. Afr. 3: 362 (1877), **syn. nov.**
Type: Ethiopia, Eritrea, Ailet, 1820-1826, Ehrenberg s.n. (K, hol.!; W iso. n.v.).

Distribution: Egypt, Sudan, Ethiopia, Djibouti, Somalia, Saudi Arabia, Yemen.

Guizotia Cass. (Heliantheae)

Guizotia scabra (Vis.) Chiov.

Siegesbeckia somalensis S. Moore, J. Linn. Soc. Bot. 35: 342 (1902), **syn. nov.**
Type: Somalia, Sheik Mahomet, 30 Oct. 1894, Donaldson-Smith 226 (BM, hol.).

The shape of the corolla and cypsela and their pubescence in the holotype is that of *Guizotia* and not *Siegesbeckia*. The holotype of *S. somalensis* is referable to *G. scabra* subsp. *schimperi* (Sch. Bip.) J. Baagoe but since cytogenetic studies are currently underway on the genus (Kifle Dagne, University of Lund & Addis Ababa University, personal communication), the infraspecific placement of the taxon is deferred until a later time.

Acknowledgements

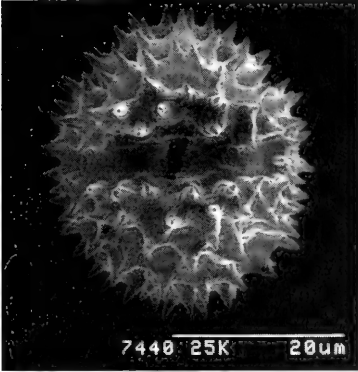
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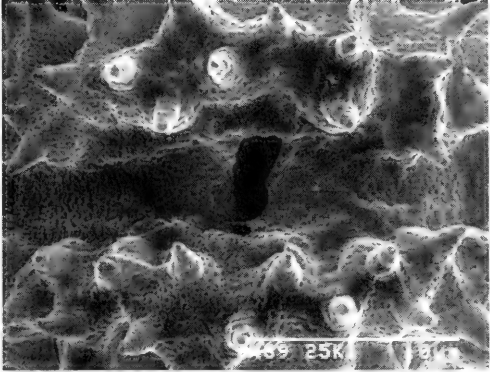
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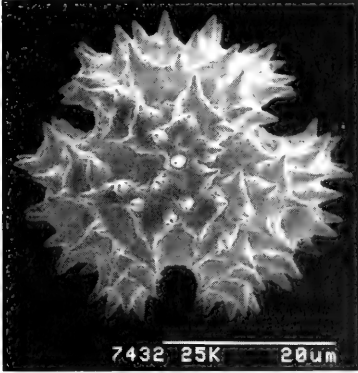
Fig. 1. Scanning electron micrographs of pollen grains of *Distephanus plumosus*. A-B: Apertural view. C: Polar view. D: Tectum perforation and spine bases.



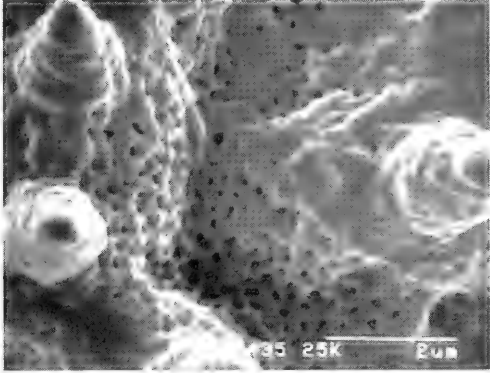
A



B



C



D

CHEMOTAXONOMY OF *ARTEMISIA* L.

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Abstract

Having researched the classification of *Artemisia* L. (Compositae) of China* and guided the group** to deal with the phytochemistry (essential oils) of the genus, the author shows that the chemical constituents of essential oils are related to the classification of the genus. Generally speaking, monoterpenoids dominate in the more primitive sections, whereas sesquiterpenoids and aromatic compounds prevail in the more advanced sections of the genus.

Material

Analyses were made of 171 plant samples, representing 64 species, incl. varieties, of *Artemisia*. Of these, 47 species belong to five sections of subgenus *Artemisia*, and 17 species are from two sections of subgenus *Dracunculus* (Bess.) Peterm. (Table 1).

Table 1. Species of *Artemisia** analysed for essential oils**

Subgen. I. *Artemisia*

Sect.1). *Absinthium* DC.

Ser. 1. *Sieversianae* (Kitam.) Y. R. Ling -- *A. macrocephala* Jacq. ex Bess. and *A. sieversiana* Ehrh. ex Willd.

* For classification and distribution of the genus, see author's Flora RPS 76(2) and articles in Bull. Bot. Res. 4(4): 1-60, 1982, & 8(4): 1-61, 1988.

** Project supported by National Science Foundation of China; the chemical analysts are B. L. Li, L. F. Zhu, B. Y. Lu and Y. J. Lo and the associates for the collection of plants are L. H. Xia, L. Jiang, X. Xion and H. G. Ye.

Ser. 2. *Absinthium* Y. R. Ling -- *A. frigida* Willd.

Ser. 3. *Xerophyticae* Y. R. Ling -- *A. xerophytica* Krasch.

Ser. 4. *Anethifoliae* Poljak. -- *A. fauriei* Nakai, *A. anethifolia* Web. ex Stechm. and *A. anethoides* Mattf.

Sect. 2). *Abrotanum* Bess.

Ser. 1. *Ponticae* Poljak. -- *A. aksaiensis* Y. R. Ling.

Ser. 2. *Pectinatae* Kitam. -- *A. sacrorum* Ledeb. and *A. vestita* Wall. ex Bess.

Ser. 3. *Annuae* (Rydb.) Poljak. -- *A. annua* L.

Ser. 4. *Hedinianae* Y. R. Ling -- *A. hedinii* Ostenf. & Pauls. ex S. Hedin.

Ser. 5. *Auratae* Poljak. -- *A. palustris* L.

Sect. 3). *Artemisia*

Ser. 1. *Umbrosae* (Pamp.) Y. R. Ling -- *A. stolonifera* (Maxim.) Komar. and *A. argyi* Levl. & Van.

Ser. 2. *Codonocephalae* (Pamp.) Y. R. Ling -- *A. lavandulaefolia* DC. and *A. verlotorum* Lamotte.

Ser. 3. *Velutinae* Y. R. Ling -- *A. calophylla* Pamp.

Ser. 4. *Microcephalae* (Kitam.) Y. R. Ling -- *A. lancea* Van.

Ser. 5. *Artemisia* -- *A. vulgaris* L., *A. yunnanensis* J. F. Jeffrey ex Diels, *A. roxburghiana* Bess. incl. var. *purpurascens* (Jacq. ex Bess.) Hook. f., *A. leucophylla* (Turcz. ex Bess.) C. B. Clarke, *A. robusta* (Pamp.) Ling & Y. R. Ling, *A. qinlingensis* Ling & Y. R. Ling, *A. phyllobotrys* (Hand.-Mazz.) Ling & Y. R. Ling, *A. mongolica* (Fisch. ex Bess.) Nakai, *A. rubripes* Nakai, *A. indica* Willd. and *A. princeps* Pamp.

Ser. 6. *Igniariae* (Pamp.) Y. R. Ling -- *A. integrifolia* L., *A. subulata* Nakai and *A. brachyphylla* Kitam.

Ser. 7. *Moorcroftianae* (Pamp.) Y. R. Ling -- *A. moorcroftiana* Wall. ex DC. and *A. abaensis* Y. R. Ling & Z. Y. Zhao.

Ser. 8. *Serpens* (Kitam.) Y. R. Ling -- *A. speciosa* (Pamp.) Ling & Y. R. Ling and *A. kawakamii* Hayata.

Ser. 9. *Selengenses* (Pamp.) Y. R. Ling -- *A. selengensis* Turcz. ex Bess.

Ser. 10. *Silvaticae* Poljak. -- *A. sylvatica* Maxim.

Sect. 4). *Viscidipubes* Y. R. Ling

Ser. 1. *Viscidipubescentes* Y. R. Ling -- *A. occidentali-sichuanensis* Y. R. Ling & Z. Y. Zhao.

Ser. 2. *Pleiocephalae* Y. R. Ling -- *A. atrovirens* Hand.-Mazz., *A. simulens* Pamp. and *A. myriantha* Wall. ex Bess. incl. var. *pleiocephala* (Pamp.) Y. R. Ling.

Sect. 5). *Albibractea* Y. R. Ling

Ser. 1. *Albibracteanae* Y. R. Ling -- *A. lactiflora* Wall. ex DC.

Ser. 2. *Anomalae* (Kitam.) Y. R. Ling -- *A. anomala* S. Moore.

Subgen. II. *Dracunculus* (Bess.) Peterm.**Sect. 6)** *Dracunculus* Bess.

Ser. 1. *Sphaerocephalae* Krasch. -- *A. sphaerocephala* Krasch. and *A. halodendron* Turcz. ex Bess.

Ser. 2. *Psammophilae* Poljak. -- *A. songarica* Schrenk, *A. ordosica* Krasch., *A. waltonii* J. R. Drumm. ex Pamp. and *A. gyangzeensis* Ling & Y. R. Ling.

Ser. 3. *Pubescentes* Krasch. -- *A. pubescens* Ledeb. and *A. capillaris* Thunb.

Ser. 4. *Scopariae* Krasch. -- *A. scoparia* Waldst. & Kit. and *A. edgeworthii* Balakr.

Sect. 7). *Latilobus* Y. R. Ling

Ser. 1. *Depauperatae* Y. R. Ling -- *A. desertorum* Spreng.

Ser. 2. *Japonicae* Krasch. -- *A. manshurica* (Komar.) Komar. ex Komar. & Alis., *A. japonica* Thunb. and *A. parviflora* Buch.-Ham. ex Roxb.

Ser. 3. *Subdigitatae* Krasch. -- *A. dubia* Wall. ex Bess. incl. var. *subdigitata* (Mattf.) Y. R. Ling.

Ser. 4. *Giraldianae* Y. R. Ling -- *A. giraldii* Pamp.

Results

Table 2 summarizes the occurrence of the different categories of essential oils found in the present investigation.

Table 2. The chemical constituents of essential oils in *Artemisia* L., in % (by B. L. Li)

Subgen.	Sections and Series		monoterpenoids		sesquiterpenoids		aromatic compounds
			monoterpenes	monoterpene oxides	sesquiterpenes	sesquiterpene oxides	
Subgen. <i>Artemisia</i>	Sect. <i>Absinthium</i> DC.			50-90	<10	<10	<1
	Sect. <i>Abrotanum</i> Bess.			50-90	<20	<10	<1
	Sect. <i>Artemisia</i>			50-90	<20	<15	<1
	Sect. <i>Viscidipubes</i> Y. R. Ling			15-80	10-40	10-50	<1
	Sect. <i>Albibractea</i> Y. R. Ling			<20	40-80	30-50	<1
Subgen. <i>Dracunculus</i> (Bess.) Peterm.	Sect. <i>Dracunculus</i> Bess.	Ser. <i>Sphaerocephalae</i> Krasch.	<20	<5	<5	10-80	50-70
		Ser. <i>Psammophilae</i> Poljak.		<5	<5	10-80	50-70
		Ser. <i>Pubescentes</i> Krasch.		30	30	10-30	20-70
	Sect. <i>Latitobus</i> Y. R. Ling	Ser. <i>Scoparieae</i> Krasch.		30	30	10-30	20-70
		Ser. <i>Japonicae</i> Krasch.		<30	<15	20-50	<5
		Ser. <i>Subdigitatae</i> Krasch.		<30	<5	5-30	30-80
		Ser. <i>Giraldianae</i> Y. R. Ling		<30	<5	5-30	30-80

The monoterpenoids found in sections *Absinthium*, *Abrotanum* and *Artemisia* are 1,8-cineole, α -thujone, camphor, borneol, terpine-4-01, artemisia ketone, piperitone, sabinol etc.

Sesquiterpenoids found in sections *Viscidipubes* and *Albibractea* include β -caryophyllene, β -farnesene (z), β -cadinene, γ -selinene, β -cubebene, α -curcumene and zingiberene, as well as some unidentified sesquiterpenes.

In subgenus *Dracunculus*, especially in species from the series *Sphaerocephalae*, *Psammophilae* and *Giraldianae*, where aromatic compounds prevail, we found e.g. capillene, capillone, eugenol, methyl eugenol, elemicin and a few unidentified oxygen aromatic compounds. Besides, α -bisabolol and α -bisabolol oxide were found in the former two series.

In the series *Pubescentes*, *Scopariae* and *Subdigitatae* both sesquiterpene oxides and aromatic compounds occur. Only series *Japonicae* is an exception with less content of aromatic compounds.

Discussion

In subgenus *Artemisia* the monoterpenoids, particularly monoterpene oxides, are usually dominating in the primitive sect. *Absinthium* and in the likewise primitive, but more actively evolving sect. *Abrotanum*, and also in the more median sect. *Artemisia*.

Sesquiterpenoids, including both sesquiterpenes and sesquiterpene oxides, are often found in the median sections *Viscidipubes* and *Albibractea*, together with some monoterpene oxides.

The advanced sections *Dracunculus* and *Latilobus*, belonging to subgenus *Dracunculus*, mainly contain aromatic compounds and sesquiterpene oxides, whereas sesquiterpenes and monoterpene oxides occur in usually smaller, but varying amounts. See further Table 2.

Thus there is a correlation between classification and phytochemistry in *Artemisia*, inasmuch as the evolution from primitive to advanced sections of the genus is paralleled by a phytochemical evolution from monoterpenoids to sesquiterpenoids and aromatic compounds.

It is not surprising that the genus *Artemisia*, with its varied and complicated chemical constituents, is used medicinally and pharmaceutically. Most species of the genus are good for antiphlogistic drugs, curing various infectious and contagious diseases and some even have anti-cancer properties. *A. argyi* Levl. & Van. can be used against cholera, and *A. annua* L. is well-known for antifebrile, detoxifying antipyretic drugs curing malaria and fever. *A. capillaris* Thunb. and *A. scoparia*

Waldst. & Kit. are well used for detoxifying drugs in curing hepatitis, cholecystitis or urosis, and hepatic cirrhosis.

STUDIES OF *EMILIA* (COMPOSITAE: SENECIONEAE) IN WEST AFRICA

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Abstract

Morphologically, the three species of *Emilia* have some distinctness. The majority of the qualitative and quantitative attributes of *E. praetermissa* show intermediacy between those of *E. sonchifolia* and *E. coccinea*.

Introduction

Emilia Cass. is in the tribe Senecioneae (Compositae) and has about 30 species which are mainly Paleotropical with a few naturalized ones in the Neotropics (Garabedian 1924, Nordenstam 1977). Three species have so far been recorded to occur in West Africa (Baldwin and Speese 1949, Milne-Redhead 1951, Hutchinson and Dalziel 1963, Olorode and Olorunfemi 1973, Olorode 1973).

Olorode and Olorunfemi (1973) have successfully proved that an interspecific hybrid obtained between *Emilia coccinea* (Sims) G. Don and *E. sonchifolia* (L.) DC. if artificially polyploidized will result in an allotetraploid, which is morphologically similar to *E. praetermissa* Milne-Redhead. However the two putative parents have been found to be reproductively isolated because of their distinct ecological preferences and because of the structural differences between their genomes (Olorode and Olorunfemi 1973). There is no known evidence of natural hybridization between the two species, *E. coccinea* and *E. sonchifolia*.

The purpose of this paper is to show the morphological distinctness of the three species with regard to the vegetative and floral structures.

Material and Methods

Specimens of the three species were collected from different locations in Nigeria and used for the investigation. The specimens of the species lodged in the herbarium of the Department of Botany, Obafemi Awolowo University, Ile-Ife (IFE) were also used.

The florets were dissected and the anthers, styles and corolla lobes were mounted in Hoyer's solution (King and Robinson 1970) before viewing them under the microscope.

Observations

Vegetative morphology

Table 1 summarizes some basic morphological characteristics of each of the three species of *Emilia* in West Africa. The habitat preferences of *E. sonchifolia* and *E. coccinea* do not overlap, but *E. praetermissa* thrives in xeric, wet and intermediate habitats. In fact *E. praetermissa* sometimes grows close to, or a few metres from each of the two other species.

E. sonchifolia is an erect annual herb, 30 cm tall, with deeply lobed leaves. *E. coccinea* is a scandent perennial about 90 - 120 cm tall. *E. praetermissa* is an erect perennial herb with an intermediate height of about 60 cm.

Floral morphology

Table 2 clearly summarizes quantitative attributes of each of the three species. In most of the attributes, *E. praetermissa* has intermediate scores.

HEAD - The heads of the three species are terminal and paniculate with *E. praetermissa* having the largest size, 14.4 x 5.3 mm (Table 2).

INVOLUCRE - Involucral bracts 1-seriate in the three species with *E. coccinea* having the highest number of bracts, viz. 12 (Table 2). The bracts are pubescent towards the apex and papillate apically.

COROLLA - The corollas of the three species are tubular basally, widening towards the apex, glabrous, 5-lobed; lobe without a distinct midvein but with two distinct lateral veins, apically papillate (Fig. 4).

STYLE - Style bifurcate in the three species; style branches flattened, dorsally glabrous in all, apically usually truncate with scanty hirsute papillae in *E. coccinea* (Fig. 1). The other two species have apically sub-conical hirsute papillate appendages (Fig. 2); *E. praetermissa* has intermediate arm length (Table 2). Stigmatic lines ventro-marginal, fused to a continuous stigmatic area in the three species.

STYLE BASE - Style base in all species swollen, placed on top of a nectary formed by the stylopodium (Fig. 5); cells of the style base are longitudinally arranged (Fig. 6) as well as those of the nectary.

ANTHER - Anthers basally sagittate; apical appendages oblong, obtuse at apex, with the cells having thickenings on vertical walls and the marginal cells larger than the inner ones; endothelial cells elongate with thickenings on vertical walls; filament collar cylindrical but dilated basally with cells having thickenings at the

corners (Fig. 3); filament collar number of rows is highest in *E. coccinea* (Fig. 3; Table 2). *E. praetermissa* has intermediate anther appendage size of 156 x 41 μm (Table 2).

ACHENE - Achenes brownish, terete, 5-costate, pubescent on the ribs (Fig. 7); achene hairs duplex with spiral thickenings, acute at tips, with one basal cell notched at the side (Figs. 8 - 10); pappus caducous, uniseriate, barbellate, white (Fig. 11).

Discussion

E. coccinea and *E. sonchifolia* are diploid with $2n = 10$ chromosomes (Olorode and Olorunfemi 1973, Olorode 1973, Baldwin and Speese 1949, Milne-Redhead 1951, Hutchinson and Dalziel 1963). The artificial tetraploid hybrid from *E. sonchifolia* and *E. coccinea* is similar to *E. praetermissa* with respect to its karyotypes and its meiotic behaviours (Olorode and Olorunfemi 1973). Both floral and vegetative attributes of *E. praetermissa* appear to be intermediate between those of the other two species (Tables 1 & 2).

Morphological and cytogenetic evidence suggest that *E. praetermissa* originated from the hybrid obtained from the two diploid species. Similarly, it could be inferred that the two diploid species evolved from a common ancestor which is now extinct.

Taxonomically, the three species are distinct (Tables 1 & 2) in spite of the artificial hybridization between the two diploid species. The most easily observable morphological distinction for the species is found in the leaf margin type (Table 1).

Acknowledgements

I thank Mr. J. O. Olaleye of the Natural History Museum, Obafemi Awolowo University, Ife, Nigeria, for the illustrations.

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FIGURE LEGENDS

Emilia coccinea - Figs. 1, 4, 6, 9.

1 - Style branches apically truncate with scanty hirsute papillae; 4 - Corolla lobe apically papillate; 6 - Style base; 9 - Achene hairs duplex with spiral thickenings.

E. praetermissa - Figs. 2, 3, 5, 7, 8, 11.

2- Style branches apically sub-conical with hirsute papillate appendages; 3 - Anther with oblong apical appendage; endothelial cells and filament collar; 5 - Nectary with style base on top; 7 - Achene pubescent on the ribs; 8 - Achene hairs duplex with spiral thickenings; 11 - Pappus seta barbellate.

E. sonchifolia - Fig. 10. Achene hairs duplex with spiral thickenings.

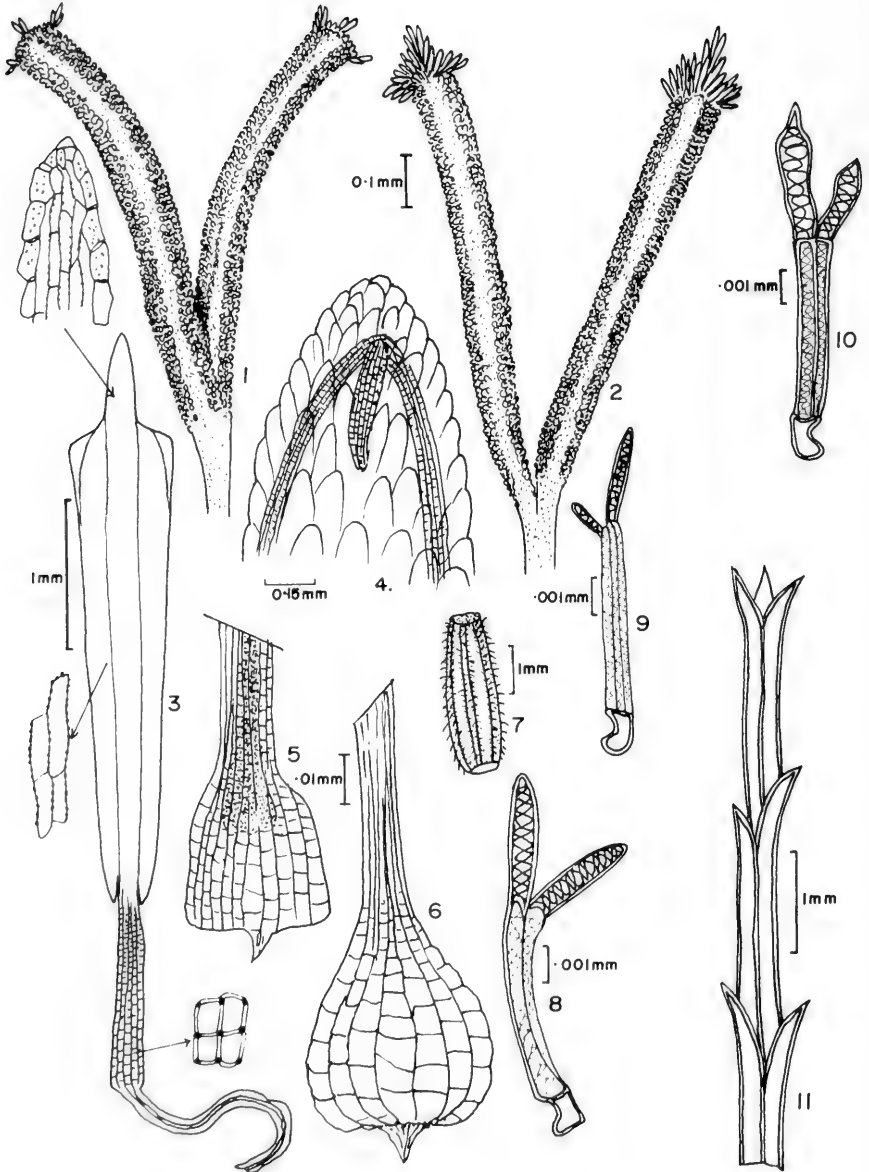


Table 1. Qualitative attributes of the three species of *Emilia*

Species	Habitat	Leaf Margin	Floret Colour
<i>E. sonchifolia</i>	Dry, stony; open area	Deeply lobed	Purple
<i>E. coccinea</i>	Wet to water- logged; shaded area	Entire	Yellow
<i>E. praetermissa</i>	Dry, wet or waterlogged; shade or open area	Toothed, sometimes with small basal lobes	Flesh-coloured, cream white (with or without purple tinge); rarely purple

Table 2. Quantitative attributes of the three species of *Emilia*

Species	Head length (mm)	Head breadth (mm)	Achene length (mm)	Achene hair length (μm)	Involucral bracts No.	Anther appendage length (μm)	Anther appendage breadth (μm)
<i>E. sonchifolia</i>	11(12.4)15.5	3(3.2)3.8	2.3(2.8)3.2	140(173)230	8	66(74)82	26(29)33
<i>E. coccinea</i>	11.2(13)15.3	4(4.8)6.1	1.2(1.8)2.2	166(204)242	12	153(173)194	54(61)69
<i>E. praetermissa</i>	13(14.4)15.7	4.5(5.3)7.1	3(3.1)3.4	306(357)383	9-10	140(156)171	36(41)46

Table 2 Cont'd.

Species	Anther length (μm)	Filament collar length (μm)	Filament collar breadth (μm)	Filament collar no. of rows	Style arm length (mm)	Style shaft length (mm)
<i>E. sonchifolia</i>	319(377)436	209(258)306	31(45)59	5-6	0.5-0.8	5-6
<i>E. coccinea</i>	956(1039)1122	255(281)306	59(61)64	7-9	1.2-1.5	6.5-9
<i>E. praetermissa</i>	918(1058)1199	357(395)434	59(69)79	4-6	1-1.2	8-9

FLORA ZAMBESIACA: FIRST PART OF THE COMPOSITAE PUBLISHED

Volume 6(1)

1992, 264 pages, 47 line drawings, (paperback)

ISBN 0 947643 49 4, Price £24.00.

Copies are obtainable from the Secretary, Flora Zambesiaca, Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AB, England.

The Compositae of the Flora Zambesiaca area (comprising some 129 genera with approx. 722 spp.) are to be published in volume 6 of this Flora. This volume will appear in 3 parts, and part 1 containing the tribes Mutisieae, Cardueae, Vernoniae, Lactuceae and Arctotideae has now been published.

Flora Zambesiaca is a comprehensive illustrated descriptive account of the native and naturalised flowering plants and ferns of the floristic area which approximates the Zambezi River drainage system in south central Africa (Zambia, Malawi, Mozambique, Zimbabwe, Botswana and Caprivi Strip). It provides keys, synonymy and relevant bibliography for all taxa, as well as brief citations of exsiccatae summarizing local distribution. A generalized summary of overall distribution and habitat is also given. Line drawings illustrate at least one species per genus and each volume contains an index to all botanical names.

The five tribes treated belong (together with the Neotropical Liabeae) to the probably paraphyletic subfamily Lactucoideae. The controversial and much debated genera *Tarchonanthus* and *Brachylaena* are here included in the Mutisieae. By far the largest genus in this volume is *Vernonia* with 124 species.

The text is exact and solid, authoritatively written by Gerald V. Pope. Much is founded on earlier work on these tribes by the late Professor Hiram Wild, but recent relevant literature is also frequently cited.

The volume is well illustrated by 47 full-page drawings. Most of them are executed by Eleanor Catherine, some by M. Tebbs or V. Goaman, and they are all excellent.

This is a significant contribution to the knowledge of African Flora and to synanthology. The compact volume contains a wealth of up-to-date information at a comfortable price.

**REQUESTS FOR MATERIAL:
BARNADESIA AND *TRIXIS***

Two doctoral dissertations on taxonomic revisions of Compositae genera have been initiated in La Plata, Argentina. Lic. **Estrella Urtubey** is working on the genus *Barnadesia*, formerly in the Mutisieae, but now in the Barnadesieae, and **Liliana Katinas** is working on *Trixis* of the Mutisieae.

They request information on obtaining fresh leaf material and/or seeds of these genera. The address of both researchers is:

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