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A new serotinous species of *Cliffortia* (Rosaceae) from the southwestern Cape with notes on *Cliffortia arborea*

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Keywords: *Cliffortia*, new species, serotiny, taxonomy

ABSTRACT

A remarkable new species, *Cliffortia* **conifera** E.G.H. Oliv. & Fellingham, from the Anysberg, Ladismith District, is described and compared to its closest ally in the genus, *Cliffortia arborea* Marloth, which is widespread along the escarpment of the Great Karoo from Calvinia in the north to Beaufort West in the southeast. It is unique in the genus for its serotinous cone-like synflorescences which are borne on determinate lateral branchlets occurring in zones on the main branches. A similar serotinous condition exists in *C. arborea*, but the inflorescence axis is the main branch. The serotinous inflorescences are complex synflorescences consisting of numerous, highly condensed, double racemes (homoeothetic dibotrya). To date serotinous inflorescences have not been recorded in *Cliffortia*. *C. arborea* and *C.* **conifera** are included in section *Arboreae*, the description of which is emended here.

UITTREKSEL

'n Merkwaardige nuwe spesie, *Cliffortia* **conifera** E.G.H. Oliv. & Fellingham, van die Anysberg, distrik Ladismith, word beskryf en vergelyk met sy naaste verwant in die genus, *Cliffortia arborea* Marloth, wat wydverspreid voorkom op die Groot Karoo-platorand vanaf Calvinia in die noorde tot by Beaufort-Wes in the suidooste. Dit is uniek in die genus vanweë die serotiniese, keëlagtige bloeiwyses (synflorescences) wat gedra word op laterale takkies met beperkte groei, wat in sones op die hooftakke voorkom. 'n Soortgelyke serotiniese toestand bestaan by *C. arborea* maar die as van die bloeiwyse is die hooftak. Die serotiniese bloeiwyses is komplekse 'synflorescences' wat uit vele, hoogs gekondenseerde dubbele raseme (homoeotetiese dibotrya) bestaan. Serotiniese bloeiwyses is nog nie voorheen by *Cliffortia* aangeteken nie. *C. arborea* en *C.* **conifera** word geplaas in seksie *Arboreae* die beskrywing waarvan hier hersien word.

INTRODUCTION

The genus *Cliffortia* is a prominent element in the fynbos vegetation of the Cape Floral Region. With a total of 110 species it is one of the largest genera, and the overwhelming majority of its species is endemic. It is surprising that *Cliffortia*, for its size, is the only representative of the Rosaceae in the fynbos.

The genus has been well researched by Weimarck in a number of publications since his expedition to southern Africa in 1930, the major one being his revision of the genus (Weimarck 1934). Since Weimarck's work there has been much collecting of fynbos elements, particularly on the mountains by Elsie Esterhuysen of the Bolus Herbarium. This has resulted in a large accumulation of material in the Cape herbaria which has needed thorough curation by the second author at the Stellenbosch Herbarium (STE). It is showing that the collecting and recording of male, female and fruiting material for every species needs special attention for a complete understanding of the species and their relationships. It has also resulted in the detection of numerous species complexes and in the uncovering of a number of new species.

Some unusual material with 'galled' branchlets (*Van Wyk 1072*) was collected on a general collecting expedition of staff from the Stellenbosch Herbarium to the Anysberg near Ladismith in October 1982. The 'galled' branch could not be identified at the time, so it was given to Pauline Fairall (Bond) of the Compton Herbarium (NBG) for an opinion. She suggested the genus *Cliffortia* and noted that the 'galls' actually contained withered flowers. The collection was placed in the *Incertae* in both herbaria. Resulting from the current curation of *Cliffortia*, the first author made a search in 1991 for fresh material of this taxon and located a small population in the vicinity of Van Wyk's original locality.

An examination of this fresh material clearly showed that we were dealing with a very distinct new species of *Cliffortia* and a remarkable situation in which the female flowers are borne in serotinous cone-like heads. This condition had never before been recorded in the genus and was very reminiscent of that occurring in the genus *Leucadendron* R. Br. (Proteaceae) and *Widdringtonia* Endl. (Cupressaceae). In old plants of *Cliffortia* the cone-like heads are clearly retained on the plant for up to six years after flowering (Figure 1).

In this paper we have followed the terminology used by Weberling (1981, 1983) to describe the structure of the inflorescences. The basic unit of flowers is a highly condensed raceme (botryum) of the third order, a second order co-florescence. These racemes are aggregated into highly condensed double racemes (dibotrya) which in turn are clustered into a compact synflorescence in the form of either a cone-like head or a subterminal zone.

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FIGURE 1.—Photograph of female synflorescences in *Cliffortia conifera* (left) showing three zones (years) of cones on short, secondary flowering branchlets, *Oliver 10055* and in *C. arborea* (right) showing five years of conoid synflorescences on proliferating main branch, three on upper half of branch and two on lower half, *Oliver 10054*.

TAXONOMY

Cliffortia conifera *E.G.H. Oliv. & Fellingham*, sp. nov. in genere singularis et distinctissima propter flores suas femineas in synflorescentibus strobilinis lignosis in extremis ramulorum lateralium breviorum noninnovantium praesentes, ad sectionem *Arboreae* pertinens sed a specie unica *C. arborea* Marloth, strobilorum positione structuraque solum in ramulis secundariis determinatis, strobilorum foliis involucratis lignosis semipermanentibus, foliis latioribus interdum dentatis, indumento densiore brevioreque incano-floccoso differt.

Frutex erectus lignosus ad 4 m altus cortice griseo desquamato. *Rami* incano-floccosi glabrescentes. *Folia* 3-foliolata, vagina lata omnino vaginanti, incano-floccosa; stipulae subulatae 0.5–2.0 mm longae, base puberulae glabrescentes; foliola (10–)12–17(–18) × (2)3–6(–9) mm, anguste elliptica vel anguste ovata ad ovata, integra interdum [2]3[4]-lobata, marginibus abaxialiter parvum revolutis, incano-floccosa, adaxialiter glabrescentia, apicibus acutis subulatis subula 0.25–1.50 mm longa. *Inflorescentia mascula*: racemosa condensata floribus 3 vel 4(5) in extremis brachyblastorum in ramulis inferioribus. *Flores masculi* brevissime pedicellati; bractea ad 1.5 mm longa, anguste triangularis ciliata; sepala 2.8–3.2 × 1.8–3.0 mm, late elliptica vel subcircularia ad late obovata, apice subacuto crasso, externe lanata ad villosa; stamina 6–9; filamenta 3.5–5.0 mm longa, filiformia glabra; antherae 1.0 × 1.2 mm. *Inflorescentia feminea*: multa dibotrya in syn-florescentias strobilinas obovoideas, interdum sphaeroideas in extremo ramuli brevis lateralis, strobili juvenes 12 × 12–30 × 22 mm albo-flavovirentes, veteres plerumque 25 × 25 mm, griseovirides, omnes incani; folia primaria strobili 1(3)-foliolata, vagina latissima, stipulis brevissimis lateralibus subulatis vel sine stipulis, ciliata, dense lanata abaxialiter, glabra adaxialiter, foliolis 0.5–2.0 mm longis; folia secundaria strobili unifoliolata circum florescentias (botrya) involucrata, 5–10 × 3–5 mm, initio oblique obovoidea mollia demum elongato-ovoidea lignosissima, subula apicali intro aspicienti, dense et breve lanata, basaliter glabra ciliata; axis florescentiae truncatus longe villosus floribus 5–18 in florescentiis capitulatis in extremis planis axium tertiorum aggregatae his in dibotryis 4–6 in extremis axium secundariorum aggregatis. *Flores feminei* pro maxime parte occulti; bractea ad 1.5 mm longa vel absens, elongato-triangularis ciliata; pedicellum 0.1–0.2 mm longum; sepala 3 vel 4, 1.7–2.0 × 0.3 mm, linearia subacuta ad obtusa, apicaliter externe lanata aliter glabra, erecta ad parum patentia; receptaculum 0.9–1.2 mm longum, obovoideum, 3–4 cristis vel alis angustis, glabrum; stigma 1 linearis planoconvexa 4.5–5.0 × 0.2–0.25 mm, torta, in dimidio superiore irregulariter dentata, alba marginibus rubris. *Fructus* 1.8–3.5 × 0.8–1.0 mm, irregulariter ellipsoideus ad ovoideus, brunneus glaber, 3 vel 4 alis vel cristis angustis longitudinalibus pallide flavis. Figurae 2 & 3.

TYPE.—3220 (Montagu): Ladismith Dist., Anysberg, E end above Prinskloof, 1 300 m, (–BC), 4-06-1992, *Oliver 10055* (STE, holotype; BOL, K, PRE, isotypes; all male & female).

Woody erect shrubs up to 4 m tall with main trunk up to 150 mm in diameter with dark grey, flaking bark, plants regenerating from a lignotuber. *Branches* incano-floccose with crisped branched hairs submedially attached, the hairs falling off with age. *Leaves* 3-foliolate with broad totally sheathing incano-floccose vagina remaining on

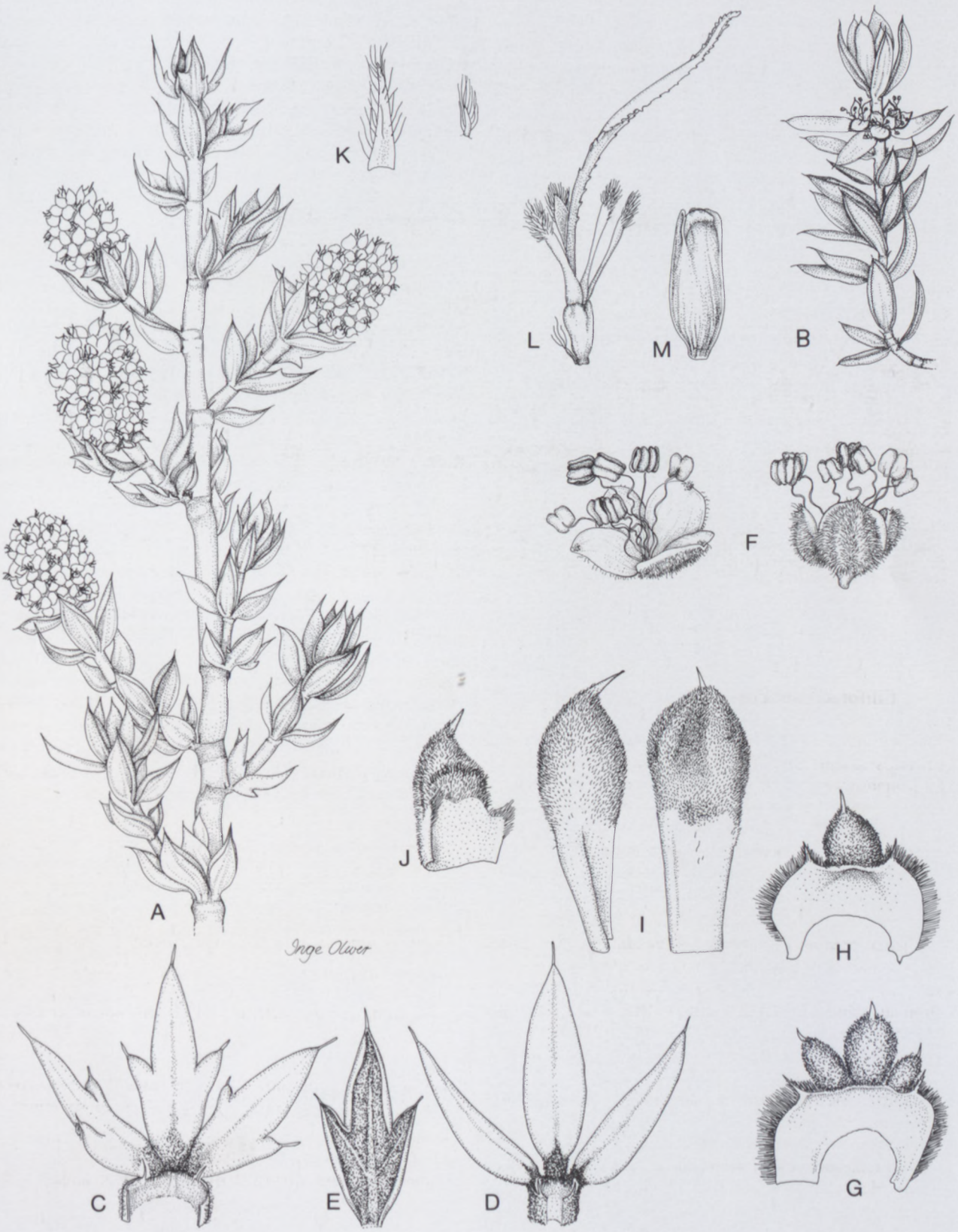

FIGURE 2.—*Cliffortia conifera*. A, branch with female cones in flower, × 1; B, male branchlet with flowers, × 1; C, leaf with lobed leaflets, adaxial view, × 3; D, leaf with entire leaflets, adaxial view, × 3; E, leaflet, adaxial view, × 3; F, male flowers, × 3; G, trifoliolate primary cone leaf, adaxial view, × 6; H, unifoliolate primary cone leaf, adaxial view, × 6; I, outer secondary cone leaf, lateral & adaxial views, × 6; J, innermost secondary cone leaf, partially lateral adaxial view, × 6; K, bracts of female flowers, × 12; L, female flower, × 12; M, fruit, × 12. All drawn from the type, *Oliver 10055* (STE).

branches after leaflets have been shed and giving segmented appearance to branches; stipules subulate from 0.5 mm long in young leaves to 2.0 mm in old leaves, remaining on vagina for some time after leaflets have been shed, hairy in lower part becoming totally glabrous, cream to reddish; leaflets (10–)12–17(–18) × (2)3–6(–9) mm, narrowly elliptic or narrowly ovate to ovate, mostly entire, occasionally [2]3[4]-lobed, with margins slightly revolute abaxially, completely incano-floccose when young soon becoming glabrous mostly on apical half of upper surface and margins and remaining incano-floccose on lower surface, all apices acute and subulate, subula 0.25–1.50 mm long, colourless or reddish. *Inflorescence (male)*: a condensed raceme of 3 or 4(5) flowers on a villous highly reduced brachyblast in axil of a subapical leaf of lower lateral branches situated well below apex of main branches. *Flowers (male)* very shortly pedicellate, creamy white; bract up to 1.5 mm long, narrowly triangular, long ciliate, whitish soon turning brown; sepals 2.8–3.2 × 1.8–3.0 mm, broadly elliptic or subcircular to broadly obovate with apex subacute thickened, mostly reflexed, villous to lanate outside; stamens 6–9; filaments 3.5–5.0 mm long, filiform glabrous; anthers 1.0 × 1.2 mm. *Inflorescence (female)*: many condensed double racemes (homoeothetic dibotrya) aggregated into an obovoid, occasionally sphaeroid, cone-like synflorescence at end of a short lateral branchlet, these cones (1–)4–10 in a subterminal zone on main branches, rarely on secondary branches, young cones 12 × 12–30 × 22 mm whitish yellow-green and old mature cones mostly 25 × 25 mm dull grey-green, all incanous, older fruiting cones retained for up to 6 years, vegetative region between zones 50–80 mm long, occasionally up to 300 mm; leaves of primary cone axis (primary cone leaves) (3-)1-foliolate, with very broad vagina, with or without short lateral subulate stipules, ciliate, densely and shortly lanate abaxially, glabrous adaxially, leaflets 0.5–2.0 mm long, reduced otherwise foliaceous, inner with an expanded sheathing base; dibotrya of 4–6 co-florescences of second order with axis 0.5–2.0 mm long; leaves of secondary cone axis (secondary cone leaves) unifoliolate, arranged involucre-like around florescences (botrya), 5–10 × 3–5 mm, at first obliquely obovoid and soft, becoming elongate-obovoid and very woody, reducing in size towards axis, with inwardly pointing apical subula, ovoid, attenuated into a long stout terminal subula, apically greenish densely and shortly lanate, basally white glabrous and ciliate; co-florescence (botryum) highly condensed with 5–18 flowers in a capitulum-like arrangement, axis very short, truncate, long villous. *Flowers (female)* mostly hidden; bract up to 1.5 mm long or absent, very thin, elongate triangular, long ciliate, brownish; pedicel 0.1–0.2 mm long; sepals 3 or 4, 1.7–2.0 × 0.3 mm, linear subacute to obtuse, lanate outside apically otherwise glabrous, erect to slightly spreading, colourless; receptacle 0.9–1.2 mm, obovoid, with 3–4 longitudinal narrow ridges or wings ending in small apical bulges, glabrous; style 1, linear, planoconvex, 4.5–5.0 × 0.2–0.25 mm, curled and twisted, exserted from cone, white, edged in upper half with short irregular red stigmatic teeth. *Fruit* 1.8–3.5 × 0.8–1.0 mm, irregularly ellipsoid to ovoid, dark brown and glabrous with 3 or 4 yellowish longitudinal narrow ridges or wings, apically emarginate, retained within cone for several years after flowering period. Figures 2 & 3.

FIGURE 3.—*Cliffortia conifera*. Photograph of female branch of holotype prior to pressing, showing cones in flowering stage (*Oliver 10055*), × 0.5.

The closest ally to *C. conifera* is *C. arborea*. *C. conifera* possesses female flowers borne in condensed cone-like structures, in a different position to those of *C. arborea*. Herbarium material of *C. arborea* was rather inadequate for a thorough investigation and is also extremely difficult to handle due to its toughness and spikiness. A trip was therefore made to collect fresh material of both species in June 1992 in order to analyse and compare the structures in detail.

Weimarck created the section *Arboreae* to provide a place for the unusual tree-like species, *C. arborea*, which had been described by Marloth in 1905. He noted that the species possesses several unique morphological characters. He described the flowers as 'closely clustered in groups of 5–8 in the axils of simple leaves on very contracted twigs'. These he noted were bunched together in such a way as to give the impression of a 'spadix'. This clearly points to the elongated compact cone-like structure that is present on those herbarium sheets which are fertile, but does not fully reflect the situation in nature. All fertile female herbarium material seen by us possesses a single subterminal 'spadix' or 'cone' on a single branch. In the

wild, branches may possess only a single subterminal cone, but others can have a series of cones spread along their main axis (Figures 1 & 4A). Needless to say the former are far easier to collect and press. The single cone situation shown by Marloth and present on all the herbarium material collected before our investigation, occurs only when an actively growing branch flowers for the first time. The spread of cones along a stem clearly showed that the current, flowering cone was subapically situated with the other cones lower down in a series at close intervals with each successive cone representing a previous year's inflorescence. Weimarck was therefore unaware of the retention of the inflorescences for a number of years following their initial formation during the flowering period. We therefore prefer to use the term 'cone' for *C. arborea*, particularly when *C. conifera* is taken into account.

A detailed examination of the cones of both species showed that they are very similar in their structure and differ mainly in their position on the main branches. In *C. arborea* the primary axis of the cone is the main relative branch which elongates beyond the cone and also laterally via sterile, lateral, secondary branchlets within the cone, whereas in *C. conifera* the primary axis of the cone is a secondary lateral branch which is determinate in growth and devoid of any lateral vegetative branching. The development of lateral branches from the cones in *C. arborea* is clearly shown in the photograph published with the protologue by Marloth (1905) and in the uppermost cone in Figure 1. His photograph shows numerous very short, lateral, leafy branchlets which conceal the true nature of the female compound inflorescence underneath.

The cones are complicated structures which require careful dissection for analysis. A simplified diagram of the cones from both species is summarized in Figure 4. In this we have followed the terminology of Weberling (1983). The order of branching refers only to the branching of the inflorescence and not to the rest of the plant. The cones are polytelic synflorescences composed of numerous, condensed, sessile, racemes (botrya), up to 50 per cone, the co-florescences (Figure 4C & D) which are grouped together in highly condensed double racemes (dibotrya) (Figure 4B & B′). The co-florescences resemble capitula with up to 16 flowers all arising at the same level from the truncated end of the very short, 3rd order, florescence axis. The flattened end of this axis is covered by long erect hairs from which the bracteoles just emerge. The subtending secondary cone leaves on the 2nd order axes are very different from the normal vegetative leaves and are considerably thickened and eventually become woody (Figures 2I & J; 5D). These enlarged, woody, involucral leaves form the basic matrix of the cone and almost completely cover the female flowers with only the stigmas protruding in most cases. There is another type of leaf in the cone and these we refer to as the primary cone leaves (Figures 2G & H; 5C). They are situated on the main or primary axis of the cone (1st order inflorescence branch) and subtend the lateral 2nd order dibotrya. In *C. conifera* these primary cone leaves are unifoliolate, occasionally trifoliolate, but they are always trifoliolate in *C. arborea*. In the latter species some of the leaflets of these primary cone leaves may be shed, but the scars indicate that the original condition was trifoliolate.

Further differences in the cones occur between the secondary cone leaves. In *C. conifera* they are mostly obovoid in shape with a stiff, apical, adaxially pointing subula. They are at first softish, but become woody and remain intact in the cone for the life of the cone (± 6 years). In *C. arborea* they are widest at the middle with the upper portion narrowing, foliaceous and reflexed and with an apical, more or less erect subula. They are softish, not becoming very woody and after several seasons abscise at the top of the sheath. Thus in *C. arborea* the old cones retain only the flattened bases of the secondary cone leaves and are considerably narrower than the flowering and fruiting cones.

Female cones are therefore found only in these two species in the genus. The possibility of other species having a similar character, but not recorded, was not discounted. Clearly one is drawn to the species *C. strobilifera* L. on account of its name. This is a common widespread species which bears small ovoid 'cones' at various points on the plant. These are just vegetative galls having no connection with the position of flowers which are borne singly over the normal branches. Another species that attracts attention is *C. heterophylla* Weim. which has two distinctly different types of leaves on the plant and these are associated with the flowers. The majority of leaves are linear-lanceolate whereas considerably broader ovate leaves occur in long terminal zones. The female flowers occur in the axils of these broader leaves. The whole appearance of the branches is rather cone-like but not comparable with those found in the section *Arboreae*.

Weimarck (1934: 170) drew attention to the existence of a true inflorescence in only three species in the genus, *C. arborea*, *C. odorata* L. f. and *C. hirsuta* Eckl. & Zeyh. In the latter two species the flowers, 5–15, occur in contracted racemes which he noted 'approach the form of heads'. He also noted that male and female flowers are frequently found in the same inflorescence. However, in a later review of the genus (Weimarck 1948) he placed the two species in a division of his key which described the flowers as 'at least the male, fascicled in the leaf axils'. He included two new species in this group, *C. discolor* Weim. and *C. viridis* Weim., but made no mention of their inflorescences in either the descriptions or the discussions.

The cone-bearing zones on the plants of *C. conifera* vary considerably depending on how vigorously the branches are growing. Most have 5–8 cones in the zones, but there can be as few as one or as many as 11 (Figure 1). The vegetative region between the zones is usually 50–80 mm long with vegetative lateral branchlets developed there, but it can be as short as 30 mm or as long as 300 mm in vigorously growing branches. These observations were made on the few, mature, cone-bearing adult plants in the type population.

Apart from the differences in the cones, the leaves in *C. conifera* are visibly very different from those in *C. arborea* which are much wider and erect-spreading. The appearance of the plants is remarkably similar to some species in the genus *Phylica* L. in the Rhamnaceae. In *C. arborea* the leaves are linear, needle-like and very revolute, in fact very ericoid, and also falcate. The recurved nature of these leaves is very marked on the

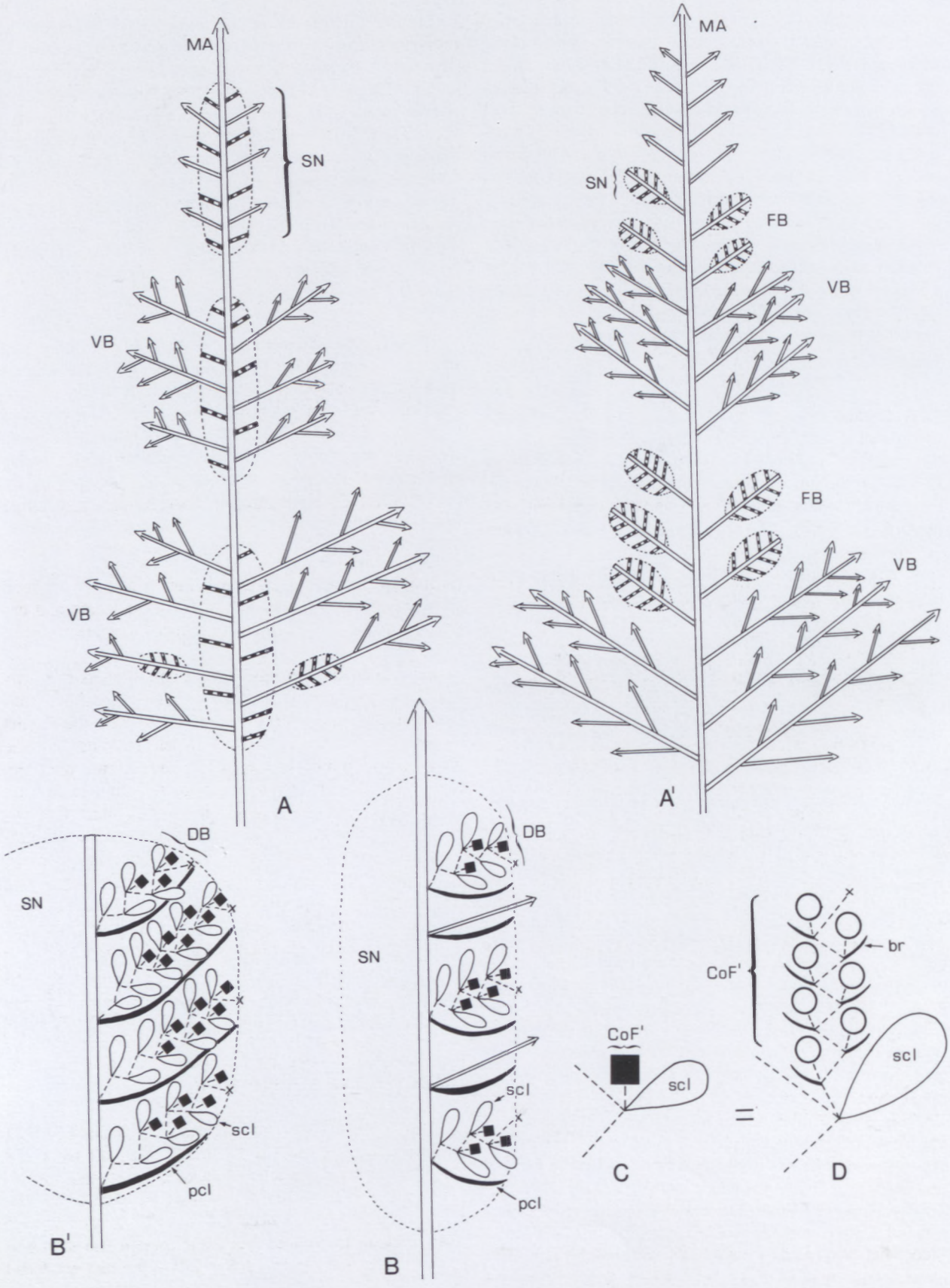

FIGURE 4.—Longitudinal diagrams of architecture and structure of synflorescence. A, B, *Cliffortia arborea*: A, three conoid synflorescences on main branch and two minor synflorescences on lateral branches; B, part of synflorescence showing three dibotrya. A′, B′, *C. conifera*: A′, two zones of four and five conoid synflorescences on lateral truncate branches; B′, part of synflorescence showing four dibotrya. C, D, single co-florescence or botryum (solid square) with its seven individual flowers (open circles). MA, main or primary axis; FB, flowering secondary branches; VB, vegetative secondary branches; SN, synflorescence; DB, dibotryum; CoF′, co-florescence or botryum; pcl, primary cone leaf; scl, secondary cone leaf; br, bract of single flower; zoned lines in synflorescences in A & A′ represent dibotrya; dotted zigzag lines in B, B′, C & D represent expanded highly condensed axes; solid squares represent botrya, and circles, single flowers.

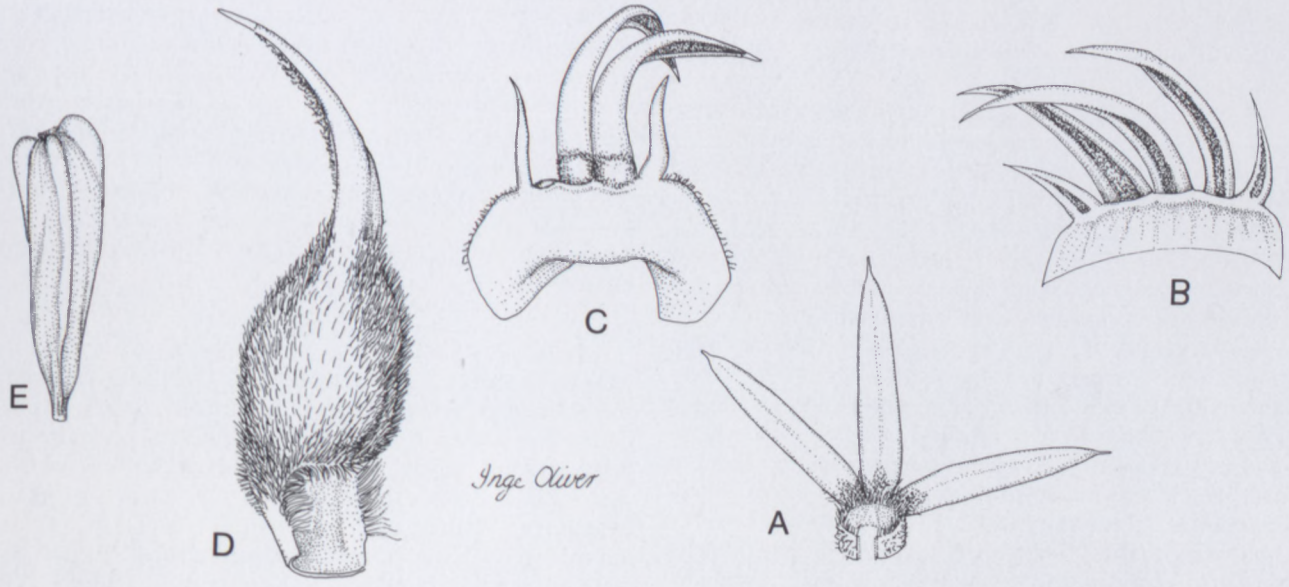

FIGURE 5.—*Cliffortia arborea*. A, leaf, adaxial view, × 3; B, leaf with foliaceous stipules from region just below synflorescence, abaxial view, × 6; C, primary cone leaf with third leaflet shed, adaxial view, × 6; D, secondary cone leaf, lateral/adaxial view, × 6; E, fruit, × 12. All drawn from *Oliver 10054* (STE).

main branches just below the young cones where even the stipules become foliaceous and recurved (Figure 5B).

The leaves in *C. conifera* are, however, problematic in that there is a clear difference between those of the collections from the type population and those of *Van Wyk 1072*. The leaflets on the latter collection are mostly linear, 1.0–1.6[2.0] mm wide, and revolute with no broad open-backed examples. Even a long period of softening by boiling in water with softener added, does not render them any broader. In the collections from the type population the leaflets are mostly much broader, (2)3–6(9) mm wide, with only the occasional leaflet being more linear. The width of the leaflets in the dried collections tends to be slightly narrower than in the fresh state. This distinct difference is puzzling seeing that we have been unable to relocate the site at which Van Wyk made her collection. Until such time as this has been rediscovered and the plants studied in the field, we are unable to assess this clear disjunction and have therefore excluded it from the type description.

Marloth described the hairs on *C. arborea* as Malphigian hairs, i.e. hairs which are attached by their middle; two-branched hairs according to Weimarck (1934). Both species have these hairs on the branches and leaves. The hairs are very flat in the middle portion where they are very flimsily attached to the surface and are easily removed when touched. The two ends are curled and somewhat erect. In *C. conifera* the hairs are very closely packed whereas in *C. arborea* they are longer and sparser.

The bracts of the female flowers in *Cliffortia* are usually well developed and amplexicaul, enveloping the base of the flower (Weimarck 1934). In *C. conifera* and *C. arborea* the bracts are much reduced to nonexistent and are flat, only slightly curved in the largest examples. They are placed on the flattened end of the axis of the co-florescences (botrya) between the closely packed flowers in a manner similar to that in the Asteraceae. Being surrounded by long transparent hairs and being themselves covered with long hairs, they are very difficult to locate and examine especially when they are reduced to mere vestiges.

Marloth (1905) described the female flowers of *C. arborea* as having a solitary style with one white, nonplumose stigma. Weimarck (1934) described the stigma as linear and a little branched which is unique for the genus in which most of the species have showy, plumose, red stigmas. He regarded the basal nonplumose portion as the style which in most species is very short. *C. conifera* and *C. arborea* have identical style/stigma configurations. The style/stigma is an elongate-linear, planoconvex, white organ with very short irregular teeth on the edges in the upper three-quarters to half and an acute, red apex (Figure 2L). The actual position of the stigmatic surfaces in these two species is not clear to us and so we refer to the structure as a style/stigma. In the other species of *Cliffortia* the lateral hairs are very well developed and Weimarck refers to the region in which these occur as the stigma. This problem will need careful examination of fresh material of both species to ascertain the position of trapped germinating pollen grains.

The type population of *C. conifera* consists of about 50 plants, most of which had been burnt off by a fire some five years previously. There were only eight mature plants which survived the fire and which were flowering. The plants which had been burnt were all regenerating from a basal lignotuber, but even though the strongest growing one was already 1.5 m tall, none had produced any cones. The oldest plant was growing protected among large boulders and was about 4 m tall, or rather, long, seeing that it was growing out diagonally from between the boulders.

Cliffortia arborea *Marloth* in Botanische Jahrbücher 39: 318 (1905); Weim.: 91 (1934). Type: Africa australis, in rupibus montium regionis Roggeveld dictae, alt. 1 500 m, Oct., *Marloth 3907* (B†, holo.; BOL female!,

K! male, P male [sec. Weimarck], STE! sterile). Lectotype here designated, *Marloth 3907* (BOL female).

Stipules 0–2, subulate or below synflorescences subulate to foliaceous. *Inflorescence (male)*: a condensed raceme of 2–4 flowers on a brachyblast in the axil of a normal vegetative leaf. *Male flowers*: sepals 3, 4 × 3 mm in the largest specimen seen, abaxially lanate, apex subulate; stamens 8–10. *Inflorescence (female)*: an ellipsoid cone-like synflorescence of condensed double racemes (dibotrya) consisting of sessile capitulum-like co-florescences (botrya), the synflorescence borne on the main branch with continued apical growth, with 2nd order axes continuing growth laterally and sometimes forming a secondary cone or male florescences in subsequent seasons; primary cone leaves trifoliate, stipules absent to well developed and foliaceous; secondary cone leaves unifoliolate, 12 mm long reducing in size towards axis of dibotryum, basally sheathing, medially ovoid, shortly lanate, distally cylindric, glabrescent, apex subulate, abscising at top of basal sheath in third or fourth year.

Several points which are at variance with Weimarck's description and do not concern the conoid inflorescences which have been dealt with in detail under *C. conifera*, need some discussion. Most of the material examined was devoid of stout subuloid stipules. In most cases there is very little indication of any stipules, but when they are present they can be prominent. However, below the cones they are usually well developed and even foliaceous. The male flowers are not borne singly in the axils of vegetative leaves but in groups of 2–4 on highly reduced short shoots and have more anthers, 8–10 per flower, than were recorded by Weimarck. The female flowers can have 3 or 4 sepals not just 3.

Both Marloth and Weimarck noted that *C. arborea* had, in addition to the branched hairs of the indumentum, pedunculate glands which produced a strongly aromatic oil. We have not been able to observe any of these glandular hairs on the material at our disposal and the fresh material from the Komsberg and the Nuweveld Mountains was not aromatic. We believe that Marloth must have confused the aromatic nature of some of the plants which he collected on his Roggeveld trip and this was repeated by Weimarck who never handled any fresh material.

The production of short, sterile, 2nd order branches within the current flowering synflorescence is peculiar to this species. During the flowering period these lateral branchlets characteristically appear just beyond the boundaries of the cone. In the following season these branchlets elongate considerably, as shown in Figure 4A, and clearly visible in Figure 1 (right). In herbarium material these branches appear to be all sterile. However, fresh material from our own collections showed some very interesting features. The collection from Komsberg (*Oliver 10054*) possessed some laterals with small female synflorescences shown in the diagram in Figure 4A. These appeared to have flowered at the same time as the synflorescence above them on the main axis, the second one from the apex. One of the collections from the Nuweveld Mountains (*Fellingham 1625*) possessed instead, numerous male florescences on these lateral branches.

Marloth did not state where his type collection was housed. Weimarck (1934) gave the location of several specimens of *Marloth 3907* with male and female material in B and BOL and only male material in K and P. The only female specimen appears to be the one in BOL, because the material in B was destroyed during the Second World War. There is no male material of *Marloth 3907* in BOL as cited by Weimarck. We have therefore selected the female collection of *Marloth 3907* in BOL as the lectotype.

Marloth also gave no exact locality for the type collection. However, in the discussion on the species he noted that it occurred only on the southern end of the Roggeveld on the Komsberg. The lectotype in BOL has appended to it the original print of the habit/habitat photograph which was published with the protologue. On the reverse it is labelled in Marloth's own handwriting as taken on the Komsberg at 1 550 m and the specimen is labelled as 'southwestern krantzes on the Komsberg, 1 550 m'. It is therefore clear that the Komsberg is the type locality for the species.

In his discussion of the species Marloth noted that the appearance of the short branchlets, i.e. those protruding from the young female inflorescence, caused the local people to give the plant the common name of 'Starboom (= Sternbaum)' or rather sterboom. This has been corrupted subsequently to 'sterkboom' as indicated by the naming of several localities at the southeastern end of the Roggeveld escarpment as Sterkboomkloof, Sterkboomplaat on the Trigonometrical Survey maps (1:250 000 & 1:50 000). However, the correct name is still included as the original farm name 'Sterboom Hoek 8' on the map 3221CA in the 1:50 000 series.

Since the discovery of the species, the distribution range has been considerably extended by further collections from as far north as the Hantams Mountain near Calvinia to the Nuweveld Mountains above Beaufort West in the east. Marloth quoted information from the local farmers in 1905 that the species used to be very common along the edge of the escarpment, but with there being no other woody plants in the whole area the species was being used in considerable quantities for firewood. It is now reduced to a few small populations in the southern Roggeveld. In the Hantams area it was fairly common on dolerite screes and krantzes in 1955 according to *Acocks 18621* with the populations above Akkerendam now in a nature reserve controlled by the Calvinia Municipality. Shearing (*Shearing 893*) records the species as fairly common locally at Mountain View on the Nuweveld Mountains which the second author confirmed during a visit to the area. Fortunately the very good populations on the Nuweveld Mountains occur in an area that now falls within the recently established Karoo National Park where the species is assured of the best possible protection.

Section **Arboreae**

The addition of the new species to the section *Arboreae* and the changes to the description of *C. arborea* necessitate the emending of the sectional description. The diag-

nostic feature of the section is now the serotinous, triple botryoid, conoid synflorescence.

Section **Arboreae** *H. Weim. emend. E.G.H. Oliv. & Fellingham*

Shrubs or small trees. *Leaves* trifoliolate; stipules 0–2, subulate to foliaceous; leaflets revolute or flat, entire to dentately 2–4-lobed. *Inflorescence (male)*: a condensed raceme of 2–5 flowers on a lateral highly condensed short shoot in axil of vegetative leaf. *Male flowers*: sepals 3 or 4; stamens 6–10. *Inflorescence (female)*: a conoid synflorescence subterminally on main branches with continued apical growth (*C. arborea*) or apically on determinate lateral short shoots (*C. conifera*), the synflorescences composed of condensed double racemes (dibotrya) each consisting of condensed co-florescences (botrya). *Female flowers*: sepals 3 or 4; receptacle triangular narrowed to base, narrowly 3-winged or 3-ridged; style/stigma single, linear, edges irregularly and shortly dentate; achene single.

Species included: *Cliffortia arborea* Marloth (type species), *C. conifera* E.G.H. Oliv. & Fellingham.

PHYTOGEOGRAPHY

C. conifera is known only from the eastern end of the Anysberg in the western part of the Ladismith District where it grows at 1 300 m on steep, east-facing, summit slopes on sandstones of the Nardouw subgroup of the Table Mountain Group in the Cape Supergroup (SACS 1980). The associated vegetation is Mesic Mountain Fynbos (Moll *et al.* 1984). The area falls within the Anysberg Nature Reserve of the Cape Department of Nature & Environmental Conservation. The weather station nearby on the mountain has recorded an annual rainfall in the region of 450 mm per annum which occurs throughout the year with peaks in mid-winter, late spring and early autumn.

The nearest locality of its closest ally, *C. arborea*, is 90 km due north on the Roggeveld escarpment at the Komsberg. This species is considerably more widespread from the Hantams Mountains at Calvinia in the north along the edge of the Roggeveld escarpment and eastwards to the Nuweveld Mountains above Beaufort West (Figure 6). In all cases it grows near the edges of escarpments or in kloofs below the escarpments which are at high altitude ranging from 1 500–1 800 m and subjected to harsh climatic extremes of heat and drought in summer and intense cold with several annual falls of snow in winter. From the rainfall maps and the rainfall figures available for nearby towns, it seems likely that the species receives in the vicinity of 300 mm of rain per annum, mostly in the winter months but occasionally in summer. In the Roggeveld the escarpment is composed of sandstones and mudstones of the Adelaide subgroup of the Beaufort Group in the Karoo Sequence with the Hantams and Nuweveld Mountains being dolerite intrusions (SACS 1980). The record at the northern end of the Hantams Mountain (*Oliver 8878*) was in a sheltered kloof at a lower altitude of only 1 300 m. In all its localities it grows amongst Karroid Shrubland (Moll *et al.* 1984) with no representatives of Fynbos in the area.

Other species occurring like *C. arborea* on the interior mountains of the southern Cape Province are *C. hantamensis* Diels, only from the Hantams Mountain and the Roggeveld at Uitkyk, both *C. arborea* localities, and *C. ramosissima* Schltr. from the Hantams Mountain, to the high mountains near Graaff-Reinet and as far north as the northern Drakensberg. Marloth (1905) pointed to the isolated taxonomic, as well as geographic, position of *C. arborea* and suggested that it is a relic of a former wider distribution of the genus during pluvial periods. With the discovery of the closely related *C. conifera* occurring in the nearby Cape Floral Region with numerous other species of *Cliffortia*, the linkup with the rest of the genus is substantiated.

PHENOLOGY

C. conifera and *C. arborea* are monoecious with unisexual male and female flowers borne on separate branches. The female flowers are borne in terminal or subterminal cones near the ends of the main branches. The male flowers are borne in small groups in the axils of vegetative leaves on lateral normal branches. In *C. conifera* these male lateral branches are situated below the female cones mostly lower down on the plant. In *C. arborea* it is clear from the herbarium material that they are also borne on lower lateral normal branches in this species. Both male and female inflorescences were attached to the same main branch with the male flowers just below a single subterminal female cone (*Acocks 18621; Marloth 9730*) or on lateral branches emanating from the lower older cones (*Fellingham 1625*) (see below under *C. arborea*). These two species are clearly wind-pollinated which is the syndrome presumed for all other species of *Cliffortia* (Koutnik 1987). The position of the flowers would indicate that updraughts of air would be responsible for transferring the pollen to the female flowers. This would fit in well with the habit and habitats observed in the field where winds would come up from below the plants on the edges of the escarpment or at the foot of summit cliffs or in steepish kloofs.

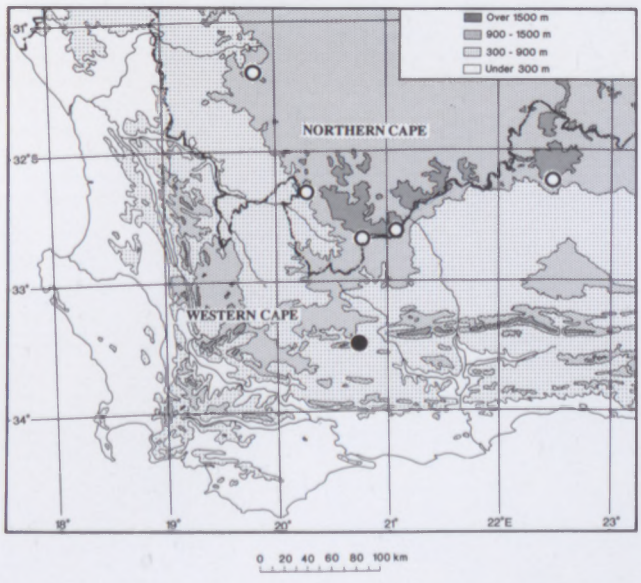

FIGURE 6.—Known distribution of *Cliffortia conifera*, ●; and *C. arborea*, ○.

The female flowers, except for the long, exserted, strap-shaped style and stigma, are totally hidden from view within the envelope of secondary cone leaves. After pollination they remain in the cones protected by these leaves which become quite woody in *C. conifera*. The entire cone in this species may remain on the plant for as long as six years after initial formation. At what stage the fruits are shed is difficult to ascertain, but we believe that this occurs during the second or third year following flowering. In *C. arborea* the secondary cone leaves abscise after about 3–4 years, apparently after the fruits are shed. The flat-ended woody bases of the secondary cone leaves remain on the main branch for several years after that, indicating where the original 'flowering' cone had been situated. It is clear that some additional monitoring of the plants in the field is necessary to ascertain the complete phenological cycle in both species.

The flowering in these species occurs at different times of the year. In *C. conifera* the female and male flowers are most prolific during the late summer and autumn months from April to June with some of the female flowers opening as late as August. In *C. arborea* we have been able to examine freshly opened flowers (*Fellingham 1624, 1625*), and deduce that the plants flower in late spring and early summer from October to December. The flowering of the latter species is therefore surprisingly soon after the advent of warmer weather, seeing that it occurs in the coldest regions of the southwestern Cape.

SPECIMENS EXAMINED

C. conifera

WESTERN CAPE.—3320 (Montagu): Ladismith, Anysberg, E end above Prinskloof, 1 300 m, (–BC), 23-09-1990, *Oliver 9730* (PRE, S, STE, all female); ibid. 10-08-1991, *Fellingham 1531* (STE female); ibid. 4-06-1992, *Oliver 10055* (BOL, K, MO, PRE, STE, all male & female); Anysberg, E end, gully leading to Prinsberg, (–DA), 6-10-1982, *M. van Wyk 1072* (NBG, STE, both female).

C. arborea

NORTHERN CAPE.—3119 (Calvinia): Akkerendam, dolerite screes & krantzes of Hantamsberg, 1 372 m, (–BD), 14-11-1955, *Acocks 18621* (BOL male & female, K male & female, NBG male); summit of Hantam Peak, 1 660 m, (–BC), *Wisura 3556* (NBG sterile); Hantamsberg, Voetpadskloof, S-facing slope, renosterveld, 1 465 m, (–BD), 3-09-1986, *Oliver 8878* (STE sterile); upper E slope of Hantam Mtn, Vanrhynshoek Farm, kloof near stream, (–BD), 7-10-1986, *Thomas & Van Jaarsveld 8961* (NBG sterile). 3220 (Sutherland): Roggeveld, Farm Uitkyk, Sneeuwkrans, below krantz facing W, 1 730 m, (–AD), 10-1920, *Marloth 9730* (PRE stem & bark only, STE male & female); Hottentotsbank near Sneeukrans, W-facing scree slopes, 1 433 m, (–AD), 22-09-1981, *Rourke 1728* (K sterile, NBG sterile); Roggeveld, southwestern krantzes on the Komsberg, 1 550 m, (–DB), 04-1905, *Marloth 3907* (BOL female, K male, STE sterile); Roggeveld Mtns, Komsberg, 1 525 m, (–DB), 10-1920, *Marloth 9770* (PRE female, STE female); just W of road at top of Komsberg Pass, sandstone escarpment, (–DB), 22-09-1977, *Moffett 1463* (STE sterile); plateau at top of Komsberg Pass, E of road, 1 600 m, (–DB), 1-03-1986, *Moffett & Steensma 4067* (STE male); Komsberg Pass, lower slopes ENE of Skurwekop, 1 500 m, (–DB), 4-06-1992, *Oliver 10054* (BOL, K, MO, PRE, S, STE, all female). Without precise locality: mountains near Sutherland, 12-1905, *Du Toit sub BOL 10057* (BM, BOL, K, all sterile); Sutherland, shady side of very inaccessible kloofs, 13-10-1969, *De Villiers s.n.* (NBG immature female). 3221 (Merweville): Sterkboomkloof near Vinkfontein, edge of kloof, 1 500 m, (–CA), 28-02-1986, *Moffett & Steensma 4060* (STE sterile).

WESTERN CAPE.—3222 (Beaufort West): Nuweveldberge, Karoo National Park, Mountain View area near FM tower, SW slope, 1 830 m, (–BA), 17-11-1992, *Fellingham 1624* (MO, PRE, STE, all female); Karoo National Park, Mountain View, top of mountain, 1 830 m (–BA), 3-01-1985, *Shearing 893* (PRE female); Nuweveld Mtns, S slopes above Beaufort West, 1 525 m (–BC), 07-1940, *Esterhuysen 2759a* (BOL sterile); Nuweveldberge, Karoo National Park, Mountain View area near the Look Out, 1 830 m, (–BC), 17-11-1992, *Fellingham 1625* (BM, PRE, STE, all male & female).

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