A new serotinous species of *Cliffortia* L. (Rosaceae) from Northern Cape, South Africa and section *Arboreae* emended

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ABSTRACT

A new species, *Cliffortia* **dichotoma** Fellingham, from the Oorlogskloof Escarpment, near Nieuwoudtville, Northern Cape, is described and compared to its closest allies 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, and *C. conifera* E.G.H.Oliv. & Fellingham from the Anysberg near Laingsburg, further east in the Karoo. The description of the section *Arboreae* is emended here to include the new species, and the description of *C. aborea* is corrected.

INTRODUCTION

The more than one hundred species of the genus *Cliffortia* L. represent an amazing variety of growth forms. These range from delicate, herbaceous ground covers to shrubs of various shapes and sizes, as well as trees. Until recently only two trees had been recognized and placed in the section *Arboreae* Weim. emend. (Oliver & Fellingham1994).

A third tree-like species was brought to my attention by Prof. D.J. von Willert, who took it to be the well-known *C. arborea*. It is indeed more closely related to *C. arborea* than to the third species in this section viz. *C. conifera*, but also distinctly different from both.

Not only does the growth form set these tree-like species apart from the rest of the species in the genus, but they are also distinct in having highly condensed female inflorescences. Furthermore, these inflorescences are borne terminally on main stems or main branches and always near the top of the trees, whereas the male inflorescences, which are much smaller and less condensed, are borne on the same plants but lower down and on lateral branchlets. This arrangement of male and female flowers is rare in wind-pollinated plants (Proctor *et al.* 1996).

The similarity in these three species also includes their habitats. In each instance it is the edge of an escarpment, in fynbos in the cases of *C. conifera* and *C. dichotoma* and in karroid shrubland for *C. arborea* (Marloth 1905; Oliver & Fellingham 1994).

According to the owners of the Farm Papkuilsfontein where the new species occurs, the known population had not been subjected to fire for more than 20 years. This could account for the fact that there are no seedlings or young trees present and many trees are partly dead.

In this paper the terminology used by Weberling (1981, 1983) for describing the structure of the inflorescence, is followed. The ultimate flower-bearing element is a highly condensed raceme (botryum), the co-florescence. These racemes are aggregated into highly condensed double racemes (dibotrya) which are clustered around the main axis of a compact synflorescence, forming the cone-like female inflorescence. The positions in which these female cones are borne, differ from each other in the three species.

Cliffortia dichotoma *Fellingham*, sp. nov., *C. arborea* proxime affinis, sed positione inflorescentiarum feminarum strobiliformium in apicibus ramorum principalium dichotomorum, non sequentialiter in ramis principalibus, et foliis unifoliolatis parvis glabrescentibus, non trifoliolatis multo longioribus et incano-pubescentibus, differt.

TYPE.—3119 (Lokenburg): Nieuwoudtville Dist., Oorlogskloof Nature Reserve, Farm Cipher Kop 804, 720 m, (–CA), 16-10-1996, *Pretorius 396* (NBG, holo.; BOL, K, MO, PRE).

Trees up to 5 m tall with main trunks butressed, up to 500 mm diam.; bark reddish brown, flaking; branching pattern dichotomous, resulting in a spreading canopy. *Branches* incano-floccose, glabrescent with age and appearing segmented with leaf sheath residues from obsolete primary leaves. *Primary leaves* unifoliolate, stipulate, caducous except at swollen branch tips which become female cone-like inflorescences; stipules lanceolate, up to 0.5 mm long, pungent, greyish brown, glabrescent; leaflets lanceolate, (10–)12(–15) mm long, pungent, glabrescent, margins revolute. *Secondary leaves* unifoliolate, exstipulate; vagina membranous, sheathing, successive vaginas imbricate; leaflets ligulate, (1.5–)2.0–3.0(–3.3) × 0.9 mm, up to 0.5 mm thick; margins revolute; upper surface glabrous greyish green, longitudinally grooved, undersurface incano-floccose except for revolute margins and distally raised main vein; apex mucronate, mucro minute, translucent. *Male inflorescence*: a condensed raceme of 2 or 3, (rarely only 1) flowers on a villous, highly condensed brachyblast in axil of a secondary leaf subapically on a brachyblast on lower part of a main branch bearing a female inflorescence apically. *Male flowers*: very shortly pedicellate,

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FIGURE 1.—*Cliffortia dichotoma*. A, initiation of female cone as apical swelling on main stem; B, young female cone with numerous strap-shaped
styles/stigmas, apical continuation of main axis as vegetative main stem and two robust lateral branches basally; C, primary cone leaf from near
apex of cone; D, apex of cone with four primary cone leaves subtending involucrally arranged groups of secondary cone leaves; E, primary
cone leaf with much-extended sheath, from equator of cone, therefore, apparently upside down; F, two female flowers with (3)4 calyx lobes and
strap-shaped styles/stigmas, borne on minute pedicels; G, pedicel with two bracteoles from female flower; H, one bracteole from female flower;
I, pedicel; J, smaller bracteole from female flower; K, male flower with pedicel, bracteoles and stamens; L, vegetative branchlet with male flow-
ers; M, vegetative leaf with amplexicaul sheath, adaxial view; N, vegetative leaf, abaxial view; O, secondary cone leaf bearing capitulum-like
botryum in axil; P, capitulum-like botryum, hairs removed to show pedicels and bracts; Q, mature female inflorescence cone with 'shroud' of
vegetative lateral branchlets and proliferating apical main axis; R, S, fruits, variously faceted and narrowly winged or ridged. A, C–E, M–S,
drawn from *Fellingham 1684*, B, F–L, from *Fellingham 1689*. Scale bars: 1 mm.

creamy white; bract narrowly triangular, up to 0.5 mm long, long ciliate, whitish; sepals 4, broadly elliptical to broadly obovate, 1.5–2.0 × 1.2–1.8 mm, apex subacute, thickened, dorsally villous; stamens 4; filaments filiform, up to 2 mm long, glabrous; anthers up to 0.75 × 0.6 mm. *Female inflorescence*: many condensed double racemes (homothetic dibotrya) each comprising a few, sessile, capitulum-like co-florescences (botrya), aggregated spirally on condensed main axis of an oblong, cone-like polytelic synflorescence apically on a main branch, one of a pair originating from below a cone of previous season; flowering cones (30–)35–40 × (15–)20–25 mm with apical proliferation of main axis (30–)40–50(–60) mm long, secondary cone leaves greenish white incanous, interspersed with long maroon styles; fruiting cones (40–)45–55 × (18–)22–25 mm with apical proliferation of main axis plus proliferation shoots of lateral dibotrya, these thin vegetative branches up to 80 mm long and shrouding cone, caducous; leaves of primary cone axis (primary cone leaves) unifoliolate, vagina grossly expanded, woody, flushed with red, interspersed with longitudinal cartilaginous veins and with pungent woody stipules up to 2 mm long, ciliate, vaginas sheathing main cone axis and segregating individual dibotrya, leaflets narrowly elliptical, up to 2.5 × 1 mm woody, pungent to minutely bifid with remnants of short lanate indumentum basally; leaves of secondary cone axis (secondary cone leaves) trifoliolate, arranged involucre-like interspersing florescences (botrya), vagina 3.0–3.5 × 4–5 mm, dorsi-ventrally flattened, woody, longitudinally furrowed, exstipulate, leaflets 3.0–3.5 × 2.0–2.5 mm, greyish green, incano-floccose, conical-mucronate, mucro 1.5–1.75 mm long, pungent, becoming woody, leaflets of each leaf arranged in triangle, reducing in size towards centre of involucre; co-florescence (botryum) 7–12-flowered, highly condensed with axis a flattened platform of irregular shape bearing minute pedicels subtended by reduced and modified bracts interspersed with villous hairs. *Female flowers:* hidden except for styles and tips of calyx lobes; bract subulate, up to 0.5 mm long, long-ciliate, translucent; pedicel 0.1–0.2 mm long; sepals (3)4, linear-acute, 2.0–2.5 × 0.3–0.5 mm, reflexed, glabrous; receptacle cylindrical, 1.5–1.7 × 0.75 mm, faintly longitudinally furrowed, glabrous; style 1, linear, plano-convex, 5.5–6.0 × 0.2–0.25 mm, acute, spirally twisted, exerted from cone, deep maroon, upper half edged with short irregular teeth. *Fruit:* irregularly longitudinally angled, 2.3–2.5 × 1.0–1.2 mm, apically concave around style remnant, dark brownish grey and glabrous with two narrow whitish longitudinal wings; retained within cone for several years. Figures 1, 2.

This new species differs from its closest ally, *C. arborea*, mainly in the ultimate position of the female inflorescence cones, which are borne terminally on the dichotomous main branches, whereas those in *C. arborea* occur sequentially on main stems. In both species the female inflorescence cones originate terminally on main branches, which subsequently proliferate beyond the cones. In *C. arborea*, the apical proliferation shoots are permanent structures, promoting longitudinal growth by continuation of the main stems, which bear sequential cones. In *C. dichotoma*, however, the proliferation shoots soon become obsolete, leaving the cones in apical positions on dichotomous branches; longitudinal growth being

achieved by means of the development of two lateral branches, from just below each cone, into dichotomous main stems. It is in their ultimate condition and position on the stem, that there is a marked difference between the cones in *C. arborea* and *C. dichotoma*, and where the similarity between the inflorescences in *C. conifera* and *C. dichotoma* is more pronounced, being terminal in both species. The markedly dichotomous branching pattern that arises as a result of the final condition and position of the cones, is another character that clearly sets this new species apart from its two allies. Furthermore, the (secondary) vegetative leaves of *C. dichotoma*, differ from those in *C. arborea* in being unifoliolate, small, and glabrescent, whereas those of *C. arborea* are trifoliolate, much longer and incano-floccose.

As in the case of *C. arborea*, herbarium specimens of the new species are not always representative of the actual condition in the wild. A far larger specimen than what is practicable will have to be collected to reflect the true positioning of the inflorescences and the vegetative branching pattern. In most cases herbarium specimens contain a single branch with a single terminal inflorescence only. This would in fact, be less than half of the specimen needed to give a true history over two seasons of the phenology and branching pattern in this species. In contrast to the series of two cones on a single main stem, which would represent the development over two seasons in *C. arborea*, the normal pattern in *C. dichotoma* would be three inflorescences, with the older one (of the previous season) in the angle between two dichotomous branches, each of which bears a terminal inflorescence of the present season (Figure 2).

During his physiological research on *C. dichotoma*, Prof. von Willert raised seedlings which he reported as being 'tri-foliolate'. Photocopies made of these seedlings seem to substantiate this finding. Close examination of the actual material, however, led to the discovery of two types of vegetative leaves, primary and secondary. Prof. von Willert's observations were of very young, trifoliolate and exstipulate, or unifoliolate and stipulate, primary leaves (see below), before the development of vegetative short shoots with unifoliolate and exstipulate secondary leaves and the subsequent loss of the caducous primary leaves.

Primary vegetative leaves occur on long shoots and secondary vegetative leaves on (vegetative) short shoots. Secondary thickening of the long shoots, causes the early loss of the vegetative primary leaves, as their sheaths do not enlarge to accommodate the thickening. They are thus best observed on the apical swellings on main branches, where they are permanent structures, destined to become primary cone leaves on the primary short shoot (main axis) of the female inflorescence cone, changing in form and dimension as the cone develops. Both the primary vegetative and primary cone leaves, can be interpreted as being trifoliolate and exstipulate, or unifoliolate with leaf-like stipules (Figure 1A, C, E). Anatomical examination will have to be done to settle this question.

Secondary vegetative leaves, borne on vegetative short shoots, are exstipulate, and of quite a different shape, size and texture to the primary leaves. On older stems
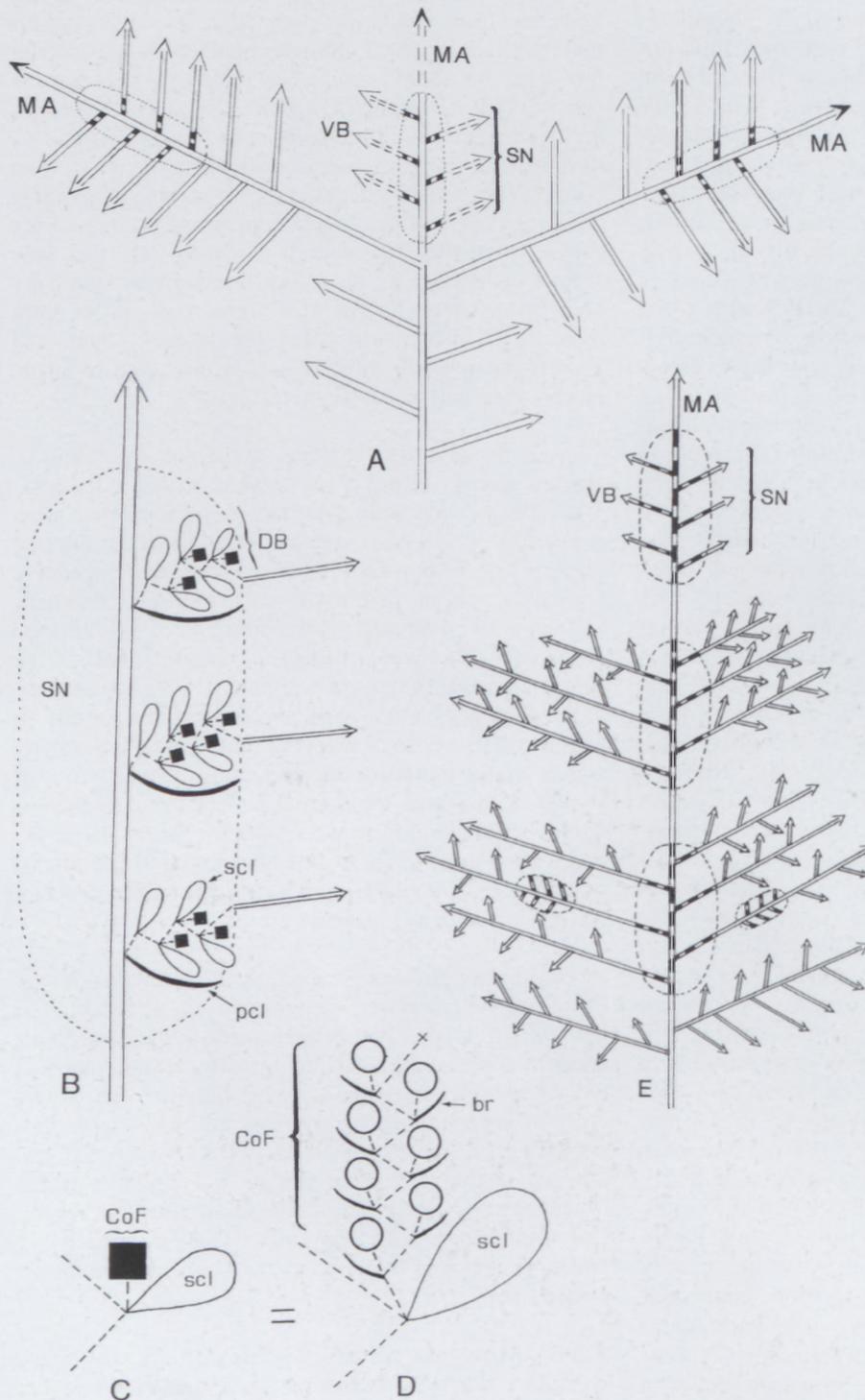
FIGURE 2.—Longitudinal diagrams of architecture and structure of synflorescences. A, *Cliffortia dichotoma*: female synflorescence cone of previous growth season, terminally on a main branch, with (younger) synflorescences on two lateral branches. B, *C. arborea*: three female synflorescence cones on main branch and two younger on lateral branches originating from older cones. C, part of synflorescence with three dibotrya as in young synflorescences in both *C. dichotoma* and *C. arborea*. D, E, single co-florescence or botryum (solid square) with its individual flowers (open circles); (similar in both species). MA, main axis; SN, synflorescence; DB, dibotryum; VB, vegetative branch; CoF, co-florescence (botryum); pcl, primary cone leaf; scl, secondary cone leaf; br, bract of single flower; broken lines in synflorescences A & B represent dibotrya; dotted zigzag lines in C–E represent expanded highly condensed axes.

only secondary leaves are visible, because of the caducous nature of the primary vegetative leaves. The secondary vegetative leaves are spirally arranged on short shoots originating immediately above the residual vaginas of the obsolete primary leaves and their vaginas are imbricate (Figure 1L–N).

Oliver & Fellingham (1994) noted 'the development of lateral branches from the cones' in *C. arborea*, but erroneously interpreted these as 'sterile, lateral, secondary branchlets within the cone', that is to say, originating as vegetative branchlets and directly on the main cone axis, independent of the secondary flower-bearing axes of the cone. During the present study, however, it became clear that these so-called 'sterile, lateral, secondary branchlets' of the female cone in *C. arborea* are

in fact, the proliferation shoots of the condensed secondary flower-bearing axes (dibotrya) of the cone. This means that they originate on the main axes as the basal parts of the lateral (fertile) cone axes and not as separate (sterile) vegetative shoots. It is only at the periphery of the cone that the short shoots change into vegetative long shoots—the proliferation shoots. As recorded in 1994, these lateral branchlets on the cones are permanent structures and can develop into main branches bearing female inflorescence cones. These in turn are capable of continuing longitudinal growth in the same way as the main axis of the cone from which they originated. The schematic interpretation for the mature (lateral) cone in *C. dichotoma*, before abortion of the lateral proliferation shoots, also pertains to the structure in *C. arborea* (Figure 2A–C).

In *C. dichotoma*, anthesis is marked by the appearance of concentric circles of long, maroon styles, and by the proliferation of the main axis of the cone into an apical vegetative stem, a few centimetres long. After anthesis this proliferation shoot lengthens somewhat. At this stage the cone also becomes shrouded in an outcrop of secondary branchlets up to about 80 mm long, originating as the proliferation shoots of the secondary inflorescence branches (dibotrya). Up to this point in the development of the inflorescence, it is similar to that in *C. arborea*. In *C. dichotoma*, however, this shroud of side branches is eventually shed, as is the main proliferation shoot, leaving the cone bare and terminal on a main branch. At this latter stage, it more closely resembles the condition in *C. conifera*, bearing its cone terminally (apically) on a branch and is devoid of any lateral proliferation shoots. In both of the last-mentioned species the growth points of the main as well as the lateral cone axes have been lost—in the case of *C. dichotoma* through abortion and in *C. conifera* through loss of viability of the apical buds of both the main axis and lateral axes of the cone. In rare instances in *C. dichotoma* the main axis proliferation shoot is retained beyond the time of fruiting *(Fellingham 1706)* (Figures 1B, S; 2A).

With the loss of the growth point of the main branch in *C. dichotoma*, two lateral branches from just below the inflorescence cone and close to each other develop into main branches which curve around the cone. These branches supply two growth points to compensate for the one lost and thus longitudinal growth is continued while giving rise to the dichotomous vegetative branching pattern that distinguishes this species. The female cones of the next season develop apically on these two branches (Figure 2A).

Rare occasions where three cones were produced in a cluster, occurred during a very dry season following an exceptionally wet one. These clusters of three cones were in fact, the terminal cone, plus two cones, terminally on extremely short lateral branches, from just below the central cone. The development of dichotomous branches and their apical cones, which normally stretches over two seasons, was contracted into the same season, with the resultant foreshortening of the branches, and the simultaneous maturing of all three cones. This condition can clearly be seen in the collections of *Fellingham 1705, 1707* and *1711*, all collected in October 1997. Another unusual feature noticed during the same dry season following a very wet one, is the development of multiple lateral branches from below an aborted cone *(Fellingham 1708)*.

The onset of anthesis, as indicated by the swelling of the apices of the dichotomous branches with their covering of enlarging imbricately arranged primary (vegetative) leaves, coincides with the maturing of the fruits in the (central) cone of the previous season. Initially these primary leaves do not differ from the primary stem leaves, found on all main stems, which become obsolete with secondary growth of the main stems, but it soon becomes evident that these primary leaves remain imbricate and the apical swelling enlarges. In contrast to the sheaths of the primary vegetative leaves, the sheaths of the primary cone leaves expand as the cone develops and

at the same time, remain in close proximity to each other basally, as the main axis of the cone remains contracted —the axis of a fertile short shoot. Furthermore, each primary leaf surrounds a developing synflorescence and thus becomes a true primary cone leaf. The curvature of the developing cone causes the imbricately attached sheaths to fan out, so that those below the equator of the cone seem to grow up-side down (Figure 1A, C–E).

In contrast to the condition in *C. dichotoma* with the loss of the growth points of both primary and secondary proliferation shoots, these growth points are both retained in *C. arborea*. Here the primary proliferation shoot continues the vegetative growth of the main branch, to give rise to a series of female cones, one per season. Any two cones are thus separated by a length of vegetative main branch, proliferating from the main axis of the older cone. Similarly, proliferation of the lateral cone axes (main axes of the dibotrya), give rise to permanent vegetative lateral branchlets, which are capable of developing into stout lateral branches bearing female inflorescence cones, which in turn can continue longitudinal growth of the plant, through proliferation of both axes of the cones. In this way a series of cones can develop out of what was initially the lateral cone branchlets (Figure 2B).

Oliver & Fellingham (1994) considered the possibility that cone-like inflorescences might still be discovered in other species. Known species with recorded compound inflorescences, viz. *C. heterophylla* Weim., *C. odorata* L.f. and *C. hirsuta* Eckl. & Zeyh. were noted, though none of these was found to be cone-bearing. Of these three species, the first two have subsequently been studied in detail (Fellingham 1999; Fellingham & Linder in press).

The initial apical arrangement of imbricate modified leaves, obscuring the reduced female flowers in *C. heterophylla*, relates to the primary leaves covering the swollen tip of a main branch, marking the onset of cone development in *C. dichotoma*. In this early stage of development of the inflorescence in *C. heterophylla*, the condensed character of the apex of the main stem is evident in the imbricate arrangement of the modified leaves on it. As the development of the inflorescence progresses through the various stages from the early female, through the bisexual to the male stage, the secondary condensed inflorescence axes become evident, as do the proliferation shoots on these secondary axes, again mimicking *C. dichotoma*. There is, however, also an unmistakable difference between the inflorescence structures in these two species, mainly in the demonstration of a peculiar plasticity manifesting itself in the total disappearance by integration and not loss of the inflorescence in *C. heterophylla*, whereas the cone-like inflorescence in *C. dichotoma* is retained for a number of years, but eventually discarded (Fellingham 1999; Fellingham & Linder in press).

The relatively large flowers in *C. odorata* obscure the complex nature of the inflorescence, to such an extent that Weimarck (1934) described the flowers as being 'fascicled in leaf axils' and in another context, in racemes that 'approach the form of heads' (Weimarck 1948). These 'heads' were found to consist of a number of head-like subclusters of flowers, each with a condensed, short-

stalked axis, and implanted on a highly condensed disc-like axis, in the axil of a vegetative leaf. The disc-like structure in this species, though totally flattened, and far more pronouncedly modified, is analogous to the highly condensed main axis of the cone in the three cone-bearing species, even to the extent of retaining a viable growth point in the centre of the disc. The stalked sub-clusters are analogous to the secondary axes of the cone-like inflorescences. The loss of the viability of the growth point of these secondary axes, renders it closer to *C. conifera* than to the other two species in the section. The arrangement on the secondary axes of the flowers in smaller, closely packed groups with modified or even absent bracts, is analogous to that of the ultimate flower-bearing platforms in the cones (Fellingham 1999; Fellingham & Linder in press).

As a result of the discovery of the error in interpretation of the lateral branchlets on the female cone in *C. arborea* as discussed above, it is necessary to emend the description of the species thus: the phrase '*with second order axes continuing growth laterally*' should read '*with second order **cone** axes continuing growth laterally*'.

Section Arboreae *H.Weim. emend. Fellingham*

Shrubs and trees up to 5 m tall. *Leaves* uni- or trifoliolate; stipules 0–2, subulate to foliaceous; leaflets revolute or flat, entire to dentately 2–4-lobed. *Male inflorescence*: 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 4–10. *Female inflorescence*: a conoid synflorescence subterminally on main branches with continued apical growth *(C. arborea)*, apically on main branches after loss of initial apical proliferation *(C. dichotoma)* or apically on determinate lateral short shoots *(C. conifera)*, the synflorescences composed of 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 *(C. arborea, C. conifera)* or irregularly longitudinally furrowed or angled, narrowly 2-winged *(C. dichotoma)*; style/stigma single, linear, edges irregular and shortly dentate, creamy white *(C. arborea, C. conifera)* or maroon *(C. dichotoma)*; achene single.

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

PHYTOGEOGRAPHY

Cliffortia dichotoma is known only from a small area on the Oorlogskloof Escarpment, around the waterfall on the Farm Papkuilsfontein, about 25 km south of Nieuwoudtville, Northern Cape (Figure 3). It grows at 700 m which is much lower than either *C. arborea* at 1 500–1 800 m or *C. conifera* at 1 300 m. It grows on west-facing, rocky ledges near the edge of the escarpment and about 500 m onto the plateau. This locality is just south of the Oorlogkloof Nature Reserve. The annual rainfall in this region is typically very low, occurring in late winter to early spring, if at all.
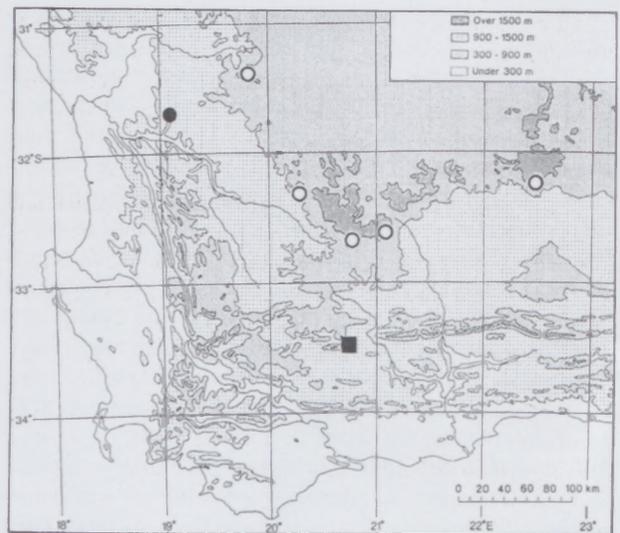

FIGURE 3.—Known distribution of *Cliffortia dichotoma*, ●; *C. arborea* ○; *C. conifera*, ■.

PHENOLOGY

Like *C. arborea* and *C. conifera*, *C. dichotoma* is monoecious with unisexual male and female flowers borne on separate branches. The female flowers are borne in terminal or subterminal cones near or on the ends of the main branches. The male flowers are borne in small clusters in the axils of vegetative leaves on vegetative short shoots on branches. As in the related two species, in *C. dichotoma* these branches are situated below the female cones and mostly much lower down on the plant *(Fellingham 1685, 1689, 1712)*. It is also clearly wind pollinated like the two known species in the section and presumed for all species in the genus (Koutnik 1987). While sharing all the adaptive characters (Koutnik 1987; Proctor *et al.* 1996) with other wind-pollinated plants, these coniferous species of *Cliffortia* have a rare reversal of location on the plant, of the male and female elements, with the male below the female. This rare condition is shared with only one gymnosperm viz. *Pinus sylvestris* (Proctor *et al.* 1996). The question remains as to whether this condition could be an adaptation to pollination by updrafts prevailing at the edges of the escarpments that are the preferred habitats of these species. Apart from the obvious parallelism between these three coniferous species and the evergreen serotinous gymnosperm, they also share the phenomena of anemophily and monoecy.

Except for the tips of the sepals and the long, strap-shaped styles/stigmas, the female flowers are totally hidden within the involucres of secondary cone leaves. The styles/stigmas in *C. dichotoma* are more showy than in either *C. arborea* or *C. conifera* by virtue of their maroon colour in contrast to the creamy white organs in the latter species. The fruits mature over a period of about a year, during which time the cone undergoes a number of changes. Apart from becoming more woody, it also develops an apical proliferation shoot and lateral proliferation shoots on the lateral cone axes. Both these types of proliferation shoots are, however, shed quite soon. This leaves the cone temporarily in an apical position on the branch. It is, however, soon over-topped by the two

or more secondary branches originating from just below the cone and destined to continue longitudinal growth of the plant. The dichotomous branching pattern that results is clearly marked by the retention of the cones for several seasons.

The flowering period in *C. dichotoma* is earlier and shorter than in *C. arborea* or *C. conifera*, viz. between late October and late November *(Fellingham 1702, 1709–1712)*. Male flowers were encountered in late August 1995 *(Fellingham 1684, 1685 & 1689)* which is rather surprising as female flowers were only found more than a month later.

Paratype material

C. dichotoma

NORTHERN CAPE.—3119 (Lokenburg): Papkuilsfontein, rocky ledges of Oorlogskloof Escarpment, SW aspect, 700 m, (–CA), 27-08-1995, *Fellingham 1684* (BOL, K, NBG, PRE); 28-11-96, *Fellingham 1702* (BOL male & female, NBG male & female, K male, PRE); Kranskloof, rocky ledges, SW aspect, 700 m, (–CA), 24-10-1997, *Fellingham 1705* (BOL, NBG, PRE); *Fellingham 1706*, (sheet 1 & 2 BOL); *Fellingham 1707* (BOL); near waterfall, 700 m, (–CA), 24-10-1997, *Fellingham 1708, 1710–1712* (BOL); *1709* (BOL, NBG, PRE); Oorlogskloof Nature Reserve, Farm Cipher Kop 804, plateau at bottom of koppie on right of Cipher Kop homestead, 720 m, (–CA), 16-10-1996, *Pretorius 396* (BOL, K, MO, NBG, PRE); 'Papkuilsfontein' on road to waterfall, on rocky, sandy, flat plateau about 1 km from Oorlogskloof, and 2 km from waterfall, (–CA), 20-08-1993, *Van Wyk 626* (NBG); Niewoudtville area, Papkuilsfontein, escarpment, from waterfall in De Hoop se Rivier, northwards only to border with Kranskloof Farm, *Von Willert s.n.* (NBG).

Additional material examined

C. arborea

NORTHERN CAPE.—3119 (Calvinia): Akkerendam, dolerite screes and 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* (NBG 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, 1 370 m, (–AD), 10-1920, *Marloth 9730* (PRE stem & bark only, NBG male & female); Hottentotsbank near Sneeukrans, W-facing scree slopes, 1 433 m, (–AD), 22-9-1981, *Rourke 1728* (K sterile, NBG sterile); Roggeveld, southwestern krantzes on the Komsberg, 1 550 m, (–DB), 04-1905, *Marloth 3907* (BOL female, K male, NBG sterile); Roggeveld Mtns, Komsberg, 1 525 m, (–DB), 10-1920, *Marloth 9770* (PRE female, NBG female); just W of road at top of Komsberg Pass, sandstone escarpment, (–DB), 22-09-1977, *Moffett 1463* (NBG sterile); plateau at top of Komsberg Pass, E of road, 1 600 m, (–DB), 02-1986, *Moffett & Steensma 4067* (NBG male); Komsberg Pass, lower slopes ENE of Skurwekop, 1 500 m, (–DB), 4-06-1992, *Oliver 10054* (BOL, K, MO, NBG, PRE, S, all female). Without precise locality: mountains near Sutherland, 12-1905, *Du Toit sub BOL10057* (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), 21-02-1986, *Moffett & Steensma 4060* (NBG 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, NBG, PRE, 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, NBG, PRE, all male & female).

C. conifera

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

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